ICES WGNSSK Report 2008

ICES Advisory Committee

ICES CM 2008\ACOM:09

Report of the Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak - Combined Spring and Autumn (WGNSSK)

7–13 May 2008

ICES Copenhagen

By Correspondence - September 2008

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Conseil International pour l'Exploration de la Mer

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Recommended format for purposes of citation:

ICES. 2008. Report of the Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak - Spring and Autumn(WGNSSK) , 7-13 May and, ICES Copenhagen and By Correspondence. Diane. 14 pp.

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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 7-13 May 2008. There were 24 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 evaluate stock recovery and management plans, to comment on the outcome of existing management measures, to update descriptions of fisheries; to report on national sampling levels and data availability; and to consider measurement and estimation of misreporting and discards. The group also met by correspondence in September of 2008 to carry out assessments of the sandeel in the North Sea and the second of the biennial assessments of the North Sea Pout; and by correspondence in October of 2008 to provide update forecasts for stocks with survey information collected after the May meeting.

0.1 Working procedures

Prior to the meeting considerable attention was given to the logistics of scheduling the WG in order to meet its objectives as a result of:

a) The reduced time made available to the WG for its May meeting

b) Data quality issues arising from

   a. the scheduling of the meeting in May imposing severe stress at some national laboratories as a result of the concentration of the majority of ICES assessment working groups into May

   b. the timing of the meeting being close to the date at which survey information from the IBTS quarter 1 survey was first complete

c) The requirement for update advice in September after the autumn surveys

The issues were raised during pre-planning discussions amongst group members and based on the experience from the previous year and with the ICES secretariat and ACOM vice chair during the March Working Group Chairs meeting. Although the Working Group met its objectives it considers that its views about the timing of the meeting are not being taken into consideration when scheduling the meeting. Errors introduced during the raising of data and compilation of survey indices could have been avoided if the time pressures were eased by delaying until the end of May.

As in the previous two years, the system of benchmark/update assessments could not be followed by the WG. The change to the timing of the meeting resulted in pressures on data compilation and potentially introduced processing errors; therefore a detailed review of input data was carried out for each stock. Ongoing developments in assessment methods and substantial revisions in stock perceptions following the inclusion of new data meant that pure update assessments were seldom appropriate for the majority of assessments. At the same time, the increasing workload reduces to almost zero the time available for the type of in-depth analysis that would be required for a benchmark analysis.

As last year, quality handbooks (stock annexes) for where available are included in the main report within Appendix 3. This was done to avoid the problem of potentially useful background stock information being lost in the grey literature. The stock annexes will be updated each time that the stock is analysed within a benchmark review.

0.2 State of the stocks

For Nephrops stocks, underwater TV surveys (where available) provided the best guide to the state of stocks. The historical practice of basing numerical assessments on pseudo-ages was not followed. In TV-based Functional Units (FUs) Firth of Forth (8) and Fladen Ground (7) abundance has increased and is currently at or close to their highest levels. Moray Firth (9) abundance has decreased and is currently towards mid to lower end of the observed range. Farn Deeps (6) abundance has decreased in 2006 and 2007 from its highest level in 2005 and is currently at its lowest recorded level. Other FUs were more difficult to assess (as there are no TV surveys) but in Noup (10), Norwegian Deeps (32), Botney Gut-Silver Pit (5) and Off Horn Reef (33) and the Division IIIa stocks (3,4) seem fairly stable and show no signs of overexploitation (LPUEs remain level and mean sizes are fairly constant). The ICES WGNSSK Report 2006 approach, based on F0.1, was proposed as the method for providing (and justifying) catch options where surveys were available. Other FUs and statistical rectangles outside of the main assessed areas were dealt with by status quo advice or mean of last three years landings.

Landings in the directed fishery for **Norway pout in Sub-area IV** (Section 3) have been low since 2001, and the 2003-2004 landings were the lowest on record. The targeted fishery for Norway pout was closed in 2005, the first half year of 2006, and in all of 2007. The fishery was reopened in the January 2008 with a provisional EU TAC of 43 300 tonnes. In Norwegian waters fisheries were restricted to the period May 1–August 31 to reduce bycatch with an initial TAC of 36 500 t. Initial indications are that a very small catch has been taken in the Danish and Norwegian commercial fisheries, mainly as a result of displacement of effort to higher value species resulting from high fuel prices.

The September update assessment estimates spawning stock biomass (SSB) at just below Bpa in 1st quarter of 2008 and, based on the slightly below average 2007 year class, the spawning stock is forecast to achieve Bpa by January 2010 with catches in 2009 of around 35 000 tonnes. Fishing mortality has generally been lower than the natural mortality for this stock and has decreased in recent years well below the long-term average F, as a result of the fishery closure in 2005, the first part of 2006 and 2007 the fishing mortality has been low during this period.

An assessment of **sandeel in Sub-area IV** was carried out during the WG September correspondence meeting. Landings in 2008 for **sandeel in Sub-area IV** (335 kt) have increased to the levels previously recorded in 2003/4 but are still below the TAC (400kt). SSB has increased in recent years and at the start of 2008 is estimated to be close to B_{pa}. Fishing mortality has been decreasing since 2001 and is now close to its lowest historical level, but the present absolute level is uncertain. Recruitment remains low.

Discrepancies between catch-at-age based analyses and survey-based analyses have previously prevented the WG from providing a definitive assessment the state of **plaice in Division VIId**. An update of the assessment data and a review of the stock and fishery trends are presented. Recent fishing mortality levels are estimated to be constant at around Fpa. The spawning stock biomass has followed a stepped decline in the last 10 years, following a peak generated by the strong 1996 year class. The current level of SSB is stable at a low level below Blim, and this confirms the fisher's impression assessed by a survey in France in 2006. The 2005 year class which recruited to the fishery in 2006, is among the lowest in the time series. Stock projections, at the current level of recruitment and with a value of F at the low 2006 level, indicate a slow rebuilding.

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

As in previous meetings, the assessment of **plaice in Subarea IV** included modelled discard estimates for recent years. Landings and discards have both declined in recent years, SSB remains at a relatively low level (between B_{lim} and B_{pa}), while human consumption fishing mortality has declined. Recent year-class strength has been poor. On this basis, short-term forecasts at current fishing levels indicate an increase in landings in 2009 to around 61 kt and stable discards (54 kt). According to the management plan adopted by the EC in 2007, the fishing mortality in 2009 should be reduced by 10% compared with the preceding year with the constraint that the change in TAC should not be more than 15%. This would result in landings of 55 kt in 2009.

Landings for **sole in Division VIId** have fluctuated around a mean level for many years, and show no significant trends. The estimated fishing mortality for 2006 was revised upwards by 16%; current fishing mortality is estimated to be at F_{pa}. SSB has increased to well above B_{pa} following improved recruitment in recent years; although the current assessment has revised the value of SSB in 2006 and 2007 downward strongly. The strong 2004 year class has been confirmed by the latest three assessments, but has been revised downward in this year's assessment by 31%. The advice for 2009 is considerably lower than last year because of a downward revision of estimated stock size and recruitment.

The reported landings for **sole in Subarea IV** in 2007 were well below the TAC which has not been restrictive for three years. SSB has fluctuated around a moderate-to-low level for several years and in 2007 is estimated to be just below B_{pa}. According to the management plan adopted in 2007, fishing mortality in 2009 should be reduced by 10% compared to the preceeding year with the constraint that the change in TAC should not be more than 15%. The 10% reduction in fishing mortality corresponds to a fishing mortality of 0.42 and landings of 14 000 t in 2009, which is an approximate 9% TAC increase. The expected SSB in 2010 would be around 28 900 t, which is below Bpa.

Although reported landings for **saithe in Subareas IV and VI and Division IIIa** in 2007 were around the recent average they are lower than the TAC. The TAC has been unrestrictive for five years. Fishing mortality has now remained at or below the target of 0.3 since 2001 (*F* ~ 0.25 in 2007) while SSB continues a steady increase. Recruitment is fluctuating about the mean level. The short-term forecast as *status quo F* indicates landings of 128 kt in 2008 and 129 kt in 2009, along with a slight decline in SSB to around 309 kt.

Catches of **whiting in Subarea IV and DivisionVIId** have been stable at a low level (~30kt) from 2005 to 2007. Historic estimates from the whiting assessment are uncertain due to conflicting information from the data sources but recent time series (since 1990) are consistent in showing a rapid decline in the SSB as a result of a series of weak recruitments. The same concerns as last year were raised about stock structure, but in the absence of improved information on stock distribution the WG decided to present the same approach as last year to illustrate the strong decline in the stock estimates. The final assessment indicates historically low estimates of SSB (60 kt) in 2007 and recruitment (241 million) during the last four years. Although recruitment in 2008 appears to be improved as indicated by a variety of sources. Fishing mortality is estimated to have increased from the recent low levels (~0.3) to 0.4, in line with the increased catches and low stock abundance. Continued at the current level will lead to a stable, low SSB at around 60kt with human consumption landings predicted to be at 13 kt. The working group considers the status of the stock unknown with respect to biological reference points. Nevertheless all indications are that the stock, at the level of the entire North Sea and Eastern Channel, is at or approaching a low level relative to the period since 1991 and although mortality rates have been relatively low, without good recruitment the stock is unlikely to recover.

The strong 1999 year-class again dynamics of the stock of **haddock in Subarea IV and Division IIIa**, which were the lowest in the available time-series although the 2005 year class is also above average and contributing. The assessment indicated a continued decline in SSB (from 527 kt in 2002 to 217 kt in 2007) as the 1999 year-class reduces in number. Until 2006, recent fishing mortality had declined to levels around the target of 0.3. However, it rose to 0.52 in 2006 and is estimated to be at 0.42 in 2007, above the target but still below Fpa (0.7). Recruitment in 2005 was above average, much larger than those in 2001–2004, but still only a third of the size of the 1999 year class. The most recent recruitments (2006 and 2007) are both estimated to be very low.

The estimated yield (reported landings and discards) in 2007 for **cod in Subarea IV and Divisions IIIa and VIId** (24.4 kt and 23.6 kt) were similar. A modified assessment has been used which is based on the combined survey series for the third quarter, and which uses an uncertainty estimation procedure. The assessment includes estimates of unaccounted removals, as for the last two years. Spawning-stock biomass in 2007 is estimated to be increasing from the recent historic low as the 2005 year class contributes and as a resulted of reduced fishing mortality. Fishing mortality is now estimated to have declined since 2000 and is now just below Fpa (median estimate for 2007 ~ 0.64). The 2000-2004 and the 2006 year-classes were poor, but indications from surveys and the fishery in 2006 and 2007 are that the 2005 year-class is stronger. Results from a number of forecast scenarios covering different changes in TAC in 20010 indicate that SSB will continue to increase. The short-term forecast as *status quo F* indicates that continued fishing at the 2007 level in 2008 will enable SSB to rise to B_{lim} (70 kt) by the start of 2009 but even with no fishing SSB (142kt) will be just below B_{pa} in 2010.

0.3 Environmental and ecosystem considerations

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

0.4 Mixed-fisheries data collation and modelling

In previous years, a considerable amount of time has been spent during the WG meeting collating mixed-fisheries data, with little mixed-fisheries modelling. This year as a result of the reduced meeting time mixed fisheries issues were not considered at the meeting as a specific topic but were raised in management considerations where appropriate.

has resulted in a pressurised compilation of the assessment data. As in 2007 the Scottish programs previously used for raising the North Sea gadoids were no longer available to the WG therefore the WG had rely on bespoke software developed previously in 2007, until the ICES INTERCATCH program is available; the program is not yet fully functional for all raising procedures. Flatfish stocks were therefore raised using either INTERCATCH where testing had established that the program could reproduce the WG raising procedures or the FishBase software.

The focus of the MAY 2008 meeting was directed towards ensuring a smooth transition of the data collation to the beginning of the year, analysis of the available information in order to meet the ToR and to provide analysis advice for any special requests. One factor that was in the groups favour this year was that a decision was made with ACOM guidance to role over advice for stocks for which no new information was available or for which the new information did not help resolve uncertain assessments. This year nephrops assessed which added a considerable number of stocks assessed.

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

1.1.3 Roundfish and flat-fish stocks

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

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

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

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

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

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

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

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

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

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

1.1.3.2 Discards

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

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

For haddock and whiting, total annual international discard estimates by age group were derived largely by extrapolation from the Scottish discard sampling programme. For cod a similar procedure was applied to all countries data apart from Denmark, England, Germany and Sweden which provided discard information for the North Sea and IIIa. Data from other sampling programmes were made available for this process, but not in a form that could be used in the roundfish discard collation procedure. Discard estimates for plaice in the North Sea were obtained by a combination of observations from the Dutch and English beam-trawl fisheries for recent years, and reconstructions based on observed growth for earlier years.

1.1.3.3 Natural mortality

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

1.1.3.4 Commercial fleet and research vessel data

Available time-series of CPUE and effort data from commercial fleets and research-vessel surveys have previously been presented in reports, and for some stocks, a subset of these data have been used to calibrate catch-at-age-based assessments. For most stocks, survey-based assessments have also been presented as exploratory analyses.

The validity of many of the commercial tuning fleets as indicators of stock size and fishing mortality in recent years has become more uncertain, since the enforcement of national quota, ITQs, and technical measures is known to have led to changes in fishing patterns (and in some cases to possible misreporting and discarding). For this reason, commercial CPUE data has been excluded from the assessments of a number of stocks. Such data has been retained in assessments only in cases where no survey data are available, or where commercial CPUE series provide reliable information that cannot be obtained elsewhere.

1.1.4 Norway pout and sandeel

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

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

- survey data: survey indices by age for Norway pout;
- data on sandeel natural mortality from the MSVPA.

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

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

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

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

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

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

1.1.4.2 Natural mortality

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

1.1.4.3 Commercial fleet and research vessel data

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

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

1.1.5 Nephrops

1.1.5.1 Landings, length frequencies

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

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

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

1.1.5.2 Discards

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

1.1.5.3 Natural mortality

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

1.1.5.4 Commercial fleet and research vessel data

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

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

1.1.6 Sampling levels and procedures

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

1.1.7 Data collation (Intercatch, FishFrame) and current problems

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

The EU Data Collection Regulation (DCR) is intended to rectify these problems. In some cases it seems to have been only partially successful. Fisheries data, particularly discard data, which countries are paid to collect and provide to ICES are not made available to the relevant WGs. Countries which do provide data on discards are highlighted as discarding fish by the EU, leading to increased legislation and an understandable reluctance to participate in observer sampling schemes (seen as self-incriminatory in some quarters).

Two complications have also arisen in recent years that have hindered the data compilation process and resulted in the WG having to develop its own data collation programs in the two weeks prior to the meeting:

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

d) The INTERCATCH program is not yet considered fully functional.

Flatfish stocks were therefore raised using the INTERCATCH where tested and considered usable or the FishBase software. For gadoid stocks the bespoke software developed in 2007 was used. Timing limitations resulted in the reduction of data from quarterly to annual estimates of numbers and weights at age (for gadoids) and the need for increased vigilance during the screening of the catch numbers and weights. The development of programs and checking of data delayed the transmission of data to assessors and the amount of analysis that could be completed prior to the meeting.

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

1.1.8 Fishers Information

This section presents information on the fishery and perceptions of stock status for 2007 provided by fishers to the working group, in the form of working documents. The 2008 report was not received by the time of the working group and will be considered during the May 2009 meeting.

1.1.8.1 Cod

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

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

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

1.1.8.2 Haddock

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

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

1.1.8.3 Whiting

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

1.1.8.4 Plaice

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

1.1.8.5 Sole

The results from the North Sea Fishers Survey indicate that perceptions of the sole abundance are different in all areas. When comparing the results to last years, areas in the north and west of the North Sea (areas 1, 3 and 4) showed modal responses for an unchanged ("same") abundance while areas in the east and southeast (areas 6a, 6b and 7) showed responses indicating a increase in abundance ("more" & "much more"). In the north-east (areas 8 and 9) there majority indicated either no change or an increase in abundance. In area 5 perceptions were fairly evenly split between "less", "same" and "more". The XSA assessment showed a decrease in SSB in 2006 compared to 2005, caused by the a below average year class 2003 (45 million) and the average 2002 year class (90 million) being caught. Year class 2005 recruitment estimate was above average (145 million).

1.1.8.6 Saithe

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

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

1.1.8.7 Nephrops

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

1.2 Working procedures

1.2.1 Update and benchmark assessments

ACFM has requested that assessment WGs work to an agreed schedule of update and benchmark assessments. After experiencing problems in 2004 trying to accommodate a strict split between update and benchmark assessments, the WG has taken a different approach during 2005 - 2008. 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 although the majority of the assessments produced by the WG this year are update assessments, if there is clear evidence that applying an update approach would be incorrect or where there has been a clear requirement for a change to the raising procedure for a data set this has been reviewed and if accepted applied. ICES is beginning a full benchmark process in 2009 and where potential for changes to assessments has been observed this has been raised within the stock section.

1.2.2 Quality control handbooks

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

1.2.3 Assessment and forecast software

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

1.2.4 Mixed-fisheries modeling

In an effort to address the need for mixed fishery advice, ICES established the Workshop on Simple Models for Mixed Fishery Management (ICES-WKMIXMAN 2006) which met in January 2006 and 2007. This group has reviewed the history of mixed-fisheries modelling, and identified the Fcube approach (Ulrich et al, 2006) as a potential appropriate framework for future development in relation to fleet and fishery-based management advice.

Mixed-fisheries work undertaken at the September 2006 WG meeting demonstrated the ability of Fcube to address a wide range of issues. The WG considered that the results were very encouraging, and that the approach may offer an effective way of including fleet- and fishery-based approaches into the work of WGNSSK and into the ICES advisory process. It was agreed that no mixed fishery work would be carried out at the WGNSSK but that the group would follow developments in ICES-WKMIXMAN and provide the required input data with an objective of including the model analyses when the model had been evaluated further.

1.2.5 Management plan evaluations

ICES have a standing requirement to evaluate current management plans for a number of stocks, and (where appropriate) suggest improvements. Section 15 of this report usually contains analyses and WG conclusions on management-plan evaluations. However none were carried out at the 2008 WG.

1.2.6 Estimation of biological reference points

Biological reference points are intended to remain unchanged from year to year, **unless** substantial changes occur in the data used (e.g. if discards are included for the first time) or the method employed. No re-estimations were deemed necessary during the 2008 meeting.

1.3 Working papers and relevant reports

1.3.1 Working documents

8 working documents were submitted to the 2008 meeting of WGNSSK. The following brief sections summarise these papers, and where relevant, the WG discussions about them.

WD 1: Quirijns, F and Poos, J.J Catch and effort data of sole and plaice in the North Sea

This working documents presents the results from commercial LPUE series that have been improved as an indicator for developments in stock sizes of sole and plaice. The improvement consists of a correction of the series for the spatial distribution of the fleet from which they are taken. Commercial LPUE series generally show a better performance for the older age groups, while the research vessel survey data show a better performance for the younger age groups. However, lack of fishing rights may affect targeting behaviour by leaving productive fishing grounds and moving to areas with lower catch rates of the restricted species and by-catch of less restricted species. This potential of bias in commercial LPUE series has raised substantial concern (Gulland 1964, ICES 1988, 1995, Harley et al. 2001). By correcting for the spatial distribution of the fleet, this potential bias is reduced. This year, the corrected LPUE series have been age structured, spanning the period 1997- 2007. The series provided are suitable for comparison with model outputs and for inclusion in the model and provide a valuable source of information on developments in the sole and plaice stock.

WD 2: Machiels M.A.M., Kraak S.B.M. & Poos .J.J. Biological evaluation of the first stage of the management plan for fisheries exploiting the stocks of plaice and sole in the North Sea according to Council Regulation (EC) no 676/2007 Report C031/08, Wageningen IMARES, April 2008, 39 pp

The Commission of the European Community has proposed a long-term management plan, which was adopted by the Council of the European Union in June 2007 and first implemented in 2008. In 2006 the EC and scientific advisers concluded that the stocks of plaice and sole in the North Sea have been subjected to levels of mortality by fishing which have exceeded the levels determined by ICES as being consistent with the precautionary approach, and the stocks are at risk of being harvested unsustainably. The long term plan for the management of plaice and sole in the North Sea is designed to gradually reduce the level of fishing activity so as to achieve greater catches, larger and more stable stocks and more profitable fisheries in the long term. The plan consists of two stages. The aim of the first phase is to ensure the return of the stocks of plaice and sole to within safe biological limits. The tools to achieve this objective are the same as those in a number of other long-term management plans already in place for other species. TACs applied will corresponds with fishing mortality that will be reduced by 10% year on year based on the most recent stock assessment until both stocks have been found have returned to safe biological limits for two years in succession. The annual variations in Total Allowable Catches (TACs) will be kept within limits (15% up or down). Other measures involve the regulation of fishing effort via the adjustment of the maximum level of fishing days at sea available for the relevant fleets necessary to take catches equal to the TACs

A simulation model was developed, which contains several modules. The operating module simulates the true stock and dynamics of the fishing fleet. An observation module mimics the indices generated by fisheries independent surveys and the observed catches and catch at age composition from the commercial catches. Based on this information a stock assessment module using the XSA procedure is executed, which results in perceived stock numbers at age and fishing mortality rates per age group. The assessment results are inputs to calculate the TACs and the maximum number of days at sea following the rules of the management strategy in a management module.

Spatial and seasonal differentiation in stock abundance and fleet effort allocation were not included. Also the fleet structure was simplified. The operating model has been conditioned using data from the ICES Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak (WGNSSK), by calibrating catchability and recruitment levels from the historical data. The behaviour of the fishing fleet was simulated using two options on the fisher's response to the annual TAC management measures. This fleet behaviour is uncertain and therefore two extreme scenarios (over quota catch discarded or misreported, or over quota catch avoided) were formulated and run in combinations with some scenarios that are related to the interpretation of the rules for the technical procedure of setting the TACs.

It must be noted that the results of the simulations are sensitive to the choice of a Stock Recruitment (SR) relationship, being Ricker in most scenarios. The spawning stock biomass, SSB, of both species are expected to increase and the modal SSB prediction is above Bpa for plaice in 2012 and for sole in 2010, in case a Ricker SR was used. The risk that SSB will fall below Blim, the biomass below which recruitment is impaired, was found to be less then 5% for sole. In case of a Ricker SR relationship the risk that plaice SSB is lower then Blim was found 0.5 in 2008 and this probability decreases to less then 0.05 after 2010. Using the Beverton & Holt SR relationship the risk of plaice SSB's below Blim found was higher and decreased to less then 0.05 in 2014. Average TACs and landings vary depending on the scenario used. TACs and landings for sole seem to level of at 1400015000 tons after approximately 10 years. For plaice the TAC and landings are predicted to increase depending on the scenarios (over quota catch discarded or misreported, or over quota catch avoided) to average levels of 70 000 and 110 000 respectively that are reached after approximately 10 years. Simulation results show that the objectives of the first stage of the management plan (both stocks above Bpa, fishing mortality below Fpa and for two years in succession), are likely to be reached in 2015, within 7 years after the implementation, with a probability of approximate 0.5. The probability of successfully attaining the objectives of the firsts stage of the plan increases to 0.8 two years later. Using the alternative SR relationship, Beverton and Holt, completion of stage one is expected to occur in 2018 with a probability of 0.5.

WD 3: Armstrong. M, Randall, P and Mulligan, B. North East Cod survey: 2003-2007 Fisheries Science Partnership: 2007/08

The trawler Emulator was chartered in October 2007 to carry out the fifth in a series of FSP

surveys of cod and other gadoids off the NE coast of England. Surveys since 2005 have utilised tows spread out over the survey area, with additional tows in defined areas with coarser seabed types (“hard” ground) where cod abundance is expected to be greatest. As in previous FSP surveys, cod were most abundant on or near the “hard” ground, whereas haddock were predominantly on the softer seabed sediments offshore. Whiting distribution showed no clear relationship with seabed type. A large proportion of the cod and haddock catches in 2007 comprised 2-year-olds of the strong 2005 year class of each species. The large increase in abundance of whiting noted in the FSP survey in 2005 was also reflected in high catch rates in 2006 and 2007. The catches of whiting in recent years have contained relatively large numbers of fish of the 2001 and earlier year classes, represented as 6–7+ year olds in 2007.

WD 5: Large ,P.A. Brown, M. South, A. Hale, N. Fisheries Science Partnership: 2007/09 Programme 18: ‘North Sea Codwatch’

This report presents the latest update of the results from FSP 2007/09 Programme 18 ‘North Sea Codwatch’, which from April 2007 to March 2009 is monitoring the status of 1 and 2-year-old cod (Gadus morhua) and also of cod in general (all ages), in catches in the North Sea made by selected commercial vessels associated with the Eastern England Fish Producers Organisation Ltd (EEFPO). This interim report has been drafted in response to a request from the EEFPO to make preliminary results from the Codwatch project available to the ICES North Sea Working Group, meeting in May 2008.

The 1999-2004 year classes of North Sea cod are all estimated to have been well below average; the 2005 year class is estimated to be more abundant, but is considered by scientists to be well below average levels (ICES, 2007). Industry indications, however, are that it is much stronger than the long-term historical average.

The data collected so far suggest that the 2005 year class was fairly widely distributed in sampled rectangles throughout the period, with the highest levels of abundance observed in the western central North Sea in Q3 and in the western central and southern North Sea in Q4. However, abundance was recorded as “high” or “very high” in only 10 of the 143 rectangle/quarter combinations sampled. This suggests that the abundance of the 2005 year class, based on the historical perception of participating fishers, may be similar to the results of recent ICES assessments, showing this year class to have been one of the most abundant in the last 10 years, though not as strong as many of the large year classes formed historically. This is consistent with the results of the first Codwatch interim report based on data from April to July 2007. Industry partners do not support this conclusion and have commented that these results may reflect the use of larger meshes than five years ago, and the deliberate attempt by fishers to move effort to areas where cod is in low abundance to eke out quotas and to minimise discarding. However, the results shown here do demonstrate that the proportion of rectangles in each quarter with high and very high abundance of the 2005 year class increased with time throughout the year.

WD 6: Nielsen, A.

The model presented is a state-space model. State-space models were first applied in stock assessment by Gudmundsson (1987) and Gudmundsson (1994). The model used here is inspired by Gudmundsson's work and by Lewy and Nielsen (2003). The model assumes that log-transformed stock sizes and fishing mortalities, which are the so-called states, follow separate random walks. The model is unique in being fully stochastic. Observed catches and survey indices are considered to be random variables with associated observation noise. All model parameters are maximum likelihood estimated. Quantification of uncertainties on all model outputs (e.g. SSB, Fbar, and estimated catch scaling) is an integrated part of the model.

The state-space assessment model (ssass) is able to take uncertainty on the catches into account. This combined with the capability to estimate year (and even year and age) specific catch scaling, allows statistical significance testing of catch scaling. The state-space assessment model showed that a year specific catch scaling significantly improved the model fit compared to the model with no adjustment for catch bias (p-value 0.000% computed by a standard likelihood ratio test). No further significant model improvement was obtained by extending the catch scaling to be year and age specific (p-value 17.4%).

Ssass showed the same pattern in SSB and recruitment as B-Adapt. The overall development in Fbar is also the same in the estimates from ssass and B-ADAPT, but the decrease in ssass Fbar in the most recent years is less steep. The B-Adapt estimates are more fluctuating, which is a consequence of B-Adapt assuming catches known without uncertainty. The retrospective analysis showed that the last years data introduced a bias in the SSB estimation pattern. It turned out that the new method was used to calculate discard in the last year, and returning to the old discard calculation method removed the retrospective bias. Changing discard calculation method did not affect any main trends in the model results.

WD 7: Bell, E. Discarding estimates for 2007 from vessels landing against UK (English) quota. Working document created for WGNSSK 208.

English discard data for North Sea Plaice in 2007 was dominated by trips from otter trawlers and no beam trawlers were sampled. This is predominantly due to the fact that the beam trawlers fishing on UK (English) quota are effectively “flag vessels”, operated by Dutch businesses, landing mainly to Dutch ports. These vessels are targeting plaice with larger mesh trawls, fishing further north than the Dutch beam trawl fleet which is mainly targeting sole.

The estimate of discarding from the English beam trawl fleet has the potential to make a significant difference to the stock assessment and a decision was required as to how to estimate discards from this fleet in 2007. Observed patterns of discarding from the unspecified otter trawl in 2007 were particularly high and are unlikely to be representative of the beam trawl fleet. An alternative solution was to use an average discard LD from the beam trawl fleet taken over a range of years, which has the advantage of appearing to have more realistic discarding numbers but does not carry the appropriate cohort signals.

It was decided that having an appropriate level of discarding was more likely to be important to the assessment than having a more representative cohort signal and so a generalised beam trawl LD (no subdivision by quarter) was created from the average of the beam trawl LDs for 2002-2004 where each year had been standardised to 1000 individuals. For other gears the discard LD appropriate to the gear and quarter was used where possible. For landings with no direct observations successive aggregations of data (quarterly all gears, annual all gears, all years and all gears) were applied until all landings were associated with an LD. All discards were raised by the ratio of retained biomass to reported landings for each gear type.

WD 8: Johannessen, T and Johnsen, E. Evidence of commercially extinct sandeel grounds in the Norwegian economical zone

Several traditionally important sandeel grounds in the Norwegian economical zone (NEEZ) have not provided landings of sandeel for the last 8-12 years. Satellite tracking data show that the fleet has visited these fishing grounds over the years. Several of these fishing grounds recovered in 2007, but were fished down again in 2007 and 2008. The Norwegian sandeel fleet operates in groups, and evidence from 2008 suggests that the fleet fished down three sandeel grounds in NEEZ to commercial extinction within 3-15 days, without a decrease in catch per unit effort (CPUE). An acoustic survey confirmed that there were no fishable concentrations in terms of larger schools at the commercially extinct fishing grounds (the commercial fleet too uses acoustic to detect sandeel schools). Results from the acoustic survey combined with observations of the fleet searching over fishing grounds without fishing, suggest that all sandeel ground in NEEZ but Vestbanken are commercially extinct. In the Vestbank area there is much rough bottom with spots of suitable habitat for sandeel that are too small for trawling. As most fishing grounds in NEEZ seem commercially extinct, the spawning stock in 2009 will probably be at a very low level. Consequently, the management regime proposed by ICES for 2008 by setting a TAC for the whole of the North Sea based on an in-year monitoring fishery, failed to protect sandeel in NEEZ. On the other hand, 70% of the sandeel in terms of numbers that was caught in NEEZ was II+-group that had the opportunity to spawn before being caught. Consequently, there is potential for good recruitment in 2008 and a recovery of the spawning stock in 2010 if I-group is protected in 2009.

2 Overview

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

2.1.1 Fishery descriptions

The demersal fisheries in the North Sea can be categorised as a) human consumption fisheries, and b) industrial fisheries which land the majority of their catch for reduction purposes. Demersal human consumption fisheries usually either target a mixture of roundfish species (cod, haddock, whiting), a mixture of flatfish species (plaice and sole) with a by-catch of roundfish, or *Nephrops* with a bycatch of roundfish and flatfish. A fishery directed at saithe exists along the shelf edge. Landings used by the WG for each North Sea stock are summarised in Table 2.1.1. On average 90% of the landings for reduction consist of sandeel, Norway pout, blue whiting and sprat. The industrial landings also contain by-catches of various other species (Table 2.1.2). The industrial by-catches of human consumption species landed for reduction by the Danish small-mash fleet are given for 1985-2006 in Tables 2.1.3 (annual by species), 2.1.4 (annual by species and fleet), and 2.1.5 (quarterly by species and fleet). Data on landings for human consumption from the industrial small-mesh fleets was not made available to the WG this year.

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

The human-consumption fisheries in the North Sea have been subject to a number of restrictive management measures in recent years, in response to declining stock abundance. These are summarised in Section 2.1.2. In addition, a series of decommissioning rounds have reduced fleet size in a number of countries. These measures have all had an effect on reported effort, although it must be remembered that fleet efficiency is not constant and realised catch rates may not have declined commensurately with effort. Trends in reported effort in the major fleets fishing in the North Sea are described annually by the STECF[1]; these showed considerable declines in recent years. Trends in commercial effort and CPUE on each stock are reported in the relevant stock sections.

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

1 Scientific, Technical and Economic Committee for Fisheries (STECF) Report of the SGRST-08-03 Working Group on Fishing Effort Regime Edited by Nick Bailey & Hans-Joachim Rätz 1 – 5 SEPTEMBER, LYSEKIL, SWEDEN

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

For some stocks, the North Sea assessment area may also cover other regions adjacent to ICES Sub-area IV. Thus, combined assessments were made for cod including IIIaN (Skagerrak) and VIId, for haddock and Norway pout including IIIa, for whiting including VIId, and for saithe including IIIa and VI. Advice for the sandeel stocks at the Shetland Islands and in IIIa is provided separately by ICES, and there are no analytic assessments for them. The state of *Nephrops* stocks are evaluated on the basis of discrete Functional Units (FU), which in turn comprise a number of Management Areas (MA) on which estimates of appropriate removals are founded. Quota management for *Nephrops* is still carried out at the Sub-Area and Division level, however.

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

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

Annex 8A of the 2008 ICES WGFTFB providing fishery development information specific to the North Sea is repeated below and commented on within each of the individual stock sections.

Annex 8A: FTFB Report to WGNSSK

This report outlines a number of technical issues relating to fishing technology that may impact on fishing mortality and more general ecological impacts. This includes information recent changes in commercial fleet behaviour that may influence commercial CPUE estimates; identification of recent technological advances (creep); ecosystem effects; and the development of new fisheries in the North Sea and Skagerrak.

It should be noted that the information contained in this report does not cover fully all fleets engaged in North Sea fisheries; information was obtained from Scotland, England-UK, Northern Ireland, France, Belgium, Netherlands, Sweden and Norway.

Fleet dynamics

- There is a gradual shift from beam trawling on flatfish to twin trawling on other species e.g. gurnards, and *Nephrops*, etc. in the Dutch fleet. A number of beam trawlers decided to shift to other techniques such as outrigging or fly-shooting in the British Channel. Caused by TAC limitations of plaice and sole and rising fuel costs. A detailed report on trends in the NL fleet is attached as Annex 1 to this section. (Netherlands: Implications: reduction in effort/landings of flatfish, transfer of effort to other species).
- There has been a shift for Scottish vessels from using 100mm-110mm for whitefish on the west coast ground (area VI) to 80mm prawn codends in the North Sea (area IV). Fuel costs are a major driver, in this and all fisheries. (Scotland: Implications: Effort shift VIa to IVa, and less selective gear, bycatch/discards).
- There is a new 2008 Scottish Conservation Credits scheme, with a number of implications:

- In early 2008, a one-net rule was introduced in Scotland as part of the new Conservation credits scheme. This is likely to improve the accuracy of reporting of landings to the correct mesh size range. Another element of the package is the standardisation of the mesh size rules for twin rig vessels so that 80mm mesh can be used in both Areas IV and VI (north of 56°N) by twin rig vessels – previously the minimum mesh size for twin rig in area VI was 100mm. As a result there may be some migration of twin riggers from area IV to area VI, thus switching effort from IV to VI. (Scotland: Implications: Selectivity is not expected to change greatly for prawns because 80mm nets must be made of 4mm single twine whereas 100mm nets were allowed to use 5mm double twine. Whitefish selection may improve because from July 2008, all nets in the 80mm range will have to have a 110mm square mesh panel installed).
- Scottish seiners have been granted a derogation from the 2 net rule until end Jan 2009 to continue to carry 2 nets (e.g. 100-119mm as well as 120+mm). They are required to record landings from each net on a separate logsheet and to carry observers when requested. (Scotland: Implications: Potential for misreporting by mesh category)
- From February 2008 there has been a concerted effort not to target cod. Real time closures and gear measures are designed to reduce cod mortality. The implication is that there will be greater effort exerted on haddock, whiting, monk, flats and *Nephrops*. (Scotland: Implications: Switch in effort to other species).

- 24 boats were decommissioned in the beginning of 2008 from the Dutch fleet. There is also a general tendency to opt for smaller multi-purpose vessels replacing the conventional beam trawler for fishermen left in the fleet (Netherlands: Implications: Reduced fleet size and shift of effort into other sectors).
- 5 beam trawlers left the Belgium fleet in 2007 (approx 5%) (Belgium: Implications: Reduced effort).
- In the first quarter of 2008, the number of vessels fishing in the Kattegatt has decreased due to an increased effort cost (2.5 days at sea per effort day deployed). This effort has mainly been reallocated to the Skagerrak and the Baltic Sea. Vessels without the possibility to change area have mainly target *Nephrops* using grid-equipped trawls (This gear type is not subject to the new effort limitation). (Sweden: Implications: reallocation of effort from Kattegatt towards the Baltic and Skagerrak.)
- In the recent years there has been an increase in the numbers of Swedish *Nephrops* vessels. This has contributed to subsequent increasex in effort and landings during 2006-2007 with the highest historical catch rates. The increase in number of vessels may be attributed to input of new capital transferred from pelagic fleets after the introduction of an ITQ-system for pelagic species. (Sweden: Implications: increased effort).
- The Farne deeps *Nephrops* fishery has been very poor in 2008. The *Nephrops* disappeared very early, so the season was very short. This will shift effort into other fisheries for whitefish (UK: Implications: increased effort in other fisheries).

Technology Creep

- A number of Dutch beam trawlers are continuing to investigate the 'out-rigging' method as an alternative to beam trawling, similar to the work in Belgium and UK. Some boats have also moved over to seining (fly-shooting) (mainly in the English Channel). (Netherlands: Implications: change in effort from flatfish to range of other species).
- The Dutch Beam trawler UK153 who was trialling the electrified pulse trawl was sold, and the skipper has opted for a smaller multi-purpose vessel. (Netherlands: Implications: Electric bam trawl method may be obsolete as an alternative method).
- Belgium Beam trawlers are generally fishing more with R-nets and chain matrices than with V-nets, using tickler chains. Fishing speed for beam trawls with R-nets is generally lower. Due to high fuel prices fewer beam trawler use of V-nets. Fewer vessels are using the outrigger trawls. Some beam trawlers have changed to twin trawls. All driven by fuel price. A Numbers of national project investigations of beam trawl modifications are continuing. (Belgium: Implications: Not clear, but fleet is in flux, and investigating many alternative options for fuel and discard reduction).
- Shift in the Scottish fleet from fish/monkfish twin trawl to single rig and an increase in the use of pair trawl/seine. Also a shift by large powered whitefish vessels to *Nephrops* and targeting North Sea grounds with double bag trawls. This is very much driven by fuel costs. (Scotland and UK: Implications: Probable reduction in LPUE, possible increase in discarding).
- In January 2008, multi-rigs (more than 2 nets) were banned under new Scottish legislation. However, a derogation to end April 2008 was granted to vessels currently fishing multi-rigs to continue. Applies to all Scottish boats in all areas. (Scotland: Implications: again some possible reduction in LPUE).
- There has been an increasing emphasis on the use of T90 trawls in Iceland. Bottom trawls made entirely of T90° except in the codend are noe being constructed and 14 stern trawlers targeting cod and haddock have shifted to T90 trawls. Some other vessels are experimenting in other fisheries as well (*Nephrops* and shrimp). All in area Va. Changes in catchability/efficiency are not known but this is being driven by high fuel costs as these trawls have reportedly reduced drag. It is known nine T90° trawls have been sold to different Europe countries (Iceland: Implications: not known but possibly reduced fuel consumption).
- The UK beam trawl has continuing to experiment with outrigger trawls, motivated by fuel. Around 4 vessels are involved but uptake is still quite slow due to catch composition differences (UK: Implications: Switch to more fuel efficient/environmentally friendly fishing method).

Technical Conservation Measures

- The Dutch beam trawl fleet is sensitive to the bad reputation of beam trawl and this is stimulating research into selective nets and reduced bottom impact. Combined research activities were started in 2007, mostly catch comparison experiments but there is an industry focus to solve this image problem (Netherlands: Implications: Improved selectivity and reduced bottom impact potentially).

- Some of the *Nephrops* fleet have been using SMP's with mesh sizes in the 100mm to 110mm still using a codend mesh size of 80mm x single 4mm twine. Also vessels have been installing the smp into the end of the tapered section of the trawl. This position offers more stability for the panel and reduces the chance that it can twist. Note: for current year: all twin-rig gear in the 80-99mm category will have to use a 110mm square mesh panel at 15-18m from the codline. This will also apply to single-rig gears from July 2008. (Scotland: Implications: Improved selectivity)
- The option of 18 extra days if a 120mm SMP at 4-9m was used with a 95mm x 5mm double codend was not taken up by the Scottish prawn fleet in 2007. The main reasons were that prawns would be lost due to twisting and too many marketable haddock and whiting lost which the extra days would not make up for. In 2008 this option attracts 39 extra days but is in competition with the Scottish Conservation Credits option whereby 21 extra days are available when a 110mm SMP is used with an 80mm codend. (Scotland: Implications: Possibly a 30% increase in L50 of haddock, whiting, saithe due to use of 110mm SMP. Smaller increase in L50 of perhaps 10% for cod).
- A large number of 110mm SMPs have been bought in the first months of 2008 by the prawn fleet so that they qualify for the basic Conservation Credits scheme. Probably affects most (~80%) of the fleet. (Scotland: Implications: Uotake of selective gear).
- Problems with the introduction of the 5% by-catch limits for dogfish (*Squalus acathias*) on west coast and North Sea grounds. They can be encountered in large congregations but it is almost impossible for vessels to identify them using sonar etc so they are difficult to avoid. (Scotland: Implications: likely discarding when encountering large aggregations).
- In the Swedish trawler fleet there has been a steady increase in uptake of the *Nephrops* grid since introduction into legislation in 2004. Approximately 75% of the *Nephrops* trawlers operating in IIIa used the grid at some time of the year during 2006 and 2007 (40% of *Nephrops* trawl landings). This can be explained by the fact that use is mandatory on coastal waters and that there are strong incentives due to unlimited days at sea. (Sweden: Implications: Improved selectivity in *Nephrops* fisheries)
- During the first Quarter of 2008 a "day at sea" in Kategatt without the grid was counted as 2.5 days. This has further increased the incentives to use the sorting grid to the point were 80 % of all *Nephrops* landins in the first quarter of 2008 were caught with sorting grids (20% previous years). (Sweden: Implications: changed effort allocation from cod towards Nephrops, decreased discard rates of roundfish)
- One Belgium beam trawler (1200hp) is using a combination of T90-codend, benthos release panel, big meshes in the top panel and roller gear. This is a research project but it is expected that more vessels will be using larger mesh sizes in the top panel of the beam trawl and/or T90- or square mesh codends (80mm) and/or the benthos release panel. Fishermen's organisation is taking initiatives to motivate fishermen to use modifications that reduce beam trawl discards. Four beam trawlers are planning to use technical modifications in 2008 The driving factor for

changes is generally reduced fuel consumption. Implications: The use of bigger meshes in the top panel is expected to increase the species selectivity, i.e. reduce the by-catch of roundfish species, especially haddock and whiting. (Belgium: Implications: improved selectivity and voluntary use of TCM)

Ecosystem Effects

- Bycatch of benthic fauna and several non-target fish species (e.g. gobies) in beam trawls. Voluntarily use of longitudinal release holes in the lower panel of the trawl, which open when nets are filled with benthos, and of Benthic Release Panels. Research is being carried out with the industry to optimise a Benthic Release Panel for the Dutch beam trawling segment. Similar initiatives in Belgium (Netherlands & Belgium: Implications: reduced benthic impact).
- Reports of problems with discarded longlines and gill nets along the Scottish west coast deep water grounds and in the northern North Sea. A lot of longline activity reported at south end Rockall plateau. (Scotland: Implications: potential for gear conflicts/ghost fishing).

New Fisheries

- There has been an increase by Dutch vessels in *Nephrops* fisheries using twin trawls. Outrigger trawls are also replacing beam trawls, or flyshooting (seining) mainly for non-quota species such as red mullet and cuttlefish. (Netherlands: Implications: These are not new fisheries but represent new trend in Dutch fishing resulting in effort and target species shift. Full implications not yet known).
- Belgium: wide range of experimental new fisheries being tried in Belgium – see Annex 2
- Squid fishery in Moray Firth continues to develop when species available on grounds, using very unselective 40mm mesh. Not much take-up in 2007 due to few squid. (Scotland: Implications: 40mm mesh means potential high bycatch of young gadoids esp. cod and haddock. This fishery may provide an alternative outlet for the *Nephrops* fleet seasonally, and hence reduce effort in that sector).

Additional Reports

Economic report on Netherlands fishing fleet 2007

This information is taken from:

Taal C., H. Bartelings, A. Klok , J.A.E. van Oostenbrugge, 2007. Fisheries in figures 2007. The Hague, LEI, 2007, Report PR 07.04; ISBN 978-90-8615-192-9.

General

The revenue of 438 million euros generated by the Dutch high-sea and coastal fisheries in 2006 was slightly lower than in the previous year. The total turnover, including the fish farming sector (48 million euros), amounted to 486 million euros.

The cutter fleet's revenue increased (by 7%) to 256 million euros. The large high-sea fishing fleet recorded a landing value of 125 million euros, a decline of al-most 9% as compared to 2005. The mussel farming sector's revenue fell by 7 million euros to 49 million euros (-12%).

The active high-sea and coastal fishing fleet was comprised of 440 vessels, al-most the same number as in the previous year. The number of jobs provided by the fisheries sector declined by almost 8% to about 2,100. Following the extremely low investments in 2005, the sector's investments almost trebled to 30 million euros in 2006.

The turnover of the Dutch fish auctions increased slightly to 336 million euros, whilst the volume of landings declined by 3%. In particular, the volume of sole landed in 2006 was lower (-23%), whereas the volume of plaice increased slightly (+3%). The volume of the landings of almost all other types of fish was lower. The average landing price at the auctions rose by 3% to 3.42 euros per kg. The landings of shrimp increased slightly (2%); however, the price increased by 4%.

Cutter fisheries

The cutter sector once again recorded a net loss in 2006 (for the fifth consecutive year). The economic loss amounted to ten million euros, almost the same as in the previous year.

The landing value increased by almost 7% to 256 million euros. Although the deployment of the fleet declined by 2.5%, the total costs increased by the same percentage as the revenue (+7%). The major cost item - gas oil - increased by 17% in 2006. The average price of gas oil increased to 41 euro cents per litre (2005: 35 euro cents per litre). The revenues from sole increased by 2 million euros; although the price increased by 22%, landings fell by 16%. The revenues from plaice increased by 4 million euros: the price was 3% higher, and landings increased by 7%. The landing value of shrimps increased to 38 million euros, the net result of the 3% increase in volume of landings and the 6% increase in price. The total labour income from cutter fishing (landing value less the technical costs) increased slightly to 54 million euros.

The number of vessels in the active cutter fleet fell to 344 cutters, and the total engine power declined by 8% to 304,000 horse power. The number of crew members also declined further by almost 5%, especially on the large beam-trawling cutters. Gas-oil consumption remained at roughly the same level, due to the virtually unchanged deployment of the fleet.

Cutters in the 261-300 HP category (primarily Euro cutters) recorded a total landing value roughly equal to the level in 2005. This group exhibits a very large variation in the costs and landing values: the highest daily landing value was 43% above average, and the lowest 33% below. On average, the cutters operated at a net loss. The earnings of the crew members amounted to 42,000 euros, the same level as in the previous year.

The largest category of large beam-trawling cutters (2,000 HP) accounted for more than 53% of the total engine power. The deployment of these cutters increased in 2006. Although the average landing value increased by 21%, this was insufficient to offset the greatly increased costs (fuel). Consequently, the operations, as in 2005, recorded a loss (-89,000 euros).

Shrimp cutters with an engine power of up to 261 HP recorded a 9% increase in revenue in 2006, and the net profit amounted to 7,000 euros per vessel.

The financial position of the cutter sector deteriorated slightly as compared to the previous year, a year in which the sector's solvency had already exhibited a substantial decline. The overall cutter fisheries sector's equity at the beginning of 2005 averaged about 0% of the total balance sheet capital. Investments were at a low level, and the level of loans increased slightly. The long-term borrowed capital now amount to 270 million euros, more than 960,000 euros per company. The net cash flow was negative in the year under review (-11 million euros).

The initial forecasts for the cutter fisheries sector in 2007 indicate a result equal to or slightly higher than that in 2006, although on balance the sector will still operate at a loss. The total deployment of the fleet is expected to remain virtually unchanged, at just under 54 million HP days. Estimates based on the data until the end of September 2007 indicate that the sector's revenue will probably be slightly higher, and will amount to a maximum of 260 million euros.

Only a small fraction of the beam-trawler fleet will be able to operate at a profit. The prospects for this major segment of the cutter fisheries sector remain gloomy. The shrimp fisheries sector would appear to be having a good year; shrimp prices have re-turned to a high level for the first time in many years (a few dozen percent higher), and it would seem that the problems encountered by the sector for many years have come to an at least temporary end. The smaller shrimp cutters, in particular, will be able to close the year with a profit. In analogy with the previous year, the twin-rigs and snurrevod (Danish nets) would once again be appearing to achieve reasonable to good results.

The cutter fisheries sector's labour income and net results have, in general, re-mained stagnant during the past years. These are estimated to amount to about 54 million euros, roughly the same level as in 2006.

A restructuring round is scheduled for the end of 2007, and consequently the size of the fleet will probably decline by some 24 cutters (primarily beam-trawlers) to a total active fleet of 320 vessels. When expressed in terms of capacity (in HP), the size of the fleet will probably decrease by at least 15% (when expressed in terms of the flatfish fleet, about 20%).

Large-scale high-seas fishing (pelagic fleet)

The size and composition of the large high-sea fishing fleet changed once again, in analogy with 2005, following the sale of a further two vessels outside the Netherlands. The fleet now totals 13 freezer trawlers. With the exception of a limited number of relatively minor renovations of the vessels, virtually no further investments were made in the fleet. The total deployment in terms of days at sea was 12% lower, primarily due to the reduced size of the fleet. Fishing declined, in particular in African waters. A new development was the deployment of one trawler in the fishing grounds around Chile and Peru (international waters). Landings decreased as compared to the previous year by 19%, to a little over 378,000 tonnes of fish. Landings of herring, blue whiting and sardinella, in particular, exhibited a substantial decline. Only Atlantic horse mackerel landings increased.

The total costs fell by 9%, primarily due to the reduced deployment. Following the great increase in the price of fuel (fuel oil), this cost item now accounts for 18% of the revenue. The average price of fuel oil was 29 euro cents per litre.

The landing value decreased by 9% to more than 125 million euros, a decline of more than 11 million euros. The fleet closed 2006 with a net profit of almost 7 million euros.

Changes in the Belgian Fleet 2006-2008

	2006/7	2007/8
Outrigger trawl fisheries (mixed fisheries)	4 beam trawlers	2 beam trawlers (and 1 on project scale, aiming for squid, see below)
Handline fisheries for seabass (seasonally: May-October, ICES-subarea IVc)	1 catamaran	2 catamarans (one new vessel, replacing a beam trawler)
Scallop dredging in ICES-subarea VIId and VIIe (seasonally, during winter months)	None.	1 beam trawler is now scallop dredging.
Squid fisheries (project scale)	Several beam trawlers target squid and cuttlefish in winter months in ICES-subarea VII	Next to those beam trawlers, 2 beam trawlers will target squid and cuttlefish (one with an outrigger trawl and one with a twintrawl)
Fisheries on project scale: i. Gill net fisheries for turbot (ICES-subarea IVc) ii. Gill net fisheries for cuttlefish (ICES-subarea IVc) iii. Gill net fisheries for sole (ICES-subarea VIIf) iv. Whelk pots (ICES-subarea VIIe) v. Pots for cuttlefish (ICES-subarea IVc) vi. Longlining for seabass	None.	3 netters (generally using trammel nets for sole and/or gill nets for cod) will conduct experimental trials for the mentioned passive fishing methods.

2.1.2 Technical measures

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

Until 2001, the technical measures applicable to the North Sea demersal stocks in EU waters were laid down in the Council Regulation (EC) No 850/98. Additional technical measures have been established in 2001 by the Commission Regulation (EC) No 2056/2001, for the recovery of the stocks of cod in the North Sea and to the west of Scotland. Their implementation in EU waters is described below. In 2001, an emergency measure was enforced by the Commission to enhance cod spawning (Commission Regulation EC No 259/2001). Council Regulation (EC) 2341/2002, Annex XVII, regulated the fishing effort in 2003 in the context of recovery of certain cod stocks. Council Regulation (EC) No 423/2004, the cod stocks recovery plan, was put into force by 26 February 2004. The TAC and Quota regulation for 2004 in Council Regulation (EC) No 2287/2003 further establishes a revised interim effort management based on days at sea by area, vessel, month and gear (Annex V) and an area based management to enhance the utilisation of the North Sea haddock TAC with the aim to prevent cod by-catches Annex (IV, Article 17). Such effort regulations were revised for 2005 in Council Regulation (EC) No 27/2005, Annex IVa. From 2006 a more complicated effort-limitation scheme was introduced, in which days-at-sea allocations were determined by vessel and gear type, area, and target species. The regulations for 2007 and 2008 are defined in Council Regulation (EC) No 41/2007 and N°40/2008). The allocations are summarised in full in Table 2.1.6a and 2.1.6b.

2.1.2.1 Minimum landing size

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

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

2.1.2.2 Minimum mesh size

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

Towed nets excluding beam trawls

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

- ***Nephrops* fishing.** It is possible to use a mesh size in range 70-99 mm, provided catches retained on board consist of at least 30% of *Nephrops*. However, the net needs to be equipped with a 80 mm square-meshed panel if a mesh size of 70-99 mm is to be used in the North Sea and if a mesh size of 70-89 mm is to be used in the Skagerrak and Kattegatt the codend has to be square meshed.
- **Saithe fishing.** It is possible to use a mesh size range of 110-119 mm, provided catches consist of at least 70% of saithe and less than 3% of cod. This exception however does not apply to Norwegian waters, where the minimum mesh size for all human consumption fishing is 120 mm. Since January 2002 Norwegian trawlers (human consumption) have had a minimum mesh size of 120 mm in EU-waters. However, since August 2004 they have been allowed to use down to 110 mm mesh size in EU-waters (but minimum mesh size is still 120 mm in Norwegian waters).

- **Fishing for other stocks.** It is possible to use a mesh size range of 100-119 mm, provided the net is equipped with a square-meshed panel of at least 90 mm mesh size and the catch composition retained on board consists of no more than 3 % of cod.
- **2002 exemption.** In 2002 only, it was possible to use a mesh size range of 110-119 mm, provided catches retained on board consist of at least 50% of a mixture of haddock, whiting, plaice sole, lemon sole, skates and anglerfish, and no more than 25% of cod.

Beam trawls

- **Northern North Sea.** It is prohibited to use any beam trawl of mesh size range 32 to 119 mm in that part of ICES Sub-area IV to the north of 56° 00' N. However, it is permitted to use any beam trawl of mesh size range 100 to 119 mm within the area enclosed by the east coast of the United Kingdom between 55° 00' N and 56° 00' N and by straight lines sequentially joining the following geographical coordinates: a point on the east coast of the United Kingdom at 55° 00' N, 55° 00' N 05° 00' E, 56° 00' N 05° 00' E, a point on the east coast of the United Kingdom at 56° 00' N, provided that the catches taken within this area with such a fishing gear and retained on board consist of no more than 5 % of cod.
- **Southern North Sea.** It is possible to fish for sole south of 56° N with 80-99 mm meshes in the cod end, provided that at least 40 % of the catch is sole, and no more than 5 % of the catch is composed of cod, haddock and saithe.

Combined nets.

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

Fixed gears.

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

2.1.2.3 Closed areas

Twelve mile zone

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

Plaice box

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

Cod box

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

Sandeel box

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

Cod protection area in the North Sea

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

2.1.3 Environmental considerations

The WG considers that although it is clear that the North Sea ecosystem is undergoing change and this will affect fish stocks, the causal mechanisms linking the environment with fish stock dynamics are not yet clearly-enough understood for such information to be used as part of fisheries management advice.

2.1.4 Human consumption fisheries

2.1.4.1 Data

Estimates of discarding rates provided by a number of countries Scotland, England and Wales, Danish, German and Swedish observer sampling programme were used in the assessments of cod, haddock and whiting in the North Sea, to raise landings to catch. A combination of observed (from the Dutch and English sampling programmes) and reconstructed discard rates were used in the North Sea plaice assessment. Other discard sampling programmes have been in place in recent years, but have not been used in the assessments yet because of short time-series or because of collation problems. In general, some discarding occurs in most human-consumption fisheries, particularly when strong year-classes are approaching the minimum landing size.

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

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

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

2.1.4.2 Stock impressions

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 has resulted from excessive fishing effort, possibly combined with an effect of a climatic phase which is unfavourable to recruitment. For a number of years, ICES has recommended significant and sustained reductions in fishing mortality on some of the stocks. In order to achieve this, significant reductions in fishing effort are required. In recent years, estimated fishing mortality has declined in most stocks for which analytic assessments are available.

Catches of **cod** in Sub-area IV and Divisions IIIa and VIId have stabilised at a low level over the past three years. Estimated spawning-stock biomass reached a low in 2006 (31kt) but has subsequently increased by 60% to (50kt). Fishing mortality is now estimated to have declined since 2000 (~ 0.64 in 2007). Recruitment of the 2000-2004 year-classes was poor the 2005 year class is stronger but still below the long-term average and the 2006 year class is again estimated to be low in the majority of the North Sea; but there are indications of a strong 2006 year class in the Southern North Sea and VIId. Recent reductions in realised fishing mortality should enable biomass to increase in the short-term, however there has been a significant increase in discarding in 2007, equivalent to landings in weight, which is maintaining the fishery induced mortality at a high level.

Haddock fishing mortality in 2007, at 0.42, is below that of 2006, 0.52. The decline in abundance of the dominant 1999 year-class has been offset to a certain extent by an improved 2005 year class; consequently catches in Sub-area IV and Division IIIa in 2007 were just above those of 2006. However, the reduction in mortality rate has not prevented a continued decline in SSB (from 307 kt in 2006 to 218 kt in 2007). The 2005 year-class is estimated to be quite abundant (39 000 million) and the largest since the 1999 year-class.

The assessment of **whiting** in Sub-area IV and Division VIId is again problematic in that the historic estimates of biomass derived from surveys exhibit differing trends from those based on catch data. However the recent trends are consistent and the WG accepted that assessment based on data from 1990. The final assessment indicates low estimates of yield and recruitment, historically low SSB and an increasing level of fishing mortality. Without good recruitment the stock is unlikely to rebuild. This assessment must be considered in the light of industry reports that older whiting are more abundant than for several years, particular off the northeast coast of England and indications from surveys and the fishery that the stock is undergoing a strong decline in the southern and eastern North Sea and the Channel.

Landings of **saithe** in Sub-areas IV and VI and Division IIIa have been stable for several years at a level well-below the permitted TAC. Fishing mortality has now remained at or below 0.3 for seven years (*F* ~ 0.25 in 2007) while SSB has stabilised at just below 300 kt (280 kt in 2007) Recruitment is fluctuating about the mean level.

The reported landings for **sole** in Subarea IV in 2007 (14.6 kt) increased over those in 2006 (12.6kt) but are still below the landings of recent years and well below the TAC for the third year. SSB has fluctuated around a moderate-to-low level for several years before declining to its lowest level in 2007 (19 kt) well below Blim. It will increase to just below Bpa at 33kt in 2008 following the maturation of the relatively strong 2005 year class.

As in the previous two meetings, the assessment of **plaice** in Subarea IV included modelled discard estimates for recent years. Landings and discards have both declined in recent years. SSB remains at a relatively low level just below B_{pa}. Total fishing mortality has remained just above 0.4 since 2004, the human consumption component has continued to decline however the discarding mortality has remained high. Recent year-class strength has been at the long-term mean.

The yields for stocks of Nephrops are fairly stable from year to year. Reported landings for FU 3 (Skagerrak) and FU 4 (Kattegat) have averaged 2500t and 1500t respectively since 2000 with little variation. There are no signs of overexploitation in IIIa and given the apparent stability of the stock, the current levels of exploitation appear to be sustainable.

FU 5 (Botney Gut, 1300t), FU 7 (Fladen, 11900 t), FU 8 (Firth of Forth, 2600 t), FU 9 (Moray Firth, 1800 t), and FU 33 (Off Horn Reef, 1000 t) are at or near their highest-observed levels of landings. Landings from FU 6 (Farne Deeps, 3000 t), FU 10 (Noup, 155 t) and FU 32 (Norwegian Deeps, 755 t) have all declined in recent years, in particular for Farne Deeps the stock is considered to have declined due to recent high levels of fishing effort.

2.1.5 Industrial fisheries

2.1.5.1 Description of fisheries

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

2.1.5.2 Data available

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

2.1.5.3 Trends in landings and effort

Sandeel landings in 1974–1985 fluctuated between 428 kt and 787 kt with a mean of 611 kt. In the period 1986–2000 the landings increased to a generally higher level between 591 kt and 1091 kt and a mean of 819 kt. In 1997 the combined Danish and Norwegian landings of more than 1 million tonnes were the highest ever recorded. Landings in 2002 for Norway and Denmark were 804 kt (Table 2.1.2) which is just above the average of 779 kt for the period 1980-2002. Landings from 2003 to 2007 were relatively low following a series of weak recruitments. Until 2007 when the fishery was closed in May, the TAC has never been restrictive on the sandeel fishery. Therefore TAC regulation of the fishery is does not explain the reduced level of landings (except in the Norwegian EEZ where there was only a limited monitoring fishery permitted in 2006). The reductions result from effort restriction, decreases in fleet size and diversion of effort to other species as a result of low catch rates.

Norway pout landings showed a downward trend in the period 1974–1988. Thereafter the landings fluctuated around a level of 150 kt until 1998. Since 1996 there has only been one strong year class to the fishery (1999) and consequently landings have been lower. Following the recruitment of two very low abundance year classes in 2003 and 2004, SSB declined to a historic low and the targeted fishery for directed fishery Norway pout was closed in 2005, the first half of 2006, and all of 2007.

2.1.5.4 Stock impressions

Estimated **sandeel** SSB was below B_{lim} from 2001 to 2007, but is estimated to be above B_{pa} at the start of 2008. Fishing mortality has declined in recent years and is estimated to be well below the long time average in both 2007 and 2008. Recruitment remains low.

The directed fishery for **Norway pout** in Sub-area IV was closed during 2005, most of 2006 and all of 2007; the low level of landings in 2005 and 2007 were mainly by-catch in the blue whiting fishery and experimental fishing. The 2005 and 2007 year-classes are estimated to be around the long-term mean and consequently SSB has increased and in 2007 was just above B_{pa} at 154kt. Due to the closure in 2007 fishing mortality was negligible.

2.2 Stocks in the Skagerrak and Kattegat (Division IIIa)

2.2.1 Fishery descriptions

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

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

The industrial fishery is a small-mesh trawl fishery mainly carried out by vessels of a size above 20 m. This fleet component has also decreased over the past decade. Highest catches are from fisheries targeting sandeel, sprat and herring. There is also a trawl fishery landing a mixture of species for reduction purposes. Catches from the industrial fishery are given in Table 2.2.1, while bycatches of commercial stocks are summarised in Table 2.2.2; data are available for 1989-2004 only.

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

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

2.2.2 Technical measures

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

2.2.3 Environmental considerations

Several of the stocks in the Skagerrak may not be separate stocks but may interact with stocks in the North or Baltic Seas. This is the case for cod, haddock, whiting, and Norway pout. Plaice in Division IIIa in considered as being a mix of several subpopulations, 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 in 2007 were 2946 tonnes in the human consumption fisherya reduction from 3366 in 2006. The majority of catches were taken by Denmark. The WG has no updated information on the distribution of catches, but in previous years around 90% of the Division IIIa total was taken in the Skagerrak. Cod in Skagerrak is assessed together with the North Sea (Division IV) and Eastern Channel (Division VIId) stock. Cod in Kattegat is assessed as a separate stock by the Baltic Fisheries Assessment Working Group. Since 2002, ICES has advised that no fishery should take place on this stock. However, the Kattegat cod is covered by the EC recovery plan (Council Regulation no. 423/2004, of 26 February 2004), which allows a TAC even though biomass is below B_{lim}.

Landings of **haddock** in Division IIIa, in the human consumption fishery, amounted to 1614 tonnes a small increase from 2006 (1537 tonnes) and double the landings for 2005 (764kt). 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 152 tonnes in 2007, similar to the levels of 2006. Denmark recorded 227t of industrial whiting catch in 2007. Recent catches have been the lowest in the time-series. Most of the landings were taken in the Skagerrak. No analytical assessment of whiting in IIIa was possible.

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

The source of **Plaice** landings in Division IIIa is uncertain with the majority of landings being recorded close to the North Sea; about 82% of the landings are taken in the Skagerrak. The available quota has never been restrictive for this stock. Survey information from the Skagerrak indicate that the stock in that area has increased in recent years following improved recruitment. Information to resolve the uncertainties in the assessment that were highlighted in last years report could not be resolved in the past year therefore the previous advice applies for this stock.

The **sole** landings in Division IIIa are mostly taken in Kattegat and this stock is assessed by the Baltic Fisheries Assessment Working Group. 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). The yields for stocks of Nephrops are fairly stable from year to year. Reported landings for FU 3 (Skagerrak) and FU 4 (Kattegat) have averaged 2500t and 1500t respectively since 2000 with little variation. There are no signs of overexploitation in IIIa and given the apparent stability of the stock, the current levels of exploitation appear to be sustainable.

2.2.5 Industrial fisheries

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

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

2.3 Stocks in the Eastern Channel (Division VIId)

2.3.1 Fishery descriptions

Flatfish

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

Roundfish

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

Effort

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

2.3.2 Technical measures

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

2.3.3 Data

Discards

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

Catch at age

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

Surveys

The 4th quarter French Groundfish Survey (FraGFS) provides information on cod, whiting and plaice in VIId. A research vessel survey using beam trawl which covers most of Division VIId in August (BTS) is used in tuning assessments for sole and plaice. An International Young Fish Survey (YFS) is carried out along the English coast (discontinued in 2007) and in the Baie de Somme on the French coast and is used to calculate an index for 0-gp and 1-gp of sole and plaice.

2.3.4 State of the stocks

Cod and whiting have been assessed with the North Sea stocks since 1998 and are included in the overview for the North Sea (Section 2.1.3).

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

Discrepancies between catch-at-age based analyses and survey-based analyses have prevented the WG from assessing the state of **plaice in Division VIId**. Landings have declined steadily since 2002.

2.4 Industrial fisheries in Division VIa

There are two distinct industrial fisheries operating in Division VIa; a Norway pout fishery and a sandeel fishery. The Norway pout fishery is now exclusively Danish, whereas the sandeel fishery is almost exclusively Scottish and operates in more inshore areas. No information is available on by-catches in the Norway pout fishery. The sandeel fishery has a small by-catch of other species; information from the 1995 and 1996 catches indicated that more than 97% of the catch consisted of *Ammodytes marinus*, with the by-catch consisting mostly of other species of sandeel. Landings from both fisheries have historically been small compared to the fisheries in the North Sea. There were no officially reported landings of sandeel from Division VIa in 2005 - 2007.

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

	Human consumption landings							
year	cod-347d	had-34	nop-nsea	ple-nsea	sai-3a46	san-nsea	sol-nsea	whg-47d
1957				70563			12067	
1958				73354			14287	
1959				79300			13832	
1960				87541			18620	
1961				85984			23566	
1962				87472			26877	
1963	116457	68779		107118			26164	
1964	126041	130944		110540			11342	
1965	181036	162418		97143			17043	
1966	221336	226184		101834			33340	
1967	252977	147742		108819	88326		33439	
1968	288368	105811		111534	113751		33179	
1969	200760	331625		121651	130588		27559	
1970	226124	524773		130342	234962		19685	
1971	328098	237502		113944	265381		23652	
1972	353976	195545		122843	261877		21086	
1973	239051	181592		130429	242499		19309	
1974	214279	153057		112540	298351		17989	
1975	205245	151349		108536	271584		20773	
1976	234169	172680		113670	343967		17326	
1977	209154	145118		119188	216395		18003	
1978	297022	91683		113984	155141		20280	
1979	269973	87069		145347	128360		22598	
1980	293644	105041		139951	131908		15807	100810
1981	335497	136132		139747	132278		15403	89524
1982	303251	173335		154547	174351		21579	80549
1983	259287	165337	475746	144038	180044	530640	24927	87972
1984	228286	133568	376555	156147	200834	750040	26839	86281
1985	214629	164119	227450	159838	220869	707105	24248	62127
1986	204053	168236	180376	165347	198596	685950	18200	64114
1987	216212	110299	148856	153670	167514	791050	17368	68300
1988	184240	106973	109294	154475	135172	1007304	21590	56103
1989	139936	78439	166559	169818	108877	826835	21806	45189
1990	125314	53780	138719	156240	103800	584912	35120	46896
1991	102478	47715	190194	148004	108048	898959	33513	53025
1992	114020	72790	302365	125190	99742	820140	29341	52188
1993	121749	82176	181256	117113	111491	576932	31491	53196
1994	110634	82074	183585	110392	109622	770747	33002	49242
1995	136096	77458	231772	98356	121810	915043	30467	46442
1996	126320	79148	156079	81673	114997	776126	22651	41074
1997	124158	82574	156938	83048	107327	1114044	14901	35920
1998	146014	81054	73974	71534	106123	1000375	20868	28464
1999	96225	65588	92276	80662	110716	718668	23475	30412
2000	71371	47553	184969	81148	91322	692498	22532	28807
2001	49694	40856	64372	81963	95042	858619	19944	25216
2002	54865	58348	77109	70217	115395	806921	16945	21716
2003	30872	41964	24574	66502	105569	309725	17920	16372
2004	28188	48734	13488	61436	104237	359361	17147	13583
2005	28708	48357	1900	55700	124532	171790	16355	15304
2006	26590	37613	46626	57943	125681	286751	12600	18589
2007	24369	32130	5745	49744	100404	205371	14635	19437
2008						335046		

	Industrial by catch					
year	cod-347d	had-34	ple-nsea	sai-3a46	sol-nsea	whg-47d
1957						
1958						
1959						
1960						
1961						
1962						
1963		13700				
1964		88600				
1965		74600				
1966		46700				
1967		20700				
1968		34200				
1969		338353				
1970		179729				
1971		31546				
1972		29585				
1973		11267				
1974		47505				
1975		41487				
1976		48163				
1977		35022				
1978		10903				
1979		16240				
1980		22472				45760
1981		17041				66610
1982		19383				33040
1983		12898				23680
1984		10080				18900
1985		5998				15320
1986		2643				17970
1987		4410				16480
1988		4002				49220
1989		2410				42710
1990		2589				50720
1991		5386				38310
1992		10927				26900
1993		10766				20100
1994		3576				10350
1995		7695				26560
1996		5000				4700
1997		6684				5960
1998		5101				3140
1999		3835				5180
2000		8134				8890
2001		7879				7360
2002		3717				7330
2003		1150				2740
2004		554				1220
2005		168				880
2006		535				2190
2007		48				1230
2008						

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

Year	Sandeel	Sprat	Herring	Norway pout	Blue whiting	Haddock	Whiting	Saithe	Other	Total
1974	525	314	-	736	62	48	130	42		1857
1975	428	641	-	560	42	41	86	38		1836
1976	488	622	12	435	36	48	150	67		1858
1977	786	304	10	390	38	35	106	6		1675
1978	787	378	8	270	100	11	55	3		1612
1979	578	380	15	320	64	16	59	2		1434
1980	729	323	7	471	76	22	46	-		1674
1981	569	209	84	236	62	17	67	1		1245
1982	611	153	153	360	118	19	33	5	24	1476
1983	537	88	155	423	118	13	24	1	42	1401
1984	669	77	35	355	79	10	19	6	48	1298
1985	622	50	63	197	73	6	15	8	66	1100
1986	848	16	40	174	37	3	18	1	33	1170
1987	825	33	47	147	30	4	16	4	73	1179
1988	893	87	179	102	28	4	49	1	45	1388
1989	1039	63	146	162	28	2	36	1	59	1536
1990	591	71	115	140	22	3	50	8	40	1040
1991	843	110	131	155	28	5	38	1	38	1349
1992	854	214	128	252	45	11	27	-	30	1561
1993	578	153	102	174	17	11	20	1	27	1083
1994	769	281	40	172	11	5	10	-	19	1307
1995	911	278	66	181	64	8	27	1	15	1551
1996	761	81	39	122	93	5	5	0	13	1119
1997	1091	99	15	126	46	7	7	3	21	1416
1998	956	131	16	72	72	5	3	3	24	1283
1999	678	166	23	97	89	4	5	2	40	1103
2000	655	191	24	176	98	8	8	6	21	1187
2001	810	156	21	59	76	6	7	3	14	1152
2002	804	142	26	73	107	4	8	8	15	1186
2003	303	175	16	18	139	1	3	8	18	681
2004	324	193	19	12	107	1	2	7	29	692
2005	172	207	23	1	101	0	1	6	13	524
2006	256	107	13	48	82	0	2	7	15	530
2007	196	75	7	5	48	0	1	3	9	349
Avg 75-07	661	193	56	212	66	11	33	8	30	1260

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

Year quarter	Sandeel	Sprat	Herring	Norway pout	Blue whiting	Haddock	Whiting	Saithe	Other	Total
1999 q1	14	14	4	8	23	1	1	1	8	74
1999 q2	507	2	4	22	30	1	2	1	8	577
1999 q3	139	129	10	41	18	1	2	0	7	347
1999 q4	17	21	6	25	17	1	1	0	18	106
2000 q1	10	42	1	9	13	1	0	0	5	82
2000 q2	581	2	4	17	32	3	2	0	4	646
2000 q3	63	133	10	30	39	2	3	6	5	291
2000 q4	0	15	8	119	14	2	3	0	8	169
2001 q1	12	40	2	20	15	1	1	0	3	94
2001 q2	462	1	2	10	32	3	1	2	4	517
2001 q3	314	44	4	4	12	1	2	0	5	386
2001 q4	22	72	13	24	16	1	2	0	2	152
2002 q1	11	5	6	8	18	0	0	0	2	50
2002q2	772	0	3	5	19	1	2	0	4	806
2002q3	21	71	8	31	46	1	3	5	4	189
2002q4	0	66	10	28	24	1	2	3	6	141
2003 q1	3	18	1	2	14	0	0	1	5	45
2003 q2	239	1	2	4	42	0	1	1	3	292
2003 q3	57	56	4	5	56	0	1	4	4	188
2003 q4	4	100	9	7	28	0	1	2	6	157
2004 q1	2	1	4	1	19	0	0	1	12	41
2004 q2	273	0	2	1	33	0	1	1	5	315
2004 q3	50	55	5	4	37	0	0	2	7	160
2004 q4	0	136	9	6	18	0	0	2	5	177
2005 q1	0	12	1	0	11	0	0	0	3	28
2005 q2	158	3	1	1	37	0	0	1	3	204
2005 q3	14	108	6	0	36	0	0	3	3	170
2005 q4	0	84	15	0	16	0	0	2	3	122
2006 q1	0	37	1	0	3	0	0	0	1	42
2006 q2	235	1	1	3	34	0	0	1	8	283
2006 q3	20	42	7	9	31	0	0	4	4	117
2006 q4	0	28	4	36	14	0	2	2	2	88
2007 q1	0	0	0	1	5	0	0	0	2	8
2007 q2	196	0	0	1	24	0	0	2	4	228
2007 q3	0	17	1	2	14	0	0	2	3	40
2007 q4	0	58	5	0	5	0	0	0	1	70

0 denotes < 500 tonnes

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

Species	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Gadus morhua	544	710	1092	1404	2988	2948	570	1044	1052	876
Scomber scombrus	4	534	2663	6414	8013	5212	7466	4631	4386	3576
Trachurus trachurus	22789	16658	7391	18104	22723	14918	5704	6651	6169	4886
Trigla sp.	0	888[2]	4534	5394	9391	2598	5622	4209	1593	1139
Limanda limanda	187	3209	4632	3781	7743	4706	5578	3986	4871	528
Argentina spp.	8714	5210	3033	1918	778	2801	3434	2024	2874	2209
Hippoglossoides platessoides	59	718	1173	946	2160	1673	1024	1694	1428	529
Pleuronectes platessa	34	119	109	372	582	566	1305	218	128	143
Merluccius merluccius[4]	349	165	261	242	290	429	28	359	109	10
Trisopterus minutus	0	68[3]	0	5	48	121	79	111	36	0
Molva molva[3]	51	1	40	39	37	13	65	10	28	0
Glyptocephalus cynoglossus	236	132	341	44	255	251	1439	195	246	40
Gadiculus argenteus[3]	1210	729	3043	2494	741	476	801	0	0	0
Others	31715	3853	3604	3670	3528	3154	4444	4553	4106	5141
Total	65892	32994	72724	44827	59277	39866	37559	29685	27026	19077

Species	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Gadus morhua	955	366	1688	1281	532	383	192	29	49	44
Scomber scombrus	2331	2019	3153	1934	2728	2443	1749	1260	2549	6515
Trachurus trachurus	2746	2369	3332	2576	5116	5312	1159	2338	5791	10272
Trigla sp.	2091	897	2618	1015	2566	1343	2293	1071	847	1101
Limanda limanda	1028	1065	2662	6620	4317	441	1441	321	596	386
Argentina spp.	292	3101	2604	5205	3580	333	397		1376	786
Hippoglossoides platessoides	617	339	1411	2229	1272	493	431	112	208	174
Pleuronectes platessa	33	90	73	91	88	64	56	51	28	1
Merluccius merluccius[4]	0	3625	2364	33	211	231	167	6	301	423
Trisopterus minutus	9	30	181	261	922	518	0	196	5	91
Molva molva[3]	0	0	31	31	125	19	49	0	42	169
Glyptocephalus cynoglossus	0	97	394	860	437	154	246	58	437	286
Gadiculus argenteus[3]	0	7	248	248	387	532	942	459	993	1550
Others	5158	50	749	5405	17931	8927	301	2226	4888	6953
Total	15260	14055	21508	27787	40211	21192	12523	8127	20115	28750

Species	2005	2006	2007
Gadus morhua	22	72	119
Scomber scombrus	2195	2313	466
Trachurus trachurus	5226	1390	608
Trigla sp.	597	1849	278
Limanda limanda	287	839	76
Argentina spp.	1348	2025	1382
Hippoglossoides platessoides	61	302	30
Pleuronectes platessa	38	10	0
Merluccius merluccius[4]	254	597	494
Trisopterus minutus	0	0	0
Molva molva[3]	34	131	15
Glyptocephalus cynoglossus	87	68	43
Gadiculus argenteus[3]	909	1926	3955
Others	1964	3295	1682
Total	13022	14815	9146

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

Table 2.1.4. Danish by-catch landings of cod, haddock and saithe in 1994–2006 from small-meshed fisheries in the North Sea. Landings (tonnes) used for reduction.

Landings in tonnes used for reduction purposes.

Cod	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Sandeel fishery	70	79	288	375	202	51	56	7	12	5	10	2	1	0
Sprat fishery	493	174	23	40	11	7	4	4	0	11	3	16	4	18
Norway pout fishery	201	680	4	242	161	11	0	81	3	3	1		19	0
Blue whiting fishery	0		24	37	20	28	0	0	14	0	0		0	0
"Others" fishery	14	23	2	94	6	4	1	4	1	2	1		0	0
Total	778	956	341	789	400	101	61	97	30	21	16	18	24	18

Haddock	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Sandeel fishery	528	534	1,600	524	202	364	1,226	1,557	220	103	33	0	97	20
Sprat fishery	685	1,097	18	11	6	62	66	223	27	15	0	4	25	6
Norway pout fishery	1,399	4,766	1,774	1,454	251	318	1,734	1,252	1,545	16	57		243	0
Blue whiting fishery	10		153	205	66	195	258	218	133	59	16	13	0	0
"Others" fishery	71	349	77	137	218	117	40	42	183	96	10	0	0	0
Total	2,693	6,745	3,622	2,331	744	1,055	3,324	3,292	2,108	289	116	18	364	27

Whiting	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Sandeel fishery	1,392	3,322	1,909	2,143	902	2,121	1,539	2,761	1,397	444	653	261	274	326
Sprat fishery	4,352	10,386	784	107	673	1,088	2,107	1,700	2,238	1,105	333	545	343	900
Norway pout fishery	3,121	7,291	1,373	2,235	178	331	2,935	1,559	1,675	265	232		1536	0
Blue whiting fishery	0		126	113	83	169	71	217	123	30	0		0	0
"Others" fishery	187	4,422	22	173	112	116	89	184	127	63	0	19	1	0
Total	9,053	25,422	4,214	4,771	1,948	3,825	6,740	6,420	5,560	1,907	1,218	825	2154	1226

Saithe	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Sandeel fishery	0	0	40	0		28		1	0	30	14			
Sprat fishery	11	297	0	0				3	0	0	0	7		5
Norway pout fishery	135	490	84	209			116	22	246	0	0		14	
Blue whiting fishery	0		20	80	11	8	2	84	72	17	51	7	27	1
"Others" fishery	0	542	0	40	1	4	2	7	109	69	0			
Total	146	1,329	144	329	12	40	120	117	427	116	65	14	41	6

All species	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Sandeel fishery	611,554	644,473	622,211	761,963	624,925	514,047	551,008	637,518	628,205	274,854	291,445	150,426	254,210	145845
Sprat fishery	314,970	344,309	107,243	103,523	145,978	171,757	208,641	170,862	167,472	194,210	200,907	234,251	120,033	82807
Norway pout fishery	111,208	140,550	76,390	104,499	33,515	29,361	135,196	47,788	54,980	9,020	8,980	0	38,943	0
Blue whiting fishery	419		34,857	13,181	46,052	51,060	34,129	26,038	27,052	21,320	20,295	0	2037	3137
"Others" fishery	19,480	48,936	8,882	14,554	17,893	26,945	7,433	10,554	8,503	6,184	10,298	6,944	137	2110
Total	1,057,632	1,178,268	849,584	997,719	868,363	793,169	936,408	892,760	886,212	505,588	531,925	408488	415361	233900

Table 2.1.5. Quarterly Danish by-catch landings of cod, haddock and saithe in 2006 from small-meshed fisheries in the North Sea. Landings (tonnes) used for reduction purposes.

Cod	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total
Sandeel fishery					
Blue whiting fishry					
Sprat fishery			2	17	18
Norway pout fishery					
"Others" fishery					
Total			2	17	18

Haddock	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total
Sandeel fishery		20			20
Sprat fishery				6	6
Norway pout fishery					
"Others" fishery					
Total		20	8	6	27

Whiting	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total
Sandeel fishery		326			326
Blue whiting fishery					
Sprat fishery			409	492	900
Norway pout fishery					
"Others" fishery					
Total		326	409	492	1226

Saithe	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total
Sandeel fishery					
Blue whiting fishery		1			1
Sprat fishery				5	5
Norway pout fishery					
"Others" fishery					
Total		1		5	6

All species	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total
Sandeel fishery		145845			145845
Blue whiting fishery	3106	30			3137
Sprat fishery	111		18656	64040	82807
Norway pout fishery					
"Others" fishery	2073	37			2110
Total	5291	145913	18656	64040	233900

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

Table I

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

			Areas as defined in point:					
Gear Point 4.1	Special condition Point 8	Denomination (1)	2.a Kattegat	2.b 1 — Skaggerak 2 — II, IVa, b,c, 3 — VIId			2.c VIIa	2.d VIa
				1	2	3		
a.i		Trawls or Danish seines with mesh size ≥ 16 and < 32 mm	228	228 (2)			228	228
a.ii		Trawls or Danish seines with mesh size ≥70 and <90 mm	n.r.	n.r.	204	221	204	227
a.iii		Trawls or Danish seines with mesh size ≥90 and <100 mm	95	95	209		227	227
a.iv		Trawls or Danish seines with mesh size ≥100 and <120 mm	103	95			105	84
a.v		Trawls or Danish seines with mesh size ≥120 mm	103	96			114	85
a.iii	8.1.(a)	Trawls or Danish seines with mesh size ≥90 and <100 mm with a 120 mm square mesh window	126	126	227		227	227
a.iv	8.1.(a)	Trawls or Danish seines with mesh size ≥100 and <120 mm with a 120 mm square mesh window	137	137	103		114	91
d	8.1.(g)	Trammel nets with mesh size < 110 mm. The vessel shall be absent from the port no more than 24 h.	140	140	205		140	140
e		Long-lines	173	173			173	173

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

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

			Areas as defined in point:					
Gear Point 4.1	Special condi-tion Point 8	Denomination (¹)	2.a Kattegat	2.b 1 — Skaggerak 2 — II, IVa, b,c, 3 — VIId			2.c VIIa	2.d VIa
				1	2	3		
a.v	8.1.(a)	Trawls or Danish seines with mesh size ≥120 mm with a 120 mm square mesh window	137	137	103		114	91
a.v.	8.1.(j)	Trawls or Danish seines with mesh size ≥120 mm with a 140 mm square mesh window	149	149	115		126	103
a.ii	8.1.(b)	Trawls or Danish seines with mesh size ≥70 and <90 mm complying with the conditions laid down in Appendix 2 to Annex III	Unl.	Unlimited			Unl.	Unl.
a.ii	8.1.(c)	Trawls or Danish seines with mesh size ≥70 and <90 mm track records shall represent less than 5 % of cod	n.r	n.r	215	227	204	227
a.iii	8.1.(i)	Trawls or Danish seines with mesh size ≥90 and <100 mm complying with the conditions laid down in Appendix 3	132	132	238		238	238
a.iv	8.1.(c)	Trawls or Danish seines with mesh size ≥100 and <120 mm track records shall represent less than 5 % of cod	148	148			148	148
a.v	8.1.(c)	Trawls or Danish seines with mesh size ≥120 mm track records shall represent less than 5 % of cod	160	160			160	160
a.iv	8.1.(k)	Trawls or Danish seines with mesh size ≥100 and <120 mm track records shall represent less than 5 % of cod and more than 60 % of plaice	n.r.	n.r.			166	n.r.
a.v	8.1.(k)	Trawls or Danish seines with mesh size ≥120 mm track records shall represent less than 5 % of cod and more than 60 % of plaice	n.r.	n.r.			178	n.r.
a.v	8.1.(h)	Trawls or Danish seines with mesh size ≥120 mm operating under a system of automatic suspension of fishing licences	115	115			126	103
a.ii	8.1.(d)	Trawls or Danish seines with mesh size ≥70 and <90 mm track records represent less than 5 % of cod, sole and plaice	280	280			280	252
a.iii	8.1.(d)	Trawls or Danish seines with mesh size ≥90 and <100 mm track records represent less than 5 % of cod, sole and plaice	Unl.	Unl.	280		280	280
a.iv	8.1.(d)	Trawls or Danish seines with mesh size ≥100 and <120 mm track records represent less than 5 % of cod, sole and plaice	Unl.	Unlimited			276	276
a.v	8.1.(d)	Trawls or Danish seines with mesh size >120 mm track records represent less than 5 % of cod, sole and plaice	Unl.	Unlimited			Unl.	279

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

			Areas as defined in point:					
Gear Point 4.1	Special condition Point 8	Denomination (1)	2.a Kattegat	2.b 1 — Skaggerak 2 — II, IVa, b,c, 3 — VIId			2.c VIIa	2.d VIa
				1	2	3		
a.v	8.1.(h) 8.1.(j)	Trawls or Danish seines with mesh size >120 mm with a 140 mm square mesh window and operating under a system of automatic suspension of fishing licenses	n.r.	n.r.	127		138	115
b.i		Beam trawls with mesh size ≥80 and < 90 mm	n.r.	132 (2)	Unl.		132	143 (2)
b.ii		Beam trawls with mesh size ≥90 and < 100 mm	n.r.	143 (2)	Unl.		143	143 (2)
b.iii		Beam trawls with mesh size ≥100 and < 120 mm	n.r.	143	Unl.		143	143
b.iv		Beam trawls with mesh size ≥ 120 mm	n.r.	143	Unl.		143	143
b.iii	8.1.(c)	Beam trawls with mesh size ≥100and < 120 mm track records shall represent less than 5 % of cod	n.r.	155	Unl.		155	155
b.iii	8.1 (i)	Beam trawls with mesh size ≥100 and < 120 mm for vessels having used beam trawls in 2003, 2004, 2005 or 2006.	n.r.	155	Unl.		155	155
b.iv	8.1.(c)	Beam trawls with mesh size ≥ 120 mm track records shall represent less than 5 % of cod	n.r.	155	Unl.		155	155
b.iv	8.1 (i)	Beam trawls with mesh size ≥ 120mm for vessels having used beam trawls in 2003, 2004, 2005 or 2006.	n.r.	155	Unl.		155	155
b.iv	8.1.(e)	Beam trawls with mesh size ≥ 120 mm track records shall represent less than 5 % of cod and more than 60 % of plaice	n.r.	155	Unl.		155	155
c.i		Gillnets and entangling nets with mesh sizes < 110 mm	140		140		140	140
c.ii		Gillnets and entangling nets with mesh sizes ≥110 mm and < 150 mm	140		140		140	140
c.iii		Gillnets and entangling nets with mesh sizes ≥ 150 mm and < 220 mm	140		130		140	140
c.iv		Gillnets and entangling nets with mesh sizes ≥ 220 mm	140		140		140	140
d		Trammel nets	140		140		140	140
c.iii	8.1.(f)	Gillnets and entangling nets with mesh size ≥ 220 mm track records shall represent less than 5 % of cod and more than 5 % of turbot and lumpsucker	162	140	162	140	140	140

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

Corrigendum to Council Regulation (EC) No 41/2007 of 21 December 2006 fixing for 2007 the fishing opportunities and associated conditions for certain fish stocks and groups of fish stocks, applicable in Community waters and, for Community vessels, in waters where catch limitations are required

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

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

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

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

Table 2.1.6b. Maximum days a vessel may be present in 2008 within an area, by fishing gear. Source: Council Regulation (EC) No 40/2008.

Maximum days a vessel may be present in 2008 within an area by fishing gear

			Areas as defined in point:					
Gear Point 4.1	Special condition Point 8	Denomination ([1])	2.1.a Kattegat	2.1.b (i) — Skaggerak (ii) — EC waters of zone IIa, IVa, b,c, (iii) — VIId			2.1.c VIIa	2.1.d VIa
				(i)	(ii)	(iii)		
a.i		Trawls or Danish seines with mesh size ≥ 16 and < 32 mm	228	228 ([2])			228	228
a.ii		Trawls or Danish seines with mesh size ≥ 70 and < 90 mm	n.r.	n.r.	184	199	184	204
a.iii		Trawls or Danish seines with mesh size ≥ 90 and < 100 mm	71	86	188		227	227
a.iv		Trawls or Danish seines with mesh size ≥ 100 and < 120 mm	103	86			86	69
a.v		Trawls or Danish seines with mesh size ≥ 120 mm	103	86			114	70
a.iii	8.3(a)	Trawls or Danish seines with mesh size ≥ 90 and < 100 mm with a 120 mm square mesh window (Appendix 1)	126	126	227		227	227
a.iv	8.3(a)	Trawls or Danish seines with mesh size ≥ 100 and < 120 mm with a 120 mm square mesh window (Appendix 1)	137	137	103		114	91

			Areas as defined in point:					
Gear Point 4.1	Special condition Point 8	Denomination ([1])	2.1.a Kattegat	2.1.b (i) — Skaggerak (ii) — EC waters of zone IIa, IVa, b,c, (iii) — VIId			2.1.c VIIa	2.1.d VIa
				(i)	(ii)	(iii)		
c.iii	8.3(f)	Gillnets and entangling nets with mesh size ≥ 220 mm track records shall represent less than 5 % of cod and more than 5 % of turbot and lumpsucker	162	140	162	140	140	140
d	8.3(g)	Trammel nets with mesh size < 110 mm. The vessel shall be absent from the port no more than 24 h.	140	140	185 ([3])		140	140
e		Long-lines	173	173			173	173

([1]) Only the denominations in points 4.1 and 8.3 are used.
([2]) Application of Title V of Regulation (EC) No 850/98 where restrictions exist.
([3]) For Member States whose quotas are less than 5 % of the Community share of the TACs of both plaice and sole, the number of days at sea shall be 205.

n.r. means 'non relevant'

Table 2.1.6b. Maximum days a vessel may be present in 2008 within an area, by fishing gear.

			Areas as defined in point:					
Gear Point 4.1	Special condition Point 8	Denomination (1)	2.1.a Kattegat	2.1.b (i) — Skaggerak (ii) — EC waters of zone IIa, IVa, b,c, (iii) — VIId			2.1.c VIIa	2.1.d VIa
				(i)	(ii)	(iii)		
a.v	8.3(a)	Trawls or Danish seines with mesh size ≥ 120 mm with a 120 mm square mesh window (Appendix 1)	137	137	103		114	91
a.v.	8.3(j)	Trawls or Danish seines with mesh size ≥ 120 mm with a 140 mm square mesh window (Appendix 2)	149	149	115		126	103
a.ii	8.3(b)	Trawls or Danish seines with mesh size ≥ 70 and < 90 mm complying with the conditions laid down in Appendix 2 to Annex III	Unl.	Unlimited			Unl.	Unl.
a.ii	8.3(c)	Trawls or Danish seines with mesh size ≥ 70 and < 90 mm track records shall represent less than 5 % of cod	n.r	n.r	215	227	204	227
a.iii	8.3(l)	Trawls or Danish seines with mesh size ≥ 90 and < 100 mm complying with the conditions laid down in Appendix 3	132	132	238		238	238
a.iv	8.3(c)	Trawls or Danish seines with mesh size ≥ 100 and < 120 mm track records shall represent less than 5 % of cod	148	148			148	148
a.v	8.3(c)	Trawls or Danish seines with mesh size ≥ 120 mm track records shall represent less than 5 % of cod	160	160			160	160
a.iv	8.3(k)	Trawls or Danish seines with mesh size ≥ 100 and < 120 mm track records shall represent less than 5 % of cod and more than 60 % of plaice	n.r.	n.r.			166	n.r.
a.v	8.3(k)	Trawls or Danish seines with mesh size ≥ 120 mm track records shall represent less than 5 % of cod and more than 60 % of plaice	n.r.	n.r.			178	n.r.
a.v	8.3(h)	Trawls or Danish seines with mesh size ≥ 120 mm operating under a system of automatic suspension of fishing licences	115	115			126	103
a.ii	8.3(d)	Trawls or Danish seines with mesh size ≥ 70 and < 90 mm track records represent less than 5 % of cod, sole and plaice	280	280			280	252
a.iii	8.3(d)	Trawls or Danish seines with mesh size ≥ 90 and < 100 mm track records represent less than 5 % of cod, sole and plaice	Unl.	Unl.	280		280	280
a.iv	8.3(d)	Trawls or Danish seines with mesh size ≥ 100 and < 120 mm track records represent less than 5 % of cod, sole and plaice	Unl.	Unlimited			276	276

Source: Council Regulation (EC) No 40/2008.

Table 2.1.6b. Maximum days a vessel may be present in 2008 within an area, by fishing gear. Source: Council Regulation (EC) No 51/2008.

			Areas as defined in point:					
Gear Point 4.1	Special condition Point 8	Denomination (1)	2.1.a Kattegat	2.1.b (i) — Skaggerak (ii) — EC waters of zone IIa, IVa, b,c, (iii) — VIId			2.1.c VIIa	2.1.d VIa
				(i)	(ii)	(iii)		
a.v	8.3(d)	Trawls or Danish seines with mesh size >120 mm track records represent less than 5 % of cod, sole and plaice	Unl.	Unlimited			Unl.	279
a.v	8.3(h) 8.3(j)	Trawls or Danish seines with mesh size >120 mm with a 140 mm square mesh window (Appendix 2) and operating under a system of automatic suspension of fishing licenses	n.r.	n.r.	127		138	115
b.i		Beam trawls with mesh size ≥ 80 and < 90 mm	n.r.	119 (2)		Unl.	132	143 (2)
b.ii		Beam trawls with mesh size ≥ 90 and < 100 mm	n.r.	143 (2)		Unl.	143	143 (2)
b.iii		Beam trawls with mesh size ≥ 100 and < 120 mm	n.r.	129		Unl.	143	143
b.iv		Beam trawls with mesh size ≥ 120 mm	n.r.	129		Unl.	143	143
b.iii	8.3(c)	Beam trawls with mesh size ≥ 100 and < 120 mm track records shall represent less than 5 % of cod	n.r.	155		Unl.	155	155
b.iii	8.3(i)	Beam trawls with mesh size ≥ 100 and < 120 mm for vessels having used beam trawls in 2003, 2004, 2005 or 2006.	n.r.	155		Unl.	155	155
b.iv	8.3(c)	Beam trawls with mesh size ≥ 120 mm track records shall represent less than 5 % of cod	n.r.	155		Unl.	155	155
b.iv	8.3(i)	Beam trawls with mesh size ≥ 120 mm for vessels having used beam trawls in 2003, 2004, 2005 or 2006.	n.r.	155		Unl.	155	155
b.iv	8.3(e)	Beam trawls with mesh size ≥ 120 mm track records shall represent less than 5 % of cod and more than 60 % of plaice	n.r.	155		Unl.	155	155
c.i		Gillnets and entangling nets with mesh sizes < 110 mm	140	140			140	140
c.ii		Gillnets and entangling nets with mesh sizes ≥ 110 mm and < 150 mm	140	126			140	140
c.iii		Gillnets and entangling nets with mesh sizes ≥ 150 mm and < 220 mm	140	117			115	140
c.iv		Gillnets and entangling nets with mesh sizes ≥ 220 mm	140	140			140	140
d		Trammel nets	140	140			140	140

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

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

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

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

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

3 *Nephrops* (Norway lobster) in Division IIIa and Subarea IV

Nephrops stocks have previously been identified by WGNEPH on the basis of population distribution and characteristics, and established as separate Functional Units. The Functional Units (FU) are defined by the groupings of ICES statistical rectangles given in Table 3.1.1 and illustrated in Figure 3.1.1. The statistical rectangles making up each FU encompass the distribution of mud sediment on which *Nephrops* live. There are two FUs in Division IIIa. and eight FUs in Division IV. It is important to note that additional catches of *Nephrops* are also taken from smaller, isolated pockets of mud distributed throughout the ICES divisions. In recent years some of these areas have contributed significant landings despite their small size (eg Devils Hole). Management of *Nephrops* currently operates at the Division level.

Functional Units were previously aggregated by WGNEPH into a series of nominal Management Areas (MA) intended to provide a pragmatic solution for more localised management. The Working Group agreed that this process had served no useful purpose and should be discontinued.

The presentation of data and assessments for the Division IIIa FUs can be found as follows: Skagerrak (FU3) in Section 3.2.1; Kattegat (FU4) in Section 3.2.2; Divison IIIa overall in Section 3.2.3. The presentation of data and assessments for the Division IV FUs can be found as follows: Moray Firth (FU9) in Section 3.3.1; Noup (FU10) in Section 3.3.2; Fladen Ground (FU7) in Section 3.3.3; Norwegian Deeps (FU32) in Section 3.3.4; Farn Deeps (FU6) in Section 3.3.5; Firth of Forth (FU8) in Section 3.3.6; Botney Gut – Silver Pit (FU5) in Section 3.3.7; Off Horn Reef (FU33) in Section 3.3.8; Division IV overall in Section 3.3.9

Overall landings for Divisions IIIa and IV reported to the WG are summarised by Functional Unit in Table 3.1.2

The trends observed in the 2007 North Sea Commission Fisheries Partnership stock survey for *Nephrops* are shown in Figure 3.5.1. These are discussed in the Quality of Assessment sections.

General comments relating to *Nephrops* stocks, developments in assessments and the approaches employed are set out in the following section

3.1 General comments relating to all *Nephrops* stocks

During the early 1990s ICES assessed *Nephrops* stocks on an annual basis but this changed to biennial in 1995. With the advent of the area working groups, assessments were performed in 2005 and 2006 but then reverted to a biennial frequency. The last ICES advice was given in 2006 and remained unchanged in 2007 when basic data were simply updated.

Overarching ICES advice in 2006 and 2007 affecting all *Nephrops* stocks

2006

Fisheries in Division IIIa (Skagerrak-Kattegat), in Subarea IV (North Sea) and in Division VIId (Eastern Channel) should in 2007 be managed according to the following rules, which should be applied simultaneously:

Demersal fisheries

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

2007

Fisheries in Division IIIa (Skagerrak–Kattegat), in Subarea IV (North Sea), and in Division VIId (Eastern Channel) should in 2008 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 (see text table above);
- where stocks extend beyond this area, e.g. into Division VI (saithe and anglerfish) or are widely migratory (Northern hake), taking into account the exploitation of the stocks in these areas so that the overall exploitation remains within precautionary limits;
- with minimum bycatch of spurdog, porbeagle, and thornback ray and skate.

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.

Assessment approaches

Assessment and provision of catch predictions has not proved straightforward for *Nephrops* owing to its biology. Particular difficulties arise from the fact that *Nephrops* cannot be aged and because the species a burrowing crustacean exhibiting a variable emergence pattern. Furthermore, the biology and behaviour of the sexes differs markedly leading to different exploitation rates. Previously WGNEPH has conducted a variety of analyses on *Nephrops* data, including the review of basic fishery indicators, the use of LCA and XSA, and examination of trends in underwater TV surveys. Other assessment approaches have also been considered by WKNEPH (Workshop on *Nephrops* stocks), including length based SURBA and VPA methods, and CSA.

Length cohort analysis was used to provide a general indication of the state of the stock but the method does not allow the production of time series of stock trends and does not indicate problems with recruitment. Typically, Y/R curves were constructed during the analysis but the tendency of LCA to overestimate current mortality rate led to misleading interpretations of the current state of exploitation. Use of LCA in this working group is presently limited to providing guidance on potential target mortalities such as F0.1 and Fmax.

In an effort to circumvent the problem of ageing these animals, pseudo-ages from slicing length frequency distributions (on the basis of growth parameters) were used in age-based based cohort analysis such as XSA. Concerns raised at WGNEPH, and WGNSDS and WGNSSK in 2005 about the implications of the use of the knife edge slicing technique for catch at age analysis of pseudo ages led to these types of assessments not being performed in 2005. The main problem is that increase in variability in length at age for older individuals may lead to a number of "real" ages being included within a sliced age, leading to an overestimation of F. There was broad acceptance by the WGNSSK Review Group in 2005 that XSA was not advised at the present time.

Owing to the variable emergence of *Nephrops*, trawl catch rates are difficult to interpret so that traditional fishery independent surveys have not been widely employed for *Nephrops*. Instead underwater television (UTV) surveys have been developed to survey *Nephrops* burrows and have been employed on a number of the Functional Units (up to 15 years in the case of the Fladen Ground FU7). Data from these surveys have been used for a number of years to give an indication of relative trends in *Nephrops* populations and the 2006 Review Group agreed that, where available, UTV provided the best indication of stock condition. In 2007 a meeting of WKNEPHTV took place and provided a comprehensive overview of the state of play on the underwater television technique. This identified areas for development and for the establishment of protocols and standardisation. A second meeting to specifically examine burrow counting took place in earlier in 2008.

The Working Group agreed that its approach in 2008 should be essentially the same as in 2006. Numerical assessments were not performed and judgements about the states of the populations of *Nephrops* in the various FUs in both Division IIIa and Division IV relied on three main approaches:

- For all FUs there was consideration of basic fishery data such as catch, landings and effort
- For most FUs, attention was paid to length composition data and length distributions were included as well as the mean size information used in previous years. The additional information afforded by looking at the tails of length distributions and in comparison to MLS was beneficial.

- For FUs where a reasonable time-series of UTV data is available, this was used as the principle indicator of stock condition.

Providing catch advice

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

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

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

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

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

The Study Group WKNEPH 2006 concluded that notwithstanding the need for further developmental work, the approach offered a useful way forward (ICES WKNEPH 2006) and both WGNSSK and WGNSSD adopted the approach in their 2006 catch advice for *Nephrops* in IV and VI respectively. In developing its advice, ACFM again took the view that landings should inform the harvest rate and subsequently STECF was asked to examine whether this was reliable. STECF reiterated its 2005 advice.

The methodology for providing catch advice using a target harvest rate approach is developing and its suitability under various population circumstances is being investigated. WKNEPHTV 2007 examined some of the issues affecting the process including: the potential for different exploitation rates on the two sexes; differences in burrow emergence patterns in relation to reproductive behaviour resulting in lower exploitation of the female component of some stocks; the effect of assumptions about the size range of counted burrow compared to the size ranges in catches used to generate an 'abundance to weight' conversion. Aspects of the WKNEPHTV report were considered by ICES' reviewers. Their main conclusions were: i) at a harvest rate of 20%, actual fishing mortality might be less precautionary than assumed (between $F_{0.1}$ and F_{max} rather than at $F_{0.1}$) if biomass was biased upwards; ii) that the approach does not use all available information and that other indicators based on length compositions should be used; iii) that uncertainties in the process may be accumulated; iv) that an indicator approach could complement the method by adapting a TAC in the light of indicator trends; v) that ongoing developments will reduce uncertainties in the process

WGNSSK notes that the first conclusion is most likely to be relevant if $F_{0.1}$ is always as high as 20%, sometimes lower values are estimated. It is also the case that the WG already uses a number of indicators and time trends in making its judgements about stocks and adjusts the approach to TAC advice in the light of this. More caution (and harvest rates lower than $F_{0.1}$ or 20%) is already advised where information is limited – for example 10% at the Fladen Ground. Suggestions for developments of more adaptive approaches are welcome but WGNSSK considers that the benchmark meetings in 2009 are the appropriate place to investigate these. WGNSSK agrees that current developments should reduce uncertainties in the estimates – for the present, however, it is by no means clear that the balance of uncertainties is giving rise to overestimated stock biomass as the reviewers appear to imply.

Further work incorporating variable recruitment in a simulated age based approach was presented at the ICES ASC (Dobby et al 2007). Results indicate that if there are serious errors in the assumptions made about the youngest age of *Nephrops* comprising the burrow count compared with the age in catches, then biomass estimates will be in error and there is the potential for harvest rates to produce higher mortality than expected. Simulations also suggest however, that a harvest rate of 20% by number applied to counts of burrows assumed to comprise 2+ individuals (the most likely situation based on present knowledge) is sustainable even if the catch age composition is not the same as that in the population.

Given the variable types and quality of information available for different FUs, the Working Group agreed that several different approaches for providing advice on future catches should be used:

- Status quo advice essentially reiterating the ACFM advice of the previous year
- An average of recent landings, for FUs where landings data arre the only source of information. Progress to a more satisfactory method should be encouraged.

- Catches based on harvest rates applied to TV abundance estimates (where available), using $F_{0.1}$ as a sustainable option or lower value where other stock indicators or lack of knowledge about population dynamics suggest a more cautious approach is required.

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

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

Medium-term projections were again not conducted. WGNEPH has previously expressed concerns over the appropriateness of such approaches for *Nephrops*, where stock recruit relationships are poorly understood, and WGNSDS had further concerns over the required age structured assessment.

General recommendations on the management of *Nephrops*

WGNEPH and subsequent assessment WG dealing with *Nephrops* have recommended that this species is more appropriately managed at the Functional Unit level. The distribution of the species in discrete populations of varying sizes often with different biological characteristics and population dynamics implied that a global approach carries a risk that inappropriate exploitation rates will occur in some areas. Two particular problems can arise a) inappropriately high effort diverts to a Functional Unit giving rise to higher fishing mortality than the catch advice implies – a stock sustainability issue b) rapid uptake of catch from a number of Functional Units in a global TAC area leads to closure of the overall fishery before legitimate catches can be taken in the remaining Functional Units – a local fishery issue. The WG draws attention to an example of this in the Farn Deeps where effort in 2006 was very high and may be responsible for the apparent drop in the stock.

3.2 *NEPHROPS* IN Division IIIa

3.2.1 *Nephrops* in Division IIIa

Official landings supplied to ICES for Division IIIa are shown in Table 3.2.1.3.

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

3.2.1.1 General

3.2.1.1.1 Ecosystem aspects

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

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

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

3.2.1.1.2 Functional units and their fisheries.

Denmark

The restrictions in the fisheries for especially cod seem to have resulted in some significant changes in the Danish fisheries for *Nephrops*. Traditionally, *Nephrops* have mainly been caught in trawls using 70–89 mm mesh sizes. In the last five years an increasing proportion of total landings of *Nephrops* have been caught by vessels using gears with mesh sizes >89 mm (which previously have been used in the fishery for cod, plaice and other demersal fish species). In Skagerrak and Kattegat it is since 2005 not allowed to use mesh sizes between 70–89 mm unless the codend and the extension piece is constructed of square meshed netting with a sorting grid (Council Regulation 27/2005).According to Council Regulation 51/2006 there is unlimited days when using this species selective trawl.

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

A new national management system was introduced in Denmark from the 1st of January 2007, see Sect. 14. In this new, rather complex, fishing rights system (FKA, 'vessel quota share') each fisher is allocated an annual share of the national quota, which he can dispose of in a much more flexible way than previously. He may now trade his share, exchange it or pool it with other fishers share within the frames of the other regulations, e.g. total effort (fishing days) and national quotas and/or closed seasons.

The sharp increase in LPUE observed for the Danish vessels both in IIIa and in the North Sea, mainly in the Norwegian Deep, may to some extent be explained as a consequence of the regulation system.

- One would expect that the shares targeting *Nephrops* gradually will be concentrated among the more skilled *Nephrops* fishers.

- The fishers targeting *Nephrops* will optimise (minimise) their use of effort in catching their share of the FKA.

One consequence of this new system is a more efficient use of the effort by the skilled fishers, which again renders the use of logbook recorded effort data even more problematic when using the data for tuning assessment models or for instance LPUEs directly as indicators of stock fluctuations for *Nephrops* stocks,

Sweden

The specialised Swedish *Nephrops* trawler (catching >3t/yr) shows a decrease in number during 2000 to 2004 (123 to 83 trawler) and an increase the last three years. The increase is mainly due to an increase of trawlers catching >10 t/yr (from 18 in 2004 to 52 in 2007) (see Figure 3.2.1.6). In 2007, mean length was 14 m (ranging from 8 to 26 m) and GRT of 43 (3 to 161)

Since 2004, new technical regulations were introduced for Swedish national waters in both FU 3 and FU 4. As Sweden has bilateral agreements with Denmark and Norway to fish inside the 12 NM limit, the regulations cover only waters exclusively fished by Swedish vessels (inside 3 NM in Kattegat and 4 NM in Skagerrak). The new regulations imply that it is mandatory to use a 35 mm species selective grid and 8 meter of 70 mm full square mesh codend and extension piece when trawling for *Nephrops* on Swedish national waters. The Swedish *Nephrops* landings from MA IIIa by gear 1989–2007 is shown in Figure 3.2.1.7. Twin trawls were introduced in 1990 and the grid and square mesh trawls were legislated in Sweden during 2004 and show an increasing use since then. Approximately 75% of the Nephrops trawlers operating in IIIa used the grid at some time of the year during 2006 and 2007

A new coding of fishing gears in the Swedish log books has taken place since 2007 where the twin trawl code is phased out and the number of trawls of the new trawl codes should be registered. This mean that twin trawls in 2007 likely is included in other trawl categories that earlier was considered as single trawls. During 2007, 42% of the *Nephrops* trawl landings in IIIa was caught with this new trawl. In the Skagerrak 52% was caught with the grid trawl. In the first quarter of 2008 a new effort regulation was introduced in the Kattegat, meaning that a "day at sea" with out the grid equipped trawl was counted as 2.5 This has further increased the incentives to use the sorting grid to the point were 80% of all Kattegat *Nephrops* landings in the first quarter of 2008 were caught with sorting grids (compared to around 20% previous years).

The landings from the Swedish creel fishery show an increasing trend in recent years and comprise 26–28% of the Swedish Skagerrak landings in recent four years. The trends in effort and LPUE (g/creel) are shown in Figure 3.2.1.8 and show an increasing trend in effort during the last ten years and an increase in LPUE the most recent years..

Norway

In 2007, 245 boats (average length 13 m) in Skagerrak and the Norwegian Deep landed *Nephrops*, however, only 13 vessels had annual landings exceeding 4 t, and only 4 vessels had landings exceeding 10 t.

In Skagerrak *Nephrops* is fished all year round. Landings (2001–2007) are low in July in all years. The largest part of the catches is taken with trawl (*Nephrops* and shrimp trawls (as bycatch)). In 2001 a creel fishery started developing with landings constituting about 12% of total annual landings.

Nephrops recordings in Norwegian log books from Skagerrak are incomplete. In 2004–2006 logbook recorded catches constituted only 1% of the landings, but increased to 22% in 2007. Furthermore, records on the use of *Nephrops* trawl are lacking in the 2006 and 2007 logbooks. Norwegian trawlers fish in the whole Skagerrak. In 2007 the highest effort (hrs trawled) was allocated to the statistical location just west of Hirtshals, but it is impossible to know whether this is representative of the total catches. Catches from along the Norwegian coast are landed in Norway. Some catches are also landed in Sweden.

The following regulations apply: Fishing with mesh sizes down to 70 mm is legal, but requires square meshes in the cod end, and that the bycatch of other species should not exceed 70% of the total weight. The minimum legal size is 40 mm CL, but landings can none the less contain up to 10% animals (in weight) below the legal size. In Skagerrak in 2000–2005, 97% of *Nephrops* landings were taken by small-meshed trawls (<90 mm).

3.2.1.1.3 ICES Advice

In 2006 ICES concluded that:

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

and advised that:

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

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

3.2.1.1.4 Management for FU 3 and FU 4

The 2006, 2007and 2008 TAC for *Nephrops* in ICES area IIIa was set to 5170 tonnes. The minimum landings size for *Nephrops* in area IIIa is 40 mm carapace length.

Days at sea limits restrict *Nephrops* trawlers to 19 days per month when using 90 mm mesh with no square mesh panel, and 22 days with a square mesh panel. New gear regulations imply that it is mandatory to use a 35 mm species selective grid and 8 m of 70 mm full square mesh codend and extension piece when trawling for *Nephrops* in Swedish national waters. As Sweden has bilateral agreements with Denmark and Norway to fish inside the 12 nm limit, the regulations cover only waters exclusively fished by Swedish vessels (inside 3 nm in Kattegat and 4 nm in Skagerrak). Since 2006, days at sea is unlimited for this species selective trawl (Council Regulation 51/2006). The changes in the national Danish regulation system from 2007 are described in Sect. 3.1.2. 1.1.2 and Sect.14

3.2.1.2 The Skagerrak (FU3)

3.2.1.2.1 Data available

Landings

Denmark, Sweden and Norway exploit this FU. Denmark and Sweden dominate this fishery, with 60 % and 35 % by weight of the landings in 2007. Landings by the Swedish creel fishery represent 13-18 % of the total Swedish *Nephrops* landings from the Skagerrak in the period 1991 to 2002 and has increased to 26% in 2006 and 2007 (Table 3.2.1.4)

In the early 1980s, total *Nephrops* landings from the Skagerrak increased from around 1000 t to just over 2670 t. Since then they have been fluctuating around a mean of 2500 t (Figure 3.2.1.1)).

Length compositions

For the Skagerrak, size distributions of both the landings and discards are available from both Denmark and Sweden for 1991–2007. Of these, the Swedish data series can be considered as being the most complete, since sampling took place regularly throughout the time period and usually covered the whole year. In earlier years the Swedish discard samples were obtained by agreement with selected fishermen, and this might tempt fishermen to bias the samples. However, the reliability of the catch samplings is cross-checked by special discard sampling projects in both the Skagerrak and the Kattegat. In recent years the Swedish *Nephrops* sampling is carried out by onboard observers in 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. Due to increasing lack of resources the Danish at sea sampling in Skagerrak was at unsatisfactory low level in 2007, and for this year the length composition data for Skagerrak are based on Swedish samples only. The Norwegian *Nephrops* fishery is small and has not been sampled. Trends in mean size in catch and landings are shown in Figure 3.2.1.1) and Table 3.2.1.5. Mean sizes in landings, in both sexes are fluctuating without trend while there is a slightly decreasing trend for discards.

Maturity and natural mortality

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

Catch, effort and research vessel data

Effort data for the Swedish fleet are available from logbooks for 1978–2007 (Figure 3.2.1.1) with the last 18 years being separated into single and twin trawl (Table 3.2.1.6). From 2007 the new codes for gear categories make it difficult to distinguish between single and twin trawls (Sect. 3.2.1.1.2). The *Nephrops* single trawlers can be distinguished in the logbook records to target *Nephrops* during the whole period while the twin trawlers have shifted to target both fish and *Nephrops* in recent years. This shift has resulted in a decreasing trend in LPUE from 1998 to 2005 (see Figure 3.2.1.1)). In the most recent years LPUEs have increased for both gear types. The long term trend in LPUEs (an increase from 1992 to 1998, a decrease from 1999 to 2001 and a subsequent increase in the last 6 years) is similar in the Swedish and Danish fisheries. Total Swedish trawling effort shows a decreasing trend since 1992...

Figure 3.2.1.2. show the landings, effort and LPUEs by quarter and sex from Swedish single trawlers. Males are dominating the landings for all years, but females show a higher contribution to LPUE since 2000 compared to earlier years. The effort is usually

highest in 2nd and 3rd quarter. After a decline in LPUE for males in 2000 and 2001 an increasing trend is seen.

Danish effort figures for the Skagerrak (Table 3.2.1.7 and Figure 3.2.1.1)) were estimated from logbook data. For the whole period, it is assumed that effort is exerted mainly by vessels using twin trawls. The overall trend in effort for the Danish fleet is similar to that in the Swedish fishery. After having been at a relatively low level in 1994–97, effort did increase again in the next five years followed by a decrease in recent five years. Also the trend in LPUE is similar to that in the Swedish single trawl fishery, however with a much more marked increase in the Danish LPUE for 2007. This sharp increase may be partly a consequence of the new national (Danish) management system introduced in 2007 (see Sect. 3.2.1.1.2, Figure 3.2.1.4).

It has not been possible to incorporate 'technological creeping' in a further evaluation of the Danish effort data. However, use of twin trawls has been widespread for many years. The Danish logbook data have been analysed in various ways to elucidate the effect of some factors likely to influence the effort/LPUE (Figure 3.2.1.5):

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

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

Norwegian logbook records of *Nephrops* trawl are lacking for the last four years. Additionally, LPUE data for all trawl gears have covered 9% on the average of the Norwegian landings in the last 7 years. Norwegian data are therefore not included in the analysis.

3.2.1.3 The Kattegat (FU4)

3.2.1.3.1 Data available

Catch

Both Denmark and Sweden have *Nephrops* directed fisheries in the Kattegat. In 2007, Denmark accounted for about 71 % of total landings, while Sweden took remaining 29 % (Table 3.2.1.8). Minor landings are taken by Germany.

After the low that was observed in 1994, total *Nephrops* landings from the Kattegat increased again until 1998. Since then, they have fluctuated around 1500 t . Swedish landings increased in 2007 (Figure 3.2.1.6).

Length compositions

For the Kattegat, size distributions of both the landings and discards are available from Sweden for 1990–1992 and 2004–2007, and from Denmark for 1992–2007. The at-sea-sampling intensity has generally increased since 1999 (Section 2), but the Danish sampling decreased in 2007. Information on mean size is given in Table 3.2.1.9. Trends in mean size are shown in Figure 3.2.1.9 and after some years of small mean sizes 1993 to 1996 all categories are fluctuating without trend the last 11 years.

Maturity and natural mortality

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

Catch, effort and research vessel data

Swedish total effort, adjusted to single trawl effort, has been relatively stable over the period 1978–90. An increase is noted in 1993 and 1994, followed by a decrease to 1996, and a stabilisation at intermediate levels in the past years (Figure 3.2.1.6 and Table 3.2.10)). Figures for total Danish effort are based on logbook records since 1987. Danish effort increased during 1995 to 2001, but since then it has been showing a decreasing trend until 2007 (Figure 3.2.1.9 and Table 3.2.1.11)).

It has not been possible to incorporate 'technological creep' in a further evaluation of the Danish effort data. However, use of twin trawls has been widespread for many years. The Danish logbook data have been analysed in various ways to elucidate the effect of some factors likely to influence the effort/LPUE (Figure 3.2.1.10):

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

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

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

3.2.1.4 Combined assessment (FU 3&4)

3.2.1.4.1 Data Analysis

Reviews of last year's assessment

Last review of this assessment (2006) was:

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

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

Exploratory assessment

No analytical assessment is presented for this stock.

The assessment of the state of the *Nephrops* stocks in the Skagerrak and Kattegat area is based on the patterns in fluctuations of total combined LPUE by Denmark and Sweden during the period 1990−2007 and the patterns in fluctuations of discards in the fisheries as estimated from the catch samples for the same period.

In 2006 and 2007 a Danish UWTV survey has been established and a first data set for 2007 is available (Table 3.2.1.12, Figures 3.2.1.12 and 3.2.3.13). However, since the 2007 data only covers a small area in the northern Kattegat. They are not considered sufficient to cover neither FU 4 nor the entire IIIa. In 2008 the survey is expected to cover a larger area and the data may then be in the 2009 assessment. Furthermore, from 2009 Sweden is expected to participate in a joint UWTV survey covering also Skagerrak.

The densities found from the 2007 survey are of similar magnitudes as the ones found in other *Nephrops* grounds covered by UWTVs.

Exploratory analyses of catch data

Combined relative effort declined slightly over the period 1990 to 2007 (Figure 3.2.1.14) while combined relative LPUE has increased over the last five years and is at present at the highest level (Figure 3.1.1.10). Changes in LPUE may reflect changes in stock size, catchability but also consequences of changes in management system. High LPUEs attributable to sudden changes in catchability (caused by e.g. poor oxygen conditions) are generally of short duration. The WG assumes that the fluctuations in LPUE from 1992 to 2006 to a large extent reflect similar fluctuations in stock size. The sharp increase in LPUE for 2007 seen in the Danish trawl fishery is probably to some extent explained by the change in new Danish management system as described in Section 3.2.1.1.2 However, an increase is also seen in the Swedish trawl LPUEs as well as in the Swedish creel LPUEs.

Since the abundance of *Nephrops* discards (mainly small specimens below minimum landing size) may also be regarded as an index of recruitment, they can be used to further explain the current developments in the stocks. The large amounts of discards in the periods 1993−95 and 1999−2000 reflect strong recruitment during these years (Figure 3.2.1.16). The high levels of recruitment in 1993−95 are believed to have significantly contributed to the high LPUE in 1998−99. The high amount of discards observed in 2007 would then indicate high recruitment in this year.

Conclusions drawn from exploratory analyses

The combined logbook recorded effort has decreased since 2002 and is currently at a low level while LPUE shows an increasing trend in recent years (Figures 3.2.1.14 and 3.2.1.15). Mean sizes are fluctuating without trend. There are no signs of overexploitation in IIIa.

Discards are known to be very high and any improvement of the fishing pattern of the catches would benefit the stock and medium-term yield. (Figure 3.2.1.17).

3.2.1.4.2 Biological reference points

No biological reference points are used for this stock.

3.2.1.4.3 Quality of the assessment

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

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

3.2.1.4.4 Status of the Stock

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

3.3 Division IIIa *Nephrops* Management Considerations

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 are treated as one single 'stock' in the assessment.

The combined logbook recorded effort has decreased since 2002 and is currently at a low level while LPUE shows an increasing trend in recent years (Figures 3.2.1.14 and 3.2.1.15). Mean sizes are fluctuating without trend. There are no signs of overexploitation in IIIa.

Given the apparent stability of the stock, the WG concludes that current levels of exploitation appear to be sustainable.

The high amount of discards observed in 2007 could indicate high recruitment in this year.

However, even if the nominal effort has decreased, it is probable that the effective effort has increased somewhat due to technological creeping. Moreover, the current Danish management system encourages the efficiency of the fishery concentrating effort to areas and periods with high catchability. In view of these factors the WG does not recommend any further increase in effective effort. The increases in TAC for 2006, 2007 and 2008, were not founded on any scientific bases.

Mixed fishery aspects

In view of the catch restrictions for cod and other demersal fish species in the North Sea and IIIa it should also be noted that if *Nephrops* fishing effort is allowed to increase, this may have implications for those stocks in mixed fisheries where *Nephrops* is targeted, unless species and size selectivity of the gears is improved (see above). Cod and sole are significant bycatch species in these fisheries in IIIa, and even if data on catch including discards of the bycatch gradually become available, they have not yet been used in the management. The WG has for many years recommended the use of species selective grids in the fisheries targeting *Nephrops* as legislated for Swedish national waters. The current effort regulation (days at sea) in IIIa may increase the incentives to use the sorting grid as this gear is not subject to the otherwise restrictive effort limitations in force.

3.4 *Nephrops* in Subarea IV

Subarea IV contains eight FUs 5, 6, 7, 8, 9, 10, 32, and 33. Management is applied at the scale of ICES Subarea through the use of a TAC and an effort regime.

Management at ICES Subarea Level

The 2007 EC TAC for *Nephrops* in ICES area IV was 26144 tonnes in EC waters and 1300 tonnes in Norwegian waters). In 2008 the TACs were the same.

The TAC outcome for 2007 in EU waters differs from the 2006 ICES advice. ACFM suggested that harvest rates at 15% were consistent with maintaining effort at the present level. This judgement was, however, founded on the time series of reported landings (essentially by adopting the harvest rate which delivered future landings closest to the present ones). Both the WGNSSK and ACFM 2005 reports draw attention to the likelihood of misreporting in these fisheries and it therefore cannot be concluded that harvest rates at this level are a proxy for recent effort. STECF reiterated their 2005 advice that a harvest rate based on a fishing mortality rate equivalent to $F_{0.1}$ from a yield per recruit curve was likely to be sustainable providing that fishing effort was controlled and providing Nephrops were managed at the Functional Unit level.

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

Days at sea limits apply to *Nephrops* trawlers when using mesh sizes 70–99 mm and in 2008, under the Conservation Credits scheme the number of days available to Scottish vessels is the same as for 2007. EU catch composition regulations apply to *Nephrops* trawlers.

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

Under EU legislation, a maximum of 120 meshes round the cod-end circumference is permissible for all mesh sizes less than 90 mm. 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 100 mm in the north Sea south of 57°30’N.

The Conservation Credits scheme introduced in Scotland requires smaller meshed vessels targetting Nephrops to use a 110 mm square mesh panel.

Official catch statistics for Division IV are presented in Table 3.4.1.1 and a summary of landings by Country is shown in Table 3.4.1.2 and by Functional Units (including from the ‘other rectangles in Sub Area IV not contained within Functional Units) is given in Table 3.4.1.3.

3.4.1 Moray Firth FU9

3.4.1.1 General

3.4.1.1.1 Ecosystem aspects

The Moray Firth is located to the north west of Division IV. In common with other *Nephrops* fisheries the bounds of the Functional Unit are defined by the limits of muddy substrate. The major *Nephrops* fisheries within this management area fall within 30 miles of the UK coast. The Moray Firth (FU9) is a relatively sheltered inshore area that supports populations of juvenile pelagic fish and relatively high densities of squid at certain times.

3.4.1.1.2 The Fishery in 2006 and 2007

FU 9 Moray Firth landings are shown in Table 3.4.1.4

The general situation in the Moray Firth is similar to previous years. The area is fished by a number of the smaller class of *Nephrops* boat (12–16 m) regularly fishing short trips from Buckie, Helmsdale, Macduff and Burghead. Most boats still fish out of Burghead, and are about 15 in number; leaving and returning to port within 24 hours (day boats). Many of the smaller boats are now only manned by one or two people. Several of the larger *Nephrops* trawlers fish the outer Moray Firth grounds on their way to or from the Fladen grounds (especially when they are fishing the Skate Hole area). Also in times of bad weather many of the larger *Nephrops* trawlers which would normally be fishing the Fladen grounds fish the Moray Firth grounds. In recent years a squid fishery has been seasonally important in the Moray Firth. Squid appear to the east of the Firth and gradually move west during the summer, increasing in size as they shift. During the autumn the movement is reversed. A large fishery took place in 2004 that attracted a number of *Nephrops* vessels and in 2005, additional vessels joined in the seasonal fishery, but catches were noticeably down in 2006. In 2007 however the fishery for squid improved again and a number of boats switched effort until around October, with some boats fishing squid until December.

3.4.1.1.3 ICES Advice in 2006

In 2006 ICES concluded that

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

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

and advised that

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

ACFM also provided a table of harvest rate options.

3.4.1.1.4 Management

TAC and effort management affecting this Functional Unit takes place at the ICES Division level as described at the beginning of Section 1.2.

In addition to the EU management measures, a number of UK measures apply. In addition to the ones outlined at the beginning of Section 1.2, part of the Moray Firth is designated as a Special Area of Conservation for the protection of a population of bottle-nosed dolphins which are periodically resident in the area.

3.4.1.2 Assessment

3.4.1.2.1 Data available

Catch

Landings from this Functional Unit are predominantly reported from Scotland, with very small contributions from England in the mid 1990s and are presented in Table 3.4.1.4, together with a breakdown by gear type. The long term landings trends are shown in Figure 3.4.1.1. 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 2005 to 2007 for this stock were about 10% by number, or 5% by weight. This represents a reduction in discarding rate compared to the average for the period 2003 to 2005 presented in 2006. It is likely that some *Nephrops* survive the discarding process; an estimate of 25% survival was adopted by WGNEPH in order to calculate removals (landings + dead discards) from the population.

Length compositions

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

Figure 3.4.1.2 shows a series of annual length compositions raised to fleet landings for the period 1996 to 2007. Catch (removals) and landings length compositions are shown for each sex with the mean catch and landings lengths shown in relation to MLS and 35 mm. In both sexes there has been a tendency for the mean sizes to increase over time, although this seems to have levelled out over the past three years. Examination of the tails of the distributions above 35 mm shows no evidence of reductions in relative numbers of larger animals.

The observation of relatively stable length compositions is further confirmed in the series of mean sizes of larger *Nephrops* (>35 mm) shown in Figure 3.4.1.1 and Table 3.4.1.5. This parameter might be expected to reduce in size if overexploitation were taking place but has in fact shown a slight increase since 1996, which has now levelled off.

Figure 3.4.1.3 shows the average length composition for 2005−2007 divided into landed and discard components

Natural mortality, maturity at age and other biological parameters

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

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

Growth parameters:

Males; L_∞ = 62 mm, k = 0.165

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

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

Weight length parameters:

Males a = 0.00028, b = 3.24

Females a= 0.00074, b = 2.91

Catch, effort and research vessel data

Data collation procedures for the Commercial CPUE and research-vessel survey data series are described in the Stock Annex (Sections B.3 and B.4).

LPUE data were available for Scottish *Nephrops* trawls. Table 3.4.1.6 shows the data for single trawls, multiple trawls and combined. Examination of the long term commercial LPUE data (Figure 3.4.1.4) suggests that the stock increased in the mid- 1980s, declined to a stable level over the next 12 years or so and has recently increased to its highest level in 2007. It is thought that gear efficiency changes have occurred over time, particularly in relation to multiple trawl gears but this has not been quantified. Concerns over the quality of landings and effort information mean that care is required in placing undue reliance on these trends.

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

CPUE data for each sex, above and below 35 mm CL, are shown in Figure 3.4.1.5. This size was chosen for all the Scottish stocks examined as the general size limit for discarded animals. The data show a slight peak in CPUE for smaller individuals (both sexes) in 1995, with a slight decline after this and relatively stable values from 2001 onwards. There is a peak in catches of small males in 2006 quarter 4 but taken annually the pattern is relatively stable. The CPUE for larger males shows relatively stable levels during the late 1990s, and slightly higher levels in the most recent years, particularly from 2003 onwards. CPUE for large females declined in 2005 but have risen again over the past two years, and showed a significant large value in 2007 quarter 3. Taken with mean size information above, the latter observation supports the view that exploitation has not had adverse effects on this stock.

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

The numbers of valid stations used in the final analysis in each year are shown in Table 3.4.1.8. On average, about 36 stations have been considered valid each year, and are raised to a stock area of 2195 km^2. General analysis methods for underwater TV survey data are similar for each of the Scottish surveys, and are described in Annex 2 of the *Nephrops* section.

3.4.1.2.2 Data analyses

Reviews of last year's assessment

The last assessment for *Nephrops* was conducted in 2006 and was based principally on the underwater television survey series, supported by presentation of basic fishery parameters and mean size information in catches and landings. The WG and ACFM considered the TV data as the best indicator of stock status. According to the survey, abundance increased in 2002 and remained relatively high until 2005. The review group commented on the better reliability of UK landings data since the introduction of regulations for buyers and sellers, but warned this may require treating the effort data as two separate time series.

Exploratory analyses of catch data

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

Exploratory analyses of survey data

Table 3.4.1.7 shows the basic analysis for the three most recent TV surveys conducted in FU 9 including the 2007 results. The table includes estimates of abundance and variability in each of the strata adopted in the stratified random approach. The ground is predominantly of coarser muddy sand and most of the variance in the survey is associated with a patchy area of this sediment to the west of the ground.

Figure 3.4.1.6 shows the distribution of stations in TV surveys, with the size of the symbol reflecting the *Nephrops* burrow density. Abundance has generally been higher towards the west of the ground but in recent years higher densities have been recorded throughout, and are quite evenly distributed at the east and west ends in 2006 and 2007. Table 3.4.1.8 and Figure 3.4.1.7 show the time series estimated abundance for the TV surveys, with 95% confidence intervals on annual estimates. With the exception of 2003, the confidence intervals have been fairly stable in this survey.

Final assessment

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

3.4.1.2.3 Historic Stock trends

The TV survey estimate of abundance for *Nephrops* in the Moray Firth suggests that the population has fluctuated between two levels of abundance over the time period of the survey – one of roughly 400 million animals and one of 700 million. In the most recent years there was a drop in abundance in 2006 to previous lower levels around the 400 million mark, followed by an increase in 2007 of approximately 100 million animals. It is worth nothing that in 2006 the UWTV survey was conducted in December in this area rather than June, when the other surveys in the series took place, and this may have had an effect on the 2006 abundance estimate.

3.4.1.2.4 Recruitment estimates

Recruitment estimates were not available for this stock.

3.4.1.2.5 Short-term forecasts

A catch prediction for 2009 was made for the Moray Firth Functional Unit using the approach outlined in the introductory section on *Nephrops*. In order to provide guidance on a sustainable harvest rate to use, combined sex Y/R calculations were made using an adapted version of LBA (developed by WGNEPH in the 1990s to perform Jones' length cohort analysis and Y/R prediction).

The text table below shows the $F_{0.1}$ and F_{max} obtained from the curve. The calculation has only been used to provide guidance on a sustainable harvest rate and no attempt is made to derive current F from these calculations owing to the tendency for length cohort analysis to overestimate current fishing mortality through variability in length at age in *Nephrops* leading to overlap of ages. The text table below shows the $F_{0.1}$ and F_{max} obtained.

Functional Unit	$F_{0.1}$	F_{max}
Moray Firth	0.24	0.71

The estimates of $F_{0.1}$ and F_{max} were included in the calculations of predicted landings using the approach outlined shown in Figure 3.4.1.9 diagrammatic. Average TV derived abundance values for 2005–2007 and average length compositions for the same period were used. A summary of the input length composition and the calculations made is given in Table 3.4.1.9. In addition to the harvest rates discussed above, predicted landings for arbitrary values of 15%, 20% and 25% have also been computed.

Harvest rate	Moray Firth
15%	2097.2
21.3% (F0.1 = 0.24)	3032.9
20%	2796.2
25%	3495.3
50.8% (Fmax=0.71)	7094.2

3.4.1.2.6 Medium -term forecasts

Medium term forecasts were not performed for this stock.

3.4.1.2.7 Biological Reference points

Biological reference points have not been defined for this stock.

3.4.1.2.8 Quality of assessment

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

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

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

The new TV survey data presented at the meeting extends the time series by 2 years. The abundance estimate shows a decrease in 2006 to an abundance typical of the late 1990s, followed by a slight recovery in 2007 to an abundance just above the long term average for the stock. (Figure 3.4.1.7).

3.4.1.2.9 Status of the stock

The evidence from the TV survey suggests that the population had been fluctuating around a long term average, and length composition data indicate the mean size has been stable over the sampling period, suggesting the current exploitation rate is sustainable.

3.4.1.3 Moray Firth FU9 Management considerations

The approach using a harvest rate equivalent to $F_{0.1}$ is considered by the Working Group to be sustainable for this stock. There is a small decrease in predicted catch compared to the 2006 estimate (3032 tonnes) in accordance with the fact the estimated average abundance (2005–2007) declined slightly. The removals by the fishery over this period implies harvest rates of between 10.4% and 18.3%, although unreliable landings early in the period mean these could be underestimates.

The WG, ACFM and STECF have repeatedly advised that management should be at a smaller scale than the ICES Division level. Management at the Functional Unit level could confer controls to ensure effort and catch were in line with resources available.

There is a bycatch of other species in the area of the Moray Firth. It is important that efforts are made to ensure that unwanted bycatch is kept to a minimum in this fishery. Current efforts to reduce discards and unwanted bycatches of cod under the Scottish Conservation credits scheme, include the implementation of larger meshed square meshed panels and real time closures to avoid cod.

3.4.2 Noup

3.4.2.1 Noup (FU 10)

3.4.2.2 General

3.4.2.2.1 Ecosystem aspects

The Noup is located to the far north west of Division IV adjacent to ICES VIa and closer to the influence of the west of Scotland waters. In common with other *Nephrops* fisheries the bounds of the Functional Unit are defined by the limits of muddy substrate. This small stock is one of the most isolated Functional Units. Particle tracking models suggest that plankton is transported from the west coast of Scotland and passes across this area.

3.4.2.2.2 The Fishery in 2006 and 2007

FU 10 Noup landings are shown in Table 3.4.1.3

The Noup grounds are regularly fished by 3–4 boats (16–24 m) from Scrabster. They mainly target a mixed fish (mainly flat fish and monkfish) and *Nephrops* fishery using 100 mm (twin-rig) to stay within the catch composition regulations. Boats land an average of around 1.5 tonnes of *Nephrops* from a 6–7 day trip. Occasionally some of the Fraserburgh *Nephrops* fleets fish the Noup grounds although this did not happen in 2005–2007, as many of the boats who used to make the journey have been decommissioned. The Noup ground has previously produced a period of good fishing every year but the area has not been important in the last couple, of years.

3.4.2.2.3 Advice

In 2006 ICES concluded that

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

b) Noup: The TV survey estimate of abundance for Nephrops in the Noup suggests that the population declined between the two surveys in 1994 and 1999, but unfortunately no recent data are available".

and advised that

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

ACFM also provided a table of harvest rate options.

3.4.2.3 Assessment

3.4.2.3.1 Data available

Catch

Landings from this fishery are solely reported from Scotland, and are presented in Table 3.4.1.10, together with a breakdown by gear type. Total international reported landings in 2006 was 133 tonnes and in 2007 was 155 tonnes, which represents a decline from the recent high value of 401 tonnes in 2002. Reported effort by Scottish *Nephrops* trawlers increased rapidly in the late 1980s and early 1990s, to a peak in 1994, and has shown a general decline since this date, levelling off in the past three years (Table 3.4.1.12 and Figure 3.4.11). Scottish *Nephrops* trawler LPUE has shown an increasing trend since the mid 1980s until 2005, after which point it drops in 2006 and again in 2007.

Length compositions

Given that the levels of market sampling are low and discard sampling is not available, the length structure of removals in the fishery is not considered to be well represented. Mean sizes of landings are shown in Table 3.4.1.11.

Natural mortality, maturity at age and other biological parameters

No data available

Catch, effort and research vessel data

The low levels of sampling for this fishery mean it is not realistic to draw conclusions from changes in size composition or sex ratio. Figures 3.4.1.12 and 3.4.1.13 show landings and effort, and LPUE data, respectively. Due to the very low levels of effort, small changes are likely to have very large effects and for this reason some data points in Figure 3.4.1.13 have been removed.

The available research-vessel survey data are described in the Stock Annex and tabulated in Table 3.4.1.13.

Figure 3.4.1.14 shows the distribution of stations in TV surveys, with the size of the symbol reflecting the *Nephrops* burrow density. Underwater TV surveys are available for this stock in 1994 and 1999 and were also carried out in 2006 and 2007, where 7 and 9 stations were successfully surveyed in each year respectively. These 2 most recent surveys give consistent estimates of population size which are slightly lower than the 1999 value. All of these are lower than the very high value observed in 1994.

3.4.2.3.2 Data analyses

Reviews of last year's assessment

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

Exploratory analyses of catch data

Exploratory analyses of survey data

General analysis methods for underwater TV survey data are similar for each of the Scottish surveys, and are described in Annex 2 of the *Nephrops* section. The numbers of valid stations used in the final analysis in each year are shown in Table 3.4.1.13, and are raised to a stock area of 339 km².

Final assessment

No assessment is presented for this stock

Comparison with last years assessment

3.4.2.3.3 Historic Stock trends

The TV survey estimate of abundance for *Nephrops* in the Noup suggests that the population declined between the two surveys in 1994 and 1999, and remains at a lower level. Landings have fluctuated between 200 and 400 tonnes between 1995 and 2005, and were in the region of 100 to 200 tonnes in 2006 and 2007, showing no long term trend.

3.4.2.3.4 Recruitment estimates

Recruitment estimates are not available for this stock

3.4.2.3.5 Short-term forecasts

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

3.4.2.3.6 Medium -term forecasts

There were no medium term forecasts for this stock

3.4.2.3.7 Biological Reference points

Biological reference points have not been defined for this stock

3.4.2.3.8 Quality of assessment

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

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.

3.4.2.3.9 Status of the stock

There is only limited information available for this stock but indications from LPUE of increased abundance suggest the stock is being fished sustainably.

3.4.2.4 Noup FU10 Management considerations

Little information is available for the Noup stock although surveys are now being carried out on a more regular basis which should provide a time-series for further analysis.

The Working Group proposes that the previous catch advice is appropriate.

The WG, ACFM and STECF have repeatedly advised that management should be at a smaller scale than the ICES Division level. Management at the Functional Unit level could confer controls to ensure effort and catch were in line with resources available.

There is a bycatch of other species in the area of the Moray Firth. It is important that efforts are made to ensure that unwanted bycatch is kept to a minimum in this fishery. Current efforts to reduce discards and unwanted bycatches of cod under the Scottish Conservation credits scheme, include the implementation of larger meshed square meshed panels and real time closures to avoid cod.

3.4.3 Fladen Ground (FU7)

3.4.3.1 General

3.4.3.1.1 Ecosystem aspects

The Fladen Ground is located towards the centre of the northern part of Division IV. Its eastern boundary is adjacent to the Norwegian Deeps area. The ground represents one of the largest areas of soft muddy sediments in the North Sea and there are wide variations in sediment composition across the ground. *Nephrops* is distributed throughout the area and is associated with various benthic communities reflecting the variations in physical environment.

A density driven gyre centred on the ground influences the hydrographic features of the area. The gyre relies on persistent cold dense bottom water and sustained periods of these conditions may affect *Nephrops* growth and other biological features.

The abundance of fish is currently higher in this area than in a number of the inshore grounds close to the Scottish coast, particularly towards the north of the ground.

3.4.3.1.2 The Fishery in 2006 and 2007

General information on the fishery can be found in the Stock Annex. The Fladen fishery (FU7), the largest Scottish *Nephrops* fishery, takes a mixed catch mainly of haddock, whiting, cod, monkfish and flatfish such as megrim, making an important contribution to vessel earnings. The Fladen *Nephrops* fleet comprises vessels from 12 m up to 35 m fishing mainly with 80 mm twin-rig. The fleet has a diverse range of boats, and includes some of the largest most modern purpose built boats in the Scottish fleet and vessels which have recently converted to *Nephrops* fishing.

The area supports well over 100 vessels and the majority of the fleet (80%) fish out of Fraserburgh, with the other important ports being Peterhead, Buckie, Macduff, and Aberdeen. Boats fish varying lengths of trip between 3 days (small boats) and 8–9 day trips (larger vessels). During 2006 and 2007 around 20 vessels joined the fleet and 5 on-going new boat builds have the capability to fish at Fladen. Some whitefish vessels have converted to *Nephrops* twin-rigging. Important developments that have mitigated effort increases to some extent are the number of larger boats taking up oil guard vessel duties in 2007 and the high oil prices during the latter part of 2007 and into 2008 which have curtailed some activity.

The Fladen fishery generally follows a similar pattern every year, with different areas of the Fladen grounds producing good fishing at different times of the year (boats fish the north of the ground in winter, then move east towards the sector line in the summer. During 2004–5 there was less of this seasonal pattern with fishing being good throughout the year on a range of grounds. There was also no lull in catch rates which traditionally happens in April-May. In 2006 however, there was a return to a more normal pattern of fishing with catches poor for most of the spring and slowly getting better throughout the summer. Some participating vessels explored slightly different areas to fish in 2006, particularly on the eastern edge of the ground. Bad weather at the start of 2006 and part of 2007 also contributed to the slower start to the fishery in recent years. In some years, high squid abundance in the Moray Firth attracts Fladen vessels but in the last two years this was not so evident compared to 2005.

Other developments include the capability of freezing at sea and in one case, processing at sea. A recent tendency towards shorter trip lengths and improved handling practice is associated with market demand for high quality which appears to have increased dramatically. The implementation of buyers and sellers legislation in 2006 has reduced the problem of underreporting and prices have risen, while weighing at sea has improved the accuracy of reported landings.

3.4.3.1.3 Advice in 2006

In 2006 ICES concluded that

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

and advised that

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

ICES did not provide new advice for this FU in 2007

3.4.3.1.4 Management

Management is at the ICES Sub Area level as described at the beginning of Section 1.2 and for 2007 and 2008 was based on advice from STECF in 2006.

3.4.3.2 Assessment

An update assessment was performed using the same approach used by the 2006 WGNSSK.

3.4.3.2.1 Data available

Catch

Landings from this fishery are predominantly reported from Scotland, with small contributions from Denmark and others, and are presented in Table 3.4.2.2, together with a breakdown by gear type. Total international reported landings in 2007 was 11907 tonnes, consisting of 11788 tonnes landed by Scotland and 119 tonnes landed by Denmark. Reported effort by all Scottish *Nephrops* trawlers showed an increasing trend up to 2002, but dropped sharply in 2003 apparently as a result of reduced twin trawl effort (Table 3.4.2.4 and Figure 3.4.2.1). Since then it has increased again slightly. Scottish *Nephrops* trawler LPUE fluctuates around a relatively high level, with a considerable increase from 2003 onwards that has been maintained. The interpretation of this increase is complex but is partly because of a sustained improvement in the quality of reporting of landings in recent years. Danish LPUE data also show a marked increase in recent years (Table 3.4.2.5).

Discarding of undersized and unwanted *Nephrops* occurs in this fishery, and quarterly discard sampling has been conducted on the Scottish *Nephrops* trawler fleet since 2000. Discarding rates averaged over the period 2005 to 2007 for this stock were about 18% by number, or 11% by weight. This represents an increase on the discarding rate observed for the 2003 to 2005 period. It is likely that some *Nephrops* survive the discarding process, an estimate of 25% survival is assumed in order to calculate removals (landings + dead discards) from the population.

Length compositions

Length compositions of landings and discards are obtained during monthly market sampling and quarterly on-board observer sampling respectively. Levels of sampling have increased since 2000 and are considered good for providing representative length structure of removals at the Fladen Ground. Although assessments based on detailed catch analysis are not presently possible, examination of length compositions can provide a preliminary indication of exploitation effects.

Figure 3.4.2.2 shows a series of annual length compositions raised to fleet landings for the period 1990 to 2007. Catch (removals) length compositions are shown for each sex with the mean catch and landings lengths shown in relation to MLS and 35 mm. In both sexes the mean sizes have been fairly stable over time and examination of the tails of the distributions above 35 mm shows no evidence of reductions in relative numbers of larger animals.

The observation of relatively stable length compositions is further confirmed in the series of mean sizes of larger *Nephrops* (>35 mm) shown in Figure 3.4.2.1 and Table 3.4.2.3. This parameter might be expected to reduce in size if overexploitation were taking place but there is no evidence of this. The mean size of smaller animals (<35 mm) is also quite stable through time. The slight drop in the last couple of years may be associated with increased recruitment that has led to increased densities in this area (see below)

Figure 3.4.2.3 shows the average length composition for 2005−2007 divided into landed and discard components

In previous years the raised length compositions of removals were experimentally sliced using the WGNEPH program L2AGE into pseudo-age groups with associated weights at age−procedures are described in the Stock Annex. Owing to the concerns expressed at the 2005 meetings of WGNSDS and WGNSSK over the lack of knowledge on growth in this stock, the reliability of age structures derived from slicing and the short time series of more reliable landings statistics, slicing procedures have not been performed since then.

Natural mortality, maturity at age and other biological parameters

Dynamics for this stock are poorly understood and studies to estimate growth have not been carried out. Biological parameter values adopted from other areas are included in the Stock Annex. Parameters applied in a preliminary simple length based combined yield per recruit to inform the catch forecast process were as follows:

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

Growth parameters for age slicing are as follows:

Males; L_∞ = 66 mm, k = 0.16

Immature Females; L_∞ = 66 mm, k = 0.16

Mature Females; L_∞ = 56 mm, k = 0.10, Size at maturity = 25 mm

Weight length parameters:

Males a = 0.0003, b = 3.25

Females a= 0.00074, b = 2.91

Discard survival rate was assumed to be 25%.

Catch, effort and research vessel data

The collation of commercial CPUE and research-vessel survey data series are described in the Stock Annex for *Nephrops*.

LPUE and CPUE data were available for Scottish *Nephrops* trawls. Table 3.4.2.4 shows the data for single trawls, multiple trawls and combined. Examination of the long term commercial LPUE data (Figure 3.4.2.1) suggests that the stock rapidly increased since 2003. It is likely, however, that improved reporting of fishery data (landings and effort) in recent years particularly arising from 'buyers and sellers legislation has contributed to the increase. The high levels have been maintained since 2003.

Males consistently make the largest contribution to the landings and the LPUEs (Figure 3.4.2.4), although the sex ratio does vary. In earlier years effort was generally highest in the latter part of the year in this fishery, but the pattern varies between years, and the seasonal pattern does not appear as strong in recent years. LPUE of both sexes remained relatively constant up to 2002, and in common with the overall figure has shown a marked increase since then. This suggests that exploitation (or other external factors) are not disproportionately affecting one sex or the other. LPUE is fairly similar through the year for males but for females there is no consistent pattern in these data.

LPUE data for each sex, above and below 35 mm CL, are shown in Figure 3.4.2.5. This size was chosen for all the Scottish stocks examined as the size above which the effects of discarding practices were not expected to occur and the size below which recruitment events might be observed in the length composition. The data show a rise in LPUE for smaller individuals (both sexes) in recent years. The LPUE for larger individuals shows a rise during the late 1990s, and slightly higher levels in the most recent years. Notwithstanding the fact that size specific LPUE values are also influenced by changes in the quality of reporting, taken with mean size information above, the LPUE observations generally support the view that exploitation has not had adverse effects on this stock. There is, however, no apparent lag between the increased LPUEs of <35 mm animals and >35 mm animals which one might expect if the reason was increasing abundance. Danish effort and LPUE is shown in Table 3.4.2.5

TV surveys using a stratified random design are available for FU 7 since 1992 (missing survey in 1996). Underwater television surveys of *Nephrops* burrow number and distribution; reduce the problems associated with traditional trawl surveys that arise from variability in burrow emergence of *Nephrops*.

The numbers of valid stations used in the final analysis in each year are shown in Table 3.4.2.7. On average, about 60 stations have been considered valid each year with over 70 stations in the last three years. Data are raised to a stock area of 28153 km^2 based on the stratification. 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.

3.4.3.2.2 Data analyses

Review of previous assessment

The assessment in 2006 was based principally on the underwater television survey series, supported by presentation of basic fishery parameters and mean size information in catches and landings. The WG and ACFM considered the TV data as the best indicator of stock status. According to the survey, abundance increased in 2002 and declined to a low value in 2005.

Exploratory analyses of catch data

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

Exploratory analyses of survey data

Table 3.4.2.6 shows the basic analysis for the three most recent TV surveys conducted in FU 7 including the 2006 and 2007 results not previously reported. The table includes estimates of abundance and variability in each of the strata adopted in the stratified random approach. The ground has a range of mud types from soft silty clays to coarser sandy muds, the latter predominate. Most of the variance in the survey is associated with this variable sediment which surrounds the main centres of abundance.

Figure3.4.2.6 shows the distribution of stations in TV surveys, with the size of the symbol reflecting the *Nephrops* burrow density. Abundance is generally higher in the soft and intermediate sediments located to the centre and south east of the ground but in 2007, higher densities were also recorded in the more northerly parts of the ground. Table 3.4.2.7 and Figure 3.4.2.7 show the time series estimated abundance for the TV surveys, with 95% confidence intervals on annual estimates. In general the confidence intervals have been fairly stable in this survey.

Final assessment

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

The new TV survey data presented at the meeting extends the time series by 2 year. The abundance estimate shows that the stock has increased recently (Figure 3.4.2.7).

It should be noted that the area included in the survey (28153 $km^{2)}$ covers the main part of the ground but that areas to the north (amounting to a further 2400 km^2) are not surveyed. Overall abundance is expected to be higher than estimated here.

3.4.3.2.3 Historic Stock trends

The TV survey estimate of abundance for *Nephrops* in the Fladen suggests that the population has fluctuated without trend. The recent increase takes the stock to its highest estimated abundance in the time series.

3.4.3.2.4 Recruitment estimates

Recruitment estimates from surveys were not available for this stock. However the drop in mean size of small animals <35 mm is indicative of good recruitment.

3.4.3.2.5 Short-term forecasts

A catch prediction for 2009 was made for the Fladen Ground (FU7) using the approach outlined in the introductory section on *Nephrops*. Combined sex Y/R calculations were made using an adapted version of 'LBA' (developed by WGNEPH in the 1990s to perform Jones' length cohort analysis and Y/R prediction). The Y/R plot is shown in Figure 3.4.2.8 based on average length compositions of removals for 2005–2007. The text table below shows the $F_{0.1}$ and F_{max} obtained from the curve. The $F_{0.1}$ estimate is similar to other North Sea *Nephrops* stocks for which these calculations were made, driven by the input parameters (see Stock Annex) which are similar for these stocks. The calculation has only been used to provide guidance on a sustainable harvest rate and no attempt is made to derive current F from these calculations owing to the tendency for length cohort analysis to overestimate current fishing mortality through variability in length at age in *Nephrops* leading to overlap of ages.

Functional Unit	$F_{0.1}$	F_{max}
Fladen Ground	0.18	0.33

The estimates of $F_{0.1}$ and F_{max} were included in the calculations using the approach outlined in Figure 3.4.1.9. Average TV derived abundance values for 2005–2007 and the average length compositions used in the Y/R were used in the calculations. A summary of the input length composition and the calculations made is given in Table 3.4.2.8.

The previous Working Group and STECF (2006) detailed a number of factors which suggest that for this stock a more cautious approach is required until information improves. The main concerns are as follows: i) the stock exhibits a comparatively low density (number $m^{-2)}$ and the large stock size arises from its widespread distribution over a large area; ii) the biological data available for this stock on which the above yield curve calculations are based is limited; iii) The fishery is a comparatively recent one (developed mainly in the 1990s) and recruitment dynamics are less well known. The use of a target based on Y/R principles assumes that recruitment is fairly constant, but this is not known for the Fladen so a more cautious target may be appropriate.

Predicted landings for arbitrary values of 10%, 15%, 20% and 25% have been computed in addition to the harvest rates discussed above and are shown in the text table provides a summary (all tonnes) for the Functional Unit.

Harvest rate	Fladen Gound
10%	15865
15%	23797
16.5% (F0.1 = 0.18)	26187

20%	31730
25%	39662
28.0% (Fmax=0.33)	45103

The Working Group considered carefully an appropriate harvest rate for this stock. The estimate of $F_{0.1}$ is quite low and use of this as a guide to the harvest rate appears to represent a sustainable approach for most stocks. Nevertheless, for the reasons given above, the WG considers that a recommendation for a more cautious harvest rate would again be prudent. The 2006 WG proposed a harvest rate of 10% which was also recommended by STECF (2006) as a cautious approach for this stock. This rate is well below the harvest rates examined in Dobby et al (2007) which appeared to be sustainable in studies of simulated *Nephrops* populations. Adopting a more cautious approach is also in line with comments made by the reviewers of WKNEPHTV report who suggested that adopted harvest rates may imply somewhat higher fishing mortalities than expected.

3.4.3.2.6 Medium –term forecasts

Medium term forecasts were not performed for this stock.

3.4.3.2.7 Biological Reference points

Biological reference points have not been defined for this stock.

3.4.3.2.8 Quality of assessment

The length and sex composition of the landings data is considered to be well sampled. Discard sampling has been conducted on a quarterly basis for Scottish *Nephrops* trawlers in this fishery since 2000, and is considered to represent the fishery adequately.

The quality of landings and effort data has improved in the last two years but because of concerns over the accuracy of earlier years, the final assessment adopted is independent of official statistics.

Underwater TV surveys have been conducted for this stock since 1992, with a continual annual series available since 1997. The number of valid stations in the survey has remained relatively stable throughout the time period, with more stations in the last couple of years. . Confidence intervals are relatively small.

The trends in abundance observed in the TV survey data have not been reflected in LPUE data. This may be for a number of reasons including the short time series of discard data, spatial changes in the fishery or inaccuracies in landings data in earlier years.

NSCFP stock survey trends are shown in Figure 3.5.1. The areas which correspond to the Fladen Ground Functional Unit shows an increase in *Nephrops* between 2001 and 2002, a slight decrease to 2003, and a marked increase since this date. Results for 2007 are the highest in the series. This is similar to the recent results for 2007 from the TV survey.

3.4.3.2.9 Status of the stock

TV observations suggest the stock is fluctuating without obvious trend with estimates for the last 2 years increasing to the highest abundance in the series. Considering the TV result alongside the indications of stable or slightly increasing mean sizes in the length compositions (particularly larger sizes >35 mm CL) suggests that the stock is being exploited sustainably. Recent recruitment appears to have been good.

3.4.3.3 Management considerations

TV survey estimates of abundance for *Nephrops* on the Fladen Ground indicate that the stock has fluctuated without trend since 1992. Stock abundance rose in 2006 and 2007 to reach the highest estimated in the time series. Indicators of stock status based on size composition show a stable situation and the size range has not decreased through time. The mean size of *Nephrops* >35 mm carapace length (CL) has fluctuated slightly without trend while for *Nephrops* <35 mm CL the slight decline in the last couple of years is probably associated with increased recruitment that has led to increased abundance.

A harvest rate approach based on UWTV survey abundance is considered appropriate for deriving a catch for this stock, factors discussed in the forecast section suggest that a more cautious harvest rate than the $F_{0.1}$ based approach (equivalent to 16.5% for this stock) is required until information improves. A 10% harvest rate gives rise to landings in 2009 of 15865 tonnes

The TV survey is currently conducted over the main part of the ground representing an area of around 28 200 km^2 of suitable mud substrate (the largest ground in Europe). The Fladen Ground Functional Unit contains several patches of mud to the north of the ground which take the overall area of substrate to 30633 km^2–this area is not presently surveyed but would add to the abundance estimate.

The implementation of buyers and sellers legislation in the UK in 2006 is improving the reliability of fishery statistics but the transition period is accompanied in some cases by large changes in landings which produce significant changes in the LPUE and CPUE series that cannot be completely attributed to changes in stock. Until a sufficient time series of reliable data has built up, use of fishery catch and effort data in the assessment process should be avoided.

The WG, ACFM and STECF have repeatedly advised that management should be at a smaller scale than the ICES Division level and management at the Functional Unit level could provide the controls to ensure that catch opportunities and effort were compatible and in line with the scale of the resource.

In 2005, high abundance of 0 group cod was recorded in Scottish surveys near to this ground. This year class of cod has subsequently contributed to slightly improved cod stock biomass and efforts are being made to avoid the capture of cod so that the stock can build further. The Scottish industry is operating under a Conservation Credits scheme and has implemented improved selectivity measures in gears which target *Nephrops* and real time closures with a view to reducing unwanted bycatch of cod and other species. Given that the year class is now three years old, and the cod are growing quite large, additional gear related measures will require substantial improvements in selectivity or will require species selection devices to remove cod from catches.

3.4.4 Norwegian Deeps

3.4.4.1 General

3.4.4.1.1 Ecosystem aspects.

Sediment maps for the Norwegian Deep indicate that the area of suitable sediment for *Nephrops* is larger than the current extent of the fishery, and there may be possibilities of expansion into new grounds on which *Nephrops* is not currently exploited.

3.4.4.1.2 Norwegian Deep (FU 32) fisheries

Traditionally, Danish and Norwegian fisheries have exploited this stock, while exploitation by UK vessels has been insignificant. Since 2000, Sweden has landed small amounts. Denmark accounts for the majority of landings from this functional unit (Table 3.4.3.1).

Denmark

A description of the Danish *Nephrops* fisheries in Subareas IIIa and IV (including the one in the Norwegian Deep) was given in the 1999 WGNEPH report (ICES, WGNEPH 1999a). Due to changes in the management regime (mesh size regulations regarding target species) in the Norwegian zone of the northern North Sea in 2002, there was a switch to increasing Danish effort targeting *Nephrops* in the mixed fisheries in the Norwegian Deep. However, a distinction between the fishing effort directed at *Nephrops,* roundfish or anglerfish is not always clear. The mesh size in the trawls catching *Nephrops* is >100 mm

Norway

In 2007, 245 Norwegian vessels (average length 13 m) in Skagerrak and the Norwegian Deep landed *Nephrops*, however, only 13 vessels had annual landings exceeding 4 t, and only 4 vessels had landings exceeding 10 t. In the Norwegian Deep *Nephrops* is fished all year round. The Norwegian *Nephrops* fishery north of 60 °N (with 15–30% of the Norwegian FU 32 landings (2001–2007)) is mainly a creel fishery, with some landings also from *Nephrops* trawls, while the fishery south of 60 °N is mainly a trawl fishery (*Nephrops* trawls and bycatch from shrimp trawls).

Nephrops recordings in Norwegian log books from the Norwegian Deep are incomplete, with log book catches constituting 15–40% of the landings in 2001–2007. Furthermore, records on the use of *Nephrops* trawls are lacking in the 2006 and 2007 logbooks. In 2007 the highest effort (hrs trawled) was allocated to the statistical location just west of Egersund on the Norwegian west coast, but it is impossible to know whether this is representative of the total catches. Catches are landed in Norway and Denmark.

The minimum legal size is 40 mm CL. Trawls with mesh sizes down to 70 mm is legal, but requires square meshes in the cod end. There has been a change in the most commonly used mesh size. In 1999, 90% of the vessels used 70–80 mm trawls according to the logbooks. In 2000–2005 small-meshed trawls (70–80 mm) taking 17% of the *Nephrops* landings performed 22% of the trawling hours.

3.4.4.1.3 Advice in 2006

In 2006 ICES noted for this stock that the available information was inadequate to evaluate spawning stock or fishing mortality relative to risk. Furthermore, it was noted that:

- "landings have fluctuated without trend in recent years Danish LPUE has increased over the last five years.
- "The perception of the stock is based on Danish LPUE data".
- "Due to "technological creeping" there are concerns over effort data, because of changes in selectivity or in gear efficiency. Furthermore, LPUE may be affected by changes in catchability (due to sudden changes in the environmental conditions)".

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

No specific advice for this stock was given, and no TAC was suggested for 2007. In previous years TACs based on historical landings have been suggested.

3.4.4.1.4 Management

The EU fisheries in FU 32 take place mainly in the Norwegian zone of the North Sea. The EU fisheries are managed by a separate TAC for this area. For 2007 the agreed TAC for EU vessels was 1300 t.

3.4.4.2 Assessment

3.4.4.2.1 Data available

Catch

Norwegian landings have changed slightly from last year's report. Norway land *Nephrops* from both Divs. IVa and IVb. The negligible IVb landings have always been reported together with the IVa landings, but will from this year on be reported separately. Swedish landings from FU32 are incorporated in the report for the first time this year. International landings from the Norwegian Deep increased from less than 20 t in the mid-1980s to 1,190 t in 2001, the highest figure so far (Table 3.4.3.1, Figure 3.4.3.1). Since then landings have declined and total landings in 2007 amounted to 755 t, mainly due to a reduction of Danish landings. Danish vessels take 80–90 % of total landings.

Length composition

The average size of *Nephrops* as recorded from Danish landings (using a 100 mm *Nephrops* trawl) show a decreasing trend for both males and females in the period 2000–2006, but has increased again in 2007 (Figure 3.4.3.1). Average sizes in catches (for both sexes) also increased in 2007. The size distributions in the Danish catches (100 mm mesh size) from 2002 to 2007 do not show any conspicuous changes (Figure 3.4.3.2). In previous years the Norwegian shrimp survey in this area provided Norwegian data on size distribution of the *Nephrops*. Size data from Norwegian coast guard inspections of Danish and Norwegian trawlers are available for 2006–2007 (Figure 3.4.3.3). The Danish and Norwegian length distributions for 2007 are very similar (Figure 3.4.3.4). Figure 3.4.3.5 shows a time series of length compositions for this stock. There is little evidence of notable change in sizes, and maximum sizes have remained quite constant.

Since 2003 the Danish at-sea-sampling programme has provided data for discard estimates. However, the samples have not covered all quarters.

Natural mortality, maturity at age and other biological parameters

No data available.

Catch, effort and research vessel data

Effort and LPUE figures for the period 1989–2007 are available from Danish logbooks (Table 3.4.3.2, Figure 3.4.3.1). Available logbook data from Norwegian *Nephrops* trawlers cover only a small proportion of the landings (15–40%) in 2001–2005 and are lacking for 2006–2007.The working group considers them unsuitable for any LPUE analysis. In the beginning of the 1990s vessel size increased in the Danish fleet fishing in the Norwegian Deep. This increase and more directed fisheries for *Nephrops* in areas with hitherto low exploitation levels are probably partly responsible for the observed increase in the Danish LPUEs in those years (Table 3.4.3.2). A similar development has been occurring in the Norwegian fleet. Since 1994 the Danish LPUEs have fluctuated 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. The Danish effort increased from 2004 to 2006, but shows a strong decline in 2007. This decline corresponds to a large decline in landings.

It has not been possible to incorporate 'technological creeping' in the evaluation of the effort data. However, use of twin trawls has been widespread for many years. Figure 3.4.3.6 shows the logbook based effort data analysed in various ways to elucidate the effect of some factors likely to influence the effort/LPUE:

- Incorporation of HP (kw) in the effort measure
- Vessel size (GLM to standardise LPUE regarding vessel size)

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

3.4.4.2.2 Data analysis

Review of last year's assessment

There were no specific comments by the review group.

Exploratory analysis of catch data

There was no age based analysis carried out

Exploratory analysis of survey data

The only survey data for this stock are catches of *Nephrops* in shrimp trawl during the annual Norwegian shrimp trawl survey. They are too sparse to be useful for exploratory analysis.

Final assessment

No age based numerical assessment is presented for this stock. The state of the stock was judged on the basis of basic fishery data.

3.4.4.2.3 Historic stock trends

The slight increase in mean size in the catches and landings from 2006 to 2007 in females and from 2005 to 2007 in males could indicate a lower exploitation pressure in recent years and coincides well with the decreasing landings in the same time period. The Danish LPUE decreased from 2005 to 2006, and then increased again in 2007. The overall picture is that of a stable LPUE fluctuating around a mean of 200 kg/day. Thus the stock seems to be stable and shows no sign of overexploitation.

3.4.4.2.4 Recruitment estimates

There are no recruitment estimates for this stock.

3.4.4.2.5 Forecasts

There were no forecasts for this stock.

3.4.4.2.6 Biological reference points

No reference points are defined for this stock.

3.4.4.2.7 Quality of assessment

The data available for this stock remains limited.

The NSCFP survey indicates a generally increasing trend in the Northern North Sea although the responses come from an area which partly includes the Fladen Ground so the information is more difficult to interpret from a Norwegian Deeps perspective.

3.4.4.2.8 Status of stock

Perceptions of this stock (FU 32) are based on Danish LPUE data. However, the effect of technological creep on the effective effort of the fishery is not known. It is noted, that the EU-Norway agreement of 1000 t in 2005 for EU vessels in this area may have had a restrictive effect for the fleets exploiting this stock. For 2006 and 2007 the agreed catch for EU vessels was 1300 t.

3.4.4.3 Management considerations

Recent trends in overall size distribution in the catches indicate that the *Nephrops* stock in the Norwegian Deep is not over-exploited. The trend in Danish LPUE figures does not indicate any decline in stock abundance. The WG concludes that the level of exploitation on this stock is sustainable. Recent average landings have been approximately 1,000t (average landings 2002–2007).

The WG considers that the stock should be monitored more closely. The Norwegian logbook system should be improved. Sampling of Norwegian commercial catches from this area should be intensified. Also the sampling of the Danish vessels should be intensified to cover all seasons of the year.

3.4.5 Farn Deeps FU6

3.4.5.1 Fishery in 2006 & 2007

Since the beginning of the time-series, the UK fleet has accounted for virtually all landings from the Farn Deeps (table 1). In 2007 total landings were 2,966 tonnes, significantly down from the historical maximum observed in 2006 of 4,858t. The introduction of the buyers and sellers legislation in 2006 precludes direct comparison with previous years because the resulting improvement in reporting levels has created a discontinuity in the data. Effort also decreased in 2007 and has been generally declining since the early 1990s although again the change in legislation in 2006 complicates the interpretation of any trends. Effort trends in terms of KW hours are further complicated by moves towards multi-rig fishing gears which generally have a higher fishing power. The proportion of landings by multi-rig gears (mainly twin riggers) rose sharply in 2005 and reached 21% in 2007, the highest recorded proportion (figure 1).

The Farn Deeps fishery is essentially a winter fishery commencing in September and running through to March, hence the 2007 fishery comprises the end of the 2006–2007 fishery and the start of the 2007–2008 fishery. There was a distinct difference in the two fishery periods with the 2006–2007 fishery reporting high catch rates and the 2007–2008 fishery reporting very low catch rates. The number of visiting vessels decreased quickly at the start of the 2007/2008 winter fishery following low catch rates.

3.4.5.2 ICES ADVICE.in 2006

The last assessment of *Nephrops* in FU6 was in 2006.

State of the stock.

"The TV fall survey estimates of abundance for Nephrops in the Farn Deeps indicate that the population has increased from 2002 to 2005. Effort currently appears to be at its lowest level since 1984 and LPUE appears to be at its highest in the series. Mean size of the smaller length groups for males and females has increased in recent years, but the LPUE for these length groups has remained fairly static."

Exploitation boundaries in relation to precautionary limits

"The effort in this fishery should not be allowed to increase relative to the past three years. In addition to the ceiling on effort ICES advises that the harvest ratio in these stocks should be no more than 15% until more reliable catch information becomes available. This corresponds to landings of less than 3500 tonnes for the Farn Deeps stock"

3.4.5.3 Management

Management of *Nephrops* is in FU 6 is the same as for other FUs within area IV. No subdivisions of the area IV TAC are made for the individual FUs. Species composition regulation also applies, towed gears using mesh sizes 70–89 mm must have at least 30% by weight of their target species (*Nephrops* in this case). Above this mesh size there is no minimum percentage. A minimum landing size of 25 mm carapace length is in force for all of area IV.

3.4.5.4 Assessment

3.4.5.4.1 Review of the 2006 assessment and 2007 update.

October 2006:

May 2007:

"There seems to be a better reliability of the UK landings data, because of recent regulations for buyers and sellers. However, the change in statistics may preclude applications that treat the data as a single time series, because effort statistics before and after the change may not be comparable.

STECF is referring to an increase in lpue for small meshed fishery boats. This does not appear to be present for the *Nephrops* fleets. This should be explored before the assessments next year."

LPUE by mesh size category is given in figure 2. LPUE trends for the smaller meshes are no different to the other mesh categories with the exception of the 70–79 mm category which has virtually ceased to exist.

3.4.5.4.2 Data available.

Catch, effort and research vessel data

Three types of sampling occur on this stock, landings sampling, catch sampling and discard sampling providing information on size distribution and sex ratio, the sampling intensity is considered to be generally good.

Historically, estimates of discarding were been made using the difference between the catch samples and the landings samples. For the period prior to 2002, catch length samples and landings length samples are considered to be representative of the fishery. An estimate of retained numbers at length was obtained for this period from the catch sample using a discard ogive estimated from data from the 1990s, a raising factor was then determined such that the retained numbers at length matched the landings numbers at length. This raising factor was then applied to the estimate of discard numbers at length.

More recently, there has been concern that the landings sampling may be missing portions of the landings landed as tails (as opposed to whole individuals) thus leading to an artificial inflation of the estimated discards. On-board discard sampling has been of sufficient frequency since 2002 to enable the estimation of discards from these data. There are two modes of operation for "tailing" in the FU6 *Nephrops* fishery, some vessels tail at sea, others tail at the quayside. Discard estimates from the latter category only sample those animals discarded at sea, the undersize individuals discarded at the quayside are not sampled, consequently the proportion of discards at sizes below MLS for this tailing practice are very low (figure 3). Discard trips which saw less discarding of than 50% of individuals below MLS were ignored. Annual discard ogives showed no systematic change, therefore a single ogive was constructed from the pooled data from 2002–2007 (figure 4). This was then applied to the catch data to produce estimates of landings at length.

LPUE had remained relatively stable between 1993–2000, at a relatively high level around 26 kg.hour^{-1} (table 2 and figure 5). Since 2000 annual LPUE has sharply increased to its highest value in the series in 2005 (39 kg.hour^{-1}). Between 2006 and 2007 LPUE decreased by 38%, effort decreased by 8% and total international landings by 42%. The introduction of the buyers and sellers legislation in 2006 precludes comparison with previous years.

Males generally predominate in the landings, averaging about 70% (range 64%-79%) by biomass in the period 1992–2005. In 2006 and 2007 this skew in sex ratio was reversed such that the males were only 40% and 49% respectively. This pattern occurred consistently in the monthly sampling scheme and is not thought to be a sampling artefact. The sex ratio at the end of 2007 (i.e. the start of the 07/08 winter fishery) had returned to normal.

Effort is generally highest in the 1st and 4th quarter of the year in this fishery (figure 6) with landings correspondingly highest in these quarters. In recent years the third quarter has been gaining in importance at the expense of the first quarter. Quarterly LPUE values were more variable than the annual trends, but overall the same pattern is apparent. LPUEs of males are typically highest in the 1st and 4th quarters. The seasonal pattern of LPUE for females is much more variable ranging from very strong seasonality (1998) to almost none (2002). The extremely high LPUE for quarter 4 in 2006 and quarter 1 in 2007 appears to be genuine and not an artefact of sampling.

The LPUEs for *Nephrops* below 35 mm CL (figure 7) have traditionally been used to demonstrate potential changes in recruitment whilst *Nephrops* above 35 mm CL are assumed to be fully selected by the fishery and not subject to discarding hence analyses of trends in this size category is thought to reflect stock status better than the full size range. The introduction of a new discard ogive from 2002 onwards creates an obvious discontinuity in the estimated numbers landed at size and hence impacts the LPUE. In general there is a sharp decline in LPUE in 2007 for all sex/size classes except the larger males. Small males had a strong LPUE at the start of the 2007 season but this quickly dropped back to the lowest observed level (2002–2007) for quarter 4.

Length distributions of landed and estimated discarded portions of the catch are shown in figure 7. The new discarding ogive gives considerably lower estimates of discarding than the methodology used in previous assessments; 59% by number were discarded between 2002–2005 under the old method, contrasting with 37% for the same period using the new method. Catches of smaller size individuals are significantly lower in 2007. Mean sizes of catches and landings by sex are given in table 3.

Analysis of individual vessel records indicates an increase in directed *Nephrops* fishing since around 2000. Restrictions on both quota and effort for directed finfish fishing over the last seven years will have restricted the more casual effort on *Nephrops*. Further research is needed to better define directed fishing effort and thereby improve on this series.

Underwater TV surveys of the Farn Deeps grounds have been conducted at least once in each year from 1996 onwards. The most consistent series, and the one used in the assessment is the autumn survey which coincides with the start of the winter fishery. Figure 8 shows the distribution of stations in TV surveys, with the size of the symbol reflecting the *Nephrops* burrow density.

Natural mortality, maturity at age and other biological parameters

Biological parameter values are included in the Stock Annex. Relevant parameters applied in a simple length based combined yield per recruit to inform the catch forecast process are given in table 5.

3.4.5.4.3 Exploratory analyses of catch data

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

Discard survival is set to zero for this FU in contrast to the 25% used in other FUs. This is due to the practice of catch sorting and tailing whilst steaming back to port when the vessel passes over ground not suitable for *Nephrops* habitation.

Length cohort analyses (LCA) was performed for each sex on the pooled length compositions for 2002–2004 and 2005–2007 in order to get a feel for changes in exploitation and yield patterns (figure 10). LCA assumes that the stock is in a steady state and given the concerns with changes in sex-ratio and the rapid drop in LPUE for 2007 this assumption is somewhat violated for 2006–2007. The LCA appears to show a decrease in exploitation on the males and a slight increase in exploitation on the females for the two time periods. YPR analyses for the period 2005–2007 implies that male *Nephrops* are currently exploited above both $F_{0.1}$ and Fmax whilst the females are exploited at around $F_{0.1}$ (figure 11). Despite concerns about the steady state assumptions, the F0.1 value for the period 2005–2007 is considered to be a better option for the current situation given the perception of continued low recruitment in this FU.

Given the concerns surrounding the appropriateness of LCA i.e. the reliance upon the growth parameters and the assumptions of equilibrium dynamics, relatively little weight should be given to these analyses for the estimation of current exploitation rates.

3.4.5.4.4 Exploratory analyses of RV data

There has been an historical revision of burrow density estimates from the TV survey. Previous estimates of burrow density have assumed that station density was independent of burrow density and therefore used an unstratified mean density multiplied by the total area to arrive at overall abundance. Analysis of burrow density by rectangle (figure 12) shows that the distribution of stations is positively correlated with burrow density and therefore the unstratified mean density will overestimate burrow density. In order to compensate for the bias in sampling density, burrow abundance estimates are made for each rectangle and then summed to give the new total. A comparison of new and old raising methodologies is given in figure 13, abundance and biomass estimates with 95% confidence intervals are given in table 4.

3.4.5.4.5 Final Assessment.

The time series of abundance estimates from the TV survey is given in figure 10, the red dotted line represents the estimates using the unstratified raising procedure as used previously, the solid black line shows the new stratified raising procedure. The estimate in 2007 is the lowest in the observed series and is significantly lower than the 2006 estimate.

Mean size of *Nephrops* <35 mm carapace length (CL) in the catch has been increasing for both sexes since 2002 and 2007 is the peak for this period (a new discard ogive has been used since 2002, which effectively precludes comparison with previous periods). Mean size above 35 mm has been static from 2002–2007. The implication of the increase in mean size for the smaller size classes is that there has been either a significant improvement in survivorship of the older classes or a reduction in recruitment. Given the poor fishing in 2007, a reduction in recruitment would seem the more likely scenario.

3.4.5.4.6 Historic stock trends.

The time series of TV surveys is quite short (6 consecutive years) but estimates that the stock has fluctuated between 1000 and 2000 million individuals with the most recent estimate being at the bottom of this range.

Estimates of historic harvest ratio (the proportion of the stock which is removed) range from 8% to 18% (figure 12). The harvest ratio jumped from around 9% in 2004–2005 to 18% in 2006 when the new reporting legislation came in.

3.4.5.4.7 Short term forecasts.

Catch predictions for 2009 were made using Jones' length cohort analysis, a yield per recruit calculation and the latest abundance estimate. The population abundance was taken from the most recent TV survey rather than the 3 year average used in other stocks due to the concern regarding the continuing low stock size in this FU.

The following text table gives expected landings for a range of harvest ratios and their rationales.

PREDICTED LANDINGS TONNES		HR %
Landings with harvest ratio eq. to Fmax (0.345)	5398	29.18
Landings with harvest ratio eq. to F0.1 (0.173)	2939	15.89
SQ Landings	2966	16.03
Landings with harvest ratio =15%	2775	15.00
Landings with harvest ratio =10%	1850	10.00

3.4.5.4.8 Medium term forecasts

No medium term forecasts are undertaken for *Nephrops* in FU6.

3.4.5.4.9 BRPs

No biological reference points have been determined for *Nephrops* in FU6.

3.4.5.4.10 Quality of assessment

Changes to the legislation regarding the reporting of catches in 2006 means that the levels of reported landings from this point forward are considered to better reflect the true landings and hence effort input into this fishery. This does mean that comparison of LPUE with previous years is inadvisable and the independence of the final assessment from these data is likely to continue for some time.

The length and sex compositions arising from the land-based catch sampling programme are considered to be representative of the fishery. Estimates of discarded and retained length frequencies arising from the discard sampling programme are also considered robust since 2002.

The TV survey in this area has a high density of survey stations compared to other TV surveys and the abundance estimates are considered robust.

The North Sea Stock Survey of 2007 covers the fishery up to the end of the good 2006/2007 winter fishery suggesting a slight improvement in the stock from 2005–2006 in contrast to the TV survey suggesting a 50% decline in abundance. This may be due to the unusually high availability of females in the 2006/2007 fishery.

3.4.5.4.11 Status of stock

The TV survey, fishery data and length frequency data all point to the stock at the start of the 2007 fishing season being at a low level. Recruitment signals for *Nephrops* are inferred rather than estimated but recruitment in 2007 would appear to be low.

3.4.5.4.12 Management considerations

All available indices point to the stock in 2007 having been reduced to a low level following the high abundances seen in 2005/2006. Latest recruitment signals are low.

This is consistent with the industry perception of the stock.

The combined sex F0.1 value of 0.17 suggests a harvest ratio of just above 15%. Due to the male domination traditionally seen in the landings, the effective harvest ratio (and hence F) on males will be higher than this and the F0.1 estimation for males is around 0.2.

Given the current estimate of stock status, the value of F0.1 and the different exploitation patterns by sex, a maximum harvest ratio of 15% is recommended for this stock corresponding to landings of 2775t in 2009.

The parameter and population estimates used for the advice are more focussed on the current estimate of stock status in 2007–2008 rather than the broader status used in other FUs. This FU may, therefore, warrant re-assessing in 2009 rather than waiting another 2 years.

Landings from this FU count against the TAC for the entire IV area. There is no explicit management of this FU and effort is, in effect, unconstrained. *Nephrops* do not undergo migration and are confined to specific areas of suitable habitat making them particularly vulnerable to local depletion. Management on a local scale is the only realistic method of minimising the risk of local depletion.

Increases in abundance in other FUs (i.e. Firth of Forth and the Fladen grounds) are likely to translate to increases in TAC, increasing the risk of higher effort being deployed in this FU. The increasing cost of fuel combined with the relative coastal proximity of this ground may result in it attracting additional fishing effort which would be inadvisable given the current low level of the stock.

3.4.6 Firth of Forth

3.4.6.1 General

3.4.6.1.1 Ecosystem aspects

A common feature of *Nephrops* fisheries is that their bounds are defined by the limits of muddy substrate (See Stock Annex). The stocks are geographically restricted with little apparent mixing. The mud substrate in the Firth of Forth area is mainly muddy sand and sandy mud, and there is only a small amount of the softest mud. The population of *Nephrops* in this area is composed of smaller animals. Earlier research suggested that residual currents moving southward from this area transport some larvae to the Farn Deeps – recent larval surveys have not been undertaken, however, and it is unclear how significant this effect is.

The *Nephrops* fishery is located throughout the Firth but is particularly focussed on grounds to the east and south east of the Isle of May. Grounds located further up the Firth occur in areas closer to industrial activity and shipping.

3.4.6.1.2 The Fishery in 2006 and 2007

General information on the fishery can be found in the Stock Annex.

Most of the vessels are resident in ports around the Firth of Forth, particularly at Pittenweem, Port Seton and Dunbar. Some vessels, normally active in the Farn Deeps, occasionally come north from Eyemouth and South Shields. During 2006 and 2007 the number of vessels regularly fishing in the Firth of Forth was been around 40 (23 under 10 m and 19 over 10 m vessels). This number varies seasonally with vessels from other parts of the UK increasing the size of the fleet. Local boats sometimes move to other grounds when catch rates drop during the late spring *Nephrops* moulting period. Traditionally, Firth of Forth boats move south to fish the Farn Deeps grounds. In 2006 there was a good fishery in the Farn Deeps but in 2007 the catch rates were very low.

Single trawl fishing with 80 mm mesh size is the most prevalent method. Some vessels utilise a 90 mm codend. A couple of vessels have the capability for twin rigging. Night fishing for *Nephrops* is commonest in the summer. Day fishing is the norm in winter. A very small amount of creeling for *Nephrops* takes place; this is mostly by crab and lobster boats.

Nephrops is the main target species with diversification by some boats to squid, and also surf clams. Only very small amounts of whitefish are landed. The area is characterised by catches of smaller *Nephrops* and discarding is sometimes high. The latest information for 2007 suggests that large catches of small *Nephrops* were taken. In the past, small prawns generally led to high tail:whole prawn ratios in this fishery but in recent years a small whole prawn 'paella' market developed.

In 2006, buyers and sellers regulations led to increased traceability and improved reporting of catches. This continued and improved further in 2007 and the reporting of landings is now considered to be much more reliable.

3.4.6.1.3 Advice in 2006

In 2006 ICES concluded that

"The available information is inadequate to use analytical methods to evaluate spawning stock or fishing mortality relative to risk. Results from TV surveys, however, suggest that the stocks in this Management Area are exploited at a sustainable level.

Firth of Forth: The TV survey estimate of abundance for *Nephrops* in the Firth of Forth suggests that the population declined between 1993 and 1998, but has increased since then and has been at a relatively high level in the last four years. The increases in abundance in the late 1990s and most recent years have been reflected in CPUE and mean size data, in that they suggest an increase in recruitment in 1998 and 2003."

and advised that:

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

ICES did not provide new advice for this FU in 2007

3.4.6.1.4 Management

The stock is managed at the ICES Sub Area level as described in 3.1.and for 2007 and 2008 was based on advice from STECF in 2006.

3.4.7 Assessment

3.4.7.1.1 Data available

Catch

Landings from this fishery are predominantly reported from Scotland, with very small contributions from England, and are presented in Table 3.4.4.7, together with a breakdown by gear type. Total international reported landings in 2007 was 2646 tonnes. This estimate for total landings has increased by almost 200 tonnes since 2006 continuing a recent rapid increase in landings from a low of 1126 in 2003. Reported effort by Scottish *Nephrops* trawlers dipped in 2003, but has otherwise remained relatively stable since 1995 (Table 3.4.4.8 and Figure 3.4.4.10). Scottish *Nephrops* trawler LPUE was relatively stable in the late 1980s and early 1990s, but has apparently fluctuated since then and in the last couple of years has increased markedly. There are concerns over the quality of these fishery data and the trends observed need to be treated with caution.

Discarding of undersize and unwanted *Nephrops* occurs in this fishery, and quarterly discard sampling has been conducted on the Scottish *Nephrops* trawler fleet since 1990. Discarding rates averaged over the period 2005 to 2007 for this stock were about 41% by number of the catch, or 26% by weight, comparable to the 2003 to 2005 period. Discard rates are higher in this stock than the more northerly North Sea Functional Units fished for which Scottish discard estimates are available. This could arise from the fact that the use of larger meshed nets is not so prevalent in this fishery (80 mm is more common).

Length compositions

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

Figure 3.4.4.11shows a series of annual length compositions raised to fleet landings for the period 1979 to 2007. Catch (removals) are shown for each sex with the mean catch and landings lengths shown in relation to MLS and 35 mm. There is little evidence of change in the mean size of either sex over time and examination of the tails of the distributions above 35 mm shows no evidence of reductions in relative numbers of larger animals.

The observation of relatively stable length compositions is further confirmed in the series of mean sizes of larger *Nephrops* (>35 mm) shown in Figure 3.4.4.10 and Table 3.4.4.9. This parameter might be expected to reduce in size if overexploitation were taking place but over the last 15 years has in fact been quite stable and increased very slightly in the last couple of years. Dips in mean size in the <35 mm category (Figure 3.4.4.10) are generally interpreted as increases in recruitment, particularly when associated with increases in CPUE of the smaller size category. The length distributions in Figure 3.4.4.11 also shows occasions where relatively large numbers of smaller *Nephrops* appeared (e.g. 2003)

Figure 3.4.4.12 shows the average length composition for 2005–2007 divided into landed and discard components

Natural mortality, maturity at age and other biological parameters

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

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

Growth parameters for age slicing are as follows:

Males; L_∞ = 66 mm, k = 0.163

Immature Females; L_∞ = 66 mm, k = 0.163

Mature Females; L_∞ = 58 mm, k = 0.065, Size at maturity = 26 mm

Weight length parameters:

Males a = 0.00028, b = 3.24

Females a= 0.00085, b = 2.91

Discard survival rate was assumed to be 25%.

Catch, effort and research vessel data

The Commercial CPUE and research-vessel survey data series are described in the Stock Annex (Sections B.3 and B.4).

LPUE and CPUE data were available for Scottish *Nephrops* trawls. Table 3.4.4.8 shows the data for single trawls, multiple trawls and combined. Examination of the long term commercial LPUE data (Figure 3.4.4.10) suggests that the stock is currently very abundant but the recent improvements in reporting of landings may mean this is an artefact generated by more complete landings data.

Males consistently make the largest contribution to the landings and the LPUEs (Figure 3.4.4.13), although the sex ratio does vary. Effort is generally highest in the 3rd quarter of the year in this fishery, but although the pattern was fairly stable in the early years, the pattern does not appear as strong in recent years and is 2007 was fairly evenly spread throughout the year. LPUE of both sexes has fluctuated through the time series and is currently at a high level this is particularly marked in males. The comments about the quality of landings data are relevant here too. LPUE is generally higher for males in the 1st and 4th quarters, and for females in the 3rd quarter – the period when they are not incubating eggs.

CPUE data for each sex, above and below 35 mm CL, are shown in Figure 3.4.4.14. This size was chosen for all the Scottish stocks examined as the size above which the affects of discarding practices were not expected to occur and the size below which recruitment events might be observed in the length composition. The data show a slight peak in CPUE for smaller individuals (both sexes) in 1999, with a decline after this, followed by a steady increase in both sexes from 2002 onwards. The CPUE for larger individuals showed a similar pattern with higher values in the most recent years. Taken with mean size information above, the latter observation confirms the view that exploitation has not had adverse effects on this stock.

TV surveys using a stratified random design are available for FU 8 since 1993 (missing surveys in 1995 and 1997). Underwater television surveys of *Nephrops* burrow number and distribution, reduce the problems associated with traditional trawl surveys that arise from variability in burrow emergence of *Nephrops*.

The numbers of valid stations used in the final analysis in each year are shown in Table 3.4.4.11. On average, about 40 stations have been considered valid each year with more stations sampled in the last three years. The survey in 006 was conducted in December so that densities may not be strictly compatible with the remainder of the series. Abundance data are raised to a stock area of 915 km^2. General analysis methods for underwater TV survey data are similar for each of the Scottish surveys, and are described in Annex 2 of the *Nephrops* section.

3.4.7.1.2 Data analyses

Reviews of last year's assessment

The assessment in 2006 was based principally on the underwater television survey series, supported by presentation of basic fishery parameters and mean size information in catches and landings. The WG and ACFM considered the TV data as the best indicator of stock status . According to the survey, abundance increased in 2002 and has remained relatively high, this coincides with commercial CPUE information.

Last review group comments

Exploratory analyses of catch data

There were no analytical assessments performed

Exploratory analyses of survey data

Table 3.4.4.10 shows the basic analysis for the three most recent TV surveys conducted in FU 8 including the 2006 and 2007 results. The table includes estimates of abundance and variability in each of the strata adopted in the stratified random approach. The ground is predominantly of coarser muddy sand. Depending on the year, high variance in the survey is associated with different strata and there is no clear distributional or sedimentary pattern in this area.

Figure 3.4.4.15 shows the distribution of stations in TV surveys, with the size of the symbol reflecting the *Nephrops* burrow density. Abundance is generally higher towards the central part of the ground and around the Isle of May. In recent years higher densities have been recorded over quite wide areas. Table 3.4.4.11 and Figure 3.4.4.16 show the time series of estimated abundance for the TV surveys, with 95% confidence intervals on annual estimates. Confidence intervals have been fairly stable in this survey.

Final assessment

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

3.4.7.1.3 Historic Stock trends

The TV survey estimate of abundance for *Nephrops* in the Firth of Forth suggests that the population decreased between 1993 and 1998 and then began a steady increase up to 2003. Abundance is estimated to be significantly higher in recent years (2003–2007) compared to the previous period (1994 – 2001) and the most recent estimates for 2006 and 2007 are the highest in the time series.

3.4.7.1.4 Recruitment estimates

Recruitment estimates from a survey were not available for this stock.

3.4.7.1.5 Short-term forecasts

A catch prediction for 2007 was made for the Firth of Forth (FU8) using the approach outlined in the introductory section on *Nephrops*. In order to provide guidance on a sustainable harvest rate to use, combined sex Y/R calculations were made using an adapted version of LBA (developed by WGNEPH in the 1990s to perform Jones' length cohort analysis and Y/R prediction). The Y/R plot is shown in Figure 3.4.4.17 based on average length compositions of removals for 2005–2007. The text table below shows the $F_{0.1}$ and F_{max} obtained from the curve. The calculation has only been used to provide guidance on a sustainable harvest rate and no attempt is made to derive current F from these calculations owing to the tendency for length cohort analysis to overestimate current fishing mortality through variability in length at age in *Nephrops* leading to overlap of ages.

FUNCTIONAL UNIT	F0.1	FMAX
Firth of Forth	0.23	0.36

The estimates of $F_{0.1}$ and F_{max} were included in the calculations of predicted landings under a range of different harvest rates using the approach outlined shown in Figure 3.4.1.9. Average TV derived abundance values for 2005−2007 and the average length compositions used in the Y/R were used in the calculations. In addition to the harvest rates discussed above, predicted landings for arbitrary values of 15%, 20% and 25% have also been computed. A summary of the input length composition and the calculations made is given in table 3.4.4.12. under a range of different harvest rates.

The following text table provides a summary (all tonnes) for this Functional Unit. $F_{0.1}$ is equivalent to landings of 2147 tonnes.

Harvest rate	Firth of Forth
15%	1549
FU8 20.9% (F0.1 = 0.23)	2147
20%	2066
25%	2582
30.4% (Fmax=0.36)	3145

3.4.7.1.6 Medium –term forecasts

Medium term forecasts were not performed for this stock.

3.4.7.1.7 Biological Reference points

Biological reference points have not been defined for this stock.

3.4.7.1.8 Quality of assessment

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

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

UWTV surveys have been conducted for this stock since 1993, with a continual annual series available since 1998. The number of valid stations in the survey was particularly high between 1999 and 200, and slightly below average in the most recent years. Confidence intervals around the abundance estimates are greater during the most recent years, when abundance estimates have been slightly higher.

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

The NSCFP survey does not include specific information for the Firth of Forth but the NSCFP survey area containing the Firth of Forth shows a continuous increase in *Nephrops* since 2001. Adjacent North Sea areas also show this trend. This supports the suggestion of an increase in abundance since 2001, with generally moderate or high numbers of recruits.

3.4.7.1.9 Status of the stock

Stock abundance in the last two years is at the highest level in the TV time series. The evidence from the TV survey suggests that the population has been at a relatively high level since 2002. The TV survey information, taken together with information showing stable mean sizes and relatively high catch rates, suggest that the stock does not show signs of overexploitation.

3.4.7.2 Management considerations

TV survey estimates of abundance for *Nephrops* in the Firth of Forth indicate that the stock abundance has fluctuated and is currently at a high level. Stock abundance has been relatively high since about 2002. Indicators of stock condition based on size composition show a stable situation and the size range has not decreased through time. .

The Working Group agreed that the update assessment and catch forecast for the Firth of Forth should be based on the harvest ratio approach based on TV survey abundance. Modelling studies suggest this is sustainable. The harvest rate equivalent to $F_{0.1}$ is just under 21% and gives landings of 2147 tonnes, lower than in 2006 and 2007. The observed harvest rates for these years (based on removed numbers) were 32 and 23% but did not appear to adversely affect the stock, further suggesting that an F0.1 approach is sustainable for this stock.

Effort should not be allowed to increase in this Functional Unit. The WG, ACFM and STECF have repeatedly advised that management should be at a smaller scale than the ICES Division level. Management at the Functional Unit level could provide the controls to ensure that catch opportunities and effort were compatible and in line with the scale of the resource.

Nephrops discard rates in this Functional Unit are high and there is a need to reduce these and to improve the exploitation pattern. An additional reason for suggesting improved selectivity in this area relates to bycatch. It is important that efforts are made to ensure that other fish are not taken as unwanted bycatch in this fishery which uses 80 mm mesh. Larger square mesh panels implemented as part of the Scottish Conservation Credits scheme should help to improve the exploitation pattern for some species such as haddock and whiting and small cod.

3.4.8 Botney Gut – Silver Pit

3.4.8.1 Botney Gut / Silver Pit (FU 5)

3.4.8.1.1 Data available

Landings.

Table 3.4.5.2 shows the landings from this FU. For many years total landings have been at a level of 1000 t. Up to 1995, the Belgian fleet took more than 75% of the international *Nephrops* landings from this FU/stock, but since then, the Belgian landings have declined drastically. The Danish landings have also declined to almost nothing in 2007. In the most recent years UK and the Netherlands have accounted for most of the landings from this FU.

Discards

Discard data were available for the Belgian *Nephrops* fleet for the period 2002–2005. However, in view of the current low level of the Belgian *Nephrops* landings, it is very unlikely that the discard sampling programme will be resumed. In 2007, because of low catches, no data collection from the Belgian *Nephrops* fishery has been performed. No discard data are available from the other fisheries.

Length compositions

Danish sampling of landed *Nephrops* has taken place 2005−2007, mainly as a compensation for inadequate at-sea-sampling.

Data on mean sizes of male and female *Nephrops* in the Belgian landings (1991- 2005) are shown in Table 3.4.5.4 and Figure 3.4.5.1 The mean sizes of males show evidence of an overall downward trend, while mean sizes of females seem to be stable, Figure 3.4.5.2 shows a time series of landing length compositions. There is little evidence in these of a notable change in sizes and the maximum sizes have remained quite constant during this period.

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 are as follows:

Males: L_∞ = 62 mm CL, k = 0.165.

Immature females: L_∞ = 62 mm CL, k = 0.165.

Mature females: L_∞ = 60 mm CL, k = 0.080, Size at 50% maturity = 27 mm CL.

Growth parameters have been 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).

Commercial catch-effort data and research vessel surveys

Effort and LPUE figures are available for Belgian *Nephrops* specialist trawlers (1985–2005), the Dutch fleet (all vessels catching *Nephrops* for the period 2000−2005) and the Danish bottom trawlers with mesh size >70 mm (1996–2007, Table 3.4.5.3 and Figure 3.4.5.1

The effort of the Belgian *Nephrops* fleet has shown an almost continuous decrease since the all-times high in the early 1990s. In 2005, effort was at the lowest level in the time series No data are available for the 2006−2007

The effort of the Dutch (*Nephrops)* fleet was relatively stable, between 7900 and 9800 days at sea annually. Danish *Nephrops* effort in the Botney Gut was always low but has decreased drastically in recent years.

There are no fishery-independent survey data for FU 5.

3.4.8.1.2 Data analyses

Review of last year's assessments

The assessment last year was based on trends in fishery data. The Review Group requested that more efforts be put into obtaining a time series of landings and effort for the increasing Dutch fishery and recommended close monitoring of the fishery, especially the collection of discards. Concerns were expressed over reported declines in mean size although the data were difficult to interpret.

Exploratory analyses of catch data

No analytical assessments presented.

Exploratory analyses of survey data

Not relevant

Final assessment

The final assessment was based on

3.4.8.1.3 Historic Stock Trends

No analytical assessment presented.

3.4.8.1.4 Recruitment estimates

Recruitment estimates are not available

3.4.8.1.5 Forecasts

There were no forecasts

3.4.8.1.6 Biological Reference points

Biological reference points are not defined for this stock

3.4.8.1.7 Quality of assessments

No analytical assessment was presented. There is a severe shortage of data for this stock. The NSCFP survey suggests that in this area *Nephrops* abundance has been fairly constant with some evidence of decline in the far south east of the area.

3.4.8.1.8 Status of stock

The shortage of information on this stock in the recent 2 years makes an evaluation of stock condition difficult. A decline in Danish LPUE was seen in 2007, but as the Danish landings for several years has been at a very low level, the LPUE figures from this fishery should be considered cautiously. There is no other evidence of significant downward movements trends in LPUE or in mean size, but the lack of more substantial data for the two recent years gives rise for concern about the status of this stock..

3.4.9 Off Horns Reef

3.4.9.1 Data available

Catch

The landings from FU 33 were marginal for many years. However, from 1993 to 2004, Danish landings increased considerably, from 159 to 1,097 t. In this period Denmark dominated this fishery. The other countries reporting landings from the area are Belgium, Netherlands and the UK. In recent years total landings increased to around 1500 t, and while Danish landings decreased landings from Netherlands increased (Table 3.4.5.5).

Length compositions

Size distributions of the Danish catches 2001 to 2005 are shown in Figure 3.4.5.4. Note the shift in 2005 compared to the previous years. Figure 3.4.5.3 gives the development of the mean size of the catches and landings by sex. These data could indicate either a general decrease in the amount of large individuals in the population indicating some overexploiting or increase in smaller individuals (large recruitment).

A short time series of length compositions is shown in Figure 3.4.5.5. The mean size of landings is fairly constant while the catch declined noticeably (as mentioned above) – the increased numbers around 30 mm may indicate increase recruitment.

In the period 2001–2005 the Danish at-sea-sampling programme provided data for discard estimates. However, the samples did not cover all quarters.

Natural mortality, maturity at age and other biological parameters

No data available

Catch, effort and research vessel data

Table 3.4.5.6 and Figure 3.4.5.3 show the development in Danish effort and LPUE. Note that the 10-fold increase in fishing effort from 1996 to 2004 seems to correspond to the increase in landings during the same period. It appears from that LPUEs have been rather stable from 1998 to 2004, fluctuating around 200 kg.day^{-1}. Recent years' increase in LPUE could reflect increase in gear efficiency (technological creep).

3.4.9.1.1 Data analysis

Reviews of last year's assessment

Assessments were based on trends in fishery data and mean size. The assessments showed little evidence of declines in stock size and the fishery appeared to be expanding. The review wondered whether there had been increases in efficiency in this fishery. The minimum landing size applied in Denmark (40 mm) meant that a large proportion of the catch was discarded. The Review Group questioned whether further increases in effort were possible.

Exploratory analyses of catch data

Given the short series of catch sampling, the data are not considered suitable to conduct catch at age analysis for this stock.

Exploratory analyses of survey

No survey data were available

Final assessment

No analytical assessment is presented for this stock, and the assessment relies on observed trends in LPUE and mean sizes.

3.4.9.1.2 Historic stock trends

The available data do not provide any clear signals on stock development:

The upward trend in LPUE does not indicate a declining stock, rather that suggesting that the stock level is remaining relatively stable.

The decrease in mean size could indicate either high recruitment or a decline in stock reflected by fewer large individuals.

Recruitment estimates

There are no recruitment estimates.

Forecasts

Forecasts were not performed.

Biological reference points

There are no reference points defined for this stock.

Quality of the assessment

NSCFP stock survey trends are shown in Figure 3.5.1. For FU 33 the survey shows and increase between 2001 and 2002, a stable period to 2004, and an increase in 2005. There were no strong indications of changes in recruitment or discarding levels.

Perceptions of the stock are based on Danish LPUE data. The TAC is not thought to be restrictive for the fleet exploiting this stock, but no information is available on technological creep in the fishery.

Status of stock

The stock appears able to sustain current levels of effort.

Management considerations for FU 5 and FU 33.

The perception of the state of these two FUs are based on trends in LPUEs and changes in size compositions in the catches.

FU 5 (Botney Gut). The Belgian. Dutch and Danish LPUEs up to 2005 as presented in Table 3.4.5.3 and Figure 3.4.5.1 above may not be optimal as indicators of stock density. However, they do not indicate any decline in stock density for this FU. As for the size composition in catches, the mean lengths (Figure 3.4.5.1) no conspicuous declining trend can be seen, neither for females nor males. However, the lack of data for 2006 and 2007 along with the strong increase in exploitation seen in these years give rise to concern about stock status at present.

FU 33 (Horn Reef). Again here, the (increasing) trend the Danish LPUEs (Table 3.4.5.6) is not indicative of any decline in stock density. However, the marked shift in the size distribution for 2005 compared to previous years (Figure 3.4.5.4) could have been a sign of a too high exploitation level in recent years. . Also the slight decrease in mean size of landings seen in 2007 could be interpreted as signs of high exploitation. However, as LPUE further increased in 2006 and 2007was at a high level in 2005, this decrease in mean size in the catch (in 2005) could merely have been a sign of large recruitment.

Considering these 2 FUs Management Area H, the WG recommends that the exploitation of these 2 FUs remain at the same level as in previous years,. i.e. status quo.

3.5 Nephrops Sub Area IV Overview

3.5.1 Summary

Assessments of the *Nephrops* Functional Units of Division IV utilised a number of approaches including TV surveys, length composition information and basic fishery data such as landings and effort. Owing to uncertainties in the accuracy of historic landings and to inaccurate effort figures in some fisheries, greater attention was paid to survey information and size composition data.

Most stocks appear to be fairly stable in terms of abundance and size composition. At the Fladen Ground there was a marked increase in abundance but at the Farn Deeps the population size dropped in 2007 and there were unusual changes in the seasonal sex ratio pattern. For most stocks the biennial assessment approach appears to be frequent enough but the Working Group suggests that the Farn Deeps should be looked at again in 2009.

Use of the technique to estimate abundance raised to the areas of suitable *Nephrops* ground depends on as accurate an estimation of mud sediment distribution and area as possible. In ICES Area IV the mud areas are derived from British Geological Survey data. This is considered to give good coverage in the Fladen area (where extensive maritime activity and resource use led to intensive sampling) but was less adequately surveyed in places such as the Moray Firth.

Stock density varies from place to place and this probably reflects the different physical nature of the grounds and the population dynamics of *Nephrops* associated with them. This observation continues to give support to the long held ICES Working Group and ACFM view that *Nephrops* stocks should be managed at a smaller scale. This was reiterated by STECF in 2005 and 2006. As an overarching general comment, it is the Working Group's view that management at the Functional Unit level could confer controls to ensure effort and catch are in line with resources available.

The same approaches for deriving possible forecasts of catch were used as for the previous Working Group (WGNSSK, 2006). These are indicated in the sections on individual Functional Units above. These calculations take no account of other, smaller areas containing *Nephrops* populations which are not surveyed regularly and do not have adequate sediment distribution to define accurately. There are however, increasing and significant landings from some of these isolated patches, most notably the Devil's Hole area. To provide some guidance on appropriate landings for these areas, the use of average landings from 'other rectangles' shown in Table ????? for the last 3 years could be considered as follows :

Other areas in Subarea IV: 2005–2007 = 1335 tonnes

3.5.2 Management considerations

Current management of *Nephrops* in Subarea IV (both in terms of TACs and effort) does not provide adequate safeguards to ensure that TACs are commensurate with effort or that both these management control measures are applied at a scale appropriate to the resources in each Functional Unit. The current situation allows for catches to be taken anywhere in the ICES division and this could imply inappropriate harvest rates from some parts. More importantly, vessels are free to move between grounds which allows effort to develop on some grounds in a largely uncontrolled way. This appears to have been a particular problem in the Farn Deeps Functional Unit in 2006 where increased vessel activity from other parts of the UK occurred. Management at the FU level could address this problem.

It is expected that the quality of fishery data available for these stocks will continue to improve. The UK Registration of Buyers and sellers has led to more accurate landings information from these stocks and within a few years this should improve the basis for assessment and forecasts of catch. Stock monitoring continues, and enhanced work on observer trips onboard commercial vessels should furnish additional data which will be beneficial in developing assessment approaches further.

In general bycatches of cod in the *Nephrops* fisheries have been fairly small, particularly in recent years in inshore grounds of Division IV and it is important that emerging year classes should not be subject to mortality as bycatch in smaller mesh fisheries. The capture of juvenile fish or other species such as haddock is also a problem in some of the Functional Units and discarding of these is a problem in some years. This problem can be addressed with the use of more selective gear and efforts are already being made in Scotland through the Conservation Credits scheme which requires vessels targeting *Nephrops* to use gear with larger square meshed panels (110 mm). Subject to evaluation of the effectiveness of these measures, further action may be required to reduce bycatch.

Table 3.1.1 *Nephrops* Functional Units and descriptions by statistical rectangle.

Functional Unit	Stock	ICES Rectangles	Division
3	Skagerrak	47G0-G1; 46F9-G1; 45F8-G1; 44F7-G0; 43F8-F9	IIIa
4	Kattegat	44G1-G2; 42−43G0-G2; 41G1-G2	IIIa
5	Botney Gut	36−37 F1-F4; 35F2-F3	IV
6	Farn Deep	38−40 E8-E9; 37E9	IV
7	Fladen	44−49 E9-F1; 45−46E8	IV
8	Firth of Forth	40−41E7; 41E6	IV
9	Moray Firth	44−45 E6-E7; 44E8	IV
10	Noup	47E6	IV
32	Norwegian Deep	44−52 F2-F6; 43F5-F7	IV
33	Off Horn Reef	39−41F4; 39−41F5	IV

Table 3.2.1.1 Nominal landings (tonnes) of *Nephrops* in Division IIIa, 1984 – 2007, as officially reported to ICES.

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Denmark	3591	2944	2647	2840	2869	3022	3094	2790	2046	2251	2049	2419
Germany	0	0	0	0	0	0	0	0	0	0	0	1
Germany, Fed. Rep.	2	0	10	0	0	0	0	0	0	0	0	0
Netherlands	0	0	0	0	0	0	0	0	0	0	0	0
Norway	97	72	64	80	88	54	140	185	104	103	62	90
Sweden	1159	1115	1237	1240	1062	829	1098	1249	772	863	763	913
Total	4849	4131	3958	4160	4019	3905	4332	4224	2922	3217	2874	3423

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Denmark	2843	2959	3538	3487	3329	2868	3277	2752	2956	2918	2434	2890
Germany	1	5	12	6	7	1	7	12	13	2	6	13
Germany, Fed. Rep.	0	0	0	0	0	0	0	0	0	0	0	0
Netherlands	0	0	0	0	0	0	0	0	1	0	0	0
Norway	102	117	184	214	181	138	116	99	95	83	91	145
Sweden	1105	1129	1314	1259	1195	1040	1033	896	904	1044	1150	1465.05
Total	4051	4210	5048	4966	4712	4047	4433	3759	3969	4047	3681	4513.05

Table 3.2.1.2 Division IIIa: Total *Nephrops* landings (tonnes) by Functional Unit plus Other rectangles, 1991–2007.

Year	FU 3	FU 4	Total
1991	2924	1304	4228
1992	1893	1012	2905
1993	2288	924	3212
1994	1981	893	2874
1995	2429	998	3427
1996	2695	1285	3980
1997	2612	1594	4206
1998	3248	1808	5056
1999	3194	1755	4949
2000	2894	1816	4710
2001	2282	1774	4056
2002	2977	1471	4448
2003	2126	1641	3767
2004	2312	1653	3965
2005	2546	1488	4034
2006	2392	1280	3672
2007	2771	1741	4512

Table 3.2.1.3 Sub Area IIIa: Total *Nephrops* landings (tonnes) by country, 1991–2007.

Year	Denmark	Norway	Sweden	Germany	Total
1991	2824	185	1219		4228
1992	2052	104	749		2905
1993	2250	103	859		3212
1994	2049	62	763		2874
1995	2419	90	918		3427
1996	2844	102	1034		3980
1997	2959	117	1130		4206
1998	3541	184	1319	12	5056
1999	3486	214	1243	6	4949
2000	3325	181	1197	7	4710
2001	2880	138	1037	1	4056
2002	3293	116	1032	7	4448
2003	2757	99	898	13	3767
2004	2955	95	903	12	3965
2005	2901	83	1048	2	4034
2006	2432	91	1143	6	3672
2007	2887	145	1467	13	4512

Table 3.2.1.4 *Nephrops* Skagerrak (FU 3): Landings (tonnes) by country, 1991–2007.

Year	Denmark	Norway			Sweden			Total
		Trawl	Creel	Sub-total	Trawl	Creel	Sub-total	
1991	1639	185	0	185	949	151	1100	2924
1992	1151	104	0	104	524	114	638	1893
1993	1485	101	2	103	577	123	700	2288
1994	1298	62	0	62	531	90	621	1981
1995	1569	90	0	90	659	111	770	2429
1996	1772	102	0	102	708	113	821	2695
1997	1687	117	0	117	690	118	808	2612
1998	2055	184	0	184	864	145	1009	3248
1999	2070	214	0	214	793	117	910	3194
2000	1877	181	0	181	689	147	836	2894
2001	1416	125	13	138	594	134	728	2282
2002	2053	99	17	116	658	150	808	2977
2003	1421	90	9	99	471	135	606	2126
2004	1595	85	10	95	449	173	622	2312
2005	1727	71	12	83	538	198	736	2546
2006	1516	80	11	91	583	201	784	2392
2007	1664	127	18	145	709	253	962	2771

Table 3.2.1.5 Nephrops Skagerrak (FU 3): Mean sizes (mm CL) of male and female Nephrops in catches of Danish, Swedish and Norwegian trawlers combined, 1991–2007

Year	Catches					
	Undersized		**Full sized**		**All**	
	Males	Females	Males	Females	Males	Females
1991	30.2	30.9	41.2	42.7	30.9	29.8
1992	33.3	32.3	43.3	44.7	33.3	32.2
1993	33.0	31.5	42.0	43.6	33.0	31.5
1994	31.7	29.6	41.7	43.6	31.7	29.6
1995	30.0	28.5	41.6	41.3	32.9	29.8
1996	33.2	31.9	42.9	44.0	37.6	37.0
1997	35.8	34.5	44.6	44.1	39.8	39.1
1998	34.8	34.4	46.1	43.9	40.7	37.3
1999	34.6	33.9	44.9	43.8	39.3	36.1
2000	30.6	30.5	45.6	45.0	32.5	34.1
2001	33.6	33.6	45.5	43.6	37.3	36.4
2002	33.9	33.7	44.0	42.5	37.2	37.3
2003	33.5	32.6	43.2	43.4	38.0	36.7
2004	34.3	33.4	44.6	45.2	38.7	36.6
2005	33.5	32.4	43.7	43.0	36.4	35.3
2006	33.2	32.9	44.7	42.7	37.1	36.1
2007	32.6	31.9	44.4	42.4	34.9	33.5

Table 3.2.1.6 Nephrops Skagerrak (FU 3): Catches and landings (tonnes), effort ('000 hours trawling), CPUE and LPUE (kg/hour trawling) of Swedish *Nephrops* trawlers, 1991–2005 (data presented for single and twin trawls separately).

Single trawl					
Year	Catches	Landings	Effort	CPUE	LPUE
1991	676	401	71.4	9.5	5.6
1992	360	231	73.7	4.9	3.1
1993	614	279	72.6	8.4	3.8
1994	441	246	60.1	7.3	4.1
1995	501	336	60.8	7.8	5.2
1996	754	488	51.1	14.8	9.6
1997	643	437	44.4	14.4	9.8
1998	794	557	49.7	16.0	11.2
1999	605	386	34.5	17.5	9.3
2000	486	329	32.7	14.9	10.9
2001	446	236	26.2	17.0	10.4
2002	503	301	29.4	17.1	8.8
2003	310	254	21.5	13.9	11.4
2004	474	257	20.1	23.6	12.8
2005	760	339	29.7	25.6	11.4
2006	839	401	37.5	22.4	10.7
2007	1607	564	57.3	28.0	9.8

Twin trawl					
Year	Catches	Landings	Effort	CPUE	LPUE
1991	740	439	39.5	18.7	11.1
1992	370	238	34.1	10.9	7.0
1993	568	258	35.9	15.8	7.2
1994	444	248	34.1	13.1	7.3
1995	403	270	32.9	12.2	8.2
1996	187	121	13.0	14.4	9.3
1997	219	149	17.5	12.5	8.5
1998	254	178	16.7	15.2	10.6
1999	382	244	27.6	13.8	8.8
2000	349	237	31.3	11.1	10.1
2001	470	249	33.7	14.0	7.4
2002	392	244	33.3	11.8	7.1
2003	168	138	22.5	7.5	6.1
2004	217	118	21.7	10.0	5.4
2005	263	117	22.1	11.9	5.3
2006	253	121	19.6	12.9	6.2
2007	69	24	3.1	22.0	7.7

Table 3.2.1.7 *Nephrops* Skagerrak (FU 3): Logbook recorded effort (days fishing) and LPUE (kg/day) for bottom trawlers catching *Nephrops* with codend mesh sizes of 70 mm or above, and estimated total effort by Danish trawlers, 1991–2007.

Year	Logbook data		Estimated total effort
	Effort	LPUE	
1991	17136	73	22158
1992	12183	70	16239
1993	11073	105	14068
1994	10655	110	11958
1995	10494	132	11935
1996	11885	138	12793
1997	11791	140	12075
1998	12501	155	13038
1999	13686	139	14787
2000	14802	120	15663
2001	14244	100	13976
2002	16386	123	16750
2003	10645	121	11802
2004	11987	122	12996
2005	10682	144	12003
2006	9638	141	10737
2007	7598	212	7877

Table 3.2.1.8 ***Nephrops*** **Kattegat (FU 4): Landings (tonnes) by country, 1991–2007.**

Year	Denmark	Sweden		Sub-total	Total
		Trawl	Creel		
1991	1185	119	0	119	1304
1992	901	111	0	111	1012
1993	765	159	0	159	924
1994	751	142	0	142	893
1995	850	148	0	148	998
1996	1072	213	0	213	1285
1997	1272	319	3	322	1594
1998	1486	306	4	310	1796
1999	1416	329	4	333	1749
2000	1448	357	4	361	1809
2001	1464	304	6	309	1773
2002	1240	219	5	224	1464
2003	1336	287	5	292	1628
2004	1360	270	11	281	1641
2005	1175	303	8	311	1486
2006	916	347	11	358	1274
2007	1223	491	15	505	1728

Table 3.2.1.9 ***Nephrops*** **Kattegat (FU 4): Mean sizes (mm CL) of male and female** ***Nephrops*** **in discards, landings and catches of Danish trawlers, 1991–2007.**

Year	**Catches**					
	Discards		**Landings**		**All**	
	Males	Females	Males	Females	Males	Females
1991	30.7	31.1	42.4	42.5	32.5	32.9
1992	33.0	30.3	44.4	43.2	36.7	34.9
1993	30.5	29.3	42.3	43.1	31.3	30.1
1994	29.7	28.3	40.8	40.2	31.2	28.9
1995	30.8	30.5	42.4	42.0	33.7	33.2
1996	32.7	31.3	42.0	44.0	36.7	37.3
1997	33.6	33.2	45.0	44.5	37.1	35.0
1998	34.2	33.2	45.6	44.1	41.3	36.8
1999	32.9	33.8	45.3	40.9	37.8	34.9
2000	35.1	35.2	45.7	42.1	40.4	36.9
2001	32.2	33.0	44.1	41.9	35.9	36.5
2002	34.4	33.3	44.4	43.8	37.2	36.2
2003	33.0	33.2	43.5	42.2	37.1	36.0
2004	34.7	34.2	45.1	43.2	39.9	37.5
2005	33.5	33.9	45.8	43.1	38.7	38.7
2006	33.2	33.6	45.1	42.8	37.9	37.4
2007	33.9	33.2	44.8	43.5	37.2	35.5

Table 3.2.1.10 Nephrops Kattegat (FU 4): Catches and landings (tonnes), effort ('000 hours trawling), CPUE and LPUE (kg/hour trawling) of Swedish *Nephrops* trawlers, 1991–2007 (data presented for single and twin trawls separately).

Single trawl					
Year	Catches	Landings	Effort	CPUE	LPUE
1991	66	39	10.3	6.4	3.7
1992	44	28	11.6	3.8	2.4
1993	128	58	14.9	8.6	3.9
1994	95	53	16.2	5.7	3.2
1995	79	53	9.6	7.8	5.5
1996	207	134	13.7	15.1	9.8
1997	269	183	18.0	15.0	10.2
1998	181	127	13.1	13.8	9.7
1999	146	93	8.1	17.9	11.4
2000	114	77	8.5	13.4	9.1
2001	117	62	7.6	15.4	8.2
2002	42	25	3.7	11.2	6.7
2003	49	40	4.6	10.7	8.7
2004	70	44	4.3	16.2	10.1
2005	147	100	12.3	11.9	8.1
2006	234	154	15.1	15.5	10.2
2007	588	282	21.4	27.4	13.1

Twin trawl					
Year	Catches	Landings	Effort	CPUE	LPUE
1991	93	55	8.8	10.6	6.2
1992	101	65	14.2	7.1	4.6
1993	187	85	17.8	10.6	4.8
1994	138	77	14.2	9.7	5.4
1995	125	84	11.0	12.2	7.7
1996	97	63	7.5	13.0	8.4
1997	183	124	12.7	14.3	9.7
1998	215	151	15.0	14.4	10.1
1999	306	195	20.1	15.2	9.7
2000	330	224	24.5	13.5	9.1
2001	353	187	25.1	14.1	7.4
2002	256	153	23.2	11.0	6.6
2003	222	181	24.8	9	7.3
2004	253	158	16.5	15.4	9.6
2005	198	135	15.3	12.9	8.8
2006	183	121	12.7	14.4	9.5
2007	60	29	1.9	31.8	15.2

Table 3.2.1.11 ***Nephrops*** **Kattegat (FU 4): Logbook recorded effort (days fishing) and LPUE (kg/day) for bottom trawlers catching Nephrops with codend mesh sizes of 70 mm or above, and estimated total effort by Danish trawlers, 1991–2007.**

Year	Logbook data		Estimated total effort
	Effort	LPUE	
1991	13494	69	17175
1992	12126	65	13627
1993	8815	75	10195
1994	9403	77	9802
1995	9039	91	9357
1996	9872	96	11209
1997	10028	112	11348
1998	10388	122	12144
1999	11434	109	13019
2000	12845	100	14448
2001	13017	93	15870
2002	11571	88	13772
2003	11768	103	13015
2004	11122	115	11669
2005	9286	127	9286
2006	8080	113	7998
2007	7165	162	7588

Table 3.2.1.12 *Nephrops* Kattegat (FU 4): Danish UTV survey, 2007. Density estimates

Station (10 min. hauls)	area (sq m)	nos / sq m (corr. f. visibility)	grams / sq m
KA1	132.0	1.01	27.85
KA2	108.7	0.74	20.35
KA3	126.4	0.78	21.67
KA4	126.7	0.37	10.19
KA6	106.9	0.13	3.58
KA7	98.2	0.14	3.81
KA8	149.0	0.08	2.23
KA9	134.3	0.37	10.25
KA10	134.6	0.69	19.00
KA11	104.7	0.66	18.28
KA12	107.7	0.54	14.95
KA13	153.0	0.44	12.15
KA14	136.2	0.44	12.16
KA15	132.9	0.49	13.60
KA16	116.2	0.72	19.89
KA17	138.6	0.46	12.79
KA18	139.4	0.51	14.12
KA19	144.2	0.38	10.36
KA20	119.1	0.29	8.10
KA21	140.4	0.51	14.04
KA22	132.9	0.52	14.24
KA23	123.9	0.50	13.74
KA24	126.7	0.41	11.26
KA25	128.5	0.50	13.83
KA26	104.3	0.48	13.35
KA27	100.2	0.61	16.86
KA28	98.7	0.37	10.14
KA29	144.7	0.55	15.26
Average		**0.49**	**13.50**

Table 3.4.1.1 Nominal landings (tonnes) of *Nephrops* in Division IV, 1984 – 2007, as officially reported to ICES.

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Belgium	638	679	344	437	500	574	610	427	384	418	304	410
Denmark	7	50	323	479	409	508	743	880	581	691	1128	1182
Faeroe Islands	-	-	-	0	0	0	0	0	0	1	3	12
France	-	-	-	7	0	0	0	0	0	0	0	0
Germany	.	.	.	0	0	0	0	2	2	16	24	16
Germany (Fed. Rep.)	5	4	5	1	2	1	2	0	0	0	0	0
Ireland	-	-	-	0	0	0	0	0	0	0	0	0
Netherlands	-	-	-	0	0	0	9	3	134	131	159	254
Norway	1	1	1	2	17	17	46	117	125	107	171	74
Sweden	-	1	-	0	0	0	0	4	0	1	1	1
UK (Eng + Wales + NI)	.	.	.	0	0	2938	2332	1955	1451	2983	3613	2530
UK (Eng + Wales)	1477	2052	2002	2173	2397	0	0	0	0	0	0	0
UK (Scotland)	4158	5369	6190	5304	6527	7065	6871	7501	6898	8250	8850	10018
UK	-	-	-	-	-	-	-	-	-	-	-	-
Total	6286	8156	8865	8403	9852	11103	10613	10889	9575	12598	14253	14497

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Belgium	185	311	238	350	252	283	284	229	213	183	211	206.2
Denmark	1315	1309	1440	1963	1747	1935	2154	2128	2244	2339	2021	1407
Faeroe Islands	0	1	1	1	0	0	0	0	0	0	0	0
France	0	0	0	0	0	0	0	0	0	0	0	0.04
Germany	69	64	58	104	79	140	125	50	50	109	288	602
Germany (Fed. Rep.)	0	0	0	0	0	0	0	0	0	0	0	0
Ireland	0	0	0	0	0	0	0	1	2	0	0	0
Netherlands	423	627	695	662	572	851	966	940	918	1019	982	1147
Norway	83	64	93	144	147	115	130	100	93	131	96	99
Sweden	0	1	3	4	37	26	14	1	1	3	2	5.89
UK (Eng + Wales + NI)	2462	2206	2094	2431	2210	2691	1964	2295	2241	3622	0	0
UK (Eng + Wales)	0	0	0	0	0	0	0	0	0	0	0	0
UK (Scotland)	8981	10466	8980	10715	9834	9681	11045	10094	12912	14446	0	0
UK	-	-	-	-	-	-	-	-	-	-	21003	21160
Total	13518	15049	13602	16374	14878	15722	16682	15838	18674	21851	24603	24627

Table 3.4.1.2 *Nephrops*, International landings from Division IV.

Year	Belgium	Denmark	Germany	Netherl.	Norway	Sweden	UK
1981							3980
1982							5437
1983							5551
1984							5628
1985		7					7380
1986		50					8186
1987		323					7468
1988		91					8914
1989		175					10001
1990	7	242			1		9194
1991	708	733			4		9455
1992	593	486			28		8344
1993	707	682			105		11235
1994	515	1126			171		12425
1995	657	1179		256	75		12552
1996	290	1310		424	83		11599
1997	491	1302		629	64		12677
1998	380	1437	57	708	91		11071
1999	491	1961	103	670	144		13142
2000	398	1743	79	613	147	37	12049
2001	434	1902	139	945	114	26	12377
2002	327	2148	126	1032	126	13	12978
2003	281	2117	50	1034	100	1	12073
2004	228	2229	50	1048	93	1	14950
2005	192	2191	108	1027	132	2	18241
2006	227	2015	287	989	114	1	20811
2007*	209	1430	623	1162	97	5	21071

* provisional

Table 3.4.1.3 Nephrops, Landings from functional units and other areas in Division IV

Year	FU 5	FU 6	FU 7	FU 8	FU 9	FU10	FU32	FU 33	Other	Total
1981		1073	373	1006	1416	36			76	3980
1982		2524	422	1195	1120	19			157	5437
1983		2078	693	1724	940	15			101	5551
1984		1479	646	2134	1170	111			88	5628
1985		2027	1148	1969	2081	22			139	7386
1986		2015	1543	2263	2143	68			204	8236
1987		2191	1696	1674	1991	44			195	7791
1988		2505	1573	2528	1959	76			364	9005
1989		3098	2299	1886	2576	84			233	10176
1990		2498	2540	1930	2038	217			222	9445
1991	862	2064	4221	1404	1519	196		74	560	10900
1992	612	1463	3363	1757	1591	188		76	401	9451
1993	721	3030	3493	2369	1808	376	339	160	434	12730
1994	503	3684	4569	1850	1538	495	755	137	703	14234
1995	869	2568	6440	1763	1297	280	489	164	844	14714
1996	679	2482	5218	1688	1451	344	952	77	808	13699
1997	1149	2189	6171	2194	1446	316	760	276	662	15163
1998	1111	2176	5136	2145	1032	254	836	357	694	13741
1999	1244	2401	6521	2205	1008	279	1119	737	988	16502
2000	1121	2178	5570	1785	1541	275	1084	610	900	15064
2001	1443	2574	5541	1528	1403	177	1190	791	1268	15915
2002	1231	1953	7247	1340	1118	401	1170	861	1383	16704
2003	1144	2245	6294	1126	1079	337	1089	929	1390	15633
2004	1070	2152	8729	1658	1335	228	922	1268	1224	18586
2005	1066	3093	10685	1990	1605	165	1089	1050	1120	21863
2006	986	4835	10693	2425	1771	133	1028	1292	1249	24412
2007*	1311	2955	11910	2566	1841	155	755	1467	1637	24598

* provisional

Table 3.4.1.4 *Nephrops*, Moray Firth (FU 9), Nominal Landings of *Nephrops*, 1981–2007, 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	210	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	2101	475	0	2576	0	2576
1990	1698	340	0	2038	0	2038
1991	1285	234	0	1519	0	1519
1992	1285	306	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	193	2	1008	0	1008
2000	1344	194	3	1541	0	1541
2001	1188	213	2	1403	0	1403
2002	884	232	2	1118	0	1118
2003	874	194	11	1079	0	1079
2004	1223	103	9	1335	0	1335
2005	1526	64	12	1602	3	1605
2006	1718	73	11	1802	1	1803
2007	1818	16	6	1840	2	1843

* provisional na = not available

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

Table 3.4.1.5 *Nephrops*, Moray Firth (FU 9): Mean sizes (CL mm) above and below 35 mm of male and female *Nephrops* in Scottish catches and landings, 1991–2007.

Year	Catches		Landings			
	< 35 mm CL		< 35 mm CL		=> 35 mm CL	
	Males	Females	Males	Females	Males	Females
1981	na	na	30.5	28.2	39.1	37.7
1982	na	na	30.2	29.0	40.0	37.9
1983	na	na	29.9	29.1	40.6	38.3
1984	na	na	29.7	29.3	39.4	38.1
1985	na	na	28.9	28.7	38.7	37.8
1986	na	na	28.7	27.8	39.1	38.4
1987	na	na	29.0	28.3	39.5	38.6
1988	na	na	29.1	28.7	38.9	38.4
1989	na	na	29.8	28.8	40.1	39.4
1990	28.8	28.1	30.4	29.1	38.4	38.7
1991	28.4	27.4	30.1	28.7	38.2	38.2
1992	29.4	28.6	31.0	30.5	38.3	38.0
1993	29.8	29.9	31.3	30.9	38.6	37.7
1994	28.9	30.1	30.8	31.0	39.5	37.5
1995	25.8	25.0	29.9	29.3	39.1	38.0
1996	29.3	28.4	30.6	29.7	38.5	38.0
1997	28.5	27.9	29.5	28.9	38.8	38.2
1998	28.7	28.2	30.1	29.3	38.8	38.2
1999	29.5	28.8	30.4	29.7	38.9	37.6
2000	29.8	29.1	31.5	30.6	39.2	38.3
2001	30.0	29.2	30.9	30.2	39.6	37.9
2002	27.2	27.0	31.2	30.9	41.0	38.7
2003	29.3	29.2	30.3	30.1	39.8	38.0
2004	29.3	28.3	31.1	30.3	39.0	39.1
2005	30.0	28.6	31.0	29.6	39.2	38.5
2006	30.2	29.3	30.6	29.6	39.3	38.6
2007	30.0	28.8	30.3	29.0	39.4	38.6
* provisional na = not available						

Table 3.4.1.6 *Nephrops*, Moray Firth (FU 9): Landings (tonnes), effort ('000 hours trawling) and LPUE (kg/hour trawling) of Scottish *Nephrops* trawlers, 1981–2007 (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	1526	35.5	43.0	649	27.2	23.9	234	7.9	29.6
2003	1718	41.1	41.8	737	25.3	29.1	135	3.6	37.5
2004	1818	36.9	49.3	1100	29.2	37.7	123	2.5	49.2
2005	1526	37.6	40.6	1309	34.0	38.5	217	3.6	60.3
2006	1718	41.1	41.8	1477	37.4	39.5	241	3.7	65.1
2007	1818	36.9	49.3	1503	32.4	46.4	315	4.5	70.0

Table 3.4.1.7 *Nephrops*, Moray Firth (FU 9):Summary of TV results for most recent 3 years (2005–2007) showing strata surveyed, numbers of stations in each strata, mean density and observed variance, overall abundance and variance raised to stratum area. Proportion indicates relative amounts of overall raised variance attributable to each stratum.

Stratum	Area (km²)	Number of Stations	Mean burrow density (no./m²)	Observed variance	Abundance (millions)	Stratum variance	Proportion of total variance
2005 TV survey							
M & SM	169	7	0.65	0.19	110	755	0.070
MS(west)	682	10	0.44	0.10	298	4510	0.418
MS(mid)	698	12	0.35	0.04	247	1631	0.151
MS(east)	646	13	0.33	0.12	211	3904	0.362
Total	2195	42			866	10799	1
2006 TV survey							
M & SM	169	6	0.43	0.02	72	107	0.021314
MS(west)	682	19	0.16	0.05	112	1305	0.260038
MS(mid)	698	12	0.19	0.04	132	1515	0.301956
MS(east)	646	13	0.30	0.07	193	2091	0.416692
Total	2195	50			509	5018	1
2007 TV survey							
M & SM	169	3	0.42	0.10	72	976	0.098
MS(west)	682	12	0.29	0.11	195	4283	0.430
MS(mid)	698	11	0.22	0.01	156	408	0.041
MS(east)	646	13	0.33	0.13	215	4288	0.431
Total	2195	39			637	9955	1

Table 3.4.1.8 *Nephrops*, Moray Firth (FU 9): Results of the 1993–2007 TV surveys.

Year	Stations	Mean density	Abundance	95% confidence interval
		burrows/m²	millions	millions
1993	31	0.19	418	94
1994	29	0.39	850	213
1995		no survey		
1996	27	0.26	563	109
1997	34	0.14	317	66
1998	31	0.18	391	115
1999	52	0.22	484	105
2000	44	0.21	467	118
2001	45	0.19	417	135
2002	31	0.29	630	146
2003	32	0.32	706	306
2004	42	0.31	686	200
2005	42	0.36	801	192
2006	50	0.22	437	140
2007	39	0.28	566	190

Table 3.4.1.9 *Nephrops*, Moray Firth (FU 9): Predicted landings potential based on abundance estimates using TV surveys, current landings and discard length distributions for the Moray Firth, and a range of harvest ratios.

Males

Weight = a*CL^b — a = 0.00028, b = 3.24

CL	Landings ('000)	Discards ('000)	Removals ('000)	wt (g)	Landings (t)
11	0.0	0.0	0.0	0.88	0.00
13	0.0	0.0	0.0	1.45	0.00
15	7.6	0.7	8.1	2.23	16.96
17	32.4	16.5	44.8	3.27	105.87
19	125.3	72.0	179.3	4.60	576.03
21	259.9	326.3	504.6	6.26	1627.10
23	576.4	608.0	1032.4	8.30	4783.73
25	1679.0	1130.7	2527.0	10.76	18060.19
27	3958.6	1035.8	4735.5	13.68	54136.69
29	5470.3	375.5	5751.9	17.10	93549.62
31	6692.9	122.7	6784.9	21.08	141077.68
33	6010.4	51.8	6049.3	25.65	154188.90
35	4832.4	27.3	4852.9	30.87	149190.45
37	3548.5	3.7	3551.3	36.78	130527.40
39	2236.3	6.6	2241.3	43.43	97132.03
41	1478.9	0.7	1479.4	50.87	75235.80
43	972.4	0.0	972.4	59.15	57516.13
45	517.6	3.1	519.9	68.31	35358.00
47	297.8	0.0	297.8	78.41	23350.94
49	144.1	0.0	144.1	89.50	12896.88
51	79.6	0.0	79.6	101.63	8089.50
53	37.8	0.0	37.8	114.85	4341.16
55	16.9	0.0	16.9	129.21	2183.60
57	24.4	0.0	24.4	144.77	3532.28
59	4.1	0.0	4.1	161.57	662.45
61	2.6	0.0	2.6	179.68	467.18
63	0.0	0.0	0.0	199.15	0.00
65	0.0	0.0	0.0	220.03	0.00
67	0.0	0.0	0.0	242.37	0.00
69	0.0	0.0	0.0	266.24	0.00
Total			41842.25		1068.61

Females

a = 0.00085, b = 2.91

CL	Landings ('000)	Discards ('000)	Removals ('000)	wt (g)	Landings (t)
11	0.0	0.0	0.0	1.17	0.00
13	0.0	0.0	0.0	1.84	0.00
15	26.1	0.0	26.1	2.71	70.80
17	73.0	30.4	95.8	3.82	278.99
19	215.0	171.7	343.8	5.19	1116.49
21	731.0	503.8	1108.9	6.85	5009.41
23	1739.9	753.8	2305.3	8.83	15358.82
25	3469.7	1102.8	4296.8	11.14	38661.91
27	5375.5	929.0	6072.3	13.82	74313.49
29	6233.1	380.7	6518.6	16.90	105328.49
31	5403.9	144.5	5512.3	20.39	110182.51
33	3982.8	76.3	4040.0	24.32	96874.86
35	3002.2	11.7	3011.0	28.72	86238.03
37	2184.7	1.3	2185.7	33.62	73448.17
39	1329.5	1.3	1330.5	39.03	51892.17
41	689.3	0.0	689.3	44.99	31008.63
43	377.6	0.0	377.6	51.51	19449.04
45	143.8	0.0	143.8	58.62	8429.52
47	90.5	0.7	91.0	66.35	6004.54
49	31.8	0.0	31.8	74.72	2376.01
51	12.9	0.0	12.9	83.75	1080.38
53	7.1	0.0	7.1	93.47	663.66
55	2.8	0.0	2.8	103.91	290.94
57	1.3	0.0	1.3	115.08	149.60
59	0.6	0.0	0.6	127.01	76.21
61	0.1	0.0	0.1	139.73	13.97
63	0.0	0.0	0.0	153.25	0.00
65	0.0	0.0	0.0	167.61	0.00
67	0.0	0.0	0.0	182.82	0.00
69	0.0	0.0	0.0	198.91	0.00
Total			38205.20		728.32

Removals (M+F 000s) 80047.45 Land Wt 1796.92

TV abundance (thousands) 622820.2

Predicted Landings = Land Wt * TV abundance * harvest rate / removals

Predicted Landings (tonnes)

Landings with harvest ratio eq. Fmax (0.71)	7094.19
Landings with harvest ratio eq. to F0.1 (0.24)	3032.86
Landings potential with 25% harvest rate	3495.30
Landings potential with 20% harvest rate	2796.24
Landings potential with 15% harvest rate	2097.18
Landings potential with 18% removals	2516.62
Landings potential with 10% removals	1398.12

Table 3.4.1.10 *Nephrops*, Noup (FU 10), Nominal Landings of *Nephrops*, 1981–2007, as officially reported.

Year	UK Scotland				Total **
	Nephrops trawl	Other trawl	Creel	Sub-total	
1981	13	23	0	36	36
1982	12	7	0	19	19
1983	9	6	0	15	15
1984	75	36	0	111	111
1985	2	20	0	22	22
1986	46	22	0	68	68
1987	12	32	0	44	44
1988	23	53	0	76	76
1989	24	61	0	84	84
1990	101	116	0	217	217
1991	110	86	0	196	196
1992	56	130	0	188	188
1993	200	176	0	376	376
1994	308	187	0	495	495
1995	162	118	0	280	280
1996	180	164	0	344	344
1997	185	130	1	316	316
1998	183	71	0	254	254
1999	211	68	0	279	279
2000	196	79	0	275	275
2001	89	88	0	177	177
2002	244	157	0	401	401
2003	258	79	0	337	337
2004	175	53	0	228	228
2005	81	84	0	165	165
2006	44	89	0	133	133
2007*	47	108	0	155	155

* provisional na = not available

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

Table 3.4.1.11 *Nephrops*, Noup (FU 10): Mean sizes (CL mm) above and below 35 mm of male and female *Nephrops* in Scottish catches and landings, 1991–2007

Year	Catches		Landings			
	< 35 mm CL		< 35 mm CL		> 35 mm CL	
	Males	Females	Males	Females	Males	Females
1997	na	na	29.7	28.3	40.4	38.2
1998	na	na	30.4	29.8	38.8	38.6
1999	na	na	30.4	30.1	39.2	37.8
2000	na	na	31.8	30.1	38.2	39.1
2001	na	na	31.4	29.6	38.7	37.9
2002	na	na	30.8	29.9	39.7	38.5
2003	na	na	29.3	30.4	39.9	38.5
2004	na	na	31.0	30.0	39.2	38.9
2005	na	na	31.0	29.3	39.3	38.4
2006	na	na	30.8	30.2	40.4	38.7
2007	na	na	30.7	29.4	40.2	38.7

* provisional na = not available

Table 3.4.1.12*Nephrops*, Noup (FU 10): Landings (tonnes), effort ('000 hours trawling) and LPUE (kg/hour trawling) of Scottish *Nephrops* trawlers, 1981–2007 (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	81	0.6	133.9	185	2.1	88.1	59	1.2	49.2
2003	258	0.5	551.3	217	2.3	94.3	41	0.4	102.5
2004	175	2.2	79.5	144	2.2	65.2	31	0.0	-
2005	81	0.6	135.0	58	0.6	98.3	23	0.0	-
2006	44	0.3	146.7	42	0.4	94.6	2	0.0	-
2007	47	0.6	78.3	43	0.6	71.3	4	0.0	-

Table 3.4.1.13 *Nephrops*, Noup (FU 10): Results of the 1994–1999 and 2006–2007 TV surveys. No TV surveys were possible for this stock between 2000–2004 and in 2005 poor visibility prevented a full analysis

Year	Stations	Mean density	Abundance	95% confidence interval
		burrows/m²	millions	millions
1994	10	0.63	250	90
1995	no survey			
1996	no survey			
1997	no survey			
1998	no survey			
1999	10	0.30	120	42
2000	no survey			
2001	no survey			
2002	no survey			
2003	no survey			
2004	no survey			
2005	2	poor visibility, limited survey - see text		
2006	7	0.18	73.7	47.1
2007	9	0.15	60	25

Table 3.4.2.2 *Nephrops*, Fladen (FU 7), Nominal Landings of *Nephrops*, 1981–2007, 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	6	4223
1992	359	1794	1179	2973	31	3363
1993	224	2033	1233	3266	3	3493
1994	390	1817	2356	4173	6	4569
1995	439	3569	2428	5997	4	6440
1996	286	2338	2592	4930	2	5218
1997	235	2713	3221	5934	2	6171
1998	173	2291	2672	4963	0	5136
1999	96	2860	3549	6409	16	6521
2000	103	2915	2546	5461	6	5570
2001	64	3539	1936	5475	2	5541
2002	173	4513	2546	7059	15	7247
2003	82	4175	2033	6208	4	6294
2004	136	7274	1319	8593	0	8729
2005	321	8849	1514	10363	0	10684
2006	283	9469	1028	10497	2	10782
2007*	119	11054	734	11788	0	11907

Table 3.4.2.3*Nephrops*, Fladen (FU 7): Mean sizes (CL mm) above and below 35 mm of male and female *Nephrops* in Scottish catches and landings, 1993–2007.

Year	Catches		Landings			
	< 35 mm CL		< 35 mm CL		> 35 mm CL	
	Males	Females	Males	Females	Males	Females
1993	na	na	30.4	29.6	38.7	38.2
1994	na	na	30.0	28.9	39.2	37.8
1995	na	na	30.6	29.8	39.9	38.1
1996	na	na	30.4	29.1	40.6	38.8
1997	na	na	30.2	29.1	40.9	38.8
1998	na	na	30.8	29.4	40.7	38.4
1999	na	na	30.9	29.6	40.5	38.5
2000	30.8	30.1	31.2	30.5	41.3	38.7
2001	30.1	29.4	30.7	29.7	39.6	38.0
2002	30.6	30.1	31.3	30.7	39.5	38.3
2003	30.9	29.8	31.3	30.1	40.0	38.1
2004	30.8	29.6	31.1	29.8	39.9	38.8
2005	30.9	30.0	31.2	30.1	40.1	38.2
2006	30.1	29.5	30.8	30.0	40.7	38.3
2007*	29.8	28.8	30.4	29.4	40.9	38.9

* provisional   na = not available

Table 3.4.2.4 *Nephrops*, Fladen (FU 7): Landings (tonnes), effort ('000 hours trawling) and LPUE (kg/hour trawling) of Scottish *Nephrops* trawlers, 1981–2007 (data for all *Nephrops* gears combined, and for single and multirigs separately).

Year	All *Nephrops* gears combined			Single rig			Multirig		
	Landings	Effort	LPUE	Landings	Effort	LPUE	Landings	Effort	LPUE
1981	304	8.6	35.3	304	8.6	35.3	na	na	na
1982	382	12.2	31.3	382	12.2	31.3	na	na	na
1983	548	15.4	35.6	548	15.4	35.6	na	na	na
1984	549	11.4	48.2	549	11.4	48.2	na	na	na
1985	1016	26.6	38.2	1016	26.6	38.2	na	na	na
1986	1398	37.8	37.0	1398	37.8	37.0	na	na	na
1987	1024	41.6	24.6	1024	41.6	24.6	na	na	na
1988	1306	41.7	31.3	1306	41.7	31.3	na	na	na
1989	1719	47.2	36.4	1719	47.2	36.4	na	na	na
1990	1703	43.4	39.2	1703	43.4	39.2	na	na	na
1991	3024	78.5	38.5	410	11.4	36.0	2614	67.1	39.0
1992	1794	38.8	46.2	340	9.4	36.2	1454	29.4	49.5
1993	2033	49.9	40.7	388	9.6	40.4	1645	40.3	40.8
1994	1817	48.8	37.2	301	8.4	35.8	1516	40.4	37.5
1995	3569	75.3	47.4	2457	52.3	47.0	1022	23.0	44.4
1996	2338	57.2	40.9	2089	51.4	40.6	249	5.8	42.9
1997	2713	76.5	35.5	2013	54.7	36.8	700	21.8	32.1
1998	2291	60.0	38.2	1594	39.6	40.3	697	20.5	34.0
1999	2860	76.8	37.2	1980	50.3	39.4	880	26.5	33.2
2000	2915	92.1	31.7	2002	62.9	31.8	913	29.2	31.3
2001	3539	108.2	32.7	2162	65.8	32.9	1377	42.4	32.5
2002	4513	109.6	41.2	2833	58.9	48.1	1680	50.7	33.1
2003	4175	53.7	77.7	3388	42.8	79.2	787	10.9	72.2
2004	7274	56.1	129.8	6177	47.5	130.2	1097	8.6	127.6
2005	8849	61.3	144.4	6834	43.4	157.5	2015	17.9	112.7
2006	9469	65.7	144.1	7149	50.2	142.4	2320	15.5	149.7
2007	11054	69.6	158.8	8232	52.2	157.7	2822	17.4	162.2

Table 3.4.2.5*Nephrops*, Fladen (FU 7): Logbook recorded effort (days fishing) and LPUE (kg/day) for bottom trawlers catching Nephrops with codend mesh sizes of 70 mm or above, and estimated total effort by Danish trawlers, 1991–2007.

Year	Logbook data	
	Effort	LPUE
1991	3115	116
1992	2289	130
1993	820	130
1994	1209	251
1995	841	343
1996	568	254
1997	395	349
1998	268	165
1999	197	251
2000	292	170
2001	213	181
2002	335	368
2003	194	308
2004	290	461
2005	607	482
2006	576	450
2007*	274	426

* provisional na = not available

Table 3.4.2.6 *Nephrops*, Fladen Ground (FU 7):Summary of TV results for most recent 3 years (2005–2007) showing strata surveyed, numbers of stations in each strata, mean density and observed variance, overall abundance and variance raised to stratum area. Proportion indicates relative amounts of overall raised variance attributable to each stratum.

Stratum (ranges of % silt clay)	Area (km²)	Number of Stations	Mean burrow density (no./m²)	Observed variance	Abundance (millions)	Stratum variance	Proportion of total variance	
2005 TV survey								
>80	3248	13	0.30	0.01	967	5940	0.055	0
55<80	4967	22	0.25	0.01	1257	9540	0.088	0
40<55	4304	12	0.22	0.01	961	9410	0.087	0
<40	15634	25	0.10	0.01	1607	83635	0.771	1
Total	28153	72			4793	108524	1	
2006 TV survey								
>80	3248	11	0.31	0.00	1019	2921	0.019	0
55<80	4967	17	0.31	0.02	1525	23357	0.153	0
40<55	4304	13	0.23	0.02	996	21936	0.143	0
<40	15634	28	0.16	0.01	2568	104780	0.685	1
Total	28153	69			6109	152993	1	
2007 TV survey								
>80	3248	12	0.48	0.00	1567	2176	0.010	
55<80	4967	17	0.40	0.01	1995	18922	0.089	
40<55	4304	17	0.33	0.02	1430	21414	0.101	
<40	15634	36	0.25	0.02	3861	169149	0.799	
Total	28153	82			8854	211661	1	

Table 3.4.2.7 ***Nephrops*****, Fladen (FU 7): Results of the 1992–2007 TV surveys.**

Year	Stations	Mean density	Abundance	95% confidence interval
		burrows/m²	millions	millions
1992	69	0.17	4942	508
1993	74	0.21	6007	768
1994	59	0.30	8329	1099
1995	61	0.24	6733	1209
1996	No survey			
1997	56	0.13	3736	689
1998	60	0.18	5181	968
1999	62	0.20	5597	876
2000	68	0.17	4898	663
2001	50	0.23	6725	1310
2002	54	0.29	8217	1022
2003	55	0.21	5890	1129
2004	52	0.21	5976	1112
2005	72	0.17	4793	659
2006	69	0.23	6464	892
2007	82	0.31	8854	920

Table 3.4.2.8 ***Nephrops*****, Fladen (FU 7): Predicted landings potential based on abundance estimates using TV surveys, current landings and discard length distributions for the Fladen, and a range of harvest ratios.**

Males Weight = a*CL^b a = 0.00028 b = 3.24

Females a = 0.00085 b = 2.91

CL	Landings ('000)	Discards ('000)	Removals ('000)	wt (g)	Landings (t)	CL	Landings ('000)	Discards ('000)	Removals ('000)	wt (g)	Landings (t)
11	0.0	0.0	0.0	0.88	0.00	11	0.0	0.0	0.0	1.17	0.00
13	0.0	1.1	0.8	1.45	0.00	13	0.0	1.1	0.8	1.84	0.00
15	37.3	25.2	56.2	2.23	83.22	15	58.1	29.3	80.1	2.71	157.61
17	109.6	123.8	202.5	3.27	358.14	17	283.1	118.5	372.0	3.82	1081.94
19	445.5	329.5	692.6	4.60	2048.06	19	732.7	498.8	1106.8	5.19	3804.89
21	1076.3	1017.8	1839.7	6.26	6738.15	21	2894.7	1873.8	4300.1	6.85	19836.84
23	2914.6	2134.2	4515.3	8.30	24189.19	23	7964.1	5286.4	11928.9	8.83	70302.43
25	7106.2	5610.6	11314.2	10.76	76437.96	25	16748.9	9908.2	24180.1	11.14	186628.37
27	15517.2	8791.6	22110.9	13.68	212208.81	27	26128.0	12053.2	35167.9	13.82	361206.01
29	23290.7	9083.5	30103.3	17.10	398302.87	29	33388.9	10711.8	41422.8	16.90	564214.04
31	29101.4	4791.6	32695.1	21.08	613419.88	31	32424.6	6086.9	36989.8	20.39	661119.53
33	29516.5	1699.2	30790.9	25.65	757206.93	33	25666.4	3014.1	27927.0	24.32	624291.66
35	26846.2	560.3	27266.4	30.87	828821.40	35	16473.1	1110.4	17305.9	28.72	473188.89
37	23122.5	120.8	23213.1	36.78	850533.99	37	10256.3	457.0	10599.1	33.62	344810.04
39	16553.9	56.3	16596.1	43.43	719006.36	39	5913.1	146.9	6023.3	39.03	230796.24
41	12995.1	20.1	13010.2	50.87	661097.26	41	3271.2	25.3	3290.2	44.99	147157.18
43	9484.9	4.2	9488.1	59.15	561018.86	43	1710.6	19.9	1725.5	51.51	88107.87
45	6291.9	1.3	6292.9	68.31	429808.72	45	972.2	6.2	976.9	58.62	56990.15
47	4264.9	0.0	4264.9	78.41	334417.11	47	541.8	0.0	541.8	66.35	35947.60
49	2469.9	0.0	2469.9	89.50	221054.94	49	162.7	1.3	163.7	74.72	12156.52
51	1503.2	0.0	1503.2	101.63	152765.62	51	59.4	0.0	59.4	83.75	4974.79
53	846.6	0.0	846.6	114.85	97228.16	53	53.2	0.0	53.2	93.47	4972.75
55	504.8	0.0	504.8	129.21	65223.87	55	23.9	0.0	23.9	103.91	2483.38
57	285.1	0.0	285.1	144.77	41272.61	57	15.3	0.0	15.3	115.08	1760.70
59	138.2	0.0	138.2	161.57	22329.35	59	14.0	0.0	14.0	127.01	1778.14
61	67.9	0.0	67.9	179.68	12200.48	61	2.7	0.0	2.7	139.73	377.26
63	18.2	0.0	18.2	199.15	3624.54	63	0.3	0.0	0.3	153.25	45.98
65	6.5	0.0	6.5	220.03	1430.19	65	6.8	0.0	6.8	167.61	1139.73
67	10.9	0.0	10.9	242.37	2641.88	67	0.6	0.0	0.6	182.82	109.69
69	1.7	1.3	2.7	266.24	452.61	69	0.0	0.0	0.0	198.91	0.00

Total	240307.00		7095.92	224278.53	3899.44
Removals (M+F 000s)	464585.53	Land Wt	10995.36		
TV abundance (thousands)	6703362.4				

Predicted Landings = Land Wt * TV abundance * harvest rate / removals

Predicted Landings (tonnes)

Landings with harvest ratio eq. Fmax (0.33)	44364.04
Landings with harvest ratio eq. to F0.1 (0.18)	26187.16
Landings potential with 25% harvest rate	39662.18
Landings potential with 20% harvest rate	31729.74
Landings potential with 15% harvest rate	23797.31
Landings potential with 10% harvest rate	15864.87

Table 3.4.3.1 *Nephrops* Norwegian Deep (FU 32): Landings (tonnes) by country, 1993–2007.

Year	Denmark	Norway			Sweden	UK	Total
		Trawl	Creel	Sub-total			
1993	220	102	1	103		16	339
1994	584	161	0	161		10	755
1995	418	68	1	69		2	489
1996	868	73	1	74		10	952
1997	689	56	8	64		7	760
1998	743	88	1	89		4	836
1999	972	119	15	134		13	1119
2000	871	143	0	143	37	33	1084
2001	1026	72	13	85	26	53	1190
2002	1043	42	21	63	13	52	1171
2003	996	68	11	79	1	14	1090
2004	835	72	8	80	1	6	922
2005	979	89	13	102	2	6	1089
2006	939	62	19	81	1	6	1027
2007*	652	77	20	97	5	1	755

* provisional   na = not available

Table 3.4.3.2 *Nephrops* Norwegian Deep (FU 32): Danish effort(days and LPUE, 1993 to 2007

Year	Effort	LPUE
1993	1317	121
1994	2126	208
1995	1792	198
1996	3139	235
1997	3189	218
1998	2707	214
1999	3710	226
2000	3986	192
2001	5372	166
2002	4968	188
2003	5273	177
2004	3488	216
2005	3919	234
2006	4796	196
2007	2878	226

Table 3.4.4.2*Nephrops* Farn Deeps (FU 6): Landings (tonnes) by country, 1981–2007

Year	UK England	UK Scotland	Sub total	Other countries**	Total
1981	1006	67	1073	0	1073
1982	2443	81	2524	0	2524
1983	2073	5	2078	0	2078
1984	1471	8	1479	0	1479
1985	2009	18	2027	0	2027
1986	1987	28	2015	0	2015
1987	2158	33	2191	0	2191
1988	2390	105	2495	0	2495
1989	2930	168	3098	0	3098
1990	2306	192	2498	0	2498
1991	1884	179	2063	0	2063
1992	1403	60	1463	10	1473
1993	2941	89	3030	0	3030
1994	3530	153	3683	0	3683
1995	2478	90	2568	1	2569
1996	2386	96	2482	1	2482
1997	2109	80	2189	0	2189
1998	2029	147	2176	1	2177
1999	2197	194	2391	0	2391
2000	1947	231	2178	0	2178
2001	2319	255	2574	0	2574
2002	1739	215	1953	0	1953
2003	2031	214	2245	0	2245
2004	1952	201	2152	0	2152
2005	2936	158	3093	0	3094
2006	4385	434	4819	39	4858
2007*	2525	437	2962	4	2966

* provisional   na = not available
** Other countries includes Ne, Be and Dk

Table 3.4.4.3 *Nephrops* Farn Deeps (FU 6): Mean sizes (CL mm) of male and female *Nephrops* in English catches and landings, 1985–2007.

	Catches		**Landings**	
Year	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	35.3	33.3
1988	28.7	27.3	35	33.9
1989	29	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	33	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	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
2002	28.5	27.4	31.3	30.4
2003	29.6	27.8	32.2	31.2
2004	29.4	27.3	32.6	30.9
2005	30.1	28.6	32.5	31.3
2006	29.3	30.4	31.7	32.6
2007*	31.3	30.9	33.4	32.9

* provisional   na = not available

Table 3.4.4.4 ***Nephrops*** **Farn Deeps (FU 6): Catches and landings (tonnes), effort ('000 hours trawling), CPUE and LPUE (kg/hour trawling) of UK** ***Nephrops*** **trawlers, 1985–2007.**

Year	Catches	Landings	Effort	CPUE	LPUE
1985	3942	2012	88.7	44.5	22.7
1986	2597	1995	90.1	28.8	22.1
1987	4221	2177	98.3	43	22.2
1988	5312	2472	118.1	45	20.9
1989	4437	3076	133.5	33.2	23
1990	3501	2471	116.2	30.1	21.3
1991	2824	2020	114.7	24.6	17.6
1992	2178	1437	69.5	31.3	20.7
1993	3391	3011	111.8	30.3	26.9
1994	5094	3684	143.4	35.5	25.7
1995	4714	2539	97	48.6	26.2
1996	4417	2475	90.5	48.8	27.4
1997	3263	2155	85.3	38.2	25.3
1998	3154	2128	78.2	40.3	27.2
1999	3936	2369	86.7	45.4	27.3
2000	3804	2073	88.7	42.9	23.4
2001	5069	2412	103.6	48.9	23.3
2002	2683	1898	75.2	36	25.2
2003	2834	2165	77.9	46.4	27.8
2004	2607	1986	60.8	47.2	32.7
2005	3586	2819	72.8	49.9	38.7
2006	5755	4620	98.1	62.9	47.1
2007*	3084	2633	90.6	37.5	29.1

* provisional   na = not available

Table 3.4.4.5 *Nephrops* Farn Deeps (FU 6): Results from TV surveys carried out in 1996–2007, 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	0.53	1751	120	19.5 - 40.7
	-	Autumn	No survey			
1997	105	Spring	0.53	1793	167	13.0 - 36.4
	87	Autumn	0.55	1800	150	20.4 - 29.2
1998	78	Spring	0.25	795	58	9.7 - 12.1
	91	Autumn	0.39	1308	107	9.6 - 48.7
1999	95	Spring	0.29	994	94	18.9 - 25.5
	-	Autumn	No survey			
2000	98	Spring	0.33	1113	80	12.5 - 20.0
	-	Autumn	No survey			
2001	-	Spring	No survey			
	180	Autumn	0.67	2022	80	17.1 - 39.0
2002	180	Spring	0.54	1668	112	19.1 - 37.5
	37	Autumn	0.39	1258	134	14.2 - 23.0
2003	-	Spring	No survey			
	89	Autumn	0.39	1302	108	16.1 - 32.0
2004	-	Spring	No survey			
	76	Autumn	0.51	1652	121	19.9 - 40.8
2005	-	Spring	No survey			
	105	Autumn	0.59	1988	177	23.4 - 45.2
2006	-	Spring	No survey			
	105	Autumn*	0.44	1492	137	22.0 - 36.7
2007*	-	Spring	No survey			
	105	Autumn*	0.34	1149	137	11.4 - 36.7

* provisional

Table 3.4.4.7*Nephrops*, Firth of Forth (FU 8), Nominal Landings of *Nephrops*, 1981–2007, as officially reported.

Year	UK Scotland				UK England	Total **
	Nephrops trawl	Other trawl	Creel	Sub-total		
1981	945	61	0	1006	0	1006
1982	1138	57	0	1195	0	1195
1983	1681	43	0	1724	0	1724
1984	2078	56	0	2134	0	2134
1985	1908	61	0	1969	0	1969
1986	2204	59	0	2263	0	2263
1987	1582	92	0	1674	0	1674
1988	2455	73	0	2528	0	2528
1989	1833	52	0	1885	1	1886
1990	1901	28	0	1929	1	1930
1991	1359	45	0	1404	0	1404
1992	1714	43	0	1757	0	1757
1993	2349	18	0	2367	2	2369
1994	1827	17	0	1844	6	1850
1995	1708	53	0	1761	2	1763
1996	1621	66	1	1688	0	1688
1997	2137	55	0	2192	2	2194
1998	2105	38	0	2143	2	2145
1999	2192	9	1	2202	3	2205
2000	1775	9	0	1784	1	1785
2001	1484	35	0	1519	9	1528
2002	1302	31	1	1334	6	1340
2003	1115	8	0	1123	3	1126
2004	1651	4	0	1655	3	1658
2005	1973	0	6	1979	11	1990
2006	2437	4	12	2453	5	2458
2007*	2622	9	8	2639	7	2646

* provisional   na = not available

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

Table 3.4.4.8*Nephrops*, Firth of Forth (FU 8): Landings (tonnes), effort ('000 hours trawling) and LPUE (kg/hour trawling) of Scottish *Nephrops* trawlers, 1981–2007 (data for all *Nephrops* gears combined, and for single and multirigs separately).

Year	All *Nephrops* gears combined			Single rig			Multirig		
	Landings	Effort	LPUE	Landings	Effort	LPUE	Landings	Effort	LPUE
1981	945	42.6	22.2	945	42.6	22.2	na	na	na
1982	1138	51.7	22.0	1138	51.7	22.0	na	na	na
1983	1681	60.7	27.7	1681	60.7	27.7	na	na	na
1984	2078	84.7	24.5	2078	84.7	24.5	na	na	na
1985	1908	73.9	25.8	1908	73.9	25.8	na	na	na
1986	2204	74.7	29.5	2204	74.7	29.5	na	na	na
1987	1582	62.1	25.5	1582	62.1	25.5	na	na	na
1988	2455	94.8	25.9	2455	94.8	25.9	na	na	na
1989	1833	78.7	23.3	1833	78.7	23.3	na	na	na
1990	1901	81.8	23.2	1901	81.8	23.2	na	na	na
1991	1359	69.4	19.6	1231	63.9	19.3	128	5.5	23.3
1992	1714	73.1	23.4	1480	63.3	23.4	198	8.5	23.3
1993	2349	100.3	23.4	2340	100.1	23.4	9	0.2	45.0
1994	1827	87.6	20.9	1827	87.6	20.9	0	0.0	0.0
1995	1708	78.9	21.6	1708	78.9	21.6	0	0.0	0.0
1996	1621	69.7	23.3	1621	69.7	23.3	0	0.0	0.0
1997	2137	71.6	29.8	2137	71.6	29.8	0	0.0	0.0
1998	2105	70.7	29.8	2105	70.7	29.8	0	0.0	0.0
1999	2192	67.7	32.4	2192	67.7	32.4	0	0.0	0.0
2000	1775	75.3	23.6	1761	75.0	23.5	14	0.3	46.7
2001	1484	68.8	21.6	1464	68.3	21.4	20	0.5	40.0
2002	1302	63.6	20.5	1286	63.3	20.3	16	0.3	53.3
2003	1115	53.0	21.0	1082	52.4	20.6	33	0.6	55.0
2004	1651	63.2	26.1	1633	62.9	26.0	18	0.4	49.7
2005	1973	66.6	29.6	1970	66.5	29.6	3	0.1	58.8
2006	2437	61.4	39.7	2432	61.0	39.9	5	0.4	14.2
2007	2622	57.6	45.5	2601	57.1	45.6	21	0.5	43.2

Table 3.4.4.9*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, 1991–2007.

Year	Catches		Landings			
	< 35 mm CL		< 35 mm CL		> 35 mm CL	
	Males	Females	Males	Females	Males	Females
1981	na	na	31.5	31.0	39.7	38.7
1982	na	na	30.4	30.1	40.0	39.1
1983	na	na	31.1	30.8	40.2	38.7
1984	na	na	30.3	29.7	39.4	38.4
1985	na	na	30.6	29.9	39.5	38.2
1986	na	na	29.7	29.2	39.1	38.5
1987	na	na	29.9	29.6	39.1	38.2
1988	na	na	28.5	28.5	39.2	39.0
1989	na	na	29.2	28.9	38.7	38.9
1990	28.5	27.5	29.8	28.6	38.3	38.8
1991	28.7	27.5	29.8	28.7	38.3	38.7
1992	29.5	28.0	30.2	28.7	38.1	38.7
1993	28.7	28.0	30.3	29.5	39.0	38.6
1994	25.7	25.1	29.1	28.5	38.8	37.8
1995	27.9	27.1	29.4	28.9	38.7	37.9
1996	28.0	27.4	29.8	28.8	38.6	38.6
1997	27.3	27.0	29.2	28.7	38.8	38.2
1998	27.7	26.4	29.0	27.9	38.6	38.4
1999	27.2	26.5	29.6	28.8	38.0	37.9
2000	28.5	27.2	30.7	29.8	38.2	38.3
2001	28.1	26.7	30.6	29.2	38.0	37.9
2002	27.1	26.3	29.8	29.3	38.3	37.9
2003	27.2	25.5	30.2	29.1	38.1	38.0
2004	28.7	27.8	30.7	29.9	38.4	37.7
2005	27.6	26.9	30.3	30.0	38.8	38.2
2006	28.2	26.6	29.8	29.9	38.7	37.8
2007	29.3	28.2	29.8	28.6	39.1	38.6

* provisional na = not available

Table 3.4.4.10 ***Nephrops*****, Firth of Forth (FU 8):Summary of TV results for most recent 3 years (2005–2007) showing strata surveyed, numbers of stations in each strata, mean density and observed variance, overall abundance and variance raised to stratum area. Proportion indicates relative amounts of overall raised variance attributable to each stratum.**

Stratum	Area (km²)	Number of Stations	Mean burrow density (no./m²)	Observed variance	Abundance (millions)	Stratum variance	Proportion of total variance
2005 TV survey							
M & SM	171	12	0.86	0.51	147	1223	0.238
MS(west)	139	8	0.43	0.29	60	709	0.138
MS(mid)	211	13	0.99	0.37	209	1276	0.248
MS(east)	395	21	0.70	0.26	277	1942	0.377
Total	915	54			694	5150	1
2006 TV survey							
M & SM	171	9	0.70	0.45	120	1448	0.160
MS(west)	139	9	1.75	0.11	244	229	0.025
MS(mid)	211	17	0.92	0.22	195	573	0.063
MS(east)	395	8	0.51	0.35	199	6823	0.752
Total	915	43			758	9073	1
2007 TV survey							
M & SM	171	10	0.92	0.55	156	1590	0.345
MS(west)	139	8	0.57	0.20	79	482	0.105
MS(mid)	211	12	1.11	0.38	233	1400	0.304
MS(east)	395	19	0.73	0.14	287	1134	0.246
Total	915	49			755	4605	1

Table 3.4.11*Nephrops*, Firth of Forth (FU 8): Results of the 1993–2007 TV surveys.

Year	Stations	Mean density	Abundance	95% confidence interval
		burrows/m²	millions	millions
1993	37	0.72	655	167
1994	30	0.58	529	92
1995	no survey			
1996	27	0.48	443	104
1997	no survey			
1998	32	0.38	345	95
1999	49	0.60	546	92
2000	53	0.57	523	83
2001	46	0.54	494	93
2002	41	0.66	600	140
2003	36	0.80	735	150
2004	37	0.65	594	126
2005	54	0.76	694	144
2006	43	0.83	758	191
2007	49	0.82	755	136

Table 3.4.4.12*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

Males Weight = a*CL^b a = 0.00028 b = 3.24

Females a = 0.00085 b = 2.91

CL	Landings ('000)	Discards ('000)	Removals ('000)	wt (g)	Landings (t)	CL	Landings ('000)	Discards ('000)	Removals ('000)	wt (g)	Landings (t)
11	0.0	3.9	2.9	0.88	0.00	11	0.0	0.0	0.0	1.17	0.00
13	0.0	6.3	4.7	1.45	0.00	13	0.0	2.5	1.9	1.84	0.00
15	6.0	56.1	48.1	2.23	13.39	15	4.7	94.3	75.4	2.71	12.75
17	19.0	405.2	322.9	3.27	62.09	17	22.6	711.0	555.9	3.82	86.37
19	110.1	1513.0	1244.9	4.60	506.15	19	219.7	2178.9	1853.9	5.19	1140.90
21	785.8	3741.0	3591.6	6.26	4919.48	21	1067.8	7706.4	6847.6	6.85	7317.43
23	2432.2	6212.6	7091.7	8.30	20185.60	23	3079.0	14889.9	14246.4	8.83	27179.62
25	5082.6	7093.4	10402.7	10.76	54671.07	25	5508.2	12998.5	15257.1	11.14	61376.35
27	8481.9	4675.7	11988.7	13.68	115996.05	27	8321.4	7391.0	13864.7	13.82	115039.03
29	10822.3	2713.7	12857.6	17.10	185076.15	29	9971.9	3517.7	12610.2	16.90	168507.68
31	10961.9	1100.9	11787.6	21.08	231062.68	31	9195.8	1495.8	10317.7	20.39	187497.24
33	8298.7	425.9	8618.1	25.65	212892.22	33	5751.4	520.6	6141.9	24.32	139893.05
35	6117.3	99.4	6191.9	30.87	188859.10	35	3246.2	176.8	3378.8	28.72	93246.92
37	3920.9	30.3	3943.6	36.78	144225.70	37	1883.0	63.4	1930.6	33.62	63305.22
39	2467.0	1.3	2468.0	43.43	107152.31	39	1070.6	25.0	1089.4	39.03	41786.96
41	1612.3	4.0	1615.3	50.87	82022.23	41	580.2	2.7	582.2	44.99	26100.70
43	896.2	2.7	898.2	59.15	53009.00	43	246.1	0.0	246.1	51.51	12675.87
45	502.9	1.3	503.9	68.31	34353.82	45	111.1	0.0	111.1	58.62	6512.66
47	236.0	0.0	236.0	78.41	18505.11	47	59.8	0.0	59.8	66.35	3967.64
49	106.3	0.0	106.3	89.50	9513.80	49	15.7	0.0	15.7	74.72	1173.06
51	55.3	0.0	55.3	101.63	5619.97	51	8.5	0.0	8.5	83.75	711.88
53	30.5	0.0	30.5	114.85	3502.79	53	3.4	0.0	3.4	93.47	317.81
55	15.5	0.0	15.5	129.21	2002.71	55	2.7	0.0	2.7	103.91	280.55
57	5.2	0.0	5.2	144.77	752.78	57	1.0	0.0	1.0	115.08	115.08
59	1.5	0.0	1.5	161.57	242.36	59	0.1	0.0	0.1	127.01	12.70
61	0.4	0.0	0.4	179.68	71.87	61	0.0	0.0	0.0	139.73	0.00
63	0.2	0.0	0.2	199.15	39.83	63	0.0	0.0	0.0	153.25	0.00
65	0.1	0.0	0.1	220.03	22.00	65	0.0	0.0	0.0	167.61	0.00
67	0.1	0.0	0.1	242.37	24.24	67	0.0	0.0	0.0	182.82	0.00
69	0.0	0.0	0.0	266.24	0.00	69	0.0	0.0	0.0	198.91	0.00
Total			84033.23		1475.30				89201.78		958.26

Removals (M+F 000s) 173235.00 Land Wt 2433.56

TV abundance (thousands) 735331.97

Predicted Landings = Land Wt * TV abundance * harvest rate / removals

Predicted Landings (tonnes)

Landings with harvest ratio eq. Fmax (0.36)	3144.52
Landings with harvest ratio eq. to F0.1 (0.23)	2147.00
Landings potential with 25% harvest rate	2582.44
Landings potential with 20% harvest rate	2065.95
Landings potential with 15% harvest rate	1549.46

Table 3.4.5.2 ***Nephrops*** **Botney Gut–Silver Pit (FU 5): Landings (tonnes) by country, 1991–2007.**

Year	Belgium	Denmark	Netherl.	Germany	UK	Total **
1991	682	176	na		4	***862***
1992	571	22	na		19	***612***
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	***1149***
1998	372	88	584	39	28	***1111***
1999	436	53	538	59	158	***1244***
2000	366	83	402	52	218	***1121***
2001	353	145	553	114	278	***1443***
2002	281	94	617	88	151	***1231***
2003	265	36	661	24	158	***1144***
2004	171	39	646	16	198	***1070***
2005	109	87	654	51	157	***1058***
2006	77	24	444	99	342	***986***
2007	75	3	464	201	568	***1311***

* provisional   na = not available

** Totals for 1991-94 exclusive of landings by the Netherlands

Table 3.4.5.3 ***Nephrops*** **Botney Gut–Silver Pit (FU 5): Landings (tonnes), effort ('000 hours trawling) and LPUE (kg/hour trawling) of Belgian Nephrops trawlers, 1991–2005. Dutch trawlers 2000 – 2005 and Danish trawlers 1996 -2007**

Year	Belgium (1)				Netherlands (2)			Denmark (3)		
	Landings	Effort	LPUE		Landings	Effort	LPUE	Landings	Effort	LPUE
	tons	'000 hrs	kg/hour		tons	days at sea	kg/day	tons	days at sea	kg/day
1991	566	74.0	7.7							
1992	525	74.5	7.0							
1993	672	58.3	11.5							
1994	453	35.5	12.7							
1995	559	32.5	17.2							
1996	245	30.1	8.1					34	132	261.0
1997	399	31.8	12.5					24	59	412.0
1998	309	28.6	10.8					78	174	447.0
1999	322	31.8	10.1					44	107	408.0
2000	174	21.8	8.0		402	7936	50.7	76	247	306.0
2001	195	21.5	9.1		553	9797	56.5	78	283	275.0
2002	144	15.8	9.1		617	8999	68.6	47	200	237.0
2003	118	6.2	19.3		661	9043	73.1	33	132	247.3
2004	106	5.7	18.8		646	8676	74.5	36	149	241.9
2005	69	2.9	23.9		654	7912	82.7	87	297	290.9
2006								24	66	365.6
2007								3	13	253.6

* provisional   na = not available

(1) Vessels directed towards Nephrops at least 10 months per year

(2) All vessels operating in FU 5, regardless of directedness towards Nephrops

(3) Logbook records from vessels operating in FU 5, with mesh size >=70 mm with Nephrops in catches

Table 3.4.5.4 *Nephrops* Botney Gut–Silver Pit (FU 5): Mean sizes of *Nephrops* >35 mm CL landed by Belgian *Nephrops* trawlers, 1991–2005 (no data from 2006–2007).

Year	Landings	
	Males	Females
1991	40.8	41.3
1992	40.9	40.9
1993	41.0	40.9
1994	40.3	40.6
1995	40.7	39.8
1996	41.3	39.4
1997	41.2	39.0
1998	41.0	39.2
1999	40.9	39.5
2000	40.8	39.9
2001	40.3	39.7
2002	39.7	39.3
2003	40.5	39.3
2004	40.1	39.9
2005 *	40.2	39.5
* provisional na = not available		

Table 3.4.5.5 *Nephrops* Off Horn Reef (FU 33): Landings (tonnes) by country, 1993–2007.

Year	Belgium	Denmark	Germany	Netherl.	UK	Total **
1993	0	159		na	1	160
1994	0	137		na	0	137
1995	3	158		3	1	164
1996	1	74		2	0	77
1997	0	274		2	0	276
1998	4	333	8	12	1	350
1999	22	683	14	12	6	724
2000	13	537	12	39	9	597
2001	52	667	11	61	+	791
2002	21	772	13	51	4	861
2003	15	842	4	67	1	929
2004	37	1097	24	109	1	1268
2005	16	803	31	191	9	1050
2006	97	710	151	314	15	1288
2007	118	610	201	496	42	1467

* provisional na = not available

** Totals for 1993-94 exclusive of landings by the Netherlands

Table 3.4.5.6*Nephrops* Off Horns Reef (FU 33): Logbook recorded effort (days fishing) and LPUE (kg/day) for bottom trawlers catching *Nephrops* with codend mesh sizes of 70 mm or above, and estimated total effort by Danish trawlers, 1993–2007.

Year	Logbook data		Estimated total effort
	Effort	LPUE	
1993	975	170	971
1994	739	165	830
1995	724	194	816
1996	370	157	471
1997	925	161	1702
1998	1442	208	1601
1999	2323	252	2710
2000	2286	209	2569
2001	2818	191	3489
2002	3214	207	3734
2003	3640	212	3973
2004	4306	234	4694
2005	2524	285	2776
2006	2062	308	2288
2007	1609	337	1818

* provisional   na = not available

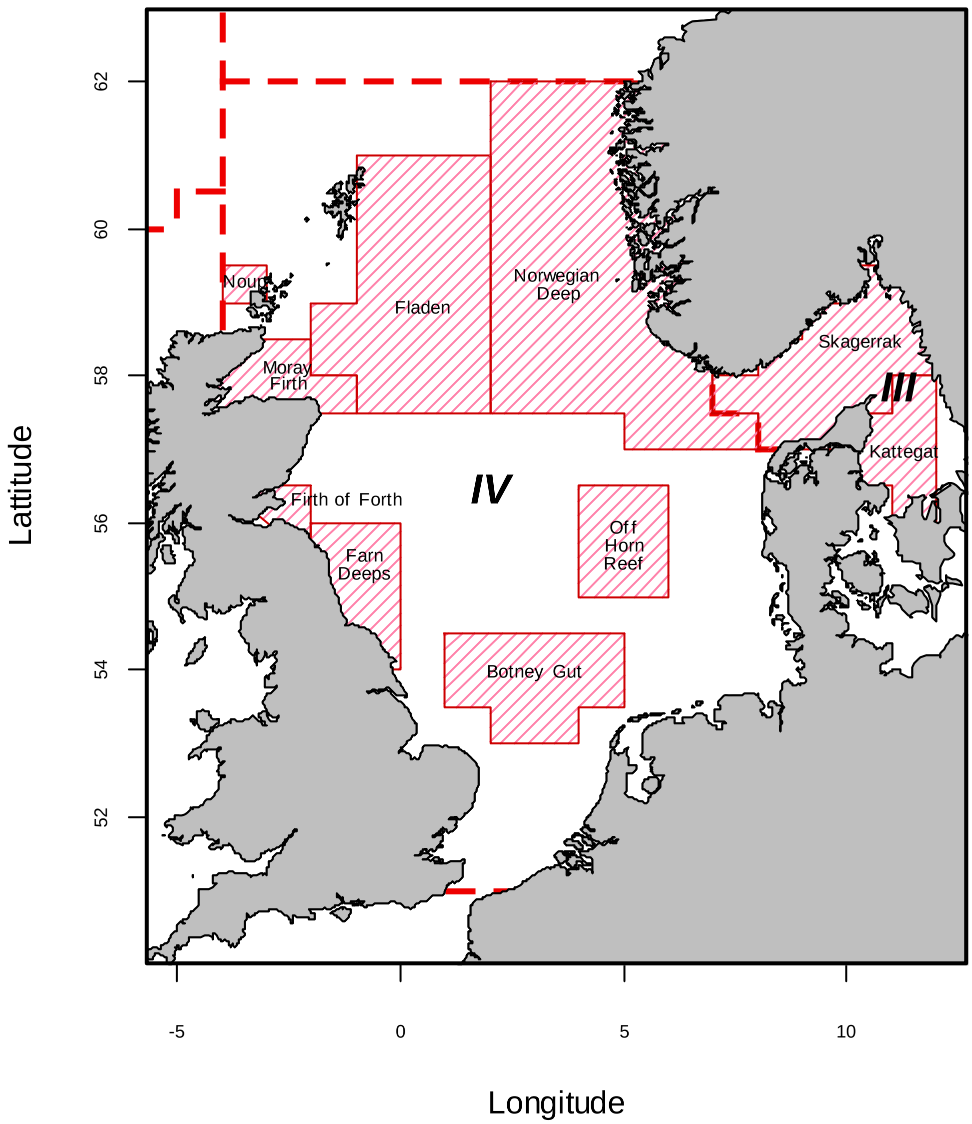


Figure 3.1.1 ***Nephrops*** **Functional Units and Management Areas in the North Sea and Skagerrak/Kattegat region.**

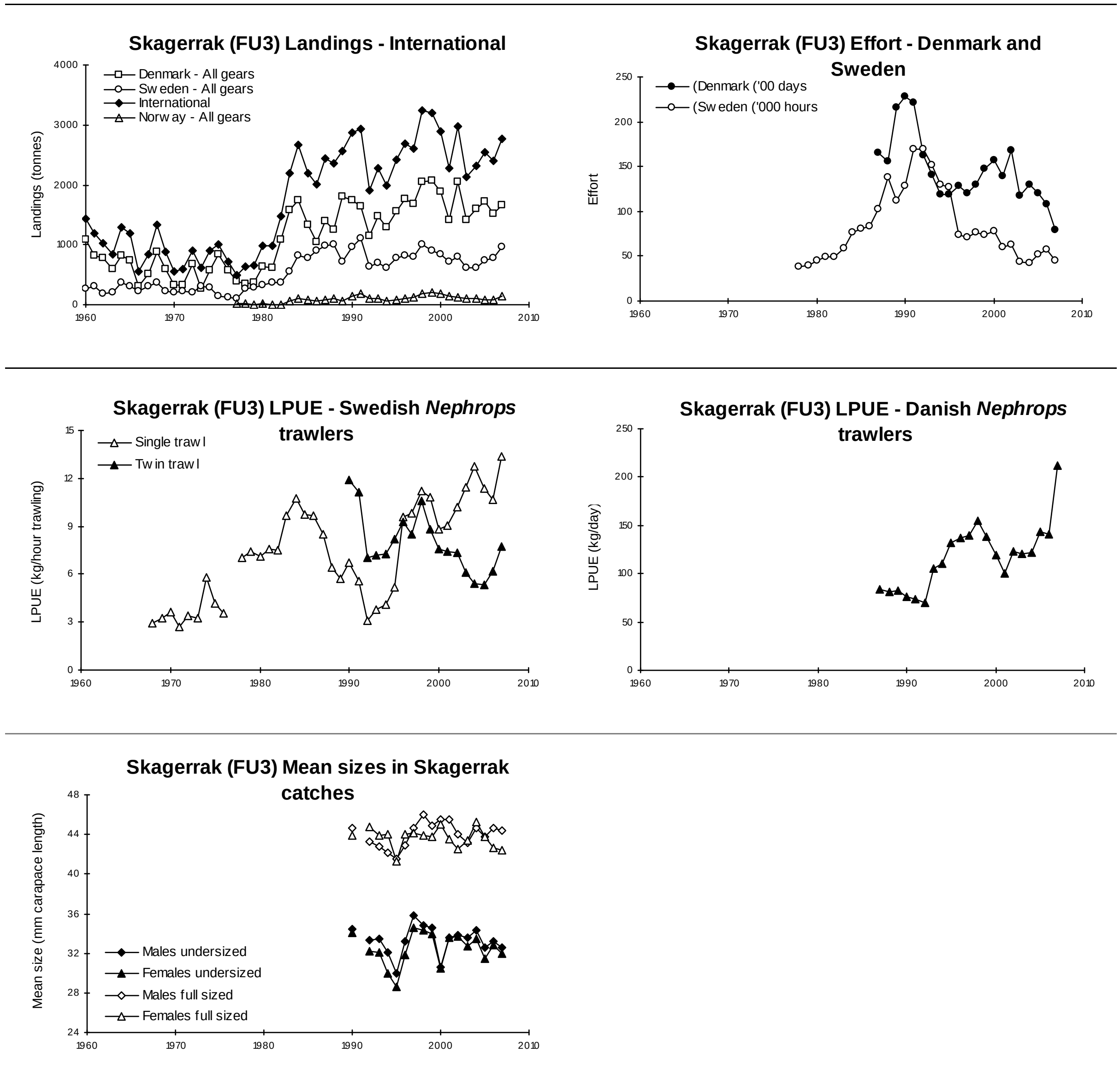


Figure 3.2.1.1 *Nephrops* Skagerrak (FU 3): Long-term trends in landings, effort, LPUEs, and mean sizes of *Nephrops*.

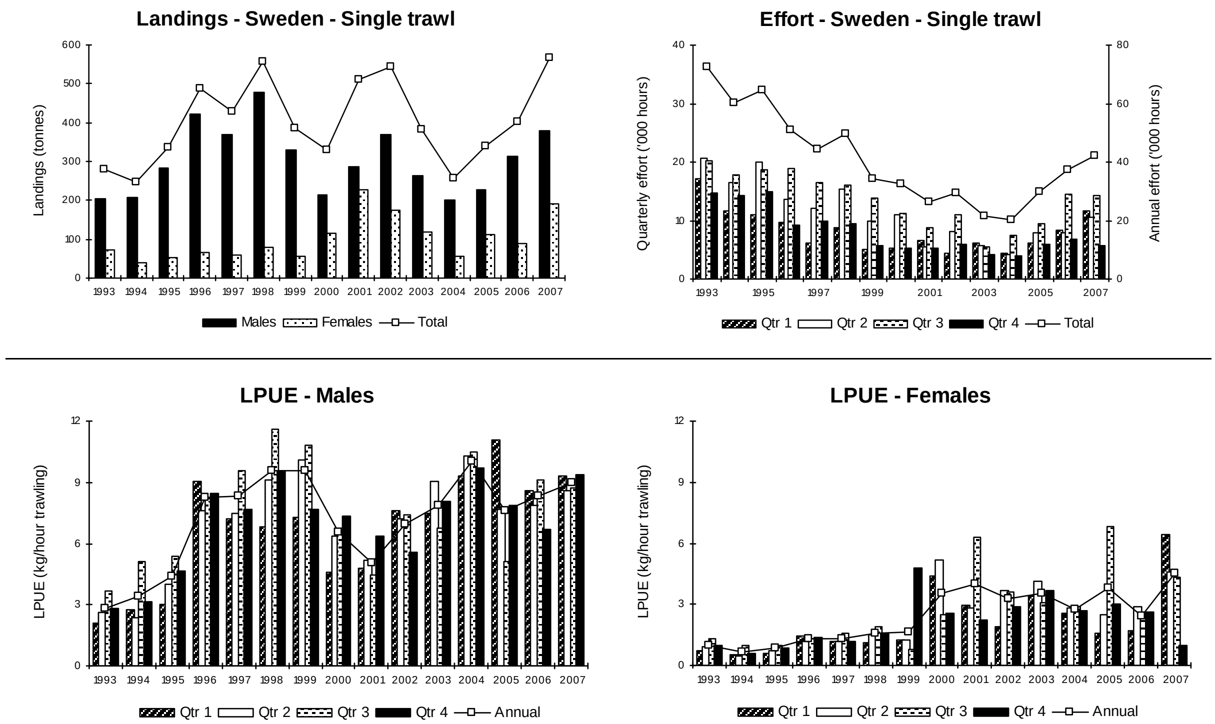


Figure 3.2.1.3 ***Nephrops*** **Skagerrak (FU 3): Landings, effort and LPUEs by quarter and sex from Swedish** ***Nephrops*** **trawlers–Single trawl.**

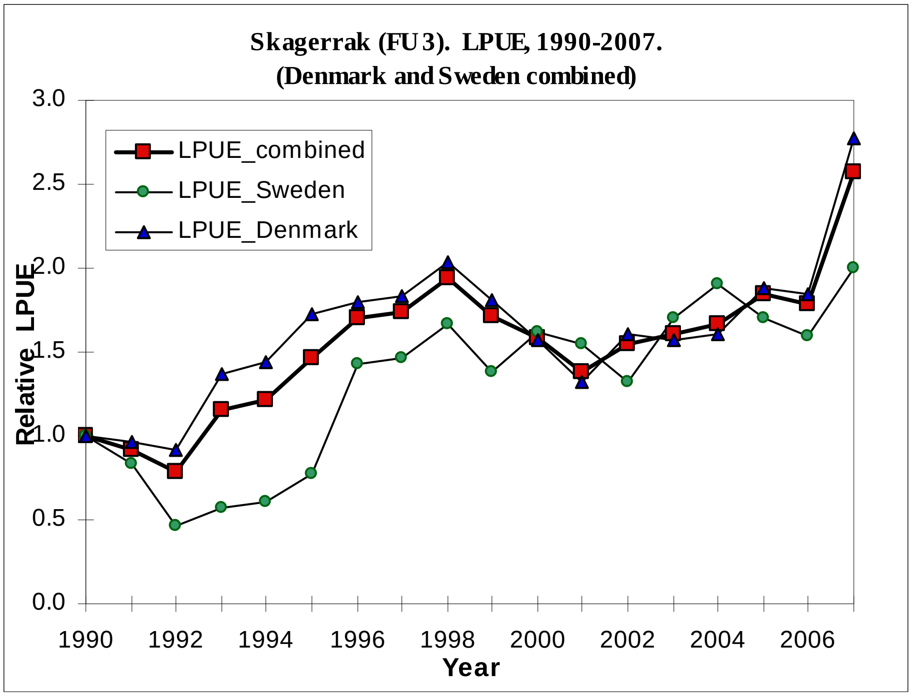


Figure 3.2.1.4. ***Nephrops*** **Skagerrak (FU 3): Analysis of Danish and Swedish LPUE in FU3.**

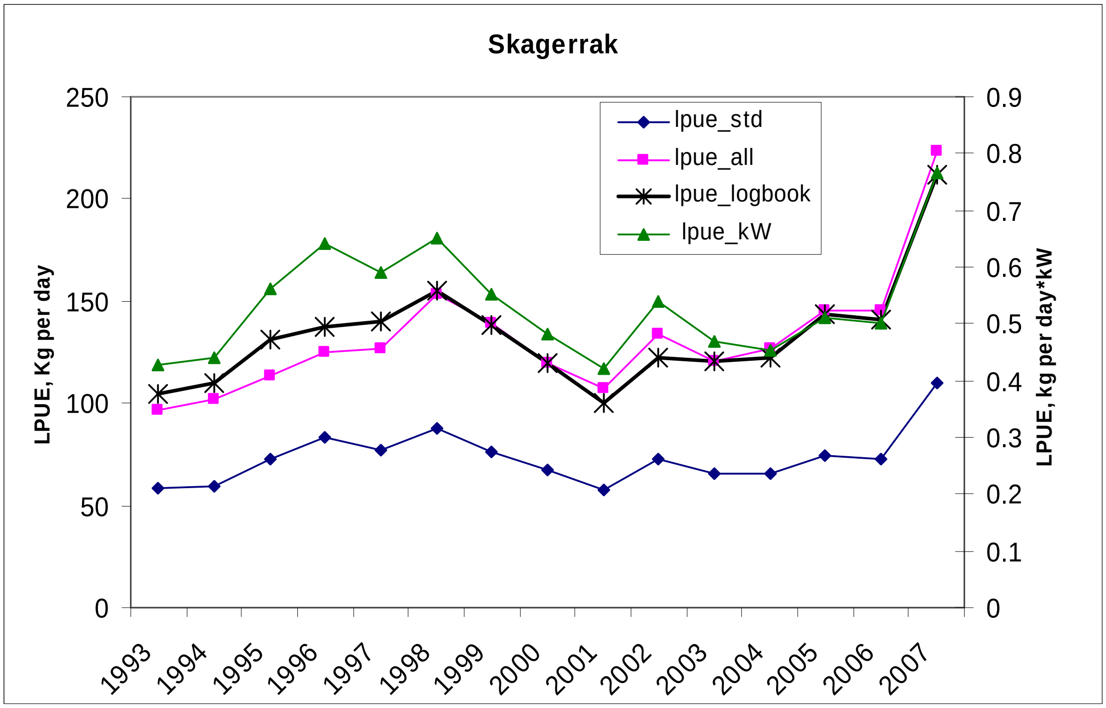


Figure 3.2.1.5. ***Nephrops*** **Skagerrak (FU 3): Danish LPUEs**

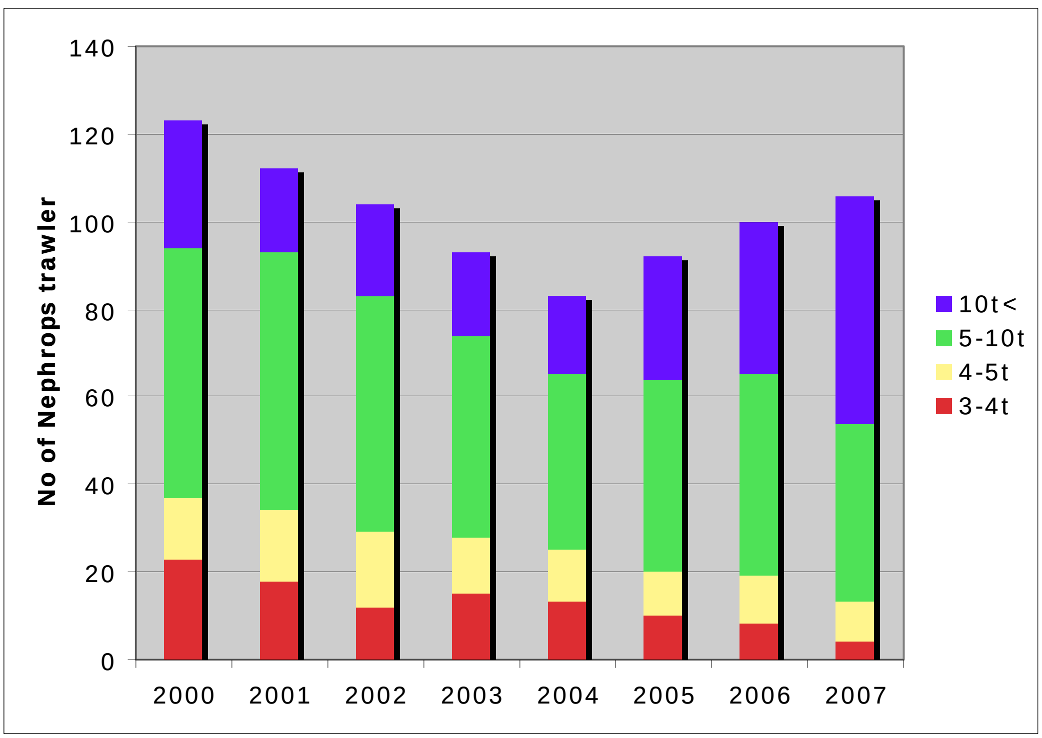


Figure 3.2.1.6 ***Nephrops*** **Kattegat (FU 4): Number of Swedish Nephrops trawler with respect to yearly landings during 2000 to 2007.**

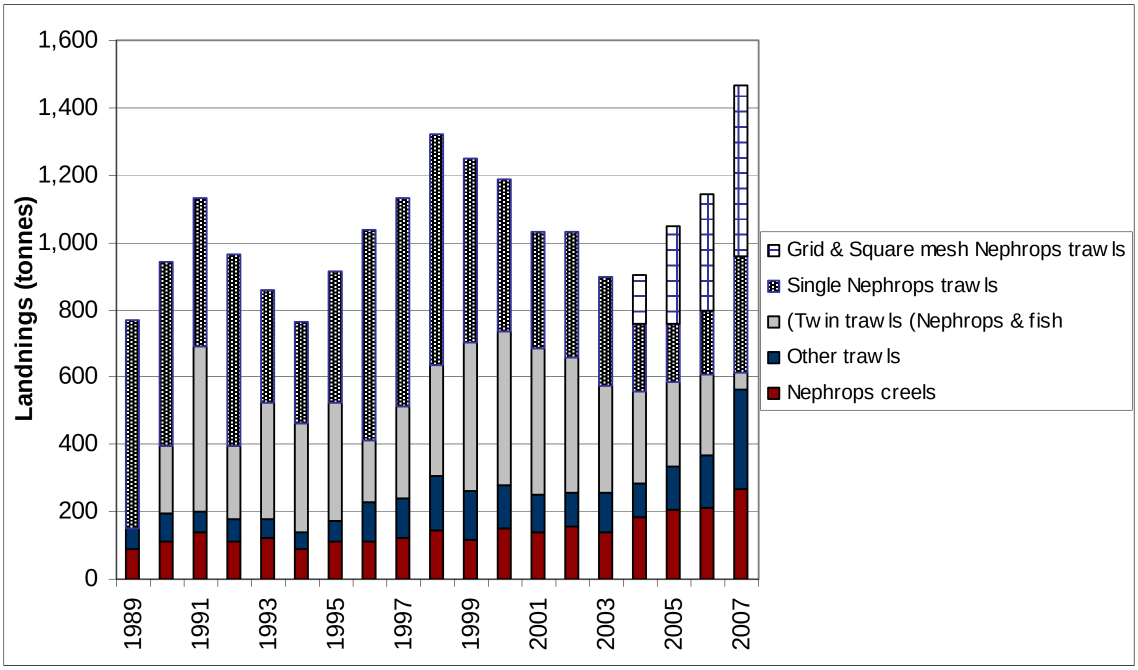


Figure 3.2.1.7 ***Nephrops Nephrops*** **Kattegat (FU 4): Swedish Nephrops landings from IIIa by gear 1989–2007. Other trawls are mainly finfish and Pandalus trawls.**

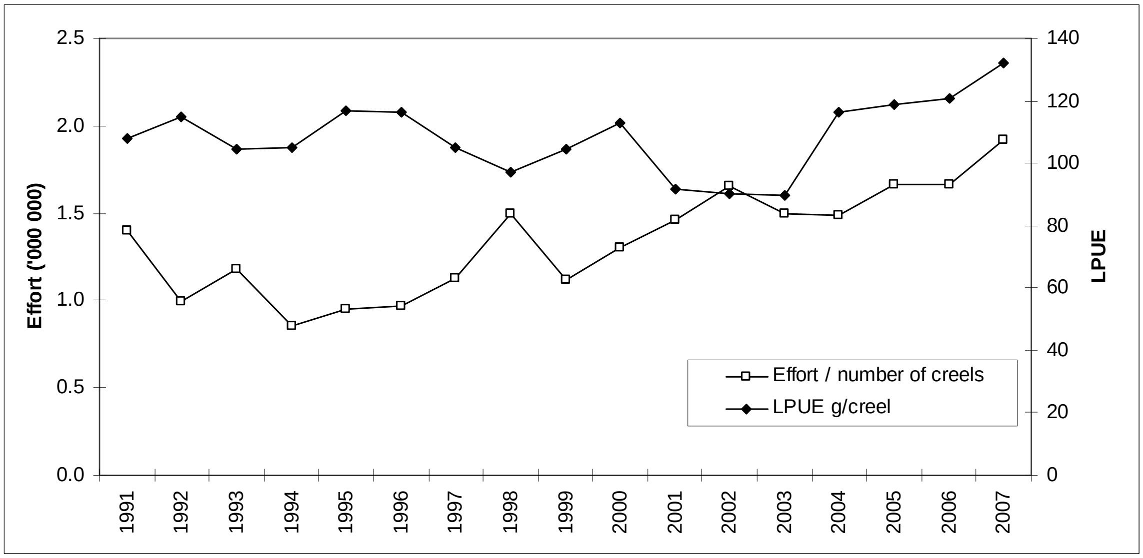


Figure 3.2.1.8 ***Nephrops*** **Kattegat (FU 4): Long term trend in effort and LPUE from the Swedish creel fishery.**

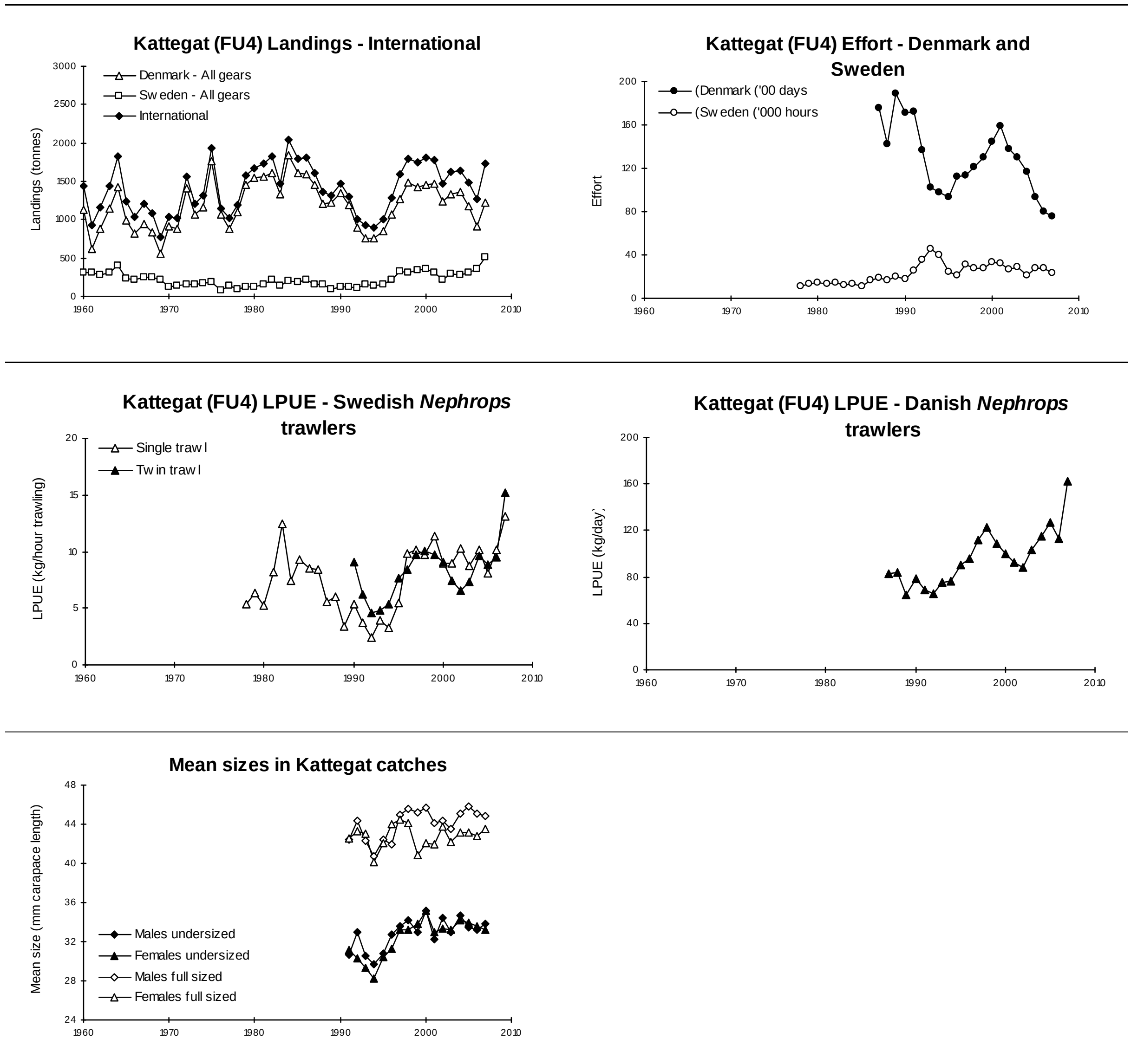


Figure 3.2.1.9 ***Nephrops*** **Kattegat (FU 4): Long-term trends in landings, effort, LPUEs, and mean sizes of** ***Nephrops*****.**

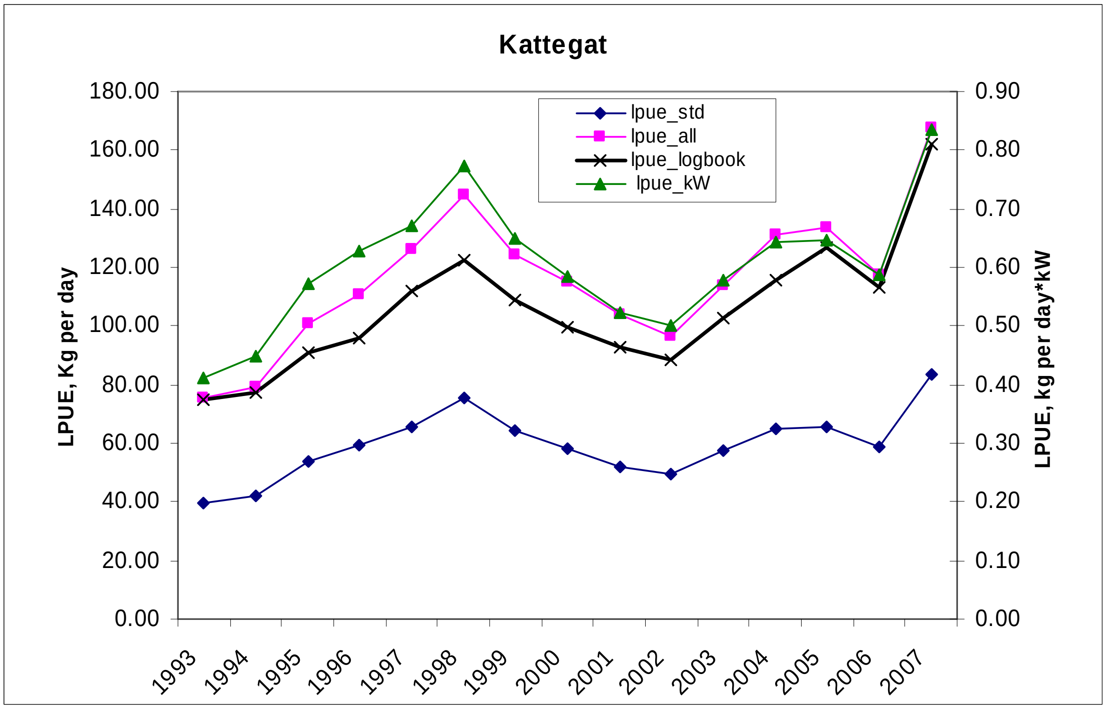


Figure 3.2.1.10 ***Nephrops*** **Kattegat (FU 4): Danish LPUEs**

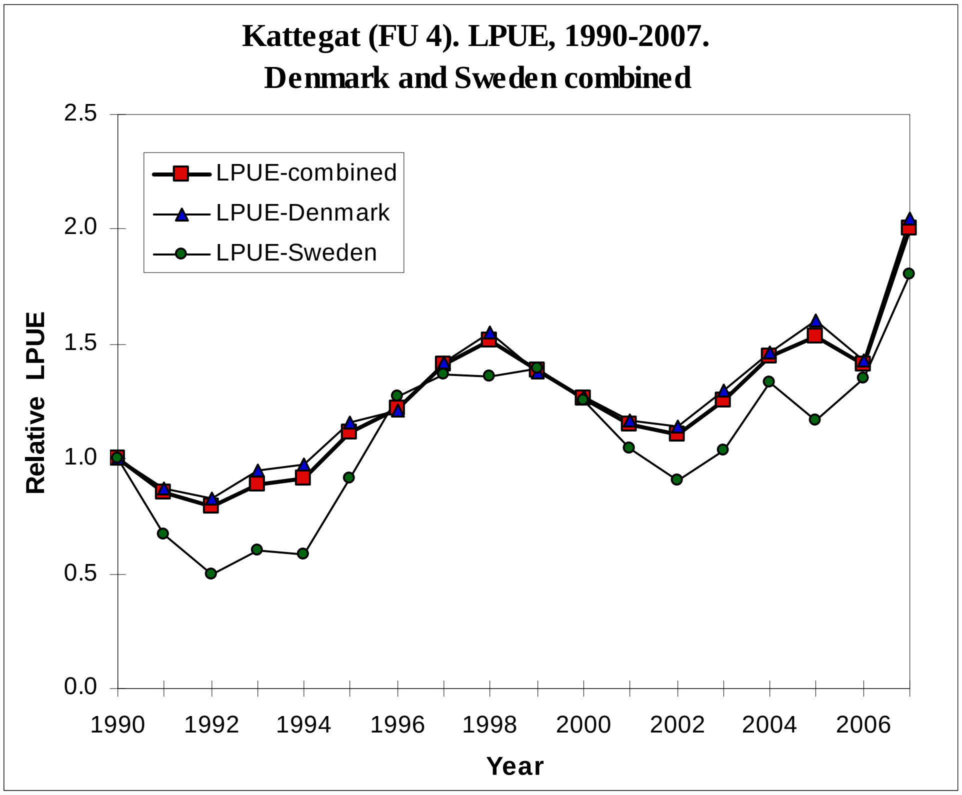


Figure 3.2.1.11. ***Nephrops*** **Kattegat (FU 4): Analysis of Danish and Swedish LPUE in FU4.**

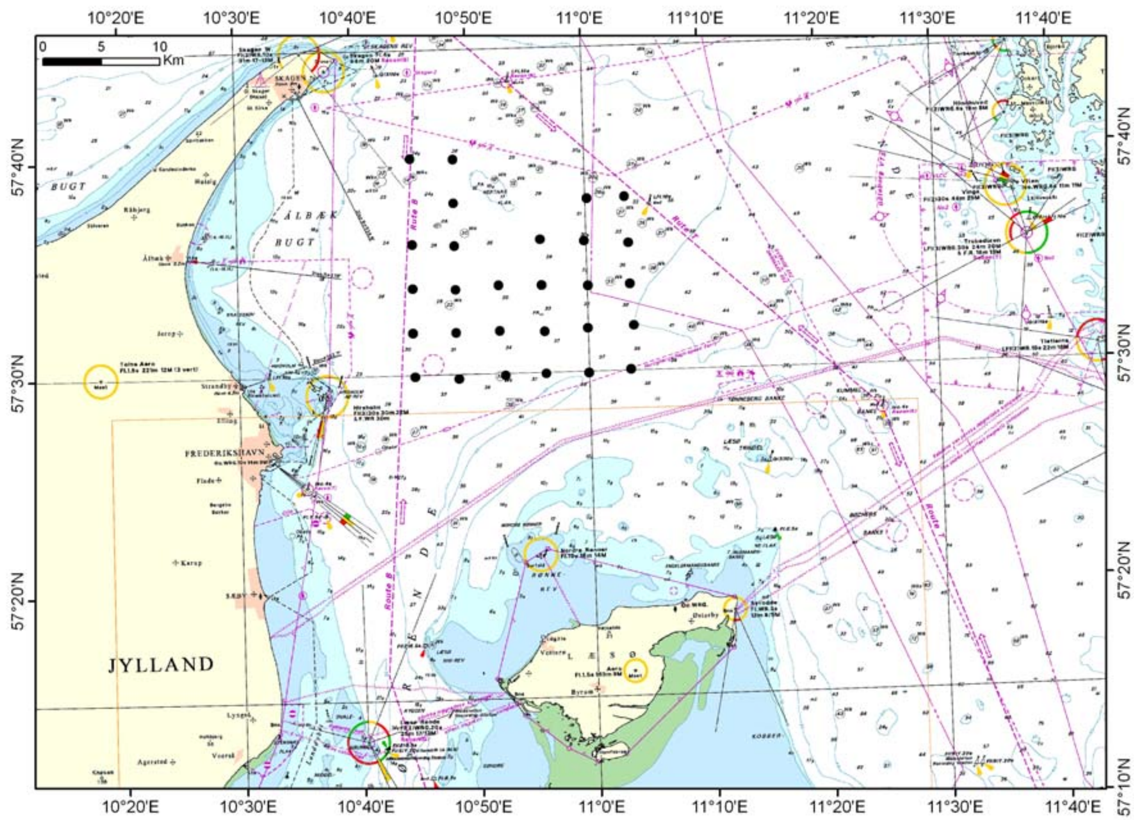


Figure 3.2.1.12 Nephrops Kattegat (FU4): Location of the stations for the Danish UTV survey in 2007. Northern Kattegat.

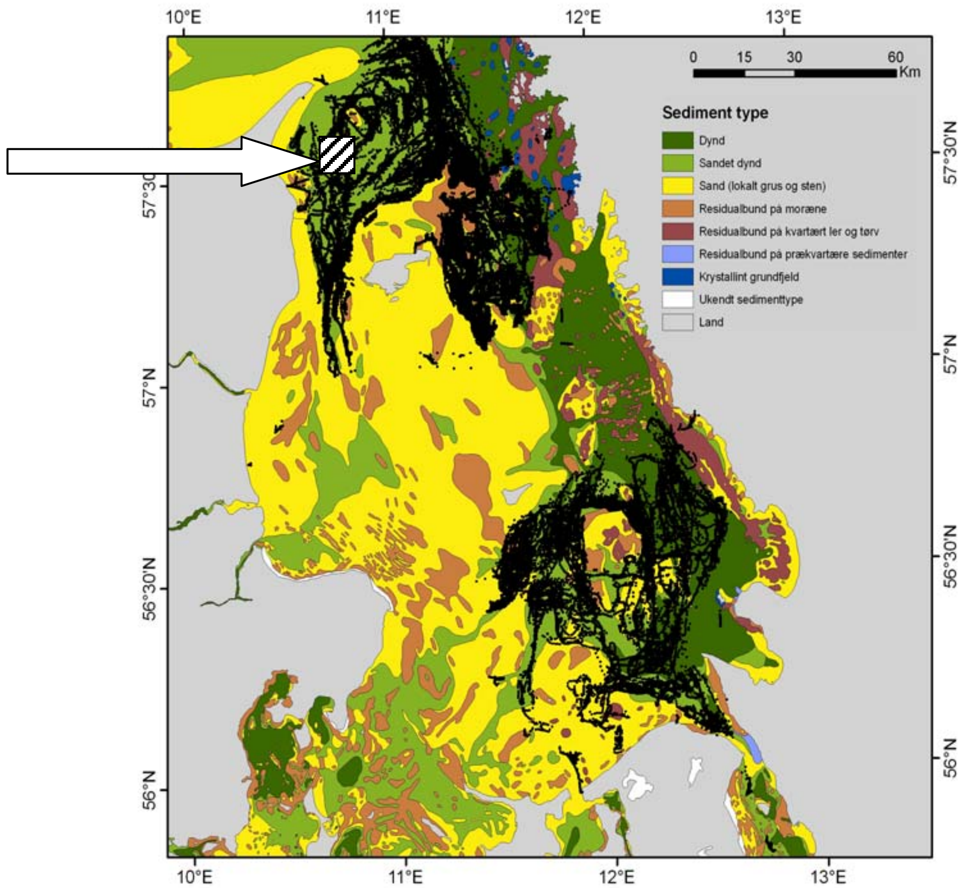


Figure 3.2.1.13 Nephrops Kattegat (FU4): Area (in Kattegat) of the Danish UTV survey in 2007. Dark areas is muddy bottom. Black lines trawl areas for bottom trawl

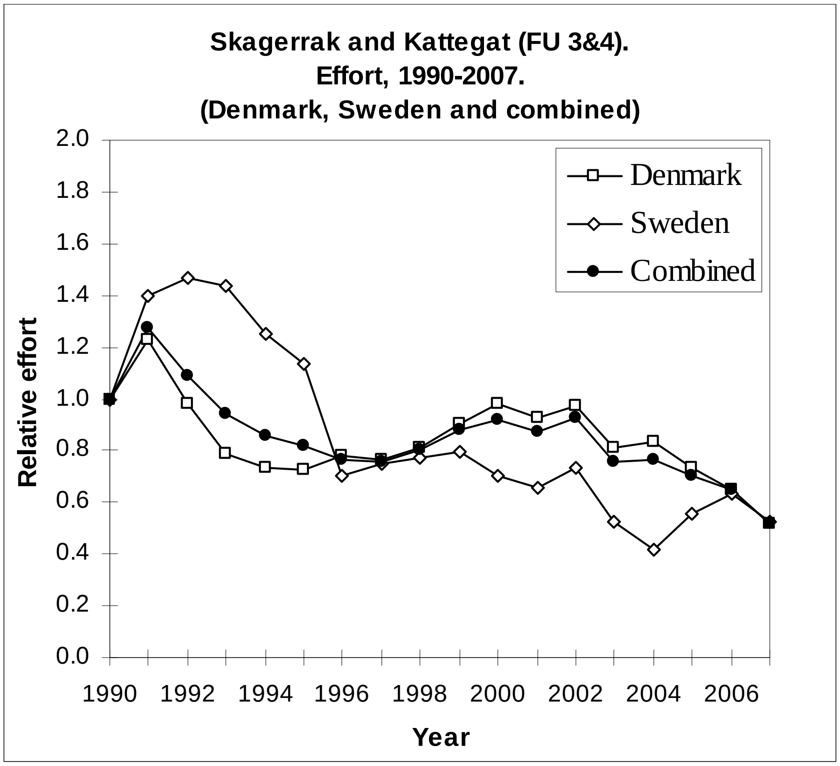


Figure 3.2.1.14 Nephrops Skagerrak (FU3) and Kattegat (FU4) Relative changes in effort

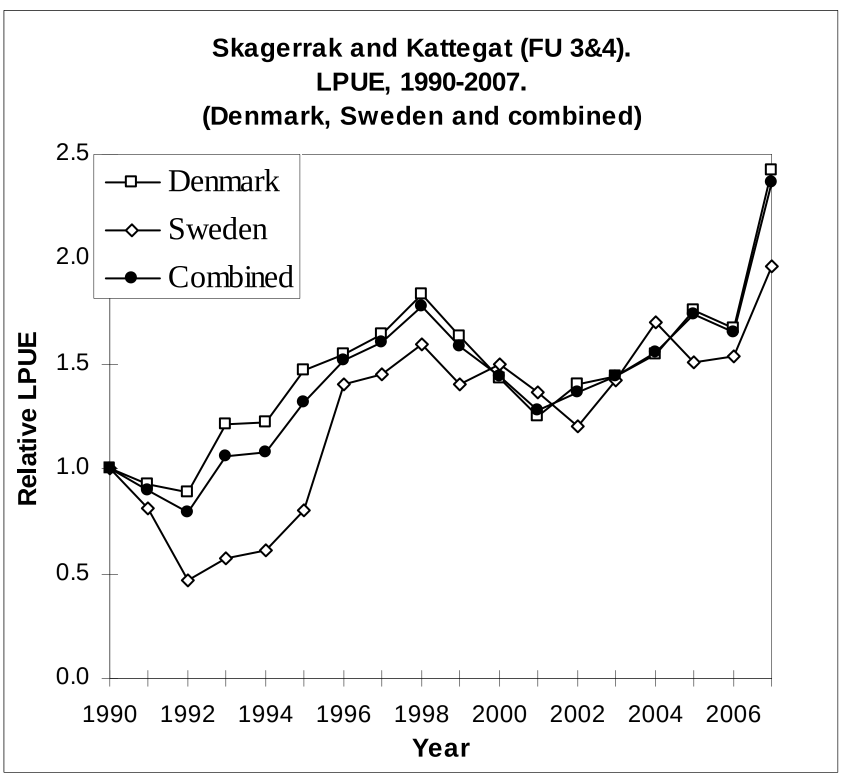


Figure 3.2.1.15 Nephrops Skagerrak (FU3) and Kattegat (FU4) Relative changes in LPUE

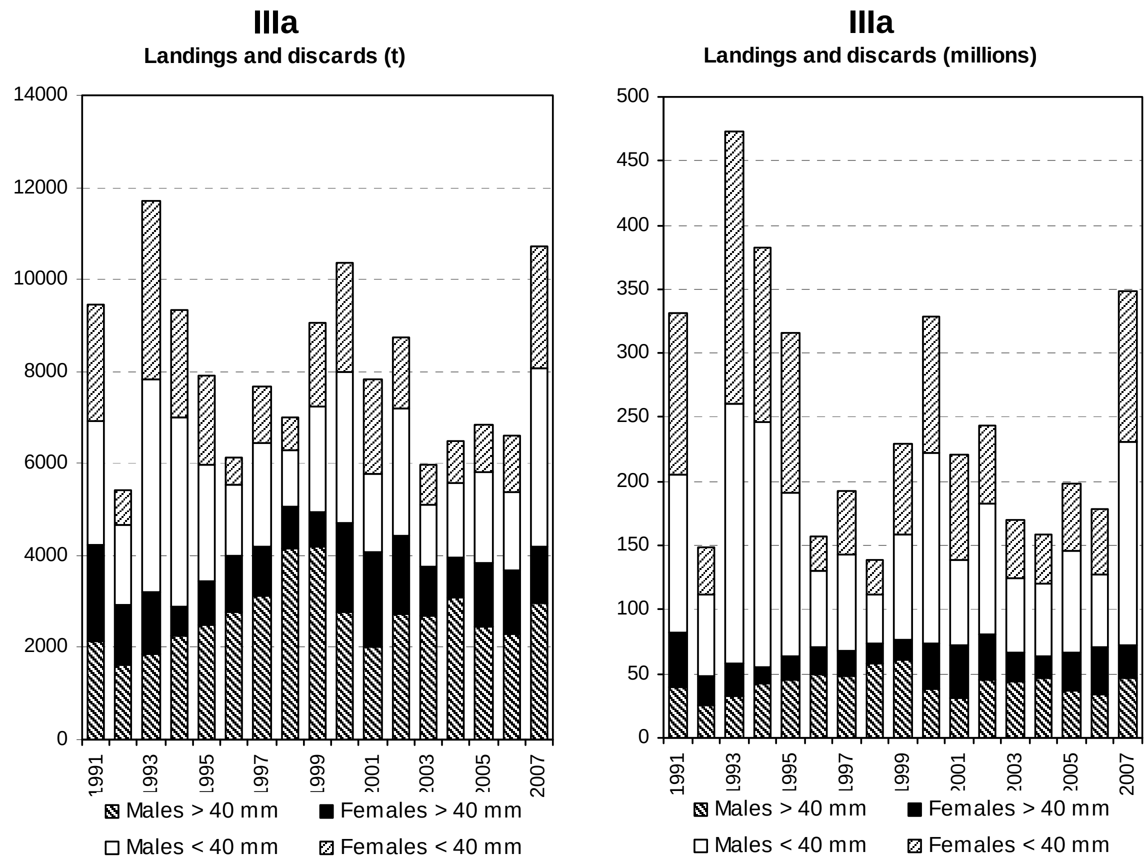


Figure 3.2.1.16 ***Nephrops*** **Skagerrak (FU 3) and Kattegat (FU 4): Composition of** ***Nephrops*** **catches, split by catch fraction (landings and discards) and by sex, 1991–2007.**

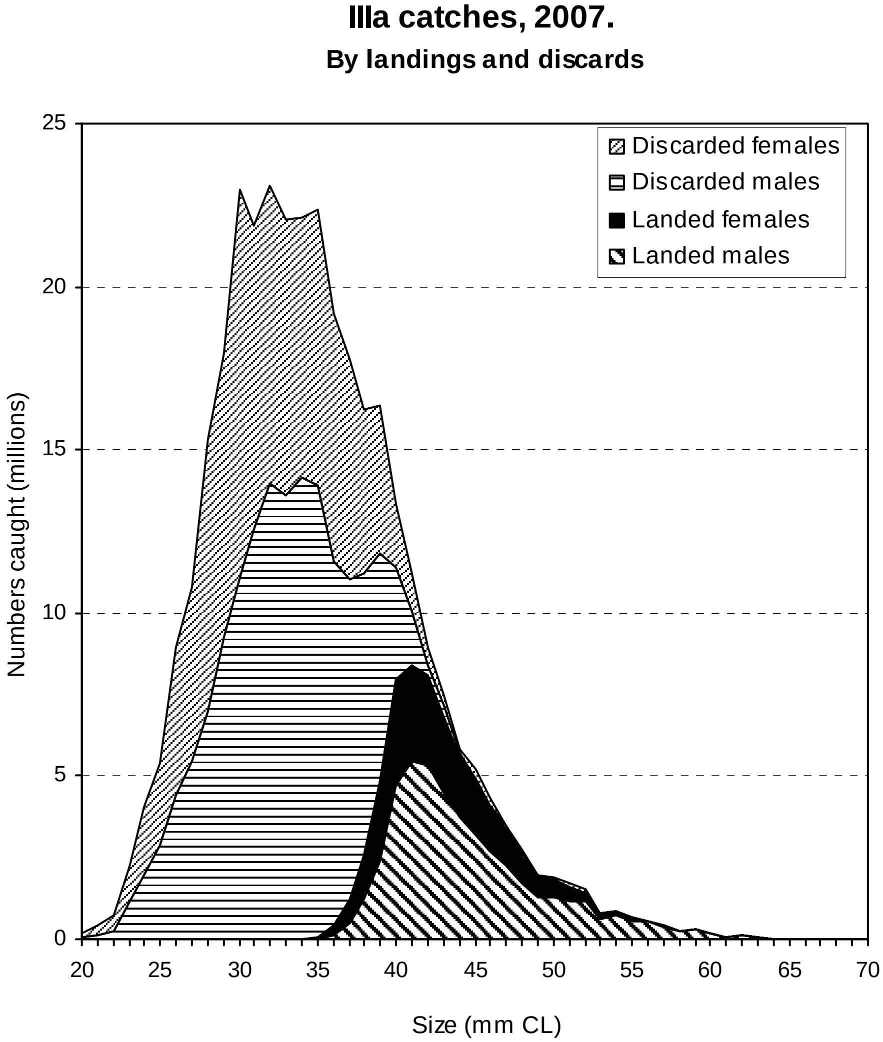


Figure 3.2.1.17 ***Nephrops*** **Skagerrak (FU 3) and Kattegat (FU4): Length frequency distributions of** ***Nephrops*** **catches, split by catch fraction (landings and discards) and sex. Data for Denmark and Sweden combined for 2007 only.**

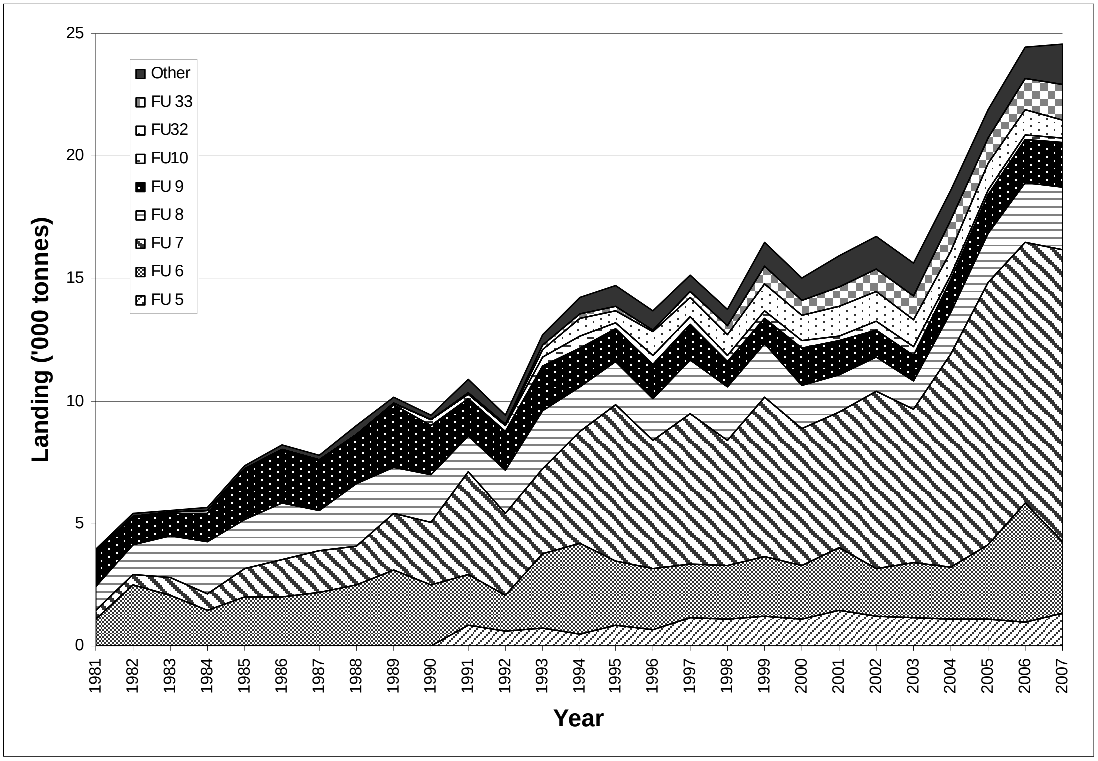


Figure 3.3.1 ***Nephrops*** **in Division IV. Landings by functional unit and other areas in Division IV.**

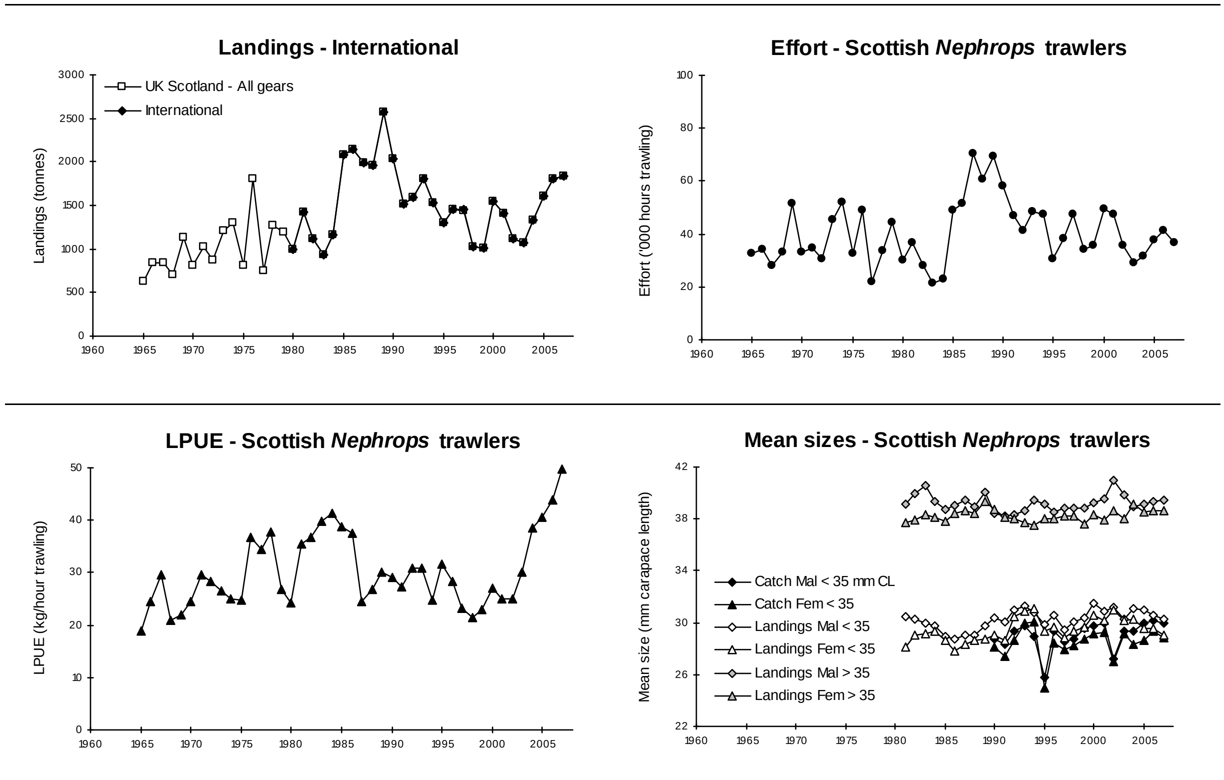


Figure 3.4.1.1 ***Nephrops*****, Moray Firth (FU 9), Long term landings, effort, LPUE and mean sizes.**

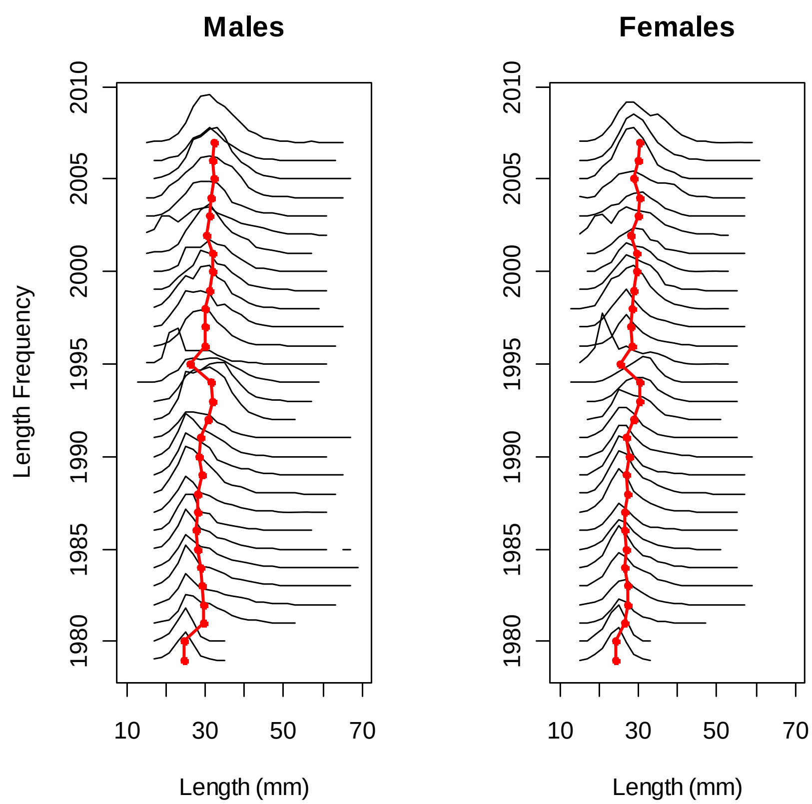
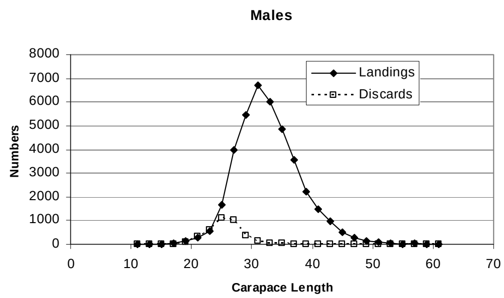


Figure 3.4.1.2 ***Nephrops*** **Moray Firth (FU 9)) Catch length frequency distribution and mean sizes (red line) for** ***Nephrops*** **in the Moray Firth, 1979–2007**



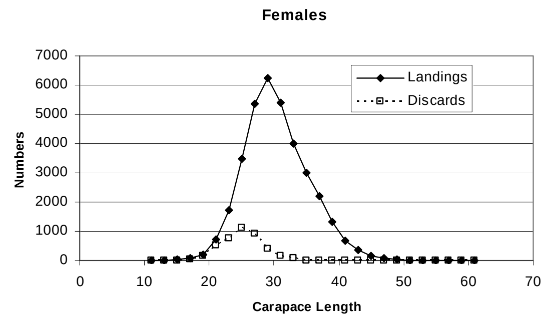


Figure 3.4.1.3 *Nephrops*, Moray Firth (FU 9), Length frequency distributions of male and female landings and discards, averaged over 2005 – 2007.

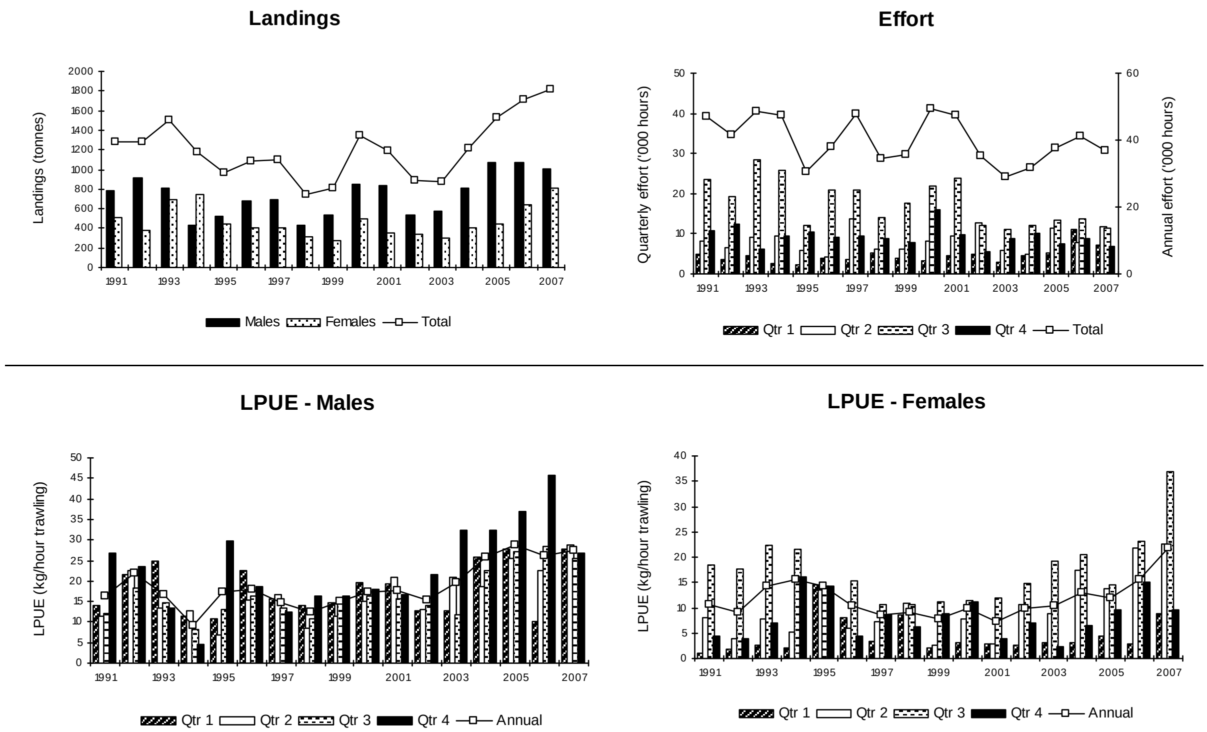


Figure 3.4.1.4 *Nephrops*, Moray Firth (FU 9), Landings, effort and unstandardised LPUEs by quarter and sex from Scottish *Nephrops* trawlers.

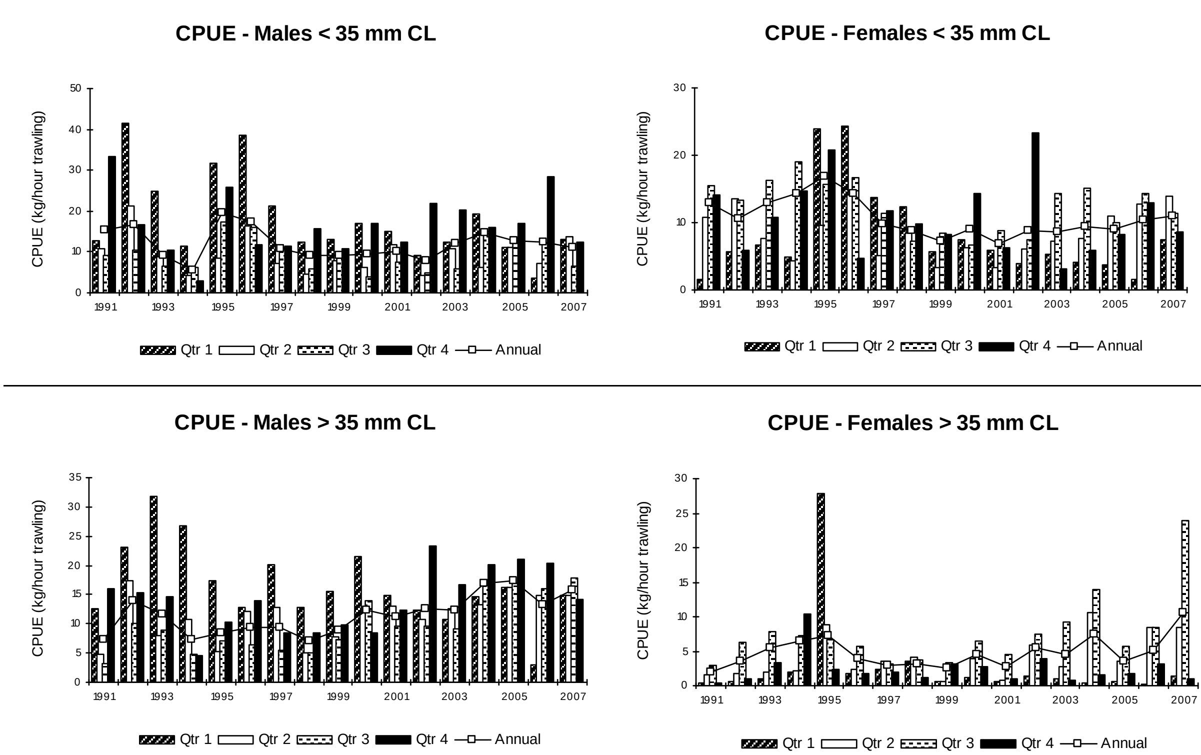
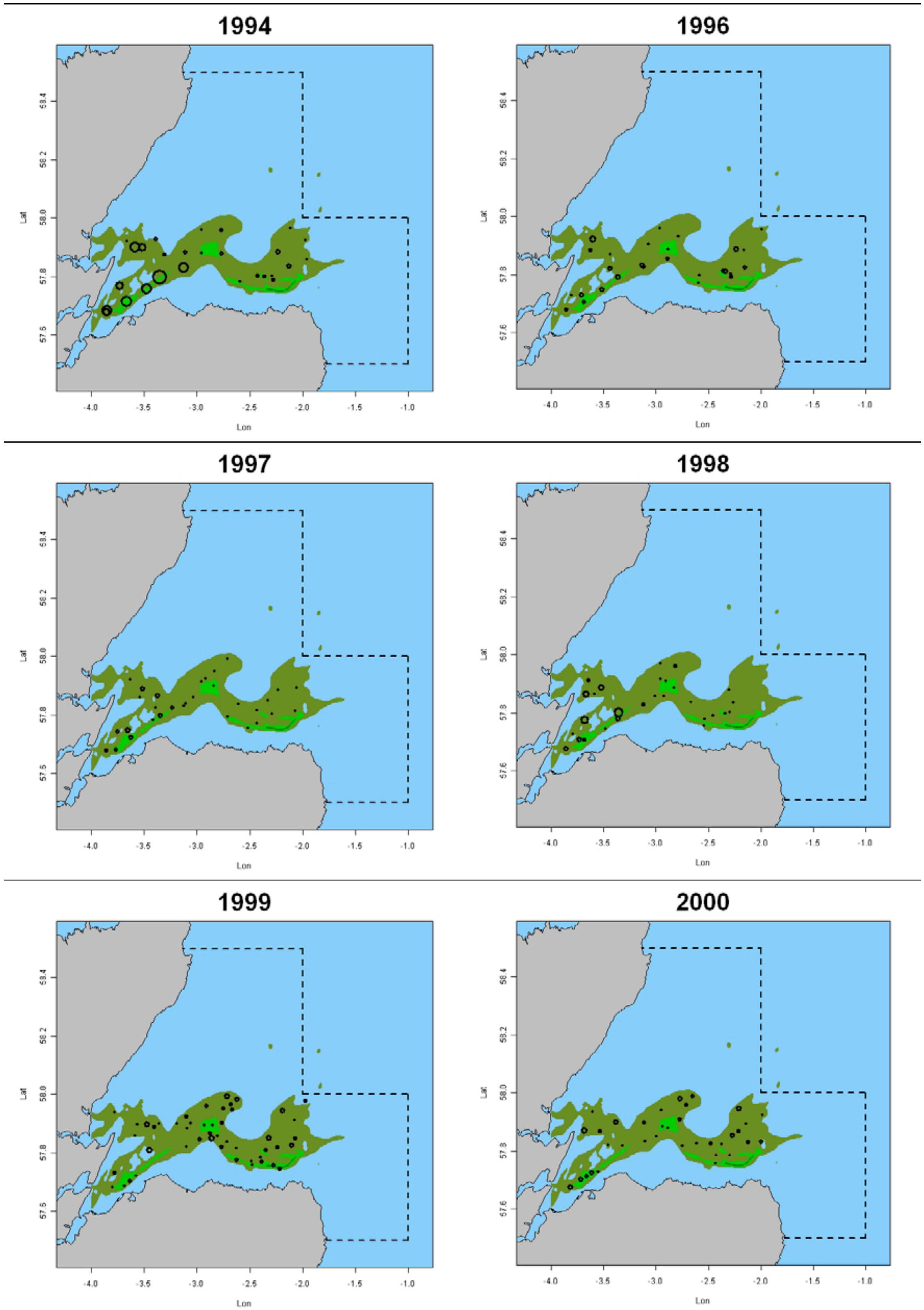
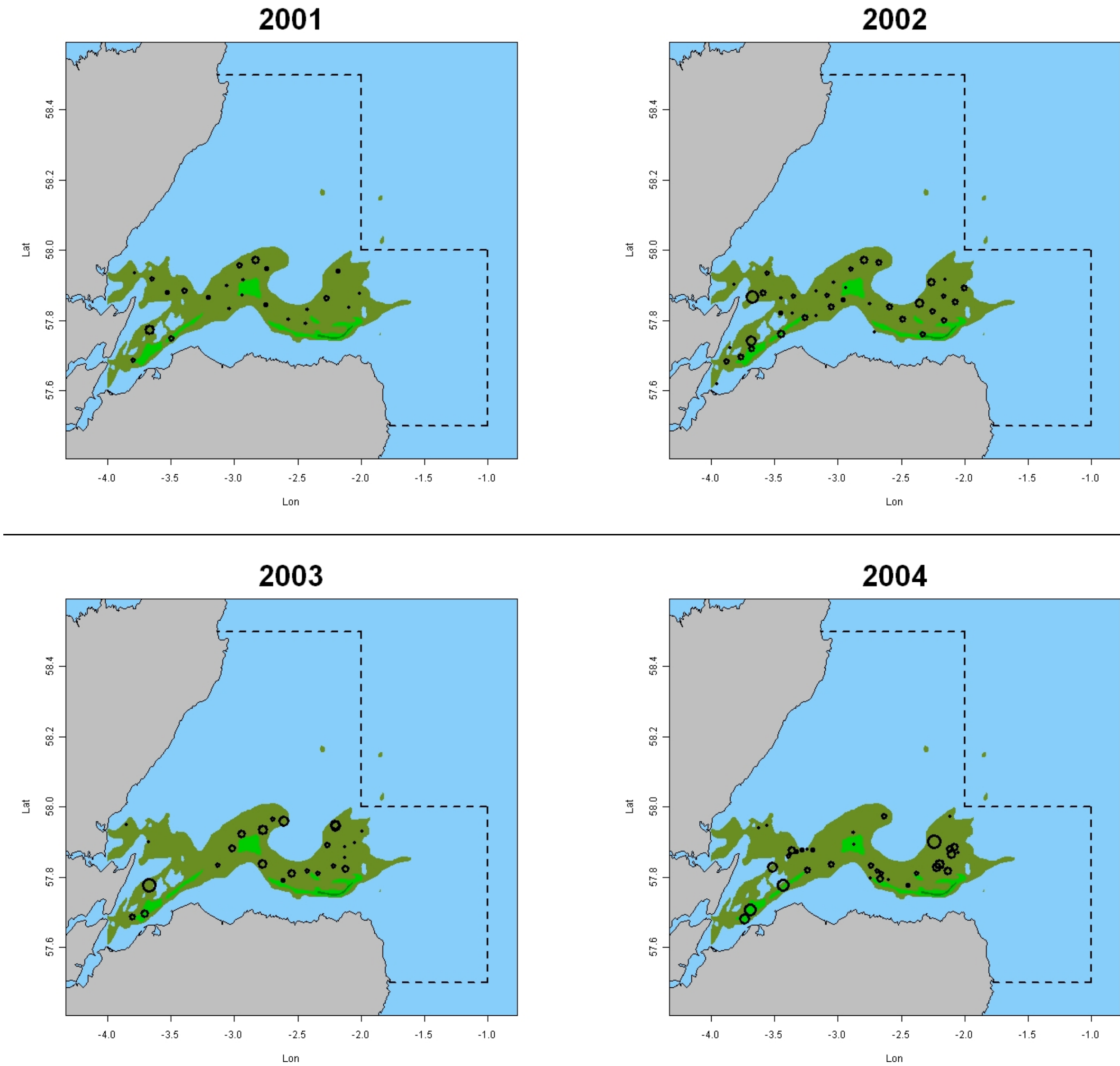


Figure 3.4.1.5 ***Nephrops*****, Moray Firth (FU 9), CPUEs by sex and quarter for selected size groups, Scottish** ***Nephrops*** **trawlers.**

Figure 3.4.1.6 ***Nephrops*, Moray Firth (FU 9), Historical TV survey station distribution and relative density, 1994–2000. Green and brown areas represent areas of suitable sediment for *Nephrops*.**




2001
2002
2003
2004
Lat
Lon
58.4
58.2
58.0
57.8
57.6
-4.0
-3.5
-3.0
-2.5
-2.0
-1.5
-1.0

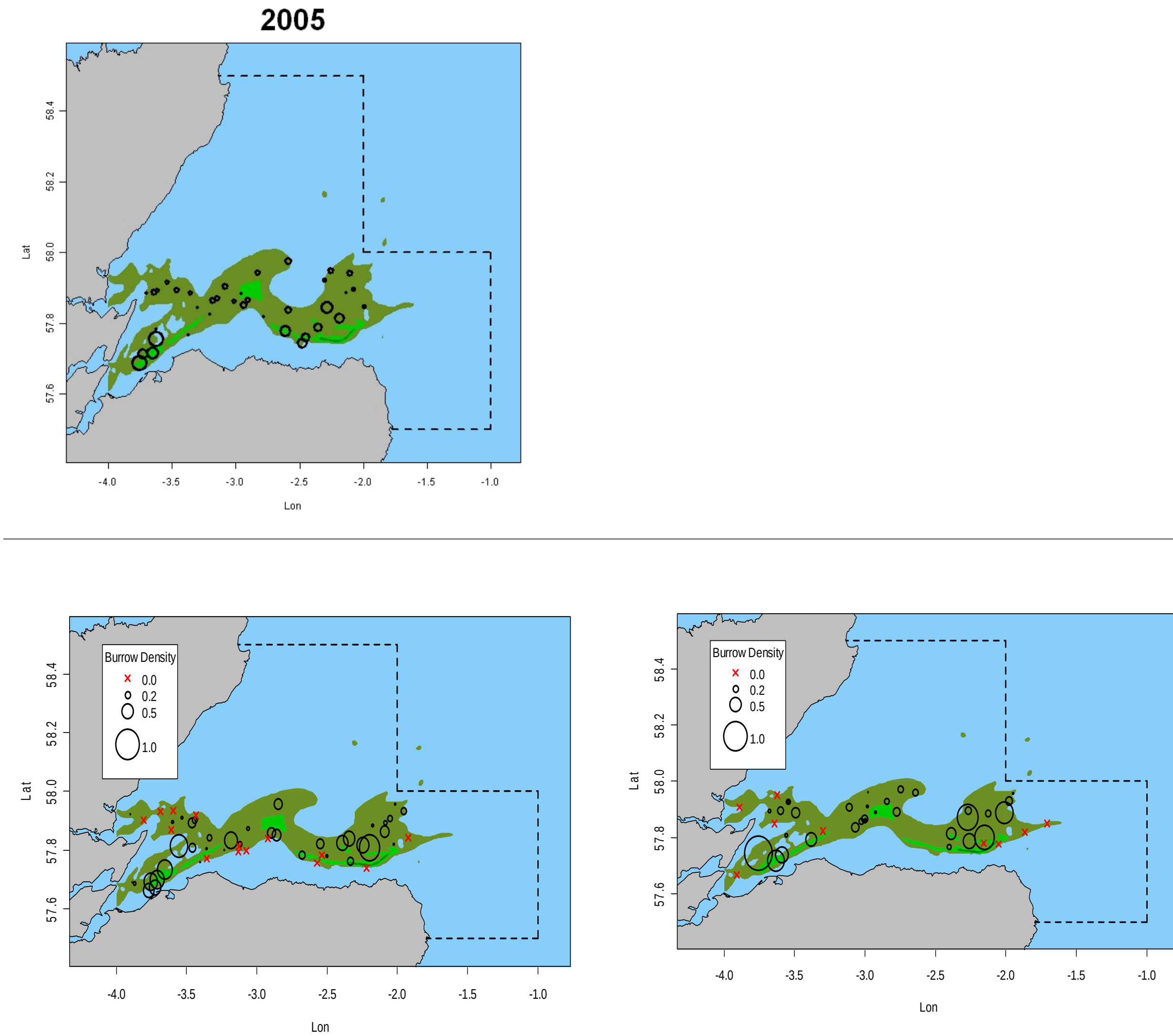


Figure 3.4.1.7 ***Nephrops*****, Moray Firth (FU 9), TV survey station distribution and relative density, 2001–2005 and 2006(bottom left) and 2007 (bottom right). Green and brown areas represent areas of suitable sediment for** ***Nephrops*****.**

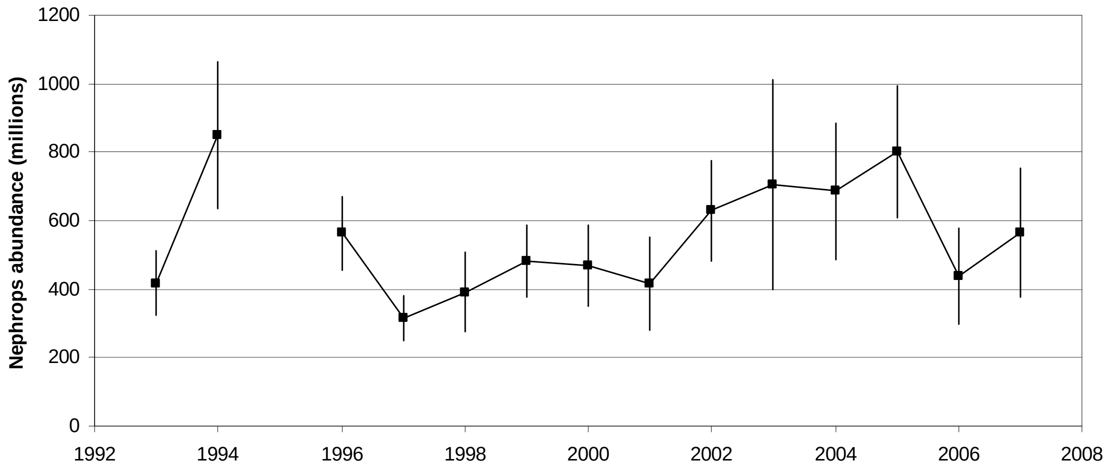


Figure 3.4.1.8 ***Nephrops*****, Moray Firth (FU 9), Time series of TV survey abundance estimates, with 95% confidence intervals, 1993 – 2007.**

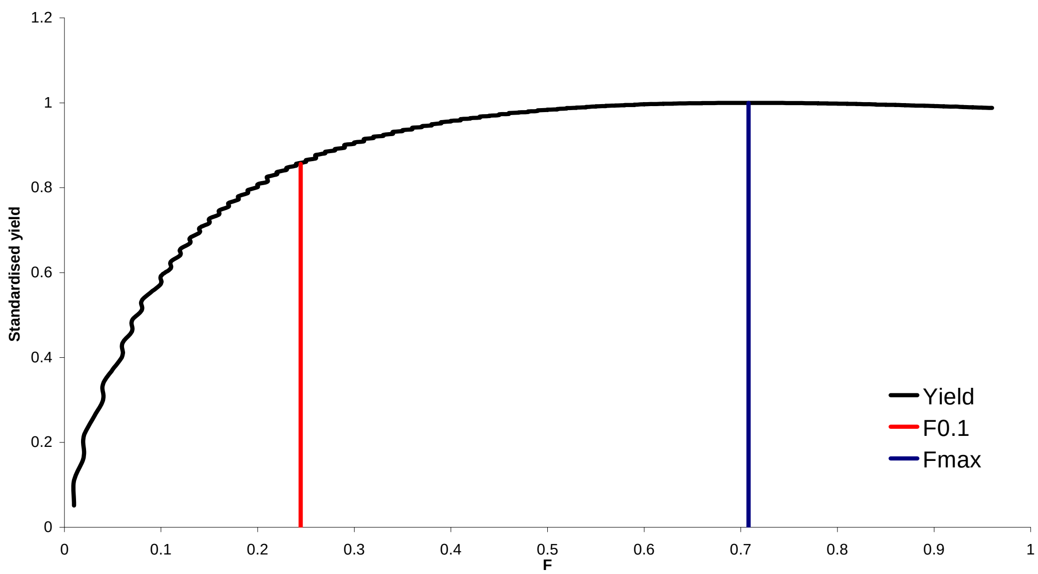


Figure 3.4.1.9 ***Nephrops*****, Moray Firth (FU 9)Combined sex yield per recruit plot (ave length distribution 2003–2005) showing position of F_{max} and $F_{0.1}$**

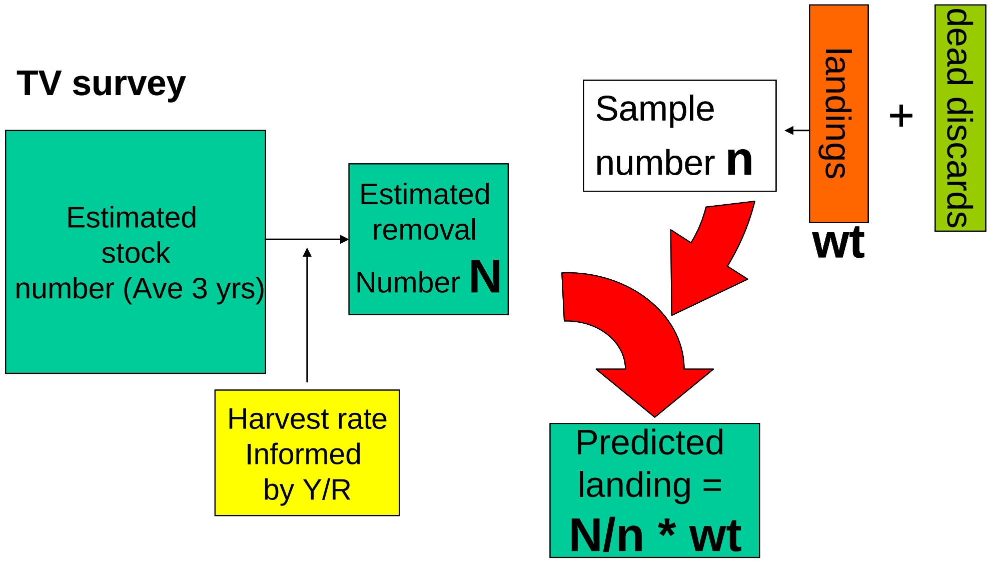


Figure 3.4.1.10 Diagram to illustrate the process of calculating a predicted landing from TV survey abundance estimates

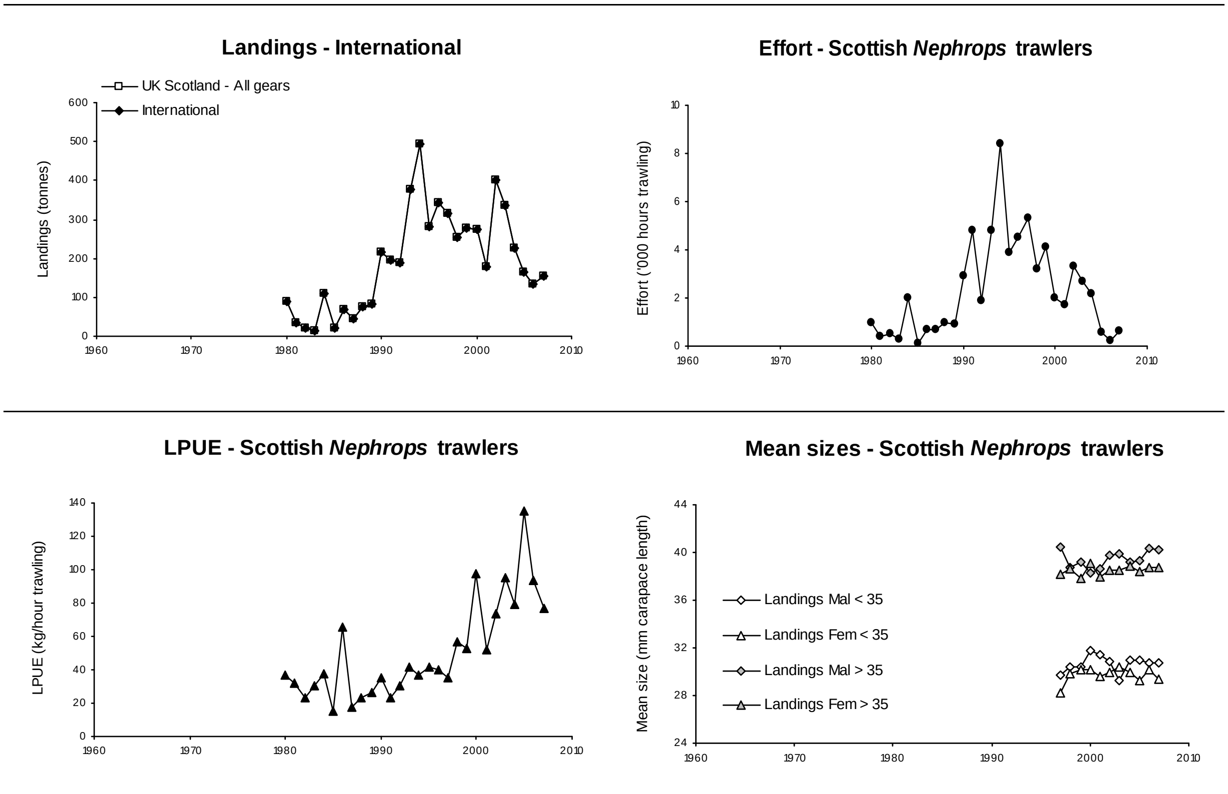


Figure 3.4.1.11 ***Nephrops*****, Noup (FU 10), Long term landings, effort, LPUE and mean sizes.**

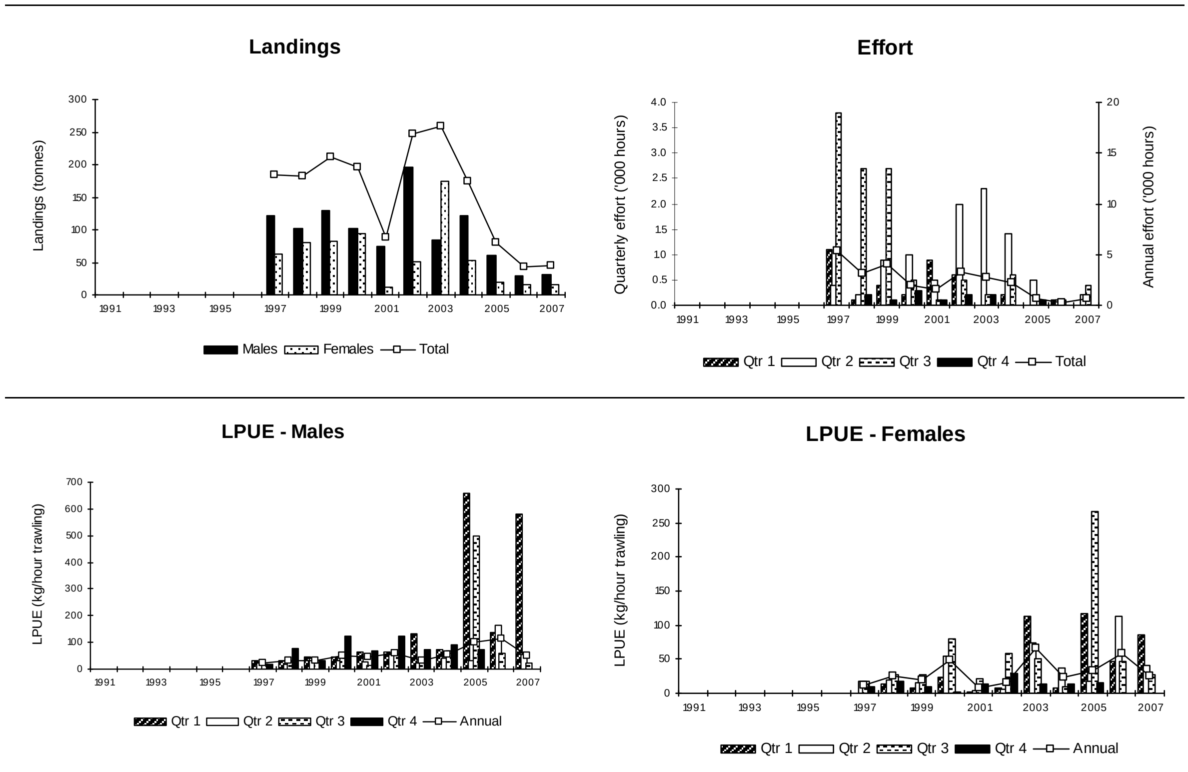


Figure 3.4.1.12 ***Nephrops*****, Noup (FU 10), Landings, effort and LPUEs by quarter and sex from Scottish** ***Nephrops*** **trawlers.**

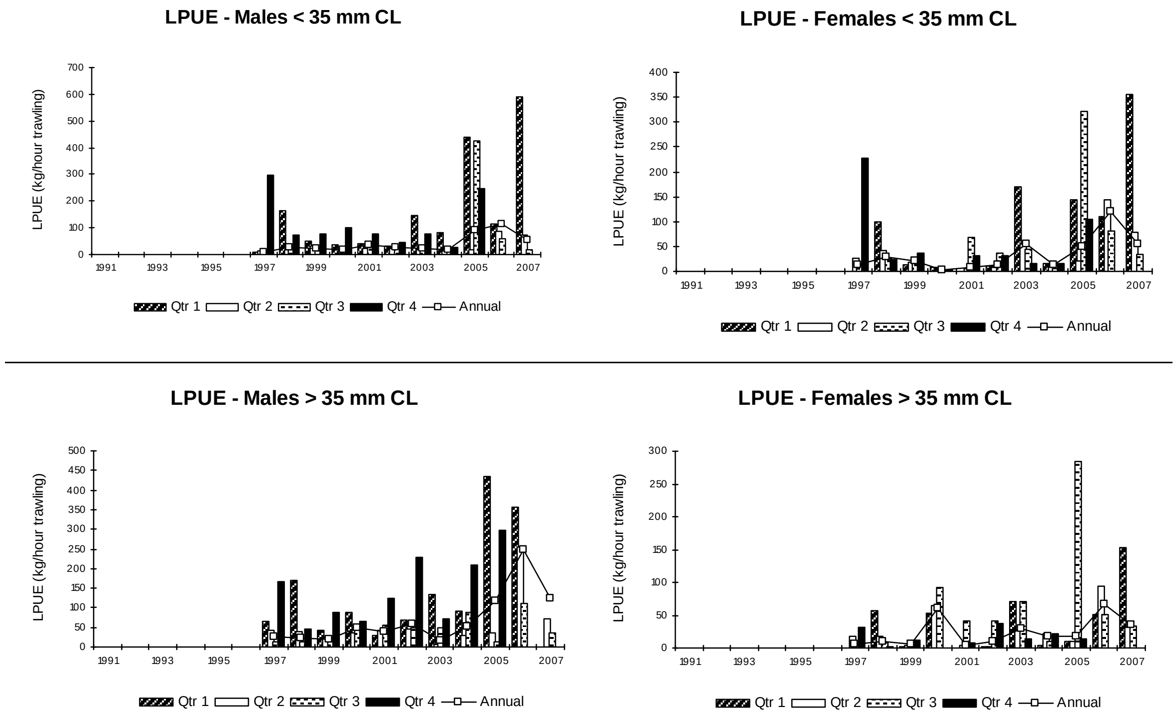


Figure 3.4.1.13 ***Nephrops*****, Noup (FU 10), LPUEs by sex and quarter for selected size groups, Scottish** ***Nephrops*** **trawlers.**

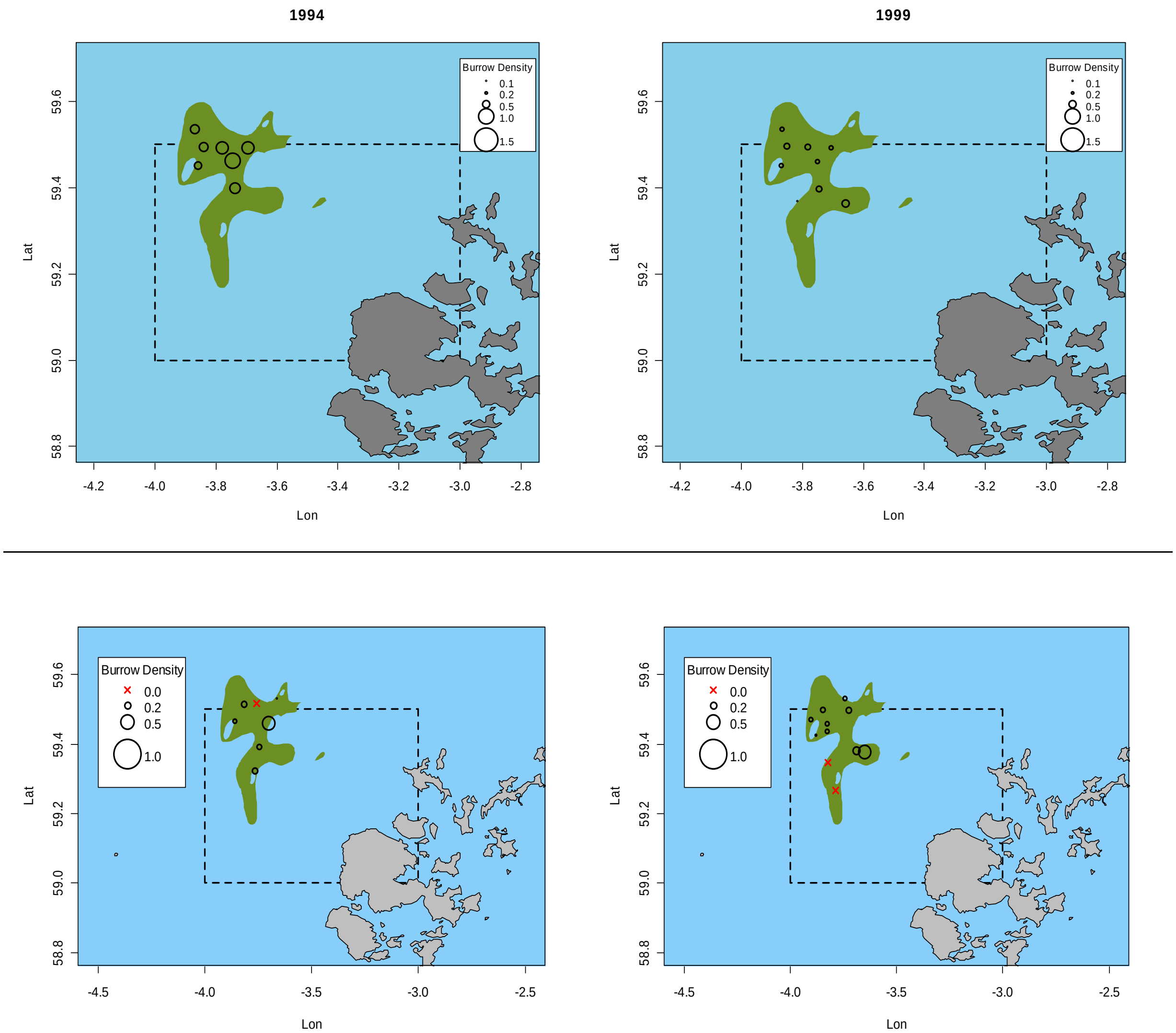


Figure 3.4.1.14 ***Nephrops*****, Noup (FU 10), TV survey station distribution and relative density, 1994, 1999 and 2006 and 2007 (bottom left and right respectively). Green and brown areas represent areas of suitable sediment for** ***Nephrops*****.**

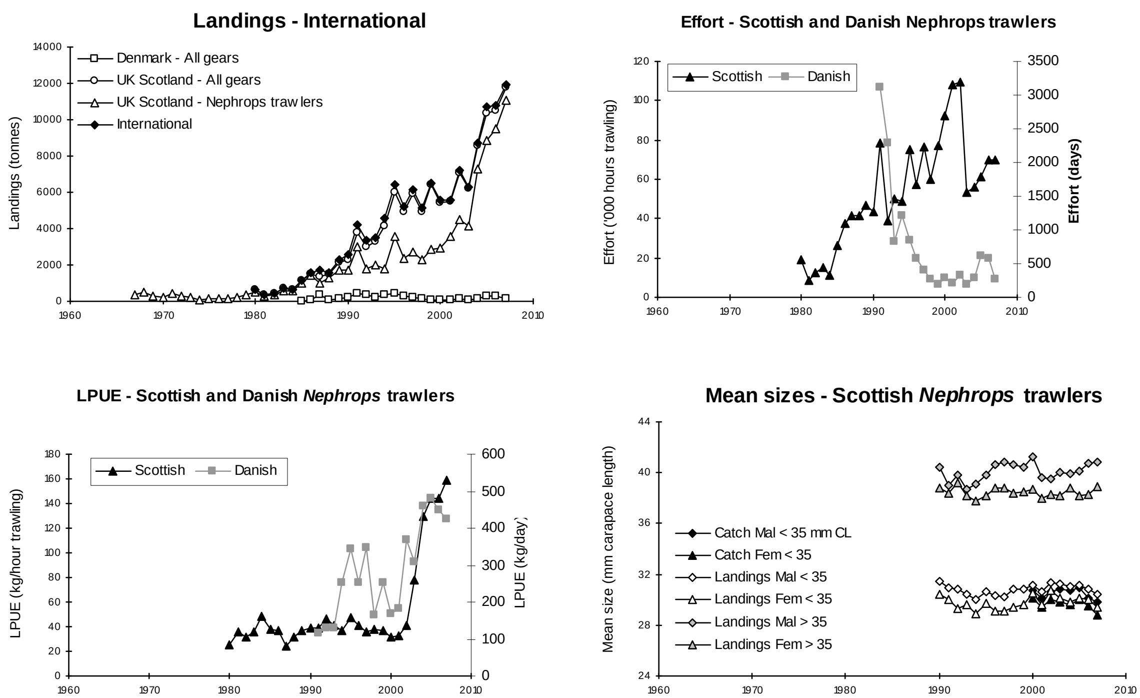


Figure 3.4.2.1 *Nephrops*, Fladen (FU 7), Long term landings, effort, LPUE and mean sizes.

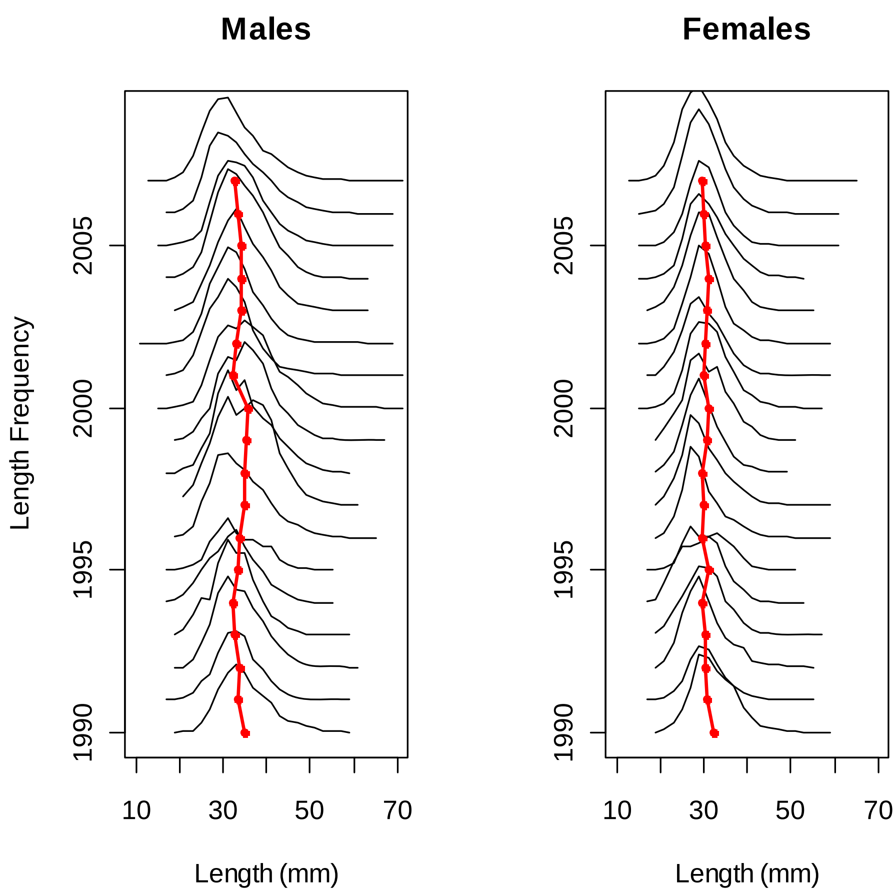


Figure 3.4.2.2 *Nephrops* Fladen Ground (FU 7)Length composition of catch of males (right) and females left from 1990 (bottom) to 2007 (top). Red line shows the mean sizes of catch.

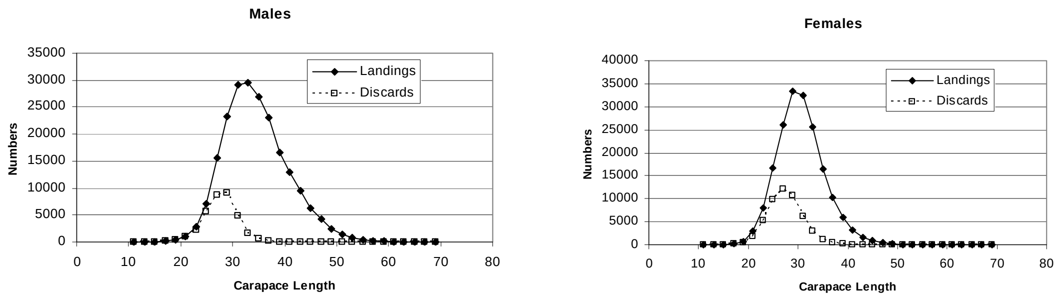


Figure 3.4.2.3 ***Nephrops*****, Fladen (FU 7), Length frequency distributions of male and female landings and discards, averaged over 2005 – 2007.**

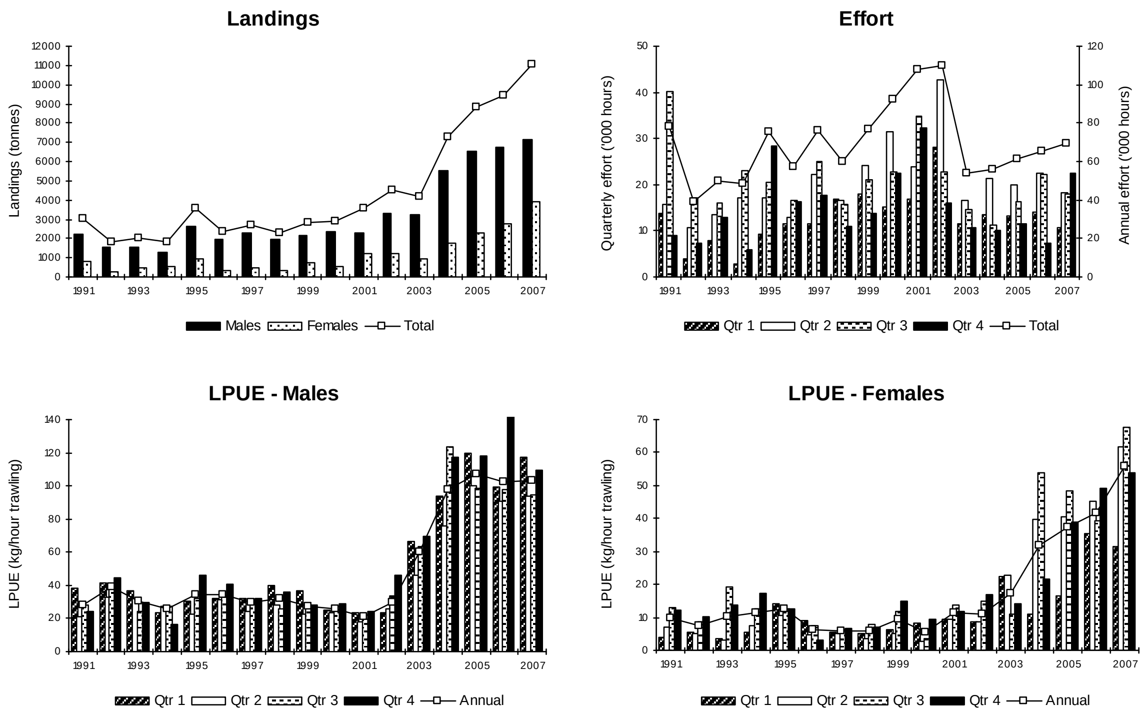


Figure 3.4.2.4 ***Nephrops*****, Fladen (FU 7), Landings, effort and LPUEs by quarter and sex from Scottish** ***Nephrops*** **trawlers.**

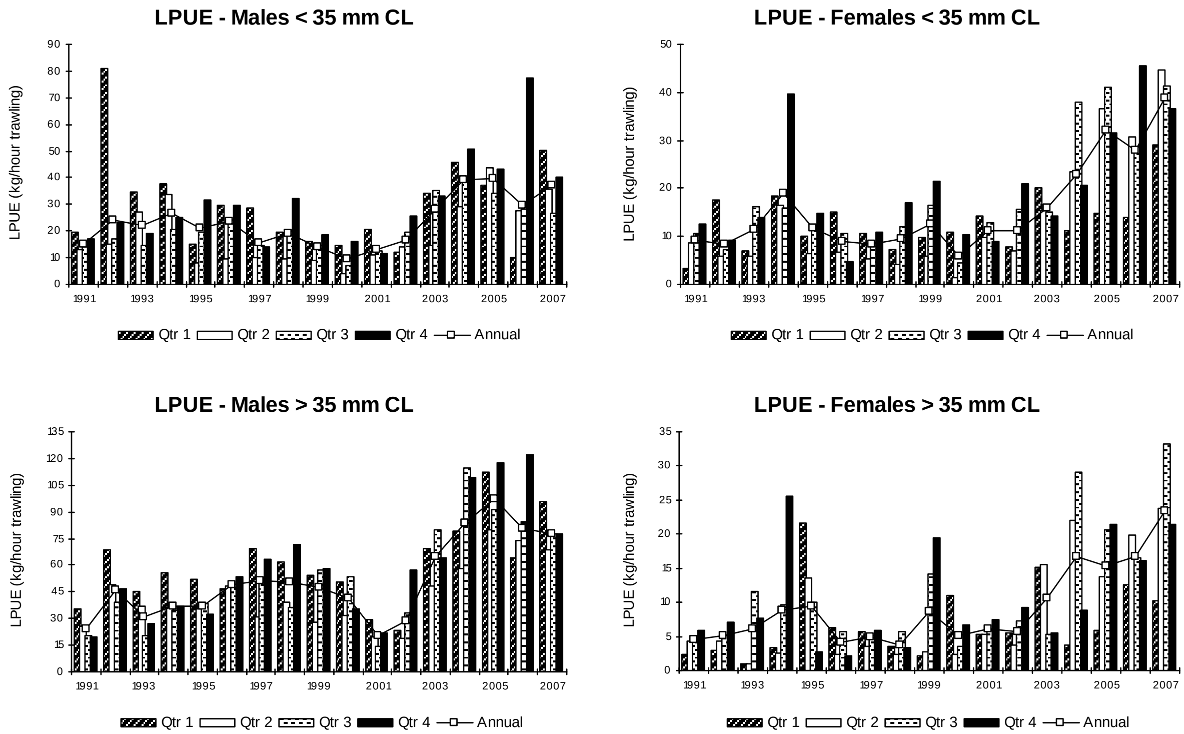


Figure 3.4.2.5 *Nephrops*, Fladen (FU 7), CPUEs by sex and quarter for selected size groups, Scottish *Nephrops* trawlers.

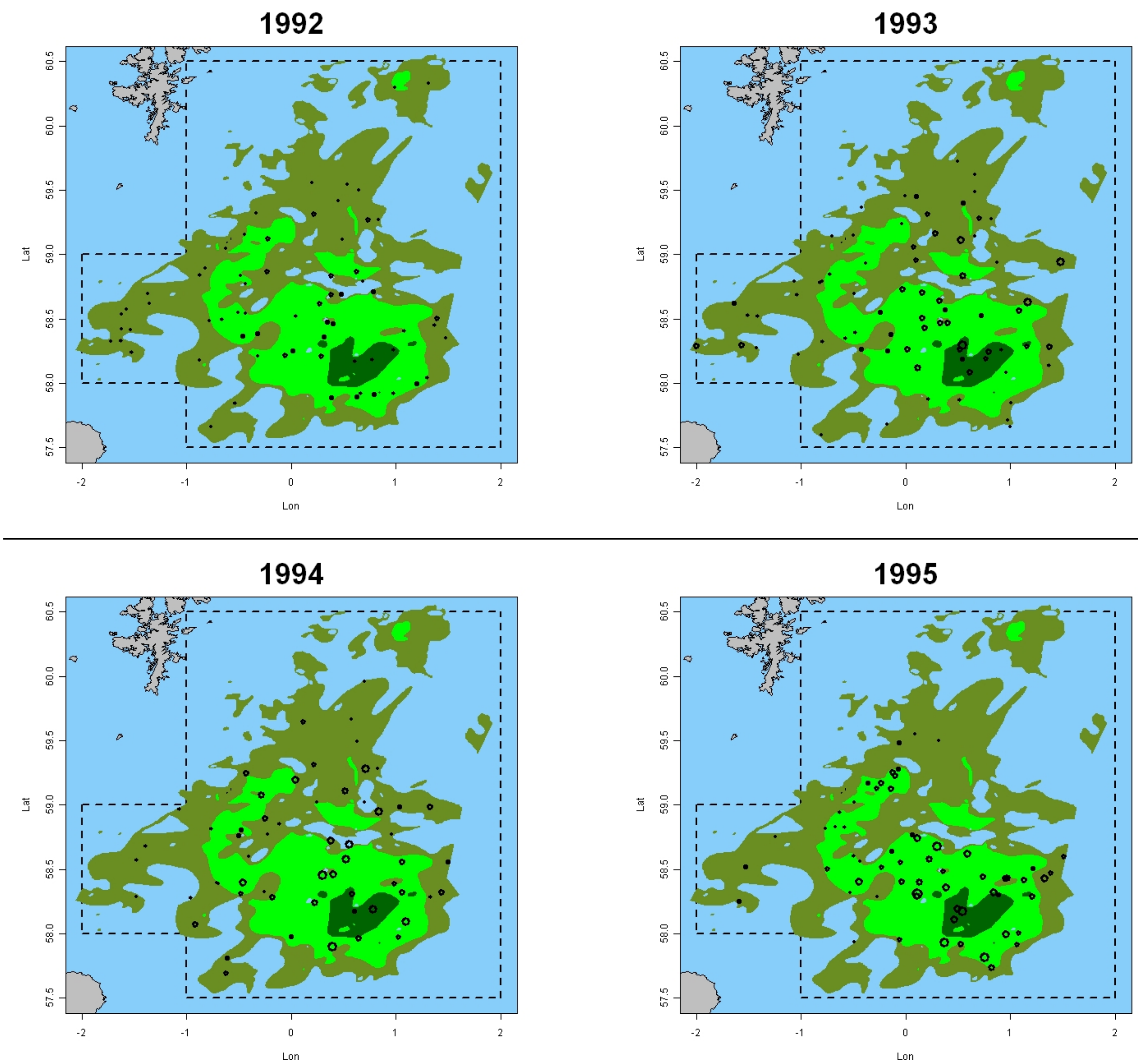


Figure 3.4.2.6 *Nephrops*, Fladen (FU 7), TV survey station distribution and relative density, 1992 – 1995. Green and brown areas represent areas of suitable sediment for *Nephrops*.

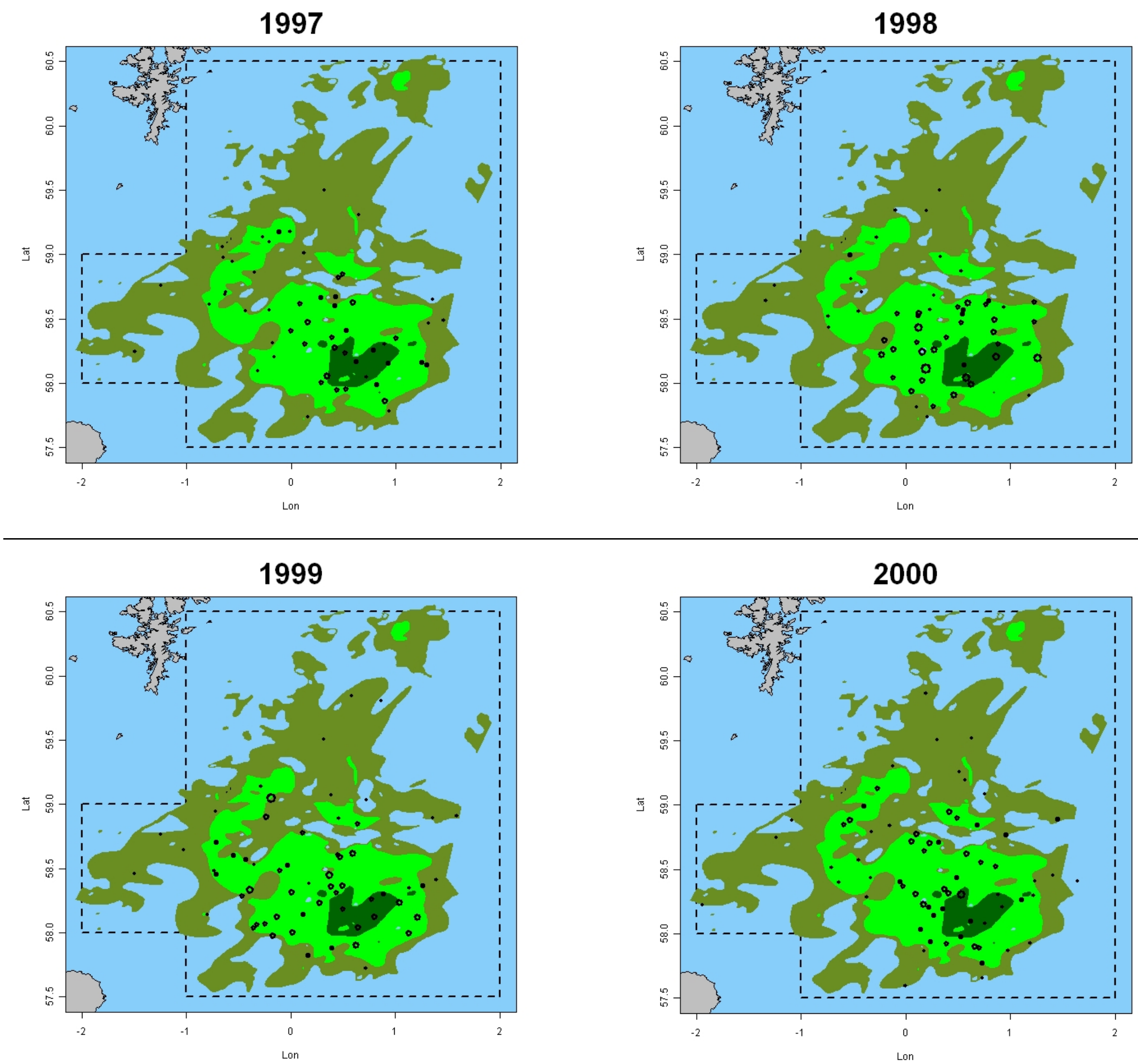
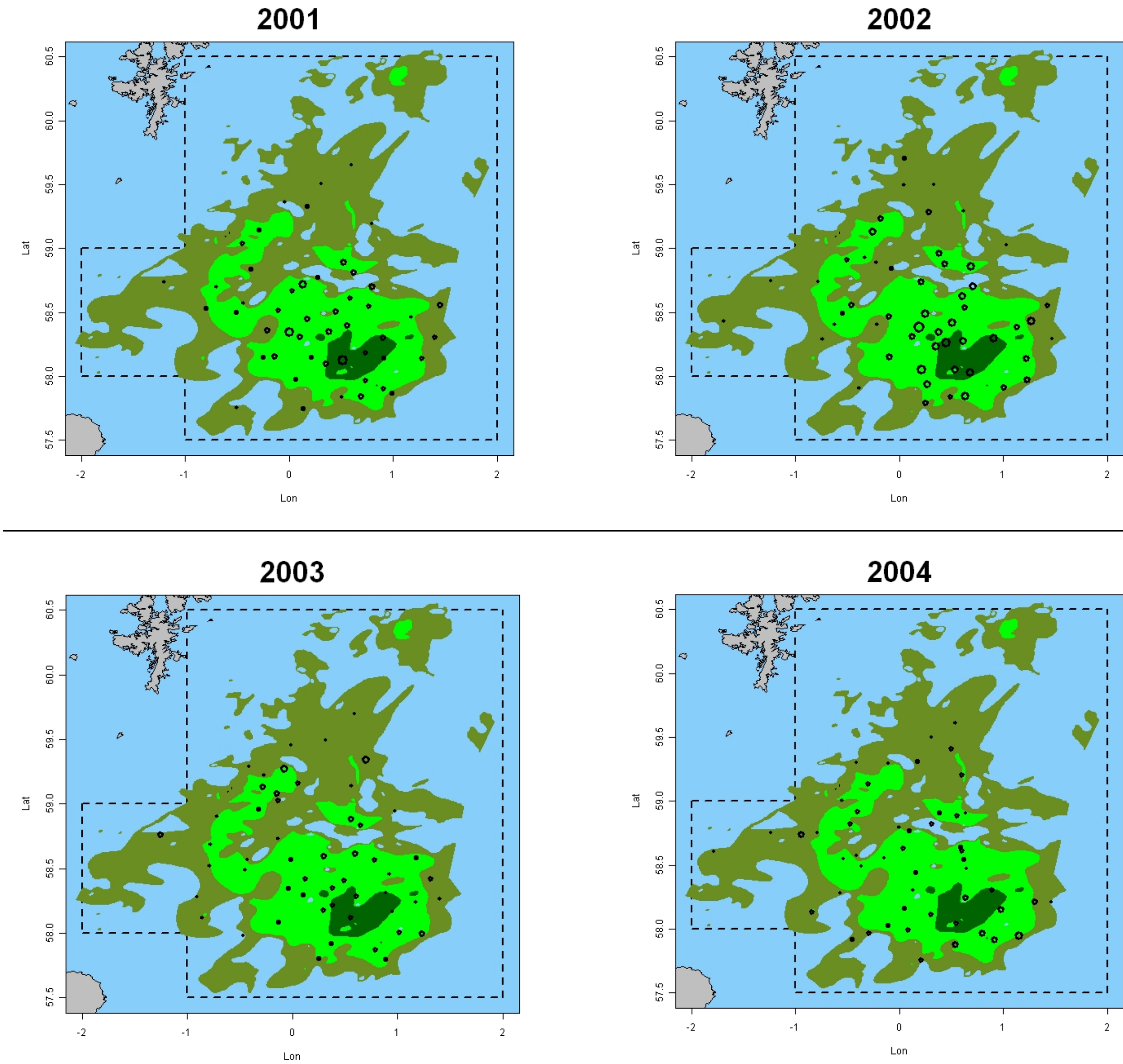


Figure 3.4.2.6 cont *Nephrops*, Fladen (FU 7), TV survey station distribution and relative density, 1997 – 2000. Green and brown areas represent areas of suitable sediment for *Nephrops*.


2001
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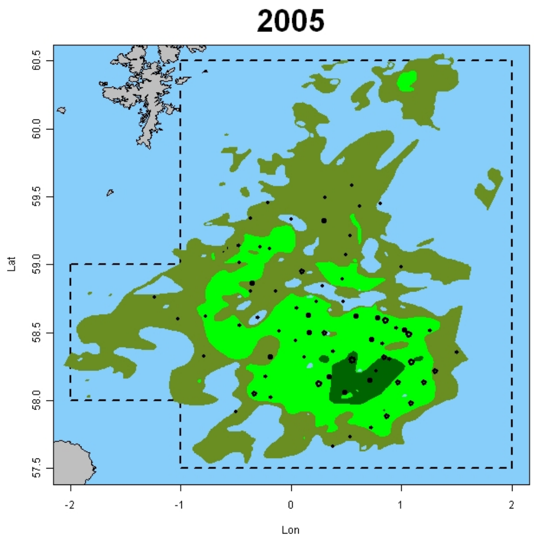

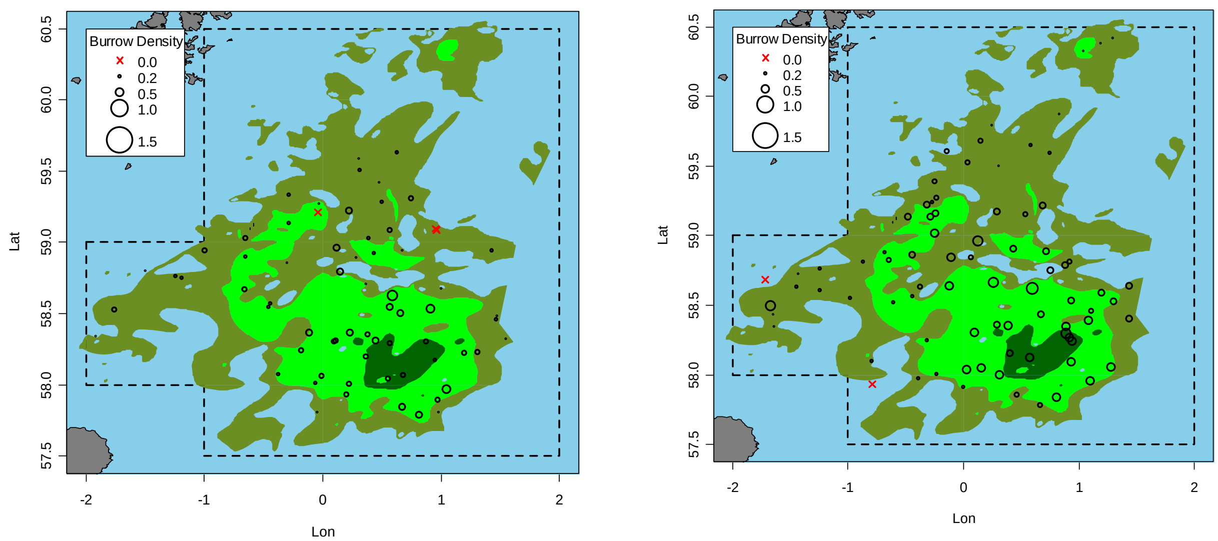

Figure 3.4.2.6 cont *Nephrops*, Fladen (FU 7), TV survey station distribution and relative density, 2006 (left) – 2007 (right). Green and brown areas represent areas of suitable sediment for *Nephrops*.

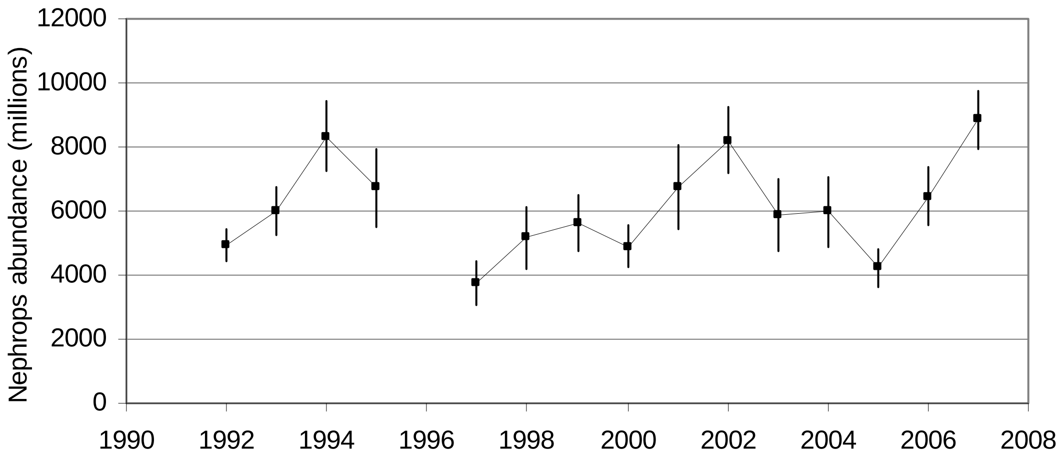

Figure 3.4.2.7 ***Nephrops*****, Fladen (FU 7), Time series of TV survey abundance estimates, with 95% confidence intervals, 1992 – 2005.**

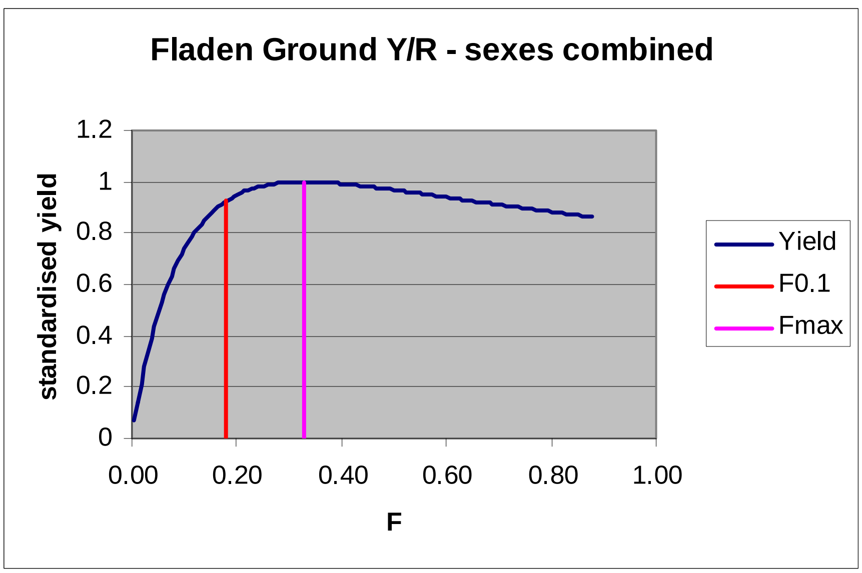

Figure 3.4.2.8 ***Nephrops*****, Fladen (FU 7) Combined sex yield per recruit plot (ave length distribution 2005–2007) showing position of F_{max} and $F_{0.1}$**

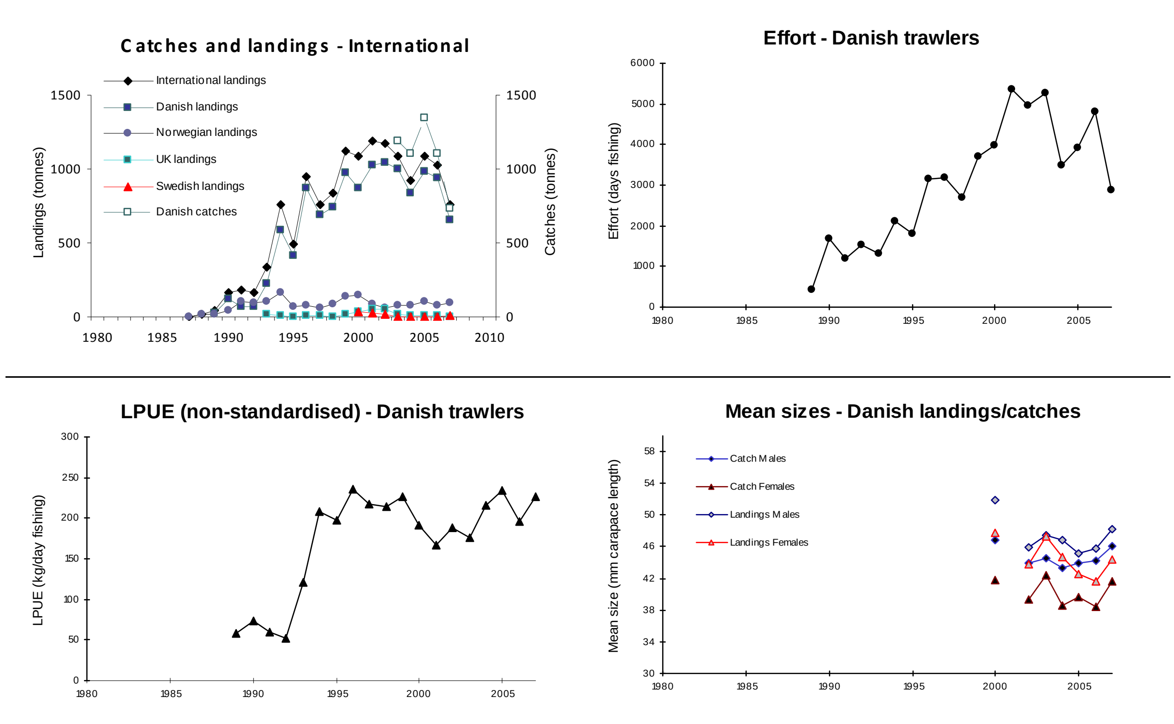

Figure 3.4.3.1 ***Nephrops*** **Norwegian Deep (FU 32): Long-term trends in landings, effort, CPUEs and/or LPUEs, and mean sizes of** ***Nephrops*****.**

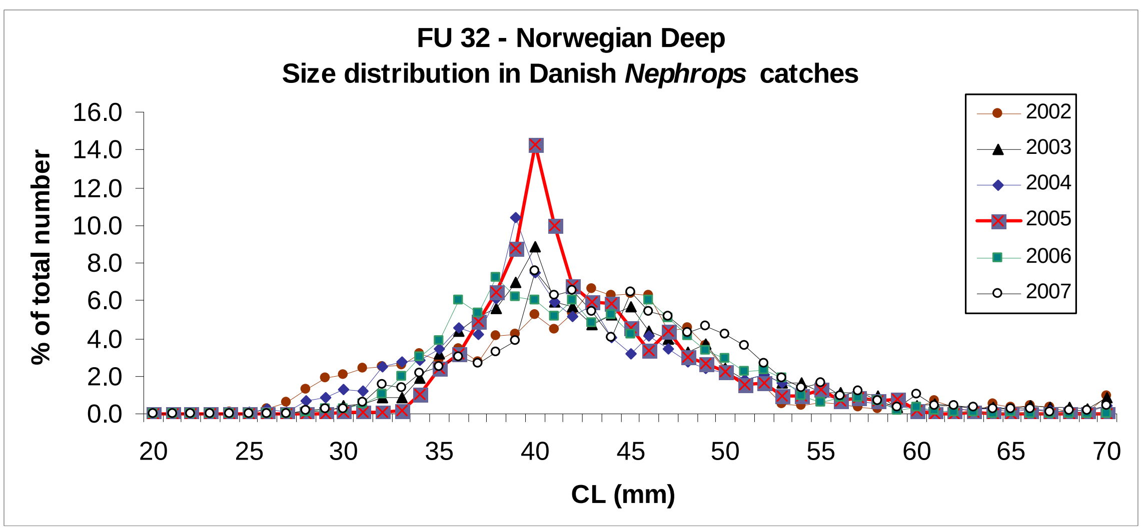

Figure 3.4.3.2 ***Nephrops*** **Norwegian Deep (FU 32): LFDs from Danish Nephrops/finfish trawlers in FU 32.**

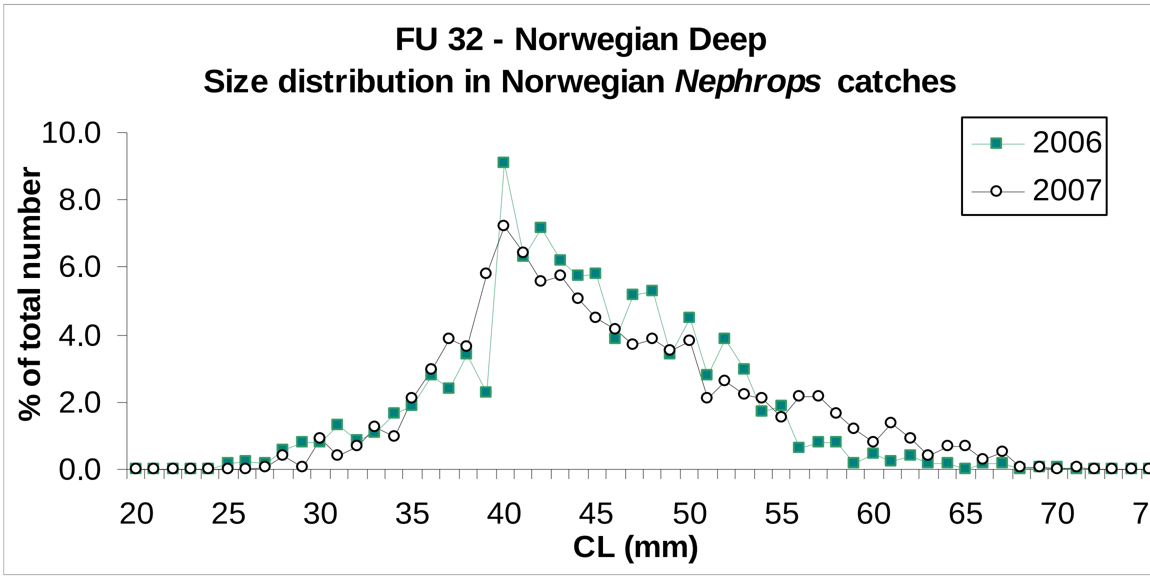

Figure 3.4.3.3 ***Nephrops*** **Norwegian Deep (FU 32): LFDs from Norwegian Nephrops/finfish trawlers in FU 32 (using 100 mm mesh trawls).**

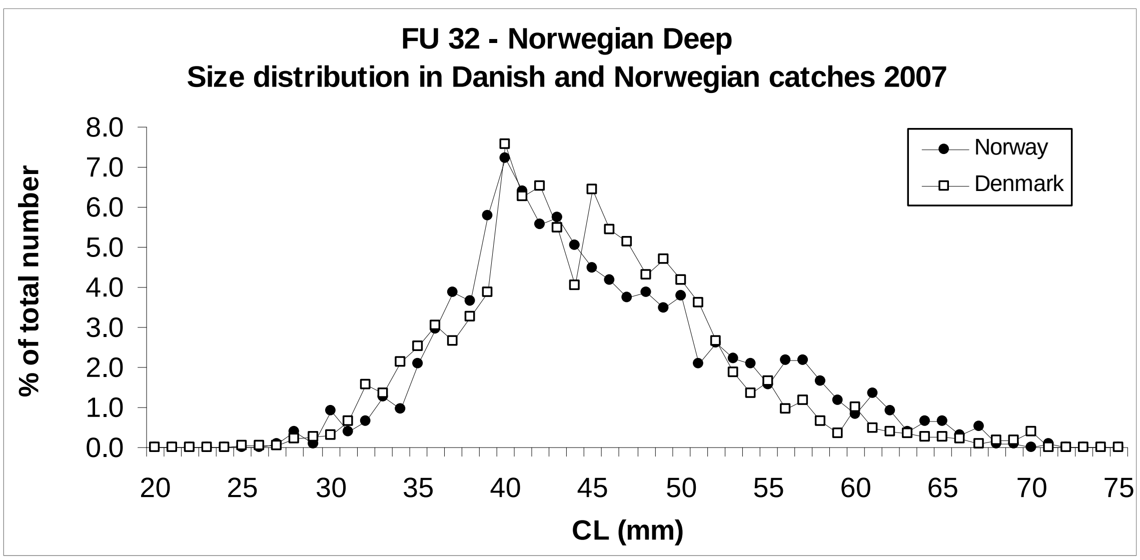

Figure 3.4.3.4 ***Nephrops*** **Norwegian Deep (FU 32): LFDs from Danish and Norwegian Nephrops/finfish trawlers in FU 32 (using 100 mm mesh trawls).**

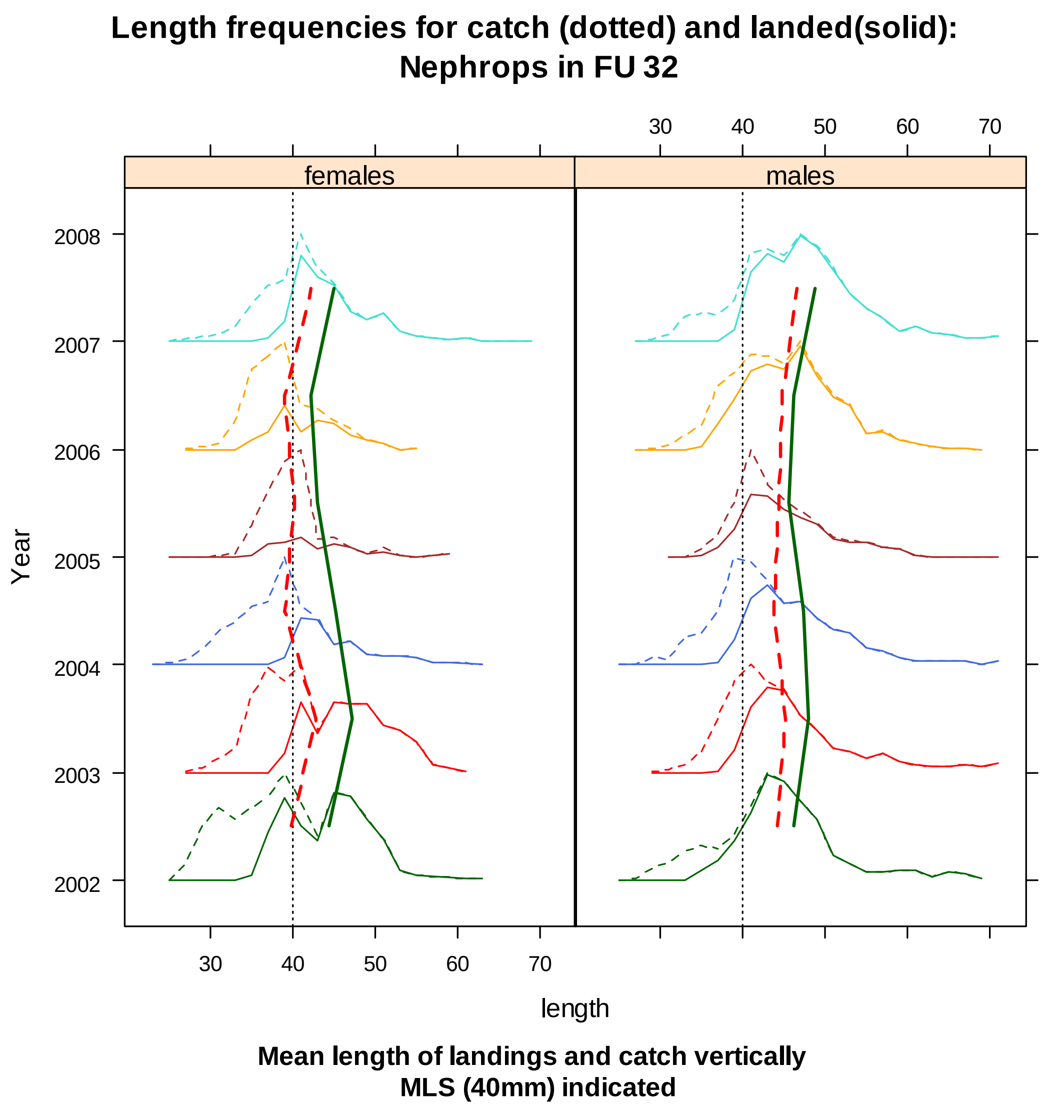

Figure 3.4.3.5 ***Nephrops*** **Norwegian Deep (FU 32) Length composition of catch (dotted) and landed (solid) of males (right) and females left from 2002 (bottom) to 2007 (top). Mean sizes of catch and landings (using same line types) is shown in relation to MLS**

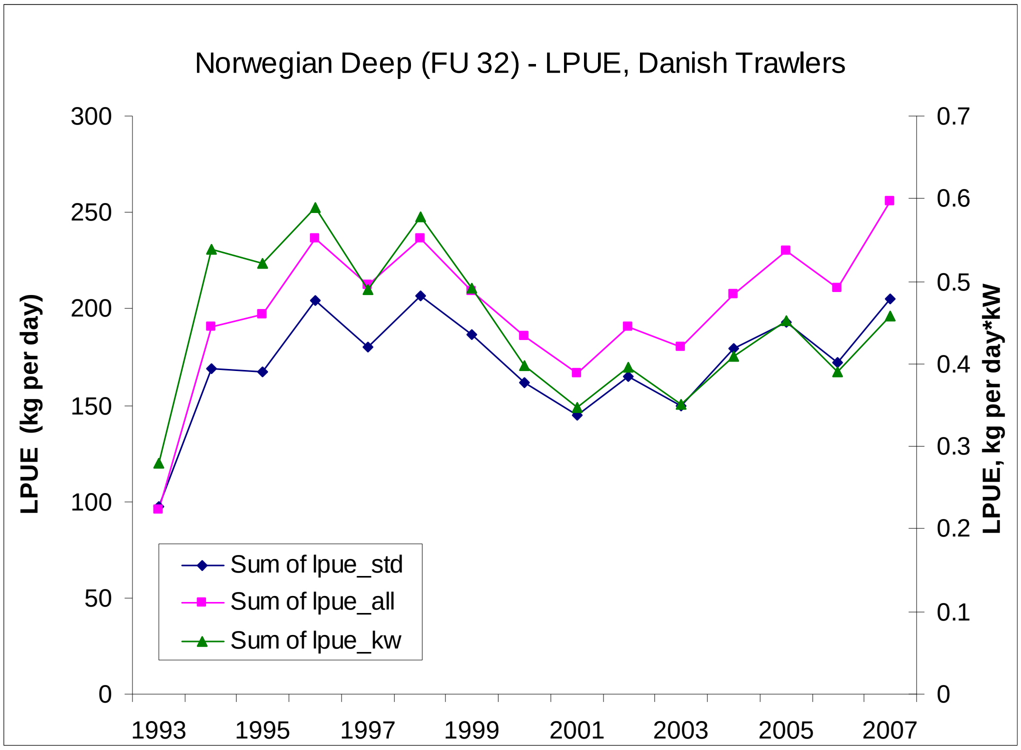

Figure 3.4.3.6. ***Nephrops*** **Norwegian Deep (FU 32) Relative LPUE of Danish trawlers calculated in various ways**

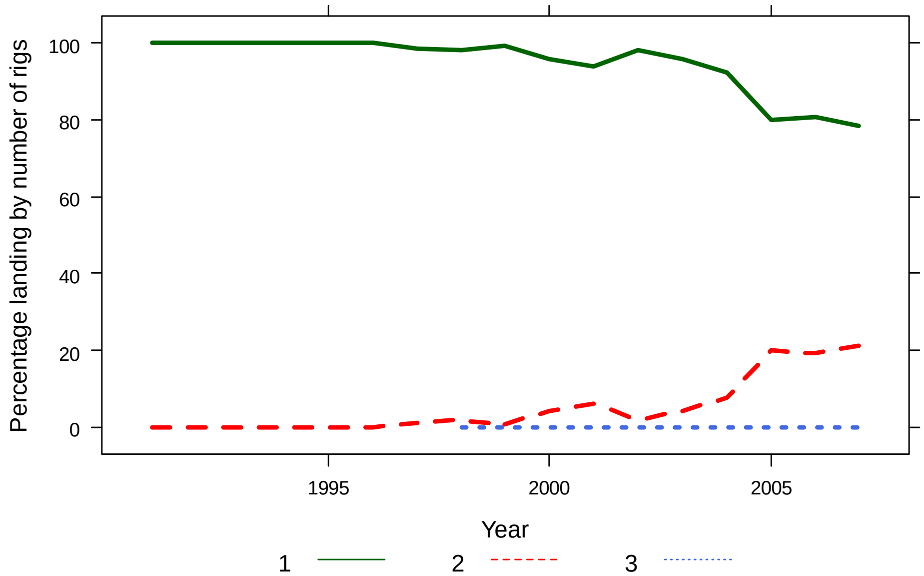

Figure 3.4.4.1. Farn Deeps (FU 6): Percentage of landings by number of rigs in each gear set.

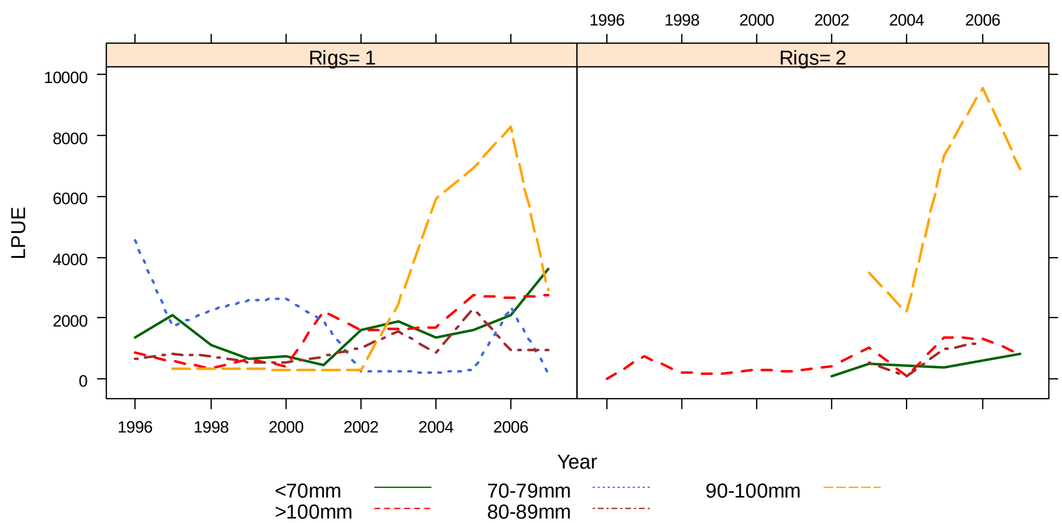

Figure 3.4.4.2. Farn Deeps (FU 6): LPUE trends by mesh category and number of rigs.

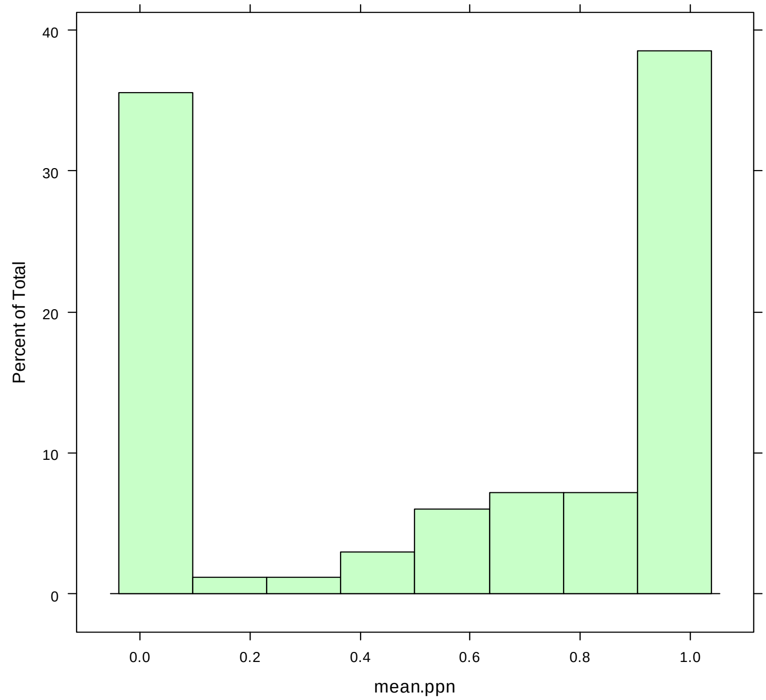

Figure 3.4.4.3. Farn Deeps (FU 6): Histogram of proportion individuals <26 mm discarded.

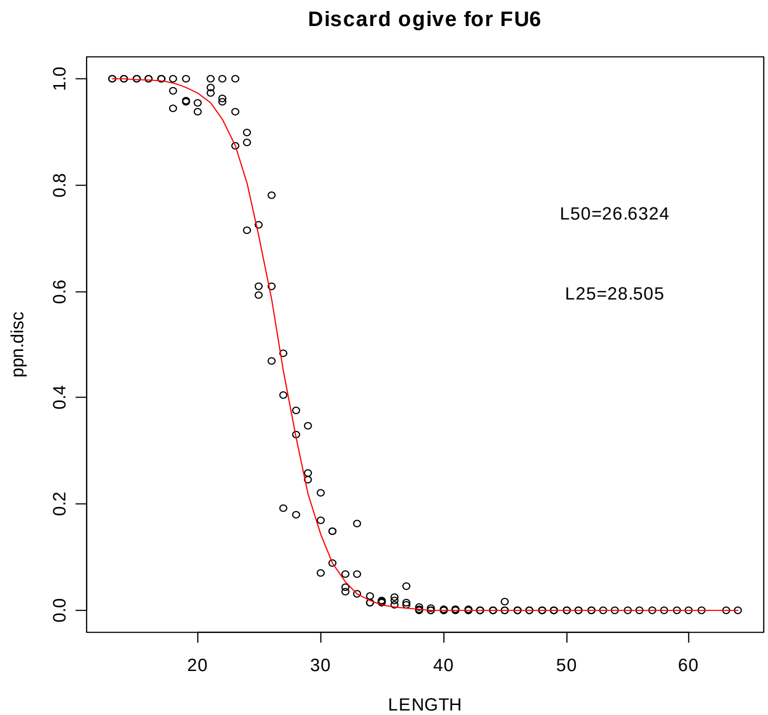

Figure 3.4.4.4. Farn Deeps (FU 6): Discard ogive selected for FU6 *Nephrops*, trip level data pooled to year.

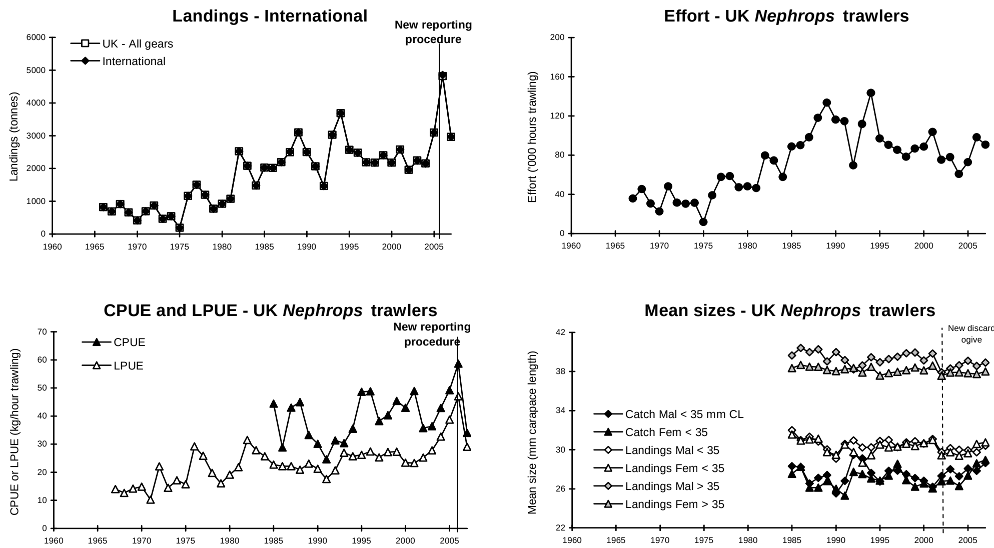

Figure 3.4.4.5 *Nephrops* Farn Deeps (FU 6): Long-term trends in landings, effort, CPUEs and/or LPUEs, and mean sizes of *Nephrops*

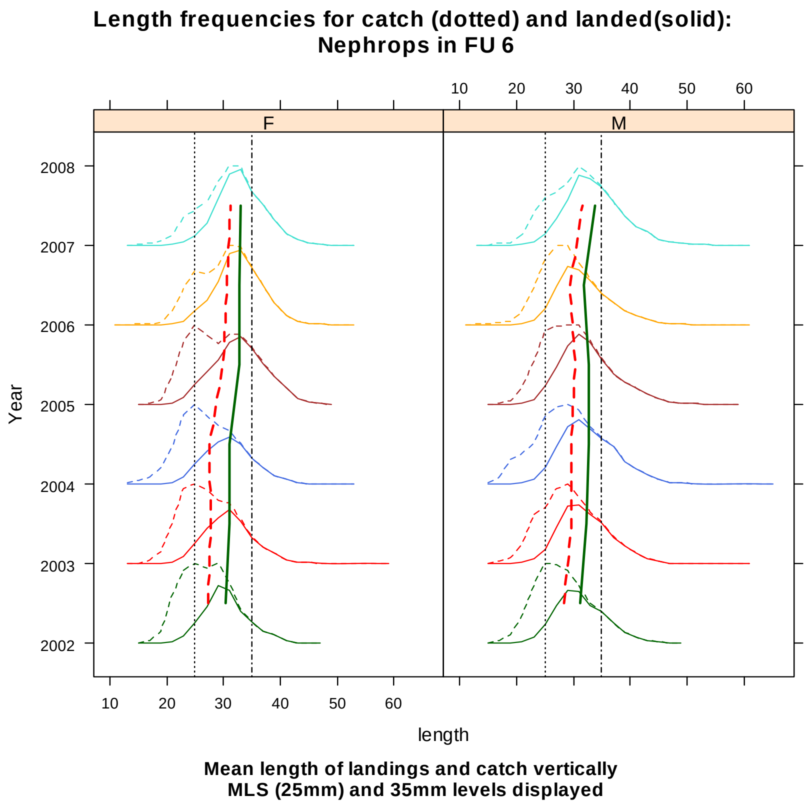

Figure 3.4.4.6 *Nephrops* Farn Deeps (FU 6) Length composition of catch (dotted) and landed (solid) of males (right) and females left from 1996 (bottom) to 2007 (top). Mean sizes of catch and landings (using same line types) is shown in relation to MLS

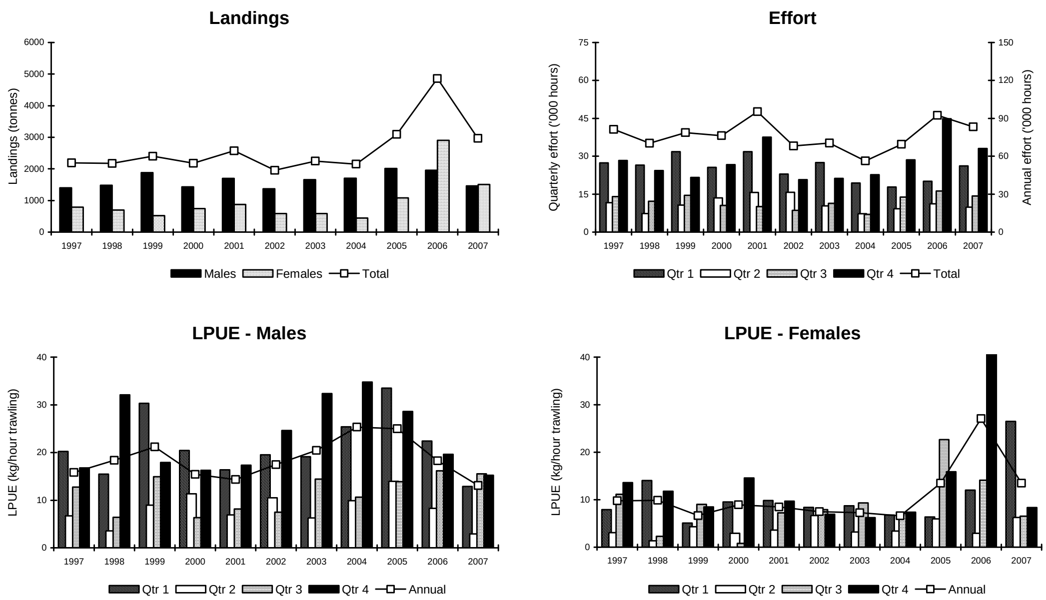

Figure 3.4.4.7 ***Nephrops*** **Farn Deeps (FU 6): Landings, effort and LPUEs by quarter and sex from English** ***Nephrops*** **trawlers.**

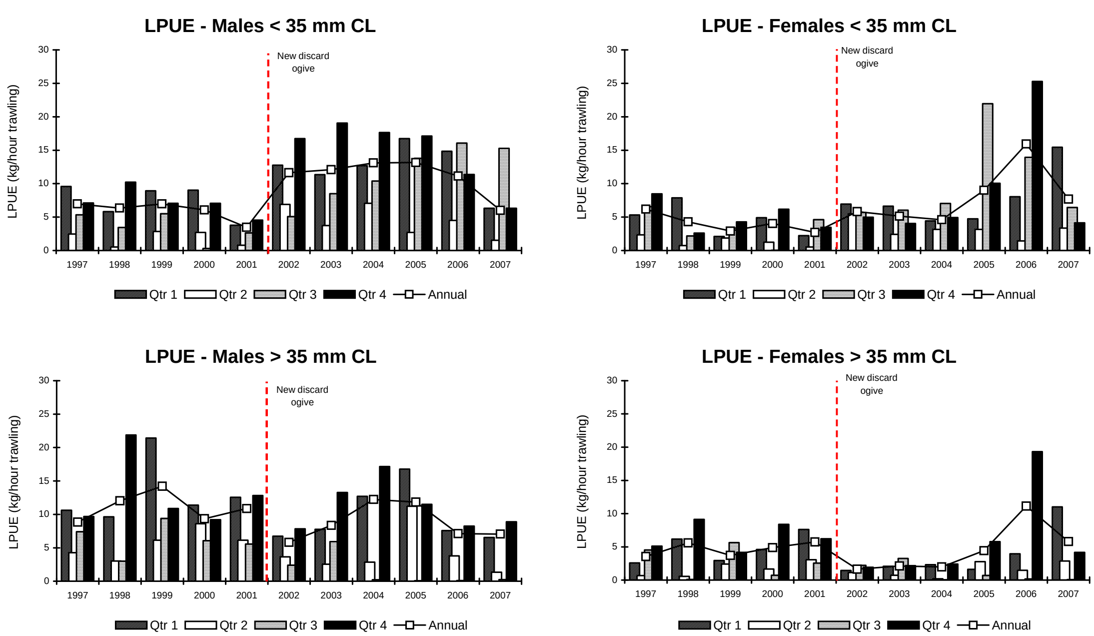

Figure 3.4.4.8 ***Nephrops*** **Farn Deeps (FU 6): LPUEs by sex and quarter for selected size groups, English** ***Nephrops*** **trawlers.**

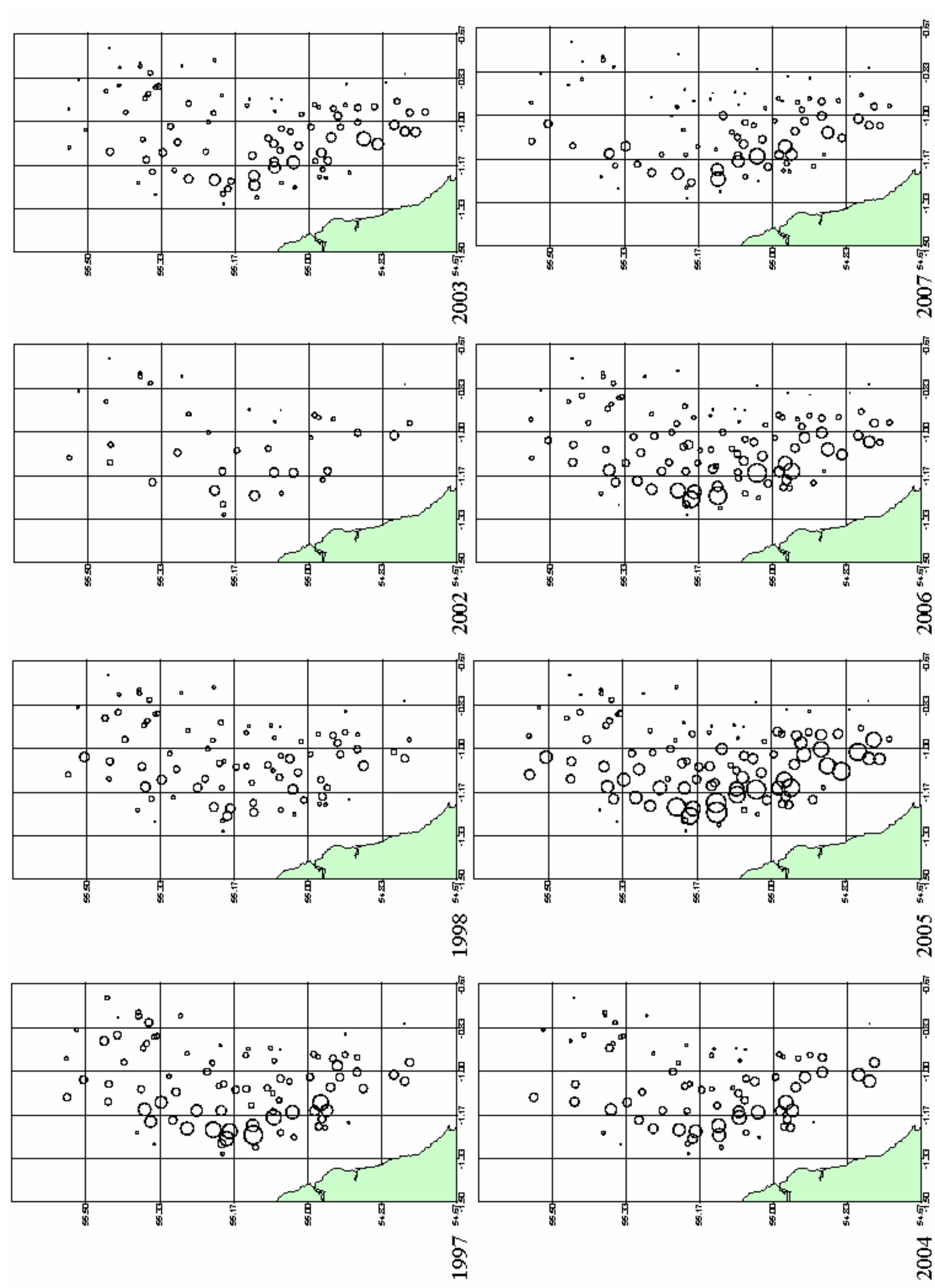

Figure 3.4.4.9 ***Nephrops*** **Farn Deeps (FU6)–): Estimates of burrow density by TV station, bubble area is proportional to density.**

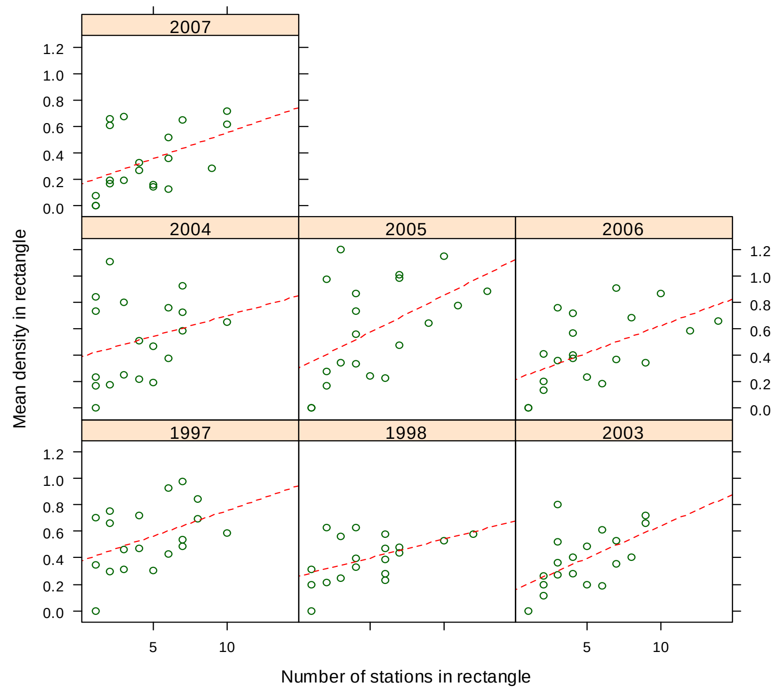

Figure 3.4.4.10. Farn Deeps (FU 6): Station density vs burrow density with linear regression line.

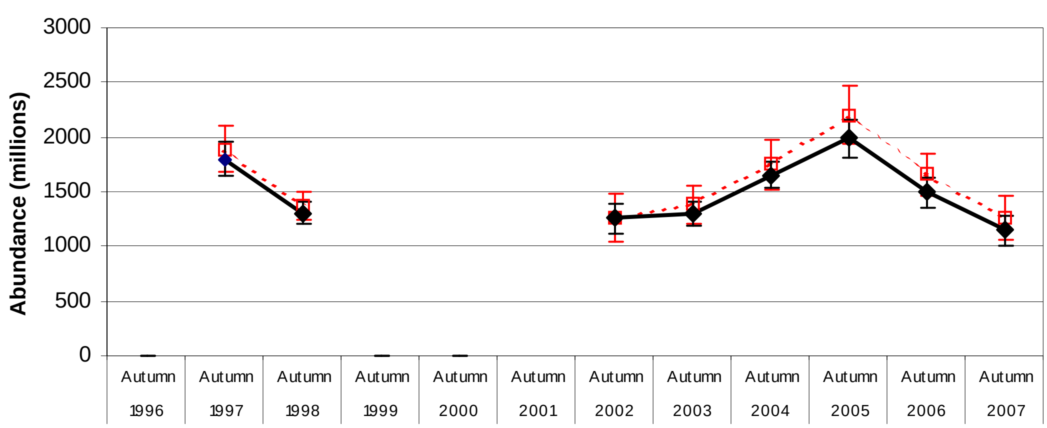

Figure 3.4.4.11 *Nephrops*, Farn Deeps (FU 6), Farn Deeps (FU 6): Abundance estimates from TV survey. Red dotted line uses the unstratified raising procedure followed in previous years, the solid black line uses the new stratified procedure introduced in 2008 to reduce bias in survey design.

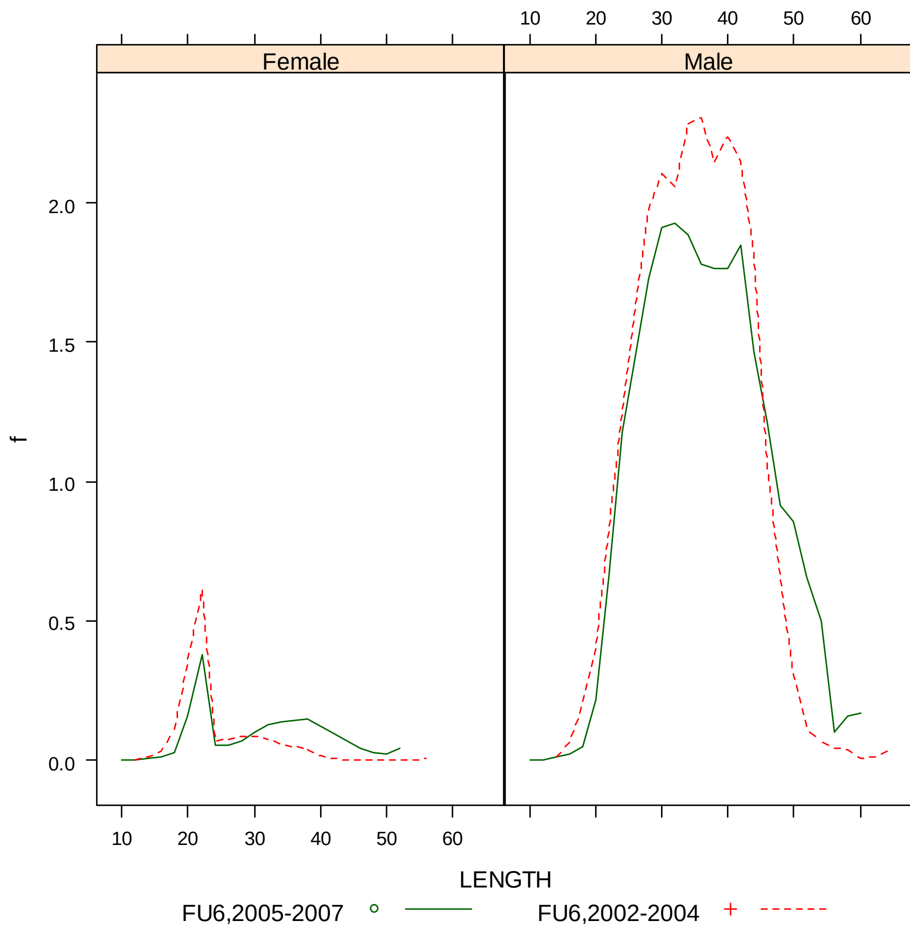

Figure 3.4.4.12. Farn Deeps (FU 6): Results of LCA analyses.

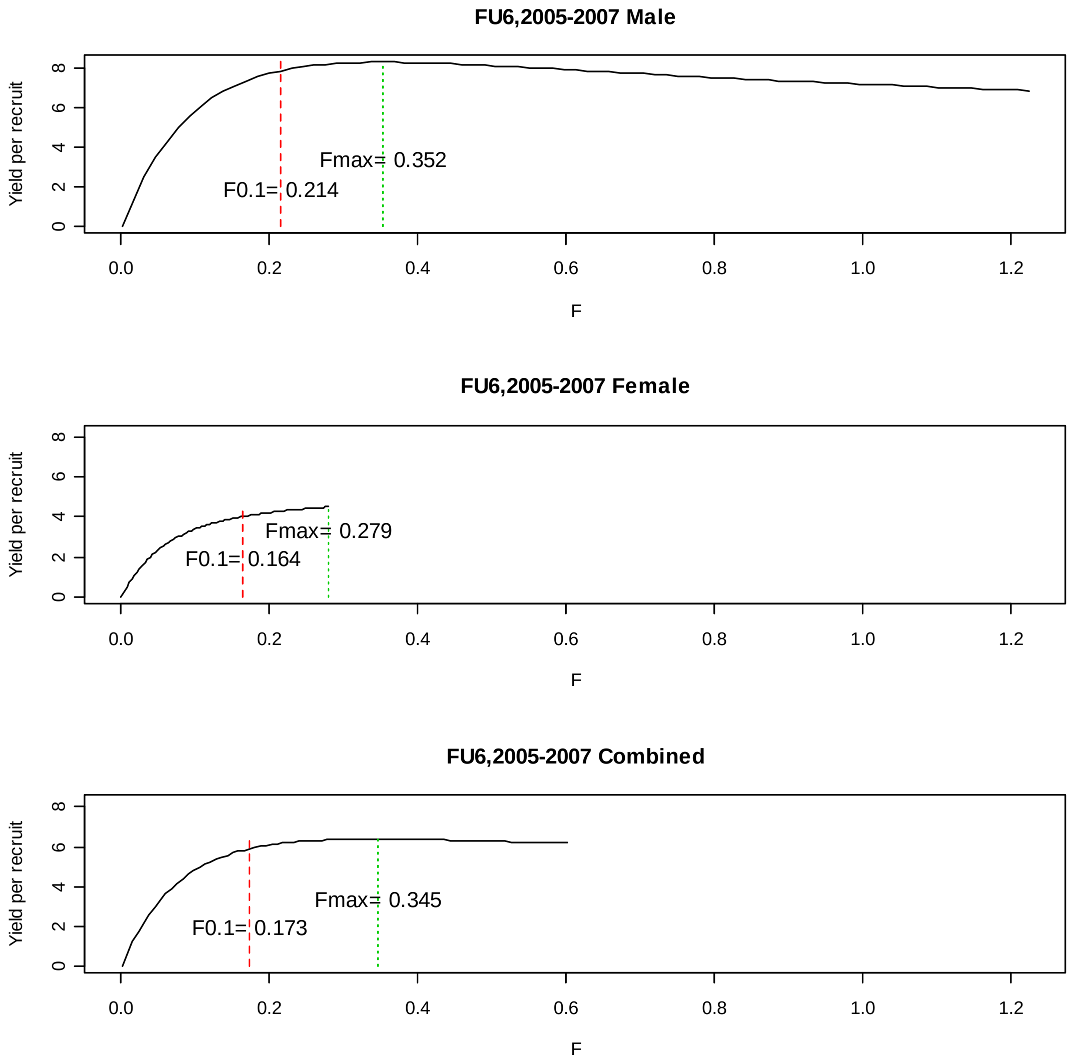

Figure 3.4.4.13. Farn Deeps (FU 6): Yield per recruit analyses of Farn Deeps Nephrops.

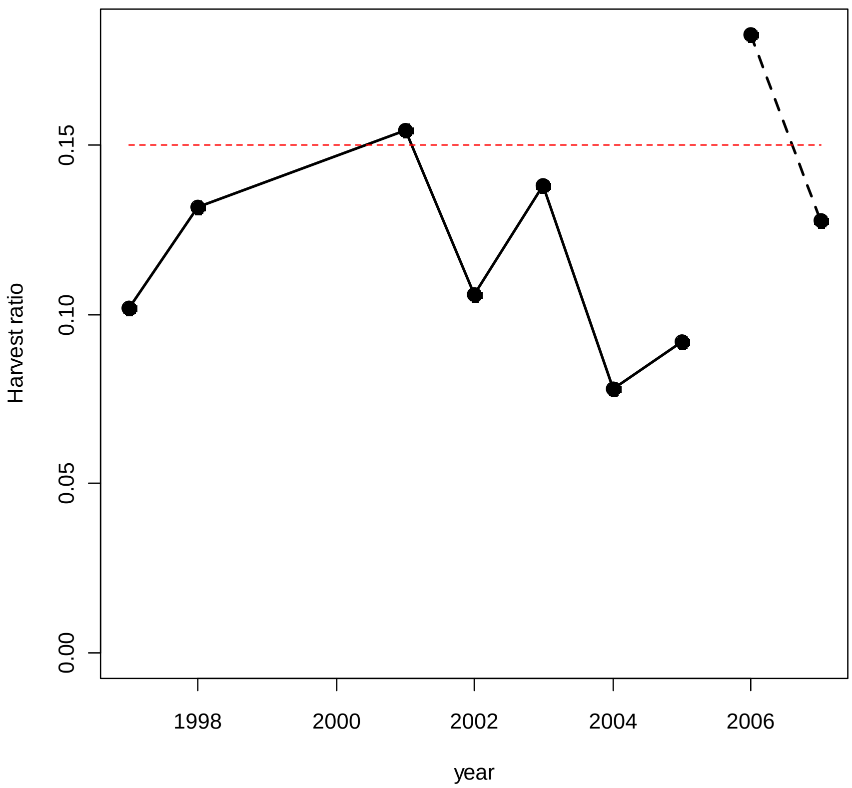

Figure 3.4.4.14. Farn Deeps (FU 6): Historic trend of harvest ratio

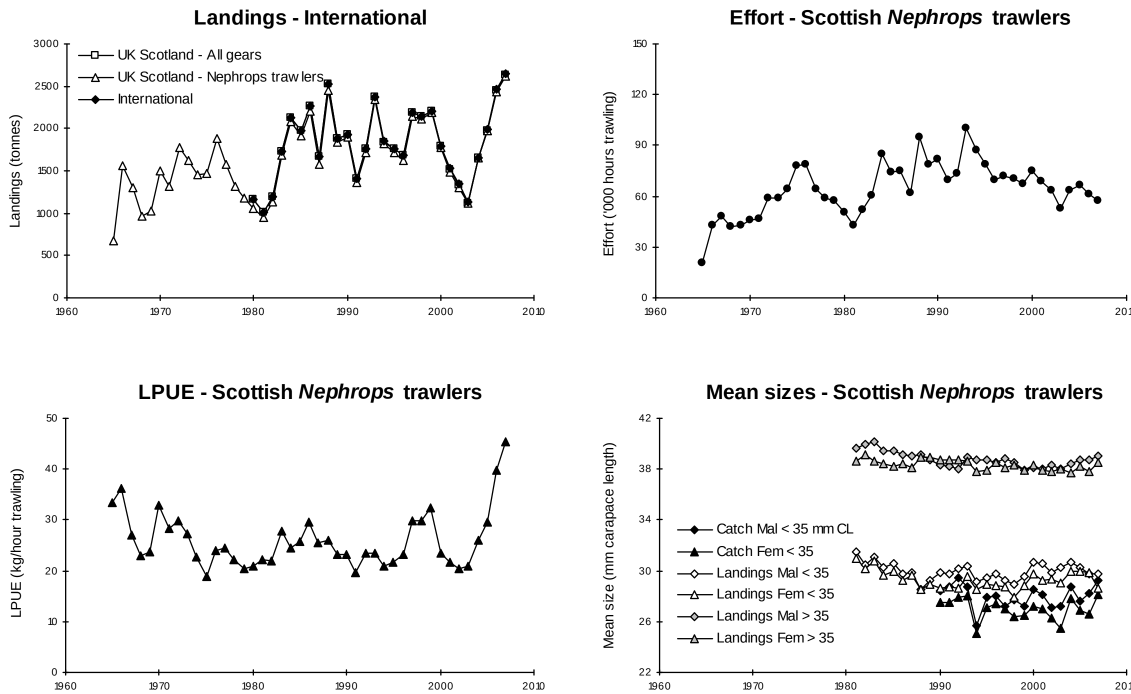

Figure 3.4.4.10 ***Nephrops*****, Firth of Forth (FU 8), Long term landings, effort, LPUE and mean sizes.**

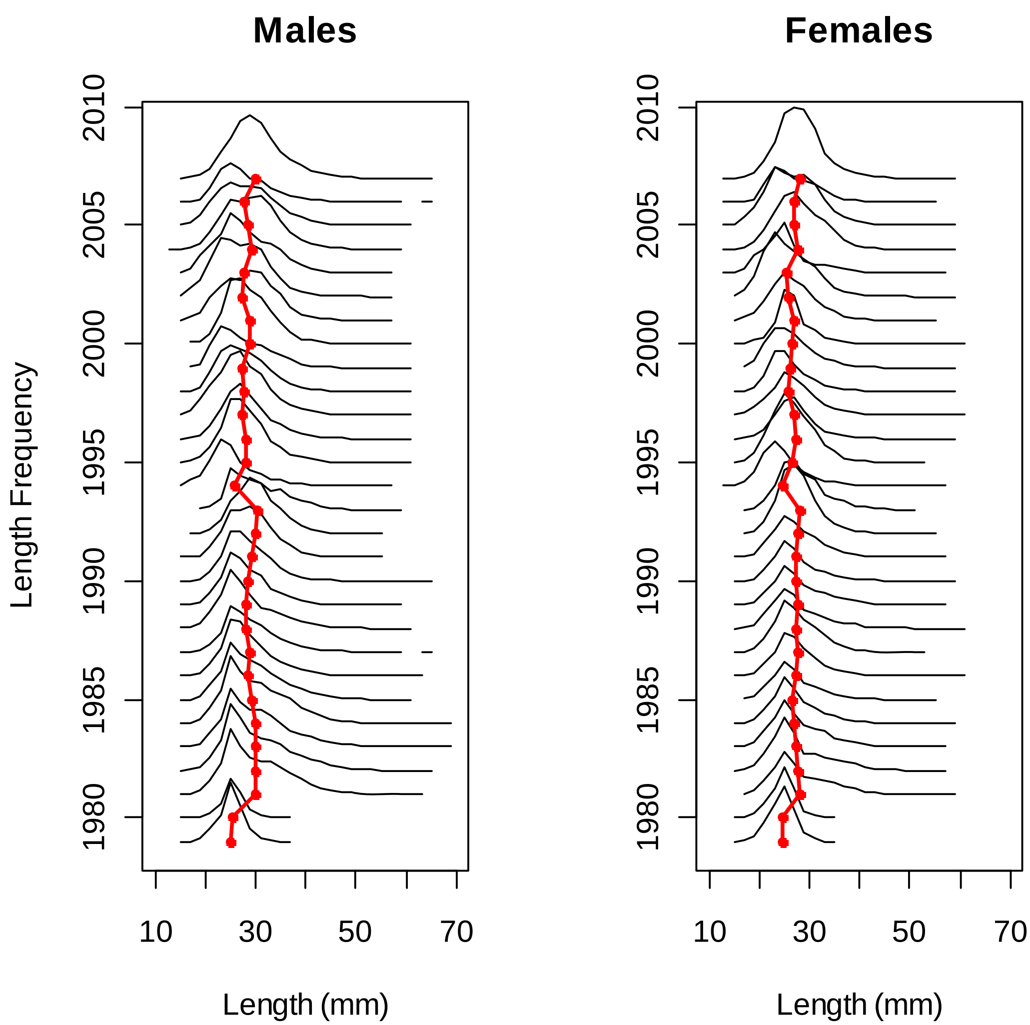

Figure 3.4.4.11 ***Nephrops*** **Firth of Forth (FU 8) Length composition of catch of males (right) and females left from 1979 (bottom) to 2007 (top). Red line shows the mean sizes of catch.**

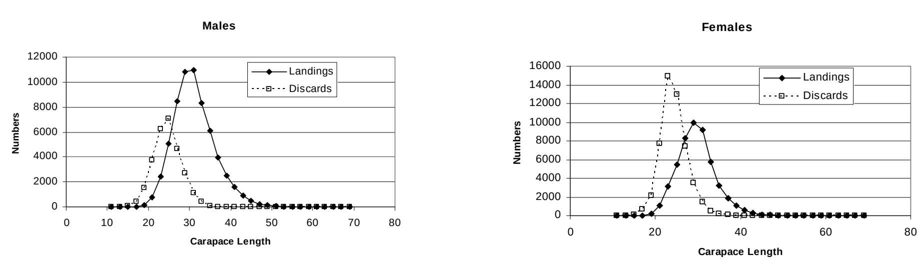

Figure 3.4.4.12 ***Nephrops*****, Firth of Forth (FU 8), Length frequency distributions of male and female landings and discards, averaged over 2005 – 2007.**

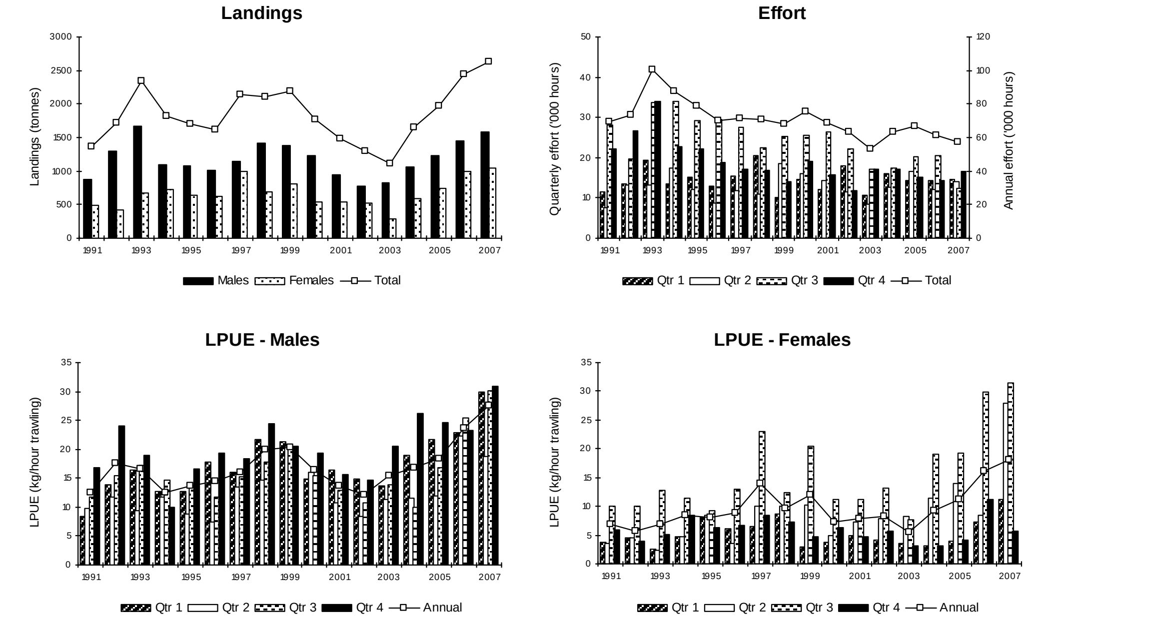

Figure 3.4.4.13 ***Nephrops*****, Firth of Forth (FU 8), Landings, effort and LPUEs by quarter and sex from Scottish** ***Nephrops*** **trawlers.**

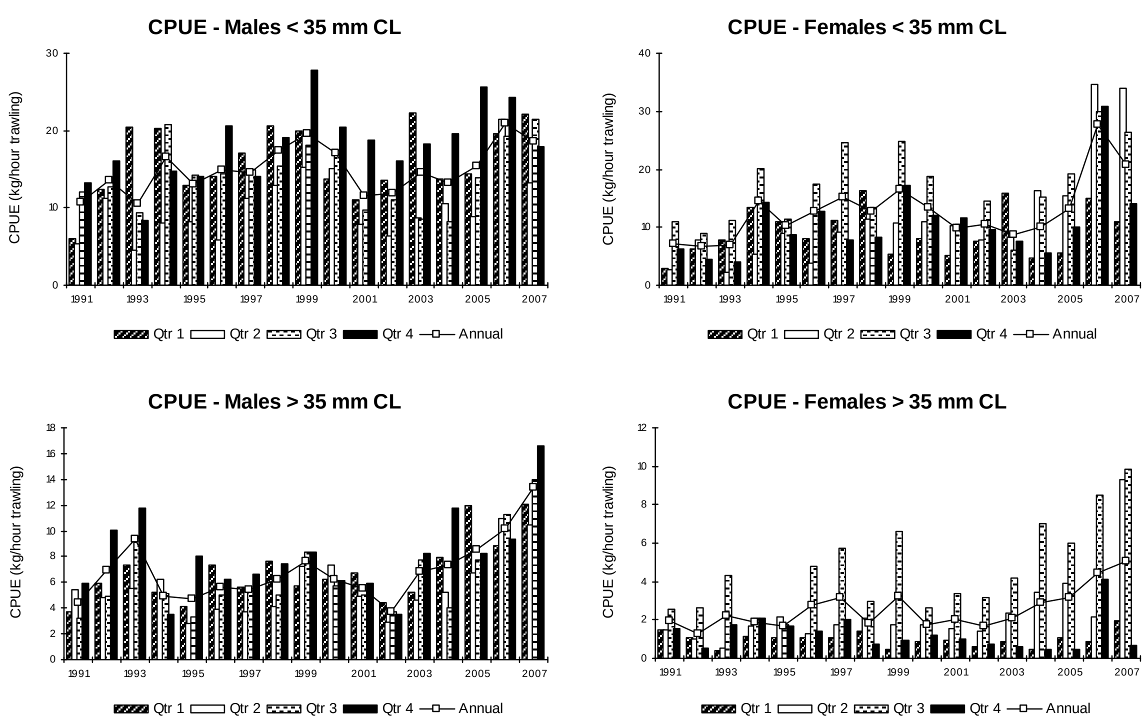

Figure 3.4.4.14 ***Nephrops*****, Firth of Forth (FU 8), CPUEs by sex and quarter for selected size groups, Scottish** ***Nephrops*** **trawlers.**

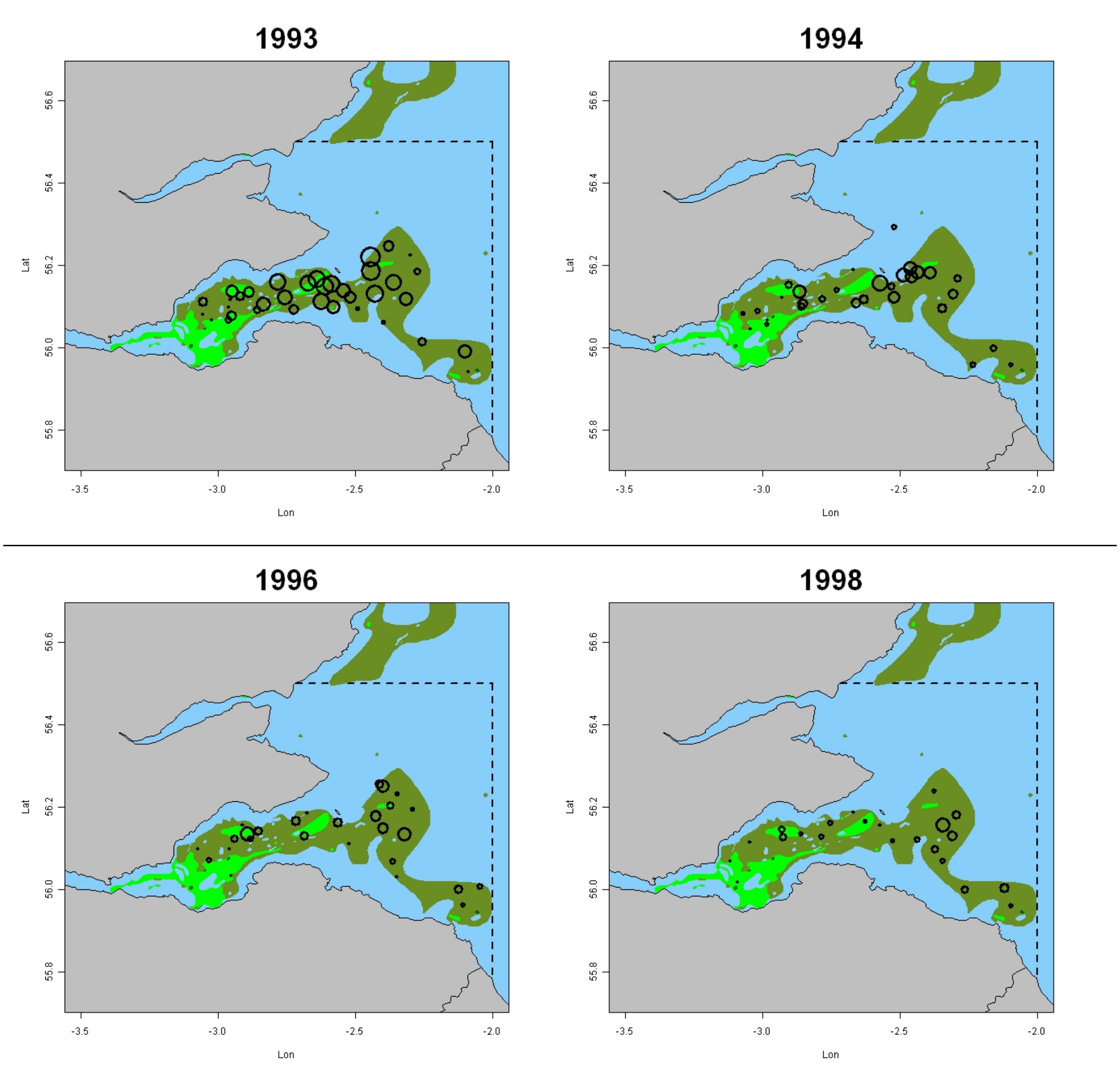

Figure 3.4.4.15 *5Nephrops*, Firth of Forth (FU 8), TV survey station distribution and relative density, 1993 – 1998 (no surveys in 1995 and 1997). Green and brown areas represent areas of suitable sediment for *Nephrops*.

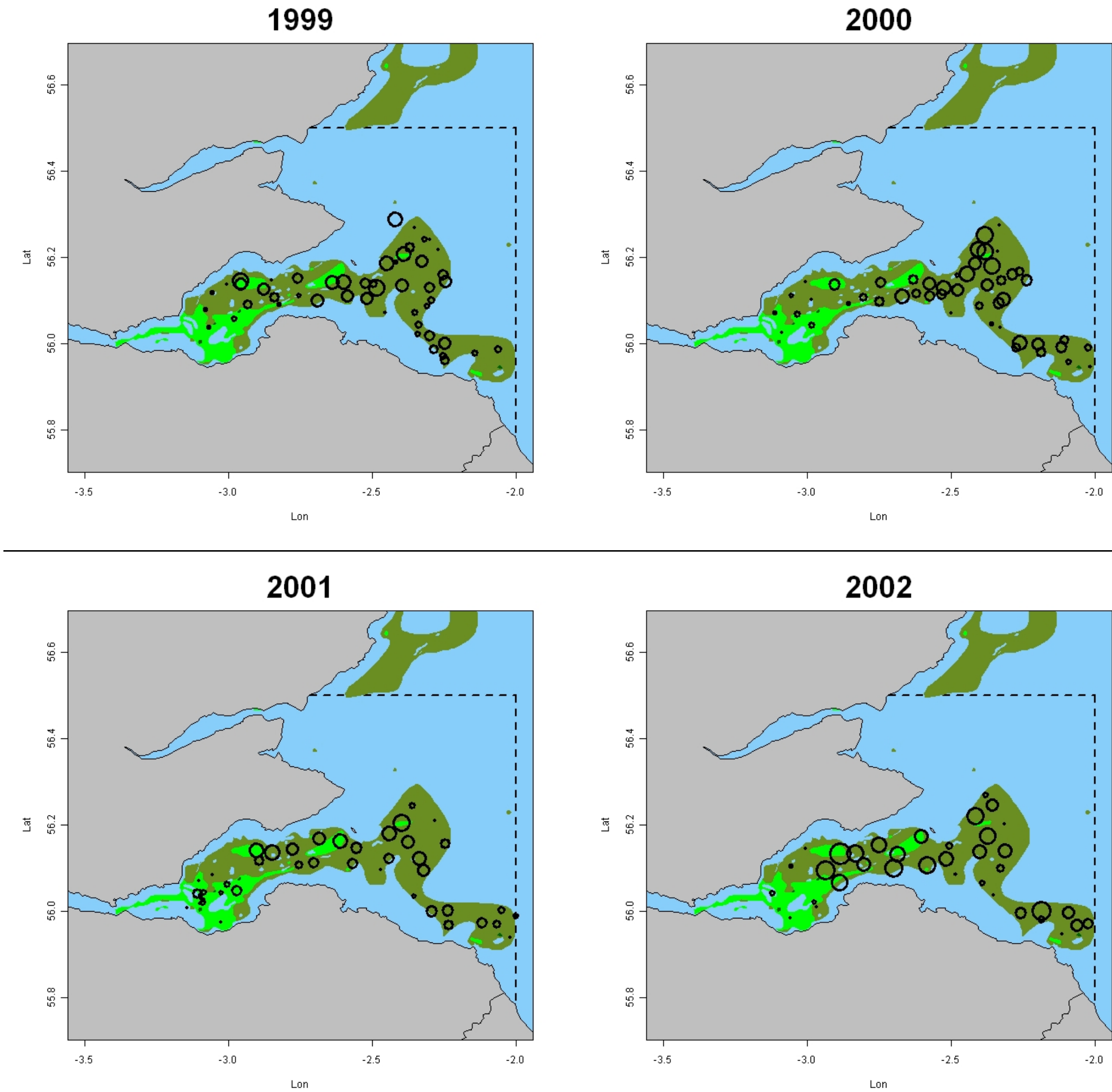

Figure 3.4.4.15 cont *Nephrops*, Firth of Forth (FU 8), TV survey station distribution and relative density, 1999 – 2002. Green and brown areas represent areas of suitable sediment for *Nephrops*.

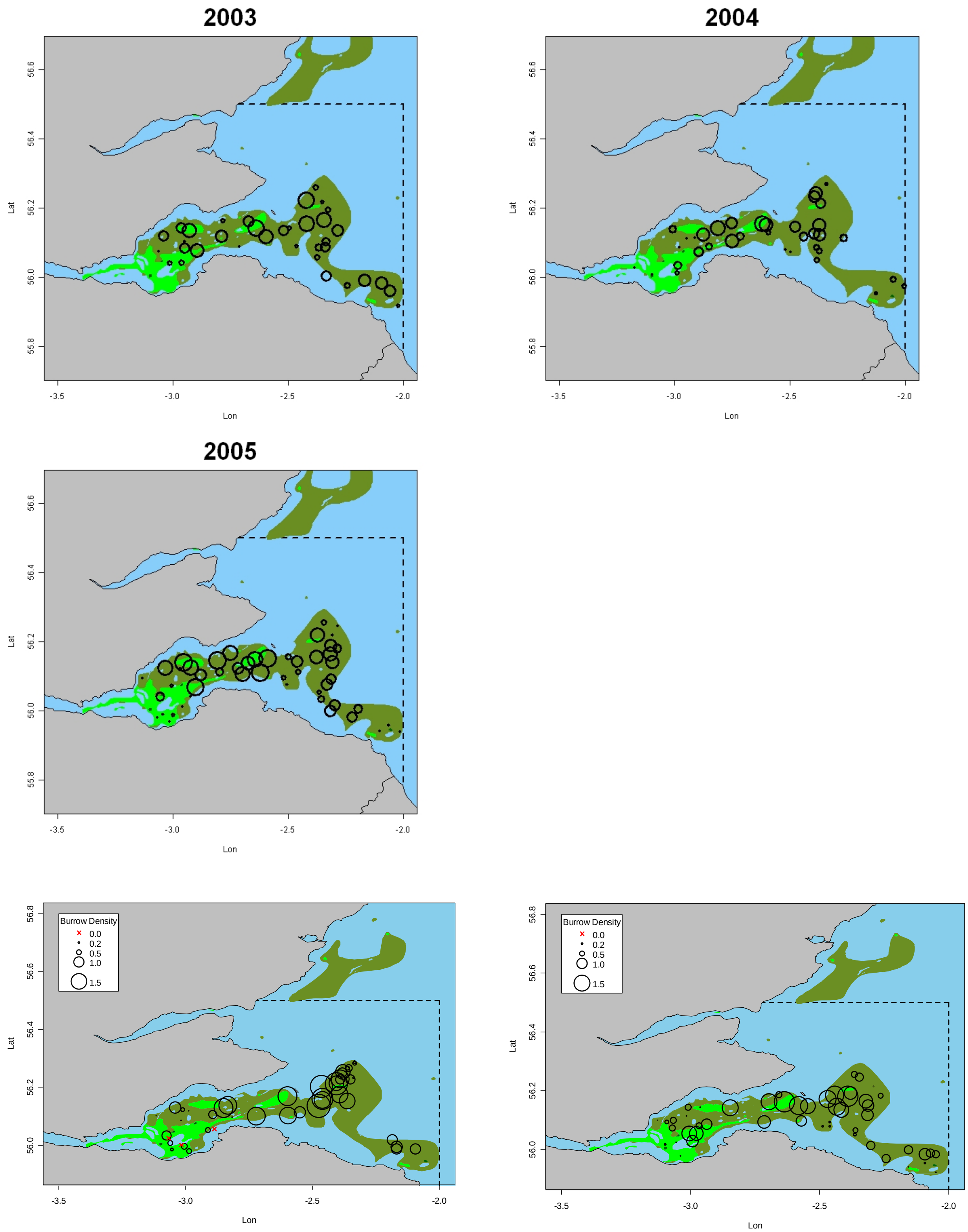

Figure 3.4.4.15 *Nephrops*, Firth of Forth (FU 8), TV survey station distribution and relative density, 2003 – 2007. Green and brown areas represent areas of suitable sediment for *Nephrops*.

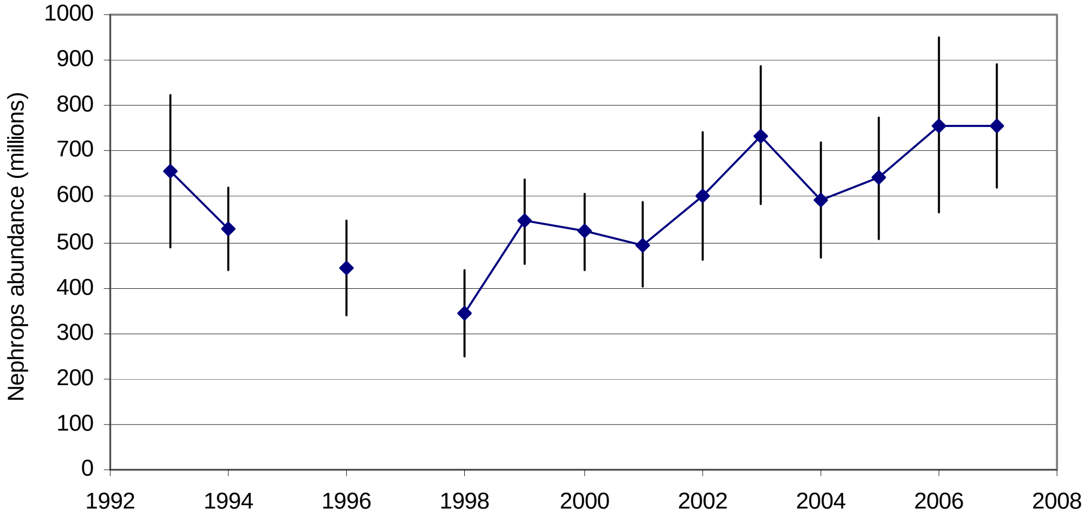

Figure 3.4.4.16 ***Nephrops*****, Firth of Forth (FU 8), Time series of TV survey abundance estimates, with 95% confidence intervals, 1995 – 2007.**

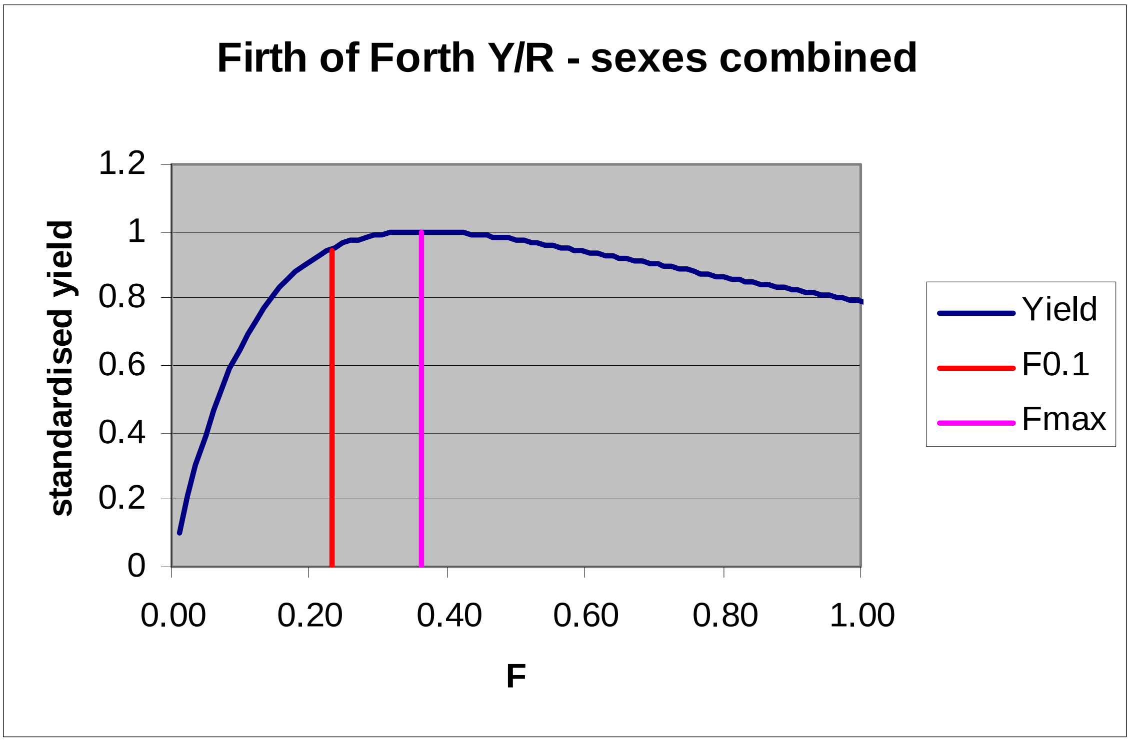

Figure 3.4.4.17 ***Nephrops*****, Firth of Forth (FU 8) Combined sex yield per recruit plot (ave length distribution 2005–2007) showing position of F_{max} and $F_{0.1}$**

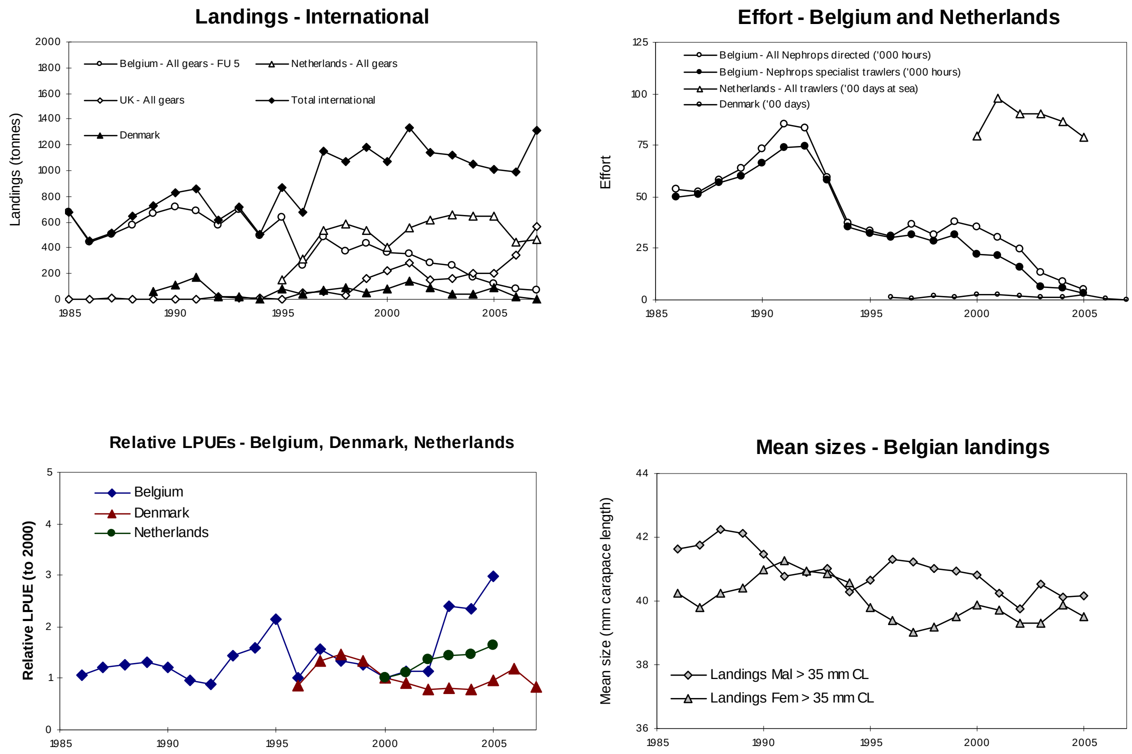

Figure 3.4.5.1 Botney Gut–Silver Pit (FU 5): Long-term trends in landings, effort, CPUEs and/or LPUEs, and mean sizes of Nephrops.

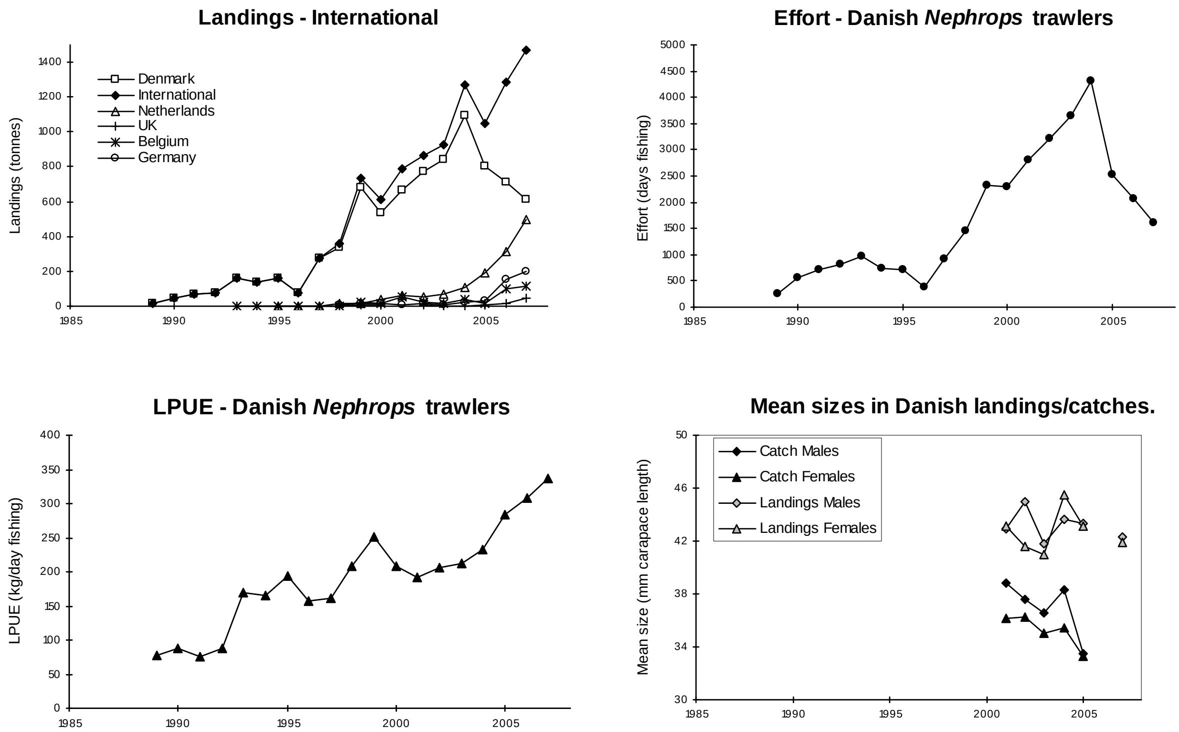

Figure 3.4.5.2 *Nephrops* Off Horn Reef (FU 33): Long-term trends in landings, effort, CPUEs and/or LPUEs, and mean sizes of *Nephrops*.

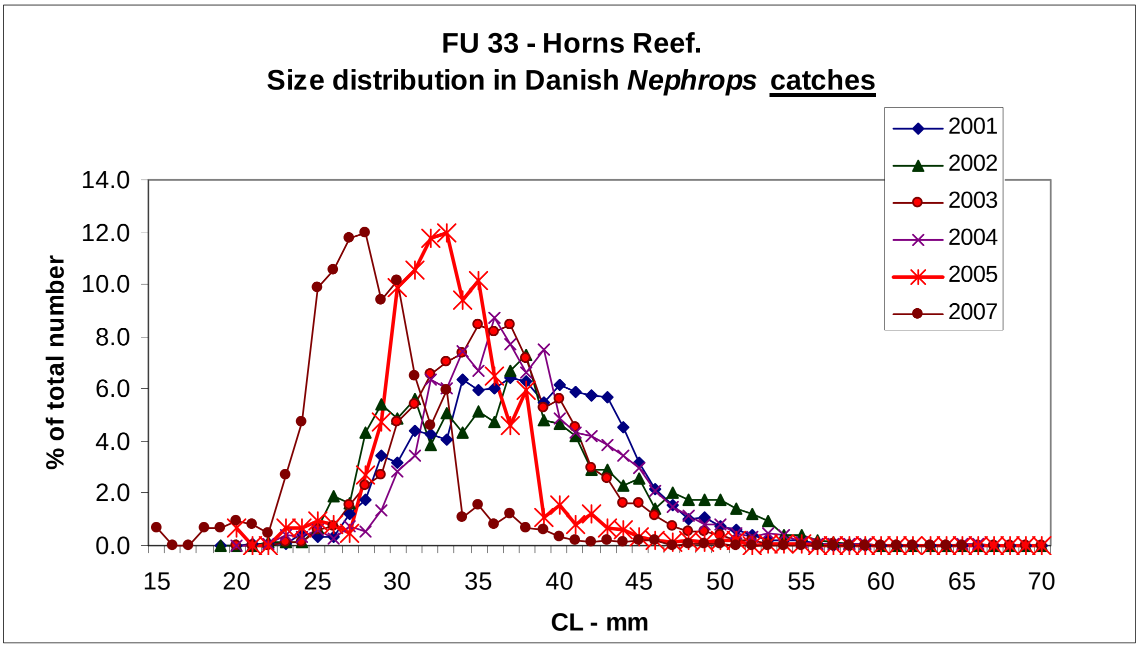

Figure 3.4.5.3 ***Nephrops*** **Off Horn Reef Size distributions of Danish catches, 2001–2007 (no data for 2006).**

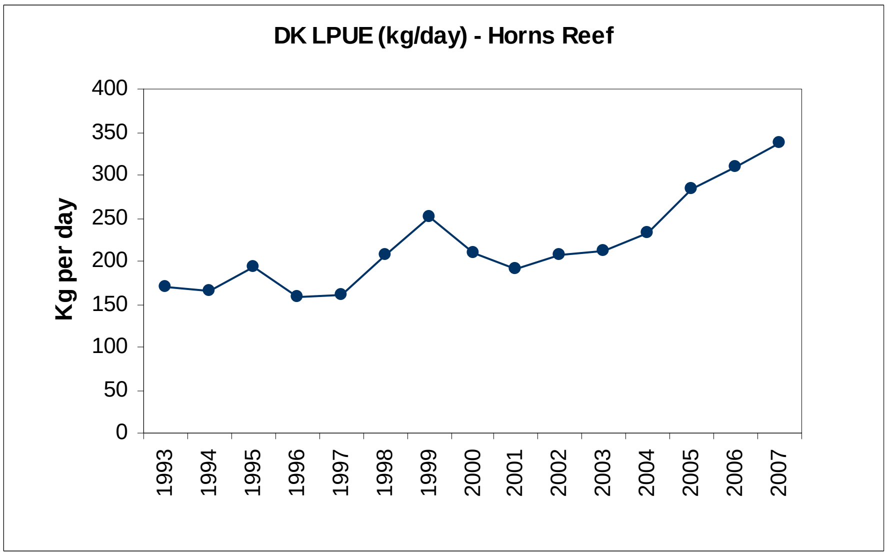

Figure 3.4.5.4 ***Nephrops*** **Off Horn Reef (FU 33) Danish relative LPUE.**

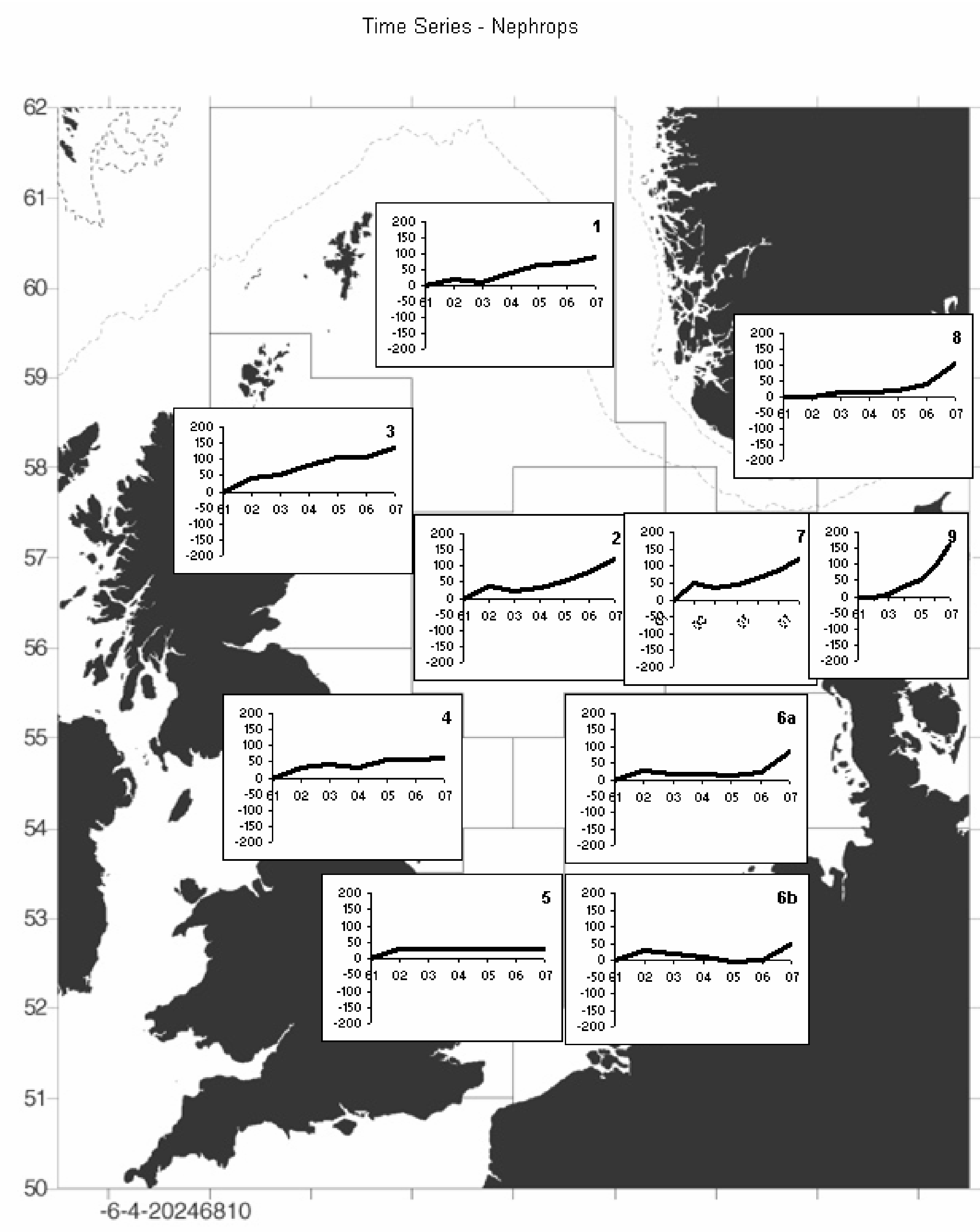

Figure 3.5.1 North Sea Commission Fisheries Partnership stock survey for *Nephrops*

4 Sandeel in IV (WGNSSK Sep. 2008)

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

4.1 General

4.1.1 Ecosystem aspects

Sandeels in the North Sea can be divided into a number of reproductively isolated sub-populations (see the Stock Quality Handbook no. Q4). A decline in the sandeel population in recent years, with SSB being below B_{lim} from 2001 to 2007 concurrent with a marked change in distribution has increased the concern about local depletion, of which there has been some evidence (ICES WGNSSK 2006b, ICES AGSAN 2008b). This may be of consequence for marine predators that are dependent on sandeels as a food source.

This year's assessment indicates an improvement of the overall stock situation from 2006 to 2008 as well as an increase of sandeels in several areas in which local stock size was low, indicating that the risk of local depletion has decreased. However, total SSB is predicted to decrease from above to below B_{pa} from 2008 to 2009, and recruitment has been below average since 2002. A decline in CPUE in the Northern part of the North Sea from 2007 to 2008 and a low proportion of age-1 sandeels in the catches in 2008 in the same area suggest that recruitment to the grounds in the northern North Sea is low. Evidence suggests that all fishing grounds in the Norwegian EEZ are commercially extinct except for the Vestbank area.

It is presently not possible to make an assessment that takes account of the sub-population structure of sandeels, although a framework for carrying out such analyses has been proposed (ICES AGSAN 2008a).

The stock annex contains a broader description of ecosystem aspects.

4.1.2 Fisheries

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

There has been a substantial decrease in the Danish fishing fleet due to decommissioning in recent years. The Norwegian fleet also declined in the number of vessels fishing sandeels around 2005, but has increased again in recent years (section 4.2.5).How changes in the fleet structure have affected the catching efficiency and thereby the CPUE trends is unknown.

The sandeel fishery in 2008 was first opened 1st of April, both in the EU zone and in the Norwegian EEZ. The sandeel fishery in 2008 included most of the grounds that have contributed to the North Sea sandeel fishery in recent years, except for the most northerly fishing grounds where there have been no landings over last 8–12 years. There were marked differences between age distributions in the catches from the northern and southern North Sea (see section 4.2.2). Development in CPUE over the 2008 season differed from that of most recent years, starting with CPUE ata low level, as observed in 2004 to 2006, and increasing to similar high levels in week 16 as were observed in 2007. As in 2007 there was a large fishery in the northern North Sea in 2008 in addition to a large fishery in the Dogger Bank area and grounds north east of Dogger Bank.

The Norwegian monitoring fishery for sandeel opened on April 1, but the fishery started with only one landing before 20th April. In the latter half of April the fishery picked up with a total of 37 landings by May 2 when the fishery was temporarily closed in accordance with agreed effort limitations for the monitoring fishery.

Until 2007 when the fishery was closed in May, the TAC has never been restrictive on the sandeel fishery. Therefore TAC regulation of the fishery does not explain the reduced level of landings observed from 2003 to 2006 (section 4.2.1), except in the Norwegian EEZ where there was only a limited monitoring fishery permitted in 2006. The reductions in landings results from effort restriction, decreases in fleet size and diversion of effort to other species as a result of low catch rates.

4.1.3 ICES Advice

Based on the 2007 assessment ICES stated that SSB was estimated to be at Blim in 2007 and that fishing mortality has been decreasing since 2001 (ICES Advice 2007). Recruitment has been below average since 2002. In the absence of an F reference points, the state of the stock could not be evaluated with regard to sustainable harvest rates.

ICES noted that the management of sandeel fisheries should try to prevent depletion of local aggregations, particularly in areas where predators congregate.

ICES also advised that, the fishery in 2008 should only be allowed if monitoring information was available which showed that the stock could be rebuilt to Bpa by 2009. If a real-time management using an escapement strategy were to be applied in 2008, the escapement target should be defined so that the SSB would reach at least Bpa in 2009. The in-season management procedure should be evaluated, taking into account all sources of uncertainty in the fishery assessment and forecast.

The following request from the EC and Norway, was evaluated by ICES in November 2007:

Real time management (RTM) of the sandeel fishery in 2008

The EC and Norway requested ICES to provide further advice to the European Community and Norway on:

1. Harvest control rules for sandeel in the North Sea and Skagerrak in 2008 that:
    - are flexible to account for changes in the biology of sandeel and specifically changes in the time that sandeels start feeding;
    - are based on a fisheries-independent information. In 2006 ICES was unable to provide advice on recent developments of survey methodologies and their application for recruitment and stock estimation (abundance and distribution);

An ICES Ad Hoc Group on sandeel and Norway Pout (ICES AGSANNOP 2007) met at ICES 6−8 November 2007 and suggested the following HCR for 2008 for sandeel in the North Sea (Subarea IV):

1) The aim of management in 2008 should be to rebuild SSB to above Bpa in 2009;
2) An exploratory fishery should start not earlier than 1st April 2008
3) The total kilowatt-days for fisheries for sandeel in 2008 should be constrained to no more than total kilowatt-days applied during the exploratory fishing in 2007 during weeks 14–18, (1 700 000 kW-days) ;
4) A TAC for 2008 and the maximum number of kilowatt-days shall be determined on the basis of the exploratory fishing as soon as possible and in accordance with the following rules:
    a) TAC 2008= −138 + 3.77 × N1× Wobs / Wm (N1 is the real-time estimate of age group 1 in billions, derived from the exploratory fishery in 2008, the TAC is expressed in 1000 t, Wobs is the observed mean weight of age group 1 during the exploratory fishery, and , Wm (4.75 g) is the long term mean weight of age group 1.
    b) If the TAC calculated in point 3a) exceeds 400 000 t the TAC shall be set at 400 000 t,
    c) The number of kilowatt-days for 2008 shall not exceed the effort in 20051;
5) The fishery shall be closed 1 August 2008.

The ICES Assessment Group on Sandeels (AGSAN) worked by correspondence to provide an estimate of the size of the 2007 year class of North Sea sandeel at age 1, producing its final report in May (ICES AGSAN 2008a). Using real-time monitoring data from weeks 14 to 17 in 2008, the stock size of age 1 sandeel in 2008 was estimated to 217 billion individuals. Using the HCR the TAC for 2008 was set to 400 000 t (ICES Advice 2008).

4.1.4 Management

The suggestion from ICES on a management strategy for 2008 (section 4.1.3) was later used in the regulation of the 2008 fishing opportunities in Community waters (Council Regulation (EC) No 40/2008 of 16 January 2008) and in the Norwegian EEZ

TAC

In the fishery consultations between EU and Norway for 2008, the agreed record allowed the parties to fish 20 000 tonnes of sandeel in each others zones. These quotas were primarily for an experimental fishery, but fishing against these quotas could continue if the commercial fishery was opened.

Both EU and Norway accepted the TAC of 400 000 t as suggested by ICES (COMMISSION REGULATION (EC) No 697/2008 of 23 July 2008). However, there was no agreement between EU and Norway on how to share the sandeel stock, and EU and Norway set their respectively quotas to 360 000 t and 128 000 tonnes.

The TAC in 2008 was not fully taken (see section 4.2).

Closed periods

Since 2004 the fishery in the Norwegian EEZ has been opened April 1 and closed again June 23. Since 2005 Danish vessels have not been allowed to fish sandeels before 31st of March. In 2008 sandeel fishery in the EU zone was opened on the 1st of April and closed from the 1t of August.

Closed areas

Following the ICES TAC recommendation for 2008 the Norwegian authorities reopened the fishery on May 6, but closed the ICES statistical rectangles indicated in red in Fig 4.1.4.1. IMR recommended an immediate stop in the sandeel fishery in the Norwegian EEZ on May 19 due to a low abundance of recruits (1-year old sandeel) in the Norwegian EEZ. This advice was based on a low proportion of 1-group sandeel in the catches (~25%), and a significant reduction in sandeel abundance from 2007 to 2008 at most fishing grounds as indicated by acoustic surveys (see ICES AGSAN 2008b). The Norwegian authorities closed the sandeel fishery on June 2, except for 5 vessels that were allowed to fish between June 2 and 8 in the ICES rectangles; 44F2, 44F3, 45F2 and 44F3, which comprise Østbanken, Albjørn-Lingbanken and Nordgyden. These fishing grounds had been closed during the ordinary fishery.

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 2008, with an increase in the effort of the monitoring fishery to 40 boat days. There is presently no decision on whether a full commercial sandeel fishery will be reopened in the Firth of Forth area.

Effort

Owing to the large change in the North Sea sandeel stock a harvest control rule has been implemented since 2004, to adjust the fishing effort to the reduced size of the sandeel population in order to prevent recruitment overfishing (see e.g. STECF, 2004, 2005a and b, 2006, ICES 2006a, 2006b, ICES Advice 2007 and 2008).

4.2 Data available

4.2.1 Catch

Landing and trends in landings

Landings statistics of sandeels are given in Tables 4.2.1.1 to 4.2.1.5. Official landings were only available up to and including 2006. Figure 4.1.2.1 shows the areas for which catches are tabulated in Tables 4.2.1.1 to 4.2.1.5. The catch history is shown in Figure 4.2.1.1.

The sandeel fishery developed during the 1970s, and landings peaked in 1998 at more than 1 million tons. Since then there has been a rapid decrease in landings, with a steep drop from 2002 to 2003, after which total landings have been low and at a historic low in 2005 (Figure 4.2.1.1 and Table 4.2.1.2). Average landings in the last 20 years are on 666 000 t and total landings in 2008 were 335 000 t.

There are large differences in regional patterns in landings. This is shown in Figure 4.2.1.2 in which landings are given for the three regions: i) north-western North Sea,

ii) north-eastern North Sea and iii) the southern North Sea. From 2006 to 2007, a large increase was seen in landings in the north-eastern North Sea. A small decrease in landings was observed again from 2007 to 2008 due to national regulation of the fishery in the Norwegian EEZ (see section 4.1.4). There was a marked increase in landings in the southern North Sea from 2007 to 2008.

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 are applied (i.e. the Firth of Forth, Shetland areas, Norwegian EEZ from 2006 to 2007 and in the North Sea in 2007). Figure 4.2.1.3 shows the distribution of catches for 2007 and 2008 by quarter and ICES statistical rectangle. There was only a fishery in the second quarter of 2007 and 2008. Yearly landings for the period 1995–2008 distributed by ICES rectangle are shown in Figure 4.2.1.4.

Large variations in the fishing pattern occurred concurrent with the decline in landings and CPUE (section 4.2.5). The distribution of landings in the southern North Sea in 2003 to 2005 (i.e. from the first year when landings were at a low level in both the northern and southern North Sea) seemed more dispersed than the typical long-term pattern in the same area. Hence, grounds usually less exploited became more important for the total fishery during this period. In 2006 there was another large change in the fishing pattern, when the fishery showed a strong concentration at the fishing grounds in the Dogger Bank area. In the Norwegian EEZ there was only a limited monitoring fishery in 2006. In 2007 yet another change in the distribution of landings was observed, when landings in the north-eastern part of the North Sea were on about the same level as those in the southern North Sea. The fishing pattern in 2008 is to some extent similar to that in 2007, but with the largest fishery in the Norwegian EEZ in ICES rectangle 44F4 and with an expansion of the number of grounds fished in the Dogger Bank area and central North Sea north east of the Dogger Bank area.

4.2.2 Age compositions

Catch numbers at age by half-year is given in Table 4.2.2.1.

In 2008 there were large differences in the age composition of sandeels in the catches from the northern and southern North Sea. The proportion of 1-group in the catch was 55% in the northern North Sea and 82% in the southern North Sea.

4.2.3 Weight at age

The compilation of age-length-weight keys was carried out using the method described in the Stock Quality Handbook no. Q4. The mean weights-at-age in the catch for the northern and southern North Sea in the time period 2001 to 2008 are given by country in Tables 4.2.3.1 and 4.2.3.2. The mean weight at age in the catch used in the assessment is the mean weights at age in the catch for the Southern and Northern North Sea weighted by catch numbers. Mean weight in the catch from 1983 to 2008, used in the assessment is given in Table 4.2.3.3 by half year.

The mean weight at age in the stock is the mean weight in the catch first half-year, and an arbitrary weight of 1 gram for the 0-group. Mean weight in the stock from 1983 to 2008 is given in Table 4.2.3.4 by half year. Due to no fishery in second half of 2005 and 2007 mean weight at age for second half year of 2004 was used for 2005 and mean weight at age for second half year of 2006 was used for 2007.

The time series of mean weight in the catch and in the stock is shown in Figure 4.2.3.1 and 4.2.3.2. Mean weight at age shows large fluctuations over time, especially the large changes in mean weight from 1994 to 1996, which, partly, may be explained by a change in the methodology used for age determination (ICES 1995) that was applied from 1995 and 1996. An increase in mean weight is observed from 2004 to 2006 in first half year in both the northern and southern North Sea. From 2007 to 2008 there was a decrease in mean weight at age for all age groups except for age-2 sandeels and for age-1 sandeels in the southern North Sea.

Because it is not possible to forecast mean weight at age (ICES WGNSSK 2007), an average of the time period 1996 to 2008 is used for 2009 and 2010 in the short term forecast (section 4.6).

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

4.2.4 Maturity and natural mortality

The maturity and natural mortality used in this year's sandeel assessment are assumed to be constant at age as described in the Stock Quality Handbook no. Q4. Natural mortality values are presented below. The proportion mature is assumed constant over the whole period with 100% mature from age 2 and 0% of age 0 and 1.

Values for natural mortality by age and half year used in the assessments.

Age	First half year	Second half year
0	0.0	0.8
1	1.0	0.2
2	0.4	0.2
3	0.4	0.2
4+	0.4	0.2

4.2.5 Catch, effort and research vessel data

Catch data

Catch data used in the assessment is given in Table 4.2.2.1.

Recent changes in the fleet composition

The size distribution of the Danish fleet has changed through time, with a clear tendency towards fewer and larger vessels (ICES WGNSSK 2006b). This change is especially apparent in 2005, when only 98 Danish vessels participated in the North Sea sandeel fishery, compared to 200 vessels in 2004 (Table 4.2.5.1). The Danish industrial vessels were, in 2007, given individual tradable quotas (ITQ) on sandeels. The introduction of ITQ accelerated the change towards fewer and larger vessels, and in 2008 only Danish 83 were fishing sandeels.

The same tendency was seen for the Norwegian vessels fishing sandeels until 2005 (Table 4.2.5.1). In 2006 only 6 Norwegian vessels were allowed to participate in an experimental sandeel fishery in the Norwegian EEZ. In 2007 and 2008 41and 42 Norwegian vessels with individual quotas participated in the sandeel fishery, respectively. From 2002 to 2008 the average GRT per trip in the Norwegian fleet increased from 269 to 507 t. Of the 41 Norwegian vessels that fished sandeel in 2007, 9 participated for the first time. Since 1998 25 of the 41 vessels entered the fishery during this

10 yr period, 9 vessels were rebuilt (either extended or had larger engines installed) whereas only 7 vessels remained unaltered. In addition, there is likely to be a continuous increase in efficiency due to improvement in fishing gear, instruments etc.

The rapid changes of the structure of the fleet that have occurred in recent years may introduce more uncertainty in the assessment, as the fishing pattern and efficiency of the "new" fleet may differ from the previous fleet.

Trends in overall effort and CPUE

Tables 4.2.5.2 and 4.2.5.3 and Figure 4.2.5.1 show the trends in the international effort over years. Total international standardized effort peaked in 1989, and was at a relative stable level from 1989 to 2001. Total international effort decreased from 2001 and was historic low in 2007 when the fishery was closed due to regulation. The decrease in effort was particularly large from 2001 to 2002 and from 2004 to 2005. Effort increased from 2007 to 2008, but is still at a low level compared to before 2001.

The decrease in effort is most likely due to a combination of decreasing catch opportunities and increasing fuel prices. In 2007 the regulation of the fishery was a strong limitation on the effort used. In 2008, when the TAC was not reached, high fuel prices and low prices of fish meal were claimed by the industry to limit the fishery. The reduction of fleet capacity in combination with the introduction of ITQ is now considered to be a strong limitation of effort.

Figure 4.2.5.1 shows the trends in CPUE over years. CPUE fluctuated without a clear trend throughout the period 1983 to 2001. A large increase in CPUE was observed from 2001 to 2002, followed by a steep decrease from 2002 to 2003. CPUE has been increasing since 2004 but showed a small decrease from 2007 to 2008. A discussion about the possible problems of using commercial CPUE as an index of sandeel population size was included in ICES WGNSSK (2006a) and ICES AGSAN (2007a).

The tuning series used in the assessments

The commercial tuning fleets used are the same as those used in previous assessments with the addition of information for second half year of 2007 and first half year of 2008. The following tuning series were used (Table 4.2.5.4):

Fleet 1: Northern North Sea 1983–1998 first half year

Fleet 2: Northern North Sea 1999–2008 first half year

Fleet 3: Southern North Sea 1983–1998 first half year

Fleet 4: Southern North Sea 1999–2008 first half year

Fleet 5: Northern North Sea 1983–2007 second half year

Fleet 6: Southern North Sea 1983–2007 second half year

The effort data for the southern North Sea prior to 1999 are only available for Danish vessels. In 2003 Norwegian vessel data for the years from 1999 first became available and was included in the tuning series. The tuning fleet used for the northern North Sea is a mixture of Danish and Norwegian vessels.

No effort data was available for second half year of 2008 because no fishery was recorded.

Standardisation of effort data

Due to the change in size distribution of the vessels fishing sandeels in the North Sea (see e.g. ICES WGNSSK 2006b or STECF 2004 and 2005a and b) and the relationship between vessel size and fishing power, effort standardisation is required when establishing the commercial tuning series used in the sandeel assessment. The standardisation was carried out using the same procedure as that of last years WG. The standardisation procedure is described in the Stock Quality Handbook no. Q4.

The combined Norwegian and Danish effort is shown in Tables 4.2.5.2 and 4.2.5.3. The tuning fleets used in the assessments are given in Table 4.2.5.4. The CPUE for these fleets are summarised in Figures 4.2.5.2 and 4.2.5.3.

Trends in CPUE tuning series

Similar trends were observed in CPUE in the northern and southern North Sea in first and second half of the year (Figure 4.2.5.2). The main exception is 2002 when there was a markedly increase in CPUE in the first half year and a large decrease in the second half year; smaller discrepancies between the two areas occurred in 1997 and 1998.

CPUE in first half year was at a historic low level in 2003, after which CPUE increased until 2007. This increase is due to an increase in CPUE only for age-1 sandeels, whereas CPUE for age 2+ sandeels has not increased (Figure 4.2.5.3). The exception is in 2007 when CPUE of age-2 sandeels increased in southern North Sea first half-year.

The increase in CPUE (Figure 4.2.5.2) continued from 2007 to 2008 in the southern North Sea whereas a decrease was observed in the Northern North Sea. This difference between northern and southern North Sea was due to different trends in CPUE by age groups, where CPUE of age-1 sandeels increased in southern North Sea and decreased in the northern North Sea (Figure 4.2.5.3). In contrast CPUE for age-2 sandeels increased from 2007 to 2008 in the Northern North Sea and decreased in the southern North Sea.

The text table below gives the p-values from linear fits of the tuning indices used in the assessment in the model: $CPUE_{age,year} = a*CPUE_{age+1,year+1} + c$

	Fleet					
Age	1	2	3	4	5	6
0–1	0.823	0.530	0.589	0.57	0.255	0.332
1–2	<0.001	0.808	<0.001	0.012	0.084	<0.001
2–3	0.755	0.11	0.003	0.094	0.75	0.003

The p-values indicate how well the tuning fleets are able to track the cohorts. The relationship between CPUE of age-0 sandeels and age-1 sandeels the year after is poor for all of the tuning fleets. The best relationship was found between age-1 CPUE and age-2 CPUE the year after for fleets 1, 3, 4 and 6, and between CPUE of age-2 and age-3 the year after for fleet 3 and 6. This is roughly in line with the tuning diagnostics of the XSA presented in WGNSSK (2004). The effect of excluding tuning fleets with the poorest ability to track the cohorts should be explored at the next benchmark assessment.

Fisheries independent tuning

A time series of fishery independent surveys are being conducted for this stock (see ICES AGSAN 2008b). Currently, the time series are too short or do not cover the entire distribution area of sandeels in IV, preventing evaluation as tuning time series for stock assessment.

4.3 Data analyses

Seasonal XSA (SXSA) is used as the assessment model for sandeels in IV.

4.3.1 Exploratory catch-at-age-based analyses

Settings used in the assessment 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 2007 and first half year of 2008. The settings used in the SXSA are listed in Table 4.3.2.1. The settings used for this year's SXSA assessment are the same as those used for the final 2007 SXSA assessment.

Results of the SXSA analysis

Output from the SXSA analysis is presented in Tables 4.3.2.2 (fishing mortality at age by half year), 4.3.2.3 (fishing mortality at age by year), 4.3.2.4 (stock numbers at age), 4.3.2.5 (catchabilities for the tuning fleets). The stock summary is presented in Table 4.3.2.6.

The residuals of log stock number for the SXSA analysis are given in Figure 4.3.2.1. There are no strong trends in the residuals, with the exception of low residuals for age-2 sandeels from 1991 to 1998 in first half year in the southern North Sea.

The retrospective analysis (Figure 4.3.2.2) shows that the SXSA still has a tendency to underestimate F and overestimate stock size. The retrospective bias is about the same level as that of last year's assessment.

4.3.2 Exploratory survey-based analyses

No survey based analyses were carried out.

4.3.3 Conclusions drawn from exploratory analyses

The SXSA estimates the 2007 year-class to $301 x 10^9$ individuals at age 0, which is below average. $F_{(1-2)}$ declines from 2004 to 2007 with 2007 being a historic low and increases again from 2007 to 2008. SSB has been below B_{lim} from 2001 to 2007, and is estimated to be above B_{pa} in 2008.

4.3.4 Final assessment

The SXSA update assessment was accepted as the final assessment.

4.4 Historic Stock Trends

The stock summary is given in Figure 4.3.2.3. The final assessment estimates SSB to have been below B_{lim} from 2001 to 2007 and above B_{pa} in 2008. $F_{(1-2)}$ is estimated to be well below the long time average in both 2007 and 2008.

4.5 Recruitment estimates

As no recruitment estimates from surveys are available, recruitment estimated in the assessments are based exclusively on commercial catch-at-age data. The tuning diagnostics indicate that the 0-group CPUE is a rather poor predictor of recruitment.

Provisional information about the 2008 year class

Due to no fishing in the second half of 2008 (see section 4.2.1) there are no data from 2008 that can be used to estimate the relative size of the 2008 year-class.

DTU AQUA has measured sandeel larvae abundance in the North Sea in April 2008. This material is presently being analysed. In addition, DTU AQUA will carry out a survey in December 2008 that may provide information about the size of the 2008 year class. Further the Institute of Marine research (IMR) plan to conduct surveys in 2009 to measure the abundance 1-group and older sandeels in April/May.

Recruitment estimates used for short term forecasting

For the short term forecast (section 4.6) the 25th percentile, of $304x10^9$ age-0 sandeels, of the long-term recruitment estimated in the final SXSA assessment was used as the recruitment in 2008 and 2009. This was used because recruitment has been below average since 2002. The 25^{th} percentile corresponds almost exactly to the average recruitment over the last 3 years 2005 to 2007 on $304x10^9$.

4.6 Short-term forecasts

The high natural mortality of sandeel and the few year classes contributing to the fishery make the stock size and catch opportunities largely dependent on the size of the incoming year classes. Commercial CPUE is a poor predictor of 0-group recruitment and reliable indices from surveys are not yet available, therefore prediction of 1 group abundance in the year following an assessment has a high degree of uncertainty and stock and fishery forecasts are not usually considered appropriate.

However, because of the low state of the sandeel stock the working group has, since 2004, provided an indicative short-term prognosis, using a range of scenarios for the recruitment and exploitation pattern. The same approach as used for the prognosis in 2007 was taken during this WG meeting to carry out a short-term prognosis for 2009 and 2010.

Prognosis for 2009 and 2010

The prediction was made using half year time steps. Stock numbers at 1st of January 2008 were taken from the final SXSA assessment. Values for natural mortalities and proportion mature are the same as those used in the assessment.

As discussed previously, a low recruitment was assumed for 2008 and 2009 because recruitment has been below average since 2002. Recruitment in 2008 and 2009 was assumed to be $304x10^9$, which is the 25th percentile of the long-term recruitment (section 4.5). The 25^{th} percentile corresponds almost exactly to the average recruitment over the last 3 years 2005 to 2007, and is lower than that ($324x10^9$) used in last years prognosis.

Due to no or very limited fisheries in second half of the year in 2005, 2006, 2007 and 2008, no fishery was assumed for second half year of 2009. F-at-age for the first half year of 2008 was used for the first half year of the forecast year. Due to the increase in

F from 2007 to 2008, the fishing mortality at age used in this years prognosis for age-1 sandeels (0.417), is much higher than the F used in last years prognosis (0.166), whereas the F at age for age-2 sandeels is about the same.

Stock and catch weights for the first half of 2008 were those used in the assessment. Average weights of the time period 1995 to 2008 were used for first half year of 2009 and 2010. Stock and catch weight prior to 1995 were not used, due to a change in the procedure used for age determination from 1995 (section 4.2.3 and ICES 1995). Stock and catch weight of second half year of 2008 and 2009 are irrelevant, because SSB is estimated at the start of first half year and no fishery is assumed in second half year. The data used in the forecast is given in Table 4.6.1.

The forecast predicts SSB in 2009 at 545 000 t, which is above B_{lim}, but below B_{pa}. In the low recruitment scenario landings in 2009 of 250 000 t will result in a SSB in 2010 above B_{pa}. Landings of 250 000t will lead to an F in 2009 that is less than 90% of F in 2008.

It was noted that short-term forecasts from 2004 and 2005 overestimated the SSB in 2005 and 2006 by a factor 2–3 when compared to the SSB estimated by the SXSA in 2006 (ICES 2006b). However, the standard forecast from 2007 estimated SSB in 2008 to be 681 000 t. SSB is in this years assessment estimated to 631 000 tonnes, e.g. at about the same level as the standard forecast in 2007.

SSB(2009) = 545 000 t; landings (2008) = 331 000 t. Input data in Table 4.6.1.

Rationale	Relative effort $\frac{F_{2009}}{F_{2008}}$	F_{2009}	Landings (2009) ‘000	SSB (2010) ‘000
Zero catch	0.0	0.000	0	809
	0.1	0.035	33	781
	0.2	0.071	65	755
	0.3	0.106	96	729
	0.4	0.141	126	705
	0.5	0.176	155	681
	0.6	0.212	183	658
	0.7	0.247	210	636
	0.8	0.282	237	615
	0.9	0.318	262	594
Status quo	1.0	0.353	287	574
	1.1	0.388	311	555
	1.2	0.424	335	537
	1.3	0.459	357	519
	1.4	0.494	379	502
	1.5	0.530	401	485
	1.6	0.565	422	469
	1.7	0.600	442	454
	1.8	0.635	461	439
	1.9	0.671	480	424
	2.0	0.706	499	411
	2.1	0.741	517	397
	2.2	0.777	534	384
	2.3	0.812	551	372
	2.4	0.847	567	360
	2.5	0.882	583	348
	2.6	0.918	599	337
	2.7	0.953	614	326
	2.8	0.988	628	316
	2.9	1.024	643	305
	3.0	1.059	656	296
	3.1	1.094	670	286
	3.2	1.130	683	277
	3.3	1.165	696	268
	3.4	1.200	708	260

Shaded scenarios are not considered consistent with the precautionary approach.

The settings applied in the forecast were used to estimate the relationship between recruitment in 2008 and the catch in 2009 that will lead to SSB being 600 000 t in 2010, i.e. the maximum catch in 2009 that will meet the objective of SSB to be above Bpa in 2010. The result of this analysis is the relationship:

TAC_{2009}=-287+$R_{0,2008}$*1.788 (1)

where $R_{0,2008}$ is recruitment at age-0 in 2008 and TAC_{2009} is the catch in 2009 that will result in SSB=Bpa in 2010.

The relationship (1) can be translated into a relationship between the stock size of 1-group sandeels in 2009 and the TAC in 2009, that will lead to SSB being 600 000 t in 2010, by projecting age-0 sandeels in second half year of 2008 to age-1 sandeels 1st of January 2009 applying natural mortality of age-0 sandeels for second half year of 2008. This result is the relationship (Figure 4.6.1):

TAC_{2009}=-287+$R_{1,2009}$*3.98 (2)

where $R_{1,2009}$ is the stock size of age-1 sandeels in 2009.

The TAC for 2007, based on 2007 RTM, was set at a lower level than the stock size in 2007 allowed, because mean weights used for 2007 in the estimation procedure were much lower than the mean weights measured during the 2007 fishery. When estimating the TAC for 2009 it is therefore suggested to adjust the mean weight for age-1 sandeels used in (2) using observed mean weights from the 2009 RTM. This gives the relationship:

$$TAC = -287 + \left(R_{1,2009} \cdot 3.98 \cdot \frac{W_{obs}}{W_m} \right) \quad (3)$$

where W_{obs} is mean weight of age-1 sandeels observed during 2009 RTM and W_m is the mean weight of age-1 sandeels observed in RTM in 2004 to 2008 (see text table below). The reason for using an average from previous years RTM as W_m is that mean weight at age used in the assessment are based on half years data and are thus not comparable to the mean weight at age from RTM that are based on data only up to week 17.

Mean weight of age-1 sandeels in week 17, as measured in RTM from 2004 to 2008.

Year	Mean weight age-1 g
2004	3.7
2005	3.5
2006	3.5
2007	4.6
2008	3.7
Average	3.8

Using this correction (3) of mean weight of age-1 sandeels will reduce the risk of over and underestimating the TAC for 2009 leading to under exploitation or overexploitation of the stock. Relationship (3) is suggested as a harvest control rule for the fishery in 2009.

The forecast assumption is based on the relationship between effort and F. However this relationship is poor. The relationship between the effort and landings in the table above are therefore doubtful.

4.6.1 Stochastic short-term forecast.

The deterministic short-term forecast above aims to find the TAC for 2009 that allows SSB in 2010 to be at or above Bpa, which is set at 600 000 t. The stochastic short-term forecast simulates the distribution of SSB in 2010, and aims to find the TAC in 2009 that gives 95% probability of SSB in 2010 being above Blim, which is set at 430 000t. The stochastic short-term forecast is a more direct implementation of the precautionary approach.

In order to set up a stochastic short-term forecast the uncertainties of the current assessment and on the projected recruitment of zero year old sandeel in 2008 need to be quantified, which is problematic, as the current assessment is a deterministic approach, and not capable of estimating uncertainties. To illustrate the sensibility of the calculated TAC when including uncertainties the following is assumed. Recruitment of zero year old sandeel in 2008 is expected to be low, which is here defined like in the deterministic short-term forecast above as the 25th percentile of the long-term recruitment, equivalent to average recruitment over the last 3 years. A log-normal error with a standard error of 0.35 is added, which is in line with the variability in the recent period with low recruitment (2002–2007). To acknowledge the fact that current assessment is also uncertain, a log-normal error with a standard error of 0.25 is added to the final estimated stock sizes. This is important as the current assessment is the starting point from which the forecast is computed.

The stochastic short-term forecast suggests that a higher relative effort (F multiplier) is acceptable w.r.t. the precautionary approach. The estimated precautionary relative effort from the deterministic short-term forecast was below 0.9 with a resulting TAC of ca. 250 000t (see table above). The stochastic short-term forecast estimated the precautionary relative effort to 1.06 with a resulting TAC of ca. 300 000t (see figure 4.6.2 and table above). The ad-hoc manner in which the uncertainties were quantified does limit the usefulness of this result, and is included here as a sensitivity analysis.

4.7 Medium-term forecasts

Medium term prognoses can not be made for sandeels.

4.8 Biological reference points

B_{lim} is set at 430,000 t, the lowest observed SSB. The Bpa is estimated to 600,000 t. Further information about biological reference points for sandeels in IV can be found in the Stock Quality Handbook no. Q4.

4.9 Quality of the assessment

A tendency in the assessment to underestimate F and overestimate stock size has been problematic in recent years given the current low status of the sandeel stock. In recent years this bias in the assessment seems to be related to changes in the stock size and distribution pattern of sandeels (section 4.6 and ICES 2006b). The changes in the sandeel stock have subsequently led to a large change in the fishing pattern (section 4.2.1) and fleet structure (section 4.2.5). As a consequence the assumptions about constant catchability of the commercial fleets seems to be violated.

Since 2006 the starting populations and fishing mortalities used in the short term forecast have been adjusted according to the degree of bias estimated from the retrospective analysis. A detailed description of the uncertainties in the assessment and forecast was given in the WG report, and the method used for bias correction was evaluated by the WG during the 2007 meeting in May (ICES WGNSSK 2007).

This year's assessment follows the tendency of underestimating F and overestimating stock size as seen in the previous years (Figure 4.3.2.2).

Suggestions for modifications of the assessment

The assessment should take account of the spatial stock structure of sandeels. It is accordingly important to define the population units to be assessed. A framework for implementing area based population analysed is presented in ICES (ICES AGSAN 2007a and ICES 2008a).

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

It is a prerequisite for the improvement of the assessment that a fisheries independent time series of sandeel abundance is established that can be used in the assessment. This is dependent on the effort used for establishing such time series and coordination of both methodology and effort between European institutes.

4.10 Status of the Stock

Recruitment has been below average since 2002. SSB is estimated to have been below Bpa from 2001 to 2007, and above Bpa in 2008. The stock size increased from 2006 to 2008, due to low fishing mortality. Concurrent with the increase in the stock size some areas with recent low abundance were repopulated, especially in the northern North Sea. There was a small increase in $F_{(1-2)}$ from 2007 to 2008, and SSB is forecast to be above B_{lim} but below B_{pa} in 2009.

A decline in CPUE in the Northern part of the North Sea from 2007 to 2008 and a low proportion of age-1 sandeels in the catches in 2008 in the same area suggest that recruitment to the grounds in the northern North Sea in 2007 is at a low level. Evidence suggests that all fishing grounds in the Norwegian EEZ are depleted, except for the Vestbank area (WD by Johannessen and Johnsen), and that the spawning stock is likely to be at a very low level in the Norwegian EEZ in 2009. Hence, the management regime proposed by ICES for 2008 by setting a TAC for the whole of the North Sea based on an in-year monitoring fishery, failed to protect sandeel in the Norwegian EEZ. On the other hand, 70% of the sandeel that was caught in the Norwegian EEZ was II-group that had the opportunity to spawn before being caught. Consequently, there is potential for good recruitment in 2008 and a recovery of the spawning stock in 2010 if I-group is protected in 2009.

4.11 Management Considerations

No fishing mortality (F) reference points are given for sandeels in the North Sea because there is no clear relationship between the size of the spawning stock biomass and the recruitment. The recruitment of sandeels seems more linked to environmental factors than to the size of the spawning stock biomass (see the Stock Quality Handbook no. Q4).

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

Suggestion for management of the sandeel fishery in 2009

The aim of management in 2009 should be to achieve SSB in 2010 bthat exceeds B_{lim} with a high (95%) probability, and to prevent local depletion.

Based on the uncertain short-term forecast (section 4.6) a provisional TAC of 250 000 in 2009 would achieve this.

Statistical rigorous ways to quantify the uncertainties in the assessment results and the poor stock recruitment relationship are needed before a provisional TAC should be based on the stochastic short-term forecast. With an index of recruitment in 2008, the uncertainties in stock recruitment relationship would not be critical for the stochastic short-term forecast. A recruitment index will be derived from the DTU AQUA coordinated dredge survey that is scheduled for December 2008.

A final TAC for 2009 could be determined, based on advice from ICES and STECF on the size of the 2008 year class of North Sea sandeel in accordance with the following rules:

$$TAC_{2009} = -287 + \left(R_{1,2009} \cdot 3.98 \cdot \frac{W_{obs}}{3.8} \right)$$

where $R_{1,2009}$ is recruitment at age-1 in 2009, TAC_{2009} is the catch in 2009 that will result in SSB=Bpa in 2010, W_{obs} is mean weight of age-1 sandeels observed during 2009 RTM.

The relationship between the TAC and the real-time recruitment estimate is conditional on the assessment of age group 2 and older at the start of 2009 from the final assessment (section 4.4).

The estimate of age group 1 sandeels at the start of 2009 ($R_{1,2009}$) is to be derived from real-time monitoring in 2009, using the same regression between historical CPUE observations and stock numbers at age 1 as that used in RTM in 2008.

The fishery shall be closed 1 August 2009.

Due to the different and likely smaller stock in the Northern North Sea special management should be considered for this area in 2009 to prevent further depletion at grounds with known local low stock size.

Changes in the fleet composition

There was a 50% decline in the number of Danish vessels (from 200 to 98 vessels) fishing sandeels from 2004 to 2005, and a 53% reduction in total kilowatt days. In 2006 and 2007 the Danish fleet increased to 124 and 116 vessels participating in the sandeel fishery. The Danish industrial vessels were in 2007 given individual tradable quotas (ITQ) on sandeels. The introduction of ITQ accelerated the change towards fewer and larger vessels, and in 2008 only 83 Danish vessels were fishing sandeels.

Also for the Norwegian fleet a drastic decline in number of vessels fishing sandeels has been observed in recent years, with a marked increase again in 2007 and 2008 when the vessels were given individual quotas.

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Table 4.2.1.1. SANDEEL in IV. Official landings reported to ICES

SANDEELS IVa

Country	1998	1999	2000	2001	2002	2003	2004	2005	2006
Denmark	23.138	3.388	4.742	1.058	111	399	147	-	-
Faroe Islands	11.000	6.582	-	-	-	-	15	-	-
Norway	172.887	44.620	11.522	4.121	185	280	64	-	-
Sweden	55	495	55	-	-	73	-	-	-
UK (E/W/NI)	-	-	-	-	-	-	-	-	-
UK (Scotland)	5.742	4.195	4.781	970	543	186	-	-	-
Total	212.822	59.280	21.100	6.149	839	938	226	0	0

*Preliminary.

SANDEELS IVb

Country	1998	1999	2000	2001	2002	2003	2004	2005	2006
Denmark	603.491	503.572	533.905	638.657	627.097	245.096	273492	129776	241257
Faroe Islands	-	-			16.167	5.168	3461	-	-
Germany	-	-	-	-	-	534	2658	-	3304
Ireland	-	389	-	-	-	-	-	-	-
Norway	170.737	142.969	107.493	183.329	175.799	29.336	48464	17341	5814
Sweden	8.465	21.920	27.867	47.080	36.842	21.444	34477	8327	32709
UK (E/W/NI)	-	-	-	-	-	-	-	-	-
UK (Scotland)	18.008	7.280	5.978	-	2.442	115	29	-	688
Total	800.701	676.130	675.243	869.066	858.347	301.693	362.552	155.444	283.772

*Preliminary.

SANDEELS IVc

Country	1998	1999	2000	2001	2002	2003	2004	2005	2006
Denmark	9.674	10.356	11.993	7.177	4.996	28.646	14.104	22.985	10.595
Germany	-	-	-	-	-	-	-	-	301
France	-	-	1	-	-	-	+	-	2
Netherlands	+	+	-	-	+	-	-	-	-
Norway	-	-	-	-	-	-	139	-	-
Sweden	-	-	-	-	-	160	-	-	-
UK (E/W/NI)	-	-	+	-	-	+	-	-	-
Total	9.674	10.356	11.994	7.177	4.996	28.806	14.243	22.985	10.898

*Preliminary.

Summary table official landings

	1998	1999	2000	2001	2002	2003	2004	2005	2006
Total IV tonnes	1.023.197	745.766	708.337	882.392	864.182	331.437	377.021	178.429	294.670
TAC	1.000.000	1.000.000	1.020.000	1.020.000	1.020.000	918.000	826.200	660.960	300.000

By-catch and other landings

	1998	1999	2000	2001	2002	2003	2004	2005	2006
Area IV tonnes: official-WG	18.797	10.628	9.188	20.781	53.482	5.817	15.521	6.329	6.770

Summary table - landing data provided by Working Group members

	1998	1999	2000	2001	2002	2003	2004	2005	2006
Total IV - tonnes	1.004.400	735.138	699.149	861.611	810.700	325.620	361.500	172.100	287.900

Table 4.2.1.2. SANDEEL in IV. Landings ('000 t), 1952-2008 (Data provided by Working Group members)

Year	Denmark	Germany	Faroes	Ireland	Netherlands	Norway	Sweden	UK	Total
1952	1.6	-	-	-	-	-	-	-	1.6
1953	4.5	+	-	-	-	-	-	-	4.5
1954	10.8	+	-	-	-	-	-	-	10.8
1955	37.6	+	-	-	-	-	-	-	37.6
1956	81.9	5.3	-	-	+	1.5	-	-	88.7
1957	73.3	25.5	-	-	3.7	3.2	-	-	105.7
1958	74.4	20.2	-	-	1.5	4.8	-	-	100.9
1959	77.1	17.4	-	-	5.1	8.0	-	-	107.6
1960	100.8	7.7	-	-	+	12.1	-	-	120.6
1961	73.6	4.5	-	-	+	5.1	-	-	83.2
1962	97.4	1.4	-	-	-	10.5	-	-	109.3
1963	134.4	16.4	-	-	-	11.5	-	-	162.3
1964	104.7	12.9	-	-	-	10.4	-	-	128.0
1965	123.6	2.1	-	-	-	4.9	-	-	130.6
1966	138.5	4.4	-	-	-	0.2	-	-	143.1
1967	187.4	0.3	-	-	-	1.0	-	-	188.7
1968	193.6	+	-	-	-	0.1	-	-	193.7
1969	112.8	+	-	-	-	-	-	0.5	113.3
1970	187.8	+	-	-	-	+	-	3.6	191.4
1971	371.6	0.1	-	-	-	2.1	-	8.3	382.1
1972	329.0	+	-	-	-	18.6	8.8	2.1	358.5
1973	273.0	-	1.4	-	-	17.2	1.1	4.2	296.9
1974	424.1	-	6.4	-	-	78.6	0.2	15.5	524.8
1975	355.6	-	4.9	-	-	54.0	0.1	13.6	428.2
1976	424.7	-	-	-	-	44.2	-	18.7	487.6
1977	664.3	-	11.4	-	-	78.7	5.7	25.5	785.6
1978	647.5	-	12.1	-	-	93.5	1.2	32.5	786.8
1979	449.8	-	13.2	-	-	101.4	-	13.4	577.8
1980	542.2	-	7.2	-	-	144.8	-	34.3	728.5
1981	464.4	-	4.9	-	-	52.6	-	46.7	568.6
1982	506.9	-	4.9	-	-	46.5	0.4	52.2	610.9
1983	485.1	-	2.0	-	-	12.2	0.2	37.0	536.5
1984	596.3	-	11.3	-	-	28.3	-	32.6	668.5
1985	587.6	-	3.9	-	-	13.1	-	17.2	621.8
1986	752.5	-	1.2	-	-	82.1	-	12.0	847.8
1987	605.4	-	18.6	-	-	193.4	-	7.2	824.6
1988	686.4	-	15.5	-	-	185.1	-	5.8	892.8
1989	824.4	-	16.6	-	-	186.8	-	11.5	1039.1
1990	496.0	-	2.2	-	0.3	88.9	-	3.9	591.3
1991	701.4	-	11.2	-	-	128.8	-	1.2	842.6
1992	751.1	-	9.1	-	-	89.3	0.5	4.9	854.9
1993	482.2	-	-	-	-	95.5	-	1.5	579.2
1994	603.5	-	10.3	-	-	165.8	-	5.9	785.5
1995	647.8	-	-	-	-	263.4	-	6.7	917.9
1996	601.6	-	5.0	-	-	160.7	-	9.7	776.9
1997	751.9	-	11.2	-	-	350.1	-	24.6	1137.8
1998	617.8	-	11.0	-	+	343.3	8.5	23.8	1004.4
1999	500.1	-	13.2	0.4	+	187.6	22.4	11.5	735.1
2000	541.0	-	-	-	+	119.0	28.4	10.8	699.1
2001	630.8	-	-	-	-	183.0	46.5	1.3	861.6
2002	629.7	-	-	-	-	176.0	0.1	4.9	810.7
2003	274.0	-	-	-	-	29.6	21.5	0.5	325.6
2004	277.1	2.7	-	-	-	48.5	33.2	+	361.5
2005	154.8	-	-	-	-	17.3	-	-	172.1
2006	250.6	3.2	-	-	-	5.6	27.8	-	287.9
2007	144.6	1.0	2.0	-	-	51.1	6.6	1.0	206.3
2008	234.4	4.4	2.4	-	-	81.6	12.4	-	335.2

2008 only include first half year.
+ = less than half unit.
- = no information or no catch.

Table 4.2.1.3. SANDEEL in IV. Monthly landings (ton) by Denmark, Norway and Scotland from each area defined in Fig 4.1.2.1. Data provided by Working Group members.

	1A	1B	1C	2A	2B	2C	3	4	5	6	Shetland	Total
2001												
Mar	3205	0	0	5235	2078	0	915	218	334	180	144	12309
Apr	60040	10891	0	19956	16609	0	1968	916	0	265	295	110940
May	96489	2014	0	71446	20668	0	15266	4829	510	3767	589	215578
Jun	72384	0	1556	15160	8103	120	8265	4790	4291	22748	0	137417
Jul	6703	90	0	67814	24065	0	8769	1664	2204	13747	0	125056
Aug	473	0	0	51965	61169	0	8679	0	0	2927	236	125449
Sep	578	0	0	24926	31178	0	4802	0	0	4840	0	66324
Oct	0	0	0	6464	14027	0	972	0	0	500	0	21963
Total	239872	13026	1556	262966	177898	120	49635	12417	7339	48974	1264	815067
2002												
Mar	3077	0	0	3911	2715	0	928	322	0	0	0	10953
Apr	104033	1745	0	66992	51007	0	15466	904	59	475	109	240790
May	176437	3341	0	78497	37385	0	37058	915	151	3272	12	337068
Jun	118879	125	0	27386	19380	10	10561	8673	2531	12498	0	200043
Jul	1128	0	0	90	48	0	193	2744	204	9869	0	14276
Aug	0	0	0	109	261	0	397	0	0	5146	422	6335
Sept	0	0	0	0	74	0	290	0	0	0	0	364
Oct	0	0	0	1	0	0	0	0	0	2	0	3
Dec	0	0	0	0	0	0	0	0	2	0	0	2
Total	403554	5211	0	176986	110870	10	64893	13558	2947	31262	543	809834
2003												
Mar	1947	52	0	97	380	7	225	325	0	0		3033
Apr	28806	5026	0	8341	6072	0	1900	81	0	662	49	50937
May	59890	1812	24	8884	9357	0	4532	10995	1020	9991	16	106521
Jun	11737	49	0	11906	398	10	2140	20891	13318	21639		82088
Jul	3604	0	0	9857	2013	0	3272	2738	1697	5790		28971
Aug	960	6	0	4381	4687	0	11293	16	175	687	121	22326
Sept	0	255	73	35	1551	0	2955	0	0	1094		5963
Oct	0	0	0	114	0	0	1589	0	0	127		1830
Nov	0	0	0	0	0	0	2070	0	0	0		2070
Dec	0	0	0	0	0	0	45	0	0	0		45
Total	106944	7200	97	43615	24458	17	30021	35046	16210	39990	186	303784
2004												
Feb	0	0	0	0	0	0	0	0	0	7		7
Mar	326	0	0	1001		0	37		260	2		1626
Apr	15893	627	0	15824	4847	0	10732	471	322	834		49550
May	46631	1044	0	21607	5495	0	22629	20484	233	8578		126701
Jun	21841	146	0	5077	1800	0	13821	13680	4789	35909		97063
Jul	1146	116		813	2272		6019	7430	1184	12923		31903
Aug	325			3963	5449		2589			3357		15683
Sept					3006		116			2		3124
Oct												
Total	86162	1933	0	48285	22869	0	55943	42065	6788	61612	0	325657
2005												
Apr	4017			71	1476		462	144		88		6258
May	34506	57		9536	7512		6507	13333	32	2410		73893
Jun	19216	21		8952	2545		8107	8224	19370	21959		88394
Jul				1668			987	922				3577
Aug				3			2					5
Sep												0
Okt										1		1
Total	57739	78	0	20230	11533	0	16065	22623	19402	24457	0	172128
2006												
Apr	10141			8733	1387		188	111		82		20642
May	96349			25020	3096		3830	201		6455		134951
Jun	59827	34		3184	47		4815	12035	5236	9506		94684
Jul	1122			94			3309	2600	1171	11745		20041
Aug				2			94			283		379
Sep				5			2			2		9
Oct					5		257					262
Nov		30										30
Total	167439	64	0	37038	4530	0	12495	14947	6407	28073	0	270998
2007												
Apr	23545			6378	19966		7098	646		406		58039
May	65238	308	4	4990	31062		22979	3024	244	1470		129319
Jun	501	69		50	4512		4032	25	559	2966		12714
Total	89284	377	4	11418	55540	0	34109	3695	803	4842	0	200072
%	45%	0%	0%	6%	28%	0%	17%	2%	0%	2%	0%	100%
Average 2001-2007												
	40%	1%	0%	21%	14%	0%	9%	5%	2%	8%	0%	100%
2008												
Apr	26865	41		8148	10313		3884			460		49711
May	109897	9972		26263	29615		15986	1291		4700		197724
Jun	62816			3452	1599		10738	5152	384	3574		87715
Total	199578	10013	0	37863	41527	0	30608	6443	384	8734	0	335150
%	60%	3%	0%	11%	12%	0%	9%	2%	0%	3%	0%	100%

Table 4.2.1.4. SANDEEL in IV. Annual landings ('000 t) by area of the North Sea. Data provided by Working Group members (Denmark, Norway and Scotland).

	Area										Sampling area		
Year	1A	1B	1C	2A	2B	2C	3	4	5	6	Shetland	Northern	Southern
1972	98,8	28,1	3,9	24,5	85,1	0,0	13,5	58,3	6,7	28,0	0	130,6	216,3
1973	59,3	37,1	1,2	16,4	60,6	0,0	8,7	37,4	9,6	59,7	0	107,6	182,4
1974	50,4	178,0	1,7	2,2	177,9	0,0	29,0	27,4	11,7	25,4	7,4	386,6	117,1
1975	70,0	38,2	17,8	12,2	154,7	4,8	38,2	42,8	12,3	19,2	12,9	253,7	156,5
1976	154,0	3,5	39,7	71,8	38,5	3,1	50,2	59,2	8,9	36,7	20,2	135,0	330,6
1977	171,9	34,0	62,0	154,1	179,7	1,3	71,4	28,0	13,0	25,3	21,5	348,4	392,3
1978	159,7	--50.2--		346,5	--70.3--		42,5	37,4	6,4	27,2	28,1	163,0	577,2
1979	194,5	0,9	61,0	32,3	27,0	72,3	34,1	79,4	5,4	44,3	13,4	195,3	355,9
1980	215,1	3,3	119,3	89,5	52,4	27,0	90,0	30,8	8,7	57,1	25,4	292	401,2
1981	105,2	0,1	42,8	151,9	11,7	23,9	59,6	63,4	13,3	45,1	46,7	138,1	378,9
1982	189,8	5,4	4,4	132,1	24,9	2,3	37,4	75,7	6,9	74,7	52,0	74,4	479,2
1983	197,4	-	2,8	59,4	17,7	-	57,7	87,6	8,0	66,0	37,0	78,2	419,0
1984	337,8	4,1	5,9	74,9	30,4	0,1	51,3	56,0	3,9	60,2	32,6	91,8	532,8
1985	281,4	46,9	2,8	82,3	7,1	0,1	29,9	46,6	18,7	84,5	17,2	79,7	513,5
1986	295,2	35,7	8,5	55,3	244,1	2,0	84,8	22,5	4,0	80,3	14,0	375,1	457,4
1987	275,1	63,6	1,1	53,5	325,2	0,4	5,6	21,4	7,7	45,1	7,2	395,9	402,8
1988	291,1	58,4	2,0	47,0	256,5	0,3	37,6	35,3	12,0	102,2	4,7	384,8	487,6
1989	228,3	31,0	0,5	167,9	334,1	1,5	125,3	30,5	4,5	95,1	3,5	492,4	526,3
1990	141,4	1,4	0,1	80,4	156,4	0,6	61,0	45,5	13,8	85,5	2,3	219,5	366,7
1991	228,2	7,1	0,7	114,0	252,8	1,8	110,5	22,6	1,0	93,1	+	372,9	458,9
1992	422,4	3,9	4,2	168,9	67,1	0,3	101,2	20,1	2,8	54,4	0	176,7	668,6
1993	196,5	21,9	0,1	26,2	164,9	0,3	88,0	26,6	3,9	48,7	0	276,0	301,9
1994	157,0	108,6	-	61,7	203,4	2,7	175,0	16,0	2,8	42,0	0	489,7	279,5
1995	322,4	43,9	147,4	86,7	169,5	1,0	59,4	26,6	5,3	55,8	1,3	421,2	496,8
1996	310,5	18,6	31,2	40,8	153,0	4,5	134,1	12,7	3,0	52,5	1	341,2	419,5
1997	352,0	53,3	8,9	92,8	390,5	1,2	112,9	18,1	4,7	88,6	2,4	566,8	535,8
1998	282,2	58,3	2,0	90,3	395,3	1,0	40,6	34,5	4,2	63,4	5,2	497,2	480,7
1999	266,7	32,6	0,1	132,8	167,9	0,0	48,0	16,9	2,7	27,2	4,2	248,7	446,4
2000	226,1	29,2	0,0	87,2	139,9	0,3	111,7	20,4	8,3	43,3	4,3	281,0	385,4
2001	239,9	13,0	1,6	263,0	177,9	0,1	49,6	12,4	7,3	49,0	1,3	242,2	571,6
2002	403,6	5,2	0,0	177,0	110,9	0,0	64,9	13,6	3,0	31,3	0,5	181,0	628,4
2003	106,9	7,2	0,1	43,6	24,5	0,0	30,0	35,0	16,2	40,0	0,5	61,8	241,7
2004	86,2	1,9	0,0	48,3	22,9	0,0	55,9	42,1	6,8	61,6	0,0	80,7	245,0
2005	57,7	0,1	0,0	20,2	11,5	0,0	16,1	22,6	19,4	24,5	0,0	27,7	144,4
2006	184,4	0,1	0,0	37,0	4,5	0,0	12,5	14,9	6,4	28,1	0,0	17,1	270,8
2007	93,6	0,4	0,0	11,4	55,5	0,0	34,1	3,7	0,8	4,8	0	92,0	114,3

Sampling areas: Northern - Areas 1B, 1C, 2B, 2C, 3.

Southern - Areas 1A, 2A, 4, 5, 6.

Table 4.2.1.5. SANDEEL in IV. Monthly landings (t) by Denmark, Norway and Scotland (data provided by Working Group Members).

Year	Month	Denmark	Norway	Scotland	Total
2001	Mar	10,684	1,481	144	12,310
	Apr	95,723	14,922	295	110,940
	May	183,757	31,231	589	215,577
	Jun	127,292	10,124	0	137,416
	Jul	106,654	18,403	0	125,057
	Aug	65,021	60,192	236	125,449
	Sep	33,741	32,583	0	66,324
	Oct	7,910	14,054	0	21,963
	Nov	30	0	0	30
	Total	630,811	182,991	1,264	815,066
2002	Mar	10,236	717	0	10,953
	Apr	177,597	63,083	109	240,789
	May	247,494	86,942	2,898	337,334
	Jun	174,467	24,568	1,448	200,483
	Jul	14,228	48	0	14,276
	Aug	5,652	261	422	6,335
	Sep	0	364	0	364
	Oct	3	0	0	3
	Dec	2	0	0	2
	Total	629,679	175,983	4,877	810,539
2003	Mar	2,802	231		3,033
	Apr	42,885	8,003	366	51,254
	May	96,105	10,401		106,506
	Jun	80,271	1,817		82,088
	Jul	27,784	1,186		28,970
	Aug	15,782	6,422	121	22,325
	Sep	4,407	1,555		5,962
	Oct	1,831	0		1,831
	Nov	2,070	0		2,070
	Dec	45	0		45
	Total	273,982	29,615	487	304,084
2004	Feb	7	0		7
	Mar	1,444	183		1,627
	Apr	42,664	6,886		49,550
	May	100,715	25,986	29	126,730
	Jun	89,369	7,695		97,064
	Aug	30,485	1,419		31,904
	Sep	12,191	3,492		15,683
	Oct	254	2,869		3,123
	Total	277,129	48,530	29	325,688
2005	Apr	4,350	1,876		6,226
	May	60,473	12,556		73,029
	Jun	76,234	2,900		79,134
	Jul	13,719			13,719
	Oct	18			18
	Sep	2			2
	Total	154,796	17,332	0	172,128
2006	Apr	19,258	1,385		20,643
	May	115,949	4,200		120,149
	Jun	94,683			94,683
	Jul	20,042			20,042
	Aug	379			379
	Sep	9			9
	Oct	266			266
	Nov	30			30
	Total	250,616	5,585	678	256,879
2007	Apr	46,817	11,222		58,039
	May	89,057	35,976		125,033
	Jun	8,775	3,938		12,713
	Total	144,649	51,136	1,000	196,785
2008	Apr	33,541	9,377		42,918
	May	120,635	68,744		189,379
	Jun	80,224	3,432		83,656
	Total	234,400	81,553	0	315,953

* No data available

Table 4.2.2.1. SANDEEL in IV. Catch numbers at age (numbers · 10^{-6}) by half year.

Fishery in the northern North Sea

Year	1983		1984		1985		1986		1987		1988	
Season	1	2	1	2	1	2	1	2	1	2	1	2
AGE												
0	*	7911.	*	0.	*	349.	*	7105.	*	455.	*	13196.
1	5684.	303.	11692.	1207.	2688.	109.	23934.	7077.	26236.	5768.	9855.	1283.
2	1215.	316.	1647.	121.	3292.	239.	2600.	473.	10855.	198.	25922.	340.
3	89.	19.	153.	43.	1002.	89.	200.	0.	350.	0.	1319.	119.
4+	12.	0.	5.	0.	480.	11.	0.	0.	155.	0.	26.	17.
SOP	50871.	37464.	91792.	20871.	106279.	12946.	174378.	128325.	305979.	83202.	430970.	71479.

Year	1989		1990		1991		1992		1993		1994	
Season	1	2	1	2	1	2	1	2	1	2	1	2
AGE												
0	*	3380.	*	12107.	*	13616.	*	6797.	*	26960.	*	457.
1	56661.	4038.	13101.	1670.	41855.	866.	9871.	48.	15768.	1004.	28490.	829.
2	2219.	274.	3907.	342.	2342.	28.	4056.	3.	2635.	112.	7225.	1211.
3	3385.	0.	578.	51.	908.	8.	486.	0.	1023.	34.	5954.	396.
4+	0.	0.	175.	15.	318.	3.	305.	0.	646.	22.	2155.	25.
SOP	437540.	57222.	148411.	70806.	374465.	55536.	115957.	38189.	188264.	86785.	413536.	83222.

Year	1995		1996		1997		1998		1999		2000	
Season	1	2	1	2	1	2	1	2	1	2	1	2
AGE												
0	*	4046.	*	31817.	*	2431.	*	35220.	*	33653.	*	0.
1	36140.	3374.	11524.	1706.	67038.	11346.	6667.	10005.	2118.	694.	22887.	467.
2	3360.	338.	5385.	1772.	3640.	633.	33216.	1837.	3491.	551.	8810.	84.
3	1091.	26.	761.	136.	5254.	25.	2039.	79.	5086.	58.	1420.	24.
4+	145.	2.	301.	55.	1206.	2.	410.	1.	1023.	0.	1470.	46.
SOP	348280.	71351.	201546.	141902.	451606.	103226.	360999.	148508.	135432.	115849.	270507.	9974.

Year	2001		2002		2003		2004		2005		2006	
Season	1	2	1	2	1	2	1	2	1	2	1	2
AGE												
0	*	46385.	*	0.	*	7510.	*	2961.	*	0.	*	0.
1	6434.	771.	21719.	157.	2315.	118.	6819.	656.	2550.	0.	1408.	230.
2	2408.	73.	2649.	6.	1305.	164.	542.	9.	412.	0.	122.	37.
3	472.	134.	402.	0.	456.	0.	375.	11.	97.	0.	17.	9.
4+	1035.	0.	219.	0.	635.	0.	213.	0.	49.	0.	2.	2.
SOP	88280.	153698.	179581.	1263.	51447.	29772.	59588.	19555.	27623.	0.	13400.	3703.

Year	2007		2008
Season	1	2	1
AGE			
0	*	0.	*
1	8494.	0.	3597.
2	778.	0.	2417.
3	134.	0.	440.
4+	40.	0.	82.
SOP	91249.	0.	81802.

Fishery in the southern North Sea

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

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

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

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

Year	2007		2008
Season	1	2	1
AGE			
0	*	0.	*
1	9301.	0.	27073.
2	4871.	0.	4375.
3	365.	0.	1302.
4+	129.	0.	170.
SOP	114122.	0.	252430.

Table 4.2.3.1. SANDEEL in IV. Northern North Sea. Mean weight (g) in the catch by country and combined. Age group 4++ is the 4-plus group used in assessment

		Denmark		Norway		Combined	
		Half-year		Half-year		Half-year	
Year	Age	1	2	1	2	1	2
2003	0	2.26	3.56		2.82	2.26	3.37
	1	5.34	15.74	5.23	12.13	5.30	13.00
	2	13.03	17.90	15.72		14.70	17.90
	3	11.86		20.57		17.81	
	4	14.47				14.47	
	5	17.24				17.24	
	5+						
	6						
	4++	14.82		29.93		18.69	
2004	0		3.76	1.73	3.46	1.73	3.56
	1	6.07	13.13	7.36		6.27	13.13
	2	11.10		10.07	21.42	10.64	21.42
	3	11.23	18.50	15.78		13.40	18.50
	4	25.01				25.01	
	5	33.17				33.17	
	5+						
	6						
	4++	30.69		27.53		28.39	
2005	0	1.00				1.00	
	1	7.36		7.56		7.43	
	2	15.44		14.28		14.42	
	3	17.16		15.99		16.06	
	4	22.56				22.56	
	5	33.00				33.00	
	5+						
	6						
	4++	23.41		23.94		23.90	
2006	0						
	1	8.35	11.99	6.99		7.92	11.99
	2	13.79	17.62	15.28		14.42	17.62
	3	26.02	27.45	24.23		25.47	27.45
	4	16.30	16.30			16.30	16.30
	5	31.00	31.00			31.00	
	5+						
	6						
	4++	30.95	30.94	23.00		30.61	30.94
2007	0	1.00		1.74		1.74	
	1	7.50		10.72		8.60	
	2	15.97		16.81		16.68	
	3	21.10		26.95		26.48	
	4	30.93				30.93	
	5						
	5+						
	6						
	4++	30.93		41.93		41.62	
2008	0	1.36		1.19		1.28	
	1	7.31		8.74		7.77	
	2	16.57		16.85		16.81	
	3	25.89		23.84		24.01	
	4	24.41				24.41	
	5	32.34				32.34	
	5+						
	6	38.00					
	4++	26.41		32.74		32.56	

Table 4.2.3.2. SANDEEL in IV. Southern North Sea. Mean weight (g) in the catch by (Denmark). Age group 4++ is the 4-plus group used in assessment

		Half-year	
Year	Age	1	2
2003	0	2.13	2.65
	1	5.25	7.47
	2	7.86	15.72
	3	9.33	17.30
	4	11.65	13.80
	5	15.27	-
	6	24.43	-
	7	15.05	-
	8+	15.90	-
	4++	12.47	13.80
2004	0		2.60
	1	5.49	7.35
	2	10.49	13.31
	3	11.34	13.37
	4	10.27	12.97
	5		
	6		
	7		
	8+		
	4++	10.27	12.97
2005	0	2.46	-
	1	5.54	-
	2	9.17	-
	3	10.73	-
	4	11.93	-
	5	13.63	-
	6	14.35	-
	7	12.67	-
	8+		-
	4++	12.18	-
2006	0	1.81	-
	1	6.19	8.97
	2	10.66	9.69
	3	12.83	13.30
	4	14.09	16.30
	5	15.35	-
	6	16.06	-
	7		-
	8+		-
	4++	15.15	16.30
2007	0	1.40	-
	1	5.91	-
	2	10.60	-
	3	14.90	-
	4	16.08	-
	5	16.73	-
	6	16.37	-
	7		-
	8+		-
	4++	16.18	-
2008	0	1.31	-
	1	6.62	-
	2	12.07	-
	3	13.60	-
	4	15.28	-
	5	17.35	-
	6	19.13	-
	7		-
	8+		-
	4++	15.89	-

Table 4.2.3.3. SANDEEL in IV. Mean weight (g) in the catch by half year.

Northern North Sea, first half-year

year	age-1	age-2	age-3	age-4+
1983	5.64	13.05	27.30	43.97
1984	5.64	13.05	27.30	42.20
1985	5.64	13.05	27.30	43.34
1986	5.64	13.05	27.30	
1987	5.64	13.05	27.30	43.84
1988	5.64	13.05	27.30	42.20
1989	6.20	14.00	16.30	
1990	5.64	13.05	27.30	44.32
1991	7.43	14.23	22.40	30.87
1992	5.45	10.86	18.49	29.92
1993	5.97	20.62	24.92	22.14
1994	6.43	13.70	15.08	19.29
1995	6.95	19.75	24.90	24.70
1996	7.80	14.98	25.93	37.49
1997	4.94	7.95	11.76	24.64
1998	4.24	8.73	14.21	33.61
1999	6.53	8.08	13.20	25.68
2000	6.78	7.90	11.86	19.66
2001	6.29	11.78	15.82	11.58
2002	6.17	11.77	18.40	31.98
2003	5.30	14.70	17.81	18.69
2004	6.27	10.64	13.40	28.39
2005	7.43	14.42	16.06	23.90
2006	7.92	14.44	25.47	30.61
2007	8.60	16.68	26.48	41.62
2008	7.77	16.81	24.01	32.56

Northern North Sea, second half-year

year	age-0	age-1	age-2	age-3	age-4+
1983	3.03	13.23	27.84	36.20	
1984	3.03	13.23	27.84	36.20	
1985	3.03	13.23	27.84	36.20	51.91
1986	3.03	13.23	27.84	36.20	
1987	3.03	13.23	27.84	36.20	
1988	3.03	13.23	27.84	36.20	44.00
1989	5.00	8.90	16.00		
1990	3.03	13.23	27.84	36.20	44.00
1991	3.42	9.57	14.99	16.20	44.00
1992	5.48	18.03	25.40	21.56	
1993	2.71	10.37	19.22	20.28	21.37
1994	6.58	22.75	30.20	58.07	72.15
1995	5.08	13.46	14.20	21.00	19.00
1996	2.94	10.85	14.92	15.59	23.58
1997	1.71	8.11	10.15	23.96	17.19
1998	2.48	3.91	11.13	20.15	13.39
1999	3.07	7.78	10.43	24.15	
2000		14.92	17.95	19.18	22.67
2001	3.10	9.61	17.50	9.07	
2002		7.33	17.52		
2003	3.37	13.00	17.90		
2004	3.56	13.13	21.42	18.50	
2005					
2006		11.99	17.62	27.45	30.94
2007					

Southern North Sea, first half-year

year	age-1	age-2	age-3	age-4+
1983	5.51	9.96	13.74	16.90
1984	5.51	9.96	13.74	16.95
1985	5.51	9.96	13.74	16.51
1986	5.51	9.96	13.74	16.30
1987	5.80	11.00	15.60	18.04
1988	4.00	12.50	15.50	18.73
1989	4.00	12.50	15.50	18.01
1990	4.00	12.50	15.50	19.28
1991	8.20	16.40	16.90	17.20
1992	7.43	13.83	17.51	22.60
1993	6.08	11.54	15.09	20.31
1994	6.07	11.01	13.46	16.94
1995	7.30	13.20	16.60	20.48
1996	5.57	8.31	13.16	16.89
1997	6.52	10.92	11.81	16.27
1998	5.54	8.38	10.64	13.21
1999	5.52	9.27	13.50	18.33
2000	6.16	9.56	14.42	15.93
2001	4.22	7.93	12.57	16.76
2002	6.14	8.10	12.49	16.73
2003	5.25	7.86	9.33	12.47
2004	5.49	10.49	11.34	10.27
2005	5.54	9.17	10.73	12.18
2006	6.19	10.66	12.83	15.15
2007	5.91	10.60	14.90	16.18
2008	6.62	12.07	13.6	15.89

Southern North Sea, second half-year

year	age-0	age-1	age-2	age-3	age-4+
1983	2.42	7.50	10.75	14.12	17.71
1984	2.42	7.50	10.75	14.12	17.71
1985	2.42	7.50	10.75	14.12	18.66
1986	2.42	7.50	10.75	14.12	18.76
1987	1.30	8.90	10.80	21.40	19.85
1988	1.00	10.50	14.00	17.00	19.11
1989	1.00	10.50	14.00	17.00	19.01
1990	1.00	10.50	14.00	17.00	20.05
1991	2.60	7.50	13.60	12.00	
1992	3.40	9.43	16.61	20.04	22.58
1993	3.08	10.13	15.66	17.04	21.96
1994		8.56	17.16	19.50	23.74
1995		6.60	13.60	17.70	21.22
1996	2.34	9.90	16.66	21.77	33.39
1997	4.72	7.99	13.54	14.73	18.88
1998	2.79	3.01	12.65	11.57	17.14
1999	5.42	10.02	11.05	16.85	15.68
2000	1.66	6.61	13.68	15.74	18.34
2001	2.40	9.51	17.00		
2002		8.40	12.53		
2003	2.65	7.47	15.72	17.30	13.80
2004	2.60	7.35	13.31	13.37	12.97
2005					
2006		8.97	9.69	13.30	16.30
2007					

Table 4.2.3.4. SANDEEL in IV. Mean weight (g) in the stock by half year.

First half-year

Year	age-1	age-2	age-3	age-4+
1983	5.03	12.89	16.92	24.76
1984	4.10	13.81	16.28	21.01
1985	4.19	12.79	18.75	22.08
1986	4.18	13.10	16.32	27.79
1987	4.70	12.82	16.00	21.23
1988	4.40	14.84	15.81	19.17
1989	4.40	13.49	19.58	18.28
1990	4.26	13.31	17.59	19.26
1991	4.29	13.22	16.95	20.65
1992	4.08	13.07	17.18	21.15
1993	4.50	12.70	16.38	21.34
1994	6.26	12.99	14.58	18.71
1995	7.13	15.41	20.02	20.93
1996	6.75	9.99	14.52	21.10
1997	5.63	9.44	11.77	21.61
1998	5.01	8.54	12.03	16.34
1999	5.59	8.85	13.42	22.15
2000	6.40	8.57	13.30	17.03
2001	4.41	8.51	13.51	15.19
2002	6.14	8.96	14.11	23.85
2003	5.26	8.39	10.29	14.62
2004	5.62	10.54	11.51	18.25
2005	5.81	9.55	12.00	13.37
2006	6.26	10.82	13.03	15.30
2007	7.19	11.44	18.01	22.25
2008	6.76	13.76	16.23	21.32

Second half-year

Year	age-0	age-1	age-2	age-3	age-4+
1983	1.11	11.83	14.73	19.14	24.35
1984	1.19	10.58	16.58	19.54	21.90
1985	1.19	10.69	14.65	22.49	24.95
1986	1.72	10.64	14.75	17.96	30.44
1987	1.43	11.18	14.29	17.26	20.91
1988	1.44	10.81	18.07	17.19	20.61
1989	1.28	10.76	15.80	17.05	19.39
1990	1.36	10.72	15.51	19.37	19.95
1991	1.10	10.67	15.49	18.02	19.39
1992	1.54	10.57	14.85	18.67	20.44
1993	1.44	10.91	14.25	17.61	20.49
1994	6.58	10.95	27.46	45.24	31.15
1995	5.08	10.14	13.66	17.96	21.19
1996	2.90	10.33	16.13	20.52	32.88
1997	1.94	8.04	11.70	15.27	18.86
1998	2.49	3.84	12.03	13.92	17.11
1999	3.15	8.29	10.49	17.14	15.68
2000	1.66	7.56	14.29	15.96	18.87
2001	2.67	9.56	17.42	9.07	17.22
2002	2.49	8.29	12.60	14.06	17.22
2003	3.07	8.10	16.30	17.30	13.80
2004	3.13	9.00	13.46	13.51	12.97
2005	3.13	9.00	13.46	13.51	12.97
2006	3.11	9.31	13.61	17.59	28.91
2007	3.11	9.31	13.61	17.59	28.91

Table 4.2.5.1. SANDEEL in IV. Effort of Danish vessels (kilo watt days · 10^3) and number of Danish and Norwegian vessels participating in the sandeel fishery by year. In 2006 only experimental fishing was allowed for 6 Norwegian vessels. In 2007 the fishery was stopped in May due to RTM. Information about effort in the Danish sandeel fishery for 2008 only include up to 1st of September.

	Denmark		Norway
Year	**Kilo watt days (thousands)**	**Number of vessels**	**Number of vessels**
2002	7.867	207	53
2003	7.306	171	35
2004	7.334	200	40
2005	3.390	98	22
2006	3.946	122	6
2007	2.316	112	41
2008	3.728	83	42

Table 4.2.5.2. SANDEEL in IV. Fishing effort in the Northern North Sea (days fishing times scaling factors for each vessel category to represent days fishing for a vessel of 200 GT), based on Danish and Norwegian data.

	Norweigian			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	13.9	28.2	28.78	27.7	0.96
2006	112	5.6	50.0	8.5	27.8	36.68	13.4	0.37
2007	704	49.0	69.6	39.7	49.2	60.47	92.0	1.52
2008	1202	60.2	50.1	21.8	40.0	47.41	82.1	1.73
				Second half-year				
1976	108	2.0	18.5	-	-	18.5	44.9	2.43
1977	445	11.8	26.5	-	-	26.5	110.0	4.15
1978	811	22.5	27.6	-	-	27.8	53.3	1.92
1979	1688	52.2	30.9	-	-	30.9	147.7	4.78
1980	1117	33.1	29.6	-	-	29.5	71.1	2.41
1981	398	7.9	19.6	-	-	19.9	44.9	2.26
1982	-	-	-	1.8	32.3	33.0	12.0	0.36
1983	65	2.4	36.9	12.3	36.6	37.3	23.7	0.64
1984	-	-	-	10.7	29.6	30.2	17.7	0.59
1985	-	-	-	16.4	38.0	38.8	16.8	0.43
1986	555	21.8	39.3	96.1	60.2	57.4	153.8	2.68
1987	1586	68.1	42.9	3.1	24.7	42.1	76.9	1.83
1988	922	26.9	29.2	64.3	29.4	29.3	71.4	2.43
1989	590	11.5	19.5	44.9	25.6	24.4	57.2	2.35
1990	721	22.8	31.6	61.0	31.1	31.3	70.8	2.26
1991	943	30.3	32.1	72.0	38.7	36.8	90.7	2.47
1992	24	1.5	63.8	43.0	34.8	35.8	25.5	0.71
1993	972	30.7	31.6	59.1	28.4	29.5	87.0	2.95
1994	777	35.7	45.9	82.8	43.6	44.3	76.4	1.73
1995	1009	53.3	52.8	59.4	44.8	48.6	72.6	1.49
1996	749	42.9	57.3	93.9	36.5	43.0	140.7	3.27
1997	1542	95.7	62.1	22.9	27.5	55.4	121.5	2.19
1998	2257	114.4	50.7	35.5	24.6	44.5	148.5	3.34
1999	1665	77.8	46.7	37.8	29.3	41.0	125.2	3.05
2000	0	0.0	0.0	7.6	33.3	33.3	10.0	0.30
2001	1508	122.2	81.0	28.0	36.9	72.8	153.8	2.11
2002	0	0.7	0.0	0.5	10.6	4.5	1.3	0.29
2003	295	7.5	25.4	19.5	21.0	22.23	29.8	1.34
2004	419	7.8	18.6	9.6	19.0	18.76	19.6	1.04
2005	0	0	-	0.0	-	-	*	-
2006	0	0	-	2.3	30.2	30.2	3.7	0.1
2007	0	0	-	0.0	-	-	0	-

- No data * Added to first half year

Table 4.2.5.3. SANDEEL in IV. Fishing effort in the southern North Sea (days fishing times scaling factors for each vessel category to represent days fishing for a vessel of 200 GT), based on Danish and Norwegian data.

	First half year			Second half year		
Year	CPUE (t/day)	Total Int'l catch ('000 t)	Total int'l effort ('000 days)	CPUE (t/day)	Total Int'l catch ('000 t)	Total int'l effort ('000 days)
1982	48.2	427	8.85	35.7	53	1.47
1983	42.8	360	8.41	33.9	59	1.75
1984	50.5	461	9.13	32.9	71	2.16
1985	41.9	417	9.95	33.6	111	3.29
1986	53.7	386	7.20	44.1	76	1.71
1987	57.4	298	5.19	37.1	105	2.83
1988	46.7	462	9.89	30.2	33	1.11
1989	43.8	506	11.54	29.5	19	0.63
1990	31.0	342	11.03	35.6	24	0.67
1991	47.0	327	6.95	46.6	132	2.84
1992	54.9	621	11.31	36.2	73	2.02
1993	38.6	268	6.94	32.0	34	1.07
1994	53.4	226	4.24	48.9	48	0.97
1995	56.8	429	7.56	52.0	68	1.30
1996	41.6	294	7.05	50.1	139	2.77
1997	64.2	421	6.55	41.1	138	3.36
1998	46.6	448	9.61	26.2	43	1.64
1999	40.9	432	10.56	31.9	36	1.13
2000	43.1	360	8.36	33.4	53	1.59
2001	38.7	433	11.20	46.4	185	3.98
2002	62.2	609	9.79	22.4	19	0.86
2003	22.6	211	9.33	20.5	31	1.53
2004	25.2	250	9.91	23.5	31	1.32
2005	27.9	145	5.18	*	*	*
2006	39.0	254	6.50	30.3	17	0.56
2007	45.1	114	2.53	-	-	-
2008	51.1	253	4.95			

- No data (due to no fishery) * Added to first half year

Table 4.2.5.4. SANDEEL in IV. Tuning fleets used in the SXSA assessment. Total international standardised effort and catch at age in numbers (millions)

Year	Season	Fleet	Effort	a-0	a-1	a-2	a-3	a-4+
1976	1	1	5.90	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	8.43	2453	9855	25922	1319	26
1989	1	1	12.43	6124	56661	2219	3385	0
1990	1	1	5.95	0	13101	3907	578	175
1991	1	1	7.26	0	41855	2342	908	318
1992	1	1	4.07	137	9871	4056	486	305
1993	1	1	5.04	1112	15768	2635	1023	646
1994	1	1	7.69	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	0.96	5	2550	412	97	49
2006	1	2	0.37	0	1408	122	17	2
2007	1	2	1.52	470	8494	778	134	40
2008	1	2	1.73	276	3597	2417	440	82
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	6.96	0	3581	14659	3707	1012
1994	1	3	4.25	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	6.56	0	52359	3648	2405	683
1998	1	3	9.62	57	9546	39553	3188	2260

Table 4.2.5.4. Continued.

Year	Season	Fleet	Effort	a-0	a-1	a-2	a-3	a-4+
1999	1	4	10.57	0	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	5.18	74	15842	5204	312	439
2006	1	4	6.50	869	33256	2801	1035	240
2007	1	4	2.53	145	9301	4871	365	129
2008	1	4	4.95	352	27073	4375	1302	170
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
2005	2	5	0.00	0	0	0	0	0
2006	2	5	0.12	0	230	37	9	2
2007	2	5	0.00	0	0	0	0	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	1.32	2383	1637	473	405	68
2005	2	6	0.00	0	0	0	0	0
2006	2	6	0.56	0	1827	38	20	0
2007	2	6	0.00	0	0	0	0	0

Table 4.3.2.1. SANDEEL in IV. Options for seasonal survivor analysis (SXSA)

```
Dankert Skagens SXSA program
   last updated 5/9 - 1995
 ============================
 Name of the stock:
 Sandeel in the North Sea

Data were input from the following files:
  1: Catch in numbers:       CANUM4.hyr
  2: Weight in catch:        WECA4.hyr
  3: Weight in stock:        WEST4.hyr
  4: Natural mortalities:    natmor.hyr
  5: Maturity ogive:         matprop.hyr
  6: Tuning data (CPUE):     Tuning4.hyr
  7: *Weighting for rhats:   tweq.new
  8: *Weighting for shats:   twred.xsa
  9: *Catches to be fitted:

The following fleets were used:
Fleet:  1: Northern First Half 76-98
Fleet:  2: Northern First Half 99-08
Fleet:  3: Southern First Half 82-98
Fleet:  4: Southern First Half 99-08
Fleet:  5: Northern Secon Half 76-07
Fleet:  6: Southern Secon Half 82-07

The following values was used:
 1: First VPA year                  1983
 2: Last VPA year                   2008
 3: Youngest age                       0
 4: Oldest true age                    3
 5: Number of seasons                  2
 6: Recruiting season                  2
 7: Last season in last year           1
 8: Spawning season                    1
 9: Number of fleets                   6

The following options were used:
 1: Inv. catchability: (1: Linear; 2: Log; 3: Cos. filter)                  2
 2: Indiv. shats: (1: Direct; 2: Using z)                                   2
 3: Comb. shats: (1: Linear; 2: Log.)                                       2
 4: *Fit catches: (0: No fit; 1: No SOP corr; 2: SOP corr.)                 0
 5: *Est. unknown catches: (0: No; 1: No SOP corr; 2: SOP corr.; 3: Sep. F)  0
 6: *Weighting of r: (0: Manual; (1: not available at present).)            0
 7: *Weighting of shats: (0: Manual; 1: Linear; 2: Log.)                    0
 8: Handling of the plus group: (1: Dynamic; 2: Extra age group)            1

 You need a factor for weighting the inverse catchabilities at the oldest age vs. the second oldest age
 It must be between 0.0 and 1.0.
 Factor 1.0 means that the catchabilities for the oldest are used as they are
 Present value 0.0000000E+00

 You have to specify a minimum value for the survivor number.
 This is used instead of the estimate if the estimate becomes very low
 Present value: 1.000000

 The iteration will carry on until convergence.

Weighting factors for computing catchability for both fleets (Weighting for rhats)

Year 1983-2007              Year 2008
Season  1    2              Season  1   2
Age                          Age
0       1    1               0    0.5   0.1
1       1    1               1    0.5   0.1
2       1    1               2    0.5   0.1
3       1    1               3    0.5   0.1

Weighting factors for computing survivors in all years (Weighting for shats)

Season  1    2
AGE
0       *  0.02
1       1  0.1
2       1  0.1
3       1  0.1
```

Table 4.3.2.2 SANDEEL in IV. SXSA fishing mortality at age.

Partial fishing mortality
Northern North Sea

Year	1983		1984		1985		1986		1987		1988	
Season	1	2	1	2	1	2	1	2	1	2	1	2
AGE												
0	*	0.013	*	0.000	*	0.000	*	0.017	*	0.003	*	0.027
1	0.090	0.010	0.055	0.015	0.045	0.004	0.077	0.053	0.162	0.082	0.192	0.057
2	0.021	0.012	0.080	0.009	0.087	0.027	0.174	0.071	0.136	0.005	0.788	0.037
3	0.034	0.015	0.012	0.012	0.120	0.024	0.046	0.000	0.089	0.000	0.067	0.021
4+	0.051	0.000	0.009	0.000	0.231	0.010	0.000	0.000	0.055	0.000	0.015	0.199
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	*	0.032	*	0.065	*	0.001
1	0.358	0.087	0.169	0.059	0.278	0.017	0.052	0.001	0.198	0.029	0.199	0.015
2	0.170	0.041	0.171	0.042	0.162	0.005	0.146	0.000	0.058	0.004	0.355	0.118
3	0.717	0.000	0.169	0.042	0.194	0.003	0.139	0.000	0.120	0.008	0.394	0.054
4+	0.000	*	0.211	0.069	0.485	0.018	0.202	0.000	0.578	0.232	1.240	*
F (1- 2)	0.264	0.064	0.170	0.051	0.220	0.011	0.099	0.000	0.128	0.017	0.277	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	*	0.140	*	0.103	*	0.000
1	0.167	0.040	0.127	0.044	0.139	0.056	0.078	0.292	0.026	0.023	0.224	0.015
2	0.097	0.017	0.105	0.068	0.151	0.044	0.311	0.039	0.208	0.069	0.556	0.016
3	0.186	0.008	0.073	0.031	0.382	0.004	0.261	0.023	0.204	0.006	0.335	0.015
4+	0.031	0.001	0.086	0.038	0.426	0.002	0.090	0.000	0.317	0.000	0.252	0.022
F (1- 2)	0.132	0.028	0.116	0.056	0.145	0.050	0.195	0.166	0.117	0.046	0.390	0.015

Year	2001		2002		2003		2004		2005		2006	
Season	1	2	1	2	1	2	1	2	1	2	1	2
AGE												
0	*	0.086	*	0.000	*	0.040	*	0.029	*	0.000	*	0.000
1	0.059	0.024	0.144	0.004	0.123	0.017	0.118	0.043	0.077	0.000	0.019	0.009
2	0.160	0.016	0.143	0.001	0.056	0.017	0.136	0.004	0.051	0.000	0.017	0.009
3	0.156	0.089	0.150	0.000	0.101	0.000	0.075	0.007	0.086	0.000	0.007	0.007
4+	*	*	0.257	0.000	*	*	0.235	0.000	0.045	0.000	0.003	0.004
F (1- 2)	0.110	0.020	0.144	0.002	0.090	0.017	0.127	0.023	0.064	0.000	0.018	0.009

Year	2007		2008
Season	1	2	1
AGE			
0	*	0.000	*
1	0.107	0.000	0.049
2	0.049	0.000	0.103
3	0.050	0.000	0.072
4+	0.034	0.000	0.045
F (1- 2)	0.078	0.000	0.076

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	*	0.015	*	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	0.603	0.106	0.110	0.007	1.043	0.369	0.490	0.044	0.285	0.159	0.306	0.025
3	0.359	0.411	1.066	0.169	0.297	0.613	0.370	0.103	0.294	0.089	0.904	0.365
4+	1.654	0.472	0.850	0.243	0.128	0.276	0.012	0.010	0.058	0.026	1.612	0.796
F (1- 2)	0.319	0.057	0.201	0.061	0.586	0.219	0.315	0.042	0.156	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	0.281	0.035	0.260	0.051	0.133	0.218	0.319	0.053	0.045	0.030	0.172	0.074
2	0.346	0.025	0.728	0.059	0.637	0.059	0.361	0.026	0.321	0.037	0.127	0.031
3	0.203	0.021	0.722	0.058	0.281	0.045	0.287	0.083	0.436	0.063	0.176	0.027
4+	1.781	*	0.900	0.097	0.692	0.000	0.410	0.047	0.906	0.917	0.412	*
F (1- 2)	0.313	0.030	0.494	0.055	0.385	0.139	0.340	0.040	0.183	0.033	0.150	0.053

Year	1995		1996		1997		1998		1999		2000	
Season	1	2	1	2	1	2	1	2	1	2	1	2
AGE												
0	*	0.000	*	0.002	*	0.001	*	0.005	*	0.004	*	0.020
1	0.183	0.037	0.112	0.052	0.108	0.076	0.112	0.022	0.394	0.007	0.348	0.112
2	0.191	0.140	0.313	0.156	0.151	0.038	0.370	0.057	0.388	0.007	0.377	0.092
3	0.265	0.100	0.617	0.122	0.175	0.060	0.409	0.060	0.528	0.136	0.431	0.209
4+	0.265	0.057	0.334	0.699	0.242	0.109	0.496	0.029	0.293	0.111	0.605	0.158
F (1- 2)	0.187	0.089	0.212	0.104	0.130	0.057	0.241	0.039	0.391	0.007	0.363	0.102

Year	2001		2002		2003		2004		2005		2006	
Season	1	2	1	2	1	2	1	2	1	2	1	2
AGE												
0	*	0.136	*	0.000	*	0.029	*	0.024	*	0.000	*	0.000
1	0.589	0.025	0.563	0.032	0.266	0.134	0.588	0.106	0.477	0.000	0.455	0.071
2	0.901	0.003	0.469	0.054	0.672	0.046	0.280	0.233	0.648	0.000	0.398	0.010
3	0.382	0.000	0.397	0.000	0.797	0.102	0.857	0.254	0.274	0.000	0.466	0.017
4+	*	*	0.293	0.000	*	*	0.299	0.156	0.399	0.000	0.283	0.001
F (1- 2)	0.745	0.014	0.516	0.043	0.469	0.090	0.434	0.170	0.563	0.000	0.427	0.040

Year	2007		2008
Season	1	2	1
AGE			
0	*	0.000	*
1	0.117	0.000	0.368
2	0.309	0.000	0.186
3	0.136	0.000	0.212
4+	0.108	0.000	0.094
F (1- 2)	0.213	0.000	0.277

Table 4.3.2.3. SANDEEL in IV. SXSA annual fishing mortality at age.

Year	age-0	age-1	age-2	age-3	age-4+	F1-2
1983	0.029	0.147	0.791	0.783	4.172	0.469
1984	0.000	0.456	0.221	1.375	1.215	0.338
1985	0.015	0.232	1.609	0.984	0.634	0.921
1986	0.017	0.291	0.835	0.544	0.021	0.563
1987	0.006	0.278	0.598	0.494	0.145	0.438
1988	0.027	0.292	1.301	1.411	3.689	0.796
1989	0.015	0.777	0.626	1.058	0.000	0.702
1990	0.029	0.534	1.097	1.088	1.531	0.816
1991	0.048	0.589	0.949	0.565	1.518	0.769
1992	0.032	0.437	0.584	0.539	0.733	0.511
1993	0.067	0.299	0.451	0.675	3.325	0.375
1994	0.001	0.458	0.655	0.699	0.000	0.557
1995	0.017	0.428	0.445	0.588	0.375	0.436
1996	0.026	0.316	0.644	0.896	1.100	0.480
1997	0.012	0.346	0.399	0.671	0.854	0.372
1998	0.145	0.388	0.839	0.816	0.686	0.614
1999	0.108	0.477	0.726	0.935	0.784	0.601
2000	0.020	0.705	1.144	1.041	1.160	0.924
2001	0.223	0.745	1.227	0.670	0.000	0.986
2002	0.000	0.805	0.727	0.607	0.619	0.766
2003	0.069	0.514	0.866	1.097	0.000	0.690
2004	0.053	0.869	0.653	1.265	0.730	0.761
2005	0.000	0.610	0.782	0.396	0.494	0.696
2006	0.000	0.568	0.474	0.543	0.319	0.521
2007	0.000	0.244	0.395	0.203	0.156	0.320
2008	0.000	0.423	0.291	0.286	0.139	0.357

Table 4.3.2.4. SANDEEL in IV. SXSA stock numbers at age (millions)

Stock numbers (at start of season)
****

Year	1983		1984		1985		1986		1987		1988	
Season	1	2	1	2	1	2	1	2	1	2	1	2
AGE												
0	*	879860.	*	226440.	*	1202412.	*	623337.	*	199025.	*	717315.
1	104769.	33741.	383811.	96186.	101746.	31075.	532041.	154748.	275246.	82705.	88923.	25311.
2	90399.	30922.	27134.	14992.	69132.	11469.	23628.	7706.	115452.	49859.	59694.	10543.
3	3719.	1655.	22492.	4086.	12082.	5240.	6252.	2714.	5616.	2530.	34612.	7455.
4+	498.	6.	877.	222.	2926.	1352.	3015.	1997.	3622.	2166.	3621.	139.
SSN	94617.		50503.		84141.		32895.		124690.		97927.	
SSB	1240510.		759308.		1175364.		495346.		1646848.		1502492.	
TSN	199386.	946185.	434314.	341926.	185887.	1251547.	564936.	790501.	399936.	336286.	186850.	760762.
TSB	1767499.	1863112.	2332934.	1620384.	1601680.	2082652.	2719277.	2941832.	2940503.	2010696.	1893754.	1628064.

Year	1989		1990		1991		1992		1993		1994	
Season	1	2	1	2	1	2	1	2	1	2	1	2
AGE												
0	*	324827.	*	634015.	*	802182.	*	317555.	*	620109.	*	868252.
1	313465.	53994.	143688.	32674.	276366.	64117.	343196.	83671.	138041.	39047.	259999.	63389.
2	19562.	7591.	39088.	9354.	23939.	6578.	41386.	16217.	64929.	29364.	30122.	12152.
3	8112.	1883.	5818.	1407.	6918.	2813.	5049.	2166.	12929.	4794.	23078.	8422.
4+	4146.	22.	1510.	259.	1221.	186.	2345.	814.	2267.	162.	3687.	121.
SSN	31821.		46416.		32078.		48780.		80125.		56887.	
SSB	498529.		651678.		458940.		677246.		1084743.		796742.	
TSN	345286.	388317.	190103.	677710.	308443.	875876.	391975.	420423.	218165.	693476.	316886.	952336.
TSB	1877774.	1149226.	1263787.	1390031.	1644549.	1722716.	2077485.	1671328.	1705926.	1825131.	2424339.	7125679.

Year	1995		1996		1997		1998		1999		2000	
Season	1	2	1	2	1	2	1	2	1	2	1	2
AGE												
0	*	356818.	*	1919881.	*	325976.	*	387268.	*	493419.	*	490907.
1	389825.	97419.	157617.	44812.	839931.	236576.	144708.	43402.	149637.	34385.	198263.	37455.
2	47445.	23643.	73843.	31977.	33308.	16360.	169638.	54133.	25814.	9125.	27341.	6224.
3	8562.	3573.	16528.	5213.	20886.	7730.	12337.	3990.	40240.	12044.	6920.	1982.
4+	6358.	3139.	5050.	2182.	4471.	1450.	7001.	2507.	4999.	1738.	9821.	2491.
SSN	62364.		95421.		58665.		188976.		71053.		44082.	
SSB	1035600.		1084228.		656868.		1711516.		879199.		493598.	
TSN	452189.	484593.	253037.	2004065.	898595.	588091.	333684.	491300.	220690.	550711.	242345.	539059.
TSB	3815050.	3254121.	2148140.	6725070.	5385677.	2871256.	2436503.	1880619.	1715669.	2168724.	1762482.	1265647.

Year	2001		2002		2003		2004		2005		2006	
Season	1	2	1	2	1	2	1	2	1	2	1	2
AGE												
0	*	856605.	*	76130.	*	278692.	*	150386.	*	305133.	*	304137.
1	216115.	36733.	304574.	47405.	34207.	8158.	116625.	18201.	63991.	12386.	137105.	29414.
2	26985.	5039.	28635.	9930.	37430.	11259.	5739.	2492.	12826.	4000.	10140.	4404.
3	4571.	1730.	4046.	1516.	7697.	1845.	8661.	1976.	1605.	741.	3275.	1335.
4+	2994.	0.	1295.	484.	1637.	0.	1363.	518.	1603.	675.	1160.	579.
SSN	34550.		33976.		46764.		15762.		16034.		14575.	
SSB	336878.		344539.		417169.		185039.		163184.		170135.	
TSN	250665.	900107.	338550.	135464.	80971.	299954.	132387.	173573.	80025.	322935.	151680.	339869.
TSB	1289945.	2741773.	2214626.	737308.	597099.	1137102.	840470.	701473.	534970.	1139150.	1028414.	1319865.

Year	2007		2008
Season	1	2	1
AGE			
0	*	301679.	*
1	136658.	39480.	135553.
2	22222.	10271.	32324.
3	3538.	1963.	8409.
4+	1538.	893.	2338.
SSN	27298.		43071.
SSB	352169.		631104.
TSN	163956.	354286.	178624.
TSB	1334736.	1505912.	1547444.

Table 4.3.2.5. SANDEEL in IV. SXSA catchability.

Fleet 1: Northern North Sea 83-98

	Log inverse q		q	
Season	1	2	1	2
Age				
0	*	*	*	*
1	3.680	*	0.0252	*
2	3.588	*	0.0277	*
3	3.588	*	0.0277	*

Fleet 2: Northern North Sea 99-08

	Log inverse q		q	
Season	1	2	1	2
Age				
0	*	*	*	*
1	3.212	*	0.0403	*
2	2.957	*	0.0520	*
3	2.957	*	0.0520	*

Fleet 3: Southern North Sea 83-98

	Log inverse q		q	
Season	1	2	1	2
Age				
0	*	*	*	*
1	4.219	*	0.0147	*
2	3.179	*	0.0416	*
3	3.179	*	0.0416	*

Fleet 4: Southern North Sea 99-08

	Log inverse q		q	
Season	1	2	1	2
Age				
0	*	*	*	*
1	2.955	*	0.0521	*
2	2.818	*	0.0597	*
3	2.818	*	0.0597	*

Fleet 5: Northern North Sea 83-07

	Log inverse q		q	
Season	1	2	1	2
Age				
0	*	4.567	*	0.0104
1	*	4.065	*	0.0172
2	*	4.545	*	0.0106
3	*	4.545	*	0.0106

Fleet 6: Southern North Sea 83-07

	Log inverse q		q	
Season	1	2	1	2
Age				
0	*	6.255	*	0.0019
1	*	3.490	*	0.0305
2	*	3.558	*	0.0285
3	*	3.558	*	0.0285

Table 4.3.2.6. SANDEEL in IV. Assessment summary for SXSA.

Year	Recruitment Age 0 thousands	TSB tonnes	SSB tonnes	Landings tonnes	Yield/SSB	Mean F Ages 1-2
1983	879860	1767499	1240510	530640	0,428	0,469
1984	226440	2332934	759308	750040	0,988	0,338
1985	1202412	1601680	1175364	707105	0,602	0,921
1986	623337	2719277	495346	685950	1,385	0,563
1987	199025	2940503	1646848	791050	0,480	0,438
1988	717315	1893754	1502492	1007304	0,670	0,796
1989	324827	1877774	498529	826835	1,659	0,702
1990	634015	1263787	651678	584912	0,898	0,816
1991	802182	1644549	458940	898959	1,959	0,769
1992	317555	2077485	677246	820140	1,211	0,511
1993	620109	1705926	1084743	576932	0,532	0,375
1994	868252	2424339	796742	770747	0,967	0,557
1995	356818	3815050	1035600	915043	0,884	0,436
1996	1919881	2148140	1084228	776126	0,716	0,480
1997	325976	5385677	656868	1114044	1,696	0,372
1998	387268	2436503	1711516	1000375	0,584	0,614
1999	493419	1715669	879199	718668	0,817	0,601
2000	490907	1762482	493598	692498	1,403	0,924
2001	856605	1289945	336878	858619	2,549	0,986
2002	76130	2214626	344539	806921	2,342	0,766
2003	278692	597099	417169	309725	0,742	0,690
2004	150386	840470	185039	359361	1,942	0,761
2005	305133	534970	163184	171790	1,053	0,696
2006	304137	1028414	170135	286751	1,685	0,521
2007	301679	1334736	352169	205371	0,583	0,320
2008		1547444	631104	335046	0,531	0,357
2009			545000*			
Average	546494		740517	673114	1,127	0,607
Units	(Millions)		(Tonnes)	(Tonnes)		

*Forecast

Table 4.6.1. SANDEEL in IV. Data used for short term forecast.

```
#input in assessment year

Year        Season      Age                                 N           F                                   WEST
                                    WECA                                            M           PROPMAT
2008        1                                   0                            0      0                                   0
                                                            0                                                           0
                        0
2008        1                                   1                       135553      0.417                   0.00676
                        0.00676                             1                       0
2008        1                                   2                        32324      0.289                   0.01376
                        0.01376                             0.4         1
2008        1                                   3                         8409      0.284                   0.01623
                        0.01623                             0.4         1
2008        1                                   4                         2338      0.139                   0.02132
                        0.02132                             0.4         1
2008        2                                   0                       304137      0
            0.002917692 0.002917692 0.8         0
2008        2                                   1                            0      0
            0.008520769 0.008520769 0.2         0
2008        2                                   2                            0      0
            0.013750769 0.013750769 0.2         1
2008        2                                   3                            0      0
            0.015646154 0.015646154 0.2         1
2008        2                                   4                            0      0
            0.019737692 0.019737692 0.2         1

# Input for forecast Year and forward
Year        Season      Age                                 N           F                                   WEST
                                    WECA                                            M           PROPMAT
2009        1                                   0                                               0           0
                        0                                                           0
                        0                       0
2009        1                                   1                                               0           0.417
            0.005997143 0.005997143 1                       0
2009        1                                   2                                               0           0.289
            0.010197857 0.010197857 0.4         1
2009        1                                   3                                               0           0.284
            0.013839286 0.013839286 0.4         1
2009        1                                   4                                               0           0.139
            0.018807857 0.018807857 0.4         1
2009        2                                   0                       304137      0
            0.002917692 0.002917692 0.8         0
2009        2                                   1                                               0           0
                        0.008520769 0.008520769 0.2         0
2009        2                                   2                                               0           0
                        0.013750769 0.013750769 0.2         1
2009        2                                   3                                               0           0
                        0.015646154 0.015646154 0.2         1
2009        2                                   4                                               0           0
                        0.019737692 0.019737692 0.2         1
```

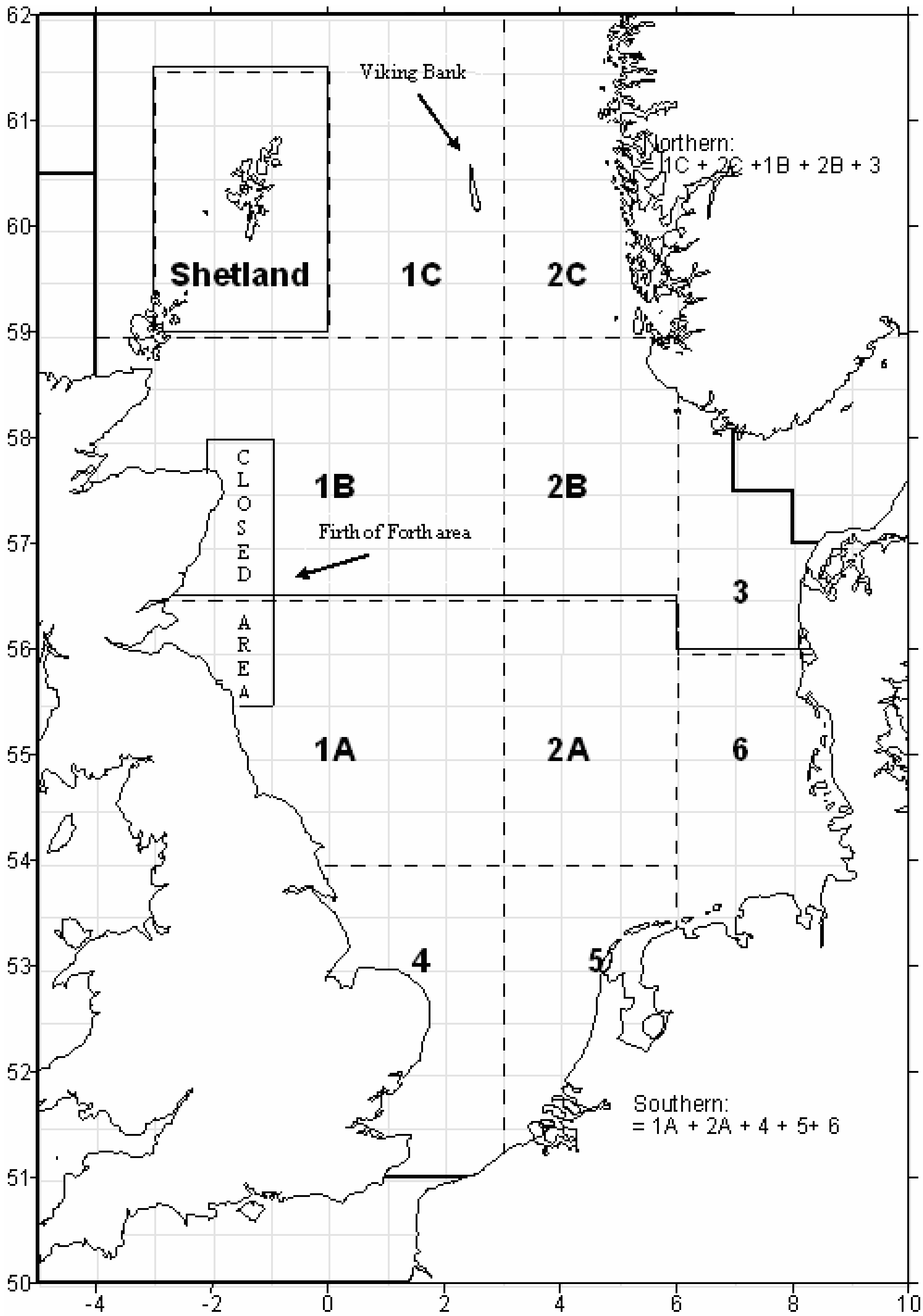


Figure 4.1.2.1. SANDEEL in IV. Danish sandeel sampling areas.

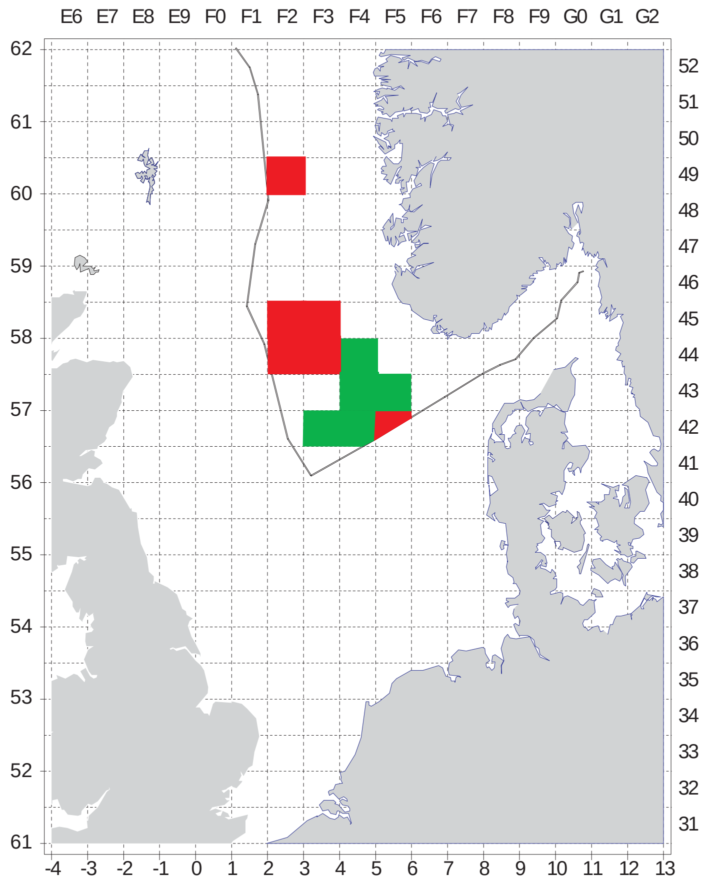


Figure 4.1.4.1. SANDEEL in IV. Closed (red) and open (green) areas in the Norwegian EEZ during the post-monitoring fishery between mid-May and mid-June 2008. White areas do not have significant sandeel fishing grounds..

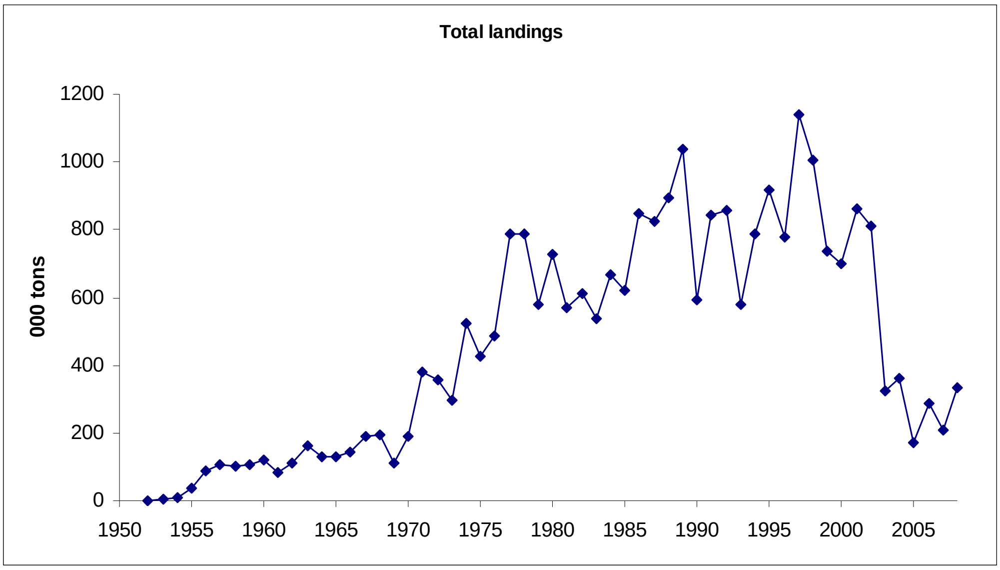
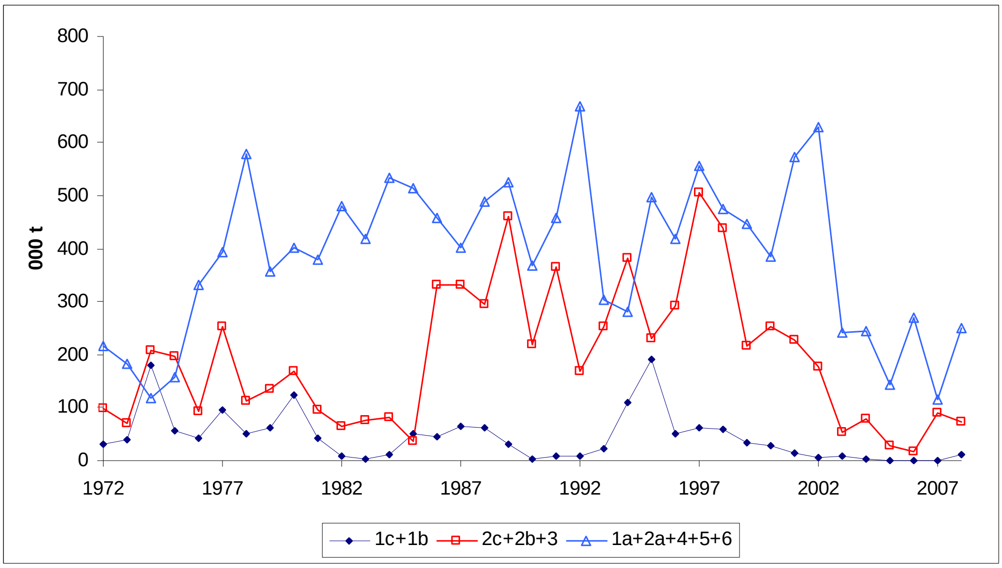


Figure 4.2.1.1. SANDEEL in IV. Total international landings..



2008 only include 1 half years data

Figure 4.2.1.2. SANDEEL in IV. Total international landings by three areas (see Figure 4.1.2.1): 1B+1C (north-western North Sea), 2B+2C+3 (north-eastern North Sea) and 1A+2A+4+5+6 (Southern North Sea).

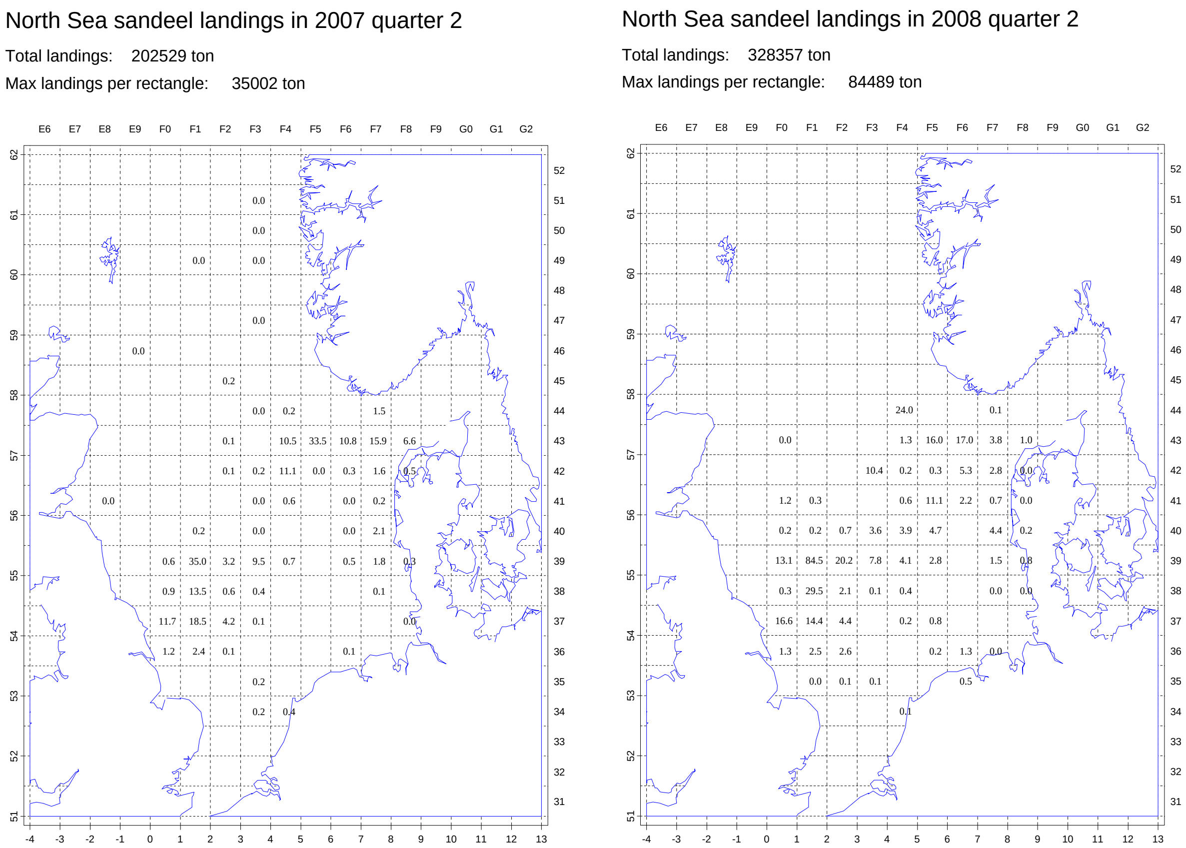


Figure 4.2.1.3. SANDEEL in IV. Quarterly catches of sandeels by Denmark, Norway and Sweden in 2007 and 2008 by ICES rectangle ('000 tonnes).

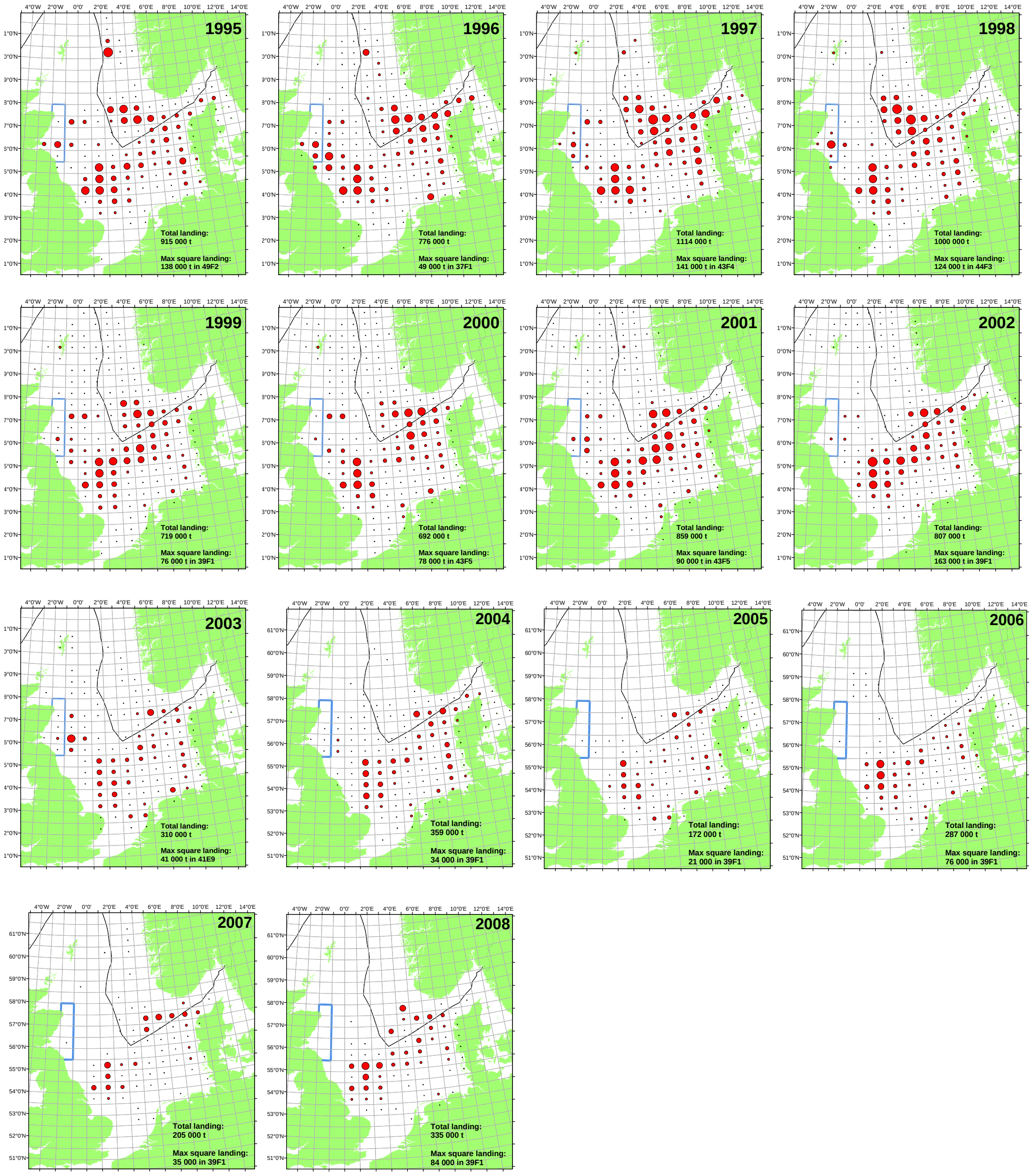


Figure 4.2.1.4. SANDEEL in IV. Landings of Sandeel by year and ICES rectangles for the period 1995-2008. Landings include Danish and Norwegian landing for the whole period. Scottish landings are included from 1997 and onwards; Swedish landings are included from 1998. Landing from other countries are negligible. The area of the circles corresponds to landings by rectangle. All rectangle landings are scaled to the largest rectangle landings shown at the 1995 map. The area that was closed to sandeel fishery in 2000 and the boundary between the EU and the Norwegian EEZ are shown on the map

Figure 4.2.3.1 SANDEEL in IV. Mean weight at age in the catch by area and half year.

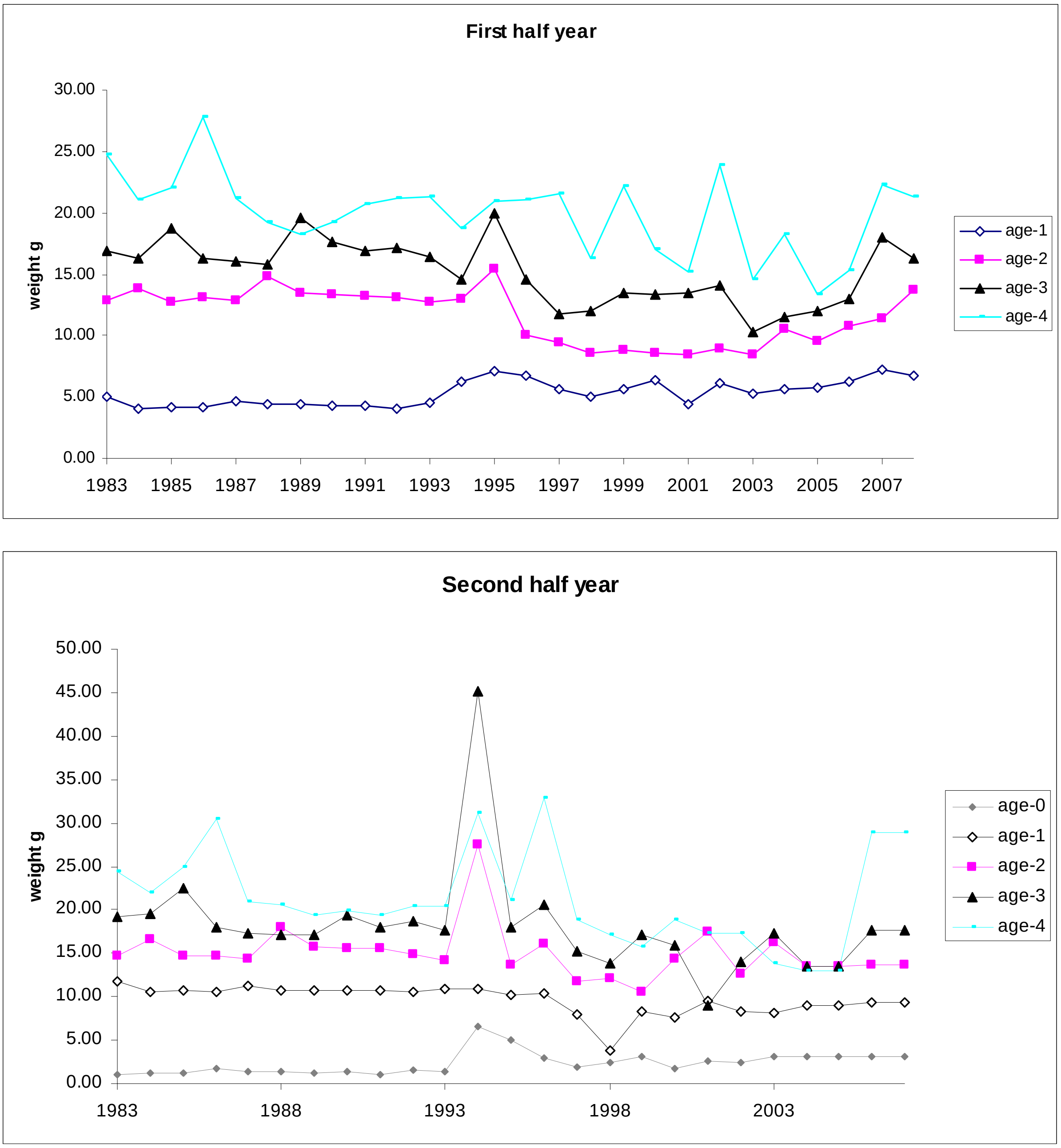


Figure 4.2.3.2 SANDEEL in IV. Mean weight at age in the stock by half year.

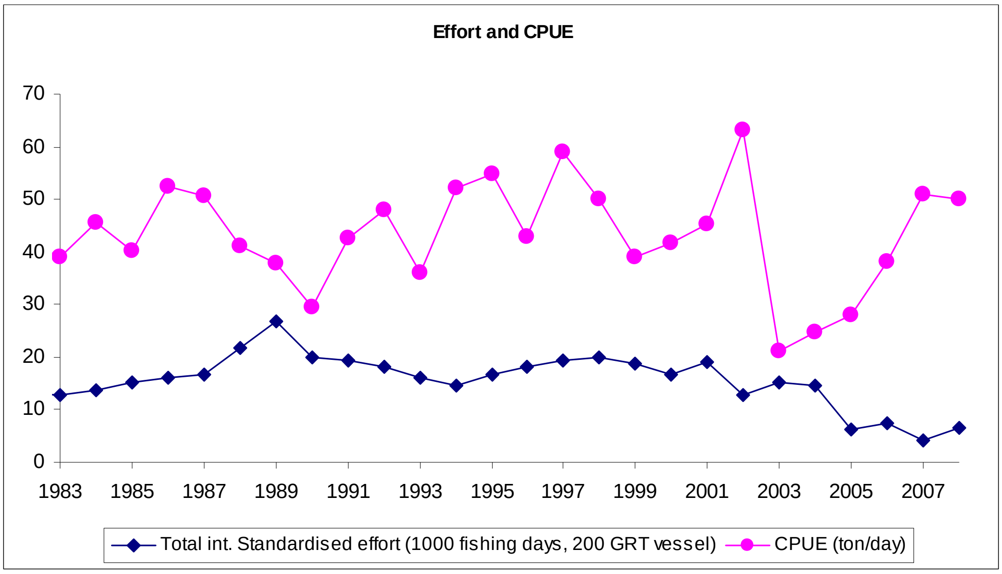
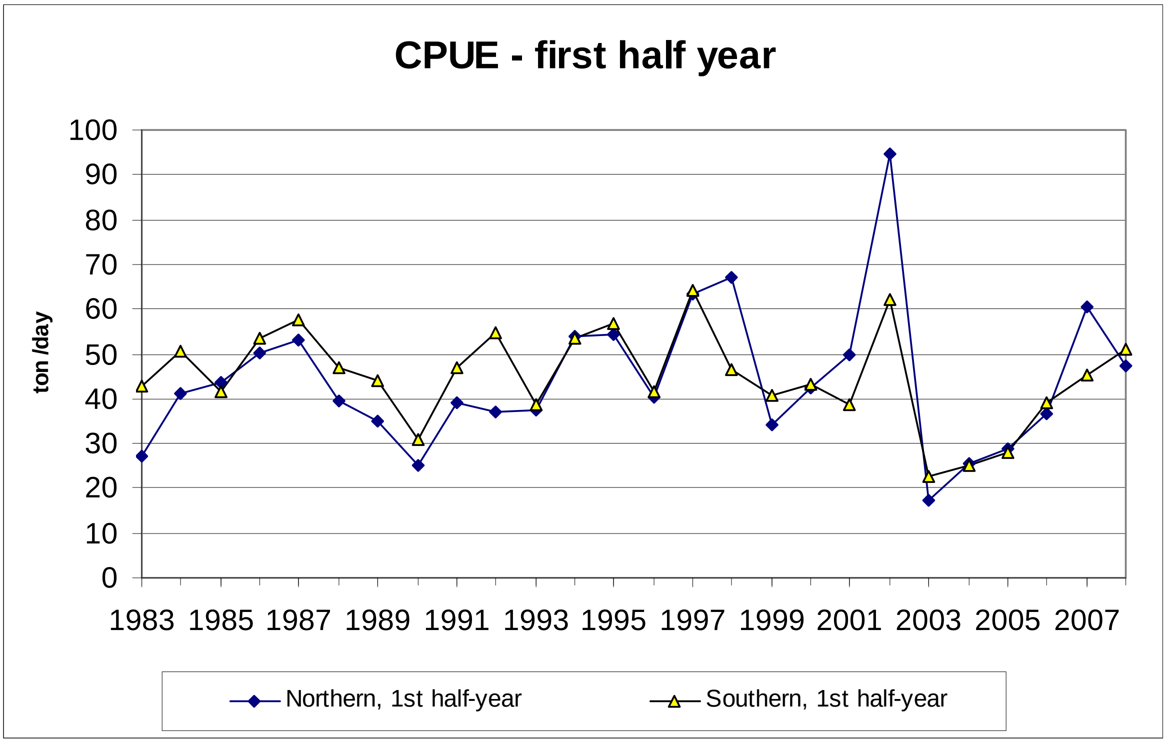


Figure 4.2.5.1. SANDEEL in IV. Total international effort and CPUE.2007 only represent first half year (see the text for further details about landings in second half year of 2007).



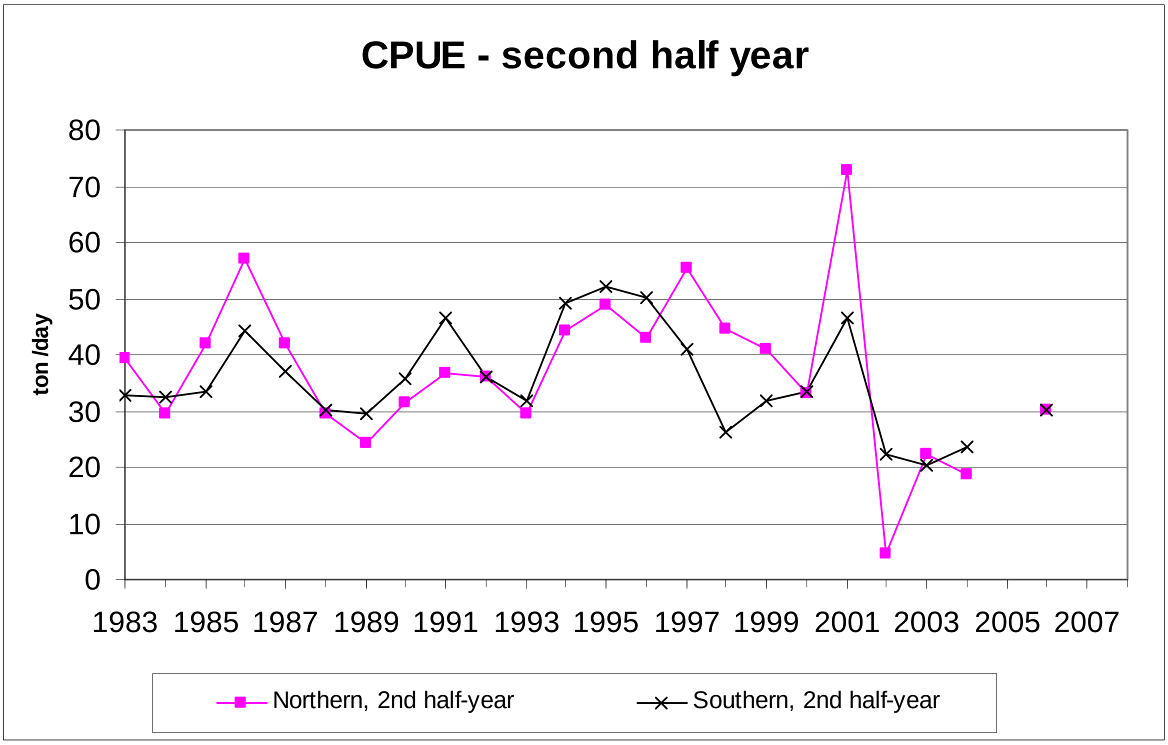


Figure 4.2.5.2. SANDEEL in IV. CPUE (ton/day) by area, half year and year.

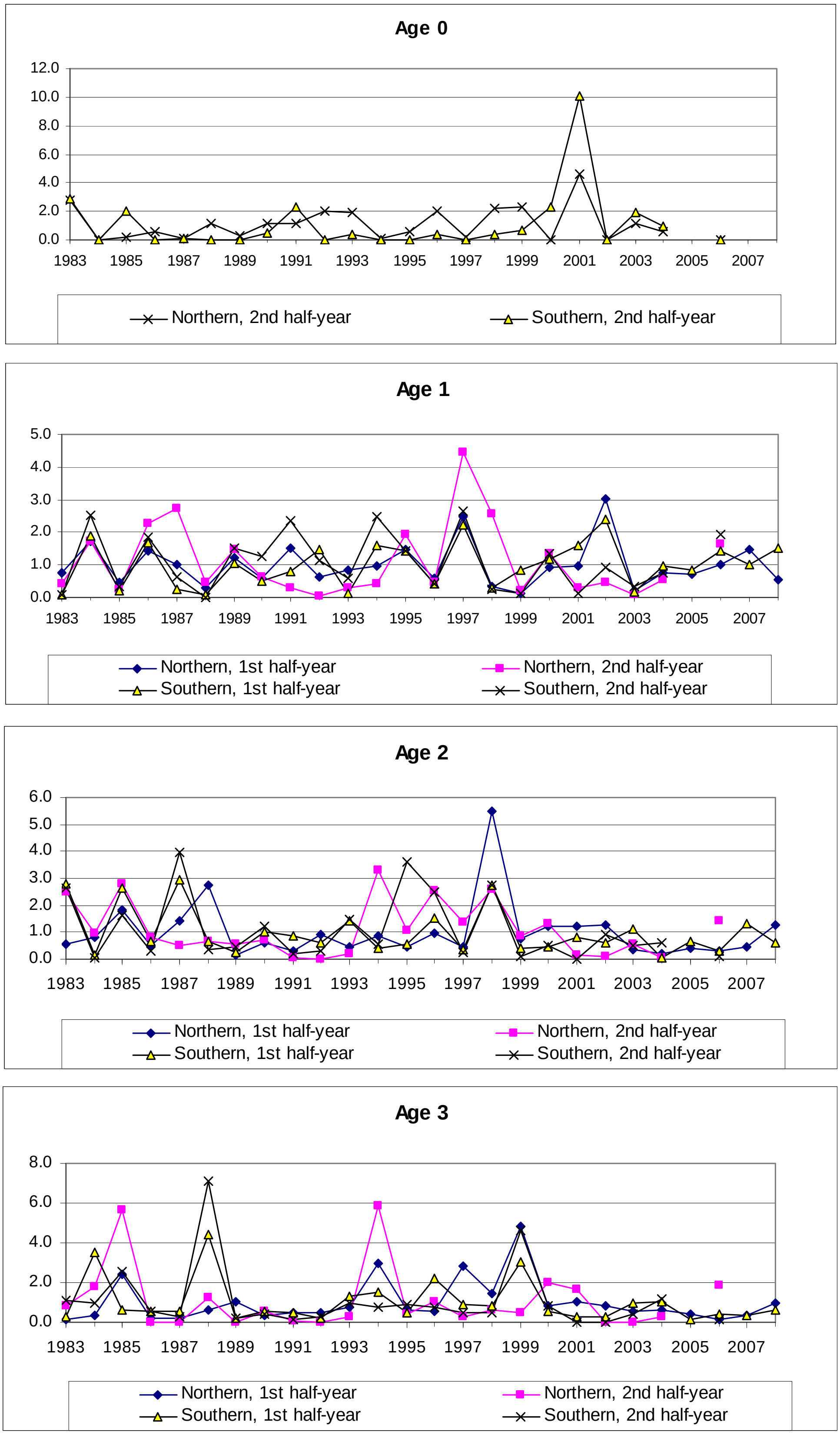


Figure 4.2.5.3 SANDEEL in IV. CPUE (ton/day) by area age group and year.

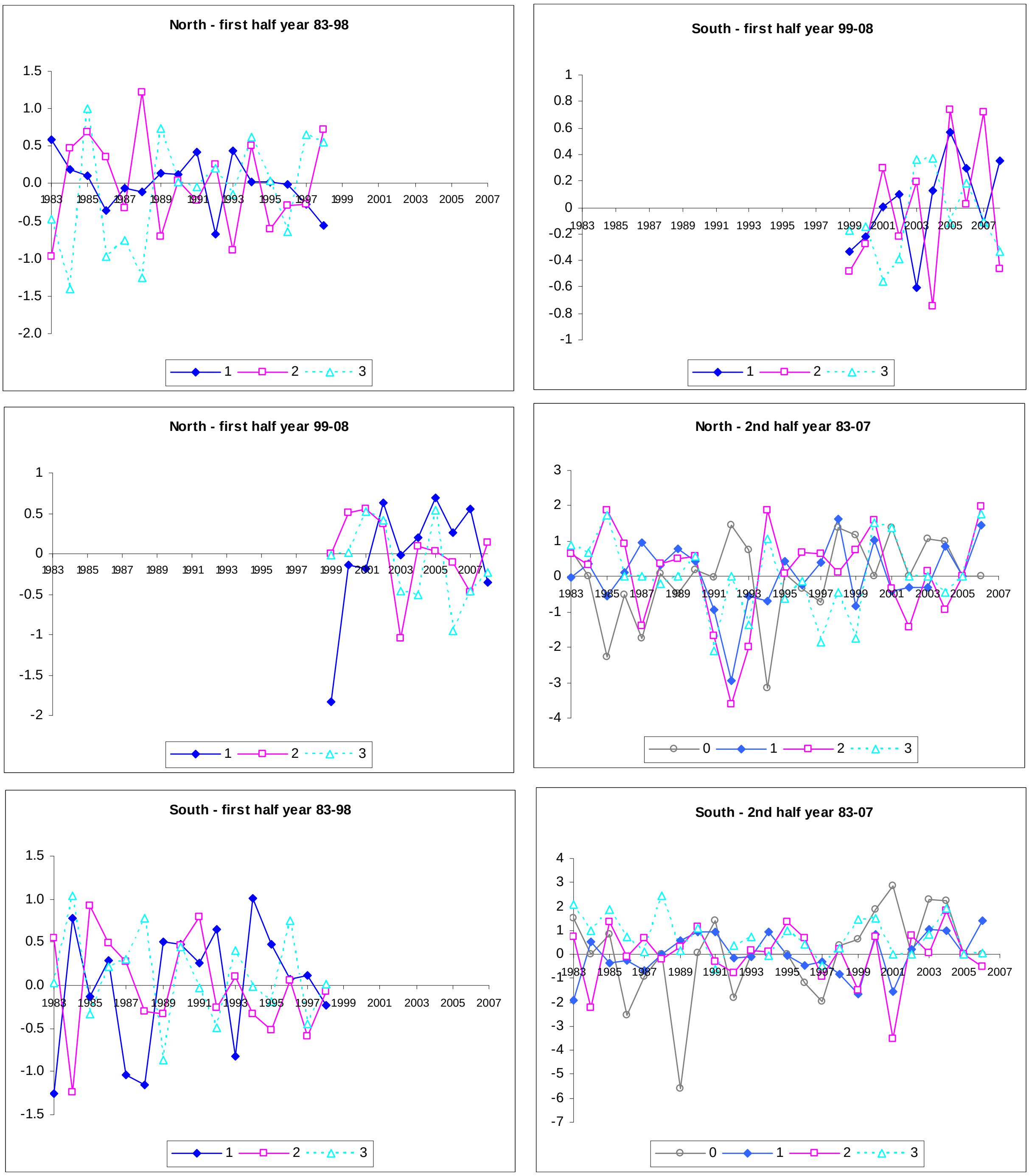


Figure 4.3.2.1 SANDEEL in IV. Log residual stocknr. (nhat/n) by fleet. SXSA.

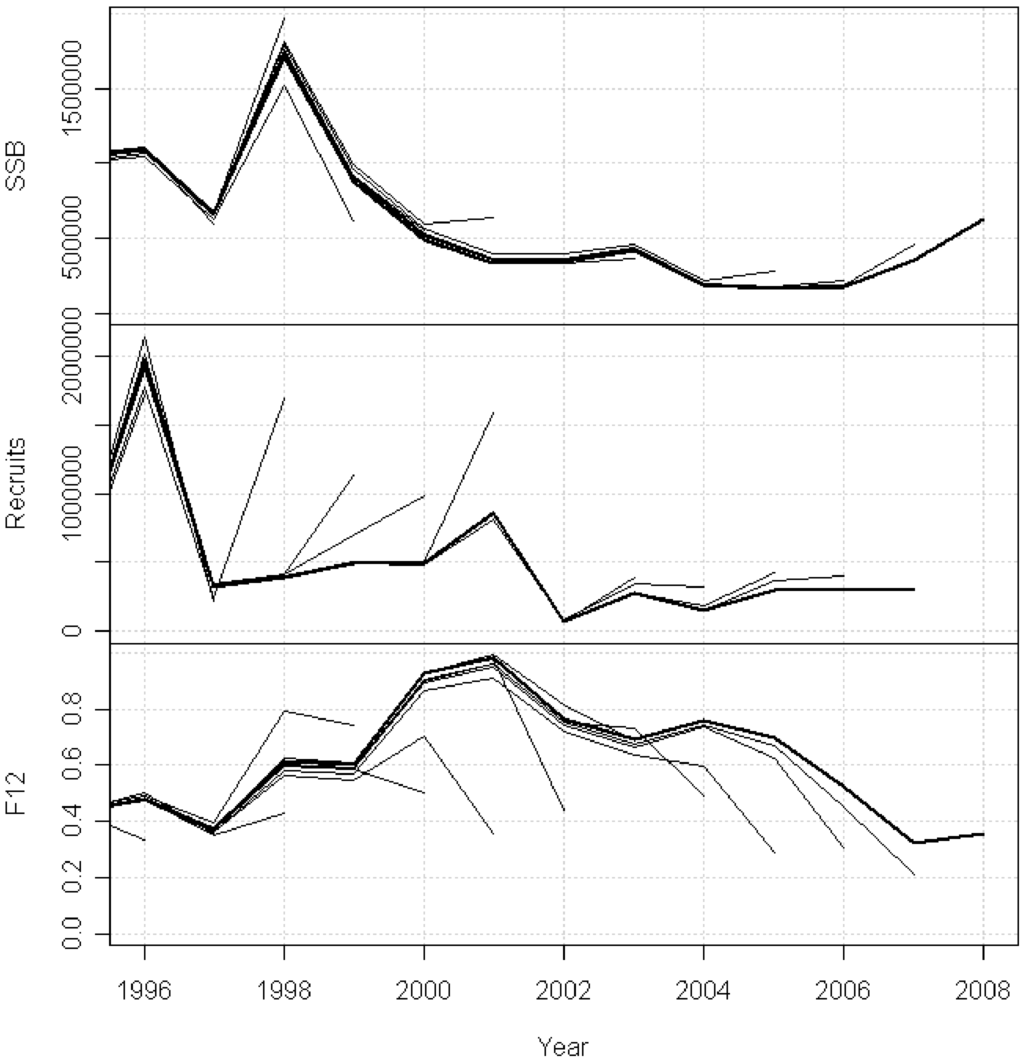


Figure 4.3.2.2. SANDEEL in IV. Retrospective analysis of SSB, recruitment, and F_{bar} 1996-2008 for the SXSA analysis.

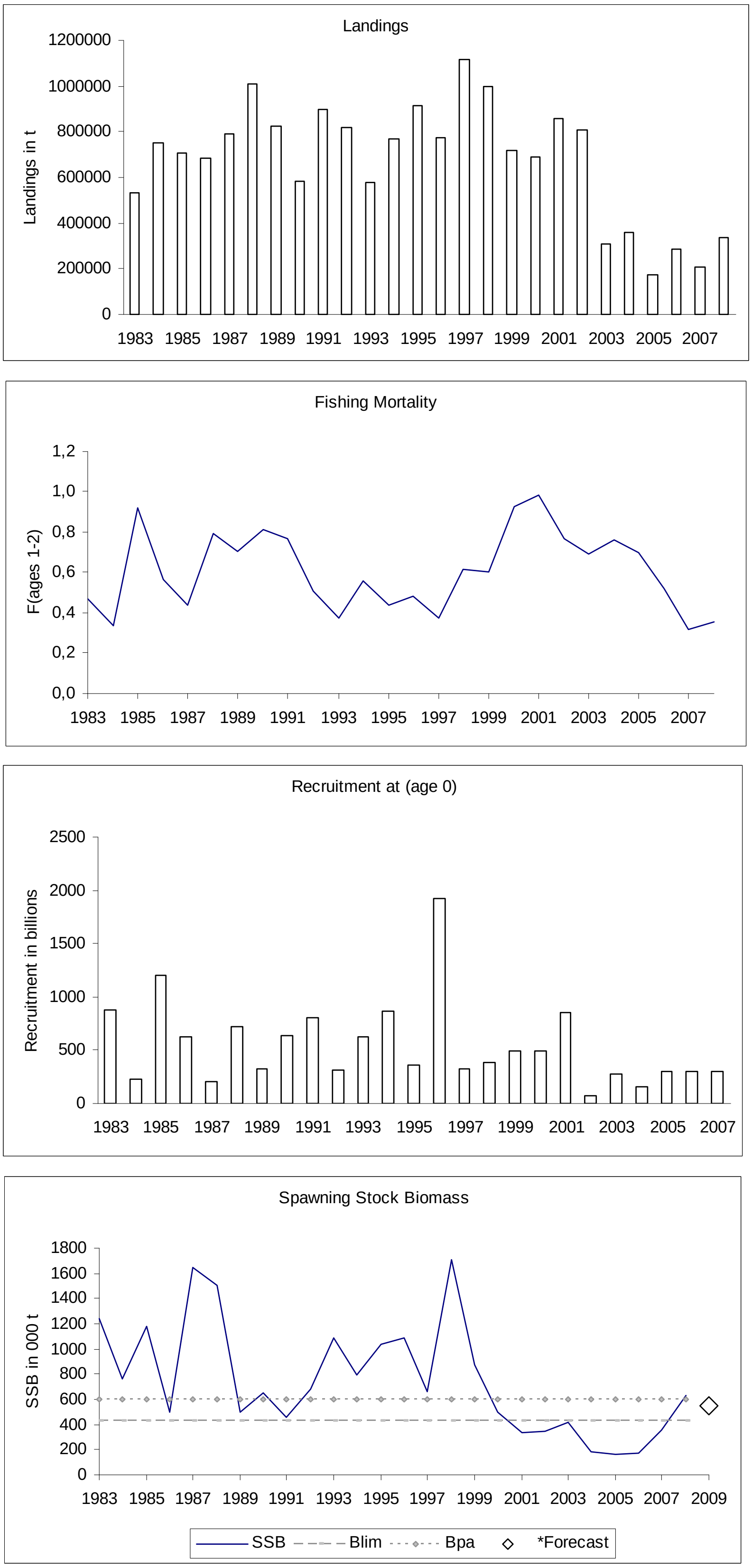


Figure 4.3.2.3. SANDEEL in IV. SXSA Stock Summary.

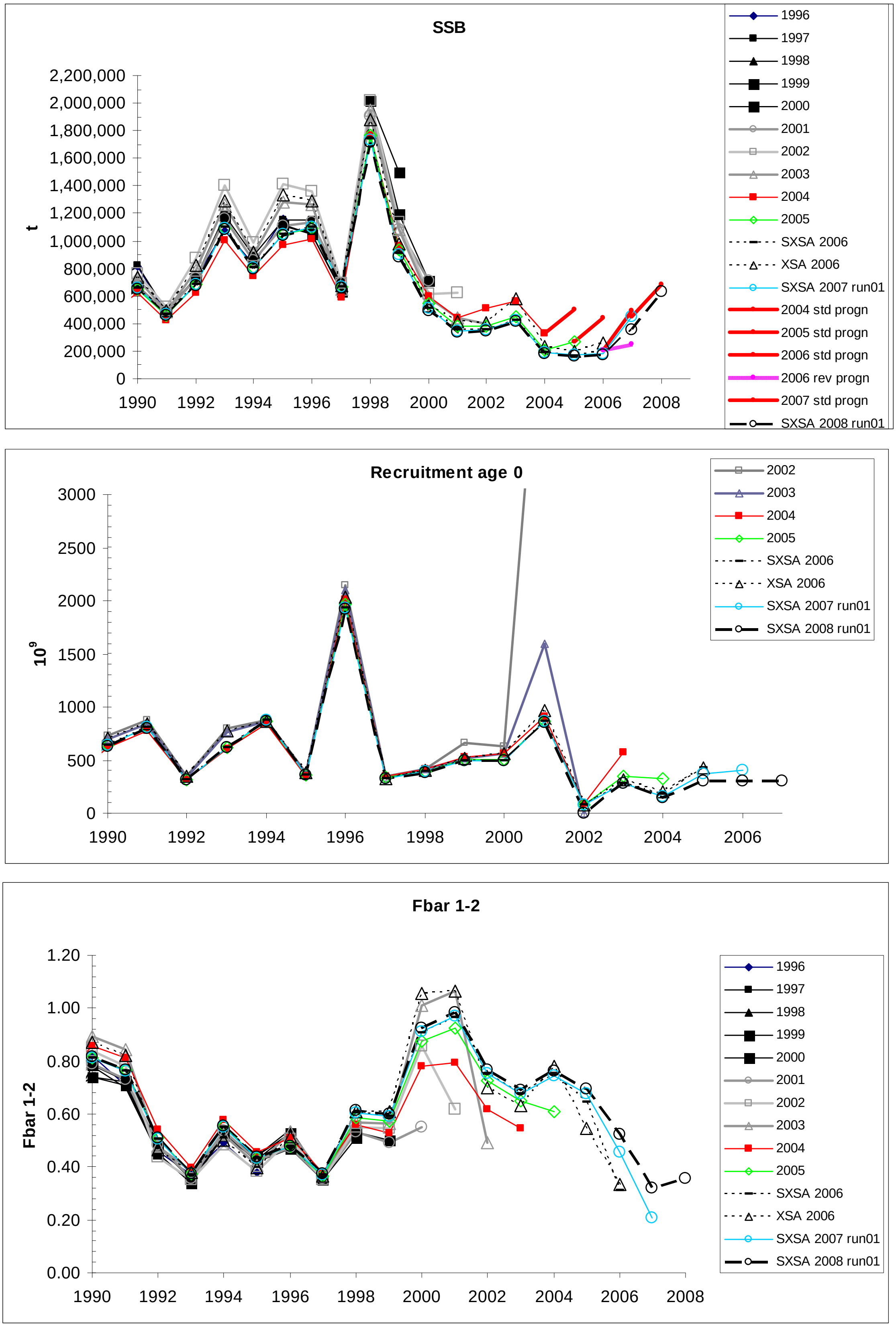


Figure 4.3.2.4. SANDEEL in IV. Comparison of historical performance of assessments in 2008. F_{bar1-2} in 2008 based on data for only first half year of 2008.

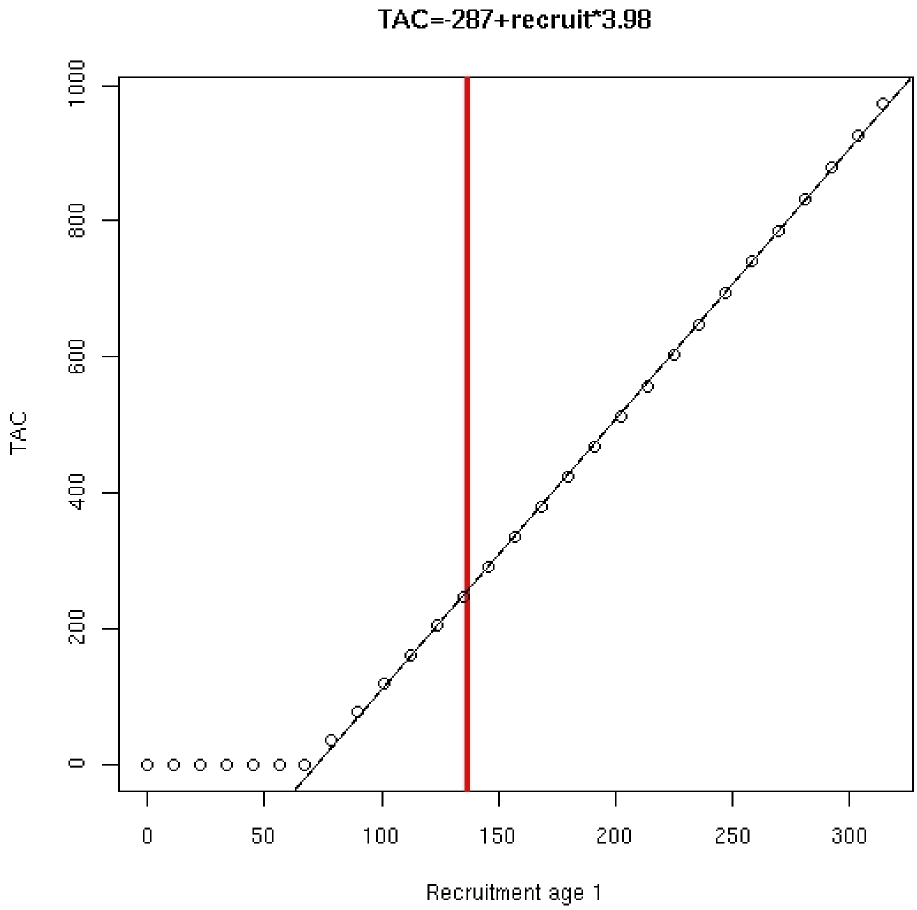


Figure 4.6.1. SANDEEL in IV. Regression of recruitment in 2008 against TAC in 2009, where TAC in 2009 will lead to SSB in 2010 being B_{pa}. The red solid line is the 25th percentile of long term N age-1

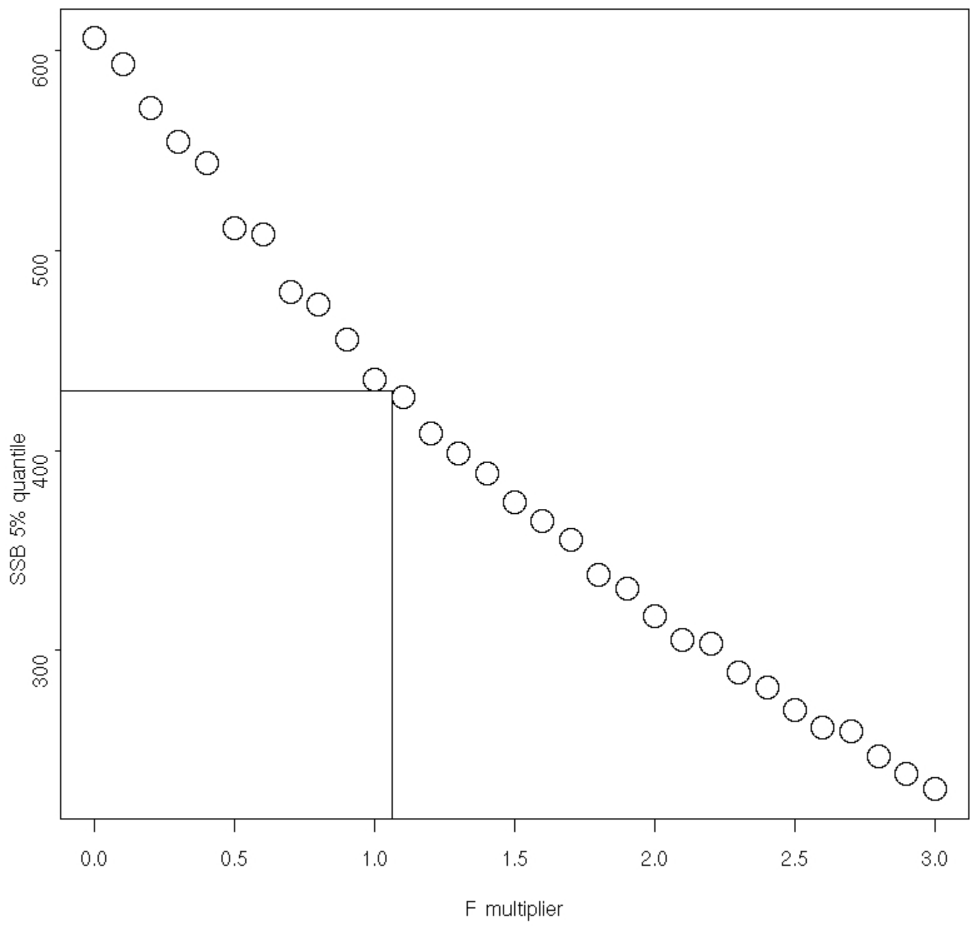


Figure 4.6.2. SANDEEL in IV. Five percent quantile of SSB in 2010 based on the stochastic short-term forecast against the corresponding F multipliers relative to fishing mortalities in 2007. The intersecting lines indicate the highest F multiplier where the resulting SSB in 2010 is above Blim in 95% of the simulated cases.

5 Norway Pout in ICES Subarea IV and Division IIIa

The May 2008 assessment of Norway pout in the North Sea and Skagerrak is an up-date assessment from the May and September 2007 assessments all of which are essentially up-date assessments of the 2004 benchmark assessment using the same tuning fleets and parameter settings. The assessment is a "real time" monitoring (and management) run up to 1st April 2008 and includes information from 1st quarter 2008.

A short term forecast up to 1st January 2009 is presented.

5.1 General

5.1.1 Ecosystem aspects

Stock definition: Norway pout is a small, short-lived gadoid species, which rarely gets older than 5 years. It is distributed from the west of Ireland to Kattegat, and from the North Sea to the Barents Sea. The distribution for this stock is in the northern North Sea (>57°N) and in Skagerrak at depths between 50 and 250 m (Raitt 1968; Sparholt, Larsen and Nielsen 2002b). Spawning in the North Sea takes place mainly in the northern part in the area between Shetland and Norway.

Around 10 % (varying between years and sex) of the Norway pout reach maturity at age 1, however, most individuals reach maturity at age 2.

An analysis of regionalized survey data on Norway pout maturity, presented in Larsen, Lassen, Sparholt and Nielsen (2001), gave no evidence for a stock separation in the whole northern area.

The population dynamics of Norway pout in the North Sea and Skagerrak are very dependent on changes caused by high recruitment variation and variation in predation mortality (or other natural mortality causes) due to the short life span of the species (Sparholt, Larsen and Nielsen 2002a,b). With present fishing mortality levels in recent years the status of the stock is more determined by natural processes and less by the fishery. In general the fishing mortality on 0-group Norway pout is low. There is a need to ensure that the stock remains high enough to provide food for a variety of predator species. This stock is among other important as food source for other species (e.g. saithe, haddock and mackerel). Natural mortality levels by age and season used in the stock assessment correspond to the predation mortality levels estimated for this stock from the most recent multi-species stock assessment performed by ICES (ICES-SGMSNS 2006).

Natural mortality varies between age groups, and natural mortality at age varies over different time periods. Even though different sources of information (surveys, MSVPA) give slightly different perception of natural mortality at age (see below), the natural mortalities obtained from the most recent run with the North Sea MSVPA model (presented and used in the ICES SGMSNS (2006)) indicate high predation mortality on Norway pout. Especially the more recent high abundance of saithe predators and the more constant high stock level of western mackerel as likely predators on smaller Norway pout are likely to significantly effect the Norway pout population dynamics.

5.1.2 Fisheries

The fishery is mainly performed by Danish and Norwegian vessels using small mesh trawls in the north-western North Sea especially at the Fladen Ground and along the edge of the Norwegian Trench in the north-eastern part of the North Sea. Main fishing seasons are 3rd and 4th quarters of the year with also high catches in 1st quarter of the year especially previous to 1999. The average quarterly spatial distribution of the Norway pout catches during a ten year period from 1994-2003 is shown in figures in the **Stock Quality Handbook (Q5)**. The Norway pout fishery is a mixed commercial, small meshed fishery conducted mainly by Denmark and Norway directed towards Norway pout as one of the target species together with Blue Whiting.

The targeted Norway pout fishery was closed for 2005 and in the first half year of 2006. The fishery was opened by 4th of August 2006 for the second half year of 2006 with a quota on 95.000 t based on the 2005 year class being at the long term average level. Of this quota 39 kt was taken by Denmark, and the Norwegian catches were 14 kt. Trends in yield are shown in **Table** 5.2.2 and **Figures** 5.3.2-3.

Based on the relatively weak 2006 Norway pout year class the fishery was closed on 1st of January 2007 resulting in no directed fishing effort for Norway pout for all of 2007. Norway pout were taken in 2007 as a by-catch in the Norwegian mixed blue whiting and Norway pout fishery as well as in a small experimental fishery. Following opening of the fishery on the 1st January 2008 (with an EU quota of 36,500 t and a Norwegian quota of 4,750 t) only very small Danish and Norwegian landings in 1st quarter 2008 have been reported. According to information from the fishery associations this is due mainly to high fuel prices and to a lesser extent to the relative high by-catch percentages of other species during this season.

By-catch of herring, saithe, cod, haddock, whiting, and monkfish at various levels in the small meshed fishery in the North Sea and Skagerrak directed towards Norway pout has been documented (Degel *et al.*, 2006, ICES CM 2007/ACFM:35, (WD 22 and section 16.5.2.2)), and recent by-catch numbers are given in section 2 of this report. Review of scientific documentation reveals that by-catch reduction by gear selective devices can be used in the Norway pout fishery, significantly reducing by-catches of juvenile gadoids, larger gadoids, and other non-target species (Nielsen and Madsen, 2006, ICES CM 2007/ACFM:35, WD 23 and section 16.5.2.2). 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.

5.1.3 ICES advice

ICES advised in 2005 real time management of this stock. In previous years the advice was produced in relation to a precautionary TAC, which was set to 198 000 t in the EC zone and 50 000 t in the Norwegian zone.

Based on estimates of SSB, ICES classified the stock as being at risk of reduced reproductive capacity in 2005 and first part of 2006 (SSB was below $\mathbf{B}_{lim}$ and well below B_{pa} in 2005) as well as in 2007. On that basis ICES advised a closure of the fishery (TAC=0 t except for an yearly 5000 t by-catch TAC to Norway) in 2005 as well as in the first part of 2006, and in all of 2007.

Recruitment reached historic minima in 2003-2004 and was low in 2006 (38 billions), but was about the long term average (at 81 billions, arithmetic mean) in 2005 (76 billions) and 2007 (86 billions). Based on the real time management and confirmation of recruitment estimates through consecutive surveys, the fishery was opened for second half of 2006 with a TAC of 95 000 ton and on 1st January 2008 with a TAC of 41 000 t. The below average recruitment in 2006 resulted in closure of the fishery in 2007.

ICES advices that there is a need to ensure that the stock remains high enough to provide food for a variety of predator species. It is advised that by-catches of other species should also be taken into account in management of the fishery. Also it is advised that 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. No F-based reference points are advised for this stock.

5.1.4 Management up to 2008

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

Prior to 2005, a precautionary TAC was set at 198 000 t in the EC zone and 50 000 t in the Norwegian zone. On basis of the ICES advice for 2005 from ICES, EU and Norway agreed to close the directed Norway pout fishery in 2005 and in the first part of 2006. Accordingly, the TAC was in 2005 and for the first part of 2006 set to 0 in the EC zone and 5 000 t in the Norwegian zone – the latter to allow for by-catches of Norway pout in the directed Norwegian blue whiting fishery. On basis of the real time management advice provided by ICES in spring 2006 EU set a quota on 95.000 t for 2006 (intended for the whole year – EU fishery opened 4th August). At the beginning of September 2006 Norway opened a directed Norway pout fishery without quota limitations in Norwegian EEZ. However, the area (Egersund Bank) was closed for this fishery from 1st of October 2006. Based on the management advice from ICES in autumn 2006 taking the low recruitment in 2006 into consideration the fishery was closed again by 1st of January 2007. This advice was extended to coverthe whole of 2007 by ICES in May 2007, and resulted in a management where the directed Norway pout fishery continued to be closed for all of 2007. Following the September 2007 management advice which took into consideration the average recruitment (2007 year class) the fishery was opened again 1st of January 2008 with a quota of 41,250 tons (following an escapement strategy).

Long term management strategies have been evaluated for this stock (Section 5.11).

In managing this fishery by-catches of other species have been taken into account. Existing technical measures such as the closed Norway pout box, minimum mesh size in the fishery, and by-catch regulations to protect other species have been maintained.

An overview of recent relevant management measures and regulations for the Norway pout fishery and the stock can be found in the Stock **Quality Handbook (Q5).**

5.2 Data available

5.2.1 Landings

Data for annual nominal landings of Norway pout as officially reported to ICES are shown in **Table** 5.2.1. Historical data for annual landings as provided by Working Group members are presented in **Table** 5.2.2, and data for national landings by quarter of year and by geographical area are given in **Table** 5.2.3.

The landings of Norway pout were very low in 2007 due to the ban on the directed fishery for Norway pout in the North Sea and Skagerrak. The only landings of Norway pout in 2007 were mainly by-catch from the Norwegian targeted blue whiting fishery. Small catches (around 680 t) were taken in a directed Danish experimental fishery in 4th quarter 2007 at Fladen Ground in relation to testing by-catch reduction gear devices in the Norway pout fishery. All these catches have been included in the up-date assessment. However, only limited biological sampling has been performed from this small fishery.

5.2.2 Age compositions in Landings

Age compositions were available from Norway and Denmark (except for Norway 2007-08). Catch at age by quarter of year is shown in **Table** 5.2.4. Only very few biological samples were taken from the low Norway pout catches in 2005, first half year 2006 and in 2007.

Landings for the 1st quarter 2008 are very low (below 500 t). At present there is no biological information for this catch consequently catches of 0.1 million individuals per age (for age group 1-3) have been assumed for the first quarter in 2008 in the SXSA. Weight at age in the catch for 1st quarter 2008 has been assumed equal to those used for the 1st quarter of 2007.

5.2.3 Weight at age

Mean weight at age in the catch is estimated as a weighted average of Danish and Norwegian data. Mean weight at age in the catch is shown in **Table** 5.2.5 and the historical levels, trends and seasonal variation in this is shown in **Figure** 5.2.1. In general, the mean weights at age in the catches are variable between seasons of year. Mean weight at age in the stock is given in **Table** 5.2.6. 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. The estimation of mean weights at age in the catches and the used mean weights in the stock in the assessment is described in the Stock **Quality Handbook (Q5).**

Mean weight at age from Danish and Norwegian landings from 2005-2007 are uncertain because of the few observations. Missing values have been filled in using a combination of sources (values from 2004, from adjacent quarters and areas, and from other countries within the same year). The assumptions of no changes in weight at age in catch in these recent years do not affect assessment output significantly because the catches in the same period were low.

5.2.4 Maturity and natural mortality

Maturity and natural mortality used in the assessment is described in the **Stock Quality Handbook (Q5)**. Proportion mature and natural mortality by age and quarter used in the assessment is given in **Table** 5.2.6.

The same proportion mature and natural mortality are used for all years in the assessment. The proportion mature used is 0% for the 0-group, 10% of the 1-group and 100% of the 2+-group independent of sex. Preliminary results from an analysis of regionalized survey data on Norway pout maturity, presented in Larsen, Lassen, Nielsen and Sparholt (2001), indicated variation in maturity at age between years and sexes, especially for the 1-group.

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.

In response to the wish from ACFM RG on a separate description of natural mortality aspects for Norway pout in the North Sea a summary of the September 2006 benchmark assessment on this issue is given here (ICES CM 2006/ACFM:35):

Investigations on population dynamics (natural mortality, distribution, and spawning and maturity as well as growth patterns) of Norway pout in the North Sea are ongoing, and extensive description of that is given in the Stock Quality Handbook (Q5).

Studies presented to the working group in 2001 and published in 2002 indicate that natural mortality may be significantly different between age groups compared to constant as currently assumed in the assessment model Sparholt, Larsen and Nielsen (2002a,b).

Exploratory runs of the SXSA model were presented in the 2001 and 2002 assessment reports as well as in the 2004 and 2006 Norway pout benchmark assessments 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*) as well as natural mortality estimates from the North Sea MSVPA model in the 2006 assessment.

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 appeared that the implications of these revised input data are very significant. The results of the exploratory runs have been consistent throughout all years of exploratory runs. The working group recommended in 2005 that there was made a limited benchmark assessment for Norway pout in the 2006 assessment with specific reference to evaluation of effects of using revised natural mortalities, and that the WG on this basis decides on which natural mortalities to use in the assessment.

The benchmarking evaluated three independent sources and data time series for natural mortality and made exploratory SMS assessment model runs for those:

1) Constant natural mortalities by age, quarter and year as used in previous years standard assessment
2) Revised natural mortalities obtained from and based on the results from Sparholt et al (2002a,b)
3) Revised natural mortalities obtained from most recent run with the North Sea MSVPA model (presented and used in the ICES-SGMSNS 2006).

The survey based mortality estimates all indicate age specific differences in Z and M. These mortality estimates show high within-survey variability and, periodically, contradictory patterns between the surveys. Sparholt, Larsen and Nielsen (2002a,b) discussed their results in context of changed catchability in the surveys, migration out of the area, or age specific distribution patterns of Norway pout and concluded that the mortality patterns were not caused by this.

In contrast, the MSVPA estimates indicate rather constant M between age groups and years, and do not provide the most recent estimates of M.

In conclusion, the exploratory runs gave very much similar results and showed no differences in the perception of the stock status and dynamics. However, with respect to the exploratory runs using different natural mortalities no conclusions could be reached as the mortality between age groups was contradictive and inconclusive between periods (variable) from the different sources showing different trends with no obvious biological explanation. On that basis it was in the 2006 benchmark assessment decided that the final assessment continues using the baseline assessment constant values for natural mortality at age and quarter by year as in previous years assessment. This has been adopted in this year's up-date assessment.

Evaluation of total mortality Z in recent years, where fishing mortality has been very low and where total mortality accordingly approximately equals natural mortality, has been performed and is shown in the September 2007 report (ICES CM 2007/ACFM:18 and 30, **Table** 5.2.12). The evaluation has been based on catch curve analysis on the most recent survey estimates for Norway pout. The results indicate somewhat different levels of Z between different survey time series mirroring the results from the 2006 benchmark assessment. The overall Z estimates for the period 2003-2007 indicates present levels of Z at age between 1.2 - 1.9. Also the results confirm the results from the 2006 benchmark assessment on different natural mortality at age. The assessment uses constant values of M at age of 0.4 per quarter (totally 1.6 per year).

5.2.5 Catch, Effort and Research Vessel Data

Description of catch, effort and research vessel data used in the assessment is given in the Stock Quality Handbook (Q5). Data used in the present assessment is given in **Table**s 5.2.7-5.2.11 as described below. No commercial fishery tuning fleet is included for 2005-2008 except for second half year 2006. Recent catch information for 2007-08 is included in this assessment. Catches in all of 2005 as well as in 1st quarter 2008 were nearly 0 and only very limited information exist about this catch. Consequently, there has been assumed and used low catches of 0.1 million individuals per age (for age group 1-3) per quarter in the SXSA for 2005 and 1st quarter 2008.

Effort standardization:

The method for effort standardization of the commercial Norway pout fishery tuning fleet is described in the **Stock Quality Handbook (Q5)**, which has also been used with up-dated data in the May 2008 assessment. Information from 2nd half year 2006 has been included. The results of the standardization are also presented in the **Stock Quality Handbook (Q5).**

Up-dated effort data from the commercial fishery is given in **Tables** 5.1.7-5.1.9, and the CPUE trends in the commercial fishery are shown in **Table** 5.2.10 and **Figure** 5.2.2.

Danish effort data

Table 5.2.7 shows CPUE data by vessel size category and year for the Danish commercial fishery in ICES area IVa. The basis for these data is described in the **Stock Quality Handbook (Q5)**. No Danish effort data exist for the commercial fishery tuning fleet in 2005, the first part of 2006, and in 2007 due to closure of the fishery.

Norwegian effort data

Observed average GRT and effort for the Norwegian commercial fleets are given in **Table** 5.2.8. No Norwegian effort data exist for the commercial fishery tuning fleet in 2005, the first part of 2006, and in 2007.

Standardized effort data

The resulting combined and standardized Danish and Norwegian effort for the commercial fishery used in the assessment is presented in **Table** 5.2.9. No standardized effort data for the commercial fishery tuning fleet is included for 2005-2008 except for 2nd half year 2006.

Commercial fishery standardized CPUE data

Combined CPUE indices by age and quarter for the commercial fishery tuning fleet are shown in **Table** 5.2.10. Trends in CPUE (normalized) by quarterly commercial tuning fleet and survey tuning fleet for each age group and all age groups together are shown in **Figure** 5.2.2. No combined CPUE indices by age and quarter for the commercial fishery tuning fleet are used for 2005, first half year 2006 and for 2007.

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 1st and 3rd quarter) and the EGFS (English Ground Fish Survey, 3rd quarter) and SGFS (Scottish Ground Fish Survey, 3rd quarter), **Table** 5.2.11. The new survey data from the 1st quarter 2008 IBTS and the 3rd quarter 2007 IBTS research surveys have been included in this assessment (as well as the 3rd quarter 2007 EGFS and SGFS research survey information which also were included in the September 2007 assessment). The survey data time series including the new information is presented in **Table** 5.2.11, as well as trends in survey indices in **Figure** 5.2.2. Surveys covering the Norway pout stock are described in the **Stock Quality Handbook (Q5)**. Survey data time series used in tuning of the Norway pout stock assessment are described below.

Revision of assessment tuning fleets

The revision of the tuning fleets used in the benchmark 2004 assessment as used also in the 2005-2006-2007 and May 2008 up-date assessments is summarised in **Table** 5.3.1. Details of the revision are described in the **Stock Quality Handbook (Q5).**

Besides the up-dated catch data and research survey indices, all other data and data standardization methods used in this assessment are identical to those used and described in the May and September 2007 assessments (see also **Table** 5.3.1).

5.3 Catch at Age Data Analyses

5.3.1 Review of last year's assessment

May 2007:

General comments: During this year's WG meeting, an update assessment was completed. The assessment was consistent with last year and appears to be stable.

Technical comments: The RG recommends an exploration of an alternative stock assessment model that removes commercial lpue data, because there seem to be problems with lpue when the fishery has been closed. The WG should explore the use of survey data only in the assessment.

The RG recommends a benchmark assessment in 2008.

Conclusions: The stock is above B_{pa} (1st Jan 2007) and it will increase to B_{pa} in 2008 with no fishing in 2007. SSB decreased and has been at low levels in recent years. Fishing mortality decreased and was close to zero in 2005.

The advice should relate to the HCR, which is currently not yet been evaluated by ICES.

ACFM should make options on the basis of the testing of the HCR.

September 2007:

Conclusions: The RG concludes that the assessment is in accordance with the up-date procedure. However, the RG still awaits clarification on the precision of the 2007 year class estimates before advising on the necessity to revise the forecast produced in May.

October up-dates of June advice: The new update process was discussed and the RG agreed to limit revisions except when there are major changes in perception. The RG is of the opinion that up-dates of survey estimates should not automatically mean an update in the assessment. The RG should check for consistency in the update and consider if the new data are robust enough for use in the assessment / forecast. ACFM should decide whether or not an update is acceptable. ACFM / ACOM should lay down a basic procedure for the update work in September: is the update to be based on the June advice or last years October advice? What procedure is reviewed: just putting the correct figures in? or judge the robustness of the figures? The update process seems to be based on the premise that only the forecast needs to be updated in light of the new survey information and that the assessment itself should not be changed. There are cases where the assessment and the forecast are part of the same model and both need updating. If the additional survey information is not robust for the current year and thus rejected, the confidence in the assessment may change and the update process may not be a routine computation. Updated, but not revised stocks should be explained in a general document.

5.3.2 Final Assessment

The SXSA (Seasonal Extended Survivors Analysis) was used to estimate quarterly stock numbers (and fishing mortalities) for Norway pout in the North Sea and Skagerrak in September 2007. A general description of and reference to documentation for the SXSA model is given in the **Stock Quality Handbook (Q5).** Stock indices and assessment settings used in the assessment is presented in **Tables** 5.3.1-2. The SXSA uses the geometric mean for the stock-recruitment relationship (see **Table** 5.3.6).

In contrast to the September 2007 assessment, no back-shifting of the third quarter survey indices was undertaken, and the recruitment season to the fishery in the assessment is accordingly set to quarter 3. All other aspects and settings in the assessment are an up-date of the May 2007 assessment.

Results of the SXSA analysis are presented in **Table** 5.3.1-2 (assessment model parameters, settings, and options), **Table** 5.3.3 (population numbers at age (recruitment), SSB and TSB), **Table** 5.3.4 (fishing mortalities by year), **Table** 5.3.5 (diagnostics), and Table 5.3.6 (stock summary). The summary of the results of the assessment are shown in **Table** 5.3.6 and **Figures** 5.3.1-5.

Fishing mortality has generally been lower than natural mortality and has decreased in the recent decade below the long term average (0.6). Fishing mortality for the 1st and 2nd quarter has decreased to insignificant levels in recent years (F less than 0.05), while fishing mortality for 4th quarter, that historically constitutes the main part of the annual F, has not decreased in the recent 3-4 years up to 2006. Fishing mortality in 2005, first part of 2006, and in 2007 was close to zero due to the closure of the Norway pout fishery in these periods.

Spawning stock biomass (SSB) has since 2001 decreased continuously until 2005 but has increased again in recent years again due to the average 2005 and 2007 year classes. Spawning stock biomass fell to a level well below $\mathbf{B_{lim}}$ in 2005 which is the lowest level ever recorded. By 1st January 2007 and 2008 the stock has been just above $\mathbf{B_{pa}}$.

5.3.3 Comparison with 2007 assessment

The final, accepted May 2008 SXSA assessment run was compared to the September 2007 SXSA assessment. The results of the comparative run between the May 2008 and the September 2007 assessments are shown in **Figure** 5.3.5. The resulting outputs of these assessments showed to be identical giving similar perception of stock status and dynamics. The difference in recruitment is because of use of different recruitment seasons in the two assessments (as described above).

5.4 Historical stock trends

The assessment and historical stock performance is consistent with previous years assessments.

5.5 Recruitment Estimates

The long-term average recruitment (age 0, 3rd quarter) is 80 millions (arithmetic mean) and 67 millions (geometric mean) for the period 1983-2008 (**Table** 5.3.6). Recruitment is highly variable and influences SSB and TSB rapidly due to the short life span of the species. The recruitment in 2005 and 2007 (age 0, 3rd quarter) has been around the long term average of 81 billions, while the 2006 year class was weak (38 billions).

5.6 Short-term prognoses

Deterministic short-term prognoses were performed for the Norway pout stock. The forecast was calculated as a stock projection up to 1st of January 2009 using full assessment information for 2007 and 1st quarter 2008, i.e. is based on the SXSA assessment estimate of stock numbers at age at the start of 2008.

Input to the forecast is given in **Table** 5.6.1. The forecast assumes a 2008 (the forecast year) fishing pattern scaled to long term seasonal exploitation pattern for 1991-2004 (standardized with yearly Fbar to F(1,2)=1) which has been used in the ICES WGNSSK Report 2007 (ICES CM 2007/ACFM:30) and the ICES AGNOP Report as well (ICES CM 2007/ACFM:39). Recruitment in the forecast year is assumed to the 25th percentile = 47733 millions of the SXSA recruitment estimates (GM = 66915 millions) in the 3rd quarter of the year.

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

Ten percent of age 1 is mature and is included in SSB.

Previously three management strategies have been put forward for Norway Pout: An escapement management strategy, a fixed effort or constant fishing mortality management strategy and a fixed TAC strategy (see ICES WGNSSK Report ICES CM 2007/ACFM:30 section 5.3, and ICES AGNOP Report ICES CM 2007/ACFM:39, and the ICES AGSANNOP Report ICES CM 2007/ACFM:40) as well as section 5.11 below. The results of the forecasts are presented in **Table** 5.6.2. If the objective is to maintain the spawning stock biomass above B_{pa} by 1st of January 2009 then a catch around 148 000 t can be taken in 2008 according to the escapement strategy. Under a fixed F-management-strategy with F around 0.35 a catch around 95 000 t would be taken in 2008. Under a fixed TAC strategy a TAC of 50 000 t can be taken in 2008 (corresponding to a F around 0.17).

5.7 Medium-term projections

No medium-term projections are performed for this stock. The stock contains only a few age groups and is highly influenced by recruitment.

5.8 Biological reference points

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

Technical basis:

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

Biomass based reference points have been unchanged since 1997.

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

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

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

5.9 Quality of the assessment

The estimates of the SSB, recruitment and the average fishing mortality of the 1- and 2-group are consistent with the estimates of previous years assessment. This appears from the results of the assessment as well as from **Figures** 5.3.4 and 5.3.5 with among other the comparisons of the 2007 assessment.

The assessment is considered appropriate to indicate trends in the stock and immediate changes in the stock because of the seasonal assessment taking into account the seasonality in fishery, use seasonal based fishery independent information, and using most recent information about recruitment. The assessment provides stock status and year class strengths of all year classes in the stock up to the first quarter of the assessment year. The real time assessment method with up-date every half year also gives a good indication of the stock status the 1st January the following year based on projection of existing recruitment information in 3rd quarter of the assessment year.

5.10 Status of the stock

Stock biomass (SSB) was just above B_{pa} in 1st quarter of 2007 and 1st quarter 2008 (**Tables** 5.3.3 and 5.3.6), having been well below **B_{lim}** in 2005 (55 000 t) which is the lowest level ever recorded. Based on the most recent estimates of SSB (in 2008) the stock has full reproductive capacity (SSB>Bpa). Fishing mortality has generally been lower than the natural mortality for this stock and has decreased in recent years well below the long term average F (0.6). The targeted fishery for Norway pout was closed in 2005, first half year 2006, and in all of 2007 and fishing mortality and effort has accordingly reached historical minima in these periods (**Table** 5.3.6). The fishery was re-opened from 1st January 2008. Recruitment reached historical minima in 2003-2004 and was low in 2006 (38 billions), but was about the long term average (at 81 billions, arithmetic mean) in 2005 (76 billions) and 2007 (86 billions) (**Tables** 5.3.3 and Table 5.3.6).

5.11 Management considerations

There are no management objectives for this stock.

Following the September 2007 management advice, taking into consideration the 2007 recruitment, the fishery was opened again 1st of January 2008 with a quota of 41,250 tons (following the escapement strategy management advice). From the results of the forecast presented here it can be seen that if the objective is to maintain the spawning stock biomass above B_{pa} by 1st of January 2009 then a catch around 148 000 t can be taken in 2008 according to the escapement strategy. Under a fixed F-management-strategy with F around 0.35 a catch around 95 000 t can be taken in 2008. Under the fixed TAC strategy a TAC of 50 000 t taken in 2008 will correspond to a fishing mortality of around 0.17 – see section 5.11.1 below.

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. Natural mortality levels by age and season used in the stock assessment reflects the predation mortality levels estimated for this stock from the most recent multi-species stock assessment performed by ICES (ICES-SGMSNS 2006).

There is consistent bi-annual 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. Real time advice (forecast) and management should also be provided for the stock in autumn 2008.

An overview of recent relevant management measures and regulations for the Norway pout fishery and the stock can be found in the **Stock Quality Handbook (Q5).**

In autumn 2006 management plans and harvest control rules for Norway pout were evaluated by ICES based on an EU request with respect to by-catches in the fishery and evaluation of recent initiatives to introduce more selective fishing methods in the Norway pout fishery (ICES CM 2006/ACFM:35). Recent developments in gear technology using by-catch excluding devices can reduce by-catches of among other juvenile gadoids significantly. The working group concludes that these devices (or modified forms of those) should be brought into use in the fishery. Introduction of those should be followed by adequate landings or at sea catch control measures to assure effective implementation of the existing by-catch measures.

5.11.1 Long term management strategies

5.11.1.1 Background

On the basis of a joint EU and Norwegian Requests in autumn 2006 with respect to Norway pout management strategies and by-catches in the Norway pout fishery as well as on basis of the work by ICES WGNSSK in autumn 2006 and spring 2007 during the ICES AGNOP 2007 (ICES CM 2007/ACFM:39). In May 2007 ACFM discussed management plans and harvest control rules evaluations, considering two different management strategies for Norway pout, i.e. the real time escapement management strategy and the long term fixed fishing mortality or effort management strategy. The fixed TAC long term management strategy was not evaluated in depth by the ICES AGNOP as it was not considered realistic at that time because of substantial loss in yield (ICES CM 2007/ACFM:30).

In addition to the ICES response on the EC and Norway joint request on management measures for Norway pout, Denmark, in autumn 2007, requested ICES to provide a full evaluation of the fixed TAC strategy for Norway pout including an estimation of the long term TAC which would be sustainable with a low probability (5%) of the stock falling below Blim. An ICES ACFM subgroup considered the documentation during the autumn 2007 ACFM meeting and found that some further studies would be required in order to provide a well documented answer. All this was provided through the ICES AGSANNOP Report (ICES CM 2007/ACFM:40).

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

ICES and DTU-Aqua have now provided comprehensive evaluation for 3 types of long term management strategies for the stock which all have been reviewed by ICES:

- Escapement strategy
- Long term fixed fishing mortality or fishing effort strategy, and
- Long term fixed TAC strategy,

The conclusions from the evaluation methods used for the three strategies are the following:

Escapement strategy

ICES evaluated an escapement strategy defined as follows: 1) an initial TAC that would be set for the first half of the TAC year, based on a recruitment index, and 2) a TAC for the second half of the year which would be based on a survey assessment conducted in the first half of the TAC year and the setting TAC for the second half of the year based on an SSB escapement rule. This escapement strategy shall generally assure an SSB above B_{pa}, i.e. with a target of obtaining an SSB that is truly above B_{lim} with a high probability (95%). In practice this Harvest Control Rule (HCR) is an escapement strategy with an additional maximum effort. The simulations established that the equilibrium median yield is around 110 kt, and there is a 50 % risk for a closure of the fishery in the first half-year and a 20–25% risk of a closure in the second half-year. The distribution of F shows that the fishery will mostly alternate between a low and a high effort situation. When the fishery has been closed in the second half-year, there is around 20 % probability for another closure in the following year.

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

Caveats to the evaluation of the escapement strategy:

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

Effort control strategy

The effort control scenario with a fixed F indicates that an F of around 0.35 is expected to give a low (5 %) probability of the stock going below B_{lim}. The scenario appears robust to implementation uncertainties, and a target F below 0.35 and an implementation noise CV around 25 % is expected to give a long-term yield around 90 kt and no closures of the fishery would be needed. This management strategy is not dependent on an yearly assessment because it assumes a direct link between fishing effort and fishing mortality which is also apparent from the historical assessment of this stock.

Caveats to the evaluation of the effort control strategy:

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

Fixed TAC strategy

The scenario with fixed TAC indicates that a long term TAC around 50 kt will be sustainable with a low (5 %) probability of the stock going below B_{lim}. ICES concludes that a fixed TAC rule for Norway pout would be in accordance with the precautionary approach provided the fixed TAC is not greater than 50 kt and F does not exceed the value of 0.5, and provided measures are in place to reduce TAC in the exceptional case of a low recruitment in a number of consecutive years. The evaluations indicate that if a target TAC below 50 kt is implemented no closures of the fishery would be needed.

Caveats to the evaluation of the fixed TAC strategy:

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

Conclusions from management strategy evaluations

No particular management strategy is recommended. All strategies that have a low risk of depleting the stock below B_{lim} are considered to be in accordance with the precautionary approach and being sustainable. The choice between different strategies depends on the requirements that fisheries managers and stakeholders have regarding stability in catches or the overall level of the catches. It should be noted that this is a long term management strategy evaluation and it is accordingly not possible to switch between strategies from year to year. Often switching between different long term strategies will be in conflict with the basic assumptions behind the evaluations of them.

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

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

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

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

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

5.12 Other issues

Recommendations for future assessments:

Coming benchmark assessment should consider recent developments in research survey based natural mortality estimates and new research results on natural mortality for the stock as well as up-dated natural mortality from the MSVPA model. Also variation in maturity at age as well as growth variation in the stock should be considered in relation to the assessment based on new research results. It is suggested that variable M be examined to determine the amount of biomass removed via predation, to serve as a baseline biomass requirement for predators.

Furthermore, consideration of revision of the tuning fleets with special focus on the commercial tuning fleets should be done in coming benchmark assessment of the stock (see also the May 2007 assessment ICES CM 2007/ACFM:18 and 30, as well as the stock quality handbook).

Assessment of stock status based exclusively on survey indices should be considered and robustness of survey indices should be considered.

Recent developments in relation to implementation of seasonal stochastic assessment models not dependent on constant exploitation patterns (F-patterns between years and ages) should be considered for the assessment of the stock.

New research findings on developments in by-catch reducing gear devices should be reported and evaluated under ecosystem aspects and fisheries aspects in relation to future benchmark assessment.

Trends and dynamics in landings of Norway pout in VIa are presented in table 5.12.1.

Table 5.2.1 NORWAY POUT IV & IIIa. Nominal landings (tonnes) from the North Sea and Skagerrak / Kattegat, ICES areas IV and IIIa in the period 1998-2007, as officially reported to ICES and EU.

By-catches of Norway pout in other (small meshed) fishery included.

Norway pout ICES area IIIa

Country	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Denmark	11,080	7,194	14,545	13,619	3,780	4,235	110	-	18	24
Faroe Islands	-	-	-	-	-	50	-	-	-	-
Norway	-	-	-	-	96	30	41	-	2	34
Sweden	-	-	133	780	-	-	-	-	-	-
Germany	-	-	-	-	-	-	54	-	-	-
Total	11,080	7,194	14,678	14,399	3,876	4,315	205	0	20	58

*Preliminary.

Norway pout ICES area IVa

Country	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Denmark	42,154	39,319	133,149	44,818	68,858	12,223	10,762	941***	38,676	2,032 ****
Faroe Islands	4,707	2,534		49	3,367	2,199	-	-	-	-
Netherlands	-	-	-	-	-	-	-	-	-	-
Germany	-	-	-	-	-	-	27	-	15	-
Norway	22,213	44,841	48,061	17,158	23,657	11,357	4,958	311	13,618	3,713
Sweden	-	-	-	-	-	-	-	-	-	-
Total	69,074	86,694	181,210	62,025	95,882	25,779	15,747	1,092	52,309	5,745

*Preliminary.

Norway pout ICES area IVb

Country	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Denmark	3,258	5,299	158	632	556	191	473	-	1248	0
Germany	-	-	2	-	-	-	26	-	19	-
Netherlands	2	-	3	-	-	-	-	-	-	-
Norway	57	-	34	-	-	-	-	-	2	0
Sweden	-	-	-	-	-	-	2	-	-	-
UK (E/W/NI)	-	-	+	-	+	-	-	-	-	-
UK (Scotland)	-	-	-	-	-	-	-	-	-	-
Total	3,317	5,299	197	632	556	191	501	0	1,269	0

*Preliminary.

Norway pout ICES area IVc

Country	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Denmark	-	514	182	304	-	-	-	-	-	-
Netherlands	-	+	-	-	-	-	-	-	-	-
UK (E/W/NI)	-	-	-	+	-	-	-	-	-	-
Total	0	0	0	0	0	0	0	0	0	0

*Preliminary.

Norway pout Sub-area IV and IIIa (Skagerrak) combined

Country	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Denmark	56,492	51,812	147,852	59,069	73,194	16,649	11,345	941***	39,942	2,056
Faroe Islands	4,707	2,534	0	49	3,367	2,249	0	0	0	0
Norway	22,270	44,841	48,095	17,158	23,753	11,387	4,999	311	13,622	3,747
Sweden	0	0	133	780	0	0	2	0	0	0
Netherlands	2	0	3	0	0	0	0	0	0	0
Germany	0	0	2	0	0	0	107	0	34	0
UK	0	0	0	0	0	0	0	0	0	0
Total nominal landings	83,471	99,187	196,085	77,056	100,314	30,285	16,453	1,252	53,598	5,803
By-catch of other species and other	-3,671	-7,187	-11,685	-11,456	-23,614	-5,385	-2,953	-	-6,972	-
WG estimate of total landings (IV+IIIaN)	79800	92000	184400	65600	76700	24900	13500	-	46626	-
Agreed TAC	220000	220000	220000	211200	198000	198000	198000	0****	95000	0****

* provisional
** provisional
*** 781 ton from trial fishery (directed fishery); 160 ton from by-catches in other fisheries
**** A by-catch qouta of 5000 t has been set.
***** 681 t taken in trial fishery; 1300 t in by-catches in other (small meshed) fisheries.
+ Landings less than 1
n/a not available

Table 5.2.2 NORWAY POUT IV & IIIa. Annual landings ('000 t) in the North Sea and Skagerrak (not incl. Kattegat, IIIaS) by country, for 1961-2007 (Data provided by Working Group members). (Norwegian landing data include landings of by-catch of other species). Includes by-catch of Norway pout in other (small meshed) fisheries).

Year	Denmark		Faroes	Norway	Sweden	UK (Scotland)	Others	Total
	North Sea	Skagerrak						
1961	20.5	-	-	8.1	-	-	-	28.6
1962	121.8	-	-	27.9	-	-	-	149.7
1963	67.4	-	-	70.4	-	-	-	137.8
1964	10.4	-	-	51	-	-	-	61.4
1965	8.2	-	-	35	-	-	-	43.2
1966	35.2	-	-	17.8	-	-	+	53.0
1967	169.6	-	-	12.9	-	-	+	182.5
1968	410.8	-	-	40.9	-	-	+	451.7
1969	52.5	-	19.6	41.4	-	-	+	113.5
1970	142.1	-	32	63.5	-	0.2	0.2	238.0
1971	178.5	-	47.2	79.3	-	0.1	0.2	305.3
1972	259.6	-	56.8	120.5	6.8	0.9	0.2	444.8
1973	215.2	-	51.2	63	2.9	13	0.6	345.9
1974	464.5	-	85.0	154.2	2.1	26.7	3.3	735.8
1975	251.2	-	63.6	218.9	2.3	22.7	1	559.7
1976	244.9	-	64.6	108.9	+	17.3	1.7	437.4
1977	232.2	-	48.8	98.3	2.9	4.6	1	387.8
1978	163.4	-	18.5	80.8	0.7	5.5	-	268.9
1979	219.9	9	21.9	75.4	-	3	-	329.2
1980	366.2	11.6	34.1	70.2	-	0.6	-	482.7
1981	167.5	2.8	16.4	51.6	-	+	-	238.3
1982	256.3	35.6	12.3	88	-	-	-	392.2
1983	301.1	28.5	30.7	97.3	-	+	-	457.6
1984	251.9	38.1	19.11	83.8	-	0.1	-	393.01
1985	163.7	8.6	9.9	22.8	-	0.1	-	205.1
1986	146.3	4	2.5	21.5	-	-	-	174.3
1987	108.3	2.1	4.8	34.1	-	-	-	149.3
1988	79	7.9	1.3	21.1	-	-	-	109.3
1989	95.7	4.2	0.8	65.3	+	0.1	0.3	166.4
1990	61.5	23.8	0.9	77.1	+	-	-	163.3
1991	85	32	1.3	68.3	+	-	+	186.6
1992	146.9	41.7	2.6	105.5	+	-	0.1	296.8
1993	97.3	6.7	2.4	76.7	-	-	+	183.1
1994	97.9	6.3	3.6	74.2	-	-	+	182
1995	138.1	46.4	8.9	43.1	0.1	+	0.2	236.8
1996	74.3	33.8	7.6	47.8	0.2	0.1	+	163.8
1997	94.2	29.3	7.0	39.1	+	+	0.1	169.7
1998	39.8	13.2	4.7	22,1	-	-	+	57.7
1999	41	6.8	2.5	44.2	+	-	-	94.5
2000	127	9.3	-	48	0.1	-	+	184.4
2001	40.6	7.5	-	16.8	0.7	+	+	65.6
2002	50.2	2.8	3.4	23.6	-	-	-	80.0
2003	9.9	3.4	2.4	11.4	-	-	-	27.1
2004	8.1	0.3	-	5	-	-	0.1	13.5
2005	0.9*	-	-	1	-	-	-	1.9
2006	35.1	0.1	-	11.4	-	-	-	46.6
2007	2.0**	-	-	3.7	-	-	-	5.7

* 781 t taken in a trial fishery; 160 t in by-catches in other (small meshed) fisheries.

** 681 t taken in trial fishery; 1300 t in by-catches in other (small meshed) fisheries.

Table 5.2.3 NORWAY POUT IV & IIIa. National landings (t) by quarter of year 1993-2007. (Data provided by Working Group members. Norwegian landing data include landings of by-catch of other species). (By-catch of Norway pout in other (small meshed) fisheries included).

Year	Quarter	Denmark									Norway		Total
	Area	IIIaN	IIIaS	Div. IIIa	IVaE	IVaW	IVb	IVc	Div. IV	Div. IV + IIIaN	IVaE	Div. IV	Div. IV + IIIaN
1994	1	568	75	643	18,660	3,588	533	-	22,781	23,350			
	2	4	0	4	511	170	-	-	681	685			
	3	2,137	74	2,211	5,674	12,604	493	-	18,772	20,908			
	4	3,623	116	3,739	5,597	49,935	91	-	55,622	59,246			
	Total	6,332	265	6,598	30,442	66,298	1,117	-	97,857	104,189			
1995	1	576	9	585	19,421	1,336	7	-	20,764	21,339	15521	15521	36,860
	2	10,495	290	10,793	2,841	30	3,670	-	6,540	17,035	10639	10639	27,674
	3	20,563	976	21,540	13,316	17,681	11,445	-	42,442	63,004	5790	5790	68,794
	4	14,748	2,681	17,430	10,812	56,159	1,426	-	68,396	83,145	11131	11131	94,276
	Total	46,382	3,956	50,347	46,390	75,205	16,547	-	138,142	184,524	43,081	43081	227,605
1996	1	1,231	164	1,395	6,133	3,149	658	2	9,943	11,174	10604	10604	21,778
	2	7,323	970	8,293	1,018	452	1,476	-	2,946	10,269	4281	4281	14,550
	3	20,176	836	21,012	7,119	17,553	1,517	-	26,188	46,364	27466	27466	73,830
	4	5,028	500	5,528	9,640	25,498	42	-	35,180	40,208	5466	5466	45,674
	Total	33,758	2,470	36,228	23,910	46,652	3,692	2	74,257	108,015	47,817	47817	155,832
1997	1	2,707	460	3,167	6,203	2,219	7	-	8,429	11,137	4183	4183	15,320
	2	5,656	200	5,857	141	-	45		185	5,842	8466	8466	14,308
	3	16,432	649	17,081	19,054	21,024	740	-	40,818	57,250	21546	21546	78,796
	4	4,464	1,042	5,505	6,555	38,202	7		44,765	49,228	4884	4884	54,112
	Total	29,259	2,351	31,610	31,953	61,445	799	-	94,197	123,456	39,079	39079	162,535
1998	1	1,117	317	1,434	7,111	2,292	-	-	9,403	10,520	8913	8913	19,433
	2	3,881	103	3,984	131	5	124	-	259	4,140	7885	7885	12,025
	3	6,011	406	6,417	7,161	1,763	2,372	-	11,297	17,308	3559	3559	20,867
	4	2,161	677	2,838	1,051	17,752	77	-	18,880	21,041	1778	1778	22,819
	Total	13,171	1,503	14,673	15,454	21,811	2,573	-	39,838	53,009	22,135	22135	75,144
1999	1	4	12	15	2,769	1,246	1	-	4,016	4,020	3021	3021	7,041
	2	1,568	36	1,605	953	361	418	-	1,731	3,300	10321	10321	13,621
	3	3,094	109	3,203	7,500	3,710	2,584	-	13,794	16,887	24449	24449	41,336
	4	2,156	517	2,673	3,577	16,921	928	1	21,426	23,583	6385	6385	29,968
	Total	6,822	674	7,496	14,799	22,237	3,931	1	40,968	47,790	44,176	44176	91,966
2000	1	0	11	12	3,726	1,038	-	-	4,764	4,765	5440	5440	10,205
	2	929	15	944	684	22	227	-	933	1,862	9779	9779	11,641
	3	7,380	139	7,519	1,708	5,613	515	-	7,836	15,216	28428	28428	43,644
	4	947	209	1,157	1,656	111,732	76	-	113,464	114,411	4334	4334	118,745
	Total	9,257	375	9,631	7,774	118,406	818	-	126,998	136,255	47,981	47981	184,236
2001	1			302	7,341	9,734	103	72	17,250	17,250	3838	3838	21,088
	2			2,174	31	30	269	-	330	330	9268	9268	9,598
	3			2,006	15	154	191	-	360	360	2263	2263	2,623
	4			3,059	2,553	19,826	329	-	22,708	22,708	1426	1426	24,134
	Total			7,541	9,940	29,744	892	72	40,648	40,648	16,795	16795	57,443
2002	1	-	1	1	4,869	1,660	114	-	6,643	6,643	1896	1896	8,539
	2	883	161	1,045	56	9	22	-	87	970	5563	5563	6,533
	3	1,567	213	1,778	2,234	14,739	104	-	17,077	18,644	14147	14147	32,791
	4	393	100	492	1,787	24,273	335	-	26,395	26,788	2033	2033	28,821
	Total	2,843	475	3,316	8,946	40,681	575	-	50,202	53,045	23,639	23639	76,684
2003	1	-	1	1	615	581	22	-	1,218	1,218	1977	1977	3,195
	2	246	160	406	76	-	22	-	98	344	2773	2773	3,117
	3	2,984	1,005	3,989	172	1,613	89	-	1,874	4,858	5989	5989	10,847
	4	188	547	735	0	6270	457	-	6,727	6,915	644	644	7,559
	Total	3,418	1,713	5,131	863	8,464	590	-	9,917	13,335	11,383	11,383	24,718
2004	1	316	-	316	87	650	-	-	737	1,053	989	989	2,042
	2	-	-	-	-	-	7	-	7	7	660	660	667
	3	14	-	14	289	1,195	9	-	1,493	1,507	2484	2484	3,991
	4	13	-	13	93	5,683	107	-	5,883	5,896	865	865	6,761
	Total	343	-	343	469	7,528	123	-	8,120	8,463	4,998	4,998	13,461
2005	1	-	-	-	9	-	-	-	9	9	12	12	21
	2	-	-	-	151	-	-	-	151	151	352	352	503
	3	-	-	-	781	-	-	-	781	781	387	387	1,168
	4	-	-	-	-	-	-	-	-	-	211	211	211
	Total	-	-	-	941	-	-	-	941	941	962	962	1,903
2006	1	-	-	-	75	83	-	-	158	158	2,205	2205	2,363
	2	-	-	-	-	-	15	-	15	15	2,846	2846	2,861
	3	114	-	114	-	649	20	-	669	783	5,749	5749	6,532
	4	3	-	3	-	34,262	-	-	34,262	34,265	605	605	34,870
	Total	117	-	117	75	34,994	35	-	35,104	35,221		11,405	46,626
2007	1	-	-	-	561	789	-	-	1,350	1,350	74	74	1,424
	2	-	-	-	4	-	-	-	4	4	1,097	1097	1,101
	3	1	2	3	-	-	-	-	-	1	2,429	2429	2,430
	4	-	-	-	-	682	-	-	682	682	155	155	837
	Total	1	2	3	565	1,471	-	-	2,036	2,037		3,755	5,792

Table 5.2.4 NORWAY POUT in IV and IIIaN (Skagerak). Catch in numbers at age by quarter (millions). SOP is given in tonnes. Data for 1990 were estimated within the SXSA program

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	0	32	368	0	0	340	290	0	0	7	1
1		220	133	122	267	485	351	621	473	59	64	191	54
2		845	246	27	439	148	24	284	347	76	49	121	161
3		35	100	1	1	17	5	24	26	22	25	16	32
4+		0	0	0	0	0	0	0	0	0	0	0	1
SOP		21400	11778	4630	26565	8553	6686	32922	28947	3190	3106	10842	7549
Age	Year	2004				2005				2006			
	Quarter	1	2	3	4	1	2	3	4	1	2	3	4
0		0	0	14	57	*	*	*	*			10	368
1		13	4	51	100	*	*	*	*	30	56	130	1086
2		55	16	51	78	*	*	*	*	52	45	65	50
3		9	6	7	2	*	*	*	*	9	24	7	1
4+		0	0	0	0	*	*	*	*	0	0	0	0
SOP		2040	667	4018	6762	8	8	13	13	2205	2848	6551	34949
Age	Year	2007											
	Quarter	1	2	3	4								
0		0	0	0	0								
1		20	41	32	10								
2		43	26	16	6								
3		0	0	2	1								
4+		0	0	0	0								
SOP		1428	1100	2430	838								

In 2007: Catch numbers from Norwegian fishery calculated from Norwegian total catch weight divided by mean weight at age from Danish Fishery.

used in the 1996 assessment.

Table 5.2.5 NORWAY POUT in IV and IIIaN (Skagerak). Mean weights (grams) at age in catch, by quarter 1983-2007, from Danish and Norwegian catches combined. Data for 1974 to 1982 are assumed to be the same as in 1983. See footnote concerning data from 2005-2007.

Year	1983				1984				1985			
Quarter of year	1	2	3	4	1	2	3	4	1	2	3	4
Age 0			4.00	6.00			6.54	6.54			8.37	6.23
1	7.00	15.00	25.00	23.00	6.55	8.97	17.83	20.22	7.86	12.56	23.10	26.97
2	22.00	34.00	43.00	42.00	24.04	22.66	34.28	35.07	22.7	28.81	36.52	40.90
3	40.00	50.00	60.00	58.00	39.54	37.00	34.10	46.23	45.26	43.38	58.99	
4									41.80			
Year	1986				1987				1988			
Quarter of year	1	2	3	4	1	2	3	4	1	2	3	4
Age 0				7.20			5.80	7.40			9.42	7.91
1	6.69	14.49	28.81	26.90	8.13	12.59	20.16	23.36	9.23	11.61	26.54	30.60
2	29.74	42.92	43.39	44.00	28.26	31.51	34.53	37.32	27.31	33.26	39.82	43.31
3	44.08	55.39	47.60		52.93			46.60	38.38			
4	82.51				63.09				69.48			
Year	1989				1990				1991			
Quarter of year	1	2	3	4	1	2	3	4	1	2	3	4
Age 0			7.48	6.69			6.40	6.67			6.06	6.64
1	7.98	13.49	26.58	26.76	6.51	13.75	20.29	28.70	7.85	12.95	30.95	30.65
2	26.74	28.70	35.44	34.70	25.47	25.30	32.92	38.90	20.54	28.75	44.28	43.10
3	39.95	44.39		46.50	37.72	40.35	39.40	52.94	35.43	49.87	67.25	59.37
4					68.00				44.30			
Year	1992				1993				1994			
Quarter of year	1	2	3	4	1	2	3	4	1	2	3	4
Age 0		8.00	6.70	8.14			4.40	8.14			5.40	8.81
1	8.78	11.71	26.52	27.49	9.32	14.76	25.03	26.24	8.56	15.22	29.26	31.23
2	25.73	31.25	42.42	44.14	24.94	30.58	35.19	36.44	25.91	29.27	38.91	49.59
3	41.80	49.49	50.00	50.30	46.50	48.73	55.40	70.80	42.09	46.88	53.95	
4	43.90											
Year	1995				1996				1997			
Quarter of year	1	2	3	4	1	2	3	4	1	2	3	4
Age 0			5.01	7.19			3.88	5.95			3.61	10.18
1	7.70	10.99	25.37	24.6	8.95	12.06	27.81	28.09	7.01	11.69	20.14	22.11
2	24.69	22.95	33.40	39.57	21.47	25.72	40.90	38.81	23.11	26.40	31.13	32.69
3	50.78	37.69	45.56	57.00	37.58	37.94	50.44	56.00	39.11	34.47	44.03	38.62
4												
Year	1998				1999				2000			
Quarter of year	1	2	3	4	1	2	3	4	1	2	3	4
Age 0			4.82	8.32			2.84	7.56			7.21	13.86
1	8.76	12.55	23.82	24.33	8.98	12.40	22.16	25.60	10.05	15.65	23.76	22.98
2	22.16	25.27	31.73	30.93	25.84	24.15	32.66	37.74	19.21	25.14	38.90	34.48
3	34.84	32.18	44.92	33.24	36.66	35.24	43.98	51.63	32.10	41.30	39.61	50.04
4	42.40	40.00			46.57	46.57						
Year	2001				2002				2003			
Quarter of year	1	2	3	4	1	2	3	4	1	2	3	4
Age 0			6.34	7.90			7.28	7.20			9.12	9.79
1	8.34	16.79	27.00	30.01	8.59	16.40	27.13	27.47	11.58	13.13	28.33	15.98
2	21.50	23.57	39.54	35.51	25.98	30.39	43.37	36.87	22.85	26.19	38.01	31.87
3	39.84	37.63	54.20	55.70	32.30	40.10	54.11	41.28	34.96	39.89	46.24	45.79
4											70.00	70.00
Year	2004				2005				2006			
Quarter of year	1	2	3	4	1	2	3	4	1	2	3	4
Age 0			9.80	7.89			9.8	7.89			8.90	8.90
1	11.54	14.63	31.02	31.75	11.97	14.65	31.02	31.75	14.80	14.70	27.42	26.92
2	27.41	26.22	38.44	39.31	27.90	26.24	38.44	39.31	27.20	26.24	39.16	47.80
3	41.52	34.80	49.50	49.80	41.36	34.80	49.50	49.80	40.60	34.80	49.80	48.50
4												
Year	2007											
Quarter of year	1	2	3	4								
Age 0			8.9	8.9								
1	7.8	7.8	45.00	45.00								
2	29.86	29.86	57.07	57.07								
3	41.52	34.80	56.22	56.22								
4												

Mean weights at age from Danish and Norwegian landings from 2005-2007 uncertain because of few observations and use of values from 2004 and from adjacent quarters in the same year where observations have been missing.

Table 5.2.6 NORWAY POUT IV & IIIaN (Skagerak). Mean weight at age in the stock, proportion mature and natural mortality used in the assessment (as well as revised natural mortality used in previous exploratory assessment runs).

Age	Weight (g)				Proportion mature	M (quarterly)	Revised M vers.1 (quarterly)
	Q1	Q2	Q3	Q4			(Exploratory run)
0	-	-	4	6	0	0.4	0.25
1	7	15	25	23	0.1	0.4	0.25
2	22	34	43	42	1	0.4	0.55
3	40	50	60	58	1	0.4	0.75

Table 5.2.7 NORWAY POUT IV & IIIaN (Skagerak). Danish CPUE data (tonnes / fishing day) and fishing activities by vessel category for 1988-2007. Non-standardized CPUE-data for the Danish part of the commercial tuning fleet. (Logbook information).

Vessel GRT	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
51-100	20.27	14.58	10.03	12.56	31.75	31	24.8	29.53	-	20
101-150	18.83	19.59	17.38	24.14	26.42	23.72	26.76	38.96	20.48	22.68
151-200	22.71	23.17	25.6	28.22	34.2	27.36	31.52	34.73	22.05	27.45
201-250	30.44	26.1	24.87	29.74	36	27.76	40.59	39.34	24.96	30.59
251-300	23.29	26.14	21.3	28.15	31.9	32.05	36.98	38.84	31.43	32.55
301-	38.81	28.58	24.96	36.48	42.6	34.89	44.91	57.9	39.14	43.01

1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-
16.85	12.43	29.13	-	20.45	-	-	-	-	-
19.68	26.69	48.55	25.35	17.09	12.94	8.88	n/a*	-	n/a*
17.48	23.98	45.92	20.02	21.73	10.8	5.50	n/a*	41.11	n/a*
32.32	31	64.33	52.95	46.36	30.86	37.14	n/a*	60.39	n/a*

* Non-available data from 2005 and 2007 is due to closure of the Norway pout fishery the whole year

Data for 2006 does only cover 2nd half year as the directed fishery was closed 1st half year

Table 5.2.8 NORWAY POUT IV & IIIaN (Skagerak). Effort in days fishing and average GRT of Norwegian vessels fishing for Norway pout by quarter, 1983-2007.

	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	197.9
2005*	0	0.0	0	0.0	0	0.0	0	0.0
2006*	0	0.0	0	0.0	169	267.1	132	279.0
2007*	0	0.0	0	0.0	0	0	0	0

* 0-values in all of 2005 and 2007 as well as in first half year 2006 is due to closure of the fishery (no directed fishery for Norway pout)

Table 5.2.9 NORWAY POUT IV and IIIaN (Skagerak). 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	1125	1566	547	31	578	197	1192	1388	355	1634	1989	1540	3981	5522
1988	315	881	1196	144	13	156	75	416	491	617	1891	2507	1150	3201	4351
1989	146	776	922	485	195	680	1093	1746	2839	1701	2280	3981	3424	4999	8423
1990	406	990	1395	2002	87	2089	1162	462	1624	1185	1650	2835	4754	3189	7943
1991	824	1316	2140	833	33	866	1027	484	1511	869	1721	2590	3553	3554	7107
1992	866	2089	2955	354	17	371	1051	1527	2578	1154	1240	2393	3424	4873	8298
1993	483	1232	1715	1056	37	1094	1145	1557	2702	508	1668	2176	3193	4494	7687
1994	463	1263	1726	477	74	551	1363	616	1978	717	1224	1942	3020	3177	6197
1995	577	808	1385	254	99	352	164	851	1015	313	1483	1796	1308	3241	4548
1996	478	577	1055	144	184	328	570	758	1328	137	1237	1374	1329	2756	4085
1997	137	393	530	203	17	220	617	1241	1857	220	1118	1338	1177	2768	3945
1998	509	445	954	285	34	319	264	560	824	208	455	663	1265	1494	2760
1999	266	304	571	740	56	796	1184	386	1570	226	731	957	2417	1477	3894
2000	303	302	605	351	75	425	965	220	1185	207	1898	2104	1825	2494	4319
2001	261	440	701	304	15	319	128	48	176	69	540	608	762	1042	1804
2002	94	387	480	251	21	271	1069	674	1744	207	550	757	1621	1632	3252
2003	171	211	382	336	15	351	599	79	678	78	101	179	1184	406	1590
2004	99	151	246	87	35	122	222	65	287	102	95	197	510	346	856
2005*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2006*	0	0	0	0	0	0	186	32		147	641	787	333	673	1005
2007*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

* 0-values in all of 2005 and 2007 as well as in first half year 2006 is due to closure of the fishery (no directed fishery for Norway pout). The 0-values not used.

Table 5.2.10 NORWAY POUT IV & IIIaN (Skagerak). 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, 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
1982	.	2144.5	169.0	87.9	.	1320.2	86.5	12.4	368.4	1050.5	16.0	0.0
1983	.	1524.2	470.0	5.4	.	969.6	262.0	2.8	604.9	972.9	85.9	1.7
1984	.	1137.9	566.8	59.1	.	990.2	314.9	1.5	462.0	723.1	152.1	0.0
1985	.	877.1	528.2	74.3	.	599.0	339.0	8.3	183.6	809.5	47.2	0.0
1986	.	108.5	292.9	19.8	.	531.1	109.7	2.7	892.9	277.1	5.9	0.0
1987	.	1701.8	254.2	7.7	.	1141.9	118.9	0.0	111.1	1074.9	115.6	2.5
1988	.	205.5	584.0	16.4	.	373.1	510.0	0.0	1175.5	252.0	161.5	0.0
1989	.	1862.8	52.1	7.6	.	386.3	69.7	0.0	1185.8	488.6	22.7	3.2
1990	.	1065.1	451.5	25.7	.	571.3	126.7	7.2	444.6	394.9	39.7	2.3
1991	.	693.9	623.8	43.4	.	668.6	44.0	1.0	1006.5	397.7	71.6	6.6
1992	.	1130.2	361.0	39.7	.	1011.6	144.2	0.4	190.5	1104.5	106.1	1.0
1993	.	1122.3	403.7	7.9	.	384.9	328.9	6.9	427.1	474.8	203.2	0.8
1994	.	1102.1	341.3	32.6	.	520.1	203.4	35.7	1953.6	591.0	69.0	0.0
1995	.	2850.1	171.3	4.0	.	1864.2	38.6	3.0	198.7	1705.6	33.0	1.7
1996	.	365.7	732.0	13.2	.	346.7	715.5	27.5	1066.5	473.4	242.5	0.2
1997	.	990.6	480.2	146.8	.	1256.7	154.4	56.5	75.2	1347.0	152.9	25.9
1998	.	150.0	723.5	49.3	.	319.5	350.1	1.1	233.1	775.7	322.9	20.0
1999	.	351.0	224.6	128.0	.	726.4	213.8	22.0	1086.8	516.2	166.9	24.1
2000	.	1079.3	305.3	4.5	.	895.6	207.0	17.2	122.2	2180.3	114.9	2.8
2001	.	300.7	1198.6	50.1	.	369.2	142.7	6.3	559.2	322.6	720.8	1.5
2002	.	1010.9	308.4	34.8	.	321.3	157.9	13.5	383.2	602.0	454.9	34.9
2003	.	153.6	200.1	57.2	.	174.7	156.1	23.3	3.9	276.4	893.3	178.2
2004	.	26.9	189.7	35.1	.	176.1	177.6	24.0	289.1	505.5	394.6	8.6
2005	.	.	.	.	.	.	.	.	.	.	.	.
2006	.	.	.	.	.	588.6	294.2	32.6	467.1	1379.8	64.0	0.9
2007	.	.	.	.	.	.	.	.	.	.	.	.

Table 5.2.11 NORWAY POUT IV & IIIA (Skagerak). Research vessel indices (CPUE in catch in number per trawl hour) of abundance for Norway pout.

Year	IBTS/IYFS[1] February (1st Q)			EGFS[2,3] August				SGFS[4] August				IBTS 3rd Quarter[1]			
	1-group	2-group	3-group	0-group	1-group	2-group	3-group	0-group	1-group	2-group	3-group	0-group	1-group	2-group	3-group
1970	35	6	-	-	-		-	-	-	-	-	-	-		-
1971	1,556	22	-	-	-	-	-	-	-	-	-	-	-	-	-
1972	3,425	653	-	-	-	-	-	-	-	-	-	-	-	-	-
1973	4,207	438	-	-	-	-	-	-	-	-	-	-	-	-	-
1974	25,626	399	-	-	-	-	-	-	-	-	-	-	-	-	-
1975	4,242	2,412	-	-	-	-	-	-	-	-	-	-	-	-	-
1976	4,599	385	-	-	-	-	-	-	-	-	-	-	-	-	-
1977	4,813	334	-	-	-	-	-	-	-	-	-	-	-	-	-
1978	1,913	1,215	-	-	-	-	-	-	-	-	-	-	-	-	-
1979	2,690	240	-	-	-	-	-	-	-	-	-	-	-	-	-
1980	4,081	611	-	-	-	-	-	-	1,928	346	12	-	-	-	-
1981	1,375	557	-	-	-	-	-	-	185	127	9	-	-	-	-
1982	3,315	403	-	6,594	2,609	39	77	8	991	44	22	-	-	-	-
1983	2,258	592	7	6,067	1,558	114	0.4	13	490	91	1	-	-	-	-
1984	4,994	982	75	457	3,605	359	14	2	615	69	8	-	-	-	-
1985	2,342	1,429	73	362	1,201	307	0	5	636	173	5	-	-	-	-
1986	2,070	383	20	285	717	150	80	38	389	54	9	-	-	-	-
1987	3,171	481	61	8	552	122	0.9	7	338	23	1	-	-	-	-
1988	124	722	15	165	102	134	20	14	38	209	4	-	-	-	-
1989	2,013	255	172	1,531	1,274	621	20	2	382	21	14	-	-	-	-
1990	1,295	748	39	2,692	917	158	23	58	206	51	2	-	-	-	-
1991	2,450	712	130	1,509	683	399	6	10	732	42	6	7,301	1,039	189	2
1992	5,071	885	32	2,885	6,193	1,069	157	12	1,715	221	24	2,559	4,318	633	48
1993	2,682	2,644	258	5,699	3,278	1,715	0	2	580	329	20	4,104	1,831	608	53
1994	1,839	374	66	7,764	1,305	112	7	136	387	106	6	3,196	704	102	14
1995	5,940	785	77	7,546	6,174	387	14	37	2,438	234	21	2,860	4,440	597	69
1996	923	2,631	228	3,456	1,332	319	3	127	412	321	8	4,554	763	362	12
1997	9,752	1,474	670	1,045	6,262	376	30	1	2,154	130	32	490	3,447	236	46
1998	1,010	5,336	265	2,573	404	260	0	2,628	938	127	5	2,931	801	748	12
1999	3,527	597	667	6,358	1,930	88	26	3,603	1,784	179	37	7,844	2,367	201	94
2000	8,095	1,535	65	2,005	6,261	141	2	2,094	6,656	207	23	1,643	7,868	282	11
2001	1,305	2,861	235	3,948	1,013	693	5	759	727	710	26	2,088	1,274	862	27
2002	1,795	809	880	9,678	1,784	61	21	2,559	1,192	151	123	1,974	766	64	48
2003	1,239	575	94	379	681	85	5	1,767	779	126	1	1,812	1,063	146	7

2004	895	376	34	564	542	90	7	731	719	175	19	773	647	153	12
2005	691	131	37	6,912	803	67	11	3,073	343	132	18	2,614	439	125	17
2006	3,340	146	27	1,680	2,147	151	18	1,127	1,285	69	9	1,349	1,869	150	15
2007	1,286	778	23	3,329	1,084	332	1	5,003	1,023	395	8	4,143	1,191	447	11
2008	2,342	508	186	-	-	-	-	-	-	-	-	-	-	-	-

[1]International Bottom Trawl Survey, arithmetic mean catch in no./h in standard area. [2]English groundfish survey, arithmetic mean catch in no./h, 22 selected rectangles within Roundfish areas 1, 2, and 3. [3]1982-91 EGFS numbers adjusted from Granton trawl to GOV trawl by multiplying by 3.5. Minor GOV sweep changes in 2006 EGFS. [4]Scottish groundfish surveys, arithmetic mean catch no./h. Survey design changed in 1998 and 2000. [5]English groundfish survey: Data for 1996, 2001, 2002, and 2003 have been revised compared to the 2003 assessment. In 2007 numbers for 1997 and 1998 as well as 2002 has been adjusted based on new authomatic calculation and processing process has been introduced.

Table 5.3.1 Norway pout IV & IIIaN (Skagerak). Stock indices and tuning fleets used in final 2004 benchmark assessment as well as in the 2005-2008 assessments compared to the 2003 assessment.

		2003 ASSESSMENT	2004, 2005, April 2006 ASSESSMENT	Sept. 2006 ASSESSMENT	2007-08 ASSESSMENTS
Recruiting season		3rd quarter	2nd quarter (SXSA)	3rd quarter (SMS); 2nd quarter (SXSA)	3rd quarter (SXSA)
Last season in last year		3rd quarter	2nd quarter (SXSA)	3rd quarter (SMS); 2nd quarter (SXSA)	1st quarter (SXSA)
Plus-group		4+	4+ (SXSA)	None (SMS); 4+ (SXSA)	4+ (SXSA)
FLT01: comm Q1					
	Year range	1982-2003	1982-2004	1982-2004	1982-2004, 2006
	Quarter	1	1	1	1
	Ages	1-3	1-3	1-3	1-3
FLT01: comm Q2			NOT USED	NOT USED	NOT USED
	Year range	1982-2003			
	Quarter	2			
	Ages	1-3			
FLT01: comm Q3					
	Year range	1982-2003	1982-2004	1982-2004	1982-2004, 2006
	Quarter	3	3	3	3
	Ages	0-3	1-3	1-3	1-3
FLT01: comm Q4					
	Year range	1982-2003	1982-2004	1982-2004	1982-2004, 2006
	Quarter	4	4	4	4
	Ages	0-3	0-3	0-2 (SMS); 0-3 (SXSA)	0-3 (SXSA)
FLT02: ibtsq1					
	Year range	1982-2003	1982-2006	1982-2006	1982-2008
	Quarter	1	1	1	1
	Ages	1-3	1-3	1-3	1-3
FLT03: egfs					
	Year range	1982-2003	1992-2005	1992-2005	1992-2007
	Quarter	3	Q3 -> Q2	Q3 -> Q2	Q3
	Ages	0-3	0-1	0-1	0-1
FLT04: ibtsq3		NOT USED			
	Year range		1991-2005	1991-2005	1991-2007
	Quarter		3	3	Q3
	Ages		2-3	2-3	2-3
FLT05: sgfs					
	Year range	1982-2003	1998-2006	1998-2006	1998-2007
	Quarter	3	Q3 -> Q2	Q3 -> Q2	Q3
	Ages	0-3	0-1	0-1	0-1

Table 5.3.2 Norway pout IV & IIIaN (Skagerak). Baseline run with SXSA

seasonal extended survivor analysis)of Norway pout in the North Sea and Skagerrak: Parameters, settings and the options of the SXSA as well as the input data used in the SXSA.

SURVIVORS ANALYSIS OF: Norway pout stock in May 2008

Run: Baseline May 2008 (Summary from NP0508_1)

The following parameters were used:

```
Year range:                                  1983 - 2008
Seasons per year:                            4
The last season in the last year is season:         1
Youngest age:                         0
Oldest age:                                  3
Plus age:                                    4
Recruitment in season:                              3
Spawning in season:                          1
```

The following fleets were included:

```
Fleet  1:    commercial q134 (Q1: Age 1-3; Q2: None; Q3: Age 1-3; Q4:
0-3)
Fleet  2:           ibtsq1       (Age 1-3)
Fleet  3:           egfsq3       (Age 0-1)
Fleet  4:           sgfsq3       (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):                                 tun2008.xsa
Weighting for rhats:                                rweigh.xsa
```

Table 5.3.3 Norway pout IV & IIIaN (Skagerak). Seasonal extended survivor analysis (SXSA) of Norway pout in the North Sea and Skagerrak. Stock numbers, SSB and TSB at start of season.

Year	1983				1984				1985			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	*	148044.	98871.	*	*	79934.	53580.	*	*	57347.	38436.
1	108919.	69566.	45136.	25487.	64088.	40701.	25438.	12720.	34089.	20997.	13373.	7818.
2	13108.	7725.	4167.	1505.	13567.	7969.	4388.	1564.	5668.	2683.	1680.	477.
3	115.	65.	36.	10.	698.	350.	15.	3.	447.	143.	85.	41.
4+	6.	3.	0.	0.	1.	0.	0.	0.	2.	1.	1.	0.
SSN	24122.				20674.				9527.			
SSB	369585.				371285.				166580.			
TSN	122149.	77358.	197383.	125873.	78354.	49020.	109776.	67868.	40207.	23823.	72486.	46772.
TSB	1055774.	1309514.	1901910.	1243200.	775043.	898990.	1145282.	679930.	381343.	413364.	641038.	432839.

Year	1986				1987				1988			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	*	106062.	71096.	*	*	31033.	20795.	*	*	85602.	56774.
1	25209.	16574.	10897.	6333.	43095.	26687.	17009.	10069.	13754.	9016.	5966.	3849.
2	2792.	996.	596.	199.	2779.	1534.	979.	517.	4989.	2771.	1797.	1000.
3	177.	60.	38.	20.	102.	58.	39.	26.	156.	88.	59.	39.
4+	28.	16.	11.	7.	18.	12.	8.	5.	17.	11.	8.	5.
SSN	5518.				7209.				6537.			
SSB	87703.				96411.				126548.			
TSN	28206.	17645.	117604.	77656.	45995.	28292.	49067.	31413.	18915.	11886.	93431.	61667.
TSB	246520.	286345.	724563.	581779.	367911.	456040.	593799.	379577.	213197.	234480.	572359.	473460.

Year	1989				1990				1991			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	*	91059.	60909.	*	*	85399.	57228.	*	*	163044.	108691.
1	35481.	22362.	14434.	8307.	36855.	23198.	14093.	8652.	37548.	23940.	15527.	9164.
2	2063.	1343.	792.	312.	4143.	2299.	1073.	568.	4832.	2146.	1108.	566.
3	339.	222.	144.	93.	133.	73.	33.	17.	286.	115.	62.	23.
4+	30.	20.	13.	9.	58.	30.	20.	14.	18.	7.	5.	3.
SSN	5979.				8020.				8890.			
SSB	85436.				125505.				145004.			
TSN	37912.	23948.	106442.	69630.	41189.	25600.	100618.	66478.	42684.	26208.	179745.	118447.
TSB	308967.	393334.	767774.	575014.	357689.	431491.	742046.	567210.	381557.	438211.	1091698.	888040.

Year	1992				1993				1994			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	*	69398.	45799.	*	*	48690.	32559.	*	*	206719.	138039.
1	70004.	44013.	28256.	16111.	29919.	18465.	11712.	6912.	20863.	12368.	7986.	4510.
2	5285.	2653.	1539.	713.	8520.	5139.	3058.	1303.	3773.	2045.	1138.	418.
3	227.	56.	21.	13.	259.	162.	61.	25.	509.	295.	174.	59.
4+	3.	0.	0.	0.	7.	5.	3.	2.	17.	11.	8.	5.
SSN	12515.				11778.				6385.			
SSB	174496.				219157.				118914.			
TSN	75518.	46722.	99214.	62635.	38705.	23771.	63524.	40801.	25162.	14720.	216024.	143031.
TSB	615520.	753187.	1051418.	676041.	407647.	460061.	622694.	410502.	250352.	270462.	1085892.	952939.

Year	1995				1996				1997			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	*	65168.	43110.	*	*	157828.	105202.	*	*	45024.	30092.
1	89060.	56431.	36267.	22227.	27512.	18004.	11610.	6928.	68458.	45339.	30310.	17788.
2	2084.	1200.	595.	360.	12158.	7517.	4874.	2447.	4112.	2490.	1562.	743.
3	171.	110.	48.	29.	193.	118.	48.	2.	1368.	852.	474.	232.
4+	43.	29.	19.	13.	26.	17.	12.	8.	7.	4.	3.	2.
SSN	11203.				15128.				12332.			
SSB	117396.				295903.				193454.			
TSN	91357.	57769.	102096.	65740.	39889.	25657.	174373.	114588.	73944.	48685.	77373.	48856.
TSB	678473.	894359.	1195764.	786723.	469231.	532528.	1134048.	893490.	624742.	807585.	1033446.	634304.

Table 5.3.3 (Cont´d.). Norway pout IV & IIIaN (Skagerak).

Year	1998				1999				2000			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	*	62774.	42002.	*	*	153834.	103085.	*	*	53761.	35977.
1	19890.	13119.	8622.	5443.	27878.	18521.	12155.	7085.	68177.	45166.	30046.	19021.
2	10350.	6373.	4018.	2421.	3214.	2049.	1194.	523.	4277.	2716.	1651.	889.
3	328.	181.	107.	70.	1447.	910.	534.	330.	220.	145.	58.	22.
4+	128.	79.	33.	22.	51.	34.	23.	15.	212.	142.	95.	64.
SSN	12795.				7499.				11527.			
SSB	261929.				150957.				162504.			
TSN	30697.	19753.	75555.	49959.	32589.	21515.	167739.	111037.	72886.	48169.	85611.	55973.
TSB	387239.	426976.	645821.	482961.	326586.	394894.	1002574.	822558.	592020.	785042.	1040641.	691949.

Year	2001				2002				2003			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	*	47733.	31971.	*	*	32964.	21818.	*	*	14398.	9645.
1	23869.	15820.	10496.	6936.	21129.	13766.	8940.	5484.	14388.	9596.	6380.	4120.
2	8970.	5321.	3366.	2234.	4431.	2849.	1890.	1034.	3289.	2142.	1396.	837.
3	395.	236.	77.	50.	1138.	749.	498.	314.	409.	257.	152.	89.
4+	53.	35.	24.	16.	44.	29.	20.	13.	198.	133.	89.	59.
SSN	11805.				7725.				5335.			
SSB	232827.				160225.				109901.			
TSN	33288.	21413.	61695.	41207.	26741.	17393.	44312.	28664.	18284.	12128.	22414.	14750.
TSB	383204.	432018.	602655.	448093.	293339.	342440.	466507.	318727.	200543.	237041.	286225.	192922.

Year	2004				2005				2006			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	*	18954.	12694.	*	*	76251.	51112.	*	*	37946.	25428.
1	6465.	4323.	2895.	1899.	8462.	5672.	3802.	2549.	34261.	22941.	15332.	10171.
2	2717.	1776.	1178.	747.	1191.	798.	535.	359.	1708.	1103.	702.	417.
3	429.	280.	183.	117.	437.	293.	196.	132.	240.	154.	84.	50.
4+	72.	48.	32.	22.	92.	62.	41.	28.	107.	71.	48.	32.
SSN	3865.				2566.				5481.			
SSB	85516.				54759.				77147.			
TSN	9683.	6427.	23242.	15479.	10182.	6825.	80825.	54179.	36317.	24270.	54112.	36099.
TSB	126243.	141956.	209815.	158029.	108071.	130326.	434846.	387981.	292995.	393316.	570294.	406943.

Year	2007				2008
Season	1	2	3	4	1
AGE					
0	*	*	85923.	57596.	*
1	16744.	11207.	7479.	4987.	38607.
2	5929.	3940.	2620.	1743.	3334.
3	238.	160.	107.	70.	1164.
4+	55.	37.	25.	16.	58.
SSN	7896.				8416.
SSB	154752.				150156.
TSN	22966.	15343.	96152.	64412.	43163.
TSB	260238.	312090.	649713.	537564.	393382.

Table 5.3.4 Norway pout IV & IIIaN (Skagerak). Seasonal extended survivor analysis (SXSA) of Norway pout in the North Sea and Skagerrak. Fishing mortalities by quarter of year.

Year	1983				1984				1985			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	*	0.004	0.033	*	*	0.000	0.052	*	*	0.000	0.022
1	0.048	0.032	0.169	0.225	0.054	0.069	0.285	0.392	0.084	0.051	0.135	0.588
2	0.127	0.213	0.578	0.355	0.130	0.193	0.590	0.768	0.336	0.068	0.773	0.555
3	0.169	0.194	0.781	1.516	0.281	1.608	0.937	0.000	0.681	0.119	0.317	0.000
4+	0.000	1.807	*	*	0.000	0.000	0.000	0.000	0.433	0.000	0.000	0.000
F (1- 2)	0.087	0.122	0.373	0.290	0.092	0.131	0.437	0.580	0.210	0.059	0.454	0.571

Year	1986				1987				1988			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	*	0.000	0.099	*	*	0.000	0.013	*	*	0.011	0.069
1	0.019	0.019	0.140	0.406	0.078	0.050	0.122	0.294	0.022	0.013	0.038	0.219
2	0.589	0.111	0.644	0.265	0.190	0.049	0.234	0.727	0.184	0.033	0.183	0.632
3	0.638	0.061	0.213	0.000	0.154	0.000	0.010	0.262	0.169	0.000	0.000	0.000
4+	0.140	0.000	0.000	0.000	0.069	0.000	0.000	0.000	0.000	0.000	0.000	0.000
F (1- 2)	0.304	0.065	0.392	0.336	0.134	0.049	0.178	0.510	0.103	0.023	0.110	0.426

Year	1989				1990				1991			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	*	0.002	0.101	*	*	0.000	0.021	*	*	0.005	0.040
1	0.061	0.037	0.150	0.287	0.062	0.097	0.087	0.179	0.050	0.033	0.125	0.148
2	0.029	0.127	0.501	0.431	0.185	0.350	0.231	0.279	0.395	0.255	0.264	0.489
3	0.022	0.033	0.040	0.184	0.198	0.368	0.242	0.318	0.481	0.220	0.550	1.646
4+	0.000	0.000	0.000	0.000	0.233	0.000	0.000	0.000	0.510	0.000	0.000	0.000
F (1- 2)	0.045	0.082	0.326	0.359	0.124	0.223	0.159	0.229	0.222	0.144	0.195	0.318

Year	1992				1993				1994			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	*	0.015	0.026	*	*	0.002	0.045	*	*	0.004	0.038
1	0.063	0.043	0.159	0.232	0.082	0.055	0.126	0.201	0.121	0.037	0.168	0.359
2	0.281	0.143	0.356	0.572	0.104	0.118	0.433	0.510	0.208	0.183	0.563	0.472
3	0.882	0.545	0.060	0.201	0.071	0.542	0.457	0.100	0.142	0.126	0.637	0.000
4+	*	*	*	*	0.029	0.000	0.000	0.000	0.000	0.000	0.000	0.000
F (1- 2)	0.172	0.093	0.258	0.402	0.093	0.086	0.279	0.356	0.165	0.110	0.366	0.416

Year	1995				1996				1997			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	*	0.013	0.049	*	*	0.006	0.029	*	*	0.003	0.014
1	0.056	0.042	0.089	0.199	0.024	0.038	0.115	0.120	0.012	0.003	0.131	0.139
2	0.149	0.294	0.099	0.219	0.080	0.033	0.281	0.179	0.100	0.066	0.332	0.400
3	0.040	0.418	0.079	0.131	0.091	0.474	1.581	0.167	0.072	0.183	0.306	0.198
4+	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
F (1- 2)	0.102	0.168	0.094	0.209	0.052	0.036	0.198	0.149	0.056	0.034	0.232	0.270

Year	1998				1999				2000			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	*	0.002	0.010	*	*	0.000	0.013	*	*	0.002	0.010
1	0.016	0.020	0.059	0.125	0.009	0.021	0.138	0.103	0.012	0.008	0.057	0.340
2	0.084	0.061	0.105	0.113	0.049	0.138	0.407	0.445	0.054	0.097	0.214	0.394
3	0.189	0.129	0.018	0.257	0.063	0.131	0.081	0.088	0.015	0.495	0.530	0.382
4+	0.078	0.446	0.000	0.000	0.013	0.006	0.000	0.000	0.000	0.000	0.000	0.000
F (1- 2)	0.050	0.040	0.082	0.119	0.029	0.080	0.272	0.274	0.033	0.052	0.135	0.367

Table 5.3.4 (Cont´d.). Norway pout IV & IIIaN (Skagerak).

Year	2001				2002				2003			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	*	0.001	0.014	*	*	0.013	0.016	*	*	0.001	0.000
1	0.011	0.010	0.014	0.048	0.028	0.031	0.088	0.110	0.005	0.008	0.037	0.016
2	0.121	0.057	0.010	0.268	0.041	0.010	0.199	0.499	0.029	0.028	0.110	0.261
3	0.113	0.668	0.018	0.022	0.018	0.008	0.059	0.107	0.067	0.124	0.134	0.543
4+	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.005	0.026
F (1- 2)	0.066	0.034	0.012	0.158	0.035	0.021	0.143	0.304	0.017	0.018	0.074	0.138

Year	2004				2005				2006			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	*	0.001	0.005	*	*	0.000	0.000	*	*	0.000	0.018
1	0.002	0.001	0.021	0.066	0.000	0.000	0.000	0.000	0.001	0.003	0.010	0.138
2	0.025	0.011	0.054	0.134	0.000	0.000	0.000	0.000	0.038	0.051	0.119	0.157
3	0.026	0.025	0.047	0.018	0.000	0.000	0.001	0.001	0.044	0.206	0.108	0.017
4+	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
F (1- 2)	0.014	0.006	0.038	0.100	0.000	0.000	0.000	0.000	0.019	0.027	0.065	0.147

Year	2007				2008
Season	1	2	3	4	1
AGE					
0	*	*	0.000	0.000	*
1	0.001	0.005	0.005	0.002	0.000
2	0.009	0.008	0.007	0.004	0.000
3	0.001	0.001	0.018	0.010	0.000
4+	0.000	0.000	0.000	0.000	0.000
F (1- 2)	0.005	0.006	0.006	0.003	0.000

Table 5.3.5 Norway pout IV & IIIaN (Skagerak). SXSA (Seasonal extended survivor analysis) of Norway pout in the North Sea and Skagerrak. Diagnostics of the SXSA.

Log inverse catchabilities, fleet no: 1 (commercial q134)

Year 1983-2008 (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	*	*	*	11.539
1	10.719	*	9.874	9.180
2	9.251	*	8.756	8.427
3	9.251	*	8.756	8.427

Log inverse catchabilities, fleet no: 2 (ibtsq1)

Year 1983-2008 (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	2.505	*	*	*
2	1.510	*	*	*
3	1.510	*	*	*

Log inverse catchabilities, fleet no: 3 (egfsq3)

Year 1992-2007 (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	*	*	2.783	*
1	*	*	1.642	*
2	*	*	*	*
3	*	*	*	*

Log inverse catchabilities, fleet no: 4 (sgfsq3)

Year 1998-2007 (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	*	*	2.985	*
1	*	*	1.857	*
2	*	*	*	*
3	*	*	*	*

Log inverse catchabilities, fleet no: 5 (ibtsq3)

Year 1991-2007 (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	*	*	1.495	*
3	*	*	1.495	*

Table 5.3.5 (Cont´d.). Norway pout IV & IIIaN (Skagerak).

Weighting factors for computing survivors:
Fleet no: 1 (commercial q134)

Year 1983-2008 (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	*	*	*	1.077
1	1.341	*	3.159	2.068
2	2.150	*	1.698	1.248
3	1.263	*	0.834	0.775

Weighting factors for computing survivors:
Fleet no: 2 (ibtsq1)

Year 1983-2008 (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	1.655	*	*	*
2	1.760	*	*	*
3	1.008	*	*	*

Weighting factors for computing survivors:
Fleet no: 3 (egfsq3)

Year 1992-2007 (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	*	*	1.373	*
1	*	*	2.226	*
2	*	*	*	*
3	*	*	*	*

Weighting factors for computing survivors:
Fleet no: 4 (sgfsq3)

Year 1998-2007 (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	*	*	1.635	*
1	*	*	2.322	*
2	*	*	*	*
3	*	*	*	*

Weighting factors for computing survivors:
Fleet no: 5 (ibtsq3)

Year 1991-2007 (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	*	*	1.370	*
3	*	*	0.822	*

Table 5.3.6 Norway pout IV & IIIaN (Skagerak). Stock summary table. (SXSA Baseline May 2008). (Recruits in millions. SSB and TSB in t, and Yield in '000 t).

Year	Recruits (age 0 3rd qrt)	SSB (Q1)	TSB (Q3)	Landings ('000 t)	Fbar(1-2)
1983	148044	369585	1901910	457.6	0.872
1984	79934	371285	1145282	393.01	1.240
1985	57347	166580	641038	205.1	1.294
1986	106062	87703	724563	174.3	1.097
1987	31033	96411	593799	149.3	0.871
1988	85602	126548	572359	109.3	0.662
1989	91059	85436	767774	166.4	0.812
1990	85399	125505	742046	163.3	0.735
1991	163044	145004	1091698	186.6	0.879
1992	69398	174496	1051418	296.8	0.925
1993	48690	219157	622694	183.1	0.814
1994	206719	118914	1085892	182.0	1.057
1995	65168	117396	1195764	236.8	0.573
1996	157828	295903	1134048	163.8	0.435
1997	45024	193454	1033446	169.7	0.592
1998	62774	261929	645821	57.7	0.291
1999	153834	150957	1002574	94.5	0.655
2000	53761	162504	1040641	184.4	0.587
2001	47733	232827	602655	65.6	0.270
2002	32964	160225	466507	80.0	0.503
2003	14398	109901	286225	27.1	0.247
2004	18954	85516	209815	13.5	0.158
2005	76251	54759	434846	1.9	0.000
2006	37946	77147	570294	46.6	0.258
2007	85923	154752	649713	5.7	0.020
2008		150156			
Arit mean	**80,996**	**165,156**	**808,513**		**0.634**
Geomean	**66,915**				

Table 5.6.1 NORWAY POUT IV and IIIaN (Skagerak). Input data to forecast for Norway pout in the North Sea and Skagerak May 2008.

Basis: Year 2007 closed for directed fishery and 2008 (forecast year) fishing pattern scaled to long term seasonal exploitation pattern for 1991-2004 (standardized with yearly Fbar to F(1,2)=1). Recruitment in forecast year is assumed to the 25% percentile = 47 733 millions of recruitment during the period 1983-2008 in the 3rd quarter of the year (long term geometric mean is 66 915 millions).

Year	Season	Age	N	F	WEST	WECA	M	PROPMAT
2007	1	0	0	0	0.000	0.000	0.4	0
2007	1	1	16744	0	0.007	0.012	0.4	0.1
2007	1	2	5929	0	0.022	0.028	0.4	1
2007	1	3	293	0.000	0.040	0.041	0.4	1
2007	2	0	0	0.000	0.000	0.000	0.4	0
2007	2	1	11201	0	0.015	0.015	0.4	0
2007	2	2	3940	0	0.034	0.026	0.4	0
2007	2	3	197	0	0.050	0.035	0.4	0
2007	3	0	85923	0.000	0.004	0.010	0.4	0
2007	3	1	7479	0.000	0.025	0.029	0.4	0
2007	3	2	2620	0.000	0.043	0.039	0.4	0
2007	3	3	132	0	0.060	0.049	0.4	0
2007	4	0	57596	0	0.006	0.009	0.4	0
2007	4	1	4987	0	0.023	0.027	0.4	0
2007	4	2	1743	0.000	0.042	0.040	0.4	0
2007	4	3	86	0.000	0.058	0.048	0.4	0

Year	Season	Age	N	F	WEST	WECA	M	PROPMAT
2008	1	0	0	0	0.000	0.000	0.4	0
2008	1	1	38607	0.052	0.007	0.012	0.4	0.1
2008	1	2	3334	0.211	0.022	0.028	0.4	1
2008	1	3	1222	0.269	0.040	0.041	0.4	1
2008	2	0	0	0	0.000	0.000	0.4	0
2008	2	1	0	0.043	0.015	0.015	0.4	0
2008	2	2	0	0.176	0.034	0.026	0.4	0
2008	2	3	0	0.615	0.050	0.035	0.4	0
2008	3	0	47733	0.009	0.004	0.010	0.4	0
2008	3	1	0	0.163	0.025	0.029	0.4	0
2008	3	2	0	0.407	0.043	0.039	0.4	0
2008	3	3	0	0.597	0.060	0.049	0.4	0
2008	4	0	0	0.038	0.006	0.009	0.4	0
2008	4	1	0	0.277	0.023	0.027	0.4	0
2008	4	2	0	0.668	0.042	0.040	0.4	0
2008	4	3	0	0.507	0.058	0.048	0.4	0
2008	4	3	0	0.507	0.058	0.048	0.4	0

Table 5.6.2 NORWAY POUT IV and IIIaN (Skagerrak). Results of the short term forecast for Norway pout in the North Sea and Skagerrak May 2008 with different levels of fishing mortality.

Basis: Year 2007 closed for directed fishery and 2008 (forecast year) fishing pattern scaled to long term seasonal exploitation pattern for 1991-2004 (standardized with yearly Fbar to F(1,2)=1). Recruitment in forecast year is assumed to the 25% percentile = 47 733 millions of recruitment during the period 1983-2008 in the 3rd quarter of the year (long term geometric mean is 66 915 millions).

SSB in the start of the Forecast year (1st Jan. 2008): 150 000 t

F(2008)	Landings(2008) `000 t	SSB(2009) ´000t
0.00	0	214
0.05	15	207
0.10	30	201
0.15	44	195
0.17	50	193
0.20	58	189
0.25	70	184
0.30	83	178
0.35	95	173
0.40	106	168
0.45	117	164
0.50	128	159
0.55	138	155
0.60	148	150
0.65	157	146
0.70	166	142
0.75	175	138
0.80	184	135
0.85	192	131
0.90	201	128
0.95	208	124
1.00	216	121
1.05	224	118
1.10	231	115
1.15	238	112
1.20	245	109
1.50	283	94
1.60	294	89

Shaded scenarios are not considered consistent with the precautionary approach.

Table 5.12.1 **Norway pout in Division VIa (West of Scotland)**
Total landings (tonnes) by Subdivision and country.

	Denmark	Faeroe Islands	Germany	Netherlands	UK - Eng+Wales+N.Irl.	UK - Scotland	Total
1987	37714					553	38267
1988	5849	376				517	6742
1989	28180	11				5	28196
1990	3316					0.5	3317
1991	4348						4348
1992	5147			10	1		5158
1993	7338				0.5		7339
1994	14147				1	0.5	14149
1995	24431		1	7			24439
1996	6175			7		140	6322
1997	9549					13	9562
1998	7186						7186
1999	4624			1			4625
2000	2005						2005
2001	3214						3214
2002	4815	4					4819
2003	6395		2				6397
2004	2281					4	2285
2005	0						0
2006	32						32
2007	0						0

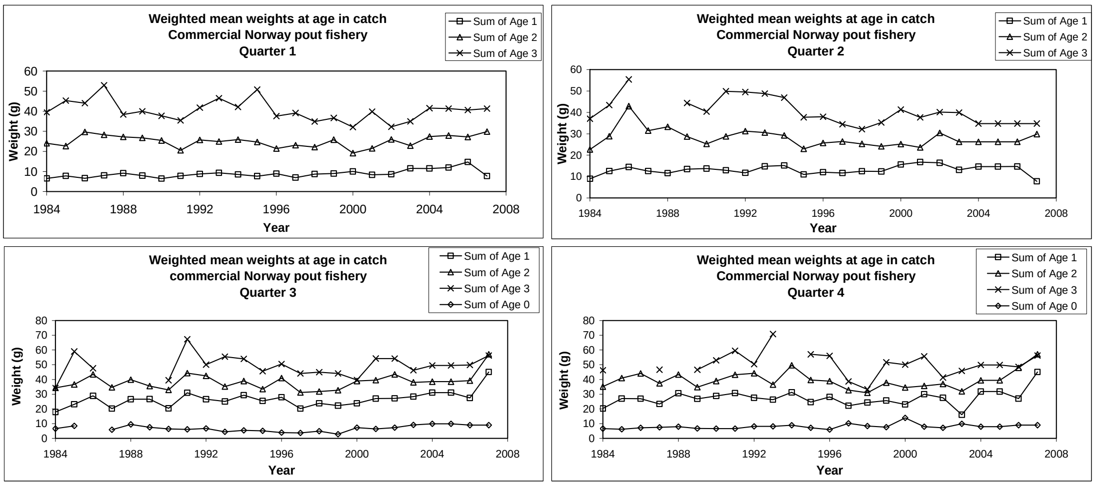


Figure 5.2.1. NORWAY POUT IV and IIIaN (Skagerak). Weighted mean weights at age in catch of the Danish and Norwegian commercial fishery for Norway pout by quarter of year during the period 1982-2007.

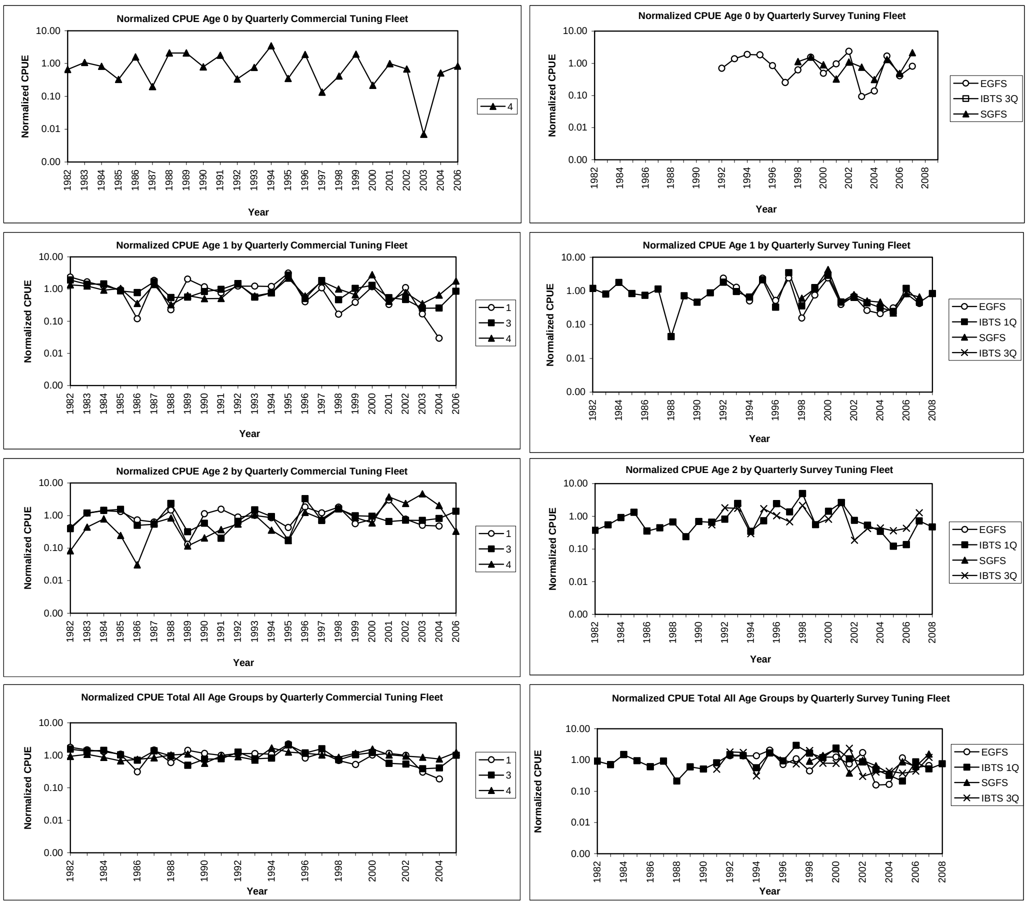


Figure 5.2.2 NORWAY POUT IV and IIIaN (Skagerak). Trends in CPUE (normalized to unit mean) by quarterly commercial tuning fleet and survey tuning fleet used in the Norway pout SXSA assessment for each age group and all age groups together.

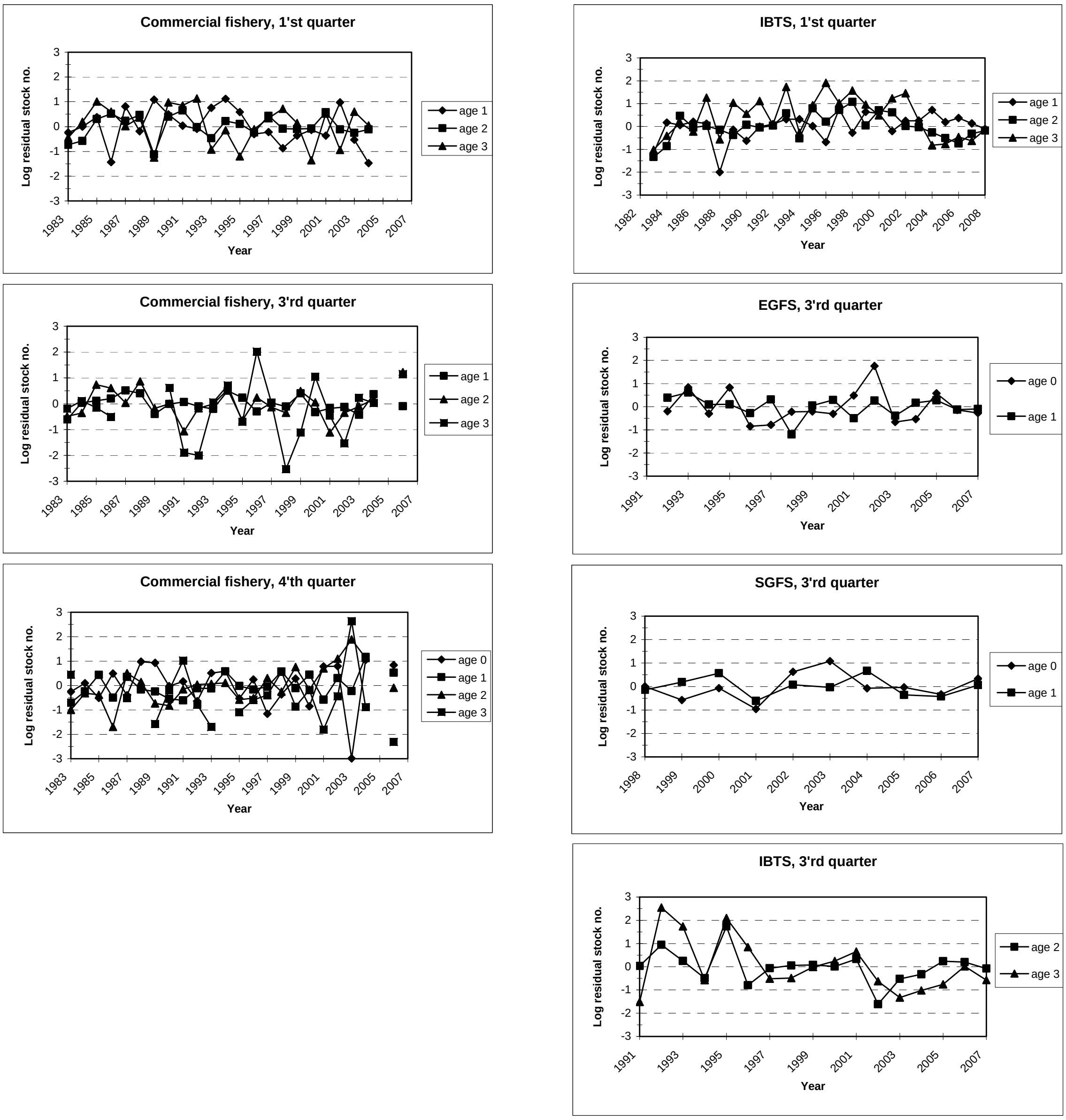


Figure 5.3.1 **Norway pout IV & IIIa (Skagerak). Log residual stock numbers (log (Nhat/N)) per age group. SXSA-Norway pout in the North Sea and Skagerak divided by fleet and season.**

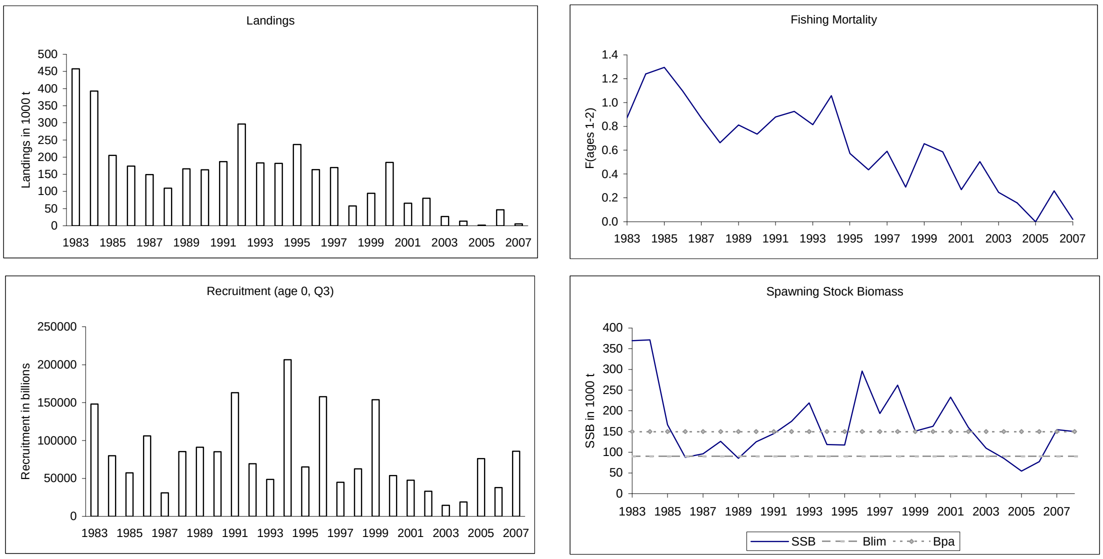


Figure 5.3.2 Norway Pout IV and IIIaN (Skagerak). Stock Summary Plots. SXSA baseline run May 2008.

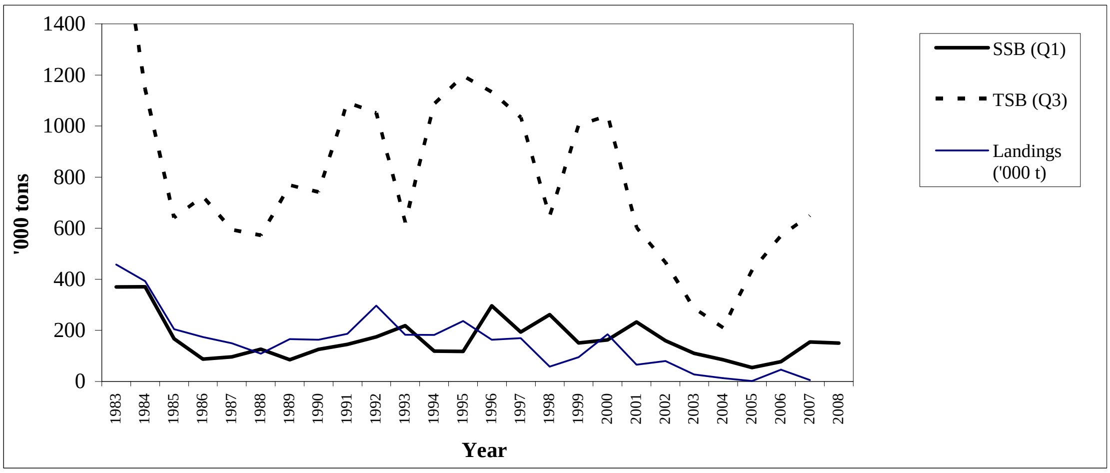


Figure 5.3.3 Norway pout IV & IIIaN (Skagerak). Trends in yield, SSB and TSB for Norway pout in the North Sea and Skagerrak during the period 1983-2008.

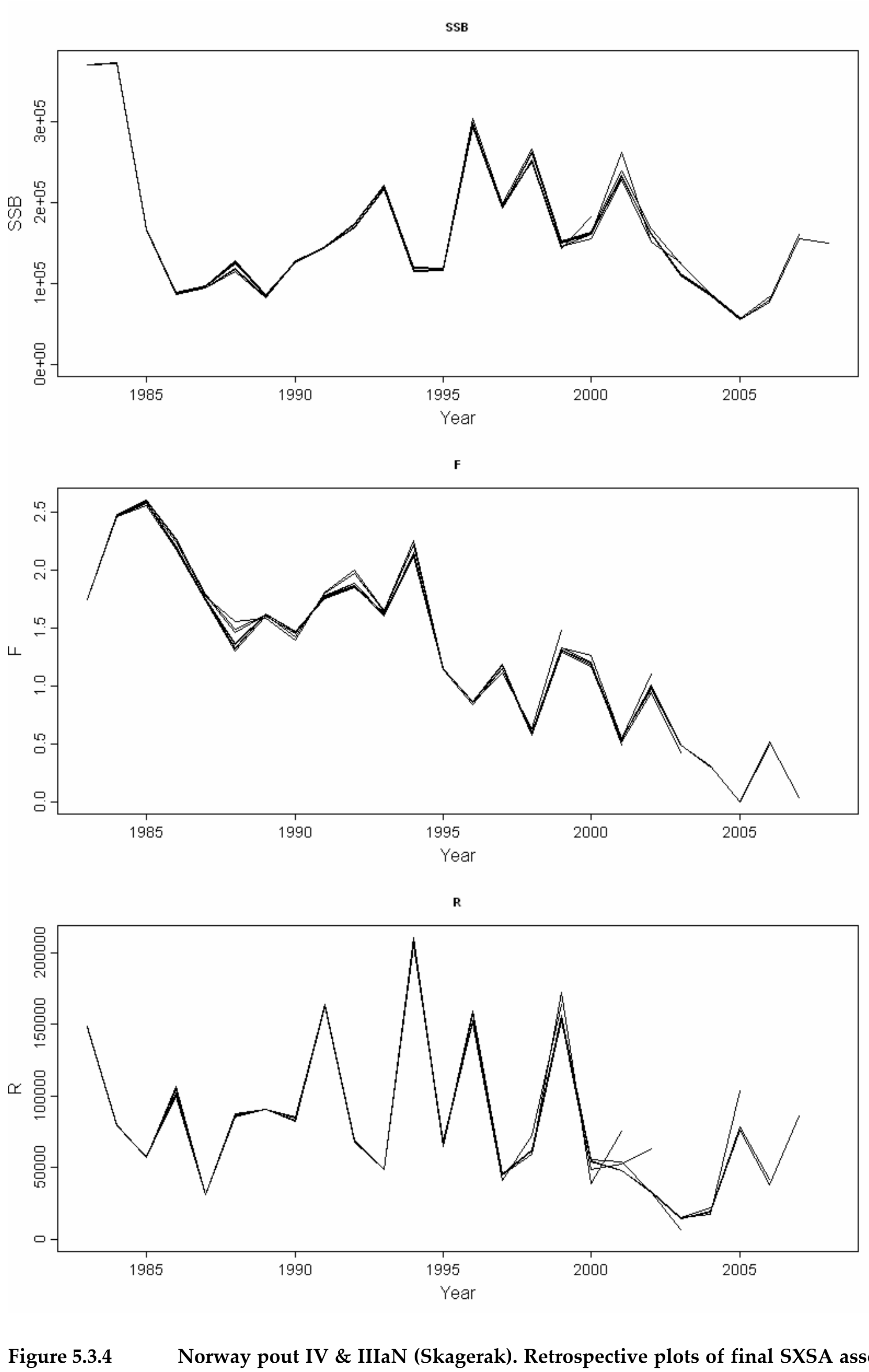


Figure 5.3.4 Norway pout IV & IIIaN (Skagerak). Retrospective plots of final SXSA assessment May 2008, with terminal assessment year ranging from 2002-2008.

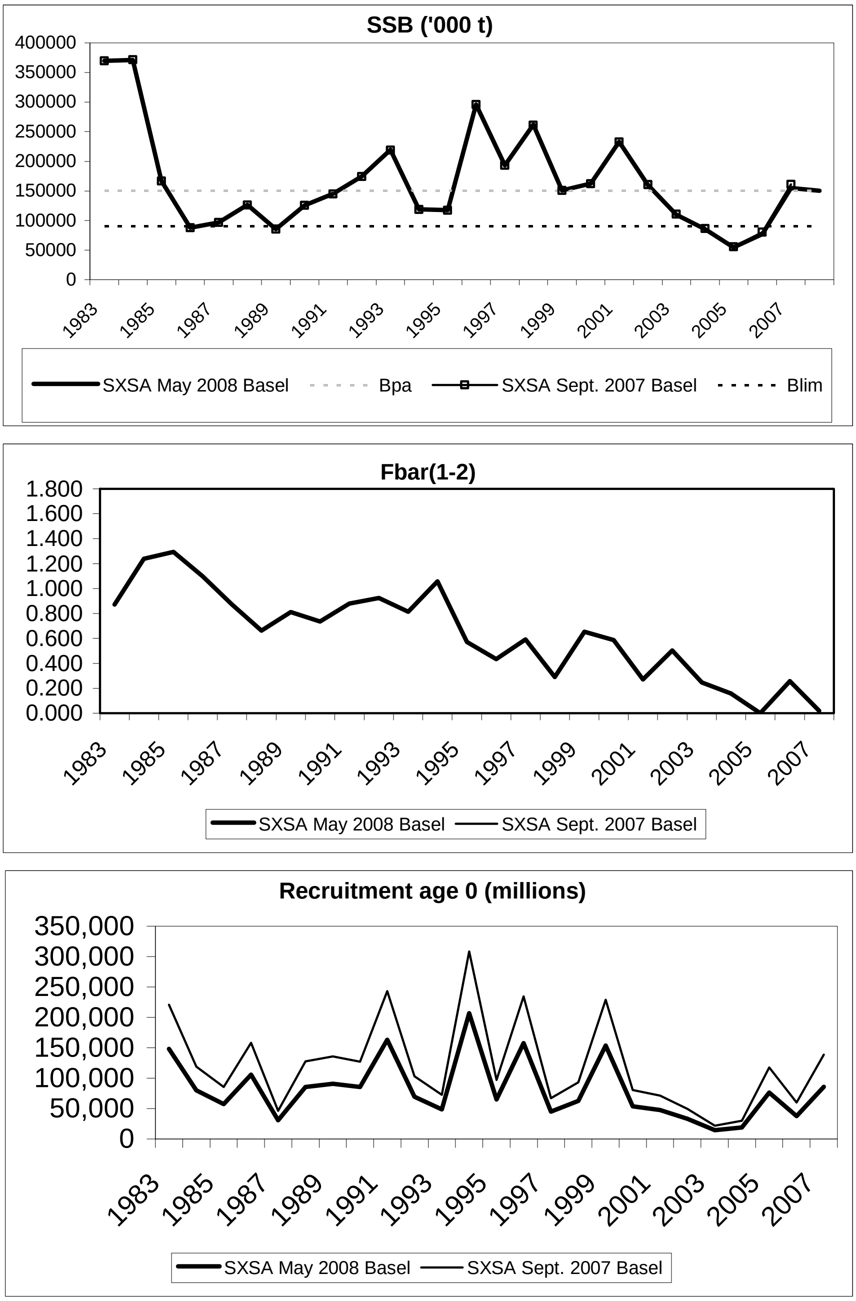


Figure 5.3.5 Norway pout IV and IIIaN (Skagerak). Comparison of May 2008 SXSA baseline assessment with SXSA September 2007 baseline assessment. (OBS: In Sept 2007 recruitment were calculated for 2nd quarter and in May 2008 for 3rd quarter)

6 Plaice in Division VIId

This assessment of plaice in Division VIId is an update. All the relevant biological and methodological information can be found in the Stock Annex dealing with this stock.

6.1 General

6.1.1 Ecosystem aspects

See section 9.1.1.

6.1.2 Fisheries

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

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

The first quarter is usually the most important for the fisheries but the share of the landings for this quarter has been decreasing from the early 1990s to a value around 30 – 38% of the total recently. In 2007, the beginning of the year remains slightly predominant with the first semester corresponding to 55% of the total landings (see text table below). It is noticeable that the quarterly distribution in 2007 is very much similar to the 2005 and 2006 values.

Quarter	Landings	Cum. Landings	Cum. %
I	1323.9	1323.9	38
II	607.2	1931.1	55
III	734.8	2665.9	76
IV	863.0	3528.9	100

Age distributions (exploitation pattern) may be quite different between quarters, as shown for 2007 in Figure 6.1.2.1, with older fish being caught in quarter 1 and recruit at age 1 starting to be caught after summer. This is in line with what is known of the biology of this species, which operates spawning migration in the centre of the Eastern channel during winter.

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

6.1.3 ICES advice

State of the stock: In the absence of a reliable assessment, the state of the stock cannot be evaluated in relation to the precautionary approach. An exploratory assessment suggests that the spawning-stock biomass has declined through the last 15 years. The current level of SSB is low.

Exploitation boundaries in relation to precautionary limits: In the absence of short-term forecasts, ICES recommends that landings in 2008 do not increase above the average of landings from the last three years (2004–2006), corresponding to 3500 t.

6.1.4 Management

There are no explicit management objectives for this stock.

The TACs in 2007 and 2008 have been both set to 5050t for the combined ICES Divisions VIId & VIIe.

The minimum landing size for plaice is 27 cm, which is not in accordance with the minimum mesh size of 80 mm, permitted for catching plaice by beam and otter trawling. Fixed nets are required to use 100-mm mesh since 2002 although an exemption to permit 90 mm has been in force since that time.

For 2007, Council Regulation (EC) N°41/2007 allocated different days at sea depending on gear, mesh size and catch composition (see section 1.2.1 for complete list). The days at sea limitations for the major fleets operating in Subarea VIId could be summarised as follows: Days at sea limitations for Trawls or Danish seines varied between 95 and unlimited days per year. Beam trawlers had an unlimited number of days permit. Maximum days at sea for Gillnets varied between 130 and 140 days per year. Trammel nets were allowed a maximum of 205 days for trip length less than 24 hours; otherwise the limit is 140 days.

For 2008, Council Regulation (EC) N°40/2008 allocates different days at sea depending on gear, mesh size and catch composition (see section 1.2.1 for complete list). The days at sea limitations for the major fleets operating in Subarea VIId could be summarised as follows: Trawls or Danish seines can fish between 86 and an unlimited number of days. Beam trawlers have an unlimited number of days permit. Maximum days at sea for Gillnets vary between 117 and 140 days per year. Trammel nets are allowed a maximum of 205 days for member states whose quotas are less than 5% of the Community share of the TACs of both place and sole; otherwise the limit is 180 days.

6.2 Data available

6.2.1 Catch

Landings data as reported to ICES together with the total landings estimated by the Working Group are shown in Table 6.2.1.1. From 1992 to 2002, the landings have remained steady between 5100 t and 6300 t. The 2007 landings of 3510t represents an increase after five years of decrease from 5777t in 2002. It is well below the agreed combined area TAC, even considering the landings of 875t in VIIe as officially reported to ICES. As usual, France contributed the largest share (48%) of the total VIId landings in 2007 followed by Belgium (38%) and UK (13%).

Routine discard monitoring has recently begun following the introduction of the EU data collection regulations. Discards data for 2007 are available from France, UK (Tables 6.2.1.2 and Figure 6.2.1.1a-c) though sampling levels are not high. Discards from the Belgian beam trawler fleet could not be processed in time for the working group due to logistic problems.

The percentage discarded per period, métier and country (Table 6.2.1.3) is highly variable and in every case substantial. Gillnetters had no discards in 2006 which was considered doubtful. In 2007, 26% of the catch are discarded by this metier but again the sampling level is very low (4 trips) to consider this rate to be representative. French trawlers had their discard rate doubled (74%) and discards from beam trawlers remained stable (45%).

The time series of discards is currently not long enough to be used in analytical assessment. Discards at young ages influence the recruitment level, forecast and predictions, but do not influence estimates of F and SSB.

6.2.2 Age compositions

Age compositions of the landings are presented in Table 6.2.2.1.

6.2.3 Weight at age

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

6.2.4 Maturity and natural mortality

Information about maturity per age class is given with the table included in this section. At an age of three years more than 50 percent and at age four years 96 percent of the plaice are mature. The natural mortality is assumed at a fixed value of 0.1 through all ages.

Age	1	2	3	4	5	6	7	8	9	10
Proportion of mature	0	0.15	0.53	0.96	1	1	1	1	1	1

6.2.5 Catch, effort and research vessel data

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

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

The survey series consist of:

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

All survey and commercial data available for calibration of the assessment are presented in Tables 6.2.5.1, Figures 6.2.5.1 and 6.2.5.2 and fully described in the Stock Annex. Effort from the French trawlers has been relatively stable since 2002. Effort of the UK inshore fleet has dropped sharply for the last decade while the Belgian beam trawler fleet has been increasing since 1998 due to the absence of restriction on fishing efforts. However, LPUE has been decreasing for Belgium to one of its lowest level. LPUE tends to increase from the UK fleet. Those opposite trends for Belgium and UK may be linked to regional difference. LPUE for the French fleet is at its lowest value of the time series.

6.3 Data analyses

An update assessment has been carried out this year. As in 2007, a series of exploratory analysis have been carried out to examine the effect of different F shrinking and the respective performance of individual tuning fleets. In the following sections, the catch at age matrix and the tuning fleets are examined, plus an analysis of a survey-based assessment with SURBA which avoids the use of commercial CPUE.

6.3.1 Reviews of last years assessment

In 2007, RGNSSK stated that :

- There appear to be stock definition problems for this stock. Tagging studies show that there are migrations of plaice from the North Sea to VIId and plaice also migrate from VIId to North Sea to feed.
- Discards are not included, but are substantial for younger ages. The RG recommends including discard data in the assessment.
- Surveys are noisy. The UK beam trawl survey is more positive than some of the commercial fleets. There is a need for more information in central parts of the VIId area. The French survey covers this area but is very noisy for older ages.
- Figures showing consistency in the data are missing in the report. Catch curve analyses (for consistency) would be nice to see.
- The assessment is indicative for trends only.

- F seems to have decreased and is estimated at F_{pa}
- SSB is estimated to increase somewhat in recent years after a long period of decreasing trend.

The working group is aware of the comments of the review group. The different points will be addressed during the next benchmark analysis of this stock.

For this meeting, discards were not included in the assessment as the group considered the time series not long enough. The French survey data have been revised and substantially present less noise than in the previous report.

6.3.2 Exploratory catch-at-age-based analyses

The investigation on the level of shrinking has confirmed the result found the last two years, i.e. visible but no drastic effect on retrospective performance (Figure 6.3.2.1). The tendency to underestimate F and overestimate SSB and recruitment from year to year is slightly constrained by a strong shrinkage but never disappears The similarities between results obtained with F shrinkage values of 1.0, 1.5 and 2.0 may be explained by the large reduction of influence on the estimates of survivors at age when shifting from 0.5 to 1.0, as shown in the text table below. Higher F shrinkage values (1.5–2.0) have almost no influence on the estimates.

Age / F shrinkage	0.5	1	1.5	2
1	0.57	0.19	0.10	0.06
2	0.18	0.05	0.02	0.01
3	0.15	0.04	0.02	0.01
4	0.15	0.04	0.02	0.01
5	0.17	0.05	0.02	0.01
6	0.13	0.03	0.02	0.01
7	0.15	0.04	0.02	0.01
8	0.14	0.04	0.02	0.01
9	0.21	0.04	0.02	0.01

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

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

The log catchability residuals from single fleet runs (with settings as in XSA and F shrinkage = 1.0) are shown in Figure 6.3.2.3 for all the fleets including the new UK Beam trawler fleet. Together with the two surveys covering the entire geographical area of the stock (UK BTS and French GFS), the UK Inshore Trawl residuals are increasing from the mid 1990s, indicating a progressive divergence with the landings at age. There is a jump in the residuals of the UK BTS in 2000, correlated to the decrease of the SSB that same year and the discrepancy between the surveys and the commercial fleets originates from that period. A similar pattern occurs also in the log catchability residuals of this survey for sole VIId. The French Otter trawlers series show a step shift in 1997, although no known reason was found for this. The group recommended to separate this series into two parts, one ending in 1996 and the other beginning in 1997. The log catchability residuals from a XSA run combining all fleets are shown in Figure 6.3.2.4.

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

6.3.3 Exploratory survey-based analyses

The survey-based analysis was carried out with SURBA software, the results being shown in Figures 6.3.3.1. The parameters used for this exercise are a smoothing coefficient lambda set to 1.0 and a reference age set to 4, the age range being 0−10+, the range of F values for calculating the mean being 3 to 6 like the XSA analysis. The SURBA analysis has been proven to be insensitive to the choice of the initial parameters in the neighbourhood of those chosen here (ICES WGNSSK 2005). Figures 6.3.3.1 shows a good performance of the UK beam trawl survey for tracking year classes through time. This is different from the French GFS, which exhibits rather erratic patterns and has a low internal consistency. The French GFS indices have been revised since the 2007 report and standardized index per survey shows year class strength estimated by the FR GFS are now similar to those estimated by UK BTS. Considering the relative consistency of FR GFS at younger ages, the group recommended in 2007 to truncate the age range of this survey to ages 1 to 3 in the assessment.

The retrospective analysis (Figure 6.3.3.2) does not show tendencies to under or over estimate SSB as does the XSA but the estimates of mean Z are given with confidence bounds that question on the quality of this information. Some extreme values prevent from drawing a contrasted picture of the recruitment estimates by SURBA.

6.3.4 Conclusions drawn from exploratory analyses

In 2007, the group agreed that the new parametrisation of the model should exclude UK inshore trawl, include the new UK Beam trawl fleet, split the FR otter trawlers fleet in two, truncate FR GFS to ages 1 to 3 and use a level of F shrinkage of 1.0. A summary table of these settings can be found section 6.3.5.

There is a decreasing trend in the contribution of the first quarter to the whole landings, where a fishery on the spawners takes place, yielding an age distribution different from the rest of the year. It is unknown whether there is major interannual variability in the immigration from the North Sea to these spawning grounds, which could distort any catch-based analysis. Any migration events taking place in the first quarter cannot be represented in the surveys in the second semester.

Discarding is shown to take place and is substantial, but is constrained to younger ages. The year range of the data series is too short to make use of it in the analysis.

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

Comparison of historical dynamics perceived through XSA and SURBA models and from current and previous year's analysis is shown Figure 6.3.4.1 on SSB, F and Recruitment estimates. The values shown in this figure are all respectful of the new settings used in 2007 (see section above). The F signals coming from SURBA and XSA are hardly comparable, but the discrepancies are not considered problematic given the uncertainty surrounding F estimates from SURBA. The recruitment estimates are much more volatile in SURBA than in XSA but the high and low values are found concurrently. The mean standardized values of SSB obtained from XSA and SURBA diverged in 2000 and 2001, and followed a strict parallel behaviour since then. Looking solely on the recent years trends, the two models agree that the SSB followed a stepped decline (taking into account the overestimation tendency of the two last years) since the end of the 1990s. This tendency was confirmed by a survey carried out in 2006 to assess French fisher's perception of the Eastern Channel ecosystem (Prigent *et al.*, 2007). 76% of the interviewees expressed their worry and found the fisheries resources depleted, especially flatfish and gadoids.

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

6.3.5 Final assessment

The settings in the XSA assessment for last year are (parameters were unchanged in 2008):

Year of assessment:		2007	2008
Assessment model:		XSA	XSA
Assessment software		FLR library	FLR library
Fleets:			
UK Inshore Trawlers	Age range	**Excluded**	**Excluded**
UK Beam Trawl	Age range	**2–10**	**2–10**
BE Beam Trawlers	Age range	2–10	2–10
FR Otter Trawlers	Age range	**2–10**	**2–10**
	Year range	**2–10**	**2–10**
UK Beam Trawl Survey	Age range	1–6	1–6
FR Ground Fish Survey	Age range	**1–3**	**1–3**
Intern'l Young Fish Survey	Age range	1	1
Catch/Landings			
Age range:		1–10+	1–10+
Landings data:		1980–2006	1980–2007
Discards data		None	None
Model settings			
Fbar:		3–6	3–6
Time series weights:		None	None
Power model for ages:		No	No

Catchability plateau:	Age 7	Age 7
Survivor est. shrunk towards the mean F:	5 years / 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

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

6.4 Historic Stock Trends

Fishing mortality has decreased over the last 4 years. It is noticeable that the dynamic of F seems to be similar to the dynamic of the French trawlers effort series.

The 1985 year class dominates the history of this stock. The 1985 year class was followed by the 4 most productive years in history in terms of landings. A second peak occurred with the 1996 year class, although estimated to be at 65% of the 1985 year class. The ephemeral peek of SSB in 1999 has been followed by years of stepped decline. Previous reports (WGNSSK, 2007) considered the SSB to be stable at its lowest level for the 2003–2006 period. This was confirmed by the fisher's perception and assessed by a survey in France in 2006. In 2007, SSB was higher than the previous years.

Recruitment in 2007 is close to the level of 1997, about twice the value of GM (17 millions) for the period 1998 – 2005. This strong recruitment has been confirmed by surveys. GM 1980 – 1997 is around 24 millions fish at age 1.

6.5 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 6.5.1. Results are presented in Table 6.5.2 and 6.5.3. For the estimation of year classes 2006 and 2007, the new information brought in by the RCT3 analysis was not considered to be reliable enough to be taken into the forecast. For the 2007 year class (age 1 in 2008), R-square was close to 0 with high standard error. For the 2006 year class (age 2 in 2008), the RCT3 estimate was well below the survey estimates. The estimation from XSA was closer to the survey estimates than RCT3.

The 2006 year class was estimated to be around 39 millions fish at age 1 in 2007 (35 millions fish at age 2 in 2008) from the XSA estimate.

The 2007 and 2008 year classes were estimated using the average recruitment calculated over the period 1998–2005. The truncation was meant to take into account the relative stability of the recruitment in the recent years at a lower level than at the beginning of the series. The geometric mean was about 17 millions 1-year-old-fish. Year class strength estimates used for short term prognosis are summarized in the text table below.

Year	Age in	XSA	RCT3	GM (1998–2005)	Survey estimates
2006	2	**34541**	23622	-	YFS0: 37049
2007	1	-	20179	**16960**	-
2008	0	-	-	**16960**	-

6.6 Short-term forecasts

The short term prognosis was carried out with FLR package. The average F for the last three years was used for the forecast. Although the 2006 exploitation pattern shows a noisy signal (Figure 6.6.2), it expresses a trend of F decreasing in the younger ages and increasing in the older ages in the recent years (Figure 6.6.2). the exploitation pattern used was then the mean F-at-age over the period 2004–2006 to the last year. The weights used for prediction were the average over the last three years.

Input to the short term predictions are presented in Table 6.6.1 and results in Table 6.6.2.

Assuming *status quo F* implies a catch in 2008 in VIId of 5300t (the agreed TAC is 5050t for both VIId and VIIe) and a catch of 5400t in 2009. Assuming *status quo F* will result in a SSB in 2008 and 2009 of 6500t and 8100t , respectively.

6.7 Medium-term forecasts

No medium-term forecast is available for this stock.

6.8 Biological reference points

ICES considers that:	**ICES proposes that:**
B_{lim} = 5 600 t	B_{pa} = 8 000 t
F_{lim} = 0.54	F_{pa} = 0.45.
Technical basis	
B_{lim} ~ B_{loss} (= 5 584 t)	B_{pa} = 1.4 B_{lim}
F_{lim} = F_{loss}	F_{pa} = 5th percentile of F_{loss}; long-term SSB > B_{pa} and P ($SSB_{MT} < B_{pa}$) < 10%

6.9 Quality of the assessment

- The sampling for plaice in VIId are considered to be at a reasonable level
- Discarding of plaice is significant and variable depending on the gear used. The omission of young fish discards has influence on the forecast and the predictions, but is not considered to severely affect the estimates of F and SSB.
- The assessment has a tendency to overestimate SSB and underestimate F, especially from 2000 when surveys and commercial fleets information began to diverge.
- Trends from surveys and commercial fleets are similar before and after 2000. The rescaling of surveys estimates operated in 2000 is consistent with the shift

in log q residuals seen for FR GFS and UK BTS, both for plaice and sole in VIId.

6.10 Status of the stock

Fishing mortality is estimated in 2007 at 0.55. F has been stable for the last four years.

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

1) The year class 2006 (recruited in 2007) indicates a strong recruitment of 39 millions fish, which corresponds to the level observed in 1997.

2) The projections based on the strong recruitment of year class 2006 and on a low F value in 2007 show a stock recovering by Bpa in 2009.

6.11 Management considerations

SSB in 2007 was close to its lowest level and below B_{lim}. Projections based on the strong recruitment for year class 2006 and on a low F value in 2007 indicate a stock recovering by B_{pa} in 2009.

The stock identity of plaice in the Channel is unclear and may raise some issues :

- The TAC is combined for Divisions VIId and VIIe. Plaice in VIIe is considered at risk of being harvested unsustainably and estimated from trends in the assessment to be at a very low level.
- The plaice stock in VIId is mostly harvested in a mixed fishery with sole in VIId. There exists a directed fishery on plaice occurring in a limited period at the beginning of the year on the spawning grounds. Plaice is mainly taken as by-catch by the demersal fisheries, especially targeting sole.

Due to the minimum mesh size (80 mm) in the mixed beam and otter trawl fisheries, a large number of undersized plaice are discarded. The 80 mm mesh size is not matched to the minimum landing size of plaice (27 cm). Measures taken specifically to control sole fisheries will impact the plaice fisheries.

Council Regulation (EC) N°40/2008 allocates different days at sea depending on gear, mesh size and catch composition.

Table 6.2.1.1–Plaice in VIId. Nominal landings (tonnes) as officially reported to ICES , 1976–2007.

Year	Belgium	Denmark	France	UK(E+W)	Others	Total reported	Un-allocated	Total as used by WG	Agreed TAC (5)
1976	147	1(1)	1439	376	-	1963	-	1963	
1977	149	81(2)	1714	302	-	2246	-	2246	
1978	161	156(2)	1810	349	-	2476	-	2476	
1979	217	28(2)	2094	278	-	2617	-	2617	
1980	435	112(2)	2905	304	-	3756	-1106	2650	
1981	815	-	3431	489	-	4735	34	4769	
1982	738	-	3504	541	22	4805	60	4865	
1983	1013	-	3119	548	-	4680	363	5043	
1984	947	-	2844	640	-	4431	730	5161	
1985	1148	-	3943	866	-	5957	65	6022	
1986	1158	-	3288	828	488 (2)	5762	1072	6834	
1987	1807	-	4768	1292	-	7867	499	8366	8300
1988	2165	-	5688 (2)	1250	-	9103	1317	10420	9960
1989	2019	+	3265 (1)	1383	-	6667	2091	8758	11700
1990	2149	-	4170 (1)	1479	-	7798	1249	9047	10700
1991	2265	-	3606 (1)	1566	-	7437	376	7813	10700
1992	1560	1	3099	1553	19	6232	105	6337	9600
1993	877	+(2)	2792	1075	27	4771	560	5331	8500
1994	1418	+	3199	993	23	5633	488	6121	9100
1995	1157	-	2598 (2)	796	18	4569	561	5130	8000
1996	1112	-	2630 (2)	856	+	4598	795	5393	7530
1997	1161	-	3077	1078	+	5316	991	6307	7090
1998	854	-	3276 (23)	700	+	4830	932	5762	5700
1999	1306	-	3388 (23)	743	+	5437	889	6326	7400
2000	1298	-	3183	752	+	5233	781	6014	6500
2001	1346	-	2962	655	+	4963	303	5266	6000
2002	1204		3454	841		5499	278	5777	6700
2003	995	-	2783 (3)	756		4536	-	4536	6000
2004	987		2439 (4)	580		4007	-	4007	6060
2005	830		1756	411	20	3018	428	3446	5150
2006	1031		1713	545	16	3305	-	3305	5080
2007	1356		1696	458		3510	-	3510	5050

1 Estimated by the working group from combined Division VIId+e
2 Includes Division VIIe
3 Provisional
4 Data provided to the WG but not officially provided to ICES
5 TAC´s for Divisions VII d, e.

Table 6.2.1.2. Plaice in VIId. Discards

(numbers raised to sampled trips)

	Discards							Landings								
	FR trawl			FR gillnet	UK			FR trawl			FR gillnet		UK			
	Q2	Q3	Q4	Q1	Q1	Q2	Q3	Q2	Q3	Q4	Q1	Q4	Q1	Q2	Q3	Q4
	5 trips	14 trips	8 trips	2 trips	4 trips	10 trips	5 trips	5 trips	14 trips	8 trips	2 trips	2 trips	4 trips	10 trips	5 trips	1 trip
LG	14 hauls	23 hauls	47 hauls	6 hauls	12 hauls	37 hauls	27 hauls	14 hauls	23 hauls	47 hauls	6 hauls	14 hauls	12 hauls	37 hauls	27 hauls	16 hauls
10																
11																
12																
13																
14																
15	30					6										
16	91					9										
17	15					29	1									
18	15	7				47	1									
19					1	97	9									
20	30				2	112	5									
21	15	5			3	124	12									
22	45	39			9	122	8									
23	45	28		3	3	93	12									
24	46	10		2	1	73	10									
25	15	33		6	7	160	7	1				1				
26				2	3	77	5	5				1		1		
27	60				5	39	2	6	5	1			1	79	2	4
28	15		4		7	10	1	15	2	2	3		3	128	7	1
29				1	2	24	2	30	4				10	114	6	6
30					0	2		17	3	1	4		13	128	9	4
31					2	0		10	2		1		6	126	6	1
32				1		0		6	1	2			5	99	6	6
33						1		3	1	1	2	3	10	66	5	7
34								8	2	2	2		4	76	6	7
35								3				2	3	59	3	13
36								6		1		1	1	40	2	11
37								6	1			2	1	33	3	11
38										4		1	1	25	3	12
39									2				0	25	2	8
40								1		1		1	0	17	2	15
41													0	11	0	10
42								3				3	0	19	0	11
43									1	1		5	1	4	0	5
44												1		11	0	9
45												3		5	0	4
46												1		9	1	6
47										1				3	1	3
48												4		1	1	3
49												1		0		2
50														1		2
51														3		0
52														0		0
53														3		2
54											1			0		1
55														1		
56																
57																
58																
59																
60																

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

Period	Métier	Country	Numbers Trips sampled	Hauls sampled	Landed	Discarded	%D
Quarter 1	Gillnet	France	2	6	13	15	54%
Quarter 1	Beam Trawl	UK	4	12	59	45	43%
Quarter 2	Trawl	France	5	14	115	424	79%
Quarter 2	Beam Trawl	UK	10	37	1087	1025	49%
Quarter 3	Trawl	France	14	23	65	121	65%
Quarter 3	Beam Trawl	UK	5	27	65	75	54%
Quarter 4	Trawl	France	8	47	17	4	19%
Quarter 4	Gillnet	France	2	14	30	0	0%
Quarter 4	Beam Trawl	UK	1	16	164	0	0%
2007	Gillnet	France	4	20	43	15	26%
2007	Trawl	France	27	84	197	549	74%
2007	Beam Trawl	UK	20	92	1375	1145	45%

Table 6.2.2.1. Plaice in VIId. Landings in numbers (thousands)

	1	2	3	4	5	6	7	8	9	10+
1980	53	2644	1451	540	490	75	45	44	4	103
1981	16	2446	6795	2398	290	159	51	42	56	200
1982	265	1393	6909	3302	762	206	96	62	21	88
1983	92	3030	3199	5908	931	226	92	122	4	101
1984	350	1871	7310	2814	1874	533	236	101	34	100
1985	142	5714	6195	4883	413	612	164	99	139	50
1986	679	4884	7034	3663	1458	562	254	69	19	34
1987	25	8499	7508	3472	1257	430	442	154	105	77
1988	16	5011	18813	4900	1118	541	439	127	105	174
1989	826	3638	7227	9453	2672	588	288	179	81	197
1990	1632	2627	8746	5983	3603	801	243	203	178	231
1991	1542	5860	5445	4524	2437	1681	286	120	113	125
1992	1665	6193	4450	1725	1187	1044	698	200	116	118
1993	740	7606	3817	1259	542	468	334	287	102	152
1994	1242	3633	6968	3111	850	419	312	267	275	312
1995	2592	4340	2933	2928	922	228	277	225	122	258
1996	1119	4847	3606	1547	1436	488	179	176	165	347
1997	550	4246	7189	3434	1080	752	464	199	114	306
1998	464	4400	8629	3419	537	143	136	81	52	188
1999	741	1758	12104	6460	1043	171	86	81	38	111
2000	1383	6214	4284	7241	1652	307	82	27	42	98
2001	2682	4159	4380	2141	1985	310	87	22	13	78
2002	902	7204	5191	1907	1565	888	234	62	25	92
2003	646	4874	5668	1864	424	373	333	75	50	62
2004	967	4964	5471	894	389	152	133	133	38	48
2005	324	3080	3876	2282	461	195	107	88	68	48
2006	509	3027	3128	1610	878	204	84	92	61	72
2007	691	2754	2889	1804	866	565	152	49	18	74

Table 6.2.3.1. Plaice in VIId. Weights in the landings

	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10+
1980	0.309	0.312	0.499	0.627	0.787	1.139	1.179	1.293	1.475	1.557
1981	0.239	0.299	0.373	0.464	0.712	0.87	0.863	0.897	0.992	1.174
1982	0.245	0.271	0.353	0.431	0.64	0.795	1.153	1.067	1.504	1.355
1983	0.266	0.296	0.349	0.42	0.542	0.822	0.953	1.144	0.943	1.591
1984	0.233	0.295	0.336	0.402	0.508	0.689	0.703	0.945	1.028	1.427
1985	0.254	0.278	0.301	0.427	0.502	0.57	0.557	1.081	0.849	1.421
1986	0.226	0.306	0.331	0.406	0.546	0.486	0.629	0.871	1.446	1.579
1987	0.251	0.282	0.36	0.477	0.577	0.783	0.735	1.142	1.268	1.515
1988	0.292	0.268	0.321	0.432	0.56	0.657	0.77	0.908	1.218	1.328
1989	0.201	0.268	0.321	0.37	0.473	0.648	0.837	0.907	1.204	1.519
1990	0.201	0.256	0.326	0.378	0.483	0.61	0.781	0.963	1.159	1.31
1991	0.225	0.277	0.311	0.39	0.454	0.556	0.745	1.087	0.924	1.602
1992	0.182	0.277	0.352	0.429	0.509	0.585	0.701	0.837	0.85	1.195
1993	0.22	0.272	0.336	0.432	0.507	0.591	0.741	0.82	0.934	1.156
1994	0.243	0.27	0.288	0.356	0.466	0.576	0.686	0.928	0.969	1.287
1995	0.218	0.271	0.313	0.39	0.485	0.688	0.612	0.806	1.15	1.298
1996	0.221	0.3	0.29	0.396	0.475	0.643	0.764	0.934	1.057	1.312
1997	0.199	0.252	0.298	0.332	0.442	0.577	0.801	0.894	1.055	1.395
1998	0.159	0.244	0.267	0.381	0.502	0.762	0.839	0.981	0.986	1.379
1999	0.197	0.245	0.235	0.306	0.461	0.751	0.768	0.868	0.885	1.508
2000	0.207	0.245	0.261	0.283	0.375	0.576	0.687	0.875	0.926	1.067
2001	0.215	0.252	0.303	0.37	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	0.88	0.909	1.33
2003	0.254	0.268	0.271	0.363	0.556	0.643	0.624	0.85	0.583	1.205
2004	0.217	0.243	0.295	0.421	0.493	0.61	0.636	0.933	1.093	1.348
2005	0.21	0.263	0.293	0.36	0.527	0.536	0.753	0.778	0.82	1.014
2006	0.209	0.263	0.318	0.374	0.463	0.611	0.711	0.732	0.858	1.071
2007	0.247	0.293	0.316	0.375	0.469	0.538	0.699	0.802	0.996	1.193

Table 6.2.3.2. Plaice in VIId. Weights in the stock.

	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10+
1980	0.171	0.332	0.482	0.622	0.751	0.87	0.977	1.074	1.161	1.339
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	0.143	0.219	0.275	0.335	0.375	0.472	0.633	1.057	1.022	1.502
1992	0.088	0.241	0.336	0.421	0.477	0.521	0.634	0.713	0.741	1.229
1993	0.108	0.258	0.296	0.379	0.493	0.539	0.573	0.699	0.787	1.056
1994	0.165	0.198	0.276	0.331	0.383	0.493	0.603	0.903	0.781	1.15
1995	0.124	0.257	0.286	0.354	0.442	0.707	0.531	0.703	1.092	1.194
1996	0.178	0.229	0.263	0.347	0.354	0.474	0.536	0.907	0.958	1.126
1997	0.059	0.202	0.256	0.266	0.417	0.53	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	0.61	0.759	1.053	1.25
2003	0.103	0.191	0.249	0.33	0.496	0.492	0.548	0.748	0.522	0.982
2004	0.172	0.183	0.268	0.408	0.471	0.521	0.616	0.892	1.102	1.287
2005	0.096	0.201	0.269	0.308	0.47	0.492	0.707	0.629	0.814	0.89
2006	0.106	0.209	0.275	0.336	0.397	0.525	0.636	0.704	0.842	1.09
2007	0.125	0.224	0.265	0.323	0.431	0.463	0.62	0.831	1.04	1.222

Table 6.2.5.1. Plaice in VIId. Tuning fleets

FLT01: UK INSHORE TRAWL METIER <40 trawl EXCLUDED from XSA

1985	2007								
1	1	0	1						
2	10								
2520	618.3	419.7	221.1	18.8	0	0	0	19	0
1804	237.9	300.2	132.9	51.6	6.5	4.7	2.9	0	0
2556	456	430.2	153.2	48	25.1	5	6.3	4.3	0
2500	382.4	856.1	141.7	57.8	30.1	14.1	2.8	4	5.2
2131	47.4	221.7	465.4	97.1	41.3	19	5.5	1.2	6.2
1094	34.3	92.1	52.6	56.9	18	7.5	5.5	3.6	3.1
2349	240.2	229.7	166.6	76.6	64.9	10.7	4.3	2.1	1.3
2527	298	225.5	140.4	77.8	55.3	44.2	14.6	2.9	2.4
2503	309.3	181.4	66.6	40.5	30.1	21.5	25.1	8.5	3.8
2635	176	240.2	99.7	37.8	21	17	8.9	17.9	3.5
1531	124.1	70.7	54.6	23.5	8.5	5	5.5	3.9	6.8
1659	274.4	63.8	16.9	19.1	10	2.5	3.1	2.5	2.5
2024	317.1	223.8	20.4	7.7	10.2	8	4.9	2.8	4
813	104.3	77.7	27.6	3.7	1.7	3.9	1.4	1.2	0.3
861	53.4	222.2	27	8.7	1.2	0.4	1.4	0.5	0.4
652	75	46	81.3	13.8	4.5	1.1	0.5	1	0.4
491	29.4	21.3	13.8	17.5	3.3	0.9	0.6	0.2	0.2
607	120.2	77.2	17.2	8.5	14.7	2.2	1.5	0.3	0.2
653	216.9	46.4	24.9	5.1	4.1	6.9	5.1	0.3	0.3
661	84.6	127.5	13.5	5.4	2.3	1.9	3.8	1.7	0.5
235	52.2	23	19.3	2.4	1.8	0.5	0.4	1.1	0.2
634	190.7	124.5	39.8	28.1	4	3.4	1.9	1.2	2.4
464	83.9	64.9	33.1	9.9	7.6	1.6	1.2	0.4	0.5

FLT02: BELGIAN BEAM TRAWL Ages 2 – 10 used for XSA

1981	2007								
1	1	0	1						
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
26.4	476.7	654.3	1384.5	165	52.2	23	31.6	1.3	1.4
35.4	92	1570.4	712.1	467.5	134.3	61	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	343.1	92.7	154.5	41.1	28	14.1
48.9	773	4264.6	1301.8	237.1	109.9	113.2	35.8	25.4	24
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	184.8	43.9	50.5	13.1	14
32.8	595.4	1689.2	1149.4	1089.5	698.4	86.9	36	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	132.6	109.5	75.5	90	37.6
31.7	39.8	591.9	925.2	396.5	82	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	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	39	40	18.2	18.4	13.7
27.6	40.7	1687.7	1366.6	370.5	67.5	25.4	13.5	14	12.7
37	60.4	369.7	529	235.4	43.4	12.1	5.9	10.4	1.5
40.2	422.6	1759.9	1085	705.3	119.4	26.5	9.3	7.6	26.9
41.1	412.7	1361.3	641	578	138.7	62.7	9.6	5	26.4
40	407.2	1194.7	581.6	144	176.8	130.8	25	18.2	24.9
39.1	317.8	1329.4	313.9	154.7	48.8	68.3	51.5	13.3	23.4
44	299.6	737.6	708.8	239.5	73.6	39.8	35.3	21.3	1.1
56.9	475.7	882.2	758.5	440.6	78.1	34.5	41.6	40.7	25
65.1	826.7	911.5	725.5	493.7	374.6	104.7	21.7	6.2	39.3

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

FLT03: FRENCH TRAWLERS (EFFORT H*KW*10 – 4)Ages 2 – 10 used for XSA

1989	2007								
1	1	0	1						
2	10								
6983	1190.1	1635.9	1643.2	466.2	73.5	34.3	34.1	19.3	16.1
8395	698.2	1876.1	1289.5	728.3	153.7	42.6	33.1	46.5	14.4
10689	1938.7	1474.1	1430	399.5	255.2	41	17.6	11.9	9.9
10519	1802.9	1396.1	370.2	269.4	230.7	143.5	21.2	12.1	11.6
10217	2124.4	1118.2	268.4	56	73.4	48.7	32.3	14.3	4.6
10609	1034.2	2271.2	476.4	177.6	69.5	48.2	48.3	32	25
12384	1354.7	686.5	578.5	95.4	21.4	19.5	27.5	21.8	28.2
14476	1133.3	1283.9	352.7	317.5	98.8	43.6	33.3	34.6	36.9
10921	1396.2	3536	1155.4	139	170.7	88.3	50.8	22.4	28.2
11707	1446	3541.9	1534.4	205.4	29.8	20.2	17.8	6.9	8.2
10625	1139.1	5654.6	2456	254.4	36.1	24.8	23.5	4.4	16.6
13779	2757.4	1634	3110.4	781.5	130.9	21.2	6.1	12.9	19.9
11376	2113.6	1726.3	663.1	642.5	81.3	21.6	1.4	1.2	16.4
13489	3130.4	1134.9	336.6	230.9	186.2	36.7	9.5	2.9	13.1
12647	1984.9	2715.5	701.5	129.6	82.8	75.1	17.8	16.3	11.2
11582	3107.1	2308.6	284.8	110.4	50.1	22.3	24.4	5.9	6.7
12157	1131.3	1428.8	652.9	63.1	37.1	22.4	15.1	10.6	8.9
11779	1009	922	333.6	140.1	43.5	14.5	14.7	5	10.6
10513	713.7	771.1	383.8	127.4	50.3	12.4	6.5	3.1	8.4

FLT04: UK BEAM TRAWL SURVEY true age 6 Ages 1 – 6 used for XSA

1988	2007					
1	1	0.5	0.75			
1	6					
1	26.5	31.3	43.8	7	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	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	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	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	3.1	0.3	0.2
1	11.3	14.1	15.9	2.9	1	0.2
1	13.2	21	14.4	13.8	3.5	0.9
1	17.9	13	10	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	2.9	1.6	0.8
1	36.2	15	13.2	3.4	0.9	0.2
1	10.8	31.2	13.8	10.3	2.9	1.2
1	17.2	16.1	9.2	3.3	2.6	0.8
1	42.6	18.8	8.7	3.9	1.7	2

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

```
FLT05: French GFS [option 2] true age 5Ages 1 – 3 used for XSA
1988   2007
1      1      0.75   1
0      5
1      1.9    8      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      4.4    18.7   8.8    4.2    1.2    0.5
1      3.8    5      2.2    0.8    0.2    0.1
1      1.4    4.9    3      1.1    0.7    0.2
1      21.3   4.5    2.6    0.3    0.1    0.1
1      8.5    34.5   8.3    4.3    0.3    0.1
1      7.8    12.4   14     3.1    0.5    0
1      0.9    7.1    4.2    7.7    1.3    0.2
1      16.6   9.8    13.7   3.4    2.4    0.5
1      4.6    7.4    3.5    1.2    0.8    0.3
1      0.2    12.8   6.5    3.4    1      0.5
1      9.7    5.8    9.4    1.3    0.3    0.2
1      2.1    9.8    9.3    4.5    0.9    0.1
1      1.2    5.7    12.4   6.8    2.1    0.6
1      128    12.9   9.9    3.8    1.3    0.5
1      1      11.3   8.6    3.6    1.4    0.4
FLT06: Intl YFS             Age 1 used fro XSA
1987   2006
1      1      0.5    0.75
0      1
1      11.68  1.44
1      5.56   1.3
1      3.97   0.6
1      3.42   0.7
1      4.36   0.6
1      4.04   1.8
1      3.7    0.8
1      8.69   0.8
1      6.87   1.7
1      4.07   0.7
1      2.23   0.8
1      5.3    0.8
1      3.81   0.8
1      5.14   0.48
1      3.74   0.83
1      0.67   0.92
1      4.86   0.2
1      4.83   0.78
1      2.19   0.17
1      7.62   0.3
FLT07: UK BEAM TRAWL >=10 METRES PLAICE CATCH IS >=20% Age 2 – 10 used
for XSA
1991   2007
1      1      0      1
2      10
9794   518.2  495.5  359.4  165.2  140    23.1   9.2    4.5    2.8
10270  524    396.5  246.9  136.8  97.2   77.7   25.7   5.1    4.2
8993   476.8  279.8  102.7  62.5   46.4   33.2   38.6   13.1   5.8
7398   238.6  325.6  135.1  51.2   28.4   23.1   12     24.3   4.7
6293   346    197.2  152.2  65.5   23.7   13.9   15.2   10.7   18.9
8124   785.2  182.5  48.4   54.8   28.5   7.2    8.8    7.1    7.2
9258   781.9  552    50.4   19     25     19.8   12.1   7      9.9
```

5954	342	254.8	90.6	12.1	5.7	12.9	4.5	3.9	0.9
5181	151.8	632.1	76.8	24.7	3.3	1.2	4	1.4	1.1
4640	258.7	158.9	280.7	47.6	15.4	3.8	1.6	3.5	1.4
5762	211.3	153.2	99	126	23.4	6.6	4	1.4	1.6
7634	430.3	276.2	61.7	30.5	52.6	7.9	5.2	1.1	0.7
6441	684.2	146.5	78.6	16	13	21.8	16.1	1	1.1
3726	206.2	310.8	33	13.1	5.6	4.6	9.3	4.1	1.2
2944	188.5	83	69.9	8.8	6.4	1.8	1.6	4	0.8
2819	196.2	130	41.5	29.4	4.2	3.6	2	1.2	2.6
2658	124.3	96.2	49.1	14.7	11.3	2.3	1.7	0.6	0.8

Table 6.3.5.1. Plaice in VIId. XSA diagnostics

```
FLR XSA Diagnostics 2008 – 05 – 06 09:56:19
CPUE data from My.Fleet
Catch data for 28 years. 1980 to 2007. Ages 1 to 10.
 fleet first age last age first year last year alpha beta
1 UK B TRAWL 2 9 1991 2007 0 1
2 BE BEAM TRAWL 2 9 1981 2007 0 1
3 FR TRAWL-1 2 9 1989 1996 0 1
4 FR TRAWL-2 2 9 1997 2007 0 1
5 UK BTS 1 6 1988 2007 0.5 0.75
6 FR GFS 1 3 1988 2007 0.75 1
7 Intl YFS 1 1 1987 2006 0.5 0.75
 Time series weights :
 Tapered time weighting not applied
Catchability analysis :
 Catchability independent of size for ages > 1
 Catchability independent of age for ages > 7
Terminal population estimation :
 Survivor estimates shrunk towards the mean F
 of the final 5 years or the 3 oldest ages.
 S.E. of the mean to which the estimates are shrunk = 1
 Minimum standard error for population
 estimates derived from each fleet = 0.3
 prior weighting not applied
Regression weights
 year
age 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007
 all 1 1 1 1 1 1 1 1 1 1
 Fishing mortalities
 year
age 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007
 1 0.033 0.045 0.089 0.141 0.047 0.042 0.070 0.025 0.033 0.019
 2 0.148 0.152 0.552 0.371 0.597 0.339 0.456 0.295 0.303 0.225
 3 0.603 0.660 0.586 0.853 0.967 1.239 0.694 0.690 0.486 0.466
 4 1.033 1.153 0.963 0.579 1.043 1.041 0.558 0.619 0.610 0.508
 5 0.857 0.941 0.949 0.675 1.005 0.601 0.549 0.555 0.453 0.692
 6 0.538 0.648 0.710 0.398 0.647 0.609 0.395 0.520 0.450 0.523
 7 0.385 0.642 0.661 0.392 0.524 0.473 0.401 0.473 0.392 0.631
 8 0.498 0.370 0.374 0.325 0.474 0.280 0.311 0.448 0.855 0.371
 9 0.369 0.408 0.297 0.276 0.659 0.778 0.199 0.231 0.567 0.345
 10 0.369 0.408 0.297 0.276 0.659 0.778 0.199 0.231 0.567 0.345
```

Table 6.3.5.1. (cont.) Plaice in VIId. XSA diagnostics

```
 XSA population number ( thousands )
 age
year 1 2 3 4 5 6 7 8 9 10
 1998 14941 33727 20038 5581 981 361 447 217 177 639
 1999 17801 13078 26332 9923 1798 377 191 275 119 347
 2000 17040 15402 10161 12312 2834 635 178 91 172 400
 2001 21434 14103 8026 5119 4253 993 282 83 57 339
 2002 20655 16843 8805 3095 2595 1960 603 173 54 199
 2003 16429 17832 8388 3029 987 860 929 323 97 120
 2004 15035 14251 11499 2198 968 490 423 524 221 279
 2005 13812 12685 8173 5200 1139 506 298 256 347 245
 2006 16422 12189 8548 3708 2535 592 272 168 148 174
 2007 38900 14375 8150 4759 1824 1458 341 166 65 265
 Estimated population abundance at 1st Jan 2008
 age
year 1 2 3 4 5 6 7 8 9 10
 2008 0 34541 10388 4626 2590 826 782 164 104 42
 Fleet: UK B TRAWL
 Log catchability residuals.
 year
age 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000
 2 0.079 -0.143 -0.388 -0.136 0.131 0.319 -0.139 -0.778 -0.502 0.163
 3 0.313 0.216 -0.361 -0.208 0.155 -0.489 0.172 -0.623 0.176 -0.175
 4 0.363 0.520 -0.114 -0.047 0.118 -0.639 -0.753 -0.068 -0.621 0.493
 5 0.060 0.290 -0.025 0.153 0.287 -0.241 -0.531 -0.291 -0.008 0.306
 6 0.123 0.249 -0.085 -0.120 0.151 -0.163 -0.200 -0.148 -0.549 0.608
 7 -0.196 0.192 -0.004 -0.019 -0.034 -0.763 0.311 0.499 -0.770 0.569
 8 -0.223 0.360 0.073 -0.346 0.220 -0.167 0.244 0.220 -0.054 0.249
 9 -0.391 -0.244 0.314 0.231 0.183 -0.199 0.148 0.220 -0.251 0.359
 year
age 2001 2002 2003 2004 2005 2006 2007
 2 -0.250 0.104 0.564 0.190 0.378 0.505 -0.094
 3 -0.076 0.187 -0.119 0.639 -0.105 0.251 0.048
 4 -0.053 -0.107 0.326 0.120 0.272 0.129 0.061
 5 0.540 -0.526 -0.206 0.138 -0.185 0.219 0.020
 6 0.223 0.183 -0.237 -0.066 0.328 -0.238 -0.059
 7 0.325 -0.476 0.255 0.000 -0.322 0.471 -0.038
 8 1.013 0.334 0.918 0.449 -0.298 0.567 0.262
 9 0.328 0.017 -0.437 0.439 0.213 0.059 0.151
 Mean log catchability and standard error of ages with catchability
 independent of year class strength and constant w.r.t. time
 2 3 4 5 6 7 8
Mean_Logq -12.3834 -12.1025 -12.2314 -12.3561 -12.3911 -12.5040 -12.5040
S.E_Logq 0.3581 0.3163 0.3765 0.2985 0.2729 0.4067 0.3838
 9
Mean_Logq -12.5040
S.E_Logq 0.2723
```

Table 6.3.5.1. (cont.) Plaice in VIId. XSA diagnostics

```
 Fleet: BE BEAM TRAWL
 Log catchability residuals.
 year
age 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990
 2 0.016 -0.162 0.487 -1.242 0.492 0.570 0.400 0.142 -1.943 0.363
 3 0.382 -0.283 0.018 0.025 -0.051 0.066 -0.408 -0.118 -0.333 0.487
 4 0.415 0.066 0.365 -0.012 0.017 -0.245 -0.344 -0.477 -0.116 0.055
 5 -0.534 0.039 -0.286 0.067 -1.243 -0.372 -0.501 -0.769 0.276 -0.197
 6 -0.648 -0.206 -0.194 0.251 0.364 0.004 -1.048 -0.714 0.195 -0.143
 7 -0.204 -0.365 -0.515 0.349 0.117 -0.062 0.329 -0.275 0.019 -0.587
 8 0.082 0.408 0.883 -0.185 0.602 -0.862 -0.324 -0.404 -0.192 -0.065
 9 0.082 0.159 0.153 -0.239 -0.861 -0.437 0.253 -0.095 -0.220 -0.917
 year
age 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000
 2 1.023 1.299 0.508 0.964 -1.634 -0.165 NA -0.873 -1.477 -1.355
 3 0.815 0.554 -0.126 0.139 0.122 -0.066 -1.453 -0.254 -0.030 -0.923
 4 0.143 -0.263 -0.448 0.647 0.133 0.213 0.534 0.299 0.412 -1.123
 5 0.530 -0.312 -0.224 0.111 0.263 0.380 1.207 0.435 0.819 -0.379
 6 0.562 0.254 -0.224 -0.027 -0.184 0.063 0.856 0.439 0.838 -0.391
 7 -0.115 -0.224 -0.372 0.012 0.624 -0.324 0.802 0.218 0.574 -0.384
 8 -0.103 0.041 -0.618 -0.032 0.260 0.143 -0.121 0.205 -0.546 -0.558
 9 0.937 1.095 -1.076 0.016 -0.578 0.064 0.033 0.359 0.343 -0.664
 year
age 2001 2002 2003 2004 2005 2006 2007
 2 0.514 0.393 0.232 0.285 0.150 0.399 0.616
 3 0.906 0.582 0.637 0.226 -0.141 -0.355 -0.418
 4 0.225 0.377 0.328 -0.151 -0.289 -0.144 -0.618
 5 0.112 0.525 -0.043 0.048 0.207 -0.287 0.128
 6 -0.049 -0.490 0.588 -0.211 0.107 -0.279 0.285
 7 -0.263 -0.123 0.185 0.312 0.035 -0.309 0.547
 8 -0.121 -0.771 -0.504 -0.226 0.056 0.562 -0.425
 9 0.041 -0.188 0.603 -0.771 -0.854 0.543 -0.747
 Mean log catchability and standard error of ages with catchability
 independent of year class strength and constant w.r.t. time
 2 3 4 5 6 7 8 9
Mean_Logq -7.4894 -5.6787 -5.1501 -5.2406 -5.5243 -5.5609 -5.5609 -5.5609
S.E_Logq 0.8712 0.5096 0.3981 0.5023 0.4563 0.3713 0.4239 0.5724
 Fleet: FR TRAWL-1
 Log catchability residuals.
 year
age 1989 1990 1991 1992 1993 1994 1995 1996
 2 -0.140 -0.301 0.508 0.266 0.177 0.167 0.017 -0.695
 3 -0.136 0.070 0.219 0.354 -0.200 0.277 -0.371 -0.213
 4 0.268 0.301 0.615 -0.140 -0.322 -0.188 -0.264 -0.271
 5 0.797 0.423 0.069 0.157 -1.048 0.250 -0.800 0.151
 6 0.385 0.612 0.093 0.547 -0.297 -0.128 -1.171 -0.040
 7 0.272 0.516 -0.135 0.356 -0.175 -0.070 -0.798 0.035
 8 0.671 0.646 -0.088 -0.282 -0.658 0.260 -0.290 0.160
 9 1.109 1.483 0.068 0.170 -0.152 -0.279 -0.208 0.381
 Mean log catchability and standard error of ages with catchability
 independent of year class strength and constant w.r.t. time
```

Table 6.3.5.1. (cont.) Plaice in VIId. XSA diagnostics

```
 2 3 4 5 6 7 8
Mean_Logq -11.5810 -11.0057 -11.1907 -11.5698 -11.8483 -12.0783 -12.0783
S.E_Logq 0.3744 0.2662 0.3470 0.6174 0.5741 0.4068 0.4695
 9
Mean_Logq -12.0783
S.E_Logq 0.6464
```

Table 6.3.5.1. (cont.) Plaice in VIId. XSA diagnostics

```
 Fleet: FR TRAWL-2
 Log catchability residuals.
 year
age 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006
 2 -0.620 -0.909 -0.101 0.545 0.477 0.623 0.058 0.872 -0.144 -0.184
```

```
 3 0.491 -0.040 0.276 -0.305 0.293 -0.342 0.753 0.138 -0.051 -0.593
 4 0.757 0.629 0.670 0.353 -0.288 -0.436 0.384 -0.315 -0.368 -0.673
 5 0.106 0.677 0.418 0.828 0.301 -0.259 0.023 -0.053 -0.821 -0.838
 6 0.632 -0.094 0.202 0.735 -0.136 -0.046 0.016 0.067 -0.257 -0.255
 7 0.848 -0.521 0.747 0.407 0.037 -0.302 0.024 -0.349 -0.011 -0.359
 8 0.721 0.126 0.205 -0.294 -1.509 -0.425 -0.450 -0.514 -0.264 0.339
 9 0.353 -0.678 -0.617 -0.218 -1.300 -0.376 0.887 -1.124 -1.023 -0.737
 year
age 2007
 2 -0.618
 3 -0.619
 4 -0.714
 5 -0.384
 6 -0.865
 7 -0.521
 8 -0.565
 9 -0.374
 Mean log catchability and standard error of ages with catchability
 independent of year class strength and constant w.r.t. time
 2 3 4 5 6 7 8
Mean_Logq -11.4875 -10.7296 -10.7750 -11.1682 -11.4671 -11.7111 -11.7111
S.E_Logq 0.5773 0.4402 0.5622 0.5490 0.4352 0.4827 0.5887
 9
Mean_Logq -11.7111
S.E_Logq 0.6448
 Fleet: UK BTS
 Log catchability residuals.
 year
age 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997
 1 0.195 -0.771 -0.415 -0.076 -0.085 -0.430 -0.099 -0.193 -0.280 0.059
 2 0.227 -0.571 -0.913 -0.218 -0.096 -0.315 -0.147 -1.022 -0.347 -0.560
 3 0.455 0.023 -0.731 0.112 -0.230 -0.475 -0.016 -0.454 -1.612 -0.708
 4 -0.151 0.339 -0.289 -0.045 0.250 -0.563 0.284 -0.270 -1.290 -1.299
 5 0.552 -0.207 -0.067 0.103 0.579 -0.196 0.035 -0.495 -0.694 -1.129
 6 0.030 0.188 0.043 -0.171 0.800 -0.088 -0.511 -0.526 -0.331 -1.118
 year
age 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007
 1 0.168 0.038 0.171 0.186 0.260 -0.233 0.810 0.194 0.324 0.178
 2 -0.115 0.175 0.658 0.154 0.319 0.461 0.340 1.088 0.471 0.413
 3 -0.698 -0.115 0.692 0.729 0.446 0.413 0.548 0.932 0.355 0.334
 4 -0.097 -0.665 0.561 0.536 0.620 0.452 0.632 0.917 0.112 -0.034
 5 -0.984 -0.334 0.469 1.029 -0.073 0.525 -0.063 0.948 -0.025 0.028
 6 -0.514 -0.487 0.534 0.640 0.725 0.050 -0.907 0.931 0.325 0.385
```

Table 6.3.5.1. (cont.) Plaice in VIId. XSA diagnostics

```
 Mean log catchability and standard error of ages with catchability
 independent of year class strength and constant w.r.t. time
 2 3 4 5 6
Mean_Logq -6.8495 -6.8236 -6.6937 -6.5127 -6.5879
S.E_Logq 0.5318 0.6335 0.6073 0.5750 0.5748
 Regression statistics
 Ages with q dependent on year class strength
 slope intercept
Age 1 0.7406028 7.975296
 Fleet: FR GFS
 Log catchability residuals.
 year
age 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998
 1 -0.879 -2.991 -2.708 -4.794 4.962 4.041 -1.614 -2.306 -3.291 4.212 2.093
 2 0.480 -0.242 -1.487 -0.781 -0.453 0.144 -0.492 -0.462 -1.018 -0.222 0.032
 3 0.115 -0.699 -0.338 -0.870 0.158 0.451 -1.297 -0.323 -1.960 0.497 -0.380
 year
age 1999 2000 2001 2002 2003 2004 2005 2006 2007
 1 -0.406 1.100 -0.281 1.623 -1.051 1.282 -0.834 2.061 -0.218
 2 -0.221 1.147 -0.287 0.351 0.438 0.753 1.017 0.838 0.465
 3 0.307 0.377 -0.196 0.852 0.175 0.627 1.379 0.574 0.550
 Mean log catchability and standard error of ages with catchability
 independent of year class strength and constant w.r.t. time
 2 3
Mean_Logq -7.6023 -7.7805
S.E_Logq 0.6943 0.7806
 Regression statistics
 Ages with q dependent on year class strength
 slope intercept
Age 1 1.982731 5.444778
 Fleet: Intl YFS
 Log catchability residuals.
 year
age 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998
 1 0.123 0.195 0.053 0.065 -0.182 0.422 0.459 0.235 0.499 -0.379 -0.475 0.342
 year
age 1999 2000 2001 2002 2003 2004 2005 2006
 1 0.195 -0.133 0.107 0.172 -0.786 0.335 -0.766 -0.483
```

Table 6.3.5.1. (cont.) Plaice in VIId. XSA diagnostics

```
 Regression statistics
 Ages with q dependent on year class strength
 slope intercept
Age 1 0.8699577 10.12668
 Terminal year survivor and F summaries:

 Age 1 Year class = 2006
source
 survivors N scaledWts
UK BTS 43917 1 0.716
FR GFS 30939 1 0.094
fshk 14785 1 0.191
 Age 2 Year class = 2005
source
 survivors N scaledWts

UK B TRAWL 9451 1 0.278

BE BEAM TRAWL 19227 1 0.048
FR TRAWL-2 5601 1 0.104
UK BTS 15912 2 0.283
FR GFS 18497 2 0.093
Intl YFS 5965 1 0.148
fshk 5342 1 0.047
 Age 3 Year class = 2004
source
 survivors N scaledWts
UK B TRAWL 5735 2 0.356
BE BEAM TRAWL 3591 2 0.111
FR TRAWL-2 2840 2 0.162
UK BTS 6558 3 0.191
FR GFS 8198 3 0.081
Intl YFS 1918 1 0.060
fshk 2166 1 0.038
 Age 4 Year class = 2003
source
 survivors N scaledWts
UK B TRAWL 3157 3 0.354
BE BEAM TRAWL 1570 3 0.200
FR TRAWL-2 1476 3 0.158
UK BTS 4457 4 0.162
FR GFS 5616 3 0.046
Intl YFS 3805 1 0.042
fshk 1459 1 0.037
 Age 5 Year class = 2002
source
 survivors N scaledWts
UK B TRAWL 856 4 0.425
BE BEAM TRAWL 820 4 0.197
FR TRAWL-2 616 4 0.150
UK BTS 944 5 0.146
FR GFS 2121 3 0.020
Intl YFS 335 1 0.014
fshk 928 1 0.047
```

Table 6.3.5.1. (cont.) Plaice in VIId. XSA diagnostics

```
 Age 6 Year class = 2001
source
 survivors N scaledWts
UK B TRAWL 892 5 0.443
BE BEAM TRAWL 798 5 0.194
FR TRAWL-2 397 5 0.174
UK BTS 1116 6 0.135
FR GFS 1377 3 0.011
Intl YFS 953 1 0.010
fshk 776 1 0.033
 Age 7 Year class = 2000
source
 survivors N scaledWts
UK B TRAWL 144 6 0.403
BE BEAM TRAWL 211 6 0.275
FR TRAWL-2 110 6 0.194
UK BTS 282 6 0.081
FR GFS 204 3 0.004
Intl YFS 186 1 0.003
fshk 251 1 0.040
 Age 8 Year class = 1999
source
 survivors N scaledWts
UK B TRAWL 141 7 0.397
BE BEAM TRAWL 82 7 0.317
FR TRAWL-2 74 7 0.192
UK BTS 176 6 0.055
FR GFS 146 3 0.002
Intl YFS 89 1 0.002
fshk 77 1 0.035
 Age 9 Year class = 1998
source
 survivors N scaledWts
UK B TRAWL 46 8 0.538
BE BEAM TRAWL 37 8 0.247
FR TRAWL-2 40 8 0.141
UK BTS 33 6 0.029
FR GFS 57 3 0.001
Intl YFS 52 1 0.001
fshk 26 1 0.042
```

Table 6.3.5.2. Plaice in VIId. Fishing mortality (F) at age

age	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
1	0.002	0.001	0.011	0.005	0.015	0.005	0.012	0.001	0.001	0.054
2	0.169	0.119	0.134	0.153	0.116	0.314	0.213	0.180	0.205	0.174
3	0.277	0.742	0.500	0.451	0.580	0.601	0.697	0.515	0.659	0.449
4	0.386	0.873	0.892	0.949	0.808	0.869	0.772	0.797	0.666	0.730
5	0.628	0.328	0.672	0.596	0.810	0.225	0.611	0.583	0.569	0.845
6	0.406	0.376	0.363	0.377	0.725	0.598	0.477	0.321	0.472	0.590
7	0.365	0.472	0.363	0.243	0.751	0.449	0.471	0.759	0.557	0.439
8	0.222	0.606	1.666	0.955	0.407	0.732	0.306	0.516	0.447	0.409
9	0.332	0.431	0.617	0.365	0.679	1.442	0.260	0.923	0.711	0.507
10	0.332	0.431	0.617	0.365	0.679	1.442	0.260	0.923	0.711	0.507

age	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1	0.095	0.077	0.064	0.061	0.078	0.115	0.039	0.015	0.033	0.045
2	0.219	0.504	0.442	0.409	0.413	0.378	0.290	0.184	0.148	0.152
3	0.701	0.822	0.799	0.476	0.718	0.610	0.549	0.800	0.603	0.660
4	0.731	0.870	0.591	0.482	0.798	0.668	0.672	1.466	1.033	1.153
5	0.602	0.664	0.515	0.329	0.619	0.510	0.724	1.346	0.857	0.941
6	0.580	0.555	0.591	0.347	0.404	0.293	0.493	0.955	0.538	0.648
7	0.458	0.371	0.417	0.335	0.365	0.452	0.351	1.110	0.385	0.642
8	0.561	0.381	0.427	0.268	0.434	0.433	0.513	0.726	0.498	0.370
9	0.810	0.621	0.683	0.357	0.393	0.321	0.577	0.653	0.369	0.408
10	0.810	0.621	0.683	0.357	0.393	0.321	0.577	0.653	0.369	0.408

age	2000	2001	2002	2003	2004	2005	2006	2007
1	0.089	0.141	0.047	0.042	0.070	0.025	0.033	0.019
2	0.552	0.371	0.597	0.339	0.456	0.295	0.303	0.225
3	0.586	0.853	0.967	1.239	0.694	0.690	0.486	0.466
4	0.963	0.579	1.043	1.041	0.558	0.619	0.610	0.508
5	0.949	0.675	1.005	0.601	0.549	0.555	0.453	0.692
6	0.710	0.398	0.647	0.609	0.395	0.520	0.450	0.523
7	0.661	0.392	0.524	0.473	0.401	0.473	0.392	0.631
8	0.374	0.325	0.474	0.280	0.311	0.448	0.855	0.371
9	0.297	0.276	0.659	0.778	0.199	0.231	0.567	0.345
10	0.297	0.276	0.659	0.778	0.199	0.231	0.567	0.345

Table 6.3.5.3. Plaice in VIId. Stock number at age

age	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
1	25448	12950	25116	19885	25006	29763	60647	31495	26521	16396
2	17856	22976	11702	22474	17905	22293	26795	54230	28474	23982
3	6311	13642	18463	9264	17453	14422	14736	19600	40985	20998
4	1774	4330	5880	10134	5339	8839	7156	6643	10593	19189
5	1104	1091	1637	2180	3549	2154	3353	2991	2708	4924
6	236	533	711	757	1087	1429	1556	1647	1511	1387
7	155	142	331	448	470	476	711	874	1081	852
8	232	97	80	208	318	200	275	402	370	561
9	15	168	48	14	73	191	87	183	217	214
10	382	598	200	346	212	68	156	133	357	518

age	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1	18912	21750	28060	13250	17315	25121	30584	37852	14941	17801
2	14050	15560	18213	23806	11285	14486	20265	26609	33727	13078
3	18239	10214	8505	10589	14305	6755	8979	13726	20038	26332
4	12125	8184	4062	3462	5951	6316	3322	4694	5581	9923
5	8371	5280	3102	2035	1935	2425	2929	1535	981	1798
6	1913	4147	2459	1677	1326	943	1317	1285	361	377
7	696	969	2153	1232	1073	801	636	728	447	191
8	497	398	605	1285	797	674	461	405	217	275
9	337	257	246	357	889	467	396	250	177	119
10	434	283	249	531	1005	985	828	667	639	347

age	2000	2001	2002	2003	2004	2005	2006	2007	2008
1	17040	21434	20655	16429	15035	13812	16422	38900	16960**
2	15402	14103	16843	17832	14251	12685	12189	14375	34541
3	10161	8026	8805	8388	11499	8173	8548	8150	10388
4	12312	5119	3095	3029	2198	5200	3708	4759	4626
5	2834	4253	2595	987	968	1139	2535	1824	2590
6	635	993	1960	860	490	506	592	1458	826
7	178	282	603	929	423	298	272	341	782
8	91	83	173	323	524	256	168	166	164
9	172	57	54	97	221	347	148	65	104
10	400	339	199	120	279	245	174	265	212

** GM : 1998- 2005

Table 6.3.5.4. Plaice in VIId. Summary table

	Recruitment (age 1)	ssb	catch	landings	fbar3−6	Y/ssb
1980	25448	5525	2650	2650	0.42	0.48
1981	12950	6559	4769	4769	0.58	0.73
1982	25116	7472	4865	4865	0.61	0.65
1983	19885	8046	5043	5043	0.59	0.63
1984	25006	7268	5161	5161	0.73	0.71
1985	29763	7898	6022	6022	0.57	0.76
1986	60647	10004	6834	6834	0.64	0.68
1987	31495	13194	8366	8366	0.55	0.63
1988	26521	13043	10420	10420	0.59	0.8
1989	16396	14370	8758	8758	0.65	0.61
1990	18912	14632	9047	9047	0.65	0.62
1991	21750	10291	7813	7813	0.73	0.76
1992	28060	8861	6337	6337	0.62	0.72
1993	13250	8195	5331	5331	0.41	0.65
1994	17315	8931	6121	6121	0.63	0.69
1995	25121	8053	5130	5130	0.52	0.64
1996	30584	6786	5393	5393	0.61	0.79
1997	37852	7103	6307	6307	1.14	0.89
1998	14941	7916	5762	5762	0.76	0.73
1999	17801	8504	6326	6326	0.85	0.74
2000	17040	6592	6015	6015	0.8	0.91
2001	21434	6462	5266	5266	0.63	0.81
2002	20655	6069	5777	5777	0.92	0.95
2003	16429	4409	4536	4536	0.87	1.03
2004	15035	4926	4007	4007	0.55	0.81
2005	13812	4742	3446	3446	0.6	0.73
2006	16422	4747	3305	3305	0.5	0.7
2007	38900	5306	3510	3510	0.55	0.66

Table 6.5.1. Plaice in VIId. RCT3 input

year class	XSA (Age 1)	XSA (Age 2)	yfs0	yfs1	bts1	gfs0	gfs1
1986	31495	28474	-11	144	-11	-11	-11
1987	26521	23982	1168	132	2647	-11	80
1988	16396	14050	556	58	231	19	35
1989	18912	15560	397	71	516	16	39
1990	21750	18213	342	62	1175	1	25
1991	28060	23806	436	178	1653	1	344
1992	13250	11285	404	84	322	9	187
1993	17315	14486	370	79	833	44	50
1994	25121	20265	869	168	1132	38	49
1995	30584	26609	687	66	1320	14	45
1996	37852	33727	407	82	3310	213	345
1997	14941	13078	223	80	1140	85	124
1998	17801	15402	530	76	1130	78	71
1999	17040	14103	381	48	1319	9	98
2000	21434	16843	514	83	1791	166	74
2001	20655	17832	374	92	2066	46	128
2002	16429	14251	67	20	618	2	58
2003	15035	12685	486	78	3618	97	98
2004	13812	-11	483	17	1084	21	57
2005	-11	-11	219	30	1721	12	129
2006	-11	-11	762	-11	4261	1280	113
2007	-11	-11	-11	-11	-11	10	-11

Table 6.5.2. Plaice in VIId. RCT3 results (Age 1)

```
Analysis by RCT3 ver3.1 of data from file :
 pl7 drec1.txt
 7D Plaice (1 year old)
 Data for 5 surveys over 22 years : 1986 – 2007
 Regression type = C
 Tapered time weighting not applied
 Survey weighting not applied
 Final estimates shrunk towards mean
 Minimum S.E. for any survey taken as .00
 Minimum of 3 points used for regression
 Forecast/Hindcast variance correction used.
```

Table 6.5.2. (cont.) Plaice in VIId. RCT3 results (Age 1)

```
Yearclass = 2005
I-----------Regression----------I I-----------Prediction---------I
Survey/ Slope Inter- Std Rsquare No. Index Predicted Std WAP
Series cept Error Pts Value Value Error Weights
yfs0 1.37 1.63 .77 .134 18 5.39 9.00 .865 .069
yfs1   .95 5.83 .48 .298 19 3.43 9.08 .551 .171
bts1   .78 4.40 .51 .262 18 7.45 10.21 .557 .167
gfs0   3.39 -.86 5.03 .004 17 2.56 7.82 5.540 .002
gfs1   1.65 2.65 1.19 .061 18 4.87 10.67 1.310 .030
VPA Mean = 9.92 .304 .561
Yearclass = 2006
I-----------Regression----------I I-----------Prediction---------I
Survey/ Slope Inter- Std Rsquare No. Index Predicted Std WAP
Series cept Error Pts Value Value Error Weights
yfs0 1.37 1.63 .77 .134 18 6.64 10.70 .859 .087
yfs1
bts1   .78 4.40 .51 .262 18 8.36 10.92 .599 .179
gfs0   3.39 -.86 5.03 .004 17 7.16 23.36 6.638 .001
gfs1   1.65 2.65 1.19 .061 18 4.74 10.46 1.302 .038
VPA Mean = 9.92 .304 .695
Yearclass = 2007
I-----------Regression----------I I-----------Prediction---------I
Survey/ Slope Inter- Std Rsquare No. Index Predicted Std WAP
Series cept Error Pts Value Value Error Weights
yfs0
yfs1
bts1
gfs0   3.39 -.86 5.03 .004 17 2.40 7.26 5.558 .003
gfs1
VPA Mean = 9.92 .304 .997
Year Weighted Log Int Ext Var VPA Log
Class Average WAP Std Std Ratio VPA
Prediction Error Error
2005 17701 9.78 .23 .20 .76
2006 27060 10.21 .25 .33 1.65
2007 20179 9.91 .30 .15 .23
```

Table 6.5.3. Plaice in VIId. RCT3 results (Age 2)

```
Analysis by RCT3 ver3.1 of data from file :
 pl7 drec2.txt
 7D Plaice (2 years old)
 Data for 5 surveys over 22 years : 1986 – 2007
 Regression type = C
 Tapered time weighting not applied
 Survey weighting not applied
 Final estimates shrunk towards mean
 Minimum S.E. for any survey taken as .00
 Minimum of 3 points used for regression
 Forecast/Hindcast variance correction used.
 Yearclass = 2005
 I-----------Regression----------I I-----------Prediction---------I
 Survey/ Slope Inter- Std Rsquare No. Index Predicted Std WAP
 Series cept Error Pts Value Value Error Weights
 yfs0   1.28 2.01 .74 .147 17 5.39 8.92 .835 .081
 yfs1   1.39 3.68 .62 .210 18 3.43 8.45 .748 .101
 bts1   .73 4.59 .48 .286 17 7.45 10.05 .534 .198
 gfs0   3.49 -1.36 5.37 .003 16 2.56 7.60 5.949 .002
 gfs1   1.58 2.77 1.17 .064 17 4.87 10.47 1.293 .034
 VPA Mean = 9.78 .311 .584
 Yearclass = 2006
 I-----------Regression----------I I-----------Prediction---------I
 Survey/ Slope Inter- Std Rsquare No. Index Predicted Std WAP
 Series cept Error Pts Value Value Error Weights
 yfs0   1.28 2.01 .74 .147 17 6.64 10.52 .830 .094
 yfs1
 bts1   .73 4.59 .48 .286 17 8.36 10.71 .574 .196
 gfs0   3.49 -1.36 5.37 .003 16 7.16 23.62 7.121 .001
 gfs1   1.58 2.77 1.17 .064 17 4.74 10.26 1.286 .039
 VPA Mean = 9.78 .311 .670
```

Table 6.5.3. (cont.) Plaice in VIId. RCT3 results (Age 2)

```
Yearclass = 2007
I-----------Regression----------I I-----------Prediction---------I
Survey/ Slope Inter- Std Rsquare No. Index Predicted Std WAP
Series cept Error Pts Value Value Error Weights
yfs0
yfs1
bts1
gfs0    3.49 -1.36 5.37 .003 16 2.40 7.01 5.968 .003
gfs1
VPA Mean = 9.78 .311 .997

Year Weighted Log Int Ext Var VPA Log
Class Average WAP Std Std Ratio VPA
Prediction Error Error
2005 15521 9.65 .24 .23 .92
2006 23622 10.07 .25 .31 1.51
2007 17589 9.78 31 .31 14.21
```

Table 6.6.1. Plaice in VIId. Input to catch forecast

Age	Stock	Mat	M	F
1	16960	0	0.1	0.03
2	34541	0.15	0.1	0.27
3	10388	0.53	0.1	0.55
4	4626	0.96	0.1	0.58
5	2590	1	0.1	0.57
6	826	1	0.1	0.5
7	782	1	0.1	0.5
8	164	1	0.1	0.56
9	104	1	0.1	0.38
10	212	1	0.1	0.38

Table 6.6.2. Plaice in VIId. Management option table

2008

fmult	f3−6	landings	catch	ssb
1	0.547	5312	5312	6489

2009

fmult	f3−6	landings	catch	ssb 2009	ssb 2010
0	0.000	0	0	8117	13956
0.1	0.055	971	971	8117	13289
0.2	0.109	1815	1815	8117	12656
0.3	0.164	2547	2547	8117	12056
0.4	0.219	3179	3179	8117	11486
0.5	0.274	3723	3723	8117	10945
0.6	0.328	4188	4188	8117	10432
0.7	0.383	4585	4585	8117	9945
0.8	0.438	4921	4921	8117	9483
0.9	0.493	5204	5204	8117	9044
1	0.547	5439	5439	8117	8628
1.1	0.602	5633	5633	8117	8232
1.2	0.657	5791	5791	8117	7856
1.3	0.712	5917	5917	8117	7500
1.4	0.766	6015	6015	8117	7161
1.5	0.821	6090	6090	8117	6839
1.6	0.876	6143	6143	8117	6534
1.7	0.930	6178	6178	8117	6243
1.8	0.985	6197	6197	8117	5968
1.9	1.040	6203	6203	8117	5706
2	1.095	6197	6197	8117	5457

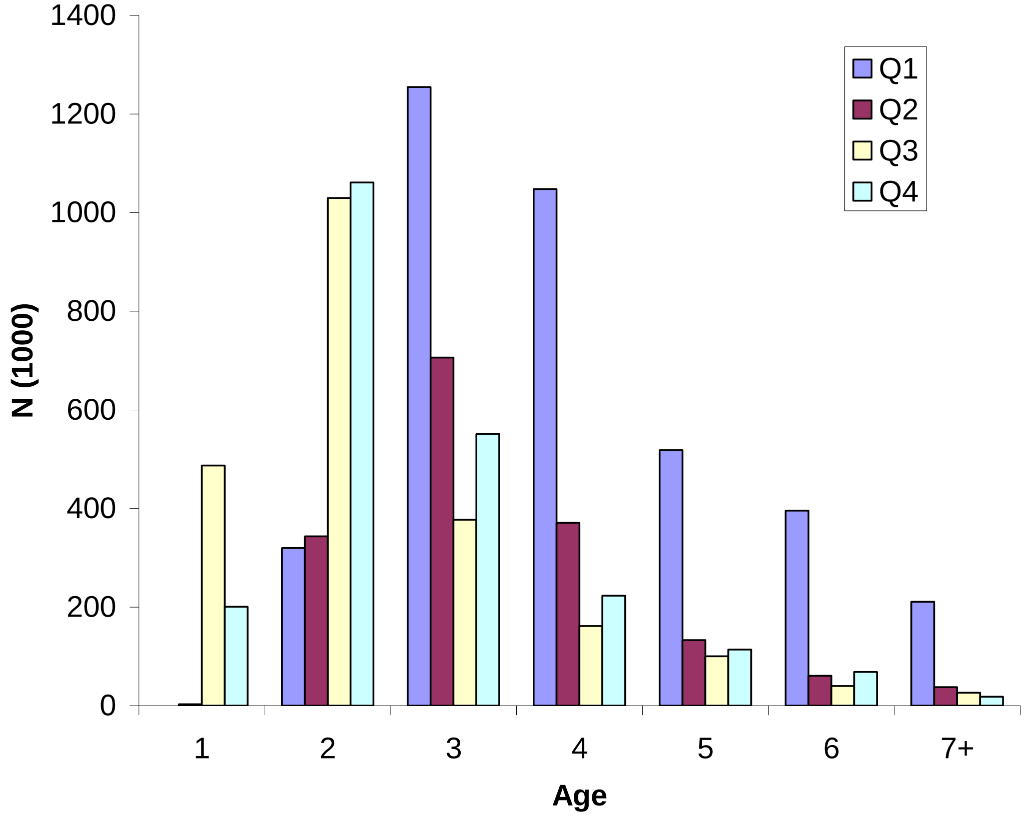
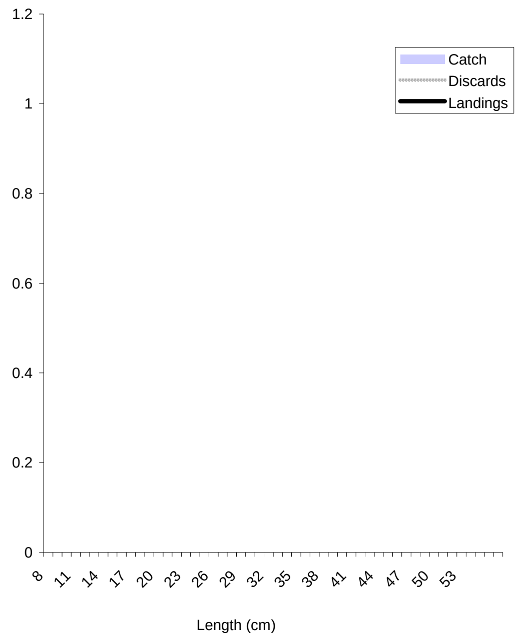
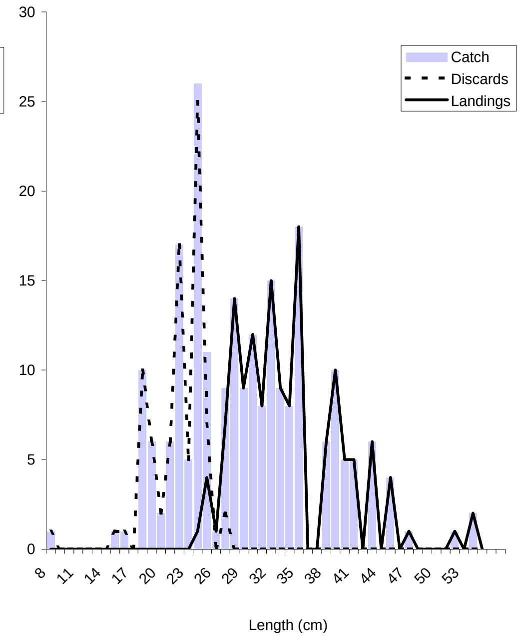


Figure 6.1.2.1. Plaice in VIId. Age distribution in the landings per quarter

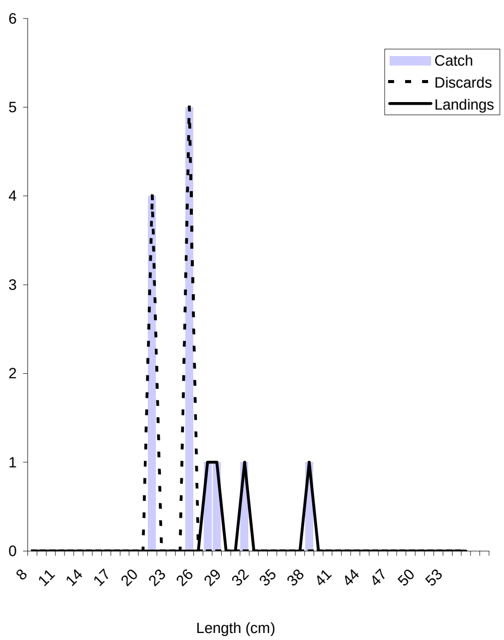
Plaice VIId France, Trawl Quarter 1, Year 2006
No sample



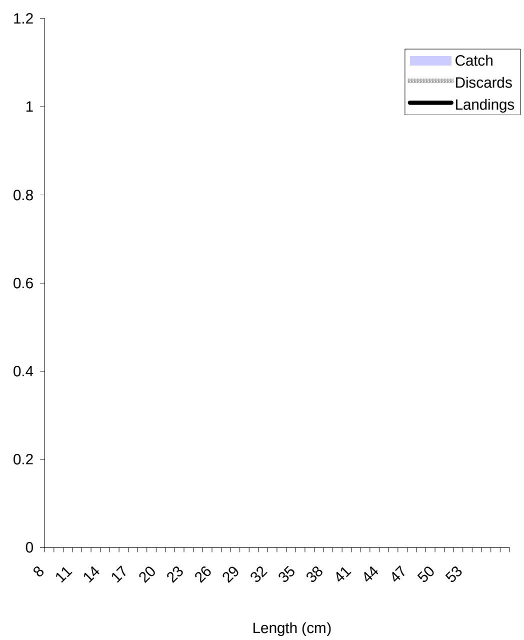
France, Trawl Quarter 2, Year 2006
5 trips, 20 hauls / 59 total



France, Trawl Quarter 3, Year 2006
4 trips, 14 hauls / 26 total



France, Trawl Quarter 4, Year 2006
No sample



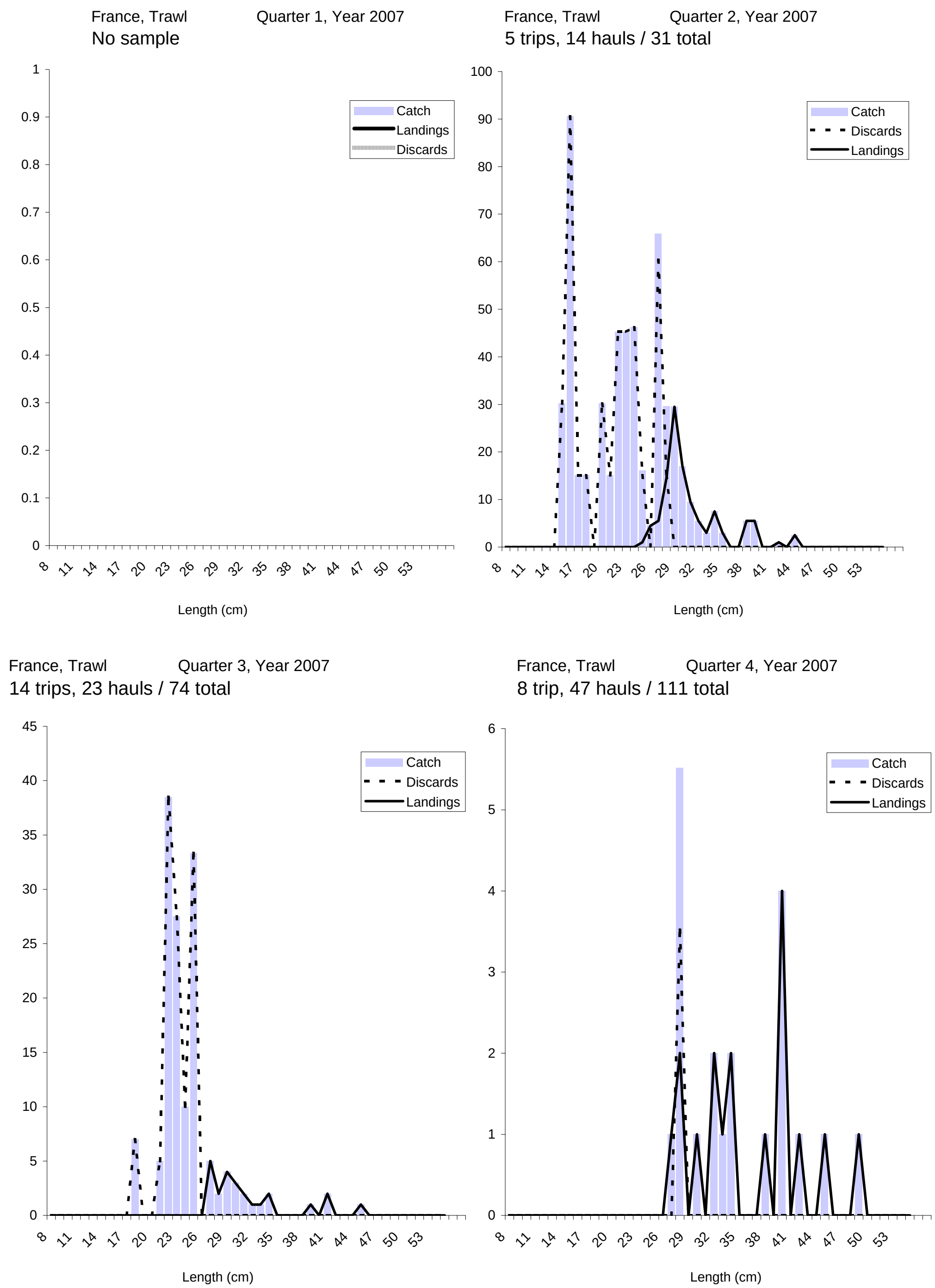
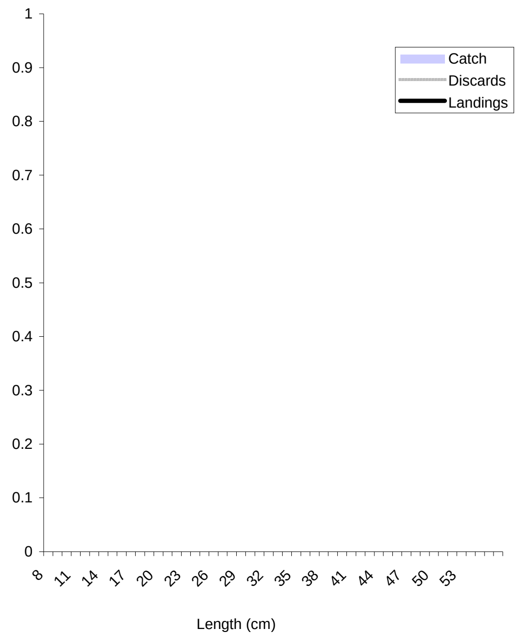
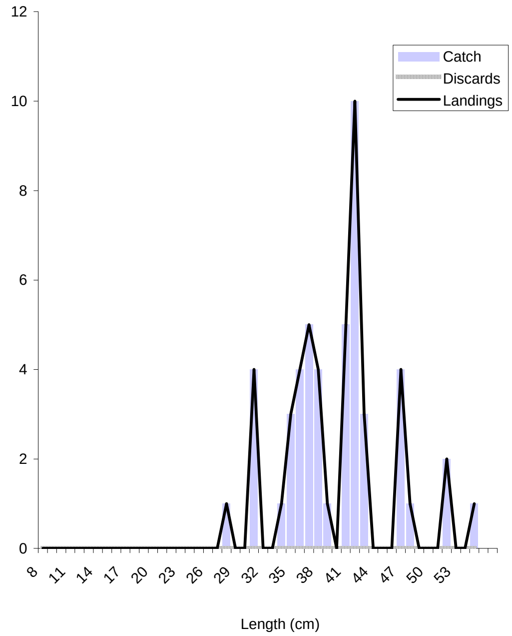


Figure 6.2.1.1a–Plaice VIId–Length structure of discards and landings collected by observations on board

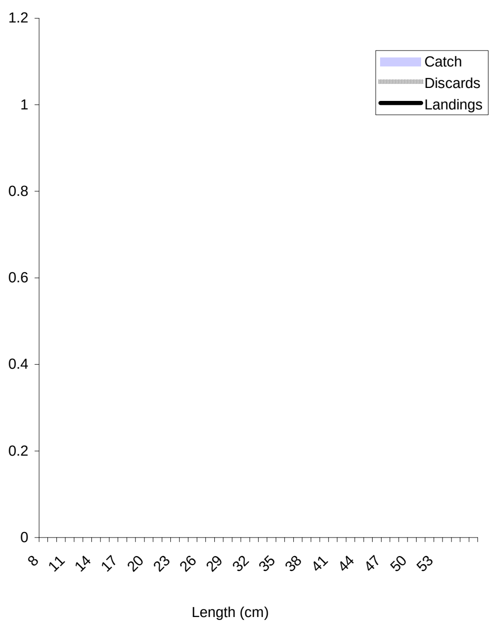
Plaice VIId France, Gillnet Quarter 1, Year 2006
No sample



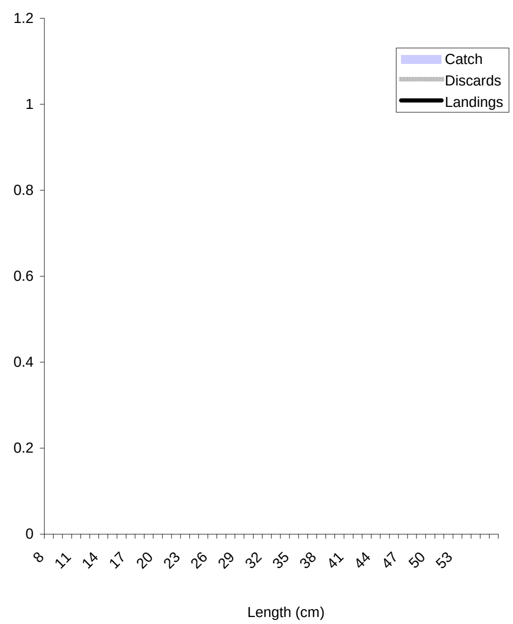
France, Gillnet Quarter 2, Year 2006
1 trips, 12 FO / total



France, Gillnet Quarter 3, Year 2006
No sample



France, Gillnet Quarter 4, Year 2006
No sample



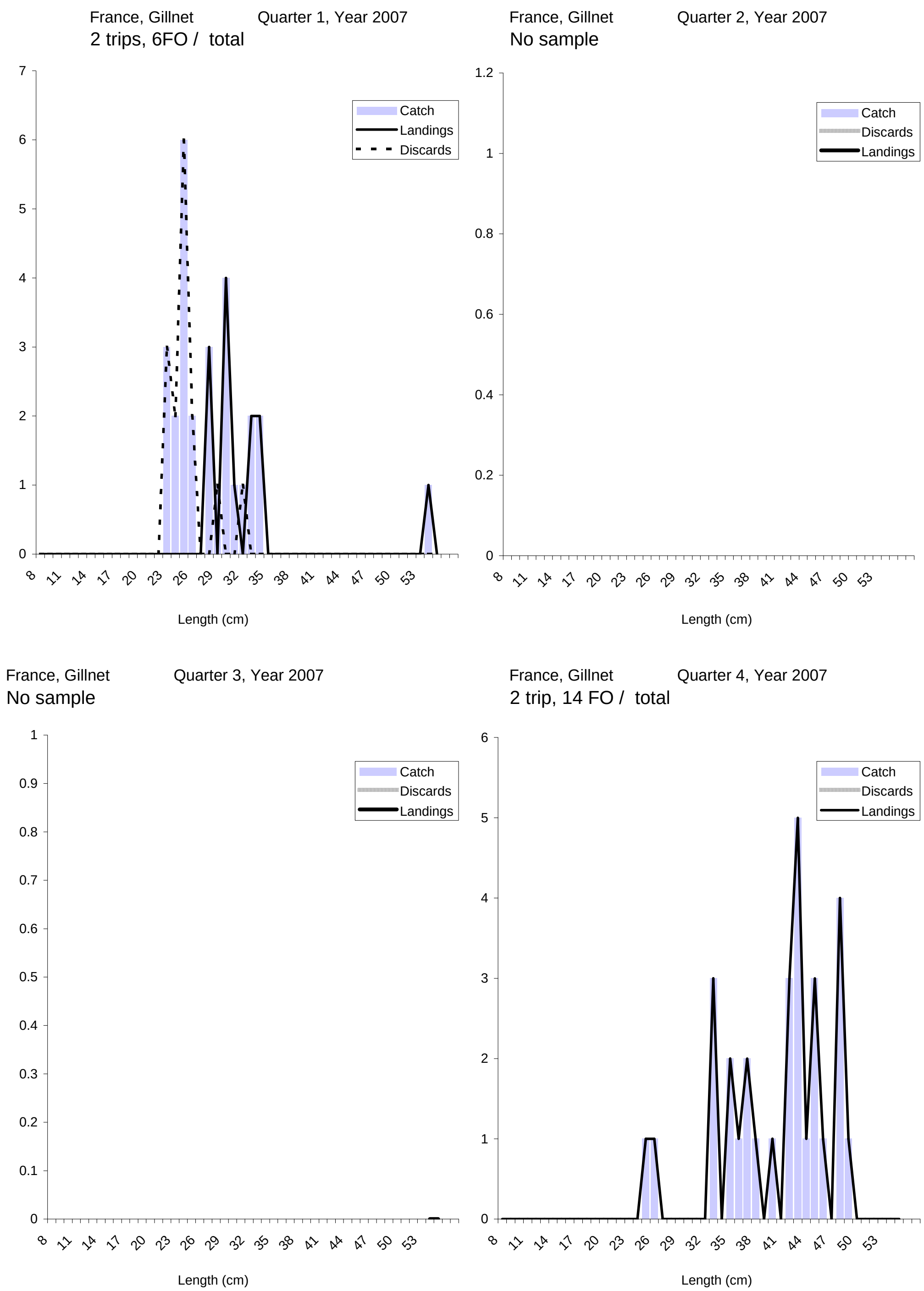
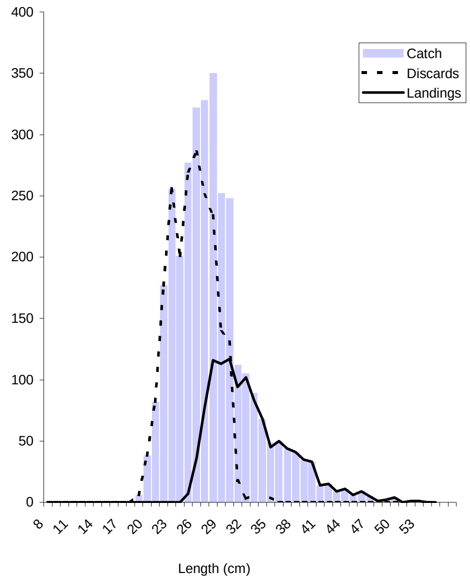
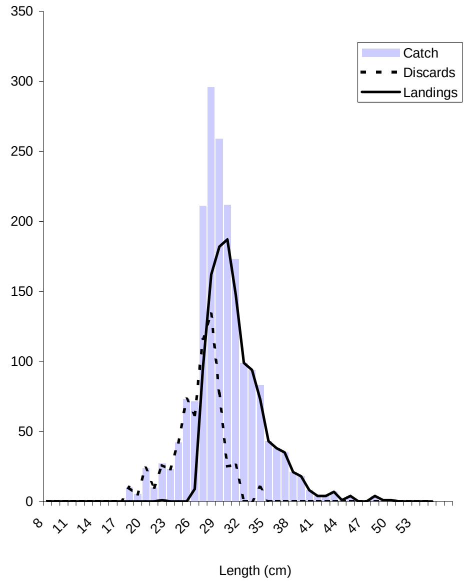


Figure 6.2.1.1b–Plaice VIId–Length structure of discards and landings collected by observations on board

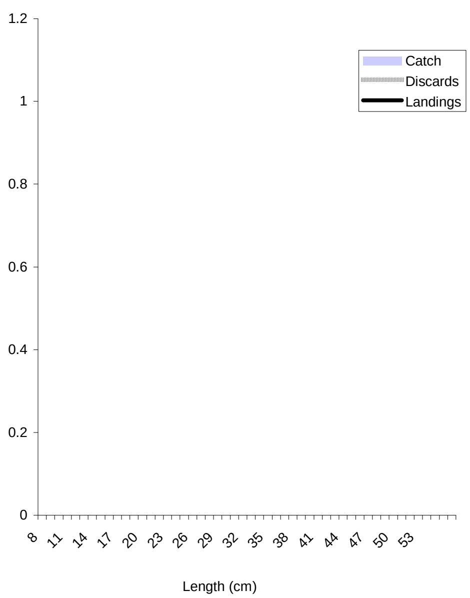
Plaice VIId UK, Trawl Quarter 1, Year 2006
2 trips, 46 hauls / total



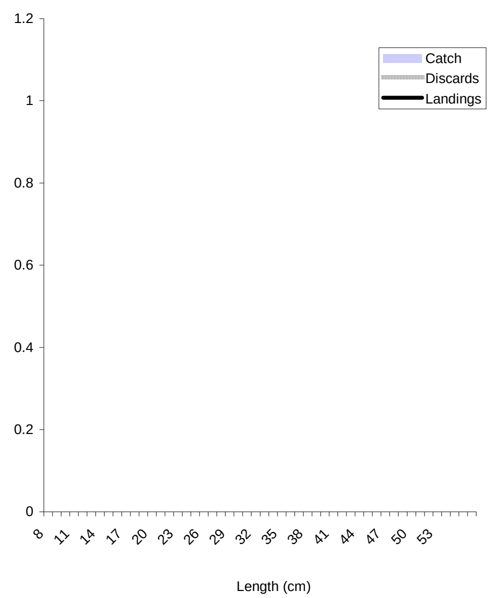
UK, Trawl Quarter 2, Year 2006
2 trips, 26 hauls / total



UK, Trawl Quarter 3, Year 2006
4 trips, 14 hauls / total



UK, Trawl Quarter 4, Year 2006
No sample



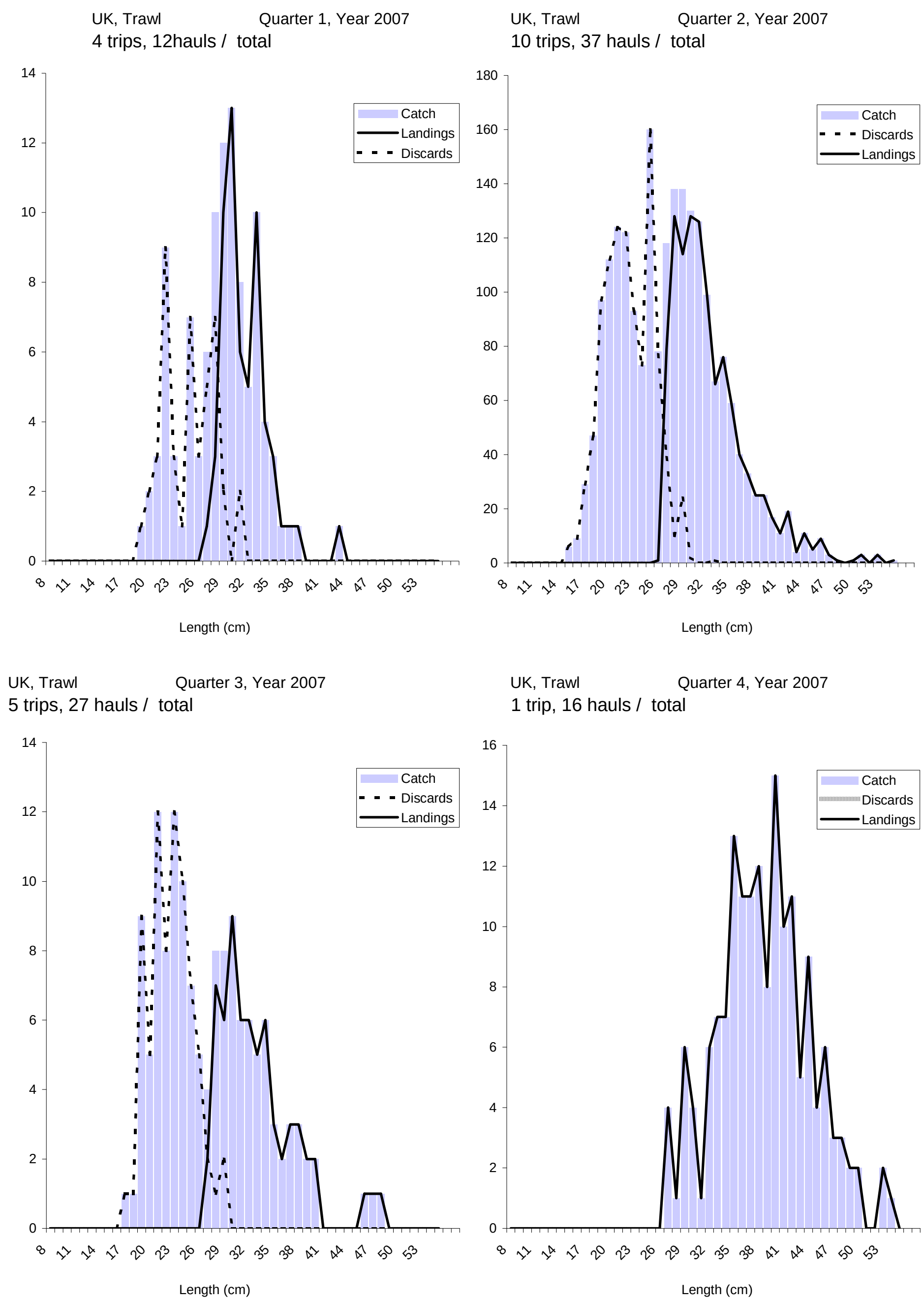


Figure 6.2.1.1 c- Plaice VIId–Length structure of discards and landings collected by observations on board.

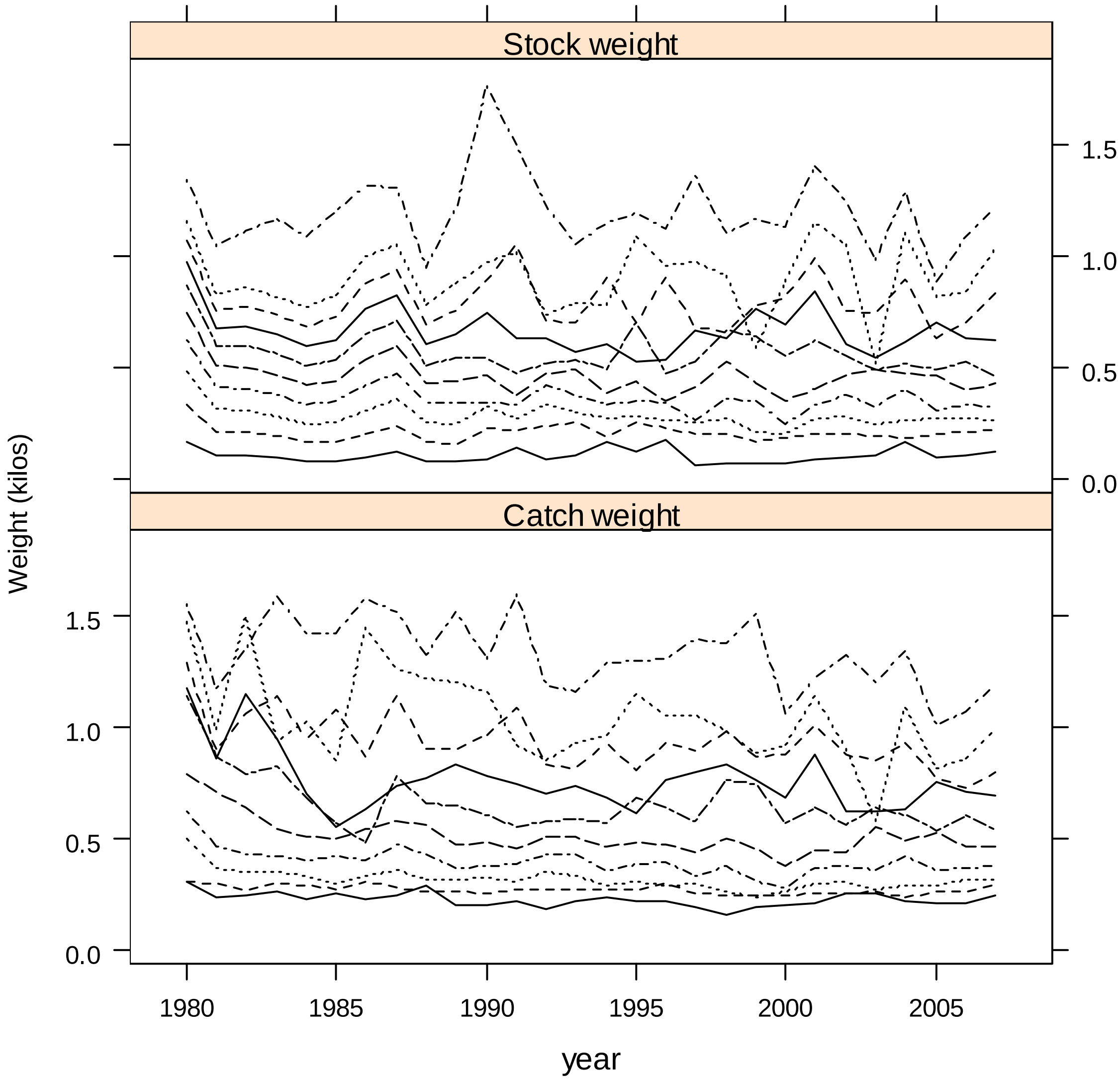


Figure 6.2.3.1. Plaice in VIId. Stock and Catch weight

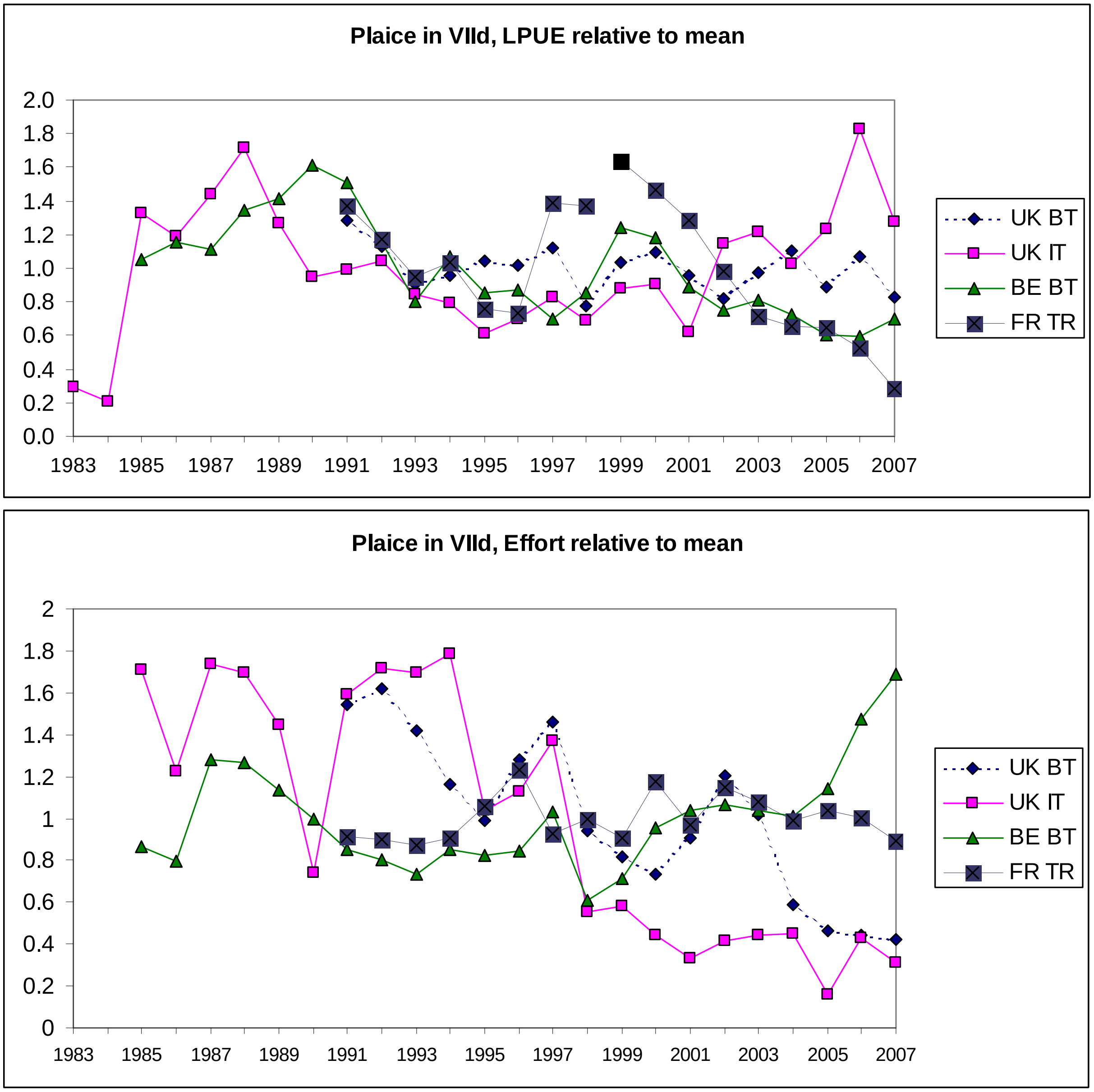


Figure 6.2.5.1–Plaice in VIId. LPUE and effort

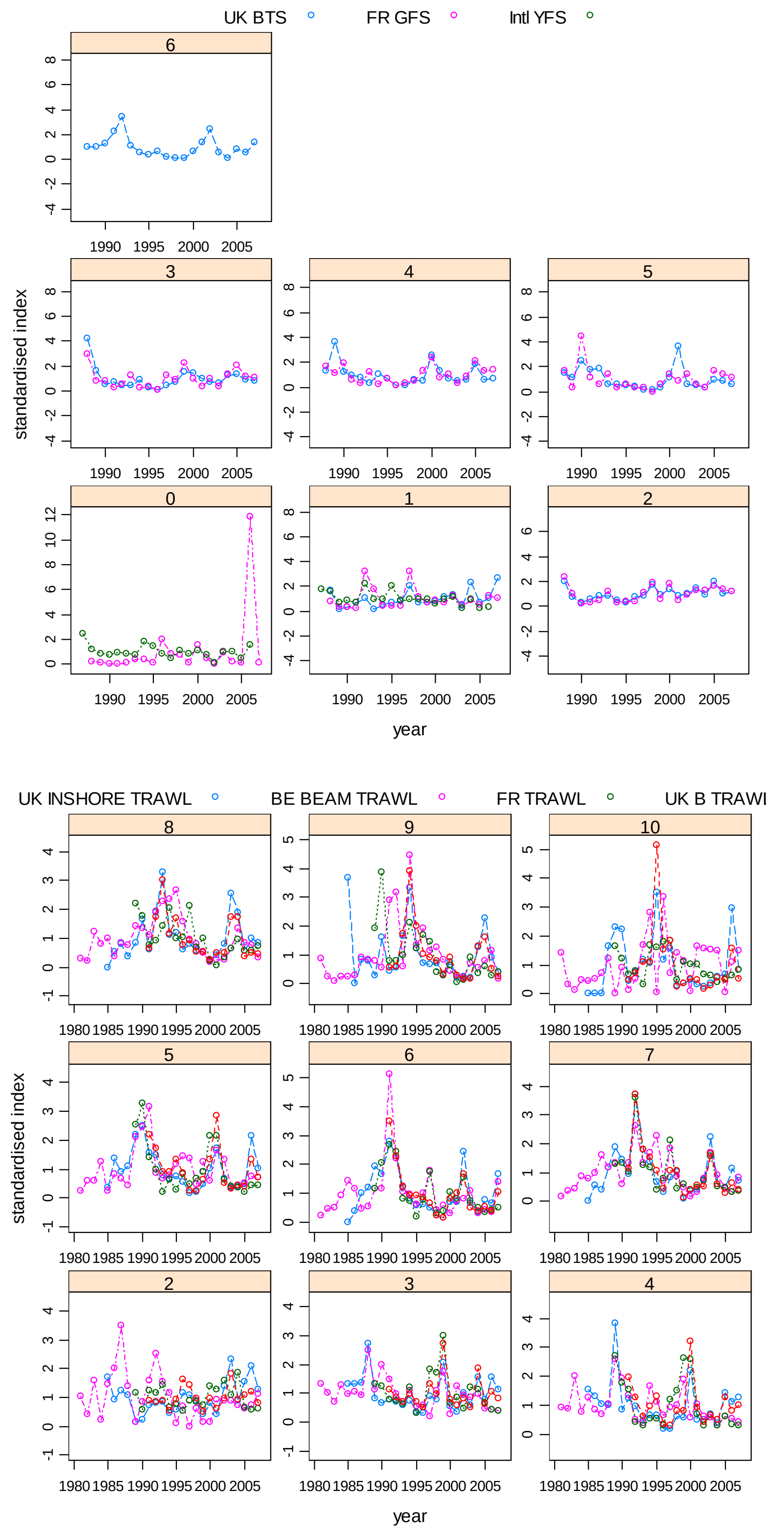


Figure 6.2.5.2. Plaice in VIId. Between survey consistency. Mean standardised indices by surveys for each age

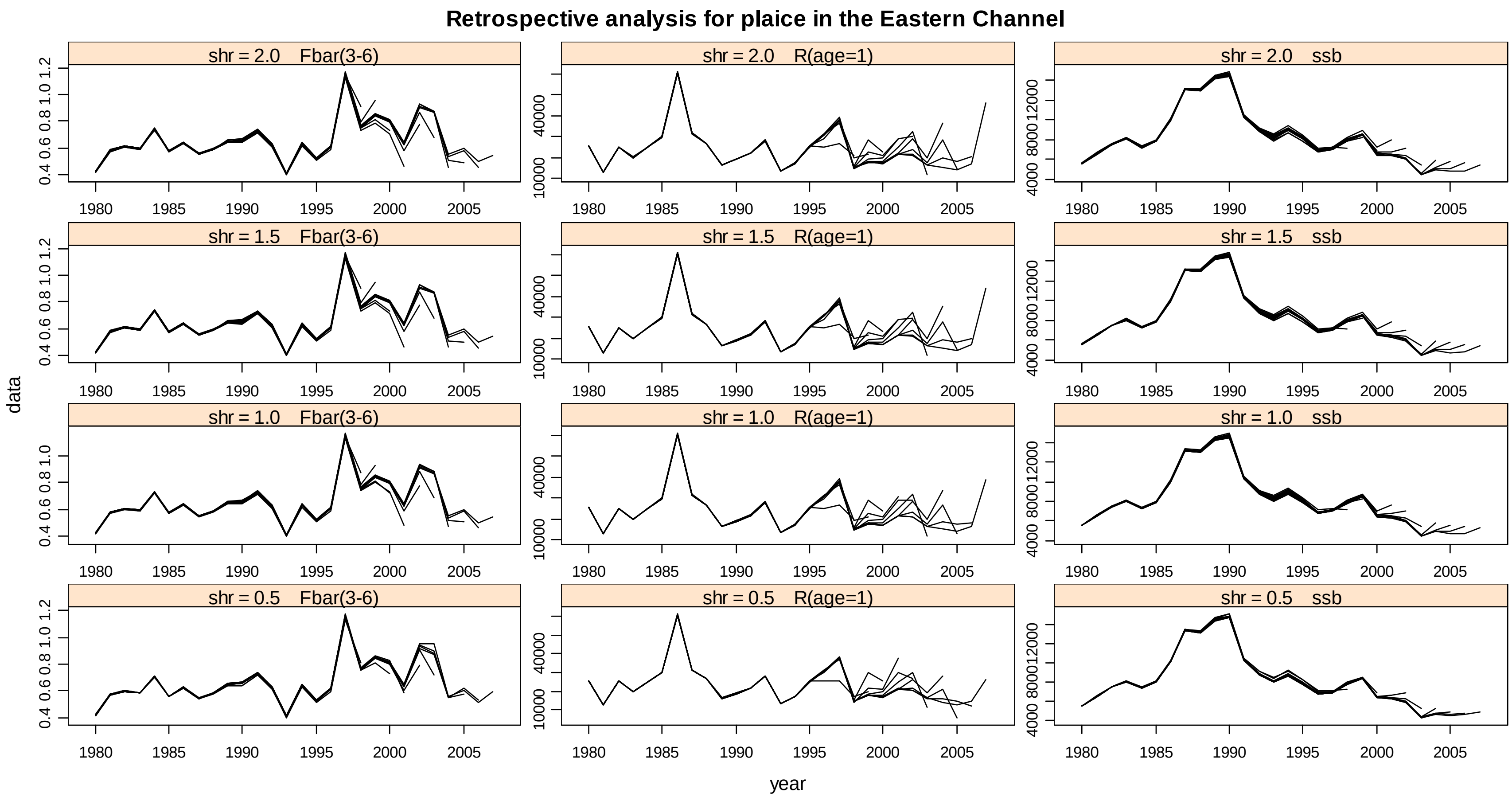


Figure 6.3.2.1. Plaice in VIId. Retrospective analysis for different values of F shrinkage

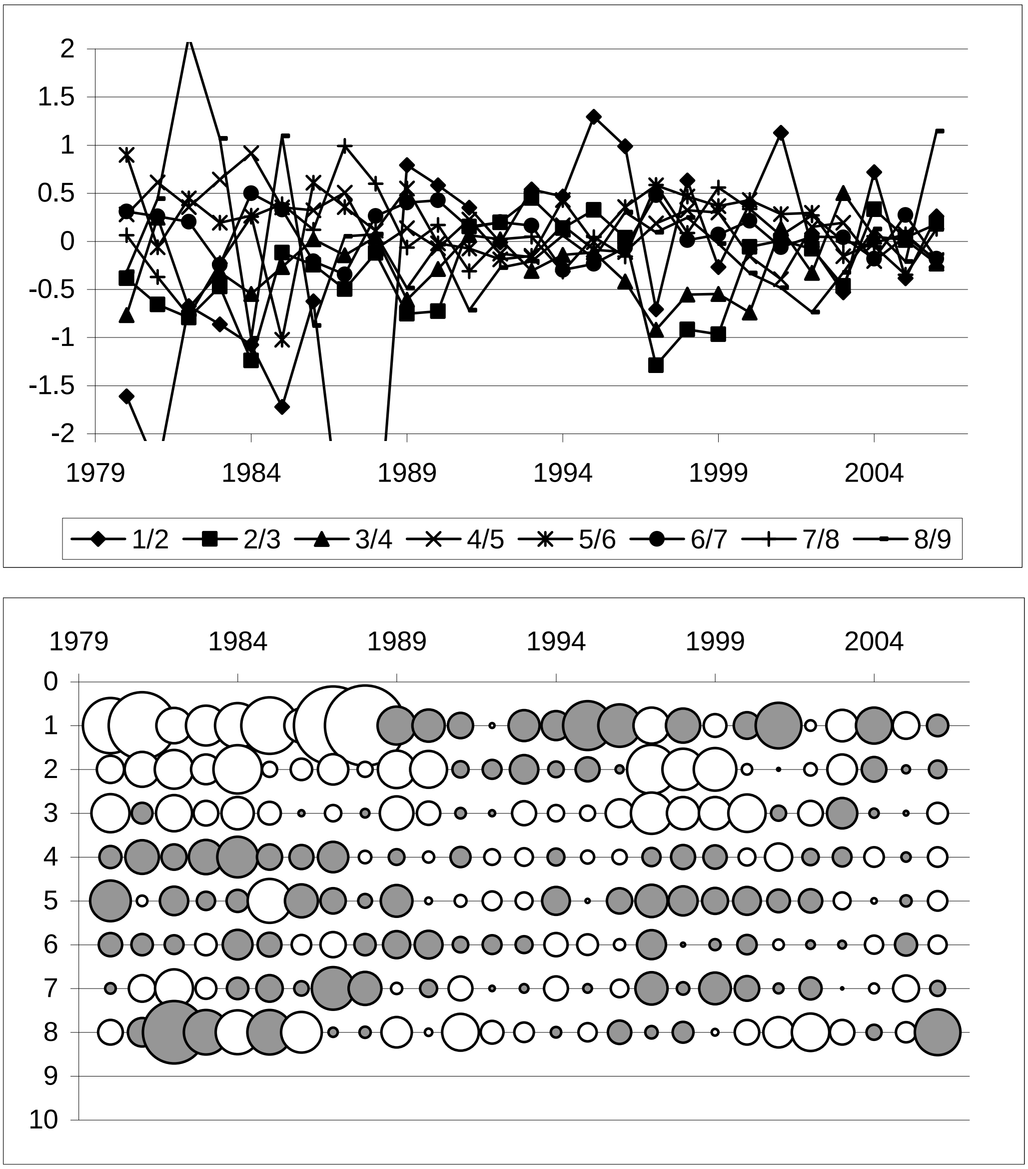


Figure 6.3.2.2–Plaice in VIId. Separable VPA

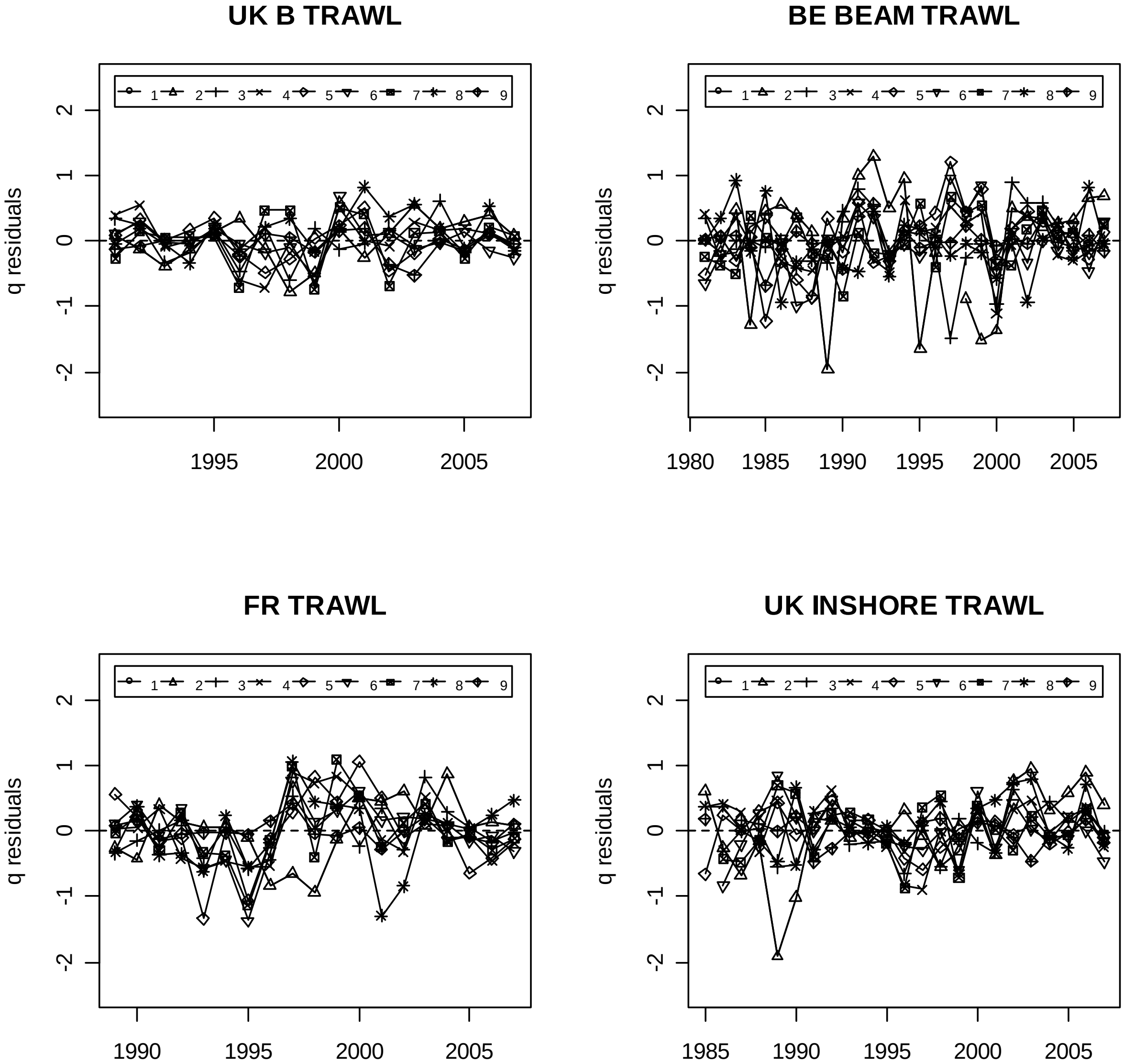


Figure 6.3.2.3. Plaice in VIId. Log q residuals for the single fleet runs (XSA settings and F shrinkage = 1.0)

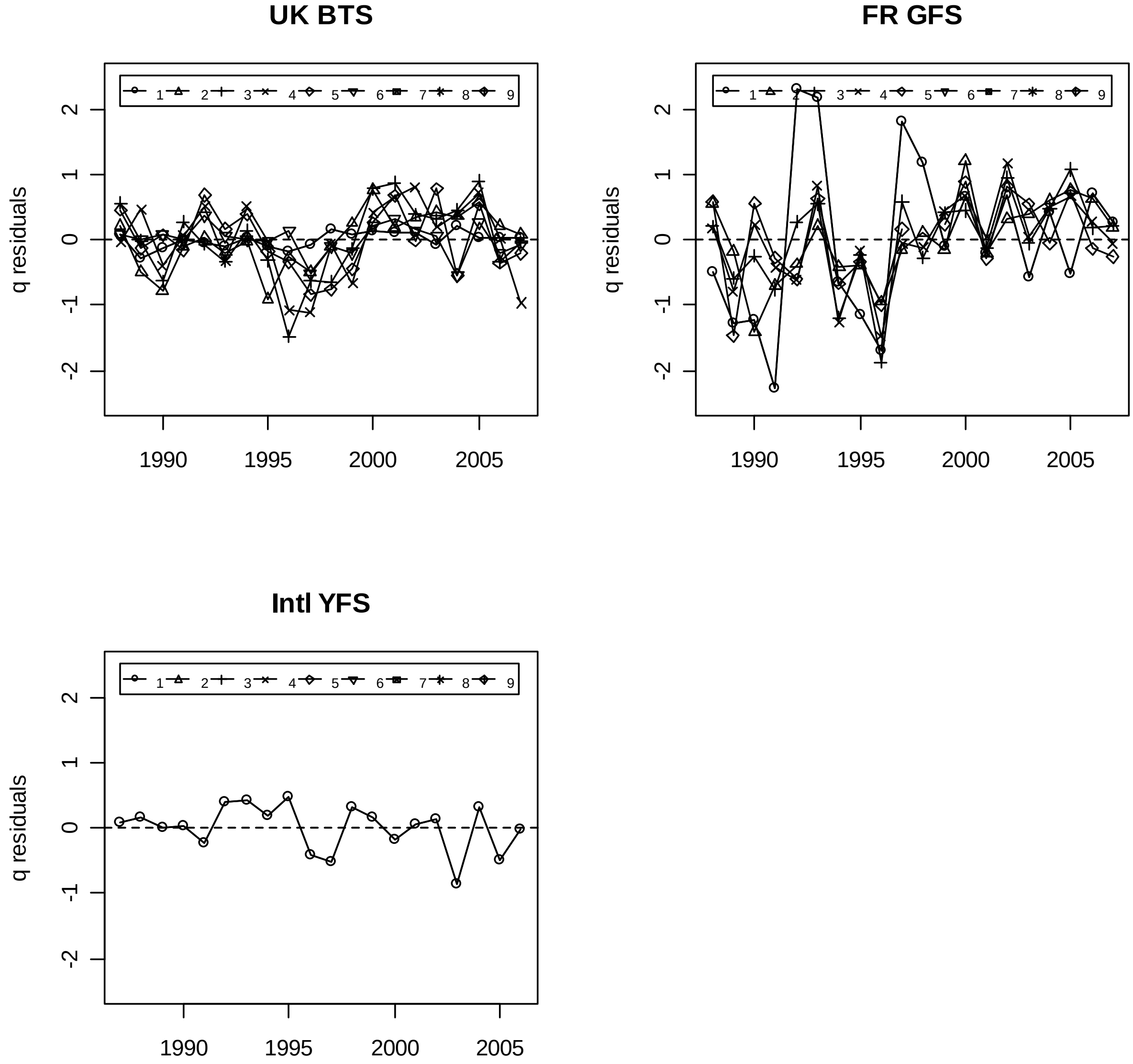


Figure 6.3.2.3 (cont.). Plaice in VIId. Log q residuals for the single fleet runs (XSA settings and F shrinkage = 1.0)

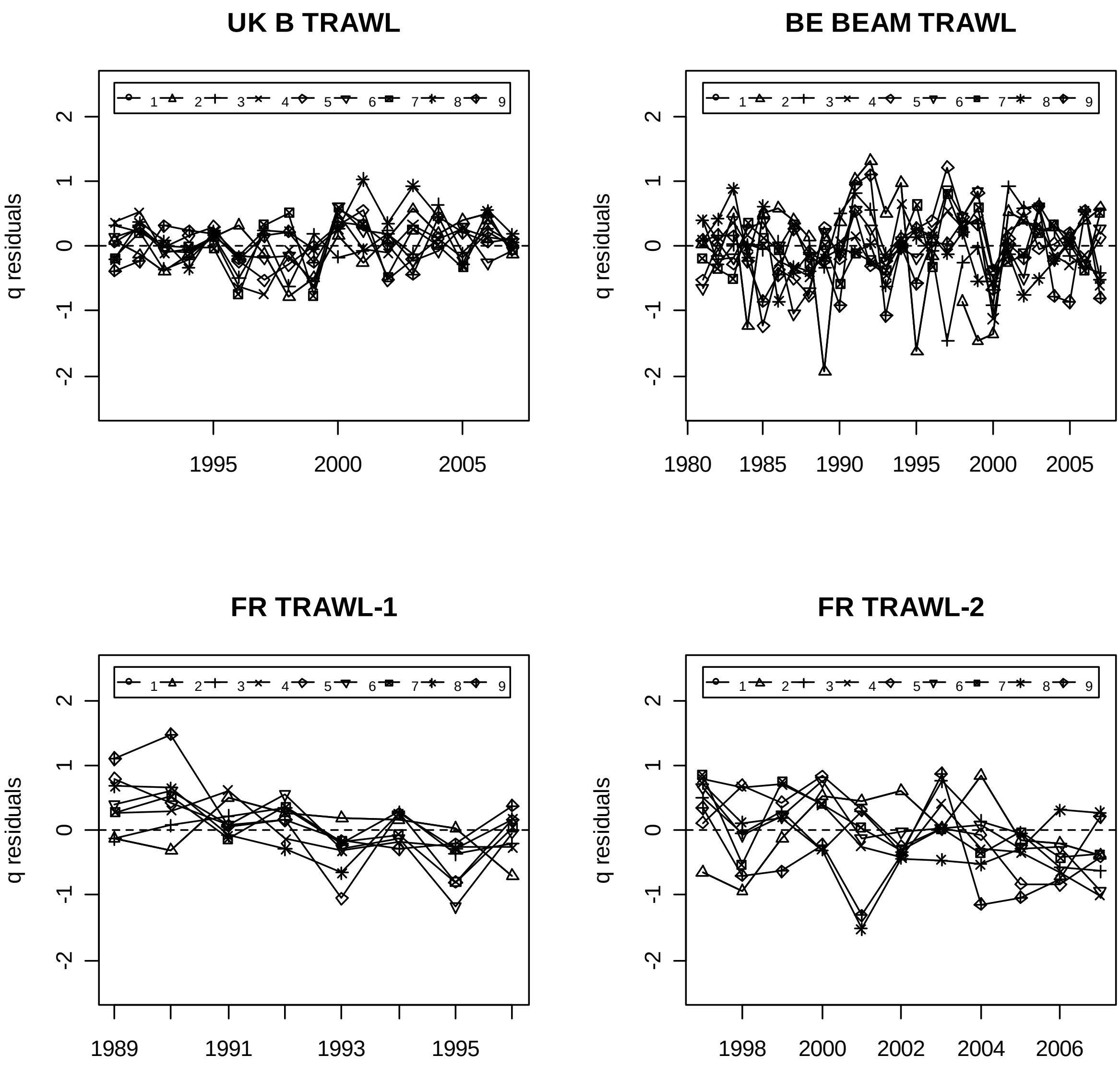


Figure 6.3.2.4. Plaice in VIId. Log q residuals. All fleets combined. Settings as proposed section 6.3.5.

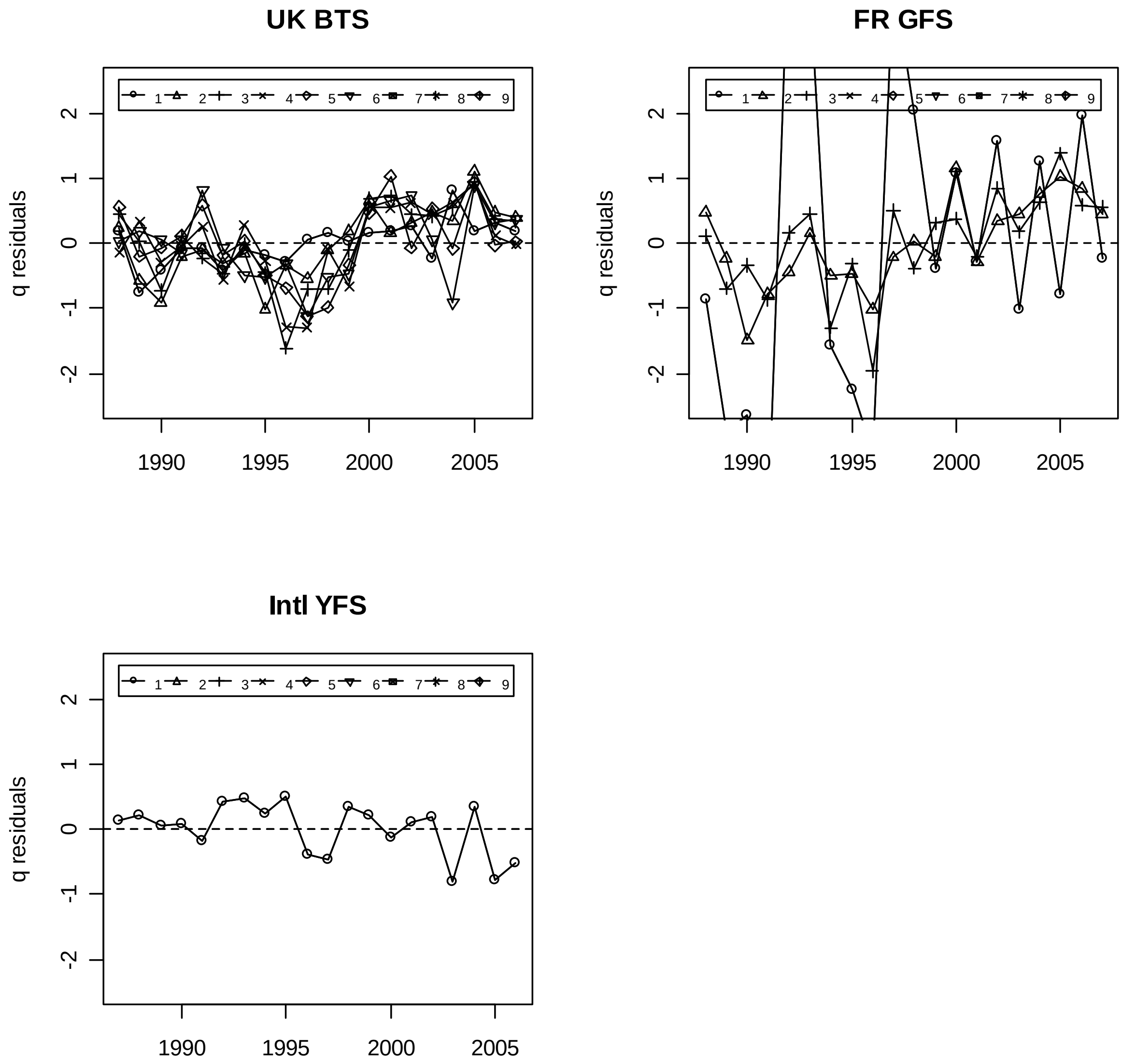


Figure 6.3.2.4 (cont.). Plaice in VIId. Log q residuals. All fleets combined. Settings as proposed section 6.3.5.

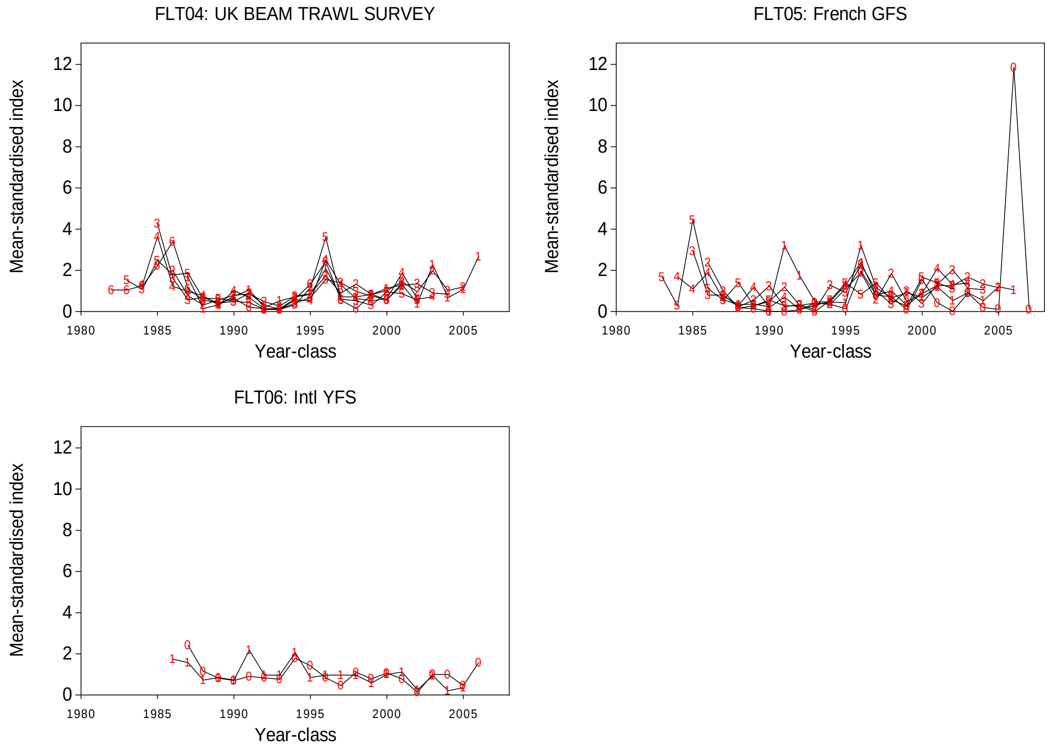


Figure 6.3.3.1. Plaice in VIId. Within survey consistency. Mean standardised indices by year class for each of the surveys.

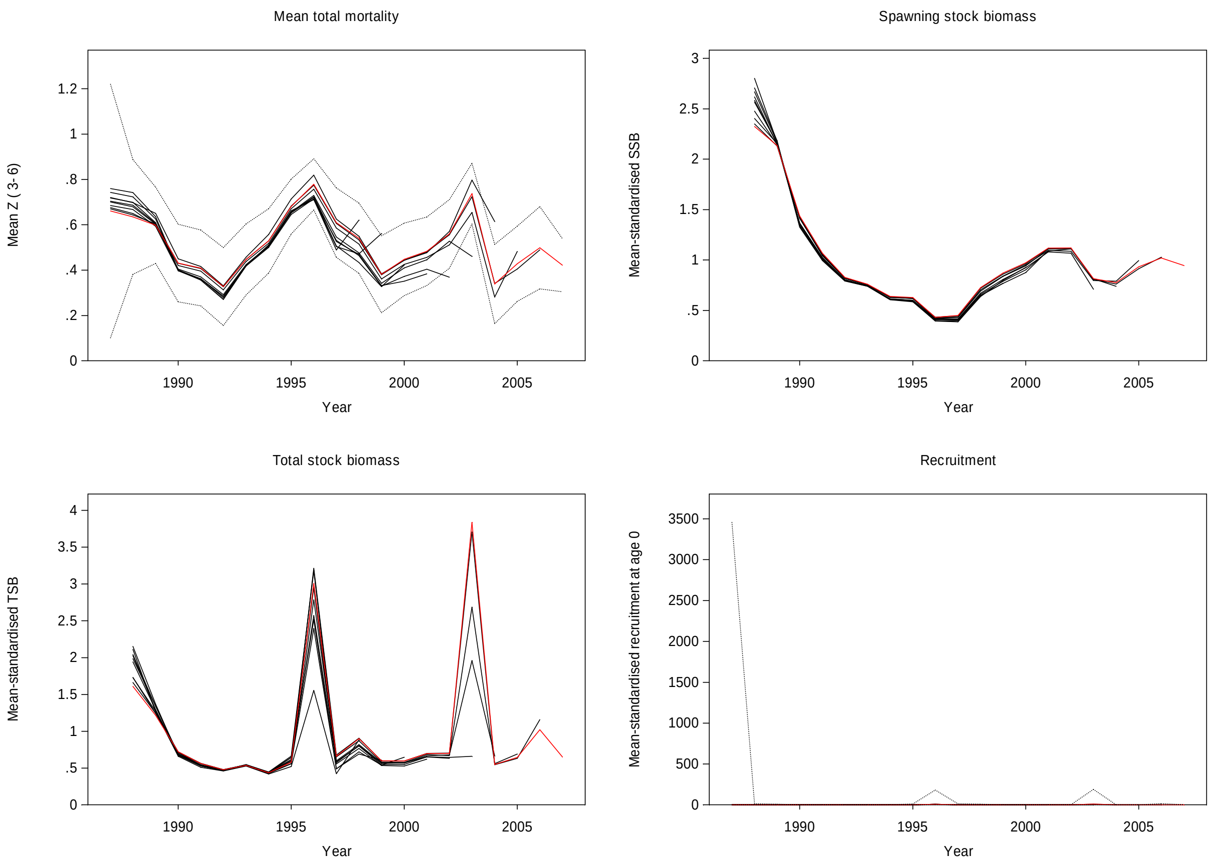


Figure 6.3.3.2. Plaice in VIId. Summary plots of the retrospective analysis from SURBA

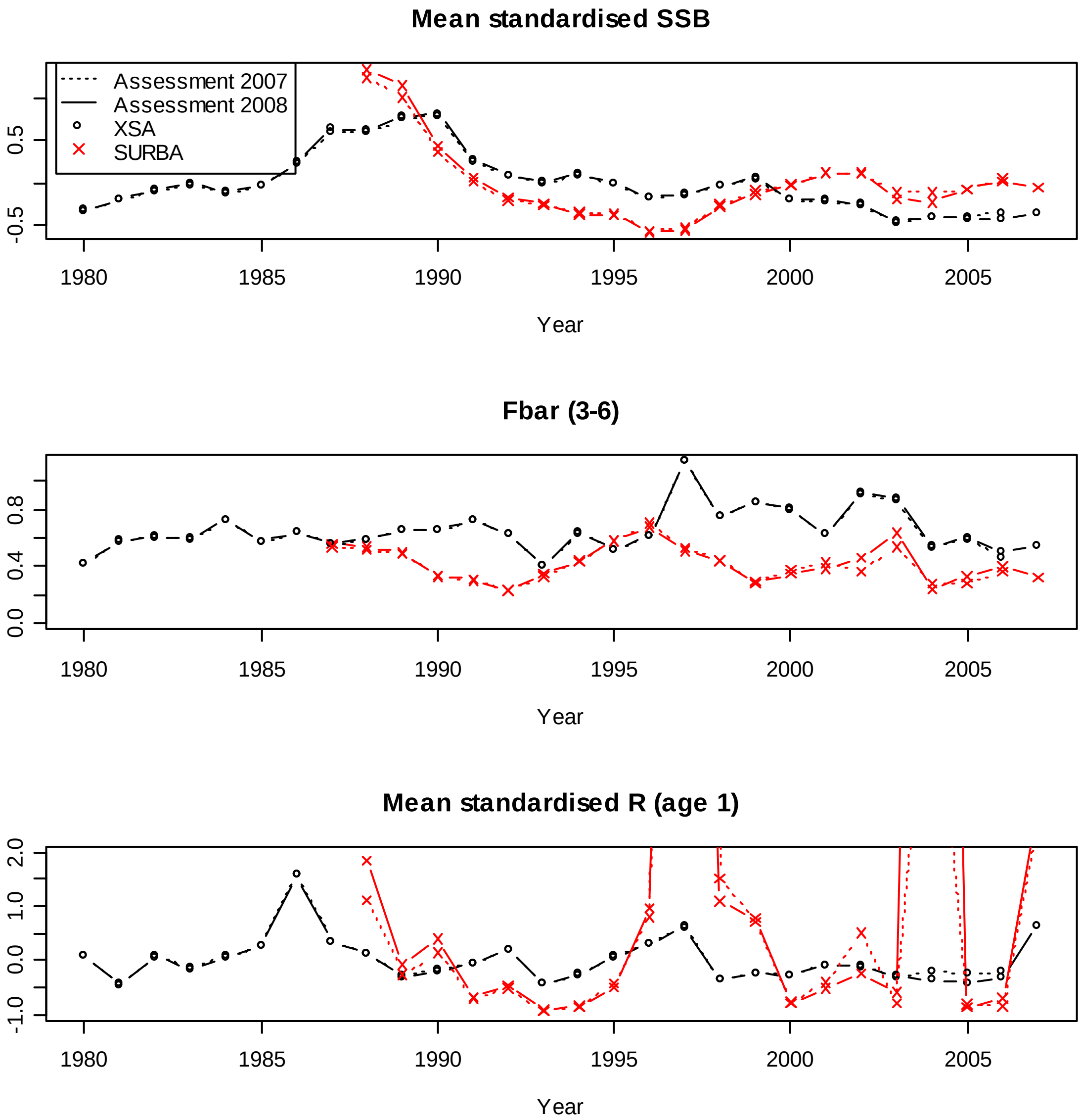


Figure 6.3.4.1. Plaice in VIId. Comparison between 2006 and 2007 assessment and between SURBA and XSA results.

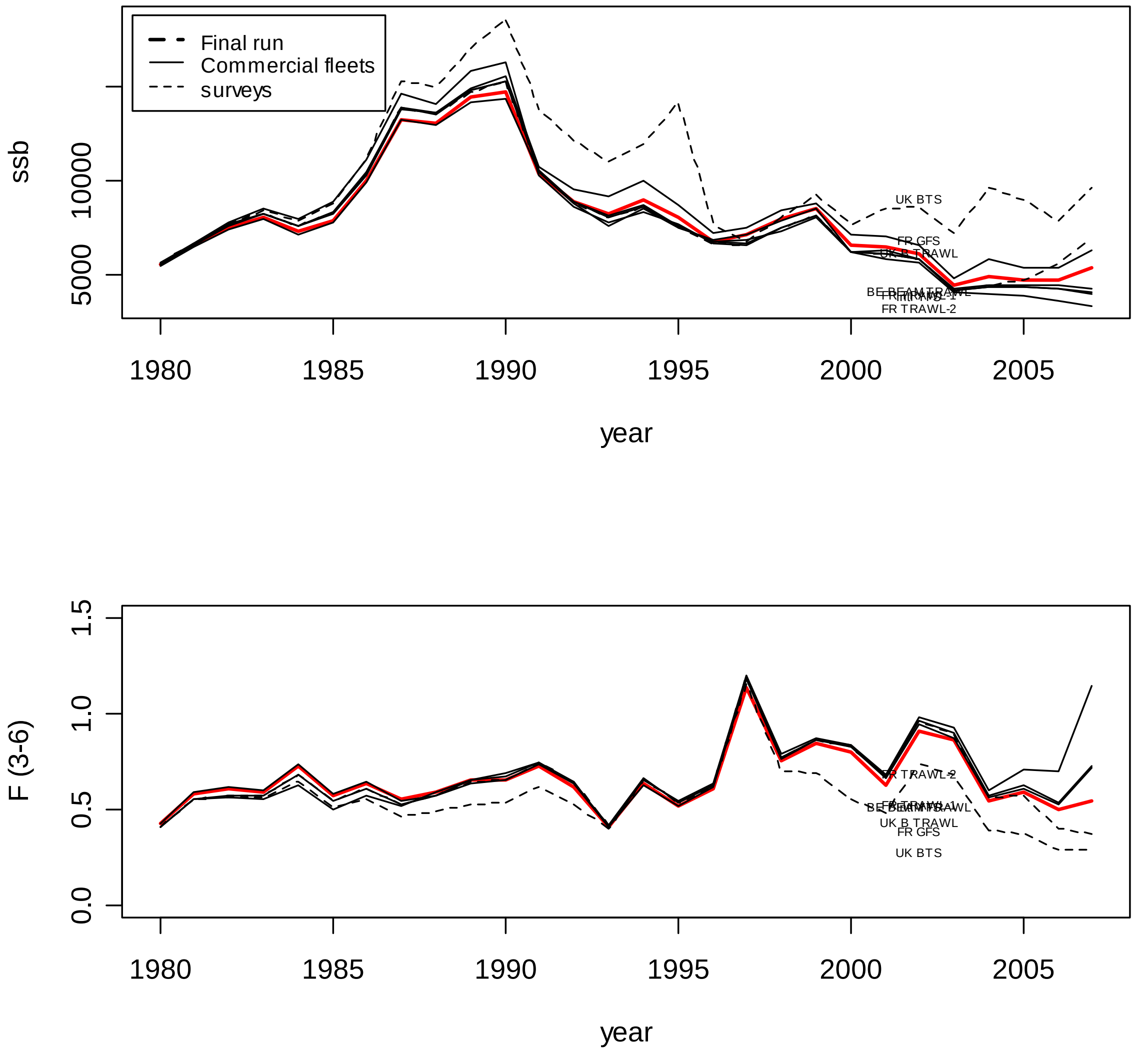


Figure 6.3.4.2. Plaice in VIId. Individual fleet historical performance.

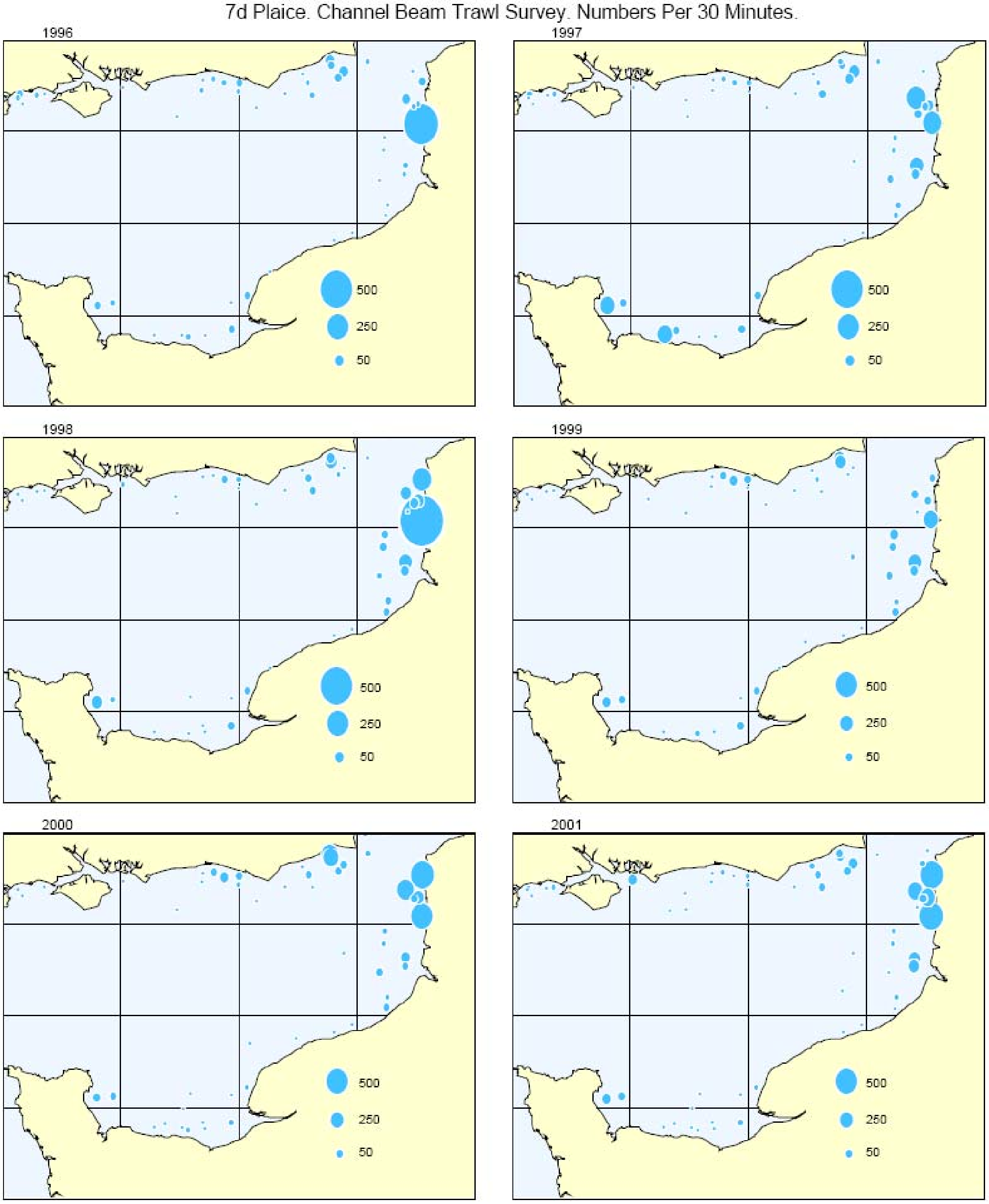


Figure 6.3.4.3. Plaice in VIId. Locations of tows and relative indices of the UK BTS survey from 1996 to 2006.

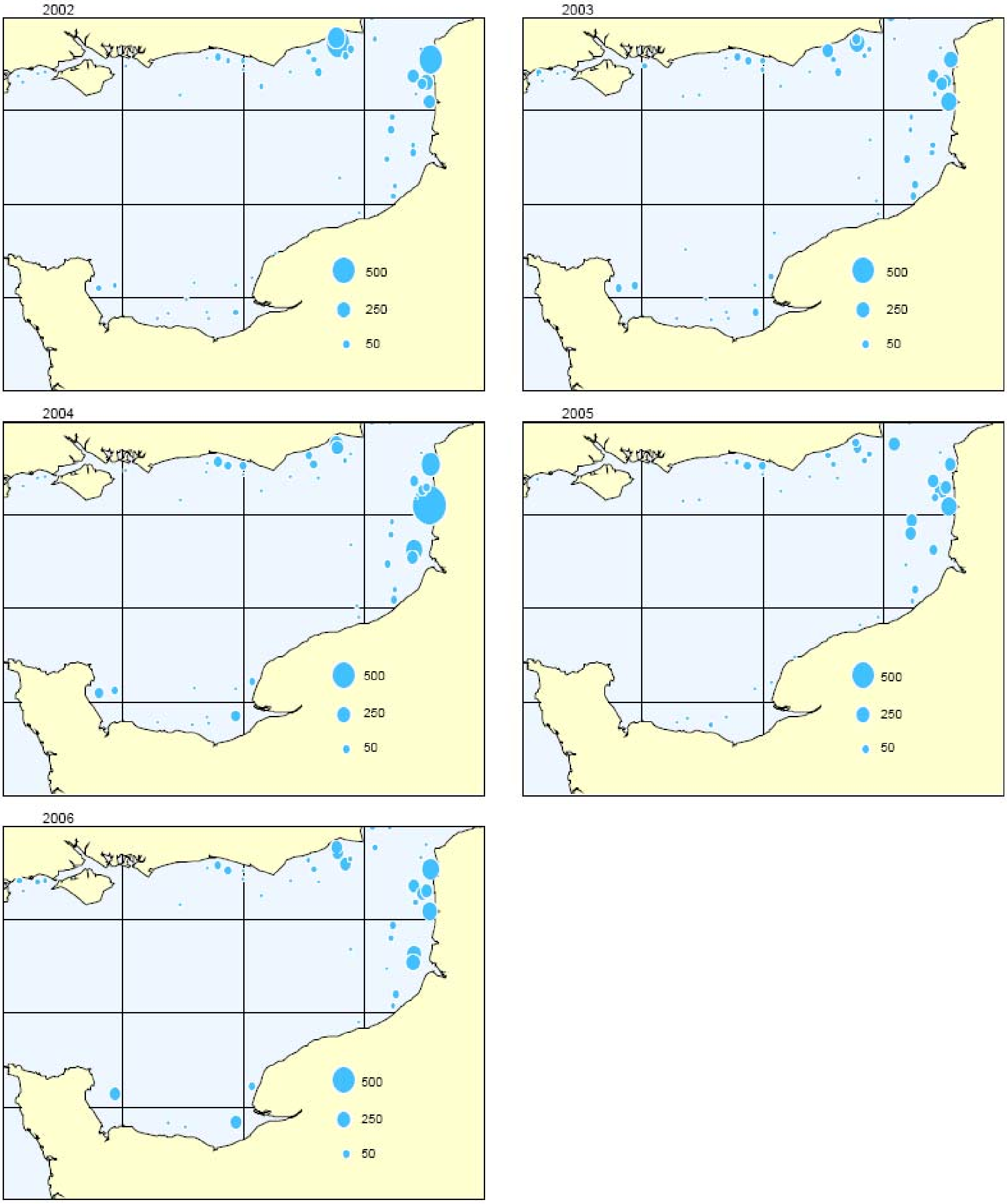


Figure 6.3.4.3. Plaice in VIId. Locations of tows and relative indices of the UK BTS survey from 1996 to 2006.

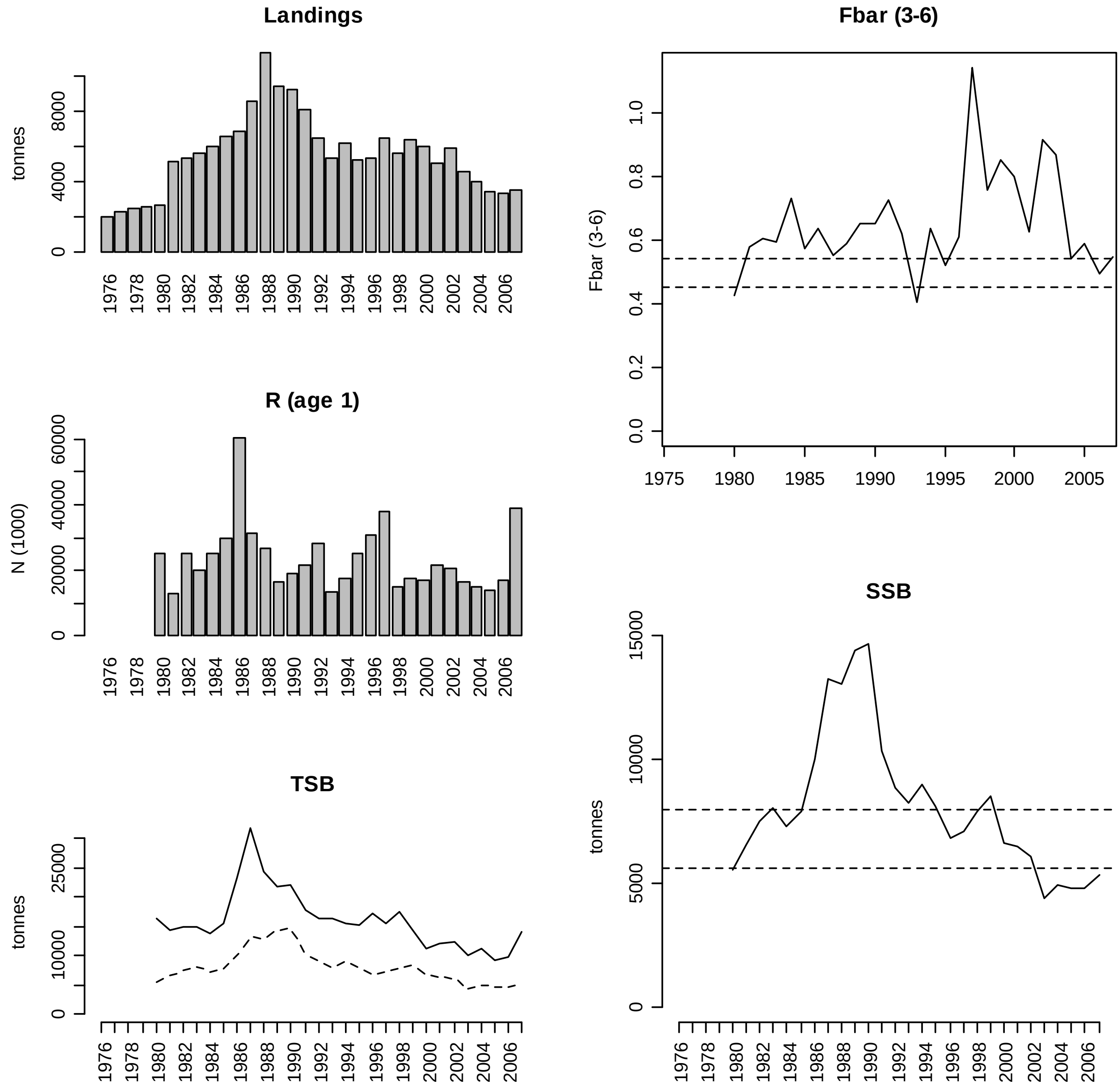


Figure 6.3.5.4. Plaice in VIId. Summary of assessment results

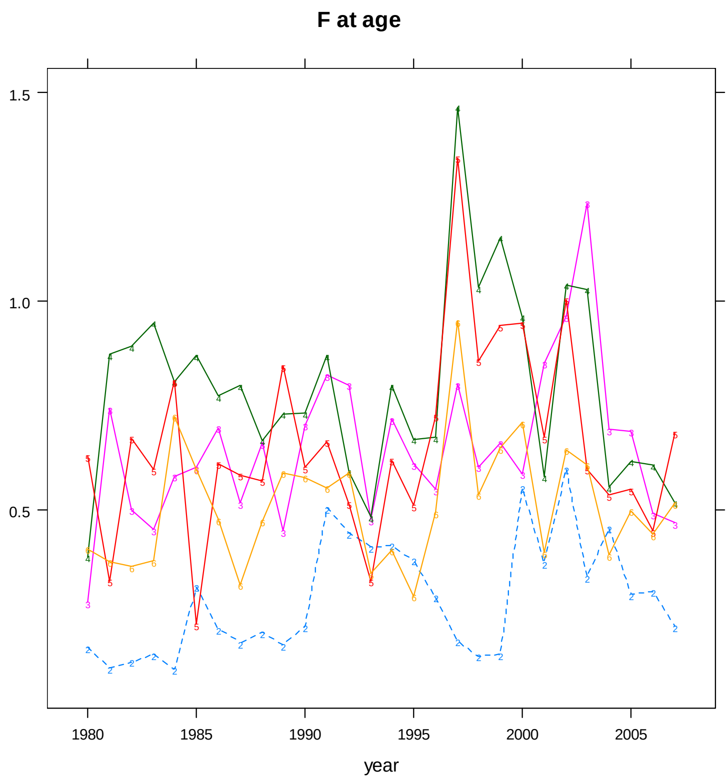


Figure 6.6.1 Plaice in VIId. Trends in F (Age 2 to 6)

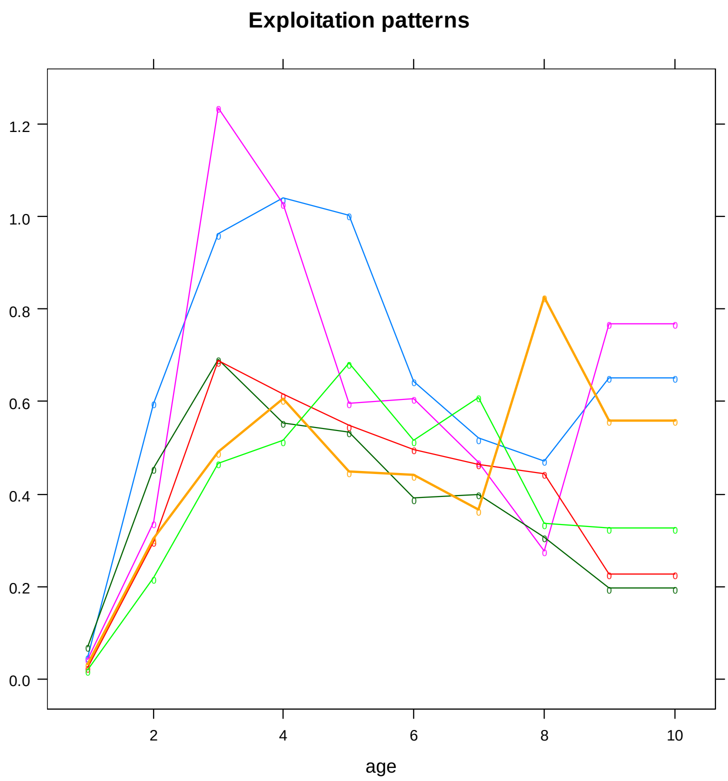


Figure 6.6.2 Plaice in VIId. Exploitation patterns over the last 6 years

7 Plaice in Division IIIa

This year plaice in IIIa was not assessed.

In 2007, the working group identified key issues that would need to be resolved before further assessments could be carried out for this stock. The various surveys give a reasonably consistent result for the eastern part of the area. The status of the western part is more uncertain, due to potential mixing with North Sea plaice and limited survey coverage. The landings at age matrix does not show proper tracking of the cohorts, probably due to i) mixing of the IIIa stock with North Sea plaice stock on the main fishing ground in Southwestern Skagerrak and ii) age misspecification due to low sampling levels and uncertainty in age reading.

The new data available for this stock are too sparse to revise the assessment or advice from last year, apart from updating the landings time series (Table 7.1 - 3)

Table 7.1. Plaice in IIIa. Official landings in tonnes as reported to ICES and WG estimates, 1972-2007

Year	Denmark		Sweden		Germany		Belgium		Norway		Netherlands		Total			
	Official	WG est.	Official	WG est.	Official	WG est.	Official	WG est.	Official	WG est.	Official	WG est.	Official	Unalloc.	WG est.	TAC
1972		20,599		418		77				3					21,097	
1973		13,892		311		48				6					14,257	
1974		14,830		325		52				5					15,212	
1975		15,046		373		39				6					15,464	
1976		18,738		228		32		717		6					19,721	
1977		24,466		442		32		846		6					25,792	
1978		26,068		405		100		371		9					26,953	
1979		20,766		400		38		763		9					21,976	
1980		15,096		384		40		914		11					16,445	
1981		11,918		366		42		263		13					12,602	
1982		10,506		384		19		127		11					11,047	
1983		10,108		489		36		133		14					10,780	
1984		10,812		699		31		27		22					11,591	
1985		12,625		699		4		136		18					13,482	
1986		13,115		404		2		505		26					14,052	
1987		14,173		548		3		907		27					15,658	19,250
1988		11,602		491		0		716		41					12,850	19,750
1989		7,023		455		0		230		33					7,741	19,000
1990		10,559		981		2		471		69					12,082	13,000
1991		7,546		737		34		315		68					8,700	11,300
1992		10,582		589		117		537		106					11,931	14,000
1993		10,419		462		37		326		79					11,323	14,000
1994		10,330		542		37		325		91					11,325	14,000
1995	9,722	9,722	470	470	48	48	302	302	224	224			10,766	0	10,766	14,000
1996	9,593	9,641	465	465	31	11			428	428			10,517	28	10,545	14,000
1997	9,505	9,504	499	499	39	39			249	249			10,292	-1	10,291	14,000
1998	7,918	7,918	393	393	22	21			181	181			8,514	-1	8,513	14,000
1999	7,983	7,983	373	394	27	27			336	336			8,719	21	8,740	14,000
2000	8,324	8,324	401	414	15	15			163	163			8,789	127	8,916	14,000
2001	11,114	11,114	385	385	1	0			61	61			11,561	-1	11,560	11,750
2002	8,275	8,276	322	338	29	29			58	58			8,684	17	8,701	12,800
2003	6,884	6884	377	396	14	14			341	341	1494	1584	9,110	109	9,219	16,600
2004	7,135	7,135	317	244	77	77			106	106	1455	1511	9,090	-17	9,073	11,173
2005	5,605	5,619	244	244	21	47			116	116	808	915	6,794	147	6,941	9,500
2006	7,690	7,689	349	350	34	34			142	142	1,167	1,190	9,382	23	9,405	9,600
2007	6,665	6,664	333	331	31	31			99	100		1,659			8,785	10,625
2008																

Table 7.2 Plaice in Kattegat. Landings in tonnes Working Group estimates, 1972-2007. Note the landings in the years 1972-1990 refer to IIIA

Year	Denmark	Sweden	Germany	Belgium	Norway	Total
1972	15,504	348	77			15,929
1973	10,021	231	48			10,300
1974	11,401	255	52			11,708
1975	10,158	296	39			10,493
1976	9,487	177	32			9,696
1977	11,611	300	32			11,943
1978	12,685	312	100			13,097
1979	9,721	333	38			10,092
1980	5,582	313	40			5,935
1981	3,803	256	42			4,101
1982	2,717	238	19			2,974
1983	3,280	334	36			3,650
1984	3,252	388	31			3,671
1985	2,979	403	4			3,386
1986	2,470	202	2			2,674
1987	2,846	307	3			3,156
1988	1,820	210	0			2,030
1989	1,609	135	0			1,744
1990	1,830	202	2			2,034
1991	1,737	265	19			2,021
1992	2,068	208	101			2,377
1993	1,294	175	0			1,469
1994	1,547	227	0			1,774
1995	1,254	133	0			1,387
1996	2,337	205	0			2,542
1997	2,198	255	25			2,478
1998	1,786	185	10			1,981
1999	1,510	161	20			1,691
2000	1,644	184	10			1,838
2001	2,069	260				2,329
2002	1,806	198	26			2,030
2003	2,037	253	6			2,296
2004	1,395	137	77			1,609
2005	1,104	100	47			1,251
2006	1,355	175	20			1,550
2007	1,198	172	10			1,380

Table 7.3 Plaice in Skagerrak. Landings in tonnes. Working Group estimates, 1972-2007

Year	Denmark	Sweden	Germany	Belgium	Norway	Netherlands	Total
1972	5,095	70			3		5,168
1973	3,871	80			6		3,957
1974	3,429	70			5		3,504
1975	4,888	77			6		4,971
1976	9,251	51		717	6		10,025
1977	12,855	142		846	6		13,849
1978	13,383	94		371	9		13,857
1979	11,045	67		763	9		11,884
1980	9,514	71		914	11		10,510
1981	8,115	110		263	13		8,501
1982	7,789	146		127	11		8,073
1983	6,828	155		133	14		7,130
1984	7,560	311		27	22		7,920
1985	9,646	296		136	18		10,096
1986	10,645	202		505	26		11,378
1987	11,327	241		907	27		12,502
1988	9,782	281		716	41		10,820
1989	5,414	320		230	33		5,997
1990	8,729	779		471	69		10,048
1991	5,809	472	15	315	68		6,679
1992	8,514	381	16	537	106		9,554
1993	9,125	287	37	326	79		9,854
1994	8,783	315	37	325	91		9,551
1995	8,468	337	48	302	224		9,379
1996	7,304	260	11		428		8,003
1997	7,306	244	14		249		7,813
1998	6,132	208	11		98		6,449
1999	6,473	233	7		336		7,049
2000	6,680	230	5		67		6,982
2001	9,045	125			61		9,231
2002	6,470	140	3		58		6,671
2003	4,847	143	8		74	1,584	6,656
2004	5,717	179			106	1,511	7,513
2005	4,515	144			116	915	5,690
2006	6,334	175	14		142	1,190	7,855
2006	5,467	159	21		100	1,659	7,406

8 Plaice in Subarea IV

A Stock Appendix is not yet available for North Sea plaice. Therefore information that should be given in the Stock Appendix is currently still presented within this Section of the report.

8.1 General

8.1.1 Ecosystem aspects

Adult North Sea plaice have an annual migration cycle between spawning and feeding grounds. The spawning grounds are located in the central and southern North Sea, overlapping with the distribution area of Sole. The feeding grounds are located more northerly than the sole distribution areas.

Juvenile stages are concentrated in shallow inshore waters and move gradually offshore as they become larger. The nursery areas on the eastern side of the North Sea contribute most of the total recruitment. Sub-populations have strong homing behaviour to specified spawning grounds and rather low mixing rate with other sub-populations during the feeding season (De Veen, 1978; Rijnsdorp and Pastoors, 1995). Genetically, North Sea and Irish Sea plaice are weakly distinguishable from Norway, Baltic and Bay of Biscay stocks using mitochondrial DNA (Hoarau *et al*., 2004).

Juvenile plaice were distributed more offshore in recent years. Surveys in the Wadden Sea have shown that 1-group plaice is almost absent from the area where it was very abundant in earlier years. The Wadden Sea Quality Status Report 2004 (Vorberg et al. 2005) notes that increased temperature, lower levels of eutrophication, and decline in turbidity have been suggested as causal factors, but that no conclusive evidence is available; taking into account the temperature tolerance of the species there is ground for the hypothesis that a temperature rise contributes to the shift in distribution.

A shift in the age and size at maturation of plaice has been observed (Grift *et al.* 2003): plaice become mature at younger ages and at smaller sizes in recent years than in the past. This shift is thought to be a genetic fisheries-induced change: Those fish that are genetically programmed to mature late at large sizes are likely to have been removed from the population before they have had a chance to reproduce and pass on their genes. This results in a population that consists ever more of fish that are genetically programmed to mature early at small sizes. Reversal of such a genetic shift may be difficult. This shift in maturation also leads to mature fish being of a smaller size at age, because growth rate diminishes after maturation.

8.1.2 Fisheries

North Sea plaice is taken mainly in a mixed flatfish fishery by beam trawlers in the southern and south-eastern North Sea. Directed fisheries are also carried out with seines, gill nets, and twin trawls, and by beam trawlers in the central North Sea. Due to the minimum mesh size enforced (80 mm in the mixed beam trawl fishery), large numbers of (undersized) plaice are discarded.

Fleets exploiting North Sea plaice have generally decreased in number of vessels in the last 10 years. In January 2008 a further 23 Dutch trawl vessels were decommissioned. However, in some instances, reflagging vessels to other countries has partly compensated these reductions. Also, the decrease in fleet size may partially have been compensated by slight increases in the technical efficiency of vessels. In the Dutch beam trawl fleet indications of an increase of technical efficiency of around 1.65% by year was found over the period 1990–2004 (Rijnsdorp *et al*, 2006).

The Dutch beam trawl fleet, one of the major operators in the mixed flatfish fishery in the North Sea, has seen a shift towards more inshore fishing grounds. This shift may be caused by a number of factors, such as the implementation of fishing effort restrictions, the increase in fuel prices and changes in the TAC for the target species. However, the contribution of each of these factors is yet unknown.

The Dutch beam trawl fleet has reduced in number of vessels and shifted towards two categories of vessels: 2000HP (the maximum engine power allowed) and 300 HP (the maximum engine power for vessels that are allowed to fish within the 12 mile coastal zone and the plaice box). Approximately 85% of plaice landings from the UK (England and Scotland) is landed into the Netherlands by Dutch vessels fishing on the UK register. Vessels fishing under foreign registry are referred to as flag vessels. As described in the 2001 report of this WG (ICES CM 2002/ACFM:01), the fishing pattern of flag vessels can be very different from that of other fleet segments.

8.1.3 ICES Advice

The information in this section is taken from the ACFM summary sheet 2007, section 6.4.7a and b.

Single-stock exploitation boundaries

Exploitation boundaries in relation to existing management plans

ACFM summary sheet in section 6.4.7 b states: *"According to the new EC management plan, fishing mortality 2008 should be reduced by 10% compared to the fishing mortality in 2007 (F2007 = 0.55) with the constraint that the change in TAC should not be more than 15%. The 10% reduction of fishing mortality corresponds to landings of 49 000 t. in 2008 which is within the 15% TAC change (TAC 2007 = 50 kt). The expected SSB in 2009 would be around 200 000 t, which is below B_{pa}."*

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

ACFM summary sheet in section 6.4.7 a states: "*The current total fishing mortality (including discards) is estimated at 0.55, which is above the rate expected to lead to high long-term yields (F_{max} = 0.25).*"

Exploitation boundaries in relation to precautionary limits

The exploitation boundaries in relation to precautionary limits imply human consumption landings of less than 35 000 t in 2008, which is expected to rebuild SSB to the $\mathbf{B}_{pa}$ (=230 000 t) in 2009.

Advice for mixed fisheries management

Demersal fisheries in Division IIIa (Skagerrak-Kattegat), in Subarea IV (North Sea) and in Division VIId (Eastern Channel) should in 2008 be managed according to the following rules, which should be applied simultaneously:

- *with minimal bycatch or discards of cod;*
- *Implement TACs or other restrictions that will curtail fishing mortality for those stocks mentioned above for which reduction in fishing pressure is advised;*
- *within the precautionary exploitation limits for all other stocks;*

- *Where stocks extend beyond this area, e.g. into Division VI (saithe and anglerfish) or are widely migratory (Northern hake), taking into account the exploitation of the stocks in these areas so that the overall exploitation remains within precautionary limits.*
- *With minimum by-catch of spurdog, porbeagle and thornback ray and skate.*

Mixed fisheries management options should be based on the expected catch in specific combinations of effort in the various fisheries taking into consideration the advice given above. The distributions of effort across fisheries should be responsive to objectives set by managers, which is also the basis for the scientific advice presented above.

Key points highlighted in the ACFM summary sheet

Based on the most recent estimate of SSB and fishing mortality, ICES classifies the stock as being at risk of reduced reproductive capacity and as being harvested sustainably. SSB in 2007 is estimated at around 193 000 t and is below the $\mathbf{B}_{pa}$ of 230 000 t. Fishing mortality in 2006 is estimated as below $\mathbf{F}_{pa}$. Recruitment since 2003 has been below the long-term average.

Due to a range of factors such as TAC constraints on plaice, effort limitations, and increases in fuel prices, the fishing effort of the major fleets has concentrated in the southern part of the North Sea. This is the area where many juvenile fish are found. In addition, juvenile plaice has shown a more offshore distribution in recent years. The combination of a change in fishing pattern and the spatial distribution of juvenile plaice has led to an apparent increase in discarding of plaice. Technical measures applicable to the mixed flatfish fishery will affect both sole and plaice. The minimum mesh size of 80 mm in the beam trawl fishery selects sole at the minimum landing size. However, this mesh size generates catches of plaice from 17 cm, while the minimum landing size is 27 cm, leading to a high discard rate (F_{bar} 2 3 = 0.6). Mesh enlargement would reduce the catch of undersized plaice, but would also result in a short-term loss of marketable sole. An increase in the minimum landing size of sole could provide an incentive to fish with larger mesh sizes and therefore mean a reduction in the discarding of plaice.

Estimates of discards are based on a few observations of the dominant fleets since 1999, and by using a reconstruction model for the years prior to 1999. The most recent information shows that nearly 80% of the catch by number is discarded. The inclusion of discard estimates reduces the retrospective bias that was previously observed in this assessment. However, the apparent reduction in bias has probably been accompanied by decreased precision.

Different trends in catch are observed in different areas of the North Sea. Commercial cpue series and a survey in the central part of the North Sea appear to indicate an increase in the plaice stock, whereas a survey in the southern North Sea indicates that the stock has remained at a low level, and a survey in the coastal region indicates a decrease in the plaice stock. This discrepancy adds to noise in the assessment.

8.1.4 Management

A long term management plan proposed by the Commission of the European Community was adopted by the Council of the European Union in June 2007 and first implemented in 2008 (EC Council Regulation No 676/2007). The plan consists of two stages. The aim of the first phase is to ensure the return of the stocks of plaice and sole to within safe biological limits. This should be reached through a reduction of fishing mortality by 10% in relation to the fishing mortality estimated for the preceding year. ICES interprets the F for the preceding year as the estimate of F for the year in which the assessment is carried out. The basis for this F estimate will be constant over the years. The plan sets a maximum change of 15% of the TAC between consecutive years.

ICES is in the process of evaluating the management plan for North Sea plaice and sole by checking if this management plan is in accordance with the precautionary approach (see also Machiels et al. 2008, WD) and will report on this.

Articles 1 to 9 of Council Regulation (EC) No 676/2007 of 11 June 2007 establishing a multiannual plan for fisheries exploiting stocks of plaice and sole in the North Sea can be found in Chapter 10.1.4.

The TAC in 2007 was agreed at 50 261 tonnes. For 2008 the TAC was agreed at 49.000 tonnes.

Fishing effort has been restricted for demersal fleets as part of the cod recovery plan (EC Council Regulation No. 2056/2001; EC Council Regulation No 51/2006). For 2007, Council Regulation (EC) No 41/2007 allocates different days at sea depending on gear, mesh size, and catch composition. The days at sea limitations for the major fleets operating in sub-area IV could be summarized as follows: Beam Trawls can fish between 123 and 143 days per year. Trawls or Danish seines can fish between 103 and 280 days per year. Gillnets are allowed to fish between 140 and 162 days per year. Trammel nets can fish between 140 and 205 days per year.

For 2008 Council Regulation N°40/2008, annex II[a] allocates different days at sea depending on gear, mesh size and catch composition. (see section *2.1.2* for a complete list). The days at sea limitations for the major fleets operating in ICES sub-area IV could be summarised as follow: Beam trawlers can fish between 119–143 days per year. Trawls or Danish seines can fish between 103 and 280 days per year. Gillnets are allowed to fish between 140 and 162 days per year and Trammel nets between 140 and 205 days.

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 100 mm 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 <120 mm 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 9 m. A closed area has been in operation since 1989 (the plaice box). Since 1995 this area was closed in all quarters. The closed area applies to vessels using towed gears, but vessels smaller than 300 HP are exempted from the regulation. An evaluation of the plaice box (Grift et al, 2004) has indicated that: From trends observed it was inferred that the Plaice Box has likely had a positive effect on the recruitment of Plaice but that its overall effect has decreased since it was established. There are two reasons to assume that the Plaice Box has a positive effect on the recruitment of Plaice: 1) at present, the Plaice Box still protects the majority of undersized Plaice. Approximately 70% of the undersized Plaice are found in the Plaice Box and Wadden Sea, and despite the changed distribution, densities of juvenile Plaice inside the Box are still higher than outside; 2) In the 80 mm fishery, discard percentages in the Box are higher than outside. Because more than 90% of the Plaice caught in the 80 mm fishery in the Box are discarded, any reduction in this fishery would reduce discard mortality. There is, however, no proof of a direct relationship between total discard mortality and recruitment.

8.2 Data available

8.2.1 Catch

Total landings of North Sea plaice in 2007 (Table 8.2.1) were estimated by the WG at 49 744t, which is 8 199 t less than the 2006 landings. The TAC of 50 261 t, 517 t more than the WG estimated landings, was thus almost taken in 2007. Discard sampling programmes started in the late 1990s to obtain discard estimates from several fleets fishing for flatfish. These sampling programmes give information on discard rates from 1999 but not for the historical time series. Observations indicate that the proportions of plaice catches discarded at present are high (80% in numbers and 50% in weight: Van Keeken et al. 2004) and have increased since the 1970s (51% in numbers and 27% in weight: Van Beek 1998)

The discards time series used in the assessment was derived from Dutch, Danish, German and UK discards observations for 2000–2007. The discard time series for 1957–1999 was derived from a discard reconstruction using a reconstructed population and selection and distribution ogives (ICES CM 2005/ACFM:07 Section 9.2.3).

This year was the first year that discards observations were made available from the German discard sampling program. These data were provided as age structured estimates for the entire German beam trawl fleet from 2000 to 2007, similar to the Dutch data.

The UK discard samples for 2007 were taken mainly from the UK *Nephrops* and otter trawl fishery. These fisheries represent only a small fraction of the total UK plaice landings, and raising the UK discards using only samples from this fleet would potentially lead to incorrect estimates. Since the UK landings represents 24% of the total nominal landings, obtaining accurate discard estimates is crucial. Hence raising the UK discards was done applying a mean discard length distribution based on the 2002–2004 for the UK beam trawl fleet to the total landings. The WG recommends that in the next benchmark assessment the insufficient UK discard data in most recent years should be considered in more detail.

After raising to the fleet total and estimation of discards-at age using age length keys from the Dutch BTS surveys, discard observations at age are thus available from the Dutch, Danish, German and the UK discard sampling programmes. The sampling effort in the Dutch and UK programmes is given in Table 8.2.2. Discards data from other countries were not available. Because the Danish and German discard observations are only available from 2000 onwards, the discards reconstruction was used for 1957–1999. This is a change with respect to the procedure of WGNSSK 2006, which used the reconstruction from 1957 -1998.

The quality of the estimation of total discards numbers at age depends on the quality of the available discards data, which are derived from low sampling level discards observations within the four countries that have provided discard estimates.

Discards at age were raised from the Dutch and UK sampling programmes by effort ratio (based on hp days at sea for the Dutch fleets, and on trips for the UK fleets). Discards at age from the Danish and German sampling programs were raised by landings. Discards at age for the other fleets for which no estimates were available, were calculated as a weighted average of the Dutch, Danish, German and UK discards at age and raised to the proportion in landings (tonnes). This is the same method as used in the final assessment by WGNSSK 2005 (method B). Until 2006, UK discards estimates without UK age-length key, were age-structured using a combined Dutch-UK ALK. This resulted in age estimation that was in some cases based on a very small number of samples, sensitive to errors in e.g. age-reading. To avoid these problems, a simpler approach was adopted, where the UK samples were age-structured using annual age-length keys from the BTS surveys. This key represents the age-length conversion in the third quarter of the year, but is well sampled, and therefore less prone to errors in individual age readings.

Figure 8.2.1 presents a time series of landings, catches and discards from these different sources.

A self sampling program for discards was started by the Dutch beam trawl fishery in 2004, and is still running. This sampling program has a high number of samples, taken on board by the fishermen, estimating the percentage of discards by volume. The program indicates a strong spatial pattern in the discarding of the fleet (Fig 8.2.2). The percentage discards estimated in the self sampling program is significantly lower than that in the Dutch sampling program in the same years (Aarts & van Helmond 2008). Currently, an evaluation is being undertaken to analyse the causes of the difference.

To reconstruct the number of plaice discards at age before 2000, catch numbers at age are calculated from fishing mortality at age corrected for discard fractions, using a reconstructed population and selection and distribution ogives (ICES CM 2005/ACFM:07 Appendix 1).

8.2.2 Age compositions

Market sampling programmes supplied age distributions for the official landings in 2007. Age compositions by sex and quarter were available for the Dutch landings. Combined age compositions by quarter were available from Germany, Belgium, Denmark and France. Landings from countries that do not provide age compositions were raised to the international age composition.

Until 2002 an age composition of the UK beam trawl fleet was provided, but since 2003 this fleet has ceased to exist. As the UK fleet historically fished further north than the other fleets, a larger proportion of their catches consisted of older animals.

From 2002 onwards, following EU regulation (1639/2001), each country is obliged to sample landings from foreign vessels that land in their country. Since many flag vessels still bring the catches to the Dutch auctions, a substantial sample of these vessels exists in the Netherlands. These samples have so far been included in the Dutch age composition. A separate age composition for foreign vessels could not be generated because the sampling programme is based on sampling by market category and category information for the foreign vessels is not available. The landing numbers at age are presented in Table 8.2.3.

The discard numbers at age were calculated using the discards raising procedures described above. The discard numbers at age are presented in Table 8.2.4. Catch numbers-at-age are presented as the sum of landings numbers at age and discards numbers at age in Table 8.2.5. Figure 8.2.3 presents the landings-at-age, and discards-at-age. Figure 8.2.4 presents the resulting catch-at-age.

8.2.3 Weight at age

The stock weights of age groups 1–4 are calculated using modelled mean lengths from survey and back-calculation data (see ICES CM 2005/ACFM:07 Appendix 1) and converted to mean weight using a fixed length-weight relationship. Stock weights of the older ages are based on the market samples in the first quarter. Stock weights at age are presented in Table 8.2.6. Stock weight at age has varied considerably over time, especially for the older ages. Discard weights at age are calculated the same way as the stock weights of age groups 1–4, after which gear selection and discarding ogives are applied. Landing weights at age are derived from market sampling programmes. Catch weights at age are calculated as the weighted average of the discard and landing weights at age. There appear to be cohort effects on landings weight at age, which are also reflected in the stock weights at age. In addition to the cohort effects, there is a long term decline in weight at age for the older ages. In 2007, stock weight estimates for several of the older ages are below the weights of the same cohort in the previous year. This may be an extension of the long-term decline in stock weight at age (Figure 8.2.5). However it may also be due to non-representative sampling of the different sexes in the population, mainly in the Dutch sampling programme. The stock weights of the older ages are based on the market samples in the first quarter. In these market samples, the sex ratio for the older ages is skewed towards the lighter males. The WG suggests a more in depth study into the causes and consequences of the perceived decreases in stock weights for the next benchmark assessment. Discard, landing, and catch weights at age are presented in Table 8.2.7, 8.2.8 and 8.2.9 respectively. Figure 8.2.5 presents the stock, discards, landings and catch weights at age.

8.2.4 Maturity and natural mortality

Natural mortality is assumed to be 0.1 for all age groups and constant over time. A fixed maturity ogive (Table 8.2.10) is used for the estimation of SSB in North Sea plaice, but maturity at-age is not likely to be constant over time. However, a study of the effect of the fluctuations of natural mortality on the SSB by the WG in 2004 showed that incorporating the historic fluctuations had little effect on SSB estimates in the period 1999–2003.

8.2.5 Catch, effort and research vessel data

Three different survey indices can been used as tuning fleets are (Table 8.2.11 and Figure 8.2.6.):

- Beam Trawl Survey RV Isis (BTS-Isis)
- Beam Trawl Survey RV Tridens (BTS-Tridens)
- Sole Net Survey in September-October (SNS)

Additional Survey indices that can be used for recruitment estimates are (Table 8.2.12):

- Demersal Fish Survey (DFS)

The Beam Trawl Survey RV Isis (BTS-Isis) was initiated in 1985 and was set up to obtain indices of the younger age groups of plaice and sole, covering the south-eastern part of the North Sea (RV Isis). Since 1996 the BTS-Tridens covers the central part of the North Sea, extending the survey area of the surveys. Both vessels use an 8-m beam trawl with 40 mm stretched mesh codend, but the Tridens beam trawl is rigged with a modified net. Owing to the spatial distribution of both BTS surveys, considerable numbers of older plaice and sole are caught. Previously age groups 1 to 4 were used for tuning the North Sea plaice assessment, but the age range has been extended to 1 to 9 in the revision done by ACFM in October 2001.

The Sole Net Survey (SNS & SNSQ2) was carried out with RV Tridens until 1995 and then continued with the RV Isis. Until 1990 this survey was carried out in both spring and autumn, but after that only in autumn. The gear used is a 6 m beam trawl with 40 mm stretched mesh cod-ends. The stations fished are on transects along or perpendicular to the coast. This survey is directed to juvenile plaice and sole. Ages 1 to 3 are used for tuning the North Sea plaice assessment; the 0-group index is used in the RCT3. In an attempt to solve the problem of not having the survey indices in time for the WG, the SNS was moved to spring in 2003. However, because of the gap in the spring series these data could not be used in the plaice assessment or in RCT3. In 2004, the SNS was moved back to autumn as before, based on the recommendation of the WGNSSK in 2004.

As in the previous three years, the 1997 survey results for the 1995 and 1996 year classes (at ages 1 and 2) in the BTS and SNS surveys were not used in the assessment, due to age reading problems in that year. Also, the research vessel survey time series have been revised in May 2006 by WGBEAM (ICES 2006), because of small corrections in data bases and new solutions for missing lengths in the age-length-keys. The internal consistency of the survey indices used for tuning appears relatively high for the entire age-range of each individual survey (Figures 8.2.7–8.2.9).

The Demersal Fish Survey (DFS) is the more coastal of the surveys, conducted by several countries. This survey is not used in the assessment, but rather used to estimate the recruitment of juvenile fish in the RCT3 analysis. The survey estimates abundances for North Sea plaice age 0 and age 1. However, the age 1 has not been used for recruitment estimation since a number of years, and the time series for this age was stopped in 2005. The UK contribution to the DFS survey was revised in 2008, affecting the estimates between 2001 and 2006.

Commercial LPUE series (consisting of an effort series and landings-at-age series) that can be used as tuning fleets are (Table 8.2.13 and Figure 8.2.10):

- The Dutch beam trawl fleet
- The UK beam trawl fleet excluding all flag vessels

Effort has decreased in the Dutch beam trawl fleet since the early/mid 1990s. Up until 2002, the age-classes available in both the Dutch and the UK fleets generally show equal trends in LPUE through time.

The WG used both survey data and commercial LPUE data for tuning until the mid 1990s. The commercial LPUE was calculated as the ratio of the annual landings over the total number of fishing days of the fleet. At that time, however, it was realised that the commercial LPUE data of the Dutch beam trawl-fleet, which dominated the fishery, were likely to be biased due to quota restrictions. Vessels were reported to adjust their fishing patterns in accordance to the individual quota available for that year. Fishermen reported to leave productive fishing grounds because they lacked the fishing rights and moved to areas with lower catch rates of the restricted species with a bycatch of non-quota, or less restricted species. A method that corrects for this bias is to calculate LPUEs at a smaller spatial scale, e.g. ICES rectangles, and then calculate the average of these ICES rectangle-specific LPUEs (Quirijns and Poos 2008 WD 1). This year, age-information is available at this spatial level since 1997, and LPUE series could be used for tuning in XSA (alternatively, age-aggregated tuning series could be used in other analytical assessment methods than XSA). Under the assumption that discarding is negligible for the older ages, the LPUE represents CPUE, and this timeseries could be used to tune age structured assessment methods. Also, age-aggregated LPUE series, corrected for directed fishing under a TAC-constraint (see Quirijns and Poos 2007, WD 1), by area and fleet component, can be used as indication of stock development (Figure 8.2.11 and Figure 8.2.12):

- The Dutch beam trawl fleet (only large cutters with engine powers above 221 kW)
- The UK beam trawl flag vessels landing in the Netherlands (only large cutters with engine powers above 221 kW)
- Several Danish fleets (trawl, gillnet and seines) mainly operating in the Northern area

Effort of the Dutch beam trawl fleet and of the English beam trawl vessels landing in the Netherlands, by area and fleet component, are in Figure 8.2.13.

Plaice LPUE, corrected for directed fishing under a TAC constraint, of the Dutch fleet shows a substantial decrease in the years 1990–1997, after which overall LPUE remains more or less at the same level. 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 shows a increase in LPUE in 2007, compared to 2006, especially for the Northern area. The Dutch fleet shows a rather stable LPUE pattern over recent years, but there is an increase during the last two years. This increase is especially pronounced in the Northern area, but also apparent in the Central area. The LPUEs in the Southern North Sea decreased substantially since 2002, but appear to have stabilized in the last 2 year. This is a continuation of the trends observed previously. The LPUE pattern of the Dutch fleet appears to correspond well with the stock dynamics of the XSA assessment. On average the LPUE in 2005 has decreased to about 58% of the level it had in 1990.

8.3 Data analyses

The assessment of North Sea plaice by XSA was carried out using the FLR version of XSA (1.4.2) in R version 2.4.1. All analyses were done in FLR

8.3.1 Reviews of last year’s assessment

The following comments relevant to this stock were made in 2007 by the RGNSSK (Technical Minutes) and the NSCFP, and it is explained how this WG addressed the comments.

RGNSSK:

- “There seems to be a stock definition problem for plaice, both in relation to IIIa, and VIId” This is most likely true, but given the size of the IV stock this is unlikely to change the perception of the dynamics. The WG suggests that during the next benchmark assessment this will be explored further.
- “Discard estimates are of marginal quality. The discards data should be further developed. The method of estimating historic discards by raising

- "There appear to be strong cohort effects on weights at age. In addition to the cohort effects, there is a long term negative decline in weight at age. Weight at age should be investigated by sex and by area." The WG acknowledges this important trend in the observations, which seems to have persisted also in this years data. Part of the effect could be explained by changes in growth between the cohorts, as there appears to be a clear cohort structure in the observations. However, the long term trend could be caused by changes in the environment, or by changes in the fisheries from which the landings have been used to estimate the stock weights. Such problems could indeed be studies using age and sex specific estimates. However, weight at age for all the fleets catching plaice are not readily available. In a benchmark assessment, the cause for the decrease in observed weights at age should be addressed.
- "There is a need for bringing the surveys together, because they show different signals. A combined survey should be carried out." The surveys indeed currently show two different signals, as the WG has clearly stated last year. In theory, the two BTS surveys could be combined to get a single survey index. However, this would substantially shorten the timespan of this "integrated survey" because the BTS Tridens started only in 1997 and a combination would only be valid from the onset of the shortest time series. Also, by combining the surveys, the information that there are differences between the areas that the surveys cover get lost, and valuable information on the distribution of the stock will be obscured. At the same time, WGBEAM is currently looking at the possibility to indeed combine the different surveys, and in the future, the applicability of such a tuning index can be explored.
- "The age samples from 1997 should be re-processed and included in the assessment in order to include the 1997 SNS survey in the assessment." Unfortunately an attempt to re-process the age samples has shown this it not possible to age-read these samples with sufficient precision.

8.3.2 Exploratory catch-at-age-based analyses

The following exploratory analysis have been carried out:

1) explore sensitivity to different structural model assumption in XSA

2) explore sensitivity to different combinations of tuning series in XSA

3) explore internal consistency for the age-structured corrected LPUE series and investigating the correlation between LPUE and stock size at age

Structural model assumptions

The effect of setting the plus-group at different ages was studied by running XSA with either a plus group at age 10 or at 15. The setting of the plus group has an effect on both the SSB and F estimates coming from the XSA assessment (Fig 8.3.2). In the beginning of the resulting time series, the SSB is higher with the plus group set at age

15 compared to age 10. In the more recent part of the assessment, the SSB estimates are lower when using a plus group at age 15 compared to age 10. For the estimates of fishing mortality the opposite effect can be found.

Different combinations of tuning series

A series of XSA runs was carried out with all possible permutations of the available survey tuning fleets. The settings of the XSA model were the same as in WGNSSK 2007. The results (Figure 8.3.3) indicate that the selection of tuning fleets does strongly affect the perception of SSB and F in the most recent part of the assessment; The variance in the SSB estimates for the terminal year as a result of the permutations is high. The inclusion of only the BTS –Tridens would lead to a much higher perception of the final year SSB, combined with a much lower F estimate. Inclusion of only the BTS index, or a combination of the indices result in estimates between these two extremes.

Corrected age-structured LPUE data

Internal consistency plots were generated to explore the within year class correlation. The results (Figure 8.3.5) suggest weak correlation with for ages below 4. This is most likely a reflection of the low selectivity for these ages and the fact that most juveniles are not landed. However, ages 4 and older, show strong internal consistency. The explore the benefits for including the LPUE in future XSA analysis, correlations between current estimated stock size and LPUE is investigated. Age-structured pairwise plots (Figure 8.3.6) show strong correlation between LPUE and stock size for the ages 4 and older, but the estimated correlations will be strongly influenced by the strong 1996 and 2001 year classes.

8.3.3 Conclusions drawn from exploratory analyses

Like in previous years, the plus group was set to 10, which has a minor effect on the assessment of F and SSB in the terminal year. The different survey tuning series available give different perceptions of the development of the stock in the most recent part of the assessment. This difference in the signals from different areas in the North Sea corresponds to the observations from the landings per unit effort from the Dutch beam trawl fleet. Because the working group has not been able to model these differences, all the available survey tuning indices are used to average across the signals.

8.3.4 Final assessment

The settings for the final assessment, compared to the settings in earlier years is given below:

Year	2006	2007	2008
Catch at age	Landings + (reconstructed) discards based on NL + UK fleets	Landings + (reconstructed) discards based on NL, DK + UK fleets	Landings + (reconstructed) discards based on NL, DK + UK + GE fleets
Fleets	BTS-Isis 1985–2005 1–9 BTS-Tridens 1996–2005 1–9 SNS 1982–2005 1–3	BTS-Isis 1985–2006 1–8 BTS-Tridens 1996–2006 1–9 SNS 1982–2006 1–3	BTS-Isis 1985–2007 1–8 BTS-Tridens 1996–2007 1–9 SNS 1982–2007 1–3
Plus group	10	10	10
First tuning year	1982	1982	1982
Last data year	2005	2006	2007
Time series weights	No taper	No taper	No taper
Catchability dependent on stock size for age <	1	1	1
Catchability independent of ages for ages >=	6	6	6
Survivor estimates shrunk towards the mean F	5 years / 5 ages	5 years / 5 years	5 years / 5 years
s.e. of the mean for shrinkage	2.0	2.0	2.0
Minimum standard error for population estimates	0.3	0.3	0.3
Prior weighting	Not applied	Not applied	Not applied

The full diagnostics are presented in Table 8.3.2. The log catchability residuals for the tuning fleets in the final run are dominated by negative values for the SNS tuning index in the most recent period, and positive values for the BTS-Tridens in the younger ages (Figure 8.3.4). The high BTS-Tridens tuning index for 1 year old individuals leads to a high residual in the XSA assessment for this survey, year and age. Fishing mortality and stock numbers are shown in Tables 8.3.2 and 8.3.3. respectively. The SSB in 2007 was estimated at 216 kt. Mean F(2–6) was estimated at 0.39. Recruitment of the 2006 year class, in 2007 at the age of 1, was estimated at 936721 thousand in the XSA. Retrospective analysis of the XSA presented in Figure 8.3.7 indicate that historic estimates for SSB during the last two years were low compared to the current estimate. Accordingly, the fishing mortality since 2005 estimated in this year are lower than the estimates in the previous assessments. This is likely the result of the high survey estimates this year.

8.4 Historic Stock Trends

Table 8.4.1. and Figure 8.4.1. present the trends in landings, mean F(2–6), F(human consumption, 2–6), SSB, TSB and recruitment since 1957. Reported landings gradually increased up to the late 1980s and then rapidly declined until 1996, in line with

the decrease in TAC. The landings show a decline from 1989 onwards. Discards were particularly high in 1997 and 1998 (reconstructed), and in 2002–2003 (observed), resulting from strong year classes. Fishing mortality increased until the late 1990s and reached its highest observed level in 1997. Since then, the estimates of fishing mortality have been fluctuating strongly. However, overall F has been lower since 2004, decreasing down to 0.4 in 2005, with a slight increase in the most recent years. The peaks during 1997–1998 and 2001–2002 have been mainly caused by peaks in F(discards). The F(human consumption) is estimated to decline since 1997, with little inter-annual variability. This year (2007), the F(human consumption) is the lowest estimate historically. Current fishing mortality is estimated at 0.39 (Fhc,2–6 = 0.18). The SSB increased to a peak in 1967 when the strong 1963 year class became mature. Since then, SSB declined to a level of around 260 kt in the early 1980s. Due to the recruitment of the strong year-classes 1981 and 1985, SSB again increased to a peak in 1987 of around 441 kt followed by a rapid decline (up to 1996). SSB has fluctuated around 220 kt in the last 10 years. In plaice the inter-annual variability in recruitment is relatively small, except for a limited number of strong year classes. Previously only year classes 1963, 1981, 1985 and 1996 were considered to be strong. Including discard data in the assessment alters the recruitment estimates and indicates that 1984, 1986, 1987 were also relatively strong year classes and that the 1985 year class was by far the strongest year class on record. Recruitment shows a periodic change with relatively poor recruitment in the 1960s and relatively strong recruitment in the 1980s. The recruitment level in the 1990s appears to be somewhat lower than in the 1980s. The 1996 and 2001 year classes are estimated to be relatively strong, while the year classes since 2002 appear weak to average.

The North Sea Fishers' Survey has not yet been completed, so no comparison can be made between the stock trends observed from the assessment and the fishermen's perceptions from the Fishers' survey.

8.5 Recruitment estimates

Input to the RCT3 analysis is presented in Table 8.5.1. Estimates from the RCT3 analysis of age 1 are presented in Table 8.5.2, and of age 2 in Table 8.5.3. For year class 2007 (age 1 in 2008) the values predicted by the two surveys (SNS and DFS) in RCT3 differ considerably (Table 8.5.2.), and therefore the geometric mean was accepted for the short-term forecasts (which is quite similar to the RCT3 estimate). Also for year class 2006 (age 2 in 2008), the estimates from SNS 0-group and DFS 0-group differ considerably, and so do the SNS 1-group and BTS 1-group (also used for the XSA) estimates. The WG decides to use the RCT3 estimate for the 2006 year class. In practice the estimates (XSA survivors, RCT3 or geometric mean) are quit similar

The recruitment estimates from the different sources are summarized in the text table below.

Year class	At age in 2008	XSA Survivors	RCT3	GM 1957–2005	Accepted estimate
2006	2	769722	**746834**	675366	RCT3 estimate
2007	1		1 015 480	**910440**	GM 1957–2005
2008	0			**910440**	GM 1957–2005

8.6 Short-term forecasts

Short-term prognoses have been carried out in FLR using FLSTF (1.4.3). Weight-at-age in the stock and weight-at-age in the catch are taken to be the average over the last 3 years. The exploitation pattern was taken to be the mean value of the last three years, scaled to F in 2007. The proportion of landings at age was taken to be the mean of the last three years, this proportion was used for the calculation of the discard and human consumption partial fishing mortality. Population numbers at ages 3 and older are XSA survivor estimates. Numbers at age 2 were based on RCT3 estimates (see table in previous section). Numbers at age 1 and recruitment of the 2008 year-class are taken from the long-term geometric mean (1957–2004). Input to the short term forecast is presented in table 8.6.1. The management options are given in Table 8.6.2A-C. The management options are given for three different assumptions on the F values for 2008; A) F_{2008} is assumed to be equal to the estimate for F in 2007, B) F_{2008} is 0.9 times F_{2007}, and C) F_{2008} is set such that the landings in 2008 equal the TAC of that same year. The table below shows the predicted F values in the intermediate year, SSB for 2009 and the corresponding landings for 2008, given the different assumptions about F in the intermediate year in the different scenarios.

Scenario	Assumption	F_{2008}	SSB_{2009}	$Landings_{2008}$
A	$F_{2008} = F_{2007}$	0.39	265 083	59 223
B	$F_{2008} = 0.9F_{2007}$	0.35	274 215	54 189
C	$TAC_{2008} = Landings_{2008}$	0.31	283 662	49 004

The detailed table for a forecast based on Fsq is given in Table 8.6.3A-C. ICES interprets the F for the preceding year as the estimate of F for the year in which the assessment is carried out. The basis for this F estimate in the preceding year will be a constant application of the procedure used by ICES in 2007 (see section 8.1.4). Using this ICES rule of application the will presents scenario A as the basis for its forecast.

Yield and SSB, per recruit, under the condition of the current exploitation pattern are given in Figure 8.6.1. Fmax is estimated at 0.17.

8.7 Medium-term forecasts

No medium term projections were done for this stock because of time constraints.

8.8 Biological reference points

The current reference points were established by the WGNSSK in 2004, when the discard estimates were included in the assessment for the first time. The stock-recruitment relationship for North Sea plaice did not show a clear breakpoint where recruitment is impaired at lower spawning stocks. Therefore, ICES considered that $\mathbf{B_{lim}}$ can be set at 160 000 t and that $\mathbf{B_{pa}}$ can then be set at 230 000 t using the default multiplier of 1.4 (although the WG acknowledges that, since the noisy discards estimates have been included, the uncertainty of the estimates of stock status is much greater than that, see Dickey-Collas et al. 2008. $\mathbf{F_{lim}}$ was set at $\mathbf{F_{loss}}$ (0.74). $\mathbf{F_{pa}}$ was proposed to be set at 0.6 which is the 5th percentile of $\mathbf{F_{loss}}$ and gave a 50% probability that SSB is around $\mathbf{B_{pa}}$ in the medium term. Equilibrium analysis suggests that F of 0.6 is consistent with an SSB of around 230 000 t.

	ICES considered that:	**ICES proposed that:**
Precautionary Approach Reference point	$\mathbf{B_{lim}}$ is 160 000 t	$\mathbf{B_{pa}}$ be set at 230 000 t

	F_{lim} is 0.74	F_{pa} be set at 0.60
Target reference points		F_y undefined

8.9 Quality of the assessment

The assessment presented by the WG incorporates discards. WGNSSK noted in 2002 (ICES 2003) that not considering discard catches in stock assessments could introduce bias and affect estimates of F and stock biomass, particularly when discard patterns vary over time. The discards estimates since 2000 have been derived under EC project 98/097 and under the EC data regulation (EC 2001). Because of the different sampling strategies by the different countries, data from the UK, Denmark, Germany and the Netherlands were used in this assessment. These countries contribute to approximately 85% of the landings. Total sampling effort of the discards is low, and data is sparse. Also, samples may not always be available from relevant fleets and fisheries within a country. The assessment is considered to be uncertain because discards form a substantial part of the total catch but cannot be well estimated from the sparse sampling trips.

Differences are found in the trends in tuning series over the last six years. The more northern BTS-Tridens index indicates higher stock abundances than the two other tuning indices, BTS-Isis and SNS. Because of the historic correspondence between the VPA estimates and the BTS-Isis tuning index in the XSA assessment, it has a higher weight in estimating the stock numbers for ages 1–4 in recent years. The spatial difference of the stock trends is corroborated by the area disaggregated LPUE estimates from the Dutch beam trawl fleet. However, the historic development of the stock abundance as estimated by XSA shows good correspondence with the development of the average commercial LPUE of the Dutch beam trawl fleet. Also some independent estimates of SSB from the annual egg production method correspond to the general pattern of a decrease in estimated SSB seen in the first half of the 1990s, as shown by last years WG.

A retrospective analysis of the assessment shows some recurring bias (Figure 8.3.7.). An underestimation of the SSB is found in four of the five years, but this bias is in the same order of magnitude as the variance in the SSB time series of the last assessment of those five years. The current estimates of the biomass over the last three years considerably higher than the previous assessments. This retrospective pattern is the result of the high 2007 tuning indices in general, and the fact that the cohorts being estimated stronger by BTS Tridens than the other surveys now reach the age where the index has a higher weighting in the assessment.

8.10 Status of the Stock

SSB in 2008 is estimated around 254 thousand tonnes which is above Bpa (230 000 t). Fishing mortality is estimated to have decrease from 0.43 in 2006 to 0.39 in 2007 (both below Fpa = 0.60), and at the same level as 2005 (0.41). At the same time, Fishing mortality of the human consumption part of the catch is estimated to 0.18 Projected landings for 2009 at Fsq are 61 kt, which is slightly higher than to the projected landings for 2008 at Fsq (59 kt) which are much higher than the estimated landings of 2007 (50 kt). Projected discards for 2009 are approximately equal to the projected discards for 2008 at Fsq, but this is mainly based on the estimates of the abundance of year classes 2007 and 2008 coming in. Therefore, development of discarding in the next couple of years will depend on the true size of these year classes.

8.11 Management Considerations

Plaice is mainly taken by beam trawlers in a mixed fishery with sole in the southern and central part of the North Sea.

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 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. Recent discards estimates indicate fluctuations around 50% discards in weight. Mesh enlargement would reduce the catch of undersized plaice, but would also result in loss of marketable sole.

The combination of days-at-sea regulations, high oil prices, and the decreasing TAC for plaice and the relatively stable TAC for sole, appear to have induced a more coastal fishing pattern in the southern North Sea. This concentration of fishing effort results in increased discarding of juvenile plaice that are mainly distributed in those areas. This process could be aggravated by movement of juvenile plaice to deeper waters in recent years where they become more susceptible to the fishery. Also the LPUE data show a slower recovery of stock size in the southern regions that may be caused by higher fishing effort in the more coastal regions.

An STECF 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. 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." (Grift *et al.* 2004).

The stock dynamics are dependent on the occurrence of strong year classes.

The mean age in the landings is currently just around age 4, but used to be around age 5 in the beginning of the time series. This change may be caused by the high exploitation levels, but also by the shift in the spatial distribution of fishing effort towards inshore waters and by the shift in the spatial distribution of the fish. A lower exploitation level is expected to improve the survival of plaice, which could enhance the stability in the catches.

A shift in the age and size at maturation of plaice has been observed (Grift *et al.* 2003): plaice become mature at younger ages and at smaller sizes in recent years than in the past. There is a risk that this is caused by a genetic fisheries-induced change: Those fish that are genetically programmed to mature late at large sizes are likely to have been removed from the population before they have had a chance to reproduce and pass on their genes. This results in a population that consists ever more of fish that are genetically programmed to mature early at small sizes. Reversal of such a genetic shift may be difficult. This shift in maturation also leads to mature fish being of a smaller size at age, because growth rate diminishes after maturation.

A long term management plan proposed by the Commission of the European Community was adopted by the Council of the European Union in June 2007 and first implemented in 2008 (EC Council Regulation No 676/2007). The plan consists of two stages. The aim of the first phase is to ensure the return of the stocks of plaice and sole in the North sea to within safe biological limits. This should be reached through an annual reduction of fishing mortality (F) by 10% in relation to the fishing mortality estimated for the preceding year. ICES interprets the F for the preceding year as the estimate of F for the year in which the assessment is carried out. The basis for this F estimate in the preceding year will be a constant application of the procedure used by ICES in 2007. The plan sets a maximum change of 15% of the TAC between consecutive years

The EC management plan has not been evaluated by ICES at the time of the working group meeting. ICES cannot conclude if this management plan is in accordance with the precautionary approach. ICES is currently in the process of evaluating the agreed management and will report on results of such an evaluation in June 2008.

The assessment is considered to be uncertain partly because discards form a substantial part of the total catch and cannot be well estimated from the sparse sampling trips. Also, the different survey tuning series in different areas of the North Sea indicate different trends in the most recent development of the stock. This uncertainty is compounded by a relatively strong retrospective pattern, where this years' assessment result estimates higher SSBs and lower fishing mortalities for the most recent years.

Table 8.2.1. North Sea Plaice. Nominal landings

YEAR	Belgium	Denmark	France	Germany	Nether-lands	Norway	Sweden	UK	Others	Total	Un-allocated	WG estimate	TAC
1980	7005	27057	711	4319	39782	15	7	23032		101928	38023	139951	
1981	6346	22026	586	3449	40049	18	3	21519		93996	45701	139697	105000
1982	6755	24532	1046	3626	41208	17	6	20740		97930	56616	154546	140000
1983	9716	18749	1185	2397	51328	15	22	17400		100812	43218	144030	164000
1984	11393	22154	604	2485	61478	16	13	16853		114996	41153	156149	182000
1985	9965	28236	1010	2197	90950	23	18	15912		148311	11527	159838	200000
1986	7232	26332	751	1809	74447	21	16	17294		127902	37445	165347	180000
1987	8554	21597	1580	1794	76612	12	7	20638		130794	22876	153670	150000
1988	11527	20259	1773	2566	77724	21	2	24497	43	138412	16063	154475	175000
1989	10939	23481	2037	5341	84173	321	12	26104		152408	17410	169818	185000
1990	13940	26474	1339	8747	78204	1756	169	25632		156261	-21	156240	180000
1991	14328	24356	508	7926	67945	560	103	27839		143565	4438	148003	175000
1992	12006	20891	537	6818	51064	836	53	31277		123482	1708	125190	175000
1993	10814	16452	603	6895	48552	827	7	31128		115278	1835	117113	175000
1994	7951	17056	407	5697	50289	524	6	27749		109679	713	110392	165000
1995	7093	13358	442	6329	44263	527	3	24395		96410	1946	98356	115000
1996	5765	11776	379	4780	35419	917	5	20992		80033	1640	81673	81000
1997	5223	13940	254	4159	34143	1620	10	22134		81483	1565	83048	91000
1998	5592	10087	489	2773	30541	965	2	19915	1	70365	1169	71534	87000
1999	6160	13468	624	3144	37513	643	4	17061		78617	2045	80662	102000
2000	7260	13408	547	4310	35030	883	3	20710		82151	-1001	81150	97000
2001	6369	13797	429	4739	33290	1926	3	19147		79700	2147	81847	78000
2002	4859	12552	548	3927	29081	1996	2	16740		69705	512	70217	77000
2003	4570	13742	343	3800	27353	1967	2	13892		65669	820	66489	73250
2004	4314	12123	231*	3649	23662	1744	1	15284		61008	428	61436	61000
2005	3396	11385	112	3379	22271	1660	0	12705		54908	792	55700	59000
2006	3487	11907	132	3599	22764	1614	0	12429		55933	2010	57943	57441
2007	3866	8128	144	2643	21465	1224	4	11557		49031	713	49744	50261
2008													49000

Table 8.2.2. North Sea plaice. Sampling effort in number of trips for the NL, UK, DE and DK discards sampling programmes used for estimating discards at age.

NL UK-BT UK-Oth. DE DK

Year

2000 18 7 19

2001 6 4 38

2002 8 8 29

2003 10 5 34

2004 10 9 59

2005 9 1 39

2006 11 2 45 16

2007 10 0 123 38

Table 8.2.3. North Sea plaice. Landing numbers-at-age

2008 – 04 – 22 14:42:24 units= thousands

age

year	1	2	3	4	5	6	7	8	9	10
1957	0	4315	59818	44718	31771	8885	11029	9028	4973	10859
1958	0	7129	22205	62047	34112	19594	8178	8000	6110	13148
1959	0	16556	30427	25489	41099	22936	13873	6408	6596	16180
1960	0	5959	61876	51022	21321	27329	14186	9013	5087	15153
1961	0	2264	33392	67906	32699	12759	14680	9748	5996	14660
1962	0	2147	35876	66779	50060	20628	9060	9035	5257	12801
1963	0	4340	21471	76926	54364	31799	12848	6833	7047	16592
1964	0	14708	40486	64735	57408	37091	15819	6595	3980	16886
1965	0	9858	42202	53188	43674	30151	18361	8554	4213	17587
1966	0	4144	65009	51488	36667	27370	16500	10784	6467	14928
1967	0	5982	30304	112917	41383	22053	16175	8004	6728	11175
1968	0	9474	40698	38140	123619	17139	10341	10102	3925	13365
1969	3	15017	45187	36084	35585	102014	10410	6086	8192	16092
1970	76	17294	51174	56153	40686	35074	78886	6311	4185	14840
1971	19	29591	48282	33475	26059	22903	16913	29730	6414	16910
1972	2233	36528	62199	52906	23043	16998	14380	10903	18585	15651
1973	1268	31733	59099	73065	42255	13817	8885	9848	6084	23978
1974	2223	23120	55548	42125	41075	19666	8005	6321	5568	21980
1975	981	28124	61623	31262	25419	21188	11873	5923	4106	19695
1976	2820	33643	77649	96398	13779	9904	9120	6391	2947	12552
1977	3220	56969	43289	66013	83705	9142	5912	5022	4061	9191
1978	1143	60578	62343	54341	50102	35510	5940	3352	2419	7468
1979	1318	58031	118863	48962	47886	39932	24228	4161	2807	9288
1980	979	64904	133741	77523	24974	17982	13761	8458	1864	5377
1981	253	100927	122296	57604	35745	12414	9564	8092	4874	5903
1982	3334	47776	209007	69544	28655	16726	7589	5470	4482	8653
1983	1214	119695	115034	99076	29359	12906	8216	4193	3013	8287
1984	108	63252	274209	53549	37468	13661	6465	5544	2720	6565
1985	121	73552	144316	185203	32520	15544	6871	3650	2698	5798
1986	1674	67125	163717	93801	84479	24049	9299	4490	2733	6950
1987	0	85123	115951	111239	64758	34728	11452	4341	2154	5478
1988	0	15146	250675	74335	47380	25091	16774	5381	3162	6233
1989	1261	46757	105929	231414	52909	19247	10567	7561	2120	5580
1990	1550	32533	97766	110997	159814	26757	8129	4216	3451	3808
1991	1461	43266	83603	116155	72961	77557	14910	5233	3141	5591
1992	3410	43954	85120	72494	72703	33406	29547	6970	3200	6928
1993	3461	53949	98375	72286	51405	29001	13472	11272	3645	5883
1994	1394	45148	101617	80236	38542	20388	15323	6399	5368	5433
1995	7751	36575	81398	78370	36499	17953	9772	4366	2336	3753
1996	1104	42496	64382	46359	32130	14460	10605	4528	2624	4892
1997	892	42855	86948	43669	22541	13518	6362	3632	2179	4181
1998	196	30401	68920	56329	16713	6432	4986	2506	1761	3119
1999	549	8689	155971	39857	24112	6829	2783	2246	1521	3093
2000	2634	15819	39550	164330	14993	9343	2130	1030	940	2097
2001	4509	35886	52480	48238	89949	6836	4418	1127	637	2309
2002	1233	15596	58262	48361	36551	37877	4644	1788	742	1586
2003	694	42594	47802	48894	27126	15999	17069	1608	650	859
2004	543	10317	102332	35165	20527	11293	4787	4555	412	540
2005	2937	16685	26069	82278	17039	9533	5332	2614	2223	613
2006	355	18987	67465	25254	42525	6555	4967	2053	1235	1319
2007	1286	19205	37309	47053	14971	17142	2459	1856	543	1259

Table 8.2.4. North Sea Plaice. Discards numbers-at-age

2008 - 04 - 28 10:53:56 units= thousands age

year	1	2	3	4	5	6	7	8	9	10
1957	32356	45596	9220	909	961	25	0	0	0	0
1958	66199	73552	23655	2572	2137	65	0	0	0	0
1959	116086	127771	46402	11407	4737	106	0	0	0	0
1960	73939	167893	44948	997	1067	519	0	0	0	0
1961	75578	144609	89014	538	1612	130	0	0	0	0
1962	51265	181321	87599	21716	799	186	0	0	0	0
1963	90913	136183	129778	9964	2112	188	0	0	0	0
1964	66035	153274	64156	33825	3011	323	0	0	0	0
1965	43708	426021	59262	3404	923	267	0	0	0	0
1966	38496	163125	349358	14399	1402	125	0	0	0	0
1967	20199	133545	87532	152496	623	260	0	0	0	0
1968	73971	72192	46339	26530	22436	58	0	0	0	0
1969	85192	67378	16747	19334	773	2024	0	0	0	0
1970	123569	152480	27747	1287	5061	161	0	0	0	0
1971	69337	96968	42354	2675	426	81	0	0	0	0
1972	70002	55470	33899	5714	567	73	0	0	0	0
1973	132352	49815	4008	673	1289	67	0	0	0	0
1974	211139	308411	3652	285	611	109	0	0	0	0
1975	244969	280130	190536	4807	253	123	0	0	0	0
1976	183879	140921	71054	18013	174	41	0	0	0	0
1977	256628	103696	79317	33552	9317	129	0	0	0	0
1978	226872	154113	27257	10775	1244	570	0	0	0	0
1979	293166	215084	57578	18382	589	310	0	0	0	0
1980	226371	122561	932	687	193	86	0	0	0	0
1981	134142	193241	1850	373	431	55	0	0	0	0
1982	411307	204572	4624	1109	216	98	0	0	0	0
1983	261400	436331	30716	2235	804	72	0	0	0	0
1984	310675	313490	52651	24529	1492	69	0	0	0	0
1985	405385	229208	35566	2221	200	78	0	0	0	0
1986	1117345	490965	48510	26470	1451	146	0	0	0	0
1987	361519	1374202	180969	1427	1348	248	0	0	0	0
1988	348597	608109	459385	61167	882	177	0	0	0	0
1989	213291	485845	193176	85758	7224	115	0	0	0	0
1990	145314	279298	168674	28102	5011	177	0	0	0	0
1991	183126	301575	141567	40739	5528	939	0	0	0	0
1992	138755	219619	94581	34348	4307	880	0	0	0	0
1993	96371	154083	48088	11966	1635	216	0	0	0	0
1994	62122	95703	35703	1038	822	144	0	0	0	0
1995	118863	82676	15753	860	663	120	0	0	0	0
1996	111250	331065	27606	3930	451	116	0	0	0	0
1997	128653	510918	193828	588	271	108	0	0	0	0
1998	104538	646250	191631	53354	297	33	0	0	0	0
1999	127321	208401	231769	54869	278	58	0	0	0	0
2000	95567	183545	64331	51493	1803	236	138	8	0	0
2001	27006	303961	152801	52090	38729	300	89	45	0	0
2002	460559	259405	115157	23454	5970	2431	598	421	0	0
2003	74446	602876	84025	49184	11444	4012	4784	196	0	0
2004	170186	177783	95874	8347	2180	414	68	115	0	0
2005	78946	275471	35724	14286	2943	2065	44	3	0	0
2006	178244	206120	98403	11034	6014	1250	1503	287	0	0
2007	80564	191776	61644	13678	2186	4904	777	1003	0	0

Table 8.2.5. North Sea plaice. Catch numbers-at-age

2008 - 04 - 28 10:53:57 units= thousands age

year	1	2	3	4	5	6	7	8	9	10
1957	32356	49911	69038	45627	32732	8910	11029	9028	4973	10859
1958	66199	80681	45860	64619	36249	19659	8178	8000	6110	13148
1959	116086	144327	76829	36896	45836	23042	13873	6408	6596	16180
1960	73939	173852	106824	52019	22388	27848	14186	9013	5087	15153
1961	75578	146873	122406	68444	34311	12889	14680	9748	5996	14660
1962	51265	183468	123475	88495	50859	20814	9060	9035	5257	12801
1963	90913	140523	151249	86890	56476	31987	12848	6833	7047	16592
1964	66035	167982	104642	98560	60419	37414	15819	6595	3980	16886
1965	43708	435879	101464	56592	44597	30418	18361	8554	4213	17587
1966	38496	167269	414367	65887	38069	27495	16500	10784	6467	14928
1967	20199	139527	117836	265413	42006	22313	16175	8004	6728	11175
1968	73971	81666	87037	64670	146055	17197	10341	10102	3925	13365
1969	85195	82395	61934	55418	36358	104038	10410	6086	8192	16092
1970	123645	169774	78921	57440	45747	35235	78886	6311	4185	14840
1971	69356	126559	90636	36150	26485	22984	16913	29730	6414	16910
1972	72235	91998	96098	58620	23610	17071	14380	10903	18585	15651
1973	133620	81548	63107	73738	43544	13884	8885	9848	6084	23978
1974	213362	331531	59200	42410	41686	19775	8005	6321	5568	21980
1975	245950	308254	252159	36069	25672	21311	11873	5923	4106	19695
1976	186699	174564	148703	114411	13953	9945	9120	6391	2947	12552
1977	259848	160665	122606	99565	93022	9271	5912	5022	4061	9191
1978	228015	214691	89600	65116	51346	36080	5940	3352	2419	7468
1979	294484	273115	176441	67344	48475	40242	24228	4161	2807	9288
1980	227350	187465	134673	78210	25167	18068	13761	8458	1864	5377
1981	134395	294168	124146	57977	36176	12469	9564	8092	4874	5903
1982	414641	252348	213631	70653	28871	16824	7589	5470	4482	8653
1983	262614	556026	145750	101311	30163	12978	8216	4193	3013	8287
1984	310783	376742	326860	78078	38960	13730	6465	5544	2720	6565
1985	405506	302760	179882	187424	32720	15622	6871	3650	2698	5798
1986	1119019	558090	212227	120271	85930	24195	9299	4490	2733	6950
1987	361519	1459325	296920	112666	66106	34976	11452	4341	2154	5478
1988	348597	623255	710060	135502	48262	25268	16774	5381	3162	6233
1989	214552	532602	299105	317172	60133	19362	10567	7561	2120	5580
1990	146864	311831	266440	139099	164825	26934	8129	4216	3451	3808
1991	184587	344841	225170	156894	78489	78496	14910	5233	3141	5591
1992	142165	263573	179701	106842	77010	34286	29547	6970	3200	6928
1993	99832	208032	146463	84252	53040	29217	13472	11272	3645	5883
1994	63516	140851	137320	81274	39364	20532	15323	6399	5368	5433
1995	126614	119251	97151	79230	37162	18073	9772	4366	2336	3753
1996	112354	373561	91988	50289	32581	14576	10605	4528	2624	4892
1997	129545	553773	280776	44257	22812	13626	6362	3632	2179	4181
1998	104734	676651	260551	109683	17010	6465	4986	2506	1761	3119
1999	127870	217090	387740	94726	24390	6887	2783	2246	1521	3093
2000	98201	199364	103881	215823	16796	9579	2268	1038	940	2097
2001	31515	339847	205281	100328	128678	7136	4507	1172	637	2309
2002	461792	275001	173419	71815	42521	40308	5242	2209	742	1586
2003	75140	645470	131827	98078	38570	20011	21853	1804	650	859
2004	170729	188100	198206	43512	22707	11707	4855	4670	412	540
2005	81883	292156	61793	96564	19982	11598	5376	2617	2223	613
2006	178599	225107	165868	36288	48539	7805	6470	2340	1235	1319
2007	81850	210981	98953	60731	17157	22046	3236	2859	543	1259

Table 8.2.6. North Sea plaice. Stock weight-at-age

2008 - 04 - 22 14:46:24 units= kg age

year	1	2	3	4	5	6	7	8	9	10
1957	0.039	0.099	0.160	0.248	0.325	0.485	0.719	0.682	0.844	1.143
1958	0.042	0.091	0.183	0.279	0.303	0.442	0.577	0.778	0.793	1.112
1959	0.046	0.103	0.177	0.271	0.329	0.470	0.650	0.686	0.908	1.042
1960	0.039	0.108	0.185	0.279	0.364	0.469	0.633	0.726	0.845	1.090
1961	0.038	0.095	0.188	0.313	0.337	0.483	0.579	0.691	0.779	1.067
1962	0.036	0.093	0.176	0.308	0.424	0.573	0.684	0.806	0.873	1.303
1963	0.042	0.100	0.180	0.280	0.378	0.540	0.663	0.788	0.882	1.252
1964	0.025	0.110	0.187	0.304	0.373	0.477	0.645	0.673	0.845	1.232
1965	0.032	0.066	0.202	0.302	0.333	0.430	0.516	0.601	0.722	0.909
1966	0.032	0.097	0.129	0.313	0.403	0.455	0.503	0.565	0.581	0.984
1967	0.030	0.101	0.182	0.210	0.442	0.528	0.585	0.650	0.703	0.985
1968	0.056	0.091	0.178	0.294	0.344	0.532	0.592	0.362	0.667	0.887
1969	0.048	0.153	0.192	0.273	0.344	0.390	0.565	0.621	0.679	0.857
1970	0.044	0.110	0.243	0.281	0.369	0.410	0.468	0.636	0.732	0.896
1971	0.052	0.106	0.259	0.354	0.413	0.489	0.512	0.583	0.696	0.877
1972	0.057	0.154	0.225	0.418	0.473	0.534	0.579	0.606	0.655	0.929
1973	0.037	0.129	0.243	0.320	0.468	0.521	0.566	0.583	0.617	0.804
1974	0.050	0.102	0.224	0.427	0.437	0.524	0.570	0.629	0.652	0.852
1975	0.065	0.138	0.193	0.399	0.483	0.544	0.610	0.668	0.704	0.943
1976	0.083	0.165	0.233	0.316	0.484	0.550	0.593	0.658	0.694	0.931
1977	0.066	0.179	0.274	0.319	0.405	0.551	0.627	0.690	0.667	0.938
1978	0.066	0.148	0.329	0.383	0.411	0.467	0.547	0.630	0.704	0.943
1979	0.063	0.174	0.266	0.375	0.414	0.459	0.543	0.667	0.764	1.004
1980	0.050	0.159	0.299	0.440	0.444	0.524	0.582	0.651	0.778	1.058
1981	0.042	0.136	0.246	0.433	0.473	0.536	0.570	0.624	0.707	1.033
1982	0.049	0.125	0.258	0.361	0.490	0.589	0.631	0.679	0.726	0.981
1983	0.046	0.124	0.250	0.392	0.494	0.559	0.624	0.712	0.754	0.917
1984	0.049	0.126	0.223	0.425	0.464	0.571	0.649	0.692	0.787	1.029
1985	0.050	0.144	0.238	0.326	0.452	0.536	0.635	0.656	0.764	1.011
1986	0.044	0.124	0.252	0.317	0.440	0.533	0.692	0.779	0.888	1.092
1987	0.037	0.103	0.204	0.383	0.401	0.503	0.573	0.711	0.747	0.984
1988	0.037	0.096	0.176	0.269	0.426	0.467	0.547	0.644	0.706	0.973
1989	0.040	0.099	0.193	0.245	0.362	0.484	0.553	0.616	0.759	0.884
1990	0.045	0.109	0.184	0.270	0.343	0.422	0.555	0.647	0.701	0.972
1991	0.050	0.131	0.191	0.269	0.342	0.401	0.463	0.633	0.652	0.826
1992	0.047	0.123	0.204	0.275	0.318	0.403	0.500	0.573	0.683	0.834
1993	0.052	0.117	0.214	0.327	0.330	0.391	0.490	0.587	0.633	0.811
1994	0.054	0.143	0.220	0.297	0.360	0.404	0.462	0.533	0.653	0.798
1995	0.051	0.140	0.260	0.342	0.399	0.448	0.509	0.584	0.678	0.804
1996	0.044	0.116	0.234	0.375	0.390	0.462	0.488	0.554	0.660	0.815
1997	0.032	0.116	0.186	0.375	0.439	0.492	0.521	0.543	0.627	0.852
1998	0.039	0.080	0.208	0.339	0.474	0.577	0.581	0.648	0.656	0.812
1999	0.045	0.090	0.153	0.320	0.437	0.524	0.586	0.644	0.664	0.780
2000	0.052	0.105	0.169	0.224	0.408	0.467	0.649	0.695	0.656	0.787
2001	0.062	0.121	0.207	0.237	0.331	0.452	0.560	0.641	0.798	0.830
2002	0.049	0.117	0.218	0.306	0.319	0.403	0.446	0.612	0.685	0.873
2003	0.061	0.112	0.228	0.270	0.344	0.391	0.464	0.600	0.714	0.787
2004	0.048	0.116	0.206	0.313	0.384	0.430	0.489	0.495	0.780	0.875
2005	0.054	0.105	0.219	0.241	0.378	0.422	0.434	0.527	0.621	1.010
2006	0.053	0.129	0.195	0.321	0.354	0.424	0.439	0.506	0.583	0.731
2007	0.048	0.093	0.239	0.241	0.337	0.394	0.458	0.412	0.526	0.548

Table 8.2.7. North Sea plaice. Landings weight-at-age

2008 - 04 - 22 14:44:27 units= kg age

year	1	2	3	4	5	6	7	8	9	10
1957	0.000	0.183	0.223	0.287	0.392	0.506	0.592	0.654	0.440	1.108
1958	0.000	0.211	0.235	0.275	0.358	0.482	0.546	0.654	0.707	1.055
1959	0.000	0.223	0.251	0.299	0.370	0.483	0.605	0.637	0.766	1.021
1960	0.000	0.201	0.238	0.291	0.389	0.488	0.605	0.688	0.729	1.101
1961	0.000	0.194	0.237	0.307	0.418	0.517	0.613	0.681	0.825	1.088
1962	0.000	0.204	0.240	0.290	0.387	0.523	0.551	0.669	0.751	1.090
1963	0.000	0.258	0.292	0.325	0.407	0.543	0.636	0.680	0.729	1.048
1964	0.000	0.252	0.275	0.314	0.391	0.491	0.633	0.705	0.743	1.012
1965	0.000	0.243	0.284	0.323	0.387	0.474	0.542	0.667	0.730	0.892
1966	0.000	0.236	0.275	0.354	0.444	0.493	0.569	0.635	0.703	0.950
1967	0.000	0.237	0.285	0.328	0.433	0.558	0.609	0.675	0.753	0.998
1968	0.000	0.275	0.307	0.341	0.377	0.532	0.607	0.613	0.706	0.937
1969	0.230	0.311	0.328	0.352	0.380	0.436	0.606	0.693	0.696	0.945
1970	0.307	0.279	0.310	0.347	0.408	0.432	0.486	0.655	0.725	0.869
1971	0.264	0.329	0.368	0.416	0.463	0.531	0.560	0.627	0.722	0.920
1972	0.253	0.304	0.362	0.440	0.507	0.556	0.625	0.664	0.693	0.965
1973	0.286	0.332	0.361	0.426	0.511	0.566	0.636	0.659	0.711	0.884
1974	0.296	0.322	0.367	0.420	0.494	0.574	0.631	0.719	0.733	0.960
1975	0.265	0.319	0.351	0.446	0.526	0.624	0.676	0.747	0.832	1.082
1976	0.272	0.302	0.347	0.385	0.526	0.609	0.657	0.723	0.760	1.005
1977	0.254	0.324	0.354	0.381	0.419	0.557	0.648	0.722	0.716	0.980
1978	0.235	0.304	0.356	0.383	0.422	0.473	0.587	0.662	0.748	0.916
1979	0.235	0.310	0.348	0.387	0.428	0.473	0.549	0.674	0.795	0.959
1980	0.241	0.290	0.349	0.406	0.479	0.552	0.596	0.671	0.782	1.027
1981	0.241	0.279	0.335	0.423	0.514	0.568	0.615	0.653	0.738	1.025
1982	0.281	0.264	0.313	0.427	0.517	0.612	0.668	0.716	0.743	0.990
1983	0.199	0.248	0.298	0.381	0.512	0.600	0.673	0.766	0.810	0.978
1984	0.229	0.259	0.279	0.369	0.483	0.603	0.673	0.714	0.824	1.019
1985	0.242	0.259	0.284	0.330	0.453	0.565	0.664	0.714	0.788	1.001
1986	0.218	0.266	0.300	0.343	0.420	0.482	0.667	0.742	0.843	1.001
1987	0.218	0.246	0.296	0.347	0.397	0.498	0.576	0.719	0.819	0.978
1988	0.218	0.250	0.274	0.347	0.446	0.504	0.599	0.688	0.801	0.999
1989	0.233	0.276	0.305	0.327	0.386	0.525	0.594	0.660	0.780	0.929
1990	0.267	0.281	0.293	0.312	0.360	0.440	0.588	0.681	0.749	0.989
1991	0.219	0.276	0.283	0.295	0.352	0.438	0.509	0.646	0.720	0.887
1992	0.246	0.258	0.285	0.312	0.335	0.417	0.521	0.594	0.702	0.875
1993	0.243	0.267	0.282	0.318	0.348	0.413	0.506	0.616	0.704	0.836
1994	0.223	0.256	0.278	0.330	0.387	0.437	0.489	0.595	0.713	0.883
1995	0.270	0.275	0.299	0.336	0.399	0.451	0.525	0.607	0.729	0.902
1996	0.236	0.276	0.302	0.350	0.414	0.479	0.491	0.580	0.709	0.844
1997	0.206	0.269	0.310	0.361	0.453	0.520	0.598	0.611	0.678	0.917
1998	0.150	0.256	0.305	0.388	0.489	0.597	0.623	0.684	0.689	0.900
1999	0.242	0.249	0.276	0.350	0.449	0.539	0.621	0.672	0.742	0.802
2000	0.221	0.259	0.276	0.305	0.420	0.486	0.664	0.690	0.729	0.862
2001	0.236	0.264	0.289	0.306	0.361	0.477	0.586	0.701	0.787	0.793
2002	0.232	0.259	0.283	0.309	0.341	0.436	0.500	0.678	0.745	0.881
2003	0.227	0.248	0.281	0.319	0.363	0.406	0.477	0.641	0.750	0.837
2004	0.212	0.245	0.280	0.325	0.394	0.433	0.505	0.552	0.789	0.861
2005	0.267	0.262	0.277	0.327	0.385	0.427	0.463	0.545	0.603	0.888
2006	0.257	0.272	0.289	0.338	0.399	0.409	0.475	0.489	0.533	0.755
2007	0.262	0.267	0.303	0.345	0.378	0.452	0.539	0.481	0.590	0.619

Table 8.2.8. North Sea plaice. Discards weight-at-age

2008 - 04 - 22 14:45:06 units= kg age

year	1	2	3	4	5	6	7	8	9	10
1957	0.046	0.102	0.147	0.180	0.204	0.231	0.244	0.231	0	0
1958	0.049	0.095	0.158	0.186	0.198	0.244	0.244	0.000	0	0
1959	0.053	0.106	0.155	0.185	0.193	0.231	0.000	0.000	0	0
1960	0.047	0.110	0.159	0.186	0.199	0.210	0.231	0.000	0	0
1961	0.046	0.098	0.160	0.192	0.202	0.212	0.211	0.244	0	0
1962	0.044	0.097	0.155	0.192	0.211	0.219	0.220	0.220	0	0
1963	0.049	0.103	0.156	0.186	0.203	0.231	0.220	0.231	0	0
1964	0.034	0.112	0.160	0.191	0.202	0.220	0.231	0.231	0	0
1965	0.040	0.071	0.165	0.191	0.210	0.220	0.220	0.000	0	0
1966	0.040	0.100	0.126	0.192	0.203	0.231	0.220	0.231	0	0
1967	0.038	0.104	0.157	0.169	0.211	0.219	0.231	0.244	0	0
1968	0.062	0.095	0.156	0.190	0.189	0.244	0.212	0.000	0	0
1969	0.055	0.144	0.161	0.185	0.205	0.210	0.244	0.231	0	0
1970	0.051	0.113	0.178	0.187	0.192	0.000	0.212	0.231	0	0
1971	0.059	0.109	0.182	0.198	0.211	0.000	0.000	0.231	0	0
1972	0.063	0.145	0.173	0.210	0.205	0.244	0.000	0.000	0	0
1973	0.045	0.128	0.178	0.193	0.204	0.231	0.244	0.000	0	0
1974	0.057	0.105	0.173	0.210	0.212	0.231	0.244	0.000	0	0
1975	0.070	0.134	0.162	0.204	0.220	0.244	0.244	0.000	0	0
1976	0.088	0.151	0.175	0.193	0.219	0.244	0.244	0.000	0	0
1977	0.071	0.157	0.185	0.193	0.196	0.211	0.000	0.000	0	0
1978	0.071	0.141	0.196	0.203	0.205	0.211	0.220	0.000	0	0
1979	0.069	0.155	0.184	0.202	0.219	0.231	0.220	0.244	0	0
1980	0.057	0.147	0.190	0.211	0.220	0.000	0.244	0.000	0	0
1981	0.050	0.133	0.178	0.210	0.219	0.244	0.000	0.000	0	0
1982	0.056	0.125	0.182	0.199	0.231	0.231	0.244	0.000	0	0
1983	0.054	0.124	0.180	0.203	0.205	0.244	0.244	0.000	0	0
1984	0.055	0.125	0.172	0.210	0.203	0.000	0.244	0.000	0	0
1985	0.056	0.138	0.176	0.195	0.231	0.244	0.000	0.000	0	0
1986	0.051	0.123	0.180	0.192	0.211	0.244	0.231	0.000	0	0
1987	0.044	0.104	0.165	0.203	0.211	0.231	0.000	0.000	0	0
1988	0.044	0.098	0.154	0.184	0.211	0.231	0.000	0.000	0	0
1989	0.047	0.102	0.163	0.180	0.192	0.244	0.000	0.000	0	0
1990	0.054	0.113	0.159	0.185	0.205	0.231	0.000	0.000	0	0
1991	0.058	0.130	0.162	0.185	0.199	0.220	0.220	0.231	0	0
1992	0.055	0.124	0.167	0.186	0.200	0.210	0.220	0.244	0	0
1993	0.059	0.120	0.171	0.196	0.205	0.231	0.231	0.000	0	0
1994	0.062	0.141	0.175	0.192	0.211	0.231	0.244	0.220	0	0
1995	0.060	0.140	0.185	0.199	0.212	0.231	0.231	0.244	0	0
1996	0.053	0.122	0.178	0.203	0.220	0.231	0.000	0.244	0	0
1997	0.042	0.118	0.160	0.202	0.220	0.244	0.000	0.000	0	0
1998	0.049	0.086	0.168	0.197	0.212	0.000	0.244	0.000	0	0
1999	0.055	0.096	0.144	0.193	0.211	0.244	0.000	0.000	0	0
2000	0.061	0.110	0.152	0.173	0.231	0.000	0.198	0.000	0	0
2001	0.070	0.122	0.167	0.177	0.195	0.231	0.000	0.231	0	0
2002	0.058	0.119	0.171	0.191	0.196	0.211	0.000	0.000	0	0
2003	0.068	0.114	0.174	0.184	0.198	0.204	0.220	0.000	0	0
2004	0.057	0.117	0.167	0.192	0.196	0.211	0.199	0.000	0	0
2005	0.063	0.109	0.172	0.178	0.220	0.204	0.219	0.231	0	0
2006	0.062	0.128	0.162	0.193	0.197	0.199	0.210	0.211	0	0
2007	0.057	0.097	0.177	0.178	0.192	0.197	0.220	0.197	0	0

Table 8.2.9. North Sea plaice. Catch weight-at-age

2008 - 04 - 28 12:16:50 units= thousands age

year	1	2	3	4	5	6	7	8	9	10
1957	0.046	0.109	0.213	0.284	0.386	0.506	0.592	0.654	0.440	1.108
1958	0.049	0.105	0.195	0.272	0.349	0.481	0.546	0.654	0.707	1.055
1959	0.053	0.119	0.193	0.264	0.352	0.482	0.605	0.637	0.766	1.021
1960	0.047	0.113	0.205	0.289	0.380	0.483	0.605	0.688	0.729	1.101
1961	0.046	0.099	0.181	0.306	0.408	0.514	0.613	0.681	0.825	1.088
1962	0.044	0.098	0.180	0.266	0.384	0.520	0.551	0.669	0.751	1.090
1963	0.049	0.108	0.175	0.309	0.399	0.541	0.636	0.680	0.729	1.048
1964	0.034	0.124	0.205	0.272	0.381	0.488	0.633	0.705	0.743	1.012
1965	0.040	0.075	0.214	0.315	0.384	0.471	0.542	0.667	0.730	0.892
1966	0.040	0.103	0.149	0.319	0.435	0.492	0.569	0.635	0.703	0.950
1967	0.038	0.110	0.190	0.237	0.430	0.554	0.609	0.675	0.753	0.998
1968	0.062	0.116	0.226	0.279	0.348	0.531	0.607	0.613	0.706	0.937
1969	0.055	0.174	0.283	0.294	0.376	0.432	0.606	0.693	0.696	0.945
1970	0.051	0.130	0.263	0.343	0.384	0.430	0.486	0.655	0.725	0.869
1971	0.059	0.160	0.281	0.400	0.459	0.529	0.560	0.627	0.722	0.920
1972	0.069	0.208	0.295	0.418	0.500	0.555	0.625	0.664	0.693	0.965
1973	0.047	0.207	0.350	0.423	0.502	0.565	0.636	0.659	0.711	0.884
1974	0.059	0.120	0.355	0.419	0.489	0.573	0.631	0.719	0.733	0.960
1975	0.071	0.151	0.208	0.414	0.523	0.621	0.676	0.747	0.832	1.082
1976	0.091	0.180	0.265	0.354	0.522	0.608	0.657	0.723	0.760	1.005
1977	0.073	0.216	0.245	0.317	0.396	0.552	0.648	0.722	0.716	0.980
1978	0.072	0.187	0.307	0.353	0.417	0.469	0.587	0.662	0.748	0.916
1979	0.070	0.188	0.295	0.337	0.426	0.471	0.549	0.674	0.795	0.959
1980	0.058	0.196	0.348	0.405	0.477	0.550	0.596	0.671	0.782	1.027
1981	0.050	0.183	0.332	0.422	0.510	0.566	0.615	0.653	0.738	1.025
1982	0.058	0.151	0.310	0.423	0.515	0.610	0.668	0.716	0.743	0.990
1983	0.055	0.151	0.273	0.377	0.504	0.598	0.673	0.766	0.810	0.978
1984	0.055	0.147	0.261	0.319	0.473	0.600	0.673	0.714	0.824	1.019
1985	0.056	0.167	0.263	0.329	0.451	0.564	0.664	0.714	0.788	1.001
1986	0.051	0.140	0.273	0.310	0.416	0.481	0.667	0.742	0.843	1.001
1987	0.044	0.112	0.216	0.345	0.393	0.496	0.576	0.719	0.819	0.978
1988	0.044	0.102	0.196	0.273	0.442	0.502	0.599	0.688	0.801	0.999
1989	0.048	0.117	0.213	0.287	0.363	0.524	0.594	0.660	0.780	0.929
1990	0.056	0.130	0.208	0.286	0.356	0.439	0.588	0.681	0.749	0.989
1991	0.059	0.148	0.207	0.266	0.341	0.436	0.509	0.646	0.720	0.887
1992	0.060	0.146	0.223	0.272	0.327	0.412	0.521	0.594	0.702	0.875
1993	0.065	0.158	0.246	0.301	0.343	0.412	0.506	0.616	0.704	0.836
1994	0.066	0.178	0.252	0.328	0.383	0.436	0.489	0.595	0.713	0.883
1995	0.073	0.181	0.281	0.334	0.396	0.450	0.525	0.607	0.729	0.902
1996	0.055	0.139	0.265	0.338	0.411	0.477	0.491	0.580	0.709	0.844
1997	0.043	0.130	0.207	0.359	0.451	0.518	0.598	0.611	0.678	0.917
1998	0.049	0.094	0.204	0.295	0.484	0.594	0.623	0.684	0.689	0.900
1999	0.056	0.102	0.197	0.259	0.446	0.537	0.621	0.672	0.742	0.802
2000	0.065	0.122	0.199	0.273	0.399	0.474	0.636	0.684	0.729	0.862
2001	0.094	0.137	0.198	0.239	0.311	0.467	0.575	0.683	0.787	0.793
2002	0.058	0.127	0.209	0.271	0.320	0.422	0.443	0.548	0.745	0.881
2003	0.069	0.123	0.213	0.251	0.314	0.365	0.421	0.571	0.750	0.837
2004	0.057	0.124	0.225	0.299	0.375	0.425	0.501	0.538	0.789	0.861
2005	0.070	0.118	0.216	0.305	0.361	0.387	0.461	0.544	0.603	0.888
2006	0.062	0.140	0.214	0.294	0.374	0.375	0.413	0.455	0.533	0.755
2007	0.060	0.112	0.225	0.308	0.354	0.395	0.462	0.381	0.590	0.619

Table 8.2.10. North Sea plaice. Natural mortality at age and maturity ate age vector used in assessments

2007 - 05 - 01 19:41:03

	age									
metric	1	2	3	4	5	6	7	8	9	10
natural mortality	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
maturity	0	0.5	0.5	1.0	1.0	1.0	1.0	1.0	1.0	1.0

Table 8.2.11 North Sea plaice. Survey tuning indices.

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BTS-Isis (Ages 1 – 8 used in the assessment)

		age								
year	effort	1	2	3	4	5	6	7	8	9
1985	1	116	179.9	38.81	11.84	1.371	1.048	0.362	0.167	0.098
1986	1	667	131.8	51.00	8.89	3.285	0.428	0.338	0.129	0.038
1987	1	226	764.3	33.06	4.77	2.039	1.017	0.352	0.087	0.072
1988	1	680	147.0	182.31	9.99	2.810	0.814	0.458	0.036	0.112
1989	1	468	319.3	38.66	47.30	5.850	0.833	0.311	0.661	0.132
1990	1	115	102.6	55.67	22.78	5.572	0.801	0.205	0.374	0.259
1991	1	185	122.1	28.55	11.86	4.264	5.710	0.257	0.219	0.099
1992	1	177	125.9	27.31	5.62	3.184	2.662	1.136	0.259	0.053
1993	1	125	179.1	38.40	6.12	0.931	0.812	0.629	0.465	0.167
1994	1	145	64.2	35.24	10.88	2.857	0.638	0.861	0.957	0.401
1995	1	252	43.5	14.22	8.11	1.195	0.868	0.356	1.131	0.218
1996	1	218	212.3	23.02	4.83	3.404	0.917	0.047	0.173	0.131
1997	1	NA	NA	19.91	2.79	0.219	0.390	0.171	0.121	0.000
1998	1	343	431.9	47.40	8.91	1.440	0.755	0.145	0.078	0.105
1999	1	306	130.0	182.52	3.65	2.107	0.137	0.140	0.029	0.032
2000	1	278	74.4	31.38	24.00	0.613	0.175	0.540	0.029	0.013
2001	1	223	78.4	19.39	9.97	9.474	0.294	0.143	0.041	0.043
2002	1	541	47.7	16.05	5.38	2.734	1.422	0.091	0.138	0.000
2003	1	126	170.1	10.78	5.94	1.525	1.214	0.684	0.112	0.104
2004	1	226	41.8	66.60	6.62	2.650	1.603	1.021	3.054	0.000
2005	1	158	69.6	7.23	13.74	1.167	1.254	0.313	0.164	0.530
2006	1	135	39.0	19.50	3.21	6.343	0.934	0.815	0.043	0.289
2007	1	329	72.3	21.22	15.53	3.168	6.553	0.737	0.895	0.168

BTS-Tridens

age										
Year	effort	1	2	3	4	5	6	7	8	9
1996	1	1.593	5.59	4.40	3.31	2.37	1.84	0.830	0.529	0.177
1997	1	NA	NA	10.41	3.95	2.84	1.93	0.471	1.102	0.424
1998	1	0.557	30.14	9.93	5.57	2.67	1.35	0.911	0.789	0.308
1999	1	2.387	8.29	36.93	6.47	2.65	2.13	0.600	0.771	0.326
2000	1	4.639	9.45	12.74	17.23	2.94	1.89	1.076	0.954	0.247
2001	1	0.672	6.93	9.05	7.23	7.67	1.21	0.691	0.480	0.603
2002	1	18.480	13.54	11.27	6.87	4.23	4.43	0.741	0.723	0.340
2003	1	4.108	34.84	11.91	8.57	4.75	2.72	3.973	0.699	0.703
2004	1	5.689	10.63	29.05	7.92	4.19	2.23	1.131	2.460	0.396
2005	1	7.340	23.70	11.30	16.20	2.57	5.42	1.552	0.536	3.335
2006	1	7.024	17.45	25.06	9.91	11.39	1.93	3.874	0.835	0.716
2007	1	29.707	21.89	17.26	20.79	4.55	9.70	1.829	3.545	0.314

Table 8.2.11 North Sea plaice. Survey tuning indices. (Cont'd)

SNS

Age

Year	effort	1	2	3
1970	1	9311	9732	3273
1971	1	13538	28164	1415
1972	1	13207	10785	4472
1973	1	65639	5046	1578
1974	1	15366	16509	1129
1975	1	11628	8168	9556
1976	1	8537	2403	868
1977	1	18537	3424	1737
1978	1	14012	12678	345
1979	1	21495	9829	1575
1980	1	59174	12882	491
1981	1	24756	18785	834
1982	1	69993	8642	1261
1983	1	33974	13909	249
1984	1	44965	10413	2467
1985	1	28101	13848	1598
1986	1	93552	7580	1152
1987	1	33402	32991	1227
1988	1	36609	14421	13153
1989	1	34276	17810	4373
1990	1	25037	7496	3160
1991	1	57221	11247	1518
1992	1	46798	13842	2268
1993	1	22098	9686	1006
1994	1	19188	4977	856
1995	1	24767	2796	381
1996	1	23015	10268	1185
1997	1	NA	NA	1391
1998	1	33666	30242	5014
1999	1	32951	10272	13783
2000	1	22855	2493	891
2001	1	11511	2898	370
2002	1	30813	1103	265
2003	1	NA	NA	NA
2004	1	18202	1350	1081
2005	1	10118	1819	142
2006	1	12164	1571	384
2007	1	14175	2134	140

Table 8.2.12. North Sea plaice. DFS index catches (numbers per hour), used only for RCT3.

DFS

	Effort	age 0	age 1
1981	1	605.96	169.78
1982	1	433.67	299.36
1983	1	431.72	163.53
1984	1	261.80	124.19
1985	1	716.29	103.27
1986	1	200.11	288.27
1987	1	516.84	195.87
1988	1	318.36	116.45
1989	1	435.70	125.72
1990	1	465.47	130.13
1991	1	498.49	152.35
1992	1	351.59	137.08
1993	1	262.26	75.16
1994	1	445.66	30.60
1995	1	184.51	37.74
1996	1	572.80	116.89
1997	1	149.19	209.92
1998	1	NA	NA
1999	1	NA	NA
2000	1	183.83	11.31
2001	1	500.43	5.90
2002	1	210.70	17.79
2003	1	359.59	11.31
2004	1	243.15	14.97
2005	1	129.25	NA
2006	1	232.28	NA
2007	1	175.65	NA

Table 8.2.13 North Sea plaice. Commercial tuning fleets (not used in the final assessment)

2008 – 04 – 23 16:10:48

NL Beam Trawl

year	Effort	2	3	4	5	6	7	8	9
1989	72.5	557.8	1016	1820	318.1	132.9	72.3	37.45	13.06
1990	71.1	308.8	844	701	1076.2	171.4	51.8	25.18	16.33
1991	68.5	401.5	619	776	448.1	497.7	100.4	28.53	16.60
1992	71.1	341.4	623	448	382.1	171.9	133.4	34.66	13.97
1993	76.9	358.3	605	407	256.2	142.8	78.5	46.96	13.33
1994	81.4	370.9	591	441	188.8	97.5	75.8	35.21	23.70
1995	81.2	277.3	536	417	178.0	81.0	42.1	19.08	11.47
1996	72.1	368.9	383	290	193.9	73.7	50.5	18.95	13.09
1997	72.0	320.8	634	252	95.6	60.2	28.0	13.54	6.39
1998	70.2	217.8	463	381	91.0	32.6	19.4	9.53	4.47
1999	67.3	64.5	1134	271	164.3	44.6	14.8	12.38	7.52
2000	64.6	138.9	263	1118	89.6	60.1	11.4	5.20	3.31
2001	61.4	264.3	367	321	664.6	44.7	28.6	6.35	3.19
2002	56.7	177.0	575	383	250.8	292.2	18.5	9.96	2.75
2003	51.6	372.8	387	406	186.4	103.8	129.1	6.03	5.02
2004	48.1	102.5	925	228	150.5	73.8	30.6	44.51	1.95
2005	49.1	154.2	222	727	96.2	59.2	34.1	14.81	23.54
2006	44.1	245.7	593	190	452.9	45.9	50.7	16.30	28.55
2007	42.9	201.6	416	464	109.7	208.1	23.1	26.62	7.53

English Beam trawl excl Flag-vessels

year	Effort	4	5	6	7	8	9	10	11	12
1990	102.3	27.0	92.7	17.46	11.08	7.06	8.23	2.45	1.662	0.958
1991	123.6	21.9	28.6	53.39	10.72	6.77	3.45	4.94	1.828	1.481
1992	151.5	19.2	29.3	18.40	24.25	6.39	3.68	3.20	3.281	1.096
1993	146.6	23.4	20.9	17.26	6.30	12.80	4.33	2.73	2.435	1.739
1994	131.4	23.1	22.0	13.49	9.53	4.51	6.47	3.28	1.438	1.218
1995	105.0	34.0	15.8	14.05	9.71	5.90	3.16	3.60	2.733	1.362
1996	82.9	13.3	19.0	10.74	10.08	6.55	4.68	2.50	3.305	1.966
1997	76.3	16.4	11.1	13.97	7.85	8.99	6.62	2.77	1.940	3.001
1998	68.8	23.6	13.0	8.97	8.69	5.04	6.03	4.61	1.948	1.599
1999	68.6	14.7	15.2	6.66	4.77	5.35	3.76	3.27	2.813	1.429
2000	57.8	63.2	15.0	9.95	4.41	2.44	3.48	1.87	1.782	2.526
2001	54.1	14.7	45.0	8.89	6.21	2.48	1.72	2.07	0.906	1.682
2002	30.6	23.4	20.8	29.61	5.13	4.12	1.41	1.73	1.503	1.340

Table 8.2.14 . North Sea plaice. Commercial LPUE

2008 – 05 – 11 10:14:23

	1	2	3	4	5	6	7	8	9	10	11	12
1997	1.70	245.7	595	287	131.3	89.9	46.1	21.95	11.73	8.71	5.327	4.558
1998	0.00	99.3	280	314	100.2	50.8	28.2	16.91	7.75	4.18	3.664	2.735
1999	1.82	26.9	571	201	173.2	59.1	24.9	20.53	14.72	9.52	2.924	4.379
2000	7.38	69.7	145	724	95.4	77.5	22.1	10.15	7.82	6.30	2.814	1.895
2001	9.88	152.8	243	230	602.6	55.3	46.0	11.85	6.76	5.17	2.833	3.795
2002	4.22	86.1	329	254	190.3	302.3	24.3	17.25	5.68	1.43	4.788	0.613
2003	4.09	257.6	298	348	176.3	107.4	145.8	8.39	6.88	3.20	0.514	5.022
2004	2.85	66.6	673	202	148.8	78.0	35.2	54.46	3.03	3.59	1.830	0.223
2005	24.74	103.0	171	674	113.2	80.3	44.9	23.59	41.09	2.40	2.313	0.805
2006	2.98	150.3	413	159	442.3	56.2	58.1	19.88	14.72	25.56	0.780	0.292
2007	12.92	151.4	356	436	119.7	266.3	35.1	36.06	10.89	7.28	18.825	0.343

	13	14	15	16	17	18	19	20	21
1997	1.0436	0.759	0.3795	0.190	0.2846	0.0949	0.000	0.000	0.0000
1998	1.2385	0.722	0.3096	0.206	0.0000	0.0000	0.000	0.000	0.0000
1999	2.0681	2.311	0.6063	0.364	0.2425	0.1213	0.000	0.000	0.2425
2000	1.3736	1.374	0.6254	0.625	0.0000	0.3127	0.000	0.208	0.2085
2001	1.4034	0.748	1.4969	0.579	0.6549	0.0936	0.000	0.000	0.2894
2002	0.9190	0.511	1.0211	0.204	0.3063	0.2042	0.000	0.000	0.2042
2003	0.0826	1.529	0.0826	1.010	0.0000	0.2478	0.000	0.431	0.0826
2004	2.8216	0.124	0.3720	0.000	0.3100	0.2480	0.124	0.000	0.0620
2005	0.0000	2.006	0.0000	0.000	0.0000	0.2011	0.438	0.101	0.4971
2006	0.5850	0.000	1.5600	0.000	0.0975	0.0000	0.195	0.195	0.1950
2007	1.0285	0.965	0.0000	0.768	0.0000	0.1143	0.000	0.000	0.2286

Table 8.3.1. North Sea plaice. XSA diagnostics from final run

```
FLR XSA Diagnostics 2008 - 05 - 08 11:45:29
CPUE data from xsa.indices
Catch data for 51 years. 1957 to 2007. Ages 1 to 10.
 fleet first age last age first year last year alpha beta
1 BTS-Isis 1 8 1985 2007 0.66 0.75
2 BTS-Tridens 1 9 1996 2007 0.66 0.75
3 SNS 1 3 1982 2007 0.66 0.75
 Time series weights :
 Tapered time weighting not applied
Catchability analysis :
 Catchability independent of size for all ages
 Catchability independent of age for ages >= 6
Terminal population estimation :
 Survivor estimates shrunk towards the mean F
 of the final 5 years or the 5 oldest ages.
 S.E. of the mean to which the estimates are shrunk = 2
 Minimum standard error for population
 estimates derived from each fleet = 0.3
 prior weighting not applied
Regression weights
 year
age 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007
 all 1 1 1 1 1 1 1 1 1 1
 Fishing mortalities
 year
age 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007
 1 0.154 0.175 0.111 0.051 0.293 0.161 0.183 0.141 0.300 0.096
 2 0.509 0.481 0.399 0.593 0.705 0.746 0.662 0.477 0.617 0.611
 3 0.997 0.545 0.396 0.818 0.609 0.783 0.472 0.417 0.483 0.535
 4 1.075 1.160 0.591 0.730 0.673 0.743 0.567 0.392 0.409 0.289
 5 0.648 0.643 0.561 0.757 0.701 0.843 0.331 0.490 0.310 0.307
 6 0.453 0.524 0.497 0.436 0.497 0.751 0.586 0.250 0.319 0.202
 7 0.568 0.318 0.289 0.407 0.586 0.488 0.356 0.519 0.193 0.189
 8 0.452 0.479 0.168 0.212 0.318 0.361 0.161 0.295 0.396 0.110
 9 0.535 0.483 0.334 0.132 0.181 0.130 0.116 0.096 0.197 0.133
 10 0.535 0.483 0.334 0.132 0.181 0.130 0.116 0.096 0.197 0.133
```

Table 8.3.1. North Sea plaice. XSA diagnostics from final run (Cont'd)

XSA population number (thousands)

age

year 1 2 3 4 5 6 7 8 9 10

1998 770467 1782870 434202 175071 37496 18667 12099 7248 4471 7881

1999 837778 597522 969557 145038 54077 17748 10741 6205 4174 8451

2000 986285 636419 334158 508462 41130 25731 9508 7072 3478 7734

2001 664506 799016 386215 203544 254778 21239 14170 6445 5411 19586

2002 1912327 571292 399707 154193 88739 108130 12430 8535 4717 10064

2003 530130 1291075 255337 196709 71207 39847 59498 6261 5621 7418

2004 1074896 408206 554222 105641 84695 27742 17020 33049 3949 5168

2005 654375 810204 190434 312942 54198 55035 13966 10782 25462 7013

2006 723809 514214 455195 113532 191307 30033 38766 7523 7267 7745

2007 936721 485041 251151 254099 68210 126930 19751 28922 4581 10605

Estimated population abundance at 1st Jan 2008

age

year 1 2 3 4 5 6 7 8 9 10

2008 0 769728 238195 133129 172153 45400 93884 14794 23452 3629

Fleet: BTS-Isis

Log catchability residuals.

year

age 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1 -1.240 -0.415 -0.655 0.553 0.563 -0.736 -0.081 0.018 0.052 0.348 -0.098 -0.364 2 0.312 -0.325 0.534 -0.307 0.552 -0.282 0.071 0.269 0.712 0.071 -0.207 0.427 3 -0.024 0.369 -0.317 0.491 -0.301 0.111 -0.228 -0.057 0.403 0.391 -0.110 0.508 4 -0.261 -0.212 -0.606 -0.145 0.470 0.436 -0.084 -0.499 -0.214 0.513 0.334 0.203 5 -0.537 -0.167 -0.281 0.247 0.636 -0.330 0.034 0.031 -0.917 0.324 -0.295 0.883 6 0.281 -0.723 -0.337 -0.138 0.020 -0.406 0.769 0.480 -0.261 -0.297 0.078 0.463 7 0.038 -0.149 -0.054 -0.376 -0.343 -0.729 -0.774 -0.067 -0.417 0.774 -0.152 -2.020 8 -0.165 -0.230 -0.797 -1.322 0.730 0.484 0.062 0.058 -0.333 0.428 1.903 -0.172

age 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007

1 NA 0.644 0.462 0.156 0.289 0.290 0.024 -0.084 0.027 -0.121 0.369

2 NA 0.463 0.336 -0.343 -0.381 -0.463 0.021 -0.291 -0.596 -0.622 0.049

3 -0.395 0.640 0.867 0.066 -0.263 -0.633 -0.461 0.366 -0.825 -0.658 0.058

4 -0.180 0.520 -0.123 0.104 0.240 -0.141 -0.235 0.372 -0.108 -0.535 0.150

5 -1.472 0.498 0.509 -0.510 0.543 0.315 0.051 0.070 -0.192 0.113 0.448

6 -0.216 0.645 -0.961 -1.107 -0.439 -0.447 0.571 1.096 -0.071 0.288 0.712

7 -0.492 -0.490 -0.582 0.869 -0.776 -0.970 -0.588 0.971 0.101 -0.192 0.379

8 -0.345 -0.680 -1.495 -1.845 -1.374 -0.367 -0.236 1.265 -0.444 -1.352 0.135

Table 8.3.1. North Sea plaice. XSA diagnostics from final run (Cont'd)

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

	1	2	3	4	5	6	7	8
Mean_Logq	-8.1832	-8.3595	-8.9898	-9.5788	-10.1382	-10.3709	-10.3709	-10.3709
S.E_Logq	0.4658	0.4034	0.4510	0.3405	0.5381	0.5731	0.6506	0.8921

Fleet: BTS-Tridens

Log catchability residuals.

year

age	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
1	-1.347	NA	-1.840	-0.454	0.002	-1.577	0.851	0.537	0.171	0.893	0.860	1.901
2	-1.189	NA	-0.178	-0.395	-0.385	-0.787	0.298	0.456	0.363	0.347	0.595	0.876
3	-0.443	-0.340	-0.219	-0.027	-0.132	-0.320	-0.282	0.343	0.241	0.326	0.297	0.556
4	-0.348	-0.003	-0.120	0.277	-0.399	-0.253	-0.067	-0.040	0.379	-0.115	0.420	0.270
5	-0.266	0.304	0.331	-0.046	0.271	-0.454	-0.034	0.402	-0.259	-0.187	-0.087	0.025
6	-0.075	0.149	-0.008	0.550	0.040	-0.259	-0.544	0.145	0.194	0.159	-0.221	-0.130
7	-0.383	-0.713	0.113	-0.361	0.324	-0.434	-0.107	-0.063	-0.161	0.468	0.132	0.053
8	-0.289	0.630	0.400	0.552	0.414	-0.148	0.055	0.361	-0.185	-0.494	0.380	0.278
9	-0.156	0.158	0.001	0.090	-0.110	0.198	-0.203	0.312	0.082	0.335	0.121	-0.287

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

	1	2	3	4	5	6	7	8	9
Mean_Logq	-12.1212	-10.3805	-9.6939	-9.4071	-9.3523	-9.1368	-9.1368	-9.1368	-9.1368
S.E_Logq	1.1867	0.6354	0.3356	0.2775	0.2743	0.2772	0.3393	0.3636	0.1997

Fleet: SNS

Log catchability residuals.

year

age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
1	0.344	0.059	0.421	-0.460	-0.186	-0.372	-0.174	0.144	-0.069	0.938	0.882	0.516	0.518
2	0.454	0.143	0.314	0.643	-0.285	0.287	0.267	0.561	-0.004	0.583	0.957	0.690	0.409
3	0.142	-1.341	0.178	0.150	-0.058	-0.247	1.225	0.883	0.606	0.201	0.818	0.124	0.037

age	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
1	-0.224	-0.420	NA	0.519	0.428	-0.146	-0.479	-0.381	NA	-0.409	-0.530	-0.334	-0.583
2	-0.057	0.294	NA	0.700	0.694	-0.843	-0.784	-1.335	NA	-0.827	-1.345	-0.939	-0.578
3	-0.366	0.905	0.307	1.757	1.647	-0.132	-0.858	-1.374	NA	-0.391	-1.391	-1.221	-1.599

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

	1	2	3
Mean_Logq	-3.4699	-4.3474	-5.4455
S.E_Logq	0.4617	0.6935	0.9340

Table 8.3.1. North Sea plaice. XSA diagnostics from final run (Cont'd)

```
 Terminal year survivor and F summaries:

 Age 1 Year class = 2006
source
 survivors N scaledWts
BTS-Isis 1112787 1 0.448
BTS-Tridens 5150629 1 0.066
SNS 429847 1 0.458
fshk 322802 1 0.028
 Age 2 Year class = 2005
source
 survivors N scaledWts
BTS-Isis 235509 2 0.517
BTS-Tridens 570277 2 0.156
SNS 155687 2 0.301
fshk 221971 1 0.026
 Age 3 Year class = 2004
source
 survivors N scaledWts
BTS-Isis 112859 3 0.408
BTS-Tridens 235688 3 0.399
SNS 53742 3 0.176
fshk 126930 1 0.017
 Age 4 Year class = 2003
source
 survivors N scaledWts
BTS-Isis 149107 4 0.420
BTS-Tridens 228017 4 0.489
SNS 73630 3 0.082
fshk 77134 1 0.009
 Age 5 Year class = 2002
source
 survivors N scaledWts
BTS-Isis 34653 5 0.352
BTS-Tridens 56072 5 0.614
SNS 14831 2 0.025
fshk 22958 1 0.009
```

Table 8.3.1. North Sea plaice. XSA diagnostics from final run (Cont'd)

```
 Age 6 Year class = 2001
source
 survivors N scaledWts
BTS-Isis 116118 6 0.298
BTS-Tridens 87446 6 0.674
SNS 63853 2 0.020
fshk 33820 1 0.007
 Age 7 Year class = 2000
source
 survivors N scaledWts
BTS-Isis 17565 7 0.259
BTS-Tridens 14231 7 0.721
SNS 6977 2 0.011
fshk 5733 1 0.009
 Age 8 Year class = 1999
source
 survivors N scaledWts
BTS-Isis 20845 8 0.242
BTS-Tridens 24948 8 0.736
SNS 12741 3 0.014
fshk 7575 1 0.007
 Age 9 Year class = 1998
source
 survivors N scaledWts
BTS-Isis 3314 8 0.122
BTS-Tridens 3705 9 0.863
SNS 2974 3 0.004
fshk 2101 1 0.011
```

Table 8.3.2. North Sea plaice. Fishing mortality estimates in final XSA run

2008 - 05 - 08 11:43:32 units= f age

year	1	2	3	4	5	6	7	8	9	10
1957	0.077	0.229	0.255	0.304	0.347	0.208	0.274	0.314	0.290	0.290
1958	0.105	0.250	0.302	0.358	0.374	0.321	0.268	0.291	0.323	0.323
1959	0.152	0.310	0.355	0.376	0.412	0.383	0.350	0.309	0.367	0.367
1960	0.108	0.318	0.353	0.384	0.366	0.419	0.383	0.359	0.383	0.383
1961	0.097	0.289	0.344	0.357	0.417	0.330	0.361	0.437	0.381	0.381
1962	0.096	0.319	0.373	0.398	0.434	0.426	0.362	0.350	0.395	0.395
1963	0.149	0.364	0.418	0.434	0.423	0.474	0.450	0.452	0.448	0.448
1964	0.032	0.399	0.448	0.469	0.540	0.488	0.403	0.390	0.459	0.459
1965	0.068	0.267	0.397	0.412	0.355	0.508	0.417	0.352	0.410	0.410
1966	0.071	0.356	0.388	0.430	0.477	0.343	0.506	0.409	0.435	0.435
1967	0.054	0.352	0.405	0.408	0.476	0.504	0.310	0.435	0.428	0.428
1968	0.197	0.287	0.344	0.361	0.366	0.323	0.410	0.289	0.351	0.351
1969	0.149	0.313	0.327	0.341	0.315	0.428	0.295	0.399	0.356	0.356
1970	0.223	0.435	0.492	0.505	0.462	0.504	0.594	0.261	0.467	0.467
1971	0.196	0.332	0.388	0.388	0.407	0.395	0.428	0.412	0.407	0.407
1972	0.232	0.381	0.401	0.413	0.419	0.443	0.408	0.478	0.434	0.434
1973	0.113	0.394	0.433	0.542	0.545	0.413	0.387	0.480	0.475	0.475
1974	0.221	0.399	0.491	0.515	0.597	0.452	0.394	0.465	0.486	0.486
1975	0.355	0.501	0.531	0.557	0.600	0.618	0.477	0.503	0.553	0.553
1976	0.333	0.407	0.426	0.432	0.383	0.434	0.518	0.452	0.446	0.446
1977	0.324	0.472	0.495	0.500	0.666	0.420	0.441	0.533	0.514	0.514
1978	0.305	0.429	0.465	0.472	0.461	0.520	0.462	0.427	0.470	0.470
1979	0.428	0.639	0.666	0.676	0.684	0.709	0.705	0.606	0.679	0.679
1980	0.239	0.471	0.668	0.624	0.509	0.519	0.494	0.503	0.532	0.532
1981	0.178	0.487	0.579	0.602	0.584	0.452	0.507	0.536	0.538	0.538
1982	0.242	0.518	0.701	0.681	0.606	0.524	0.485	0.541	0.570	0.570
1983	0.238	0.520	0.569	0.760	0.616	0.535	0.465	0.480	0.573	0.573
1984	0.301	0.554	0.585	0.604	0.661	0.560	0.493	0.583	0.583	0.583
1985	0.263	0.474	0.495	0.701	0.485	0.536	0.536	0.507	0.555	0.555
1986	0.285	0.610	0.635	0.640	0.723	0.713	0.629	0.717	0.791	0.791
1987	0.217	0.644	0.682	0.734	0.787	0.649	0.785	0.601	0.812	0.812
1988	0.232	0.620	0.666	0.679	0.719	0.704	0.662	0.966	1.089	1.089
1989	0.211	0.582	0.608	0.629	0.647	0.629	0.639	0.630	1.233	1.233
1990	0.161	0.473	0.573	0.563	0.699	0.599	0.522	0.501	0.584	0.584
1991	0.239	0.606	0.658	0.700	0.637	0.761	0.698	0.668	0.768	0.768
1992	0.214	0.554	0.653	0.670	0.799	0.562	0.643	0.736	1.028	1.028
1993	0.220	0.487	0.606	0.648	0.741	0.719	0.397	0.479	0.992	0.992
1994	0.164	0.484	0.611	0.716	0.637	0.634	0.942	0.295	0.390	0.390
1995	0.121	0.461	0.644	0.771	0.751	0.602	0.626	0.678	0.149	0.149
1996	0.096	0.546	0.691	0.729	0.751	0.664	0.766	0.591	1.035	1.035
1997	0.067	0.794	0.926	0.753	0.771	0.728	0.607	0.573	0.559	0.559
1998	0.154	0.509	0.997	1.075	0.648	0.453	0.568	0.452	0.535	0.535
1999	0.175	0.481	0.545	1.160	0.643	0.524	0.318	0.479	0.483	0.483
2000	0.111	0.399	0.396	0.591	0.561	0.497	0.289	0.168	0.334	0.334
2001	0.051	0.593	0.818	0.730	0.757	0.436	0.407	0.212	0.132	0.132
2002	0.293	0.705	0.609	0.673	0.701	0.497	0.586	0.318	0.181	0.181
2003	0.161	0.746	0.783	0.743	0.843	0.751	0.488	0.361	0.130	0.130
2004	0.183	0.662	0.472	0.567	0.331	0.586	0.356	0.161	0.116	0.116
2005	0.141	0.477	0.417	0.392	0.490	0.250	0.519	0.295	0.096	0.096
2006	0.300	0.617	0.483	0.409	0.310	0.319	0.193	0.396	0.197	0.197
2007	0.096	0.611	0.535	0.289	0.307	0.202	0.189	0.110	0.133	0.133

Table 8.3.3. North Sea plaice. Stock number estimates in the final XSA runs

2008 - 05 - 08 11:44:29 units= thousands age

year	1	2	3	4	5	6	7	8	9	10
1957	457973	256778	322069	182986	117504	49780	48438	35192	20763	45210
1958	698110	383613	184865	225749	122171	75186	36568	33338	23255	49887
1959	863385	568706	270362	123650	142799	76063	49331	25309	22555	55137
1960	757298	670799	377298	171551	76786	85609	46907	31440	16805	49877
1961	860575	614899	441591	239779	105744	48183	50972	28949	19875	48420
1962	589153	706789	416673	283132	151855	63044	31337	32158	16921	41052
1963	688365	484323	465009	259569	172009	89026	37245	19737	20503	48075
1964	2231495	536379	304564	276885	152215	101919	50127	21480	11359	47990
1965	694571	1956326	325547	176042	156783	80258	56631	30309	13162	54735
1966	586774	586898	1355536	198051	105458	99441	43686	33776	19288	44345
1967	401292	494317	371936	832381	116530	59210	63824	23833	20304	33590
1968	434273	343890	314554	224452	500701	65484	32350	42364	13951	47348
1969	648860	322583	233481	201828	141577	314121	42894	19435	28723	56232
1970	650566	506073	213508	152349	129906	93519	185265	28910	11797	41652
1971	410256	471042	296420	118118	83212	74028	51103	92596	20155	52937
1972	366596	305241	305830	181996	72491	50100	45120	30152	55504	46554
1973	1311919	262998	188683	185315	108916	43134	29094	27148	16911	66360
1974	1132584	1059971	160400	110698	97538	57131	25822	17874	15197	59724
1975	864600	821848	643739	88823	59822	48603	32883	15751	10160	48493
1976	692460	548367	450418	342618	46060	29709	23706	18460	8618	36554
1977	988333	448970	330133	266105	201183	28405	17422	12775	10624	23933
1978	911796	647106	253416	182090	146072	93552	16883	10140	6782	20849
1979	889887	608133	381305	144070	102822	83330	50329	9626	5987	19691
1980	1125186	525081	290466	177183	66300	46926	37121	22493	4752	13641
1981	865996	801848	296791	134720	85926	36051	25274	20498	12307	14833
1982	2029345	655745	445721	150456	66750	43338	20760	13771	10850	20840
1983	1305788	1441809	353302	200093	68931	32935	23210	11565	7257	19858
1984	1258414	931720	775694	181039	84682	33679	17456	13186	6476	15549
1985	1846108	843034	484687	390958	89541	39563	17414	9645	6658	14236
1986	4747571	1284699	474815	267454	175471	49896	20938	9221	5255	13271
1987	1946926	3231336	631572	227754	127597	77033	22133	10100	4072	10283
1988	1769555	1417764	1535681	289031	98909	52572	36432	9133	5010	9784
1989	1187569	1269564	689988	714112	132632	43588	23534	17009	3145	8193
1990	1036356	870469	642122	339809	344452	62810	21022	11243	8198	8999
1991	914002	798032	491010	327571	175157	154887	31213	11289	6162	10895
1992	776668	651439	394067	230096	147156	83828	65479	14060	5237	11239
1993	531257	567527	338728	185629	106568	59898	43236	31142	6092	9748
1994	442179	385738	315633	167174	87821	45973	26406	26307	17456	17603
1995	1163967	339682	215049	154974	73955	42020	22068	9318	17717	28416
1996	1291842	932762	193922	102172	64860	31567	20830	10672	4278	7905
1997	2106563	1062033	488656	87966	44612	27696	14698	8760	5350	10213
1998	770467	1782870	434202	175071	37496	18667	12099	7248	4471	7881
1999	837778	597522	969557	145038	54077	17748	10741	6205	4174	8451
2000	986285	636419	334158	508462	41130	25731	9508	7072	3478	7734
2001	664506	799016	386215	203544	254778	21239	14170	6445	5411	19586
2002	1912327	571292	399707	154193	88739	108130	12430	8535	4717	10064
2003	530130	1291075	255337	196709	71207	39847	59498	6261	5621	7418
2004	1074896	408206	554222	105641	84695	27742	17020	33049	3949	5168
2005	654375	810204	190434	312942	54198	55035	13966	10782	25462	7013
2006	723809	514214	455195	113532	191307	30033	38766	7523	7267	7745
2007	936721	485041	251151	254099	68210	126930	19751	28922	4581	10605
2008	769722	238192	133124	172149	45399	93880	14793	23450	12029	

Table 8.4.1. North Sea plaice. Stock summary table.

	recruits	ssb	catch	landings	discards	fbar2 - 6	fbar hc2 - 6	fbar dis2 - 3	Y/ssb
1957	457973	274205	78423	70563	7860	0.27	0.22	0.12	0.26
1958	698110	288540	88240	73354	14886	0.32	0.24	0.19	0.25
1959	863385	296825	109238	79300	29938	0.37	0.24	0.24	0.27
1960	757298	308164	117138	87541	29597	0.37	0.27	0.23	0.28
1961	860575	321353	118331	85984	32347	0.35	0.24	0.27	0.27
1962	589153	372863	125272	87472	37800	0.39	0.25	0.29	0.23
1963	688365	370372	148170	107118	41052	0.42	0.27	0.36	0.29
1964	2231495	363076	147357	110540	36817	0.47	0.30	0.32	0.30
1965	694571	344012	139820	97143	42677	0.39	0.28	0.25	0.28
1966	586774	361547	166784	101834	64950	0.40	0.24	0.34	0.28
1967	401292	416559	163178	108819	54359	0.43	0.25	0.32	0.26
1968	434273	402516	139503	111534	27969	0.34	0.21	0.22	0.28
1969	648860	377425	142896	121651	21245	0.34	0.25	0.17	0.32
1970	650566	333924	160026	130342	29684	0.48	0.35	0.28	0.39
1971	410256	316329	136932	113944	22988	0.38	0.29	0.22	0.36
1972	366596	319040	142495	122843	19652	0.41	0.33	0.19	0.39
1973	1311919	268688	143883	130429	13454	0.47	0.41	0.13	0.49
1974	1132584	278603	157804	112540	45264	0.49	0.41	0.20	0.40
1975	864600	293060	195154	108536	86618	0.56	0.37	0.43	0.37
1976	692460	310819	167089	113670	53419	0.42	0.30	0.27	0.37
1977	988333	316712	176691	119188	57503	0.51	0.34	0.31	0.38
1978	911796	303099	159727	113984	45743	0.47	0.36	0.22	0.38
1979	889887	296565	213422	145347	68075	0.67	0.49	0.36	0.49
1980	1125186	271535	171235	139951	31284	0.56	0.49	0.16	0.52
1981	865996	260549	172671	139747	32924	0.54	0.47	0.16	0.54
1982	2029345	261799	204286	154547	49739	0.61	0.52	0.22	0.59
1983	1305788	310859	218424	144038	74386	0.60	0.49	0.26	0.46
1984	1258414	322200	226930	156147	70783	0.59	0.44	0.28	0.48
1985	1846108	344376	220928	159838	61090	0.54	0.44	0.23	0.46
1986	4747571	368893	296876	165347	131529	0.66	0.50	0.34	0.45
1987	1946926	441005	342985	153670	189315	0.70	0.49	0.51	0.35
1988	1769555	386497	311635	154475	157160	0.68	0.41	0.52	0.40
1989	1187569	406612	277738	169818	107920	0.62	0.38	0.46	0.42
1990	1036356	376353	228734	156240	72494	0.58	0.40	0.39	0.42
1991	914002	343909	229607	148004	81603	0.67	0.44	0.47	0.43
1992	776668	277854	183284	125190	58094	0.65	0.43	0.40	0.45
1993	531257	239962	152242	117113	35129	0.64	0.50	0.28	0.49
1994	442179	213816	134392	110392	24000	0.62	0.51	0.24	0.52
1995	1163967	204606	120316	98356	21960	0.65	0.56	0.21	0.48
1996	1291842	180329	133797	81673	52124	0.68	0.52	0.35	0.45
1997	2106563	197715	179957	83048	96909	0.79	0.52	0.69	0.42
1998	770467	225420	175002	71534	103468	0.74	0.39	0.61	0.32
1999	837778	200059	151708	80662	71046	0.67	0.38	0.39	0.40
2000	986285	223792	126298	81148	45150	0.49	0.32	0.31	0.36
2001	664506	263121	163306	81963	81343	0.67	0.31	0.57	0.31
2002	1912327	218840	153653	70217	83436	0.64	0.35	0.53	0.32
2003	530130	235808	168099	66502	101597	0.77	0.38	0.60	0.28
2004	1074896	190564	110079	61436	48643	0.52	0.32	0.43	0.32
2005	654375	217160	100466	55700	44766	0.41	0.23	0.35	0.26
2006	723809	225169	115258	57943	57315	0.43	0.21	0.43	0.26
2007	936721	215990	88038	49744	38294	0.39	0.18	0.44	0.23

Table 8.5.1. North Sea plaice. Input table for RCT3 analysis.

Year class	XSA age 1	XSA age 2	SNS0	SNS1	SNS2	BTS1	BTS2	DFS0
1968	648860	506073	-11	-11	9732	-11	-11	-11
1969	650566	471042	-11	9311	28164	-11	-11	-11
1970	410256	305241	1200	13538	10785	-11	-11	-11
1971	366596	262998	4456	13207	5046	-11	-11	-11
1972	1311919	1059971	7757	65639	16509	-11	-11	-11
1973	1132584	821848	7183	15366	8168	-11	-11	-11
1974	864600	548367	2568	11628	2403	-11	-11	-11
1975	692460	448970	1314	8537	3424	-11	-11	-11
1976	988333	647106	11166	18537	12678	-11	-11	-11
1977	911796	608133	4373	14012	9829	-11	-11	-11
1978	889887	525081	3267	21495	12882	-11	-11	-11
1979	1125186	801848	29058	59174	18785	-11	-11	-11
1980	865996	655745	4210	24756	8642	-11	-11	-11
1981	2029345	1441809	35506	69993	13909	-11	-11	605.96
1982	1305788	931720	24402	33974	10413	-11	-11	433.67
1983	1258414	843034	32942	44965	13848	-11	179.9	431.72
1984	1846108	1284699	7918	28101	7580	115.58	131.77	261.8
1985	4747571	3231336	47256	93552	32991	667.44	764.29	716.29
1986	1946926	1417764	8820	33402	14421	225.82	146.99	200.11
1987	1769555	1269564	21335	36609	17810	680.17	319.27	516.84
1988	1187569	870469	15670	34276	7496	467.88	102.64	318.36
1989	1036356	798032	24585	25037	11247	115.31	122.05	435.7
1990	914002	651439	9368	57221	13842	185.45	125.93	465.47
1991	776668	567527	17257	46798	9686	176.97	179.1	498.49
1992	531257	385738	6473	22098	4977	124.76	64.22	351.59
1993	442179	339682	9234	19188	2796	145.21	43.55	262.26
1994	1163967	932762	26781	24767	10268	252.16	212.32	445.66
1995	1291842	1062033	12541	23015	-11	218.28	-11	184.51
1996	2106563	1782870	84042	-11	30242	-11	431.9	572.8
1997	770467	597522	14328	33666	10272	342.51	130	149.19
1998	837778	636419	25522	32951	2493	305.9	74.4	-11
1999	986285	799016	39262	22855	2898	277.61	78.44	-11
2000	664506	571292	24214	11511	1103	222.71	47.74	183.83
2001	1912327	1291075	99628	30813	-11	541.25	170.08	500.43
2002	530130	408206	31350	-11	1350	126.11	41.75	210.7
2003	1074896	810204	-11	18202	1819	226.2	69.6	359.59
2004	-11	-11	13537	10118	1571	158.45	38.99	243.15
2005	-11	-11	27391	12164	2134	135.11	72.29	129.25
2006	-11	-11	51124	14175	-11	329.34	-11	232.28
2007	-11	-11	40581	-11	-11	-11	-11	175.65

Table 8.5.2. North Sea plaice. RCT3 results for age 1.

```
 Analysis by RCT3 ver3.1 of data from file :
 ple_iv1.txt, North Sea Plaice Age 1
 Data for 6 surveys over 40 years : 1968 – 2007
 Regression type = C
 Tapered time weighting not applied
 Survey weighting not applied
 Final estimates shrunk towards mean
 Minimum S.E. for any survey taken as .20
 Minimum of 3 points used for regression
 Forecast/Hindcast variance correction used.
Yearclass = 2007
 I-----------Regression----------I I-----------Prediction---------I
 Survey/ Slope Inter- Std Rsquare No. Index Predicted Std WAP
 Series cept Error Pts Value Value Error Weights
 SNS0 .92 5.16 .85 .293 33 10.61 14.90 .901 .216
 DFS0 2.45 -.41 .96 .268 21 5.17 12.28 1.095 .146
 VPA Mean = 13.82 .523 .639
 Year Weighted Log Int Ext Var VPA Log
 Class Average WAP Std Std Ratio VPA
 Prediction Error Error
 2007 1015480 13.83 .42 .55 1.71
```

Table 8.5.3. North Sea plaice. RCT3 results for age 2.

```
Analysis by RCT3 ver3.1 of data from file :
ple_iv2.txt, North Sea Plaice Age 2

Data for 6 surveys over 40 years : 1968 - 2007
Regression type = C
Tapered time weighting not applied
Survey weighting not applied
Final estimates shrunk towards mean
Minimum S.E. for any survey taken as .20
Minimum of 3 points used for regression
Forecast/Hindcast variance correction used.
I-----------Regression----------I I-----------Prediction---------I
Survey/ Slope Inter- Std Rsquare No. Index Predicted Std WAP
Series cept Error Pts Value Value Error Weights
SNS0 .83 5.72 .72 .361 33 10.84 14.67 .776 .161
SNS1 1.28 .52 .58 .438 33 9.56 12.74 .620 .251
BTS1 1.57 4.99 .73 .367 19 5.80 14.08 .793 .154
DFS0 2.53 -1.16 1.02 .232 21 5.45 12.64 1.119 .077
VPA Mean = 13.51 .521 .356
Year Weighted Log Int Ext Var VPA Log
Class Average WAP Std Std Ratio VPA
Prediction Error Error
2006 746834 13.52 .31 .34 1.22
```

Table 8.6.1. North Sea plaice. Input to the short term forecast (f values presented are for Fsq)

age	f	fdisc	fland	stock n	catch wt	landings wt	discards wt	stock wt	mat	M
Year 2008										
1	0.171	0.17	0.00	910440	0.06	0.26	0.06	0.05	0.0	0.1
2	0.542	0.50	0.04	746834	0.11	0.27	0.10	0.09	0.5	0.1
3	0.457	0.27	0.18	238192	0.22	0.30	0.18	0.24	0.5	0.1
4	0.347	0.08	0.27	133124	0.31	0.35	0.18	0.24	1.0	0.1
5	0.352	0.05	0.31	172149	0.35	0.38	0.19	0.34	1.0	0.1
6	0.245	0.05	0.20	45399	0.40	0.45	0.20	0.39	1.0	0.1
7	0.287	0.05	0.24	93880	0.46	0.54	0.22	0.46	1.0	0.1
8	0.255	0.04	0.21	14793	0.38	0.48	0.20	0.41	1.0	0.1
9	0.136	0.00	0.14	23450	0.59	0.59	0.00	0.53	1.0	0.1
10	0.136	0.00	0.14	12029	0.62	0.62	0.00	0.55	1.0	0.1
Year 2009										
1	0.171	0.17	0.00	910440	0.06	0.26	0.06	0.05	0.0	0.1
2	0.542	0.50	0.04		0.11	0.27	0.10	0.09	0.5	0.1
3	0.457	0.27	0.18		0.22	0.30	0.18	0.24	0.5	0.1
4	0.347	0.08	0.27		0.31	0.35	0.18	0.24	1.0	0.1
5	0.352	0.05	0.31		0.35	0.38	0.19	0.34	1.0	0.1
6	0.245	0.05	0.20		0.40	0.45	0.20	0.39	1.0	0.1
7	0.287	0.05	0.24		0.46	0.54	0.22	0.46	1.0	0.1
8	0.255	0.04	0.21		0.38	0.48	0.20	0.41	1.0	0.1
9	0.136	0.00	0.14		0.59	0.59	0.00	0.53	1.0	0.1
10	0.136	0.00	0.14		0.62	0.62	0.00	0.55	1.0	0.1
Year 2010										
1	0.171	0.17	0.00	910440	0.06	0.26	0.06	0.05	0.0	0.1
2	0.542	0.50	0.04		0.11	0.27	0.10	0.09	0.5	0.1
3	0.457	0.27	0.18		0.22	0.30	0.18	0.24	0.5	0.1
4	0.347	0.08	0.27		0.31	0.35	0.18	0.24	1.0	0.1
5	0.352	0.05	0.31		0.35	0.38	0.19	0.34	1.0	0.1
6	0.245	0.05	0.20		0.40	0.45	0.20	0.39	1.0	0.1
7	0.287	0.05	0.24		0.46	0.54	0.22	0.46	1.0	0.1
8	0.255	0.04	0.21		0.38	0.48	0.20	0.41	1.0	0.1
9	0.136	0.00	0.14		0.59	0.59	0.00	0.53	1.0	0.1
10	0.136	0.00	0.14		0.62	0.62	0.00	0.55	1.0	0.1

Table 8.6.2A. North Sea plaice. Results from the short term forecast assuming $F_{2008} = F_{2007}$

year	fmult	f2 – 6	f_dis2 – 3	f_hc2 – 6	landings	discards	catch	ssb2008
2008	1	0.39	0.39	0.2	59223	51409	110601	253846

year	fmult	f2 – 6	f_dis2 – 3	f_hc2 – 6	landings	discards	catch	ssb	ssb2010
2009	0.2	0.08	0.08	0.04	13890	12902	26792	265083	374826
2009	0.3	0.12	0.12	0.06	20475	18934	39409	265083	362015
2009	0.4	0.16	0.15	0.08	26831	24704	51536	265083	349704
2009	0.5	0.19	0.19	0.10	32969	30225	63195	265083	337872
2009	0.6	0.23	0.23	0.12	38895	35508	74405	265083	326497
2009	0.7	0.27	0.27	0.14	44619	40565	85186	265083	315562
2009	0.8	0.31	0.31	0.16	50147	45407	95556	265083	305046
2009	0.9	0.35	0.35	0.18	55487	50043	105532	265083	294933
2009	1.0	0.39	0.39	0.20	60646	54483	115131	265083	285205
2009	1.1	0.43	0.43	0.22	65631	58736	124370	265083	275847
2009	1.2	0.47	0.46	0.24	70449	62811	133262	265083	266842
2009	1.3	0.51	0.50	0.26	75104	66716	141823	265083	258177
2009	1.4	0.54	0.54	0.28	79605	70460	150067	265083	249837
2009	1.5	0.58	0.58	0.30	83955	74049	158007	265083	241808
2009	1.6	0.62	0.62	0.32	88162	77490	165655	265083	234078
2009	1.7	0.66	0.66	0.34	92229	80791	173024	265083	226635
2009	1.8	0.70	0.70	0.36	96163	83958	180124	265083	219466
2009	1.9	0.74	0.73	0.38	99967	86997	186968	265083	212561
2009	2.0	0.78	0.77	0.40	103648	89914	193565	265083	205908

Table 8.6.2B. North Sea plaice. Results from the short term forecast assuming $F_{2008} = 0.9 * F_{2007}$

year	fmult	f2 – 6	f_dis2 – 3	f_hc2 – 6	landings	discards	catch	ssb2008
2008	0.9	0.35	0.35	0.18	54189	47226	101387	253846

year	fmult	f2 – 6	f_dis2 – 3	f_hc2 – 6	landings	discards	catch	ssb	ssb2010
2009	0.2	0.08	0.08	0.04	14426	13241	27667	274215	386878
2009	0.3	0.12	0.12	0.06	21265	19431	40696	274215	373619
2009	0.4	0.16	0.15	0.08	27866	25352	53219	274215	360877
2009	0.5	0.19	0.19	0.10	34240	31017	65257	274215	348632
2009	0.6	0.23	0.23	0.12	40393	36438	76832	274215	336860
2009	0.7	0.27	0.27	0.14	46336	41627	87964	274215	325543
2009	0.8	0.31	0.31	0.16	52076	46594	98670	274215	314662
2009	0.9	0.35	0.35	0.18	57620	51349	108970	274215	304197
2009	1.0	0.39	0.39	0.20	62976	55904	118881	274215	294131
2009	1.1	0.43	0.43	0.22	68150	60266	128418	274215	284448
2009	1.2	0.47	0.46	0.24	73151	64445	137598	274215	275132
2009	1.3	0.51	0.50	0.26	77983	68450	146435	274215	266167
2009	1.4	0.54	0.54	0.28	82654	72289	154945	274215	257539
2009	1.5	0.58	0.58	0.30	87169	75969	163140	274215	249234
2009	1.6	0.62	0.62	0.32	91534	79497	171033	274215	241238
2009	1.7	0.66	0.66	0.34	95755	82882	178638	274215	233539
2009	1.8	0.70	0.70	0.36	99836	86128	185966	274215	226124
2009	1.9	0.74	0.73	0.38	103783	89243	193028	274215	218982
2009	2.0	0.78	0.77	0.40	107601	92232	199836	274215	212102

Table 8.6.2C. North Sea plaice. Results from the short term forecast assuming a F for 2008 such that the landings in 2008 equal the TAC for 2008

year	fmult	f2 – 6	f_dis2 – 3	f_hc2 – 6	landings	discards	catch	ssb2008
2008	0.80	0.31	0.31	0.16	49004	42880	91859	253846

year	fmult	f2 – 6	f_dis2 – 3	f_hc2 – 6	landings	discards	catch	ssb	ssb2010
2009	0.2	0.08	0.08	0.04	14983	13592	28575	283662	399378
2009	0.3	0.12	0.12	0.06	22085	19945	42031	283662	385653
2009	0.4	0.16	0.15	0.08	28941	26023	54964	283662	372464
2009	0.5	0.19	0.19	0.10	35559	31837	67396	283662	359789
2009	0.6	0.23	0.23	0.12	41949	37401	79350	283662	347606
2009	0.7	0.27	0.27	0.14	48119	42725	90845	283662	335893
2009	0.8	0.31	0.31	0.16	54078	47822	101901	283662	324631
2009	0.9	0.35	0.35	0.18	59834	52702	112536	283662	313801
2009	1.0	0.39	0.39	0.20	65394	57375	122769	283662	303385
2009	1.1	0.43	0.43	0.22	70766	61850	132617	283662	293365
2009	1.2	0.47	0.46	0.24	75956	66138	142095	283662	283725
2009	1.3	0.51	0.50	0.26	80972	70246	151219	283662	274449
2009	1.4	0.54	0.54	0.28	85819	74183	160003	283662	265522
2009	1.5	0.58	0.58	0.30	90505	77958	168463	283662	256929
2009	1.6	0.62	0.62	0.32	95034	81576	176612	283662	248657
2009	1.7	0.66	0.66	0.34	99414	85046	184461	283662	240692
2009	1.8	0.70	0.70	0.36	103649	88375	192025	283662	233023
2009	1.9	0.74	0.73	0.38	107744	91568	199314	283662	225636
2009	**2.0**	**0.78**	**0.77**	**0.40**	**111705**	**94633**	**206339**	**283662**	**218520**

Table 8.6.3A. North Sea plaice. Detailed STF table, assuming $F_{2008} = F_{2007}$

age	f	stock	ctch	land	disc	stck	mat	M	fdis	flan	catch	catch	land	land	disc	disc	SSB	TSB
		n	wt	wt	wt	wt					n		n		n			
Year 2008																		
1	0.17	910440	0.06	0.26	0.06	0.05	0.0	0.1	0.17	0.00	136447	8775	2436	638	134011	8130	0	47039
2	0.54	746834	0.12	0.27	0.11	0.11	0.5	0.1	0.50	0.04	298847	36885	23159	6175	275688	30693	40702	81405
3	0.46	238192	0.22	0.29	0.17	0.22	0.5	0.1	0.27	0.18	83410	18200	33521	9714	49889	8498	25923	51846
4	0.35	133124	0.30	0.34	0.18	0.27	1.0	0.1	0.08	0.27	37266	11262	28853	9718	8413	1539	35633	35633
5	0.35	172149	0.36	0.39	0.20	0.36	1.0	0.1	0.05	0.31	48808	17712	42323	16389	6485	1316	61342	61342
6	0.25	45399	0.39	0.43	0.20	0.41	1.0	0.1	0.05	0.20	9420	3636	7660	3289	1760	352	18765	18765
7	0.29	93880	0.45	0.49	0.22	0.44	1.0	0.1	0.05	0.24	22315	9944	18740	9227	3575	773	41652	41652
8	0.25	14793	0.46	0.50	0.21	0.48	1.0	0.1	0.04	0.21	3172	1459	2670	1348	502	107	7125	7125
9	0.14	23450	0.58	0.58	0.00	0.58	1.0	0.1	0.00	0.14	2833	1630	2833	1630	0	0	13523	13523
10	0.14	12029	0.75	0.75	0.00	0.76	1.0	0.1	0.00	0.14	1453	1096	1453	1096	0	0	9180	9180
Year 2009																		
1	0.17	910440	0.06	0.26	0.06	0.05	0.0	0.1	0.17	0.00	136447	8775	2436	638	134011	8130	0	47039
2	0.54	694247	0.12	0.27	0.11	0.11	0.5	0.1	0.50	0.04	277804	34288	21528	5740	256276	28532	37836	75673
3	0.46	392883	0.22	0.29	0.17	0.22	0.5	0.1	0.27	0.18	137579	30020	55291	16023	82288	14016	42759	85518
4	0.35	136516	0.30	0.34	0.18	0.27	1.0	0.1	0.08	0.27	38215	11549	29588	9966	8627	1579	36541	36541
5	0.35	85124	0.36	0.39	0.20	0.36	1.0	0.1	0.05	0.31	24134	8758	20928	8104	3207	651	30333	30333
6	0.25	109495	0.39	0.43	0.20	0.41	1.0	0.1	0.05	0.20	22720	8770	18474	7932	4246	849	45258	45258
7	0.29	32140	0.45	0.49	0.22	0.44	1.0	0.1	0.05	0.24	7639	3404	6416	3159	1224	265	14259	14259
8	0.25	63779	0.46	0.50	0.21	0.48	1.0	0.1	0.04	0.21	13675	6292	11511	5811	2163	461	30720	30720
9	0.14	10376	0.58	0.58	0.00	0.58	1.0	0.1	0.00	0.14	1254	721	1254	721	0	0	5983	5983
10	0.14	28032	0.75	0.75	0.00	0.76	1.0	0.1	0.00	0.14	3387	2553	3387	2553	0	0	21393	21393
Year 2010																		
1	0.17	910440	0.06	0.26	0.06	0.05	0.0	0.1	0.17	0.00	136447	8775	2436	638	134011	8130	0	47039
2	0.54	694247	0.12	0.27	0.11	0.11	0.5	0.1	0.50	0.04	277804	34288	21528	5740	256276	28532	37836	75673
3	0.46	365219	0.22	0.29	0.17	0.22	0.5	0.1	0.27	0.18	127892	27906	51398	14894	76494	13029	39748	79496
4	0.35	225175	0.30	0.34	0.18	0.27	1.0	0.1	0.08	0.27	63034	19050	48804	16438	14230	2604	60272	60272
5	0.35	87293	0.36	0.39	0.20	0.36	1.0	0.1	0.05	0.31	24749	8982	21461	8310	3288	668	31105	31105
6	0.25	54143	0.39	0.43	0.20	0.41	1.0	0.1	0.05	0.20	11235	4336	9135	3922	2100	420	22379	22379
7	0.29	77516	0.45	0.49	0.22	0.44	1.0	0.1	0.05	0.24	18425	8211	15473	7618	2952	639	34391	34391
8	0.25	21835	0.46	0.50	0.21	0.48	1.0	0.1	0.04	0.21	4682	2154	3941	1989	741	158	10517	10517
9	0.14	44735	0.58	0.58	0.00	0.58	1.0	0.1	0.00	0.14	5405	3110	5405	3110	0	0	25797	25797
10	0.14	30345	0.75	0.75	0.00	0.76	1.0	0.1	0.00	0.14	3666	2764	3666	2764	0	0	23159	23159

Table 8.6.3B. North Sea plaice. Detailed STF table, assuming $F_{2008} = 0.9 * F_{2007}$

age	f	stock	ctch	land	disc	stck	mat	M	fdis	flan	catch	catch	land	land	disc	disc	SSB	TSB
		n	wt	wt	wt	wt					n		n		n			
Year 2008																		
1	0.17	910440	0.06	0.26	0.06	0.05	0.0	0.1	0.17	0.00	136447	8775	2436	638	134011	8130	0	47039
2	0.54	746834	0.12	0.27	0.11	0.11	0.5	0.1	0.50	0.04	298847	36885	23159	6175	275688	30693	40702	81405
3	0.46	238192	0.22	0.29	0.17	0.22	0.5	0.1	0.27	0.18	83410	18200	33521	9714	49889	8498	25923	51846
4	0.35	133124	0.30	0.34	0.18	0.27	1.0	0.1	0.08	0.27	37266	11262	28853	9718	8413	1539	35633	35633
5	0.35	172149	0.36	0.39	0.20	0.36	1.0	0.1	0.05	0.31	48808	17712	42323	16389	6485	1316	61342	61342
6	0.25	45399	0.39	0.43	0.20	0.41	1.0	0.1	0.05	0.20	9420	3636	7660	3289	1760	352	18765	18765
7	0.29	93880	0.45	0.49	0.22	0.44	1.0	0.1	0.05	0.24	22315	9944	18740	9227	3575	773	41652	41652
8	0.25	14793	0.46	0.50	0.21	0.48	1.0	0.1	0.04	0.21	3172	1459	2670	1348	502	107	7125	7125
9	0.14	23450	0.58	0.58	0.00	0.58	1.0	0.1	0.00	0.14	2833	1630	2833	1630	0	0	13523	13523
10	0.14	12029	0.75	0.75	0.00	0.76	1.0	0.1	0.00	0.14	1453	1096	1453	1096	0	0	9180	9180
Year 2009																		
1	0.17	910440	0.06	0.26	0.06	0.05	0.0	0.1	0.17	0.00	136447	8775	2436	638	134011	8130	0	47039
2	0.54	694247	0.12	0.27	0.11	0.11	0.5	0.1	0.50	0.04	277804	34288	21528	5740	256276	28532	37836	75673
3	0.46	392883	0.22	0.29	0.17	0.22	0.5	0.1	0.27	0.18	137579	30020	55291	16023	82288	14016	42759	85518
4	0.35	136516	0.30	0.34	0.18	0.27	1.0	0.1	0.08	0.27	38215	11549	29588	9966	8627	1579	36541	36541
5	0.35	85124	0.36	0.39	0.20	0.36	1.0	0.1	0.05	0.31	24134	8758	20928	8104	3207	651	30333	30333
6	0.25	109495	0.39	0.43	0.20	0.41	1.0	0.1	0.05	0.20	22720	8770	18474	7932	4246	849	45258	45258
7	0.29	32140	0.45	0.49	0.22	0.44	1.0	0.1	0.05	0.24	7639	3404	6416	3159	1224	265	14259	14259
8	0.25	63779	0.46	0.50	0.21	0.48	1.0	0.1	0.04	0.21	13675	6292	11511	5811	2163	461	30720	30720
9	0.14	10376	0.58	0.58	0.00	0.58	1.0	0.1	0.00	0.14	1254	721	1254	721	0	0	5983	5983
10	0.14	28032	0.75	0.75	0.00	0.76	1.0	0.1	0.00	0.14	3387	2553	3387	2553	0	0	21393	21393
Year 2010																		
1	0.17	910440	0.06	0.26	0.06	0.05	0.0	0.1	0.17	0.00	136447	8775	2436	638	134011	8130	0	47039
2	0.54	694247	0.12	0.27	0.11	0.11	0.5	0.1	0.50	0.04	277804	34288	21528	5740	256276	28532	37836	75673
3	0.46	365219	0.22	0.29	0.17	0.22	0.5	0.1	0.27	0.18	127892	27906	51398	14894	76494	13029	39748	79496
4	0.35	225175	0.30	0.34	0.18	0.27	1.0	0.1	0.08	0.27	63034	19050	48804	16438	14230	2604	60272	60272
5	0.35	87293	0.36	0.39	0.20	0.36	1.0	0.1	0.05	0.31	24749	8982	21461	8310	3288	668	31105	31105
6	0.25	54143	0.39	0.43	0.20	0.41	1.0	0.1	0.05	0.20	11235	4336	9135	3922	2100	420	22379	22379
7	0.29	77516	0.45	0.49	0.22	0.44	1.0	0.1	0.05	0.24	18425	8211	15473	7618	2952	639	34391	34391
8	0.25	21835	0.46	0.50	0.21	0.48	1.0	0.1	0.04	0.21	4682	2154	3941	1989	741	158	10517	10517
9	0.14	44735	0.58	0.58	0.00	0.58	1.0	0.1	0.00	0.14	5405	3110	5405	3110	0	0	25797	25797
10	0.14	30345	0.75	0.75	0.00	0.76	1.0	0.1	0.00	0.14	3666	2764	3666	2764	0	0	23159	23159

Table 8.6.3C. North Sea plaice. Detailed STF table, forecast assuming a F for 2008 such that the landings in 2008 equal the TAC for 2008

age	f	stock	ctch	land	disc	stck	mat	M	fdis	flan	catch	catch	land	land	disc	disc	SSB	TSB
		n	wt	wt	wt	wt					n		n		n			
Year 2008																		
1	0.17	910440	0.06	0.26	0.06	0.05	0.0	0.1	0.17	0.00	136447	8775	2436	638	134011	8130	0	47039
2	0.54	746834	0.12	0.27	0.11	0.11	0.5	0.1	0.50	0.04	298847	36885	23159	6175	275688	30693	40702	81405
3	0.46	238192	0.22	0.29	0.17	0.22	0.5	0.1	0.27	0.18	83410	18200	33521	9714	49889	8498	25923	51846
4	0.35	133124	0.30	0.34	0.18	0.27	1.0	0.1	0.08	0.27	37266	11262	28853	9718	8413	1539	35633	35633
5	0.35	172149	0.36	0.39	0.20	0.36	1.0	0.1	0.05	0.31	48808	17712	42323	16389	6485	1316	61342	61342
6	0.25	45399	0.39	0.43	0.20	0.41	1.0	0.1	0.05	0.20	9420	3636	7660	3289	1760	352	18765	18765
7	0.29	93880	0.45	0.49	0.22	0.44	1.0	0.1	0.05	0.24	22315	9944	18740	9227	3575	773	41652	41652
8	0.25	14793	0.46	0.50	0.21	0.48	1.0	0.1	0.04	0.21	3172	1459	2670	1348	502	107	7125	7125
9	0.14	23450	0.58	0.58	0.00	0.58	1.0	0.1	0.00	0.14	2833	1630	2833	1630	0	0	13523	13523
10	0.14	12029	0.75	0.75	0.00	0.76	1.0	0.1	0.00	0.14	1453	1096	1453	1096	0	0	9180	9180
Year 2009																		
1	0.17	910440	0.06	0.26	0.06	0.05	0.0	0.1	0.17	0.00	136447	8775	2436	638	134011	8130	0	47039
2	0.54	694247	0.12	0.27	0.11	0.11	0.5	0.1	0.50	0.04	277804	34288	21528	5740	256276	28532	37836	75673
3	0.46	392883	0.22	0.29	0.17	0.22	0.5	0.1	0.27	0.18	137579	30020	55291	16023	82288	14016	42759	85518
4	0.35	136516	0.30	0.34	0.18	0.27	1.0	0.1	0.08	0.27	38215	11549	29588	9966	8627	1579	36541	36541
5	0.35	85124	0.36	0.39	0.20	0.36	1.0	0.1	0.05	0.31	24134	8758	20928	8104	3207	651	30333	30333
6	0.25	109495	0.39	0.43	0.20	0.41	1.0	0.1	0.05	0.20	22720	8770	18474	7932	4246	849	45258	45258
7	0.29	32140	0.45	0.49	0.22	0.44	1.0	0.1	0.05	0.24	7639	3404	6416	3159	1224	265	14259	14259
8	0.25	63779	0.46	0.50	0.21	0.48	1.0	0.1	0.04	0.21	13675	6292	11511	5811	2163	461	30720	30720
9	0.14	10376	0.58	0.58	0.00	0.58	1.0	0.1	0.00	0.14	1254	721	1254	721	0	0	5983	5983
10	0.14	28032	0.75	0.75	0.00	0.76	1.0	0.1	0.00	0.14	3387	2553	3387	2553	0	0	21393	21393
Year 2010																		
1	0.17	910440	0.06	0.26	0.06	0.05	0.0	0.1	0.17	0.00	136447	8775	2436	638	134011	8130	0	47039
2	0.54	694247	0.12	0.27	0.11	0.11	0.5	0.1	0.50	0.04	277804	34288	21528	5740	256276	28532	37836	75673
3	0.46	365219	0.22	0.29	0.17	0.22	0.5	0.1	0.27	0.18	127892	27906	51398	14894	76494	13029	39748	79496
4	0.35	225175	0.30	0.34	0.18	0.27	1.0	0.1	0.08	0.27	63034	19050	48804	16438	14230	2604	60272	60272
5	0.35	87293	0.36	0.39	0.20	0.36	1.0	0.1	0.05	0.31	24749	8982	21461	8310	3288	668	31105	31105
6	0.25	54143	0.39	0.43	0.20	0.41	1.0	0.1	0.05	0.20	11235	4336	9135	3922	2100	420	22379	22379
7	0.29	77516	0.45	0.49	0.22	0.44	1.0	0.1	0.05	0.24	18425	8211	15473	7618	2952	639	34391	34391
8	0.25	21835	0.46	0.50	0.21	0.48	1.0	0.1	0.04	0.21	4682	2154	3941	1989	741	158	10517	10517
9	0.14	44735	0.58	0.58	0.00	0.58	1.0	0.1	0.00	0.14	5405	3110	5405	3110	0	0	25797	25797
10	0.14	30345	0.75	0.75	0.00	0.76	1.0	0.1	0.00	0.14	3666	2764	3666	2764	0	0	23159	23159

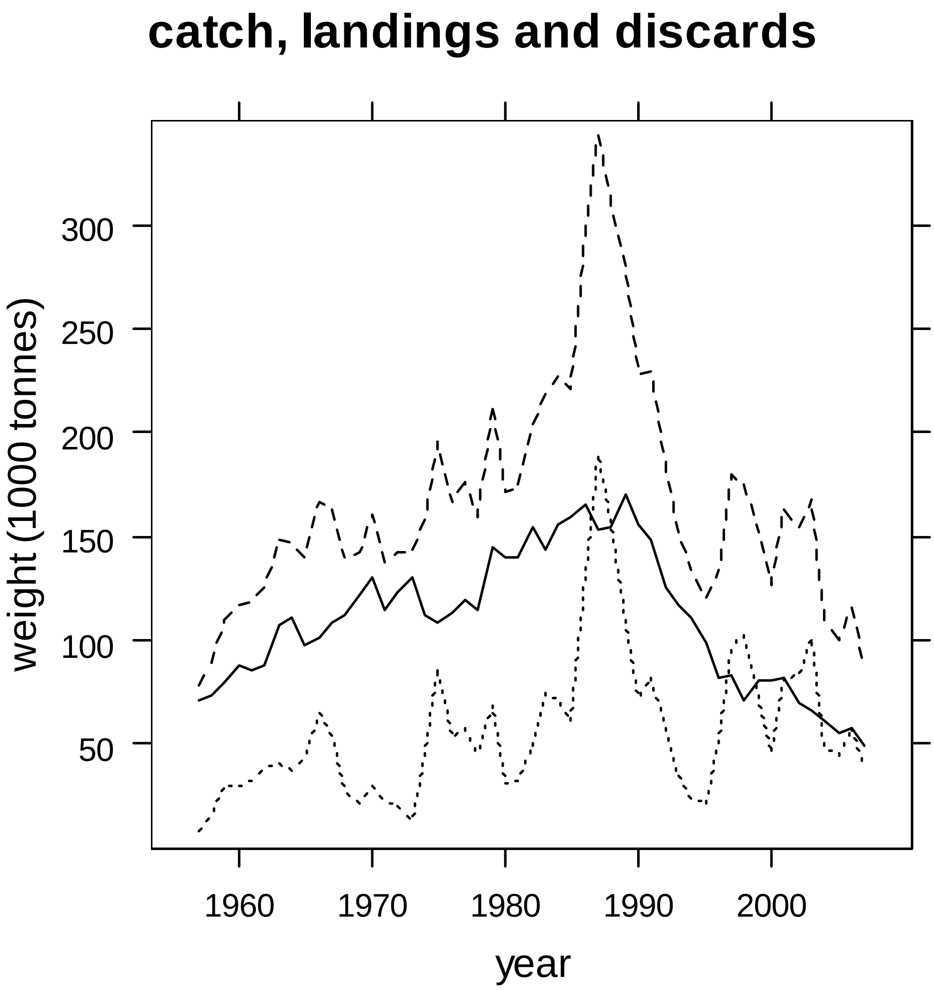


Figure 8.2.1 North Sea plaice. Time series of catch (dashed line), landings (solid line) and discards (dotted line) estimates.

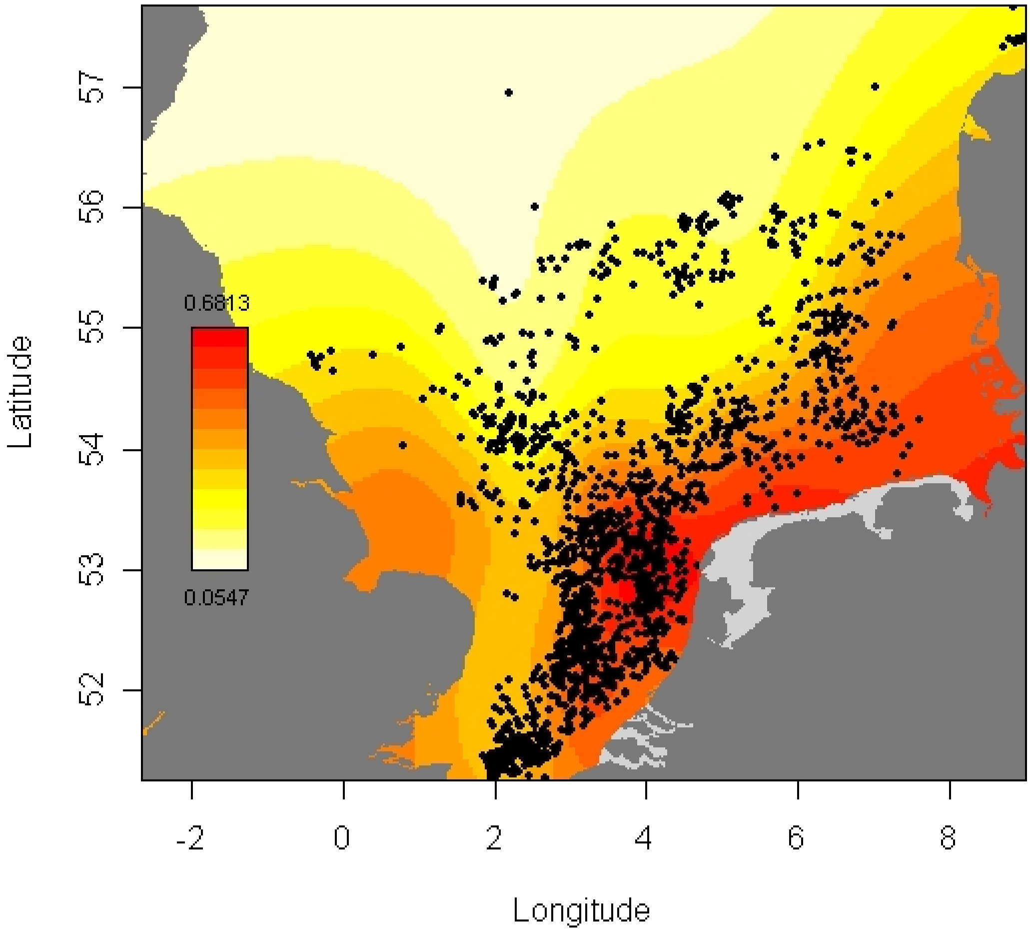


Figure 8.2.2 North Sea plaice. Model predictions of plaice discard fractions and distribution of the Dutch self sampling program from 2004 to 2006 plotted on top. Predictions are made for the beginning of July for a vessel with 8 ticklers chains from the trawl head or shoe and the absolute discard levels only apply to those conditions. Source: Aarts & van Helmond, IMARES report C120/07.

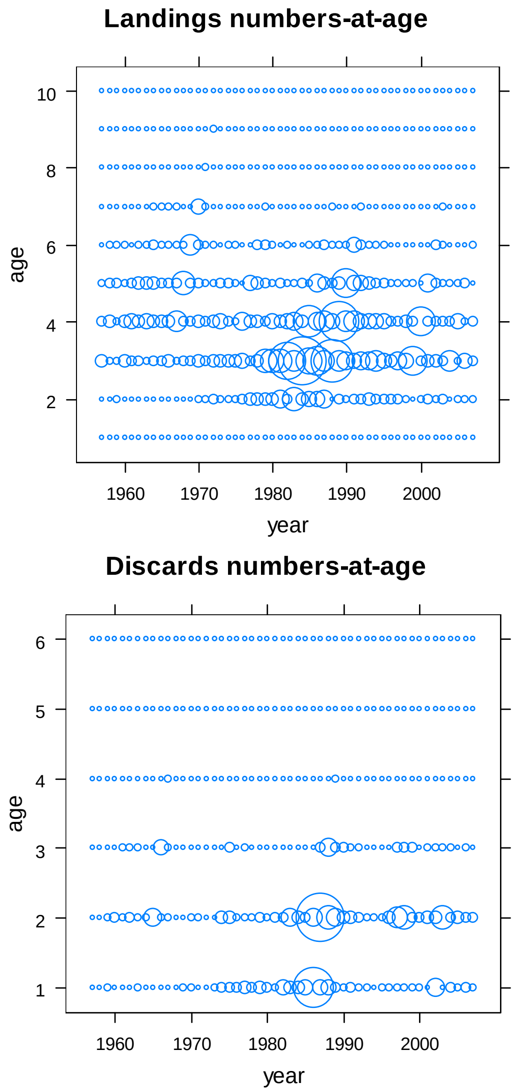


Figure 8.2.3 North Sea plaice. Landing numbers-at-age (left) and discards numbers-at-age (right).

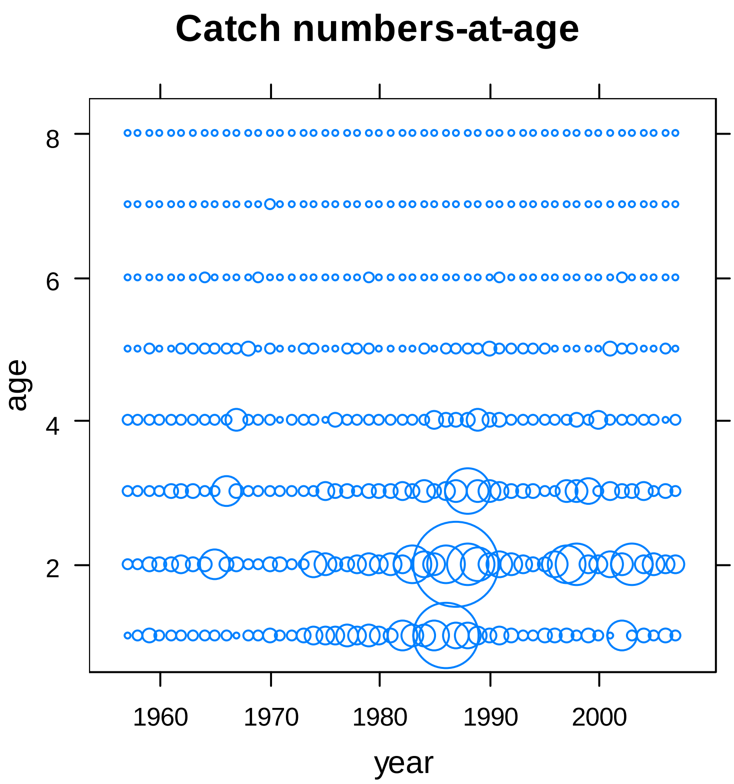
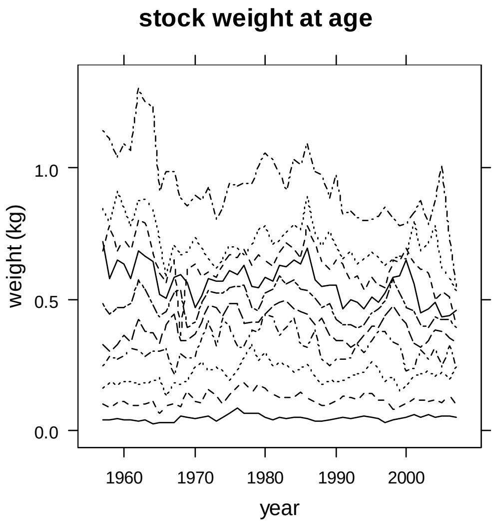
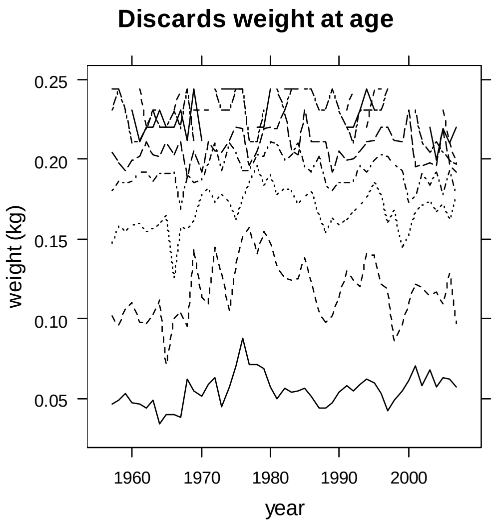


Figure 8.2.4 North Sea plaice. Catch numbers-at-age.


stock weight at age
weight (kg)
1.0
0.5
0.0
1960
1970
1980
1990
2000
year


Discards weight at age
weight (kg)
0.25
0.20
0.15
0.10
0.05
1960
1970
1980
1990
2000
year

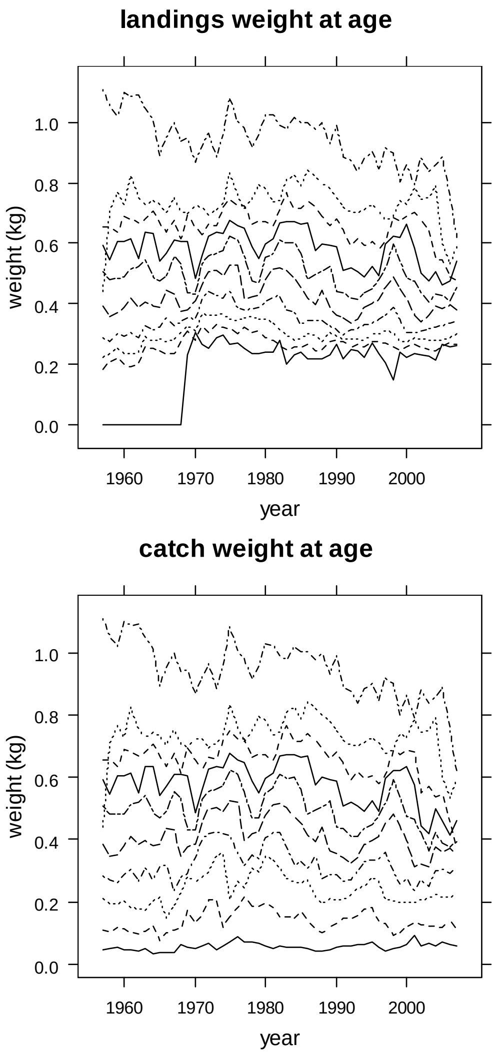


Figure 8.2.5 North Sea plaice. Stock weight-at-age (top left), discards weight-at-age (top right), landings weight-at-age (bottom left) and catch weight-at-age (bottom right)..

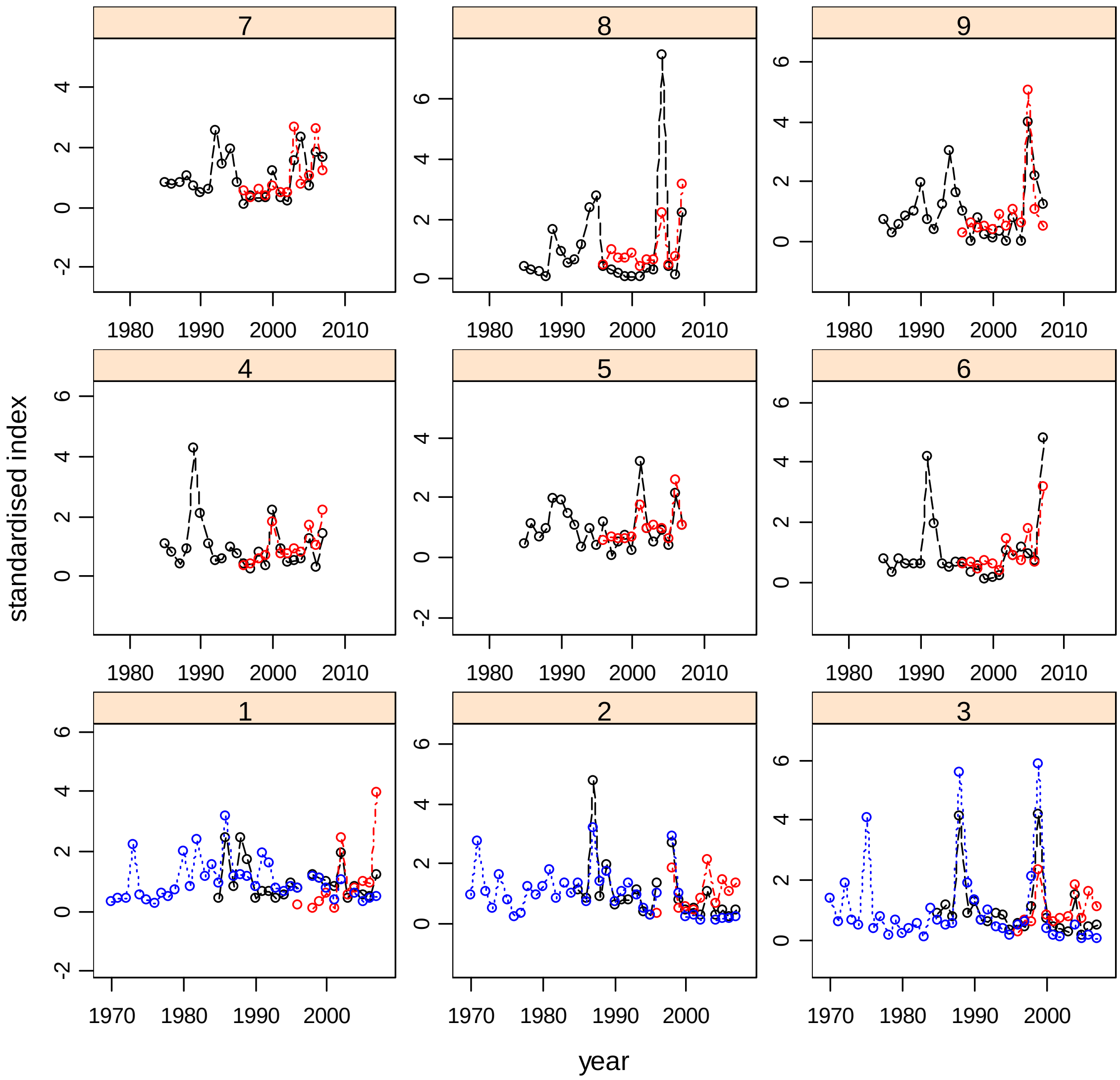


Figure 8.2.6 North Sea plaice. Standardized survey tuning indices used for tuning XSA: BTS-Isis (black), BTS-Tridens (red) and SNS (blue).

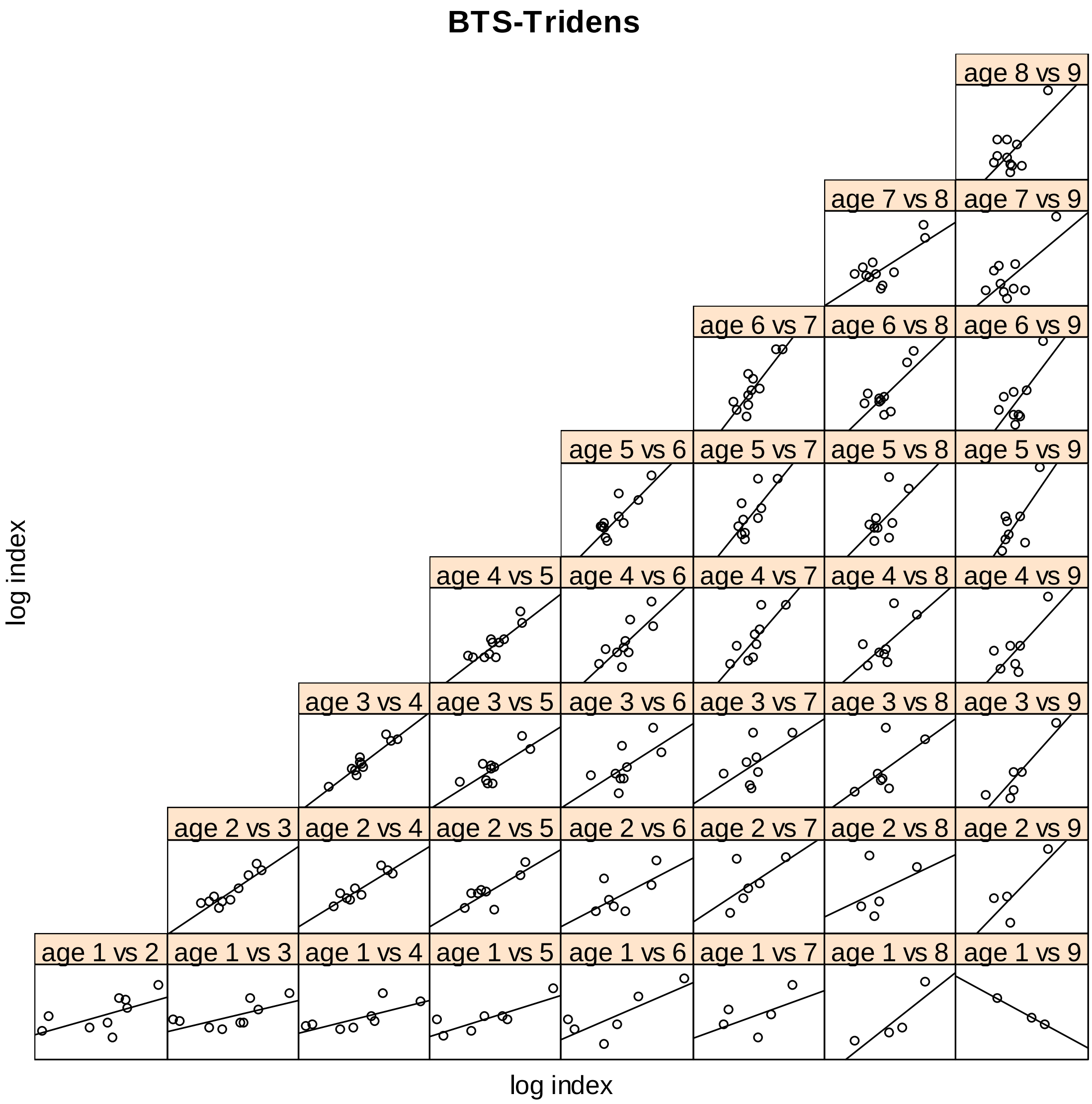


Figure 8.2.7 North Sea plaice. Internal consistency plot for the BTS-Tridens survey.

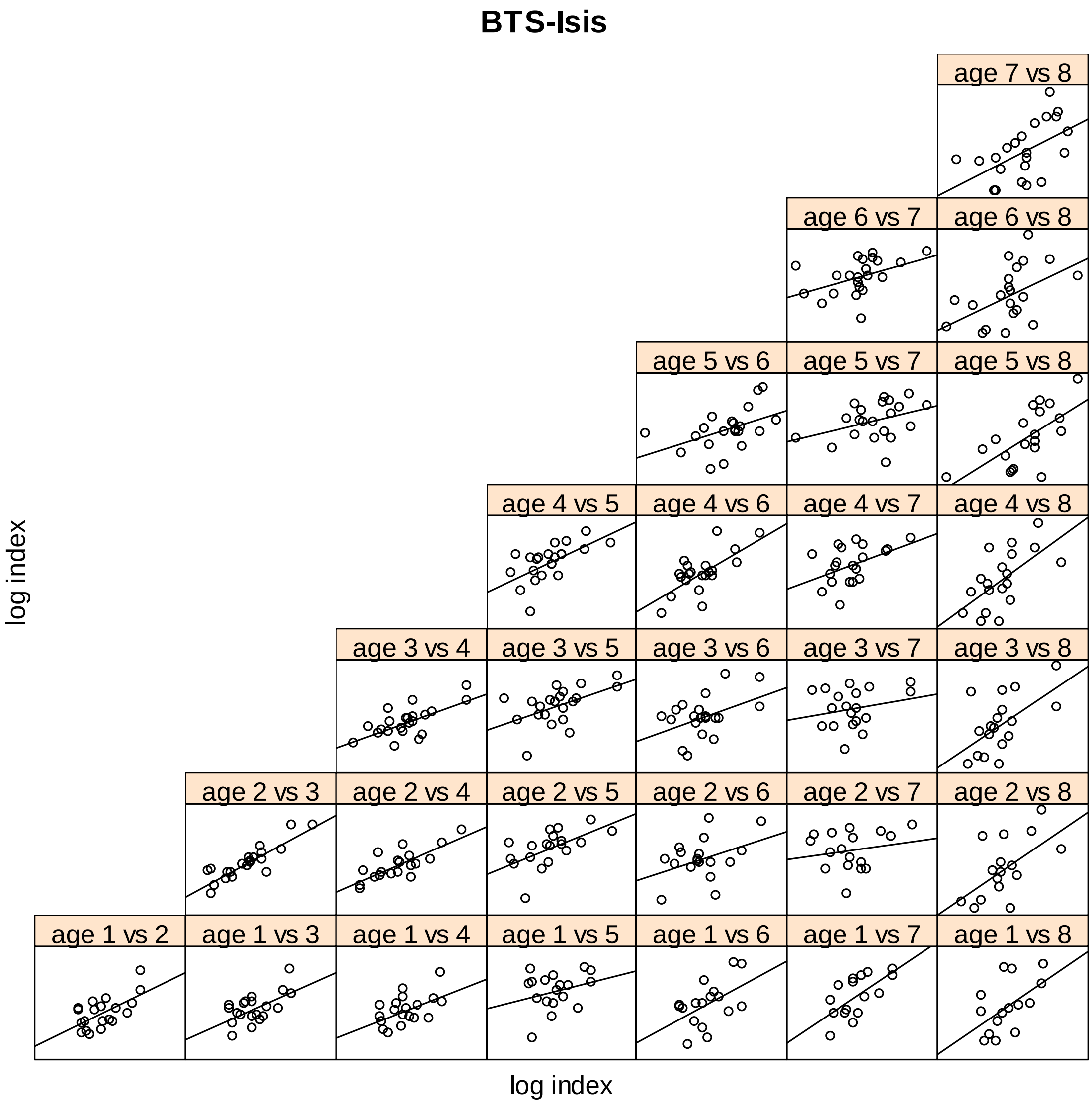


Figure 8.2.8. North Sea plaice. Internal consistency plot for the BTS-Isis survey.

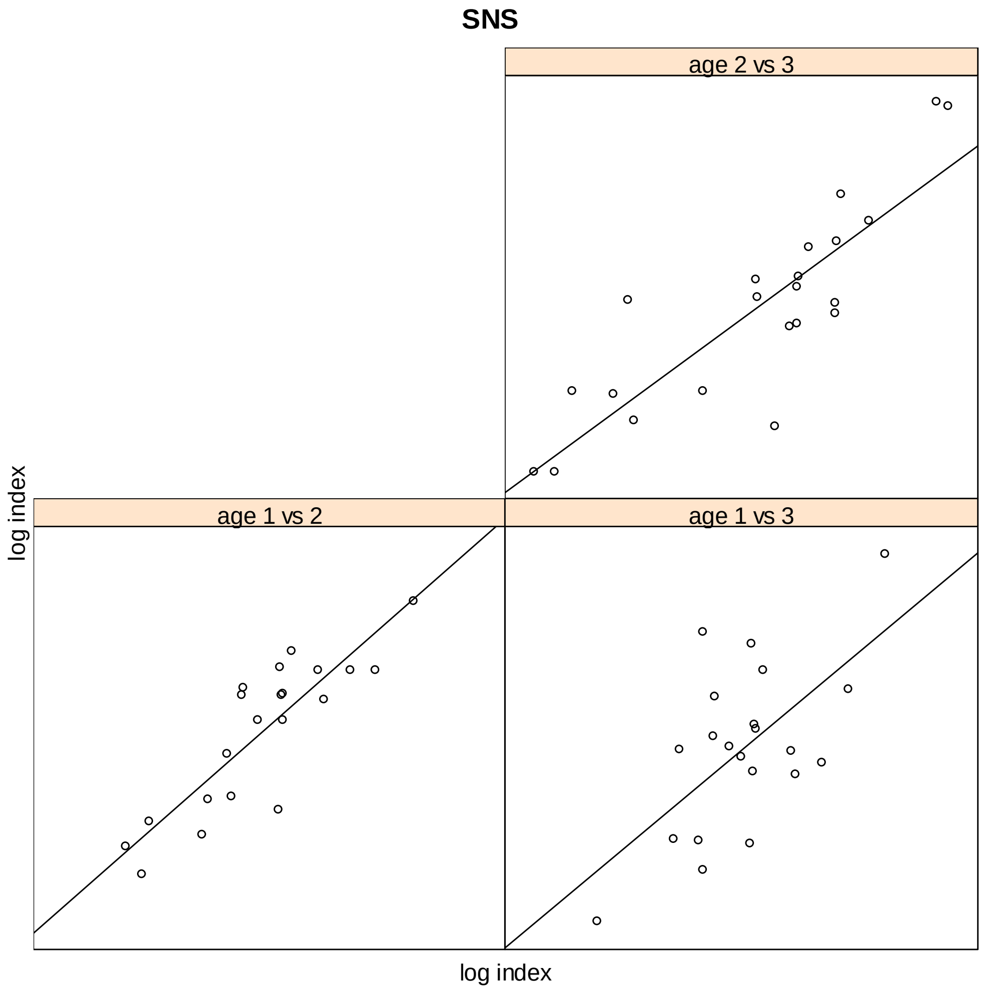


Figure 8.2.9. North Sea plaice. Internal consistency plot for the SNS survey.

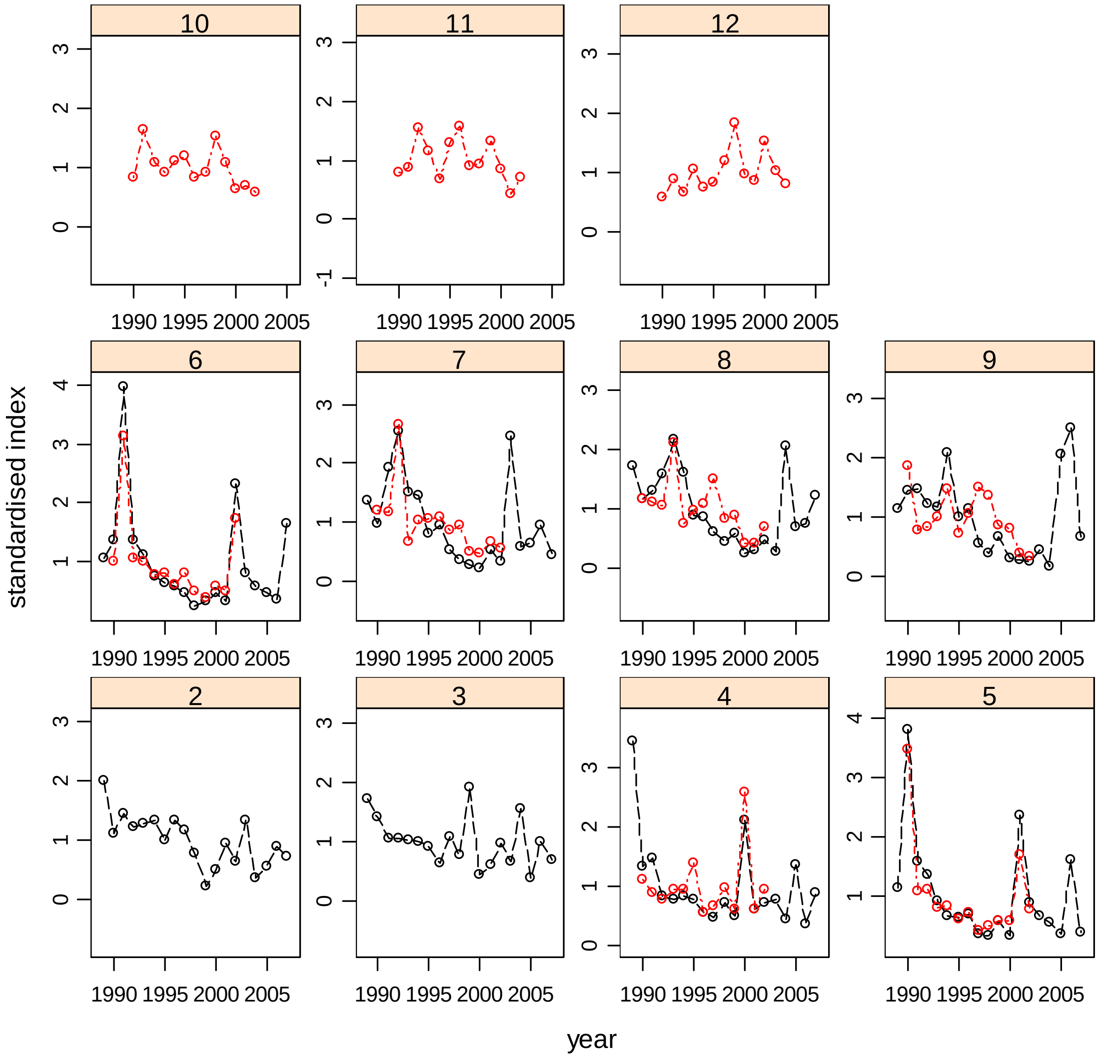
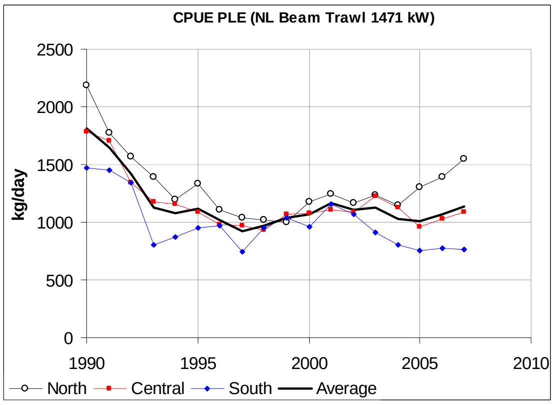


Figure 8.2.10 North Sea plaice. Standardized commercial tuning indices available for tuning: Dutch beam trawl fleet (black) and UK beam trawl fleet excluding all flag vessels (red).



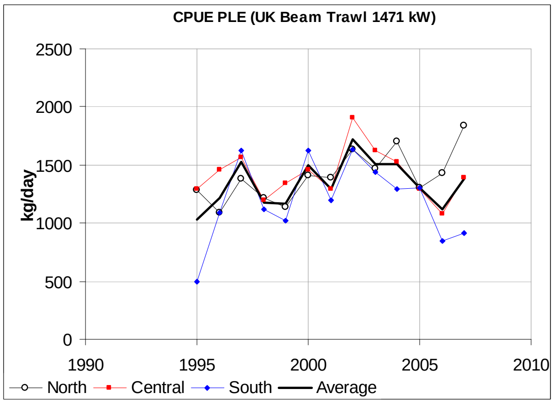


Figure 8.2.11. North Sea plaice. LPUE of the Dutch (left) and UK large trawler fleet (right), in areas north, central and south and the combined North Sea. Source: VIRIS Taken from Quirijns and Poos 2008,Working paper 1

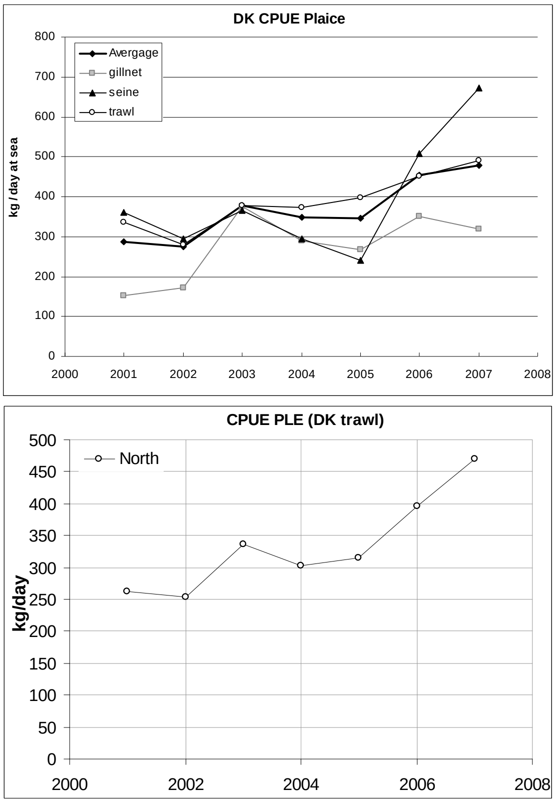


Figure 8.2.12 Danish CPUE. Left: average plaice CPUE (bold line), and split up by gear: trawl, gillnet and seines. Right: plaice CPUE in the northern North Sea by trawlers. Source: Danish log-book data. Taken from Quirijns and Poos 2008,Working paper 1

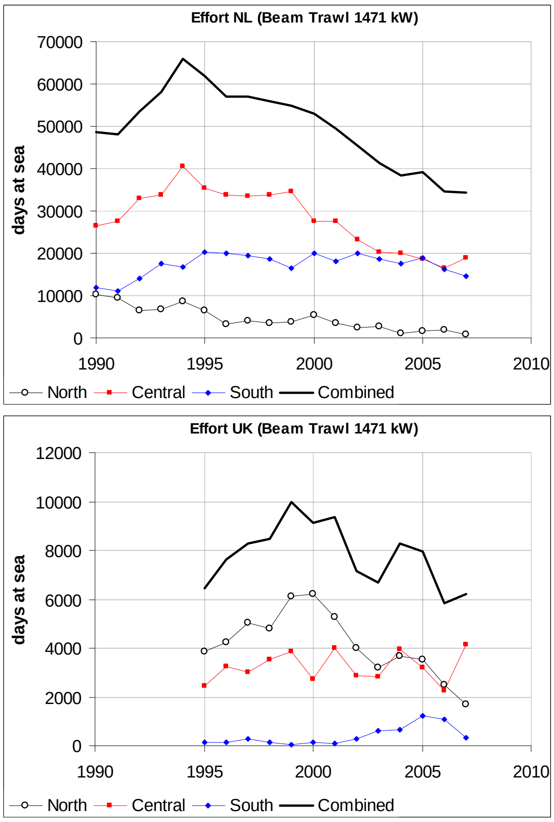


Figure 8.2.13. North Sea plaice. Effort (days at sea per 1471 kW vessel) for the Dutch fleet (left) and UK large trawler fleet (right), in areas north, central and south and the combined North Sea. Source: VIRIS. Taken from Quirijns and Poos 2008, Working paper 1.

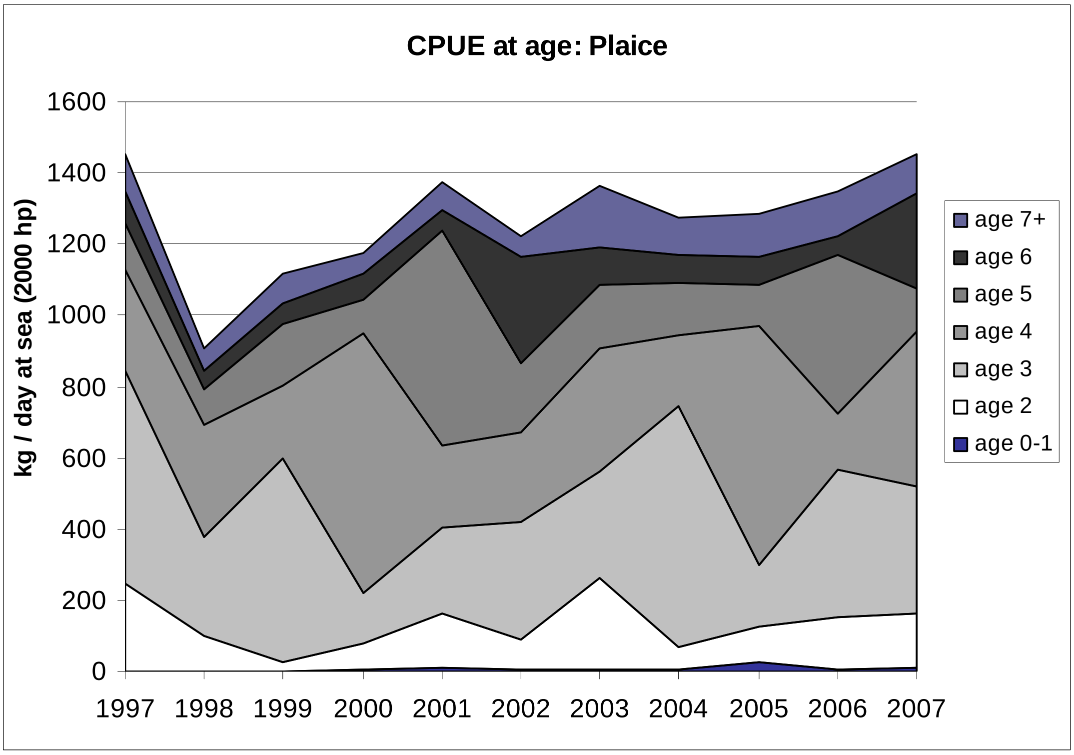


Figure 8.2.14. North Sea plaice. Age composition of Dutch Plaice LPUE.

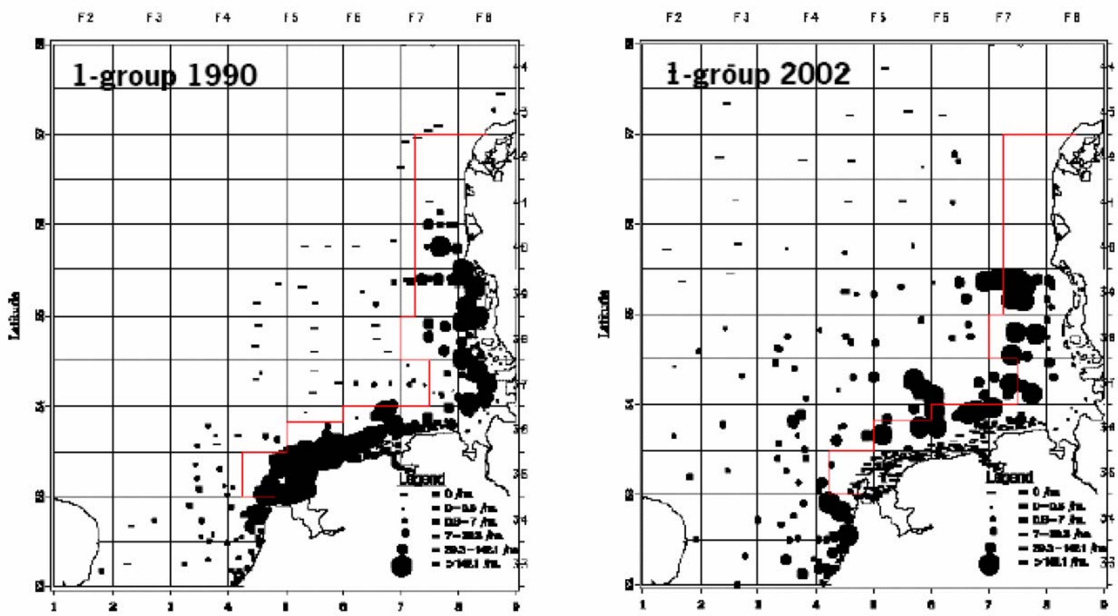


Figure 8.2.15. North Sea plaice. Spatial distribution of plaice age 1 (taken from Grift et al., 2004) in the DFS survey.

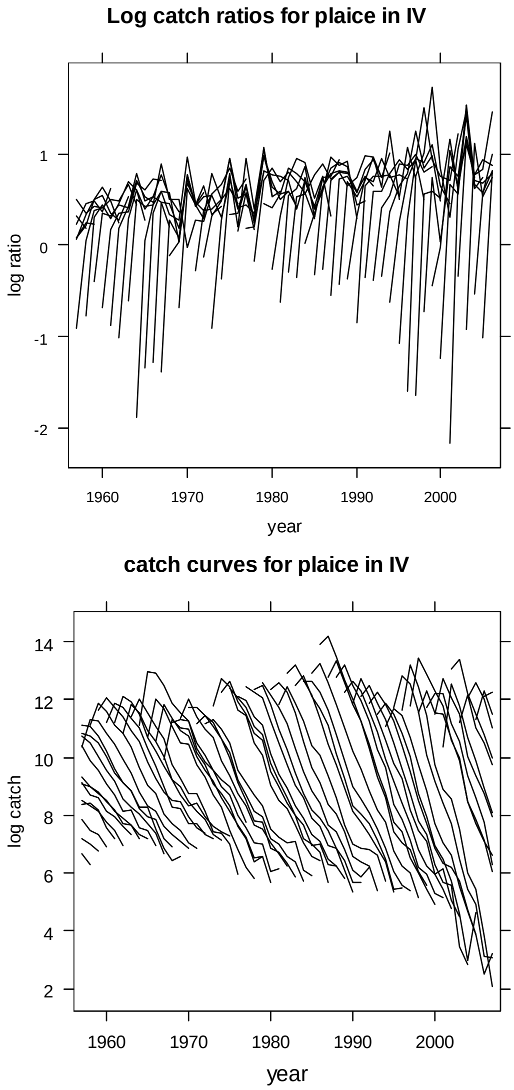


Figure 8.3.1. North Sea plaice. Log catch ratios (left panel) and catch curves (right panel).

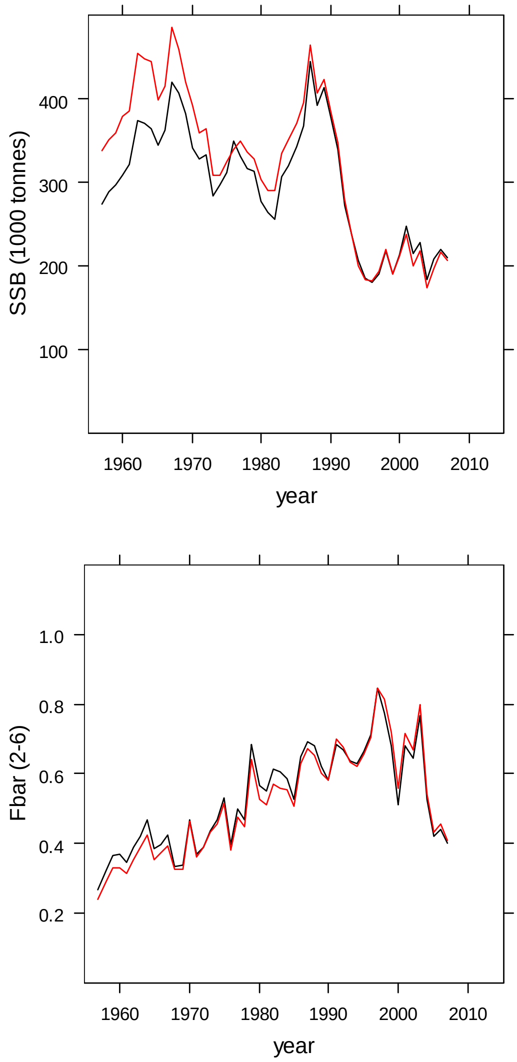


Figure 8.3.2. North Sea plaice. XSA results with respect to SSB (left) and F (right) estimate for different plus group settings used in the assessment. Red line indicates plus group at age 15, black line indicates plus group at age 10.

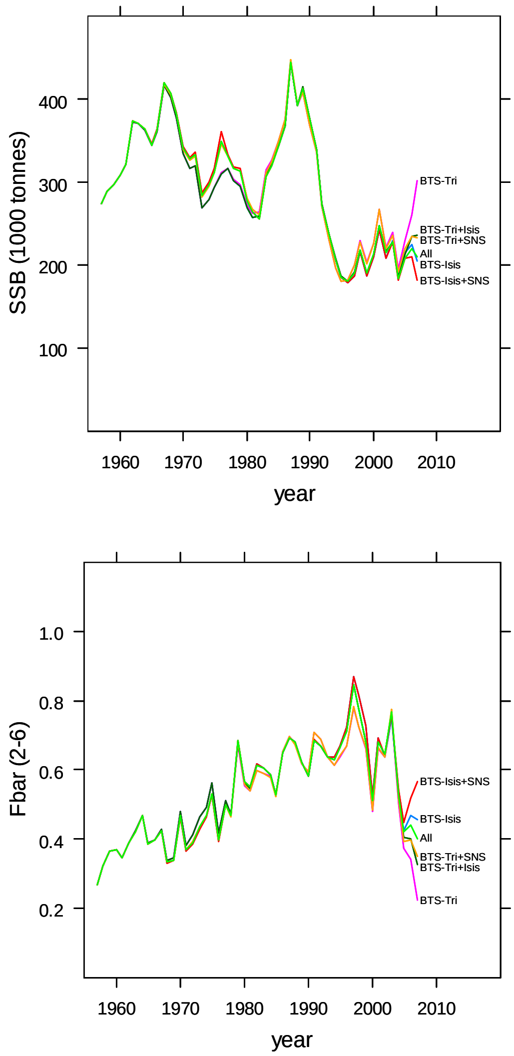


Figure 8.3.3 North Sea plaice XSA results with respect to SSB (left) and F (right) estimates for different permutations of the available survey tuning indices. XSA run with only SNS survey tuning index is omitted because no reliable SSB or F estimates are available owing to the limited age range (only ages 1–3). Labels indicate used tuning indices.

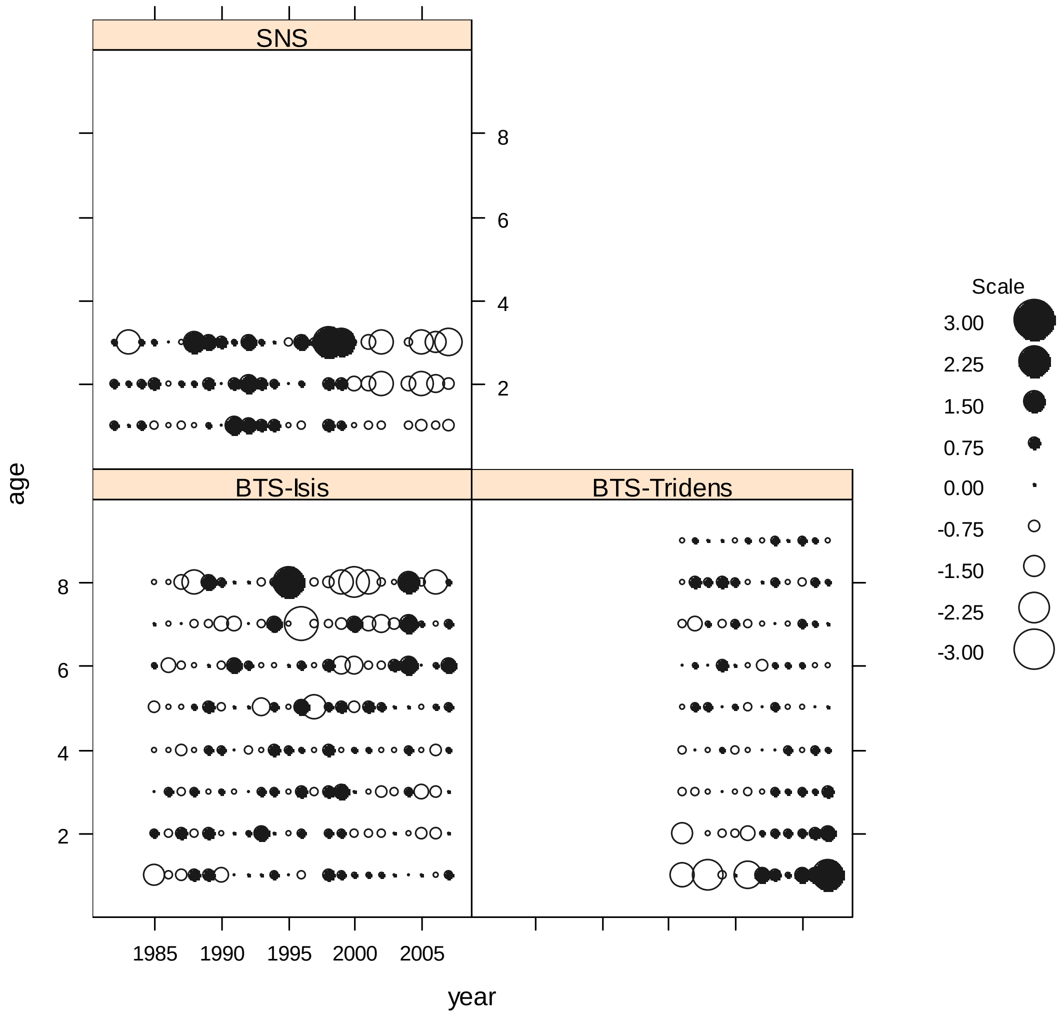


Figure 8.3.4. North Sea plaice. Log catchability residuals for the final XSA run from the three tuning series.

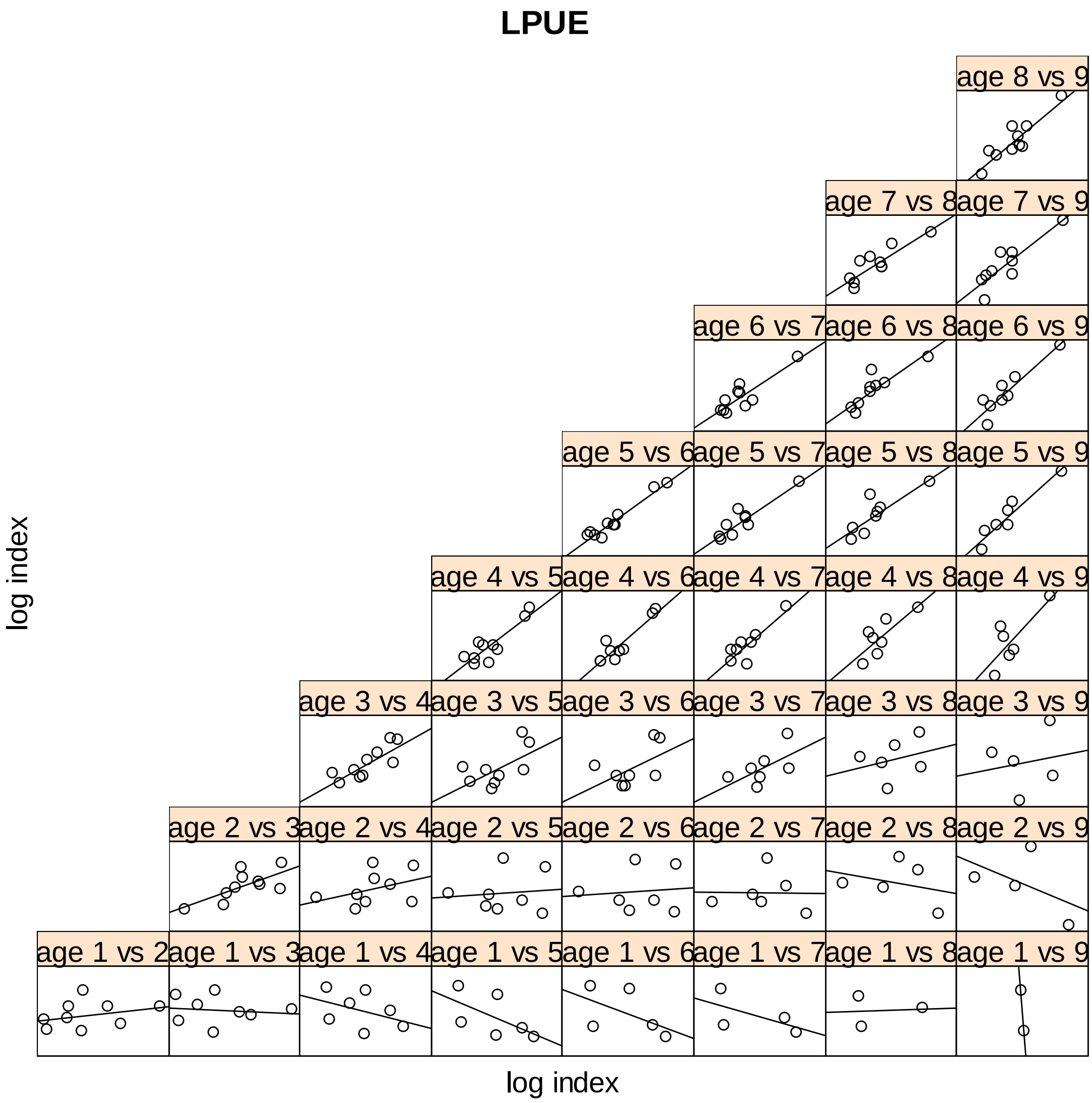


Figure 8.3.5. North Sea plaice. Internal consistency plot for the corrected age structured LPUE

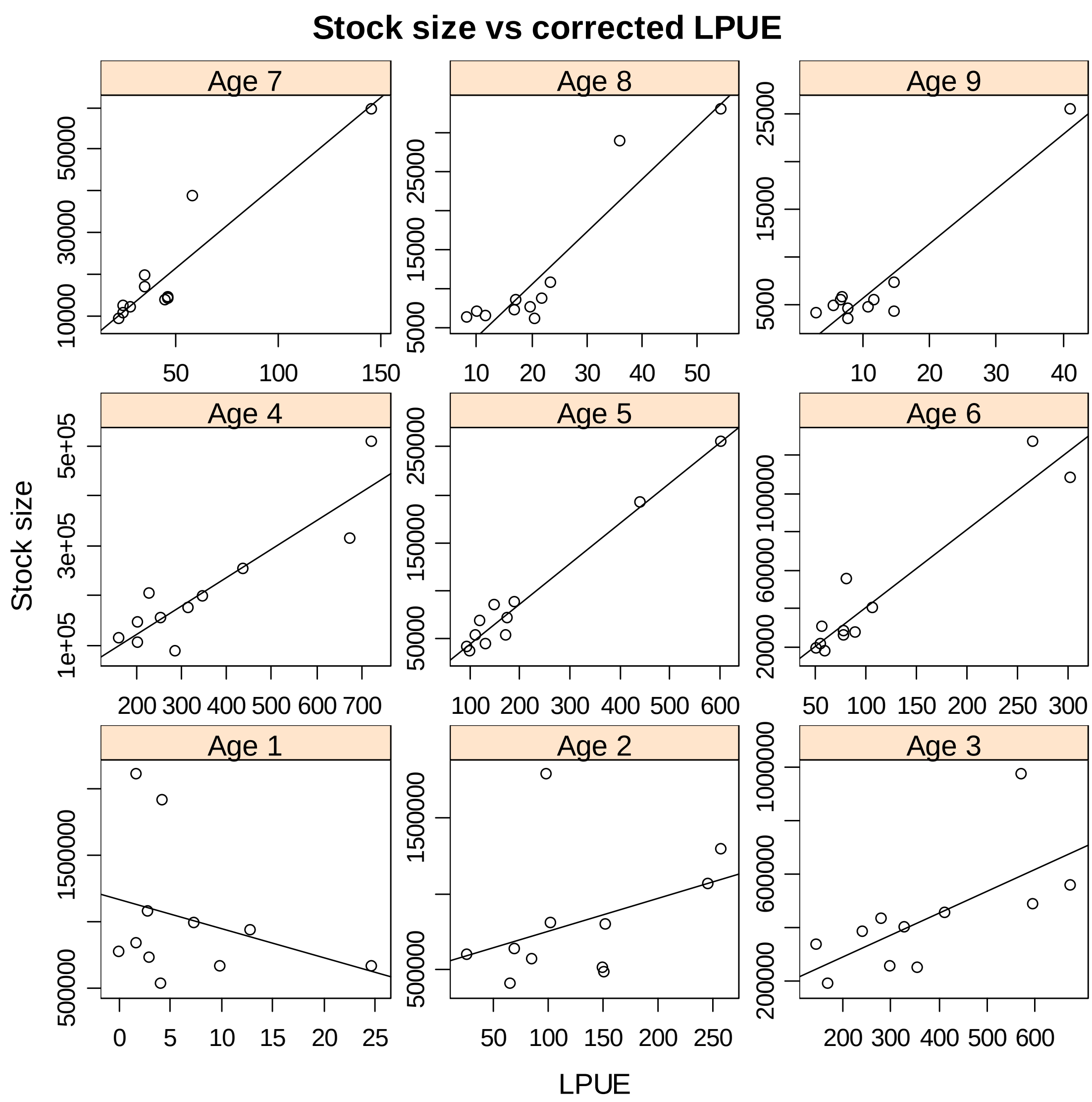


Figure 8.3.6. North Sea plaice. Stock size as a function of the corrected LPUE (working document) for ages 1–9.

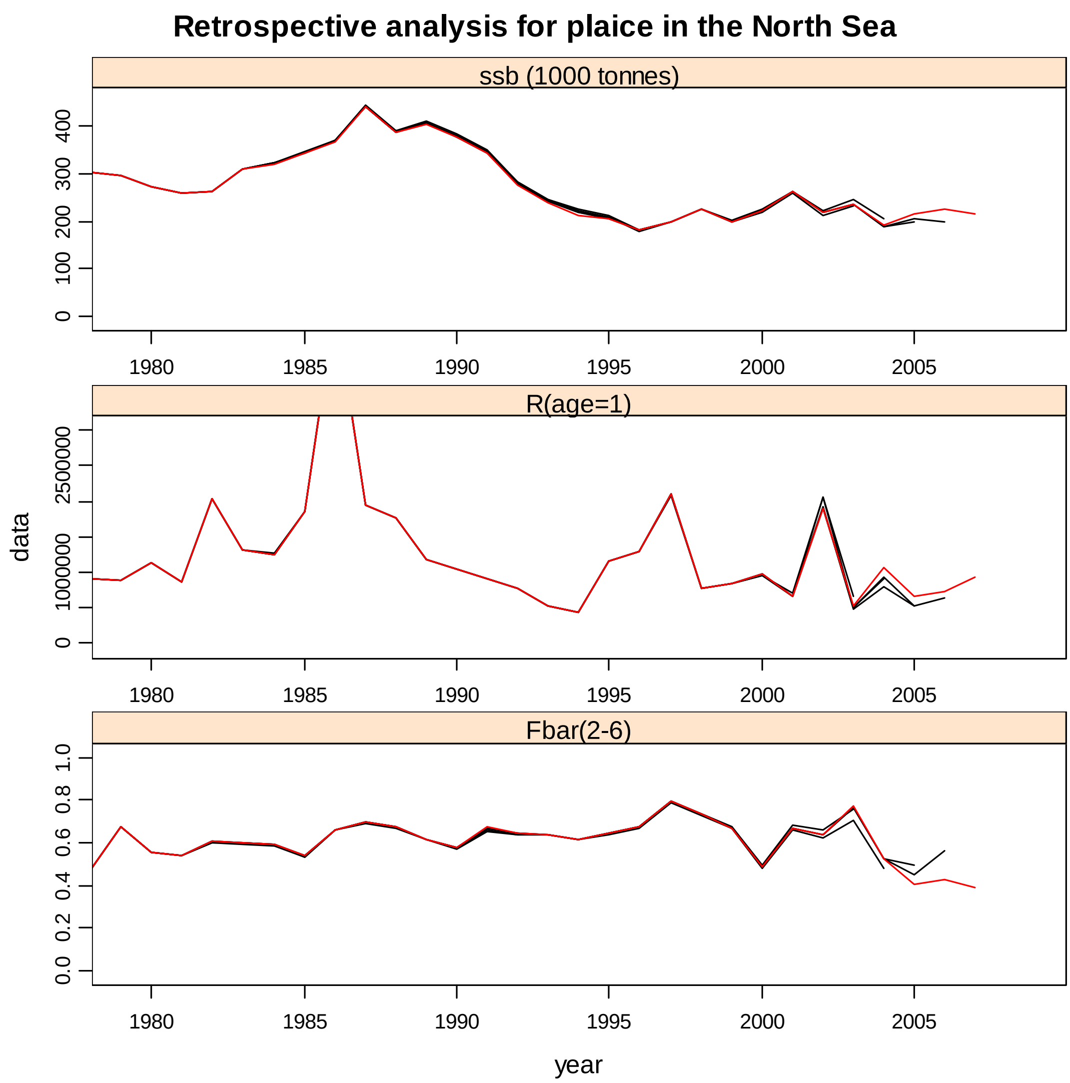
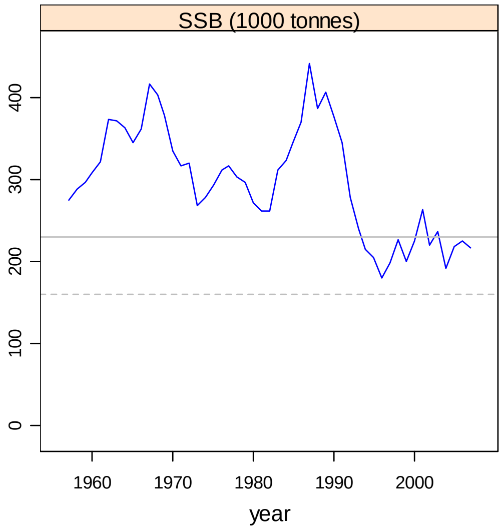
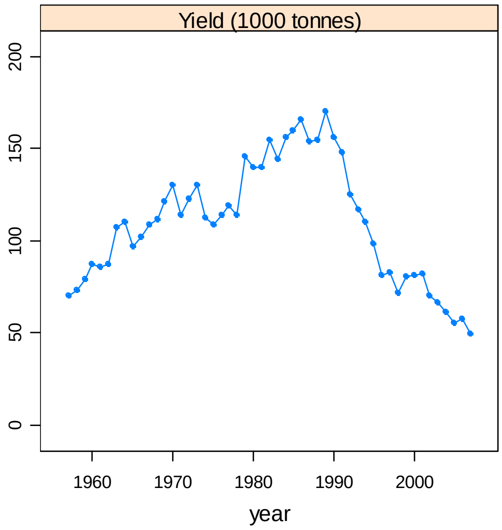


Figure 8.3.7. North Sea plaice. Retrospective pattern of the final XSA run with respect to SSB, recruitment and F.


SSB (1000 tonnes)
0
100
200
300
400
1960
1970
1980
1990
2000
year


Yield (1000 tonnes)
0
50
100
150
200
1960
1970
1980
1990
2000
year

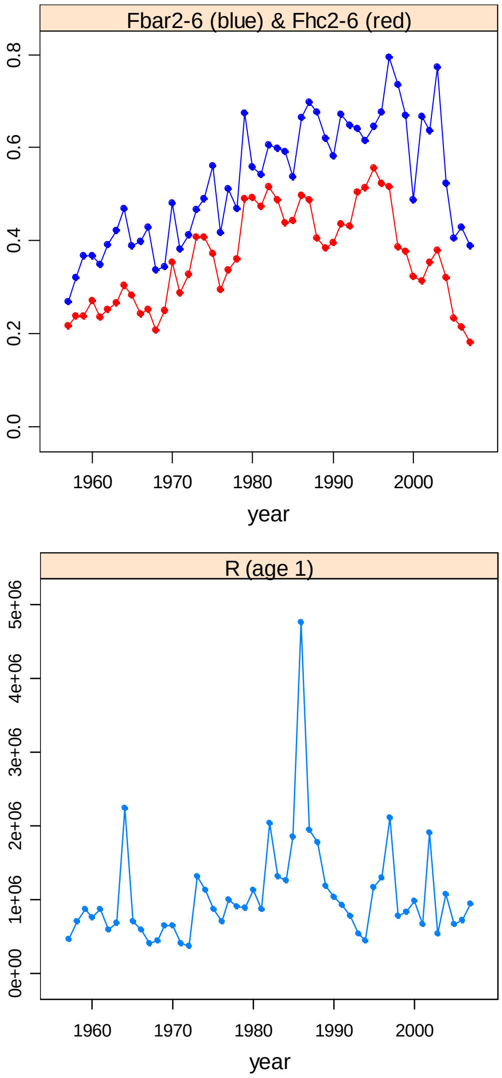


Figure 8.4.1. North Sea plaice. Stock summary figure, time series on SSB, Yield, Fishing mortality, and recruitment at age 1. Drawn line in top right panel indicates B_{pa} , dashed line indicates B_{lim}.

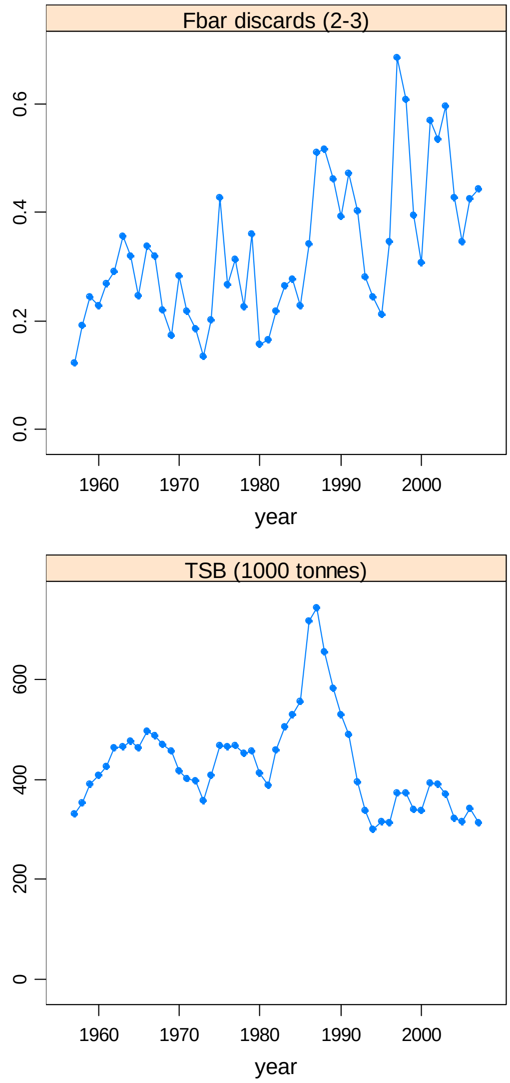


Figure 8.4.2. North Sea plaice. Stock summary figure. Time series on human consumption (left) fishing mortality and total stock biomass (right)

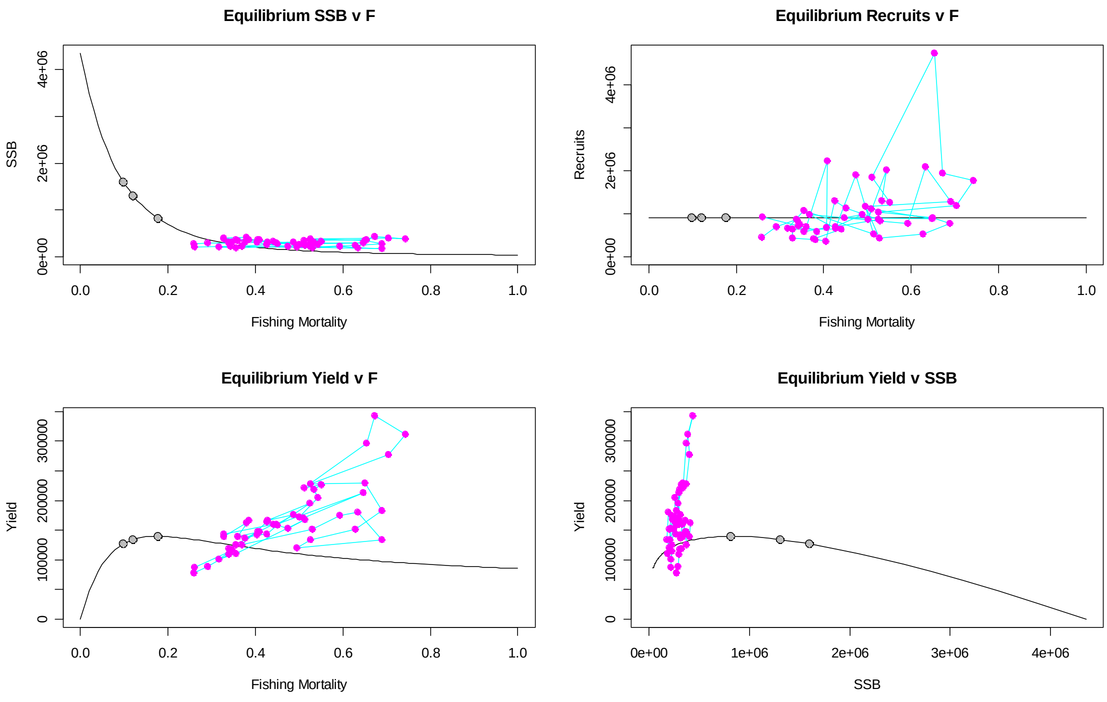


Figure 8.6.1 North Sea plaice. Yield per recruit analysis.

9 Sole in Subarea VIId

The assessment of sole in subarea VIId is presented here as an update assessment.

Procedures and settings are the same as in last year's assessment.

All the relevant biological and methodological information can be found in the Stock Annex dealing with this stock. Here, only the basic input and output from the assessment model will be presented.

9.1 General

9.1.1 Ecosystem aspects

A study by Vaz et al. (2007) indicated that a coastal heterogeneous sediment type was preferred by sole in ICES subdivision VIId. Vaz et al. used a multivariate and spatial analyses to identify and locate fish, cephalopod, and macrocrustacean species assemblages in the eastern English Channel from 1988 to 2004 (Figure 9.1.1). Four sub-communities with varying diversity levels were identified in relation to depth, salinity, temperature, seabed shear stress, sediment type, and benthic community nature. One Group (class 4 in Figure 9.1.1) was a coastal heterogeneous community represented by pouting, poor cod, and sole and was classified as preferential for many flatfish and gadoids. It displayed the greatest diversity and was characterized by heterogeneous sediment type (from muds to coarse sands) and various associated benthic community types, as well as by coastal hydrology and bathymetry. It was mostly near the coast, close to large river estuaries, and in areas subject to big salinity and temperature variations. Possibly resulting from this potentially heterogeneous environment (both in space and in time), this sub-community type was the most diverse.

Community evolution over time: (From Vaz *et al.*, 2007). The community relationship with its environment was remarkably stable over the 17 year of observation. However, community structure changed significantly over time without any detectable trend, as did temperature and salinity. The community is so strongly structured by its environment that it may reflect inter-annual climate variations, although no patterns could be distinguished over the study period. The absence of any trend in the structure of the eastern English Channel fish community suggests that fishing pressure and selectivity have not altered greatly over the study period at least. However, the period considered here (1988–2004) may be insufficient to detect such a trend.

Further information on ecological aspects can be found in the Stock Annex.

9.1.2 Fisheries

A detailed description of the fishery can be found in the Stock Annex.

It is likely that the high oil prices have had some impact on the fishing behavior of the Belgian and UK beam trawl fleets. For the French and UK inshore fleets however this will probably not be the case since they are constrained to the inshore areas.

For the eleventh consecutive year, neither France, Belgium nor UK was able to take up their quota (see section 9.2.1).

9.1.3 ICES advice

In the advice for both 2007 and 2008 ICES considered the stock as having full reproductive capacity and being harvested sustainably.

Single-stock exploitation boundaries

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

Target reference points have not been agreed for this stock. The current fishing mortality ($\mathbf{F}_{sq}$) is estimated at 0.36, which is above the rate that would lead to high long-term yields and low risk of stock depletion $\mathbf{F}_{max}$ (= 0.30). However this value is not well defined. Fishing at $\mathbf{F}_{max}$ is expected to lead to landings in 2008 of 5170t and an SSB in 2009 at around 16 500t.

Exploitation boundaries in relation to precautionary limits

The exploitation within the precautionary limits would imply landings of less than 6590 t in 2008, which is expected to lead to a 14% decrease in SSB in 2009.

Mixed fisheries management options should be based on the expected catch in specific combinations of effort in the various fisheries taking into consideration the advice given above. The distributions of effort across fisheries should be responsive to objectives set by managers, which is also the basis for the scientific advice presented below.

Demersal fisheries in Division IIIa (Skagerrak-Kattegat), in Subarea IV (North Sea) and in Division VIId (Eastern Channel) should in 2008 be managed according to the following rules, which should be applied simultaneously:

with minimal bycatch or discards of cod;

Implement TACs or other restrictions that will curtail fishing mortality for those stocks mentioned above for which reduction in fishing pressure is advised;

within the precautionary exploitation limits for all other stocks;

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

With minimum by-catch of spurdog, porbeagle and thornback ray and skate.

9.1.4 Management

No explicit management objectives are set for this stock.

Management of sole in VIId is by TAC and technical measures. The agreed TACs in 2007 and 2008 are 6220t and 6593t respectively. Technical measures in force for this stock are minimum mesh sizes, minimum landing size. The minimum landing size for sole is 24 cm. Demersal gears permitted to catch sole are 80 mm for beam trawling and 80 mm for otter trawlers. Fixed nets are required to use 100 mm mesh since 2002 although an exemption to permit 90 mm has been in force since that time.

For 2007 Council Regulation (EC) N°41/2007 allocates different days at sea depending on gear, mesh size and catch composition. (see section 1.2.1 for complete list). The days at sea limitations for the major fleets operating in Subarea VIId could be summarised as follows: Days at sea limitations for Trawls or Danish seines varies between 95 and unlimited days per year. Beam trawlers have an unlimited number of days permit. Maximum days at sea for Gillnets vary between 130 and 140 days per year. Trammel nets are allowed a maximum of 205 days for trip length less than 24 hours; otherwise the limit is 140 days.

For 2008 Council Regulation (EC) N°40/2008 allocates different days at sea depending on gear, mesh size and catch composition. (see section 1.2.1 for complete list). The days at sea limitations for the major fleets operating in Subarea VIId could be summarised as follows: Days at sea limitations for Trawls or Danish seines varies between 86 and unlimited days per year. Beam trawlers have an unlimited number of days permit. Maximum days at sea for Gillnets vary between 117 and 140 days per year. Trammel nets are allowed a maximum of 205 days for Member States whose quotas are less than 5% of the Community share of the TACs of both plaice and sole; otherwise the limit is 180 days. Long-lines have a maximum of 173 days per year.

9.2 Data available

9.2.1 Catch

French landings submitted to the Working Group for 2006 were revised upward by 12% to 2611t and UK landings by 1% to 670t. The 2006 values for the numbers at age were therefore also updated. Total landings now amount to 4834t instead of 4554t.

The 2007 landings used by the Working Group were 4686t (Table 9.2.1) which is 20% below the agreed TAC of 6220t and 26% below the predicted landings at a status quo fishing mortality in 2007 (6157t). The contribution of France, Belgium and the UK to the landings in 2007 is 51%, 33% and 16% respectively.

Landing data reported to ICES are shown in Table 9.2.1 together with the total landings estimated by the Working Group. As in last year’s assessment, misreporting by UK beam trawlers from Division VIIe into VIId has been taken into account and corrected accordingly (see also section 9.3.1). It should be noted that historically there is also thought to be a considerable under-reporting by small vessels, which take up a substantial part of the landings in the eastern Channel. In the UK buyers and sellers registration is considered to have reduced this significantly since 2005. Substantial progress has been made in recent years by including all return rates of the small vessels.

Discard estimates since 2005 are available for the UK and French static gear and the French otter trawl (Figure 9.2.1a-c). Numbers are raised to the sampled trips. It should be noted that the number of sampled trips is low. Discards from the Belgian beam trawler fleet could not been processed in time for the working group due to the shift of the working group to an earlier time in the year. The data will be available later in the year when time permits to compile the data.

The available information suggests that discards are not a substantial part of the catch for this high valued species. Although French otter trawl discards information suggest that occasionally discarding of predominantly 1-year old fish occur in the first and second quarter these otter trawls only comprise 13% of the sole landings in VIId. The Working Group therefore decided not to include discards in the assessment at this stage due to the scarcity of the data but will monitor the situation in the future.

Sampling levels for those countries providing age compositions will be provided in the September report.

9.2.2 Age compositions

Quarterly data for 2007 were available for landing numbers and weight at age, for the French, Belgian, and UK fleets. These comprise around 99% of the international landings. Age compositions of the landings are presented in Table 9.2.2.

9.2.3 Weight at age

Weight at age in the catch is presented in Table 9.2.3 and weight at age in the stock in Table 9.2.4. The procedure for calculating mean weights is described in the Stock Annex.

9.2.4 Maturity and natural mortality

As in previous assessments, a knife-edged maturity-ogive was used at age 3.

Natural mortality is assumed at fixed values (0.1) for all ages in time.

9.2.5 Catch, effort and research vessel data

Available estimates of effort and LPUE are presented in Tables 9.2.5a,b and Figures 9.2.2a-c. Revisions have been made to the French and UK effort and LPUE series for 2005 and 2006. The Belgian data has been revised for 2006. Effort for the Belgian beam trawl fleet increased to the highest level in 2007. This is mainly due to the unrestrictive "days at sea" EU regulation in ICES subdivision VIId in the last 3 years, as well as the good fishing opportunities for sole in that area. The mobile Belgian fleet are predominantly fishing in the most favourable area which is subdivision VIId at the moment. The UK (E&W) beam trawl fleet effort has increased from the late 1980s, reaching its peak in 1997. Since then, effort has decreased and fluctuated around 60% of its peak level. Since last year information has been provided on effort and LPUE from the recent period of the French fleets in the Eastern Channel. This short data series will be extended historically and for recent years and therefore will provide information on the trends in the main French fisheries.

The Belgian LPUE has fluctuated around the mean with no strong trend until recently when catch rates have been increasing consistent with the UK beam trawl fleet up to 2005. Both fleets show a decrease in the last 2 years. The recent time series of the French beam trawl LPUE has been decreasing until 2006 with a slight increase in 2007. The French OTB and GTR have remained relatively stable.

Survey and commercial data used for calibration of the assessment are presented in Table 9.2.6.

The UK beam trawl series have been revised for the years 2004–2006, as well as the Belgian beam trawl for 2006. It should be noted that the Young fish survey (YFS) was not updated for 2007 as the UK survey was not conducted in 2007. The missing information for that survey has implications for the assessment of sole in subdivision VIId (see also section 9.3.2).

9.3 Data analyses

9.3.1 Reviews of last year's assessment

The RG noted that similar pattern of trends in residuals for sole and plaice in this area were observed and requested that the WG should look into this feature in VIId. Due to work pressure at this year's meeting, the Working Group was unable to fully evaluate this feature but will address it during the next benchmark assessment of sole or plaice in VIId.

9.3.2 Exploratory catch at age analysis

Catch at age analysis was carried out according to the specifications in the Stock Annex. The model used was XSA. The results of exploratory XSA runs, which are not included in this report, are available in ICES files.

A preliminary inspection of the quality of international catch-at-age data was carried out using separable VPA with a reference age of 4, terminal F=0.5 and terminal S=0.8. As last year, the log-catch ratios for the fully recruited ages (3–10) did not show any patterns or large residuals (in ICES files).

The tuning data were examined for trends in catchability by carrying out XSA tuning runs (lightly shrunk (se=2.0), mean q model for all ages, full time series and untapered), using data for each of the four fleets individually (in ICES files). Apart from the first few year's in the Belgian series (1982–1985, which were excluded from the analyses, as in previous assessments), there were no strong trends for any of the fleets. The Belgian beam trawl fleet had a somewhat noisier log catchability residual pattern, especially for age 2 and age 11. Year effects were noted for the UK(E&W) beam trawl fleet (UK-BT) in 2000. The UK(E&W) beam trawl survey (UK-BTS) showed year effects for 3 consecutive year (1999, 2000 and 2001).

The time series of the standardized indices for ages 1 to 6 from the four tuning fleets (BEL-BT commercial, UK-BT commercial, UK-BTS survey and the YFS survey) are plotted in Figure 9.2.3. All tuning fleets appear to track the year classes reasonably well. Internal consistency plots for the 2 commercial fleets and the UK beam trawl survey are presented in Figure 9.2.4–6. The internal consistency of the Belgian beam trawl fleet appears relatively high for the older ages. The UK commercial fleet and the survey show high consistencies for the entire age-range.

The catchability residuals for the proposed final XSA are shown in Figure 9.3.1 and the XSA tuning diagnostics are given in Table 9.3.1.

As no Young fish survey (YFS) index was available for the 2006 year class at age 1, the only information for that year class was provided by the UK(E&W) beam trawl survey. It should be noted that the Young fish survey (YFS) has been very consistent in estimating year class strength in the past. The weighting of this survey for the incoming year class has been around 80% in all recent assessments. The rest of the weighting for the final estimates were coming from the UK(E&W) beam trawl survey (around 15%) and F-shrinkage (around 5%). In this year's assessment, the estimates for the recruiting year class 2006 were estimated by the UK(E&W) beam trawl survey and the F-shrinkage giving 83% and 17% respectively of the weighting.

At age 2, the 2005 year class is estimated very consistently by surveys and commercial fleets. Apart for age 1 (17%), F shrinkage gets low weights for all ages (<2%). The weighting of the 2 surveys decreases for the older ages as the commercial fleets are given more weight (Figure 9.3.2).

9.3.3 Exploratory survey-based analyses

In 2005, exploratory SURBA-runs (v3.0) were carried out on the UK(E&W) Beam-trawl Survey (UK-BTS) (1988–2004) and the International Young Fish Survey (1988–2004) to investigate whether the surveys-only analysis suggests different trends in recruitment, SSB and fishing mortality. From the diagnostics on Mean Z, it was concluded that the surveys could not estimate any trend in fishing mortality. Given also that the SSB and recruitment trends from both XSA and SURBA runs showed similar patterns, the Working Group decided to accept the XSA as the final assessment.

In this update assessment Surba runs were not executed.

9.3.4 Conclusion drawn from exploratory analyses

The XSA analyses was taken as the final assessment, giving mostly consistent survivor estimates between fleets for all ages. The estimates of recruiting age 1 (year class 2006) are far below average values in the time series, indications of a far below average 2006 year class (Figure 9.3.2).

9.3.5 Final assessment

The final settings used in this year's assessment are the same as in last year's assessment and are detailed below:

	2007 assessment			2008 assessment		
Fleets	Years	Ages	α-β	Years	Ages	α-β
BEL-BT commercial	86–06	2–10	0–1	86–07	2–10	0–1
UK-BT commercial	86–06	2–10	0–1	86–07	2–10	0–1
UK-BTS survey	88–06	1–6	0.5–0.75	88–07	1–6	0.5–0.75
YFS–survey	87–06	1–1	0.5–0.75	87–**06**	1–1	0.5–0.75

-First data year	1982	1982
-Last data year	2006	2007
-First age	1	1
-Last age	11+	11+
Time series weights	None	None
-Model	No Power model	No Power model
-Q plateau set at age	7	7
-Survivors estimates shrunk towards mean F	5 years / 5 ages	5 years / 5 ages
-s.e. of the means	2.0	2.0
-Min s.e. for pop. Estimates	0.3	0.3
-Prior weighting	None	None

The final XSA output is given in Table 9.3.2 (fishing mortalities) and Table 9.3.3 (stock numbers). A summary of the XSA results is given in Table 9.3.4 and trends in yield, fishing mortality, recruitment and spawning stock biomass are shown in Figure 9.3.3.

Retrospective patterns for the final run are shown in Figure 9.3.4. There is good consistency between estimates in successive years.

9.4 Historical Stock Trends

Trends in landings, SSB, F(3–8) and recruitment are presented Table 9.3.4 and Figure 9.3.3.

For most of the time series, fishing mortality has been fluctuating between Fpa (0.4) and Flim (0.57). In the early 1990s it dropped below Fpa. Since 1999 it decreased steadily from 0.59 to around 0.4 in 2002 after which it remained stable.

Recruitment has fluctuated around 25 million recruits with occasional strong year classes. The two highest values in the time series have been recorded in the last 6 years.

The spawning stock biomass has been stable for most of the time series. Since 2001 SSB has increased due to average and above average year classes to well above Bpa (8000 t).

9.5 Recruitment estimates

The 2005 year class in 2006 was confirmed by XSA to be around average with 36 million fish at age 1 which is the fourth highest in the time series. 98% of the weight estimate comes from the tuning fleets, giving rather similar results. The XSA survivor estimates for this year class were used for further prediction.

The 2006 year class in 2007 was estimated by XSA to be 8 million one year olds which is the lowest in the time series. F shrinkage gets 17% of the weight, the other 83% is coming from the survey. The XSA survivor estimates for this year class were used for further prediction.

The long term GM recruitment (23 million, 1982–2005) was assumed for the 2007 and subsequent year classes.

For comparison, RCT3 runs were carried out. Input to the RCT3 model is given in Table 9.5.1 and results are presented in Table 9.5.2. However RCT3 estimates were not taken forward into predictions since they performed poorly in recent assessments. Although the RCT3 results are not used for prediction, it should be noted that the Young fish survey (YFS) at age 0 (not included in the XSA) confirms a strong 2005 year class and a below average 2006 year class. Hence there is still a marked difference between the RCT3 and the XSA estimates for that year class.

The working group estimates of year class strength used for prediction can be summarised as follows:

Year class	At age in 2008	XSA	GM 82–05	RCT3	Accepted Estimate
2005	3	23799	15568	-	XSA
2006	2	7400	20269	16758	XSA
2007	1	-	23482	-	GM 1982–05
2008 & 2009	recruits	-	23482	-	GM 1982–05

9.6 Short term forecasts

The short term prognosis was carried out according to the specifications in the stock annex. As fishing mortality has remained stable in the last seven years, the selection pattern for prediction has been taken as a 3 year unscaled average. Weights at age in the catch and in the stock are averages for the years 2005–2007.

Input to the short term predictions and the sensitivity analysis are presented in Table 9.6.1. Results are presented in Table 9.6.2 (management options) and Table 9.6.3 (detailed output).

Assuming *status quo* F, implies a catch in 2008 of 4900t (the agreed TAC is 6593t) and a catch of 4380t in 2009. Assuming *status quo* F will result in a SSB in 2009 and 2010 of 10940t and 10410t respectively.

Assuming *status quo* F, the proportional contributions of recent year classes to the landings in 2009 and SSB in 2010 are given in Table 9.6.4. The assumed GM recruitment accounts for 17% of the landings in 2009 and 29% of the 2010 SSB.

Results of a sensitivity analysis are presented in Figure 9.6.1 (probability profiles). The approximate 90% confidence intervals of the expected status quo yield in 2009 are 3500t and 5400t. There is about 5% probability that at current fishing mortality SSB will fall below the B_{pa} of 8000t in 2010.

9.7 Medium-term forecasts and Yield per recruit analyses

This year, no Medium-term forecasts were carried out for this stock.

Yield-per-recruit results, long-term yield and SSB, conditional on the present exploitation pattern and assuming *status quo* F in 2008, are given in Table 9.7.1 and Figure 9.7.1. F_{max} is not well estimated and calculated by this year's assessment to be 0.27 (0.40 = F_{sq}).

9.8 Biological reference points

		Basis
Flim	0.55	Fishing mortality at or above which the stock has shown continued decline.
Fpa	0.40	F is considered to provide approximately 95% probability of avoiding Flim
Blim	-	Not defined
Bpa	8000	Lowest observed biomass at which there is no indication of impaired recruitment.
Fmax	0.30	
F2006	0.36	
Fsq	0.36	

9.9 Quality of the assessment

Revisions in landings for France and UK (E&W) together with revisions in some tuning fleet indices (see section 9.2.5) resulted in an upward revision of fishing mortality in 2006 by 12% and a downward revision of SSB by 6%. Recruitment was not affected.

Sampling for sole landings in division VIId are considered to be at a reasonable level.

Information available on discards for 2007 suggest, as in previous years that discards are not substantial and therefore discards are not incorporated in the assessment. Discard information from French otter trawls suggest however that some discarding of 1 year old sole is taking place in the first 2 quarters of the year. Although the observed discarding at age 1 will not affect the assessment substantially, they will have an impact on forecasts, but the low level of discards are not considered a significant factor in catch forecasts.

The trends and estimates of fishing mortality, SSB and recruitment were consistent with last year's assessment apart from the downward revision of the 2004 year class by 30%.

Except year class 2002 and 2003, all year classes from 1998 to 2005 are estimated to be at or above long term average which explains the increase in SSB since 1998. Although the strong 2004 year class has been confirmed by three consecutive assessments, it has been revised downward in this year's assessment by 31%. The 2006 year class is predicted to be the weakest in the time series by two survey indices. Last year this year class was assumed to be GM in the forecast, resulting in status quo landings of 6070 t in 2008. Due to the large revisions of the 2004 and 2006 year classes by this year's assessment, landings in 2008 are now predicted to be 4900 t.

There is no apparent stock/recruitment relationship for this stock and no evidence of reduced recruitment at low levels of SSB (Figure 9.9.1).

The historical performance of this assessment is rather noisy (Figure 9.9.2) but has been more constant in recent years.

Although the Belgian beam trawl fleet effort increased in the last three years, and no increase of fishing mortality was observed. The Belgian fleet only accounts for 32% of the landings and more than 50% of the landings come from small vessels (< 10 m) which have a stable effort pattern.

9.10 Status of the Stock

Fishing mortality has been stable for the last 7 years around Fpa.

The spawning stock biomass has been stable for most of the time series and SSB is presently well above Bpa. The strong 2004 year class is predicted to increase SSB to a record high level of the time series in 2008.

9.11 Management Considerations

There is misreporting from adjacent areas. The Working group has addressed this by modifying landings data accordingly. In 2002 the UK(E&W) beam trawl landings from two rectangles 28E8 and 29E8 (in VIId) were re-allocated to VIIe on a quarterly basis, (based on information provided to the Working Group by the fishing industry) and the age compositions raised accordingly. This was done back to 1986. For VIId sole, UK(E&W) beam trawl and otter trawl data are processed together (as trawl), so the landings from these two rectangles were removed from the trawl data on a quarterly basis, and the age compositions adjusted to take that into account.

Although the Belgian beam trawl fleet effort increased in the last three years, and no increase of fishing mortality was observed. The Belgian fleet only accounts for 32% of the landings and more than 50% of the landings come from small vessels (< 10 m) which have a stable effort pattern.

There is a high probability that SSB will remain above B_{pa} in the short term due to the strong 2004 year class.

EU Council Regulation (EC) N°40/2008 allocates different days at sea depending on gear, mesh size and catch composition. (see section 1.2.1 for complete list). The days at sea limitations for the major fleets operating in Subarea VIId could be summarised as follows: Days at sea limitations for Trawls or Danish seines varies between 86 and unlimited days per year. Beam trawlers have an unlimited number of days permit. Maximum days at sea for Gillnets vary between 117 and 140 days per year. Trammel nets are allowed a maximum of 205 days for Member States whose quotas are less than 5% of the Community share of the TACs of both plaice and sole; otherwise the limit is 180 days. Long-lines have a maximum of 173 days per year. It is unlikely that these effort limitations will restrict the effort on sole in Subarea VIId.

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. Measures to reduce discarding in the sole fishery would greatly benefit the plaice stock and future yields. Mesh enlargement would reduce the catch of undersized plaice, but would also result in short-term loss of marketable sole. An increase in the minimum landing size of sole could provide an incentive to fish with larger mesh sizes and therefore mean a reduction in the discarding of plaice.

Table 9.2.1 Sole VIId. Nominal landings (tonnes) as officially reported to ICES and used by the Working Group

Year	Belgium	France		UK(E+W)	others	reported	Unallocated*	Total used by WG	TAC
1974	159	469		309	3	940	-56	884	
1975	132	464		244	1	841	41	882	
1976	203	599		404	.	1206	99	1305	
1977	225	737		315	.	1277	58	1335	
1978	241	782		366	.	1389	200	1589	
1979	311	1129		402	.	1842	373	2215	
1980	302	1075		159	.	1536	387	1923	
1981	464	1513		160	.	2137	340	2477	
1982	525	1828		317	4	2674	516	3190	
1983	502	1120		419	.	2041	1417	3458	
1984	592	1309		505	.	2406	1169	3575	
1985	568	2545		520	.	3633	204	3837	
1986	858	1528		551	.	2937	995	3932	
1987	1100	2086		655	.	3841	950	4791	3850
1988	667	2057		578	.	3302	551	3853	3850
1989	646	1610		689	.	2945	860	3805	3850
1990	996	1255		742	.	2993	654	3647	3850
1991	904	2054		825	.	3783	568	4351	3850
1992	891	2187		706	10	3794	278	4072	3500
1993	917	1907		610	13	3447	852	4299	3200
1994	940	2001		701	15	3657	726	4383	3800
1995	817	2248		669	9	3743	677	4420	3800
1996	899	2322		877	.	4098	699	4797	3500
1997	1306	1702		933	.	3941	823	4764	5230
1998	541	1703		803	.	3047	316	3363	5230
1999	880	2239		769	.	3888	247	4135	4700
2000	1021	2190		621	.	3832	-356	3476	4100
2001	1313	2482		822		4617	-592	4025	4600
2002	1643	2780		976		5399	-666	4733	5200
2003	1659	3475		1114	1	5672	-634	5038	5400
2004	1465	3070	***	1102		5636	-810	4826	5900
2005	1217	2832		558		4607	-223	4384	5700
2006	1532	2627		669		4828	6	4834	5720
2007	1532	2145	**	793		4470	216	4686	6220

* Unallocated mainly due misreporting

** Preliminary

*** Data provided to the WG but not officially provided to ICES

Table 9.2.2 - Sole VIId - Landing numbers at age (kg)

Run title : Sole in VIId - 2008WG - Sol7d.txt

At 22/04/2008 14:11

Table 1 Catch numbers at age Numbers*10**-3

YEAR	1982	1983	1984	1985	1986	1987
AGE						
1	155	0	24	49	49	9
2	2625	852	1977	3693	1251	3117
3	5256	3452	3157	5211	5296	3730
4	1727	3930	2610	1646	3195	3271
5	570	897	1900	1027	904	2053
6	653	735	742	1860	768	1042
7	549	627	457	144	1056	1090
8	240	333	317	158	155	784
9	122	108	136	156	190	111
10	83	89	99	69	212	163
+gp	202	193	238	128	372	459
0 TOTALNUM	12182	11216	11657	14141	13448	15829
TONSLAND	3190	3458	3575	3837	3932	4791
SOPCOF %	97	99	99	100	100	100

Table 1 Catch numbers at age Numbers*10**-3

YEAR	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
AGE										
1	95	163	1245	383	105	85	31	838	9	24
2	2162	3484	2851	7166	4046	5028	694	2977	1825	1489
3	7174	3220	5580	4105	8789	6442	6203	4375	7764	6068
4	1602	4399	1151	4160	1888	5444	5902	4765	3035	5008
5	1159	1434	1496	604	1993	1008	3404	2968	3206	2082
6	856	840	301	996	288	563	584	1980	1823	1670
7	388	571	390	257	368	162	567	375	1283	916
8	255	201	260	247	135	188	109	278	271	775
9	256	166	129	258	171	116	147	88	319	239
10	83	224	126	92	95	62	93	106	112	169
+gp	275	282	489	382	231	129	258	241	344	267
0 TOTALNUM	14305	14984	14018	18650	18109	19227	17992	18991	19991	18707
TONSLAND	3853	3805	3647	4351	4072	4299	4383	4420	4797	4764
SOPCOF %	100	100	100	100	100	100	100	100	100	100

Table 1 Catch numbers at age Numbers*10**-3

YEAR	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
AGE										
1	33	168	138	168	707	379	1030	206	608	137
2	1376	3268	3586	6042	7011	10957	4254	3468	7370	5676
3	5609	8506	4852	6194	7513	5086	8623	4034	3753	6664
4	2704	3307	4395	1595	3767	3178	2545	5458	2821	2784
5	1636	1311	1076	2491	1414	1805	2272	1543	3433	1395
6	609	869	505	728	655	671	1108	1143	1103	1941
7	558	350	319	290	298	588	371	633	796	705
8	441	672	148	128	129	198	448	218	403	462
9	354	351	328	56	97	70	94	283	191	245
10	239	192	150	81	57	88	88	127	208	139
+gp	301	359	248	265	197	245	233	271	307	226
0 TOTALNUM	13860	19353	15745	18038	21845	23265	21066	17384	20993	20374
TONSLAND	3363	4135	3476	4025	4733	5038	4826	4383	4833	4686
SOPCOF %	100	100	100	100	100	100	100	100	100	100

Table 9.2.3 - Sole VIId - Catch weights at age (kg)

Run title : Sole in VIId - 2008WG - Sol7d.txt

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Table 2 Catch weights at age (kg)

YEAR		1982	1983	1984	1985	1986	1987
AGE							
	1	0.102	0.000	0.100	0.090	0.135	0.095
	2	0.171	0.173	0.178	0.182	0.180	0.175
	3	0.225	0.230	0.234	0.230	0.212	0.236
	4	0.312	0.302	0.314	0.281	0.306	0.295
	5	0.386	0.404	0.380	0.368	0.363	0.353
	6	0.428	0.436	0.436	0.394	0.387	0.407
	7	0.439	0.435	0.417	0.516	0.437	0.411
	8	0.509	0.524	0.538	0.543	0.520	0.482
	9	0.502	0.537	0.529	0.594	0.502	0.465
	10	0.463	0.583	0.565	0.595	0.523	0.538
+gp		0.6729	0.6283	0.7135	0.8005	0.6015	0.6176
0 SOPCOFAC		0.9713	0.991	0.9884	0.998	1.0006	1.0004

Table 2 Catch weights at age (kg)

YEAR		1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
AGE											
	1	0.102	0.106	0.120	0.114	0.103	0.085	0.099	0.129	0.142	0.139
	2	0.152	0.154	0.178	0.161	0.153	0.147	0.150	0.176	0.165	0.153
	3	0.226	0.192	0.238	0.208	0.203	0.197	0.186	0.179	0.178	0.188
	4	0.278	0.271	0.289	0.266	0.267	0.247	0.235	0.230	0.229	0.233
	5	0.360	0.293	0.349	0.354	0.290	0.335	0.288	0.255	0.269	0.292
	6	0.409	0.358	0.339	0.394	0.403	0.384	0.355	0.333	0.324	0.343
	7	0.459	0.388	0.470	0.421	0.391	0.537	0.381	0.357	0.361	0.390
	8	0.514	0.472	0.465	0.430	0.462	0.553	0.505	0.385	0.405	0.404
	9	0.553	0.515	0.487	0.434	0.459	0.515	0.484	0.490	0.435	0.503
	10	0.563	0.547	0.518	0.478	0.463	0.766	0.496	0.494	0.465	0.474
+gp		0.6647	0.7014	0.5621	0.5656	0.5661	0.6666	0.6156	0.6536	0.5854	0.6509
0 SOPCOFAC		1.0001	0.9994	0.9995	1.0001	1.0001	1.0002	1.0001	0.9997	0.9999	1

Table 2 Catch weights at age (kg)

YEAR		1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
AGE											
	1	0.132	0.130	0.145	0.108	0.120	0.114	0.120	0.135	0.139	0.162
	2	0.159	0.151	0.142	0.152	0.162	0.170	0.179	0.172	0.162	0.187
	3	0.172	0.189	0.176	0.211	0.204	0.208	0.205	0.208	0.192	0.200
	4	0.235	0.215	0.223	0.283	0.253	0.257	0.255	0.253	0.249	0.226
	5	0.286	0.260	0.332	0.288	0.316	0.277	0.296	0.303	0.284	0.275
	6	0.343	0.280	0.377	0.334	0.375	0.357	0.304	0.337	0.328	0.293
	7	0.383	0.290	0.424	0.367	0.376	0.381	0.348	0.368	0.353	0.315
	8	0.417	0.341	0.427	0.374	0.393	0.438	0.403	0.433	0.402	0.378
	9	0.484	0.358	0.384	0.493	0.469	0.482	0.492	0.570	0.457	0.438
	10	0.435	0.374	0.459	0.511	0.420	0.494	0.509	0.445	0.450	0.442
+gp		0.6162	0.5354	0.68	0.5445	0.5308	0.5274	0.525	0.5369	0.557	0.5224
0 SOPCOFAC		1.0013	0.9992	1.0009	1.0005	0.9995	1.0002	0.9983	0.9989	1	1.001

Table 9.2.4 - Sole VIId - Stock weights at age (kg)

Run title : Sole in VIId - 2008WG - Sol7d.txt

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Table 3 Stock weights at age (kg)

YEAR	1982	1983	1984	1985	1986	1987
AGE						
1	0.059	0.070	0.067	0.065	0.070	0.072
2	0.114	0.135	0.131	0.129	0.136	0.139
3	0.167	0.197	0.192	0.192	0.198	0.203
4	0.217	0.255	0.249	0.254	0.256	0.262
5	0.263	0.309	0.304	0.315	0.309	0.318
6	0.306	0.359	0.355	0.376	0.358	0.370
7	0.347	0.406	0.403	0.436	0.403	0.417
8	0.384	0.448	0.448	0.495	0.443	0.461
9	0.418	0.487	0.490	0.554	0.480	0.500
10	0.450	0.522	0.529	0.611	0.512	0.536
+gp	0.5300	0.6008	0.6265	0.7798	0.5761	0.6156

Table 3 Stock weights at age (kg)

YEAR	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
AGE										
1	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050
2	0.145	0.113	0.138	0.138	0.144	0.130	0.116	0.126	0.155	0.139
3	0.223	0.182	0.232	0.225	0.199	0.189	0.161	0.129	0.176	0.165
4	0.268	0.269	0.305	0.279	0.277	0.246	0.215	0.220	0.258	0.220
5	0.365	0.323	0.400	0.380	0.305	0.366	0.273	0.234	0.286	0.264
6	0.425	0.335	0.361	0.384	0.454	0.377	0.316	0.333	0.308	0.317
7	0.477	0.480	0.476	0.410	0.405	0.545	0.368	0.357	0.366	0.376
8	0.498	0.504	0.535	0.449	0.459	0.560	0.530	0.330	0.391	0.404
9	0.572	0.586	0.571	0.474	0.430	0.559	0.461	0.614	0.438	0.563
10	0.636	0.536	0.507	0.451	0.528	0.813	0.470	0.382	0.466	0.494
+gp	0.7498	0.7135	0.5765	0.6203	0.5269	0.5664	0.6122	0.6292	0.6304	0.6536

Table 3 Stock weights at age (kg)

YEAR	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
AGE										
1	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050
2	0.140	0.128	0.122	0.127	0.136	0.151	0.137	0.157	0.161	0.163
3	0.158	0.180	0.148	0.157	0.179	0.207	0.185	0.203	0.185	0.195
4	0.233	0.205	0.208	0.216	0.209	0.249	0.236	0.241	0.246	0.239
5	0.299	0.253	0.402	0.226	0.258	0.314	0.265	0.267	0.272	0.287
6	0.374	0.277	0.440	0.223	0.254	0.376	0.267	0.309	0.326	0.296
7	0.363	0.298	0.395	0.231	0.301	0.399	0.273	0.349	0.339	0.339
8	0.357	0.324	0.554	0.253	0.234	0.418	0.331	0.401	0.394	0.400
9	0.450	0.336	0.443	0.256	0.326	0.446	0.504	0.608	0.416	0.427
10	0.372	0.323	0.420	0.301	0.404	0.444	0.409	0.425	0.461	0.441
+gp	0.5768	0.5118	0.6822	0.4204	0.4170	0.5032	0.4501	0.5602	0.5553	0.5128

Table 9.2.5a **Sole in VIId. Indices of effort**

Year	France Beam trawl[1]	France GTR_Demersal_fish[4]	France OTB_Demersal_fish[4]	France TBB_Demersal_fish[4]	England & Wales Beam trawl[2]	Belgium Beam trawl[3]
1971						
1972						
1973						
1974						
1975						5.02
1976						6.56
1977						6.87
1978						8.22
1979						7.30
1980						12.81
1981						19.00
1982						23.94
1983						23.64
1984						28.00
1985						25.29
1986					2.79	23.54
1987					5.64	27.11
1988					5.09	38.52
1989					5.65	35.67
1990					7.27	30.33
1991	10.69				7.67	24.29
1992	10.52				8.78	21.99
1993	10.22				6.40	20.02
1994	10.61				5.43	25.17
1995	12.38				6.89	24.17
1996	14.09				10.31	25.00
1997	10.92				10.25	30.89
1998	11.71				7.31	18.12
1999	10.63				5.86	21.39
2000	13.78				5.65	30.54
2001	11.38				7.64	32.39
2002		12.92	17.90	4.01	7.90	33.68
2003		14.81	16.19	4.17	6.69	47.50
2004		14.18	17.38	3.55	4.87	41.60
2005		15.36	15.69	2.72	6.00	35.80
2006		15.70	18.48	3.08	5.94	48.80
2007		12.20	17.36	2.62	4.98	57.90

[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

[4] Days at sea (x 10^3)

Table 9.2.5b **Sole in VIId. LPUE indices**

Year	France[1] Beam trawl	France GTR_Demersal_fish[4]	France OTB_Demersal_fish[4]	France TBB_Demersal_fish[4]	England & Wales[2] Beam trawl	Belgium[3] Beam trawl
1971						
1972						
1973						
1974						
1975						24.09
1976						27.28
1977						29.99
1978						26.27
1979						37.42
1980						23.26
1981						24.52
1982						23.65
1983						22.37
1984						21.61
1985						22.90
1986					39.48	33.48
1987					32.82	36.56
1988					27.67	15.89
1989					26.59	16.82
1990					26.88	25.94
1991	18.52				22.09	22.56
1992	18.12				25.29	29.11
1993	21.60				23.75	34.77
1994	17.78				31.83	27.89
1995	18.46				28.39	24.70
1996	19.79				25.79	29.80
1997	14.41				25.40	32.57
1998	17.33				25.71	23.51
1999	30.40				27.29	26.41
2000	19.10				27.46	24.49
2001	46.10				26.58	24.58
2002		106.00	35.35	147.32	31.63	27.33
2003		113.05	40.42	134.92	32.81	33.13
2004		105.54	30.21	128.53	38.80	30.86
2005		106.62	28.91	127.26	40.51	31.97
2006		98.09	33.44	91.56	39.01	27.47
2007		104.92	33.58	119.85	35.57	23.43

[1] in h*KW-04

[2] in Kg/1000 HP*HRS >10% sole

[3] in Kg/hr corrected for fishing power using P = 0.000204 BHP^1.23

[4] in Kilos/days at sea

Table 9.2.6 - Sole VIId - tuning files

Bolded numbers = used in XSA

SOLE	7d,TUNING													
104	1													
BEL	**BT**													
1980	**2007**													
1	**1**	**0**	**1**											
2	**15**													
12.8	**69.3**	**46.1**	**298.7**	**189.6**	**57.4**	**24.7**	**10.3**	**5.1**	**8.6**	**3.1**	**5.5**	**2.4**	**2.6**	**37.9**
19.0	**640.7**	**161.4**	**82.1**	**312.8**	**229.6**	**44.7**	**32.9**	**33.1**	**6.9**	**9.0**	**18.4**	**9.3**	**0.8**	**51.9**
23.9	**148.7**	**980.9**	**128.0**	**93.4**	**155.9**	**112.6**	**38.8**	**60.1**	**15.2**	**14.0**	**7.4**	**12.5**	**5.9**	**54.3**
23.6	**190.4**	**373.0**	**818.9**	**65.5**	**54.0**	**81.7**	**73.2**	**23.5**	**20.2**	**27.0**	**5.0**	**1.0**	**7.1**	**33.0**
28.0	**603.8**	**347.2**	**311.2**	**436.0**	**53.7**	**38.5**	**104.9**	**59.9**	**25.4**	**23.2**	**25.3**	**9.0**	**8.2**	**42.4**
25.3	**382.9**	**612.1**	**213.0**	**209.1**	**260.2**	**58.2**	**34.1**	**48.0**	**31.0**	**16.9**	**19.6**	**9.2**	**7.7**	**21.3**
23.4	**215.0**	**1522.3**	**675.0**	**233.7**	**170.6**	**194.0**	**30.1**	**53.1**	**64.2**	**32.6**	**12.7**	**2.6**	**43.0**	**29.3**
27.1	**843.6**	**451.0**	**739.3**	**724.4**	**344.5**	**232.4**	**152.7**	**25.3**	**86.5**	**56.0**	**56.1**	**54.5**	**9.3**	**109.0**
38.5	**131.6**	**990.4**	**243.3**	**362.9**	**216.7**	**111.8**	**41.8**	**73.8**	**47.0**	**9.8**	**22.3**	**35.8**	**8.6**	**25.3**
35.7	**47.5**	**512.6**	**543.6**	**748.0**	**276.6**	**225.0**	**53.1**	**36.4**	**12.7**	**4.7**	**0.0**	**0.0**	**4.7**	**27.0**
30.3	**1011.4**	**1375.2**	**218.1**	**366.2**	**85.3**	**198.2**	**65.5**	**39.0**	**22.4**	**22.2**	**25.4**	**2.8**	**24.0**	**18.2**
24.3	**320.2**	**1358.6**	**710.1**	**125.6**	**283.9**	**60.6**	**56.2**	**21.0**	**19.8**	**22.2**	**18.0**	**5.6**	**0.3**	**21.4**
22.0	**499.3**	**1613.7**	**523.3**	**477.7**	**36.9**	**67.9**	**28.2**	**31.7**	**11.2**	**11.4**	**6.0**	**5.7**	**3.2**	**16.7**
20.0	**1654.5**	**1520.4**	**889.5**	**215.5**	**78.5**	**38.9**	**40.8**	**37.8**	**11.3**	**8.7**	**13.3**	**1.5**	**3.0**	**22.4**
22.2	**196.9**	**1183.2**	**1598.5**	**912.9**	**201.0**	**160.0**	**39.5**	**33.8**	**46.2**	**16.0**	**10.2**	**14.9**	**8.8**	**18.6**
24.2	**206.2**	**542.7**	**671.3**	**590.9**	**409.4**	**100.6**	**40.3**	**25.4**	**14.2**	**9.3**	**5.0**	**11.9**	**3.4**	**8.0**
25.0	**284.1**	**975.5**	**628.7**	**560.1**	**354.3**	**316.8**	**68.3**	**77.6**	**34.2**	**26.2**	**15.8**	**10.8**	**1.1**	**4.2**
30.9	**196.0**	**1282.3**	**966.1**	**500.2**	**422.3**	**301.1**	**144.7**	**56.6**	**29.3**	**25.8**	**12.1**	**12.6**	**3.4**	**1.4**
18.1	**254.1**	**450.3**	**375.4**	**175.1**	**54.8**	**116.1**	**95.9**	**59.1**	**12.4**	**16.0**	**7.7**	**2.9**	**4.4**	**19.2**
21.4	**367.7**	**1043.6**	**640.2**	**308.3**	**94.6**	**48.7**	**90.6**	**68.3**	**28.2**	**44.7**	**22.9**	**4.7**	**8.5**	**11.3**
30.5	**569.1**	**1170.7**	**1225.1**	**239.1**	**139.4**	**68.4**	**66.6**	**74.4**	**46.0**	**26.9**	**7.6**	**6.6**	**0.3**	**1.9**
32.4	**1055.5**	**1385.4**	**375.0**	**617.9**	**351.1**	**105.4**	**31.6**	**15.2**	**18.7**	**35.5**	**11.6**	**6.9**	**12.3**	**4.6**
33.7	**1267.7**	**1612.6**	**804.3**	**286.3**	**122.4**	**95.7**	**45.2**	**24.8**	**28.6**	**15.8**	**13.8**	**8.0**	**6.0**	**2.6**
47.5	**2157.2**	**1848.1**	**1368.5**	**737.0**	**395.3**	**191.8**	**97.9**	**15.0**	**47.9**	**33.5**	**30.8**	**37.9**	**0.0**	**1.2**
41.6	**959.7**	**1846.2**	**778.1**	**1050.9**	**331.1**	**82.3**	**93.5**	**30.7**	**51.2**	**22**	**34.8**	**0.7**	**8.3**	**0.7**
35.8	**1150.8**	**1156.5**	**1259.7**	**309.1**	**201.7**	**156.5**	**74.2**	**37.9**	**16.4**	**44.8**	**1.3**	**6.2**	**0.8**	**3.3**
48.8	**1341.0**	**1050.9**	**1009.4**	**885.8**	**434.9**	**370.7**	**147.7**	**79.2**	**75.7**	**35.9**	**25.4**	**27.4**	**19.5**	**4.1**
57.9	**1736.5**	**1888.6**	**808.5**	**415.2**	**550.6**	**207.8**	**258.0**	**117.2**	**47.6**	**36.6**	**21.5**	**9.2**	**5.5**	**31.4**
UK	**BT**													
1986	**2007**													
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	**111.9**	**440.4**	**103.2**	**62.2**	**32.6**	**9.6**	**18.2**	**4.3**	**3.2**	**2.9**	**0.5**	**3.3**	**1.2**	**4.2**
6.0	**170.7**	**178.3**	**376.4**	**69.4**	**72.3**	**35.4**	**17.4**	**15.6**	**11.2**	**4.3**	**7.9**	**2.7**	**3.2**	**10.9**
5.9	**395.2**	**350.5**	**113.5**	**189.0**	**31.7**	**28.1**	**13.6**	**9.0**	**5.4**	**2.8**	**0.8**	**1.5**	**0.3**	**2.9**
5.0	**167.1**	**302.5**	**114.4**	**34.5**	**102.4**	**23.9**	**23.5**	**9.4**	**1.3**	**4.1**	**2.8**	**0.9**	**1.8**	**5.9**

Table 9.2.6 - Sole VIId - tuning files - continued

Bolded numbers = used in XSA

UK	**BTS**					
1988	**2007**					
1	**1**	**0.5**	**0.75**			
1	**6**					
1	**8.20**	**14.20**	**9.90**	**0.80**	**1.30**	**0.60**
1	**2.60**	**15.40**	**3.40**	**1.70**	**0.60**	**0.20**
1	**12.10**	**3.70**	**3.40**	**0.70**	**0.80**	**0.20**
1	**8.90**	**22.80**	**2.20**	**2.30**	**0.30**	**0.50**
1	**1.40**	**12.00**	**10.00**	**0.70**	**1.10**	**0.30**
1	**0.50**	**17.50**	**8.40**	**7.00**	**0.80**	**1.00**
1	**4.80**	**3.20**	**8.30**	**3.30**	**3.30**	**0.20**
1	**3.50**	**10.60**	**1.50**	**2.30**	**1.20**	**1.50**
1	**3.50**	**7.30**	**3.80**	**0.70**	**1.30**	**0.90**
1	**19.00**	**7.30**	**3.20**	**1.30**	**0.20**	**0.50**
1	**2.00**	**21.20**	**2.50**	**1.00**	**0.90**	**0.10**
1	**28.10**	**9.40**	**13.20**	**2.50**	**1.70**	**1.30**
1	**10.49**	**22.03**	**4.15**	**4.24**	**1.03**	**0.58**
1	**9.09**	**21.01**	**8.36**	**1.20**	**1.91**	**0.54**
1	**31.76**	**11.42**	**5.42**	**3.45**	**0.27**	**0.71**
1	**6.47**	**28.48**	**4.13**	**2.46**	**1.58**	**0.30**
1	**7.35**	**8.49**	**7.71**	**1.57**	**1.45**	**0.99**
1	**25**	**5.04**	**2.86**	**3.47**	**1.63**	**1.02**
1	**6.3**	**29.2**	**2.8**	**2**	**1.9**	**0.3**
1	**2.1**	**21.9**	**12.9**	**1.2**	**0.8**	**1.2**
YFS						
1981	**2006**					
1	**1**	**0.5**	**0.75**			
0	**1**					
1	1.88	0.20				
1	2.66	0.70				
1	11.89	-11				
1	-11.00	-11				
1	-11.00	-11				
1	-11.00	**0.66**				
1	8.00	**0.94**				
1	1.19	**0.36**				
1	12.59	**1.15**				
1	3.33	**1.87**				
1	1.39	**0.80**				
1	1.28	**0.62**				
1	6.53	**1.59**				
1	8.10	**1.46**				
1	5.31	**0.34**				
1	0.99	**0.52**				
1	1.94	**0.56**				
1	9.37	**0.85**				
1	2.75	**1.28**				
1	1.85	**0.84**				
1	4.51	**1.93**				
1	2.52	**0.82**				
1	2.16	**1.30**				
1	7.15	**2.28**				
1	4.51	**1.45**				
1	1.96	-11.00				

Table 9.3.1 - Sole VIId - XSA diagnostics

Lowestoft VPA Version 3.1

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Extended Survivors Analysis

Sole in VIId - 2008WG - Sol7d.txt

CPUE data from file Tun7d.txt

Catch data for 26 years. 1982 to 2007. Ages 1 to 11.

Fleet	First year	Last year	First age	Last age	Alpha	Beta
BEL BT	1986	2007	2	10	0	1
UK BT	1986	2007	2	10	0	1
UK BTS	1988	2007	1	6	0.5	0.75
YFS	1987	2007	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 60 iterations

Total absolute residual between iterations
59 and 60 = .00011

Final year F values

Age	1	2	3	4	5	6	7	8	9	10
Iteration 59	0.0175	0.2045	0.282	0.4493	0.4777	0.3558	0.572	0.3099	0.3712	0.7021
Iteration 60	0.0175	0.2045	0.282	0.4493	0.4777	0.3558	0.572	0.3099	0.3712	0.7021

1

Regression weights

	1	1	1	1	1	1	1	1	1	1

Table 9.3.1 - Sole VIId - XSA diagnostics - continued

Fishing mortalities

Age	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
1	0.002	0.007	0.005	0.007	0.015	0.02	0.053	0.005	0.018	0.017
2	0.059	0.237	0.174	0.248	0.381	0.307	0.286	0.228	0.22	0.204
3	0.546	0.538	0.577	0.45	0.49	0.465	0.375	0.426	0.366	0.282
4	0.586	0.642	0.522	0.334	0.481	0.351	0.396	0.383	0.528	0.449
5	0.561	0.558	0.391	0.561	0.491	0.396	0.403	0.394	0.391	0.478
6	0.493	0.583	0.382	0.443	0.247	0.405	0.399	0.323	0.48	0.356
7	0.232	0.518	0.387	0.35	0.29	0.326	0.364	0.371	0.347	0.572
8	0.307	0.426	0.382	0.235	0.231	0.284	0.391	0.335	0.379	0.31
9	0.339	0.38	0.337	0.216	0.251	0.169	0.189	0.407	0.487	0.371
10	1.138	0.277	0.246	0.116	0.317	0.337	0.297	0.373	0.525	0.702

1

XSA population numbers (Thousands)

YEAR	AGE 1.00E+00	2.00E+00	3.00E+00	4.00E+00	5.00E+00	6.00E+00	7.00E+00	8.00E+00	9.00E+00	1.00E+01
1998	1.80E+04	2.52E+04	1.40E+04	6.41E+03	4.01E+03	1.65E+03	2.84E+03	1.75E+03	1.29E+03	3.70E+02
1999	2.63E+04	1.63E+04	2.15E+04	7.34E+03	3.22E+03	2.07E+03	9.10E+02	2.04E+03	1.17E+03	8.33E+02
2000	3.21E+04	2.36E+04	1.16E+04	1.14E+04	3.50E+03	1.67E+03	1.05E+03	4.90E+02	1.20E+03	7.23E+02
2001	2.59E+04	2.89E+04	1.80E+04	5.91E+03	6.10E+03	2.14E+03	1.03E+03	6.43E+02	3.03E+02	7.78E+02
2002	4.89E+04	2.33E+04	2.04E+04	1.04E+04	3.83E+03	3.15E+03	1.24E+03	6.57E+02	4.60E+02	2.21E+02
2003	2.03E+04	4.36E+04	1.44E+04	1.13E+04	5.81E+03	2.12E+03	2.22E+03	8.41E+02	4.72E+02	3.24E+02
2004	2.08E+04	1.80E+04	2.90E+04	8.18E+03	7.20E+03	3.54E+03	1.28E+03	1.45E+03	5.73E+02	3.61E+02
2005	43600	17900	12200	18100	4980	4350	2150	805	889	429
2006	36300	39300	12900	7230	11100	3040	2850	1340	521	535
2007	8320	32300	28500	8090	3860	6820	1700	1820	831	290

Estimated population abundance at 1st Jan 2008

0	7400	23800	19500	4670	2170	4320	869	1210	519

Taper weighted geometric mean of the VPA populations:

22900	21200	15800	8580	4720	2780	1610	979	606	377

Standard error of the weighted Log(VPA populations) :

0.4377	0.3886	0.37	0.4244	0.4557	0.49	0.4946	0.5073	0.4947	0.54

Log catchability residuals.

Fleet : BEL BT

Age	1986	1987
1	No data for this fleet at this age	
2	0.01	0.55
3	0.7	-0.23
4	0.17	0.34
5	-0.09	0.57
6	-0.09	0.94
7	-0.18	0.63
8	0.09	-0.08
9	0.76	0.37
10	0.1	2.18

Age	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
1	No data for this fleet at this age									
2	-0.76	-2.59	1.09	-0.79	-0.06	1.28	-0.32	-0.78	-0.14	-0.75
3	-0.45	-0.02	0.07	0.81	0.07	0.23	-0.05	-0.31	-0.07	0.36
4	-0.74	-0.42	-0.16	0.05	0.39	-0.06	0.55	-0.36	0.26	0.34
5	-0.25	1.01	-0.1	-0.05	0.23	-0.03	0.26	-0.07	-0.13	0.46
6	-0.21	0.28	-0.15	0.66	-0.47	-0.84	0.44	0.09	0.15	0.15
7	0.07	0.34	0.54	0.09	-0.22	0.02	0.03	0	0.25	0.25
8	-0.73	-0.04	-0.26	-0.06	-0.13	-0.25	0.32	-1.1	-0.01	-0.2
9	-0.73	-0.3	0.37	-0.68	-0.09	0.72	-0.19	0.2	-0.14	0.09
10	1.5	-2.07	-0.05	0.59	-0.7	-0.64	1.43	-0.77	1.13	-0.96

Table 9.3.1 - Sole VIId - XSA diagnostics - continued

Age	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
1	No data for this fleet at this age									
2	-0.37	0.35	0.03	0.43	0.85	0.38	0.57	0.88	-0.06	0.21
3	-0.23	0.01	0.4	0.02	0.02	0.15	-0.46	0.11	-0.37	-0.79
4	0.26	0.51	0.32	-0.36	-0.13	-0.09	-0.18	-0.34	0.11	-0.43
5	-0.16	0.46	-0.31	0.1	-0.27	-0.13	0.15	-0.56	-0.63	-0.46
6	-0.24	-0.06	0.1	0.75	-0.82	0.47	-0.09	-0.67	0.22	-0.58
7	-0.23	0.01	-0.21	0.16	-0.19	-0.4	-0.54	-0.27	-0.01	-0.14
8	0.1	-0.22	0.52	-0.62	-0.33	-0.12	-0.53	-0.05	-0.16	-0.11
9	-0.07	0.03	-0.29	-0.61	-0.56	-1.47	-0.81	-0.79	0.21	-0.09
10	-0.03	-0.56	-0.3	-1.4	0.35	0.14	0.22	-0.91	0.16	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	-7.0451	-5.7982	-5.6661	-5.5576	-5.7714	-5.7044	-5.7044	-5.7044	-5.7044
S.E(Log q)	0.8404	0.3738	0.3508	0.3871	0.4886	0.2862	0.3916	0.5705	0.9951

Regression statistics :

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

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
2	0.92	0.19	7.29	0.21	22	0.79	-7.05
3	1.48	-1.555	3.93	0.34	22	0.54	-5.8
4	0.93	0.387	5.9	0.62	22	0.33	-5.67
5	1.18	-0.82	5.02	0.5	22	0.46	-5.56
6	1.21	-0.789	5.31	0.41	22	0.6	-5.77
7	0.98	0.162	5.74	0.75	22	0.29	-5.7
8	1.28	-1.577	5.61	0.62	22	0.43	-5.89
9	1.4	-1.257	5.68	0.33	22	0.74	-5.89
10	-2.88	-5.628	6.7	0.1	22	1.83	-5.72

Fleet : UK BT

Age	1986	1987
1	No data for this fleet at this age	
2	-0.34	0.4
3	0.51	-0.07
4	0.53	0.4
5	0.3	0.54
6	0.4	-0.27
7	0.64	-0.28
8	-0.72	0.38
9	0.09	-0.67
10	0.01	-1.34

Age	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
1	No data for this fleet at this age									
2	0.6	-0.03	-0.19	-0.06	-0.38	-0.34	-1.19	-0.16	0.27	0.15
3	0.35	-0.02	0.1	-0.27	-0.11	-0.51	-0.11	-0.64	-0.5	0.15
4	-0.04	0.24	-0.12	0.05	-0.42	-0.19	-0.31	-0.08	-0.79	-0.23
5	0.41	-0.47	0.01	-1.21	0.49	-0.34	-0.03	-0.13	-0.06	-0.52
6	0.25	0.09	-0.38	-0.28	-0.61	0.04	0	0.02	-0.25	0.18
7	-0.13	0.2	-0.31	-0.94	-0.21	-0.56	0.47	-0.16	-0.12	-0.13
8	0.3	-0.25	-0.01	-0.64	-0.4	-0.15	-0.18	0.37	-0.19	0.1
9	0.07	-0.32	-0.16	0.11	0.35	0.02	0.34	0.2	0.19	-0.1
10	0.66	0.31	0.56	0.04	-0.31	-0.53	0.46	0.37	0.19	0.19

Table 9.3.1 - Sole VIId - XSA diagnostics - continued

Age		1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
	1	: at this age									
	2	0.02	0.37	-0.11	0.05	0.4	0.1	0.06	0.25	0.31	-0.18
	3	-0.26	0.1	0.25	-0.14	0.24	0.03	0.29	0.07	0.67	-0.13
	4	-0.05	0.14	0.17	-0.09	0.17	-0.21	0.08	0.37	0.16	0.2
	5	0.15	0.18	0.29	0.23	0.18	-0.21	-0.15	0.12	0.32	-0.1
	6	-0.11	0.29	0.24	0.25	-0.04	-0.1	-0.12	0.23	-0.16	0.33
	7	0.16	0.22	0.45	0.19	0.13	0.06	-0.25	0.33	-0.19	0.44
	8	0.09	0.13	0.23	0.64	0.53	0.26	0.27	0.58	-0.15	0.24
	9	0.16	-0.05	0.46	0.16	-0.24	-0.21	-0.33	0.4	0.44	0.13
	10	0.41	-0.33	0.12	0.1	-0.13	0.29	-0.12	0.79	-0.08	-0.62

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	10
Mean Log q	-6.5357	-5.837	-5.8031	-5.9456	-5.9117	-5.9974	-5.9974	-5.9974	-5.9974
S.E(Log q)	0.378	0.3251	0.2965	0.3965	0.2607	0.3716	0.3744	0.2901	0.481

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	1.03	-0.129	6.44	0.51	22	0.4	-6.54
3	1.07	-0.327	5.58	0.54	22	0.35	-5.84
4	0.92	0.521	6.05	0.7	22	0.28	-5.8
5	0.74	1.881	6.59	0.73	22	0.28	-5.95
6	0.81	2.102	6.29	0.86	22	0.2	-5.91
7	0.78	1.837	6.32	0.77	22	0.27	-6
8	0.83	1.395	6.1	0.77	22	0.3	-5.93
9	0.81	2.078	6.04	0.86	22	0.21	-5.95
10	0.97	0.175	5.95	0.61	22	0.47	-5.95

Fleet : UK BTS

Age		1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
	1	0.27	-0.44	0.13	0.06	-1.77	-2.1	-0.29	-0.27	-0.27	1.03
	2	1.02	0.19	-0.76	0.1	-0.36	0.07	-1.02	-0.23	-0.26	-0.29
	3	0.67	0.64	-0.47	-0.35	0.14	0.08	0.14	-0.95	-0.31	-0.1
	4	-0.25	-0.01	0.07	0.08	-0.59	0.64	0.04	-0.3	-0.75	-0.22
	5	0.43	0.18	-0.14	-0.23	-0.09	0.02	0.4	-0.42	-0.31	-1.2
	6	0.14	-0.78	-0.22	0.12	0.39	0.35	-0.8	0.26	0	-0.56
	7	No data for this fleet at this age									
	8	No data for this fleet at this age									
	9	No data for this fleet at this age									
	10	No data for this fleet at this age									

Age		1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
	1	-0.78	1.49	0.3	0.37	0.99	0.28	0.41	0.86	-0.32	0.05
	2	0.37	0.1	0.54	0.34	0.03	0.27	-0.07	-0.62	0.34	0.24
	3	-0.45	0.79	0.27	0.45	-0.08	-0.02	-0.15	-0.25	-0.36	0.32
	4	-0.19	0.62	0.64	-0.09	0.5	0	-0.1	-0.11	0.34	-0.33
	5	0.16	1.01	0.32	0.49	-1.04	0.25	-0.05	0.43	-0.22	0.02
	6	-1.05	1.34	0.63	0.35	0.11	-0.26	0.42	0.2	-0.57	-0.07
	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	-8.2605	-7.3472	-7.7831	-8.1461	-8.1465	-8.2914
S.E(Log q)	0.8654	0.4721	0.4399	0.3882	0.5101	0.5628

Table 9.3.1 - Sole VIId - XSA diagnostics - continued

Regression statistics :

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

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
1	0.62	1.337	8.98	0.4	20	0.52	-8.26
2	0.8	0.901	7.89	0.52	20	0.38	-7.35
3	0.86	0.589	8.05	0.5	20	0.39	-7.78
4	0.82	1.112	8.32	0.67	20	0.32	-8.15
5	1.05	-0.19	8.13	0.43	20	0.55	-8.15
6	1.02	-0.068	8.3	0.44	20	0.59	-8.29

Fleet : YFS

Age	1986	1987
1	99.99	0.48
2	No data for this fleet at this age	
3	No data for this fleet at this age	
4	No data for this fleet at this age	
5	No data for this fleet at this age	
6	No data for this fleet at this age	
7	No data for this fleet at this age	
8	No data for this fleet at this age	
9	No data for this fleet at this age	
10	No data for this fleet at this age	

Age	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
1	-0.02	-0.55	-0.35	0.37	-0.45	-0.01	0.47	0.73	-0.73	-0.69
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	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
1	-0.18	-0.14	0.07	-0.14	0.07	0.09	0.55	0.34	0.08	99.99
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	-10.1343
S.E(Log q)	0.4144

Regression statistics :

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

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
1	1.08	-0.278	10.13	0.43	20	0.46	-10.13

Table 9.3.1 - Sole VIId - XSA diagnostics - continued

Terminal year survivor and F summaries :

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

Year class = 2006

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	7773	0.887	0	0	1	0.833	0.017
YFS	1	0	0	0	0	0	0
F shrinkage mean	5790	2				0.167	0.022

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
7400	0.81	0.12	2	0.148	0.017

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

Year class = 2005

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
BEL BT	29434	0.859	0	0	1	0.07	0.168
UK BT	19787	0.387	0	0	1	0.346	0.241
UK BTS	26664	0.425	0.237	0.56	2	0.286	0.184
YFS	25775	0.425	0	0	1	0.282	0.19
F shrinkage mean	16376	2				0.016	0.285

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
23799	0.23	0.09	6	0.388	0.204

Age 3 Catchability constant w.r.t. time and dependent on age

Year class = 2004

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
BEL BT	9755	0.35	0.25	0.71	2	0.217	0.501
UK BT	20144	0.253	0.213	0.84	2	0.395	0.274
UK BTS	28671	0.311	0.117	0.38	3	0.257	0.2
YFS	27371	0.425	0	0	1	0.121	0.208
F shrinkage mean	11953	2				0.009	0.425

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
19460	0.16	0.16	9	0.99	0.282

Table 9.3.1 - Sole VIId - XSA diagnostics - continued

Age 4 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	3333	0.255	0.212	0.83	3	0.264	0.585
UK BT	6645	0.199	0.15	0.75	3	0.416	0.335
UK BTS	3282	0.252	0.121	0.48	4	0.254	0.592
YFS	8072	0.425	0	0	1	0.058	0.284
F shrinkage mean	4945	2				0.008	0.429

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
4669	0.13	0.13	12	1.012	0.449

Age 5 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	1892	0.228	0.175	0.77	4	0.313	0.531
UK BT	2263	0.191	0.065	0.34	4	0.4	0.461
UK BTS	2357	0.244	0.109	0.45	5	0.243	0.447
YFS	2379	0.425	0	0	1	0.035	0.443
F shrinkage mean	2569	2				0.009	0.416

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
2167	0.12	0.06	15	0.507	0.478

Age 6 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	2630	0.212	0.087	0.41	5	0.277	0.532
UK BT	5936	0.169	0.03	0.18	5	0.475	0.271
UK BTS	4037	0.232	0.096	0.41	6	0.216	0.377
YFS	4615	0.425	0	0	1	0.025	0.337
F shrinkage mean	4098	2				0.007	0.372

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
4320	0.11	0.09	18	0.795	0.356

Table 9.3.1 - Sole VIId - XSA diagnostics - continued

Age 7 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	763	0.193	0.103	0.54	6	0.401	0.631
UK BT	993	0.168	0.11	0.66	6	0.441	0.516
UK BTS	802	0.237	0.163	0.69	6	0.136	0.608
YFS	759	0.425	0	0	1	0.013	0.633
F shrinkage mean	1653	2				0.009	0.34

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
869	0.11	0.07	20	0.592	0.572

Age 8 Catchability constant w.r.t. time and age (fixed at the value for age) 7

Year class = 1999

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
BEL BT	1107	0.176	0.085	0.48	7	0.409	0.334
UK BT	1287	0.159	0.082	0.52	7	0.464	0.294
UK BTS	1295	0.234	0.063	0.27	6	0.109	0.292
YFS	1299	0.425	0	0	1	0.012	0.291
F shrinkage mean	1144	2				0.007	0.325

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
1210	0.11	0.05	22	0.429	0.31

Age 9 Catchability constant w.r.t. time and age (fixed at the value for age) 7

Year class = 1998

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
BEL BT	440	0.181	0.03	0.17	8	0.354	0.425
UK BT	543	0.158	0.064	0.4	8	0.559	0.357
UK BTS	807	0.237	0.089	0.37	6	0.071	0.254
YFS	451	0.425	0	0	1	0.008	0.416
F shrinkage mean	662	2				0.008	0.302

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
519	0.11	0.04	24	0.402	0.371

Table 9.3.1 - Sole VIId - XSA diagnostics - continued

Age 10 Catchability constant w.r.t. time and age (fixed at the value for age) 7

Year class = 1997

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
BEL BT	116	0.186	0.122	0.66	9	0.33	0.761
UK BT	141	0.159	0.157	0.98	9	0.59	0.663
UK BTS	96	0.24	0.195	0.81	6	0.06	0.867
YFS	108	0.425	0	0	1	0.006	0.798
F shrinkage mean	254	2				0.014	0.419

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
130	0.12	0.09	26	0.74	0.702

Table 9.3.2 - Sole VIId - Fishing mortality (F) at age

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Table 8 Fishing mortality (F) at age

YEAR	1982	1983	1984	1985	1986	1987
AGE						
1	0.0129	0.0000	0.0012	0.004	0.002	0.0009
2	0.1865	0.0821	0.1136	0.2216	0.12	0.1518
3	0.3103	0.3538	0.4315	0.4314	0.4995	0.5448
4	0.4884	0.3576	0.438	0.3724	0.4549	0.5838
5	0.2293	0.4486	0.2609	0.2732	0.3201	0.5261
6	0.2270	0.4578	0.729	0.3894	0.3006	0.655
7	0.4672	0.3153	0.5091	0.2615	0.3549	0.7984
8	0.4106	0.5094	0.2321	0.2926	0.4394	0.4301
9	0.3462	0.2910	0.3565	0.1533	0.6009	0.574
10	0.3370	0.4057	0.4189	0.2746	0.286	1.5187
+gp	0.3370	0.4057	0.4189	0.2746	0.286	1.5187
0 FBAR 3- 8	0.3555	0.4071	0.4335	0.3368	0.3949	0.5897

Table 8 Fishing mortality (F) at age

YEAR	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
AGE										
1	0.0039	0.0103	0.0299	0.0116	0.0033	0.0053	0.0012	0.0464	0.0005	0.0009
2	0.2598	0.1707	0.2223	0.2147	0.1467	0.1906	0.0495	0.1398	0.1213	0.0963
3	0.5394	0.6700	0.3998	0.5045	0.3926	0.3258	0.3373	0.4358	0.5664	0.6424
4	0.4213	0.6626	0.4732	0.5191	0.4057	0.3992	0.4942	0.4163	0.5426	0.7834
5	0.3718	0.7304	0.4358	0.4322	0.4468	0.3499	0.4140	0.4389	0.4845	0.7901
6	0.3842	0.4473	0.2872	0.5139	0.3353	0.1934	0.3124	0.4001	0.4684	0.4445
7	0.4792	0.4237	0.3417	0.3767	0.3207	0.2846	0.2711	0.3014	0.4343	0.4031
8	0.3797	0.4338	0.3085	0.3357	0.3087	0.2401	0.2808	0.1848	0.3297	0.4511
9	0.2156	0.4039	0.4865	0.5048	0.3641	0.4207	0.2672	0.3414	0.2977	0.4792
10	1.0236	0.2649	0.5404	0.6809	0.3109	0.1936	0.6225	0.2799	0.8496	0.2269
+gp	1.0236	0.2649	0.5404	0.6809	0.3109	0.1936	0.6225	0.2799	0.8496	0.2269
0 FBAR 3- 8	0.4293	0.5613	0.3744	0.4470	0.3683	0.2988	0.3516	0.3629	0.4710	0.5858

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Table 8 Fishing mortality (F) at age

YEAR	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	FBAR 05-07
AGE											
1	0.0019	0.0067	0.0045	0.0068	0.0153	0.0198	0.0533	0.0050	0.0178	0.0175	0.0134
2	0.0591	0.2369	0.1737	0.2484	0.3808	0.3069	0.2857	0.2280	0.2198	0.2045	0.2174
3	0.5464	0.5379	0.5773	0.4496	0.4902	0.4646	0.3746	0.4256	0.3656	0.2820	0.3577
4	0.5865	0.6419	0.5222	0.3338	0.4805	0.3506	0.3961	0.3826	0.5276	0.4493	0.4531
5	0.5608	0.5576	0.3910	0.5612	0.4914	0.3955	0.4031	0.3940	0.3915	0.4777	0.4210
6	0.4928	0.5826	0.3824	0.4428	0.2469	0.4047	0.3992	0.3230	0.4804	0.3558	0.3864
7	0.2315	0.5184	0.3868	0.3504	0.2904	0.3255	0.3636	0.3707	0.3474	0.5720	0.4301
8	0.3068	0.4258	0.3820	0.2350	0.2311	0.2842	0.3915	0.3351	0.3795	0.3099	0.3415
9	0.3394	0.3795	0.3373	0.2163	0.2508	0.1695	0.1893	0.4073	0.4868	0.3712	0.4218
10	1.1376	0.2773	0.2459	0.1160	0.3170	0.3366	0.2965	0.3729	0.5248	0.7021	0.5332
+gp	1.1376	0.2773	0.2459	0.1160	0.3170	0.3366	0.2965	0.3729	0.5248	0.7021	
0 FBAR 3- 8	0.4541	0.5440	0.4403	0.3955	0.3717	0.3709	0.3880	0.3718	0.4153	0.4078	

Table 9.3.3 - Sole VIId - Stock numbers at age

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

	YEAR	1982	1983	1984	1985	1986	1987
	AGE						
	1	12718	21392	21612	12907	25769	10989
	2	16219	11361	19357	19533	11632	23270
	3	20714	12178	9469	15634	14161	9335
	4	4698	13743	7736	5565	9189	7776
	5	2924	2609	8697	4517	3470	5276
	6	3380	2103	1507	6062	3110	2280
	7	1546	2437	1204	658	3716	2084
	8	749	877	1609	655	458	2358
	9	438	450	477	1154	442	267
	10	305	281	304	302	896	219
	+gp	740	606	728	559	1568	610
0	TOTAL	64432	68037	72700	67545	74411	64463

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

	YEAR	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
	AGE										
	1	25891	16788	44392	34854	33773	16798	26544	19440	18849	27879
	2	9934	23337	15035	38983	31172	30459	15119	23989	16793	17046
	3	18091	6932	17802	10892	28457	24357	22778	13020	18874	13459
	4	4899	9545	3210	10800	5951	17389	15912	14710	7619	9693
	5	3924	2909	4452	1809	5815	3589	10555	8783	8777	4007
	6	2821	2448	1268	2606	1063	3366	2288	6313	5124	4892
	7	1071	1738	1416	861	1410	688	2510	1515	3829	2902
	8	848	600	1030	911	534	926	468	1732	1014	2244
	9	1388	525	352	684	589	355	659	320	1303	660
	10	136	1012	317	196	374	370	211	456	206	875
	+gp	447	1271	1225	808	906	769	582	1035	627	1380
0	TOTAL	69451	67105	90499	103404	110044	99066	97626	91313	83015	85038

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

	YEAR	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	GMST 82-05	AMST 82-05
	AGE													
	1	18037	26307	32061	25896	48911	20285	20848	43605	36301	8323	0*	23482	25273
	2	25203	16289	23644	28879	23272	43584	17994	17884	39259	32268	7400	20269	21666
	3	14008	21495	11631	17983	20383	14388	29014	12235	12883	28512	23799	15568	16554
	4	6406	7339	11359	5908	10380	11297	8181	18050	7233	8087	19460	8658	9473
	5	4007	3225	3495	6097	3829	5809	7199	4982	11141	3862	4669	4587	5031
	6	1645	2069	1671	2139	3147	2120	3539	4353	3040	6815	2167	2669	2971
	7	2838	910	1046	1031	1243	2225	1280	2148	2851	1701	4320	1563	1763
	8	1755	2037	490	643	657	841	1454	805	1342	1823	869	942	1071
	9	1293	1168	1204	303	460	472	573	889	521	831	1210	602	684
	10	370	833	723	778	221	324	361	429	535	290	519	375	437
	+gp	461	1554	1193	2541	760	898	952	912	787	468	340		
0	TOTAL	76024	83228	88517	92197	113263	102242	91393	106292	115894	92980	64753		

* Replaced with GM in prediction

Table 9.3.4 - Sole VIId - Summary

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Table 16 Summary (without SOP correction)

	RECRUITS Age 1	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	FBAR 3- 8
1982	12718	10418	7819	3190	0.4080	0.3555
1983	21392	12608	9577	3458	0.3611	0.4071
1984	21612	12964	8980	3575	0.3981	0.4335
1985	12907	13347	9988	3837	0.3842	0.3368
1986	25769	14002	10616	3932	0.3704	0.3949
1987	10989	13062	9036	4791	0.5302	0.5897
1988	25891	12863	10128	3853	0.3804	0.4293
1989	16788	11959	8483	3805	0.4486	0.5613
1990	44392	13935	9641	3647	0.3783	0.3744
1991	34854	15950	8828	4351	0.4929	0.4470
1992	33773	17489	11312	4072	0.3600	0.3683
1993	16798	18092	13292	4299	0.3234	0.2988
1994	26544	15705	12624	4383	0.3472	0.3516
1995	19440	15202	11208	4420	0.3944	0.3629
1996	18849	15781	12236	4797	0.3920	0.4710
1997	27879	14429	10665	4764	0.4467	0.5858
1998	18037	12592	8162	3363	0.4121	0.4541
1999	26307	12551	9151	4135	0.4519	0.5440
2000	32061	13047	8560	3476	0.4061	0.4403
2001	25896	12697	7735	4025	0.5204	0.3955
2002	48911	14300	8689	4733	0.5447	0.3717
2003	20285	18053	10458	5038	0.4817	0.3709
2004	20848	15354	11846	4826	0.4074	0.3880
2005	43605	16803	11815	4383	0.3710	0.3718
2006	36301	18715	10580	4833	0.4568	0.4153
2007	8323	18323	12647	4686	0.3705	0.4078
2008	23482[1]	16477[2]	14117[2]			0.3983[3]
Arith. Mean	25045	14625	10157	4180	0.4169	0.4203
0 Units	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)		

[1] Geometric mean 1982-2005

[2] From forecast

[3] $F_{(05\text{-}07)}$ NOT rescaled to F_{2007}

Table 9.5.1 - Sole VIId – RCT3 input

Yearclass	XSA (Age 2)	yfs0	yfs1	bts1	bts2
1981	11361	1.881	0.2005	-11	-11
1982	19357	2.6555	0.695	-11	-11
1983	19533	11.887	-11	-11	-11
1984	11632	-11	-11	-11	-11
1985	23270	-11	-11	-11	-11
1986	9934	-11	0.6595	-11	14.2
1987	23337	7.995	0.935	8.2	15.4
1988	15035	1.1875	0.356	2.6	3.7
1989	38983	12.588	1.152	12.1	22.8
1990	31172	3.3285	1.8695	8.9	12
1991	30459	1.3865	0.796	1.4	17.5
1992	15119	1.281	0.615	0.5	3.2
1993	23989	6.534	1.591	4.8	10.6
1994	16793	8.1035	1.4635	3.5	7.4
1995	17046	5.3135	0.339	3.5	7.3
1996	25203	0.9865	0.5205	19	21.23
1997	16289	1.942	0.559	2	9.44
1998	23644	9.3725	0.854	28.14	22.03
1999	28879	2.7455	1.282	10.49	21.01
2000	23272	1.8475	0.8365	9.09	-11
2001	43584	4.5135	1.93	31.76	28.48
2002	17994	2.52	0.82	6.47	8.49
2003	17884	2.16	1.3	7.35	5.04
2004	-11	7.15	2.28	25.00	29.2
2005	-11	4.51	1.45	6.3	21.9
2006	-11	1.96	-11	2.1	-11
2007	-11	-11	-11	-11	-11

Table 9.5.2 – 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 27 years : 1981 – 2007
 Regression type = C
 Tapered time weighting not applied
 Survey weighting not applied
 Final estimates shrunk towards mean
 Minimum S.E. for any survey taken as .00
 Minimum of 3 points used for regression
 Forecast/Hindcast variance correction used.
 Yearclass = 2005
 I-----------Regression----------I I-----------Prediction---------I
 Survey/ Slope Inter- Std Rsquare No. Index Predicted Std WAP
 Series cept Error Pts Value Value Error Weights
 yfs0    1.81 7.24 1.10 .091 20 1.71 10.33 1.191 .034
 yfs1    2.33 8.48 .46 .424 20 .90 10.57 .508 .185
 bts1    .61 8.81 .41 .401 17 1.99 10.02 .452 .234
 bts2    .95 7.58 .42 .470 17 3.13 10.56 .476 .211
 VPA Mean = 9.93 .377 .337
 Yearclass = 2006
 I-----------Regression----------I I-----------Prediction-------------------I
 Survey/ Slope Inter- Std Rsquare No. Index Predicted Std WAP
 Series cept Error Pts Value Value Error Weights
 yfs0    1.81 7.24 1.10 .091 20 1.09 9.21( 9997) 1.203 .056
 yfs1
 bts1    .61 8.81 .41 .401 17 1.13 9.50(13360) .466 .373
 bts2
 VPA Mean = 9.93(20537) .377 .571

 Year Weighted Log Int Ext Var VPA Log
 Class Average WAP Std Std Ratio VPA
 Prediction Error Error
 2005 27275 10.21 .22 .15 .45
 2006 16758 9.73 .28 .17 .35
 2007 No valid surveys
```

Table 9.6.1 - Sole in VIId
Input for catch forecast and linear sensitivity analysis

Label	Value	CV	Label	Value	CV
Number at age			Weight in the stock		
N1	23481	0.39	WS1	0.050	0.00
N2	7400	0.81	WS2	0.160	0.02
N3	23799	0.23	WS3	0.194	0.05
N4	19460	0.16	WS4	0.242	0.01
N5	4668	0.13	WS5	0.275	0.04
N6	2166	0.12	WS6	0.310	0.05
N7	4319	0.11	WS7	0.342	0.02
N8	868	0.11	WS8	0.398	0.01
N9	1209	0.11	WS9	0.484	0.22
N10	519	0.11	WS10	0.442	0.04
N11	339	0.12	WS11	0.543	0.05
H.cons selectivity			Weight in the HC catch		
sH1	0.0130	0.51	WH1	0.145	0.1
sH2	0.2170	0.11	WH2	0.174	0.07
sH3	0.3580	0.25	WH3	0.200	0.04
sH4	0.4530	0.11	WH4	0.243	0.06
sH5	0.4210	0.11	WH5	0.287	0.05
sH6	0.3860	0.17	WH6	0.319	0.07
sH7	0.4300	0.27	WH7	0.345	0.08
sH8	0.3410	0.10	WH8	0.404	0.07
sH9	0.4220	0.13	WH9	0.488	0.15
sH10	0.5330	0.27	WH10	0.446	0.01
sH11	0.5330	0.27	WH11	0.539	0.03
Natural mortality			Proportion mature		
M1	0.1	0.1	MT1	0	0
M2	0.1	0.1	MT2	0	0.1
M3	0.1	0.1	MT3	1	0.1
M4	0.1	0.1	MT4	1	0
M5	0.1	0.1	MT5	1	0
M6	0.1	0.1	MT6	1	0
M7	0.1	0.1	MT7	1	0
M8	0.1	0.1	MT8	1	0
M9	0.1	0.1	MT9	1	0
M10	0.1	0.1	MT10	1	0
M11	0.1	0.1	MT11	1	0
Relative effort in HC fihery			Year effect for natural mortality		
HF08	1	0.06	K08	1	0.1
HF09	1	0.06	K09	1	0.1
HF10	1	0.06	K10	1	0.1
Recruitment in 2007 and 2008					
R09	23482	0.39			
R10	23482	0.39			

Table 9.6.2 Sole in VIId - Management option table

MFDP version 1a
Run: Sole7D_Fin
Sole in VIId
Time and date: 18:12 07/05/2008
Fbar age range: 3-8

2008 Biomass	SSB	FMult	FBar	Landings
16477	14117	1.0000	0.3983	4898

2009 Biomass	SSB	FMult	FBar	Landings	2010 Biomass	SSB
15473	10937	0.0000	0.0000	0	19593	15012
.	10937	0.1000	0.0398	517	19043	14466
.	10937	0.2000	0.0797	1015	18513	13942
.	10937	0.3000	0.1195	1494	18004	13437
.	10937	0.4000	0.1593	1955	17515	12952
.	10937	0.5000	0.1992	2398	17044	12486
.	10937	0.6000	0.2390	2825	16591	12038
.	10937	0.7000	0.2788	3236	16156	11607
.	10937	0.8000	0.3187	3632	15736	11192
.	10937	0.9000	0.3585	4013	15333	10793
.	10937	1.0000	0.3983	4380	14945	10410
.	10937	1.1000	0.4381	4733	14572	10041
.	10937	1.2000	0.4780	5073	14212	9686
.	10937	1.3000	0.5178	5401	13866	9345
.	10937	1.4000	0.5576	5717	13533	9016
.	10937	1.5000	0.5975	6021	13213	8700
.	10937	1.6000	0.6373	6314	12904	8396
.	10937	1.7000	0.6771	6597	12607	8103
.	10937	1.8000	0.7170	6869	12321	7821
.	10937	1.9000	0.7568	7131	12045	7550
.	10937	2.0000	0.7966	7384	11780	7289

Input units are thousands and kg - output in tonnes

Fmult corresponding to Fpa = 1.00

.	10937	1	0.3983	4380	14945	10410

Bpa = 8 000 t

Table 9.6.3 Sole in VIId. Detailed results

MFDP version 1a
Run: Sole7D_Fin
Time and date: 18:12 07/05/2008
Fbar age range: 3-8

Year: 2008 F multiplier: 1 Fbar: 0.3983

Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
1	0.0134	298	43	23482	1174	0	0	0	0
2	0.2174	1379	239	7400	1186	0	0	0	0
3	0.3577	6831	1366	23799	4625	23799	4625	23799	4625
4	0.4532	6773	1644	19460	4709	19460	4709	19460	4709
5	0.4211	1532	440	4669	1286	4669	1286	4669	1286
6	0.3864	663	212	2167	672	2167	672	2167	672
7	0.4300	1442	498	4320	1479	4320	1479	4320	1479
8	0.3415	240	97	869	346	869	346	869	346
9	0.4218	398	194	1210	585	1210	585	1210	585
10	0.5333	205	91	519	230	519	230	519	230
11	0.5333	134	72	340	185	340	185	340	185
Total		19896	4898	88235	16477	57353	14117	57353	14117

Year: 2009 F multiplier: 1 Fbar: 0.3983

Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
1	0.0134	298	43	23482	1174	0	0	0	0
2	0.2174	3906	678	20964	3361	0	0	0	0
3	0.3577	1546	309	5387	1047	5387	1047	5387	1047
4	0.4532	5241	1272	15058	3644	15058	3644	15058	3644
5	0.4211	3673	1055	11192	3082	11192	3082	11192	3082
6	0.3864	848	271	2773	861	2773	861	2773	861
7	0.4300	445	154	1332	456	1332	456	1332	456
8	0.3415	702	284	2543	1013	2543	1013	2543	1013
9	0.4218	184	90	559	270	559	270	559	270
10	0.5333	284	126	718	318	718	318	718	318
11	0.5333	180	97	456	247	456	247	456	247
Total		17307	4380	84464	15473	40018	10937	40018	10937

Year: 2010 F multiplier: 1 Fbar: 0.3983

Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
1	0.0134	298	43	23482	1174	0	0	0	0
2	0.2174	3906	678	20964	3361	0	0	0	0
3	0.3577	4381	876	15262	2966	15262	2966	15262	2966
4	0.4532	1186	288	3409	825	3409	825	3409	825
5	0.4211	2842	817	8660	2384	8660	2384	8660	2384
6	0.3864	2034	649	6647	2063	6647	2063	6647	2063
7	0.4300	569	197	1705	584	1705	584	1705	584
8	0.3415	217	88	784	312	784	312	784	312
9	0.4218	537	262	1635	791	1635	791	1635	791
10	0.5333	131	58	332	147	332	147	332	147
11	0.5333	246	133	623	338	623	338	623	338
Total		16347	4089	83503	14945	39057	10410	39057	10410

Input units are thousands and kg - output in tonnes

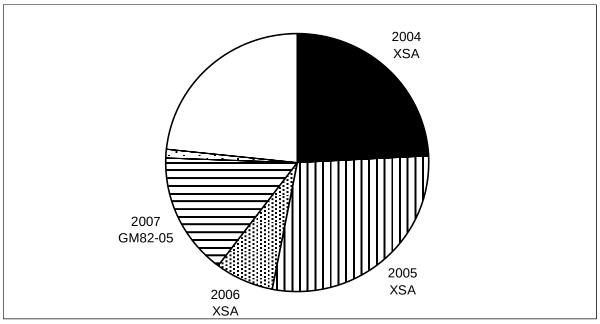
Table 9.6.4 **Sole VIId**
Stock numbers of recruits and their source for recent year classes used in predictions, and the relative (%) contributions to landings and SSB (by weight) of these year classes

Year-class	2004	2005	2006	2007	2008
Stock No. (thousands) of 1 year-olds	43605	36301	8323	23482	23482
Source	XSA	XSA	XSA	GM82-05	GM82-05
Status Quo F:					
% in 2008 landings	33.6	27.9	4.9	0.9	-
% in 2009 landings	24.1	29.0	7.1	15.5	1.0
% in 2008 SSB	33.4	32.8	0.0	0.0	-
% in 2009 SSB	28.2	33.3	9.6	0.0	0.0
% in 2010 SSB	19.8	22.9	7.9	28.5	0.0

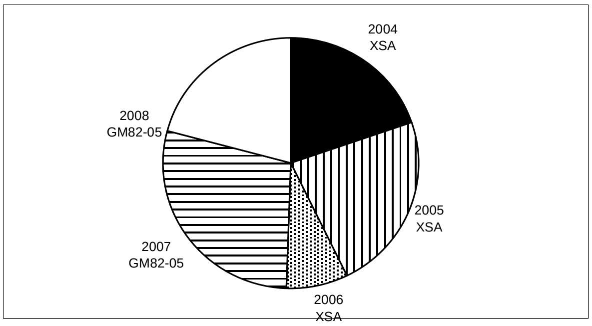
GM : geometric mean recruitment

Sole VIId : Year-class % contribution to

a) 2009 landings



b) 2010 SSB



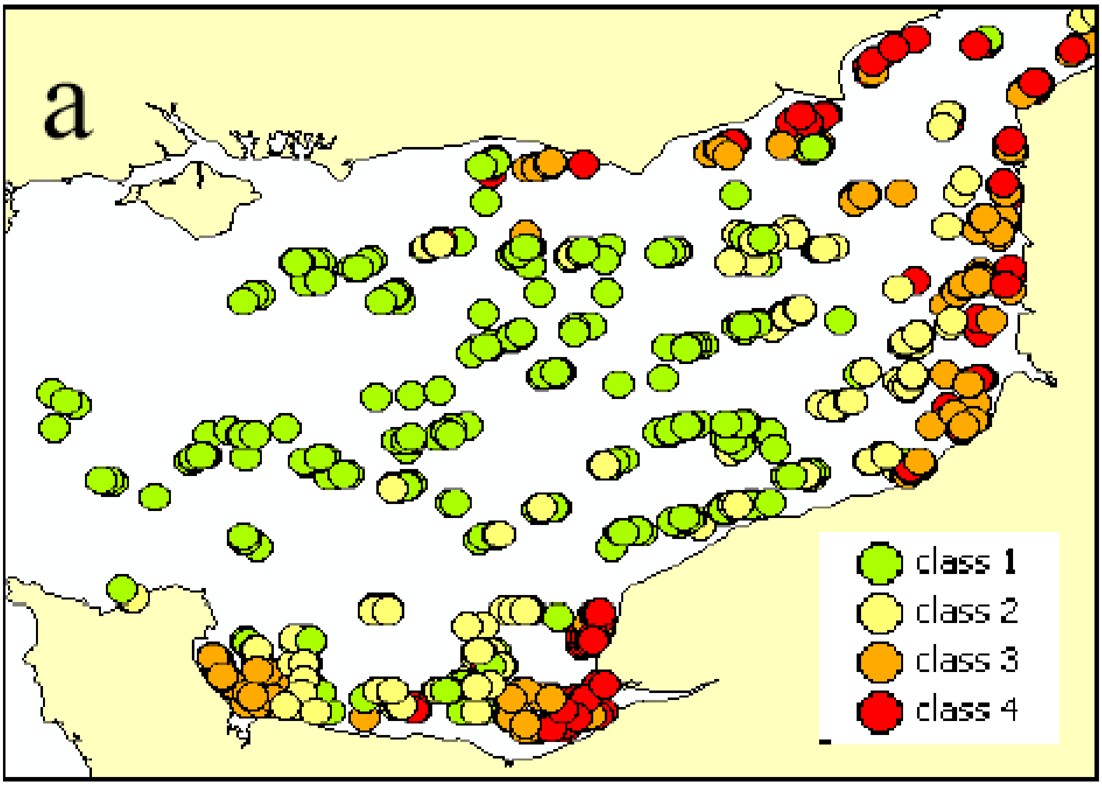


Figure 9.1.1–Spatial distribution of Fish Subcommunities in the Eastern Channel from 1988 to 2003. Observed assemblage type at each station, These illustrate the gradation from open sea community to coastal and estuarine communities. (In Vaz et al., 2004)

Figure 9.2.1a - Sole VIId - UK Length distributions of discarded and retained fish from discard sampling studies for static gear (2005 - 2006 - 2007)

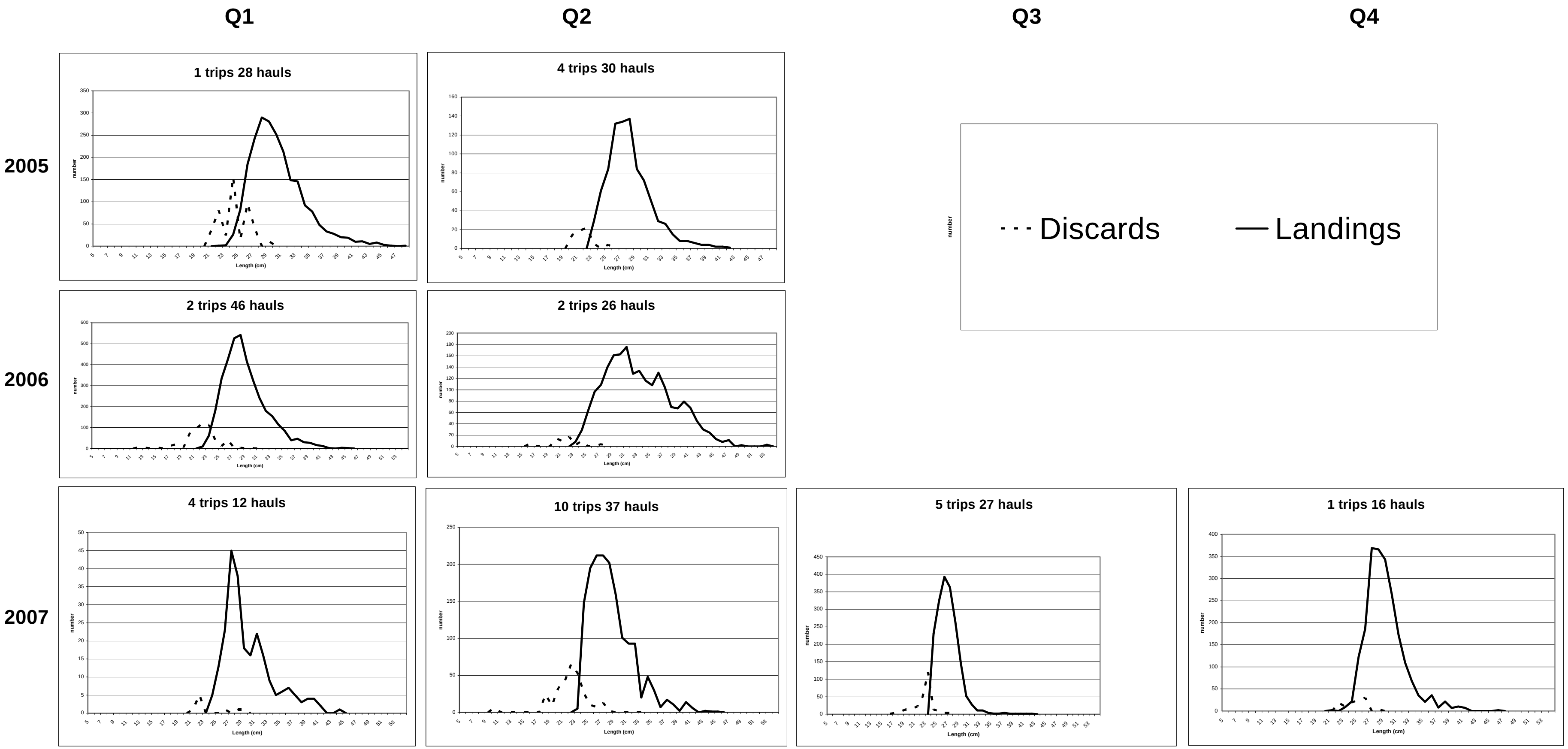


Figure 9.2.1b - Sole VIId - French Length distributions of discarded and retained fish from discard sampling studies for Otter trawl (2005 - 2006 - 2007)

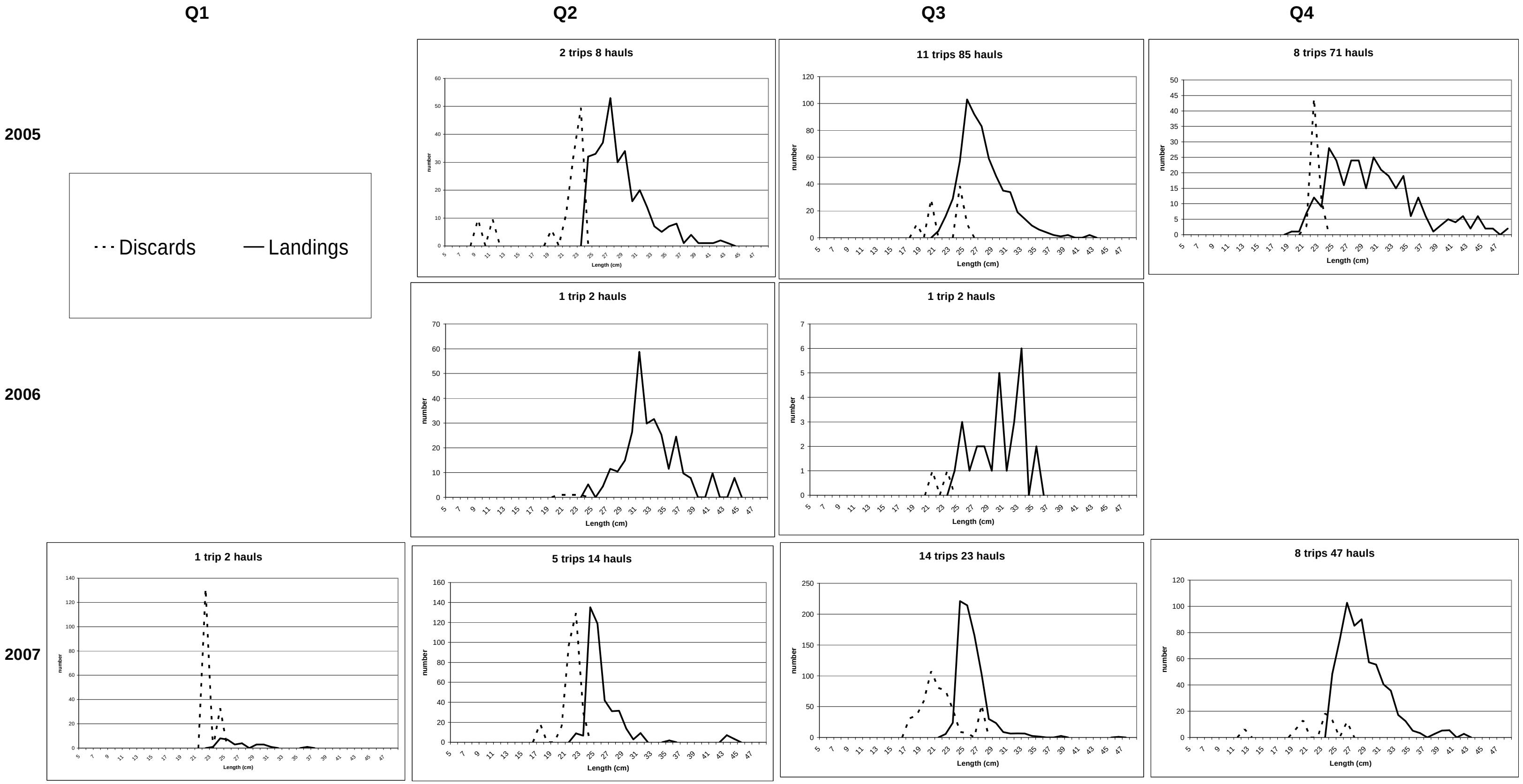
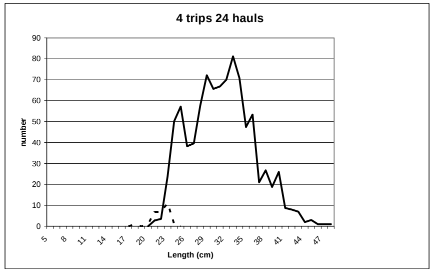
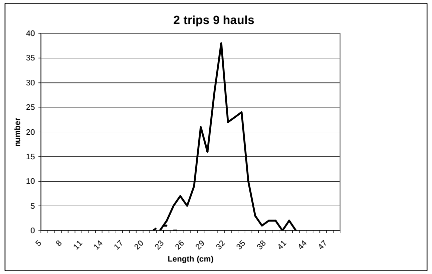


Figure 9.2.1c - Sole VIId - French Length distributions of discarded and retained fish from discard sampling studies fo Gillnets (2005 and 2007)

Q1 Q2 Q3 Q4

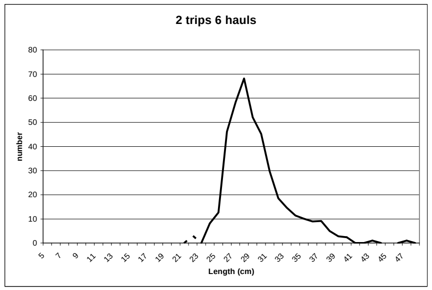
2005





2006

2007



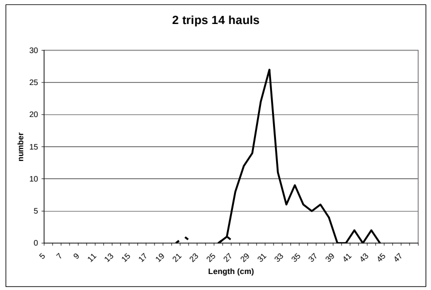


Figure 9.2.2a

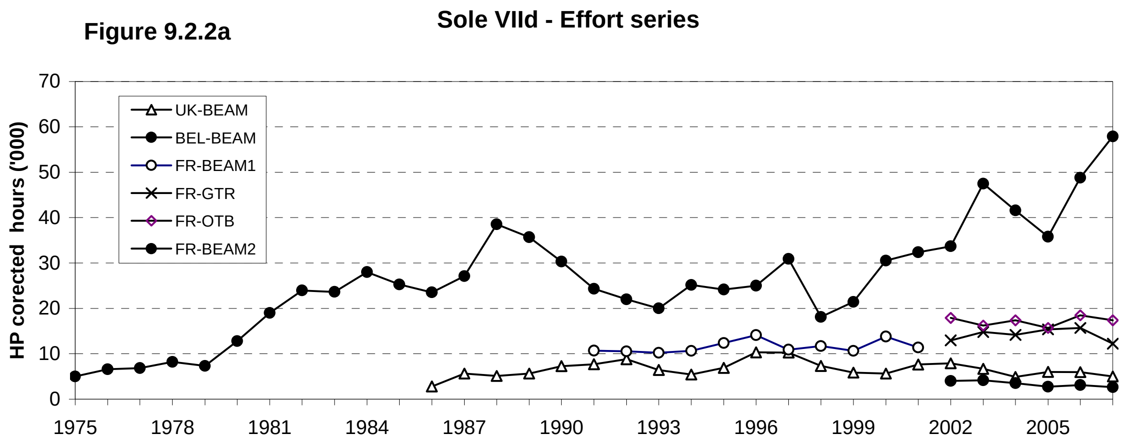


Figure 9.2.2b

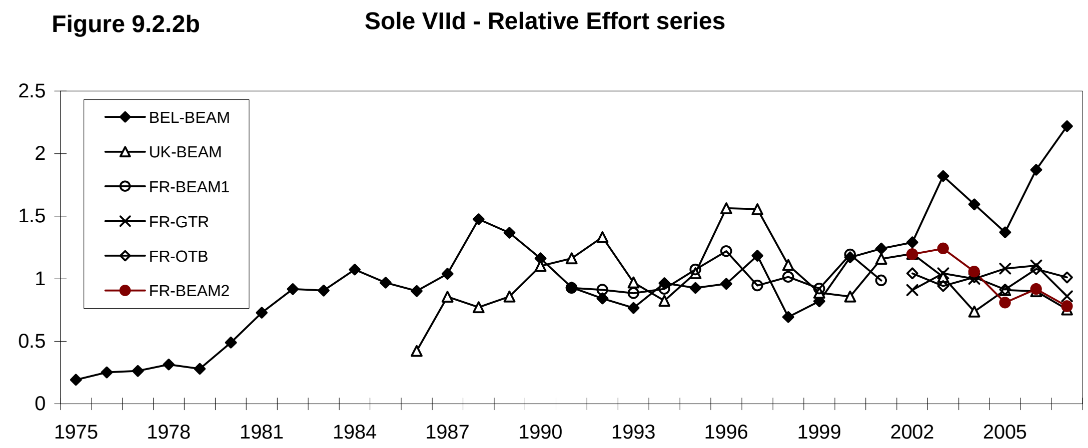
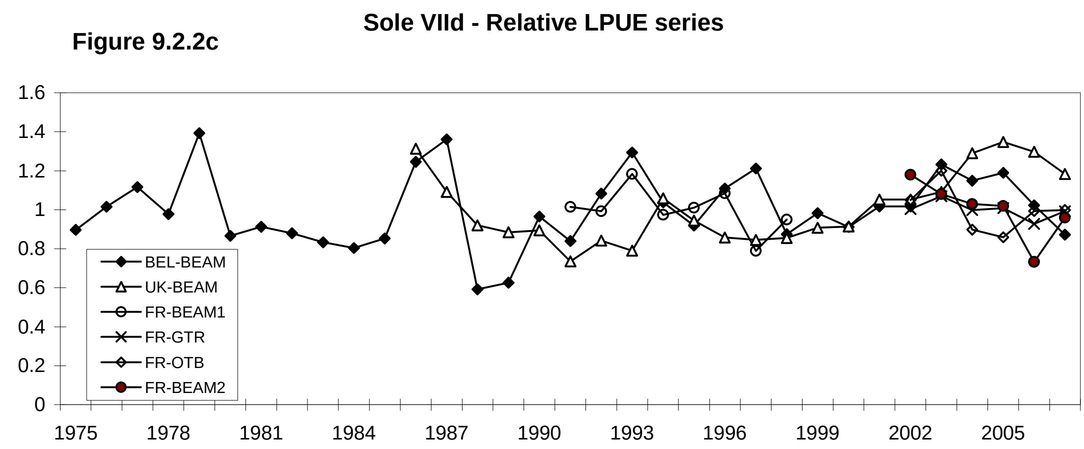


Figure 9.2.2c



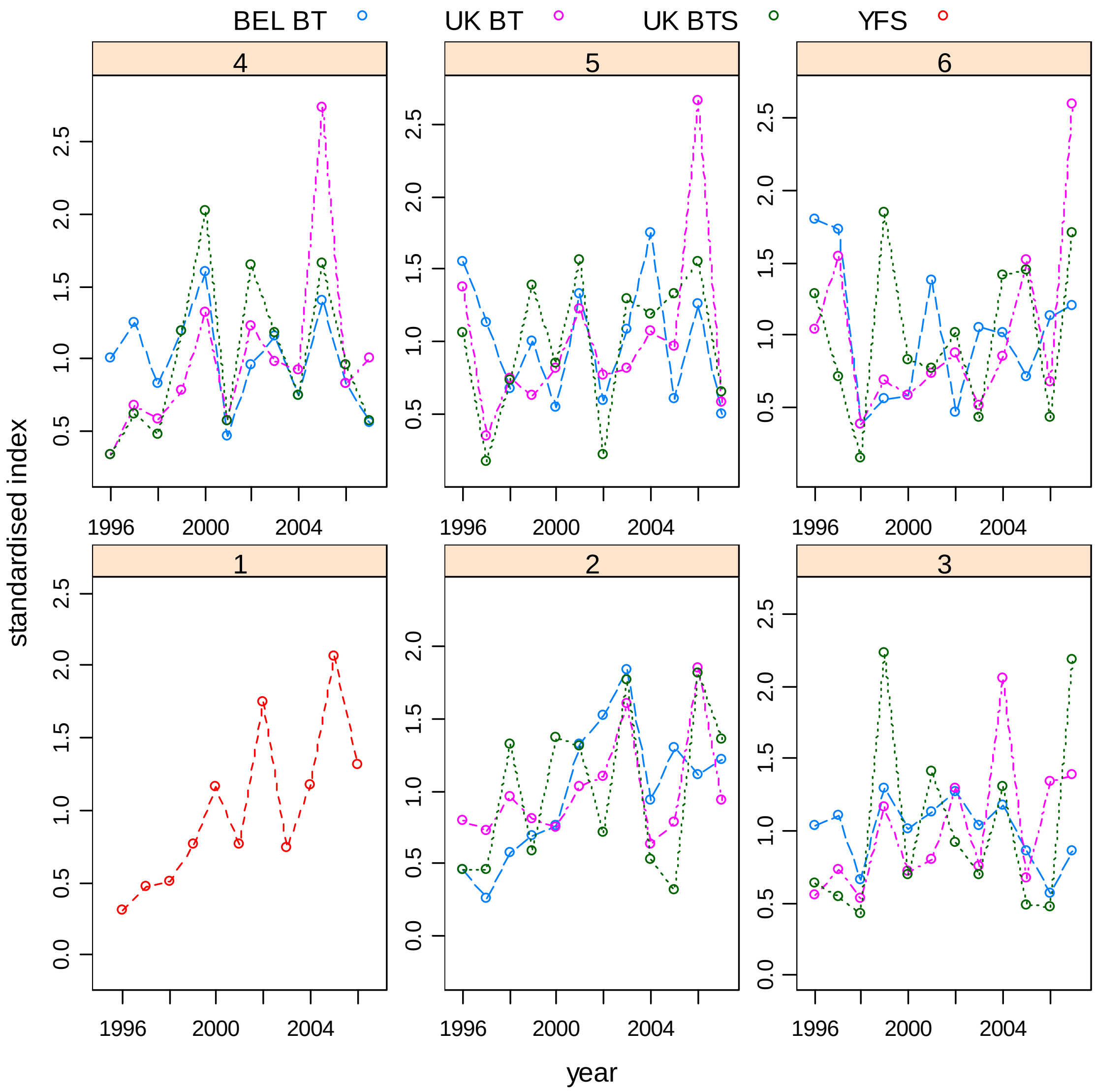


Figure 9.2.3 Sole in VIId. Standardized tuning indices used for tuning XSA: BEL-BT (blue), UK-BT (pink), UK-BTS (green) and YFS (red).

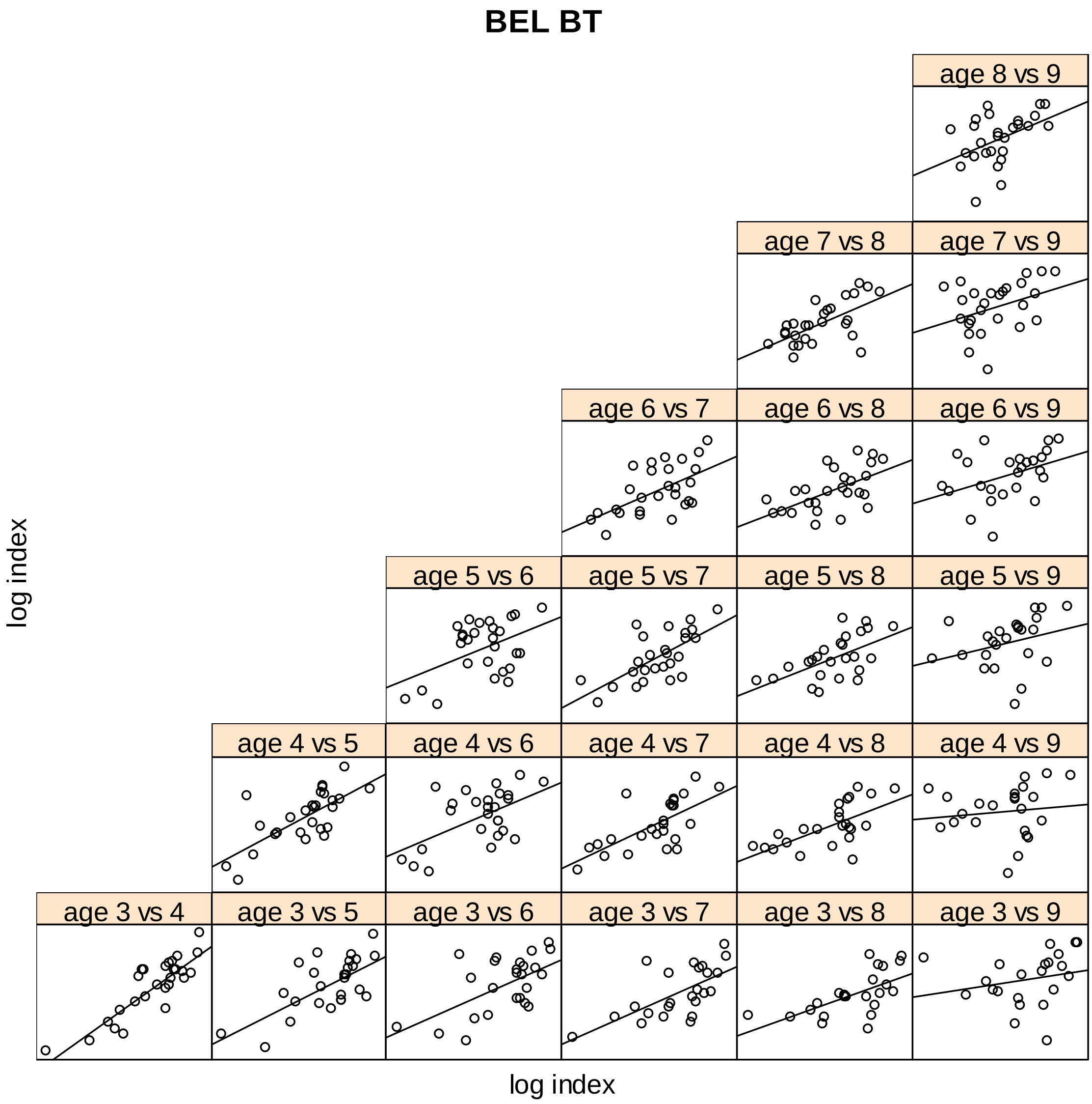


Figure 9.2.4 Sole in VIId. Internal concistency plot for the Belgian commercial fleet (BEL-BT).

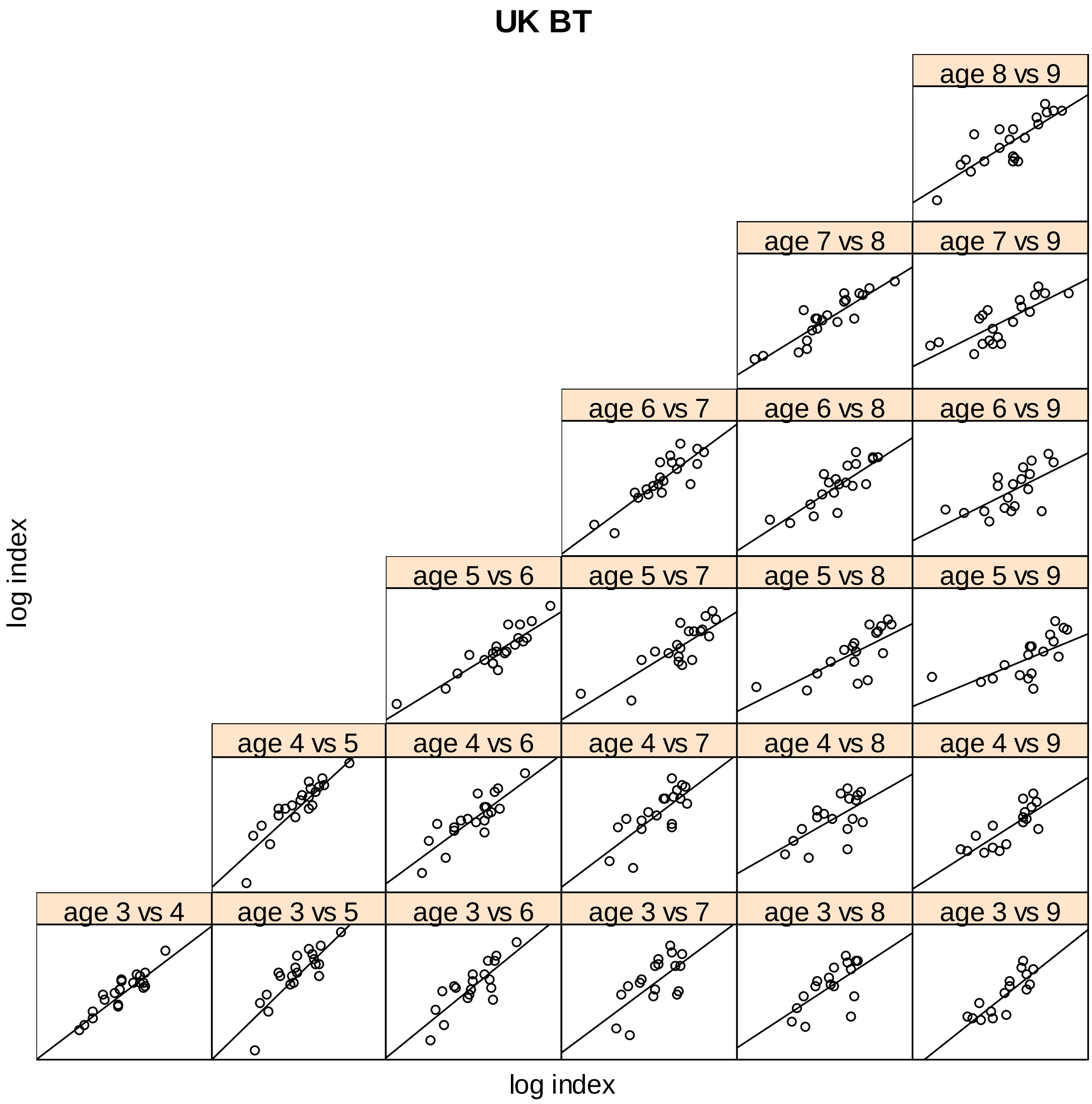


Figure 9.2.5 Sole in VIId. Internal concistency plot for the UK commercial fleet (UK-BT).

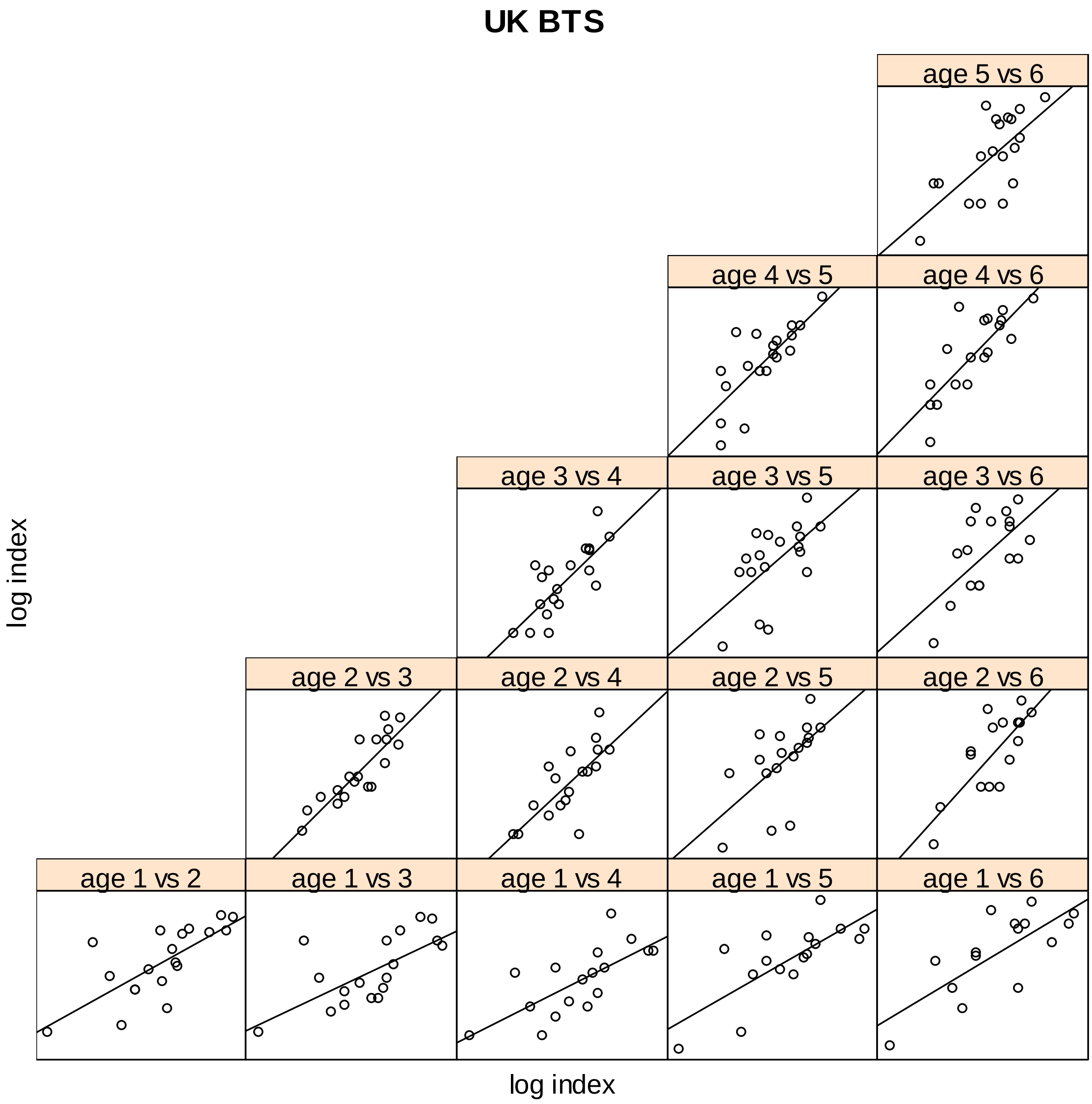
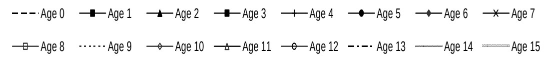


Figure 9.2.6 Sole in VIId. Internal concistency plot for the UK beam trawl survey (UK-BTS).

Figure 9.3.1 - VIId SOLE LOG CATCHABILITY RESIDUAL PLOTS - Final XSA



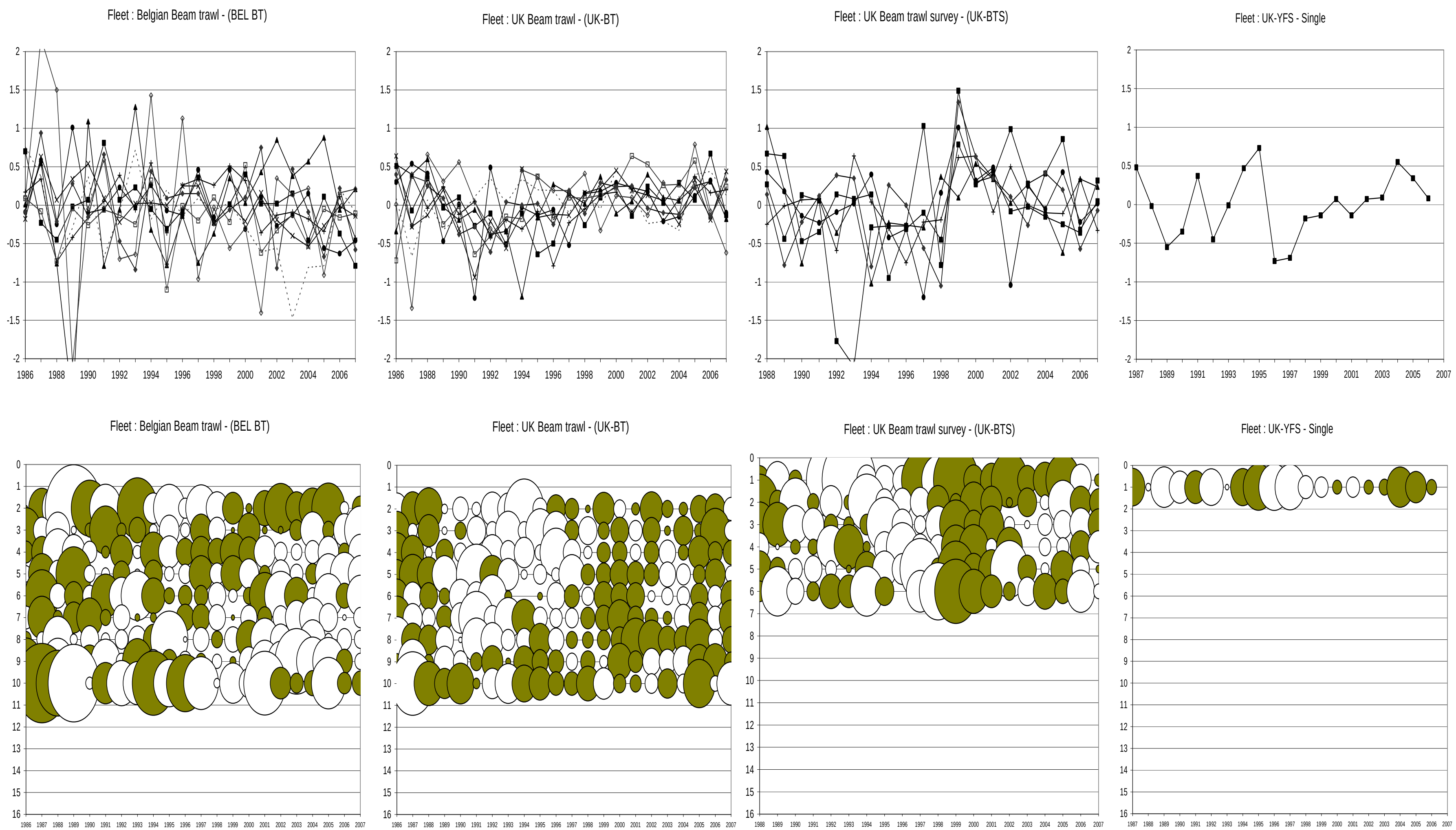
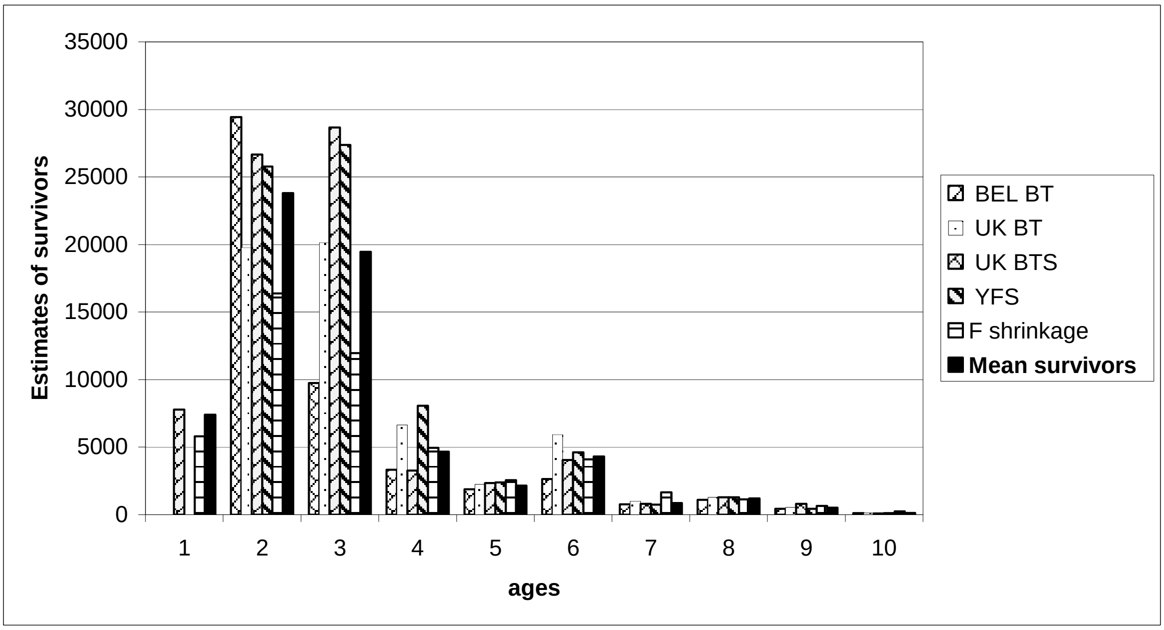


Figure 9.3.2 Sole in VIId. Estimates of survivors from different fleets and shrinkage, as well as their different weighting in the final XSA-run



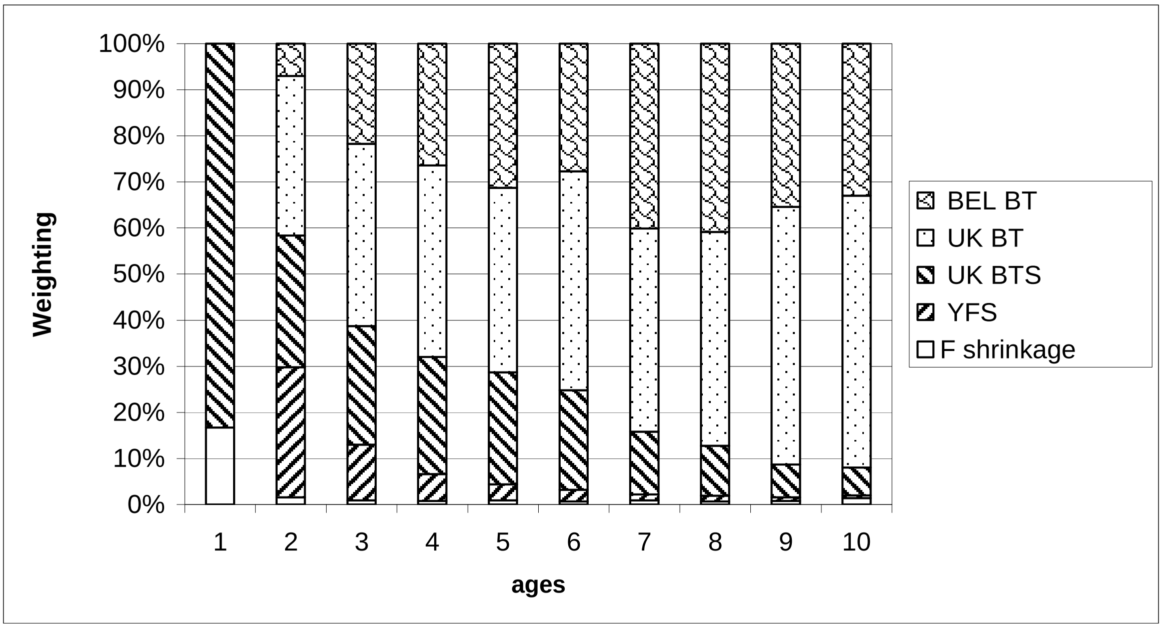


Figure 9.3.3 Sole in VIId. Summary plots

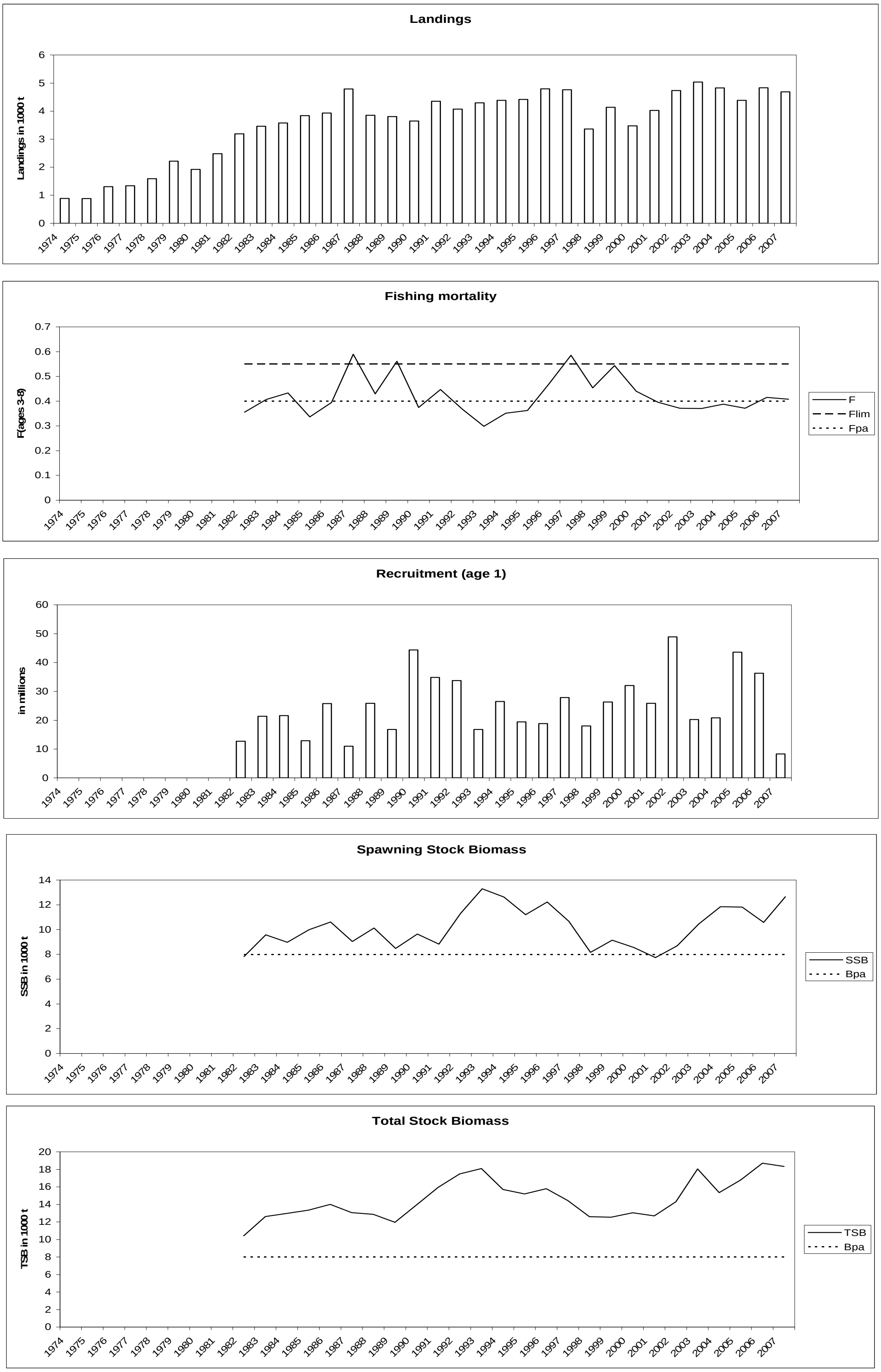


Figure 9.3.4 - Sole VIId retrospective XSA analysys (shinkage SE=2.0)

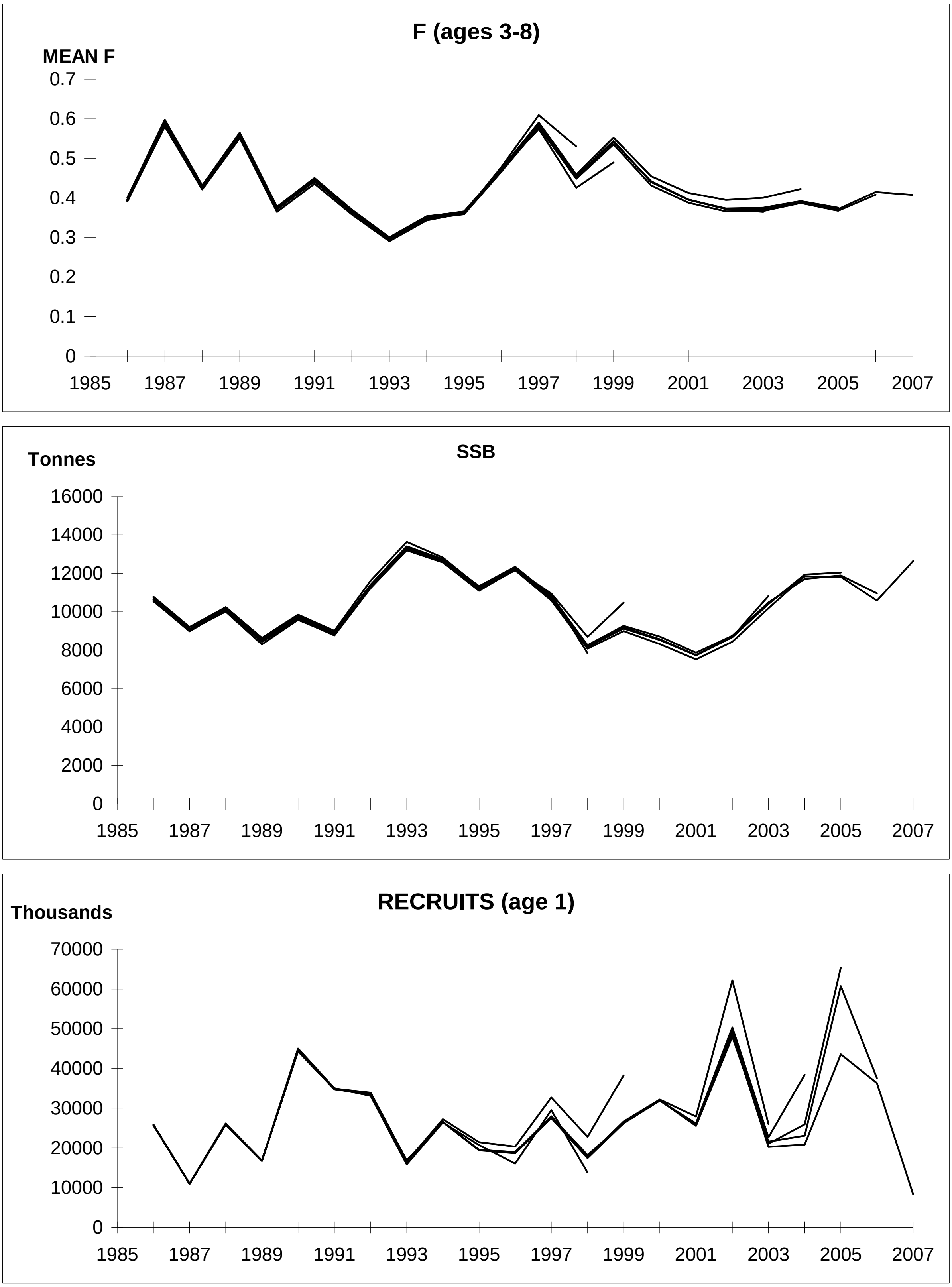
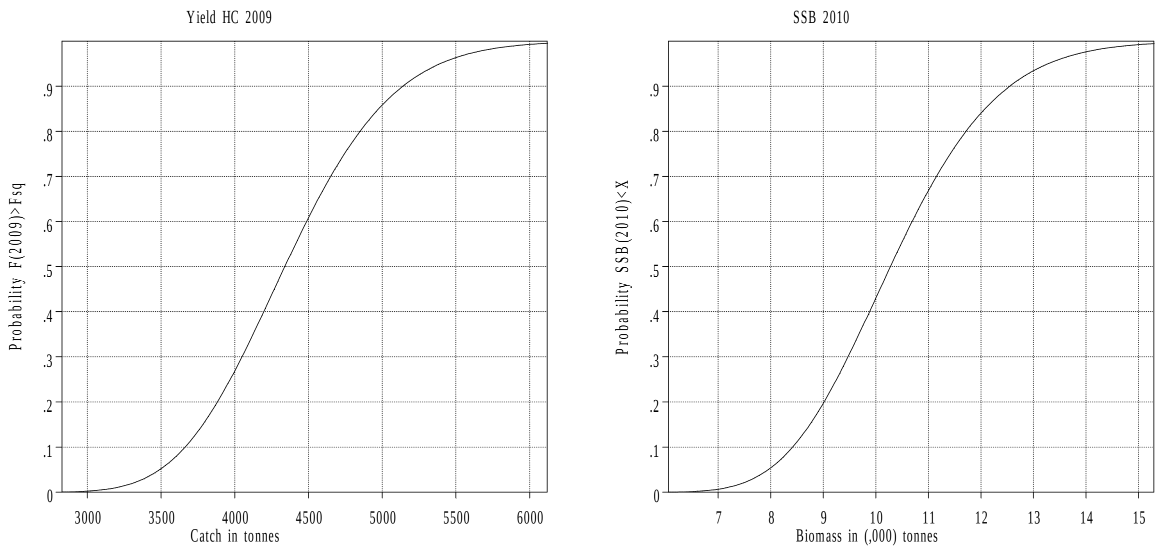
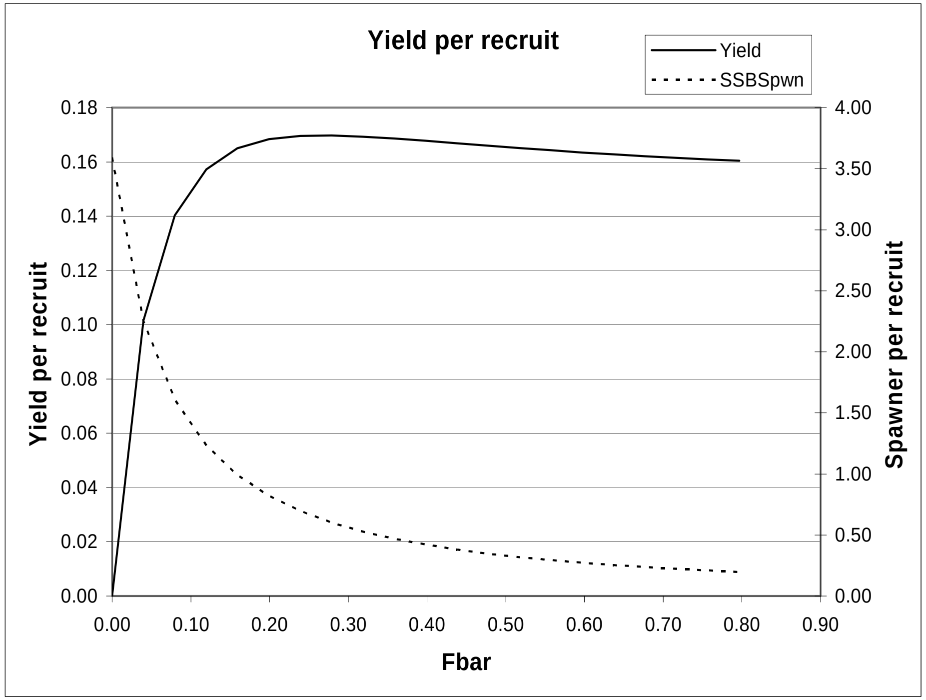


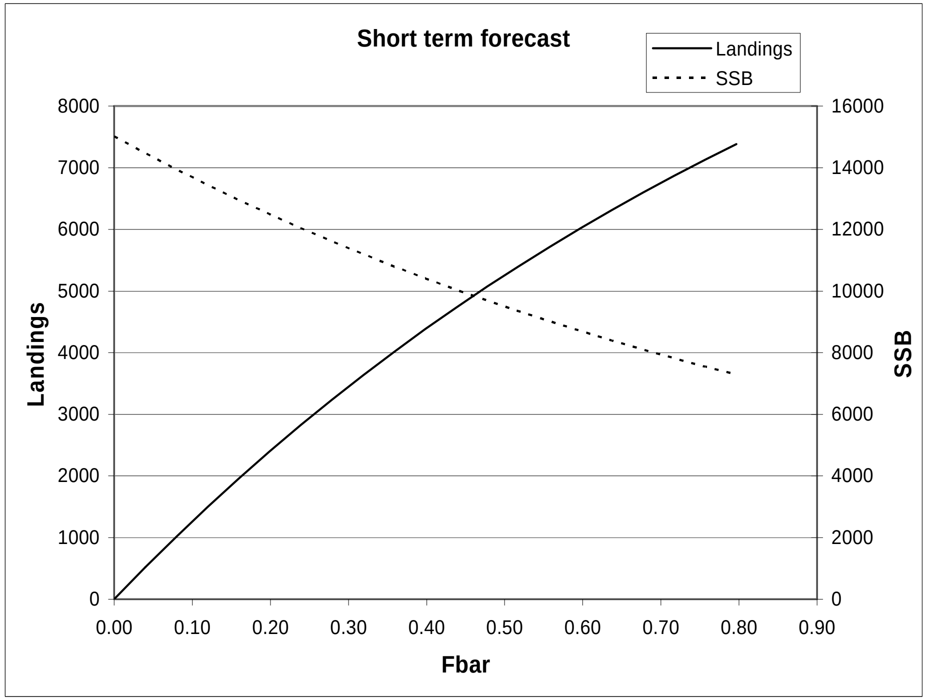
Figure 9.6.1 - Sole VIId - Probability profiles for short term forecast.



Data from file:D:\2008\WGNSSK_2008\SolVIId\Pre\Prediction\Sensitivity_Insens\Pie

Figure 9.7.1 - Sole in VIId Yield per recruit and short term forecast plots





MFYPR version 2a
Run: Sole7d_Fin_yield
Time and date: 18:36 07/05/2008

Reference point	F multiplier	Absolute F
Fbar(3-8)	1.0000	0.3983
FMax	0.6663	0.2654
F0.1	0.2464	0.0981
F35%SPR	0.2917	0.1162

Weights in kilograms

MFDP version 1a
Run: Sole7D_Fin
Sole in VIId
Time and date: 18:12 07/05/2008
Fbar age range: 3-8

Input units are thousands and kg - output in tonnes

Figure 9.9.1–Sole VIId Stock/recruitment plot

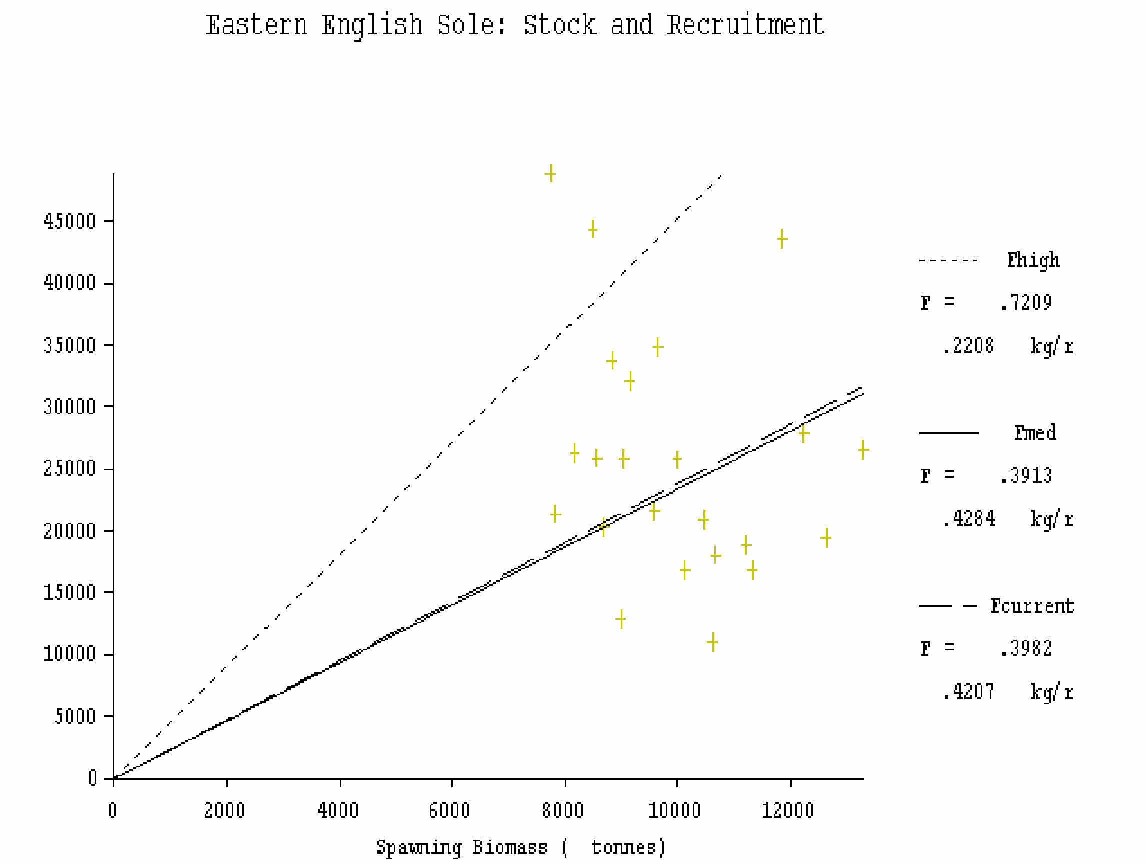
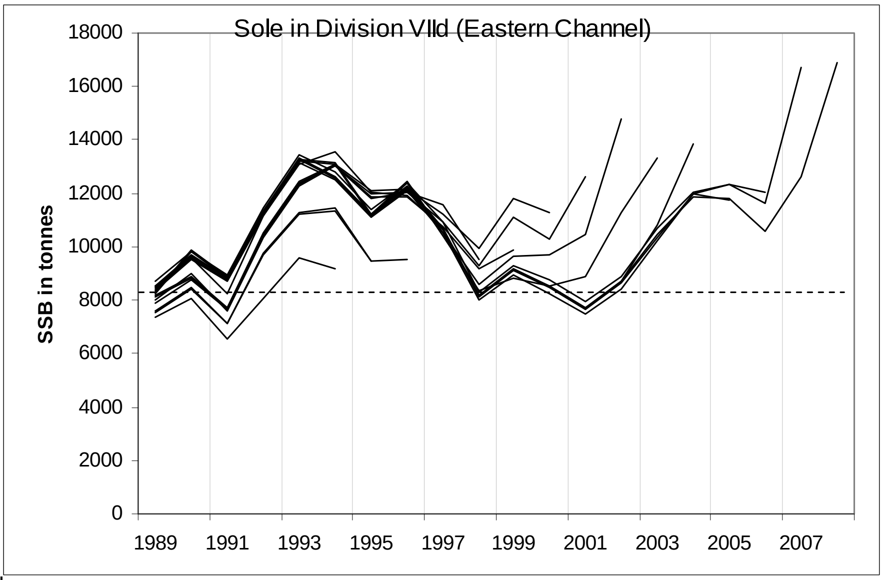
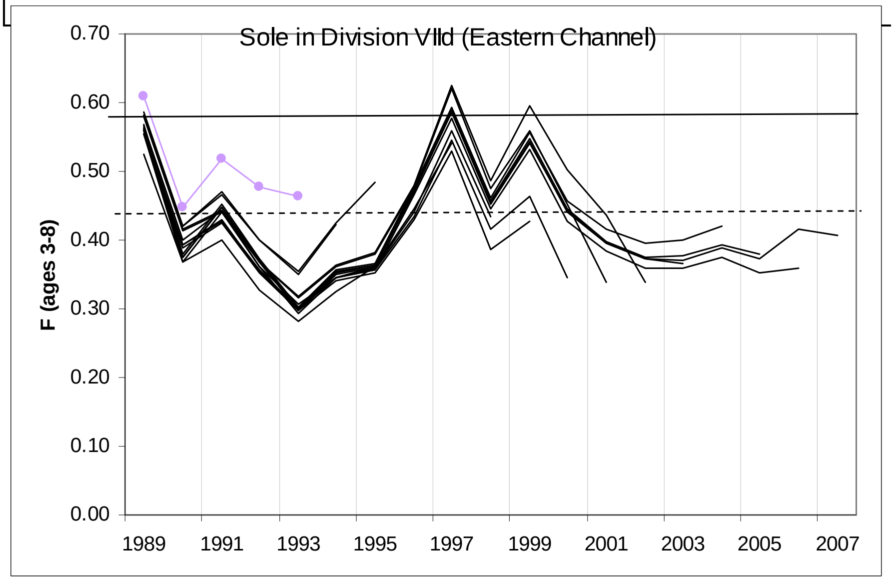
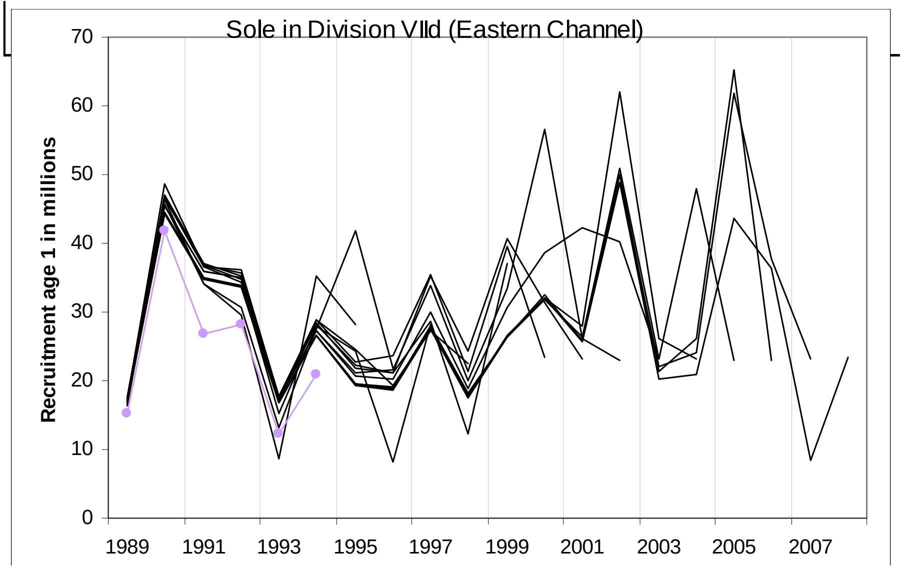


Figure 9.9.2 Sole in VIId. Historical Performance of assessment of successive WG assessment and forecast







10 Sole in Subarea IV

The assessment of sole in Subarea IV is presented as an update assessment with minor analysis requested by the review group. The most recent benchmark assessment was carried out in 2003.

10.1 General

10.1.1 Ecosystem aspects

Changes in growth of sole in relation to changes in environmental factors were analysed (Rijnsdorp *et al*., 2004) to explore changes in the productivity of the south-eastern North Sea. Based on market sampling data, Rijnsdorp *et al*. concluded that both length at age and condition factors of sole increased since the mid 1960s to a high point in the mid 1970s. Since the mid 1980s, length at age and condition have been intermediate between the low around 1960 and the high in the mid 1970s. Growth rate of the juvenile age groups was negatively affected by intra-specific competition. Length of 0-group fish in autumn showed a positive relationship with the temperature in the 2nd and 3rd quarter, but for the older fish no temperature effect could be detected. The overall pattern of the increase in growth and the later decline correlated with the temporal patterns in eutrophication, in particular the discharge of dissolved phosphates by the Rhine. Trends in the stock indicators e.g. SSB and recruitment did however not coincide with the observed patterns in eutrophication.

In recent years no changes in the spatial distribution of juvenile and adult sole was observed (Grift et al. 2004, Verver *et al,* 2001) The proportion of undersized sole (<24 cm) inside the Plaice Box did not change after closure and remained stable at a level of 60–70% (Grift *et al.*, 2004). The different length groups showed different patterns in abundance. Sole of around 5 cm showed a decrease in abundance from 2000 onwards, while the groups of 10 and 15 cm seemed rather stable. The largest groups showed a declining trend in abundance, which had already set in years before the closure.

Mollet *et al* (2007) used the reaction norm approach to investigate the change in maturation in North see sole and showed that age and size at first maturity significantly shifted to younger ages and smaller sizes. These changes occurred from 1980 onwards. Size at 50% probability of maturation at age 3 decreased from 29 to 25 cm.

10.1.2 Fisheries

Sole is mainly caught by beam trawlers. A large proportion of the fishing effort for sole is taken by the Dutch beam trawl fleet fishing for sole and plaice using 80 mm mesh size. The fishing effort of the Dutch fleet peaked mid 1990s and decreased thereafter to a level comparable to the 1980s. Apart from the Dutch fleet, Belgium and German beam trawlers, UK otter trawlers and a Danish fleet, fishing with fixed nets, catch sole.

The effort restriction of days at sea regulation, high oil prices, and different changes in TAC between plaice and sole induced a more coastal fishing pattern in the southern North Sea, which is the area where sole and juvenile plaice are abundant. This leads to increased discarding of plaice.

A change in efficiency of the commercial Dutch beam trawl fleet has been described by Rijnsdorp *et al* (2006) and was analyzed by the 2006 working group. Although the efficiency change improved XSA estimates, it was not included in the final assessment for data consistency reasons.

10.1.3 ICES Advice

In 2007, based on the estimate of SSB and fishing mortality, ICES classifies the stock as having reduced reproductive capacity, and as being harvested sustainably. SSB in 2007 was estimated at 23 600 t which is below Blim (25 000 t), while F in 2006 (0.38) is below Fpa (0.4). The 2005 year class is estimated to be relatively strong and recruitment of the subsequent 2006 year class was estimated below the long term average.

Mixed fishery advice:

Demersal fisheries in Division IIIa (Skagerrak-Kattegat), in Subarea IV (North Sea) and in Division VIId (Eastern Channel) should in 2007 be managed according to the following rules, which should be applied simultaneously:

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

Mixed fisheries management options should be based on the expected catch in specific combinations of effort in the various fisheries taking into consideration the advice given above. The distributions of effort across fisheries should be responsive to objectives set by managers, which is also the basis for the scientific advice presented above

10.1.4 Management

The TAC for 2008 was set at 12 800 tonnes, which is 2 200 tonnes lower then the agreed TAC of 2007 (Table 10.2.1). A long term management plan proposed by the Commission of the European Community was adopted by the Council of the European Union in June 2007 and first implemented in 2008 (EC Council Regulation No 676/2007). The plan consists of two stages. The aim of the first phase is to ensure the return of the stocks of plaice and sole to within safe biological limits. This should be reached through a reduction of fishing mortality by 10% in relation to the fishing mortality estimated for the preceding year. ICES interprets the F for the preceding year as the estimate of F for the year in which the assessment is carried out. The basis for this F estimate will be constant over the years. The plan sets a maximum change of 15% of the TAC between consecutive years.

Articles 1 to 9 of Council Regulation (EC) No 676/2007 of 11 June 2007 establishing a multiannual plan for fisheries exploiting stocks of plaice and sole in the North Sea. Official Journal L 157 , 19/06/2007 P. 0001–0006

CHAPTER I

SUBJECT-MATTER AND OBJECTIVE

Article 1

Subject-matter

1) This Regulation establishes a multiannual plan for the fisheries exploiting the stocks of plaice and sole that inhabit the North Sea.

2) For the purposes of this Regulation, "North Sea" means the area of the sea delineated by the International Council for the Exploration of the Sea as Subarea IV.

Article 2

Safe biological limits

1) For the purposes of this Regulation, the stocks of plaice and sole shall be deemed to be within safe biological limits in those years in which, according to the opinion of the Scientific, Technical, and Economic Committee for Fisheries (STECF), all of the following conditions are fulfilled:

   a) the spawning biomass of the stock of plaice exceeds 230000 tonnes;

   b) the average fishing mortality rate on ages two to six years experienced by the stock of plaice is less than 0,6 per year;

   c) the spawning biomass of the stock of sole exceeds 35000 tonnes;

   d) the average fishing mortality rate on ages two to six years experienced by the stock of sole is less than 0,4 per year.

2) If the STECF advises that other levels of biomass and fishing mortality should be used to define safe biological limits, the Commission shall propose to amend paragraph 1.

Article 3

Objectives of the multiannual plan in the first stage

1) The multiannual plan shall, in its first stage, ensure the return of the stocks of plaice and of sole to within safe biological limits.

2) The objective specified in paragraph 1 shall be attained by reducing the fishing mortality rate on plaice and sole by 10% each year, with a maximum TAC variation of 15% per year until safe biological limits are reached for both stocks.

Article 4

Objectives of the multiannual plan in the second stage

1) The multiannual plan shall, in its second stage, ensure the exploitation of the stocks of plaice and sole on the basis of maximum sustainable yield.

2) The objective specified in paragraph 1 shall be attained while maintaining the fishing mortality on plaice at a rate equal to or no lower than 0,3 on ages two to six years.

3) The objective specified in paragraph 1 shall be attained while maintaining the fishing mortality on sole at a rate equal to or no lower than 0,2 on ages two to six years.

Article 5

Transitional arrangements

1) When the stocks of plaice and sole have been found for two years in succession to have returned to within safe biological limits the Council shall decide on the basis of a proposal from the Commission on the amendment of Articles 4(2) and 4(3) and the amendment of Articles 7, 8 and 9 that will, in the light of the latest scientific advice from the STECF, permit the exploitation of the stocks at a fishing mortality rate compatible with maximum sustainable yield.

2) The Commission's proposal for review shall be accompanied by a full impact assessment and shall take into account the opinion of the North Sea Regional Advisory Council.

CHAPTER II

TOTAL ALLOWABLE CATCHES

Article 6

Setting of total allowable catches (TACs)

Each year, the Council shall decide, by qualified majority on the basis of a proposal from the Commission, on the TACs for the following year for the plaice and sole stocks in the North Sea in accordance with Articles 7 and 8 of this Regulation.

Article 7

Procedure for setting the TAC for plaice

1) The Council shall adopt the TAC for plaice at that level of catches which, according to a scientific evaluation carried out by STECF is the higher of:

a) that TAC the application of which will result in a 10% reduction in the fishing mortality rate in its year of application compared to the fishing mortality rate estimated for the preceding year;

b) that TAC the application of which will result in the level of fishing mortality rate of 0,3 on ages two to six years in its year of application.

2) Where application of paragraph 1 would result in a TAC which exceeds the TAC of the preceding year by more than 15%, the Council shall adopt a TAC which is 15% greater than the TAC of that year.

3) Where application of paragraph 1 would result in a TAC which is more than 15% less than the TAC of the preceding year, the Council shall adopt a TAC which is 15% less than the TAC of that year.

Article 8

Procedure for setting the TAC for sole

1) The Council shall adopt a TAC for sole at that level of catches which, according to a scientific evaluation carried out by STECF is the higher of:

a) that TAC the application of which will result in the level of fishing mortality rate of 0,2 on ages two to six years in its year of application;

b) that TAC the application of which will result in a 10% reduction in the fishing mortality rate in its year of application compared to the fishing mortality rate estimated for the preceding year.

2) Where the application of paragraph 1 would result in a TAC which exceeds the TAC of the preceding year by more than 15%, the Council shall adopt a TAC which is 15% greater than the TAC of that year.

3) Where the application of paragraph 1 would result in a TAC which is more than 15% less than the TAC of the preceding year, the Council shall adopt a TAC which is 15% less than the TAC of that year.

CHAPTER III

FISHING EFFORT LIMITATION

Article 9

Fishing effort limitation

1) The TACs referred to in Chapter II shall be complemented by a system of fishing effort limitation established in Community legislation.

2) Each year, the Council shall decide by a qualified majority, on the basis of a proposal from the Commission, on an adjustment to the maximum level of fishing effort available for fleets where either or both plaice and sole comprise an important part of the landings or where substantial discards are made and subject to the system of fishing effort limitation referred to in paragraph 1.

3) The Commission shall request from STECF a forecast of the maximum level of fishing effort necessary to take catches of plaice and sole equal to the European Community's share of the TACs established according to Article 6. This request shall be formulated taking account of other relevant Community legislation governing the conditions under which quotas may be fished.

4) The annual adjustment of the maximum level of fishing effort referred to in paragraph 2 shall be made with regard to the opinion of STECF provided according to paragraph 3.

5) The Commission shall each year request the STECF to report on the annual level of fishing effort deployed by vessels catching plaice and sole, and to report on the types of fishing gear used in such fisheries.

6) Notwithstanding paragraph 4, fishing effort shall not increase above the level allocated in 2006.

7) Member States whose quotas are less than 5% of the European Community's share of the TACs of both plaice and sole shall be exempted from the effort management regime.

8) A Member State concerned by the provisions of paragraph 7 and engaging in any quota exchange of sole or plaice on the basis of Article 20(5) of Regulation (EC) No 2371/2002 that would result in the sum of the quota allocated to that Member State and the quantity of sole or plaice transferred being in excess of 5% of the European Community's share of the TAC shall be subject to the effort management regime.

9) The fishing effort deployed by vessels in which plaice or sole are an important part of the catch and which fly the flag of a Member State concerned

by the provisions of paragraph 7 shall not increase above the level authorised in 2006.

ICES is in the process of evaluating the management plan for North Sea plaice and sole by checking if this management plan is in accordance with the precautionary approach (see also Machiels et al. 2008, WD2) and will report on this.

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 9 m.

Effort has been restricted because of implementation of days-at-sea regulation for the cod recovery plan and fishing effort limitation of the long term management plan (EC Council Regulation No. 2056/2001; EC Council Regulation No 676/2007; EC Council Regulation 40/2008).

For 2007 Council Regulation N°41/2007, annex IIa allocates different days at sea depending on gear, mesh size and catch composition.. The days at sea limitations for the major fleets operating in ICES sub-area IV could be summarised as follow: Beam trawlers can fish between 132–143 days per year. Trawls or Danish seines can fish between 103 and 280 days per year. Gillnets are allowed to fish between 140 and 162 days per year and Trammel nets between 140 and 205 days..

For 2008 Council Regulation N°40/2008, annex II[a] allocates different days at sea depending on gear, mesh size and catch composition. (see section 2.1.2 for a complete list). The days at sea limitations for the major fleets operating in ICES sub-area IV could be summarised as follow: Beam trawlers can fish between 119–143 days per year. Trawls or Danish seines can fish between 103 and 280 days per year. Gillnets are allowed to fish between 140 and 162 days per year and Trammel nets between 140 and 205 days.

Technical measures applicable to the flatfish beam trawl fishery before 2000 were an exemption to use 80 mm mesh cod-end when fishing south of 55°North. From January 2000, the exemption area extends from 55°North to 56°North, east of 5°East latitude. Fishing with 80 mm mesh cod-end 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 European Community (EC Council Regulation 1543/2000). From January 2002 the cod recovery plan was installed, allowing a maximum cod by-catch of 20% of the total catch. In the area extending from 55°North to 56° North, east of 5°East latitude, a maximum cod by-catch of 5% is allowed. Minimum cod-end mesh in this area is 100 mm, while above 56°North the minimum cod-end mesh is 120 mm (EC Council Regulation 2056/2001) .

10.2 Data available

10.2.1 Catch

Landings data by country and TACs are presented in Table 10.2.1 and total landings are presented in Figure 10.2.1a. In 2007 approximatly 95% of the TAC was taken. The discards percentages observed in the Dutch discards sampling programme sampling beam trawl vessels fishing for sole with 80 mm mesh size were much lower for sole (for 2002–2007, between 10–17% in weight, see Table 10.2.2) than for plaice. No significant trends in discard percentages were observed. Inclusion of a stable time series of discards in the assessment will have minor effect on the relative trends in stock indications (Kraak *et a*l 2002; Van Keeken *et al* 2003). The main reason for not including discards in the assessment is that the discarding is relatively low in all periods for which observations are available. In addition gaps in the discards sampling programs of North Sea sole resulting in an incomplete time series.

10.2.2 Age compositions

The age composition of the landings is presented in Table 10.2.3. Age compositions and mean weight at age in the landings were available on a quarterly basis from Denmark, France, Germany (sexes combined) and The Netherlands (by sex). Age compositions on an annual basis were available from Belgium (by sex). Overall, the samples are thought to be representative for around 85% of the total landings in 2007. The age compositions were combined separately by sex on a quarterly basis and then raised to the annual international total (see also section 1.2.4). Landing numbers at age are shown in Figure 10.2.1 b and show a relatively strong 2005 year class, age 2 in 2007 (~40 million). Catch curve consistency for ages 2 to 9 is shown in Figures 2.2.2 a and b showing the log catch ratios and catch curves of sole over the period 1957 to 2007.

10.2.3 Weight at age

Weights at age in the landings (Table 10.2.4) are measured weights from the various national market sampling programs. Weights at age in the stock (Table 10.2.5) are the 2nd quarter landings weights. Over the entire time series, weights were higher during the 1980s compared to time periods before and after (Figure 10.2.1 c & d). Estimates of weights for older ages fluctuate more because of smaller samples sizes due to decreasing numbers of older fish in the stock and landings.

10.2.4 Maturity and natural mortality

As in previous North Sea sole assessments, a knife-edged maturity-ogive was used, assuming full maturation at age 3. The maturity-ogive is based on market samples of females from observations in the sixties and seventies. Mollet *et. al*. (2007) described the shift of the age at maturity towards younger ages and the results should be taken in consideration in the next benchmark assessment.

Natural mortality in the period 1957–2007 has been assumed constant over all ages at 0.1, except for 1963 where a value of 0.9 was used to take into account the effect of the severe winter (1962–1963) (ICES-FWG 1979).

10.2.5 Catch, effort and research vessel data

One commercial and two survey series were used to tune the assessment. Effort for the Dutch commercial beam trawl fleet is expressed as total HP effort days. Two numbers at age data for 2006 were revised. Effort nearly doubled between 1978 and 1994 and declined since 1996. Effort is currently around 50% of the maximum effort (1994) (Table 10.2.6 and 10.2.7 cont.).

Trends in commercial LPUE of the Dutch beam trawl fleet by area are shown in Figure 10.2.3. The data are based on various sources (Quirijns and Poos, 2008, WD1). There is a clear separation in LPUE between areas, with the southern area producing a substantially higher LPUE than the Northern area. Average LPUE of a standardized

NL beam trawler (1471 kW) over the period 1999 to 2007 was 278 kg/day, and the time-series shows a significant (P<0.01) trend of -6.3 kg/year. The LPUE estimated for 2007 (257 kg/day) was above the trend-line.

The BTS (Beam Trawl Survey) is carried out in the southern and south-eastern North Sea in August and September using an 8-m beam trawl. The SNS (Sole Net Survey) is a coastal survey with a 6-m beam trawl carried out in the 3rd quarter. In 2003 the SNS survey was carried out during the 2nd quarter and data from this year were omitted (Table 10.2.7 and Figure 10.2.4). The research vessel survey time series have been revised by WGBEAM (ICES-WGBEAM, 2007), because of small corrections in data bases and new solutions for missing lengths in the age-length-keys.

10.3 Data analyses

The assessment of North Sea sole was carried out using the FLR version of XSA (1.4.2) in R version 2.4.1.

Reviews of last year's assessment

In the following bullet points the comments made in 2007 by the RGNSSK (Technical Minutes) that are relevant to this stock are summarised, and it is explained how this WG addressed the comments.

- Apart from the suggestion to examine the effect of including discards, the main concern remains differences in conclusion when fitting survey or commercial LpUE series as tuning series. These issues will be investigated in a benchmark assessment
- The comments that the consistency in the data should be shown by means of (log) catch-curve and catch-ratio plotting and the standardized log catchability plots should be of higher quality are taken into account.

10.3.1 Exploratory catch-at-age-based analysis

3 tuning indices were included in the assessment. Last year, some exploratory analyses were carried out to explore the sensitivity of an assessment with and without the commercial NL BT LpUE series. Depending on the inclusion of the commercial NL BT series the perception of last years fishing mortalities estimates differ. The standardized log catchability residual plots of the 3 tuning series included as single fleets in the assessments is shown in figure 10.3.1 and the log catchability residual plot for the combined fleets of the 3 tuning series is shown in figure 10.3.3. Figure 10.3.2 shows the XSA retrospective analysis of fishing mortality for different combinations of indices. Figure 10.3.4 presents the retrospective analysis of F, SSB and recruitment when the 3 fleets of the tuning series were combined.

10.3.2 Exploratory survey-based analyses

No survey-based analysis was carried out in this year's WG.

10.3.3 Conclusions drawn from exploratory analyses

The WG concluded to continue the update assessment with the inclusion of NL beam trawl as commercial tuning series.

10.3.4 Final assessment

Catch at age analysis was carried out with XSA using the settings given below.

YEAR	2006	2007	2008
Catch at age	Landings	Landings	Landings
Fleets	BTS-Isis1985–2005 SNS 1982–2005 Nl-BT 1990–2005	BTS-Isis 1985–2006 SNS 1982–2006 Nl-BT 1990–2006	BTS-Isis 1985–2007 SNS 1982–2007 Nl-BT 1990–2007
Plus group	10	10	10
First tuning year	1982	1982	1982
Last data year	2005	2006	2007
Time series weights	No taper	No taper	No taper
Catchability dependent on stock size for age <	2	2	2
Catchability independent of ages for ages >=	7	7	7
Survivor estimates shrunk towards the mean F	5 years / 5 ages	5 years / 5 ages	5 years / 5 ages
s.e. of the mean for shrinkage	2.0	2.0	2.0
Minimum standard error for population estimates	0.3	0.3	0.3
Prior weighting	Not applied	Not applied	Not applied

The full diagnostics are presented in Table 10.3.1 A summary of the input data is given in Figure 10.2.1. Figure 10.3.2 shows the log catchability residuals for the tuning fleets in the final run. Figures 10.3.3 shows the time series of the standardized stock numbers at age of the tuning series. Fishing mortality and stock numbers per age group are shown in Tables 10.3.2 and 10.3.3 respectively. The SSB in 2007 was estimated at around 19 000 t. Mean F(2–6) was estimated at 0.43. Recruitment of the 2006 year class, in 2007 at the age of 1, was estimated at 59 million. Retrospective analysis is presented in Figure 10.3.2. Downwards biases of mean *F* estimates from 2000 to 2004 were observed. In the same period upwards biases of the SSB estimates were found. Recruit estimates were relatively unbiased.

10.4 Historic Stock Trends

Table 10.4.1. and Figure 10.4.1 present the trends in landings, mean F(2–6), recruitment 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 (30 000 t) again during the early 1990s. In 2007 landings were estimated to be around 14 500 t.

Recruitment was high in 1959 and 1964 and SSB increased from the end of the 1950s to a peak in early 1960s, followed by a period of declining SSB until the 1990s. Recruitment was high in 1988 and 1992. Between 1990–1995 a period of higher SSB was observed. The SSB in 2007 decreased by 7000 t compared to 2006. The SSB in 2007 is estimated at around 19 000 t. The year-classes 2003 and 2004 show a low recruitment level for 2 consecutive years. Recruitment in 2007 of the 2006 year class at the age of 1 was estimated at 59 million, lower then the long term geometric mean of 93.6 million.

The mean fishery mortality on age 2–6 increased with large variation from circa 0.4–0.5 per year around 1970 to 0.5 to 0.6 per year up to 2000. In recent years fishing mortality has decreased gradually. Fishing mortality decreased from 0.56 per year in 2005 to 0.42 per year in 2006 and 0.43 per year in 2007.

10.5 Recruitment estimates

Recruitment estimation was carried out using RCT3. Input to the RCT3 model is presented in Table 10.5.1. Results are presented in Table 10.5.2 for age-1 and Table 10.5.3 for age-2. Average recruitment of 1-year-old-fish in the period 1957–2005 was around 93.6 million (geometric mean). For year class 2007 (age 1 in 2008) the value predicted by the RCT3 was approximately 30% lower than the geometric mean (Table 10.5.2.). The estimate was based on the estimate of the DSF0 survey (50 000) and showed a large standard error (1.1) giving an uncertainty multiplier of $9^{\pm 1}$, and therefore the geometric mean was accepted for the short-term forecasts. For year class 2006 (age 2 in 2008), the data are also noisy (high s.e. of the predicted value, Table 10.5.3.). Apart from DFS0 data the RCT3 estimate is based on the same data as the XSA; the WG finds it not desirable to use the same data twice and therefore accepts the XSA estimate. The year class strength estimates from the different sources are summarized in the table below and the estimates used for the short-term forecast are bold-underlined.

Year Class	Age in 2008	XSA thousands	RCT3 thousands	GM(1957 - 2004) thousands
2006	2	**<u>52 642</u>**	56 700	84 500
2007	1		65 700	**<u>93 570</u>**
2008	Recruit			**<u>93 570</u>**

10.6 Short-term forecasts

The short-term forecasts were carried out with FLR using FLSTF (1.4.3). Weight-at-age in the stock and weight-at-age in the catch are taken to be the average over the last 3 years. The exploitation pattern was taken to be the mean value of the last three years. Weight-at-age in the stock and weight-at-age in the catch were taken to be the average over the last 3 years. Population numbers at ages 2 and older are XSA survivor estimates. Numbers at age 1 and recruitment of the 2007 year-class are taken from the long-term geometric mean (1957–2005: 93.6 million).

Input to the short term forecast is presented in Table 10.6.1.The management options are given in Table 10.6.2 (A-C). The management options are given for three different assumptions on the F values for 2008; A) F2008 is assumed to be equal to Fsq, the average estimate for F from 2005 to 2007, B) F2008 is 0.9 times Fsq, and C) F2008 is set such that the landings in 2008 equal the TAC of that same year. The table below shows the predicted F values in the intermediate year, SSB for 2009 and the corresponding landings for 2008, given the different assumptions about F in the intermediate year in the different scenarios.

Scenario	Assumption	F_{2008}	SSB_{2009}	$Landings_{2008}$
A	$F_{2008} = F_{sq}$	0.47	28 000	16 500
B	$F_{2008} = 0.9F_{sq}$	0.42	29 300	15 200
C	F~$Landings_{2008}$= TAC_{2008}	0.34	31 700	12 800

The detailed table for a forecast based on these 3 scenarios is given in Table 8.6.3A-C. At status quo fishing mortality in 2008 and 2009, SSB is expected to decrease from 33 200 t in 2008 to 28 000 t in 2009. The 2010 SSB is predicted to be 27 700 t. The landings at Fsq are expected to be around 16 500 t in 2008 which is above the 2008 TAC (12 800) and higher than last years status quo forecast (15 200 t). The landings in 2009 are predicted to be around 15 200 t at Fsq.

Figure 10.6.1 shows the projected contribution of different sources of information to estimates of the landings in 2008 and of the SSB in 2009, when fishing at Fsq in 2008. The landings in 2008 will consist for a large part of uncertain year classes (2004–2008), and for almost 20% of year classes for which the geometric mean was taken (2007–2008). Other stock number estimates originate from XSA. The contribution of year classes 2007 and 2008 to SSB forecast in 2010 is approximately 35%. These forecasts are subject to revision by ACFM in October 2008 when new survey information becomes available.

Yield and SSB, per recruit, under the condition of the current exploitation pattern and assuming Fsq as exploitation rate in 2008 are given in Figure 10.6.2. Fmax is poorly estimated at 0.6.

10.7 Medium-term forecasts

No medium term projections were done this year.

10.8 Biological reference points

The current reference points are $\mathbf{B_{lim}}$= $\mathbf{B_{loss}}$= 25 000 t and $\mathbf{B_{pa}}$ is set at 35 000 t using the default multiplier of 1.4. $\mathbf{F_{pa}}$ was proposed to be set at 0.4 which is the 5th percentile of $\mathbf{F_{loss}}$ and gave a 50% probability that SSB is around $\mathbf{B_{pa}}$ in the medium term. Equilibrium analysis suggests that F of 0.4 is consistent with an SSB of around 35 000 t.

	ICES CONSIDERED THAT:	ICES PROPOSED THAT:
Precautionary Approach Reference point	$\mathbf{B_{lim}}$ is 25 000 t	$\mathbf{B_{pa}}$ be set at 35 000 t
		$\mathbf{F_{pa}}$ be set at 0.40
Target reference points		$\mathbf{F_{y}}$ undefined

10.9 Quality of the assessment

This year's assessment of North Sea sole was carried out as an update assessment. Retrospective patterns from previous years suggested that F has been underestimated in previous years, and SSB overestimated. This was also confirmed in this year's assessment results. The terminal mean F (2007) estimate for 2006 of 0.38 was estimated to be 0.42 in this year's assessment. The (2007) SSB estimate for 2006 was 28 000 t, which is 2 000 t higher then the estimate in the current assessment. The historic performance of the assessment is summarized in Figure 10.9.1.

The XSA assessment showed a decrease in SSB in 2008 compared to 2007 caused by weak year classes in 2003 and 2004 (44 000 million). A strong 2005 year class will increase the SSB in 2009.

During the next benchmark assessment for this stock, attention should be paid to the following issues:

- In 2003 the plus-group was set from age 15 to age 10. The choice to reduce the plusgroup to age 10 needs further analysis.
- Follow changes in technical efficiency in the commercial fleets and look for external evidence.
- Trends in mean weights and maturity and how that could affect the assessment and forecasts.
- Explore the effects of including discards
- Investigate the considerable differences in retrospective patterns of XSA results when run survey or commercial LPUE series separately.
- Study the effects of using an un-scaled F in the forecast procedure.

10.10 Status of the Stock

Fishing mortality was estimated at 0.43 in 2007, Fishing mortality is above Fpa (=0.4). The SSB in 2007 was estimated at about 19 000 t which is below Blim (25 000t) and Bpa (35 000 t). Two weak year classes in 2003 and 2004 are followed by a strong year class in 2005 and a weak year class in 2006. Projected landings for 2009 at Fsq are 15 200 t. and lower than projected landings for 2008 (16 500)

10.11 Management Considerations

Sole is mainly taken by beam trawlers in a mixed fishery with plaice in the southern and central part of the North Sea. Fishing effort (kWdays) has been substantially reduced since 1995. Technical measures applicable to the mixed flatfish fishery will affect both sole and plaice. The minimum mesh size of 80 mm in the beam trawl fishery selects sole at the minimum landing size. However, this mesh size generates high discards of plaice. Mesh enlargement would reduce the catch of undersized plaice, but would also result in loss of marketable sole. The combination of days-at-sea regulations, higher oil prices, and decreasing TAC for plaice and relatively stable TAC for sole, appear to have induced a shift in fishing effort towards the southern North Sea. This concentration of fishing effort result in higher plaice discards because juveniles are mainly distributed in this area.

The sole stock dynamics is heavily dependent on the occasional occurrence of strong year classes.

The mean age in the landings is currently just above age 3, but used to be around age 6 in the beginning of the time series. A lower exploitation level is expected to improve the survival of sole to the spawning population, which could enhance the stability in the catches.

The peaks in the historical time-series of SSB of North Sea sole correspond with the occasional occurrence of strong year classes. Due to a high fishing mortality the SSB has declined during the nineties. The fishery opportunities and SSB are now dependent on incoming year classes and can therefore fluctuate considerably between years. The SSB and landings in recent years have been dominated by the 2001 and 2005 year classes. The predicted SSB in 2010 is largely dependent on the above-average recruitment of the 2005 year class.

For sole there will be new recruitment information from the 3rd quarter surveys. ICES will only issue an updated advice if these surveys provide a very different perspective on the short-term developments.

Table 10.2.1 Sole in Sub-Area IV: Nominal landings and landings as estimated by the Working Group (tonnes).

Year	Belgium	Denmark	France	Germany	Netherlands	UK (E/W/NI)	Other countries	Total reported	Unallocated landings	WG Total	TAC
1982	1900	524	686	266	17686	403	2	21467	112	21579	21000
1983	1740	730	332	619	16101	435		19957	4970	24927	20000
1984	1771	818	400	1034	14330	586	1	18940	7899	26839	20000
1985	2390	692	875	303	14897	774	3	19934	4314	24248	22000
1986	1833	443	296	155	9558	647	2	12934	5266	18200	20000
1987	1644	342	318	210	10635	676	4	13829	3539	17368	14000
1988	1199	616	487	452	9841	740	28	13363	8227	21590	14000
1989	1596	1020	312	864	9620	1033	50	14495	7311	21806	14000
1990	2389	1427	352	2296	18202	1614	263	26543	8577	35120	25000
1991	2977	1307	465	2107	18758	1723	271	27608	5905	33513	27000
1992	2058	1359	548	1880	18601	1281	277	26004	3337	29341	25000
1993	2783	1661	490	1379	22015	1149	298	29775	1716	31491	32000
1994	2935	1804	499	1744	22874	1137	298	31291	1711	33002	32000
1995	2624	1673	640	1564	20927	1040	312	28780	1687	30467	28000
1996	2555	1018	535	670	15344	848	229	21199	1452	22651	23000
1997	1519	689	99	510	10241	479	204	13741	1160	14901	18000
1998	1844	520	510	782	15198	549	339	19742	1126	20868	19100
1999	1919	828		1458	16283	645	501	21634	1841	23475	22000
2000	1806	1069	362	1280	15273	600	539	20929	1603	22532	22000
2001	1874	772	411	958	13345	597	394	18351	1593	19944	19000
2002	1437	644	266	759	12120	451	292	15969	976	16945	16000
2003	1605	703	728	749	12469	521	363	17138	782	17920	15850
2004	1477	808	655	949	12860	535	544	17828	-681	17147	17000
2005	1374	831	676	756	10917	667	357	15579	776	16355	18600
2006	980	585	648	475	8299	910		11933	667	12600	17670
2007	955	413	401	458	10365	1203	5	13800	835	14635	15000

TAC 2008: 12 800 t

Table 10.2.2 Sole in sub-area IV: Overview of landings and discards numbers and weights (kg) per hour and there percentages in the Dutch discards

		Numbers			Weight		
Period	trips	Landings	Discards	%D	Landings	Discards	%D
	n	$n \cdot h^{-1}$	$n \cdot h^{-1}$		$kg \cdot h^{-1}$	$kg \cdot h^{-1}$	
1976–1979	21	116	8	6%	38	1	3%
1980–1983	22	84	23	21%	27	3	9%
1989–1990	6	286	83	22%	72	11	13%
1999–2001	20	92	21	19%	22	2	8%
2002	6	124	37	24%	18	3	13%
2003	9	95	32	25%	20	3	14%
2004	8	174	58	25%	28	5	17%
2005	9	99	29	23%	20	2	11%
2006	9	64	26	29%	16	2	13%
2007	10	94	27	23%	22	2	10%

Table 10.2.3 Sole in sub-area IV: Landings numbers at age (thousands)

2008 – 04 – 22 15:40:01 units= thousands

year \ age	1	2	3	4	5	6	7	8	9	10
1957	0	1415	10148	12642	3762	2924	6518	1733	509	6288
1958	0	1854	8440	14169	9500	3484	3008	4439	2253	6557
1959	0	3659	12025	10401	8975	5768	1206	2025	2574	5615
1960	0	12042	14133	16798	9308	8367	4846	1593	1056	7901
1961	0	959	49786	19140	12404	4695	3944	4279	836	7254
1962	0	1594	6210	59191	15346	10541	4826	4112	2087	7494
1963	0	676	8339	8555	46201	8490	6658	2423	3393	8384
1964	55	155	2113	5712	3809	17337	3126	1810	818	3015
1965	0	47100	1089	1599	5002	2482	12500	1557	1525	3208
1966	0	12278	133617	990	1181	3689	744	6324	702	2450
1967	0	3686	25683	85127	1954	536	1919	760	5047	2913
1968	1037	17148	13896	24973	48571	462	245	1644	324	6523
1969	396	23922	21451	5326	12388	25139	331	244	1190	5272
1970	1299	6140	25993	8235	1784	3231	11960	246	140	5234
1971	420	33369	14425	12757	4485	1442	2327	7214	192	4594
1972	358	7594	36759	7075	4965	1565	523	1232	4706	2801
1973	703	12228	12783	16187	4025	2324	994	765	1218	5790
1974	101	15380	21540	5487	7061	1922	1585	658	401	4814
1975	264	22954	28535	11717	2088	3830	790	907	508	3445
1976	1041	3542	27966	14013	4819	966	1909	550	425	2663
1977	1747	22328	12073	15306	7440	1779	319	1112	256	2115
1978	27	25031	29292	6129	6639	4250	1738	611	646	1602
1979	9	8179	41170	16060	2996	3222	1747	816	241	1527
1980	637	1209	12511	17781	7297	1450	2197	1409	367	1203
1981	423	29217	3259	6866	8223	3661	948	886	766	908
1982	2660	26435	45746	1843	3535	4789	1678	615	605	1278
1983	389	34408	41386	21189	624	1378	1950	978	386	1176
1984	191	30734	43931	22554	8791	741	854	1043	524	894
1985	165	16618	43213	20286	9403	3556	209	379	637	975
1986	374	9363	18497	17702	7747	5515	2270	110	283	1682
1987	94	29053	22046	8899	6512	3119	1567	903	81	694
1988	10	13219	47182	15232	4381	3882	1551	891	524	317
1989	117	46387	18263	22654	4624	1653	1437	647	458	468
1990	863	11939	104454	9767	9194	3349	1043	1198	554	845
1991	120	13163	25420	77913	6724	3675	1736	719	730	1090
1992	980	6832	44378	16204	38319	2477	3041	741	399	1180
1993	54	50451	16768	31409	13869	24035	1489	1184	461	842
1994	718	7804	87403	13550	18739	5711	11310	464	916	908
1995	4801	12767	16822	68571	6308	7307	1995	6015	295	668
1996	172	18824	16190	16964	27257	3858	4780	943	3305	988
1997	1590	6047	23651	7325	5108	12793	1201	2326	333	1688
1998	244	56648	15141	14934	3496	1941	4768	794	1031	846
1999	287	15762	72470	8187	6111	1212	664	1984	331	812
2000	2351	15073	32738	42803	3288	2477	804	435	931	714
2001	884	25846	21595	19876	16730	1427	834	274	168	724
2002	1055	11053	32852	12290	8215	6448	673	597	89	364
2003	1048	32330	17498	16090	5820	3906	2430	400	128	451
2004	516	14950	47970	9524	7457	2165	901	961	389	389
2005	1156	7417	23141	29523	4262	3948	1524	616	785	401
2006	6814	9690	10109	9340	10640	1572	1533	704	363	538
2007	317	39888	10887	6447	5741	5513	824	729	501	544

Table 10.2.4 Sole in sub-area IV: Landing weights at age (kg)

2008 – 04 – 22 15:42:31 units= kg

age

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	0.127	0.180	0.209	0.252	0.263	0.284	0.378	0.367	0.327	0.425
2005	0.172	0.185	0.207	0.243	0.241	0.282	0.265	0.377	0.318	0.401
2006	0.156	0.190	0.220	0.263	0.291	0.322	0.293	0.358	0.397	0.397
2007	0.154	0.180	0.205	0.237	0.253	0.273	0.295	0.299	0.281	0.326

Table 10.2.5 Sole in sub-area IV: Stock weights at age (kg)

2008 – 04 – 23 08:59:01 units= kg

age										
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	0.601
2005	0.050	0.150	0.189	0.234	0.237	0.258	0.276	0.396	0.369	0.428
2006	0.050	0.148	0.197	0.250	0.270	0.319	0.286	0.341	0.409	0.456
2007	0.050	0.152	0.179	0.216	0.242	0.245	0.275	0.252	0.257	0.364

Table 10.2.6 Sole in subarea IV: Effort and CpUE series

year	NL beam Effort HP days ($\cdot 10^6$)	LpUE kg$\cdot$ 1000HP $days^{-1}$
1990	71.1	423.0
1991	68.5	386.0
1992	71.1	339.8
1993	76.9	338.3
1994	81.4	331.2
1995	81.2	298.3
1996	72.1	244.6
1997	72.0	165.2
1998	70.2	250.8
1999	67.3	283.6
2000	64.6	259.3
2001	61.4	263.8
2002	56.7	243.2
2003	51.6	279.9
2004	48.1	309.0
2005	49.1	260.2
2006	44.1	190.4
2007	42.9	258.4

Table 10.2.7 Sole in subarea IV: Tuning data. BTS and SNS surveys and commercial series from NL beam trawl

```
2008 – 04 – 23 08:59:02[1] BTS-ISIS units= NA
 1 2 3 4 5 6 7 8 9
1985 1 2.65 7.89 3.541 1.669 0.620 0.279 0.000 0.000 0.000
1986 1 7.88 4.49 1.726 0.826 0.590 0.221 0.108 0.000 0.018
1987 1 6.97 12.55 1.834 0.563 0.583 0.222 0.228 0.058 0.000
1988 1 83.11 12.51 2.684 1.032 0.123 0.149 0.132 0.103 0.014
1989 1 9.02 68.08 4.191 4.096 0.677 0.128 0.242 0.000 0.051
1990 1 22.60 22.36 20.090 0.611 0.682 0.511 0.078 0.055 0.013
1991 1 3.71 23.19 5.843 6.011 0.103 0.137 0.064 0.040 0.011
1992 1 74.44 23.20 9.879 2.332 2.903 0.061 0.142 0.065 0.016
1993 1 4.99 27.36 0.987 4.367 2.376 4.295 0.024 0.090 0.057
1994 1 5.88 4.99 15.422 0.133 1.412 0.095 1.006 0.010 0.000
1995 1 27.86 8.46 7.039 6.718 0.476 0.913 0.314 0.966 0.049
1996 1 3.51 6.17 1.909 1.488 2.493 0.308 0.406 0.051 0.299
1997 1 173.94 5.37 3.234 0.800 0.769 0.403 0.105 0.038 0.045
1998 1 14.12 29.21 1.998 1.346 0.079 0.016 0.424 0.000 0.000
1999 1 11.41 19.26 16.626 0.629 2.061 0.334 0.224 0.651 0.003
2000 1 14.46 6.53 4.207 1.587 0.283 0.153 0.064 0.008 0.162
2001 1 8.17 10.71 2.335 1.683 0.737 0.081 0.040 0.030 0.000
2002 1 21.90 4.17 3.431 0.906 0.356 0.359 0.022 0.060 0.000
2003 1 10.76 10.55 2.506 1.752 0.380 0.202 0.337 0.000 0.022
2004 1 3.65 4.40 3.618 0.630 0.650 0.122 0.072 0.075 0.000
2005 1 3.14 3.29 2.375 1.337 0.137 0.139 0.078 0.046 0.000
2006 1 16.82 2.44 0.300 0.763 0.516 0.163 0.095 0.000 0.008
2007 1 5.80 19.97 1.510 0.608 0.333 0.572 0.034 0.010 0.000
[1] SNS units= NA
 1 2 3 4
1970 1 5410 734 238 35
1971 1 893 1844 110 3
1972 1 1455 272 149 0
1973 1 5587 935 84 37
1974 1 2348 361 65 0
1975 1 529 848 166 47
1976 1 1399 74 229 27
1977 1 3743 776 104 43
1978 1 1548 1355 294 28
1979 1 94 408 301 77
1980 1 4313 89 109 61
1981 1 3737 1413 50 20
1982 1 5856 1146 228 7
1983 1 2621 1123 121 40
1984 1 2493 1100 318 74
1985 1 3619 716 167 49
1986 1 3705 458 69 31
1987 1 1948 944 65 21
1988 1 11227 594 282 82
1989 1 2831 5005 208 53
1990 1 2856 1120 914 100
1991 1 1254 2529 514 624
1992 1 11114 144 360 195
1993 1 1291 3420 154 213
1994 1 652 498 934 10
1995 1 1362 224 143 411
1996 1 218 349 30 36
1997 1 10279 154 190 26
1998 1 4095 3126 142 99
1999 1 1649 972 456 10
2000 1 1639 126 166 118
2001 1 970 655 107 35
2002 1 7542 379 195 0
2003 1 NA NA NA NA
2004 1 1367 623 396 69
2005 1 568 163 124 0
2006 1 4167 382 80 105
2007 1 848 911 33 40
```

Table 10.2.7 cont.

```
2008 – 04 – 23 10:25:06[1] NL Beam Trawl units= NA
 2 3 4 5 6 7 8 9
1990 71.1 127.6 1190 101.9 92.6 23.5 8.93 11.52 5.288
1991 68.5 107.1 251 872.3 67.7 31.2 9.97 4.55 5.723
1992 71.1 71.0 477 156.6 419.6 20.5 29.27 6.27 3.080
1993 76.9 510.9 142 313.8 125.2 242.2 11.53 10.56 3.069
1994 81.4 66.2 858 91.1 159.8 38.1 109.74 2.33 6.437
1995 81.2 120.4 140 658.7 35.0 63.2 11.05 57.66 1.810
1996 72.1 219.7 126 154.9 294.2 21.8 44.01 6.55 38.474
1997 72.0 62.6 256 62.6 46.2 135.7 6.90 25.00 1.319
1998 70.2 720.4 129 158.4 26.0 16.3 48.36 3.01 4.801
1999 67.3 175.6 820 61.7 66.3 10.8 4.99 22.69 1.976
2000 64.6 190.5 458 336.6 31.7 24.5 7.04 4.98 9.923
2001 61.4 305.0 222 243.8 213.0 11.7 8.24 2.21 1.515
2002 56.7 158.8 437 140.0 106.4 89.6 7.48 6.77 0.952
2003 51.6 502.8 224 241.1 65.8 54.7 38.02 4.36 1.202
2004 48.1 232.6 774 117.1 105.2 24.7 13.31 11.27 2.807
2005 49.1 103.1 333 428.3 77.3 40.8 18.76 5.89 12.607
2006 44.1 154.0 177 152.1 186.5 21.6 21.43 11.84 6.100
2007 42.9 775.6 178 104.5 85.3 86.2 7.81 7.60 2.960
```

Table 10.3.1. Sole in sub area IV: XSA diagnostics

```
FLR XSA Diagnostics 2008 – 04 – 24 13:53:38
CPUE data from xsa.indices
Catch data for 51 years. 1957 to 2007. Ages 1 to 10.
 fleet first age last age first year last year alpha beta
1 BTS-ISIS 1 9 1985 2007 0.66 0.75
2 SNS 1 4 1970 2007 0.66 0.75
3 NL Beam Trawl 2 9 1990 2007 0 1
 Time series weights :
 Tapered time weighting not applied
Catchability analysis :
 Catchability independent of size for ages > 1
 Catchability independent of age for ages >= 7
Terminal population estimation :
 Survivor estimates shrunk towards the mean F
 of the final 5 years or the 5 oldest ages.
 S.E. of the mean to which the estimates are shrunk = 2
 Minimum standard error for population
 estimates derived from each fleet = 0.3
 prior weighting not applied
Regression weights
 year
age 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007
 all 1 1 1 1 1 1 1 1 1 1
 Fishing mortalities
 year
age 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007
 1 0.002 0.004 0.020 0.015 0.006 0.013 0.012 0.027 0.039 0.006
 2 0.279 0.175 0.239 0.286 0.230 0.221 0.230 0.208 0.294 0.301
 3 0.616 0.609 0.580 0.559 0.627 0.604 0.521 0.582 0.429 0.554
 4 0.790 0.711 0.792 0.749 0.637 0.639 0.691 0.626 0.435 0.475
 5 0.762 0.786 0.615 0.737 0.712 0.628 0.613 0.678 0.426 0.462
 6 0.735 0.576 0.766 0.524 0.624 0.788 0.446 0.683 0.503 0.362
 7 0.611 0.529 0.848 0.559 0.444 0.447 0.364 0.574 0.545 0.476
 8 0.936 0.490 0.702 0.698 0.897 0.458 0.283 0.404 0.504 0.479
 9 1.005 1.251 0.397 0.570 0.451 0.422 0.978 0.350 0.392 0.725
 10 1.005 1.251 0.397 0.570 0.451 0.422 0.978 0.350 0.392 0.725
 XSA population number ( thousands )
 age
year 1 2 3 4 5 6 7 8 9 10
 1998 114116 244239 34619 28745 6889 3920 10967 1374 1710 1391
 1999 82547 103024 167111 16922 11804 2908 1700 5388 488 1183
 2000 123042 74418 78227 82273 7524 4867 1479 907 2988 2283
 2001 63329 109097 52999 39641 33728 3680 2048 573 407 1744
 2002 190286 56462 74129 27413 16962 14604 1973 1060 258 1050
 2003 85787 171174 40575 35825 13114 7534 7081 1145 391 1372
 2004 46346 76626 124132 20069 17111 6330 3101 4096 655 650
 2005 45360 41445 55113 66689 9100 8389 3668 1949 2792 1421
 2006 185462 39944 30446 27856 32259 4180 3835 1869 1178 1739
 2007 58512 161331 26926 17933 16321 19068 2286 2012 1022 1102
 Estimated population abundance at 1st Jan 2008
 age
year 1 2 3 4 5 6 7 8 9 10
 2008 0 52643 108036 14007 10094 9307 12010 1285 1127 448
```

Table 10.3.1. Continued

```
 Fleet: BTS-ISIS
 Log catchability residuals.
 year
age 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995
 1 -0.482 -0.448 0.025 -0.091 -0.128 -0.045 -0.238 0.027 -0.094 0.113 0.476
 2 0.197 -0.623 -0.211 0.574 0.353 0.683 0.194 1.137 -0.268 -0.368 0.482
 3 -0.044 -0.119 -0.438 -0.547 0.595 0.129 0.352 0.346 -1.015 0.222 1.002
 4 0.303 -0.402 -0.228 0.054 0.947 -0.406 -0.185 0.282 0.444 -2.052 0.465
 5 -0.100 0.192 0.040 -0.906 0.397 -0.008 -1.266 -0.186 1.247 0.180 0.066
 6 0.203 -0.124 0.115 -0.454 -0.065 0.992 -0.835 -0.817 1.059 -0.801 0.626
 7 NA -0.124 0.365 0.070 0.415 -0.149 -0.491 -0.266 -1.020 0.073 1.146
 8 NA NA 0.041 0.087 NA -0.438 -0.106 0.252 -0.053 -1.086 0.636
 9 NA -0.136 NA -0.433 -0.155 -1.073 -1.233 -0.124 1.004 NA 1.501
 year
age 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005
 1 -0.026 0.588 0.039 0.161 0.005 0.192 -0.105 0.112 0.038 -0.011
 2 -0.337 0.052 0.135 0.509 -0.202 -0.057 -0.381 -0.569 -0.634 -0.324
 3 0.246 0.178 0.215 0.755 0.119 -0.095 0.002 0.275 -0.535 -0.101
 4 0.663 0.468 0.423 0.136 -0.463 0.296 -0.033 0.360 -0.047 -0.541
 5 0.418 1.086 -0.878 1.862 0.206 -0.251 -0.309 -0.045 0.214 -0.665
 6 0.710 -0.365 -1.724 1.501 0.339 -0.188 -0.007 0.195 -0.376 -0.360
 7 0.414 0.244 0.271 1.439 0.551 -0.448 -1.089 0.364 -0.412 -0.352
 8 0.358 -1.058 NA 1.325 -1.142 0.636 0.854 NA -0.707 -0.368
 9 0.066 1.383 NA -1.116 0.459 NA NA 0.513 NA NA
 year
age 2006 2007
 1 -0.196 0.088
 2 -0.526 0.185
 3 -1.684 0.142
 4 -0.364 -0.122
 5 -0.782 -0.514
 6 0.369 0.008
 7 -0.220 -0.779
 8 NA -1.873
 9 -1.622 NA
 Mean log catchability and standard error of ages with catchability
 independent of year class strength and constant w.r.t. time
 2 3 4 5 6 7 8 9
Mean_Logq -8.8993 -9.4706 -9.7648 -9.8904 -10.0962 -9.9309 -9.9309 -9.9309
S.E_Logq 0.4713 0.5706 0.5970 0.7203 0.7149 0.6236 0.8306 0.9759
 Regression statistics
 Ages with q dependent on year class strength
 slope intercept
Age 1 0.6705193 9.879568
 Fleet: SNS
 Log catchability residuals.
 year
age 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980
 1 0.252 0.154 -0.023 0.469 -0.033 -0.105 -0.330 0.043 0.362 -0.120 0.058
 2 0.740 0.792 -0.004 0.606 -0.672 0.192 -1.370 0.071 0.399 0.267 0.071
 3 0.489 0.148 -0.293 0.245 -0.716 -0.137 0.230 0.259 0.448 0.296 0.271
 4 0.081 -2.580 NA -0.421 NA 0.243 -0.787 -0.200 0.131 0.364 -0.048
 year
age 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991
 1 -0.007 0.222 -0.162 0.322 0.424 -0.061 0.171 -0.234 0.078 -0.279 -0.044
 2 0.368 0.156 0.184 0.206 0.494 -0.209 -0.100 0.224 0.440 0.386 0.676
 3 0.766 -0.025 -0.736 0.387 -0.206 -0.446 -0.886 0.092 0.484 -0.070 0.813
 4 -0.198 -0.012 -0.407 0.068 -0.086 -0.546 -0.378 0.661 -0.261 0.923 0.688
 year
age 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002
 1 -0.056 -0.016 -0.236 -0.207 -0.723 0.098 0.238 -0.012 -0.302 -0.099 0.192
 2 -1.247 0.351 0.024 -0.452 -0.511 -0.801 0.598 0.220 -1.453 -0.154 -0.082
 3 -0.074 0.019 0.310 -0.003 -1.015 0.236 0.463 0.050 -0.221 -0.286 0.027
 4 0.939 0.563 -1.501 0.810 0.081 0.180 0.952 -0.867 0.077 -0.438 NA
```

Table 10.3.1. Continued

```
 year
age 2003 2004 2005 2006 2007
 1 NA 0.313 -0.137 -0.094 -0.116
 2 NA 0.109 -0.632 0.317 -0.205
 3 NA 0.145 -0.161 -0.114 -0.789
```

```
 4 NA 0.881 NA 0.792 0.296
 Mean log catchability and standard error of ages with catchability
 independent of year class strength and constant w.r.t. time
 2 3 4
Mean_Logq -4.6891 -5.4550 -5.9960
S.E_Logq 0.5632 0.4363 0.7436
 Regression statistics
 Ages with q dependent on year class strength
 slope intercept
Age 1 0.7324117 5.825105
 Fleet: NL Beam Trawl
 Log catchability residuals.
 year
age 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999
 2 -0.511 -1.200 -0.676 -0.286 -0.719 0.164 0.270 -0.430 0.373 -0.225
 3 -0.254 -0.357 -0.249 -0.511 -0.240 -0.485 -0.102 0.042 -0.138 0.138
 4 -0.208 -0.128 -0.414 -0.206 -0.469 0.070 0.267 -0.135 0.204 -0.244
 5 -0.185 0.085 -0.276 0.056 -0.204 -0.733 0.069 0.034 -0.218 0.189
 6 -0.301 -0.478 -0.122 -0.017 0.001 -0.236 -0.213 0.299 0.052 -0.128
 7 -0.251 -0.334 0.173 0.212 -0.084 -0.216 0.197 -0.443 0.134 -0.309
 8 0.039 -0.258 -0.051 -0.140 -0.516 -0.120 0.234 0.497 -0.427 0.034
 9 0.063 0.105 0.196 0.049 0.155 0.127 0.077 -0.243 -0.149 0.316
 year
age 2000 2001 2002 2003 2004 2005 2006 2007
 2 0.212 0.322 0.302 0.341 0.378 0.168 0.647 0.871
 3 0.301 -0.040 0.330 0.252 0.338 0.335 0.227 0.413
 4 -0.094 0.295 0.061 0.338 0.218 0.285 0.038 0.121
 5 -0.173 0.286 0.268 0.008 0.204 0.557 0.059 -0.026
 6 0.253 -0.308 0.391 0.631 -0.140 0.183 0.167 -0.033
 7 0.314 0.020 -0.092 0.258 -0.004 0.266 0.342 -0.182
 8 0.394 0.041 0.628 -0.081 -0.487 -0.338 0.448 -0.080
 9 -0.246 -0.053 -0.115 -0.312 0.261 0.040 0.196 -0.236
 Mean log catchability and standard error of ages with catchability
 independent of year class strength and constant w.r.t. time
 2 3 4 5 6 7 8 9
Mean_Logq -6.0149 -5.1214 -4.9922 -4.9609 -5.1442 -5.2236 -5.2236 -5.2236
S.E_Logq 0.5389 0.3040 0.2483 0.2795 0.2802 0.2480 0.3405 0.1907
 Terminal year survivor and F summaries:

 Age 1 Year class = 2006
source
 survivors N scaledWts
BTS-ISIS 60059 1 0.405
SNS 44916 1 0.490
fshk 15369 1 0.014
nshk 83642 1 0.090
 Age 2 Year class = 2005
source
 survivors N scaledWts
BTS-ISIS 96852 2 0.428
SNS 93046 2 0.435
NL Beam Trawl 258157 1 0.124
fshk 141651 1 0.013
```

Table 10.3.1. Continued

```
 Age 3 Year class = 2004
source
 survivors N scaledWts
BTS-ISIS 12402 3 0.295
SNS 10079 3 0.358
NL Beam Trawl 22144 2 0.336
fshk 13960 1 0.012
 Age 4 Year class = 2003
source
 survivors N scaledWts
BTS-ISIS 6841 4 0.252
SNS 11096 4 0.271
NL Beam Trawl 11861 3 0.468
fshk 7328 1 0.010
 Age 5 Year class = 2002
source
 survivors N scaledWts
BTS-ISIS 7116 5 0.226
SNS 11148 3 0.110
NL Beam Trawl 9970 4 0.653
fshk 6444 1 0.011
 Age 6 Year class = 2001
source
 survivors N scaledWts
BTS-ISIS 8370 6 0.191
SNS 14844 2 0.072
NL Beam Trawl 13051 5 0.727
fshk 6225 1 0.010
 Age 7 Year class = 2000
source
 survivors N scaledWts
BTS-ISIS 931 7 0.180
SNS 1475 3 0.034
NL Beam Trawl 1377 6 0.774
fshk 1283 1 0.013
 Age 8 Year class = 1999
source
 survivors N scaledWts
BTS-ISIS 584 8 0.163
SNS 916 3 0.023
NL Beam Trawl 1300 7 0.798
fshk 1040 1 0.015
 Age 9 Year class = 1998
source
 survivors N scaledWts
BTS-ISIS 360 7 0.074
SNS 315 3 0.018
NL Beam Trawl 454 8 0.889
fshk 833 1 0.019
```

Table 10.3.2. Sole in sub area IV: fishing mortality at age

2008 – 04 – 23 08:59:03 units= f

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	0.437	0.205	0.490	0.369	0.318	0.360	0.349	0.349
1967	0.000	0.114	0.366	0.488	0.683	0.382	0.296	0.549	0.481	0.481
1968	0.011	0.308	0.695	0.643	0.506	0.296	0.268	0.395	0.423	0.423
1969	0.008	0.333	0.691	0.554	0.683	0.473	0.318	0.413	0.490	0.490
1970	0.010	0.153	0.643	0.549	0.320	0.332	0.382	0.368	0.391	0.391
1971	0.011	0.335	0.560	0.672	0.581	0.411	0.376	0.372	0.484	0.484
1972	0.005	0.238	0.661	0.523	0.531	0.362	0.228	0.310	0.392	0.392
1973	0.007	0.207	0.693	0.608	0.566	0.451	0.365	0.535	0.507	0.507
1974	0.001	0.188	0.592	0.643	0.517	0.513	0.560	0.389	0.527	0.527
1975	0.007	0.278	0.553	0.664	0.477	0.521	0.363	0.645	0.521	0.521
1976	0.010	0.107	0.566	0.513	0.560	0.374	0.472	0.411	0.633	0.633
1977	0.013	0.263	0.555	0.617	0.500	0.366	0.181	0.492	0.303	0.303
1978	0.001	0.236	0.573	0.538	0.525	0.526	0.648	0.545	0.525	0.525
1979	0.001	0.225	0.660	0.633	0.486	0.463	0.378	0.640	0.380	0.380
1980	0.004	0.128	0.555	0.592	0.585	0.408	0.587	0.526	0.590	0.590
1981	0.003	0.255	0.522	0.599	0.532	0.582	0.453	0.440	0.537	0.537
1982	0.018	0.231	0.697	0.559	0.628	0.601	0.511	0.528	0.539	0.539
1983	0.003	0.310	0.598	0.725	0.328	0.472	0.463	0.561	0.659	0.659
1984	0.003	0.290	0.720	0.679	0.670	0.714	0.534	0.428	0.589	0.589
1985	0.002	0.320	0.741	0.771	0.594	0.556	0.393	0.425	0.448	0.448
1986	0.002	0.145	0.622	0.687	0.675	0.747	0.743	0.328	0.574	0.574
1987	0.001	0.238	0.521	0.614	0.514	0.560	0.429	0.663	0.380	0.380
1988	0.000	0.238	0.660	0.737	0.619	0.585	0.532	0.411	0.925	0.925
1989	0.001	0.126	0.529	0.684	0.455	0.443	0.393	0.392	0.340	0.340
1990	0.005	0.137	0.408	0.531	0.581	0.619	0.492	0.586	0.605	0.605
1991	0.002	0.090	0.425	0.536	0.763	0.428	0.676	0.661	0.769	0.769
1992	0.003	0.120	0.435	0.467	0.488	0.627	0.670	0.608	0.856	0.856
1993	0.001	0.182	0.423	0.556	0.827	0.572	0.866	0.528	0.857	0.857
1994	0.013	0.140	0.480	0.636	0.674	0.881	0.513	0.643	0.903	0.903
1995	0.054	0.306	0.445	0.764	0.611	0.535	0.790	0.501	1.005	1.005
1996	0.004	0.275	0.696	0.980	0.700	0.842	0.718	0.989	0.503	0.503
1997	0.006	0.154	0.578	0.699	0.806	0.747	0.605	0.831	1.077	1.077
1998	0.002	0.279	0.616	0.790	0.762	0.735	0.611	0.936	1.007	1.007
1999	0.004	0.175	0.609	0.711	0.786	0.577	0.529	0.490	1.251	1.251
2000	0.020	0.240	0.580	0.792	0.615	0.766	0.848	0.702	0.397	0.397
2001	0.015	0.286	0.559	0.749	0.737	0.524	0.559	0.699	0.570	0.570
2002	0.006	0.231	0.627	0.638	0.712	0.624	0.444	0.898	0.451	0.451
2003	0.013	0.221	0.604	0.639	0.628	0.788	0.447	0.458	0.422	0.422
2004	0.012	0.230	0.521	0.691	0.613	0.446	0.364	0.283	0.978	0.978
2005	0.027	0.208	0.582	0.626	0.678	0.683	0.574	0.404	0.350	0.350
2006	0.039	0.294	0.429	0.435	0.426	0.503	0.545	0.504	0.392	0.392
2007	0.006	0.301	0.554	0.475	0.462	0.362	0.476	0.479	0.725	0.725

Table 10.3.3 Sole in sub area IV: stock numbers at age

2008 – 04 – 23 08:59:03 units= thousands

	age									
year	1	2	3	4	5	6	7	8	9	10
1957	128908	72453	89306	59105	17318	15057	27046	11836	2500	30811
1958	128641	116640	64213	71155	41455	12092	10843	18272	9061	26295
1959	488745	116399	103777	50074	50905	28474	7627	6950	12311	26788
1960	61713	442234	101842	82463	35415	37524	20277	5754	4362	32546
1961	99481	55840	388696	78707	58637	23191	25994	13738	3691	31943
1962	22894	90014	49614	304348	53010	41258	16518	19769	8360	29932
1963	20418	20715	79932	38985	219082	33368	27305	10355	13976	32248
1964	539022	8301	7991	27181	10395	59613	8153	6856	2665	9787
1965	121943	487675	7364	5221	19161	5783	37448	4404	4482	9389
1966	39894	110339	396464	5627	3203	12579	2872	21994	2503	8708
1967	75122	36097	88159	231635	4150	1775	7873	1891	13886	7979
1968	99255	67973	29156	55340	128616	1896	1096	5298	988	19808
1969	50722	88823	45193	13163	26318	70175	1276	759	3230	14248
1970	137729	45518	57615	20487	6844	12030	39584	840	454	16924
1971	42102	123386	35346	27407	10704	4496	7812	24440	526	12533
1972	76494	37696	79903	18261	12664	5419	2696	4855	15252	9045
1973	104808	68874	26885	37333	9793	6736	3415	1942	3221	15240
1974	109880	94166	50688	12167	18383	5033	3884	2144	1030	12304
1975	40793	99328	70575	25375	5790	9917	2725	2007	1315	8872
1976	113266	36660	68041	36715	11815	3253	5330	1715	953	5939
1977	140282	101497	29802	34964	19892	6107	2024	3007	1028	8470
1978	47226	125271	70599	15482	17077	10922	3833	1528	1663	4104
1979	11710	42706	89539	36017	8178	9137	5840	1815	802	5061
1980	151665	10587	30862	41857	17313	4550	5202	3622	866	2824
1981	149212	136626	8429	16024	20960	8724	2738	2618	1937	2285
1982	152721	134610	95832	4527	7968	11143	4412	1576	1526	3207
1983	142138	135657	96654	43198	2343	3847	5527	2396	841	2546
1984	70767	128241	90018	48089	18931	1527	2170	3146	1237	2100
1985	80799	63851	86803	39663	22059	8767	677	1152	1855	2827
1986	159603	72953	41967	37437	16592	11015	4550	413	681	4029
1987	72529	144059	57104	20378	17035	7644	4721	1958	269	2300
1988	454315	65537	102714	30699	9974	9220	3950	2781	913	548
1989	108277	411071	46726	48058	13288	4858	4650	2098	1669	1700
1990	177690	97862	327828	24908	21936	7625	2823	2840	1283	1947
1991	70469	159960	77193	197271	13247	11103	3714	1562	1431	2122
1992	354078	63649	132216	45667	104385	5590	6550	1709	730	2142
1993	69269	319451	51093	77421	25907	58002	2702	3034	842	1526
1994	57048	62626	241061	30281	40176	10249	29619	1028	1619	1593
1995	96086	50936	49243	134981	14510	18528	3841	16042	489	1098
1996	49489	82375	33945	28555	56909	7129	9814	1578	8794	2617
1997	271595	44616	56630	15314	9701	25565	2780	4333	531	2666
1998	114114	244237	34618	28744	6889	3919	10964	1373	1708	1390
1999	82525	103023	167110	16921	11803	2908	1700	5385	487	1183
2000	123016	74399	78225	82271	7523	4867	1478	906	2985	2281
2001	63299	109074	52981	39640	33727	3680	2047	573	406	1742
2002	190139	56435	74108	27397	16961	14603	1972	1059	258	1049
2003	85696	171042	40550	35806	13099	7533	7080	1144	390	1370
2004	46221	76544	124012	20047	17094	6317	3100	4095	655	650
2005	45123	41331	55039	66580	9080	8374	3656	1948	2791	1421
2006	184709	39729	30343	27789	32161	4162	3821	1859	1177	1738
2007	58512	161331	26926	17933	16321	19068	2286	2012	1022	1102
2008	52642	108036	14007	10093	9307	12010	1285	1127	931	

Table 10.4.1. Sole in sub area IV: XSA summary

	recruitment	ssb	landings	fbar2 – 6	Y/ssb
1957	128908	55107	12067	0.178	0.22
1958	128641	60919	14287	0.207	0.23
1959	488745	65580	13832	0.171	0.21
1960	61713	73397	18620	0.204	0.25
1961	99481	117096	23566	0.190	0.20
1962	22894	116827	26877	0.213	0.23
1963	20418	113623	26164	0.313	0.23
1964	539022	37125	11342	0.289	0.31
1965	121943	30026	17043	0.317	0.57
1966	39894	84233	33340	0.325	0.40
1967	75122	82944	33439	0.407	0.40
1968	99255	72287	33179	0.490	0.46
1969	50722	55245	27559	0.547	0.50
1970	137729	50653	19685	0.399	0.39
1971	42103	43703	23652	0.512	0.54
1972	76494	47379	21086	0.463	0.45
1973	104809	36707	19309	0.505	0.53
1974	109882	36025	17989	0.491	0.50
1975	40793	38270	20773	0.499	0.54
1976	113267	38852	17326	0.424	0.45
1977	140284	34391	18003	0.460	0.52
1978	47227	36077	20280	0.480	0.56
1979	11710	44780	22598	0.493	0.50
1980	151665	33477	15807	0.454	0.47
1981	149214	22829	15403	0.498	0.67
1982	152722	32752	21579	0.543	0.66
1983	142139	39859	24927	0.487	0.63
1984	70767	43355	26839	0.615	0.62
1985	80800	40960	24248	0.596	0.59
1986	159604	34429	18201	0.575	0.53
1987	72529	29563	17368	0.489	0.59
1988	454329	38687	21590	0.568	0.56
1989	108278	33971	21805	0.448	0.64
1990	177693	89534	35120	0.455	0.39
1991	70469	77364	33513	0.448	0.43
1992	354085	76650	29341	0.427	0.38
1993	69270	54645	31491	0.512	0.58
1994	57049	74226	33002	0.562	0.44
1995	96087	58827	30467	0.532	0.52
1996	49490	38198	22651	0.698	0.59
1997	271597	28016	14901	0.597	0.53
1998	114116	20835	20868	0.637	1.00
1999	82547	41865	23475	0.571	0.56
2000	123042	39148	22641	0.598	0.58
2001	63329	30692	19944	0.571	0.65
2002	190286	31234	16945	0.566	0.54
2003	85787	25534	17920	0.576	0.70
2004	46346	38584	18757	0.500	0.49
2005	45360	33766	16355	0.556	0.48
2006	185462	26013	12594	0.417	0.48
2007	58512	19114	14635	0.431	0.77

Table 10.5.1. Sole in sub area IV: RCT3 input table

Year Class	N age 1	N age 2	DFS 0	DFS 2	SNS 1	SNS 2	SNS 3	BTS 1	BTS 2
1968	50659	45461	-11.00	-11.00	-11	734	110.35	-11.00	-11.00
1969	137647	123313	-11.00	-11.00	5410	1844	148.55	-11.00	-11.00
1970	42054	37653	-11.00	-11.00	893	272	83.81	-11.00	-11.00
1971	76466	68849	-11.00	-11.00	1455	935	65.16	-11.00	-11.00
1972	104733	94098	-11.00	-11.00	5587	361	165.84	-11.00	-11.00
1973	109877	99325	-11.00	-11.00	2348	848	229.11	-11.00	-11.00
1974	40800	36667	-11.00	2.86	529	74	103.84	-11.00	-11.00
1975	113287	101516	168.84	6.95	1399	776	294.07	-11.00	-11.00
1976	140279	125268	82.28	9.69	3743	1355	300.84	-11.00	-11.00
1977	47222	42703	33.80	2.13	1548	408	109.33	-11.00	-11.00
1978	11727	10602	96.87	2.27	94	89	49.97	-11.00	-11.00
1979	151673	136633	392.08	48.21	4313	1413	227.78	-11.00	-11.00
1980	149243	134639	404.00	13.39	3737	1146	120.58	-11.00	-11.00
1981	152775	135707	293.93	14.28	5856	1123	318.32	-11.00	-11.00
1982	142187	128286	328.52	20.32	2621	1100	167.07	-11.00	-11.00
1983	70797	63878	104.38	11.89	2493	716	69.24	-11.00	7.89
1984	80799	72953	186.53	3.43	3619	458	64.82	2.65	4.49
1985	159603	144059	315.03	10.47	3705	944	281.61	7.88	12.55
1986	72529	65537	73.22	6.43	1948	594	207.56	6.97	12.51
1987	454315	411071	523.86	35.04	11227	5005	914.25	83.11	68.08
1988	108277	97862	50.07	11.59	2831	1120	513.84	9.02	22.36
1989	177690	159960	77.80	11.25	2856	2529	360.41	22.60	23.19
1990	70469	63649	21.09	8.26	1254	144	153.78	3.71	23.20
1991	354078	319451	391.93	17.90	11114	3420	934.10	74.44	27.36
1992	69269	62626	25.30	10.67	1291	498	142.85	4.99	4.99
1993	57048	50936	25.13	6.18	652	224	29.60	5.88	8.46
1994	96086	82375	69.11	9.82	1362	349	189.82	27.86	6.17
1995	49489	44616	19.07	3.99	218	154	141.71	3.51	5.37
1996	271595	244237	59.62	19.02	10279	3126	455.61	173.94	29.21
1997	114114	103023	44.08	-11.00	4095	972	166.28	14.12	19.26
1998	82525	74399	-11.00	-11.00	1649	126	106.67	11.41	6.53
1999	123016	109074	-11.00	4.53	1639	655	195.30	14.46	10.71
2000	63299	56435	15.51	3.93	970	379	-11.00	8.17	4.17
2001	190139	171042	85.31	18.19	7542	-11	393.00	21.90	10.55
2002	85696	76544	64.97	5.19	-11	624	124.00	10.76	4.40
2003	46221	41331	16.82	8.68	1369	163	79.80	3.65	3.30
2004	-11	-11	40.10	8.85	568	382	33.30	3.14	2.44
2005	-11	-11	46.81	-11.00	4167	911	-11.00	16.82	19.97
2006	-11	-11	14.69	-11.00	849	-11	-11.00	5.81	-11.00
2007	-11	-11	23.51	-11.00	-11	-11	-11.00	-11.00	-11.00

Table 10.5.2. Sole in sub area IV: RCT3 analysis

```
Analysis by RCT3 ver3.1 of data from file : altin_1.txt
Sole North Sea Age 1
 Data for 8 surveys over 40 years : 1968 – 2007
 Regression type = C; Tapered time weighting not applied;
 Survey weighting not applied
 Final estimates shrunk towards mean;
Minimum S.E. for any survey taken as .00
 Minimum of 3 points used for regression;
Forecast/Hindcast variance correction used.
 Yearclass = 2005
 I-----------Regression----------I I-----------Prediction---------I
 Survey/ Slope Inter- Std Rsquare No. Index Predicted Std WAP
 Series cept Error Pts Value Value Error Weights
 DFS0   1.17 6.28 1.05 .336 27 3.87 10.82 1.119 .031
 SNS1    .74 5.81 .35 .802 34 8.34 11.98 .367 .293
 SNS2    .77 6.49 .42 .733 35 6.82 11.75 .436 .207
 BTS1    .70 9.77 .37 .763 20 2.88 11.78 .398 .249
 BTS2   1.08 8.90 .50 .633 21 3.04 12.18 .540 .135
 Yearclass = 2006
 I-----------Regression----------I I-----------Prediction---------I
 Survey/ Slope Inter- Std Rsquare No. Index Predicted Std WAP
 Series cept Error Pts Value Value Error Weights
 DFS0   1.17 6.28 1.05 .336 27 2.75 9.52 1.164 .045
 SNS1    .74 5.81 .35 .802 34 6.74 10.80 .369 .447
 BTS1    .70 9.77 .37 .763 20 1.92 11.11 .401 .377
 Yearclass = 2007
 I-----------Regression----------I I-----------Prediction---------I
 Survey/ Slope Inter- Std Rsquare No. Index Predicted Std WAP
 Series cept Error Pts Value Value Error Weights
 DFS0   1.17 6.28 1.05 .336 27 3.20 10.04 1.141 .262
 VPA Mean = 11.47 .680 .738

 Year Weighted Log Int Ext Var
 Class Average WAP Std Std Ratio
 Prediction Error Error
 2005 137061 11.83 .20 .12 .35
 2006 56737 10.95 .25 .22 .81
 2007 65658 11.09 .58 .63 1.16
```

Table 10.5.3. Sole in sub area IV: Output RCT3 – age 2

```
Sole North Sea-Age 2

 Yearclass = 2005
 I-----------Regression----------I I-----------Prediction---------I
 Survey/ Slope Inter- Std Rsquare No. Index Predicted Std WAP
 Series cept Error Pts Value Value Error Weights
 DFS0    1.17 6.19 1.05 .337 27 3.87 10.72 1.115 .032
 SNS1    .74 5.70 .35 .804 34 8.34 11.87 .365 .297
 SNS2    .77 6.39 .41 .735 35 6.82 11.64 .433 .211
 BTS1    .71 9.64 .38 .755 20 2.88 11.68 .409 .237
 BTS2    1.08 8.80 .49 .639 21 3.04 12.07 .535 .138
 Yearclass = 2006
 I-----------Regression----------I I-----------Prediction---------I
 Survey/ Slope Inter- Std Rsquare No. Index Predicted Std WAP
 Series cept Error Pts Value Value Error Weights
 DFS0    1.17 6.19 1.05 .337 27 2.75 9.41 1.159 .046
 SNS1    .74 5.70 .35 .804 34 6.74 10.69 .367 .458
 BTS1    .71 9.64 .38 .755 20 1.92 11.00 .413 .362
 Yearclass = 2007
 I-----------Regression----------I I-----------Prediction---------I
 Survey/ Slope Inter- Std Rsquare No. Index Predicted Std WAP
 Series cept Error Pts Value Value Error Weights
 DFS0    1.17 6.19 1.05 .337 27 3.20 9.93 1.136 .264
 VPA Mean = 11.36 .680 .736
 Year Weighted Log Int Ext Var VPA Log
 Class Average WAP Std Std Ratio VPA
 Prediction Error Error
 2005 123271 11.72 .20 .12 .35
 2006 50654 10.83 .25 .22 .80
 2007 58893 10.98 .58 .63 1.16
```

Table 10.6.1. Sole in sub area IV: STF Input table (F values presented are for Fsq)

```
age year f stock.n stock.wt landings.wt mat M
 1 2008 0.024 93570 0.05 0.16 0 0.1
 2 2008 0.268 52642 0.15 0.19 0 0.1
 3 2008 0.522 108036 0.19 0.21 1 0.1
 4 2008 0.512 14007 0.23 0.25 1 0.1
 5 2008 0.522 10093 0.25 0.26 1 0.1
 6 2008 0.516 9307 0.27 0.29 1 0.1
 7 2008 0.532 12010 0.28 0.28 1 0.1
 8 2008 0.462 1285 0.33 0.34 1 0.1
 9 2008 0.489 1127 0.34 0.33 1 0.1
 10 2008 0.489 931 0.42 0.37 1 0.1
 1 2009 0.024 93570 0.05 0.16 0 0.1
 2 2009 0.268 0.15 0.19 0 0.1
 3 2009 0.522 0.19 0.21 1 0.1
 4 2009 0.512 0.23 0.25 1 0.1
 5 2009 0.522 0.25 0.26 1 0.1
 6 2009 0.516 0.27 0.29 1 0.1
 7 2009 0.532 0.28 0.28 1 0.1
 8 2009 0.462 0.33 0.34 1 0.1
 9 2009 0.489 0.34 0.33 1 0.1
 10 2009 0.489 0.42 0.37 1 0.1
 1 2010 0.024 93570 0.05 0.16 0 0.1
 2 2010 0.268 0.15 0.19 0 0.1
 3 2010 0.522 0.19 0.21 1 0.1
 4 2010 0.512 0.23 0.25 1 0.1
 5 2010 0.522 0.25 0.26 1 0.1
 6 2010 0.516 0.27 0.29 1 0.1
 7 2010 0.532 0.28 0.28 1 0.1
 8 2010 0.462 0.33 0.34 1 0.1
 9 2010 0.489 0.34 0.33 1 0.1
 10 2010 0.489 0.42 0.37 1 0.1
```

Table 10.6.2. (A) Sole in sub area IV: STF option table, assuming F(2008) = F(sq)

2008

SSB	Fmult	Fbar	Landings
33236	1	0.468	16552

year	fmult	f2 – 6	landings	ssb 2009	ssb 2010
2009	0.0	0.000	0	28016	42334
2009	0.1	0.047	1842	28016	40550
2009	0.2	0.094	3605	28016	38847
2009	0.3	0.140	5291	28016	37221
2009	0.4	0.187	6904	28016	35667
2009	0.5	0.234	8449	28016	34184
2009	0.6	0.281	9926	28016	32766
2009	0.7	0.328	11341	28016	31412
2009	0.8	0.374	12696	28016	30117
2009	0.9	0.421	13993	28016	28881
2009	1.0	0.468	15236	28016	27699
2009	1.1	0.515	16426	28016	26569
2009	1.2	0.561	17567	28016	25489
2009	1.3	0.608	18660	28016	24456
2009	1.4	0.655	19708	28016	23469
2009	1.5	0.702	20712	28016	22525
2009	1.6	0.749	21675	28016	21621
2009	1.7	0.795	22599	28016	20758
2009	1.8	0.842	23485	28016	19931
2009	1.9	0.889	24335	28016	19141
2009	2.0	0.936	25150	28016	18384

Table 10.6.2. (B) Sole in sub area IV: STF option table, assuming F(2008) = 0.9*F(sq)

2008

SSB	Fmult	Fbar	Landings
33236	1	0.421	15222

2009

year	fmult	f2 – 6	landings	ssb 2009	ssb 2010
2009	0.0	0.000	0	29332	43674
2009	0.1	0.047	1910	29332	41824
2009	0.2	0.094	3736	29332	40058
2009	0.3	0.140	5483	29332	38373
2009	0.4	0.187	7154	29332	36762
2009	0.5	0.234	8753	29332	35225
2009	0.6	0.281	10283	29332	33756
2009	0.7	0.328	11748	29332	32353
2009	0.8	0.374	13150	29332	31013
2009	0.9	0.421	14493	29332	29732
2009	1.0	0.468	15778	29332	28508
2009	1.1	0.515	17009	29332	27339
2009	1.2	0.561	18189	29332	26221
2009	1.3	0.608	19319	29332	25152
2009	1.4	0.655	20402	29332	24131
2009	1.5	0.702	21440	29332	23154
2009	1.6	0.749	22435	29332	22220
2009	1.7	0.795	23389	29332	21327
2009	1.8	0.842	24303	29332	20473
2009	1.9	0.889	25181	29332	19656
2009	2.0	0.936	26023	29332	18874

Table 10.6.2. (C) Sole in sub area IV: STF option table, assuming F(2008)~Landings for 2008=TAC for 2008

2008

SSB	Fmult	Fbar	Landings
33236	1	0.341	12800

2009

year	fmult	f2 – 6	landings	ssb 2009	ssb 2010
2009	0.0	0.000	0	31735	46116
2009	0.1	0.047	2032	31735	44146
2009	0.2	0.094	3975	31735	42266
2009	0.3	0.140	5833	31735	40471
2009	0.4	0.187	7609	31735	38758
2009	0.5	0.234	9309	31735	37122
2009	0.6	0.281	10935	31735	35560
2009	0.7	0.328	12490	31735	34069
2009	0.8	0.374	13979	31735	32644
2009	0.9	0.421	15403	31735	31283
2009	1.0	0.468	16767	31735	29983
2009	1.1	0.515	18073	31735	28741
2009	1.2	0.561	19323	31735	27555
2009	1.3	0.608	20521	31735	26421
2009	1.4	0.655	21668	31735	25337
2009	1.5	0.702	22767	31735	24301
2009	1.6	0.749	23820	31735	23311
2009	1.7	0.795	24829	31735	22365
2009	1.8	0.842	25797	31735	21460
2009	1.9	0.889	26724	31735	20595
2009	2.0	0.936	27614	31735	19767

Table 10.6.3. (A) Sole in sub area IV: STF detailed, assuming F(2008) = F(sq)

age	year	f	stock.n	stock.wt	landings.wt	mat	M	landings.n	landings	SSB	TSB
1	2008	0.024	93570	0.05	0.16	0	0.1	2120	340	0	4678
2	2008	0.268	52642	0.15	0.19	0	0.1	11801	2184	0	7896
3	2008	0.522	108036	0.19	0.21	1	0.1	41973	8849	20347	20347
4	2008	0.512	14007	0.23	0.25	1	0.1	5363	1329	3268	3268
5	2008	0.522	10093	0.25	0.26	1	0.1	3922	1028	2520	2520
6	2008	0.516	9307	0.27	0.29	1	0.1	3586	1050	2550	2550
7	2008	0.532	12010	0.28	0.28	1	0.1	4734	1347	3351	3351
8	2008	0.462	1285	0.33	0.34	1	0.1	455	157	424	424
9	2008	0.489	1127	0.34	0.33	1	0.1	416	139	389	389
10	2008	0.489	931	0.42	0.37	1	0.1	344	129	387	387
1	2009	0.024	93570	0.05	0.16	0	0.1	2120	340	0	4678
2	2009	0.268	82651	0.15	0.19	0	0.1	18528	3429	0	12398
3	2009	0.522	36437	0.19	0.21	1	0.1	14156	2984	6862	6862
4	2009	0.512	58017	0.23	0.25	1	0.1	22212	5506	13537	13537
5	2009	0.522	7597	0.25	0.26	1	0.1	2952	774	1897	1897
6	2009	0.516	5420	0.27	0.29	1	0.1	2088	611	1485	1485
7	2009	0.532	5026	0.28	0.28	1	0.1	1981	564	1402	1402
8	2009	0.462	6385	0.33	0.34	1	0.1	2258	778	2105	2105
9	2009	0.489	732	0.34	0.33	1	0.1	271	90	253	253
10	2009	0.489	1142	0.42	0.37	1	0.1	422	158	475	475
1	2010	0.024	93570	0.05	0.16	0	0.1	2120	340	0	4678
2	2010	0.268	82651	0.15	0.19	0	0.1	18528	3429	0	12398
3	2010	0.522	57207	0.19	0.21	1	0.1	22226	4686	10774	10774
4	2010	0.512	19567	0.23	0.25	1	0.1	7491	1857	4566	4566
5	2010	0.522	31465	0.25	0.26	1	0.1	12227	3205	7856	7856
6	2010	0.516	4079	0.27	0.29	1	0.1	1572	460	1118	1118
7	2010	0.532	2927	0.28	0.28	1	0.1	1154	328	817	817
8	2010	0.462	2672	0.33	0.34	1	0.1	945	326	881	881
9	2010	0.489	3638	0.34	0.33	1	0.1	1344	447	1255	1255
10	2010	0.489	1040	0.42	0.37	1	0.1	384	144	433	433

Table 10.6.3. (B) Sole in sub area IV: STF detailed, assuming F(2008) = 0.9*F(sq)

age	year	f	stock.n	stock.wt	landings.wt	mat	M	landings.n	landings	SSB	TSB
1	2008	0.020	93570	0.05	0.16	0	0.1	1759	283	0	4678
2	2008	0.222	52642	0.15	0.19	0	0.1	9990	1849	0	7896
3	2008	0.432	108036	0.19	0.21	1	0.1	36207	7633	20347	20347
4	2008	0.424	14007	0.23	0.25	1	0.1	4623	1146	3268	3268
5	2008	0.432	10093	0.25	0.26	1	0.1	3383	887	2520	2520
6	2008	0.427	9307	0.27	0.29	1	0.1	3092	905	2550	2550
7	2008	0.441	12010	0.28	0.28	1	0.1	4087	1163	3351	3351
8	2008	0.383	1285	0.33	0.34	1	0.1	390	135	424	424
9	2008	0.405	1127	0.34	0.33	1	0.1	358	119	389	389
10	2008	0.405	931	0.42	0.37	1	0.1	296	111	387	387
1	2009	0.022	93570	0.05	0.16	0	0.1	1953	314	0	4678
2	2009	0.247	82993	0.15	0.19	0	0.1	17297	3201	0	12449
3	2009	0.480	38151	0.19	0.21	1	0.1	13900	2930	7185	7185
4	2009	0.471	63452	0.23	0.25	1	0.1	22774	5646	14805	14805
5	2009	0.480	8294	0.25	0.26	1	0.1	3022	792	2071	2071
6	2009	0.475	5928	0.27	0.29	1	0.1	2141	627	1624	1624
7	2009	0.489	5492	0.28	0.28	1	0.1	2031	578	1532	1532
8	2009	0.426	6995	0.33	0.34	1	0.1	2316	798	2306	2306
9	2009	0.450	793	0.34	0.33	1	0.1	274	91	273	273
10	2009	0.450	1242	0.42	0.37	1	0.1	430	161	517	517
1	2010	0.022	93570	0.05	0.16	0	0.1	1953	314	0	4678
2	2010	0.247	82809	0.15	0.19	0	0.1	17259	3194	0	12421
3	2010	0.480	58682	0.19	0.21	1	0.1	21381	4507	11052	11052
4	2010	0.471	21357	0.23	0.25	1	0.1	7665	1900	4983	4983
5	2010	0.480	35843	0.25	0.26	1	0.1	13062	3424	8949	8949
6	2010	0.475	4642	0.27	0.29	1	0.1	1677	491	1272	1272
7	2010	0.489	3335	0.28	0.28	1	0.1	1234	351	931	931
8	2010	0.426	3046	0.33	0.34	1	0.1	1008	348	1004	1004
9	2010	0.450	4135	0.34	0.33	1	0.1	1431	476	1427	1427
10	2010	0.450	1174	0.42	0.37	1	0.1	406	152	488	488

Table 10.6.3. (B) Sole in sub area IV: STF detailed, assuming F(2008) = TAC

age	year	f	stock.n	stock.wt	landings.wt	mat	M	landings.n	landings	SSB	TSB

```
1 2008 0.018 93570 0.05 0.16 0 0.1 1550 249 0 4678
2 2008 0.195 52642 0.15 0.19 0 0.1 8901 1647 0 7896
3 2008 0.380 108036 0.19 0.21 1 0.1 32621 6877 20347 20347
4 2008 0.373 14007 0.23 0.25 1 0.1 4163 1032 3268 3268
5 2008 0.380 10093 0.25 0.26 1 0.1 3048 799 2520 2520
6 2008 0.376 9307 0.27 0.29 1 0.1 2785 815 2550 2550
7 2008 0.388 12010 0.28 0.28 1 0.1 3684 1048 3351 3351
8 2008 0.337 1285 0.33 0.34 1 0.1 351 121 424 424
9 2008 0.356 1127 0.34 0.33 1 0.1 322 107 389 389
10 2008 0.356 931 0.42 0.37 1 0.1 266 100 387 387
1 2009 0.022 93570 0.05 0.16 0 0.1 1953 314 0 4678
2 2009 0.247 83192 0.15 0.19 0 0.1 17339 3209 0 12479
3 2009 0.480 39183 0.19 0.21 1 0.1 14276 3010 7379 7379
4 2009 0.471 66836 0.23 0.25 1 0.1 23989 5947 15595 15595
5 2009 0.480 8728 0.25 0.26 1 0.1 3181 834 2179 2179
6 2009 0.475 6244 0.27 0.29 1 0.1 2256 660 1711 1711
7 2009 0.489 5781 0.28 0.28 1 0.1 2138 608 1613 1613
8 2009 0.426 7375 0.33 0.34 1 0.1 2442 842 2431 2431
9 2009 0.450 830 0.34 0.33 1 0.1 287 96 286 286
10 2009 0.450 1304 0.42 0.37 1 0.1 451 169 543 543
1 2010 0.022 93570 0.05 0.16 0 0.1 1953 314 0 4678
2 2010 0.247 82809 0.15 0.19 0 0.1 17259 3194 0 12421
3 2010 0.480 58823 0.19 0.21 1 0.1 21432 4518 11078 11078
4 2010 0.471 21934 0.23 0.25 1 0.1 7873 1952 5118 5118
5 2010 0.480 37755 0.25 0.26 1 0.1 13758 3607 9426 9426
6 2010 0.475 4885 0.27 0.29 1 0.1 1765 517 1339 1339
7 2010 0.489 3513 0.28 0.28 1 0.1 1299 370 980 980
8 2010 0.426 3206 0.33 0.34 1 0.1 1062 366 1057 1057
9 2010 0.450 4360 0.34 0.33 1 0.1 1509 502 1504 1504
10 2010 0.450 1231 0.42 0.37 1 0.1 426 160 512 512
```

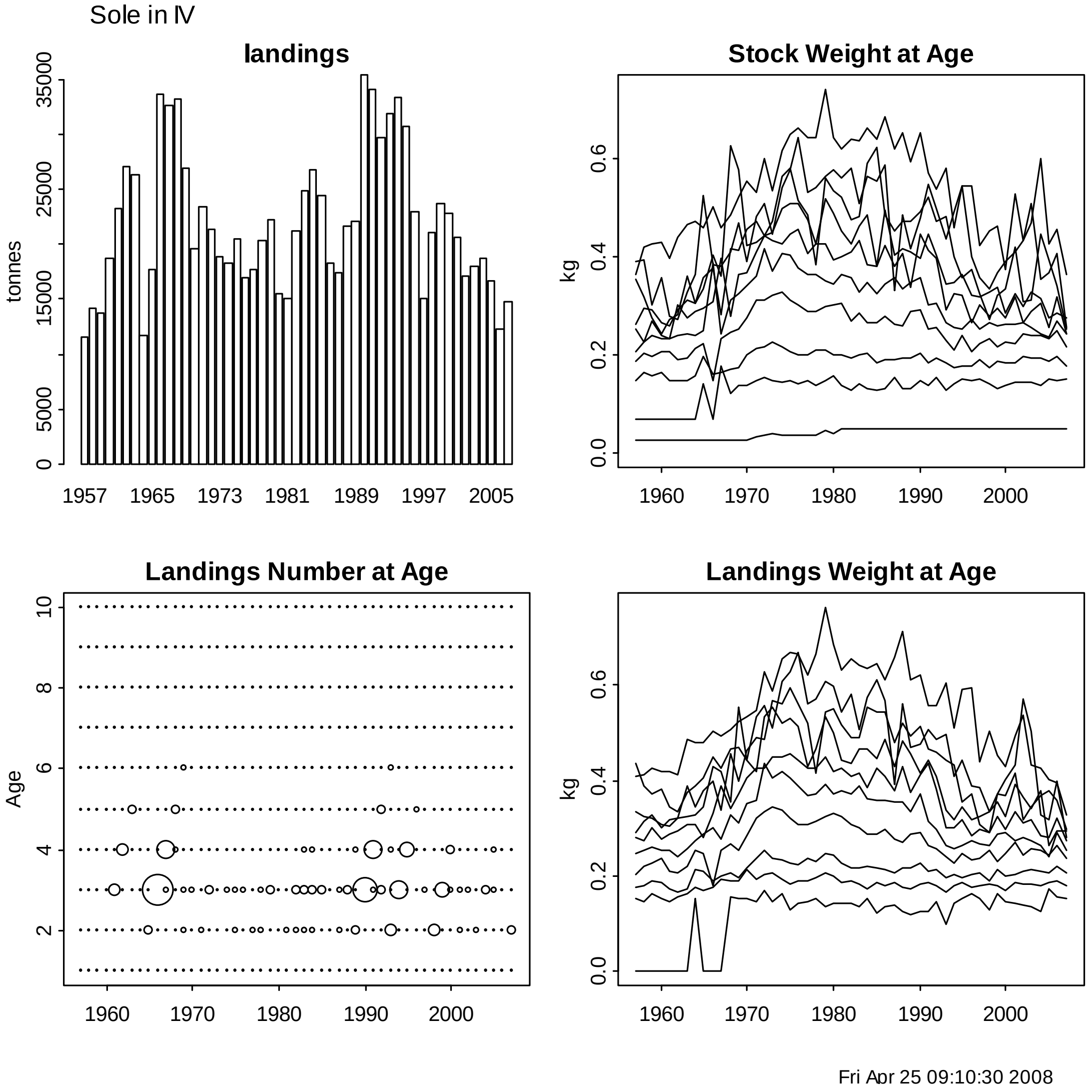


Figure 10.2.1. Sole in Sub-Area IV: Time series of landings (a- top left), standardised landing numbers at age (b-bottom left), stock weights and landing weights (c & d left).

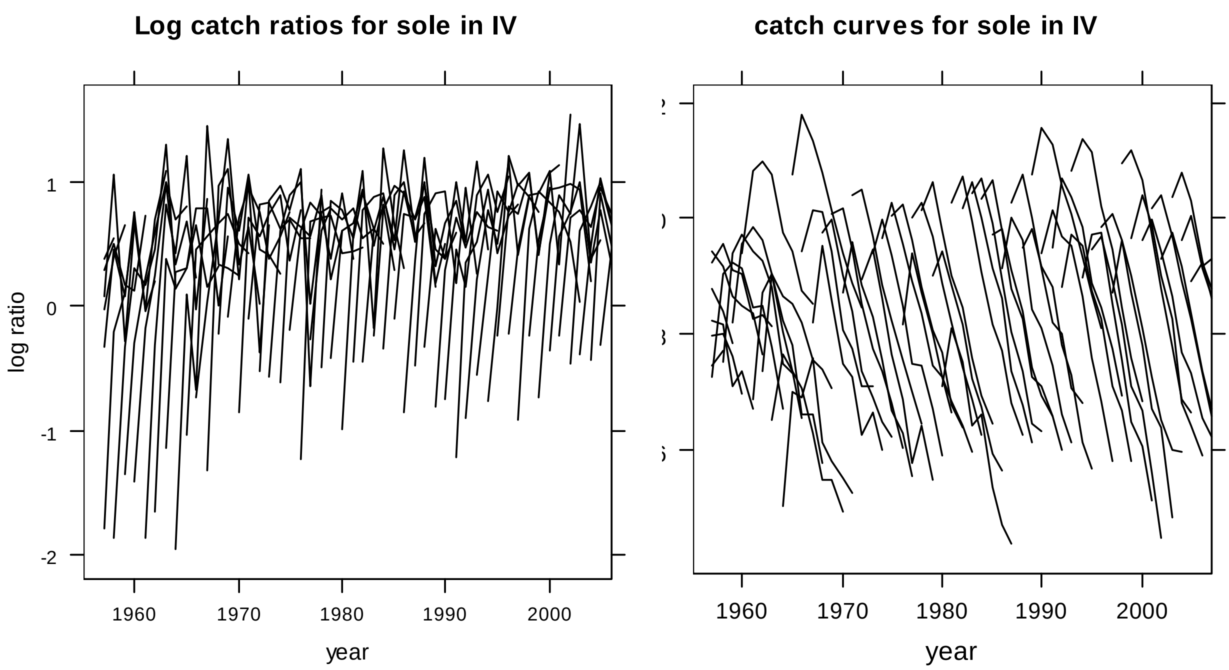


Figure 10.2.2. Sole in Sub-Area IV: (a) Log catch ratio (top figure) and (b) catch curves from 1957 to 2007.

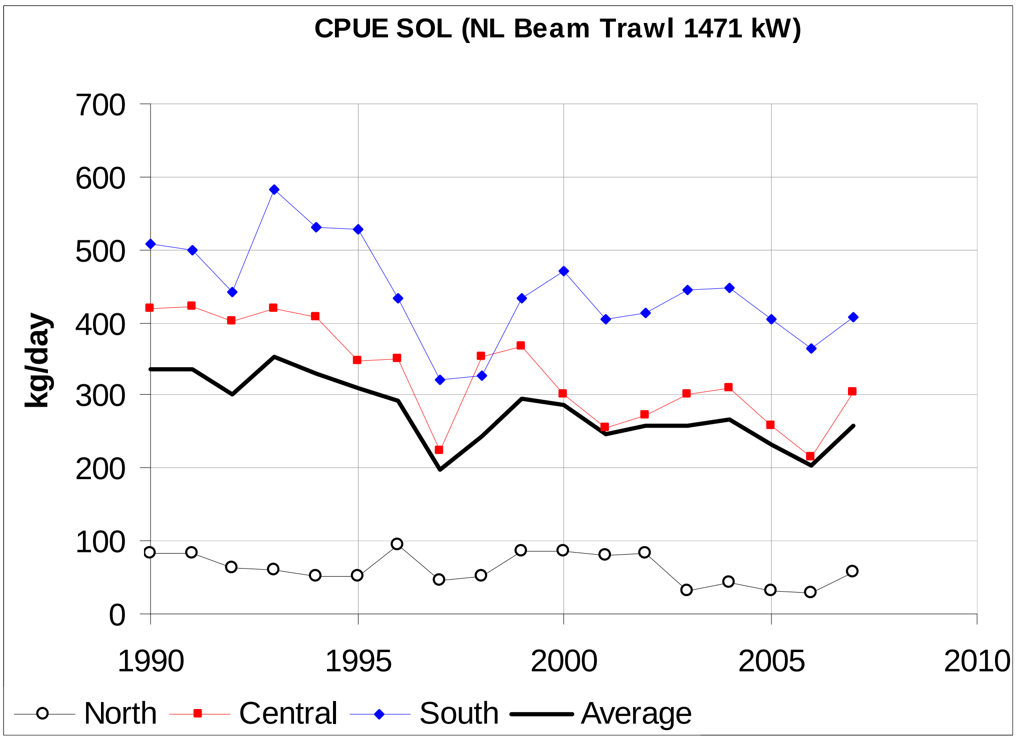


Figure 10.2.3. Sole in Sub-Area IV: LpUE serie

LpUE trends in the Dutch beam trawl fleet (only large vessels, 2000 HP,) based on landings and effort records in the Dutch logbook database from vessels landings into the Netherlands. Three (North Sea) areas are considered: a) (north, open circles), b) (central, red squares) and c) (south, diamond blue). Black line indicates the overall trend in LpUE)

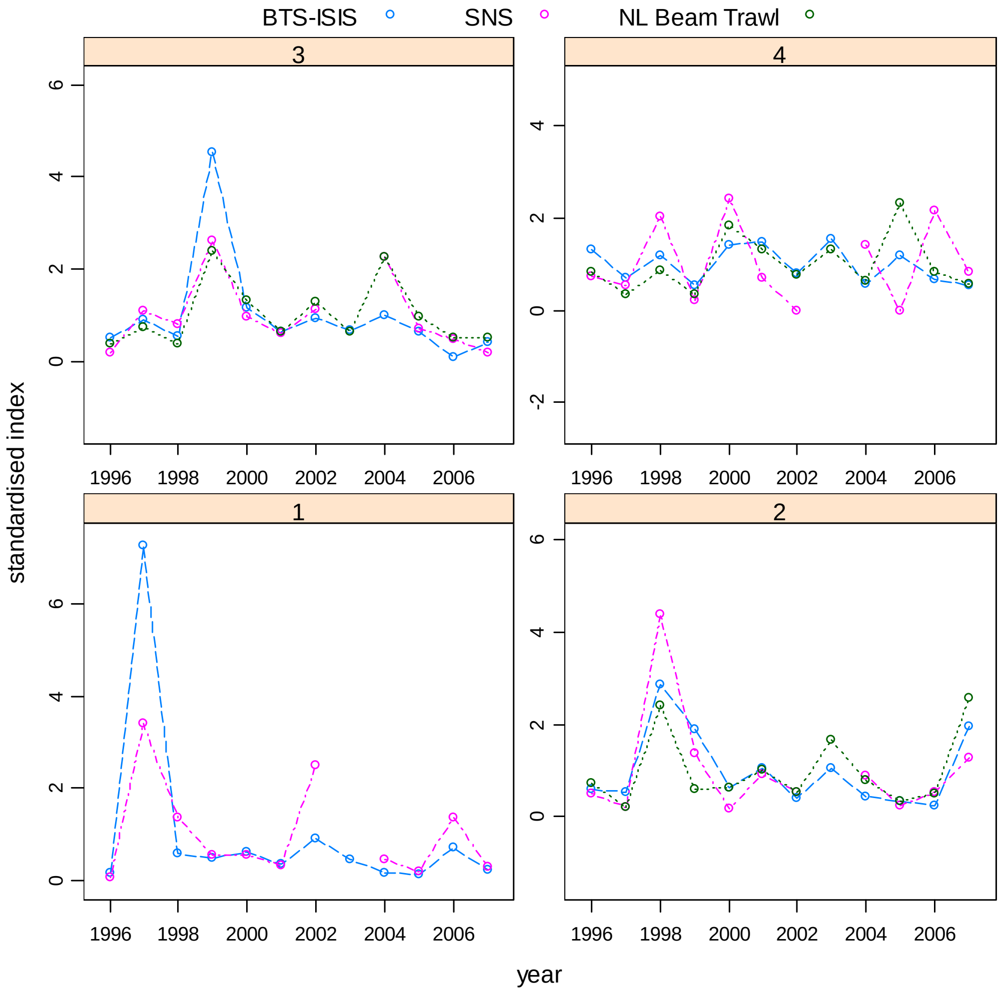


Figure 10.2.4 Sole in sub-area IV. Time series of the standardized indices age 1 to 4 from tuning fleets BTS-ISIS, SNS and NL beam trawl.

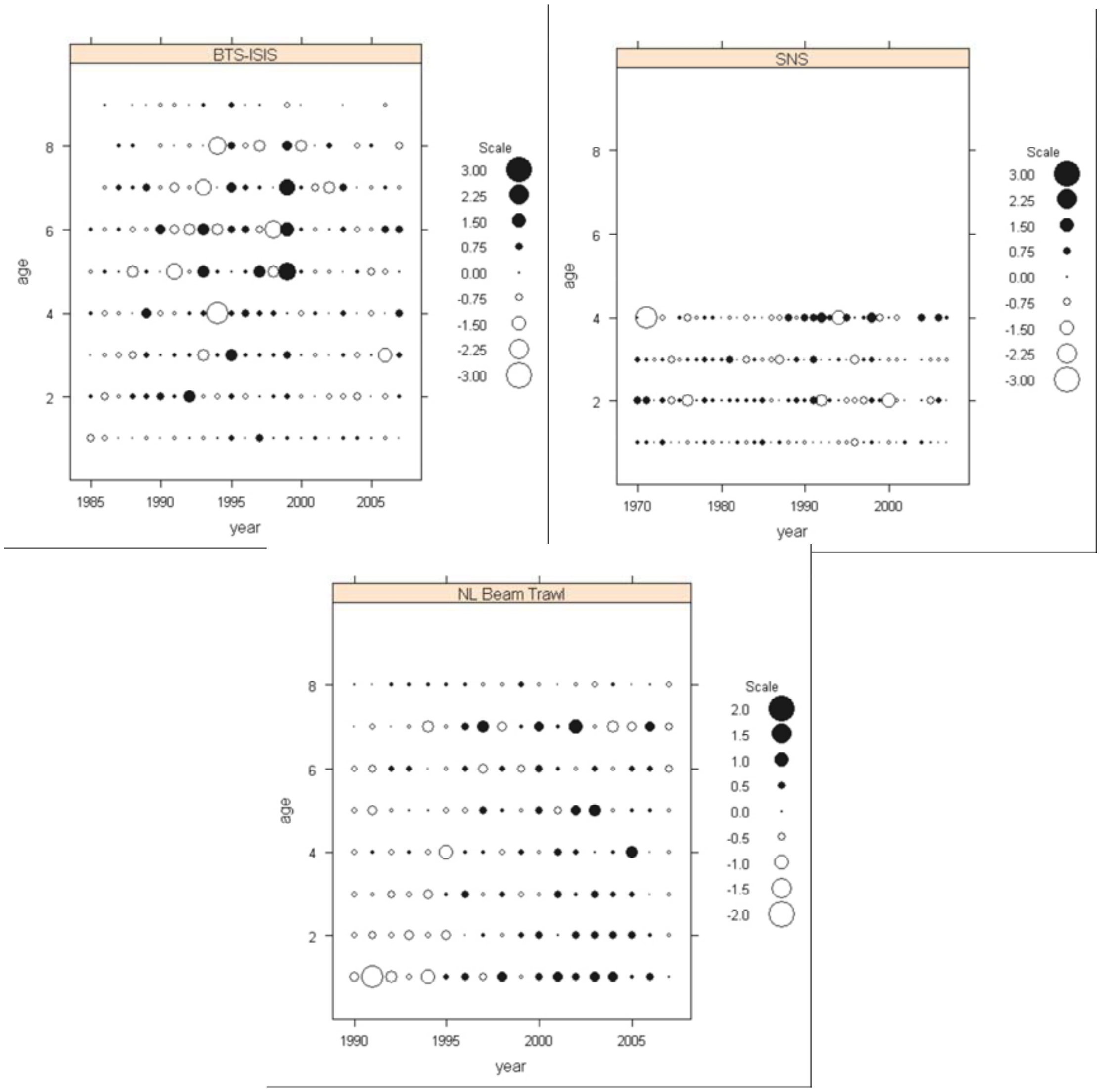


Figure 10.3.1 Sole in sub-area IV. log catchability residuals for the tuning fleets, BTS, SNS and NL beam trawl, in the single fleet runs. Closed and dark- circles indicate positive residuals, Open circles indicate negative residuals

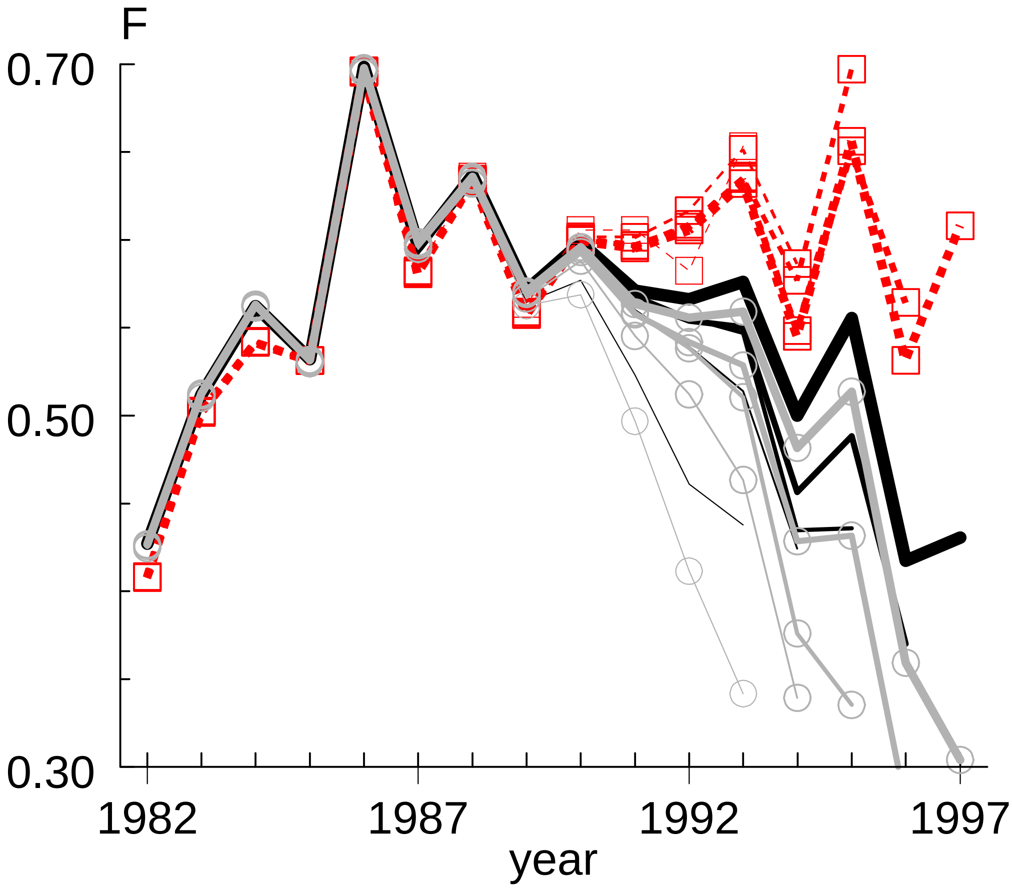


Figure 10.3.2 Sole in sub-area IV. XSA retrospective analysis of assessment estimates of fishing mortality using different combinations of indices. Open squares markers: using survey indices only, open circle markers is the result of using the commercial lpue index only and black without markers is the result of assessments using all three indices

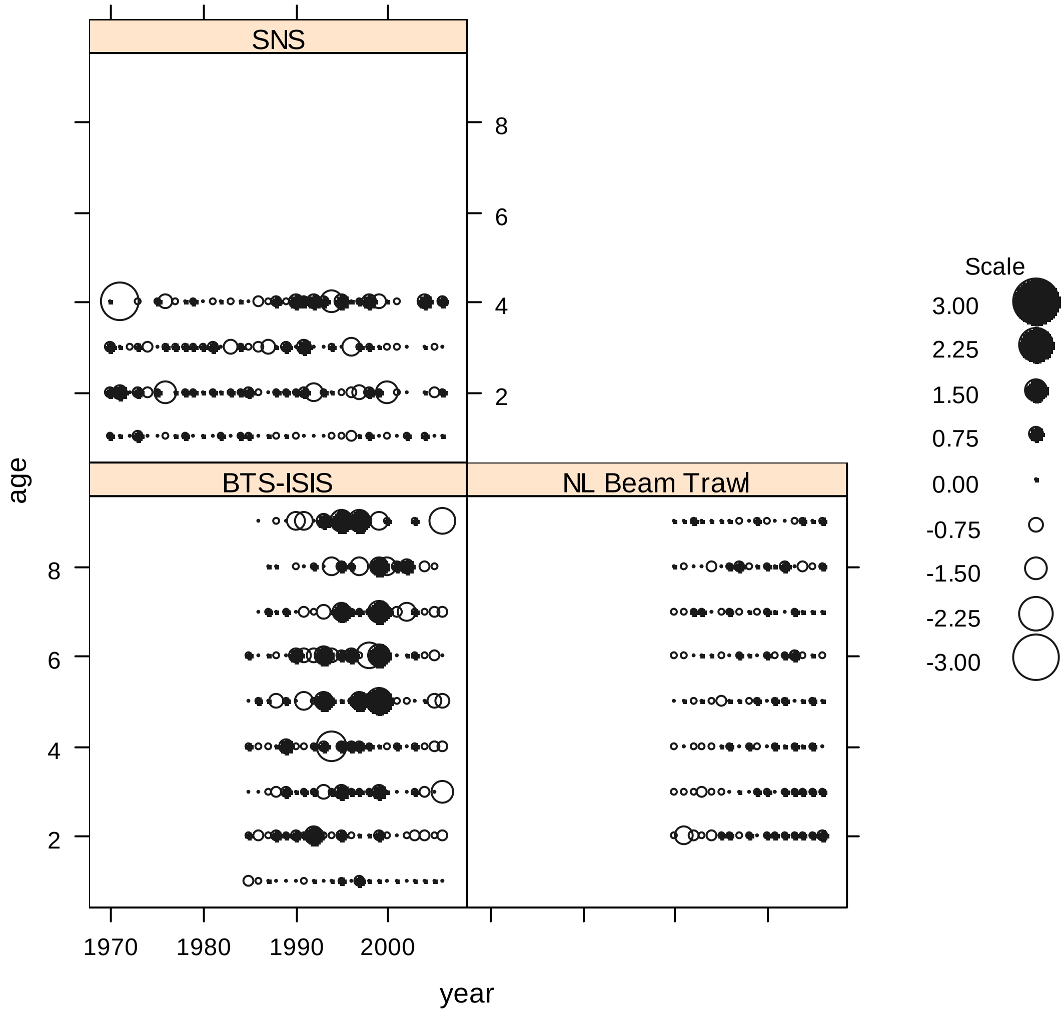


Figure 10.3.3 Sole in sub-area IV. log catchability residuals for the tuning fleets, BTS, SNS and NL beam trawl, in the final run. Closed and dark- circles indicate positive residuals, Open circles indicate negative residuals

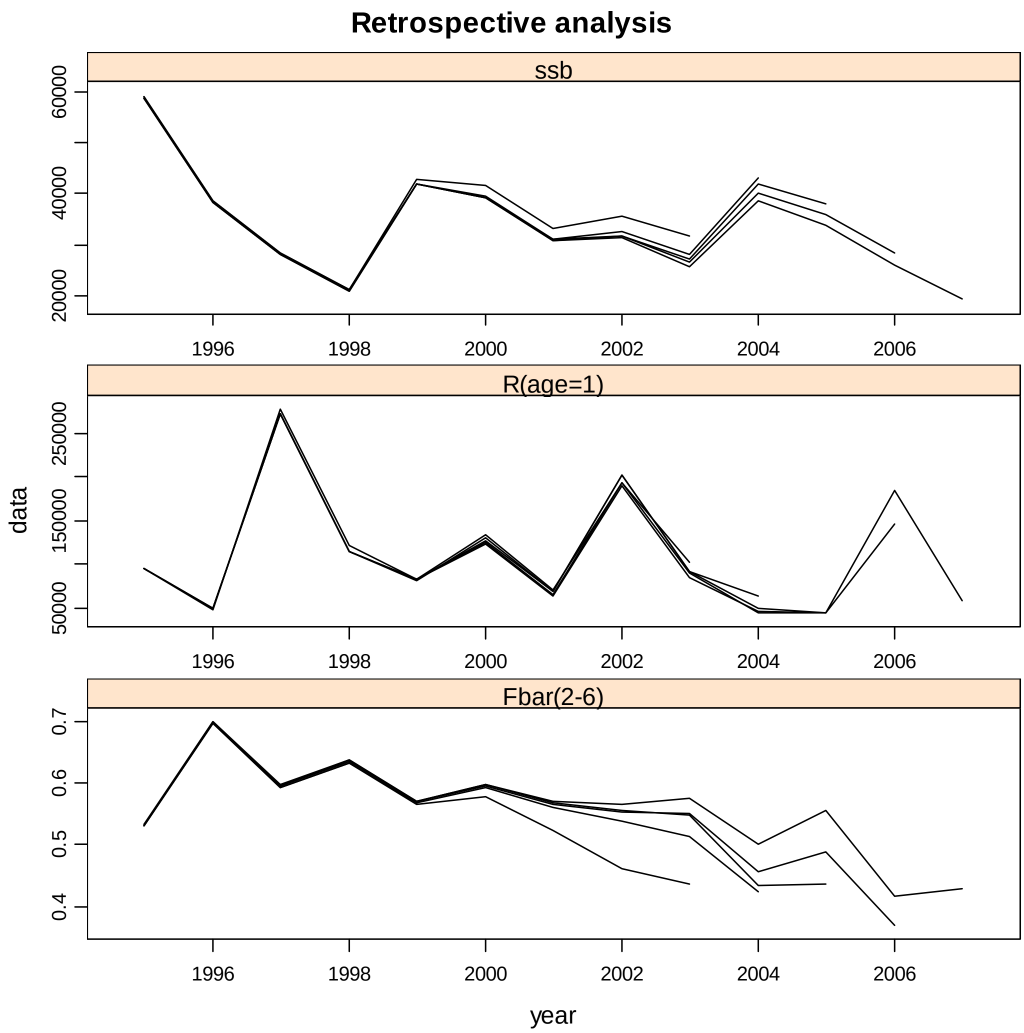


Figure 10.3.4 Sole in sub-area IV. Retrospective analysis of F, SSB and recruitment for 1995–2006

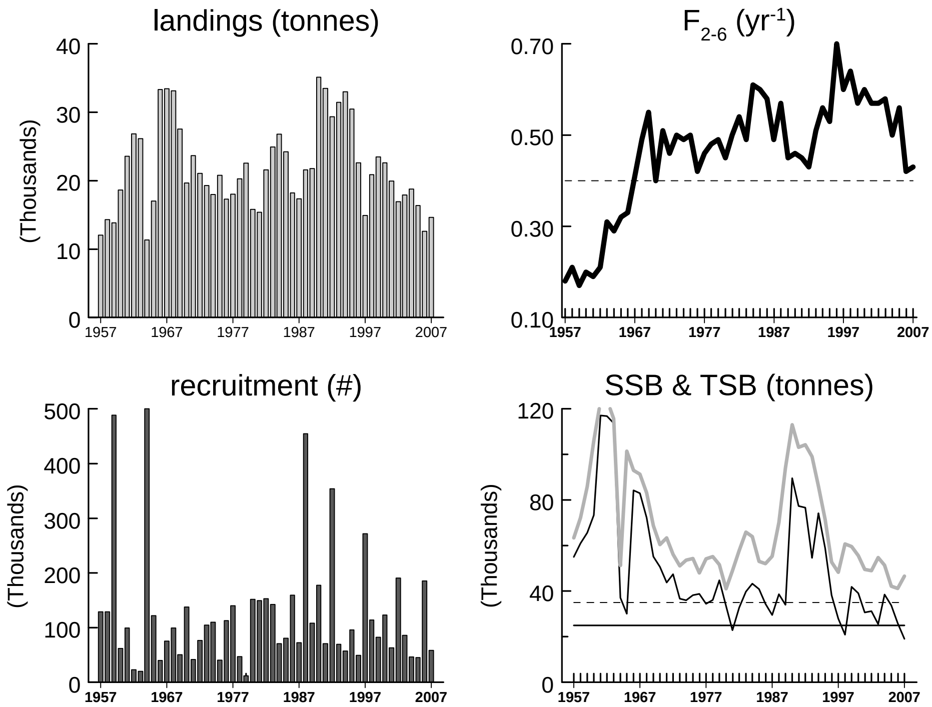


Figure 10.4.1 Sole in sub-area IV. XSA summary plots. Time series of landings (a- top left), recruitment (b-bottom left), fishing mortality and SSB & TSB (c & d left).

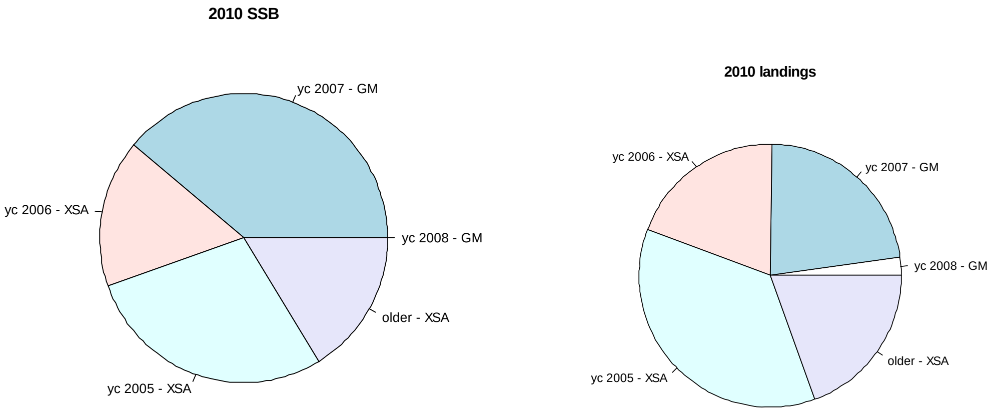
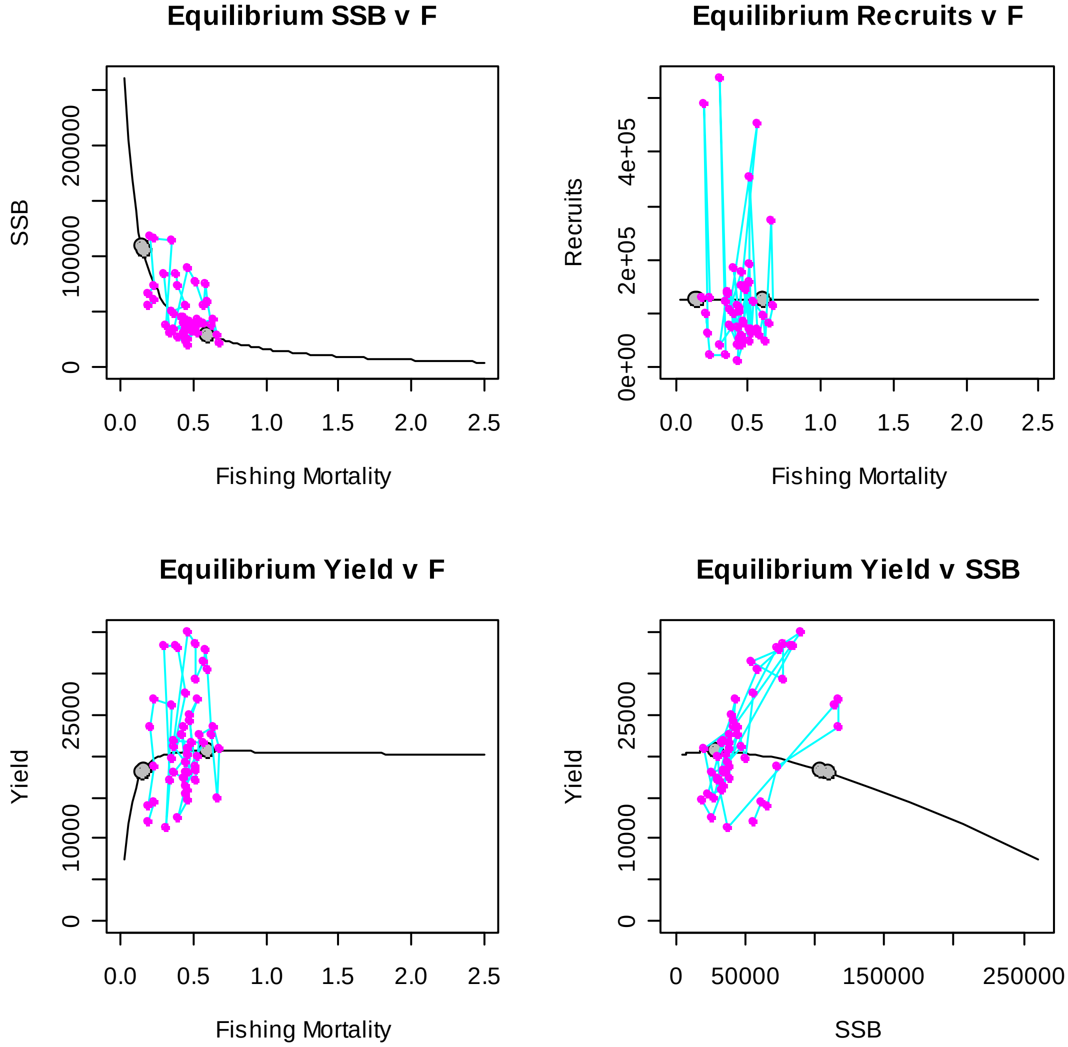


Figure 10.6.1 Sole in sub-area IV. Relative year class contribution to 2009 predicted landings (right) and 2010 SSB (left). Stock numbers of 1 year olds: (2004/XSA) 45 100, (2005/XSA) 184 700, (2006/XSA) 58 500, (2007/GM) 93 600 & (2008/GM) 93 600.



Reference point	F multiplier	Absolute F
Fbar(2 – 6)	1.0	0.43
FMax	1.4	0.60
F0.1	0.34	0.15

Figure 10.6.3 Sole in sub-area IV. YPR results.

11 Saithe in Subarea IV, VI and Division IIIa

The 2008 assessment of saithe in Subareas IV and VI and Division IIIa is formally classified as an update assessment, using the same settings and tuning series as last year. The assessment of the 2007 working group meeting was accepted by the ACFM review group in October 2007.

11.1 Ecosystem aspects

The geographical distributions of juvenile (< age 3) and adult saithe differ. Typical for all saithe stocks are the inshore nursery grounds. Juvenile saithe in the North Sea are therefore mainly distributed along the west and south coast of Norway, the coast of Shetland and the coast of Scotland. At around age 3 the individuals gradually migrate from the coastal areas to the northern part of the North Sea (57°N - 62°N).

The age at first maturity is between 4 and 6 years, and spawning takes place in January-March at about 200 m depth along the Northern Shelf edge and the western edge of the Norwegian Deeps. Larvae and post-larvae are widely distributed in Atlantic water masses across the northern part of the North Sea, and around May the 0-group appears along the coasts (of Norway, Shetland and Scotland). The mechanisms behind the 0-group's migration from oceanic to coastal areas remain unknown, but it seems like they are actively swimming towards the coasts. The west coast of Norway is probably the most important nursery ground for saithe in the North Sea.

When saithe exceeds 60-70 cm in length the diet changes from plankton (krill, copepods) to fish (mainly Norway pout, blue whiting, haddock and herring). Large saithe (>70 cm) have a highly migratory behaviour and the feeding migrations extend from far into the Norwegian Sea to across the Norwegian Deeps to the Norwegian coast.

Tagging experiments by various countries have shown that exchange takes place between all saithe stock components in the northeast Atlantic. In particular, exchange between the saithe stock north of 62°N (Northeast Arctic saithe) and saithe in the North Sea has been observed.

A decrease in the mean weight at age the last ten years has been observed, but there is insufficient information to establish whether these reductions are linked to changes in the environment. The effect of further declines in growth rates needs monitoring as this will have an impact on stock productivity. However, there are no indications that the observed decline in weight at age is density dependent (ICES Advice, 2008. Book 6, Evaluation of the EU-Norway saithe management plan).

The impact of the large saithe stock on prey species such as Norway pout and herring is unknown. Poor spatial and temporal data from sampling of saithe stomachs make the estimation of the saithe diet uncertain.

11.1.1 Fisheries

Saithe in the North Sea are mainly taken in a directed trawl fishery in deep water near the Northern Shelf edge and the Norwegian deeps. Norwegian, French, and German trawlers take the majority of the catches. In the first quarter of the year the fisheries are directed towards mature fish in spawning aggregations, while concentrations of immature fish (age 3-4) often are targeted during the rest of the year. In recent years the French fishery deployed less effort along the Norwegian deeps, while the German and Norwegian fisheries have maintained their effort there.

The main fishery developed at the beginning of the 1970s. The fishery in Area VI consists largely of a directed French, German, and Norwegian deep-water fishery operating on the shelf edge, and a Scottish fishery operating inshore. In both areas most of the saithe do not enter the main fishery before age 3, because the younger ages are staying in inshore waters. A small proportion of the total catch is taken in a limited purse seine fishery along the west coast of Norway targeting juveniles (age 3-4). Minimum landing size for saithe is currently 35 cm in the EU zone and 32 cm in the Norwegian zone (south of 62°N).

Since the fish are distributed inshore until they are about 3 years old, discarding of young fish is assumed to be a small problem in this fishery. Problems with by-catches in other fisheries when saithe quotas are exceeded may cause discarding. French and German trawlers are targeting saithe and they have larger quotas, so the problem may be less in these fleets. The Norwegian trawlers move out of the area when the boat quotas are reached, and in addition the fishery is closed if the seasonal quota is reached.

In 2007 the landings were estimated to be around 93 618 t in Subarea IV and Division IIIa, and around 6800 t in Subarea VI, which both well below the TACs for these areas. Which for 2007 were 123 250 and 12 787 t respectively. Significant discards appear only in Scottish trawlers. However, as Scottish discarding rates are not representative of the majority of the saithe fisheries, these have not been used in the assessment. Ages 1 and 2 are mainly distributed close to the shores and are very scarce in the main fishing areas for saithe. Therefore, these age-groups are not relevant for discarding practices in the North Sea. The strong 2004 cohort may lead to higher by-catches in the industrial trawl fisheries.

11.1.2 ICES Advice

ICES ACFM advice for 2008

In 2007 ICES considered the stock as having full reproductive capacity and as being harvested sustainably.

Exploitation boundaries in relation to existing management plans

At the present SSB level, F should be below 0.3 to be in accordance with the management plan. This corresponds to landings of 150 thousands t in 2008.

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

The current fishing mortality is estimated at 0.25, which is above the rate expected to lead to high long-term yields ($F_{0.1}$ = 0.11). Fishing at $F_{0.1}$ is expected to lead to landings of 57 thousands t in 2008.

Exploitation boundaries in relation to precautionary limits

The exploitation boundaries in relation to precautionary limits imply human consumption landings of about 188 thousands t in 2008, where the SSB is expected to remain above B_{pa} (200 000 t) in 2009.

ICES conclusion on exploitation boundaries

No evaluation of the agreed management plan had been carried out prior to the ACFM advice for 2008, but the target fishing mortality in the management plan is expected to give higher long-term gains in the present situation with a stock that is well above B_{pa} and ICES therefore recommended to limit landings in 2008 to 150 000 t.

11.1.3 Management

Management of saithe is by TAC and technical measures. The fishery is not regulated by days at sea for vessels that have less than 5% bycatch of each of cod, plaice and sole. The agreed TAC for saithe in Subarea IV and Division IIIa for 2007 was 123 250 t. In Division Vb and Subareas VI, XII, and XIV the TAC for 2007 was 12 787 t. For 2008 the TACs were 135 900 t and 14 100 t, respectively. Current technical measures are described in Section 2.

In 2004 EU and Norway *"agreed to implement a long-term plan for the saithe stock in the Skagerrak, the North Sea and west of Scotland, which is consistent with a precautionary approach and designed to provide for sustainable fisheries and high yields. The plan shall consist of the following elements:*

1. *Every effort shall be made to maintain a minimum level of Spawning biomass (SSB) greater than 106 000 tonnes (B_{lim}).*
2. *Where the SSB is estimated to be above 200 000 tonnes the Parties agreed to restrict their fishing on the basis of a TAC consistent with a fishing mortality rate of no more than 0.30 for appropriate age groups.*
3. *Where the SSB is estimated to be below 200 000 tonnes but above 106 000 tonnes The TAC shall not exceed a level which, on the basis of a scientific evaluation by ICES, will result in a fishing mortality rate equal to 0.30-0.20*(200 000-SSB)/94 000.*
4. *Where the SSB is estimated by the ICES to be below the minimum level of SSB of 106 000 tonnes the TAC shall be set at a level corresponding to a fishing mortality rate of no more than 0.1.*
5. *Where the rules in paragraphs 2 and 3 would lead to a TAC which deviates by more than 15% from the TAC the preceding year the Parties shall fix a TAC that is no more tha 15% greater or 15% less than the TAC of the preceding year.*
6. *Notwithstanding paragraph 5 the Parties may where considered appropriate reduce the TAC by more than 15% compared to the TAC of the preceding year.*
7. *A review of this arrangement shall take place no later than 31 December 2007.*

This arrangement enters into force on 1 January 2005."

11.1.4 Evaluation of the Management plan

The management plan is considered by ICES to be consistent with the precautionary approach in the short term, conditional on the absence of major changes in stock productivity and the absence of measurement and implementation error (ICES Advice 2008, Book 6).

11.2 Data available

11.2.1 Catch

Landings data by country and TACs are presented in Table 11.2.1. In the data provided landings from the industrials fleet is only specified when saithe is delivered separately, and therefore bycatch of saithe that has not been separated from the bulk catch, will not be reported as saithe.

11.2.2 Age compositions

Age compositions of the landings are presented in Table 11.2.2. Landings-at-age data by fleet are supplied by Denmark, Germany, France, Norway, UK (England), and UK (Scotland) for Area IV and only UK (Scotland) for Area VI. The differences between the sum-of-products (SOP) and the working group estimate is about 1% in 2007, which is considered with acceptable limits. Fig. 11.2.1 shows that the proportions of older saithe (age>5) in the catches have increased in recent years.

11.2.3 Weight at age

Weight at age in the catch is presented in Table 11.2.3 and Fig. 11.2.2. These are also used as stock weights. There has been a decreasing trend in mean weights from the mid-1990s for ages 4 and older.

11.2.4 Maturity and natural mortality

A natural mortality rate of 0.2 is used for all ages and years, and the following maturity ogive is used for all years:

Age	1	2	3	4	5	6	7+
Proportion mature	0.0	0.0	0.0	0.15	0.7	0.9	1.0

11.2.5 Catch, effort and research vessel data

Fleet data used for calibration of the assessment are presented in Table 11.2.4. Three commercial series of effort and catch at age and two series of survey indices were available:

Commercial fleets:

- French fresh fish trawl, age range: 3-9, year range 1990-2007 (“FRATRB”)
- German bottom trawl, age range: 3-9, year range 1995-2007 (“GEROTB”)
- Norwegian bottom trawl, age range: 3-9, year range 1980-2007 (“NORTRL”)

Surveys:

- Norwegian acoustic survey, age range 3-6, year range 1995-2007 (“NORACU”)
- IBTS quarter 3, age range: 3-5, year range 1991-2007 (“IBTSq3”)

Trends in relative LPUE and effort for the commercial fleets are shown in Figure 11.2.3. The LPUE shows an increasing trend for all fleets from 2003, however, the LPUE of the French fresh fish trawlers and Norwegian bottom trawlers decreased from 2006 to 2007.

11.3 Data analyses

This year’s assessment is classified as an update assessment, the consistency in the input data is analysed using catch curves, separable VPA, correlation plots and standardised tuning indices.

11.3.1 Reviews of last year's assessment

The Review Group in ACFM had the following comments:

Technical comments:

There have been long term changes in weight at age, and a substantial decrease in length at age over time. There are also indications of density dependence, as observed in other saithe stocks. The RG requested information on observed condition factor (i.e., weight at length). The fixed proportion of maturity at age in the assessment should be explored in association with the changing weights at age. The HCR evaluation should include density dependent mean weights.

The RG noted that there was no a priori justification for removal of the first year of survey data from the stock assessment model and recommends that the observations be included to represent the measurement error in the assessment.

The responses of the Working Group:

The HCR evaluation estimated the weight at age as the average of the last three years and did not include a density dependent mean weight as there is no evidence of a direct relationship between density and weight at age.

The observed changes in weight at age could lead to a shift in the maturity ogive, however, no data for eventual adjustment of the ogive are available.

A detailed and thorough study in 2007 of the log catchability residuals from the XSA runs showed very high residuals for the first year in the surveys. The fact that these residuals are extremely large and found in the starting year of the time series supports the conclusion to remove the data in the stock assessment model.

11.3.2 Exploratory survey-based analyses

Log-abundance indices by cohort for the tuning series are shown in Figure. 11.3.1. The pattern is similar to the pattern in the catch data curves (Figure. 11.3.9), with partial recruitment of age 3 for recent cohorts. The curves for the most recent cohorts of the NORTRL time series show a pattern that differs markedly from earlier cohorts in the NORTRL series and from the curves of the other tuning series (Figure 11.3.1). This indicates considerable changes in the exploitation pattern or data problems in the Norwegian trawler fleet.

Within-survey correlations for the available tuning series are shown in Figs. 11.3.2 – 11.3.6. For the FRATRB the relationship between cohort values from one age to the next is significant, except for the ages 3 to 4. (Fig. 11.3.6). The poor relationship between the two youngest ages can be explained by the variation in the recruitment to the fishery. For the other tuning series, there is a better relationship between the ages 3 and 4, but not as strong as between the older ages (Figure 3.3.2-5). For the NORACU series there is also a poor relationship between age 5 and 6, which may be explained by the movement of older fish out of the survey area (Figure 11.3.3).

The relationship between cohort values at different ages when the difference in years are greater than one is generally weak, especially for age 3 and 4 in GERTRB, NONRTRL_2 and FRATRB (Figure 11.3.4-6).

The two survey time series are relatively consistent (Figure 11.3.7). They are, however, not entirely independent since the age-disaggregation of both indices is based on the same age and length samples. The relative CPUEs in the commercial tuning series are compared in Figure 11.3.8. For age 3 and 9 the consistency between the series is poor, but better for the age groups in-between.

The time series of the GEROTB and FRATRL indicate a very strong 2004 cohort. In contrast, the NORTRL series indicates at best a medium strong 2004 cohort (Figure 11.3.8).

11.3.3 Exploratory catch-at-age-based analyses

Catch curves (log numbers caught at age linked by cohort) for the total catch-at-age matrix are shown in Fig 11.3.9. The plot shows that age 3 is partly recruited to the fishery for recent cohorts, but fully recruited for some of the earlier cohorts. Moreover the catch curves are less steep in recent years compared to earlier. The negative slopes in the catch curves, which give an indication of total mortality inferred from the catch data, are shown in Figure 11.3.10. The trend in the gradients is in agreement with the trend in estimated fishing mortality.

A separable VPA was run to check the consistency in the catch data, and the resulting log catch residuals are shown in Fig. 11.3.11. The residuals do not indicate problems with the data in terms of large year effects etc.

Single fleet XSAs were run with each of the available 3 commercial tuning fleets using the same settings as in the final assessment last year. The log-catchability residuals from these runs are shown in Figure 11.3.12. There is a change in the residual pattern for the NORTRL from large values for the younger age-classes in the beginning of the time series to smaller residuals in more recent years. For the FRATRB, the older ages have large negative residuals caused by the targeting of small to medium sized saithe in the French trawler fleet. No clear signals are evident for the German trawler fleet. The survey time series have a too narrow age range for single fleet runs due to lack of tuning information for some ages leads to unreliable results.

11.3.4 Conclusions drawn from exploratory analyses

Both the catch curves of the total landings data and the residuals from the separable VPA indicate changes in the relative exploitation of age 3 with time. A likely explanation of this apparent change in exploitation pattern is that the proportion of catches taken by purse seine decreased significantly in the early 1990s, and purse seiners mainly target young saithe. Therefore, it may now be more appropriate to use a reference-F that does not include age 3. Such a change of the reference F will affect the biological reference points and is outside the scope of this update assessment.

The explorations of the within and between consistencies in the available tuning series indicate that the abundance indices of age 3 are uncertain, and that age 4 indices seem to give more reliable information about year class strength.

The working group still supports the decision to exclude the NORTRL tuning series from the assessment based on the recent diverging pattern in log-cpue curves and the large log catchability residuals from the XSA runs. In addition, the working group still suggests the removal of the first year in both the survey series (1991 in IBTSq3 and 1995 in NORACU) because of large negative log-catchability residuals for these values.

11.3.5 Final assessment

The settings in final XSA assessment in 2008 are the same as in 2007. Settings from the 2006 assessment is also presented.

Year of assessment:	2006	2007	2008
Assessment model:	XSA	no change	no change
Fleets:	FRAtrb (age range: 3-9, 1990 onwards)	no change	no change
	GERotb (age range: 3-9, 1995 onwards)	no change	no change
	NORtrl (age range: 3-9, 1980 onwards)	removed	removed
	NORacu (age range: 3-6, 1995 onwards)	NORacu (age range: 3-6, 1996 onwards)	NORacu (age range: 3-6, 1996 onwards)
	IBTSq3 (age range: 3-6, 1991 onwards)	IBTSq3 (age range: 3-5, 1992 onwards)	IBTSq3 (age range: 3-5, 1992 onwards)
Age range:	3-10+	no change	no change
Catch data:	1967-2005	1967-2006	1967-2007
Fbar:	3-6	no change	no change
Time series weights:	Tricubic over 20 years	no change	no change
Power model for ages:	No	no change	no change
Catchability plateau:	Age 7	no change	no change
Survivor est. shrunk towards the mean F:	5 years / 3 ages	no change	no change
S.e. of mean (F-shrinkage):	1.0	no change	no change
Min. s.e. of population estimates:	0.3	no change	no change
Prior weighting:	No	no change	no change
Number of iterations before convergence:	40	51	47

Outputs from the final run are given in Table 11.3.1 (diagnostics), Table 11.3.2 (fishing mortality at age), Table 11.3.3 (population numbers at age), and Table 11.3.4 (stock summary).

The log catchability residuals from the final XSA-run are shown in Figure 11.3.13, the relative weights of F-shrinkage by tuning fleets are shown in Figure 11.3.14, a retrospective analysis is shown in Figure 11.3.15 and the historical performance of the assessment is shown in Figure 11.3.16.

11.4 Historic Stock Trends

The historic stock and fishery trends are presented in Figure 11.4.1 (and Table 11.3.4). The reported landings increased from 1967 to the highest observed landing levels in the mid-1970s. After 1976 the landings decreased rapidly to a stable level between 1979-1981 and increased again from 1981 to 1985. From 1985 the reported landings decreased and levelled off in 1989 to a fairly stable level where they have stayed since. During the last 6 years (2002-2007), TAC levels have been higher than the reported landings. Estimated fishing mortality shows the same trends as landings in the period 1967-1985, while it has decreased continuously since 1985 until present (except for some small jumps), dropping below F_{lim} in 1993 and below F_{pa} in 1997. Estimated SSB increased from 1967 reaching the highest observed level in 1974 after which it decreased to below B_{lim} in 1990. After 1991 SSB increased to above B_{pa} in 1999. SSB is estimated to have been slightly above B_{pa} since 2001. The level and variation in estimated recruitment (measured at age 3) are higher before about 1985 than after, e.g., the six strongest year classes observed all occurred in the earliest period. The 2003 year class, which is the youngest cohort where the strength now probably can be measured fairly precisely, seems below average. Although there is a large uncertainty regarding the 2004 year class strength, the tuning series indicate the year class to be well above long term average.

11.5 Recruitment estimates

The numbers of age 4 saithe at the start of the forecast period have previously been derived from the VPA estimates, but the retrospective recruitment pattern shows that strong VPA recruitments have been overestimated. Alternative methods to estimate the year class strength were investigated. The regression procedure RCT3 that estimates recruitment based on indices of year-class strength from the tuning series and the converged VPA estimates (Table 11.5.1) shows a considerable lower abundance of the 2004 year class (Table 11.5.2). The estimated standard errors and WAP weights from the RCT3 show that the explanatory power of the tuning series is relatively low, and the output is sensitive to the settings.

However, both the survey and commercial data indicate that the 2004 year class is strong, but due to the high uncertainty in the VPA and RCT3 estimates the working group suggests that the year class is estimated using the average of the three highest year classes the last 20 years. This approach gives a more conservative result as seen in text table below.

Year class in 2007	XSA estimate	RCT3 estimate	Avg. 3 highest years
2004	333027	249080	219835

Reliable abundance information does not exist for the 2005 and 2006 year classes. It was therefore decided to use the geometric mean of recruits (age 3 from the final assessment) from the period 1988-2005, as the estimated recruitment for these year classes. The reason for excluding data before 1988 is that the recruitment dynamics (level and variation) seems quite different before and after 1988.

Year class	Age in 2008	AVG. 3 High*	GM(88-05)
2004	4	167937	
2005	3		127227
2006	Age 3 in 2009		127227

* Average of the three highest VPA estimates for age 3 the last twenty years: ,(y1995 = 226369, y2001 = 221029 and y2005 = 212105) projected as 4 years old.

11.6 Short-term forecasts

The short-term prognosis was performed using the same settings as last year. Inputs are presented in Table 11.6.1. Although substantial reduction in weight at age has been recorded for the saithe stock in the North Sea, in common with adjacent saithe stocks from other areas, modelling such changes and predicting future dynamics cannot be achieved without further information and analysis. Therefore it was decided to use the average of the weight at age over the last three years in the forecast. Fishing mortalities at age are estimated as an arithmetic average over the last three years. Number at age 3 (recruitment) is taken as the geometric mean of age 3 from the period 1988-2005.

Population numbers at age 5 and older are the XSA survivor estimates from the final assessment. Population numbers at age 4 is estimated as the average of the 3 largest year classes during the last twenty years projected as 4 years old.

The management options table are given in Table 11.6.2. Status quo fishing mortality (F_{sq}) in 2008 and 2009 is expected to lead to landings of about 126 000 tonnes in 2009 and a slight increase in the expected spawning stock biomass in 2009. A fishing mortality in 2009 according to the current EU-Norway management plan is expected to lead to landings of about 139 000 tonnes and SSB above Bpa in 2010. The forecasted contribution of the most recent year classes in landings and SSB are shown in Table 11.6.3 and Fig. 11.6.1.

11.7 Medium-term forecasts

No medium-term forecasts were carried out however simulations were carried out during the evaluation of the EU-Norway management plan (ICES Advice, 2008. Book 6).

11.8 Biological reference points

The biological reference points were derived in 2006 and are:

$\mathbf{F}_{0.1}$	0.10	$\mathbf{F}_{lim}$	0.60
$\mathbf{F}_{max}$	0.22	$\mathbf{F}_{pa}$	0.40
$\mathbf{F}_{med}$	0.35	$\mathbf{B}_{lim}$	106 000 t
$\mathbf{F}_{high}$	>0.49	$\mathbf{B}_{pa}$	200 000 t

These reference points are based on a Fbar from ages 3 to 6. The proportion of catches taken by purse seine decreased significantly in the early 1990s. This caused a change in the exploitation pattern as the purse seiners mainly targeted young saithe. Therefore, it may be more appropriate to use a reference-F that does not include age 3. The perception of the recent trend in fishing mortality does not change much when varying the age range used in the reference F (Figure 11.8.1).

The influence on the maturity ogive from the observed decrease in the weight at age is unknown, but it is reasonable to believe that the spawning capacity of the stock will be affected.

The change of the reference F and the possible change in maturity may affect the biological reference points but are outside the scope of this update assessment.

11.9 Quality of the assessment

The retrospective patterns for F and SSB (Figure 11.3.16) seem fairly good for the most recent years, but the uncertainty in the size of the relatively strong 1998 and 1999 year classes reduced the quality of the SSB and F estimates in the assessment years 2001-2003.

The poor reliability of the recruitment (age 3) estimate seems to be a major problem for the saithe assessment. Hence, the quality of this year's assessment is strongly affected by the uncertainty about the size of the strong 2004 year class. To improve the reliability of the information about year class strength before age 4, IMR in Norway has started an acoustic recruitment survey for saithe (ages 2-4) along the Norwegian west coast. The survey has been carried out in May 2006, 2007 and 2008. Although the time series is very short, the survey data will be investigated and compared with the other tuning data in autumn 2008.

Another important problem with this assessment is the necessity to use commercial CPUE for tuning as 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. A serious reason is hyperstability; that is commercial catch rates remaining high while population abundance drops, which may occur when vessels are able to locate high fish concentration independently of population size. Hyperstability may be demonstrated if the degree of the fleet's spatial concentration is monitored. Norway and Germany have now permitted the use of data from their satellite based vessel monitoring systems for research purposes, which makes it possible to perform such monitoring of the German and Norwegian tuning fleets.

11.10 Status of the Stock

The general perception of the status of the saithe stock remains unchanged from last year's assessment. Fishing mortality is estimated to be well below F_{pa} and the spawning stock biomass is estimated to be well above B_{pa}.

11.11 Management Considerations

The ICES advice applies to the combined areas IIIa, IV, and VI.

The reported landings have been lower than the TAC over the last six years, and the total landing in 2007 in areas IIIa and IV is considerable lower than the TAC. Information from fishermen indicates that low prices for saithe combined with high fuel prices are causing this.

By-catch of other demersal fish species occurs in the trawl fishery for saithe. Saithe is also taken as unintentional by-catch in other fisheries.

The spawning stock of saithe in the North Sea is expected to remain above B_{pa} if the TAC for 2009 is set according to the agreed management plan.

The poor reliability of the recruitment (age 3) estimate seems to be a major problem for the saithe assessment. Hence, the quality of this year's assessment is strongly affected by the uncertainty about the size of the strong 2004 year class. The IBTSq3 and acoustic survey in July 2008 will provide updated and more reliable information regarding the strength of the 2004 survey.

In addition, to improve the reliability of the information about year class strength before age 4, IMR in Norway has started an acoustic recruitment survey for saithe (ages 2-4) along the Norwegian west coast. The survey has been carried out in May 2006, 2007 and 2008. Although the time series is very short, the survey data will be investigated and compared with the other tuning data in autumn 2008.

In 2008 ICES carried out an evaluation of the management plans agreed between Norway and the European Community (ICES Advice, 2008. Book 6.), and the response is described below.

Recent reductions in recruitment levels and growth rates indicate that the productivity of the saithe stock in the North Sea, Skagerrak, and West of Scotland has declined. Assuming continuation of the current selection pattern and growth rates, annual yields are expected to be relatively stable at about 100 000 t for fishing mortalities between 0.1 and 0.4. A target F below 0.3, or an increase in the upper spawning-stock biomass (SSB) threshold (i.e., above the current Bpa = 200 000 t), are likely to give similar yields with lower risks in the medium term.

The 15% TAC change constraint is likely to be invoked in ~50% of the years in which the harvest control rule is applied. TAC change constraints less than 15% would require a lower target fishing mortality in order to balance the increased risk to the stock. The equilibrium yield from the saithe stock is fairly insensitive to the TAC constraint. Given the low productivity of saithe (low mean recruitment and low weight-at-age) and the limited treatment of measurement errors in the assessment and implementation errors in the fishery, the harvest control rule should be reviewed again within 4 years.

Table 11.2.1 Nominal landings (in tonnes) of Saithe in Subarea IV and Division IIIa and SubareaVI, 1999-2006, as officially reported to ICES, and WG estimates

SAITHE IV and IIIa

Country	1999	2000	2001	2002	2003	2004*	2005*	2006	2007*
Belgium	200	122	24	107	45	22	28	16	18
Denmark	4494	3529	3575	5668	6954	7991	7498	7471	5458
Faroe Islands	1101		289	872	495	558	184	62	15
France	24305	19200	20472	25441	18001	13628	10768	15739	13043
Germany	10481	9273	9479	10999	8956	9589	12401	14390	12790
Greenland	-	60	152	62	1616	403	-	-	-
Ireland	-	1		-	-	1	-	0	-
Netherlands	7	11	20	6	1[illegible]	3	40	28	5
Norway	56150	43665	44397	60013	61735	62783	67365	61268	45395
Poland	862	747	727	752	734[illegible]	0	1100	-	-
Russia	-	67		-	-	-	35	2	5
Sweden	1929	1468	1627	1863	1876	2249	2114	1695	1380
UK (E/W/NI)	2874	1227	1186	2521	1215	457	1190		
UK (Scotland)	5420	5484	5219	6596	5829	5924	7703	9129**	9628**
Total reported	107823	85395	88541	114900	107467	103608	110575	109800	87377
Unallocated	-509	2281	1030	1291	-5809	-3646	968	7312	6241
W.G. Estimate	107314	87676	89571	116191	101658	99962	111543	117112	93618
TAC	110000	85000	87000	135000	165000	190000	145000	123250	135900

*Preliminary, [1]reportedbyTACarea, IIa(EC), IIIa-d(EC) and IV, [2]Preliminary data reported in IVa
**Scotland+E/W/NI combined

Table 11.2.1 continued

SAITHE VI

Country	1999	2000	2001	2002	2003	2004*	2005*	2006	2007*
Faroe Islands	2			-	2	34	21	76	32
France	346[illegible]	3310	5157	3062	3499	3053	3452	5782	3956
Germany	250	305	466	467	54	4	373	532	580
Ireland	320	410	399	91	170	95	168	243	322
Norway	126	58	31	12	28	16	20	28	377
Russia	3	25	1	1	6	6	25	7	2
Spain	23	3	15	4	6	2	3	-	-
UK (E/W/NI)	503	276	273	307	263	37	203		
UK (Scotland)	2084	2463	2246	1567	1189	1563	4433	2748**	1419**
Total reported	6778	6850	8588	5513	5215	4810	8699	9416	6688
Unallocated	564	-960	-1770	-327	35	-296	-2960	848	98
W.G.Estimate	7342	5890	6818	5186	5250	4514	5739	8568	6786
TAC	7500	7000	9000	14000	17119	20000	15044	12787	14100

*Preliminary, [1]reported by TAC area, IIa(EC), IIIa-d(EC) and IV
**Scotland+E/W/NI combined

SAITHE IV, IIIa and VI

	1999	2000	2001	2002	2003	2004	2005	2006	2007
WG estimate	114656	93566	96389	121377	106908	104476	117282	125680	100404
TAC	117500	92000	96000	149000	182119	210000	160044	136037	150000

Table 11.2.2 Saithe in Subareas IV, VI and Division IIIa. Landed numbers (in thousands) at age.

[redacted]

Table 11.2.3 Saithe in Subareas IV, VI and Division IIIa. Landings weights at age (kg).

[redacted]

Table 11.2.4 Saithe in Subareas IV,VI and Division IIIa. Tuning data. Data in bold are used in the final assessment.

Saithe in IV, VI and IIIa - Combined tuning data

106							
FRATRB_IV							
1990	2007						
1	1	0	1				
3	9						
21758	**3379.574**	**2471.553**	**1405.54**	**304.063**	**290.298**	**32.728**	**14.813**
15248	**1381.383**	**2538.766**	**731.379**	**372.239**	**130.79**	**67.67**	**11.93**
7902	**717.161**	**1480.817**	**498.716**	**73.572**	**24.402**	**7.133**	**5.741**
13527	**3917.8**	**2253.44**	**1162.23**	**103.625**	**8.299**	**8.648**	**6.183**
14417	**1770.754**	**3652.84**	**1381.104**	**434.086**	**38.895**	**5.317**	**2.71**
14632	**3151.807**	**1682.869**	**921.653**	**225.695**	**70.393**	**24.088**	**13.317**
16241	**895.031**	**4286.247**	**1053.226**	**535.95**	**107.63**	**24.634**	**15.158**
12903	**1087.28**	**1914.745**	**3175.192**	**190.091**	**83.908**	**16.535**	**13.738**
13559	**799.753**	**2538.413**	**1870.453**	**1480.902**	**52.256**	**23.023**	**10.381**
14588	**852.467**	**1233.817**	**2666.699**	**620.174**	**399.661**	**24.212**	**13.688**
8695	**889.314**	**1993.229**	**1038.898**	**1195.148**	**214.774**	**180.514**	**31.751**
6366	**724.1021**	**1339.454**	**2372.881**	**269.951**	**144.906**	**25.554**	**29.28**
11022	**3275.662**	**7576.645**	**1220.435**	**1242.118**	**175.302**	**151.434**	**40.935**
10536	**1516.931**	**3235.528**	**2354.784**	**264.339**	**325.113**	**80.521**	**112.883**
5234	**447.218**	**977.66**	**1020.943**	**494.617**	**92.582**	**35.628**	**19.772**
3015	**406.936**	**660.534**	**643.107**	**428.406**	**209.713**	**15.685**	**14.262**
5710	**1681.537**	**3142.212**	**551.3929**	**144.5056**	**199.2849**	**39.65778**	**13.23932**
8255	**4200.934**	**1040.925**	**2807.48**	**240.7597**	**99.80143**	**3.070924**	**1**
NORTRL_IV1							
1980	1992						
1	1	0	1				
3	9						
18317	186	1290	658	980	797	261	60
28229	88	844	1345	492	670	699	119
47412	6624	12016	2737	2112	341	234	19
43099	4401	4963	8176	1950	2367	481	357
47803	20576	7328	2207	3358	433	444	106
66607	27088	21401	5307	1569	637	56	46
57468	5297	29612	3589	818	393	122	25
30008	2645	18454	2217	290	235	201	198
18402	3132	2042	2214	141	157	74	134
17781	649	2126	835	694	309	154	65
10249	804	781	924	519	203	63	12
28768	14348	4968	1194	518	203	51	56
35621	3447	9532	4031	1087	465	165	109

Table 11.2.4 (Cont'd). Saithe in Subareas IV, VI and Division IIIa. Tuning data. Data in bold are used in the final assessment.

NORTRL_IV2							
1993	2007						
1	1	0	1				
3	9						
24572	7635	4028	2878	1018	526	365	252
30628	3939	16098	4276	926	251	72	203
32489	4347	9366	5412	833	1644	273	203
40400	3790	14429	4414	2765	1144	189	16
36026	2894	5266	9837	1419	892	299	72
24510	1376	8279	5454	5662	977	489	243
21513	813	2595	6869	2368	3602	1168	346
15520	284	1628	2054	4261	1066	1203	221
23106	4808	5228	6513	935	1235	509	390
38114	4015	12063	3474	3775	981	1632	1050
41645	1630	5451	10452	3602	4432	792	1004
32726	663	2677	5709	6578	2256	2640	656
34964	1202	3080	5177	9204	6954	1728	1434
30190	797	4116	3842	4611	7310	3974	811
26354	1563	1442	4684	3506	2655	3121	887
GER_OTB_IV							
1995	2007						
1	1	0	1				
3	9						
21167	**1158**	**2359**	**1350**	**589**	**152**	**30**	**16**
19064	**510**	**3167**	**1081**	**517**	**257**	**148**	**41**
21707	**816**	**2475**	**3636**	**292**	**163**	**70**	**24**
20153	**591**	**2744**	**1395**	**1776**	**238**	**100**	**39**
18596	**284**	**1065**	**2264**	**943**	**1015**	**77**	**36**
12223	**542**	**2185**	**823**	**1216**	**242**	**325**	**38**
11008	**892**	**1329**	**2317**	**372**	**532**	**249**	**155**
12789	**650**	**3658**	**1230**	**1100**	**99**	**140**	**69**
14560	**500**	**1399**	**2630**	**438**	**392**	**58**	**72**
13708	**334**	**2040**	**1928**	**1079**	**200**	**235**	**47**
11700	**434**	**510**	**1623**	**1543**	**787**	**205**	**119**
10815	**374**	**1575**	**690**	**668**	**685**	**350**	**147**
12606	**1002**	**762**	**3006**	**649**	**432**	**446**	**187**

Table 11.2.4 (Cont'd). Saithe in Subareas IV, VI and Division IIIa. Tuning data. Data in bold are used in the final assessment.

NORACU

1995	2007			
1	1	0.5	0.75	
3	6			
1	56244	4756	1214	174
1	**21480**	**29698**	**6125**	**4593**
1	**22585**	**16188**	**24939**	**3002**
1	**15180**	**48295**	**13540**	**11194**
1	**16933**	**21109**	**27036**	**4399**
1	**34551**	**82338**	**14213**	**13842**
1	**72108**	**28764**	**17405**	**3870**
1	**82501**	**163524**	**17479**	**4475**
1	**67774**	**107730**	**41675**	**4581**
1	**34153**	**43811**	**31636**	**6413**
1	**48446**	**36560**	**27859**	**10174**
1	**18909**	**58132**	**11378**	**7922**
1	**77958**	**12070**	**32445**	**2384**

IBTSq3

1991	2007		
1	1	0.5	0.75
3	5		
1	1.946	0.402	0.064
1	**1.077**	**2.76**	**0.516**
1	**7.965**	**2.781**	**1.129**
1	**1.117**	**1.615**	**0.893**
1	**13.959**	**2.501**	**1.559**
1	**3.825**	**6.533**	**1.112**
1	**3.756**	**3.351**	**7.461**
1	**1.027**	**3.921**	**1.333**
1	**2.1**	**2.019**	**2.949**
1	**3.479**	**8.836**	**1.081**
1	**21.496**	**6.173**	**3.937**
1	**10.748**	**18.974**	**1.327**
1	**19.272**	**23.802**	**13.402**
1	**4.979**	**6.896**	**3.158**
1	**8.893**	**6.87**	**4.994**
1	**10.636**	**29.82**	**2.934**
1	**34.018**	**5.594**	**11.763**

Table 11.3.1 Saithe in Subareas IV, VI and Division IIIa. XSA diagnostics.

```
FLR XSA Diagnostics 2008-05-22 10:53:59

CPUE data from x.idx

Catch data for 41 years. 1967 to 2007. Ages 3 to 10.

       fleet first age last age first year last year alpha beta
1  FRATRB_IV         3        9       1990      2007     0    1
2 GER_OTB_IV         3        9       1995      2007     0    1
3     NORACU         3        6       1996      2007   0.5 0.75
4     IBTSq3         3        5       1992      2007   0.5 0.75


 Time series weights :

   Tapered time weighting applied
   Power =   3 over  20 years

Catchability analysis :

    Catchability independent of size for all ages

    Catchability independent of age for ages >   7

Terminal population estimation :

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

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

    Minimum standard error for population
    estimates derived from each fleet =  0.3

   prior weighting not applied

Regression weights
     year
age    1998 1999  2000  2001  2002  2003 2004  2005 2006 2007
  all 0.751 0.82 0.877 0.921 0.954 0.976 0.99 0.997    1    1


 Fishing mortalities
    year
age   1998  1999  2000  2001  2002  2003  2004  2005  2006  2007
  3  0.174 0.077 0.086 0.083 0.127 0.107 0.075 0.075 0.140 0.069
  4  0.335 0.371 0.199 0.319 0.325 0.183 0.195 0.253 0.215 0.186
  5  0.468 0.542 0.437 0.428 0.262 0.336 0.243 0.351 0.427 0.271
  6  0.426 0.468 0.521 0.289 0.299 0.299 0.292 0.411 0.336 0.469
  7  0.349 0.522 0.321 0.278 0.353 0.413 0.301 0.444 0.506 0.292
  8  0.509 0.770 0.313 0.300 0.393 0.387 0.451 0.383 0.432 0.440
  9  0.608 0.912 0.490 0.254 0.598 0.496 0.557 0.480 0.372 0.221
  10 0.608 0.912 0.490 0.254 0.598 0.496 0.557 0.480 0.372 0.221
```

Table 11.3.1(cont d). Saithe in Subareas IV, VI and Division IIIa. XSA diagnostics.

XSA population number (thousands)

year \ age	3	4	5	6	7	8	9	10
1998	71803	120389	48376	51175	8362	3343	1375	664
1999	139984	49411	70501	24798	27351	4828	1646	1194
2000	95065	106078	27902	33577	12712	13281	1830	1248
2001	223868	71441	71200	14755	16326	7549	7954	1203
2002	184741	168763	42524	38007	9050	10122	4578	3937
2003	127039	133235	99868	26789	23066	5204	5595	2907
2004	81401	93460	90798	58457	16260	12496	2892	2064
2005	212330	61836	62958	58327	35725	9857	6517	1321
2006	83617	161234	39310	36289	31652	18767	5501	5062
2007	333027	59528	106481	21005	21238	15622	9974	5612

Estimated population abundance at 1st Jan 2008

year \ age	3	4	5	6	7	8	9	10
2008	9330	254409	40451	66461	10759	12982	8238	6547

Fleet: FRATRB_IV

Log catchability residuals.

age \ year	1990	1991	1992	1993	1994	1995	1996	1997	1998
3	0.437	-0.250	0.055	0.760	0.255	-0.015	-0.678	-0.651	-0.153
4	0.255	0.327	0.274	0.240	0.329	-0.199	-0.370	-0.260	-0.419
5	0.029	0.033	0.176	0.160	0.233	-0.444	-0.223	-0.094	0.029
6	-0.253	0.367	-0.293	-0.428	0.377	-0.341	0.244	-0.541	0.228
7	0.755	0.478	-0.576	-1.714	-0.285	-0.101	0.024	-0.079	-0.864
8	-0.349	0.417	-1.163	-1.340	-1.525	-0.142	-0.256	-0.799	-0.696
9	-0.012	-0.302	-0.708	-1.064	-1.554	0.208	-0.097	0.115	-0.561

age \ year	1999	2000	2001	2002	2003	2004	2005	2006	2007
3	-0.875	0.076	-0.676	0.497	0.138	0.046	-0.456	1.287	0.419
4	-0.306	-0.153	0.212	0.539	-0.095	-0.233	0.367	0.312	-0.179
5	-0.033	0.422	0.619	-0.155	-0.273	-0.356	0.149	-0.138	0.054
6	0.027	0.921	0.463	0.499	-0.654	-0.111	0.353	-0.932	-0.183
7	-0.011	0.562	0.210	0.476	0.230	-0.028	0.619	0.078	-0.679
8	-0.973	0.340	-0.744	0.235	0.312	-0.651	-0.714	-1.046	-3.786
9	-0.409	0.664	-0.681	-0.188	0.626	0.270	-0.352	-0.944	NA

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

	3	4	5	6	7	8	9
Mean_Logq	-13.6785	-12.6994	-12.4815	-12.9880	-13.4636	-13.4636	-13.4636
S.E_Logq	0.5605	0.3058	0.2656	0.4792	0.6116	0.9670	0.5939

Table 11.3.1(cont d). Saithe in Subareas IV, VI and Division IIIa. XSA diagnostics.

```
Fleet:  GER_OTB_IV

 Log catchability residuals.

   year
age   1995   1996   1997   1998   1999   2000  2001   2002   2003
  3 -0.094 -0.110 -0.168  0.439 -0.926  0.531 0.276  0.022 -0.005
  4  0.488 -0.115  0.195 -0.019  0.022  0.317 0.375  0.381 -0.539
  5 -0.046  0.028 -0.093 -0.275 -0.054  0.234 0.433  0.090 -0.100
  6  0.183 -0.019 -0.698 -0.053  0.137  0.531 0.169  0.162 -0.539
  7 -0.046  0.389 -0.281 -0.090  0.333 -0.005 0.617 -0.590 -0.252
  8 -0.637  1.031 -0.221  0.031 -0.405  0.242 0.640 -0.337 -0.685
  9 -0.323  0.392 -0.192  0.021 -0.030  0.158 0.092 -0.160 -0.493
   year
age   2004   2005   2006   2007
  3  0.082 -0.456  0.436 -0.147
  4  0.259 -0.529 -0.299 -0.195
  5 -0.298  0.104 -0.167  0.084
  6 -0.360  0.212 -0.106  0.319
  7 -0.566  0.240  0.329  0.017
  8 -0.073  0.155  0.147  0.423
  9 -0.173  0.068  0.479 -0.097


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

                  3        4        5        6        7        8
Mean_Logq -14.9694 -13.4181 -12.8671 -12.9216 -13.1180 -13.1180
S.E_Logq    0.3962   0.3456   0.2009   0.3484   0.3684   0.4963
                  9
Mean_Logq -13.1180
S.E_Logq    0.2688


 Fleet:  NORACU

 Log catchability residuals.

   year
age   1996   1997   1998   1999  2000   2001   2002   2003   2004
  3 -0.321 -0.671 -0.203 -0.821 0.284  0.161  0.516  0.681  0.421
  4 -0.834 -0.755 -0.049  0.037 0.526 -0.055  0.826  0.558  0.020
  5 -0.409 -0.233 -0.134  0.226 0.445 -0.295  0.122  0.182 -0.056
  6  0.559  0.091  0.188  0.004 0.880  0.284 -0.511 -0.138 -0.586
   year
age   2005   2006   2007
  3 -0.188 -0.157 -0.166
  4  0.288 -0.230 -0.824
  5  0.251 -0.127 -0.172
  6 -0.048  0.129 -0.442
```

Table 11.3.1(cont d). Saithe in Subareas IV, VI and Division IIIa. XSA diagnostics.

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

                3       4       5      6
Mean_Logq -1.1179 -0.5308 -0.7224 -1.317
S.E_Logq   0.4625  0.5509  0.2580  0.430


 Fleet:  IBTSq3

 Log catchability residuals.

   year
age   1992   1993   1994   1995   1996   1997   1998   1999   2000
  3 -1.364  0.194 -1.431  0.247 -0.351 -0.768 -1.200 -1.212 -0.315
  4 -0.396 -0.350 -1.188 -0.509 -0.596 -0.579 -0.808 -0.559  0.046
  5 -0.552 -0.156 -0.419 -0.135 -0.285  0.392 -0.622 -0.159 -0.300
   year
age  2001   2002  2003   2004   2005  2006  2007
  3 0.648  0.174 1.120  0.192 -0.187 0.964 0.701
  4 0.157  0.424 0.799 -0.078  0.368 0.854 0.159
  5 0.050 -0.625 0.879 -0.529  0.363 0.349 0.644


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

                3       4       5
Mean_Logq -9.7221 -9.1902 -9.4612
S.E_Logq   0.8370  0.5790  0.4689


 Terminal year survivor and F summaries:

 Age 3 Year class = 2004

source
           survivors N scaledWts
FRATRB_IV     386673 1     0.166
GER_OTB_IV    219597 1     0.379
NORACU        215485 1     0.290
IBTSq3        512865 1     0.094
fshk          164709 1     0.072

 Age 4 Year class = 2003

source
           survivors N scaledWts
FRATRB_IV      44637 2     0.319
GER_OTB_IV     42928 2     0.342
NORACU         25582 2     0.193
IBTSq3         60641 2     0.112
fshk           31226 1     0.034
```

Table 11.3.1(cont d). Saithe in Subareas IV, VI and Division IIIa. XSA diagnostics.

Age 5 Year class = 2002

source	survivors	N	scaledWts
FRATRB_IV	73622	3	0.303
GER_OTB_IV	58387	3	0.319
NORACU	55306	3	0.254
IBTSq3	119459	3	0.104
fshk	53850	1	0.020

Age 6 Year class = 2001

source	survivors	N	scaledWts
FRATRB_IV	10879	4	0.275
GER_OTB_IV	10476	4	0.357
NORACU	9612	4	0.266
IBTSq3	14991	3	0.075
fshk	16491	1	0.027

Age 7 Year class = 2000

source	survivors	N	scaledWts
FRATRB_IV	9810	5	0.290
GER_OTB_IV	13509	5	0.405
NORACU	16625	4	0.217
IBTSq3	18054	3	0.063
fshk	8795	1	0.024

Age 8 Year class = 1999

source	survivors	N	scaledWts
FRATRB_IV	6484	6	0.264
GER_OTB_IV	9047	6	0.455
NORACU	9018	4	0.186
IBTSq3	8316	3	0.056
fshk	8925	1	0.040

Age 9 Year class = 1998

source	survivors	N	scaledWts
FRATRB_IV	6856	6	0.183
GER_OTB_IV	6408	7	0.614
NORACU	6614	4	0.133
IBTSq3	13318	3	0.037
fshk	3260	1	0.033

Table 11.3.2 Saithe in Subareas IV, VI and Division IIIa. Fishing mortality (F) at age.

age \ year	1967	1968	1969	1970	1971	1972	1973	1974
3	0.1628	0.2548	0.1178	0.1521	0.2682	0.3711	0.4990	0.6879
4	0.2632	0.3074	0.3145	0.4897	0.3728	0.4397	0.5628	0.6748
5	0.3781	0.3551	0.2599	0.4828	0.3998	0.2767	0.3202	0.4242
6	0.4836	0.2455	0.3574	0.5070	0.2735	0.4925	0.2838	0.4388
7	0.4161	0.1524	0.3913	0.3127	0.3319	0.3538	0.3695	0.4556
8	0.2603	0.1004	0.4639	0.2016	0.3965	0.4054	0.3317	0.4106
9	0.3893	0.1668	0.4070	0.3425	0.3360	0.4201	0.3303	0.4381
10	0.3893	0.1668	0.4070	0.3425	0.3360	0.4201	0.3303	0.4381

age \ year	1975	1976	1977	1978	1979	1980	1981	1982
3	0.4269	0.9112	0.2973	0.5432	0.2646	0.3397	0.1833	0.3869
4	0.6292	0.9305	0.6548	0.5446	0.4421	0.3279	0.2685	0.4795
5	0.4462	0.6615	0.7374	0.4639	0.4503	0.5632	0.2995	0.5344
6	0.4243	0.5383	0.7713	0.3552	0.4265	0.5401	0.4726	0.4753
7	0.5872	0.4143	0.7468	0.3485	0.5819	0.5491	0.5696	0.5631
8	0.5974	0.4831	0.7841	0.4633	0.3977	0.5028	0.7687	0.5257
9	0.5407	0.4822	0.7751	0.3916	0.4722	0.5350	0.6089	0.5256
10	0.5407	0.4822	0.7751	0.3916	0.4722	0.5350	0.6089	0.5256

age \ year	1983	1984	1985	1986	1987	1988	1989	1990
3	0.3067	0.5727	0.6452	0.2395	0.3652	0.3762	0.3786	0.4706
4	0.4663	0.6921	1.0463	1.4006	0.8705	0.6078	0.7479	0.6882
5	0.6570	0.6094	0.6994	0.9576	0.8504	0.9531	0.7136	0.6938
6	0.7635	0.8384	0.4732	0.6952	0.5238	0.5941	0.9250	0.6063
7	0.9376	0.5248	0.4624	0.5172	0.5323	0.7095	0.5159	0.6370
8	1.0311	0.6644	0.4258	0.4276	0.5010	0.7407	0.6708	0.5018
9	0.9207	0.6822	0.4571	0.5512	0.5232	0.6878	0.7106	0.5871
10	0.9207	0.6822	0.4571	0.5512	0.5232	0.6878	0.7106	0.5871

age \ year	1991	1992	1993	1994	1995	1996	1997	1998
3	0.4587	0.2470	0.3226	0.2419	0.1404	0.1174	0.1071	0.1738
4	0.7708	0.7300	0.4899	0.6815	0.5728	0.3125	0.3082	0.3351
5	0.6183	0.9306	0.6213	0.6600	0.5784	0.5579	0.4276	0.4683
6	0.4896	0.5922	0.6157	0.4807	0.4014	0.6928	0.3349	0.4265
7	0.4632	0.3976	0.6629	0.3784	0.9493	0.7044	0.5392	0.3494
8	0.4679	0.3449	0.8948	0.2922	0.5108	0.5927	0.5105	0.5086
9	0.4972	0.5043	0.8885	0.6921	1.0822	0.2919	0.4405	0.6080
10	0.4972	0.5043	0.8885	0.6921	1.0822	0.2919	0.4405	0.6080

Table 11.3.2 (cont d)Saithe in Subareas IV, VI and Division IIIa. Fishing mortality (F) at age

	year							
age	1999.0000	2000	2001	2002	2003	2004	2005	2006
3	0.0774	0.0857	0.0826	0.1268	0.1070	0.0749	0.0753	0.1398
4	0.3715	0.1987	0.3188	0.3246	0.1835	0.1951	0.2530	0.2149
5	0.5418	0.4371	0.4277	0.2621	0.3356	0.2426	0.3509	0.4267
6	0.4682	0.5211	0.2888	0.2994	0.2993	0.2924	0.4113	0.3357
7	0.5224	0.3211	0.2781	0.3533	0.4130	0.3006	0.4438	0.5062
8	0.7702	0.3126	0.3003	0.3929	0.3873	0.4509	0.3831	0.4321
9	0.9121	0.4898	0.2539	0.5983	0.4958	0.5571	0.4799	0.3715
10	0.9121	0.4898	0.2539	0.5983	0.4958	0.5571	0.4799	0.3715

	year
age	2007
3	0.0693
4	0.1864
5	0.2714
6	0.4690
7	0.2922
8	0.4399
9	0.2210
10	0.2210

Table 11.3.3 Saithe in Subareas IV, VI and Division IIIa. Stock numbers at age.

age	1967	1968	1969	1970	1971	1972	1973	1974
3	127456	114114	300688	291835	327931	171372	152852	148740
4	77470	88671	72416	218825	205231	205322	96808	75983
5	54512	48750	53388	43291	109793	115736	108298	45149
6	6638	30578	27984	33705	21871	60268	71849	64373
7	5177	3351	19585	16026	16622	13622	30155	44292
8	1407	2796	2356	10843	9597	9765	7829	17063
9	680	888	2070	1213	7256	5286	5330	4601
10	621	1041	490	1008	2974	5132	9288	6037

age	1975	1976	1977	1978	1979	1980	1981	1982	1983
3	181238	384109	118013	92450	77640	67129	172768	109877	118163
4	61210	96821	126436	71773	43969	48788	39131	117764	61100
5	31681	26711	31260	53781	34088	23136	28778	24493	59692
6	24186	16601	11286	12242	27689	17791	10785	17463	11752
7	33984	12956	7934	4273	7027	14799	8487	5505	8889
8	22993	15467	7009	3078	2469	3215	6996	3931	2566
9	9266	10359	7811	2620	1586	1358	1592	2656	1903
10	7036	9984	9495	11785	6074	6076	6075	3356	2397

age	1984	1985	1986	1987	1988	1989	1990	1991
3	205138	311531	287617	112770	114824	77587	120137	138543
4	71189	94721	133791	185322	64079	64532	43501	61436
5	31382	29174	27238	26996	63534	28569	25009	17896
6	25334	13969	11869	8560	9444	20055	11459	10231
7	4484	8969	7125	4849	4151	4269	6511	5117
8	2850	2172	4625	3478	2331	1672	2086	2819
9	749	1201	1162	2469	1725	910	700	1034
10	1425	2213	2322	1878	1491	1046	896	1279

age	1992	1993	1994	1995	1996	1997	1998	1999
3	92929	151602	102644	224924	110450	163660	71803	139984
4	71701	59431	89898	65979	160026	80415	120389	49411
5	23271	28289	29813	37234	30463	95855	48376	70501
6	7896	7512	12443	12615	17095	14276	51175	24798
7	5134	3575	3323	6300	6913	7001	8362	27351
8	2636	2824	1509	1864	1996	2798	3343	4828
9	1446	1529	945	922	916	904	1375	1646
10	1165	1895	1734	1311	2129	887	664	1194

age	2000	2001	2002	2003	2004	2005	2006	2007
3	95065	223868	184741	127039	81401	212330	83617	333027
4	106078	71441	168763	133235	93460	61836	161234	59528
5	27902	71200	42524	99868	90798	62958	39310	106481
6	33577	14755	38007	26789	58457	58327	36289	21005
7	12712	16326	9050	23066	16260	35725	31652	21238
8	13281	7549	10122	5204	12496	9857	18767	15622
9	1830	7954	4578	5595	2892	6517	5501	9974
10	1248	1203	3937	2907	2064	1321	5062	5612

Table 11.3.4 Saithe in Subareas IV, VI and Division IIIa. Stock summary.

Year	Landings	Fbar 3-6	RECRUITS (Age 3)	SSB	TSB	Yield/SSB
1967	88326	0.322	127456	150838	395635	0.5856
1968	113751	0.291	114114	211723	520415	0.5373
1969	130588	0.262	300688	263959	694141	0.4947
1970	234962	0.408	291835	312007	890606	0.7531
1971	265381	0.329	327931	429569	1018304	0.6178
1972	261877	0.395	171372	474092	903656	0.5524
1973	242499	0.416	152852	534485	847490	0.4537
1974	298351	0.556	148740	554905	833738	0.5377
1975	271584	0.482	181238	472065	743439	0.5753
1976	343967	0.760	384109	351530	752267	0.9785
1977	216395	0.615	118013	263120	509428	0.8224
1978	155141	0.477	92450	268085	463817	0.5787
1979	128360	0.396	77640	241045	419114	0.5325
1980	131908	0.443	67129	235136	396725	0.5610
1981	132278	0.306	172768	241173	495061	0.5485
1982	174351	0.469	109877	210390	511513	0.8287
1983	180044	0.548	118163	214166	466982	0.8407
1984	200834	0.678	205138	176485	465629	1.1380
1985	220869	0.716	311531	160601	490022	1.3753
1986	198596	0.823	287617	151525	486514	1.3106
1987	167514	0.652	112770	152746	384181	1.0967
1988	135172	0.633	114824	147541	319437	0.9162
1989	108877	0.691	77587	114256	256744	0.9529
1990	103800	0.615	120137	101886	261955	1.0188
1991	108048	0.584	138543	99240	281163	1.0887
1992	99742	0.625	92929	101169	276231	0.9859
1993	111491	0.512	151602	107252	324133	1.0395
1994	109622	0.516	102644	115621	315345	0.9481
1995	121810	0.423	224924	135704	457188	0.8976
1996	114997	0.420	110450	156681	445529	0.7340
1997	107327	0.294	163660	195469	467235	0.5491
1998	106123	0.351	71803	194232	386246	0.5464
1999	110716	0.365	139984	203593	401401	0.5438
2000	91322	0.311	95065	190856	408644	0.4785
2001	95042	0.279	223868	212942	488770	0.4463
2002	115395	0.253	184741	205995	501662	0.5602
2003	105569	0.231	127040	237696	473873	0.4441
2004	104237	0.201	81401	280277	475802	0.3719
2005	124532	0.273	212330	283558	515407	0.4392
2006	125681	0.279	83617	280031	513781	0.4488
2007	100404	0.249	219835*	279918	535774	0.3587
Mean	155061	0.450	161230	236916	507195	0.7192
Unit	Tonnes		Tonnes	Thousands	Tonnes	

***The numbers are derived from using the average of three highest recruitment estimates the last 20 years.**

Table 11.5.1. Input data for RCT3 run

```
Saithe (Age 3) Final run XSA
4       18      2
1990    151731.12      0.28962815      -11     -11     -11
1991    102355.82      0.12282403      -11     -11     1.117
1992    226369.71      0.21540507      0.0547078       -11     13.959
1993    110620.76      0.05510935      0.02675199      21480   3.825
1994    162703.65      0.08426567      0.03759156      22585   3.756
1995    71647.18       0.05898318      0.02932566      15180   1.027
1996    140537.04      0.05843618      0.0152721       16933   2.1
1997    96194.54       0.10227878      0.04434263      34551   3.479
1998    221029.19      0.11374522      0.08103198      72108   21.496
1999    184601.93      0.29719307      0.05082493      82501   10.748
2000    127108.36      0.14397599      0.03434066      67774   19.272
2001    81332.42       0.08544478      0.02436533      34153   4.979
2002    212105.55      0.13497048      0.03709402      48446   8.893
2003    83704.99       0.29448977      0.0345816       18909   10.636
2004    333027.68      0.5088957       0.07948596      77958   34.018
2005    -11     -11     -11     -11     -11
2006    -11     -11     -11     -11     -11
2007    -11     -11     -11     -11     -11
FRATRB_IV
GER_OTB_IV
NORACU
IBTSq3
```

Table 11.5.2. Results of the RCT3 run

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

Age3run1.txt

 Saithe (Age 3) Final run XSA

 Data for    4 surveys over   18 years :  1990 - 2007

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

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

 Forecast/Hindcast variance correction used.

 Yearclass =   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

 FRATRB   10.63  10.49    .67   .262     13    .26   13.24     .855     .082
 GER_OT   38.82  10.33    .55   .375     11    .03   11.65     .643     .146
 NORACU    1.10    .28    .59   .333     10   9.85   11.11     .727     .114
 IBTSq3     .69  10.52    .43   .490     12   2.45   12.20     .495     .246

                                        VPA Mean =   11.82     .382     .412


 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

 FRATRB   18.80   9.26   1.44   .074     14    .41   17.00    2.243     .016
 GER_OT   42.09  10.18    .58   .361     12    .08   13.40     .796     .127
 NORACU    1.04    .94    .53   .385     11  11.26   12.63     .663     .184
 IBTSq3     .85  10.13    .59   .341     13   3.56   13.17     .757     .141

                                        VPA Mean =   11.79     .390     .532


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

 2003      151133     11.93     .25     .25     1.05  83705    11.34
 2004      249080     12.43     .28     .44     2.35 333028    12.72
 2005      No valid surveys
 2006      No valid surveys
 2007      No valid surveys
```

Table 11.6.1 Saithe in Subareas IV, VI and Division IIIa. Input data for short term forecast.

2008

age	stock.n	mat	M	F
3	127168	0	0.2	0.09
4	167937	0.15	0.2	0.22
5	40450	0.7	0.2	0.35
6	66460	0.9	0.2	0.41
7	10759	1	0.2	0.41
8	12982	1	0.2	0.42
9	8238	1	0.2	0.36
10	10231	1	0.2	0.36

Table 11.6.2 Saithe in Subareas IV, VI and Division IIIa. Management option table.

2008

fmult	f3-6	landings	ssb2007
1	0.27	127861	303355

2009

fmult	f3-6	landings	ssb2009	ssb2010
0	0	0	319970	435017
1	0.27	125718	319970	310507
0.37	0.1	51921	319970	383102
0.11	0.03	16249	319970	418704
0.28	0.07	39530	319970	395435
0.56	0.15	75601	319970	359641
0.84	0.23	108539	319970	327264
1.01	0.27	126923	319970	309336
1.12	0.3	138640	319970	297966
1.24	0.33	149946	319970	287041
1.4	0.38	166168	319970	271447
0.15	0.04	21534	319970	413411
0.75	0.2	97889	319970	337698
1.35	0.36	160856	319970	276542
1.5	0.4	174814	319970	263176
1.65	0.44	188131	319970	250499
1.87	0.5	206972	319970	232695

*$F_{sq,}$, **$F_{man.plan}$, ***F_{pa}

Table 11.6.3 Saithe in Subareas IV, VI and Division IIIa. Stock numbers of recruits and their source for recent year classes used in predictions, and relative (%) contributions to landings and SSB (by weight) of these year classes.

Year-class	2002	2003	2004	2005	2006
Stock no. (thousands) of 3 years old	212330	83617	219835	127168	127168
Source	XSA	XSA	HIGH AVG	GM88-05	GM88-05
Status Quo F:					
% in 2008 landings	26.48	10.84	24.63	6.23	-
% in 2009 landings	18.65	9.46	30.13	14.13	6.33
% in 2008 SSB	33.03	11.89	8.74	0	-
% in 2009 SSB	23.69	11.00	30.81	4.67	0.00
% in 2010 SSB	17.56	8.57	30.98	17.90	4.81

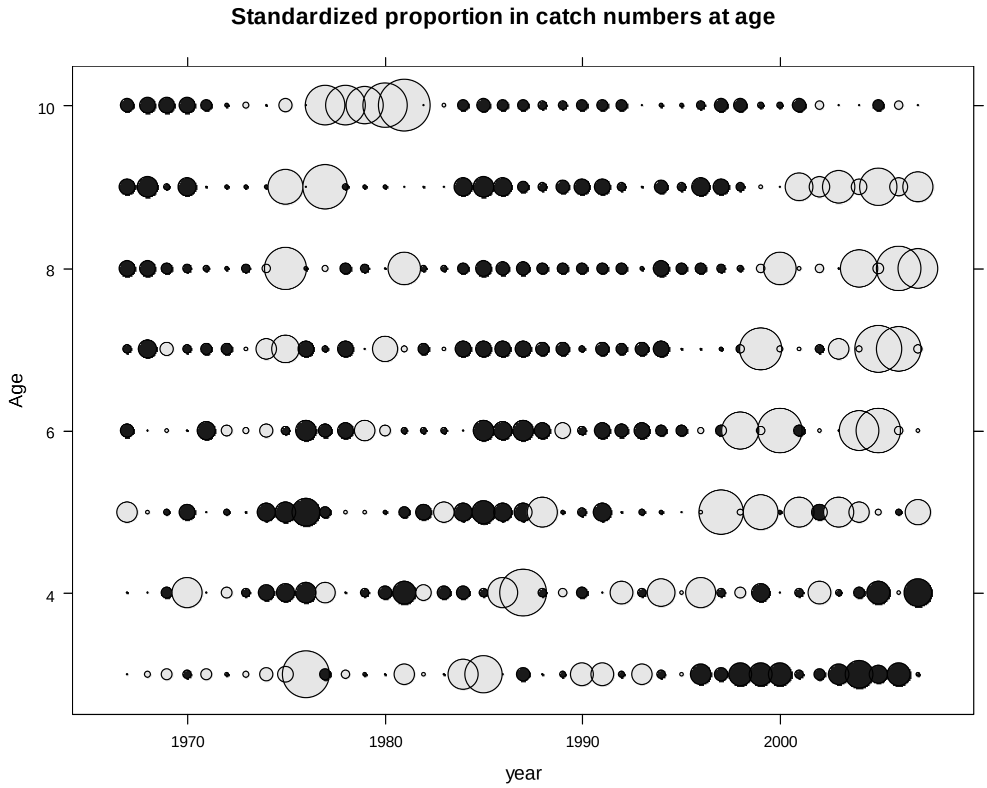


Figure 11.2.1. Saithe in Subarea IV, VI and Division IIIa. Standardised proportion of catch at age (scaled to zero mean for each age). Grey circles are positive numbers and black are negative.

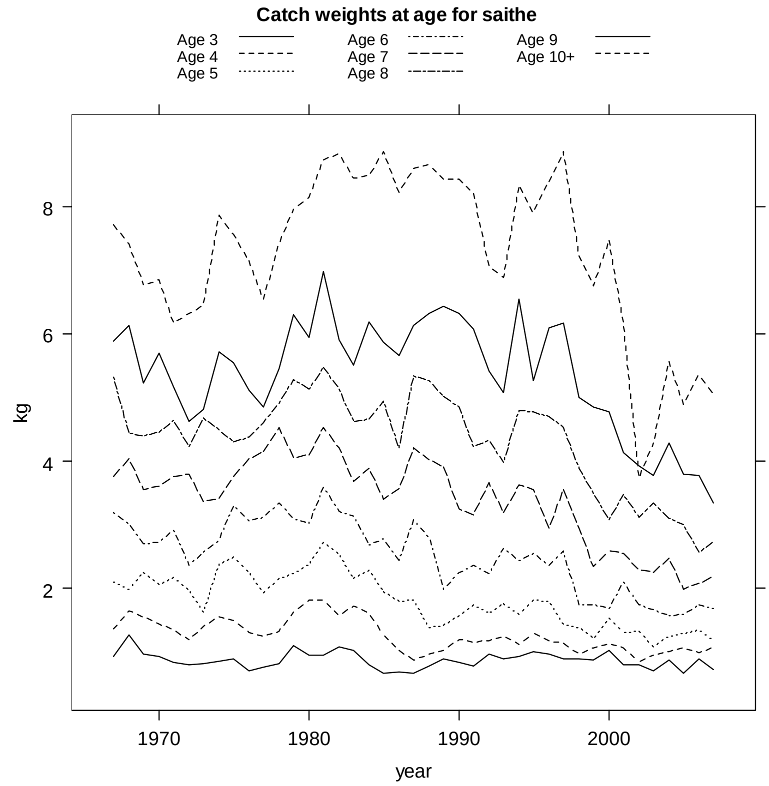


Figure 11.2.2. Saithe in Subarea IV, VI and Division IIIa. Trends in mean weights at age in landings.

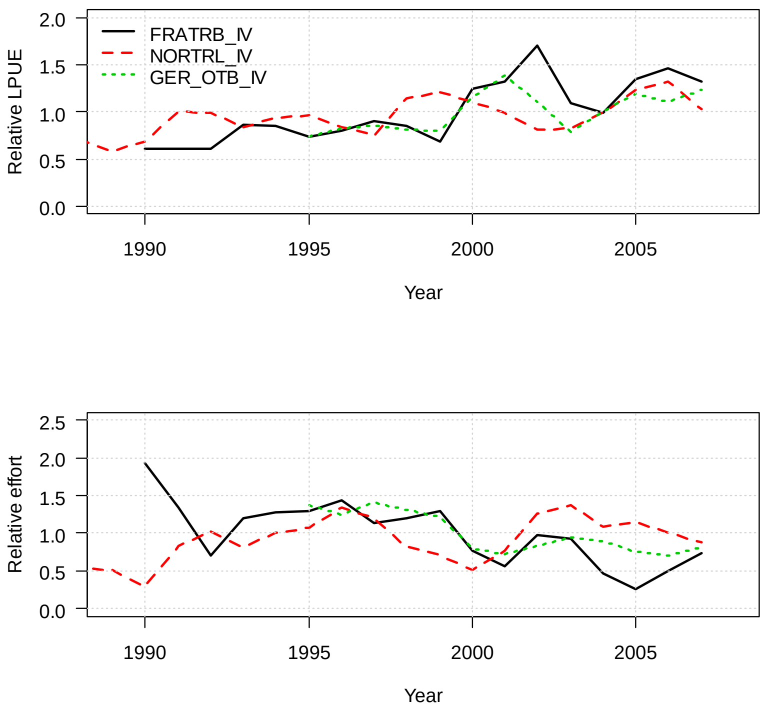


Figure 11.2.3. Saithe in Subarea IV, VI and Division IIIa. Relative trends in total landings per unit effort and effort for the commercial tuning fleets.

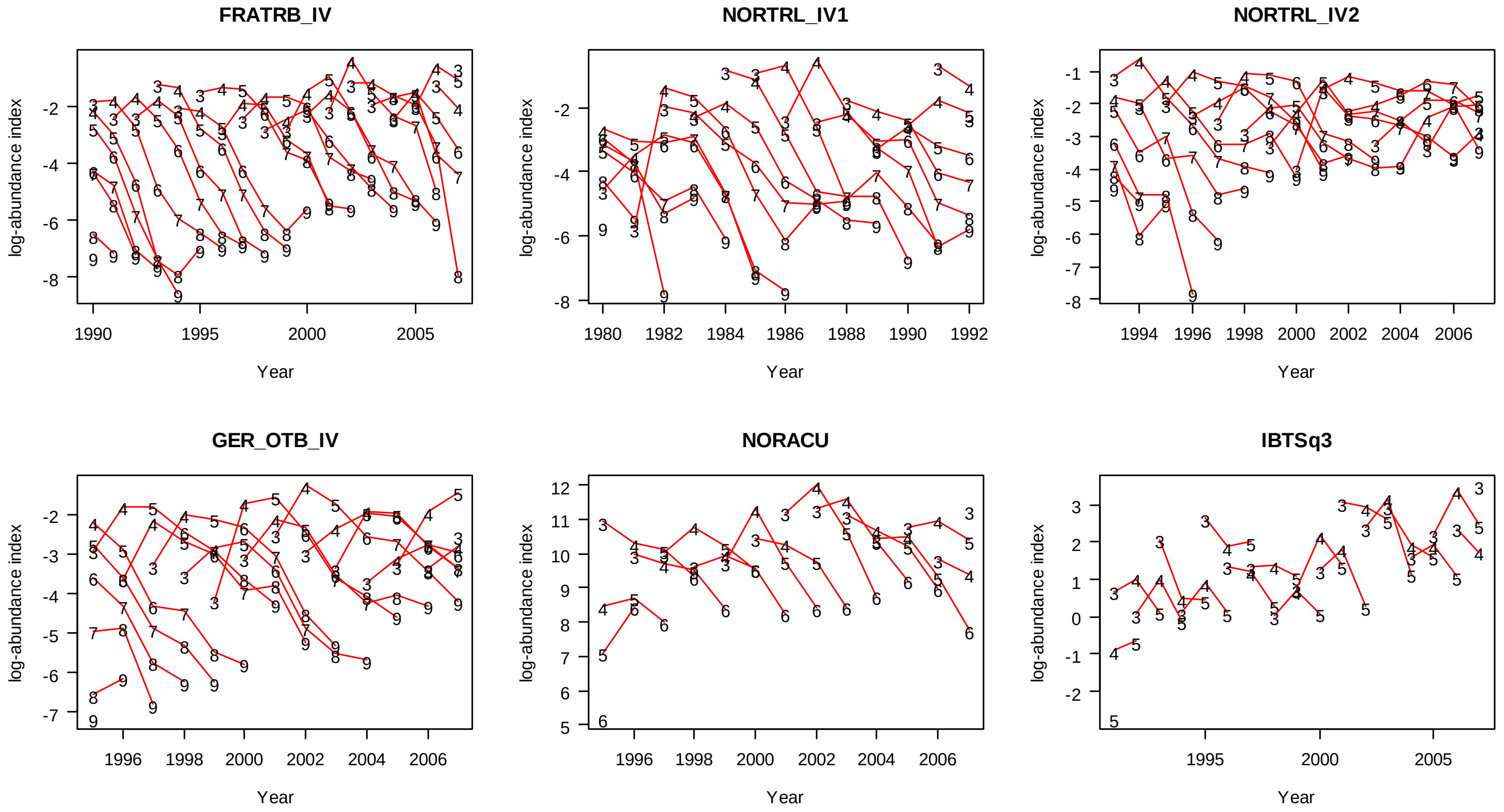


Figure 11.3.6. Saithe in Subarea IV, VI and Division IIIa. Log-abundance indices by cohort for each of the available tuning series.

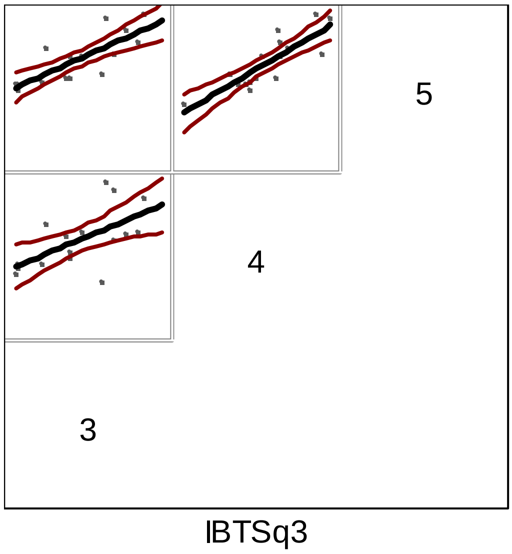


Figure 11.3.2. Saithe in Subarea IV, VI and Division IIIa. Within-survey correlations for IBTSq3 for the period 1991-2007. Correlations in the catch-at-age matrix comparing estimates at different ages for the same year-classes (cohorts). The straight line is a normal linear model fit: a thick line represents a significant ($p < 0.05$) regression, while a thin line is not significant. Approximate 95% confidence intervals for each fit are also shown.

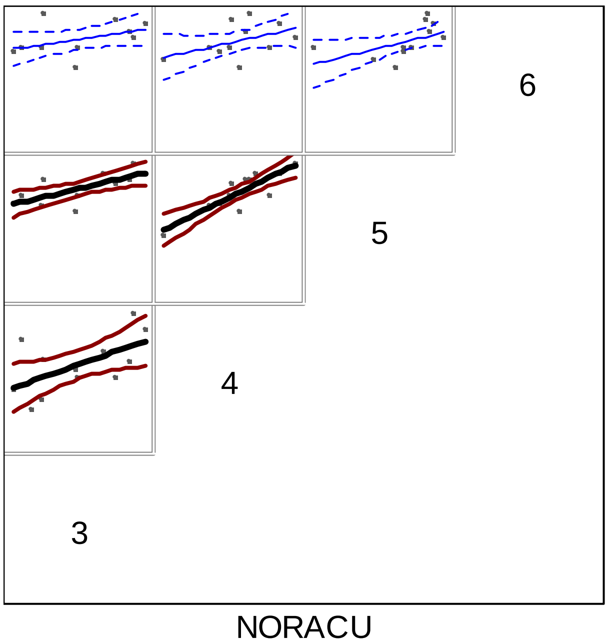


Figure 11.3.3. Saithe in Subarea IV, VI and Division IIIa. Within-survey correlations for NORACU for the period 1994-2007. Correlations in the catch-at-age matrix comparing estimates at different ages for the same year-classes (cohorts). The straight line is a normal linear model fit: a thick line represents a significant ($p < 0.05$) regression, while a thin line is not significant. Approximate 95% confidence intervals for each fit are also shown.

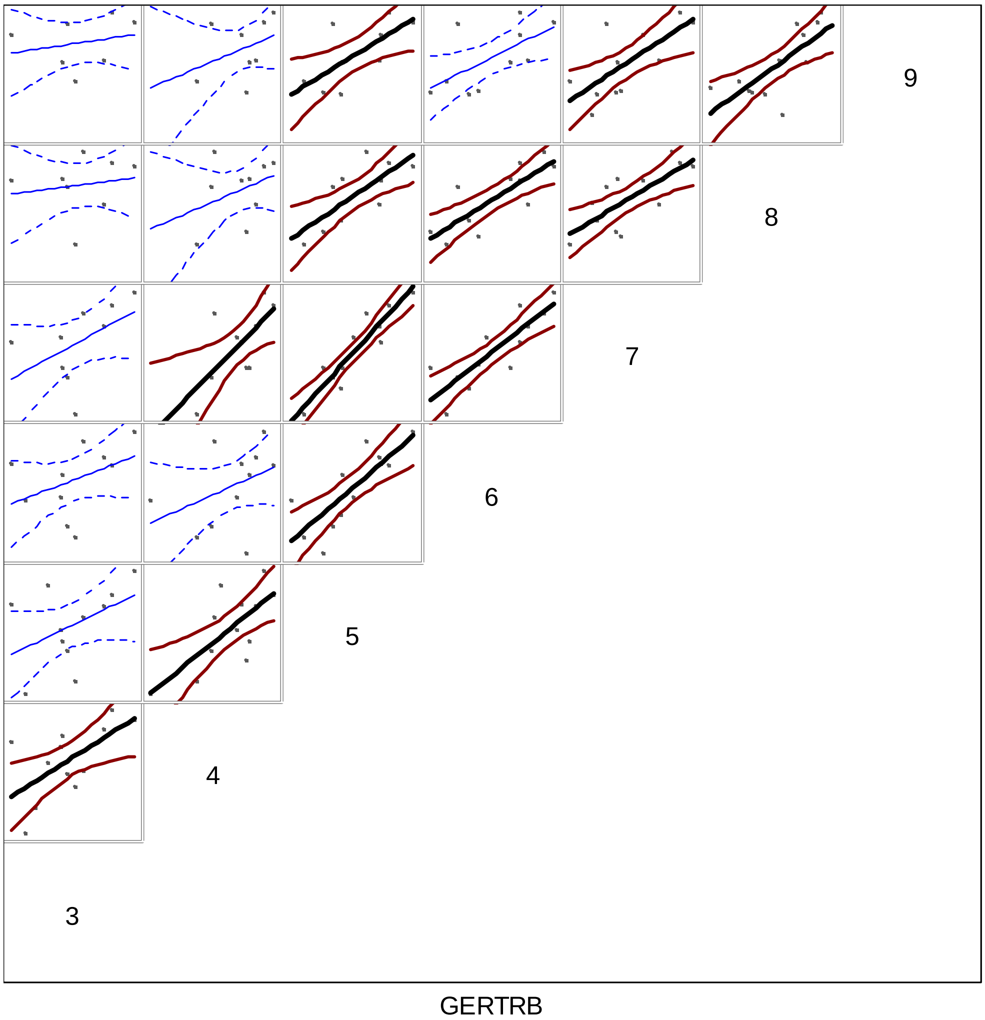


Figure 11.3.4. Saithe in Subarea IV, VI and Division IIIa. Within-survey correlations for GEROTB. Correlations in the catch-at-age matrix comparing estimates at different ages for the same year-classes (cohorts). The straight line is a normal linear model fit: a thick line represents a significant ($p < 0.05$) regression, while a thin line is not significant. Approximate 95% confidence intervals for each fit are also shown.

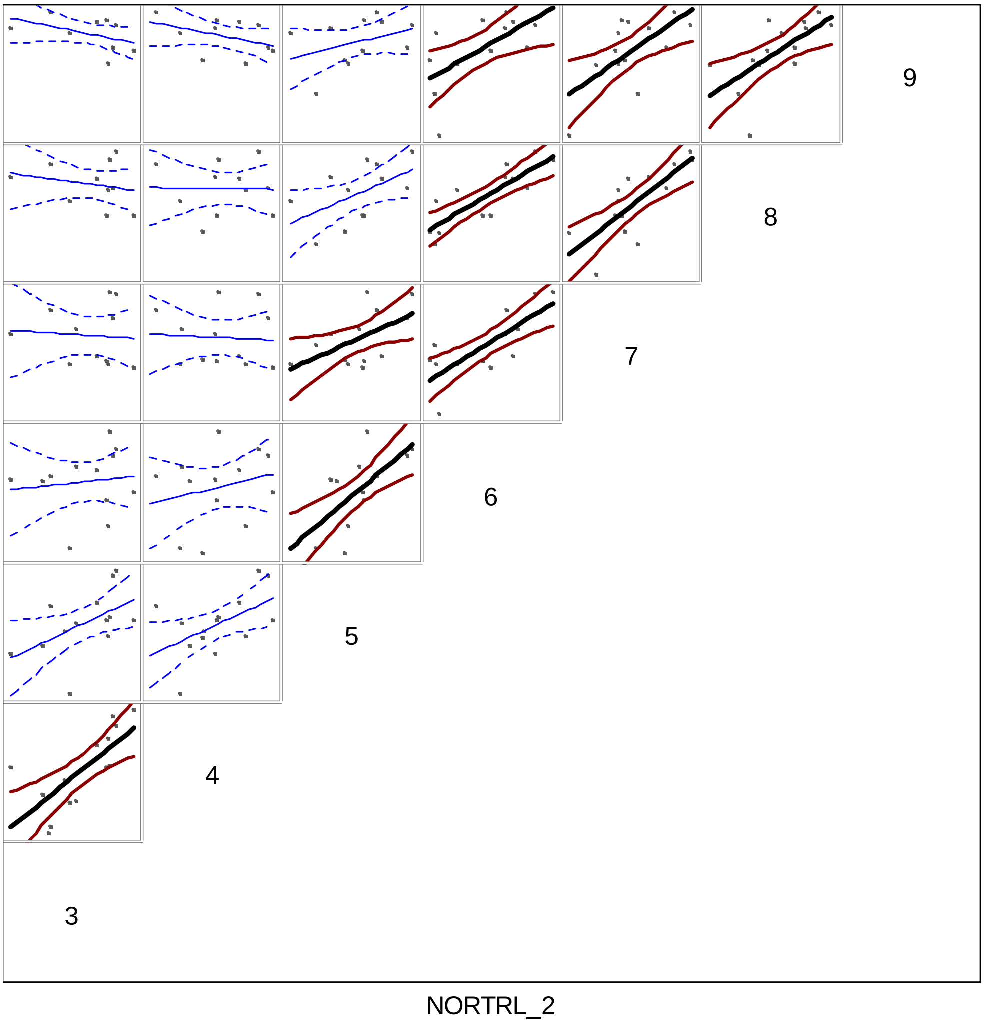


Figure 11.3.5. Saithe in Subarea IV, VI and Division IIIa. Within--survey correlations for NORTRL (1993-2007). Correlations in the catch-at-age matrix comparing estimates at different ages for the same year-classes (cohorts). The straight line is a normal linear model fit: a thick line represents a significant ($p < 0.05$) regression, while a thin line is not significant. Approximate 95% confidence intervals for each fit are also shown.

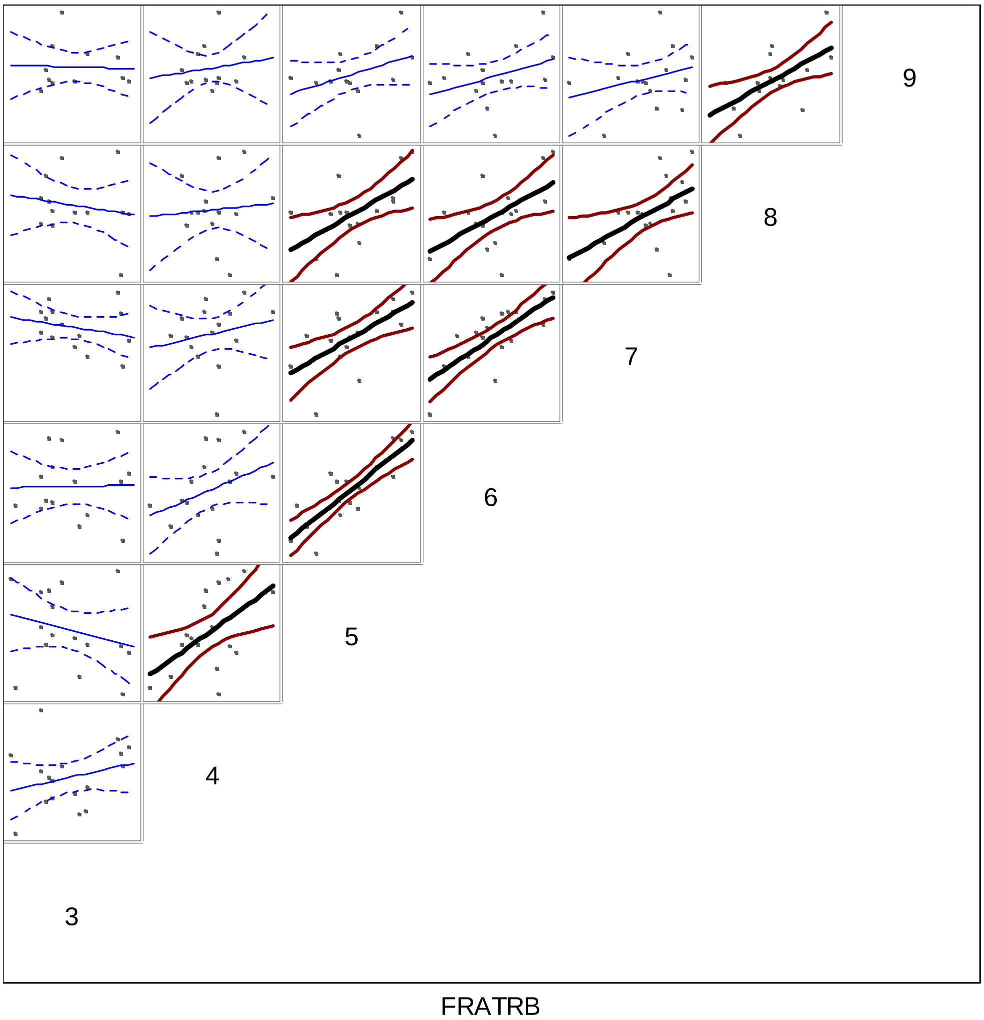


Figure 11.3.6. Saithe in Subarea IV, VI and Division IIIa. Within--survey correlations for FRATRL. Correlations in the catch-at-age matrix comparing estimates at different ages for the same year-classes (cohorts). The straight line is a normal linear model fit: a thick line represents a significant ($p < 0.05$) regression, while a thin line is not significant. Approximate 95% confidence intervals for each fit are also shown.

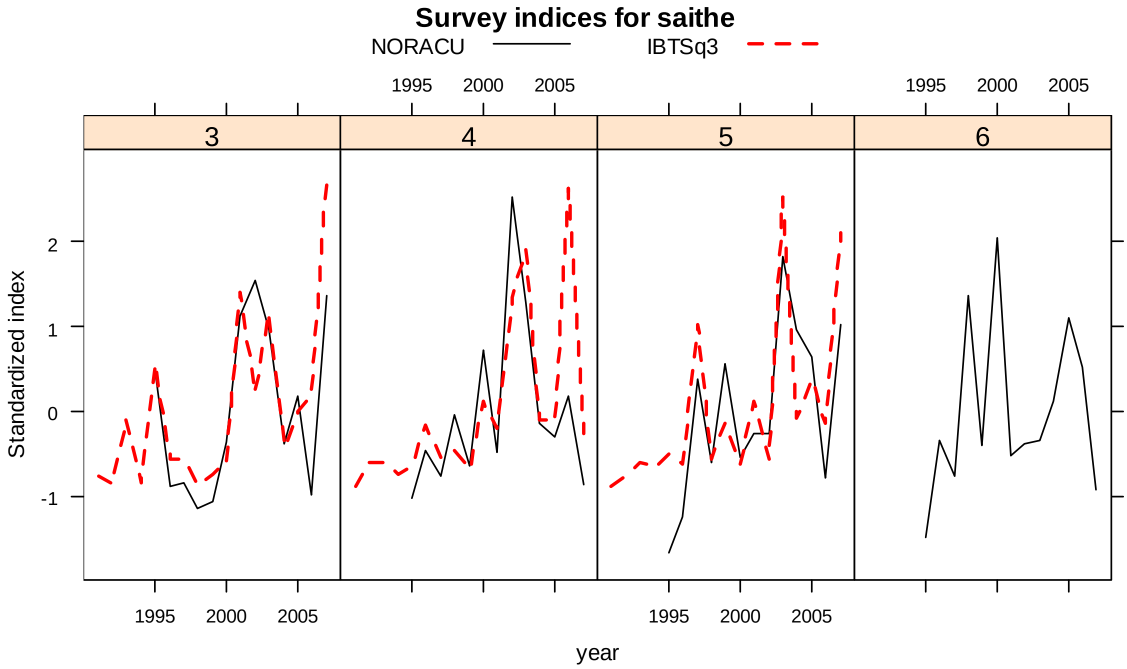


Figure 11.3.7. Saithe in Subarea IV, VI and Division IIIa. Standardised indices from the two survey time series.

sp

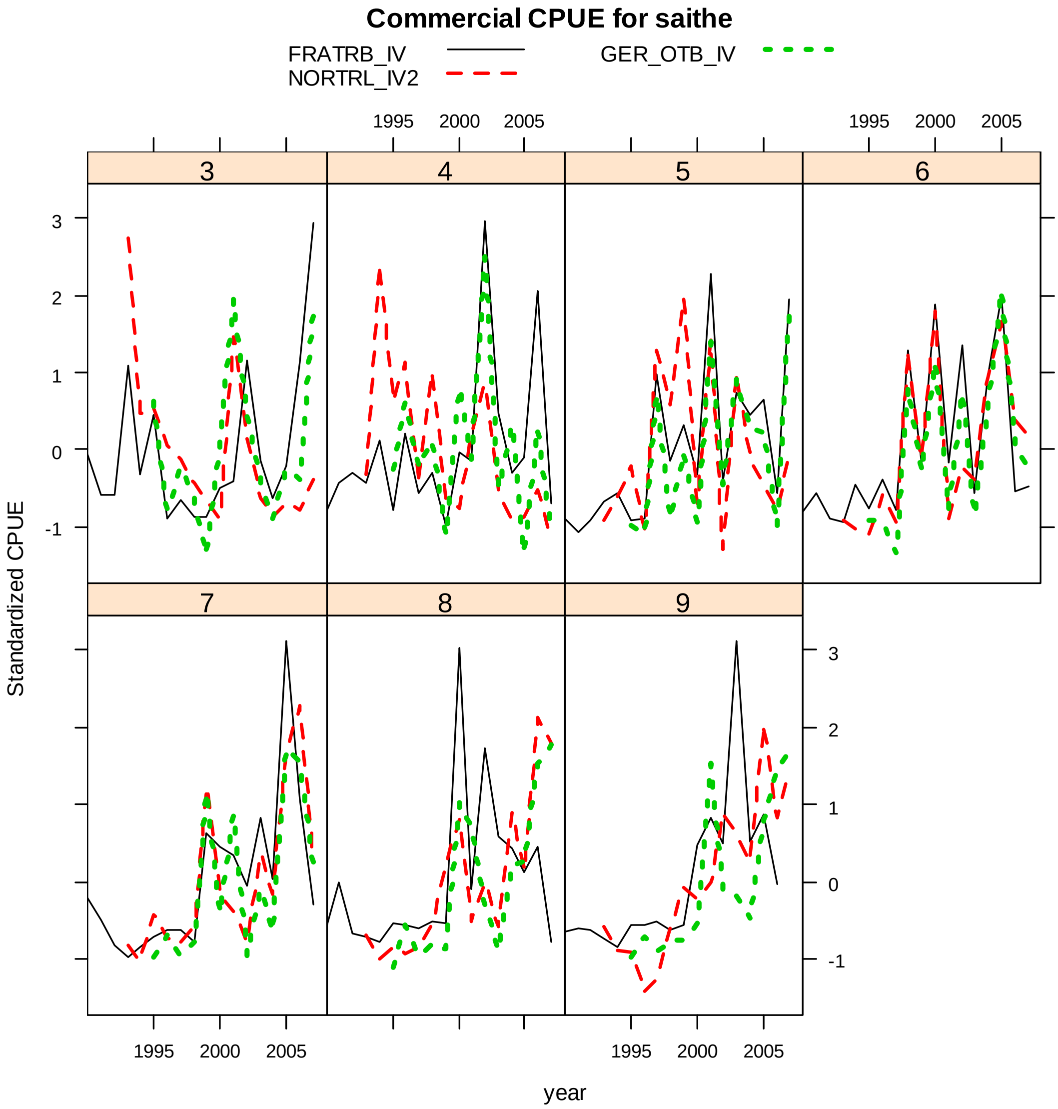


Figure 11.3.8. Saithe in Subarea IV, VI and Division IIIa. Standardised indices from the commercial tuning series.

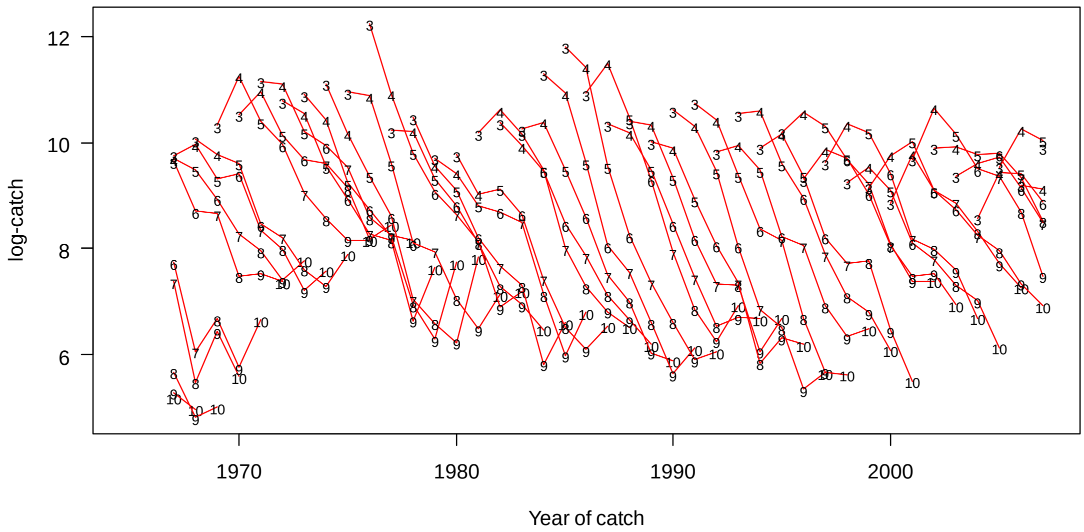


Figure 11.3.9. Saithe in Subarea IV, VI and Division IIIa. Log number by cohort for total catches.

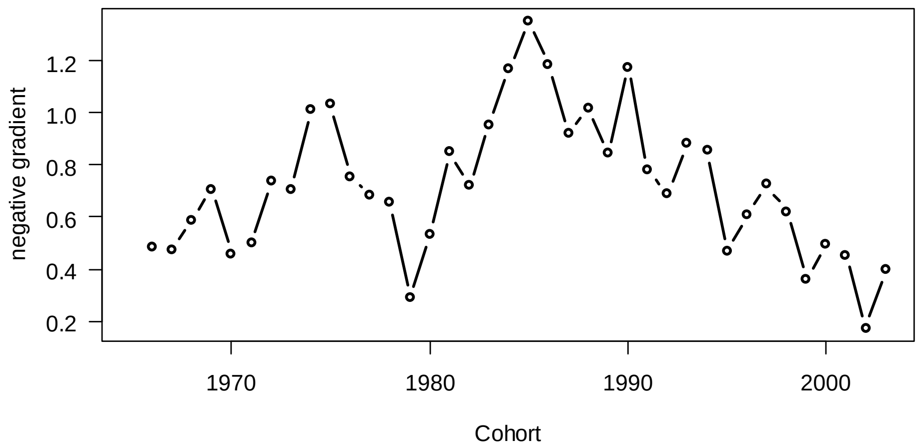


Figure 11.3.10. Saithe in Subarea IV, VI and Division IIIa. Negative gradients of log-numbers per cohort in the catches for the age-range 4-7.

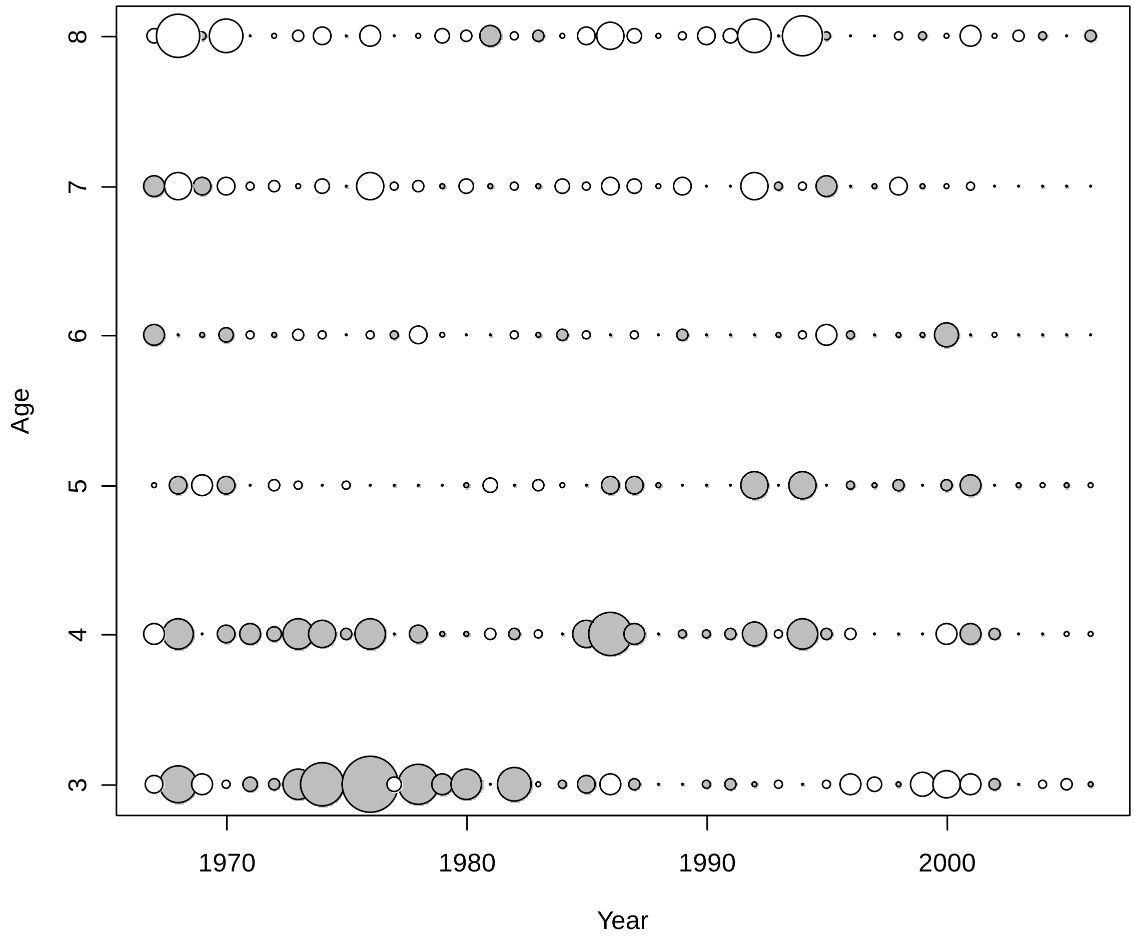


Figure 11.3.11. Saithe in Subarea IV, VI and Division IIIa. Log catch residuals from a separable VPA run.

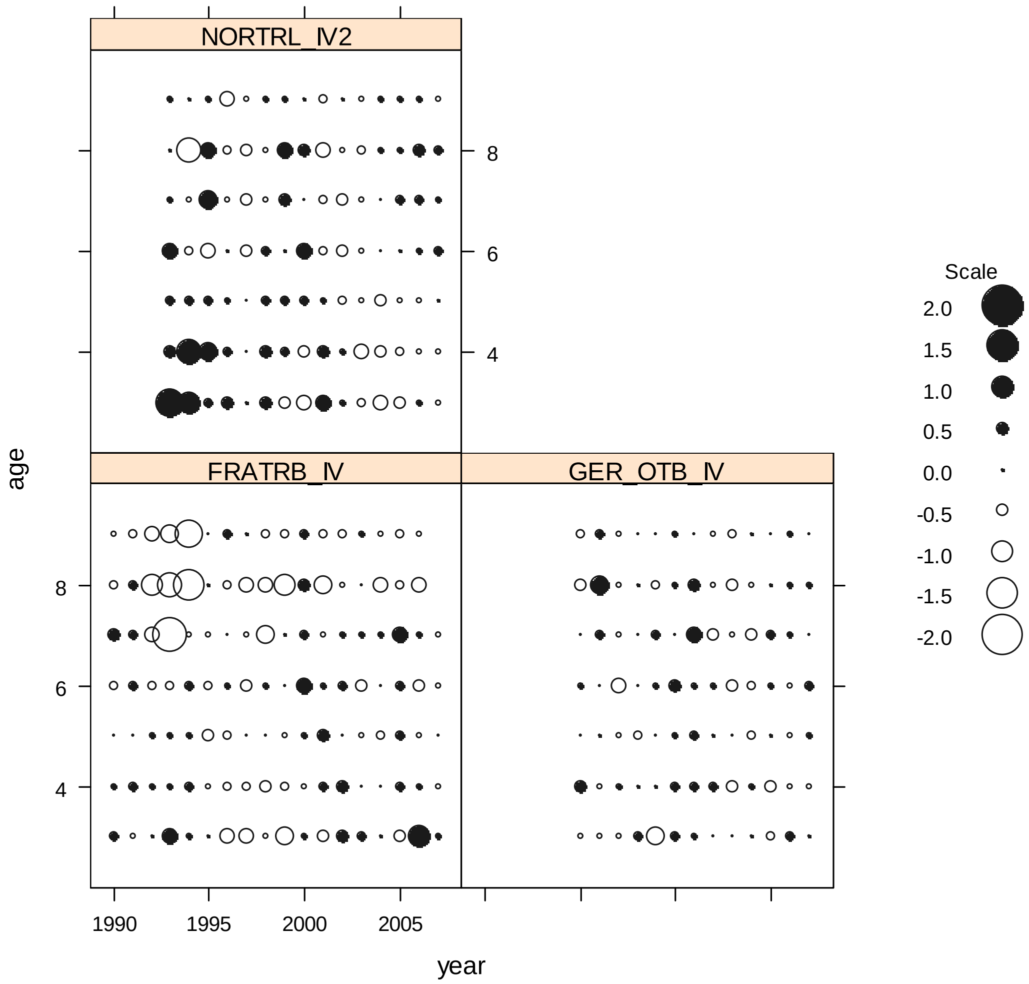


Fig 11.3.12. Saithe in Subarea IV, VI and Division IIIa. Log catchability residuals from single-fleet XSAs. (SPALY). that the residual age 3 in year 2007(-3.3) is removed in the plot to make the signal in the other residuals clearer.

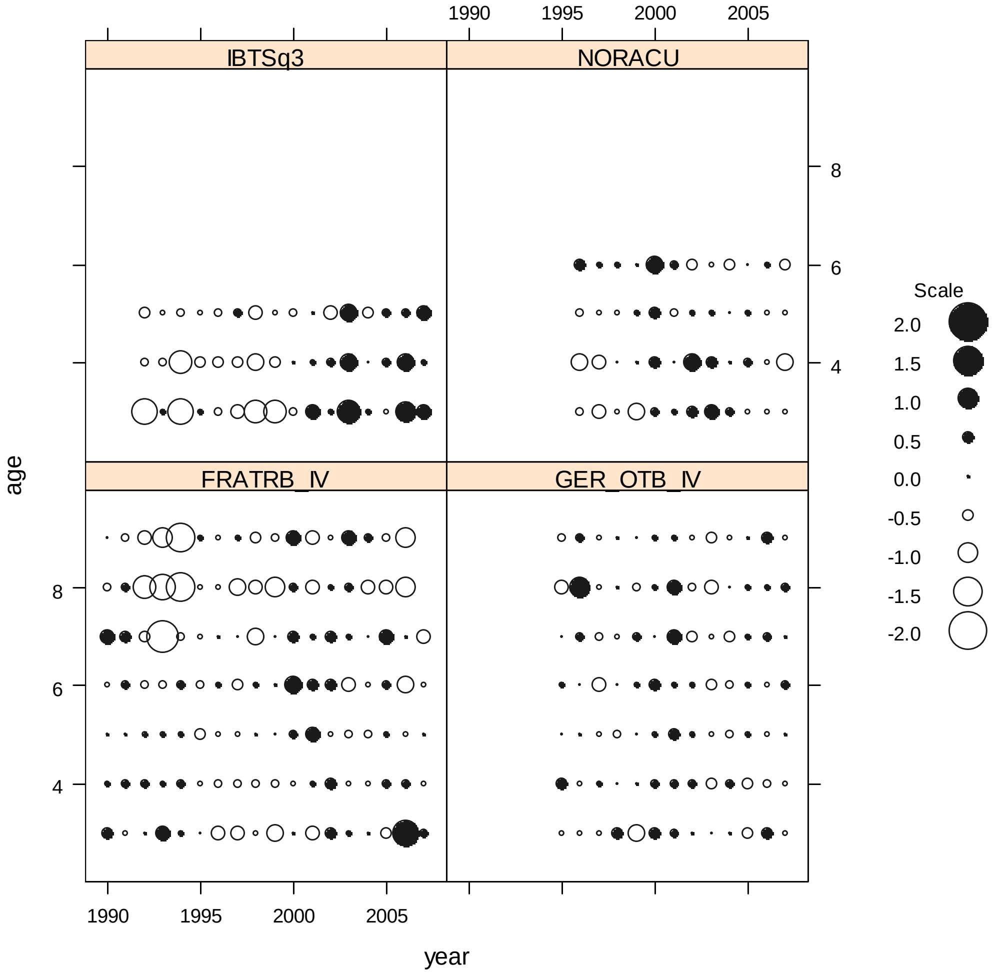


Figure 11.3.13. Saithe in Subarea IV, VI and Division IIIa. Log catchability residuals from the final XSA run, (SPALY). Note that the residual age 3 in year 2007(-3.8) is removed in the plot to make the signal in the other residuals clearer.

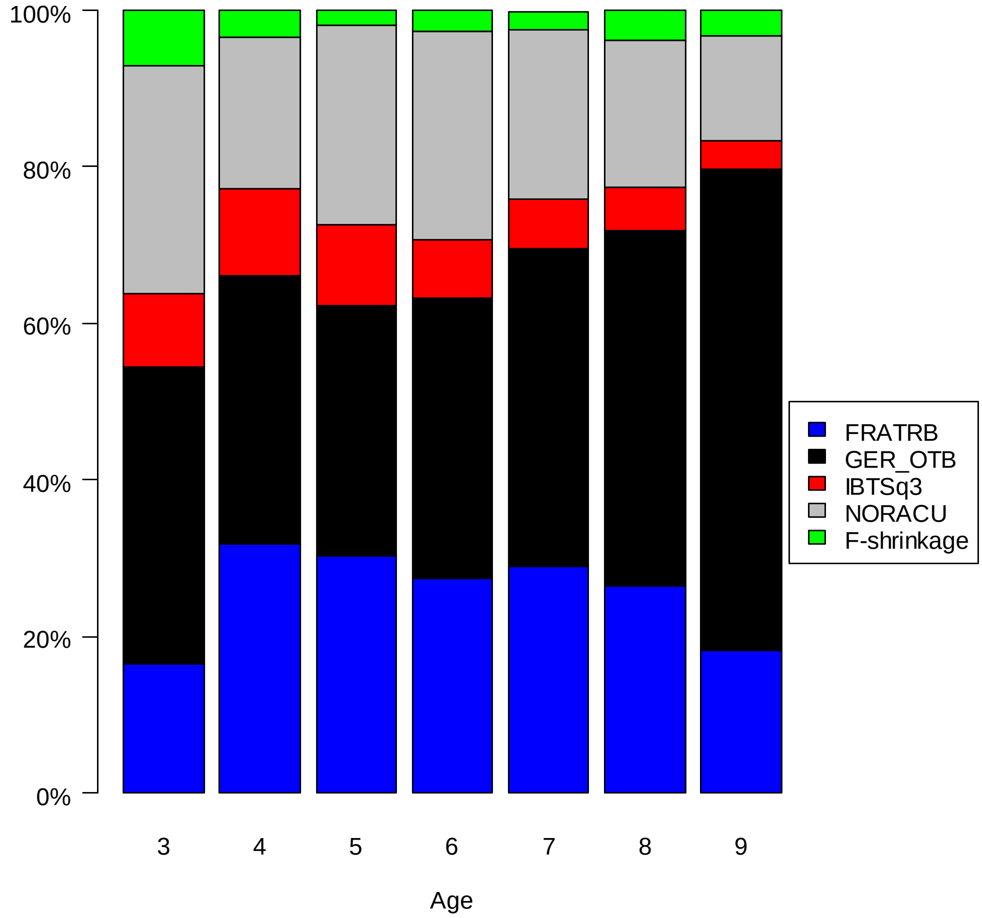


Figure 11.3.14. Saithe in Subarea IV, VI and Division IIIa. Relative weights of F-shrinkage and tuning fleets in the final XSA run.

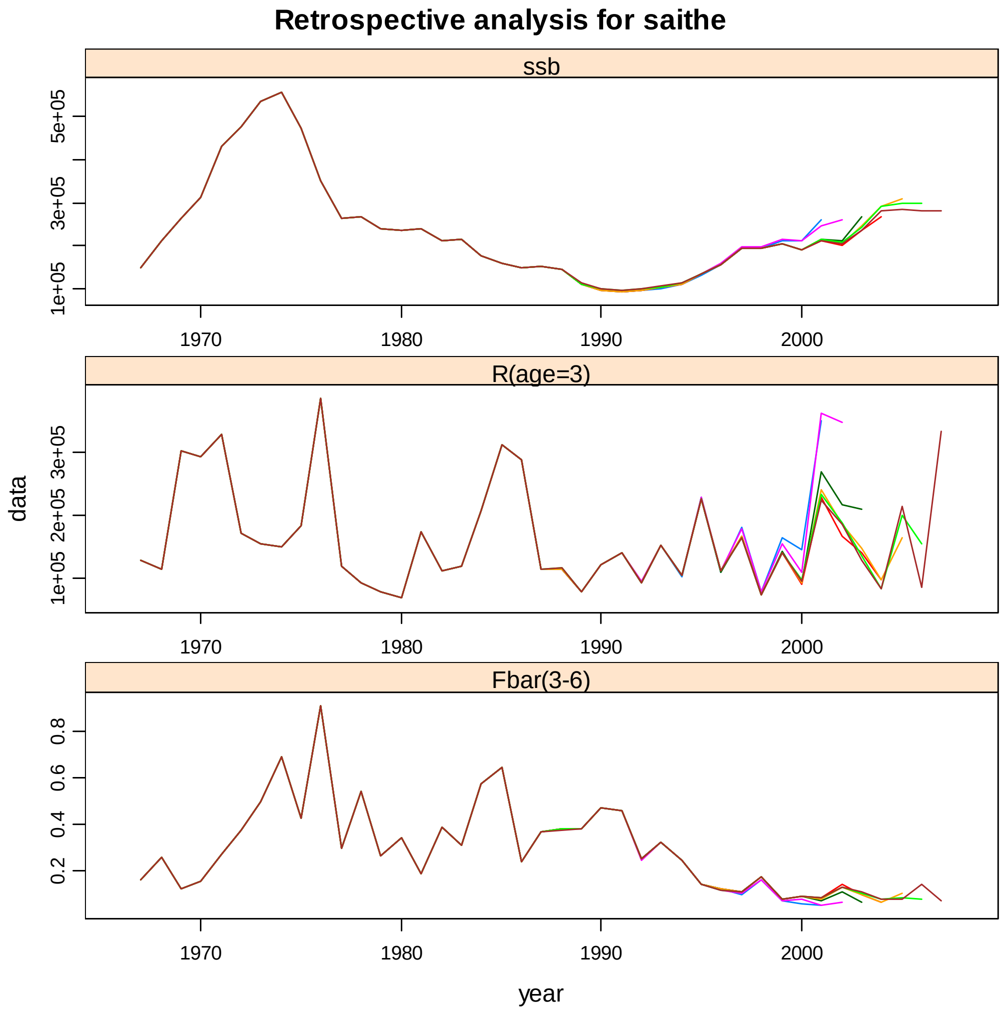


Figure 11.3.15. Saithe in Subarea IV, VI and Division IIIa. Retrospective analysis of the final XSA run.

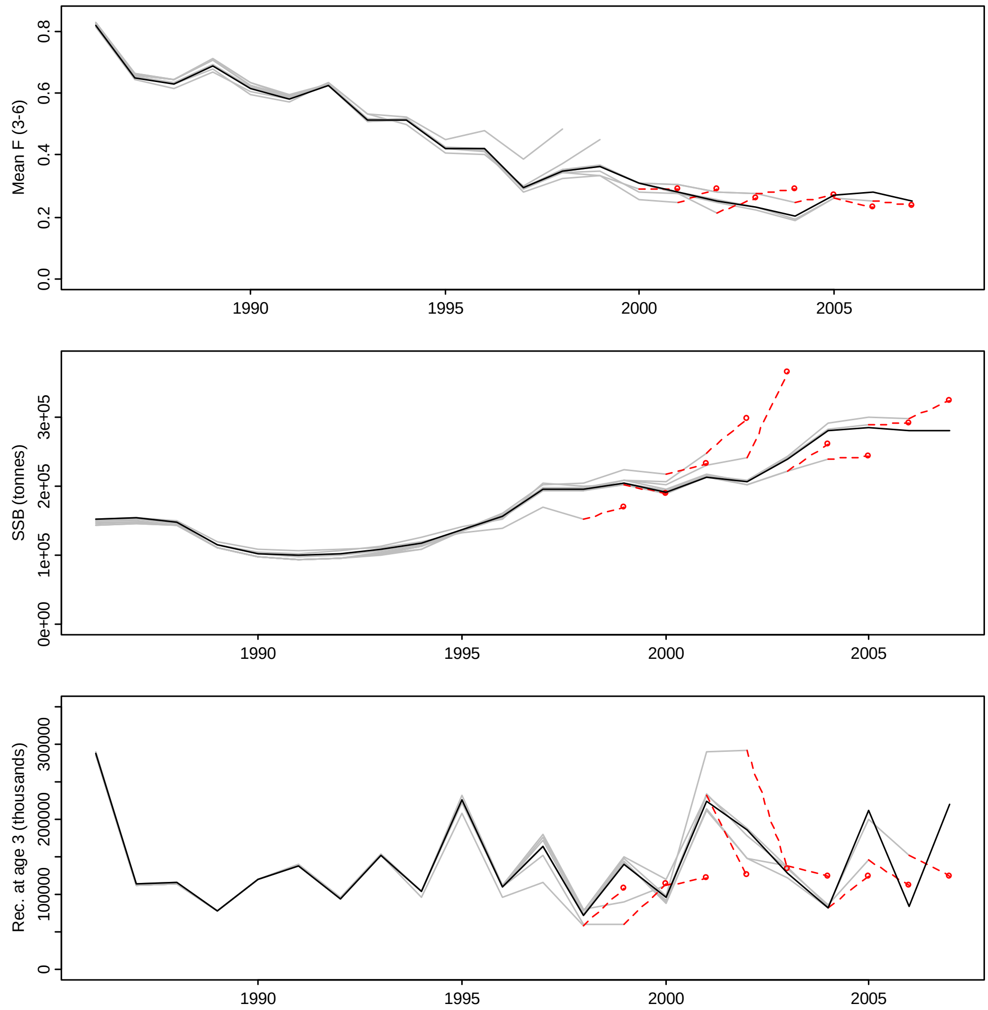


Figure 11.3.16. Saithe in Subarea IV, VI and Division IIIa. Assessments generated in successive working groups. Red circles represent forecasts for the assessment year.

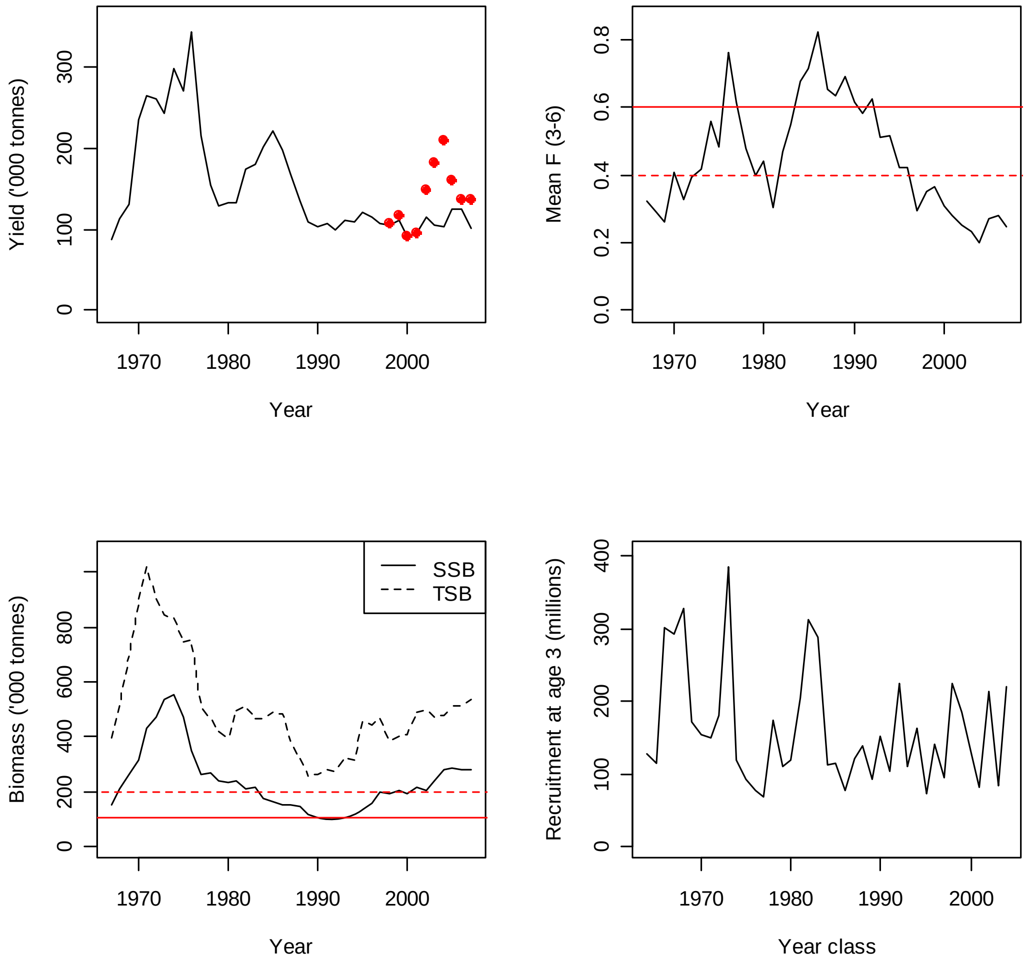
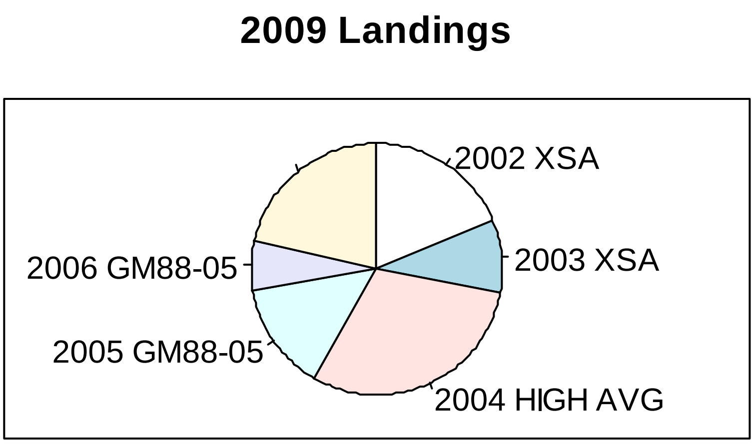


Figure 11.4.1. Stock summary for saithe in Subarea IV, VI and Division IIIa. The red dots in the yield graph are TACs.



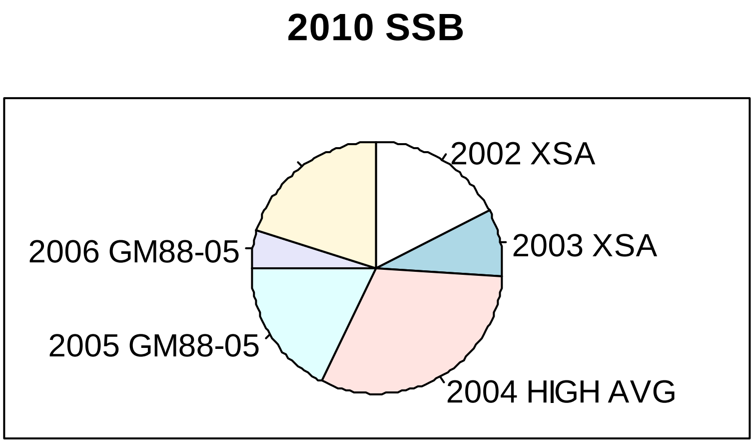


Figure 11.6.1 Saithe in Subarea IV, VI and Division IIIa. The relative biomass contribution (%) of recent year classes in the prediction with F status quo.

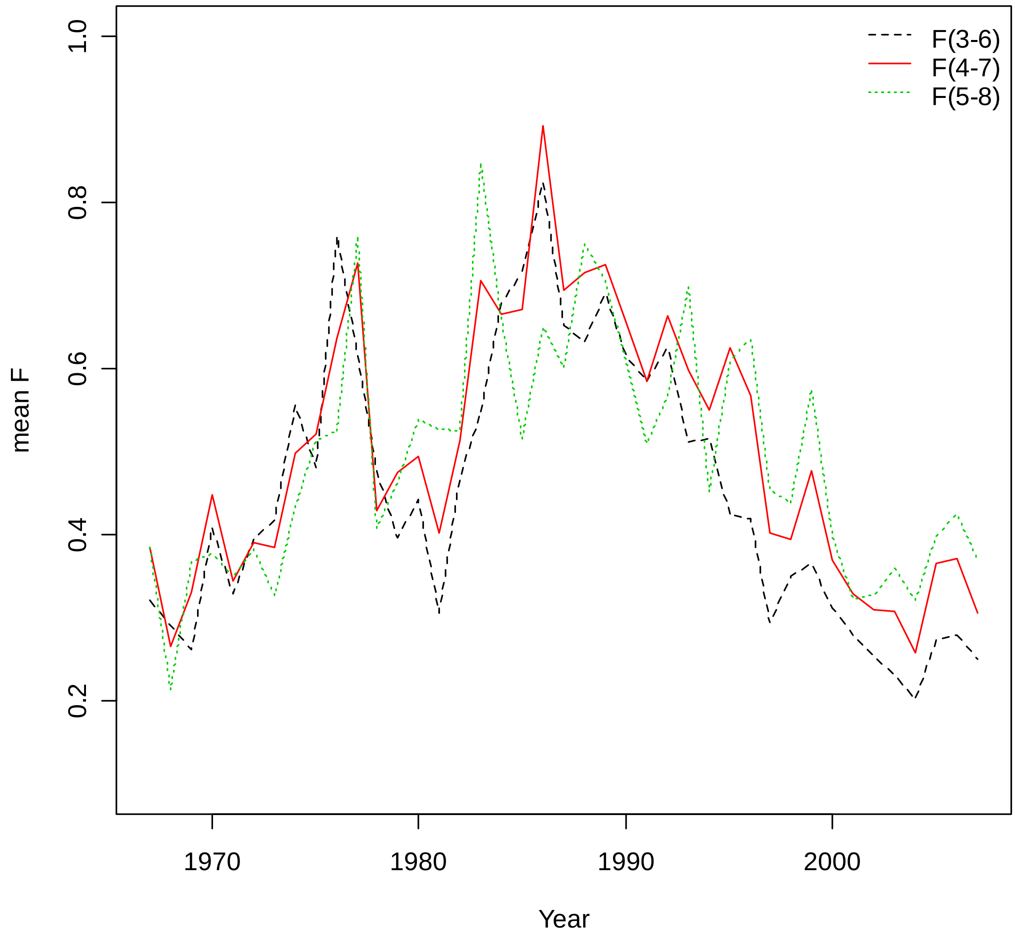


Figure 11.8.1. Saithe in Subarea IV, VI and Division IIIa. Average F (Fbar) using different age ranges.

12 Whiting in Subarea IV and Divisions VIId and IIIa

This assessment relates to whiting in the North Sea (ICES Subarea IV) and eastern Channel (ICES Division VIId). The current assessment is formally classified as an update assessment. The assessment from the last working group meeting (2007) was accepted by the ACFM review group in October 2007. This review group concluded that the assessment was consistent since 1995 and offers a reliable basis for determining stock status, including estimation of current stock size and fishing mortality.

12.1 General

12.1.1 Ecosystem aspects

Whiting are found throughout the North Sea, predominantly to the south of the Norwegian Deep and around the north of the Shetland Isles. The report of the SGSIMUW (ICES – WGNSSK 2005) documents the background to the basis of the long-held view that whiting in the northern and southern North Sea comprise different stock units, and concludes that sufficient information exists to support the view of stock units that are separated in the region of the Dogger Bank – an area associated in the summer with the separation of mixed and stratified water and roughly bounded by the 50 m depth contour. Limited tagging information indicates limited movement of whiting across this boundary.

Results from key runs of the ICES SG on Multispecies Assessment in the North Sea (ICES–SGMSNS 2005) indicate three major sources of mortality for whiting. For ages 0–1, grey gurnard is a very important predator and for ages 1–2 cod becomes an important predator. For ages three and above, the primary source of mortality is the fishery, followed by predation by seals. More notably, there is evidence for cannibalism on the 0- and 1-group. It has been postulated by Bromley et al. (1997) that the spawning habit of whiting, *i.e.*, multiple spawning over a protracted period, may provide continued food resources for earlier spawned 0-group whiting.

Results from SGMSNS (ICES–SGMSNS 2005) show that that the main diet of whiting is commercially important fish species, and that the predominant prey species of whiting were whiting, sprat, Norway pout, sandeel and haddock.

12.1.2 Fisheries

For whiting, there are three distinct areas of major catch: a northern zone, an area off the eastern English coast; and a southern area extending into the English Channel.

Northern area

In the northern area, roundfish are caught in otter trawl and seine fisheries, currently with a 120 mm minimum mesh size. Some vessels operating to the east of this area are using 130 mm mesh. These are mixed demersal fisheries with more specific targeting of individual species in some areas and/or seasons. Cod, haddock and whiting form the predominant roundfish catch in the mixed fisheries, although there can be important bycatches of other species, notably saithe and anglerfish in the northern and eastern North Sea and of *Nephrops* in the more offshore *Nephrops* grounds. Minimum mesh size in *Nephrops* trawls is 80 mm but a range of larger mesh sizes are also used when targeting *Nephrops*. Whiting is becoming a more important species for the

Scottish fleet, with many vessels actively targeting whiting during a fishing trip and Scottish single seiners have been working closer to shore to target smaller haddock and whiting. Technological developments have included a shift towards pair trawling and the development of double bag trawls which reduce costs compared to twin trawling. The derogation in the EU effort management scheme allowing for extra days fishing by vessels using 90 mm mesh gears with a 120 mm square mesh panel close to the codend (a configuration which releases cod) has so far, been taken up by few vessels.

Recent fuel price increases and a lack of quota for deep-water species has resulted in some vessels formerly fishing in deep-water and along the shelf edge to move into the northern North Sea with the shift in fishing grounds likely to result in a change in the species composition of their catches from monkfish to roundfish species including whiting. Following the major decommissioning schemes a few years ago by the UK, there have not been further reductions, although a number of boats have taken advantage of oil support work and effort has probably been reduced.

Eastern English coast

Whiting are an important component in the mixed fishery occurring along the English east coast. Industry reports suggest better catch rates here than are implied by the overall North Sea assessment. Darby (2006, 2007 WD7) analysed the catch per unit of effort (CPUE) of the English fishery. In recent years the vessels have been reporting unusually high catch rates of large whiting. Recent catch rates appear to have peaked and have recently begun to decline (Figure 12.1.1) but are still well above historic levels. The Cefas – Industry Fisheries Science partnership survey conducted during the autumn of 2007 (Armstrong 2007) reported that the majority of the catch (63%) taken by an 80 mm trawl survey of the area comprised whiting of ages 5 and older. Under an assumption that the current English fleet CPUE represents these ages, comparisons can be made between i) English fleet CPUE during the years 2000 – 2007 ii) the International Bottom Trawl Survey (IBTS) estimates of biomass and iii) the time series of older ages taken from the 2006 ICES assessment (considered by ICES ACFM (2006) to be indicative of trends in the stock only). The increase in the English otter trawler CPUE of whiting clearly exceeds that of the survey and assessment by a factor of three to four. The degree of difference in the level of increase is dependent on the age ranges used in the analysis; there is more divergence for catches of 5+ whiting than for 6+ (Figure 12.1.1 c.f. Figure 12.1.2). The Industry Fisheries Science partnership survey has confirmed the increased CPUE and that the local abundance of whiting and that the northeast coast fleet cannot avoid them without considerable displacement of vessels.

General

The current spatial distribution of North Sea whiting could result from local increases in the stock abundance or from a spatial contraction of the stock as its total abundance declines following recent poor recruitment. The latter hypothesis would seem to be indicated by the spatial distribution of IBTS whiting catch rates during recent years (Figures 12.2.5 and 12.2.6) that indicate that ages 3+ whiting are located primarily around the North east coast of England and the East coat of Scotland with very low catch rates in the southern North Sea. This appears to be confirmed by a displacement of some French vessels steaming from Boulogne-sur-Mer from their traditional grounds in the southern North Sea and English Channel where they have reported very low catch rates during the past two years.

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.

Historically, by-catch of whiting by industrial fisheries for reduction purposes was an important part of the catch, but due to the recent reduced fishery for sandeel and Norway pout impact of this fishery on the whiting stock is considered much reduced.

Changes in fleet dynamics

The following is taken from the WGFTFB(2008):

In Belgium the use of bigger meshes in the top panel of beam trawler gear is expected to reduce the by-catch of roundfish species, especially haddock and whiting.

In Scotland there has been a shift for Scottish vessels from using 100 mm-110 mm for whitefish on the west coast ground (Area VI) to 80 mm prawn codends in the North Sea (area IV). Fuel costs are a major driver, in this and all fisheries. The implications are that there will be increased effort in the North Sea with more effort by less selective gears; this implies increased bycatches and discards.

There is a new 2008 Scottish Conservation Credits scheme, with a number of implications:

- In early 2008, a one-net rule was introduced in Scotland as part of the new Conservation credits scheme. This is likely to improve the accuracy of reporting of landings to the correct mesh size range. Another element of the package is the standardisation of the mesh size rules for twin rig vessels so that 80 mm mesh can be used in both Areas IV and VI (north of 56°N) by twin rig vessels – previously the minimum mesh size for twin rig in area VI was 100 mm. As a result there may be some migration of twin riggers from area IV to area VI, thus switching effort from IV to VI. Implications: Selectivity is not expected to change greatly for prawns because 80 mm nets must be made of 4 mm single twine whereas 100 mm nets were allowed to use 5 mm double twine. Whitefish selection may improve because from July 2008, all nets in the 80 mm range will have to have a 110 mm square mesh panel installed.

- Scottish seiners have been granted a derogation from the 2 net rule until end Jan 2009 to continue to carry 2 nets (e.g. 100−119 mm as well as 120+mm). They are required to record landings from each net on a separate log-sheet and to carry observers when requested. Implications: Potential for misreporting by mesh category

- From February 2008 there has been a concerted effort not to target cod. Real time closures and gear measures are designed to reduce cod mortality. Implication: that there will be greater effort exerted on haddock, whiting, monk, flats and *Nephrops*.

Technical Conservation Measures

- The option of 18 extra days if a 120 mm SMP at 4–9 m was used with a 95 mm x 5 mm double codend was not taken up by the Scottish prawn fleet in 2007. The main reasons were that prawns would be lost due to twisting and too many marketable haddock and whiting lost which the extra days would not make up for. In 2008 this option attracts 39 extra days but is in competition with the Scottish Conservation Credits option whereby 21 extra days are available when a 110 mm SMP is used with an 80 mm codend. Implications: Possibly a 30% increase in L50 of haddock, whiting, saithe due to use of 110 mm SMP. Smaller increase in L50 of perhaps 10% for cod.

- A large number of 110 mm SMPs have been bought in the first months of 2008 by the prawn fleet so that they qualify for the basic Conservation Credits scheme. Probably affects most (~80%) of the fleet

12.1.3 ICES Advice

ICES ACFM advice for 2007:

Single-stock exploitation boundaries

Exploitation boundaries in relation to precautionary considerations

The stock status cannot be assessed with reference to precautionary reference points. However, in the light of the low estimate of stock size in combination with the low recent landings with indication of current low exploitation rates, ICES recommends that total human consumption landings in 2007 should not be allowed to increase above the recent (2003 to 2005) average of 15 100 t for Subarea IV and Division VIId.

Given the problem with the interpretation of historical stock trends, ICES considers that the current state of the stock, with respect to biological reference points, is unknown.

ICES ACFM advice for 2008:

Single-stock exploitation boundaries

Exploitation boundaries in relation to precautionary considerations

Low catches have contributed to low fishing mortality from 2002–2005; however, low recruitment has resulted in a declining SSB to the lowest observed. The recent recruitment has been approximately 30% of average recruitments (year classes 1994–2001). Given the relative reduction in recruitment it is necessary to reduce future landings in order to keep fishing mortality low. Applying the reduction in recruitment to the average landings from the past three years corresponds to human consumption landings of 5000 t in 2008.

12.1.4 Management

Management of whiting is by TAC and technical measures. The agreed TACs for whiting in Subarea IV and Division IIa (EU waters) was 23 800 t in 2007 and 17 850 t in 2008 and where EC vessels may take no more than 10 880 t from the Norwegian waters of Subarea IV. There is no separate TAC for Division VIId, landings from this Division are counted against the TAC for Divisions VIIb-k combined (19 940 t in 2007 and again 19 940 t in 2008).

EU technical regulations in force in 2004 and 2005 are contained in Council Regulation (EC) 850/98 and its amendments. For the North Sea, the basic minimum mesh size for towed gears for roundfish was 120 mm from the start of 2002, although under a transitional arrangement until 31 December 2002 vessels were allowed to fish with a 110 mm codend provided that the trawl was fitted with a 90 mm square mesh panel and the catch composition of cod retained on board was not greater than 30% by weight of the total catch. From 1 January 2003, the minimum mesh size for towed roundfish gears has been 120 mm. Restrictions on fishing effort were introduced in 2003 and details of its implementation in 2004 can be found in Annex V of Council Regulation (EC) no. 2287/2003; for 2005 in Annex IVa of Council Regulation (EC) no 27/2005 and for 2006 in Annex IIa of Council Regulation (EC) 51/2006. Currently, vessels fishing with towed gears for roundfish in Subareas IV and VIId and Division IIa (EU waters) are restricted to 103 days at sea per year, excluding derogations. The minimum landing size for whiting in the North Sea is 27 cm. The minimum mesh size for whiting in Division VIId is 80 mm, with a 27 cm minimum landing size.

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.

In 2008 the following European Council regulation applies (EU40/2008, annex III, part A section 9):

Reduction of whiting discards in the North Sea

1. *In the North Sea, Member States shall undertake in 2008 trials and experiments as necessary on technical adaptations of the trawls, Danish seines or similar gears with a mesh size equal to or greater than 80 mm and less than 90 mm in order to reduce the discards of whiting by at least 30%.*

2. *Member States shall make the results of the trials and experiments laid down in point 1 available to the Commission no later than 31 August 2008.*

3. *The Council shall, on the basis of a proposal from the Commission, decide on appropriate technical adaptations to reduce discards of whiting in conformity with the objective laid down in point 1.*

TACs for this stock are split between two areas: (i) Subarea IV and Division IIa (EU waters) and, (ii) Divisions VIIb-k. Since 1996 when the North Sea and eastern Channel whiting assessments were first combined into one, 11.5% of any combined area catch option has been attributed to the VIId component for TAC management purposes. This value is based on the average contribution of Division VIId human consumption landings to the combined area human consumption landings over the period 1992–1996.

12.2 Data available

12.2.1 Catch

Total nominal landings are given in Table 12.2.1 for the North Sea (Subarea IV) and Eastern Channel (Division VIId). Industrial bycatch is almost entirely due to the Danish sandeel and sprat fisheries.

In 2002, the working group decided to truncate the catch data to start from 1980. This was due to the very large change in estimated recruitment levels around 1980 that was present in the assessment. The working group could not determine whether this was due to a shift in the recruitment regime or because discard data for years prior to 1978 were not measured but estimated according to a discard ogive. This may not have been representative of discarding during the earlier period. Biological reference points for this stock had originally been established on the basis of the truncated series, so this represented no change with respect to them.

Working group estimates of weights and numbers of the catch components for the North Sea and Eastern Channel are given in Tables 12.2.2 and 12.2.3, both tables cover the period 1980 to 2007. Total catch shows a 1 500 t decrease on last year, with this decrease being largely due to reduced discards – human consumption landings increased by around 1 000 t. The reported tonnages of the catch components remain among the lowest in the series, and whiting industrial by-catch remains very low due to the limited fishery for Norway pout and a reduced sandeel fishery in 2005, 2006 and 2007. For the Eastern Channel, the total catch (landings) in 2007 is a further reduction on the last two years and is the lowest in the series.

Discard data apply to the North Sea catches only. Assuming that discards are negligible in the English Channel may not be appropriate given the current low population size; however investigation of this is intended for a future benchmark. No information on discards of the French fleets fishing in IV or VIId were supplied to the WG.

Figure 12.2.1 plots the trends in the commercial catch for each component, note that estimates of discards from VIId are not included. Each component shows a general decline. Industrial by-catch can be seen to be removing proportionately less through time. Human consumption landings have fluctuated around 45% of the total catch during the period 1980–2004, rising to 70% in the recent year. The proportion of discards has increased over the last ten years, but has been decreasing in the most recent period.

12.2.2 Age compositions

Age compositions in the landings are supplied by Scotland, England, The Netherlands and Germany. Age compositions in the discards are supplied by Scotland, England, Germany and Denmark. And for industrial bycatch, age compositions were supplied by Denmark.

Limited sampling of the industrial bycatch component has resulted in a few years' data appearing as outliers, in particular 2006 and potentially 2007. In 2006 the samples used to raise Danish industrial bycatches (accounting for 98% of the industrial bycatch that year) were taken from Norwegian vessels whose catches have a different age structure. In 2007 samples from the industrial bycatch indicate that the landings are entirely composed of 0 and 1 year olds – this was estimated from a single sample and results in a large number of (albeit small) fish landed by this fishery in 2007. The data for 2006 have been replaced with an estimate $\hat{n}_{a,y}$ given by

$$\hat{n}_{a,y} = \hat{N}_y \hat{p}_{a,y},$$

where $\hat{p}_{a,y}$ is the mean proportion at age over the years 1980 to 2005 (excluding 2006), and $\hat{N}_y$ is estimated to give a sums of products correction (SOP) factor of 1 by

$$\hat{N}_y = \frac{\sum_a \hat{p}_{a,y} \hat{w}_{a,y}}{W_y},$$

where W_y is the reported weight of industrial bycatch. Here $\hat{w}_{a,y}$ have been estimated by taking the mean weights at age in the industrial bycatch over the period 1995 to 2005 (zero weights are taken as missing values). The data for 2007 remains unchanged as these data may represent reality better than some average however a sensitivity analysis will be conducted on the final assessment.

Proportion in number at ages 0 to 8+ in the catch, human consumption landings, discards and industrial by-catch as provided to the working group are plotted in Figure 12.2.2. Since only ages 1 to 8+ are used in last years final assessment, proportion in number for these ages is presented in Figure 12.2.3. Removing the estimates of age 0 shows a cleaner picture of the trends. Landings of whiting during 1980–2004 have generally consisted of around 80% in number of 1 to 4 year olds. Since 2002 the proportion has declined to approximately 60% in 2006 after the introduction of the 120 mm mesh. However, in 2007, due to an increased number of 2 and 3 year olds this proportion has risen to historical levels. The proportion of age 1 in the landings of the last three years are around the highest in the series.

Discards at age 1 have been increasing over the last three years while in the industrial bycatch 2007 shows a marked increase in the proportion of age 1 landed. These both translate to an increase in the proportion of age 1 in the total catch to around 50%.

Total international catch numbers at age (IV and VIId combined) are presented in Table 12.2.4. Total catch comprises human consumption landings, discards and industrial by-catch for reduction purposes. Discards are for the North Sea (area IV) only. Total international human consumption landings (North Sea and Eastern Channel combined) are given in Table 12.2.5. Discard numbers at age for the North Sea are presented in Table 12.2.6. Industrial by-catch numbers at age for the North Sea are presented in Table 12.2.7.

12.2.3 Weight at age

Mean weights at age (Subarea IV and Division VIId combined) in the catch are presented in Table 12.2.8. These are also used as stock weights. Mean weights at age (both areas combined) in human consumption landings are presented in Table 12.2.9, and for the discards and industrial by-catch in the North Sea in Tables 12.2.10 and 12.2.11. These are shown graphically in Figure 12.2.4, which indicates a decline in mean weight in the landings and catch for ages 6 to 8, and a reasonably constant mean weights for all other ages in all the catch components. From 1990 to 2005 ages 4 and above in the catch and landings have shown a periodic increase and decrease in mean weight, and ages 1 to 3 show what might be a recent increase.

Unrepresentative sampling of industrial bycatch in 2006 and 2007 resulted in poor estimates of the mean weights at age and these have been replaced by the mean weight at age for the period 1995 to 2005 (zero weights are taken as missing values).

Mean weights at age will be looked at in more detail in a future benchmark assessment.

12.2.4 Maturity and natural mortality

Values for natural mortality and maturity remain unchanged from those used in recent assessments and are:

Age	1	2	3	4	5	6	7	8+
Natural Mortality	0.95	0.45	0.35	0.3	0.25	0.25	0.2	0.2
Maturity Ogive	0.11	0.92	1	1	1	1	1	1

Their derivation is given in the Stock Annex.

12.2.5 Catch, effort and research vessel data

Since this is an update assessment, this section will concentrate mainly on those data that are used in the assessment.

Survey tuning indices, as used in last years' final assessment, are presented in Table 12.2.12. The report of the 2001 meeting of this WG (ICES WGNSSK 2002), and the ICES advice for 2002 (ICES ACFM 2001) provides arguments for the exclusion of commercial CPUE tuning series from calibration of the catch-at-age analysis see section 14.2.4. Such arguments remain valid and only survey data have been considered for tuning purposes. A summary of all available tuning series and data from commercial fleets are presented in the stock annex.

Data from the VIId French groundfish survey for 2004 to 2006 are available but in a form that was different from previous data and have not been presented here. The English groundfish survey and Scottish groundfish survey series form part of the third-quarter IBTS index (IBTS_Q3). The practice of this working group for this stock has been to use the English groundfish survey and Scottish groundfish survey series individually rather than to use a combined IBTS_Q3 index as they pre-date it. A thorough evaluation of the IBTS_Q3 index and the separate English groundfish survey and Scottish groundfish survey series will be required at a future benchmark assessment if the former is to be considered a replacement for the latter two.

Density maps for the IBTS Q1 survey are shown in Figure 12.2.5. These plots show low recruitment in recent years (2003 to 2008), but also show an apparent shift in where the recruiting year class is found. In 2007, perhaps the lowest densities of age 1 whiting were seen, but in 2008 this year class was found particularly in the southern North Sea at densities similar to that of the 2001 year class (a year class from a period of much higher recruitment). Large numbers of 3+ whiting were seen in 2003 and 2004. Numbers of these ages have declined in recent years, but remain widespread up the east UK coast and in the northern North Sea.

Density maps for the IBTS Q3 survey are shown in Figure 12.2.6. These plots also show a marked decline in the numbers of whiting in the years 2003 to 2007. It can also be seen that young whiting are historically distributed widely in the North Sea with concentrations mostly to the east coast of the UK and southern North Sea coast. Most recently observations of whiting have been restricted to the north eastern coast of the England with sparse observations north of the Dogger Bank. The IBTS Q1 also seems not to have detected the large recruitment in 2007 indicated by the age 2 index of the IBTS Q1 survey.

12.3 Data analyses

The methods used in this section comprise various summaries of the raw data and some modeling approaches. Two models were used: XSA and SURBA. XSA was used to assess stock trends for the North Sea and the Eastern Channel using commercial catch data in conjunction with suitable survey information. SURBA was used last used in the 2006 WG to assess stock trends in the North Sea and the Eastern Channel using only survey information, the impression from this study is not considered to have changed by comparison of single fleet XSA runs and is not updated in this report. This analysis is presented again in this section as it provides a good summary of the issues with the current assessment.

12.3.1 Reviews of last year's assessment

Several comments were made by the RGNSSK regarding last years' assessment. These are summarised below. Review group comments are *italicized* and WG responses, where appropriate, follow in plain text.

1. *The RG recommends that the potential for different mortality rates among areas should be studied by re-establishing the study group on stock identity and management units of whiting (SGSIMUW). SGSIMUW should continue their work on whiting (the group was dissolved in 2006).*

The WG agrees, and adds that this should be on the understanding that spatially disaggregated landings and discard data be made available.

2. *The RG also noted the regional problems with discards. The RG considers the sampling of discards to be important, but questioned if sampling was good enough in all fishing areas.*

The WG also agrees and comments that such information will be required for the SGSIMUW to be successful.

3. *The RG recommends exploring variable maturity at age, in association with changes in mean weights.*

The WG defers any detailed investigation for future benchmark assessments.

4. *The RG also recommends that the inclusion of age zero in the XSA be explored.*

This was investigated and the inclusion of age zero did not change the current or historical perception of the stock. The only difference being that recruitment at age 0 was noisier than that at age 1 and created a downward retrospective bias in recruitment estimates.

12.3.2 Exploratory survey-based analyses

Catch curve analysis provides a useful method of inspecting the data and looking for changes in the exploitation of the stock. Catch curve analyses are shown in Figures 12.3.1 to 12.3.3. These show consistent tracking of year classes across cohorts with the exception being the IBTS Q1 index of age 1 for the 2006 year class. The IBTS Q1 survey gives an indication of declining mortality.

The consistency within surveys is assessed using correlation plots. Only survey indices used in the final assessment are presented as this is an update assessment. The English groundfish survey shows good internal consistency across all ages (Figure 12.3.4). The Scottish groundfish survey shows a lower degree of internal consistency (Figure 12.3.5), while the IBTS Q1 shows reasonable consistency over all ages (Figure 12.3.6).

In 2006 single fleet analyses were carried out using SURBA. The mean standardised SSB for these runs, a multi-fleet SURBA, and a multi-fleet XSA (using the same surveys) is presented in Figure 12.3.7. This figure is included as it provides a good summary the main issues with the current assessment and these are: there is a discrepancy between the signals in the survey indices and the signals in the catch data prior to 1990; since 1990, the catch data and the IBTS, the Scottish groundfish survey and the English groundfish survey all show consistent trends.

12.3.3 Exploratory catch-at-age-based analyses

Catch curves for the catch data are plotted in Figure 12.3.8 and shows numbers-at-age on the log scale linked by cohort. This shows partial recruitment to the fishery up to age 2. The plot also shows in the most recent years a decline in numbers of young fish in the catch, and an increase in numbers in the catch of older fish of the 1998 to 2001 year classes.

Within cohort correlations between ages are presented in Figure 12.3.9. In general catch numbers correlate well between cohorts with the relationship breaking down as you compare cohorts across increasing years.

Single fleet XSA runs were conducted to compare trends in the catch data with trends in the survey data. These used the same procedure as last years' final assessment. Summary plots of these runs are presented in Figure 12.3.10. The population trends from each survey are very consistent. Residual patterns (Figure 12.3.11) show year effects at the start of the English groundfish survey series indicating a conflict in these years between this survey and the commercial catch data.

Sensitivity analyses

Due the uncertainty in the estimates of the age composition of the industrial bycatch component and the large influence that this data is likely to have on the estimates of mortality at age 1 and recruitment at age 1 in 2007, it was decided to carry out a SPALY assessment which ignored this information. It is important to investigate this issue since the apparently large 2006 year class (as seen at age 2 in 2008, Figure 12.2.5) is not represented in any tuning series used in the assessment and the low estimate of recruitment in 2007 resulting from this, combined with a large catch of age 1 (due in large part to the uncertain industrial bycatch data) will give a high value for fishing mortality at age 1 in 2007. Moreover, at age 2 in 2008, XSA survivors may be greatly underestimated.

The age composition of industrial bycatch in 2007 was taken to be the same as that estimated for 2006 (see section 12.2.2). Full diagnostic outputs of the sensitivity run of the SPALY assessment are not included, a plot of F-at-age from retrospective runs is presented in Figures 12.3.12 and 12.3.13 and F at age is given in Table 12.3.1. The age composition of the stock is very similar in both runs. Fishing mortality, as can be seen by the figures only differs at age 1 in 2007. Ignoring the large catch of age 1 in the industrial bycatch F still increases in 2007 on this age. This may well be due to increased discarding but may also be due to an underestimation of the 2006 year class.

12.3.4 Conclusions drawn from exploratory analyses

Catch curve analysis and correlation plots show that both surveys and catch data track cohorts well and are internally consistent, with the possible exception of the 2006 year class. This will have implications for the estimation of recruitment at age 1 in 2007. All sources of information indicate a generally declining mortality in the recent period.

SURBA and XSA analyses show that all three surveys are consistent with the catch data for the last decade.

The sensitivity analysis showed that the trends in the wider population are not affected by the imprecise industrial bycatch, however, mortality at age 1 certainly is. It was decided to keep the original data and but to bear in mind these conclusions for the short term forcast.

12.3.5 Final assessment

The final assessment was as XSA fitted to the combined landings, discard and industrial by-catch data for the period 1980–2007. This is the same procedure as last year. The settings are contained in the table below. Those from previous years are also presented.

	year range used	2006	2007	**This year(2008)**
Catch at age data		1980-2005 Ages 1 to 8+	1980-2006 Ages 1 to 8+	**1980-2007** **Ages 1 to 8+**
Calibration period		1990-2005	1990-2006	**1990-2007**
ENGGFS Q3 GRT (1990-1991	1990-1991	Ages 1 to 6	-	-
ENGGFS Q3 (GOV)	**1992-2007**	Ages 1 to 6	Ages 1 to 6	**Ages 1 to 6**
SCOGFS Q3 (Scotia II)	1990-1997	Ages 1 to 6	-	-
SCOGFS Q3 (Scotia III)	**1998-2007**	Ages 1 to 6	Ages 1 to 6	**Ages 1 to 6**
IBTS Q1	**1990-2008**	Ages 1 to 5	Ages 1 to 5	**Ages 1 to 5**
Catchability independent of stock size		Age 1	Age 1	**Age 1**
Catchability plateau		Age 4	Age 4	**Age 4**
Weighting		Tricubic over 16 years	Tricubic over 17 years	**Tricubic over 18 years**
Shrinkage		Last 3 years and 4 ages	Last 3 years and 4 ages	**Last 3 years and 4 ages**
Shrinkage SE		2.0	2.0	**2.0**
Minimum SE for fleet survivors estimates		0.3	0.3	**0.3**

Full diagnostics for the final XSA run are given in Table 12.3.2. Residual plots are presented in Figure 12.3.14. These show contrasting trends between the English and Scottish groundfish surveys in the most recent year, some year effects in the IBTS Q1 residuals and potentially a slight trend in the English groundfish survey. These patterns may well be due to spatial changes in the stock and also to data raising procedures connected with this. Final year contributions by tuning fleets to estimates of survivors are shown in Figure 12.3.15 and show an even contribution by all fleets.

Fishing mortality estimates are presented in Table 12.3.3, the stock numbers in Table 12.3.4 and the assessment summary in Table 12.3.5 and Figure 12.3.16. Fishing mortality can be seen to have decreased at the older ages. Noticeable is the increase in fishing mortality at age 1 in 2007.

A retrospective analysis (possible only over the last five years due to the short span of the second Scottish groundfish survey series) is shown in Figure 12.3.17. This shows little retrospective bias.

12.4 Historic Stock Trends

A plot of estimated F-at-age over the years 1991 to 2007 is presented in Figure 12.4.1. This figure shows the recent decline in F at older ages and an increase in F at the younger ages, highlighting an apparent change in selection pattern in this fishery. There is a marked increase in F at age 1 in 2007. In order to see this change in selection more clearly, trends in F(2–6), F(2–4) and F(5–7) are presented in Figure 12.4.2.

Contribution of age classes to TSB and SSB is shown in Figure 12.4.3 and as proportions in Figure 12.4.4. This shows the important contribution of ages 1 and 2 to the TSB. This figure also shows a recent increase in the contribution of ages 6 and over to stock biomass, coming from the period of increased recruitment in 1999 to 2002.

Historic trends for F, SSB and recruitment are presented in Figures 12.4.5, 12.4.6 and 12.4.7.

The North Sea Fishers' Survey for 2008 had not yet been completed, so no comparison can be made between the stock trends observed from the assessment and the fishermen's perceptions from the Fishers' survey.

12.5 Recruitment estimates

Given the following points, the WG considered alternative estimates of recruitment in 2007 and F at age 1 in 2007

- In 2007 the IBTS survey and both the Scottish and English groundfish surveys did not detect a large 2006 year class at age 1. This information is what informed the estimate of recruitment in 2007 in the assessment. In 2008, this year class appears to be moderately large, at least in terms of recent recruitments (Figure 12.2.5). This leads the WG to regard the estimate of recruitment at age 1 in 2007 to be an underestimate, and therefore, the estimate of survivors in 2008 (age 2 in 2008) may also be an underestimate.

- A sensitivity run excluding an imprecise estimate of the age composition in the industrial bycatch – resulting in very large estimates of numbers of age 1 in the catch in 2007 – showed that F at age 1 is likely to be overestimated.

An RCT3 regression was run to give a second estimate of recruitment for 2007 and this resulted in a larger estimate: 352 million compared to 244 million. All surveys indicate better recruitment for the incoming 2007 year class and this is reflected in the RCT3 estimate of 527 million for age 1 in 2008. The regression was carried out over the period 1990 to 2007 with tri-cubic weighting over 18 years following the same approach as the final assessment. The input files for the RCT3 run are presented in Table 12.5.1 and the results in Table 12.5.2.

The geometric mean of the last 5 years (excluding the potentially underestimated 2006 year class: 2003 to 2006) is 418 million.

It was agreed to use the RCT3 estimates for recruitment in 2008, and the geometric mean (2003 to 2006) for recruitment in 2009 and 2010.

Since it was accepted that the XSA estimate of recruitment in 2007 was likely to be an underestimate, the RCT3 estimate of recruitment in 2007 along with an appropriate F was used to estimate numbers at age 2 in 2008. The F used was that from the sensitivity run excluding the 2007 samples of Industrial bycatch (Table 12.3.1). The estimate of age 2 in 2008 is 91 million.

The following table summarises recruitment assumptions for the short term forecast together with XSA estimated recruitment from the previous two years.

year class	age in 2008	XSA (millions)	RCT3 (millions)	Geometric mean
2005	3	63	-	-
2006	2	39	91*	-
2007	1	-	527	-
2007	age 1 in 2009	-		418
2008	age 1 in 2010	-		418

* based on RCT3 estmate of recruitment of 352 million exploited at an F of 0.4

12.6 Short-term forecasts

A short-term forecast was carried out based on the final XSA assessment. XSA survivors in 2008 were used as input population numbers for ages 3 and older. Age 2 was estimated from an RCT3 estimate of recruitment in 2007 exploited at a rate estimated from a sensitivity run of the final assessment excluding the industrial bycatch sampling for 2007, that gave rise to a very large F at age 1 in 2007. The RCT3 estimate of 527 million was used for one-year-old abundance in 2008, and a geometric mean of the last five years (418 million) was used for 2009 and 2010.

The exploitation pattern was chosen as the mean F-at-age pattern over the years 2004–2006 as F-at-age 2007 was considered noisy. This is shown in Figure 12.6.1. Given the recent stability of F(2–6) this exploitation pattern was scaled to the F(2–6) in 2007 for forecasts.

Mean weights at age are generally consistent over the recent period but there are trends at some ages (Figure 12.2.4). Thus, the mean over the last three years was used for the purposes of forecasting.

The input to the forecast is shown in Table 12.6.1. Results are presented in Tables 12.6.2 and 12.6.3.

The TAC for 2008 for area IV and VIId was 26 000 t. Assuming $F_{2008}=F_{2007}$ results in human consumption landings in 2008 of 13 190 t from a total catch of 21 820 t resulting in an SSB in 2008 of 59 770 t, a reduction from 78 050 t in 2007. For the same fishing mortality in 2008, human consumption landings are predicted to be 12 990 t resulting in an SSB in 2009 of 64 770 t. Under the assumptions of the prediction, SSB in 2010 will not approach B_{lim} in the absence of fishing in 2009.

Comparing catch in 2007 to that predicted for 2008 we see that total catch is predicted to decline from 27 500 t to 21 820 t. This separates into declining human consumption landings from 16 000 t to 13 000 t, stable discards at 7 000 t and stable industrial by-catch at around 1 500 t.

12.7 Medium-term forecasts

No medium-term forecasts were carried out on this stock.

12.8 Biological reference points

The precautionary fishing mortality and biomass reference points agreed by the EU and Norway, (unchanged since 1999), are as follows:

B_{lim} = 225,000 t; B_{pa} = 315,000 t; F_{lim} = 0.90; F_{pa} = 0.65.

The WG considers that these reference points are not applicable to the current assessment (see discussion in 12.9)

12.9 Quality of the assessment

Previous meetings of this WG have concluded that the survey data and commercial catch data contain varying signals concerning the stock. Analyses by working group members and by the SGSIMUW in 2005 indicate that data since the early- to mid-1990s are sufficiently consistent to undertake a catch-at-age analysis calibrated against survey data from the most recent period. This has been taken forward into prediction for catch option purposes. However, due to the lack of concordance in the data pre-dating the early 1990s, the working group considers that it is not possible categorically to classify the current state of the stock with reference to precautionary reference points as the biomass reference points are derived from a consideration of the stock dynamics at a time when the commercial catch-at-age data and the survey data conflict.

Due to the likely population structuring in the North Sea and Eastern Channel, it is probable that the overall stock estimates may not reflect trends in more localised areas.

The IBTS survey in 2008 has shown the presence of a large 2006 year class (in terms of recent recruitments) which was evidently not present in 2007 in any of the surveys at age 1 (Figure 12.2.5). This leads us to view the XSA estimate of recruitment in 2007 as an underestimate. Furthermore, this could potentially lead us to consider the estimate of F at age 1 in 2007 as an overestimate.

Despite the minimum mesh-size increase in 2002 in the towed demersal roundfish gears and the decline in industrial by-catch as activity in the Norway pout and sandeel fisheries have declined, the estimates of F on the young ages appears to be increasing disproportionately to that on older ages.

Given the spatial structure of the whiting stock and of the fleets exploiting it, it is important to have data that covers all fleets. Considering that age 1 and age 2 whiting make up a large proportion of the total stock biomass, good information of the discarding practices of the major fleets is important. Unfortunately, no discard information was supplied by France and this may affect our perception of the numbers and exploitation of the younger age classes. This is most likely to affect the reliability of the forecast.

Survey information for VIId was not available in a form that could be used by the working group. Due to the recent changes in distribution of the stock, tuning information from this area would be extremely useful, and would improve the estimate of recruitment in the most recent year.

The historic performance of the assessment is summarised in Figure 12.9.1.

12.10 Status of the Stock

The working group considers the status of the stock unknown with respect to biological reference points, for the reasons given in section 12.9. Nevertheless all indications are that the stock, at the level of the entire North Sea and Eastern Channel, is at a historical low level relative to the period since 1991. Fishing mortality, previously estimated to be low relative to the period since 1991, now appears to have increased, particularly at younger ages.

The recent estimates of older whiting (ages 6 and above) is unprecedented in the assessment period. These fish have come from a period of moderate recruitment (1999 to 2002) implying that further moderate recruitments may be sufficient to allow an improvement in the stock.

12.11 Management Considerations

In recent years SSB has declined to its lowest level. Mean F has decreased from historical levels, but has been increasing over the last three years. Recent recruitment has been impaired; contributing factors may be low stock size and environmental factors.

Catches of whiting have been declining since 1980 (from 224 000 t in 1980 to 27 000 t in 2007, including discards and industrial bycatch). Distribution maps of survey IBTS indices show a change in distribution of the stock which is now mainly located in the west North Sea. Catch rates from localised fleets may not represent trends in the overall North Sea and English Channel population. The localised distribution of the population is known to be resulting in substantial differences in rate of quota uptake. This is likely to result in localised discarding problems that should be monitored carefully.

Whiting are caught in mixed demersal roundfish fisheries, fisheries targeting flatfish, the *Nephrops* fisheries and the Norway pout fishery. Mortality has been observed to have increased on younger ages due to increased discarding in the recent year as a result of recent changes in fleet dynamics of *Nephrops* fleets and small mesh fisheries in the southern North Sea.

The current minimum mesh-size in the demersal roundfish fishery in the northern North Sea has resulted in reduced discards from that sector compared with the historical discard rates. Discarding is likely to remain a problem in the other human consumption fisheries either due to their capture below the minimum landing size or because whiting is not a target 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 small mesh fisheries.

The by-catch of whiting in the Norway pout and sandeel fisheries is dependent on activity in that fishery, which has recently declined.

The only nation that makes substantial landings of whiting and does not supply the WG with estimates of discards, despite the requirement to collect such information according to EU data collection regulations is France. In order to improve the quality of the assessment, and hence management advice, this nation should be encouraged to supply discard information.

Recent measures to improve survival of young cod, such as the Scottish Credit Conservation Scheme, and increased uptake of more selective gear in the North Sea and Skagerrak, should be encouraged for whiting.

12.12 Whiting in Division IIIa

The new data available for this stock are too sparse to revise the advice from last year and therefore no assessment of this stock was undertaken.

Total landings are shown in Table 12.12.1.

Table 12.2.1 Whiting in Subarea IV and Division VIId. Nominal landings (in tonnes) as officially reported to ICES.

Subarea IV

Country	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Belgium	1042	880	843	391	268	529	536	454	270	248	144	105	92	45
Denmark	549	368	189	103	46	58	105	105	96	89	62	57	251	78
Faroe Islands	2	21	0	6	1	1	0	0	17	5	0	0	0	0
France	4735	5963	4704	3526	1908	0	2527	3455	3314	2675	1721	1059	2445	2876
Germany	239	124	187	196	103	176	424	402	354	334	296	149	252	75
Netherlands	3864	3640	3388	2539	1941	1795	1884	2478	2425	1442	977	802	702	618
Norway	79	115	66	75	65	68	33	44	47	38	23	16	18	11
Poland	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Sweden	10	1	1	1	0	9	4	6	7	10	2	1	2	1
UK (E.&W)[3]	2722	2477	2329	2638	2909	2268	1782	1301	1322	680	1209	2653		
UK (Scotland)	28974	27811	23409	22098	16696	17206	17158	10589	7756	5734	5057	5361		
UK (Total)													11481	12101
Total	**42216**	**41400**	**35116**	**31573**	**23938**	**22110**	**24453**	**18834**	**15608**	**11256**	**9491**	**10202**	**15242**	**15805**
Unallocated landings	423	-549	812	-273	-50	3884	29	552	308	-597	-258	315	-92	385
WG estimate of H.Cons. landings	42639	40851	35928	31300	23888	25994	24482	19386	15916	10659	9233.4	10517	15150	16190
WG estimate of discards	33050	30315	28156	17194	12721	23525	23214	16488	17509	24093	12561	10448	11860	6890
WG estimate of Ind. By-catch	10360	26544	4691	5974	3161	5160	8885	7357	7327	2743	1218	882	2190	1230
WG estimate of total catch	**92683**	**103095**	**73731**	**59087**	**44370**	**59108**	**60857**	**49011**	**46271**	**43208**	**27362**	**21847**	**29200**	**24310**

Division VIId

Country	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Belgium	61	68	84	98	53	48	65	75	58	66	45	45	71	75
France	6734	5202	4771	4532	4495	-	5875	6338	5172	6478	-	3819	3019	2648
Netherlands	-	-	1	1	32	6	14	67	19	175	132	125	117	118
UK (E.&W)	293	280	199	147	185	135	118	134	112	109	80	86	71	
UK (Scotland)	-	1	1	1	+	-	-	-	-	-	-	-	-	
UK (Total)														59
Total	**7088**	**5551**	**5056**	**4779**	**4765**	**189**	**6072**	**6614**	**5361**	**6828**	**274**	**4074**	**3279**	**2899**
Unallocated	-463	-161	-104	-156	-167	4,242	-1775	-810	439	-1117	4076	713	161	351
W.G. estimate	**6633**	**5385**	**4956**	**4619**	**4599**	**4428**	**4275**	**5780**	**5519**	**5712**	**4350**	**4787**	**3440**	**3250**

Table 12.2.1 (Cont'd)

Subarea IV and Division VIId

	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
W.G. estimate	116284	92683	103095	73731	59087	44370	59108	60857	49011	46271	43208	29060	26793	32320	27562

Annual TAC for Subarea IV and Division IIa

	2000	2001	2002	2003	2004	2005	2006	2006	2007
TAC	29700	32358	16000	16000	16000	28500	23800	23800	17850

Table 12.2.2 Whiting in IV and VIId. WG estimates of catch components by weight ('000s tonnes).

	Sub Area IV (North Sea)				VIId (Eastern Channel)	Total	VIId as a proportion of total HC
year	H.cons.	Disc.	Ind.BC	Tot.Catch	H.Cons		
1980	91.64	76.95	45.76	214.35	9.17	223.52	9.1%
1981	80.59	35.92	66.61	183.12	8.93	192.05	10.0%
1982	72.64	26.60	33.04	132.28	7.91	140.19	9.8%
1983	81.03	49.56	23.68	154.27	6.94	161.21	7.9%
1984	78.91	40.56	18.90	138.37	7.37	145.74	8.5%
1985	54.74	28.91	15.32	98.97	7.39	106.36	11.9%
1986	58.61	79.66	17.97	156.24	5.50	161.74	8.6%
1987	63.63	54.00	16.48	134.11	4.67	138.78	6.8%
1988	51.67	28.15	49.22	129.04	4.43	133.47	7.9%
1989	41.03	35.85	42.71	119.59	4.16	123.75	9.2%
1990	43.42	55.84	50.72	149.98	3.48	153.46	7.4%
1991	47.30	33.64	38.31	119.25	5.72	124.97	10.8%
1992	46.45	30.61	26.90	103.96	5.74	109.70	11.0%
1993	47.99	42.87	20.10	110.96	5.21	116.17	9.8%
1994	42.62	33.01	10.35	85.98	6.62	92.60	13.4%
1995	41.05	30.26	26.56	97.87	5.39	103.26	11.6%
1996	36.12	28.18	4.70	69.00	4.95	73.95	12.1%
1997	31.30	17.22	5.96	54.48	4.62	59.10	12.9%
1998	23.86	12.71	3.14	39.71	4.60	44.31	16.2%
1999	25.98	23.58	5.18	54.74	4.43	59.17	14.6%
2000	24.51	23.21	8.89	56.61	4.30	60.91	14.9%
2001	19.42	16.49	7.36	43.27	5.80	49.07	23.0%
2002	15.92	17.51	7.33	40.76	5.80	46.56	26.7%
2003	10.66	24.09	2.74	37.49	5.71	43.20	34.9%
2004	9.23	14.26	1.22	24.71	4.35	29.06	32.0%
2005	10.51	10.61	0.88	22.00	4.79	26.79	31.3%
2006	15.15	9.54	2.19	26.88	3.44	30.32	18.5%
2007	16.19	6.40	1.23	23.82	3.25	27.07	16.7%
min.	9.23	6.40	0.88	22.00	3.25	26.79	6.8%
mean	42.22	31.65	19.77	93.64	5.52	99.16	14.6%
max.	91.64	79.66	66.61	214.35	9.17	223.52	34.9%

Table 12.2.3 Whiting in IV and VIId. WG estimates of catch components by number (millions).

	Sub Area IV (North Sea)				VIId (Eastern Channel)	Total	VIId as a proportion of total HC
year	H.cons.	Disc.	Ind.BC	Tot.Catch	H.cons.		
1980	304.8	471.2	644.5	1420.5	35.5	1456.0	10.4%
1981	261.3	213.9	929.3	1404.5	34.3	1438.8	11.6%
1982	238.2	173.2	333.3	744.7	33.0	777.7	12.2%
1983	260.6	370.2	697.2	1328.0	29.5	1357.5	10.2%
1984	252.1	326.8	296.6	875.5	33.4	908.9	11.7%
1985	156.7	231.2	280.1	668.0	19.6	687.6	11.1%
1986	204.3	582.6	398.6	1185.5	21.1	1206.6	9.4%
1987	226.8	415.9	285.2	927.9	18.2	946.1	7.4%
1988	193.7	231.4	951.7	1376.8	17.9	1394.7	8.5%
1989	155.3	280.3	430.8	866.4	16.9	883.3	9.8%
1990	163.6	539.0	577.9	1280.5	13.6	1294.1	7.7%
1991	181.6	241.8	1170.1	1593.5	17.9	1611.4	9.0%
1992	163.1	215.6	464.8	843.5	19.4	862.9	10.6%
1993	155.8	342.7	714.5	1213.0	17.8	1230.8	10.3%
1994	138.1	235.3	304.4	677.8	24.0	701.8	14.8%
1995	128.9	213.6	1659.5	2002.0	18.5	2020.5	12.6%
1996	120.5	177.1	128.3	425.9	22.4	448.3	15.7%
1997	108.5	100.6	61.3	270.4	22.6	293.0	17.2%
1998	86.6	83.2	97.2	267.0	23.0	290.0	21.0%
1999	98.3	178.5	160.1	436.9	18.9	455.8	16.1%
2000	91.6	142.3	55.0	288.9	22.1	311.0	19.4%
2001	73.6	114.3	281.7	469.6	28.6	498.2	28.0%
2002	56.8	96.3	205.0	358.1	19.7	377.8	25.8%
2003	34.4	209.6	84.2	328.2	22.8	351.0	39.9%
2004	30.6	56.9	42.4	129.9	16.4	146.3	34.9%
2005	36.8	59.4	24.2	120.4	19.6	140.0	34.8%
2006	52.3	58.5	44.7	155.5	11.7	167.2	18.3%
2007	53.8	50.2	86.9	190.9	12.7	203.6	19.1%
min.	30.6	50.2	24.2	120.4	11.7	140.0	7.4%
mean	143.9	229.0	407.5	780.3	21.8	802.2	16.3%
max.	304.8	582.6	1659.5	2002.0	35.5	2020.5	39.9%

Table 12.2.4 Whiting in IV and VIId. Total catch numbers at age (thousands). Data used in the assessment are highlighted in bold.

year	0	1	2	3	4	5	6	7	8	9	10	11	12	8+
1980	332209	**265359**	**416008**	**286077**	**90718**	**52969**	**10751**	**1152**	689	58	14	5	1	**767**
1981	516869	**162899**	**346343**	**266517**	**102295**	**27776**	**12297**	**3540**	244	45	37	1	0	**326**
1982	101058	**192640**	**114444**	**245246**	**88137**	**26796**	**6909**	**2082**	400	53	26	4	1	**484**
1983	668604	**205646**	**184746**	**118412**	**131508**	**37231**	**8688**	**1780**	794	101	35	0	0	**930**
1984	157819	**323408**	**175965**	**124886**	**49505**	**59816**	**13860**	**2964**	410	182	21	0	0	**613**
1985	186723	**203321**	**141716**	**82037**	**37847**	**14420**	**17445**	**3328**	805	89	9	0	0	**904**
1986	225201	**576731**	**167077**	**169577**	**46517**	**13367**	**3487**	**3975**	497	71	0	1	0	**569**
1987	84863	**267051**	**368229**	**122748**	**85240**	**11392**	**4555**	**928**	929	98	7	0	0	**1035**
1988	416924	**430344**	**307429**	**179502**	**39635**	**17902**	**2175**	**544**	59	72	37	0	0	**168**
1989	87326	**331672**	**173676**	**191942**	**78464**	**14367**	**5050**	**516**	291	36	6	1	0	**334**
1990	284755	**253745**	**505010**	**129126**	**86324**	**32270**	**2002**	**735**	96	16	0	0	0	**112**
1991	1035089	**128507**	**191193**	**187195**	**36830**	**26209**	**5519**	**542**	255	17	1	0	0	**273**
1992	252963	**239792**	**165354**	**89563**	**93636**	**11967**	**6878**	**2609**	109	8	1	0	0	**117**
1993	622530	**217539**	**167577**	**124287**	**46543**	**46136**	**3946**	**1519**	698	58	16	0	0	**771**
1994	216868	**163609**	**147177**	**90611**	**47533**	**17384**	**17264**	**998**	386	74	0	0	0	**460**
1995	1571419	**137481**	**139010**	**111489**	**35728**	**15161**	**5159**	**4515**	318	101	55	0	0	**474**
1996	93296	**72645**	**113956**	**98476**	**48575**	**14235**	**4695**	**1294**	910	168	32	0	2	**1113**
1997	16894	**53408**	**74200**	**82944**	**42154**	**18492**	**3358**	**1020**	307	137	16	0	0	**460**
1998	68619	**71430**	**44697**	**42771**	**36459**	**17756**	**6392**	**1426**	306	66	34	0	0	**407**
1999	77814	**178079**	**91355**	**45627**	**34175**	**18528**	**7547**	**2049**	568	95	12	0	0	**676**
2000	1753	**66789**	**124365**	**63526**	**23888**	**16232**	**8791**	**4322**	970	244	48	3	0	**1265**
2001	230987	**84121**	**86178**	**58908**	**20559**	**9177**	**4814**	**2232**	897	246	124	2	0	**1268**
2002	137485	**49857**	**61239**	**82940**	**34006**	**8007**	**2043**	**1457**	620	102	13	9	10	**754**
2003	61111	**72709**	**104040**	**53560**	**42048**	**14306**	**2372**	**474**	329	50	16	1	0	**397**
2004	26426	**25440**	**16412**	**24354**	**25738**	**19126**	**7284**	**1193**	191	91	12	1	4	**298**
2005	13134	**34555**	**33605**	**12420**	**18407**	**15058**	**9102**	**3056**	540	83	29	1	0	**653**
2006	24582	**38696**	**38814**	**23204**	**8463**	**15160**	**12050**	**4759**	1360	152	16	0	0	**1528**
2007	33582	**86734**	**30562**	**23423**	**9561**	**3882**	**7603**	**5169**	2520	455	82	0	0	**3057**

Table 12.2.5 Whiting in IV and VIId. Human consumption landings numbers at age (thousands).

year	0	1	2	3	4	5	6	7	8	9	10	11	12	8+
1980	0	3656	62405	152570	68422	41430	9911	1135	689	58	14	5	1	767
1981	6	4240	69211	104348	78253	23698	12036	3530	244	45	37	1	0	326
1982	0	10890	46703	124656	59393	21376	5664	2058	400	53	26	4	1	484
1983	1	10568	68640	67312	101342	31266	8330	1730	784	101	35	0	0	921
1984	0	14388	62693	99204	41277	51745	12735	2813	410	182	21	0	0	613
1985	1	2288	51194	57049	32340	12974	16361	3238	805	89	9	0	0	904
1986	28	12879	44500	111527	37287	11285	3379	3912	485	71	0	1	0	557
1987	22	11074	72372	70504	73742	10808	4506	928	899	98	7	0	0	1004
1988	0	7462	61360	94163	29147	16556	2158	544	56	72	37	0	0	164
1989	52	8636	28406	77009	44307	9249	3888	420	208	35	6	1	0	249
1990	23	6949	54361	45423	50603	17747	1407	622	94	16	0	0	0	110
1991	410	11610	43110	91129	26170	21697	4687	405	255	17	1	0	0	273
1992	297	9603	45154	48838	60806	9956	6223	1496	101	8	1	0	0	110
1993	719	5980	29305	64353	33514	34651	2990	1361	697	58	16	0	0	771
1994	76	17126	31660	46217	36814	14169	14706	928	372	74	0	0	0	446
1995	277	8832	28132	58538	28014	13767	4954	4402	311	101	55	0	0	467
1996	1015	12516	26768	47594	36288	12022	4453	1116	910	168	32	0	2	1113
1997	608	6522	23543	48238	31904	15824	2957	1017	291	137	15	0	0	443
1998	1202	17081	19894	25016	24713	14717	5446	1213	220	64	16	0	0	301
1999	68	16689	26966	25863	23792	14708	6660	1882	517	61	12	0	0	591
2000	0	15406	31989	28500	14327	11841	6657	3774	864	244	48	3	0	1159
2001	150	12257	28499	27332	17518	8640	4506	2092	878	246	124	2	0	1250
2002	0	2606	10343	30858	22328	6703	1710	1328	510	98	10	9	10	638
2003	20	403	11610	13991	18981	9514	1862	444	329	50	16	0	0	396
2004	0	3972	2813	9633	13312	11860	4411	747	174	84	12	1	4	274
2005	73	11001	10355	5588	10774	10080	5810	2315	317	78	29	1	0	425
2006	12	11104	11078	8544	5394	12329	10217	4144	1087	106	6	0	0	1199
2007	140	10390	14783	16555	7701	3325	6709	4244	2187	385	77	0	0	2648

Table 12.2.6 Whiting in IV and VIId. Discard numbers at age (thousands), representing North Sea discards only. Data used in the assessment area highlighted in bold.

year	0	1	2	3	4	5	6	7	8	9	10	11	12	8+
1980	3144	**103203**	**250735**	**88399**	**14135**	**10795**	**786**	**0**	0	0	0	0	0	**0**
1981	867	**50407**	**96509**	**57403**	**7313**	**1285**	**149**	**10**	0	0	0	0	0	**0**
1982	18639	**53753**	**26922**	**52349**	**18230**	**2972**	**343**	**22**	0	0	0	0	0	**0**
1983	71016	**152488**	**85318**	**33325**	**23442**	**4309**	**295**	**25**	9	0	0	0	0	**9**
1984	16724	**200589**	**82563**	**16814**	**4437**	**4495**	**1034**	**151**	0	0	0	0	0	**0**
1985	8497	**154232**	**48790**	**15117**	**2985**	**761**	**801**	**65**	0	0	0	0	0	**0**
1986	7966	**404604**	**120492**	**43479**	**5242**	**626**	**108**	**63**	12	0	0	0	0	**12**
1987	9978	**158531**	**202154**	**34824**	**9776**	**582**	**49**	**0**	30	0	0	0	0	**30**
1988	21321	**65021**	**87197**	**51135**	**5877**	**846**	**16**	**0**	3	0	0	0	0	**3**
1989	6898	**150598**	**36712**	**61442**	**21267**	**3276**	**102**	**8**	12	0	0	0	0	**12**
1990	145308	**79488**	**245128**	**33194**	**23488**	**12012**	**253**	**87**	0	0	0	0	0	**0**
1991	6566	**76938**	**77383**	**74005**	**4900**	**1828**	**89**	**60**	0	0	0	0	0	**0**
1992	6880	**98967**	**57629**	**26527**	**22976**	**1199**	**350**	**1064**	2	0	0	0	0	**2**
1993	47769	**124426**	**101119**	**49064**	**8992**	**10709**	**519**	**131**	0	0	0	0	0	**0**
1994	8207	**77783**	**97847**	**36762**	**9528**	**2856**	**2337**	**6**	0	0	0	0	0	**0**
1995	32846	**46209**	**77320**	**48600**	**6943**	**1318**	**205**	**113**	6	0	0	0	0	**6**
1996	2388	**30480**	**82020**	**48240**	**11319**	**2192**	**240**	**179**	0	0	0	0	0	**0**
1997	9800	**19347**	**28836**	**30616**	**9175**	**2392**	**399**	**2**	16	0	1	0	0	**17**
1998	2850	**29979**	**18755**	**16361**	**10992**	**2976**	**934**	**213**	86	2	18	0	0	**106**
1999	14697	**84613**	**51740**	**14422**	**8844**	**3077**	**857**	**166**	51	34	0	0	0	**85**
2000	1685	**33848**	**75869**	**23590**	**2898**	**2257**	**1548**	**474**	107	0	0	0	0	**107**
2001	16865	**27570**	**44645**	**21930**	**2528**	**385**	**268**	**140**	19	0	0	0	0	**19**
2002	1158	**8670**	**31959**	**43444**	**9491**	**1098**	**211**	**128**	110	3	3	0	0	**116**
2003	3696	**54781**	**87376**	**36989**	**21853**	**4400**	**461**	**31**	0	0	0	1	0	**1**
2004	2618	**8603**	**9086**	**13669**	**12279**	**7267**	**2862**	**446**	17	7	0	0	0	**24**
2005	1134	**12622**	**22530**	**6342**	**7604**	**4944**	**3236**	**730**	214	6	0	0	0	**219**
2006	1136	**15107**	**22137**	**12323**	**2411**	**2659**	**1791**	**611**	272	46	10	0	0	**328**
2007	1894	**21006**	**15779**	**6868**	**1861**	**557**	**894**	**924**	333	70	6	0	0	**408**

Table 12.2.7 **Whiting in IV and VIId. Industrial bycatch numbers at age (thousands). Representing the industrial fishery in the North Sea.**

year	0	1	2	3	4	5	6	7	8	9	10	11	12	8+
1980	329065	158500	102869	45108	8162	744	55	18	0	0	0	0	0	0
1981	515996	108252	180623	104766	16729	2793	112	0	0	0	0	0	0	0
1982	82418	127998	40818	68242	10514	2448	902	2	0	0	0	0	0	0
1983	597587	42591	30789	17774	6723	1656	63	25	0	0	0	0	0	0
1984	141095	108431	30709	8868	3790	3577	91	0	0	0	0	0	0	0
1985	178224	46801	41731	9871	2522	685	284	26	0	0	0	0	0	0
1986	217207	159249	2086	14572	3987	1456	0	0	0	0	0	0	0	0
1987	74863	97446	93704	17420	1722	2	0	0	0	0	0	0	0	0
1988	395603	357861	158872	34205	4611	500	0	0	0	0	0	0	0	0
1989	80375	172438	108558	53491	12890	1842	1060	89	71	2	0	0	0	72
1990	139424	167308	205520	50508	12233	2511	342	26	2	0	0	0	0	2
1991	1028113	39959	70701	22062	5761	2684	743	78	0	0	0	0	0	0
1992	245786	131221	62571	14198	9854	812	305	49	6	0	0	0	0	6
1993	574042	87133	37153	10870	4037	776	437	27	0	0	0	0	0	0
1994	208585	68701	17670	7632	1192	359	222	64	14	0	0	0	0	14
1995	1538296	82439	33558	4351	772	76	0	0	0	0	0	0	0	0
1996	89893	29648	5168	2643	968	21	2	0	0	0	0	0	0	0
1997	6485	27539	21820	4091	1075	276	2	0	0	0	0	0	0	0
1998	64567	24370	6047	1395	754	63	12	0	0	0	0	0	0	0
1999	63048	76776	12648	5342	1539	743	30	0	0	0	0	0	0	0
2000	67	17535	16508	11436	6663	2134	586	74	0	0	0	0	0	0
2001	213973	44294	13034	9646	513	152	40	0	0	0	0	0	0	0
2002	136326	38580	18937	8638	2186	205	122	0	0	0	0	0	0	0
2003	57395	17525	5054	2580	1214	390	49	0	0	0	0	0	0	0
2004	23808	12865	4514	1052	148	0	11	0	0	0	0	0	0	0
2005	11926	10932	719	490	29	34	56	10	8	0	0	0	0	8
2006	23434	12485	5598	2337	658	172	41	4	1	0	0	0	0	1
2007	31548	55338	0	0	0	0	0	0	0	0	0	0	0	0

Table 12.2.8 Whiting in IV and VIId. Total catch mean weights at age (kg).

year	0	1	2	3	4	5	6	7	8	9	10	11	12	8+
1980	0.013	0.075	0.176	0.252	0.328	0.337	0.457	0.459	0.568	0.539	0.790	0.688	1.711	0.572
1981	0.011	0.083	0.168	0.242	0.322	0.379	0.411	0.444	0.651	0.833	1.041	0.695	0.000	0.720
1982	0.029	0.061	0.184	0.253	0.314	0.376	0.478	0.504	0.702	0.772	1.141	0.853	1.081	0.735
1983	0.015	0.107	0.191	0.273	0.325	0.384	0.426	0.452	0.520	0.677	0.516	0.000	0.000	0.537
1984	0.020	0.089	0.189	0.271	0.337	0.381	0.390	0.462	0.575	0.514	0.871	0.000	0.000	0.567
1985	0.014	0.094	0.192	0.284	0.332	0.401	0.435	0.494	0.426	0.507	0.852	0.976	0.000	0.438
1986	0.015	0.105	0.183	0.255	0.318	0.378	0.475	0.468	0.540	1.226	0.990	0.535	0.000	0.625
1987	0.013	0.077	0.148	0.247	0.297	0.375	0.380	0.542	0.555	0.857	0.603	0.000	0.000	0.584
1988	0.013	0.054	0.146	0.223	0.301	0.346	0.424	0.506	0.853	0.585	0.648	0.000	0.000	0.694
1989	0.023	0.070	0.157	0.225	0.267	0.318	0.391	0.431	0.369	0.517	0.857	0.609	0.000	0.394
1990	0.015	0.083	0.137	0.209	0.250	0.279	0.408	0.489	0.647	0.317	0.000	0.000	0.000	0.600
1991	0.017	0.103	0.169	0.218	0.290	0.306	0.338	0.365	0.385	0.589	0.993	0.000	0.000	0.400
1992	0.013	0.082	0.185	0.256	0.278	0.331	0.346	0.314	0.476	0.764	1.727	0.000	0.000	0.502
1993	0.012	0.073	0.175	0.252	0.319	0.329	0.350	0.403	0.378	0.418	0.359	0.000	0.000	0.381
1994	0.013	0.080	0.170	0.254	0.323	0.371	0.367	0.414	0.420	0.395	0.487	0.000	0.000	0.416
1995	0.010	0.087	0.181	0.257	0.341	0.385	0.429	0.434	0.446	0.347	0.406	0.000	0.000	0.420
1996	0.017	0.093	0.167	0.236	0.302	0.388	0.405	0.428	0.438	0.402	0.367	0.000	0.276	0.430
1997	0.026	0.091	0.178	0.243	0.295	0.333	0.381	0.382	0.390	0.476	0.450	0.000	0.000	0.418
1998	0.017	0.091	0.180	0.236	0.281	0.314	0.339	0.330	0.332	0.491	0.435	0.571	0.000	0.367
1999	0.022	0.076	0.175	0.232	0.256	0.289	0.303	0.308	0.282	0.310	0.323	0.000	0.000	0.287
2000	0.032	0.113	0.182	0.238	0.288	0.287	0.304	0.277	0.273	0.268	0.295	0.306	0.000	0.273
2001	0.010	0.072	0.191	0.227	0.284	0.269	0.300	0.287	0.288	0.303	0.315	0.495	0.000	0.294
2002	0.010	0.067	0.156	0.222	0.281	0.313	0.361	0.357	0.338	0.412	0.281	0.223	0.308	0.345
2003	0.012	0.053	0.114	0.195	0.260	0.298	0.352	0.383	0.340	0.454	0.618	0.000	0.000	0.365
2004	0.013	0.109	0.190	0.240	0.265	0.304	0.298	0.304	0.358	0.353	0.353	1.456	0.337	0.358
2005	0.018	0.120	0.196	0.238	0.246	0.282	0.302	0.303	0.296	0.483	0.314	0.337	0.670	0.321
2006	0.012	0.115	0.182	0.229	0.281	0.290	0.359	0.343	0.315	0.298	0.289	0.000	0.000	0.313
2007	0.013	0.065	0.213	0.259	0.326	0.344	0.309	0.312	0.328	0.294	0.328	0.000	0.000	0.323

Table 12.2.9 Whiting in IV and VIId. Human consumption landings mean weights at age (kg).

year	0	1	2	3	4	5	6	7	8	9	10	11	12	8+
1980	0.000	0.204	0.239	0.273	0.335	0.358	0.473	0.457	0.568	0.539	0.790	0.688	1.711	0.572
1981	0.144	0.194	0.242	0.292	0.331	0.378	0.411	0.445	0.651	0.833	1.041	0.695	0.000	0.720
1982	0.000	0.186	0.230	0.282	0.340	0.396	0.461	0.507	0.702	0.772	1.141	0.853	1.081	0.735
1983	0.132	0.199	0.240	0.282	0.332	0.383	0.429	0.452	0.522	0.677	0.516	0.000	0.000	0.539
1984	0.000	0.194	0.231	0.279	0.346	0.391	0.403	0.472	0.575	0.514	0.871	0.000	0.000	0.567
1985	0.137	0.187	0.248	0.307	0.337	0.408	0.443	0.498	0.426	0.507	0.852	0.976	0.000	0.438
1986	0.131	0.189	0.230	0.279	0.327	0.376	0.484	0.472	0.546	1.226	0.990	0.535	0.000	0.632
1987	0.135	0.188	0.226	0.286	0.310	0.381	0.381	0.542	0.564	0.857	0.603	1.193	0.000	0.593
1988	0.117	0.194	0.226	0.256	0.328	0.351	0.425	0.506	0.887	0.585	0.648	0.000	0.000	0.702
1989	0.171	0.178	0.226	0.253	0.288	0.345	0.370	0.440	0.373	0.522	0.857	0.609	0.000	0.406
1990	0.167	0.201	0.220	0.260	0.292	0.335	0.449	0.522	0.650	0.317	0.920	0.000	0.000	0.601
1991	0.139	0.204	0.250	0.252	0.309	0.318	0.349	0.388	0.385	0.589	0.993	2.756	0.000	0.400
1992	0.146	0.195	0.248	0.290	0.307	0.342	0.358	0.383	0.474	0.764	1.727	0.000	0.000	0.502
1993	0.153	0.195	0.251	0.287	0.348	0.359	0.388	0.422	0.378	0.418	0.359	0.000	0.000	0.381
1994	0.132	0.184	0.250	0.297	0.345	0.393	0.382	0.413	0.415	0.395	0.487	0.000	0.000	0.412
1995	0.140	0.172	0.255	0.298	0.367	0.398	0.437	0.437	0.449	0.347	0.406	0.000	0.000	0.422
1996	0.143	0.170	0.222	0.274	0.328	0.407	0.413	0.448	0.438	0.402	0.367	0.000	0.276	0.430
1997	0.150	0.171	0.207	0.261	0.314	0.348	0.398	0.381	0.394	0.476	0.429	0.000	0.000	0.421
1998	0.139	0.164	0.209	0.259	0.304	0.330	0.360	0.344	0.388	0.500	0.603	0.571	0.000	0.424
1999	0.135	0.184	0.237	0.270	0.280	0.302	0.314	0.317	0.287	0.359	0.323	0.000	0.000	0.295
2000	0.049	0.166	0.226	0.271	0.300	0.292	0.315	0.278	0.274	0.268	0.295	0.306	0.000	0.274
2001	0.138	0.160	0.217	0.268	0.286	0.269	0.303	0.291	0.289	0.303	0.315	0.495	0.000	0.295
2002	0.000	0.199	0.223	0.269	0.304	0.325	0.376	0.365	0.339	0.390	0.301	0.223	0.308	0.344
2003	0.128	0.209	0.239	0.263	0.309	0.310	0.373	0.389	0.340	0.454	0.618	0.000	0.000	0.366
2004	0.000	0.210	0.221	0.250	0.295	0.333	0.335	0.339	0.373	0.353	0.353	1.456	0.337	0.368
2005	0.166	0.208	0.247	0.275	0.267	0.311	0.338	0.320	0.339	0.496	0.314	0.337	0.670	0.366
2006	0.133	0.217	0.254	0.285	0.295	0.298	0.377	0.353	0.334	0.306	0.290	0.000	0.000	0.331
2007	0.202	0.199	0.264	0.280	0.351	0.361	0.319	0.332	0.342	0.318	0.334	0.000	0.000	0.338

Table 12.2.10 Whiting in IV and VIId. Discard mean weights at age (kg), representing North Sea discards only.

year	0	1	2	3	4	5	6	7	8	9	10	11	12	8+
1980	0.030	0.107	0.166	0.202	0.244	0.253	0.264	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1981	0.071	0.131	0.164	0.197	0.230	0.289	0.252	0.268	0.000	0.000	0.000	0.000	0.000	0.000
1982	0.047	0.091	0.182	0.211	0.225	0.241	0.244	0.261	0.000	0.000	0.000	0.000	0.000	0.000
1983	0.036	0.114	0.167	0.235	0.264	0.290	0.317	0.277	0.365	0.000	0.000	0.000	0.000	0.365
1984	0.038	0.101	0.162	0.216	0.246	0.265	0.248	0.278	0.000	0.000	0.000	0.000	0.000	0.000
1985	0.022	0.105	0.169	0.213	0.238	0.242	0.253	0.255	0.000	0.000	0.000	0.000	0.000	0.000
1986	0.028	0.123	0.166	0.190	0.208	0.227	0.194	0.217	0.311	0.000	0.000	0.000	0.000	0.311
1987	0.016	0.090	0.149	0.206	0.205	0.263	0.257	0.000	0.292	0.000	0.000	0.000	0.000	0.292
1988	0.030	0.063	0.146	0.181	0.210	0.219	0.235	0.000	0.284	0.000	0.000	0.000	0.000	0.284
1989	0.033	0.083	0.164	0.191	0.213	0.227	0.241	0.351	0.221	0.000	0.000	0.000	0.000	0.221
1990	0.024	0.095	0.130	0.183	0.186	0.196	0.249	0.302	0.000	0.000	0.000	0.000	0.000	0.000
1991	0.041	0.089	0.154	0.177	0.213	0.230	0.253	0.268	0.000	0.000	0.000	0.000	0.000	0.000
1992	0.037	0.093	0.173	0.210	0.215	0.241	0.245	0.220	1.183	0.000	0.000	0.000	0.000	1.183
1993	0.023	0.087	0.160	0.205	0.237	0.235	0.225	0.213	0.000	0.000	0.000	0.000	0.000	0.000
1994	0.040	0.090	0.151	0.203	0.230	0.244	0.254	0.332	0.000	0.000	0.000	0.000	0.000	0.000
1995	0.032	0.102	0.163	0.204	0.233	0.247	0.247	0.332	0.290	0.000	0.000	0.000	0.000	0.290
1996	0.031	0.094	0.151	0.198	0.225	0.281	0.265	0.304	0.000	0.000	0.000	0.000	0.000	0.000
1997	0.031	0.125	0.181	0.213	0.225	0.233	0.256	0.617	0.320	0.601	0.773	0.000	0.000	0.352
1998	0.026	0.086	0.173	0.204	0.228	0.234	0.224	0.247	0.191	0.180	0.284	0.000	0.000	0.206
1999	0.062	0.100	0.166	0.197	0.201	0.225	0.231	0.212	0.231	0.220	0.000	0.000	0.000	0.227
2000	0.033	0.127	0.167	0.195	0.226	0.209	0.219	0.222	0.264	0.000	0.000	0.000	0.000	0.264
2001	0.023	0.084	0.183	0.217	0.259	0.248	0.240	0.225	0.243	0.000	0.000	0.000	0.000	0.243
2002	0.039	0.130	0.167	0.196	0.224	0.224	0.225	0.272	0.334	1.120	0.218	0.000	0.000	0.352
2003	0.048	0.057	0.098	0.169	0.215	0.262	0.257	0.293	0.237	0.000	0.000	0.000	0.000	0.051
2004	0.044	0.178	0.233	0.240	0.232	0.257	0.241	0.246	0.204	0.351	0.000	0.000	0.000	0.245
2005	0.049	0.110	0.175	0.208	0.217	0.223	0.235	0.246	0.223	0.293	0.000	0.000	0.000	0.225
2006	0.032	0.099	0.162	0.196	0.251	0.247	0.253	0.273	0.239	0.279	0.289	0.000	0.000	0.246
2007	0.029	0.055	0.166	0.207	0.222	0.241	0.238	0.222	0.235	0.165	0.241	0.350	0.000	0.223

Table 12.2.11 Whiting in IV and VIId. Industrial bycatch mean weights at age (kg).

year	0	1	2	3	4	5	6	7	8	9	10	11	12	8+
1980	0.013	0.051	0.164	0.281	0.412	0.380	0.389	0.561	0.000	1.000	0.000	0.000	0.000	0.000
1981	0.011	0.056	0.141	0.218	0.318	0.433	0.596	0.600	0.800	0.000	0.000	0.000	0.000	0.000
1982	0.025	0.038	0.133	0.232	0.320	0.366	0.674	0.284	0.800	1.000	1.200	0.000	0.000	0.000
1983	0.012	0.058	0.148	0.311	0.431	0.651	0.565	0.602	0.800	1.000	0.000	0.000	0.000	0.800
1984	0.018	0.053	0.173	0.289	0.343	0.390	0.228	0.600	0.800	1.000	0.000	0.000	0.000	0.000
1985	0.014	0.054	0.150	0.263	0.382	0.454	0.504	0.584	0.800	1.000	0.000	0.000	0.000	0.000
1986	0.014	0.054	0.150	0.262	0.381	0.455	0.500	0.600	0.800	0.000	0.000	0.000	0.000	0.000
1987	0.012	0.043	0.085	0.173	0.262	0.400	0.500	0.600	0.800	1.000	0.000	0.000	0.000	0.000
1988	0.012	0.050	0.115	0.197	0.245	0.380	0.500	0.600	0.800	0.000	0.000	0.000	0.000	0.800
1989	0.022	0.053	0.137	0.224	0.285	0.344	0.482	0.396	0.385	0.401	0.000	0.000	0.000	0.385
1990	0.006	0.073	0.123	0.181	0.199	0.280	0.355	0.335	0.473	0.000	0.000	0.000	0.000	0.473
1991	0.017	0.101	0.136	0.213	0.269	0.265	0.279	0.322	0.000	0.000	0.000	0.000	0.000	0.000
1992	0.012	0.066	0.150	0.228	0.242	0.335	0.219	0.255	0.282	0.000	0.000	0.000	0.000	0.282
1993	0.011	0.044	0.155	0.259	0.264	0.308	0.235	0.392	0.000	0.000	0.000	0.000	0.000	0.000
1994	0.012	0.042	0.132	0.242	0.374	0.521	0.555	0.440	0.555	0.000	0.000	0.000	0.000	0.555
1995	0.009	0.069	0.159	0.310	0.373	0.511	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1996	0.015	0.059	0.143	0.235	0.233	0.347	0.250	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1997	0.007	0.048	0.144	0.250	0.321	0.348	0.588	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1998	0.014	0.045	0.105	0.200	0.304	0.286	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1999	0.013	0.027	0.077	0.146	0.196	0.286	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2000	0.011	0.041	0.164	0.242	0.289	0.339	0.401	0.588	0.530	0.000	0.000	0.000	0.000	0.000
2001	0.009	0.040	0.164	0.132	0.320	0.351	0.386	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2002	0.010	0.044	0.101	0.184	0.293	0.415	0.380	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2003	0.010	0.035	0.101	0.189	0.302	0.418	0.462	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2004	0.010	0.032	0.083	0.143	0.264	0.000	0.380	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2005	0.014	0.043	0.133	0.196	0.205	0.366	0.438	0.541	0.530	0.000	0.000	0.000	0.000	0.530
2006	0.011	0.043	0.121	0.196	0.277	0.362	0.401	0.564	0.530	0.000	0.000	0.000	0.000	0.527
2007	0.011	0.043	0.121	0.196	0.277	0.362	0.401	0.564	0.530	0.000	0.000	0.000	0.000	0.000

Table 12.2.12 Whiting in IV and VIId. Complete tuning series. Data used in assessment is highlighted in bold.

English groundfish survey (EngGFS)

year	effort	0	1	2	3	4	5	6	7	8	9	10
1992	100	83.60	**48.73**	**23.98**	**5.59**	**4.80**	**0.91**	**1.08**	0.00	0.00	0.00	0.00
1993	100	46.22	**46.18**	**17.75**	**6.91**	**2.14**	**1.37**	**0.35**	0.11	0.01	0.00	0.00
1994	100	38.75	**54.23**	**18.79**	**4.24**	**1.94**	**0.58**	**0.20**	0.04	0.00	0.00	0.00
1995	100	66.59	**65.11**	**43.17**	**13.12**	**2.77**	**0.56**	**0.19**	0.04	0.01	0.01	0.00
1996	100	18.26	**34.72**	**20.15**	**11.13**	**2.51**	**0.49**	**0.22**	0.13	0.07	0.00	0.00
1997	100	90.28	**28.39**	**16.06**	**13.88**	**4.18**	**1.57**	**0.88**	0.04	0.05	0.00	0.00
1998	100	292.56	**32.66**	**20.97**	**5.41**	**4.33**	**1.66**	**0.30**	0.12	0.05	0.00	0.00
1999	100	194.67	**82.02**	**18.42**	**6.92**	**2.63**	**1.44**	**0.29**	0.34	0.01	0.01	0.00
2000	100	129.30	**110.71**	**34.22**	**6.54**	**1.75**	**0.95**	**0.37**	0.31	0.03	0.00	0.00
2001	100	183.90	**100.93**	**27.29**	**9.49**	**2.35**	**0.61**	**0.71**	0.18	0.06	0.11	0.00
2002	100	9.77	**114.83**	**33.06**	**14.74**	**4.50**	**0.50**	**0.10**	0.03	0.08	0.01	0.00
2003	100	27.64	**13.33**	**25.91**	**18.34**	**9.31**	**3.97**	**0.75**	0.18	0.20	0.01	0.02
2004	100	117.52	**10.21**	**7.31**	**11.32**	**5.53**	**2.87**	**1.16**	0.46	0.16	0.02	0.00
2005	100	13.16	**23.14**	**7.05**	**4.69**	**9.19**	**10.24**	**3.97**	2.07	0.21	0.00	0.00
2006	100	20.35	**11.90**	**7.60**	**2.42**	**1.34**	**3.46**	**2.08**	0.99	0.25	0.00	0.00
2007	100	171.49	**12.04**	**5.17**	**2.27**	**0.83**	**0.37**	**1.12**	1.07	0.49	0.19	0.12

Scottish groundfish survey (ScoGFS)

year	effort	0	1	2	3	4	5	6	7	8
1998	100	12302	**4141**	**5426**	**649**	**321**	**131**	**62**	0	0
1999	100	15276	**5410**	**2090**	**615**	**329**	**129**	**58**	0	0
2000	100	17076	**6646**	**3329**	**676**	**202**	**130**	**81**	0	0
2001	100	117	**3499**	**2451**	**844**	**207**	**51**	**48**	0	0
2002	100	1606	**4980**	**2422**	**1608**	**724**	**94**	**44**	0	0
2003	100	5393	**1891**	**1433**	**1211**	**823**	**276**	**36**	9	6
2004	100	2553	**2580**	**440**	**583**	**566**	**408**	**96**	19	6
2005	100	1765	**1355**	**1015**	**304**	**411**	**289**	**248**	46	5
2006	100	397	**1580**	**699**	**333**	**121**	**280**	**197**	135	54
2007	100	4874	**960**	**1108**	**545**	**170**	**113**	**118**	133	35

International bottom trawl survey (IBTS)

year	effort	1	2	3	4	5	6
1983	100	126.62	125.03	110.00	76.43	32.20	6.08
1984	100	434.49	177.97	88.98	30.26	25.36	10.46
1985	100	339.18	362.26	65.85	18.64	7.14	7.38
1986	100	468.74	268.27	194.65	32.12	6.60	3.85
1987	100	684.90	561.08	90.44	45.50	4.90	1.91
1988	100	447.99	865.72	314.31	32.98	12.61	1.32
1989	100	1446.08	538.56	414.76	109.90	12.05	5.09
1990	100	**518.94**	**862.35**	**198.16**	**91.61**	**16.94**	3.67
1991	100	**1007.62**	**686.45**	**479.62**	**70.95**	**37.64**	7.59
1992	100	**907.30**	**665.71**	**240.16**	**150.83**	**12.67**	13.93
1993	100	**1075.62**	**522.81**	**244.59**	**65.49**	**59.02**	11.44
1994	100	**721.71**	**627.41**	**181.02**	**68.08**	**11.86**	9.11
1995	100	**678.59**	**448.48**	**239.45**	**58.07**	**11.87**	5.58
1996	100	**502.36**	**485.97**	**244.70**	**69.74**	**23.09**	9.85
1997	100	**287.73**	**342.21**	**162.52**	**60.43**	**18.01**	9.18
1998	100	**543.12**	**160.70**	**125.38**	**54.05**	**15.50**	9.26
1999	100	**676.27**	**305.45**	**94.68**	**57.45**	**25.83**	11.08
2000	100	**756.87**	**537.86**	**182.22**	**53.07**	**20.02**	14.74
2001	100	**648.65**	**598.39**	**299.18**	**98.32**	**25.72**	26.16
2002	100	**670.59**	**416.82**	**275.25**	**66.63**	**22.11**	10.41
2003	100	**131.60**	**298.87**	**237.01**	**133.36**	**48.37**	12.63
2004	100	**184.58**	**90.95**	**170.60**	**98.99**	**50.25**	23.14
2005	100	**167.63**	**55.97**	**31.48**	**56.39**	**37.85**	29.36
2006	100	**223.01**	**92.38**	**32.56**	**16.54**	**28.25**	27.14
2007	100	**42.47**	**167.02**	**71.49**	**18.89**	**9.05**	25.40
2008	100	**144.19**	**324.28**	**72.34**	**22.82**	**8.92**	14.61

Table 12.2.13 Whiting in IV and VIId. Summary of available tuning series.

Country	Fleet	Name / Code	Time of year	Year range	Age Range
England	Groundfish survey	ENGGFS GRT	Q3	1977–1991	0–10
		ENGGFS GOV	Q3	1992–2007	0–10
France	Groundfish survey	FRAGFS 7 d	Q3	1988–2003[1]	0–3
	Trawlers[6]	FRATRO IV	-	1986–2006[1]	0–8
		FRATRB IV	-	1978–2001	1–9
		FRATRO 7 d	-	1986–2006	1–7
International	Groundfish survey[2]	IBTS_QI	Q1	1983–2008	1–6[3]
	Q II survey[4]	IBTS_Q2_SCO	Q2	1991–1997	1–6
	Q IV survey[5]	IBTS_Q4_ENG	Q4	1991–1996	0–7
Scotland	Groundfish survey	SCOGFS Scotia II	Q3	1982–1997	0–8
	Seiners[6]	SCOGFS Scotia III	Q3	1998–2007	0–8
	Light trawlers[6]	SCOSEI IV	-	1978–2007	1–9
		SCOLTR IV	-	1978–2007	1–9

[1] Excluding 2002.

[2] Formerly IYFS

[3] Age 6 is a plus group

[4] Scottish sub-set of IBTS data – discontinued in 1997.

[5] English sub-set of IBTS data – discontinued in 1996.

[6] Commercial tuning indices are tabled in the stock annex.

Table 12.3.1 Whiting in IV and VIId. XSA fishing mortality from a sensitivity run that excludes information from industrial bycatch sampling in 2007.

year	1	2	3	4	5	6	7	8	Fbar(2-6)
1980	0.101	0.440	0.822	0.975	1.230	0.944	1.004	1.004	0.882
1981	0.165	0.329	0.752	0.998	1.095	1.278	1.043	1.043	0.890
1982	0.173	0.293	0.531	0.719	0.893	1.010	0.796	0.796	0.689
1983	0.210	0.455	0.747	0.734	0.880	0.918	0.828	0.828	0.747
1984	0.223	0.516	0.871	1.028	1.048	1.122	1.029	1.029	0.917
1985	0.190	0.249	0.635	0.874	1.165	1.182	0.975	0.975	0.821
1986	0.270	0.425	0.705	1.192	1.047	1.156	1.037	1.037	0.905
1987	0.140	0.507	0.869	1.243	1.345	1.654	1.294	1.294	1.124
1988	0.358	0.430	0.655	0.965	1.147	1.191	1.001	1.001	0.878
1989	0.129	0.431	0.695	0.821	1.495	1.504	1.142	1.142	0.989
1990	0.227	0.551	0.910	0.980	1.169	0.964	1.017	1.017	0.915
1991	0.117	0.489	0.522	0.882	1.093	0.668	0.799	0.799	0.731
1992	0.237	0.388	0.580	0.644	0.931	1.104	0.826	0.826	0.729
1993	0.194	0.472	0.758	0.834	0.882	1.052	0.817	0.817	0.800
1994	0.159	0.346	0.667	0.918	1.023	1.140	0.893	0.893	0.819
1995	0.153	0.351	0.630	0.728	0.999	1.135	1.192	1.192	0.769
1996	0.119	0.324	0.587	0.752	0.826	1.146	1.089	1.089	0.727
1997	0.120	0.301	0.536	0.640	0.826	0.493	0.876	0.876	0.559
1998	0.119	0.243	0.359	0.564	0.688	0.845	0.413	0.413	0.540
1999	0.199	0.396	0.542	0.651	0.707	0.776	0.761	0.761	0.614
2000	0.066	0.370	0.700	0.737	0.851	0.985	1.842	1.842	0.729
2001	0.110	0.195	0.380	0.605	0.802	0.716	0.763	0.763	0.540
2002	0.078	0.188	0.370	0.461	0.556	0.433	0.505	0.505	0.402
2003	0.351	0.415	0.314	0.377	0.392	0.332	0.172	0.172	0.366
2004	0.107	0.212	0.198	0.281	0.320	0.377	0.285	0.285	0.278
2005	0.130	0.358	0.311	0.261	0.288	0.262	0.275	0.275	0.296
2006	0.154	0.380	0.587	0.422	0.390	0.420	0.219	0.219	0.440
2007	0.406	0.355	0.577	0.638	0.392	0.368	0.329	0.329	0.466

Table 12.3.2 Whiting in IV and VIId. XSA tunning diagnostics.

```
FLR XSA Diagnostics 2008 – 05 – 08 09:37:44
CPUE data from wk.index.xsa
Catch data for 28 years. 1980 to 2007. Ages 1 to 8.
 fleet first age last age first year last year alpha beta
1 EngGFS_GOV 1 6 1992 2007 0.5 0.75
2 ScoGFS_GOV 1 6 1998 2007 0.5 0.75
3 IBTS_Q1 1 5 1990 2007 0 0.25
 Time series weights :
 Tapered time weighting applied
 Power = 3 over 18 years
Catchability analysis :
 Catchability independent of size for all ages
 Catchability independent of age for ages > 4
Terminal population estimation :
 Survivor estimates shrunk towards the mean F
 of the final 3 years or the 4 oldest ages.
 S.E. of the mean to which the estimates are shrunk = 2
 Minimum standard error for population
 estimates derived from each fleet = 0.3
 prior weighting not applied
Regression weights
 year
age 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007
 all 0.67 0.759 0.834 0.893 0.937 0.967 0.986 0.996 0.999 1
 Fishing mortalities
 year
age 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007
 1 0.119 0.199 0.066 0.110 0.078 0.351 0.107 0.130 0.159 0.862
 2 0.243 0.396 0.370 0.195 0.188 0.416 0.212 0.359 0.379 0.321
 3 0.359 0.542 0.700 0.380 0.370 0.314 0.199 0.311 0.588 0.535
 4 0.564 0.650 0.737 0.605 0.461 0.376 0.281 0.261 0.421 0.610
 5 0.688 0.707 0.851 0.801 0.555 0.392 0.320 0.288 0.391 0.380
 6 0.844 0.776 0.984 0.715 0.432 0.332 0.376 0.262 0.420 0.369
 7 0.412 0.759 1.839 0.761 0.504 0.171 0.285 0.275 0.218 0.329
 8 0.412 0.759 1.839 0.761 0.504 0.171 0.285 0.275 0.218 0.329
 XSA population number ( thousands )
 age
year 1 2 3 4 5 6 7 8
 1998 1020411 259671 168784 98271 40464 12707 4669 1321
 1999 1589364 350213 129883 83036 41420 15844 4255 1384
 2000 1683317 503928 150358 53225 32100 15907 5679 1613
 2001 1294076 609473 222011 52628 18869 10675 4631 2595
 2002 1069939 448159 319803 106997 21293 6597 4065 2083
 2003 394732 382784 236859 155736 49997 9517 3335 2778
 2004 401766 107442 160996 121950 79181 26313 5319 1322
 2005 454231 139558 55403 93008 68190 44787 14064 2988
 2006 422623 154181 62153 28616 53059 39818 26848 8575
 2007 241494 139381 67316 24319 13915 27943 20377 11964
 Estimated population abundance at 1st Jan 2008
 age
year 1 2 3 4 5 6 7 8
 2008 0 39457 64470 27775 9787 7411 15053 12007
```

Table 12.3.2 (cont.) **Whiting in IV and VIId. XSA tunning diagnostics.**

```
Fleet: EngGFS_GOV
 Log catchability residuals.
 year
age 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003
 1 -0.501 -0.660 -0.418 -0.102 -0.350 -0.232 -0.391 0.136 0.297 0.495 0.794 -0.194
 2 -0.333 -0.438 -0.581 0.322 -0.326 -0.200 0.351 0.017 0.256 -0.269 0.226 0.282
 3 -0.663 -0.480 -0.797 0.060 -0.058 0.235 -0.471 0.150 0.045 -0.171 -0.102 0.382
 4 -0.640 -0.456 -0.464 -0.087 -0.456 0.014 0.055 -0.223 -0.130 0.092 -0.055 0.244
 5 0.165 -0.836 -0.548 -0.473 -0.763 0.143 0.026 -0.126 -0.201 -0.141 -0.617 0.507
 6 1.104 0.466 -1.449 -0.336 -0.062 0.689 -0.437 -0.724 -0.347 0.522 -1.102 0.462
 year
age 2004 2005 2006 2007
 1 -0.629 0.081 -0.494 0.511
 2 0.160 -0.046 -0.059 -0.378
 3 0.214 0.469 -0.136 -0.314
 4 -0.092 0.674 0.024 -0.171
 5 -0.323 1.079 0.309 -0.585
 6 -0.094 0.534 0.105 -0.193
 Mean log catchability and standard error of ages with catchability
 independent of year class strength and constant w.r.t. time
 1 2 3 4 5 6
Mean_Logq -13.8988 -13.9485 -14.0397 -14.1518 -14.1518 -14.1518
S.E_Logq 0.4438 0.3047 0.3665 0.3171 0.5109 0.6812
Fleet: ScoGFS_GOV
 Log catchability residuals.
 year
age 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007
 1 -0.046 -0.173 -0.107 -0.458 0.065 0.263 0.406 -0.347 -0.103 0.392
 2 1.227 0.069 0.154 -0.450 -0.159 -0.385 -0.421 0.244 -0.216 0.309
 3 -0.282 0.039 0.085 -0.281 -0.008 -0.026 -0.442 0.043 0.192 0.572
 4 -0.311 -0.064 -0.054 -0.100 0.353 0.054 -0.135 -0.197 -0.142 0.479
 5 -0.274 -0.301 0.051 -0.384 -0.046 0.076 -0.038 -0.253 0.030 0.454
 6 0.233 -0.096 0.362 0.072 0.290 -0.339 -0.348 -0.002 -0.016 -0.207
 Mean log catchability and standard error of ages with catchability
 independent of year class strength and constant w.r.t. time
 1 2 3 4 5 6
Mean_Logq -9.4009 -9.2689 -9.4419 -9.4803 -9.4803 -9.4803
S.E_Logq 0.2933 0.5030 0.2843 0.2463 0.2472 0.2501
 Fleet: IBTS_Q1
 Log catchability residuals.
 year
age 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002
 1 -0.477 0.245 0.178 0.263 -0.037 0.038 0.135 -0.104 0.233 0.019 0.058 0.172 0.392
 2 -0.313 0.330 0.249 0.161 0.206 -0.061 0.147 0.161 -0.282 0.080 0.279 0.174 0.119
 3 -0.058 0.024 0.155 0.056 -0.029 -0.001 0.088 -0.224 -0.160 -0.156 0.371 0.439 -0.011
 4 -0.232 0.289 -0.130 -0.067 0.021 -0.025 -0.124 -0.251 -0.319 -0.079 0.297 0.909 -0.207
 5 -0.796 0.165 -0.252 -0.102 -0.625 -0.504 0.086 -0.423 -0.672 -0.182 -0.165 0.612 0.310
 year
age 2003 2004 2005 2006 2007
 1 -0.207 0.085 -0.131 0.230 -0.787
 2 -0.029 0.028 -0.702 -0.298 0.388
 3 0.133 0.176 -0.433 -0.481 0.219
 4 0.101 0.036 -0.258 -0.286 0.032
 5 0.219 -0.211 -0.349 -0.378 -0.180
 Mean log catchability and standard error of ages with catchability
 independent of year class strength and constant w.r.t. time
 1 2 3 4 5
Mean_Logq -12.2463 -11.6256 -11.5633 -11.6861 -11.6861
S.E_Logq 0.2865 0.2773 0.2407 0.2930 0.3661
```

Table 12.3.2 (cont.) **Whiting in IV and VIId. XSA tunning diagnostics.**

Terminal year survivor and F summaries:

```
 Age 1 Year class = 2006
source
 survivors N scaledWts
EngGFS_GOV 65785 1 0.176
ScoGFS_GOV 58380 1 0.411
IBTS_Q1 17967 1 0.389
fshk 363361 1 0.025
 Age 2 Year class = 2005
source
 survivors N scaledWts
EngGFS_GOV 42947 2 0.326
ScoGFS_GOV 66625 2 0.277
IBTS_Q1 88492 2 0.389
fshk 64202 1 0.008
 Age 3 Year class = 2004
source
 survivors N scaledWts
EngGFS_GOV 23617 3 0.314
ScoGFS_GOV 33078 3 0.312
IBTS_Q1 27276 3 0.367
fshk 43813 1 0.007
 Age 4 Year class = 2003
source
 survivors N scaledWts
EngGFS_GOV 8268 4 0.336
ScoGFS_GOV 14225 4 0.337
IBTS_Q1 7738 4 0.319
fshk 21473 1 0.007
 Age 5 Year class = 2002
source
 survivors N scaledWts
EngGFS_GOV 7747 5 0.284
ScoGFS_GOV 8645 5 0.390
IBTS_Q1 5891 5 0.320
fshk 8588 1 0.005
 Age 6 Year class = 2001
source
 survivors N scaledWts
EngGFS_GOV 21452 6 0.267
ScoGFS_GOV 12725 6 0.471
IBTS_Q1 14162 5 0.257
fshk 15709 1 0.005
 Age 7 Year class = 2000
source
 survivors N scaledWts
EngGFS_GOV 15532 6 0.267
ScoGFS_GOV 10458 6 0.465
IBTS_Q1 11943 5 0.260
Fshk 7649 1 0.007
```

Table 12.3.3 **Whiting in IV and VIId. Final XSA fishing mortality.**

year	1	2	3	4	5	6	7	8	Fbar(2-6)
1980	0.101	0.440	0.822	0.975	1.230	0.944	1.004	1.004	0.882
1981	0.165	0.329	0.752	0.998	1.095	1.278	1.043	1.043	0.890
1982	0.173	0.293	0.531	0.719	0.893	1.010	0.796	0.796	0.689
1983	0.210	0.455	0.747	0.734	0.880	0.918	0.828	0.828	0.747
1984	0.223	0.516	0.871	1.028	1.048	1.122	1.029	1.029	0.917
1985	0.190	0.249	0.635	0.874	1.165	1.182	0.975	0.975	0.821
1986	0.270	0.425	0.705	1.192	1.047	1.156	1.037	1.037	0.905
1987	0.141	0.507	0.869	1.243	1.345	1.654	1.294	1.294	1.124
1988	0.358	0.430	0.655	0.965	1.147	1.191	1.001	1.001	0.878
1989	0.129	0.431	0.695	0.821	1.495	1.504	1.142	1.142	0.989
1990	0.227	0.551	0.910	0.980	1.169	0.964	1.017	1.017	0.915
1991	0.117	0.489	0.522	0.883	1.094	0.668	0.800	0.800	0.731
1992	0.237	0.388	0.580	0.644	0.932	1.107	0.827	0.827	0.730
1993	0.195	0.473	0.759	0.834	0.882	1.056	0.822	0.822	0.801
1994	0.160	0.346	0.669	0.919	1.024	1.141	0.901	0.901	0.820
1995	0.154	0.351	0.631	0.734	1.001	1.139	1.195	1.195	0.771
1996	0.121	0.325	0.587	0.755	0.841	1.154	1.101	1.101	0.732
1997	0.126	0.307	0.540	0.642	0.834	0.510	0.893	0.893	0.567
1998	0.122	0.257	0.369	0.572	0.691	0.863	0.436	0.436	0.550
1999	0.198	0.406	0.590	0.682	0.727	0.783	0.798	0.798	0.638
2000	0.095	0.382	0.676	0.625	0.791	0.952	1.829	1.829	0.685
2001	0.111	0.197	0.384	0.612	0.800	0.721	0.768	0.768	0.543
2002	0.078	0.190	0.374	0.468	0.568	0.431	0.511	0.511	0.406
2003	0.355	0.420	0.318	0.383	0.402	0.344	0.170	0.170	0.373
2004	0.108	0.215	0.201	0.287	0.328	0.391	0.299	0.299	0.284
2005	0.131	0.361	0.316	0.266	0.295	0.271	0.289	0.289	0.302
2006	0.164	0.384	0.591	0.422	0.399	0.435	0.228	0.228	0.446
2007	0.876	0.343	0.559	0.655	0.394	0.379	0.326	0.326	0.466

Table 12.3.4 Whiting in IV and VIId. Final XSA stock numbers.

year	1	2	3	4	5	6	7	8	total
1980	4423047	1463367	607921	169230	84825	19941	2010	1314	6771655
1981	1719962	1545551	600895	188245	47287	19317	6042	603	4127902
1982	1945655	563876	708926	199714	51409	12315	4192	1744	3487831
1983	1743369	632664	268158	293698	72091	16391	3494	1548	3031413
1984	2598978	546344	255882	89566	104386	23289	5098	1249	3624792
1985	1888959	804009	207854	75481	23743	28508	5906	1492	3035952
1986	3923537	604096	399497	77606	23342	5766	6807	1824	5042475
1987	3276102	1158732	251774	139168	17455	6382	1413	1976	4853002
1988	2298126	1100928	444803	74381	29731	3541	951	317	3952778
1989	4391803	621155	456496	162763	20989	7357	838	286	5661687
1990	2009745	1492229	257383	160560	53043	3667	1273	219	3978119
1991	1871231	619451	548228	72979	44646	12832	1089	377	3170833
1992	1825130	643765	242309	229188	22364	11641	5123	401	2979921
1993	1977481	556730	278445	95568	89193	6856	2996	1834	3009103
1994	1784131	629489	221174	91884	30738	28749	1858	1079	2789102
1995	1550316	588251	283856	79795	27157	8598	7154	618	2545745
1996	1025985	514074	264084	106440	28362	7770	2144	1772	1950631
1997	724969	351614	236792	103430	37043	9526	1908	584	1465866
1998	1000497	247162	164949	97236	40341	12530	4455	640	1567810
1999	1593423	342512	121906	80333	40654	15748	4117	2358	2201051
2000	1717579	505497	145447	47604	30098	15310	5604	1518	2468657
2001	1282464	604218	220082	52152	18885	10622	4600	737	2193760
2002	1062221	443668	316452	105638	20940	6609	4024	1747	1961299
2003	391709	379799	233995	153375	48990	9242	3344	1977	1222431
2004	399821	106273	159093	119932	77432	25529	5105	2309	895494
2005	451151	138806	54657	91667	66695	43425	13453	3101	862955
2006	421434	152989	61673	28091	52065	38654	25787	8250	788943
2007	243965	138347	66459	24068	13651	27215	19483	16809	549997
2008	0	39288	62596	26778	9259	7170	14505	11519	171115

Stock numbers are survivors from the previous year.

Table 12.3.5 Whiting in IV and VIId. Final XSA summary table.

	recruitment (age 1)	tsb	ssb	catch	landings	discards	industrial bycatch	Y/ssb	fbar(2-6)
1980	4423047	837358	521515	223517	100810	76950	45760	0.19	0.88
1981	1719962	637378	489552	192049	89524	35915	66610	0.18	0.89
1982	1945655	492541	378611	140195	80549	26604	33040	0.21	0.69
1983	1743370	513248	337560	161212	87972	49560	23680	0.26	0.75
1984	2598981	485893	271767	145741	86281	40563	18900	0.32	0.92
1985	1888964	441553	271173	106363	62127	28912	15320	0.23	0.82
1986	3923596	664424	288920	161744	64114	79664	17970	0.22	0.90
1987	3276261	537926	299684	138775	68300	53996	16480	0.23	1.12
1988	2298262	418903	295589	133470	56103	28147	49220	0.19	0.88
1989	4391961	561269	279848	123753	45189	35852	42710	0.16	0.99
1990	2009923	482249	317420	153453	46896	55839	50720	0.15	0.91
1991	1871546	456782	276842	124975	53025	33639	38310	0.19	0.73
1992	1827868	407934	265006	109704	52188	30615	26900	0.20	0.73
1993	1979243	376322	239922	116165	53196	42871	20100	0.22	0.80
1994	1785087	359077	223408	92606	49242	33010	10350	0.22	0.82
1995	1556267	359957	230932	103268	46442	30264	26560	0.20	0.77
1996	1041537	293721	200614	73957	41074	28181	4700	0.20	0.73
1997	757314	238273	171846	59102	35920	17217	5960	0.21	0.56
1998	1020411	226083	139701	44312	28464	12708	3140	0.20	0.54
1999	1589364	251947	139540	59179	30412	23584	5180	0.22	0.61
2000	1683317	349105	172477	60907	28807	23214	8890	0.17	0.73
2001	1294076	285295	193058	49062	25216	16488	7360	0.13	0.54
2002	1069939	253877	184484	46552	21716	17509	7330	0.12	0.40
2003	394732	171777	149667	43208	16372	24093	2740	0.11	0.37
2004	401766	169165	128557	29057	13583	14256	1220	0.11	0.28
2005	454231	155902	105202	26795	15304	10609	880	0.15	0.30
2006	422623	140511	95011	30319	18589	9535	2190	0.20	0.44
2007	241494	94391	78045	27058	19437	6395	1230	0.25	0.44
min	241494	94391	78045	26795	13583	6395	880	0.11	0.28
mean	1771814	380816	240927	99161	47745	31650	19766	0.19	0.70
max	4423047	837358	521515	223517	100810	79664	66610	0.32	1.12
units	thousands	tonnes	tonnes	tonnes	tonnes	tonnes	tonnes		

Table 12.5.1 Whiting in IV and VIId. RCT3 input table

Whi4&7d (age 1)

6	28	2					
1980	1719962	-11	-11	-11	-11	-11	-11
1981	1945655	-11	-11	-11	-11	-11	**125.03**
1982	1743370	-11	-11	-11	-11	**126.62**	**177.97**
1983	2598981	-11	-11	-11	-11	**434.487**	**362.26**
1984	1888964	-11	-11	-11	-11	**339.177**	**268.27**
1985	3923596	-11	-11	-11	-11	**468.744**	**561.08**
1986	3276261	-11	-11	-11	-11	**684.898**	**865.72**
1987	2298262	-11	-11	-11	-11	**447.989**	**538.56**
1988	4391961	-11	-11	-11	-11	**1446.08**	**862.35**
1989	2009923	-11	-11	-11	-11	**518.936**	**686.45**
1990	1871546	-11	-11	-11	-11	**1007.621**	**665.71**
1991	1827868	-11	**48.725**	-11	-11	**907.297**	**522.81**
1992	1979243	**83.597**	**46.184**	-11	-11	**1075.624**	**627.41**
1993	1785087	**46.215**	**54.225**	-11	-11	**721.709**	**448.48**
1994	1556267	**38.747**	**65.114**	-11	-11	**678.59**	**485.97**
1995	1041537	**66.593**	**34.718**	-11	-11	**502.361**	**342.21**
1996	757314	**18.26**	**28.386**	-11	-11	**287.733**	**160.70**
1997	1020411	**90.277**	**32.655**	-11	**4141**	**543.117**	**305.45**
1998	1589364	**292.561**	**82.023**	**12302**	**5410**	**676.27**	**537.86**
1999	1683317	**194.674**	**110.707**	**15276**	**6646**	**756.865**	**598.39**
2000	1294076	**129.295**	**100.926**	**17076**	**3499**	**648.649**	**416.82**
2001	1069939	**183.899**	**114.831**	**117**	**4980**	**670.591**	**298.87**
2002	394732	**9.766**	**13.328**	**1606**	**1891**	**131.601**	**90.95**
2003	401766	**27.637**	**10.207**	**5393**	**2580**	**184.576**	**55.97**
2004	454231	**117.519**	**23.135**	**2553**	**1355**	**167.629**	**92.38**
2005	422623	**13.157**	**11.902**	**1765**	**1580**	**223.005**	**167.02**
2006	-11	**20.354**	**12.042**	**397**	**960**	**42.474**	**324.28**
2007	-11	**171.49**	-11	**4874**	-11	**144.191**	-11
egfs0							
egfs1							
sgfs0							
sgfs1							
ibts1							
ibts2							

Table 12.5.2 Whiting in IV and VIId. RCT3 output table.

Analysis by RCT3 ver3.1 of data from file :
whirec1.txt
Whi4&7 d (age 1)
Data for 6 surveys over 28 years : 1980 – 2007
Regression type = C
Tapered time weighting applied
power = 3 over 18 years
Survey weighting not applied
Final estimates shrunk towards mean
Minimum S.E. for any survey taken as .30
Minimum of 3 points used for regression
Forecast/Hindcast variance correction used.
Yearclass = 2006
I-----------Regression----------I I-----------Prediction---------I
Survey/ Slope Inter- Std Rsquare No. Index Predicted Std WAP
Series cept Error Pts Value Value Error Weights
egfs0 .78 10.43 .66 .484 14 3.06 12.80 .802 .042
egfs1 .78 10.82 .34 .786 15 2.57 12.81 .416 .157
sgfs0 1.25 3.42 2.13 .100 8 5.99 10.91 2.901 .003
sgfs1 1.20 3.95 .32 .817 9 6.87 12.17 .470 .123
ibts1 .91 8.20 .17 .937 24 3.77 **11.65** .270 **.301**
ibts2 .79 9.35 .21 .905 25 5.78 **13.92** .244 **.301**
VPA Mean = 13.66 .614 .072
Yearclass = 2007
I-----------Regression----------I I-----------Prediction---------I
Survey/ Slope Inter- Std Rsquare No. Index Predicted Std WAP
Series cept Error Pts Value Value Error Weights
egfs0 .82 10.18 .67 .535 15 5.15 14.41 .815 .100
egfs1
sgfs0 .93 6.15 1.49 .210 9 8.49 14.01 1.829 .020
sgfs1
ibts1 .77 9.07 .22 .918 25 4.98 12.92 .258 **.739**
ibts2
VPA Mean = 13.50 .689 .140
Year Weighted Log Int Ext Var VPA Log
Class Average WAP Std Std Ratio VPA
Prediction Error Error
2006 **352418** 12.77 .16 .38 5.45 241494 12.39
2007 527108 13.18 .26 .28 1.15

Table 12.6.1 Whiting in IV and VIId. Short term forecast input

MFDP version 1a
Run: whiting.new
Time and date: 11:19 11/05/2008
Fbar age range (Total) : 2-6
Fbar age range Fleet 1 : 2-6
Fbar age range Fleet 2 : 2-6

2008

Age	N	M	Mat	PF	PM	SWt
1	527108	0.95	0.11	0	0	0.100
2	90791	0.45	0.92	0	0	0.197
3	64470	0.35	1	0	0	0.242
4	27775	0.30	1	0	0	0.284
5	9787	0.25	1	0	0	0.305
6	7411	0.25	1	0	0	0.323
7	15053	0.20	1	0	0	0.319
8	12007	0.20	1	0	0	0.319

Catch

Age	Sel	CWt	DSel	DCWt
1	0.042	0.208	0.058	0.088
2	0.150	0.255	0.245	0.168
3	0.237	0.280	0.207	0.204
4	0.285	0.304	0.125	0.230
5	0.345	0.323	0.095	0.237
6	0.370	0.345	0.097	0.242
7	0.289	0.335	0.065	0.247
8	0.272	0.345	0.081	0.231

IndBycatch

Age	Sel	CWt
1	0.074	0.043
2	0.023	0.125
3	0.022	0.196
4	0.011	0.253
5	0.002	0.363
6	0.002	0.413
7	0.001	0.556
8	0.002	0.528

2009

Age	N	M	Mat	PF	PM	SWt
1	417712	0.95	0.11	0	0	0.100
2	.	0.45	0.92	0	0	0.197
3	.	0.35	1	0	0	0.242
4	.	0.30	1	0	0	0.284
5	.	0.25	1	0	0	0.305
6	.	0.25	1	0	0	0.323
7	.	0.20	1	0	0	0.319
8	.	0.20	1	0	0	0.319

Catch

Age	Sel	CWt	DSel	DCWt
1	0.042	0.208	0.058	0.088
2	0.150	0.255	0.245	0.168
3	0.237	0.280	0.207	0.204
4	0.285	0.304	0.125	0.230
5	0.345	0.323	0.095	0.237
6	0.370	0.345	0.097	0.242
7	0.289	0.335	0.065	0.247
8	0.272	0.345	0.081	0.231

IndBycatch

Age	Sel	CWt
1	0.074	0.043
2	0.023	0.125
3	0.022	0.196
4	0.011	0.253
5	0.002	0.363
6	0.002	0.413
7	0.001	0.556
8	0.002	0.528

2010

Age	N	M	Mat	PF	PM	SWt
1	417712	0.95	0.11	0	0	0.100
2	.	0.45	0.92	0	0	0.197
3	.	0.35	1	0	0	0.242
4	.	0.30	1	0	0	0.284
5	.	0.25	1	0	0	0.305
6	.	0.25	1	0	0	0.323
7	.	0.20	1	0	0	0.319
8	.	0.20	1	0	0	0.319

Catch

Age	Sel	CWt	DSel	DCWt
1	0.042	0.208	0.058	0.088
2	0.150	0.255	0.245	0.168
3	0.237	0.280	0.207	0.204
4	0.285	0.304	0.125	0.230
5	0.345	0.323	0.095	0.237
6	0.370	0.345	0.097	0.242
7	0.289	0.335	0.065	0.247
8	0.272	0.345	0.081	0.231

IndBycatch

Age	Sel	CWt
1	0.074	0.043
2	0.023	0.125
3	0.022	0.196
4	0.011	0.253
5	0.002	0.363
6	0.002	0.413
7	0.001	0.556
8	0.002	0.528

Input units are thousands and kg - output in tonnes

MFDP version 1a
Run: whiting.new
Time and date: 11:19 11/05/2008
Fbar age range (Total) : 2-6
Fbar age range Fleet 1 : 2-6
Fbar age range Fleet 2 : 2-6

2008

Biomass	SSB	Catch FMult	Landings FBar	Yield	Discards FBar	Yield	IndBycatch FMult	Landings FBar	Yield
108117	59773	1	0.277	13187	0.154	7181	1	0.012	1451

2009 / **2010**

2009 Biomass	SSB	Catch FMult	Landings FBar	Yield	Discards FBar	Yield	IndBycatch FMult	Landings FBar	Yield	2010 Biomass	SSB
104639	64765	0	0.000	0	0.000	0	1	0.012	1459	120577	81037
.	64765	0.1	0.028	1502	0.015	951	1	0.012	1444	118327	78811
.	64765	0.2	0.055	2953	0.031	1870	1	0.012	1429	116158	76666
.	64765	0.3	0.083	4358	0.046	2760	1	0.012	1415	114067	74598
.	64765	0.4	0.111	5716	0.062	3621	1	0.012	1401	112050	72604
.	64765	0.5	0.139	7029	0.077	4453	1	0.012	1387	110106	70682
.	64765	0.6	0.166	8301	0.092	5259	1	0.012	1373	108230	68829
.	64765	0.7	0.194	9531	0.108	6039	1	0.012	1360	106420	67041
.	64765	0.8	0.222	10722	0.123	6794	1	0.012	1347	104675	65318
.	64765	0.9	0.250	11875	0.139	7525	1	0.012	1334	102990	63655
.	**64765**	**1**	**0.277**	**12991**	**0.154**	**8233**	**1**	**0.012**	**1321**	**101364**	**62051**
.	64765	1.1	0.305	14072	0.169	8918	1	0.012	1309	99795	60503
.	64765	1.2	0.333	15119	0.185	9583	1	0.012	1297	98281	59010
.	64765	1.3	0.360	16134	0.200	10226	1	0.012	1285	96819	57569
.	64765	1.4	0.388	17117	0.216	10850	1	0.012	1274	95407	56177
.	64765	1.5	0.416	18070	0.231	11455	1	0.012	1262	94043	54835
.	64765	1.6	0.444	18993	0.246	12041	1	0.012	1251	92727	53538
.	64765	1.7	0.471	19889	0.262	12609	1	0.012	1240	91454	52286
.	64765	1.8	0.499	20758	0.277	13160	1	0.012	1230	90225	51077
.	64765	1.9	0.527	21600	0.293	13695	1	0.012	1219	89038	49909
.	64765	2	0.555	22417	0.308	14213	1	0.012	1209	87890	48781

Input units are thousands and kg - output in tonnes

Table 12.6.2 Whiting in IV and VIId. Short term forecast output.

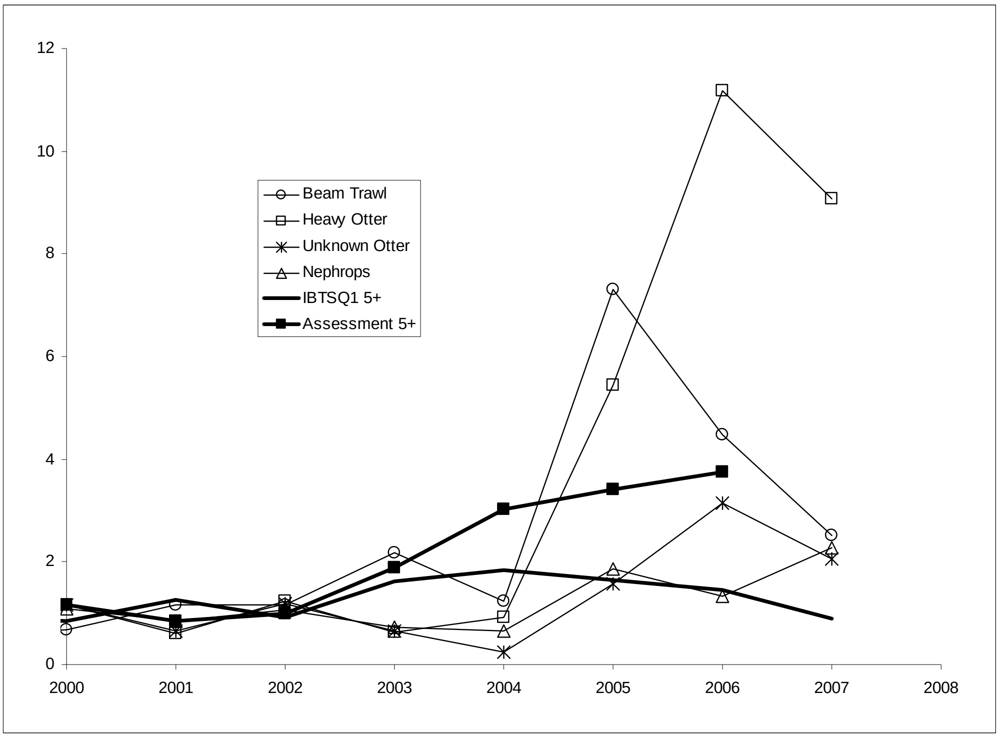


Figure 12.1.1. Whiting in IV and VIId. The time series of UK (Eng. & Wales) vessels, fishing on the northeast coast, standardised (to the average of 2000–2002) average quarter 1 North Sea whiting landings per unit effort (kg/hr uncorrected for kw) during the years 2000–2007; compared to the ICES assessment and IBTS derived estimate of 5+ biomass.

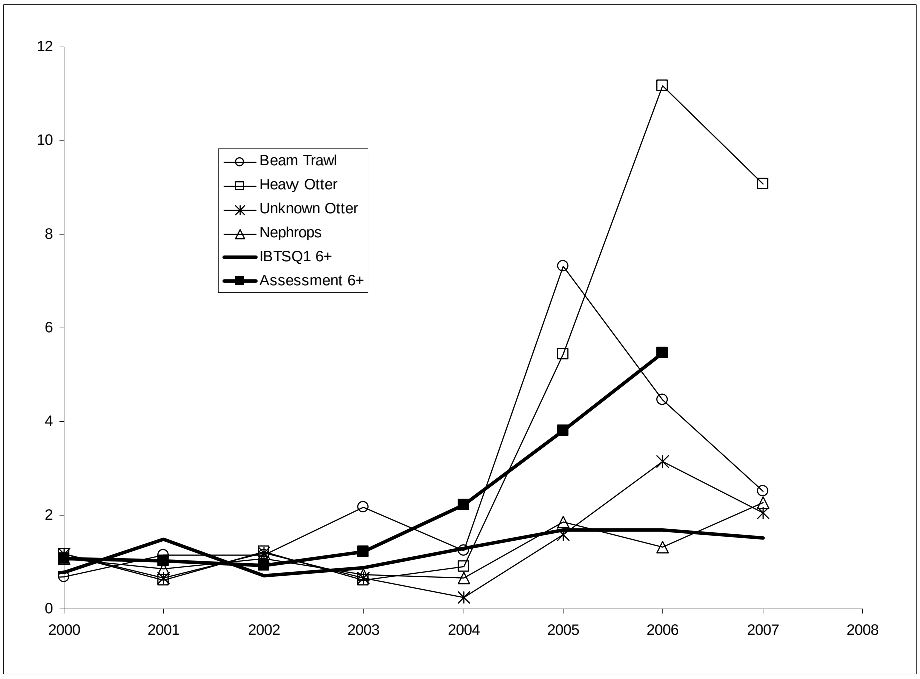


Figure 12.1.2. Whiting in IV and VIId. The time series of UK (Eng. & Wales) vessels, fishing on the northeast coast, standardised (to the average of 2000–2002) average quarter 1 North Sea whiting landings per unit effort (kg/hr uncorrected for kw) during the years 2000–2007; compared to the ICES assessment and IBTS derived estimate of 6+ biomass.

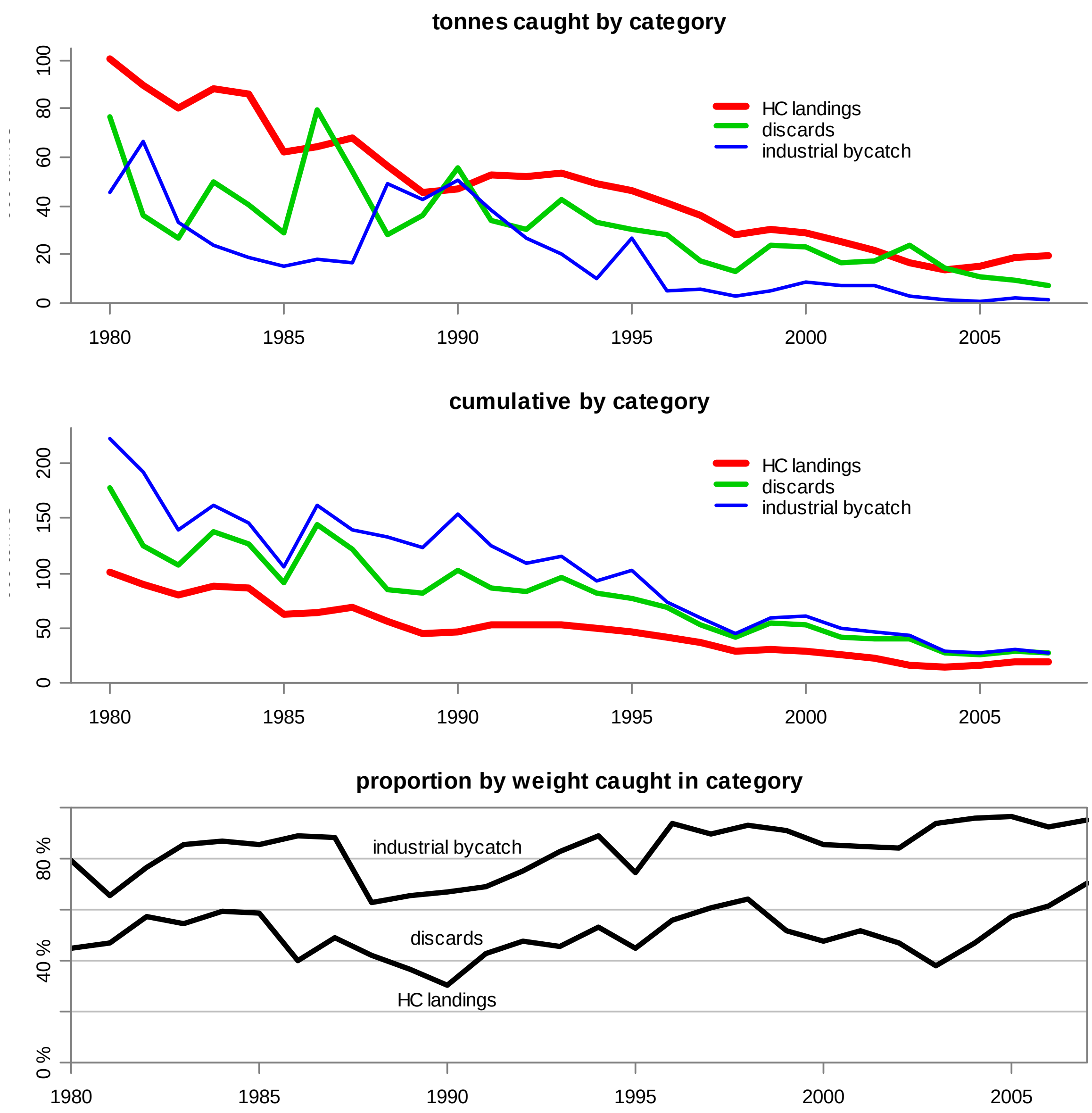


Figure 12.2.1 Whiting in IV and VIId. The contribution of different catch components to the total catch.

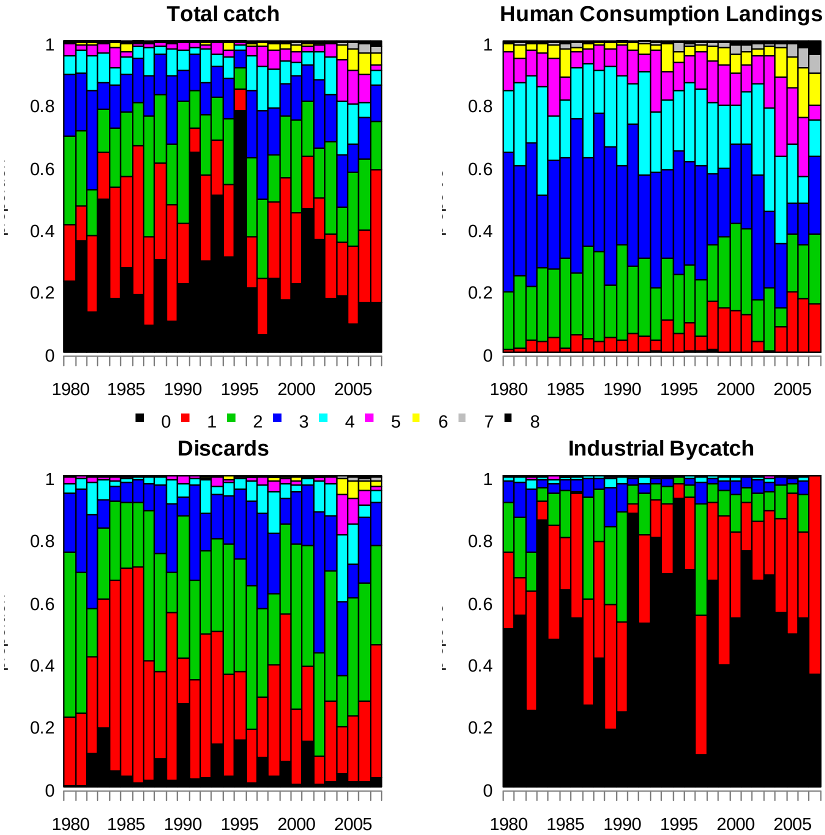


Figure 12.2.2 Whiting in IV and VIId. Proportion at age by number for each catch component.

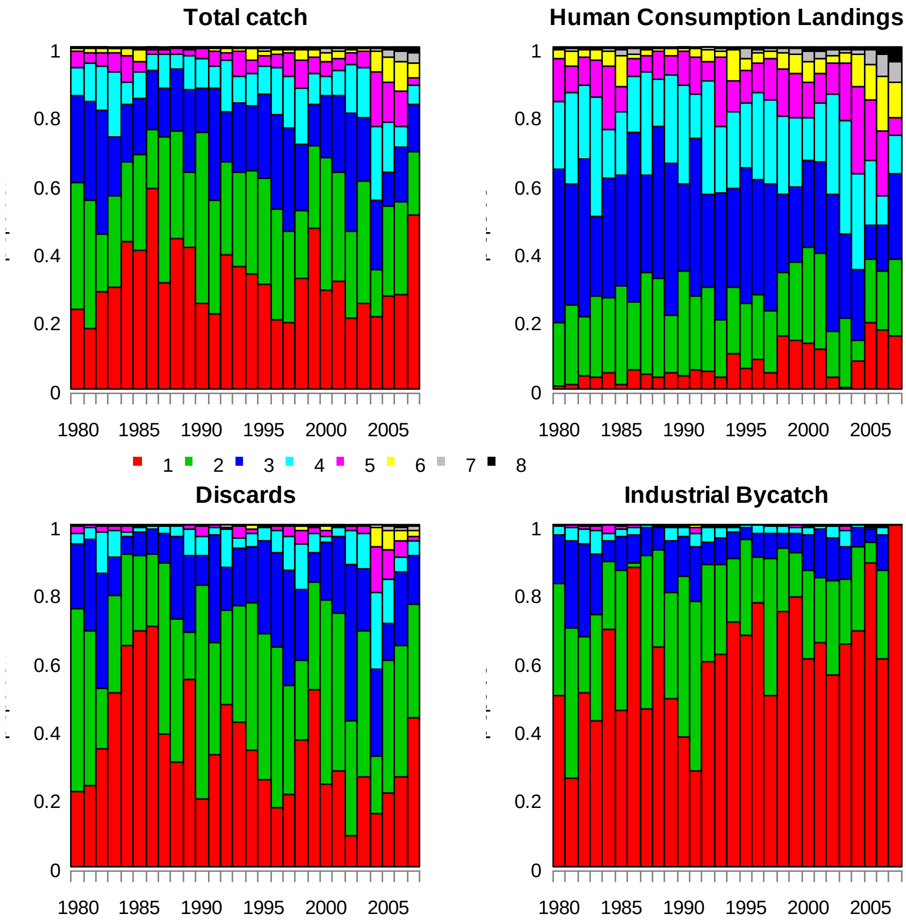


Figure 12.2.3 Whiting in IV and VIId. Proportion at age by number for each catch component excluding age 0.

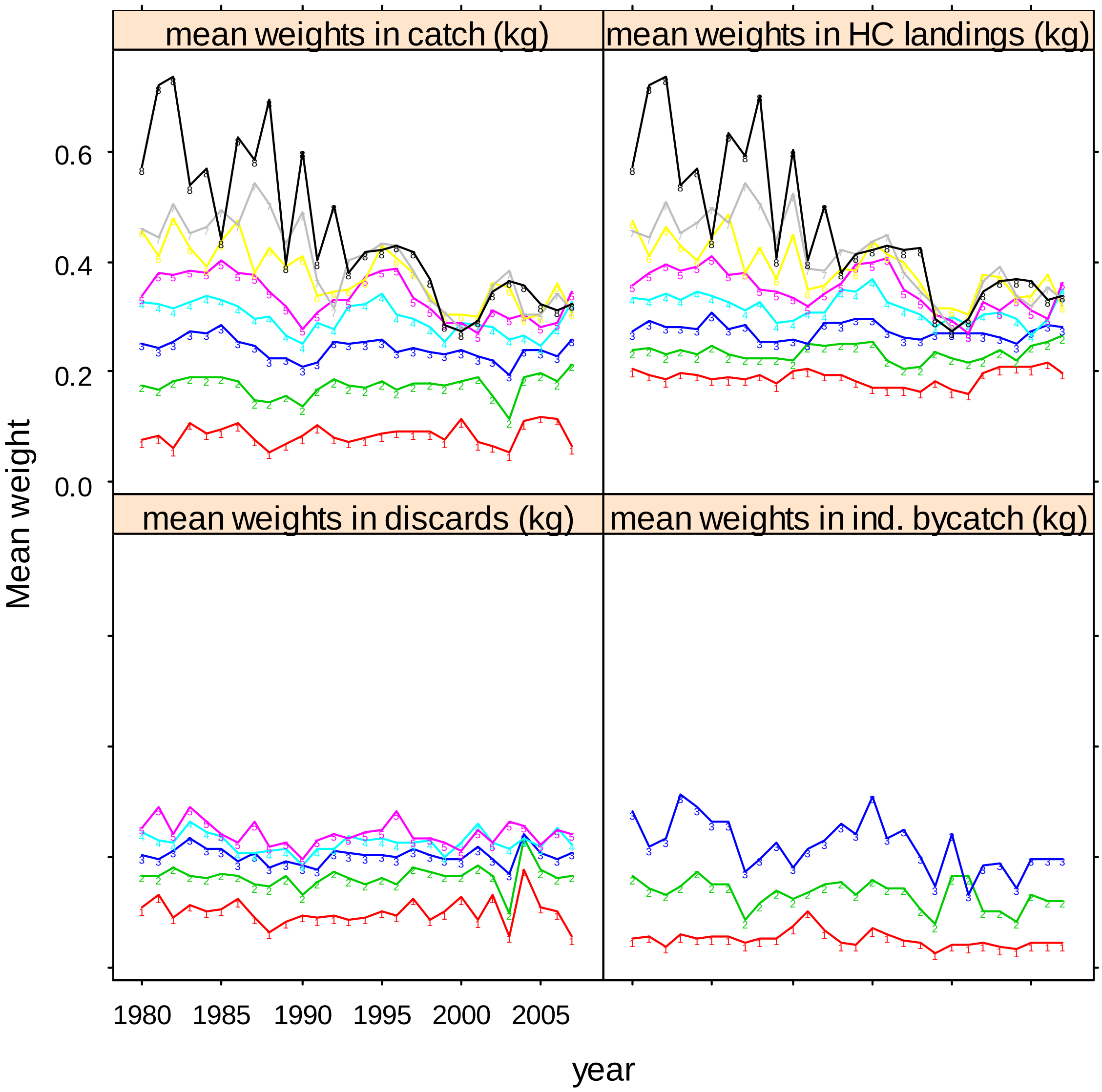


Figure 12.2.4 Whiting in IV and VIId. Mean weights at age (kg) by catch component. Catch mean weights are also used as stock mean weights.

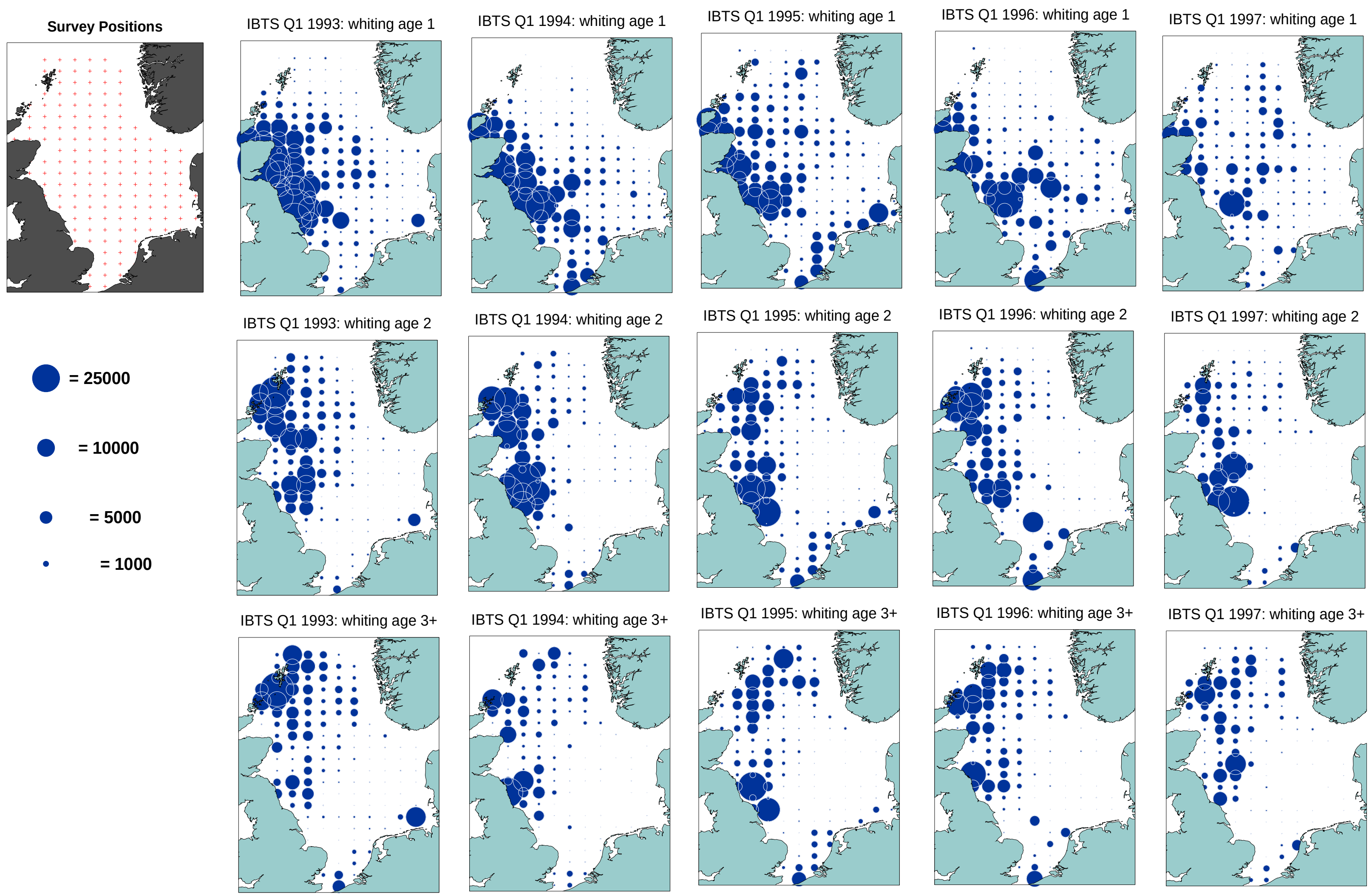


Figure 12.2.5 Whiting in IV and VIId. Distribution plot of the IBTS quarter 1 Survey.

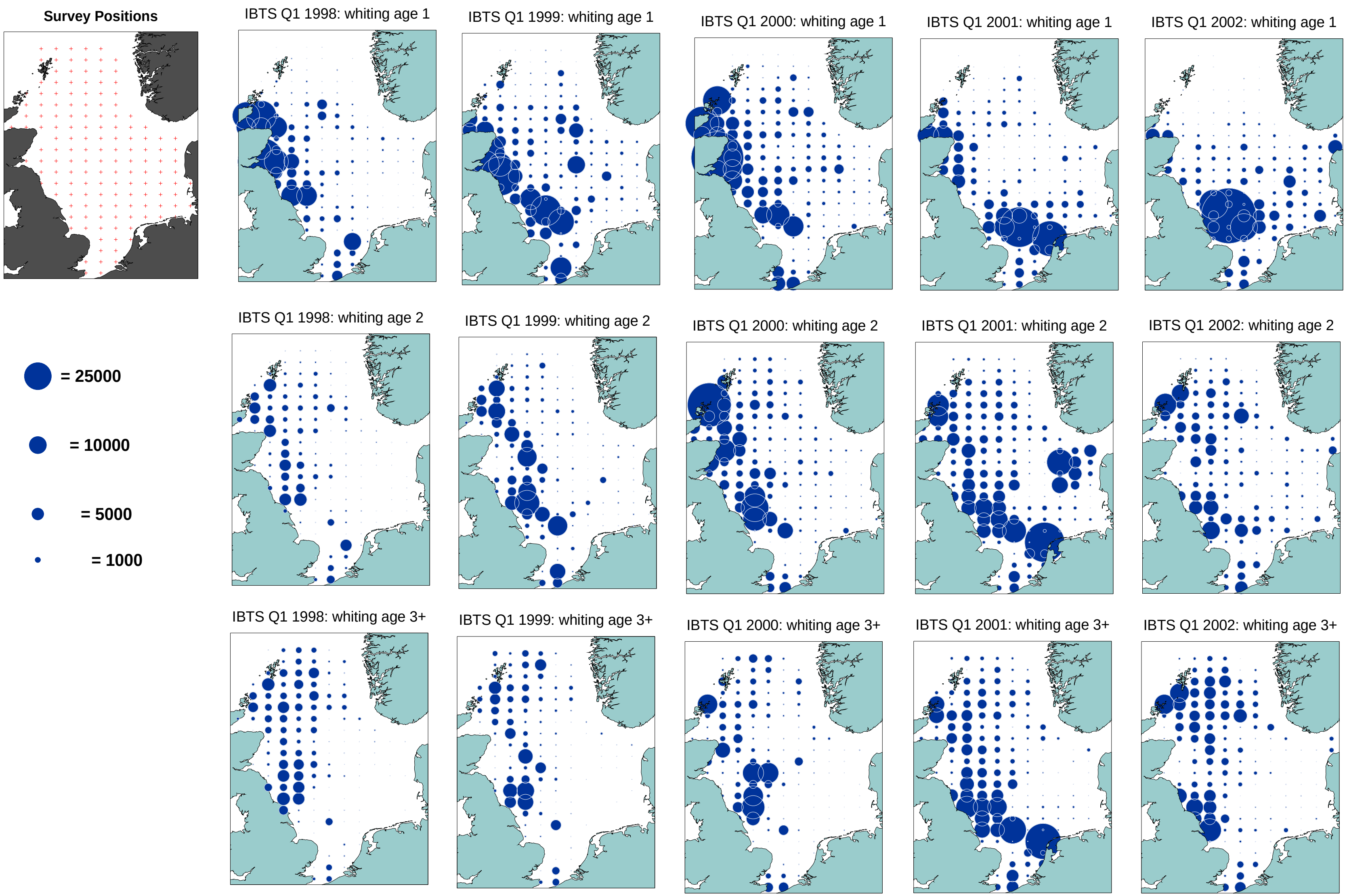


Figure 12.2.5 (cont.) **Whiting in IV and VIId. Distribution plot of the IBTS quarter 1 Survey**

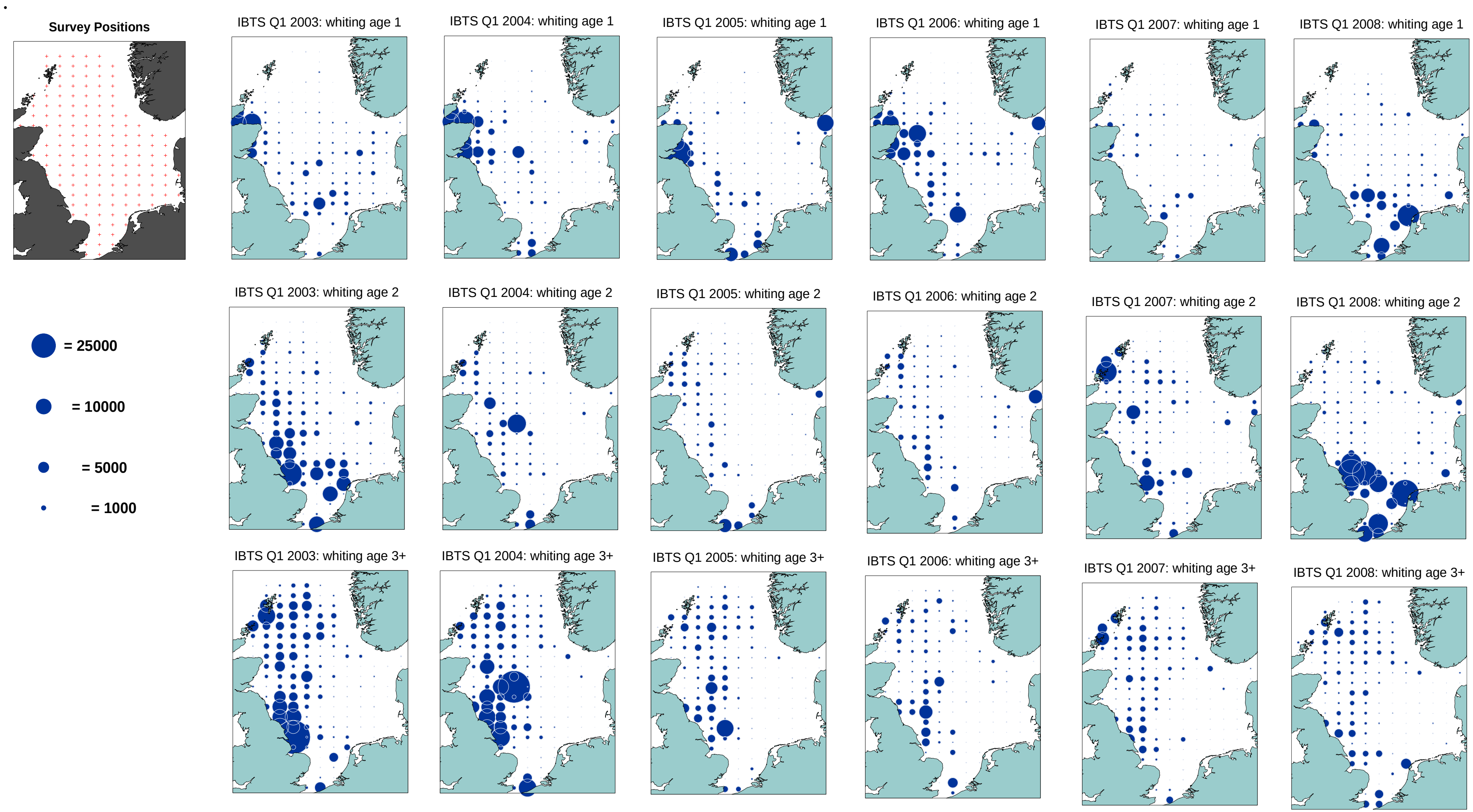


Figure 12.2.5 (cont.) **Whiting in IV and VIId. Distribution plot of the IBTS quarter 1 Survey.**

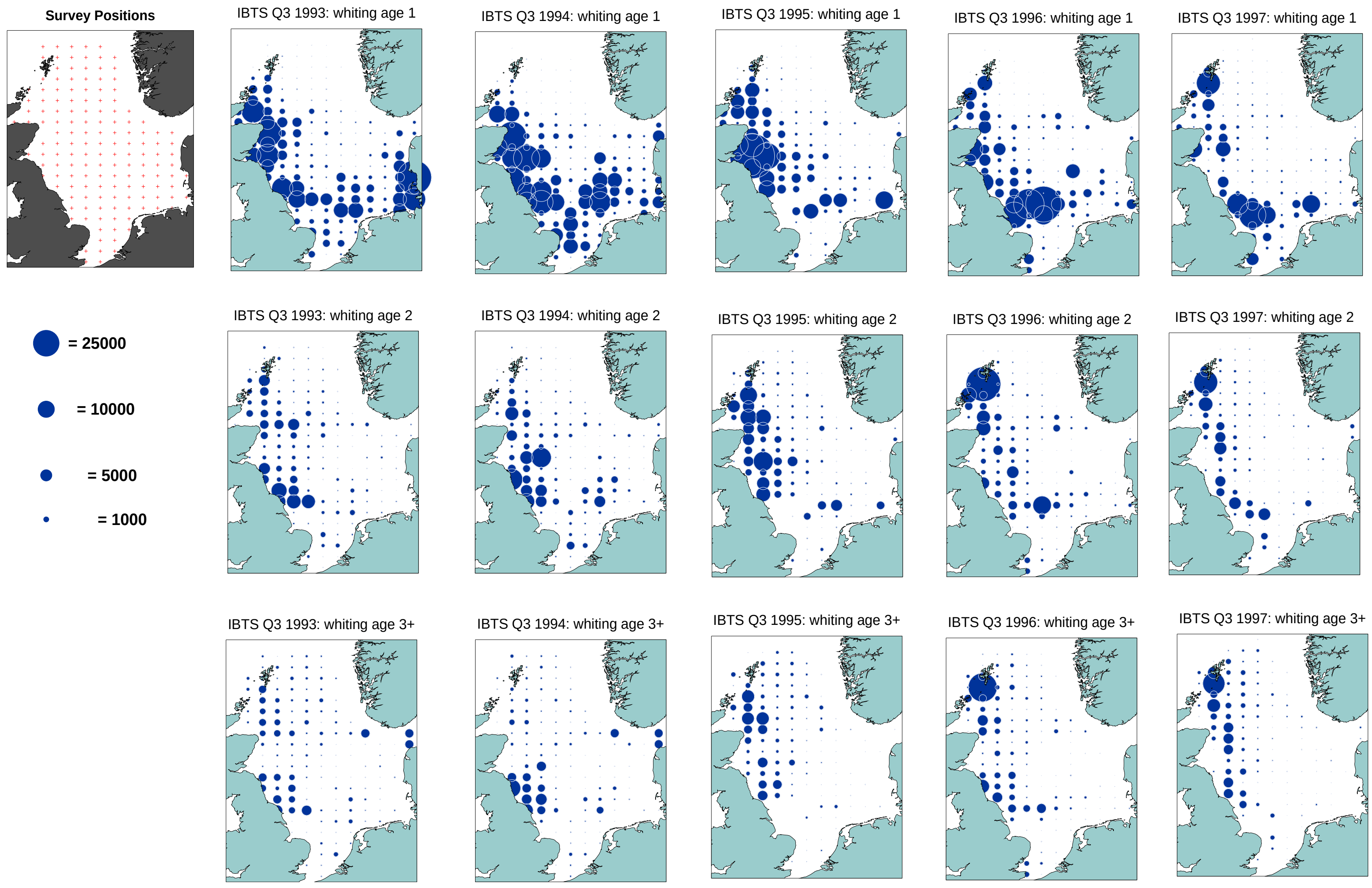


Figure 12.2.6 **Whiting in IV and VIId. Distribution plot of the IBTS quarter 3 Survey.**

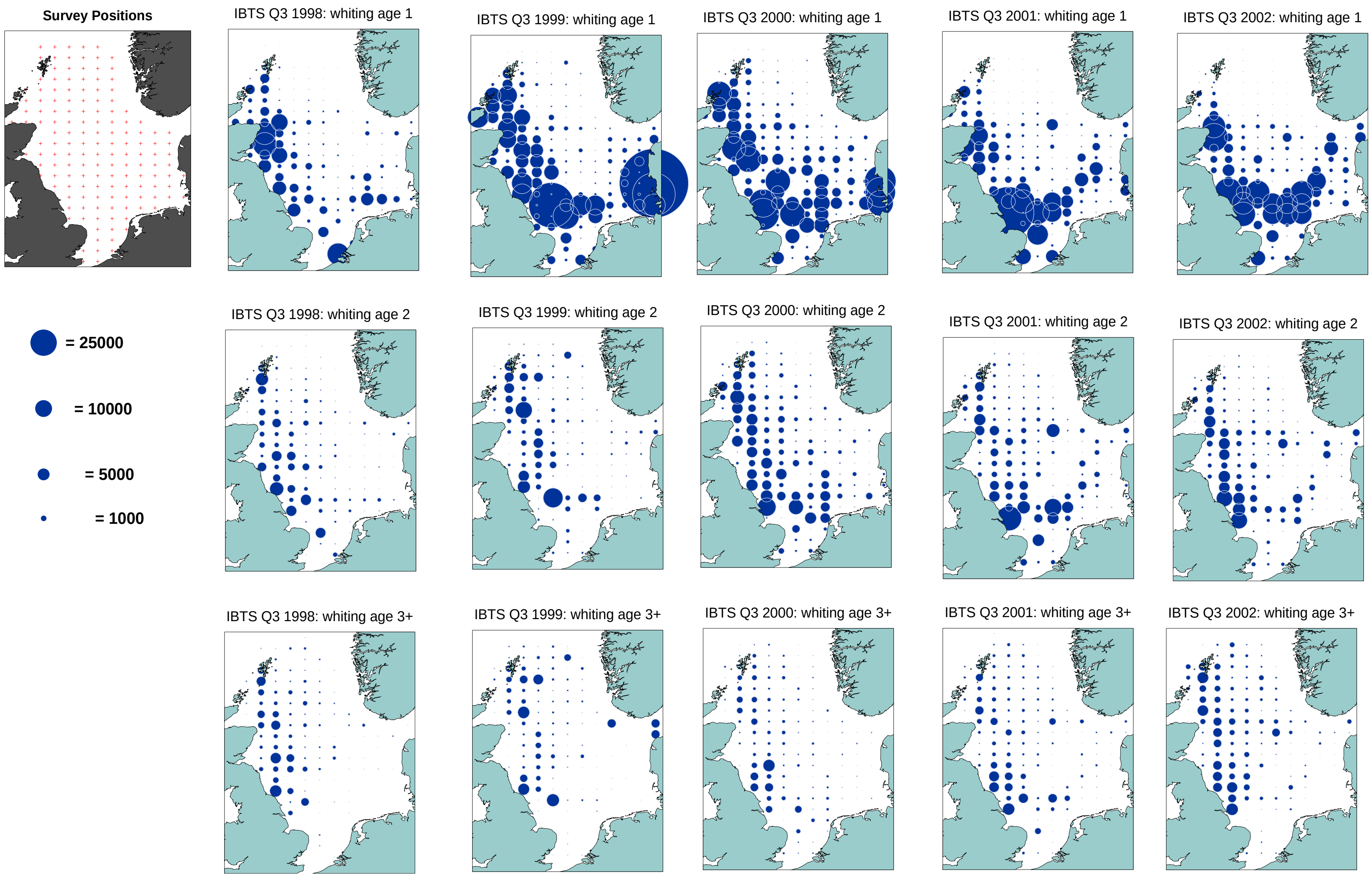


Figure 12.2.6 (cont.) **Whiting in IV and VIId. Distribution plot of the IBTS quarter 3 Survey.**

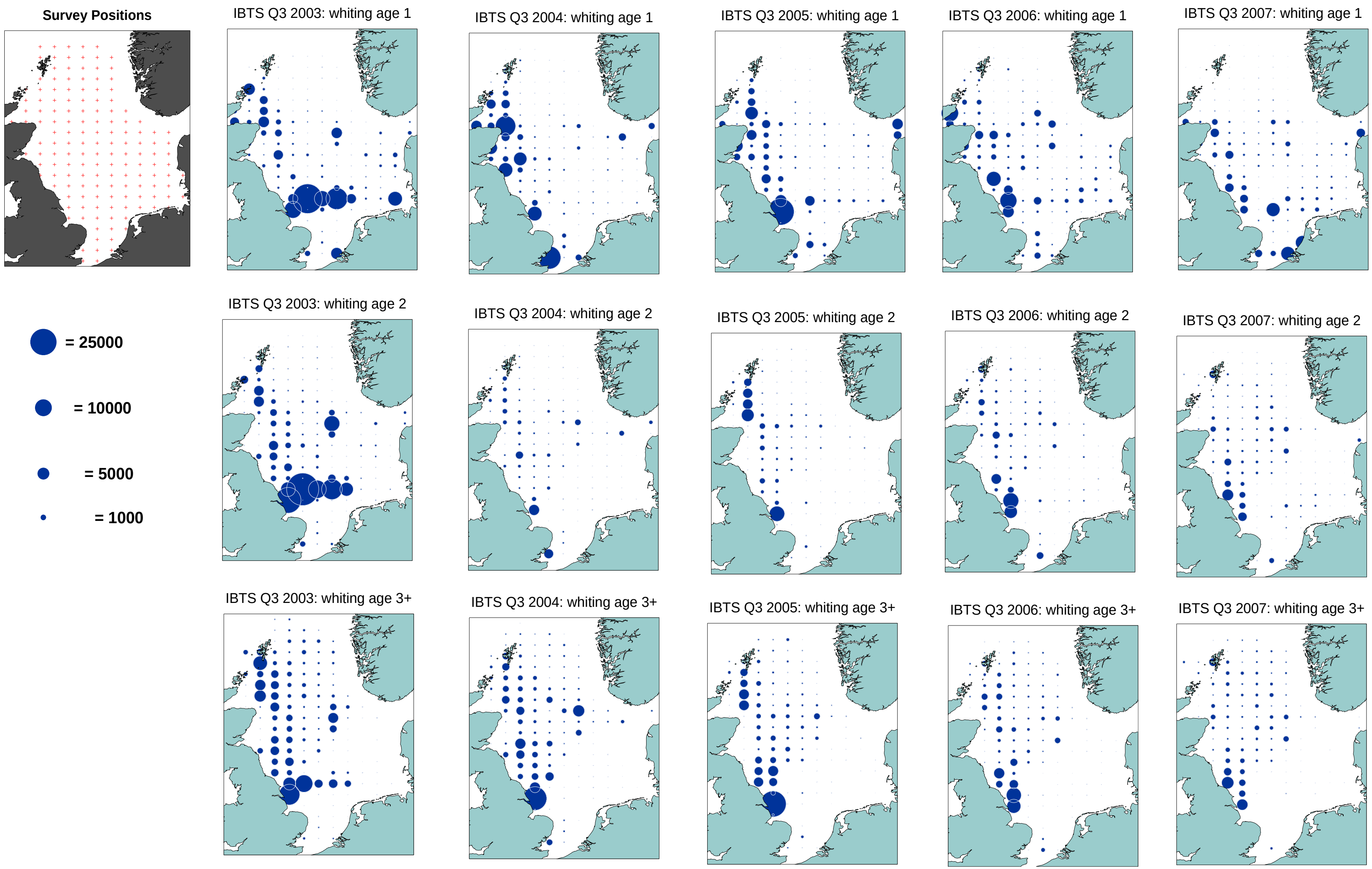


Figure 12.2.6 (cont.) **Whiting in IV and VIId. Distribution plot of the IBTS quarter 3 Survey.**

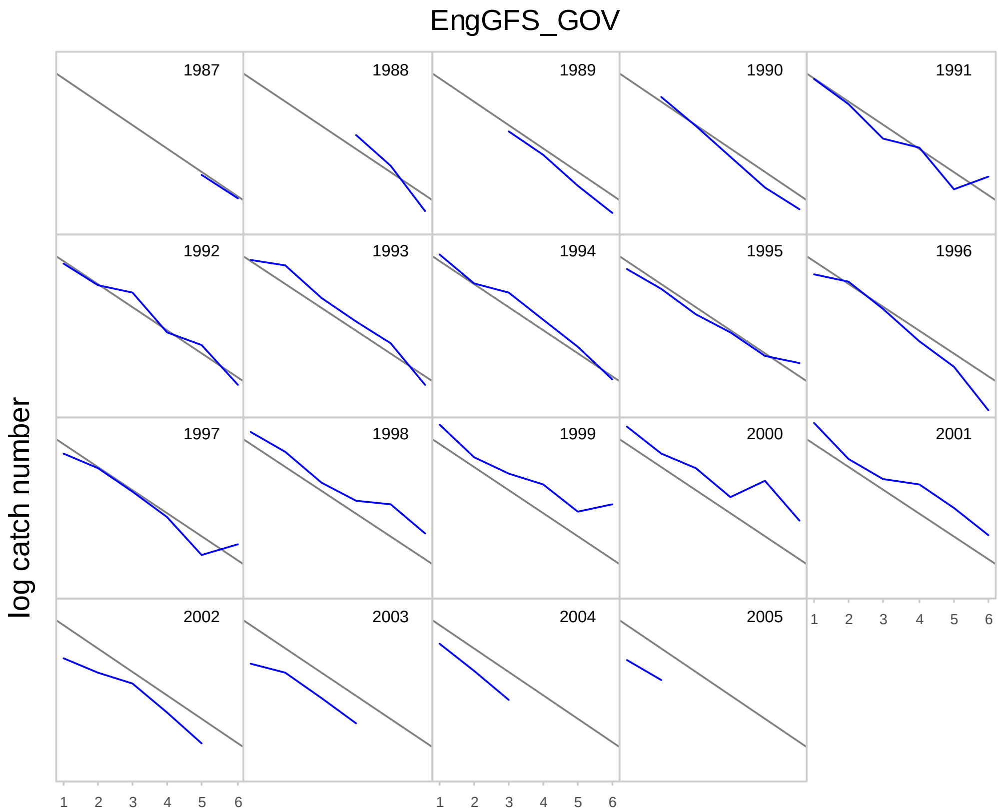


Figure 12.3.1 Whiting in IV and VIId. Log catch-numbers linked by cohort for the English groundfish survey indices (ages 1 to 6). The year specifies the year class. A reference a line with constant intercept and gradient equal to $Z_P = F_{pa} + M(2-6)$ has been drawn in grey.

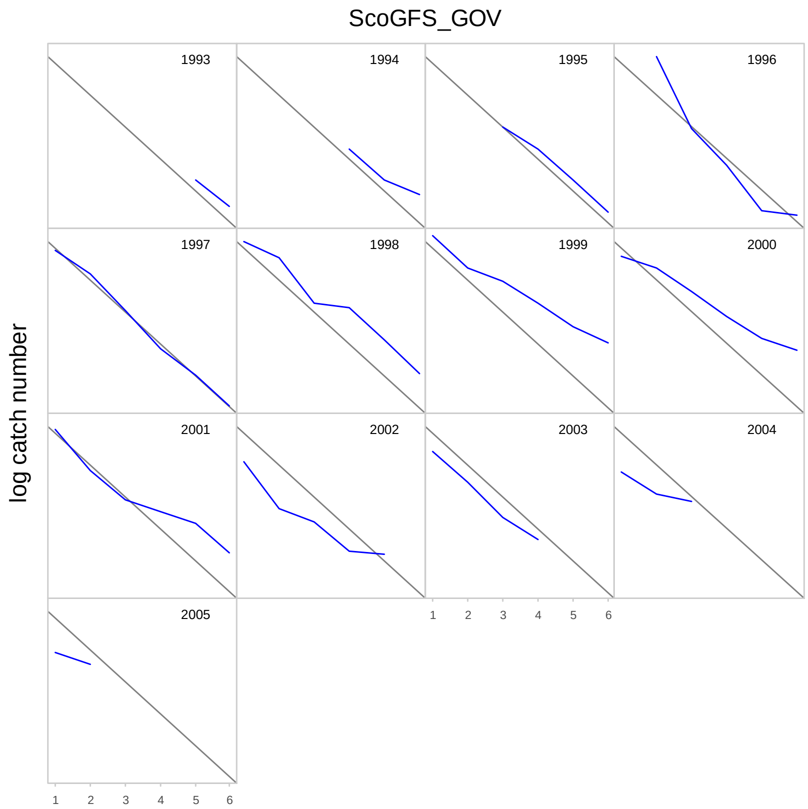


Figure 12.3.2 Whiting in IV and VIId. Log catch-numbers linked by cohort for the Scottish groundfish survey indices (ages 1 to 6). The year specifies the year class. A reference a line with constant intercept and gradient equal to $Z_{pa}=F_{pa}+M(2-6)$ has been drawn in grey.

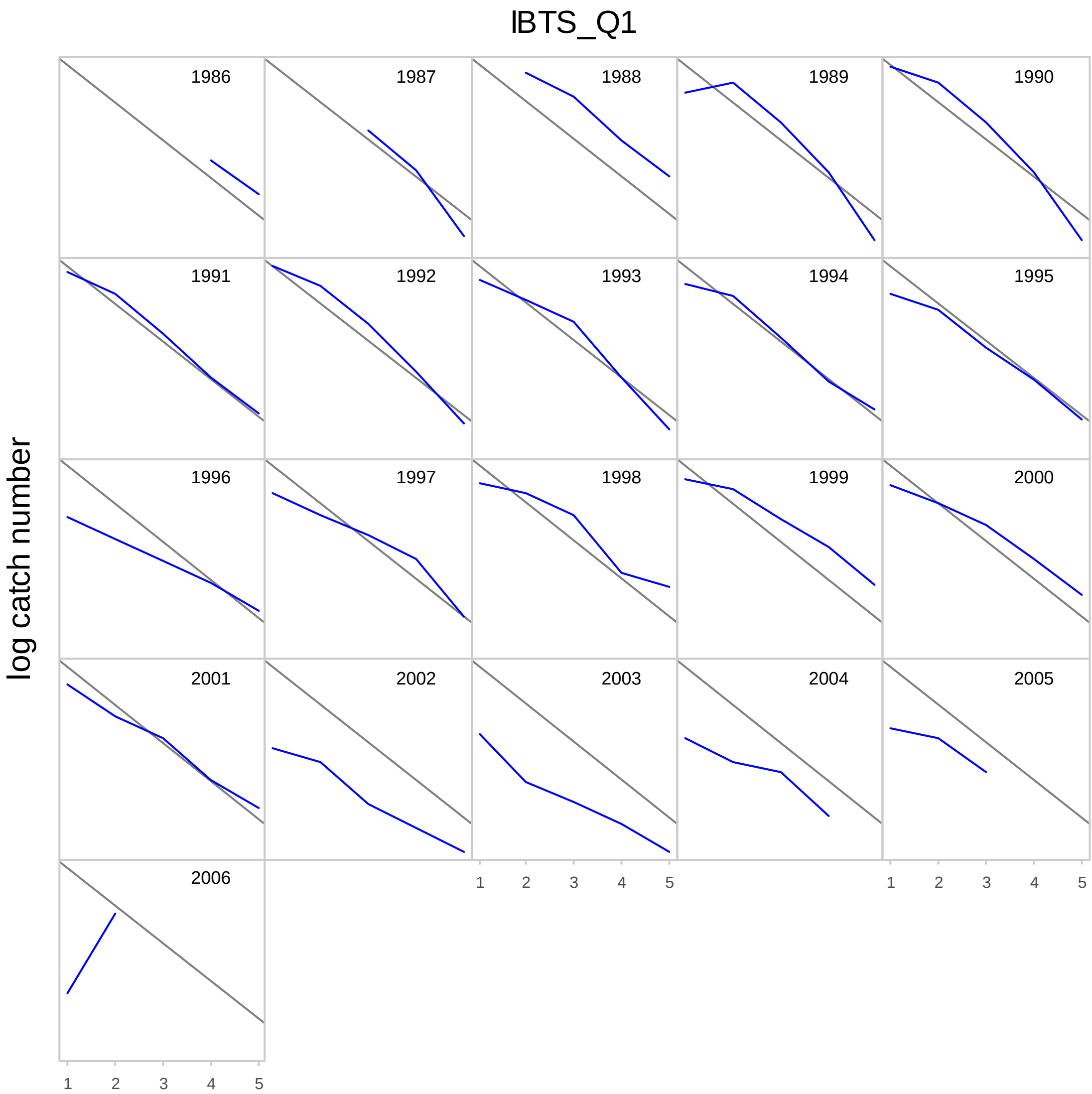


Figure 12.3.3 Whiting in IV and VIId. Log catch-numbers linked by cohort for the IBTS survey indices (ages 1 to 5). The year specifies the yearclass. A reference a line with constant intercept and gradient equal to $Z_{pa}=F_{pa}+M(2-6)$ has been drawn in grey.

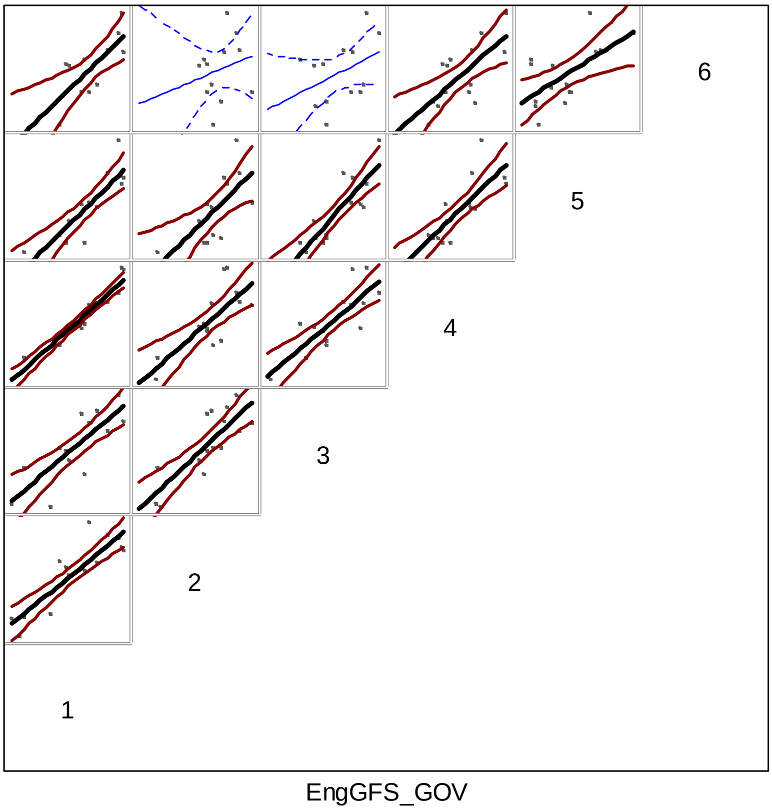


Figure 12.3.4 Whiting in IV and VIId. Within survey correlations for the English groundfish survey (1992–2006). Individual points are given by cohort, the line is a normal linear model fit. Thick lines represent a significant (p<0.05) regression and the curved lines are approximate 95% confidence intervals.

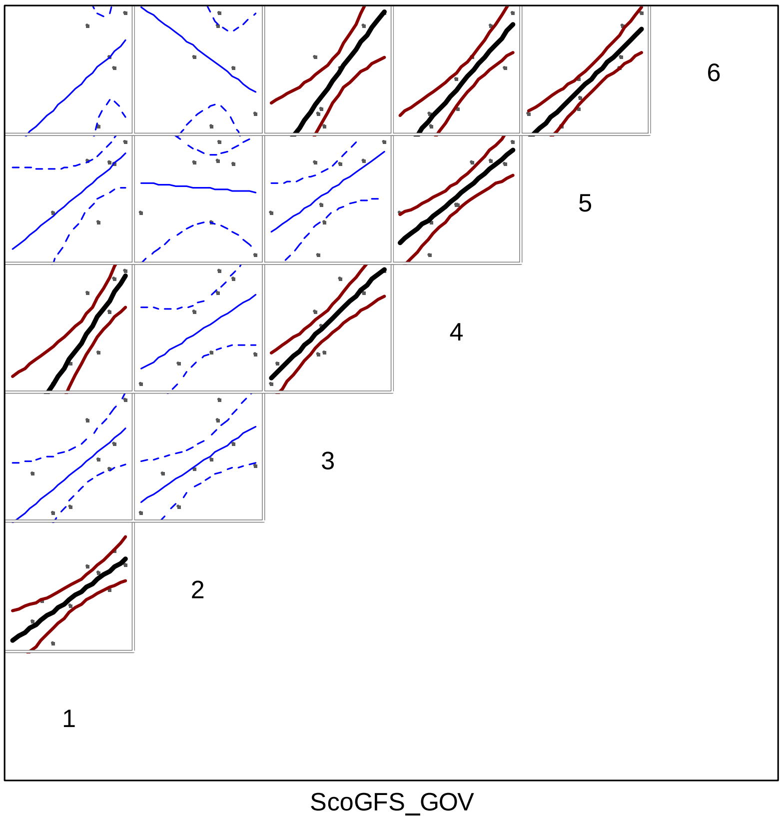


Figure 12.3.5 Whiting in IV and VIId. Within survey correlations for the Scottish groundfish survey (1998–2006). Individual points are given by cohort, the line is a normal linear model fit. Thick lines represent a significant ($p<0.05$) regression and the curved lines are approximate 95% confidence intervals.

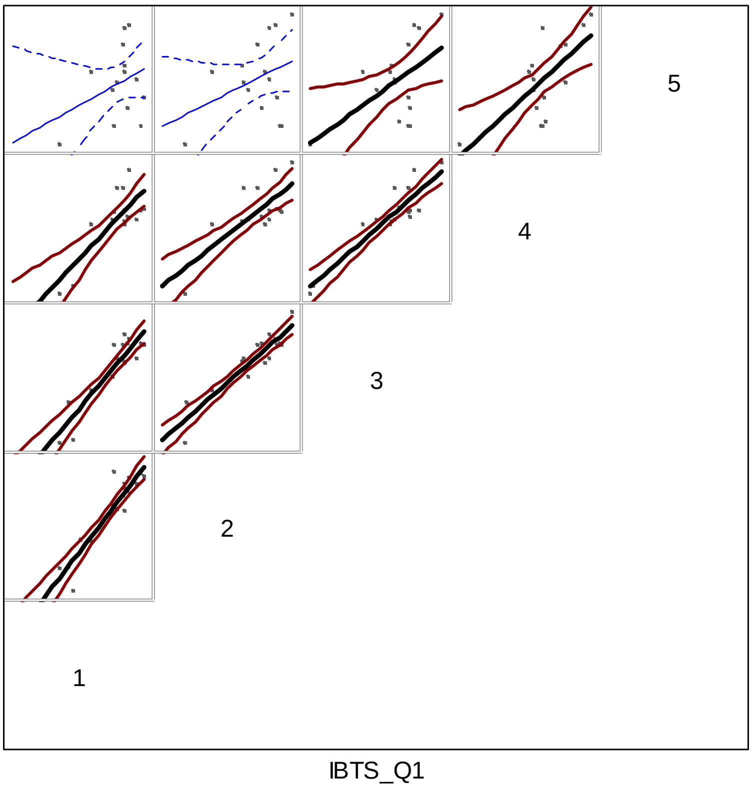


Figure 12.3.6 Whiting in IV and VIId. Within survey correlations for the IBTS quarter 1 survey (1990–2006). Individual points are given by cohort, the line is a normal linear model fit. Thick lines represent a significant (p<0.05) regression and the curved lines are approximate 95% confidence intervals.

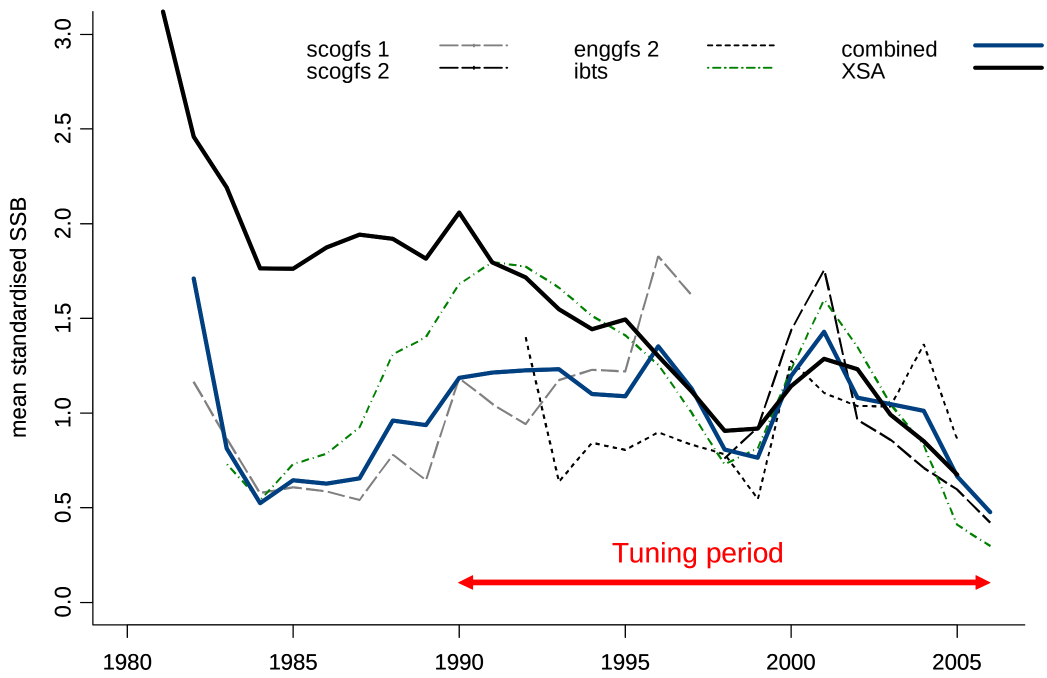


Figure 12.3.7 **Whiting in IV and VIId. Comparison of SSB trends from SURBA runs and a mutli-fleet XSA run using the 2005 benchmark settings (with shrinkage reduced to 2.0).**

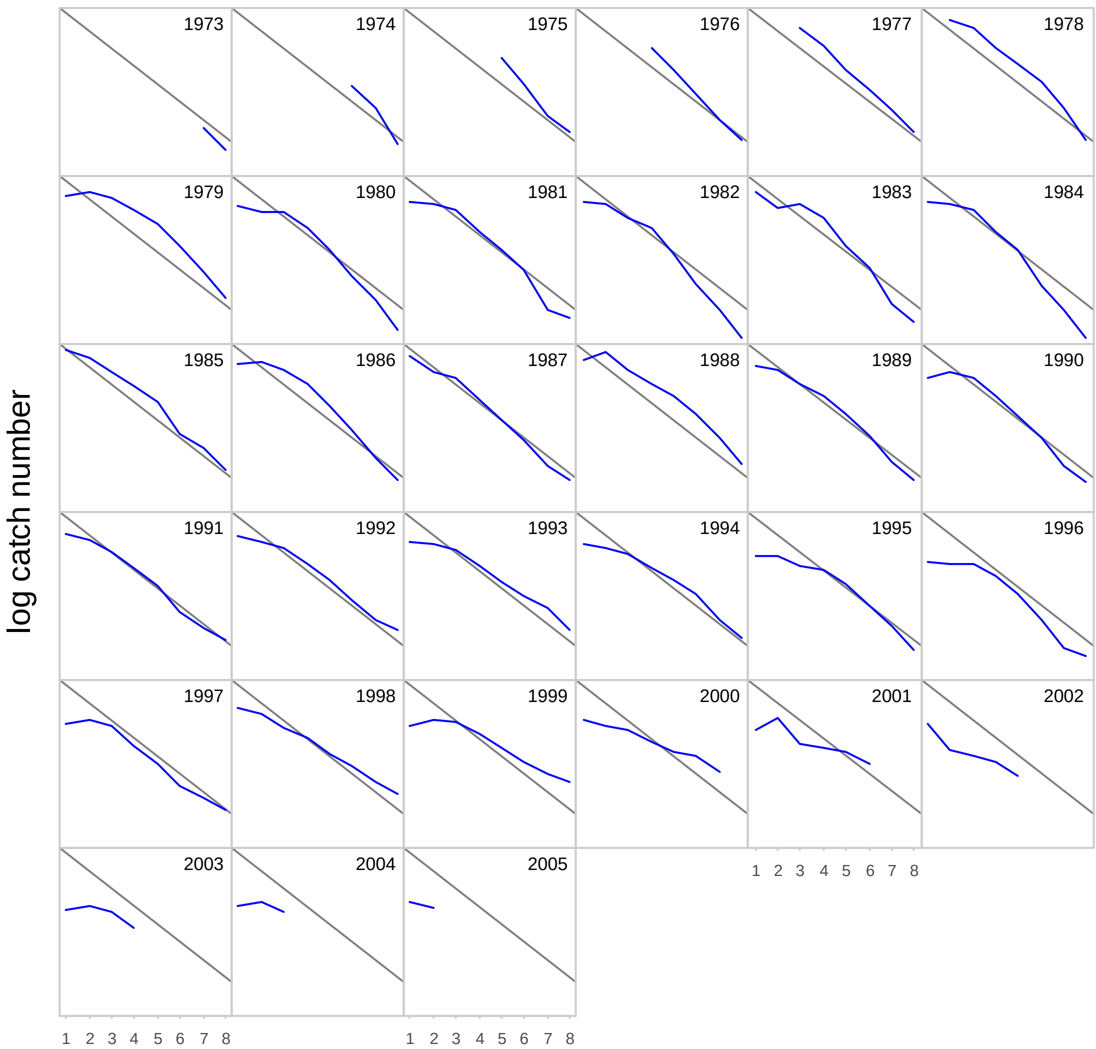


Figure 12.3.8 **Whiting in IV and VIId. Log catch-numbers linked by cohort for commercial catch data (ages 1 to 8+). The year specifies the yearclass. A reference a line with constant intercept and gradient equal to $Z_{pa} = F_{pa} + M(2-6)$ has been drawn in grey.**

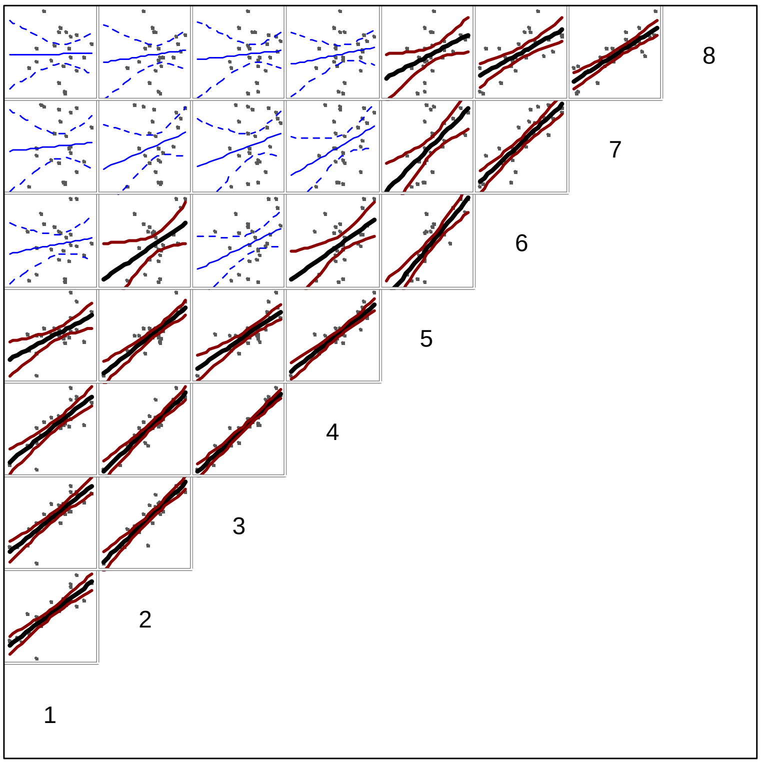


Figure 12.3.9 Whiting in IV and VIId. Correlations in the catch at age matrix (log numbers). Individual points are given by cohort, the line is a normal linear model fit. Thick lines represent a significant (p<0.05) regression.

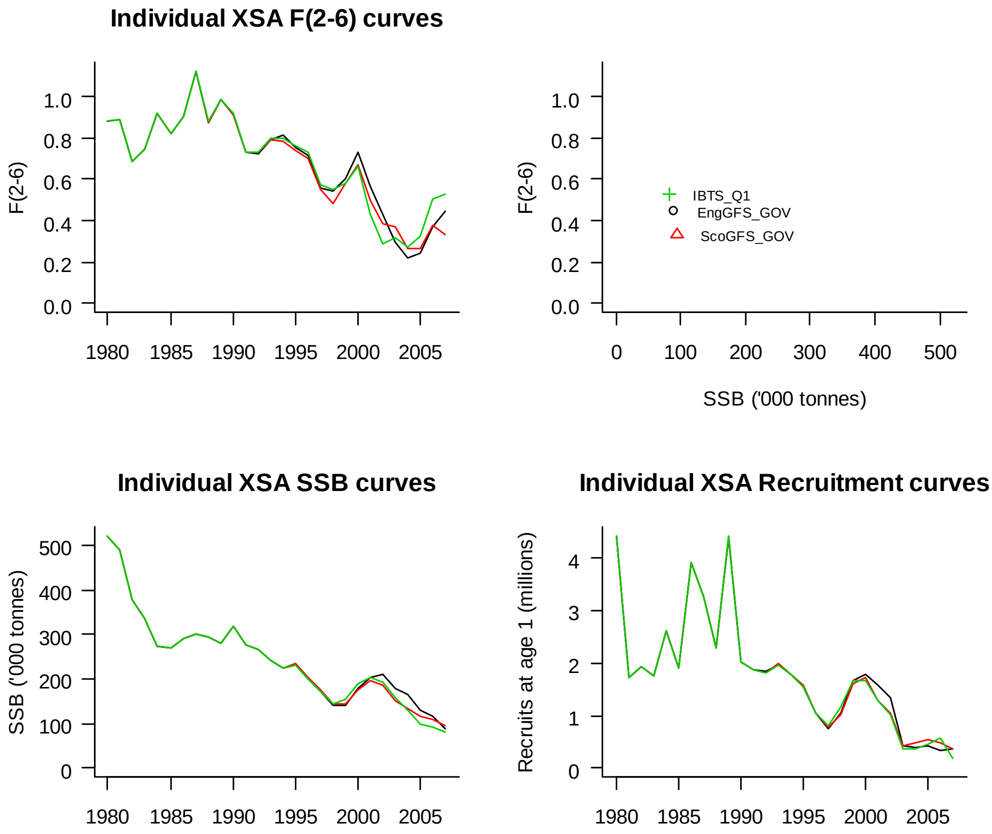


Figure 12.3.10 Whiting in IV and VIId. Comparison of F(2–6), SSB and recruitment time series for individual fleet XSA runs (with the same settings as last years final assessment).

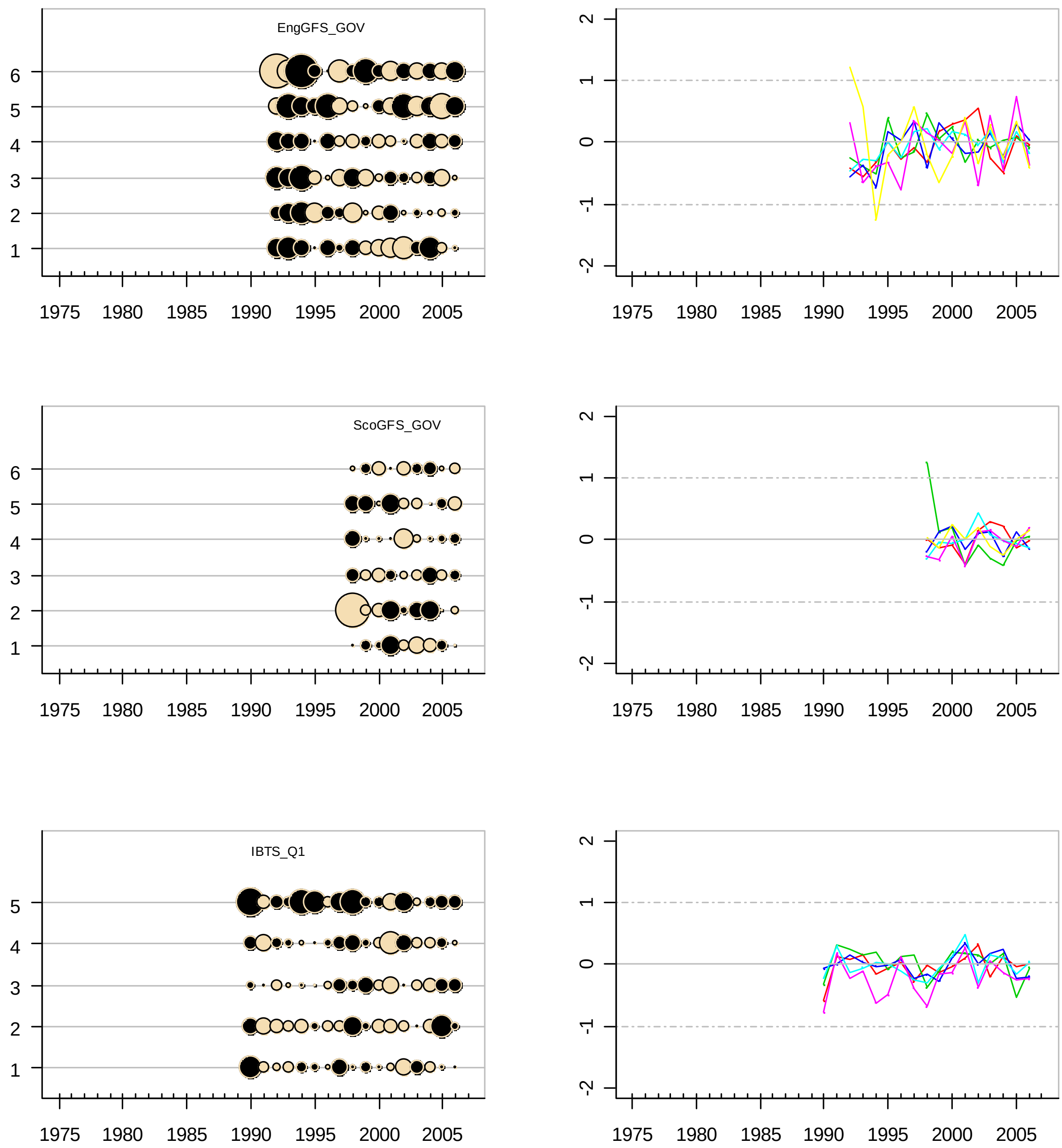


Figure 12.3.11 **Whiting in IV and VIId. Residuals from single fleet XSA runs.**

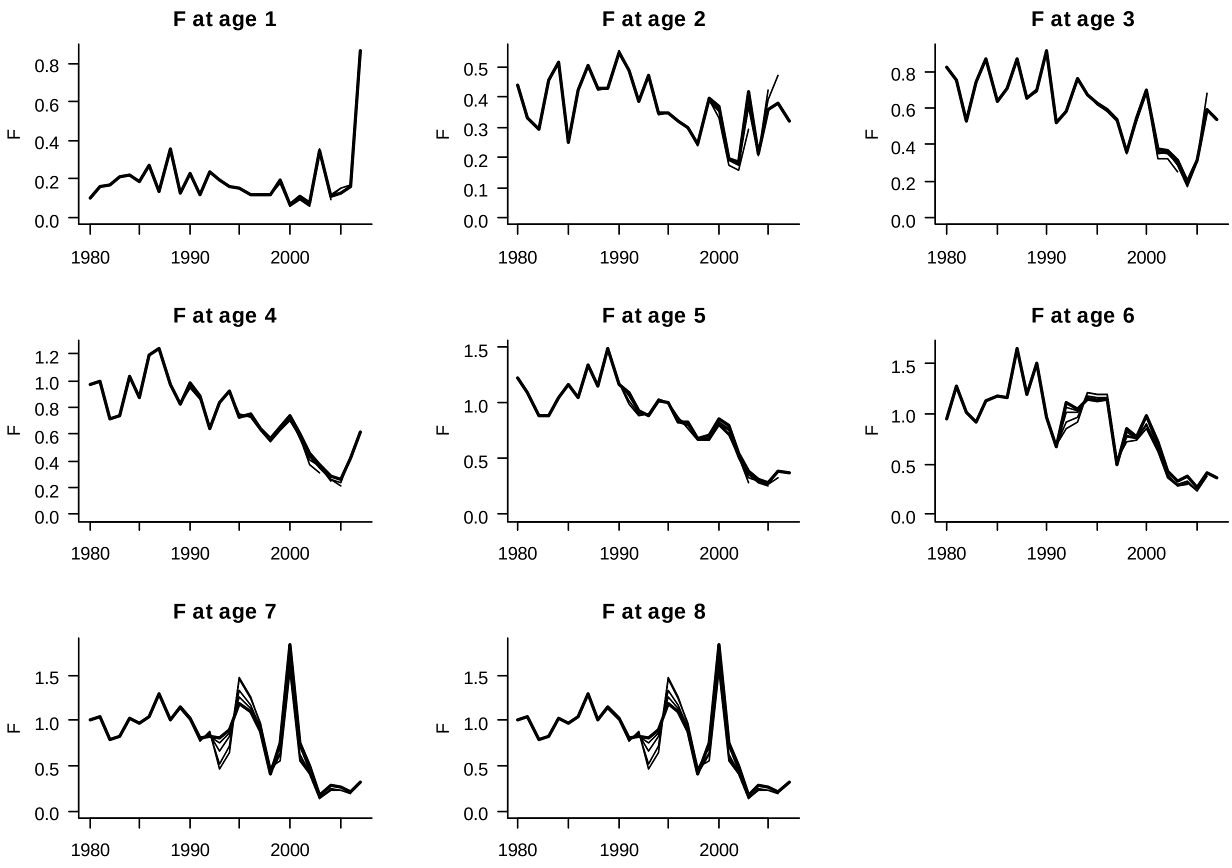


Figure 12.3.12 Whiting in IV and VIId. Summary of F at age from SPALY XSA retrospective run

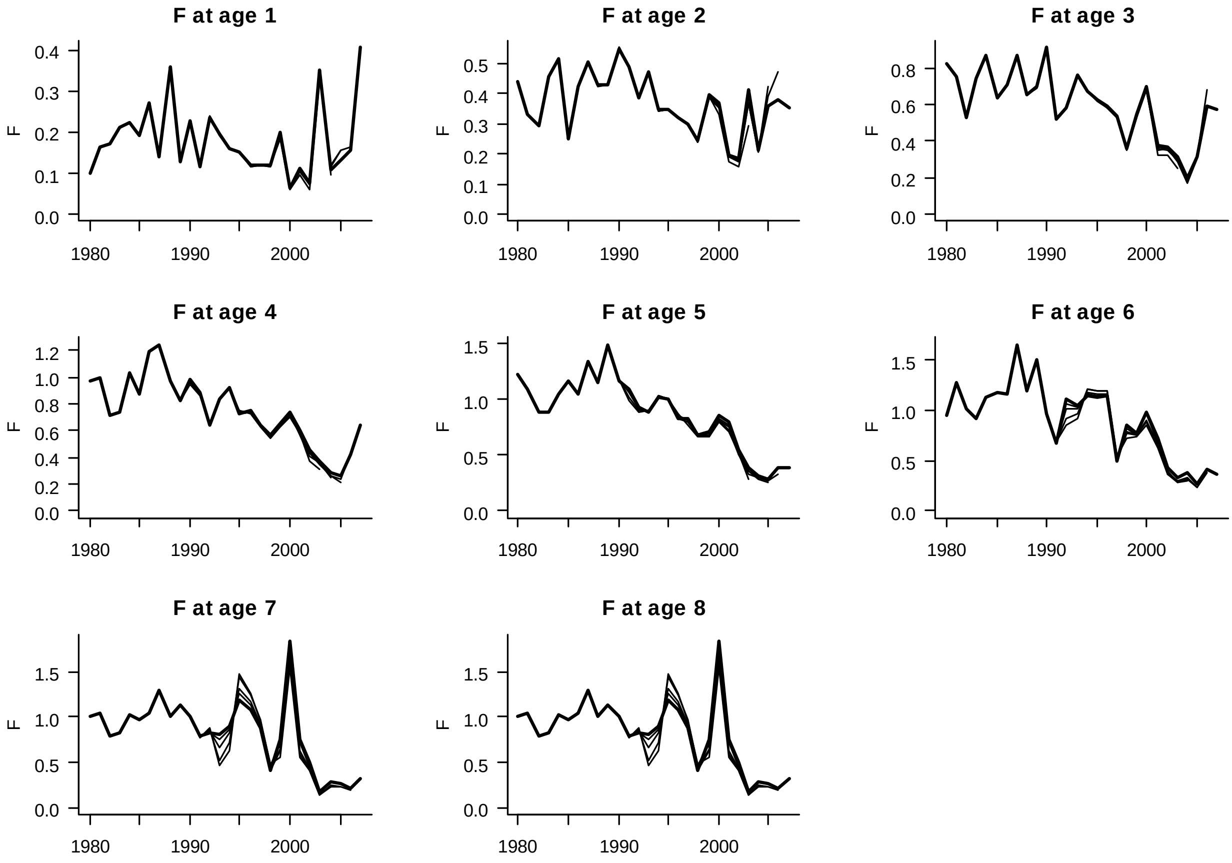


Figure 12.3.13 Whiting in IV and VIId. Summary of F at age from SPALY XSA retrospective run investigating the sensitivity of the assessment to imprecise industrial bycatch data

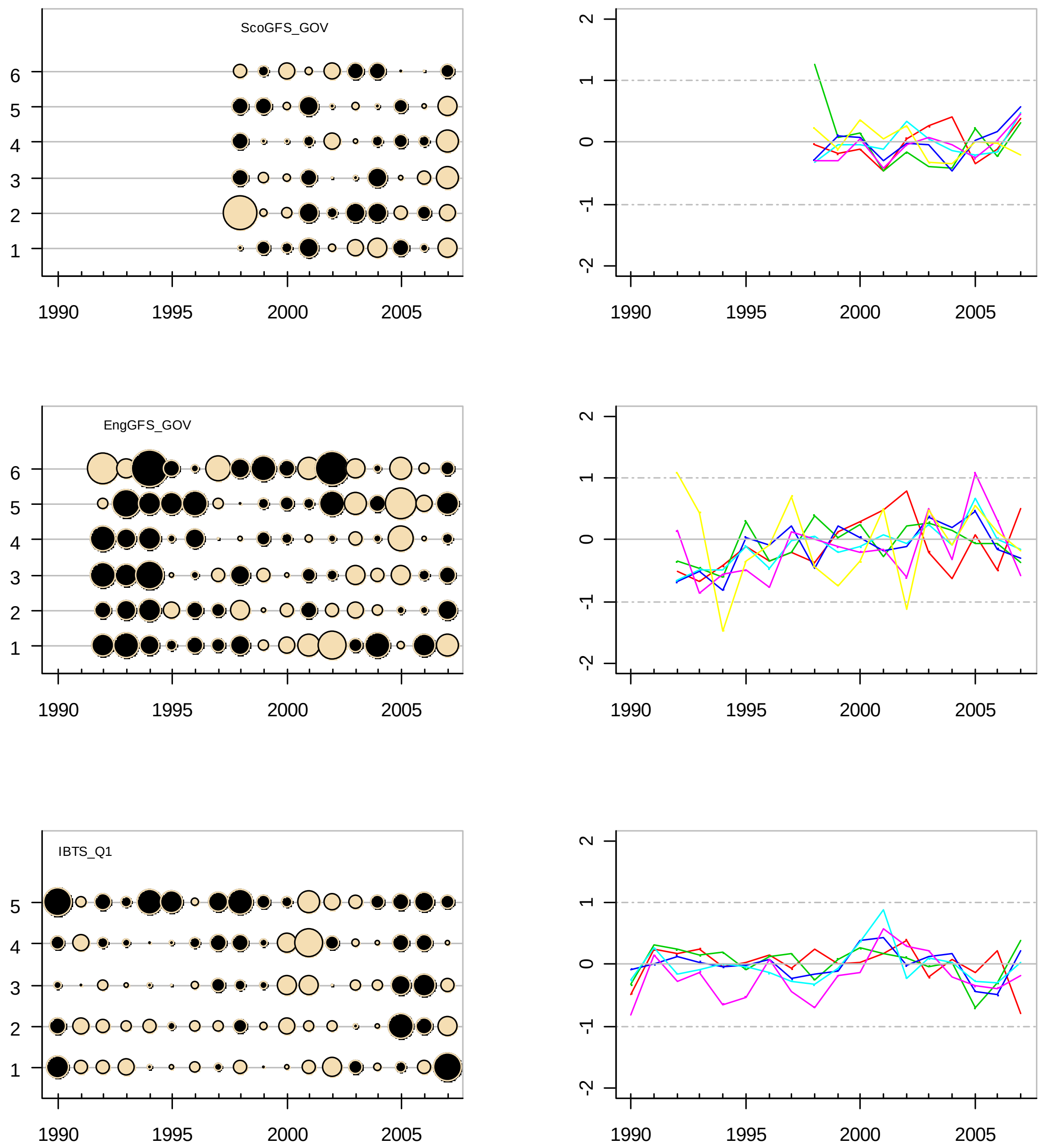


Figure 12.3.14 Whiting in IV and VIId. XSA final run: log catchability residuals.

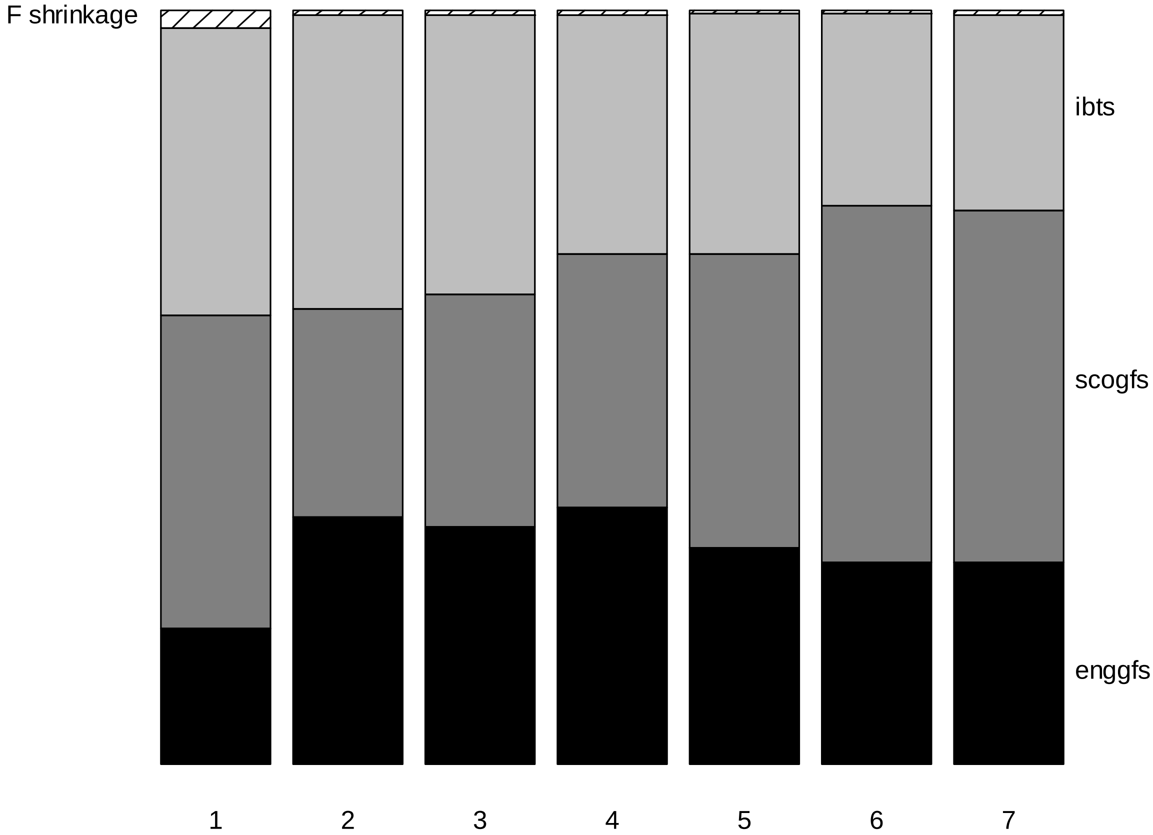


Figure 12.3.15 Whiting in IV and VIId. XSA final run: comparison of (a) fleet survivor ratios and (b) fleet weights. Note: only three fleets, ENGGFS (92–05), SCOGFS (98–05) and IBTS Q1, contribute to the survivor estimates in the final year.

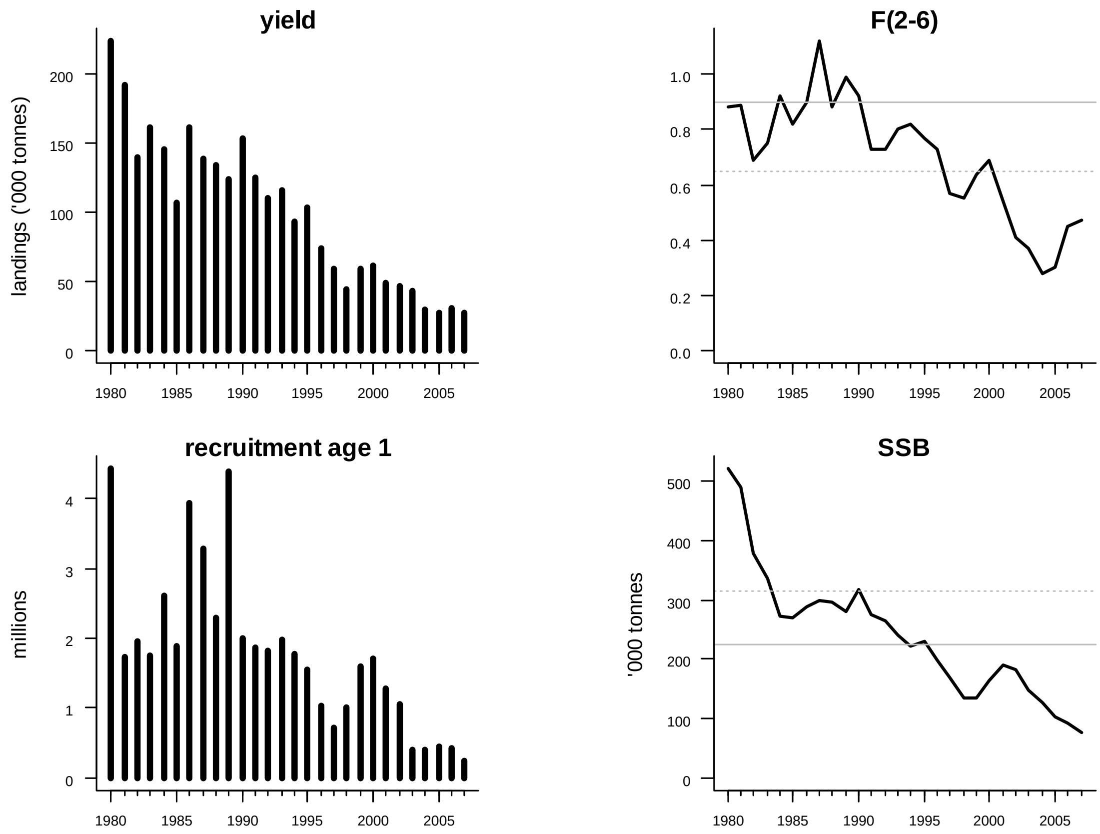


Figure 12.3.16 Whiting in IV and VIId. XSA final run: Summary plots. The dotted horizontal lines indicate Fpa, Flim, Bpa and Blim.

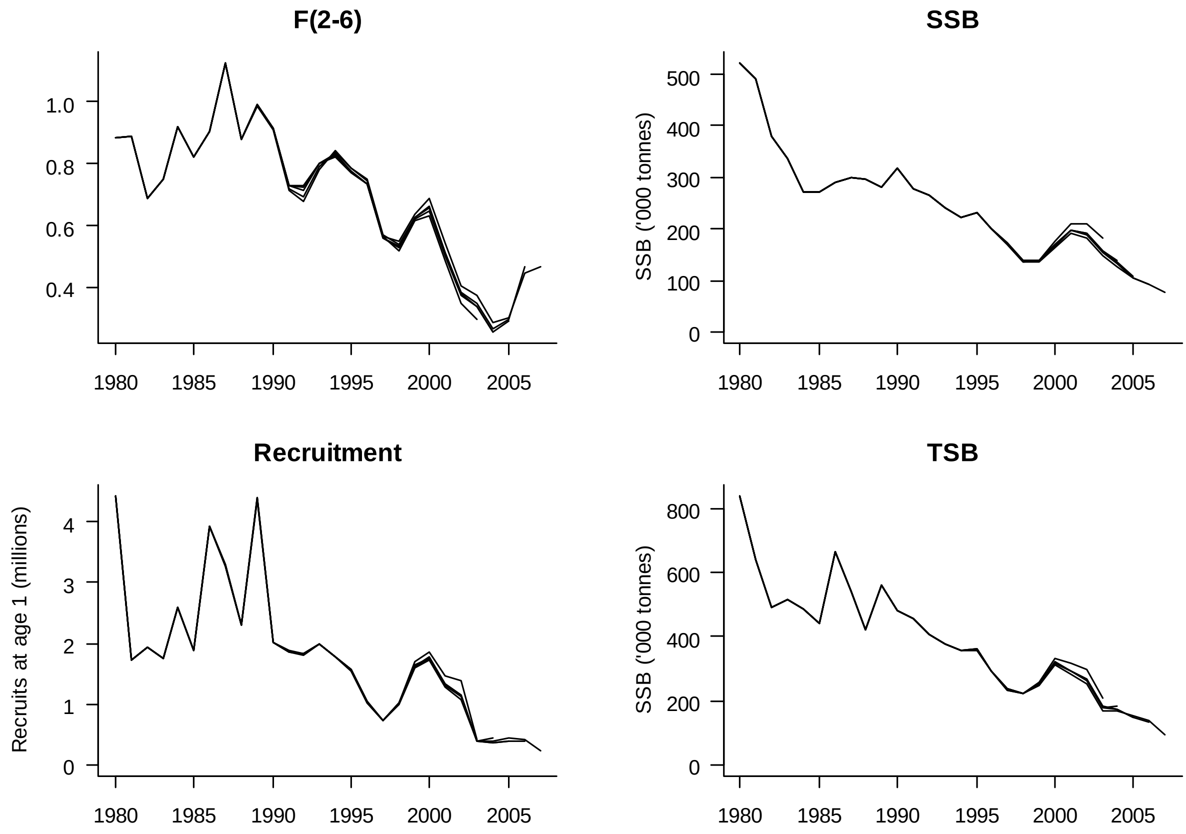


Figure 12.3.17 Whiting in IV and VIId. XSA spaly run: 5 year retrospective patterns.

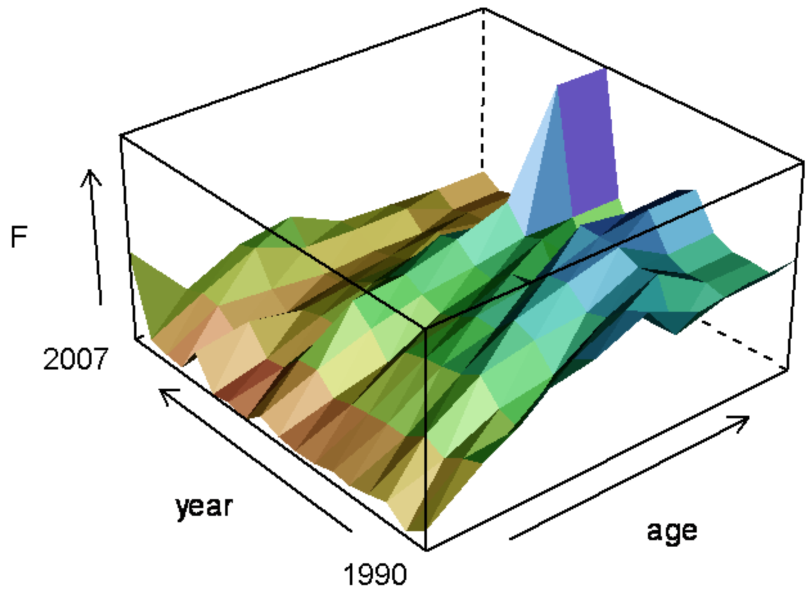


Figure 12.4.1 Whiting in IV and VIId. Changes in estimated exploitation pattern.

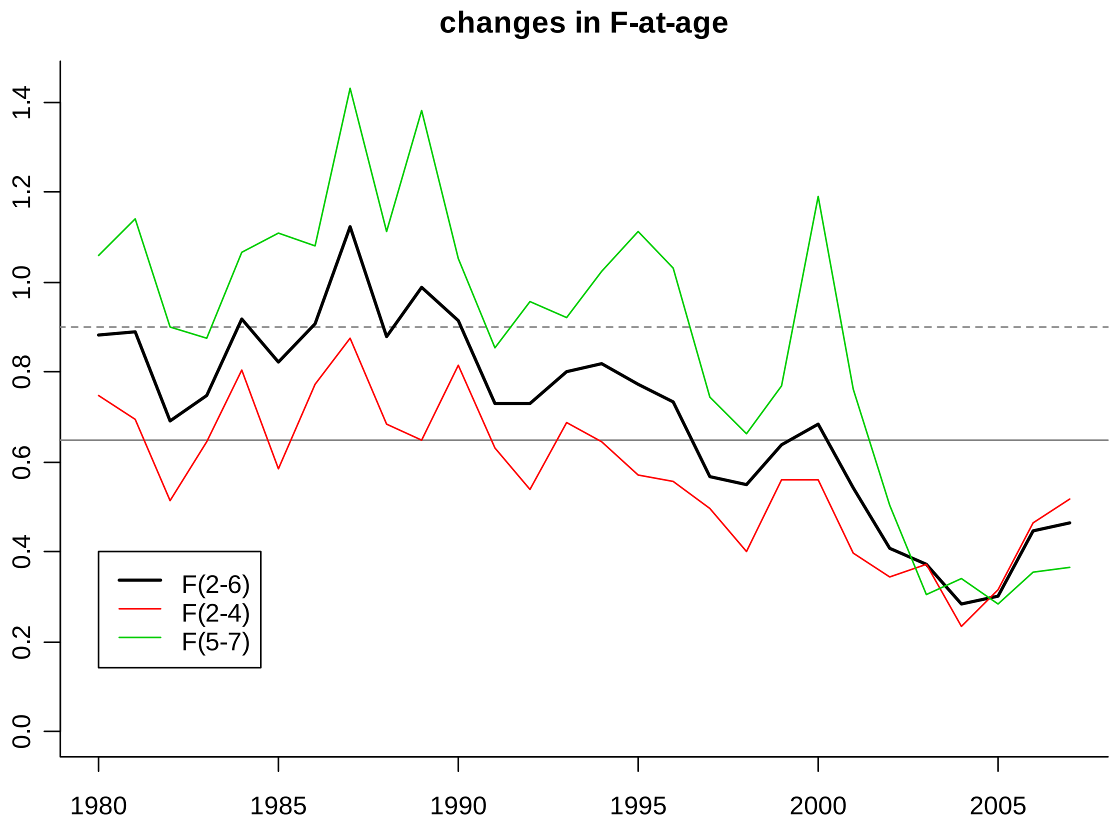


Figure 12.4.2 Whiting in IV and VIId Whiting in IV and VIId. Historical stock trends in F(2–6) (last years final runs shown as a dotted line), and changes in historic F-at-age in the recent period.

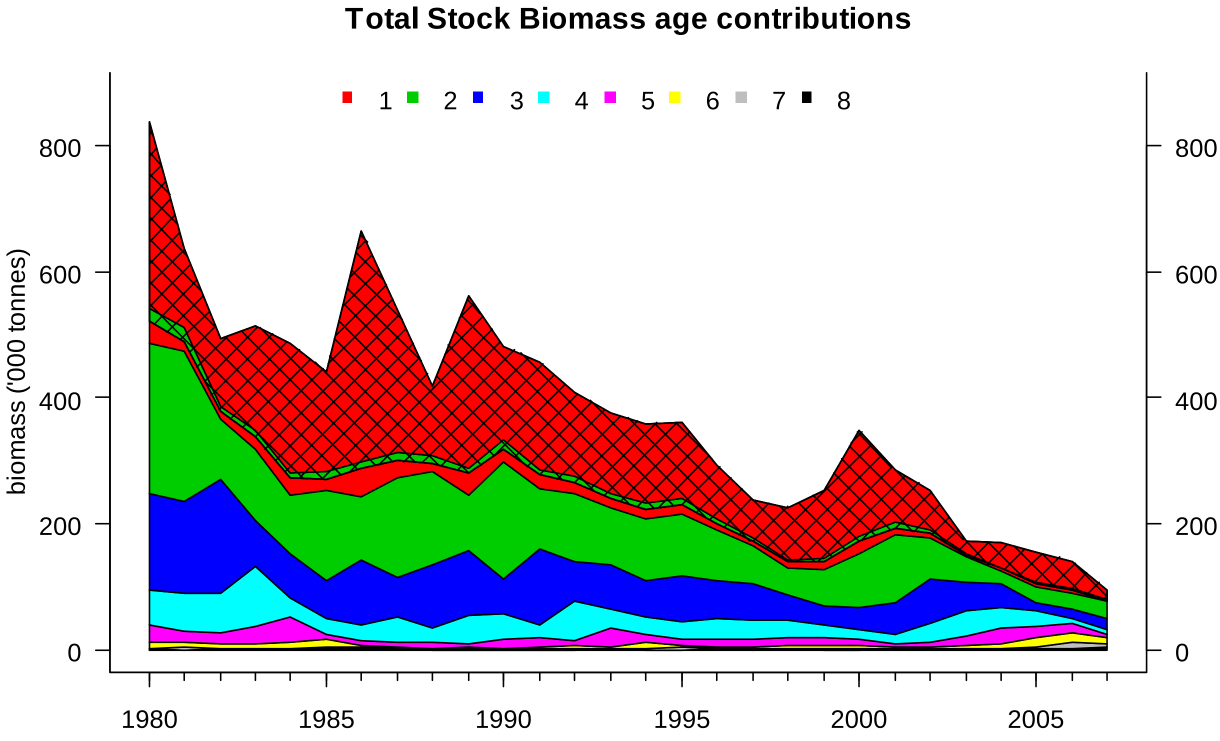


Figure 12.4.3 Whiting in IV and VIId. Age contributions to the SSB and TSB. Biomass not contributing to SSB is overlaid with hatched lines: immature age 1 lies over immature age 2, and the immature biomass lies over mature age 1, mature age 2 etc.

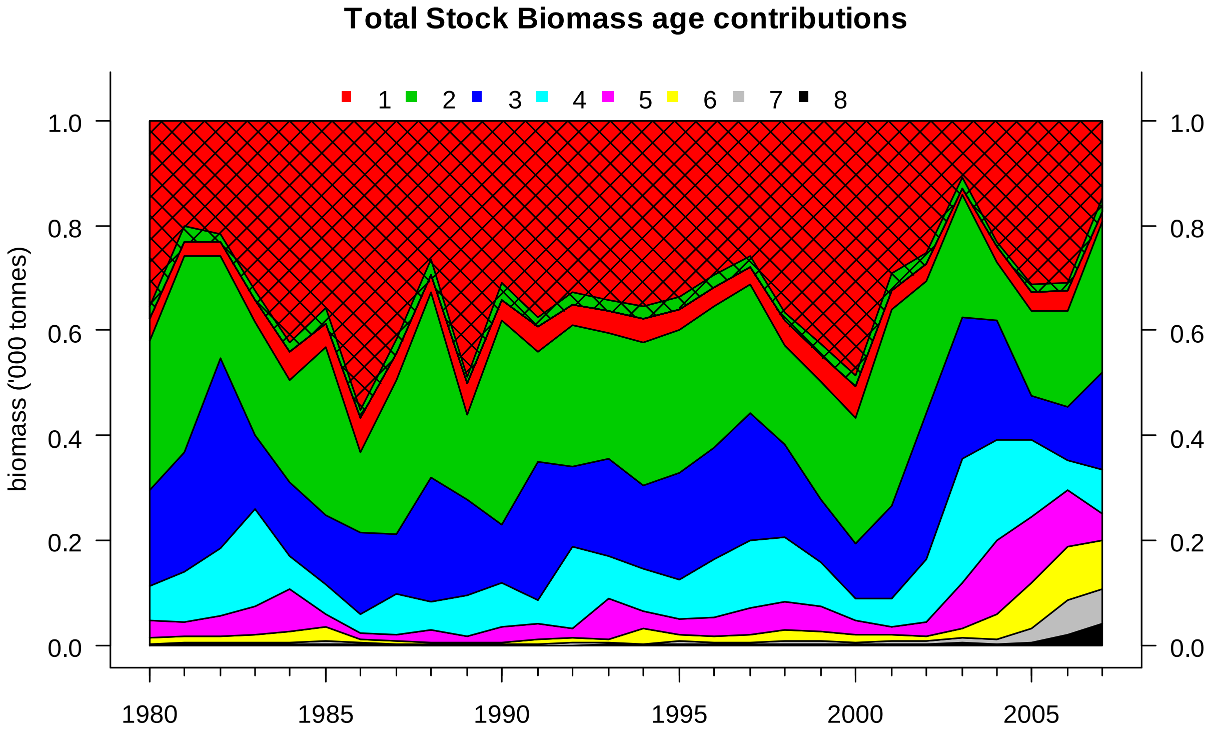


Figure 12.4.4 Whiting in IV and VIId. Age contributions to the SSB and TSB shown as proportions of the total stock biomass. Biomass not contributing to SSB is overlaid with hatched lines: immature age 1 lies over immature age 2, and the immature biomass lies over mature age 1, mature age 2 etc.

Figure 12.4.5 Whiting in IV and VIId. Historical stock trends in F.

Figure 12.4.6 Whiting in IV and VIId. Historical stock trends in SSB.

Figure 12.4.7 Whiting in IV and VIId. Historical stock trends in recruitment.

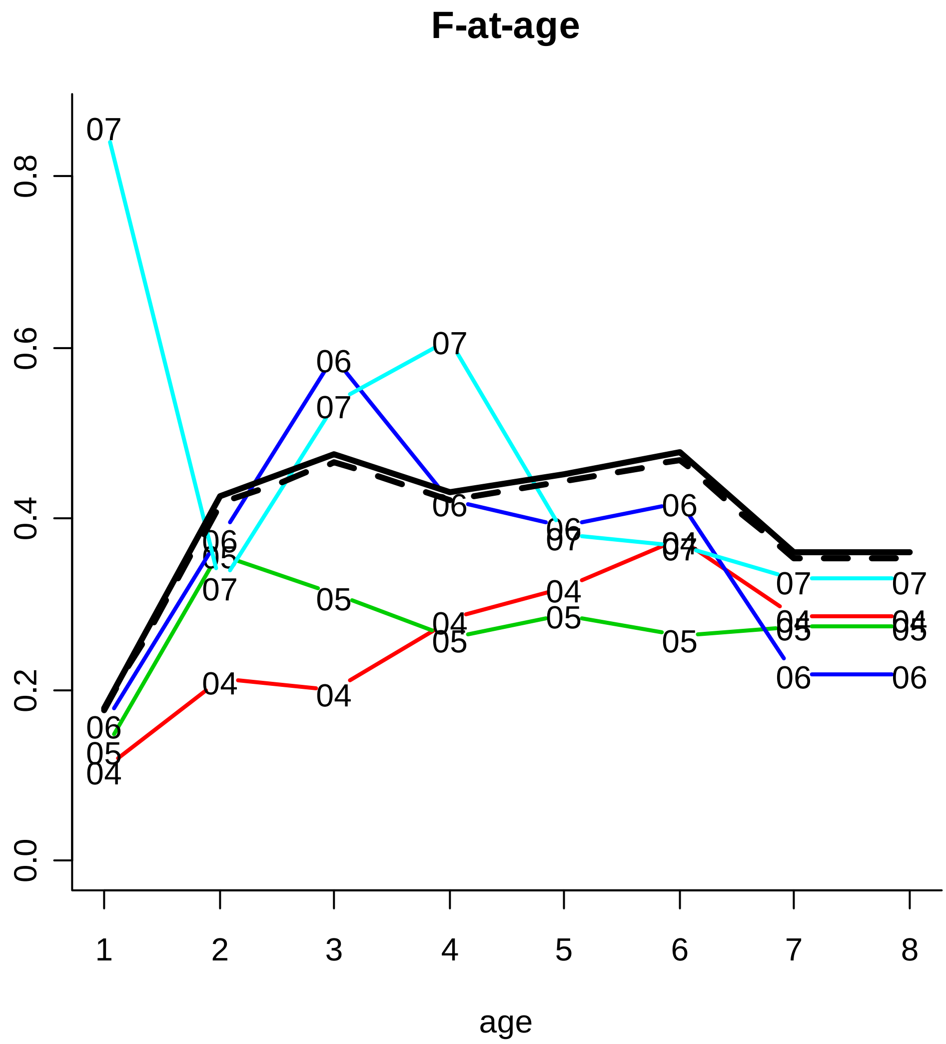


Figure 12.6.1 **Whiting in IV and VIId. Estimated fishing mortality at age for the years 2004 to 2007. The black line shows the average exploitation pattern over years 2004-2006 scaled to F(2–6) of the final year.**

NOT YET!

Figure 12.9.1 **Whiting in IV and VIId. Historical performance of the assessment.**

13 Haddock in Subarea IV and Division IIIa (N)

The assessment of haddock presented in this section is an update assessment. No changes have been made to the run settings and model configurations used in last year's assessment. Recommendations for issues to be considered at the forthcoming benchmark meetings are given in Section 13.9.

13.1 General

13.1.1 Ecosystem aspects

Haddock in Subarea IV and Division IIIa (N) occupy the northern and central North Sea and Skagerrak and are possibly linked to the Division VIa stock on the West of Scotland. Haddock are seldom found below 300 m, and prefer depths between 50 m and 200 m. They are found as juvenile fish in coastal areas in particular in the Moray Firth, around Orkney and Shetland, along the continental shelf at around 200 m and continuing round to the Skagerrak. Adult fish are predominantly found around Shetland and 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 may grow more slowly than less abundant year-classes, possibly due to density dependent effects. Haddock primarily prey on benthic and epibenthic invertebrates, sandeels and demersal herring egg deposits. They are an important prey species, mainly for saithe and other gadoids.

13.1.2 Fisheries

A general description of the fishery is presented in the Stock Annex (Quality Handbook). Most of the information presented in this section pertains to the Scottish fleet, which takes the largest proportion of the haddock stock. This fleet is not just confined to the North Sea, as vessels will often operate in Subarea VI off the west coast of Scotland.

The number of Scottish-based vessels (over 10 m) in the demersal sector was reduced by approximately one third (98 vessels) during 2002, the bulk of this being due to vessels accepting decommissioning. Although the decommissioning scheme encompassed all vessel types and sizes, the vessels eventually decommissioned included a significant number of older boats and those with track record of catching cod. Amongst the remaining vessels there has been a reduction in the segment operating seine net or pair seine. The observed shift towards pair trawling from single-vessel seine and trawls in the early 2000's may have implied an increase in catchability, but the decommissioning rounds in 2002 and 2003 included a slightly higher proportion of pair trawlers, resulting in no real overall change in fleet composition.

The number of Scottish based vessels (over 10 m) in the demersal sector was reduced by 67 in a further decommissioning round in 2004. More recently, increased fuel prices have resulted in a shift from twin trawl to single trawl and pair seine/trawl by many boats in the Scottish demersal mixed fishery sector (ICES-WGFTFB 2006). The observed shift towards pair trawling from single seine may be explained by a standardization of reporting and recording of gear types. Vessels previously participating in the seine net class may have included vessels operating pair seine whereas this classification is now recorded as pair trawl. Although there have not been major decommissioning schemes affecting haddock fisheries since 2005, a number of Scottish vessels have been taking up opportunities for oil support work during 2006-2008 with a view to saving quota and days at sea.

In 2005, there was an expansion in the squid fishery in the Moray Firth area resulting from increased effort from smaller (<10m) vessels, and from a number of larger vessels that had switched from demersal fisheries for haddock and cod, to squid fisheries, in order to avoid days-at-sea restrictions (ICES-WGFTFB 2006). The mesh regulation for squid fishing is 40 mm codend, which could lead to bycatch/discard of young haddock and cod. In 2006 and 2007, the squid fishery declined: vessels that shifted away from squid targeted *Nephrops* instead. However, the potential remains for high bycatches of young gadoids in the future, given the small mesh size used.

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 (particularly during 2006 and 2007 – there may be fewer boats changing focus in this way in 2008). Accompanying the change in emphasis towards the haddock fishery, there has also been a tendency to target smaller fish in response to market demand. Some trawlers operating in the east of the North Sea are using 130 mm mesh (to ensure they meet regulations), and this is likely to improve selectivity for haddock. Young fish from the moderate 2005 year-class are now appearing in catches, although there has been considerable discarding as many of these fish are below the minimum landings size.

During 2008, a number of Scottish vessels have switched focus to the Rockall area to take advantage of the increased quota there. The economic benefit of being able to land more haddock has outweighed the costs involved in steaming to Rockall in a climate of increased fuel prices. This fishery is very dependent on good weather, however, and is not a consistent feature. At the same time, several vessels have switched from whitefish fishing in Division VIa to *Nephrops* exploitation in Subarea IV using 80-mm gear (ICES-WGFTFB 2008). This may have implications for haddock bycatch in the *Nephrops* fishery, although (under the stipulations of the Scottish conservations credits scheme; see Section 13.1.4) all nets in the 80mm range will have to have a 110mm square mesh panel installed from July 2008. Compliance is close to 100% thus far. Trials suggest that this square-mesh panel will increase the 50% selection length (L_{50}) for haddock by around 30%, which implies increased escapement of young haddock from the *Nephrops* fishery.

In early 2008, a one-net rule was introduced in Scotland as part of the new conservation credits scheme (Section 13.1.4). This is likely to improve the accuracy of reporting of landings to the correct mesh size range. However, Scottish seiners have been granted a derogation from the one-net rule until the end of January 2009, and will be allowed to carry two nets (e.g. 100-119 mm as well as 120+ mm). They are required to record landings from each net on a separate logsheet and to carry observers when requested (ICES-WGFTFB 2008).

A number of Scottish vessels have moved from twin to single trawls, and there has also been an increase in the use of pair trawl/seine. Some high-powered whitefish vessels have switched to *Nephrops* and are targeting North Sea grounds with double bag trawls. This is very much driven by fuel costs, and may have implications for reduced LPUE and increases in discarding.

Haddock are still the mainstay of the Scottish whitefish fleet. Reports from Scottish producer organisations indicate that the quota uptake for 2007 was around 60% to 70%, in line with recent years. However, the projected quota uptake for 2008 is thought to be higher – for example, uptake in Shetland is already well up on the same time last year.

Considering the international fishery, preliminary analysis of fishing effort trends in the major fleets exploiting North Sea cod indicates that fishing effort in those fleets has been decreasing since the mid-1990s due to a combination of decommissioning and days-at-sea regulations (STECF-SGRST-05-01 & 04, 2005). The decrease in effort is most pronounced in the years 2002 and beyond.

Information presented to ICES noted that the UK large mesh, demersal trawl fleet category (>100 mm, 4A) has been reduced by decommissioning and days-at-sea regulations to 40% of the levels recorded in the EU reference year of 2001. There was a movement into the 70–90 mm sector to increase days at sea in 2002 and 2003, but the level of effort stabilised in 2004. The effort of the combined trawl gears has shown a continued decrease of 36% overall, from the EU reference year of 2001 (STECF-SGRST-05-01 & 04, 2005).

It is difficult to conclude what the likely effect of these fishery changes will be on haddock mortality. Changes in gear that are required to qualify for the conservation credits scheme are likely to reduce bycatch (and therefore) discards of haddock in the *Nephrops* fishery in particular. Scottish vessels are included in the conservation credit scheme unless they opt out of it, and as only one or two vessels have chosen to do so, compliance will be close to 100%. Cod avoidance under the real-time closures scheme could also move vessels away from haddock concentrations, but the extent of this depends on how closely cod and haddock distributions are linked. On the other hand, vessels catching fewer cod may increase their exploitation of haddock in order to maintain economic viability. At the time of writing, 13 real-time closures have been implemented.

13.1.3 ICES advice

In June 2007, ICES concluded the following:

> *Based on the most recent estimate of SSB and fishing mortality, ICES classifies the stock as having full reproductive capacity and being harvested sustainably. SSB in 2006 is estimated at 238 000 t. SSB is above the B_{pa}. The stock is still dominated by the strong 1999 year class and the 2005 year class is also estimated to be above average. Fishing mortality in 2006 is estimated at 0.49, which is below F_{pa}.*

The Q3 North Sea surveys for haddock (EngGFS and ScoGFS) did not change the perception of recruitment significantly compared to the estimates available in June. Therefore, ICES did not change its advice in October 2007.

13.1.4 Management

In 1999 the EU and Norway "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." This plan was implemented in January 2005, updated in December 2006, and implemented in revised form in January 2007. It consists of the following elements:

1) *Every effort shall be made to maintain a minimum level of Spawning Stock Biomass greater than 100,000 tonnes (Blim).*
2) *For 2007 and subsequent years the Parties agreed to restrict their fishing on the basis of a TAC consistent with a fishing mortality rate of no more than 0.3 for ap-*

propriate age-groups, when the SSB in the end of the year in which the TAC is applied is estimated above 140,000 tonnes (Bpa).

3) *Where the rule in paragraph 2 would lead to a TAC which deviates by more than 15% from the TAC of the preceding year the Parties shall establish a TAC that is no more than 15% greater or 15% less than the TAC of the preceding year.*

4) *Where the SSB referred to in paragraph 2 is estimated to be below Bpa but above Blim the TAC shall not exceed a level which will result in a fishing mortality rate equal to 0.3-0.2*(Bpa-SSB)/(Bpa-Blim). This consideration overrides paragraph 3.*

5) *Where the SSB referred to in paragraph 2 is estimated to be below Blim the TAC shall be set at a level corresponding to a total fishing mortality rate of no more than 0.1. This consideration overrides paragraph 3.*

6) *In order to reduce discarding and to increase the spawning stock biomass and the yield of haddock, the Parties agreed that the exploitation pattern shall, while recalling that other demersal species are harvested in these fisheries, be improved in the light of new scientific advice from inter alia ICES.*

7) *In the event that ICES advices that changes are required to the precautionary reference points Bpa (140 000 t) or Blim (100 000 t) the parties shall meet to review paragraphs 1-5.*

8) *No later than 31 December 2009, the parties shall review the arrangements in paragraphs 1 to 7 in order to ensure that they are consistent with the objective of the plan. This review shall be conducted after obtaining inter alia advice from ICES concerning the performance of the plan in relation to its objective.*

In October 2007, ICES evaluated this plan and concluded that it could "*provisionally be accepted as precautionary and be used as the basis for advice*." The methods used to reach this conclusion (along with illustrative results) are given in Needle (2008).

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

Annual management of the fishery operates through TACs for two discrete areas. The first is Subarea IV and Division IIIa (EC waters), which are considered jointly. The 2007 and 2008 TACs for haddock in this area were 54 640 t and 46 444 t respectively. At most 28 535 t of this 2008 TAC was to be taken in Norwegian waters of Subarea IV by EC vessels. The second area in Divisions IIIa-d, for which the TACs for 2007 and 2008 were 3 360 t and 2 856 t respectively.

EU technical regulations in force are contained in Council Regulation (EC) 850/98 and its amendments. This regulation prescribes the minimum target species composition for different mesh size ranges. In 2001, haddock in the whole of NEAFC region 2 were a legitimate target species for towed gears with a minimum codend mesh size of 100 mm. As part of the cod recovery measures, the EU and Norway introduced additional technical measures from 1 January 2002 (EC 2056/2001). The basic minimum mesh size for towed gears for cod from 2002 was 120 mm, although in a transitional arrangement running until 31 December 2002 vessels were allowed to exploit cod with 110-mm codends provided that the trawl was fitted with a 90-mm square mesh panel and the catch composition of cod retained on board was not greater than 30% by weight of the total catch. From 1 January 2003, the basic minimum mesh size for towed gears for cod was 120 mm. The minimum mesh size for vessels targeting haddock in Norwegian waters is also 120 mm.

At the December Council 2006 (EC 41/2006), additional derogations were introduced to allow additional days fishing in the smaller mesh (90 mm) trawl fishery where vessels fitted a square mesh window close to the cod end to allow for improved selectivity of these gears (and hence the possibility of lower haddock discards). The change in mesh size might be expected to shift exploitation patterns to older ages and increase the weight-at-age for retained fish from younger age classes. Improvements in the exploitation pattern have not been observed. It was not possible to determine if this is due to confounding effects from other fleet segments.

Effort restrictions in the EC were introduced in 2003 (EC 2341/2002, Annex XVII, amended in EC 671/2003). Effort restriction measures were revised for 2005 (EC 27/2005, Annex IV). Effort regulations for 2008 in days at sea per vessel and gear category are summarised in the following table, which only shows changes in 2008 compared to 2007 (2006 is included for comparison). The changes (2007-2008) are intended to lead to a cut in effort of 10% for the main gears catching cod.

Maximum number of days a vessel can be present in the North Sea, Skagerrak and Eastern Channel, by gear category and special condition (see EC 40/2008 for more details). The table only shows changes in 2008 compared to 2007, but 2006 is also included for comparison.

Description of gear and special condition (if applicable)	Area			Max days at sea		
	IV,II	Skag	VIId	2006	2007	2008
Trawls or Danish seines with mesh size ≥ 120mm	x	x	x	103	96	86
Trawls or Danish seines with mesh size ≥ 100mm and < 120mm	x	x	x	103	95	86
Trawls or Danish seines with mesh size ≥ 90mm and < 100mm	x		x	227	209	188
Trawls or Danish seines with mesh size ≥ 90mm and < 100mm		x		103	95	86
Trawls or Danish seines with mesh size ≥ 70mm and < 90mm	x			227	204	184
Trawls or Danish seines with mesh size ≥ 70mm and < 90mm			x	227	221	199
Beam trawls with mesh size ≥ 120mm	x	x		143	143	129
Beam trawls with mesh size ≥ 100mm and < 120mm	x	x		143	143	129
Beam trawls with mesh size ≥ 80mm and < 90mm	x	x		143	132	119
Gillnets and entangling nets with mesh sizes ≥ 150mm and < 220mm	x	x	x	140	130	117
Gillnets and entangling nets with mesh sizes ≥ 110mm and < 150mm	x	x	x	140	140	126
Trammel nets with mesh size < 110mm. The vessel shall be absent from port no more than 24h.	x		x	205	205	185*

*** For member states whose quotas less than 5% of the Community share of the TACs of both plaice and sole, the number of days at sea shall be 205**

Under the provisions laid down in point 8.5 of Annex IIa to the 2008 year's EU TAC and Quota Regulation, Scotland has implemented a national KWdays scheme known as the **Conservation Credits Scheme**. The principle of this two-part scheme involves credits (in terms of additional time at sea) in return for the adoption of and adherence to measures which reduce mortality on cod and lead to a reduction in discard numbers. The initial scheme was implemented from the beginning of February 2008 and grants vessels their 2007 allocation of days (operated as hours at sea) in return for observance of Real Time Closures (RTC) and a one-net rule, adoption of more selective gears (110mm square meshed panels in 80mm gears or 90mm SMP in 95mm gear), agreeing to participate in additional gear trials and participation in an enhanced observer scheme.

For the first part of 2008 the RTC system was designed to protect aggregations of larger, spawning cod (>50cm length). Trigger levels leading to closures were informed by commercial catch rates of cod observed by FRS on board vessels. Ten closures occurred to the beginning of May, since when there have been three further closures near Shetland. Protection agency monitoring suggests good observance. The scheme is now being extended for the remainder of the year to protect aggregations of all sizes of cod. A joint industry/ science partnership (SISP) has a number of gear trials programmed for 2008 examining methods to improve selectivity and reduce discards and an enhanced observer scheme has been announced by the Scottish Government.

Observance of the above conditions also gives eligibility for vessels to participate in the second, enhanced, part of the Conservation Credits scheme. This is currently under development.

13.2 Data available

13.2.1 Catch

Official landings data for each country participating in the fishery are presented in Table 13.2.1.1, together with the corresponding WG estimates and Total Allowable Catch (TAC). The full time series of landings, discards and industrial by-catch (IBC) is presented in Table 13.2.1.2. A description of how the catch data are collated is provided in the Stock Annex. These data are illustrated further in Figure 13.2.1.1. Estimates suggest that discarding increased during 2007 with the appearance in the fishery of the moderate 2005 year-class, and that the weight of haddock landed and discarded in that year was roughly equal. Subarea IV discard estimates are derived from data submitted by several countries, although as Scotland is the principal fishery in that area, Scottish discard practices dominate the overall estimates. Discard estimates from 2006 were provided for Division IIIa from Sweden, Denmark, Norway, Belgium and Germany. Industrial bycatch (IBC) has declined considerably from the high levels observed until the late 1990s.

13.2.2 Age compositions

Total catch-at-age data are given in Table 13.2.2.1, while catch-at-age data for each catch component are given in Tables 13.2.2–4. The recent fishery (landings for human consumption) is strongly reliant on the 1999 year class, although the moderate 2005 year-class was starting to be more prevalent during 2007. Discards generally consist of smaller fish, although discard estimates are also heavily influenced by the 1999 and 2005 year classes.

13.2.3 Weight at age

Weight-at-age for the total catch in the North Sea is given in Table 13.2.3.1. Weight-at-age in the total catch is a number-weighted average of weight-at-age in the human consumption landings, discards and industrial bycatch. Weight-at-age in the stock is taken to be the same as weight-at-age in the total catch. The mean weights-at-age for the separate catch components are given in Tables 13.2.3.2-4 and are illustrated in

Figure 13.2.3.1: this shows the declining trend in weights at age, as well as evidence for reduced growth rates for large year classes.

13.2.4 Maturity and natural mortality

Maturity and natural mortality are assumed fixed over time and are given below. The basis for these estimates is described in the Stock Annex.

Age	0	1	2	3	4	5	6	7+
Natural mortality	2.05	1.65	0.40	0.25	0.25	0.20	0.20	0.20
Proportion mature	0.00	0.01	0.32	0.71	0.87	0.95	1.00	1.00

13.2.5 Catch, effort and research vessel data

Survey distribution and annual density at age for recent years is given in Figure 13.2.5.1 for the IBTS Q1 survey and Figure 13.2.5.2 for the IBTS Q3 survey (which incorporates the Scottish and English groundfish surveys). Figure 13.2.5.3 gives the equivalent survey distribution for the ScoGFS Q3 survey alone. All plots show a north to north westerly distribution of haddock. The strong year classes of 1999 and (to a lesser extent) 2005 can also be identified and tracked through time.

Data available for calibration of the assessment are presented in Table 13.2.5.1, including commercial data from Scottish fleets which are not used in the assessment (see blow). The IBTS Q1 data are shown as collated, except for the plus-group (ages 6 and older) which are not included as they cannot be used in standard XSA tuning. IBTS Q1 data for age 6+ were also only provided for 1997 onwards. In addition, XSA cannot use data from the current year (2008). For this reason, the IBTS Q1 data are backshifted before being used in XSA – that is, all ages are reduced by one, and the survey is considered to have taken place at the very end of the previous year.

Trends in survey indices are shown in Figure 13.2.5.4. These indicate reasonably good consistency in stock signals from different surveys. Commercial data on landings per unit effort (LPUE) from two Scottish fleets are summarised in Figure 13.2.5.5, from which the influence of the strong 1999 year class is again apparent. Figure 13.2.5.6 shows recorded effort for these fleets. However, it must be remembered that effort recording is not mandatory in the EU, and these data must be viewed with caution (see also ICES-WGNSSK, 2000).

The data available are summarised in the following table: data used in the final assessment are highlighted in bold.

Country	Fleet	Quarter	Code	Year range	Age range available	Age range used
Scotland	Seine	All	ScoSei	1978-2007	1-13+	-
	Light trawl	All	ScoLTR	1978-2007	1-13+	-
	Groundfish survey	Q3	**ScoGFS_ABDN**	**1982-1997**	0-8	**0-7**
	Groundfish survey	Q3	**ScoGFS_GOV**	**1998-2007**	0-8	**0-7**
England	Groundfish survey	Q3	**EngGFS_GRT**	**1977-1991**	0-10+	**0-7**
	Groundfish survey	Q3	**EngGFS_GOV**	**1992-2007**	0-10+	**0-7**
International	Groundfish survey	Q1	IBTS	1983-2008	1-6+	1-5
	Groundfish survey	Q1	**IBTS (backshifted)**	**1982-2007**	0-5+	**0-4**

13.3 Data analyses

The intention for this year was to perform an update assessment; that is, to carry out the same procedure as last year. This has been done using FLXSA (the FLR implementation of XSA) as the main assessment method. Separable VPA results are presented along with catch curves and intra-series correlations to check for data consistency and validity. The results of a SURBA analysis are also shown: firstly to corroborate the update assessment, and secondly to support conclusions on the likely effects on biomass of the growth of the moderate 2005 year-class.

13.3.1 Reviews of last year's assessment

At its meeting in May 2007, RGNSSK raised the following issues:

- *The issue of the 1999 cohort in the plus group needs to be reconciled, perhaps by tuning the plus-group. Another problem is weight at age of the 1999 year class. The weight at age is important for accurate assessments and forecasts.*
- *The RG recommends that maturity at age be re-estimated, perhaps separately for each year-class. This may be important for the 1999 year-classes, which has exhibited slower growth. The RG noted a problem with the average F with respect to the 1999 year-class. The average F should represent the fishery on that year-classes, but on the other hand, changing the ages included in the average will affect the reference points and the harvest control rules.*

These are important points that need to be addressed during the forthcoming benchmark process. However, they are not considered further here.

13.3.2 Exploratory catch-at-age-based analyses

The catch-at-age data, in the form of log-catch curves linked by cohort (Figure 13.3.2.1), indicates partial recruitment to the fishery up to age 2. Gradients between consecutive values within a cohort from ages 2 to 7 have reduced for recent cohorts, reflecting a reduction in fishing mortality. Figure 13.3.2.2 plots the negative gradient fitted to each cohort over the age range 2–4, which can be viewed as a rough proxy for average total mortality for ages 2–4 in the cohort. These negative gradients are also lower in recent years.

Cohort correlations in the catch-at-age matrix (plotted as log-numbers) are shown in Figure 13.3.2.3. These correlations show good consistency within cohorts up to age 8–9, verifying the ability of the catch-at-age data to track relative cohort strengths (although data for ages 0 and 1 are more variable).

Residuals from a separable VPA carried out on the catch data (Figure 13.3.2.4) show very few outliers, and none greater than ±3. This supports the conclusion that catch data are reasonably consistent.

Single-fleet XSAs for the final assessment were produced to investigate the sensitivity of XSA to the effects of tuning by individual fleets,. Results are shown in Figure 13.3.2.5 for the latter halves of the EngGFS Q3 and ScoGFS Q3 series, as well as for the IBTS Q1 series, with corresponding log-catchability residual plots shown in Figure 13.3.2.. Overall trends are similar for the three tuning fleets, but absolute levels differ towards the end of the time series with the IBTS Q1 series producing higher estimates of SSB and recruitment.

13.3.3 Exploratory survey-based analyses

A SURBA run was carried out using the same combination of tuning indices as in the update XSA assessments, with the only difference that the IBTS Q1 survey was not backshifted. The summary plot from this run is given is Figure 13.3.3.1. The stock trends are in broad agreement with those from the XSA assessment. The main exceptions are total mortality, which is estimated to have risen much more quickly during 2003-2006 before falling in 2007; and SSB which appears to have increased slightly in 2007 with the continued growth of the moderate 2005 year-class. The SURBA estimates of recruitment confirm that year-classes since 2005 have been poor. The IBTS Q1 indices from 2008 are available, but cannot be used directly to indicate recruitment for the 2008 year-class as the survey takes place too early for these juveniles to be caught.

Log catch curves for the survey indices are given in Figure 13.3.3.2. Overall, these show good tracking of cohort strength, although there is a tendency for reduced catchability on younger ages (shown by the “hooks” at the start of many of the curves). Cohort correlations in the index-at-age matrices (plotted as log-numbers) are shown in Figure 13.3.3.3. These correlations show good consistency for nearly all of the cohorts and ages used in the final assessment (with a few minor exceptions).

13.3.4 Conclusions drawn from exploratory analyses

Exploratory analyses using survey and catch data do not indicate any serious problems with these data for North Sea haddock. Two main issues remain with the XSA assessments which have not been addressed in the assessment:

- The update assessment sets the maximum iterations for the FLXSA algorithm to a high value (200), so that the iteration process continues until the algorithm has converged. However, doing this also increases the final-year SSB considerably. FLXSA (and XSA) has no goodness-of-fit criteria, and it is not clear what the correct approach should be in this situation. In this year's assessment the previous method has been retained, but the WG has concerns about its validity which need to be addressed in any subsequent benchmark.

- Last year's WG raised the plus-group to 8+, to allow direct estimation of the mortality and abundance of the 1999 year-class (aged 7 in 2006, the final year of the assessment). Strictly speaking, the plus-group could be raised again this year (the 1999 year class was aged 8 in 2007). However, this has not been done. Both tuning data and catch data become very sparse at ages 8 and above for most years, and it is likely that the accuracy of the overall assessment would become compromised if too old a plus-group were used. The problem remains, however, and needs to be considered in future work on haddock and any other stock with sporadic recruitment.

13.3.5 Final assessment

The final XSA assessment uses the following settings, which are the same as those used last year (except for the addition of another year of data):

Assessment year		2004	2005	2006	2007	2008
q plateau		2	3	3	6	6
Tuning fleet year ranges	EngGFS Q3	92-03	77-91; 92-04	77-91; 92-05	77-91; 92-06	77-91; 92-07
	ScoGFS Q3	82-03	82-97; 98-04	82-97; 98-05	82-97; 98-06	82-97; 98-07
	IBTS Q1*	82-03	82-04	82-05	82-06	82-07
Tuning fleet age ranges	EngGFS Q3	0-5	0-5	0-5	0-7	0-7
	ScoGFS Q3	0-5	0-5	0-5	0-7	0-7
	IBTS Q1*	0-4	0-4	0-4	0-4	0-4

*Backshifted

The final XSA assessment tuning diagnostics are presented in Table 13.3.5.1, with log-catchability residuals given in Figure 13.3.5.1, and a comparison of fleet-based contributions to survivors in Figure 13.3.5.2. Fishing mortality estimates for the final XSA assessment are presented in Table 13.3.5.2, the stock numbers in Table 13.3.5.3, and the assessment summary in Table 13.3.5.4 and Figure 13.3.5.3. A retrospective analysis, shown in Figure 13.3.5.4, indicates little retrospective bias in the assessment.

13.4 Historical Stock Trends

The historical stock and fishery trends are presented in Figure 13.3.5.3.

Landings yield has stabilised since 2000, partly due (in the most recent years) to the limitation of inter-annual TAC variation to ±15% in the EU-Norway management plan. Discards have fluctuated considerably in the same period due to the appearance of the 1999 and 2005 year-classes, while industrial bycatch (IBC) is now at a very low level for haddock (Figure 13.2.1.1).

After increasing during 2005 and 2006, the estimated fishing mortality for 2007 has fallen again (although it is still above the management plan target of 0.3). This is due in part to a lower exploitation rate on the 2005 year-class, which is considered further below. The 2006 and 2007 year classes have been weak, and the fishery is likely to be sustained (over the short term at least) by the 2005 year class. The final XSA assessment indicates SSB continuing to decline: there are less fish left of the 1999 year-class, and the 2005 year-class has yet to make a significant impact on spawning biomass.

13.5 Recruitment estimates

The change in the timing of the WG (from September to May) has meant that the ScoGFS and EngGFS Q3 survey indices are not yet available. The IBTS Q1 indices are available, but do not include age-0 recruiting fish as they are too small (or not yet hatched) when the survey takes place. Therefore, there are no indications of incoming year-class strength available to the WG. For this reason, recruitment estimates of the 2008 year-class are based on a mean of previous recruitment.

In the past, a strong year-class has generally been followed by a sequence of low recruitments (Figure 13.5.1.1). In order to take this feature into account, the geometric mean of the five lowest recruitment values over the period 1994–2005 (4371 million) has been assumed for recruitment in 2008-2010. Recruitment estimates for 2006 and 2007 are not included in this calculation, because the most recent two XSA estimates of recruitment are thought to be relatively uncertain. The following table summarises the recruitment, age 1 and age 2 assumptions for the short term forecast.

Year class	Age in 2008	XSA estimate (millions)	Geometric mean of 5 lowest recruitments 1994–2005
2006	2	149	
2007	1	573	
2008	0		4371
2009	Age 0 in 2009		4371
2010	Age 0 in 2010		4371

13.6 Short-term forecasts

Weights-at-age

The observed slow growth of the 1999 and 2000 year-classes continues to pose a problem for the short-term forecast. Mean stock weights for the 1999 and 2000 year classes were calculated using proportional increments. That is: growth from age a to a+1 for these year-classes was estimated using the mean proportional increment (a+1)/a calculated over all other year classes for which this information is available. This method was approved by RGNSSK in 2006 as being appropriate to project weights at age, although alternatives have been explored in recent months and the issue needs to be considered at the forthcoming benchmark. Mean stock weights for other ages in the forecast where taken as a 5-year average (2003–2007), omitting the 1999 and 2000 year classes from the calculation where appropriate. The outcome is summarized in Figure 13.6.1.1.

The human consumption mean weights at age were derived in the same manner as for the stock weights-at-age (see Figure 13.6.1.2). 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 2003–2007 for these components.

The 1999 and 2000 year-classes are part of the plus-group during 2008-2010. The weight-modelling procedure outlined above provided weights-at-age for ages 8 and older, from which plus-group weights at age were calculated as means of weights-at-age weighted by abundance. The method for doing this was as follows. A modified XSA assessment was run using a plus-group at age 12+. This provided estimates of abundance for ages 0-12+ for 2007 in particular. These abundances were then rolled forward through 2008, 2009 and 2010, using the same assumptions on recruitment, exploitation and growth as used in the final forecast (see below). This gave numbers for ages 8-12+ in years 2008-2010, which could then be applied to the mean weights (discussed above) for those ages and years to provide appropriate plus-group weights-at-age.

Fishing mortality

The 2007 WG report included illustrative forecast results obtained when using four different approaches to generating fishing mortality rates for the forecast. These were a TAC constraint, a three-year average exploitation pattern scaled to the mean F of the final assessment year, an unscaled three-year mean of fishing mortality, and the estimated fishing mortality for 2006. The final approach (the 2006 mortality) was used in the final forecast, and in the spirit of the update process this method has been used for this year's forecast also. Therefore, the 2007 fishing mortality-at-age pattern is used for all years in the forecast.

An examination of fishing mortality estimates in Table 13.3.5.2 suggests that exploitation of the 2005 cohort (and other moderate and large cohorts) may be at a lower level than that on weaker cohorts. To explore this further, Figure 13.6.1.3 summarises relative F (that is, F_a/mean F_{2-4}) for the 15 strongest cohorts, the 15 weakest cohorts, the 2005 cohort, the 2007 fishing mortality estimates, and an average of the 2005-2007 fishing mortality estimates. For several ages (1, 2, 6, 7 and 8) the mean relative F is indeed lower for stronger cohorts than for weaker. However, the error bars overlap in all cases, so for no age is the difference significant. The 2007 relative F is close to the mean for the stronger cohorts (or at least within the error bounds) for all ages. In particular, the 2007 relative F is close to the stronger-cohort average for ages 3 and 4. These are the ages that the moderately-strong 2005 year-class reaches in the short-term forecast. This analysis suggests that the use of the 2007 exploitation pattern for all cohorts in the forecast, including the moderately-strong 2005 cohort which will dominate the population in the forecast years, is appropriate. This is the same approach as used in the forecast last year.

As mentioned above, Figure 13.6.1.3 also shows the average relative F over the period 2005-2007. This is further from the average relative F for the stronger cohorts, and lies outside or near the edges of the error bounds for several ages. It is therefore less likely to be appropriate for the forecast for the moderately-strong 2005 year-class.

This result is quite specific to the estimated characteristics of the 2005 year-class, however, and will not necessarily hold for the next moderate-to-large year-class. The WG recommends that the forthcoming benchmark process explores this issue further.

Given the choice of fishing-mortality rates discussed above, partial fishing mortality values were obtained for each catch component (human consumption, discards and bycatch) by using the relative contribution (averaged over 2005-2007) of each component to the total catch.

Forecast results

The inputs to the short-term forecast are presented in Table 13.6.1. Results for the short-term forecasts are presented in Table 13.6.2. As described above, status quo F is assumed to be the mean F (2–4) for 2007 only. The forecast has been run subject to a TAC constraint in 2007 (so that landings yield is restricted to the agreed quota of 49300 t).

On this basis (TAC constraint in 2008, status quo F in 2009), SSB is expected to rise slightly to 222 k t in 2008, due to the growth of the 2005 year-class. SSB is forecast to fall subsequently to 212 kt in 2009 and further to 172 kt in 2010. In this case, human consumption yield will be around 59 kt in 2009, with associated discards of 12 kt.

Two alternative options have been included in Table 13.6.2: a forecast allowing for a 15% decrease in the 2008 TAC (which is the maximum decrease allowed under the management plan when SSB > B_{pa}), and a forecast with total fishing mortality fixed to the level specified in the EU-Norway management plan (0.3). Under the first of these options, 2009 landings yield of 42 kt and discards of 8 kt lead to SSB in 2010 of 192 kt. Under the second, 2009 landings yield of around 45 kt and discards of 9 kt lead to SSB in 2010 of 189 kt. All of these SSB forecasts for 2010 are above B_{pa} (140 kt), but the trend in SSB is downwards and will continue thus unless a strong year-class appears.

13.7 Medium-term forecasts and yield-per-recruit analyses

No medium-term forecasts have been carried out for this stock using the usual software because of the difficulty of accounting for haddock recruitment dynamics. However, management simulations over the medium-term period have been performed for haddock (most recently by Needle, 2008), as discussed briefly in Section 13.1.4 above.

The results of a yield-per-recruit analysis (run using MFYPR) are shown in Figure 13.7.1 and Table 13.7.1. There is no maximum in the yield-per-recruit curve over the specified range of mean $F_{2\text{-}4}$, so F_{max} is undefined. An equilibrium analysis such an yield-per-recruit is difficult to interpret for a stock such as haddock with sporadic large recruitments.

13.8 Biological reference points

Biological reference points for this stock, are presented below, together with their technical basis. Target reference points have not been explicitly defined by ICES for this stock.

	ICES CONSIDERS THAT:	ICES PROPOSED THAT:
Limit reference points	B_{lim} is 100 000 t = smoothed B_{loss}.	B_{pa} be set at 140 000 t = 1.4 * B_{lim}*
	F_{lim} is 1.0 = 1.4 * F_{pa}*	F_{pa} is 0.7. This implies a long-term biomass > B_{pa} and a < 10% probability that medium-term SSB < B_{pa}.

***The multiplier of 1.4 is derived from exp(σ^2), where σ^2 ~ 0.34 is intended to reflect the variability of the time-series concerned (B or F).**

13.9 Quality of the assessment

Survey data are consistent both within and between surveys, and the catch data are internally consistent. Trends in mortality from catch data and survey indices are quite similar, although surveys do indicate higher mortality in recent years. No changes were made to the data collation or assessment methodology from last year's assessment. There is very little retrospective bias. The stock estimates from the current and previous assessments are compared in Figure 13.9.1.

Several issues remain of some concern with the assessment, and will need to be addressed during the forthcoming benchmark process:-

1) Haddock growth appears to vary by cohort, with large cohorts in particular growing more slowly than small cohorts. The pragmatic solution of applying proportional increments as a basis for predicting the weight at age for the 1999 and 2000 year classes incorporates the history of growth in the stock, while recognising the slow growth rate of these cohorts. However, intersessional work (not presented here) has suggested that alternative growth models may be more appropriate, and these need to be explored further.

2) In a similar vein, the proportion of mature individuals in each age-class is likely to vary by year and cohort. The effect of using age and year specific maturity data obtained from surveys should be considered, as well as methods by which this can be modelled in forecasts.

3) Exploitation rates also vary by cohort. The implications of this for forecasting should be addressed.

4) It is likely that haddock will continue to experience sporadic large year-classes. The problem of how to accommodate these year-classes in the plus-group structure of the assessment will therefore not go away, and a robust approach is needed that will remove the requirement to change the plus-group whenever a large year-class enters it.

5) The SSB estimates generated by the XSA/FLXSA model is strongly dependent (for haddock) on the number of algorithm iterations permitted. Interim results (not presented here) suggest that changes of ±40% or more are possible. There is no goodness-of-fit statistic in XSA which would help in the determination of the most suitable number of iterations, so the choice becomes essentially *ad hoc*. This is not a satisfactory situation and will have to be remedied. Alternative models should be explored.

6) Survey indices from the IBTS Q1 series have traditionally been supplied by ICES using a 6+ age group. Information on large year-classes at ages older than 5 is therefore lost from the tuning process. The WG recommends that ICES supply these data for a greater true age range, and that the implications of this be explored in the benchmark assessment,

13.10 Status of the Stock

The historical perception of the haddock stock remains unchanged from last year's assessment. Fishing mortality, which increased in 2006, is now estimated to have fallen slightly once more (from 0.52 in 2006 to 0.42 in 2007). Although this is still below F_{pa} (0.7), it is higher than the mortality rate recommended in the management plan (0.3). Discards have increased in 2007 due to the appearance of young fish of the 2005 year-class in the fishery. Spawning stock biomass is predicted to have continued in its decline from its peak in 2002–3, but remains above B_{pa} (140 000 t). SSB is forecast to increase slightly in 2008 with the growth of the moderate 2005 year-class, but the impact of this is relatively small (compared with the 1999 year-class). At current levels of fishing mortality, SSB is likely to continue to decline from 2009 onwards unless a strong year-class appears. The 2006 and 2007 year-classes are estimated to be weak, and there is no information yet on the 2008 year-class.

The results for North Sea haddock from the 2007 North Sea Stock Survey are summarised in Figure 13.10.1. In the main haddock areas, to the north and west of the North Sea, fishers' perceptions are of a stabilisation in abundance of haddock in the most recent years following a period of steady increase. The decline in haddock abundance estimated by the assessment is not apparent in the Survey. This suggests that demersal vessels may be able to maintain good catch rates of haddock in spite of declining abundance.

13.11 Management Considerations

In 2006 the EU and Norway agreed a revised management plan for this stock, which states that every effort will be made to maintain a minimum level of SSB greater than 100 000 t (B_{lim}). Furthermore, 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, along with a limitation on interannual TAC variability of ±15%. The stipulations of the management plan have been adhered to by the EU and Norway since its implementation in January 2007. Fishing mortality fell while the 1999 year-class dominated the fishery, and this year-class was allowed to contribute to the fishery and the stock for much longer than if the plan had not been in place.

Fishing mortality has risen slightly and SSB has fallen as the 1999 year-class has declined. This reduction in SSB has been arrested temporarily by the growth of the moderately-sized 2005 year class, but this year-class is smaller than the 1999 year-class and is unlikely to dominate SSB in the same manner. Short-term forecasts indicate a continued decline in SSB in the future until the next significant recruitment event. However, SSB is forecast to remain above B_{pa} until 2010 at least at current fishing mortality levels.

Keeping fishing mortality close to the target level would be preferable to encourage the sustainable exploitation of the 2005 year-class. With this year-class entering the fishery, and given current fishing patterns, discards were fairly substantial in 2006 and 2007. Improved gear selectivity measures, allowing for the release of small fish, would be highly beneficial not only for the haddock stock, but also for the survival of juveniles of other species that occur in mixed fisheries along with haddock. Similar considerations also apply to spatial management approaches (such as real-time closures), and other measures (such as the Scottish Conservation Credits scheme) intended to reduce unwanted bycatch and discarding of various species.

Haddock is a specific target for some fleets, but is also caught as part of a mixed fishery catching cod, whiting and *Nephrops*. It is important to consider both the species-specific assessments of these species for effective management, as well as the latest developments in the mixed fisheries approach. This is not straightforward when stocks are managed via a series of single-species management plans that do not incorporate mixed-stocks considerations. However, a reduction in effort on one stock may lead to a reduction or an increase in effort on another, and the implications of any changes need to be considered carefully.

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Table 13.2.1.1. Haddock in Subarea IV and Division IIIa. Nominal catch (000 t) during 2001–2007, as officially reported to, and estimated by, ICES.

ICES area	Country	2001	2002	2003	2004	2005	2006	2007
Division IIIa	Denmark	1590	3791	1741	1116	615	1001	1057
	Faeroe Islands	0	0	0	0	0	0	
	Germany	128	239	113	69	69	186	206
	Netherlands	0	0	6	1	0	0	
	Norway	149	149	211	154	93	113	152
	Portugal	0	0	0	0	0	30	
	Sweden	283	393	165	158	180	246	273
Division IIIa Total		2157	4572	2236	1498	957	1576	1688
WG Division IIIa	WG estimates of discards	0	0	195	1051	784	970	876
	WG estimates of IBC	218	0	0	0	0	0	0
	WG estimates of landings	1903	4137	1808	1443	764	1537	1614
WG Division IIIa Total		2121	4137	2003	2494	1548	2507	2490
Subarea IV	Belgium	606	559	374	373	190	105	178
	Denmark	2407	5123	3035	2075	1274	759	645
	Faeroe Islands	1	25	12	22	22	4	0
	France	485	914	1108	552	439	444	354
	Germany	681	852	1562	1241	733	725	727
	Greenland	0	0	149	10	0	0	
	Ireland	0	0	1	0	0	0	
	Netherlands	274	359	187	104	64	33	
	Norway	1902	2404	2196	2258	2089	1798	1706
	Poland	12	17	16	0	0	8	
	Portugal	0	0	0	0	0	76	
	Sweden	804	572	477	188	135	100	127
	UK - Eng+Wales+N.Irl.	3334	3647	1561	1159	651	477	
	UK - Scotland	29263	39624	31527	39339	25319	31905	
	UK - all							26707
Subarea IV Total		39769	54096	42205	47321	30916	36434	30443
WG Subarea IV	WG estimates of discards	118320	45892	23499	17226	9508	16943	30206
	WG estimates of IBC	7879	3717	1149	554	168	535	48
	WG estimates of landings	38958	54171	42279	47253	47616	36074	30522
WG Subarea IV Total		165157	103780	66927	65033	57292	53551	60776
TAC	TAC IIIa	4000	6300	3150	4940	4018	3189	3360
	TAC IV	61000	104000	51735	77000	66000	51850	54640
TAC Total		65000	110300	54885	81940	70018	55039	58000

Table 13.2.1.2. Haddock in Subarea IV and Division IIIa. Working Group estimates of catch components by weight (000 tonnes).

Year	Subarea IV				Division IIIa(N)				Combined			
	Landings	Discards	IBC	Total	Landings	Discards	IBC	Total	Landings	Discards	IBC	Total
1963	68.4	189.3	13.7	271.4	0.4	-	-	0.4	68.8	189.3	13.7	271.8
1964	130.6	160.3	88.6	379.5	0.4	-	-	0.4	131.0	160.3	88.6	379.9
1965	161.7	62.3	74.6	298.6	0.7	-	-	0.7	162.4	62.3	74.6	299.3
1966	225.6	73.5	46.7	345.8	0.6	-	-	0.6	226.2	73.5	46.7	346.3
1967	147.4	78.2	20.7	246.3	0.4	-	-	0.4	147.7	78.2	20.7	246.7
1968	105.4	161.8	34.2	301.4	0.4	-	-	0.4	105.8	161.8	34.2	301.8
1969	331.1	260.1	338.4	929.5	0.5	-	-	0.5	331.6	260.1	338.4	930.0
1970	524.1	101.3	179.7	805.1	0.7	-	-	0.7	524.8	101.3	179.7	805.8
1971	235.5	177.8	31.5	444.8	2.0	-	-	2.0	237.5	177.8	31.5	446.8
1972	193.0	128.0	29.6	350.5	2.6	-	-	2.6	195.5	128.0	29.6	353.1
1973	178.7	114.7	11.3	304.7	2.9	-	-	2.9	181.6	114.7	11.3	307.6
1974	149.6	166.4	47.5	363.5	3.5	-	-	3.5	153.1	166.4	47.5	367.0
1975	146.6	260.4	41.5	448.4	4.8	-	-	4.8	151.3	260.4	41.5	453.2
1976	165.7	154.5	48.2	368.3	7.0	-	-	7.0	172.7	154.5	48.2	375.3
1977	137.3	44.4	35.0	216.7	7.8	-	-	7.8	145.1	44.4	35.0	224.5
1978	85.8	76.8	10.9	173.5	5.9	-	-	5.9	91.7	76.8	10.9	179.4
1979	83.1	41.7	16.2	141.0	4.0	-	-	4.0	87.1	41.7	16.2	145.0
1980	98.6	94.6	22.5	215.7	6.4	-	-	6.4	105.0	94.6	22.5	222.1
1981	129.6	60.1	17.0	206.7	6.6	-	-	6.6	136.1	60.1	17.0	213.2
1982	165.8	40.6	19.4	225.8	7.5	-	-	7.5	173.3	40.6	19.4	233.3
1983	159.3	66.0	12.9	238.2	6.0	-	-	6.0	165.3	66.0	12.9	244.2
1984	128.2	75.3	10.1	213.6	5.4	-	-	5.4	133.6	75.3	10.1	218.9
1985	158.6	85.2	6.0	249.8	5.6	-	-	5.6	164.1	85.2	6.0	255.4
1986	165.6	52.2	2.6	220.4	2.7	-	-	2.7	168.2	52.2	2.6	223.1
1987	108.0	59.1	4.4	171.6	2.3	-	-	2.3	110.3	59.1	4.4	173.9
1988	105.1	62.1	4.0	171.2	1.9	-	-	1.9	107.0	62.1	4.0	173.1
1989	76.2	25.7	2.4	104.2	2.3	-	-	2.3	78.4	25.7	2.4	106.5
1990	51.5	32.6	2.6	86.6	2.3	-	-	2.3	53.8	32.6	2.6	88.9
1991	44.7	40.2	5.4	90.2	3.1	-	-	3.1	47.7	40.2	5.4	93.3
1992	70.2	47.9	10.9	129.1	2.6	-	-	2.6	72.8	47.9	10.9	131.7
1993	79.6	79.6	10.8	169.9	2.6	-	-	2.6	82.2	79.6	10.8	172.5
1994	80.9	65.4	3.6	149.8	1.2	-	-	1.2	82.1	65.4	3.6	151.0
1995	75.3	57.4	7.7	140.4	2.2	-	-	2.2	77.5	57.4	7.7	142.6
1996	76.0	72.5	5.0	153.5	3.1	-	-	3.1	79.2	72.5	5.0	156.6
1997	79.1	52.1	6.7	137.9	3.4	-	-	3.4	82.5	52.1	6.7	141.3
1998	77.3	45.2	5.1	127.6	3.8	-	-	3.8	81.1	45.2	5.1	131.3
1999	64.2	42.6	3.8	110.7	1.4	-	-	1.4	65.6	42.6	3.8	112.0
2000	46.1	48.8	8.1	103.0	1.5	-	-	1.5	47.6	48.8	8.1	104.5
2001	39.0	118.3	7.9	165.2	1.9	-	-	1.9	40.9	118.3	7.9	167.1
2002	54.2	45.9	3.7	103.8	4.1	-	-	4.1	58.3	45.9	3.7	107.9
2003	40.1	23.5	1.1	64.8	1.8	0.2	-	2.0	41.9	23.7	1.1	66.8
2004	47.3	15.4	0.6	63.2	1.4	0.1	-	1.6	48.7	15.6	0.6	64.8
2005	47.6	8.4	0.2	56.2	0.8	0.2	-	1.0	48.4	8.6	0.2	57.2
2006	36.1	16.9	0.5	53.6	1.5	1.0	-	2.5	37.6	17.9	0.5	56.1
2007	30.5	30.2	0.0	60.8	1.6	0.9	-	2.5	32.1	31.1	0.0	63.3
Min	30.5	8.4	0.0	53.6	0.4	0.1	-	0.4	32.1	8.6	0.0	56.1
Mean	120.1	82.6	27.9	230.5	2.9	0.5	-	3.0	123.0	82.6	27.9	233.5
Max	524.1	260.4	338.4	929.5	7.8	1.0	-	7.8	524.8	260.4	338.4	930.0

- denotes missing data.

Table 13.2.2.1. Haddock in Subarea IV and Division IIIa. Numbers at age data (thousands) for total catch. Data used in the assessment are highlighted in bold.

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	8+
1963	**1359**	**1305780**	**334953**	**20959**	**13025**	**5780**	**503**	**653**	566	59	18	0	0	0	0	0	**643**
1964	**139777**	**7425**	**1295363**	**135109**	**9066**	**5348**	**2405**	**287**	236	231	25	0	0	0	0	0	**492**
1965	**649768**	**367501**	**15151**	**649052**	**29485**	**4659**	**1971**	**452**	107	90	41	0	0	0	0	0	**238**
1966	**1666973**	**1005922**	**25658**	**6423**	**412510**	**9978**	**1045**	**601**	165	90	23	2	0	0	0	0	**280**
1967	**305249**	**837154**	**89068**	**4863**	**3585**	**177851**	**2442**	**215**	216	57	34	0	0	0	0	0	**307**
1968	**11105**	**1097030**	**439210**	**19592**	**1946**	**2529**	**45971**	**325**	40	13	5	0	0	0	0	0	**58**
1969	**72558**	**20468**	**3575922**	**303333**	**7594**	**2410**	**2515**	**19128**	200	24	7	0	0	0	0	0	**231**
1970	**924601**	**266151**	**218362**	**1908086**	**57430**	**1178**	**1196**	**256**	5954	67	11	19	0	0	0	0	**6051**
1971	**330674**	**1810248**	**70951**	**47518**	**400414**	**10371**	**463**	**195**	147	1592	160	3	5	0	0	0	**1907**
1972	**240895**	**676001**	**586824**	**40591**	**21211**	**157995**	**3563**	**190**	34	27	408	11	0	0	0	0	**480**
1973	**59872**	**364917**	**570429**	**240603**	**6192**	**4467**	**39459**	**1257**	108	29	109	49	5	0	0	0	**300**
1974	**601412**	**1214416**	**175586**	**331871**	**54207**	**1873**	**1348**	**10917**	242	23	32	4	5	0	0	0	**306**
1975	**44947**	**2097588**	**639003**	**58837**	**108893**	**15808**	**983**	**620**	2714	266	63	11	0	8	0	0	**3062**
1976	**167173**	**167694**	**1055191**	**210308**	**9950**	**31186**	**4995**	**206**	76	759	60	3	0	0	0	0	**898**
1977	**114954**	**250593**	**106011**	**390344**	**40052**	**4304**	**6261**	**1300**	135	29	200	3	0	1	0	0	**368**
1978	**285842**	**454920**	**146179**	**30321**	**113601**	**8704**	**1264**	**2075**	402	116	15	64	13	2	0	0	**612**
1979	**841439**	**345398**	**203196**	**41225**	**7402**	**28006**	**2235**	**262**	483	152	54	12	11	1	0	0	**713**
1980	**374959**	**660144**	**331839**	**72505**	**10393**	**1897**	**8061**	**598**	121	162	75	31	9	3	1	0	**402**
1981	**646419**	**134440**	**421348**	**142948**	**15205**	**2034**	**457**	**2498**	125	64	23	30	4	1	3	0	**250**
1982	**278706**	**275385**	**85474**	**299211**	**41383**	**3377**	**713**	**279**	784	30	15	7	2	2	0	0	**840**
1983	**639815**	**156257**	**251703**	**73666**	**127173**	**16480**	**1708**	**297**	61	190	53	6	4	4	0	0	**318**
1984	**95502**	**432179**	**167410**	**122783**	**22067**	**32649**	**3788**	**596**	84	41	112	16	5	1	1	0	**260**
1985	**139580**	**178878**	**533698**	**78633**	**37430**	**5303**	**7354**	**965**	212	52	21	88	4	0	0	0	**377**
1986	**56503**	**160359**	**178799**	**323639**	**27682**	**9690**	**1237**	**1810**	237	117	49	32	36	13	4	1	**489**
1987	**9419**	**277704**	**250003**	**47378**	**67865**	**4760**	**2877**	**545**	778	135	36	50	27	29	5	8	**1068**
1988	**10808**	**29421**	**484481**	**89071**	**13432**	**18579**	**1602**	**639**	166	141	50	18	11	10	15	1	**412**
1989	**10704**	**47271**	**35097**	**182331**	**18036**	**2631**	**4044**	**508**	199	83	30	13	6	2	2	1	**336**
1990	**55473**	**81336**	**101513**	**18674**	**56696**	**3731**	**877**	**1320**	206	78	41	11	11	1	4	2	**354**
1991	**123910**	**224137**	**78092**	**23167**	**3882**	**12525**	**976**	**401**	614	148	54	6	5	1	2	1	**831**
1992	**270758**	**194250**	**252885**	**32482**	**6550**	**1250**	**4861**	**454**	300	293	124	22	6	2	0	0	**747**
1993	**141210**	**345275**	**261834**	**108395**	**7106**	**1698**	**450**	**1138**	146	103	144	59	3	2	0	0	**457**
1994	**85966**	**96849**	**296529**	**100465**	**29609**	**1920**	**573**	**191**	509	115	32	27	25	5	0	0	**713**
1995	**201260**	**296237**	**85826**	**167801**	**25875**	**7644**	**511**	**127**	45	62	19	8	6	2	1	0	**143**
1996	**148437**	**46690**	**357942**	**56893**	**55147**	**7503**	**3052**	**756**	52	31	25	5	8	3	1	0	**125**
1997	**28856**	**132261**	**85854**	**213293**	**15273**	**15407**	**1892**	**679**	62	15	12	4	4	4	2	0	**103**
1998	**22115**	**82770**	**166733**	**49550**	**107994**	**5741**	**3561**	**472**	140	14	6	5	2	2	1	1	**171**
1999	**84408**	**80970**	**121248**	**87243**	**24739**	**39860**	**2338**	**1595**	342	41	6	2	1	1	0	0	**393**
2000	**6632**	**349063**	**88624**	**43352**	**26357**	**6026**	**8708**	**560**	234	32	12	2	1	1	0	0	**282**
2001	**2532**	**85435**	**632880**	**32344**	**8887**	**4123**	**1561**	**1305**	195	64	17	3	1	0	0	0	**280**
2002	**50753**	**18400**	**66344**	**242196**	**6547**	**2039**	**1066**	**549**	458	265	15	8	5	0	0	0	**751**
2003	**9072**	**19548**	**14261**	**44747**	**109063**	**1969**	**602**	**271**	109	89	38	5	1	0	0	0	**242**
2004	**1030**	**10538**	**18122**	**6573**	**34945**	**91121**	**723**	**146**	56	35	35	10	1	0	0	0	**137**
2005	**4814**	**10504**	**18394**	**11385**	**3329**	**25077**	**58753**	**314**	89	34	10	7	4	1	0	0	**145**
2006	**2412**	**106506**	**26164**	**16812**	**7482**	**2970**	**13685**	**30229**	123	29	16	6	3	0	0	0	**177**
2007	**1926**	**20506**	**168019**	**14613**	**6726**	**2444**	**1480**	**6199**	7029	72	8	14	3	1	0	0	**7127**

Table 13.2.2.2. Haddock in Subarea IV and Division IIIa. Numbers at age data (thousands) for landings. Data used in the assessment are highlighted in bold.

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	8+
1963	**0**	**27353**	**118185**	**16692**	**12212**	**5644**	**498**	**653**	566	59	18	0	0	0	0	0	**643**
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	**58**
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	**300**
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	**898**
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	**713**
1980	**0**	**8982**	**141895**	**61901**	**9063**	**1843**	**7975**	**591**	121	161	75	31	9	3	1	0	**401**
1981	**0**	**1759**	**153466**	**112407**	**14679**	**2025**	**455**	**2498**	125	64	23	30	4	1	3	0	**250**
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	**318**
1984	**0**	**19501**	**75963**	**104651**	**21372**	**31874**	**3788**	**596**	84	41	112	16	5	1	1	0	**260**
1985	**0**	**2120**	**248125**	**70806**	**36734**	**5076**	**7329**	**965**	212	52	21	88	4	0	0	0	**377**
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	**336**
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	**831**
1992	**0**	**2853**	**117953**	**28828**	**6485**	**1247**	**4779**	**454**	300	293	124	22	6	2	0	0	**747**
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	**143**
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	**751**
2003	**0**	**32**	**1091**	**13925**	**73059**	**1920**	**571**	**270**	109	89	38	5	1	0	0	0	**242**
2004	**0**	**481**	**2897**	**4101**	**22159**	**73191**	**710**	**139**	56	35	35	10	1	0	0	0	**137**
2005	**0**	**782**	**5490**	**8086**	**2926**	**21703**	**54742**	**313**	89	34	10	7	4	1	0	0	**145**
2006	**0**	**2062**	**9849**	**10267**	**6302**	**2705**	**12486**	**28158**	116	28	15	6	3	0	0	0	**168**
2007	**0**	**1174**	**29119**	**10468**	**6157**	**2377**	**1475**	**6139**	6956	72	8	14	3	1	0	0	**7054**

Table 13.2.2.3. Haddock in Subarea IV and Division IIIa. Numbers-at-age data (thousands) for discards. Data used in the assessment are highlighted in bold.

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	8+
1963	42	1047925	193718	3476	708	51	2	0	0	0	0	0	0	0	0	0	0
1964	2395	4182	623111	13597	262	21	10	0	0	0	0	0	0	0	0	0	0
1965	5307	110628	4020	130369	3641	4	1	0	0	0	0	0	0	0	0	0	0
1966	7880	444111	12388	1166	24114	35	2	0	0	0	0	0	0	0	0	0	0
1967	6250	389691	49635	863	216	1576	9	0	0	0	0	0	0	0	0	0	0
1968	39	615649	219022	3006	94	15	186	0	0	0	0	0	0	0	0	0	0
1969	1732	5152	1158445	37686	420	16	8	0	0	0	0	0	0	0	0	0	0
1970	51717	92978	77992	289679	2640	13	4	0	0	0	0	0	0	0	0	0	0
1971	7586	1205838	35117	8960	24590	66	2	0	0	0	0	0	0	0	0	0	0
1972	4231	424657	322547	6353	1212	1212	13	0	0	0	0	0	0	0	0	0	0
1973	18540	241423	352310	46740	352	33	123	0	0	0	0	0	0	0	0	0	0
1974	24758	915157	90904	57011	2814	6	4	0	0	0	0	0	0	0	0	0	0
1975	630	1478590	353422	15781	13388	143	0	0	0	0	0	0	0	0	0	0	0
1976	2191	98420	648662	38317	183	137	0	0	0	0	0	0	0	0	0	0	0
1977	11812	95090	44918	73431	605	9	0	0	0	0	0	0	0	0	0	0	0
1978	5250	316339	80219	4207	12085	72	106	0	0	0	0	0	0	0	0	0	0
1979	1824	205555	75517	3232	34	84	0	0	0	0	0	0	0	0	0	0	0
1980	644	369727	168124	2346	39	0	0	0	0	0	0	0	0	0	0	0	0
1981	1509	33434	237524	25928	86	3	0	0	0	0	0	0	0	0	0	0	0
1982	3703	93865	31915	49462	1845	0	0	0	0	0	0	0	0	0	0	0	0
1983	151108	85338	128171	15966	7112	717	105	0	0	0	0	0	0	0	0	0	0
1984	2915	314421	80803	13430	327	240	0	0	0	0	0	0	0	0	0	0	0
1985	17501	165086	267747	6088	149	4	8	0	0	0	0	0	0	0	0	0	0
1986	23807	108204	114606	61612	31	12	0	0	0	0	0	0	0	0	0	0	0
1987	1166	188582	133010	9320	1506	0	0	0	0	0	0	0	0	0	0	0	0
1988	1528	24588	325259	9684	788	67	0	0	0	0	0	0	0	0	0	0	0
1989	1790	40211	16959	51491	814	20	42	0	0	0	0	0	0	0	0	0	0
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	4927	13533	11069	29537	34480	37	31	1	0	0	0	0	0	0	0	0	0
2004	1030	9467	14960	2388	12528	17177	5	3	0	0	0	0	0	0	0	0	0
2005	4814	9546	12807	3273	394	3369	3810	0	0	0	0	0	0	0	0	0	0
2006	2412	102672	15599	6304	1133	219	1125	1963	6	1	1	0	0	0	0	0	8
2007	1926	19324	138705	4141	568	67	5	60	73	0	0	0	0	0	0	0	73

Table 13.2.2.4. Haddock in Subarea IV and Division IIIa. Numbers-at-age data (thousands) for IBC. Data used in the assessment are highlighted in bold.

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	8+
1963	1317	230502	23050	791	105	85	3	0	0	0	0	0	0	0	0	0	0
1964	137382	3195	421729	35144	638	638	112	1	0	0	0	0	0	0	0	0	0
1965	644461	254237	7686	183288	2365	592	118	6	0	0	0	0	0	0	0	0	0
1966	1659093	548835	6546	1007	15861	755	25	2	0	0	0	0	0	0	0	0	0
1967	298999	392510	5539	155	24	2264	12	0	0	0	0	0	0	0	0	0	0
1968	11066	462938	81153	2029	46	19	738	1	0	0	0	0	0	0	0	0	0
1969	70826	15178	1703617	98650	632	380	126	252	0	0	0	0	0	0	0	0	0
1970	872884	170914	88509	485274	3967	153	61	2	0	0	0	0	0	0	0	0	0
1971	323088	570391	9972	3390	6381	299	6	0	0	0	0	0	0	0	0	0	0
1972	236664	238566	57010	1023	146	439	0	0	0	0	0	0	0	0	0	0	0
1973	41332	117470	12402	11	11	196	0	0	0	0	0	0	0	0	0	0	0
1974	576654	275266	32266	46862	4600	82	112	224	0	0	0	0	0	0	0	0	0
1975	44317	594854	84620	4761	5203	141	5	0	5	0	0	0	0	0	0	0	5
1976	164982	66973	183064	29188	46	2946	17	0	0	0	0	0	0	0	0	0	0
1977	103142	147019	29352	67628	2355	238	240	0	0	0	0	0	0	0	0	0	0
1978	280592	125698	11330	809	1480	64	6	5	0	0	0	0	0	0	0	0	0
1979	839615	125834	17671	1507	84	379	16	0	0	0	0	0	0	0	0	0	0
1980	374315	281436	21820	8258	1291	54	86	7	0	1	0	0	0	0	0	0	1
1981	644910	99247	30358	4613	440	6	2	0	0	0	0	0	0	0	0	0	0
1982	275002	174147	14740	13540	1810	464	0	0	0	0	0	0	0	0	0	0	0
1983	488707	63818	14331	5134	2242	3	0	0	0	0	0	0	0	0	0	0	0
1984	92587	98257	10644	4702	368	535	0	0	0	0	0	0	0	0	0	0	0
1985	122078	11672	17826	1739	547	223	17	0	0	0	0	0	0	0	0	0	0
1986	32696	40023	1831	802	103	7	0	0	0	0	0	0	0	0	0	0	0
1987	8253	82226	3797	295	138	0	0	0	0	0	0	0	0	0	0	0	0
1988	9280	3309	12819	2462	620	202	0	0	0	0	0	0	0	0	0	0	0
1989	8914	2541	1751	2789	460	37	86	10	0	0	0	0	0	0	0	0	0
1990	2996	7218	1986	359	1491	227	25	78	4	0	0	0	0	0	0	0	4
1991	116909	22493	3248	601	43	43	0	0	0	0	0	0	0	0	0	0	0
1992	241702	80402	10971	356	27	3	17	0	0	0	0	0	0	0	0	0	0
1993	124495	107664	13220	3214	82	9	0	18	0	0	0	0	0	0	0	0	0
1994	69907	14349	9534	1011	160	7	1	0	0	0	0	0	0	0	0	0	0
1995	198032	102560	2201	888	65	0	0	0	0	0	0	0	0	0	0	0	0
1996	144469	10608	7453	3338	107	0	0	0	0	0	0	0	0	0	0	0	0
1997	21694	45264	10935	4451	184	17	0	0	0	0	0	0	0	0	0	0	0
1998	18983	9155	16337	2649	1490	63	0	0	0	0	0	0	0	0	0	0	0
1999	69820	10780	4531	2932	344	166	3	0	0	0	0	0	0	0	0	0	0
2000	4158	71419	21740	2085	186	5	0	0	0	0	0	0	0	0	0	0	0
2001	1987	22946	35776	10127	35	8	0	0	0	0	0	0	0	0	0	0	0
2002	49807	13889	4489	3638	504	27	0	0	0	0	0	0	0	0	0	0	0
2003	4145	5983	2101	1285	1524	12	0	0	0	0	0	0	0	0	0	0	0
2004	0	590	265	84	258	753	8	4	0	0	0	0	0	0	0	0	0
2005	0	176	97	26	9	5	201	1	0	0	0	0	0	0	0	0	0
2006	0	1772	716	241	47	46	74	108	1	0	0	0	0	0	0	0	1
2007	0	8	195	4	1	0	0	0	0	0	0	0	0	0	0	0	0

Table 13.2.3.1. Haddock in Subarea IV and Division IIIa. Mean weight at age data (kg) for total catch. Data used in the assessment are highlighted in bold.

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	8+
1963	0.012	0.123	0.253	0.473	0.695	0.807	1.003	1.131	1.173	1.576	1.825	0	0	0	0	0	1.228
1964	0.011	0.118	0.239	0.403	0.664	0.814	0.908	1.382	1.148	1.47	1.781	0	0	0	0	0	1.331
1965	0.01	0.069	0.226	0.366	0.648	0.845	1.193	1.173	1.482	1.707	2.239	0	0	0	0	0	1.697
1966	0.01	0.088	0.247	0.367	0.533	0.949	1.266	1.525	1.938	1.727	2.963	2.04	0	0	0	0	1.955
1967	0.011	0.115	0.281	0.461	0.594	0.639	1.057	1.501	1.922	2.069	2.348	0	0	0	0	0	1.996
1968	0.01	0.126	0.253	0.51	0.731	0.856	0.837	1.606	2.26	2.702	2.073	0	0	0	0	0	2.343
1969	0.011	0.063	0.216	0.406	0.799	0.891	1.031	1.094	2.04	3.034	3.264	0	0	0	0	0	2.18
1970	0.013	0.073	0.222	0.352	0.735	0.874	1.191	1.362	1.437	2.571	3.95	3.869	0	0	0	0	1.462
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	0	0	1.349
1972	0.024	0.116	0.243	0.388	0.506	0.606	1.001	1.366	2.241	2.006	1.651	2.899	0	0	0	0	1.741
1973	0.044	0.112	0.241	0.373	0.586	0.649	0.725	1.044	1.302	2.796	1.726	2.02	2.158	0	0	0	1.732
1974	0.024	0.128	0.227	0.344	0.549	0.892	0.896	0.952	1.513	2.315	2.508	4.152	2.264	0	0	0	1.724
1975	0.02	0.101	0.242	0.357	0.45	0.681	1.245	1.124	1.093	1.72	2.217	2.854	0	3.426	0	0	1.183
1976	0.013	0.125	0.225	0.402	0.512	0.589	0.922	1.933	1.784	1.306	2.425	2.528	0	0	0	0	1.425
1977	0.019	0.109	0.243	0.347	0.602	0.614	0.803	1.181	1.943	2.322	1.78	3.189	0	4.119	0	0	1.9
1978	0.011	0.144	0.256	0.42	0.443	0.719	0.745	0.955	1.398	2.124	2.868	1.849	2.454	4.782	0	0	1.652
1979	0.009	0.096	0.292	0.444	0.637	0.664	0.934	1.187	1.187	1.468	2.679	1.624	1.76	1.643	0	0	1.377
1980	0.012	0.104	0.286	0.488	0.733	1.046	0.936	1.394	1.599	1.593	1.726	3.328	1.119	3.071	3.111	0	1.758
1981	0.009	0.074	0.265	0.477	0.745	1.148	1.48	1.18	1.634	1.764	1.554	1.492	3.389	4.273	1.981	0	1.686
1982	0.011	0.1	0.293	0.462	0.785	1.17	1.441	1.672	1.456	2.634	2.164	1.924	1.886	3.179	0	0	1.52
1983	0.022	0.136	0.298	0.449	0.651	0.916	1.215	1.162	1.92	1.376	1.395	1.907	2.853	4.689	0	0	1.554
1984	0.01	0.141	0.302	0.489	0.671	0.805	1.097	1.1	1.868	2.425	1.972	2.247	2.422	2.822	4.995	0	2.05
1985	0.013	0.149	0.28	0.481	0.668	0.858	1.049	1.459	1.833	2.124	2.145	2.003	2.387	0	0	0	1.936
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	1.916
1987	0.008	0.126	0.267	0.406	0.615	1.029	1.276	1.433	1.529	1.877	2.054	1.94	2.471	2.411	2.996	2.638	1.673
1988	0.024	0.166	0.217	0.418	0.59	0.748	1.284	1.424	1.551	1.627	1.68	3.068	2.468	2.885	3.337	2.863	1.784
1989	0.027	0.198	0.304	0.372	0.606	0.811	0.982	1.364	1.653	1.684	2.236	2.166	2.364	2.389	2.307	1.146	1.752
1990	0.044	0.195	0.293	0.434	0.474	0.772	0.971	1.168	1.53	2.037	2.653	2.53	2.392	3.444	1.852	4.731	1.857
1991	0.029	0.179	0.322	0.473	0.64	0.651	1.042	1.232	1.481	1.776	1.996	2.253	2.404	1.07	3.509	2.936	1.584
1992	0.018	0.108	0.307	0.486	0.748	1.016	0.896	1.395	1.537	1.912	1.997	2.067	2.441	1.781	0	0	1.784
1993	0.01	0.116	0.282	0.447	0.68	0.893	1.173	1.102	1.592	1.737	1.92	1.718	2.274	2.516	0	0	1.753
1994	0.017	0.116	0.251	0.42	0.597	0.943	1.209	1.57	1.469	1.62	2.418	2.108	2.849	2.403	0	0	1.615
1995	0.013	0.102	0.301	0.366	0.597	0.768	1.118	1.444	1.761	1.873	1.881	2.508	1.674	1.699	2.243	0	1.866
1996	0.019	0.128	0.248	0.399	0.49	0.795	0.879	0.855	1.833	2.018	1.623	2.393	2.369	2.598	3.439	0	1.925
1997	0.021	0.134	0.286	0.362	0.591	0.621	0.921	0.974	1.647	2.209	2.146	2.032	2.757	2.262	2.867	0	1.893
1998	0.023	0.154	0.258	0.405	0.442	0.66	0.769	1.113	1.2	1.834	2.34	2.15	1.115	2.423	2.085	2.509	1.346
1999	0.023	0.168	0.244	0.365	0.48	0.499	0.691	0.785	0.758	1.258	1.559	1.913	2.232	2.392	0	0	0.836
2000	0.048	0.12	0.256	0.37	0.501	0.619	0.653	1.104	1.1	1.757	1.963	2.323	2.385	2.315	0	0	1.229
2001	0.021	0.11	0.217	0.315	0.472	0.706	0.762	0.976	1.891	1.216	2.144	2.891	3.237	0	0	0	1.768
2002	0.016	0.1	0.271	0.328	0.541	0.744	0.931	0.848	1.426	1.942	2.346	1.84	2.349	0	0	0	1.637
2003	0.03	0.097	0.214	0.33	0.406	0.682	0.791	1.158	1.386	1.659	2.181	2.209	2.506	0	0	0	1.633
2004	0.053	0.177	0.256	0.41	0.404	0.445	0.744	1.071	1.372	1.741	1.777	2.355	2.172	0	0	0	1.647
2005	0.055	0.2	0.295	0.387	0.522	0.484	0.521	0.882	1.119	1.36	1.835	2.682	2.553	2.319	0	0	1.348
2006	0.048	0.122	0.289	0.358	0.47	0.545	0.546	0.549	0.994	1.606	2.096	2.641	1.926	0	0	0	1.266
2007	0.039	0.162	0.226	0.422	0.498	0.624	0.718	0.715	0.749	0.91	2.278	0.954	1.712	2.348	0	0	0.753

Table 13.2.3.2. Haddock in Subarea IV and Division IIIa. Mean weight at age data (kg) for landings. Data used in the assessment are highlighted in bold.

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	8+
1963	**0**	**0.233**	**0.326**	**0.512**	**0.715**	**0.817**	**1.009**	**1.131**	1.173	1.576	1.825	0	0	0	0	0	**1.228**
1964	**0**	**0.221**	**0.313**	**0.459**	**0.695**	**0.87**	**0.934**	**1.386**	1.148	1.47	1.781	0	0	0	0	0	**1.331**
1965	**0**	**0.31**	**0.357**	**0.41**	**0.679**	**0.907**	**1.242**	**1.182**	1.482	1.707	2.239	0	0	0	0	0	**1.697**
1966	**0**	**0.301**	**0.384**	**0.416**	**0.553**	**0.995**	**1.288**	**1.529**	1.938	1.727	2.963	2.04	0	0	0	0	**1.955**
1967	**0**	**0.26**	**0.404**	**0.51**	**0.614**	**0.645**	**1.063**	**1.501**	1.922	2.069	2.348	0	0	0	0	0	**1.996**
1968	**0**	**0.256**	**0.361**	**0.591**	**0.761**	**0.863**	**0.846**	**1.61**	2.26	2.702	2.073	0	0	0	0	0	**2.343**
1969	**0**	**0.178**	**0.302**	**0.506**	**0.87**	**0.984**	**1.065**	**1.102**	2.04	3.034	3.264	0	0	0	0	0	**2.18**
1970	**0**	**0.242**	**0.31**	**0.403**	**0.786**	**0.949**	**1.235**	**1.37**	1.437	2.571	3.95	3.869	0	0	0	0	**1.462**
1971	**0**	**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	0	0	**1.349**
1972	**0**	**0.244**	**0.329**	**0.421**	**0.523**	**0.609**	**1.003**	**1.366**	2.241	2.006	1.651	2.899	0	0	0	0	**1.741**
1973	**0**	**0.225**	**0.315**	**0.406**	**0.606**	**0.663**	**0.726**	**1.044**	1.302	2.796	1.726	2.02	2.158	0	0	0	**1.732**
1974	**0**	**0.275**	**0.32**	**0.389**	**0.585**	**0.908**	**0.954**	**0.963**	1.513	2.315	2.508	4.152	2.264	0	0	0	**1.724**
1975	**0**	**0.258**	**0.345**	**0.408**	**0.487**	**0.686**	**1.248**	**1.124**	1.094	1.72	2.217	2.854	0	3.426	0	0	**1.184**
1976	**0**	**0.25**	**0.344**	**0.467**	**0.516**	**0.614**	**0.923**	**1.933**	1.784	1.306	2.425	2.528	0	0	0	0	**1.425**
1977	**0**	**0.286**	**0.362**	**0.396**	**0.614**	**0.63**	**0.817**	**1.181**	1.943	2.322	1.78	3.189	0	4.119	0	0	**1.9**
1978	**0**	**0.275**	**0.356**	**0.457**	**0.47**	**0.725**	**0.789**	**0.956**	1.398	2.124	2.868	1.849	2.454	4.782	0	0	**1.652**
1979	**0**	**0.274**	**0.361**	**0.468**	**0.642**	**0.668**	**0.935**	**1.187**	1.187	1.468	2.679	1.624	1.76	1.643	0	0	**1.377**
1980	**0**	**0.299**	**0.367**	**0.526**	**0.75**	**1.056**	**0.934**	**1.392**	1.599	1.592	1.726	3.328	1.119	3.071	3.111	0	**1.758**
1981	**0**	**0.339**	**0.385**	**0.525**	**0.754**	**1.149**	**1.481**	**1.18**	1.634	1.764	1.554	1.492	3.389	4.273	1.981	0	**1.686**
1982	**0**	**0.3**	**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	0	**1.52**
1983	**0**	**0.312**	**0.387**	**0.482**	**0.663**	**0.925**	**1.243**	**1.162**	1.92	1.376	1.395	1.907	2.853	4.689	0	0	**1.554**
1984	**0**	**0.281**	**0.376**	**0.515**	**0.677**	**0.81**	**1.097**	**1.1**	1.868	2.425	1.972	2.247	2.422	2.822	4.995	0	**2.05**
1985	**0**	**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	3.97	**1.936**
1986	**0**	**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	**1.916**
1987	**0**	**0.274**	**0.345**	**0.451**	**0.622**	**1.029**	**1.276**	**1.433**	1.529	1.877	2.054	1.94	2.471	2.411	2.996	2.638	**1.673**
1988	**0**	**0.258**	**0.324**	**0.445**	**0.619**	**0.752**	**1.284**	**1.424**	1.551	1.627	1.68	3.068	2.468	2.885	3.337	2.863	**1.784**
1989	**0**	**0.31**	**0.388**	**0.415**	**0.617**	**0.81**	**0.982**	**1.361**	1.653	1.684	2.236	2.166	2.364	2.389	2.307	1.146	**1.752**
1990	**0**	**0.308**	**0.379**	**0.484**	**0.516**	**0.802**	**1.039**	**1.191**	1.543	2.037	2.653	2.53	2.392	3.444	1.852	4.731	**1.868**
1991	**0**	**0.319**	**0.377**	**0.48**	**0.643**	**0.653**	**1.042**	**1.232**	1.481	1.776	1.996	2.253	2.404	1.07	3.509	2.936	**1.584**
1992	**0**	**0.336**	**0.379**	**0.51**	**0.751**	**1.017**	**0.904**	**1.395**	1.538	1.912	1.997	2.067	2.441	1.781	0	0	**1.784**
1993	**0**	**0.326**	**0.393**	**0.483**	**0.684**	**0.896**	**1.173**	**1.111**	1.592	1.737	1.92	1.718	2.274	2.516	0	0	**1.753**
1994	**0**	**0.288**	**0.39**	**0.482**	**0.617**	**0.962**	**1.296**	**1.57**	1.469	1.62	2.418	2.108	2.849	2.403	2.58	0	**1.615**
1995	**0**	**0.323**	**0.403**	**0.425**	**0.608**	**0.772**	**1.118**	**1.444**	1.761	1.873	1.881	2.508	1.674	1.699	2.243	0	**1.866**
1996	**0**	**0.351**	**0.364**	**0.475**	**0.523**	**0.795**	**0.879**	**0.855**	1.833	2.018	1.623	2.393	2.369	2.598	3.439	0	**1.925**
1997	**0**	**0.388**	**0.416**	**0.417**	**0.614**	**0.624**	**0.921**	**0.974**	1.647	2.209	2.146	2.032	2.757	2.262	2.867	2.782	**1.893**
1998	**0**	**0.28**	**0.377**	**0.444**	**0.462**	**0.666**	**0.771**	**1.113**	1.2	1.834	2.34	2.15	1.115	2.423	2.085	2.509	**1.346**
1999	**0**	**0.291**	**0.349**	**0.423**	**0.489**	**0.511**	**0.729**	**0.785**	0.758	1.258	1.559	1.913	2.232	2.392	2.912	2.225	**0.836**
2000	**0**	**0.345**	**0.37**	**0.423**	**0.524**	**0.626**	**0.656**	**1.104**	1.1	1.757	1.963	2.323	2.385	2.315	3.595	1.843	**1.229**
2001	**0**	**0.433**	**0.355**	**0.447**	**0.505**	**0.723**	**0.762**	**0.98**	1.922	1.216	2.144	2.891	3.237	2.534	1.239	3.425	**1.787**
2002	**0**	**0.475**	**0.458**	**0.399**	**0.57**	**0.75**	**0.931**	**1**	1.426	1.942	2.346	1.84	2.349	2.762	0	0	**1.637**
2003	**0**	**0.311**	**0.438**	**0.476**	**0.443**	**0.687**	**0.798**	**1.159**	1.386	1.659	2.181	2.209	2.506	2.606	1.981	3.092	**1.633**
2004	**0**	**0.369**	**0.388**	**0.489**	**0.46**	**0.469**	**0.747**	**1.086**	1.372	1.741	1.777	2.355	2.172	0	0	0	**1.647**
2005	**0**	**0.4**	**0.401**	**0.429**	**0.551**	**0.512**	**0.533**	**0.883**	1.119	1.36	1.835	2.682	2.553	2.319	3.431	0	**1.348**
2006	**0**	**0.396**	**0.389**	**0.422**	**0.514**	**0.581**	**0.582**	**0.58**	1.051	1.663	2.236	2.641	1.926	3.022	2.901	2.709	**1.331**
2007	**0**	**0.384**	**0.386**	**0.473**	**0.515**	**0.631**	**0.719**	**0.719**	0.753	0.91	2.278	0.954	1.712	2.348	4.244	0	**0.757**

Table 13.2.3.3. Haddock in Subarea IV and Division IIIa. Mean weight at age data (kg) for discards. Data used in the assessment are highlighted in bold.

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	8+
1963	**0.064**	**0.139**	**0.218**	**0.327**	**0.397**	**0.321**	**0.321**	**0**	0	0	0	0	0	0	0	0	**0**
1964	**0.065**	**0.177**	**0.249**	**0.306**	**0.337**	**0.321**	**0.321**	**0**	0	0	0	0	0	0	0	0	**0**
1965	**0.064**	**0.131**	**0.2**	**0.341**	**0.613**	**0.321**	**0.321**	**0**	0	0	0	0	0	0	0	0	**0**
1966	**0.063**	**0.141**	**0.208**	**0.244**	**0.31**	**0.321**	**0.321**	**0**	0	0	0	0	0	0	0	0	**0**
1967	**0.064**	**0.171**	**0.209**	**0.274**	**0.306**	**0.321**	**0.321**	**0**	0	0	0	0	0	0	0	0	**0**
1968	**0.063**	**0.186**	**0.212**	**0.256**	**0.318**	**0.321**	**0.321**	**0**	0	0	0	0	0	0	0	0	**0**
1969	**0.064**	**0.129**	**0.216**	**0.237**	**0.301**	**0.321**	**0.321**	**0**	0	0	0	0	0	0	0	0	**0**
1970	**0.063**	**0.129**	**0.21**	**0.238**	**0.263**	**0.321**	**0.321**	**0**	0	0	0	0	0	0	0	0	**0**
1971	**0.063**	**0.134**	**0.201**	**0.242**	**0.263**	**0.321**	**0.321**	**0**	0	0	0	0	0	0	0	0	**0**
1972	**0.063**	**0.139**	**0.206**	**0.237**	**0.261**	**0.321**	**0.321**	**0**	0	0	0	0	0	0	0	0	**0**
1973	**0.063**	**0.131**	**0.201**	**0.235**	**0.263**	**0.321**	**0.321**	**0**	0	0	0	0	0	0	0	0	**0**
1974	**0.062**	**0.145**	**0.2**	**0.233**	**0.259**	**0.321**	**0.321**	**0**	0	0	0	0	0	0	0	0	**0**
1975	**0.05**	**0.123**	**0.2**	**0.257**	**0.275**	**0.348**	**0**	**0**	0	0	0	0	0	0	0	0	**0**
1976	**0.079**	**0.176**	**0.197**	**0.237**	**0.292**	**0.337**	**0**	**0**	0	0	0	0	0	0	0	0	**0**
1977	**0.071**	**0.196**	**0.197**	**0.216**	**0.309**	**0.347**	**0**	**0**	0	0	0	0	0	0	0	0	**0**
1978	**0.037**	**0.18**	**0.199**	**0.222**	**0.224**	**0.265**	**0.284**	**0**	0	0	0	0	0	0	0	0	**0**
1979	**0.053**	**0.118**	**0.219**	**0.242**	**0.259**	**0.34**	**0**	**0**	0	0	0	0	0	0	0	0	**0**
1980	**0.051**	**0.149**	**0.231**	**0.274**	**0.324**	**0**	**0**	**0**	0	0	0	0	0	0	0	0	**0**
1981	**0.073**	**0.16**	**0.198**	**0.29**	**0.65**	**0.727**	**0**	**0**	0	0	0	0	0	0	0	0	**0**
1982	**0.072**	**0.197**	**0.248**	**0.271**	**0.264**	**0**	**0**	**0**	0	0	0	0	0	0	0	0	**0**
1983	**0.067**	**0.187**	**0.237**	**0.347**	**0.476**	**0.711**	**0.792**	**0**	0	0	0	0	0	0	0	0	**0**
1984	**0.046**	**0.162**	**0.245**	**0.317**	**0.3**	**0.314**	**0**	**0**	0	0	0	0	0	0	0	0	**0**
1985	**0.04**	**0.155**	**0.214**	**0.264**	**0.336**	**0.423**	**0.421**	**0**	0	0	0	0	0	0	0	0	**0**
1986	**0.045**	**0.138**	**0.184**	**0.245**	**0.408**	**0.329**	**0**	**0**	0	0	0	0	0	0	0	0	**0**
1987	**0.023**	**0.159**	**0.2**	**0.225**	**0.287**	**0**	**0**	**0**	0	0	0	0	0	0	0	0	**0**
1988	**0.063**	**0.172**	**0.17**	**0.238**	**0.254**	**0.36**	**0**	**0**	0	0	0	0	0	0	0	0	**0**
1989	**0.085**	**0.187**	**0.229**	**0.268**	**0.335**	**0.708**	**0.844**	**0**	2.572	0	3.048	0	0	0	0	0	**0**
1990	**0.046**	**0.196**	**0.229**	**0.249**	**0.266**	**0.29**	**0.333**	**0**	0	0	0	0	0	0	0	0	**0**
1991	**0.065**	**0.179**	**0.243**	**0.344**	**0.464**	**0.493**	**0**	**0**	0	0	0	0	0	0	0	0	**0**
1992	**0.043**	**0.137**	**0.246**	**0.286**	**0.347**	**0**	**0.415**	**0**	0	0	0	0	0	0	0	0	**0**
1993	**0.027**	**0.142**	**0.237**	**0.287**	**0.344**	**0.369**	**0**	**0.369**	0	0	0	0	0	0	0	0	**0**
1994	**0.044**	**0.126**	**0.211**	**0.269**	**0.306**	**0.304**	**0.27**	**0**	0	0	0	0	0	0	0	0	**0**
1995	**0.064**	**0.131**	**0.251**	**0.275**	**0.363**	**0.384**	**0**	**0**	0	0	0	0	0	0	0	0	**0**
1996	**0.046**	**0.138**	**0.219**	**0.279**	**0.297**	**0.358**	**0**	**0**	0	0	0	0	0	0	0	0	**0**
1997	**0.063**	**0.161**	**0.254**	**0.286**	**0.321**	**0.385**	**0**	**0**	0	0	0	0	0	0	0	0	**0**
1998	**0.041**	**0.162**	**0.231**	**0.293**	**0.315**	**0.391**	**0.428**	**0**	0	0	0	0	0	0	0	0	**0**
1999	**0.049**	**0.183**	**0.217**	**0.273**	**0.307**	**0.304**	**0.25**	**0**	0	0	0	0	0	0	0	0	**0**
2000	**0.03**	**0.129**	**0.246**	**0.281**	**0.319**	**0.355**	**0.287**	**0**	0	0	0	0	0	0	0	0	**0**
2001	**0.045**	**0.116**	**0.205**	**0.307**	**0.308**	**0.364**	**0**	**0.411**	0.416	0	0	0	0	0	0	0	**0.416**
2002	**0.042**	**0.166**	**0.226**	**0.268**	**0.352**	**0.378**	**0**	**0.357**	0	0	0	0	0	0	0	0	**0**
2003	**0.046**	**0.125**	**0.222**	**0.265**	**0.332**	**0.536**	**0.654**	**0.951**	0.946	1.154	0	0	0	0	0	0	**0**
2004	**0.053**	**0.171**	**0.232**	**0.28**	**0.308**	**0.342**	**0.639**	**0.716**	0	0	0	0	0	0	0	0	**0**
2005	**0.055**	**0.185**	**0.251**	**0.283**	**0.313**	**0.305**	**0.345**	**0.621**	0	0	0	0	0	0	0	0	**0**
2006	**0.048**	**0.116**	**0.228**	**0.257**	**0.233**	**0.152**	**0.162**	**0.115**	0	0	0	0	0	0	0	0	**0**
2007	**0.039**	**0.149**	**0.192**	**0.292**	**0.315**	**0.371**	**0.426**	**0.341**	0.371	0.4	0	0	0	0	0	0	**0.371**

Table 13.2.3.4. Haddock in Subarea IV and Division IIIa. Mean weight at age data (kg) for IBC. Data used in the assessment are highlighted in bold.

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	8+
1963	**0.01**	**0.04**	**0.18**	**0.302**	**0.4**	**0.42**	**0.44**	**0**	0	0	0	0	0	0	0	0	**0**
1964	**0.01**	**0.04**	**0.18**	**0.302**	**0.4**	**0.42**	**0.44**	**0.5**	0	0	0	0	0	0	0	0	**0**
1965	**0.01**	**0.04**	**0.18**	**0.302**	**0.4**	**0.42**	**0.44**	**0.5**	0	0	0	0	0	0	0	0	**0**
1966	**0.01**	**0.04**	**0.18**	**0.302**	**0.4**	**0.42**	**0.44**	**0.5**	0	0	0	0	0	0	0	0	**0**
1967	**0.01**	**0.04**	**0.18**	**0.302**	**0.4**	**0.42**	**0.44**	**0**	0	0	0	0	0	0	0	0	**0**
1968	**0.01**	**0.04**	**0.18**	**0.302**	**0.4**	**0.42**	**0.44**	**0.5**	0	0	0	0	0	0	0	0	**0**
1969	**0.01**	**0.04**	**0.18**	**0.302**	**0.4**	**0.42**	**0.44**	**0.5**	0	0	0	0	0	0	0	0	**0**
1970	**0.01**	**0.04**	**0.18**	**0.302**	**0.4**	**0.42**	**0.44**	**0.5**	0	0	0	0	0	0	0	0	**0**
1971	**0.01**	**0.04**	**0.18**	**0.302**	**0.4**	**0.42**	**0.44**	**0**	0	0	0	0	0	0	0	0	**0**
1972	**0.023**	**0.067**	**0.136**	**0.255**	**0.288**	**0.231**	**0**	**0**	0	0	0	0	0	0	0	0	**0**
1973	**0.035**	**0.068**	**0.141**	**0.246**	**0.327**	**0.396**	**0**	**0**	0	0	0	0	0	0	0	0	**0**
1974	**0.022**	**0.058**	**0.15**	**0.26**	**0.359**	**0.579**	**0.277**	**0.447**	0	0	0	0	0	0	0	0	**0**
1975	**0.02**	**0.039**	**0.173**	**0.275**	**0.267**	**0.413**	**0.585**	**0**	0.585	0	0	0	0	0	0	0	**0.585**
1976	**0.012**	**0.046**	**0.181**	**0.304**	**0.473**	**0.36**	**0.725**	**0**	0	0	0	0	0	0	0	0	**0**
1977	**0.013**	**0.042**	**0.184**	**0.307**	**0.49**	**0.352**	**0.442**	**1.234**	1.315	1.319	0	0	0	0	0	0	**1.317**
1978	**0.011**	**0.04**	**0.174**	**0.286**	**0.372**	**0.473**	**0.411**	**0.456**	1.315	0	1.4	0	0	0	0	0	**1.345**
1979	**0.009**	**0.039**	**0.177**	**0.285**	**0.384**	**0.461**	**0.735**	**1.234**	1.315	0	1.4	0	0	0	0	0	**1.333**
1980	**0.012**	**0.039**	**0.176**	**0.268**	**0.623**	**0.722**	**1.102**	**1.591**	0	1.796	0	0	0	0	0	0	**1.796**
1981	**0.009**	**0.04**	**0.176**	**0.371**	**0.467**	**0.858**	**1.2**	**1.234**	1.315	1.319	1.4	0	0	0	0	0	**1.346**
1982	**0.01**	**0.04**	**0.206**	**0.379**	**0.636**	**0.751**	**1.225**	**1.233**	1.315	1.319	0	0	0	0	0	0	**1.316**
1983	**0.008**	**0.047**	**0.173**	**0.428**	**0.584**	**1.006**	**1.225**	**1.234**	1.315	1.319	0	0	0	0	0	0	**1.318**
1984	**0.009**	**0.045**	**0.211**	**0.414**	**0.626**	**0.751**	**1.225**	**1.234**	1.315	1.319	1.4	1.4	0	0	0	0	**1.356**
1985	**0.009**	**0.043**	**0.186**	**0.371**	**0.55**	**0.563**	**0.565**	**1.234**	1.315	1.319	1.4	0	0	0	0	0	**1.319**
1986	**0.01**	**0.04**	**0.186**	**0.375**	**0.626**	**1.259**	**1.225**	**1.234**	1.315	1.319	1.4	0	0	0	0	0	**1.328**
1987	**0.006**	**0.038**	**0.258**	**0.442**	**0.908**	**1.171**	**1.225**	**1.234**	1.315	1.319	0	0	0	0	0	0	**1.316**
1988	**0.018**	**0.077**	**0.196**	**0.274**	**0.455**	**0.549**	**1.225**	**1.234**	1.315	1.319	1.4	0	0	0	0	0	**1.33**
1989	**0.015**	**0.165**	**0.251**	**0.347**	**0.67**	**0.923**	**1.065**	**1.492**	1.315	0	1.4	0	0	0	0	0	**1.329**
1990	**0.005**	**0.104**	**0.229**	**0.506**	**0.609**	**0.842**	**0.829**	**0.796**	0.956	1.319	0	0	0	0	0	0	**0.956**
1991	**0.027**	**0.058**	**0.206**	**0.357**	**0.472**	**0.477**	**1.225**	**1.234**	1.315	1.319	0	0	0	0	0	0	**1.316**
1992	**0.015**	**0.059**	**0.217**	**0.422**	**0.552**	**0.615**	**0.548**	**1.234**	0.621	0.82	0	0	0	0	0	0	**0.659**
1993	**0.008**	**0.053**	**0.206**	**0.399**	**0.521**	**0.578**	**1.225**	**0.582**	1.315	0	0	0	0	0	0	0	**1.315**
1994	**0.011**	**0.055**	**0.155**	**0.435**	**0.595**	**0.698**	**0.49**	**0**	0	0	0	0	0	0	0	0	**0**
1995	**0.012**	**0.045**	**0.193**	**0.285**	**0.387**	**0**	**0**	**0**	0	0	0	0	0	0	0	0	**0**
1996	**0.018**	**0.077**	**0.136**	**0.162**	**0.264**	**0**	**0**	**0**	0	0	0	0	0	0	0	0	**0**
1997	**0.007**	**0.076**	**0.149**	**0.309**	**0.419**	**0.601**	**0**	**0**	0	0	0	0	0	0	0	0	**0**
1998	**0.02**	**0.075**	**0.166**	**0.291**	**0.351**	**0.453**	**0**	**0**	0	0	0	0	0	0	0	0	**0**
1999	**0.018**	**0.064**	**0.177**	**0.304**	**0.416**	**0.309**	**0**	**0**	0	0	0	0	0	0	0	0	**0**
2000	**0.058**	**0.07**	**0.113**	**0.176**	**0.37**	**0.203**	**0**	**0**	0	0	0	0	0	0	0	0	**0**
2001	**0.014**	**0.086**	**0.133**	**0.11**	**0.353**	**0.431**	**0**	**0**	0	0	0	0	0	0	0	0	**0**
2002	**0.016**	**0.064**	**0.178**	**0.283**	**0.374**	**0.431**	**0**	**0**	0	0	0	0	0	0	0	0	**0**
2003	**0.012**	**0.031**	**0.056**	**0.231**	**0.326**	**0.339**	**0**	**0**	0	0	0	0	0	0	0	0	**0**
2004	**0**	**0.116**	**0.183**	**0.255**	**0.276**	**0.446**	**0.539**	**0.84**	0	0	0	0	0	0	0	0	**0**
2005	**0**	**0.107**	**0.187**	**0.239**	**0.268**	**0.287**	**0.598**	**0.619**	0	0	0	0	0	0	0	0	**0**
2006	**0**	**0.127**	**0.232**	**0.273**	**0.273**	**0.28**	**0.283**	**0.286**	0.287	0	0	0	0	0	0	0	**0.287**
2007	**0**	**0.127**	**0.232**	**0.273**	**0.273**	**0.28**	**0.283**	**0.286**	0.287	0	0	0	0	0	0	0	**0.287**

Table 13.2.5.1. Haddock in Subarea IV and Division IIIa. Data available for calibration of the assessment. Data used in the final assessment are highlighted in bold.

EngGFS_GRT. Period: 0.5 - 0.75

	Effort	0	1	2	3	4	5	6	7	8	9	10+
1977	100	**53.480**	**6.681**	**3.206**	**6.163**	**0.925**	**0.073**	**0.091**	0.013	0.004	0.007	0.000
1978	100	**35.827**	**13.688**	**2.618**	**0.239**	**2.220**	**0.214**	**0.005**	0.074	0.009	0.000	0.005
1979	100	**87.551**	**29.555**	**5.461**	**0.872**	**0.108**	**0.438**	**0.035**	0.005	0.018	0.000	0.005
1980	100	**37.403**	**62.331**	**16.732**	**2.570**	**0.273**	**0.042**	**0.142**	0.022	0.000	0.000	0.000
1981	100	**153.746**	**17.318**	**43.910**	**7.557**	**0.742**	**0.064**	**0.003**	0.061	0.009	0.004	0.006
1982	100	**28.134**	**31.546**	**7.980**	**11.800**	**1.025**	**0.237**	**0.098**	0.015	0.008	0.000	0.000
1983	100	**83.193**	**21.820**	**10.952**	**2.143**	**2.174**	**0.265**	**0.040**	0.013	0.002	0.003	0.000
1984	100	**22.847**	**59.933**	**6.159**	**3.078**	**0.418**	**0.478**	**0.103**	0.013	0.002	0.006	0.020
1985	100	**24.587**	**18.656**	**23.819**	**2.111**	**0.698**	**0.196**	**0.128**	0.041	0.009	0.002	0.002
1986	100	**26.600**	**14.974**	**4.472**	**3.382**	**0.277**	**0.175**	**0.038**	0.036	0.012	0.005	0.003
1987	100	**2.241**	**28.194**	**4.310**	**0.532**	**0.686**	**0.048**	**0.033**	0.003	0.000	0.002	0.000
1988	100	**6.073**	**2.856**	**18.352**	**1.549**	**0.160**	**0.279**	**0.041**	0.012	0.002	0.000	0.002
1989	100	**9.428**	**8.168**	**1.447**	**3.968**	**0.253**	**0.031**	**0.061**	0.014	0.018	0.000	0.004
1990	100	**28.188**	**6.645**	**1.983**	**0.287**	**0.878**	**0.048**	**0.026**	0.012	0.008	0.003	0.000
1991	100	**26.333**	**11.505**	**0.961**	**0.231**	**0.048**	**0.219**	**0.005**	0.007	0.003	0.003	0.000

EngGFS Q3 GOV. Period: 0.5 - 0.75

	Effort	0	1	2	3	4	5	6	7	8	9	10+
1992	100	**246.021**	**58.746**	**29.133**	**1.742**	**0.146**	**0.037**	**0.251**	0.010	0.135	0.000	0.016
1993	100	**40.336**	**73.145**	**17.435**	**4.951**	**0.176**	**0.048**	**0.000**	0.026	0.003	0.000	0.000
1994	100	**279.344**	**23.990**	**26.992**	**2.511**	**0.894**	**0.058**	**0.003**	0.003	0.000	0.003	0.000
1995	100	**53.435**	**113.775**	**13.223**	**11.032**	**0.827**	**0.275**	**0.021**	0.000	0.000	0.008	0.003
1996	100	**61.301**	**26.747**	**43.044**	**3.603**	**2.052**	**0.207**	**0.088**	0.006	0.000	0.003	0.000
1997	100	**40.653**	**45.346**	**12.608**	**19.968**	**0.719**	**0.718**	**0.067**	0.019	0.000	0.000	0.000
1998	100	**15.747**	**26.497**	**16.778**	**4.079**	**4.141**	**0.226**	**0.141**	0.009	0.021	0.000	0.000
1999	100	**626.100**	**16.551**	**8.404**	**3.663**	**1.258**	**1.201**	**0.040**	0.036	0.011	0.000	0.000
2000	100	**92.139**	**249.813**	**4.528**	**1.634**	**0.740**	**0.336**	**0.350**	0.000	0.004	0.000	0.000
2001	100	**1.097**	**28.622**	**96.498**	**3.039**	**0.828**	**0.350**	**0.135**	0.058	0.177	0.003	0.000
2002	100	**2.721**	**3.954**	**22.559**	**60.583**	**0.542**	**0.097**	**0.153**	0.096	0.034	0.007	0.000
2003	100	**3.199**	**6.015**	**1.247**	**13.967**	**45.079**	**0.719**	**0.026**	0.221	0.082	0.014	0.003
2004	100	**3.398**	**6.599**	**3.864**	**0.448**	**6.836**	**17.406**	**0.217**	0.093	0.089	0.083	0.082
2005	100	**122.383**	**9.740**	**5.992**	**2.584**	**1.249**	**6.617**	**3.654**	0.021	0.007	0.000	0.000
2006	100	**11.825**	**54.816**	**3.270**	**1.140**	**0.433**	**0.150**	**0.859**	1.569	0.020	0.011	0.003
2007	100	**8.463**	**10.628**	**43.401**	**1.402**	**0.624**	**0.092**	**0.078**	0.315	0.559	0.046	0.015

Table 13.2.5.1. Haddock in Subarea IV and Division IIIa. Data available for calibration of the assessment. Data used in the final assessment are highlighted in bold.

ScoGFS_ABN. Period: 0.5 - 0.75

	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	0
1987	100	**277**	**2393**	**704**	**106**	**128**	**8**	**5**	1	2
1988	100	**406**	**467**	**1982**	**170**	**27**	**23**	**2**	1	0
1989	100	**432**	**886**	**214**	**574**	**31**	**4**	**7**	1	0
1990	100	**3163**	**1002**	**240**	**32**	**103**	**7**	**1**	3	1
1991	100	**3471**	**1705**	**178**	**21**	**5**	**16**	**2**	0	1
1992	100	**8270**	**3832**	**963**	**48**	**8**	**3**	**8**	0	0
1993	100	**859**	**5836**	**1380**	**269**	**6**	**4**	**1**	3	0
1994	100	**13762**	**1265**	**2080**	**210**	**53**	**2**	**0**	0	0
1995	100	**1566**	**8153**	**734**	**926**	**74**	**28**	**2**	0	0
1996	100	**1980**	**2231**	**4705**	**231**	**206**	**22**	**6**	0	0
1997	100	**972**	**2779**	**849**	**1397**	**66**	**56**	**6**	0	0

ScoGFS_GOV. Period: 0.5 - 0.75

	Effort	0	1	2	3	4	5	6	7	8
1998	100	**3280**	**6349**	**1924**	**490**	**511**	**24**	**18**	2	0
1999	100	**66067**	**1907**	**1141**	**688**	**197**	**164**	**6**	7	1
2000	100	**11902**	**30611**	**460**	**221**	**130**	**73**	**27**	4	3
2001	100	**79**	**3790**	**11352**	**179**	**65**	**40**	**18**	14	1
2002	100	**2149**	**675**	**2632**	**6931**	**70**	**37**	**18**	3	3
2003	100	**2159**	**1172**	**307**	**2092**	**4344**	**22**	**17**	8	2
2004	100	**1729**	**1198**	**547**	**101**	**819**	**1420**	**9**	1	1
2005	100	**19708**	**761**	**657**	**153**	**112**	**347**	**483**	4	3
2006	100	**2280**	**7275**	**272**	**158**	**33**	**14**	**73**	227	2
2007	100	**1119**	**1810**	**5527**	**117**	**57**	**11**	**5**	38	36

IBTS_Q1. Period: 0 - 0.25

	Effort	1	2	3	4	5
1983	100	**302.278**	**403.079**	**89.463**	**116.447**	**13.182**
1984	100	**1072.285**	**221.275**	**127.77**	**20.41**	**20.9**
1985	100	**230.968**	**833.257**	**107.598**	**32.317**	**3.575**
1986	100	**573.023**	**266.912**	**303.546**	**17.888**	**6.49**
1987	100	**912.559**	**328.062**	**45.201**	**58.262**	**4.345**
1988	100	**101.691**	**677.641**	**97.149**	**12.684**	**13.965**
1989	100	**219.705**	**98.091**	**274.788**	**16.653**	**2.113**
1990	100	**217.448**	**139.114**	**32.997**	**50.367**	**3.163**
1991	100	**680.231**	**134.076**	**25.032**	**4.26**	**8.476**
1992	100	**1141.396**	**331.044**	**17.035**	**3.026**	**0.664**
1993	100	**1242.121**	**519.521**	**152.384**	**8.848**	**1.076**
1994	100	**227.919**	**491.051**	**97.656**	**23.308**	**1.566**
1995	100	**1355.485**	**201.069**	**176.165**	**24.354**	**5.286**
1996	100	**267.411**	**813.268**	**65.869**	**46.691**	**7.734**
1997	100	**849.943**	**353.882**	**466.731**	**24.987**	**15.238**
1998	100	**357.597**	**420.926**	**103.531**	**112.632**	**8.758**
1999	100	**211.139**	**222.907**	**127.064**	**48.217**	**36.65**
2000	100	**3734.185**	**107.06**	**48.638**	**24.549**	**15.589**
2001	100	**894.651**	**2255.213**	**47.899**	**10.962**	**7.218**
2002	100	**58.211**	**492.299**	**1387.877**	**10.01**	**7.457**
2003	100	**89.958**	**38.585**	**251.271**	**524.144**	**4.275**
2004	100	**71.875**	**79.622**	**35.473**	**173.589**	**330.011**
2005	100	**69.976**	**60.993**	**32.625**	**10.997**	**61.287**
2006	100	**1212.163**	**47.784**	**28.576**	**8.977**	**4.404**
2007	100	**109.096**	**963.325**	**36.603**	**15.483**	**3.374**
2008	100	**60.115**	**106.489**	**239.315**	**14.783**	**1.554**

Table 13.2.5.1. Haddock in Subarea IV and Division IIIa. Data available for calibration of the assessment. Data used in the final assessment are highlighted in bold.

ScoLTR_IV. Period: 0 - 1

	Effort	1	2	3	4	5	6	7	8	9	10	11	12	13+
1978	236929	45733	11471	2914	12279	774	110	167	24	4	0	5	1	0
1979	287494	44562	23135	4109	714	3644	203	20	57	20	0	0	1	0
1980	333197	92519	46282	8062	755	197	1015	61	18	8	5	0	0	0
1981	251504	7979	58146	13653	1518	161	20	320	12	6	7	6	0	0
1982	250870	24575	10170	33463	3937	133	67	7	58	0	0	2	0	0
1983	244349	19635	48680	6955	11807	1258	124	27	4	25	7	0	0	2
1984	240725	56769	22191	13375	2074	3392	402	98	15	7	14	1	0	0
1985	268136	38850	57422	4913	2787	414	872	128	27	2	0	18	0	0
1986	279767	26322	26549	32339	2797	1014	124	307	43	37	2	2	2	3
1987	351128	26220	33648	6464	7197	496	377	72	119	27	2	4	3	4
1988	391988	2931	57589	14075	2367	2924	167	84	28	21	6	0	0	0
1989	405883	10415	2919	24895	2754	541	627	109	30	21	7	4	1	1
1990	441084	11886	19205	2665	10237	669	168	264	45	14	5	2	1	0
1991	408056	44141	12394	3356	564	2213	226	80	146	38	16	2	1	0
1992	473955	20443	31073	3889	757	144	766	98	52	58	17	3	1	0
1993	447064	39863	39176	20213	1527	362	84	274	29	27	26	8	2	1
1994	480400	8267	49047	23557	6304	474	128	42	64	13	7	7	2	2
1995	442010	22874	13762	32063	5821	1658	97	15	13	17	3	2	1	1
1996	445995	14281	72692	9860	13959	2041	955	304	10	14	7	1	2	1
1997	479449	15907	13451	49548	3537	4511	553	163	13	2	2	1	1	1
1998	427868	27498	33166	9597	29614	1666	1228	173	46	4	1	1	0	1
1999	329750	24475	36849	24426	5531	11752	841	579	94	9	2	0	0	0
2000	280938	64710	15038	11707	7061	1300	2593	174	83	8	2	1	0	0
2001	245489	15567	173376	6323	2897	1253	365	444	62	17	9	0	0	0
2002	184096	982	11514	53313	1738	664	395	165	218	94	5	4	2	0
2003	98723	2804	3186	10931	30249	601	235	123	56	35	15	2	1	0
2004	63953	1114	3797	1602	6436	18851	243	68	26	17	11	3	0	0
2005	54905	1571	4512	2971	760	5634	11540	42	30	11	2	2	1	0
2006	51456	154	1583	2445	1042	492	2412	5486	32	10	7	2	3	0
2007	50035	12	4104	1315	1068	373	217	675	1027	3	1	0	0	0

Table 13.2.5.1. Haddock in Subarea IV and Division IIIa. Data available for calibration of the assessment. Data used in the final assessment are highlighted in bold.

ScoSEI_IV. Period: 0 - 1

	Effort	1	2	3	4	5	6	7	8	9	10	11	12	13+
1978	325246	160843	69033	14340	44152	2366	482	673	86	29	3	16	6	0
1979	316419	83631	78815	17215	3040	8073	648	70	113	24	4	1	1	0
1980	297227	131314	128306	26205	3393	501	2415	123	20	56	23	13	1	1
1981	289672	10367	134260	55726	5181	702	102	579	15	22	1	10	2	0
1982	297730	31143	30969	118898	14297	682	145	39	230	1	9	1	0	0
1983	333168	29021	77289	30414	50115	6394	583	119	15	69	26	1	2	0
1984	388085	120868	63391	49286	9426	14977	1594	254	18	8	38	3	2	0
1985	382910	29239	164839	33203	15993	2293	2846	308	47	19	9	28	2	0
1986	425017	33999	72604	155836	12895	4169	490	620	58	11	20	15	11	3
1987	418734	43646	97731	19731	28883	1989	1174	199	285	31	16	15	12	7
1988	377132	11576	201533	37421	4736	7415	718	290	80	70	27	6	6	7
1989	355735	19004	19274	91070	8389	1091	1611	223	89	40	13	6	4	1
1990	300076	35844	46489	9055	26705	1434	302	408	67	29	5	3	0	0
1991	336675	66144	30755	9531	1485	5028	308	122	183	42	11	1	1	0
1992	300217	30384	64733	8588	1512	290	1180	79	57	53	18	4	0	1
1993	268413	74523	88375	34997	2349	446	100	314	29	15	14	3	0	1
1994	264738	26626	125357	34127	10522	415	138	42	95	9	7	7	2	1
1995	204545	67772	32301	70290	8734	2181	117	39	13	9	4	2	3	1
1996	177092	9192	123829	18532	17077	2161	707	84	12	8	11	3	2	1
1997	166817	30046	19165	59309	3918	4083	495	195	10	7	2	0	0	2
1998	150361	12692	36813	12003	26564	1659	856	69	22	4	2	2	0	0
1999	93796	23253	35102	21991	6628	11164	690	456	56	12	0	1	0	0
2000	69505	46422	13650	8497	5610	1761	2357	110	41	4	1	0	0	0
2001	36135	3973	91165	4469	1720	799	273	263	27	18	1	1	0	0
2002	21817	708	10089	45219	1177	400	169	61	45	15	1	1	0	0
2003	15374	395	1312	8571	23778	346	80	32	11	4	5	2	0	0
2004	15674	3711	6459	868	9719	24783	125	19	4	4	3	1	0	0
2005	16149	1841	3189	3210	491	5839	14660	26	2	6	1	1	0	0
2006	13539	206	1348	2163	1119	433	2336	6209	20	1	0	0	0	0
2007	20241	44	4719	1736	1260	461	134	864	961	9	1	1	0	0

Table 13.3.5.1. Haddock in Subarea IV and Division IIIa. XSA final assessment: Tuning diagnostics.

FLR XSA Diagnostics 2008-05-04 23:22:49

CPUE data from x.idx

Catch data for 45 years. 1963 to 2007. Ages 0 to 8.

	fleet	first age	last age	first year	last year	alpha	beta
1	EngGFS Q3 GRT	0	6	1977	1991	0.5	0.75
2	EngGFS Q3 GOV	0	6	1992	2007	0.5	0.75
3	ScoGFS Aberdeen Q3	0	6	1982	1997	0.5	0.75
4	ScoGFS Q3 GOV	0	6	1998	2007	0.5	0.75
5	IBTS Q1 (backshifted)	0	4	1982	2007	0.99	1

Time series weights :

Tapered time weighting not applied

Catchability analysis :

Catchability independent of size for ages > 0

Catchability independent of age for ages > 6

Terminal population estimation :

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

S.E. of the mean to which the estimates are shrunk = 2

Minimum standard error for population
estimates derived from each fleet = 0.3

prior weighting not applied

Regression weights

age \ year	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
all	1	1	1	1	1	1	1	1	1	1

Fishing mortalities

age \ year	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
0	0.006	0.002	0.001	0.002	0.040	0.007	0.001	0.000	0.001	0.001
1	0.122	0.156	0.046	0.058	0.120	0.104	0.051	0.048	0.050	0.059
2	0.577	0.757	0.724	0.273	0.139	0.322	0.333	0.291	0.419	0.253
3	0.481	0.834	0.820	0.770	0.182	0.150	0.277	0.420	0.557	0.516
4	0.718	0.504	0.704	0.407	0.359	0.122	0.177	0.233	0.582	0.483
5	0.500	0.664	0.223	0.223	0.156	0.177	0.146	0.191	0.346	0.390
6	0.213	0.390	0.289	0.082	0.082	0.063	0.091	0.133	0.151	0.290
7	0.150	0.139	0.150	0.063	0.038	0.027	0.019	0.052	0.093	0.095
8	0.150	0.139	0.150	0.063	0.038	0.027	0.019	0.052	0.093	0.095

XSA population number (thousands)

year \ age	0	1	2	3	4	5	6	7	8
1998	9994167	1641771	464321	147098	238997	16119	20555	3749	1353
1999	137380451	1278663	279029	174734	70832	90826	8002	13607	3339
2000	26773523	17655374	210083	87769	59092	33332	38295	4436	2225
2001	2894893	3444307	3237741	68264	30097	22761	21837	23474	5023
2002	3651268	371765	624038	1652164	24621	15597	14904	16466	22473
2003	3811617	451836	63334	363988	1072970	13397	10925	11238	10014
2004	3961768	487433	78208	30778	243985	739382	9187	8400	7841
2005	39022498	509648	88993	37588	18169	159177	522905	6868	3163
2006	6383210	5021830	93274	44594	19226	11212	107632	374956	2186
2007	4454262	820876	917767	41102	19893	8371	6493	75739	86798

Table 13.3.5.1. Haddock in Subarea IV and Division IIIa. XSA final assessment: Tuning diagnostics (cont.)

Estimated population abundance at 1st Jan 2008

year	age 0	1	2	3	4	5	6	7	8
2008	6018	572734	148664	477642	19115	9558	4642	3977	56405

Fleet: EngGFS Q3 GRT

Log catchability residuals.

age	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
0	0.379	-0.271	-0.123	0.575	0.990	0.130	-0.093	0.117	-0.112	-0.676	-0.379	-0.243	0.053
1	-0.502	-0.243	-0.008	0.157	0.434	0.295	0.361	0.159	0.392	-0.207	-0.319	-0.120	0.214
2	0.226	-0.305	-0.110	0.312	0.544	0.381	0.104	-0.035	0.060	0.076	-0.444	0.175	0.054
3	-0.242	-0.812	0.123	0.558	0.817	0.364	0.303	0.169	0.232	-0.407	-0.509	0.174	0.030
4	0.362	0.179	-0.134	0.376	0.486	0.034	0.002	0.029	0.089	-0.209	-0.466	-0.148	0.010
5	0.234	0.183	-0.083	0.288	0.032	0.164	-0.083	-0.180	0.462	0.046	-0.477	0.129	-0.371
6	0.264	-0.651	-0.423	0.206	-1.009	1.525	-0.723	0.251	-0.228	-0.077	-0.205	0.964	0.139

age	1990	1991
0	-0.163	-0.183
1	0.024	-0.638
2	-0.076	-0.961
3	-0.124	-0.677
4	-0.049	-0.560
5	-0.191	-0.154
6	0.969	-1.001

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

	1	2	3	4	5	6
Mean_Logq	-15.5126	-15.0322	-15.2097	-15.3563	-15.5446	-15.9928
S.E_Logq	0.3308	0.3661	0.4590	0.2887	0.2539	0.7384

Table 13.3.5.1. Haddock in Subarea IV and Division IIIa. XSA final assessment: Tuning diagnostics (cont.)

```
 Regression statistics
 Ages with q dependent on year class strength
         slope intercept
Age 0 0.858127  16.96477


 Fleet:  EngGFS Q3 GOV

 Log catchability residuals.

   year
age   1992   1993   1994   1995   1996   1997   1998   1999   2000   2001   2002   2003   2004
  0  0.130  0.149 -0.006  0.202  0.003  0.163 -0.053 -0.249  0.023 -0.325 -0.104 -0.076 -0.077
  1  0.223  0.039  0.086  0.137  0.057  0.205  0.175 -0.025 -0.004 -0.528 -0.244 -0.029 -0.045
  2  0.461  0.010 -0.102  0.305 -0.072  0.031  0.074  0.003 -0.352 -0.308 -0.198 -0.692  0.235
  3  0.397  0.082 -0.499  0.217  0.211  0.184 -0.150 -0.211 -0.338  0.502 -0.057 -0.031 -0.922
  4 -0.200 -0.320 -0.091 -0.091 -0.084 -0.111 -0.131 -0.239 -0.464  0.139 -0.115  0.385  0.014
  5  0.088  0.346 -0.039  0.126 -0.070  0.118 -0.088 -0.045 -0.591 -0.168 -1.115  1.053  0.210
  6  1.347     NA -0.431  0.317  0.507  0.193 -0.290 -0.496  0.045 -0.475  0.032 -1.442  0.871
   year
age   2005   2006   2007
  0 -0.102  0.114  0.208
  1  0.298 -0.261 -0.085
  2  0.518 -0.054  0.141
  3  0.720 -0.184  0.078
  4  0.946  0.047  0.317
  5  0.806 -0.231 -0.400
  6 -0.321 -0.177  0.319


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

                 1        2        3        4        5        6
Mean_Logq -14.7147 -14.2988 -14.4924 -14.8351 -15.2556 -15.9478
S.E_Logq    0.2097   0.3068   0.3987   0.3313   0.5041   0.6562
```

Table 13.3.5.1. Haddock in Subarea IV and Division IIIa. XSA final assessment: Tuning diagnostics (cont.)

```
 Regression statistics
 Ages with q dependent on year class strength
          slope intercept
Age 0 0.6273048  16.39311


 Fleet:  ScoGFS Aberdeen Q3

 Log catchability residuals.

   year
age   1982   1983   1984   1985   1986   1987   1988   1989   1990   1991   1992   1993   1994
  0 -0.134 -0.731 -0.251 -0.585 -0.646  0.114 -0.203 -0.184  0.270  0.370  0.653 -0.028  0.774
  1 -0.215 -0.098 -0.431  0.176 -0.038 -0.756  0.098  0.022  0.161 -0.517  0.321  0.338 -0.030
  2  0.292  0.180 -0.099 -0.026  0.016 -0.264 -0.058  0.134 -0.195 -0.655 -0.223  0.199  0.061
  3  0.238  0.605  0.008  0.077 -0.086 -0.069  0.018  0.150 -0.264 -1.021 -0.424 -0.060 -0.210
  4  0.030  0.622  0.184  0.359 -0.066  0.039  0.257  0.095 -0.008 -0.638 -0.399 -0.993 -0.211
  5 -1.089  0.577  0.094  0.092  0.446  0.001 -0.097 -0.150  0.153 -0.502  0.134  0.419 -0.848
  6 -0.274  0.166 -0.094  0.104 -0.235  0.001  0.037  0.067 -0.196  0.176  0.039  0.226     NA
   year
age  1995   1996   1997
  0 0.341  0.165  0.076
  1 0.328  0.400  0.240
  2 0.139  0.440  0.059
  3 0.510  0.234  0.294
  4 0.200  0.322  0.206
  5 0.400  0.246  0.125
  6 0.104 -0.040 -0.081


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

                 1        2        3        4        5        6
Mean_Logq -10.6342 -10.1167 -10.3551 -10.6325 -10.9059 -11.1782
S.E_Logq    0.3360   0.2577   0.3835   0.4013   0.4613   0.1523
```

Table 13.3.5.1. Haddock in Subarea IV and Division IIIa. XSA final assessment: Tuning diagnostics (cont.)

Regression statistics
Ages with q dependent on year class strength

	slope	intercept
Age 0	0.8630913	13.39340

Fleet: ScoGFS Q3 GOV

Log catchability residuals.

age \ year	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
0	0.002	-0.176	0.036	-1.389	0.550	0.506	0.330	0.056	0.126	-0.041
1	0.737	-0.195	-0.112	-0.560	-0.021	0.326	0.239	-0.260	-0.290	0.136
2	0.057	0.154	-0.490	-0.299	-0.198	0.055	0.428	0.456	-0.393	0.229
3	-0.064	0.323	-0.133	-0.124	-0.019	0.276	-0.205	0.099	0.046	-0.199
4	-0.101	0.029	-0.081	-0.284	-0.039	0.167	0.014	0.656	-0.406	0.046
5	-0.041	0.254	0.173	-0.047	0.211	-0.144	-0.006	0.148	-0.312	-0.234
6	-0.003	-0.048	-0.172	-0.145	0.237	0.478	0.033	0.000	-0.297	-0.083

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

	1	2	3	4	5	6
Mean_Logq	-9.7977	-9.5397	-9.7906	-10.0493	-10.6377	-11.3850
S.E_Logq	0.3713	0.3330	0.1860	0.2839	0.1937	0.2196

Regression statistics
Ages with q dependent on year class strength

	slope	intercept
Age 0	0.7991183	12.31268

Table 13.3.5.1. Haddock in Subarea IV and Division IIIa. XSA final assessment: Tuning diagnostics (cont.)

```
 Fleet:  IBTS Q1 (backshifted)

 Log catchability residuals.

   year
age   1982   1983   1984   1985   1986   1987  1988  1989   1990   1991   1992   1993   1994
  0 -0.354 -0.380 -0.440  0.027 -0.251  0.163 0.174 0.136  0.006  0.481  0.166 -0.195 -0.040
  1 -0.134 -0.308 -0.204  0.089 -0.113 -0.142 0.425 0.047  0.056 -0.263  0.210 -0.240  0.022
  2 -0.023 -0.172  0.099 -0.142 -0.201  0.035 0.199 0.449 -0.099 -0.771  0.144 -0.215 -0.267
  3  0.014 -0.014 -0.046 -0.199 -0.026  0.136 0.110 0.005  0.071 -0.647  0.234 -0.208 -0.060
  4  0.112 -0.113 -0.227 -0.060  0.280  0.188 0.127 0.228 -0.144 -0.382 -0.043 -0.043 -0.214
   year
age   1995   1996   1997   1998   1999   2000   2001   2002   2003   2004   2005   2006   2007
  0 -0.139  0.461  0.192 -0.025 -0.005  0.288  0.020  0.207 -0.051 -0.114  0.199 -0.176 -0.351
  1 -0.103  0.419  0.233  0.106 -0.343 -0.030  0.094 -0.165  0.349 -0.046 -0.338  0.380 -0.002
  2 -0.152  0.229  0.040  0.071 -0.201  0.035  0.217  0.021  0.533  0.249 -0.054  0.275 -0.300
  3 -0.246  0.250 -0.082  0.286 -0.209 -0.341 -0.231 -0.044  0.332  0.170 -0.090  0.420  0.414
  4  0.228 -0.035  0.373  0.075  0.224 -0.166  0.246 -0.158  0.179  0.031  0.051  0.075 -0.833


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

                 1        2        3        4
Mean_Logq -11.8528 -11.9076 -12.1875 -12.5005
S.E_Logq    0.2316   0.2662   0.2465   0.2509

 Regression statistics
 Ages with q dependent on year class strength
          slope intercept
Age 0 0.9213171  13.51726
```

Table 13.3.5.1. Haddock in Subarea IV and Division IIIa. XSA final assessment: Tuning diagnostics (cont.)

```
 Terminal year survivor and F summaries:

 Age 0 Year class = 2007

source                 survivors N scaledWts
EngGFS Q3 GOV             798225 1     0.446
ScoGFS Q3 GOV             544212 1     0.068
IBTS Q1 (backshifted)     391417 1     0.446
fshk                       60021 1     0.010
nshk                     2847489 1     0.030

 Age 1 Year class = 2006

source                 survivors N scaledWts
EngGFS Q3 GOV             156058 2     0.419
ScoGFS Q3 GOV             171075 2     0.157
IBTS Q1 (backshifted)     134936 2     0.419
fshk                      103073 1     0.005

 Age 2 Year class = 2005

source                 survivors N scaledWts
EngGFS Q3 GOV             432859 3     0.391
ScoGFS Q3 GOV             482690 3     0.201
IBTS Q1 (backshifted)     523666 3     0.405
fshk                      385574 1     0.004

 Age 3 Year class = 2004

source                 survivors N scaledWts
EngGFS Q3 GOV              20096 4     0.327
ScoGFS Q3 GOV              15214 4     0.269
IBTS Q1 (backshifted)      21229 4     0.400
fshk                       34224 1     0.005

 Age 4 Year class = 2003

source                 survivors N scaledWts
EngGFS Q3 GOV              11007 5     0.311
ScoGFS Q3 GOV              11029 5     0.300
IBTS Q1 (backshifted)       7568 5     0.384
fshk                       17185 1     0.005

 Age 5 Year class = 2002

source                 survivors N scaledWts
EngGFS Q3 GOV               4750 6     0.294
ScoGFS Q3 GOV               4125 6     0.407
IBTS Q1 (backshifted)       5264 5     0.293
fshk                        9753 1     0.006

 Age 6 Year class = 2001

source                 survivors N scaledWts
EngGFS Q3 GOV               3599 7     0.278
ScoGFS Q3 GOV               3891 7     0.451
IBTS Q1 (backshifted)       4496 5     0.267
fshk                       12173 1     0.004

 Age 7 Year class = 2000

source                 survivors N scaledWts
EngGFS Q3 GOV              53457 7     0.293
ScoGFS Q3 GOV              53066 7     0.409
IBTS Q1 (backshifted)      65809 5     0.295
fshk                       11750 1     0.003
```

Table 13.3.5.2. Haddock in Subarea IV and Division IIIa. Estimates of fishing mortality at age from the final XSA assessment. Estimates refer to the full year (January – December) except for age 0, for which the mortality rate given refers to the second half-year only (July – December).

Year	Age								
	0	1	2	3	4	5	6	7	8+
1963	0.002	0.125	0.805	0.668	0.762	0.902	0.648	0.779	0.779
1964	0.043	0.059	0.457	1.174	0.751	0.886	1.365	1.012	1.012
1965	0.071	1.359	0.421	0.513	0.984	1.275	1.026	1.108	1.108
1966	0.070	1.304	0.828	0.367	0.792	1.237	1.225	1.098	1.098
1967	0.002	0.262	1.085	0.412	0.382	1.057	1.313	0.927	0.927
1968	0.002	0.051	0.578	0.908	0.304	0.529	0.900	0.582	0.582
1969	0.017	0.021	0.654	1.377	1.332	0.801	1.871	1.352	1.352
1970	0.030	0.503	1.036	1.145	1.274	0.781	1.364	1.153	1.153
1971	0.012	0.474	0.665	0.793	0.860	0.873	0.838	0.866	0.866
1972	0.032	0.168	0.793	1.380	1.183	1.120	0.880	1.074	1.074
1973	0.002	0.373	0.565	1.161	0.873	0.909	0.995	0.936	0.936
1974	0.013	0.351	0.934	0.944	1.006	0.751	0.791	0.858	0.858
1975	0.011	0.333	0.956	1.261	1.085	1.004	1.263	1.131	1.131
1976	0.029	0.306	0.808	1.309	0.797	1.212	1.102	1.049	1.049
1977	0.012	0.327	0.995	1.013	1.080	1.078	0.864	1.019	1.019
1978	0.020	0.373	0.989	1.122	1.066	0.753	1.191	0.812	0.812
1979	0.033	0.171	0.826	1.076	1.048	0.886	0.435	0.866	0.866
1980	0.068	0.182	0.689	1.006	0.982	0.903	0.695	0.196	0.196
1981	0.057	0.176	0.438	0.894	0.630	0.526	0.566	0.477	0.477
1982	0.039	0.172	0.417	0.778	0.770	0.280	0.352	0.837	0.837
1983	0.027	0.151	0.653	0.959	1.029	0.864	0.222	0.242	0.242
1984	0.016	0.125	0.669	0.971	0.966	0.862	0.487	0.112	0.112
1985	0.016	0.208	0.613	0.967	1.029	0.672	0.473	0.217	0.217
1986	0.003	0.129	1.029	1.239	1.333	0.874	0.319	0.200	0.200
1987	0.006	0.106	0.909	1.077	1.078	0.920	0.706	0.226	0.226
1988	0.004	0.135	0.786	1.310	1.220	1.094	0.969	0.326	0.326
1989	0.003	0.106	0.655	0.973	1.216	0.882	0.751	1.005	1.005
1990	0.005	0.184	1.112	1.141	1.070	0.953	0.859	0.591	0.591
1991	0.013	0.152	0.778	1.035	0.841	0.755	0.712	1.424	1.424
1992	0.018	0.136	0.724	1.131	1.075	0.759	0.766	0.891	0.891
1993	0.030	0.160	0.789	0.996	0.891	0.985	0.692	0.399	0.399
1994	0.004	0.144	0.539	1.015	0.914	0.666	1.175	0.729	0.729
1995	0.039	0.098	0.483	0.820	0.871	0.660	0.367	0.933	0.933
1996	0.019	0.061	0.428	0.842	0.768	0.702	0.609	1.621	1.621
1997	0.006	0.118	0.391	0.581	0.608	0.518	0.376	0.259	0.259
1998	0.006	0.122	0.577	0.481	0.718	0.500	0.213	0.150	0.150
1999	0.002	0.156	0.757	0.834	0.504	0.664	0.390	0.139	0.139
2000	0.001	0.046	0.724	0.820	0.704	0.223	0.289	0.150	0.150
2001	0.002	0.058	0.273	0.770	0.407	0.223	0.082	0.063	0.063
2002	0.040	0.120	0.139	0.182	0.359	0.156	0.082	0.038	0.038
2003	0.007	0.104	0.322	0.150	0.122	0.177	0.063	0.027	0.027
2004	0.001	0.051	0.333	0.277	0.177	0.146	0.091	0.019	0.019
2005	0.000	0.048	0.291	0.420	0.233	0.191	0.133	0.052	0.052
2006	0.001	0.050	0.419	0.557	0.582	0.346	0.151	0.093	0.093
2007	0.001	0.059	0.253	0.516	0.483	0.390	0.290	0.095	0.095

Table 13.3.5.3. Haddock in Subarea IV and Division IIIa. Estimates of stock numbers at age from the final XSA assessment. Estimates refer to January 1st, except for age 0 for estimates refer to July 1st. *Estimated survivors.

Year	Age								
	0	1	2	3	4	5	6	7	8+
1963	2315066	25450193	739727	48722	27676	10748	1165	1334	1295
1964	9155384	297542	4315469	221617	19449	10059	3570	499	839
1965	26286798	1128466	53889	1832192	53362	7146	3396	746	385
1966	68923278	3150894	55670	23718	854125	15538	1635	997	455
1967	388351931	8274728	164299	16310	12804	301155	3693	393	552
1968	17114937	49884926	1222290	37210	8411	6808	85639	814	144
1969	12133886	2199305	9099638	459731	11689	4833	3286	28519	336
1970	87607625	1536021	413406	3171953	90348	2402	1776	414	9575
1971	78218014	10946416	178356	98335	786439	19681	901	372	3580
1972	21427780	9950744	1308944	61466	34648	259115	6729	319	791
1973	72965393	2672071	1614792	396960	12048	8265	69186	2285	536
1974	132889901	9371711	353251	615400	96822	3919	2725	20941	578
1975	11408671	16891784	1267637	93033	186399	27568	1514	1012	4897
1976	16406795	1452567	2324829	326551	20531	49071	8266	350	1499
1977	26236141	2052146	205476	694462	68722	7209	11957	2248	625
1978	39850695	3336262	284296	50940	196371	18175	2008	4124	1198
1979	72697413	5027616	441367	70888	12914	52681	7005	500	1338
1980	15816231	9056789	814188	129495	18827	3525	17791	3712	2486
1981	32627556	1901567	1450057	274080	36865	5491	1170	7272	721
1982	20493870	3968372	306279	627032	87302	15293	2656	544	1612
1983	66968031	2538278	641442	135325	224280	31471	9465	1529	1628
1984	17182282	8391560	418999	223895	40382	62440	10855	6204	2697
1985	23923464	2177694	1422202	143799	66014	11976	21580	5460	2122
1986	49056133	3029704	339835	516376	42598	18379	5006	11013	2961
1987	4157650	6294963	511579	81410	116544	8746	6280	2980	5807
1988	8340001	531855	1087247	138237	21591	30874	2853	2538	1625
1989	8608520	1069771	89250	332145	29054	4962	8466	886	575
1990	28370716	1104376	184734	31091	97767	6710	1682	3272	868
1991	27500082	3632398	176451	40719	7734	26107	2117	584	1180
1992	42030485	3495762	599377	54342	11268	2597	10042	850	1378
1993	13184770	5313643	586234	194730	13656	2994	995	3823	1522
1994	56274675	1646675	869173	178593	55998	4365	916	408	1501
1995	14505860	7213670	273801	339847	50428	17482	1837	231	256
1996	21538634	1795199	1255563	113266	116589	16439	7396	1041	168
1997	12833540	2719515	324307	548571	38003	42133	6670	3294	497
1998	9994167	1641771	464321	147098	238997	16119	20555	3749	1353
1999	137380451	1278663	279029	174734	70832	90826	8002	13607	3339
2000	26773523	17655374	210083	87769	59092	33332	38295	4436	2225
2001	2894893	3444307	3237741	68264	30097	22761	21837	23474	5023
2002	3651268	371765	624038	1652164	24621	15597	14904	16466	22473
2003	3811617	451836	63334	363988	1072970	13397	10925	11238	10014
2004	3961768	487433	78208	30778	243985	739382	9187	8400	7841
2005	39022498	509648	88993	37588	18169	159177	522905	6868	3163
2006	6383210	5021830	93274	44594	19226	11212	107632	374956	2186
2007	4454262	820876	917767	41102	19893	8371	6493	75739	86798
2008*		572734	148664	477642	19115	9558	4642	3977	56405

Table 13.3.5.4. Haddock in Subarea IV and Division IIIa. Stock summary table.

Year	Recruitment	TSB	SSB	Catch	Landings	Discards	Bycatch	Yield/SSB	Mean F(2-4)
1963	2315066	3412699	137054	271851	68821	189330	13700	0.502	0.745
1964	9155384	1281824	417716	379915	131006	160309	88600	0.314	0.794
1965	26286798	1081002	521741	299343	162418	62325	74600	0.311	0.639
1966	68923278	1480501	427843	346349	226184	73465	46700	0.529	0.662
1967	388351931	5527463	224795	246664	147742	78222	20700	0.657	0.626
1968	17114937	6852032	259402	301821	105811	161810	34200	0.408	0.597
1969	12133886	2477691	810551	930043	331625	260065	338353	0.409	1.121
1970	87607625	2541799	900226	805776	524773	101274	179729	0.583	1.152
1971	78218014	2546600	420408	446824	237502	177776	31546	0.565	0.773
1972	21427780	2182459	302987	353084	195545	127954	29585	0.645	1.119
1973	72965393	4089143	297190	307594	181592	114735	11267	0.611	0.866
1974	132889901	4712332	260838	366992	153057	166429	47505	0.587	0.962
1975	11408671	2386044	238438	453205	151349	260370	41487	0.635	1.101
1976	16406795	1098176	309809	375306	172680	154462	48163	0.557	0.971
1977	26236141	1070411	242795	224516	145118	44376	35022	0.598	1.029
1978	39850695	1139315	138694	179375	91683	76789	10903	0.661	1.059
1979	72697413	1354201	117780	145019	87069	41710	16240	0.739	0.983
1980	15816231	1473486	170434	222126	105041	94614	22472	0.616	0.892
1981	32627556	998493	258459	213240	136132	60067	17041	0.527	0.654
1982	20493870	1093871	322349	233283	173335	40564	19383	0.538	0.655
1983	66968031	2255693	278075	244212	165337	65977	12898	0.595	0.880
1984	17182282	1693194	225745	218945	133568	75298	10080	0.592	0.869
1985	23923464	1190168	262801	255365	164119	85249	5998	0.624	0.869
1986	49056133	1944062	238576	223081	168236	52203	2643	0.705	1.200
1987	4157650	1099174	167980	173852	110299	59143	4410	0.657	1.021
1988	8340001	631293	160671	173124	106973	62148	4002	0.666	1.105
1989	8608520	624278	128300	106527	78439	25677	2410	0.611	0.948
1990	28370716	1584160	81319	88934	53780	32565	2589	0.661	1.108
1991	27500082	1554616	63578	93286	47715	40185	5386	0.750	0.885
1992	42030485	1367036	103846	131650	72790	47934	10927	0.701	0.977
1993	13184770	1021557	139513	172550	82176	79609	10766	0.589	0.892
1994	56274675	1492365	162179	151020	82074	65370	3576	0.506	0.823
1995	14505860	1178349	163890	142524	77458	57371	7695	0.473	0.724
1996	21538634	1066718	203676	156609	79148	72461	5000	0.389	0.679
1997	12833540	983798	229063	141347	82574	52089	6684	0.360	0.526
1998	9994167	799151	206928	131315	81054	45160	5101	0.392	0.592
1999	137380451	3654529	160928	112021	65588	42598	3835	0.408	0.698
2000	26773523	3558645	139431	104457	47553	48770	8134	0.341	0.749
2001	2894893	1241789	319807	166960	40856	118225	7879	0.128	0.483
2002	3651268	898316	526932	107923	58348	45857	3717	0.111	0.226
2003	3811617	776362	515911	66805	41964	23691	1150	0.081	0.198
2004	3961768	785171	443252	64838	48734	15551	554	0.110	0.262
2005	39022498	2658158	383985	57162	48357	8637	168	0.126	0.315
2006	6383210	1242384	307001	56056	37613	17908	535	0.123	0.519
2007	4454262	670869	217729	63226	32130	31048	48	0.148	0.417
Units	Thousands	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes		

Table 13.6.1. Haddock in Subarea IV and Division IIIa. Short-term forecast input.

MFDP version 1a
Run: had03
Time and date: 11:14 12/05/2008
Fbar age range (Total) : 2-4
Fbar age range Fleet 1 : 2-4
Fbar age range Fleet 2 : 2-4

2008

Age	N	M	Mat	PF	PM	SWt
0	4370833	2.05	0	0	0	0.045
1	572734	1.65	0.01	0	0	0.152
2	148664	0.4	0.32	0	0	0.256
3	477642	0.25	0.71	0	0	0.394
4	19115	0.25	0.87	0	0	0.497
5	9558	0.2	0.95	0	0	0.617
6	4642	0.2	1	0	0	0.751
7	3977	0.2	1	0	0	1.037
8	56405	0.2	1	0	0	0.957

Catch

Age	Sel	CWt	DSel	DCWt
0	0	0	0.001	0.048
1	0.002	0.372	0.056	0.149
2	0.053	0.4	0.199	0.225
3	0.347	0.453	0.165	0.275
4	0.424	0.527	0.058	0.3
5	0.343	0.633	0.047	0.341
6	0.27	0.755	0.019	0.445
7	0.089	1.043	0.005	0.549
8	0.094	0.957	0.001	0.371

IBC

Age	Sel	CWt
0	0	0.0024
1	0.001	0.1016
2	0.001	0.178
3	0.003	0.2542
4	0.002	0.2832
5	0.001	0.3264
6	0.001	0.4258
7	0	0.5078
8	0	0.287

2009

Age	N	M	Mat	PF	PM	SWt
0	4370833	2.05	0	0	0	0.045
1	.	1.65	0.01	0	0	0.152
2	.	0.4	0.32	0	0	0.256
3	.	0.25	0.71	0	0	0.394
4	.	0.25	0.87	0	0	0.497
5	.	0.2	0.95	0	0	0.617
6	.	0.2	1	0	0	0.751
7	.	0.2	1	0	0	1.037
8	.	0.2	1	0	0	1.163

Catch

Age	Sel	CWt	DSel	DCWt
0	0	0	0.001	0.048
1	0.002	0.372	0.056	0.149
2	0.053	0.4	0.199	0.225
3	0.347	0.453	0.165	0.275
4	0.424	0.527	0.058	0.3
5	0.343	0.633	0.047	0.341
6	0.27	0.755	0.019	0.445
7	0.089	1.043	0.005	0.549
8	0.094	1.165	0.001	0.371

IBC

Age	Sel	CWt
0	0	0.0024
1	0.001	0.1016
2	0.001	0.178
3	0.003	0.2542
4	0.002	0.2832
5	0.001	0.3264
6	0.001	0.4258
7	0	0.5078
8	0	0.287

2010

Age	N	M	Mat	PF	PM	SWt
0	4370833	2.05	0	0	0	0.045
1	.	1.65	0.01	0	0	0.152
2	.	0.4	0.32	0	0	0.256
3	.	0.25	0.71	0	0	0.394
4	.	0.25	0.87	0	0	0.497
5	.	0.2	0.95	0	0	0.617
6	.	0.2	1	0	0	0.751
7	.	0.2	1	0	0	1.037
8	.	0.2	1	0	0	1.37

Catch

Age	Sel	CWt	DSel	DCWt
0	0	0	0.001	0.048
1	0.002	0.372	0.056	0.149
2	0.053	0.4	0.199	0.225
3	0.347	0.453	0.165	0.275
4	0.424	0.527	0.058	0.3
5	0.343	0.633	0.047	0.341
6	0.27	0.755	0.019	0.445
7	0.089	1.043	0.005	0.549
8	0.094	1.372	0.001	0.371

IBC

Age	Sel	CWt
0	0	0.0024
1	0.001	0.1016
2	0.001	0.178
3	0.003	0.2542
4	0.002	0.2832
5	0.001	0.3264
6	0.001	0.4258
7	0	0.5078
8	0	0.287

Input units are thousands and kg - output in tonnes

Table 13.6.2. Haddock in Subarea IV and Division IIIa. Short-term forecast output. Options are highlighted for the management plan target F, a 15% TAC increase, and the status quo F forecast (unshaded box).

MFDP version 1a
Run: had03
Time and date: 11:14 12/05/2008
Fbar age range (Total) : 2-4
Fbar age range Fleet 1 : 2-4
Fbar age range Fleet 2 : 2-4

2008

Biomass	SSB	Catch FMult	Fbar	Landings FBar	Yield	Discards FBar	Yield	IBC FMult	Landings FBar	Yield
586979	222122	0.7145	0.2988	0.1963	49300	0.1005	17173	1	0.002	332

2009											2010		
Biomass	SSB	Catch FMult	Fbar	Landings FBar	Yield	Discards FBar	Yield	IBC FMult	Landings FBar	Yield	Biomass	SSB	
537619	211522	0	0.002	0.000	0	0.000	0	1	0.002	234	559861	241317	
.	211522	0.10	0.044	0.028	7088	0.014	1356	1	0.002	229	550682	232953	
.	211522	0.20	0.085	0.055	13879	0.028	2669	1	0.002	225	541892	224950	
.	211522	0.30	0.127	0.082	20387	0.042	3940	1	0.002	220	533474	217290	
.	211522	0.40	0.168	0.110	26624	0.056	5170	1	0.002	216	525411	209958	
.	211522	0.50	0.210	0.137	32602	0.070	6363	1	0.002	212	517686	202939	
.	211522	0.60	0.251	0.165	38334	0.084	7518	1	0.002	208	510285	196218	
.	211522	0.66	0.278	0.183	41905	0.094	8246	1	0.002	205	505677	192036	(15% TAC de
.	211522	0.70	0.293	0.192	43830	0.099	8638	1	0.002	204	503193	189782	
.	211522	0.72	0.300	0.197	44747	0.101	8827	1	0.002	203	502011	188710	(plan target)
.	211522	0.80	0.334	0.220	49101	0.113	9724	1	0.002	200	496395	183618	
.	211522	0.90	0.376	0.247	54158	0.127	10778	1	0.002	197	489879	177713	
.	211522	1	0.417	0.275	59008	0.141	11801	1	0.002	193	483631	172056	(status quo)
.	211522	1.10	0.459	0.302	63663	0.155	12793	1	0.002	190	477639	166636	
.	211522	1.20	0.500	0.330	68131	0.169	13757	1	0.002	187	471892	161441	
.	211522	1.30	0.542	0.357	72419	0.183	14693	1	0.002	183	466380	156461	
.	211522	1.40	0.583	0.385	76537	0.197	15603	1	0.002	180	461090	151688	
.	211522	1.50	0.625	0.412	80491	0.211	16488	1	0.002	177	456013	147110	
.	211522	1.60	0.667	0.440	84289	0.225	17347	1	0.002	174	451140	142720	
.	211522	1.70	0.708	0.467	87938	0.239	18184	1	0.002	171	446462	138510	
.	211522	1.80	0.750	0.494	91444	0.253	18997	1	0.002	169	441969	134470	
.	211522	1.90	0.791	0.522	94815	0.267	19789	1	0.002	166	437654	130593	
.	211522	2	0.833	0.549	98054	0.281	20561	1	0.002	163	433509	126872	

Input units are thousands and kg - output in tonnes

Table 13.7.1. Haddock in Subarea IV and Division IIIa. Summary of yield-per-recruit analysis.

MFYPR version 2a
Run: had01
Time and date: 13:48 12/05/2008
Yield per results

FMult	Fbar	CatchNos	Yield	StockNos	Biomass	SpwnNosJan	SSBJan	pwnNosSpwn	SSBSpwn
0	0.0000	0.0000	0.0000	1.2384	0.1320	0.0871	0.0565	0.0871	0.0565
0.1	0.0417	0.0029	0.0013	1.2262	0.1224	0.0754	0.0472	0.0754	0.0472
0.2	0.0835	0.0053	0.0022	1.2162	0.1148	0.0659	0.0398	0.0659	0.0398
0.3	0.1252	0.0073	0.0030	1.2080	0.1086	0.0581	0.0338	0.0581	0.0338
0.4	0.1669	0.0091	0.0036	1.2012	0.1036	0.0516	0.0289	0.0516	0.0289
0.5	0.2087	0.0107	0.0041	1.1954	0.0995	0.0463	0.0249	0.0463	0.0249
0.6	0.2504	0.0120	0.0045	1.1906	0.0962	0.0418	0.0217	0.0418	0.0217
0.7	0.2921	0.0132	0.0048	1.1865	0.0934	0.0381	0.0191	0.0381	0.0191
0.8	0.3339	0.0143	0.0050	1.1831	0.0911	0.0349	0.0169	0.0349	0.0169
0.9	0.3756	0.0152	0.0052	1.1800	0.0891	0.0322	0.0150	0.0322	0.0150
1	0.4173	0.0161	0.0054	1.1774	0.0875	0.0299	0.0135	0.0299	0.0135
1.1	0.4591	0.0169	0.0055	1.1752	0.0861	0.0279	0.0122	0.0279	0.0122
1.2	0.5008	0.0177	0.0056	1.1732	0.0849	0.0262	0.0112	0.0262	0.0112
1.3	0.5425	0.0184	0.0057	1.1714	0.0839	0.0247	0.0102	0.0247	0.0102
1.4	0.5843	0.0190	0.0058	1.1698	0.0830	0.0234	0.0095	0.0234	0.0095
1.5	0.6260	0.0196	0.0059	1.1684	0.0822	0.0223	0.0088	0.0223	0.0088
1.6	0.6677	0.0202	0.0060	1.1672	0.0816	0.0212	0.0082	0.0212	0.0082
1.7	0.7095	0.0208	0.0060	1.1660	0.0810	0.0203	0.0077	0.0203	0.0077
1.8	0.7512	0.0213	0.0061	1.1650	0.0805	0.0195	0.0072	0.0195	0.0072
1.9	0.7929	0.0218	0.0061	1.1640	0.0800	0.0188	0.0068	0.0188	0.0068
2	0.8347	0.0223	0.0062	1.1631	0.0796	0.0181	0.0065	0.0181	0.0065

Reference point	F multiplier	Absolute F
Fbar(2-4)	1	0.417
FMax	>=1000000	
F0.1	1.0321	0.431
F35%SPR	0.6706	0.280

Weights in kilograms

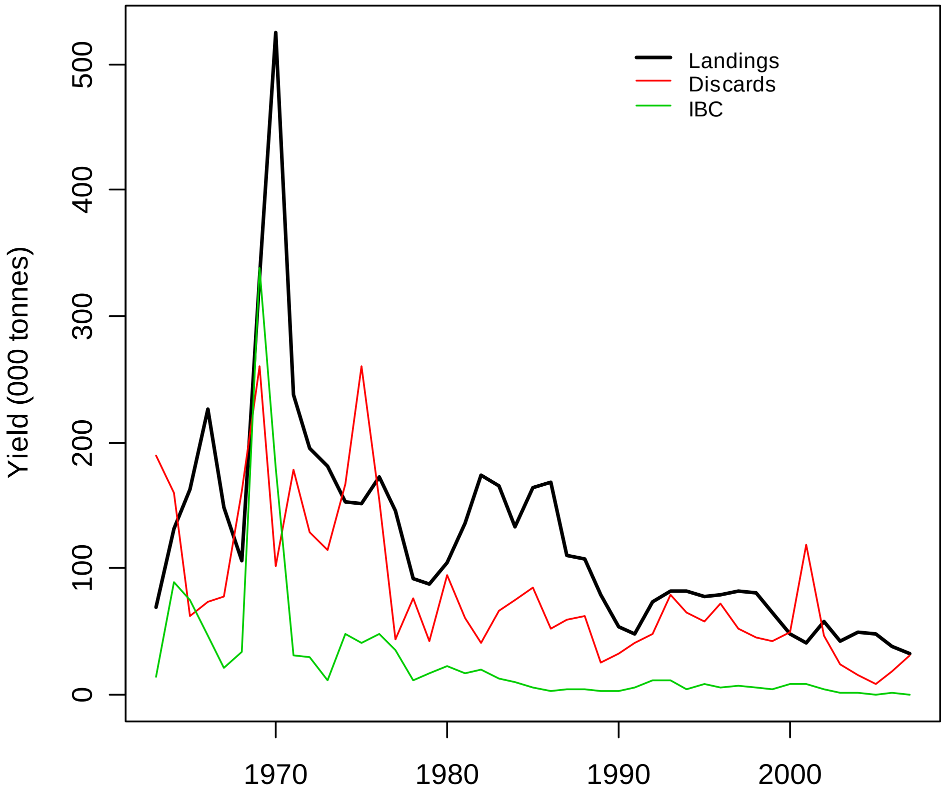


Figure 13.2.1.1. Haddock in Subarea IV and Division IIIa. Yield by catch components.

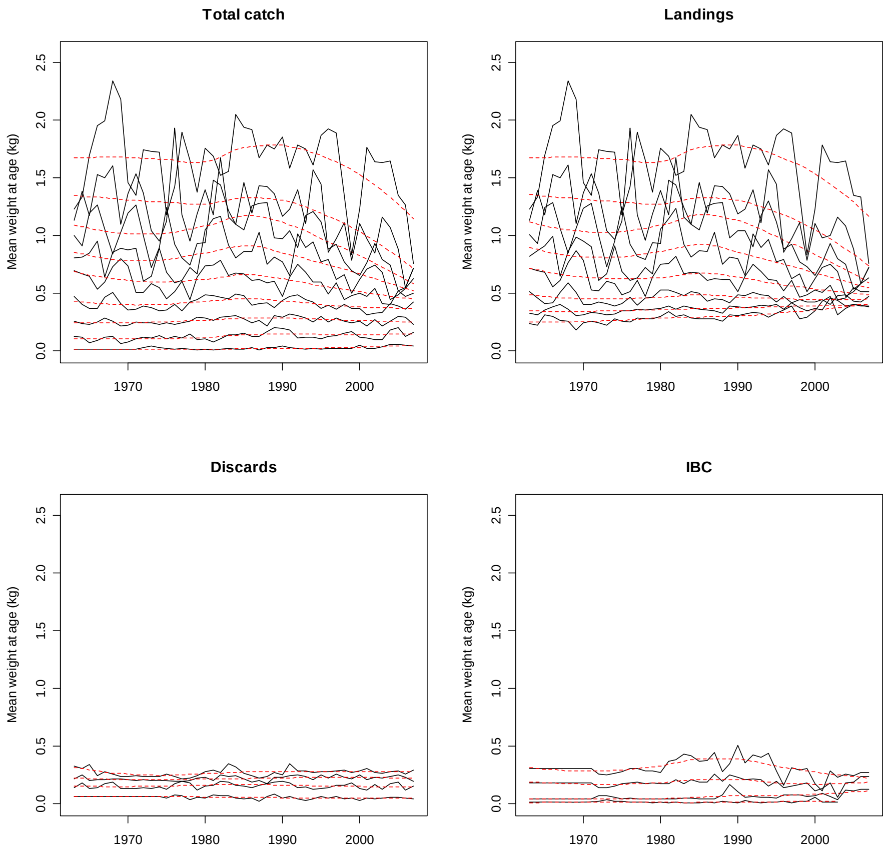


Figure 13.2.3.1. Haddock in Subarea IV and Division IIIa. Mean weights-at-age (kg) by catch component. Catch mean weights are also used as stock mean weights. Red dotted line give loess smoothers through each time-series of mean weights-at-age.

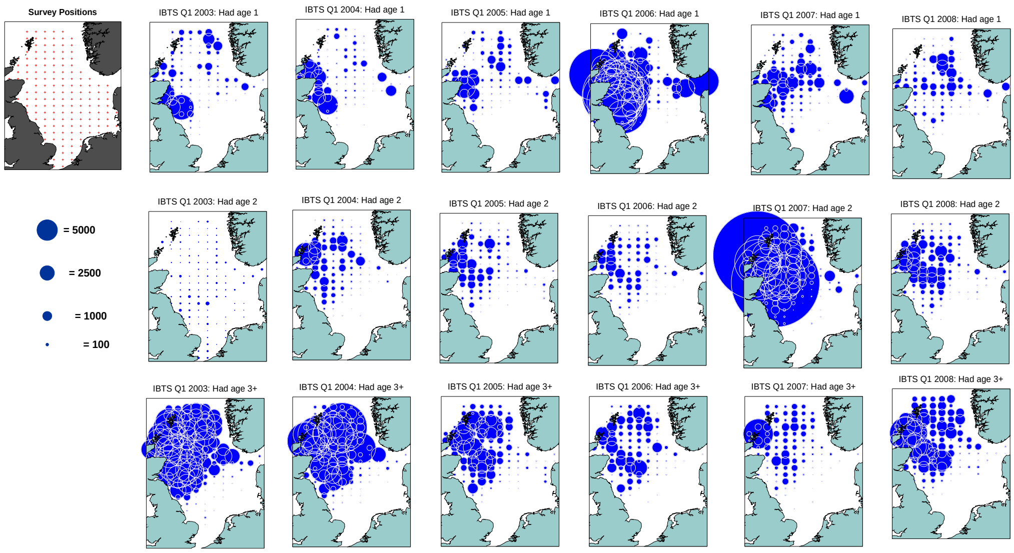


Figure 13.2.5.1. Haddock in Subarea IV and Division IIIa. Spatial distribution from the IBTS Q1 survey.

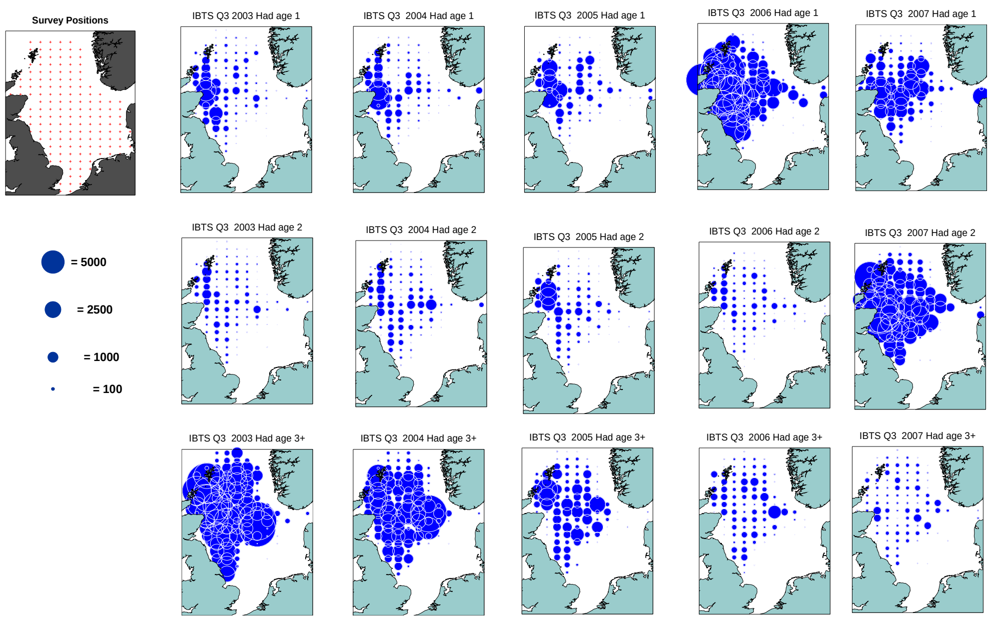


Figure 13.2.5.2. Haddock in Subarea IV and Division IIIa. Spatial distribution from the IBTS Q3 survey.

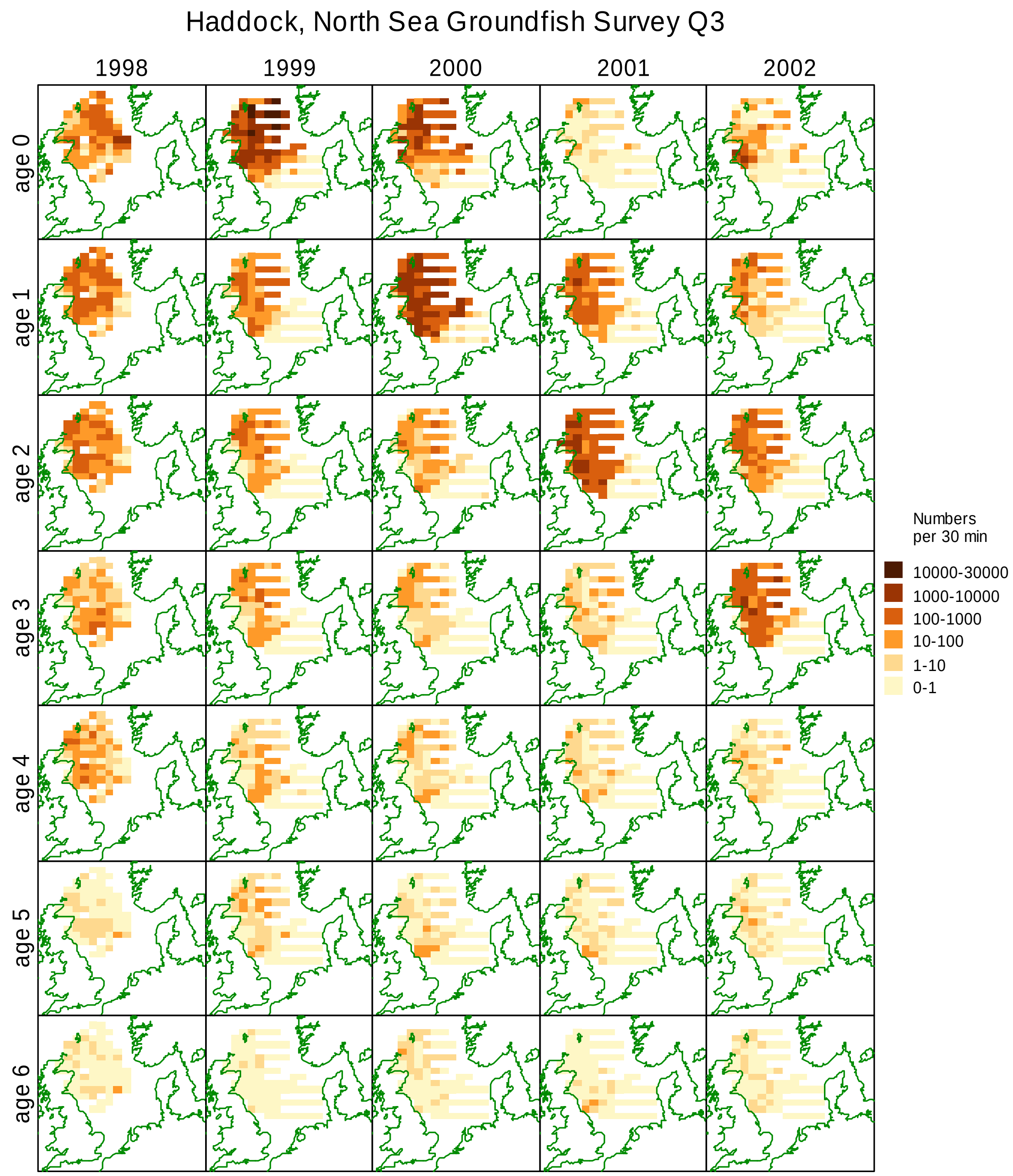


Figure 13.2.5.3. Haddock in Subarea IV and Division IIIa. Spatial distribution from the ScoGFS Q3 survey.

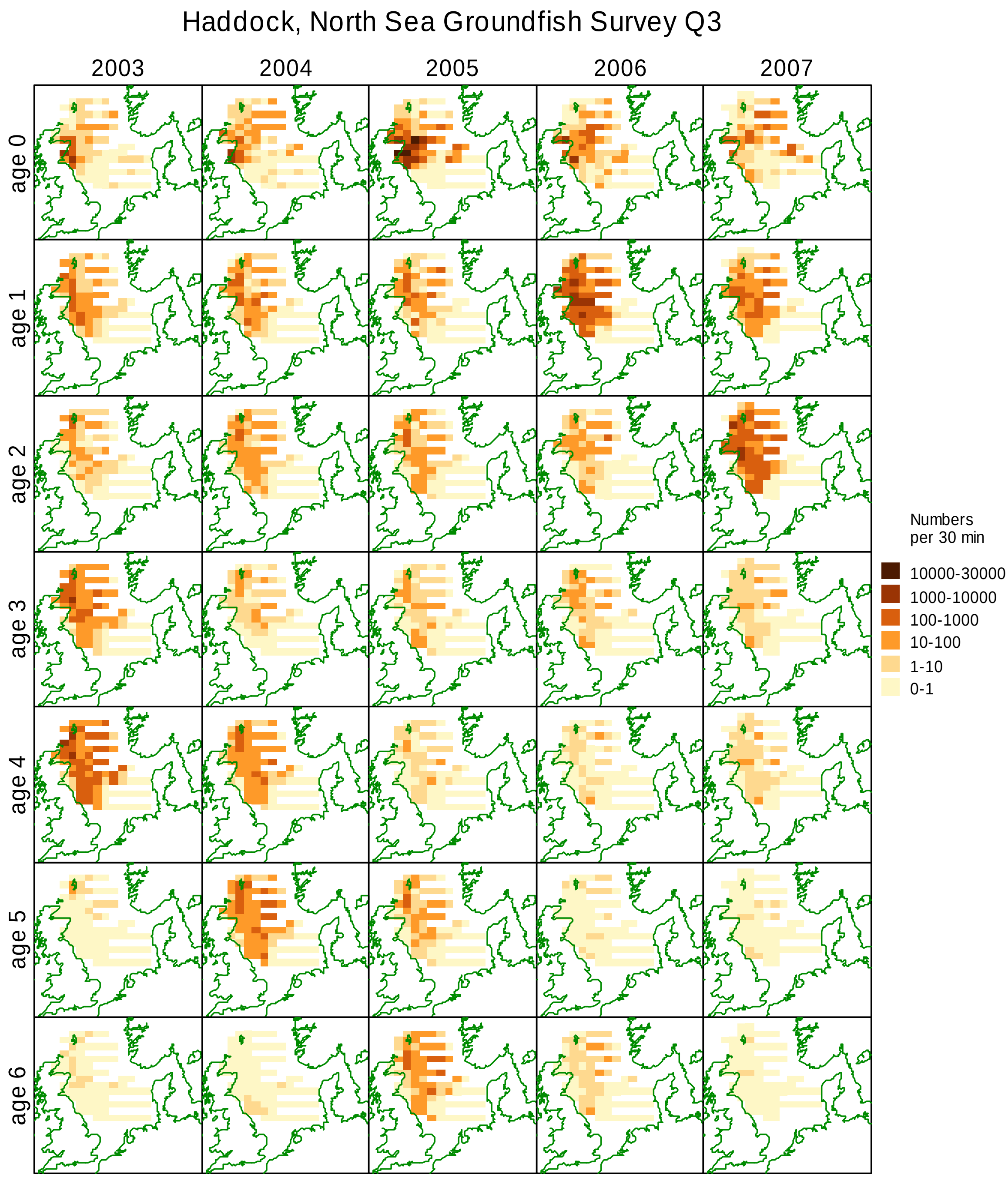


Figure 13.2.5.3. Haddock in Subarea IV and Division IIIa. Spatial distribution from the ScoGFS Q3 survey. (cont.)

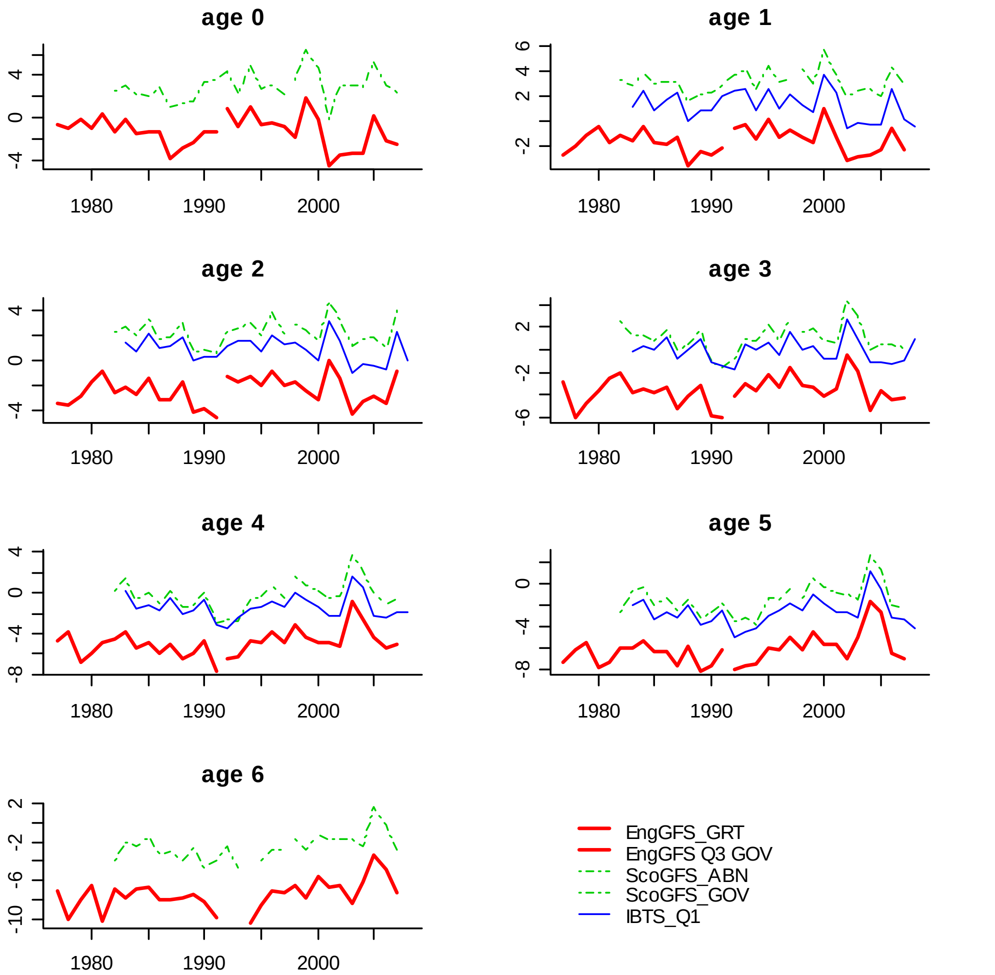


Figure 13.2.5.4. Haddock in Subarea IV and Division IIIa. Survey log CPUE (catch per unit effort) at age.

Figure 13.2.5.5. Haddock in Subarea IV and Division IIIa. Commercial log LPUE (landings per unit effort) at age. Red lines: Scottish light trawl. Green lines: Scottish seine.

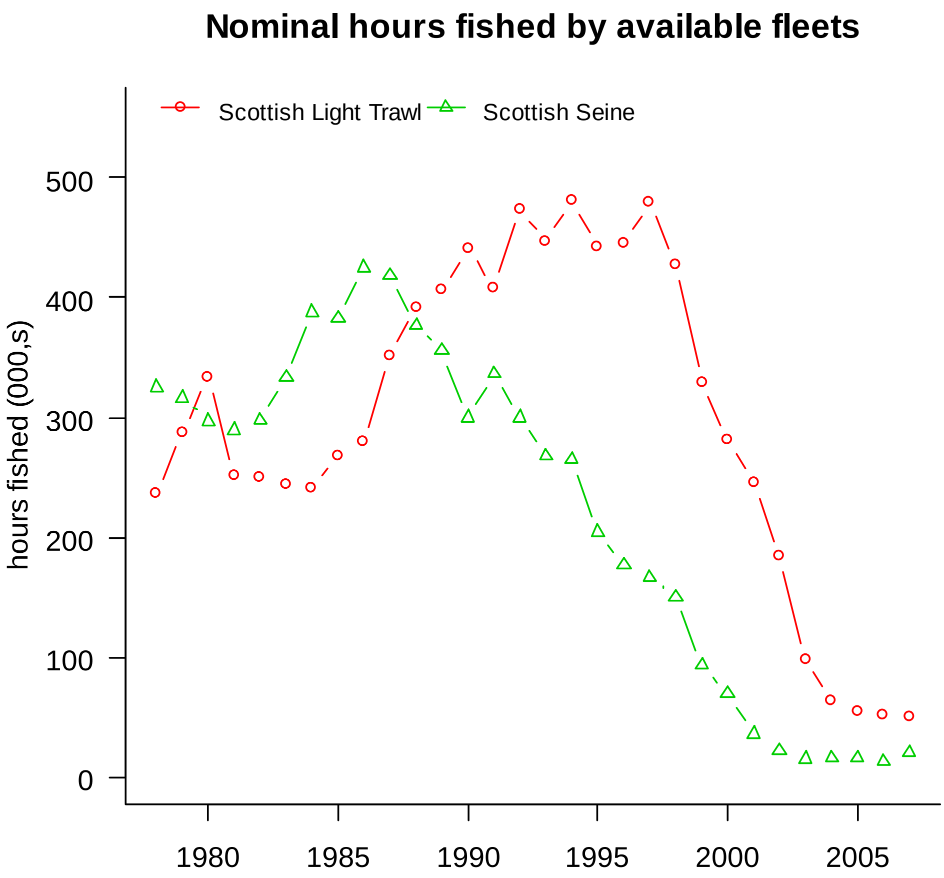


Figure 13.2.5.5. Haddock in Subarea IV and Division IIIa. Nominal hours fished by Scottish fleets, as provided to the WG. Recording of hours fished is not mandatory in European logbooks and is not considered to be a reliable indicator of deployed fishing effort.

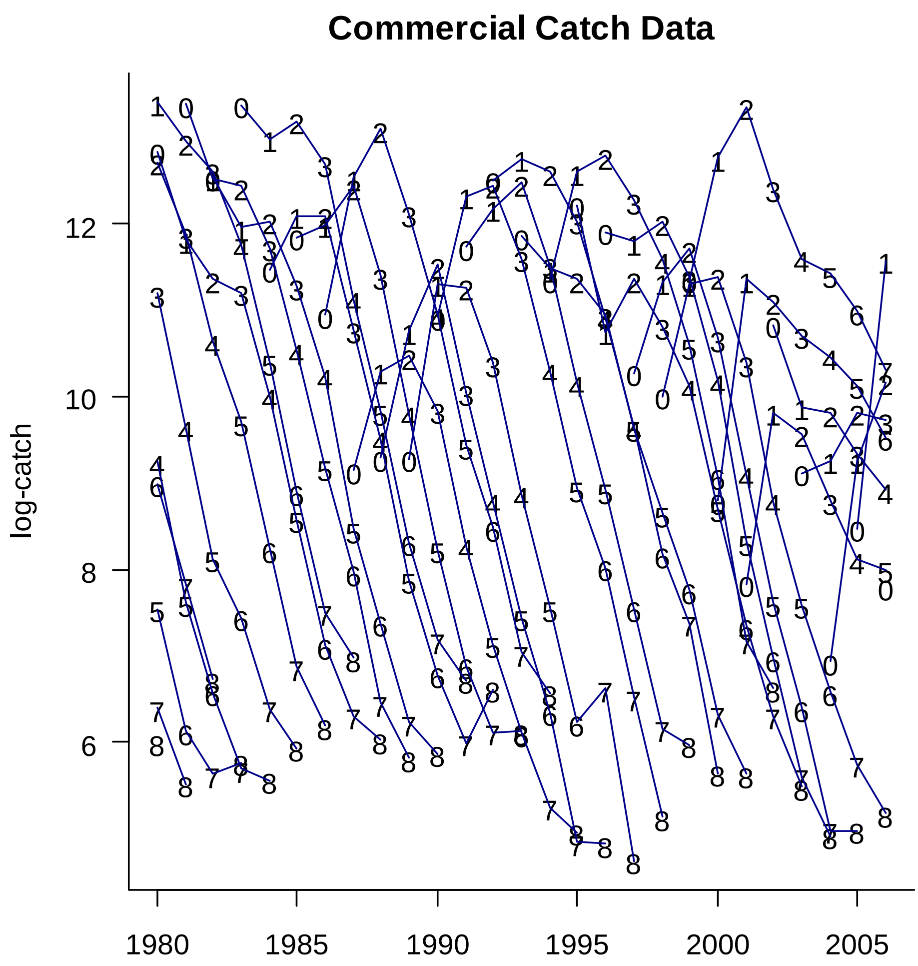


Figure 13.3.2.1. Haddock in Subarea IV and Division IIIa. Log catch by cohort for total catches.

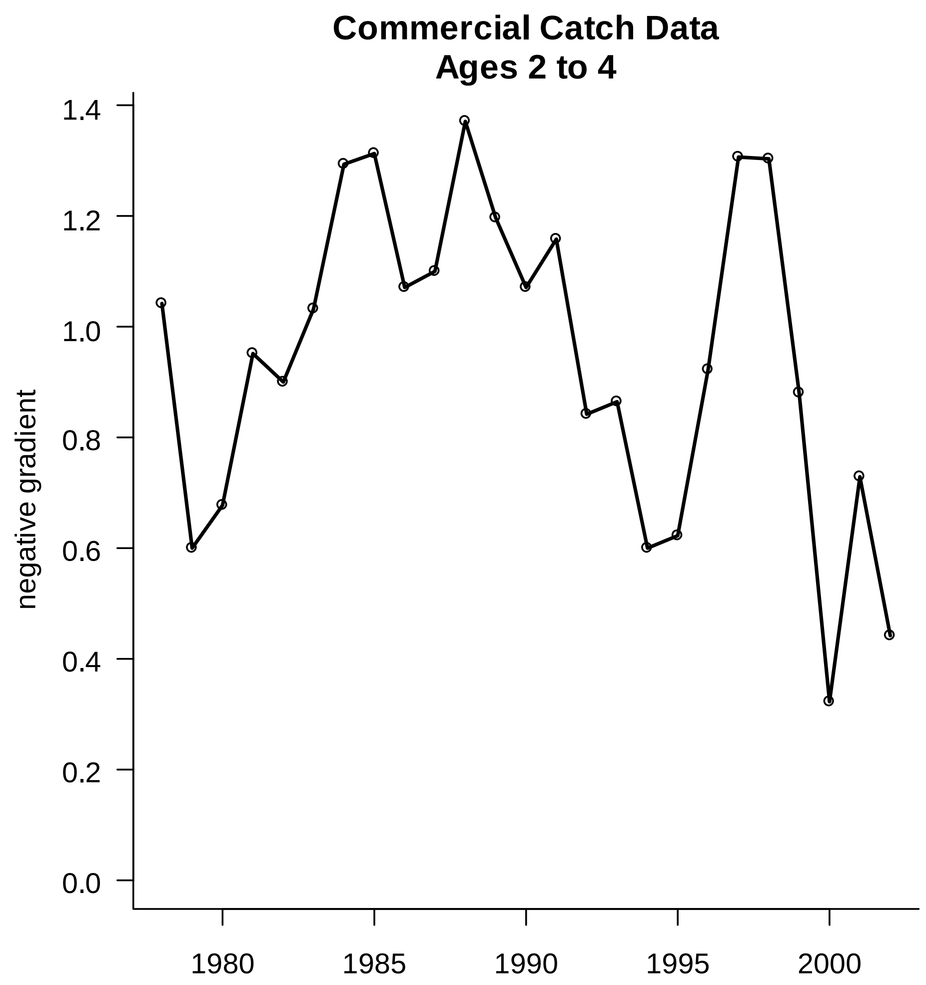


Figure 13.3.2.2. Haddock in Subarea IV and Division IIIa. Negative gradients of log catches per cohort, averaged over ages 2-4. The x-axis represents spawning year of cohort.

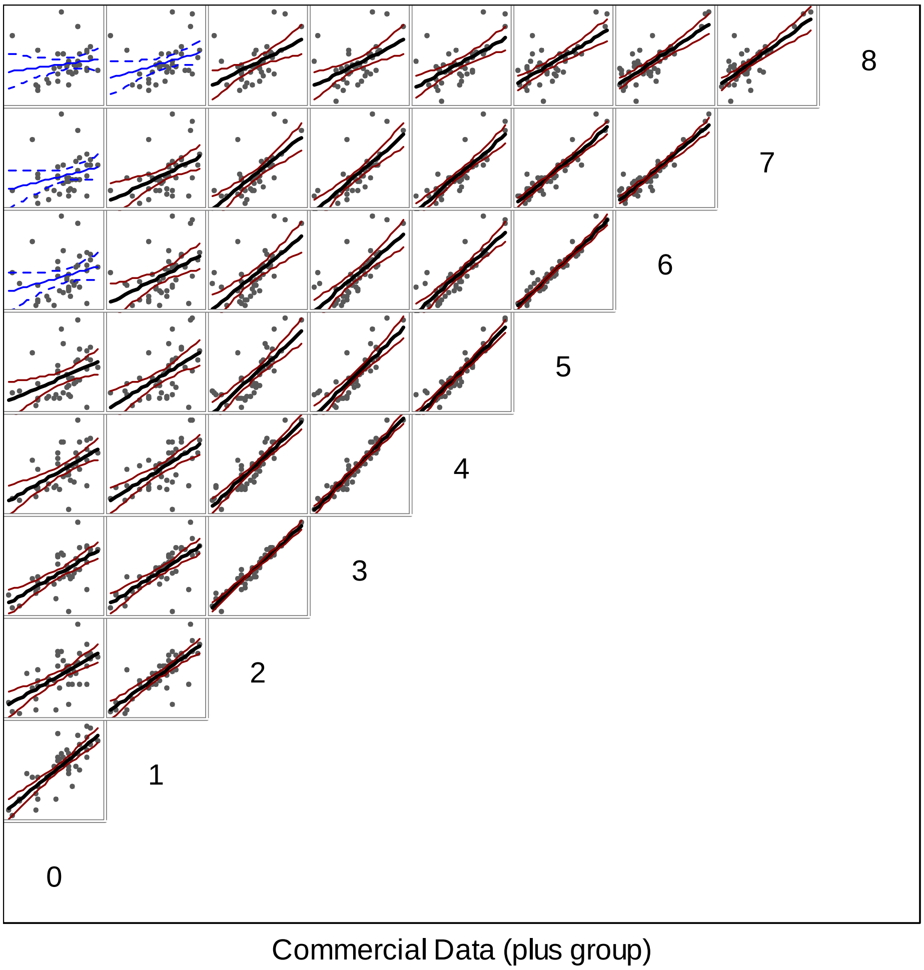
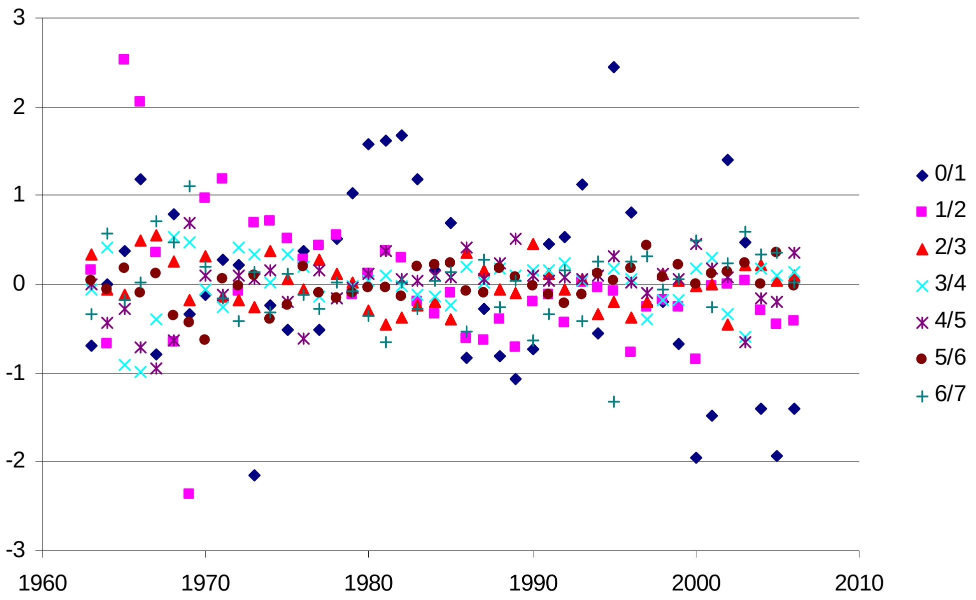


Figure 13.3.2.3. Haddock in Subarea IV and Division IIIa. Correlations in the catch-at-age matrix (including the plus-group for ages 8 and older), comparing estimates at different ages for the same year-classes (cohorts). In each plot, the straight line is a normal linear model fit: a thick line represents a significant ($p < 0.05$) regression, while a thin line is not significant. Approximate 95% confidence intervals for each fit are also shown.



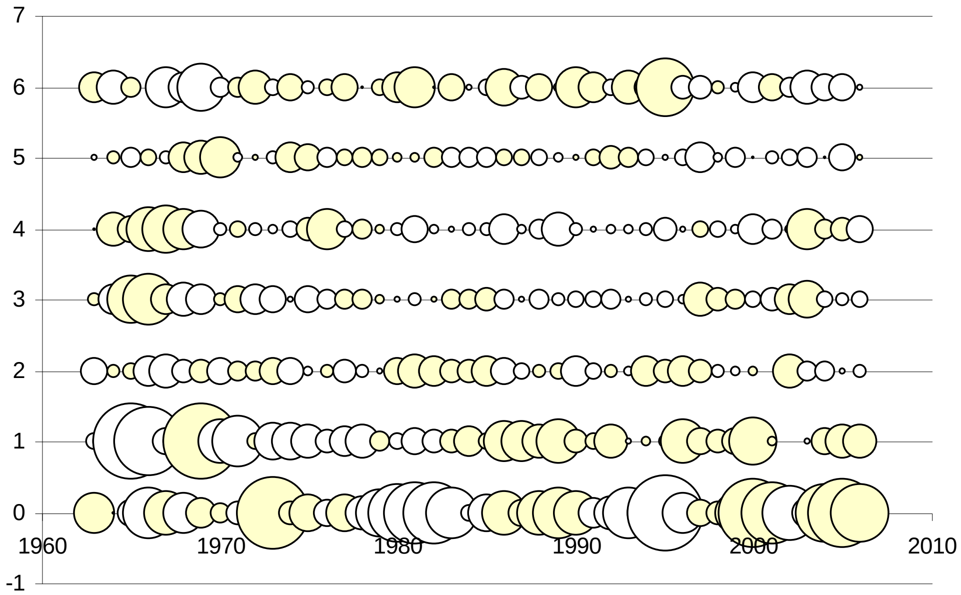


Figure 13.3.2.4. Haddock in Subarea IV and Division IIIa. Residuals from separable VPA analysis. The x-axis labels give the first year only of the actual year ratio used (so "1960" denotes 1960/1961). The y-axis labels for the lower plot give the first age only of the actual age ratio used (so "1" denotes 1/2). The area of the bubbles in the lower plot is proportional to the size of the residual.

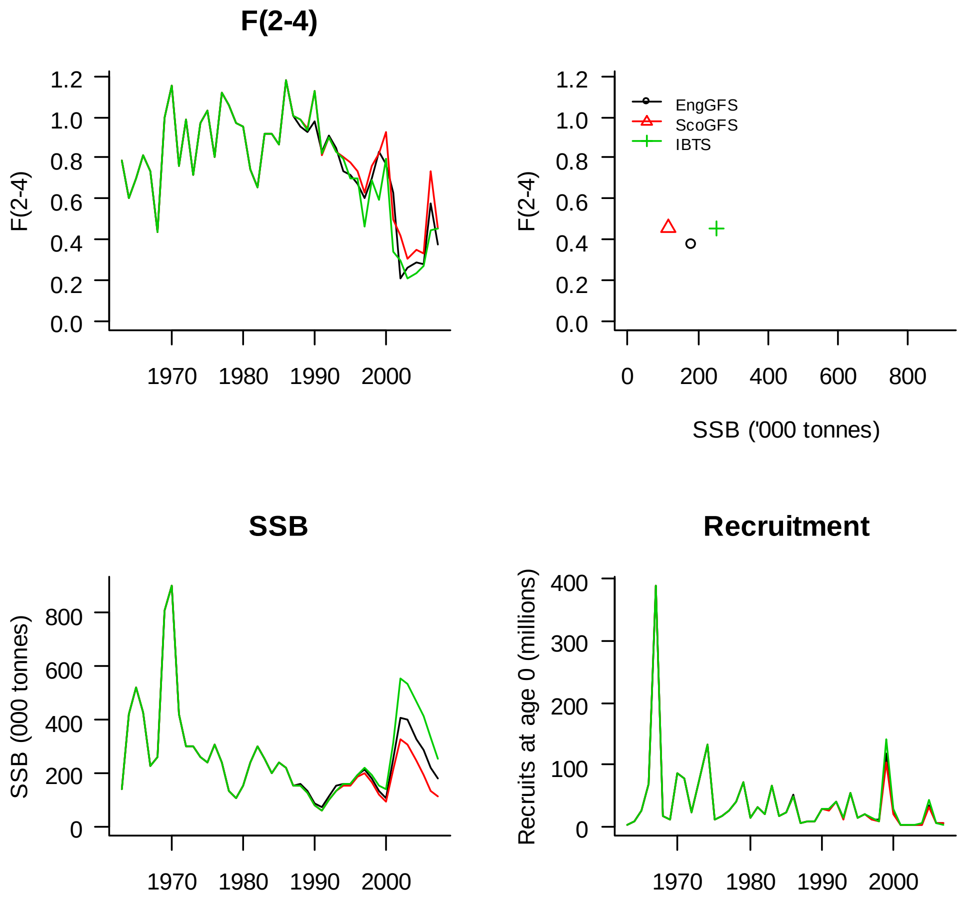


Figure 13.3.2.5. Haddock in Subarea IV and Division IIIa. Stock summary plots for single-fleet XSA runs. Only the more recent segments of the EngGFS and ScoGFS surveys have been used here. Final year (2007) values of SSB and mean F(2-4) are plotted against each other in the upper right plot.

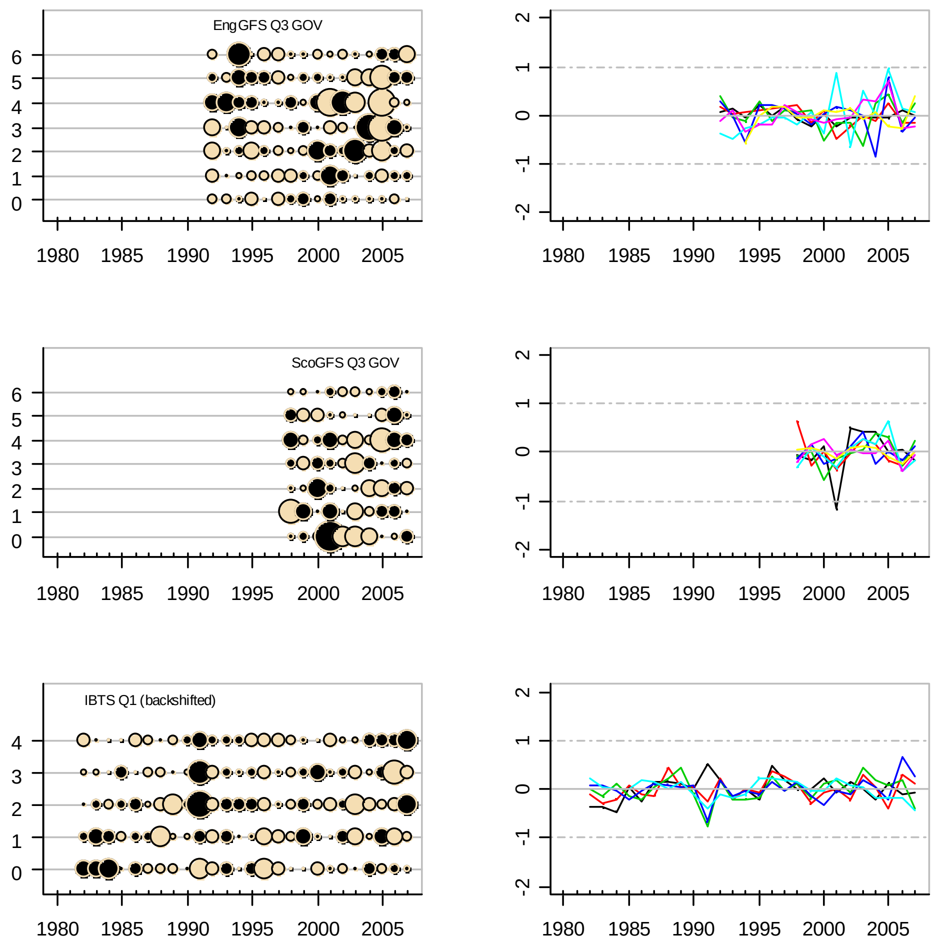


Figure 13.3.2.6. Haddock in Subarea IV and Division IIIa. Log catchability residuals from single-fleet XSA runs. Only the more recent segments of the EngGFS and ScoGFS surveys have been used here.

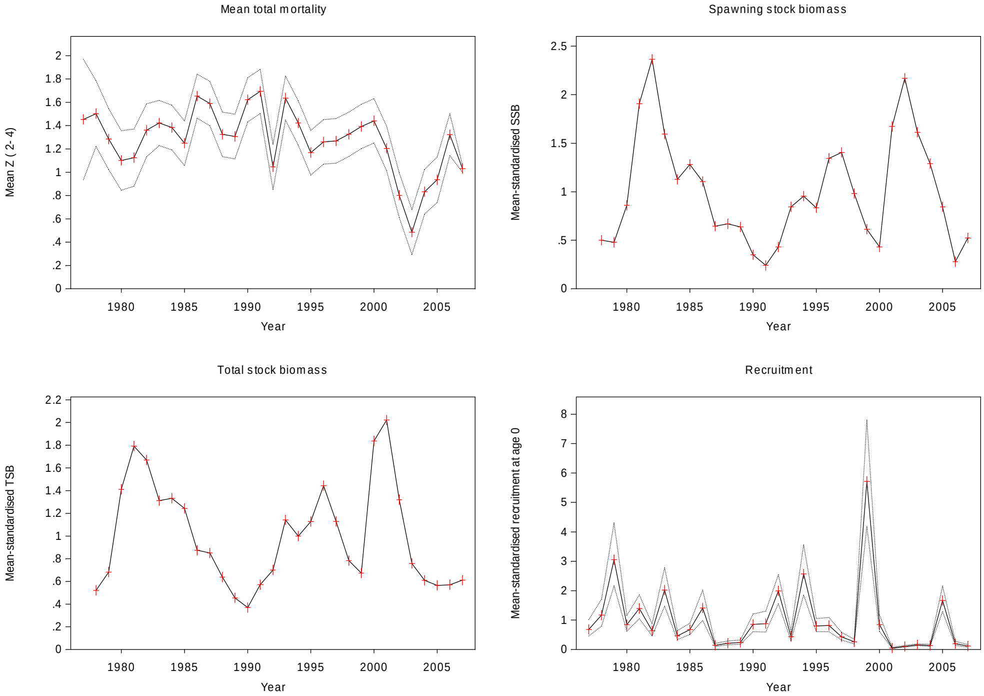
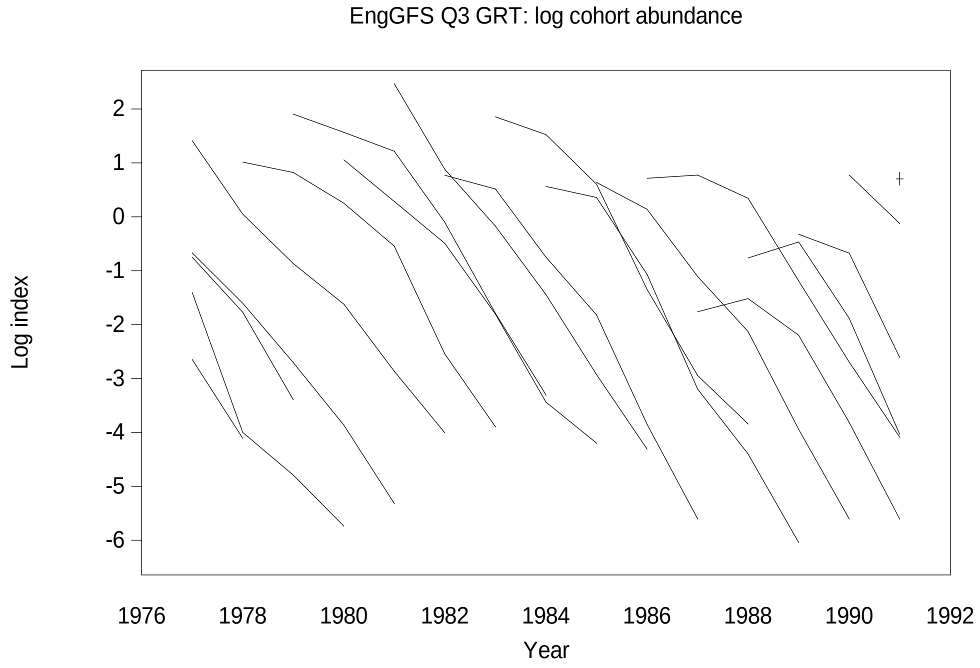


Figure 13.3.3.1. Haddock in Subarea IV and Division IIIa. Summary plots from an exploratory SURBA assessment, using all available surveys (EngGFS Q3, ScoGFS Q3, IBTS Q1). Solid lines give median estimates, dotted lines give approximate 95% confidence bounds for mean Z and recruitment.



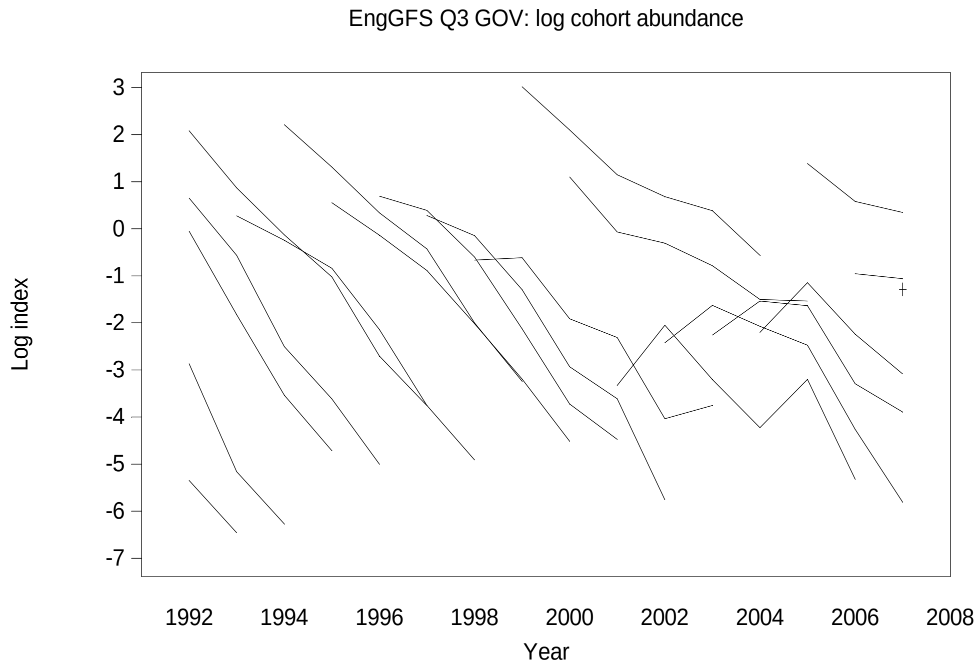
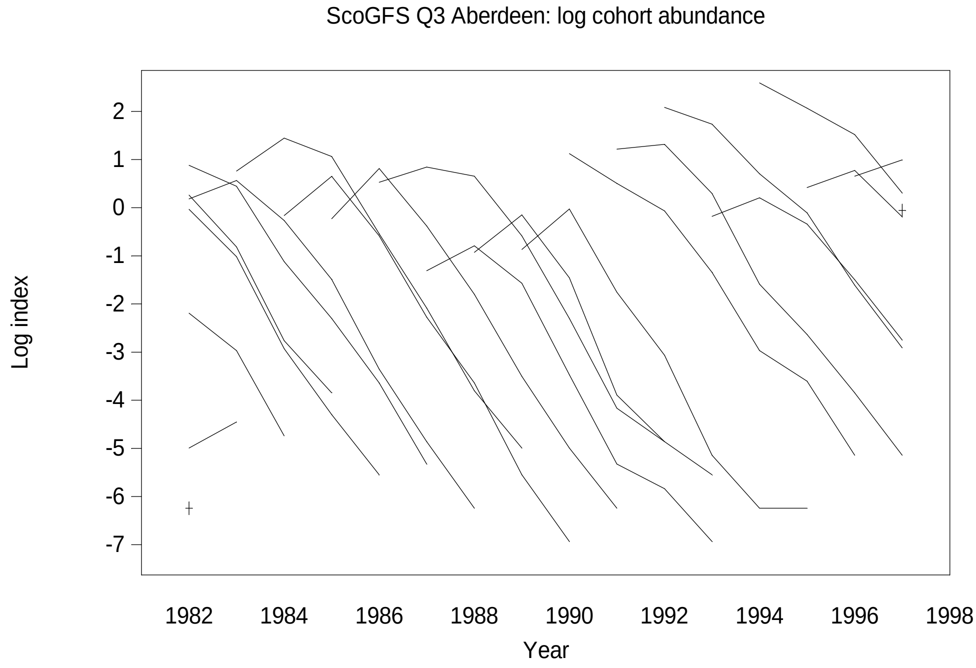


Figure 13.3.3.2. Haddock in Subarea IV and Division IIIa. Log abundance indices by cohort for each of the five survey indices.



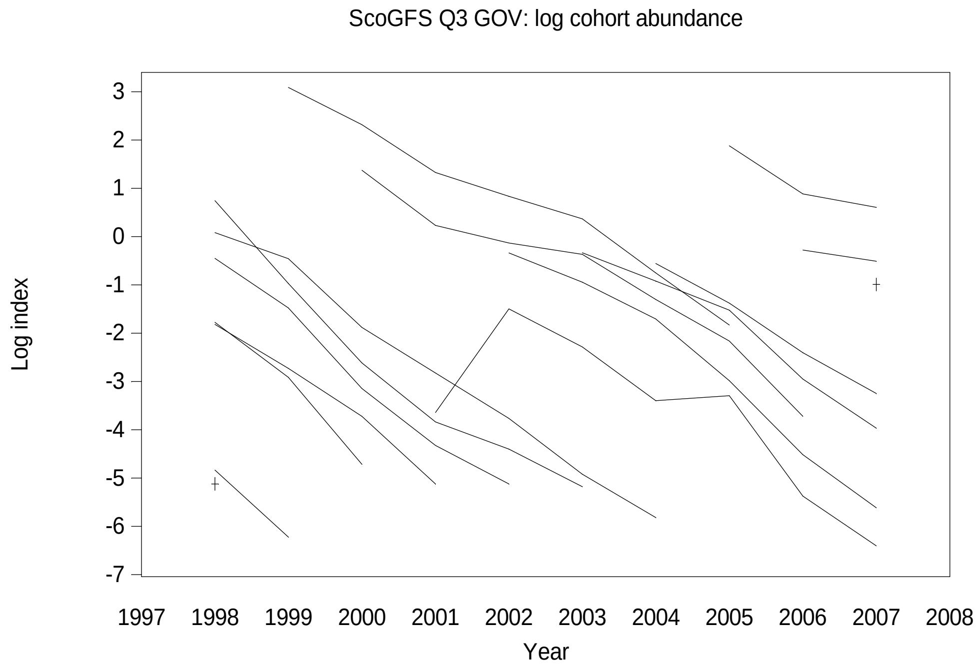


Figure 13.3.3.2. Haddock in Subarea IV and Division IIIa. Log abundance indices by cohort for each of the five survey indices (cont.)

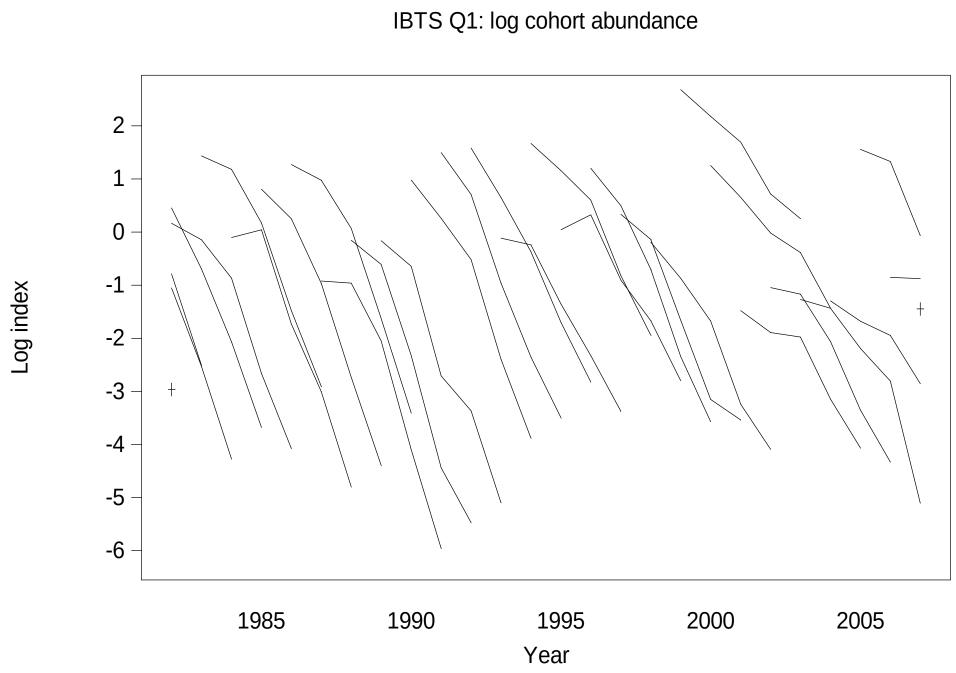


Figure 13.3.3.2. Haddock in Subarea IV and Division IIIa. Log abundance indices by cohort for each of the five survey indices (cont.).

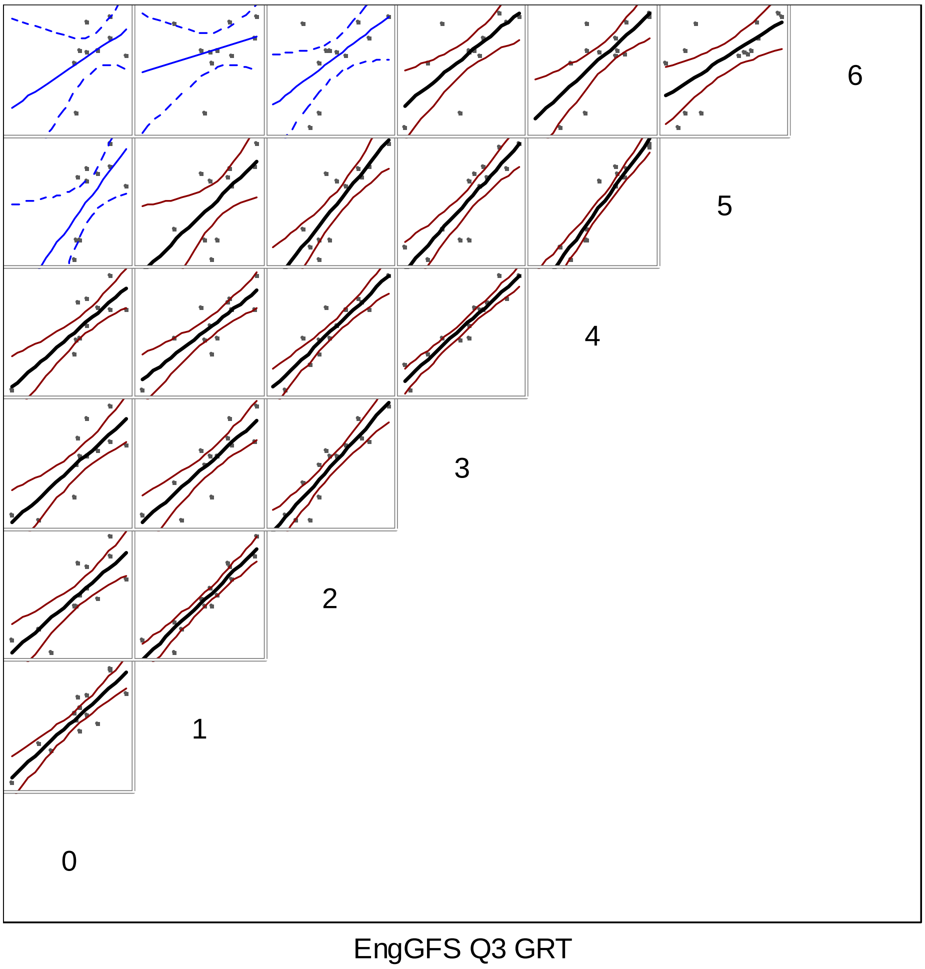


Figure 13.3.3.3. Haddock in Subarea IV and Division IIIa. Within-survey correlations for the EngGFS (GRT) survey series, comparing index values at different ages for the same year-classes (cohorts). In each plot, the straight line is a normal linear model fit: a thick line represents a significant ($p < 0.05$) regression, while a thin line is not significant. Approximate 95% confidence intervals for each fit are also shown.

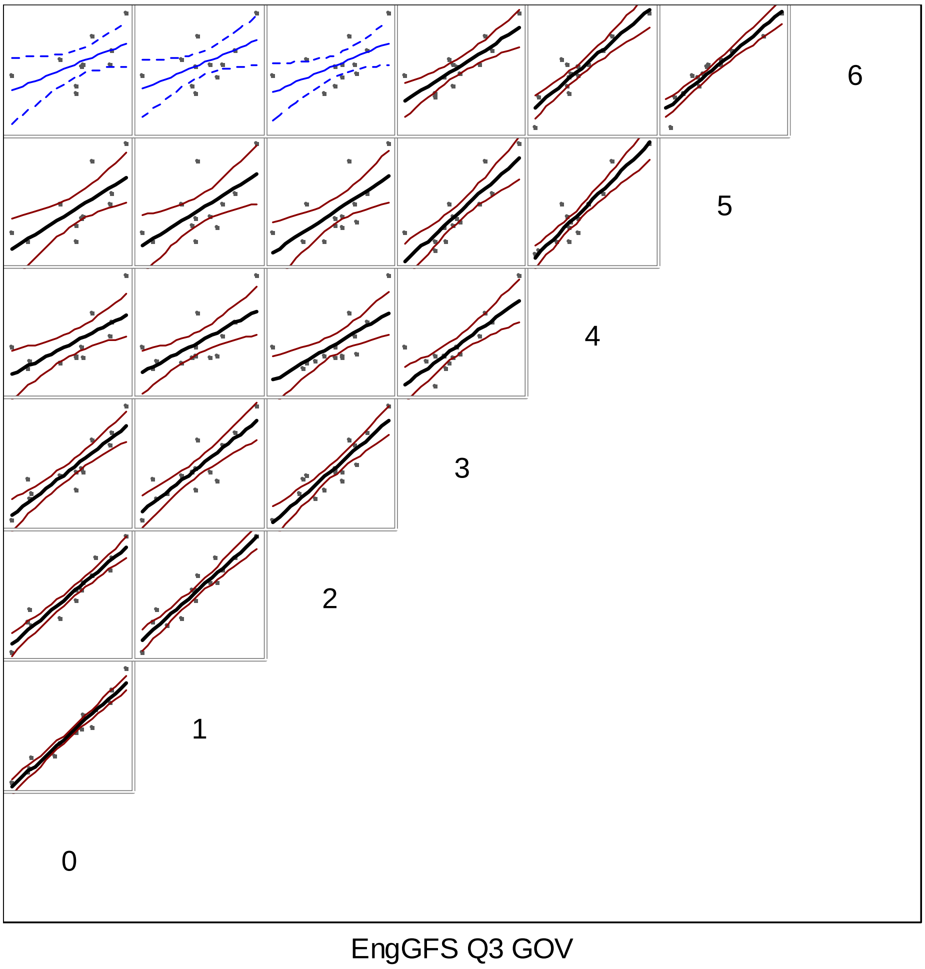


Figure 13.3.3.3. Haddock in Subarea IV and Division IIIa. Within-survey correlations for the EngGFS (GOV) survey series, comparing index values at different ages for the same year-classes (cohorts). In each plot, the straight line is a normal linear model fit: a thick line represents a significant ($p < 0.05$) regression, while a thin line is not significant. Approximate 95% confidence intervals for each fit are also shown.

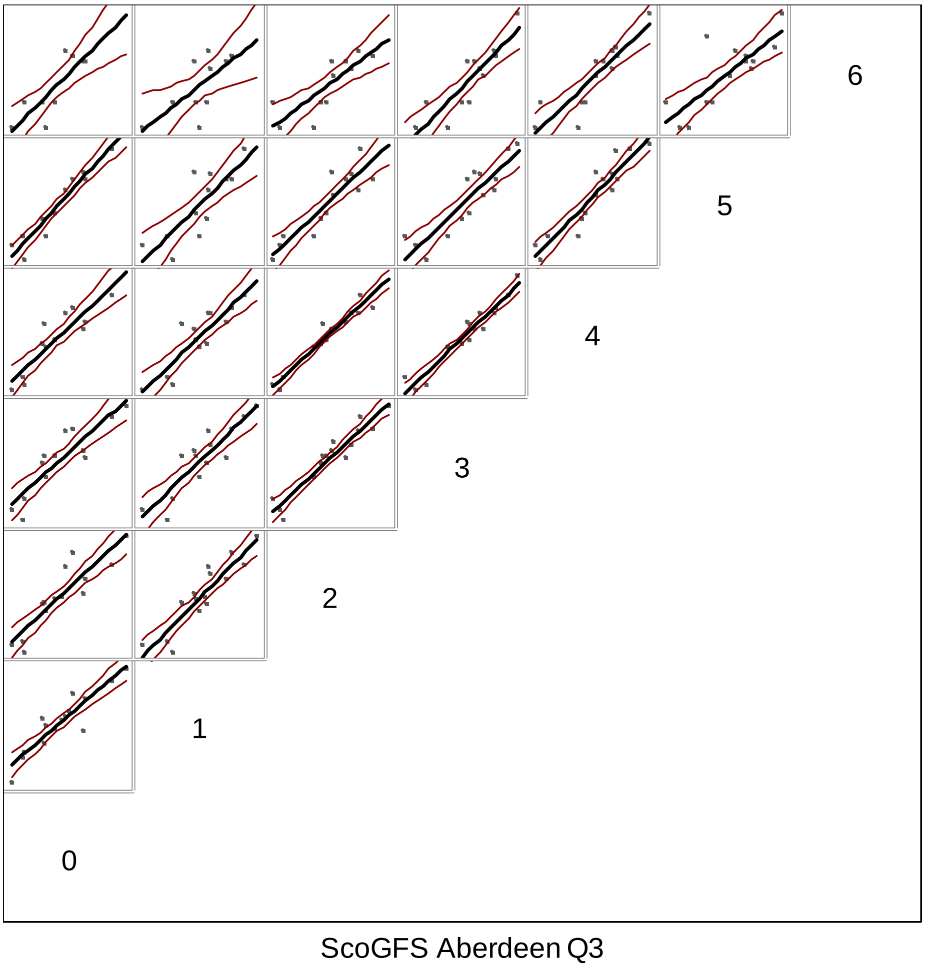


Figure 13.3.3.3. Haddock in Subarea IV and Division IIIa. Within-survey correlations for the ScoGFS (Aberdeen) survey series, comparing index values at different ages for the same year-classes (cohorts). In each plot, the straight line is a normal linear model fit: a thick line represents a significant ($p < 0.05$) regression, while a thin line is not significant. Approximate 95% confidence intervals for each fit are also shown.

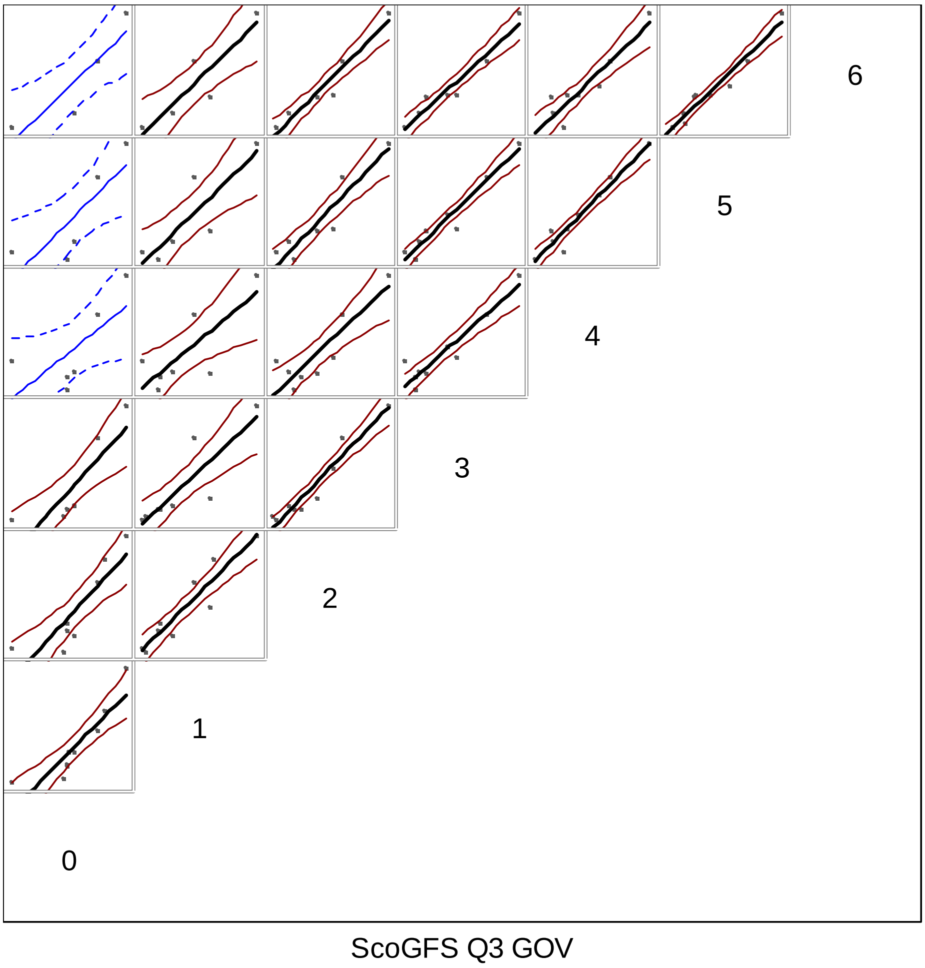


Figure 13.3.3.3. Haddock in Subarea IV and Division IIIa. Within-survey correlations for the ScoGFS (GOV) survey series, comparing index values at different ages for the same year-classes (cohorts). In each plot, the straight line is a normal linear model fit: a thick line represents a significant ($p < 0.05$) regression, while a thin line is not significant. Approximate 95% confidence intervals for each fit are also shown.

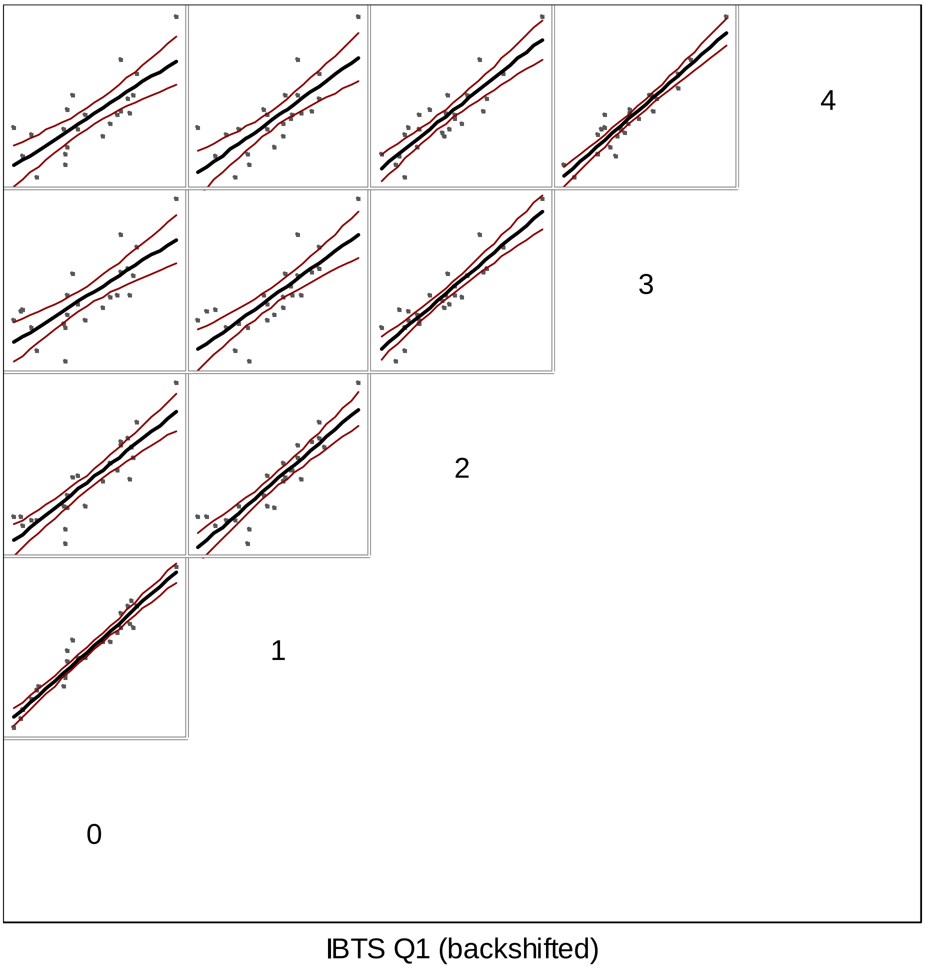


Figure 13.3.3.3. Haddock in Subarea IV and Division IIIa. Within-survey correlations for the IBTS Q1 survey series, comparing index values at different ages for the same year-classes (cohorts). In each plot, the straight line is a normal linear model fit: a thick line represents a significant ($p < 0.05$) regression, while a thin line is not significant. Approximate 95% confidence intervals for each fit are also shown.

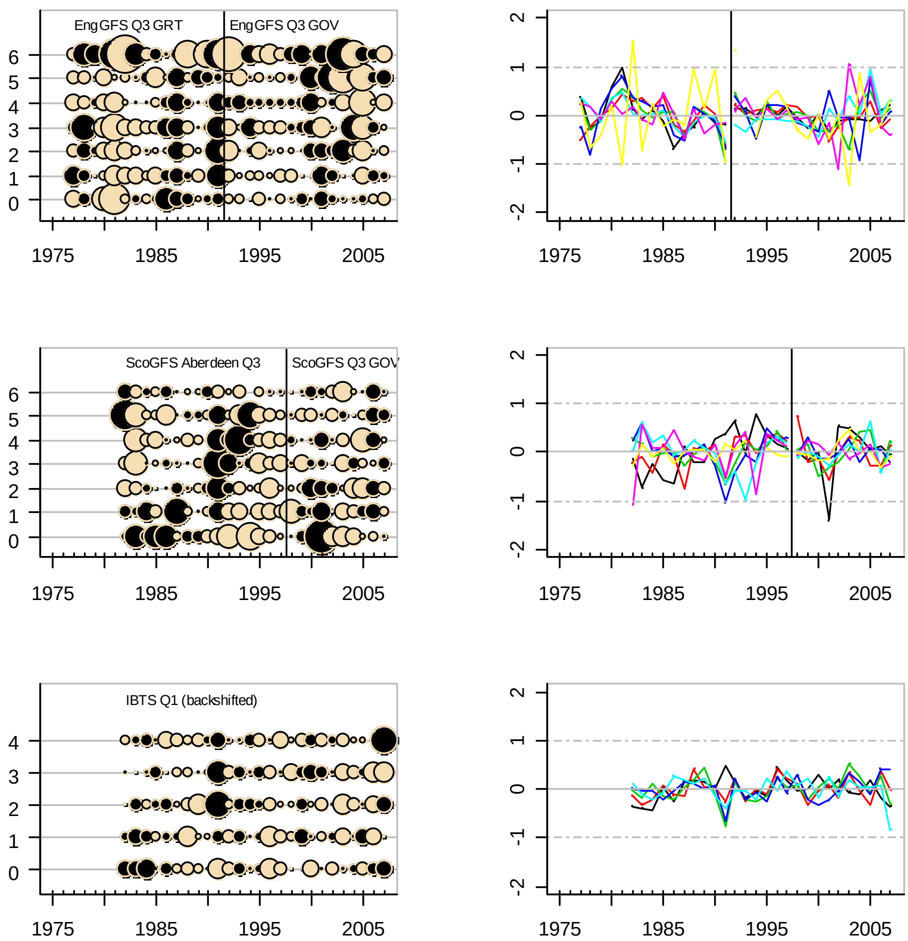


Figure 13.3.5.1 Haddock in Subarea IV and Division IIIa. Log catchability residuals for final XSA assessment. Both EngGFS and ScoGFS are split when used as tuning indices, and this split is shown by vertical lines on the relevant plots.

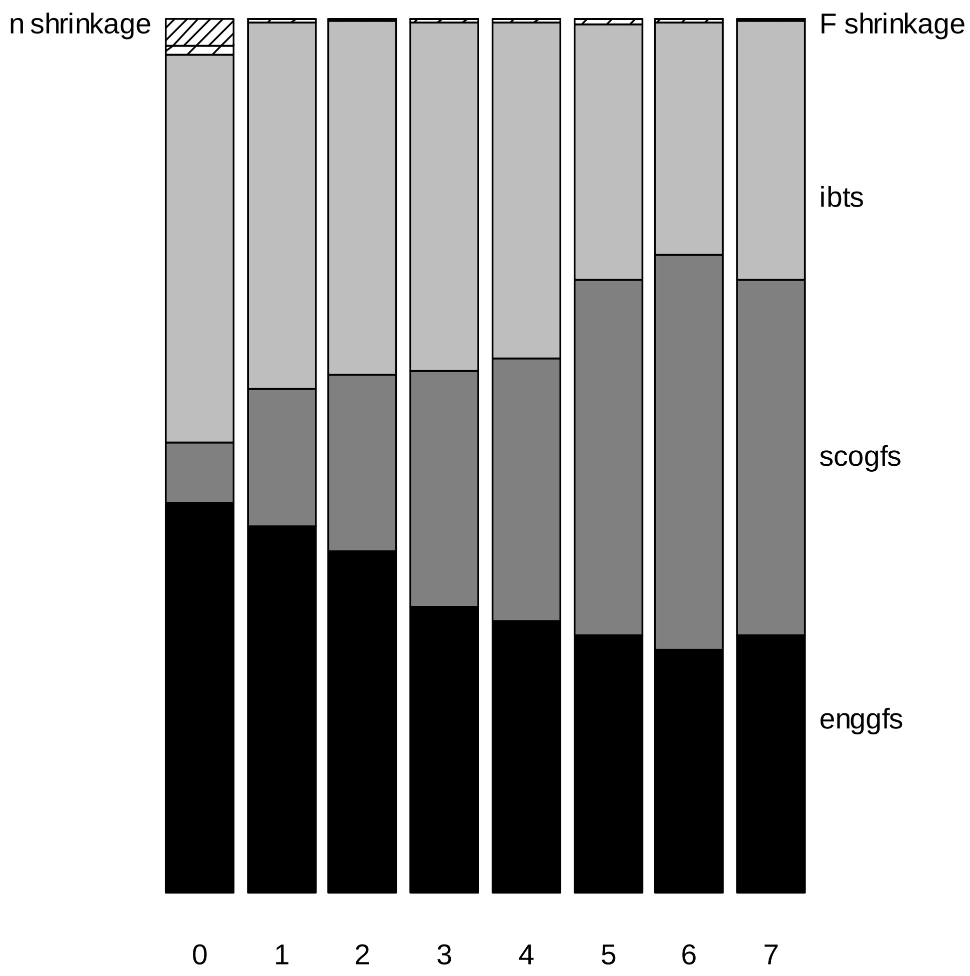


Figure 13.3.5.2. Haddock in Subarea IV and Division IIIa. Contribution to survivors' estimates in final XSA assessment.

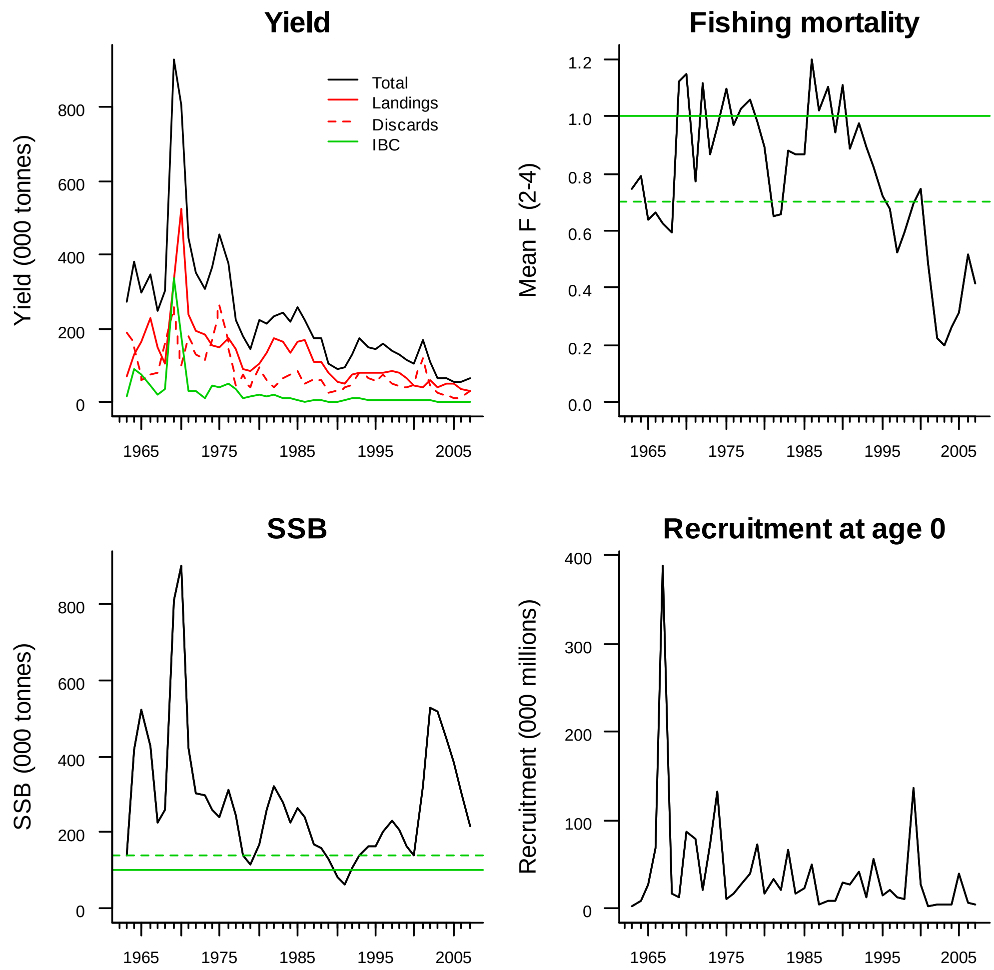


Figure 13.3.5.3. Haddock in Subarea IV and Division IIIa. Summary plots for final XSA assessment. Dotted horizontal lines indicate F_{pa} (top right plot) and B_{pa} (bottom left plot), while solid horizontal lines indicate F_{lim} and B_{lim} in the same plots.

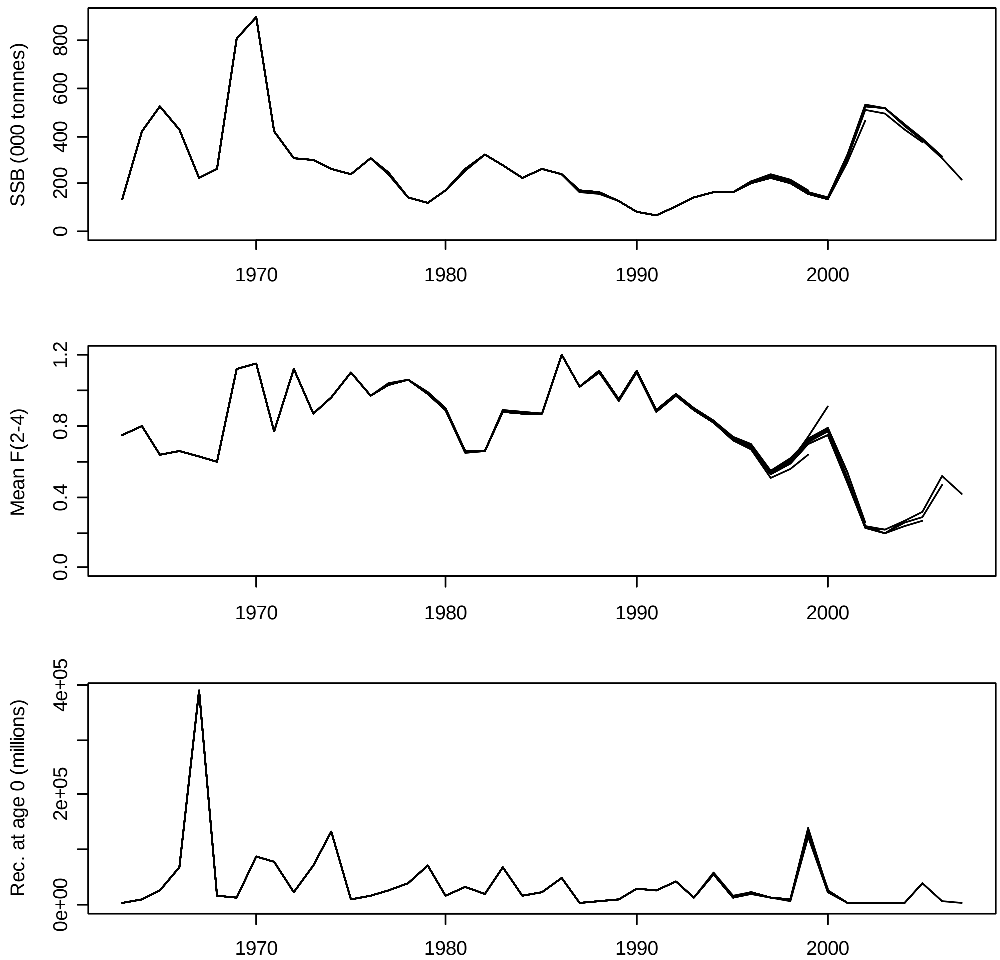


Figure 13.3.5.4. Haddock in Subarea IV and Division IIIa. Eight-year retrospective plots for final XSA assssment.

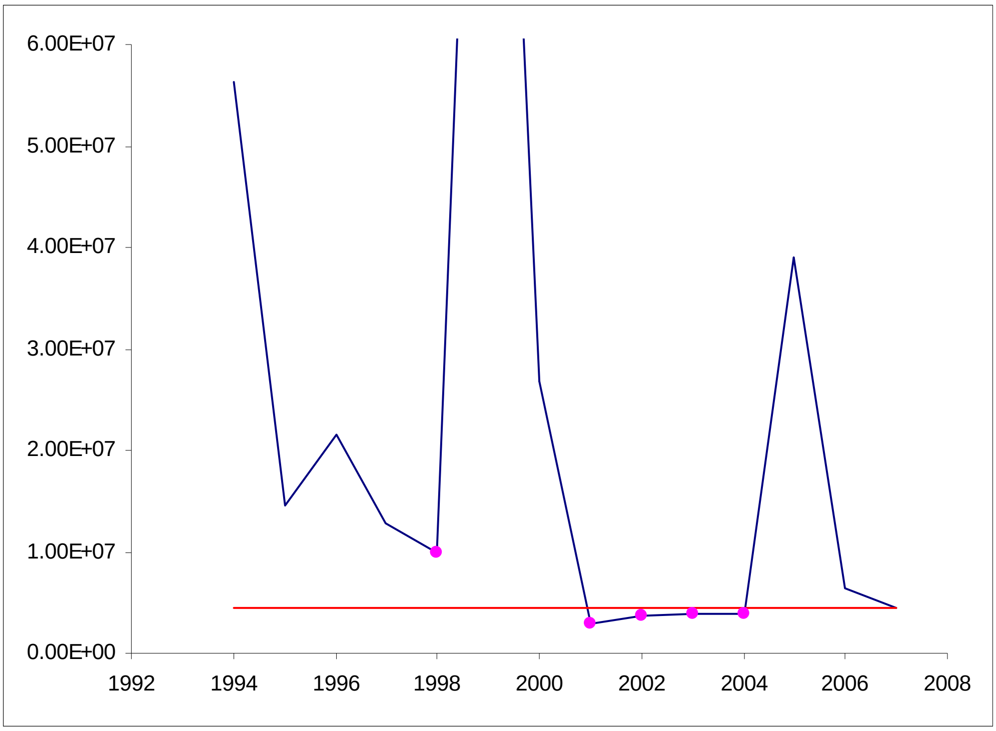


Figure 13.5.1.1. Haddock in Subarea IV and Division IIIa. Estimated recruitment from final XSA assessment for 1994-2007 (black line), with 5 lowest values (pink dots) and geometric mean of these (red line).

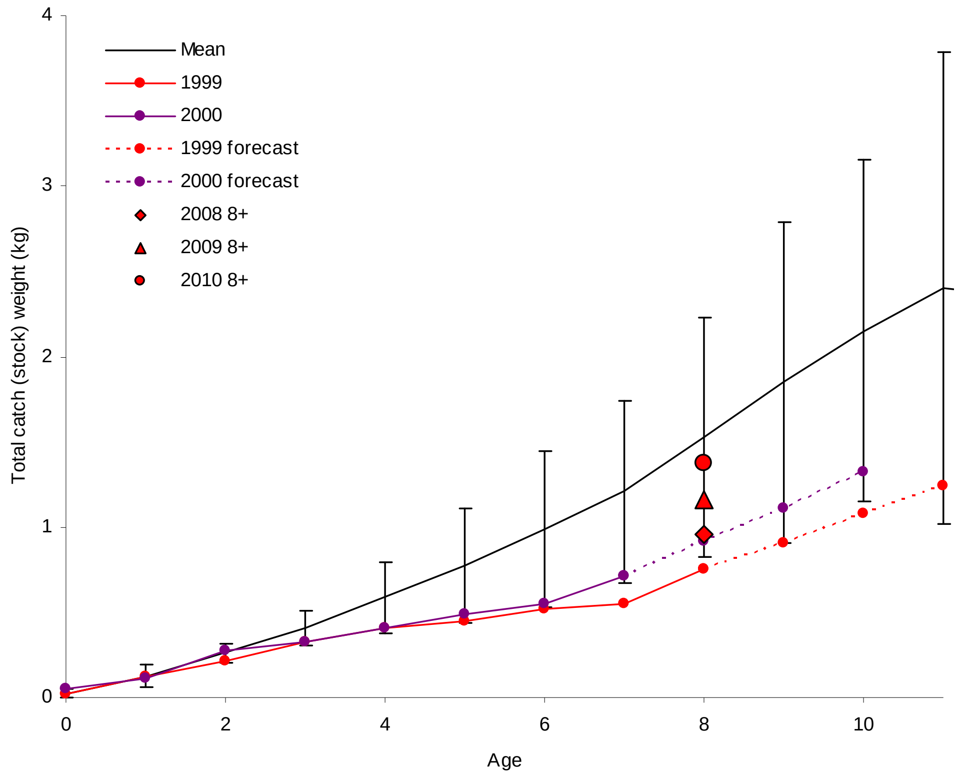


Figure 13.6.1.1. Haddock in Subarea IV and Division IIIa. Results of growth modelling for total catch weights (also used as stock weights) using proportional increments. Black line: arithmetic mean weight-at-age of 1953-2007 cohorts (error bars give ±2 standard deviations. Red and purple lines: weights-at-age for the 1999 and 2000 cohorts respectively (solid = observed, dotted = forecast).

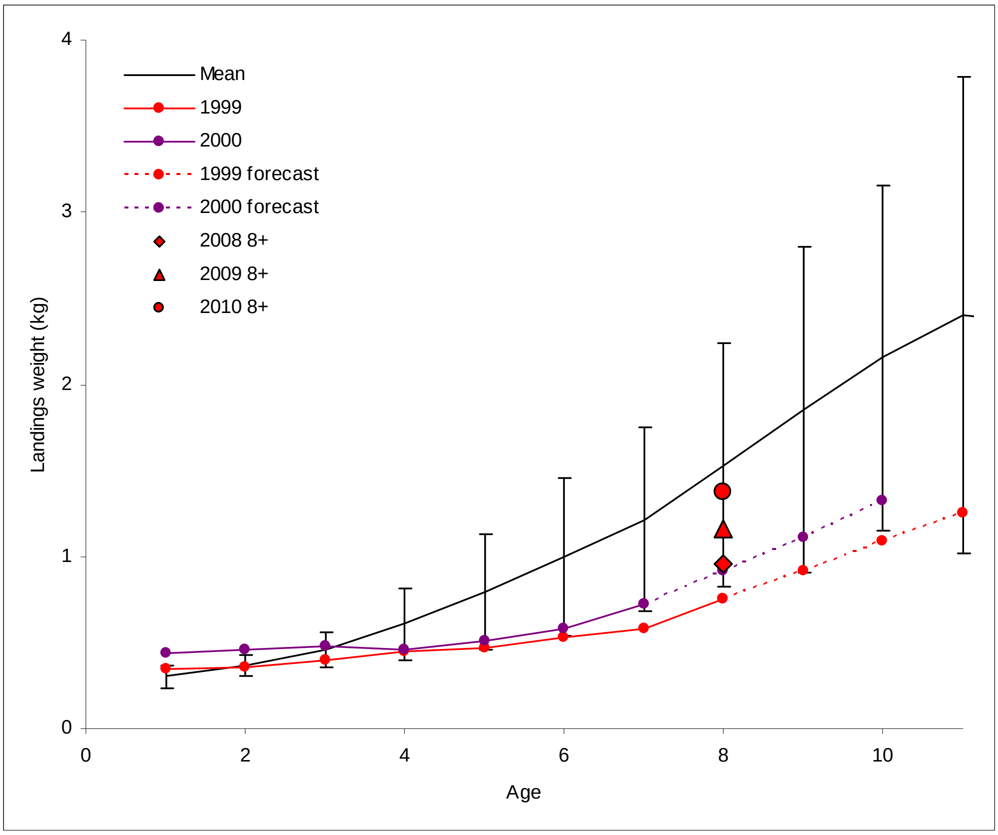


Figure 13.6.1.2. Haddock in Subarea IV and Division IIIa. Results of growth modelling for human consumption landings using proportional increments. Black line: arithmetic mean weight-at-age of 1953-2007 cohorts (error bars give ±2 standard deviations. Red and purple lines: weights-at-age for the 1999 and 2000 cohorts respectively (solid = observed, dotted = forecast). Large red symbols indicate forecast weight for the 8+ group in 2008 (diamond), 2009 (triangle) and 2010 (circle).

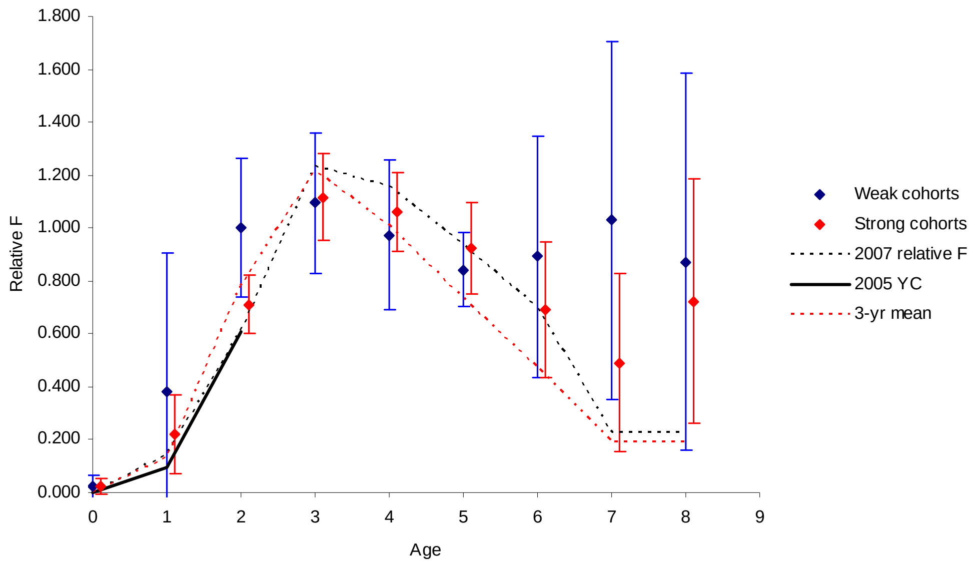


Figure 13.6.1.3. Haddock in Subarea IV and Division IIIa. Relative (F_a/mean F_{2-4}) from final XSA assessment. Blue markers show relative F averaged across the 15 weakest cohorts in the time-series. Red markers show relative F averaged across the 15 strongest cohorts in the time-series. For both, error bars show ±2 SEs. The dotted black line shows the relative F for 2007. The solid black line gives the relative F for the 2005 year-class. The dotted red line gives the average relative F for 2005-2007.

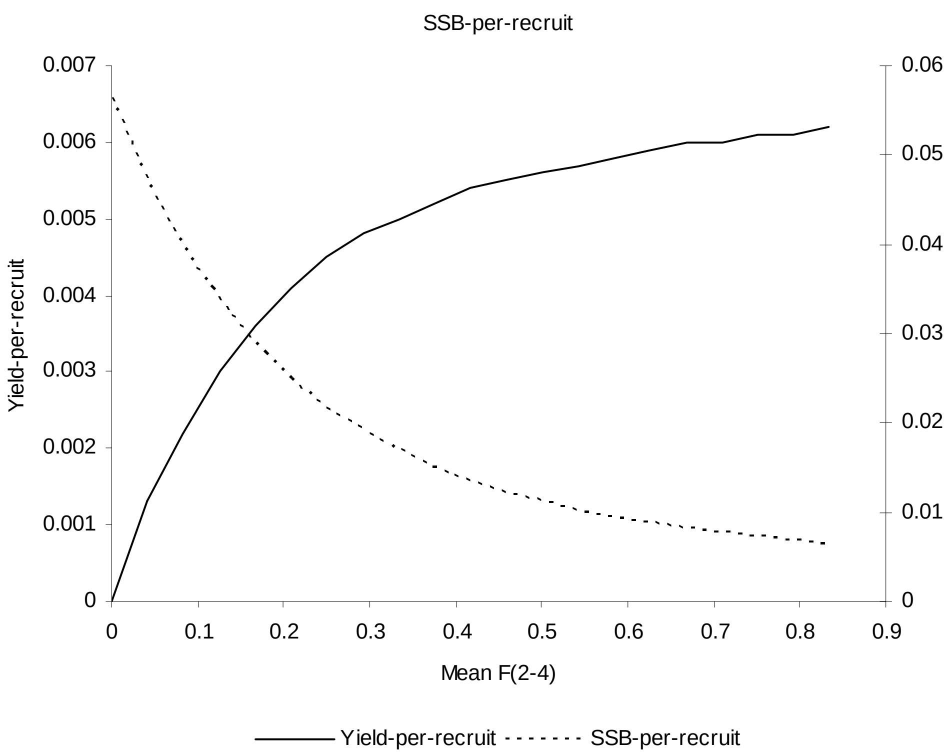


Figure 13.7.1. Haddock in Subarea IV and Division IIIa. Summary of yield-per-recruit analysis.

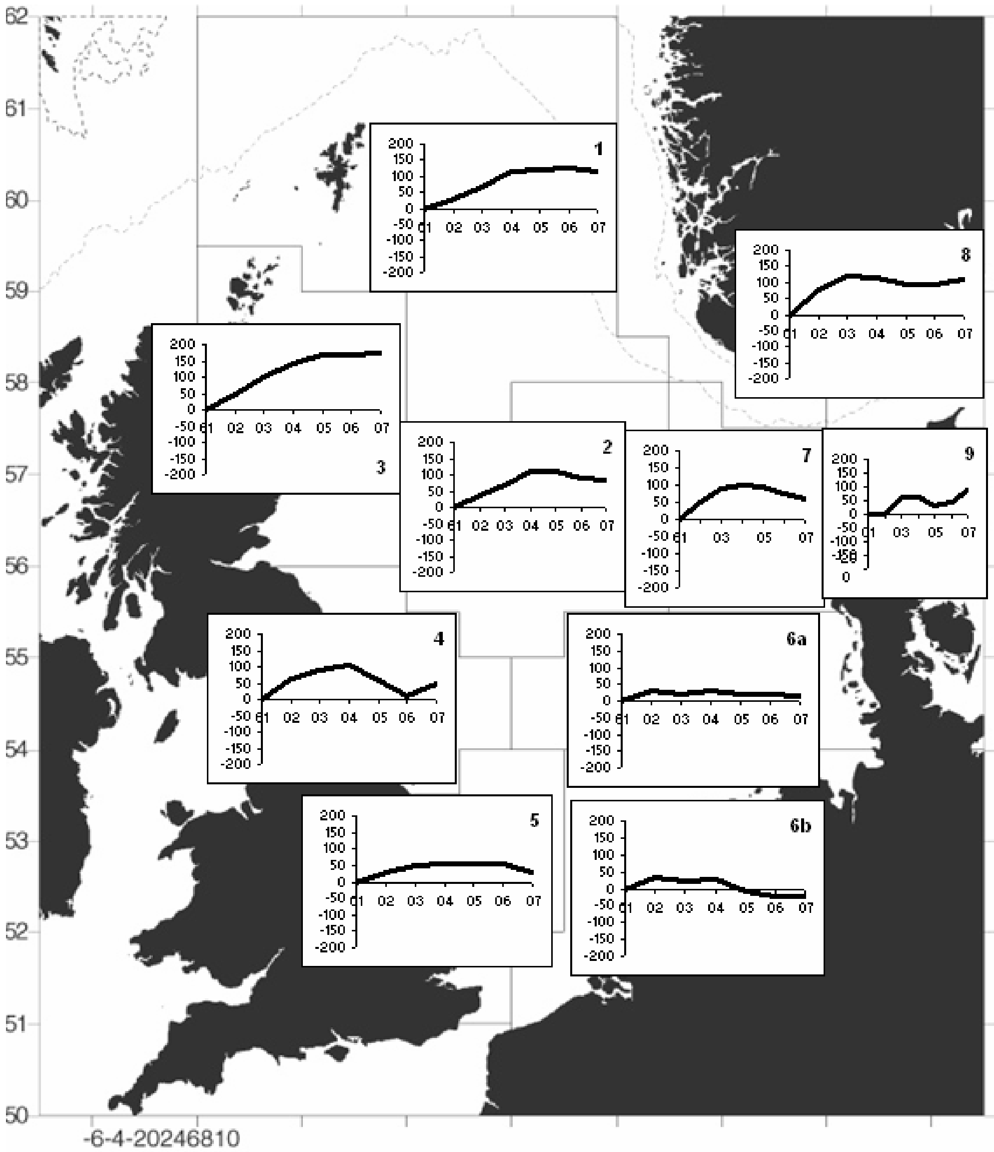


Figure 13.10.1. Haddock in Subarea IV and Division IIIa. Results of 2007 North Sea Stock Survey.

14 Cod

This assessment relates to the cod stock in the North Sea (Subarea IV), the Skagerrak (the northern section of Division IIIa) and the eastern Channel (Division VIId). This assessment is presented as an update assessment (same B-ADAPT settings as last year). There are minor changes to the IBTS Q1 data for 2004 and catch data for 2006. With additional discard data becoming available, the discard raising procedure for 2007 data differs from previous years.

The cod fishery is managed through a multi-annual plan aimed at the recovery of cod stocks (Council Regulation: EC 423/2004). The recovery plan specifies that once recovery has been achieved, the EU Commission should propose follow-up measures on the conservation and sustainable exploitation of fisheries resources under the common fisheries policy. The current agreement between the EU and Norway includes a plan for managing the stock after the rebuilding target has been reached. This agreement includes a fishing mortality target of 0.4 and a 15% constraint on annual changes in TAC.

14.1 General

14.1.1 Ecosystem aspects

This text in this section is the same as last year.

Cod are widely distributed throughout the North Sea. Scientific survey data indicate that historically, young fish (ages 1 and 2) have been found in large numbers in the southern part of the North Sea. Adult fish have in the past been 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 discrete but the area occupied has contracted. During recent years, the highest densities of 3+ cod have been observed in the deeper waters of the central to northern North Sea.

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

Available information indicates that spawning takes place from December 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 sites at Great Fisher Bank and Aberdeen Bank no longer being used by the 1980s, and more recently other coastal spawning sites around Scotland and in the Forties area.

At the North Sea scale, there has been a northerly shift in the mean latitudinal distribution of the stock (e.g. Perry *et al.*, 2005). However the evidence for this being a migratory response is slight or non-existent. More likely, cod in the North Sea are composed of a complex of more or less isolated sub-stocks (as indicated above) and the southern units have been subjected to disproportionately high rates of fishing mortality. Blanchard *et al.* (2005) demonstrated that the contraction in range of the North Sea cod stock could be linked to reduced abundance as well as temperature, and they also noted that the combined negative effects of increased temperature on recruitment rates and the reduced availability of optimal habitat may have increased the vulnerability of the cod population to fishing mortality. Rindorf and Lewy (2006) linked the northward shift in distribution to the effect of a series of warm, windy winters on larvae and the resultant distribution of recently settled cod. They also note that this effect is emphasised by the low abundance of older age cod due to heavy fishing pressure (STECF-SGRST-07-01).

The consumption of cod in the North Sea in 2002 by grey seals (*Halichoerus grypus*) has recently been estimated (Hammond and Grellier, 2006). For the North Sea it was estimated that in 1985 grey seals consumed 4150 tonnes of cod (95% confidence intervals: 2484-5760 tonnes), and in 2002 the population tripled in size (21-68 000) and consumed 8344 tonnes (95% confidence intervals: 5028-14941 tonnes). These consumption estimates were compared to the Total Stock Biomass (TSB) for cod of 475 000 tonnes and 225 000 tonnes for 1985 and 2002 respectively. The mean length of cod in the seal diet was estimated as 37.1 cm and 35.4 cm in 1985 and 2002 respectively. It should be noted, however, that seal diet analysis must be treated with a degree of caution because of the uncertainties related to modelling complex processes (e.g. using scat analysis to estimate diet composition involves complex parameters, and can overestimate species with more robust hard parts), and the uncertainties related to estimating seal population size from pup production estimates (involving assumptions about the form of density-dependent dynamics). The analysis may also be subject to bias because scat data from haul-out sites may reflect the composition of prey close to the sites rather than further offshore. Furthermore, seals may be exploiting components of the cod stock unavailable to the fishery (STECF-SGRST-07-01).

The effect of seal predation on cod mortality rates has been estimated for the North Sea within a multi-species assessment model (MSVPA), which was last run in 2005 (ICES-SGMSNS, 2005). At the time the revised estimates of cod consumption by grey seals were not available and data was not available to allow the inclusion of common seals into the key run of the model. The grey seal population size was obtained from WGMME (ICES-WGMME, 2005) and was assumed to be 68,000 in 2002 and 2003 respectively. Estimates of cod consumption were 19,000 tonnes in 2002 and 11,000 tonnes in 2003, higher than the values estimated by Hammond and Grellier (2006). Sensitivity analysis of the North Sea cod stock assessment estimates to the inclusion of the revised multi-species mortality rates were carried out at the 2003 meeting of the WGNSSK (ICES-WGNSSK, 2003). Inclusion of the multi-species mortality rates had a relatively minor effect on the high levels of estimated fishing mortality rates and low levels of spawning stock biomass abundance. Inclusion of the new grey seal diet data and seal population abundance are expected to reduce historic estimates of cod consumption in the North Sea by seals generated from the MSVPA model and therefore this suggests that the new estimates of seal predation will not alter the current perception of North Sea cod stock dynamics (STECF-SGRST-07-01).

A recent meeting of the STECF reviewed the broad scale environmental changes in the north-eastern Atlantic that has influenced all areas under the cod recovery plan (STECF-SGRST-07-01), and concluded that:

- Warming has occurred in all areas of the NW European shelf seas, and is predicted to continue.
- A regime shift in the North Sea ecosystem occurred in the mid-1980s.
- These ecological changes have, in addition to the decline in spawning stock size, negatively affected cod recruitment in all areas.
- Biological parameters and reference points are dependent on the time-period over which they are estimated. For example, for North Sea cod F_{MSY}, MSY and B_{MSY} are lower when calculated for the recent warm period (after 1988) compared to values derived for the earlier cooler period.
- The decline in F_{MSY}, MSY and B_{MSY} can be expected to continue due to the predicted warming, and possible future change should be accounted for in stock assessment and management regimes.
- Modelling shows that under a changing climate, reference points based on fishing mortality are more robust to uncertainty than those based on biomass.
- Despite poor recruitment, modelling suggests that cod recovery is possible, but ecological change may affect the rate of recovery, and the magnitude of achievable stock sizes.
- Recovery of cod populations may have implications to their prey species, including *Nephrops*.

With the exception of the general effects noted above, the overall conclusion from the STECF meeting (STECF-SGRST-07-01) for the North Sea was that there is no specific significant environmental or ecosystem change in the Skagerrak, North Sea and eastern Channel (e.g. the effects of gravel extraction, etc.) affecting potential cod recovery. The conclusions from the STECF meeting merit further discussion within ICES, which is ongoing (e.g. ICES-WKREF, 2007).

14.1.2 Fisheries

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

An analysis of landings and estimated discards of cod by gear category (excluding Norwegian data) highlighted the following fleets as the most important in terms of cod for 2003-5 (accounting for close to 88% of the EU landings), listed with the main use of each gear (STECF SGRST-07-01):

- Otter trawl, ≥ 120mm, a directed roundfish fishery by UK, Danish and German vessels.
- Otter trawl, 70-89mm, comprising a 70-79mm French whiting trawl fishery centered in the Eastern Channel, but extending into the North Sea, and an 80-89mm UK *Nephrops* fishery (with smaller landings of roundfish and anglerfish) occurring entirely in the North Sea.

- Otter trawl, 90-99mm, a Danish and Swedish mixed demersal fishery centered in the Skagerrak, but extending into the Eastern North Sea.
- Beam trawl, 80-89mm, a directed Dutch and Belgian flatfish fishery.
- Gillnets, 110-219mm, a targeted cod and plaice fishery.

For Norway in 2007, trawls (mainly bycatch in the saithe fishery) and gillnets account for around 60% (by weight) of cod catches, with the remainder taken by other gears mainly in the fjords and on the coast, whereas in the Skagerrak, trawls and gillnets account for up to 90% of cod catches.

With regard to trends in effort for these major cod fisheries since 2000, the largest changes to have happened in North Sea fisheries have involved an overall reduction in trawl effort and changes in the mesh sizes in use, due to a combination of decommissioning and days-at-sea regulations. In particular 100-119mm meshes have now virtually disappeared, and instead vessels are using either 120mm+ (in the directed whitefish fishery) or 80-99mm (primarily in the *Nephrops* fisheries and in a variety of mixed fisheries). The use of other mesh sizes largely occurs in the adjacent areas, with the 70-79mm gear being used in the Eastern Channel/Southern North Sea Whiting fishery, and the majority of the landings by 90-99mm trawlers coming from the Skagerrak. Higher discards are associated with these smaller mesh trawl fisheries, but even when these are taken into account, the directed roundfish fishery (trawls with ≥ 120mm mesh) still has the largest impact of any single fleet on the cod stock, followed by the mixed demersal fishery (90-99mm trawls) in the Skagerrak.

Technical Conservation Measures

The present technical regulations for EU waters came into force on 1 January 2000 (EC 850/98 and its amendments). The regulation prescribes the minimum target species' composition for different mesh size ranges. Additional measures were introduced in Community waters from 1 January 2002 (EC 2056/2001).

In 2001, the European Commission implemented an emergency closure of a large area of the North Sea from 14 February to 30 April 2001 (EC 259/2001). An EU-Norway expert group in 2003 concluded that the emergency closure had an insignificant effect upon the spawning potential for cod in 2001. There were several reasons for the lack of impact. The redistribution of the fishery, especially along the edges of the box, coupled to the increases in proportional landings from January and February appear to have been able to negate the potential benefits of the box. The conclusion from this study was that the box would have to be extended in both space and time to be more effective. This emergency measure has not been adopted after 2001. A cod protection area was implemented in 2004 (EC 2287/2003 and its amendments), which defined conditions under which certain stocks, including haddock, could be caught in Community waters, but this was only in force in 2004.

Apart from the technical measures set by the Commission, additional unilateral measures are in force in the UK, Denmark and Belgium. The EU minimum landing size (mls) is 35cm, but Belgium operate a 40cm mls, while Denmark operate a 35cm mls in the North Sea and 30cm in the Skagerrak. Additional measures in the UK relate to the use of square mesh panels and multiple rigs, restrictions on twine size in both whitefish and *Nephrops* gears, limits on extension length for whitefish gear, and a ban on lifting bags. In 2001, vessels fishing in the Norwegian sector of the North Sea had to comply with Norwegian regulations setting the minimum mesh size at 120mm. Since 2003, the basic minimum mesh size for towed gears targeting cod is 120mm.

Effort regulations in days at sea per vessel and gear category are summarised in the following table, which only shows changes in 2008 compared to 2007 (2006 is included for comparison). The changes (2007-2008) were intended to generate a cut in effort of 10% for the main gears catching cod.

Maximum number of days a vessel can be present in the North Sea, Skagerrak and Eastern Channel, by gear category and special condition (see EC 40/2008 for more details). The table only shows changes in 2008 compared to 2007, but 2006 is also included for comparison.

Description of gear and special condition (if applicable)	Area			Max days at sea		
	IV,II	Skag	VIId	2006	2007	2008**
Trawls or Danish seines with mesh size ≥ 120mm	x	x	x	103	96	86
Trawls or Danish seines with mesh size ≥ 100mm and < 120mm	x	x	x	103	95	86
Trawls or Danish seines with mesh size ≥ 90mm and < 100mm	x		x	227	209	188
Trawls or Danish seines with mesh size ≥ 90mm and < 100mm		x		103	95	86
Trawls or Danish seines with mesh size ≥ 70mm and < 90mm	x			227	204	184
Trawls or Danish seines with mesh size ≥ 70mm and < 90mm			x	227	221	199
Beam trawls with mesh size ≥ 120mm	x	x		143	143	129
Beam trawls with mesh size ≥ 100mm and < 120mm	x	x		143	143	129
Beam trawls with mesh size ≥ 80mm and < 90mm	x	x		143	132	119
Gillnets and entangling nets with mesh sizes ≥ 150mm and < 220mm	x	x	x	140	130	117
Gillnets and entangling nets with mesh sizes ≥ 110mm and < 150mm	x	x	x	140	140	126
Trammel nets with mesh size < 110mm. The vessel shall be absent from port no more than 24h.	x		x	205	205	185*

* For member states whose quotas less than 5% of the Community share of the TACs of both plaice and sole, the number of days at sea shall be 205

** If member states opt for an overall kilowatt-days regime, then the maximum number of days at sea per vessel could be different to that set out for 2008 (see text below and EC 40/2008 for details).

Additional provisions have been introduced for 2008 (points 8.5-7, Annex IIa, EC 40/2008) to provide Member States greater flexibility in managing their fleets, in order to encourage a more efficient use of fishing opportunities and stimulate fishing practices that lead to reduced discards and lower fishing mortality of both juvenile and adult fish. This measure allows a Member State that fulfils the requirements laid out in EC 40/2008 to manage a fleet (i.e. group of vessels with a specific combination of geographical area, grouping of fishing gear and special condition) to an overall kilowatt-days limit for that fleet, instead of managing each individual vessel in the fleet to its own days-at-sea limit. The overall kilowatt-days limit for a fleet is initially calculated as the sum of all individual fishing efforts for vessels in that fleet, where an individual fishing effort is the product of the number of days-at-sea and engine power for the vessel concerned. This provision allows Member States to draw up fishing plans in collaboration with the Fishing Industry, which could, for example, specify a target to reduce cod discards to below 10% of the cod catch, allow real-time closures for juveniles and spawners, implement cod avoidance measures, trial new selective devices, etc.

Incentives of up to 12 additional days at sea per vessel are in place for 2008 to encourage vessels to sign up to a Discard Reduction Plan (points 12.9-10, Annex IIa, EC 40/2008). The plan focuses on discarding of cod or other species with discard problems for which a management/recovery plan is adopted, and should include measures to avoid juvenile and spawning fish, to trial and implement technical measures for improving selectivity, to increase observer coverage, and to provide data for monitoring outcomes. For vessels participating in a Cod Avoidance Reference Fleet Programme in 2008 (points 12.11-14, Annex IIa, EC 40/2008), a further 10-12 additional days at sea is possible (over and above that for the Discard Reduction Plan). Vessels participating in this program should meet a specific target to reduce cod discards to below 10% of cod catches, and be subject to observer coverage of at least 10%.

Under the provisions laid down in point 8.5 of Annex IIa (EC 40/2008), Scotland has implemented a national kilowatt-days scheme known as the 'Conservation Credits Scheme'. The principle of this two-part scheme involves credits (in terms of additional time at sea) in return for the adoption of and adherence to measures which reduce mortality on cod and lead to a reduction in discard numbers. The initial, basic scheme was implemented from the beginning of February 2008 and essentially grants vessels their 2007 allocation of days (operated as hours at sea) in return for: observance of Real Time Closures (RTC), observance of a one net rule, adoption of more selective gears (110mm square meshed panels in 80mm gears or 90mm square meshed panels in 95mm gear), agreeing to participate in additional gear trials, and participation in an enhanced observer scheme.

For the first part of 2008, the RTC system was designed to protect aggregations of larger, spawning cod (>50cm length). Commercial catch rates of cod observed by FRS on board vessels was used to inform trigger levels leading to closures. Ten closures occurred to the beginning of May and protection agency monitoring suggests good observance. The scheme is now being extended for the remainder of the year to protect aggregations of all sizes of cod. A joint industry/ science partnership (SISP) has a number of gear trials programmed for 2008 examining methods to improve selectivity and reduce discards, and an enhanced observer scheme has been announced by the Scottish Government.

Observance of the above conditions also gives eligibility for vessels to participate in the second, enhanced, part of the Conservation Credits scheme. This is currently under development and details will be released shortly.

Changes in fleet dynamics

The introduction of the one-net rule as part of the Scottish Conservation Credit Scheme and new Scottish legislation implemented in January 2008 is both likely to improve the accuracy of reporting of Scottish landings to the correct mesh size range, although some sectors of the Scottish industry have been granted derogations to continue carrying two nets (seiners until the end of January 2009, and others until the end of April 2008). The concerted effort to reduce cod mortality, through implementation of the Conservation Credit Scheme from February 2008, could lead to greater effort is exerted on haddock, whiting, monk, flatfish and *Nephrops*.

Shifts in the UK fleet include: (a) a move of Scottish vessels using 100-110mm for whitefish on west coast ground (subarea VI) to the North Sea using 80mm prawn codends (motivated by fuel costs, and could increase effort on North Sea stocks; the simultaneous requirement to use 110 square mesh panels may mitigate unwanted selectivity implications – see below); (b) a move away from the Farne Deeps *Nephrops* fishery into other fisheries for whitefish because of poor *Nephrops* catch rates (implying increased effort in whitefish fisheries); and (c) a move of Scottish vessels from twin trawls to single rig, and increased use of pair trawls, seines and double bag trawls (motivated by fuel costs). For the current year in the Scottish fleet, all twin-rig gear in the 80-99mm category have to use a 110mm square mesh panel, but this will also apply to single-rig gears from July 2008 onwards, which should improve whitefish selection. A large number of 110mm square mesh panels have been bought by Scottish fishers at the beginning of 2008 in order to qualify for the Conservation Credit Scheme, which has dramatically improved the uptake of selective gear. The ban on the use of multi-rigs in Scotland, implemented in January 2008, could limit the potential for an uncontrolled increase in effective effort.

The Dutch fleet has been reduced, through decommissioning, by 23 vessels from the beginning of 2008, while 5 Belgian beam trawlers (approximately 5% of the Belgian fleet) left the fishery in 2007, both changes implying reductions in effort in the beam trawl sector. The introduction of an ITQ regulation system in Denmark in 2007 might have influenced the effort distribution over the year, but this should not affect the total Danish effort deployed or the size distribution of catches.

Dutch beam trawlers have gradually shifted to other techniques such as twin trawling, outrigging and fly-shooting, as well as opting for smaller, multi-purpose vessels, implying a shift in effort away from flatfish to other sectors. These changes are likely caused by TAC limitations on plaice and sole, and rising fuel costs. Belgian and UK vessels have also been experimenting with outrigger trawls as an alternative to beam trawling, motivated by more fuel efficient and environmentally friendly fishing methods.

The increased effort costs in the Kattegat (2.5 days at sea per effort day deployed) has led to a shift in effort by Swedish vessels to the Skagerrak and Baltic Sea. There has also been an increase in the number of Swedish *Nephrops* vessels in recent years, attributed to the input of new capital transferred from pelagic fleets following the introduction of an ITQ-system for pelagic species, and leading to further increases in effort. The Swedish trawler fleet operating in IIIa has had a steady increase in the uptake of the *Nephrops* grid since the introduction of legislation in 2004 (use of the grid is mandatory in coastal waters), and given the strong incentives to use the grid (unlimited days at sea). Uptake of the *Nephrops* grid should result in improved selection.

A squid fishery in the Moray Firth continues to develop using very unselective 40mm mesh when squid species are available on the grounds. Although the uptake was poor in 2007 due to the lack of squid, the potential for high bycatches of young gadoids in future, including those of cod and haddock, remains. This fishery may provide an alternative outlet for the Scottish *Nephrops* fleet seasonally, and hence reduce effort in the *Nephrops* sector.

Fisheries Science Partnerships

The NE Coast cod survey (WD3) is a designated time-series survey conducted since 2003 as part of the UK Fisheries Science Partnership (FSP). The objective of the survey series is to provide year-on-year comparative information on distribution, relative abundance and size/age composition of cod and whiting off the NE coast of England. The surveys also provide data on catches of other species important to the NE coast fishery, including haddock. Results indicate that the population of cod in the survey area has primarily comprised 1- and 2-year-olds, with some 3- and 4-year-olds. Older fish are scarce. The relative strength of recent year classes of cod, as indicated by the time-series of FSP catch rates of 1-year-olds, has been very similar to the trends given in last year's ICES assessment (ICES-WGNSSK 2007). Furthermore, the bulk of the FSP cod catches in 2005, 2006 and 2007 were fish of 21–45 cm, predominantly 1-year-olds which were most abundant on the inshore hard ground. Catch rates of cod in this length range were generally higher in 2006 than in 2005, owing to the relative strength of the 2005 year class. Both this FSP survey and the IBTS surveys indicate that the 2006 year-class of cod is less than half as abundant as the relatively strong 2005 year class.

A new UK FSP project in 2007 (the "North Sea Codwatch" project, WD4) has been mapping the distribution of young cod of the 2005 and 2006 year classes in the North Sea using a fisher self-sampling scheme (www.cefas.co.uk/fsp). The project involves 12 Eastern England Fish Producer Organisation (EEFPO) vessels, representing a wide range of fishing gears and target species, and operating throughout the North Sea. These vessels observe and record the incidence, and fine-scale distribution and abundance of the 2005 and 2006 year classes of cod, and of cod in general in the North Sea from commercial catches made between April 2007 and March 2008. The project has now been extended to March 2009, and will also consider the 2007 and 2008 year classes.

Based on fishers' perception of current year class strength relative to previous year classes (participants have an average of 30 years fishing experience), provisional North Sea Codwatch results suggest that the 2005 year class was widely distributed throughout the North Sea (appearing in most sampled areas), with the highest levels of abundance occurring in the western-central North Sea in Q3, and in the western central and southern North Sea in Q4. Of all rectangles sampled (153 in total), only 19% recorded perceptions of "high" or "very high" abundance of the 2005 year class relative to historical abundance (the remainder recording perceptions of "zero", "low" or "moderate" abundance), but the proportion of rectangles recording "high" or "very high" increased with time (from 10% in Q2 to 26% in Q4). In contrast, the 2006 year class was present in relatively few of the sampled rectangles, with 80% of sampled rectangles recording perceptions of "zero" or "low", but skippers noted that this may be a consequence of the gear used. Nevertheless, these perceptions are consistent with WG estimates of these two year classes, both relative to each other and in the historical context.

A collaborative biologist-fishermen project on North Sea cod (REX, WD5) was initiated by DTU-Aqua (Institute for Aquatic Resources at the Technical University of Denmark) and the Danish Fishermen Association in summer 2006. Three commercial vessels representing different fishing methods participated in the study. These were a trawler, a flyshooter and a gillnetter. The original survey area consisted of 7 ICES statistical rectangles in the north-eastern North Sea.

During the first two surveys in June and August 2006 the fishermen were free to select the fishing positions that tended to be mainly located on rough bottom, which is usually not covered by scientific bottom trawl surveys. In order to allow the investigation of a potential effect of bottom type, the fishermen were subsequently requested to select paired stations within 10×10 nmi^2 with one station on sand bottom and the other on different bottom types (gravel and stone bottom, as well as ship wrecks in the case of the gillnetter) during the next two surveys in January/February and June 2007. In order to obtain a better impression of the spatial distribution, a higher degree of randomisation in the survey design was used in surveys conducted in August 2007 and in February 2008 (survey area divided into 5×5 nmi^2; randomly selected fishing position with the square chosen by the fishermen; at least 25 % of the stations on sand bottom; number of squares covered in an ICES rectangles differed between the vessels to account for differences in fishing method). This strategy was also used in an additional survey with the flyshooter in the western Skagerrak in September 2007.

The first three surveys resulted in sampling of a few clusters of stations in favourite spots of fishermen, yielding considerable catch rates of cod. In the later surveys a much wider extension of areas with high densities of cod were recorded (e.g. catch rates of more than 1 ton of cod per nmi^2 were found in 25 % of the stations in the August 2007 survey). In general, catch rates were lower in spring than in summer, and catches were considerably higher on rough bottom than on sand in the summer surveys. Considering the changes in survey strategy, the results suggest an increase in cod density from the 3rd quarter 2006 to the 3rd quarter 2007, while no significant change was detected between the 1st quarter 2007 and the 1st quarter 2008. The length frequencies ranged from 20 to 120 cm with a peak at 30 to 40 cm for the trawler and flyshooter, and at larger sizes for the gillnetter. Cod between 60 and 80 cm was well represented in the length frequencies for all vessels, and larger cod was caught regularly, in particular by the trawler and gillnetter. A comparison with the IBTS catches from the same area suggests a marked decline of the efficiency of the IBTS for cod larger than 40 cm compared to the catches rates of the commercial vessels. This, however, needs further investigation, and an analysis based on age disaggregated data is required before conclusive results can be obtained.

The WG welcomes this work, particularly as it enhances the quality of management advice (e.g. the FSP results provide support for perceptions of year class strength).

Additional information provided by the fishing industry

In May 2008, French fishers targeting cuttlefish in the eastern Channel reported discards of several tons per haul of undersized cod in ICES rectangle 28F0, forcing them to leave their usual cuttlefish fishing area. They reported that this also occurred in 2007. At the time of the WG meeting, the local fishermen were gathering additional information to verify these observations. Based upon the preliminary observations of fishermen in 2008, and observations during the summer of 2007, it seems undersized cod move westwards into VIIe in the spring. Inshore trawlers based in Granville have reported experiencing, for the first time, recurring bycatches of cod in some areas west of 28F0 during summer 2007. Bycatches of cod have already been reported this year in 28E91.

14.1.3 ICES Advice

ICES ACFM advice for 2007:

In 2006, ICES continued to advise on exploitation boundaries in relation to precautionary limits, because the existing recovery plan did not include the elements or measures necessary for rebuilding the stock at the then current SSB (well below B_{lim}). ICES recommended that the fisheries for cod be closed until an initial recovery of the cod SSB had been proven, and concluded that any catches that were taken in 2007 would prolong the recovery to B_{pa}.

ICES ACFM advice for 2008:

In 2007, ICES accepted the assessment and was able to make a forecast.

Single-stock exploitation boundaries

Exploitation boundaries in relation to existing management plans

In May 2007, the exploitation boundaries in relation to the existing management plan were based on the fact that "B_{lim} cannot be reached within a 30% increase in SSB". With the new information available, it is expected that B_{lim} can in fact be reached with a 30% increase in SSB. Therefore the recovery plan defines a maximum +15% change in TAC from 2007 to 2008. Given that applying the recovery plan procedure for setting TACs requires some understanding of how a change in TAC relates to changes in total removals, ICES is unable to advise on the consequences of a TAC consistent with the recovery plan for 2008. The recovery plan implies a level of control in total removals that is not present in the management of the fishery.

Exploitation boundaries in relation to precautionary limits

Despite the low stock size and recent poor recruitment, it is estimated that the stock can be rebuilt to B_{pa} (with a 50% probability) at the beginning of 2009 with a fishing mortality less than 0.13, corresponding to total removals (landings, discards, and unaccounted removals) of 22 000 t. ICES is unable to translate this figure for removals into a TAC with the required precision.

Conclusions regarding exploitation boundaries

Because the existing recovery plan is not considered to be in accordance with the precautionary approach, ICES continues to advise on exploitation boundaries in relation to precautionary limits.

14.1.4 Management

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

TAC(000t)	2004	2005	2006	2007	2008
IIIa (Skagerrak)	3.9	3.9	3.3	2.9	3.2
IIa + IV	27.3	27.3	23.2	20.0	22.2

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

EU Cod Recovery plan

A Cod Recovery Plan is in place because cod is still not considered to be recovered. ICES has previously concluded that a precautionary recovery plan must include an adaptive element, implying that fisheries for cod remain closed until an initial recovery of the cod SSB has been proven. Such an element is not included in the existing plan. ICES therefore considers the recovery plan as not consistent with the precautionary approach.

The recovery plan adopted by the EU Council in 2004, is still to be fully implemented. Details of it are given in EC 423/2004:

Article 1. This Regulation establishes a recovery plan for the following cod stocks (hereinafter referred to as "depleted cod stocks"):

(a) cod in the Kattegat;

(b) cod in the North Sea, in the Skagerrak and the eastern Channel;

(c) cod to the west of Scotland;

(d) cod in the Irish Sea.

Article 2. Definitions of geographical areas

For the purposes of this Regulation, the following definitions of geographical areas shall apply:

(a) "Kattegat" means that part of division III a, as delineated by ICES, that is bounded on the north by a line drawn from the Skagen lighthouse to the Tistlarna lighthouse, and from this point to the nearest point on the Swedish coast, and on the south by a line drawn from Hasenore to Gnibens Spids, from Korshage to Spodsbjerg and from Gilbjerg Hoved to Kullen;

(b) "North Sea" means ICES subarea IV and that part of ICES division III a not covered by the Skagerrak and that part of ICES division II a which lies within waters under the sovereignty or jurisdiction of Member States;

(c) "Skagerrak" means that part of ICES division III a bounded on the west by a line drawn from the Hanstholm lighthouse to the Lindesnes lighthouse and on the south by a line drawn from the Skagen lighthouse to the Tistlarna lighthouse and from that point to the nearest point on the Swedish coast;

(d) "eastern Channel" means ICES division VII d;

(e) "Irish Sea" means ICES division VII a;

(f) "west of Scotland" means ICES division VI a and that part of ICES division V b which lies within waters under the sovereignty or jurisdiction of Member States.

Article 3. Purpose of the recovery plan: The recovery plan (...) shall aim to increase the quantities of mature fish to values equal to or greater than 150 000 t (Cod in the North Sea, Skagerrak and eastern Channel)

Article 4: Reaching of target levels. Where the Commission finds, on the basis of advice (...), that for two consecutive years the target level for any cod stock concerned has been reached, the Council shall decide by (...) to remove that stock from the scope of this Regulation (...)

Article 5: Setting of TACs. A TAC shall be set in accordance with Article 6 where the quantities of mature cod have been estimated by the STECF, in the light of the most recent report of ICES, to be equal to or above the minimum level of 70 000 t (Cod in the North Sea, Skagerrak and eastern Channel).

Article 6: Procedure for setting TACs. (1.) Each year, the Council shall decide (...) on a TAC for the following year for each of the depleted cod stocks. (2.) The TACs shall not exceed a level of catches which a scientific evaluation (...) has indicated will result in an increase of 30 % in the quantities of mature fish in the sea at the end of the year of their application, compared to the quantities estimated to have been in the sea at the start of that year. (3.) The Council shall not adopt a TAC whose capture is predicted (...) to generate in its year of application a fishing mortality rate greater than 0.65 (Cod in the North Sea, Skagerrak and eastern Channel). (4.) (...) (5.) Except for the first year of application of this Article: (a) where the rules provided for *in paragraphs 2 or 4 would lead to a TAC which exceeds the TAC of the preceding year by more than 15 %, the Council shall adopt a TAC which shall not be more than 15 % greater than the TAC of that year; or (b) where the rules provided for in paragraphs 2 or 4 would lead to a TAC which is more than 15 % less than the TAC of the preceding year, the Council shall adopt a TAC which is not more than 15 % less than the TAC of that year.*

Article 7: Setting TACs in exceptional circumstances. Where the quantities of mature fish of any of the cod stocks concerned have been estimated by the STECF, in the light of the most recent report of the ICES, to be less than the quantities set out in Article 5, the following rules shall apply: (a) Article 6 shall apply where its application is expected to result in an increase in the quantities of mature fish at the end of the year of application of the TAC to a quantity equal to or greater than the quantity indicated in Article 5; (b) where the application of Article 6 is not expected to result in an increase in the quantities of mature fish at the end of the year of application of the TAC to a quantity equal to or greater than the quantity indicated in Article 5, the Council shall decide (...) on a TAC for the following year that is lower than the TAC resulting from the application of the method described in Article 6.

Article 8. Fishing effort limitations and associated conditions. (1.) The TACs referred to in Chapter III shall be complemented by a system of fishing effort limitation based on the geographical areas and groupings of fishing gear, and the associated conditions for the use of these fishing opportunities specified in Annex V to Council Regulation (EC) No 2287/2003 of 19 December 2003 fixing for 2004 the fishing opportunities and associated conditions for certain fish stocks and groups of fish stocks, applicable in Community waters and, for Community vessels, in waters where catch limitations are required. (2.) Each year, the Council shall decide by a qualified majority, on the basis of a proposal from the Commission, on adjustments to the number of fishing days for vessels deploying gear of mesh size equal to or greater than 100 mm in direct proportion to the annual adjustments in fishing mortality that are estimated by ICES and STECF as being consistent with the application of the TACs established according to the method described in Article 6.

In April 2008, the European Commission adopted a proposal to amend the cod recovery plan, based on input from stakeholders, and on scientific advice from both ICES and STECF that current measures have been inadequate to reduce fishing pressure on cod to enable stock recovery. The main changes proposed are replacing targets in terms of biomass levels with new targets expressed as optimum fishing rates intended to guarantee the highest sustainable yield, and introducing a new system of effort management by setting effort ceilings (kilowatt-days) for groups of vessels or fleet segments to be managed at a national level by Member States. The new system is intended to be simpler, more flexible and more efficient than the current one, and will allow effort reductions to be proportionate to targeted reductions in fishing mortality for the segments that contribute the most to cod mortality, while for other segments effort will be frozen at the average level for 2005-2007. New measures are also proposed to encourage fishers to engage in cod avoidance programmes.

EU-Norway Cod long-term Management Plan

Once cod is considered to have recovered, the 2005 agreement between the EU and Norway (a renewal of the 1999 agreement) comes into force, and states that the EU and Norway *"agreed to implement a long-term management plan for the cod stock, which is consistent with the precautionary approach and is intended to provide for sustainable fisheries and high yield.*

Once the stock of cod has been measured for the current year and for the previous year as no longer being at risk of reduced reproductive capacity, the plan will come into operation on 1 January of the subsequent year.

The plan shall consist of the following elements:

1. *Every effort shall be made to maintain a minimum level of Spawning Stock Biomass (SSB) greater than 70,000 tonnes (Blim).*
2. *Where the SSB is estimated to be above 150,000 tonnes the parties agreed to restrict their fishing on the basis of a TAC consistent with a fishing mortality rate that maximises long term yield. The parties agreed to use F=0.4 on appropriate age groups.*
3. *Where the rule in paragraph 2 would lead to a TAC which deviates by more than 15% from the TAC for the preceding year, the Parties shall fix a TAC that is neither more than 15% greater nor 15% less than the TAC of the preceding year.*
4. *Should the SSB of cod fall below 150 000t (Bpa) the Parties shall decide on a TAC that is lower than that corresponding to the application of the rules in paragraphs 2 and 3.*
5. *The Parties may where considered appropriate reduce the TAC by more than 15% compared to the TAC of the preceding year.*
6. *This plan shall be subject to triennial review, the first of which will take place before 1 January 2009, including appropriate adaptations to the target mortality rate specified in paragraph 2."*

The main changes between this and the plan of 1999 is the reduction of a target F to 0.4, and a limitation of the change of the TAC between years of 15%. ICES has not evaluated the consistency of the new management plan with the precautionary approach.

14.2 Data available

14.2.1 Catch

Landings data from human consumption fisheries for recent years as officially reported to ICES together with those estimated by the WG are given for each area separately and combined in Table 14.1. The WG estimate for landings from the three areas (IV, IIIa-Skagerrak and VIId) in 2006 and 2007 they were based on annual data, as opposed to quarterly data in the past, because of ongoing difficulties with international data aggregation procedures, particularly with regard to discard raising.

France, Belgium and Sweden, who respectively land 10%, 5% and 2% of all cod for combined area IV and VIId, do not provide discard estimates for this combined area. Similarly, Belgium and Germany, who each land 2% of all cod in area IIIa, do not provide discard estimates for this area. Norwegian discarding is illegal, so although this nation lands 15% and 6% of all cod in combined area IV and VIId, and area IIIa respectively, it does not provide discard estimates. Although the Netherlands (8% of all cod landed in IV and VIId, 1% in IIIa) does provide discard data for area IV, these are based on very low sample sizes for cod, and are therefore not reliable enough to be raised to fleet level.

The landings estimate for 2007 is 24.4 thousand tonnes, split as follows for the separate areas (thousand tonnes):

	Landings	TAC	Discards
IIIa-Skagerrak	2.9	2.9	2.8
IV	19.7	20.0	20.7
VIId	2.0	Comb VIIb-k*	
Total	24.4		23.6

*Division VIId is included in the TAC relevant to Divisions VIIb-k

WG estimates of discards are also shown in the above table.

Discard numbers-at-age were estimated for areas IV and VIId by applying the Scottish discard ogives to the international landings-at-age. For 2006, Denmark was excluded from this calculation as they provided their own discard estimates. For 2007, Scottish, Danish, German and England & Wales discard estimates were combined (sum of discards divided by sum of landings) and used to raise landings-at-age from the remaining nations in subarea IV to account for missing discards. Discard numbers-at-age for IIIa-Skagerrak were based on observer sampling estimates. For 2006 and 2007, Danish and Swedish discard estimates were combined (sum of discards divided by sum of landings) and used to raise landings-at-age from the remaining nations in Division IIIa-Skagerrak to account for missing discards. Although in some cases other nations' discard proportions are available for a range of years, these have not been transmitted to the relevant WG data coordinator in an appropriate form for inclusion in the international dataset. Because of the data co-ordination difficulties in 2006, which has continued in 2007, it was not possible to consistently apply Danish (and now also England and Wales) discard age compositions to other years, even though these are now available. Figure 14.1a plots reported landings and estimated discards used in the assessment.

For cod in IV, IIIa-Skagerrak and VIId, ICES first raised concerns about the misreporting and non-reporting of landings in the early 1990s, particularly when TACs became intentionally restrictive for management purposes. Some WG members have since provided estimates of under-reporting of landings to the WG, but by their very nature these are difficult to quantify. In terms of events since the mid-1990s, the WG believes 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 3000t 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 believe that there was significant under-reporting of landings. However, the substantial reduction in fishing effort implied by the 2001, 2002 and 2003 TACs is likely to have resulted in an increase in unreported catch in those years. Anecdotal information from the fisheries in some countries indicated that this may indeed have been the case, but the extent of the alleged under-reporting of catch varies considerably. Since the WG has no basis to judge the overall extent of under-reported catch, it has no alternative than to use its best estimates of landings, which in general are in line with the officially reported landings. An attempt is made to incorporate a statistical correction to the sum of reported landings and discards data in the assessment of this stock, but the figures shown in Table 14.1 and Figure 14.1a nevertheless comprise the input values to the assessment. Buyers and Sellers legislation introduced in the UK towards the end of

2005 is expected to have improved the accuracy of reported cod landings for the UK. This has brought the UK in line with existing EU legislation.

The by-catch of cod from the Danish and Norwegian industrial fisheries that was sent for reduction to fishmeal and oil in 2007 was 119 tonnes (Table 2.1.3).

Age compositions

Age compositions were provided by Denmark, England, Germany, the Netherlands, Scotland and Sweden.

Landings in numbers at age for age groups 1-11+ and 1963-2007 are given in Table 14.2. SOP values are shown. These data form the basis for the catch at age analysis but do not include industrial fishery by-catches landed for reduction purposes. By-catch estimates are available for the total Danish and Norwegian small-meshed fishery in Subarea IV (Tables 2.1.3 to 2.1.5) and separately for the Skagerrak (Table 14.1). During the last five years an average of 82% (84% in 2007) of the international landings in number were accounted for by juvenile cod aged 1-3. In 2007, age 1 cod comprised 32% of the total catch by number, and age 2 (the 2005 year class), 55%.

Discard numbers-at-age are shown in Table 14.3. The proportions of the estimated total numbers discarded are plotted in Figure 14.1b and the proportion of the estimated discards for ages 1-3, in Figure 14.1c. Estimated total numbers discarded have varied between 35 and 55% since 1995, but have shown an increase to above 70% in 2006 and 2007, due to the stronger 2005 year class entering the fishery (estimated to be almost the size of the 1999 year class), and a mismatch between the TAC and effort. Historically, the proportion of numbers discarded at age 1 have fluctuated around 80% with no decline apparent after the introduction of the 120mm mesh in 2002. During the last four years, it is estimated to be at around 90%. At ages 2 and 3 discard proportions have been increasing steadily and are currently estimated to be 75% and 38% respectively in 2007. Note that these observations refer to **numbers** discarded, not weight.

14.2.2 Weight at age

Mean weight at age data for landings, discards and catch, are given in Tables 14.4-6. Total catch mean weight values were also used as stock mean weights. Long-term trends in mean catch weight at age for ages 1-9 are plotted in Figure 14.2, which indicates that there have been short-term trends in mean weight at age and that the decline over the recent decade on ages 3-5 now seems to have been reversed. The data also indicate a slight downward trend in mean weight for ages 3-6 during the 1980'and 90's. Ages 1 and 2 show little absolute variation over the long-term.

14.2.3 Maturity and natural mortality

Values for natural mortality and maturity are given in Table 14.7; they are applied to all years and are unchanged from those used in recent assessments. The natural mortality values are model estimates from a multi-species VPA fitted by the Multi-species WG in 1986. The maturity values were estimated using the International Bottom trawl Survey series for 1981-1985. These values were derived for the North Sea. **V**ariability in maturity at age, and how to account for it in the assessment, should be investigated at future benchmark meetings.

14.2.4 Catch, effort and research vessel data

Reliable, individual, disaggregated trip data were not available for the analysis of CPUE. Since the mid-to-late 1990s, changes to the method of recording data means that individual trip data are now more accessible than before; however, the recording of fishing effort as hours fished has become less reliable as it is not a mandatory field in the logbook data. Consequently, the effort data, as hours fished, are not considered to be representative of the fishing effort actually deployed.

The WG has previously argued that, although they are in general agreement with the survey information, commercial CPUE tuning series should not be used for the calibration of assessment models due to potential problems with effort recording and hyper-stability (ICES-WGNSSK 2001), and also changes in gear design and usage, as discussed by ICES-WGFTFB (2006, 2007). Therefore, although the commercial fleet series are available, only survey and commercial landings and discard information are analysed within the assessment presented.

Four survey series are available for this assessment:

- English third-quarter groundfish survey (EngGFS), ages 0-7, which covers the whole of the North Sea in August-September each year to about 200m depth using a fixed station design of 75 standard tows. The survey was conducted using the Granton trawl from 1977-1991 and with the GOV trawl from 1992-2007. Only ages 1–6 should be used for calibration, as catch rates for older ages are very low.
- Scottish third-quarter groundfish survey (ScoGFS): ages 1–8. This survey covers the period 1982–2007. This survey is undertaken during August each year using a fixed station design and the GOV trawl. Coverage was restricted to the northern part of the North Sea until 1998, corresponding to only the northernmost distribution of cod in the North Sea. Since 1999, it has been extended into the central North Sea and made use of a new vessel and gear. Only ages 1–6 should be used for calibration, as catch rates for older ages are very low.
- Quarter 1 international bottom-trawl survey (IBTSQ1): ages 1–6+, covering the period 1976–2008. This multi-vessel survey covers the whole of the North Sea using fixed stations of at least two tows per rectangle with the GOV trawl.
- Quarter 3 international bottom-trawl survey (IBTSQ3): ages 0–6+, covering the period 1991–2007. This multi-vessel survey covers the whole of the North Sea using fixed stations of at least two tows per rectangle with the GOV trawl. The Scottish and English third quarter surveys described above contribute to this index.

The data used for calibrating the catch-at-age analysis are shown in Table 14.8.

Maps showing the IBTS distribution of cod are presented in Figures 14.3a-b (ages 1-3+). The recent dominant effect of the size and distribution of the 1996 and, to a lesser extent, the 1999 and 2005 year-classes are clearly apparent from these charts. However, fish of older ages have continued to decline due to the very weak 2000, 2002 and 2004 year classes. The abundance of 3+ fish is at a low level in recent years.

An analysis of the third quarter Scottish and English survey data by Parker-Humphries and Darby (WD 24 in ICES-WGNSSK, 2006) showed that the extremely high catch rates estimated for ages 2-4 in a single station in the third quarter Scottish survey in 2004 resulted in the estimation of a strong reduction in mortality in 2004 followed by high mortality in 2005. When the station with high catch rates was removed, total mortality was then consistent with values obtained in previous years. The WG agreed that it would be *ad hoc* and statistically inappropriate to remove the station from the calculation of the Scottish index. After reviewing the information available on survey catch rates and spatial distribution, the WG decided to discontinue the use of the English and Scottish surveys on their own in the cod assessment because of the current low catch rates recorded by these surveys and the potential for noise at the oldest ages due to low sampling levels. Instead, the WG decided to use the IBTSQ3 survey, which incorporates both the Scottish and English surveys, together with the IBTSQ1 survey.

An analysis of IBTSQ1 data by Rindorf and Vinther (WD 4 in ICES-WGNSSK, 2007) illustrated the increased importance of recruitment from the Skagerrak. The survey indices from IBTSQ1 and Q3 used in the stock assessment only include catch rates from the three most easterly rectangles of Skagerrak. More of the Skagerrak area should be considered for inclusion in the IBTS standard areas for abundance indices, in order to produce an unbiased abundance index for the management unit (IV, IIIa-Skagerrak and VIId) of cod. Furthermore, the Skagerrak is almost entirely covered by a single vessel in both the IBTSQ1 and Q3 surveys. This is not advantageous as it does not allow for a comparison of cod catchability between vessels, which is essential for comparison of catch rates between roundfish areas. In the North Sea, each rectangle is covered by at least 2 nations to reduce bias in indices. This issue should be pursued at future benchmark workshops.

14.3 Data analyses

14.3.1 Reviews of last year's assessment

In 2007 the ACFM review group raised the following issues (given in italics in quotes), and the WG responds as follows (given in normal text):

a) *"The RG recommends that the WG try to improve estimation of total catch to get beyond the need to estimate a catch multiplier. The catch multiplier estimate can hide a lot of problems in the assessment. The WG is challenged to try to get better estimates of catches and discards."* – B-Adapt was developed to handle the specific problem of mis-reported catch (by incorporating a statistical correction to the sum of reported landings and discards in the assessment model) because there was no means to otherwise quantify the problem outside an assessment model. In addition to B-Adapt, a new state-space model was run. The state-space assessment model (SSASS) is able to take uncertainty on the catches into account. This combined with the capability to estimate year (and even year and age) specific catch scaling, allows statistical significance testing of catch scaling. The inclusion of an annual catch multiplier was found to be highly significant in the SSASS model, indicating the necessity of including such a parameter in any approach used.

b) *"The RG suggested that variability in maturity at age and individual weights should be investigated"* – The nature of the May WG in 2008 (only update assessments) means that it is not the appropriate forum to investigate such matters. Future benchmark workshops would be more suitable.

14.3.2 Exploratory survey-based analyses

Survey abundance indices are plotted in log-mean standardised form by year and cohort in Figure 14.4a for the IBTSQ1 survey, together with log-abundance curves and associated negative gradients for the age range 2-4. Similar plots are shown for the IBTSQ3 survey in Figure 14.4b. The log-mean standardised curves indicate no obvious year effects (top-left plots), and tracks cohort signals well (top right) The log abundance curves for each survey series indicate consistent gradients (bottom left), with less steep gradients in recent years (bottom right).

Figures 14.5a and b show within-survey consistency (in cohort strength) for the IBTSQ1 and Q3 surveys, while Figure 14.5c shows between-survey consistency (for each age) for the two surveys. These show generally good consistency, justifying their use for survey tuning. Correlations deteriorate for age 5 for the IBTSQ3 survey, and this age is not used for tuning.

The SURBA survey analysis model was fitted to the survey data for the IBTSQ1 and IBTSQ3. The summary plots are presented in Figures 14.6a-b.

Biomass - Both time series estimated in SURBA indicate that spawning stock biomass reached the lowest level in the time series in 2005-6 caused by a series of poor recruitments coupled with high fishing mortality and discard rates at the youngest ages, but that it is now increasing again because the stronger 2005 year class is starting to mature. This increase can also be seen in the time series for total stock biomass.

Total mortality – In all SURBA model fits, there is a high level of uncertainty in the model estimates, and trends in mean Z cannot be determined with any confidence.

Recruitment – SURBA estimates of recruitment appear to have very wide confidence intervals for the IBTSQ3 survey, the reason for which is not immediately clear. The IBTSQ1 survey indicates that the recruiting years classes since 1996 have been relatively weak, but that the 2005 year class is one of the highest of the recent low values. The variation recorded in year class strength at age 1 is substantially higher than that recorded subsequently at ages 2 and 3, indicating that the high rates of discarding (90%) and high mortality rates at this age are resulting in reduced contributions from one year old fish to the stock and catches.

14.3.3 Exploratory catch-at-age-based analyses

Catch-at-age matrix and Separable VPA

The total catch-at-age matrix (combination of landings and discards shown in Tables 14.2 and 14.3) is expressed as proportions-at-age, standardised over time in Figure 14.7. It shows clearly the contribution of the 1996 and 1999 year classes to catches in recent years, with the larger 1996 year class disappearing more rapidly from the catches compared to the 1999 year class. It also shows the greater proportion of older fish in the catches at the start of the time series relative to recent years.

As in previous years, a separable VPA model was used to examine the structure of the catch numbers at age data before its use in a catch at age analysis. The results of the model fit are within ICES files. The residuals in the most recent years indicated no strong patterns or large values for ages less than age 8. The fitted model indicates that the age structure of the recorded landings has been relatively consistent in recent years and that the catch data are not subject to large random or process errors that would lead to concerns as to the way in which the recorded catch has been processed.

Catch curve cohort trends

The top panel of Figure 14.8 presents the log catch curve plot for the catch at age data. Through time there is an increase in the slope of the cohort plots indicating faster removal rates or high total mortality. In the most recent years there has been a gradual decrease in the slope at the youngest ages – a sign of decreased mortality rates. The bottom panel plots the negative slope of a regression fitted to the ages 2-4, the age range used as the reference for mortality trends. The decrease in the negative slope indicates that total mortality rates at the ages comprising the dominant ages within the fishery are declining.

State-Space Model

Nielsen (WD6) presented a state-space model (SSASS). State-space models were first applied in stock assessment by Gudmundsson (1987, 1994; but see also Fryer 2002). The model used here is inspired by Gudmundsson's work and by Lewy and Nielsen (2003). The model assumes that log-transformed stock sizes and fishing mortalities, which are the so-called states, follow separate random walks. The model is unique in being fully stochastic. Observed catches and survey indices are considered to be random variables with associated observation noise. All model parameters are maximum likelihood estimated. Quantification of uncertainties on all model outputs (e.g. SSB, Fbar, and estimated catch scaling) is an integrated part of the model.

The SSASS mode showed that a year specific catch scaling significantly improved the model fit compared to the model with no adjustment for catch bias (p-value 0.000% computed by a standard likelihood ratio test). No further significant model improvement was obtained by extending the catch scaling to be year and age specific (p-value 17.4%), hence the year specific scaling is chosen for the results presented here.

SSASS showed the same pattern in SSB (Figure 14.9) and recruitment as B-ADAPT. The overall development in Fbar is also the same in the estimates from SSASS and B-ADAPT, but the decrease in SSASS Fbar in the most recent years is less steep. The B-ADAPT estimates are more fluctuating, which is a consequence of B-ADAPT assuming reported catches and age compositions known without error (Figure 14.10). The estimated catch multiplier (Figure 14.11) is similar to that estimated by B-ADAPT.

B-ADAPT

The following table presents a selection of the exploratory runs considered, comprising single fleet B-ADAPT runs fitted to the IBTSQ1 and IBTSQ3 groundfish surveys respectively, the base run (update assessment using the same settings as last year), and sensitivity of the base run.

Description	Period for catch multiplier
Single Fleet Runs	
1. IBTSQ1	1998-2007
2. IBTSQ3	1998-2007
Candidate Assessments	
3. Base run (update assessment)	1993-2007
Sensitivity Runs	
4. No final-year catch multiplier	1993-2006
5. Catch multiplier not estimated	-

Single fleet runs of the B-ADAPT model were fitted to the IBTSQ1 (run 1) and IBTSQ3 (run 2) groundfish surveys in order to examine the time series of estimates derived from independent survey data sets. Because B-ADAPT requires a reasonable period of overlap (at least 5 years) between the survey data and the period for which a catch multiplier is not estimated, and because the base run estimated catch multipliers close to 1 for 1997, the IBTSQ3 run only estimated the catch multiplier for the period 1998-2007, with the values used for the period 1993-1997 taken from the base run (run

3). To ensure consistency between the single fleet runs, the same procedure was used for IBTSQ1 (setting multipliers for 1993-1997 equal to base run values, and estimating those from 1998 on), despite enough data being available for estimating catch multpliers from 1993.

Figure 14.12 plots trajectories of SSB, recruitment (age 1), mean F(2-4) and the catch multiplier for the two single fleet runs. Both surveys indicate that the estimated removals since 1998 are higher than indicated by the catch data, but that they are closer to the catch data in 2007 compared to recent years (with the IBTSQ1 multiplier being close to 1), that SSB is now no longer in decline having attained the lowest level in the time series in 2006, and that fishing mortality is on the decline. For both surveys, the 90% probability interval for the catch multiplier encompasses a value of 1 for 2007.

Residual plots are shown in Figure 14.13 for the base run, indicating no obvious model misspecification. Retrospective plots for the base run are shown in Figure 14.14. These show a slight under-estimation of fishing mortality, but the end points of each of the historic time series fall within the 5^{th} and 95^{th} percentiles (see Figure 14.16).

Sensitivity of the base run to fixing the catch multiplier to 1 in the final year (run 4) and to fixing the catch multiplier to 1 for all years (i.e. not estimating it, run 5) is shown in Figure 14.15. Forcing the multiplier to equal 1 in the final year (run 4) results in a greater decline in F than estimated for the base run, but SSB and recruitment trajectories are relatively insensitive to this. Run 5 results in greater differences, with lower SSB and recruitment levels estimated in recent years, but this is associated with residual trends (not shown).

14.3.4 Conclusions drawn from exploratory analyses

All of the time series used to examine the dynamics of the North Sea cod stock indicate that SSB has increased marginally from the lowest level within the recorded time series. This conclusion is robust to the source of information used for the analysis and changes the previous perception of a continuously declining SSB, to one where SSB is now no longer in decline.

The time series of abundance of the recruiting year classes are also consistent between analyses. All indicate the recruitment of 1-year-old cod has varied considerably since the 1960s, but since 1998, average recruitment has been lower than at any other time (see e.g. Figure 14.14).

Mortality trends cannot be determined from the fit of the survey-only models. The B-ADAPT and SSASS model estimates indicate that the mortality rate remained high through the 70's to the late 90's with a reduction since 2000. The magnitude of the decline differs between series and models (e.g. the B-ADAPT model indicating a stronger reduction than the SSASS model), and there is uncertainty associated with the final year estimates from the separate model fits (see also Figure 14.16).

A significantly improved SSASS model fit is achieved when including an annual catch multiplier as opposed to ignoring it, which confirms the necessity of including a catch multiplier for any assessment of North Sea cod, as has been the case in B-ADAPT.

The WG considers the B-ADAPT base run (run 3) as appropriate to take forward as the final assessment for cod.

14.3.5 Final assessment

The base run (run 3) was accepted as the final assessment. B-ADAPT was fitted to landings data for the years 1963-2007 and ages 1-7+, adjusted for discarding as described in Section 14.2. Survey data used for tuning are the International Bottom Trawl Survey Q1 (1983-2008, ages 1-5) and Q3 (1991-2007, ages 1-4). Surviving population numbers at ages 1-5 were estimated in 2008 with fishing mortality at age 6 in all years calculated as the average of ages 3-5. Bias parameters (catch multipliers) were estimated in the years 1993-2007. A smoothing weight of 0.5 was applied to between-year residuals of the log-total catch in tonnes. No time series weighting was applied and survey residuals were given equal weight in the analysis. Survey catchability was assumed to be constant in time and independent of age for ages 1-5 for the IBTSQ1 survey, and 1-3 for the IBTSQ3 survey. These run settings are the same as for last year's assessment.

This being an update assessment, and given the conclusions drawn from the exploratory analyses, the WG considered the smoothed B-ADAPT to be an appropriate model for estimating the dynamics of the fishery and stock.

The diagnostics and stock estimates of the fitted model expected values are presented in Tables 14.9-14.12. Median values from the bootstrapped estimates for fishing mortality are presented in Table 14.10, stock numbers in Table 14.11, and the median of the assessment summary time series in Table 14.12a, while Table 14.12b summarises landings, discards and bootstrap median estimates of total removals. Figure 14.13 presents the time series of log catchability residuals from the fitted smoothed B-ADAPT model. Figure 14.16 presents the time series of B-ADAPT derived assessment estimates of the stock, recruitment, exploitation trends, catch, and the catch multipliers, together with estimates of precision represented by bootstrap percentiles.

Retrospective estimates of median fishing mortality, SSB, recruitment and the catch multiplier from the B-ADAPT bootstrap model are presented in Figure 14.14.

14.4 Historic Stock Trends

The historic stock and fishery trends are presented in Figures 14.16 and Table 14.12a.

Recruitment has fluctuated at a relatively low level since 1998. The 1996 year class was the last large year class that contributed to the fishery, and subsequent year classes have been the lowest in the time series apart from the 1999 and 2005 year classes. The addition of discards to the assessment has raised the overall level of recruitment abundance but not the trend in recent year class strengths. The 2006 year class is estimated to be weak.

Fishing mortality increased until the early 1980's remained high until 2000 after which it has decreased. Median fishing mortality (human consumption and discard mortality) at ages 2-4 in 2007 is estimated to be 0.64.

SSB declined steadily during the 1970's and 80's. There was a small increase in SSB following the recruitment of the 1995 and 1996 year classes, but with low recruitment abundance since 1998 and continued high mortality rates, SSB continued to decline. SSB is estimated to have increased from the lowest level in the time series of 31 000t in 2006 to 37 000t in 2007. TSB estimates have been increasing for longer than SSB because of the 2005 year class, but this year class is now starting to mature and contribute to SSB.

The North Sea Fishers' Survey has not yet been updated to reflect perceptions since mid-2007 so no comparisons are made between the stock trends observed from the assessment and the fishermen's perception from the Fishers' survey.

14.5 Recruitment estimates

Estimates of recruitment were sampled from the 1997-2006 year classes, reflecting recent low levels of recruitment, but including the stronger 1999 and 2005 year classes. These are only used for B-ADAPT medium term forecasts in order to evaluate future stock dynamics.

14.6 Short-term forecasts

Due to the uncertainty in the final year estimates of fishing mortality the WG agreed that a standard (deterministic) short-term forecast was not appropriate for this stock.

14.7 Medium-term forecasts

Stochastic projections were carried out using each of 1000 non-parametric bootstrap iterations. Starting populations were taken from each bootstrap iteration, fishing mortalities were taken as a three year average scaled to the final year. Mean weights and mortalities were taken from the average of the final three years of assessment data. Recruitment was re-sampled from the 1997-2006 year-classes, eight years with low recruitment and two with the slightly higher levels (1999 and 2005 year classes). This is a conservative estimate to account for the possibility that the low levels estimated in the last few years may continue.

For the purposes of the forecast, the WG assumes that future removals due to fishing comprise only landings and discards. Landings and discards in the forecasts were estimated by applying the landings- and discard-at-age ratios for 2007 to total fishing mortility-at-age for the projection period.

All the scenarios assume a 10% reduction in fishing mortality in 2008 to account for a 10% reduction in effort for the main cod gears, as stipulated in EC 40/2008. The scenarios explored were:

1. a reduction in fishing mortality by 10% in 2008, followed by constant fishing mortality at the 2008 level for 2009 onwards;
2. a reduction in1 fishing mortality by 10% in 2008, followed by further reductions in 2009 (relative to 2008) of:
    a. 10%,
    b. 15%,
    c. 20%,
    d. 25%,
    e. 30%;

    in each of these scenarios, fishing mortality is held constant at the 2009 level for 2010 onwards;
3. a reduction in fishing mortality by 10% in 2008, followed by a further reduction to the target fishing mortality of 0.4 for 2009 onwards;
4. a reduction in fishing mortality by 10% in 2008, followed by a closure of the fishery from 2009 onwards;

5. a reduction in fishing mortality by 10% in 2008, followed by a further reduction in F in 2009 that results in landings in 2009 equal to 1.15 times the TAC in 2008, then holding F constant at the 2009 level for 2010 onwards;
6. a reduction in fishing mortality by 10% in 2008, followed by further reductions of 15% in 2009 and 2010, each relative to the preceding year, and then setting F=0.4 from 2011 onwards (this option mimics the Commission's proposed amendments to the Cod Recovery Plan of April 2008).

Tables 14.13-14.18 present the results of the stochastic projections, while Table 14.19 summarises outcomes for all options in a single table for ease of comparison. For each scenario, the associated figures present fishing mortality, catch, SSB and recruitment. The 5th, 25th, median, 75th and 95th percentiles from the bootstrap distributions are plotted. Percentiles of fishing mortality, SSB and catch in 2007, 2008, 2009 and 2010 are tabulated with the probability that SSB in a year exceeds the SSB estimated for 2007 and the ratio of median SSB at the start of the year to the end of the year in order to quantify stock rebuilding.

In each of the stock projections SSB starts to increase following a historic low in 2006, due to a combination of lower fishing mortality and the 2005 year class starting to mature. Subsequent increases in SSB rely on the scale of the reduction in fishing mortality.

All options considered result both in a greater than 30% increase in SSB from 2008 to 2009, and a return of SSB to levels above Blim (70 000t) from 2009 onwards.

14.8 Biological reference points

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

Reference point:

Blim	70 000 t.	Bpa	150 000 t.
Flim:	0.86	Fpa	0.65

Technical basis:

Blim	Rounded Bloss. The lowest observed spawning stock biomass.
Bpa	The previously agreed MBAL and affords a high probability of maintaining SSB above Blim, taking into account the uncertainty of assessments. Below this value the probability of below average recruitment increases. Previous MBAL and signs of impaired recruitment below: 150 000 t.
Flim	Floss
Fpa	Approx. 5th percentile of Floss

A stochastic yield per recruit analysis was conducted, based on results from the base run, assuming stock weights-at-age are the average for 2005-7, and using the same maturity- and natural mortality-at-age values as used in the base run. Figure 14.17 plots yield per recruit against F(2-4). This analysis yielded a $\mathbf{F}_{0.1}$ value of 0.09, and a $\mathbf{F}_{max}$ value of 0.15. The 5^{th} and 95^{th} percentiles were [0.06; 0.13] for $\mathbf{F}_{0.1}$ and [0.10; 0.19] for $\mathbf{F}_{max}$.

14.9 Quality of the assessment

The quality of the commercial landings and catch-at-age data for this stock deteriorated in the 1990s following reductions in the TAC without associated control of fishing effort. The WG considers the international landings figures from 1993 onwards to have inaccuracies that lead to retrospective underestimation of fishing mortality and over estimation of spawning stock biomass and other problems with an analytical assessment. The mismatch between reported and actual landings is now estimated to be decreasing.

Prior to 2006 estimates of discards for areas IV and VIId are taken from the Scottish discard sampling program and the average proportions across gears applied to raise the landings data from other areas. If the gear and fishery characteristics differ this could introduce bias. This bias is likely to introduce sensitivity to the estimates of the youngest age classes (1 and 2) and will not affect estimates of SSB. For 2006, Scottish discard sampling was used to raise all landings data apart from Danish landings, because Danish discard data were provided. For 2007, a combination of Scottish, Danish, German and England and Wales discard estimates was used to raise landings from countries that did not provide discard estimates. Although discard estimates were provided by Denmark for years prior to 2006, and by Germany and England and Wales for years prior to 2007, these have not been used as it was not possible to re-work earlier discard estimates.

The North Sea surveys have good consistency within and between the indices. The indication that SSB in 2006 was at or around a historical low, and is now increasing, is supported by SURBA analyses and single survey assessment model fits. The low level of recent recruitments is consistent between model fits and within and between survey indices, which also confirm a higher 2005 year class compared to recent years.

The survey indices from IBTSQ1 and Q3 used in the stock assessment only include catch rates from the three most easterly rectangles of Skagerrak. More of the Skagerrak area should be considered for inclusion in the IBTS standard areas for abundance indices, in order to produce an unbiased abundance index for the management unit (IV, IIIa-Skagerrak and VIId) of cod. Any such review of the area coverage of IBTS should also include a consideration of the north westerly extent of the survey, west of Shetland, where good catches of cod have been reported.

The B-ADAPT model was developed to correct for retrospective bias by estimating the quantity of additional "unallocated removals" that would be required to be added or removed from the catch-at-age data in order to remove any persistent trends in survey catchability. The unallocated removals figures given by B-ADAPT could potentially include components due to increased natural mortality and discarding as well as misreported landings.

The estimates of bias can also be influenced by any trends in survey catchability or outlying values, particularly where the calibration period surveys are noisy at the oldest and youngest ages. For this reason, the bootstrap percentiles are used to provide stock and exploitation trends and the estimated values should not be over-interpreted.

Retrospective plots (Figure 14.14) show a slight under-estimation of fishing mortality, but the end points of each of the historic time series fall within the 5^{th} and 95^{th} percentiles shown in Figure 14.16. The perception of a decrease in mortality rates for the stock is robust to the period over which the model is fitted.

Values for natural mortality and maturity are applied to all years. They are model estimates from a multi-species VPA fitted by the Multi-species WG in 1986. The maturity values were estimated using the International Bottom trawl Survey series 1981-1985. These values were derived for the North Sea.

In its 2003 meeting (ICES-WGNSSK, 2003), this WG examined the sensitivity of XSA estimates to recent revision of the Multi-species WG estimates of natural mortality, concluding that the estimates of recruitment were rescaled, but otherwise stock parameters were unaffected. The MSVPA estimates of natural mortality are based on diet data from more than 15 years age. Due to the change in the stock distributions of both predator and prey species since this data was collected, the estimates of natural mortality from MSVPA are probably biased, and should not be used without additional sampling of diet data.

Similarly, the estimated constant maturity ogive should be examined in order to investigate its relevance in the current low stock situation.

The historical performance of the assessment is summarised in Figure 14.18.

14.10 Status of the Stock

The general perception of the overall level of cod abundance remains unchanged, although the 2007 estimate of SSB has shown a marginal increase compared to the historical low value in 2006.

Survey indices and results from models fitted to the commercial catch at age data indicate that the spawning stock biomass is at about 20-25% of the level it was in the 1980's and that it is likely to continue increasing in 2008 due to lower fishing mortality levels and a higher 2005 year class relative to recent year classes.

The assessment models indicate that, since 2000, the fishing mortality rate has begun to decline towards the lower levels required to allow the stock to rebuild, but the most recent values are uncertain.

The proportion of older individuals in the estimated stock remains very low. In recent years, less than 1% of individuals at age 1 survive to age 5; this contrasts with around 2.5% of individuals surviving to age 5 at the beginning of the time series (mid-1960s).

Recruitment of 1 year old cod has varied considerably since the 1960s, but since 1998, average recruitment has been lower than any other time. The 2005 year class is of higher abundance than the recent low levels, especially in the central and northern north sea (Figures 14.3a and b).

Although the UK-FSP surveys (NE coast cod, and North Sea Codwatch), the IBTS surveys and the assessment all indicate a poorer 2006 year class relative to the one in 2005, there have been indications of relatively large numbers of the 2006 year class in the southern North Sea and eastern Channel. These indications initially came from observations of substantial amounts of this year class as 0-group fish in the English Channel beam trawl survey (ENG-CBTS; Figure 14.19), reinforced by the Belgian beam trawl survey fishing in the same area, and in both the English Thames herring and bass surveys (Figures 14.20a and b). Subsequent indications have come from French Channel groundfish survey (FRA-CGFS; Figure 14.21), where the 2006 year class has been observed as large numbers of age 1 fish, and from French fishers targeting cuttlefish in the eastern Channel, who have encountered large numbers of this year class at 25-32cm (age 1). The ENG-CBTS confirmed the presence of the 2006 year class as age 1 in the southern North Sea and Eastern Channel (Figure 14.22). The differences in perception of the size of the 2006 year class relative to earlier year classes between the FRA-CGFS and IBTS surveys is illustrated with between-survey correlation plots at age 1 for these surveys (Figure 14.23).

High rates of discarding in 2006-2008 could reduce the contribution that the 2005 year class makes to the catches and the stock in future years. The last substantial year class to enter the fishery was the 1996 year class. This year class was a prominent feature in all surveys, was heavily exploited and discarded by the fishery at ages 1-5, and disappeared relatively quickly from the fishery (Figure 14.7).

14.11 Management Considerations

Although the current SSB and fishing mortality are uncertain, it is clear that the stock has been reduced to a level at which recruitment is impaired and the biological dynamics of the stock are difficult to predict.

In the past years, emergency measures have been taken and a recovery plan has been implemented with the aim of reversing the declining trend in SSB and increasing the spawning stock above Blim. These measures have contributed to a reduction in fishing mortality and stabilisation in SSB.

There is a need to reduce fishing mortality on North Sea cod, particularly for younger ages, in order to allow more fish to reach maturity and increase the probability of good recruitment; this could be achieved by reducing discarding. During the last five years, an average of 82% (84% in 2007) of the international landings in numbers consisted of juvenile cod aged 1-3. Because the fishery is at present so dependent on incoming year classes, fishing mortalities on these year classes is high, and only 12% of 2 year olds currently survive to maturity (compared to 22% in the early 1960s). At the same time, the unbalanced age structure of the stock reduces its reproductive capacity even if a sufficient SSB were reached, as first-time spawners reproduce less successfully than older fish. Both factors are believed to have contributed to the reduction in recruitment of cod.

The recruitment of the relatively more abundant 2005 year class to the fishery may have no beneficial effect on the stock if it is caught and heavily discarded. In 2006, the 2005 year class comprised 62% of the total catch by number, and in 2007 it comprised 55%. Discarding rates have increased in 2007 and are expected to remain high in 2008. The last substantial year class to enter the fishery was the 1996 year class. This year class was a prominent feature in all surveys, was heavily exploited and discarded by the fishery at ages 1-5, and disappeared relatively quickly from the fishery.

French fishers have been reporting substantial discards of undersize cod in the eastern Channel (VIId) in 2007 and early 2008. Relatively large numbers of the 2006 year class were first observed as 0-group fish in several surveys in the eastern Channel and southern North Sea. This year class has been observed again in large numbers as age 1 fish in the French groundfish survey in eastern Channel, and by French fishers targeting cuttlefish in this area. This appears to be a localised phenomenon, since this 2006 year class is estimated to be poor, based on the IBTS Q1 and Q3 surveys.

Several nations who make substantial landings of cod do not supply the WG with estimates of discards, despite the requirement to do so according to EU data collection regulations. In order to improve the quality of the assessment, and hence management advice, these nations should be encouraged to do so.

Recent measures to improve survival of young cod, such as the Scottish Credit Conservation Scheme, and increased uptake of more selective gear in the North Sea and Skagerrak, should be encouraged.

The reported landings in 2007 were 24 400 t and the estimated discards in 2007 were 23 600 t, giving a total of 48 000 t. Surveys indicate that the year classes are depleting faster than one would expect from these catches and point to unaccounted removals. There is no documented information on the source of these unaccounted removals;

while it is assumed that these removals originate mostly from fishing activities, changes in natural mortality may also have an influence. Their magnitude is difficult to predict in the future. Plausible fishery-based contributions to these unaccounted removals are discards that do not count against quota, and the mis- and underreporting of catches. The recent recorded landings (2005-2007) have fluctuated between 40% and 55% of the total removals. This indicates that the management system does not control the catches effectively.

Cod are taken by towed gears in mixed demersal fisheries, which include haddock, whiting, Nephrops, plaice, and sole. They are also taken in directed fisheries using fixed gears.

Cod catch in Division VIId is managed by a TAC for Divisions VIIb-k,VIII, IX, X, and CECAF 34.1.1, (i.e. the TAC covers a small proportion of the North Sea cod stock together with cod in Divisions VIIe-k). Cod taken in Division VIId should be included in the North Sea cod TAC.

It is considered that conclusions drawn from the trends in the historic stock dynamics are robust to the uncertainty in the level of recent recorded catches.

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Table 14.1. Nominal landings (in tons) of COD in IIIa (Skagerrak), IV and VIId, 1988-2007 as officially reported to ICES, and as used by the Working Group.

Sub-area IV										
Country	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Belgium	5,508	3,398	2,934	2,331	3,356	3,374	2,648	4,827	3,458	4,642
Denmark	34,905	25,782	21,601	18,998	18,479	19,547	19,243	24,067	23,573	21,870
Faroe Islands	46	35	96	23	109	46	80	219	44	40
France	8,323	2,578	1,641	975	2,146	1,868	1,868	3,040	1,934	3,451
Germany	7,707	11,430	11,725	7,278	8,446	6,800	5,974	9,457	8,344	5,179
Greenland										
Netherlands	16,968	12,028	8,445	6,831	11,133	10,220	6,512	11,199	9,271	11,807
Norway	3,585	4,813	5,168	6,022	10,476	8,742	7,707	7,111	5,869	5,814
Poland	19	24	53	15	-	-	-	-	18	31
Sweden	367	501	620	784	823	646	630	709	617	832
UK (E/W/NI)	23,496	18,375	15,622	14,249	14,462	14,940	13,941	14,991	15,930	13,413
UK (Scotland)	41,382	31,480	31,120	29,060	28,677	28,197	28,854	35,848	35,349	32,344
United Kindom										
Total Nominal Catch	142,306	110,444	99,025	86,566	98,107	94,380	87,457	111,468	104,407	99,423
Unallocated landings	14,253	5,256	5,726	1,967	-758	10,200	7,066	8,555	2,161	2,746
WG estimate of total landings	**156,559**	**115,700**	**104,751**	**88,533**	**97,349**	**104,580**	**94,523**	**120,023**	**106,568**	**102,169**
Agreed TAC	**160,000**	**124,000**	**105,000**	**100,000**	**100,000**	**101,000**	**102,000**	**120,000**	**130,000**	**115,000**

Division VIId										
Country	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Belgium	486	173	237	182	187	157	228	377	321	310
Denmark	+	+	-	-	1	1	9	-	-	-
France	8,795	n/a	n/a	n/a	2,079	1,771	2,338	3,261	2,808	6,387
Netherlands	1	1	-	-	2	-	-	-	+	-
UK (E/W/NI)	867	562	420	341	443	530	312	336	414	478
UK (Scotland)	-	-	7	2	22	2	+	+	4	3
United Kingdom										
Total Nominal Catch	10,149	n/a	n/a	n/a	2,734	2,461	2,887	3,974	3,547	7,178
Unallocated landings	580	-	-	-	-65	-29	-37	-10	-44	-135
WG estimate of total landings	**10,729**	**5,538**	**2,763**	**1,886**	**2,669**	**2,432**	**2,850**	**3,964**	**3,503**	**7,043**

Division IIIa (Skagerrak)										
Country	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Denmark	14,806	16,634	15,788	10,396	11,194	11,997	11,953	8,948	13,573	12,164
Sweden	1,648	1,902	1,694	1,579	2,436	2,574	1,821	2,658	2,208	2,303
Norway	392	256	143	72	270	75	60	169	265	348
Germany	-	12	110	12	-	-	301	200	203	81
Others	106	34	65	12	102	91	25	134	-	-
Norwegian coast *	769	888	846	854	923	909	760	846	748	911
Danish industrial by-catch *	1,103	428	687	953	1,360	511	666	749	676	205
Total Nominal Catch	16,952	18,838	17,800	12,071	14,002	14,737	14,160	12,109	16,249	14,896
Unallocated landings	0	-141	0	-12	0	0	-899	0	0	50
WG estimate of total landings	**16,952**	**18,697**	**17,800**	**12,059**	**14,002**	**14,737**	**13,261**	**12,109**	**16,249**	**14,946**
Agreed TAC	**21,500**	**20,500**	**21,000**	**15,000**	**15,000**	**15,000**	**15,500**	**20,000**	**23,000**	**16,100**

Sub-area IV, Divisions VIId and IIIa (Skagerrak) combined										
	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Total Nominal Catch	169,407	n/a	n/a	n/a	114,843	111,578	104,504	127,551	124,203	121,497
Unallocated landings	14,833	-	-	-	-823	10,171	6,130	8,545	2,117	2,661
WG estimate of total landings	**184,240**	**139,936**	**125,314**	**102,478**	**114,020**	**121,749**	**110,634**	**136,096**	**126,320**	**124,158**

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

Division IIIa (Skagerrak) landings not included in the assessment										
Country	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Norwegian coast *				854	923	909	760	846	748	911
Danish industrial by-catch *				953	1,360	511	666	749	676	205
Total				**1,807**	**2,283**	**1,420**	**1,426**	**1,595**	**1,424**	**1,116**

Table 14.1. cont. Nominal landings (in tons) of COD in IIIa (Skagerrak), IV and VIId, 1988-2007 as officially reported to ICES, and as used by the Working Group.

Sub-area IV										
Country	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Belgium	5,799	3,882	3,304	2,470	2,616	1,482	1,615	1,715	1,316	1,007
Denmark	23,002	19,697	14,000	8,358	9,022	4,676	5,889	6,291	5,104	3,441
Faroe Islands	102	96		9	34	36		15	4	0
France	2,934	1,750	1,222	717	1,777	617		515	227	425
Germany	8,045	3,386	1,740	1,810	2,018	2,048	2,212	2,648	2,526	1,899
Greenland						1,352				
Netherlands	14,676	9,068	5,995	3,574	4,707	2,305	1,728	1,659	1,585	n/a
Norway	5,823	7,432	6,410	4,383	4,994	4,518	3,205	2,886	2,733	3,056
Poland	25	19	18	18	39	35				
Sweden	540	625	640	661	463	252	226	306	309	386
UK (E/W/NI)	17,745	10,344	6,543	4,087	3,112	2,213	1,889	1,364		
UK (Scotland)	35,633	23,017	21,009	15,640	15,416	7,852	6,644	6,667		
United Kindom									8,341	8,096
Norwegian indust by-catch *									48	101
Danish industrial by-catch *									34	18
Total Nominal Catch	114,324	79,316	60,881	41,727	44,198	27,386	23,408	24,065	22,144	18,310
Unallocated landings	7,779	-924	-1,114	-754	102	-1,539	141	-194	49	1,372
WG estimate of total landings	**122,103**	**78,392**	**59,767**	**40,973**	**44,300**	**25,847**	**23,549**	**23,870**	**22,193**	**19,683**
Agreed TAC	**140,000**	**132,400**	**81,000**	**48,600**	**49,300**	**27,300**	**27,300**	**27,300**	**23,205**	**19,957**

Division VIId										
Country	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Belgium	239	172	110	93	51	54	47	50	80	84
Denmark	-	-	-	-	-					
France	7,788		3,084	1,677	1,361	1,127		467	668	1,127
Netherlands	19	3	4	17	6	36	14	9	9	n/a
UK (E/W/NI)	618	454	385	249	145	121	100	179		
UK (Scotland)	1	-	-	-	-					
United Kingdom									269	181
Total Nominal Catch	8,665	629	3,583	2,036	1,563	1,338	161	705	1,026	1,392
Unallocated landings	-85	6,229	-1,258	-463	1,534	-104	646	328	101	348
WG estimate of total landings	**8,580**	**6,858**	**2,325**	**1,573**	**3,097**	**1,234**	**807**	**1,033**	**1,127**	**1,740**

Division IIIa (Skagerrak)										
Country	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Denmark	12,340	8,734	7,683	5,901	5,526	3,071	3,039	3,613	3,054	2,649
Sweden	1,608	1,909	1,350	1,035	1,716	509	495	824	688	618
Norway	303	345	301	134	146	193	133	120	101	101
Germany	16	54	9	32	83	-			82	67
Others	-	-	-	-	-	-			47	0
Norwegian coast *	976	788	624	846	n/a	n/a	720	759	524	494
Danish industrial by-catch *	97	62	99	687	n/a	n/a	10	18	9	n/a
Total Nominal Catch	14,267	11,042	9,343	7,102	7,471	3,773	3,667	4,557	3,972	3,435
Unallocated landings	1,064	-68	-66	-16	-3	18	120	-752	-606	-489
WG estimate of total landings	**15,331**	**10,974**	**9,277**	**7,086**	**7,468**	**3,791**	**3,787**	**3,805**	**3,366**	**2,946**
Agreed TAC	**20,000**	**19,000**	**11,600**	**7,000**	**7,100**	**3,900**	**3,900**	**3,900**	**3,315**	**2,851**

Sub-area IV, Divisions VIId and IIIa (Skagerrak) combined										
	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Total Nominal Catch	137,256	90,987	73,807	50,865	53,232	32,497	27,236	29,327	27,142	23,137
Unallocated landings	8,758	5,238	-2,438	-1,233	1,633	-1,625	907	-618	-457	1,232
WG estimate of total landings	**146,014**	**96,225**	**71,369**	**49,632**	**54,865**	**30,872**	**28,143**	**28,708**	**26,686**	**24,369**

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

Division IV and IIIa (Skagerrak) landings not included in the assessment										
Country	1998	1999	2000	2001	2002	2003	2003	2005	2006	2007
Norwegian coast *	976	788	624	846	n/a	n/a	720	759	524	494
Norwegian indust by-catch *									48	101
Danish industrial by-catch *	97	62	99	687	n/a	n/a	10	18	43	18
Total	**1,073**	**850**	**723**	**1,533**	**0**	**0**	**730**	**777**	**615**	**613**

Table 14.2 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Landings numbers at age (Thousands).

Landings numbers at age (thousands)

AGE/YEAR	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
1	3214	5029	15813	18224	10803	5829	2947	54493	44824	3832	25966
2	42591	22486	51888	62516	70895	83836	22674	33917	155345	187686	31755
3	7030	20104	17645	29845	32693	42586	31578	18488	17219	48126	54931
4	3536	4306	9182	6184	11261	12392	13710	13339	6754	5682	14072
5	2788	1917	2387	3379	3271	6076	4565	6297	7101	2726	2206
6	1213	1818	950	1278	1974	1414	2895	1763	2700	3201	1109
7	81	599	658	477	888	870	588	961	893	1680	1060
8	492	118	298	370	355	309	422	209	458	612	489
9	14	94	51	126	138	151	147	186	228	390	80
10	6	12	75	56	40	111	46	98	77	113	58
+gp	0	4	8	83	17	24	78	40	94	18	162
TOTALNUM	60965	56486	98957	122538	132335	153600	79651	129791	235691	254064	131888
TONSLAND	116457	126041	181036	221336	252977	288368	200760	226124	328098	353976	239051
SOPCOF %	100	100	100	100	100	100	100	100	100	100	100

AGE/YEAR	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
1	15562	33378	5724	75413	29731	34837	62605	20279	66777	25733	64751
2	58920	47143	100283	51118	175727	91697	104708	189007	65299	129632	66428
3	11404	18944	18574	25621	17258	44653	35056	34821	60411	21662	31276
4	15824	4663	6741	4615	9440	4035	12316	9019	9567	11900	4264
5	4624	7563	1741	2294	3003	3395	1965	4118	3476	2830	3436
6	961	2067	3071	836	1108	712	1273	785	2065	1258	1019
7	438	449	924	1144	410	398	495	604	428	595	437
8	395	196	131	371	405	140	197	134	236	181	244
9	332	229	67	263	153	158	74	65	78	90	60
10	81	95	63	26	36	42	55	37	27	28	45
+gp	189	63	43	96	44	17	25	21	16	23	20
TOTALNUM	108729	114791	137361	161797	237314	180085	218770	258889	208380	193932	171978
TONSLAND	214279	205245	234169	209154	297022	269973	293644	335497	303251	259287	228286
SOPCOF %	100	100	100	100	100	101	100	100	99	100	100

AGE/YEAR	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
1	8845	100239	24915	21480	22239	11738	13466	27668	4783	15557	15717
2	118047	32437	128282	55330	36358	54290	23456	32059	55272	25279	63586
3	18995	34109	9800	43955	18193	11906	16776	8682	11360	21144	12943
4	7823	5814	8723	3134	9866	4339	3310	5007	3190	3083	5301
5	1377	2993	1534	2557	1002	2468	1390	1060	1577	870	802
6	1265	604	1075	655	1036	310	1053	491	435	519	286
7	373	556	235	295	251	310	225	329	204	142	151
8	173	171	215	66	140	54	139	52	108	58	42
9	79	69	55	63	27	60	28	40	18	32	15
10	16	44	48	23	31	12	4	17	10	7	13
+gp	31	23	12	18	10	9	10	9	13	16	5
TOTALNUM	157022	177058	174895	127577	89153	85496	59857	75415	76970	66706	98861
TONSLAND	214629	204053	216212	184240	139936	125314	102478	114020	121749	110634	136096
SOPCOF %	100	101	100	100	100	99	100	99	99	99	98

AGE/YEAR	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
1	4938	23769	1255	5941	8294	2220	7192	400	1589	1502	1906
2	36805	29194	81737	9731	23033	20832	7870	9615	4083	8210	4931
3	23364	18646	16958	32224	6472	6200	13252	3511	4949	2865	4447
4	3169	6499	5967	4034	6697	1142	2519	2660	1965	1628	1015
5	1860	1238	2402	1446	1021	1080	366	449	988	474	471
6	399	700	509	626	385	144	349	66	150	392	151
7	162	153	236	223	139	84	51	49	43	44	116
8	88	47	41	91	40	27	31	13	23	11	22
9	43	14	16	14	18	14	13	7	8	8	4
10	4	15	4	10	5	6	5	3	3	2	2
+gp	8	10	12	2	1	1	0	1	0	0	0
TOTALNUM	70837	80285	109137	54342	46105	31750	31649	16774	13800	15135	13064
TONSLAND	126320	124158	146014	96225	71371	49694	54865	30872	28188	28708	26590
SOPCOF %	100	100	100	100	100	100	100	102	100	100	103

AGE/YEAR	2007
1	1235
2	6838
3	2437
4	1527
5	306
6	114
7	39
8	36
9	6
10	1
+gp	0
TOTALNUM	12541
TONSLAND	24369
SOPCOF %	100

Table 14.3 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Discard numbers at age (Thousands).

Discards numbers at age (thousands)

AGE/YEAR	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
1	16231	8089	98414	108921	50467	31272	2515	53225	260226	38442	86349
2	20003	6199	6632	22236	24861	23073	10331	8700	37412	59641	17475
3	33	116	90	71	160	198	113	153	47	178	247
4	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0
+gp	0	0	0	0	0	0	0	0	0	0	0
TOTALNUM	36267	14404	105136	131229	75489	54542	12959	62078	297686	98261	104071
TONSDISC	12247	4731	29251	38109	23438	17575	4816	17928	84392	33848	30190
SOPCOF %	100	101	100	100	100	100	101	101	100	100	100

AGE/YEAR	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
1	124777	137341	227925	474377	29043	584603	1189692	156878	183476	55478	540795
2	15958	16296	83630	48189	78477	5302	17751	34559	8448	11237	12594
3	71	0	193	466	0	0	0	80	99	25	5
4	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0
+gp	0	0	0	0	0	0	0	0	0	0	0
TOTALNUM	140807	153637	311747	523032	107520	589904	1207444	191516	192022	66740	553394
TONSDISC	39807	37060	72840	139820	32583	163279	295449	57897	54501	22101	151923
SOPCOF %	100	100	100	100	100	100	100	101	100	102	100

AGE/YEAR	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
1	63659	565753	24732	15461	178265	34194	48110	104321	34112	324703	45425
2	36780	5784	62194	17179	8751	48699	8495	10065	29119	17012	44083
3	115	305	0	218	492	79	454	2	12	162	30
4	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0
+gp	0	0	0	0	0	0	0	0	0	0	0
TOTALNUM	100555	571842	86927	32858	187508	82972	57059	114388	63242	341877	89539
TONSDISC	31503	139081	27839	10714	62119	27022	18552	36920	21860	99578	32188
SOPCOF %	100	100	100	101	100	100	101	100	100	100	100

AGE/YEAR	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
1	14451	87308	15608	31550	37981	5600	13373	8511	11865	11290	26690
2	23376	13892	91140	5737	5650	33946	2622	9976	4661	5673	5563
3	774	41	1514	8437	0	773	1972	1118	1158	108	804
4	0	0	0	0	0	0	0	69	0	19	53
5	0	0	0	0	0	0	0	11	0	4	12
6	0	0	0	0	0	0	0	2	0	3	2
7	0	0	0	0	0	0	0	1	0	0	1
8	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0
+gp	0	0	0	0	0	0	0	0	0	0	0
TOTALNUM	38601	101241	108262	45725	43631	40319	17967	19688	17684	17097	33126
TONSDISC	14255	33616	40480	14180	13713	13871	5706	6372	5849	6272	8050
SOPCOF %	100	100	100	102	100	100	100	101	102	103	102

AGE/YEAR	2007
1	14549
2	20337
3	1507
4	370
5	49
6	24
7	0
8	2
9	0
10	0
+gp	0
TOTALNUM	36838
TONSDISC	23569
SOPCOF %	100

Table 14.4 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Landings weights at age (kg).

Landings weights at age (kg)

AGE/YEAR	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
1	0.538	0.496	0.581	0.579	0.590	0.640	0.544	0.626	0.579	0.616	0.559
2	1.004	0.863	0.965	0.994	1.035	0.973	0.921	0.961	0.941	0.836	0.869
3	2.657	2.377	2.304	2.442	2.404	2.223	2.133	2.041	2.193	2.086	1.919
4	4.491	4.528	4.512	4.169	3.153	4.094	3.852	4.001	4.258	3.968	3.776
5	6.794	6.447	7.274	7.027	6.803	5.341	5.715	6.131	6.528	6.011	5.488
6	9.409	8.520	9.498	9.599	9.610	8.020	6.722	7.945	8.646	8.246	7.453
7	11.562	10.606	11.898	11.766	12.033	8.581	9.262	9.953	10.356	9.766	9.019
8	11.942	10.758	12.041	11.968	12.481	10.162	9.749	10.131	11.219	10.228	9.810
9	13.383	12.340	13.053	14.060	13.589	10.720	10.384	11.919	12.881	11.875	11.077
10	13.756	12.540	14.441	14.746	14.271	12.497	12.743	12.554	13.147	12.530	12.359
+gp	0.000	18.000	15.667	15.672	19.016	11.595	11.175	14.367	15.544	14.350	12.886

AGE/YEAR	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
1	0.594	0.619	0.568	0.541	0.573	0.550	0.550	0.723	0.589	0.632	0.594
2	1.039	0.899	1.029	0.948	0.937	0.936	1.003	0.837	0.962	0.919	1.007
3	2.217	2.348	2.470	2.160	2.001	2.411	1.948	2.190	1.858	1.835	2.156
4	4.156	4.226	4.577	4.606	4.146	4.423	4.401	4.615	4.130	3.880	3.972
5	6.174	6.404	6.494	6.714	6.530	6.579	6.109	7.045	6.785	6.491	6.190
6	8.333	8.691	8.620	8.828	8.667	8.474	9.120	8.884	8.903	8.423	8.362
7	9.889	10.107	10.132	10.071	9.685	10.637	9.550	9.933	10.398	9.848	10.317
8	10.791	10.910	11.340	11.052	11.099	11.550	11.867	11.519	12.500	11.837	11.352
9	12.175	12.339	12.888	11.824	12.427	13.057	12.782	13.338	13.469	12.797	13.505
10	12.425	12.976	14.139	13.134	12.778	14.148	14.081	14.897	12.890	12.562	13.408
+gp	13.731	14.431	14.760	14.362	13.981	15.478	15.392	18.784	14.608	14.426	13.472

AGE/YEAR	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
1	0.590	0.583	0.635	0.585	0.673	0.737	0.670	0.699	0.699	0.677	0.721
2	0.932	0.856	0.976	0.881	1.052	0.976	1.078	1.146	1.065	1.075	1.021
3	2.141	1.834	1.955	1.982	1.846	2.176	2.038	2.546	2.479	2.201	2.210
4	4.164	3.504	3.650	3.187	3.585	3.791	3.971	4.223	4.551	4.471	4.293
5	6.324	6.230	6.052	5.992	5.273	5.931	6.082	6.247	6.540	7.167	7.220
6	8.430	8.140	8.307	7.914	7.921	7.890	8.033	8.483	8.094	8.436	8.980
7	10.362	9.896	10.243	9.764	9.724	10.235	9.545	10.101	9.641	9.537	10.282
8	12.074	11.940	11.461	12.127	11.212	10.923	10.948	10.482	10.734	10.323	11.743
9	13.072	12.951	12.447	14.242	12.586	12.803	13.481	11.849	12.329	12.223	13.107
10	14.443	13.859	18.691	17.787	15.557	15.525	13.171	13.904	13.443	14.247	12.052
+gp	16.588	14.707	16.604	16.477	14.695	23.234	14.989	15.794	13.961	12.523	13.954

AGE/YEAR	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
1	0.699	0.656	0.542	0.640	0.611	0.725	0.758	0.608	0.700	0.828	0.750
2	1.117	0.960	0.922	0.935	1.021	1.004	1.082	1.174	0.997	1.190	1.161
3	2.147	2.120	1.724	1.663	1.747	2.303	1.916	1.849	2.014	1.978	2.192
4	4.034	3.821	3.495	3.305	3.216	3.663	3.857	3.256	3.096	3.690	3.731
5	6.637	6.228	5.387	5.726	4.903	5.871	5.372	5.186	5.172	5.060	5.660
6	8.494	8.394	7.563	7.403	7.488	7.333	7.991	7.395	7.426	7.551	6.882
7	9.729	9.979	9.628	8.582	9.636	9.264	9.627	8.703	8.675	9.607	8.896
8	11.080	11.424	10.643	10.365	10.671	10.081	10.403	12.178	9.797	11.229	10.639
9	12.264	12.300	11.499	11.600	10.894	12.062	10.963	12.846	11.684	11.501	12.216
10	12.756	12.761	13.085	12.330	11.414	12.009	12.816	10.771	13.058	13.333	9.212
+gp	11.304	13.416	14.921	11.926	15.078	10.196	11.842	17.494	14.140	15.340	10.786

AGE/YEAR	2007
1	0.805
2	1.161
3	2.376
4	4.046
5	5.523
6	8.197
7	8.986
8	9.777
9	12.357
10	13.724
+gp	9.486

Table 14.5 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Discard weights at age (kg).

Discards weights at age (kg)

AGE/YEAR	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
1	0.270	0.270	0.269	0.269	0.269	0.269	0.268	0.268	0.268	0.268	0.268
2	0.393	0.393	0.392	0.392	0.392	0.392	0.392	0.392	0.392	0.392	0.392
3	0.505	0.508	0.506	0.509	0.506	0.505	0.504	0.505	0.508	0.507	0.507
4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
7	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
8	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
9	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
+gp	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

AGE/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	0.270
2	0.392	0.359	0.354	0.382	0.309	0.361	0.411	0.396	0.489	0.458	0.469
3	0.508	0.000	0.412	0.376	0.000	0.000	0.000	0.517	0.593	0.534	0.509
4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
7	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
8	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
9	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
+gp	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

AGE/YEAR	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
1	0.276	0.242	0.237	0.300	0.326	0.260	0.315	0.314	0.274	0.287	0.316
2	0.376	0.365	0.353	0.339	0.431	0.371	0.366	0.408	0.429	0.362	0.404
3	0.652	0.437	0.000	0.463	0.484	0.526	0.395	2.309	0.705	0.483	0.553
4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
7	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
8	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
9	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
+gp	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

AGE/YEAR	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
1	0.342	0.313	0.358	0.257	0.298	0.232	0.294	0.259	0.293	0.284	0.179
2	0.380	0.453	0.375	0.389	0.422	0.361	0.420	0.344	0.384	0.468	0.426
3	0.515	0.616	0.481	0.422	0.000	0.406	0.340	0.540	0.427	1.084	0.751
4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.675	0.000	4.099	1.300
5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	2.272	0.000	4.501	2.862
6	0.000	0.000	0.000	0.000	0.000	0.000	0.000	2.849	0.000	8.197	4.663
7	0.000	0.000	0.000	0.000	0.000	0.000	0.000	3.585	0.000	0.000	10.895
8	0.000	0.000	0.000	0.000	0.000	0.000	0.000	5.033	0.000	0.000	0.000
9	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
+gp	0.000	0.000	0.000	0.000	0.000	0.000	0.000	5.771	0.000	0.000	0.000

AGE/YEAR	2007
1	0.226
2	0.756
3	1.878
4	4.135
5	6.131
6	9.723
7	1.737
8	15.585
9	0.000
10	0.000
+gp	0.500

Table 14.6 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Catch and stock weights at age (kg).

Catch weights at age (kg)

AGE/YEAR	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
1	0.314	0.357	0.313	0.314	0.326	0.328	0.416	0.449	0.313	0.300	0.335
2	0.808	0.762	0.900	0.836	0.868	0.847	0.755	0.845	0.834	0.729	0.700
3	2.647	2.367	2.295	2.437	2.395	2.215	2.127	2.028	2.188	2.080	1.912
4	4.491	4.528	4.512	4.169	3.153	4.094	3.852	4.001	4.258	3.968	3.776
5	6.794	6.447	7.274	7.027	6.803	5.341	5.715	6.131	6.528	6.011	5.488
6	9.409	8.520	9.498	9.599	9.610	8.020	6.722	7.945	8.646	8.246	7.453
7	11.562	10.606	11.898	11.766	12.033	8.581	9.262	9.953	10.356	9.766	9.019
8	11.942	10.758	12.041	11.968	12.481	10.162	9.749	10.131	11.219	10.228	9.810
9	13.383	12.340	13.053	14.060	13.589	10.720	10.384	11.919	12.881	11.875	11.077
10	13.756	12.540	14.441	14.746	14.271	12.497	12.743	12.554	13.147	12.530	12.359
+gp	0.000	18.000	15.667	15.672	19.016	11.595	11.175	14.367	15.544	14.350	12.886

AGE/YEAR	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
1	0.304	0.304	0.199	0.295	0.432	0.291	0.258	0.329	0.358	0.403	0.304
2	0.901	0.760	0.722	0.673	0.743	0.905	0.917	0.769	0.908	0.882	0.921
3	2.206	2.348	2.449	2.128	2.001	2.411	1.948	2.186	1.856	1.833	2.156
4	4.156	4.226	4.577	4.606	4.146	4.423	4.401	4.615	4.130	3.880	3.972
5	6.174	6.404	6.494	6.714	6.530	6.579	6.109	7.045	6.785	6.491	6.190
6	8.333	8.691	8.620	8.828	8.667	8.474	9.120	8.884	8.903	8.423	8.362
7	9.889	10.107	10.132	10.071	9.685	10.637	9.550	9.933	10.398	9.848	10.317
8	10.791	10.910	11.340	11.052	11.099	11.550	11.867	11.519	12.500	11.837	11.352
9	12.175	12.339	12.888	11.824	12.427	13.057	12.782	13.338	13.469	12.797	13.505
10	12.425	12.976	14.139	13.134	12.778	14.148	14.081	14.897	12.890	12.562	13.408
+gp	13.731	14.431	14.760	14.362	13.981	15.478	15.392	18.784	14.608	14.426	13.472

AGE/YEAR	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
1	0.314	0.293	0.437	0.466	0.364	0.382	0.392	0.395	0.327	0.305	0.420
2	0.800	0.782	0.773	0.753	0.931	0.690	0.889	0.970	0.845	0.788	0.768
3	2.132	1.822	1.955	1.974	1.810	2.165	1.994	2.545	2.478	2.188	2.207
4	4.164	3.504	3.650	3.187	3.585	3.791	3.971	4.223	4.551	4.471	4.293
5	6.324	6.230	6.052	5.992	5.273	5.931	6.082	6.247	6.540	7.167	7.220
6	8.430	8.140	8.307	7.914	7.921	7.890	8.033	8.483	8.094	8.436	8.980
7	10.362	9.896	10.243	9.764	9.724	10.235	9.545	10.101	9.641	9.537	10.282
8	12.074	11.940	11.461	12.127	11.212	10.923	10.948	10.482	10.734	10.323	11.743
9	13.072	12.951	12.447	14.242	12.586	12.803	13.481	11.849	12.329	12.223	13.107
10	14.443	13.859	18.691	17.787	15.557	15.525	13.171	13.904	13.443	14.247	12.052
+gp	16.588	14.707	16.604	16.477	14.695	23.234	14.989	15.794	13.961	12.523	13.954

AGE/YEAR	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
1	0.433	0.386	0.372	0.317	0.354	0.372	0.456	0.275	0.341	0.348	0.217
2	0.831	0.797	0.633	0.732	0.903	0.605	0.916	0.752	0.671	0.895	0.771
3	2.095	2.117	1.622	1.405	1.747	2.093	1.712	1.533	1.713	1.945	1.972
4	4.034	3.821	3.495	3.305	3.216	3.663	3.857	3.191	3.096	3.695	3.610
5	6.637	6.228	5.387	5.726	4.903	5.871	5.372	5.113	5.172	5.055	5.590
6	8.494	8.394	7.563	7.403	7.488	7.333	7.991	7.270	7.426	7.555	6.848
7	9.729	9.979	9.628	8.582	9.636	9.264	9.627	8.630	8.675	9.607	8.911
8	11.080	11.424	10.643	10.365	10.671	10.081	10.403	12.056	9.797	11.229	10.639
9	12.264	12.300	11.499	11.600	10.894	12.062	10.963	12.846	11.684	11.501	12.216
10	12.756	12.761	13.085	12.330	11.414	12.009	12.816	10.771	13.058	13.333	9.212
+gp	11.304	13.416	14.921	11.926	15.078	10.196	11.842	17.351	14.140	15.340	10.786

AGE/YEAR	2007
1	0.271
2	0.858
3	2.186
4	4.063
5	5.606
6	8.466
7	8.918
8	10.019
9	12.357
10	13.724
+gp	8.155

Table 14.7 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Natural mortality and proportion mature by age-group.

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

Table 14.8 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Survey tuning CPUE. Data used in the assessment are highlighted in bold text

North Sea/Skagerrak/Eastern Channel Cod, Tuning data.

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IBTS_Q1, 6 is a plusgroup

1983	2008					
1	1	0	0.25			
1	5					
1	**4.734**	**16.699**	**2.749**	**1.932**	**0.798**	1.357
1	**15.856**	**8.958**	**4.059**	**0.905**	**0.976**	0.875
1	**0.928**	**18.782**	**3.217**	**1.744**	**0.476**	0.93
1	**16.785**	**3.627**	**7.079**	**2.242**	**1.28**	0.967
1	**9.425**	**28.833**	**1.515**	**1.789**	**0.636**	0.819
1	**5.638**	**6.334**	**6.204**	**0.658**	**0.86**	1.127
1	**15.117**	**6.328**	**5.044**	**2.345**	**0.394**	0.992
1	**3.953**	**15.665**	**1.885**	**1.034**	**0.967**	0.619
1	**2.481**	**4.714**	**4.254**	**0.861**	**0.42**	0.771
1	**13.129**	**4.346**	**1.183**	**0.996**	**0.288**	0.483
1	**13.088**	**19.521**	**2.025**	**0.688**	**0.565**	0.377
1	**14.66**	**4.387**	**2.876**	**0.815**	**0.483**	0.521
1	**9.832**	**22.062**	**2.731**	**1.105**	**0.276**	0.335
1	**3.441**	**7.97**	**5.922**	**0.679**	**0.639**	0.384
1	**39.951**	**6.897**	**2.247**	**1.069**	**0.458**	0.417
1	**2.672**	**26.368**	**2.003**	**0.884**	**0.505**	0.392
1	**2.112**	**1.583**	**8.078**	**0.764**	**0.439**	0.495
1	**6.563**	**3.767**	**0.738**	**2.05**	**0.387**	0.504
1	**2.786**	**8.647**	**1.659**	**0.231**	**0.394**	0.262
1	**7.755**	**3.38**	**4.278**	**0.496**	**0.119**	0.218
1	**0.584**	**2.86**	**1.144**	**1.361**	**0.514**	0.192
1	**6.722**	**2.051**	**1.293**	**0.302**	**0.497**	0.15
1	**2.272**	**2.197**	**0.629**	**0.551**	**0.227**	0.424
1	**6.642**	**1.644**	**0.994**	**0.293**	**0.152**	0.27
1	**3.091**	**5.83**	**1.222**	**0.423**	**0.261**	0.286
1	**2.638**	**1.265**	**2.573**	**0.545**	**0.392**	0.178

IBTS_Q3, 6 is a plusgroup

1991	2007						
1	1	0.5	0.75				
0	4						
1	29.207	**8.17**	**2.438**	**1.164**	**0.164**	0.066	0.069
1	19.591	**43.487**	**3.596**	**0.737**	**0.457**	0.153	0.136
1	16.288	**10.473**	**7.903**	**0.861**	**0.183**	0.136	0.061
1	16.112	**42.737**	**6.155**	**2.389**	**0.213**	0.082	0.073
1	10.864	**22.282**	**17.419**	**1.468**	**0.762**	0.068	0.07
1	68.916	**10.283**	**5.327**	**1.833**	**0.39**	0.183	0.036
1	0.13	**60.518**	**5.471**	**1.659**	**0.636**	0.13	0.125
1	91.708	**2.397**	**20.057**	**1.294**	**0.386**	0.235	0.117
1	9.543	**11.952**	**0.961**	**3.863**	**0.291**	0.089	0.037
1	1.845	**10.689**	**2.294**	**0.205**	**0.523**	0.075	0.09
1	4.669	**4.723**	**5.533**	**0.792**	**0.15**	0.153	0.145
1	0.767	**11.334**	**2.117**	**1.557**	**0.439**	0.1	0.046
1	12.854	**1.735**	**2.475**	**0.516**	**0.483**	0.401	0.504
1	2.287	**12.178**	**1.703**	**1.088**	**0.202**	0.143	0.046
1	13.755	**4.745**	**2.062**	**0.622**	**0.218**	0.049	0.124
1	7.329	**15.215**	**1.89**	**1.252**	**0.219**	0.044	0.059
1	8.135	**9.079**	**6.154**	**0.975**	**0.344**	0.137	0.122

Table 14.9a Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. B-ADAPT base run tuning model specification

Lowestoft VPA Program

23/04/2008 16:29

Adapt Analysis

North Sea/Skagerrak Tuning data. INCLUDES DISCARDS

CPUE data from file Cod347_2008.tun

Catch data for 45 years : 1963 to 2007. Ages 1 to 7+

Fleet	First year	Last year	First age	Last age	Alpha	Beta
IBTS_Q1	1983	2008	1	5	0	0.25
IBTS_Q3	1991	2007	1	4	0.5	0.75

Time series weights :

Tapered time weighting not applied

Catchability analysis :

Fleet	PowerQ ages<x	QPlateau ages>x
IBTS_Q1	1	5
IBTS_Q3	1	3

Catchability independent of stock size for all ages

Bias estimation : Bias estimated for the final 15 years.
Oldest age F estimates in 1963 to 2008 calculated as 1.000 * the mean F of ages 3- 5
Total catch penalty applied lambda = 0.500

Individual fleet weighting not applied

INITIAL SSQ =	32.01164	SSQ =	24.95541	IFAIL =	3
PARAMETERS =	20	QSSQ =	24.16416	IFAILCV = 0	
OBSERVATIONS =	213	CSSQ =	0.79125		

Table 14.9b Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. B-ADAPT base run IBTSQ1 tuning diagnostics

Fleet : IBTS_Q1

Log index residuals

Age	1983	1984	1985	1986	1987
1	-0.52	-0.44	-1.62	-0.53	0.34
2	0.10	0.01	0.13	-0.21	0.36
3	-0.06	-0.16	0.08	0.34	-0.05
4	-0.17	0.03	0.02	0.73	0.06
5	-0.15	-0.17	-0.02	0.26	0.18

Age	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
1	0.26	0.04	-0.70	0.20	0.94	-0.24	0.14	-0.33	0.90	0.25
2	0.18	0.44	0.15	-0.21	0.55	-0.33	0.33	-0.17	0.10	0.28
3	0.64	0.00	0.43	-0.31	0.00	-0.24	0.03	0.25	-0.28	-0.30
4	0.25	0.16	0.21	-0.05	-0.01	0.16	-0.30	-0.23	-0.22	-0.21
5	0.25	0.08	-0.12	-0.32	-0.02	0.40	-0.42	-0.18	0.09	-0.33

Age	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
1	-0.56	0.01	0.31	0.70	-1.03	0.97	0.08	0.25	0.33	99.99
2	-0.45	-0.03	0.09	0.16	-0.46	0.14	-0.40	-0.40	-0.11	-0.72
3	0.36	-0.25	0.15	0.28	-0.28	0.01	-0.33	-0.35	0.00	-0.22
4	0.00	0.60	-0.13	-0.23	0.22	-0.46	0.10	-0.21	-0.40	-0.08
5	-0.02	0.39	0.00	-0.21	0.67	0.00	-0.07	-0.40	0.11	0.02

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

Age	1	2	3	4	5
Mean Log	-10.7523	-9.4884	-9.1946	-8.9917	-8.5348
S.E(Log q)	0.6177	0.2876	0.2684	0.2794	0.2617

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	1.07	-0.39	10.63	0.61	25	0.67014	-10.75
2	0.82	3.173	9.86	0.93	25	0.19985	-9.49
3	0.83	2.407	9.37	0.89	25	0.20217	-9.19
4	0.89	1.181	8.99	0.83	25	0.24573	-8.99
5	1.07	-0.642	8.58	0.79	25	0.2835	-8.53

Table 14.9c Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. B-ADAPT base run IBTSQ3 tuning diagnostics

Fleet : IBTS_Q3

Log index residuals

Age	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
1	99.99	99.99	-0.35	0.55	-0.18	0.09	0.08	-0.18	0.38	-0.76
2	99.99	99.99	-0.19	-0.07	0.07	0.26	0.56	-0.13	0.11	0.47
3	99.99	99.99	-0.26	-0.26	-0.19	0.14	0.10	-0.16	0.02	0.01
4	99.99	99.99	-0.71	-0.09	-0.49	-0.49	0.10	0.03	0.01	-0.15
5	No data for this fleet at this age									

Age	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
1	0.34	-0.42	-0.14	0.16	-0.78	0.62	-0.06	0.15	0.53	99.99
2	-0.64	-0.16	-0.07	-0.17	-0.10	0.15	-0.18	-0.06	0.16	99.99
3	0.56	-0.74	-0.08	-0.08	-0.37	0.42	0.23	0.40	0.26	99.99
4	0.01	0.24	0.16	0.52	0.05	-0.08	0.03	0.17	0.11	99.99
5	No data for this fleet at this age									

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

Age	1	2	3	4
Mean Log	-9.3112	-9.1877	-9.2088	-9.2088
S.E(Log q)	0.4235	0.277	0.3244	0.2978

Regression statistics :

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

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
1	0.84	1.354	9.8	0.83	17	0.34754	-9.31
2	0.79	3.248	9.62	0.94	17	0.17426	-9.19
3	0.91	0.697	9.29	0.79	17	0.29933	-9.21
4	1.04	-0.228	9.26	0.7	17	0.31632	-9.24

Table 14.9d Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. B-ADAPT base run parameter estimates

Parameters

Age	Survivors	s.e log est
1	38480	0.24
2	34987	0.25
3	5291	0.25
4	2128	0.26
5	592	0.48

Year	Multiplier	s.e log est
1993	1.23	0.19
1994	1.00	0.22
1995	1.42	0.20
1996	1.47	0.19
1997	0.99	0.22
1998	1.09	0.19
1999	1.24	0.19
2000	1.14	0.19
2001	1.07	0.22
2002	1.43	0.20
2003	2.33	0.18
2004	1.25	0.23
2005	1.71	0.20
2006	1.42	0.23
2007	1.51	0.28

Variance covariance matrix

0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.06	0.01	0.01	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	-0.02
0.00	0.01	0.06	0.01	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.02
0.00	0.01	0.01	0.07	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.02
0.00	0.02	0.02	0.02	0.23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.02	-0.05
0.00	0.00	0.01	0.01	0.00	0.04	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
0.00	0.00	0.00	0.00	0.00	0.00	0.05	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.04	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.01	0.00	-0.01	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.05	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	-0.01	0.03	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	-0.01	0.04	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	-0.01	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	-0.01	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.04	-0.01	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.03	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	-0.01	0.00	0.00
0.00	0.01	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.04	-0.01	0.00
0.00	0.00	0.00	0.00	-0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.05	0.00
0.00	-0.02	-0.02	-0.02	-0.05	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08

Table 14.10 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. B-ADAPT base run median fishing mortality at age.

At 23/04/2008 16:29

Table 8 Fishing mortality (F) at age

AGE\YEAR	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
1	0.1307	0.0487	0.3157	0.2953	0.1554	0.2259	0.0352	0.1817	0.3671	0.2552
2	0.7065	0.4656	0.5105	0.6941	0.6354	0.7478	0.5262	0.6908	1.0117	1.0478
3	0.3951	0.6023	0.6849	0.6194	0.7507	0.7724	0.5983	0.7531	0.7932	0.9151
4	0.5009	0.4628	0.6372	0.5655	0.5215	0.7559	0.6358	0.5680	0.7178	0.6965
5	0.4232	0.5623	0.5077	0.5131	0.6741	0.5989	0.7104	0.6892	0.6858	0.7289
6	0.4397	0.5425	0.6099	0.5660	0.6488	0.7091	0.6482	0.6701	0.7323	0.7802
+gp	0.4397	0.5425	0.6099	0.5660	0.6488	0.7091	0.6482	0.6701	0.7323	0.7802
FBAR 2- 4	0.5342	0.5102	0.6109	0.6263	0.6359	0.7587	0.5868	0.6706	0.8409	0.8865

AGE\YEAR	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
1	0.4107	0.5416	0.3245	0.6564	0.6161	0.1740	0.9836	1.0840	0.6057	0.5075
2	0.9380	0.9534	0.9049	1.3386	1.2759	1.2662	0.8271	0.9735	1.0755	1.0105
3	0.8348	0.6866	0.8024	0.9001	0.8020	0.9601	0.9553	0.9979	1.0208	1.2422
4	0.7979	0.6386	0.7011	0.8003	0.6047	0.8200	0.6475	0.8128	0.8122	0.9501
5	0.6496	0.6751	0.7361	0.6233	0.7142	1.0656	0.8167	0.7775	0.7194	0.8892
6	0.7608	0.6668	0.7465	0.7746	0.7070	0.9485	0.8065	0.8627	0.8508	1.0271
+gp	0.7608	0.6668	0.7465	0.7746	0.7070	0.9485	0.8065	0.8627	0.8508	1.0271
FBAR 2- 4	0.8569	0.7595	0.8028	1.0130	0.8942	1.0154	0.8099	0.9281	0.9695	1.0676

AGE\YEAR	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	0.3169	0.8906	0.5052	0.8302	0.2238	0.2530	0.5749	0.3839	0.3904	0.3872
2	1.1285	1.0575	1.1502	0.9997	1.1579	1.0635	0.9961	1.2922	0.8936	0.8993
3	1.1986	1.0094	0.9709	1.0682	0.9205	1.1754	1.0983	0.9658	0.9370	0.7683
4	0.9494	0.8589	0.8001	0.9885	0.9435	0.9356	0.9987	0.8831	0.8362	0.8404
5	0.8531	0.8205	0.7708	0.8493	0.7887	0.8275	0.9283	0.7465	0.8112	0.7183
6	1.0004	0.8963	0.8473	0.9687	0.8842	0.9795	1.0085	0.8652	0.8611	0.7753
+gp	1.0004	0.8963	0.8473	0.9687	0.8842	0.9795	1.0085	0.8652	0.8611	0.7753
FBAR 2- 4	1.0922	0.9753	0.9738	1.0188	1.0073	1.0582	1.0311	1.0469	0.8887	0.8356

AGE\YEAR	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
1	0.2889	0.6261	0.2996	0.1703	0.2390	0.2401	0.4033	0.2351	0.1390	0.2284
2	1.1140	0.7707	1.1407	1.0952	0.8426	1.0737	0.8816	0.9542	0.9199	0.5221
3	1.0742	0.8650	1.0545	1.2147	1.0482	1.1158	1.6029	1.2513	0.8338	1.0278
4	1.0647	0.7735	0.8695	0.9670	0.9689	1.0524	1.3246	1.3382	0.9053	1.0895
5	0.9779	0.7309	0.6972	1.0164	0.9156	1.0381	1.2660	1.4255	0.9043	1.0420
6	1.0385	0.7883	0.8740	1.0660	0.9777	1.0688	1.3980	1.3383	0.8812	1.0531
+gp	1.0385	0.7883	0.8740	1.0660	0.9777	1.0688	1.3980	1.3383	0.8812	1.0531
FBAR 2- 4	1.0837	0.8032	1.0217	1.0926	0.9536	1.0806	1.2695	1.1816	0.8864	0.8798

AGE\YEAR	2003	2004	2005	2006	2007
1	0.3455	0.2467	0.2844	0.2729	0.2858
2	1.1237	0.7758	0.7213	0.7280	0.5964
3	0.9934	1.0471	0.7608	0.8491	0.6093
4	0.9885	1.0951	0.9608	0.7924	0.7054
5	1.1439	0.7939	0.8751	0.9462	0.5216
6	1.0424	0.9789	0.8673	0.8578	0.6183
+gp	1.0424	0.9789	0.8673	0.8578	0.6183
FBAR 2- 4	1.0351	0.9736	0.8147	0.7879	0.6391

Table 14.11 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. B-ADAPT base run median population numbers at age.

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

AGE\YEAR	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
1	228540	399443	600416	708510	612282	262676	228850	930946	1407998	268139
2	143487	90105	170946	196744	236947	235527	94166	99272	348820	438247
3	24260	49885	39859	72302	69256	88447	78577	39207	35061	89377
4	9821	12727	21273	15650	30311	25461	31816	33643	14379	12353
5	8853	4873	6560	9209	7278	14731	9789	13793	15608	5743
6	3734	4747	2274	3232	4514	3037	6626	3939	5669	6436
+gp	1823	2157	2608	2812	3289	3146	2932	3339	3673	5654
TOTAL	420520	563939	843934	1008461	963876	633026	452756	1124139	1831208	825950

AGE\YEAR	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
1	471632	470719	876154	675946	1668615	528504	1350162	2566638	544678	883780
2	93345	140541	123065	284582	157542	404910	199543	226882	390098	133548
3	108306	25746	38174	35087	52584	30994	80439	61496	60395	93776
4	27877	36604	10092	13327	11109	18365	9242	24099	17657	16947
5	5040	10277	15824	4098	4901	4968	6622	3960	8753	6417
6	2269	2155	4283	6206	1799	1965	1401	2396	1490	3490
+gp	3782	3216	2139	2481	4090	1858	1484	1595	1634	1327
TOTAL	712249	689257	1069730	1021728	1900641	991563	1648893	2887066	1024705	1139285

AGE\YEAR	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	425490	1409444	256977	1626314	354511	236177	641820	204133	269785	582416
2	239054	139261	259926	69669	318573	127356	82403	162296	62482	82039
3	34259	54497	34085	57986	18066	70522	30984	21445	31413	18017
4	21088	8048	15468	10054	15518	5604	16954	8046	6358	9585
5	5366	6681	2791	5690	3063	4946	1800	5113	2724	2256
6	2159	1872	2408	1057	1992	1140	1770	583	1984	991
+gp	1573	1478	1278	1511	1047	809	784	837	765	904
TOTAL	728990	1621281	572933	1772280	712770	446553	776516	402453	375511	696208

AGE\YEAR	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
1	272894	1026370	455365	258502	837455	110145	202650	356541	104694	195938
2	177689	91820	243903	150807	98219	295647	38793	60661	126872	40858
3	23521	41105	29642	55006	35662	29687	70608	11235	16530	35540
4	6508	6255	13394	8058	12740	9725	7524	11030	2517	5575
5	3387	1838	2352	4588	2515	3947	2759	1633	2380	831
6	901	1039	720	957	1365	823	1136	634	323	787
+gp	731	509	567	730	468	500	617	335	297	229
TOTAL	485629	1168935	745944	478648	988424	450474	324087	442069	253614	279758

AGE\YEAR	2003	2004	2005	2006	2007
1	91243	135611	112261	274458	118989
2	69956	28993	47306	38012	93633
3	17078	15993	9419	16241	12885
4	9910	4918	4355	3406	5382
5	1537	3024	1343	1371	1258
6	240	400	1115	463	432
+gp	260	205	185	436	263
TOTAL	190224	189144	175984	334387	232844

Table 14.12a Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. B-ADAPT median stock and management metrics.

Run title: North Sea/Skagerrak/Eastern Channel Cod
Tuning data. INCLUDES DISCARDS
23/04/2008 16:29

B-ADAPT median values

	RECRUITS Age 1 ('000)	TSB (tons)	SSB (tons)	CATCH (tons)	YIELD/SSB	FBAR 2-4
1963	228540	413071	157257	128686	0.818	0.534
1964	399443	482315	158695	130740	0.824	0.510
1965	600416	630354	184554	210237	1.139	0.611
1966	708510	759390	213361	259416	1.216	0.626
1967	612282	800508	236547	276387	1.168	0.636
1968	262676	718662	242373	305911	1.262	0.759
1969	228850	585188	240302	205510	0.855	0.587
1970	930946	866955	249236	243867	0.978	0.671
1971	1407998	1062013	252747	412264	1.631	0.841
1972	268139	780669	230917	387737	1.679	0.886
1973	471632	617157	195341	269139	1.378	0.857
1974	470719	596439	224052	253989	1.134	0.760
1975	876154	654859	202909	242349	1.194	0.803
1976	675946	593758	172324	307102	1.782	1.013
1977	1668615	854151	155895	349038	2.239	0.894
1978	528504	737068	144003	328585	2.282	1.015
1979	1350162	880983	149493	430688	2.881	0.810
1980	2566638	1159434	170284	590678	3.469	0.928
1981	544678	785346	181696	393451	2.165	0.970
1982	883780	771572	176435	359372	2.037	1.068
1983	425490	596832	142449	281696	1.978	1.092
1984	1409444	779628	125186	379974	3.035	0.975
1985	256977	478356	118027	247031	2.093	0.974
1986	1626314	732356	109154	341047	3.124	1.019
1987	354511	540559	101929	244809	2.402	1.007
1988	236177	410877	92688	194798	2.102	1.058
1989	641820	459239	87450	202639	2.317	1.031
1990	204133	311096	75914	153021	2.016	1.047
1991	269785	289718	72091	121204	1.681	0.889
1992	582416	427941	72023	151755	2.107	0.836
1993	272894	365189	74178	177550	2.394	1.084
1994	1026370	531035	70023	212907	3.041	0.803
1995	455365	531562	89256	229144	2.567	1.022
1996	258502	432399	96045	203801	2.122	1.093
1997	837455	556788	84603	176460	2.086	0.954
1998	110145	342600	71482	182499	2.553	1.081
1999	202650	246748	68019	139129	2.045	1.270
2000	356541	252940	45445	95472	2.101	1.182
2001	104694	178998	35220	75782	2.152	0.886
2002	195938	222038	42542	81706	1.921	0.880
2003	91243	147628	39550	76491	1.934	1.035
2004	135611	129031	35559	51992	1.462	0.974
2005	112261	132755	32830	52384	1.596	0.815
2006	274458	148133	30985	53501	1.727	0.788
2007	118989	176318	36866	62588	1.698	0.639
2008			49941			

Table 14.12b Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Landings, discards and estimated total removals, based on the B-Adapt base run.

	Landings	Discards	Catch (L+D)	Total estimated removals
1985	214.6	31.5	246.1	247.0
1986	204.1	139.1	343.1	341.0
1987	216.2	27.8	244.1	244.8
1988	184.2	10.7	195.0	194.8
1989	139.9	62.1	202.1	202.6
1990	125.3	27.0	152.3	153.0
1991	102.5	18.6	121.0	121.2
1992	114.0	36.9	150.9	151.8
1993	121.7	21.9	143.6	177.5
1994	110.6	99.6	210.2	212.9
1995	136.1	32.2	168.3	229.1
1996	126.3	14.3	140.6	203.8
1997	124.2	33.6	157.8	176.5
1998	146.0	40.5	186.5	182.5
1999	96.2	14.2	110.4	139.1
2000	71.4	13.7	85.1	95.5
2001	49.7	13.9	63.6	75.8
2002	54.9	5.7	60.6	81.7
2003	30.9	6.4	37.2	76.5
2004	28.2	5.8	34.0	52.0
2005	28.7	6.3	35.0	52.4
2006	26.6	8.1	34.6	53.5
2007	24.4	23.6	47.9	62.6

Table 14.13 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. B-ADAPT median term forecast Option 1: reduction in fishing mortality by 10% in 2008, followed by constant fishing mortality at the 2008 level for 2009 onwards.

	2007	2008	2009	2010
F2007 mult	1.000	0.900	0.900	0.900

Fbar(2-4)	Year			
Percentile	2007	2008	2009	2010
0.05	0.43	0.38	0.38	0.38
0.25	0.55	0.50	0.50	0.50
0.5	0.64	0.58	0.58	0.58
0.75	0.73	0.66	0.66	0.66
0.95	0.85	0.76	0.76	0.76

SSB	Year			
Percentile	2007	2008	2009	2010
0.05	31279	41103	50776	49926
0.25	34257	45702	61776	65729
0.5	36866	49941	70732	79623
0.75	39451	54424	81702	96384
0.95	43476	61750	101947	127685

Landings	Year			
Percentile	2007	2008	2009	2010
0.05	21258	29217	36039	36297
0.25	27234	35306	41528	42717
0.5	31788	38783	45474	48238
0.75	36979	42660	49807	55432
0.95	45039	48976	57631	66525

Discards	Year			
Percentile	2007	2008	2009	2010
0.05	20597	17458	18601	18661
0.25	26388	21704	22662	22982
0.5	30800	25198	26478	27893
0.75	35830	28747	32567	33980
0.95	43639	34803	43448	44642

P(SSBYear > SSB 2007)				
2008	2009	2010	2011	2012
0.99	1.00	0.99	0.98	0.98

In year SSB change	2007	2008	2009
Median	1.35	1.42	1.13
P25/P75	1.16	1.14	0.80

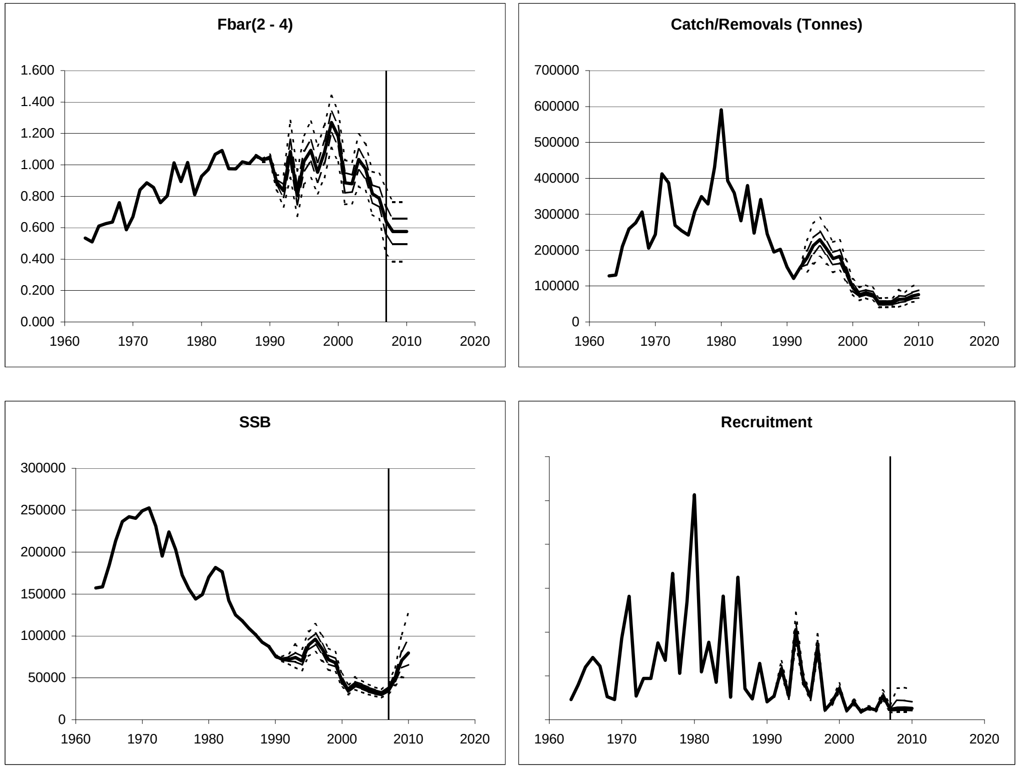


Table 14.14a Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. B-ADAPT median term forecast Option 2a: reduction in fishing mortality by 10% in 2008, followed by a further reduction of 10% in 2009 (relative to 2008), then held constant for at the 2009 level for 2010 onwards.

	2007	2008	2009	2010
F2007 mult	1.000	0.900	0.810	0.810

Fbar(2-4)	Year			
Percentile	2007	2008	2009	2010
0.05	0.43	0.38	0.35	0.35
0.25	0.55	0.50	0.45	0.45
0.5	0.64	0.58	0.52	0.52
0.75	0.73	0.66	0.59	0.59
0.95	0.85	0.76	0.69	0.69

SSB	Year			
Percentile	2007	2008	2009	2010
0.05	31279	41103	50776	53538
0.25	34257	45702	61776	69965
0.5	36866	49941	70732	84626
0.75	39451	54424	81702	101361
0.95	43476	61750	101947	132513

Landings	Year			
Percentile	2007	2008	2009	2010
0.05	21258	29217	33190	35378
0.25	27234	35306	38312	41609
0.5	31788	38783	41992	47134
0.75	36979	42660	45979	53807
0.95	45039	48976	53389	64616

Discards	Year			
Percentile	2007	2008	2009	2010
0.05	20597	17458	17065	17758
0.25	26388	21704	20844	21797
0.5	30800	25198	24352	26523
0.75	35830	28747	30000	32449
0.95	43639	34803	40117	42452

P(SSBYear > SSB 2007)				
2008	2009	2010	2011	2012
0.99	1.00	1.00	1.00	1.00

In year SSB change			
	2007	2008	2009
Median	1.35	1.42	1.20
P25/P75	1.16	1.14	0.86

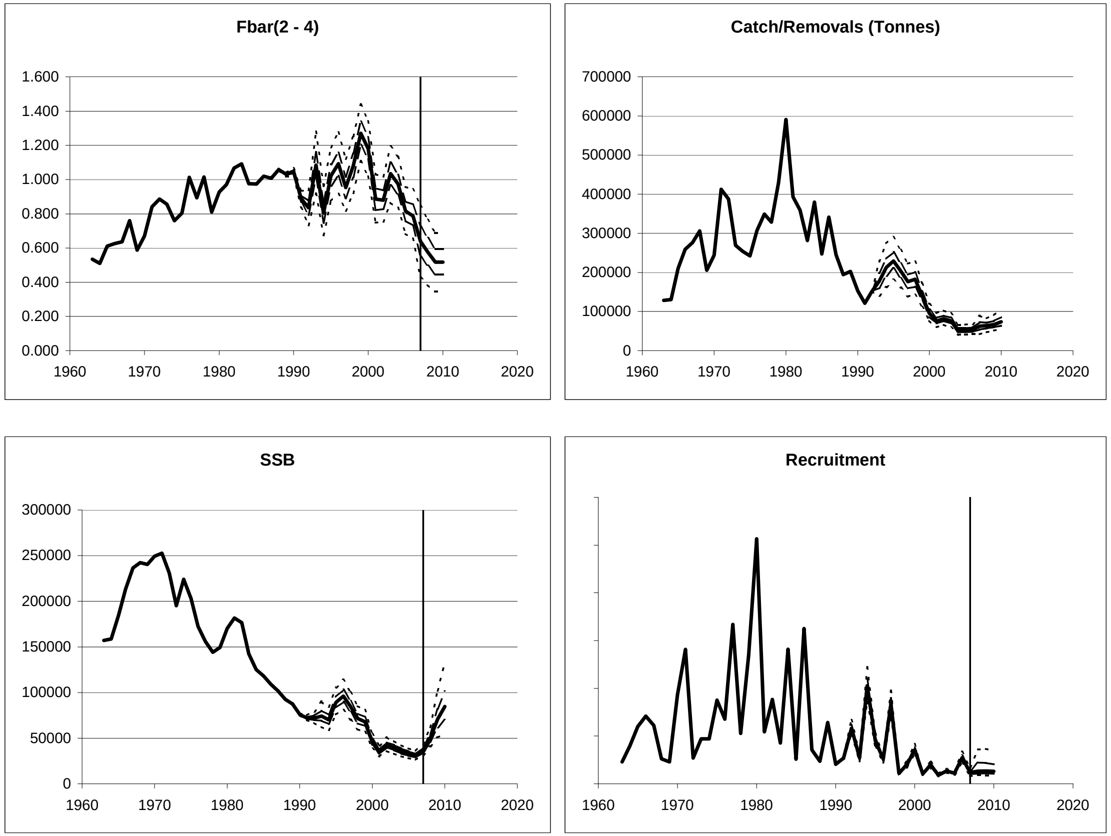


Table 14.14b Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. B-ADAPT median term forecast Option 2b: reduction in fishing mortality by 10% in 2008, followed by a further reduction of 15% in 2009 (relative to 2008), then held constant at the 2009 level for 2010 onwards.

	2007	2008	2009	2010
F2007 mult	1.000	0.900	0.765	0.765

Fbar(2-4)	Year			
Percentile	2007	2008	2009	2010
0.05	0.43	0.38	0.33	0.33
0.25	0.55	0.50	0.42	0.42
0.5	0.64	0.58	0.49	0.49
0.75	0.73	0.66	0.56	0.56
0.95	0.85	0.76	0.65	0.65

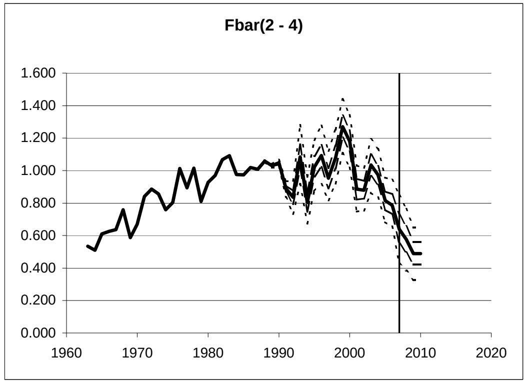
SSB	Year			
Percentile	2007	2008	2009	2010
0.05	31279	41103	50776	55558
0.25	34257	45702	61776	72412
0.5	36866	49941	70732	86909
0.75	39451	54424	81702	103961
0.95	43476	61750	101947	135439

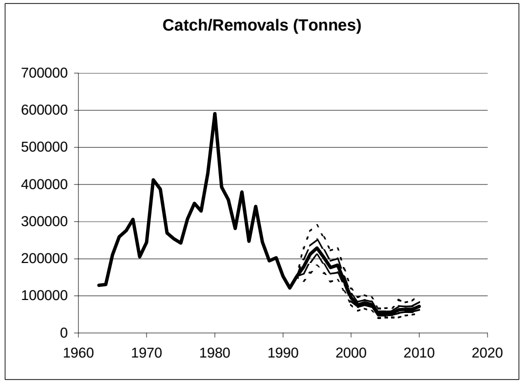
Landings	Year			
Percentile	2007	2008	2009	2010
0.05	21258	29217	31716	34851
0.25	27234	35306	36629	40760
0.5	31788	38783	40198	46181
0.75	36979	42660	43992	52733
0.95	45039	48976	51097	63320

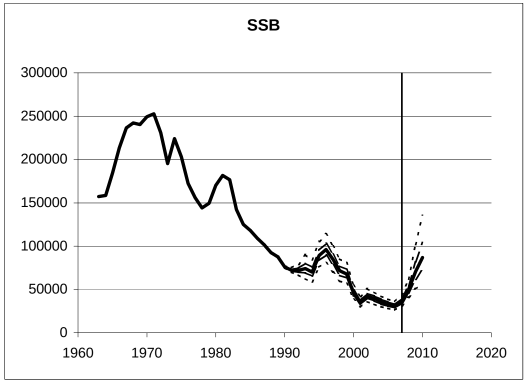
Discards	Year			
Percentile	2007	2008	2009	2010
0.05	20597	17458	16301	17174
0.25	26388	21704	19902	21205
0.5	30800	25198	23292	25799
0.75	35830	28747	28675	31440
0.95	43639	34803	38408	41338

P(SSBYear > SSB 2007)				
2008	2009	2010	2011	2012
0.99	1.00	1.00	1.00	1.00

In year SSB change			
	2007	2008	2009
Median	1.35	1.42	1.23
P25/P75	1.16	1.14	0.89







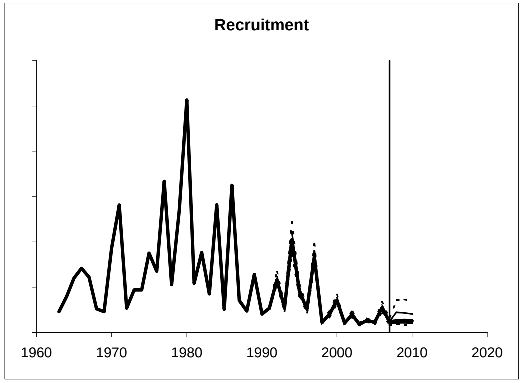


Table 14.14c Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. B-ADAPT median term forecast Option 2c: reduction in fishing mortality by 10% in 2008, followed by a further reduction of 20% in 2009 (relative to 2008), then held constant at the 2009 level for 2010 onwards.

	2007	2008	2009	2010
F2007 mult	1.000	0.900	0.720	0.720

Fbar(2-4)	Year			
Percentile	2007	2008	2009	2010
0.05	0.43	0.38	0.31	0.31
0.25	0.55	0.50	0.40	0.40
0.5	0.64	0.58	0.46	0.46
0.75	0.73	0.66	0.53	0.53
0.95	0.85	0.76	0.61	0.61

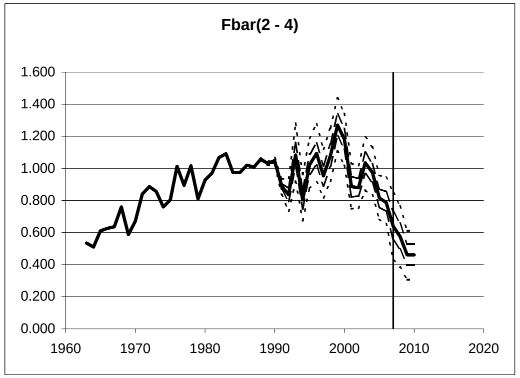
SSB	Year			
Percentile	2007	2008	2009	2010
0.05	31279	41103	50776	57662
0.25	34257	45702	61776	74763
0.5	36866	49941	70732	89502
0.75	39451	54424	81702	106476
0.95	43476	61750	101947	138299

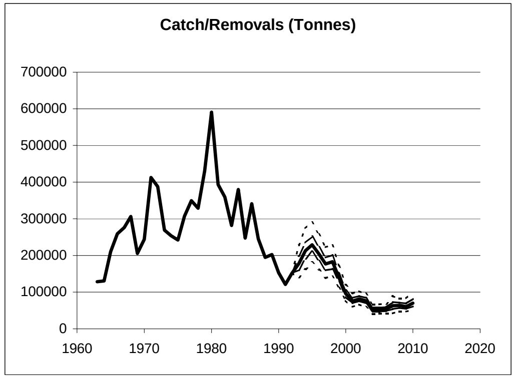
Landings	Year			
Percentile	2007	2008	2009	2010
0.05	21258	29217	30201	34188
0.25	27234	35306	34902	39926
0.5	31788	38783	38318	45075
0.75	36979	42660	42004	51637
0.95	45039	48976	48658	61878

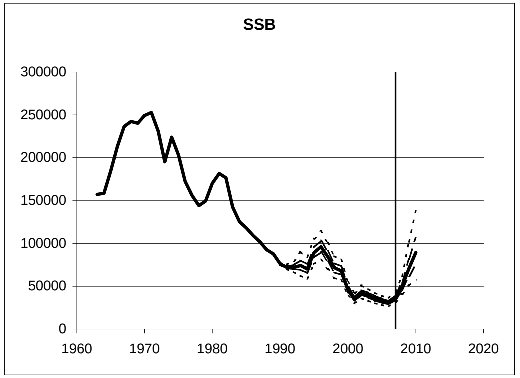
Discards	Year			
Percentile	2007	2008	2009	2010
0.05	20597	17458	15498	16592
0.25	26388	21704	18934	20465
0.5	30800	25198	22183	24975
0.75	35830	28747	27304	30498
0.95	43639	34803	36649	40012

P(SSBYear > SSB 2007)				
2008	2009	2010	2011	2012
0.99	1.00	1.00	1.00	1.00

In year SSB change			
	2007	2008	2009
Median	1.35	1.42	1.27
P25/P75	1.16	1.14	0.92







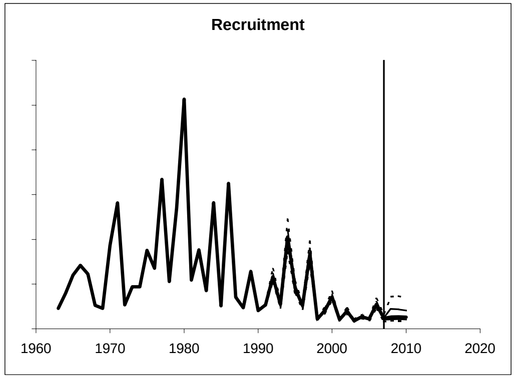


Table 14.14d Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. B-ADAPT median term forecast Option 2d: reduction in fishing mortality by 10% in 2008, followed by a further reduction of 25% in 2009 (relative to 2008), then held constant at the 2009 level for 2010 onwards.

	2007	2008	2009	2010
F2007 mult	1.000	0.900	0.675	0.675

Fbar(2-4)	Year			
Percentile	2007	2008	2009	2010
0.05	0.43	0.38	0.29	0.29
0.25	0.55	0.50	0.37	0.37
0.5	0.64	0.58	0.43	0.43
0.75	0.73	0.66	0.49	0.49
0.95	0.85	0.76	0.57	0.57

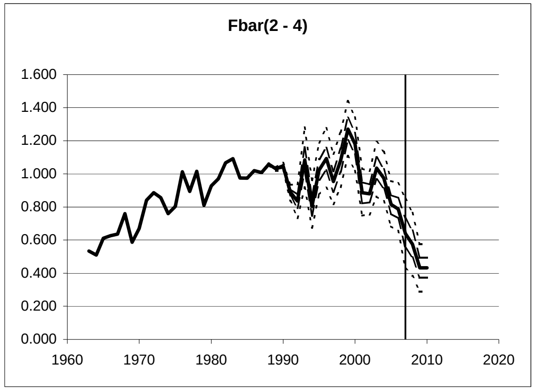
SSB	Year			
Percentile	2007	2008	2009	2010
0.05	31279	41103	50776	59842
0.25	34257	45702	61776	77234
0.5	36866	49941	70732	92098
0.75	39451	54424	81702	109025
0.95	43476	61750	101947	140939

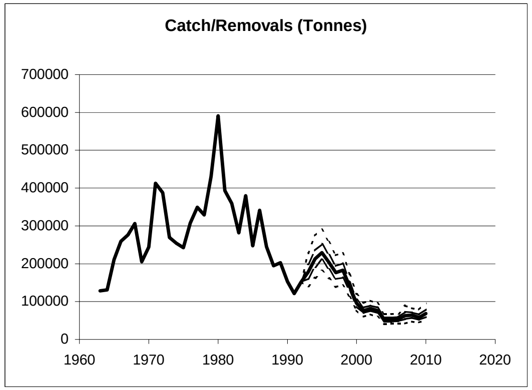
Landings	Year			
Percentile	2007	2008	2009	2010
0.05	21258	29217	28651	33479
0.25	27234	35306	33128	38929
0.5	31788	38783	36409	43857
0.75	36979	42660	39993	50444
0.95	45039	48976	46239	60522

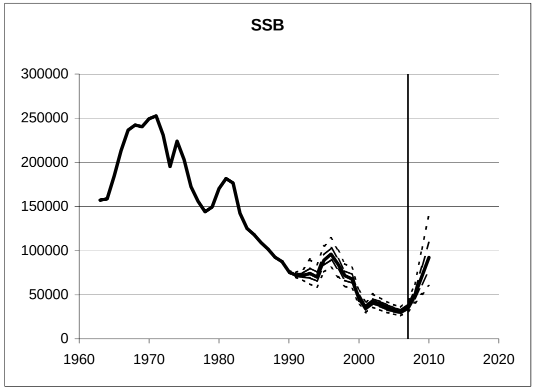
Discards	Year			
Percentile	2007	2008	2009	2010
0.05	20597	17458	14666	15946
0.25	26388	21704	17945	19695
0.5	30800	25198	21017	24090
0.75	35830	28747	25893	29390
0.95	43639	34803	34836	38577

P(SSBYear > SSB 2007)				
2008	2009	2010	2011	2012
0.99	1.00	1.00	1.00	1.00

In year SSB change			
	2007	2008	2009
Median	1.35	1.42	1.30
P25/P75	1.16	1.14	0.95







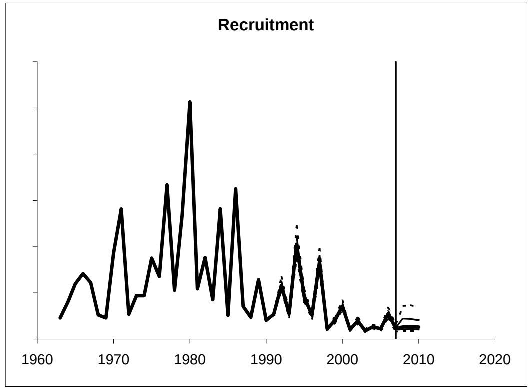


Table 14.14e Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. B-ADAPT median term forecast Option 2e: reduction in fishing mortality by 10% in 2008, followed by a further reduction of 30% in 2009 (relative to 2008), then held constant at the 2009 level for 2010 onwards.

	2007	2008	2009	2010
F2007 mult	1.000	0.900	0.630	0.630

Fbar(2-4)	Year			
Percentile	2007	2008	2009	2010
0.05	0.43	0.38	0.27	0.27
0.25	0.55	0.50	0.35	0.35
0.5	0.64	0.58	0.40	0.40
0.75	0.73	0.66	0.46	0.46
0.95	0.85	0.76	0.54	0.54

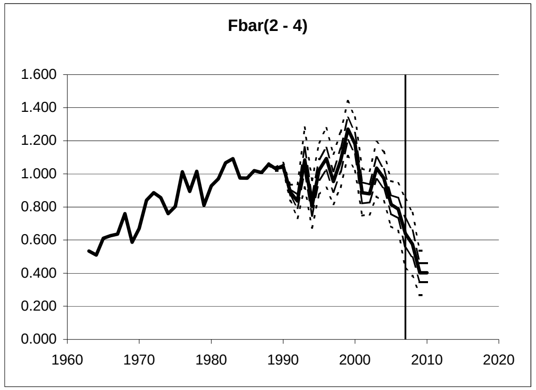
SSB	Year			
Percentile	2007	2008	2009	2010
0.05	31279	41103	50776	62103
0.25	34257	45702	61776	79763
0.5	36866	49941	70732	94762
0.75	39451	54424	81702	111855
0.95	43476	61750	101947	143345

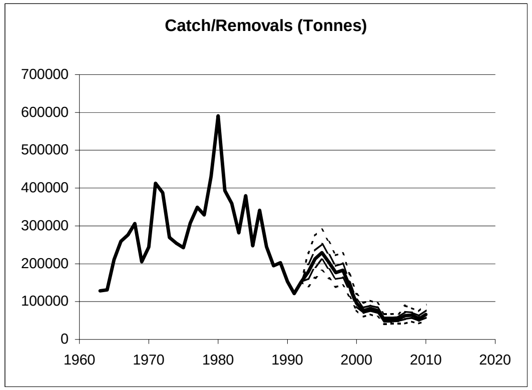
Landings	Year			
Percentile	2007	2008	2009	2010
0.05	21258	29217	27066	32528
0.25	27234	35306	31303	37726
0.5	31788	38783	34439	42516
0.75	36979	42660	37823	48869
0.95	45039	48976	43727	58797

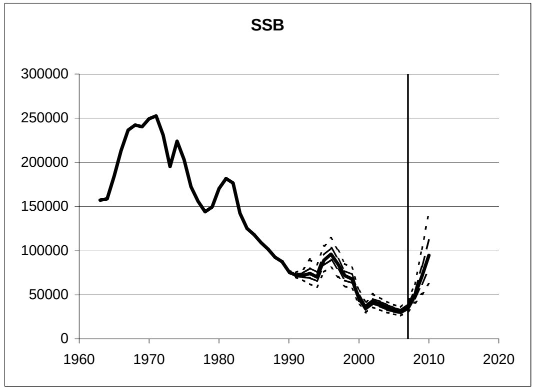
Discards	Year			
Percentile	2007	2008	2009	2010
0.05	20597	17458	13814	15228
0.25	26388	21704	16947	18879
0.5	30800	25198	19816	23178
0.75	35830	28747	24460	28206
0.95	43639	34803	32966	37036

P(SSBYear > SSB 2007)				
2008	2009	2010	2011	2012
0.99	1.00	1.00	1.00	1.00

In year SSB change			
	2007	2008	2009
Median	1.35	1.42	1.34
P25/P75	1.16	1.14	0.98







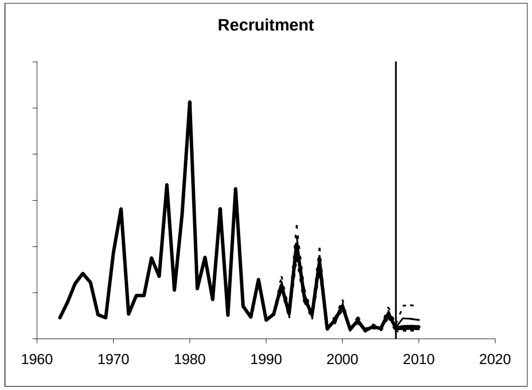


Table 14.15 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. B-ADAPT median term forecast Option 3: reduction in fishing mortality by 10% in 2008, followed by a further reduction to the target fishing mortality of 0.4 for 2009 onwards.

	2007	2008	2009	2010
F2007 mult	1.000	0.900	0.626	0.626

Fbar(2-4)	Year			
Percentile	2007	2008	2009	2010
0.05	0.43	0.38	0.27	0.27
0.25	0.55	0.50	0.35	0.35
0.5	0.64	0.58	0.40	0.40
0.75	0.73	0.66	0.46	0.46
0.95	0.85	0.76	0.53	0.53

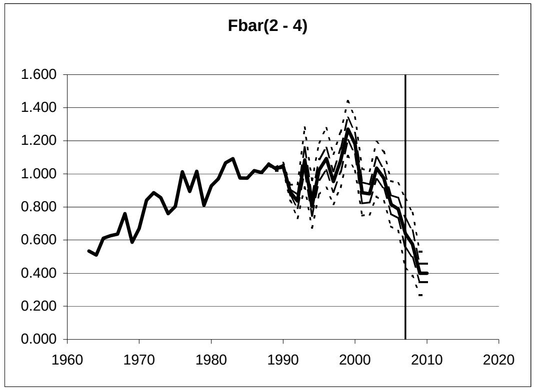
SSB	Year			
Percentile	2007	2008	2009	2010
0.05	31279	41103	50776	62309
0.25	34257	45702	61776	79985
0.5	36866	49941	70732	94997
0.75	39451	54424	81702	112108
0.95	43476	61750	101947	143617

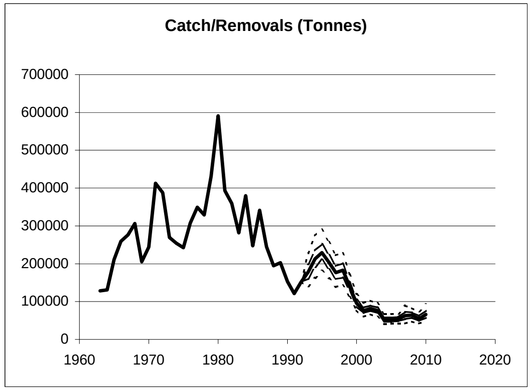
Landings	Year			
Percentile	2007	2008	2009	2010
0.05	21258	29217	26928	32427
0.25	27234	35306	31131	37624
0.5	31788	38783	34265	42386
0.75	36979	42660	37628	48712
0.95	45039	48976	43499	58647

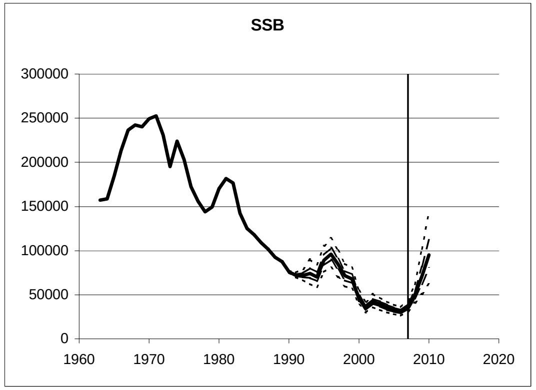
Discards	Year			
Percentile	2007	2008	2009	2010
0.05	20597	17458	13740	15156
0.25	26388	21704	16861	18819
0.5	30800	25198	19712	23089
0.75	35830	28747	24332	28109
0.95	43639	34803	32792	36894

P(SSBYear > SSB 2007)				
2008	2009	2010	2011	2012
0.99	1.00	1.00	1.00	1.00

In year SSB change			
	2007	2008	2009
Median	1.35	1.42	1.34
P25/P75	1.16	1.14	0.98







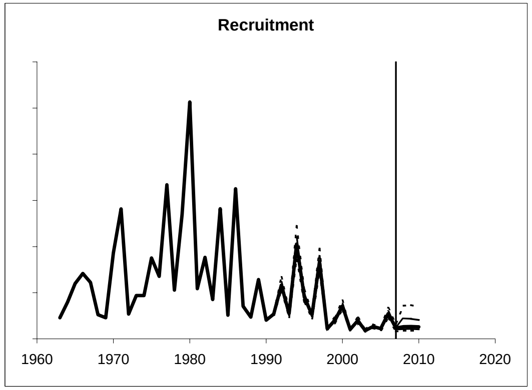


Table 14.16 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. B-ADAPT median term forecast Option 4: reduction in fishing mortality by 10% in 2008, followed by a closure of the fishery from 2009 onwards.

	2007	2008	2009	2010
F2007 mult	1.000	0.900	0.000	0.000

Fbar(2-4)	Year			
Percentile	2007	2008	2009	2010
0.05	0.43	0.38	0.00	0.00
0.25	0.55	0.50	0.00	0.00
0.5	0.64	0.58	0.00	0.00
0.75	0.73	0.66	0.00	0.00
0.95	0.85	0.76	0.00	0.00

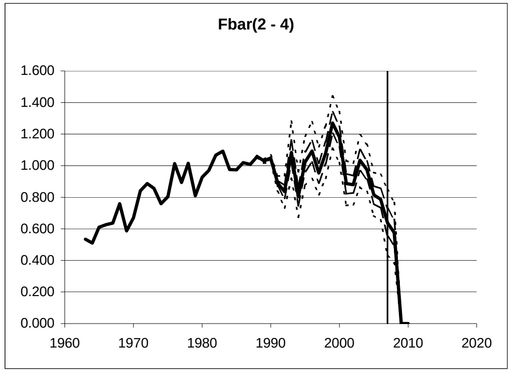
SSB	Year			
Percentile	2007	2008	2009	2010
0.05	31279	41103	50776	104305
0.25	34257	45702	61776	125408
0.5	36866	49941	70732	141890
0.75	39451	54424	81702	161634
0.95	43476	61750	101947	195424

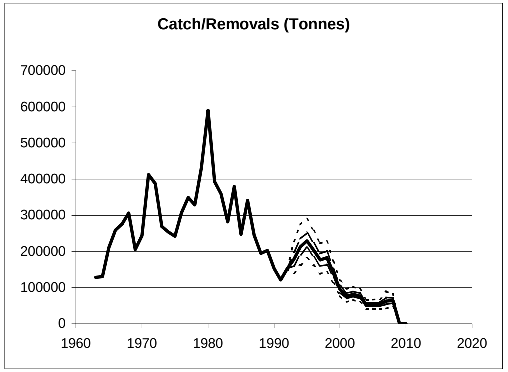
Landings	Year			
Percentile	2007	2008	2009	2010
0.05	21258	29217	0	0
0.25	27234	35306	0	0
0.5	31788	38783	0	0
0.75	36979	42660	0	0
0.95	45039	48976	0	0

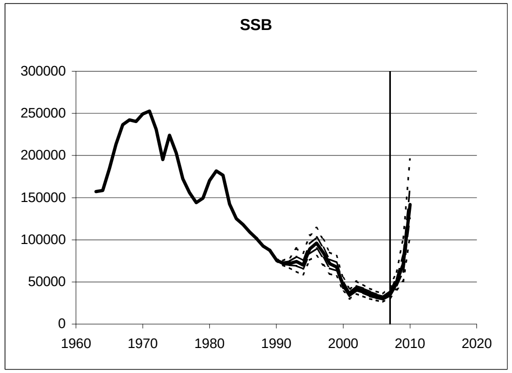
Discards	Year			
Percentile	2007	2008	2009	2010
0.05	20597	17458	0	0
0.25	26388	21704	0	0
0.5	30800	25198	0	0
0.75	35830	28747	0	0
0.95	43639	34803	0	0

P(SSBYear > SSB 2007)				
2008	2009	2010	2011	2012
0.99	1.00	1.00	1.00	1.00

In year SSB change			
	2007	2008	2009
Median	1.35	1.42	2.01
P25/P75	1.16	1.14	1.53







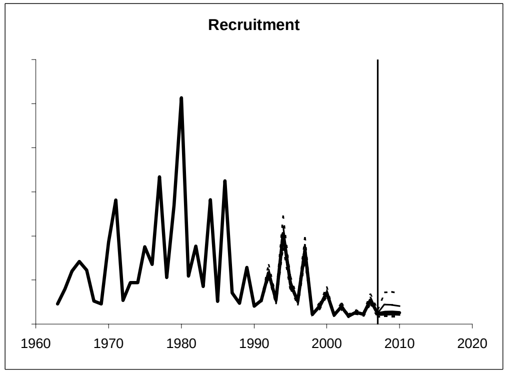


Table 14.17 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. B-ADAPT median term forecast Option 5: reduction in fishing mortality by 10% in 2008, followed by a further reduction in F in 2009 that results in landings in 2009 equal to 1.15 times the TAC in 2008, then holding F constant at the 2009 level for 2010 onwards.

	2007	2008	2009	2010
F2007 mult	1.000	0.900	0.513	0.513

Fbar(2-4)	Year			
Percentile	2007	2008	2009	2010
0.05	0.43	0.38	0.22	0.22
0.25	0.55	0.50	0.28	0.28
0.5	0.64	0.58	0.33	0.33
0.75	0.73	0.66	0.37	0.37
0.95	0.85	0.76	0.44	0.44

SSB	Year			
Percentile	2007	2008	2009	2010
0.05	31279	41103	50776	68437
0.25	34257	45702	61776	86607
0.5	36866	49941	70732	102145
0.75	39451	54424	81702	119718
0.95	43476	61750	101947	151104

Landings	Year			
Percentile	2007	2008	2009	2010
0.05	21258	29217	22700	29077
0.25	27234	35306	26367	33950
0.5	31788	38783	29115	38241
0.75	36979	42660	31905	44118
0.95	45039	48976	36861	53427

Discards	Year			
Percentile	2007	2008	2009	2010
0.05	20597	17458	11526	13222
0.25	26388	21704	14232	16537
0.5	30800	25198	16632	20382
0.75	35830	28747	20520	24782
0.95	43639	34803	27753	32488

P(SSBYear > SSB 2007)				
2008	2009	2010	2011	2012
0.99	1.00	1.00	1.00	1.00

In year SSB change			
	2007	2008	2009
Median	1.35	1.42	1.44
P25/P75	1.16	1.14	1.06

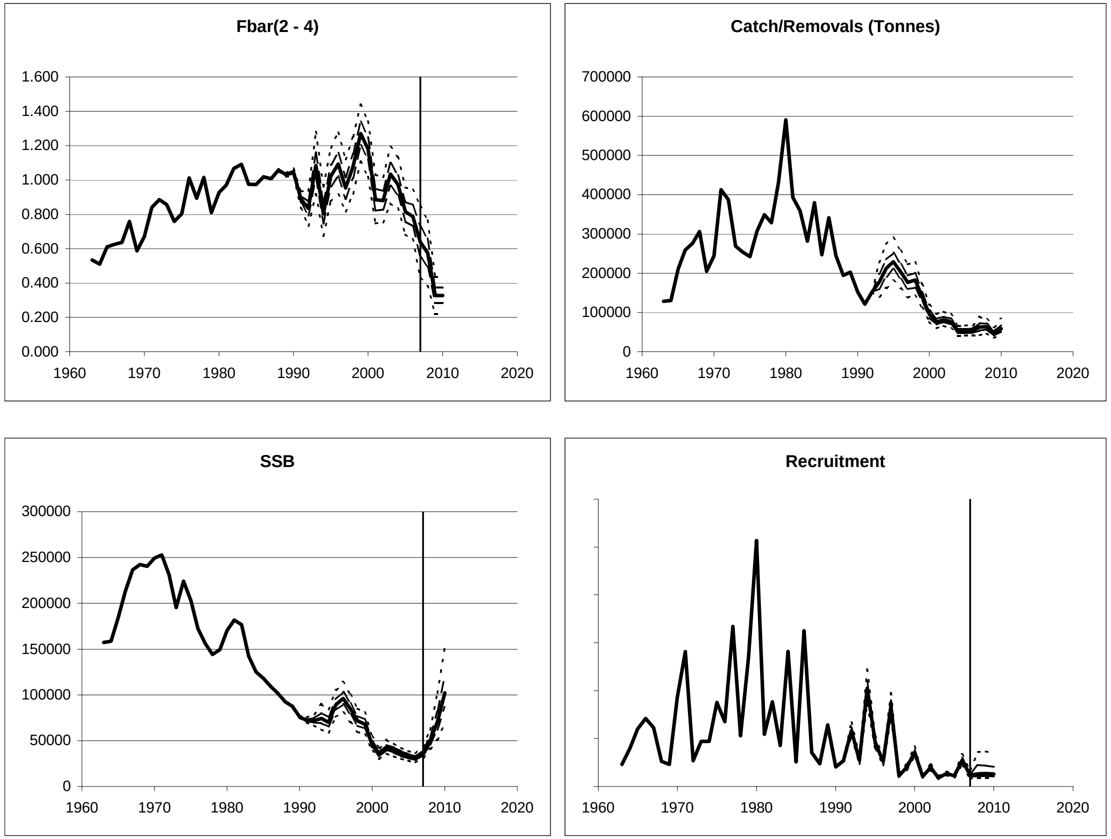


Table 14.18 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. B-ADAPT median term forecast Option 6: reduction in fishing mortality by 10% in 2008, followed by further reductions of 15% in 2009 and 2010, each relative to the preceding year, and then setting F=0.4 from 2011 onwards (this option mimics the Commission's proposed amendments to the Cod Recovery Plan of April 2008).

	2007	2008	2009	2010
F2007 mult	1.000	0.900	0.765	0.650

Fbar(2-4)	Year			
Percentile	2007	2008	2009	2010
0.05	0.43	0.38	0.33	0.28
0.25	0.55	0.50	0.42	0.36
0.5	0.64	0.58	0.49	0.42
0.75	0.73	0.66	0.56	0.48
0.95	0.85	0.76	0.65	0.55

SSB	Year			
Percentile	2007	2008	2009	2010
0.05	31279	41103	50776	55558
0.25	34257	45702	61776	72412
0.5	36866	49941	70732	86909
0.75	39451	54424	81702	103961
0.95	43476	61750	101947	135439

Landings	Year			
Percentile	2007	2008	2009	2010
0.05	21258	29217	31716	30669
0.25	27234	35306	36629	35831
0.5	31788	38783	40198	40454
0.75	36979	42660	43992	46374
0.95	45039	48976	51097	55563

Discards	Year			
Percentile	2007	2008	2009	2010
0.05	20597	17458	16301	14980
0.25	26388	21704	19902	18469
0.5	30800	25198	23292	22566
0.75	35830	28747	28675	27567
0.95	43639	34803	38408	36240

P(SSBYear > SSB 2007)				
2008	2009	2010	2011	2012
0.99	1.00	1.00	1.00	1.00

In year SSB change			
	2007	2008	2009
Median	1.35	1.42	1.23
P25/P75	1.16	1.14	0.89

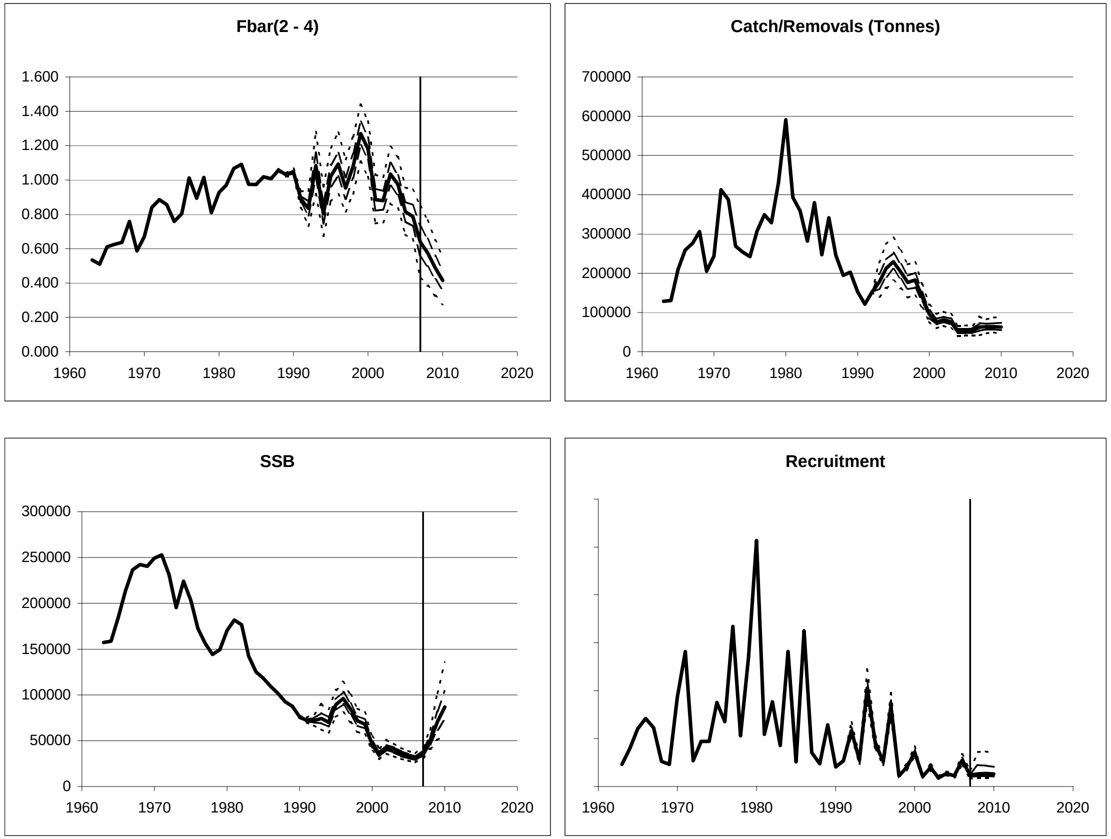


Table 14.19 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. B-ADAPT median term forecast summary of options 1-6, ordered by size of F-multiplier assumed for 2009-10 for options 1-4, with options 5 and 6 given in the final columns.

			Option 1		Option 2a		Option 2b		Option 2c		Option 2d		Option 2e		Option 3		Option 4	
	2007	2008	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010
F2007 mult	1.000	0.900	0.900	0.900	0.810	0.810	0.765	0.765	0.720	0.720	0.675	0.675	0.630	0.630	0.626	0.626	0.000	0.000
			cut in F = 0%		cut in F = 10%		cut in F = 15%		cut in F = 20%		cut in F = 25%		cut in F = 30%		F = 0.4		F = 0	

Fbar(2-4)		Year																
Percentile	2007	2008	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010
0.05	0.43	0.38	0.38	0.38	0.35	0.35	0.33	0.33	0.31	0.31	0.29	0.29	0.27	0.27	0.27	0.27	0.00	0.00
0.25	0.55	0.50	0.50	0.50	0.45	0.45	0.42	0.42	0.40	0.40	0.37	0.37	0.35	0.35	0.35	0.35	0.00	0.00
0.5	0.64	0.58	0.58	0.58	0.52	0.52	0.49	0.49	0.46	0.46	0.43	0.43	0.40	0.40	0.40	0.40	0.00	0.00
0.75	0.73	0.66	0.66	0.66	0.59	0.59	0.56	0.56	0.53	0.53	0.49	0.49	0.46	0.46	0.46	0.46	0.00	0.00
0.95	0.85	0.76	0.76	0.76	0.69	0.69	0.65	0.65	0.61	0.61	0.57	0.57	0.54	0.54	0.53	0.53	0.00	0.00

SSB		Year																
Percentile	2007	2008	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010
0.05	31279	41103	50776	49926	50776	53538	50776	55558	50776	57662	50776	59842	50776	62103	50776	62309	50776	104305
0.25	34257	45702	61776	65729	61776	69965	61776	72412	61776	74763	61776	77234	61776	79763	61776	79985	61776	125408
0.5	36866	49941	70732	79623	70732	84626	70732	86909	70732	89502	70732	92098	70732	94762	70732	94997	70732	141890
0.75	39451	54424	81702	96384	81702	101361	81702	103961	81702	106476	81702	109025	81702	111855	81702	112108	81702	161634
0.95	43476	61750	101947	127685	101947	132513	101947	135439	101947	138299	101947	140939	101947	143345	101947	143617	101947	195424

Landings		Year																
Percentile	2007	2008	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010
0.05	21258	29217	36039	36297	33190	35378	31716	34851	30201	34188	28651	33479	27066	32528	26928	32427	0	0
0.25	27234	35306	41528	42717	38312	41609	36629	40760	34902	39926	33128	38929	31303	37726	31131	37624	0	0
0.5	31788	38783	45474	48238	41992	47134	40198	46181	38318	45075	36409	43857	34439	42516	34265	42386	0	0
0.75	36979	42660	49807	55432	45979	53807	43992	52733	42004	51637	39993	50444	37823	48869	37628	48712	0	0
0.95	45039	48976	57631	66525	53389	64616	51097	63320	48658	61878	46239	60522	43727	58797	43499	58647	0	0

Discards		Year																
Percentile	2007	2008	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010
0.05	20597	17458	18601	18661	17065	17758	16301	17174	15498	16592	14666	15946	13814	15228	13740	15156	0	0
0.25	26388	21704	22662	22982	20844	21797	19902	21205	18934	20465	17945	19695	16947	18879	16861	18819	0	0
0.5	30800	25198	26478	27893	24352	26523	23292	25799	22183	24975	21017	24090	19816	23178	19712	23089	0	0
0.75	35830	28747	32567	33980	30000	32449	28675	31440	27304	30498	25893	29390	24460	28206	24332	28109	0	0
0.95	43639	34803	43448	44642	40117	42452	38408	41338	36649	40012	34836	38577	32966	37036	32792	36894	0	0

P(SSBYear > SSB 2007)																		
2008	2009	2010	2011	2012	2011	2012	2011	2012	2011	2012	2011	2012	2011	2012	2011	2012	2011	2012
0.99	1.00	0.99	0.98	0.98	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

In year SSB change									
	2007	2008	2009	2009	2009	2009	2009	2009	2009	2009
Median	1.35	1.42	1.13	1.20	1.23	1.27	1.30	1.34	1.34	2.01
P25/P75	1.16	1.14	0.80	0.86	0.89	0.92	0.95	0.98	0.98	1.53

Table 14.19 (Cont'd)

Option 5		Option 6	
2009	2010	2009	2010
0.513	0.513	0.765	0.650

tac09 = 1.15*tac08		Amend Rec Plan	
2009	2010	2009	2010
0.22	0.22	0.33	0.28
0.28	0.28	0.42	0.36
0.33	0.33	0.49	0.42
0.37	0.37	0.56	0.48
0.44	0.44	0.65	0.55

2009	2010	2009	2010
50776	68437	50776	55558
61776	86607	61776	72412
70732	102145	70732	86909
81702	119718	81702	103961
101947	151104	101947	135439

2009	2010	2009	2010
22700	29077	31716	30669
26367	33950	36629	35831
29115	38241	40198	40454
31905	44118	43992	46374
36861	53427	51097	55563

2009	2010	2009	2010
11526	13222	16301	14980
14232	16537	19902	18469
16632	20382	23292	22566
20520	24782	28675	27567
27753	32488	38408	36240

2011	2012	2011	2012
1.00	1.00	1.00	1.00

2009	2009
1.44	1.23
1.06	0.89

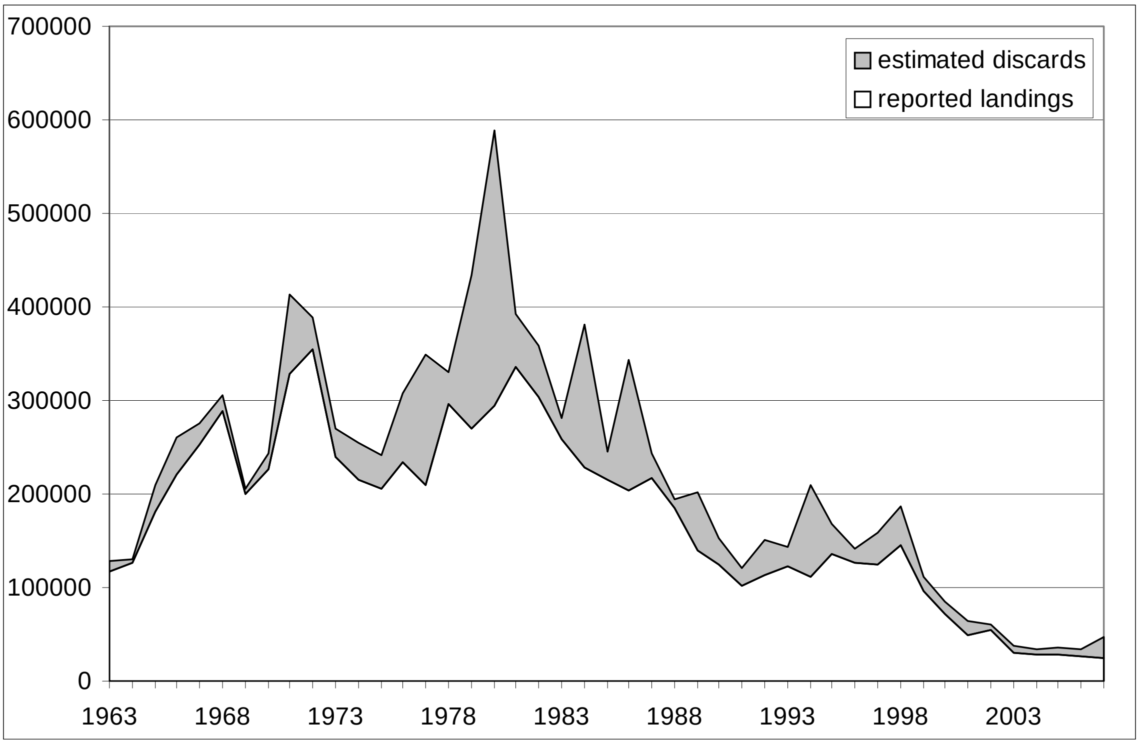


Figure 14.1a Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId: Stacked area plot of reported landings and estimated discards (in tons).

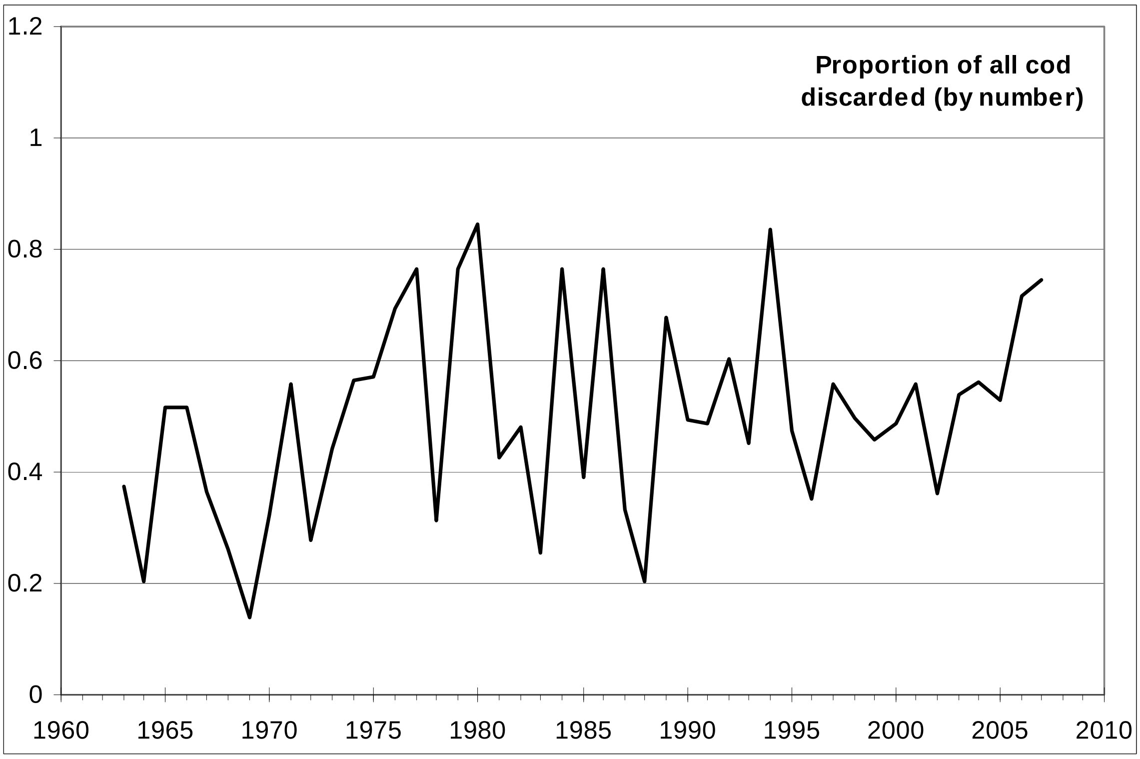


Figure 14.1b Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId: Proportion of total numbers caught that are discarded.

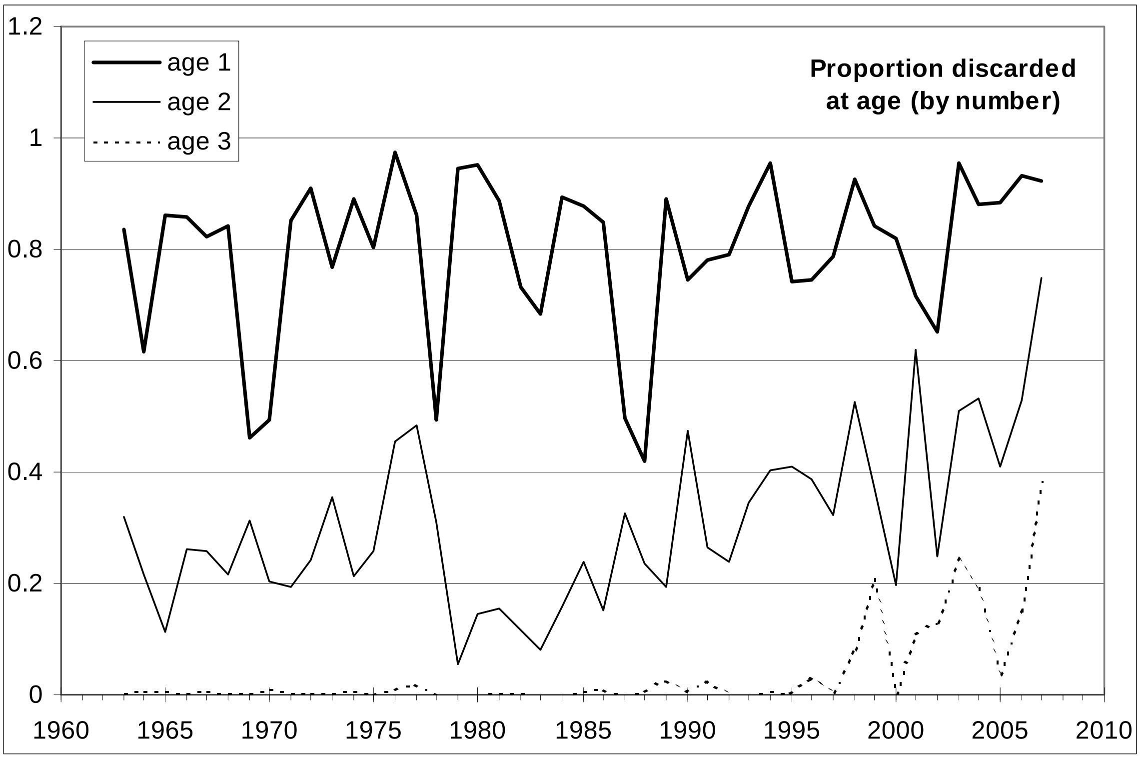


Figure 14.1c Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId: Proportion of total numbers caught at age that are discarded.

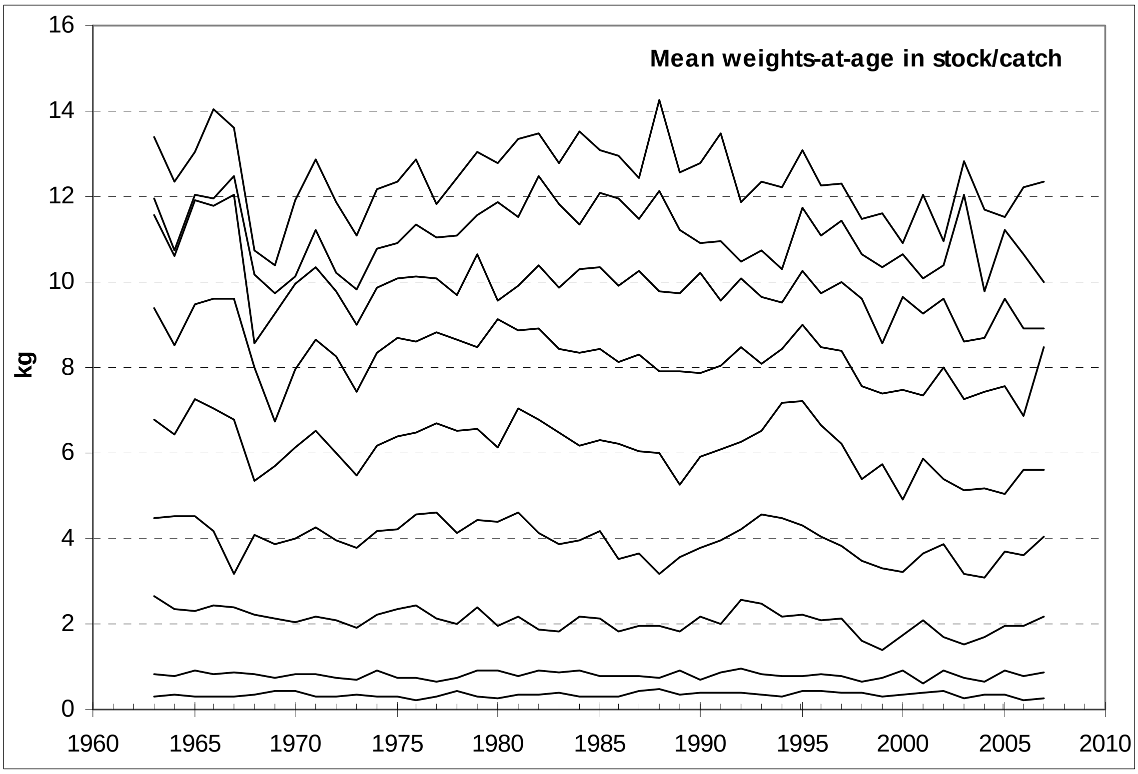


Figure 14.2 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId: Mean weight at age in the catch for ages 1-9.

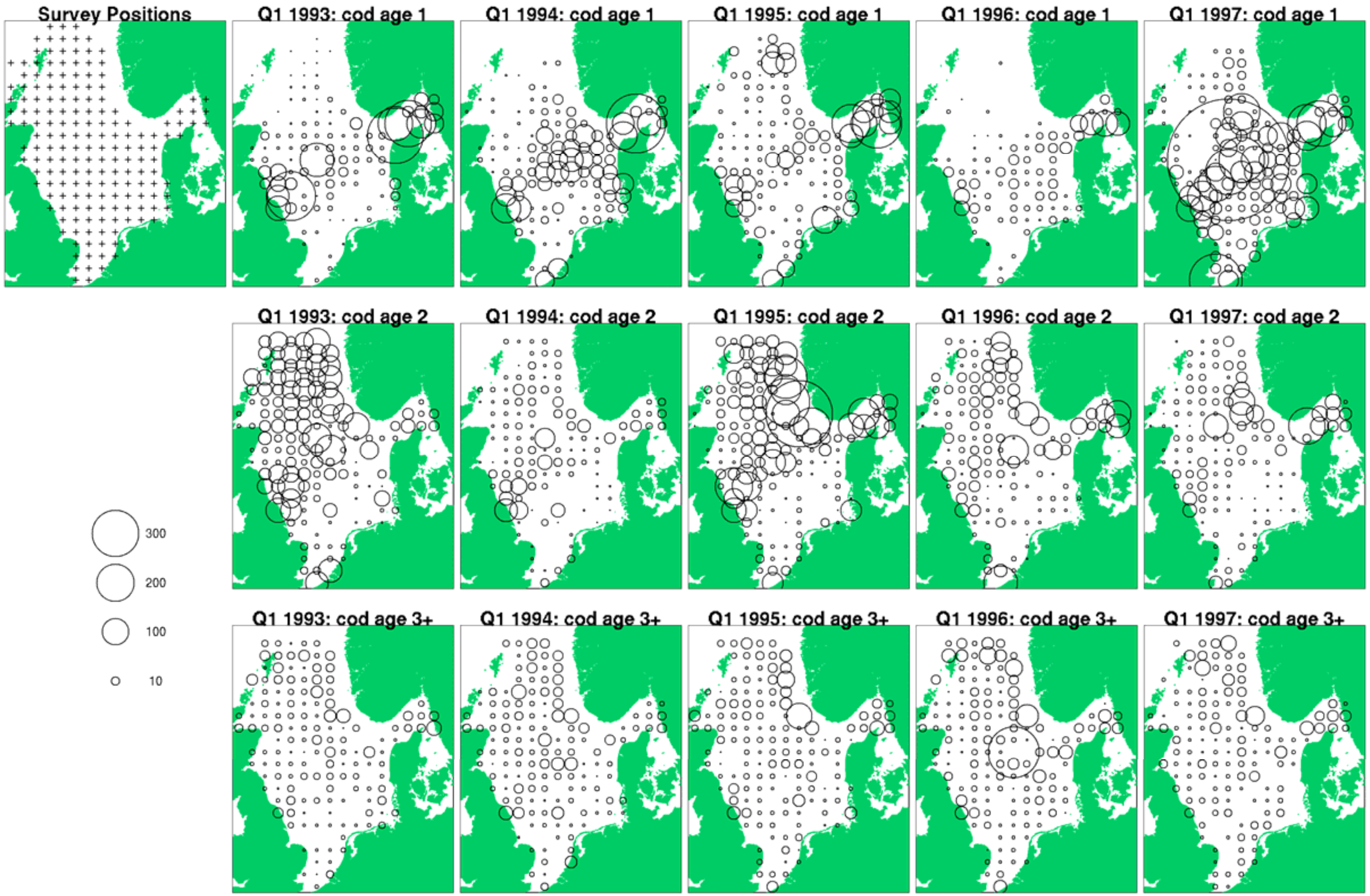


Figure 14.3(a) Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Distribution charts of cod ages 1-3+ caught in the IBTS Q1 survey 1993-2008 in the North Sea.

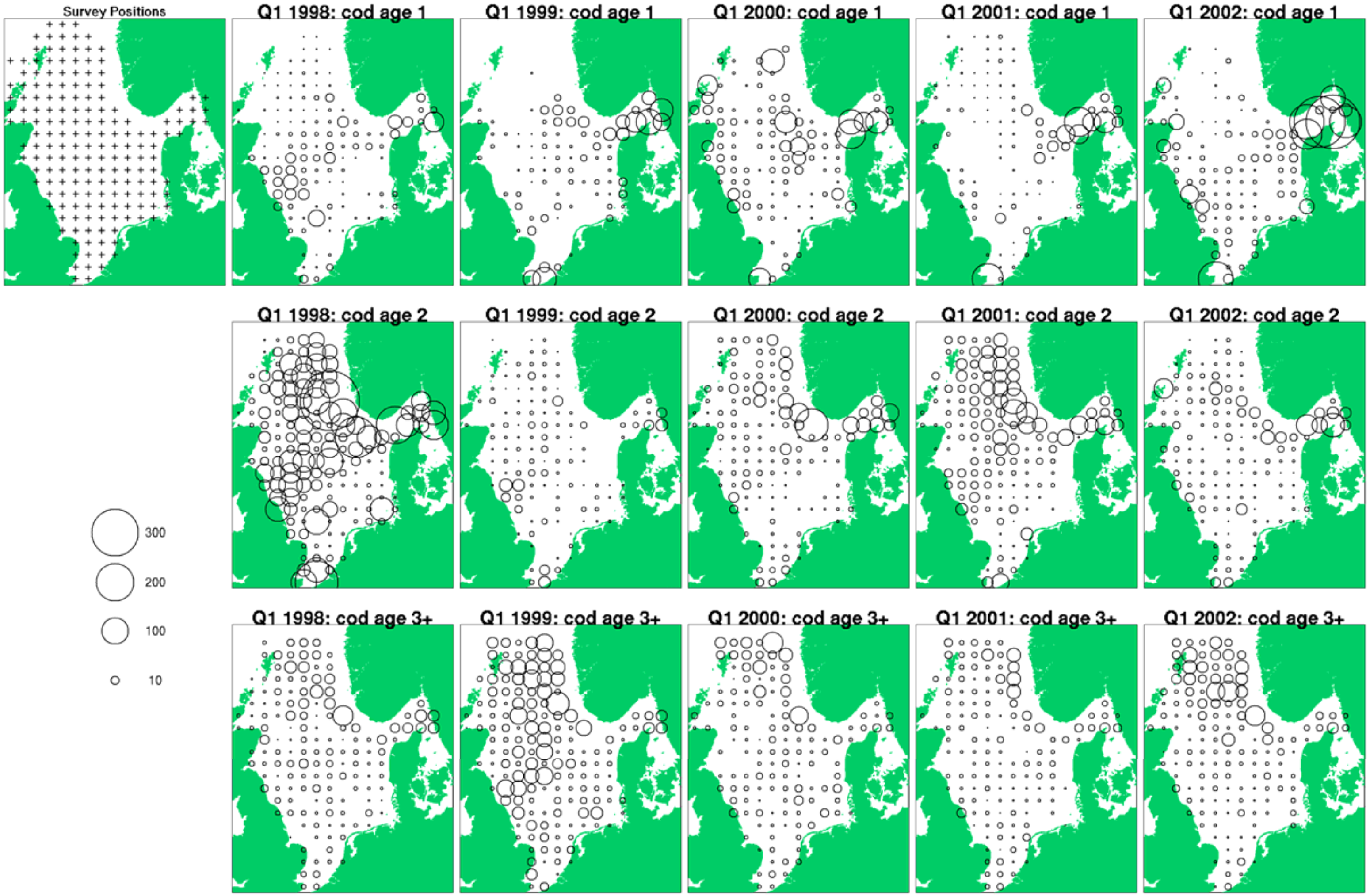


Figure 14.3(a) contd. Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Distribution charts of cod ages 1-3+ caught in the IBTS Q1 survey 1993-2008 in the North Sea.

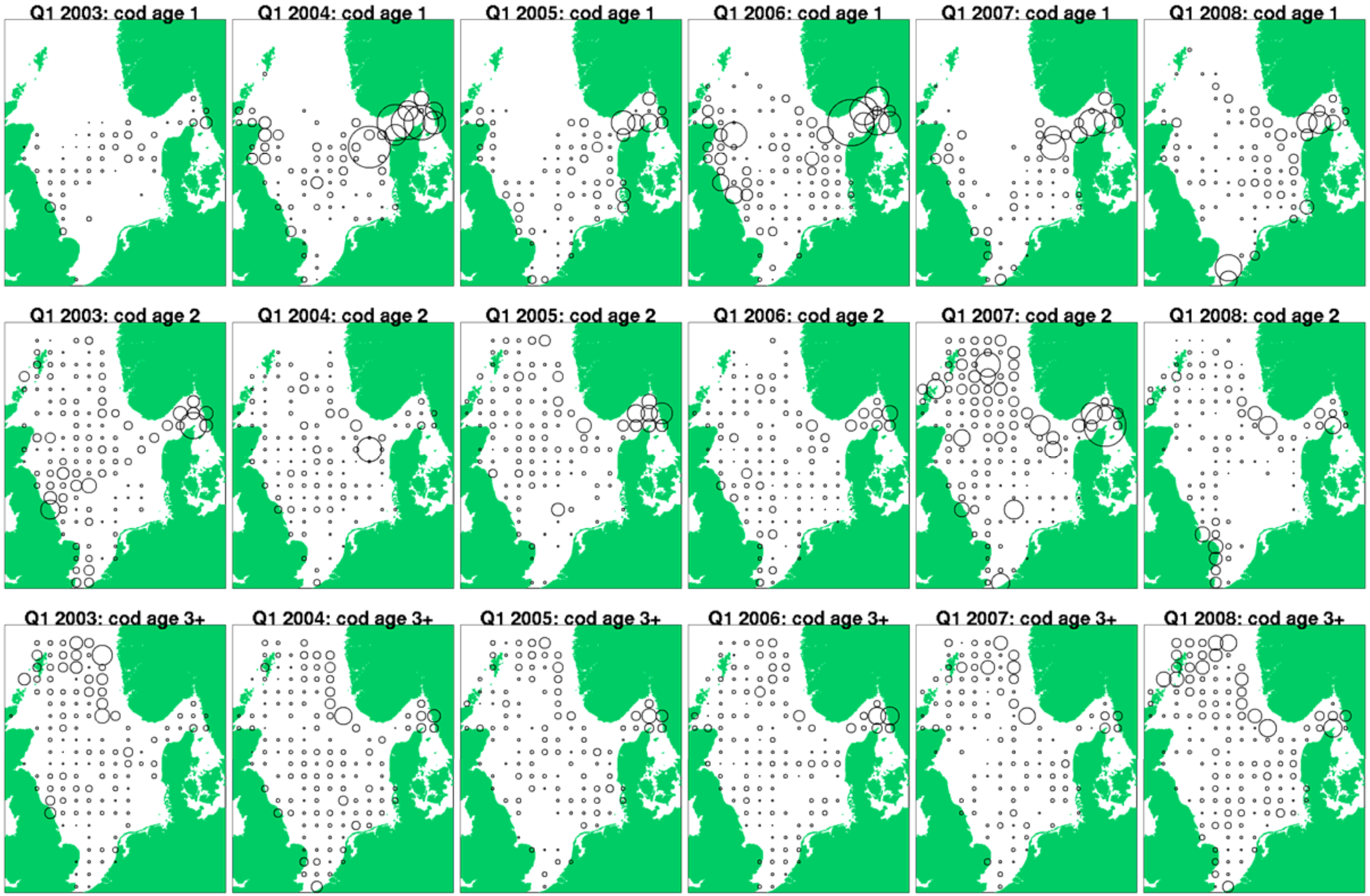


Figure 14.3(a) contd. Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Distribution charts of cod ages 1-3+ caught in the IBTS Q1 survey 1993-2008 in the North Sea.

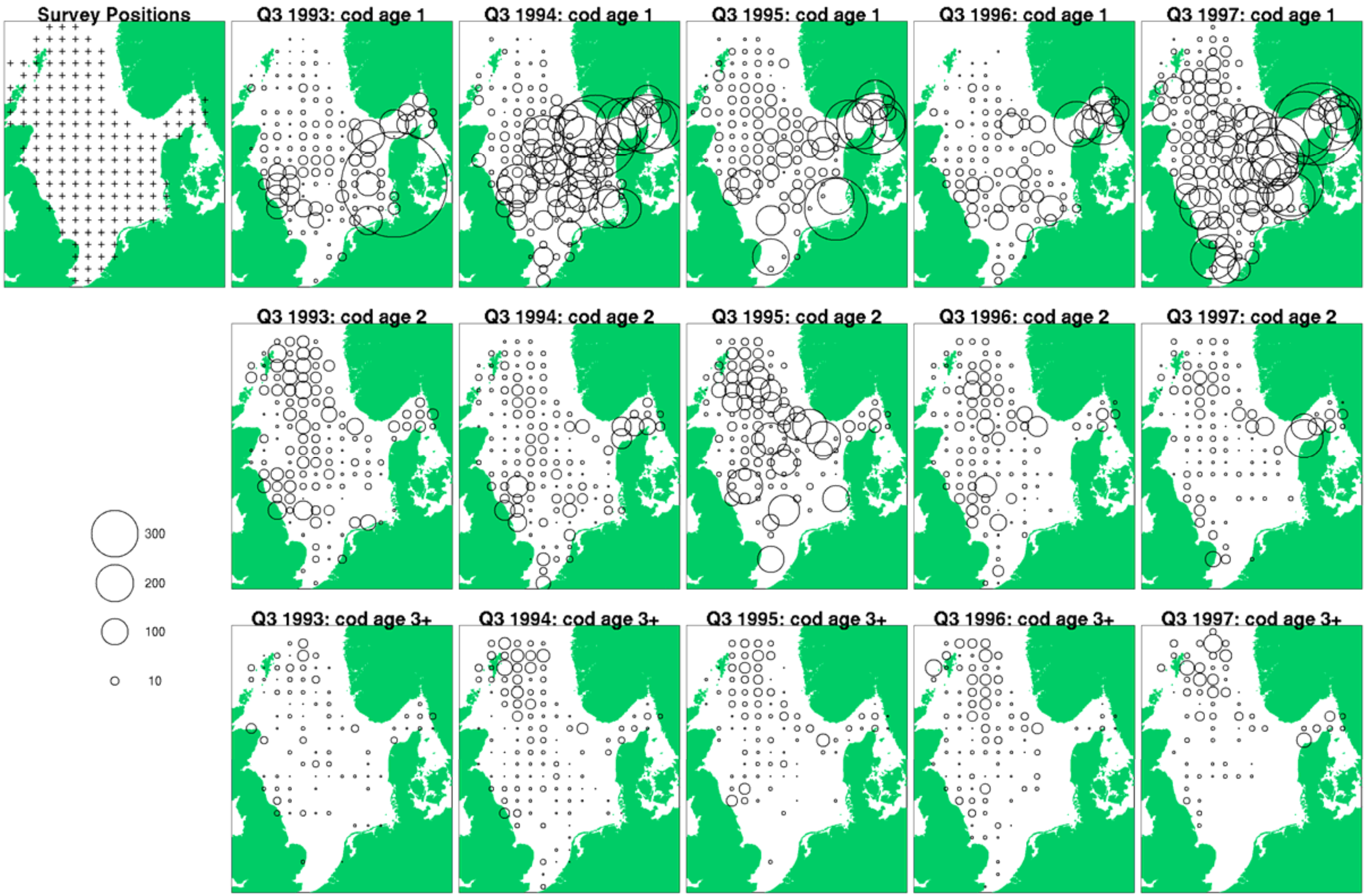


Figure 14.3(b). Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Distribution charts of cod ages 1-3+ caught in the IBTS Q3 survey 1993-2007 in the North Sea.

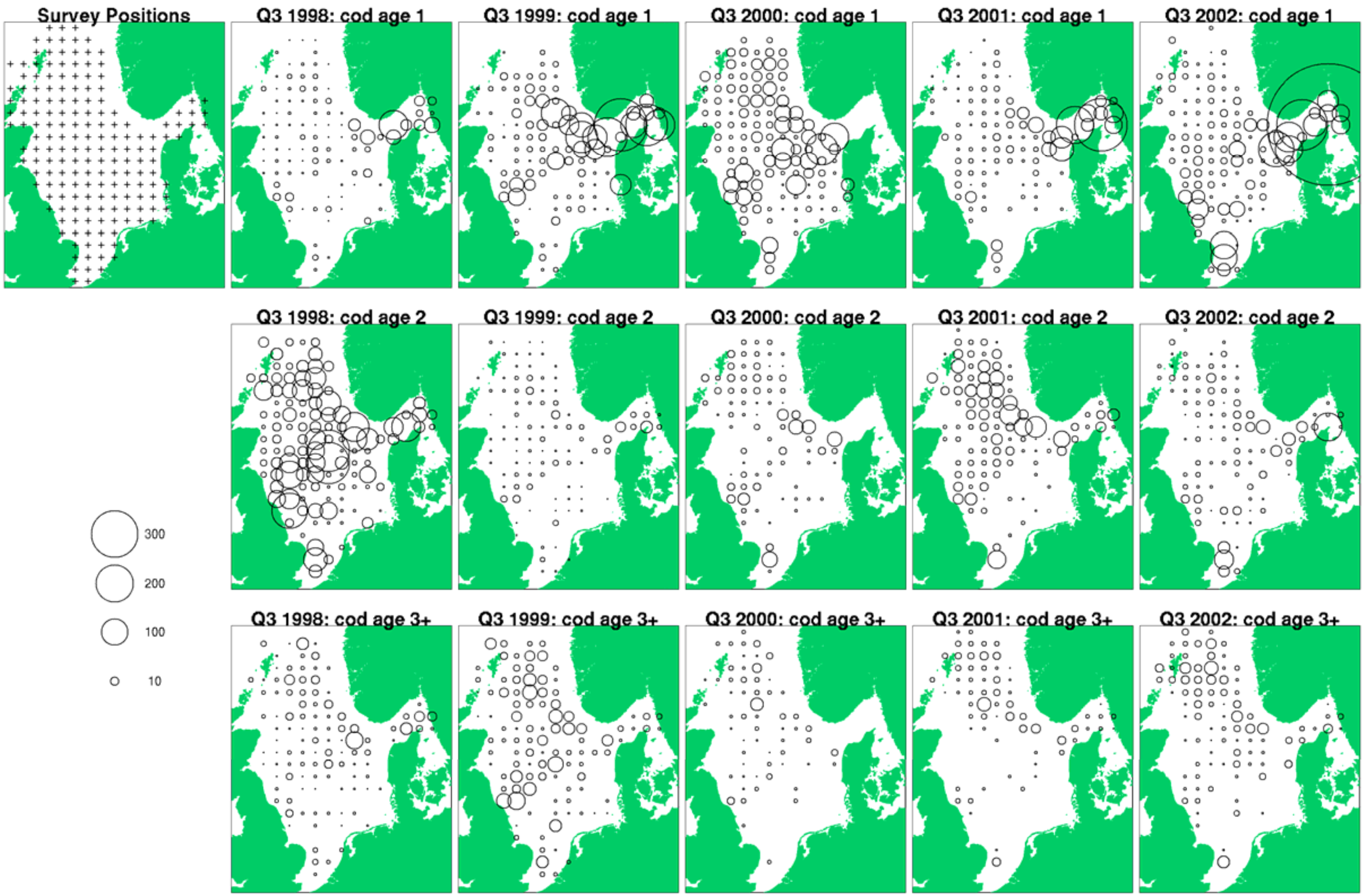


Figure 14.3(b) contd. Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Distribution charts of cod ages 1-3+ caught in the IBTS Q3 survey 1993-2007 in the North Sea.

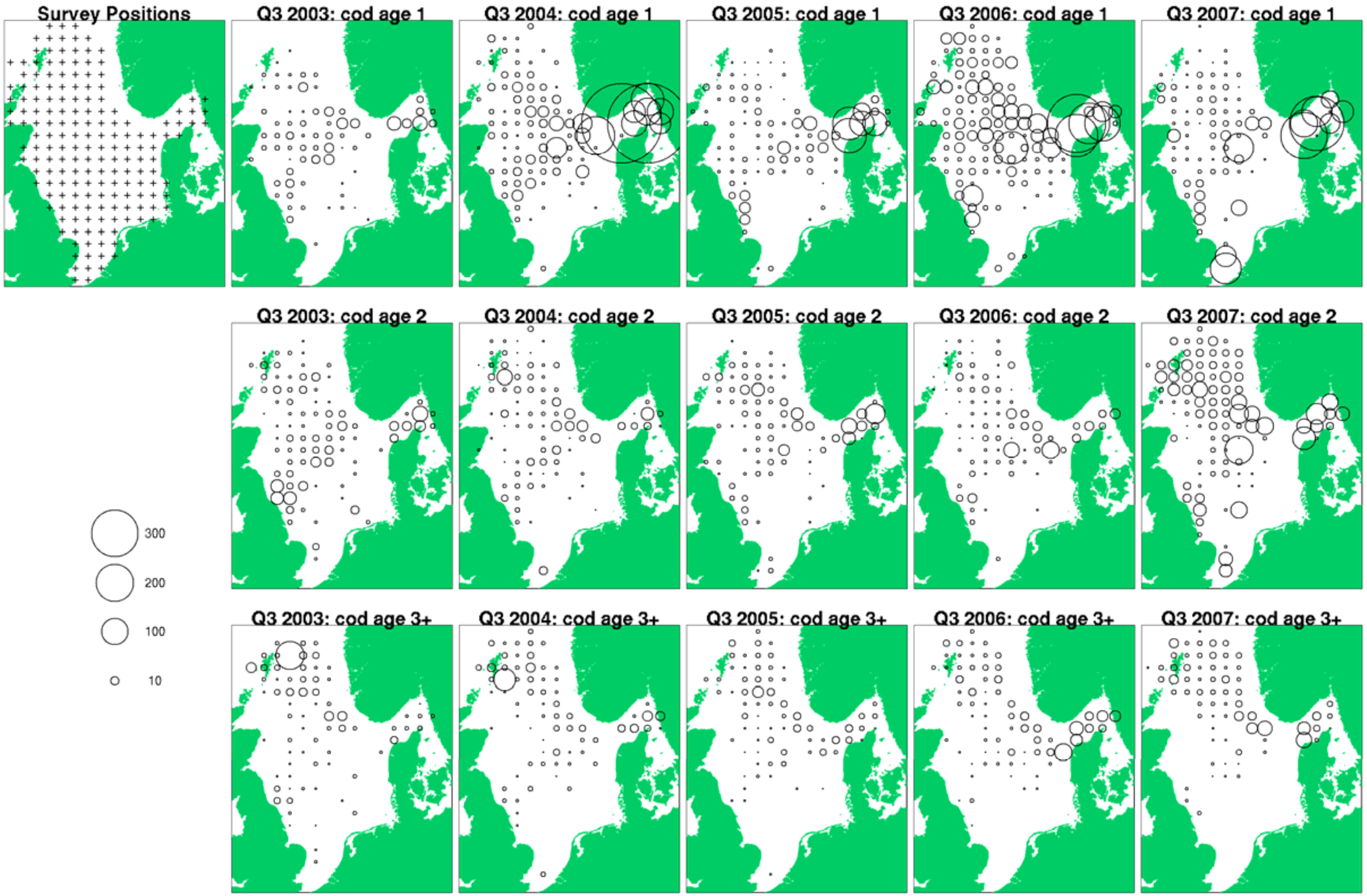


Figure 14.3(b) contd. Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Distribution charts of cod ages 1-3+ caught in the IBTS Q3 survey 1993-2007 in the North Sea.

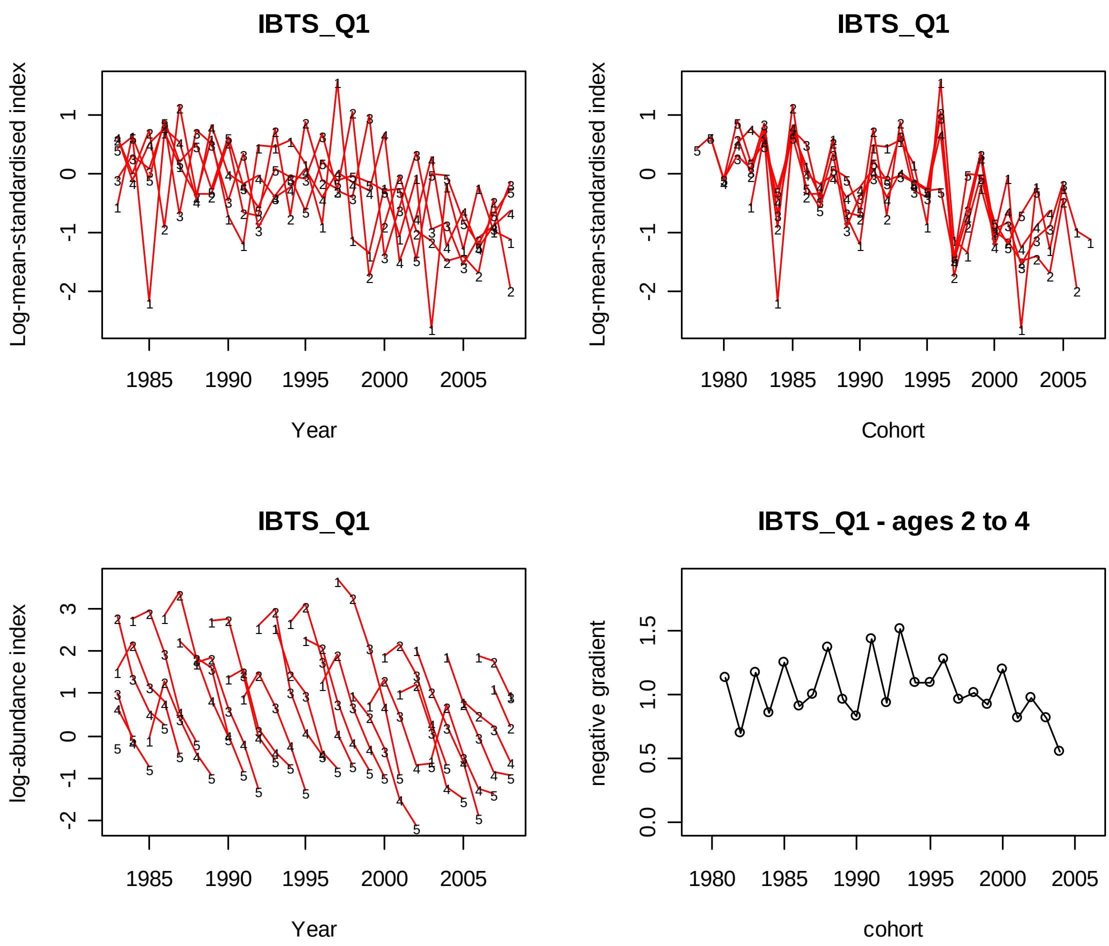


Figure 14.4a Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Log mean standardised indices plotted by year (top left) and cohort (top right), log abundance curves (bottom left) and associated negative gradients for each cohort across the reference fishing mortality of age 2-4 (bottom right), for the IBTSQ1 groundfish survey.

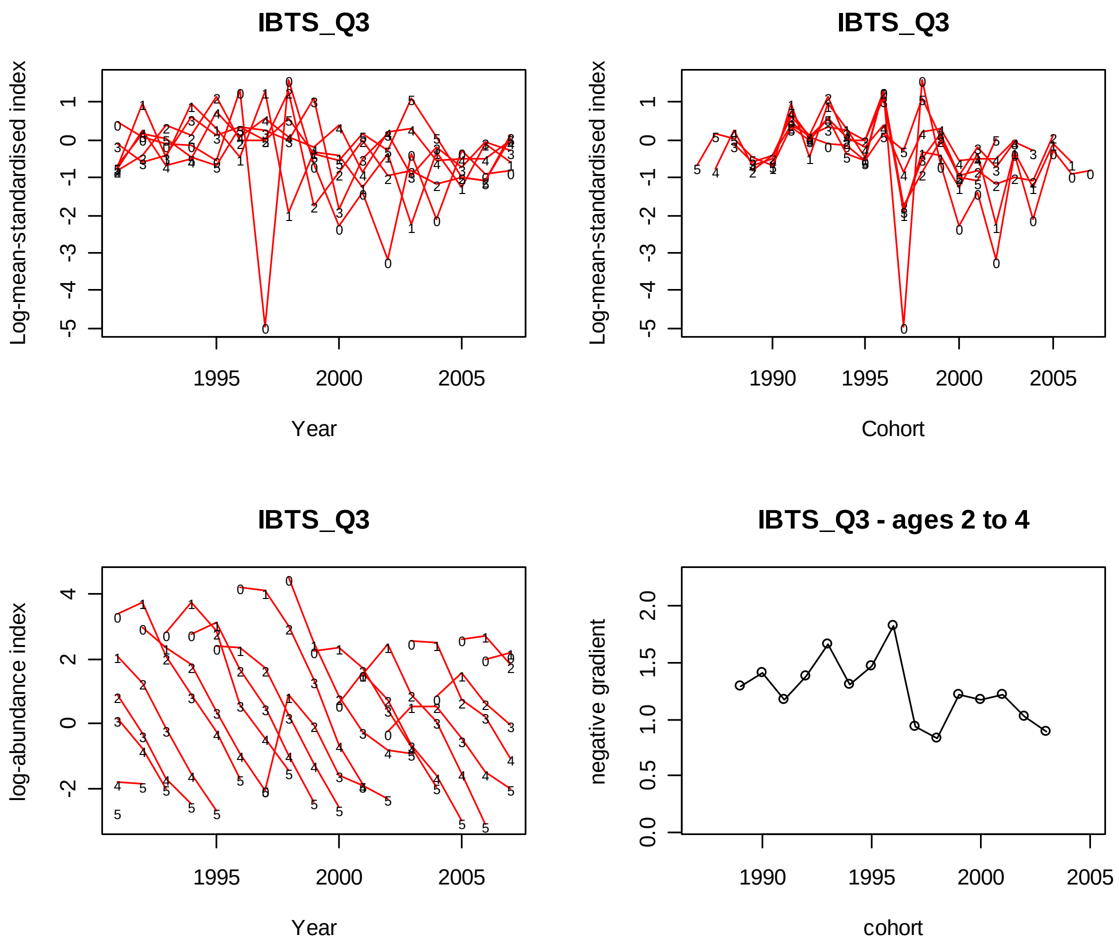


Figure 14.4b Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Log mean standardised indices plotted by year (top left) and cohort (top right), log abundance curves (bottom left) and associated negative gradients for each cohort across the reference fishing mortality of age 2-4 (bottom right), for the IBTSQ3 groundfish survey.

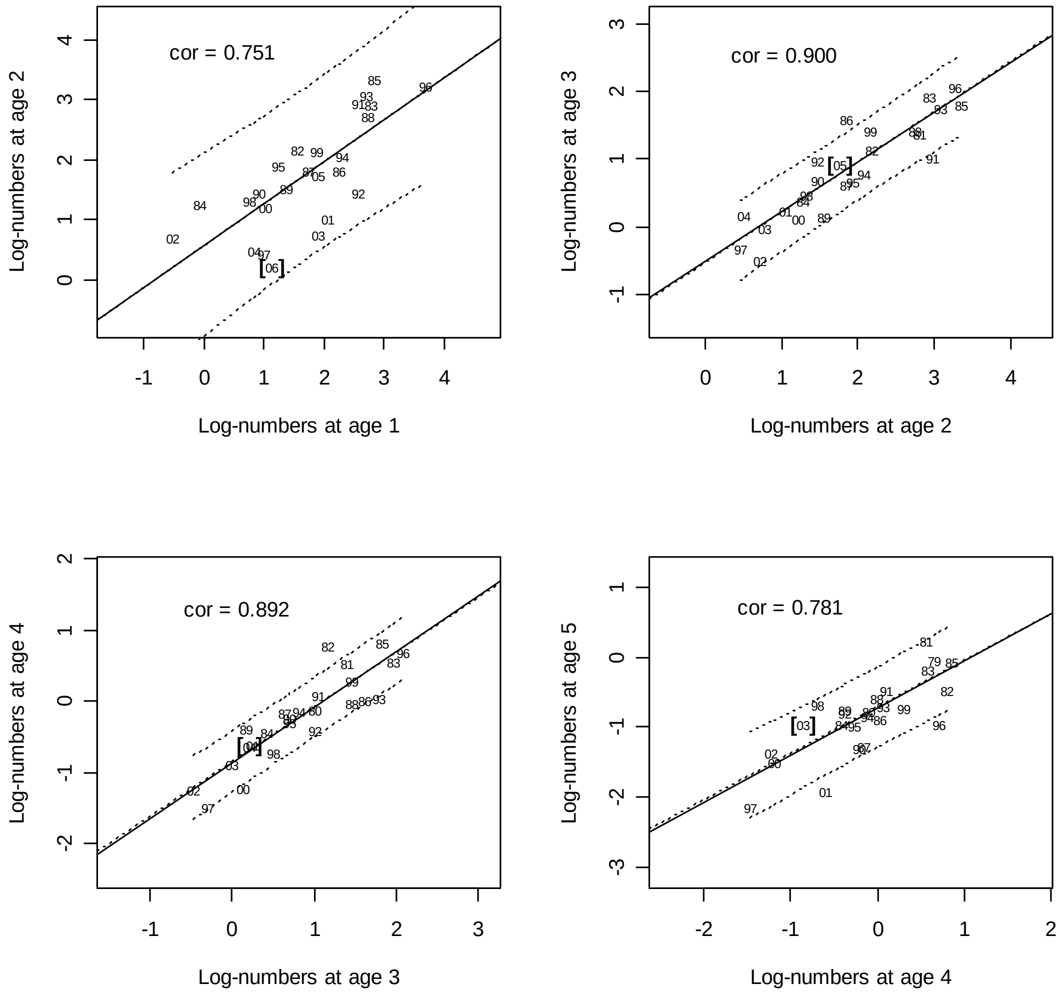


Figure 14.5a Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Within-survey correlations for IBTSQ1 for the period 1983-2008. Individual points are given by cohort (year-class), the solid line is a standard linear regression line, the broken line nearest to it a robust linear regression line, and "cor" denotes the correlation coefficient. The pair of broken lines on either side of the solid line indicate prediction intervals. The most recent data point appears in square brackets.

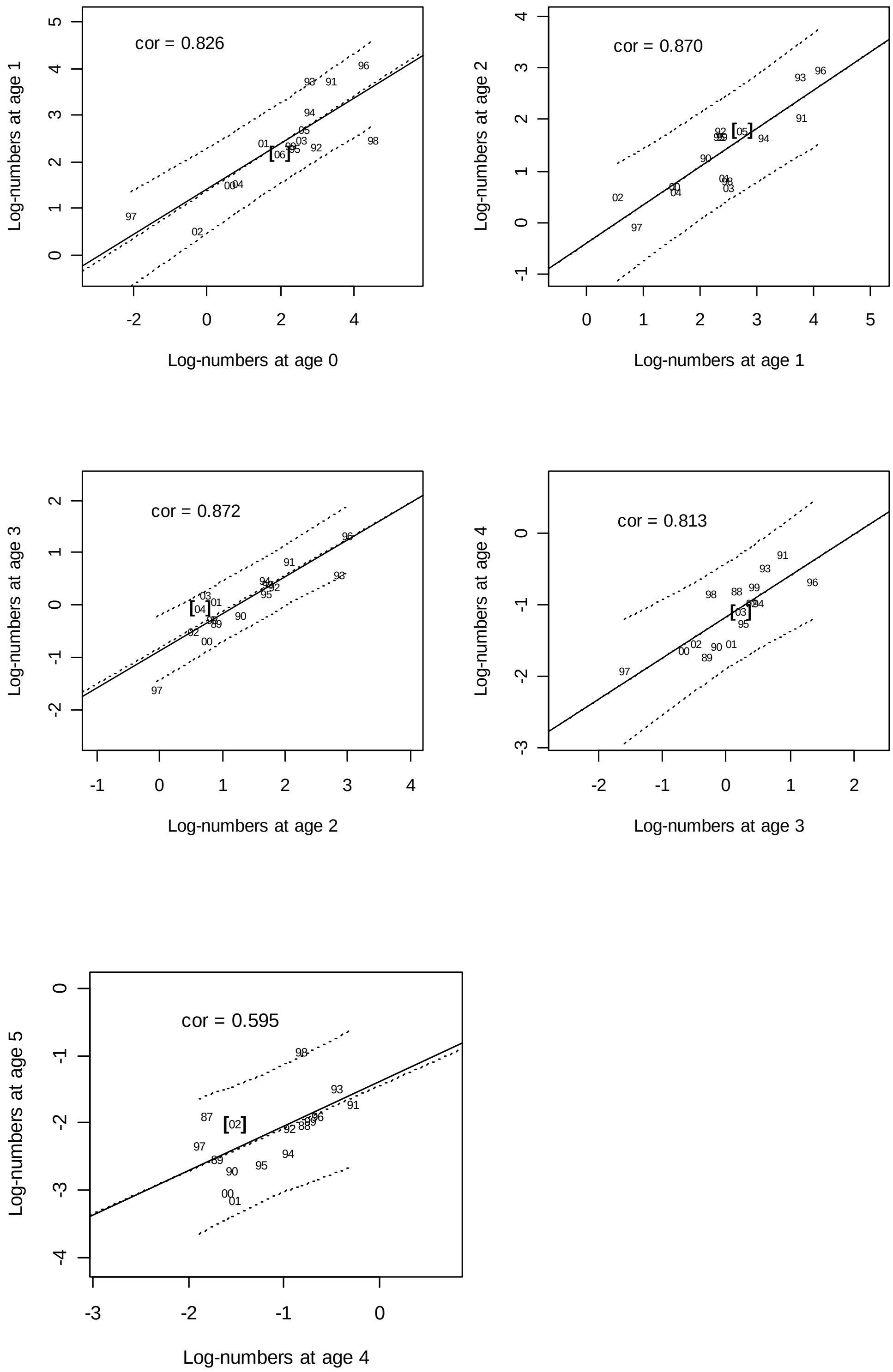


Figure 14.5b Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Within-survey correlations for IBTSQ3 for the period 1991-2007. Individual points are given by cohort (year-class), the solid line is a standard linear regression line, the broken line nearest to it a robust linear regression line, and "cor" denotes the correlation coefficient. The pair of broken lines on either side of the solid line indicate prediction intervals. The most recent data point appears in square brackets.

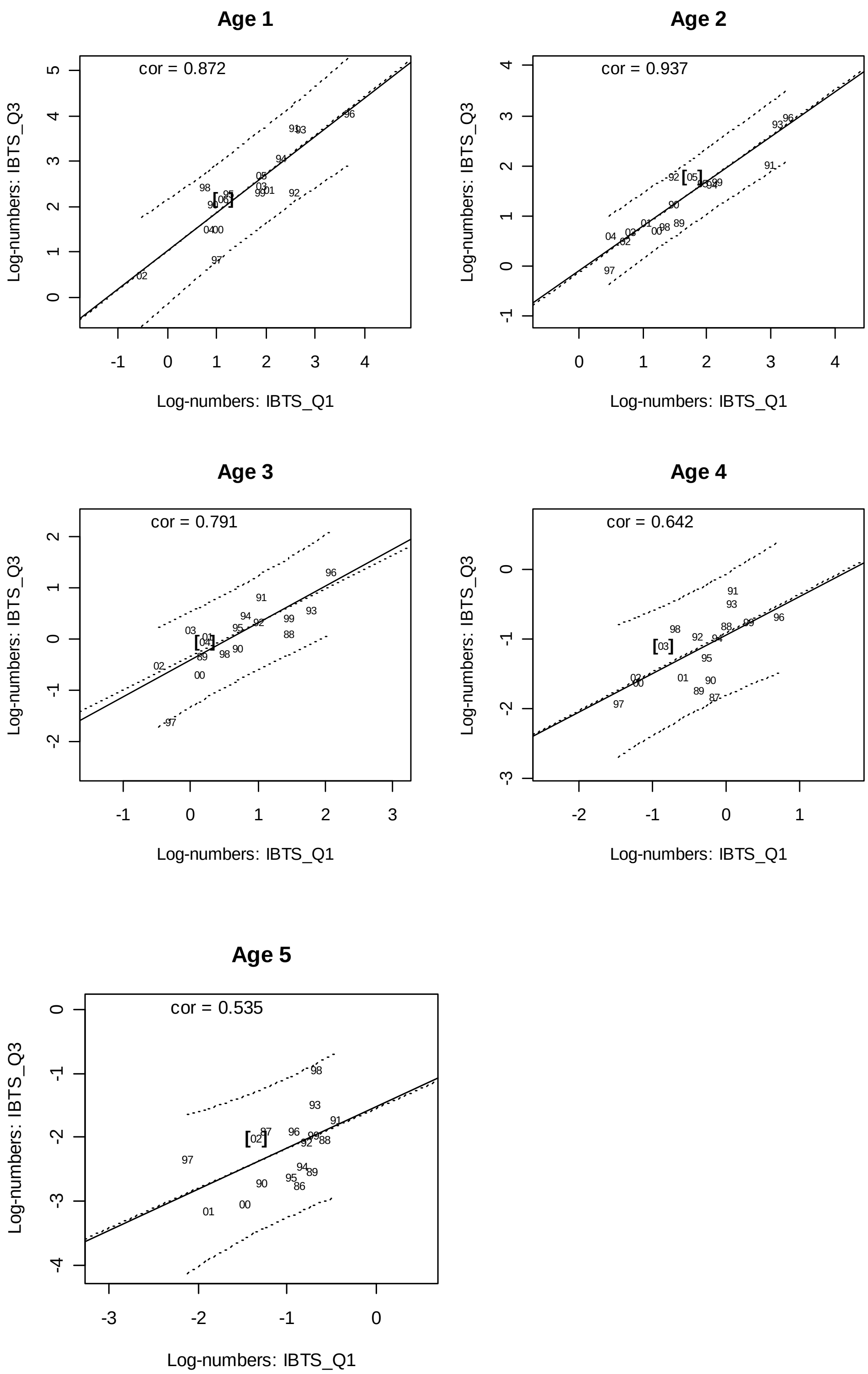


Figure 14.5c Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Between-survey correlations for IBTSQ1 and Q3 surveys for the period 1991-2007. Individual points are given by cohort (year-class), the solid line is a standard linear regression line, and the broken line nearest to it a robust linear regression line. The pair of broken lines on either side of the solid line indicate prediction intervals. The most recent data appear in square brackets.

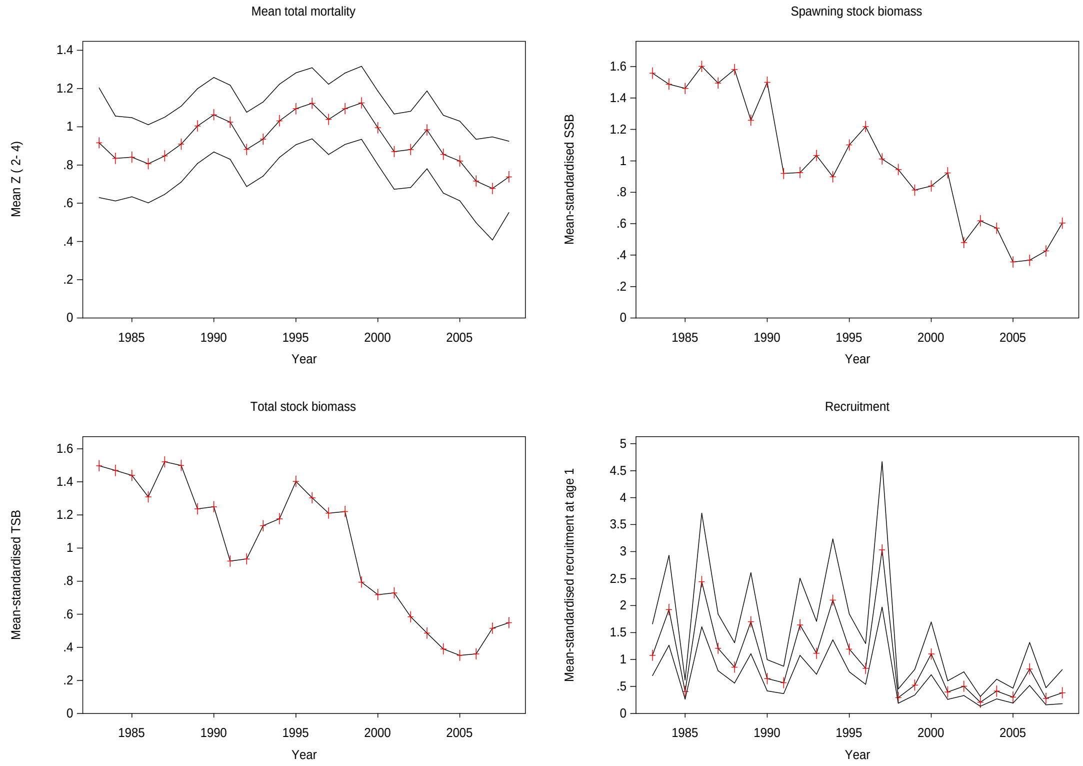


Figure 14.6a Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Surba summary plots for estimates of total mortality, spawning stock biomass, total biomass and recruitment for the IBTSQ1 survey. The smoothing parameter λ is set to 2, and reference age at 3. Broken lines are 95% confidence bounds.

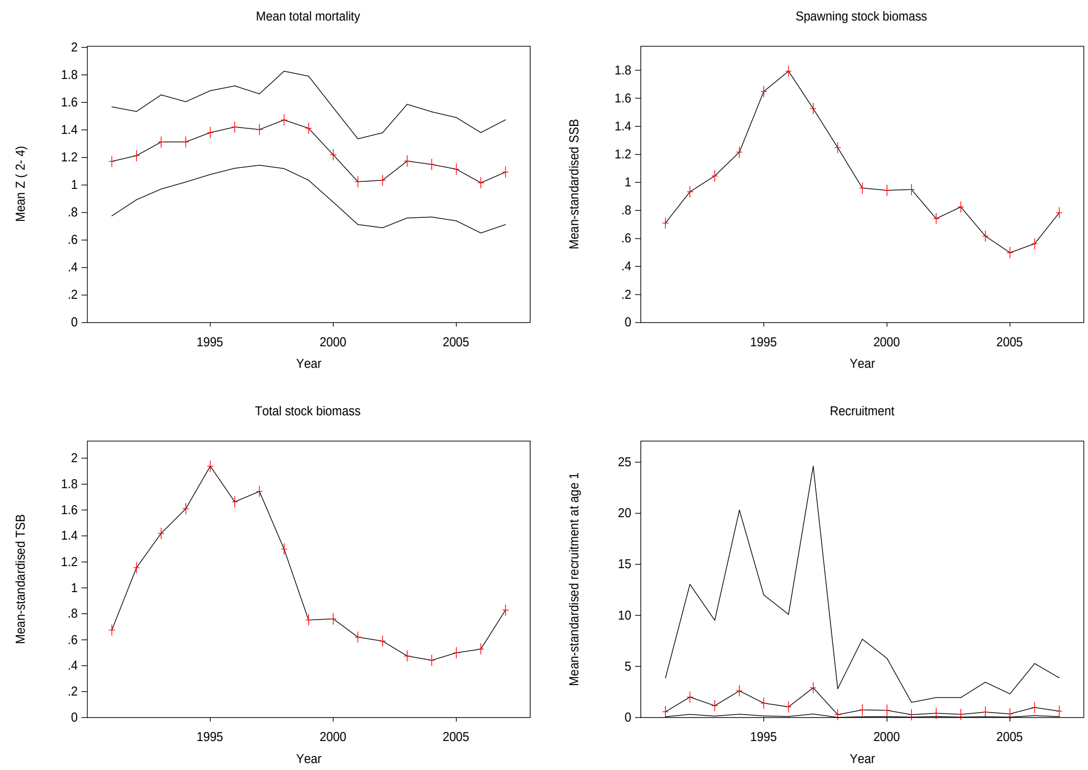


Figure 14.6b Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Surba summary plots for estimates of total mortality, spawning stock biomass, total biomass and recruitment for the IBTSQ3 survey. The smoothing parameter λ is set to 2, and reference age at 3. Broken lines are 95% confidence bounds.

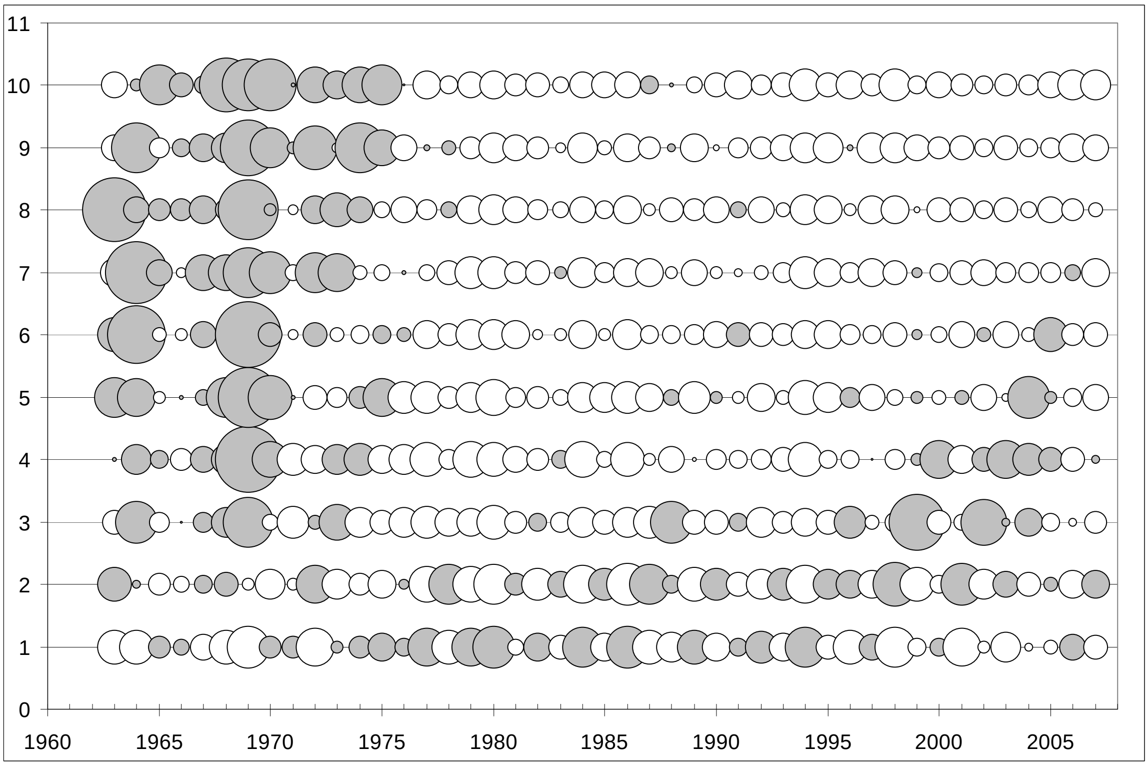
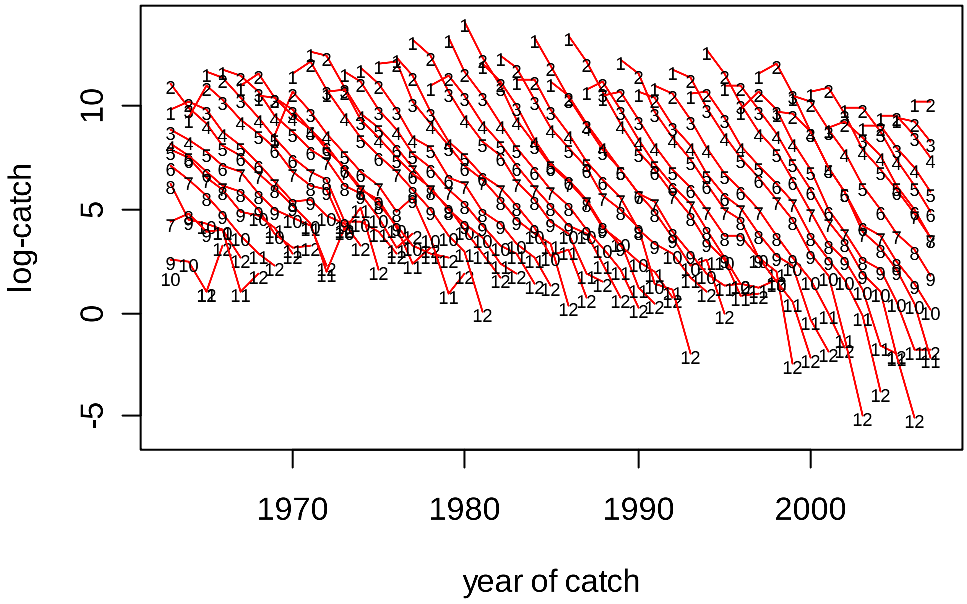


Figure 14.7 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Total catch-at-age matrix expressed as proportions-at-age which have been standardised over time (for each age, this is achieved by subtracting the mean proportion-at-age over the time series, and dividing by the corresponding variance). Grey bubbles indicate proportions above the mean over the time series at each age.



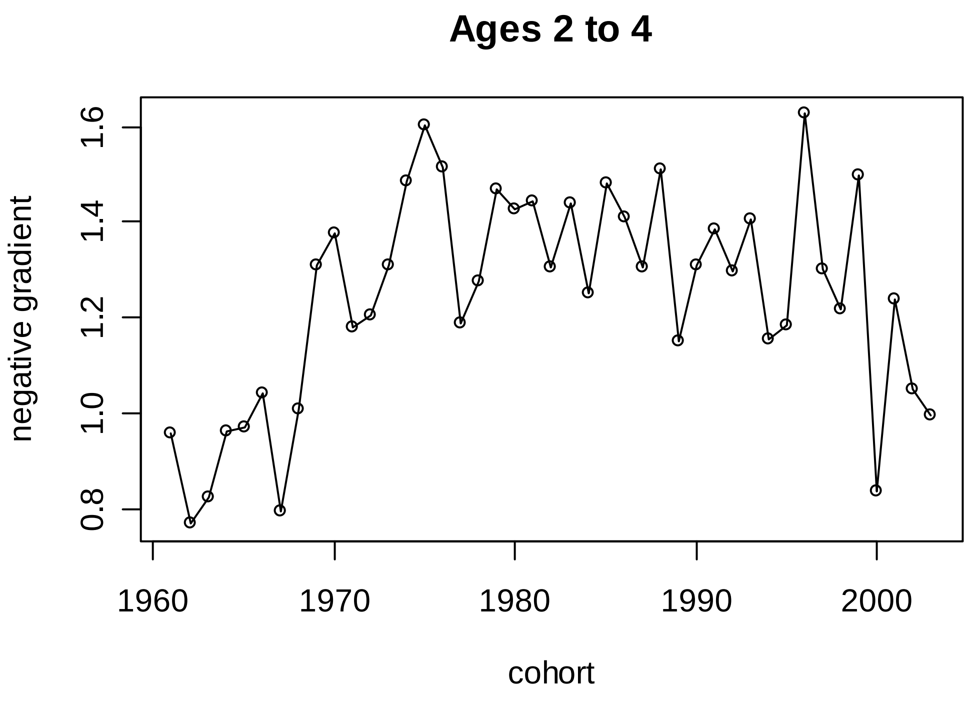


Figure 14.8 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Log-catch cohort curves (top panel) and the associated negative gradients for each cohort across the reference fishing mortality of age 2-4.

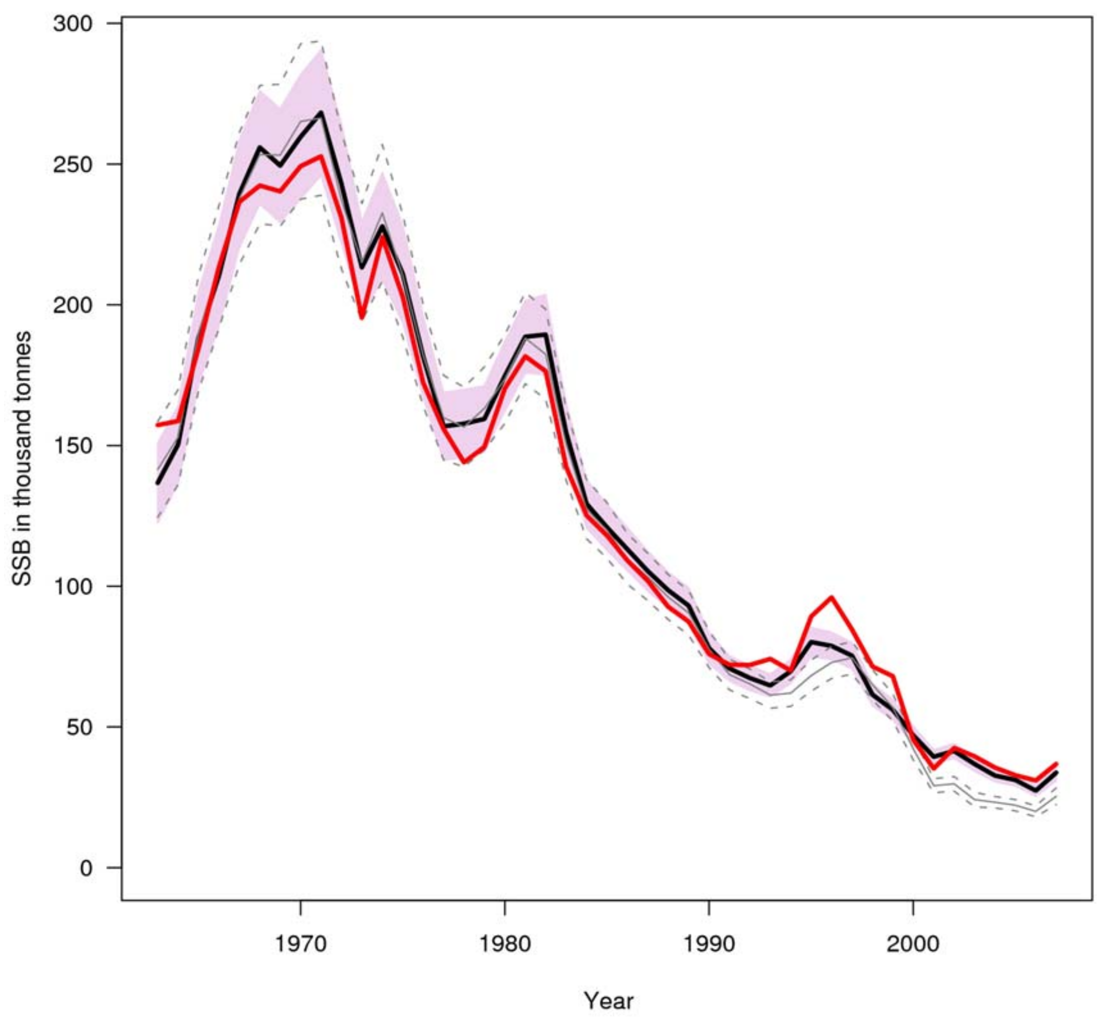


Figure 14.9 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Estimated SSB from the SSASS model. Grey lines are results without estimation of catch scaling in last fifteen years and solid black line and shaded area are results from a model with year specific scaling. Red line is B-ADAPT result.

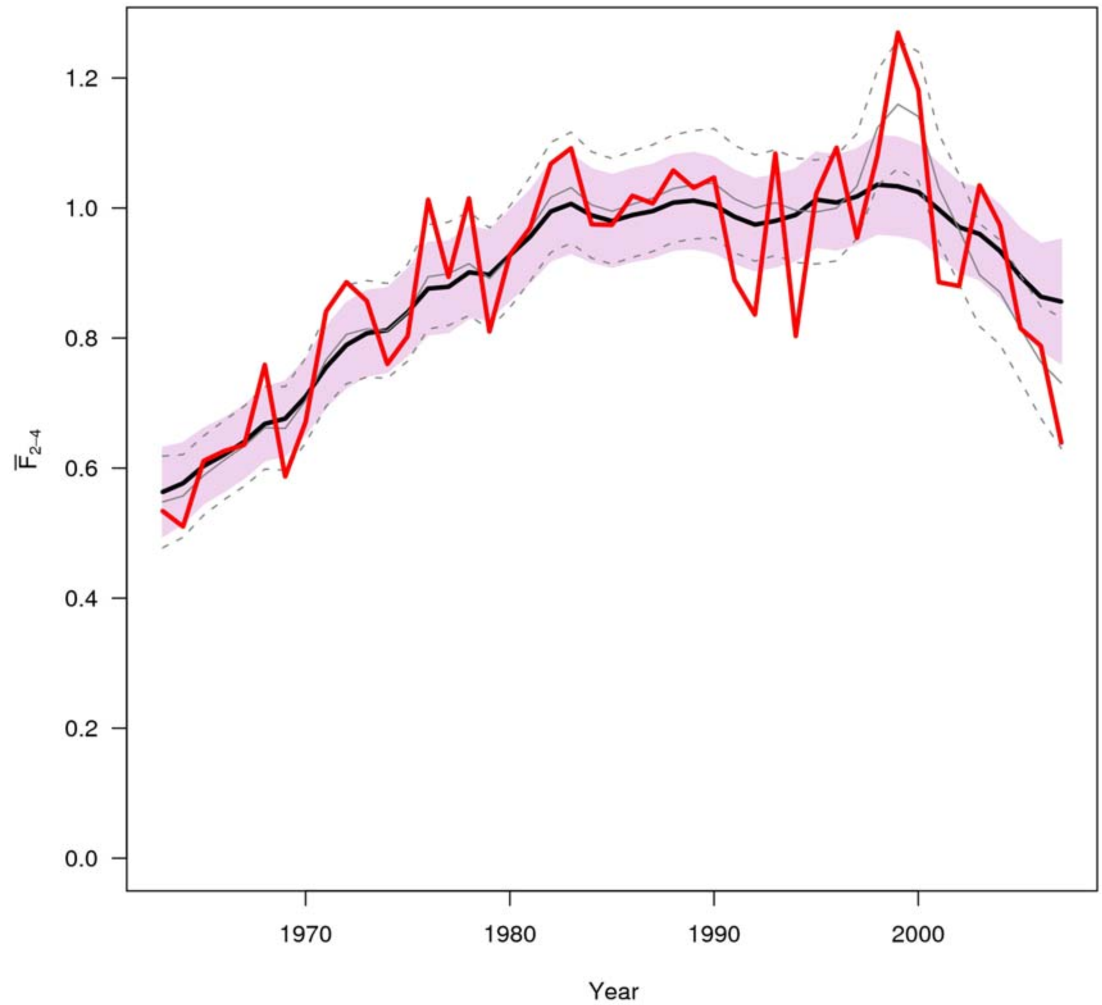


Figure 14.10 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Estimated F(2-4) from the SSASS model. Grey lines are results without estimation of catch scaling in last fifteen years and solid black line and shaded area are results from model with year specific scaling. Red line is B-ADAPT result.

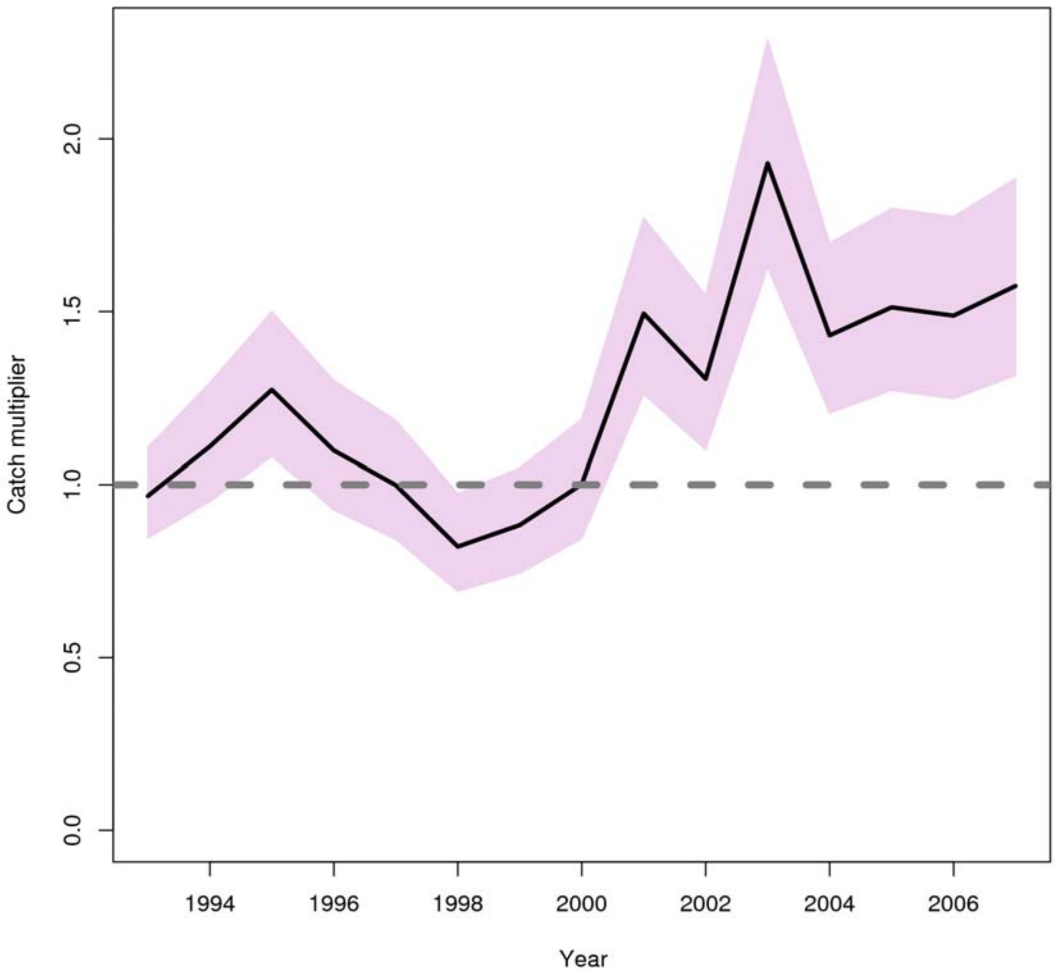


Figure 14.11 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Estimated yearly catch multiplier (solid line), and corresponding 95% confidence intervals from the SSASS model where catch scaling was estimated.

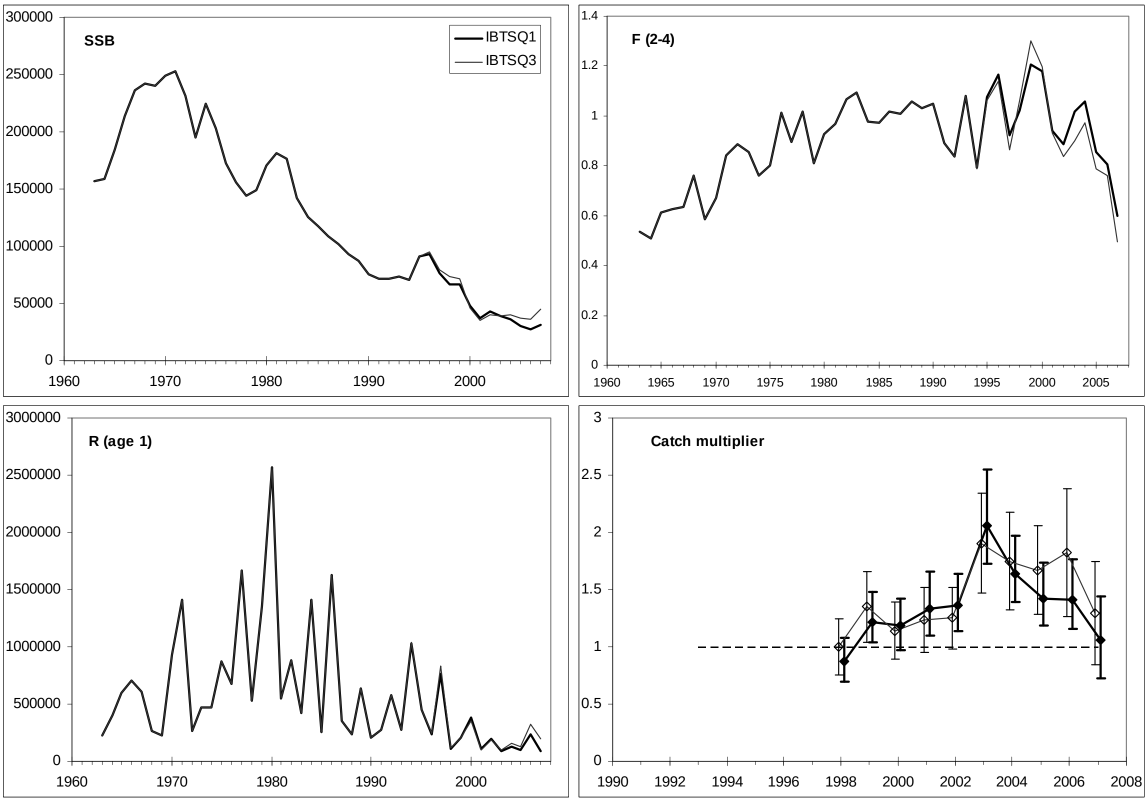


Figure 14.12 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Median of bootstrap estimates of spawning stock biomass (SSB), recruitment (R (age 1)), average fishing mortality (F (2-4)) and the catch multiplier for B-ADAPT single fleet runs for the IBTSQ1 and Q3 groundfish surveys. The error bars in the catch multiplier plot indicate 5th and 95th percentiles.

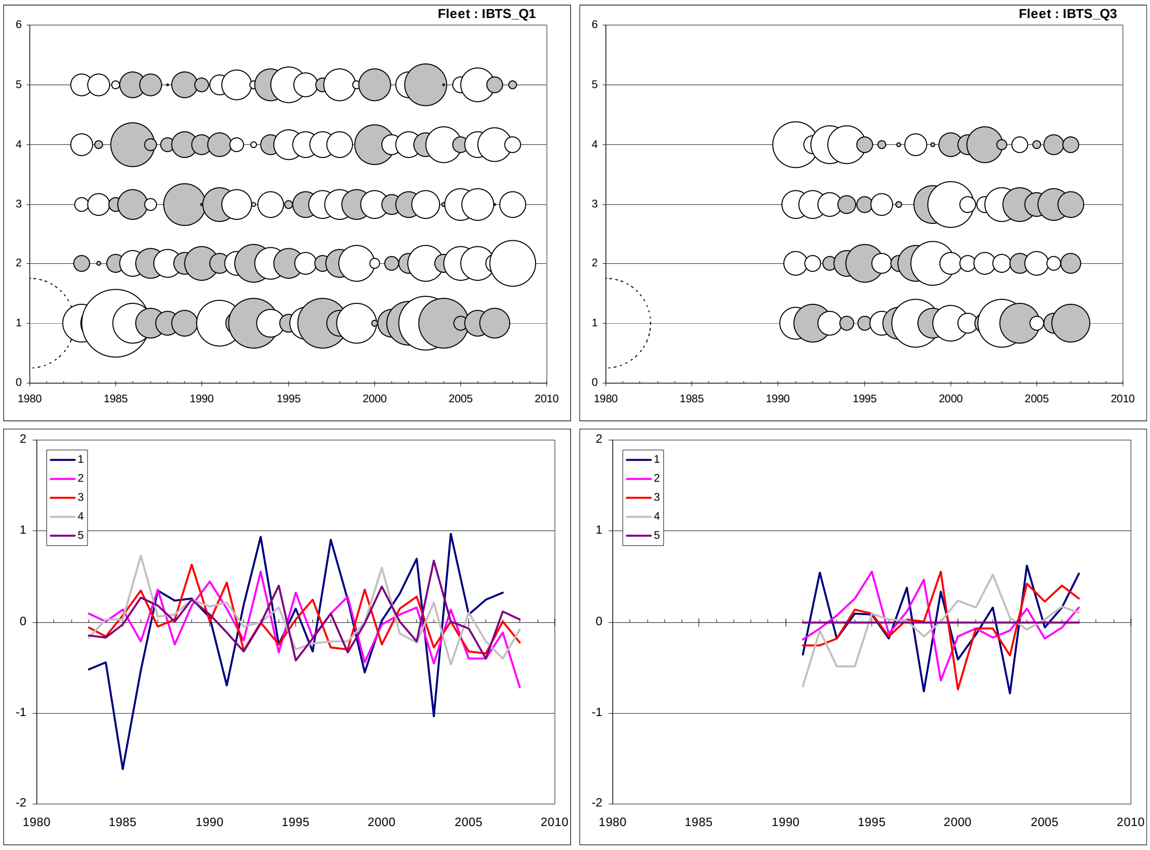


Figure 14.13 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Residual plots for the B-Adapt base run. In the top row grey bubbles indicate positive values, and white ones negative. The partially displayed dotted bubble indicates an absolute residual of size 3. The bottom row provides an alternative display of the residuals.

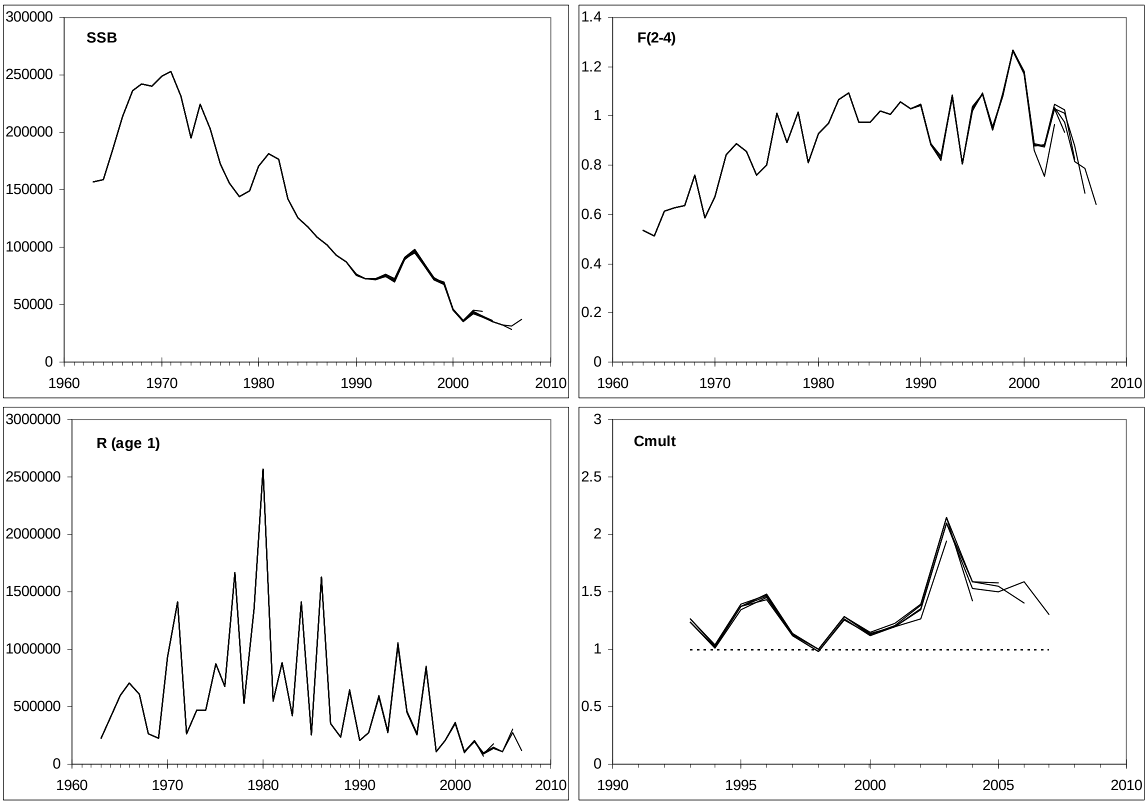


Figure 14.14 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. 5-year retrospective plots of median bootstrap values for SSB, Recruitment (age 1), F(2-4) and the catch multiplier for B-Adapt base run.

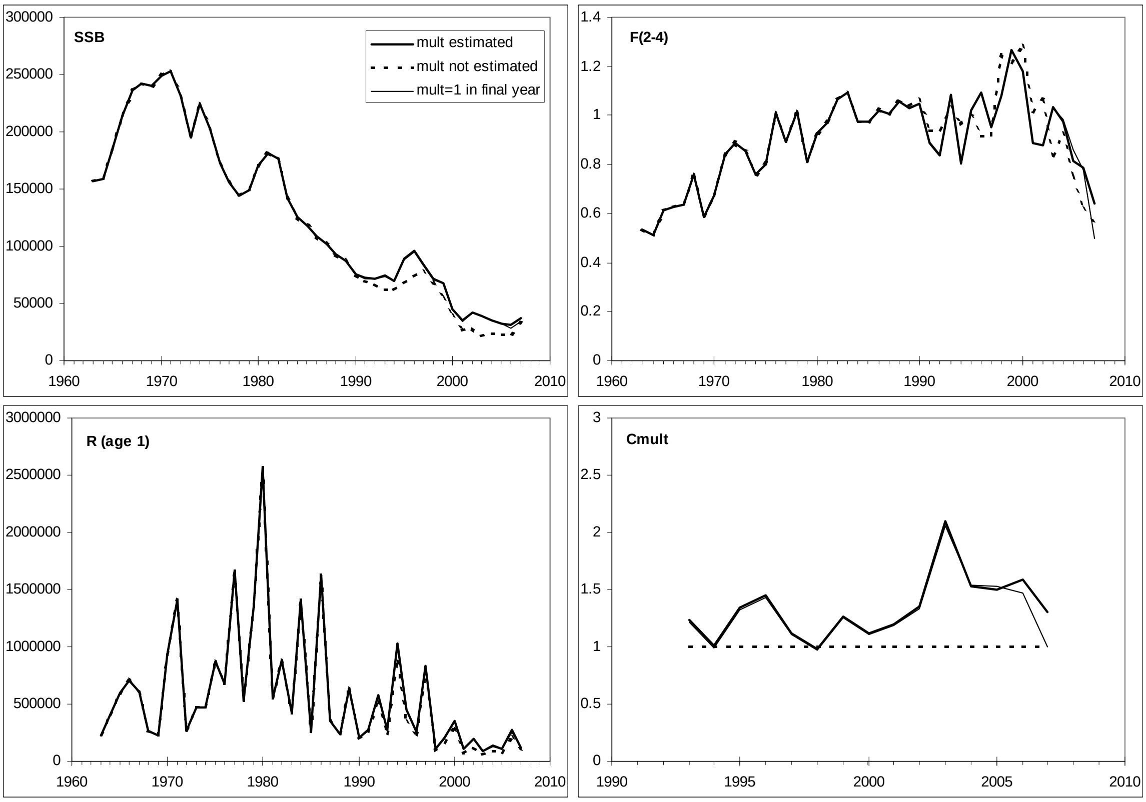


Figure 14.15 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Sensitivity of the B-Adapt base run (indicated as "mult estimated") to fixing the catch multiplier at 1 in 2007 ("mult=1 in final yr") and not estimating the catch multiplier ("mult not estimated"). Values shown are medians of bootstrap estimates.

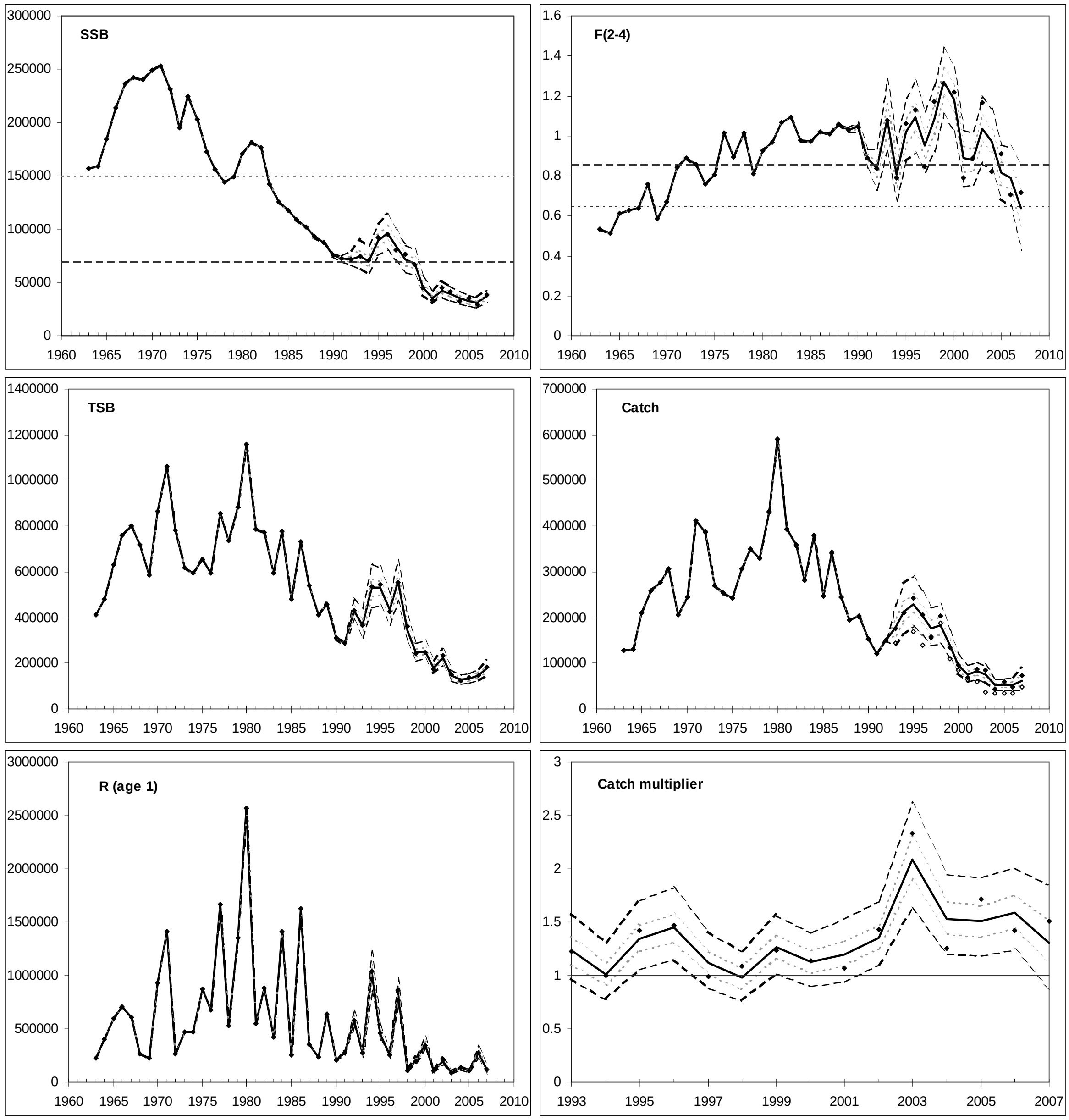


Figure 14.16 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Clockwise from top left, percentiles (5,25,50,75,95) of the estimated spawning stock biomass (SSB), total stock biomass (TSB), recruitment (R(age 1)), the catch multiplier, catch and mean fishing mortality for ages 2-4 (F(2-4)), from the B-ADAPT base run. The heavy lines represent the bootstrap median, the light broken lines the 25th and 75th percentiles and the heavy broken lines the 5th and 95th percentiles. The solid diamonds represent point estimates, and the open diamonds given in the catch plot the recorded total catch. The horizontal broken lines in the SSB plot indicate Blim=70 000t and Bpa=150 000t, and those in the F(2-4) plot Fpa=0.65 and Flim=0.86. The horizontal solid line in the catch multiplier plot indicates a multiplier of 1. Catch, SSB and TSB are in tons, and R in thousands.

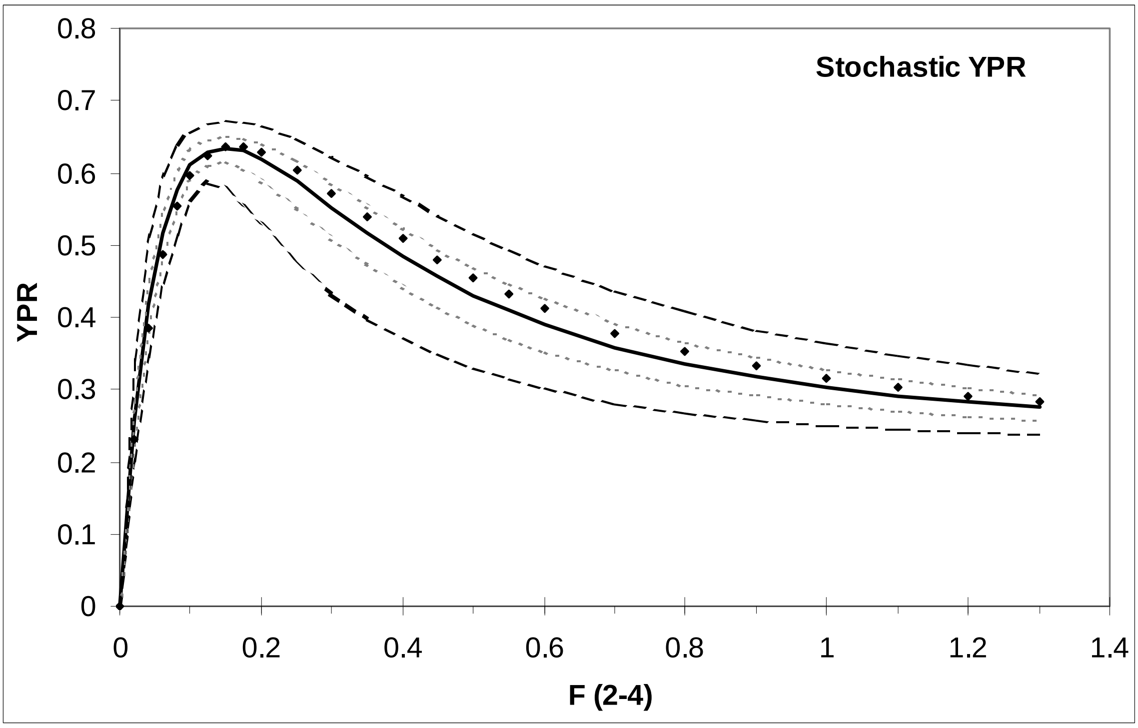


Figure 14.17. Cod in Sub-Area IV and Divisions IIIa (Skagerrak) and VIId. Stochastic yield per recruit based on the results for the B-Adapt base run, assuming stock weights-at-age, are the average for 2005-7, and using the same maturity- and natural mortality-at-age values as used in the base run. The heavy line represents the bootstrap median, the light broken lines the 25th and 75th percentiles and the heavy broken lines the 5th and 95th percentiles. The solid diamonds represent point estimates.

MISSING

Figure 14.18. Cod in Sub-Area IV and Divisions IIIa and VIId. Historical performance of the assessment. Circles indicate forecasts.

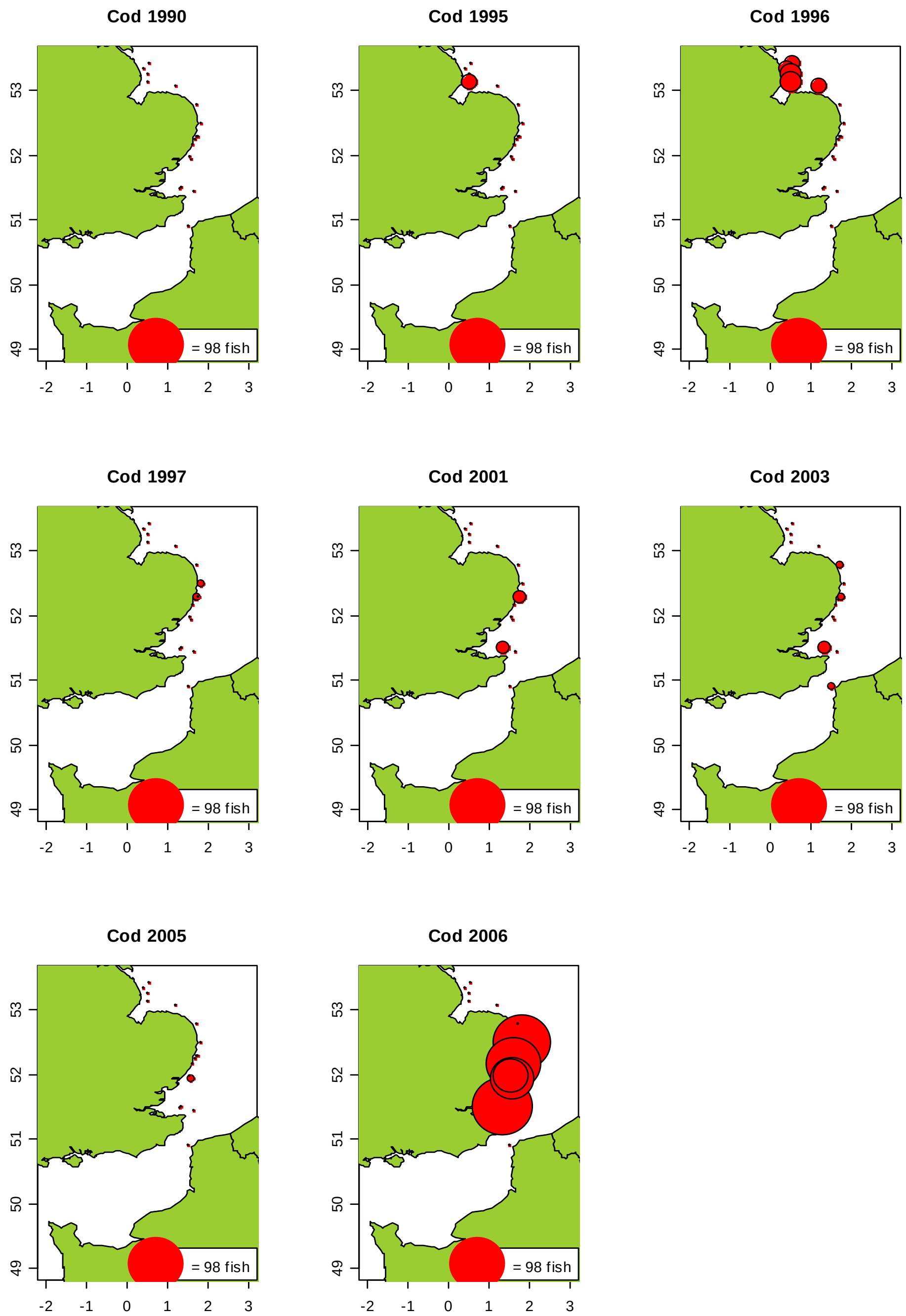


Figure 14.19. Cod in Sub-Area IV and Divisions IIIa and VIId. The spatial distribution of the catches of 0-group cod in the English Channel Beam Trawl Survey (ENG-CBTS, which also extends into the southern North Sea), held in July/August.

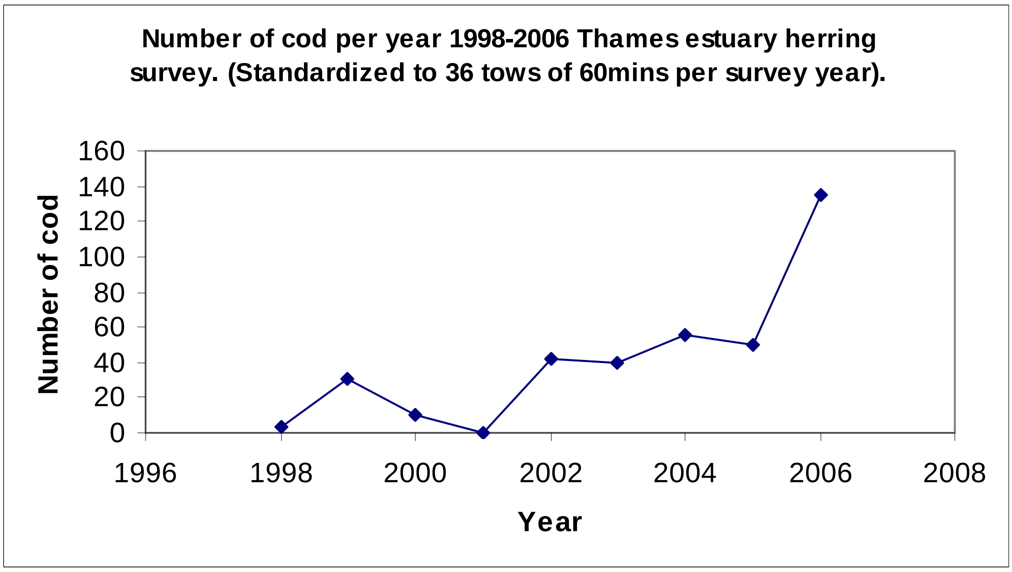


Figure 14.20a Cod in Sub-Area IV and Divisions IIIa and VIId. The total number of cod (all ages) caught within the English Thames Estuary annual herring survey. In 2006 the catches were almost exclusively 0-group cod.

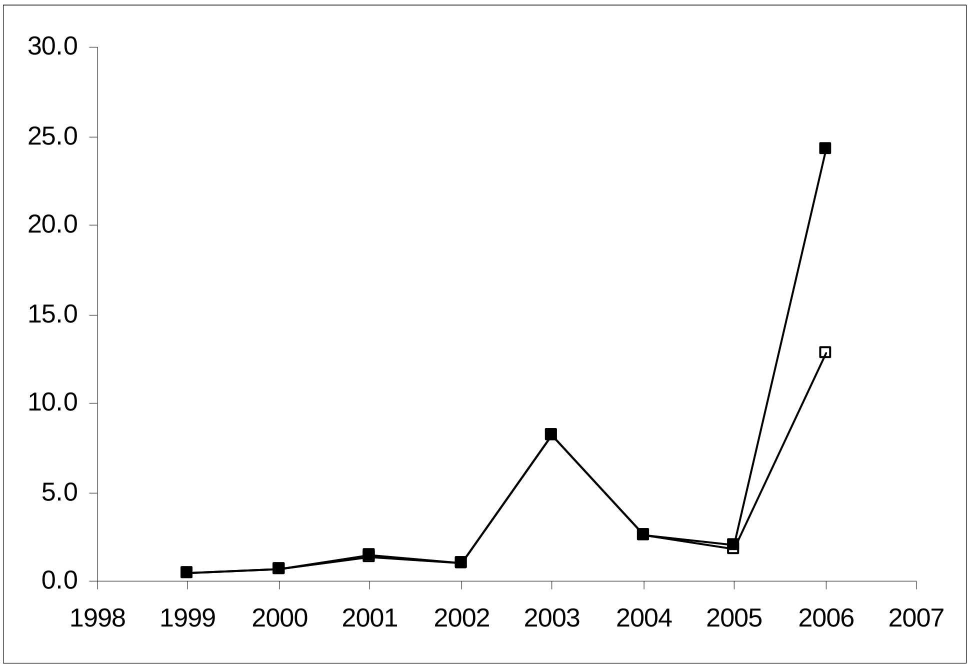


Figure 14.20b. Cod in Sub-Area IV and Divisions IIIa and VIId. The total number of 0-group cod caught within the English Thames Estuary annual bass survey. Solid squares indicate inclusion of one station at which 400 fish were caught, open squares exclusion of that station from the average.

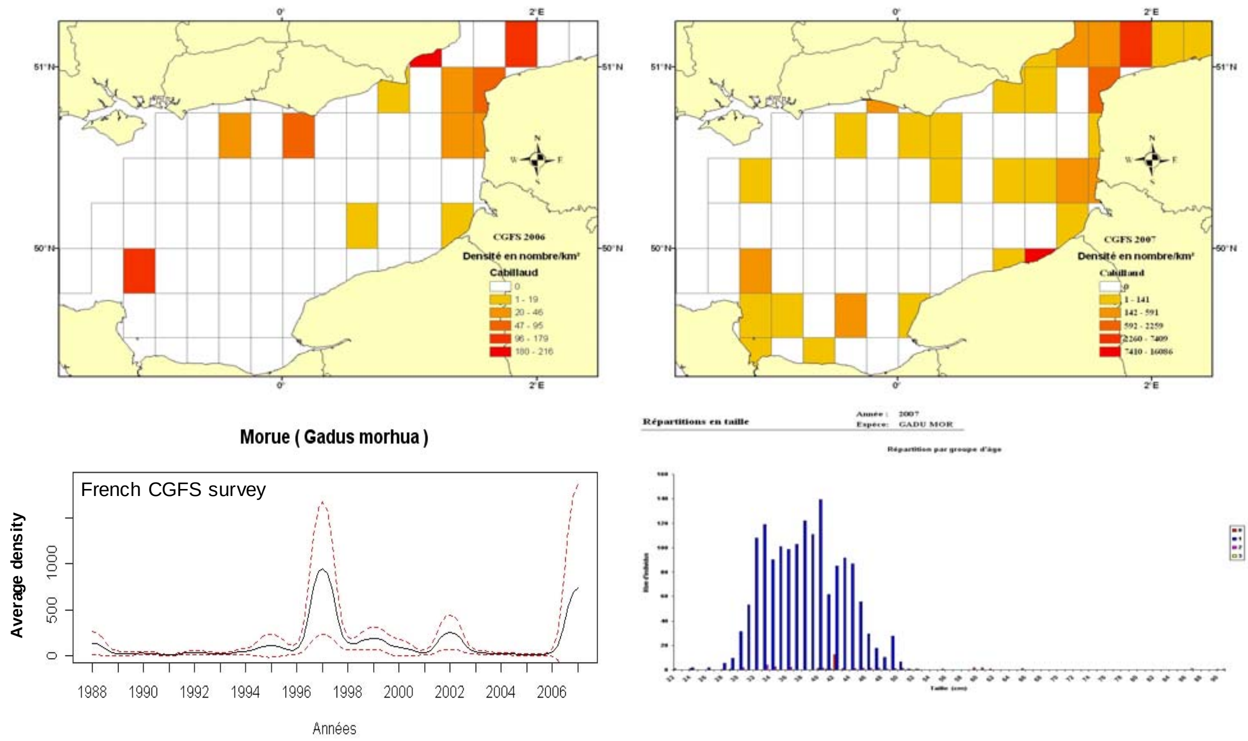


Figure 14.21. Cod in Sub-Area IV and Divisions IIIa and VIId. The spatial distribution (numbers per km2) of cod in 2006 (top left) and 2007 (top right) for the French Channel Groundfish Survey (FRA-CGFS) held in October each year, together with a times series of average density of age 1 cod (bottom left), and length distribution for 2007, ranging from 30 to 50 cm (bottom right). The broken line in the bottom left plot represents 95% confidence intervals.

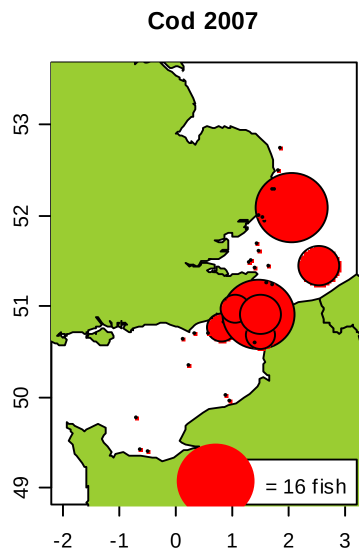


Figure 14.22. Cod in Sub-Area IV and Divisions IIIa and VIId. Numbers of 1-group cod in 2007 from the ENG-CBTS Survey (July/August 2007).

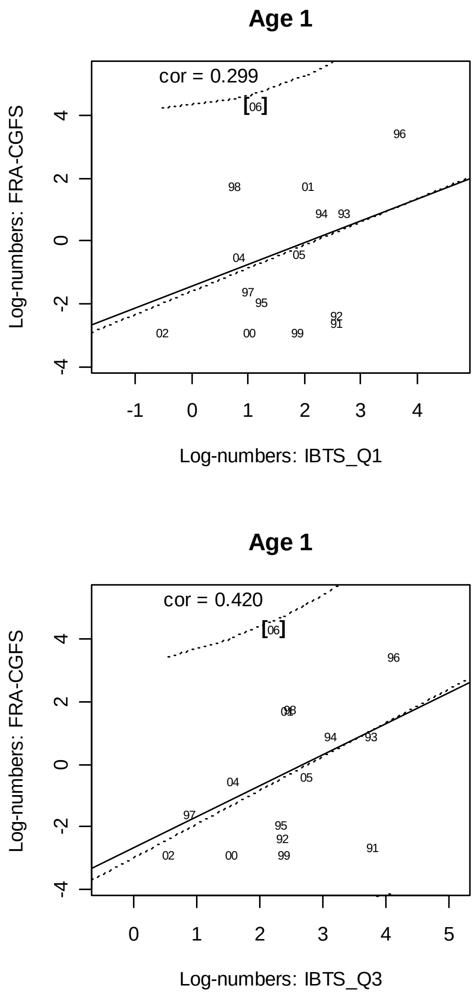


Figure 14.23. Cod in Sub-Area IV and Divisions IIIa and VIId. Between-survey correlation plots for age 1 cod for the FRA-CGFS survey (vertical axis) and the IBTS Q1 and Q3 surveys (horizontal axis, left and right plots respectively). The 2006 year class appears in square parentheses.

15 Management Plan Evaluations

ICES have a standing requirement to evaluate current management plans for a number of stocks, and (where appropriate) suggest improvements. This section of the report usually contains analyses and WG conclusions on management-plan evaluations. However none were carried out at the 2008 WG. A management plan evaluation conducted outside of the WG during 2008 was that for the combined management plan for North Sea plaice and sole (Machiels et al 2008 WD 2). The study was presented and reviewed at the May meeting and formed part of the Group's and ACOM's advice to managers.

Annex 1: List of Participants

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

ICES, Headquarters, 7–13 May 2008

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Annex 2: Update forecasts and assessments

Working Group on the Assessment of North Sea and Skagerrak Demersal Stocks

2.1 Summary

The Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak [WGNSSK] (Chair: Chris Darby*, UK) met by correspondence at the beginning of October 2008 to evaluate new information from the fisheries independent surveys carried out during 2008 subsequent to the min meeting of the group in May.

The WGNSSK followed the protocol defined by the Ad hoc Group on Criteria for Reopening Fisheries Advice (AGCREFA; ICES CM 2008/ACOM:60) in its evaluation of the survey information - fitting the RCT3 regression model to data that included the 2008 survey information to estimate the 2008 recruitment abundance and then comparing the prediction and its associated uncertainty with the estimate from previous surveys used as the basis for the ACOM spring advice.

The comparisons indicated that there was potential for re-opening of the advice for whiting and haddock. The estimates of recruitment for cod and saithe used in the assessments are based on the geometric mean and the new information is either too uncertain to provide a change to the advice (saithe) or indicates that the estimate from the new information does not differ from the assumptions used in the spring forecast (cod, plaice,sole).

2.2 Cod in Sub-Area IV, VIID and IIIa

2.2.1 New survey information

Research surveys were conducted as part of the IBTS 3rd quarter survey of 2008. This survey, in conjunction with the IBTS quarter 1 survey, provides information on year class strength for the incoming year class (2007 year class) that could potentially be used in a TAC forecast. However, these surveys are not considered to provide reliable enough information on the incoming year class to be used in the TAC forecast, and the approach for North Sea cod has been to replace estimates of the incoming 2007 year class, and subsequent year classes, with re-sampled values from the 1997-2006 year classes. Nevertheless, an RCT3 analysis was conducted to see if the information on the 2007 year class provided by these surveys is significantly different to the median implied by the forecast re-sampling.

2.2.2 RCT3 Analysis

RCT3 was run using the new information from the surveys to predict recruitment at age 1 in 2008. The input data are presented in Table 2.2.1 and the output in Table 2.2.2.

2.2.3 Update protocol calculations

The recruitment value for 2008 used in the forecast was 132033. This was based on values sampled from the 1997-2006 year classes, and was a median from the 1000 B-Adapt bootstraps. According to the protocol (AGCREFA), this is compared with the output from RCT3 as follows:

Log WAP = 12.15, internal s.e. = 0.34, D = 1.06

2.2.4 Forecast

Although D > 1, it is not appropriate to consider re-opening the advice for North Sea cod because the most recent survey estimate of age 1 receives no weight in the assessment, and does not feature in the TAC forecast.

2.2.5 Conclusions

Based on considering only the most recent estimate of age 1 in the surveys as a criteria for re-opening advice, it is not appropriate to re-open advice for North Sea cod because the most recent survey estimates of age 1 do not feature in either the assessment or the TAC forecast.

Table 2.2.1 The RCT3 input data file updated with the North Sea cod CPUE from the third quarter IBTS surveys.

Cod NS & Skag. Age 1			
2	26	2	
'Year'	'Badapt'	'Q1_1'	'Q3_1'
1982	425490	4.734	-11
1983	1409444	15.856	-11
1984	256977	0.928	-11
1985	1626314	16.785	-11
1986	354511	9.425	-11
1987	236177	5.638	-11
1988	641820	15.117	-11
1989	204133	3.953	-11
1990	269785	2.481	8.17
1991	582416	13.129	43.487
1992	272894	13.088	10.473
1993	1026370	14.66	42.737
1994	455365	9.832	22.282
1995	258502	3.441	10.283
1996	837455	39.951	60.518
1997	110145	2.672	2.397
1998	202650	2.112	11.952
1999	356541	6.563	10.689
2000	104694	2.786	4.723
2001	195938	7.755	11.334
2002	91243	0.584	1.735
2003	135611	6.74	12.178
2004	112261	2.272	4.745
2005	274458	6.642	15.215
2006	118989	3.091	9.079
2007	-11	2.688	9.961

Table 2.2.2 The RCT3 output file for North Sea cod.

```
Analysis by RCT3 ver3.1 of data from file :
 nscod2.txt
 Cod NS & Skag. Age 1
 Data for    2 surveys over   26 years :  1982 - 2007
 Regression type = C
 Tapered time weighting not applied
 Survey weighting not applied
 Final estimates not shrunk towards mean
 Estimates with S.E.'S greater than that of mean
+                                                   included
 Minimum S.E. for any survey taken as    .00
 Minimum of   3 points used for regression
 Forecast/Hindcast variance correction used.
 Yearclass =   2007
          I-----------Regression----------I  I-----------Prediction---------I

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

 Q1_1      1.33  10.03    .65   .616     25   1.31   11.76     .705     .235
 Q3_1       .96   9.97    .36   .822     17   2.39   12.27     .391     .765

                                        VPA Mean =   12.61     .811     .000

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

 2007      189581     12.15     .34     .22      .40
```

2.3 Haddock in Sub-Area IV and Division IIIa

2.3.1 New survey information

The new data available for a potential autumn forecast are the third-quarter groundfish surveys carried out by Scotland (ScoGFS) and England (EngGFS), and the international third-quarter IBTS survey (IBTS Q3). The latter is not used in the haddock assessment or forecast, and is not considered further here. The full available dataset for the ScoGFS and EngGFS series is given in Table 2.3.1.

2.3.2 RCT3 analysis

Following the protocol stipulated by AGCREFA (ICES 2008), an RCT3 analysis was run to provide an estimate of the abundance of the incoming (2008) year class at age 0. The RCT3 input and output files are given in Tables 2.3.2 and 2.3.3.

2.3.3 Update protocol calculations

The outcome of the application of the protocol was as follows:

CALCULATIONS FOR 2008 YEAR CLASS	
Log WAP from RCT3	8.09
Log of recruitment assumed in spring	8.38
Int SE of log WAP	0.23
Distance D	**-1.27**

2.3.4 Conclusions from protocol

As the distance D < -1.0, the protocol concludes that the advisory process for North Sea haddock should be **reopened**.

2.3.5 Updated forecast

The RCT3 analysis indicates that the recruitment of the 2008 year class at age 0 in 2007 should be exp(8.09) = 3261.688 millions. This value was included in the MFDP input file given in Table 2.3.4. The remaining forecast assumptions (regarding growth, exploitation and so on) were unchanged from the spring forecast.

The results of the MFDP run are given in Table 2.3.5. The following text table summarises the differences in forecast landings yield at key *F*-multipliers:

	15% TAC DECREASE	PLAN TARGET	STATUS QUO
Spring	41905	44747	59008
Autumn	41905	44711	58958
Difference	0.000%	-0.080%	-0.085%

The difference between the spring and autumn forecast landings is less than 0.1%. On this basis, **the advisory process should not be taken further for North Sea haddock.**

Table 2.3.1. Haddock in Sub-Area IV and Division IIIa. Indices from the third-quarter English (EngGFS) and Scottish (ScoGFS) groundfish survey series. New data from autumn 2008 are highlighted in bold.

EngGFS Q3 GOV							
1992	2008						
1	1	0.5	0.75				
0	6						
100	246.021	58.746	29.133	1.742	0.146	0.037	0.251
100	40.336	73.145	17.435	4.951	0.176	0.048	0
100	279.344	23.99	26.992	2.511	0.894	0.058	0.003
100	53.435	113.775	13.223	11.032	0.827	0.275	0.021
100	61.301	26.747	43.044	3.603	2.052	0.207	0.088
100	40.653	45.346	12.608	19.968	0.719	0.718	0.067
100	15.747	26.497	16.778	4.079	4.141	0.226	0.141
100	626.1	16.551	8.404	3.663	1.258	1.201	0.04
100	92.139	249.813	4.528	1.634	0.74	0.336	0.35
100	1.097	28.622	96.498	3.039	0.828	0.35	0.135
100	2.721	3.954	22.559	60.583	0.542	0.097	0.153
100	3.199	6.015	1.247	13.967	45.079	0.719	0.026
100	3.398	6.599	3.864	0.448	6.836	17.406	0.217
100	122.383	9.74	5.992	2.584	1.249	6.617	3.654
100	11.825	54.816	3.27	1.14	0.433	0.15	0.859
100	8.463	10.628	43.401	1.402	0.624	0.092	0.078
100	**2.613**	**6.494**	**5.801**	**18.534**	**0.727**	**0.266**	**0.137**
ScoGFS Q3 GOV							
1998	2008						
1	1	0.5	0.75				
0	6						
100	3280	6349	1924	490	511	24	18
100	66067	1907	1141	688	197	164	6
100	11902	30611	460	221	130	73	27
100	79	3790	11352	179	65	40	18
100	2149	675	2632	6931	70	37	18
100	2159	1172	307	2092	4344	22	17
100	1729	1198	547	101	819	1420	9
100	19708	761	657	153	112	347	483
100	2280	7275	272	158	33	14	73
100	1119	1810	5527	117	57	11	5
100	**1885**	**733**	**1002**	**2424**	**28**	**24**	**6**

Table 2.3.2. Haddock in Sub-Area IV and Division IIIa. RCT3 input file.

HADDOCK IN IV, RCT3 INPUT VALUES							
6	28	2					
'YEARCLASS'	'VPA'	'EGFS0'	'EGFS1'	'EGFS2'	'SGFS0'	'SGFS1'	'SGFS2'
1981	32627.556	-1	-1	-1	-1	-1	-1
1982	20493.870	-1	-1	-1	-1	-1	-1
1983	66968.031	-1	-1	-1	-1	-1	-1
1984	17182.282	-1	-1	-1	-1	-1	-1
1985	23923.464	-1	-1	-1	-1	-1	-1
1986	49056.133	-1	-1	-1	-1	-1	-1
1987	4157.650	-1	-1	-1	-1	-1	-1
1988	8340.001	-1	-1	-1	-1	-1	-1
1989	8608.520	-1	-1	-1	-1	-1	-1
1990	28370.716	-1	-1	29.133	-1	-1	-1
1991	27500.082	-1	58.746	17.435	-1	-1	-1
1992	42030.485	246.021	73.145	26.992	-1	-1	-1
1993	13184.770	40.336	23.990	13.223	-1	-1	-1
1994	56274.675	279.344	113.775	43.044	-1	-1	-1
1995	14505.860	53.435	26.747	12.608	-1	-1	-1
1996	21538.634	61.301	45.346	16.778	-1	-1	1924
1997	12833.540	40.653	26.497	8.404	-1	6349	1141
1998	9994.167	15.747	16.551	4.528	3280	1907	460
1999	137380.451	626.100	249.813	96.498	66067	30611	11352
2000	26773.523	92.139	28.622	22.559	11902	3790	2632
2001	2894.893	1.097	3.954	1.247	79	675	307
2002	3651.268	2.721	6.015	3.864	2149	1172	547
2003	3811.617	3.199	6.599	5.992	2159	1198	657
2004	3961.768	3.398	9.740	3.270	1729	761	272
2005	39022.498	122.383	54.816	43.401	19708	7275	5527
2006	6383.210	11.825	10.628	5.801	2280	1810	1002
2007	4454.262	8.463	6.494	-1	1119	733	-1
2008	-1	2.613	-1	-1	1885	-1	-1

Table 2.3.3. Haddock in Sub-Area IV and Division IIIa. RCT3 output file.

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

 hadivrct.in

 HADDOCK IN IV, RCT3 INPUT VALUES

 Data for    6 surveys over   28 years :  1981 - 2008

 Regression type = C
 Tapered time weighting not applied
 Survey weighting not applied
 Final estimates not shrunk towards mean
 Estimates with S.E.'S greater than that of mean included
 Minimum S.E. for any survey taken as    .00
 Minimum of   3 points used for regression

 Forecast/Hindcast variance correction used.

 Yearclass =   2008

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

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

 EGFS0      .67   7.16    .21   .970     16   1.28    8.03     .240     .925
 EGFS1
 EGFS2
 SGFS0      .80   2.75    .71   .784     10   7.54    8.77     .841     .075
 SGFS1
 SGFS2

                                       VPA Mean =    9.66    1.028     .000


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

 2008        3246      8.09     .23     .20      .72
```

Table 2.3.4. Haddock in Sub-Area IV and Division IIIa. MFDP input file (October revision).

MFDP version 1a
Run: filt01
Time and date: 02:10 15/10/2008
Fbar age range (Total) : 2-4
Fbar age range Fleet 1 : 2-4
Fbar age range Fleet 2 : 2-4

2008

Age	N	M	Mat	PF	PM	SWt
0	3261688	2.05	0	0	0	0.045
1	572734	1.65	0.01	0	0	0.152
2	148664	0.4	0.32	0	0	0.256
3	477642	0.25	0.71	0	0	0.394
4	19115	0.25	0.87	0	0	0.497
5	9558	0.2	0.95	0	0	0.617
6	4642	0.2	1	0	0	0.751
7	3977	0.2	1	0	0	1.037
8	56405	0.2	1	0	0	0.957

Catch

Age	Sel	CWt	DSel	DCWt
0	0	0	0.001	0.048
1	0.002	0.372	0.056	0.149
2	0.053	0.4	0.199	0.225
3	0.347	0.453	0.165	0.275
4	0.424	0.527	0.058	0.3
5	0.343	0.633	0.047	0.341
6	0.27	0.755	0.019	0.445
7	0.089	1.043	0.005	0.549
8	0.094	0.957	0.001	0.371

IBC

Age	Sel	CWt
0	0	0.0024
1	0.001	0.1016
2	0.001	0.178
3	0.003	0.2542
4	0.002	0.2832
5	0.001	0.3264
6	0.001	0.4258
7	0	0.5078
8	0	0.287

2009

Age	N	M	Mat	PF	PM	SWt
0	3261688	2.05	0	0	0	0.045
1	.	1.65	0.01	0	0	0.152
2	.	0.4	0.32	0	0	0.256
3	.	0.25	0.71	0	0	0.394
4	.	0.25	0.87	0	0	0.497
5	.	0.2	0.95	0	0	0.617
6	.	0.2	1	0	0	0.751
7	.	0.2	1	0	0	1.037
8	.	0.2	1	0	0	1.163

Catch

Age	Sel	CWt	DSel	DCWt
0	0	0	0.001	0.048
1	0.002	0.372	0.056	0.149
2	0.053	0.4	0.199	0.225
3	0.347	0.453	0.165	0.275
4	0.424	0.527	0.058	0.3
5	0.343	0.633	0.047	0.341
6	0.27	0.755	0.019	0.445
7	0.089	1.043	0.005	0.549
8	0.094	1.165	0.001	0.371

IBC

Age	Sel	CWt
0	0	0.0024
1	0.001	0.1016
2	0.001	0.178
3	0.003	0.2542
4	0.002	0.2832
5	0.001	0.3264
6	0.001	0.4258
7	0	0.5078
8	0	0.287

2010

Age	N	M	Mat	PF	PM	SWt
0	3261688	2.05	0	0	0	0.045
1	.	1.65	0.01	0	0	0.152
2	.	0.4	0.32	0	0	0.256
3	.	0.25	0.71	0	0	0.394
4	.	0.25	0.87	0	0	0.497
5	.	0.2	0.95	0	0	0.617
6	.	0.2	1	0	0	0.751
7	.	0.2	1	0	0	1.037
8	.	0.2	1	0	0	1.37

Catch

Age	Sel	CWt	DSel	DCWt
0	0	0	0.001	0.048
1	0.002	0.372	0.056	0.149
2	0.053	0.4	0.199	0.225
3	0.347	0.453	0.165	0.275
4	0.424	0.527	0.058	0.3
5	0.343	0.633	0.047	0.341
6	0.27	0.755	0.019	0.445
7	0.089	1.043	0.005	0.549
8	0.094	1.372	0.001	0.371

IBC

Age	Sel	CWt
0	0	0.0024
1	0.001	0.1016
2	0.001	0.178
3	0.003	0.2542
4	0.002	0.2832
5	0.001	0.3264
6	0.001	0.4258
7	0	0.5078
8	0	0.287

Input units are thousands and kg - output in tonnes

Table 2.3.5. Haddock in Sub-Area IV and Division IIIa. MFDP output table (October revision). Options are highlighted for the management plan target F, a 15% TAC increase, and the status quo F forecast (unshaded box).

MFDP version 1a
Run: filt01
Time and date: 02:10 15/10/2008
Fbar age range (Total) : 2-4
Fbar age range Fleet 1 : 2-4
Fbar age range Fleet 2 : 2-4

2008

Biomass	SSB	Catch FMult	Fbar	Landings FBar	Yield	Discards FBar	Yield	IBC FMult	Landings FBar	Yield
537068	222122	0.7145	0.2988	0.1963	49300	0.1005	17157	1	0.002	332

2009											2010		
Biomass	SSB	Catch FMult	Fbar	Landings FBar	Yield	Discards FBar	Yield	IBC FMult	Landings FBar	Yield	Biomass	SSB	
466019	211305	0	0.002	0.000	0	0	0	1	0.002	227	481238	238857	
.	211305	0.10	0.044	0.028	7083	0	1296	1	0.002	222	472101	230507	
.	211305	0.20	0.085	0.055	13869	0	2548	1	0.002	217	463354	222516	
.	211305	0.30	0.127	0.082	20371	0	3759	1	0.002	213	454978	214869	
.	211305	0.40	0.168	0.110	26603	0	4930	1	0.002	209	446957	207550	
.	211305	0.50	0.210	0.137	32577	0	6063	1	0.002	205	439274	200543	
.	211305	0.60	0.251	0.165	38303	0	7159	1	0.002	201	431915	193835	
	211305	0.67	0.278	0.183	41905	0	7855	1	0.002	198	427291	189622	(15% TAC decrease)
.	211305	0.70	0.293	0.192	43795	0	8220	1	0.002	197	424864	187412	
	211305	0.72	0.300	0.197	44711	0	8399	1	0.002	196	423689	186342	(plan target)
.	211305	0.80	0.334	0.220	49061	0	9248	1	0.002	193	418107	181260	
.	211305	0.90	0.376	0.247	54112	0	10243	1	0.002	190	411632	175368	
.	211305	1	0.417	0.275	58958	0	11208	1	0.002	186	405424	169723	(status quo)
.	211305	1.10	0.459	0.302	63607	0	12142	1	0.002	183	399473	164315	
.	211305	1.20	0.500	0.330	68070	0	13048	1	0.002	180	393767	159132	
.	211305	1.30	0.542	0.357	72353	0	13927	1	0.002	176	388294	154165	
.	211305	1.40	0.583	0.385	76466	0	14780	1	0.002	173	383044	149403	
.	211305	1.50	0.625	0.412	80415	0	15607	1	0.002	170	378007	144838	
.	211305	1.60	0.667	0.440	84209	0	16410	1	0.002	167	373173	140460	
.	211305	1.70	0.708	0.467	87853	0	17190	1	0.002	165	368534	136261	
.	211305	1.80	0.750	0.494	91354	0	17947	1	0.002	162	364080	132233	
.	211305	1.90	0.791	0.522	94720	0	18683	1	0.002	159	359804	128368	
.	211305	2	0.833	0.549	97955	0	19398	1	0.002	156	355697	124659	

Input units are thousands and kg - output in tonnes

2.4 Saithe in Sub-area IV, VI and Division IIIa

2.4.1 New survey information

The new data available for the recruitment (Age3) for a potential autumn forecast are the Norwegian acoustic survey (NORACU) and IBTS quarter 3 (IBTSq3).

2.4.2 RCT3 analysis

Following the protocol stipulated by AGCREFA (ICES 2008), an RCT3 analysis was run to provide an estimate of the abundance of the incoming (2005) year class at age 3. The RCT3 input and output files are given in Tables XXXX.1 and XXXX.2.

2.4.3 Update protocol calculations

The outcome of the application of the protocol was as follows:

CALCULATIONS FOR 2005 YEAR CLASS	
Log WAP from RCT3	10.92
Log of recruitment assumed in spring	11.75
Int SE of log WAP	0.41
Distance D	**-2.02**

2.4.4 Conclusions from protocol

Although the distance D is less than -1, the protocol emphasises that a reopening of the advice depends on new reliable survey information. The IBTSq3 and NORACU estimates of age 3 are very noisy and not reliable, and in addition previous saithe forecasts in the autumn have used geometric mean as number of recruits. **Therefore, the advisory process for saithe should not be reopened.**

Table 2.4.1. The RCT3 input data file updated with the North Sea saithe NORACU and IBTSq3 indices.

Saithe (all surveys)						
5	18	2				
1990	152036.3	0.289628	0.31072	-11	-11	7.965
1991	103066	0.122824	0.128608	-11	-11	1.117
1992	227364.2	0.215405	0.133799	0.054708	56244	13.959
1993	111232.7	0.055109	0.093812	0.026752	21480	3.825
1994	162610.5	0.084266	0.080331	0.037592	22585	3.756
1995	71020.84	0.058983	0.05614	0.029326	15180	1.027
1996	141791.4	0.058436	0.037791	0.015272	16933	2.1
1997	95650.01	0.102279	0.018299	0.044343	34551	3.479
1998	223838.7	0.113745	0.208084	0.081032	72108	21.496
1999	192653.9	0.297193	0.105342	0.050825	82501	10.748
2000	125031.2	0.143976	0.03914	0.034341	67774	19.272
2001	85752.75	0.085445	0.020259	0.024365	34153	4.979
2002	201691.9	0.13497	0.034378	0.037094	48446	8.893
2003	81703.97	0.29449	0.026399	0.034582	18909	10.636
2004	302274.2	0.508896	0.059308	0.079486	77958	34.018
2005	-11	-11	-11	-11	7123	3.426
2006	-11	-11	-11	-11	-11	-11
2007	-11	-11	-11	-11	-11	-11
FRATRB_IV						
NORTRL_IV2						
GER_OTB_IV						
NORACU						
IBTSq3						

Table 2.4..2. Saithe in Sub-area IV, VI and Division IIIa

```
Analysis by RCT3 ver3.1 of data from file :
 Age3ALL.txt
 Saithe (all available surveys)
 Data for    5 surveys over   18 years :  1990 - 2007
 Regression type = C
 Tapered time weighting not applied
 Survey weighting not applied
 Final estimates not shrunk towards mean
 Estimates with S.E.'S greater than that of mean
+                                                   included
 Minimum S.E. for any survey taken as    .00
 Minimum of   3 points used for regression

 Forecast/Hindcast variance correction used.

 Yearclass =   2005

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

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

 FRATRB
 NORTRL
 GER_OT
 NORACU    1.02   1.10    .46   .513     13   8.87   10.18     .651     .405
 IBTSq3     .73  10.34    .48   .469     15   1.49   11.43     .537     .595

                                        VPA Mean =   11.84     .432     .000

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

 2005       55369     10.92     .41     .62     2.21
 2006      No valid surveys
 2007      No valid surveys
```

2.5 Whiting in Sub-Area IV and VIID

2.5.1 New survey information

Research surveys were conducted by Scotland and England in the 3rd quarter of 2008. The surveys are used in conjunction with the IBTS quarter 1 survey for calibrating the assessment and providing indices of incoming recruitment.

2.5.2 RCT3 Analysis

RCT3 was run using the new information from the surveys to predict recruitment at age 1 in 2008. The input data are presented in Table 1 and the output in Tables 2, 3 and 4

2.5.3 Update protocol calculations

The change in whiting (age 1) recruitment estimates with respect to the age 1 autumn survey indices is significant (as defined by AGCREFA):

Spring RCT3:

Log WAP - 13.18 s.e. 0.26

English and Scottish groundfish surveys age 1 indices only (Table 2):

Log WAP - 13.76, s.e. 0.28, D = 2.07

English and Scottish groundfish survey age 1 2008 added (using update settings) (Table 3):

Log WAP - 13.39, s.e. 0.19, D = 1.12

In numbers this change corresponds to an increase in assumed recruitment in 2008 from 527,108 to 655,687 (both surveys).

2.5.4 Forecast

Although borderline, the absolute value is above 1 therefore the forecast was recalculated with the new recruitment. The forecast (Table 4) indicates the upward revision results resulting from the improved estimate of recruitment. An increase in status quo human consumption landings yield in 2009 from 13,000t to 14,000t and spawning stock biomass in 2010 from 62,000t to 66,000t. At F0.1 (0.19) human consumption landings are increased to 6.6 kt.

2.5.5 Conclusions

The indices indicate a potential for reopening the advice based on the statistic devised by AGCREFA, the forecast based on the new indices would increase catches by 12% over the advised 5.9 kt and spawning stock biomass in 2010 by 7%.

Table 2.5.1 The RCT3 input data file updated with the North Sea whiting CPUE from the third quarter English and Scottish surveys.

Whi4&7d (age 1)

6	28	2					
1980	1719962	-11	-11	-11	-11	-11	-11
1981	1945655	-11	-11	-11	-11	-11	**125.03**
1982	1743370	-11	-11	-11	-11	**126.62**	**177.97**
1983	2598981	-11	-11	-11	-11	**434.487**	**362.26**
1984	1888964	-11	-11	-11	-11	**339.177**	**268.27**
1985	3923596	-11	-11	-11	-11	**468.744**	**561.08**
1986	3276261	-11	-11	-11	-11	**684.898**	**865.72**
1987	2298262	-11	-11	-11	-11	**447.989**	**538.56**
1988	4391961	-11	-11	-11	-11	**1446.08**	**862.35**
1989	2009923	-11	-11	-11	-11	**518.936**	**686.45**
1990	1871546	-11	-11	-11	-11	**1007.621**	**665.71**
1991	1827868	-11	**48.725**	-11	-11	**907.297**	**522.81**
1992	1979243	**83.597**	**46.184**	-11	-11	**1075.624**	**627.41**
1993	1785087	**46.215**	**54.225**	-11	-11	**721.709**	**448.48**
1994	1556267	**38.747**	**65.114**	-11	-11	**678.59**	**485.97**
1995	1041537	**66.593**	**34.718**	-11	-11	**502.361**	**342.21**
1996	757314	**18.26**	**28.386**	-11	-11	**287.733**	**160.70**
1997	1020411	**90.277**	**32.655**	-11	**4141**	**543.117**	**305.45**
1998	1589364	**292.561**	**82.023**	**12302**	**5410**	**676.27**	**537.86**
1999	1683317	**194.674**	**110.707**	**15276**	**6646**	**756.865**	**598.39**
2000	1294076	**129.295**	**100.926**	**17076**	**3499**	**648.649**	**416.82**
2001	1069939	**183.899**	**114.831**	**117**	**4980**	**670.591**	**298.87**
2002	394732	**9.766**	**13.328**	**1606**	**1891**	**131.601**	**90.95**
2003	401766	**27.637**	**10.207**	**5393**	**2580**	**184.576**	**55.97**
2004	454231	**117.519**	**23.135**	**2553**	**1355**	**167.629**	**92.38**
2005	422623	**13.157**	**11.902**	**1765**	**1580**	**223.005**	**167.02**
2006	-11	**20.354**	**12.042**	**397**	**960**	**42.474**	**324.28**
2007	-11	**171.49**	**71.008**	**4874**	**2651**	**144.191**	-11

egfs0
egfs1
sgfs0
sgfs1
ibts1
ibts2

Table 2.5.2 The RCT3 ouput file including updated the third quarter English and Scottish surveys - only the age 1 indices for these surveys are used in this run.

```
 Analysis by RCT3 ver3.1 of data from file : whinew.txt
Whi4&7d (age 1)
Data for    2 surveys over   28 years :  1980 - 2007
Regression type = C
Tapered time weighting applied
power =    3 over  18 years
Survey weighting not applied
Final estimates not shrunk towards mean
Estimates with S.E.'S greater than that of mean included
Minimum S.E. for any survey taken as    .00
Minimum of   3 points used for regression

Forecast/Hindcast variance correction used.

Yearclass =   2007

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

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

egfs1      .75  10.91    .32   .808     15   4.28   14.10     .382     .521
sgfs1     1.20   3.95    .33   .813      9   7.88   13.39     .399     .479

                                       VPA Mean =   13.61     .614     .000

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

2007      944244     13.76     .28     .35     1.65
```

Table 2.5.3 The RCT3 ouput file including updated the third quarter English and Scottish survey.

Analysis by RCT3 ver3.1 of data from file :

Whirec1.txt

Whi4&7d (age 1) update run

Data for 6 surveys over 28 years : 1980 - 2007

Regression type = C

Tapered time weighting applied

power = 3 over 18 years

Survey weighting not applied

Final estimates shrunk towards mean

Minimum S.E. for any survey taken as .30

Minimum of 3 points used for regression

Forecast/Hindcast variance correction used.

Yearclass = 2007

	I-----------Regression	----------	---------I		I-----------Prediction	---------	---------I		
Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
egfs0	.74	10.54	.63	.512	14	5.15	14.36	.775	.058
egfs1	.75	10.91	.32	.808	15	4.28	14.10	.382	.239
sgfs0	1.30	3.07	2.21	.093	8	8.49	14.08	2.777	.005
sgfs1	1.20	3.95	.33	.813	9	7.88	13.39	.399	.219
ibts1	.91	8.24	.17	.937	24	4.98	12.76	.217	.387
ibts2									
					VPA Mean =		13.61	.614	.092

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
2007	655687	13.39	.19	.26	1.93		

Table 2.5.4The input data for the MFDP whiting in the North Sea and VIId update forecast.

MFDP version 1a
Run: update
Time and date: 11:54 08/10/2008
Fbar age range (Total) : 2-6
Fbar age range Fleet 1 : 2-6
Fbar age range Fleet 2 : 2-6

2008

Age	N	M	Mat	PF	PM	SWt
1	655687	0.95	0.11	0	0	0.100
2	90791	0.45	0.92	0	0	0.197
3	64470	0.35	1	0	0	0.242
4	27775	0.30	1	0	0	0.284
5	9787	0.25	1	0	0	0.305
6	7411	0.25	1	0	0	0.323
7	15053	0.20	1	0	0	0.319
8	12007	0.20	1	0	0	0.319

Catch

Age	Sel	CWt	DSel	DCWt
1	0.042	0.208	0.058	0.088
2	0.150	0.255	0.245	0.168
3	0.237	0.280	0.207	0.204
4	0.285	0.304	0.125	0.230
5	0.345	0.323	0.095	0.237
6	0.370	0.345	0.097	0.242
7	0.289	0.335	0.065	0.247
8	0.272	0.345	0.081	0.231

IndBycatch

Age	Sel	CWt
1	0.074	0.043
2	0.023	0.125
3	0.022	0.196
4	0.011	0.253
5	0.002	0.363
6	0.002	0.413
7	0.001	0.556
8	0.002	0.528

2009

Age	N	M	Mat	PF	PM	SWt
1	417712	0.95	0.11	0	0	0.100
2	.	0.45	0.92	0	0	0.197
3	.	0.35	1	0	0	0.242
4	.	0.30	1	0	0	0.284
5	.	0.25	1	0	0	0.305
6	.	0.25	1	0	0	0.323
7	.	0.20	1	0	0	0.319
8	.	0.20	1	0	0	0.319

Catch

Age	Sel	CWt	DSel	DCWt
1	0.042	0.208	0.058	0.088
2	0.150	0.255	0.245	0.168
3	0.237	0.280	0.207	0.204
4	0.285	0.304	0.125	0.230
5	0.345	0.323	0.095	0.237
6	0.370	0.345	0.097	0.242
7	0.289	0.335	0.065	0.247
8	0.272	0.345	0.081	0.231

IndBycatch

Age	Sel	CWt
1	0.074	0.043
2	0.023	0.125
3	0.022	0.196
4	0.011	0.253
5	0.002	0.363
6	0.002	0.413
7	0.001	0.556
8	0.002	0.528

2010

Age	N	M	Mat	PF	PM	SWt
1	417712	0.95	0.11	0	0	0.100
2	.	0.45	0.92	0	0	0.197
3	.	0.35	1	0	0	0.242
4	.	0.30	1	0	0	0.284
5	.	0.25	1	0	0	0.305
6	.	0.25	1	0	0	0.323
7	.	0.20	1	0	0	0.319
8	.	0.20	1	0	0	0.319

Catch

Age	Sel	CWt	DSel	DCWt
1	0.042	0.208	0.058	0.088
2	0.150	0.255	0.245	0.168
3	0.237	0.280	0.207	0.204
4	0.285	0.304	0.125	0.230
5	0.345	0.323	0.095	0.237
6	0.370	0.345	0.097	0.242
7	0.289	0.335	0.065	0.247
8	0.272	0.345	0.081	0.231

IndBycatch

Age	Sel	CWt
1	0.074	0.043
2	0.023	0.125
3	0.022	0.196
4	0.011	0.253
5	0.002	0.363
6	0.002	0.413
7	0.001	0.556
8	0.002	0.528

Table 2.5.5 The update whiting in the North Sea and VIId forecast.

2008

Biomass	SSB	Catch FMult	Landings FBar	Yield	Discards FBar	Yield	IndBycatch FMult	Landings FBar	Yield
120975	61188	1	0.277	13866	0.154	7576	1	0.012	1699

2009										2010	
Biomass	SSB	Catch FMult	Landings FBar	Yield	Discards FBar	Yield	IndBycatch FMult	Landings FBar	Yield	Biomass	SSB
112862	72331	0	0.000	0	0.000	0	1	0.012	1555	126871	87332
112862	72331	0.1	0.028	1626	0.015	1085	1	0.012	1538	124378	84862
112862	72331	0.2	0.055	3199	0.031	2134	1	0.012	1522	121975	82482
112862	72331	0.3	0.083	4719	0.046	3148	1	0.012	1506	119659	80189
112862	72331	0.4	0.111	6189	0.062	4129	1	0.012	1490	117426	77979
112862	72331	0.43	0.119	6621	0.066	4416	1	0.012	1485	116771	77331
112862	72331	0.5	0.139	7611	0.077	5077	1	0.012	1474	115273	75849
112862	72331	0.6	0.166	8987	0.092	5995	1	0.012	1459	113197	73796
112862	72331	0.7	0.194	10318	0.108	6882	1	0.012	1444	111195	71816
112862	72331	0.8	0.222	11606	0.123	7742	1	0.012	1430	109265	69908
112862	72331	0.9	0.250	12852	0.139	8573	1	0.012	1416	107403	68067
112862	**72331**	**1**	**0.277**	**14059**	**0.154**	**9378**	**1**	**0.012**	**1402**	**105606**	**66293**
112862	72331	1.1	0.305	15227	0.169	10157	1	0.012	1388	103873	64581
112862	72331	1.2	0.333	16358	0.185	10911	1	0.012	1375	102201	62930
112862	72331	1.3	0.360	17454	0.200	11642	1	0.012	1362	100587	61337
112862	72331	1.4	0.388	18515	0.216	12349	1	0.012	1349	99029	59800
112862	72331	1.5	0.416	19544	0.231	13035	1	0.012	1336	97525	58317
112862	72331	1.6	0.444	20540	0.246	13699	1	0.012	1324	96074	56885
112862	72331	1.7	0.471	21506	0.262	14343	1	0.012	1312	94672	55504
112862	72331	1.8	0.499	22443	0.277	14967	1	0.012	1300	93319	54170
112862	72331	1.9	0.527	23351	0.293	15572	1	0.012	1289	92011	52882
112862	72331	2	0.555	24232	0.308	16159	1	0.012	1277	90748	51639

2.6 North Sea plaice

2.6.1 New survey information

In spring, the assumptions made on the recruitment of North Sea plaice ages 1 and 2 were

Year class	At age in 2008	XSA Survivors	RCT3	GM 1957-2005	Accepted estimate
2006	2	769722	**746834**	675366	RCT3 estimate
2007	1		1 015 480	**910440**	GM 1957-2005

The new survey information that is available comes from the Beam Trawl Survey RV Isis (BTS-Isis) that was initiated in 1985 and was set up to obtain indices of the younger age groups of plaice and sole, covering the south-eastern part of the North Sea (RV Isis). It uses an 8-m beam trawl with 40 mm stretched mesh codend. This year, owing to bad weather conditions, some ICES rectangles in the index area could not be sampled by BTS ISIS. Therefore, 8 TRIDENS-hauls in ICES squares 35F3, 36F3, 36F4 en 37F4, have been converted to ISIS-hauls using the relative gear efficiency estimations in the WG beam report of 2005.

2.6.2 RCT3 Analysis

The RCT3 analysis on the BTS ISIS survey indices for ages 1 and 2 was conducted as specified in the Report of the Ad hoc Group on Criteria for Reopening Fisheries Advice (AGCREFA; ICES CM 2008/ACOM:60). Hence, the specifications for the RCT3 were:

Regression type?	C
Tapered time weighting required?	N
Shrink estimates toward mean?	N
Exclude surveys with SE's greater than that of mean:	N
Enter minimum log S.E. for any survey:	0.0
Min. no. of years for regression (3 is the default)	3
Apply prior weights to the surveys?	N

The input data including the assessment estimates for the two ages are presented in table 2.7.1. In 2008, the new data comprises age 1 of year class 2007 and age 2 of year class 2006. The last 4 years from the assessment estimates were removed from the time series.

The outcomes from the RCT3 analyses for the two ages are presented in table 2.7.1 and 2.7.2. For age 1, year class 2007 is estimated to be 1024271, with an internal standard error (on the log scale) of 0.84. For age 2, year class 2006 is estimated to be 854632, with an internal standard error (on the log scale) of 0.38.

2.6.3 Update protocol calculations

For age 1, the recruitment estimate in spring was 910440, based on the geometric mean from the assessment estimates. The RCT3 estimate of year class strength based on the BTS ISIS survey is 1024271. Given the internal standard error, the D value for this age is thus (13.84 - log(910440))/0.84 = 0.141, being a small positive signal, smaller than 1

For age 2, the recruitment estimate in spring was 746834, based on RCT3 estimates of surveys in 2007 and 2006. The new RCT3 estimate of year class strength based on the BTS ISIS survey is 854632. Given the internal standard error, the D value for this age is thus (13.66 - log(746834))/0.38= 0.359 being a small positive signal, smaller than 1.

2.6.4 Conclusions from protocol

Following the AGCREFA protocol, the new available survey indices for North Sea plaice ages 1 and 2 do not indicate a survey signal strong enough to justify the re-opening of advice.

2.6.5 Forecast or not

No forecast is needed, given that no D values >1 are found.

Table 2.6.1 North Sea plaice RCT3 input data

Year	XSA age1	BTS Isis age1	XSA age2	BTS Isis age2
1983	-11	-11	843034	179.9
1984	1846108	115.58	1284699	131.77
1985	4747571	667.44	3231336	764.29
1986	1946926	225.82	1417764	146.99
1987	1769555	680.17	1269564	319.27
1988	1187569	467.88	870469	102.64
1989	1036356	115.31	798032	122.05
1990	914002	185.45	651439	125.93
1991	776668	176.97	567527	179.1
1992	531257	124.76	385738	64.217
1993	442179	145.21	339682	43.55
1994	1163967	252.16	932762	212.32
1995	1291842	218.28	1062033	-11
1996	2106563	-11	1782870	431.9
1997	770467	342.51	597522	130
1998	837778	305.9	636419	74.399
1999	986285	277.61	799016	78.438
2000	664506	222.71	571292	47.742
2001	1912327	541.25	1291075	170.08
2002	530130	126.11	408206	41.75
2003	1074896	226.2	810204	69.604
2004	-11	158.45	-11	38.994
2005	-11	135.11	-11	72.294
2006	-11	329.34	-11	130.58
2007	-11	235.37	-11	-11

Table 2.6.2 North Sea plaice RCT3 output for age 1

Analysis by RCT3 ver3.1 of data from file : ple_iv1n.txt, NS Plaice Age 1, 1 survey over 1984 - 2007

Regression type = C, Tapered time weighting not applied, Survey weighting not applied
Final estimates not shrunk towards mean
Estimates with S.E.'S greater than that of mean
+ included
Minimum S.E. for any survey taken as .00, Minimum of 3 points used for regression

Forecast/Hindcast variance correction used.

2007 I-----------Regression--------------------I I-----------Prediction---------------------I

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
BTS1	1.67	4.74	.77	.365	19	5.47	13.84	.837	1.000
						VPA Mean =	13.93	.573	.000

Year Class	Weighted Average Prediction	Log WAP	Int Std Error
2007	1024271	13.84	.84

Table 2.6.3 North Sea plaice RCT3 output for age 2

Analysis by RCT3 ver3.1 of data from file : ple_iv2n.txt, NS Plaice Age 2, 1 survey over 1983 - 2006

Regression type = C, Tapered time weighting not applied, Survey weighting not applied
Final estimates not shrunk towards mean
Estimates with S.E.'S greater than that of mean
+ included
Minimum S.E. for any survey taken as .00, Minimum of 3 points used for regression

Forecast/Hindcast variance correction used.

2006 I-----------Regression--------------------I I-----------Prediction---------------------I

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
BTS2	.86	9.48	.35	.724	20	4.88	13.66	.376	1.000
						VPA Mean =	13.64	.537	.000

Year Class	Weighted Average Prediction	Log WAP	Int Std Error
2006	854632	13.66	.38

2.7 North Sea sole

2.7.1 New survey information

In spring, the assumptions made on the recruitment of North Sea sole ages 1 and 2 were

Year Class	Age in 2008	XSA thousands	RCT3 thousands	GM(1957-2004) thousands
2006	2	**52 642**	56 700	84 500
2007	1		65 700	**93 570**

The new survey information that is available comes from the Beam Trawl Survey RV Isis (BTS-Isis) that was initiated in 1985 and was set up to obtain indices of the younger age groups of plaice and sole, covering the south-eastern part of the North Sea (RV Isis). It uses an 8-m beam trawl with 40 mm stretched mesh codend. This year, owing to bad weather conditions, some ICES rectangles in the index area could not be sampled by BTS ISIS. Therefore, 8 TRIDENS-hauls in ICES squares 35F3, 36F3, 36F4 en 37F4, have been converted to ISIS-hauls using the relative gear efficiency estimations in the WG beam report of 2005.

2.7.2 RCT3 Analysis

The RCT3 analysis on the BTS ISIS survey indices for ages 1 and 2 was conducted as specified in the Report of the Ad hoc Group on Criteria for Reopening Fisheries Advice (AGCREFA; ICES CM 2008/ACOM:60). Hence, the specifications for the RCT3 were:

Regression type?	C
Tapered time weighting required?	N
Shrink estimates toward mean?	N
Exclude surveys with SE's greater than that of mean:	N
Enter minimum log S.E. for any survey:	0.0
Min. no. of years for regression (3 is the default)	3
Apply prior weights to the surveys?	N

The input data including the assessment estimates for the two ages are presented in table 2.7.1. In 2008, the new data comprises age 1 of year class 2007 and age 2 of year class 2006. The last 4 years from the assessment estimates were removed from the time series.

The outcomes from the RCT3 analyses for the two ages are presented in table 2.7.1 and 2.7.2. For age 1, year class 2007 is estimated to be 121456, with an internal standard error (on the log scale) of 0.39. For age 2, year class 2006 is estimated to be 77730, with an internal standard error (on the log scale) of 0.53.

2.7.3 Update protocol calculations

For age 1, the recruitment estimate in spring was 93570, based on the geometric mean from the assessment estimates. The RCT3 estimate of year class strength based on the BTS ISIS survey is 121456. Given the internal standard error, the D value for this age is thus (11.71 - log(93570))/0.39 = 0.676, being a small positive signal, smaller than 1

For age 2, the recruitment estimate in spring was 52 642, based on RCT3 estimates of surveys in 2007 and 2006. The new RCT3 estimate of year class strength based on the BTS ISIS survey is 77730. Given the internal standard error, the D value for this age is thus (11.26 - log(52642))/0.53= 0.733 being a small positive signal, smaller than 1.

2.7.4 Conclusions from protocol

Following the AGCREFA protocol, the new available survey indices for North Sea sole ages 1 and 2 do not indicate a survey signal strong enough to justify the reopening of advice.

2.7.5 Forecast or not

No forecast is needed, given that no D values >1 are found.

Table 2.7.1 North Sea sole RCT3 input data

Year class	XSA age1	BTS Isis age1	XSA age2	BTS Isis age2
1983	-11	-11	63851	7.89
1984	80799	2.65	72953	4.49
1985	159603	7.88	144059	12.55
1986	72529	6.97	65537	12.51
1987	454315	83.11	411071	68.08
1988	108277	9.02	97862	22.36
1989	177690	22.6	159960	23.19
1990	70469	3.71	63649	23.2
1991	354078	74.44	319451	27.36
1992	69269	4.99	62626	4.99
1993	57048	5.88	50936	8.46
1994	96086	27.86	82375	6.17
1995	49489	3.51	44616	5.37
1996	271595	173.94	244237	29.21
1997	114114	14.12	103023	19.26
1998	82525	11.41	74399	6.53
1999	123016	14.46	109074	10.71
2000	63299	8.17	56435	4.17
2001	190139	21.9	171042	10.55
2002	85696	10.76	76544	4.4
2003	46221	3.65	41331	3.3
2004	45123	3.14	-11	2.44
2005	-11	16.82	-11	19.97
2006	-11	5.805	-11	8.87
2007	-11	15.04	-11	-11

Table 2.7.2 North Sea sole RCT3 output for age 1

Analysis by RCT3 ver3.1 of data from file : sol_iv1n.txt, NS Sole Age 1, 1 survey over 1984 - 2007

Regression type = C, Tapered time weighting not applied, Survey weighting not applied
Final estimates not shrunk towards mean
Estimates with S.E.'S greater than that of mean
+ included
Minimum S.E. for any survey taken as .00, Minimum of 3 points used for regression,

Forecast/Hindcast variance correction used.

2007 I-----------Regression--------------------I I-----------Prediction---------------------I

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
BTS1	.70	9.76	.36	.778	21	2.78	11.71	.387	1.000
						VPA Mean =	11.56	.655	.000

Year Class	Weighted Average Prediction	Log WAP	Int Std Error
2007	121456	11.71	.39

Table 2.7.3 North Sea sole RCT3 output for age 1

Analysis by RCT3 ver3.1 of data from file: sol_iv2n.txt, NS Sole Age 2, 1 survey over 1983 - 2006

Regression type = C,Tapered time weighting not applied, Survey weighting not applied
Final estimates not shrunk towards mean
Estimates with S.E.'S greater than that of mean
+ included
Minimum S.E. for any survey taken as .00, Minimum of 3 points used for regression

Forecast/Hindcast variance correction used.

2006 I-----------Regression--------------------I I-----------Prediction---------------------I

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
BTS2	1.08	8.80	.49	.639	21	2.29	11.26	.529	1.000
						VPA Mean =	11.47	.635	.000

Year Class	Weighted Average Prediction	Log WAP	Int Std Error
2006	77730	11.26	.53

Annex 3: Stock Annexes

Quality handbook: Plaice in Division VIId

Working Group: **ICES Working Group for the Assessment of Demersal Stocks in the North Sea and Skagerrak (WGNSSK)**

General

Stock Definition

There is mixing of plaice between the North Sea and VIId both as adults and juveniles. Analysis of tagging data shows that around 40% of the juvenile plaice in VIId come from nursery grounds in the North Sea. The eastern Channel supplies very few recruits to the North Sea. There is also an adult migration between the North Sea and Channel with 20-30% of the plaice caught in the winter in VIId were from migratory North Sea fish. Separation between VIId and the western Channel (VIIe) is much clearer. VIId does not receive significant numbers of juvenile plaice from VIIe but contributes around 20% of the recruits to VIIe. Similarly, around 20% of the adult plaice spawning in VIId may have spent part of the year in VIIe but few plaice tagged in VIIe during the spawning period are recaptured in VIId. It can be concluded that there is considerable interchange of plaice from the North Sea into VIId but a much smaller interchange between VIId and VIIe. Since the exploitation patterns between the three areas are very different, it has been concluded that separate assessments should be carried out.

The management area for channel plaice is a combined one between VIId and VIIe. TACs are obtained by combining the agreed TAC from each area.

Fishery

Plaice is mainly caught in beam trawl fisheries for sole or in mixed demersal fisheries using otter trawls. There is also a directed fishery during parts of the year by inshore trawlers and netters on the English and French coasts. The main fleet segments are the English and Belgian beam trawlers. The Belgian beam trawlers fish mainly in the 1st and 4th quarters and their area of activity covers almost the whole of VIId south of the 6 mile contour from the English coast. There is only light activity by this fleet between April and September. The second offshore fleet is mainly large otter trawlers from Boulogne, Dieppe and Fecamp. The target species of these vessels are cod, whiting, plaice mackerel, gurnards and cuttlefish and the fleet operates throughout VIId. The inshore trawlers and netters are mainly vessels <10m operating on a daily basis within 6 miles of the coast. There are a large number of these vessels (in excess of 400) operating from small ports along the French and English coast. These vessels target sole, plaice, cod and cuttlefish.

The minimum landing size for plaice is 27cm. Demersal gears permitted to catch plaice are 80mm for beam trawling and 100mm for otter trawlers. Fixed nets are required to use 100mm mesh since 2002 although an exemption to permit 90mm has been in force since that time.

There is widespread discarding of plaice, especially from beam trawlers. The 25 and 50% retention lengths for plaice in an 80mm beam trawl are16.4cm and 17.6cm respectively which are substantially below the MLS. Routine data on discarding is not available but comparison with the North Sea suggests that discarding levels in excess of 40% by weight are likely. Discard survival from small otter trawlers can be in excess of 50% (Millner et al., 1993). In comparison discard mortality from large beam trawlers has been found to be between less than 20% after a 2h haul and up to 40% for a one-hour tow (van Beek et al 1989).

Ecosystem Aspects

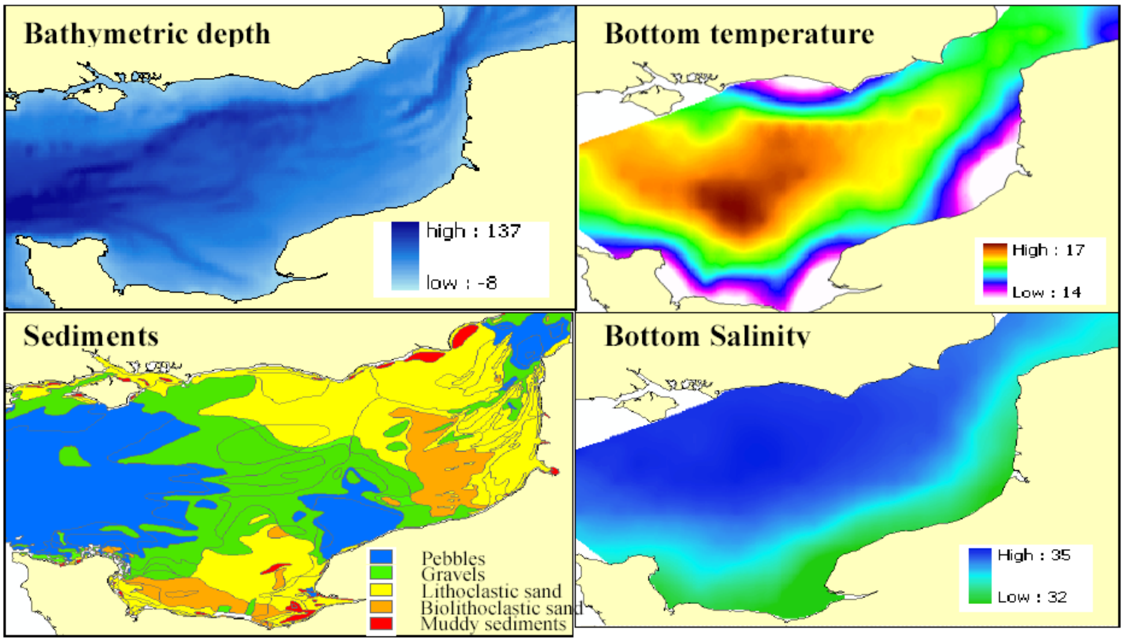

Figure 1 Eastern English Channel physical and hydrological features: Bathymetric depth and simplified sediment types representation. Survey bottom temperature and bottom salinity (averaged for 1997 to 2003) obtained by kriging. (in Vaz *et al.* 2004)

Biology : Adult plaice feed essentially on annelid polychaetes, bivalve molluscs, coelenterates, crustaceans, echinoderms, and small fish. In the English Channel, spawning occurs from December to March between 20 and 40 m. depth. At the beginning, pelagic eggs float at the surface and then progressively sink into deeper waters during development. Hatching occurs 20 (5-6°C) to 30 (2-2.5°C) days after fertilization. Larvae spend about 40 days in the plankton before migrating to the bottom and moving to coastal waters when metamorphosing (10-17 mm). The fry undergo relatively fast growth during the first year (*Carpentier et al., 2005*).

Environment: This bentho-demersal species prefers living on sand but also gravel or mud bottoms, from the coast to 200 m depth. The sepcies is found from marine to brackish waters in temperate climate (*Carpentier et al., 2005*)..

Geographical distribution : Northeast Atlantic, from northern Norway and Greenland to Morocco, including the White Sea; Mediterranean and Black Seas (*Carpentier et al., 2005*)..

Vaz et al. (2007) used a multivariate and spatial analyses to identify and locate fish, cephalopod, and macrocrustacean species assemblages in the eastern English Channel from 1988 to 2004. Four sub-communities with varying diversity levels were identified in relation to depth, salinity, temperature, seabed shear stress, sediment type, and benthic community nature. One Group (class 4 in Fig.2 below) was a coastal heterogeneous community represented by pouting, poor cod, and sole and was classified as preferential for many flatfish and gadoids. It displayed the greatest diversity and was characterized by heterogeneous sediment type (from muds to coarse sands) and various associated benthic community types, as well as by coastal hydrology and bathymetry. It was mostly near the coast, close to large river estuaries, and in areas subject to big salinity and temperature variations. Possibly resulting from this potentially heterogeneous environment (both in space and in time), this sub-community type was the most diverse.

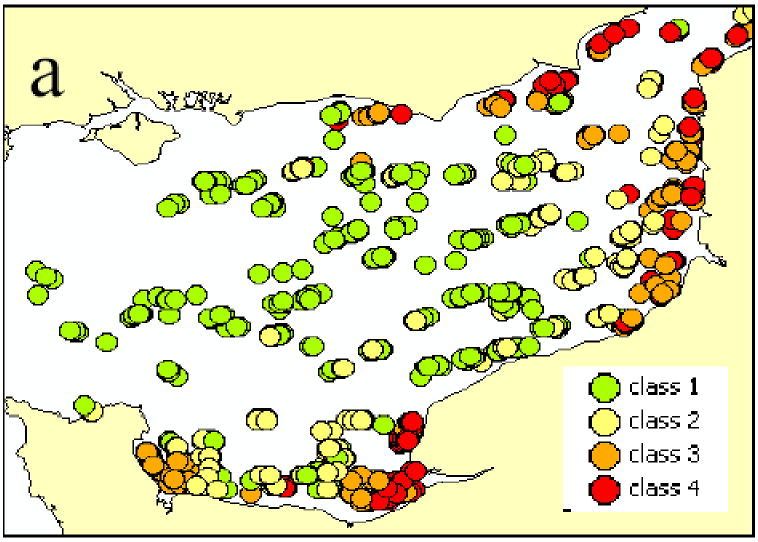

Figure 2 : Spatial distribution of Fish Subcommunities in the Eastern Channel from 1988 to 2003. Observed assemblage type at each station, These illustrate the gradation from open sea community to coastal and estuarine communities. (In Vaz *et al.*, 2004)

Community evolution over time : (From Vaz *et al.*, 2007). The community relationship with its environment was remarkably stable over the 17 y of observation. However, community structure changed significantly over time without any detectable trend, as did temperature and salinity. The community is so strongly structured by its environment that it may reflect interannual climate variations, although no patterns could be distinguished over the study period. The absence of any trend in the structure of the eastern English Channel fish community suggests that fishing pressure and selectivity have not altered greatly over the study period at least. However, the period considered here (1988–2004) may be insufficient to detect such a trend.

Data

Commercial Catch

The landings are taken by three countries France (55% of combined TAC), England (29%) and Belgium (16%). Quarterly catch numbers and weights were available for a range of years depending on country; the availability is presented in the text table below. Levels of sampling prior to 1985 were poor and these data are considered to be less reliable. In 2001 international landings covered by market sampling schemes represented the majority of the total landings.

Belgium

Belgian commercial landings and effort information by quarter, area and gear are derived from log-books (CHECK).

Sampling for age and length occurs for the beam trawl fleet (main fleet operating in Belgium).

Quarterly sampling of landings takes place at the auctions of Zeebrugge and Oostende (main fishing ports in Belgium). Length is measured to the cm below. Samples are raised per market category to the catches of both harbours.

Quarterly otolith samples are taken throughout the length range of the landings (sexes separated). These are aged and combined to the quarterly level. The ALK is used to obtain the quarterly age distribution from the length distribution.

In 2003 a pilot study started on on-board sampling with respect to discarded and retained catch.

France

French commercial landings in tonnes by quarter, area and gear are derived from log-books for boats over 10m and from sales declaration forms for vessels under 10m. These self declared production are then linked to the auction sales in order to have a complete and precise trip description.

The collection of discard data has begun in 2003 within the EU Regulation 1639/2001. This first year of collection will be incomplete in term of time coverage, therefore the use of these data should be investigated only from 2005.

The length measurements are done by market commercial categories and by quarter into the principal auctions of Grandcamp, Port-en-Bessin, Dieppe and Boulogne. Samplings from Grandcamp and Port-en-Bessin are used for raising catches from Cherbourg to Fecamp and samplings from Dieppe and Boulogne are used to raise the catches from Dieppe to Dunkerque

Otoliths samples are taken by quarter throughout the length range of the landed catch for quarters 1 to 3 and from the october GFS survey in quarter 4. These are aged and combined to the quarterly level and the age-length key thus obtained is used to transform the quarterly length compositions. The length not sampled during one quarter are derived from the same year close quarter.

Weight, sex and maturity at length and at age are obtained from the fish sampled for the age-length keys.

England

English commercial landings in tonnes by quarter, area and gear are derived from the sales notes statistics for vessels under 12m who do not complete logbooks. For those over 12m (or >10m fishing away for more than 24h), data is taken from the EC logbooks. Effort and gear information for the vessels <10m is not routinely collected and is obtained by interview and by census. . No information is collected on discarding from vessels <10m. Discarding from vessels >10m has been obtained since 2002 under the EU Data Collection Regulation.

The gear group used for length measurements are beam trawl, otter trawl and net.

Separate-sex length measurements are taken from each of the gear groupings by trip. Trip length samples are combined and raised to monthly totals by port and gear group. Months and ports are then combined to give quarterly total length compositions by gear group; unsampled port landings are added in at this stage. Quarterly length compositions are added to give annual totals by gear. These are for reference only, as ALK conversion takes place at the quarterly level. Otoliths samples are taken by 2cm length groups separately for each sex throughout the length range of the landed catch. These are aged and combined to the quarterly level, and include all ports, gears and months. The quarterly sex-separate age-length-keys are used to transform quarterly length compositions by gear group to quarterly age compositions.

A minimum of 24 length samples are collected per gear category per quarter. Age samples are collected by sexes separately and the target is 300 otoliths per sex per quarter. If this is not reached, the 1st and 2nd or 3rd and 4th quarters are combined.

The text table below shows which country supplies which kind of data:

Country	Numbers	Weights-at-age
Belgium	1981-present	1986-present
France	1989- present	1989- present
UK	1980- present	1989- present

Data are supplied as FISHBASE files containing quarterly numbers at age, weight at age, length at age and total landings. The files are aggregated by the stock co-ordinator to derive the input VPA files in the Lowestoft format. No SOP corrections are applied to the data because individual country SOPs are usually better than 95%. The quarterly data files by country can be found with the stock co-ordinator

The resulting files (FAD data) can be found at ICES and with the stock co-ordinator, either in the IFAP system as SAS datasets or as ASCII files on the Lowestoft format, either under w:\acfm\nsskwg\2002\data\ple_eche or w:\ifapdata\eximport\nsskwg\ple_eche.

Biological

Natural mortality

Natural mortality was assumed constant over ages and years at 0.1 as in the North Sea.

Maturity

The maturity ogive used assumes that 15% of age 2, 53% of age 3 and 96% of age 4 are mature and 100% for ages 5 and older.

Weight at age

Prior to 2001, stock weights were calculated from a smoothed curve of the catch weights interpolated to the 1st January. From 2001, second quarter catch weights were used as stock weights in order to be consistent with North Sea sole. The database was revised back to 1990.

Proportion mortality before spawning

Both the proportion of natural mortality before spawning (Mprop) and the proportion of fishing mortality before spawning (Fprop) are set to 0.

Surveys

A dedicated 4m beam trawl survey for plaice and sole has been carried out by England using the RV Corystes since 1988. The survey covers the whole of VIId and is a depth stratified survey with most samples allocated to the shallower inshore stations where the abundance of sole is highest. In addition, inshore small boat surveys using 2m beam trawls are undertaken along the English coast and in a restricted area of the Baie de Somme on the French coast. In 2002, The English and French Young Fish Surveys were combined into an International Young Fish Survey. The dataset was revised for the period back to 1987. The two surveys operate with the same gear (beam trawl) during the same period (September) in two different nursery areas. Previous analysis (Riou et al, 2001) has shown that asynchronous spawning occurs for flatfish in Division VIId. Therefore both surveys were combined based on weighting of the individual index with the area nursery surface sampled (Cf. Annex 1). Taking into account the low, medium, and high potential area of recruitment, the French YFS got a weight index of 55% and the English YFS of 45%.

A third survey consists of the French otter trawl groundfish survey (FR GFS) in October

(Annex 2). Prior to 2002, the abundance indices were calculated by splitting the survey area into five zones, calculating a separate index for each zone each zone, and then averaging to obtain the final GFS index. This procedure was not thought to be entirely satisfactory, as the level of sampling was inconsistent across geographical strata. A new procedure was developed based on raising abundance indices to the level of ICES rectangles, and then by averaging those to calculate the final abundance index. Although there are only minor differences between the two indices, the revised method was used in 2002 and subsequently.

Commercial CPUE

Three commercial fleets have been used in tuning. UK inshore trawlers, Belgian beam trawl fleet and French otter trawlers as well as three survey fleets.

The effort of the French otter trawlers is obtained by the log-books information on the duration of the fishing time weighted by the engine power (in KW) of the vessel. Only trips where sole and/or plaice have been caught is accounted for.

Other Relevant Data

None.

Historical Stock Development

Deterministic Modelling

Model used: XSA

Software used: IFAP / Lowestoft VPA suite

Model Options chosen:

Tapered time weighting not applied

Catchability independent of stock size for all ages

Catchability independent of age for ages >= 7

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

S.E. of the mean to which the estimate are shrunk = 0.500

Minimum standard error for population estimates derived from each fleet = 0.300

Prior weighting not applied

Input data types and characteristics:

Catch data available for 1982-present year. However, there was no French age compositions before 1986 and large catchability residuals were observed in the commercial data before 1986. In the final analyses only data from 1986-present were used in tuning.

TYPE	NAME	YEAR RANGE	AGE RANGE	VARIABLE FROM YEAR TO YEAR YES/NO
Caton	Catch in tonnes	1980 – last data year	2– 10+	Yes
Canum	Catch at age in numbers	1980 – last data year	2– 10+	Yes
Weca	Weight at age in the commercial catch	1980 – last data year	2– 10+	Yes
West	Weight at age of the spawning stock at spawning time.	1980 – last data year	2– 10+	Yes - assumed to be the weight at age in the Q1 catch
Mprop	Proportion of natural mortality before spawning	1980 – last data year	2– 10+	No – set to 0 for all ages in all years
Fprop	Proportion of fishing mortality before spawning	1980 – last data year	2– 10+	No – set to 0 for all ages in all years
Matprop	Proportion mature at age	1980 – last data year	2– 10+	No – the same ogive for all years
Natmor	Natural mortality	1980 – last data year	2– 10+	No – set to 0.2 for all ages in all years

Tuning data:

TYPE	NAME	YEAR RANGE	AGE RANGE
Tuning fleet 1	English commercial Inshore trawl	1985 – last data year	2 – 10
Tuning fleet 2	Belgian commercial Beam trawl	1981 – last data year	2-10
Tuning fleet 3	French trawlers	1989 – last data year	2 - 10
Tuning fleet 4	English BT survey	1988 – last data year	1 – 6
Tuning fleet 5	French GFS	1988 – last data year	1 - 5
Tuning fleet 6	International YFS	1987 – last data year	1 - 1

Uncertainty Analysis

Retrospective Analysis

Short-Term Projection

Model used: Age structured

Software used: IFAP prediction with management option table and yield per recruit routines

Initial stock size: Taken from XSA for age 3 and older. The number at age 2 in the last data year is estimated using RCT3. The recruitment at age 1 in the last data year is estimated using the geometric mean over a long period (1980 – last data year)

Natural mortality: Set to 0.1 for all ages in all years

Maturity: The same ogive as in the assessment is used for all years

F and M before spawning: Set to 0 for all ages in all years

Weight at age in the stock: Average weight of the three last years

Weight at age in the catch: Average weight of the three last years

Exploitation pattern: Average of the three last years, scaled by the Fbar (2-6) to the level of the last year

Intermediate year assumptions:

Stock recruitment model used: None, the long term geometric mean recruitment at age 1 is used

Procedures used for splitting projected catches: Not relevant

Medium-Term Projections

The segmented stock/recruitment relationship is considered not significant (ICES, 2003a). There is therefore no consistent basis to build a medium term projection.

Long-term projections, yield per recruit

Biological Reference Points

Blim = 5400 t.

Bpa = 8000 t.

Flim = 0.54

Fpa = 0.45

Other Issues

None.

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

Carpentier, A., Vaz, S., Martin, C. S., Coppin, F., Dauvin, J.- C., Desroy, N., Dewarumez, J.-M., Eastwood, P. D., Ernande, B., Harrop, S., Kemp, Z., Koubbi, P., Leader-Williams, N., Lefèbvre, A., Lemoine, M., Loots, C., Meaden, G. J., Ryan, N., Walkey, M., 2005. Eastern Channel Habitat Atlas for Marine Resource Management (CHARM), Atlas des Habitats des Ressources Marines de la Manche Orientale, INTERREG IIIA, 225 pp.

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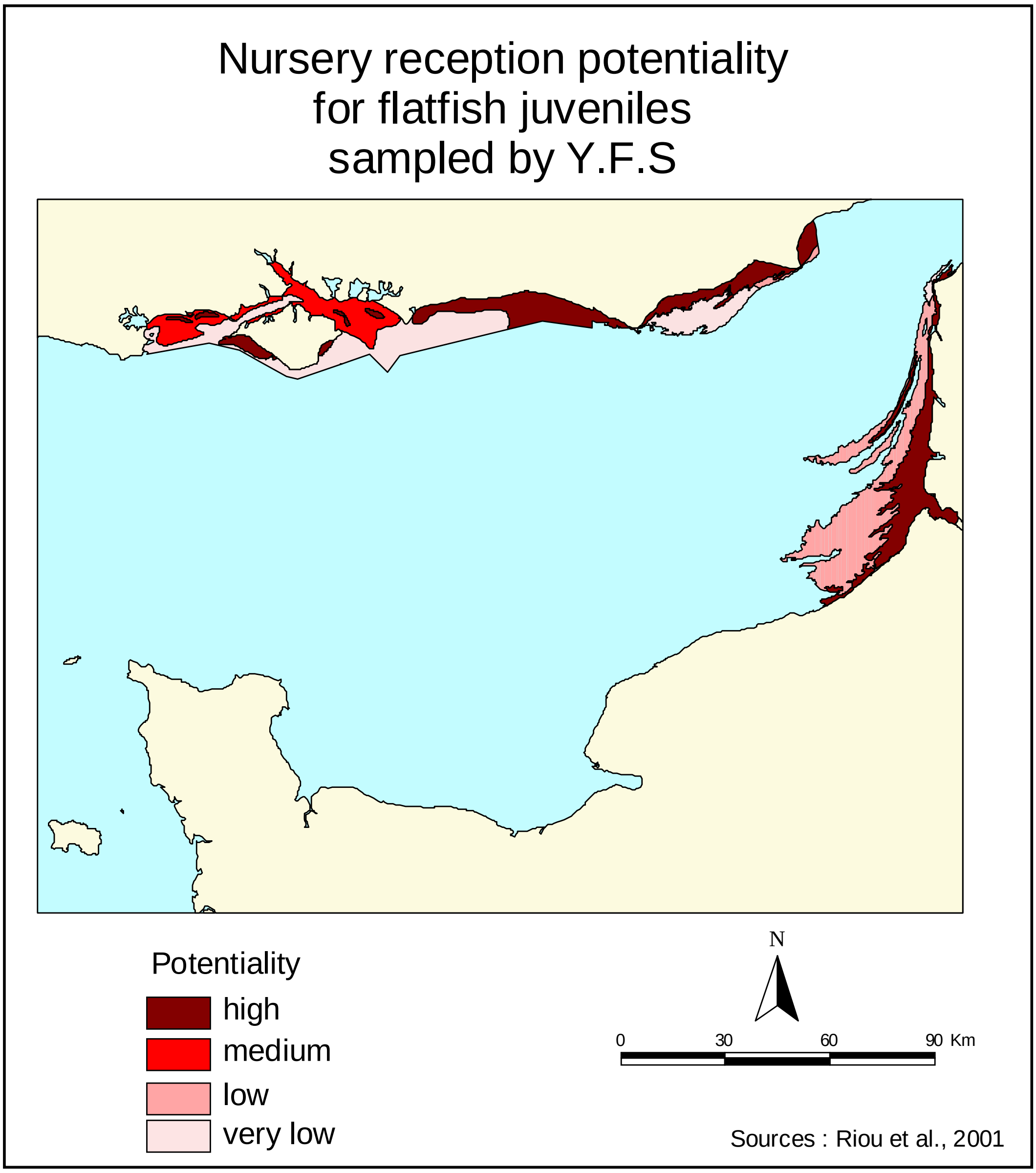
ICES 2003b. Report of the Study Group on Precautionary Reference Points For Advice on Fishery Management ICES CM 2003/ACFM:15

Millner, R.S., Whiting, C.L and Howlett, G.J. 1993. Estimation of discard mortality of plaice from small otter trawlers using tagging and cage survival studies. ICES C.M. 1993/G:24, 6pp

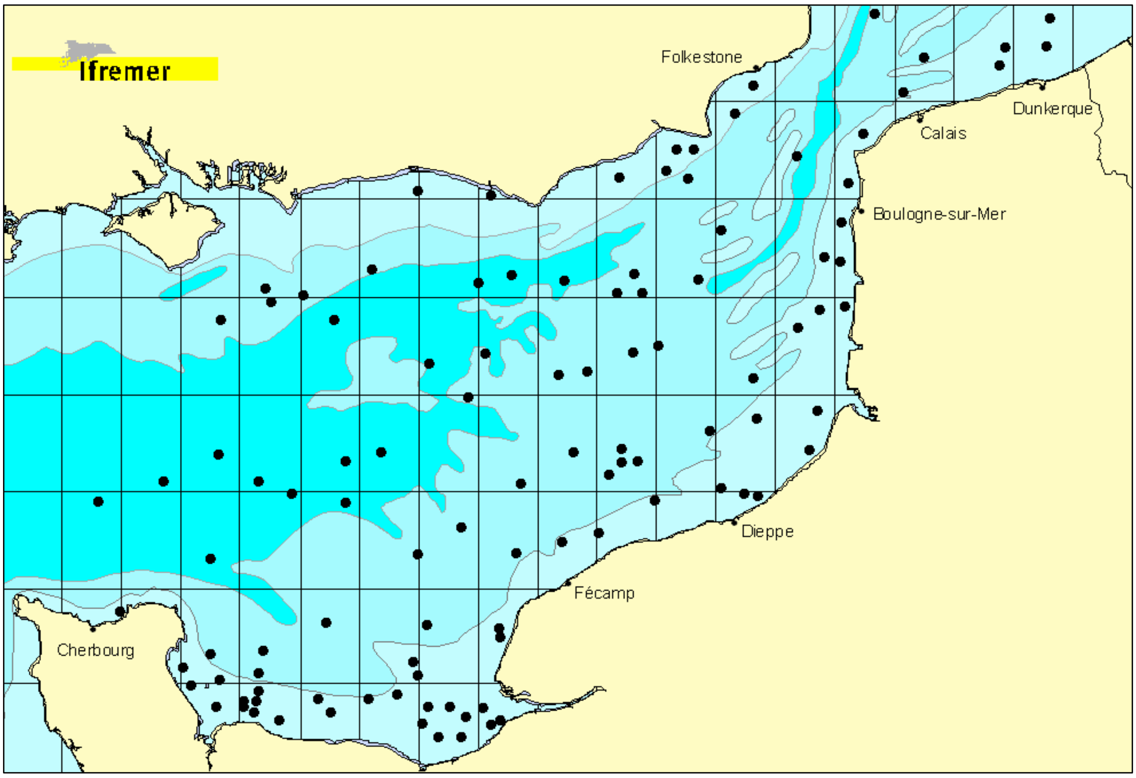
Riou et al. 2001. Relative contributions of different sole and plaice nurseries to the adult population in the Eastern Channel : application of a combined method using generalized linear models and a geographic information system. Aquatic Living Resources. 14 (2001) 125-135

Appendix 1 – Nursery reception potentiality for flatfish used as a basis for the combination of FR and UK YFS

Potentiality surface (Km²)	South England	Bay of Somme
High	756	575.1
Medium	484.7	0
Low	30.5	953.1
Very low	993.3	21.3
Total	2264.5	1549.5
Total (Low – Medium – High)	1271.2	1528.2



Appendix 2 – FR GFS. Sampling tows location grid



Quality Handbook ANNEX:__SAN-NSEA

Stock specific documentation of standard assessment procedures used by ICES.

Working group: North Sea Demersal Working Group

Updated: 8/5//2006 by: Henrik Jensen (hj@dfu.min.dk)

Sandeel in IV

General

Stock definition

For assessment purposes, the European continental shelf was divided into four regions for sandeel assessment purposes up to 1995: Division IIIa (Skagerrak), northern North Sea, southern North Sea, and Shetland Islands and Division VIa. These divisions were based on regional differences in growth rate and evidence for a limited movement of adults between divisions (e.g. ICES CM 1977/F:7, ICES CM 1991/Assess:14.). The two North Sea divisions were revised in 1995, and it was decided to amalgamate the two stocks into a single stock unit with two fleets, one fleet in the northern North Sea and one in the southern North Sea. The Shetland sandeel stock is assessed separately. ICES assessments have used these stock definitions since 1995.

Sandeels are largely stationary after settlement and the North Sea sandeel fishery must be considered as exploiting a complex of local populations (Proctor et al. 1998, Wright et al. 1998). Recruitment to local areas may not only be related to the local stock, as some interchange between areas situated close to each other seems to take place during the early phases of life before settlement.

Based on the distribution and simulated dispersal of larval stages, Wright et al. (1998) suggest that the North Sea stock could be split into six areas, including the Shetland as a separate population. Assessments have tentatively been made for some of these areas (Pedersen et al. 1999) and there was high correlation between the results from the study and the assessment made by the WG for the whole North Sea. Presently there are insufficient information about sandeel biology, especially about the intermixing of the early life stages between spawning aggregations, to allow for and alternative separation of the North Sea into separate population units to be assessed.

Recent studies indicate a low interchange of pre-settled sandeels between the spawning grounds identified (Christensen et al. Accepted, Christensen et al. Submitted). These results also indicate that the population structure suggested by Wright et al. (1998) need to be revised. Work is currently conducted to do this.

Fishery

Sandeel is taken by trawlers using small meshed trawls with mesh sizes < 16 mm. The fishery is seasonal. The geographical distribution of the sandeel fishery varies seasonally and annually, taking place mostly in the spring and summer. In the third quarter of the year the distribution of catches generally changes from a dominance of the west Dogger Bank area back to the more easterly fishing grounds.

The sandeel fishery developed during the 1970’s, and landings peaked in 1998 at more than 1 million tons. Since then there have been a rapid decrease in landings, and the total landings were at a historic low level in 2005 with a small increase from 2005 to 2006. Danish and Norwegian landings in 2003 were only 44% and 17% of those in 2002.

The spatial distribution of sandeel landings is considered as a good representation of stock distribution, except for areas where severe restrictions on fishing effort is applied (i.e. the Firth of Forth, Shetland areas, and Norwegian EEZ in 2006). Up to 2002 and particularly prior to 1998, most landings of sandeels in March were taken from the eastern North Sea banks whilst sandeel landings in April-June were mainly from the west Dogger Bank. In some years a relatively large part of the sandeel landings are taken from the central and eastern North Sea along the Danish west coast. From 1991, grounds off the Scottish east coast have been targeted particularly in June. However, since 2000 the banks in the Firth of Forth area have been closed to fishing.

Large variations in the fishing pattern occurred concurrent with the decline in the total fishery and CPUE in 2003. The distribution of landings in the southern North Sea in 2003 to 2005 seemed more extensive than the typical long-term pattern in the same area. Further, grounds usually less exploited became more important for the total fishery during the same period. In 2006 there was another large change in the fishing pattern, when the fishery showed a strong concentration at the fishing grounds in the Dogger Bank area. Although this overall large variation in fishing pattern there is a general high importance for most years of the Dogger Bank area.

In the Northern North Sea, mainly NEEZ, the change in the spatial pattern was significantly different from southern part. The highest landings from a single statistical square were taken in 1995 on the Vikingbank, the most northerly fishing ground for sandeel in the North Sea. However, in 1996 landings from the Vikingbank dropped substantially, and since 1997 have been close to null. The marked reduction in landings around 2000 in NEEZ was accompanied by a marked contraction of the fishery to a small area in the southern part of NEEZ, the Vestbank area. In this area landings remained high in 2001 and 2002 due to the strong 2001 year-class. However, the 2001 year-class was only abundant in the Vestbank area, which resulted in a highly concentrated fishery and the decimation of the year-class before it reached maturity in 2003. This may have led to the collapse of the sandeel fishery in NEEZ. In the EU EEZ any contraction of the fishery has been less apparent.

The sandeel fishing season was unusual short in both 2005 and 2006, starting later and ending earlier than in previous years. The late start of the fishery was partly because the Danish fishery first opened the 1st April, in accordance with a national regulation introduced in 2005. Further, weekly data on the oil content of sandeels in the commercial landings, provided by Danish fish meal factories, indicated a late onset of sandeels feeding season in both 2005 and 2006 and that sandeels therefore became available to the fishery later than usual. Landings in the second half year of both 2005 and 2006 were on a low level compared to previous years. Only 14.000 tones were recorded in 2005 and 17.000 tones in 2006.

Regulation of the fishery is no explanation to the small fishery observed from 2003 and onwards. The TAC in force has never been restrictive in the sandeel fishery, and in 2005 (the only year when additional regulation was introduced) the fishery was first regulated in July after the main fishing season.

There was a 50% decline in the number of Danish vessels (from 200 to 98 vessels) fishing sandeels from 2004 to 2005. In 2006 the Danish fleet increased to 124 vessels participating in the sandeel fishery. The capacity of the Danish fleet participating in the North Sea sandeel fishery is not likely to increase much further, due to decommission of a substantial number of vessels during the last years. Also for the Norwegian fleet a drastic decline in number of vessels fishing sandeels has been observed in recent years.

Technical measures for the sandeel fishery include a minimum percentage of the target species at 95% for meshes < 16 mm, or a minimum of 90% target species and maximum 5% of the mixture of cod, haddock, and saithe for 16 to 31 mm meshes.

Most of the sandeel catch consists of the lesser sandeel *Ammodytes marinus*, although small quantities of other Ammodytoidei spp. are caught as well. There is little by-catch of protected species (ICES WGNSSK 2004).

Ecosystem aspects

Due to the stationary habit of post-settled sandeels (DIFRES unpublished information, Gauld 1990), a patchy distribution of the sandeel habitat (Jensen et al. 2001, Jensen and Rolev 2004), and a limited interchange of the planktonic stages between the spawning areas (Christensen et al. Accpeted, Christensen et al. Submitted, Gauld et al. 1998) the sandeel stock in IV consist of a number of sub-populations (Wright et al. 1998). Due to a to coarse spatial aggregation level of the fisheries data that is used in the sandeel assessment and a lack of biological information for defining the limits of each of the reproductively isolated population units, it is presently not possible to make an assessment that take account of the sub-population structure of sandeels. The ICES Ad Hoc Group on Sandeels (ICES AGSAN 2007) outlined some feasible management strategies in the context of management aims and recent understanding of population biology. It will require modelling and simulation work well beyond what has been common practise for other stocks.

The catches of sandeels in area IV consist mainly of the lesser sandeel Ammodytes marinus. However, other species of sandeels is also caught. At some of the grounds in the Dogger Bank area the smooth sandeel Gymnammodytes semisquamatus can be important, and in the catches from more coastal grounds the other Ammodytes species Ammodytes tobianus can be important. The greater sandeel Hyperoplus lanceolatus appears in the catches from all grounds, but usually in insignificant numbers compared to A. marinus. The population dynamics of A. tobianus, G. semisquamatus, and H. lanceolatus are largely unknown, and so are the possible effects on these species of commercial fisheries.

The stock dynamics of sandeels is driven by a highly variable recruitment and a high natural mortality in addition to fishing. The recruitment seems more linked to environmental factors than to the size of the spawning stock biomass. This was confirmed by analyses carried out by the ICES Study Group on Recruitment Variability in North Sea Planktivorous Fish (ICES-SGRECVAP 2006). SGRECVAP considered there was a common trend in recruitment for herring, Norway pout and sandeel with significant shift in recruitment in 2001. However, it could not be assumed that the same mechanism was common for all three species. It was clear that the poor sandeel recruitment from 2002 occurred at low spawning-stock biomass. Further, although the decline in recruitment in sandeels could be linked to both the NAO index and to annual average abundance of Calannus finmarchicus in the central North Sea, it was not possible to determine the mechanisms driving recruitment in sandeels or the link between changes in the environment and sandeel population dynamics.

ACFM consider that there is a need to ensure that the sandeel stock remains high enough to provide food for a variety of predator species.

The decline in the sandeel population concurrent with a markedly change in distribution (ICES WGNSSK 2007) has increased the possibility of local depletion, of which there now is some evidence (ICES WGNSSK 2007). This may be of consequence for marine predators that are dependent on sandeels as a food source. It is presently not possible to make an assessment that takes account of the sub-population structure of sandeels (ICES AGSAN 2007).

Sandeels are important prey species for many marine predators, but the effects of variation in the size of this stock on predators are poorly known. Although the direct effects of sandeel fishing that have been identified on other species fished for human consumption, e.g. haddock and whiting are relatively small in comparison to the effects of directed fisheries for human consumption species there is still relatively scant information on the indirect effects of the sandeel fishery.

In 1999 the U.K called for a moratorium on sandeel fishing adjacent to seabird colonies along the U.K. coast and in response the EU requested advice from ICES. An ICES Study Group, was convened in 1999 to assess whether removal of sandeel by fisheries has a measurable effect on sandeel, whether establishment of closed areas and seasons for sandeel fisheries could ameliorate any effects, and to identify possible spatial and/or temporal restrictions of the fishery as specifically as possible. The ICES Advisory committees (ACFM and ACE) accepted the advice from the study group. STECF (1999) agreed with this ICES advice and the EU advised to close the fishery whilst maintaining a commercial monitoring. A 3-year closure, from 2000 to 2002, was decided. All commercial fishing was excluded, except for a maximum of 10 boat days in each of May and June for stock monitoring purposes. The closure was maintained for three years (see e.g. Wright et *al.* 2002) and has been extended until 2007, with a small increase in the effort of the monitoring fishery. There is presently no decision on weather a full commercial sandeel fishery will be reopened in the Firth of Forth area.

In general, fishing on sandeel aggregations at a distance less than 100 km from seabird colonies has been found to affect some surface feeding bird species, especially black-legged kittiwake and sandwich tern (Frederiksen et al. 2004, 2005). Recent research of effects on seabird predators due to changes in sandeel availability showed that black-legged kittiwake Rissa tridactyla in the Firth of Forth area off the Scottish east coast was related to abundance of both 1+ group, the age class targeted by the fishery, and 0 group sandeels. The same relationship was not found for six other sandeel dependent seabird species. Controlling for environmental variation (sea surface temperature, abundance of larval sandeels and size of adult sandeels), Frederiksen et al. (submitted) found that breeding productivity in the seabird colony on the Isle of May was significantly depressed by the fishery during periods of unregulated fishery for one surface-feeding seabird species (black-legged kittiwake), but not for four diving species. The mechanism by which the fishery affects the seabird however remains unclear as the fishery is not always in direct competition with the birds. The strong impact on these surface-feeding species, while no effects are documented found for diving species, could result from its inherently high sensitivity to reduced prey availability, from changes in the vertical distribution of sand lance at lower densities, or from sand lance showing avoidance behaviour to fishery vessels.

The ecosystem effects of industrial fisheries are discussed in the Report of the ICES Advisory Committee on Ecosystems, June 2003, Section 11 (ICES Cooperative Research Report No. 262).

Other ecosystem effects of the sandeel fishery are discussed in section 16.5 and in the ICES Report of the Advisory Committee on Ecosystems, June 2003, Section 11.

Data

Commercial catch

In the last 20 years the landings of sandeels in IV have been taken mainly by Denmark and Norway with UK/Scotland, Sweden and Faroes Isl. taken a much smaller part of total landings. In the 1950’s also Germany and the Netherlands participated in this fishery, but since the start of the 1970’s no landings have been recorded for these countries.

Age, length and weight at age data are available for Denmark and Norway to estimate numbers by age in the landings. Prior to 1996, the Norwegian age composition data were based on Danish ALK’s. Catch numbers and weight at age for the southern North Sea are based only on Danish age compositions.

Denmark More details to be included in this section

Industrial species are not sorted by species before processing and it is assumed that the landings consist of one species only in the calculation of the official landings. The WG estimate of landings is based on samples for species composition taken by the Fishery Inspectors for control of the by-catch regulation. At least one sample (10-15 kg) per 1000 tons landings is taken and these samples are used to estimate average species composition by area (ICES rectangles) and month. This species/area/period key, logbook data (spatial distribution) and landings slip data (quantity) are used to derive the Danish WG estimates of landings of sandeel and by-catch of other species (further information can be found in ICES, 1994/Assess:7; Dalskov, 2002).

Norway Text to be inserted by Norway

For Norway and Sweden, the official landings and the WG estimated landings are the same.

UK/Scotland Text to be inserted by UK/Scotland

Sweden Text to be inserted by Sweden

The text table below shows which country supplies which kind of data:

	Data				
Country	Caton (catch in weight)	Canum (catch at age in numbers)	Weca (weight at age in the catch)	Matprop (proportion mature by age)	Length composition in catch
Denmark	x	x	x		x
Norway	x	x	x		x
UK/Scotland	x				
Sweeden	x				
Farao Islands	x				

All input files are Excel spreadsheet files.

The national data sets have been imported in a database aggregated to international data by DIFRES.

The combined Danish and Norwegian age composition data and weight at age data are applied on the landings of UK, Sweeden and Farao Isl., assuming catches from these countries have the same age composition and weight at age as the Danish and Norwegian landings.

Biological

Historically, assessments were done separately for the Northern and Southern North Sea. In recent years, the assessment has been done for the whole North Sea, but data are still compiled separately for the two areas. The catch numbers and weight at age data for the Northern North Sea are constructed by combining Danish and Norwegian data by half-year.

The catch numbers and weight-at-age data for the northern North Sea were constructed by combining Danish and Norwegian data by half-year. Prior to 1996, the Norwegian age composition data were based on Danish ALK’s. Catch numbers and weight-at-age for the southern North Sea are based on Danish age compositions. The mean weight at age in the catch used in the assessment is the mean weights at age in the catch for the Southern and Northern North Sea weighted by catch numbers. The mean weight at age in the stock is copied from the mean weight in the catch first half-year, and an arbitrary chosen weight at 1 gram was used for the 0-group.

Both the proportion of natural mortality before spawning (Mprop) and the proportion of fishing mortality before spawning (Fprop) are set to 0.

Values for natural mortalities are the same as used since 1989 (ICES CM 1989/Asssess:13). During the WGNSSK 2005 meeting an exploratory assessment was carried out, using the natural mortality for sandeels estimated by ICES-SGMSNS (2005). The time series of natural mortality only include up to 2003, so 2003 estimates were copied to 2004 and 2005. In contras to the fixed values of natural mortality used in previous sandeel assessments, the natural mortalities estimated by ICES-SGMSNS (2005) show large variability over years. The most significant differences between the natural mortalities of sandeels used in previous sandeel assessments and those estimated by ICES-SGMSNS (2005) are those for age-0 sandeels. The natural mortalities of age-0 sandeels estimated by ICES-SGMSNS (2005) are about twice as high than those used in previous sandeel assessments.

The proportion mature is assumed constant over the whole period with 100% mature from age 2 and 0% of age 0 and 1. Recent research indicates however, that there are large regional variations in age at maturity of *Ammodytes marinus* in the North Sea (Boulcott et al. 2006). Whilst sandeels in some areas seem to spawn at age 2 or older, sandeels in other regions seem to mature and spawn at age 1. As the decision to spawn at age 1 or 2 is an annual event, it is likely that there are large regional and annual variations in the fraction of the populations of the sandeels that contribute to the spawning. The age at maturity keys used in the assessment might thus considerably underestimate the spawning biomass of sandeels in the North Sea.

The fishing fleet catches sandeels in different parts of the North Sea during the year, and the fishing pattern changes from year to year. Because sandeels, *Ammodytes marinus*, in the North Sea consist of a number of sub populations (section 1.1.1) the industrial fishery target different part of the sandeel populations during the year and between years. There seem to be significant spatial and temporal variations in emergence behaviour (e.g. Rindorf *et al*. 2000) and growth (e.g. Boulcott et al. 2006, Pedersen et al. 1999; Wright et al. 1998) of sandeels in the North Sea. Further, there are age/length dependent variations in the burrowing behaviour of sandeels (Kvist et al. 2001). The information about age compositions in the catches and the age and weight relationships thus represent average values over time and space and reflect the variability in emergence behaviour and growth. For example, weight at age of sandeels seems to vary both between years and between Danish and Norwegian catches.

Surveys

As no recruitment estimates (abundance of age-0 sandeels second half year) from surveys are available, recruitment estimated in the assessments are based exclusively on commercial catch-at-age data. The tuning diagnostics indicate that the 0-group CPUE is a poor predictor of recruitment.

The need for fishery independent information on sandeel distribution and abundance has been highlighted by ICES-WGNSSK (2006 and 2007). The demand for such information has increased due to the recent years decline in the North Sea sandeel stock concurrent with large changes in distribution and in the fishing pattern.

Different survey approaches are presently investigated by European research institutes, to establish a time series of fishery independent abundance estimates for sandeels in the North Sea. This is not a trivial job, because of the unpredictable emergence behaviour of sandeels, i.e. any sampling approach must take account of that part of the population can be in the water column as well as in the sea bed (Greenstreet et al. 2006). Further, more in total 238 individual sandeel fishing grounds are identified (Jensen and Rolev 2004). The total area of the sandeel fishing constitutes 15831 km2.

Descriptions of the survey methods that are presently explored and preliminary information from these surveys are given by ICES WGNSSK (2006 and 2006) and ICES_AGSAN (2007).

Commercial CPUE

There is no survey time-series available for this stock. As in previous assessments effort data from the commercial fishery in the northern and southern North Sea are treated as two independent tuning fleets, separated into first and second half year.

Because of the trends in the residuals for 1-group sandeels in the first half year, the two tuning fleets in the first half year were in the final assessment from 2005 split into two time periods, i.e. before and after 1999. This change in the tuning series removed the trends in the residuals of log stock numbers, and the tendency to underestimate F and overestimate SSB was reduced. Information about the size of the trawls used by Danish vessels fishing sandeels show an increase in trawl size from 1988 to 1994 and a larger increase from 1997 to 1998. This is a clear indication of an increase in catchability of the Danish vessels fishing sandeels, due to gear technology. However based only on this information it is not possible to quantify the likely change in catchability over the years.

The definition of tuning fleets used in 2005 was also used in 2006. The following tuning series were from 2005 are:

Fleet 1: Northern North Sea 1983-1998 first half year

Fleet 2: Northern North Sea 1999-2006 first half year

Fleet 3: Southern North Sea 1983-1998 first half year

Fleet 4: Southern North Sea 1999-2006 first half year

Fleet 5: Northern North Sea 1983-2005 second half year

Fleet 6: Southern North Sea 1983-2005 second half year

The effort data for the southern North Sea prior to 1999 are only available for Danish vessels, but since 1999 Norwegian vessels have also provided effort data. These data for the first half year has since 2003 been included in tuning series. The effect of this on the assessment is analysed in this year’s assessment. The reason for including the Norwegian effort data for first half year for the southern North Sea into the tuning fleet is that in recent years Norwegian catches in the southern North Sea in first half year constitute a significant part of Norwegian landings in the North Sea. The tuning fleet used for the northern North Sea is a mixture of Danish and Norwegian vessels. A separation of the Danish and Norwegian fleets is presently not possible, due to the lack of Norwegian age-length keys for the period before 1996. Separate national fleets would have been preferable because this would have made procedure for the generation of the tuning series more transparent. This issue should be addressed at the next benchmark assessment.

The size distribution of the fleet has changed through time. Therefore effort standardisation is required. The assumption underlying the standardisation procedure is that CPUE is a function of sandeel abundance and vessel size. Standardised effort is calculated from standardised CPUE and total catch. CPUE is standardized to a vessel size of 200 Gross Tonnes (GR) using the relationship:

$CPUE = a * GR^{b}$ (1)

where *a* and *b* are constants and GR is vessel size in GR

The constants *a* and *b* were prior to 2003 estimated for each year by performing the regression analysis:

$Ln(C/e)=ln(a)+b*ln(GR)$ (2)

where C=catch in ton, e=effort in days spend fishing, and the rest of the parameters are as in (1).

Since 2003 the parameters in (2) have estimated using catch and effort data on single trip level, instead of average values of catch and effort for each vessel size category (see ICES 2004). The data used for the regression is logbook data for the Danish industrial fleet for the years 1984 to 2003 and first half year of 2004. General linear models were used to estimate the parameters in:

$ln(CPUE) = d_y + f_y*ln(GR)$ (3)

where *y*=year, GR=vessel size in GR as defined in Table 1, and the remaining factors are constants. Log transformation was required to stabilise the variance in CPUE to fit the model although it does result in a more skewed distribution of GT leading to the smaller vessels receiving a higher weight in the subsequent regression. The GLM was carried out by half year (first and second half year) and area (northern and southern North Sea) to generate estimates of effort for the fleets presently used in the assessment of sandeels in IV. Type III analysis was used to test for significance of parameters. All analyses were weighted by the number of days spend fishing, as the variation on the average catch per day fishing decreases with the number of days fished. The results of the analysis and the parameter estimates are given in Table 13.1.3.2.

The parameters estimated in (3) were used to estimate CPUE for a vessel size of 200 GR from:

$CPUE=e^{dy}*200^{fy}$ (4)

Mean CPUE of Danish and Norwegian fleets, after the Norwegian CPUE had been standardised to a vessel size of 200 GR, was estimated as a weighted mean weighted by the catches sampled used to estimate CPUE. Total standardised effort was afterwards estimated from the combined Danish and Norwegian CPUE and total international catches.

As no recruitment estimates from surveys are available, recruitment estimates are based exclusively on commercial catch-at-age data. The tuning diagnostics indicate that the 0-group CPUE is a poor predictor of recruitment.

There is a relatively poor correlation between the tuning indices and the stock, which may be due to the fact that several sub-stocks are assessed as a single unit.

Other relevant data

None.

Estimation of Historical Stock Development

The Seasonal XSA (SXSA) developed by Skagen (1993) was up to 2001 used for stock assessment of sandeel in IV. Annual XSA was tried in 2002 WG where it was concluded that the two approaches gave similar results. For a standardization of methodology, it was decided to shift to XSA in 2003. In 2004 SXSA was used again for the final assessment, the reason being that data were available for the first half year of 2004 for the assessment. SXSA has been used or the final assessment since 2004. The XSA are used for comparison using the following settings:

Time series weights	none
Power model	no
Catchability independent of age	>=2
F-shrinkage S.E.	1.5 (5 years and 2 ages)
Min. standard error for pop. estimate	0.3
Prior weighting	none
Number of iterations	20
Convergence	Yes

In the SXSA weighting of estimated catchabilities (rhat) is set manually, where last years data is down weighted compared to previous years. Estimated survivors are weighted from manually entered data, where estimates of survivors are given a lower weighting in the second half of the year. This setting was chosen because the fishery inflicts the majority of the fishing mortality in the 1st half of the year and thus the signal from the fishery is considered less reliable in the second half.

During the benchmark assessment in 2004 (ICES-WGNSSK 2005) the effect of changing some of the default settings was explored. The assumption in the assessment of constant catchability for the tuning fleets over years, was analysed. Further, the effect of weighting the survivors with the inverse variance of the estimated log catchability, instead of the manual weighting, was explored. At last, the effect of down weighting last half years data in the estimation of the inverse catchability was analysed. There were no major effects on the assessment results of changing these settings, i.e. the same trends were seen in SSB, R and F. It was therefore decided to keep the default settings.

During the 2005 WG meeting the SMS model was used as a comparison to the SXSA. The SXSA and SMS explorative runs gave quite similar results for the time trend of SSB, but the absolute levels differ between model configurations. The main difference in the explorative runs is in the estimate of fishing mortality. Fs for the most recent years were estimated higher and more variable by the SMS model. All SXSA runs showed a decrease in F since 2001, while SMS estimated a step decrease in F in 2003 followed by a seep increase in 2003 and subsequently decreases in 2004 and 2005. Both SXSA and SMS assume constant catchability in the CPUE time series. In addition, SMS assumes constant catchability (or more correctly, constant exploitation pattern) for the F-model and catch data. CPUE time series are however, subset of the total international catch data and changes in the exploitation pattern will violate the assumption of constant catchability for the CPUE time series. Said in another way; if exploitation pattern changes, the assumptions for both models are violated. It is difficult to judge whether the SXSA assumption that catch data are exact, or the SMS assumption that exploitation pattern are constant, violates the assumptions most. The F values from SXSA shows a very variable exploitation pattern from year to year, and extreme F values for age 4. This indicates that there might be a considerable sampling uncertainty in the international catch at age data, which SMS might be better to handle. However, SXSA was chosen for the final assessment, because the model is the default model for this stock and SXSA does not rely on the assumption of constant exploitation pattern in catch at age data.

During the WGNSSK 2005 meeting an exploratory assessment was carried out, using the natural mortality for sandeels estimated by ICES-SGMSNS (2005, see section 1.1.2). The assessment using the natural mortalities estimated by ICES-SGMSNS (2005) showed similar trends in SSB as the assessment using the fixed natural mortalities, whereas the estimates of recruitment and F, were generally higher in assessment using the natural mortalities estimated by ICES-SGMSNS (2005). This difference was mainly due to the larger natural mortality for the 0-group sandeels used in the assessment using the natural mortalities estimated by ICES-

SGMSNS (2005). There was no difference in the performance of the two assessments, and as such, no basis for an objective choice between configurations. Because the SGMSNS group express some reservation about the quality of the estimate of natural mortality for the most recent years these natural mortalities have not been used in the final assessment for sandeels in IV.

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.

Short-Term Projection

The high natural mortality of sandeel and the few year classes in the fishery make the stock size and catch opportunities largely dependent on the size of the incoming year classes. Quantitative estimates of recruits (age 0) in the year of the assessment are not available at the time of the WG. Traditional deterministic forecasts are therefore not considered appropriate.

The high natural mortality of sandeel and the few year classes in the fishery make the stock size and catch opportunities largely dependent on the size of the incoming year classes.

0-group CPUE is a poor predictor of recruitment (ICES-WGNSSK 2003) why traditional deterministic forecasts are not considered appropriate. However, because of the low sandeel stock WGNSSK provided indicative short term prognoses during the meetings from 2004 and on, using a range of scenarios for the recruitment and exploitation pattern.

The short term forecasts from 2004 and 2005 overestimated the SSB in 2005 and 2006 by a factor 2-3 when compared to the SSB estimated by the SXSA in 2006. This overestimation bias was addressed during the 2006 WG meeting, carrying out a short term forecast, where the start population and the F-s-at-age in the first half year of 2006 was corrected according to the bias identified in the assessment. In order to estimate potential bias in the terminal population sizes and F's, an analysis was made from the retrospective SXSA runs. A bias factor was determined for each year by dividing the terminal estimate of each retrospective run with the "true" value as estimated by this year's final assessment. The bias factor taken forwards to the short term forecast was the mean ratio over the period 2000-2005. As retrospective corrections continue to be made for several years, the bias correction factors for the most recent 1-2 years may be underestimates. Additional analyses were made to investigate the change in bias correction when comparing terminal values with "converged" values taken from retrospective runs 1 or 2 years later. This demonstrated that the bulk of the correction is made in the first year with much smaller corrections in the second year.

Medium-Term Projections

Not done

Long-Term Projections

Not done

Biological Reference Points

There is no management objective set for this stock. There is a need to ensure that the stock remains high enough to provide food for a variety of predator species. Management of fisheries should try to prevent local depletion of sandeel aggregations, particularly in areas where predators congregate.

In 1998 ACFM proposed that $\mathbf{B}_{lim}$ be set at 430,000 t, the lowest observed SSB. The $\mathbf{B}_{pa}$ was estimated at 600,000 t, approximately $\mathbf{B}_{lim}$ * 1.4. This corresponds to that if SSB is estimated to be at $\mathbf{B}_{pa}$ then the probability that the true SSB is less than $\mathbf{B}_{lim}$ will be less than 5% (assuming that estimated SSB is log normal distributed with a CV of 0.2). No fishing mortality reference points are given. These reference points are based on an assessment using another tuning method than used from 2002 (see section 1.2.4).

Other Issues

Recent investigations (Greenstreet et al. 2006) showed the biomass of age 1+ sandeels increased sharply in the Firth of Forth area in the first year of the closure and remained higher in all four of the closure years analysed, than in any of the preceding three years, when the fishery was operating. Further, the biomass of 0-group sandeels in three of the four closure years exceeded the biomass present in the three years of commercial fishing. The closure appears to have coincided with a period of enhanced recruit production.

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Quality handbook: Stock Annex– Sole in Division VIId

Working Group: ICES Working Group for the Assessment of Demersal Stocks in the North Sea and Skagerrak (WGNSSK)

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General

Stock Definition

The sole in the eastern English Channel (VIId) are considered to be a separate stock from the larger North Sea stock to the east and the smaller geographically separate stock to the west in VIIe. There is some movement of juvenile sole from the North Sea into VIId (ICES CM 1989/G:21) and from VIId into the western Channel (VIIe) and into the North Sea. Adult sole appear to largely isolated from other regions except during the winter, when sole from the southern North Sea may enter the Channel temporarily (Pawson, 1995).

Fishery

There is a directed fishery for sole by small inshore vessels using trammel nets and trawls, who fish mainly along the English and French coasts and possibly exploit different coastal populations. Sole represents the most important species for these vessels in terms of the annual value to the fishery. The fishery for sole by these boats occurs throughout the year with small peaks in landings in spring and autumn. There is also a directed fishery by English and Belgian beam trawlers who are able to direct effort to different ICES divisions. These vessels are able to fish for sole in the winter before the fish move inshore and become accessible to the local fleets. In cold winters, sole are particularly vulnerable to the offshore beamers when they aggregate in localised areas of deeper water. Effort from the beam trawl fleet can change considerably depending on whether the fleet moves to other areas or directs effort at other species such as scallops and cuttlefish. A third fleet is made up of French offshore trawlers fishing for mixed demersal species and taking sole as a by-catch.

The minimum landing size for sole is 24cm. Demersal gears permitted to catch sole are 80mm for beam trawling and 90mm for otter trawlers. Fixed nets are required to use 100mm mesh since 2002 although an exemption to permit 90mm has been in force since that time.

Ecosystem Aspects

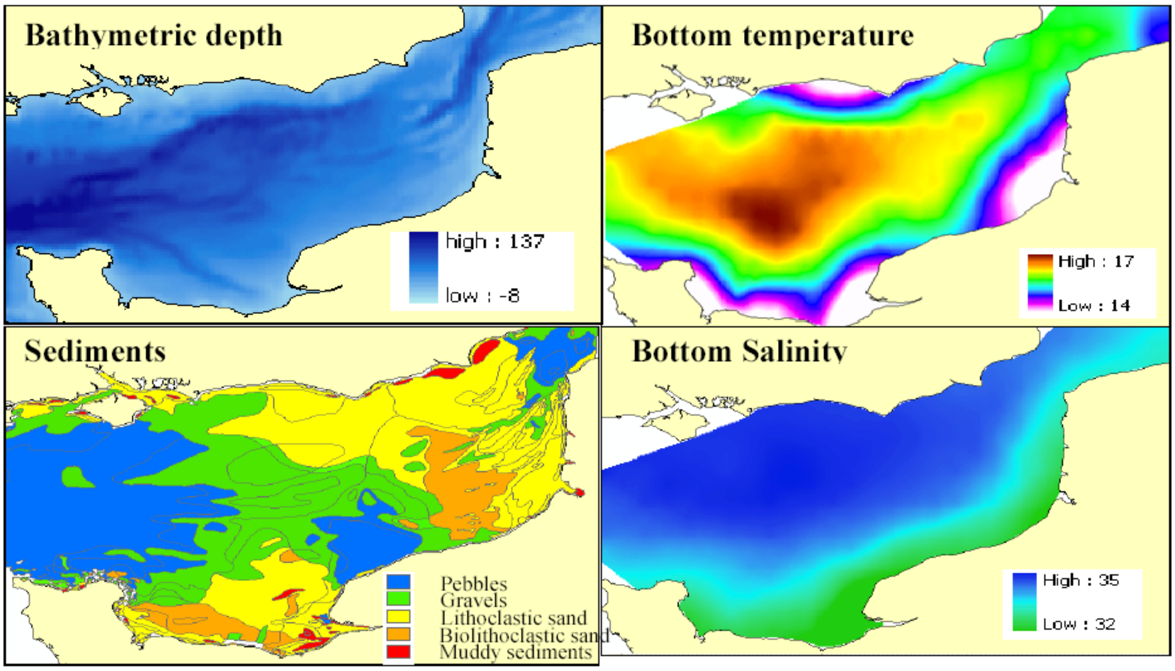

Figure 1 Eastern English Channel physical and hydrological features: Bathymetric depth and simplified sediment types representation. Survey bottom temperature and bottom salinity (averaged for 1997 to 2003) obtained by kriging. (in Vaz *et al.* 2004)

Biology: Adult sole feeds on worms, small molluscs and crustaceans. In the English Channel, reproduction occurs between February and April, mainly in the coastal areas of the Dover Strait and in large bays (Somme, Seine, Solent, Mont-Saint-Michel, Start et Lyme Bay). Pelagic eggs hatch after 5 to 11 days leading to larvae that are also pelagic and that will metamorphose into benthic fry after 1 or 2 weeks. Juveniles spend the first 2 or 3 years in coastal nurseries (bays and estuaries) where fast growth occurs (11 cm at 1 year old) before moving to deeper waters.

The spatial distribution of life stages of common sole shows a particular pattern: larvae distribution (on spanning grounds) and juvenile distributions (in nursery grounds) overlap. If larvae are found everywhere during spring, the potential habitat for stage 2 larvae is along the Flanders coast and near the Pays de Caux, to the central zone of the English Channel. Older larvae have a more coastal preference habitat, which can be explained by a retention phenomenon linked to estuaries.

Environment: A benthic species that lives on fine sand and muddy seabeds between 0 and 150 meters depth. Ranges from marine to brackish waters with temperatures between 8 and 24°C.

Geographical distribution: Eastern Atlantic, from southern Norway to Senegal, Mediterranean Sea including Sea of Marmara and Black Sea.

Vaz et al. (2007) used a multivariate and spatial analyses to identify and locate fish, cephalopod, and macrocrustacean species assemblages in the eastern English Channel from 1988 to 2004. Four sub-communities with varying diversity levels were identified in relation to depth, salinity, temperature, seabed shear stress, sediment type, and benthic community nature. One Group (class 4 in Fig.2 below) was a coastal heterogeneous community represented by pouting, poor cod, and sole and was classified as preferential for many flatfish and gadoids. It displayed the greatest diversity and was characterized by heterogeneous sediment type (from muds to coarse sands) and various associated benthic community types, as well as by coastal hydrology and bathymetry. It was mostly near the coast, close to large river estuaries, and in areas subject to big salinity and temperature variations. Possibly resulting from this potentially heterogeneous environment (both in space and in time), this sub-community type was the most diverse.

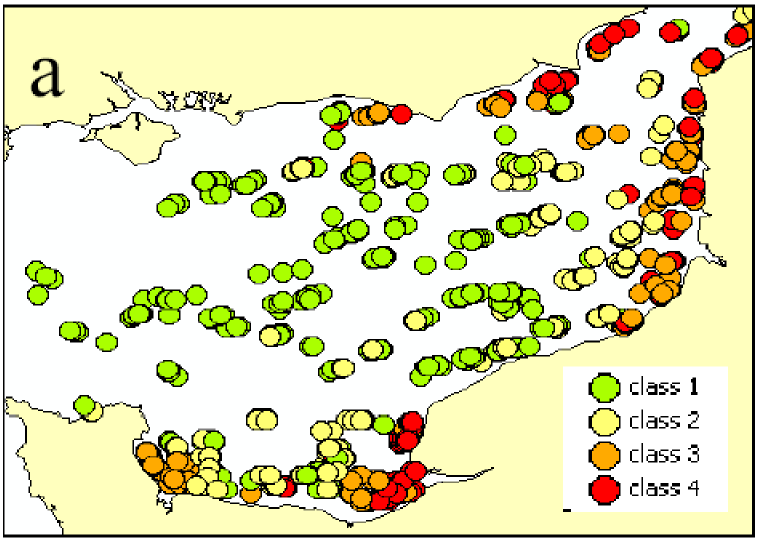

Figure 2 : Spatial distribution of Fish Subcommunities in the Eastern Channel from 1988 to 2003. Observed assemblage type at each station, These illustrate the gradation from open sea community to coastal and estuarine communities. (In Vaz *et al.*, 2004)

Community evolution over time : (From Vaz *et al*., 2007). The community relationship with its environment was remarkably stable over the 17 y of observation. However, community structure changed significantly over time without any detectable trend, as did temperature and salinity. The community is so strongly structured by its environment that it may reflect interannual climate variations, although no patterns could be distinguished over the study period. The absence of any trend in the structure of the eastern English Channel fish community suggests that fishing pressure and selectivity have not altered greatly over the study period at least. However, the period considered here (1988–2004) may be insufficient to detect such a trend.

Data

Commercial Catch

The landings are taken by three countries France (50%), Belgium (30%) and England (20%). Age sampling for the period before 1980 was poor, but between 1981 and 1984 quarterly samples were provided by both Belgium and England. Since 1985, quarterly catch and weight-at-age compositions were available from Belgium, France, and England.

Belgium

Belgian commercial landings and effort information by quarter, area and gear are derived from log-books.

Sampling for age and length occurs for the beam trawl fleet (main fleet operating in Belgium).

Quarterly sampling of landings takes place at the auctions of Zeebrugge and Oostende (main fishing ports in Belgium). Length is measured to the cm below. Samples are raised per market category to the catches of both harbours.

Quarterly otolith samples are taken throughout the length range of the landings (sexes separated). These are aged and combined to the quarterly level. The ALK is used to obtain the quarterly age distribution from the length distribution.

In 2003 a pilot study started on on-board sampling with respect to discarded and retained catch. Since 2004 it is part of the DCR.

France

England

English commercial landings in tonnes by quarter, area and gear are derived from the sales notes statistics for vessels under 12m who do not complete logbooks. For those over 12m (or >10m fishing away for more than 24h), data is taken from the EC logbooks. Effort and gear information for the vessels <10m is not routinely collected and is obtained by interview and by census. .No information is collected on discarding from vessels <10m but it is known to be low. Discarding from vessels >10m has been obtained since 2002 under the EU Data Collection Regulation and is also relatively low.

Length samples are combined and raised to monthly totals by port and gear group for each stock. Months and ports are then combined to give quarterly total length compositions by gear group; unsampled port landings are added in at this stage. Quarterly length compositions are added to give annual totals by gear. These are for reference only, as ALK conversion takes place at the quarterly level. Age structure from otolith samples are combined to the quarterly level, and generally include all ports, gears and months. For sole the sex ratio from the randomally collected otolih samples are used to spli the unsexed length composition into sex-separate length compositions. The quarterly ses separate age-length-keys are used to transform quarterly length compositions by gear group to quarterly age compositions. At this stage the age compositions by gear group are combined to give total quarterly age compositions.

A minimum of 24 length samples are collected per gear category per quarter. Age samples are collected by sexes separately and the target is 300 otoliths per sex per quarter. If this is not reached, the 1st and 2nd or 3rd and 4th quarters are combined.

Weight at age is derived from the length samples using [to be completed].

The text table below shows which country supply which kind of data:

KIND OF DATA SUPPLIED QUARTERLY					
Country	Caton (catch in weight)	Canum (catch at age in numbers)	Weca (weight at age in the catch)	Matprop (proportion mature by age)	Length composition in catch
Belgium	x	x	x		x
England	x	x	x		x
France	x	x	x		x

Data are supplied as FISHBASE files containing quarterly numbers at age, weight at age, length at age and total landings. The files are aggregated by the stock coordinator to derive the input VPA files in the Lowestoft format. No SOP corrections are applied to the data because individual country SOPs are usually better than 95%. The quarterly data files by country can be found with the stock co-ordinator

The resulting files (FAD data) can be found at ICES and with the stock co-ordinator, either in the IFAP system as SAS datasets or as ASCII files on the Lowestoft format, either under w:\acfm\nsskwg\2002\data\sol_eche or w:\ifapdata\eximport\nsskwg\sol_eche.

Biological

Natural mortality

Natural mortality was assumed constant over ages and years at 0.1.

Maturity

The maturity ogive used was knife-edged with sole regarded as fully mature at age 3 and older as in the North Sea.

Weight at age

Prior to 2001 WG, stock weights were calculated from a smoothed curve of the catch weights interpolated to the 1st January. Since the 2002 WG, second quarter catch weights were used as stock weights in order to be consistent with North Sea sole.

Proportion mortality before spawning

Both the proportion of natural mortality before spawning (Mprop) and the proportion of fishing mortality before spawning (Fprop) are set to 0.

Surveys

A dedicated 4m beam trawl survey for plaice and sole has been carried out by England using the RV Corystes since 1988. The survey covers the whole of VIId and is a depth stratified survey with most samples allocated to the shallower inshore stations where the abundance of sole is highest. In addition, inshore small boat surveys using 2m beam trawls are undertaken along the English coast and in a restricted area of the Baie de Somme on the French coast. In 2002, The English and French Young Fish Surveys were combined into an International Young Fish Survey. The dataset was revised for the full period back to 1981. The two surveys operate with the same gear (beam trawl) during the same period (September) in two different nursery areas. Previous analysis (Riou et al, 2001) has shown that asynchronous spawning occurs for flatfish in Division VIId. Therefore both surveys were combined based on weighting of the individual index with the area nursery surface sampled. Taking into account the low, medium, and high potential area of recruitment, the French YFS got a weight index of 55% and the English YFS of 45%. (see Annex 1)

Commercial CPUE

Three commercial fleets have been used in tuning. The Belgian beam trawl fleet (BEL BT), the UK Beam Trawl fleet (UK BT) and a French otter trawl fleet (FR OT). The two beam trawl fleets carry out fishing directed towards sole but can switch effort between ICES areas. The UK BT CPUE data is derived from trips where landings of sole from VIId exceeded 10% of the total demersal catch by weight on a trip basis. Effort from both the BT fleets is corrected for HP. The French otter trawl fleet is description needed.

Other Relevant Data

None.

Historical Stock Development

Deterministic Modelling

Model used: XSA

Software used: IFAP / Lowestoft VPA suite

Model Options chosen:

Tapered time weighting not applied

Catchability independent of stock size for all ages

Catchability independent of age for ages >= 7

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

S.E. of the mean to which the estimate are shrunk = 0.500

Since 2004 - S.E. of the mean to which the estimate are shrunk = 2.000

Minimum standard error for population estimates derived from each fleet = 0.300

Prior weighting not applied

Input data types and characteristics:

Catch data available for 1982-present year. However, there was no French age compositions before 1986 and large catchability residuals were observed in the commercial data before 1986. In the final analyses only data from 1986-present were used in tuning

TYPE	NAME	YEAR RANGE	AGE RANGE	VARIABLE FROM YEAR TO YEAR YES/NO
Caton	Catch in tonnes	1982 – last data year	2 – 11+	Yes
Canum	Catch at age in numbers	1982 – last data year	2 – 11+	Yes
Weca	Weight at age in the commercial catch	1982 – last data year	2 – 11+	Yes
West	Weight at age of the spawning stock at spawning time.	19682 – last data year	2 – 11+	Yes - assumed to be the same as weight at age in the Q2 catch
Mprop	Proportion of natural mortality before spawning	1982 – last data year	2 – 11+	No – set to 0 for all ages in all years
Fprop	Proportion of fishing mortality before spawning	1982 – last data year	2 – 11+	No – set to 0 for all ages in all years
Matprop	Proportion mature at age	1982 – last data year	2 – 11+	No – the same ogive for all years
Natmor	Natural mortality	1982 – last data year	2 – 11+	No – set to 0.2 for all ages in all years

Tuning data:

TYPE	NAME	YEAR RANGE	AGE RANGE
Tuning fleet 1	Belgian commercial BT	1986 – last data year	2-10
Tuning fleet 2	English commercial BT	1986 – last data year	2-10
Tuning fleet 3	English BT survey	1988 – last data year	1-6
Tuning fleet 4	International YFS	1994 – last data year	1-1

Uncertainty Analysis

Retrospective Analysis

Short-Term Projection

Model used: Age structured

Software used: WGFRANSW

Initial stock size is taken from the XSA for age 3 and older and from RCT3 for age 2. The long-term geometric mean recruitment is used for age 1 in all projection years.

Since 2004 initial stock size for age 2 was taken from XSA.

Natural mortality: Set to 0.1 for all ages in all years

Maturity: The same ogive as in the assessment is used for all years

F and M before spawning: Set to 0 for all ages in all years

Weight at age in the stock: Average weight over the last three years

Weight at age in the catch: Average weight over the three last years

Exploitation pattern: Average of the three last years, scaled to the level of Fbar (3-8) in the last year

Intermediate year assumptions: F status quo

Stock recruitment model used: None, the long term geometric mean recruitment at age 1 is used

Procedures used for splitting projected catches: Not relevant

Medium-Term Projections

Model used: Age structured

Software used: WGMTERMc

Settings as in short term projection except for the weights in the catch and in the stock which are averaged over the last 10 years

Long-Term Projections, yield per recruit

Model used: Age structured

Software used: WGMTERMc

Settings as in short term projection except for the weights in the catch and in the stock which are averaged over the last 10 years

Biological Reference Points

Biological reference points

Bpa	Fpa	Flim
8000 t	0.4	0.55

Other Issues

None.

References

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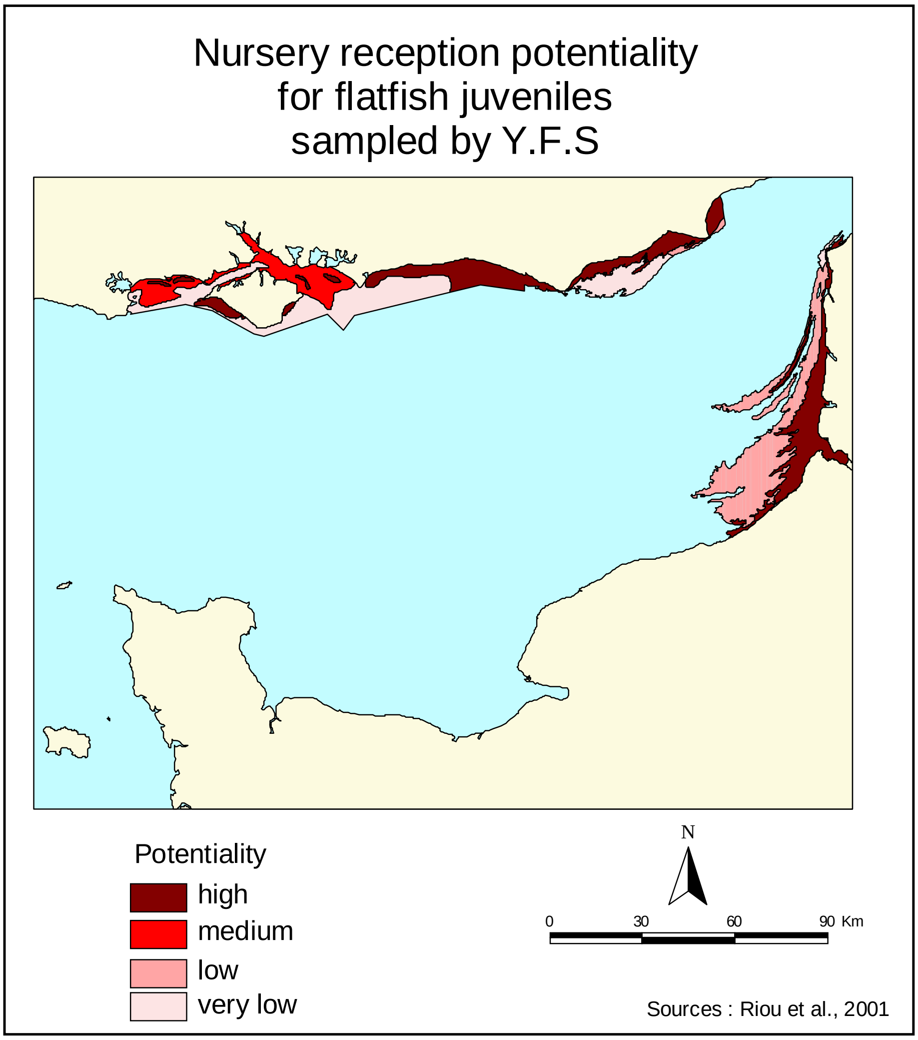
Riou et al. 2001. Relative contributions of different sole and plaice nurseries to the adult population in the Eastern Channel : application of a combined method using generalized linear models and a geographic information system. Aquatic Living Resources. 14 (2001) 125-135.

Vas *et al.* 2007, Modelling Fish Habitat Suitability in the Eastern English Channel. Application to community habitat level. ICES CM 2004/ P:26

Appendix 1 – Nursery reception potentiality for flatfish used as a basis for the combination of FR and UK YFS

Potentiality surface (Km2)	South England	Bay of Somme
High	756	575.1
Medium	484.7	0
Low	30.5	953.1
Very low	993.3	21.3
Total	2264.5	1549.5
Total (Low – Medium – High)	1271.2	1528.2



Quality Handbook Annex: WGNSSK: IV & VIId Whiting

Stock specific documentation of standard assessment procedures used by ICES.

Stock:	Whiting in Division IV
Working Group:	Assessment of Demersal Stocks in the North Sea and Skagerrak
Date:	16 September 2004
Last updated:	08 May 2007

A. General

A.1. Stock definition

Whiting is known to occur exclusively in some localised areas, but for the most part it is caught as part of a mixed fishery operating throughout the entire year. Adult whiting are widespread in the North Sea, while high numbers of immature fish occur off the Scottish coast, in the German Bight and along the coast of the Netherlands.

Tagging experiments, and the use of a number of fish parasites as markers, have shown that the whiting found to the north and south of the Dogger Bank form two virtually separate populations (Hislop & MacKenzie, 1976). It is also possible that the whiting in the northern North Sea may contain 'inshore' and 'offshore' populations.

A.2. Fishery

A.3. Ecosystem aspects

Results from key runs of the North Sea MSVPA in 2002 and 2003 indicate three major sources of mortality. For ages two and above, the primary source of mortality is the fishery, followed by predation by seals, which increases with fish age. For ages 0–1, though more notable on 0–group, there is evidence for cannibalism. This is corroborated by Bromley *et al.* (1997), who postulate that multiple spawings over a protracted period may provide continued resources for earlier spawned 0–group whiting.

Results from key runs of the North Sea MSVPA in 2002 and 2003 indicate that, as a predator, whiting tend to feed on (in order of importance): whiting, sprat, Norway pout, sandeel and haddock.

B. Data

B.1. Commercial catch

For North Sea catches, human consumption landings data and age compositions were provided by Scotland, the Netherlands, England, and France. Discard data were provided by Scotland and used to estimate total international discards. Other discard estimates do exist (Section 1.11.4, 2002 WG), but were not made available to Working Group data collators. Since 1991 the age composition of the Danish industrial by-catch has been directly sampled, whereas it was calculated from research vessel survey data during the period 1985–1990. Norway provides age composition data for its industrial by-catch.

For eastern Channel catches, age composition data were supplied by England and France. No estimates of discards are available for whiting in the Eastern Channel, although given the relatively low numbers in the Channel catch compared to that in the North Sea, this is not considered to be a major omission. There is a small industrial fishery in this area.

B.2. Biological

Weight at age in the stock is assumed to be the same as weight at age in the catch.

Natural mortality values are rounded averages of estimates produced by previous key runs of the North Sea MSVPA (see Section 1.3.1.3 of the 1999 WG report: ICES CM 2000/ACFM:7). The values used in both the assessment and the forecast are:

AGE	1	2	3	4	5	6	7	8+
Natural Mortality	0.95	0.45	0.35	0.30	0.25	0.25	0.20	0.20

The maturity ogive is based on North Sea IBTS quarter 1 data, averaged over the period 1981-1985. The maturity ogive used in both the assessment and forecast is:

AGE	1	2	3	4	5	6	7	8+
Maturity Ogive	0.11	0.92	1.00	1.00	1.00	1.00	1.00	1.00

Both the proportion of natural mortality before spawning (Mprop) and the proportion of fishing mortality before spawning (Fprop) are set to zero.

B.3. Surveys

The Scottish Groundfish Survey (SCOGFS) is carried out in August each year, and covers depths of roughly 35m to 200m in the North Sea to the north of the Dogger Bank. It samples at most one survey station per statistical rectangle. In 1998 the coverage of this survey was extended into the central North Sea, but the index available to the Working Group has been modified so as to cover a consistent area throughout the time-series.

In 1998 FRS (Aberdeen) introduced a new survey vessel; it was considered at the time that no evidence existed to say the new vessel had different catch abilities to the old vessel (Zuur *et al.*, 1999). This is now generally considered not to be the case. In line with other roundfish stock assessments we present the Scottish groundfish survey as two separate series.

The English Groundfish Survey (ENGGFS) is carried out in August each year, and samples at most one station per rectangle. It covers depths of roughly 35 m to 200 m in the whole of the North Sea basin.

In 1991 the English groundfish survey changed fishing gear from the Granton trawl to the GOV trawl. For this reason the English groundfish survey is treated as two independent series.

The time-series of the survey indices of whiting supplied by the French Channel Groundfish Survey (FRAGFS) was revised in 2002. In 2001, the Eastern Channel was split into five zones. Abundance indices were first calculated for each zone, and then averaged to obtain the final FRAGFS index. This procedure was not thought to be entirely satisfactory, as the level of sampling was inconsistent across geographical strata. In 2002, it was thought more appropriate first to raise abundance indices to the level of ICES rectangles, and then to average those to calculate the final abundance index. Previous to the 2002 WG, only the hauls in which whiting were caught were used to derive abundance indices. This procedure biased estimates, and therefore, the indices supplied from 2002 are calculated on the basis of all hauls.

The first quarter International Bottom Trawl Survey (IBTS Q1) is undertaken in February and March of each year, and covers depths of roughly 35m to 200m in the whole of the North Sea basin. It uses a higher density of survey stations than either the SCOGFS or the ENGGFS, with several hauls per statistical rectangle.

B.4. Commercial cpue

Effort data are available for two Scottish commercial fleets: seiners (SCOSEI) and light trawlers (SCOLTR). Non-mandatory reporting of fishing effort for these fleets means that they cannot be viewed as strictly reliable for use for catch-at-age tuning.

Effort data are available for two French commercial fleets: otter trawl (FRATRO) and beam trawl (FRATRB). The same comment on non-mandatory reporting of fishing effort applies to these fleets.

B.5. Other relevant data

None.

C. Historical Stock Development

N/A for the time being.

D. Short-term Projection

N/A for the time being.

E. Medium-Term Projections

N/A for the time being.

F. Yield and Biomass per Recruit / Long-Term Projections

N/A for the time being.

G. Biological Reference Points

The precautionary fishing mortality and biomass reference points agreed by the EU and Norway, (unchanged since 1999), are as follows:

Blim=225 000t; Bpa=315 000t; Flim=0.90; Fpa=0.65.

H. Other Issues

References

Bromley, P. J., Watson, T., and Hislop, J. R. G. (1997). Diel feeding patterns and the development of food webs in pelagic 0-group cod (*Gadus morhua* L.), *haddock (Melanogrammus aeglefinus* L.), whiting (*Merlangius merlangus* L.), saithe (*Pollachius virens* L.), and Norway pout (*Trisopterus esmarkii* Nilsson) in the northern North Sea. *Ices Journal of Marine Science* **54:** 846–853.

Hislop, J. R. G & MacKenzie, K. (1976). Population studies of the whiting (*Merlangius merlangus* L.) of the northern North Sea. *Journal du Conseil International pour l'Exploration de laMer.* **37:** 98–111.

Table 12.2.13 Whiting in IV and VIId. Complete available tuning series.

SCOSEI_IV units = individuals

year	effort	1	2	3	4	5	6	7	8	9
1978	325246	14994	29308	43711	15390	1058	1409	201	36	0
1979	316419	90750	41092	28124	14745	6084	677	156	3	0
1980	297227	27032	73704	37658	11915	9368	2556	260	229	27
1981	289672	8727	22244	25048	10552	2402	2084	374	41	4
1982	297730	3721	7032	26194	13117	2713	539	277	81	5
1983	333168	11565	14957	21690	34199	9831	2155	407	158	16
1984	388035	4923	24016	20670	14986	21269	4715	960	87	50
1985	381647	20068	20263	19696	8956	4796	8013	1363	334	18
1986	425017	139498	48705	34509	11341	2624	1098	1771	216	7
1987	418536	13793	52715	38939	18440	3638	1097	298	348	16
1988	377132	2502	28446	44869	12631	4072	679	64	21	17
1989	355735	6879	15704	41407	23710	4769	1323	112	43	11
1990	252732	14230	124636	27694	29921	14768	721	207	23	0
1991	336675	11952	44964	63414	10436	8730	1743	195	94	0
1992	300217	16614	19452	21217	27962	2805	1958	565	32	3
1993	268413	9564	31623	26013	12458	14446	899	332	153	8
1994	264738	9236	21452	22571	11778	5531	5612	204	116	15
1995	204545	8288	22153	30007	9019	3875	1373	1270	86	15
1996	177092	5732	26021	21430	10506	3483	1031	296	289	28
1997	166817	6628	8974	16231	9922	4445	575	110	62	37
1998	150361	3711	4695	6806	6840	3670	1417	244	13	2
1999	93796	13384	13750	7009	6068	3462	1684	409	77	3
2000	69505	5176	11208	6458	2112	1972	836	298	90	7
2001	36135	607	6352	5592	1715	486	353	146	66	11
2002	21830	1017	3349	7716	2182	363	140	79	23	6
2003	15371	388	1089	2514	2980	1046	256	30	17	5
2004	15663	282	689	1912	2003	1711	456	108	16	4
2005	16149	1131	1889	994	1638	1852	1035	362	41	1
2006	13539	25	435	874	695	966	960	433	99	18

SCOLTR_IV units = individuals

year	effort	1	2	3	4	5	6	7	8	9
1978	236944	8785	19910	30722	14473	956	1612	635	72	6
1979	287494	171147	42910	23155	17996	4058	377	286	57	5
1980	333197	20806	58382	38436	9525	9430	1864	144	145	3
1981	251504	6576	19069	21550	9706	1777	1455	310	9	1
1982	250870	5214	8197	26681	12945	3334	647	339	74	16
1983	244349	37496	17926	12535	19234	6124	1217	183	141	26
1984	240775	38267	16048	10784	6307	9019	2371	479	13	30
1985	267393	28761	9368	7617	3086	1333	2901	443	173	14
1986	279727	8138	8572	9578	4109	767	425	609	52	2
1987	351131	18761	25933	16161	5954	1183	388	116	129	4
1988	391988	2398	15779	22526	5128	1641	207	31	15	6
1989	405883	20319	10052	21390	10837	2394	448	33	54	2
1990	371493	3677	35322	7665	8960	3423	160	40	5	0
1991	408056	8727	11908	22146	3192	2906	629	50	41	0
1992	473955	17581	14551	11823	15418	1500	1160	304	13	0
1993	447064	16439	20513	14386	6591	10105	574	204	97	24
1994	480400	4133	15771	13005	6454	2710	2997	172	84	14
1995	442010	9248	15887	19322	6262	2983	1092	1132	89	3
1996	445995	6662	12461	13523	9223	3012	861	282	243	9
1997	479449	2557	6768	15603	9464	4535	628	181	52	31
1998	427868	5096	5350	8058	9507	4312	1729	276	58	12
1999	329750	26519	20672	9295	6706	4080	2051	487	41	7
2000	280938	8385	16220	9287	3788	2621	1470	602	79	7
2001	245489	1303	11409	10419	3287	745	431	247	66	27
2002	184099	980	4653	11067	3686	818	221	180	60	13
2003	98721	871	1639	3986	5136	2080	286	73	59	7
2004	63953	224	1088	2225	2463	2168	669	123	18	15
2005	54905	954	2414	1236	1448	1901	831	251	26	2
2006	51456	66	495	1487	990	1055	1067	604	105	6

Table 12.2.13 (cont'd) Whiting in IV and VIId. Complete available tuning series.

FRATRO_IV units = individuals

year	effort	0	1	2	3	4	5	6	7	8
1986	56099	19	1542	1892	7146	3783	600	158	39	2
1987	71765	12	2508	4985	1271	5713	413	258	92	70
1988	84052	0	2537	8982	3223	704	1321	123	55	1
1989	88397	27	2958	3740	5629	1654	209	280	47	11
1990	71750	38	3210	6170	3781	2456	365	29	44	2
1991	67836	323	4465	6084	2864	1412	777	85	6	3
1992	51340	355	3427	6498	1940	635	358	96	5	0
1993	62553	938	3950	4586	4307	877	290	68	40	6
1994	51241	87	7006	3298	1191	612	108	11	8	1
1995	57823	263	6331	6125	2674	544	99	19	0	2
1996	50163	577	5523	4743	3214	890	156	8	12	0
1997	48904	267	1961	4677	3929	1020	221	18	3	0
1998	38103	567	4893	1959	533	161	68	36	0	2
1999	-9	51	7652	2886	1453	960	500	133	46	31
2000	30082	129	7367	8191	2453	1056	737	455	345	95
2001	50846	3357	10767	15476	6923	3227	1701	638	345	128
2002	-9	-9	-9	-9	-9	-9	-9	-9	-9	-9
2003	52609	625	9277	16880	7857	5528	1701	188	19	23
2004	21074	0	938	367	919	946	743	256	36	4
2005	23683	0	1037	1665	386	178	149	103	52	14
2006	19100	4.918	4402.199	2229.464	373.059	37.178	183.608	226.409	0.27	-9

FRATRB_IV units = individuals

year	effort	1	2	3	4	5	6	7	8	9
1978	69739	1153	10312	14789	8544	807	1091	227	34	4
1979	89974	698	12272	14379	10884	3789	394	315	45	14
1980	63577	90	5388	11298	4605	4051	1004	78	71	10
1981	76517	144	6591	13139	8196	2090	1644	314	16	10
1982	78523	173	1643	16561	11241	3948	1035	539	119	14
1983	69720	500	4407	8188	16698	5541	1061	228	126	19
1984	76149	317	4281	7465	4576	5999	1596	308	32	26
1985	25915	315	3653	2942	1225	566	599	117	12	4
1986	28611	891	3830	3991	1202	369	94	160	22	1
1987	28692	431	4823	3667	2152	497	166	48	46	3
1988	25208	150	2718	4815	1125	530	100	31	3	4
1989	25184	448	2064	4351	1877	314	106	10	4	1
1990	21758	164	3794	2124	2010	620	55	13	1	0
1991	19840	292	2224	3829	819	657	138	15	3	0
1992	15656	365	1598	1686	2204	248	195	44	3	0
1993	19076	173	1225	2633	1141	1233	97	37	14	4
1994	17315	108	1806	1721	1466	413	430	29	8	1
1995	17794	114	1023	3304	1537	1163	240	212	14	7
1996	18883	21	655	1594	1438	482	199	38	30	10
1997	15574	40	357	1407	1139	606	86	16	10	2
1998	14949	32	126	317	326	192	63	8	2	1
1999	-9	96	490	489	684	452	239	59	14	1
2000	11747	47	1148	2968	1205	320	298	124	54	5
2001	6771	298	649	528	150	36	36	14	6	2

FRATRO_7D units = individuals

year	effort	1	2	3	4	5	6	7
1986	257794	2587	2250	7741	4463	804	198	19
1987	188236	1955	5050	907	4606	331	218	54
1988	215422	2233	7957	2552	537	1193	127	61
1989	320383	2578	3916	6006	1490	216	343	50
1990	257120	2492	5240	3363	2168	251	30	51
1991	294594	4009	8177	3985	2625	1474	155	11
1992	285718	5733	10924	3241	882	587	171	3
1993	283999	3158	6543	8607	1677	442	124	79
1994	286019	13932	7980	3269	1776	444	40	21
1995	268151	6301	8450	5261	1217	264	63	8
1996	274495	6140	6466	5465	1623	324	47	14
1997	282216	3320	8144	6608	1974	451	59	8
1998	291360	9921	6863	2385	781	265	105	15
1999	-9	-9	-9	-9	-9	-9	-9	-9
2000	215553	7096	7026	1734	1724	1375	877	675
2001	163848	89	6101	10124	3976	2563	2303	1040
2002	192589	985	1922	6247	6476	2270	461	463
2003	296717	155	6896	5489	5551	2397	312	65
2004	89127	1831	706	2312	2945	2611	902	109
2005	108369	5813	3730	793	813	720	510	262
2006	78600	2864	1912	457	133	800	1013	0

Annex 4: Assessment Methods and Software

Assessment methods

XSA and SXSA

Extended Survivors' Analysis (XSA; Darby and Flatman 1994) has been used for catch-at-age analysis for most stocks, although it has not been selected as the final assessment in all cases. Three implementations were used. Some older analysts used version 3.1 of the Lowestoft VPA DOS based package. For an increasing number of stocks, younger members of the group used the version (FLXSA) incorporated in the FLR package (FLR Team 2006) following validation against the DOS based version and further development which have resulted in the ability to produce tuning diagnostics output. Seasonal XSA (Skagen 1993, 1994) was used for analyses of Norway pout and sandeel to allow for seasonal data.

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

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

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

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

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

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

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

B-ADAPT

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

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

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

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

and for the years with bias

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

$$SSQ = SSQ_{vpa} + SSQ_{catches}$$

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

SMS

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

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

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

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

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

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

with F-components defined as follows:

$F(a)$:

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

$F(q)$:

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

F(*y*):

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

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

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

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

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

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

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

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

SURBA

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

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

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

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

ASPIC

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

Methods

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

At present, assessments are evaluated largely through qualitative visual inspection of results such as catchability residuals. It could be argued that this is not sufficient, and should be supplemented by a more quantitative approach. One way of potentially improving assessment methodology is summarised below.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

FLR

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

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

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

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

Recruitment estimation

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

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

Short-term prognoses and sensitivity analyses

Short-term prognoses (forecasts) are made for all stocks for which a final assessment is presented. Half-year forecasts are produced for the industrial stocks in order to give ACFM further information on which to base advice in the current situation of low biomass. These are based on survivors' estimates at the end of the second quarter in the year of the meeting (final assessment year + 1) from Seasonal XSA or SMS, rolled forwards to the start of the first quarter in the next using assumed mortality and weights-at-age.

Forecasts in all other cases were based on initial stock sizes as estimated by XSA or B-ADAPT (in a number of cases supplemented with separate recruitment estimates as described above), natural mortalities and maturity ogives as used in the age based assessment model, and mean weights at age averaged over recent years (normally 3). For haddock, the mean weight-at-age of the large 1999 and moderate 2000 year-classes in the forecast has been modelled using a fitted growth curve. Fishing mortalities-at-age in forecasts are taken to be either the final year values, or a scaled or unscaled mean *F*-pattern over the most recent 3 years (depending on whether or not mean *F* showed a recent trend).

Forecasts and corresponding sensitivity analyses were undertaken using either the Aberdeen suite of forecast programs, the MFDP/MFYPR software, or more recent implementations in the FLR suite. Where the latter have been used, they have been cross-checked with the equivalent standard software.

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

Stock-recruit modelling and medium-term projections

To be done

Estimation of biological reference points

Yield and spawning stock biomass per recruit are undertaken using either the Aberdeen suite of forecast programs, the MFDP/MFYPR software, or more recent implementations in the FLR suite. Where the latter have been used, they have been cross-checked with the equivalent standard software.

Precautionary approach reference points

Precautionary approach reference points are intended to remain unchanged from year to year, **unless** substantial changes occur in the data used (e.g. if discards are included for the first time) or the method employed. When reviewed the change point models developed by Obrien and Maxwell (2003) and PASOFT (Smith et al.) are used to provide values.

Software versions

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

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