REPORT OF THE

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

Hamburg, Germany
19–28 June 2001

International Council for the Exploration of the Sea

Conseil International pour l'Exploration de la Mer

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TABLE OF CONTENTS

Section **Page**

Tables 5.1.1.1 - 5.2.1.1 ... 169
Figures 5.1.2.1 - 5.1.9.3 ... 187

Section	Page

1 GENERAL

1.1 Participants

The Working Group met in Hamburg from 19–28 June 2001 with the following participants:

Martin Pastoors (Chair)	Netherlands
Ewen Bell	England
John Casey	England
Robin Cook	Scotland
Wim Demaré	Belgium
Uli Damm	Germany
Maria Hansson	Sweden
Tore Johannessen	Norway
Knut Korsbrekke (parttime)	Norway
Paul Marchal	Denmark
Capucine Mellon	France
Richard Millner	England
Coby Needle	Scotland
J. Rasmus Nielsen	Denmark
Hans-Joachim Rätz	Germany
Odd M. Smedstad	Norway
Joël Vigneau	France
Clara Ulrich	Denmark
Sieto Verver	Netherlands
Morten Vinther	Denmark

1.2 Terms of Reference

The **Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak** [WGNSSK] (Chair: Dr M. Pastoors, Netherlands) will meet in Hamburg, Germany from 19–28 June 2001 to:

a) assess the status of and provide catch options for 2002 for the following stocks:
   1) cod in Sub-area IV and Division IIIaN (Skagerrak), and Division VIId,
   2) haddock in Sub-area IV and Division IIIa,
   3) whiting and plaice in Sub-area IV, Division IIIa, and Division VIId,
   4) sole in Sub-area IV and Division VIId,
   5) saithe in Sub-area IV, Sub-area VIa and Division IIIa.

The assessment should take into account the technical interactions among the stocks due to the mixed-species fisheries and the new management measures coming into force in 2000;

b) assess the status of and provide catch forecasts for 2002 for Norway pout and sandeel stocks in Sub-area IV and Divisions IIIa and VIa, and identify any needs for management measures (including TACs) required to safeguard the stocks;

c) quantify the species and size composition of by-catches taken in the fisheries for Norway pout and sandeel in the North Sea and adjacent waters, and make this information available to WGECO;

d) provide the data required to carry out multispecies assessments (quarterly catches and mean weights at age in the catch and stock for 2000 for all species in the multispecies model that are assessed by this Working Group);

e) identify major deficiencies in the assessments;

f) review the layout of a Quality Handbook and prepare a workplan for writing such a document. A draft of the Quality Handbook shall be reviewed by the Working Group in 2002.

g) investigate the reason for the past consistent overestimation in the short- term forecasts of the North Sea cod stock and other demersal North Sea stocks where this is relevant, and suggest how to correct it.

WGNSSK will report by 6 July 2001 for the attention of ACFM.

The WG noted that medium predictions were required not explicitly requested for in the terms of reference, but that the technical minutes from ACFM (October 2000) indicated that these analyses were required. Therefore, the WG decided to carry out medium term analysis where the data allowed such an analysis.

An additional request was received during the meeting. The Fisheries Adviser informed the Group that ICES would be required to evaluate if the North Sea cod recovery plan (under development) is consistent with the PA. The Fisheries Adviser asked the WG to assist ACFM in this task and to prepare suitable background studies and simulation that would make it possible for ACFM to make a clear advice in the autumn of 2001.

The terms of reference g) and the additional request mentioned above, were only received during the course of the meeting and could not be addressed in full detail. Notably, there was no room for additional analysis to be carried out during the Working Group. Therefore, the group summarized some general points to address the terms of reference as best as it could.

The organization of the report is structured in a similar fashion to last year. However, the terms of reference c-g will be dealt with explicitly in section 1. ToR's a and b will be dealt with in the sections 3-14, and a general overview of the state of the stocks considered by this WG is presented in section 2.

Term of reference	**Section(s)**
a) Assess status of cod, haddock, whiting, saithe, sole and plaice	3-11
b) Assess status of sandeel and pout	12-14
c) Quantify bycatch in sandeel and pout fisheries	1.7
d) Provide quarterly catch data needed for multispecies assessments	1.8
e) Identify major deficiencies	1.10
f) Review layout of Quality Handbook	1.9
g) Investigate reason for constant overestimation	1.10
Comments to the EU-agreement on technical measures	1.11

The meeting was held at the Bundesforschungsamstalt für Fischerei, Institut für Seefischerei (BFA-FISCH) in Hamburg. The WG was very pleased with the accommodation which was offered by the German Institute and the hospitality offered to the group.

In 2000, the WG used a record high number of copies last year (37,000). It was decided for this year to do the presentations of explorations and intermediate results via the network or the LCD projector. The WG thereby reduced the number of copies and prints in the year to around 17,000.

1.3 Data

1.3.1 Data sources roundfish and flatfish

The data used in the assessment for roundfish and flatfish stocks are based on:

- total landings by market size categories
- sampling market size categories for weight, length, age and sometimes maturity
- discard data: available only for whiting and haddock in Division IV as a time series
- fleet data: effort data from logbooks and CPUE data from associated fleet landings
- survey data: catch per unit effort by age
- data on natural mortality from the MSVPA

1.3.1.1 Data on landings, age compositions, weight at age, maturity ogive

For most stocks, the Working Group estimates of total landings deviate from official figures. The discrepancies are shown in the landings Tables under the heading “unallocated landings”. These unallocated landings will in most cases include discrepancies which are due to differences in the calculation procedures, for instance that official landings use nominal box weights whereas the Working Group estimates are based on box weights are as measured during market samplings. Also in some cases national gutted-fresh conversion factors have been changed in the official statistics but not in the Working Group database. The SOP and differences introduced by conversion factors are in most cases minor. For all stocks except cod, haddock, saithe and whiting, SOP uncorrected estimates have been used in the assessments. The reason the SOP corrected data have been used for roundfish stocks is that some data in the historical time series have been corrected and that it has proven difficult to rectify this in a consistent manner. However, these corrections are relatively small.

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

Uncertainties on the data on landings have seriously affected the quality of some of the assessments and catch forecasts. In some cases, the Working Group estimates of the landings include corrections for mis- or unreported landings. Such corrections may be based on direct information such as estimation from alternative sources or softer information. However, there are also situations that signals of mis- or unreported landings exist but could not be verified or quantified. Estimates of unreported landings for cod in area IV were estimated by the Working Group for part of the fleets. They have been included in the assessment for the year 1998 but not for other years. Estimates for other fleets were not available, although it is known that there is underreporting as well. A Historical time series of age compositions, weight and length at age by fleet for most of the stocks, considered by the Working Group, are kept and maintained in databases at some national institutes. The roundfish data (cod, haddock, whiting and saithe) are kept in Aberdeen. North Sea plaice and sole are kept in IJmuiden, VIId sole in Lowestoft, VIId plaice in Port-en-Bessin and IIIa plaice, sandeel and Norway pout in Denmark. No major revisions have been made in the catch, and weight at age data in the roundfish and flatfish stocks for years before 1999. The revisions made, are indicated in the relevant stock sections.

The mean weights at age used for stock biomass are in most cases derived from catch at age weights. Such weights may not accurately represent the stock at young age groups due to selectivity.

Maturity ogives are generally based on historical biological information and kept constant over the whole time period of the assessment. For a number of stocks a knife-edge maturity has been assumed. Maturity at age data for some stocks from the samples of the landings in some fleets indicates that changes in age of first maturation occur (see for instance WD:6). In the case of plaice the data suggest that the existing maturity ogive significantly overestimates the proportion of age 3 and 4 fish which are mature. However, unbiased estimates for the stock are not available. The assumption of constant maturity-ogives may introduce bias in the trends in SSB developments, especially when exceptionally large or small year classes enter the spawning stock.

The WG did not feel that it was in a position to evaluate the consequences of adjusting the maturity ogive during the meeting and recommended that some analyses should be carried out before revised maturity ogives are implemented.

1.3.1.2 Discard data used in the assessment

Estimates of discards are used in the assessment for North Sea haddock and North Sea whiting only.

Total annual international discard estimates by age group were derived by extrapolation from Scottish data. The inclusion of discard catches is considered to reduce bias and to give more realistic values of fishing mortality and biomass for these stocks but also contributes to the noise in the data. For the other stocks discard data from EC PROJECT 98/097 for the period Q3 1999 to Q4 2000 was made available to the WG (Table 1.3.1.2). This information did not cover a long enough period to be included in the analytical assessment but provided useful additional information for individual stocks.

1.3.1.3 Natural mortality

Natural mortality for plaice and sole in all areas has been taken as 0.1. Natural mortality for saithe has been taken as 0.2. The values of M in use for the assessment of North Sea cod, haddock and whiting have been reconsidered a few years ago in the light of new information but have not been changed. The existing values are as follows:

	COD	HADDOCK	WHITING
0	[2.70]	2.05	2.55
1	0.80	1.65	0.95
2	0.35	0.40	0.45
3	0.25	0.25	0.35
4	0.20	0.25	0.30
5	0.20	0.20	0.25

Unless specified otherwise, the same values have been used in all years of the assessment.

1.3.1.4 Fleet and research vessel data

Time series of CPUE and effort data from commercial fleets and research vessels have been used to 'tune' the assessments. These indices have become increasingly important as catch data has deteriorated for many stocks. In the assessments of cod and haddock, the commercial catch and effort data has been excluded from the to remedy the retrospective patterns evident for the stocks.

Because of the change in timing of the Working Group from October to June, most of the important recruitment indices for 2001 were not available to the WG. These included the English and Scottish Q3 Groundfish surveys, the BTS and SNS flatfish surveys in the North Sea, English and French groundfish surveys in VIId, the International combined inshore surveys for flatfish in the North Sea and the French and English Young Fish surveys.

The validity of many of these time series as indicators of stock size and fishing mortality in recent years has become more uncertain since enforcement of national quota, ITQ's and technical measures are known to have led to changes in directivity of some fleets to other species and in some cases to underreporting and discarding.

French commercial tuning series in 1999 were discontinued because of problems with the national French fishery statistics database. These problems arose from a transfer to new software. This made it impossible to obtain catch data by (Sub)Division and size category and effort data by fleet. This problem did not affect the data for 2000 but it has still not been possible to obtain the 1999 data.

1.3.2 Data sources Norway pout and sandeel

The data used in assessment for Norway pout and sandeel stock 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 by-catch species and to get percentage target-species.
- fleet data: effort data from logbooks and CPUE data from associated fleet landings
- survey data: catch per unit effort by age for Norway pout
- data on sandeel natural mortality from the MSVPA

1.3.2.1 Data on landings, age composition, weight at age, maturity ogive

The sampling of Norway pout and sandeel landings were described in detail in the 1995 report of the Working Group (ICES CM 1996/Assess:6). The sampling system has generally not changed since then. The applied sampling systems vary between countries.

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

For Norway pout, the mean weights at age used for stock biomass is the same for all years. Samples from the landings suggest, however, high variability both between years and seasons. One problem using catch mean weights is that the 0-group is not fully recruited in the 3. quarter, giving an overestimate of weight at age in the stock for this age-group. More knowledge is needed before variable weight at age in the catches can fully be taken into account in the assessment. For sandeel, weights at age in the catches are used as an estimator for weight at age in the stock.

The maturity ogives for Norway pout and sandeel are kept constant over the whole period of assessment. For both species knife-edge maturity are assumed. A paper (WD-7) presented at the meeting indicated that the age of 50% maturation of sandeel from the east central North was 3.2 years. The age estimate is one year higher than that found previously in the southern North Sea and adopted for the ICES-assessments of the North Sea spawning stock. Hence, the SSB may be significantly overestimated.

Another paper (WD-12) indicated high variability in maturity for the 1-group Norway pout.

1.3.2.2 Natural mortality

Natural mortality for Norway pout has been taken as 0.4 per quarter, corresponding to an annual figure of 1.6. A paper (WD-11) on Norway pout indicated a much higher natural mortality.

For sandeel, natural mortality has been derived from MSVPA results, and varies with age and season:

Age	M: Jan – Jun	M: Jul - Dec
0	-	0.8
1	1.0	0.2
2+	0.4	0.2

1.3.2.3 Fleet and research vessel data

For Norway pout, time series of CPUE and effort data from Danish and Norwegian commercial fleets and data from research vessels have been used to tune the assessment. The same survey tuning series was used as in previous years. The research vessel data include 1. quarter IBTS, 3. quarter EGFS and 3. quarter SGFS. This year, data from the 3. quarter IBTS was made available, but not used.

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

1.3.3 Sampling levels and sampling procedures

The methods of data collection and processing vary between countries and stocks. Sampling procedures applied in the various countries to the various stocks have been described in detail in the report of the WGNSSK meeting in 1998 (ICES 1999a) and have not been changed since then. Table 1.3.3.1 gives an overview of the sampling levels in 1999 for each stock.

1.4 Methods and software

1.4.1 Assessment

Extended survivors analysis (XSA) has been used as the main tool for catch-at-age analysis for all stocks, except for whiting in IV and VIId (see below). Three implementations were used: version 3.1 of the Lowestoft VPA package was used for roundfish and flatfish stocks; the Seasonal XSA (Skagen 1993, 1994) was used for Norway pout (quarterly) and sandeel (by half year) to allow for seasonal data. A beta-release of a new version (XXSA) was explored in some stocks. This new release allows for using research vessel data beyond the last year in the assessment and furthermore allows the setting of shrinkage options by age and year.

In the last year's WG reports, the general approach to tuning the XSA has been to use a 10-year tuning window without a time taper. However, this may not be appropriate. A main drawback of using only 10 years of data in the tuning is that the regression between stock numbers and CPUE is limited to 10 points. By adding one year and taking off the first year, the possibility that the regression changes drastically is relatively large, as was observed for a number of stocks during this year's assessments (e.g. plaice in IV, plaice in IIIa and whiting). Furthermore, as there is expected to be no trend in catchability over time in research vessel survey series, the use of longer time series seems appropriate. In the case of commercial tuning series the effect of changes in fishing power over time could be remedied by using a tricubic time-taper over 20 years. Therefore, the WG now applied either an increasing tuning window without time taper (using all the data which was considered reliable) or alternatively used the full available time series with a tricubic time taper.

The general approach to carrying out the explorations leading to the final assessment was as follows:

- 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 all available tuning series, single fleet runs were carried out using XSA with a low shrinkage (SE = 1.5) and no time taper over the whole time period. These runs were used to explore the consistency of the surveys with the catch-at-age data. Results were used to determine the fleet year and age ranges to be used for the final assessment.

- Given the selection of fleets and ages from the above analysis, a run was carried out with all selected fleets combined, with the time period of tuning as selected for the final run, but with catchability set to be independent of year class strength for all ages (that is, no power model for recruits). From this analysis, graphs of log catchability residuals were plotted against log stock numbers to judge whether the slope of the regression was consistently different from zero for the most important fleets. If so, a power model of catchability would be used for those ages.

- Then the final run was carried out. Plots of log CPUE against log stock numbers were generated to visually inspect the quality of the regressions (or alternatively the residuals were plotted). A poor performance of a fleet at this stage was no longer considered a decisive argument against the use of that fleet (or age), if it had performed acceptably in the single fleet runs.

There was high uncertainty about the assessment produced using this scheme for whiting in IV and VIId. For that stock, an implementation (TSA) of the Kalman filter algorithm was used instead, as it was thought that it best encapsulated the uncertainty in terminal-year estimates. Details of the method and its interpretation are given in Section 5.1.4. A supplementary assessment was also produced for this stock using the ICA model.

1.4.2 Recruitment estimation

As in previous years, in several cases recruitment estimates have been made with RCT3. This was the case when recruitment indices from 2000 surveys are available, and especially when indices are available from later than the first quarter. The present implementation of XSA cannot accommodate survey data in the year following the last catch data year and RCT3 is therefore implemented to utilise this information. This does in itself create 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 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 undesirable strong influence on the recruitment estimates originating from XSA. The XXSA program may solve this problem, but it has not been fully tested yet.

The TSA model used for whiting in IV and VIId produced 2-year ahead predictions of recruitment, with estimates of associated standard errors. These were used as recruitment estimates for that stock.

1.4.3 Forecasts, sensitivity analysis and medium-term projections, roundfish and flatfish

Short-term forecasts were made for each stock for which a full analytical assessment could be carried out. They are based on initial stock sizes as estimated by XSA (in a number of cases supplemented with separate recruitment estimates as described above), natural mortalities and maturity ogives as used in the XSA, mean weights at age averaged over recent years (normally 3) and fishing mortalities at age as a mean F-pattern over the most recent 3 years. The estimate of *status quo* F used by default in short-term predictions was the scaled mean F at age for the most recent three years. For whiting in IV and VIId, the TSA predictions of recruitment were used to generate probabilistic estimates of the likelihood of F exceeding F_{sq} for given levels of catch.

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

1.4.4 Biological Reference points

Established biological reference points ($\mathbf{F}_{med}$, F_{high}, $F_{0.1}$, F_{max} etc) have been estimated using the REFPOINT software and given for each stock where possible. No additional work was carried out to evaluate the management reference points (Fpa, Bpa, Flim, Blim).

1.4.5 Software

Overview of the versions used:

Software	Purpose	Version
VPA-suite	Historical assessment (e.g. separable VPA, XSA)	version: VPA95PA. Compiled: 30/4/1998
ICA (Integrated Catch Analysis)	Historical assessment	version: 1.4
TSA (Time series analysis)	Historical assessment. Catch-at-age data only, 2-year projections	no formal version number.
GSA	Historical assessment. Seasonal XSA.	compiled: 9/10/1995
RCT3	Recruitment estimation	compiled: 2/10/1992
RETVPA (Retrospective VPA)	Retrospective analysis	version: 00-1
Insens	Generate input files for predictions	version: 1.25, June 2000
Recruit	Estimation of stock recruitment parameters	compiled: 4/10/1996
WGFRANSW	Short term prediction and sensitivity analysis	version 1.0, 22/5/2001
WGMTERMC	Medium term analysis	compiled: 3/11/1999
REFPOINT	Calculation of reference points and yield per recruit	compiled: 12/6/1997

1.5 Biological Reference points

Established biological reference points (**F_{med}**, F_{high}, $F_{0.1}$, F_{max} etc) have been estimated according to standard procedures and given for each stock where possible.

Three years ago, the Working Group proposed limit- and precautionary reference points for fishing mortality and SSB (**F_{lim}**, **F_{pa}**, **B_{lim}** and **B_{pa}**) for all stocks based on guidelines by the ICES Study Group of the Precautionary approach to Fisheries Management (ICES 1998). These proposals were reviewed by ACFM and in most cases taken over or modified to ICES proposals of precautionary reference points to managers. Some of the reference points for North Sea stocks have been adopted by managers (Norway and EU) notably those for cod, haddock and plaice.

ACFM states that future management advice by ICES will be constrained by **F_{pa}** and **B_{pa}**, the precautionary thresholds which imply a reasonably high probability of remaining below a limit fishing mortality and above a limit spawning stock biomass. **F_{pa}** and **B_{pa}** are thus the main devices to be used by ICES in providing Management Advice.

The reference points adopted by ICES and proposed to the managers are given in the text table below:

Stock	**B_{lim}**	**B_{pa}**	**F_{lim}**	**F_{pa}**
Cod in IIIa (Skagerrak), IV and VIId	70	150	0.86	0.65
Haddock in IIIa and IV	100	140	1.00	0.70
Whiting in IV and VIId	225	315	0.90	0.65
Saithe in IV, VI and IIIa	106	200	0.60	0.40
Sole in IV	25	35	-	0.40
Sole in VIId	-	8	0.55	0.40
Plaice in IV	210	300	0.60	0.30
Plaice in VIId	5.6	8	0.54	0.45
Plaice in IIIa	-	24	-	0.73
Norway pout in IV and IIIa	90	150	-	-
Sandeel IV	430	600	-	-

Biomass in '000 tonnes
– no estimate available

1.6 Working Documents and reports

1.6.1 Medium term projections for North Sea cod haddock and whiting

The WD summarizes medium term simulations run for North Sea cod, haddock and Saithe in response to a request from the European Commission, to evaluate the effect of various mesh size changes. Simulation results are presented and discussed in Sections 1.12 and 1.13, so this section focusses on the method.

The ICES assessment for North Sea cod does not take account of discards. However, the expert group from “The scientific meeting on improvement of selectivity of fishing gears, spring 2001” (Anon., 2001) estimated fishing mortalities for cod in the North Sea by discards and landings separately.

To allow cod discards to be accounted for in the projections, a new XSA-tuned assessment was made with an increase in the natural mortality equivalent to the estimated discards. This allowed estimation of historical SSB/recruitment time series, which was used as the basis for a SSB/recruitment relationship in the projections. The result of the XSA gave stock numbers at 1 Jan. 2000, and Fs for landings. Discards Fs was finally extracted from the natural mortality. A ten years geometric mean was used as the estimate of recruitment in year 2000. The projections used the same methodology as WGNSSK along with a Ricker stock-recruitment curve fitted to the full year range of data points.

The estimated 1999 Fs (landings and discards) from the revised VPA were scaled to the Fpa to give baseline Fs.

Cod mean length by age and quarter in combination with a gear selection model and parameter, agreed by the expert group, was used to predict the instantaneous change in exploitation pattern for both landings and discards. Scenarios were made with mesh size increases to 110, 120, 140 and 150 mm. It was assumed that the mesh change was only implemented for the trawl-seine fleet using meshes >=100 mm.

The initial inputs to prediction used for the haddock and the whiting projections were the same as those used by the ICES WGNSSK in their 2000 assessment (ICES CM 2001/ACFM:07). The current exploitation pattern was assumed to correspond to a mesh size of 100mm mesh in the major gears, so the prediction inputs were unchanged for the baseline (100mm) projection. For all projections, an F-multiplier of 0.68 was assumed, corresponding to the reduction in F required to reduce fishing mortality on cod to the F_{PA}. This was done to take account for mixed-species catches by the 100 mm trawl-seine fleet.

To modify the exploitation pattern to correspond with the increased mesh sizes, the fleet-disaggregated mesh assessment model of Reeves & Furness (in prep.) was used. The selectivity parameters of the gears were estimated using the values of selection factor and selection ration given by the Expert group. The projections for haddock assumed that the revised mesh size would apply to all gears taking haddock in the North Sea apart from *Nephrops* trawlers, which take a haddock bycatch, and vessels prosecuting the small mesh fisheries for sandeel and Norway Pout which also take a small bycatch of haddock. Haddock taken in the Skagerrak are also included in the North Sea

The approach used to model exploitation patterns for whiting was identical to that for haddock. In the case of whiting the assessment includes minor catches taken in the Eastern Channel (ICES Division VIId) and it has been assumed that this area is not affected by the increased mesh size. Similarly, by-catches by *Nephrops* trawlers and small mesh industrial trawlers are also assumed to be unaffected.

The results from the projections should be interpreted with great caution. The selectivity parameters used for the large mesh sizes involve linear extrapolation well beyond the range of mesh sizes for which data are available, and they consider only mesh size when factors such as cod-end construction and twine thickness can also affect selectivity. Furthermore, the projections assume fixed weights and natural mortality at age, whereas at the high stock sizes implied by some scenarios, factors such as density dependent growth and increased predation would become important. No attempt has been made to account for such effects.

1.6.2 Paper: “Biological investigations on Norway Pout” by Henrik Sparholt, Lena I. Larsen and J. Rasmus Nielsen

A WG Doc was presented on Residual natural mortality of Norway pout in the North Sea (WD-2). Residual mortality, M1, is defined as the natural mortality by other causes than predation mortality, i.e. mortality caused by diseases, spawning stress, growth stress, other predators, etc. Various authors have indicated that M increases with age. In the routine assessment this is not assumed. The WG Doc tried to resolve the discrepancy.

The paper attempts primarily to estimate residual natural mortality, M1, i.e. the part of the natural mortality that is not covered by the MSVPA estimate of predation mortality from the five MSVPA predators (cod, haddock, whiting, saithe, and mackerel).

Based on data from various surveys (see table below), commercial catch at age data, and number of Norway pout predated by the MSVPA predators, simple catch curve analysis showed that Z increases form age 1 and onwards:

Data source / Age	0	1	2	3	4
IBTS 1q, y.c 1977-1981	-	1.92	2.55	2.92	3.39
Commercial catch, y.c. 1977-1981	-	1.45	2.69	4.58	
Numbers predated, y.c. 1977-1981	0.91	2.33	3.48	-	-
IBTS 1q, y.c 1987-1991	-	0.75	2.29	3.17	4.30
EGFS 3q, y.c. 1987-1991	-	0.84	3.02	-	-
SGFS 3q, y.c. 1987-1991	-	1.53	2.44	-	-
Commercial catch, y.c. 1987-1991	-	1.20	2.69	4.17	
Numbers predated, y.c. 1987-1991	2.01	2.17	3.23	-	-
IBTS 1q entire period 1974-1999	-	1.02	2.13	3.13	3.99
EGFS entire period 1982-1999	-	1.78	2.68	-	-
SGFS entire period 1980-1999	-	1.51	2.73	-	-
Commercial catch	-	1.53	2.78	4.41	-
Numbers predated	1.35	2.45	3.45	-	-

A simple steady state model with IBTS 1q data, commercial catch data, and numbers predated gave the following maximum likelihood estimates of F, M1, and M2.

Model using year classes 1977-1981

		Age 0	Age 1	Age 2	Age 3	Age 4	Age 5
Parameters estimated (shaded) or calculated	F	0.04	0.29	0.29	0.29	0.29	
	M1	0.08	0.16	1.61	2.63	3.22	
	M2	0.73	1.25	0.52	0.24	0.12	
	Z	0.85	1.70	2.42	3.16	3.63	
	IBTS catchability (% in swept area caught)	-	6.8%	6.8%	6.8%	6.8%	6.8%
	Stock biomass ('000 t) at 1st January	-	834	529	86	5.1	0.1
		Total 1.5 million t					

Model using year classes 1987-1991

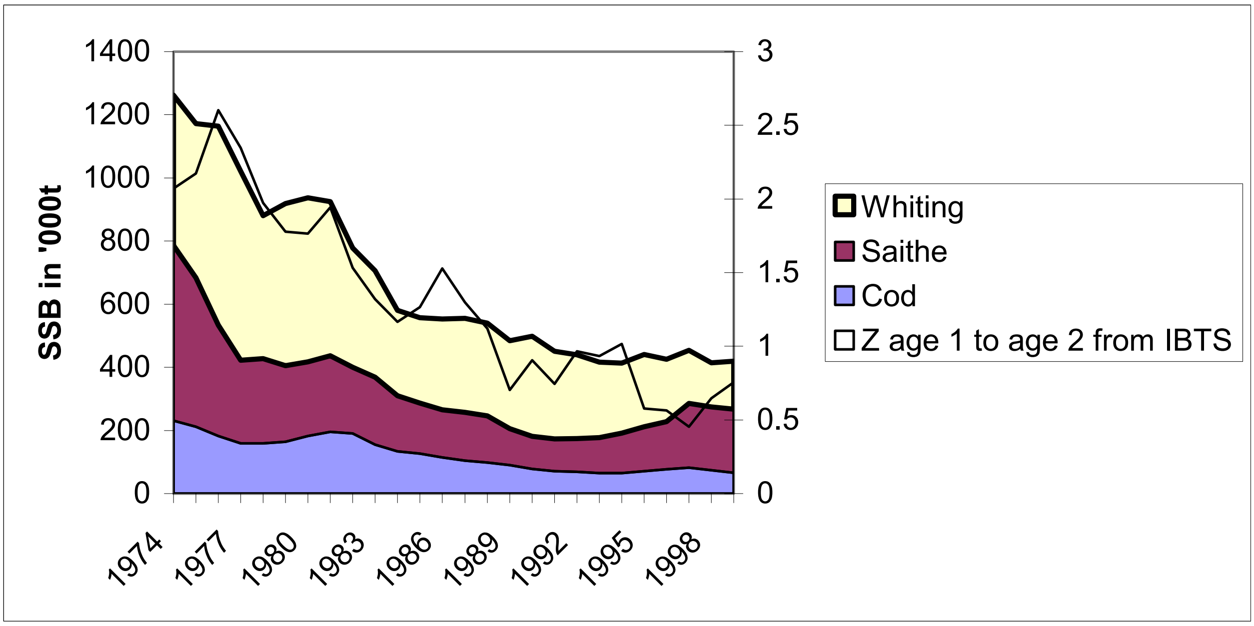
		Age 0	Age 1	Age 2	Age 3	Age 4	Age 5
Parameters estimated (shaded) or calculated	F	0.02	0.10	0.10	0.10	0.10	
	M1	0.05	0.10	2.03	3.04	4.26	
	M2	1.19	0.49	0.19	0.11	0.04	
	Z	1.26	0.69	2.32	3.25	4.39	
	IBTS catchability (% in swept area caught)	-	9.12%	9.12%	9.12%	9.12%	9.12%
	Stock biomass ('000 t) at 1st January	-	554	962	173	9.4	0.1
		Total 1.7 million t					

It can still be postulated that old Norway pout might migrate out of the North Sea to the North and the Northwest (which possibility not have been tested) and Z therefore is over-estimated. However, around the Faroe Islands very few N. pout of age 3 and older are found (Jakup Reinert, pers. comm.). Furthermore, it would be an unusual phenomenon if N. pout spawn in the North Sea as 2 groups and to some extent 3 groups and then migrate out and spawn outside the North Sea as 3+ groups. At least homing can then not be a feature for N. pout. Norway pout has normally a depth range distribution limit of 250-300 m bottom depth. Extensive migration to the Skagerrak Trench or out of the North Sea area to the deeper northern and north-western areas is not likely.

The only realistic conclusion at the moment of the estimated increase in Z is that M1 (residual natural mortality) increase by age.

Consequences for the assessment (and for the MSVPA) of this is that SXSA (or XSA) has to be run with revised M values (MSVPA with revised M1 values) and it is a question whether SXSA will then be sufficiently converging to give reasonable results if the latter is the case. Alternative assessment methods would be preferable.

A second Working Document was presented on verification of multispecies interactions in the North Sea by trawl survey data on Norway pout (WD-3). Extensive stomach sampling programmes of North Sea fish during the recent 2 decades have shown that cod, whiting and saithe are by far the main predators on Norway pout of age 1 and older. As the stock sizes of cod, whiting and saithe have decreased significantly over the period this offers a unique opportunity to test whether a decrease in natural mortality of Norway pout can be detected in mortality estimates obtained directly from abundance data of Norway pout. Two surveys, which cover the Norway pout distribution well, have been analyzed in this regard. Both showed clear decrease in total mortality consistent with the decrease in amounts of predators. The level of predation mortality is similar to that from the ICES North Sea Multispecies model (MSVPA), but the MSVPA does not reflect the variation in mortality over time. It is speculated that this might be a consequence of the model ignoring the very high spawning or growth mortality of Norway pout of age 2 and older. The figure below shows the spawning stock biomass (SSB) of cod, whiting and saithe in the North Sea from routine single species fish stock assessments (ICES 2001) and total mortality, Z, of age 1 Norway pout calculated from IBTS survey data.



1.6.3 A new German Otter trawl tuning series for Saithe in IV, VI and IIIa

The WD presents commercial catch and effort data of saithe, which are derived from the official German logbook statistics, which have been made available in a consistent database for the period 1995-2000. Only otter trawl board catches were considered of 7 vessels continuously being engaged in the directed saithe fishery. The selected data include effort and catches in Sub-areas IV only, while negligible records from Sub-area VI and Division IIIa were omitted. During 1995-2000, this fleet consisting of 7 vessels accounted for 75 % of the entire saithe catch officially reported. The catch and effort data were aggregated by year and are listed in Table 1. CPUE (kg/h) was calculated on a haul by haul basis and the annual means and accompanied standard deviations are also given. They reveal that the CPUE is a highly variable estimate throughout the time series with CVs in excess of 1.0. Although highly significant, the standardisation of the CPUE based on vessel (machine power), quarter and year effects accounted only for 2 % of the overall variation. Therefore unstandardised mean CPUE and accompanied standard deviations were presented. The information on age group representation based on biological samples, on the annual catch and the effort was used to calculate abundance indices for the various age groups.

The CPUE was found to be a highly variable estimate throughout the time series. Compared with the relatively stable period 1995-1999 the catch rate in 2000 almost doubled. The age disaggregated abundance indices derived from CPUE indicated the 1992 and 1994 year classes as strong. Catch curves also revealed that the year classes 1992 to 1994 were subject to lower mortality rates at ages 4 to 7 than the previous year classes. This indicates a significant reduction in fishing mortality. It was also concluded that the recruiting year class 1996 at age 4 is the strongest year class since 1995.

1.6.4 Evaluation of market sampling

A working document was presented that contained some examples of the results of the research project Evaluation of MArket Sampling strategies for a number of commercially exploited stocks in the North Sea and development of procedures for consistent data storage and retrieval (EMAS) which was carried out between April 1999 and May 2001 (WD 5). The project aimed to provide insight into the measures of uncertainty that are associated with the catch-at-age data and their influence of management parameters of stock assessment (Pastoors *et al*. 2001). To this end a limited number of international market sampling programs were investigated, the selected programs were those for North Sea cod, plaice and herring. These provide good examples of well sampled roundfish, flatfish and pelagic fish stocks. For cod and plaice stocks, in addition to the analysis of total catch at age data an analysis of assessment commercial catch per unit effort (CPUE) indices which is included.

Information on the fishery regulations, national monitoring systems, sampling designs, total landings and the methods for raising national samples to the total national catch numbers at age (and mean weight at age) were collated in the project and are described in the EMAS report. The designs and data storage methods used for providing national catch at age data were found to be incompatible with one another and creation of an international database at the sample level was not feasible. The project has addressed the data needs for stock assessment working groups and has provided a design for a database that can combine national catch at age data to give international data output in an appropriate form for assessment models.

Results of detailed analysis are only reported for England and Wales, here. However, similar results are available for the other partners in the research project EMAS. Mean catch number at age, weights at age and coefficients of variation (CV) from the bootstrap analysis of the English and Wales cod market sampling data are presented in the final report of the EMAS project. The estimated CVs are around 15% for age 1, decrease to 5-10% for 2 to 4 year-olds, increase to around 25% for 8 year-olds and are mostly 30% or 40% for 9 year-olds and above (Figure 1.6.4.1). The quarterly data show a similar pattern across age as in the annual data (Figure 1.6.4.2). The only exception to this is that there are few 1 year-olds in the first two quarters; resulting in much higher CVs. The CVs for quarterly catch-at-age are higher than for the annual data. However, they broadly appear to follow the anticipated pattern that the quarterly CVs are twice those of the annual CVs.

Mean catch number at age, weights at age and coefficients of variation (CV) from the bootstrap analysis of the English and Wales plaice market sampling data are presented for both the annual (Figure 1.6.4.3) and quarterly data (Figure 1.6.4.4), and for both combined and single sex data (Figure 1.6.4.5). As with North Sea cod, the CVs for quarterly data are generally twice those for the annual data. Quarterly CVs at ages 4-7 are around 10-15%. The CVs for females are slightly higher than the sexes combined data. CVs for males are again higher than those for the females. The quarterly CVs for females aged 4-7 years are between 15-20%. The quarterly CVs for males aged 4-7 years are between 15-30%.

The coefficients of variation (CV) on the international catch at age data were estimated at around 2.5% for cod and 3.5% for plaice for the most exploited ages, rising to about 40% for cod and 15% for plaice at the older ages (Figure

1.6.4.6). While the precision of these well-sampled fisheries appears to be rather good, no attempt has been made to check whether the sampling is representative. Parameter error distributions are found to be close to normal and strong linear relationships between mean and variance were observed for all three stocks.

To determine the influence of the market sampling programme on the determination of stock management variables, SSB, F and recruitment, the sample data was used to run bootstrapped assessments based on 1000 realisations of the international catch at age matrices and CPUE series. The results from these analyses, which are conditional on accurate catch census, indicated that the inclusion of CPUE indices had considerable influence on the precision of some of the management variables (notably the exploitation pattern in the final year). For the data sets examined the current levels of market sampling cause only small amounts of variability in the outputs for assessments without commercial fleet CPUE indices (Figure 1.6.4.7). Initial studies indicate that CPUE indices contribute a much larger part of the variability (Figure 1.6.4.8).

Figure 1.6.4.1 Coefficients of variation by year in COD numbers at age from bootstrap analysis for England and Wales.

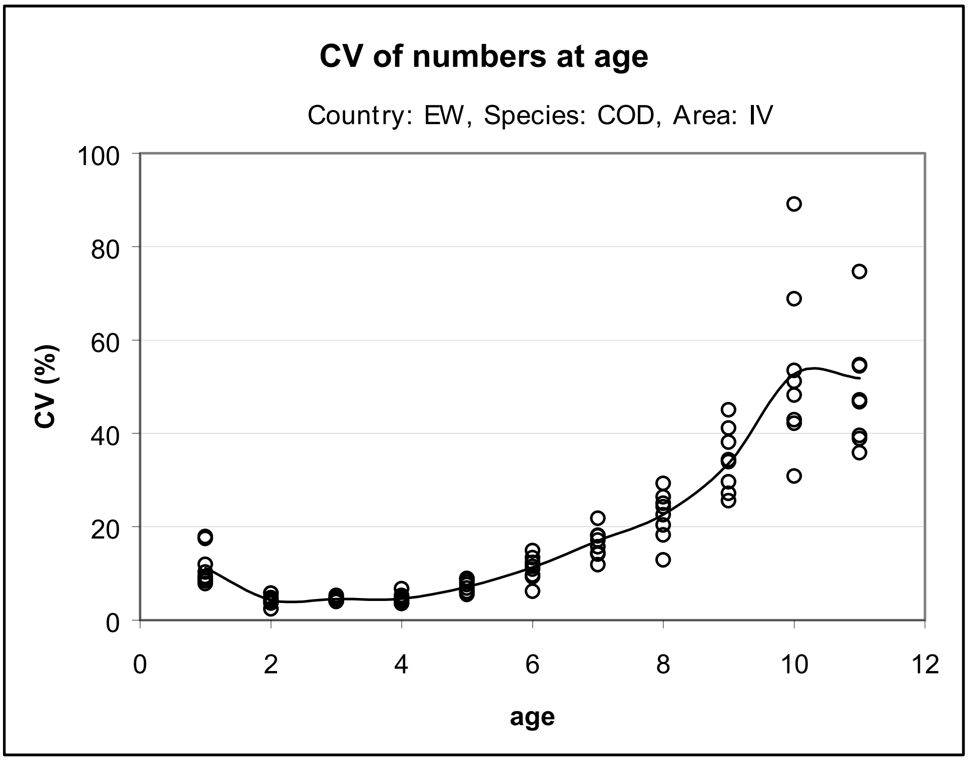


Figure 1.6.4.2 Coefficients of variation by quarter in COD numbers at age from bootstrap analysis for England and Wales

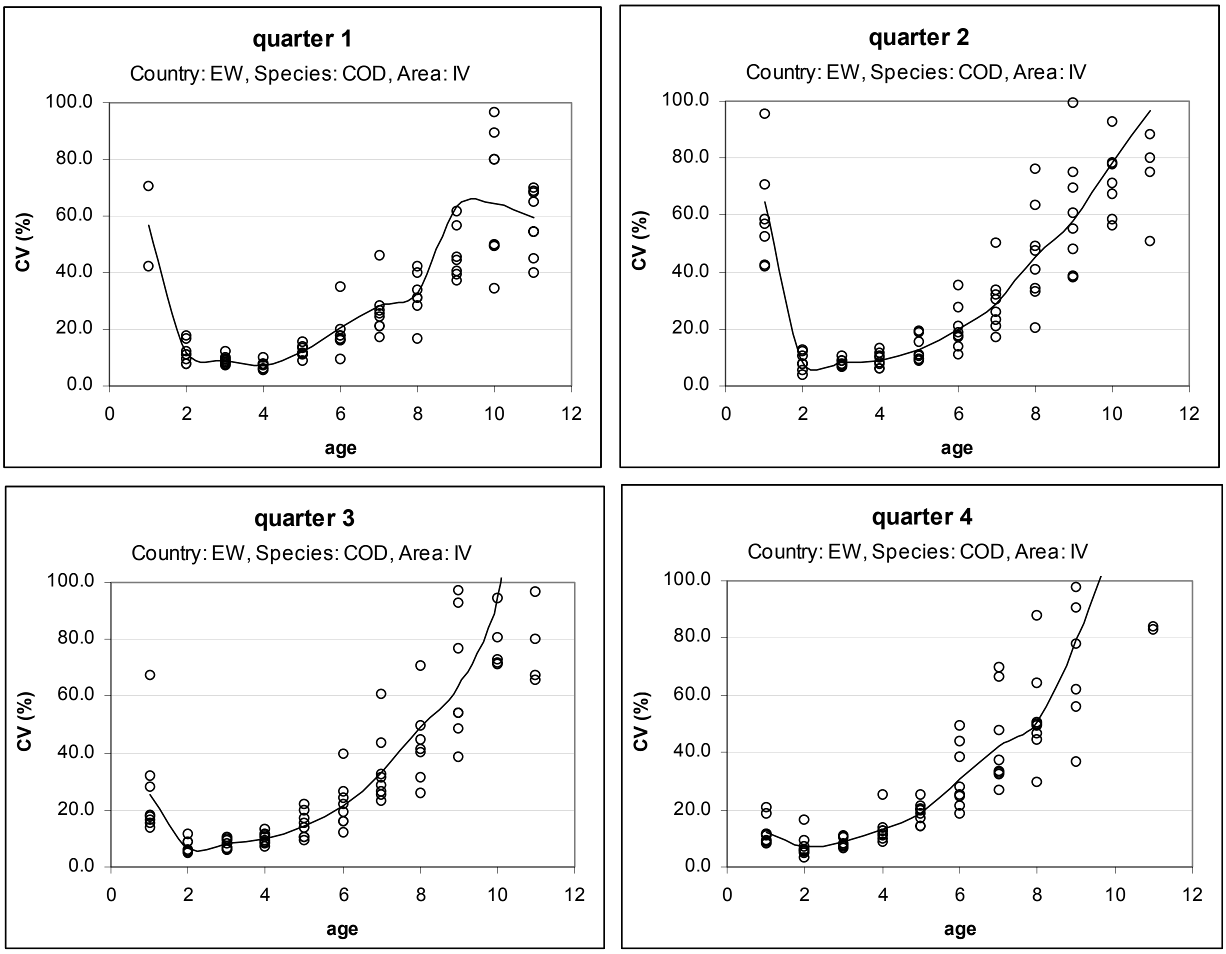


Figure 1.6.4.3 England and Wales. PLAICE. Coefficients of Variation by year in numbers at age from bootstrap analysis.

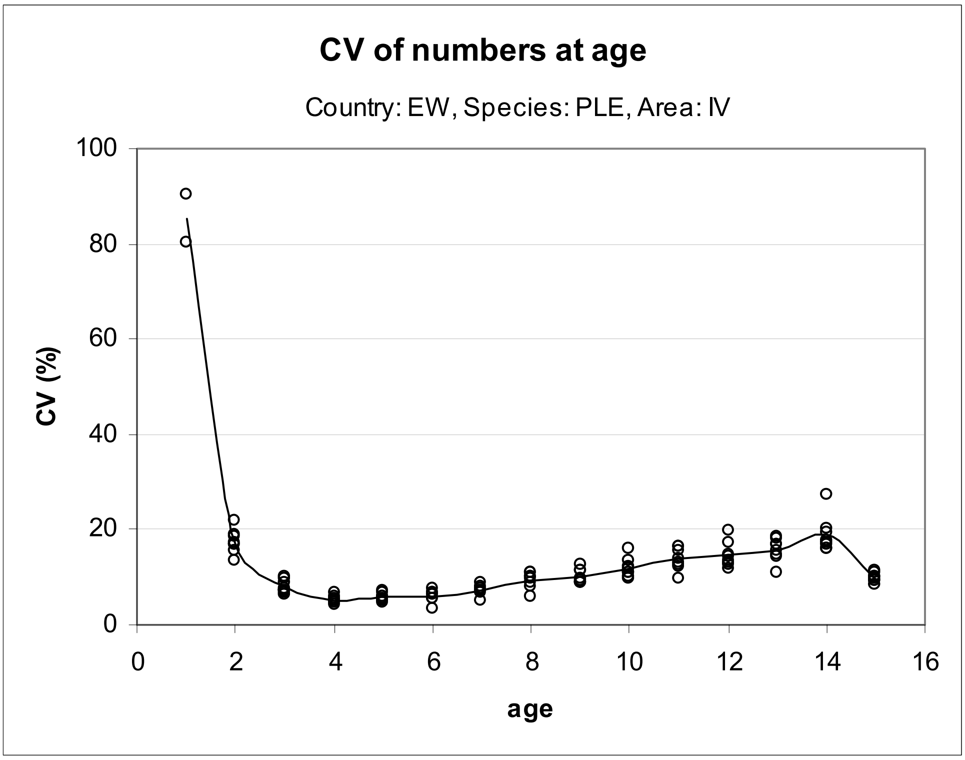


Figure 1.6.4.4 England and Wales. PLAICE. Coefficients of variation by quarter in numbers at age from bootstrap analysis.

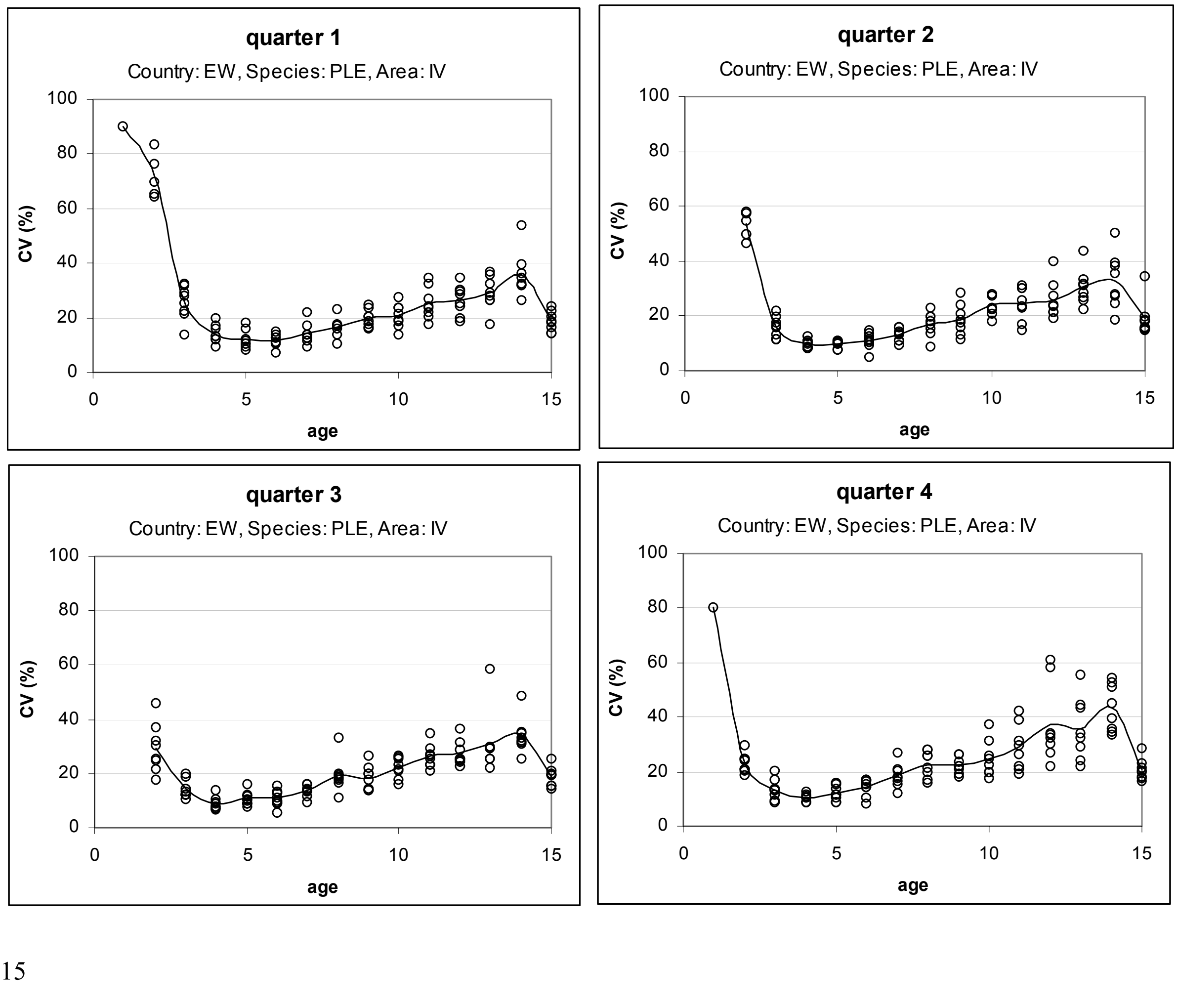


Figure 1.6.4.5 England and Wales. PLAICE. Coefficients of variation by quarter and by sex in numbers at age from bootstrap analysis.

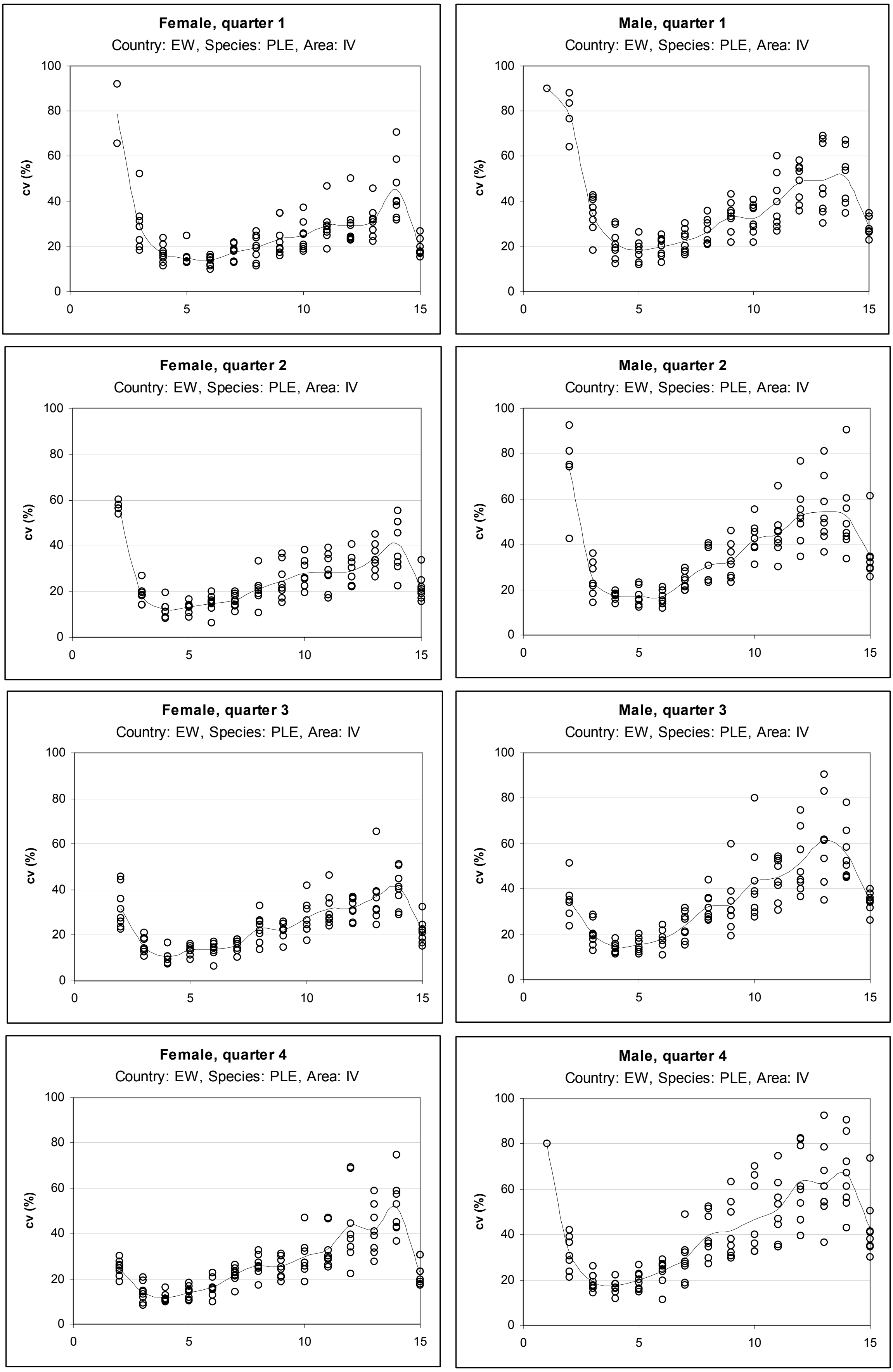
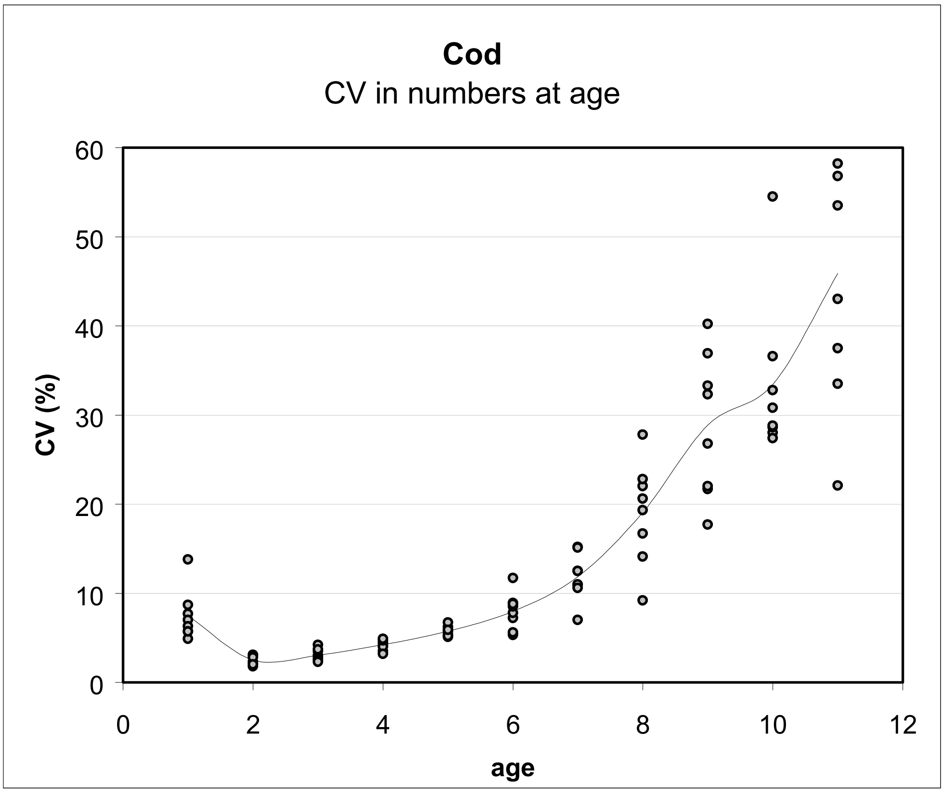


Figure 1.6.4.6 Coefficients of variation of international catch numbers at age for Cod and Plaice.



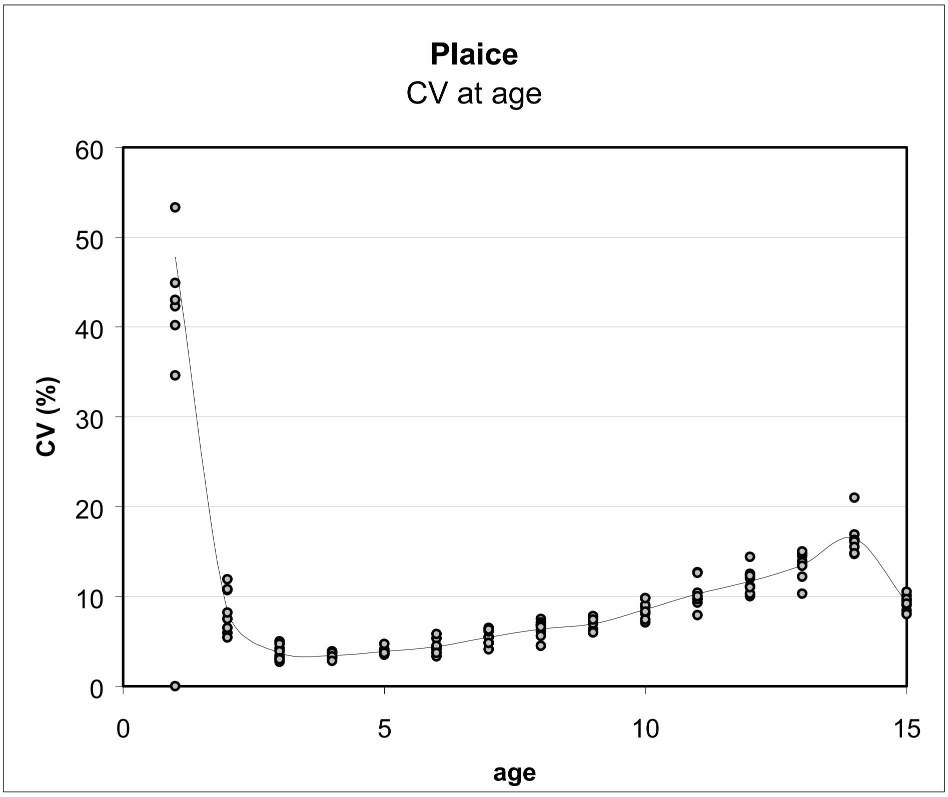


Figure 1.6.4.7 PLAICE. The 5,25,50,75,95th percentiles of Fbar (2-10), recruitment at age 1, SSB and F at age in the 1998 resulting from fitting the 1999 ICES WG XSA model to 1000 bootstraps of the North Sea plaice catch at age data for the years 1991 - 1998.

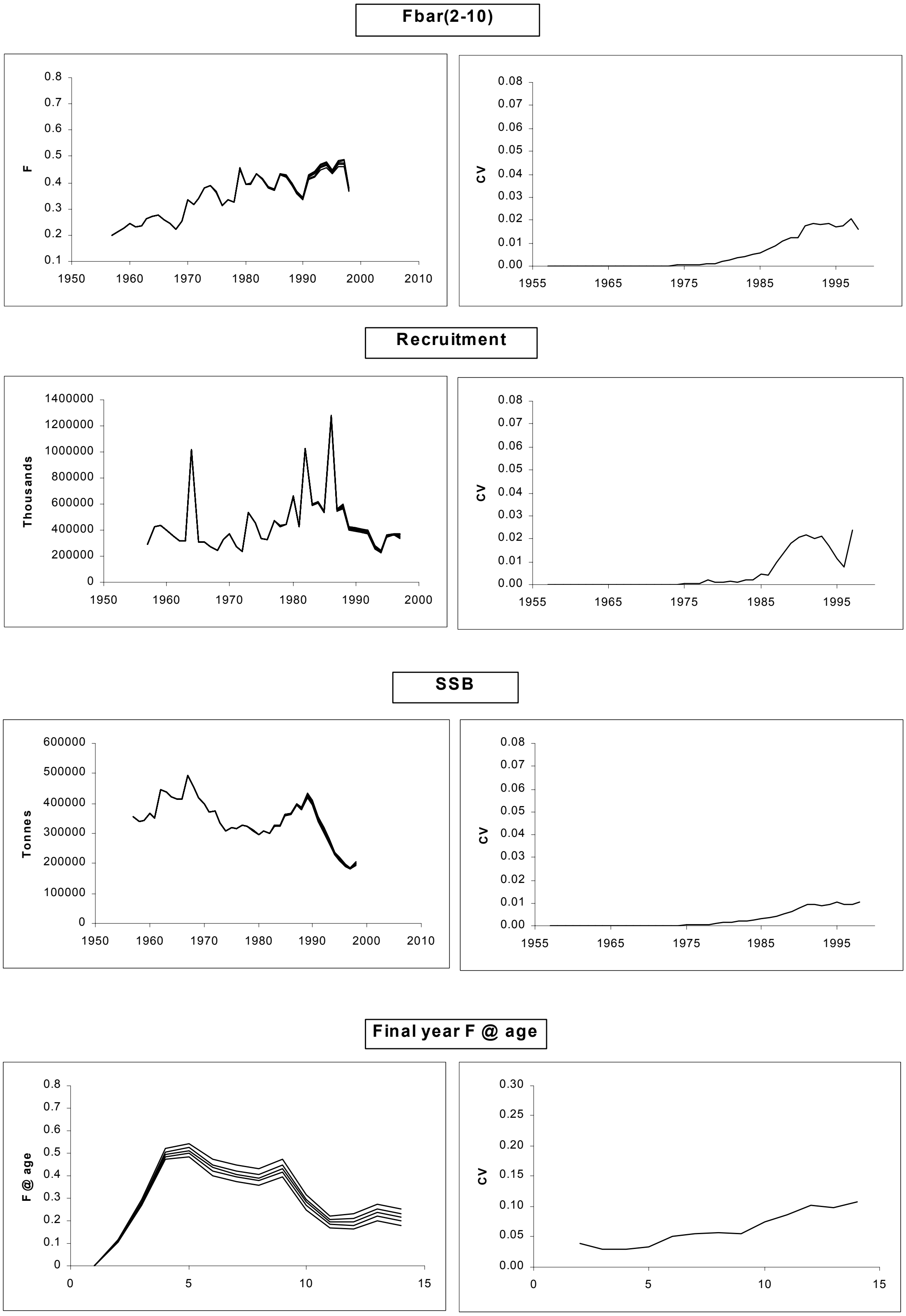
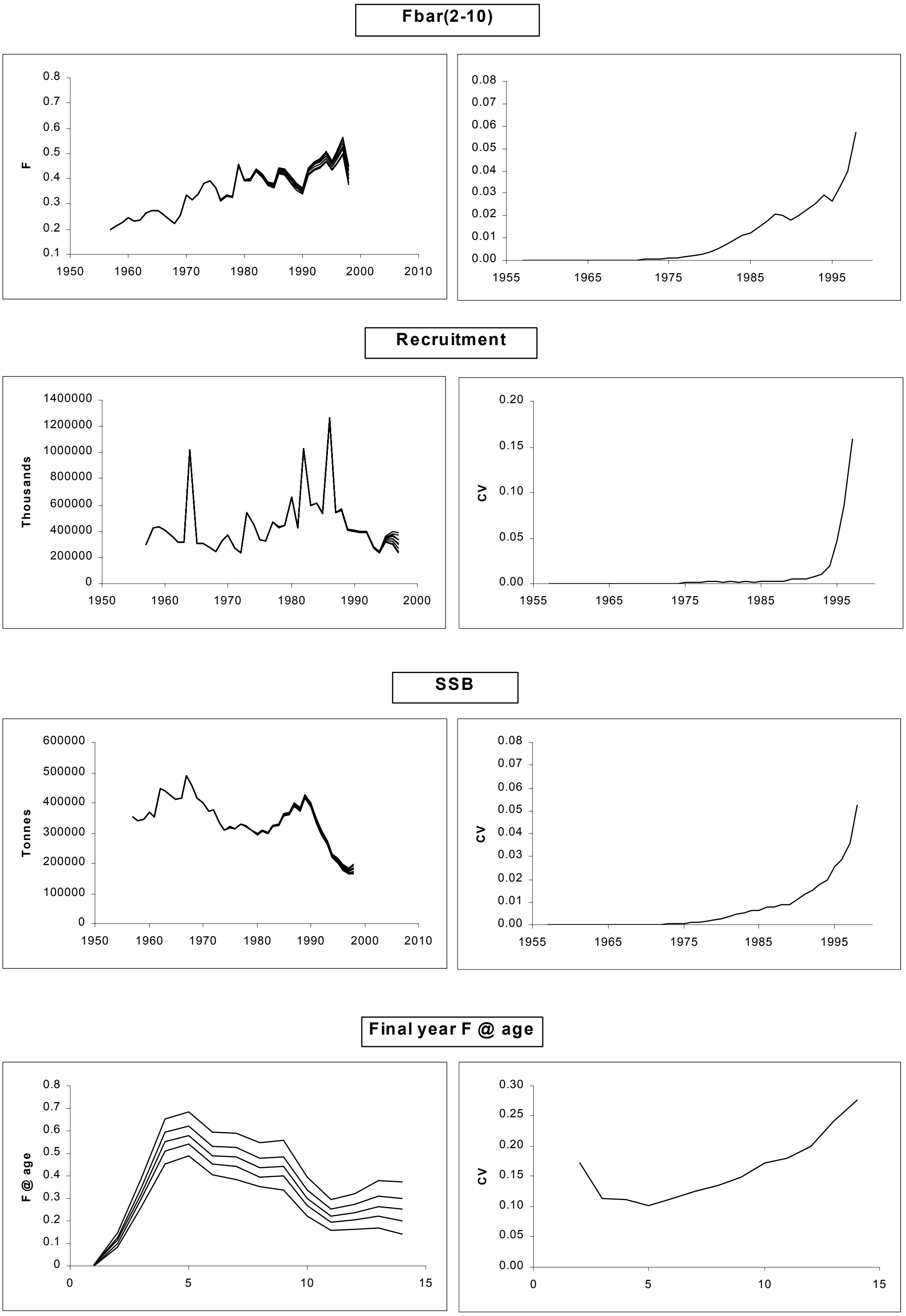


Figure 1.6.4.8 PLAICE. The 5,25,50,75,95th percentiles of Fbar (2-10), recruitment at age 1 and SSB resulting from fitting the 1999 ICES WG, North Sea plaice XSA model structure to 1000 non-parametric bootstraps of the CPUE tuning series.



1.6.5 Maturity changes in cod and plaice in IV

A working document was presented on a preliminary analysis of the trends in maturity for cod and plaice in the North Sea (WD 6). For North Sea cod, data from the Dutch contribution to the IBTS survey were available from 1970 onwards. From these data, the proportion mature at age was calculated. The results indicate an increase in maturity at age for the ages 2-5 (figure 1.6.5.1) and were found to be consistent with results obtained by Cook *et al*. (1999). The comparison between the proportion mature at age in the IBTS data and the assumed maturity ogive in the XSA is shown in Figure 1.6.5.2. Especially for the younger ages there is a tendency for maturity to be higher than assumed in the assessment.

For North Sea plaice data from the Dutch commercial market sampling program were available for analysis from 1957 onwards. The methodology of analysis is described in (Rijnsdorp and Vethaak 1997). Results of the analysis of the Dutch market sampling data for North Sea plaice are presented in Figure 1.6.5.3. The results indicate in increase in female maturity at age for the ages 2-5. The comparison of the maturity data with the assumed maturity in the XSA assessment of plaice shows that maturity may be overestimated in the assessment (Figure 1.6.5.4).

Figure 1.6.5.1 North Sea cod. Maturity at age calculated from the Dutch IBTS data.

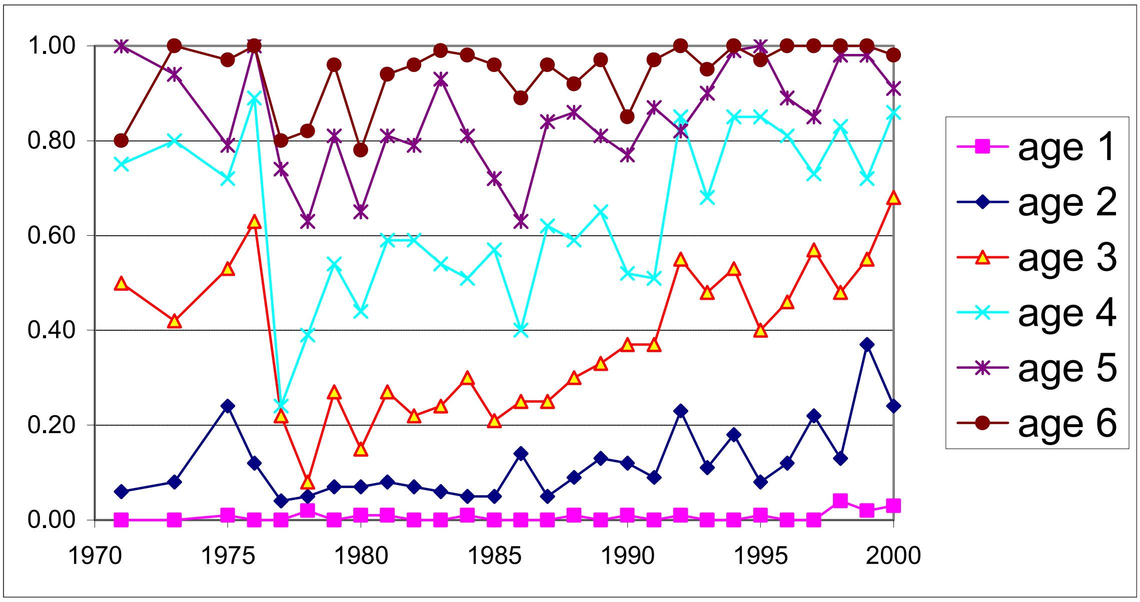


Figure 1.6.5.2 North Sea cod. Comparison between proportion mature in Dutch contribution to IBTS and assumed maturity in XSA. Ages 2-5.

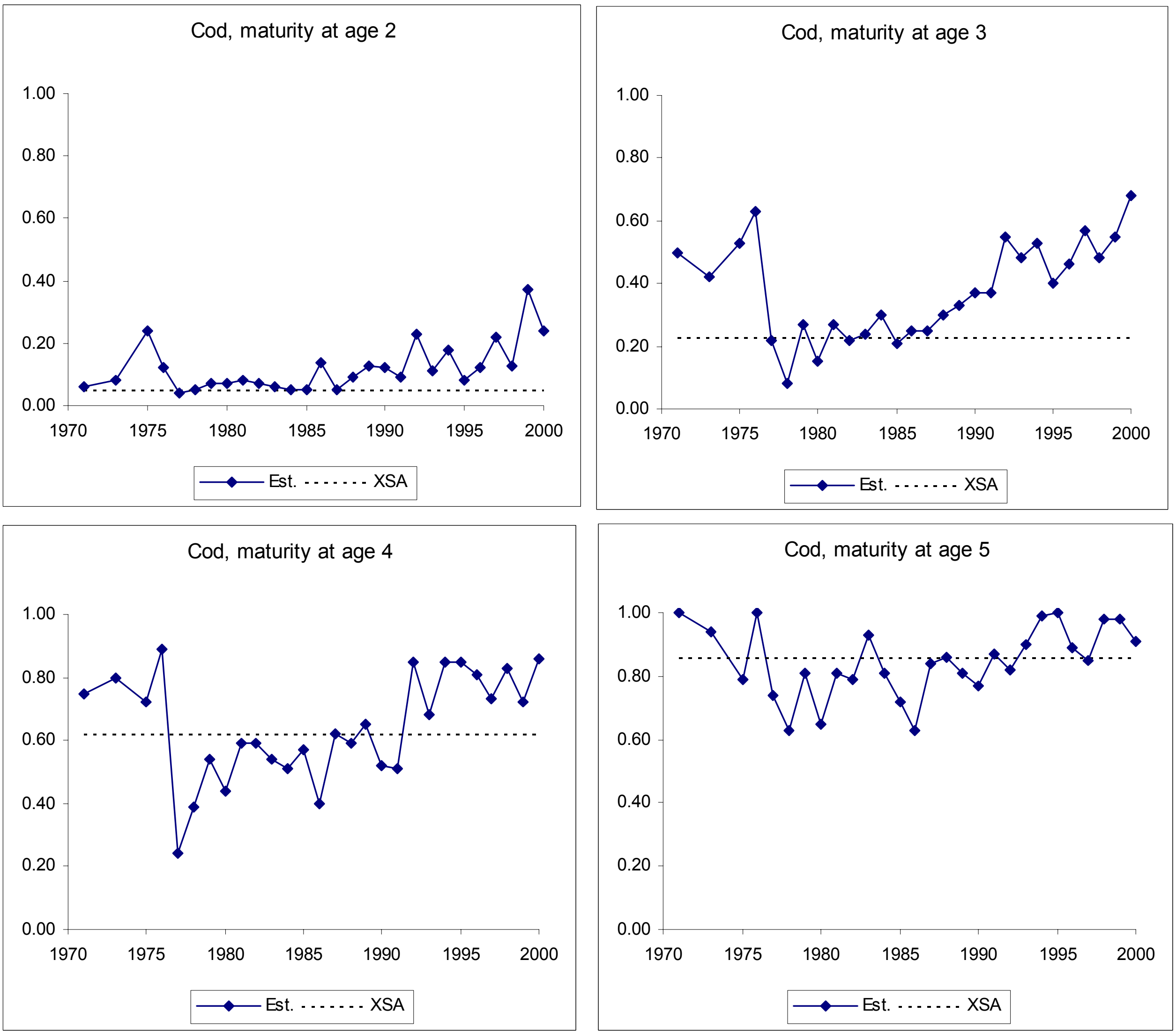


Figure 1.6.5.3 North Sea plaice. Maturity at age from the Dutch market sampling data

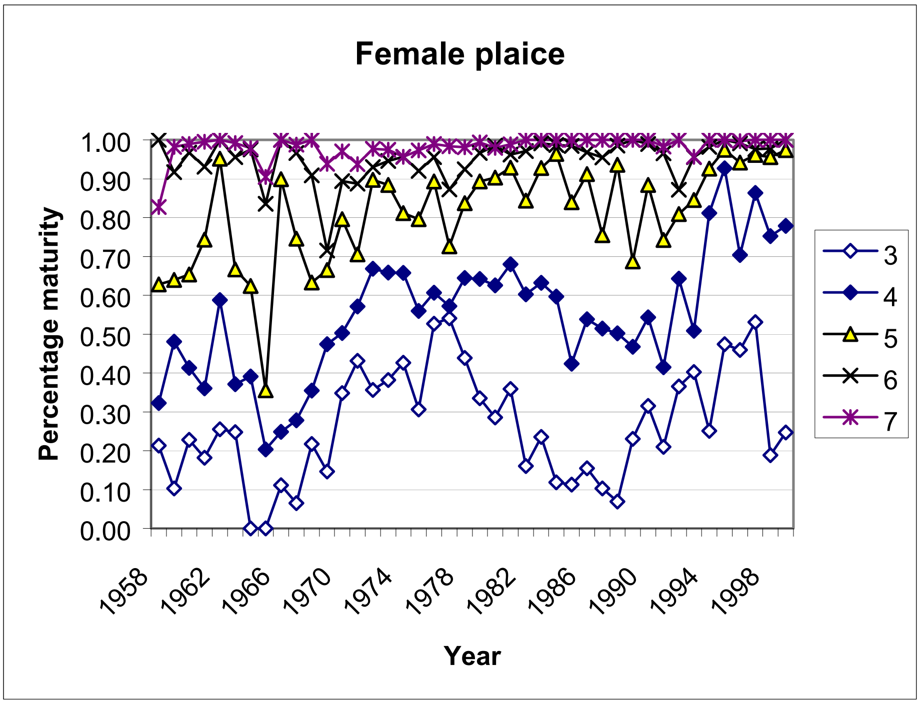
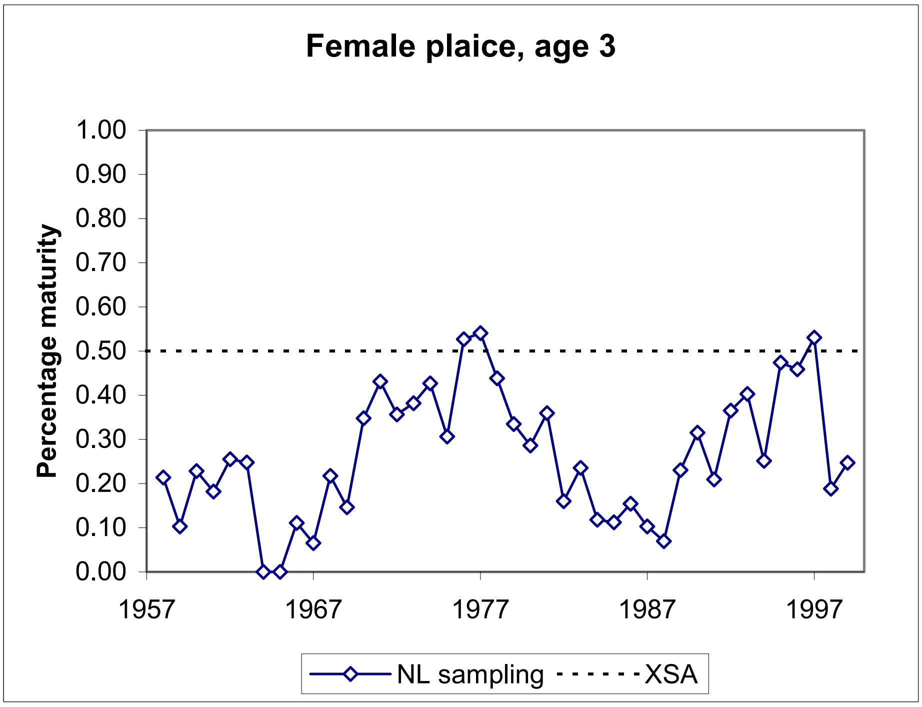
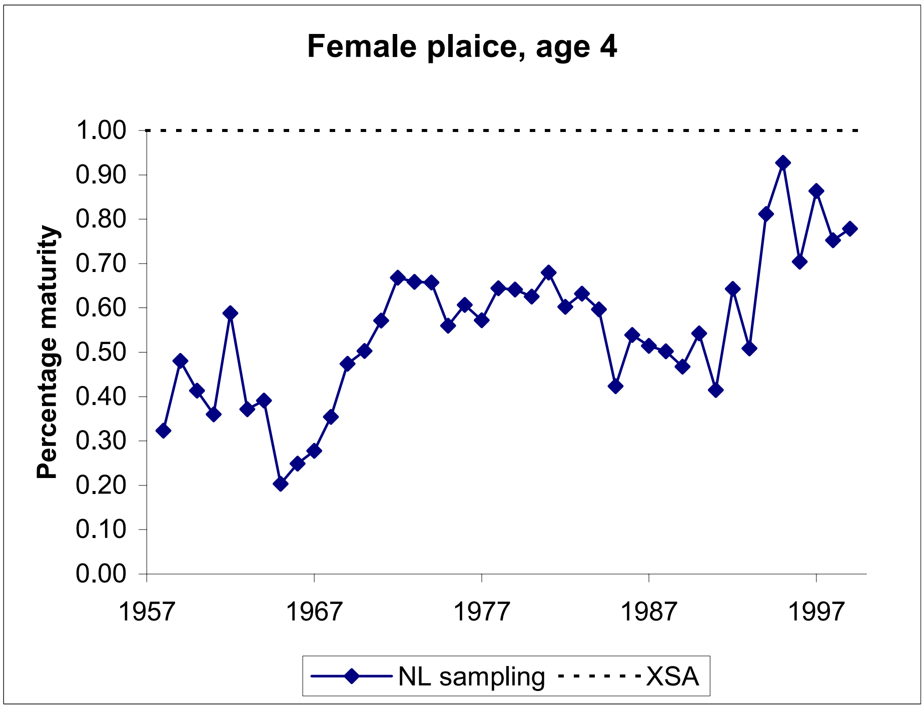


Figure 1.6.5.4 North Sea plaice. Comparison between proportion mature in Dutch sampling and assumed maturity in XSA. Ages 3 and 4.





1.6.6 CPUE in French fleet and trend in International Catches for saithe

A working document (WD9) presents catch and effort data of saithe as calculated from two French commercial trawler fleets which count for around 20% of yearly international catches in the North Sea and target saithe or deep sea species. These fleets are used as tuning fleets in the assessments. Database is available from logbook database on a day basis for the period 1992-2000. Charts of geographic distribution of catches by ICES rectangles are presented. The yearly CPUE from both fleet were relatively stable and showed a high CPUE in 2000 (Fig.1). Annual CPUE by age for both fleets showed high CPUE indices at age 3 between 1992 and 1995 (Fig. 2) corresponding to the good 1990 and 1992 year classes but low CPUE from 1996. The good 1994 year class which was at a similar level as the 1990 year class did not appear before age 4. So we can conclude that from 1996, a strong year class is no more perceptible from age 3 but only from age 4 for both French fleets. This could means that saithe recruit to the fishery later from this date. Total International catches in numbers were taken from ICES Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak database (ICES 2001) and show a decreasing trend at age 1 to 3 in favour of age 4 and older from 1992 (Fig. 3). This observation has been related to two events which happened from 1992, (1) a regulation establishing a new mesh size (EU Regulation n°345/92) and (2) the start of decreasing TAC. In addition the recruitment of three successive good year classes (1990, 1992, 1994) will also increase the proportion of older fish. The observed trend can be the result of the combination of relative abundance of young fish (age 1 to 3) and older age groups, and of fleet strategies that would have targeted older age group as they became more abundant or targeted other species to avoid exceeding TAC.

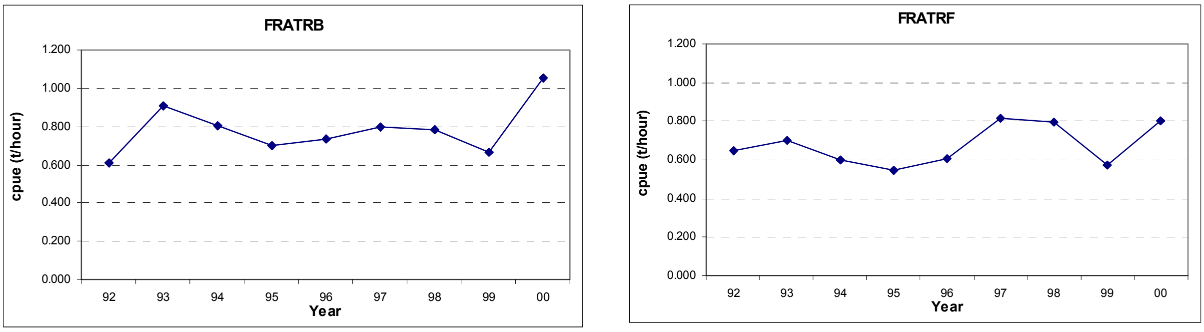


Figure 1 : Annual saithe CPUE for both French fleets from 1992 to 2000.

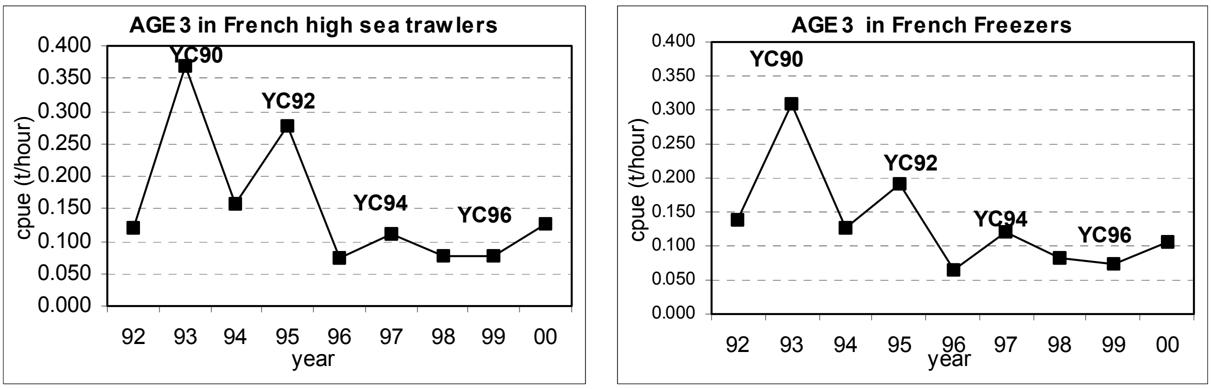


Figure 2 : Annual saithe CPUE by age for both fleet from 1992 to 2000..

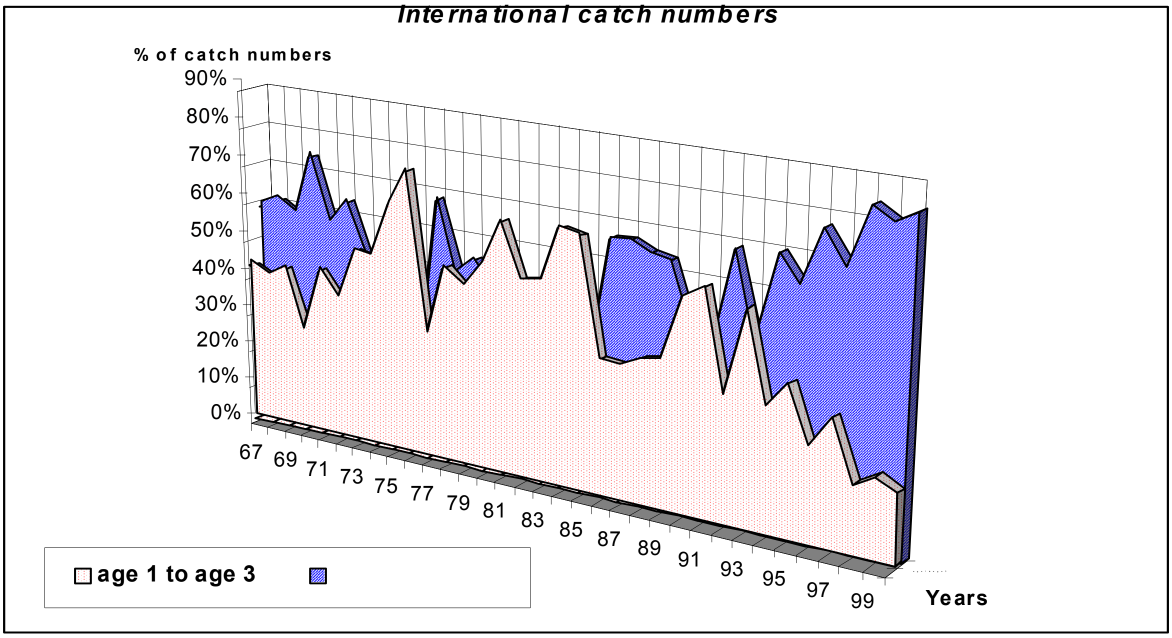


Figure 3: International catches of saithe divided in two age groups, age1-3 and age 4+, from 1967 to 2000.

1.6.7 BTS survey confirms SSB trends for plaice and sole in IV

A working document was presented on the trends in SSB as calculated from the Dutch Beam Trawl Survey (BTS) for plaice and sole. Usually, the age disaggregated indices from this survey are used as tuning fleets in the assessments of plaice and sole. Catches from the RV Isis recorded as numbers per length class per hour per haul were transformed to weight per hour by excluding undersized individuals and applying a length-weight relationship. The log-transformed CPUE per haul is transformed to a index per ICES rectangle by means of a arithmetic average. Finally, the stock index is given by the arithmetic average of the log-transformed CPUE (weight/hr) per ICES rectangle. Because the survey is performed during August and September is calculated as a two-year running average. Results are shown in Figure 1.6.7.1 and compared to the XSA estimates of SSB from the 2000 assessment (ICES 2001). It is concluded that the stock indices derived from the BTS index are well correlated to the stock index calculated in the XSA assessment, which gives increased confidence in the trends observed in the stocks.

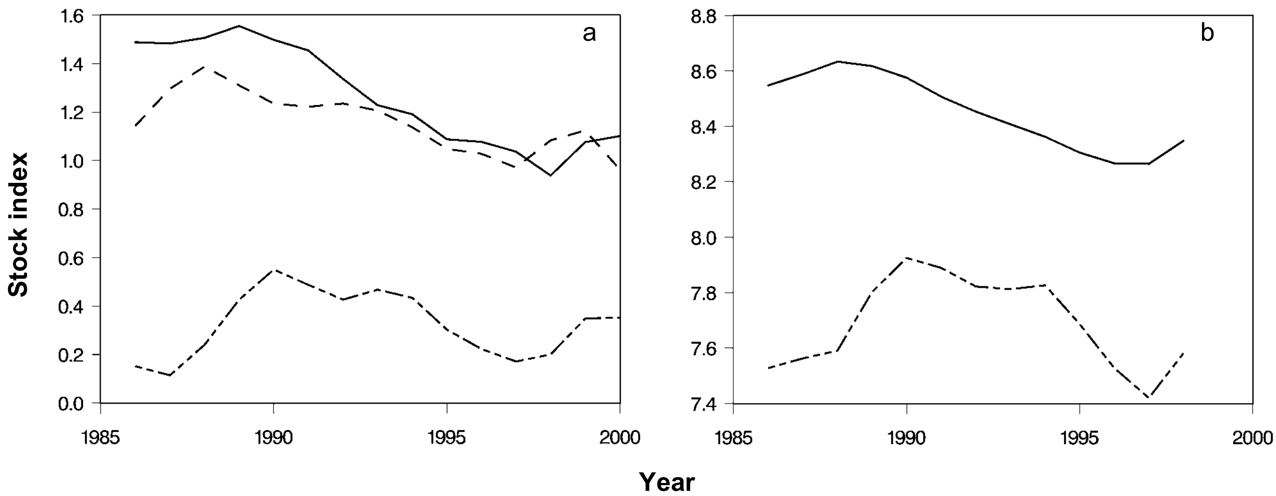


Figure 1 Stock index derived from BTS survey (a) and XSA analyses performed by the ICES working group on demersal stocks in the North Sea in 2000 (b): (____) Plaice, (.-.-.-.-) Sole and (----) Dab.

1.6.8 Splitting of the English age composition for flag vessels.

Approximately 60% of plaice from the UK quota is landed into Holland by Dutch 'flag' vessels fishing on the UK register. The pattern of fishing activity is very different between the two fleets (Figure 9.1). The English vessels fish mainly in the northern part of IVb and the Norwegian sector of the North Sea using 110mm mesh cod-ends. The Dutch flag vessels fish mainly to the south of this and generally with 80mm mesh cod-ends for sole. The differences in mesh size and fishing pattern result in a higher proportion of older plaice being taken by the English fleet. These fish also have a different age growth relationship because growth tends to be slower in fish from the colder deeper water in the north of the fishing area.

As the landings of the Dutch vessels are not sampled by the UK, there is no complete ALK to apply to the landings and the English ALK has previously been used to raise the data to a total age composition for English plus Dutch vessel landings. This was defined as the English beam trawl age composition. The effect of adding the Dutch flag landings to the English age composition leads to an over-estimation in the numbers of older fish.

In order to correct this, a revised age composition and effort data series were calculated for the English landings by using the ratio of landings made in England to landings made abroad. It had been previously established that this approximates closely to the landings by each fleet. This was done on a quarterly basis for all years from 1990 to 2000. The Dutch flag landings were used to raise to the international age composition also on a quarterly basis. A new effort series was calculated for the English beam trawl fleet based on the trips by English vessels only.

1.7 Data for WGECO

This section deals with the terms of reference c) quantify the species and size composition of by-catches taken in the fisheries for Norway pout and sandeel in the North Sea and adjacent waters, and make this information available to WGECO; By-catches of the protected species, haddock, whiting and saithe in the industrial fisheries for Denmark and Norway are presented in Table 2.1.2 for the years 1974-2000. For the last five years quarterly data are presented as well. In 2000 the combined by-catch of haddock, whiting and saithe was about 22,000 t, which is a 100% increase compared to 1999, however, well below the average of 65,000 t in the period 1974 - 2000.

Detailed catches of the "other" species mentioned in Table 2.1.2 are for the period 1985-2000 given in Table 1.7.1. The total catches of 21,000 t in year 2000 are half of the landings in 1999, and at the same levels as the catches in 1993-1998.

1.8 Data for multispecies assessments

Data for the MSVPA WG (quarterly numbers caught and mean weights at age from Sub-area IV) were delivered only for plaice and sole (Table 1.8.1).

1.9 Comment on the ICES quality handbook

The Working Group was asked to: review the layout of a Quality Handbook and prepare a workplan for writing such a document. A draft of the Quality Handbook shall be reviewed by the Working Group in 2002 (ToR f). A draft of the quality handbook and a draft of the stock specific annex were available at the WG (refs). The WG focused it's comments on the draft quality handbook. The WG further considered a workplan for the implementation of the quality handbook in this working group.

1.9.1 Comments

The development of a quality handbook is clearly desirable. The present draft contains useful information which will assist working groups in improving working practices. There are two important concerns which were raised at the working group however.

1. It is important that scientists active in the assessment/advisory process are directly involved in steering the development of the handbook. It would be preferable to set a up a steering group under the auspices of either ACFM or MCAP which could oversee the handbook development to ensure that adequate account is taken of the problems and difficulties facing those directly involved in stock assessment work.

2. There are potentially substantial resource implications in executing the quality procedures and this cannot be ignored. There is little point in developing detailed protocols which cannot be implemented because resources are already over-stretched. Much more consideration needs to be given by ICES to the whole advisory process so that the issue of workload can be addressed. Since this may mean changing the way assessments and advice are done, it has implications for the details of a quality handbook. The present proposals in the handbook are designed to support a system which is already stressed. Unless more thought is given to the way assessments and advice are prepared there is a danger that work on the handbook will be wasted. A particular need is to address the question of the frequency and depth of assessments, an issue which needs to be urgently addressed by ACFM and MCAP.

Some of the information that would be required for a handbook would not be stock specific. This is mainly to do with the general application of methods and the way in which statistics are interpreted. Guidelines in how to explore the data before starting the assessment and how to interpret the results from the assessment would be useful to put in the handbook, ie step by step information, what graphs to produce in the different steps and what conclusions to be made. This should not be generated by the individual stock coordinators (except for stocks that have very specific methods), but rather by the chair of the WG or by the methods WG. In general it is found that the diagnostics allow multiple interpretations and it would be useful to document the procedure of setting up the assessment with all the diagnostics and plots that are required.

1.9.2 Comments to the content of the Handbook

3. STOCK SPECIFIC ANNEXES

3.1 General

3.1.2 Fishery

- *Information of the fishery in the handbook help us keeping historical information. Updated information should be put in the WG report.*
- *We suggest that a separate text considering 'Management / regulation of the fishery' should be put in.*

3.1.3 Ecosystem aspects

- *General information of each stock could be put in the handbook. Updated information should be put in the WG report.*
- *This headline should be included in the WG report.*

3.2 Data

3.2.1 Commercial catch

- Information on where the landing data comes from, for each stock and country should be documented in the handbook. (Logbook, Landing statistics). Also description of general procedure to arrive at WG estimate of landings.

- General comments regarding 1-5. As a start it would be useful to document the current procedure, data formats and program which is used for each stock to aggregate the national data to the international level. The next step would be to agree upon a standard procedure for all stocks.

3.2.2 Biological data

-Documentation of where biological data come from (e.g. references for source of natural mortality estimates)

3.2.3 Surveys

-Information on where and when surveys are conducted and how the index is calculated should be documented in the handbook. Also the timing and spatial extent of the survey.

3.2.4 Commercial CPUE

-how effort is estimated
-what is the size of fleet
-proportion of the catch taken by the fleet
-spatial distribution of the fleet (charts)

3.3 Assessment Models

-Headline might be changed to 'ASSESSMENT METHODS'
-'SGFADS' does not exist anymore and should be deleted.
-'Mla' is not an assessment method. There should be a documentation of which software is used (including version or compilation date).

1.10 Workplan

Given the comments above, the WG decided that the development of a workplan was premature.

1.11 Comments on the quality of the assessment and forecasts

The WG has been asked to:

- identify major deficiencies in the assessments;
- investigate the reason for the past consistent overestimation in the short- term forecasts of the North Sea cod stock and other demersal North Sea stocks where this is relevant, and suggest how to correct it.

These two terms of reference are taken together below, with a main focus on North Sea cod, plaice and saithe.

1.11.1 North sea cod – over-estimation of stock size

In the WG 2000 the approach to the assessment of North Sea cod was substantially revised. This took place after the annual stock assessment had resulted in progressive upward revisions of fishing mortality in the previous year. It was apparent to both the Working Group and ACFM that there was a significant problem in the assessment. During 2000 the assessment methodology was reviewed in July and September. Working documents were prepared which analysed the problem and proposed solutions. So far as the estimates of stock size and F are concerned the main problem in the most recent assessments appears to have been due to the use of commercial CPUE data, which are not consistent with the assumption of constant catchability in the analytical model. The exclusion of these data from XSA and the use of survey data alone for tuning appears to have reduced the retrospective problem substantially (figure 3.4.7 and figure 3.10.1). There is still some evidence of retrospective bias but the cause is not yet clear. An examination of survey catchability suggests that it may have increased due to a northerly shift in the distribution of cod (WD 13 in WGNSSK2000).

There has been a tendency for recruitment estimates of the youngest age group used in the forecast to be too optimistic. This will tend to inflate the catch forecast but the cause of the problem is not known. It may be the result of the analytical tools used to estimate recruitment from the most recent survey indices, but it could also be due to bias and error in the catch-at-age data, particularly at the youngest ages. Traditionally, for example, discards are not included in the analysis and these may be substantial at age 1. Changes in discarding practice may easily result in distortions ion the VPA which will contaminate recruitment estimates. The problem of bias in the estimation of recruitment is still being investigated.

1.11.2 Overestimation in predictions

In a recent ICES paper (Van Beek and Pastoors 1999; Van Beek 2000) the issue of apparent overestimation of stock sizes for a number of stocks assessed in this working group is discussed (see also: Brander 1987; Daan 1997; Gascuel *et al*. 1998). The short term catch predictions carried out by the WGNSSK are mostly based on the assumption of maintaining *status quo* fishing mortality in the intermediate year, based on the experience that fishing mortality does not change significantly between years irrespectively of whether the TACs have been adhered to or not.

In the Working Document presented to the WG last year (Van Beek 2000), a preliminary analysis was carried out on the catch forecasts of cod, plaice and sole (in the North Sea). The evaluation was based on the forecasts presented in the reports of WGNSSK, the Roundfish WG and the Flatfish WG for the years 1983-1999. The restriction of the evaluation to this period was based on the availability of the data. For all stocks considered fishing mortality in this period has remained high and fluctuating with no apparent trend.

The results are presented in an 8 panel presentation for each stock.

- Panel 1 shows actual landings, predicted landings and agreed TAC's over time
- Panel 2 compares the TAC year predictions to the intermediate year predictions for the same year
- Panel 3 compares the predicted landings in the TAC year with the actual landings assuming status quo F in both the intermediate year and the TAC year.
- Panel 4 compares the predicted landings in the intermediate year with the actual landings assuming status quo F.
- Panels 5 and 6 and show the residuals of SQ predictions and actual landings, presented against the actual landings. The residual of a prediction to the actual landing in a certain year is calculated as: R = (pred – landing) / landing.
- Panels 7 and 8 show the same residuals as in panels 5 and 6, now plotted against year

1.11.2.1 Cod

Previous to 1996, the cod assessment reflected cod in the North Sea only. Since 1996 the cod assessment includes cod in VIId and IIIa. Data compared for 1996 and later include these areas.

Over most of the period the agreed TAC is set below the predicted *status quo* TAC predictions (Figure 1.10.1-1. Landings are close to the agreed TAC, however this has not lead to a reduction in fishing mortality. The landings in the TAC year are overestimated in 14 out of 17 years (figure 1.10.1-7). The average error on the prediction of the landings in the TAC year is 32% ranging between –17% to +64% per year (Figure 1.10.1-7).

The prediction of the landings in the current (intermediate) year is slightly better. Also here the landings are overestimated in most years (Figure 1.10.1-8). The average prediction error is 25% ranging between –4 to +56 % per year. There are no clear time trends in the residuals between predicted and actual landings although most of the lowest residuals are in the earlier years.

1.11.2.2 Plaice

Up to 1997 TACs have been agreed at or above *status quo* F TAC prediction (Figure 1.10.2-1). Only in the most recent years they have been set below the predicted landings for the TAC year. Landings have been below the TAC is almost all years, however not resulting in a reduction of fishing mortality until recently (but this may an artefact caused by increased discarding).

In most years the landings in the TAC year have been overestimated (Figure 1.10.2-7). The average error on the prediction of the landings in the TAC year is 19% ranging between –9% to +74% per year.

The predicted landings in the current year are also overestimated in most years (Figure 1.10.2-8). The average prediction error is also 19% ranging between –13 to +61% per year. Predictions for the current (intermediate) year are not better than those made one year earlier for the TAC year. The residual plots suggest that predictions of higher landings around 150 Kt have been considerable more accurate that of landings below this value. However, plotted against time it seems to be more likely that predictions have deteriorated considerable in recent years.

1.11.3 Saithe: underestimation of stock size

There has been a tendency in each recent working group to overestimate F and underestimate SSB for Saithe. This year's estimation of fishing mortality in 2000 of 0.29 is 55 % lower than the predicted *status quo* F from last years assessment, but 14 % below the fishing mortality of about 0.33 corresponding to the agreed TAC. This assessment gives a reduction in fishing mortalities for the years 1999 and 1998 of 32 % and 16 % respectively, and an increase in the SSB for 2000 of about 16%.

The assessment is only calibrated by commercial CPUE series and fishery independent information is highly needed. On one hand, the CPUE data from the commercial fleets may be biased because the saithe are partly schooling, and it is possible to find the schools with echo sounders. In that case, CPUE may not be a good index of abundance. On the other hand, CPUE data may be biased because of the TAC constraint in the recent years. The consequence of these constraints may have been that the fleets concentrated their effort in the first part of the year on mature fish but also targeting other species during the same trip to avoid exceeding TAC.

The CPUE for the Norwegian trawlers showed a decreasing trend in 1996 and 1997 and a high increase in 1998 and 1999 and a decreasing in 2000 (figure 6.3.1), while the CPUE for the French and German fleets were stable between 1995 and 1999 and showed a high increase in 2000 (WD 9 in section 1.6.6 Fig. 1 and WD 4 in section 1.6.3). The CPUE indices give different signals regarding to the development in the stock.

Because of the fact that saithe is schooling species, the TAC is constraining the fishery and the signals from the indices are conflicting, there are several reasons why the use of CPUE data for tuning may give biased results of stock development. However, the available surveys are also not considered representative for the stock, because ..

The assessment and the present stock and catch prediction suffer from the lack of recruitment indices for ages 1-3. In all areas most of the saithe do not enter the main fishery before age 3, because the younger ages are staying in inshore waters.

1.11.4 Conclusion

Concerning the cod assessment and the overestimation of stock size which was apparent in both the recent assessments and short term forecasts, the WG is of the opinion that by excluding the commercial CPUE data, the retrospective pattern has improved, both from the analysis and when compared with the historical time series of assessments.

Concerning plaice, the WG has not resolved the problem of overestimation. Here the overestimation may be due to both recruitment overestimation for the predictions and to overestimation of stock size in the assessment. Again here the use of commercial CPUE series may be the cause of the bias, but this needs to be looked at in more detail. For plaice, also increased discarding may be a major cause for the discrepancy between predicted recruitment (based on survey data) and observed recruitment from the converged part of the VPA.

Concerning saithe, the opposite pattern is observed. Stock size is usually under-estimated and revised upward. The saithe assessment is tuned with commercial CPUE data only, and representative survey indices are highly needed.

In all cases, the use of fixed numbers for maturity and natural mortality may influence the perception of the (spawning) stock.

Figure 1.10.1 North Sea cod. Comparison of predicted landings at *status quo* fishing mortality to the actual landings and the TAC's that have been set. See text for explanation.

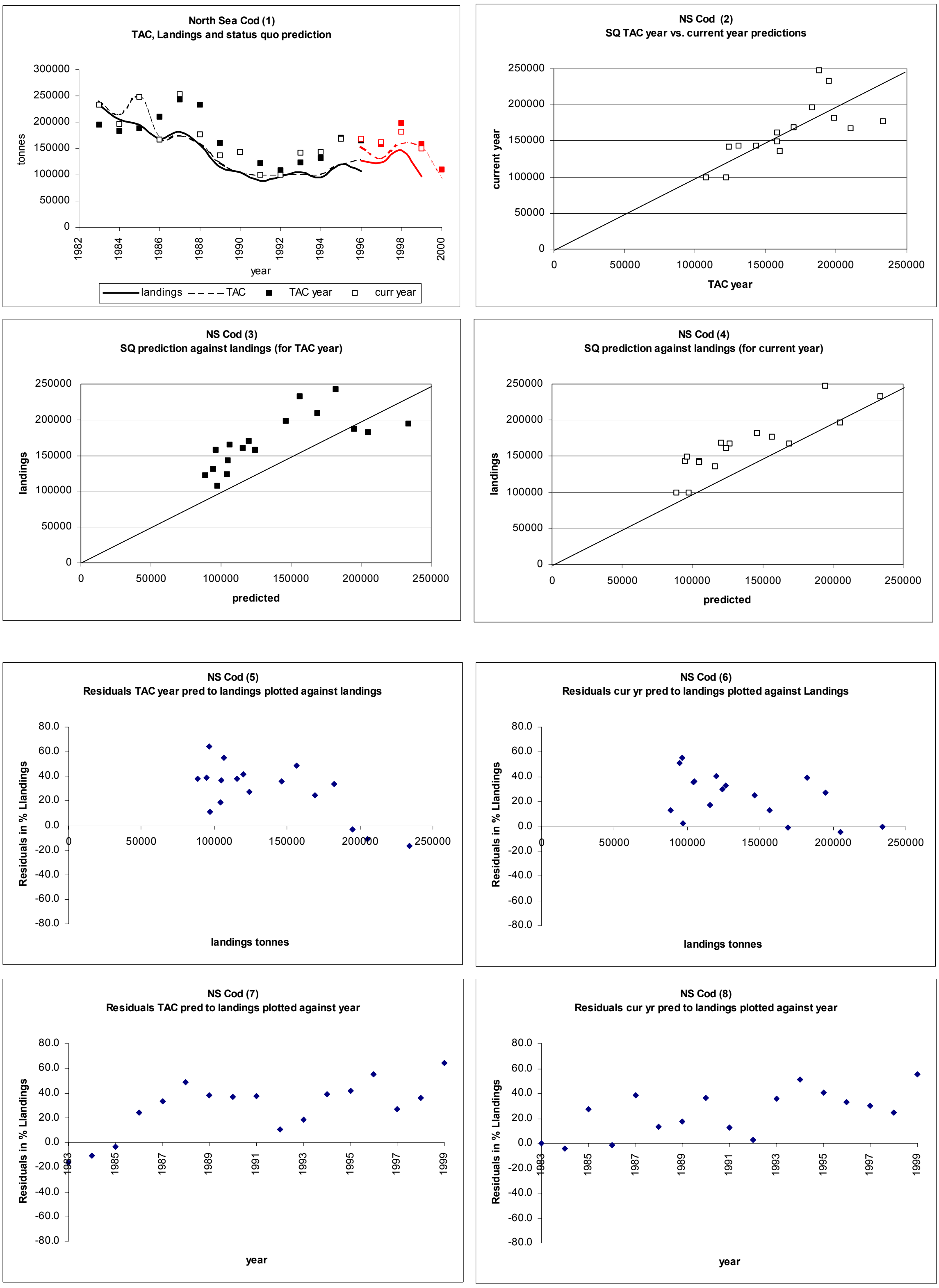
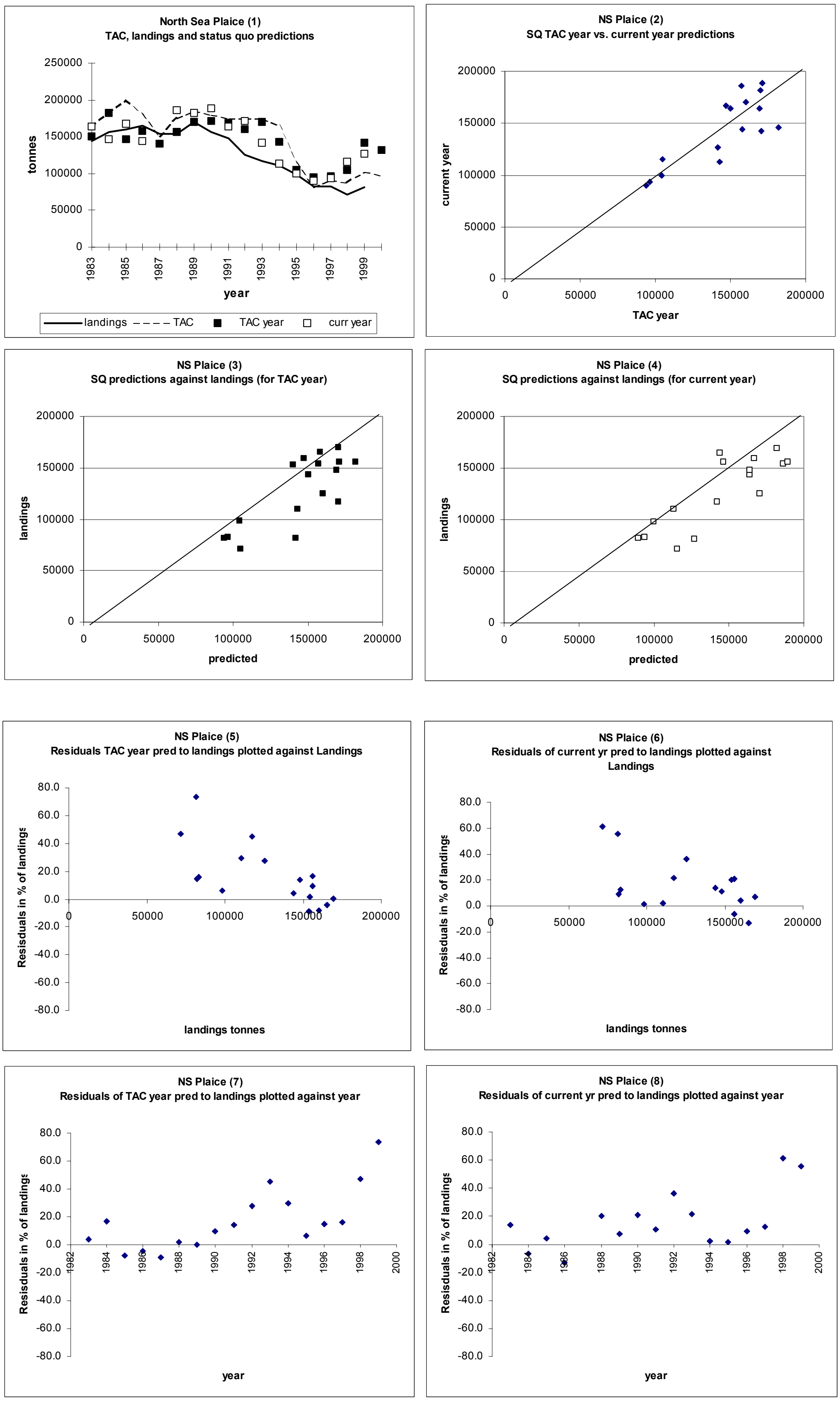


Figure 1.10.2 North Sea plaice. Comparison of predicted landings at status quo fishing mortality to the actual landings and the TAC's that have been set. See text for explanation.



1.12 Comments to the EU-Norway agreement on technical measures

The following comments are to the "Agreed record of conclusions of fisheries consultations between the European Community and Norway on improvement of exploitation pattern in the North Sea, in context of recovery measures for cod". The comments are made as a response to the ICES Fisheries Adviser who asked the working group to assist ACFM in their considerations in the autumn 2001.

The agreement was reached on June 21. 2001 after a long series of meetings between delegations from the European Community and Norway. The comments given here are partly based on the joint Report of the Scientific Meeting between EU and Norwegian experts on 5. – 9. March 2001 (Anon. 2001a) on Improvement of Selectivity of Fishing Gears and a working document presented to EC DGFish on medium term projections for North Sea cod, haddock and whiting by S. A. Reeves & M. Vinther from the Danish Institute for Fisheries Research. This last working document was also presented to the working group (WGNSSK WD:1, see also section 1.6.1).

A short summary of the agreement.

The measures to be implemented are a mixture of increased mesh sizes in combination with bycatch regulations and additional technical regulations on trawl construction (twine thickness, trawl geometry) in order to prevent deliberate changes to the trawl aimed at changing the selectivity.

A minimum mesh size rule of 120 mm when towing for demersal species in the North Sea will be implemented in the Norwegian zone from 1. January 2002 and 1. January 2003 in the EU zone. An increase to 110 mm will be implemented in the EU zone until 31. December 2002 in combination with a square mesh window of 90 mm and a maximum of 25% cod in the retained onboard catch.

EU will in its zone permit fishing for saithe with mesh sizes between 110 and 119 mm provided that the catch retained on board consists of at least 70% saithe and no more than 3% cod.

Other exemptions concerns fishing for Nephrops and shrimp (Pandalus spp). In fishing for Nephrops EU vessels will use a minimum mesh size of 80 mm and with a top window with minimum mesh size 140 mm. Norwegian vessels fishing for *Nephrops* will use a minimum 70 mm square mesh size in the whole codend. Norwegian vessels will be allowed to fish in both zones for shrimp using a mesh sizes between 32 and 54 mm with an additional sorting grid installed.

When using static nets fishing for cod, haddock, saithe, plaice, ling, pollack and hake the minimum mesh size will be 148 mm in the Norwegian zone while the minimum mesh size when using static nets fishing for cod will be 140 mm in the EU zone.

Fishing with beam trawls will require the installation of a diamond-meshed top window with a minimum of 180 mm mesh size and beam trawls operating in ICES Division IVa and the northern part of IVb will have minimum mesh size of 120 mm.

Fishing for Norway pout, blue whiting and sandeel for industrial purposes will be prohibited in an area within the Norwegian zone given by the following coordinates:

59° 30'N	01° 50.3'E
59° 30'N	03° 00.0'E
59° 00'N	03° 00.0'E
59° 00'N	01° 38.4'E

Effects on cod and other species

The possible effects of these technical measures will depend very much on the state of the stock in question and the fishing mortality. Measures to enhance juvenile survival have been addressed through several increases in mesh size from 70 mm to 100 mm the last 15 years and it is difficult to detect any improvement in fishing pattern. Cod is currently being harvested with a *(status quo*) fishing mortality of around 0.83 (section 3.7 of this report) which is much higher than F_{PA}=0.65. Fishermen have in the past circumvented the agreed technical measures to avoid short-term loss of catches.

If properly implemented by the fishermen, an increase from 100 to 120 mm mesh size will give an increase in the 50% retention length (L50) of about 5 cm for North Sea cod. This is a modest increase, but could potentially reduce discards to some extent again depending on the state of the stock.

1.13 Simulations

Simulations (WGNSSK WD:1) indicate that an increased mesh size in combination with a reduction of fishing mortality to the precautionary level (and a similar reduction in fishing mortalities for haddock and whiting due to the mixed species nature of the fishery) the potential effect of the mesh size change would be a relative reduction in landings of around 10% of cod the first year, a status quo catch the second year and a potential increase of more than 20% relative to 100 mm mesh size in the medium-term (WGNSSK WD:1). These simulations indicated that the reduction of F to the precautionary level in combination with the continued use of 100 mm mesh size would bring the SSB above B_{PA} in the year 2005, while a full effect of a change to 120 mm mesh size would bring the SSB to well above B_{PA} in 2004. Please note that the simulations (WGNSSK WD:1) use 2000 as the starting year (in combination with a reduction of fishing mortality to F_{PA}) while the agreed technical measures will be in full effect from 2003. The results must be viewed as indicative of the likely change and not as predictions.

The potential effect for haddock is also quite positive, but with a longer time span before the yield is higher than the potential yield with the combination of reduced fishing mortality and 100 mm mesh size. The 1999 year class of haddock is strong and if these measures had been implemented and fully effective from the beginning of 2001 the result would have been a substantial reduction in the current discarding of small haddock.

The simulations indicated a higher short-term reduction in landings with 120 mm relative to 100 mm for whiting, but the long-term loss in yield would be relatively small (less than 10%).

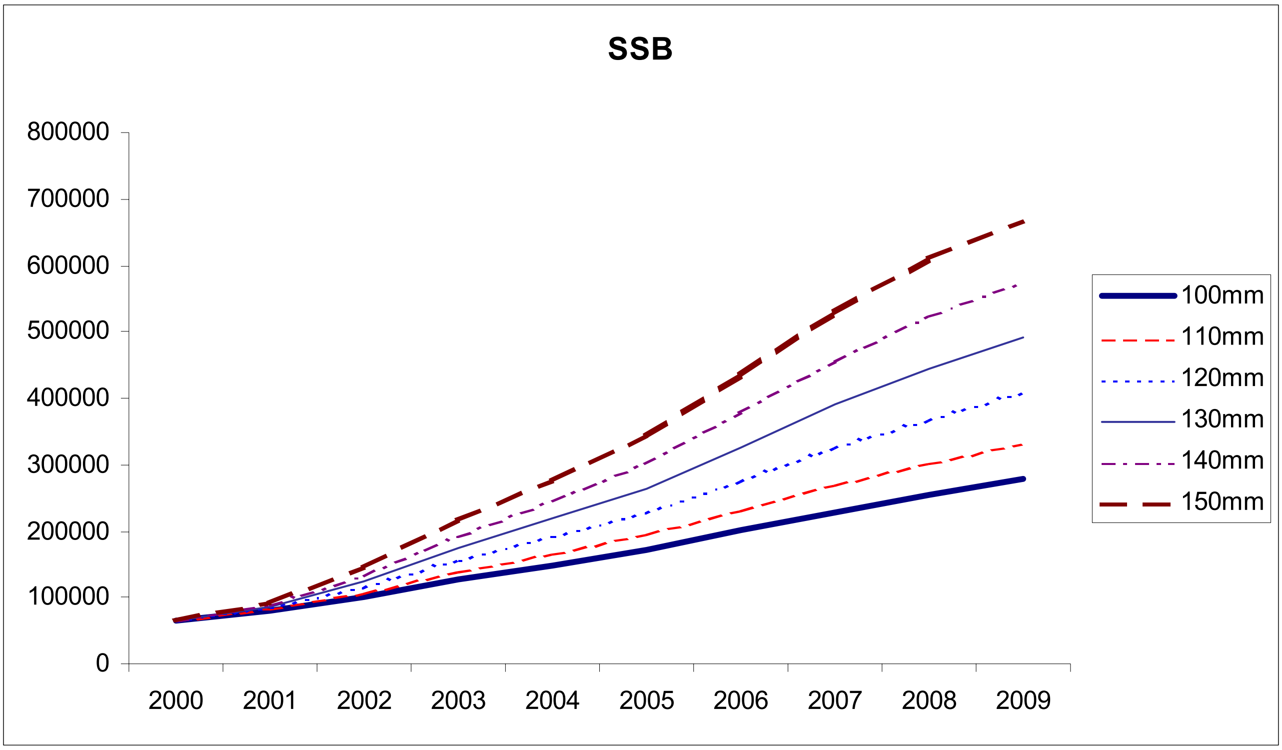


Figure 1.11.1 Simulated development of the cod SSB harvested at F_{PA} under different mesh size regulations (taken from WGNSSK WD:1).

1.14 Other considerations

There is a potential for increased discarding due to the by-catch "ceiling" introduced in fisheries with mesh sizes lower than 120 mm. The future catch composition in these fisheries (fishing for saithe with a mesh size of 110 mm, fishing for *Nephrops* or fishing for shrimp) will depend very much on the development of other stocks relative to the cod stock. The effectiveness of improvements in fishing gear selectivity could be dependent on survival of escapees. Any escape mortality would be species and size dependent. Any such mortality would reduce the effect of improved selectivity and an overall reduction in fishing mortality would in such a case be even more important.

Additional technical measures to ensure that gears are not "tampered" with are included in the agreement. The effectiveness of these measures (twine thickness, shape of the codend, shape of meshes etc) depends on the acceptance by the industry and how these measures are enforced. The problem of short-term loss of catch makes it advantageous for an individual vessel to negate the effect of a selectivity improvement by one ore more countermeasures.

1.15 Conclusions

The agreed record of conclusions from the consultations between Norway and EU could represent a positive step towards an improved exploitation pattern for cod and haddock. The working group has within the time available not been able to analyse the possible effects of these measures in any detail. The working group therefore sees the need for more analyses that evaluate the effect of the agreed technical measures under different fishing mortalities. This work should in addition to the overall effects in the medium and long-term also look at short-term effects in relation to the rebuilding need for the cod spawning stock. In light of previous experiences with such technical measures, the work should also include a discussion on factors that effect the implementation of such measures.

1.16 Recommendations

The Working Group made the following recommendations:

1. The timing of the working group in June was found to obstruct the work of the group. The third quarter surveys which are very important for the assessments of sandeel and norway pout and for the prediction of yearclass strength of a number of roundfish and flatfish stocks, were not available due to the meeting date in June. For that reason the WG recommends to ACFM to reconsider the timing of the WG.

2. The WG recommends that intersessional work be carried out by ICES to explore the availability and useability of alternative software approaches to assemble the national catch at age data. Notably, the software approach proposed in the EMAS report and the already available SALLOC program should be evaluated on their applicability for this WG.

3. The WG recommends that an ad hoc SG should meet to consider the international coordination of the Demersal Young Fish Surveys which are carried out in the coastal waters of the North Sea. Also the stratification used and the calculation of the index should be evaluated.

Table 1.3.1.2 Estimates of average discard percentages by number from sampling in the North Sea and Skagerrak from Q3 1999 to Q4 2000
(ref: EC Discard Project 98/097)

	Beam trawl	Danish seine	Nephrops trawl	otter trawl	Pair trawl	seine	shrimp trawl	Twin trawl	Total
cod	78.4	62.5	99.9	52.4	26.7	44.1	48.4	0.0	96.2
haddock	80.8	16.9	97.9	64.0	53.9	17.7	98.5		65.4
whiting	97.5		94.4	73.5	62.8	80.1	99.9	100.0	83.0
saithe	98.5	0.0	99.8	2.0	1.9	0.0	82.7		6.6
plaice	81.6	41.6	97.6	60.4	38.9	5.4	73.6	50.9	76.0
sole	27.4		98.4	32.0	0.0	0.0	100.0	93.3	33.8

Table 1.3.3.1. Biological sampling level by stock and country: Official landings (t) and number of fish measured and aged to analyse commercial landings in 2000.

	Cod in IV, IIIa, VIId			Haddock in IV, IIIa		
	Landings (t)	Lengths (No)	Ages (No)	Landings (t)	Lengths (No)	Ages (No)
Belgium	3 414	3 884	862	399	3 942	935
Denmark	21 683	2198	2188	2 703	5 240	5 155
England	(UK)	69 028	7 536	(UK)	35 266	2 541
Faroes	0	0	0		0	0
France*	2 348	462	439	1 152	2 584	366
Germany	1 749	1 685	1 105	343	0	0
Netherlands	5 999	7 080	2 179	119	0	0
Norway*	6 703	7 349	617	3 244	25 268	653
Poland	18	0	0	13	0	0
Scotland	(UK)	59 444	11 805	(UK)	148 961	9 126
Sweden*	1 972	0	0	978	0	0
UK	27 877	-	-	39 648	-	-
Total	71 763	151 130	26 731	48 599	221 261	18 776

* Preliminary landings

	Whiting in IV, VIId			Saithe in IV, IIIa		
	Landings (t)	Lengths (No)	Ages (No)	Landings (t)	Lengths (No)	Ages (No)
Belgium	536	4 036	885	122	0	0
Denmark	105	0	0	3 529	1 664	1 635
England	(UK)	22 634	2 838	(UK)	988	28
Faroes	0	0	0	0	0	0
France*	2 529	14 282	3 218	20 399	0	0
Germany	424	0	0	9 273	4 696	1 842
Netherlands	1 884	7 021	1 200	11	0	0
Norway*	33	10 620	372	43 224	10 223	743
Poland	0	0	0	747	0	0
Scotland	(UK)	85 404	4 612	(UK)	8 336	2 988
Sweden*	4	0	0	1 421	0	0
UK	18 941	-	-	6 711	-	-
others	0	0	0	67	0	0
Total	24 456	143 997	13 125	85 504	25 907	7 236

* Preliminary landings

	Sola in IV			Sole in VIId		
	Landings (t)	Lengths (No)	Ages (No)	Landings (t)	Lengths (No)	Ages (No)
Belgium	1 921	4 839	93	1 021	3 930	836
Denmark	1 066	1 097	448	0	0	0
England	584	19196	2041	615	10 230	2 077
Faroes	0	0	0	0	0	0
France*	851	2 777	1 233	2 171	4 923	1 233
Germany	1 284	3936	0	0	0	0
Netherlands	16 287	3 971	3 971	0	0	0
Norway*	0	0	0	0	0	0
Scotland	0	0	0	0	0	0
Sweden*	0	0	0	0	0	0
others	539	0	0	0	0	0
Total	22 532	35 816	7 786	3 807	19 083	4 146

* Preliminary landings

Table 1.3.3.1. (Cont`d)

	Plaice in IV			Plaice in VIId		
	Landings (t)	Lengths (No)	Ages (No)	Landings (t)	Lengths (No)	Ages (No)
Belgium	7 620	4 034	875	1 315	3 434	698
Denmark	13 408	3 722	3 582	0	0	0
England	(UK)	28 777	2436	752	15 021	1 901
Faroes	0	0	0	0	0	0
France*	836	2 478	1552	3 513	3 968	1 552
Germany	4 310	6 409	0	0	0	0
Netherlands	35 030	4 919	4 919	0	0	0
Norway*	835	0	0	0	0	0
Scotland	(UK)	0	0	0	0	0
Sweden*	3	0	0	0	0	0
UK	20 711	-	-	-	-	-
Total	82 753	50 339	13 364	5 580	22 423	4 151

* Preliminary landings

	Plaice in IIIa			Norway Pout in IV, IIIa		
	Landings (t)	Lengths (No)	Ages (No)	Landings (t)	Lengths (No)	Ages (No)
Belgium	0	0	0	0	0	0
Denmark	8 324	4 038	3 861	136 255	4 536	2 273
England	0	0	0	0	0	0
Faroes	0	0	0	0	0	0
France*	0	0	0	0	0	0
Germany	15	0	0	0	0	0
Netherlands	0	0	0	0	0	0
Norway*	67	0	0	47 981	2 350	509
Scotland	0	0	0	0	0	0
Sweden*	414	0	0	1	0	0
Total	8 820	4 038	3 861	184 237	6 886	2 782

* Preliminary landings

	Sandeel in IV			Sandeel in IV, Shetland		
	Landings (t)	Lengths (No)	Ages (No)	Landings (t)	Lengths (No)	Ages (No)
Belgium	0	0	0	0	0	0
Denmark	540 992	7 121	2 300	0	0	0
England	(UK)	0	0	0	0	0
Faroes	0	0	0	0	0	0
France*	0	0	0	0	0	0
Germany	0	0	0	0	0	0
Netherlands	0	0	0	0	0	0
Norway*	119 015	1 953	402	0	0	0
Scotland*	(UK)	0	0	4 778	16 632	1 200
Sweden*	28 398	0	0	0	0	0
UK	10 759	-	-	0	-	-
Total	699 164	9 074	2 702	4 778	16 632	1 200

* Preliminary landings

Table 1.7.1 Sum of Danish and Norwegian North Sea by-catch (ton) landed for industrial reduction in the small meshes 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	1995	1996	1997	1998	1999	2000
Gadus morhua	544	710	1092	1404	2988	2948	570	1044	1052	876	955	366	1688	1281	532	383
Scomber scombrus	4	534	2663	6414	8013	5212	7466	4631	4386	3576	2331	2019	3153	1934	2728	2443
Trachurus trachurus	22789	16658	7391	18104	22723	14918	5704	6651	6169	4886	2746	2369	3332	2576	5116	5312
Trigla sp.	0	888[2]	45342[2]	5394[2]	9391[2]	2598[2]	5622[2]	4209	1593	1139	2091	897	2618	1015	2566	1343
Limanda limanda	187	3209	4632	3781	7743	4706	5578	3986	4871	528	1028	1065	2662	6620	4317	441
Argentina spp.	8714	5210	3033	1918	778	2801	3434	2024	2874	2209	292	3101	2604	5205	3580	333
Hippoglossoides platessoides	59	718	1173	946	2160	1673	1024	1694	1428	529	617	339	1411	2229	1272	493
Pleuronectes platessa	34	119	109	372	582	566	1305	218	128	143	33	90	73	91	88	64
Merluccius merluccius[4]	349	165	261	242	290	429	28	359	109	10	-	3625	2364	33	211	231
Trisopterus minutus	0	68[3]	0	5[2]	48[2]	121[2]	79[2]	111	36	0	9	30	181	261	922	518
Molva molva[3]	51	1	40	39	37	13	65	10	28	0	-	0	31	31	125	19
Glyptocephalus cynoglossus	236[3]	132	341	44	255[3]	251[3]	1439[3]	195[3]	246	40	-	97	394	860	437	154
Gadiculus argenteus[3]	1210	729	3043	2494	741	476	801	0	0	0	-	7	248	248	387	532
Others	31715[1]	3853	3604	3670	3528	3154	4444	4553	4106	5141	5158	50	749	5405	17931	8927
Total	65892	32994	72724	44827	59277	39866	37559	29685	27026	19077	15260	14055	21508	27787	40211	21192

[1]Danish cod and mackerel included.
[2]Only Danish catches.
[3]Norwegian catches. Danish catches included in "Others".
[4]Until 1995 Norwegian catches only with Danish catches included in "Others".

Table 1.8.1 Quartely age compositions and weights at age in 2000

Plaice in the North Sea

2000

age composition (thousands)

quarter	1	2	3	4	
age					
0			0.2	0.2	
1		4.6	1004.2	1751.5	
2	409.9	2161.9	5845.7	7478	
3	3638.4	7896.3	13557.4	14220.7	
4	40814.2	44820.2	40370	32972.7	
5	6141.6	3422.2	2163.7	2405.3	
6	4340.9	2316	846.4	1234	
7	755.2	559.8	317	370.8	
8	406.9	370.5	92.6	97.8	
9	399.5	257.8	141	82.6	
10	204.1	138.5	69.3	104.2	
11	120.2	135	81.7	34	
12	135.1	110.7	70.7	44.5	
13	47.7	82.9	48.1	16.5	
14	41.5	39.5	24.8	21.7	
15+	159.8	114.6	88.2	35.2	
reference NC	18906.1	19583.6	20652.4	20202.6	79344.7
total NC					83058

2000

weight at age (kg)

quarter	1	2	3	4
age				
0			0.115	0.116
1		0.113	0.236	0.223
2	0.224	0.24	0.273	0.273
3	0.236	0.281	0.298	0.286
4	0.29	0.301	0.326	0.35
5	0.409	0.419	0.485	0.47
6	0.468	0.476	0.62	0.594
7	0.687	0.56	0.728	0.846
8	0.742	0.625	0.798	0.806
9	0.707	0.707	0.906	0.854
10	0.864	0.787	0.65	0.934
11	0.872	0.742	0.815	1.208
12	0.744	0.789	0.7	0.746
13	0.818	0.766	1.116	0.615
14	1.082	0.858	1.231	0.87
15+	1.081	1.061	1.077	1.296

Table 1.8.1 (Cont'd)

Sole in the North Sea

2000	age composition (thousands)			
quarter	1	2	3	4
age				
1		123	1455.4	1519.4
2	3352.1	2716.1	5981.8	5073.4
3	12200.4	9979	8197.5	9163.7
4	10206.1	9225.3	4748.4	6891.7
5	1254.4	1400.8	556.2	462.5
6	473.2	1055.3	389.1	460.5
7	228.3	275.5	201.7	72.2
8	250.4	130.5	109	69.1
9	400.8	323.4	75.7	115.5
10	206.4	106	87.3	53.7
11	50.3	114.2	12	32.5
12	17.1	24.9	6.1	6.8
13	41.5	23.8	4.2	9.7
14	6.7	5.1	0.6	0.5
15+	11.5	18.4	8.1	4.1
reference NC	6694.4	5450.3	4766	5380
total NC				

2000	weight at age (kg)			
quarter	1	2	3	4
age				
1		0.139	0.154	0.144
2	0.146	0.16	0.178	0.186
3	0.212	0.198	0.226	0.217
4	0.259	0.226	0.254	0.268
5	0.28	0.259	0.314	0.319
6	0.392	0.266	0.298	0.263
7	0.415	0.296	0.26	0.31
8	0.412	0.33	0.294	0.439
9	0.391	0.374	0.448	0.463
10	0.324	0.274	0.266	0.354
11	0.555	0.308	0.602	0.48
12	0.554	0.489	0.659	0.419
13	0.646	0.705	0.626	0.677
14	0.887	1.104	0.893	1.232
15+	0.902	0.601	0.509	0.546

2 OVERVIEW

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

2.1.1 Description of the fisheries

The demersal fisheries in the North Sea can be grouped in human consumption fisheries and industrial fisheries which land their catch for reduction purposes. Demersal human consumption fisheries usually either target a mixture of roundfish species (cod, haddock, whiting), or a mixture of flatfish species (plaice and sole) with a by-catch of roundfish. A fishery directed at saithe exists along the shelf edge. The catch of the industrial fisheries mainly consists of sandeel, Norway pout and sprat. The industrial landings also contain by-catches of various other species (Table 2.1.2).

Each fishery uses a variety of gears. Human consumption fisheries: otter trawls, pair trawls, seines, gill nets, beam trawls. Industrial fisheries: small meshed otter trawls.

Trends in effort of selected fleets are shown in Figure 2.1.1. The trends in landings of the most important species landed by all fleets during the last 30 years, as compiled by the WG, are shown in Table 2.1.1 and in the Figure 2.1.2. The human consumption landings have steadily declined over the last 30 years, with an intermediate high in the early 80's. The landings of the industrial fisheries are fluctuating around 1 million t over the years. These landings show the largest annual variations, probably due to the short life span of the 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.

Most demersal effort series are stable or show a downward trend in the recent past. To what extent this is caused by poor economic results or effort reduction programmes is not clear in every case. Effort in some fleets may vary between years because they visit other areas as well.

For most stocks, the North Sea management area also comprises adjacent areas in addition to Division IV: Combined assessments were made for cod including IIIaN (Skagerrak) and VIId, for haddock and Norway pout including IIIa, for whiting including VIId, and for saithe including IIIa and VI. Sandeel stocks at Shetlands and in IIIa are seperately dealt with.

The national management measures with regard to the implementation of the quota in the fisheries differ between species and countries. The industrial fisheries are subject to regulations for the by-catches of other species (e.g. herring, whiting, haddock, cod). TACs for these fisheries have only recently been introduced.

Biological interactions are not incorporated in the assessments or the forecasts for the North Sea stocks. However, average values of natural mortalities estimated by multispecies assessments for cod, haddock, whiting and sandeel are incorporated in the assessments of these species.

2.1.2 Human consumption fisheries

2.1.2.1 Data

Data available from scientific sources for the assessment of roundfish and flatfish stocks are relatively good, but the volume of biological sampling for most of the stocks is less in 2000 than in the year before (Table 1.3.3.1).

Discard data used in the assessments are only the series for haddock and whiting from the sampling programme of one country. Other discard sampling programmes are ongoing in recent years, and the results of a sampling project from 4 countries have recently become available (EU document COM(2001) 326). Discard information is discussed in the respective stock sections. In general, considerable discarding (notably of haddock, whiting, plaice and cod) is occurring in most human consumption fisheries, with indications for an increase in some cases (e.g. plaice).

In a number of past years, substantial misreporting of roundfish and flatfish landings had occurred, associated to restrictive TACs. There are no indications that this had happened on a large scale in 2000.

Several series of research vessel survey indices are available for most species and were used in the VPA runs in some stocks. Commercial CPUE series are available for a number of fleets/stocks, but for various reasons only few of them could be accepted for tuning purposes, and the use of such series is progressively reduced.

Of the species considered in this report, only whiting used to be subject to a significant by-catch in the industrial fisheries. This bycatch appears to be much reduced in recent years.

2.1.2.2 Stock impressions

In the North Sea all stocks of roundfish and flatfish species have been exposed to high levels of fishing mortality for a long period. For most of these stocks their lowest observed spawning stock size has been seen in recent years. This may be an indication of an excessive effort and/or an effect of a climatic phase which is unfavourable to the recruitment of some species.

For a number of years, ACFM 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.

Landings of cod in 2000 (59,000 t) were the lowest on record. The 1996 year-class was relatively strong and would have been expected to have contributed significantly to the landings in 2000. In fact this year class comprised 35% of the landings weight in 2000 but only 14% of the numbers landed. The 1996-year class only accounted for 5% of the total stock numbers at the start of 2000 and only 3% of the stock numbers of this year class at age 1, reflecting the high mortality through heavy fishing on 2 year-olds and significant discarding of 1-year olds. Since 1997, recruitment has fluctuated at a low level. Spawning stock and landings have fluctuated about a declining trend, and fishing mortality has fluctuated about a high level since the mid-1980. The perilous state of the stock resulted in the implementation of an emergency closed area in 2001. This represented the first stage in the development of a recovery plan, which is the subject of negotiations between the EU and Norway.

Human consumption landings of haddock in 2000 with 47,000 t are continuing a downward trend. Historically the stock size has shown large variation due to the occasional occurrence of a very strong year class. This was happening again in 1999, and though this year-class suffered from slow growth and massive discarding, it is predicted to enhance the spawning stock from 2001 onwards. Spawning stock size is fluctuating around 150,000 t for 25 years and presently less than half the long-term average. Fishing mortality is fluctuating on a high level, around a slowly decreasing trend over the last 20 years.

The assessment of whiting has always been of lower precision than the assessment for other stocks. The human consumption yield in 2000 of 28000 t (restricted by TAC) is at the record-low level of the previous two years, after having declined for 20 years. The spawning stock biomass also followed a gradual decline over more than 20 years. Fishing mortalities have been highly variable with no clear trend in the past, but decreasing since the mid-90’s. The most recent estimates indicate a stably low level for fishing mortality and a rise in spawning stock biomass, but associated with high levels of uncertainty. Recruitment in recent years was always below the long-term geometric mean, with the 1996 year class as the weakest on record.

The spawning stock of saithe is at a low level compared to the seventies when recruitment was higher. Landings in 2000 were 87,000 t (by TAC), somewhat less than the level of the previous 10 years, and thus the lowest on record. Fishing mortality has declined considerably since 1986, and remains at a low level.

Landings of sole were at high levels in the early 90’s but decreased to a historic low of 15,000 t in 1997, rising to 23000 t in 2000. Fishing mortality varies on a historically high level, recently dropping from a record peak in 1996. The spawning stock was at a record low of 25,000 t in 1998 but went up thereafter. All the recovery signals are due to the entry of the strong 1996 year class into the fishery

The spawning stock of plaice has been decreasing steadily until arriving at its lowest observed level in 1997, from which it has risen now. Landings have fallen since 1990 to 71000 t in 1998, and are still low with 83000 t in 2000. Fishing mortality in the most recent three years is lower than the record-high level in the 90’s. Recent good recruitment from the 1996 year class is contributing substantially to yield and spawning stock, but the benefits are reduced because of the retarded growth and heavy discarding of that year class.

2.1.3 Industrial fisheries

2.1.3.1 Description of fisheries

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

2.1.3.2 Data available

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

2.1.3.3 Trends in landings and effort

The sandeel landings in 1974-1985 of around 600,000 t have increased to about 800,000 t in 1986-1999. In 1997 the combined Danish and Norwegian landings were more than 1 million t and the highest ever recorded. Landings in 2000 for Norway and Denmark were 655,000 t (Table 2.1.2) which is below the average for 1983-1999. The fishery ended quite early in 2000, and the catch in the second half-year was just 10,000 t in the northern North Sea, the lowest recorded in the available time series 1976-2000. The catches for 2001 are not included in this assessment, however provisional Danish landings statistics for the period until mid June shows catches a little below the landings in 2000 for the same period. By the end of May the Norwegian landings in 2001 have been low with less than half of landings at the same time in 2000. The Danish sandeel fishery is in general more southerly than the Norwegian fishery, and it seems as if the decrease in landings in 2001 is highest in the northern part of the North Sea.

The Norway pout catches showed a decreasing trend in the period 1974 - 1988. Thereafter the catches have fluctuated around a level of 150,000 t. The landings in 1998 and 1999 were less than 100,000 t and the lowest recorded after 1974. However, in 2000 the Norway pout landings increased to around 200,000 t based on fishery on the strong 1999 year class. The landings of Norway pout in the first quarter of the year in 2001 was around 20,000 t which is above average for this quarter in the period 1996-2001.

Trends in effort of the Norwegian and Danish small meshed fishing for Norway pout and sandeel are shown in Figure 2.1.1. The effort of the Danish fleet is gradually decreasing from 1989 to 1995 and then slowly increasing again until 1998. This development is mainly determined by the Danish fishery targeting sandeel. From 1998 and onwards there was a slight increase in effort for Norway pout while effort targeting sandeel were declining. The Norwegian effort for both sandeel and Norway pout has varied little over years during the period 1987-2000. The effort is fluctuating between 1000-5000 fishing days per year for each species without any clear trends over years within the period 1987-2000 (Figure 2.1.1).

2.1.3.4 Stock impressions

The SSB of Norway pout shows an increasing trend in the period 1974-1984. The next two years SSB dropped to a low level and was then followed by an increase. SSB peaked in 1996 due to the big 1994 year class but decreased again in the period up to 1999 reaching a low level. In 2000 and 2001 the SSB has increased to reach a similar level as in 1996 because of the strong 1999 year class. Fishing mortality has generally been decreasing since 1974. In 1995-1998 the fishing mortality fell to about 0.4 compared to the level of about 0.6 in 1988-1994. In 1999 and 2000 the fishing mortality increased again to a level around 0.5-0.6. The long term average fishing mortality in the period 1974 to 2000 is around 0.8.

Over the years, SSB of sandeel has been fluctuating around 1 million t without a trend. There is a general pattern of large SSB being followed by a low SSB. This is caused by similar fluctuation in recruiting year classes. The 1996 year class and the spawning stock biomass at the start of 1998 were the highest recorded. Spawning stock biomass at the start at 2000 is estimated to 700,000 t and below the long term average. Number of recruits for the 2000 year class could not be estimated due to conflicting signals from the fishery and the absence of 2001, 1st half-year data.

2.1.3.5 By-catches in industrial fisheries

By-catches of haddock, whiting and saithe in the industrial fisheries are presented in Table 2.1.2 for the years 1974-2000. For the last five years quarterly data are presented. In 2000 the combined by-catch of haddock, whiting and saithe was about 22,000 t, which is well below the average of 64,000 t in the period 1974 – 2000. It should be noted that the Norwegian landings of Norway pout given in Table 2.1.2 include by-catches of Norway pout in the small-meshed fishery for blue whiting, whereas the figures given in section 12.1.1 are landings in the Norway pout fishery. Note also that the Norwegian landings of sandeel in Table 2.1.2 as compared to in section 13.1.1 are without by-catches. Detailed catches of "other" species mentioned in Table 2.1.2 are for the period 1984-2000 given in Table 1.7.1.

Area distribution of industrial landings and associated by-catches of selected species from the North Sea in small meshed fisheries by Denmark and Norway divided by fishery (target species) is shown in Table 2.1.3. These data are for four small meshed fisheries in 2000 divided in relation to two areas in the North Sea, north and south of 57 degrees N. This table is based on Danish and Norwegian estimates. In the northern area, the Norwegian fishery for Norway pout is associated with by-catch of blue whiting. The Danish fishery for blue whiting is included in the “other” fishery. There is a by-catch of totally 17,000 t of haddock, whiting and saithe in the combined small meshed fisheries in the northern area. In the southern area the by-catch of these species is totally about 6,000 tons. The by-catch of cod is generally low. The sprat fishery has had increasing landings since 1996 and has a by-catch of mainly herring.

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

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

The roundfish, flatfish and *Nephrops* stocks are mainly exploited by Danish and Swedish fleets consisting of bottom trawlers (*Nephrops* trawls with >70 mm mesh size and bottom trawls with >100 mm mesh size), gill-netters and Danish seiners. The number of vessels operating in IIIa has decreased in recent years. This is partly an effect of the EU withdrawal programme, which until now has affected the Danish fleets only, but these fleets still dominate the fishery in IIIa.

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. The most important fisheries are those targeting sandeel and Norway pout. There is also a trawl fishery landing a mixture of species for reduction purposes. A description of the industrial fishery is given in Table 2.2.1.

There are important technical interactions between the fleets. Most of the human consumption demersal fleets are involved in mixed fisheries and the Norway pout and the mixed clupeoid fishery have by-catches of protected species.

Misreporting and non-reporting of catches have occurred in recent years, particularly for cod, but the amounts vary between years. Discard data are collected for cod, whiting, haddock and flatfish in the area since the second half of 1999. Due to the short time series the data was not included in the assessment this year. The time series of age samples from landings for industrial purposes is short and there are gaps in this series.

The Skagerrak-Kattegat area is to a large extent a transition area between the North Sea and the Baltic, with regards to the hydrology, the biology and the identity of stocks in the area. The exchange of water between the North Sea and the Baltic is the main hydrographic feature of the area.

Several of the stocks in the Skagerrak show close affinities to the North Sea stocks: cod, haddock, whiting, plaice and Norway pout.

The landings of cod in the Division IIIa (Skagerrak) were of 9 277 tonnes in the human consumption fishery. Landings have slightly decreased since 1992. The majority of catches were taken by Denmark and Sweden. Cod in Skagerrak is assessed alongside with the North Sea (Division IV) and Eastern Channel (Division VIId) stock. Cod in Kattegat is assessed as a separate stock by the Baltic Sea Working Group.

Landings of haddock in Division IIIa, in the human consumption fishery, amounted to 1 485 tonnes in 2000, which is sligthly above the landings last year, which was the lowest on record since 1990. Most of the catches are taken in Skagerrak. Haddock in IIIa is assessed alongside with the North Sea (Division IV) stock.

Landings of whiting for human consumption were about 230 tonnes in 2000, which was 100 tonnes more than was reported in 1999. Official landings have steadily decreased since 1992 except from the landings in 2000. Most of the landings are taken in Skagerrak. No analytical assessment of whiting in IIIa was done.

Landings of saithe, included Divisions IV and IIIa, amounted 87 450 t in 2000 which is the lowest record since 1988. The saithe assessment comprises Divisions IV, IIIa and VI.

The plaice landings in division IIIa amounted to 8 820 tonnes in 2000, which is a slight increase from 1999. Landings have steadily decreased since 1992. About 80% of the landings were taken in Skagerrak. Plaice in IIIa is assessed as a separate stock.

The sole landings in division IIIa are mostly taken in Kattegat and this stock is assessed by the Baltic Fishery Assessment Working Group. Landings data are available in the report of the Baltic Fishery Assessment Working Group.

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

Most of the landings from the industrial fisheries in IIIa consisted of sandeel, Norway pout, herring and sprat (Table 2.2.1). The table was revised this year, but only for 1999 and 2000 data were provided by Denmark and Sweden. All other years refers to data provided by Denmark only. The whole time serie will be revised until next year. The landing figures still point out that landings in 2000 are below or around the mean landings (1989-2000) for all species. The Norway pout assessment comprises Divisions IIIa and IV. It was not possible to assess sandeel in Division IIIa.

2.3 Stocks in the eastern Channel (Sub-area VIId)

2.3.1 Description of the fisheries

Flatfish: The main feature of the flatfish fisheries in VIId are their importance to small (<10m) vessel fleets. Approximately 500 vessels fish for sole and plaice at some time during the year in the eastern Channel and are heavily dependent on sole. This fishery is unique in the ICES divisions IV and VII because more than 50% of the reported landings come from these small vessels. 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. These vessels switch effort to other areas and onto scallops leading to periodic large changes in effort in VIId.

Roundfish: The offshore French trawlers are the main fleet fishing for cod and whiting using high headline trawls, but cod is also very important for inshore vessels who target this species during the winter using fixed nets. Cod and whiting are part of a mixed fishery which includes a number of small species such as red mullet, gurnards and squid all of which are very important for these vessels. The mixed nature of these fisheries poses different but equally difficult problems to managers compared with the typical cod/haddock/whiting mixed fishery in the North Sea.

Effort

Effort by English and Belgian beam trawlers and large French otter trawlers has increased by a factor of 7 between 1980s and 1990's (Figure 2.3.1). Effort has remained high for the large trawler fleets but shows a decline in recent years for he English fixed net fleet. No information is available for the important French fixed net fleet.

2.3.2 Data

a) Landings and discards: French data which had not been available in 1999 was provided for 2000. There is no data routinely collected for the level of discarding on any of the main species from VIId but levels are probably similar to the North Sea where average discards across all fleets by number were 76% for plaice and 34% for sole.

b) Catch at age: French fleets are responsible for the major landings of cod, whiting, sole and plaice, taking around 80-95% of the roundfish species and between 45 and 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. Ageing problems identified in 1999 were apparent again in French sole catch numbers and the French data was revised using the English ALK.

c) Surveys: There is a 4st quarter research vessel survey which is used in tuning for whiting. A research vessel survey using beam trawl which covers most of VIId in August (EBTS) is used in tuning sole and plaice. There are two inshore surveys for 0- and 1-gp sole and plaice along the English coast and in the Baie de Somme on the French coast.

2.3.3 State of the stocks

General: Cod and whiting have been assessed with the North Sea stocks since 1998 and are included in the overview for the North Sea.

Sole: The stock is considered to be within safe biological limits. The SSB is well above Bpa (8000t) following improved recruitment in recent years particularly of the 1996 and 1998 year classes. There is considerable uncertainty about the substantial decrease in F in 2000, which is driven by the two commercial fleets and is not apparent in the survey estimates of fishing mortality. Neither this nor the increase in SSB is entirely in line with the perception of the fishery.

Plaice: Plaice in VIId follows the pattern of a general decline in plaice stocks observed in other areas, although it does not appear to be as severe as in the North Sea. The SSB and F are close to their precautionary reference levels. Recruitment remains close to mean levels apart from the 1996 year class which will only make a small contribution to the SSB in 2003.

Table 2.1.1 Human consumption (hc) and industrial landings (ib = industrial bycatch) of assessed species from the North Sea management area. ('000 t)

Year	cod	had hc	had ib	whit hc	whit ib	saithe hc	saithe ib	sole	plaice	N pout	sandeel	h cons total	industrial sum	total
1970	226	525	180	83	115	163	59	20	130	238	191	1147	783	1930
1971	328	235	32	61	72	218	35	24	114	305	382	980	826	1806
1972	354	193	30	64	61	248	28	21	123	445	359	1003	923	1926
1973	239	179	11	71	90	229	31	19	130	346	297	867	775	1642
1974	214	150	48	81	130	267	42	18	113	736	524	843	1480	2323
1975	205	147	41	84	86	271	38	21	108	560	428	836	1153	1989
1976	234	166	48	83	150	295	67	17	114	437	488	909	1190	2099
1977	209	137	35	78	106	217	6	18	119	390	786	778	1323	2101
1978	297	86	11	97	55	163	3	20	114	270	787	777	1126	1903
1979	270	83	16	107	59	134	2	23	145	329	578	762	984	1746
1980	294	99	22	101	46	142		16	140	483	729	792	1280	2072
1981	335	130	17	90	67	145	1	15	140	239	569	855	893	1748
1982	303	166	19	81	33	185	5	22	155	395	611	912	1063	1975
1983	259	159	13	88	24	197	1	25	144	451	537	872	1026	1898
1984	228	128	10	86	19	214	6	27	156	393	669	839	1097	1936
1985	215	159	6	62	15	222	8	24	160	205	622	842	856	1698
1986	204	166	3	64	18	202	1	18	165	178	848	819	1048	1867
1987	216	108	4	68	16	177	4	17	154	149	825	740	998	1738
1988	184	105	4	56	49	140	1	22	154	110	893	661	1057	1718
1989	140	76	2	45	36	117	1	22	170	168	1039	570	1246	1816
1990	125	51	3	47	50	100	8	35	156	152	591	514	804	1318
1991	102	45	5	53	38	115	1	34	148	193	843	497	1080	1577
1992	114	70	11	52	27	104		29	125	300	855	494	1193	1687
1993	122	80	11	53	20	118	1	31	117	184	579	521	795	1316
1994	111	80	5	49	10	115		33	110	182	786	498	983	1481
1995	136	75	8	46	27	124	1	30	98	241	918	509	1195	1704
1996	126	76	5	41	5	120	0	23	82	166	777	468	953	1421
1997	124	79	7	36	7	110	3	15	83	170	1137	447	1324	1771
1998	146	77	5	28	3	107	3	21	71	80	1004	450	1095	1545
1999	96	66	4	30	5	114	3	23	81	93	735	410	840	1250
2000	59	47	8	28	8	93	6	26	83	185	699	336	906	1242

Table 2.1.2 Species composition in the Danish and Norwegian small meshed fisheries in the North Sea ('000 t). (Data provided by WG members.The category other is subdivided by species in Table 1.7.1).

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
Mean 1974-2000	727	204	66	259	58	14	41	9	36	1398
1996 q1	3	34	5	21	4	0	1	0	0	68
1996 q2	479	3	1	7	28	1	1	0	1	521
1996 q3	256	7	11	54	30	2	1	0	1	362
1996 q4	22	37	22	41	31	1	1	0	1	156
1997 q1	37	7	1	11	4	0	1	0	2	65
1997 q2	802	1	2	7	11	3	2	0	4	833
1997 q3	238	28	5	59	16	3	2	2	11	363
1997 q4	13	63	7	49	14	1	1	0	5	155
1998 q1	37	7	7	13	11	1	0	0	5	80
1998 q2	754	1	2	8	12	2	1	0	4	784
1998 q3	153	60	4	29	38	2	1	2	9	298
1998 q4	12	63	4	23	12	0	0	0	6	121
1999 q1	14	14	4	8	23	1	1	1	8	74
1999 q2	507	2	4	22	30	1	2	1	8	577
1999 q3	139	129	10	41	18	1	2	0	7	347
1999 q4	17	21	6	25	17	1	1	0	18	106
2000 q1	10	42	1	9	13	1	0	0	5	82
2000 q2	581	2	4	17	32	3	2	0	4	646
2000 q3	63	133	10	30	39	2	3	6	5	291
2000 q4	0	15	8	119	14	2	3	0	8	169

Table 2.1.3 **Distribution of landings and associated by-catches of selected species ('000 t) from the North Sea small meshed fisheries in 2000 by Denmark and Norway north and south of 57 N.**

	Fishery (target species)	Species Composition									Total
		Norway pout	Sandeel	Sprat	Herring	Haddock	Whiting	Saithe	Blue whiting	Others	
Area north											
	Nor.pout	172	0	0	7	5	4	6	66	6	266
	Sandeel	1	221	1	2	2	0	0	0	1	229
	Sprat	0	0	1	0	0	0	0	0	0	1
	Sum	176	221	1	10	7	4	6	66	7	496
Area south											
	Nor. Pout	0	0	0	0	0	0	0	0	5	6
	Sandeel	0	433	2	2	1	1	0	0	2	441
	Sprat	0	0	188	11	0	2	0	0	6	207
	Sum	0	434	190	13	1	4	0	0	13	654
Total	Sum	176	655	191	23	8	8	6	67	20	1151

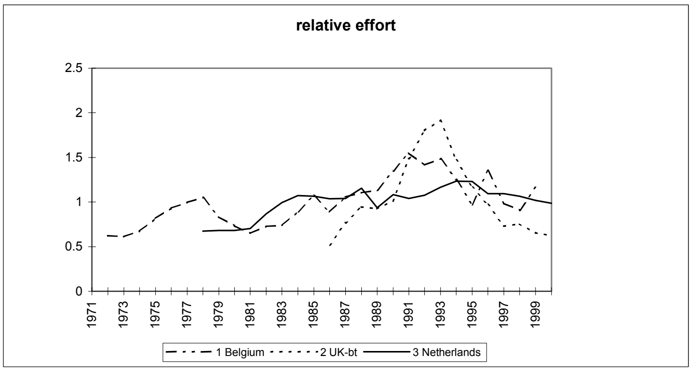
Table 2.2.1 Catches of the most important species in the industrial fisheries in Division IIIa ('000 t), 1989-2000.

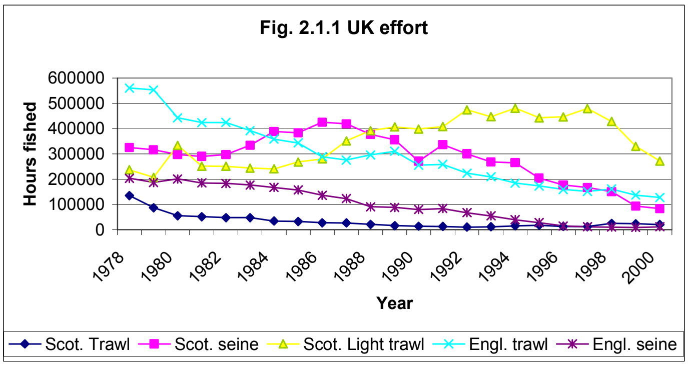
Year	Sandeel	Sprat[1]	Herring	Norway pout	Blue whiting	Total
1989	18	4	52	5	9	88
1990	16	2	51	27	10	106
1991	24	14	44	39	10	131
1992	39	4	66	45	19	173
1993	45	2	71	8	32	158
1994	55	58	30	7	12	162
1995	12	42	34	50	10	148
1996	53	10	26	36	15	140
1997	82	12	6	32	4	136
1998	11	11	5	15	7	49
1999*	13	26	11	7	16	73
2000*	17	19	18	10	7	72
Mean 1989-2000	32	17	35	23	13	120

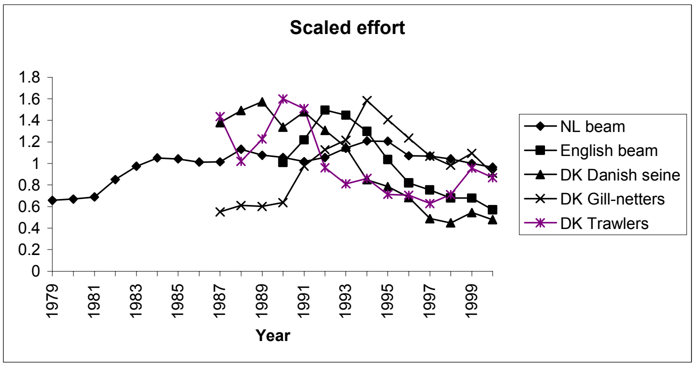
* 1999-2000 data provided from Denmark and Sweden. Other years, only data from Denmark is presented

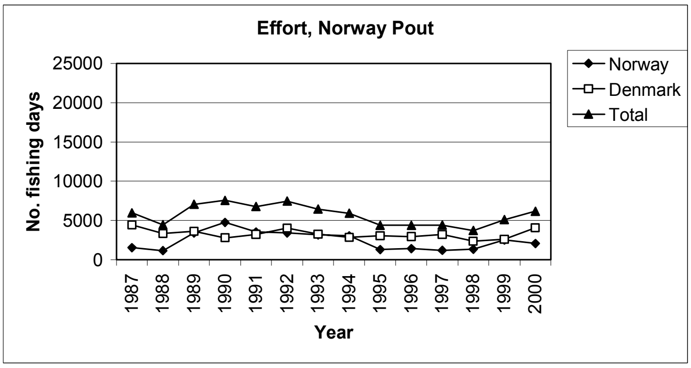
[1] data provided by working group members

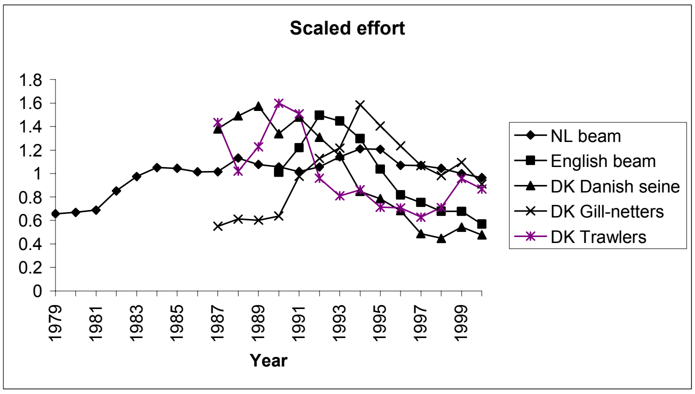
Fig. 2.1.1 Fishing effort of North Sea demersal fleets

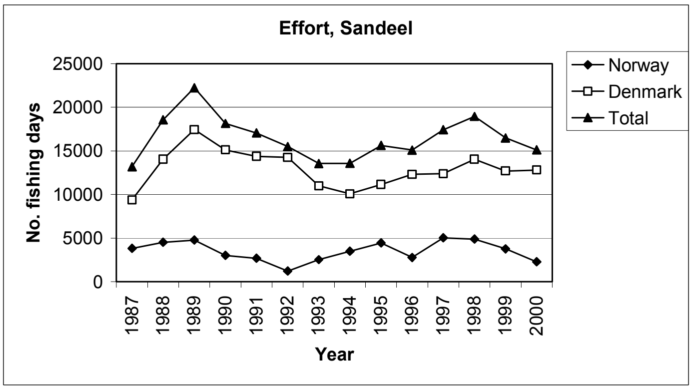












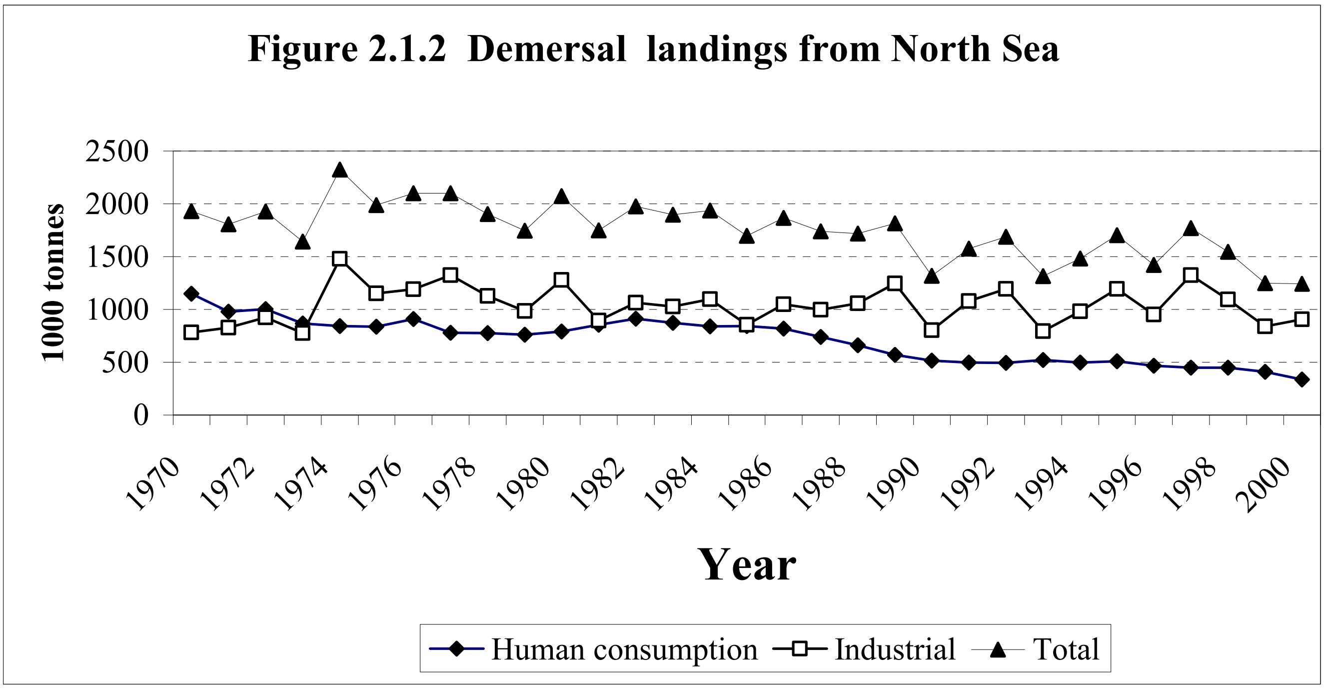
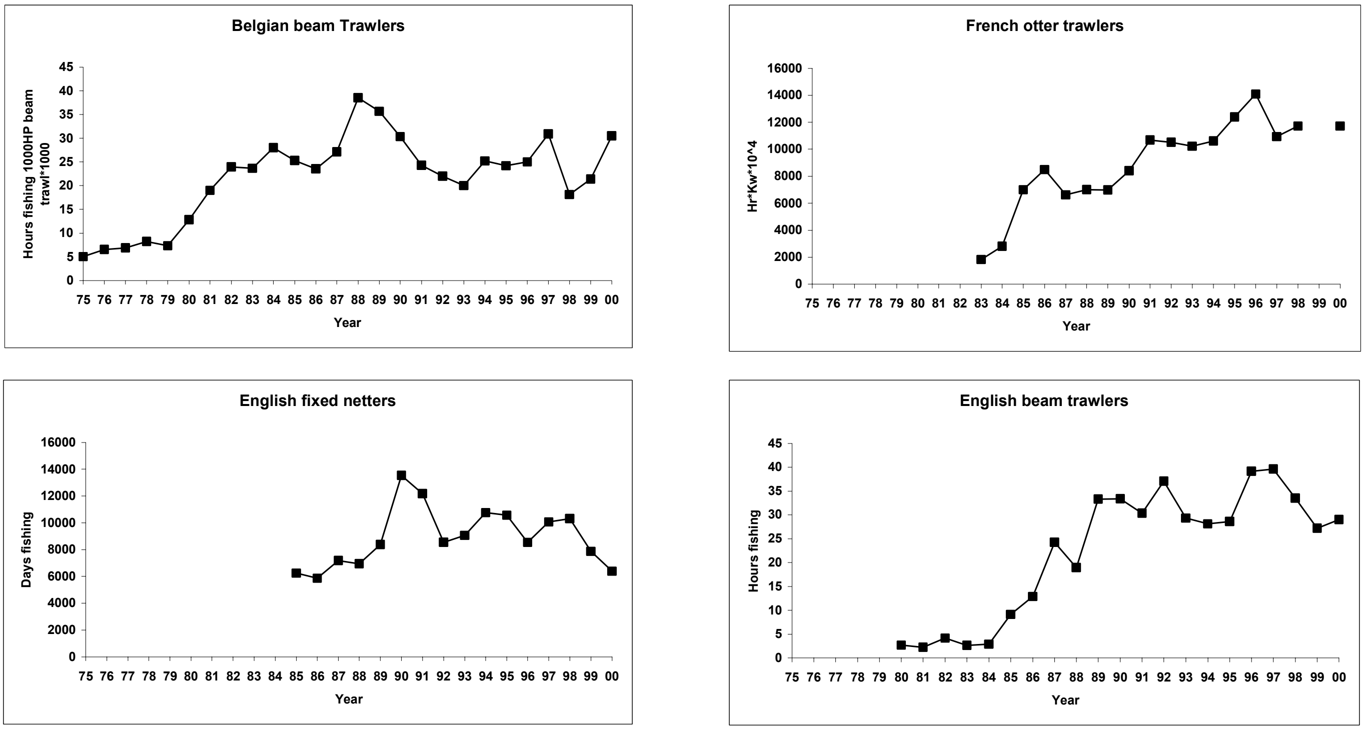


Figure 2.1.2 Demersal landings from North Sea
2500
2000
1500
1000
500
0
1000 tonnes
1970
1972
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
Year
Human consumption
Industrial
Total

Figure 2.3.1. Fishing effort of demersal fleets in division VIId
(revised indices for French otter trawlers from 1991)



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

Since 1996, this assessment has related to the cod stock in the Skagerrak (Division IIIa), the North Sea (Sub-area IV), and the Eastern Channel (Division VIId). Prior to 1996 cod in these areas were assessed as separate stocks.

3.1 The Fishery

3.1.1 ACFM advice applicable to 2000 and 2001

The advice from ICES for 2000 was that in order to prevent further decline of SSB in the short term, "*fishing mortality in 2000 should be less than 0.55*". ICES advice for 2001 was that "*fishing mortality on cod should be reduced to the lowest possible level. A rebuilding plan should be developed and implemented in order to rebuild SSB above* $\boldsymbol{B_{pa}}$*. The necessary reduction in fishing mortality on cod cannot be achieved by a reduction in TAC alone. The rebuilding plan should include provisions to deter directed fishing, reduce by-catches of cod in fisheries for other species to the lowest practical levels, and to deter discarding and mis-reporting of cod in all fisheries*".

ICES also pointed out that assessments in 1997, 1998 and 1999 overestimated SSB and underestimated F, largely because of inconsistencies in commercial effort data.

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

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

3.1.2 Management applicable in 2000 and 2001

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

	2000 Agreed TAC (000 t)	2001 Agreed TAC (000 t)
IIIa (Skagerrak)	11.6	7.0
IIa + IV	81.4	48.6

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.

New technical regulations for EU waters came into force on 1 January 2000 (Council Regulation (EC) 850/98). The regulation prescribes the minimum target species' composition for different mesh size ranges. Cod in the whole of NEAFC region 2 can now only be a legitimate target species for towed gears with a minimum codend mesh size of 100 mm. Cod will continue to form a by-catch in the fisheries using 80mm codend meshes targeting sole, south of 56^{o} N, and in the fisheries targeting *Nephrops*. The minimum mesh size for fixed gears targeting cod remains unchanged at 120 mm. In addition, the UK has unilaterally introduced the mandatory use of square mesh panels in the codend of trawls.

In 2001, an additional emergency measure was implemented as part of a cod recovery programme which is still to be agreed between the EU and Norway. The emergency measure (Commission regulation (EC) 259/2001) involved the closure of a significant area of the North Sea from 14 February to 30 April 2001 to all gears likely to catch cod. The closure area is shown in Figure 3.1. Although these additional measures will have no effect on the outcome of this assessment, they will have implications for the outcome of the catch predictions for 2001 and 2002 (see Section 3.7).

3.1.3 The fishery in 2000

Landings data from human consumption fisheries for recent years as officially reported to ICES together with those estimated by the Working Group are given for each area separately and combined in Table 3.1.1 and the data are plotted in Figure 3.1.1. The Working Group estimate for landings from the three areas combined in 2000 is 70,687 t, split as follows for the separate areas.

	2000 Landings 000 t)
IIIa(Skagerrak)	9.3
IV	59.0
VIId	2.3
Total	70.6

In 2000, the landings were dominated by the 1998 year class as 2-year olds, which accounted for 41% of the total numbers landed from VIId, 50% from Sub-area IV and 49% from Division IIIa Skagerrak. The relatively strong 1996 year-class which dominated the landings in 1998 and 1999, accounted for only 14% of the international landings number in 2000. The 1997 year-class, the weakest on record, accounted for only 14 % of the total international landings number in 2000, and it is important to note that only about 5% of the total international landings from the stock in 2000 comprised age groups 5 and older.

For 1999, French landings from Sub-area VII were unavailable by Division, and the landings from Division VII d were estimated by the Working Group using the 1998 landings ratio: Landings from VIId (1999) = VIId landings (1998) / Total Sub-area VII landings (1998). In addition, for both Sub-area IV and Division VIId, 1999 landings by individual fleets were estimated in a similar manner e.g. Fleet landings (VIId, 1999) = Fleet landings (VIId, 1998) / Total landings (VIId, 1998). These estimates remain the same in the current assessment.

Officially reported landings and WG estimates indicate that the TAC uptake for Sub-area IV was undershot by 25-30% in 2000. The TAC for Division IIIa was undershot by about 20%. This has been a regular feature for a number of years. The WG suspects that under-reporting of landings by some countries may have been significantly greater in 1998 than in other years. However, for 1999 and 2000, the WG has no evidence that there was significant under-reporting of landings.

Estimates of total international discards are not available. However, discard sampling carried out under EU contract 98/097 indicate that in 2000, the proportion in number of cod discarded by age group over the year was as follows (approximate values only):

	Q1	Q2	Q3	Q4
Age 1	100%	97%	84%	57%
Age 2	13%	9%	31%	2%
Age 3	1%	0%	8%	0%
Age 4	0-6%	0%	4%	0%
Age 5+	0%	0%	7%	0%

The variations in the quarterly discard proportions are primarily due to the different discarding patterns for the different fleets sampled. The discard of cod aged 4 and older is most likely a reflection of the particular fleet sampled and is almost certainly due to quota restrictions or poor quality fish. A more comprehensive summary of the quarterly discard pattern by age group is given in Table 3.1.2. The report to the WG on EC project 98/097, Report on Discards was provided to the WG on CD. The report documents discard rates by fleet and quarter for selected national fleets fishing in the North Sea in 2000 and the second half of 1999.

The industrial by-catch of cod sent for reduction to fishmeal and oil in 2000, is small (383 t) compared to the overall landings from this stock (see Table 1.7.1).

Cod are caught by virtually all the demersal gears in Sub-area IV and Divisions IIIa (Skagerrak) and VIId, including trawls, seines, gill nets and lines. Most of these gears take a mixture of species, but some of the fixed gear fisheries are directed mainly towards cod.

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

Values for natural mortality and maturity are given in Table 3.2.1, and are unchanged from those used in last year's assessment and are applied to all years. The sources of these data are multi-species VPA as performed by the Multi-species Working Group in 1986, and the International Bottom trawl Survey (maturity). These values were derived for the North Sea and are equally applied to the three stock components. However, results from IBTS Q1 surveys indicate that the proportion mature at age has gradually increased over time especially for age groups 3 and 4 (see section 1.6.5. and WD-6)

Landings in numbers at age for 1963-1998 are given in Table 3.2.2. SOP corrections have been applied. These data form the basis for the catch at age analysis but do not include industrial fishery by-catches landed for reduction purposes, or discards. By-catch estimates are available for the total Danish and Norwegian small-meshed fishery in Sub-area IV (Table 2.1.3) and separately for the Skagerrak (Table 3.1.1.), but as in previous years, these data were not included in the assessment.

Age compositions were provided by Belgium, Denmark, England, France, Germany, the Netherlands and Scotland (Table. 1.3.3.1). Mean weight at age data for landings are given in Table 3.2.3. These values were also used as stock mean weights.

Long-term trends in mean weight at age for age groups 1-6 are plotted in Figure 3.2.1 relative to the mean weight for each age group in 1963. Figure 3.2.1 indicates that there have been short-term trends in mean weight about a long term mean and that the decline in mean weight at age over the past few years on age groups 1-3 now seems to have stabilised. For age groups 4-6, there is no indication that the declining trend has stabilised.

3.3 Catch, Effort, and Research Vessel Data

Trends in fishing effort for selected commercial fleets exploiting cod are shown in Figure 2.1.1.

Data from 3 surveys and 6 commercial fleets were available for tuning XSA: Scottish Heavy Trawl (SCOTRL), Scottish seine (SCOSEI), Scottish light trawl (SCOLTR), English Groundfish Survey (EGFS), Scottish Groundfish survey (SCOGFS), International quarter 1 Bottom trawl survey (IBTS Q1), English Trawl (ENGTRL), English seine (EGNSEI) and a Danish Gill net fleet (DANGIL). The Scottish commercial fleets mainly fish in the Northern North Sea, while the English trawl fleet primarily exploits cod in the central western North Sea, although some vessels venture into the Norwegian Zone. The Danish Gill netters, fish in the central eastern North Sea and in the Skagerrak. Both the IBTS Q1 and EGFS surveys cover the whole of the North Sea basin to depths down to 200 m. The SCOGFS survey covers the Northern North sea north of the Dogger Bank. None of the surveys covers the coastal areas at depths less than about 35 m.

In it’s 2000 assessment report (CM 2001/ACFM:07), the WG outlined specific concerns with the Scottish commercial fleets’ effort data, and these were excluded from the catch at age analysis. These concerns remain and hence the Scottish commercial data has also been excluded in this year’s assessment. Apart from the database problem, commercial catch and effort data are prone to biases if the distribution of the fleet effort changes in relation to the distribution of the stock and there appears to have been a major expansion of effort by the Scottish heavy otter trawl fleet over the past 10 years. Similarly, the time series of catch and effort data for the English seiners has also been excluded this year for the same reasons as outlined in last year’s report of the WG, namely that there have been significant changes in fleet composition and fishing pattern. In addition, the partial F for this fleet over the converged part of the VPA has previously been shown to be highly variable. The fleets remaining for calibrating the analysis were therefore English trawl , Danish gill net and the three surveys.

The time series of landings and cpue for age-groups 1-4, normalised to the mean of each series are given in Figure 3.3.1 The data indicate that apart from the Danish gill net fleet, the year-class signals are relatively consistent for these important age-groups, but that the signal seems to be more variable in the recent period.

3.4 Catch at Age Analysis

3.4.1 Exploration of the data

In the report of its 2000 meeting (CM 2001/ACFM:07) the WG chose a 10-year time window from 1990-1999 for tuning the VPA. Since such a procedure means the loss of information and that the addition of new data can change the slope of the calibration regression significantly, leading to poor retrospective patterns in the analysis, the WG chose to use the full time-series of catch and effort data for tuning. The tuning fleet data are given in Table 3.4.1.

Single fleet XSA calibration runs were carried out with no taper, light shrinkage (1.5) and the minimum standard error of the fleet estimates set to 0.1 (runs 17-21) to allow each of the fleets to maximally influence the terminal population and F. Plots of the log catchability (q) residuals over time are given in Figures 3.4.1a-c. The data indicate that there is an increasing trend in catchability over time for the most important age groups (1-3), suggesting that a time-series taper is appropriate for tuning the XSA.

In the 2000 assessment, age groups 1-3 were treated as being dependent on year class strength since the relatively large 1996 year class as three year-olds was dominant in the landings and in the surveys. The subsequent 1997 year class was the lowest on record and can be expected to give comparable problems as 3-year-olds in 2001. As a result, and because of the variation in catchability by year class strength and also for consistency, the WG chose to treat age groups 1-3 as recruits in the current assessment.

The results of the exploratory runs in terms of terminal F and SSB are shown in Figure 3.4.2c. The results indicate that whichever of these tuning configurations is used, the resulting SSB is very low between 50,000 –60,000 t. However the estimate of reference F(2-8) is sensitive to the tuning configuration, and ranges between about 0.7 and 1.2. The Danish gillnet fleet gives the lowest estimate of F, at about F=0.7, whereas the English trawl fleet gives the highest estimate at F=1.2. The reasons for these estimates can be seen in Figure 3.4.4. which shows the terminal exploitation pattern generated by the different runs.

From Figure 3.4.4, it is evident that the two commercial fleets generate radically different exploitation patterns to the survey series,. Furthermore the exploitation patterns from the commercial fleets are significantly different to the historic exploitation pattern for this stock. The WG therefore considered that the terminal Fs from the commercial fleet tuning are unrepresentative. In addition, the effort data for both commercial fleets is un-standardised and both fleets fish in restricted areas of the North Sea. On the other hand the three surveys each cover the majority of the North Sea and the main distributional area of the cod stock. As a result the WG decided to exclude all commercial fleet data from tuning.

Although the terminal exploitation patterns from the single fleet survey tunings differ, the results of the assessment in terms of mean F and SSB are similar (Figure 3.4.2c) and the average exploitation patterns over 1998-2000 for the individual survey tuning runs are essentially the same (Figure 3.4.5).

3.4.2 Final assessment

The final assessment was carried out using the full time series of tuning data, run with a tricubic taper over 20 years. The tuning fleet data are given in Table 3.4.1. Catchability was set dependent on year class strength (stock size) for age groups 1-3, and with age independent catchability on age groups older than 4. Age group 6 was removed from the IBTS_Q1 series since the WG discovered that the age 6 index is a 6+ group index, despite it having been used in previous assessments.

A comparison of the configuration used in the 2000 assessment with the current assessment is given below:

			2000 XSA	2001 XSA
Fleets	SCOTRL_IV		Not used	Not used
	SCOSEI_IV		Not used	Not used
	SCOLTR_IV		Not used	Not used
	ENGTRL_IV		1-10	**Not used**
	ENGSEI_IV		Not used	Not used
	SCOGFS_IV		1-5	**1-6**
	ENGGFS_IV		1-5	1-5
	IBTS+Q1_IV		1-6	**1-5**
Time-series Taper			No	Yes
Tuning range			10 yr	**20 yr**
q independent catchability			4+	4+
age independent q			>=5	>=5
F shrinkage			0.5	0.5
Min SE of fleet estimates of Population size			0.3	0.3

The diagnostics from the final XSA run are given in Table 3.4.2. and plots of the log catchability residuals for each fleet from this run are given in Figure 3.4.2a,b.

Plots of log VPA population numbers against log tuning index are given in Figure 3.4.3, which indicates relatively good fits to the catch data for the surveys at younger ages, but poorer fits for older ages. The relative importance for the result in terms of regression weights by type of fleet or shrinkage, are shown in Fig. 3.4.6.

The estimates of fishing mortality rates and population numbers resulting from the tuning procedure and XSA are given in Tables 3.4.3 and 3.4.4 and are summarized in Table 3.4.5. The mean F(2-8) for 2000 is estimated to be 0.83 and the estimate for 1999 has been revised upwards from F = 0.9 to F = 1.06. SSB in 2000 is estimated to be 54,000 t (based on 53.7 kt, see summary Table 3.4.5) compared to 67,000t predicted from the 2000 assessment. SSB in 2001 was predicted to be 59,000 t in the 2000 assessment, and this figure has been revised downward to 55,000 t in the current assessment.

The results from a retrospective XSA analysis using the full time series of tuning data and the options specified above are shown in Figure 3.4.7. The retrospective plots indicate that although there appears to be less than a 10% retrospective bias in SSB and recruitment with mean F 2-8 for 1999 underestimated by about 20%, the configuration omitting the commercial catch and effort series seems to have reduced the bias compared to other recent assessments. Tables 3.4.4 and 3.4.5 also document two levels of mean F; the standard age range of 2-8, and a shortened age range of 2-4, the ages that are predominant in the landings. The mean F(2-4) retrospective pattern appears less biased than that for mean F(2-8).

3.5 Recruitment Estimates

Average recruitment at age 1 over the period 1963-1998 was 322 million (geometric mean). The GM recruitment in the recent period (1989-1998) is 200 million 1- year old fish.

Since the estimates of the 1998 and earlier year classes were derived using the year class dependent (power) model in XSA, the WG accepted the estimates of stock numbers at age and F in 2000 for age-groups 2 and older.

Using RCT3, research vessel survey data for 1-year old fish (Table 3.5.1) were regressed against VPA population numbers for year classes back to and including 1970 to compare the estimate of 1-groups in 2000 (1999 year class) with the XSA estimate and to estimate recruitment at age 1 in 2001. The results of survey indices regressed against XSA recruitment at age 1 are presented in Table 3.5.2.

Year class 1999: The weighted mean estimated by RCT3 using 1 group recruitment from XSA was 227 million 1-year olds in 2000. This is close to the short-term GM of 200 million and is consistent with the XSA estimate of 215 million. Only about 10% of the weighting used for this estimate is derived from population shrinkage. Since there was little to choose between these estimates, the WG accepted the XSA estimate of 215 million as input to the catch predictions.

Year class 2000. The only new recruitment estimates available for the 2000 year class at age 1 in 2001, are derived from the EGFS Q3 research vessel survey 0-group index for 2000 and the 2001 IBTS_Q1 1-group index. The RCT 3 estimate (152 million) is less than the short-term GM from XSA (200 million). Approximately 50% of the RTC3 estimate of the 2000-year class is derived from the long-term mean from RCT3 (257 million over the period 1970-1997). Since the mid-1980s, apart from the 1996 year class which was relatively large, all year classes as 1-year-olds have been at or below the long-term average. The RCT3 GM estimate of 257 million was therefore rejected on the grounds that it is likely to be over-optimistic. The EGFS and IBTS survey estimates from RCT3 of the 2000 year class are 91 million and 102 million. These estimates are not dissimilar and since their combined weighting to the RCT3 estimate was about 50%, the WG accepted the RCT3 estimate as a basis for the predictions.

Year class 2001. In the absence of any predictor for the 2001 year class, the WG chose to use the short term GM recruitment of 200 million 1-year-olds for the 2001 and 2002 year classes.

Working group estimates of year class strength used for the prediction can be summarised as follows:

Year class	XSA Estimate (Millions age 1)	RCT3 estimate	Short-term GM
1999	**215**	227	200
2000	-	**152**	200
2001	-	-	**200**
2002	-	-	**200**

Values used for input to prediction are underlined in bold.

3.6 Historical Stock Trends

Historical trends in mean fishing mortality, landings, spawning stock biomass, and recruitment are shown in Table 3.4.5 and Figure 3.1.1. Mean fishing mortality (F2-8) has shown a more or less continuous increase over the whole period up to the early 80's and has remained at about that level since that time. Spawning biomass decreased from a peak of 277,000 t in 1971 to a historical low of about 54,000 t in 2000, although SSB has remained below 100,000 t since the late 1980s. Recruitment has fluctuated considerably over the period but the frequency of poor year classes has increased since 1985. The 1996 year class is still estimated as the largest since 1985, but the 1997 and subsequent year classes at age 1 have been poor and of these year-classes, only the 1999 year class is above the short-term (1989-1997) mean. It seems that since 1997, there has been a succession of 4 relatively poor year classes, and the 1997 year class (70 million age 1) is the poorest on record. The 1998 year class (139 million) together with the 1989 year class (134 million) are the second poorest and the 2000 year class appears to be only about 40% of the long-term GM.

The historic trajectory of SSB and mean F is given in Figure 3.6.1.

Historically, landings increased in the 1960s and early 1970s to reach a peak of 350,000 t in 1972. After a further peak of about 335,000 t in 1981, landings have declined to an historical low in 2000.

3.7 Short Term Forecast

The input data for the *status quo* prediction are given in Table 3.7.1. Mean weight at age is the average for the period 1998-2000. Fishing mortalities at age are the means for the same period, scaled to the mean F(2-8) of F=0.83 in 2000. Population numbers in 2001 are XSA survivor estimates, except for age 1, which was derived from RCT3.

The results of a *status quo* landings prediction for 2000 and 2001 are given in Tables 3.7.2 and 3.7.3 and shown graphically in Figure 3.7.1. The predicted status quo landings are 82,000 t for 2001, and 86,000 t for 2002. Under these conditions spawning biomass is estimated to be 55,000 t at the start of 2001, 57,000 t in 2002 and 62,000 at the start of 2003. The detailed output tables (Table 3.7.3) and Figure 3.7.2 confirm that the landings in 2002 and SSB in 2003 will be dominated by the recruiting year classes 1999 and 2000 while the importance of the previously strong 1996 year class is negligible. Figures 3.7.2 and 3.7.3 indicate that landings in 2002 and SSB in 2003 are primarily influenced by the 1999 year class which at best is only at about the level of the short term mean.

The results of sensitivity analyses of the short-term prediction are presented in Figure 3.7.3 and probability profiles in Figure 3.7.4. 56 % of the variance in landings in 2002 is accounted for by the estimate of the 2000 year class. Figure 3.7.4 indicates that there is little chance of the stock reaching $\mathbf{B}_{pa}$ (150,000 t) by 2003 at *status quo* F and a high probability that it will remain below 100,000 t.

The WG is unable to evaluate the potential effect of the management measures introduced in 2001 on the catch of cod in 2001 and 2002. The management in 2001 is a TAC in sub-area IV of only 48,600 t and 7,000 t for the Skagerrak. These TACs corresponded to a nominal reduction in fishing mortality on mean F in 1999 of 50%. In addition, the closed area in the North Sea from 14 February to 30 April, may also affect the catch of cod in 2001. The WG carried out an additional catch prediction for 2001 and 2002 using a TAC constraint. Outputs are given in Tables 3.7.4 - 3.7.5.

Assuming a catch of 55,600 t in 2001, and *status quo* fishing mortality (0.83) in 2002, landings and SSB in 2002 are predicted to be 105,000 t and 77,000t respectively. SSB at the start of 2003 is predicted to be 78,000 t.

3.8 Medium term projections

The WG undertook medium-term projections of landings and SSB for a range of fishing mortalities over a 10 year period. The input values are given in Table 3.8.1, and are the same as for the short-term forecast, except that mean weight at age is the average over the period 1990-99. The projections were carried forward for 10 years using the software WGMTERMC and assuming a Shepherd stock-recruit model (Fig. 3.8.1 and Table 3.8.2). This was the model accepted in 1999 and 2000 and the one used to calculate precautionary reference points for cod. Figure 3.8.1 displays trajectories of catch, recruits and SSB at *status quo* F expressed as percentiles (10, 25, 50, 75, and 90).

The trajectories under *status quo* fishing mortality indicate that the observed low recruitment variation at SSB levels below $\mathbf{B}_{pa}$, implies a weak recovery potential with a very little chance of the SSB to exceed the $\mathbf{B}_{pa}$ by 2010. Figure 3.8.2 (contour plot) illustrates probability trajectories of the SSB being below $\mathbf{B}_{pa}$ as a function of time and fishing mortality. The current high fishing mortality ($F_{2\text{-}8}$=0.83) implies a 90 % probability that $\mathbf{B}_{pa}$ will not be reached by 2010. A reduction in the fishing mortality to $\mathbf{F}_{pa}$ (0.65) results in a 30 % probability that the SSB will not exceed the $\mathbf{B}_{pa}$

level of 150 000 t by 2010. Figure 3.8.2 illustrates that significant reductions in the fishing mortalities would be required if the SSB recovery is to be achieved earlier.

3.9 Biological reference points

Inputs for long-term equilibrium yield and SSB-per-recruit analyses are the same as the medium term inputs (mean 1991-2000) and are given in Table 3.8.1 and results are presented in Figure 3.9.1. The stock recruit relationship showing $\mathbf{F}_{high}$, $\mathbf{F}_{med}$ and F_{2000} is given in Figure 3.9.2.

Biological reference points and management reference points for cod are given in the text table below.

Reference Point	Estimate
$\mathbf{B}_{lim}$	70,000 t
$\mathbf{B}_{pa}$	150,000 t
$\mathbf{F}_{lim}$	0.86
$\mathbf{F}_{pa}$	0.65
$\mathbf{F}_{max}$	0.24
$\mathbf{F}_{0.1}$	0.14
$\mathbf{F}_{med}$	0.78
$\mathbf{F}_{high}$	1.13

3.10 Comments on the Assessment

3.10.1 Assessment quality

Figure 3.10.1 shows a retrospective analysis of the assessments carried out since 1990 as adopted by ACFM relative to the current assessment. Over this period there is a strong tendency to over-estimate SSB and under-estimate F. It is likely that part of this problem is due to the inclusion of commercial CPUE data in past assessments which are no longer used. There appears to be more consistency between this assessment and last year’s assessment than in assessments prior to 2000.

The configuration of the XSA has little effect on the estimate of SSB, and all configurations estimate the SSB to be in the region of 50,000 to 60,000 t. The tuning configuration can however, significantly affect the terminal exploitation pattern which can influence the mean F value and therefore affect the catch forecast. The WG is of the opinion that the greatest uncertainty is associated with catch predictions rather than the assessment of the current state of the stock. Despite some uncertainty in the forecasts , there is no doubt that the cod stock is at or about an historic low level. The estimate of mean F(2-8) for 2000 is lower than for 1999, but is still within the range of values observed for over a decade.

The catch forecast is sensitive to the estimate of the strength of the 1999 and 2000 year classes. For the forecasts a RCT3 estimate for the 2000 year class of 152 million was used. Although this value is conservative relative to the Short term GM (200 million) and long-term GM (322 million), previous analyses have shown that on average RCT3 estimates of cod recruitment have been over-estimated by about 15%. The 2001 Q3 survey indices will be available ahead of the November meeting of the ACFM. These data will prove useful in confirming the strength of the 2000 year class.

The WG notes that although the medium term projections presented in section 3.8 were undertaken assuming a Shepherd stock recruit relationship using the whole time series of data from 1963 to 1998, the form of the stock recruit relationship has a large influence on the outcome of the projections. Furthermore, there is evidence that average recruitment of cod in the period since the mid-1980s has, been lower than prior to the mid-1980s. If there has been a regimen shift in the recruitment of cod, then it would be more appropriate to use only the post mid-1980s stock and recruit data as input to medium term projections. In addition, if this is the case, biological reference points would need to be re-estimated and the results of medium term projections presented in this report would most likely be over optimistic.

Further comments on the quality of the assessments are given in Section 1.10.

3.10.2 State of the stock

The results from the current configuration indicate that mean F remains at the high level observed since the early 1980s. SSB is now estimated at an historic low level of 54,000 t in 2000 and at *status quo* F is predicted to remain at about this low level in 2002 and 2003. The SSB has been in the region of $\mathbf{B}_{\mathrm{lim}}$ (70,000 t) since 1990. Furthermore, current F (0.9) has been at or above $\mathbf{F}_{\mathrm{lim}}$ (0.86) since the late 1980s. The results of this assessment are generally in agreement with the assessment presented at the 2000 meeting of the WG. The current fishing mortality rate is not sustainable. Approximately 85 % of the stock in number consists of fish aged 1-4. Over the past decade, approximately 60% of the spawning stock in number has comprised 1-3 year-old cod, despite about 75% of the SSB comprising age-groups 4 and older.

3.10.3 Management considerations

There is a need to reduce overall fishing mortality on North Sea cod significantly in order to allow more fish to reach sexual maturity and increase the probability of good recruitment. In addition, there is also a need to reduce the mortality rate on younger age groups (1-3). The highest exploitation rate is on age group 3, followed by ages 4 and 2. This exploitation pattern has been approximately the same since the early 1960s despite various changes to technical regulations (gear modifications and mesh size changes) aimed at improving this pattern.

Cod is a specific target for some fleets but the majority of cod are caught in the demersal mixed fisheries for other gadoids (mainly haddock and whiting) in the central and northern North Sea and as a by-catch in the beam-trawl fisheries. This means it is important to take into account the impact of management of cod on other stocks, especially haddock and whiting, although fishing opportunities for other commercially important stocks may also be affected. The reverse is also true. Recent measures to protect North sea cod, such as the closed area, and proposals to increase mesh size, will most likely have a greater beneficial effect to stocks other than cod.

There is frequently debate about the extent to which the cod-haddock-whiting fisheries are linked. This linkage is not one-to-one but it is also true that they are far from separate. It is possible for fishing vessels to increase their targeting of individual species but this is never perfect and there will always be a significant by-catch of other roundfish. Hence, for example, measures to protect cod will require at least some reduction in the fishing mortality for haddock and vice versa. This means that TACs for the three main roundfish species do need to be set in a way which acknowledges the fishery linkage but it remains a difficult to judge how close this linkage should be.

Management of cod is also discussed in Section 1.11 of this report.

Table 3.1.1. **Nominal landings (in tonnes) of COD in IIIa (Skagerrak), IV and VIId, 1984–2000 as officially reported to ICES and as used by the Working Group.**

Sub-area IV

Country	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000****
Belgium	2,934	2,331	3,356	3,374	2,648	4,827	3,458	4,642	5,799	3,882	3,304
Denmark	21,601	18,998	18,479	19,547	19,243	24,067	23,573	21,870	23,002	19,697	14,000
Faroe Islands	96	23	109	46	80	219	44	40	102	96	
France	1,641	975	2,146	1,868	1,868	3,040	1,934	3,451	2,934	1,750	2,348
Germany	11,725	7,278	8,446	6,800	5,974	9,457	8,344	5,179	8,045	3,386	1,740
Netherlands	8,445	6,831	11,133	10,220	6,512	11,199	9,271	11,807	14,676	9,068	5,995
Norway	5,168	6,022	10,476	8,742	7,707	7,111	5,869	5,829	5,749	7,770	6,402
Poland	53	15	-	-	-	-	18	31	25	19	18
Sweden	620	784	823	646	630	709	617	832	540	625	622
UK (E/W/NI)	15,622	14,249	14,462	14,940	13,941	14,991	15,930	13,413	17,745	10,344	
UK (Scotland)	31,120	29,060	28,677	28,197	28,854	35,848	35,349	32,344	35,633	23,017	
United Kindom											27,541
Total Nominal Catch	99,025	86,566	98,107	94,380	87,457	111,468	104,407	99,438	114,250	79,654	61,970
Unallocated landings	5,726	1,967	-758	10,200	7,066	8,555	2,161	2,731	7,853	-1,262	-2,885
WG estimate of total landings	**104,751**	**88,533**	**97,349**	**104,580**	**94,523**	**120,023**	**106,568**	**102,169**	**122,103**	**78,392**	**59,085**
Agreed TAC	**105,000**	**100,000**	**100,000**	**101,000**	**102,000**	**120,000**	**130,000**	**115,000**	**140,000**	**132,400**	**81,000**

Division VIId

Country	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000****
Belgium	237	182	187	157	228	377	321	310	239	172	110
Denmark	-	-	1	1	9	-	-	-	-	-	
France	n/a	n/a	2,079	1,771	2,338	3,261	2,808	6,387	7,788		
Netherlands	-	-	2	-	-	-	+	-	19	3	4
UK (E/W/NI)	420	341	443	530	312	336	414	478	618	454	
UK (Scotland)	7	2	22	2	+	+	4	3	1	-	
United Kingdom											336
Total Nominal Catch	n/a	n/a	2,734	2,461	2,887	3,974	3,547	7,178	8,665	629	450
Unallocated landings	-	-	-65	-29	-37	-10	-44	-135	-85	6,229	1,875
WG estimate of total landings	**2,763**	**1,886**	**2,669**	**2,432**	**2,850**	**3,964**	**3,503**	**7,043**	**8,580**	**6,858**	**2,325**

Division IIIa (Skagerrak)

Country	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000****
Denmark	15,788	10,396	11,194	11,997	11,953	8,948	13,573	12,164	12,340	8,734	7,683
Sweden	1,694	1,579	2,436	2,574	1,821	2,658	2,208	2,303	1608	1,909	1,350
Norway	143	72	270	75	60	169	265	348	303	345	301
Germany	110	12	-	-	301	200	203	81	16	54	9
Others	65	12	102	91	25	134	-	-	-	-	-
Norwegian coast *	846	854	923	909	760	846	748	911	976	788	624
Danish industrial by-catch *	687	953	1,360	511	666	749	676	205	97	62	99
Total Nominal Catch	17,800	12,071	14,002	14,737	14160	12109	16249	14896	14267	11042	9343
Unallocated landings	0	-12	0	0	-899	0	0	50	1,064	-68	-66
WG estimate of total landings	**17,800**	**12,059**	**14,002**	**14,737**	**13,261**	**12,109**	**16,249**	**14,946**	**15,331**	**10,974**	**9,277**
Agreed TAC	**21,000**	**15,000**	**15,000**	**15,000**	**15,500**	**20,000**	**23,000**	**16,100**	**20,000**	**19,000**	**11,600**

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

	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000****
Total Nominal Catch	n/a	n/a	114,843	111,578	104,504	127,551	124,203	121,512	137,182	91,325	71,763
Unallocated landings	-	-	-823	10,171	6,130	8,545	2,117	2,646	8,832	4,900	-1,076
WG estimate of total landings	**125,314**	**102,478**	**114,020**	**121,749**	**110,634**	**136,096**	**126,320**	**124,158**	**146,014**	**96,225**	**70,687**

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

Table 3.1.2. Cod in Sub-areas IV and Divisions IIIa (Skagerrak) and VIId). Proportions at age discarded from all sampled North sea fleets.

Summary results of EC PROJECT 98/097.
Combined numbers and weights at age for all countries that supplied aged data and proportions at age discarded
Discards

	1st Quarter (raised to fleet)		2nd Quarter (raised to fleet)		3rd Quarter (raised to fleet)		4th Quarter (raised to fleet)		Total For All Quarters	
Winter Rings (Age)	Number ('000s)	Weight kg)	Number ('000s)	Weight kg)	Number ('000s)	Weight kg)	Number ('000s)	Weight kg)	Number ('000s)	Weight kg)
0	253.8	38.5	0.0	0.0	0.0	0.0	60.3	1.8	314.1	40.4
1	52501.8	20589.0	576.2	2912.9	1086.6	32219.1	36496.8	87410.1	90661.3	143131.1
2	5263.3	23853.6	53.5	1933.1	251.2	1404.6	893.2	6833.0	6461.3	34024.4
3	64.0	606.4	0.1	48.4	3.2	0.0	0.0	0.5	67.4	655.3
4	21.6	835.0	0.1	31.9	6.1	0.0	0.0	0.1	27.8	867.1
5	0.0	68.1	0.0	0.0	1.0	0.0	0.0	0.0	1.0	68.1
6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	0.0	12.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	12.4
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10+	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTALS	58104.5	46003.1	629.9	4926.3	1348.2	33623.7	37450.3	94245.6	97532.9	178798.7

Retained

	1st Quarter (raised to fleet)		2nd Quarter (raised to fleet)		3rd Quarter (raised to fleet)		4th Quarter (raised to fleet)		Total For All Quarters	
Winter Rings (Age)	Number ('000s)	Weight kg)	Number ('000s)	Weight kg)	Number ('000s)	Weight kg)	Number ('000s)	Weight kg)	Number ('000s)	Weight kg)
0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.1	0.5	0.1
1	0.0	0.0	16.7	530.6	200.0	2.2	28045.2	5544.3	28261.9	6077.1
2	36764.5	10962.5	525.5	29402.4	562.4	322.7	51941.9	8911.0	89794.2	49598.6
3	6442.7	7599.3	62.0	6383.8	38.2	171.8	4752.3	1676.3	11295.2	15831.3
4	21527.0	48034.5	178.9	20435.3	140.7	4468.5	12935.3	4402.1	34781.8	77340.5
5	2155.6	18679.0	10.1	1404.4	14.3	433.6	2273.9	1085.1	4454.0	21602.1
6	187.3	34358.8	4.4	1403.9	0.9	261.0	881.3	467.6	1073.9	36491.2
7	459.9	31061.0	1.9	1214.8	1.1	57.5	1112.7	352.3	1575.6	32685.6
8	51.3	10547.5	0.3	268.4	0.2	172.4	903.6	119.4	955.4	11107.7
9	10.9	3664.2	0.2	546.7	0.1	57.5	513.5	19.6	524.7	4288.1
10+	11.0	4997.2	0.0	0.0	0.0	0.0	351.9	0.0	362.9	4997.2
TOTALS	67610.2	169904.1	800.0	61590.3	957.9	5947.3	103712.0	22577.7	173080.1	260019.5

Percentage at Age Discarded

Winter Rings (Age)	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Weighted mean	t landed	t discarded	No landed ('000s)	No discarded ('000s)
0	100%	-	46%	99%	100%	0.0	0.0	0.5	314.1
1	100%	97%	84%	57%	76%	143.1	6.1	28261.9	90661.3
2	13%	9%	31%	2%	7%	34.0	49.6	89794.2	6461.3
3	1%	0%	8%	0%	1%	0.7	15.8	11295.2	67.4
4	0%	0%	4%	0%	0%	0.9	77.3	34781.8	27.8
5	0%	0%	7%	0%	0%	0.1	21.6	4454.0	1.0
6	0%	0%	0%	0%	0%	0.0	36.5	1073.9	0.0
7	0%	0%	0%	0%	0%	0.0	32.7	1575.6	0.0
8	0%	0%	0%	0%	0%	0.0	11.1	955.4	0.0
9	0%	0%	0%	0%	0%	0.0	4.3	524.7	0.0
10+	0%	-	0%	0%	0%	0.0	5.0	362.9	0.0
Tonnes discarded	46.0	4.9	33.6	94.2	178.8	178.8	260.0	173080.1	97532.9
Tonnes landed	169.9	61.6	5.9	22.6	260.0				
No. landed ('000s)	67610.2	800.0	957.9	103712.0	173080.1				
No.discarded ('000s)	58104.5	629.9	1348.2	37450.3	97532.9				

Table 3.2.1. Cod in Sub-area 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
8	0.2	1.0
9	0.2	1.0
10	0.2	1.0
11+	0.2	1.0

Table 3.2.2 Cod in Sub-area IV and Divisions VIId and IIIa (Skagerrak). Landings numbers at age.

Run title : Cod, North Sea/Skaggerak/Eastern Channel 7/6/2001

At 22/06/2001 13:10

Table 1 Catch numbers at age Numbers*10**-3

YEAR,	1963,	1964,	1965,	1966,	1967,	1968,	1969,	1970,
AGE								
1,	3214,	5030,	15813,	18224,	10803,	5829,	2947,	54493,
2,	42591,	22493,	51888,	62516,	70895,	83836,	22674,	33917,
3,	7030,	20113,	17645,	29845,	32693,	42586,	31578,	18488,
4,	3536,	4308,	9182,	6184,	11261,	12392,	13710,	13339,
5,	2788,	1918,	2387,	3379,	3271,	6076,	4565,	6297,
6,	1213,	1818,	950,	1278,	1974,	1414,	2895,	1763,
7,	81,	599,	658,	477,	888,	870,	588,	961,
8,	492,	118,	298,	370,	355,	309,	422,	209,
9,	13,	94,	51,	126,	138,	151,	147,	186,
10,	6,	12,	75,	56,	40,	111,	46,	98,
+gp,	0,	4,	8,	83,	17,	24,	78,	40,
0 TOTALNUM,	60965,	56505,	98957,	122538,	132335,	153600,	79651,	129791,
TONSLAND,	116457,	126041,	181036,	221336,	252977,	288368,	200760,	226124,
SOPCOF %,	100,	100,	100,	100,	100,	100,	100,	100,

Table 1 Catch numbers at age Numbers*10**-3

YEAR,	1971,	1972,	1973,	1974,	1975,	1976,	1977,	1978,	1979,	1980,
AGE										
1,	44824,	3832,	25966,	15562,	33378,	5724,	75413,	29731,	34837,	62605,
2,	155345,	187686,	31755,	58920,	47143,	100283,	51118,	175727,	91697,	104708,
3,	17219,	48126,	54931,	11404,	18944,	18574,	25621,	17258,	44653,	35056,
4,	6754,	5682,	14072,	15824,	4663,	6741,	4615,	9440,	4035,	12316,
5,	7101,	2726,	2206,	4624,	7563,	1741,	2294,	3003,	3395,	1965,
6,	2700,	3201,	1109,	961,	2067,	3071,	836,	1108,	712,	1273,
7,	893,	1680,	1060,	438,	449,	924,	1144,	410,	398,	495,
8,	458,	612,	489,	395,	196,	131,	371,	405,	140,	197,
9,	228,	390,	80,	332,	229,	67,	263,	153,	158,	74,
10,	77,	113,	58,	81,	95,	63,	26,	36,	42,	55,
+gp,	94,	18,	162,	189,	63,	43,	96,	44,	17,	25,
0 TOTALNUM,	235691,	254064,	131888,	108729,	114791,	137361,	161797,	237314,	180085,	218770,
TONSLAND,	328098,	353976,	239051,	214279,	205245,	234169,	209154,	297022,	269973,	293644,
SOPCOF %,	100,	100,	100,	100,	100,	100,	100,	100,	101,	100,

1

Table 1 Catch numbers at age Numbers*10**-3

YEAR,	1981,	1982,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,
AGE										
1,	20279,	66777,	25733,	64751,	8845,	100239,	24915,	21480,	22239,	11738,
2,	189007,	65299,	129632,	66428,	118047,	32437,	128282,	55330,	36358,	54290,
3,	34821,	60411,	21662,	31276,	18995,	34109,	9800,	43955,	18193,	11906,
4,	9019,	9567,	11900,	4264,	7823,	5814,	8723,	3134,	9866,	4339,
5,	4118,	3476,	2830,	3436,	1377,	2993,	1534,	2557,	1002,	2468,
6,	785,	2065,	1258,	1019,	1265,	604,	1075,	655,	1036,	310,
7,	604,	428,	595,	437,	373,	556,	235,	295,	251,	310,
8,	134,	236,	181,	244,	173,	171,	215,	66,	140,	54,
9,	65,	78,	90,	60,	79,	69,	55,	63,	27,	60,
10,	37,	27,	28,	45,	16,	44,	48,	23,	31,	12,
+gp,	21,	16,	23,	20,	31,	23,	12,	18,	10,	9,
0 TOTALNUM,	258889,	208380,	193932,	171978,	157022,	177058,	174895,	127577,	89153,	85496,
TONSLAND,	335497,	303251,	259287,	228286,	214629,	204053,	216212,	184240,	139936,	125314,
SOPCOF %,	100,	99,	100,	100,	100,	101,	100,	100,	100,	99,

Table 1 Catch numbers at age Numbers*10**-3

YEAR,	1991,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,
AGE										
1,	13466,	27668,	4783,	15557,	15717,	4938,	23769,	1255,	5941,	7948,
2,	23456,	32059,	55272,	25279,	63586,	36805,	29194,	81737,	9731,	22853,
3,	16776,	8682,	11360,	21144,	12943,	23364,	18646,	16958,	32224,	6452,
4,	3310,	5007,	3190,	3083,	5301,	3169,	6499,	5967,	4034,	6619,
5,	1390,	1060,	1577,	870,	802,	1860,	1238,	2402,	1445,	1018,
6,	1053,	491,	435,	519,	286,	399,	700,	509,	626,	382,
7,	225,	329,	204,	142,	151,	162,	153,	236,	223,	140,
8,	139,	52,	108,	58,	42,	88,	47,	41,	91,	40,
9,	28,	40,	18,	32,	15,	43,	14,	16,	14,	18,
10,	4,	17,	10,	7,	13,	4,	15,	4,	10,	5,
+gp,	10,	9,	13,	16,	5,	8,	10,	12,	2,	7,
0 TOTALNUM,	59857,	75415,	76970,	66706,	98861,	70837,	80285,	109137,	54341,	45481,
TONSLAND,	102478,	114020,	121749,	110634,	136096,	126320,	124158,	146014,	96225,	70687,
SOPCOF %,	100,	99,	99,	99,	98,	100,	100,	100,	100,	100,

1

Table 3.2.3. Cod in Sub-area IV and Divisions VIId and IIIa (Skagerrak). Mean weights at age in the landings.

Run title : Cod, North Sea/Skaggerak/Eastern Channel 7/6/2001

At 22/06/2001 13:10

Table 2 Catch weights at age (kg)

YEAR,	1963,	1964,	1965,	1966,	1967,	1968,	1969,	1970,
AGE								
1,	.5380,	.4960,	.5810,	.5790,	.5900,	.6400,	.5440,	.6260,
2,	1.0040,	.8630,	.9650,	.9940,	1.0350,	.9730,	.9210,	.9610,
3,	2.6570,	2.3770,	2.3040,	2.4420,	2.4040,	2.2230,	2.1330,	2.0410,
4,	4.4910,	4.5280,	4.5120,	4.1690,	3.1530,	4.0940,	3.8520,	4.0010,
5,	6.7940,	6.4470,	7.2740,	7.0270,	6.8030,	5.3410,	5.7150,	6.1310,
6,	9.4090,	8.5200,	9.4980,	9.5990,	9.6100,	8.0200,	6.7220,	7.9450,
7,	11.5620,	10.6060,	11.8980,	11.7660,	12.0330,	8.5810,	9.2620,	9.9530,
8,	11.9420,	10.7580,	12.0410,	11.9680,	12.4810,	10.1620,	9.7490,	10.1310,
9,	13.3830,	12.3400,	13.0530,	14.0590,	13.5890,	10.7200,	10.3840,	11.9190,
10,	13.7560,	12.5400,	14.4410,	14.7460,	14.2710,	12.4970,	12.7430,	12.5540,
+gp,	.0000,	14.9980,	15.6669,	15.6718,	19.0163,	11.5951,	11.5675,	14.3667,
0 SOPCOFAC,	.9998,	.9999,	1.0000,	1.0001,	1.0001,	.9999,	.9999,	1.0000,

Table 2 Catch weights at age (kg)

YEAR,	1971,	1972,	1973,	1974,	1975,	1976,	1977,	1978,	1979,	1980,
AGE										
1,	.5790,	.6160,	.5590,	.5940,	.6190,	.5680,	.5420,	.5720,	.5500,	.5500,
2,	.9410,	.8360,	.8690,	1.0390,	.8990,	1.0290,	.9480,	.9370,	.9360,	1.0030,
3,	2.1930,	2.0860,	1.9190,	2.2170,	2.3480,	2.4700,	2.1600,	2.0010,	2.4110,	1.9480,
4,	4.2580,	3.9680,	3.7760,	4.1560,	4.2260,	4.5770,	4.6070,	4.1460,	4.4230,	4.4010,
5,	6.5280,	6.0110,	5.4880,	6.1740,	6.4040,	6.4940,	6.7130,	6.5310,	6.5800,	6.1090,
6,	8.6460,	8.2460,	7.4530,	8.3330,	8.6910,	8.6200,	8.8280,	8.6670,	8.4750,	9.1200,
7,	10.3560,	9.7660,	9.0190,	9.8890,	10.1070,	10.1320,	10.0710,	9.6860,	10.6370,	9.5500,
8,	11.2190,	10.2280,	9.8100,	10.7900,	10.9100,	11.3410,	11.0520,	11.0990,	11.5500,	11.8670,
9,	12.8810,	11.8750,	11.0770,	12.1750,	12.3390,	12.8880,	11.8240,	12.4270,	13.0570,	12.7820,
10,	13.1470,	12.5300,	12.3590,	12.4250,	12.9760,	14.1400,	13.1340,	12.7780,	14.1480,	14.0810,
+gp,	15.5441,	14.3504,	12.8860,	13.7308,	14.4309,	14.5568,	14.3616,	13.9808,	15.4780,	15.3918,
0 SOPCOFAC,	.9999,	1.0001,	.9999,	.9999,	.9998,	1.0000,	.9999,	1.0035,	1.0087,	.9963,

1

Run title : Cod, North Sea/Skaggerak/Eastern Channel 7/6/2001

At 22/06/2001 13:10

Table 2 Catch weights at age (kg)

YEAR,	1981,	1982,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,
AGE										
1,	.7230,	.5890,	.6320,	.5940,	.5900,	.5830,	.6350,	.5860,	.6730,	.7370,
2,	.8370,	.9620,	.9190,	1.0070,	.9330,	.8560,	.9760,	.8810,	1.0520,	.9760,
3,	2.1890,	1.8580,	1.8350,	2.1560,	2.1400,	1.8340,	1.9550,	1.9820,	1.8460,	2.1760,
4,	4.6150,	4.1300,	3.8800,	3.9720,	4.1640,	3.5040,	3.6500,	3.1870,	3.5850,	3.7910,
5,	7.0450,	6.7840,	6.4910,	6.1900,	6.3240,	6.2300,	6.0520,	5.9920,	5.2730,	5.9320,
6,	8.8840,	8.9030,	8.4230,	8.3620,	8.4300,	8.1400,	8.3070,	7.9140,	7.9210,	7.8890,
7,	9.9340,	10.3990,	9.8480,	10.3170,	10.3620,	9.8960,	10.2420,	9.7640,	9.7250,	10.2350,
8,	11.5190,	12.5000,	11.8370,	11.3520,	12.0730,	11.9390,	11.4610,	12.1270,	11.2110,	10.9240,
9,	13.3380,	13.4690,	12.7970,	13.5050,	13.0720,	12.9510,	12.4470,	14.2420,	12.5860,	12.8020,
10,	14.8970,	12.8900,	12.5620,	13.4080,	14.4430,	13.8590,	18.6910,	17.7870,	15.5570,	15.5250,
+gp,	16.6291,	14.6081,	14.4263,	13.4716,	16.5876,	14.7073,	16.6043,	16.4767,	14.6939,	23.2341,
0 SOPCOFAC,	.9985,	.9946,	.9968,	.9993,	.9952,	1.0098,	.9968,	1.0000,	.9950,	.9945,

Table 2 Catch weights at age (kg)

YEAR,	1991,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,
AGE										
1,	.6700,	.6990,	.6990,	.6780,	.7210,	.6990,	.6560,	.5420,	.6400,	.6210,
2,	1.0780,	1.1460,	1.0650,	1.0750,	1.0200,	1.1170,	.9600,	.9220,	.9350,	1.0300,
3,	2.0370,	2.5460,	2.4790,	2.2010,	2.2100,	2.1470,	2.1200,	1.7240,	1.6630,	1.7350,
4,	3.9710,	4.2230,	4.5500,	4.4710,	4.2920,	4.0340,	3.8210,	3.4950,	3.3050,	3.2050,
5,	6.0830,	6.2480,	6.5400,	7.1670,	7.2200,	6.6370,	6.2280,	5.3870,	5.7260,	4.8310,
6,	8.0340,	8.4830,	8.0940,	8.4360,	8.9800,	8.4940,	8.3940,	7.5630,	7.4030,	7.4220,
7,	9.5450,	10.1020,	9.6410,	9.5360,	10.2830,	9.7290,	9.9790,	9.6280,	8.5820,	9.5210,
8,	10.9490,	10.4810,	10.7350,	10.3230,	11.7430,	11.0800,	11.4240,	10.6430,	10.3650,	10.9590,
9,	13.4810,	11.8500,	12.3290,	12.2240,	13.1070,	12.2640,	12.3000,	11.4990,	11.6000,	11.9400,
10,	13.1700,	13.9050,	13.4430,	14.2470,	12.0520,	12.7560,	12.7610,	13.0850,	12.3300,	12.4510,
+gp,	14.9889,	15.7944,	13.9612,	12.5231,	13.9541,	11.3036,	13.4162,	14.9208,	11.9259,	14.9410,
0 SOPCOFAC,	.9970,	.9928,	.9948,	.9941,	.9836,	.9990,	1.0002,	.9998,	1.0034,	.9988,

1

Table 3.4.1. Cod in Sub-area IV and Divisions VIId and IIIa (Skagerrak). Tuning fleets.

```
"North Sea/Skagerrak/Eastern Channel Cod, Tuning data"
109
SCOTRL_IV
1978 2000
1 1 0 1
1 10
135220 303.876 1424.419 285.883 181.926 63.974 15.993 11.995 6.997 2.999 1
87467 215.635 914.453 447.243 73.875 46.921 22.961 11.98 3.993 2.995 0.998
55475 154.012 849.92 379.327 127.393 19.965 19.965 7.606 6.655 0.951 1.901
51553 95.989 928.202 387.683 113.695 51.256 13.979 5.592 1.864 0.932 0.932
47889 521.806 305.76 389.066 73.236 17.394 6.408 2.746 0.915 0.915 0
48339 178.337 1427.663 208.383 112.43 23.261 9.692 1.938 0 0 0.969
34574 316.043 772.341 345.964 32.726 16.831 7.48 0.935 0.935 0 0
33103 82.048 781.283 196.005 79.313 9.116 4.558 2.735 0.912 0.912 0
27839 251.3 190.609 256.042 19.914 10.431 0.948 0.948 0 0 0
27208 272.057 606.03 38.463 39.401 8.443 1.876 0 0.938 0 0
21559 27.259 346.285 159.513 8.077 8.077 4.038 1.01 1.01 0 0
16657 58.153 29.428 134.388 40.929 2.974 2.233 1.194 0.187 0.725 0.08
14325 15.482 327.585 18.792 22.486 5.118 1.215 1.004 0.225 0 0
13495 45.113 94.909 103.953 7.731 6.998 1.718 0.483 0 0.028 0
10887 52.261 99.87 30.235 33.291 1.153 1.211 0.12 0.03 0.053 0
11657 4.716 124.61 31.231 4.273 6.325 0.634 0.055 0.001 0 0
15671 54.896 40.799 124.96 9.461 1.713 1.656 0.52 0.373 0 0
17728 29.099 254.011 93.718 49.032 1.501 0.465 0.538 0.035 0.02 0.199
13471 6.349 139.583 108.299 23.909 15.045 1.58 0.2 0.356 0.002 0.017
12651 40.656 81.864 91.362 26.785 4.988 2.978 0.731 0.104 0.009 0
25744 44.921 983.976 153.094 91.326 20.549 6.612 3.318 0.7145989 1.10E-02 0.1699046
23859 72.856 112.635 787.046 45.336 23.229 5.972 4.037 2.009 0.417 0.358
21220 219.649 484.258 72.882 165.188 25.518 13.841 7.904 0.917 0.273 0.087
SCOSEI_IV
1978 2000
1 1 0 1
1 12
325246 1703.941 14715.49 1385.952 850.971 201.993 47.998 22.999 20.999 8 3 2 1
316419 2522.256 8021.633 3257.039 382.887 344.898 66.98 43.987 18.994 11.996 3.999 0 1.999
297227 1067.994 5957.458 2341.237 828.826 144.37 89.579 33.049 14.785 8.697 4.349 0.87 0
289672 855.604 13328.76 2355.389 698.688 204.816 18.169 10.736 12.388 3.303 0 0 0
297730 4070.478 4794.063 6023.739 822.294 291.107 151.409 25.095 20.913 11.711 0.837 1.673 0.837
333168 1342.728 13320.38 1813.966 1289.703 227.494 98.353 39.341 18.815 15.394 2.566 4.276 0
388085 4839.125 9954.796 3783.95 453.752 381.259 108.292 46.539 25.954 6.265 7.16 3.58 1.79
382910 543.929 18367.311 2498.646 835.287 127.187 107.343 26.159 24.355 9.922 3.608 3.608 0
425017 5425.851 2656.135 6865.172 824.863 285.816 42.826 38.171 13.965 7.448 2.793 2.793 0
418536 1361.396 13452.12 680.241 1423.568 283.434 186.518 24.686 35.658 15.543 4.572 1.829 0.914
377132 842.968 7091.734 4631.826 201.992 471.982 131.995 55.998 15.999 10 3 3 4
355735 1684.028 3495.714 3173.118 1092.297 91.156 185.066 44.65 18.698 2.391 7.744 2.614 0.591
270869 379.134 12625.37 1096.54 671.531 291.604 38.807 50.407 11.534 3.699 1.793 0.1 0.275
336675 1708.483 4746.648 2986.177 241.37 173.924 113.164 32.981 25.229 7.592 0.57 0.391 0.142
300217 1056.525 4120.136 942.427 618.214 97.903 59.252 31.805 8.852 8.416 3.235 0.997 1.477
268413 259.816 5561.367 776.714 208.932 142.388 26.401 19.572 9.165 2.347 0.806 0.543 0.077
264738 1172.846 3129.865 2378.035 301.222 60.54 37.716 13.282 5.077 2.267 0.873 0.537 1.072
204545 743.283 8029.209 912.815 496.574 84.516 21.557 16.616 0.914 0.967 0.903 1.267 0.22
177092 303.656 3696.333 2598.453 239.201 165.108 19.699 8.662 5.688 1.849 1.188 0.488 0.145
166817 740.271 2267.133 1581.46 687.769 118.726 71.214 17.325 6.006 2.108 0.85 0.73 0
150361 71.553 5692.333 1088.959 423.297 287.297 46.103 29.685 4.187 0.993 0.803 0.253 0
93796 366.94 540.985 2740.379 140.141 88.419 37.97 10.232 7.249 2.031 0.067 0.056 0.05
83360 468.892 2180.847 124.701 446.832 63.082 27.679 11.712 5.647 1.903 0.18 0.135 0
SCOLTR_IV
1978 2000
1 1 0 1
1 11
236929 2255.601 5379.048 670.881 269.952 50.991 27.995 6.999 7.999 4.999 0 1
207494 1973.132 5845.391 1808.121 178.012 61.004 15.001 3 4 2 0 0
333197 1849.47 5356.235 2100.709 549.199 71.405 15.868 4.408 3.526 0.882 0 0
251504 690.987 5236.821 1474.781 293.606 81.839 10.968 5.906 0 0 0 0.844
250870 4703.856 2940.357 2301.849 377.382 109.995 39.348 8.048 6.26 3.577 5.366 0
244349 1321.201 6293.185 1020.032 459.821 111.146 31.372 14.341 5.378 2.689 0.896 0.896
240725 2723.57 3022.983 1543.958 180.369 85.675 36.074 9.92 7.215 2.706 0 0
268136 430.874 5959.05 865.407 293.653 39.337 21.041 3.659 2.744 0.915 0.915 0
279767 4140.451 1166.751 1847.672 250.965 95.651 12.311 8.523 4.735 1.894 0.947 0
351131 2045.224 5662.771 530.278 468.273 45.347 31.465 10.18 5.553 0.925 0.925 0
391988 403.133 3300.276 1912.375 133.375 148.417 33.093 14.039 2.006 1.003 0 1.003
405883 1574.048 1205.534 1594.526 565.712 48.605 45.236 13.343 3.382 0.894 0.257 1.048
398153 327.094 5739.588 523.696 456.829 179.523 25.746 11.324 3.712 0.999 0.128 0.016
408056 1821.11 1904.532 2125.128 138.039 94.188 48.099 8.199 8.482 1.206 0.028 0
473955 1401.577 2749.504 747.952 646.729 44.077 36.368 11.912 2.053 2.02 0.22 0.123
447064 250.643 4891.675 1262.363 163.983 80.122 9.885 5.161 3.794 0.416 0.211 0.21
480400 722.752 1924.201 2364.757 370.592 47.312 42.371 5.792 2.346 0.3 0.224 0.145
442010 879.046 5807.931 1579.502 797.169 73.989 8.577 6.861 0.637 0.882 0.554 0.114
445995 448.536 4060.709 3048.116 424.148 296.499 31.73 9.559 5.477 1.111 0.798 0.114
479449 1477.022 2931.063 2805.271 808.326 112.982 114.511 10.293 0.947 1.937 3.068 1.069
427868 249.668 8389.377 1575.674 675.569 193.144 36.465 31.481 2.838 0.227 0.234 0.101
329750 791.7 996.744 3346.956 299.828 160.479 45.768 13.62074 7.653232 1.843825 0.6303847 4.13E-02
271687 1710.068 2440.12 364.6718 874.5258 68.56299 35.38103 8.090366 5.817904 3.063802 0.0925073 5.03E-02
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Table 3.4.1 (Continued)

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ENGTRL_IV
1978 2000
1 1 0 1
1 12
559930 2029 10576 1093 987 338 117 57 60 22 4 1 5
553020 1329 7698 3341 393 403 99 54 15 30 7 0 0
442036 1881 3786 2106 865 122 114 38 16 6 8 3 0
423658 615 12703 1886 535 250 38 48 8 6 4 2 0
424272 4074 3063 3802 587 298 179 35 24 11 2 0 0
392364 711 14220 1185 907 127 87 49 16 4 2 1 0
358387 3469 3459 2656 267 217 42 32 16 3 3 0 0
342844 675 8212 1047 533 72 54 16 10 4 1 1 0
288867 9097 2107 2388 209 161 15 12 4 2 2 0 0
275899 447 10435 682 596 36 26 3 4 2 1 1 0
296092 1173 2102 2428 90 126 17 10 0 2 0 0 0
310444 985 1958 718 501 25 34 5 4 0 0 0 0
255314 573 3101 513 134 101 11 13 4 1 0 0 0
258037 880 1559 1092 88 25 17 2 2 0 0 0 0
223702 1463 2171 481 234 19 5 5 0 0 0 0 0
209869 580 4054 442 96 55 5 3 2 0 1 0 0
184764 1264.802 2454.287 1146.382 78.19 14.284 7.036 1.762 0.673 0.847 0.023 0.063 0.002
173463 821.392 3799.572 871.882 158.03 11.028 2.992 1.896 0.662 0.132 0.247 0.048 0
159155 659.758 3179.345 1646.846 189.238 43.97 6.812 1.649 1.464 0.552 0.155 0.003 0.008
152030 828.414 2752.811 890.25 334.563 41.12 14.836 2.063 0.781 0.286 0.084 0.173 0.002
161478 174.05679 12750.6897 1722.7071 243.06975 77.41815 12.37263 4.03332 0.80703 0.32574 0.08601 0 0
137699 744.618 675.661 1951.433 97.058 11.516 3.962 0.446 0.319 0.043 0.015 0 0
127719 636.389 1640.628 154.424 143.879 10.037 1.254 0.256 0.166 0.072 0.029 0 0.025
DENGIL_IV
1987 2000
1 1 0 1
1 11
7597 1 754.8 294.3 625.8 192.1 135.7 40.1 22 2.9 1 1
8625.5 6.8 240.4 1296.6 376.7 254.1 99.3 41.9 10.7 4.9 2.9 1.9
8339.5 10.7 291.8 473.2 570.1 184.2 121.2 29.1 13.6 1.9 1 0
8117.832999 0 262 613.2 426 247.4 45.6 29.1 1 9.7 1 1
11025 52.8 448.5 631.3 291.1 134.7 115.9 25.4 13.2 1.9 1.9 2.8
12904.499 121.4 742.6 484.8 453.3 154.8 55.6 42.6 5.6 1.9 2.8 0.9
14045.99799 12.4 1072.1 976.5 301 168.2 51.6 22.9 11.5 2.9 1 1.9
16917.333 96.8 850 1410.7 374.1 143.7 89.8 25.9 7 2 1 2
15548.499 119.5 1784.4 812.1 491.5 131.1 64.1 33 12.6 1.9 0 0
14505.499 47.1 1197 1858.5 497.8 224.9 85.6 36.7 16 8.5 0.9 0.9
13649.499 18.1 740.7 1673.3 904 180.4 82.1 26.7 5.7 1 1 1.9
13826.333 4.7 1563.1 1353.5 718.9 407.8 101.5 34.1 5.7 4.7 0 3.8
14050 0.9 136.3 2123.2 745.9 226.2 117.4 66.3 20.8 0.9 2.8 0.9
11286.999 55.38464627 718.0570805 445.9921515 832.7130149 158.3806551 79.67615779 16.51822783 0.971660461 0 0 0
ENGSEI_IV
1978 2000
1 1 0 1
1 12
203382 898 12831 746 547 131 78 21 37 9 1 1 2
187180 1718 7004 2438 162 280 76 35 14 18 4 1 0
201169 2111 7760 1370 611 146 210 54 29 9 12 4 0
185423 343 12689 1053 398 359 61 74 12 8 6 3 0
183209 1486 3191 2473 330 294 189 38 31 9 3 2 0
177004 566 4741 573 557 207 150 104 18 17 8 3 2
167699 1232 1513 1215 147 290 72 50 32 6 5 1 0
157815 125 3242 326 241 72 117 40 27 13 4 2 0
136358 890 312 572 65 139 34 52 13 7 7 2 1
123281 262 2395 82 184 44 77 10 22 8 2 1 0
91178 297 879 594 19 80 19 12 3 3 1 0 0
88782 343 748 216 138 9 46 7 8 1 2 0 1
80537 176 1009 116 45 58 4 15 3 1 1 0 0
84346 129 262 207 33 26 38 6 16 1 1 1 0
67810 408 463 57 42 10 8 8 2 3 0 0 0
54574 44 497 41 19 22 4 3 2 0 1 0 0
39667 163.456 265.085 138.494 11.373 17.04 14.114 3.077 0.889 0.519 0.07 0.278 0.071
28406 91.043 444.628 83.186 21 5.216 3.742 5.623 3.043 0.608 0.162 0.755 0.085
14991 18.371 196.618 166.98 19.592 16.881 4.434 1.542 1.136 0.148 0.24 0 0
11823 23.43 76.342 35.304 27.906 6.115 5.284 1.7 0.333 0.357 0.26 0.024 0.001
10664 0.873 283.247 34.087 9.666 11.58 3.732 2.002 0.382 0.126 0.105 0 0
9720 60.374 31.308 89.091 2.902 1.297 0.928 0.329 7.30E-02 0.013 0.014 0 0
12030 26.354 60.451 2.275 7.197 0.765 0.853 0.438 1.15E-01 0.166 0.001 0 0.008
SCOGFS_IV
1982 2000
1 1 0.5 0.75
1 6
100 0.614 0.351 0.571 0.181 0.092 0.06
100 0.325 0.781 0.181 0.197 0.075 0.023
100 0.82 0.39 0.254 0.05 0.057 0.016
100 0.066 1.142 0.196 0.112 0.03 0.024
100 0.801 0.105 0.396 0.058 0.04 0.019
100 0.219 0.749 0.034 0.092 0.029 0.007
100 0.163 0.288 0.165 0.026 0.033 0.012
100 0.562 0.135 0.169 0.094 0.02 0.008
100 0.114 0.491 0.059 0.074 0.026 0.009
100 0.303 0.154 0.133 0.013 0.006 0.004
100 0.643 0.193 0.072 0.067 0.029 0.018
100 0.347 0.749 0.101 0.025 0.011 0.003
100 1.158 0.334 0.288 0.031 0.012 0.007
100 0.475 1.443 0.13 0.085 0.011 0.007
100 0.318 0.356 0.542 0.074 0.034 0.004
100 0.999 0.278 0.224 0.102 0.022 0.01
100 0.104 2.134 0.116 0.057 0.037 0.008
100 0.44 0.103 0.616 0.027 0.01 0.006
100 0.7 0.237 0.028 0.044 0 0.008
```

Table 3.4.1 (Continued)

ENGGFS_IV						
1977	2000					
1	1	0.5	0.75			
1	5					
100	6.269	0.448	0.323	0.058	0.011	
100	2.284	1.25	0.098	0.099	0.013	
100	2.423	0.58	0.2	0.027	0.036	
100	5.084	0.67	0.153	0.073	0.011	
100	1.136	1.387	0.127	0.039	0.04	
100	3.238	0.29	0.329	0.053	0.038	
100	1.539	1.096	0.12	0.111	0.028	
100	6.122	0.474	0.178	0.04	0.021	
100	0.43	1.189	0.107	0.056	0.021	
100	3.438	0.115	0.202	0.029	0.011	
100	1.422	1.065	0.027	0.061	0.014	
100	0.836	0.407	0.199	0.001	0.043	
100	2.285	0.248	0.119	0.061	0.006	
100	0.608	0.503	0.06	0.014	0.012	
100	0.752	0.155	0.072	0.013	0.003	
100	2.441	0.158	0.046	0.035	0.008	
100	0.742	0.651	0.082	0.015	0.017	
100	2.637	0.295	0.154	0.019	0.005	
100	1.028	1.277	0.119	0.056	0.002	
100	0.619	0.668	0.162	0.019	0.02	
100	4.044	0.284	0.054	0.025	0.001	
100	0.118	1.396	0.082	0.008	0.007	
100	0.367	0.055	0.236	0.013	0.006	
100	0.953	0.197	0.015	0.032	0	
IBTS_Q1_IV						
1976	2000					
1	1	0	0.25			
1	5					
1	7.9	19.9	-1	-1	-1	-1
1	36.7	3.2	-1	-1	-1	-1
1	12.9	29.3	-1	-1	-1	-1
1	9.9	9.3	-1	-1	-1	-1
1	16.9	14.8	-1	-1	-1	-1
1	2.9	25.5	-1	-1	-1	-1
1	9.2	6.7	-1	-1	-1	-1
1	3.9	16.6	2.7	1.8	0.8	1.5
1	15.2	8	3.9	0.9	1	0.9
1	0.9	17.6	3.5	1.7	0.5	1
1	17	3.6	6.8	2.3	1.3	1.1
1	8.8	28.8	1.4	1.7	0.6	0.9
1	3.6	6.1	5.8	0.6	0.9	1.1
1	13.1	6.3	5	2.3	0.4	1
1	3.4	15.2	2	1	1	0.8
1	2.4	4.1	3.4	0.8	0.4	0.8
1	13	4.5	1.2	1	0.3	0.5
1	12.7	19.9	2	0.7	0.6	0.4
1	14.8	4.4	3	0.8	0.5	0.5
1	9.7	22.1	2.8	1.1	0.3	0.3
1	3.5	8	6	0.7	0.6	0.4
1	40	6.9	2.3	1.1	0.4	0.4
1	2.7	26.4	2	0.9	0.5	0.4
1	2.1	1.6	8.1	0.8	0.5	0.5
1	6.6	3.8	0.7	2	0.4	0.5

Table 3.4.2. Cod in Sub-area IV and Divisions IIIa and VIId. XSA tuning output.

Lowestoft VPA Version 3.1

22/06/2001 12:58

Extended Survivors Analysis

Cod North Sea/Skaggerak/Eastern Channel 7/6/2001

CPUE data from file CODIVEF.TUN

Catch data for 38 years. 1963 to 2000. Ages 1 to 11.

Fl	First year	Last year	First age	Last age	Alpha	Beta
SCOTRL_	1978	2000	1	10	0	1
SCOSEI_	1978	2000	1	10	0	1
SCOLTR_	1978	2000	1	10	0	1
ENGTRL_	1978	2000	1	10	0	1
DENGIL_	1987	2000	1	10	0	1
ENGSEI_	1978	2000	1	10	0	1
SCOGFS_	1982	2000	1	6	0.5	0.75
ENGGFS_	1977	2000	1	5	0.5	0.75
IBTS_Q1	1976	2000	1	5	0	0.25

Time series weights :

Tapered time weighting applied
Power = 3 over 20 years

Catchability analysis :

Catchability dependent on stock size for ages < 4

Regression type = C
Minimum of 5 points used for regression
Survivor estimates shrunk to the population mean for ages < 4

Catchability independent of age for ages >= 5

Terminal population estimation :

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

S.E. of the mean to which the estimates are shrunk = .500

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

Prior weighting applied :

Fleet	Weight
SCOTRL_I	.00
SCOSEI_I	.00
SCOLTR_I	.00
ENGTRL_I	.00
DENGIL_I	.00
ENGSEI_I	.00
SCOGFS_I	1.00
ENGGFS_I	1.00
IBTS_Q1_	1.00

Tuning converged after 18 iterations

1

Regression weights

0.751	0.82	0.877	0.921	0.954	0.976	0.99	0.997	1	1

Fishing mortalities

Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	0.127	0.145	0.05	0.074	0.109	0.043	0.088	0.027	0.066	0.057
2	0.764	0.85	0.81	0.65	0.823	0.653	0.628	0.823	0.48	0.624
3	0.965	0.85	1.023	1.033	1.003	1.005	0.995	1.158	1.14	0.802
4	0.845	0.936	0.959	0.929	0.84	0.753	0.924	1.149	1.05	0.792
5	0.838	0.733	0.906	0.768	0.668	0.829	0.768	1.16	1.015	0.85
6	0.934	0.834	0.779	0.898	0.625	0.859	0.901	0.867	1.192	0.838
7	1.106	0.893	1.08	0.635	0.724	0.912	1.019	0.919	1.337	0.983
8	1.067	0.843	0.868	1.12	0.385	1.414	0.762	0.868	1.236	0.938
9	0.57	1.086	0.807	0.694	1.025	0.88	0.963	0.632	0.894	0.883
10	0.913	0.883	0.898	0.831	0.698	0.989	0.904	0.898	1.139	0.91

XSA population numbers (Thousands)

	AGE									
YEAR	1	2	3	4	5	6	7	8	9	10
1991	1.69E+05	5.23E+04	3.07E+04	6.41E+03	2.71E+03	1.92E+03	3.71E+02	2.35E+02	7.07E+01	7.74E+00
1992	3.05E+05	6.67E+04	1.72E+04	9.11E+03	2.26E+03	9.59E+02	6.16E+02	1.01E+02	6.61E+01	3.28E+01
1993	1.47E+05	1.19E+05	2.01E+04	5.71E+03	2.93E+03	8.88E+02	3.41E+02	2.07E+02	3.55E+01	1.83E+01
1994	3.24E+05	6.30E+04	3.72E+04	5.63E+03	1.79E+03	9.68E+02	3.33E+02	9.47E+01	7.10E+01	1.30E+01
1995	2.27E+05	1.35E+05	2.32E+04	1.03E+04	1.82E+03	6.81E+02	3.23E+02	1.45E+02	2.53E+01	2.90E+01
1996	1.73E+05	9.14E+04	4.18E+04	6.62E+03	3.65E+03	7.64E+02	2.98E+02	1.28E+02	8.06E+01	7.43E+00
1997	4.22E+05	7.45E+04	3.35E+04	1.19E+04	2.55E+03	1.30E+03	2.65E+02	9.81E+01	2.55E+01	2.74E+01
1998	6.95E+04	1.74E+05	2.80E+04	9.66E+03	3.87E+03	9.71E+02	4.33E+02	7.83E+01	3.75E+01	7.98E+00
1999	1.39E+05	3.04E+04	5.37E+04	6.86E+03	2.51E+03	9.93E+02	3.34E+02	1.41E+02	2.69E+01	1.63E+01
2000	2.15E+05	5.86E+04	1.33E+04	1.34E+04	1.96E+03	7.44E+02	2.47E+02	7.18E+01	3.36E+01	9.01E+00

Table 3.4.2 (Continued)

Estimated population abundance at 1st Jan 2001

0.00E+009.13E+042.21E+044.63E+034.96E+036.88E+022.63E+027.56E+012.30E+011.14E+01

Taper weighted geometric mean of the VPA populations:

2.05E+058.50E+042.92E+048.82E+032.80E+031.05E+033.92E+021.39E+025.16E+011.91E+01

Standard error of the weighted Log(VPA populations) :

0.5335 0.5347 0.4608 0.3629 0.3671 0.3697 0.3813 0.5064 0.6101 0.781
1

Log catchability residuals.

Fleet : SCOTRL_IV

Age	1976	1977	1978	1979	1980
1	99.99	99.99	99.99	99.99	99.99
2	99.99	99.99	99.99	99.99	99.99
3	99.99	99.99	99.99	99.99	99.99
4	99.99	99.99	99.99	99.99	99.99
5	99.99	99.99	99.99	99.99	99.99
6	99.99	99.99	99.99	99.99	99.99
7	99.99	99.99	99.99	99.99	99.99
8	99.99	99.99	99.99	99.99	99.99
9	99.99	99.99	99.99	99.99	99.99
10	99.99	99.99	99.99	99.99	99.99

Age	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
1	-0.69	0.63	0.05	0.47	0.3	0.3	1.31	-0.62	0.16	-0.42
2	-0.83	-0.77	0.12	0.4	-0.09	-0.05	-0.29	0.24	-1.45	0.58
3	-0.56	-0.88	-0.35	-0.24	-0.17	-0.35	-0.61	-0.67	0.21	-0.78
4	-0.51	-0.76	-0.56	-0.53	-0.24	-0.98	-0.71	-1.12	-0.22	0.03
5	-0.32	-1.01	-0.52	-0.75	-0.46	-0.73	-0.42	-0.67	-0.51	-0.7
6	-0.1	-1.36	-0.62	-0.34	-1.08	-1.59	-1.33	0.05	-0.65	-0.38
7	-0.56	-0.78	-1.54	-1.71	-0.38	-1.53	99.99	-0.66	0.17	-0.24
8	-0.37	-1.38	99.99	-1	-0.86	99.99	-0.49	0.83	-1.06	-0.39
9	-0.09	-0.14	99.99	99.99	-0.1	99.99	99.99	99.99	1.69	99.99
10	0.38	99.99	0.9	99.99	99.99	99.99	99.99	99.99	-0.51	99.99

Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	0.6	0.41	-1.65	-0.03	-0.5	-1.65	-0.38	0.71	0.66	1.57
2	0.15	0.19	-0.26	-1.01	-0.11	-0.09	-0.33	0.56	0.21	1.08
3	0.15	-0.04	-0.17	0	0.17	-0.12	0.02	0.11	0.69	0.36
4	-0.77	0.6	-1.05	-0.55	0.33	0.29	-0.04	0.77	0.45	1.09
5	0.32	-1.13	0.32	-0.85	-1.16	0.79	0.08	0.53	1.1	1.49
6	-0.7	-0.18	-0.84	-0.21	-1.37	0.11	0.29	0.66	0.74	1.85
7	-0.25	-2.02	-2.2	-0.42	-0.44	-0.99	0.53	0.8	1.5	2.45
8	99.99	-1.62	-5.8	0.71	-2.51	0.62	-0.53	0.95	1.62	1.51
9	-1.67	-0.53	99.99	99.99	-1.06	-4.3	-1.55	-2.59	1.57	1.03
10	99.99	99.99	99.99	99.99	0.97	0.27	99.99	1.81	2.01	1.22

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

Age	4	5	6	7	8	9	10
Mean Lo	-14.9881	-15.318	-15.318	-15.318	-15.318	-15.318	-15.318
S.E(Log	0.6929	0.8789	0.9191	1.3525	2.1478	2.2137	1.478

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Interce	RSquare	No Pts	Reg s.e	Mean Log q
1	1.11	-0.195	18.49	0.23	20	1.01	-17.86
2	0.94	0.174	15.18	0.43	20	0.65	-15.44
3	0.72	1.072	13.61	0.6	20	0.39	-14.88

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

Age	Slope	t-value	Interce	RSquare	No Pts	Reg s.e	Mean Q
4	0.58	1.274	12.53	0.48	20	0.39	-14.99
5	0.96	0.052	15.04	0.16	20	0.89	-15.32
6	3.79	-0.99	38.98	0.01	20	3.47	-15.41
7	-1.63	-1.632	-9.52	0.04	19	2.05	-15.45
8	-1.04	-1.517	-6.49	0.06	17	2.05	-15.77
9	-4.21	-0.882	-48.68	0	12	8.53	-16.22
10	1.83	-0.819	23.82	0.22	8	1.67	-14.24

1

Fleet : SCOSEI_IV

Age	1976	1977	1978	1979	1980
1	99.99	99.99	99.99	99.99	99.99
2	99.99	99.99	99.99	99.99	99.99
3	99.99	99.99	99.99	99.99	99.99
4	99.99	99.99	99.99	99.99	99.99
5	99.99	99.99	99.99	99.99	99.99
6	99.99	99.99	99.99	99.99	99.99
7	99.99	99.99	99.99	99.99	99.99
8	99.99	99.99	99.99	99.99	99.99
9	99.99	99.99	99.99	99.99	99.99
10	99.99	99.99	99.99	99.99	99.99

Table 3.4.2 (Continued)

Age	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
1	-0.38	0.2	-0.15	0.17	-0.29	0.02	-0.18	-0.11	0.15	-0.11
2	-0.49	-0.48	-0.14	-0.03	0.03	-0.73	-0.51	-0.18	-0.43	0.7
3	-0.63	-0.51	-0.26	-0.42	-0.19	-0.19	-0.37	-0.51	0.13	0.01
4	-0.57	-0.32	-0.2	-0.47	-0.48	-0.13	-0.01	-0.91	-0.14	0.34
5	-1.16	-0.51	-0.67	-0.54	-0.77	-0.65	-0.14	0.04	-0.65	-0.1
6	-2.06	-0.52	-0.73	-0.59	-0.87	-1	0.04	0.18	0.21	-0.35
7	-2.13	-0.9	-0.96	-0.72	-1.07	-1.06	-0.48	-0.01	0.23	0.24
8	-0.7	-0.58	-0.27	-0.59	-0.52	-0.84	-0.09	0.23	-0.02	0.11
9	-1.05	0.09	-0.13	-0.41	-0.66	-1.05	0.27	-0.27	-0.67	0.22
10	99.99	-1.49	-0.56	-0.15	0.07	-1.17	-0.67	-0.34	0.5	0.35

Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	0.69	-0.19	-0.53	-0.09	0.12	-0.24	-0.35	-0.36	0.65	0.51
2	0.22	-0.01	-0.21	-0.18	0.28	0	-0.22	0	-0.21	0.65
3	0.11	0.08	-0.09	-0.06	0.01	0.09	0.06	0.13	0.26	-0.09
4	-0.69	0.05	-0.44	-0.06	0.05	-0.13	0.48	0.39	0.06	0.57
5	-0.18	-0.5	-0.2	-0.61	-0.08	0.11	0.17	0.9	0.57	0.53
6	-0.22	-0.1	-0.75	-0.41	-0.48	-0.44	0.39	0.34	0.72	0.67
7	0.25	-0.26	0.03	-0.5	0.05	-0.3	0.62	0.73	0.56	0.97
8	0.43	0.25	-0.31	-0.01	-2.2	0.32	0.44	0.46	1.03	1.46
9	0.22	0.72	0.06	-0.7	-0.12	-0.55	0.83	-0.35	1.28	1.11
10	-0.01	0.38	-0.3	0.11	-0.46	1.44	-0.18	1.1	-1.53	0.08

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

Age	4	5	6	7	8	9	10
Mean Lo	-14.8409	-14.8189	-14.8189	-14.8189	-14.8189	-14.8189	-14.8189
S.E(Log	0.4056	0.4877	0.5188	0.5558	0.8976	0.7156	0.7911

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Interce	RSquare	No Pts	Reg s.e	Mean Log q
1	0.8	0.843	16.63	0.65	20	0.41	-17.7
2	0.96	0.169	14.71	0.69	20	0.37	-14.83
3	0.56	3.525	12.79	0.87	20	0.19	-14.74

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

Age	Slope	t-value	Interce	RSquare	No Pts	Reg s.e	Mean Q
4	0.64	1.847	12.77	0.72	20	0.24	-14.84
5	0.85	0.415	13.81	0.44	20	0.43	-14.82
6	0.98	0.046	14.72	0.35	20	0.53	-14.87
7	4.2	-2.035	42.61	0.04	20	2	-14.69
8	3.2	-1.354	36.15	0.04	20	2.74	-14.69
9	2.68	-2.064	32.73	0.13	20	1.65	-14.68
10	1.8	-1.551	24.29	0.27	19	1.34	-14.8

1

Fleet : SCOLTR_IV

Age	1976	1977	1978	1979	1980
1	99.99	99.99	99.99	99.99	99.99
2	99.99	99.99	99.99	99.99	99.99
3	99.99	99.99	99.99	99.99	99.99
4	99.99	99.99	99.99	99.99	99.99
5	99.99	99.99	99.99	99.99	99.99
6	99.99	99.99	99.99	99.99	99.99
7	99.99	99.99	99.99	99.99	99.99
8	99.99	99.99	99.99	99.99	99.99
9	99.99	99.99	99.99	99.99	99.99
10	99.99	99.99	99.99	99.99	99.99

Age	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
1	-0.15	0.89	0.42	0.48	0.05	0.56	0.63	-0.52	0.3	-0.35
2	-0.46	0.04	0.21	0.1	0.08	-0.25	-0.36	-0.12	-0.69	0.39
3	-0.4	-0.43	-0.04	-0.21	-0.3	-0.24	-0.28	-0.63	0.01	-0.51
4	-0.71	-0.34	-0.34	-0.33	-0.59	-0.32	-0.36	-0.78	-0.35	0.15
5	-0.98	-0.36	-0.11	-0.6	-0.63	-0.36	-0.83	-0.19	-0.45	-0.01
6	-1.46	-0.74	-0.61	-0.25	-1.18	-0.87	-0.61	-0.28	-0.37	-0.19
7	-1.63	-0.9	-0.7	-0.83	-1.72	-1.18	-0.23	-0.47	-0.15	-0.68
8	99.99	-0.65	-0.25	-0.44	-1.39	-0.54	-0.81	-0.93	-0.9	-0.45
9	99.99	0.03	-0.6	0.19	-1.73	-1.04	-1.42	-1.64	-0.83	-0.52
10	99.99	1.5	-0.34	99.99	0.01	-0.88	-1.13	99.99	-2.08	-1.72

Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	0.91	-0.04	-0.81	-0.72	-0.11	-0.46	-0.35	-0.04	0.53	0.94
2	0.03	0.02	0.01	-0.34	0.05	0.04	-0.13	0.16	0.07	0.46
3	0.2	-0.17	0.17	-0.01	0.2	0.11	0.21	0.08	0.21	-0.05
4	-0.86	0.22	-0.61	0.13	0.34	0.11	0.16	0.4	0.15	0.64
5	-0.02	-0.8	-0.33	-0.49	-0.02	0.73	0.03	0.42	0.87	0.39
6	-0.31	-0.09	-1.28	0.07	-1.21	0.07	0.77	0.02	0.61	0.7
7	-0.37	-0.74	-0.85	-0.97	-0.65	-0.17	0	0.7	0.55	0.38
8	0.11	-0.71	-0.74	-0.41	-2.37	0.32	-1.5	-0.02	0.79	1.27
9	-0.85	-0.2	-1.22	-2.36	-0.03	-1.02	0.65	-1.91	0.89	1.36
10	-2.26	-1.8	-1.19	-0.89	-0.76	1.08	1.01	-0.22	0.41	-0.81

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

Age	4	5	6	7	8	9	10
Mean Lo	-15.4226	-15.7788	-15.7788	-15.7788	-15.7788	-15.7788	-15.7788
S.E(Log	0.448	0.5213	0.6837	0.6684	1.0718	1.2843	1.284

Table 3.4.2 (Continued)

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Interce	RSquare	No Pts	Reg s.e	Mean Log q
1	0.88	0.349	17.33	0.46	20	0.61	-18.02
2	0.91	0.535	15.34	0.79	20	0.29	-15.71
3	0.77	1.375	14.15	0.78	20	0.26	-15.32

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

Age	Slope	t-value	Interce	RSquare	No Pts	Reg s.e	Mean Q
4	0.73	1	13.71	0.58	20	0.33	-15.42
5	0.86	0.352	14.72	0.4	20	0.47	-15.78
6	1.13	-0.197	17.05	0.19	20	0.79	-15.91
7	3.41	-1.59	40.41	0.04	20	1.93	-16.06
8	2.09	-0.889	28.52	0.06	19	2.07	-16.19
9	-29.46	-2.112	****	0	19	29.27	-16.35
10	1.51	-0.74	23.3	0.18	17	1.69	-16.42
1							

Fleet : ENGTRL_IV

Age	1976	1977	1978	1979	1980
1	99.99	99.99	99.99	99.99	99.99
2	99.99	99.99	99.99	99.99	99.99
3	99.99	99.99	99.99	99.99	99.99
4	99.99	99.99	99.99	99.99	99.99
5	99.99	99.99	99.99	99.99	99.99
6	99.99	99.99	99.99	99.99	99.99
7	99.99	99.99	99.99	99.99	99.99
8	99.99	99.99	99.99	99.99	99.99
9	99.99	99.99	99.99	99.99	99.99
10	99.99	99.99	99.99	99.99	99.99

Age	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
1	-1.47	-0.14	-1.26	-0.09	-0.47	0.98	-1.23	0.08	-0.5	-0.14
2	-0.77	-0.92	-0.13	-0.68	-0.47	-0.25	-0.24	-0.79	-0.5	-0.33
3	-0.77	-0.68	-0.42	-0.31	-0.46	-0.29	-0.01	-0.45	-0.5	-0.27
4	-0.44	-0.23	0.06	-0.14	-0.04	-0.34	0.32	-0.69	-0.01	-0.43
5	0.04	0.54	-0.03	0.36	0.16	0.55	-0.4	0.35	-0.42	0.28
6	-0.32	0.68	0.36	-0.07	-0.06	-0.28	-0.13	-0.24	0.03	-0.17
7	0.37	0.46	0.48	0.37	-0.06	-0.45	-0.79	-0.11	-0.44	0.33
8	-0.14	0.59	0.79	0.39	0.09	-0.32	-0.47	99.99	-0.04	0.5
9	0.55	1.05	-0.25	0.32	-0.08	-0.59	0.02	-0.25	99.99	0.35
10	0.61	0.41	0.42	0.44	0.28	0.26	-0.39	99.99	99.99	99.99

Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	0.06	0.15	-0.06	0.11	0.1	0.2	-0.38	-0.3	0.7	0.18
2	-0.23	-0.05	-0.07	0.2	-0.09	0.16	0.28	0.72	0.04	0.23
3	-0.11	-0.02	-0.15	-0.03	0.3	0.2	0.03	0.66	0.2	-0.17
4	-0.65	0.16	-0.2	-0.27	-0.15	0.53	0.63	0.55	0.09	-0.21
5	-0.47	-0.46	0.48	-0.31	-0.56	0.28	0.59	0.9	-0.47	-0.35
6	-0.47	-0.9	-0.78	-0.35	-0.9	-0.01	0.3	0.34	-0.54	-1.47
7	-0.9	-0.43	-0.21	-0.78	-0.57	-0.47	-0.04	0.04	-1.58	-1.89
8	-0.46	99.99	-0.2	-0.28	-0.97	0.45	-0.12	0.12	-1.09	-1.11
9	99.99	99.99	99.99	0.06	-0.57	-0.27	0.31	-0.15	-1.57	-1.21
10	99.99	99.99	1.54	-1.79	-0.21	0.89	-1.01	0.18	-2.03	-0.79

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

Age	4	5	6	7	8	9	10
Mean Lo	-15.6203	-16.2032	-16.2032	-16.2032	-16.2032	-16.2032	-16.2032
S.E(Log	0.4148	0.5111	0.6709	0.8743	0.6514	0.7619	1.2296

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Interce	RSquare	No Pts	Reg s.e	Mean Log q
1	1.05	-0.179	17.58	0.61	20	0.45	-17.35
2	0.83	0.812	14.45	0.69	20	0.38	-15.09
3	0.68	1.538	13.56	0.69	20	0.32	-15.11

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

Age	Slope	t-value	Interce	RSquare	No Pts	Reg s.e	Mean Q
4	0.74	1.005	13.94	0.6	20	0.31	-15.62
5	0.52	2.829	12.23	0.77	20	0.21	-16.2
6	0.61	1.549	12.85	0.61	20	0.31	-16.59
7	0.54	1.81	11.85	0.61	20	0.32	-16.77
8	0.87	0.412	15.03	0.54	18	0.52	-16.51
9	0.74	1.085	13.26	0.71	16	0.48	-16.58
10	1.05	-0.084	17.27	0.29	15	1.31	-16.57
1							

Table 3.4.2 (Continued)

Fleet : DENGIL_IV

Age	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
1	99.99	99.99	99.99	99.99	99.99	99.99	-1.93	-0.4	-0.43	99.99
2	99.99	99.99	99.99	99.99	99.99	99.99	-0.47	-0.79	-0.21	-0.65
3	99.99	99.99	99.99	99.99	99.99	99.99	-0.3	-0.2	-0.35	0.24
4	99.99	99.99	99.99	99.99	99.99	99.99	0.06	0.38	-0.16	0.28
5	99.99	99.99	99.99	99.99	99.99	99.99	0.27	-0.01	0.6	0.04
6	99.99	99.99	99.99	99.99	99.99	99.99	0.52	0.46	0.33	0.11
7	99.99	99.99	99.99	99.99	99.99	99.99	0.81	0.27	0.35	-0.01
8	99.99	99.99	99.99	99.99	99.99	99.99	0.23	0.4	0.21	-2.03
9	99.99	99.99	99.99	99.99	99.99	99.99	-0.61	-0.41	-0.36	1.48
10	99.99	99.99	99.99	99.99	99.99	99.99	-1.38	0.2	-1	0.06

Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	0.91	0.75	-0.07	0.36	0.91	0.6	-0.85	0.05	-1.71	0.66
2	0.24	0.34	0.01	0.2	0.26	0.28	0.1	-0.01	-0.64	0.48
3	-0.38	-0.25	0.26	-0.17	-0.17	0.12	0.29	0.31	0.08	0.04
4	-0.2	-0.23	-0.24	-0.21	-0.49	-0.01	0.14	0.19	0.52	0.07
5	-0.22	-0.1	-0.29	-0.2	-0.27	-0.29	-0.12	0.43	0.2	0.24
6	0.01	-0.23	-0.33	0	-0.02	0.32	-0.17	0.31	0.54	0.52
7	0.2	-0.03	-0.07	-0.29	0.1	0.44	0.34	0.04	1.12	0.11
8	-0.01	-0.27	-0.34	-0.14	-0.2	0.65	-0.31	-0.06	0.78	-1.51
9	-0.95	-0.83	0.02	-1.28	-0.08	0.27	-0.62	0.39	-0.84	99.99
10	1.4	0.18	-0.35	-0.21	99.99	0.45	-0.72	99.99	0.89	99.99

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

Age	4	5	6	7	8	9	10
Mean Lo	-11.7255	-11.611	-11.611	-11.611	-11.611	-11.611	-11.611
S.E(Log	0.2878	0.2849	0.3408	0.443	0.7907	0.7885	0.7769

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Interce	RSquare	No Pts	Reg s.e	Mean Log q
1	0.65	0.57	16.12	0.23	13	0.96	-18.25
2	0.91	0.354	13.56	0.63	14	0.42	-13.78
3	0.98	0.134	12.21	0.77	14	0.26	-12.26

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

Age	Slope	t-value	Interce	RSquare	No Pts	Reg s.e	Mean Q
4	1.02	-0.07	11.78	0.6	14	0.31	-11.73
5	0.92	0.307	11.32	0.62	14	0.27	-11.61
6	0.98	0.064	11.38	0.56	14	0.31	-11.46
7	1.26	-0.528	12.83	0.3	14	0.49	-11.39
8	0.66	0.958	9.46	0.46	14	0.51	-11.81
9	0.96	0.088	11.6	0.39	13	0.74	-11.91
10	3.79	-2.514	35.46	0.11	11	2.24	-11.57
1							

Fleet : ENGSEI_IV

Age	1976	1977	1978	1979	1980
1	99.99	99.99	99.99	99.99	99.99
2	99.99	99.99	99.99	99.99	99.99
3	99.99	99.99	99.99	99.99	99.99
4	99.99	99.99	99.99	99.99	99.99
5	99.99	99.99	99.99	99.99	99.99
6	99.99	99.99	99.99	99.99	99.99
7	99.99	99.99	99.99	99.99	99.99
8	99.99	99.99	99.99	99.99	99.99
9	99.99	99.99	99.99	99.99	99.99
10	99.99	99.99	99.99	99.99	99.99

Age	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
1	-0.46	-0.17	-0.13	-0.19	-0.32	-0.44	-0.25	0.39	0.16	0.52
2	0.35	0.26	0.05	-0.28	-0.16	-0.75	-0.35	-0.09	0.19	0.14
3	-0.36	-0.39	-0.01	-0.14	-0.23	-0.43	-0.12	-0.42	-0.02	0.09
4	0.37	0.31	0.65	0.3	0.22	-0.48	0.22	-0.8	0.23	-0.09
5	0.47	0.6	0.49	0.64	0.17	0.39	-0.15	0.31	-0.95	0.12
6	0.22	0.81	0.94	0.47	0.73	0.53	1	0.28	0.83	-0.79
7	0.87	0.63	1.27	0.82	0.87	1.01	0.46	0.49	0.39	0.86
8	0.34	0.92	0.94	1.08	1.09	0.85	1.28	0.6	1.15	0.6
9	0.9	0.93	1.23	1.01	1.12	0.65	1.45	0.57	0.47	0.75
10	1.09	0.9	1.84	0.95	1.68	1.51	0.35	0.61	1.16	1.6

Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	0.05	0.34	-0.24	0.02	0.22	-0.14	-0.71	-0.96	1.12	0.02
2	-0.32	0.11	-0.24	0.08	0.08	0.26	-0.12	0.26	0.15	-0.09
3	-0.03	0.07	-0.11	-0.06	0.34	0.33	-0.03	0.21	0.02	-0.33
4	-0.24	-0.09	-0.19	-0.38	-0.08	0.9	0.97	0.32	-0.49	-0.57
5	-0.07	-0.67	0.15	0.64	-0.26	0.92	0.48	0.96	-0.76	-1.32
6	0.69	0.01	-0.42	1.13	0.37	1.16	1.06	1.09	-0.1	-0.25
7	0.56	0.47	0.38	0.56	1.56	1.07	1.56	1.3	0.01	0.25
8	1.98	0.88	0.39	0.77	1.61	1.8	0.82	1.33	-0.67	0.13
9	0.2	1.8	99.99	0.35	2.01	0.02	2.32	0.86	-0.88	1.23
10	2.56	99.99	2.13	0.11	0.42	2.93	1.91	2.34	-0.2	-2.55

Table 3.4.2 (Continued)

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

Age	4	5	6	7	8	9	10
Mean Lo	-15.897	-15.4428	-15.4428	-15.4428	-15.4428	-15.4428	-15.4428
S.E(Log	0.528	0.7273	0.7955	0.9428	1.1733	1.2934	1.9077

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Interce	RSquare	No Pts	Reg s.e	Mean Log q
1	0.64	1.12	15.97	0.49	20	0.57	-18.06
2	0.82	1.322	14.86	0.84	20	0.24	-15.63
3	0.43	3.711	12.68	0.81	20	0.23	-15.8

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

Age	Slope	t-value	Interce	RSquare	No Pts	Reg s.e	Mean Q
4	0.72	0.865	14.01	0.49	20	0.39	-15.9
5	0.5	1.882	11.67	0.58	20	0.33	-15.44
6	0.61	1.221	11.9	0.5	20	0.39	-15
7	1.06	-0.139	15.23	0.33	20	0.57	-14.69
8	0.78	0.636	12.44	0.45	20	0.58	-14.56
9	1.47	-0.666	19.55	0.18	19	1.4	-14.58
10	1.14	-0.196	16.05	0.17	19	1.88	-14.4
1							

Fleet : SCOGFS_IV

Age	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
1	99.99	-0.69	-0.61	-0.4	-1.26	-0.58	-0.79	-0.66	0.03	-0.6
2	99.99	-0.37	-0.43	-0.31	-0.19	-0.45	-0.6	-0.35	-0.43	-0.01
3	99.99	-0.39	-0.02	-0.35	-0.05	-0.16	-0.4	-0.79	0.04	-0.22
4	99.99	0.6	0.46	0	0.17	0.01	0.02	-0.31	0.03	0.46
5	99.99	0.66	0.66	0.14	0.35	0.09	0.24	-0.05	0.33	-0.29
6	99.99	0.9	0.25	0.08	0.2	0.87	-0.55	0.35	-0.4	0.37
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	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	-0.01	0.04	0.2	0.45	0.07	-0.04	0.06	-0.08	0.47	0.42
2	-0.05	-0.12	0.12	0.2	0.4	-0.13	-0.09	0.39	0.14	0.05
3	-0.13	0.08	0.17	0.12	0.16	0.34	0.08	-0.04	0.2	-0.18
4	-1.08	0.27	-0.24	-0.02	0.32	0.57	0.42	0.18	-0.28	-0.62
5	-1.09	0.61	-0.52	-0.02	-0.19	0.35	0.23	0.58	-0.39	99.99
6	-1.09	1.05	-0.7	0.13	0.32	-0.21	0.2	0.25	0.14	0.49
7	No data for this fleet at this age									
8	No data for this fleet at this age									
9	No data for this fleet at this age									
10	No data for this fleet at this age									

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

Age	4	5	6
Mean Lo	-15.9887	-15.8927	-15.8927
S.E(Log	0.4546	0.4788	0.5493

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Interce	RSquare	No Pts	Reg s.e	Mean Log q
1	0.85	0.651	16.45	0.64	19	0.42	-17.21
2	0.61	2.439	14.36	0.8	19	0.28	-16.26
3	0.54	2.684	13.38	0.77	19	0.26	-16.01

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

Age	Slope	t-value	Interce	RSquare	No Pts	Reg s.e	Mean Q
4	0.83	0.528	14.81	0.49	19	0.39	-15.99
5	0.88	0.32	14.93	0.43	18	0.44	-15.89
6	2.44	-1.396	28.58	0.08	19	1.27	-15.81
1							

Fleet : ENGGFS_IV

Age	1976	1977	1978	1979	1980
1	99.99	99.99	99.99	99.99	99.99
2	99.99	99.99	99.99	99.99	99.99
3	99.99	99.99	99.99	99.99	99.99
4	99.99	99.99	99.99	99.99	99.99
5	99.99	99.99	99.99	99.99	99.99
6	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				

Table 3.4.2 (Continued)

Age	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
1	-0.34	-0.41	-0.19	-0.03	-0.19	-0.51	-0.09	-0.01	0.19	0.19
2	-0.63	-0.46	-0.28	-0.19	-0.24	-0.31	-0.44	-0.13	-0.02	0
3	-0.5	-0.24	0.1	-0.16	-0.05	-0.13	-0.34	-0.28	0.19	0.06
4	-0.17	0.29	0.8	0.69	0.39	0.23	0.53	-2.65	0.51	-0.29
5	0.51	0.8	0.7	0.17	1.02	-0.18	0.54	1.24	0.16	-0.03
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	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	0.07	0.13	0.17	0.09	-0.06	-0.09	0.06	-0.09	-0.15	-0.07
2	0.03	-0.17	0.01	0.16	0.26	0.23	-0.04	0.06	-0.09	0
3	-0.17	0.07	0.35	0.15	0.44	0.05	-0.44	0.08	0.1	-0.41
4	-0.16	0.54	0.17	0.4	0.82	0.13	-0.07	-0.87	-0.1	-0.03
5	-0.75	0.35	0.95	0.13	-0.87	0.84	-1.84	-0.06	0.13	99.99
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	4	5
Mean Lo	-16.9053	-16.9196
S.E(Log	0.7168	0.8459

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Interce	RSquare	No Pts	Reg s.e	Mean Log q
1	0.55	5.264	14.46	0.93	20	0.15	-16.32
2	0.55	4.539	14.06	0.91	20	0.18	-16.29
3	0.64	1.911	14.31	0.74	20	0.29	-16.57

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

Age	Slope	t-value	Interce	RSquare	No Pts	Reg s.e	Mean Q
4	0.66	0.841	14.28	0.38	20	0.48	-16.91
5	0.57	1.067	13.03	0.4	19	0.47	-16.92
1							

Fleet : IBTS_Q1_IV

Age	1976	1977	1978	1979	1980
1	99.99	99.99	99.99	99.99	99.99
2	99.99	99.99	99.99	99.99	99.99
3	99.99	99.99	99.99	99.99	99.99
4	99.99	99.99	99.99	99.99	99.99
5	99.99	99.99	99.99	99.99	99.99
6	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	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
1	-1.06	-0.87	-0.87	-0.46	-1.24	-0.56	-0.12	-0.42	0.2	-0.08
2	-0.67	-0.48	-0.5	-0.38	-0.43	-0.21	-0.25	-0.39	0.02	0.2
3	99.99	99.99	-0.18	-0.39	-0.01	-0.05	-0.04	-0.35	0.38	0.07
4	99.99	99.99	-0.35	-0.09	-0.08	0.64	-0.09	-0.16	0.16	0.05
5	99.99	99.99	-0.24	-0.25	-0.07	0.26	0.03	-0.02	0.07	0.1
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	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	-0.57	0.09	0.79	0.12	0.17	-0.33	0.59	0.39	-0.48	-0.07
2	0.09	-0.09	0.27	-0.06	0.21	-0.06	0.05	0.07	0.01	-0.09
3	0.1	-0.07	0.15	-0.17	0.25	0.2	-0.26	-0.17	0.17	-0.19
4	0.06	-0.06	0.05	0.2	-0.1	-0.12	-0.23	-0.2	0.02	0.23
5	-0.18	-0.3	0.15	0.45	-0.09	-0.07	-0.13	-0.28	0.14	0.14
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	4	5
Mean Lo	-8.9207	-8.5114
S.E(Log	0.1835	0.2104

Table 3.4.2 (Continued)

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Interce	RSquare	No Pts	Reg s.e	Mean Log q
1	0.74	0.968	10.73	0.58	20	0.48	-10.21
2	0.63	3.476	9.97	0.9	20	0.19	-9.17
3	0.71	2.016	9.46	0.83	18	0.22	-9.13

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

Age	Slope	t-value	Interce	RSquare	No Pts	Reg s.e	Mean Q
4	1.02	-0.103	8.92	0.79	18	0.2	-8.92
5	1.16	-0.798	8.61	0.7	18	0.25	-8.51
1							

Terminal year survivor and F summaries :

Age 1 Catchability dependent on age and year class strength

Year class = 1999

Fleet		Int s.e	Es	Var Ratio	N	Scaled Weights	Estimated F
SCOTRL_	1	0	0	0	0	0	0
SCOSEI_	1	0	0	0	0	0	0
SCOLTR_	1	0	0	0	0	0	0
ENGTRL_	1	0	0	0	0	0	0
DENGIL_	1	0	0	0	0	0	0
ENGSEI_	1	0	0	0	0	0	0
SCOGFS_	138903	0.445	0	0	1	0.179	0.038
ENGGFS_	85481	0.3	0	0	1	0.394	0.06
IBTS_Q1	85024	0.495	0	0	1	0.145	0.061
P shr	85039	0.53				0.131	0.061
F shr	74926	0.5				0.15	0.069

Weighted prediction :

Survivo at end	s.e	Ex s.	N	Var Ratio	F
91288	0.19	0.1	5	0.549	0.057

1

Age 2 Catchability dependent on age and year class strength

Year class = 1998

Fleet		Int s.e	Es	Var Ratio	N	Scaled Weights	Estimated F
SCOTRL_	1	0	0	0	0	0	0
SCOSEI_	1	0	0	0	0	0	0
SCOLTR_	1	0	0	0	0	0	0
ENGTRL_	1	0	0	0	0	0	0
DENGIL_	1	0	0	0	0	0	0
ENGSEI_	1	0	0	0	0	0	0
SCOGFS_	26432	0.247	0.191	0.77	2	0.235	0.546
ENGGFS_	20573	0.212	0.075	0.35	2	0.315	0.659
IBTS_Q1	18494	0.261	0.168	0.65	2	0.212	0.712
P shr	29176	0.46				0.129	0.505
F shr	19155	0.5				0.109	0.694

Weighted prediction :

Survivo at end	s.e	Ex s.	N	Var Ratio	F
22139	0.13	0.08	8	0.608	0.624

Age 3 Catchability dependent on age and year class strength

Year class = 1997

Fleet		Int s.e	Es	Var Ratio	N	Scaled Weights	Estimated F
SCOTRL_	1	0	0	0	0	0	0
SCOSEI_	1	0	0	0	0	0	0
SCOLTR_	1	0	0	0	0	0	0
ENGTRL_	1	0	0	0	0	0	0
DENGIL_	1	0	0	0	0	0	0
ENGSEI_	1	0	0	0	0	0	0
SCOGFS_	4329	0.208	0.104	0.5	3	0.22	0.84
ENGGFS_	3765	0.188	0.108	0.57	3	0.248	0.921
IBTS_Q1	4369	0.202	0.131	0.65	3	0.234	0.834
P shr	8820	0.36				0.196	0.498
F shr	2947	0.5				0.103	1.076

Weighted prediction :

Table 3.4.2 (Continued)

Survivo at end	s.e	Ex s.	N	Var Ratio	F
4630	0.12	0.12	11	1.015	0.802

1
Age 4 Catchability constant w.r.t. time and dependent on age

Year class = 1996

Fleet		Int s.e	E s	Var Ratio	N	Scaled Weights	Estimated F
SCOTRL_	1	0	0	0	0	0	0
SCOSEI_	1	0	0	0	0	0	0
SCOLTR_	1	0	0	0	0	0	0
ENGTRL_	1	0	0	0	0	0	0
DENGIL_	1	0	0	0	0	0	0
ENGSEI_	1	0	0	0	0	0	0
SCOGFS_	4244	0.245	0.249	1.02	4	0.229	0.88
ENGGFS_	5238	0.227	0.027	0.12	4	0.182	0.762
IBTS_Q1	6150	0.213	0.045	0.21	4	0.385	0.68
F shr	3755	0.5				0.204	0.954

Weighted prediction :

Survivo at end	s.e	Ex s.	N	Var Ratio	F
4961	0.15	0.09	13	0.584	0.792

Age 5 Catchability constant w.r.t. time and dependent on age

Year class = 1995

Fleet		Int s.e	E s	Var Ratio	N	Scaled Weights	Estimated F
SCOTRL_	1	0	0	0	0	0	0
SCOSEI_	1	0	0	0	0	0	0
SCOLTR_	1	0	0	0	0	0	0
ENGTRL_	1	0	0	0	0	0	0
DENGIL_	1	0	0	0	0	0	0
ENGSEI_	1	0	0	0	0	0	0
SCOGFS_	590	0.231	0.065	0.28	4	0.112	0.94
ENGGFS_	677	0.21	0.044	0.21	4	0.093	0.859
IBTS_Q1	746	0.208	0.049	0.24	5	0.514	0.804
F shr	634	0.5				0.281	0.897

Weighted prediction :

Survivo at end	s.e	Ex s.	N	Var Ratio	F
688	0.18	0.03	14	0.195	0.85

1
Age 6 Catchability constant w.r.t. time and age (fixed at the value for age) 5

Year class = 1994

Fleet		Int s.e	E s	Var Ratio	N	Scaled Weights	Estimated F
SCOTRL_	1	0	0	0	0	0	0
SCOSEI_	1	0	0	0	0	0	0
SCOLTR_	1	0	0	0	0	0	0
ENGTRL_	1	0	0	0	0	0	0
DENGIL_	1	0	0	0	0	0	0
ENGSEI_	1	0	0	0	0	0	0
SCOGFS_	315	0.329	0.166	0.5	6	0.256	0.74
ENGGFS_	221	0.298	0.184	0.62	5	0.069	0.94
IBTS_Q1	272	0.21	0.08	0.38	5	0.268	0.82
F shr	237	0.5				0.407	0.898

Weighted prediction :

Survivo at end	s.e	Ex s.	N	Var Ratio	F
263	0.23	0.07	17	0.294	0.838

Age 7 Catchability constant w.r.t. time and age (fixed at the value for age) 5

Year class = 1993

Fleet		Int s.e	E s	Var Ratio	N	Scaled Weights	Estimated F
SCOTRL_	1	0	0	0	0	0	0
SCOSEI_	1	0	0	0	0	0	0
SCOLTR_	1	0	0	0	0	0	0
ENGTRL_	1	0	0	0	0	0	0
DENGIL_	1	0	0	0	0	0	0
ENGSEI_	1	0	0	0	0	0	0
SCOGFS_	101	0.335	0.082	0.24	6	0.117	0.811
ENGGFS_	78	0.285	0.054	0.19	5	0.031	0.96
IBTS_Q1	62	0.202	0.08	0.4	5	0.117	1.114
F shr	74	0.5				0.734	0.993

Table 3.4.2 (Continued)

Weighted prediction :

Survivo at end	s.e	Ex s.	N	Var Ratio	F
76	0.37	0.04	17	0.105	0.983

1

Age 8 Catchability constant w.r.t. time and age (fixed at the value for age) 5

Year class = 1992

Fleet		Int s.e	E s	Var Ratio	N	Scaled Weights	Estimated F
SCOTRL_	1	0	0	0	0	0	0
SCOSEI_	1	0	0	0	0	0	0
SCOLTR_	1	0	0	0	0	0	0
ENGTRL_	1	0	0	0	0	0	0
DENGIL_	1	0	0	0	0	0	0
ENGSEI_	1	0	0	0	0	0	0
SCOGFS_	30	0.281	0.054	0.19	6	0.066	0.783
ENGGFS_	19	0.257	0.444	1.73	5	0.024	1.064
IBTS_Q1	21	0.194	0.077	0.4	5	0.08	0.984
F shr	23	0.5				0.831	0.943

Weighted prediction :

Survivo at end	s.e	Ex s.	N	Var Ratio	F
23	0.42	0.04	17	0.103	0.938

Age 9 Catchability constant w.r.t. time and age (fixed at the value for age) 5

Year class = 1991

Fleet		Int s.e	E s	Var Ratio	N	Scaled Weights	Estimated F
SCOTRL_	1	0	0	0	0	0	0
SCOSEI_	1	0	0	0	0	0	0
SCOLTR_	1	0	0	0	0	0	0
ENGTRL_	1	0	0	0	0	0	0
DENGIL_	1	0	0	0	0	0	0
ENGSEI_	1	0	0	0	0	0	0
SCOGFS_	14	0.301	0.038	0.13	6	0.03	0.751
ENGGFS_	17	0.291	0.18	0.62	5	0.009	0.66
IBTS_Q1	11	0.203	0.038	0.19	5	0.035	0.927
F shr	11	0.5				0.926	0.888

Weighted prediction :

Survivo at end	s.e	Ex s.	N	Var Ratio	F
11	0.46	0.03	17	0.072	0.883

1

Age 10 Catchability constant w.r.t. time and age (fixed at the value for age) 5

Year class = 1990

Fleet		Int s.e	E s	Var Ratio	N	Scaled Weights	Estimated F
SCOTRL_	1	0	0	0	0	0	0
SCOSEI_	1	0	0	0	0	0	0
SCOLTR_	1	0	0	0	0	0	0
ENGTRL_	1	0	0	0	0	0	0
DENGIL_	1	0	0	0	0	0	0
ENGSEI_	1	0	0	0	0	0	0
SCOGFS_	3	0.299	0.054	0.18	6	0.017	0.994
ENGGFS_	3	0.309	0.264	0.85	5	0.006	0.963
IBTS_Q1	3	0.211	0.071	0.34	5	0.022	0.913
F shr	3	0.5				0.955	0.908

Weighted prediction :

Survivo at end	s.e	Ex s.	N	Var Ratio	F
3	0.48	0.02	17	0.044	0.91

1

Table 3.4.3. Cod in Sub-area IV and Divisions VIId and IIIa (Skagerrak). Fishing mortality at age.

Run title : Cod, North Sea/Skaggerak/Eastern Channel 7/6/2001

At 22/06/2001 13:10

Terminal Fs derived using XSA (With F shrinkage)

Table 8 Fishing mortality (F) at age

YEAR,	1963,	1964,	1965,	1966,	1967,	1968,	1969,	1970,
AGE								
1,	.0249,	.0203,	.0585,	.0551,	.0335,	.0457,	.0213,	.1098,
2,	.5316,	.3759,	.4704,	.5499,	.4973,	.6353,	.3906,	.5787,
3,	.3677,	.5930,	.6602,	.6281,	.7287,	.7390,	.6002,	.7466,
4,	.4524,	.4171,	.6212,	.5284,	.5327,	.7115,	.5817,	.5711,
5,	.4543,	.4763,	.4313,	.4895,	.5975,	.6229,	.6285,	.5845,
6,	.5623,	.6124,	.4609,	.4349,	.5987,	.5652,	.6994,	.5320,
7,	.1599,	.6077,	.4675,	.4445,	.6205,	.5826,	.4870,	.5284,
8,	.7843,	.3674,	.7092,	.5262,	.7115,	.4541,	.6319,	.3184,
9,	.3119,	.3243,	.2683,	.7611,	.3777,	.7745,	.4081,	.6432,
10,	.4579,	.4813,	.4710,	.5356,	.5862,	.6051,	.5758,	.5255,
+gp,	.4579,	.4813,	.4710,	.5356,	.5862,	.6051,	.5758,	.5255,
0 FBAR 2- 8,	.4732,	.4928,	.5458,	.5145,	.6124,	.6158,	.5742,	.5514,
FBAR 2- 4,	.4506,	.4620,	.5839,	.5688,	.5862,	.6953,	.5242,	.6321,

Table 8 Fishing mortality (F) at age

YEAR,	1971,	1972,	1973,	1974,	1975,	1976,	1977,	1978,	1979,	1980,
AGE										
1,	.0763,	.0335,	.1292,	.0922,	.1080,	.0353,	.1439,	.0953,	.1042,	.1096,
2,	.8861,	.8906,	.6967,	.8121,	.7336,	.9390,	.8433,	1.0247,	.7936,	.8827,
3,	.7701,	.9069,	.8383,	.6699,	.7845,	.8574,	.7703,	.9248,	.9485,	.9811,
4,	.7088,	.6526,	.7781,	.6415,	.6705,	.7568,	.5485,	.7667,	.5896,	.7906,
5,	.6947,	.7105,	.5736,	.6396,	.7445,	.5718,	.6355,	.8693,	.7059,	.6495,
6,	.5377,	.8034,	.7219,	.5314,	.6716,	.7946,	.6027,	.7420,	.5132,	.6343,
7,	.5701,	.7788,	.6907,	.7152,	.5118,	.7400,	.8038,	.6837,	.6594,	.8428,
8,	.5191,	1.0295,	.5440,	.6029,	.8425,	.2718,	.7712,	.7620,	.5250,	.8330,
9,	.6926,	1.2337,	.3377,	.9113,	.8802,	.8027,	1.4552,	.8795,	.7848,	.5888,
10,	.6081,	.9211,	.5785,	.6864,	.7373,	.6419,	.8627,	.7953,	.6434,	.7165,
+gp,	.6081,	.9211,	.5785,	.6864,	.7373,	.6419,	.8627,	.7953,	.6434,	.7165,
0 FBAR 2- 8,	.6695,	.8246,	.6919,	.6589,	.7084,	.7045,	.7107,	.8247,	.6765,	.8020,
FBAR 2- 4,	.7883,	.8167,	.7711,	.7078,	.7295,	.8511,	.7207,	.9054,	.7772,	.8848,

1

Run title : Cod, North Sea/Skaggerak/Eastern Channel 7/6/2001

At 22/06/2001 13:10

Terminal Fs derived using XSA (With F shrinkage)

Table 8 Fishing mortality (F) at age

YEAR,	1981,	1982,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,
AGE										
1,	.1010,	.1756,	.1258,	.1767,	.0869,	.2342,	.1414,	.1775,	.1290,	.1401,
2,	.9718,	.9377,	1.0857,	.9549,	.9843,	.8950,	.9166,	.9153,	.8774,	.9100,
3,	1.0113,	1.2335,	1.1905,	1.0185,	.9596,	1.0604,	.8922,	1.1846,	1.0925,	.9700,
4,	.7705,	.9210,	.9170,	.8304,	.8077,	.9607,	.9278,	.8601,	1.0157,	.8962,
5,	.6772,	.7905,	.7903,	.7542,	.7143,	.8690,	.7341,	.7929,	.7601,	.7724,
6,	.5908,	.8993,	.7599,	.7539,	.7055,	.8181,	.9356,	.8334,	.9126,	.5626,
7,	.7195,	.7699,	.7191,	.6587,	.6988,	.7986,	.9182,	.7301,	.9366,	.7854,
8,	.5766,	.7000,	.9126,	.7503,	.6001,	.8345,	.8645,	.7274,	.9788,	.5268,
9,	.7392,	.8015,	.6350,	.9165,	.5782,	.5121,	.7168,	.6816,	.7536,	2.0875,
10,	.6667,	.8003,	.7710,	.7744,	.6655,	.7740,	.8422,	.7603,	.8776,	.9553,
+gp,	.6667,	.8003,	.7710,	.7744,	.6655,	.7740,	.8422,	.7603,	.8776,	.9553,
0 FBAR 2- 8,	.7597,	.8931,	.9107,	.8173,	.7815,	.8909,	.8841,	.8634,	.9391,	.7748,
FBAR 2- 4,	.9179,	1.0307,	1.0644,	.9346,	.9172,	.9720,	.9122,	.9866,	.9952,	.9254,

Table 8 Fishing mortality (F) at age

YEAR,	1991,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	FBAR 98-**	FBAR 89-98
AGE												
1,	.1269,	.1453,	.0496,	.0744,	.1091,	.0434,	.0878,	.0273,	.0657,	.0567,	.0499,	.0933,
2,	.7638,	.8496,	.8097,	.6502,	.8234,	.6531,	.6284,	.8233,	.4801,	.6241,	.6425,	.7789,
3,	.9653,	.8504,	1.0227,	1.0331,	1.0025,	1.0050,	.9948,	1.1575,	1.1398,	.8019,	1.0331,	1.0094,
4,	.8448,	.9355,	.9593,	.9294,	.8396,	.7526,	.9245,	1.1488,	1.0500,	.7918,	.9969,	.9246,
5,	.8382,	.7325,	.9058,	.7684,	.6678,	.8294,	.7676,	1.1595,	1.0147,	.8497,	1.0080,	.8202,
6,	.9345,	.8341,	.7793,	.8980,	.6248,	.8589,	.9013,	.8672,	1.1917,	.8377,	.9655,	.8173,
7,	1.1064,	.8935,	1.0803,	.6354,	.7237,	.9121,	1.0194,	.9194,	1.3372,	.9833,	1.0800,	.9012,
8,	1.0670,	.8425,	.8681,	1.1202,	.3853,	1.4139,	.7619,	.8682,	1.2361,	.9382,	1.0142,	.8833,
9,	.5698,	1.0859,	.8072,	.6942,	1.0252,	.8800,	.9630,	.6316,	.8938,	.8829,	.8028,	.9498,
10,	.9132,	.8829,	.8985,	.8313,	.6977,	.9893,	.9043,	.8978,	1.1393,	.9100,	.9824,	.8848,
+gp,	.9132,	.8829,	.8985,	.8313,	.6977,	.9893,	.9043,	.8978,	1.1393,	.9100,		
0 FBAR 2- 8,	.9314,	.8483,	.9179,	.8621,	.7239,	.9179,	.8568,	.9920,	1.0642,	.8324,		
FBAR 2- 4,	.8580,	.8785,	.9306,	.8709,	.8885,	.8036,	.8492,	1.0432,	.8900,	.7393,		

1

Table 3.4.4. Cod in Sub-area IV and Divisions VIId and IIIa (Skagerrak). Stock numbers at age.

Run title : Cod, North Sea/Skaggerak/Eastern Channel 7/6/2001

At 22/06/2001 13:10

Terminal Fs derived using XSA (With F shrinkage)

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

YEAR,	1963,	1964,	1965,	1966,	1967,	1968,	1969,	1970,
AGE								
1,	195099,	374080,	415425,	506863,	488789,	194587,	209061,	782003,
2,	123040,	85509,	164714,	176063,	215532,	212386,	83526,	91962,
3,	25890,	50951,	41375,	72514,	71590,	92370,	79289,	39826,
4,	10741,	13959,	21931,	16651,	30136,	26902,	34355,	33883,
5,	8440,	5594,	7531,	9648,	8037,	14484,	10813,	15722,
6,	3117,	4387,	2845,	4006,	4842,	3620,	6360,	4722,
7,	606,	1454,	1947,	1469,	2123,	2178,	1684,	2587,
8,	1000,	423,	648,	999,	771,	935,	996,	847,
9,	56,	374,	240,	261,	483,	310,	486,	433,
10,	17,	33,	221,	150,	100,	271,	117,	265,
+gp,	0,	11,	23,	219,	42,	57,	194,	108,
0 TOTAL,	368005,	536776,	656900,	788841,	822444,	548100,	426882,	972359,

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

YEAR,	1971,	1972,	1973,	1974,	1975,	1976,	1977,	1978,	1979,	1980,
AGE										
1,	910808,	173496,	319648,	263657,	486359,	246421,	839198,	488156,	525424,	899522,
2,	314849,	379206,	75388,	126222,	108037,	196161,	106887,	326526,	199413,	212736,
3,	36332,	91465,	109668,	26468,	39487,	36558,	54050,	32411,	82584,	63548,
4,	14701,	13100,	28762,	36933,	10549,	14034,	12080,	19483,	10011,	24910,
5,	15671,	5925,	5584,	10815,	15920,	4417,	5391,	5715,	7410,	4545,
6,	7175,	6406,	2384,	2576,	4671,	6191,	2042,	2338,	1962,	2995,
7,	2271,	3431,	2348,	948,	1240,	1954,	2290,	915,	911,	961,
8,	1249,	1051,	1289,	964,	380,	608,	763,	839,	378,	386,
9,	505,	608,	307,	613,	432,	134,	380,	289,	321,	183,
10,	187,	207,	145,	180,	202,	147,	49,	73,	98,	120,
+gp,	225,	32,	403,	415,	133,	99,	181,	87,	39,	54,
0 TOTAL,	1303972,	674928,	545928,	469790,	667408,	506723,	1023310,	876831,	828552,	1209961,

1

Run title : Cod, North Sea/Skaggerak/Eastern Channel 7/6/2001

At 22/06/2001 13:10

Terminal Fs derived using XSA (With F shrinkage)

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

YEAR,	1981,	1982,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,
AGE										
1,	314766,	618498,	324686,	596292,	158611,	716254,	281821,	197056,	274078,	133940,
2,	362216,	127840,	233147,	128641,	224528,	65340,	254642,	109930,	74144,	108244,
3,	62014,	96586,	35272,	55475,	34889,	59126,	18815,	71756,	31019,	21728,
4,	18555,	17567,	21909,	8353,	15603,	10408,	15947,	6004,	17094,	8102,
5,	9251,	7031,	5726,	7170,	2981,	5696,	3261,	5163,	2080,	5068,
6,	1944,	3848,	2611,	2127,	2761,	1195,	1956,	1281,	1913,	796,
7,	1300,	882,	1282,	1000,	819,	1117,	432,	628,	456,	629,
8,	339,	518,	334,	511,	424,	334,	411,	141,	248,	146,
9,	137,	156,	211,	110,	198,	190,	119,	142,	56,	76,
10,	83,	54,	57,	91,	36,	91,	93,	47,	59,	22,
+gp,	47,	32,	47,	40,	69,	47,	23,	38,	19,	16,
0 TOTAL,	770652,	873012,	625282,	799810,	440918,	859797,	577519,	392186,	401165,	278767,

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

YEAR,	1991,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	GMST 63-98	GMST 89-98
AGE													
1,	168570,	305294,	147325,	323678,	226904,	173262,	421717,	69536,	139369,	215023,	0,	321551,	200283,
2,	52315,	66717,	118631,	62991,	135010,	91419,	74541,	173557,	30403,	58640,	91288,	136482,	89620,
3,	30704,	17176,	20102,	37199,	23169,	41762,	33526,	28022,	53688,	13256,	22139,	43321,	27435,
4,	6414,	9108,	5715,	5630,	10311,	6621,	11905,	9655,	6858,	13375,	4630,	13982,	8532,
5,	2707,	2256,	2926,	1793,	1820,	3646,	2554,	3867,	2506,	1965,	4961,	5506,	2720,
6,	1917,	959,	888,	968,	681,	764,	1302,	971,	993,	744,	688,	2298,	1047,
7,	371,	616,	341,	333,	323,	298,	265,	433,	334,	247,	263,	942,	391,
8,	235,	101,	207,	95,	145,	128,	98,	78,	141,	72,	76,	397,	137,
9,	71,	66,	35,	71,	25,	81,	26,	38,	27,	34,	23,	161,	50,
10,	8,	33,	18,	13,	29,	7,	27,	8,	16,	9,	11,	61,	18,
+gp,	17,	17,	24,	30,	11,	14,	19,	23,	3,	13,	7,		
0 TOTAL,	263329,	402342,	296212,	432803,	398428,	318002,	545981,	286187,	234339,	303376,	124086,		

1

Table 3.4.5. Cod in Sub-area IV and Divisions VIId and IIIa (Skagerrak). Stock summary .

Run title : Cod, North Sea/Skaggerak/Eastern Channel 7/6/2001 ,

At 22/06/2001 13:10

Table 16 Summary (without SOP correction)

Terminal Fs derived using XSA (With F shrinkage)

,	RECRUITS, Age 1	TOTALBIO,	TOTSPBIO,	LANDINGS,	YIELD/SSB,	FBAR 2- 8,	FBAR 2- 4,
1963,	195099,	452116,	151521,	116457,	.7686,	.4732,	.4506,
1964,	374080,	542265,	166149,	126041,	.7586,	.4928,	.4620,
1965,	415425,	714049,	205425,	181036,	.8813,	.5458,	.5839,
1966,	506863,	859774,	230759,	221336,	.9592,	.5145,	.5688,
1967,	488789,	923749,	250046,	252977,	1.0117,	.6124,	.5862,
1968,	194587,	788620,	258219,	288368,	1.1168,	.6158,	.6953,
1969,	209061,	630758,	255921,	200760,	.7845,	.5742,	.5242,
1970,	782003,	973042,	276848,	226124,	.8168,	.5514,	.6321,
1971,	910808,	1180219,	277216,	328098,	1.1835,	.6695,	.7883,
1972,	173496,	809634,	231011,	353976,	1.5323,	.8246,	.8167,
1973,	319648,	655887,	209145,	239051,	1.1430,	.6919,	.7711,
1974,	263657,	623331,	230838,	214279,	.9283,	.6589,	.7078,
1975,	486359,	704555,	211636,	205245,	.9698,	.7084,	.7295,
1976,	246421,	610330,	182050,	234169,	1.2863,	.7045,	.8511,
1977,	839198,	822018,	159349,	209154,	1.3126,	.7107,	.7207,
1978,	488156,	812303,	159354,	297022,	1.8639,	.8247,	.9054,
1979,	525424,	804646,	164266,	269973,	1.6435,	.6765,	.7772,
1980,	899522,	1015237,	181876,	293644,	1.6145,	.8020,	.8848,
1981,	314766,	855238,	195732,	335497,	1.7141,	.7597,	.9179,
1982,	618498,	840143,	190227,	303251,	1.5942,	.8931,	1.0307,
1983,	324686,	649030,	154988,	259287,	1.6730,	.9107,	1.0644,
1984,	596292,	718052,	133415,	228286,	1.7111,	.8173,	.9346,
1985,	158611,	502680,	126208,	214629,	1.7006,	.7815,	.9172,
1986,	716254,	683073,	114215,	204053,	1.7866,	.8909,	.9720,
1987,	281821,	571198,	104724,	216212,	2.0646,	.8841,	.9122,
1988,	197056,	426081,	98643,	184240,	1.8677,	.8634,	.9866,
1989,	274078,	416228,	90606,	139936,	1.5444,	.9391,	.9952,
1990,	133940,	328421,	78046,	125314,	1.6056,	.7748,	.9254,
1991,	168570,	296651,	71119,	102478,	1.4409,	.9314,	.8580,
1992,	305294,	403065,	68904,	114020,	1.6548,	.8483,	.8785,
1993,	147325,	338005,	65099,	121749,	1.8702,	.9179,	.9306,
1994,	323678,	420826,	64828,	110634,	1.7066,	.8621,	.8709,
1995,	226904,	421873,	71003,	136096,	1.9168,	.7239,	.8885,
1996,	173262,	375847,	76361,	126320,	1.6542,	.9179,	.8036,
1997,	421717,	496291,	80188,	124158,	1.5483,	.8568,	.8492,
1998,	69536,	313810,	71542,	146014,	2.0409,	.9920,	1.0432,
1999,	139369,	256151,	61471,	96225,	1.5654,	1.0642,	.8900,
2000,	215023,	278644,	53744,	70687,	1.3153,	.8324,	.7393,
2001	**152000***		**55100****				
Arith. Mean ,	371718,	618785,	151913,	200442,	1.4355,	.7661,	.8122,
0 Units,	(Thousands),	(Tonnes),	(Tonnes),	(Tonnes),			

1

* RCT3 estimate

** predicted from survivors from 2000 + rct3 estimate of 2000 y/c in 2001 (152 million)

Table 3.5.1. Cod in Sub-area IV and Divisions VIId and IIIa (Skagerrak). RCT3 input .

COD IV RCT3 INPUT VALUES; AGE 1*100; 23-Jun-0Filename = RCT3in1.csv
20 31 2

'YRCLS'	'VPA'	'IYFS1'	'IYFS2'	'EGFS0'	'EGFS1'	'EGFS2'	'SGFS1'	'SGFS2'	'DGFS0'	'DGFS1'	'DGFS2'	'FRGSF'	'GGFS1'	'GGFS2'	'IBQ21'	'SCQ21'	'SCQ22'	'IBQ40'	'IBQ41'	'GQ40'	'GQ11'
1970	910808	9830	3450	-1	-1	-1	-1	-1	-1	-1	-1	9040	-1	-1	-1	-1	-1	-1	-1	-1	-1
1971	173496	410	1060	-1	-1	-1	-1	-1	-1	-1	-1	130	-1	-1	-1	-1	-1	-1	-1	-1	-1
1972	319648	3800	950	-1	-1	-1	-1	-1	-1	-1	-1	160	-1	-1	-1	-1	-1	-1	-1	-1	-1
1973	263657	1470	620	-1	-1	-1	-1	-1	-1	-1	-1	360	-1	-1	-1	-1	-1	-1	-1	-1	-1
1974	486359	4030	1990	-1	-1	-1	-1	-1	-1	-1	-1	800	-1	-1	-1	-1	-1	-1	-1	-1	-1
1975	246421	790	320	-1	-1	447	-1	-1	-1	-1	-1	780	-1	-1	-1	-1	-1	-1	-1	-1	-1
1976	839198	3670	2930	-1	6270	1250	-1	-1	-1	-1	-1	2820	-1	-1	-1	-1	-1	-1	-1	-1	-1
1977	488156	1290	930	1389	2284	580	-1	-1	-1	-1	-1	2720	-1	-1	-1	-1	-1	-1	-1	-1	-1
1978	525424	990	1480	1256	2423	670	-1	-1	-1	-1	450	3110	-1	-1	-1	-1	-1	-1	-1	-1	-1
1979	899522	1690	2550	1855	5084	1386	-1	-1	-1	16380	1120	3550	-1	-1	-1	-1	-1	-1	-1	-1	-1
1980	314766	290	670	1023	1136	290	-1	351	4320	4690	160	1410	-1	-1	-1	-1	-1	-1	-1	-1	-1
1981	618498	920	1660	7424	3237	1096	614	78	17680	8300	230	2320	-1	350	-1	-1	-1	-1	-1	-1	678.3
1982	324686	390	800	255	1540	475	325	391	2690	2180	160	900	590	240	-1	-1	-1	-1	-1	303	66.2
1983	596292	1520	1760	9510	6122	1189	819	1143	12150	12130	310	4300	260	2240	-1	-1	-1	-1	-1	566	406
1984	158611	90	360	38	430	115	66	104	130	360	20	90	230	260	-1	-1	-1	-1	-1	2	9.6
1985	716254	1700	2880	828	3438	1065	801	695	14360	11120	800	950	1540	1140	-1	-1	-1	-1	-1	724.6	197
1986	281821	880	610	121	1422	407	219	288	3700	4150	170	230	700	950	-1	-1	-1	-1	-1	242.3	20.8
1987	197056	360	630	38	836	248	162	135	3620	1780	220	210	200	720	-1	-1	-1	-1	-1	20	2.6
1988	274078	1310	1520	1678	2285	504	561	490	1660	1660	190	420	9020	1470	-1	-1	-1	-1	-1	148.2	2.2
1989	133940	340	410	598	608	155	114	154	1370	920	70	60	1190	620	-1	-1	3140	-1	-1	31	1
1990	168570	240	450	383	752	159	303	193	2350	720	110	-1	1550	360	850	1490	5330	-1	567	33.8	34.6
1991	305294	1300	1990	4840	2440	650	642	749	3980	4540	70	-1	1340	-1	3630	19080	14460	848	2671	-1	-1
1992	147325	1270	440	1684	742	295	347	334	1160	170	90	-1	-1	450	1100	4820	3410	722	586	-1	1.2
1993	323678	1480	2210	377	2637	1277	1158	1443	2410	4690	-1	-1	3080	1430	3200	2030	20470	358	2552	8.4	-1
1994	226904	970	800	2134	1028	668	475	356	6350	-1	-1	-1	430	-1	1960	4270	5660	518	1489	133.4	32
1995	173262	350	690	26	619	284	318	278	-1	-1	-1	-1	-1	-1	370	770	1920	1085	791	41	25.4
1996	421717	4000	2640	4122	4044	1396	999	-1	-1	-1	-1	-1	-1	-1	7580	2830	-1	2206	-1	109.2	9.4
1997	69536	270	160	4.9	118	55	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	5.5	0.6
1998	-1	210	380	389	367	197	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	4.1	1.3
1999	-1	660	880	95	953	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	10.7*	2.5*
2000	-1	270	-1	40	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	6.5*	0.5*

* not used

Table 3.5.2. Cod in Sub-area IV and Divisions VIId and IIIa (Skagerrak). RCT3 results .

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

rct3in1.csv

COD IV,RCT3 INPUT VALUES; AGE 1*100; ,,,,,23-Jun-01,,,,,,,,,,,,,,

Data for   20 surveys over   31 years :  1970 - 2000

Regression type = C
Tapered time weighting applied
power =    0 over  20 years
Survey weighting not applied

Final estimates shrunk towards mean
Minimum S.E. for any survey taken as    .30
Minimum of   5 points used for regression

Forecast/Hindcast variance correction used.

Yearclass =   1997

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

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

IYFS1     1.01   5.95    .72   .391     27   5.60   11.60     .809     .056
IYFS2     1.00   5.75    .39   .685     27   5.08   10.81     .497     .148
EGFS0      .59   8.75    .87   .310     20   1.77    9.80    1.105     .030
EGFS1      .80   6.72    .26   .832     21   4.78   10.55     .354     .290
EGFS2      .87   7.27    .37   .711     22   4.03   10.76     .474     .162
GQ40       .44  10.60    .52   .513     13   1.87   11.43     .639     .089
GQ11       .39  11.29    .48   .606     14    .47   11.47     .570     .112

                                       VPA Mean =   12.65     .565     .114


Yearclass =   1998

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

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

IYFS1     1.10   5.32    .80   .410     28   5.35   11.21     .897     .035
IYFS2      .91   6.34    .34   .791     28   5.94   11.74     .380     .193
EGFS0      .47   9.55    .73   .455     21   5.97   12.38     .786     .045
EGFS1      .72   7.36    .25   .874     22   5.91   11.59     .285     .310
EGFS2      .79   7.72    .34   .794     23   5.29   11.91     .373     .201
GQ40       .48  10.44    .54   .579     14   1.63   11.22     .654     .065
GQ11       .42  11.18    .50   .648     15    .83   11.53     .574     .085

                                       VPA Mean =   12.56     .647     .067


Yearclass =   1999

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

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

IYFS1     1.08   5.47    .80   .410     28   6.49   12.46     .867     .056
IYFS2      .89   6.44    .34   .792     28   6.78   12.49     .370     .308
EGFS0      .47   9.60    .73   .453     21   4.56   11.72     .808     .065
EGFS1      .70   7.45    .25   .879     22   6.86   12.26     .269     .470


                                       VPA Mean =   12.52     .647     .101
```

Table 3.5.2 (Continued)

Yearclass = 2000

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression----------I					I-----------Prediction---------I			
IYFS1	1.02	5.79	.78	.383	28	5.60	11.53	.873	.220
IYFS2									
EGFS0	.41	9.89	.65	.472	21	3.71	11.42	.737	.309
					VPA Mean =		12.46	.597	.471

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
1997	64725	11.08	.19	.26	1.90	69537	11.15
1998	125468	11.74	.17	.12	.55		
1999	227240	12.33	.21	.10	.23		
2000	152213	11.93	.41	.35	.74		

Table 3.7.1 cod,3an47d

Input data for catch forecast and linear sensitivity analysis.

Populations in 2001			Stock weights			Nat.Mortality			Prop.mature		
Labl	Value	CV	Labl	Value	CV	Labl	Value	CV	Labl	Value	CV
N1	152000	.61	WS1	.60	.09	M1	.80	.13	MT1	.01	.10
N2	91286	.19	WS2	.96	.06	M2	.35	.10	MT2	.05	.10
N3	22138	.13	WS3	1.71	.02	M3	.25	.18	MT3	.23	.10
N4	4629	.12	WS4	3.34	.04	M4	.20	.18	MT4	.62	.10
N5	4961	.15	WS5	5.32	.09	M5	.20	.18	MT5	.86	.10
N6	687	.18	WS6	7.46	.01	M6	.20	.18	MT6	1.00	.10
N7	262	.23	WS7	9.24	.06	M7	.20	.18	MT7	1.00	.00
N8	76	.37	WS8	10.66	.03	M8	.20	.18	MT8	1.00	.00
N9	22	.42	WS9	11.68	.02	M9	.20	.18	MT9	1.00	.00
N10	11	.46	WS10	12.62	.03	M10	.20	.18	MT10	1.00	.00
N11	6	.48	WS11	13.93	.12	M11	.20	.18	MT11	1.00	.00

HC selectivity			HC.catch wt		
Labl	Value	CV	Labl	Value	CV
sH1	.04	.42	WH1	.60	.09
sH2	.55	.29	WH2	.96	.06
sH3	.89	.10	WH3	1.71	.02
sH4	.86	.11	WH4	3.34	.04
sH5	.87	.11	WH5	5.32	.09
sH6	.83	.12	WH6	7.46	.01
sH7	.93	.15	WH7	9.24	.06
sH8	.88	.15	WH8	10.66	.03
sH9	.69	.25	WH9	11.68	.02
sH10	.85	.10	WH10	12.62	.03
sH11	.85	.10	WH11	13.93	.12

Year effect M			HC relative eff		
Labl	Value	CV	Labl	Value	CV
K01	1.00	.10	HF01	1.00	.12
K02	1.00	.10	HF02	1.00	.12
K03	1.00	.10	HF03	1.00	.12

Recruitment		
Labl	Value	CV
R02	199999	.61
R03	199999	.61

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

Stock numbers in 2001 are VPA survivors.
These are overwritten at Age 1

Table 3.7.2 cod,3an47d

Catch forecast output and estimates of coefficient of variation (CV) from linear analysis.

	Year 2001	2002						
Mean F Ages								
H.cons 2 to 8	.83	.00	.17	.33	.50	.54	.67	.83
Effort relative to 2000								
H.cons	1.00	.00	.20	.40	.60	.65	.80	1.00
Biomass at start of year								
Total	267.6	294.6	294.6	294.6	294.6	294.6	294.6	294.6
Spawning	55.1	57.1	57.1	57.1	57.1	57.1	57.1	57.1
Catch weight (,000t)								
H.cons	81.8	.0	22.4	41.8	58.5	62.3	73.0	85.7
Biomass at start of 2003								
Total		438.0	404.4	375.5	350.9	345.3	329.7	311.5
Spawning		135.5	115.6	98.7	84.5	81.3	72.5	62.3

	Year 2001	2002						
Effort relative to 2000								
H.cons	1.00	.00	.20	.40	.60	.65	.80	1.00
Est. Coeff. of Variation								
Biomass at start of year								
Total	.22	.29	.29	.29	.29	.29	.29	.29
Spawning	.10	.14	.14	.14	.14	.14	.14	.14
Catch weight								
H.cons	.16	.00	.59	.33	.26	.25	.23	.22
Biomass at start of 2003								
Total		.25	.27	.28	.29	.29	.30	.31
Spawning		.18	.21	.21	.21	.21	.22	.22

Table 3.7.3. cod,3an47d
Detailed forecast tables.

Forecast for year 2001
F multiplier H.cons=1.00

Age	Populations: Stock No.	Catch number: H.Cons	Catch number: Total
1	152000	4416	4416
2	91287	33335	33335
3	22139	11781	11781
4	4629	2458	2458
5	4961	2652	2652
6	687	357	357
7	262	146	146
8	76	41	41
9	23	11	11
10	11	6	6
11	6	3	3
Wt	268	82	82

Forecast for year 2002
F multiplier H.cons=1.00

Age	Populations: Stock No.	Catch number: H.Cons	Catch number: Total
1	200000	5811	5811
2	65423	23891	23891
3	36929	19652	19652
4	7059	3749	3749
5	1601	856	856
6	1700	884	884
7	244	136	136
8	84	45	45
9	26	12	12
10	9	5	5
11	6	3	3
Wt	295	86	86

Table 3.7.4 cod,3an47d

Catch forecast output and estimates of coefficient of variation (CV) from linear analysis.
TAC constraint of 55600 tonnes applied.

	Year							
	2001	2002						
Mean F Ages								
H.cons 2 to 8	.50	.00	.17	.33	.50	.54	.67	.83
Effort relative to 2000								
H.cons	.60	.00	.20	.40	.60	.65	.80	1.00
Biomass at start of year								
Total	267.6	331.7	331.7	331.7	331.7	331.7	331.7	331.7
Spawning	55.1	76.8	76.8	76.8	76.8	76.8	76.8	76.8
Catch weight (,000t)								
H.cons	55.6	.0	27.7	51.5	72.1	76.7	89.8	105.2
Biomass at start of 2003								
Total		487.1	445.6	410.2	380.1	373.2	354.2	332.1
Spawning		172.7	146.8	125.0	106.5	102.4	91.0	77.9

	Year							
	2001	2002						
Effort relative to 2000								
H.cons	.60	.00	.20	.40	.60	.65	.80	1.00
Est. Coeff. of Variation								
Biomass at start of year								
Total	.22	.26	.26	.26	.26	.26	.26	.26
Spawning	.10	.13	.13	.13	.13	.13	.13	.13
Catch weight								
H.cons	.21	.00	.58	.31	.24	.23	.21	.20
Biomass at start of 2003								
Total		.23	.25	.26	.27	.27	.28	.30
Spawning		.16	.19	.19	.20	.20	.20	.20

Table 3.7.5.cod,3an47d
Detailed forecast tables.

Forecast for year 2001
F multiplier H.cons= .60

Age	Stock No. (Populations)	H.Cons (Catch number)	Total (Catch number)
1	152000	2672	2672
2	91287	22048	22048
3	22139	8223	8223
4	4629	1710	1710
5	4961	1848	1848
6	687	248	248
7	262	103	103
8	76	28	28
9	23	7	7
10	11	4	4
11	6	2	2
Wt	268	56	56

Forecast for year 2002
F multiplier H.cons=1.00

Age	Stock No. (Populations)	H.Cons (Catch number)	Total (Catch number)
1	200000	5811	5811
2	66557	24304	24304
3	46092	24528	24528
4	10084	5355	5355
5	2258	1207	1207
6	2407	1252	1252
7	341	190	190
8	122	66	66
9	37	17	17
10	12	7	7
11	8	4	4
Wt	332	105	105

Table 3.8.1 Cod in Sub-area IV and Divisions VIID and IIIA (Skagerrak). Input for medium term projection.

Input for Catch Prediction

Age	2001 Stock Numbers (10**-3)	F and mean Wt at age used in prediction: Scaled Mean F 1998 - 2000	Mean Wt. at age (kg) 1991 - 2000: Stock	Catch	M and maturity: M	P. mat
1	152000	.04	.663	.663	.800	.010
2	91286	.55	1.035	1.035	.350	.050
3	22138	.89	2.086	2.086	.250	.230
4	4629	.86	3.937	3.937	.200	.620
5	4961	.85	6.207	6.207	.200	.860
6	687	.83	8.130	8.130	.200	1.000
7	262	.93	9.655	9.655	.200	1.000
8	76	.88	10.870	10.870	.200	1.000
9	22	.69	12.259	12.259	.200	1.000
10	11	.85	13.020	13.020	.200	1.000
11	6	.85	13.773	13.773	.200	1.000

Mean F	(2 - 8)
Unscaled	.963
Scaled	.830

Recruits at age 1 in 2002 = 200000
Recruits at age 1 in 2003 = 200000

Stock numbers in 2001 are VPA survivors.
These are overwritten at Age 1

Table 3.8.2 Cod in Sub-area IV and Divisions VIID and IIIA (Skagerrak). Parameters of the Shepherd stock-recruitment relationship used in the medium term projections.

cod 3an47d

Data read from file codivrec.csv

Shepherd curve
Moving average term NOT fitted

IFAIL on exit from E04FDF =	5
Residual sum of squares=	9.5654
Number of observations=	37
Number of parameters =	3
Residual mean square =	0.2813
Coefficient of determination =	0.2976
Adj. coeff. of determination =	0.2563
IFAIL from E04YCF=	0

Parameter Correlation matrix

1		
-0.5593	1	
-0.5692	0.0534	1

Parameter	s.d.
2.7672	0.3837
259.8679	24.8919
5.0524	3.5856

Y/Class	SSB	Recruits	Fit. rct	residuals	residuals	wt
1963	151.5	374	393.47	-0.0508	-0.0508	1
1964	166.1	415	416.26	-0.003	-0.003	1
1965	205.4	507	435.64	0.1517	0.1517	1
1966	230.8	489	412.27	0.1707	0.1707	1
1967	250	195	379.62	-0.6662	-0.6662	1
1968	258.2	209	363.06	-0.5522	-0.5522	1
1969	255.9	782	367.82	0.7543	0.7543	1
1970	276.8	911	322.43	1.0387	1.0387	1
1971	277.2	173	321.53	-0.6198	-0.6198	1
1972	231	320	411.98	-0.2527	-0.2527	1
1973	209.1	264	433.92	-0.4969	-0.4969	1
1974	230.8	486	412.27	0.1645	0.1645	1
1975	211.7	246	432.35	-0.5639	-0.5639	1
1976	182.1	839	432.23	0.6633	0.6633	1
1977	159.4	488	406.67	0.1823	0.1823	1
1978	159.4	525	406.67	0.2554	0.2554	1
1979	164.3	900	413.84	0.7769	0.7769	1
1980	181.9	315	432.09	-0.3161	-0.3161	1
1981	195.7	618	437.21	0.3461	0.3461	1
1982	190.2	325	436.2	-0.2943	-0.2943	1
1983	155	596	399.56	0.3999	0.3999	1
1984	133.4	159	356.86	-0.8084	-0.8084	1
1985	126.2	716	340.37	0.7436	0.7436	1
1986	114.2	282	311.13	-0.0983	-0.0983	1
1987	104.7	197	286.82	-0.3757	-0.3757	1
1988	98.6	274	270.82	0.0117	0.0117	1
1989	90.6	134	249.49	-0.6216	-0.6216	1
1990	78	169	215.35	-0.2424	-0.2424	1
1991	71.1	305	196.47	0.4398	0.4398	1
1992	68.9	147	190.43	-0.2588	-0.2588	1
1993	65.1	324	179.98	0.5879	0.5879	1
1994	64.8	227	179.16	0.2367	0.2367	1
1995	71	173	196.19	-0.1258	-0.1258	1
1996	76.4	422	210.98	0.6932	0.6932	1
1997	80.2	70	221.35	-1.1512	-1.1512	1
1998	71.6	139	197.84	-0.353	-0.353	1
1999	61.5	215	170.07	0.2344	0.2344	1

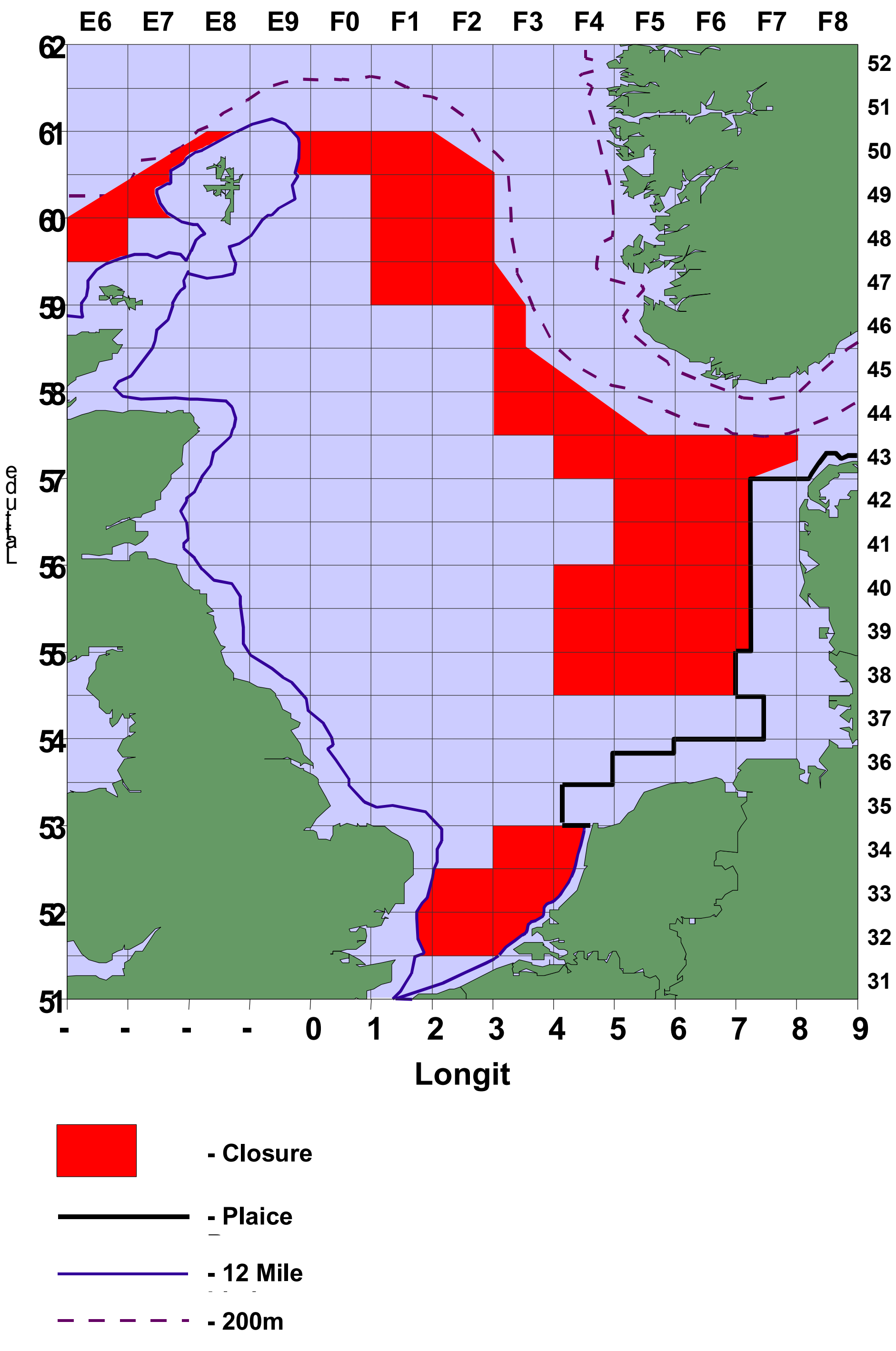


Figure 3.1. Closed area to cod fishing 14 February – 30 April 2001

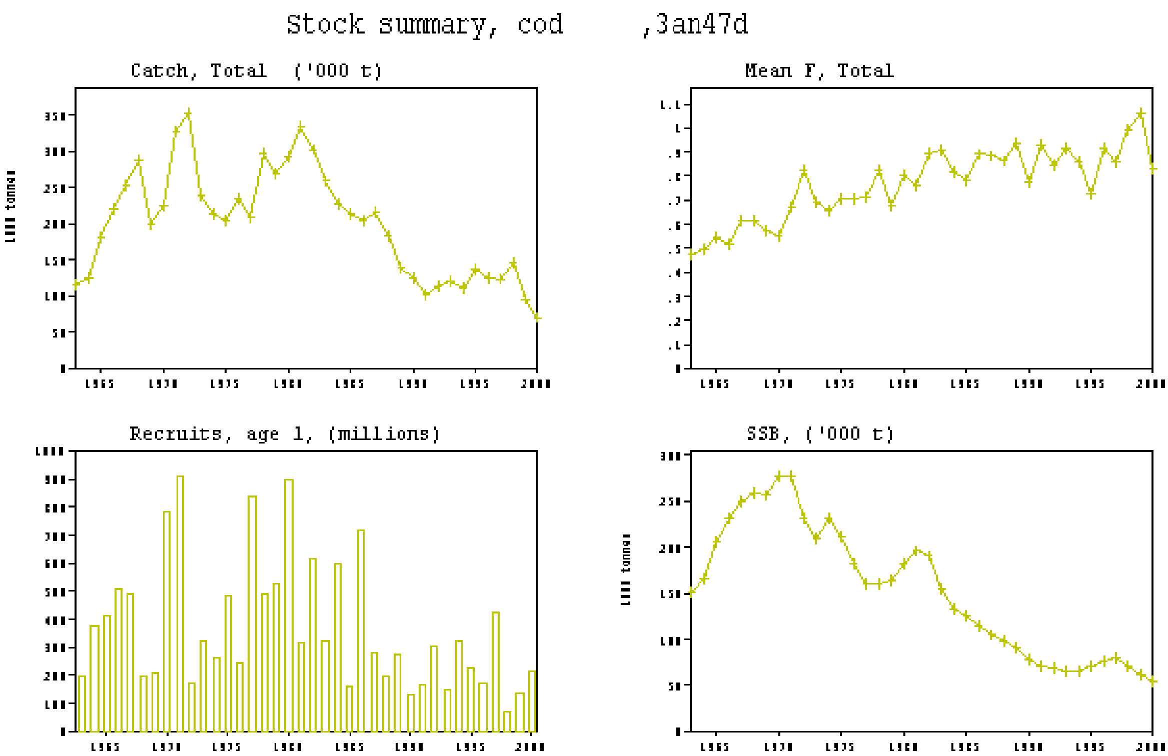


Figure 3.1.1 Cod in Sub-area IV, Division VIId and Division IIIa (Skagerrak).

Figure 3.2.1. Cod in Sub-area IV and Divisions IIIa (Skagerrak) and VIId.
Trends in mean weight at age in the landings relative to the mean weights at age in 1963.

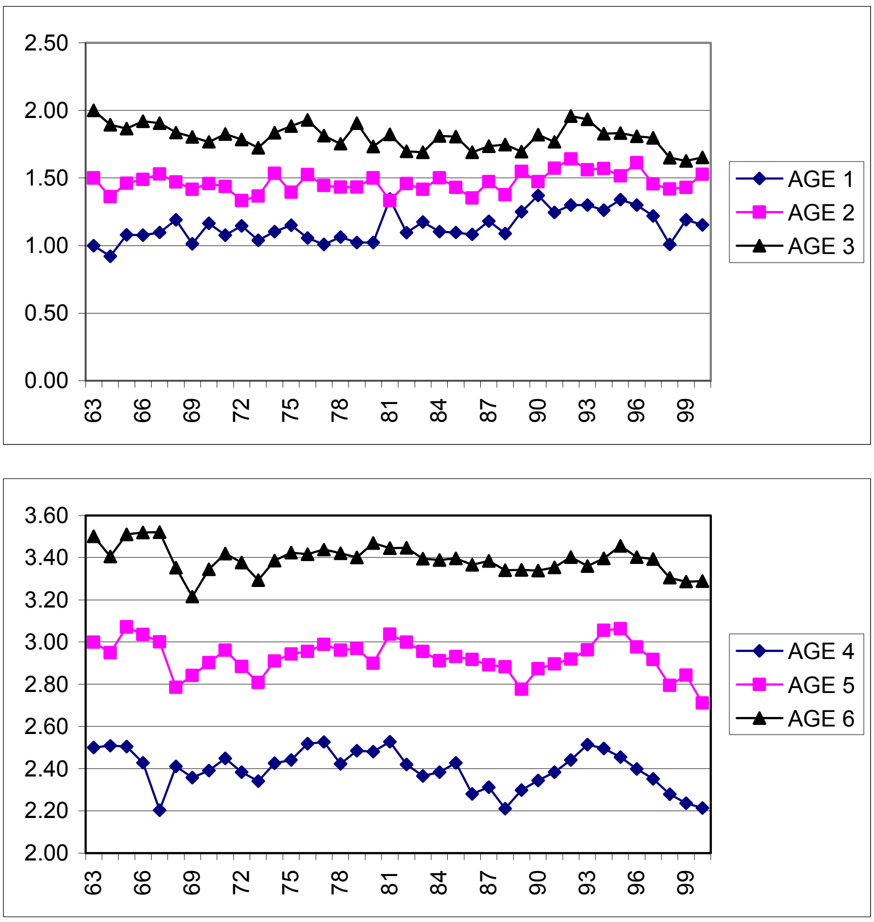


Figure 3.3.1. Cod IIIa, IV + VIId: Normalised trends in tuning fleet indices relative to international landings for ages 1 -

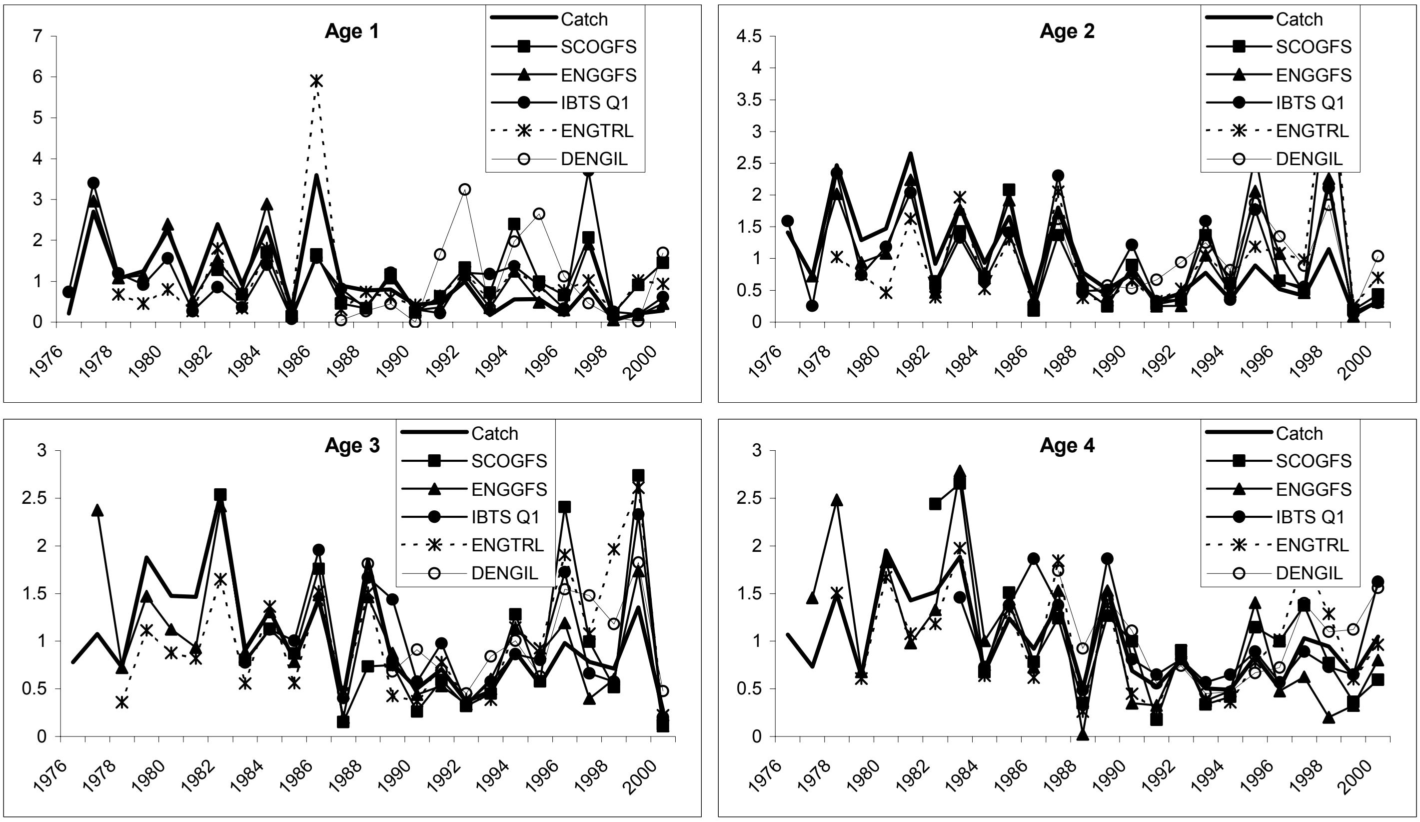


Figure 3.4.1a. Cod in Sub-area IV and Divisions IIIa (Skagerrak) and VIId. Log catchability residuals for single fleet XSA tunings

ENGTRL_4 single fleet XSA residuals. Low shrinkage, no taper.

DANGIL single fleet XSA residuals. Low shrinkage, no taper.

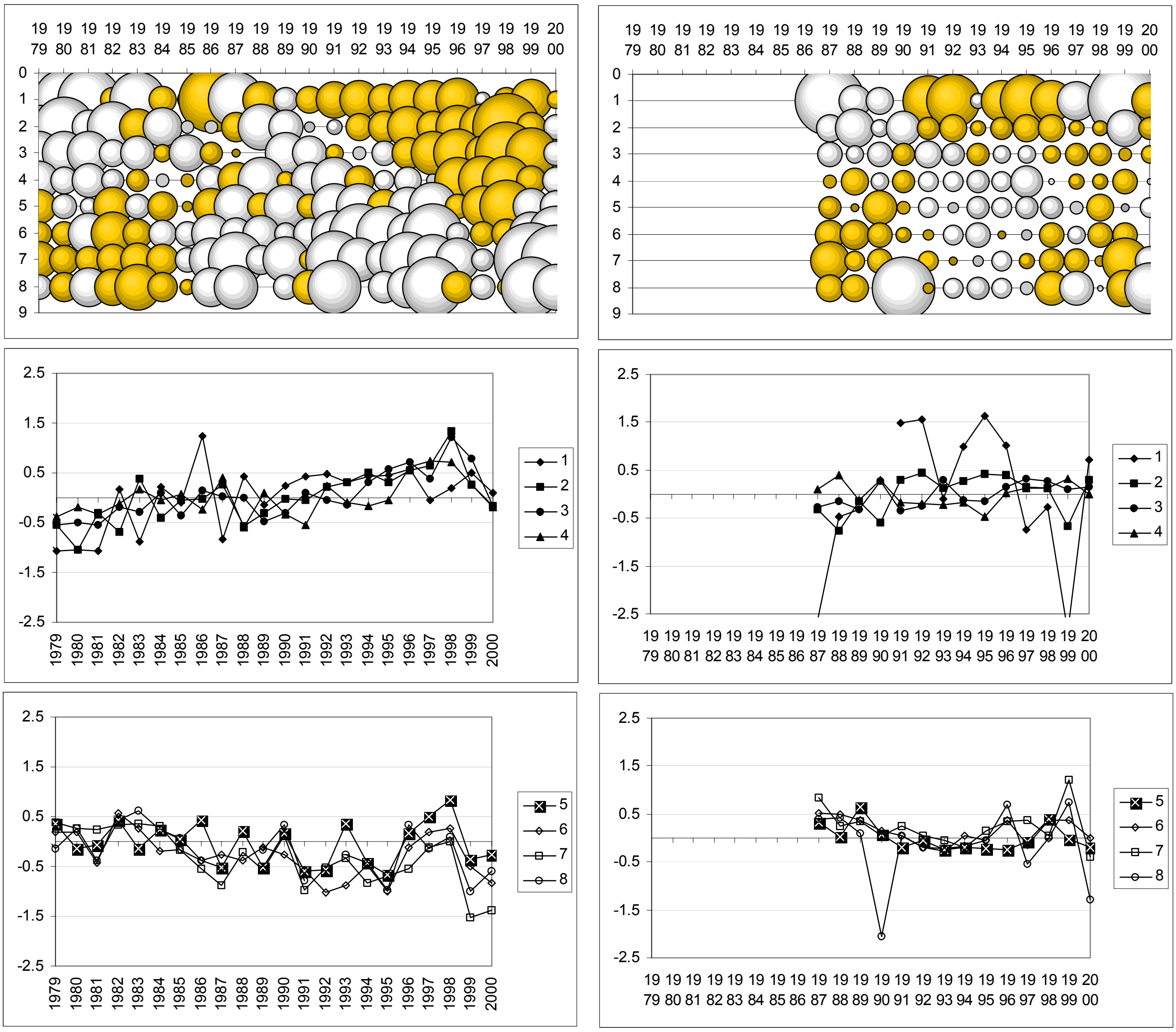


Figure 3.4.1b. Cod in Sub-area IV and Divisions IIIa (Skagerrak) and VIId. Log catchability residuals for single fleet XSA tunings

EGFS single fleet XSA residuals. Low shrinkage, no taper. | **SCOGFS single fleet XSA residuals. Low shrinkage, no taper.**

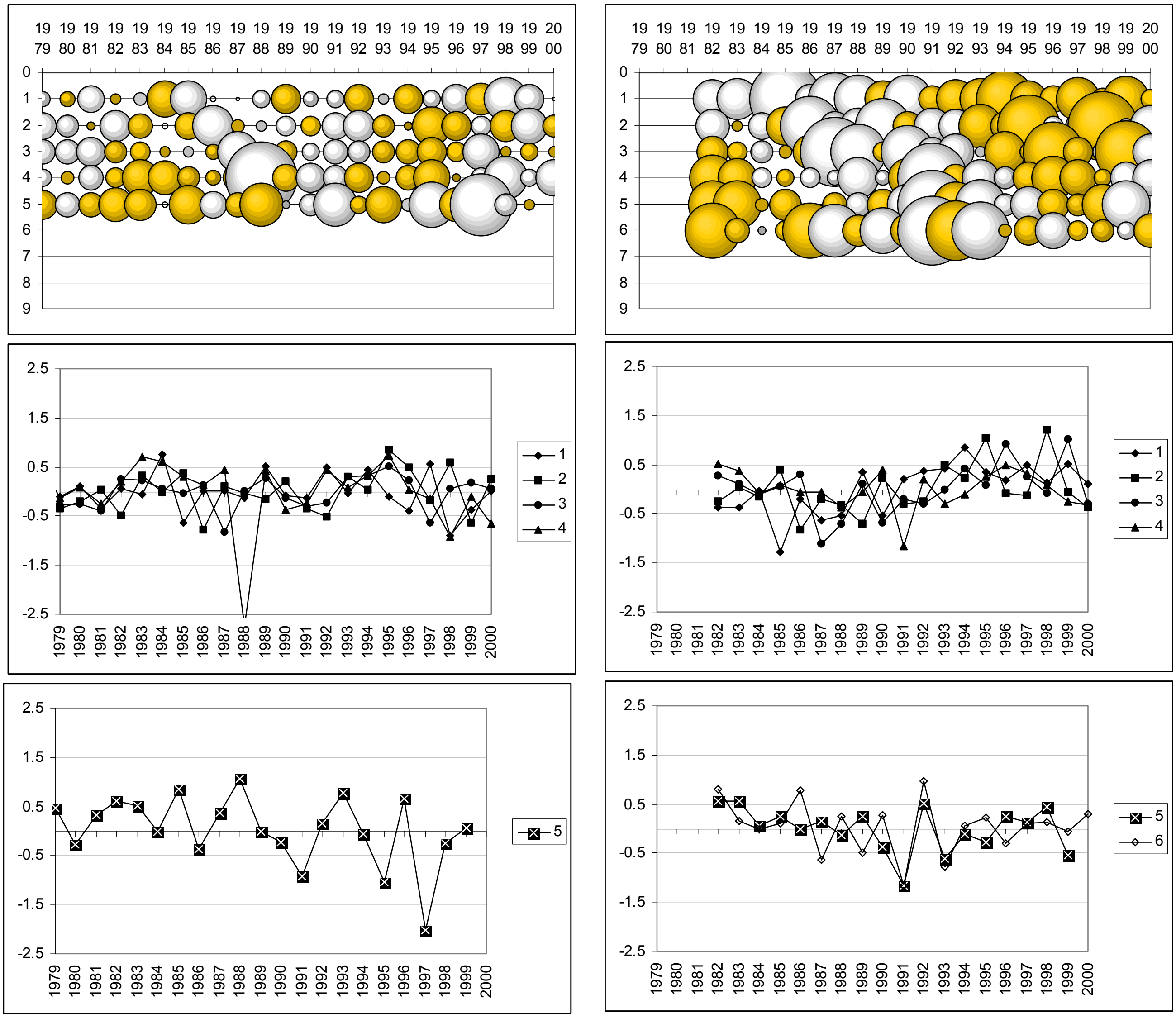


Figure 3.4.1c. Cod in Sub-area IV and Divisions IIIa (Skagerrak) and VIId. Log catchability residuals for single fleet XSA tunings

IBTS Q1_4 single fleet XSA residuals. Low shrinkage, no taper.

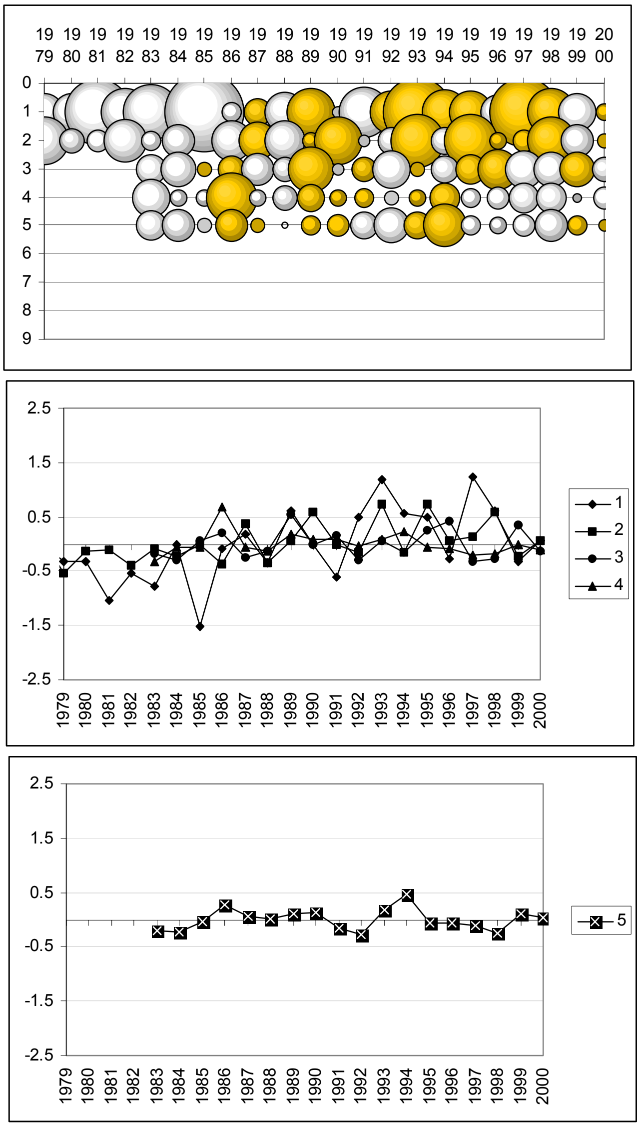


Figure 3.4.1d. Cod in Sub-area IV and Divisions IIIa (Skagerrak) and VIId. Log VPA population numbers against log q residuals from single fleet xsa tuning runs

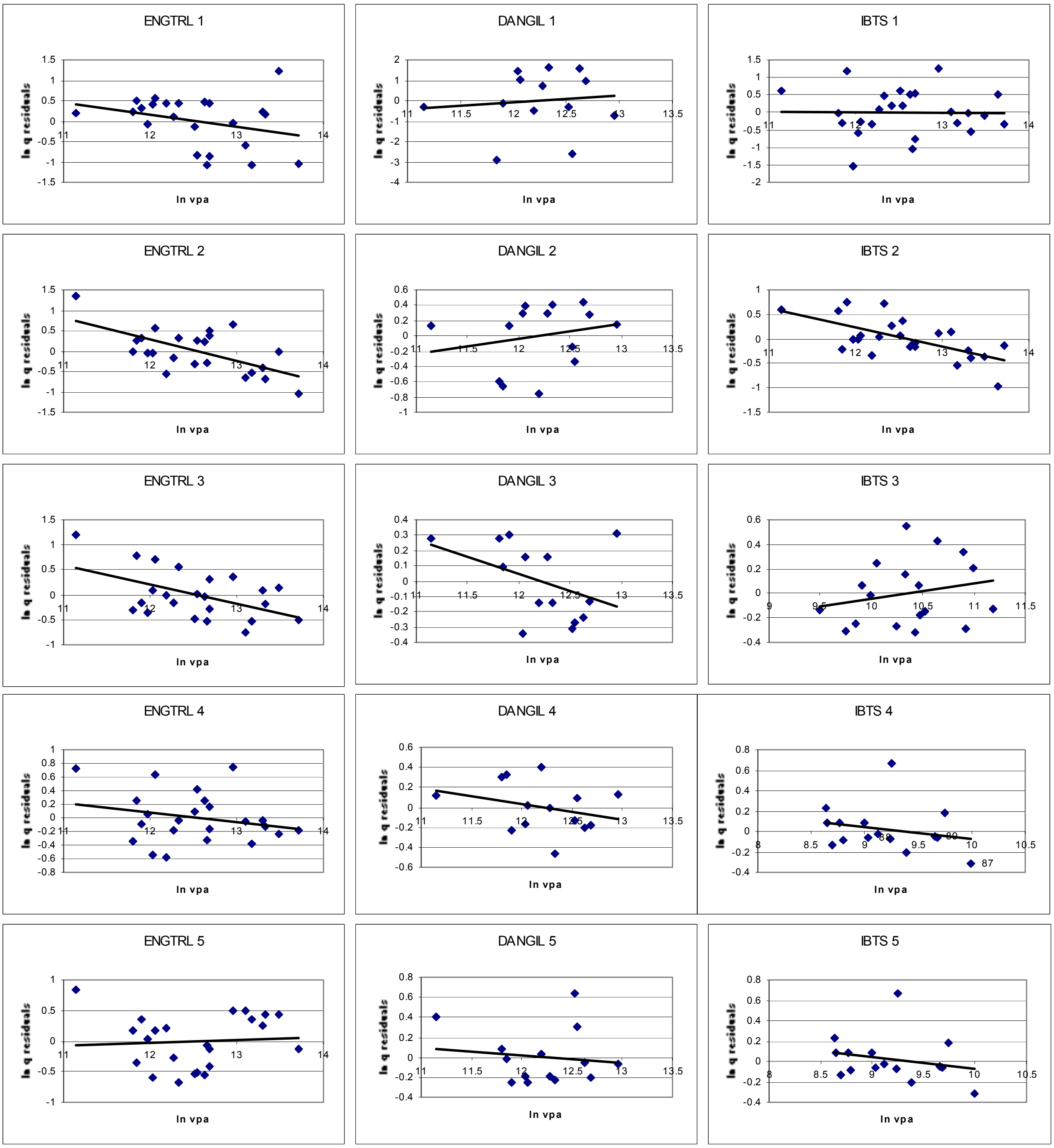


Figure 3.4.1d. Continued

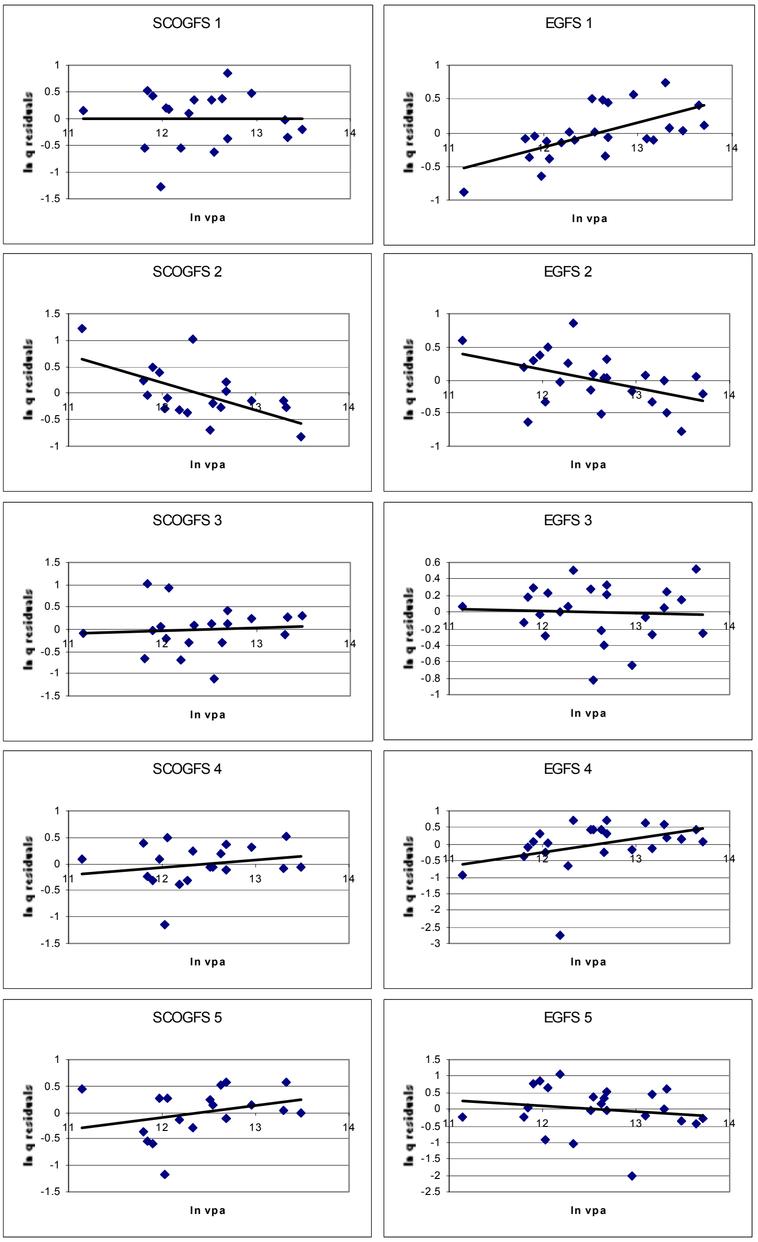


Figure 3.4.2a. Cod in Sub-area IV and Divisions IIIa (Skagerrak) and VIId. Log catchability residuals. Final XSA tuning.

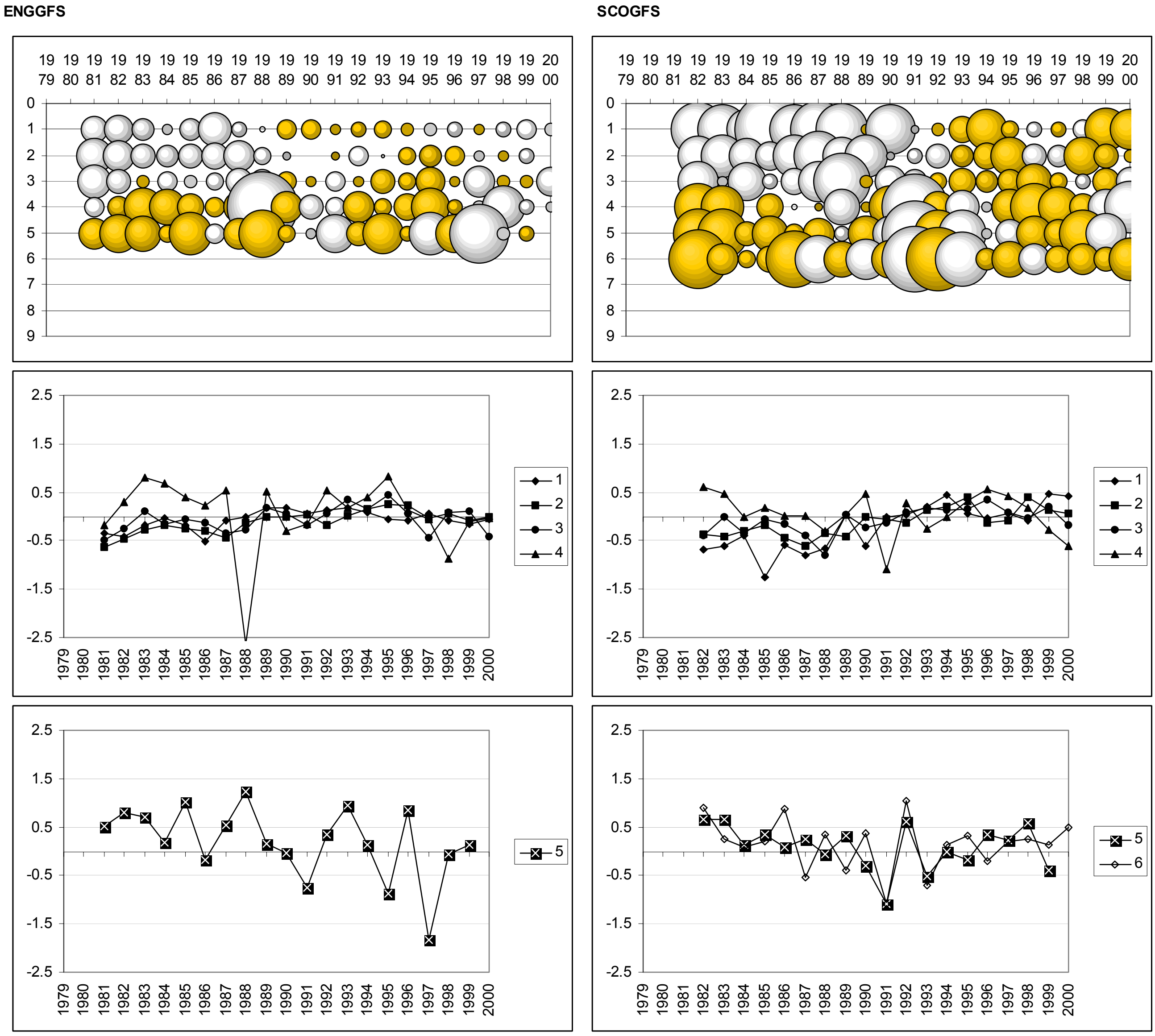


Figure 3.4.2b. Cod in Sub-area IV and Divisions IIIa (Skagerrak) and VIId. Log catchability residuals. Final XSA tuning.

IBTS Q1 IV

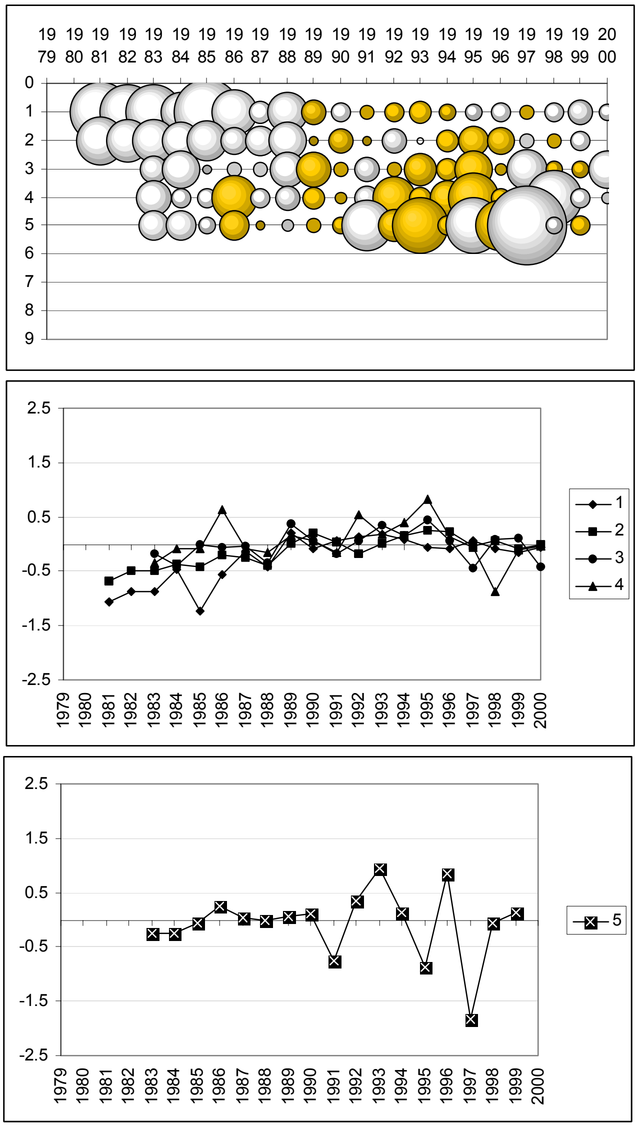
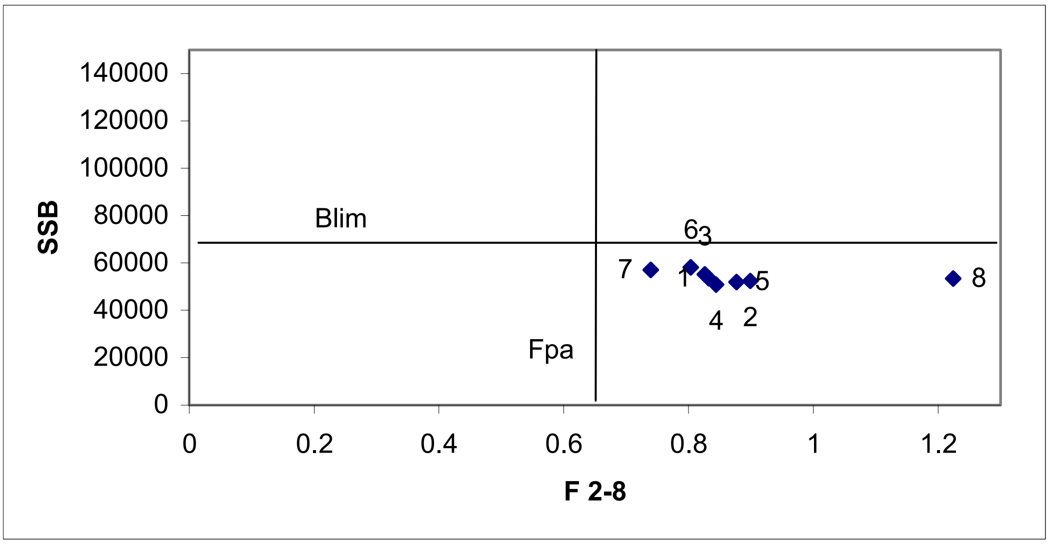


Figure 3.4.2c . Resulting F and SSB estimates from exploratory XSA calibration runs.



Key

1 Surveys only
2 Surveys + English Trawl
3 Surveys + English trawl + Danis Gillnet
4 Scottish groundfish survey
5 English Groundfish survey
6 IBTS quarter 1
7 Danish Gill net
8 English trawl only

Figure 3.4.3. Cod in Sub-area IV and Divisions IIIa (Skagerrak) and VIId. Log (n) survey cpue adjusted to the start of the year against log(n) vpa population numbers.

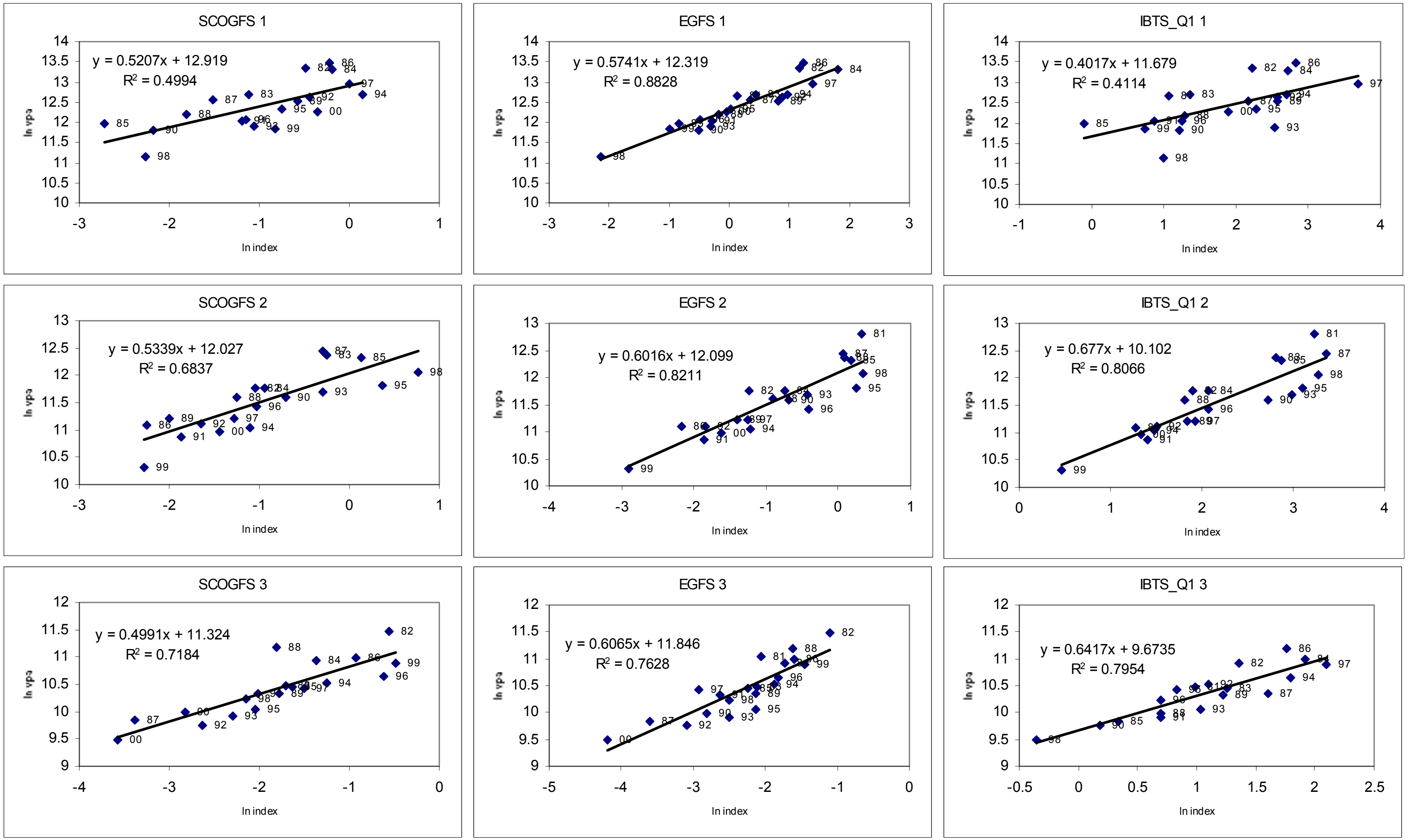
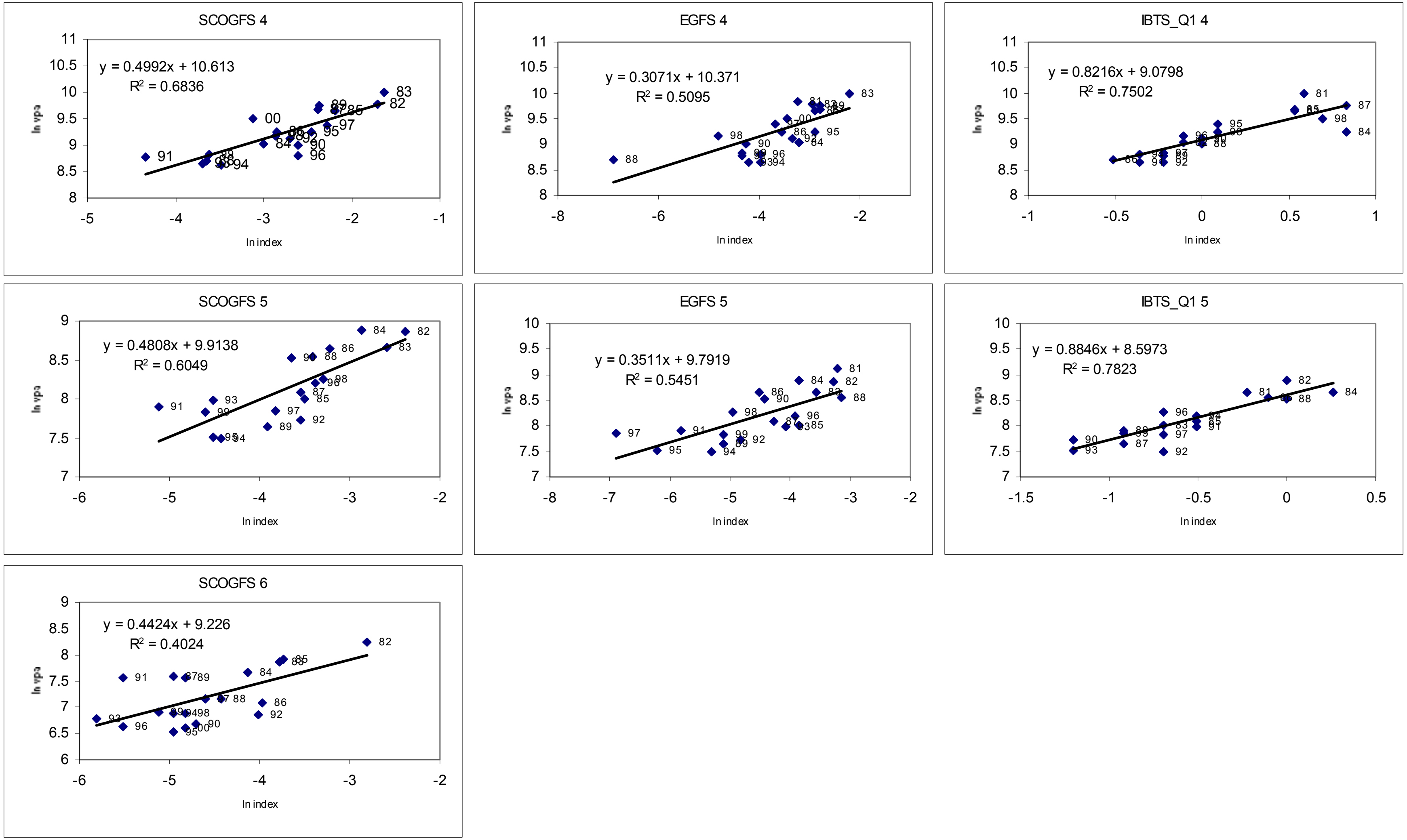


Figure 3.4.3. Continued.



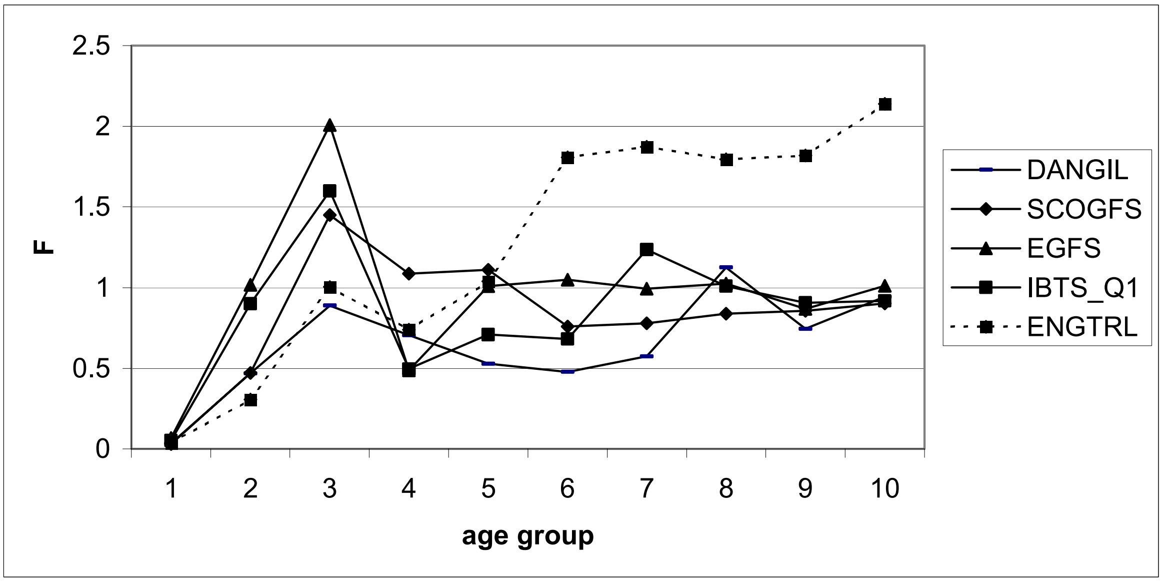


Figure 3.4.4. Cod in Sub-area IV and Divisions IIIa (Skagerrak) and VIId.
Terminal exploitation patterns by fleet from single fleet xsa tunings using low shrinkage, no taper and constant q on all ages. Minimum SE of fleet estimates set to 0.1.

99

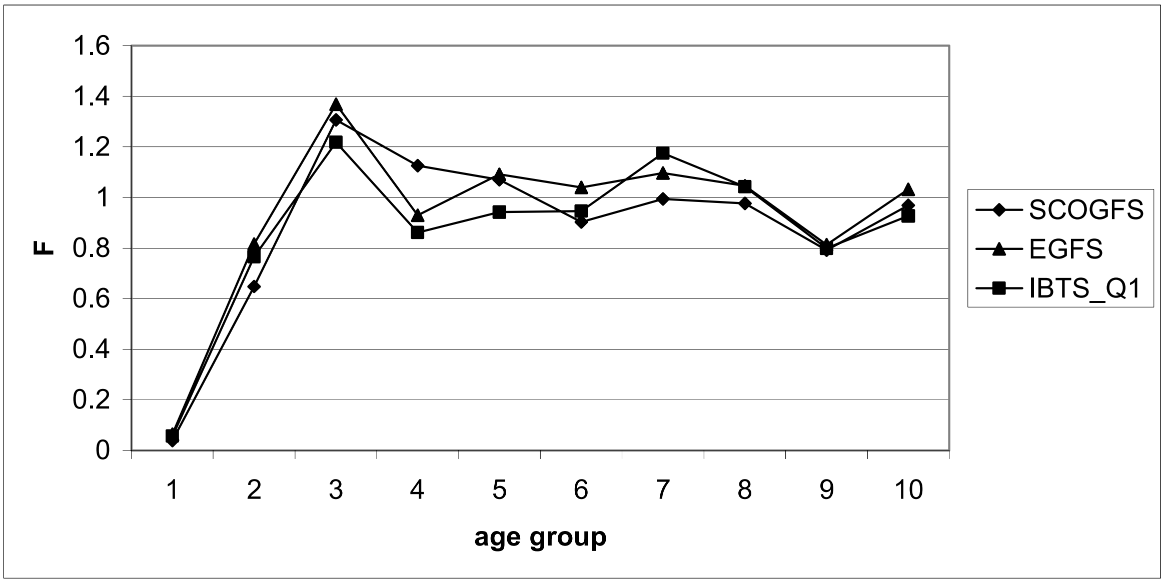


Figure 3.4.5. Cod in Sub-area IV and Divisions IIIa (Skagerrak) and VIId.
Status quo exploitation patterns (mean 1998-2000) by fleet from single fleet xsa tunings using low shrinkage no taper and constant q on all ages.
Minimum SE of fleet estimates set to 0.1.

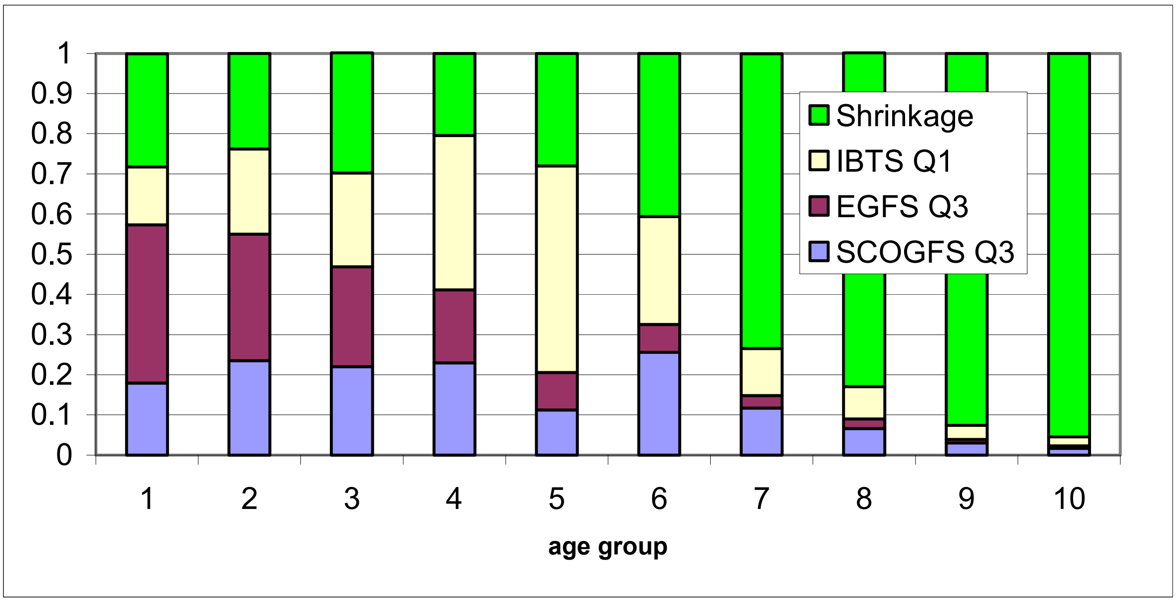
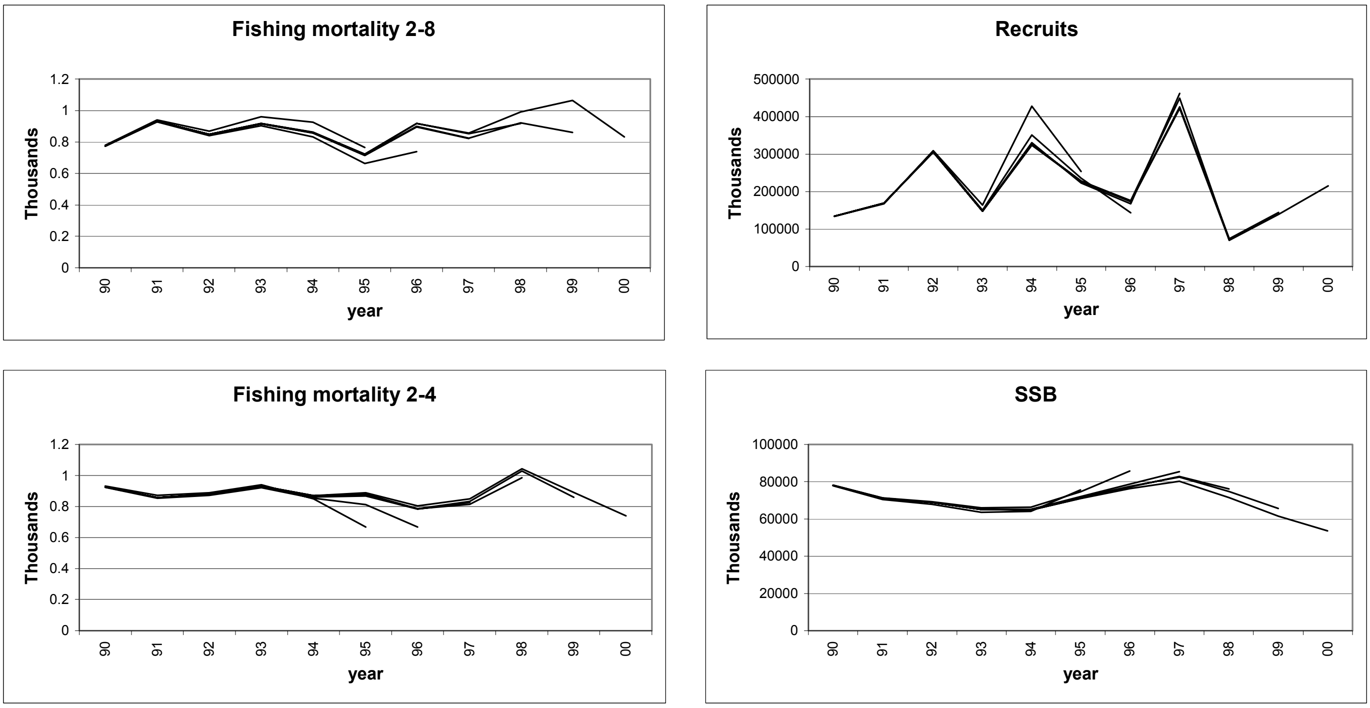


Figure 3.4.6. Cod in Sub-area IV and Divisions IIIa (Skagerrak) and VIId. Contribution of tuning fleets and shrinkage to F and population estimates

Figure 3.4.7. North Sea cod. Retrospective assessment bias using surveys only, with shrinkage (0.5,5yr, 5 ages) fleet min SE 0.3 20 yr tricubic taper.



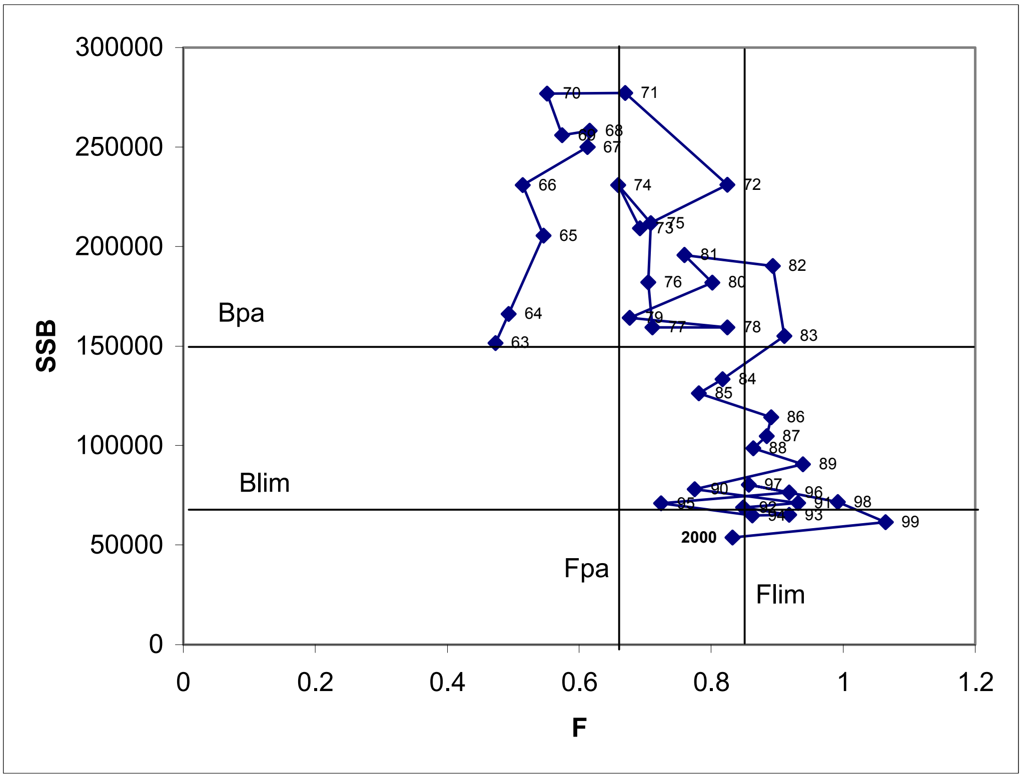
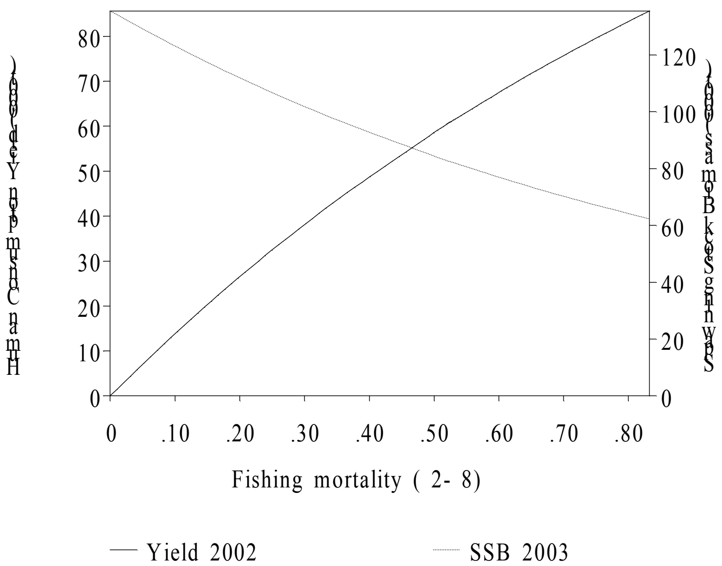


Fig_3.6.1. Cod in Sub-area IV and Divisions IIIa (Skagerrak) and VIId: Trajectory of F and SSB

Figure cod,3an47d. Short term forecast



Data from file:C:\Cod\CODIV.SEN on 25/06/2001 at 16:59:55

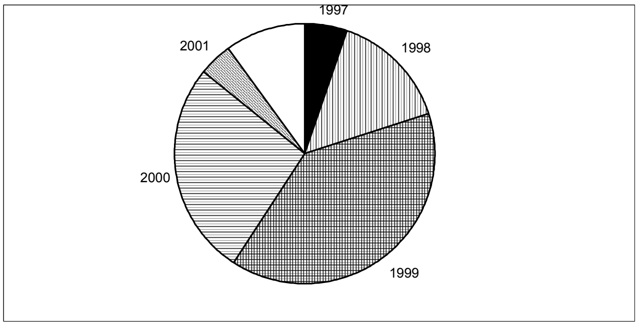
Figure 3.7.1 Cod in Sub-area IV, Division VIId and Division IIIa (Skagerrak). Short-term yield and SSB as a function of fishing mortality.

Year-class			1997	1998	1999	2000	2001
Stock No. (thousands)			69536	139369	215023	152000	200000
of	1 year-olds						
Source			VPA	VPA	VPA	RCT-3	st-GM
Status Quo F:							
% in	2001	landings	10.0	24.6	39.1	3.2	-
% in	2002		5.3	14.6	39.2	26.8	4.1
% in	2001	SSB	17.4	15.8	7.9	1.7	-
% in	2002	SSB	12.8	25.6	25.4	5.5	2.1
% in	2003	SSB	6.6	17.9	39.1	16.7	6.6

st-GM : short term geometric mean recruitment

Cod in IIIa (Skagerrak), IV and VIId : Year-class % contribution to

a) 2002 landings



b) 2003 SSB

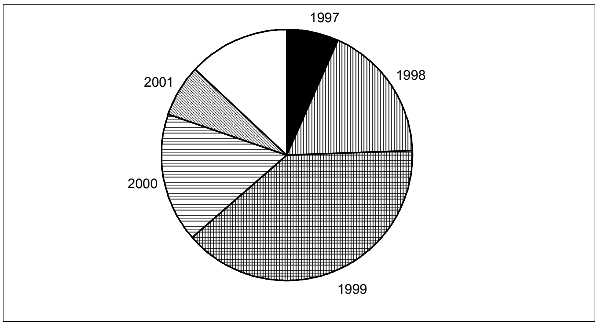


Figure 3.7.2 Cod in Sub-area IV, Division VIId and Division IIIa (Skagerrak).

Figure cod,3an47d. Sensitivity analysis of short term forecast.

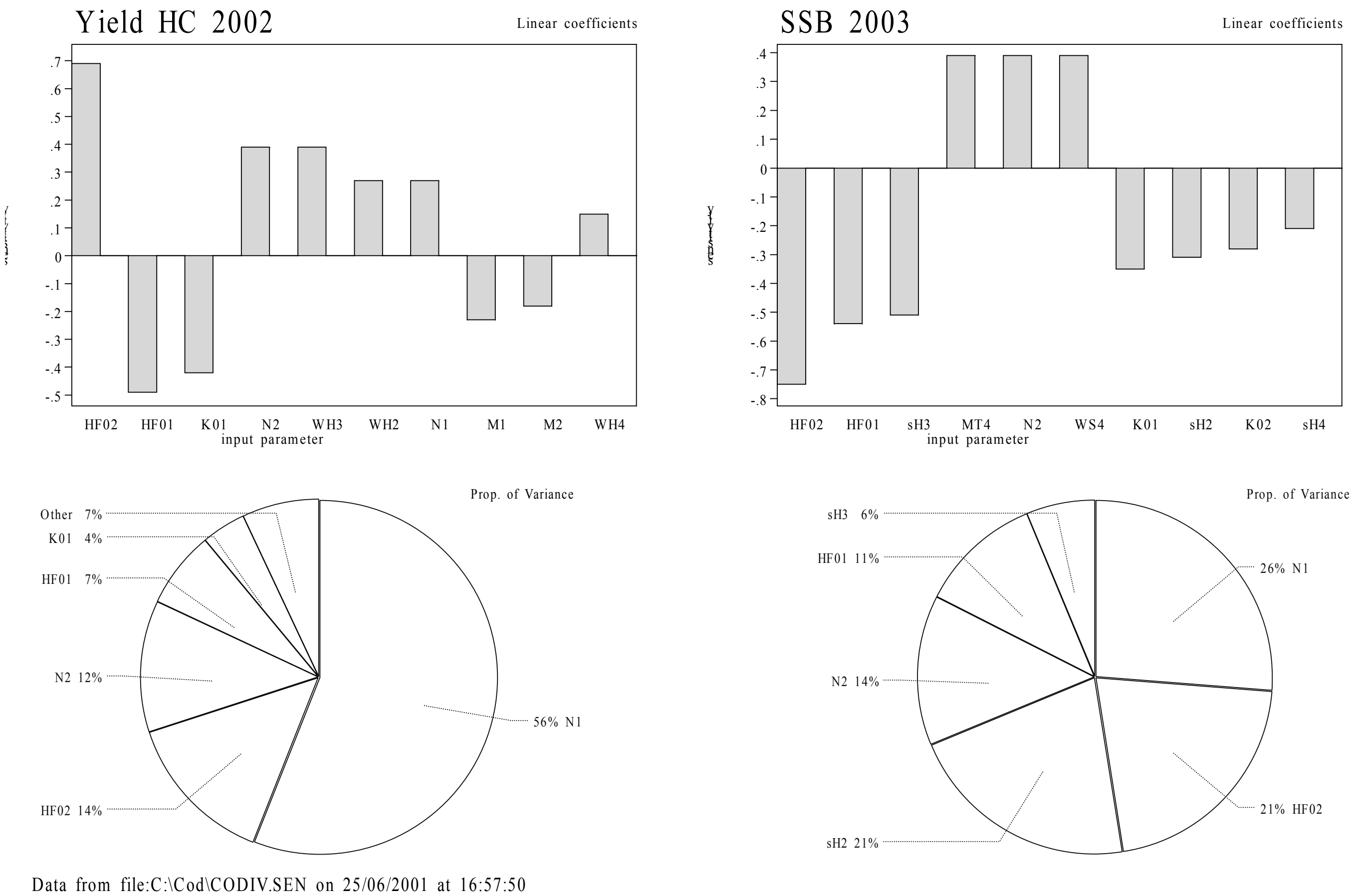
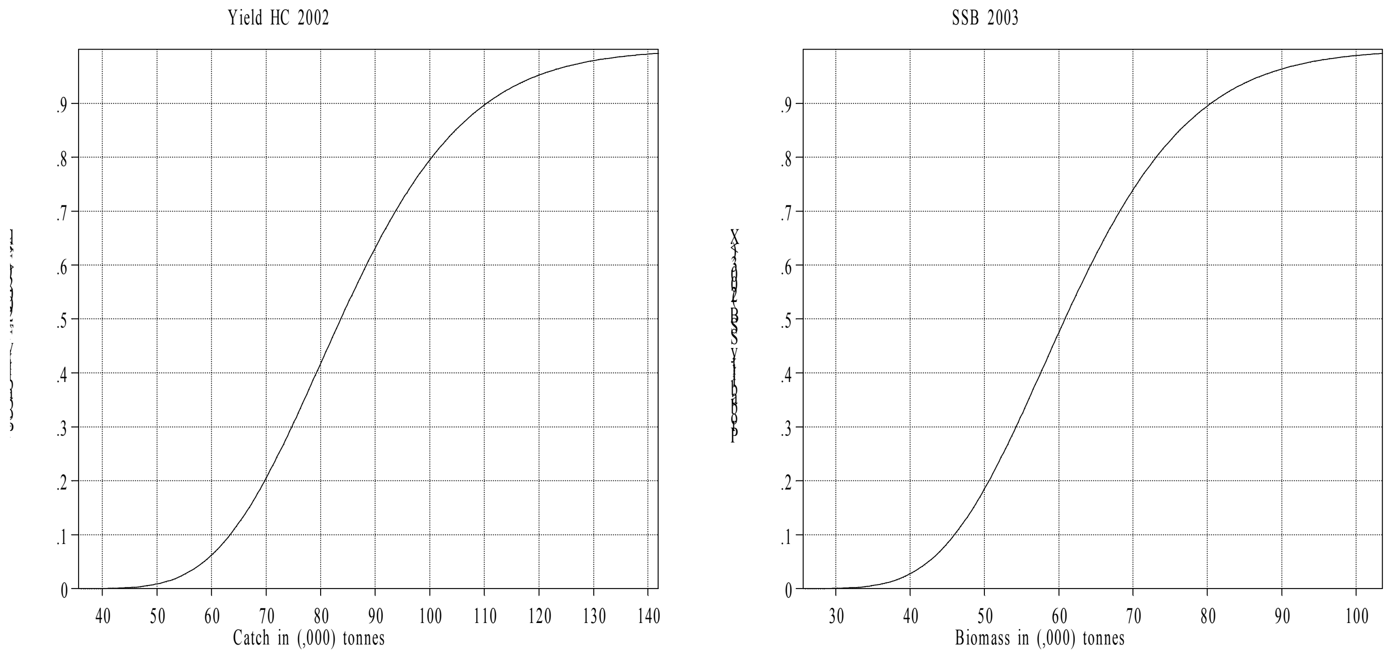


Figure 3.7.3 Cod in Sub-area IV, Division VIId and Division IIIa (Skagerrak). Sensitivity plot.

Figure cod,3an47d. Probability profiles for short term forecast.



Data from file:C:\Cod\CODIV.SEN on 25/06/2001 at 16:58:44

Fig. 3.7.4 Cod in Sub-area IV, Division VIId and Division IIIa (Skagerrak). Probability plot.

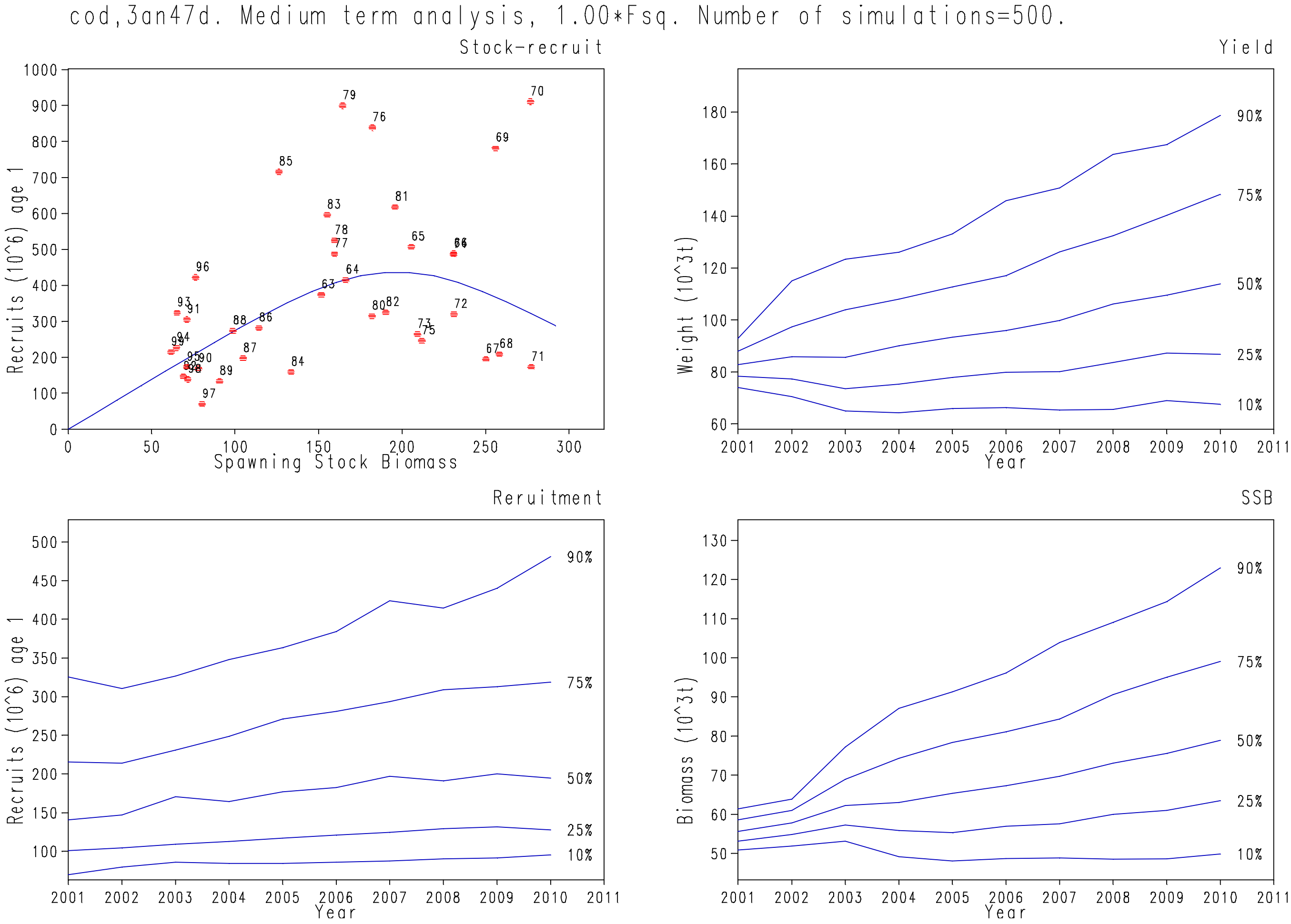


Figure 3.8.1 Cod in Sub-area IV, Division VIId and Division IIIa (Skagerrak). SSB-Recruit model (entire series) and *status quo* F medium term forecasts for yield, recruits and SSB.

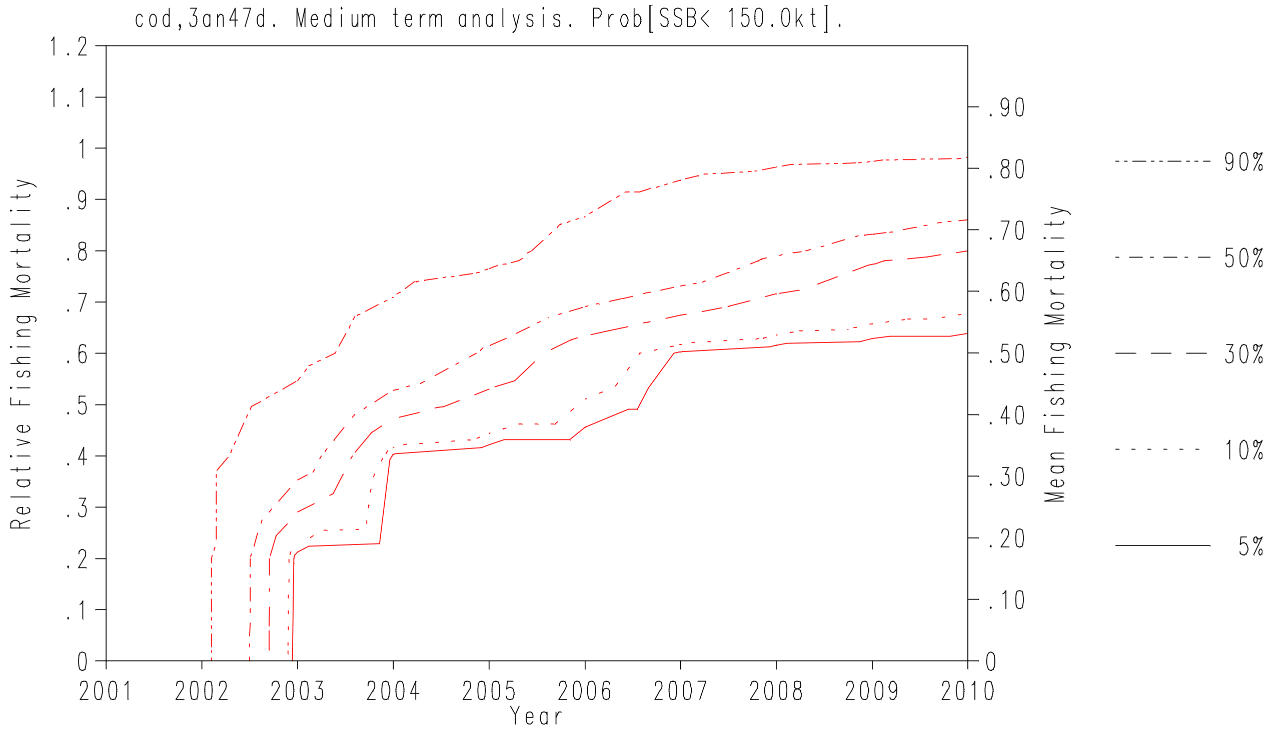


Figure 3.8.2 Cod in Sub-area IV, Division VIId and Division IIIa (Skagerrak). Contour plot based on the entire recruitment series.

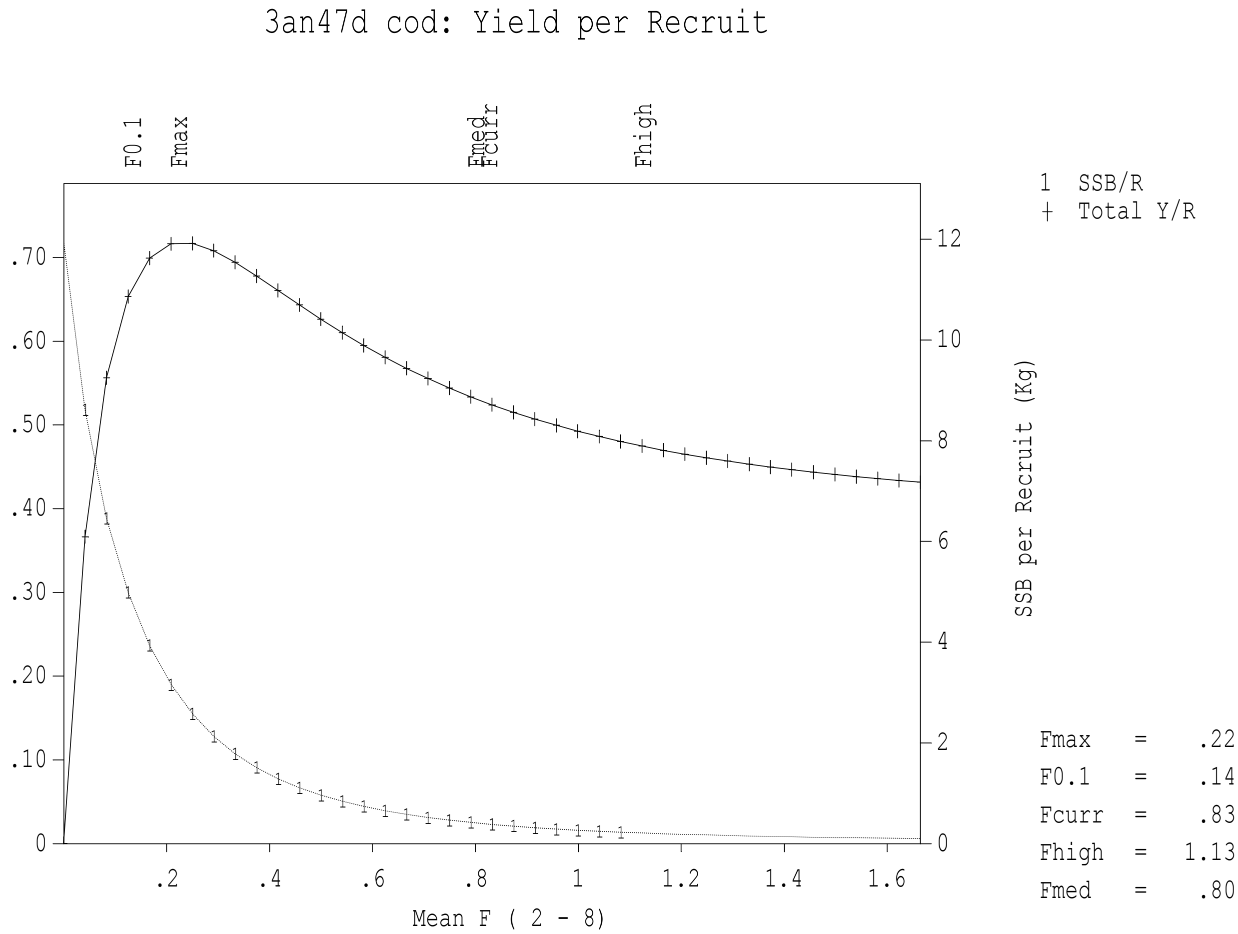


Figure 3.9.1 Cod in Sub-area IV, Division VIId and Division IIIa (Skagerrak). Long-term yield and SSB as a function of fishing mortality.

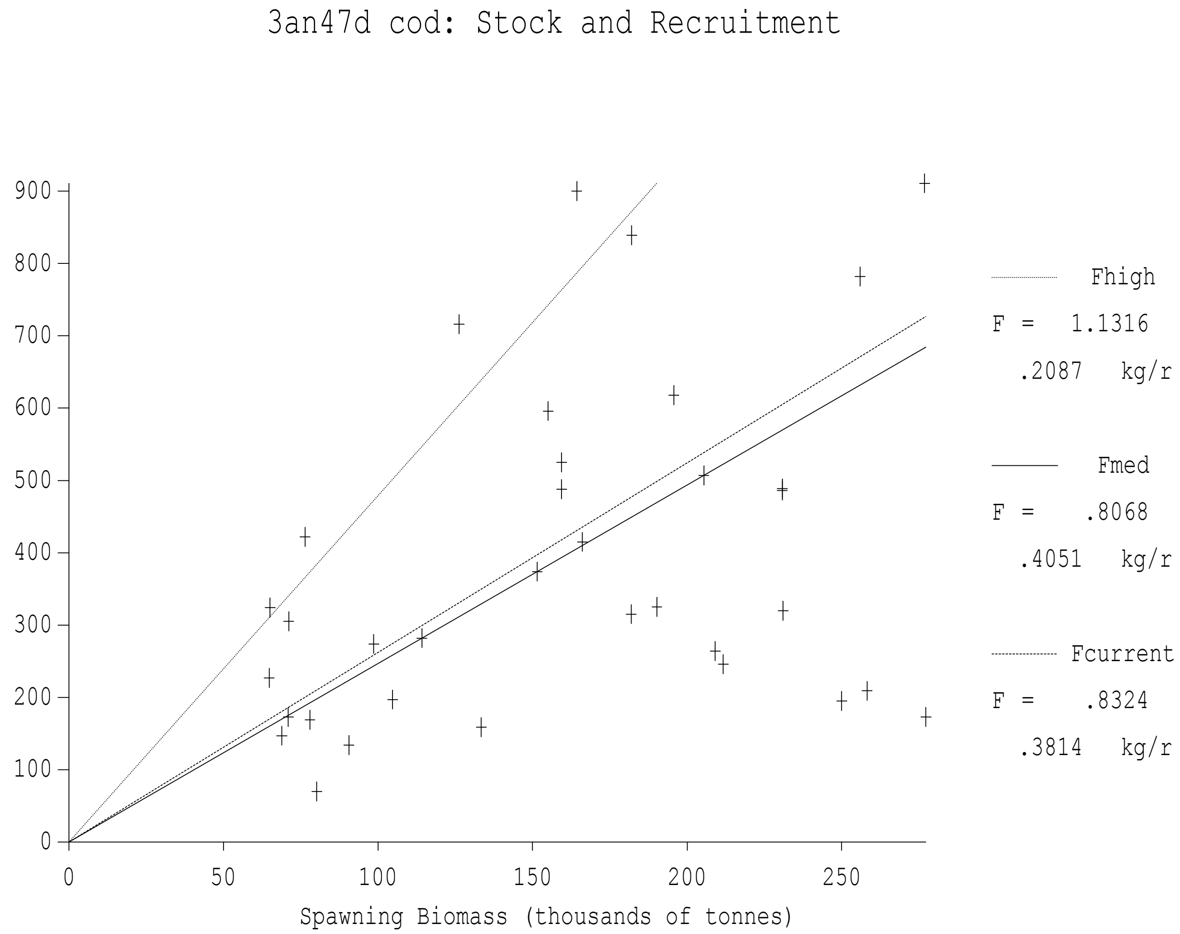
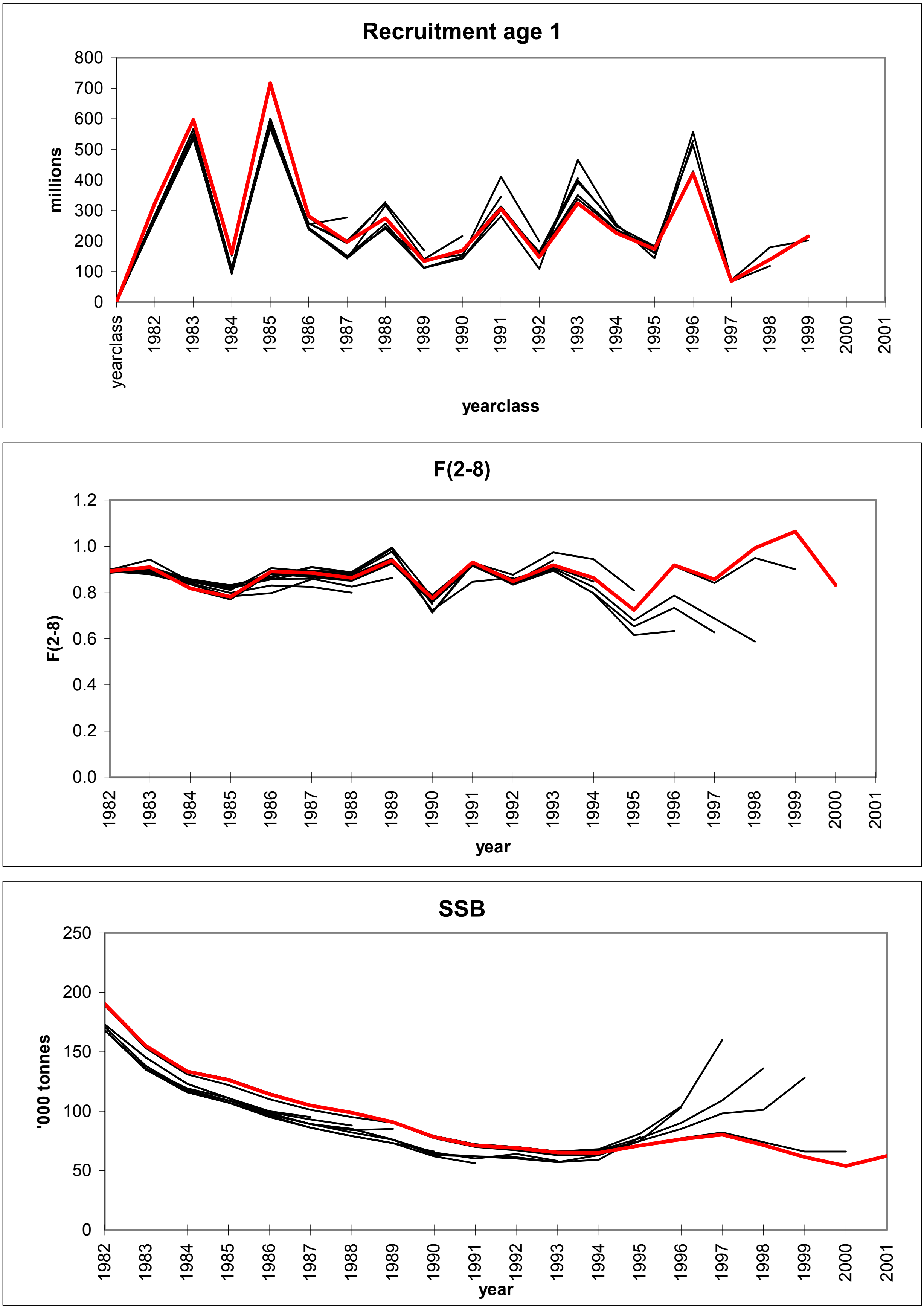


Figure. 3.9.2 Cod in Sub-area IV, Division VIId and Division IIIa (Skagerrak).

Figure 3.10.1 Quality Control Diagram
Cod in Sub-area IV, Divisions IIIa (Skegerrak) and VIId



NORTH SEA COD. Assessments generated in subsequent Working Groups.

4 HADDOCK IN SUB-AREA IV AND DIVISION IIIA

4.1 The fishery

In the North Sea, haddock is taken as part of a mixed demersal fishery, with the large majority of the catch being taken by Scottish light trawlers, seiners and pair trawlers. These gears have a minimum legal mesh size of 100 mm. Smaller quantities are taken by other Scottish vessels, including *Nephrops* trawlers which use mesh sizes between 70 and 100mm mesh and hence may have higher discard rates. Vessels from other countries including England, Denmark and Norway also participate in the fishery, and haddock are also taken as a by-catch by Danish and Norwegian vessels fishing for industrial species. In Division IIIa, haddock are taken as a by catch in a mixed demersal fishery, and in the industrial fishery. Landings from Division IIIa are small compared to the North Sea.

4.1.1 ACFM advice applicable to 2000 and 2001

In 1999 ACFM considered the stock to be within safe biological limits and recommended that fishing mortality in 2000 should be below the proposed $\mathbf{F}_{pa}$ (0.7) in order to increase or maintain SSB above the proposed $\mathbf{B}_{pa}$. (140,000t). It was clear at that time that unless F was maintained at a lower value the SSB would decline in the short term. The assessment in 2000 indicated that the fishing mortality was above $\mathbf{F}_{pa}$ and that SSB was below $\mathbf{B}_{pa}$ and advice was to reduce F below $\mathbf{F}_{pa}$ in 2001. ACFM also recommended measures to reduce discarding in view of the large 1999 year class that was entering the fishery.

4.1.2 Management applicable to 2001

In the main North Sea fishery the minimum legal mesh size is 100 mm, although vessels using smaller mesh sizes to fish for *Nephrops* or industrial species can land some haddock, but are subject to bycatch limits. Unilateral legislation making 90mm square mesh panels mandatory for UK vessels fishing for roundfish was introduced during summer 2000. The legislation also includes constraints on the positioning and construction of the panel, with the intention of making gears more selective for haddock and thus reducing discarding of the large 1999 year class. The closure of the Norway Pout box to industrial fishing is another measure by which by-catches of haddock are limited. The minimum landing size for haddock is 30 cm in the North Sea and 27cm in Division IIIa. On an annual basis, management of the fishery is through TACs. In 2001 the spring cod spawning closure displaced vessels from areas where haddock were commonly fished and for a brief period a number of vessels remained in port.

In Division IIIa the 2001 TAC is 4000 t and in the North Sea the 2001 TAC is 61000t.

4.1.3 Catches in 2000

Nominal landings of haddock from Division IIIa for recent years are given in Table 4.1.1, along with Working Group estimates of landings and industrial bycatch. Table 4.1.1 also gives the corresponding figures for haddock in the North Sea, and Table 4.1.2 gives the full time series of Working Group estimates for both areas.

In Division IIIa total landings during 2000 amounted to about 2 thousand tonnes, with industrial bycatch accounting for about 600 t of this total, an increase over 1999.

In the North Sea, human consumption landings in 2000 were around 47,000 t, which continues the decline in landings of recent years. The 2000 landing is below the TAC. The levels of discarding increased in 2000, especially as the 1999 year class entered the fishery. However, the estimated discards in 2000 were less than the predicted value made last year. This may be the result of the square mesh panel and/or a slower than expected rate of growth of the 1999 year class.

4.2 Natural Mortality, Maturity, Age Composition, Mean Weight At Age

Natural mortality estimates are given in Table 4.2.1 along with the maturity ogive. The estimates of natural mortality originate from MSVPA - see Section 1.3.1.3 of 1999 WG report (ICES CM 2000/ACFM:7). The maturities are based on IBTS data. Both natural mortality and maturity are assumed constant with time. Biomass totals are calculated as at the beginning of the year.

For Division IIIa in 2000, age composition data for the human consumption and industrial catches were supplied by Denmark, which accounts for around most of the human consumption landings and all of the industrial bycatch in this area. Age composition data for the North Sea human consumption landings were supplied by Denmark, England, France, Scotland and Belgium. These nations accounted for over 90% of the total landings. Industrial bycatch age compositions for the North Sea were supplied by Denmark and Norway. Discard totals and age compositions for the North Sea were estimated from Scottish data. No estimates of discards are available for Division IIIa. Catch-at-age data are given in Table 4.2.2. The catch-at-age data for the North Sea are SOP corrected; there are slight SOP discrepancies in the combined data arising from minor discrepancies in the Division IIIa data. The 1999 year class is numerically the largest in the catches though most of these fish were discarded.

The mean weight at age data for the Division IIIa catches do not cover all years and for earlier years are not split by catch category, so only North Sea values have been used. Weight at age data from the total catch (i.e., human consumption, discards and industrial bycatch) in the North Sea, which are also used as stock weights at age, are given in Table 4.2.3. The weight at age of the 1999 year class is particularly low.

4.3 Catch, Effort and Research Vessel data

The fleet data available for tuning are listed in Table 4.3.1 along with the age and year ranges for which data are available The fleets consist of two Scottish commercial fleets and three research vessel surveys. Definitions of the commercial fleets are the same as those given for the equivalent vessels working in Division VIa which are given in the Report of the 1998 Working Group on the Assessment of Northern Shelf Demersal Stocks (ICES CM 1999/ACFM:1, Appendix 2). In order to include the most recent information from the IBTS quarter 1 survey, this survey is treated as if it takes place at the end of the preceding year, by appropriate adjustments of the age and year ranges, and of the alpha and beta parameters. The IBTS q1 survey in 2001 is the only new fishery independent data since the last assessment. English and Scottish groundfish surveys for 2001 will be available in autumn 2001 had not been carried out at the time of the working group meeting.

4.4 Catch-at-age analysis

The five tuning fleets available for this stock include two Scottish commercial series. From 1999 onwards the Scottish commercial effort data are incomplete making these fleets unsuitable for tuning. In the Scottish August groundfish survey, the vessel and gear used were changed for the 1998 and subsequent surveys, leading to the possibility of catchability change in this series. These survey data were excluded from the 1999 assessment because of evidence of an increase in catchability for the smaller fish, and this practice has been continued for the current assessment. These fleets have, however, been included in exploratory runs.

4.4.1 Exploratory analyses

A number of exploratory runs were undertaken to evaluate the sensitivity of the assessment to both the data and the assessment model. A series of XSA runs was made tuning with the individual surveys and with the two commercial fleets combined. In each case the program default settings were used. These runs are summarised in Figure 4.4.1 which shows the terminal SSB and F(2-6) estimated for 2000. As expected the results show that the commercial data imply a much higher SSB and lower F than the surveys which is caused by the incomplete commercial effort data. This supports the view that the commercial data should be excluded from the analysis. The surveys all give similar results with the estimates lying in the range 80-90 kt for SSB and 0.8-1.0 for F. The Scottish Groundfish survey (SGFS) gives the most optimistic view of the stock, but despite the uncertainties related to the change in survey design it is consistent with the English GFS and the IBTS Q1 survey.

Three additional runs were performed using alternative analytical models. These included a separable VPA which assumed no trend in F over the most recent 10 years, Laurec-Shepherd ad hoc tuning and PSEP, a version of CAGEAN which assumed separability in F over the most recent 6 years and was tuned with the EGFS. Theses additional runs all gave similar results to XSA with survey data, although the separable VPA gave a somewhat lower SSB value.

The results of the exploratory runs suggest that the choice of model is not critical to the results and that the choice of tuning data is more important. There are good reasons to exclude the commercial CPUE from tuning, and given the doubts about the consistency of recent SGFS indices this has been excluded from the final assessment. Residual plots for individual fleets are not presented here as residual analysis was not the basis on which these fleets were rejected.

An important consideration in the assessment model formulation is the influence of the 1999 year class on the results. This year class is very large and the survey indices for it are all the largest in the time series. This means that in the most recent year, there is a danger of extrapolating beyond the range of the data. Figure 4.4.1 shows a summary of the estimates of the 1999 year class at age 0 and the F in 2000 which generated the estimate, obtained from each exploratory run. The range of estimates is very large showing that the choice of data and method is important to the result. An important feature to note is that the estimate of the size of the year class increases as the number of survey series used to tune the XSA increases. This is caused by the influence of shrinkage. In each run the same value of shrinkage has been used but its relative contribution to the result diminishes as the survey information increases. This indicates that the surveys contain a strong year class signal.

4.4.2 Key run settings

In view of the sensitivity of the assessment to the 1999 year class, it was decided to include all years of the tuning series in the analysis to reduce the leverage of the large survey indices and to treat both ages 0 and 1 as "recruits" to avoid over-estimation of a very influential population. Since the survey data only cover ages 0 to 5, the q plateau was set above age 3. A summary of the assessment settings in recent years is given below.

	1999 Assessment	2000 Assessment	2001 Assessment
Catch at age method	XSA	XSA	XSA
Fleets :	Two commercial, two survey	Two surveys	Two surveys
Scottish Light Trawl	1989 – 1998, age 0 – 9	Excluded	Excluded
Scottish Seiners	1989 – 1998, age 0 – 9	Excluded	Excluded
English Groundfish Survey	1989 – 1998, age 0 - 5	1990 – 1999, age 0 - 5	1977 – 2000, age 0 - 5
IBTS Quarter 1	1989-1999, age 0 – 5	1990 – 1999, age 0 - 5	1974 – 2001, age 0 - 5
Taper	Uniform over 10 years	Uniform over 10 years	Tricubic over 20 years
First age for constant q	0	1	2
q-plateau age	7	7	3
Shrinkage SE	0.5	0.5	0.5

4.4.3 Key run diagnostics

The consistency of the new settings was evaluated in a retrospective analysis which is shown in Figure 4.4.2. The retrospective is plotted in the conventional way which gives the trajectories of each assessment since 1981. No consistent bias is evident for either F or SSB. However, this presentation does not illustrate all the properties of the tuning method. To clarify this, the retrospective is plotted showing the deviation of each annual estimate from the value estimated in the 2001 assessment. Suppose that a particular value, X, (SSB, for example) is estimated for the year y in assessment year t. If the estimate for this SSB in the most recent (2001) assessment is denoted by X(y,*), then the deviation of the estimate in any one year is:

$$\frac{X(y,*) - X(y,t)}{X(y,*)}$$

Figure 4.4.2 shows these deviations for SSB and F(2-6). Each line on the graph corresponds to a single quantity whose estimate converges to a constant value as the assessment is updated. Hence the left extremity of each line measures the deviation of the value when it was first estimated in the terminal year of an assessment. In the case of F it can be seen that the deviation is typically in the range +/- 20% while for SSB it is much lower, being about +/- 5%. What is evident from this presentation compared with the conventional retrospective plot is that although there is no consistent bias there is auto-correlation in the assessment error. In the case of F this shows that the assessment has passed through a period of over-estimation but appears now to be in a phase of under-estimation. It seems likely that this property is related to an inconsistency between the survey data and the catch at age data.

The signal in the surveys was investigated by fitting a separable fishing mortality model (Cook, 1997) which estimates trends in F, relative catch, SSB and recruitment. Figure 4.4.3 shows the estimated trends from each of the surveys and can be compared with the key run. In all cases the surveys follow the trends emerging from the key run and suggest that F is high. It is noticeable that the trend in F from the surveys lies above the VPA for much of the early period but lies below it more recently. This change is similar to the pattern seen in Figure 4.4.2 and may explain the retrospective pattern.

Log catchability residuals are given in Table 4.4.1 shown in Figure 4.4.4 for the two tuning series. No trends are obvious for the most recent years, though the early EGFS residuals show a negative trend and there appears to be a shift in the IBTS from earlier years. However, the influence of these earlier residuals should be low due to the tri-cubic taper. The contribution of the data to the final population estimates is given in Figure 4.4.5. For ages 0-5 the surveys contribute more or less equally to the survivor values and account for between 70-80% of the total. For the oldest ages (6+) shrinkage dominates the estimate. The comparatively small contribution of shrinkage to the estimate of the 1999 year class indicates that the assessment is not sensitive to the power model at 1, though it has the effect of giving a slightly lower estimate of this year class than if a constant q model was used.

4.4.4 Key run results

Estimates of fishing mortalities at age from the final XSA run are given in Table 4.4.2, and stock numbers at age are given in Table 4.4.3. The present assessment indicates a mean total F in 2000 of 0.92. The current XSA run has revised the estimate of F in 1999 from 0.70 to 1.06. This change appears to be the result of the additional catch at age data since all exploratory runs resulted in inflated estimates of F in 1999. The changes to the tuning configuration do not appear to cause the change.

4.5 Recruitment Estimation

4.5.1 The 1999 year class

The recruitment time series for haddock in the North Sea and Skagerrak has tended to be characterised by occasional very strong year classes. However, over 1995 to 1998, the year classes which have recruited to the stock have all been of below average strength and although the 1994 year class was somewhat stronger, this has now been largely fished-out. Following this series of poor year classes, the 1999 cohort is very strong and thus forms a major part of the catch and the stock in the short to medium term. For this reason, the estimation of the strength of this year class is crucial for the short-term forecasts. The only new data, since the last assessment, on the strength of this year class comes from the catch data for 2000 and the IBTS Q1 index for 2001. Both of these data sources are included in the XSA run which gives an estimate at age 0 of 93 billion. This is a little higher than the value used last year of 73 billion which was made by replacing the 1999 y/c survey indices with the previously observed maximum. This was an inherently conservative approach and now that more data are available the XSA estimate is probably the best currently achievable. This value has been used for forecasting.

4.5.2 The 2000 and subsequent year classes

In common with the 1999 year class, the only new data for the 2000 year class in this assessment compared with last year are the catch data (mostly from discard estimates) and the IBTS Q1 survey. These data are included in the XSA run with the surveys contributing 80% of the final estimate. The value obtained (20 billion) is close to the geometric mean recruitment (25 billion) and has been used for forecasting.

For all subsequent year classes, the long term geometric mean has been used.

The text table below summarises the recruitment values used in subsequent analysis.

Year class	Age	XSA	GM(63-98)
1999	2	**2161900**	
2000	1	**2628499**	
2001	0		**24872900**

4.6 Historical Stock Trends

Trends in spawning stock biomass, recruitment and mean F since 1963 are given in Table 4.6.1 and Figure 4.6.1. Total F has fluctuated around a mean level of 0.92. Recruitment shows considerable variation, with the current estimate of the 1999 year class indicating that it is the strongest since 1974, while the four preceding year classes were all of below average strength. Spawning biomass has fluctuated, with occasional slight peaks corresponding to the maturation of strong year classes. SSB has declined in recent years as a result of a high fishing mortality rate and low recruitment. The estimate for 2000 is the third lowest recorded. However, the 1999 year class will cause a rapid increase in SSB in the short term.

4.7 Short-term forecast

The recruitment of a very strong year class following a series of below-average cohorts means that the result of the short-term forecast is strongly dependent on the estimate of the strength of the year class and also on estimates of other factors influencing its survival and contribution to catches such as fishing and natural mortality, weights at age etc. In addition, because the 1999 year class is at a size where discarding is significant, it is important to estimate the discard rate as this influences the proportion of caught fish which are actually landed. This is discussed on more detail below.

4.7.1 Fishing mortality at age.

Recent mean fishing mortality has fluctuated without trend, and there is relatively little difference between the point estimate of fishing mortality in 2000 (0.92) and the mean over 1997-1999. Following usual practice, F for 2001 onwards was taken as the mean 1998-2000 scaled to the 2000 value.

4.7.2 Discarding

For partitioning the Fs of the human consumption fleet into landings and discards, traditional practice has been to assume a three-year mean of proportion discarded at age (Table 4.7.1). However, analyses at last years meeting indicated that large year classes of haddock within the North Sea are relatively slow growing. One consequence of this is that they will take longer to reach the minimum landing size and hence a higher proportion of the catch is likely to be discarded. Figure 4.7.1 shows the relationship between mean weight at age 2 as measured during the IBTS Q1 and proportion discarded of the same cohort. Using this relationship implies that 85% of fish caught of the 1999 year class at age 2 will be discarded. This compares with the three year mean value of 69%. Although the predicted proportion lies a little beyond the range of the regression it has been used to partition the human consumption F in 2001 between landings and discards. Preliminary indications from observer trips carried out in the first quarter of 2001 support this high estimated rate of discarding.

Figure 4.7.1 also shows the relation ship for age 3 discards. This relationship is barely significant and if used to predict the discard rate for the 1999 y/c at age 3 gives a value which is only slightly more than the three year mean (35% opposed to 30%). In view of the prediction error associated with the regression, the 3 year mean value was retained but it may mean the discards are underestimated and landings over-estimated for 2002.

4.7.3 Selectivity changes

During 2000 the UK introduced unilateral measures to improve gear selectivity in roundfish fleets. This consisted primarily of a 90mm square mesh panel. During 2001 further emergency measures are being introduced in Scotland restricting the length of codend extension piece and lifting bags. These measures may lead to some improvement in selectivity but it is not possible to estimate the magnitude of the effect at present. Preliminary indications are that in 2000, the effect is likely to be small. As a result no modifications to the 3 year mean selectivity pattern have been made. If the selectivity measures prove to be effective, then the current forecast may overestimate the quantity discarded in the forecast period.

4.7.4 Weights at age

For many years, weights at age for the forecast were estimated by taking a 3 year mean of the most recent observed values. It was noticed that this can lead to weight estimates which lag behind the true value if there is a trend. Last year a two year mean was taken to try to reduce the lag. In order to try to overcome the problem this year attempts were made to try to forecast weights using the relationship:

$$w(a,t) = c + bw(a-i, t-i)$$

where w(a,t) is the log of the weight at age a in year t, i is the year lag and b and c are constants. Deriving regressions of this type were successful for predicting weights at age 4 and older. This approach produced a lower mean squared error than the 3 year mean approach when compared with a hindcast analysis. However, it was not possible to demonstrate any improvement for ages 1-3 which are the most critical in this assessment. Consequently all weights used in the forecasts were taken as the 3 year mean of 1998-2000.

4.7.5 Results

The inputs to a short term catch forecast are given in Table 4.7.2, with the management option table given in Table 4.7.3, and detailed output assuming *status quo* F in 2001 and 2002.given in Table 4.7.4. The *status quo* forecast for 2001 is very similar to the forecast made last year although the estimated discards are about 30% higher (182 kt). This is because the size of the 1999 year class has been revised upwards. For 2002, at status quo, the human consumption landings increase to 120kt with a substantial reduction in discards to 77kt. During the forecast period the SSB is expected to reach a peak of 224kt in 2002 but fall to 171kt by the beginning of 2003. The contribution of each year class to future catches and SSB is given in Table 4.7.5. Industrial catches are forecast to be relatively high but the coefficient of variation for both the 2001 and 2002 industrial by-catch is extremely large indicating that the prediction for this catch is extremely unreliable (Table 4.7.2).

A sensitivity analysis of the status quo forecast is given in Figure 4.7.2. This indicates that the landings estimate for 2002 is influenced mainly by factors related to the 1999 year class (N2: number at ge 2 in 2001, WH3: weight at age 3 sH3: selectivity at age 3) as would be expected. This means that small changes in the estimate of the size of this year class, its mean weight at age and selectivity can have a large effect on the forecast. Figure 4.7.3 shows the probability profiles for the status quo forecast. In the case of biomass in 2003, the profile indicates that there is approximately a 30% probability that the SSB will be below $\mathbf{B}_{pa}$ despite the large 1999 year class. The yield profile can be used to identify a catch associated with a chosen probability of reducing F below F *status quo*. For example, a catch of 100 thousand tonnes would be associated with a 30% chance that F would rise above F *status quo* in 2002. The point estimate of 120 thousand tonnes in 2002 has a 50% probability that F will be above F *status quo*.

The short term forecast is summarised in Figure 4.7.4.

4.7.6 Allocation to area

The short-term catch prediction for this stock considers three catch categories; human consumption landings, discards and industrial by-catch. The predicted HC landings and industrial by-catch each include a proportion which should be allocated to Division IIIa. The average proportion taken in IIIa is summarised in the following text table. These figures are based on Working Group estimates of catch. Information on the split of IIIa landings into industrial and human consumption components is only available for 1983 onwards.

Catch category	Year range	Percentage taken in IIIa
Human consumption landings	Full, 1963–2000	3.29%
Human consumption landings	Recent, 1998–2000	3.30%
Industrial by-catch	Full, 1983–2000	23.47%
Industrial by-catch	Recent, 1997–2000	6.73%

4.8 Medium-Term Projections

No medium term analyses were performed last year. Projections have been undertaken this year using a Beverton-Holt stock recruitment curve (Table 4.8.1) and using the same input values as were used in the short term forecast (Table 4.7.1), except that no adjustment was made for selectivity at age 2 in 2001. The choice of curve is consistent with previous analyses. Trials with other stock recruit curves did not produce very different results,

The results of the projections for *status quo* F and $\mathbf{F}_{pa}$ are shown in Figure 4.8.1. In addition Figure 4.8.2 gives a summary diagram showing the probability that SSB is below $\mathbf{B}_{pa}$ for any value of fishing mortality over the next decade. At *status quo* F, there is a moderate probability (ca 30%) that SSB will be below $\mathbf{B}_{pa}$ in the medium term.

4.9 Biological Reference Points

A yield-per-recruit curve based on the inputs to the short-term forecast (Table 4.7.1) is given in Figure 4.9.1, and the stock-recruitment plot is given in Figure 4.9.2. The reference points given on Figure 4..9.1 are based on the human consumption yield-per-recruit curve assuming constant industrial fishing mortality. The text table below gives the values of various biological points reference points for this stock as well as the ‘lim’ and PA reference points currently used by ACFM.

$\mathbf{F}_{max}$	$\mathbf{F}_{0.1}$	$\mathbf{F}_{med}$	$\mathbf{F}_{pa}$	$\mathbf{F}_{lim}$	$\mathbf{B}_{pa}$	$\mathbf{B}_{lim}$
0.271	0.193	0.447	0.7	1.0	140,000t	100,000t

Figure 4.9.3 shows how the stock has performed in relation to the agreed PA values. In the majority of years, F has been above $\mathbf{F}_{pa}$ but SSB above $\mathbf{B}_{pa}$. In 2000, SSB is below $\mathbf{B}_{pa}$ and F is above $\mathbf{F}_{pa}$.

4.10 Comments on the Assessment

4.10.1 Assessment quality

Figure 4.10.1 shows a retrospective analysis of the assessments carried out since 1990 as adopted by ACFM relative to the current assessment. Over this period there is a strong tendency to over-estimate SSB and under-estimate F. It is likely that part of this problem is due to the inclusion of commercial CPUE data in past assessments which are no longer used. The retrospective presented in Figure 4.4.2 of the current assessment settings suggests that the problem of under-estimating F has been reduced, but as noted earlier, due to the auto-correlation of assessment errors, the present assessment is still likely to be in a period of under-estimation of F. Typical errors appear to be in the range 10-20% for F and 5-10% for SSB.

The retrospective pattern for recruitment suggests that recent year class estimates have been better than in the early 1990s. Because the survey indices for 1999 year class are the largest in the time series it is still difficult to estimate the size of this year class with any precision. The current estimate is higher than last years because the survey indices continue to give a strong signal. It should be noted that new survey indices from the EGFS and SCFS will be available before the October ACFM meeting and it may be possible to refine the estimates of recent year classes.

The catch forecast is sensitive not only to the size of the 1999 year class but also its weight at age, which is still estimated with low precision. As a result the estimates of discards are particularly imprecise. There is some indication that the assumed discard rate of the 1999 y/c in 2002 is too low. If this proves to be the case, then forecast landings will be lower and discards higher.

It has not been possible to assess the impact of technical measures introduced in 2000 and 2001 on the selectivity of the youngest age groups of fish. While preliminary indications are that the effects are small, a positive effect may be realised.

4.10.2 State of the stock

At present the biomass and catches from the stock are driven almost entirely by the 1999 year class as most of the other cohorts are average or below. It is particularly noticeable that at the present rate of fishing mortality the spawning stock will be quickly eroded and that by 2003 there is a moderate probability that it will be below $\mathbf{B}_{pa}$. This illustrates the fact that the only factor maintaining the stock above $\mathbf{B}_{pa}$ is the random occurrence of very large year classes. A sequence of average or poor recruitment might easily result in stock collapse. Periods of poor recruitment have been more frequent from the 1980s onwards.

The present exploitation pattern combined with the large 1999 y/c means that discarding will be very high. The yield per recruit analysis indicates that the total biomass lost through discarding over the life of the year class is approximately equal to the accumulated landings of the cohort during its lifetime in the stock. This represents a very large amount of foregone catch.

4.10.3 Management considerations

Haddock , while a principal target for some fleets, are taken in a mixed roundfish fishery. This means it is important to take into account the impact of management of haddock on other stocks, notably cod and whiting. The reverse, of course, is also true. Recent measures to protect North sea cod, such as the closed area, and proposals to increase mesh size, will affect the haddock fishery. In the long term improvements in selectivity related to measures to protect cod should benefit the haddock fishery by reducing discards and increasing landings.

There is frequently debate about the extent to which the cod-haddock-whiting fisheries are linked. This linkage is not one-to-one but it is also true that they are far from separate. It is possible for fishing vessels to increase their targeting of individual species but this is never perfect and there will always be a significant by-catch of other roundfish. Hence, for example, measures to protect cod will require at least some reduction in the fishing mortality for haddock and vice versa. This means that TACs for the three main roundfish species do need to be set in a way which acknowledges the fishery linkage but it remains a difficult to judge how close this linkage should be.

Table 4.1.1 Nominal catch (t) of HADDOCK from Division IIIa and the North Sea 1991–2000, as officially reported to ICES.

Division IIIa

Country	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Belgium	4	14	9	4	18					
Denmark	2,339	3,812	1,600	1,458	1,576	2,523	2,501	3,168	1,012	1,033
Germany				1	1	5	5	11	3	1
Norway	110	184	153	142	135	115	187	188	168	129
Sweden	69	744	436	408	498	536	835	529	212	372
Total reported	**2,522**	**4,754**	**2,198**	**2,013**	**2,228**	**3,179**	**3,528**	**3,896**	**1,395**	**1,535**
Unallocated	1,564	-358	-239	-180	-37	-37	-127	-137	-35	-50
WG estimate of H.cons. landings	4,086	4,396	1,959	1,833	2,191	3,142	3,401	3,759	1,360	1,485
WG estimate of industrial bycatch	2,593	604	2,415	2,180	2,162	2,925	610	275	334	617
WG estimate of total catch	**6,679**	**9,000**	**4,374**	**4,013**	**4,353**	**6,067**	**4,011**	**4,034**	**1,694**	**2,102**

Sub-area IV

Country	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Belgium	168	415	292	306	407	215	436	724	462	399
Denmark	1,330	1,476	3,582	3,208	2,902	2,520	2,722	2,608	2,104	1,670
Faroe Islands	15	13	25	43	49	13	9	43		
France	631	508	960	587	441	369	548	427	742	1,152
Germany	535	764	348	1,829	1,284	1,769	1,462	1,314	565	342
Netherlands	100	148	192	96	147	110	480	275	110	119
Norway	2,069	3,273	2,655	2,355	2,461	2,295	2,351	3,010	3,846	3,115
Poland						18	8	7	17	13
Sweden	957	1,289	908	551	722	689	655	472	708	606
UK (Engl. & Wales)	2,173	2,926	4,259	4,043	3,616	3,379	3,330	3,280	2,398	
UK (Isle of Man)		11								
UK (N. Ireland)	48	73	18	9						
UK (Scotland)	36,474	39,896	66,799	73,793	63,411	63,542	61,098	60,234	53,486	
UK(all)										39,648
Total reported	**44,500**	**50,792**	**80,038**	**86,820**	**75,440**	**74,919**	**73,099**	**72,394**	**64,438**	**47,064**
Unallocated landings	145	19,426	-458	-5923	-127	1,115	5,996	4,917	-229	-1997
WG estimate of H.cons. landings	44,645	70,218	79,580	80,897	75,313	76,034	79,095	77,311	64,209	45,067
WG estimate of discards	40,276	47,967	79,601	65,392	57,360	72,522	52,105	45,175	42,562	46,798
WG estimate of industrial bycatch	5,421	10,816	10,741	3,561	7,747	5,048	6,689	5,101	3,834	8,133
WG estimate of total catch	**90,342**	**129,001**	**169,922**	**149,850**	**140,420**	**153,604**	**137,889**	**127,587**	**110,605**	**99,998**

Division IIIa and Sub-area IV

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2002
WG estimate of Total Catch	**97,021**	**138,001**	**174,296**	**153,863**	**144,773**	**159,671**	**141,900**	**131,621**	**112,299**	**102,100**

TABLE 4.1.2; Haddock, North Sea and Skagerrak
Annual weight and numbers caught, 1963 to 2000.

Year	Wt.('000t) Total	H.cons	Discar	Indust	Nos.(millions) Total	H.cons	Discar	Indust
1963	272	69	189	14	1685	182	1246	257
1964	380	131	160	89	1597	353	644	601
1965	299	162	62	75	1723	372	254	1097
1966	347	226	74	47	3135	408	490	2238
1967	247	148	78	21	1423	273	448	701
1968	302	106	162	34	1620	222	838	560
1969	931	331	260	339	4007	911	1203	1893
1970	807	525	101	180	3385	1247	515	1624
1971	447	237	177	32	2680	477	1282	921
1972	354	195	128	30	1735	434	760	541
1973	308	182	115	11	1290	456	660	174
1974	369	153	167	49	2414	365	1091	958
1975	455	151	260	43	2994	374	1862	758
1976	377	173	154	50	1667	412	788	466
1977	226	145	44	37	934	338	226	370
1978	180	92	77	12	1072	205	418	449
1979	146	87	42	17	1517	199	286	1032
1980	224	105	95	24	1506	233	541	732
1981	217	139	60	18	1368	288	298	782
1982	238	177	41	21	987	325	181	481
1983	254	167	66	20	1269	305	389	576
1984	223	135	75	13	878	258	412	208
1985	258	166	85	7	983	371	457	155
1986	226	169	52	4	760	376	308	76
1987	177	112	59	6	702	233	334	136
1988	176	108	62	5	662	258	362	42
1989	109	80	26	3	303	173	111	19
1990	93	56	33	5	331	114	192	25
1991	97	49	40	8	473	107	218	148
1992	138	75	48	15	780	163	267	350
1993	174	82	80	13	883	178	441	264
1994	154	83	65	6	615	171	347	98
1995	145	78	57	10	863	166	316	382
1996	160	79	73	8	882	171	340	372
1997	142	82	52	7	508	180	231	97
1998	132	81	45	5	442	178	212	52
1999	112	66	43	4	467	145	209	113
2000	102	47	47	9	561	100	314	147
Min.	93	47	26	3	303	100	111	19
Mean	263	138	91	34	1345	308	513	524
Max.	931	525	260	339	4007	1247	1862	2238

TABLE 4.2.1. Haddock, North Sea and Skagerrak
Natural Mortality and proportion mature

Age	Nat Mor	Mat.
0	2.050	.000
1	1.650	.010
2	.400	.320
3	.250	.710
4	.250	.870
5	.200	.950
6	.200	1.000
7	.200	1.000
8	.200	1.000
9	.200	1.000
10+	.200	1.000

1

TABLE 4.2.2. Haddock, North Sea and Skagerrak. International catch at age ('000), Total , 1963 to 2000.

Age	1963	1964	1965	1966	1967	1968	1969	1970
0	1367	140235	652537	1671205	306037	11146	72670	925768
1	1307178	7436	368593	1007322	838189	1098748	20493	266379
2	335092	1296771	15184	25674	89083	439511	3578611	218480
3	20963	135227	649840	6425	4863	19600	303489	1908736
4	13026	9069	29496	412551	3585	1947	7596	57435
5	5781	5350	4662	9980	177857	2529	2411	1178
6	502	2405	1972	1045	2443	45973	2515	1197
7	653	287	452	601	215	325	19129	256
8	566	236	107	165	216	40	200	5954
9	59	231	90	90	57	13	24	67
10+	18	25	41	25	34	5	7	30

Age	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
0	333396	244075	60545	614903	46388	174161	120798	305115	881823	399372
1	1815054	679205	366830	1220855	2116937	170529	258923	463554	351451	678499
2	71035	587590	570630	176342	641755	1062943	107675	146957	204046	333261
3	47546	40604	240604	332967	58991	211544	394175	30377	41297	73043
4	400469	21213	6192	54314	109062	9952	40185	113703	7406	10476
5	10374	158000	4470	1875	15813	31311	4318	8708	28024	1901
6	462	3563	39459	1351	983	4996	6275	1264	2237	8067
7	195	190	1257	10922	620	206	1300	2076	262	598
8	147	34	108	242	2714	76	135	402	483	121
9	1592	27	29	23	266	759	29	116	152	162
10+	168	419	163	41	82	63	204	94	78	119

Age	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
0	646419	278705	639814	95502	139579	56503	13384	16535	12042	57702
1	134470	275686	157259	432193	178878	160398	314017	30044	47648	86819
2	423059	86126	252258	168273	534269	178824	250496	490706	35358	103021
3	143151	299895	73920	122984	78726	323650	47432	89940	182748	18947
4	15228	41435	127250	22079	37445	27685	67864	13431	18106	57830
5	2034	3407	16480	32658	5306	9691	4761	18579	2636	3905
6	458	713	1708	3789	7355	1237	2877	1602	4058	896
7	2498	279	297	596	965	1810	545	639	510	1380
8	124	786	60	81	209	246	780	163	201	206
9	64	29	193	39	53	106	135	145	83	80
10+	61	26	67	139	114	137	152	104	54	70

Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
0	123910	270758	141209	85966	273689	347568	40082	23902	108254	52134
1	228553	209879	359995	99260	301733	53415	134642	83557	81423	340188
2	78258	253286	262765	296776	85925	357942	86231	167359	121249	86335
3	23197	32494	108421	100476	167801	56894	213293	49648	87242	41724
4	3888	6552	7107	29609	25875	55147	15272	108066	24739	25533
5	12526	1250	1698	1920	7645	7503	15406	5743	39860	5998
6	976	4861	450	573	511	3052	1892	3562	2338	8498
7	401	454	1138	191	127	756	679	472	1595	550
8	620	299	145	509	45	52	62	140	342	230
9	144	294	103	115	62	31	15	14	41	31
10+	65	154	210	89	36	42	26	17	10	16

TABLE 4.2.3. Haddock, North Sea and Skagerrak. International mean weight at age (kg), Total catch and stock weights 1963 to 2000.

Age	1963	1964	1965	1966	1967	1968	1969	1970
0	.012	.011	.010	.010	.011	.010	.011	.013
1	.123	.118	.069	.088	.115	.126	.063	.073
2	.253	.239	.225	.247	.281	.253	.216	.222
3	.473	.403	.366	.367	.461	.509	.406	.352
4	.695	.664	.648	.533	.594	.731	.799	.735
5	.807	.814	.844	.949	.639	.857	.891	.873
6	1.004	.908	1.193	1.266	1.057	.837	1.031	1.191
7	1.131	1.382	1.173	1.525	1.501	1.606	1.094	1.362
8	1.173	1.148	1.482	1.938	1.922	2.260	2.040	1.437
9	1.576	1.470	1.707	1.727	2.069	2.702	3.034	2.571
10+	1.825	1.781	2.239	2.889	2.348	2.073	3.264	3.899

Age	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
0	.011	.024	.044	.024	.020	.013	.019	.011	.009	.012
1	.107	.116	.112	.128	.101	.125	.108	.144	.095	.104
2	.247	.242	.240	.226	.241	.224	.241	.253	.290	.283
3	.362	.388	.372	.343	.356	.401	.345	.418	.443	.486
4	.506	.506	.586	.548	.449	.512	.601	.441	.637	.732
5	.887	.606	.649	.891	.680	.588	.613	.719	.664	1.046
6	1.267	1.000	.725	.895	1.245	.922	.802	.742	.933	.936
7	1.534	1.366	1.044	.952	1.124	1.933	1.181	.955	1.187	1.394
8	1.337	2.241	1.302	1.513	1.093	1.784	1.943	1.398	1.187	1.599
9	1.275	2.006	2.796	2.315	1.720	1.306	2.322	2.124	1.468	1.593
10+	2.058	1.684	1.828	2.639	2.420	2.430	1.812	2.158	2.374	2.143

Age	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
0	.009	.011	.022	.010	.013	.025	.008	.024	.027	.044
1	.074	.100	.135	.141	.149	.124	.126	.165	.197	.194
2	.262	.292	.297	.300	.279	.242	.265	.217	.300	.292
3	.476	.460	.448	.489	.480	.397	.406	.417	.372	.430
4	.745	.784	.651	.670	.668	.613	.615	.589	.605	.473
5	1.147	1.166	.915	.805	.857	.863	1.029	.748	.811	.771
6	1.479	1.441	1.214	1.097	1.049	1.257	1.276	1.284	.982	.967
7	1.180	1.672	1.162	1.100	1.459	1.195	1.433	1.424	1.364	1.167
8	1.634	1.456	1.920	1.868	1.833	1.715	1.529	1.551	1.655	1.529
9	1.764	2.634	1.376	2.425	2.124	1.525	1.877	1.627	1.684	2.037
10+	1.709	2.156	1.725	2.046	2.043	2.612	2.220	2.346	2.229	2.606

Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
0	.029	.018	.010	.017	.013	.019	.021	.023	.023	.048
1	.177	.107	.115	.116	.102	.127	.133	.153	.168	.118
2	.320	.306	.280	.250	.297	.246	.277	.252	.243	.254
3	.472	.486	.447	.419	.363	.388	.359	.392	.361	.369
4	.639	.748	.680	.597	.592	.483	.579	.440	.473	.501
5	.650	1.016	.894	.943	.763	.780	.615	.651	.498	.613
6	1.042	.896	1.173	1.208	1.099	.870	.909	.760	.680	.648
7	1.232	1.395	1.102	1.570	1.423	.846	.966	1.103	.782	1.092
8	1.481	1.537	1.592	1.469	1.685	1.833	1.647	1.153	.749	1.084
9	1.776	1.912	1.737	1.620	1.873	2.025	2.247	1.825	1.247	1.755
10+	2.064	2.021	1.873	2.444	1.986	1.970	2.388	2.352	1.780	2.093

Table 4.3.1. Haddock in the North Sea/Skagerrak;Tuning data.

102								
ENGGFS								
1977	2000							
1	1	0.5	0.75					
0	5							
100	53.480	6.680	3.210	6.160	0.920	0.070	0.090	0.010
100	35.830	13.690	2.620	0.240	2.220	0.210	0.010	0.070
100	87.550	29.550	5.460	0.870	0.110	0.440	0.040	0.000
100	37.400	62.330	16.730	2.570	0.270	0.040	0.140	0.020
100	153.750	17.320	43.910	7.560	0.740	0.060	0.000	0.060
100	28.130	31.550	7.980	11.800	1.030	0.240	0.100	0.010
100	83.190	21.820	10.950	2.140	2.170	0.270	0.040	0.010
100	22.850	59.930	6.160	3.080	0.420	0.480	0.100	0.010
100	24.590	18.660	23.820	2.110	0.700	0.200	0.130	0.040
100	26.600	14.970	4.470	3.380	0.280	0.180	0.040	0.040
100	2.240	28.190	4.310	0.530	0.690	0.050	0.030	0.000
100	6.070	2.860	18.350	1.550	0.160	0.280	0.040	0.010
100	9.430	8.170	1.450	3.970	0.250	0.030	0.060	0.010
100	28.190	6.650	1.980	0.290	0.880	0.050	0.030	0.010
100	26.330	11.500	0.960	0.230	0.050	0.220	0.000	0.010
100	82.770	19.690	9.770	0.580	0.050	0.010	0.080	0.000
100	13.580	24.610	5.860	1.660	0.060	0.020	0.000	0.010
100	94.300	8.070	9.020	0.840	0.280	0.020	0.000	0.000
100	17.990	38.310	4.450	3.400	0.280	0.090	0.010	0.000
100	19.920	8.310	14.570	1.220	0.830	0.070	0.050	0.000
100	13.032	14.863	4.334	6.607	0.227	0.216	0.027	0.006
100	5.302	8.891	5.681	1.347	1.418	0.083	0.046	0.003
100	210.984	5.572	2.830	1.233	0.423	0.405	0.014	0.012
100	31.023	84.112	1.525	0.550	0.247	0.113	0.118	0.000
IBTS_Q1								
1973	2000							
1	1	0.99	1					
0	5							
1	1.092	0.110	-1	-1	-1	-1		
1	1.168	0.385	-1	-1	-1	-1		
1	0.177	0.670	-1	-1	-1	-1		
1	0.162	0.084	-1	-1	-1	-1		
1	0.385	0.108	-1	-1	-1	-1		
1	0.480	0.240	-1	-1	-1	-1		
1	0.896	0.402	-1	-1	-1	-1		
1	0.268	0.675	-1	-1	-1	-1		
1	0.526	0.252	-1	-1	-1	-1		
1	0.307	0.400	0.089	0.114	0.013	0.002		
1	1.057	0.219	0.134	0.022	0.022	0.005		
1	0.229	0.828	0.105	0.034	0.004	0.007		
1	0.579	0.244	0.294	0.018	0.006	0.002		
1	0.885	0.326	0.048	0.061	0.005	0.003		
1	0.092	0.688	0.098	0.013	0.014	0.002		
1	0.210	0.097	0.281	0.017	0.002	0.005		
1	0.220	0.110	0.031	0.051	0.003	0.002		
1	0.679	0.131	0.024	0.004	0.009	0.002		
1	1.115	0.371	0.019	0.003	0.001	0.002		
1	1.242	0.543	0.155	0.009	0.001	0.001		
1	0.229	0.504	0.098	0.023	0.002	0.001		
1	1.375	0.205	0.181	0.025	0.005	0.001		
1	0.267	0.813	0.066	0.047	0.008	0.003		
1	0.860	0.366	0.471	0.025	0.015	0.003		
1	0.374	0.423	0.106	0.114	0.009	0.005		
1	0.212	0.233	0.130	0.048	0.037	0.004		
1	3.702	0.108	0.050	0.025	0.016	0.010		
1	0.867	2.295	0.050	0.011	0.007	0.006		

Table 4.3.1.cont Haddock in the North Sea/Skagerrak; Tuning data.

SCOGFS							
1982	2000						
1	1	0.5	0.75				
0	5						
100	12.35	24.88	9.96	13.36	1.15	0.07	0.02
100	22.03	18.13	16.11	3.72	4.55	0.53	0.12
100	8.73	43.71	7.88	3.36	0.55	0.65	0.09
100	8.18	19.76	29.81	2.32	1.03	0.14	0.22
100	17.47	23.29	5.74	5.98	0.36	0.27	0.04
100	2.77	23.86	7.04	1.06	1.28	0.08	0.05
100	4.06	4.67	19.82	1.70	0.27	0.23	0.02
100	4.32	8.86	2.14	5.74	0.31	0.04	0.07
100	31.63	10.02	2.40	0.32	1.03	0.07	0.01
100	34.71	17.05	1.78	0.21	0.05	0.16	0.02
100	82.65	38.35	9.63	0.48	0.08	0.03	0.08
100	8.59	58.36	13.80	2.69	0.06	0.04	0.01
100	137.62	12.65	20.80	2.10	0.53	0.02	0.00
100	15.66	81.53	7.34	9.26	0.74	0.28	0.02
100	19.80	22.31	47.05	2.31	2.06	0.22	0.06
100	9.72	27.79	8.49	13.97	0.66	0.56	0.06
100	32.80	63.49	19.24	4.90	5.11	0.24	0.18
100	660.67	19.07	11.41	6.88	1.97	1.64	0.06
100	119.02	306.11	4.60	2.21	1.30	0.73	0.27

Table 4.3.1.cont Haddock in the North Sea/Skagerrak;Tuningdata.

SCOSEI

1978	2000															
1	1	0	1													
0	13															
325246	1665	160843	69033	14340	44152	2366	482	673	86	29	3	16	6	0	0	0
316419	543	83631	78815	17215	3040	8073	648	70	113	24	4	1	1	0	0	0
297227	210	131314	128306	26205	3393	501	2415	123	20	56	23	13	1	1	1	0
289672	345	10367	134260	55726	5181	702	102	579	15	22	1	10	2	0	3	0
297730	1445	31143	30969	118898	14297	682	145	39	230	1	9	1	0	0	0	0
333168	18101	29021	77289	30414	50115	6394	583	119	15	69	26	1	2	0	0	0
388085	422	120868	63391	49286	9426	14977	1594	254	18	8	38	3	2	0	1	0
382910	2052	29239	164839	33203	15993	2293	2846	308	47	19	9	28	2	0	0	0
425017	8265	33999	72604	155836	12895	4169	490	620	58	11	20	15	11	3	1	0
418734	138	43646	97731	19731	28883	1989	1174	199	285	31	16	15	12	7	2	2
377132	499	11576	201533	37421	4736	7415	718	290	80	70	27	6	6	7	10	1
355735	123	19004	19274	91070	8389	1091	1611	223	89	40	13	6	4	1	0	1
300076	712	35844	46489	9055	26705	1434	302	408	67	29	5	3	0	0	3	0
336675	2226	66144	30755	9531	1485	5028	308	122	183	42	11	1	1	0	0	0
300217	1232	30384	64733	8588	1512	290	1180	79	57	53	18	4	0	1	0	0
268413	2913	74523	88375	34997	2349	446	100	314	29	15	14	3	0	1	0	0
264738	3231	26626	125357	34127	10522	415	138	42	95	9	7	7	2	1	0	0
204545	236	67772	32301	70290	8734	2181	117	39	13	9	4	2	3	1	0	0
177092	1333	9192	123829	18532	17077	2161	707	84	12	8	11	3	2	1	0	0
166817	3109	30046	19165	59309	3918	4083	495	195	10	7	2	0	0	2	1	0
150361	38	12692	36813	12003	26564	1659	856	69	22	4	2	2	0	0	0	1
93796	3466	23253	35102	21991	6628	11164	690	456	56	12	0	1	0	0	0	0
83360	118	49624	14849	9162	6111	1920	2555	122	45	4	1	0	0	0	0	0

Table 4.3.1.cont Haddock in the North Sea/Skagerrak; Tuning data.

SCOLTR																
1978	2000															
1	1	0	1													
0	13															
236929	1692	45733	11471	2914	12279	774	110	167	24	4	0	5	1	0	0	0
287494	464	44562	23135	4109	714	3644	203	20	57	20	0	0	1	0	0	0
333197	180	92519	46282	8062	755	197	1015	61	18	8	5	0	0	0	0	0
251504	436	7979	58146	13653	1518	161	20	320	12	6	7	6	0	0	0	0
250870	352	24575	10170	33463	3937	133	67	7	58	0	0	2	0	0	0	0
244349	63676	19635	48680	6955	11807	1258	124	27	4	25	7	0	0	2	0	0
240725	514	56769	22191	13375	2074	3392	402	98	15	7	14	1	0	0	0	0
268136	3548	38850	57422	4913	2787	414	872	128	27	2	0	18	0	0	0	0
279767	4371	26322	26549	32339	2797	1014	124	307	43	37	2	2	2	3	0	0
351128	97	26220	33648	6464	7197	496	377	72	119	27	2	4	3	4	0	2
391988	209	2931	57589	14075	2367	2924	167	84	28	21	6	0	0	0	0	0
405883	1077	10415	2919	24895	2754	541	627	109	30	21	7	4	1	1	1	0
441084	201	11886	19205	2665	10237	669	168	264	45	14	5	2	1	0	0	0
408056	1041	44141	12394	3356	564	2213	226	80	146	38	16	2	1	0	0	0
473955	1838	20443	31073	3889	757	144	766	98	52	58	17	3	1	0	0	0
447064	231	39863	39176	20213	1527	362	84	274	29	27	26	8	2	1	0	0
480400	1482	8267	49047	23557	6304	474	128	42	64	13	7	7	2	2	0	0
442010	144	22874	13762	32063	5821	1658	97	15	13	17	3	2	1	1	0	0
445995	353	14281	72692	9860	13959	2041	955	304	10	14	7	1	2	1	0	0
479449	460	15907	13451	49548	3537	4511	553	163	13	2	2	1	1	1	1	0
427868	157	27498	33166	9597	29614	1666	1228	173	46	4	1	1	0	1	0	0
329750	2101	24475	36849	24426	5531	11752	841	579	94	9	2	0	0	0	0	0
271687	5	61962	14460	11193	6760	1257	2483	168	80	8	2	1	0	0	0	0

Table 4.4.1. Haddock in IIIa+IV. Tuning results from key run.

```
Lowestoft VPA Version 3.1

  18/06/2001  11:00

Extended Survivors Analysis

Haddock IIIa (run: XSASAR04/X04)

CPUE data from file c:\myfiles\admin\ices\wgnssk-ham\hadiv\data\had34tun.dat

Catch data for  38 years. 1963 to 2000. Ages  0 to  10.

     Fl         Last    First   Last    Alpha    Beta
           year year     age     age
ENGGFS      1977    2000       0       5     0.5    0.75
IBTS_Q1    1973    2000       0       5    0.99       1


Time series weights :

     Tapered time weighting applied
     Power =    3 over  20 years


Catchability analysis :

     Catchability dependent on stock size for ages <    2

        Regression type = C
        Minimum of   5 points used for regression
        Survivor estimates shrunk to the population mean for ages <  2


     Catchability independent of age for ages >=    3


Terminal population estimation :

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

     S.E. of the mean to which the estimates  are shrunk =    .500

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

     Prior weighting not applied


Tuning converged after   17 iterations

      1


Regression weights
          0.751    0.82   0.877   0.921   0.954   0.976    0.99   0.997       1       1
```

Fishing mortalities

Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
0	0.013	0.019	0.031	0.004	0.061	0.047	0.009	0.008	0.003	0.007
1	0.156	0.148	0.174	0.154	0.106	0.081	0.127	0.132	0.18	0.067
2	0.781	0.74	0.811	0.576	0.515	0.46	0.48	0.631	0.841	0.875
3	1.034	1.139	1.048	1.085	0.941	0.961	0.657	0.676	1.007	0.989
4	0.864	1.07	0.908	1.048	1.043	1.077	0.813	0.928	0.963	1.058
5	0.884	0.805	0.971	0.694	0.914	1.1	1.132	0.892	1.224	0.676
6	0.641	1.119	0.786	1.129	0.394	1.304	0.96	0.9	1.261	0.982
7	0.488	0.713	0.89	0.965	0.836	2.06	1.307	0.676	1.601	1.296
8	0.713	0.851	0.521	1.53	0.63	1.059	1.157	1.137	1.929	1.195
9	0.729	0.922	0.831	1.086	0.773	1.341	1.089	0.92	1.415	1.054

Table 4.4.1.cont. Haddock in IIIa+IV. Tuning results from key run.

XSA population numbers (Thousands)

	AGE									
YEAR	0	1	2	3	4	5	6	7	8	9
1991	2.74E+07	3.60E+06	1.76E+05	4.08E+04	7.61E+03	2.36E+04	2.28E+03	1.15E+03	1.34E+03	3.08E+02
1992	4.06E+07	3.49E+06	5.92E+05	5.42E+04	1.13E+04	2.50E+03	7.98E+03	9.84E+02	5.77E+02	5.39E+02
1993	1.27E+07	5.13E+06	5.78E+05	1.89E+05	1.35E+04	3.02E+03	9.14E+02	2.13E+03	3.95E+02	2.02E+02
1994	5.36E+07	1.58E+06	8.28E+05	1.72E+05	5.17E+04	4.24E+03	9.36E+02	3.41E+02	7.18E+02	1.92E+02
1995	1.29E+07	6.86E+06	2.61E+05	3.12E+05	4.53E+04	1.41E+04	1.73E+03	2.48E+02	1.06E+02	1.27E+02
1996	2.10E+07	1.56E+06	1.19E+06	1.04E+05	9.48E+04	1.24E+04	4.63E+03	9.58E+02	8.80E+01	4.64E+01
1997	1.21E+07	2.58E+06	2.76E+05	5.02E+05	3.11E+04	2.51E+04	3.39E+03	1.03E+03	9.99E+01	2.50E+01
1998	8.82E+06	1.55E+06	4.37E+05	1.14E+05	2.03E+05	1.08E+04	6.63E+03	1.06E+03	2.28E+02	2.57E+01
1999	9.38E+07	1.13E+06	2.60E+05	1.56E+05	4.54E+04	6.24E+04	3.61E+03	2.21E+03	4.42E+02	5.99E+01
2000	2.06E+07	1.20E+07	1.81E+05	7.53E+04	4.43E+04	1.35E+04	1.50E+04	8.37E+02	3.64E+02	5.26E+01

Estimated population abundance at 1st Jan 2001

0.00E+00	2.63E+06	2.16E+06	5.05E+04	2.18E+04	1.20E+04	5.62E+03	4.61E+03	1.87E+02	9.03E+01

Taper weighted geometric mean of the VPA populations:

2.05E+07	2.58E+06	3.77E+05	1.35E+05	4.11E+04	1.15E+04	3.56E+03	1.05E+03	3.33E+02	1.06E+02

Standard error of the weighted Log(VPA populations) :

0.8031	0.8426	0.7366	0.8129	0.9156	0.9301	0.8451	0.7089	0.8508	0.9701

1

Table 4.4.1.cont. Haddock in IIIa+IV. Tuning results from key run.

Log catchability residuals.
Fleet : ENGGFS

Age	1973	1974	1975	1976	1977	1978	1979	1980
0	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
1	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
2	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
3	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
4	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
5	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99

Age	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
0	0.92	0.13	-0.26	0.15	-0.13	-0.81	-0.14	-0.11	0.18	-0.19
1	0.56	0.41	0.46	0.27	0.49	-0.11	-0.22	-0.03	0.31	0.12
2	0.78	0.62	0.33	0.17	0.28	0.28	-0.24	0.39	0.27	0.13
3	1.11	0.64	0.6	0.43	0.45	-0.18	-0.32	0.39	0.27	0.12
4	1.09	0.27	0.23	0.32	0.26	-0.17	-0.38	-0.19	0.04	0.11
5	0.33	0.96	0.24	0.14	0.87	0.19	-0.67	0.04	-0.79	-0.32

Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
0	-0.21	0.23	0.08	0.04	0.29	-0.14	0.09	-0.25	0.07	0.19
1	-0.52	0.05	-0.1	-0.06	0.01	-0.06	0.05	0.05	-0.07	0.22
2	-0.74	0.34	-0.1	-0.18	0.23	-0.13	0.13	0.04	-0.01	-0.25
3	-0.46	0.25	0	-0.57	0.15	0.23	0.16	0.06	-0.13	-0.22
4	-0.41	-0.68	-0.77	-0.49	-0.36	0.01	-0.33	-0.3	0	-0.45
5	-0.08	-0.97	-0.36	-0.88	-0.44	-0.45	0	-0.26	-0.23	-0.31

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

Age	2	3	4	5
Mean Lo	-15.2486	-15.4378	-15.4378	-15.4378
S.E(Log	0.2853	0.2911	0.4127	0.5183

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Interce	RSquare	No Pts	Reg s.e	Mean Log q
0	0.73	3.101	16.95	0.93	20	0.23	-17
1	1.01	-0.077	15.62	0.95	20	0.21	-15.62

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

Age	Slope	t-value	Interce	RSquare	No Pts	Reg s.e	Mean Q
2	0.96	0.379	15.14	0.88	20	0.28	-15.25
3	0.93	0.661	15.19	0.9	20	0.28	-15.44
4	0.87	1.816	15.05	0.95	20	0.22	-15.73
5	0.8	2.557	14.52	0.94	20	0.24	-15.79
1							

Table 4.4.1.cont. Haddock in IIIa+IV. Tuning results from key run.

Fleet : IBTS_Q1

Age	1973	1974	1975	1976	1977	1978	1979	1980
0	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
1	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
2	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
3	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
4	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
5	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99

Age	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
0	-0.51	-0.54	-0.65	-0.64	-0.16	-0.53	-0.03	-0.01	0	-0.18
1	0.04	-0.24	-0.44	-0.31	-0.12	-0.23	-0.23	0.28	-0.32	-0.09
2	99.99	-0.05	-0.17	0.01	-0.23	-0.21	-0.02	0.17	0.33	-0.2
3	99.99	-0.03	0.07	-0.05	-0.3	-0.07	0.02	0.02	-0.05	-0.07
4	99.99	-0.11	-0.27	-0.25	-0.43	-0.05	-0.21	-0.49	-0.28	-0.39
5	99.99	0.05	0.34	0.01	0.29	0.13	0.06	0.06	0.4	0.45

Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
0	0.28	-0.01	-0.32	-0.21	-0.17	0.35	0.14	-0.04	0.09	0.34
1	-0.24	0.17	-0.27	-0.03	-0.14	0.5	0.19	0.11	-0.31	0.31
2	-0.71	0.13	-0.23	-0.21	-0.12	0.27	0.26	0.15	-0.08	0.32
3	-0.75	0.17	-0.23	-0.02	-0.12	0.36	0.01	0.64	0.01	-0.11
4	-0.34	-0.53	-0.17	-0.46	0.1	0.07	0.37	0.05	0.72	0.04
5	-0.8	0.67	0.64	0.03	0.18	0.58	0.37	0.76	0.2	0.59

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
Mean Lo	-14.1551	-14.4001	-14.4001	-14.4001
S.E(Log	0.2847	0.3112	0.3725	0.5152

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Interce	RSquare	No Pts	Reg s.e	Mean Log q
0	0.87	1.3	15.52	0.91	20	0.26	-15.33
1	1.01	-0.148	14.04	0.91	20	0.28	-14.05

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

Age	Slope	t-value	Interce	RSquare	No Pts	Reg s.e	Mean Q
2	0.98	0.208	14.12	0.88	19	0.29	-14.16
3	0.97	0.282	14.32	0.88	19	0.31	-14.4
4	0.9	0.887	14.09	0.89	19	0.33	-14.47
5	1.19	-1.334	14.99	0.82	19	0.45	-14.08
1							

Table 4.4.1.cont. Haddock in IIIa+IV. Tuning results from key run.

Terminal year survivor and F summaries :

Age 0 Catchability dependent on age and year class strength

Year class = 2000

Fleet		Int s.e	E s	Var Ratio	N	Scaled Weights	Estimated F
ENGGFS	3181563	0.3	0	0	1	0.402	0
IBTS_Q1	3708432	0.3	0	0	1	0.402	0
P shr	2575604	0.84				0.051	0.007
F shr	605108	0.5				0.146	0.03

Weighted prediction :

Survivo at end	s.e	Ex s.	N	Var Ratio	F
2628546	0.19	0.39	4	2.031	0.007

Age 1 Catchability dependent on age and year class strength

Year class = 1999

Fleet		Int s.e	E s	Var Ratio	N	Scaled Weights	Estimated F
ENGGFS	2496188	0.212	0.074	0.35	2	0.467	0.058
IBTS_Q1	2612933	0.229	0.108	0.47	2	0.401	0.055
P shr	376978	0.74				0.041	0.333
F shr	985010	0.5				0.09	0.141

Weighted prediction :

Survivo at end	s.e	Ex s.	N	Var Ratio	F
2161856	0.15	0.22	6	1.506	0.067

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

Year class = 1998

Fleet		Int s.e	E s	Var Ratio	N	Scaled Weights	Estimated F
ENGGFS	41613	0.174	0.057	0.33	3	0.435	0.993
IBTS_Q1	51559	0.177	0.185	1.05	3	0.424	0.863
F shr	86545	0.5				0.141	0.597

Weighted prediction :

Survivo at end	s.e	Ex s.	N	Var Ratio	F
50531	0.13	0.13	7	0.997	0.875

Age 3 Catchability constant w.r.t. time and dependent on age

Year class = 1997

Fleet		Int s.e	E s	Var Ratio	N	Scaled Weights	Estimated F
ENGGFS	20114	0.167	0.077	0.46	4	0.418	1.04
IBTS_Q1	21467	0.17	0.061	0.36	4	0.394	0.999
F shr	27018	0.5				0.187	0.86

Weighted prediction :

Survivo at end	s.e	Ex s.	N	Var Ratio	F
21810	0.13	0.06	9	0.422	0.989

Table 4.4.1.cont. Haddock in IIIa+IV. Tuning results from key run.

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

Year class = 1996

Fleet		Int s.e	E s	Var Ratio	N	Scaled Weights	Estimated F
ENGGFS	9805	0.185	0.1	0.54	5	0.356	1.193
IBTS_Q1	13250	0.188	0.054	0.29	5	0.374	0.993
F shr	13573	0.5				0.27	0.978

Weighted prediction :

Survivo at end	s.e	Ex s.	N	Var Ratio	F
11980	0.17	0.07	11	0.396	1.058

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

Year class = 1995

Fleet		Int s.e	E s	Var Ratio	N	Scaled Weights	Estimated F
ENGGFS	5363	0.2	0.088	0.44	6	0.368	0.699
IBTS_Q1	9340	0.199	0.116	0.58	6	0.376	0.458
F shr	2856	0.5				0.257	1.065

Weighted prediction :

Survivo at end	s.e	Ex s.	N	Var Ratio	F
5618	0.17	0.16	13	0.969	0.676

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

Year class = 1994

Fleet		Int s.e	E s	Var Ratio	N	Scaled Weights	Estimated F
ENGGFS	4157	0.196	0.076	0.39	6	0.194	1.047
IBTS_Q1	4924	0.196	0.068	0.35	6	0.198	0.941
F shr	4660	0.5				0.608	0.975

Weighted prediction :

Survivo at end	s.e	Ex s.	N	Var Ratio	F
4608	0.31	0.03	13	0.109	0.982

Age 7 Catchability constant w.r.t. time and age (fixed at the value for age) 3

Year class = 1993

Fleet		Int s.e	E s	Var Ratio	N	Scaled Weights	Estimated F
ENGGFS	170	0.216	0.104	0.48	6	0.071	1.367
IBTS_Q1	268	0.214	0.156	0.73	6	0.073	1.05
F shr	183	0.5				0.856	1.312

Weighted prediction :

Survivo at end	s.e	Ex s.	N	Var Ratio	F
187	0.43	0.06	13	0.137	1.296

Table 4.4.1.cont. Haddock in IIIa+IV. Tuning results from key run.

Age 8 Catchability constant w.r.t. time and age (fixed at the value for age) 3

Year class = 1992

Fleet		Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
ENGGFS	92	0.244	0.045	0.19	6	0.016	1.183
IBTS_Q1	101	0.241	0.104	0.43	6	0.017	1.121
F shr	90	0.5				0.967	1.197

Weighted prediction :

Survivo at end	s.e	Ex s.	N	Var Ratio	F
90	0.48	0.02	13	0.044	1.195

Age 9 Catchability constant w.r.t. time and age (fixed at the value for age) 3

Year class = 1991

Fleet		Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
ENGGFS	10	0.267	0.069	0.26	6	0.006	1.319
IBTS_Q1	20	0.262	0.124	0.47	6	0.006	0.88
F shr	15	0.5				0.987	1.053

Weighted prediction :

Survivo at end	s.e	Ex s.	N	Var Ratio	F
15	0.49	0.02	13	0.037	1.054

TABLE 4.4.2.; Haddock, North Sea and Skagerrak
International F at age, Total , 1963 to 2000.

Age	1963	1964	1965	1966	1967	1968	1969	1970
0	.002	.043	.072	.070	.002	.002	.017	.030
1	.124	.058	1.363	1.303	.263	.052	.022	.500
2	.805	.454	.416	.831	1.081	.578	.655	1.038
3	.670	1.175	.509	.360	.415	.898	1.376	1.150
4	.761	.756	.985	.779	.372	.307	1.287	1.269
5	.880	.884	1.299	1.240	1.014	.508	.814	.711
6	.508	1.263	1.021	1.310	1.326	.808	1.626	1.437
7	.827	.622	.872	1.082	1.139	.597	1.000	.709
8	.777	.839	.498	.970	1.945	.659	.951	1.059
9	.758	.882	.946	1.089	1.173	.581	1.149	1.049
10+	.758	.882	.946	1.089	1.173	.581	1.149	1.049

Age	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
0	.012	.032	.002	.013	.011	.030	.013	.022	.035	.074
1	.474	.169	.374	.353	.335	.308	.338	.391	.176	.189
2	.659	.793	.565	.933	.969	.814	1.005	1.012	.882	.707
3	.798	1.339	1.158	.950	1.254	1.371	1.038	1.128	1.141	1.210
4	.871	1.201	.802	1.003	1.099	.781	1.262	1.123	1.062	1.185
5	.864	1.158	.950	.628	.992	1.271	1.031	1.163	1.023	.937
6	.686	.859	1.098	.880	.820	1.064	.989	1.036	1.171	.985
7	1.017	.684	.882	1.125	1.567	.393	.924	1.146	.617	1.296
8	1.285	.471	1.146	.405	.998	.840	.488	.853	.942	.657
9	.955	.884	.987	.817	1.108	.879	.949	1.077	.974	1.024
10+	.955	.884	.987	.817	1.108	.879	.949	1.077	.974	1.024

Age	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
0	.057	.038	.027	.015	.016	.003	.009	.005	.004	.006
1	.179	.174	.151	.125	.206	.128	.119	.137	.106	.195
2	.450	.431	.660	.668	.614	1.017	.902	.796	.656	1.121
3	.946	.816	1.021	.997	.956	1.240	1.045	1.303	.987	1.162
4	.993	.880	1.161	1.142	1.103	1.283	1.081	1.109	1.179	1.152
5	.803	.647	1.212	1.222	1.028	1.056	.825	1.103	.692	.936
6	.610	.750	.814	1.088	1.074	.715	1.139	.749	.770	.534
7	1.008	.982	.840	.767	.947	.865	.826	.858	.568	.657
8	1.116	1.105	.578	.577	.681	.676	1.285	.632	.738	.474
9	.916	.882	.931	.970	.977	.929	1.043	.900	.795	.758
10+	.916	.882	.931	.970	.977	.929	1.043	.900	.795	.758

Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
0	.013	.019	.032	.004	.061	.047	.009	.008	.003	.007
1	.156	.148	.175	.154	.106	.081	.127	.132	.180	.067
2	.781	.740	.811	.576	.515	.460	.480	.631	.841	.875
3	1.034	1.139	1.048	1.085	.941	.961	.657	.676	1.007	.989
4	.864	1.070	.908	1.048	1.043	1.077	.813	.928	.962	1.058
5	.884	.805	.971	.694	.914	1.100	1.132	.892	1.224	.676
6	.641	1.119	.786	1.129	.394	1.304	.960	.900	1.261	.982
7	.488	.713	.890	.965	.836	2.060	1.308	.676	1.601	1.296
8	.713	.851	.521	1.530	.630	1.059	1.157	1.137	1.929	1.195
9	.729	.922	.831	1.086	.773	1.341	1.089	.920	1.415	1.054
10+	.729	.922	.831	1.086	.773	1.341	1.089	.920	1.415	1.054

TABLE 4.4.3; Haddock, North Sea and Skagerrak
Tuned Stock Numbers at age (10**-5), 1963 to 2001, (numbers in 2001 are VPA survivors)

Age	1963	1964	1965	1966	1967	1968	1969	1970	1971
0	23383	91721	263363	689923	3881120	171025	121955	877639	782848
1	255640	3005	11304	31563	82821	498538	21977	15439	109661
2	7401	43367	545	556	1647	12233	90929	4131	1798
3	486	2217	18453	241	162	375	4601	31652	980
4	277	194	534	8636	131	83	119	905	7806
5	109	101	71	155	3085	70	48	26	198
6	14	37	34	16	37	917	35	17	10
7	13	7	9	10	3	8	334	6	3
8	12	5	3	3	3	1	4	101	2
9	1	4	2	1	1	0	0	1	29
10+	0	0	1	0	1	0	0	1	3

Age	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
0	215392	728983	1334930	115423	164835	257514	395489	721529	156527	324807
1	99584	26853	93628	169646	14693	20595	32718	49818	89722	18718
2	13106	16149	3549	12631	23303	2074	2821	4252	8027	14258
3	623	3975	6153	936	3213	6918	509	688	1180	2652
4	344	127	972	1853	208	635	1909	128	171	274
5	2545	81	44	278	481	74	140	483	35	41
6	68	654	26	19	84	110	22	36	142	11
7	4	24	179	9	7	24	34	6	9	43
8	1	2	8	48	1	4	8	9	3	2
9	1	1	0	4	14	1	2	3	3	1
10+	8	3	1	1	1	4	2	1	2	1

Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
0	206224	669834	172740	240529	498849	42019	84419	87062	281408	274251
1	39495	25548	83935	21895	30464	64017	5361	10808	11165	36020
2	3005	6377	4217	14226	3421	5148	10918	898	1867	1764
3	6093	1309	2209	1449	5162	829	1400	3301	312	408
4	802	2099	367	635	434	1164	227	296	958	76
5	79	259	512	91	164	94	307	58	71	236
6	15	34	63	123	27	47	34	84	24	23
7	5	6	12	17	35	11	12	13	32	11
8	13	2	2	5	6	12	4	4	6	13
9	1	4	1	1	2	2	3	2	2	3
10+	0	1	2	2	2	3	2	1	1	1

Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
0	406119	126984	535501	128784	210218	121255	88241	937731	205636	
1	34861	51310	15841	68629	15597	25815	15466	11274	120330	26285
2	5916	5775	8277	2607	11858	2761	4368	2604	1808	21619
3	542	1892	1720	3118	1044	5018	1145	1558	753	505
4	113	135	517	453	948	311	2026	454	443	218
5	25	30	42	141	124	251	108	624	135	120
6	80	9	9	17	46	34	66	36	150	56
7	10	21	3	2	10	10	11	22	8	46
8	6	4	7	1	1	1	2	4	4	2
9	5	2	2	1	0	0	0	1	1	1
10+	3	4	1	1	1	0	0	0	0	0

TABLE 4.6.1; Haddock, North Sea and Skagerrak.
Mean fishing mortality, biomass and recruitment, 1963 - 2000.

	Mean F			Stock Biomass ('000 tonnes)		Recruits Age 0	
Year	H.cons Ages 2 to 6	Discards Ages 2 to 6	Industria Ages 2 to 6	Total	Spawning	Yclass	Million
1963	.579	.125	.021	3387	137	1963	2338
1964	.699	.073	.135	1188	420	1964	9172
1965	.647	.067	.132	812	526	1965	26336
1966	.715	.104	.085	780	432	1966	68992
1967	.678	.142	.021	1216	229	1967	388112
1968	.485	.089	.045	6700	265	1968	17103
1969	.843	.093	.216	2344	816	1969	12196
1970	.804	.123	.193	1405	900	1970	87764
1971	.629	.108	.040	1672	418	1971	78285
1972	.900	.145	.025	1677	301	1972	21539
1973	.777	.126	.011	900	294	1973	72898
1974	.639	.140	.100	1568	258	1974	133493
1975	.763	.203	.061	2163	238	1975	11542
1976	.812	.153	.095	885	308	1976	16484
1977	.807	.127	.131	567	239	1977	25751
1978	.879	.185	.029	665	132	1978	39549
1979	.939	.085	.032	673	109	1979	72153
1980	.847	.080	.078	1250	153	1980	15653
1981	.654	.086	.020	671	240	1981	32481
1982	.588	.067	.050	840	300	1982	20622
1983	.802	.145	.027	759	253	1983	66983
1984	.907	.091	.025	1493	199	1984	17274
1985	.856	.078	.021	860	241	1985	24053
1986	.880	.178	.004	716	222	1986	49885
1987	.852	.142	.005	1068	158	1987	4202
1988	.836	.147	.028	428	159	1988	8442
1989	.701	.132	.024	397	129	1989	8706
1990	.698	.232	.050	343	81	1990	28141
1991	.760	.065	.015	740	63	1991	27425
1992	.863	.100	.011	602	101	1992	40612
1993	.744	.143	.018	853	133	1993	12698
1994	.715	.183	.008	501	153	1994	53550
1995	.608	.149	.004	931	148	1995	12878
1996	.808	.159	.014	591	178	1996	21022
1997	.667	.124	.018	638	190	1997	12126
1998	.641	.139	.025	494	160	1998	8824
1999	.804	.238	.017	366	115	1999	93773
2000	.707	.153	.056	1535	87	2000	20564
2001					215	2001	24872*
Min.	.485	.065	.004	343	63	Min.	2338
Mean	.751	.129	.050	1176	250	Gmean	24873
Max.	.939	.238	.216	6700	900	Max.	388112

Min, max and geo. mean recruitment calculated over years 1963 to 1998
(Arithmetic mean recruitment 1963 - 1998 = 43036)
Biomass totals calculated at start of year.

* geometric mean

Table 4.7.1. Haddock in IIIa+IV. Proportion of the catch in number discarded at each age in the last 10 years and the mean value used to partition Fs in the forecast (Table 4.7.2) For age 2 in the 2001 forecast, the mean value (0.69) has been replaced with a predicted value (0.85) from the regression in Figure 4.7.1.

	1991	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**mean(1998-2000)**
0	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1	0.91	0.98	0.99	0.99	0.99	0.98	0.99	0.99	0.99	0.98	0.99
2	0.37	0.51	0.69	0.76	0.65	0.79	0.68	0.75	0.78	0.54	0.69
3	0.03	0.10	0.18	0.29	0.39	0.32	0.41	0.22	0.37	0.30	0.30
4	0.01	0.01	0.01	0.06	0.04	0.14	0.07	0.13	0.04	0.10	0.09
5	0.01	0.00	0.00	0.03	0.01	0.00	0.01	0.01	0.05	0.02	0.03
6	0.00	0.01	0.00	0.08	0.00	0.00	0.00	0.01	0.08	0.01	0.03

Table 4.7.2.Haddock, North Sea and Skagerrak

Input data for catch forecast and linear sensitivity analysis

Label	Value	CV	Label	Value	CV	
Number at age			Weight in the stock			
N0	24872909	1.01	WS0	0.03	0.46	
N1	2628499	0.39	WS1	0.15	0.18	
N2	2161900	0.22	WS2	0.25	0.02	
N3	50499	0.13	WS3	0.37	0.04	
N4	21800	0.13	WS4	0.47	0.06	
N5	11999	0.17	WS5	0.59	0.14	
N6	5599	0.17	WS6	0.70	0.08	
N7	4599	0.31	WS7	0.99	0.18	
N8	200	0.43	WS8	1.00	0.22	
N9	100	0.48	WS9	1.61	0.20	
N10	0	0.49	WS10	2.08	0.14	
H.cons selectivity			Weight in the HC catch			
sH0	0.00	0.00	WH0	0.00	0.00	
sH1	0.00	0.33	WH1	0.28	0.07	
sH2	0.20	0.42	WH2	0.36	0.03	sH2=0.1 in 2001
sH3	0.58	0.14	WH3	0.42	0.02	
sH4	0.85	0.12	WH4	0.49	0.06	
sH5	0.87	0.20	WH5	0.60	0.13	
sH6	0.98	0.01	WH6	0.71	0.08	
sH7	1.15	0.29	WH7	0.99	0.18	
sH8	1.37	0.16	WH8	1.00	0.22	
sH9	1.09	0.07	WH9	1.61	0.20	
sH10	1.09	0.07	WH10	2.08	0.14	
Discard selectivity			Weight in the discards			
sD0	0.00	0.73	WD0	0.04	0.22	
sD1	0.10	0.43	WD1	0.16	0.17	
sD2	0.45	0.19	WD2	0.23	0.06	sD2=0.55 in 2001
sD3	0.24	0.32	WD3	0.28	0.04	
sD4	0.09	0.55	WD4	0.31	0.02	
sD5	0.03	0.84	WD5	0.35	0.12	
sD6	0.03	1.38	WD6	0.32	0.30	
sD7	0.00	0.00	WD7	0.00	0.00	
sD8	0.00	0.00	WD8	0.00	0.00	
sD9	0.00	0.00	WD9	0.00	0.00	
sD10	0.00	0.00	WD10	0.00	0.00	
Industrial selectivity			Weight in Ind. bycatch			
sI0	0.01	0.40	WI0	0.03	0.70	
sI1	0.03	0.79	WI1	0.07	0.08	
sI2	0.18	0.39	WI2	0.15	0.23	
sI3	0.07	0.38	WI3	0.26	0.27	
sI4	0.02	0.67	WI4	0.38	0.09	
sI5	0.01	0.86	WI5	0.32	0.39	
sI6	0.00	1.73	WI6	0.00	0.00	
sI7	0.00	0.00	WI7	0.00	0.00	
sI8	0.00	0.00	WI8	0.00	0.00	
sI9	0.00	0.00	WI9	0.00	0.00	
sI10	0.00	0.00	WI10	0.00	0.00	

Table 4.7.2. cont. Haddock,North Sea and Skagerrak
Input data for catch forecast and linear sensitivity analysis

Natural mortality			Proportion mature		
M0	2.05	0.10	MT0	0.00	0.10
M1	1.65	0.10	MT1	0.01	0.10
M2	0.40	0.10	MT2	0.32	0.10
M3	0.25	0.10	MT3	0.71	0.10
M4	0.25	0.10	MT4	0.87	0.10
M5	0.20	0.10	MT5	0.95	0.10
M6	0.20	0.10	MT6	1.00	0.10
M7	0.20	0.10	MT7	1.00	0.00
M8	0.20	0.10	MT8	1.00	0.00
M9	0.20	0.10	MT9	1.00	0.00
M10	0.20	0.10	MT10	1.00	0.00

Relative effort in HC fishery			Year effect for natural mortality		
HF01	1.00	0.15	K01	1.00	0.10
HF02	1.00	0.15	K02	1.00	0.10
HF03	1.00	0.15	K03	1.00	0.10

Relative effort in industrial fishery		
IF01	1.00	0.63
IF02	1.00	0.63
IF03	1.00	0.63

Recruitment in 2002 and 2003		
R02	24872900	1.01
R03	24872900	1.01

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

Stock numbers in 2001 are VPA survivors.

Human consumption + discard Fs are obtained from mean exploitation pattern over 1998 to 2000.
This is scaled to give a value for mean F (ages 2 to 6) equal to that in 2000, i.e..860
Fs are distributed between consumption and discards by mean proportion retained over 1998 to 2000.
N.B. Above value for H.cons+Discar ref F is value for both catch categories combined.

Bycatch Fs are obtained from mean exploitation pattern over 1998 to 2000.
This is scaled to give a value for mean F (ages 2 to 6) equal to that in 2000, i.e. .056

Data from file:C:\MyFiles\Admin\ICES\wgnssk-ham\hadiv\prov-final\HAD34.SEN on 24

Table 4.7.3. Haddock, North Sea and Skagerrak
Catch forecast output and estimates of coefficient of variation (CV) from linear analysis.

	Year							
	2001	2002						
Mean F Ages								
H.cons 2 to 6	0.86	0.00	0.17	0.34	0.52	0.69	0.86	1.03
Ind BC 2 to 6	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
Effort relative to 2000								
H.cons	1.00	0.00	0.20	0.40	0.60	0.80	1.00	1.20
Ind BC	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Biomass								
Total 1 January	969	827	827	827	827	827	827	827
SSB at spawning time	215	224	224	224	224	224	224	224
Catch weight (,000t)								
H.cons	65	0	32	59	83	103	120	135
Discards	182	0	18	35	50	64	77	88
Ind BC	40	25	24	23	22	21	20	19
Total Landings	196	25	56	82	104	124	140	154
Total Catch	288	25	74	117	155	188	217	243
Biomass in year.... 2003								
Total 1 January		937	887	843	806	774	746	722
SSB at spawning time		322	282	247	218	192	171	152

	Year							
	2001	2002						
Effort relative to 2000								
H.cons	1.00	0.00	0.20	0.40	0.60	0.80	1.00	1.20
Ind BC	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Est. Coeff. of Variation								
Biomass								
Total 1 January	0.21	0.61	0.61	0.61	0.61	0.61	0.61	0.61
SSB at spawning time	0.20	0.27	0.27	0.27	0.27	0.27	0.27	0.27
Catch weight								
H.cons	0.38	0.00	0.75	0.42	0.33	0.30	0.28	0.27
Discards	0.28	0.00	0.82	0.53	0.47	0.45	0.45	0.45
Ind BC	0.73	0.72	0.72	0.72	0.73	0.73	0.73	0.74
Biomass in year.... 2003								
Total 1 January		0.58	0.61	0.63	0.66	0.68	0.71	0.73
SSB at spawning time		0.30	0.32	0.33	0.34	0.36	0.38	0.40

Table 4.7.4.Haddock,North Sea and Skagerrak
Detailed forecast tables.

Forecast for year 2001
F multiplier H.cons=1.00
F multiplier Indust=1.00

Populations		Catch number			
Age	Stock No.	H.Cons	Discards	By-catch	Total
0	24872909	0	10535	94818	105353
1	2628499	1226	125042	38003	164270
2	2161900	252410	557043	223812	1033265
3	50499	17406	7270	2082	26758
4	21800	10756	1090	253	12099
5	11999	6295	189	65	6549
6	5599	3175	98	3	3276
7	4599	2896	0	0	2896
8	200	138	0	0	138
9	100	61	0	0	61
10	0	0	0	0	0
Wt	969	113	152	40	305

Forecast for year 2002
F multiplier H.cons=1.00
F multiplier Indust=1.00

Populations		Catch number			
Age	Stock No.	H.Cons	Discards	By-catch	Total
0	24872900	0	10535	94818	105353
1	3170151	1479	150809	45834	198121
2	441496	51546	113757	45706	211010
3	631276	217593	90884	26021	334497
4	16199	7993	810	188	8991
5	6533	3427	103	36	3566
6	3994	2265	70	2	2337
7	1673	1054	0	0	1054
8	1197	826	0	0	826
9	42	26	0	0	26
10	28	17	0	0	17
Wt	827	120	77	20	217

Table 4.7.5 Haddock in IIIa+IV. Contribution by weight of recent year classes to the forecast human consumption landings and SSB.

			1998	1999	2000	2001	2002
Year-class			1998	1999	2000	2001	2002
Stock No. (millions) of 0-Group			8824	93773	20564	24872	24872
Source			VPA	VPA	VPA	GM	GM
Status Quo F:							
% in	2001	landings	11.2	66.2	0.5	0.0	-
% in	2002		3.2	76.3	15.3	0.3	0.0
% in	2001	SSB	6.2	80.5	1.7	0.0	
% in	2002	SSB	2.9	75.0	15.8	2.0	0.0
% in	2003	SSB	1.6	48.6	20.1	25.0	2.7

GM : geometric mean recruitment

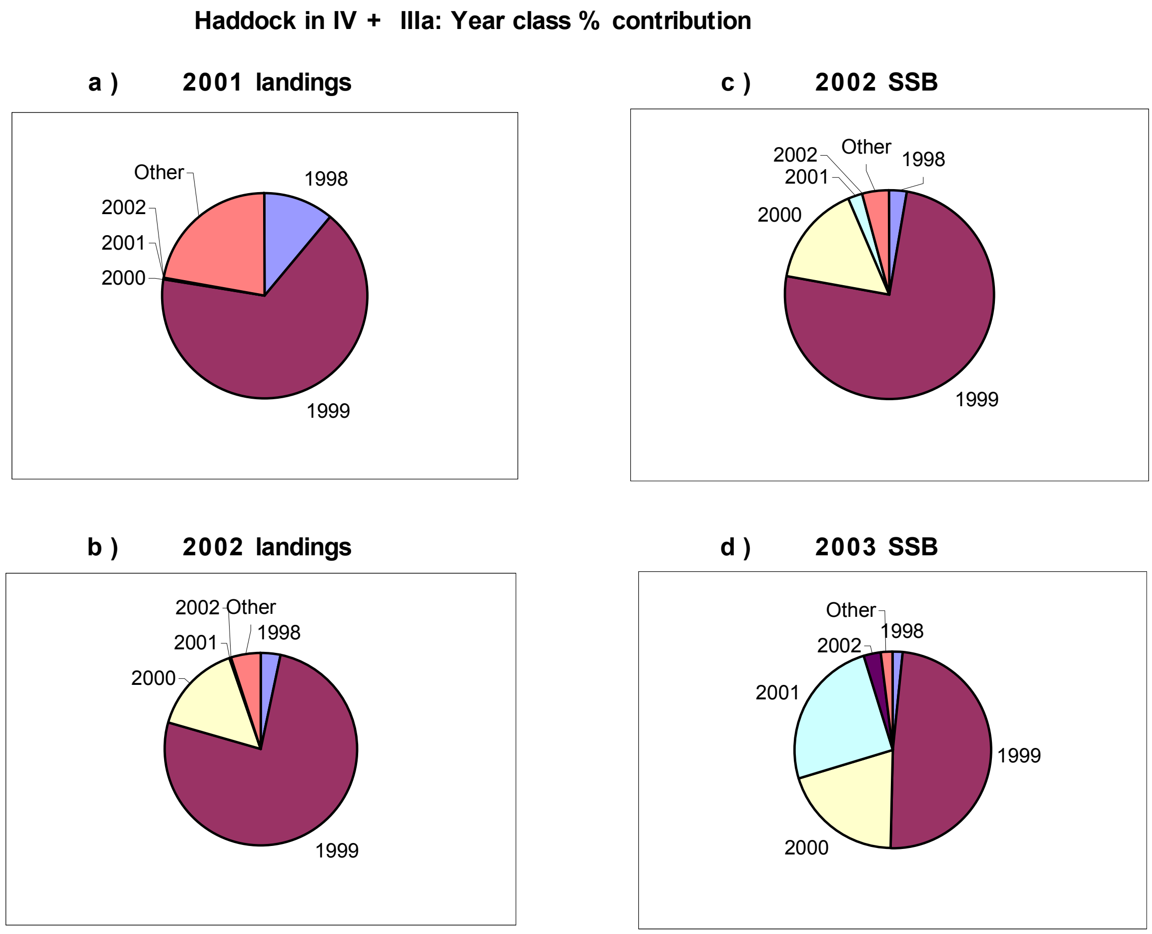


Table 4.8.1. Haddock, IIIa+IV. Results of fitting the Beverton Holt stock recruit model.

Data read from file had34.rec

Beverton-Holt curve
Moving average term NOT fitted

Number of observations=, 38

Number of parameters =, 2

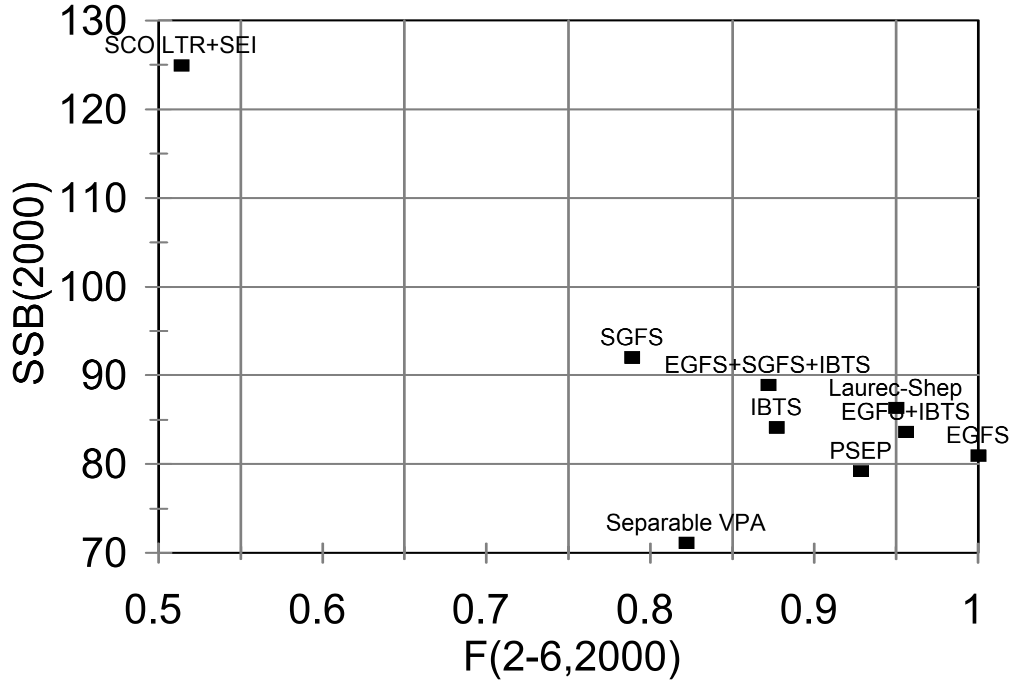
Residual mean square =, 1.0304

Coefficient of determination =, .0059

Parameter,	s.d.
401.6559,	423.2294,
83.2304,	123.7215,

Y/Class,	SSB,	Recruits,	Fit. rct,	residuals,
1963,	137.20,	2338.00,	20807.44,	-2.1860,
1964,	420.00,	9172.00,	27900.92,	-1.1125,
1965,	526.10,	26336.00,	28863.67,	-.0916,
1966,	432.20,	68992.00,	28031.79,	.9007,
1967,	229.10,	388112.00,	24521.49,	2.7617,
1968,	264.60,	17103.00,	25430.70,	-.3967,
1969,	815.80,	12196.00,	30335.10,	-.9112,
1970,	899.50,	87764.00,	30598.69,	1.0537,
1971,	417.80,	78285.00,	27876.64,	1.0326,
1972,	301.00,	21539.00,	26188.51,	-.1955,
1973,	294.50,	72898.00,	26063.90,	1.0285,
1974,	258.40,	133493.00,	25285.53,	1.6638,
1975,	238.10,	11542.00,	24771.01,	-.7637,
1976,	307.80,	16484.00,	26314.44,	-.4677,
1977,	238.60,	25751.00,	24784.46,	.0383,
1978,	132.30,	39549.00,	20520.47,	.6561,
1979,	109.20,	72153.00,	18970.77,	1.3359,
1980,	153.00,	15653.00,	21651.69,	-.3244,
1981,	240.20,	32481.00,	24827.23,	.2687,
1982,	299.60,	20622.00,	26162.03,	-.2380,
1983,	253.00,	66983.00,	25154.73,	.9794,
1984,	198.80,	17274.00,	23564.41,	-.3105,
1985,	240.90,	24053.00,	24845.81,	-.0324,
1986,	221.80,	49885.00,	24308.29,	.7189,
1987,	157.50,	4202.00,	21871.86,	-1.6496,
1988,	159.20,	8442.00,	21952.91,	-.9557,
1989,	129.20,	8706.00,	20332.09,	-.8482,
1990,	81.40,	28141.00,	16529.15,	.5321,
1991,	63.30,	27425.00,	14441.49,	.6413,
1992,	101.20,	40612.00,	18343.58,	.7948,
1993,	133.30,	12698.00,	20580.09,	-.4829,
1994,	153.00,	53550.00,	21651.69,	.9055,
1995,	148.40,	12878.00,	21417.78,	-.5087,
1996,	178.30,	21022.00,	22791.10,	-.0808,
1997,	190.40,	12126.00,	23261.55,	-.6514,
1998,	160.20,	8824.00,	22000.06,	-.9136,
1999,	114.90,	93773.00,	19386.75,	1.5763,
2000,	87.00,	20564.00,	17085.13,	.1853,

Figure 4.4.1. Haddock in IIIa+IV. Results of exploratory catch-at-age analyses using different data sets and methods.



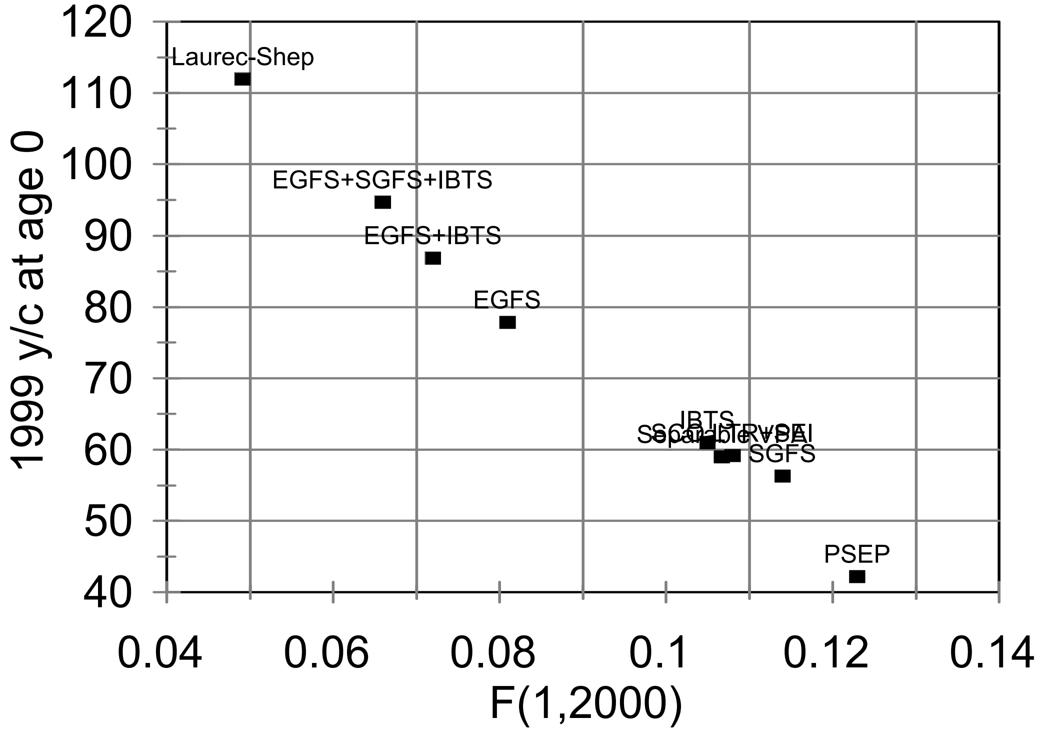


Figure 4.4.2. Haddock in IIIa+IV. Retrospective analysis for the XSA settings used in the key run. The upper two figures show the F and SSB estimates from successive assessments. The lower figures show the deviation of F and SSB each year from the 2001 assessment.

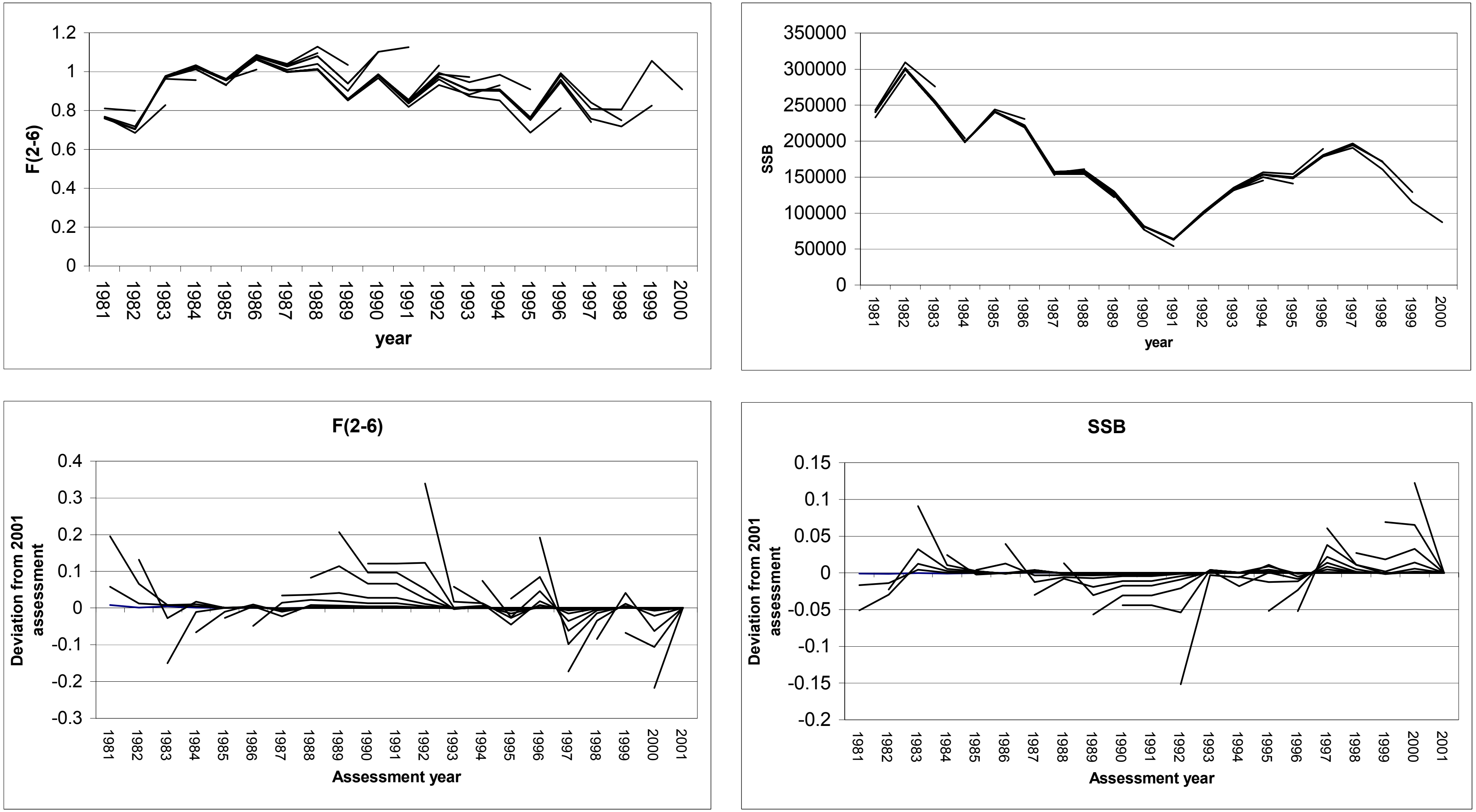


Figure 4.4.3. Haddock in IIIa+IV. Stock trends for three surveys estimated using a seprable fishing mortality model. For yield, recruitment and SSB the trends are scled to the long term mean. The heavy line shows the trend from the key run VPA.

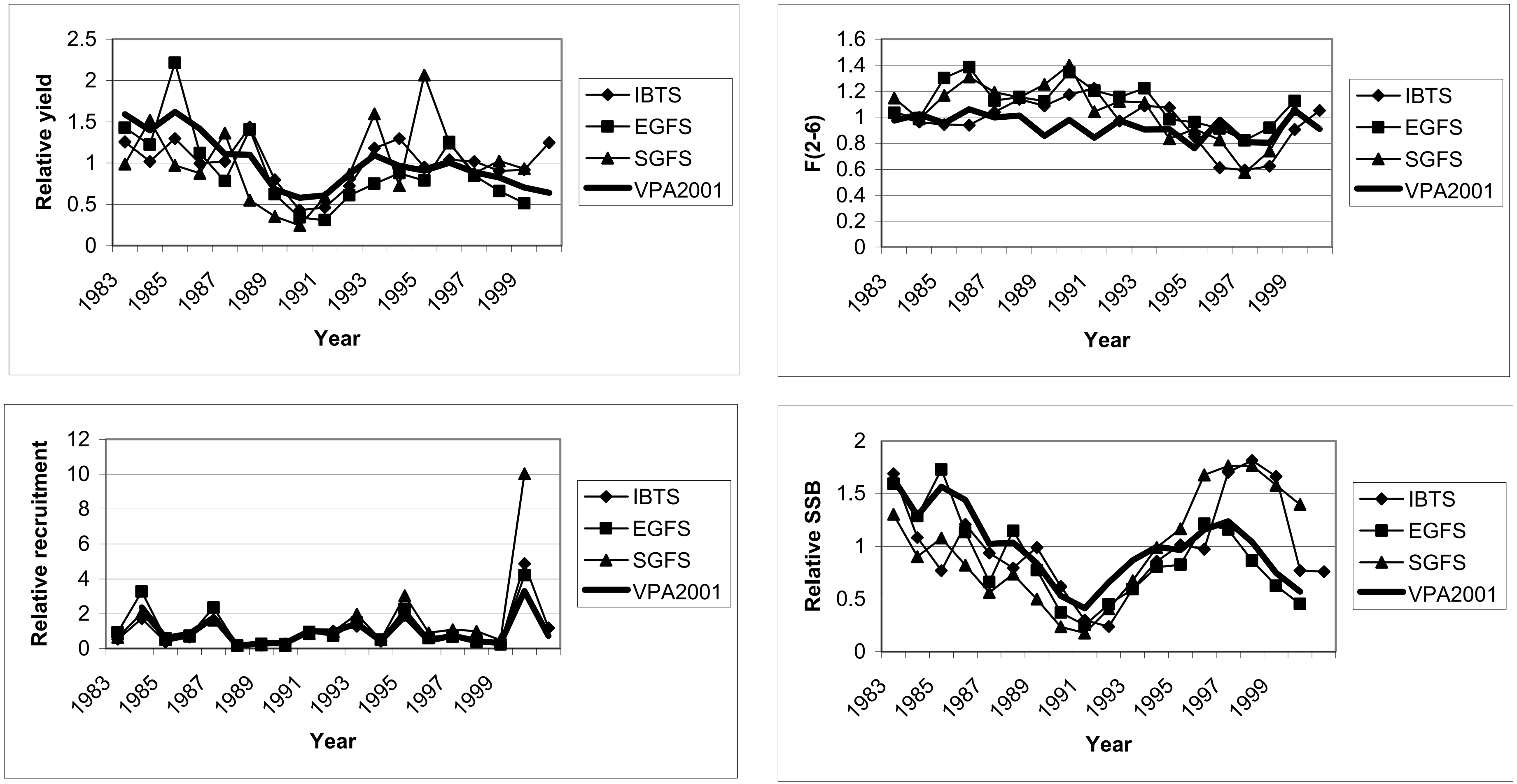


Figure 4.4.4. Haddock in IIIa+IV. Log catchability residuals from the key run.

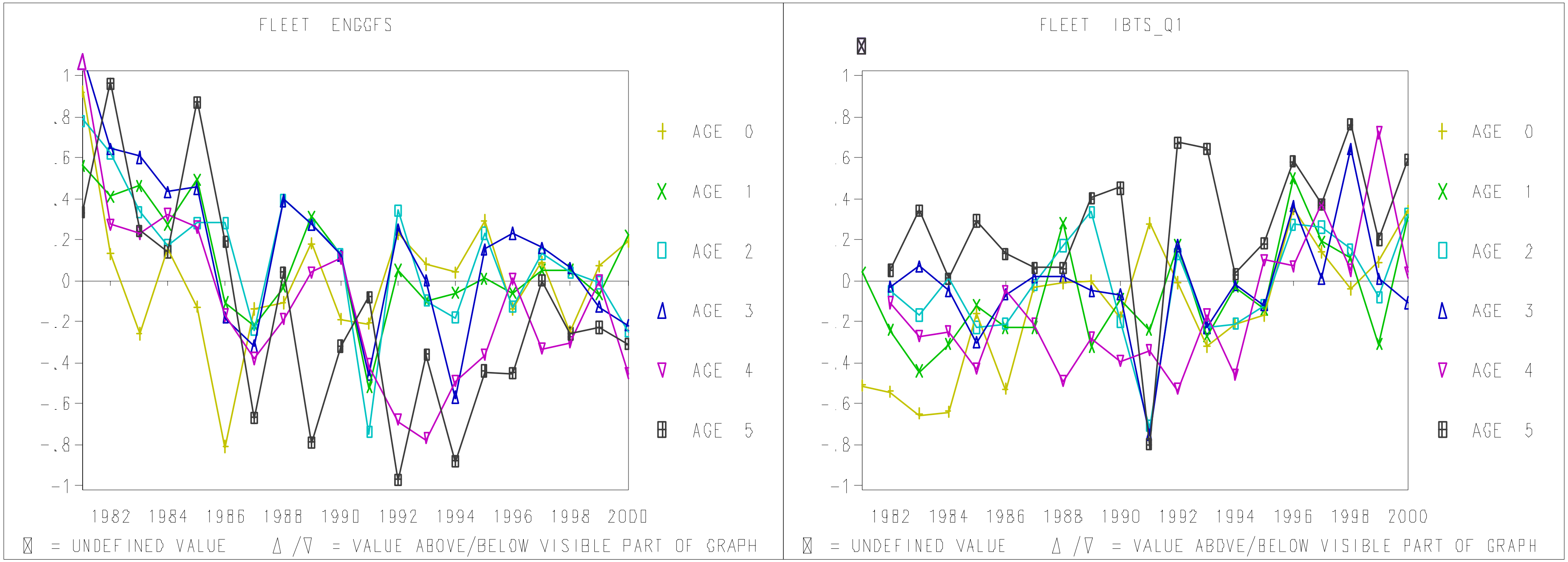


Figure 4.4.5. Haddock IIIa+IV. Contribution of tuning fleets and shrinkage to the final survivors estimates in 2001.

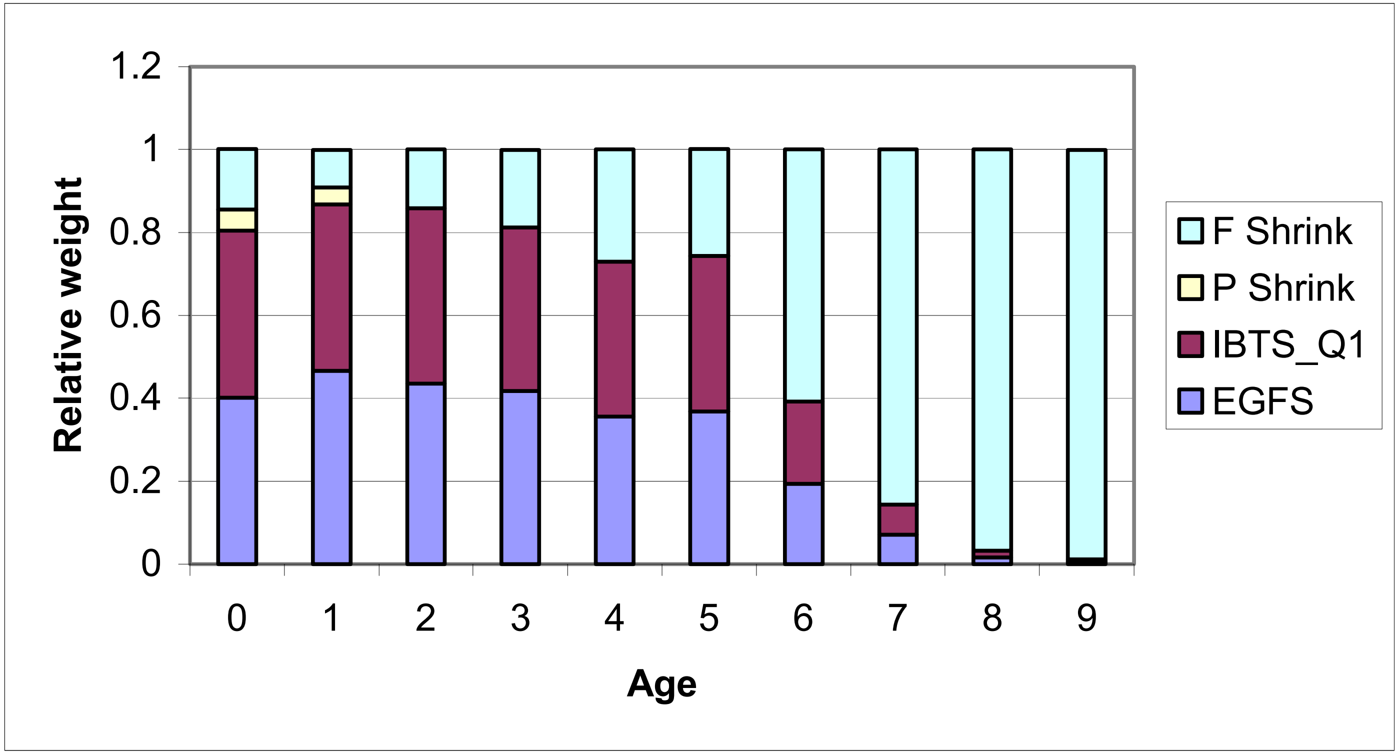


Figure 4.6.1 Haddock in IIIa+IV. Historical stock trends in catch, fishing mortality recruitment and SSB as estimated from the key run. The dashed line in the fishing mortality plot is $\mathbf{F}_{pa}$ and the dotted line in the SSB plot is $\mathbf{B}_{pa}$.

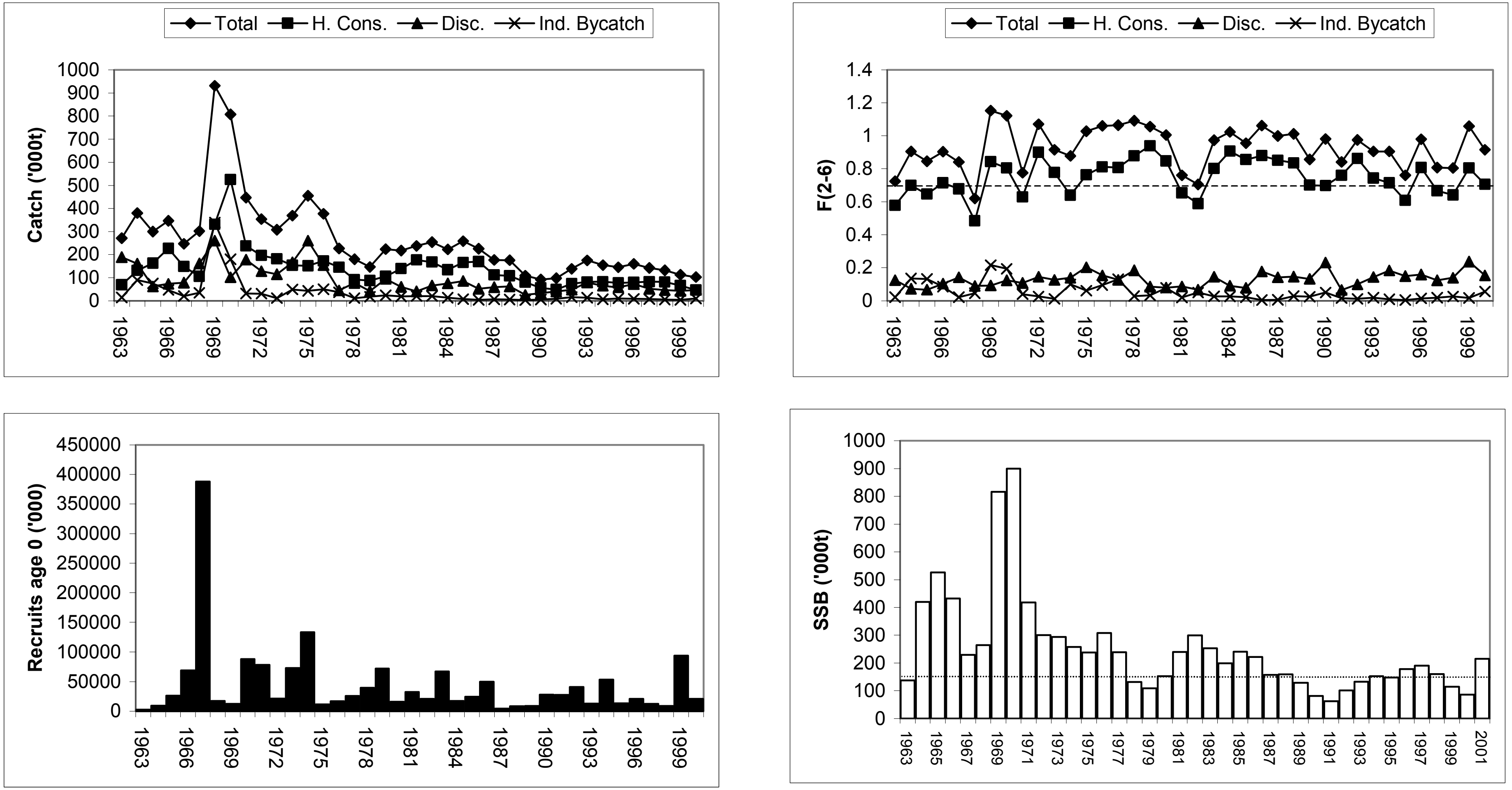


Figure 4.7.1. Haddock in IIIa+IV. Proportion of haddock discarded at age 2 and 3 as a function of mean weight at age 2.

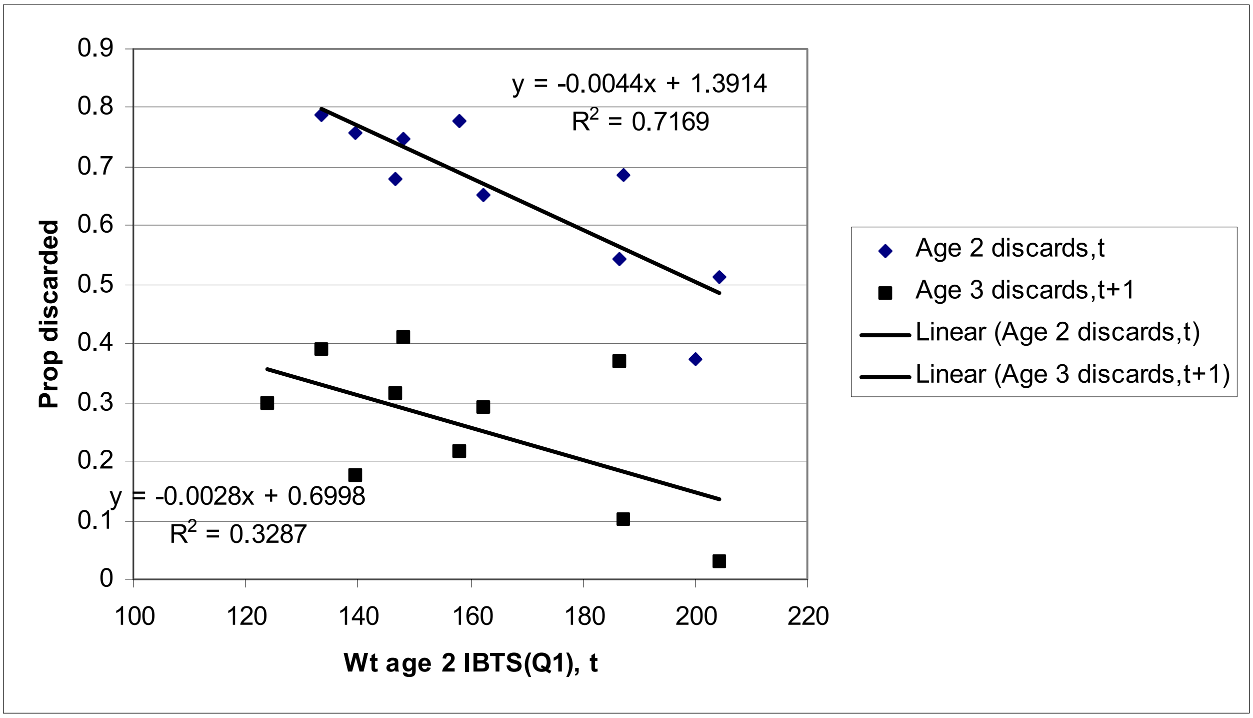


Figure 4.7.2. Haddock in IIIa+IV. Results of sensitivity analysis of the short term forecast. X axis labels are explained in Table 4.7.1.

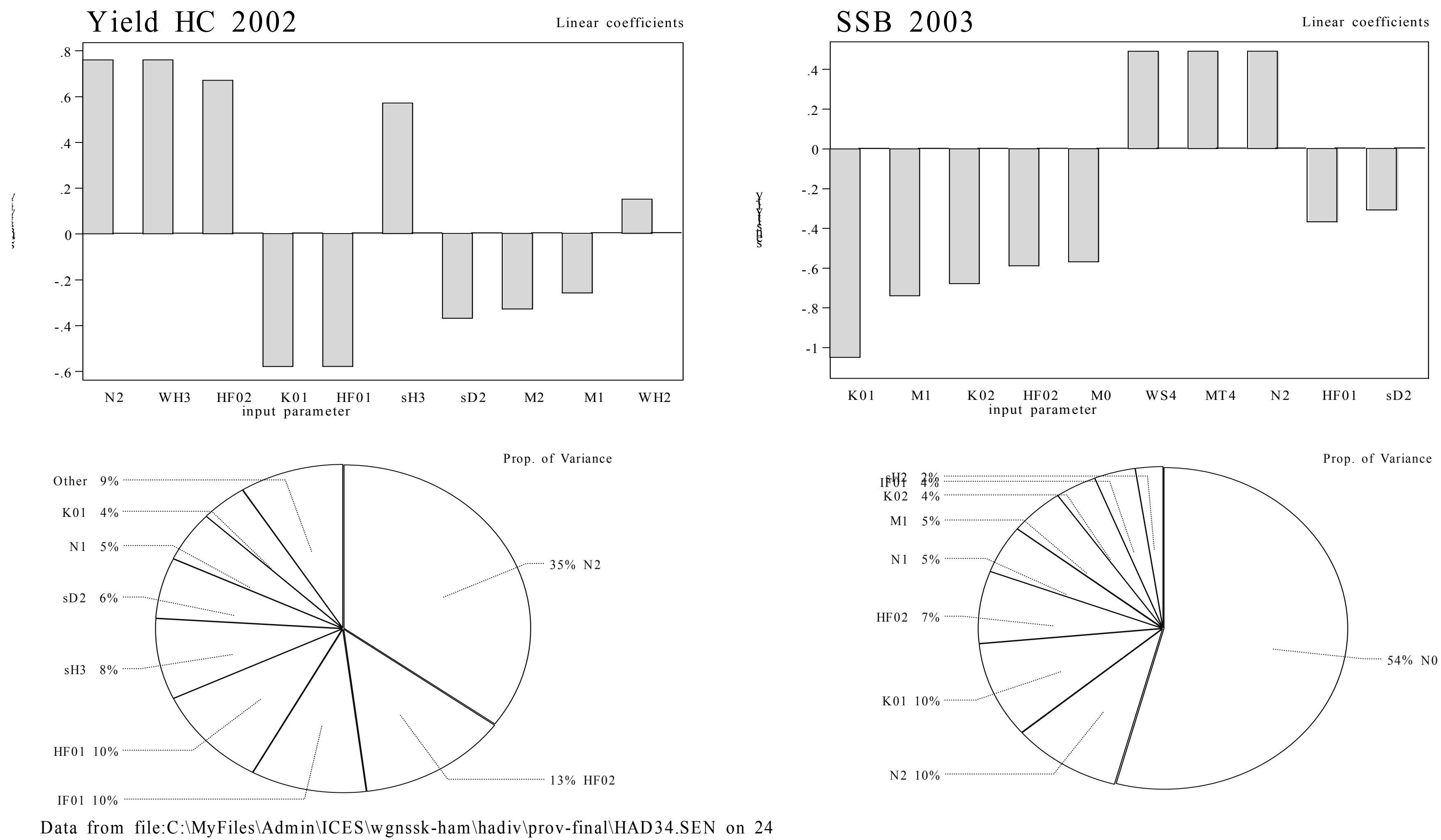
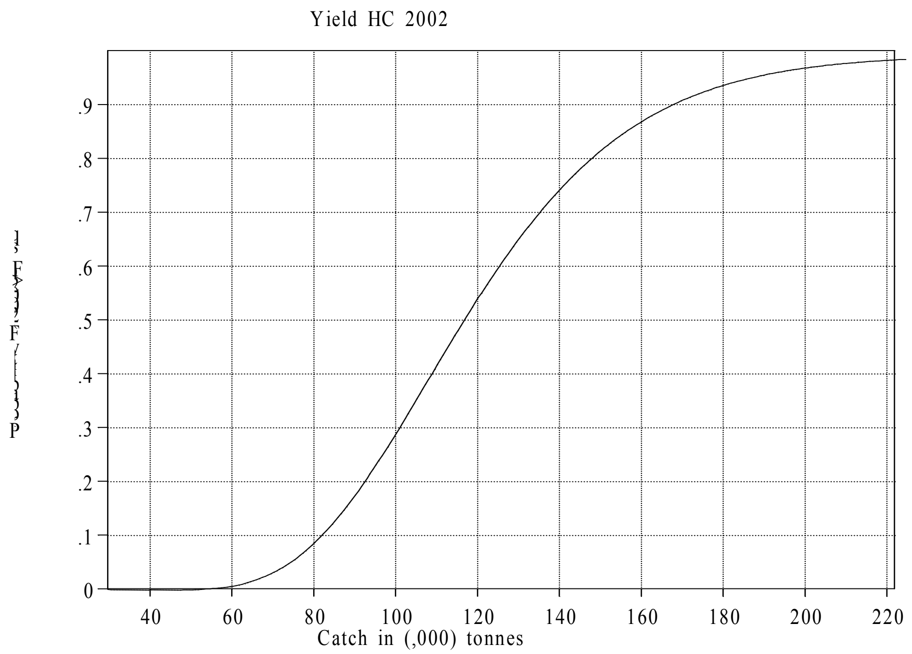


Figure 4.7.3. Haddock in IIIa+IV. Probability profiles for *status quo* forecast.



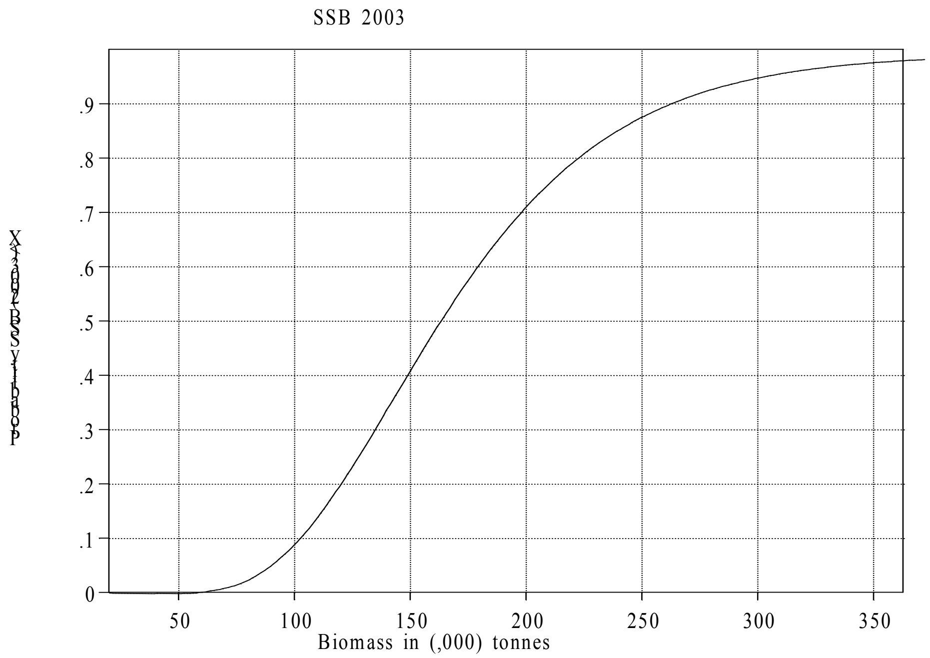


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Figure 4.7.4 . Haddock in IIIa+IV. Short term forecast.

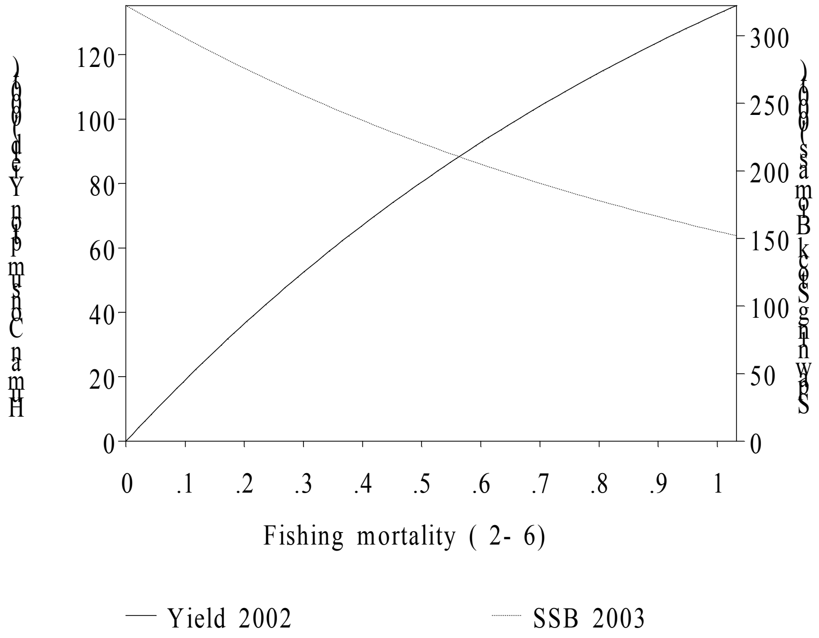

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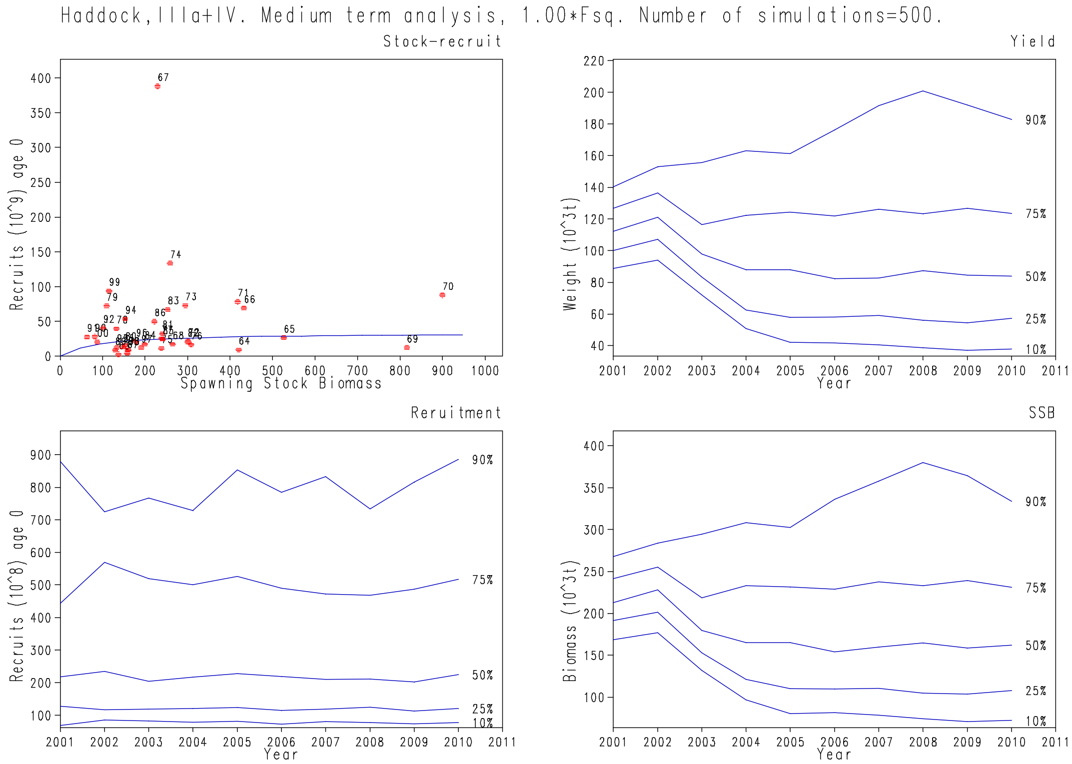
Figure 4.8.1. Results of medium term analaysis. (a) Status quo F, (b) $\mathbf{F}_{pa}$.

(a)



(b)

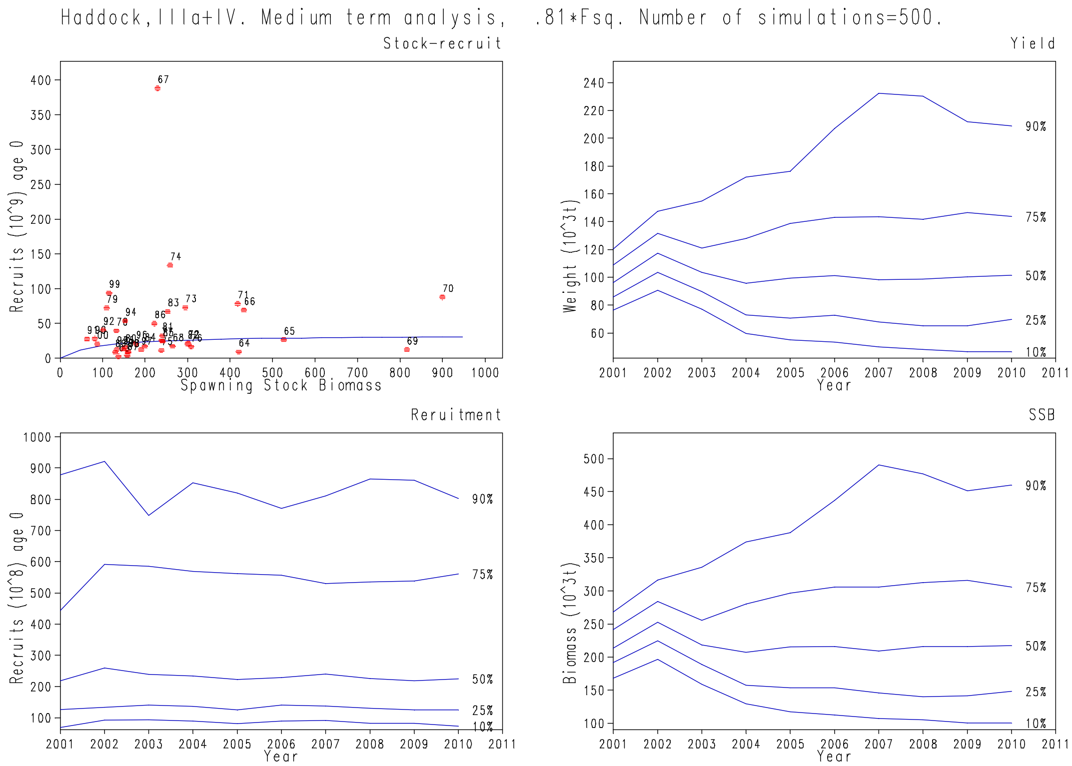


Figure 4.8.2. Summary of medium term analysis. Contours show the probability the SSB will be below $\mathbf{B}_{pa}$ for any combination of year and fishing mortality.

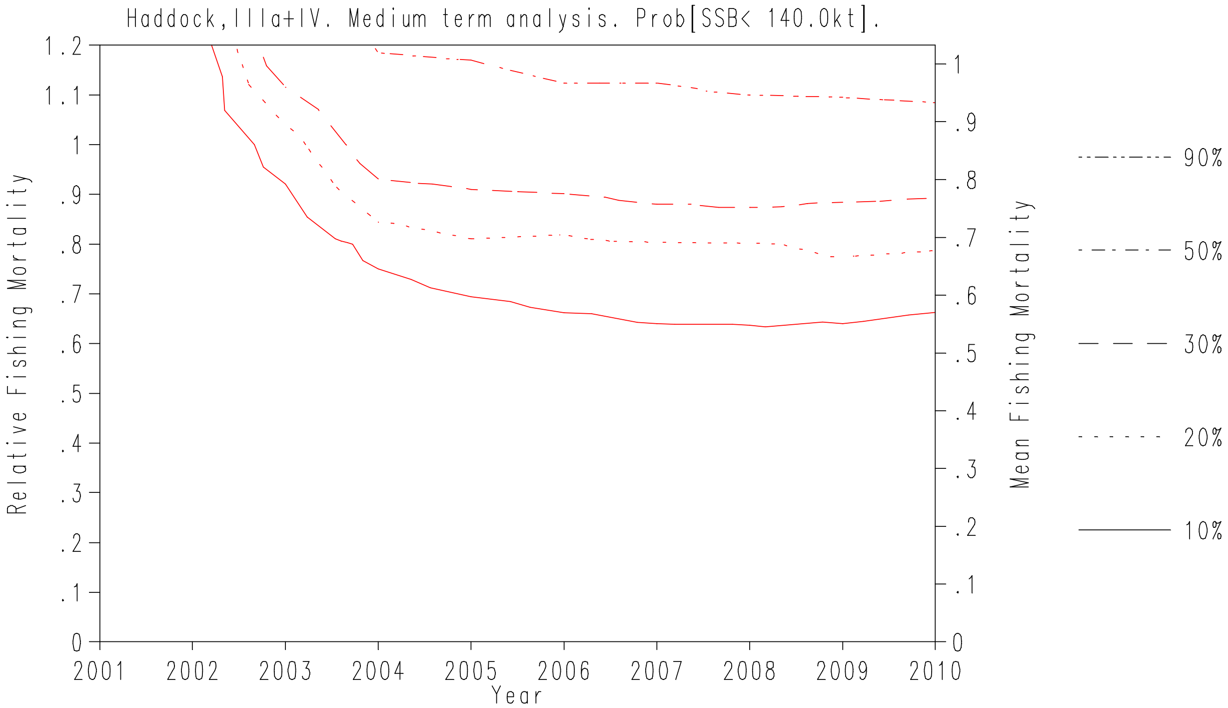
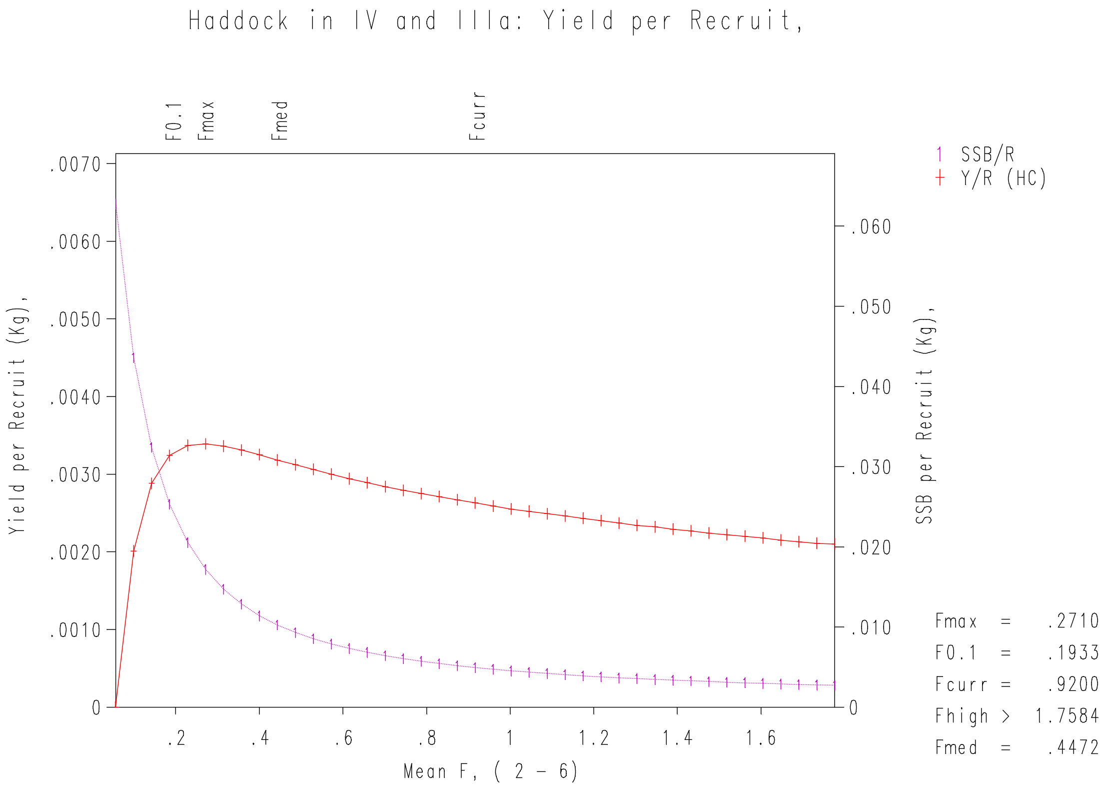


Figure 4.9.1.



Haddock in IV and IIIa: Yield per Recruit,
F0.1
Fmax
Fmed
Fcurr
Yield per Recruit (Kg),
SSB per Recruit (Kg),
Mean F, (2 - 6)
1 SSB/R
+ Y/R (HC)
Fmax = .2710
F0.1 = .1933
Fcurr = .9200
Fhigh > 1.7584
Fmed = .4472

Figure 4.9.2. Haddock in IIIa_IV. Stock-recruit scatter plot with standard replacement lines.

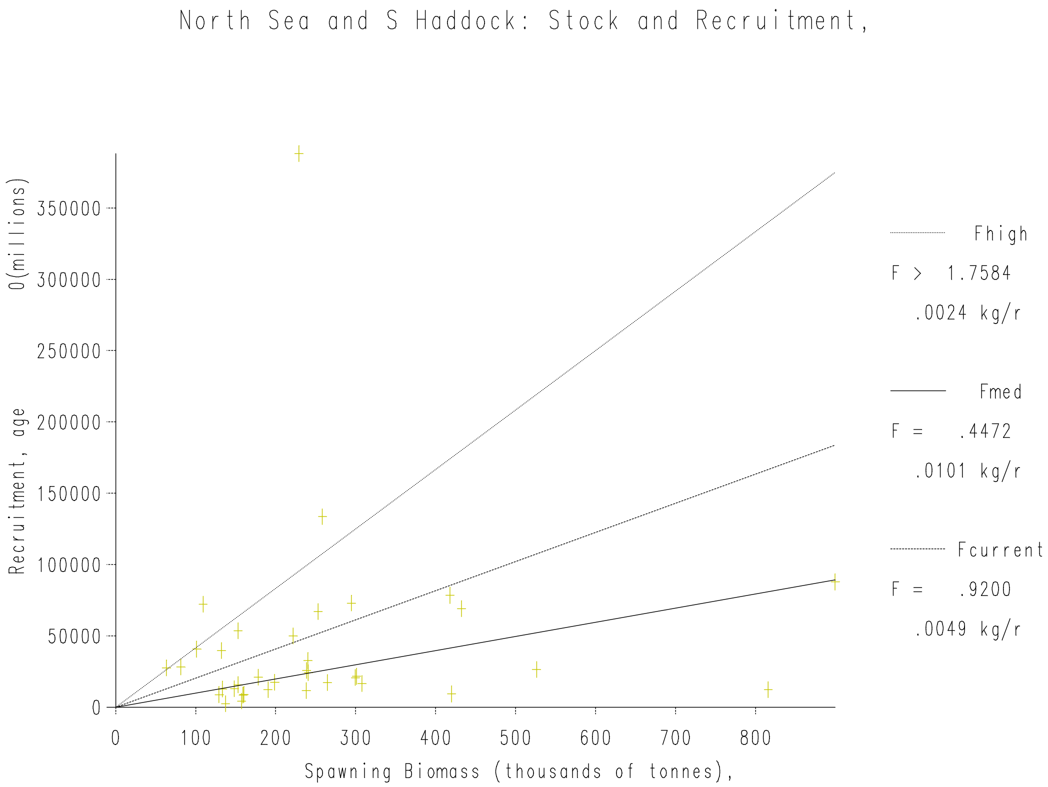
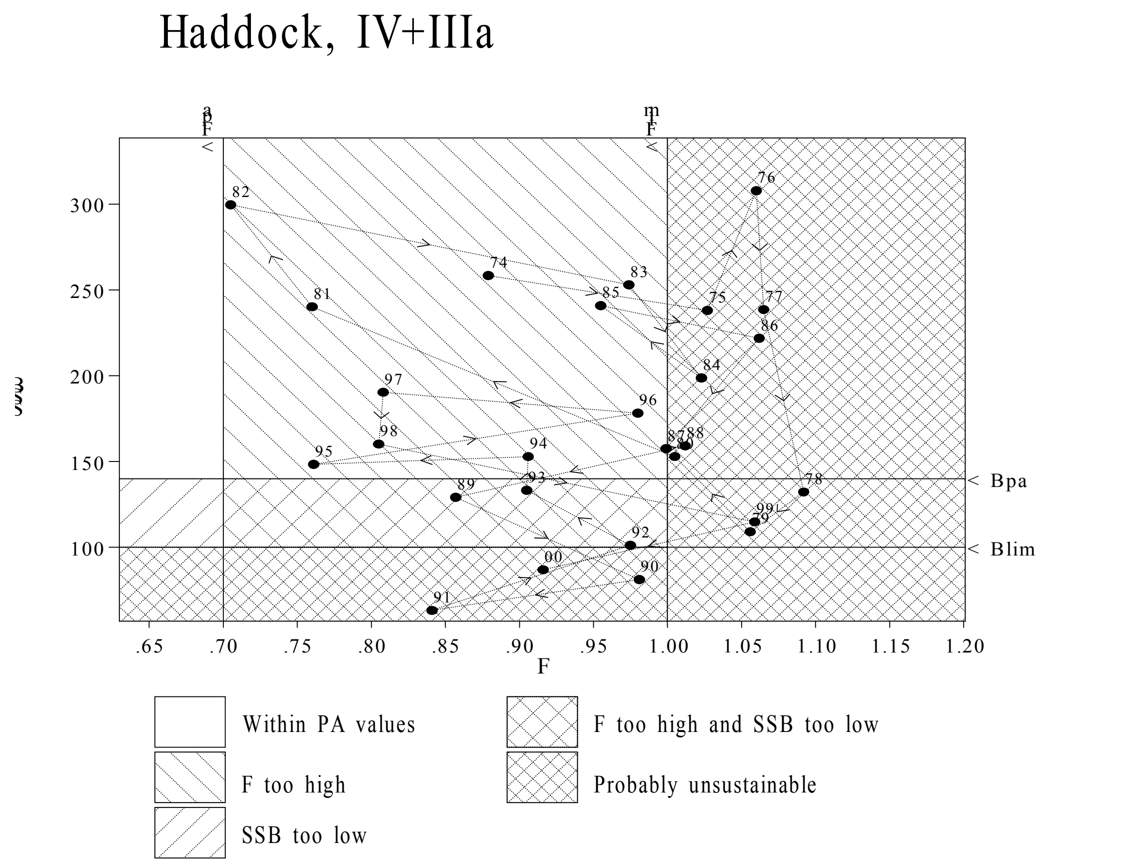


Figure 4.9.3. Historical stock performance in relation to current PA values. Data before 1974 have been excluded to make the Y axis scale more readable.



Data file(s):C:\MyFiles\Admin\ICES\wgnssk-ham\hadiv\prov-final\hadiv.pa;C:\MyFiles\Admin\ICES\wgnssk-ham\hadiv\prov-final\HAD34.SUM
Plotted on 25/06/2001 at 09:22:10

5 WHITING

5.1 Whiting in Sub-area IV and Division VIId

5.1.1 The fishery

Total nominal landings are given in Tables 5.1.1.1 for the North Sea and eastern Channel. Total international catches as estimated by the Working Group for the combined North Sea and eastern Channel are shown in Table 5.1.1.2. Eastern Channel catches as used by the Working Group are also shown separately in Table 5.1.1.3.

In the North Sea, whiting are caught for human consumption in the mixed demersal fisheries of Scotland (seine and light trawl), England (seine and trawl) and France (inshore and offshore trawlers). They are also caught in the Dutch beam trawl and German trawl fisheries. French trawlers targeting saithe also take a by-catch of whiting. Industrial by-catch is taken mostly in the Norway pout fishery.

In the eastern Channel, whiting are caught both by inshore and offshore trawlers in a mixed demersal fishery, with vessels from this area sometimes moving into the North Sea.

5.1.1.1 ICES advice applicable to 2000 and 2001

ICES advice for the fishery in 2000 was to reduce fishing mortality to bring SSB above the proposed $\mathbf{B}_{pa}$ of 315,000 t. The stock was considered to be outside safe biological limits.

In its 2000 advice, the ICES perception of the stock was that it remained outside safe biological limits. Its advice was to recommend a reduction in fishing mortality of 60%, and the implementation of technical measures to address the high rate of discarding. ICES proposed the following PA reference points: $\mathbf{B}_{pa}$ = 315,000 t, $\mathbf{B}_{lim}$ = 225,000 t, $\mathbf{F}_{pa}$ = 0.65 and $\mathbf{F}_{lim}$ = 0.9. These values were unchanged from the previous year.

The forecast catch levels provided by ACFM were divided between the North Sea (Sub-area IV) and Eastern Channel (Division VIId) on the basis of 11.5% of human consumption landings coming from the latter area. This value represents an average split of the landings' distribution during the years immediately prior to the merger of VIId and IV whiting in assessments (1992–1996).

5.1.1.2 Management applicable to 2000 and 2001

The 2000 and 2001 TACs for area IIa (EC zone) and IV are 30,000 t and 29,700 t. The minimum mesh size for vessels fishing in the mixed demersal fishery in this area is 100 mm. Whiting are a by-catch in some Nephrops fisheries that use a smaller mesh size, although landings are restricted through by-catch regulations. Industrial fishing with small-meshed gear is permitted subject to by-catch limits of protected species such as whiting. The minimum landing size of whiting in the human consumption fishery from this area is 23 cm, although the UK has adopted a minimum landing size of 27 cm. Regulations applying to the Norway pout box prevent industrial fishing with small meshes in an area where the by-catch limits are likely to be exceeded.

The UK implemented a national regulation in the late summer of 2000, requiring the mandatory fitting of a square mesh panel in certain towed gears (Ferro and Graham, 2000). These measures are likely to affect the selectivity of whiting.

The cod spawning closure in the spring of 2001 displaced vessels from areas where whiting were commonly fished and for a brief period a number of vessels remained in port.

There is no separate TAC for Division VIId, landings from this Division are counted against the TAC for Divisions VIIb-k combined. (32,500 t in 2000 and 21,000 t in 2001). Minimum mesh size for whiting in Division VIId is 80 mm with a 23 cm minimum landing size.

5.1.1.3 The fishery in 2000 and 2001

For the North Sea, the total international catches were 55,300 t in 2000, of which 24,000 t were human consumption landings, 22,400 t discards and 8,900 t industrial by-catch. All three components remained close to their lowest recorded levels: human consumption landings and discards decreased slightly from 1999 to 2000, while industrial bycatch increased by a similar amount. The total catch remains at a low level. For the eastern Channel, the total catch in

2000 (4,300 t) was similar to recent catches, and at the lower end of the available data series. The total North Sea and eastern Channel landings of 36,300 t in 2000 were 94% of the status quo forecast from the 2000 assessment.

Misreporting is not considered to be a serious problem for either the North Sea or the eastern Channel components of the stock.

5.1.2 Natural mortality, Maturity, Age compositions, Mean weight at age

The natural mortality and maturity at age values as used are shown in Table 5.1.2.1. These are unchanged from last year, and are applied to the full year range of the assessment. The natural mortality values are rounded averages of estimates produced by an earlier key run of the North Sea MSVPA (see Section 1.3.1.3 of the 1999 WG report: ICES CM 2000/ACFM:7).

The maturity ogive is based on North Sea IBTS quarter 1 data, averaged over the period 1981–1985.

For Sub-area IV catches, human consumption landings data and age compositions were provided by Scotland, the Netherlands, England, France and Belgium. Discard data were provided by Scotland and used to estimate total international discards. 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 provided age composition data for its industrial by-catch.

Mean weights at age were available separately for the human consumption, discard and industrial by-catch components of the catch.

For Division VIId catches, age composition data were supplied by England and France. No estimates of discards are available for whiting in the eastern Channel, although given the relatively low numbers in the Channel catch compared to that in the North Sea, this is not considered to be a major omission. There is no industrial fishery in this area.

Total international catch at age and mean weight at age in the catch (North Sea and eastern Channel combined) are presented in Tables 5.1.2.2 and 5.1.2.3. The catch mean weight at age was also used as the stock mean weight at age. Recent trends in mean weights-at-age are shown in Figure 5.1.2.1.

5.1.3 Catch, effort and research vessel data

Catch and effort data from five commercial and six survey-vessel series were available to calibrate catch-at-age analyses. The number of years and ages available for each fleet are listed in Table 5.1.3.1.

Continuing concerns over the validity of effort data for Scottish commercial fleets (SCOSEI and SCOLTR) meant that, as in the previous assessment, they could not reasonably be used for catch-at-age tuning. Following the practice of the previous assessment, data for 1998–2000 were removed from the SCOGFS series: these were obtained using new gear on a new vessel and are not well calibrated with historical data. There were no effort data for 1999 for the FRATRB, FRATRO_IV and FRATRO_VIId series, so these indices were truncated to 1998. All the available tuning fleet data are given in Table 5.1.3.2.

In common with previous assessments of this stock, the indices for the second-quarter IBTS consist of age-based indices from the Scottish component only of the survey, while the fourth quarter values are obtained from the English component. These surveys are now discontinued: however, as they still provide information on the abundance of extant cohorts (and will do so until 2004, assuming a maximum age of around 8) they have been used in this assessment.

Pairwise linear regression plots of tuning series (Figure 5.1.3.1) demonstrate the lack of consistency between surveys. Many of the correlations are negative, and those that are positive have low R^2 values. Inter-sessional work on methodology (e.g. factor analysis) to evaluate the degree of similarity between tuning series, and the extent to which they represent the hypothesised underlying population, would be beneficial.

All available survey indices of recruitment are tabulated in Table 5.1.3.3.

5.1.4 Catch-at-age analysis

Several different catch-at-age analyses were performed for whiting. Described below are exploratory runs using separable VPA, XSA, ICA, and TSA. Methods are described in more detail in Section 1.4.

The intention in performing alternative assessments using a variety of methods was to ascertain how robust perceptions of stock dynamics and structure are to different methodologies. To this end it was decided that these supplementary analyses would be run from scratch, and to attempt to achieve the most internally-consistent assessments that were possible with the given methods. In each case the same data were used, with the exception of tuning series which were tailored to the method in question.

Different survey series give conflicting impressions of the dynamics of the whiting stock (Figure 5.1.3.1). The different ways in which different methodologies attempt to reconcile or alleviate these inconsistencies means that the methods used here are, *a priori*, likely to give somewhat divergent impressions of the dynamics of the stock.

(i) Separable VPA analysis

A separable VPA was run on catch-at-age dataset truncated to the most recent 10 years (ages 0–12, years 1991–2000), using default options and with unit selection (1.0) and terminal *F* (0.6 on age 3) from previous assessments. The results given in Figure 5.1.4.1a suggest that residuals are large on the 0:1 log catch ratios on the one hand, and on the 6:7 and older log catch ratios on the other. The former consist of partially recruited age groups subject to discarding in the human consumption fishery and taken as by-catch in the industrial fisheries, while the latter are poorly represented in the historical record and are likely to be subject to noise as a result. These considerations support the restriction of the age range for assessment to 1–8+, the same as in the two most recent assessments. Figure 5.1.4.1b gives residuals for a separable VPA run on this reduced dataset (ages 1–8+, years 1991–2000), which are small. All catch and tuning data were therefore limited to the 1–8+ age range for all the assessment methods discussed below.

(ii) XSA

Single-fleet XSA runs were made using each of the available tuning series in turn, and assuming light shrinkage (s.e. = 1.5 on 5 years and 3 ages, 20-year tricubic time weighting, catchability model constant for all ages, catchability plateau at age 6). These runs are available in the Working Group's data directory, and were used to determine the appropriate year and age-ranges to be retained for each tuning series.

A multi-fleet XSA run was performed using tuning indices as modified after these single-fleet runs: parameter settings were as in the previous assessment, except for the replacement of a 10-year tuning window with 20-year tricubic tapered weighted tuning (see Section 1.4). Diagnostics for this run are available in the data directory. Plots of log catchability residuals against log population abundances showed weak evidence of curvilinearity at age 1, implying that a power catchability model for that age might be appropriate. Using calibrative regression for the catchability model resulted in replacement of extreme values of age-1 residuals for the SCOGFS index, and XSA could not attain a converged solution. Using predictive regression removed the former problem, but resulted in a steady increase in absolute model residuals with increasing iterations. In either case the power model does not appear to be appropriate for whiting, and constant catchability was assumed for all ages in consequence.

The assessment thus obtained was reasonably consistent in terms of internal XSA diagnostics. However, the estimate from this assessment for mean $F_{2–6}$ for 1999 was substantially revised downwards when compared with the estimate produced in the previous assessment. A second XSA run was produced using the same XSA configuration as in the previous assessment, with the new data included (10-year tuning window, no taper, year and age-ranges in tuning series as for last year). Diagnostics and outputs from this run are available in the data directory. The estimates for mean $F_{2–6}$(1999) from these runs are summarised below.

XSA run	*Estimate of mean* $F_{2–6}$(1999)
(1) Key run from this assessment	0.4170
(2) Key run from previous assessment	0.6470
(3) Run using configuration from (2) and data from (1)	0.5304

Retrospective patterns obtained using the "diminishing series" method for runs (1) and (3) are given in Figure 5.1.4.2. Of particular note is the recent pattern for mean $F_{2–6}$ for run (3), which is very noisy in comparison to that for run (1). This indicates that run (1) may be more suitable, but no firm conclusion is possible.

In summary, most diagnostics suggest that runs (1) and (3) are equally plausible in terms of XSA configurations, and indeed may form only a subset of the full range of plausible XSA runs. It would appear difficult, on this evidence, to conclude with any certainty that one XSA run or another is the most appropriate.

(iii) ICA

A series of exploratory ICA runs were performed, with diagnostics being examined for each one. The most appropriate model, in terms of goodness of fit, used a 10-year separable period, one selection pattern, reference F at age 4, a selection of 1.0 on the oldest age, all available ages in tuning indices, and linear catchability models and full correlation throughout. ICA tends to inflate estimates of mean $F_{2\text{-}6}$ for whiting over the period for which it assumes fishing-mortality separability, but this is understandable given that changes in the fishery during that time may have led to the violation of this assumption. In any case the consistency with XSA run (1) is marked.

(iv) TSA (Kalman filter)

The implementation of the Kalman filter time-series method, known as time-series analysis or TSA, has been described in detail in previous meetings, both of this Working Group and of the Working Group for the Assessment of Northern Shelf Demersal stocks (ICES CM 1999/ACFM:1, ICES CM 2001/ACFM:07, Fryer *et al* 1998, Fryer 2000). Details on the Kalman filter algorithm are available in the statistical literature (Harvey 1989, Jones 1993, Gudmundsson 1994). In this meeting a version of TSA using only catch-at-age data was used, the intention being to generate stock impressions unaffected by potential problems with commercial and survey tuning series. The method has been implemented in Fortran-90 code by R. Fryer, FRS Marine Laboratory, Aberdeen.

The Kalman filter TSA algorithm is a recursive procedure that represents the variables of interest (stock numbers and fishing mortalities at age) as unobserved state variables that evolve forward over time. Each year, observed catches-at-age are used to update the estimates of the state variables. Year class strength is assumed (in this implementation) to be distributed according to a Ricker stock-recruitment model. Model fitting proceeds by examination of standardised catch prediction errors (equivalent to model-fit residuals) and inflation of permitted variance on year-age pairs for which such errors are high. Each estimate of historical mean $F_{2–6}$ and stock numbers is produced with an associated standard error, allowing a statistical evaluation of the uncertainty in the assessment. The model is also able to roll forward and produce estimates for all parameters in the two years following the last historical year.

Model specifications are summarised in Table 5.1.4.1 and model parameter estimates in Table 5.1.4.2. From the latter it can be seen that there is good evidence of both persistent changes ($\sigma_Y = 0.2087$) and transitory (or temporary) changes ($\sigma_F = 0.1226$) in the overall level of fishing mortality over time, weak evidence of persistent changes in the fitted separable pattern over time ($\sigma_U = 0.0434$), but no evidence of transitory changes in the separable pattern ($\sigma_V = 0.0000$). Catch data are fairly noisy ($\sigma_{\text{catch}} = 0.1897$), and stock-recruitment data appear to be better fitted by a simple proportional model than by a Ricker model (Ricker $\beta = 0.0000$). The algorithm needs initial estimates of F in 1960 at ages 1, 2 and 4 (the latter being the assumed age of full maturity), which is why the final values of these quantities are listed in the output. Standardised catch prediction errors are given in Figure 5.1.4.3, and do not show any significant trends or very large outliers.

Conclusions

Figure 5.1.4.4 gives a scatterplot of the estimates from the XSA assessments of spawning stock biomass and mean $\overline{F}_{2-6}$ in 2000 for the single-fleet and multi-fleet tuning runs noted above, and compares these with the predicted values from the 2000 assessment of this stock and estimates from ICA and TSA runs. These emphasise the divergent impressions of the current situation given by different tuning series, particularly the SCOGFS, ENGGFS and FRATRB series. The estimates from the multi-fleet XSA runs can be seen to lie approximately at the midpoint of the estimates derived from the different indices, and are also quite proximate to the prediction from the previous assessment. Figure 5.1.4.4 also gives approximate pointwise 95% confidence intervals about the TSA estimate in the F and SSB directions. Estimates from all the other runs (except three single-fleet XSA runs which can be viewed as outliers) lie within these confidence intervals.

Figure 5.1.4.5 gives the estimated time-series of mean $F_{2–6}$ and spawning stock biomass from the TSA assessment, along with approximate pointwise 95% confidence intervals for TSA and the point estimates from both multi-fleet XSA runs. These highlight the uncertainty of estimates for the most recent years, and imply that on the basis of catch data alone, the range of valid point estimates of mean $F_{2–6}(2000)$ is roughly 0.2–0.6, while the range of SSB is around

150,000–300,000 tonnes. The estimates from both of the XSA runs lie within these stock bounds, but there is little basis to select one over another. Given the observed discrepancies between different tuning fleets, and the apparent sensitivity of XSA to changes in model configuration, it was decided to use the TSA run to represent the historical stock trends because it probably best captures the uncertainty in the assessment.

5.1.5 Recruitment estimates

The TSA implementation used here as the key assessment run generates predictions for all model parameters in 2001 and 2002. Recruitment predictions are based on a fitted Ricker stock-recruitment curve, and are $R(2001) = 2360$ million, $R(2002) = 2478$ million. These are both below the long-term GM recruitment (2718 million).

5.1.6 Historical stock trends

Long term trends in fishing mortality, recruitment and spawning biomass are given in Table 5.1.6.1 and plotted in Figure 5.1.6.1.

Fishing mortalities overall would appear to have been in a declining trend since 1994. The rise in F in 1999 that was apparent in the previous assessment has been substantially revised downwards in the current assessment, although the wide confidence intervals plotted in Figure 5.1.6.1 suggest that the new value cannot be quantified with any certainty.

The current assessment indicates a decline in SSB from 1990 to 1998, falling to an historical low value in 1998 (~147,000 t). However, that trend would now appear to have reversed and SSB is estimated to have increased over the most recent 2 years to a value of ~234,000 t.

Estimates of all year classes between 1989 and 2000 lie below the long term geometric mean of 2718 million fish. This is consistent with previous estimates for this stock.

5.1.7 Short term forecasts

In view of the difficulties in identifying a key run for the basis of the forecast and the very large variance of the estimates of mean $F_{2\text{–}6}$ in 2000, it was felt that a typical catch option table would not adequately convey the uncertainties of the prediction. As an alternative, it was decided to project the TSA model forward to 2002 and use the estimated variances to quantify the uncertainty in the predicted catch and SSB. The forecast catch and variance can be plotted as a probability profile which can then be used to select a catch associated with a given probability that F in 2002 exceeds *F status quo*. The procedure for generating the probability profile was as follows:

1. The catch numbers at age in 2002 were obtained by TSA projection.

2. These numbers were partitioned into human consumption landings, discards and industrial bycatch on the basis of the average proportions of each component in the catch numbers at age over the last 3 years. These proportions are in Table 5.1.7.1.

3. The weight of each component was then converted to a weight using the mean weight at age of the last three years (Table 5.1.7.1)

4. It was then assumed that the CV on the human consumption catch was the same as the CV on the total catch estimated within TSA. This CV was used with the point estimate of the human consumption landings to generate the probability profile assuming normality.

5. For SSB, the profile was generated using the projected value and SE from TSA.

The probability profiles for the status quo 2002 forecast are shown in Figure 5.1.7.1. The approximate pointwise 95% confidence interval on the catch is very large, ranging from 15,000t to 70,000t. The lower the catch, the higher the probability that F will be reduced below status quo (0.414). The probability that SSB in 2002 will be below $\boldsymbol{B}_{pa}$ (315,000t) is moderately high (approximately 50%).

5.1.8 Medium-term projections

No medium-term projections are presented for this stock. The wide uncertainty in starting population abundances renders stochastic projections invalid.

5.1.9 Biological reference points

Stock and recruitment reference points are shown in Figure 5.1.9.1 for the truncated recruitment time series (1980-1997). This was produced on the basis of the XSA run (1). The values of SSB and recruitment from 1980–1998 from this run are similar to those from the TSA analysis, so Figure 5.1.9.1 is a valid representation of the likely stock-recruitment relationship. The value of $F_{current}$ on this plot, however, should be disregarded.

Inputs to yield per recruit (derived from XSA run 1) are shown in Table 5.1.9.1. **Yield per recruit results are presented in Figure 5.1.9.2 (Figure to be updated).** As for Figure 5.1.9.1, these results are based on XSA run (1), and the same caveats apply. The text table below gives the values of various biological and management reference points for this stock.

F_{max}	$F_{0.1}$	F_{med}	F_{pa}	F_{lim}	B_{pa}	B_{lim}
>0.73	**0.49**	**0.56**	0.65	0.9	315,000 t	225,000 t

- values to be updated

Values for *F* are fishing mortality in the human consumption fishery, that is, human consumption landings plus discards, and as before are based on XSA run (1). Precautionary reference points are superimposed on the 1980–1998 (XSA run (1)) stock trajectory of SSB and fishing mortality in Figure 5.1.9.3.

5.1.10 Comments on the assessment

(i) Previous meetings of this Working Group have concluded that the survey data and commercial catch data contain varying signals concerning the stock, and that there remain inconsistencies in the annual international catch-at-age distributions. Intersessional work to quantify the extent of these problems is required.

(ii) Data inconsistencies mean that any assessment produced will be extremely uncertain. A number of different assessment methodologies were tested. These gave consistent results in the historical stock trends, but diverged widely in the most recent years. An implementation (TSA) of the Kalman filter algorithm has been used as the assessment, as it is thought to best capture the uncertainty of the terminal-year estimates.

(iii) The historical pattern of stock size, fishing mortality and recruitment resulting from this assessment is consistent with the pattern observed from the 2000 assessment. In terms of point estimates the perception of the more recent trajectory of mean $F_{2–6}$ has been revised downwards, but given the estimated uncertainty in this value it cannot be concluded that *F* has significantly reduced.

(iv) As in the previous assessment, it has not been possible to evaluate the success of implementation of UK technical conservation measures in 2001, nor whether such measures will be fully implemented in 2002. The effect on the whiting fishery of the spring cod closure in 2001 is also not quantified.

(v) An appropriate time-series of discard data suitable for use in catch-at-age analysis is available only for Scottish catches. For assessment purposes, discards for other human consumption fleets are estimated by extrapolation from Scottish data, which account for nearly 70% of human consumption landings.

(vi) No medium-term forecasts have been presented, due to the wide uncertainty in the initial conditions of the stochastic simulation.

(vii) It has been mentioned in previous assessments of this stock that there may have been a regimen shift in overall recruitment levels since the late 1970s. If this is true, then it has implications for management of this stock. In particular, biological reference points dependent upon long term historical data may be inappropriate for current management purposes. However, it is not clear to what extent a regimen shift has occurred.

5.2 Whiting in Division IIIa

Since 1981, landings have been reported separately for human consumption and reduction purposes. The Danish landings have been taken in a mixed clupeoid fishery and in industrial fisheries targeting Norway pout and sandeel.

Total landings are shown in Table 5.2.1.1

No analytical assessment of this stock was possible.

Table 5.1.1.1 Nominal catch (in tonnes) of WHITING in Sub-area IV and Division VIId, 1986–2000, as officially reported to ICES.

Sub-area IV

Country	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	***2000****
Belgium	913	1,030	944	1,042	880	843	391	268	529	536
Denmark	1,529	1,377	1,418	549	368	189	103	46	58	105
Faroe Islands		16	7	2	21		6	1	1	
France2	5,188	5,071	5,502	4,735	5,963	4,704	3,526	1,908	4,292	2,529
Germany, Fed.Rep.	865	511	441	239	124	187	196	103	176	424
Netherlands	4,028	5,390	4,799	3,864	3,640	3,388	2,539	1,941	1,795	1,884
Norway	103	232	130	79	115	66	75	64	68	33
Poland								1		
Sweden	48	22	18	10	1	1	1	1	9	4
UK (Engl.& Wales)3	2,676	2,528	2,774	2,722	2477	2,329	2,638	2,909	2,268	
UK (Scotland)	31,257	30,821	31,268	28,974	27,811	23,409	22,098	16,696	17,206	
United Kingdom										18,941
Total	**46,607**	**46,998**	**47,301**	**42,216**	**41,400**	**35,116**	**31,573**	**23,938**	**26,402**	**24,456**
Unallocated landings	701	-554	680	401	-348	1,006	-276	-72	-421	-412
WG estimate of H.Cons. landings	47,308	46,444	47,981	42,617	41,052	36,122	31,297	23,866	25,981	24,044
WG estimate of discards	33,639	30,615	42,871	33,010	30,264	28,181	17,217	12,708	23,584	22,360
WG estimate of Ind. By-catch	38,311	26,901	20,099	10,354	26,561	4,702	5,965	3,141	5,183	8,886
WG estimate of total catch	**119,258**	**103,960**	**110,951**	**85,981**	**97,877**	**69,005**	**54,479**	**39,715**	**54,748**	**55,290**

Preliminary: year 2000, France 1998,1999, Norway 1997-1998.
2) Includes Division IIa (EC).
3) 1989-1994 revised. N. Ireland included with England and Wales.

Division VIId

Year	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
Belgium	83	66	74	61	68	84	98	53	48	65
France		5414	5032	6734	5202	4771	4532	4495		
Netherlands						1	1	32	6	14
UK (E+W)	292	419	321	293	280	199	147	185	135	
UK (S)	1	24	2		1	1	1			
UK (total)										110
Total		**5923**	**5429**	**7088**	**5551**	**5056**	**4779**	**4765**		
Unallocated		-178	-214	-463	-161	-104	-156	-167		
WG estim.	**5718**	**5745**	**5215**	**6625**	**5390**	**4952**	**4623**	**4598**	**4431**	**4298**

IV+VIId

Year	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
WG estimate	**124,976**	**109,705**	**116,166**	**92,606**	**103,267**	**73,957**	**59,102**	**44,313**	**59,179**	**59,588**

Table 5.1.1.2. Whiting in IV and VIId. Annual weight and numbers caught, 1960 to 2000.

Year	Wt.('000t)				Nos.(millions)			
	Total	H. con	Disc.	Ind. b	Total	H. con	Disc.	Ind. b
1960	182	49	122	11	1009	198	720	92
1961	326	69	241	16	1958	296	1581	81
1962	222	58	157	8	1438	229	1169	40
1963	261	61	154	45	1454	226	820	408
1964	150	63	59	28	709	233	326	150
1965	187	88	77	22	906	319	465	122
1966	242	108	84	51	1258	374	489	395
1967	237	72	143	23	1414	258	1065	91
1968	265	93	115	58	1556	314	739	503
1969	328	61	115	152	1610	216	589	804
1970	272	83	74	115	1331	284	349	698
1971	195	61	63	72	894	193	446	255
1972	191	64	67	61	1384	188	379	817
1973	271	71	110	90	2003	247	646	1111
1974	296	81	85	130	2023	270	456	1297
1975	305	84	135	86	1742	264	668	810
1976	368	83	136	150	1886	275	609	1003
1977	347	78	163	106	1824	280	519	1025
1978	188	97	35	55	1082	363	213	506
1979	244	107	78	59	1437	382	641	414
1980	224	101	77	46	1124	340	468	315
1981	192	90	36	67	922	296	213	413
1982	140	81	27	33	677	271	155	251
1983	161	88	50	24	689	290	299	100
1984	146	86	41	19	751	285	310	155
1985	106	62	29	15	501	176	223	102
1986	162	64	80	18	981	225	575	181
1987	139	68	54	16	861	245	406	210
1988	133	56	28	49	978	211	210	556
1989	124	45	36	43	796	172	273	350
1990	153	47	56	51	1009	177	394	438
1991	125	53	34	38	576	199	235	142
1992	110	52	31	27	610	182	209	219
1993	116	53	43	20	608	173	295	140
1994	93	49	33	10	485	162	227	96
1995	103	46	30	27	449	147	181	121
1996	74	41	28	5	355	142	175	38
1997	59	36	17	6	276	130	91	55
1998	44	28	13	3	221	108	80	33
1999	59	30	24	5	378	117	164	97
2000	60	28	22	9	302	112	135	35
Min.	44	28	13	3	221	108	80	33
Mean	185	67	73	46	1036	233	444	358
Max.	368	108	241	152	2023	382	1581	1297

Table 5.1.1.3. Whiting in VIId. Annual weight and numbers caught, 1960 to 2000.

Year	Weight (tonnes)	Numbers (millions)
1960	1900	7.61
1961	1382	5.91
1962	1590	6.32
1963	3066	11.30
1964	3309	12.18
1965	1568	5.71
1966	2474	8.60
1967	3475	12.50
1968	4593	15.53
1969	3539	12.61
1970	3534	12.12
1971	3103	9.84
1972	3689	10.93
1973	4311	15.05
1974	6592	22.02
1975	5212	16.38
1976	7715	27.42
1977	4954	21.17
1978	9113	37.95
1979	8910	35.60
1980	9167	35.51
1981	8932	34.28
1982	7911	32.95
1983	6936	29.47
1984	7373	33.41
1985	7390	19.56
1986	5498	21.14
1987	4671	18.21
1988	4428	17.92
1989	4156	16.87
1990	3483	13.65
1991	5718	17.88
1992	5745	19.40
1993	5215	17.84
1994	6625	24.05
1995	5390	18.49
1996	4952	22.36
1997	4623	22.56
1998	4598	23.05
1999	4431	18.87
2000	4298	22.09

Table 5.1.2.1. Whiting in IV and VIId. Natural mortality and proportion mature by age.

Age	Nat Mor	Mat.
1	.950	.110
2	.450	.920
3	.350	1.000
4	.300	1.000
5	.250	1.000
6	.250	1.000
7	.200	1.000
8+	.200	1.000

Table 5.1.2.2. Whiting in IV and VIId. Total international catch at age (thousands), 1960 to 2000.

Age	1960
1	482896
2	259440
3	215393
4	21460
5	23279
6	3634
7	892
8+	2380

Age	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
1	1079197	1022790	549436	137590	342622	517081	973202	830541	374343	606831
2	619965	220148	751817	369668	148166	343402	216064	523774	1025996	83064
3	219882	156642	96115	164882	330156	93851	122955	111755	158808	571696
4	32745	31722	45332	22843	72200	255875	23958	49514	28972	52108
5	1355	5998	9334	10908	8002	37708	69082	7494	13240	11463
6	4099	276	1739	2770	3555	8535	7886	31183	1734	3723
7	385	407	9	435	765	1520	849	1940	5989	1211
8+	369	125	142	55	134	470	164	127	697	1514

Age	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
1	621941	939141	1155304	756260	955910	479610	1006082	418910	615524	265359
2	107933	319094	666563	986441	407207	1129375	480939	313391	467537	416008
3	18786	46392	135507	234063	303537	169611	279226	242370	218283	286077
4	128541	7833	19028	33307	56549	88015	30130	90047	100976	90718
5	13640	59313	5739	4977	9273	15988	21334	7563	29267	52969
6	2306	8392	18186	1243	8014	3163	5561	7565	3111	10751
7	730	3486	2504	5856	116	495	532	1851	1657	1152
8+	628	1009	546	427	1525	675	419	277	304	767

Table 5.1.2.2. cont. Whiting in IV and VIId.

Age	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
1	162899	192640	205646	323408	203321	576731	267051	430344	331672	253745
2	346343	114444	184746	175965	141716	167077	368229	307429	173676	505010
3	266517	245247	118412	124886	82037	169577	122748	179502	191942	129126
4	102295	88137	131508	49505	37847	46517	85240	39635	78464	86324
5	27776	26796	37231	59817	14420	13367	11392	17901	14367	32270
6	12297	6909	8688	13860	17445	3487	4556	2175	5050	2003
7	3540	2082	1780	2964	3328	3975	928	544	516	735
8+	326	484	930	613	904	569	1035	168	334	112

Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	128507	239791	217539	163609	137481	72645	53408	71430	178079	65855
2	191193	165354	167577	147177	139010	113956	74200	44697	91355	120941
3	187195	89563	124287	90611	111489	98476	82944	42771	45627	61560
4	36830	93636	46543	47533	35728	48575	42154	36459	34175	23651
5	26209	11967	46136	17384	15161	14235	18492	17756	18528	15958
6	5519	6878	3946	17264	5159	4695	3358	6392	7547	8503
7	543	2609	1519	998	4515	1294	1020	1426	2049	4192
8+	273	117	771	460	474	1113	460	407	676	1257

Table 5.1.2.3. Whiting in IV and VIId. Mean international catch weights at age (kg), 1960 to 2000.

Age	1960
1	.117
2	.190
3	.256
4	.314
5	.344
6	.384
7	.501
8+	.449

Age	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
1	.119	.119	.112	.124	.124	.109	.118	.112	.097	.110
2	.193	.187	.195	.174	.209	.187	.199	.188	.173	.204
3	.259	.267	.272	.268	.242	.249	.269	.295	.262	.241
4	.303	.333	.353	.355	.332	.288	.332	.359	.363	.349
5	.412	.400	.412	.444	.421	.368	.340	.484	.415	.455
6	.420	.520	.472	.489	.499	.434	.425	.447	.419	.452
7	.493	.519	.820	.535	.542	.473	.495	.620	.535	.512
8+	.442	.544	.613	.742	.642	.697	.622	.744	.677	.644

Age	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
1	.116	.071	.084	.071	.100	.107	.117	.074	.098	.075
2	.219	.201	.166	.150	.215	.194	.210	.182	.166	.176
3	.286	.284	.278	.259	.278	.294	.319	.234	.259	.252
4	.319	.389	.372	.383	.376	.348	.399	.322	.301	.328
5	.433	.419	.439	.471	.470	.439	.444	.427	.411	.337
6	.531	.521	.463	.521	.356	.501	.462	.428	.455	.458
7	.637	.575	.552	.544	.817	.514	.547	.466	.492	.458
8+	.682	.802	.777	.826	.606	.702	.475	.649	.582	.572

Table 5.1.2.3. cont. Whiting in IV and VIId.

Age	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
1	.083	.061	.107	.089	.094	.105	.077	.054	.070	.083
2	.168	.184	.191	.188	.192	.183	.148	.146	.157	.137
3	.242	.253	.273	.271	.284	.255	.247	.223	.225	.209
4	.321	.314	.325	.337	.332	.318	.297	.301	.267	.250
5	.379	.376	.384	.382	.402	.378	.375	.346	.318	.279
6	.411	.478	.426	.391	.435	.475	.379	.423	.391	.408
7	.444	.504	.452	.463	.494	.468	.542	.506	.431	.490
8+	.720	.735	.537	.567	.438	.625	.584	.694	.394	.599

Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	.103	.082	.073	.080	.087	.093	.091	.091	.076	.114
2	.169	.185	.175	.170	.181	.167	.178	.180	.174	.182
3	.218	.257	.252	.254	.258	.236	.243	.236	.233	.238
4	.290	.277	.319	.323	.341	.302	.295	.281	.256	.288
5	.307	.332	.329	.371	.385	.387	.333	.314	.289	.287
6	.338	.346	.349	.367	.430	.406	.381	.339	.303	.277
7	.365	.314	.403	.414	.434	.428	.381	.330	.309	.277
8+	.400	.503	.381	.416	.420	.430	.418	.367	.287	.273

Table 5.1.3.1 North Sea and eastern Channel whiting. Fleets available for VPA tuning.

Country	Fleet	Code	Initial Year	Age Range
Scotland	Groundfish survey	SCOGFS	1982	0-6
	Seiners	SCOSEI	1976	0-10
	Light trawlers	SCOLTR	1976	0-10
England	Groundfish survey	ENGGFS	1977	0-6
France	Trawlers	FRATRB	1985	0-11
		FRATRO_IV	1986	0-10
		FRATRO-7d	1986	1-7
		FRAGFS-7d	1988	0-3
International	Groundfish survey	IBTS-QI[3]	1973	0-5
	Q II survey[1]	IBTS_Q2_SCO	1991	1-6
	Q IV survey[2]	IBTS_Q4-ENG	1991	0-7

[1] Scottish sub-set of data – discontinued in 1997
[2]English sub-set of data – discontinued in 1996
[3]Formerly IYFS

Table 5.1.3.2. Whiting in IV and VIId. Complete available tuning-fleet data.

FRATRB_IV									
1978	1998								
1	1	0	1						
1	9								
69739	1153.00	10312.00	14789.00	8544.00	807.00	1091.00	227.00	34.00	4.00
89974	698.00	12272.00	14379.00	10884.00	3789.00	394.00	315.00	45.00	14.00
63577	90.00	5388.00	11298.00	4605.00	4051.00	1004.00	78.00	71.00	10.00
76517	144.00	6591.00	13139.00	8196.00	2090.00	1644.00	314.00	16.00	10.00
78523	173.00	1643.00	16561.00	11241.00	3948.00	1035.00	539.00	119.00	14.00
69720	500.00	4407.00	8188.00	16698.00	5541.00	1061.00	228.00	126.00	19.00
76149	317.00	4281.00	7465.00	4576.00	5999.00	1596.00	308.00	32.00	26.00
25915	314.55	3653.12	2942.09	1225.28	565.55	598.65	117.27	12.32	4.23
28611	890.57	3830.33	3990.71	1202.06	368.64	93.79	160.46	22.28	1.28
28692	431.03	4822.77	3667.48	2151.59	496.97	166.11	47.91	45.81	3.04
25208	150.44	2717.69	4815.08	1124.87	529.69	100.13	31.08	3.11	4.17
25184	447.52	2064.11	4351.49	1877.20	313.54	106.16	9.86	3.52	0.78
21758	163.76	3793.84	2123.86	2009.65	619.55	55.06	13.45	1.07	0.14
19840	292.26	2224.03	3828.93	818.81	657.22	137.59	15.33	3.49	0.08
15656	365.35	1597.81	1685.80	2204.15	248.32	195.02	43.88	2.82	0.06
19076	172.98	1224.59	2633.02	1141.30	1233.36	96.75	37.16	13.84	4.10
17315	107.74	1805.61	1720.52	1466.30	412.54	429.99	29.43	8.24	1.34
17794	114.32	1022.59	3304.45	1536.77	1162.94	240.08	211.60	13.83	6.66
18883	20.89	655.48	1594.39	1438.24	482.20	199.09	37.91	29.82	10.03
15574	39.68	356.96	1406.89	1138.71	606.01	85.94	15.86	9.70	2.25
14949	31.88	125.79	316.62	326.18	191.97	62.83	7.94	2.31	1.19
FRATRO_IV									
1986	1998								
1	1	0	1						
0	8								
56099	19.48	1541.94	1891.94	7145.98	3782.82	599.91	157.52	39.03	2.14
71765	12.20	2507.72	4984.96	1271.29	5713.14	412.56	257.90	91.79	69.82
84052	0.31	2536.92	8981.89	3222.83	704.34	1320.59	122.85	55.31	0.54
88397	26.94	2958.16	3739.55	5628.95	1654.27	208.58	280.47	47.27	10.86
71750	37.70	3209.61	6169.85	3780.85	2456.12	365.14	28.65	43.61	1.65
67836	323.02	4464.91	6083.87	2864.37	1412.45	776.93	84.61	5.78	2.53
51340	355.02	3426.92	6498.04	1939.69	635.38	358.08	96.22	4.78	0.12
62553	937.84	3950.46	4586.36	4306.75	877.04	289.87	68.31	39.73	6.21
51241	86.53	7005.88	3298.43	1190.63	612.13	108.28	11.05	8.38	0.98
57823	262.76	6331.03	6125.08	2673.85	543.82	98.58	19.19	0.03	1.79
50163	577.46	5522.73	4742.85	3214.22	890.19	155.83	7.73	12.12	0.03
48904	266.77	1961.14	4676.60	3929.12	1020.11	220.78	18.01	3.07	0.02
38103	566.68	4893.44	1959.25	532.61	161.28	68.00	35.86	0.39	1.55
-9	51.18	7651.96	2885.69	1452.71	960.37	500.08	133.31	45.54	30.71
30082	129.16	7366.57	8191.31	2452.95	1056.07	737.31	454.67	345.11	94.79
FRATRO_7D									
1986	1998								
1	1	0.00	1.00						
1	7								
257794	2586.59	2249.77	7740.58	4462.98	804.35	198.40	19.35		
188236	1954.81	5050.15	907.04	4606.14	331.43	218.34	53.97		
215422	2233.10	7957.35	2551.70	536.69	1192.83	127.34	61.15		
320383	2577.84	3916.35	6005.56	1489.83	216.08	342.97	50.48		
257120	2491.70	5240.14	3362.65	2168.19	251.50	29.80	51.08		
294594	4009.06	8176.54	3984.56	2625.40	1474.03	155.42	10.50		
285718	5732.56	10924.16	3241.05	881.71	587.01	171.40	3.38		
283999	3158.34	6542.83	8606.51	1676.81	442.49	123.89	79.06		
286019	13931.57	7979.57	3268.93	1776.04	443.66	40.33	20.73		
268151	6301.32	8449.94	5260.61	1217.42	263.53	62.53	8.18		
274495	6140.12	6465.75	5465.37	1622.56	324.48	47.21	14.16		
282216	3320.15	8143.54	6607.75	1974.21	450.88	58.75	8.43		
291360	9921.00	6863.22	2384.88	781.09	264.61	104.76	15.31		

Table 5.1.3.2 Cont.

SCOGFS_IV							
1982	1997						
1	1	0.5	0.75				
0	6						
100	1.02	6.53	9.71	9.72	2.24	0.60	0.16
100	2.10	5.63	5.78	4.07	5.11	1.16	0.17
100	4.42	10.48	3.71	1.70	0.77	0.92	0.18
100	1.69	15.77	9.73	2.47	0.63	0.36	0.18
100	4.06	11.11	4.52	2.24	0.27	0.05	0.05
100	1.20	14.05	11.50	2.08	0.77	0.16	0.03
100	6.42	9.67	16.06	4.52	0.70	0.19	0.02
100	4.27	40.43	7.41	7.33	1.57	0.13	0.06
100	19.43	22.39	20.53	2.48	2.55	0.47	0.05
100	13.79	17.69	9.50	7.59	0.51	0.40	0.09
100	24.17	29.25	12.67	5.53	5.85	0.47	0.26
100	2.47	31.69	11.68	4.23	1.56	1.82	0.06
100	6.48	26.35	9.50	2.54	0.57	0.34	0.23
100	12.43	41.76	20.10	9.03	1.96	0.58	0.22
100	4.40	28.88	30.47	12.15	4.60	0.43	0.15
100	3.17	18.24	14.34	11.91	3.19	1.22	0.17
ENGGFS_IV							
1977	2000						
1	1	0.5	0.75				
0	6						
100	28.43	21.95	7.44	1.11	0.22	0.09	0.08
100	18.44	24.71	5.15	1.06	0.34	0.05	0.02
100	35.48	20.06	7.12	1.90	0.84	0.06	0.03
100	19.90	35.33	12.51	4.81	1.20	0.31	0.06
100	34.94	18.31	28.80	16.05	0.62	0.62	0.08
100	6.93	27.72	7.93	8.59	2.22	0.34	0.05
100	71.67	11.85	10.80	1.91	1.70	0.24	0.07
100	17.25	50.61	10.82	3.01	0.89	0.77	0.38
100	19.99	15.88	17.04	1.67	0.98	0.18	0.15
100	16.33	15.16	6.59	3.85	0.41	0.10	0.01
100	13.73	22.76	13.04	2.69	2.01	0.35	0.12
100	38.17	18.81	13.16	4.55	0.64	0.17	0.02
100	116.95	29.47	11.76	7.69	1.67	0.34	0.02
100	87.53	19.01	12.84	3.85	2.32	0.33	0.05
100	16.73	33.30	7.67	3.82	1.09	0.37	0.04
100	45.50	26.55	13.07	3.05	2.61	0.49	0.59
100	25.24	25.10	9.63	3.75	1.16	0.74	0.19
100	21.14	30.55	10.59	2.44	1.12	0.33	0.11
100	36.28	35.51	23.74	7.36	1.87	0.25	0.14
100	10.29	12.38	10.44	7.39	3.23	0.59	0.17
100	59.87	20.29	9.72	6.99	5.41	1.68	0.43
100	204.77	16.48	17.89	4.01	2.56	1.28	0.28
100	132.52	47.89	21.83	7.82	3.03	0.77	0.75
100	96.15	70.25	28.03	7.42	1.65	0.47	0.29
FRAGFS_7d							
1988	2000						
1	1	0.75	1				
0	3						
27	3186	-1	-1	-1			
27	1512	-1	-1	-1			
27	1674	-1	-1	-1			
27	7155	1350	162	27			
27	6291	1674	378	54			
27	1566	675	216	54			
27	1323	6993	837	135			
27	1539	1836	216	27			
27	837	1107	297	54			
27	378	756	351	81			
27	1134	621	351	135			
27	195	2712	255	34			
27	234	172	361	19			

Table 5.1.3.2 Cont.

IBTS_Q1_IV								
1973	2000							
1	1	0.99	1					
0	5							
1	0.322	0.496	-1	-1	-1	-1		
1	0.893	0.153	-1	-1	-1	-1		
1	0.679	0.535	-1	-1	-1	-1		
1	0.418	0.219	-1	-1	-1	-1		
1	0.513	0.293	-1	-1	-1	-1		
1	0.457	0.183	-1	-1	-1	-1		
1	0.692	0.391	-1	-1	-1	-1		
1	0.227	0.485	-1	-1	-1	-1		
1	0.161	0.232	-1	-1	-1	-1		
1	0.128	0.126	0.113	0.079	0.033	0.006		
1	0.436	0.179	0.091	0.031	0.026	0.011		
1	0.341	0.359	0.066	0.019	0.007	0.007		
1	0.456	0.261	0.198	0.033	0.007	0.004		
1	0.669	0.544	0.09	0.046	0.005	0.002		
1	0.394	0.862	0.315	0.034	0.012	0.001		
1	1.465	0.542	0.421	0.112	0.012	0.005		
1	0.509	0.887	0.202	0.093	0.017	0.004		
1	1.014	0.675	0.482	0.071	0.038	0.008		
1	0.916	0.748	0.261	0.169	0.016	0.014		
1	1.087	0.524	0.245	0.066	0.059	0.012		
1	0.721	0.637	0.18	0.067	0.012	0.009		
1	0.679	0.457	0.245	0.059	0.012	0.006		
1	0.502	0.486	0.245	0.07	0.023	0.0098		
1	0.288	0.342	0.163	0.06	0.018	0.0092		
1	0.556	0.162	0.125	0.054	0.016	0.0094		
1	0.676	0.305	0.095	0.058	0.026	0.0111		
1	0.757	0.537	0.182	0.053	0.02	0.0147		
1	0.478	0.699	0.317	0.124	0.035	0.035		
IBTS_Q4_ENG_IV		Survey discontinued						
1991	1996							
1	1	0.75	1					
0	7							
100	46.83	55.28	19.64	15.09	3.25	1.85	1.33	0.03
100	94.23	45.09	26.46	5.38	5.03	0.65	0.53	0.12
100	78.87	54.21	19.47	7.16	2.33	0.83	0.24	0.01
100	69.85	61.33	26.41	4.14	0.84	0.62	0.11	0.08
100	71.33	108.00	41.72	11.19	2.56	0.52	0.20	0.07
100	29.98	36.56	30.33	8.65	4.82	1.63	0.52	0.33
IBTS_Q2_SCO_IV		Survey discontinued						
1991	1997							
1	1	0.25	0.5					
1	6							
100	94.90	38.56	22.86	3.74	1.23	0.51		
100	129.76	47.50	11.42	4.28	1.14	0.45		
100	104.67	41.49	20.86	5.17	4.85	0.36		
100	65.40	35.71	8.55	2.38	0.90	0.75		
100	191.61	77.30	26.19	4.42	2.21	0.41		
100	44.02	49.62	22.30	8.33	1.25	0.59		
100	14.07	22.60	18.02	6.43	1.40	0.13		

Table 5.1.3.3. Whiting in IV and VIId. Research vessel survey recruitment indices.

Y-class	IBTS1	IBTS2	EGFS0	EGFS1	EGFS2	SGFS0	SGFS1	SGFS2	DGFS0	DGFS1	DGFS2	GGFS1	GGFS2	IBQ21	SCQ21	SCQ22	IBQ40	IBQ41	ENQ40	ENQ41	ENQ42
1971																					
1972	332																				
1973	1156	763																			
1974	322	496																			
1975	893	153																			
1976	679	535																			
1977	418	219	284	220	74																
1978	513	293	184	247	52																
1979	457	183	355	201	71																
1980	692	391	199	353	125				166	330	62										
1981	227	485	349	183	288				1393	205	131										
1982	161	232	69	277	79	102	65	97	166	640	105										
1983	128	126	717	119	109	210	56	58	2649	431	224	6.8	15.3								
1984	436	179	173	506	108	454	108	37	143	1330	141	5.7	12.9								
1985	341	359	200	159	170	169	158	97	859	783	893	9.6	22.8								
1986	456	261	163	152	66	406	111	45	1784	384	75	12.2	24.6								
1987	669	544	137	228	130	120	141	115	2883	2004	252	91	70.8								
1988	394	862	382	188	132	642	97	161	629	1441	612	15.1	79.8								
1989	1465	542	1170	295	118	427	404	74	1882	1049	803	603.1	392.3								
1990	509	887	882	194	129	1943	224	205	5543	963	196	280.2	248.5								
1991	1014	675	167	333	77	1379	177	95	806	1552	214	324.3	163.7	1298	9490	3856	761	853	46826	55276	19642
1992	916	748	455	266	131	2417	293	127	453	272	310	120.7	73.3	816	12976	4750	1219	625	94233	45090	26462
1993	1087	524	252	251	96	247	317	117	2655	340	61			710	10467	4149	1326	807	78871	54210	19474
1994	721	637	211	305	106	648	2365	950	1795	660	353	181.8	79	806	6540	3571	1318	1136	69848	61335	26413
1995	679	457	363	355	237	1243	4176	2010				104.7	74.5	1592	19161	7730	2013	1112	71328	107996	41715
1996	502	486	103	124	104	440	2888	3047						627	4402	4962			29983	36556	30330
1997	288	342	599	203	97	317	1824	1434						254	1407	2260					
1998	556	162	2048	165	179	12302*	4141*	5426*													
1999	676	305	1325	479	218	15276*	5410*	2090*													
2000	757	537	962	703	280	17076*	6646*	3329*													
2001	478	699																			

* new vessel and gear

IBTS1	IBTS	SGFS0	Scottish GFS	GGFS1	German GFS	IBQ41	IBTS (provisional, length-based)
IBTS2	IBTS	SGFS1	Scottish GFS	GGFS2	German GFS	ENQ40	IBTS (English, age-based)
EGFS0	English GFS	SGFS2	Scottish GFS	IBQ21	IBTS (provisional, lengt	ENQ41	IBTS (English, age-based)
EGFS1	English GFS	DGFS0	Dutch GFS	SCQ21	IBTS (Scottish, age bas	ENQ42	IBTS (English, age-based)
EGFS2	English GFS	DGFS1	Dutch GFS	SCQ22	IBTS (Scottish, age based)		
		DGFS2	Dutch GFS	IBQ40	IBTS (provisional, length-based)		

Table 5.1.4.1. Whiting in IV and VIId. TSA model specifications.

Parameter	*Note*
$a_m = 4$	Age above which changes in F are only transitory.
$B_{\text{catch}}(a) = 2$ for ages 7, 8+	Allows extra measurement variability for older ages for which catches are fewer.
$H(a) = 2$ for age 1	Allows more variable F on age 1 fish.
q multiplied by 3 for the following catch values: $C(4,1966)$, $C(6,1966)$, $C(7,1972)$, $C(6,1975)$, $C(2,1976)$	Increases allowed variance on selected points following inspection of exploratory standardised catch prediction errors; reduces influence of outliers.

Table 5.1.4.2. Whiting in IV and VIId. Maximum likelihood estimates for TSA parameters.

Initial fishing mortalities

Age	F(age, 1960)
1	0.1559
2	0.3615
4	1.1650

Standard deviations

Fishing mortalities	σ_F	σ_U	σ_V	σ_Y
	0.1226	0.0434	0.0000	0.2087
Measurement	σ_{catch}			
	0.1897			
Recruitment	$CV_{\text{recruitment}}$	Ricker α	Ricker β	
	0.6763	10.3003	0.0000	

Table 5.1.6.1. Whiting in IV and VIId. Stock summary.

Year	Total catch			Mean F(2-6)		SSB		TSB		Recruitment	
	Actual	Predicted	SE	Estimate	SE	Estimate	SE	Estimate	SE	Estimate	SE
1960	178830	182670	11230	1.3474	0.0431	298270	12650	719760	31170	3917620	239040
1961	317440	361950	23970	1.2247	0.0514	365870	17060	884200	31090	4727450	213440
1962	217970	230770	21270	0.9813	0.0644	295020	11860	895070	49540	5576580	404790
1963	255740	254480	27360	0.9099	0.056	437540	26740	1186180	87020	7245150	728750
1964	140140	195730	20840	0.7269	0.0565	534810	40500	724080	47220	1433640	132050
1965	182880	183680	17150	0.6918	0.0563	412610	26130	723720	36910	2749040	198210
1966	236190	206220	16330	0.9496	0.0669	345910	17290	585310	27410	2336270	186640
1967	225890	223280	21210	0.7794	0.0437	294510	15420	790700	42420	4646230	331900
1968	261210	274600	33790	0.8971	0.0498	417470	22820	1307580	98650	8730310	851500
1969	275960	239210	27730	0.7918	0.0541	559780	44810	664900	48910	788430	71690
1970	247800	196040	18290	0.8436	0.0564	338480	25710	499090	30420	1612420	144030
1971	150400	153320	9930	0.6675	0.0514	239890	15380	547290	26540	2913900	182550
1972	179410	167870	13300	0.8221	0.063	276770	13570	604490	27460	4958830	326230
1973	265760	254100	19790	0.9647	0.0626	389020	20480	918990	45580	6799520	474370
1974	281330	266620	17510	0.9747	0.0705	445290	24940	687620	30330	3481140	204110
1975	297530	275820	19160	0.9042	0.0662	449880	22330	996100	65760	5938860	613420
1976	359730	285940	29830	0.9909	0.0714	519900	40890	1004980	64050	4828800	434090
1977	332090	324790	24980	0.8741	0.0646	576280	36180	1081270	54760	4631610	332110
1978	181270	192310	14400	0.7626	0.06	436760	24080	752050	39110	4495700	391440
1979	239410	218070	18870	0.7431	0.0569	471370	25470	886110	46890	4551800	386300
1980	219000	226740	18440	0.8948	0.0584	498650	26250	840960	43950	4834950	447340
1981	186390	194190	16840	0.849	0.0517	480370	28870	631540	33280	1764790	146230
1982	137310	140540	12090	0.6996	0.0487	364330	20050	476860	22540	1914140	145090
1983	151590	139130	9900	0.7527	0.0506	307010	13130	475860	17800	1678720	103920
1984	142480	135480	8500	0.9293	0.0466	258120	9810	478540	20070	2680540	192460
1985	97650	108180	7100	0.8468	0.0406	269930	13100	435020	18600	1815450	125550
1986	158230	149520	15620	0.865	0.0439	273740	12340	648570	39500	3905240	352840
1987	137670	142660	11230	1.035	0.0537	297920	15980	534550	27920	3252870	281360
1988	127840	125620	10550	0.8769	0.0524	289350	16950	405260	20400	2136540	174140
1989	121540	133390	11730	0.9533	0.0607	271360	13290	551450	33460	4378730	431440
1990	149100	131710	12520	0.9114	0.0574	297750	19710	455050	26390	1910360	179120
1991	107170	115750	10340	0.7911	0.0547	276660	16220	454580	24100	1851050	161400
1992	106490	107240	8990	0.7443	0.0524	255930	13290	391940	19060	1734920	150020
1993	108770	102830	8330	0.7956	0.0503	227770	11300	365250	19100	2004880	197920
1994	89830	94330	7960	0.8158	0.0458	223190	12800	366960	20540	1905840	184200
1995	88160	91760	8420	0.7657	0.0451	233580	14130	364380	20000	1577910	144210
1996	72160	77050	6720	0.723	0.0467	203550	11280	301320	15180	1099110	93020
1997	58650	58460	4710	0.5628	0.0419	174720	9260	245450	13950	808390	88480
1998	43220	42410	3140	0.4286	0.046	147060	9780	260730	24400	1359670	201670
1999	57370	47350	4800	0.4178	0.0766	166630	18840	317560	43500	2123060	393110
2000	55670	56170	4970	0.4116	0.1211	234390	43440	376380	94420	1293610	548150
2001*		66190	16690	0.4138	0.1503	240660	70840	444010	183580	2360250	1653930
2002*		77590	27730	0.4138	0.1737	294540	130260	513120	246090	2478880	1828430

*Projected values.

Table 5.1.7.1 Whiting in IV and VIId. Proportions and weights in the catch used to partition the total catch numbers from TSA into catch components by weight.

Mean proportion by number in the catch 1998–2000

Age	H. cons	Discard	Ind. Bycatch
1	0.189	0.465	0.346
2	0.334	0.530	0.137
3	0.534	0.354	0.112
4	0.658	0.227	0.116
5	0.785	0.156	0.059
6	0.833	0.142	0.025
7	0.884	0.110	0.006
8+	0.844	0.156	0.000

Mean weight at age by category, 1998-2000

Age	H. cons	Discard	Ind. Bycatch
1	0.171	0.105	0.132
2	0.224	0.169	0.115
3	0.267	0.199	0.196
4	0.295	0.218	0.263
5	0.308	0.223	0.304
6	0.329	0.225	0
7	0.313	0.227	0.196
8+	0.329	0.232	0

Table 5.1.7.2. Whiting in IVand VIId. Input data for catch forecast and linear sensitivity analysis

Label	Value	CV	Label	Value	CV
Number at age			Weight in the stock		
N1	2081015	0.41	WS1	0.09	0.20
N2	747630	0.43	WS2	0.18	0.02
N3	406440	0.16	WS3	0.24	0.01
N4	135920	0.14	WS4	0.28	0.06
N5	45570	0.13	WS5	0.30	0.05
N6	17219	0.11	WS6	0.31	0.10
N7	10630	0.12	WS7	0.31	0.09
N8	9300	0.12	WS8	0.31	0.16
H.cons selectivity			Weight in the HC catch		
sH1	0.01	0.23	WH1	0.17	0.06
sH2	0.07	0.11	WH2	0.22	0.06
sH3	0.16	0.10	WH3	0.27	0.03
sH4	0.29	0.21	WH4	0.29	0.04
sH5	0.38	0.13	WH5	0.31	0.07
sH6	0.38	0.15	WH6	0.33	0.08
sH7	0.36	0.15	WH7	0.31	0.11
sH8	0.34	0.17	WH8	0.33	0.25
Discard selectivity			Weight in the discards		
sD1	0.04	0.42	WD1	0.11	0.21
sD2	0.10	0.32	WD2	0.17	0.02
sD3	0.11	0.08	WD3	0.20	0.02
sD4	0.10	0.48	WD4	0.22	0.07
sD5	0.08	0.07	WD5	0.22	0.06
sD6	0.07	0.36	WD6	0.23	0.03
sD7	0.04	0.48	WD7	0.23	0.08
sD8	0.06	0.77	WD8	0.23	0.13
Industrial selectivity			Weight in Ind. bycatch		
sI1	0.05	0.77	WI1	0.13	1.26
sI2	0.04	0.72	WI2	0.12	0.39
sI3	0.05	0.31	WI3	0.20	0.25
sI4	0.05	0.31	WI4	0.26	0.22
sI5	0.04	0.72	WI5	0.30	0.10
sI6	0.01	1.14	WI6	0.00	0.00
sI7	0.00	1.73	WI7	0.20	1.73
sI8	0.00	0.00	WI8	0.00	0.00
Natural mortality			Proportion mature		
M1	0.95	0.11	MT1	0.11	0.10
M2	0.45	0.26	MT2	0.92	0.10
M3	0.35	0.14	MT3	1.00	0.10
M4	0.30	0.14	MT4	1.00	0.00
M5	0.25	0.14	MT5	1.00	0.00
M6	0.25	0.14	MT6	1.00	0.00
M7	0.20	0.14	MT7	1.00	0.00
M8	0.20	0.14	MT8	1.00	0.00

Human consumption + discard Fs are obtained from mean exploitation pattern over 1998 to 2000. This is scaled to give a value for mean F (ages 2 to 6) equal to that in 2000, i.e. .345. Fs are distributed between consumption and discards by mean proportion retained over 1998 to 2000. N.B. Above value for H. con+Disc. ref F is value for both catch categories combined.
Bycatch Fs are obtained from mean exploitation pattern over 1998 to 2000. This is scaled to give a value for mean F (ages 2 to 6) equal to that in 2000, i.e. .040

Table 5.1.9.1. Whiting in IVand VIId. Input data for catch forecast and linear sensitivity analysis

Label	Value	CV	Label	Value	CV
Number at age			Weight in the stock		
N1	2081015	0.41	WS1	0.09	0.20
N2	747630	0.43	WS2	0.18	0.02
N3	406440	0.16	WS3	0.24	0.01
N4	135920	0.14	WS4	0.28	0.06
N5	45570	0.13	WS5	0.30	0.05
N6	17219	0.11	WS6	0.31	0.10
N7	10630	0.12	WS7	0.31	0.09
N8	9300	0.12	WS8	0.31	0.16
H.cons selectivity			Weight in the HC catch		
sH1	0.01	0.23	WH1	0.17	0.06
sH2	0.07	0.11	WH2	0.22	0.06
sH3	0.16	0.10	WH3	0.27	0.03
sH4	0.29	0.21	WH4	0.29	0.04
sH5	0.38	0.13	WH5	0.31	0.07
sH6	0.38	0.15	WH6	0.33	0.08
sH7	0.36	0.15	WH7	0.31	0.11
sH8	0.34	0.17	WH8	0.33	0.25
Discard selectivity			Weight in the discards		
sD1	0.04	0.42	WD1	0.11	0.21
sD2	0.10	0.32	WD2	0.17	0.02
sD3	0.11	0.08	WD3	0.20	0.02
sD4	0.10	0.48	WD4	0.22	0.07
sD5	0.08	0.07	WD5	0.22	0.06
sD6	0.07	0.36	WD6	0.23	0.03
sD7	0.04	0.48	WD7	0.23	0.08
sD8	0.06	0.77	WD8	0.23	0.13
Industrial selectivity			Weight in Ind. bycatch		
sI1	0.05	0.77	WI1	0.13	1.26
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sI3	0.05	0.31	WI3	0.20	0.25
sI4	0.05	0.31	WI4	0.26	0.22
sI5	0.04	0.72	WI5	0.30	0.10
sI6	0.01	1.14	WI6	0.00	0.00
sI7	0.00	1.73	WI7	0.20	1.73
sI8	0.00	0.00	WI8	0.00	0.00
Natural mortality			Proportion mature		
M1	0.95	0.11	MT1	0.11	0.10
M2	0.45	0.26	MT2	0.92	0.10
M3	0.35	0.14	MT3	1.00	0.10
M4	0.30	0.14	MT4	1.00	0.00
M5	0.25	0.14	MT5	1.00	0.00
M6	0.25	0.14	MT6	1.00	0.00
M7	0.20	0.14	MT7	1.00	0.00
M8	0.20	0.14	MT8	1.00	0.00

Human consumption + discard Fs are obtained from mean exploitation pattern over 1998 to 2000. This is scaled to give a value for mean F (ages 2 to 6) equal to that in 2000, i.e. .345. Fs are distributed between consumption and discards by mean proportion retained over 1998 to 2000. N.B. Above value for H. con+Disc. ref F is value for both catch categories combined.
Bycatch Fs are obtained from mean exploitation pattern over 1998 to 2000. This is scaled to give a value for mean F (ages 2 to 6) equal to that in 2000, i.e. .040

Table 5.2.1.1 Nominal landings (in tonnes) of WHITING from Division IIIa as supplied by the Study Group on Division IIIa Demersal Stocks (Anon., 1992b) and updated by the Working Group.

Year	Denmark			Norway	Sweden	Others	Total
	HC	Ind	comb				
1975			19,018	57	611	4	**19,690**
1976			17,870	48	1,002	48	**18,968**
1977			18,116	46	975	41	**19,178**
1978			48,102	58	899	32	**49,091**
1979			16,971	63	1,033	16	**18,083**
1980			21,070	65	1,516	3	**22,654**
1981	1,027	23,915		70	1,054	7	**26,073**
1982	1,183	39,758		40	670	13	**41,664**
1983	1,311	23,505		48	1,061	8	**25,933**
1984	1,036	12,102		51	1,168	60	**14,417**
1985	557	11,967		45	654	2	**13,225**
1986	484	11,979		64	477	1	**13,005**
1987	443	15,880		29	262	43	**16,657**
1988	391	10,872		42	435	24	**11,764**
1989	917	11,662		29	675	-	**13,283**
1990	1,016	17,829		49	456	73	**19,423**
1991	871	12,463		56	527	97	**14,014**
1992	555	10,675		66	959	1	**12,256**
1993	261	3,581		42	756	1	**4,641**
1994	174	5,391		21	440	1	**6,027**
1995	85	9,029		24	431	1	**9,570**
1996	55	2,668		21	182		**2,926**
1997	38	568		*18*	94		**718**
1998	35	847		*16*	81		**979**
1999	37	1199		*15*	111		**1362**
2000	59	386		17	159	1	**622**

Preliminary: Norway 1997-1999

Figure 5.1.2.1. Whiting in IV and VIId. Mean weights at age in the catch.

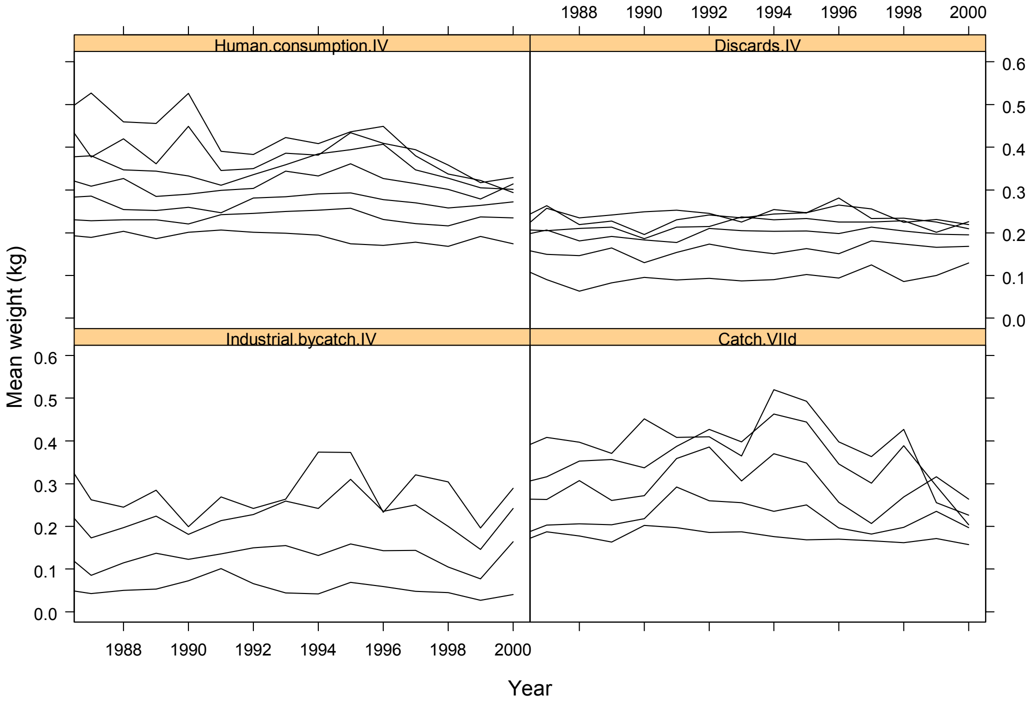


Figure 5.1.3.1. Whiting in IV and VIId. Comparison of tuning series. Each plot is overlain with a linear regression fit, for which the associated R^2 value is shown.

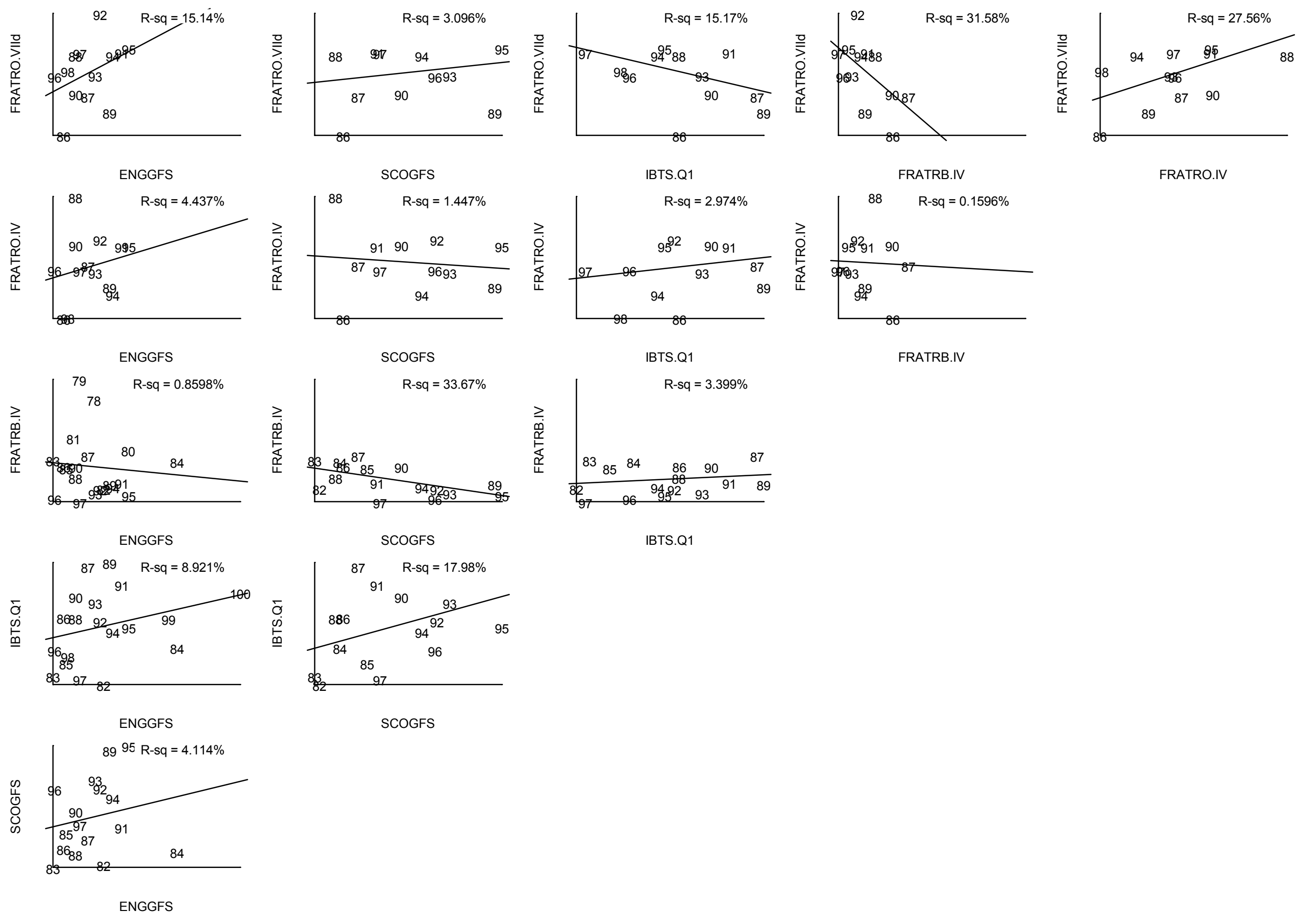
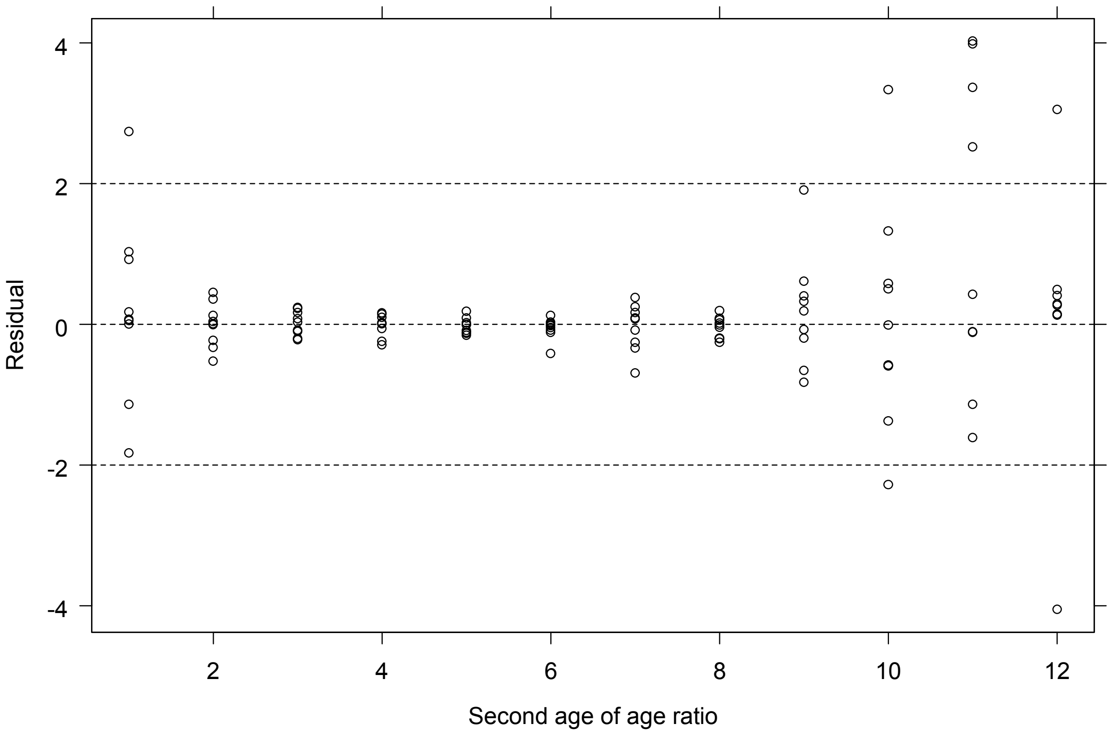


Figure 5.1.4.1. Whiting in IV and VIId. Residuals from separable VPA run.

a) Full dataset (ages 0-12, years 1991-2000)



b) Reduced dataset (ages 1-8+, years 1991-2000)

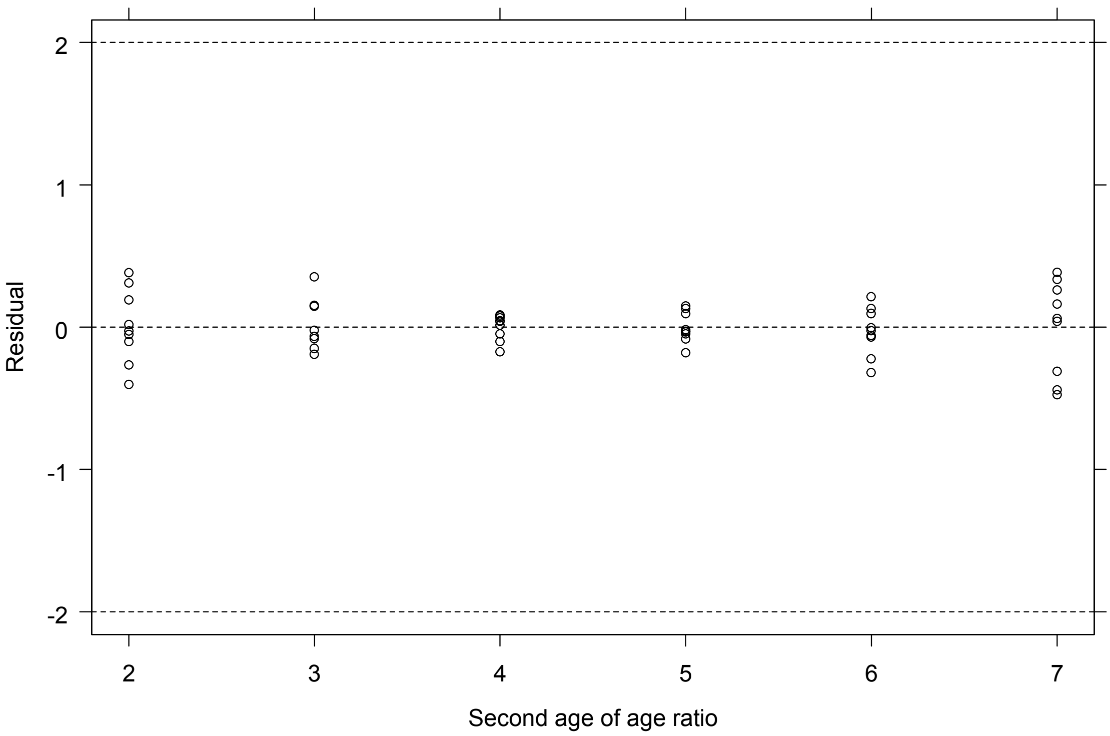


Figure 5.1.4.2. Whiting in IV and VIId. Retrospective patterns, obtained using the "diminishing series" method, of mean F_{2-6}, SSB and recruitment for two XSA runs. Upper row: run using this year's configuration and this year's data. Lower row: run using last year's configuration and this year's data.

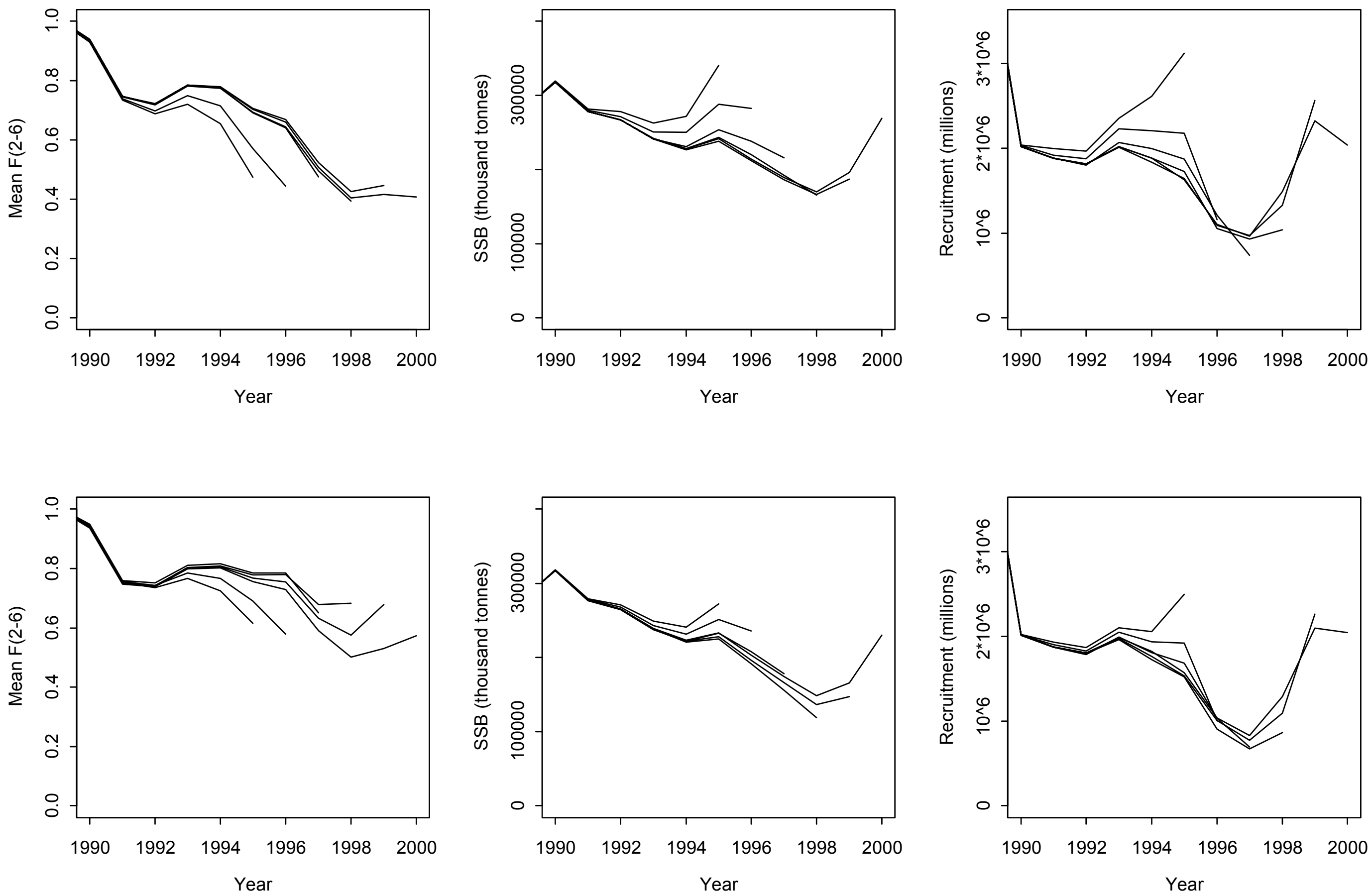


Figure 5.1.4.3. Standardised catch prediction errors from TSA analysis using only catch-at-age data.

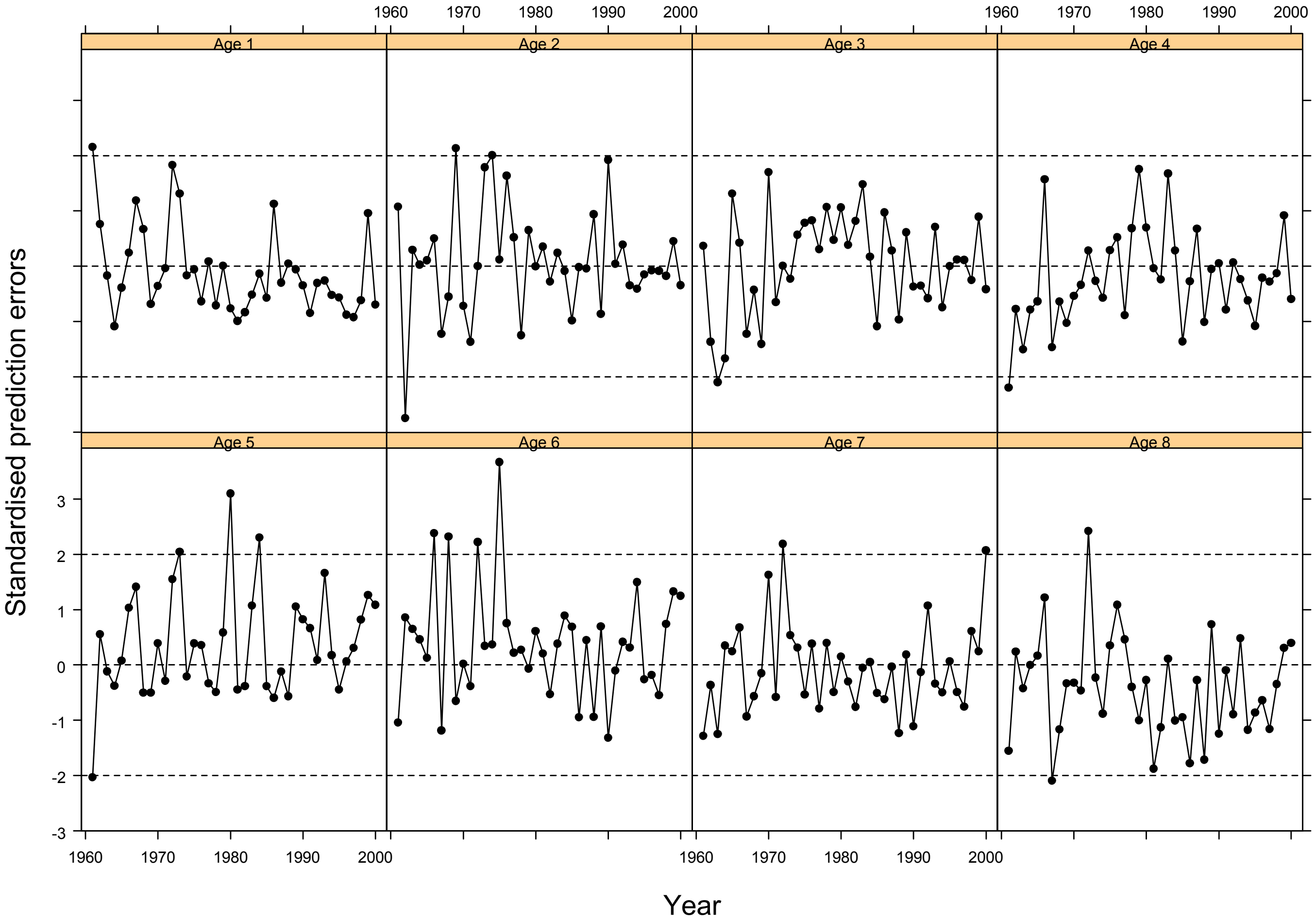


Figure 5.1.4.4. Whiting in IV and VIId. Upper plot: SSB(2000) against mean $F_{2\text{–}6}$(2000) from single-fleet XSA runs, multi-fleet XSA runs (run 1: 20-year tricubic taper, run 3: 10-year tuning window, fleet configuration as for the previous assessment), the prediction from the previous assessment, and ICA and TSA estimates. Dotted lines give approximate pointwise 95% confidence intervals about the TSA estimate.

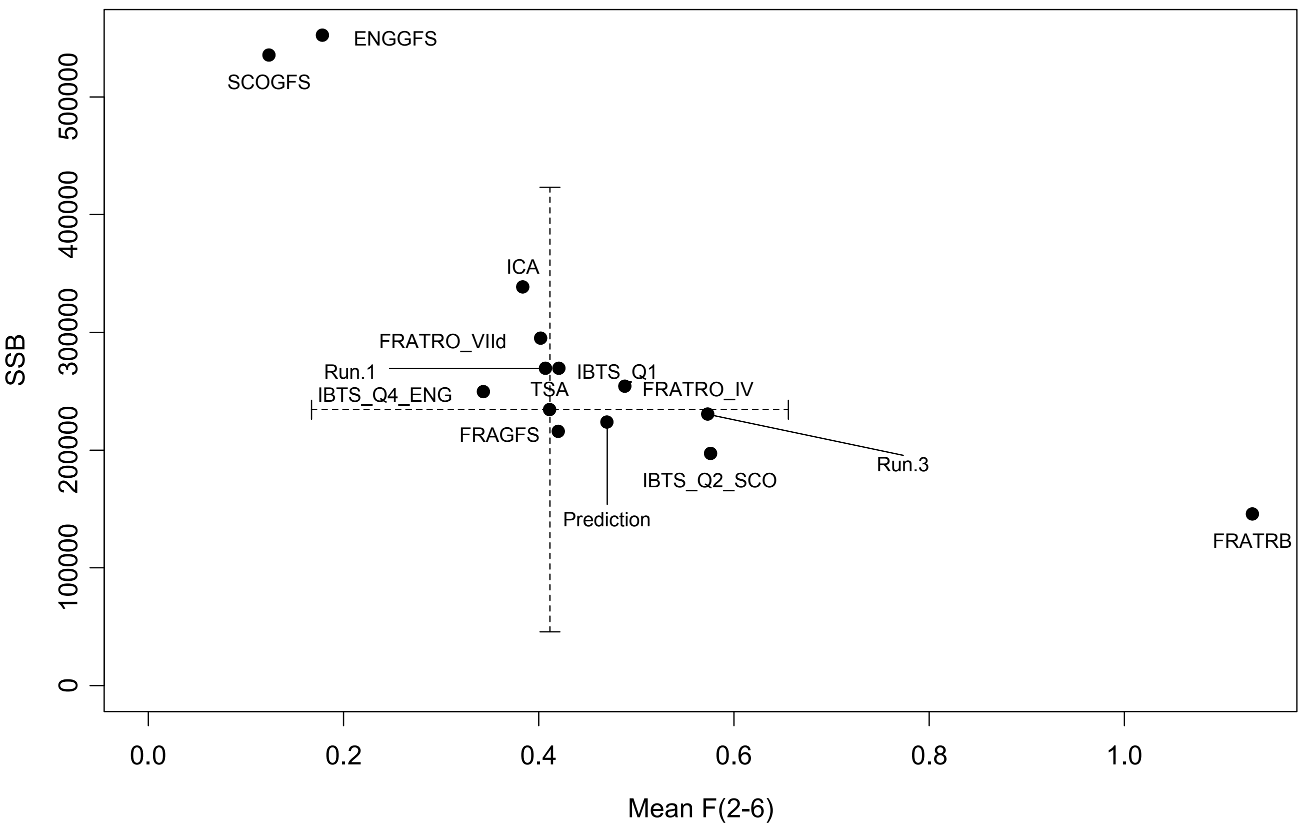


Figure 5.1.4.5. Comparison of historical estimates of mean F_{2-6} and SSB from different assessment methods. Solid line: TSA estimate. Dotted line: ±95% confidence interval for TSA estimate. Dots: estimates from XSA run 1 (this year's data and configuration). Crosses: estimate from XSA run 2 (configuration from previous assessment applied to this year's data). TSA results include projections for 2001 and 2002.

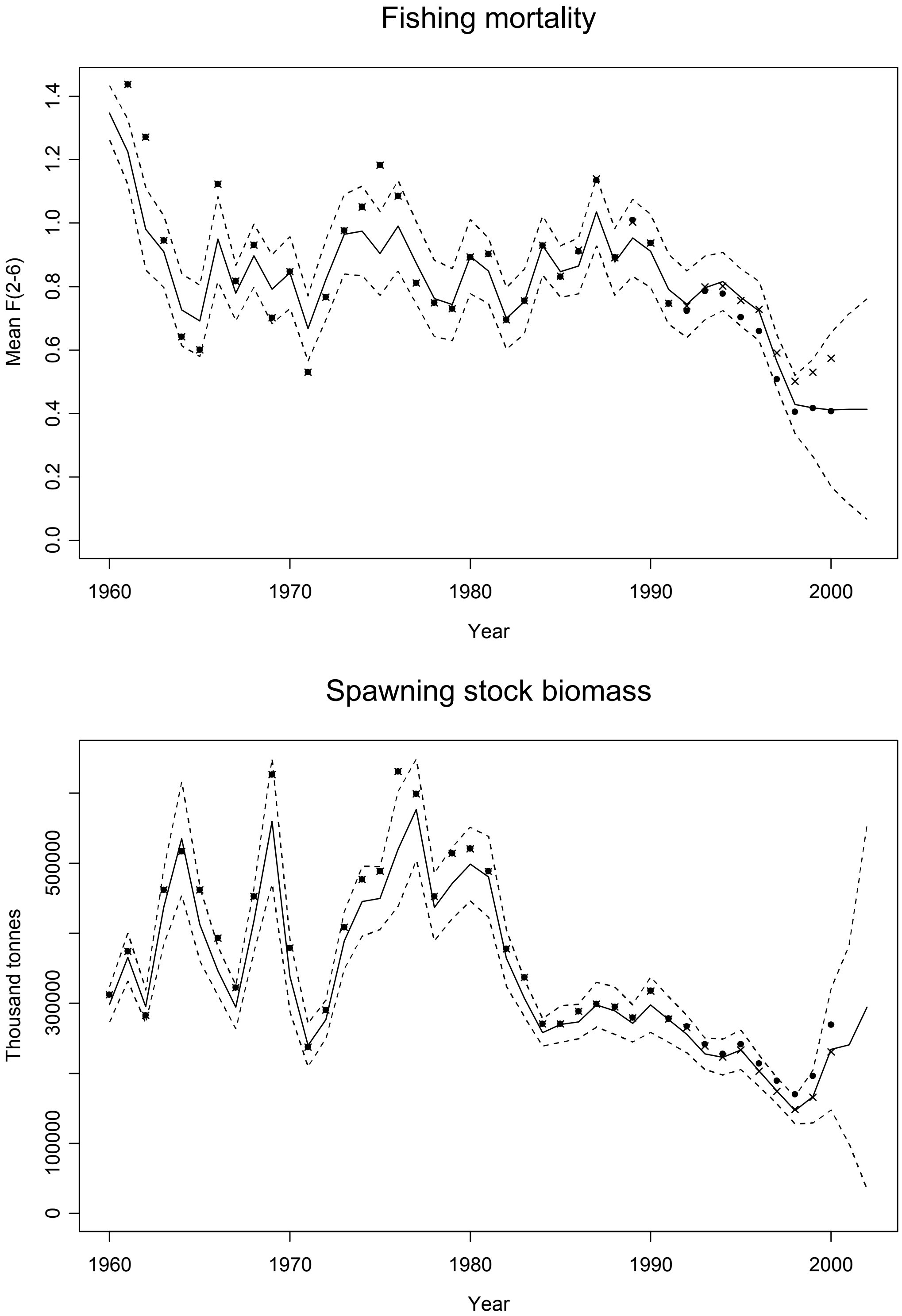


Figure 5.1.6.1. Whiting in IV and VIId. Stock summary. Dotted lines are approximate pointwise 95% confidence intervals about the TSA estimates. Data plotted to the right of the vertical dashed lines are TSA projections for 2001 and 2002.

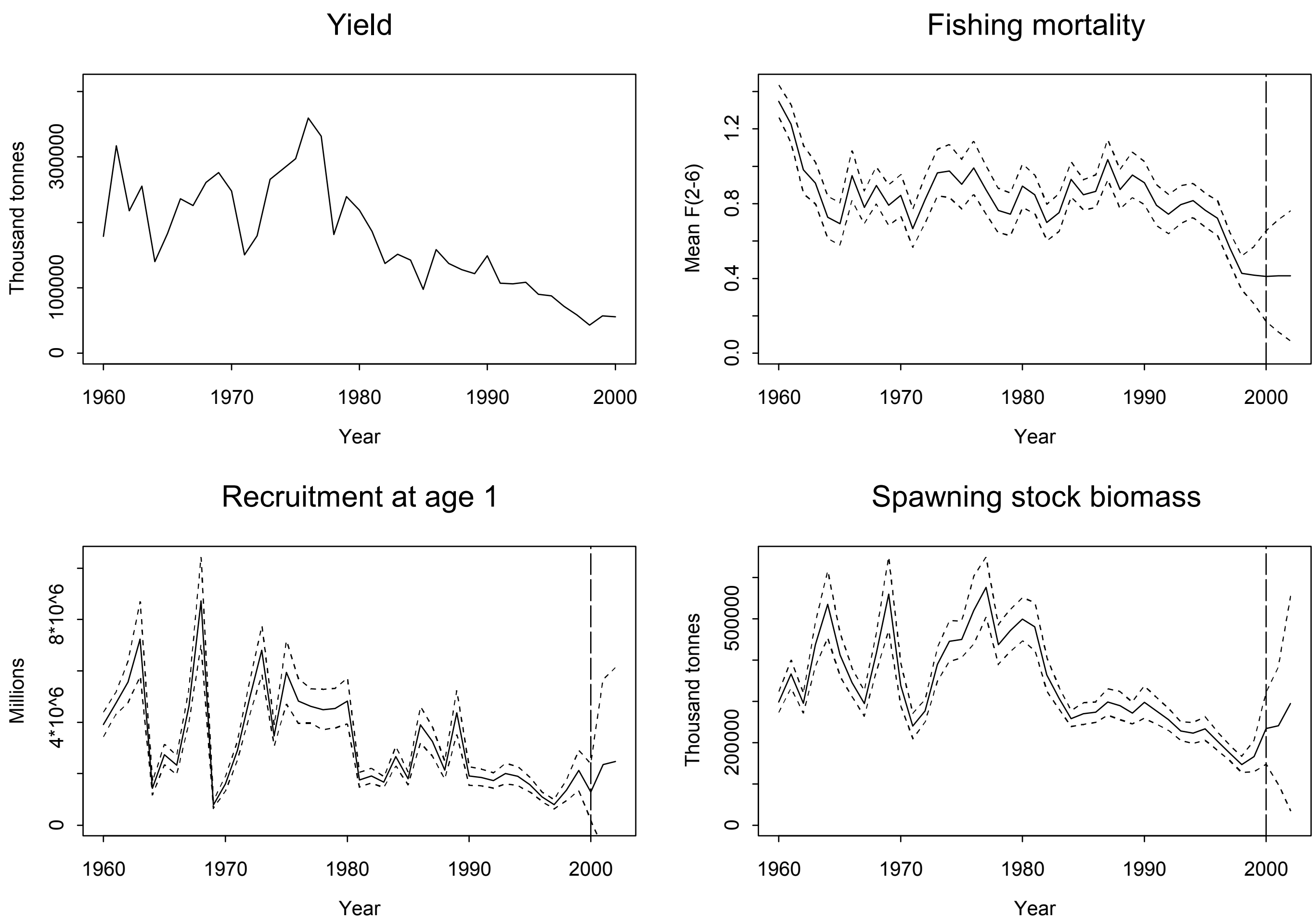
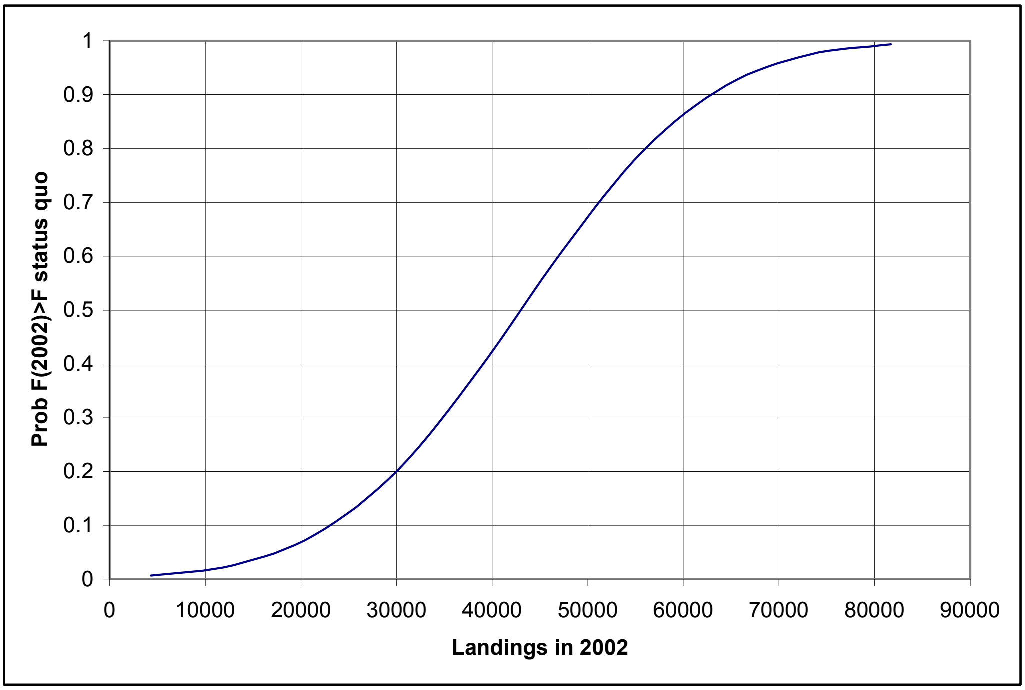


Figure 5.1.7.1. Whiting in IV and VIId. Probability profiles for a status quo forecast from TSA. Landings are human consumption landings only.



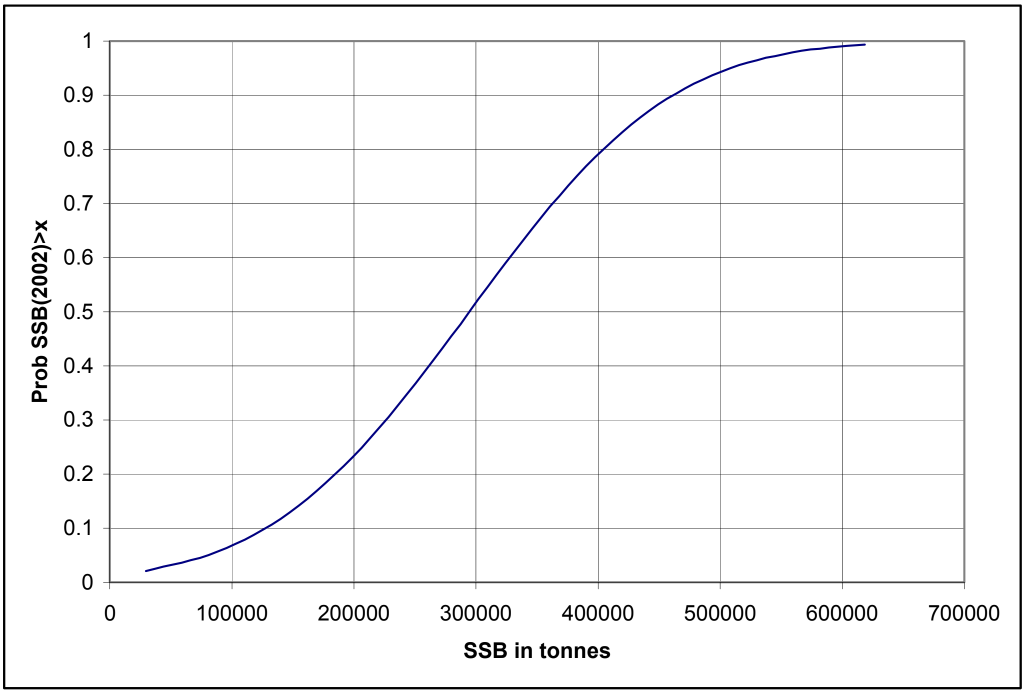


Figure 5.1.9.1. Whiting in IV and VIId. Stock and recruitment.

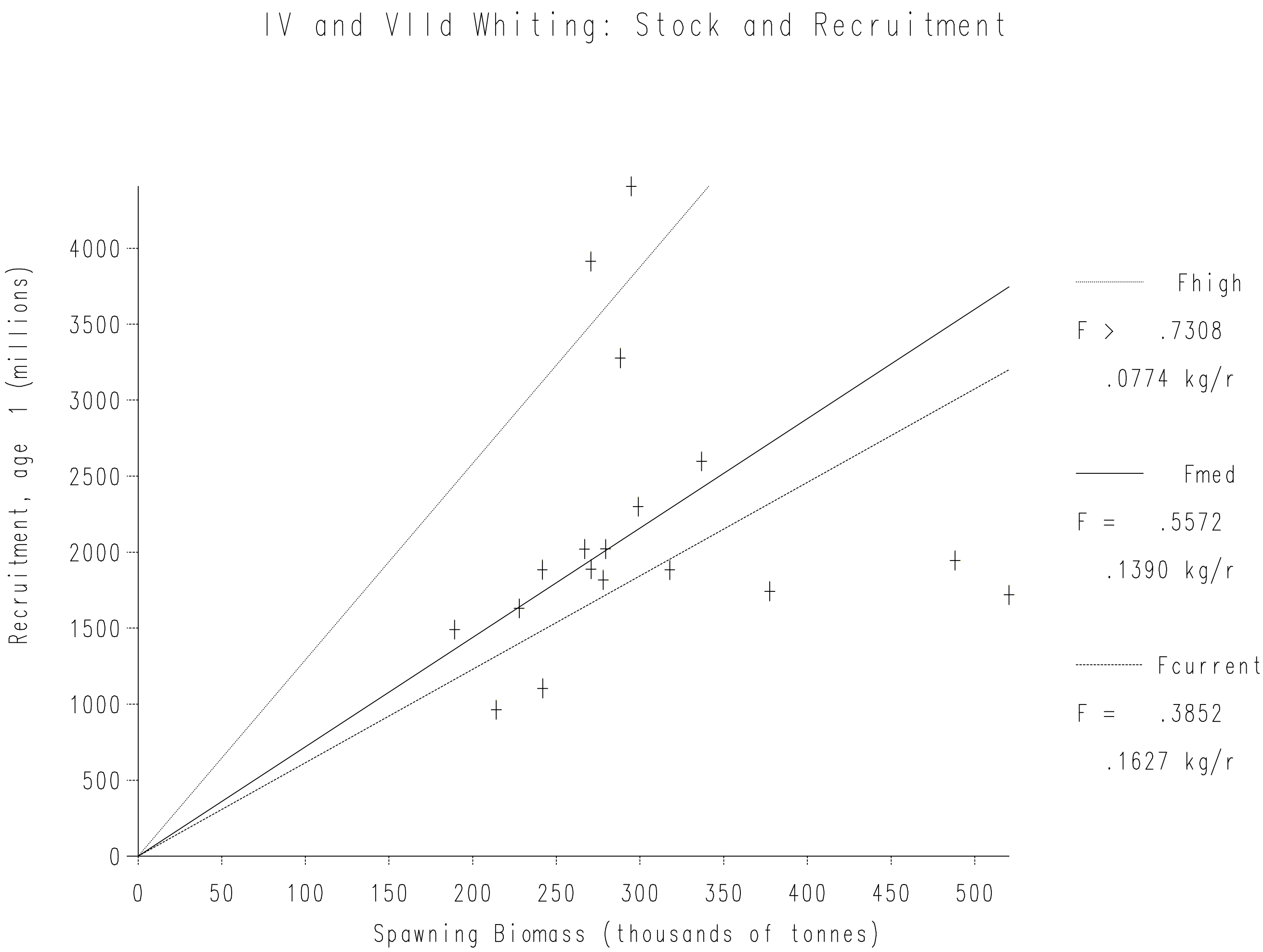


Figure 5.1.9.2. Whiting in IV and VIId. Yield per recruit.

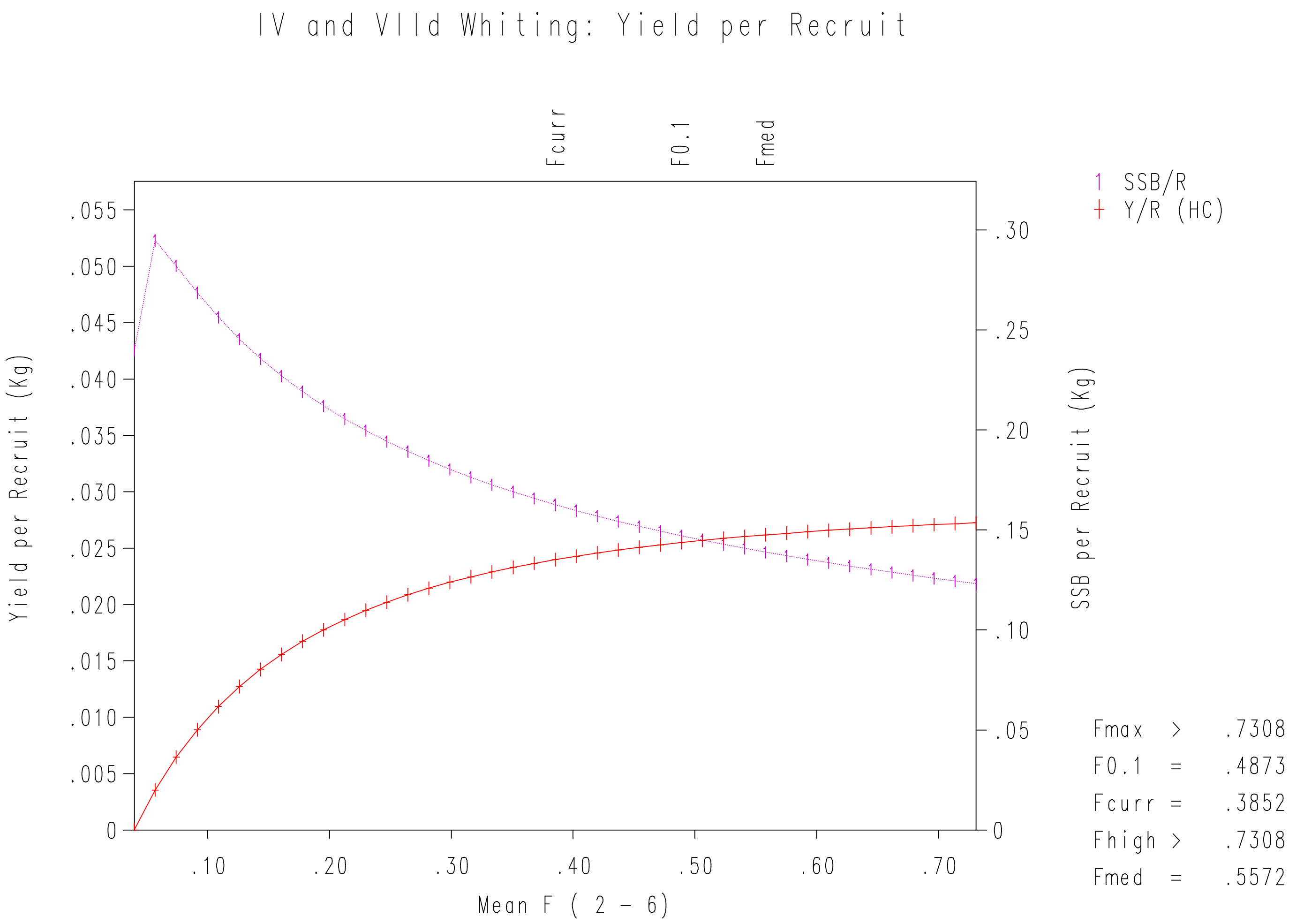
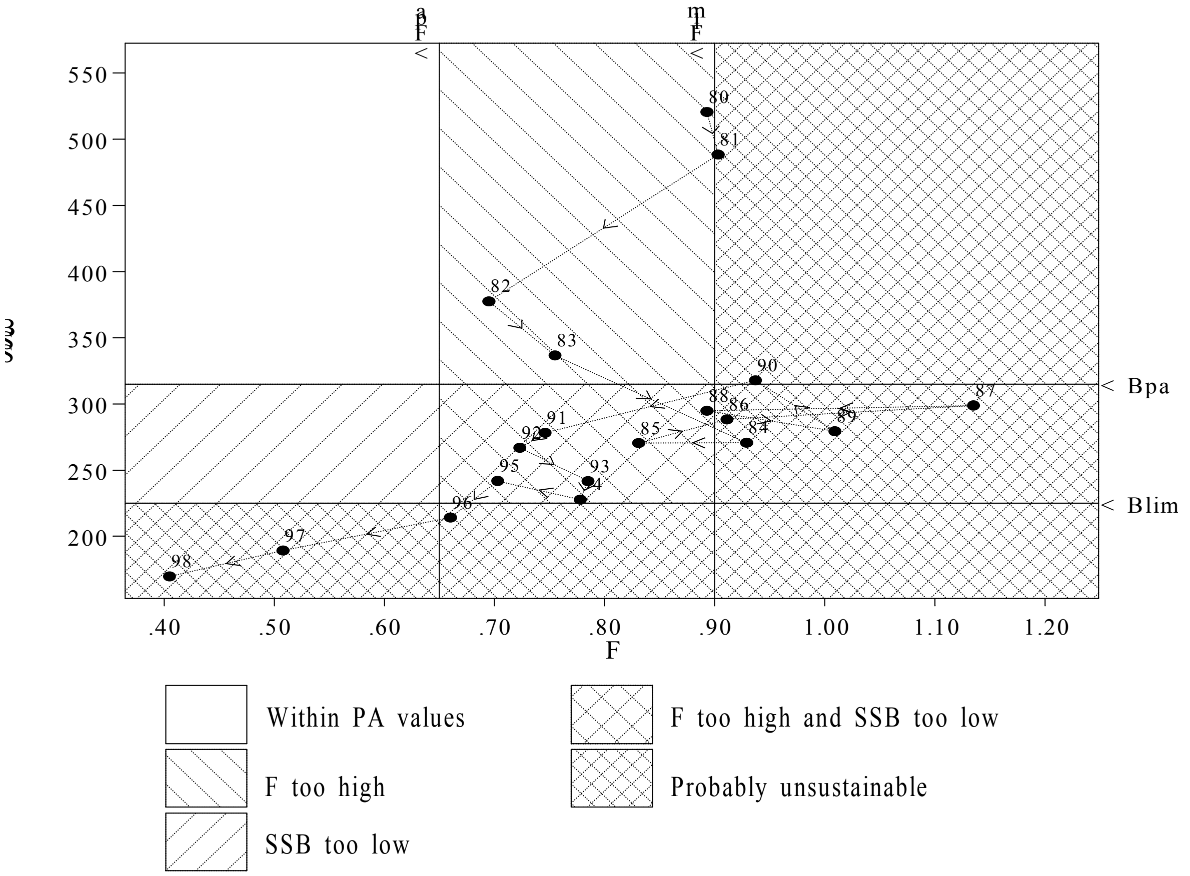


Figure 5.1.9.3. Whiting in IV and VIId



Data file(s):D:\NS 2001\Whiting\xsa\run2\whiiv.pa;D:\NS 2001\Whiting\xsa\run2\whiiv.sum
Plotted on 27/06/2001 at 18:47:22

6 SAITHE IN SUB-AREA IV, VI AND DIVISION IIIA

6.1 The fishery

Saithe in the North Sea are mainly taken in a direct trawl fishery in deep water near the Northern Shelf edge and the Norwegian deeps (working documents 4 and 9, sections 1.6.6 and 1.6.3). The majority of the catches are taken by Norwegian, French and German trawlers. In the first half of the year the fishery are directed towards mature fish, while immature fish dominate in the catches the rest of the year. The main fishery developed in the beginning of 1970s. In later years, the trawlers also go for deep sea fish, and it is necessary to take account of that when tuning series are established. The fishery in area VI consists largely of a directed French, German and Norwegian deep water fishery operating on the shelf edge, and a Scottish fishery operating inshore. In both areas most of the saithe do not enter the main fishery before age 3, because the younger ages are staying in inshore waters.

6.1.1 ACFM advice applicable to 2000 and 2001

For 2000 ACFM considered the stock to be outside biological limits and recommended that F on the combined stock should be reduced by 30%, corresponding to landings of 81,000 t in 2000 (75,000 t in IV+IIIa and 6,000 in VI). For 2001 ACFM adviced a 20 % reduction of F corresponding to landings less than 96 000 t (87,000 t in IV and IIIa and 9,000 t in VI).

6.1.2 Management applicable to 2000 and 2001

Management of saithe is by TAC and technical measures in both areas. The agreed TAC for saithe in IV and IIIa for 2000 is 85,000 t and in Division Vb, VI, XII and XIV the TAC for 2000 is 7,000 t. For 2001 the TACs were 87,000 t and 9,000 t respectively.

The minimum mesh size for towed gears is 100 mm in IV and VI and 90 mm in Skagerrak. Minimum landing size is 35 cm in EU waters. In Norwegian waters the minimum landing size is 32 cm in IV, and 30 cm in Skagerrak.

6.1.3 The fishery in 2000

Recent nominal landings are given in Tables 6.1.1. The main part of the Working group estimates are in Table 6.1.2 and are plotted in Figure 6.1.1. In 2000 the landings are estimated to be 87,449 t in area IV and IIIa, and 5,890 t in area VI, which are close to the TAC in both areas. Saithe are also taken as by-catch in the industrial fishery, but most of it is sorted out and delivered for human consumption. In 2000 a by-catch of about 6,300 t was estimated to go to industrial reduction.

Discard data were available for 2000 from the EC project 98/097. These data shows an overall discard of 6.6 % of the sampled catches. Otter- and pair trawlers, which catch the majority of the landings, discarded about 2 % of their catches. Since the fish are distributed inshore until it is 2-3 years old, discard of young fish is assumed to be a small problem in this fishery. Problems with bycatches in other fisheries when saithe quotas are exceeded may cause some discard.

6.2 Natural mortality, maturity, age compositions, mean weight at age

Conventional values of natural mortality rate, and maturity at age based on biological sampling are given in Table 6.2.1. They have been assumed to be the same all years.

Total international age compositions are given in Table 6.2.2. Catch at age data for 1999 were updated with minor changes. Catch at age and weight at age data for 2000 were supplied by Denmark, Germany, France, Norway, UK (England) and UK (Scotland) for area IV amounting to about 97 % of the reported total landings, and only UK(Scotland) for area VI .

The mean weights at age in the landings are given in Table 6.2.3 and plotted in Figure 6.2.1. These are also used as stock mean weights. They are weighted means (according to catch in numbers) and SOP corrections have been applied. However, this year the data have a SOP factor of about 1.08, and it is necessary to check the compilation of the data.

6.3 Catch, effort and research vessel data

The age composition of the fleets and surveys presented to the Working Group are listed in Table 6.3.1. The German fleet GEROTB_IV, which was new, is described in Working Document 4. The effort data from 1999 for the French fleet FRASAI_VI were not available, and due to uncertainty about the Scottish commercial fleet data in recent years, these two fleets were excluded. For the French fleet (FRATRB_IV), data before 1990 were excluded because the data included catches without any corresponding effort.

Effort by large French trawlers (FRATRB_IV), Norwegian trawlers (NORTRL_IV) and German trawlers (GEROTB_IV) in the North Sea has displayed a recent decrease (Fig. 6.3.1). Effort by French Freezer trawlers (FRATRF_IV) have been stable. The CPUE for the Norwegian trawlers increased from 1997 to 1999 and decreased in 2000, while the CPUE for the other fleets increased from 1999 to 2000 (Fig. 6.3.1). Working document 9 (sect. 1.6.6) describes a decreasing trend in the French CPUE of age 3 from 1993 in spite of good recruitment in 1994. The English groundfish survey (ENGGFS_IV), the Scottish groundfish survey (SCOGFS_IV) and the Norwegian acoustic survey (NORACU_IV) only cover area IV.

6.4 Catch-at-age analysis

6.4.1 Exploration of data

Preliminary XSA runs were done with all single fleets and different combination of fleets. Some of the results are shown in Figure 6.4.1, and the residuals from single fleet runs are shown in Figure 6.4.2. As seen from Figure 6.4.1, the survey data in combination with commercial fleets have very little influence on the results (“All data” in the Figure compared with “All commercial”). The surveys in the North Sea are not directed at saithe. All trawl hauls are taken shallower than 200 m, and the saithe are distributed further down at the edge of the Northern Shelf and Norwegian Deeps. The indices are often dominated by a few big hauls caused by the schooling of saithe. Age 1 and 2 are living inshore and are caught in low numbers in the surveys. It was therefore decided to run the tuning without the surveys as last year. Due to a missing value in 1997 for age 2 in GEROTB, that age was excluded in that fleet. The effort trends and age composition of the fleets used in the assessment are listed in Table 6.4.1.

To utilize all tuning data, exploratory runs with a longer period of tuning were done.

The results of these tuning runs were very similar, but the tuning with 20 years time span and tricubic taper gave the lowest standard errors of the weighted Log(VPA populations. This setting was therefore chosen.

Last year it was decided to treat catchability as independent of year class strength for all year classes. However, bearing in mind the biology of saithe, that they don’t enter the open sea and thus the main fishery until an age of three and that this migration could be density dependent makes it reasonable to use a power model for age 1 and 2, as were done in previous years. This is supported by the investigation presented in Working document 9.

ACFM have noted that the retrospective bias of the saithe assessment (F overestimated) is in the opposite direction of that for most of the other North Sea assessments. Figure 6.4.3 shows that the F skrinkage results in higher Fs for ages 5 – 8, and we expected to get rid of much of the retrospective bias by reducing the influence of shrinkage. Several runs were explored using lower shrinkers as last year, resulting in lower estimates of fishing mortalities. It was decided to use a SE of 1.0 in the final assessment.

6.4.2 Final assessment

The settings of the final run are presented in the text table below:

		2000 XSA		2001 XSA	
Fleets	FRATRB_IV	1990-1999	2-7	1990-2000	2-9
	FRATRF_IV	1990-1999	3-7	1990-2000	2-9
	NORTRL_IV	1980-1999	3-9	1980-2000	3-9
	GEROTB_IV	Not used		1995-2000	3-9
Taper			no		yes
Tuning rage			10 yr		20 yr
Age of cons1. q			1		3
q plateau			7		7
F shrinkage			0.5		1.0
-year range			5		5
-age range			3		3

The method used to tune the VPA was XSA. The tuning did not converge after 40 iterations. Tuning diagnostics are given in Table 6.4.2. For age 1 and 2 the P shrinker have greatest weight, while the estimation of survivors of the older ages are dominated by the commercial fleets (Figure 6.4.4).

Tables 6.4.3 and 6.4.4 list the fishing mortality and stock number by year and age, respectively. The VPA results are summarized in Table 6.4.5 and illustrated in Figure 6.1.1.

The results of the retrospective analysis are plotted in Figure 6.4.5. The retrospective analysis reveals a tendency to overestimate F_{3-6} and underestimate SSB in recent years. The retrospective estimation of the recruits at age 1 is scattered and needs almost 10 years to converge.

6.5 Recruitment Estimates

The arithmetic mean of numbers at age= 1 for the period 1972 – 1997 is 263 million and the geometric mean is 241 million.

No survey or other independent age 1 or 2 indices were available to the working group. The group therefore decided to use geometric means 1989-98 to estimate recruitment for the year classes 1998, 1999 and 2000 for the short-term prediction because they have not been well estimated by catch data. This short-term GM was used as there is evidence of reduced recruitment in recent years (Figure 6.1.1). Year class strength used for predictions are printed in bold and can be summarized as follows (numbers in thousands):

Year class	Age	XSA	GM(89-98)
1997	4	**84,576**	
1998	3	104,830	**127,419**
1999	2	152,762	**159,075**
2000	1		**194,470**
2001	1		**194,470**

6.6 Historical trends

The historical trends are given in Table 6.4.5 and shown in Fig. 6.1.1. For the combined area the landings peaked during the mid 1970s, dropped rapidly to 140,000 t in 1980, increased again and exceeded 220,000 t in 1985. During the last 10 years, the landings remained at a lower level with small variation between 93,000 and 125,000 t.

The mean F_{3-6} decreased continuously from 0.82 in 1986 to 0.29 in 2000. Recently, the SSB was estimated to have increased to about 220,000 tons in 2000 from the lowest observed 92,000 tons in the early 1990s. This increase are partly due to the good year classes 1992 and 1994 and to the decrease in fishing mortality. Since 1997 the fishing mortality have been below the $\mathbf{F}_{pa}$ and the SSB have been above $\mathbf{B}_{pa}$.

6.7 Short term forecast

Input data for the 2001-2003 prediction are given in Table 6.7.1. In 2001, numbers of ages 1 are GM(89-98) estimates, and ages 2 and 3 are GM estimates using respective Fs. The year classes 2000 and 2001 at age 1 were estimated by the short-term GM value of 194 millions. The exploitation pattern, mean weights in the stock and the catch is based on 1998-00 arithmetic means. The fishing pattern was scaled to F_{3-6} in 2000. Results of the prediction are given in Table 6.7.2 and in Fig. 6.7.1. The assumption of *status quo* fishing mortality in 2001 and 2002 corresponds to landings of 110,000 t in 2001 and 115,000 t in 2002. As a consequence, spawning stock size is predicted to increase from 232,000 t in 2001 to 234,000 in 2003. The TACs for the combined areas amount to 96,000 t in 2001.

Table 6.7.3 lists the contribution of the different recruiting year classes in the catch in 2002 and the spawning stock in 2003. 32% of the expected landings in 2002, and 32% of the predicted SSB in 2003 is made up of year classes for which GM(89-98) recruitment is assumed.

Fig. 6.7.3 shows that the forecast for catch in 2002 are not sensitive to any parameters except the effort multiplier in 2002 (HF02), and that most of the variance comes from the numbers of the year classes 1997 and 1998 and HF02. The forecast for the spawning stock in 2003 seems to be sensitive to the effort multipliers, while the 1997 and 1998 year class strength give a high contribution to the variance. Figure 6.7.2 shows that it may be about 10 % probability of being below $\mathbf{B}_{pa}$ (200,000 t) in 2003 when fishing at *status quo* in 2002. It is also seen that there will be about 50 % probability that the F will be above $\mathbf{F}_{sq}$ in 2002 with a catch of 115,000 t.

6.8 Medium term projections

The input for medium term projections is given in Table 6.7.1 A Ricker model was applied. The results indicate that under the *status quo* fishing scenario the median landings will increase to 180,000 t after 10 years (Figure 6.8.1). The median SSB is projected to remain at around 240,000 t for five years after which it is predicted to increase to about 380,000 t. The contour plot suggests there is a 30 % probability of SSB falling below $\mathbf{B}_{pa}$ after ten years of fishing at $\mathbf{F}_{pa}$ (Fig 6.8.2).

Biological reference points

The stock-recruitment plot including values of $\mathbf{F}_{med}$ and Fcurrent is given in Fig. 6.9.1. The input parameters for the yield and biomass per recruit are listed in Table 6.9.1 and the results are shown in Figure 6.9.2. The mean weights in the stock and in the catch are assumed to be the same and represents the mean over the last 10 years. The exploitation pattern is calculated as the 1998-00 mean and scaled to F_{3-6} in 2000. The oldest age group is defined as a plus group. The different reference points and agreed management points are listed in the text table below:

$\mathbf{F}_{0.1}$	0.09	$\mathbf{F}_{lim}$	0.60
$\mathbf{F}_{max}$	0.17	$\mathbf{F}_{pa}$	0.40
$\mathbf{F}_{med}$	0.43	$\mathbf{B}_{lim}$	106,000 t
$\mathbf{F}_{high}$	0.58	$\mathbf{B}_{pa}$	200,000 t

Figure 6.9.3 shows the history of F_{3-6} versus SSB. In the period 1984 – 1996 the SSB was below $\mathbf{B}_{pa}$, but the last four years SSB has been above $\mathbf{B}_{pa}$. The fishing mortality has almost always exceeded 0.4. F has shown a recent declining trend, and since 1997 it has been below $\mathbf{F}_{pa}$.

6.9 Comment on the assessment

This year's estimation of fishing mortality in 2000 of 0.29 is 55 % lower than the predicted *status quo* F from last years assessment, but 14 % below the fishing mortality of about 0.33 corresponding to the agreed TAC. This assessment gives a reduction in fishing mortalities for the years 1999 and 1998 of 32 % and 16 % respectively, and an increase in the SSB for 2000 of about 16%. The general tendency of this assessment to overestimate F and underestimate SSB seem to persist (Fig. 6.10.1).

The CPUE data from the commercial fleets may be biased because the saithe are partly schooling, and it is possible to find the schools with echo sounders. In that case CPUE may not be a reliable indicator of stock abundance.

The TAC constraint in the last years may have changed the strategy of the fleets concentrating their effort in the first part of the year on mature fish. The fleets may also target other species during the same trip, which have to be taken into account when the effort is estimated.

The assessment and the present stock and catch prediction suffer from the lack of a representative data series from surveys or commercial fleets for recruitment at ages 1-3. The assessment is therefore liable to be revised every year.

6.10 Management consideration

In previous assessments the stock was considered outside Safe Biological Limits. The present assessment indicates that SSB has been above $\mathbf{B}_{pa}$ and F has been below $\mathbf{F}_{pa}$ since 1997.

The fact that the forecast do not track recruitment fluctuations can lead to management problems.

Table 6.1.1 Nominal catch (in tonnes) of SAITHE in Sub-area IV and Division IIIa, 1987-1998, as officially reported to ICES.

Sub-area IV and division IIIa

Country	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Belgium	60	13	23	29	70	113	130	228	157	254	249	200	122
Denmark	6,868	6,550	5,800	6,314	4,669	4,232	4,305	4,388	4,705	4,513	3,967	4,494	3,529
Faroe Islands	276	739	1,650	671	2,480	2,875	1,780	3,808	617	158	1,298	1,101	
France	28,913	30,761	29,892	14,795	9,061	15,258	13,612	11,224	12,336	10,932	11,786	24,305	20,399
Germany	18,528	14,339	15,006	19,574	13,177	14,814	10,013	12,093	11,567	12,581	10,117	10,481	9,273
Netherlands	345	257	206	199	180	79	18	9	17	40	7	7	11
Norway	40,021	24,737	19,122	36,240	48,205	47,669	47,042	53,793	55,531	46,484	49,540	55,816	43,224
Poland	1,016	809	1,244	1,336	1,238	937	151	592	365	822	813	862	747
Sweden	2,064	797	838	1,514	3,302	4,955	5,366	1,891	1,771	1,647	1,857	1,929	1,421
UK (E&W)	3,790	4,012	3,397	4,070	2,893	2,429	2,354	2,522	2,864	2,556	2,293	2,874	
UK (Scot.)	10,850	9,190	7,703	8,602	6,881	5,929	5,566	6,341	5,848	6,329	5,353	5,420	
UK													6,711
USSR				*116*									67
Total reported	**112,731**	**92,204**	**84,881**	**93,460**	**92,156**	**99,290**	**90,337**	**96,889**	**95,778**	**86,316**	**87,280**	**107,489**	**85,504**
Unallocated	-6,132	-172	3,199	5,121	187	5,840	12,098	16,525	14,458	17,006	12,983	-175	1,945
WG estimate	**106,599**	**92,032**	**88,080**	**98,581**	**92,343**	**105,130**	**102,435**	**113,414**	**110,236**	**103,322**	**100,263**	**107,314**	**87,449**
TAC	*165,000*	*170,000*	*120,000*	*125,000*	*110,000*	*93,000*	*97,000*	*107,000*	*111,000*	*115,000*	*97,000*	*110,000*	*85,000*

Notes

Preliminary values for France (1989-1995, 1998-2000), Norway (1995, 1997-2000), Sweden (1999)

Includes IIa(EC), IIIa-d(EC) and IV: France (1989-1991, 1994, 1999-2000)

Includes Estonia: USSR (1991)

Sub-area VI

Country	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Belgium	14	15		6	2	2							
Denmark		2			1	2			1				
Faroe Islands	8			24	1				3	1			
France	24,656	17,106	12,961	12,423	6,534	10,216	8,423	6,145	4,781	4,662	3,635	3,467	3,314
Germany	1,584	1,116	275	590	685	222	524	321	1,012	492	506	250	305
Ireland	544	593	520	260	278	317	438	530	419	411	216	320	
Norway	50	72	64	31	67	59	74	35	34	26	41	126	58
Spain	857	65	70	49						13	54	23	
Portugal										1			
UK (E&W&NI)	1,206	462	855	593	540	799	744	317	708	294	526	503	
UK (Scotland)	3,925	2,971	3,258	3,885	2,708	2,903	2,828	3,279	2,435	2,659	2,402	2,084	
UK (total)													2,740
Russia												3	6
Total reported	**32,844**	**22,402**	**18,003**	**17,861**	**10,816**	**14,520**	**13,031**	**10,627**	**9,393**	**8,559**	**7,380**	**6,776**	**6,423**
Unallocated	1,334	3,175	1,862	-866	988	-577	-210	1,143	40	859	1,054	566	-533
WG estimate	**34,178**	**25,577**	**19,865**	**16,995**	**11,804**	**13,943**	**12,821**	**11,770**	**9,433**	**9,418**	**8,434**	**7,342**	**5,890**

Notes

Preliminary values: France (1998-2000), Norway (1994, 1997-1999)

Includes Division Vb (EC): France (1989-199)

Reported by TAC area, Vb(EC), VI, XII and XIV: France (1999-2000)

Subarea IV, VI and Division IIIa

	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
WG estimate	**140,777**	**117,609**	**107,945**	**115,576**	**104,147**	**119,073**	**115,256**	**125,184**	**119,669**	**112,740**	**108,697**	**114,656**	**93,339**

Table 6.1.2. : Saithe, IIIa, IV and VIa. Annual weight and numbers caught, 1967 to 2000.

Year	Wt.('000t)	Nos.(millions)
1967	95	63
1968	117	69
1969	132	76
1970	237	150
1971	272	187
1972	275	195
1973	260	192
1974	309	183
1975	309	205
1976	362	330
1977	223	135
1978	166	112
1979	136	75
1980	142	81
1981	146	81
1982	190	125
1983	198	126
1984	220	181
1985	226	222
1986	203	180
1987	181	182
1988	141	111
1989	118	94
1990	108	87
1991	116	104
1992	104	78
1993	119	89
1994	115	88
1995	125	81
1996	120	83
1997	113	85
1998	109	82
1999	115	79
2000	93	56
Min.	93	56
Mean	173	125
Max.	362	330

Table 6.2.1.: Saithe, IIIa, IV and VIa. Natural Mortality and proportion mature.

Age	Nat Mor	Mat.
1	.200	.000
2	.200	.000
3	.200	.000
4	.200	.150
5	.200	.700
6	.200	.900
7	.200	1.000
8	.200	1.000
9	.200	1.000
10+	.200	1.000

Table 6.2.2.: Saithe in IV, VI and IIIa. Catch numbers at age Numbers*10**-3

YEAR	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976
AGE										
1	0	174	36	234	594	430	4708	4753	335	270
2	8879	3832	2099	2261	11156	23833	37832	19206	74231	34111
3	17330	23223	30235	37249	69809	48075	54332	66938	56987	207823
4	16220	21231	17681	76661	57792	66095	37698	33740	25864	53060
5	15531	13184	11057	15000	32737	25317	26849	14123	10319	11696
6	2303	6023	7609	12128	4736	21207	16061	20688	7566	6253
7	1594	429	5738	3894	4248	3672	8428	14666	13657	3976
8	292	242	791	1792	2843	2944	2000	5199	9357	5362
9	198	123	626	318	1874	1641	1357	1477	3501	3586
+gp	183	145	150	267	774	1607	2381	1955	2687	3490
TOTALNUM	62530	68606	76022	149803	186562	194822	191646	182744	204505	329627
TONSLAND	94514	116789	131882	236636	272481	275098	259602	309439	308926	361680
SOPCOF %	100	100	100	100	100	100	100	100	100	100

YEAR	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
AGE										
1	2172	1253	916	1321	5457	1970	312	206	231	322
2	14125	20551	17756	24100	20644	29570	36824	37387	9415	7227
3	27461	35059	16332	17494	26178	31895	28242	80933	134024	55435
4	54967	27269	14216	12341	8339	40587	20604	32172	55605	91223
5	14755	18062	11182	9015	6739	9174	26013	12957	13281	15186
6	5490	3312	8699	6718	3675	5978	5678	13011	4765	5381
7	3777	1138	2805	5658	3335	2145	4893	1657	3005	2603
8	3447	1033	733	1150	3396	1454	1494	1252	682	1456
9	3812	768	540	509	657	982	1036	335	399	445
+gp	4701	3484	2089	2302	2536	1254	1327	646	742	900
TOTALNUM	134708	111927	75268	80608	80956	125010	126423	180556	222147	180178
TONSLAND	223395	166199	135967	142395	146092	189861	197774	219642	226129	202758
SOPCOF %	100	100	100	100	100	100	100	100	100	100

YEAR	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
AGE										
1	787	32	3664	355	492	319	160	106	157	354
2	31017	8762	9871	5764	13091	6679	10118	8033	4338	8963
3	31220	32578	22128	40808	46117	18404	37823	19958	26664	11066
4	97470	26408	30752	19583	29871	33614	20828	40194	26034	38861
5	13990	35323	13187	11322	7467	12753	11845	13034	14797	11786
6	3158	3828	10951	4714	3583	3193	3125	4297	3774	7731
7	1811	1908	1557	2776	1716	1524	1568	947	3494	3163
8	1240	1104	739	745	953	696	1511	346	674	808
9	910	776	419	281	367	518	814	427	552	210
+gp	700	680	488	364	458	422	1026	794	800	491
TOTALNUM	182304	111398	93755	86710	104117	78121	88817	88135	81284	83432
TONSLAND	180776	140778	117609	107945	115576	104147	119073	115255	125183	119669
SOPCOF %	100	100	100	100	100	100	100	100	100	100

YEAR	1997	1998	1999	2000
AGE				
1	27	218	64	145
2	12396	3706	6634	2622
3	15036	10363	9429	6955
4	19299	31017	13872	17142
5	30177	16367	26684	8919
6	3676	16077	8389	12348
7	2640	2231	10070	3185
8	1012	1206	2346	3244
9	291	567	891	645
+gp	288	277	657	538
TOTALNUM	84843	82028	79037	55744
TONSLAND	112740	108699	114655	93340
SOPCOF %	100	100	100	108

Table 6.2.3.: Saithe in IV, VI and IIIa. Catch weights at age and Stock weights at age (kg)

YEAR	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976
AGE										
1	0	0.5006	0.451	0.434	0.495	0.3281	0.1637	0.275	0.216	0.4588
2	0.697	0.77	0.6086	0.6955	0.6101	0.5488	0.4317	0.5093	0.5021	0.5156
3	0.9305	1.2784	0.9663	0.9414	0.8399	0.8082	0.8212	0.8608	0.8928	0.7024
4	1.362	1.6521	1.5568	1.4408	1.348	1.1958	1.4061	1.5606	1.4977	1.3092
5	2.1035	1.9886	2.2614	2.0587	2.1775	1.961	1.641	2.3834	2.4904	2.2604
6	3.1858	3.0093	2.7133	2.718	2.936	2.3687	2.5709	2.7527	3.3002	3.0706
7	3.7541	4.0404	3.5588	3.5995	3.7657	3.7941	3.3571	3.4286	3.7647	4.0347
8	5.3162	4.4278	4.4063	4.4632	4.6339	4.2276	4.6844	4.4977	4.2957	4.3833
9	5.8905	6.1355	5.2203	5.6871	5.1725	4.6304	4.8138	5.7128	5.5396	5.1117
+gp	7.719	7.4055	6.7675	6.8452	6.163	6.3263	6.4449	7.857	7.562	7.147
SOPCOFAC	0.9999	1.0001	1.0001	0.9998	1.0001	0.9999	1	1	0.9999	1.0002

YEAR	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
AGE										
1	0.4257	0.3548	0.4348	0.2586	0.2774	0.2525	0.4126	0.3886	0.1487	0.6295
2	0.4301	0.5165	0.406	0.421	0.5958	0.5077	0.478	0.5009	0.555	0.5479
3	0.7598	0.8215	1.1072	0.9546	0.9608	1.0857	1.0276	0.7948	0.6632	0.6943
4	1.256	1.3267	1.6228	1.8212	1.8211	1.5746	1.7178	1.6139	1.2654	1.0353
5	1.9348	2.1545	2.2381	2.3911	2.7175	2.5293	2.1493	2.2966	1.9505	1.7944
6	3.1107	3.3401	3.095	3.03	3.5868	3.2202	3.1377	2.6899	2.7715	2.4316
7	4.1618	4.5221	4.0504	4.0895	4.536	4.2069	3.6906	3.8959	3.4067	3.5717
8	4.6045	4.9005	5.2742	5.1262	5.4776	5.1251	4.6317	4.6647	4.9499	4.2094
9	4.8589	5.4494	6.3077	5.9393	6.9804	5.9049	5.5053	6.183	5.8649	5.6506
+gp	6.5419	7.4	7.9551	8.1476	8.7237	8.8232	8.4529	8.4735	8.8543	8.2184
SOPCOFAC	1	1.0001	1.0001	1.0001	1	1.0001	1	1	1	0.9999

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
YEAR										
AGE										
1	0.3711	0.5165	0.4264	0.2717	0.4794	0.6189	0.3585	0.2866	0.5024	0.2797
2	0.4181	0.6379	0.7263	0.7025	0.5571	0.6299	0.7437	0.6975	0.7593	0.5103
3	0.6739	0.7787	0.8954	0.8441	0.7913	0.9641	0.8994	0.9439	1.0022	0.9668
4	0.8763	0.981	1.0362	1.1958	1.1579	1.1893	1.2603	1.1188	1.2937	1.1873
5	1.8236	1.3859	1.4196	1.5828	1.7523	1.6066	1.7544	1.601	1.8159	1.8068
6	3.0747	2.7907	1.9984	2.2472	2.3646	2.2417	2.6363	2.4337	2.5619	2.3678
7	4.2098	4.0238	3.9139	3.2419	3.1653	3.6677	3.1851	3.6175	3.5549	2.9518
8	5.33	5.2544	5.0175	4.8583	4.2221	4.3296	3.9798	4.7869	4.767	4.7053
9	6.1284	6.3221	6.4298	6.3149	6.0661	5.4125	5.0802	6.5479	5.2674	6.0922
+gp	8.6026	8.6489	8.4308	8.4162	8.1914	7.0455	6.8909	8.3256	7.8907	8.3821
SOPCOFAC	1.0001	1	0.9999	0.9997	0.9998	1	0.9999	1	1.0001	1.0002

	1997	1998	1999	2000
YEAR				
AGE				
1	0.4324	0.6027	0.5195	0.5611
2	0.4357	0.6594	0.5887	0.7944
3	0.9047	0.8917	0.8808	0.9921
4	1.1448	0.966	1.0605	1.0823
5	1.4522	1.3925	1.2112	1.5249
6	2.5867	1.744	1.7537	1.6788
7	3.5556	2.9486	2.3374	2.5699
8	4.5251	3.8829	3.4934	3.0235
9	6.1575	4.9955	4.8438	4.6052
+gp	8.8663	7.2273	6.7452	7.0536
SOPCOFAC	0.9998	1	1.0016	1.0765

Table 6.3.1: Tuning fleets available to the Working Group

Fleet	Name	Area	Period	Ages	Used
French large trawlers	FRATRB_IV	IV	1978-2000	2-10	yes
French freezer trawlers	FRATRF_IV	IV	1990-2000	2-10	yes
French trawlers	FRASAI_VI	VI	1977-1998	3-10	no
Norwegian trawlers	NORTRL_IV	IV	1980-2000	3-10	yes
German trawlers*	GER_OTB_IV	IV	1995-2000	2-10	yes
Scottish light trawlers	COLTR_IV+VI	IV+VI	1989-2000	2-3	no
English groundfish survey	ENGGFS_IV	IV	1977-2000	2-9	no
Scottish groundfish survey	SCOGFS_IV	IV	1982-2000	2-3	no
Norwegian acoustic survey*	NORACU_IV	IV	1995-2000	3-7	no

* New fleet

Table 6.4.1. : Saithe in IV, VI and IIIa - Tuning Fleets.

108									
NORTRL_IV									
1980	2000								
1	1	0	1						
3	10								
18317	186	1290	658	980	797	261	60	82	
28229	88	844	1345	492	670	699	119	64	
47412	6624	12016	2737	2112	341	234	19	77	
43099	4401	4963	8176	1950	2367	481	357	84	
47803	20576	7328	2207	3358	433	444	106	51	
66607	27088	21401	5307	1569	637	56	46	4	
57468	5297	29612	3589	818	393	122	25	33	
30008	2645	18454	2217	290	235	201	198	64	
18402	3132	2042	2214	141	157	74	134	43	
17781	649	2126	835	694	309	154	65	7	
10249	804	781	924	519	203	63	12	3	
28768	14348	4968	1194	518	203	51	56	1	
35621	3447	9532	4031	1087	465	165	109	6	
24572	7635	4028	2878	1018	526	365	252	252	
30628	3939	16098	4276	926	251	72	203	21	
32489	4347	9366	5412	833	1644	273	203	104	
40400	3790	14429	4414	2765	1144	189	16	13	
36026	2894	5266	9837	1419	892	299	72	28	
24510	1376	8279	5454	5662	977	489	243	55	
20570	783	2527	6741	2333	3573	1162	342	187	
14920	249	1505	1961	4070	1018	1149	210	83	
FRATRB_IV									
1978	2000								
1	1	0	1						
2	10								
69739	248	1853	3183	5447	762	190	154	122	163
89974	230	4525	3618	4128	2809	329	87	51	84
63577	528	3149	4450	2322	1412	746	104	45	29
76517	4538	9067	2893	2423	939	456	258	36	48
78523	1285	6001	10009	2630	1328	543	164	98	21
69720	799	3487	5770	8617	1183	270	86	37	29
76149	1311	5482	8632	5121	3837	232	155	33	49
25915	836	5282	4311	1509	448	268	25	28	22
28611	730	4056	7071	1775	589	158	88	16	9
28692	936	1310	7304	2025	244	96	35	17	4
25208	540	1840	1960	5874	482	84	21	12	10
25184	803	2629	3697	1719	1878	101	23	8	6
21758	489	3380	2472	1406	304	290	33	15	6
15248	292	1381	2539	731	372	131	68	12	6
7902	352	717	1481	499	74	24	7	6	1
13527	1026	3918	2253	1162	104	8	9	6	10
14417	435	1771	3653	1381	434	39	5	3	4
14632	193	3152	1683	922	226	70	24	13	14
16241	196	895	4286	1053	536	108	25	15	8
12903	149	1087	1915	3175	190	84	17	14	6
13559	148	800	2538	1870	1481	52	23	10	12
14588	187	852	1234	2667	620	400	24	14	11
8695	184	889	1993	1039	1195	215	181	32	12
FRATRF_IV									
1990	2000								
1	1	0	1						
2	10								
19797	502	3676	2595	1377	262	251	28	11	4
18369	196	1133	2487	686	325	105	55	9	5
1868	95	188	374	110	16	5	2	1	0
8059	471	1920	1142	413	23	2	2	2	3
8650	210	863	1664	560	165	15	3	1	2
8844	68	1305	788	494	128	43	16	8	9
7824	126	379	1790	345	182	37	9	5	3
6767	112	635	1148	1644	68	29	7	4	2
10031	125	627	2113	1362	988	35	14	6	6
11667	202	642	890	1783	375	229	14	8	12
10924	141	935	2211	982	1094	163	135	23	19

Table 6.4.1. : Saithe in IV, VI and IIIa - Tuning Fleets, continued.

GER_OTB_IV

1995	2000								
1	1	0	1						
2	10								
21167	36	1158	2359	1350	589	152	30	16	52
19064	27	510	3167	1081	517	257	148	41	127
21707	0	816	2475	3636	292	163	70	24	20
20153	46	591	2744	1395	1776	238	100	39	29
18596	42	284	1065	2264	943	1015	77	36	30
12223	10	542	2185	823	1216	242	325	38	28

SCOLTR_IV+VI

1989	2000								
1	1	0	1						
2	10								
623326	405	1785	580	191	312	55	17	7	18
585390	975	2619	1047	333	94	105	28	13	8
617957	567	1184	925	263	123	67	67	27	14
663243	506	557	757	224	49	24	12	20	6
636989	939	692	265	246	121	33	26	22	17
655279	503	758	534	184	150	52	15	10	12
617641	600	1088	309	283	115	56	23	10	8
660154	502	354	824	162	129	69	41	24	19
659054	385	890	494	876	132	76	30	22	11
570325	582	480	813	308	395	57	35	12	5
428743	667	361	215	434	101	137	36	31	10
345194	143	338	316	126	216	87	91	33	25

NORACU

1995	2000				
1	1	0.5	0.75		
3	7				
1	56244	4756	1214	174	161
1	21480	29698	6125	4593	1821
1	22585	16188	24939	3002	2472
1	15180	48295	13540	11194	1173
1	16933	21109	27036	4399	3590
1	34551	82338	14213	13842	3018

ENGGFS_IV

1977	2000		
1	1	0.5	0.75
2	3		
1	105	485	
1	72	57	
1	3	105	
1	19	180	
1	95	120	
1	697	2121	
1	4	547	
1	2715	4644	
1	211	2711	
1	319	1709	
1	25	225	
1	85	787	
1	69	178	
1	581	873	
1	203	426	
1	16	94	
1	183	1091	
1	35	123	
1	51	1366	
1	298	297	
1	104	450	
1	8	54	
1	7	87	
1	20	190	

SCOGFS_IV

1982	2000		
1	1	0.5	0.75
2	3		
1	680	1370	
1	500	370	
1	8390	26470	
1	50070	40140	
1	3160	43180	
1	170	1700	
1	350	1430	
1	290	1320	
1	3130	4010	
1	700	3180	
1	310	1840	
1	2010	7890	
1	810	1390	
1	270	13920	
1	1630	4050	
1	200	3670	
1	140	1860	
1	900	710	
1	380	1970	

Table 6.4.2.: Saithe in IV, VI and IIIa. Tuning diagnostics.

Lowestoft VPA Version 3.1

23/06/2001 9:33

Extended Survivors Analysis

SAITHE IN IV VI and IIIa : 1967 - 2000

CPUE data from file c:\wgnssk01\final\final.tun

Catch data for 34 years. 1967 to 2000. Ages 1 to 10.

Fleet	First year	Last year	First age	Last age	Alpha	Beta
FRATRB_IV	1990	2000	2	9	0	1
FRATRF_IV	1990	2000	2	9	0	1
NORTRL_IV	1980	2000	3	9	0	1
GER_OTB_IV	1995	2000	3	9	0	1

Time series weights :

Tapered time weighting applied
Power = 3 over 20 years

Catchability analysis :

Catchability dependent on stock size for ages < 3

Regression type = C
Minimum of 5 points used for regression
Survivor estimates shrunk to the population mean for ages < 3

Catchability independent of age for ages >= 7

Terminal population estimation :

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

S.E. of the mean to which the estimates are shrunk = 1.000

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

Prior weighting not applied

Tuning had not converged after 40 iterations

Total absolute residual between iterations
39 and 40 = .00024

Final year F values

Age	1	2	3	4	5	6	7	8	9
Iteration 39	0.0009	0.0224	0.0718	0.348	0.3478	0.3923	0.3048	0.259	0.4065
Iteration 40	0.0009	0.0224	0.0718	0.348	0.3478	0.3923	0.3048	0.2589	0.4065

Regression weights

0.751	0.82	0.877	0.921	0.954	0.976	0.99	0.997	1	1

Fishing mortalities

Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	0.002	0.002	0	0.001	0.001	0.003	0	0.001	0	0.001
2	0.12	0.039	0.085	0.031	0.034	0.044	0.131	0.037	0.053	0.022
3	0.458	0.247	0.323	0.239	0.136	0.116	0.097	0.154	0.124	0.072
4	0.769	0.728	0.491	0.682	0.563	0.301	0.303	0.298	0.318	0.348
5	0.619	0.926	0.619	0.663	0.579	0.542	0.404	0.456	0.454	0.348
6	0.527	0.594	0.609	0.477	0.405	0.695	0.32	0.392	0.449	0.392
7	0.539	0.447	0.667	0.372	0.935	0.715	0.543	0.328	0.457	0.305
8	0.565	0.437	1.145	0.295	0.498	0.574	0.524	0.514	0.69	0.259
9	0.609	0.701	1.525	1.344	1.107	0.281	0.418	0.637	0.932	0.406

Table 6.4.2.: Saithe in IV, VI and IIIa, continued.

XSA population numbers (Thousands)

YEAR	AGE 1	2	3	4	5	6	7	8	9
1991	2.36E+05	1.28E+05	1.39E+05	6.15E+04	1.79E+04	9.67E+03	4.55E+03	2.44E+03	8.88E+02
1992	1.69E+05	1.92E+05	9.28E+04	7.18E+04	2.33E+04	7.88E+03	4.68E+03	2.17E+03	1.14E+03
1993	3.56E+05	1.38E+05	1.52E+05	5.93E+04	2.84E+04	7.57E+03	3.56E+03	2.45E+03	1.15E+03
1994	1.73E+05	2.92E+05	1.04E+05	8.98E+04	2.97E+04	1.25E+04	3.37E+03	1.49E+03	6.38E+02
1995	2.79E+05	1.42E+05	2.32E+05	6.68E+04	3.72E+04	1.25E+04	6.36E+03	1.90E+03	9.11E+02
1996	1.37E+05	2.29E+05	1.12E+05	1.65E+05	3.11E+04	1.71E+04	6.84E+03	2.04E+03	9.46E+02
1997	1.38E+05	1.12E+05	1.79E+05	8.17E+04	1.00E+05	1.48E+04	6.97E+03	2.74E+03	9.43E+02
1998	1.75E+05	1.13E+05	8.02E+04	1.33E+05	4.94E+04	5.48E+04	8.82E+03	3.32E+03	1.33E+03
1999	1.60E+05	1.43E+05	8.92E+04	5.63E+04	8.09E+04	2.56E+04	3.03E+04	5.20E+03	1.62E+03
2000	1.87E+05	1.31E+05	1.11E+05	6.45E+04	3.36E+04	4.21E+04	1.34E+04	1.57E+04	2.14E+03

Estimated population abundance at 1st Jan 2001

0.00E+00	1.53E+05	1.05E+05	8.46E+04	3.73E+04	1.94E+04	2.33E+04	8.09E+03	9.93E+03

Taper weighted geometric mean of the VPA populations:

1.90E+05	1.57E+05	1.23E+05	7.92E+04	3.69E+04	1.58E+04	6.70E+03	2.86E+03	1.10E+03

Standard error of the weighted Log(VPA populations) :

0.3056	0.3306	0.3678	0.402	0.5024	0.6278	0.6151	0.6313	0.358

Log catchability residuals.

Fleet : FRATRB_IV

Age	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
2	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	0.1
3	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	0.55
4	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	0.29
5	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	0.09
6	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	-0.17
7	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	1.04
8	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	-0.05
9	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	0.1

Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
2	0.2	1.23	2.55	0.11	-0.64	-1.27	-0.56	-0.75	-0.68	0.27
3	-0.13	0.17	0.88	0.36	0.07	-0.57	-0.63	-0.15	-0.28	0.03
4	0.36	0.3	0.27	0.36	-0.18	-0.38	-0.25	-0.51	-0.43	0.44
5	0.06	0.2	0.18	0.26	-0.42	-0.23	-0.12	0.03	-0.18	0.22
6	0.43	-0.29	-0.44	0.37	-0.34	0.24	-0.59	0.14	-0.02	0.63
7	0.81	-0.28	-1.52	-0.12	0.07	0.22	0.11	-0.74	0.04	0.68
8	0.79	-0.75	-0.91	-1.33	0.02	-0.11	-0.59	-0.5	-0.9	0.33
9	0.08	-0.2	-0.35	-0.72	0.41	0.05	0.25	-0.33	-0.2	0.66

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

Age	3	4	5	6	7	8	9
Mean Log q	-13.7967	-12.7303	-12.5073	-12.9831	-13.6461	-13.6461	-13.6461
S.E(Log q)	0.4563	0.3782	0.2238	0.4036	0.7027	0.7332	0.3998

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
2	1.78	-0.635	18.74	0.08	11	1.14	-15.76

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

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
3	0.94	0.125	13.68	0.37	11	0.46	-13.8
4	2.03	-1.727	14.24	0.26	11	0.69	-12.73
5	1.23	-1.403	12.96	0.82	11	0.26	-12.51
6	0.77	1.569	12.24	0.86	11	0.29	-12.98
7	0.79	0.733	12.63	0.6	11	0.57	-13.65
8	0.78	0.91	12.73	0.69	11	0.48	-14.03
9	0.7	1.133	11.69	0.65	11	0.28	-13.67

Table 6.4.2.: Saithe in IV, VI and IIIa, continued.

Fleet : FRATRF_IV

Age		1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
	2	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	0.35
	3	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	0.83
	4	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	0.51
	5	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	0.37
	6	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	0.09
	7	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	1.32
	8	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	0.22
	9	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	0.23

Age		1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
	2	-0.61	1.33	1.92	-0.23	-1.28	-0.61	0.21	-0.31	-0.02	-0.41
	3	-0.42	0.38	0.78	0.26	-0.2	-0.6	-0.42	0	-0.24	-0.04
	4	0.23	0.45	0.19	0.16	-0.36	-0.44	-0.04	-0.31	-0.46	0.4
	5	0.01	0.33	-0.14	0.07	-0.34	-0.41	0.06	0.21	-0.16	0.14
	6	0.43	-0.06	-1.12	0.22	-0.09	0.2	-0.66	0.35	0.01	0.63
	7	0.74	-0.09	-2.1	-0.23	0.41	0.22	0.03	-0.51	0.04	0.51
	8	0.73	-0.24	-1.53	-1.06	0.44	-0.05	-0.47	-0.36	-0.89	0.14
	9	-0.05	-0.17	-0.63	-0.87	0.74	0	-0.01	-0.24	-0.18	0.44

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

Age	3	4	5	6	7	8	9
Mean Log q	-13.8979	-12.8067	-12.7075	-13.2958	-13.9801	-13.9801	-13.9801
S.E(Log q)	0.4657	0.3678	0.2521	0.5048	0.8336	0.7404	0.4622

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
2	1.54	-0.523	17.92	0.1	11	0.96	-15.82

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

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
3	1.23	-0.37	14.39	0.25	11	0.6	-13.9
4	1.94	-1.686	14.26	0.29	11	0.65	-12.81
5	1.07	-0.393	12.86	0.8	11	0.28	-12.71
6	0.71	1.865	12.24	0.83	11	0.32	-13.3
7	0.75	0.775	12.69	0.54	11	0.64	-13.98
8	0.92	0.261	13.76	0.55	11	0.65	-14.28
9	0.74	0.782	12.24	0.54	11	0.35	-14.05

Fleet : NORTRL_IV

Age		1980
	2	No data for this fleet at this age
	3	99.99
	4	99.99
	5	99.99
	6	99.99
	7	99.99
	8	99.99
	9	99.99

Age		1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
	2	No data for this fleet at this age									
	3	-3.73	0.61	0.19	1.19	0.75	-0.84	0.12	0.76	-0.39	-0.02
	4	-1.32	-0.2	-0.34	-0.11	0.48	0.75	0.4	-0.35	-0.23	-0.33
	5	-0.86	-0.38	-0.04	-0.83	-0.19	-0.27	-0.11	-0.44	-0.65	0.12
	6	-0.65	-0.18	0.39	0.09	-0.58	-0.84	-1.01	-1.26	-0.23	0.49
	7	-0.23	-0.99	0.75	-0.48	-1.15	-1.28	-0.77	-0.51	0.18	-0.03
	8	0.1	-1.04	0.43	0.06	-2.1	-1.94	-0.55	-0.59	0.38	-0.1
	9	-0.27	-3.14	0.39	-0.05	-1.67	-1.93	-0.02	0.41	0.32	-0.82

Age		1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
	2	No data for this fleet at this age									
	3	1.68	0.34	1.05	0.51	-0.3	0.06	-0.57	-0.1	-0.61	-1.68
	4	0.18	0.45	0.04	0.88	0.52	-0.29	-0.48	-0.13	-0.27	-0.59
	5	-0.39	0.47	0.18	0.33	0.25	-0.01	-0.33	0.2	0.09	0.01
	6	-0.49	0.27	0.62	-0.26	-0.45	0.35	-0.23	0.26	0.34	0.69
	7	-0.85	-0.3	0.56	-0.47	0.96	0.21	-0.02	0.13	0.42	0.24
	8	-1.59	-0.57	0.77	-0.94	0.18	-0.44	-0.18	0.5	1.17	0.18
	9	-0.47	-0.22	1.3	1.38	0.88	-2.27	-0.59	0.77	1.21	0.54

Table 6.4.2.: Saithe in IV, VI and IIIa, continued.

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

Age	3	4	5	6	7	8	9
Mean Log q	-13.9019	-12.5169	-12.2003	-12.3578	-12.1835	-12.1835	-12.1835
S.E(Log q)	0.8458	0.4594	0.3166	0.5451	0.5569	0.8356	1.1364

Regression statistics :

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

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
3	0.85	0.245	13.57	0.21	20	0.75	-13.9
4	0.85	0.507	12.33	0.52	20	0.4	-12.52
5	1.09	-0.43	12.36	0.68	20	0.36	-12.2
6	0.75	1.352	11.67	0.74	20	0.39	-12.36
7	0.77	1.13	11.4	0.7	20	0.42	-12.18
8	0.7	1.087	11.03	0.57	20	0.57	-12.33
9	0.59	0.703	10.02	0.23	20	0.69	-12.07

Fleet : GER_OTB_IV

Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
2	No data for this fleet at this age									
3	99.99	99.99	99.99	99.99	-0.08	-0.08	-0.22	0.36	-0.41	0.41
4	99.99	99.99	99.99	99.99	0.29	-0.34	-0.01	-0.32	-0.32	0.7
5	99.99	99.99	99.99	99.99	0.08	0.12	-0.03	-0.18	-0.11	0.13
6	99.99	99.99	99.99	99.99	0.25	0.05	-0.68	-0.08	0.16	0.31
7	99.99	99.99	99.99	99.99	-0.07	0.4	-0.28	-0.16	0.19	-0.07
8	99.99	99.99	99.99	99.99	-0.67	0.99	-0.2	0.03	-0.52	0.04
9	99.99	99.99	99.99	99.99	-0.31	0.35	-0.25	0.06	-0.02	-0.04

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

Age	3	4	5	6	7	8	9
Mean Log q	-15.0143	-13.2336	-12.9873	-12.9828	-13.1102	-13.1102	-13.1102
S.E(Log q)	0.328	0.4237	0.1288	0.3633	0.2488	0.5885	0.2373

Regression statistics :

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

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
3	1.3	-0.59	15.99	0.5	6	0.46	-15.01
4	2.11	-1.275	15.3	0.25	6	0.84	-13.23
5	1.2	-1.654	13.43	0.94	6	0.13	-12.99
6	0.86	0.528	12.59	0.79	6	0.34	-12.98
7	0.9	0.549	12.73	0.89	6	0.24	-13.11
8	1.07	-0.175	13.51	0.62	6	0.7	-13.16
9	0.93	0.231	12.71	0.73	6	0.24	-13.14

Terminal year survivor and F summaries :

Age 1 Catchability dependent on age and year class strength

Year class = 1999

Fleet	Es Su	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FRATRB_IV	1	0	0	0	0	0	0
FRATRF_IV	1	0	0	0	0	0	0
NORTRL_IV	1	0	0	0	0	0	0
GER_OTB_IV	1	0	0	0	0	0	0
P shrinkage mean	157062	0.33				0.901	0.001
F shrinkage mean	118501	1				0.099	0.001

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
152762	0.31	11.94	2	38.025	0.001

Table 6.4.2.: Saithe in IV, VI and IIIa, continued.

Age 2 Catchability dependent on age and year class strength

Year class = 1998

Fleet	Es Su	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FRATRB_IV	137331	1.198	0	0	1	0.068	0.017
FRATRF_IV	69595	1.024	0	0	1	0.093	0.034
NORTRL_IV	1	0	0	0	0	0	0
GER_OTB_IV	1	0	0	0	0	0	0
P shrinkage mean	123357	0.37				0.739	0.019
F shrinkage mean	38380	1				0.1	0.06

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
104830	0.32	0.23	4	0.723	0.022

Age 3 Catchability constant w.r.t. time and dependent on age

Year class = 1997

Fleet	Es Su	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FRATRB_IV	79823	0.446	0.237	0.53	2	0.244	0.076
FRATRF_IV	81227	0.44	0.009	0.02	2	0.251	0.075
NORTRL_IV	15834	0.88	0	0	1	0.063	0.335
GER_OTB_IV	127967	0.355	0	0	1	0.389	0.048
F shrinkage mean	46894	1				0.053	0.126

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
84576	0.22	0.22	7	0.974	0.072

Age 4 Catchability constant w.r.t. time and dependent on age

Year class = 1996

Fleet	Es Su	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FRATRB_IV	42163	0.297	0.282	0.95	3	0.264	0.313
FRATRF_IV	42686	0.291	0.226	0.78	3	0.276	0.31
NORTRL_IV	20596	0.421	0.007	0.02	2	0.136	0.561
GER_OTB_IV	38789	0.281	0.543	1.93	2	0.29	0.336
F shrinkage mean	35945	1				0.035	0.359

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
37267	0.15	0.15	11	0.948	0.348

Age 5 Catchability constant w.r.t. time and dependent on age

Year class = 1995

Fleet	Es Su	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FRATRB_IV	19270	0.215	0.168	0.78	4	0.261	0.35
FRATRF_IV	18835	0.213	0.147	0.69	4	0.266	0.357
NORTRL_IV	18212	0.263	0.085	0.32	3	0.183	0.367
GER_OTB_IV	21651	0.209	0.157	0.75	3	0.271	0.317
F shrinkage mean	12738	1				0.02	0.491

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
19406	0.11	0.07	15	0.606	0.348

Table 6.4.2.: Saithe in IV, VI and IIIa, continued.

Age 6 Catchability constant w.r.t. time and dependent on age

Year class = 1994

Fleet	Es Su	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FRATRB_IV	22281	0.198	0.248	1.25	5	0.269	0.406
FRATRF_IV	22033	0.203	0.19	0.94	5	0.242	0.41
NORTRL_IV	27955	0.245	0.198	0.81	4	0.176	0.336
GER_OTB_IV	22999	0.192	0.138	0.72	4	0.291	0.396
F shrinkage mean	19367	1				0.022	0.455

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
23264	0.1	0.09	19	0.872	0.392

Age 7 Catchability constant w.r.t. time and dependent on age

Year class = 1993

Fleet	Es Su	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FRATRB_IV	8148	0.2	0.148	0.74	6	0.22	0.303
FRATRF_IV	8582	0.207	0.148	0.71	6	0.191	0.29
NORTRL_IV	9375	0.242	0.122	0.5	5	0.174	0.268
GER_OTB_IV	7697	0.175	0.053	0.3	5	0.392	0.318
F shrinkage mean	3500	1				0.023	0.601

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
8089	0.1	0.06	23	0.593	0.305

Age 8 Catchability constant w.r.t. time and age (fixed at the value for age) 7

Year class = 1992

Fleet	Es Su	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FRATRB_IV	10042	0.207	0.086	0.42	7	0.223	0.256
FRATRF_IV	10143	0.217	0.098	0.45	7	0.199	0.254
NORTRL_IV	10178	0.244	0.143	0.59	6	0.175	0.253
GER_OTB_IV	10339	0.173	0.065	0.38	6	0.376	0.25
F shrinkage mean	3868	1				0.027	0.565

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
9934	0.1	0.05	27	0.51	0.259

Age 9 Catchability constant w.r.t. time and age (fixed at the value for age) 7

Year class = 1991

Fleet	Es Su	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FRATRB_IV	1309	0.239	0.231	0.97	8	0.238	0.369
FRATRF_IV	1106	0.258	0.199	0.77	8	0.192	0.424
NORTRL_IV	1512	0.271	0.176	0.65	7	0.108	0.327
GER_OTB_IV	1024	0.186	0.098	0.53	6	0.429	0.451
F shrinkage mean	1545	1				0.032	0.321

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
1164	0.12	0.08	30	0.71	0.406

Table 6.4.3.: Saithe in IV, VI and IIIa. Fishing mortality (F) at age

YEAR	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976
AGE										
1	0	0.0004	0.0001	0.001	0.0025	0.0017	0.0174	0.0078	0.0017	0.0019
2	0.068	0.0115	0.0065	0.0062	0.0572	0.132	0.2072	0.0916	0.1613	0.2326
3	0.1628	0.2548	0.1178	0.1521	0.2683	0.3712	0.4991	0.6881	0.4271	0.9122
4	0.2632	0.3074	0.3145	0.4897	0.3729	0.4398	0.5629	0.6751	0.6296	0.9313
5	0.3782	0.3551	0.2599	0.4828	0.3998	0.2768	0.3203	0.4244	0.4465	0.6622
6	0.4836	0.2455	0.3574	0.507	0.2735	0.4926	0.2838	0.4390	0.4246	0.5389
7	0.4162	0.1524	0.3913	0.3127	0.3320	0.3538	0.3696	0.4558	0.5876	0.4148
8	0.2603	0.1004	0.4639	0.2017	0.3966	0.4054	0.3318	0.4107	0.5977	0.4837
9	0.3893	0.1668	0.4070	0.3426	0.3361	0.4202	0.3304	0.4383	0.5410	0.4828
+gp	0.3893	0.1668	0.4070	0.3426	0.3361	0.4202	0.3304	0.4383	0.5410	0.4828
FBAR 3- 6	0.322	0.2907	0.2624	0.4079	0.3286	0.3951	0.4165	0.5566	0.4819	0.7612

YEAR	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
AGE										
1	0.0167	0.0112	0.0035	0.0076	0.0276	0.0061	0.0007	0.0005	0.0015	0.0017
2	0.1297	0.2161	0.2169	0.1199	0.1579	0.2045	0.1504	0.1032	0.0293	0.057
3	0.2978	0.5443	0.2668	0.3446	0.1851	0.3899	0.3076	0.5723	0.6466	0.2405
4	0.6564	0.546	0.4437	0.3316	0.2738	0.4863	0.4719	0.6952	1.0443	1.4097
5	0.7389	0.4658	0.4523	0.5665	0.3042	0.5505	0.6739	0.6222	0.7059	0.9526
6	0.7731	0.3563	0.4293	0.5441	0.4773	0.4865	0.8094	0.8858	0.4904	0.7083
7	0.7483	0.3499	0.585	0.5551	0.5771	0.5726	0.9848	0.5875	0.514	0.549
8	0.7857	0.465	0.4	0.5074	0.7853	0.5376	1.0716	0.7424	0.5136	0.5071
9	0.7767	0.393	0.475	0.5399	0.6188	0.5474	0.9660	0.7470	0.5590	0.7677
+gp	0.7767	0.393	0.475	0.5399	0.6188	0.5474	0.9660	0.7470	0.5590	0.7677
FBAR 3- 6	0.6165	0.4781	0.398	0.4467	0.3101	0.4783	0.5657	0.6939	0.7218	0.8278

YEAR	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
AGE										
1	0.0068	0.0002	0.0187	0.0025	0.0023	0.0021	0.0005	0.0007	0.0006	0.0029
2	0.2204	0.0973	0.0716	0.0369	0.1202	0.0391	0.0846	0.0309	0.0345	0.0443
3	0.3702	0.3803	0.3788	0.4701	0.4581	0.2475	0.3228	0.2393	0.1361	0.1157
4	0.8769	0.6215	0.7626	0.6889	0.7692	0.7284	0.4912	0.6821	0.5633	0.3005
5	0.8668	0.9707	0.7457	0.7223	0.6195	0.9261	0.6186	0.6633	0.5794	0.5417
6	0.5183	0.6179	0.9700	0.6611	0.5267	0.5944	0.6094	0.4772	0.4048	0.6951
7	0.551	0.6958	0.5530	0.7074	0.5391	0.4465	0.6674	0.3721	0.9348	0.7147
8	0.5544	0.7921	0.6455	0.5648	0.5649	0.4366	1.1447	0.2953	0.4976	0.5739
9	0.7016	0.836	0.8209	0.5471	0.6093	0.7011	1.5252	1.3443	1.1068	0.281
+gp	0.7016	0.836	0.8209	0.5471	0.6093	0.7011	1.5252	1.3443	1.1068	0.281
FBAR 3- 6	0.6581	0.6476	0.7143	0.6356	0.5934	0.6241	0.5105	0.5154	0.4209	0.4133

YEAR	1997	1998	1999	2000	FBAR 98-**
AGE					
1	0.0002	0.0014	0.0004	0.0009	0.0009
2	0.1308	0.0369	0.0527	0.0224	0.0373
3	0.0974	0.154	0.1243	0.0718	0.1167
4	0.3027	0.2979	0.3178	0.348	0.3212
5	0.4043	0.456	0.4537	0.3478	0.4191
6	0.3201	0.3918	0.4489	0.3923	0.4110
7	0.5426	0.328	0.4573	0.3048	0.3633
8	0.5242	0.514	0.6902	0.2589	0.4877
9	0.4178	0.6374	0.9324	0.4065	0.6588
+gp	0.4178	0.6374	0.9324	0.4065	
FBAR 3- 6	0.2811	0.3249	0.3362	0.29	

Table 6.4.4.: Saithe in IV, VI and IIIa. Stock number at age (start of year) Numbers*10**-3

YEAR	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976
AGE										
1	453724	438349	492253	270937	260820	273390	301413	678081	222200	157062
2	149186	371478	358732	402990	221612	213004	223444	242516	550865	181619
3	127452	114109	300673	291806	327894	171347	152828	148709	181177	383843
4	77468	88668	72412	218812	205207	205292	96787	75963	61184	96771
5	54510	48749	53385	43287	109782	115716	108274	45132	31665	26690
6	6638	30576	27982	33703	21869	60260	71833	64353	24172	16588
7	5176	3351	19584	16025	16620	13620	30148	44279	33968	12944
8	1407	2795	2355	10842	9597	9763	7828	17057	22982	15453
9	680	888	2070	1213	7256	5285	5329	4599	9261	10350
+gp	621	1041	490	1008	2974	5131	9286	6035	7032	9975
TOTAL	876862	1100004	1329937	1290623	1183630	1072808	1007168	1326724	1144508	911296

YEAR	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
AGE										
1	145115	124292	288935	192200	221811	358101	514839	440479	176369	212003
2	128347	116844	100628	235731	156164	176666	291406	421232	360447	144190
3	117833	92300	77069	66321	171193	109177	117886	205263	311046	286590
4	126218	71625	43847	48321	38470	116475	60527	70962	94823	133393
5	31219	53602	33967	23035	28396	23951	58637	30912	28989	27322
6	11269	12209	27543	17692	10703	17150	11309	24470	13585	11717
7	7923	4259	6999	14679	8406	5437	8632	4121	8262	6811
8	7000	3070	2457	3193	6898	3865	2511	2640	1875	4046
9	7800	2612	1579	1349	1574	2575	1848	704	1029	919
+gp	9482	11749	6046	6033	6004	3254	2327	1338	1893	1829
TOTAL	592205	492563	589071	608554	649619	816652	1069922	1202121	998318	828818

YEAR	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
AGE										
1	128388	192736	218706	156469	235616	168651	356442	173023	279477	136828
2	173282	104402	157770	175746	127785	192460	137791	291686	141563	228674
3	111513	113806	77550	120240	138673	92776	151530	103659	231544	111977
4	184481	63051	63699	43470	61520	71808	59306	89838	66810	165445
5	26671	62845	27727	24327	17871	23339	28376	29710	37185	31143
6	8628	9177	19491	10769	9672	7875	7569	12515	12531	17056
7	4724	4207	4050	6049	4552	4676	3559	3369	6358	6845
8	3220	2229	1718	1908	2441	2174	2450	1495	1901	2044
9	1995	1515	827	737	888	1136	1150	638	911	946
+gp	1513	1306	949	944	1096	913	1412	1160	1295	2201
TOTAL	644416	555274	572486	540660	600114	565809	749585	707093	779575	703160

YEAR	1997	1998	1999	2000	2001	GMST 67-98	GMST 89-98
AGE							
1	138034	174760	159995	186738	***0****	241288	194470
2	111706	112988	142884	130935	***152762****	196889	160293
3	179113	80241	89153	110981	***104830****	147005	121519
4	81666	133040	56319	64461	84576	86149	77510
5	100293	49400	80859	33558	37267	39165	32612
6	14833	54808	25636	42057	19406	17431	13868
7	6968	8818	30326	13398	23264	7990	5276
8	2742	3316	5201	15717	8089	3708	2164
9	943	1329	1624	2135	9934	1733	931
+gp	926	642	1178	1765	2127		
TOTAL	637223	619341	593175	601746	442254		

*** overwritten by GM (89-98) in the prediction**

Table 6.4.5.: Saithe in IV, VI and IIIa. Summary (without SOP correction)

Terminal Fs derived using XSA (With F shrinkage)

	RECRUITS Age 1	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	FBAR 3- 6
1967	453724	703777	150833	94514	0.6266	0.322
1968	438349	1025897	211714	116789	0.5516	0.2907
1969	492253	1134448	263945	131882	0.4997	0.2624
1970	270937	1288398	311985	236636	0.7585	0.4079
1971	260820	1282496	429523	272481	0.6344	0.3286
1972	273390	1110115	474019	275098	0.5804	0.3951
1973	301413	993118	534364	259602	0.4858	0.4165
1974	678081	1143438	554727	309439	0.5578	0.5566
1975	222200	1067665	471828	308926	0.6547	0.4819
1976	157062	917427	351239	361680	1.0297	0.7612
1977	145115	625623	262744	223395	0.8502	0.6165
1978	124292	567035	267277	166199	0.6218	0.4781
1979	288935	583595	239979	135967	0.5666	0.398
1980	192200	542493	233565	142395	0.6097	0.4467
1981	221811	643936	238349	146092	0.6129	0.3101
1982	358101	684466	206218	189861	0.9207	0.4783
1983	514839	811675	209086	197774	0.9459	0.5657
1984	440479	840697	170172	219642	1.2907	0.6939
1985	176369	706949	151686	226129	1.4908	0.7218
1986	212003	688652	142255	202758	1.4253	0.8278
1987	128388	494374	144467	180776	1.2513	0.6581
1988	192736	478844	142808	140778	0.9858	0.6476
1989	218706	459402	110296	117609	1.0663	0.7143
1990	156469	423633	98015	107945	1.1013	0.6356
1991	235616	458376	92269	115576	1.2526	0.5934
1992	168651	494753	94091	104147	1.1069	0.6241
1993	356442	547668	100674	119073	1.1828	0.5105
1994	173023	562595	108963	115255	1.0577	0.5154
1995	279477	712680	135806	125183	0.9218	0.4209
1996	136828	610342	159236	119669	0.7515	0.4133
1997	138034	599105	201705	112740	0.5589	0.2811
1998	174760	594432	203613	108699	0.5338	0.3249
1999	**194470***	553246	222837	114655	0.5145	0.3362
2000	**194470***	625922	217544	93340	0.4291	0.29
2001	**194470***	664000	232000			
Arith. Mean	262595	734626	232583	173315	0.8361	0.4919
Units	(Thousands	(Tonnes)	(Tonnes)	(Tonnes)		

*** GM (89-98)**

Table 6.7.1.: Saithe in IIIa, IV and VIa. Input data for catch forecast and linear sensitivity analysis.

Label	Value	CV	Label	Value	CV
Number at age			Weight in the stock		
N1	194469	0.31	WS1	0.56	0.07
N2	159075	0.31	WS2	0.68	0.16
N3	127419	0.31	WS3	0.93	0.09
N4	84576	0.22	WS4	1.05	0.08
N5	37267	0.15	WS5	1.38	0.12
N6	19405	0.11	WS6	1.73	0.02
N7	23264	0.10	WS7	2.63	0.12
N8	8089	0.10	WS8	3.49	0.11
N9	9933	0.10	WS9	4.86	0.03
N10	2126	0.12	WS10	7.17	0.06
H.cons selectivity			Weight in the HC catch		
sH1	0.00	0.55	WH1	0.56	0.07
sH2	0.03	0.34	WH2	0.68	0.15
sH3	0.11	0.31	WH3	0.92	0.07
sH4	0.29	0.15	WH4	1.04	0.06
sH5	0.38	0.08	WH5	1.38	0.11
sH6	0.38	0.06	WH6	1.73	0.02
sH7	0.33	0.17	WH7	2.62	0.12
sH8	0.45	0.39	WH8	3.47	0.12
sH9	0.60	0.34	WH9	4.81	0.04
sH10	0.60	0.34	WH10	7.01	0.03
Natural mortality			Proportion mature		
M1	0.20	0.10	MT1	0.00	0.00
M2	0.20	0.10	MT2	0.00	0.00
M3	0.20	0.10	MT3	0.00	0.10
M4	0.20	0.10	MT4	0.15	0.10
M5	0.20	0.10	MT5	0.70	0.10
M6	0.20	0.10	MT6	0.90	0.10
M7	0.20	0.10	MT7	1.00	0.10
M8	0.20	0.10	MT8	1.00	0.00
M9	0.20	0.10	MT9	1.00	0.00
M10	0.20	0.10	MT10	1.00	0.00
Relative effort in HC fishery			Year effect for natural mortality		
HF01	1.00	0.08	K01	1.00	0.10
HF02	1.00	0.08	K02	1.00	0.10
HF03	1.00	0.08	K03	1.00	0.10

Recruitment in 2002 and 2003

R02	194470	0.31
R03	194470	0.31

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

Stock numbers in 2001 are VPA survivors.
These are overwritten at Age 2 Age 3

Table 6.7.2.: Saithe,IIIa, IV and VIa. Catch forecast output at *Status Quo* and estimates of coefficient of variation (CV) from linear analysis.

	Year 2001	2002						
Mean F Ages								
H.cons 3 to 6	0.29	0.12	0.17	0.23	0.29	0.35	0.40	0.44
Effort relative to 2000								
H.cons	1.00	0.40	0.60	0.80	1.00	1.20	1.38	1.50
Biomass								
Total 1 January	664	677	677	677	677	677	677	677
SSB at spawning time	232	233	233	233	233	233	233	233
Catch weight (,000t)								
H.cons	110	51	74	95	115	133	148	158
Biomass in year.... 2003								
Total 1 January		754	728	703	680	659	641	630
SSB at spawning time		294	272	252	234	217	203	194

Forecast for year 2001
F multiplier H.cons=1.00

	Populations	Catch number	
Age	Stock No.	H.Cons	Total
1	194469	176	176
2	159075	4822	4822
3	127419	11740	11740
4	84576	19621	19621
5	37267	10816	10816
6	19405	5546	5546
7	23264	5990	5990
8	8089	2658	2658
9	9933	4118	4118
10	2126	881	881
Wt	664	110	110

Forecast for year 2002
F multiplier H.cons=1.00

	Populations	Catch number	
Age	Stock No.	H.Cons	Total
1	194470	176	176
2	159059	4822	4822
3	125886	11598	11598
4	93736	21747	21747
5	51607	14978	14978
6	20803	5946	5946
7	10908	2809	2809
8	13666	4490	4490
9	4240	1757	1757
10	5402	2239	2239
Wt	677	115	115

Table 6.7.3 Saithe IIIa, IV and Via
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

			1997	1998	1999	2000	2001
Year-class			1997	1998	1999	2000	2001
Stock No. (thousands) of 1 year-olds			174760	194470	194470	194470	194470
Source			VPA	GM	GM	GM	GM
Status Quo F:							
% in	2001	landings	18.6	9.9	3.0	0.1	-
% in	2002		17.9	19.8	9.4	2.8	0.1
% in	2001	SSB	5.7	0.0	0.0	0.0	-
% in	2002	SSB	21.4	6.4	0.0	0.0	0.0
% in	2003	SSB	20.7	25.6	6.8	0.0	0.0

GM : geometric mean recruitment

Saithe IIIa, IV and Via : Year-class % contribution to

a) 2002 landings **b) 2003 SSB**

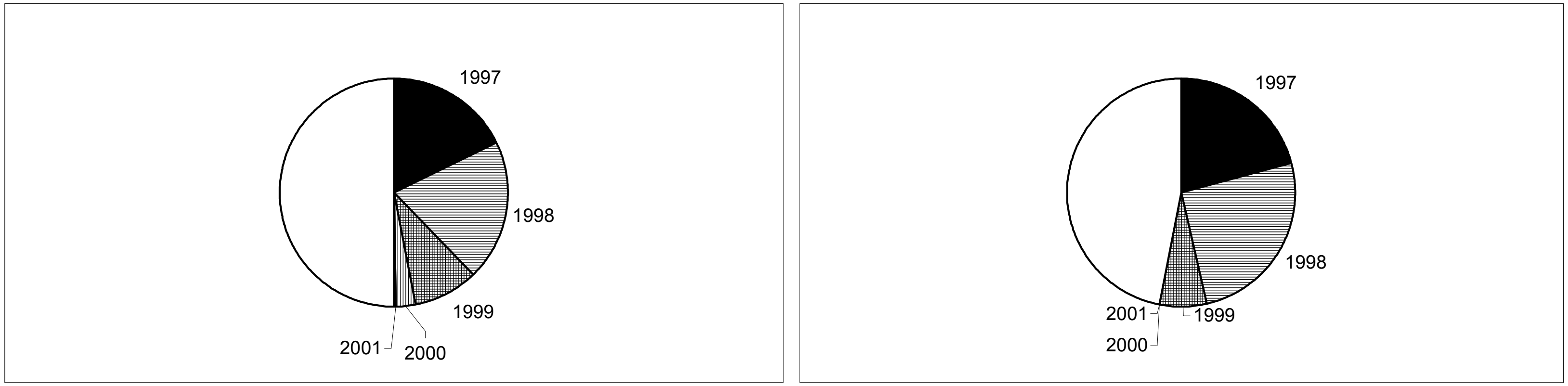


Table 6.8.1.: Saithe in IIIa, IV and VIa. Results of fitting a Ricker stock recruit model

```
Data read from file sai46.rec

Ricker curve
Moving average term NOT fitted
IFAIL on exit from E04FDF =,   5
Residual sum of squares=,    6.1289
Number of observations=,  31
Number of parameters  =,   2
Residual mean square  =,     .2113
Coefficient of determination =,    -.0228
Adj. coeff. of determination =,    -.0581
IFAIL from E04YCF=,  0
Parameter  Correlation matrix
,  1.0000,
,   .8721,  1.0000,
 Parameter,s.d.

   2.4060,     .4060,
    .0031,     .0006,


Y/Class,SSB,Recruits,Fit. rct,residuals,residuals,wt
      1967,    150.80,    438.00,    227.12,     .6568,     .6568,    1.0000
      1968,    211.70,    492.00,    263.88,     .6230,     .6230,    1.0000
      1969,    263.90,    271.00,    279.71,    -.0316,    -.0316,    1.0000
      1970,    312.00,    261.00,    284.79,    -.0872,    -.0872,    1.0000
      1971,    429.50,    273.00,    272.16,     .0031,     .0031,    1.0000
      1972,    474.00,    301.00,    261.58,     .1404,     .1404,    1.0000
      1973,    534.40,    678.00,    244.46,    1.0201,    1.0201,    1.0000
      1974,    554.70,    222.00,    238.24,    -.0706,    -.0706,    1.0000
      1975,    471.80,    157.00,    262.15,    -.5127,    -.5127,    1.0000
      1976,    351.20,    145.00,    283.82,    -.6716,    -.6716,    1.0000
      1977,    262.70,    124.00,    279.48,    -.8126,    -.8126,    1.0000
      1978,    267.30,    289.00,    280.33,     .0304,     .0304,    1.0000
      1979,    240.00,    192.00,    273.98,    -.3556,    -.3556,    1.0000
      1980,    233.60,    222.00,    272.03,    -.2032,    -.2032,    1.0000
      1981,    238.40,    358.00,    273.51,     .2692,     .2692,    1.0000
      1982,    206.20,    515.00,    261.45,     .6779,     .6779,    1.0000
      1983,    209.10,    440.00,    262.75,     .5156,     .5156,    1.0000
      1984,    170.20,    176.00,    241.34,    -.3157,    -.3157,    1.0000
      1985,    151.70,    212.00,    227.83,    -.0720,    -.0720,    1.0000
      1986,    142.30,    128.00,    220.05,    -.5418,    -.5418,    1.0000
      1987,    144.50,    193.00,    221.93,    -.1397,    -.1397,    1.0000
      1988,    142.80,    219.00,    220.48,    -.0067,    -.0067,    1.0000
      1989,    110.30,    156.00,    188.39,    -.1887,    -.1887,    1.0000
      1990,     98.00,    236.00,    173.90,     .3053,     .3053,    1.0000
      1991,     92.30,    169.00,    166.71,     .0136,     .0136,    1.0000
      1992,     94.10,    356.00,    169.02,     .7449,     .7449,    1.0000
      1993,    100.70,    173.00,    177.20,    -.0240,    -.0240,    1.0000
      1994,    109.00,    279.00,    186.92,     .4005,     .4005,    1.0000
      1995,    135.80,    137.00,    214.28,    -.4473,    -.4473,    1.0000
      1996,    159.20,    138.00,    233.59,    -.5263,    -.5263,    1.0000
      1997,    201.70,    175.00,    259.35,    -.3934,    -.3934,    1.0000
```

Table 6.9.1.: Saithe, IIIa, IV and VIa. Input data for Catch Prediction.

Age	2001 Stock Numbers (10**-3)	F and mean Wt at age used in prediction: Scaled Mean F 1998 - 2000	Mean Wt. at age (kg) 1991 - 2000: Stock	Mean Wt. at age (kg) 1991 - 2000: Catch	M and maturity: M	M and maturity: P. mat
1	194470	.001	.464	.464	.200	.000
2	159075	.034	.638	.638	.200	.000
3	127419	.107	.927	.924	.200	.000
4	84576	.294	1.151	1.146	.200	.150
5	37267	.383	1.593	1.592	.200	.700
6	19406	.376	2.238	2.237	.200	.900
7	23264	.332	3.158	3.155	.200	1.000
8	8089	.446	4.178	4.172	.200	1.000
9	9934	.603	5.521	5.507	.200	1.000
10	2127	.603	7.711	7.662	.200	1.000

Mean F	(3 - 6)
Unscaled	.317
Scaled	.290

Recruits at age 1 in 2002 = 194470
Recruits at age 1 in 2003 = 194470

Stock numbers in 2001 are VPA survivors.
These are overwritten at Age 2 Age 3

6.1.1. Stock summary, Saithe ,IIIa, IV and VI

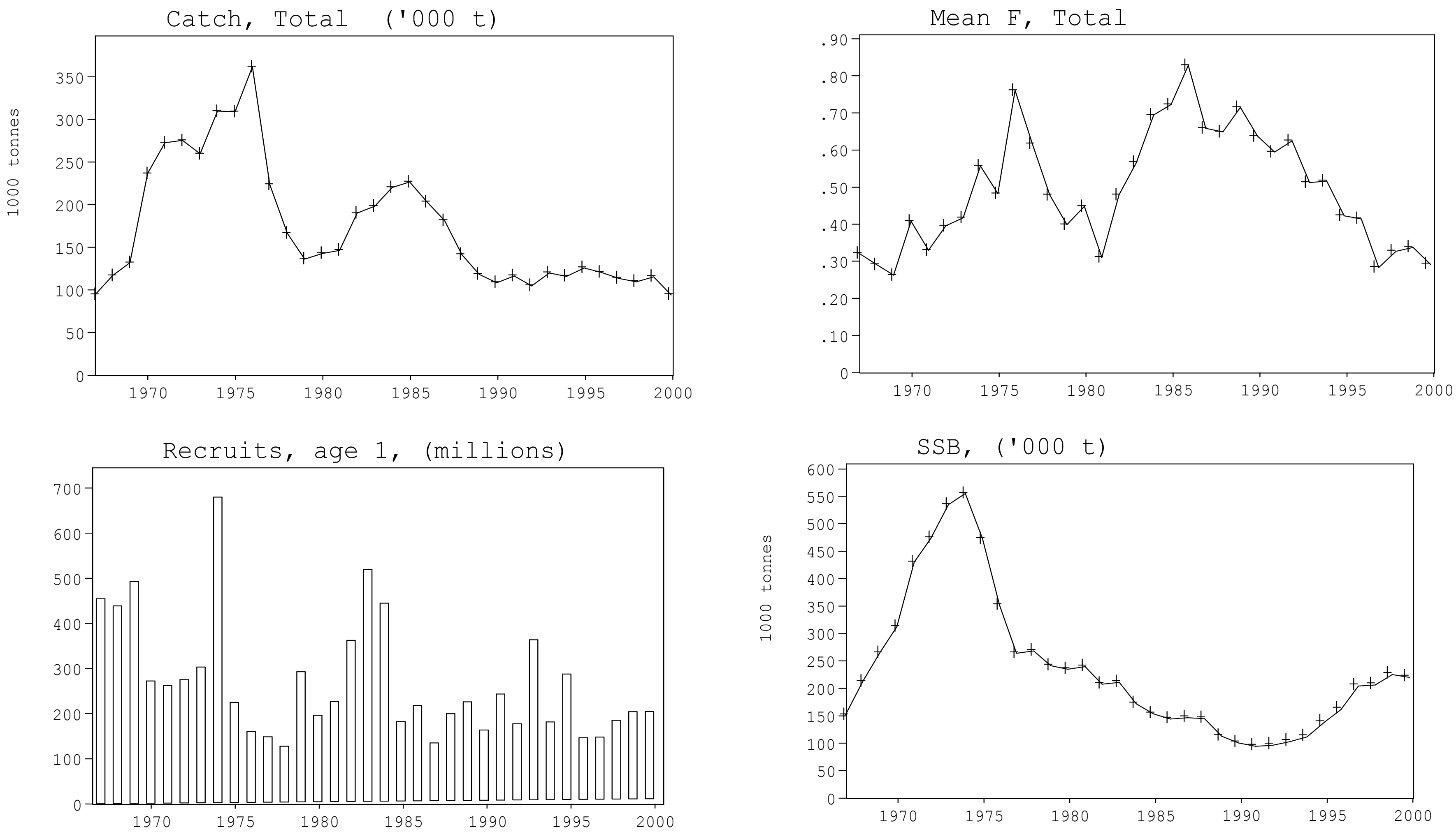
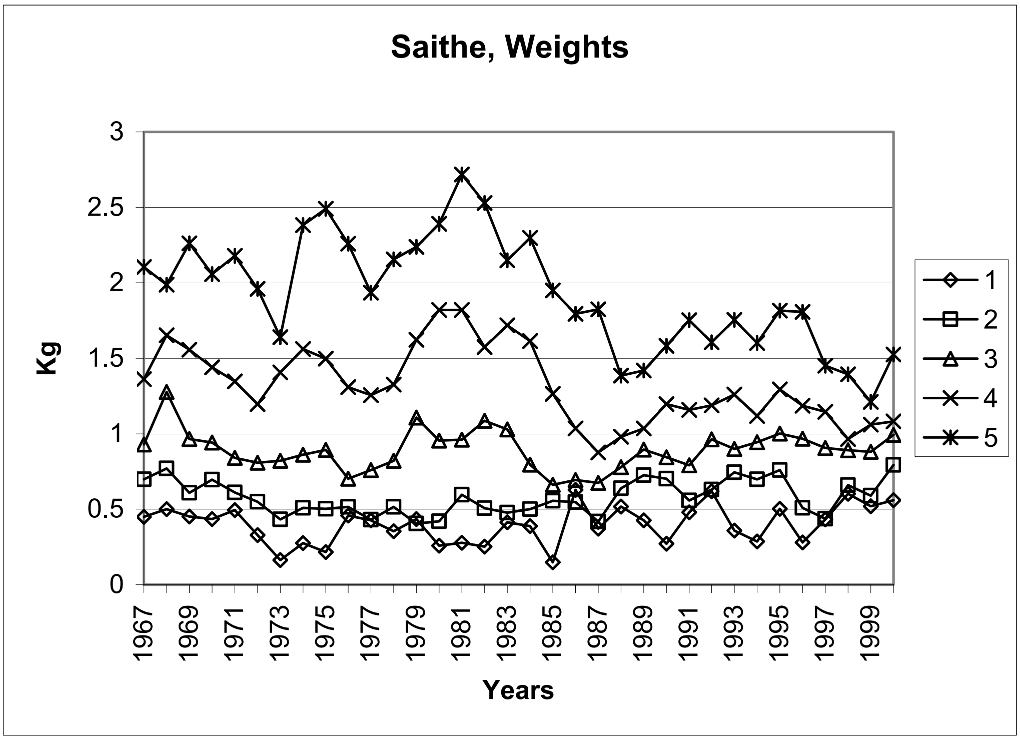


Figure 6.2.1 Saithe in IIIa, IV and Via. Mean weights at age.



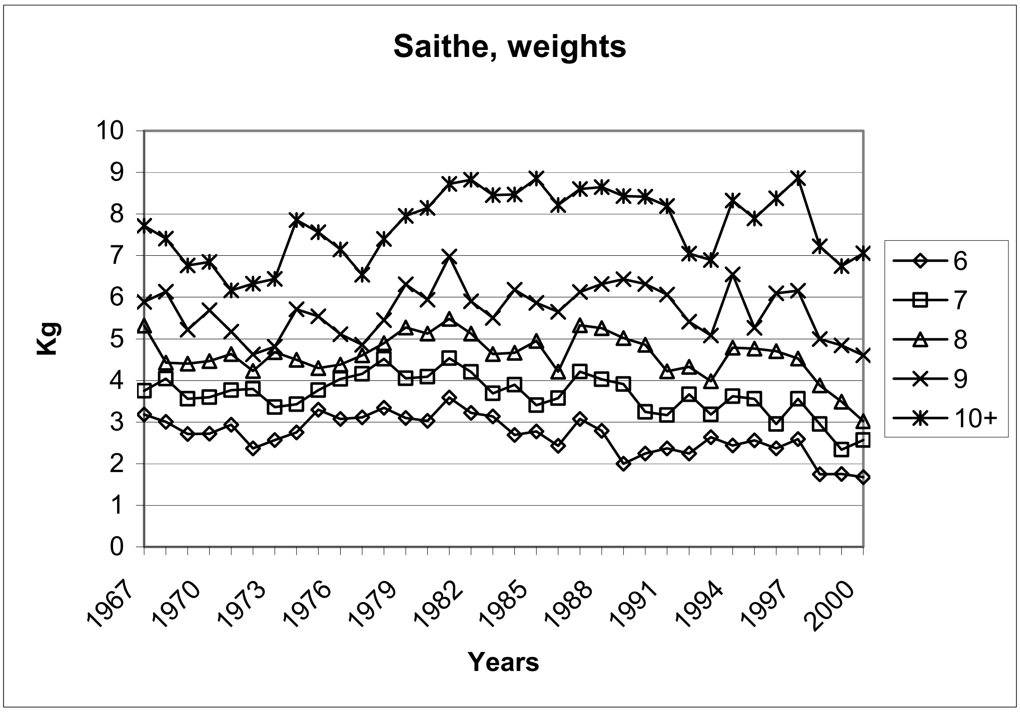
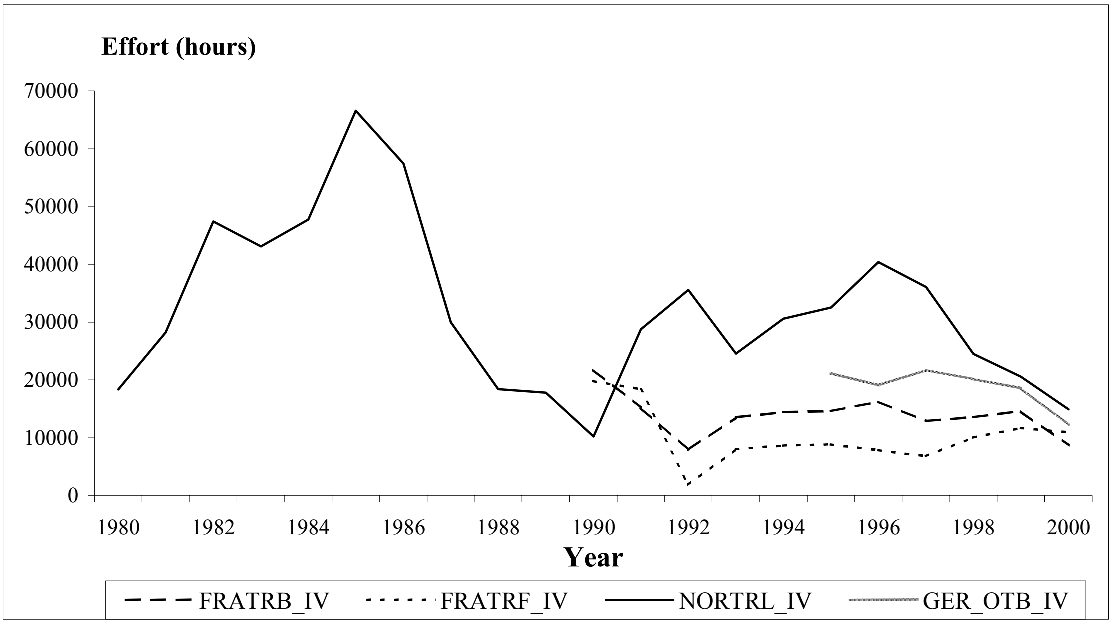


Figure 6.3.1.: Saithe in IV, VIa and III. Trends in Effort and CPUE in commercial fleets.



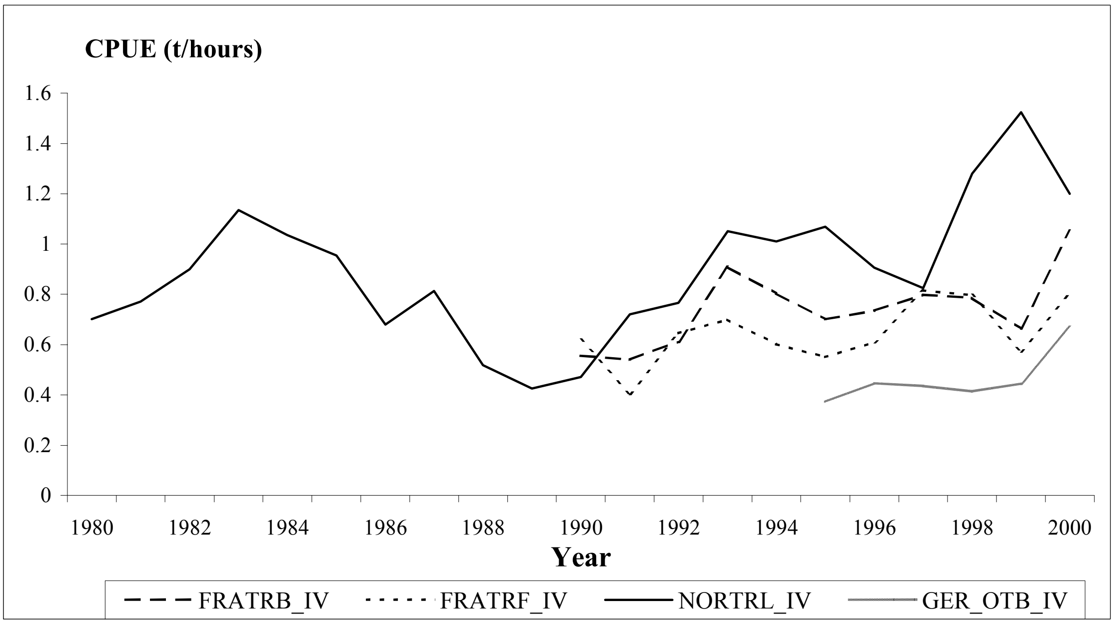


Figure 6.4.1 Saithe in IV, VI and IIIa Results from single fleet tunings and combined fleet tunings

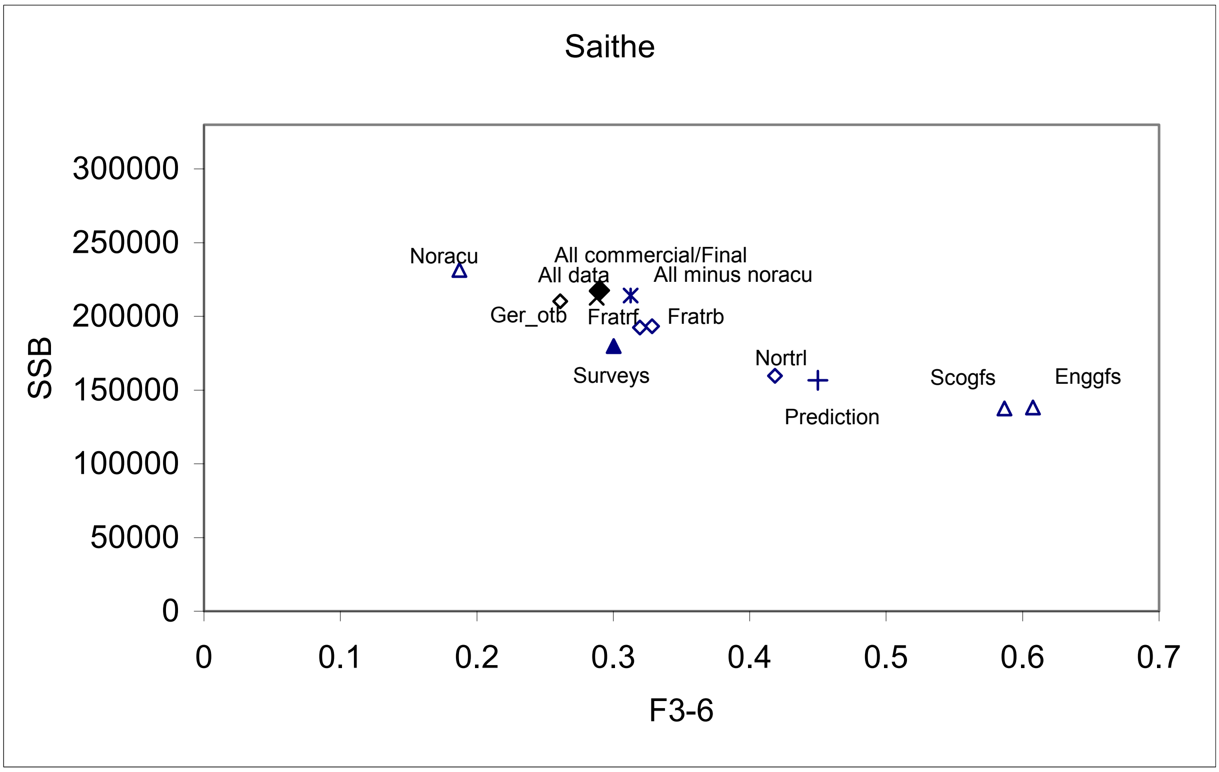
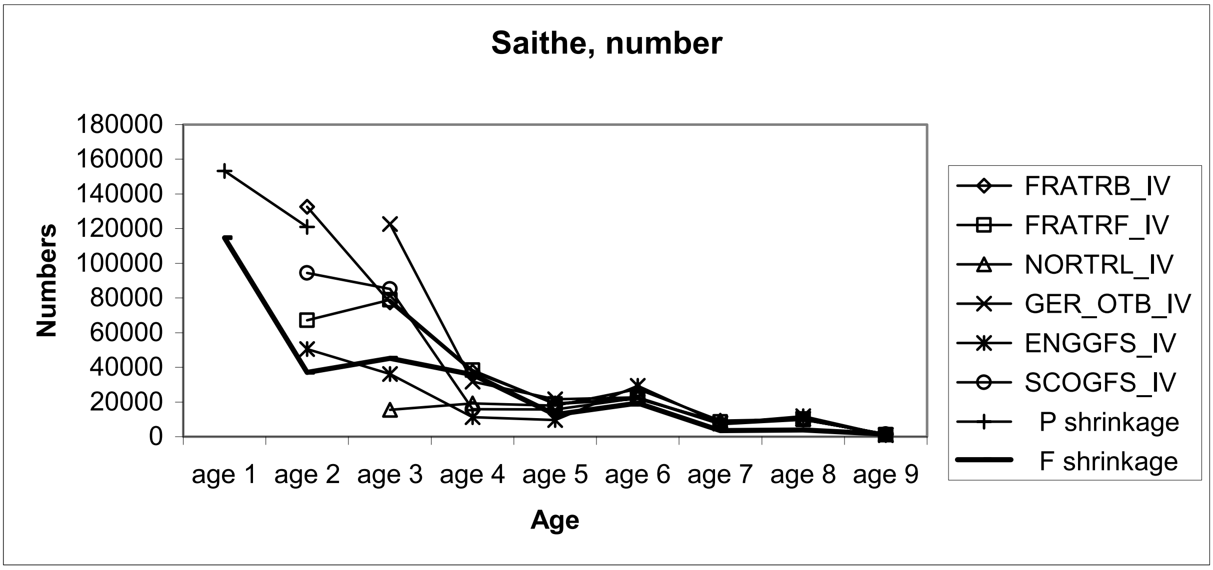


Figure 6.4.3 Saithe in IIIa, IV and Via. Numbers and F per age. Combined tuning.



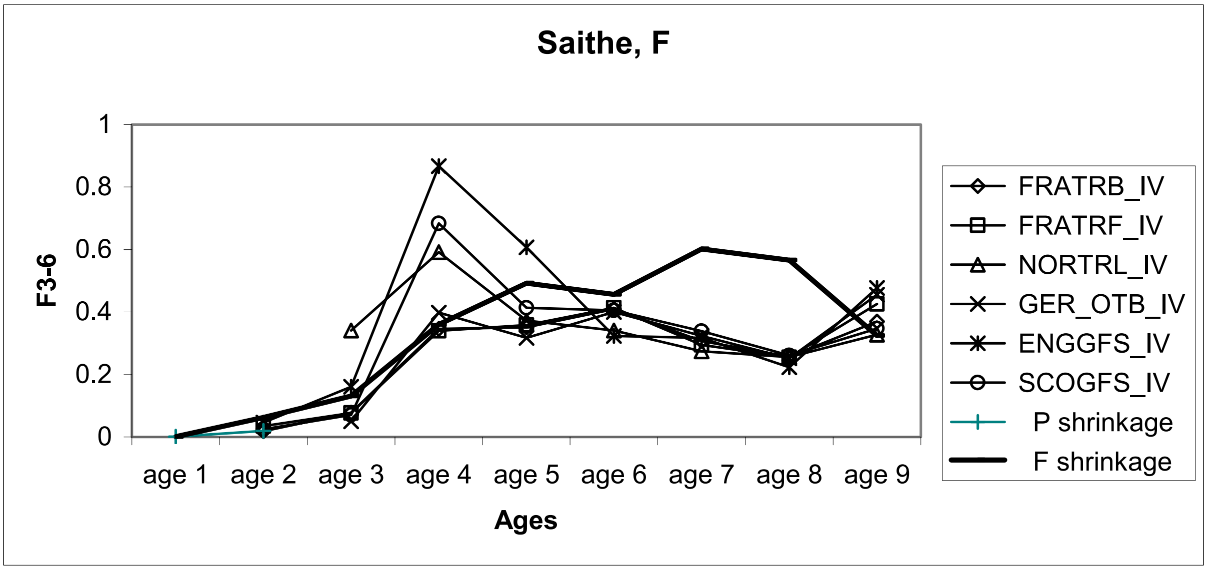


Figure 6.4.4. Saithe IV, VIa and IIIa - Contribution of Commercial fleets and shrinkage to tuned XSA

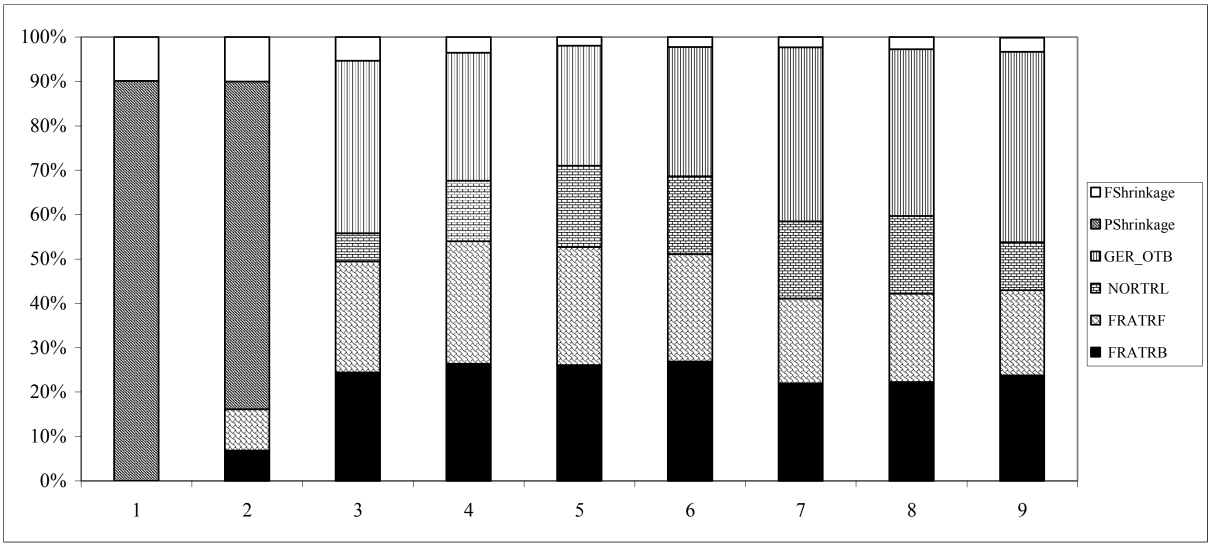
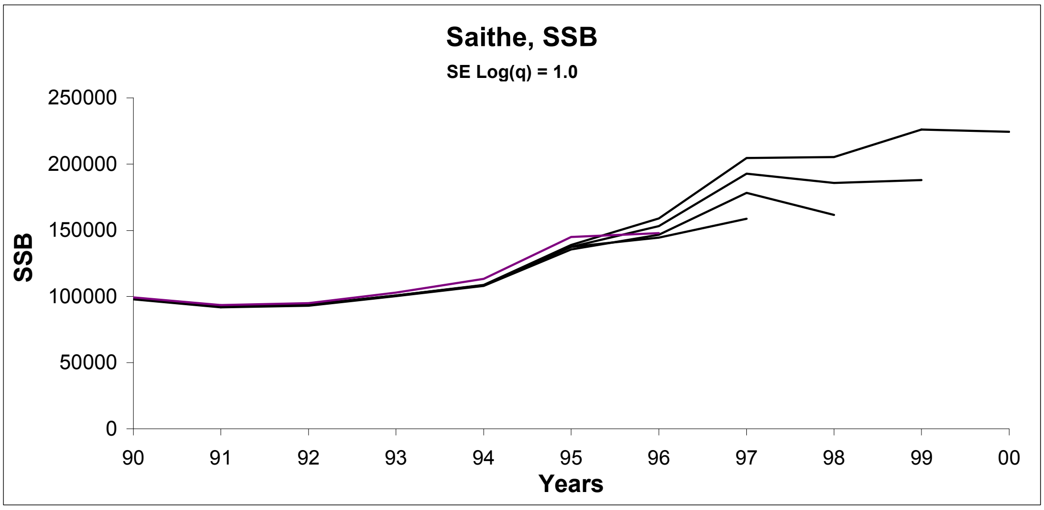


Figure 6.4.5 Saithe in IIIa, IV and Via. Retrospective analysis (GEROTB excluded).



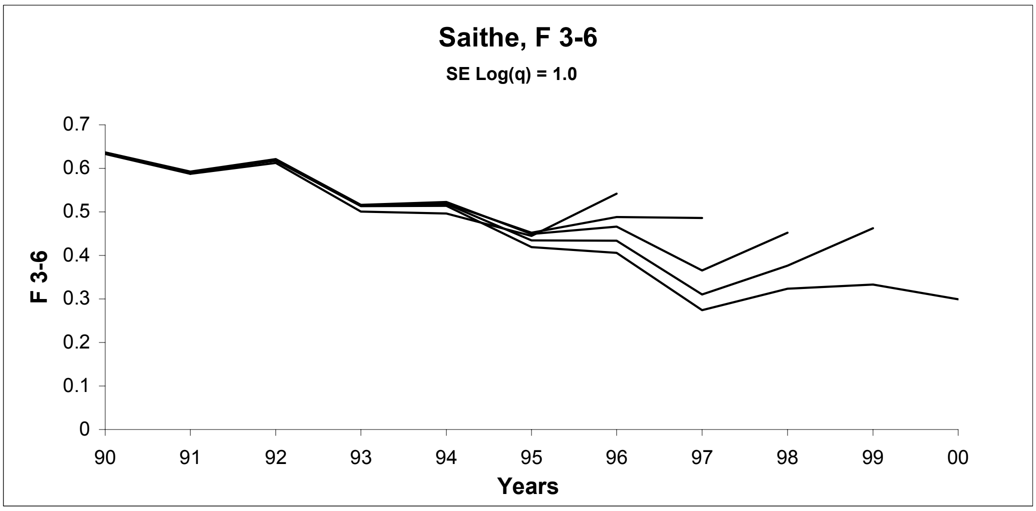


Figure 6.7.1. Saithe IV, VIa and IIIa. Short term forecast.

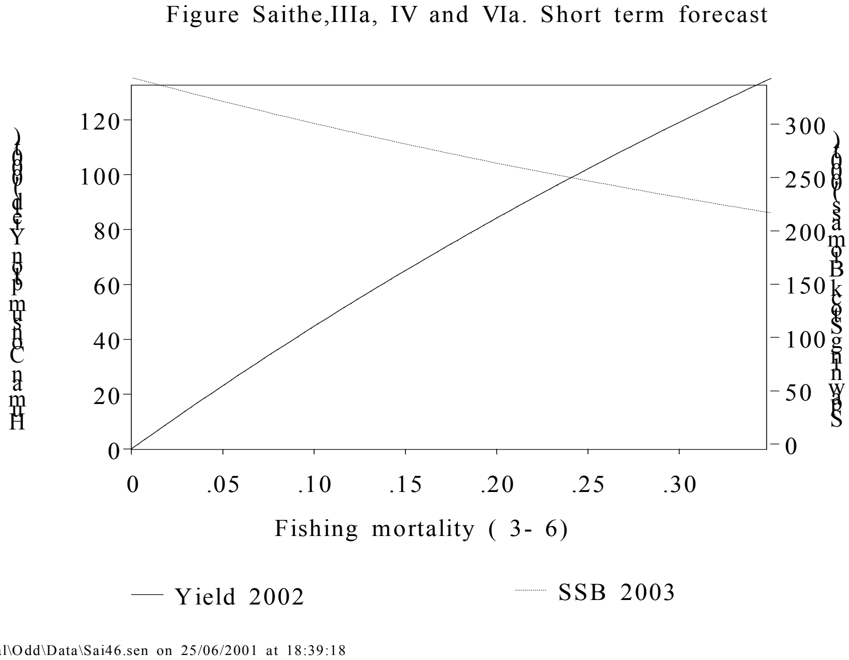


Figure 6.7. 2. Saithe IV, VIa and IIIa. Probability profiles for short term forecast.

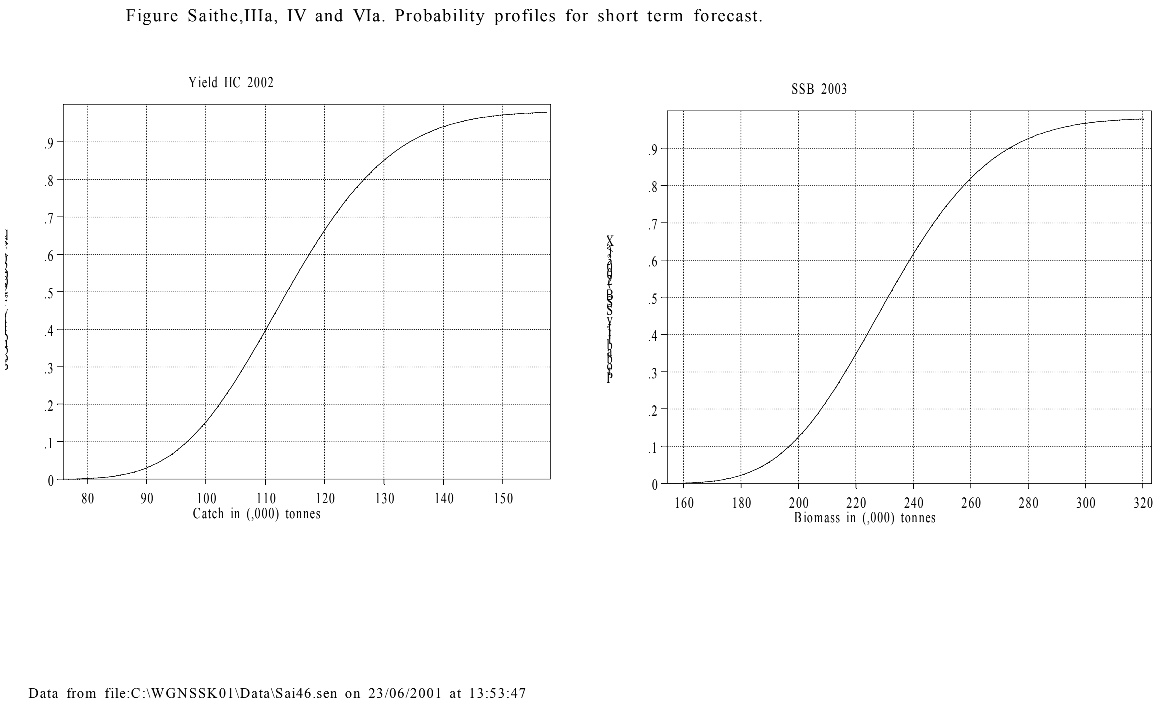
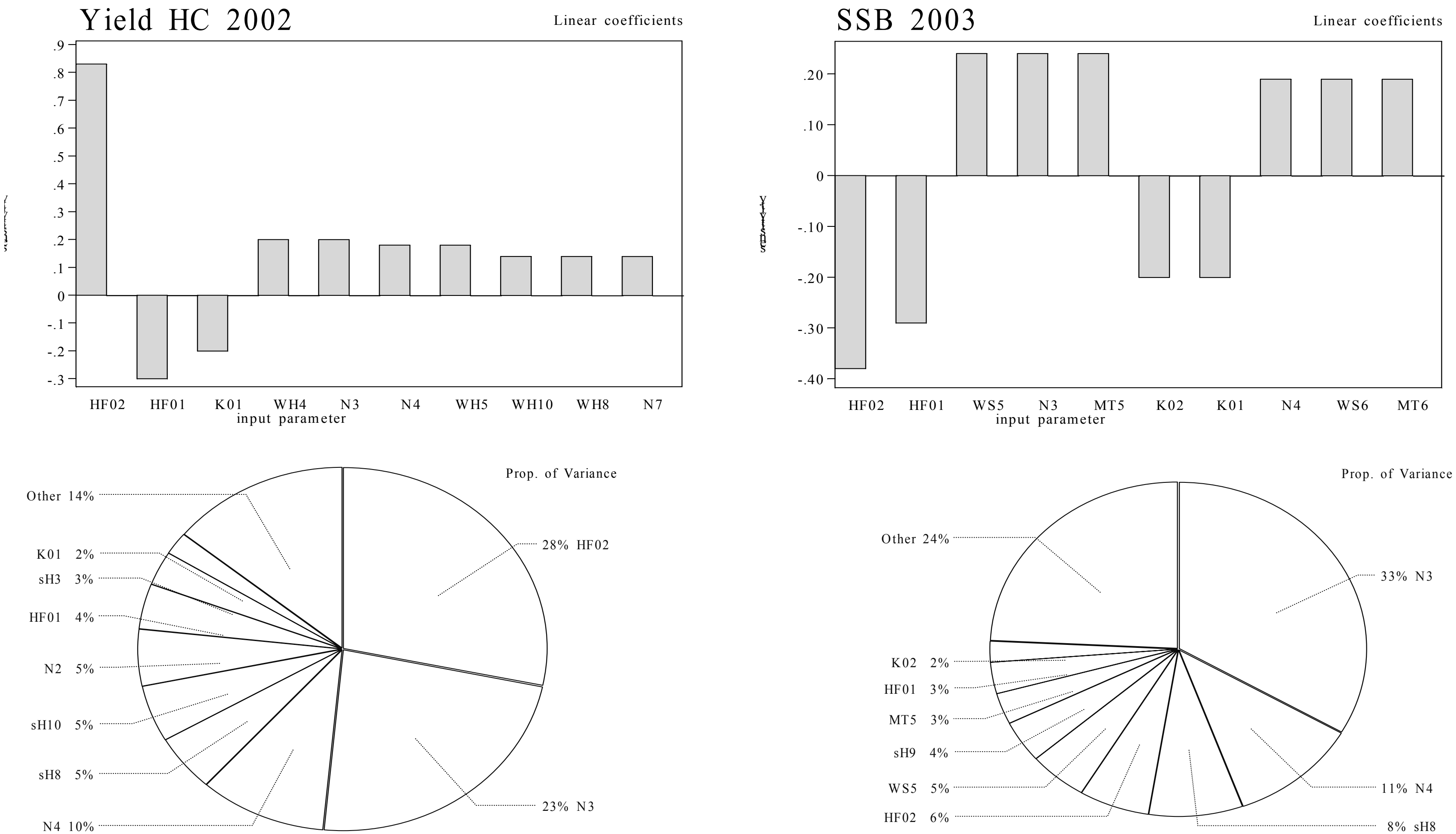


Figure 6.7.3. Saithe IV, VIa and IIIa. Sensitivity analysis of short term forecast.

Figure Saithe,IIIa, IV and VIa. Sensitivity analysis of short term forecast.



Data from file:C:\WGNSSK01\Data\Sai46.sen on 23/06/2001 at 13:51:40

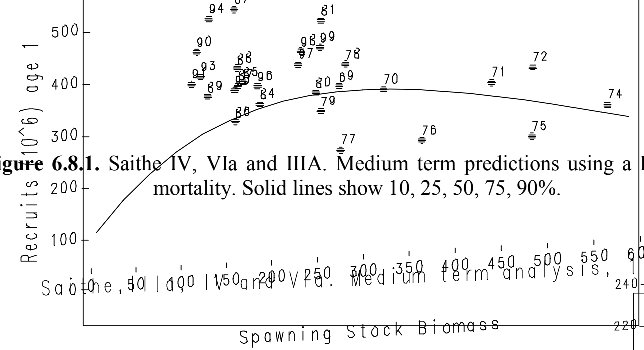


Figure 6.8.1. Saithe IV, VIa and IIIA. Medium term predictions using a Ricker Stock-Recruitment model in WGMTERMC. Status quo Fishing mortality. Solid lines show 10, 25, 50, 75, 90%.

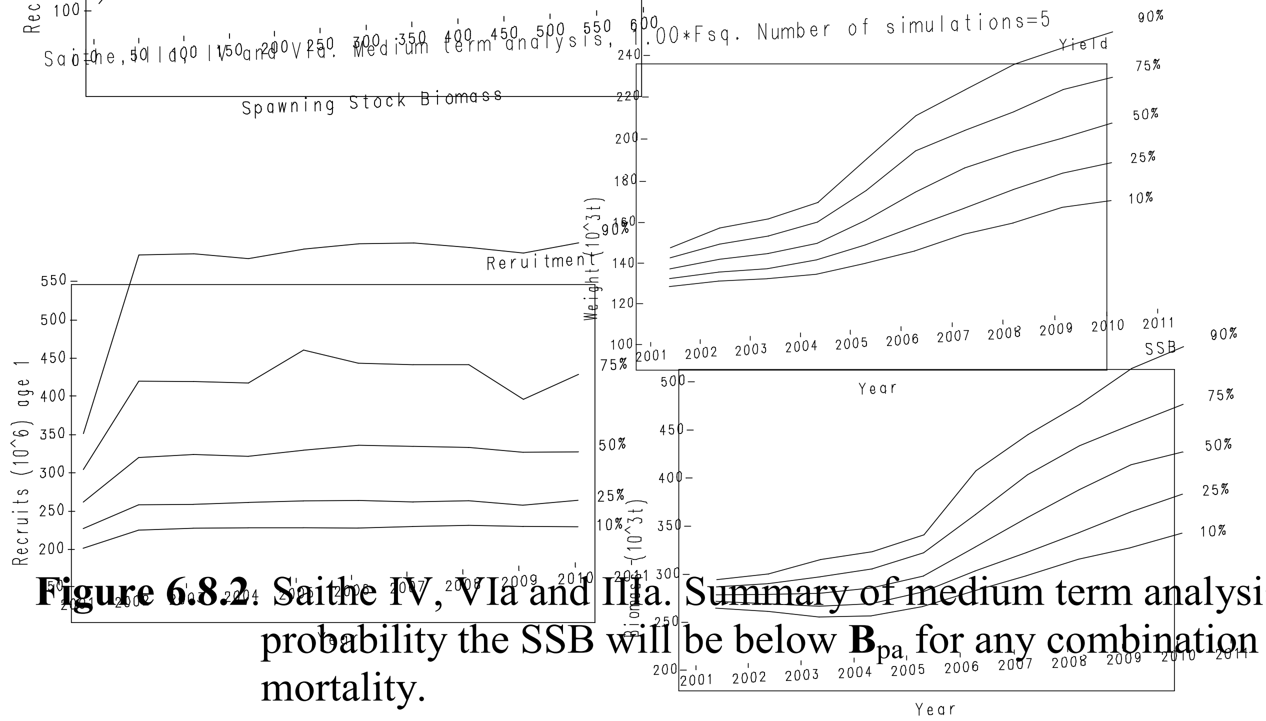


Figure 6.8.2. Saithe IV, VIa and IIIa. Summary of medium term analysis. Contou
probability the SSB will be below $\mathbf{B}_{pa}$ for any combination of year ar
mortality.

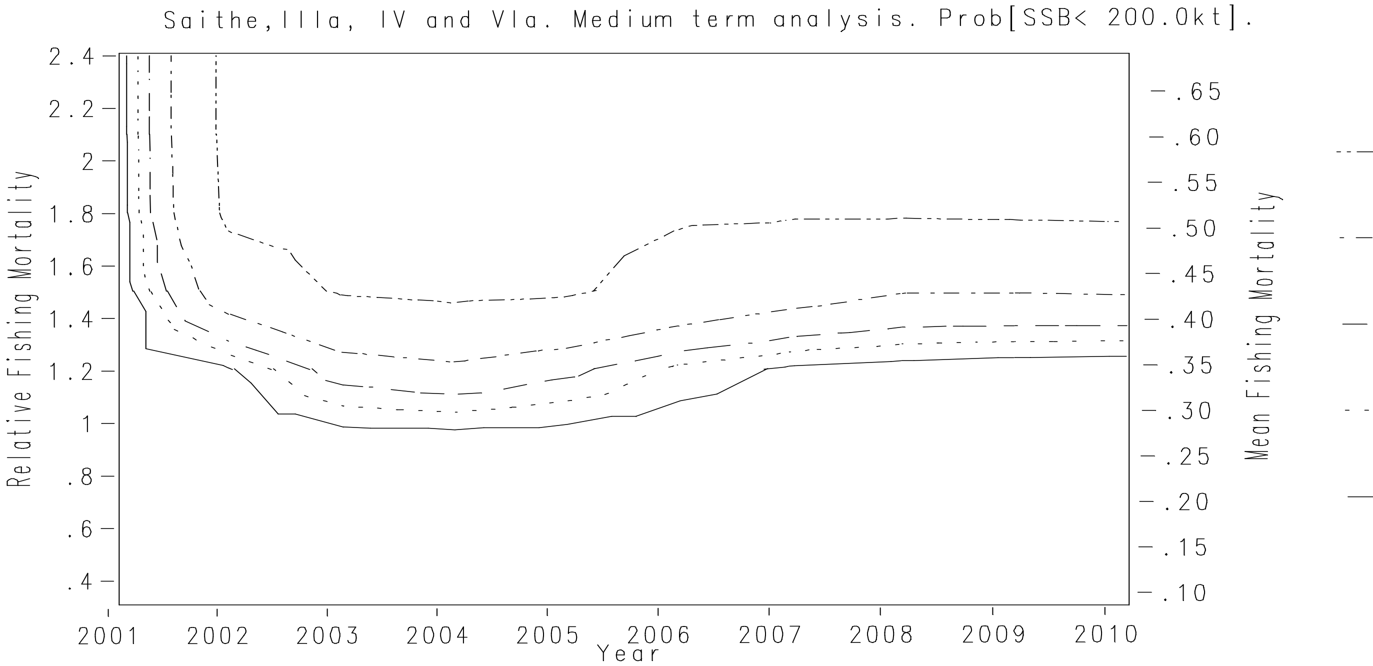


Figure 6.9.1

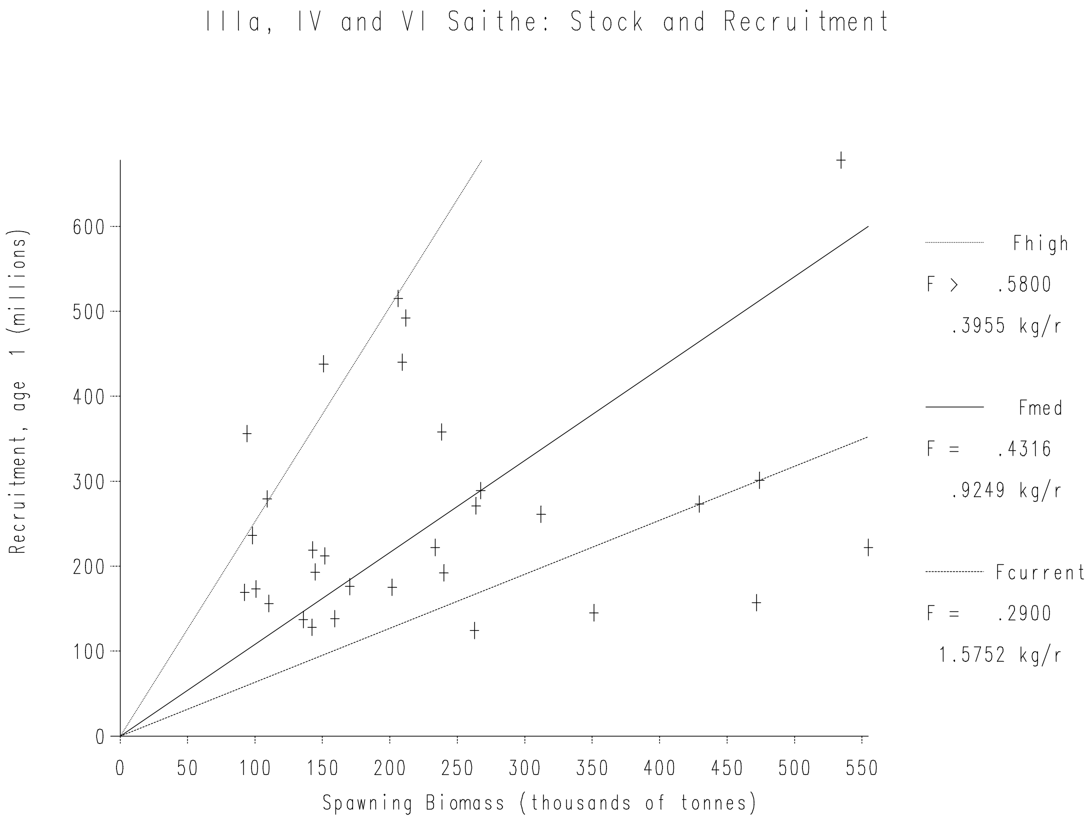


Figure 6.9.2

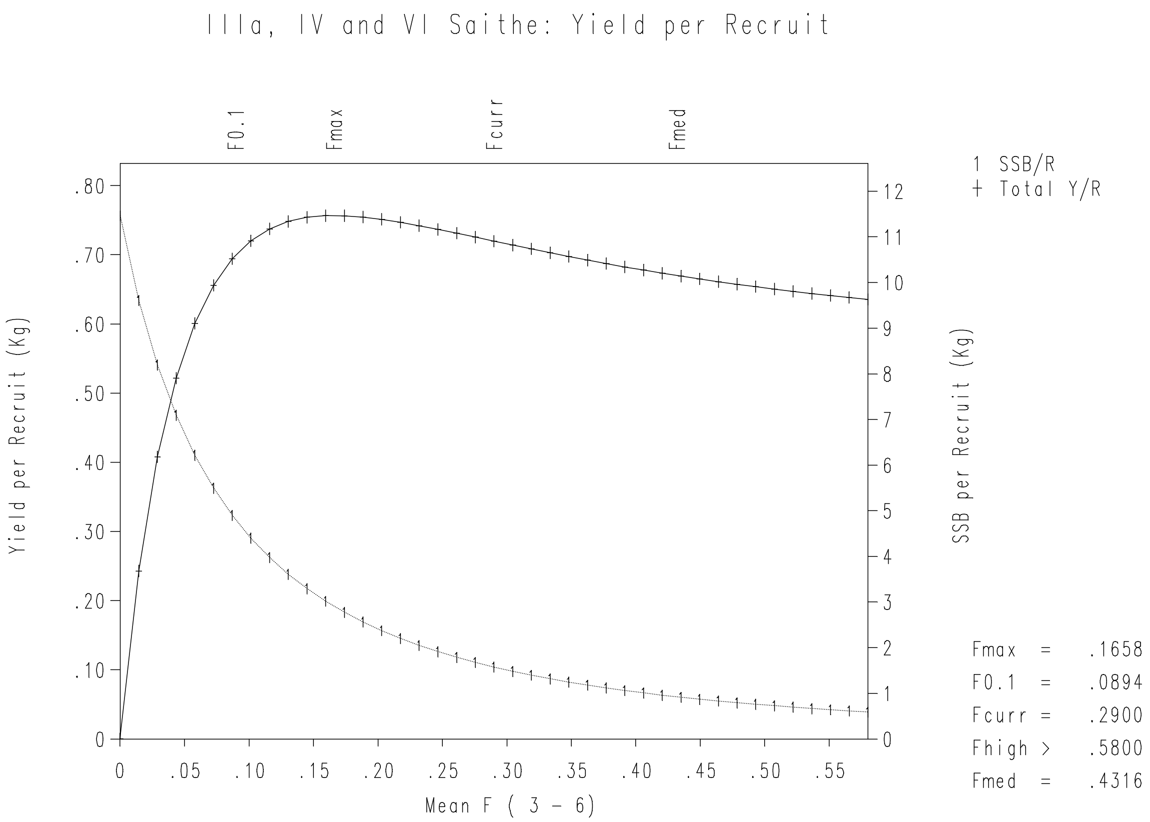


Figure 6.9.3.a : Saithe in IV, IIIa and VIa. SSB versus F 3-6 from 1967-2002.

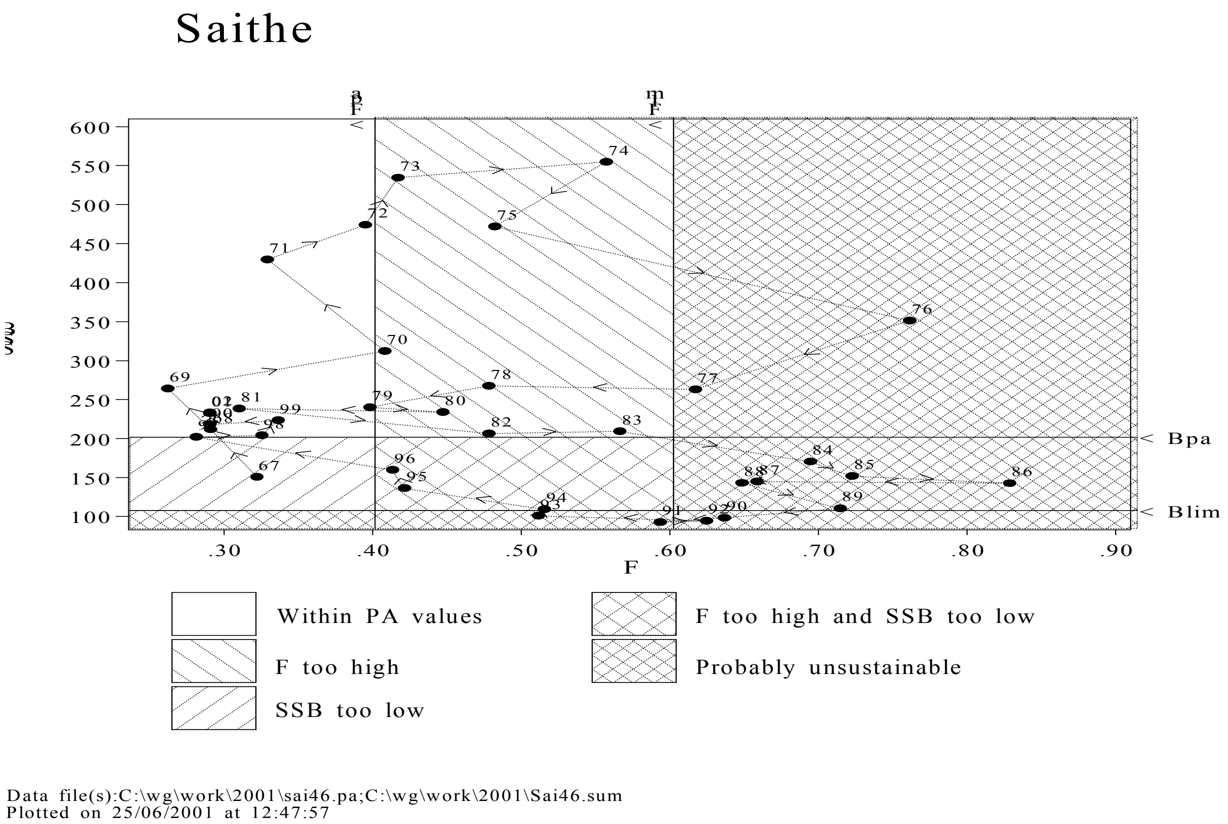
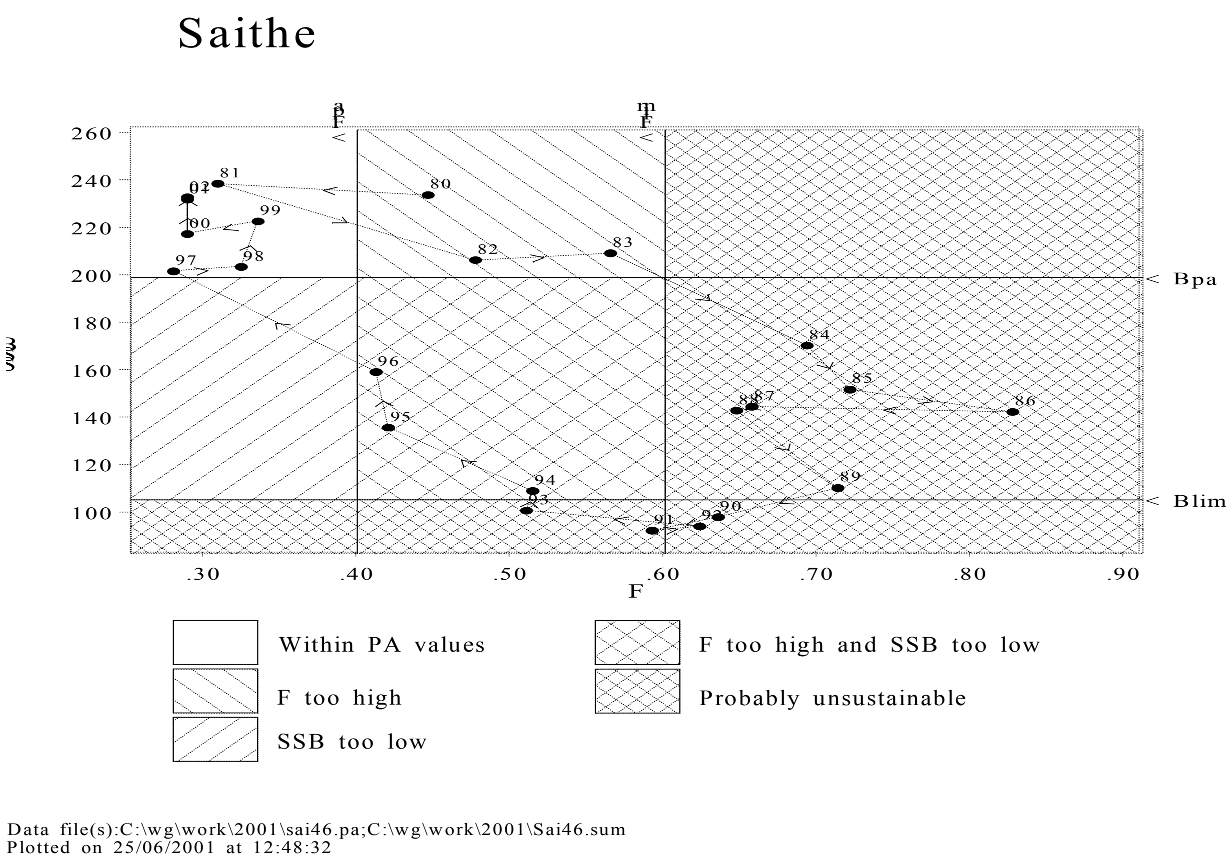


Figure 6.9.3.b : Saithe in IV, IIIa and VIa. SSB versus F 3-6 from 1980-2002.



7 SOLE IN SUB-AREA IV

7.1 Introduction

The assessment presented in this section is a completely revised assessment which has been carried out outside the WG after an error was noted in the international age composition for the year 2000. This was caused by problems in age reading. The revisions have been seen and agreed by members of the WG.

In summary the changes have resulted in the following consequences:

1. The revisions in the age composition and weight at age affect mainly the 1996 and 1997 year classes. In the previous assessment the 1997 year class appeared to be more abundant in the catches than the strong 1996 year class. This has been reversed in the new data set which is in line with expectations from the two year classes.
2. The assessment has been completely re-run because all the main input data (catch numbers, catch weights and stock weights for 2000 have been revised.
3. In addition, a minor revision to the provisional figure for the Netherlands commercial beam trawl effort was reported (change from 65 to 67.7 mill HP days) and this has been included in the revised assessment.
4. The fishing mortality on ages 3 and 4 in 2000 has changed but the overall F on ages 2-8 is the same as in the WG run.

7.2 The fishery [revised 24/9/01]

Sole is mainly taken by beam trawlers in a mixed fishery with plaice in the southern part of the North Sea. Fishing by different countries is described below:

Belgium: The Belgian fleet operates out of 4 main ports: Oostende, Zeebrugge, Nieuwport and Blankenberge. Out of a total fleet of 126 vessels, 115 use beam trawl exclusively and fish for sole and plaice. The fishing grounds change throughout the year depending on catch rates, although the central and southern North Sea (IVb,c) are the preferred fishing area of the Belgian fleet.

Denmark: The main Danish fishery for sole is by fixed nets although there is also a little effort using beam trawling, and some by-catch in otter trawlers.

Germany: The German sole fishery can be divided into three segments: 7 large beam-trawl vessels >30m, 20-30Euro-cutters and a varying number of small shrimp beam-trawl vessels catching sole during Q2 & Q3.

The Netherlands: A high proportion of the fishing effort in the North Sea is by Dutch beam trawlers. The introduction of the Plaice Box in 1989 resulted in a change in the distribution pattern of beam trawl vessels > 300 HP with an increase in activity outside and to the north of the Box.

UK: The English fleet consists of a large number of small otter trawlers fishing in the southern North Sea for sole mainly in the 2nd and 3rd quarters of the year. Sole is also taken as by-catch in the English beam trawl fishery which fishes mainly for plaice with 110mm mesh. About 70% of the total UK catch are landed abroad by Dutch vessels fishing on the UK register.

7.2.1 ACFM advice applicable to 2001

For 2001 ACFM noted that North Sea sole was being harvested outside safe biological limits. ACFM advised that fishing mortality on North Sea sole should be reduced to below the proposed Fpa of 0.4, corresponding to catches less than 17,700 t in 2001. This implies a reduction in fishing mortality of 20% from the 1999 value (0.47) and would ensure a high probability that SSB will remain above the proposed Bpa (35,000 t) in the medium term.

ACFM commented that the catch forecast was sensitive to the estimate of the abundant 1996 year class. At status quo F, this year class was expected to contribute 55% of the landings in 2000 and 38% in 2001and 41% and 26% to the SSB in 2001 and 2002 respectively.

The advice in recent years has been based on the objective to maintain the SSB above a Bpa of 35,000 t for this stock and below a $\mathbf{F_{pa}}$ of 0.4. The $\mathbf{B_{lim}}$ for this stock is considered by ICES to be 25 000 t, the lowest observed biomass but Flim is undefined.

7.3 Management applicable to 2001

The TAC's for 2001 was 19,000 t which is about 7% above the maximum value recommended by ACFM.

Technical measures applicable to the sole fishery are an exemption to use 80 mm mesh codend when fishing south of 55° North. New technical measures, which will be in operation from the year 2000, include a shift of 80 mm mesh exemption from 55° North to 56° North, East of 5° E latitude. Fishing with this mesh size is permitted within that area providing that the landings comprise at least 70% of a mix of species which are defined in the new technical measures of the EU.

Some additional protection is given to sole from the closure of the plaice box along the Dutch and Danish coast. In the years 1989 to 1993 the box was closed in the second and third quarters of the year to all vessels using towed gears and with engine power larger than 300 HP. Since the second quarter of 1994 the box has been closed during all quarters.

The emergency measures taken in 2001 (closed areas) to protect cod also affected the exploitation of flatfish.

7.3.1 Landings in 2000

The Working Group estimate of landings in 2000 (22,532 t) was 2% higher than the agreed TAC. Unallocated landings have decreased considerably since 1993 and are now mainly due to the change in the use of raising factors for converting gutted to live weight in landings reported to ICES by the Netherlands. Estimates of sole discards (EC PROJECT 98/097) are available for 1999 and 2000 for some fleets and indicate that proportions discarded by number amount to 27% by beam trawlers (excluding Netherlands where data was not yet available) and 32% from otter trawlers.

For recent years, the officially reported landing by various countries as well as Working Group estimates of the total landings are given in Table 7.1. A longer time series of landings is given in Table 7.15 and plotted in Figure 7.4.

7.4 Age composition, weight at age, maturity and natural mortality

Age compositions, mean weight at age in the catch and mean length at age in the catch were available on a quarterly or annual basis and by sex separately from Belgium, France, the Netherlands and UK (England and Wales). The samples are thought to be representative of around 80% of the total landings in 2000. However, no samples are collected from national vessels which land abroad and this constitutes an increasing proportion of the total landings by some countries. The age compositions were combined separately by sex on a quarterly basis and then raised to the annual international total. No revisions have been made to the 1999 data. After the WG, a large error was found in the age composition for 2000. This strongly under-estimated the strength of the 1996 year class and raised the size of the 1997 year class in particular. Following a revised age reading of the relevant samples, the age composition, catch weights and stock weights for 2000 were revised in Sept 2001. The revised age compositions are given in Table 7.2.

Weights at age in the catch are measured weights from the various national market sampling programmes of the landings. Weights at age in the stock are those of the 2nd quarter in the landings. Revised weights at age in the catch and stock are given in Tables 7.3 and 7.4 and the trend in catch weights at age shown in Figure 7.1a. No clear trends are evident over the last 6 years, although ages 2,3 5 and 6 all show a slight decline in 2000.

As in all previous assessments, a knife-edged maturity-ogive was used in all years, assuming full maturation at age 3 (Table 7.5). The maturity-ogive is based on market samples of females from observations in the sixties and seventies. Natural mortality in the period 1957-1999 has been assumed constant over all ages at 0.1 (Table 7.5), except for 1963 where a value of 0.9 was used to take into account the effect of the severe winter (ICES CM 1979/G:10). In 1996 additional natural mortality was observed in the cold winter of 1995/1996 (ICES 1997e/Assess:6), but in the absence of a precise estimate, the standard value of 0.1 has been retained.

7.5 Catch, effort and research vessel data

Catch and effort data, used for tuning the assessment are given in Table 7.6. Effort in the Netherlands commercial beam trawl is total HP effort days and this has nearly doubled between 1978 and 1994 but has declined slightly over last 4 years. The provisional effort estimate Netherlands in 2000 has been revised following additional information from 65 to 67.7 million HP days. The effort in the UK commercial beam trawl fleet is calculated from vessels fishing south of 56^0 North to exclude vessels targeting plaice and is measured as HP hours for trips where sole is caught. The effort of this fleet has decreased since 1993. Belgian effort data (Table 7.7) is from the beam trawl fleet and is in HP corrected hours. The effort of this fleet tends to be variable as it switches effort between area VII and the North Sea. No age composition was available for this fleet and so it was not possible to include it in tuning.

The other 2 tuning fleets are Dutch research vessel surveys. The SNS (Sole Net Survey) is a coastal survey with a 6- m beam trawl carried out in October. The BTS (Beam Trawl Survey) is carried out in the southern and south-eastern North Sea in August and September using an 8-m beam trawl.

The BTS survey indices was revised in 1998 by excluding rectangles above 55° 30', which have not been sampled in the last few years. Also market ALK's previously used in estimating the survey age distribution of older fish have been excluded. As a consequence, the tuning file has therefore been restricted to ages 1 to 4 as in last year's assessment. In 2000, a number of further changes have been introduced in the calculation of the BTS indices, which are listed below and the index has been revised over the full year range:

- age samples from market sampling have no longer been used to age the older individuals.
- 5+ has been used instead of a 10+gp
- previously, all fish smaller than 10cm were allocated to age 0 by default. In the new algorithm ALKs have been applied to all fish including individuals smaller than 10 cm if otoliths were available. For lengths below 10 cm for which no otoliths were available, the default age 0 was still used.

Available trends in effort and cpue are listed in Table 7.7 and shown in Figure 7.1b. The Dutch beam trawl cpue show a continuous decline since 1990 reaching a minimum in 1997. The good 1996 year class has resulted in an increase in cpue since 1998. The UK beam trawl CPUE series also shows a historical low value for 1997 and 1998 but has increased as the 1996-year class has recruited to the UK fishery, one year later than for the Netherlands fleet. The Belgian data indicates a minimum in 1987 but no improvement since then.

7.6 Catch at age analysis

General approaches and methods are described in section 1.4.

7.6.1 Data exploration

No revisions were carried out to the data explorations and the settings used in the WG were repeated.

Exploratory runs were carried out to look at fleet catchability trends, the influence of different fleets, ages and year ranges. The results of the exploratory runs are summarised in Table 7.8. In general, no improvements were found in alternative tuning configurations compared to the one used last year.

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. Except for ages 1/2, log-catch ratios did not show any large residuals or trends (Table 7.9). As in previous assessments, the age range for the analyses was kept as 1-15+.

Single fleet catchability: The fleet data were examined for trends in catchability by carrying out XSA for single fleets over the year range available for each fleet, (settings as last year's final run except for a weak shrinkage of 1.5). Trends in catchability (Figure 7.2a-c) were apparent in the Netherlands BT fleet before 1989, particularly at ages 2-7.This may be due to the change in fishing pattern following the introduction of the plaice Box after 1989. Years before 1990 were therefore excluded from subsequent tuning runs. The UK beam trawl fleet showed a negative trend from 1990 to 1993 and a positive trend from 1993 to 1995 for the younger ages. The survey fleets showed no clear trends. In order to remove the trends in the commercial beam trawl fleet, the tuning was run from 1990 without a taper on all fleets.

Combined fleet catchability: When combined with other fleets, the pattern of log catchability residuals for the Netherlands and surveys were not markedly different from single fleet runs (Figure 7.2a-c). However, in the UK BT fleet log catchability residuals increased considerably resulting in high SEs (>0.5) at ages above 5. The cpue trend from this fleet matches the Netherlands BT series and it is likely that the poor performance reflects the fact that it is sampling a different area and age range compared with the Netherlands fleet. Despite the relatively poor performance of the UK fleet, it was decided to retain it as it provides additional information on the stock, behaved reasonably as a single fleet and maintains consistency with last year and with previous assessments.

In order to assess the efect of downweighting earlier years to remove the trends in catchability of the commercial fleets, two alternative approaches were used. One used a tricubic time taper over 20 years to downweight the period with the trend in catchability and the second used the full year range for the surveys but with the commercial fleet files revised to exclude years before 1990. The results of the different methods on the mean F and SSB in the final year are shown in Figure 7.3a. The different approaches gave very similar results. Examination of the XSA diagnostics indicated that there was no improvement in the SE of the ln catchabilities or consistency of the survivor estimates compared with the settings as in last year's assessment.

Retrospective analyses were run with a 10 year window. Using the same configuration as in the final XSA to investigate the consistency in estimating F(2-8), SSB and recruitment at age 1. The results (Figure 7.3b) are similar to last year and suggest that F has been underestimated in previous years, and SSB slightly overestimated particularly in 1999.

Log catchability plateau. The ages at which log catchability is set independent of age has been set at 7 in previous years, although there was indications from the tuning diagnostics that it might still be declining after age 7. This was investigated by selecting age 10 for the catchability plateau but the results were no better. Since the catchability on older ages is very variable, the previous setting at age 7 was continued.

Repeating last year's final assessment, with the additional year in the database, gave almost identical results compared to those of last years Working Group.

7.6.2 Assessment

The configuration of the final XSA run was accepted as the same as last year with the additional year 2000 added:

stock	**sole**			
area	IV			
year of assessment	**2000**		**2001**	
Assessment model	XSA		XSA	
NL beamtrawl	1990-1999	2-14	**1990-2000**	2-14
UK beamtrawl	1990-1999	2-14	**1990-2000**	2-14
BTS	1990-1999	1-4	**1990-2000**	1-4
SNS	1990-1999	1-4	**1990-2000**	1-4
Time series weights	none		none	
Power model used for catchability	1-2		1-2	
Catchability plateau age	7		7	
Surv. est. shrunk towards mean F	5 years / 5 ages		5 years / 5 ages	
s.e. of the means	0.5		0.5	
Min. stand. error for pop. estimates	0.3		0.3	
Prior weighting	none		none	
Number of iterations			27	
Convergence	yes		yes	

D:\ices\WGNSSK\2001\Assessment setting WGNSSK 2001.xls

Full tuning diagnostics for the XSA run with the new age composition and revised Dutch effort are given in Table 7.10. The revised run has improved catchability SEs for the Netherlands commercial fleet at age 3 and 4 indicating that the revisions of the age composition has improved the assessment for these age groups. There also appears to be a more consistent estimate of survivors for the 1999 and 198 year classes.

The weighting given to fleets and to shrinkage is shown in Figure 7.3c and compared with previous year's assessments. There is considerable consistency across years. For age 1 (1999 year class), the two surveys, are given 80% of the weight (F-shrinkage and P-shrinkage taking only 15% and 5%). For age 2, the surveys also contribute 72 % to the weight, 15% coming from shrinkages and the remaining 12% from the two commercial fleets. From age group 3 onwards the commercial fleets start to contribute more with the most weight given to the Netherlands commercial fleet. Although estimates of survivors from most of the tuning fleets appear to be quite consistent for all ages, the UK beam trawl fleet tends to give slightly different estimates for most ages.

The fishing mortality and stock numbers estimated by the revised final XSA are given in Tables 7.11 and 7.12. The low F on age 4 in the WG run has been revised upwards from 0.46 to 0.54 while at age 3 the F has decreased from 0.56 to 0.48. Other age groups remain similar to the WG run and the revisions have not affected the mean $F_{2\text{-}8}$ which has remained at 0.46. The revised run has altered the estimate of some year classes at age 1 as shown below:

year class	WG run	Revised run
1996	278506	303366
1997	139026	127288
1998	90846	86431

7.7 Recruitment

Average recruitment in the period 1957-1998 was 136 million (arithmetic mean) or 100 million (geometric mean) 1-year-old-fish.

Recruitment indices were available from pre-recruit surveys carried out in 2000 and previous years. The surveys and indices are listed in the RCT3 input (Table 7.13). The Sole Net Survey (SNS) and Beam Trawl Survey (BTS) are Dutch surveys directed to flatfish juveniles in their coastal nurseries. The BTS is a third quarter survey and covers both inshore and offshore areas of the North Sea using a pair of 8m beam trawls with 40mm stretched mesh cod-ends. The SNS is a 4th quarter survey using 6m beam trawls with 40mm stretched mesh cod-ends.

The DFS index is an area weighted survey index combining the inshore surveys of Netherlands, Belgian, Germany and UK. **The 0gp and 1gp indices for 1998 and 1999** were not available because bad weather had prevented the completion of the surveys in these years. The 2000 survey index was available late in the WG but has not been included in the analyses.

The German survey is a beam trawl survey carried out in May during the sole spawning season in the inshore area of the German Bight. The survey uses 7m beam trawls with 80mm mesh cod-ends and age groups younger than 3 are not sampled

The options used in RCT3 are the same as those used in previous years. The input survey indices are shown in Table 7.13 together with the revised VPA recruit estimates and the outputs from revised RCT3 regressions on ages 1, 2 and 3 and are shown in Tables 7.14a,b and c.

The 1998-year class (at age 3 in 2001in thousands- Table 7.14c) was estimated as 56,357 (57,223 by the WG) by XSA and 45,407 (45,152 by WG) by RCT3. Both estimates were below the GM at age 3 of 64,000. Since the surveys in XSA receive 72% of the weight and there were no additional years in the RCT3 analysis, the XSA result was accepted. This is an upward revision of around 25% compared with last year.

The 1999-year class (at age 2 in 2001in thousands –Table 7.14b) was estimated as 101,182 (107,762 by WG) in XSA and 85,172 (85,357 by WG) in RCT3 compared with GM at age 2 of 87,000. The numbers of 1 year olds in the catch in 2000 were high compared to previous years and this has led to a high F-shrinkage estimate of survivors (237,000). The two survey indices at age 1 do not indicate that the year class is above average and in XSA the surveys estimate between 90,000 and 98,000. It was felt that the XSA value was inflated by the high F-shrinkage estimate and so the RCT3 figure of 85,172 was accepted. Additional estimates of the 1999-year class will be available to ACFM from surveys carried out in the 2nd and 3rd quarters of 2001.

The 2000-year class (at age 1 in 2001in thousands – Table 7.14a): No survey indices were available on this year class and the GM of 99,885 was used in the forecast.

The long-term GM recruitment was assumed for year classes 2001 and 2002.

Year class strength used for predictions are in bold and underlined and can be summarised as follows:

Year class	Age in 2001	XSA Thousands	RCT3 Thousands	GM (57-98) Thousands
1998	3	**56357**	45407	64439
1999	2	101182	**85172**	87446
2000	1		no estimate	**99885**
2001	0			**99885**

7.8 Historical stock trends

Revised historical trends in landings, recruitment, fishing mortality and SSB are given in Table 7.15. and plotted in Figures 7.4.

Fishing mortality F(2-8) has more than trebled in the period 1957-1984, mainly because of a developing beam trawl fishery. It has exceeded the F_{pa} of 0.4 in most years since 1970.

Recruitment varies by a factor of 50 between the smallest and largest year classes although more generally, interannual variation is relatively low. Most of the strong year classes seem to have developed following cold winters (1958,1963,1991 and 1996) and year classes recruited in recent years seem to be poor or near GM average.

A drastic decline in SSB in 1964 was caused by a high natural mortality in the strong winter of 1963-1964 when water temperatures were very low. After a 20 year period where SSB has varied between 22,000t and 50,000t, it increased sharply in 1990 and remained at a high level until 1994. Since 1994 it has declined from 75,000t to a historically low level of 23,000 t in 1998 because of below average recruitment, high fishing mortality and also an extra natural mortality in the 1995/1996 winter. Following recruitment of the strong 1996 year class, the SSB has shown a temporary recovery to above B_{pa} of 35,000t.

7.9 Short term forecast and sensitivity analysis

For the current prediction, population survivors at the start of 2001 for age 1 were from GM recruitment (1957-98). Age 2 was estimated by RCT3. Ages 3 and older were taken from the XSA output. Fishing mortality at age were the average for the years 1998-2000, scaled to the reference $F_{(2-8)}$ in 2000 of 0.46. Weight at age in the catch and in the stock are averages for the years 1998-2000. Maturity-ogive and natural mortality was the same as in the XSA and the long-term GM recruitment (99890 thousand) was assumed for age 1 in 2002. The revised input data are shown in Table 7.16.

The revised management options table is given in Table 7.17 and the revised detailed predictions for F_{sq} are presented in Table 7.18. The options are also illustrated in Figure 7.7.

Yield and SSB at *status quo* F: Assuming a *status quo* F results in an expected catch in 2001 of 19,900 t (compared with a TAC of 22,000 t and ACFM advice for a TAC of 17,700t). The yield in 2002 is expected to be 17,700 t at *status quo*. The sensitivity of the short term forecast to the various input parameters are shown in Figures 7.5 and 7.6. This forecast is particularly sensitive to the estimates of F on the 1999 and 2000 yr classes (Figure 7.5). In addition, the estimate of the 2000 yr class generates nearly half of the total variance.

The SSB in 2001 is predicted to be 39,600t compared with 42,000t in last year's assessment. At *status quo* it is expected to fall to 36,100 in 2002 and there is a 60% probability that the SSB will fall below Bpa in 2003 (Figure 7.6).

The proportional contributions of recent year classes to catch in 2002 and SSB in 2003 are given in Table 7.19. Nearly half the yield in 2002 is dependent on year classes 1999 and 2000 which are based on RCT3 and GM estimates. Similarly, 60% of the SSB in 2003 is dependent on these two recruiting year classes.

7.10 Medium term forecast

Medium term predictions were made for a period of 10 years, to estimate percentiles of the distribution of the predicted yields, SSB and recruitment at a *status quo* level of fishing mortality.

The revised input values for the medium term predictions are presented in Table 7.16. Catch and stock weights were the average for the past three years. As expected, the results are not sensitive to the small revisions in input values.

A Ricker curve was used for medium term projections as in last year's assessment.

WGMTERMC was run using *status quo* F. Figure 7.8 shows the revised trajectory of yields and SBB with associated 10, 25 50,75 and 90 percentiles for the *status quo* projection. The plots indicate that the 50percentile of yield remains close to 20,000t over the medium term. SSB is expected to remain close to Bpa of 35,000t. The contour plot (Figure 7.8b) suggests that at Fpa (0.4), there is a 25% probability of the SSB falling below Bpa over the medium term.

7.11 Biological reference points

Revised input data to the yield–per–recruit analysis are given in Table 7.16. Catch and stock weights were the averages for the last three years as in the short term forecast. The yield-per-recruit analysis, and SSB per recruit, conditional on the present exploitation pattern and assuming *status quo* F in 2001, are shown in Figure 7.9. The stock and recruitment plot is given in Figure 7.10, and includes values of F_{med} and Fcurrent which are similar to last year's values. Fsq (0.46) is estimated to be 40% above Fmed. The calculate biological reference points together with the management reference points for this stock are shown below:

$F_{0.1}$	F_{med}	F_{max}	F_{high}		F_{lim}	F_{pa}	B_{lim}	B_{pa}
0.09	0.29	0.33	0.71		not defined	0.40	25,000t	35,000t

Figure 7.11 shows the relationship between SSBs and F values, plotted into zones according to the proposed precautionary reference points. For clarity of the most recent points only years since 1990 are shown. The figure shows that F has been above Fpa during this period. The spawning stock is predicted to fall close to B_{pa} in 2002 if F in 2001 is maintained at *status quo.*

7.12 Quality of the assessment

Despite the substantial revisions in the age composition and weights at age of the 2000 data, the overall assessment is very similar to the results obtained by the WG in June 2001.

The assessment of North Sea sole appears to be relatively stable from year to year and comparison of the historical trends in F and SSB between this year and last show a close similarity. Comparisons with previous WGs (Figure 7.12) indicate that fishing mortality has generally been revised upwards in successive WGs by up to 10%. Estimates of recruitment are consistent from year to year although the 1998 year class estimated by RCT3 in 1999 has been revised upwards this year in XSA by 20%. SSB has also been estimated with consistency from year to year. The decrease in SSB estimated this year follows the levels predicted in the previous WG and results from the fishing down of the 1996 year class. Fisheries independent confirmation of the SSB trend has been obtained by comparing it with cpue data from the Netherlands BT survey in the North Sea (WD:8 Poos & Pastoors). The two indices of sole abundance are highly correlated (Pearson r=0.96, df==11, p<0.0001) (BTS and SNS).

The present assessment implies that F has decreased from 0.60 in 1999 to 0.46 in 2001 (0.47 in last year's assessment). This apparent decrease in F is not supported by the effort of the Dutch beam trawl fleet which shows a relatively small decline in effort and is the main fleet fishing for sole.

The short term prediction seems to be in line with the current TAC. In this year's assessment, the yield in 2001 at *status quo* fishing mortality, is predicted to be 20,000 t which is relatively close to the agreed TAC of 22,000 t.

The yield and SSB are heavily dependent on recruiting year classes of 1999 and 2000 which account for 45% of the landings in 2002 and 60% of the SSB in 2003. The strong 1996 year class which accounted for the upturn in SSB in 2001 will have been largely fished out by 2003 and the incoming year classes are all estimated at or close to the long term average.

There is a shortage of representative data on effort and cpue of fisheries that exploit sole. The two commercial fleets, for which measured data have been used, are mixed fisheries for sole and plaice. The variable catch opportunities of the two species between years and the improved enforcement of management measures in recent years, affect the CPUE's in this fishery and may bias the assessment.

7.13 Management Considerations

The sole stock is heavily dependent on recruiting year classes and management measures which produced a reduction in the mortality on juvenile sole would benefit the stock in the long term. The continued use of 80mm mesh together with the MLS of 24cm results in a high proportion of sole being landed which are immature. The maintenance of the plaice box is a measure which probably benefits sole by protecting juveniles in the main continental nursery areas.

Sole is mainly caught in a mixed beam trawl fishery with plaice using 80mm mesh in the southern North Sea. This means it is important to take into account the impact of management measures for plaice when considering sole. In relation to this, new technical measures introduced in January 2000 may affect the exploitation of the sole and plaice. The area where fishing with 80 mm is allowed has extended from 55ºN to 56ºN east of 5ºE. The expansion will mainly affect plaice by increasing the level of discarding from 80mm mesh nets but may also increase the mortality on sole.

Table 7.1 North Sea sole, Official landings as reported to ICES, 1982-2000

Year	Belgium	Denmark	France	Germany Fed. Rep.	Netherlands	UK (Engl. Wales)	Other countries	Total reported	Unallocated landings	WG Total	TAC
1982	1,927	522	686	290	17,749	403		21,577	2	21,579	20,000
1983	1,740	730	332	619	16,101	435		19,957	4,970	24,927	20,000
1984	1,771	818	400	1,034	14,330	586	1	18,940	7,899	26,839	20,000
1985	2,390	692	875	303	14,897	774	3	19,934	4,314	24,248	22,000
1986	1,833	443	296	155	9,558	647	2	12,934	5,266	18,200	20,000
1987	1,644	342	318	210	10,635	676	4	13,829	3,539	17,368	14,000
1988	1,199	616	487	452	9,841	740	28	13,363	8,227	21,590	14,000
1989	1,596	1,020	312	864	9,620	1,033	50	14,495	7,311	21,806	14,000
1990	2,389	1,428	352	2,296	18,202	1,614	263	26,544	8,576	35,120	25,000
1991	2,977	1,307	465	2,107	18,758	1,723	271	27,608	5,905	33,513	27,000
1992	2,058	1,359	548	1,880	18,601	1,281	277	26,004	3,337	29,341	25,000
1993	2,783	1,661	490	1,379	22,015	1,149	298	29,775	1,716	31,491	32,000
1994	2,935	1,804	499	1,744	22,874	1,137	298	31,291	1,711	33,002	32,000
1995	2,624	1,673	640	1,564	20,927	1,040	312	28,780	1,687	30,467	28,000
1996	2,555	1,018	535	670	15,344	848	229	20,351	2,300	22,651	23,000
1997	1,519	689	99	510	10,241	479	204	13,741	1,160	14,901	18,000
1998	1,844	520	510	782	15,198	549	338	19,739	1,129	20,868	19,100
1999	1,919	828	357	1,458	16,283	645	501	21,991	1,440	23,431	22,000
2000	1,806	1,069	362	1,280	15,273	600	346	20,736	1,796	22,532	22,000

French data are provisional

Table 7.2 North Sea sole, Catch numbers at age

YEAR	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
AGE										
1	0	0	0	55	0	0	0	1037	396	1299
2	959	1594	676	155	47100	12278	3686	17148	23922	6140
3	49786	6210	8339	2113	1089	133617	25683	13896	21451	25993
4	19140	59191	8555	5712	1599	990	85127	24973	5326	8235
5	12404	15346	46201	3809	5002	1181	1954	48571	12388	1784
6	4695	10541	8490	17337	2482	3689	536	462	25139	3231
7	3944	4826	6658	3126	12500	744	1919	245	331	11960
8	4279	4112	2423	1810	1557	6324	760	1644	244	246
9	836	2087	3393	818	1525	702	5047	324	1190	140
10	990	900	1566	872	389	767	538	4407	289	686
11	1711	1539	1002	495	627	287	610	254	2961	169
12	1154	977	764	217	475	473	455	820	291	2416
13	444	1161	1778	474	322	120	348	82	538	238
14	2539	389	413	336	200	87	277	396	151	582
+gp	416	2528	2861	621	1195	716	685	564	1042	1143
TOTALNUM	103297	111401	93119	37950	76062	161975	127625	114823	95659	64262
TONSLAND	23566	26877	26164	11342	17043	33340	33439	33179	27559	19685
SOPCOF %	101	99	99	97	96	99	102	100	102	100

YEAR	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
AGE										
1	420	358	703	101	264	1041	1747	27	9	637
2	33369	7594	12228	15380	22954	3542	22328	25031	8179	1209
3	14425	36759	12783	21540	28535	27966	12073	29292	41170	12511
4	12757	7075	16187	5487	11717	14013	15306	6129	16060	17781
5	4485	4965	4025	7061	2088	4819	7440	6639	2996	7297
6	1442	1565	2324	1922	3830	966	1779	4250	3222	1450
7	2327	523	994	1585	790	1909	319	1738	1747	2197
8	7214	1232	765	658	907	550	1112	611	816	1409
9	192	4706	1218	401	508	425	256	646	241	367
10	232	120	3337	609	234	204	211	191	393	54
11	826	100	221	2363	252	195	93	235	154	415
12	291	492	297	104	1905	132	122	123	117	52
13	1413	119	499	32	25	1320	108	106	103	52
14	466	922	110	305	84	39	852	68	73	32
+gp	1366	1048	1326	1401	945	773	729	879	687	598
TOTALNUM	81225	67578	57017	58949	75038	57894	64475	75965	75967	46061
TONSLAND	23652	21086	19309	17989	20773	17326	18003	20280	22598	15807
SOPCOF %	101	99	102	99	101	102	102	100	101	102

Table 7.2 (Continued)

YEAR	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
AGE										
1	423	2660	389	191	165	373	94	10	115	837
2	29217	26435	34408	30734	16618	9351	29018	13187	46108	12019
3	3259	45746	41386	43931	43213	18494	22052	47140	18198	103860
4	6866	1843	21189	22554	20286	17703	8913	15248	22567	9775
5	8223	3535	624	8791	9403	7745	6515	4400	4697	9357
6	3661	4789	1378	741	3556	5522	3121	3890	1694	3509
7	948	1678	1950	854	209	2272	1570	1554	1454	1164
8	886	615	978	1043	379	110	906	898	654	1273
9	766	605	386	524	637	282	81	526	466	604
10	197	527	301	242	200	620	103	38	240	268
11	107	149	423	209	192	355	166	34	45	324
12	160	74	31	146	189	173	145	86	36	59
13	92	201	14	30	94	126	63	42	49	28
14	21	12	177	24	33	105	56	10	27	63
+gp	331	315	230	243	267	305	165	111	95	215
TOTALNUM	55157	89184	103864	110257	95441	63536	72968	87174	96445	143355
TONSLAND	15403	21579	24927	26839	24248	18200	17368	21590	21806	35120
SOPCOF %	103	101	100	100	99	99	99	100	99	99

YEAR	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
AGE										
1	117	968	53	637	4723	171	1575	244	283	2307
2	13208	6864	49906	7663	12752	18632	6016	56378	15657	14890
3	25452	44201	16871	87050	16957	16101	23515	15173	71994	32351
4	77484	16198	31403	13776	68166	16930	7326	14883	8245	42506
5	6661	37983	13883	18787	6584	27213	5121	3528	6094	3386
6	3839	2471	23969	5723	7941	3941	12735	1993	1245	2491
7	1828	3083	1494	11263	2043	4812	1254	4767	704	822
8	760	788	1217	465	5982	981	2331	856	2008	472
9	742	430	490	925	294	3321	349	1049	373	945
10	325	481	194	281	345	239	1436	245	502	344
11	329	177	306	86	65	298	33	414	50	228
12	386	235	109	215	75	155	118	44	181	53
13	18	134	85	84	49	55	22	61	9	102
14	16	7	116	45	20	105	26	13	37	9
+gp	168	255	109	248	149	173	70	89	64	38
TOTALNUM	131333	114275	140205	147248	126145	93127	61927	99737	107446	100944
TONSLAND	33513	29341	31491	33002	30467	22651	14901	20868	23431	22532
SOPCOF %	98	98	99	99	99	99	99	99	99	99

Table 7.3 North Sea sole, Catch weight at age

YEAR	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
AGE										
1	0.000	0.000	0.000	0.153	0.000	0.000	0.000	0.157	0.152	0.154
2	0.146	0.155	0.163	0.175	0.169	0.177	0.192	0.189	0.191	0.212
3	0.174	0.165	0.171	0.213	0.209	0.190	0.201	0.207	0.196	0.218
4	0.211	0.208	0.219	0.252	0.246	0.180	0.252	0.267	0.255	0.285
5	0.255	0.241	0.258	0.274	0.286	0.301	0.277	0.327	0.311	0.350
6	0.288	0.295	0.309	0.309	0.282	0.332	0.389	0.342	0.373	0.404
7	0.319	0.320	0.323	0.327	0.345	0.429	0.419	0.354	0.553	0.441
8	0.304	0.321	0.387	0.346	0.378	0.399	0.339	0.455	0.398	0.463
9	0.346	0.334	0.376	0.388	0.404	0.449	0.424	0.465	0.468	0.443
10	0.372	0.349	0.440	0.444	0.425	0.472	0.498	0.475	0.499	0.511
11	0.369	0.347	0.397	0.439	0.459	0.541	0.456	0.674	0.496	0.512
12	0.397	0.394	0.433	0.475	0.480	0.526	0.389	0.524	0.538	0.541
13	0.478	0.435	0.444	0.403	0.458	0.521	0.519	0.656	0.474	0.456
14	0.450	0.373	0.490	0.447	0.397	0.491	0.442	0.495	0.613	0.542
+gp	0.551	0.476	0.578	0.644	0.528	0.499	0.591	0.650	0.613	0.542
0 SOPCOFAC	1.014	0.994	0.992	0.966	0.959	0.989	1.023	0.997	1.020	1.000

1

YEAR	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
AGE										
1	0.145	0.169	0.146	0.164	0.129	0.143	0.147	0.152	0.137	0.141
2	0.193	0.204	0.208	0.192	0.182	0.190	0.188	0.196	0.208	0.199
3	0.237	0.252	0.238	0.233	0.225	0.222	0.236	0.231	0.246	0.244
4	0.322	0.334	0.346	0.338	0.320	0.306	0.307	0.314	0.323	0.331
5	0.358	0.434	0.404	0.418	0.406	0.389	0.369	0.370	0.391	0.371
6	0.425	0.425	0.448	0.448	0.456	0.441	0.424	0.426	0.448	0.418
7	0.420	0.532	0.552	0.520	0.529	0.512	0.430	0.466	0.534	0.499
8	0.490	0.485	0.567	0.559	0.595	0.562	0.520	0.417	0.544	0.550
9	0.534	0.558	0.509	0.609	0.629	0.667	0.562	0.572	0.609	0.598
10	0.425	0.481	0.569	0.602	0.560	0.658	0.622	0.471	0.657	0.544
11	0.489	0.472	0.644	0.661	0.648	0.538	0.731	0.604	0.728	0.658
12	0.466	0.577	0.399	0.678	0.683	0.736	0.607	0.711	0.774	0.684
13	0.578	0.597	0.547	0.532	0.620	0.668	0.605	0.588	0.806	0.674
14	0.563	0.677	0.642	0.582	0.645	0.598	0.643	0.830	0.839	0.661
+gp	0.583	0.647	0.670	0.679	0.678	0.684	0.581	0.716	0.815	0.717
0 SOPCOFAC	1.012	0.989	1.019	0.986	1.010	1.022	1.019	0.996	1.012	1.020

Table 7.3. (Continued)

	YEAR	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
	AGE										
	1	0.143	0.141	0.134	0.153	0.122	0.135	0.139	0.127	0.118	0.124
	2	0.187	0.188	0.182	0.171	0.187	0.179	0.185	0.175	0.173	0.182
	3	0.226	0.216	0.217	0.221	0.216	0.213	0.205	0.217	0.216	0.226
	4	0.324	0.307	0.301	0.286	0.288	0.299	0.276	0.270	0.288	0.290
	5	0.378	0.371	0.389	0.361	0.357	0.357	0.356	0.353	0.335	0.368
	6	0.424	0.409	0.416	0.386	0.427	0.407	0.378	0.428	0.374	0.403
	7	0.442	0.437	0.467	0.465	0.447	0.485	0.428	0.483	0.456	0.401
	8	0.516	0.491	0.489	0.555	0.544	0.543	0.481	0.519	0.490	0.497
	9	0.542	0.580	0.505	0.575	0.612	0.568	0.394	0.558	0.472	0.457
	10	0.553	0.556	0.609	0.512	0.634	0.536	0.608	0.594	0.509	0.564
	11	0.403	0.628	0.622	0.655	0.509	0.575	0.644	0.807	0.681	0.622
	12	0.665	0.591	0.600	0.631	0.656	0.633	0.614	0.714	0.630	0.517
	13	0.565	0.771	0.334	0.722	0.767	0.631	0.695	0.754	0.709	0.571
	14	0.721	0.898	0.631	0.845	0.801	0.788	0.727	0.771	0.635	0.461
	+gp	0.745	0.768	0.756	0.707	0.680	0.715	0.696	0.694	0.727	0.630
0	SOPCOFAC	1.026	1.014	1.004	1.003	0.990	0.994	0.995	0.999	0.986	0.992

	YEAR	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
	AGE										
	1	0.127	0.146	0.097	0.142	0.151	0.162	0.151	0.128	0.163	0.145
	2	0.185	0.177	0.167	0.181	0.185	0.177	0.180	0.182	0.179	0.170
	3	0.209	0.213	0.195	0.202	0.196	0.202	0.206	0.189	0.212	0.200
	4	0.263	0.258	0.239	0.228	0.247	0.233	0.236	0.252	0.229	0.248
	5	0.314	0.299	0.264	0.257	0.264	0.274	0.267	0.262	0.288	0.288
	6	0.428	0.379	0.301	0.300	0.319	0.285	0.296	0.288	0.325	0.299
	7	0.434	0.410	0.338	0.317	0.342	0.319	0.325	0.336	0.353	0.322
	8	0.455	0.459	0.442	0.432	0.356	0.369	0.307	0.292	0.373	0.363
	9	0.505	0.484	0.493	0.411	0.445	0.390	0.387	0.335	0.372	0.402
	10	0.548	0.527	0.622	0.413	0.505	0.516	0.407	0.398	0.366	0.293
	11	0.513	0.590	0.563	0.516	0.750	0.540	0.575	0.502	0.511	0.443
	12	0.508	0.472	0.587	0.481	0.545	0.545	0.603	0.434	0.554	0.405
	13	0.819	0.618	0.639	0.669	0.758	0.590	0.653	0.648	0.684	0.638
	14	0.742	0.776	0.608	0.606	0.931	0.691	0.462	0.536	0.568	0.982
	+gp	0.552	0.635	0.640	0.559	0.602	0.747	0.748	0.724	0.677	0.711
0	SOPCOFAC	0.984	0.985	0.989	0.989	0.987	0.989	0.991	0.992	0.990	0.991

Table 7.4 North Sea sole, Stock weights at age derived from 2nd quarter

Run title : Sole in IV

Stock weights at age (kg)

YEAR	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
AGE										
1	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025
2	0.070	0.070	0.070	0.070	0.140	0.070	0.177	0.122	0.137	0.137
3	0.148	0.148	0.148	0.159	0.198	0.160	0.164	0.171	0.174	0.201
4	0.206	0.192	0.193	0.214	0.223	0.149	0.235	0.248	0.252	0.275
5	0.235	0.240	0.243	0.240	0.251	0.389	0.242	0.312	0.324	0.341
6	0.232	0.301	0.275	0.291	0.297	0.310	0.399	0.280	0.364	0.367
7	0.259	0.293	0.311	0.305	0.337	0.406	0.362	0.629	0.579	0.423
8	0.274	0.282	0.363	0.306	0.358	0.377	0.283	0.416	0.415	0.458
9	0.281	0.273	0.329	0.365	0.526	0.385	0.381	0.410	0.469	0.390
10	0.302	0.410	0.433	0.443	0.424	0.427	0.464	0.450	0.524	0.486
11	0.379	0.358	0.365	0.396	0.464	0.598	0.378	0.753	0.504	0.490
12	0.335	0.315	0.352	0.458	0.456	0.555	0.372	0.445	0.564	0.535
13	0.482	0.463	0.491	0.470	0.418	0.468	0.544	0.660	0.534	0.622
14	0.433	0.462	0.414	0.394	0.339	0.380	0.450	0.456	0.515	0.574
+gp	0.548	0.539	0.540	0.631	0.504	0.538	0.546	0.698	0.551	0.622

1

YEAR	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
AGE										
1	0.034	0.038	0.039	0.035	0.035	0.035	0.035	0.035	0.045	0.039
2	0.148	0.155	0.149	0.146	0.148	0.142	0.147	0.139	0.148	0.157
3	0.213	0.218	0.226	0.218	0.206	0.201	0.202	0.211	0.211	0.200
4	0.313	0.313	0.322	0.329	0.311	0.301	0.291	0.290	0.300	0.304
5	0.361	0.419	0.371	0.408	0.403	0.379	0.365	0.365	0.352	0.345
6	0.410	0.443	0.433	0.429	0.446	0.458	0.409	0.429	0.429	0.394
7	0.432	0.443	0.452	0.499	0.508	0.508	0.478	0.427	0.521	0.489
8	0.474	0.443	0.472	0.565	0.582	0.517	0.487	0.385	0.562	0.537
9	0.483	0.508	0.446	0.542	0.580	0.644	0.531	0.542	0.567	0.579
10	0.451	0.440	0.489	0.594	0.617	0.697	0.617	0.428	0.656	0.549
11	0.481	0.471	0.621	0.632	0.615	0.614	0.661	0.570	0.712	0.664
12	0.425	0.503	0.466	0.594	0.647	0.786	0.656	0.675	0.716	0.676
13	0.574	0.631	0.548	0.650	0.650	0.648	0.628	0.589	0.787	0.638
14	0.502	0.621	0.624	0.540	0.705	0.628	0.632	0.860	0.815	0.657
+gp	0.568	0.659	0.642	0.623	0.669	0.679	0.665	0.697	0.791	0.638

Table 7.4 (Continued)

YEAR	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
AGE										
1	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050
2	0.137	0.130	0.140	0.133	0.127	0.133	0.154	0.133	0.133	0.148
3	0.200	0.193	0.200	0.203	0.185	0.191	0.191	0.193	0.195	0.203
4	0.305	0.270	0.285	0.268	0.267	0.279	0.262	0.260	0.290	0.292
5	0.364	0.359	0.329	0.348	0.324	0.346	0.357	0.335	0.348	0.356
6	0.402	0.411	0.435	0.386	0.381	0.425	0.381	0.408	0.339	0.438
7	0.454	0.429	0.464	0.488	0.380	0.498	0.406	0.417	0.410	0.391
8	0.522	0.476	0.483	0.591	0.626	0.492	0.454	0.472	0.475	0.486
9	0.561	0.583	0.510	0.567	0.554	0.590	0.333	0.485	0.418	0.471
10	0.520	0.593	0.583	0.559	0.589	0.561	0.512	0.455	0.462	0.496
11	0.409	0.570	0.601	0.632	0.517	0.681	0.638	0.829	0.704	0.682
12	0.713	0.531	0.721	0.731	0.734	0.647	0.581	0.655	0.787	0.550
13	0.533	0.791	0.741	0.873	0.740	0.739	0.633	0.535	0.716	0.789
14	0.822	0.611	0.680	0.952	0.642	0.943	0.691	0.847	0.616	0.458
+gp	0.720	0.691	0.719	0.700	0.673	0.889	0.671	0.687	0.730	0.749

YEAR	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
AGE										
1	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050
2	0.138	0.156	0.128	0.143	0.151	0.147	0.150	0.140	0.131	0.139
3	0.183	0.194	0.183	0.174	0.178	0.177	0.190	0.173	0.187	0.184
4	0.253	0.256	0.228	0.209	0.240	0.208	0.225	0.234	0.216	0.226
5	0.300	0.307	0.264	0.257	0.251	0.274	0.252	0.267	0.259	0.263
6	0.406	0.397	0.293	0.326	0.320	0.267	0.303	0.281	0.295	0.275
7	0.437	0.405	0.344	0.349	0.363	0.320	0.318	0.327	0.339	0.285
8	0.499	0.468	0.479	0.402	0.357	0.372	0.324	0.271	0.322	0.332
9	0.545	0.494	0.433	0.493	0.544	0.402	0.358	0.335	0.361	0.39
10	0.537	0.544	0.573	0.341	0.458	0.402	0.385	0.332	0.416	0.264
11	0.501	0.488	0.563	0.433	0.395	0.468	0.578	0.487	0.418	0.328
12	0.551	0.443	0.507	0.519	0.701	0.537	0.634	0.305	0.497	0.299
13	0.430	0.595	0.676	0.480	0.692	0.614	0.710	0.548	0.562	0.686
14	1.109	0.672	0.580	0.689	0.584	0.638	0.705	0.480	0.674	1.065
+gp	0.640	0.607	0.662	0.505	0.660	0.800	0.653	0.638	0.628	0.627

1

Table 7.5 North Sea Sole: maturity ogive and Natural mortality

Age	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Maturity	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1
Nat Mortality*	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1

*Mortality on all ages in 1963=0.9

Table 7.6 North Sea sole, tuning fleets

NL commercial beam trawl

1979	2000													
1	1	0	1											
2	15													
44.9	721.2	35400.6	12904.4	2096.5	2657.4	1490	641.6	177.2	323.3	104.9	85.5	77	53.7	476.1
45	938.3	11061	14294.5	4914.8	938.1	1731.7	1133.1	214.3	17	347.8	16.5	32.5	23.7	432.2
46.3	26036	2756	5720.5	6094.5	2265.5	586.6	531.3	439.4	98.9	15.3	102.4	56.9	4.4	173.2
57.3	24290.1	38683	1085.1	2638.3	3214.2	961.1	234.8	352.9	287.6	80.2	41.7	157.3	7.9	141.1
65.6	31274.7	36706.2	16386.3	375.1	768.9	1117.8	531.2	237.5	168.1	338.6	15	2	157.6	143.2
70.8	26976.3	37398.3	18212.1	6529	301.2	492	633.5	321.8	123.7	130.9	90.3	6.4	14.5	155.4
70.3	12923.7	34685.4	16979.4	7239.6	2536.8	146.5	285.1	426.8	84.9	68.7	113.3	61.9	9.1	134.5
68.2	8027	13755	13809.8	6353.7	4342.4	1712.2	71.8	223.4	405.6	211.1	124.6	73.4	88.5	247.6
68.5	23736.2	18618.8	6796	5209.3	2597.3	1136.9	580.1	44.4	67.4	70.1	83.3	29.7	31.2	122.1
76.3	12191.9	40595.2	12448.9	2982.9	2955.6	1274.8	652.4	384.5	30.4	25.4	42.7	26.1	3.2	60.9
61.6	40284.3	13165.6	17489.4	2688.9	1099.4	1134.4	409.4	333.9	161.6	8.9	22.7	16.2	10	40
71.4	9071.1	84629.7	7242	6586.7	1669.1	634.6	819.2	375.9	137.6	134.1	42.5	10.1	12.6	138.2
68.5	7336.6	17182.4	59754	4638.3	2137.6	682.7	312.1	392.3	156.6	98.4	180.5	6.3	6	48.1
71.1	5046.7	33880.5	11131	29835.9	1457.9	2081.2	446.1	218.6	274.8	75.7	164.1	66.4	3.9	109
76.9	39284.5	10948	24132	9625.4	18624	887.1	811.5	236.1	66.4	186.3	50.2	41.6	59.1	21.8
81.4	5389.9	69878.8	7411.7	13010.4	3104.8	8932.9	190	524.2	175.9	25.9	158.5	25.2	20.1	149.5
81.2	9778	11329.4	53488.8	2839.2	5128.8	896.5	4682.4	147.4	204.8	24.4	22.4	34.7	6.4	108.6
72.1	15843.4	9093.9	11170.8	21211.9	1570	3173.4	471.9	2773.8	160	190.5	85.7	23.3	62.4	99.5
72	4505.9	18426.8	4503.6	3329	9771.1	497.2	1800.4	94.6	1155.3	5.7	76.9	11.1	14.3	43.5
70.2	50570.7	9023.1	11123.1	1826.2	1145.6	3395	210.7	337	21.4	286.6	5.2	37.2	4.9	42.9
67.3	11820.5	55177.2	4152.6	4458.8	730.2	335.7	1526.8	133.4	362.5	6	126.7	2	21.5	30.1
67.7	9864.3	22820	31475.5	1961.9	1750.1	524.8	283.2	696.1	156.9	149.5	27.2	75	0.7	5.4

UK beam trawl CPUE

1986	2000													
1	1	0	1											
2	15													
40.6	42.5	227.706	295.649	121.659	146.526	69.134	4.424	2.977	17.081	9.873	7.804	7.182	4.622	12.331
59.5	3.51	66.381	101.888	89.855	42.238	27.368	26.072	1.887	2.105	6.052	3.826	5.557	3.143	6.677
73.5	23.964	382.062	249.79	156.619	135.664	42.363	55.556	30.189	2.016	2.535	10.203	6.3	3.227	28.756
71.8	565.792	318.821	450.727	230.563	114.999	73.252	32.567	35.448	29.147	1.395	2.992	11.392	7.506	30.397
78.8	156.433	2511.246	302.16	427.945	241.296	164.299	114.464	63.3	55.541	35.517	2.404	3.588	22.576	23.777
115.6	123.4	513.669	2403.099	179.689	289.221	129.815	45.631	38.352	21.245	27.522	30.691	0.814	1.254	27.962
139.9	57.372	654.488	461.707	716.511	72.524	202.261	100.74	81.124	66.47	29.543	31.245	43.002	0.296	59.731
148.9	181.428	243.064	468.473	265.165	451.183	43.599	90.5	63.831	49.228	33.798	18.272	20.419	20.531	33.868
114.3	185.964	1036.164	505.135	465.135	142.426	186.756	13.034	40.721	32.599	25.364	13.245	14.576	8.37	16.848
90.5	86.311	303.447	783.082	456.297	226.653	110.484	106.186	9.779	31.89	20.171	19.567	6.574	1.69	17.641
75.5	92.399	136.566	221.037	464.569	201.271	166.369	80.273	99.947	7.5	23.4	13.836	11.684	12.093	24.623
56.7	24.685	124.198	111.961	111.309	113.751	120.337	47.796	32.019	20.383	3.745	8.16	4.303	5.196	11.673
58.6	456	284.2	168.5	105.9	108.8	83.5	119.5	52.2	17.3	14.5	3.2	4.4	2.4	10.7
50.8	84	516.7	177.9	83.9	62.8	62.5	76.7	64.8	25.5	11.4	13.3	2.4	4	10.4
48.4	113	255	559	167	64	37	47	35	50	14	5	3	1	6

Table 7.6 (Continued)

BTS (survey)

1985	2000			
1	1	0.67	0.75	
1	4			
1	2.64	7.28	3.75	1.97
1	7.76	4.58	1.7	0.81
1	6.96	12.5	1.85	0.55
1	81.23	12.81	2.78	0.99
1	8.67	67.76	4.19	4.09
1	22.44	22.33	20.06	0.59
1	3.43	23.2	5.84	6.01
1	72.71	22.66	9.61	2.26
1	4.63	26.61	1.58	5.23
1	5.94	4.95	15.46	0.13
1	26.31	8.68	8.27	6.47
1	3.48	5.94	1.8	1.45
1	173.51	5.36	3.23	0.8
1	14.16	29.15	2	1.33
1	11.2	19.51	16.62	0.63
1	13.6	6.1	4.5	1.1

SNS (survey)

1970	2000			
1	1	0.67	0.75	
1	4			
1	4938	745	204	31
1	613	1961	99	7
1	1410	341	161	0.1
1	4686	905	73	35
1	1924	397	69	0.1
1	597	887	174	44
1	1413	79	187	70
1	3724	762	77	85
1	1552	1379	267	27
1	104	388	325	60
1	4483	80	99	45
1	3739	1411	51	13
1	5098	1124	231	7
1	2640	1137	107	43
1	2359	1081	307	102
1	2151	709	159	59
1	3791	465	67	30
1	1890	955	59	15
1	11227	594	284	81
1	3052	5369	248	50
1	2900	1078	907	100
1	1265	2515	527	607
1	11081	114	319	194
1	1351	3489	46	166
1	559	475	943	10
1	1501	234	126	365
1	691	473	27	48
1	10132	143	231	51
1	2876	1993	131	52
1	1649	919	381	12.3
1	1735	150	189	95.7

Table 7.7 North Sea sole, Indices of effort and CPUE

	Effort			CPUE		
	1 Belgium	2 UK-bt	3 Netherlands	4 Belgium	5 UK-bt	6 Netherlands
1971						
1972	29.8			33.5		
1973	29.4			33.1		
1974	32.2			23.7		
1975	39.2			26.2		
1976	44.7			24.5		
1977	47.6			27.2		
1978	50.3		44.3	25.9		375.8
1979	40.0		44.9	38.7		423.2
1980	35.2		45.0	30.9		282.1
1981	31.1		46.3	35.2		267.8
1982	34.9		57.3	44.7		309.8
1983	35.4		65.6	42.8		319.9
1984	42.8		70.8	35.2		307.3
1985	51.4	19.6	70.3	40.8	41.7	276.3
1986	42.5	40.6	68.2	38.8	16.0	213.4
1987	50.7	59.5	68.5	28.9	11.4	204.5
1988	53.0	73.5	76.3	19.2	10.1	235.9
1989	54.3	71.8	61.6	22.7	14.0	272.7
1990	64.7	78.8	71.4	24.8	22.5	378.1
1991	74.3	115.6	68.5	33.5	14.3	350.9
1992	67.7	139.9	71.1	22.5	8.9	307.1
1993	71.1	148.9	76.9	27.2	7.6	306.4
1994	60.0	114.3	81.4	32.5	9.6	295.6
1995	46.5	90.5	81.2	34.9	10.8	275.1
1996	64.9	75.5	72.1	29.0	10.5	227.1
1997	47.2	56.7	72.0	24.2	4.1	151.7
1998	43.6	58.6	70.3	25.0	5.6	230.7
1999	55.7	50.8	67.3	24.3	6.9	257.9
2000	49.3	48.4	67.7	24.0	7.4	240.6

1 fishing hours in 1000 HP beam trawl units * 10E3
2 mllion HP hours
3 million HP days beam trawl
4 Kg/FH 1000 HP beam trawl
5 kg/1000 HP hours
6 kg/1000 HP day

Table 7.8 North Sea Sole, Preliminary Data Analysis

Run	Tuning fleets	Tuning years	Mean q age	F-shr	Comment
1	As last year: NLBT, UKBT, BTS, SNS	1985-2000			Separable VPA; no high residuals on ages, accept age range 1-15+ as last year
2	NLBT	1979-2000	7	1.5	trend in ln q residuals before 1990
	UKBT	1986-2000	7	1.5	some trend before 1990
	BTS	1985-2000	7	1.5	no clear trends
	SNS	1970-2000	7	1.5	no clear trends
3	all	1990-2000	10	0.5	no improvement in q plateau or SEs
4	all	1979-2000	7	1.0	no improvement in SEs; improved survivor estimate age 1 (1999yr cl)
5	all	NLBT & UKBT 1990-2000; surveys full range	7	0.5	no overall improvement
6	all	1990-2000	7	0.5	Final run

Table 7.9 North Sea sole: Separable VPA output

Title : Sole in IV At 19/09/2001 18:20

Separable analysis
from 1957 to 2000 on ages 1 to 14
with Terminal F of .500 on age 4 and Terminal S of .800

Initial sum of squared residuals was 1770.658 and
final sum of squared residuals is 421.353 after 150 iterations

Matrix of Residuals

Years	1980/81	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87	1987/88	1988/89	1989/90
1/ 2	-0.338	-0.648	0.66	-0.842	-1.153	-0.446	-1.158	-1.671	-5.172	-1.017
2/ 3	-0.356	0.166	-0.086	0.426	0.115	0.607	-0.531	-0.042	0.142	0.008
3/ 4	0.31	0.237	0.178	0.349	0.284	0.664	0.09	-0.108	0.311	0.562
4/ 5	0.047	-0.108	0.038	0.19	-0.061	0.303	-0.099	-0.212	0.319	0.405
5/ 6	0.054	-0.138	-0.008	-0.773	0.062	-0.036	-0.093	-0.317	0.174	-0.108
6/ 7	-0.201	0.116	-0.039	-0.112	0.434	-0.105	0.271	-0.129	0.203	-0.024
7/ 8	0.473	-0.039	-0.2	0.225	0.177	0.279	0.134	-0.074	0.275	-0.082
8/ 9	-0.003	-0.265	-0.455	0.048	-0.322	-0.24	-0.661	-0.271	-0.119	-0.313
9/10	0.359	0.076	0.137	0.238	0.504	-0.165	0.401	0.3	0.369	0.508
10/11	-1.637	-0.705	-1.051	-0.55	-0.93	-1.443	0.001	-0.057	-1.298	-1.035
11/12	1.015	0.402	1.346	1.161	-0.026	0.241	0.631	0.527	-0.157	-0.007
12/13	-1.396	-1.084	0.526	-0.755	-0.591	-0.337	-0.174	0.204	-0.436	-0.357
13/14	0.876	1.976	-0.192	-0.535	-0.316	-0.067	0.45	1.617	0.252	-0.076
TOT	0	0	0	0	0	0	0	0	0	0
WTS	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001

Years	1990/91	1991/92	1992/93	1993/94	1994/95	1995/96	1996/97	1997/98	1998/99	1999/**	TOT	WTS
1/ 2	0.716	-0.656	-0.433	-1.497	0.281	2.313	-0.464	-0.159	-1.075	-0.551	0	0.116
2/ 3	-0.113	-0.636	-0.25	0.036	-0.393	0.537	-0.041	-0.379	0.008	-0.117	0.001	0.552
3/ 4	0.017	0.1	0.058	-0.164	-0.323	-0.196	-0.038	0.051	-0.076	0.252	0	0.835
4/ 5	-0.323	-0.075	-0.563	-0.295	-0.284	0.288	-0.109	-0.119	-0.248	0.189	-0.001	0.988
5/ 6	0.269	0.29	-0.168	0.174	-0.064	-0.018	-0.436	0.188	-0.009	0.27	-0.002	0.924
6/ 7	0.037	-0.473	-0.113	0.06	0.122	-0.008	-0.026	0.242	-0.002	-0.21	-0.002	1
7/ 8	0	0.34	0.504	0.666	-0.076	0.415	-0.237	-0.164	0.021	-0.037	-0.001	0.782
8/ 9	-0.064	-0.11	-0.126	-0.401	-0.43	0.103	-0.111	0.076	-0.199	0.135	0	0.987
9/10	0.367	0.106	0.543	0.229	0.456	0.058	0.061	-0.018	0.073	-0.183	0.002	0.958
10/11	-1.152	-0.416	-0.488	-0.199	0.23	-0.663	0.485	0.181	0.203	-0.179	0.003	0.532
11/12	-0.107	0.335	0.559	0.361	-0.053	-0.683	0.507	-0.325	0.497	-0.01	0.002	0.521
12/13	0.368	0.163	0.205	-0.624	0.376	-0.375	0.592	-0.274	0.334	-0.266	0.001	0.454
13/14	0.536	0.85	0.125	0.549	1.149	-0.671	0.229	0.394	0.075	-0.041	0	0.395
TOT	0	0	0	0	0	0	0	0	0	0	-60.03	
WTS	0.001	0.001	0.001	0.001	0.001	1	1	1	1	1		

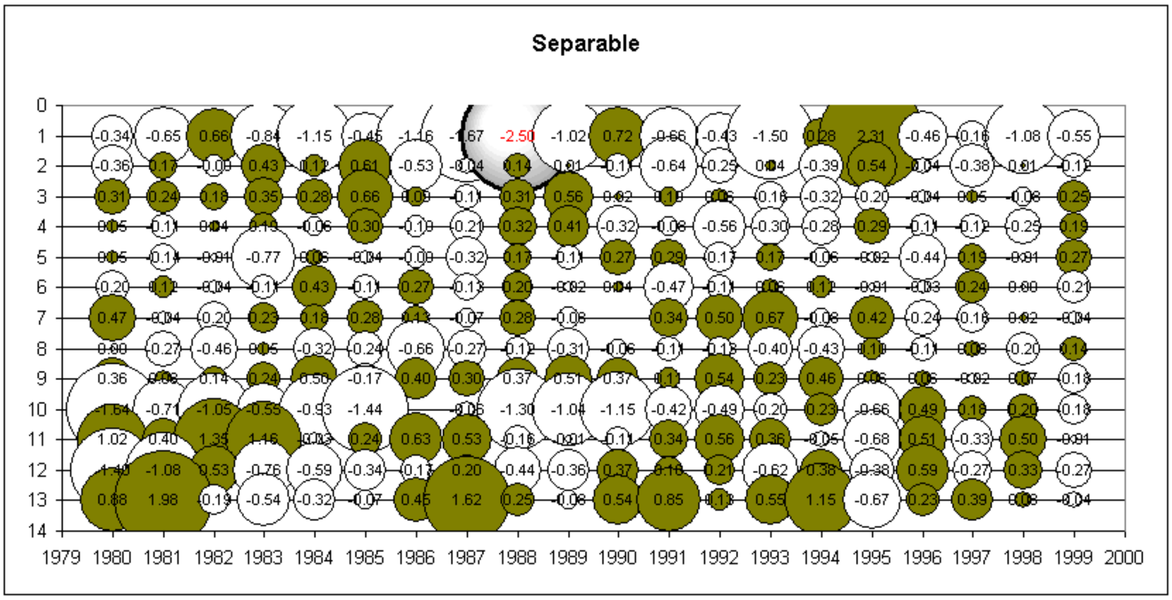


Table 7.10 North Sea Sole: XSA tuning output

Lowestoft VPA Version 3.1
14/09/2001 19:10
Extended Survivors Analysis
Sole in IV

CPUE data from file fleet2.txt

Catch data for 44 years. 1957 to 2000. Ages 1 to 15.

Fleet	First year	Last year	First age	Last age	Alpha	Beta
FLT01: NL Comm BT	1990	2000	2	14	0	1
FLT02: UK Comm BT	1990	2000	2	14	0	1
FLT03: BTS-ISIS Neth	1990	2000	1	4	0.67	0.75
FLT04: SNS-Tridens N	1990	2000	1	4	0.67	0.75

Time series weights :
Tapered time weighting not applied

Catchability analysis :
Catchability dependent on stock size for ages < 3

Regression type = C
Minimum of 5 points used for regression
Survivor estimates shrunk to the population mean for ages < 3

Catchability independent of age for ages >= 7

Terminal population estimation :

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

S.E. of the mean to which the estimates are shrunk = .500

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

Prior weighting not applied

Tuning converged after 25 iterations

Regression weights	1	1	1	1	1	1	1	1	1	1
Fishing mortalities										
Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	0.002	0.003	0.001	0.012	0.051	0.004	0.005	0.002	0.003	0.021
2	0.089	0.115	0.18	0.136	0.297	0.26	0.148	0.245	0.155	0.224
3	0.42	0.423	0.404	0.48	0.439	0.66	0.536	0.588	0.497	0.481
4	0.551	0.457	0.533	0.597	0.761	0.935	0.636	0.686	0.656	0.544
5	0.727	0.507	0.796	0.627	0.564	0.699	0.728	0.64	0.59	0.546
6	0.403	0.577	0.618	0.809	0.524	0.697	0.741	0.618	0.431	0.451
7	0.584	0.58	0.738	0.587	0.676	0.617	0.437	0.605	0.406	0.499
8	0.507	0.475	0.42	0.471	0.632	0.719	0.611	0.534	0.49	0.464
9	0.388	0.533	0.541	0.578	0.545	0.779	0.534	0.543	0.415	0.399
10	0.481	0.416	0.432	0.607	0.389	1.052	0.828	0.794	0.481	0.744
11	0.502	0.465	0.45	0.307	0.24	0.606	0.334	0.529	0.319	0.371
12	0.584	0.722	0.516	0.582	0.426	1.254	0.454	0.88	0.411	0.58
13	0.668	0.363	0.55	0.855	0.222	0.562	0.499	0.397	0.384	0.381
14	0.58	0.526	0.542	0.56	0.44	0.886	0.501	0.55	0.396	0.728

Standard error of the weighted Log(VPA populations) :

0.7804	0.8232	0.8566	0.9023	0.9397	0.9441	1.0125	1.041	1.1031	1.2711

Table 7.11 North Sea sole: Fishing Mortality

Run title : Sole in IV At 20/06/2001 13:36

Table 8 Fishing mortality (F) at age

YEAR	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
AGE										
1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.011	0.008	0.010
2	0.017	0.016	0.042	0.018	0.104	0.125	0.110	0.307	0.330	0.153
3	0.125	0.129	0.151	0.251	0.148	0.421	0.368	0.661	0.687	0.632
4	0.251	0.192	0.376	0.204	0.273	0.175	0.459	0.649	0.505	0.544
5	0.171	0.291	0.318	0.408	0.247	0.296	0.539	0.458	0.695	0.279
6	0.199	0.192	0.368	0.263	0.451	0.259	0.190	0.207	0.404	0.341
7	0.118	0.289	0.249	0.315	0.274	0.209	0.186	0.112	0.201	0.304
8	0.240	0.156	0.324	0.135	0.228	0.194	0.305	0.215	0.139	0.201
9	0.104	0.158	0.261	0.240	0.145	0.136	0.210	0.184	0.213	0.099
10	0.110	0.140	0.237	0.135	0.154	0.091	0.132	0.255	0.222	0.164
11	0.158	0.223	0.322	0.150	0.122	0.146	0.087	0.076	0.243	0.175
12	0.250	0.114	0.229	0.146	0.189	0.115	0.321	0.146	0.106	0.285
13	0.174	0.379	0.451	0.305	0.298	0.060	0.104	0.078	0.121	0.107
14	0.159	0.203	0.315	0.196	0.182	0.110	0.171	0.148	0.181	0.166
+gp	0.159	0.203	0.315	0.196	0.182	0.110	0.171	0.148	0.181	0.166
FBAR 2- 8	0.160	0.181	0.261	0.228	0.246	0.240	0.308	0.373	0.423	0.351
FBAR 3-10	0.165	0.193	0.286	0.244	0.240	0.223	0.299	0.343	0.383	0.321

YEAR	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
AGE										
1	0.011	0.005	0.007	0.001	0.007	0.010	0.013	0.001	0.001	0.004
2	0.324	0.239	0.205	0.185	0.276	0.104	0.260	0.235	0.226	0.126
3	0.563	0.627	0.698	0.586	0.540	0.557	0.533	0.564	0.657	0.558
4	0.651	0.527	0.552	0.652	0.652	0.492	0.600	0.502	0.615	0.585
5	0.570	0.502	0.573	0.438	0.488	0.541	0.466	0.501	0.434	0.556
6	0.339	0.352	0.411	0.524	0.400	0.389	0.346	0.470	0.428	0.344
7	0.391	0.176	0.351	0.483	0.376	0.316	0.190	0.592	0.318	0.516
8	0.270	0.328	0.373	0.367	0.499	0.432	0.274	0.587	0.543	0.407
9	0.214	0.253	0.553	0.304	0.476	0.408	0.326	0.226	0.427	0.444
10	0.213	0.180	0.256	0.524	0.260	0.316	0.324	0.382	0.187	0.142
11	0.271	0.120	0.512	0.259	0.378	0.320	0.207	0.636	0.535	0.274
12	0.453	0.230	0.540	0.428	0.305	0.309	0.302	0.410	0.672	0.306
13	0.239	0.300	0.341	0.089	0.153	0.319	0.397	0.413	0.633	0.636
14	0.279	0.217	0.442	0.322	0.315	0.335	0.312	0.415	0.492	0.361
+gp	0.279	0.217	0.442	0.322	0.315	0.335	0.312	0.415	0.492	0.361
FBAR 2- 8	0.444	0.393	0.452	0.462	0.461	0.404	0.381	0.493	0.460	0.442
FBAR 3-10	0.401	0.368	0.471	0.485	0.461	0.431	0.382	0.478	0.451	0.444

Table 7.11 (Continued)

YEAR	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
AGE										
1	0.003	0.018	0.003	0.003	0.002	0.002	0.001	0.000	0.001	0.005
2	0.248	0.230	0.308	0.285	0.313	0.142	0.235	0.236	0.128	0.137
3	0.513	0.668	0.595	0.712	0.717	0.602	0.506	0.645	0.522	0.415
4	0.604	0.543	0.666	0.672	0.755	0.643	0.579	0.700	0.653	0.523
5	0.522	0.639	0.314	0.570	0.583	0.646	0.457	0.559	0.423	0.549
6	0.531	0.581	0.486	0.663	0.420	0.720	0.518	0.483	0.384	0.570
7	0.351	0.438	0.438	0.560	0.347	0.460	0.403	0.467	0.296	0.439
8	0.358	0.359	0.437	0.393	0.460	0.276	0.298	0.376	0.324	0.405
9	0.359	0.392	0.357	0.393	0.392	0.654	0.300	0.252	0.303	0.496
10	0.402	0.398	0.307	0.352	0.227	0.727	0.466	0.200	0.156	0.255
11	0.405	0.534	0.567	0.322	0.462	0.692	0.380	0.244	0.342	0.290
12	0.144	0.481	0.177	0.344	0.478	0.880	0.598	0.308	0.391	0.894
13	1.205	0.242	0.138	0.232	0.346	0.601	0.839	0.304	0.257	0.529
14	0.505	0.411	0.310	0.330	0.382	0.714	0.518	0.262	0.291	0.539
+gp	0.505	0.411	0.310	0.330	0.382	0.714	0.518	0.262	0.291	0.539
FBAR 2- 8	0.447	0.494	0.464	0.551	0.514	0.498	0.428	0.495	0.390	0.434
FBAR 3-10	0.455	0.502	0.450	0.539	0.488	0.591	0.441	0.460	0.383	0.456

YEAR	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	FBAR 98-00	Fbar 98-00 scaled
AGE												to F2-9 in 2000
1	0.002	0.003	0.001	0.012	0.051	0.004	0.006	0.002	0.003	0.022	0.009	0.008
2	0.089	0.116	0.180	0.136	0.297	0.261	0.148	0.245	0.155	0.224	0.208	0.193
3	0.420	0.423	0.404	0.480	0.439	0.661	0.536	0.588	0.497	0.481	0.522	0.485
4	0.551	0.457	0.533	0.597	0.761	0.935	0.636	0.686	0.656	0.544	0.628	0.585
5	0.727	0.507	0.796	0.627	0.565	0.699	0.728	0.640	0.590	0.546	0.592	0.551
6	0.403	0.577	0.618	0.809	0.524	0.697	0.741	0.618	0.431	0.451	0.500	0.465
7	0.584	0.580	0.738	0.587	0.676	0.618	0.437	0.605	0.406	0.499	0.504	0.468
8	0.507	0.475	0.420	0.471	0.632	0.719	0.611	0.534	0.490	0.464	0.496	0.461
9	0.388	0.533	0.541	0.578	0.545	0.779	0.534	0.543	0.415	0.399	0.452	0.421
10	0.481	0.416	0.432	0.607	0.389	1.052	0.829	0.794	0.481	0.744	0.673	0.626
11	0.502	0.465	0.450	0.307	0.240	0.606	0.334	0.529	0.319	0.371	0.406	0.378
12	0.584	0.722	0.516	0.582	0.426	1.254	0.454	0.880	0.411	0.581	0.624	0.580
13	0.668	0.363	0.550	0.855	0.222	0.562	0.499	0.397	0.384	0.381	0.387	0.360
14	0.580	0.526	0.542	0.560	0.440	0.886	0.501	0.550	0.396	0.728	0.558	0.519
+gp	0.580	0.526	0.542	0.560	0.440	0.886	0.501	0.550	0.396	0.728		
FBAR 2- 8	0.469	0.448	0.527	0.529	0.556	0.655	0.548	0.559	0.461	0.458	0.493	0.458
FBAR 3-10	0.508	0.496	0.560	0.594	0.566	0.770	0.632	0.626	0.496	0.516		

Table 7.12. North Sea sole Stock Numbers at age

Run title : Sole in IV At 19/9/01

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

YEAR	1957	1958	1959	1960
AGE				
1	165506	144954	559013	66859
2	78587	149756	131160	505815
3	106075	69763	133741	115198
4	70123	86328	55095	109576
5	25073	51425	64635	39959
6	25568	19109	37494	49946
7	37658	20353	13976	28439
8	15794	27874	15555	11499
9	7421	12642	20999	12149
10	46887	6230	9296	16552
11	1774	37308	4946	7112
12	1813	1447	28797	3775
13	327	1387	1204	23322
14	745	263	1058	993
+gp	3427	1966	3376	2431
TOTAL	586777	630807	1080346	993626

YEAR	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
AGE										
1	115737	28346	23008	554360	121486	41182	75333	100100	50589	141510
2	60497	104723	25649	9354	501554	109925	37263	68164	89588	45398
3	446226	53827	93241	9997	8317	409022	87785	30211	45366	58307
4	90792	356404	42798	32592	7036	6489	242998	55001	14117	20644
5	83169	63945	266184	11945	24057	4845	4930	138898	26012	7708
6	27302	63456	43263	78763	7185	17009	3261	2602	79478	11753
7	37234	20238	47390	12176	54776	4141	11882	2441	1915	48002
8	21123	29940	13721	15022	8044	37673	3039	8926	1975	1418
9	8890	15043	23179	4034	11871	5797	28073	2027	6512	1555
10	9988	7248	11626	7260	2872	9291	4578	20600	1526	4761
11	12314	8096	5702	3728	5740	2228	7677	3630	14448	1106
12	5492	9514	5861	1680	2903	4597	1743	6366	3043	10256
13	2926	3871	7680	1896	1313	2175	3710	1145	4980	2477
14	18121	2225	2399	1989	1265	882	1854	3026	958	3995
+gp	2964	14430	15701	3668	7542	7249	4575	4302	6596	7831
TOTAL	942774	781308	627402	748464	765960	662507	518700	447439	347104	366720

Table 7.12 (Continued)

YEAR	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
AGE										
1	41940	76963	106444	110847	41933	114287	140748	47084	11842	155177
2	126808	37549	69299	95645	100202	37692	102421	125692	42578	10706
3	35237	82999	26752	51073	71914	68832	30736	71435	89921	30746
4	28033	18163	40134	12047	25723	37927	35680	16326	36774	42202
5	10846	13231	9704	20917	5681	12129	20988	17725	8943	17998
6	5277	5548	7249	4952	12210	3154	6391	11914	9723	5242
7	7561	3403	3531	4348	2653	7405	1935	4091	6737	5733
8	32057	4628	2582	2250	2427	1649	4884	1448	2048	4434
9	1049	22144	3016	1609	1410	1333	969	3362	729	1077
10	1274	767	15560	1570	1074	792	802	633	2427	430
11	3655	932	580	10905	841	749	523	525	391	1823
12	840	2522	748	314	7620	522	493	385	251	207
13	6982	483	1814	395	185	5083	346	330	231	116
14	2015	4974	324	1166	327	144	3343	211	197	111
+gp	5890	5641	3887	5341	3663	2844	2852	2713	1849	2067
TOTAL	309464	279946	291624	323379	277862	294542	353111	303873	214642	278069

YEAR	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
AGE										
1	149698	153499	144559	72015	82353	161400	72871	446608	109408	180779
2	139804	135050	136362	130432	64980	74359	145686	65847	404098	98887
3	8538	98708	97052	90655	88785	42989	58388	104219	47037	321784
4	15919	4625	45799	48449	40240	39230	21306	31855	49460	25251
5	21272	7873	2432	21285	22384	17114	18657	10800	14319	23287
6	9344	11426	3761	1607	10898	11310	8118	10685	5587	8489
7	3364	4972	5783	2093	749	6478	4981	4377	5968	3444
8	3097	2142	2903	3378	1081	479	3700	3013	2482	4017
9	2672	1960	1353	1696	2064	618	329	2486	1872	1624
10	626	1689	1198	857	1036	1262	291	220	1749	1251
11	338	379	1027	798	545	748	552	165	163	1355
12	1254	204	201	527	523	311	339	341	117	105
13	138	983	114	152	338	293	117	169	227	72
14	56	37	698	90	109	216	146	46	113	159
+gp	874	980	904	907	881	624	427	505	395	540
TOTAL	356992	424526	444146	374941	316966	357431	335906	681337	642996	671041

Table 7.12 continued. North Sea Sole Stock numbers at age

Run title : Sole in IV At 19/9/01

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

YEAR	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	GMST 57-98	AMST 57-98
AGE													
1	73248	352367	70282	58255	99370	50978	303366	127288	86431	114249***	0*	99885	136752
2	162779	66167	317914	63544	52105	85421	45964	272999	114943	77937	101182**	87446	122105
3	78044	134725	53341	240189	50207	35017	59569	35868	193391	89111	56357	64439	92187
4	192367	46406	79859	32216	134527	29300	16369	31532	18021	106505	49858	36896	56374
5	13549	100356	26582	42388	16047	56884	10407	7842	14374	8463	55937	19779	32963
6	12170	5924	54676	10846	20483	8257	25585	4545	3740	7209	4437	11378	18132
7	4343	7361	3010	26672	4370	10980	3722	11036	2217	2200	4154	7051	11946
8	2009	2191	3727	1302	13421	2011	5358	2175	5451	1336	1209	4423	7821
9	2424	1095	1233	2215	736	6453	887	2631	1154	3023	760	2880	5506
10	895	1487	582	649	1124	386	2680	470	1383	689	1836	1981	4821
11	877	500	888	342	320	689	122	1059	192	774	296	1344	3514
12	917	481	284	512	227	228	340	79	564	127	483	890	2576
13	39	463	211	154	259	134	59	196	30	339	64	565	1869
14	38	18	291	110	59	188	69	32	119	18	209	367	1311
+gp	399	653	273	605	438	307	186	220	205	77	42		
TOTAL	544099	720193	613153	480000	393695	287233	474683	497972	442216	412056	276824		

* GM 99885
** RCT3 85172
*** RCT3 95220

Table 7.13 North Sea sole, Indices of recruitment (input data for RCT3)

Year class	VPA-1	VPA-2	VPA-3	DFS INT-0	SNS-1	DFS INT-1	SNS-2	SNS-3	Ger-3	BTS-1	BTS-2
1968	50589	45398	35237	-11		-11	745	99	-11	-11	-11
1969	141510	126808	82999	-11	4938	-11	1961	161	-11	-11	-11
1970	41940	37549	26752	-11	613	-11	341	73	-11	-11	-11
1971	76963	69299	51073	-11	1410	-11	905	69	-11	-11	-11
1972	106444	95645	71914	-11	4686	-11	397	174	-11	-11	-11
1973	110847	100202	68832	-11	1924	-11	887	187	31.5	-11	-11
1974	41933	37692	30736	-11	597	2.83	79	77	16.3	-11	-11
1975	114287	102421	71435	160.94	1413	6.95	762	267	34.4	-11	-11
1976	140748	125692	89921	80.99	3724	9.63	1379	325	-11	-11	-11
1977	47084	42578	30746	27.95	1552	2.1	388	99	41.5	-11	-11
1978	11842	10706	8538	89.98	104	2.27	80	51	1.9	-11	-11
1979	155177	139804	98708	392.06	4483	-11	1411	231	76.1	-11	-11
1980	149698	135050	97052	403.86	3739	14.59	1124	107	77.1	-11	-11
1981	153499	136362	90655	295.15	5098	15.08	1137	307	147.1	-11	-11
1982	144559	130432	88785	340.01	2640	-11	1081	159	77.8	-11	-11
1983	72015	64980	42989	108.73	2359	12.31	709	67	10.8	-11	7.28
1984	82353	74359	58388	195.01	2151	3.97	465	59	29.8	2.64	4.58
1985	161400	145686	104219	300.66	3791	13.55	955	284	24.6	7.76	12.5
1986	72871	65847	47037	72.06	1890	6.18	594	248	20.3	6.96	12.81
1987	446608	404098	321784	532.11	11227	38.04	5369	907	66.9	81.23	67.76
1988	109408	98887	78044	61.15	3052	9.25	1078	527	86.4	8.67	22.33
1989	180779	162779	134725	83.38	2900	13.26	2515	319	54.1	22.44	23.2
1990	73248	66167	53341	62.16	1265	12.26	114	46	11.3	3.43	22.66
1991	352367	317914	240189	368.7	11081	18.44	3489	943	180.7	72.71	26.61
1992	70282	63544	50207	32.65	1351	11.84	475	126	-11	4.63	4.95
1993	58255	52105	35017	29.18	559	5.88	234	27	-11	5.94	8.68
1994	99370	85421	59569	76.17	1501	7.16	473	231	12.9	26.31	5.94
1995	50978	45964	35868	18.13	691	3.25	143	131	0.9	3.48	5.36
1996	303366	272999	193391	61.03	10132	24.88	1993	381	45.7	173.51	29.15
1997	127288	114943	89111	55.86	2875	-11	919	189	13.6	14.16	19.51
1998	86431	77937	56357	-11	1649	-11	150	-11	-11	11.2	6.1
1999	-11	-11	-11	-11	1735	4.6*	-11	-11	-11	13.6	-11
2000	-11	-11	-11	16.9*	-11	-11	-11	-11	-11	-11	-11
mean(68-98)	**123366**	**110981**	**81705**	**167**	**3180**	**11**	**1044**	**229**	**48**	**30**	**17**

DFS International Demersal Fish Survey
BTS International Beam Trawl Survey
SNS Sole Net Survey
GER German Solea survey

* Not available during WG

Table 7.14a North Sea sole, Recruitment estimates at age 1

```
Analysis by RCT3 ver3.1 of data from file : s4rct100.csv

Sole North Sea - Age1

Data for    8 surveys over   33 years :  1968 - 2000

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 =   1998

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

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

DFS-0
SNS-1      .76   5.67    .27   .887     28   7.41   11.32     .282     .468
DFS-1
SNS-2      .81   6.23    .43   .754     29   5.02   10.28     .464     .173
SNS-3
Solea-
BTS-1      .64  10.01    .39   .789     13   2.50   11.60     .439     .194
BTS-2     1.16   8.59    .55   .645     14   1.96   10.86     .628     .095

                                       VPA Mean =   11.49     .731     .070


Yearclass =   1999

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

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

DFS-0
SNS-1      .76   5.67    .27   .887     28   7.46   11.35     .282     .640
DFS-1
SNS-2
SNS-3
Solea-
BTS-1      .64  10.01    .39   .789     13   2.68   11.72     .438     .265
BTS-2

                                       VPA Mean =   11.49     .731     .095



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

1998       70311     11.16      .19     .22      1.34
1999       95220     11.46      .23     .11       .24
2000      No valid surveys
```

Table 7.14b North Sea sole, Recruitment estimates at age 2

```
Analysis by RCT3 ver3.1 of data from file : s4rct200.csv

Sole North Sea -Age 2.,,,,,,,,,

Data for    8 surveys over   33 years :  1968 - 2000

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 =   1998

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

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

DFS-0
SNS-1      .76   5.57    .26   .888     28   7.41   11.21     .280     .476
DFS-1
SNS-2      .81   6.13    .42   .755     29   5.02   10.17     .463     .175
SNS-3
Solea-
BTS-1      .64   9.89    .40   .780     13   2.50   11.50     .452     .183
BTS-2     1.15   8.49    .54   .651     14   1.96   10.75     .621     .097

                                       VPA Mean =   11.38     .731     .070


Yearclass =   1999

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

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

DFS-0
SNS-1      .76   5.57    .26   .888     28   7.46   11.25     .280     .653
DFS-1
SNS-2
SNS-3
Solea-
BTS-1      .64   9.89    .40   .780     13   2.68   11.61     .452     .251
BTS-2

                                       VPA Mean =   11.38     .731     .096
```

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
1998	62872	11.05	.19	.22	1.33		
1999	85172	11.35	.23	.11	.23		
2000	No valid surveys						

Table 7.14c North Sea sole, Recruitment estimates at age 3

Analysis by RCT3 ver3.1 of data from file : s4rct300.csv

Sole North Sea - Age 3

Data for 8 surveys over 33 years : 1968 - 2000

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 = 1998

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression			----------I		I-----------Prediction		---------I	
DFS-0									
SNS-1	.76	5.26	.29	.870	28	7.41	10.90	.302	.465
DFS-1									
SNS-2	.81	5.81	.44	.732	29	5.02	9.86	.485	.181
SNS-3									
Solea-									
BTS-1	.67	9.53	.46	.734	13	2.50	11.21	.519	.158
BTS-2	1.17	8.17	.53	.669	14	1.96	10.46	.611	.114
					VPA Mean =		11.08	.721	.082

Yearclass = 1999

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression			----------I		I-----------Prediction		---------I	
DFS-0									
SNS-1	.76	5.26	.29	.870	28	7.46	10.94	.302	.660
DFS-1									
SNS-2									
SNS-3									
Solea-									
BTS-1	.67	9.53	.46	.734	13	2.68	11.33	.518	.224
BTS-2									
					VPA Mean =		11.08	.721	.116

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
1998	45407	10.72	.21	.23	1.21	56357	10.94
1999	62405	11.04	.25	.11	.22		
2000	No valid surveys						

Table 7.15 North Sea sole, Assessment Summary table

Run Title Sole in IV at 14/09/2001 19:11

Table 16 Summary (without SOP correction)

	RECRUITS Age 1	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	FBAR 2- 8
1957	165506	88542	78903	12067	0.1529	0.1369
1958	144954	99677	85570	14287	0.167	0.1599
1959	559013	116349	93193	13832	0.1484	0.1324
1960	66859	138325	101247	18620	0.1839	0.1669
1961	115737	156085	148957	23566	0.1582	0.1599
1962	28346	156827	148788	26877	0.1806	0.1806
1963	23008	150776	148406	26164	0.1763	0.2612
1964	554360	68099	53585	11342	0.2117	0.2277
1965	121486	122209	48955	17043	0.3481	0.2464
1966	41182	113512	104788	33340	0.3182	0.2398
1967	75333	109356	100877	33439	0.3315	0.3081
1968	100100	99744	88925	33179	0.3731	0.3726
1969	50589	83915	70377	27559	0.3916	0.4229
1970	141510	72703	62946	19685	0.3127	0.3506
1971	41940	72575	52381	23652	0.4515	0.4439
1972	76963	64487	55742	21086	0.3783	0.3929
1973	106444	56354	41877	19309	0.4611	0.4518
1974	110847	60138	42294	17989	0.4253	0.4623
1975	41933	59335	43038	20773	0.4827	0.4615
1976	114287	52855	43503	17326	0.3983	0.4043
1977	140748	56057	36075	18003	0.499	0.3813
1978	47084	57729	38610	20280	0.5253	0.4928
1979	11842	53090	46255	22598	0.4886	0.46
1980	155177	43846	36114	15807	0.4377	0.4416
1981	149698	51449	24811	15403	0.6208	0.4467
1982	153499	60151	34920	21579	0.618	0.494
1983	144559	68663	42345	24927	0.5887	0.4636
1984	72015	66564	45616	26839	0.5884	0.5507
1985	82353	55238	42868	24248	0.5656	0.5135
1986	161400	54064	36104	18200	0.5041	0.4985
1987	72871	57537	31458	17368	0.5521	0.428
1988	446608	72852	41764	21590	0.517	0.4951
1989	109408	95552	36337	21806	0.6001	0.39
1990	180779	114577	90903	35120	0.3863	0.4339
1991	73248	104044	77918	33513	0.4301	0.4687
1992	352367	105615	77675	29341	0.3777	0.4479
1993	70282	100038	55831	31491	0.564	0.5272
1994	58255	86970	74970	33002	0.4402	0.5294
1995	99370	72724	59888	30467	0.5087	0.5562
1996	50978	53093	37987	22651	0.5963	0.6555
1997	303366	52206	30143	14901	0.4943	0.5482
1998	127288	67578	22993	20868	0.9076	0.5595
1999	86431	68347	48968	23431	0.4785	0.4605
2000	95220	64243	47698	22532	0.4724	0.4584
2001	99885		40527			
Arith. Mean	135097	82366	62105	22661	0.4276	0.4019
Units	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)		

*** RCT3 estimate**

**** GM(1957-98)**

SSB estimated using averagewt at age in the stock (1998-2000)

Table 7.16 North Sea Sole input data for catch forecast, linear sensitivity analysis and medium and long term forecasts

Label	Value	CV	Label	Value	CV
Number at age			Weight in the stock		
N1	99885	0.80	WS1	0.05	0.00
N2	85172	0.19	WS2	0.14	0.04
N3	56356	0.15	WS3	0.18	0.04
N4	49857	0.13	WS4	0.23	0.04
N5	55937	0.12	WS5	0.26	0.02
N6	4437	0.13	WS6	0.28	0.04
N7	4154	0.14	WS7	0.32	0.09
N8	1209	0.14	WS8	0.31	0.11
N9	760	0.16	WS9	0.36	0.08
N10	1835	0.18	WS10	0.34	0.23
N11	295	0.20	WS11	0.41	0.19
N12	482	0.21	WS12	0.37	0.31
N13	64	0.26	WS13	0.60	0.13
N14	208	0.25	WS14	0.74	0.40
N15	42	0.30	WS15	0.63	0.01
H.cons selectivity			Weight in the HC catch		
sH1	0.01	1.24	WH1	0.15	0.12
sH2	0.19	0.19	WH2	0.18	0.04
sH3	0.49	0.02	WH3	0.20	0.06
sH4	0.59	0.10	WH4	0.24	0.05
sH5	0.55	0.06	WH5	0.28	0.05
sH6	0.47	0.09	WH6	0.30	0.06
sH7	0.47	0.12	WH7	0.34	0.05
sH8	0.46	0.05	WH8	0.34	0.13
sH9	0.42	0.06	WH9	0.37	0.09
sH10	0.63	0.22	WH10	0.35	0.15
sH11	0.38	0.16	WH11	0.49	0.08
sH12	0.58	0.27	WH12	0.46	0.17
sH13	0.36	0.09	WH13	0.66	0.04
sH14	0.52	0.34	WH14	0.70	0.36
sH15	0.52	0.34	WH15	0.70	0.03
Natural mortality			Proportion mature		
M1	0.10	0.10	MT1	0.00	0.00
M2	0.10	0.10	MT2	0.00	0.10
M3	0.10	0.10	MT3	1.00	0.10
M4	0.10	0.10	MT4	1.00	0.00
M5	0.10	0.10	MT5	1.00	0.00
M6	0.10	0.10	MT6	1.00	0.00
M7	0.10	0.10	MT7	1.00	0.00
M8	0.10	0.10	MT8	1.00	0.00
M9	0.10	0.10	MT9	1.00	0.00
M10	0.10	0.10	MT10	1.00	0.00
M11	0.10	0.10	MT11	1.00	0.00
M12	0.10	0.10	MT12	1.00	0.00
M13	0.10	0.10	MT13	1.00	0.00
M14	0.10	0.10	MT14	1.00	0.00
M15	0.10	0.10	MT15	1.00	0.00
Relative effort in HC fishery			Year effect for natural mortality		
HF01	1.00	0.12	K01	1.00	0.10
HF02	1.00	0.12	K02	1.00	0.10
HF03	1.00	0.12	K03	1.00	0.10
Recruitment in 2002 and 2003					
R02	99885	0.80			
R03	99885	0.80			

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

Stock numbers in 2001 are VPA survivors.
These are overwritten at Age 2

Data from file:H:\ASSESS\wgnssk01\Sole\IV\rev data sep01\pastoorsrev19Sep\mla\Soliv.sen

Table 7.17 North Sea Sole Management Options

Catch forecast output and estimates of coefficient of variation (CV) from linear analysis.

	Year 2001	2002						
Mean F Ages								
H.cons 2 to 8	0.46	0.27	0.32	0.37	0.40	0.41	0.46	0.55
Effort relative to 2000								
H.cons	1.00	0.60	0.70	0.80	0.87	0.90	1.00	1.20
Biomass								
Total 1 January	57.2	53.4	53.4	53.4	53.4	53.4	53.4	53.4
SSB at spawning time	40.5	36.1	36.1	36.1	36.1	36.1	36.1	36.1
Catch weight (,000t)								
H.cons	19.9	11.5	13.2	14.7	15.8	16.2	17.7	20.3
Biomass in year.... 2003								
Total 1 January		58.2	56.6	55.0	53.9	53.5	52.1	49.4
SSB at spawning time		40.9	39.3	37.7	36.7	36.2	34.8	32.1

	Year 2001	2002						
Effort relative to 2000								
H.cons	1.00	0.60	0.70	0.80	0.87	0.90	1.00	1.20
Est. Coeff. of Variation								
Biomass								
Total 1 January	0.09	0.21	0.21	0.21	0.21	0.21	0.21	0.21
SSB at spawning time	0.07	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Catch weight								
H.cons	0.12	0.23	0.21	0.19	0.18	0.18	0.18	0.17
Biomass in year.... 2003								
Total 1 January		0.26	0.27	0.27	0.28	0.28	0.28	0.29
SSB at spawning time		0.27	0.28	0.28	0.29	0.29	0.29	0.30

Table 7.18 North Sea Sole, Detailed forecast tables

Forecast for year 2001
F multiplier H.cons=1.00

Age	Populations Stock No.	Catch number H.Cons	Catch number Total
1	99885	757	757
2	85172	14249	14249
3	56356	20693	20693
4	49857	21115	21115
5	55937	22653	22653
6	4437	1576	1576
7	4154	1483	1483
8	1209	427	427
9	760	249	249
10	1835	817	817
11	295	89	89
12	482	203	203
13	64	18	18
14	208	80	80
15	42	16	16
Wt	57	20	20

Forecast for year 2002
F multiplier H.cons=1.00

Age	Populations Stock No.	Catch number H.Cons	Catch number Total
1	99885	757	757
2	89660	15000	15000
3	63540	23331	23331
4	31396	13297	13297
5	25132	10178	10178
6	29172	10363	10363
7	2522	900	900
8	2354	831	831
9	690	226	226
10	451	201	201
11	888	267	267
12	183	77	77
13	244	70	70
14	40	16	16
15	135	52	52
Wt	53	18	18

Table 7.19 North Sea sole

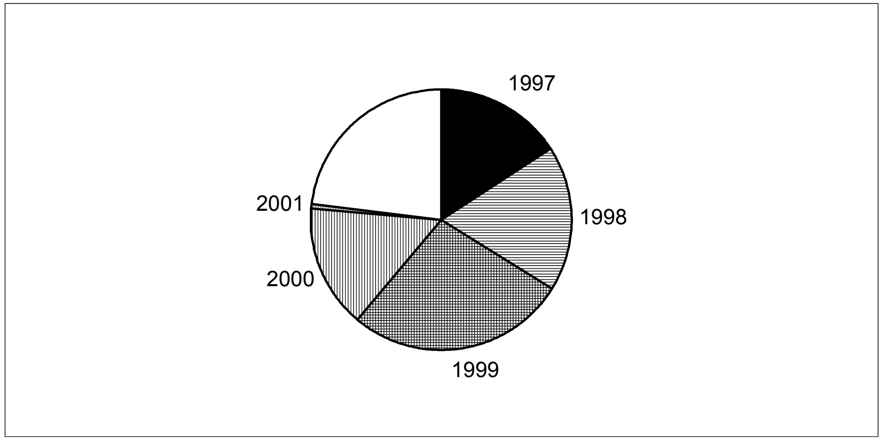
Stock numbers of recruits and their source for recent year classes used in predictions, and the relative (%) contributions to landings and SSB (by weight) of these year classes

Year-class	1997	1998	1999	2000	2001
Stock No. (thousands) of 1 year-olds	127288	86431	95220	99885	99885
Source	VPA	VPA	RCT3	GM	GM
Status Quo F:					
% in 2001 landings	25.1	21.5	12.7	0.6	-
% in 2002	15.9	17.9	27.4	15.1	0.6
% in 2001 SSB	29.3	27.2	0.0	0.0	-
% in 2002 SSB	19.3	19.6	33.4	0.0	0.0
% in 2003 SSB	11.1	11.9	22.3	36.2	0.0

GM : geometric mean recruitment

North Sea sole : Year-class % contribution to

a) 2002 landings



b) 2003 SSB

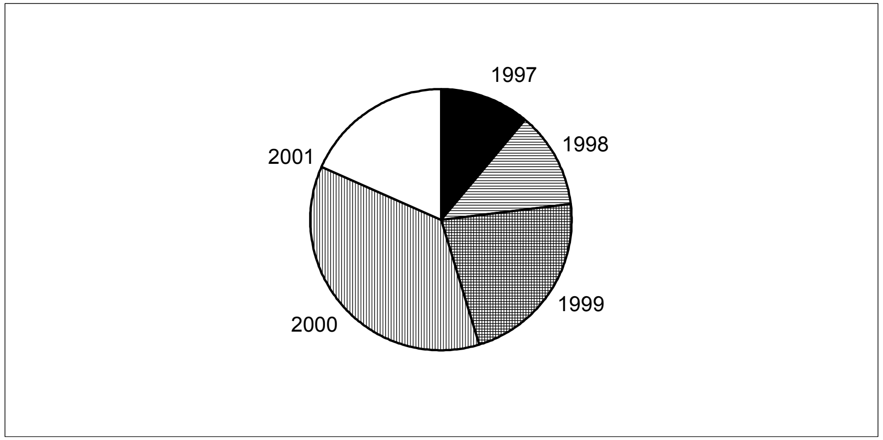
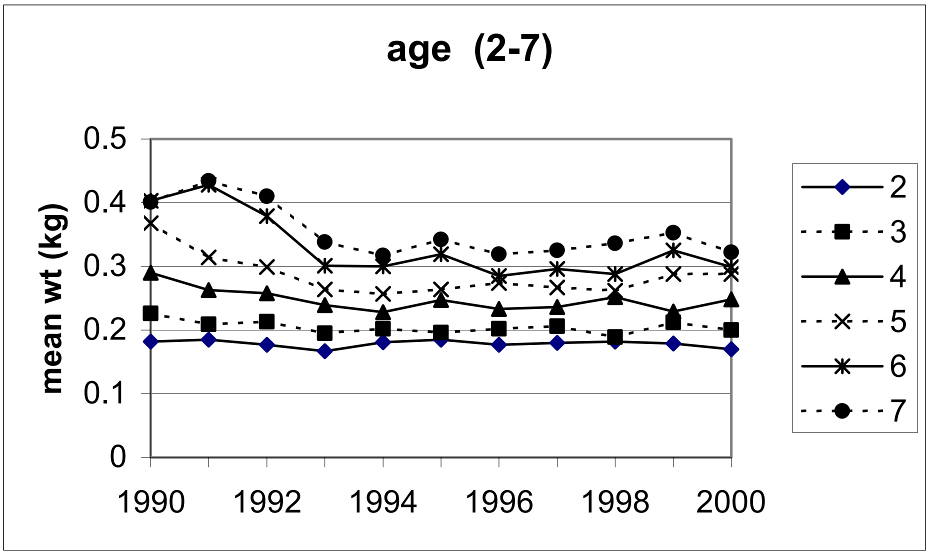


Figure 7.1a North Sea Sole: Catch weights at age



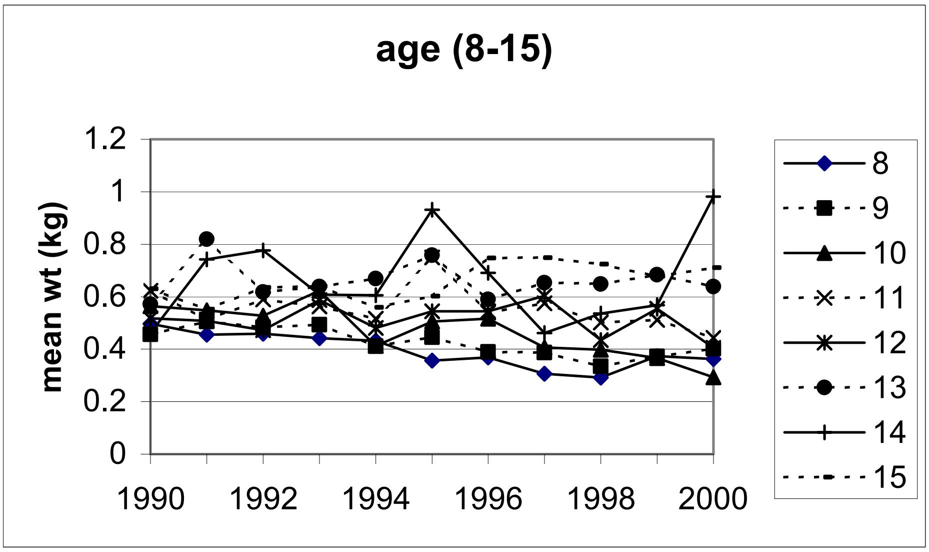
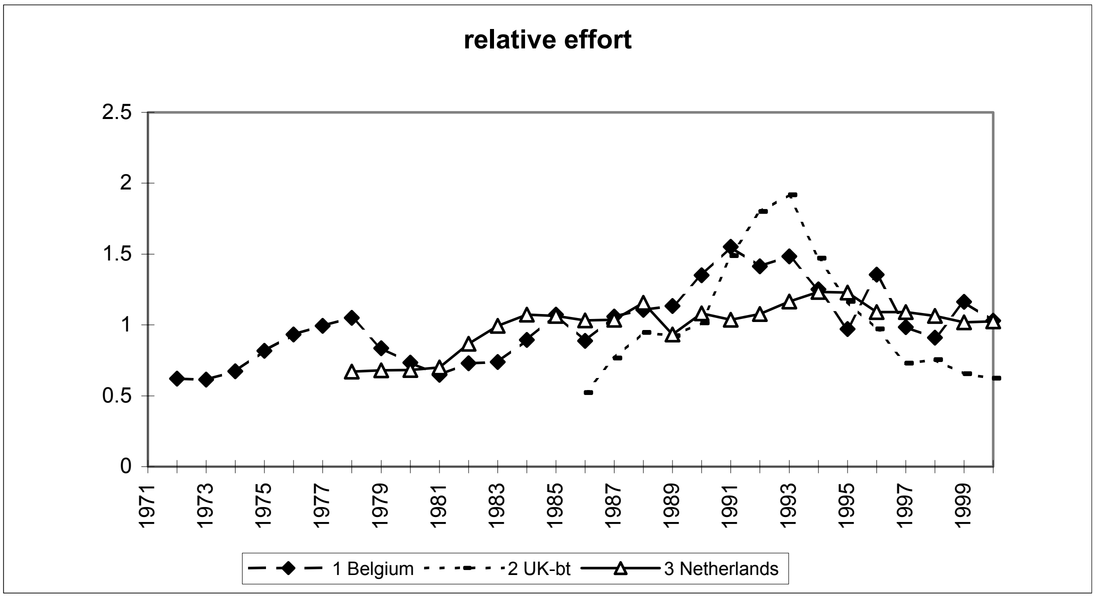


Figure 7.1b North Sea Sole, trends in effort and cpue in commercial fleets.



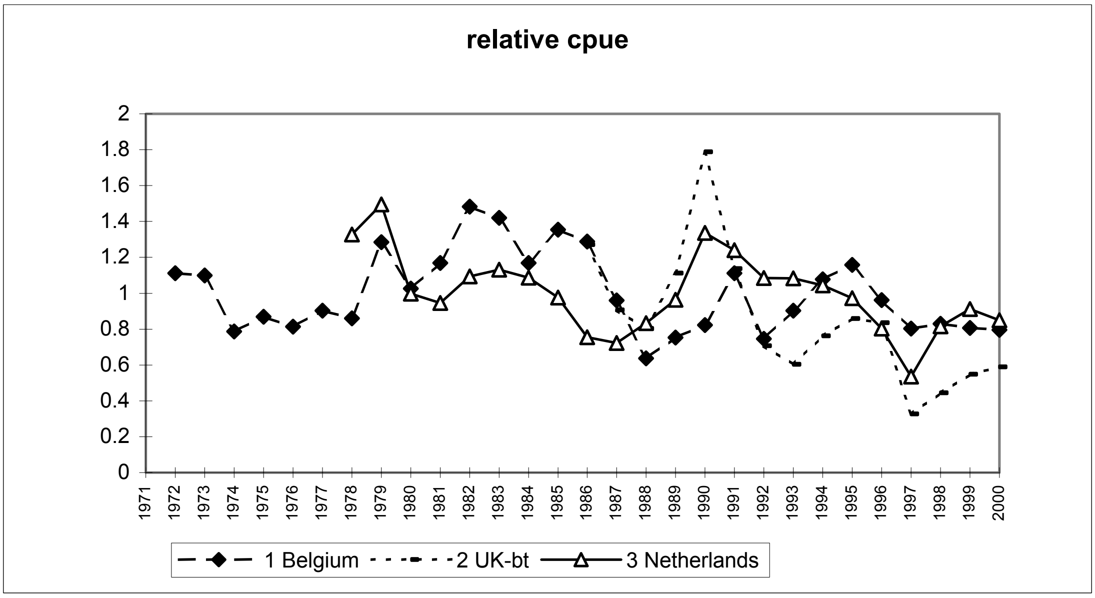


Figure 7.2a Comparison between single fleet XSA-runs and combined runs by fleet

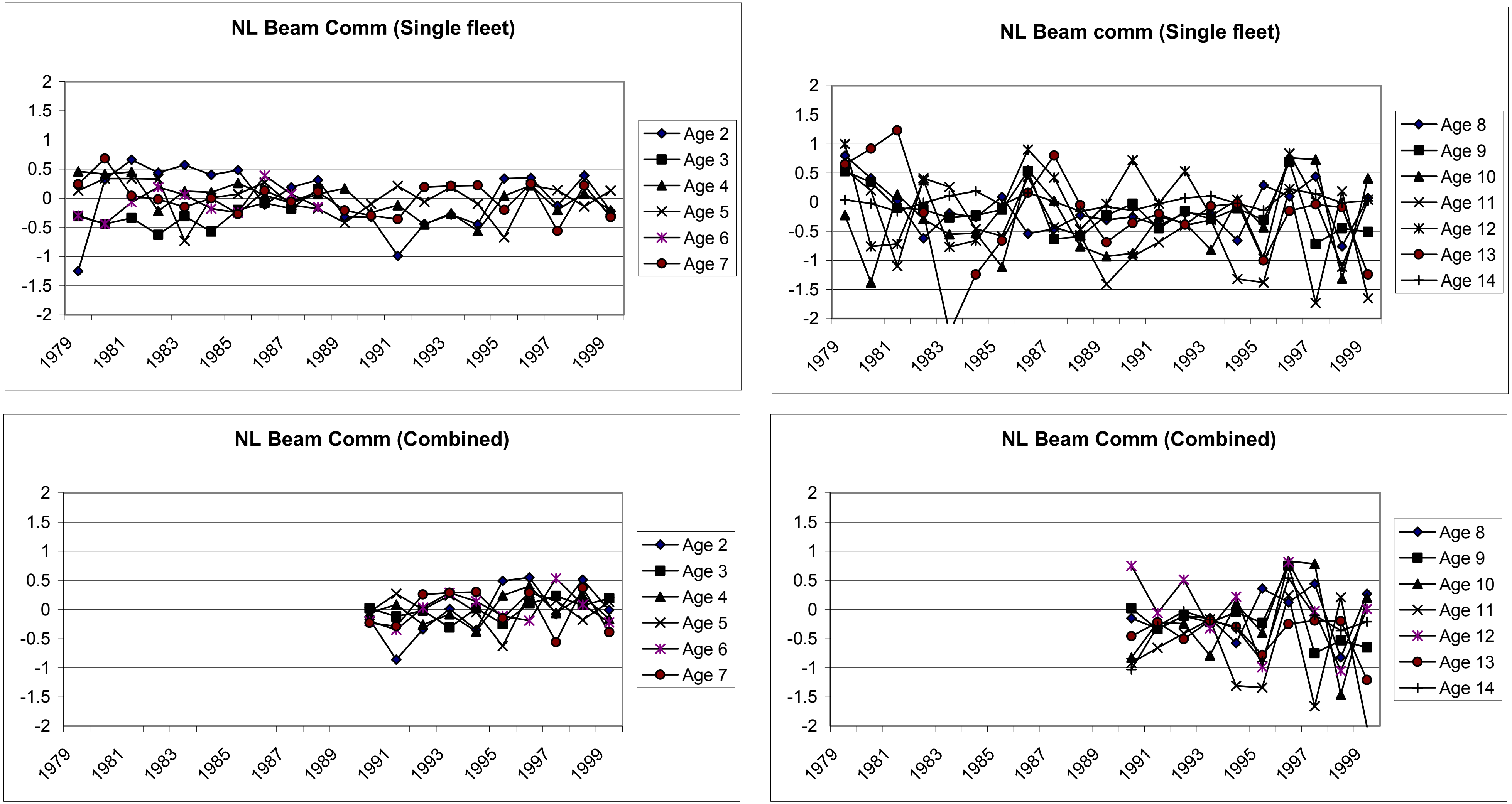


Figure 7.2b Comparison between single fleet XSA-runs and combined runs by fleet

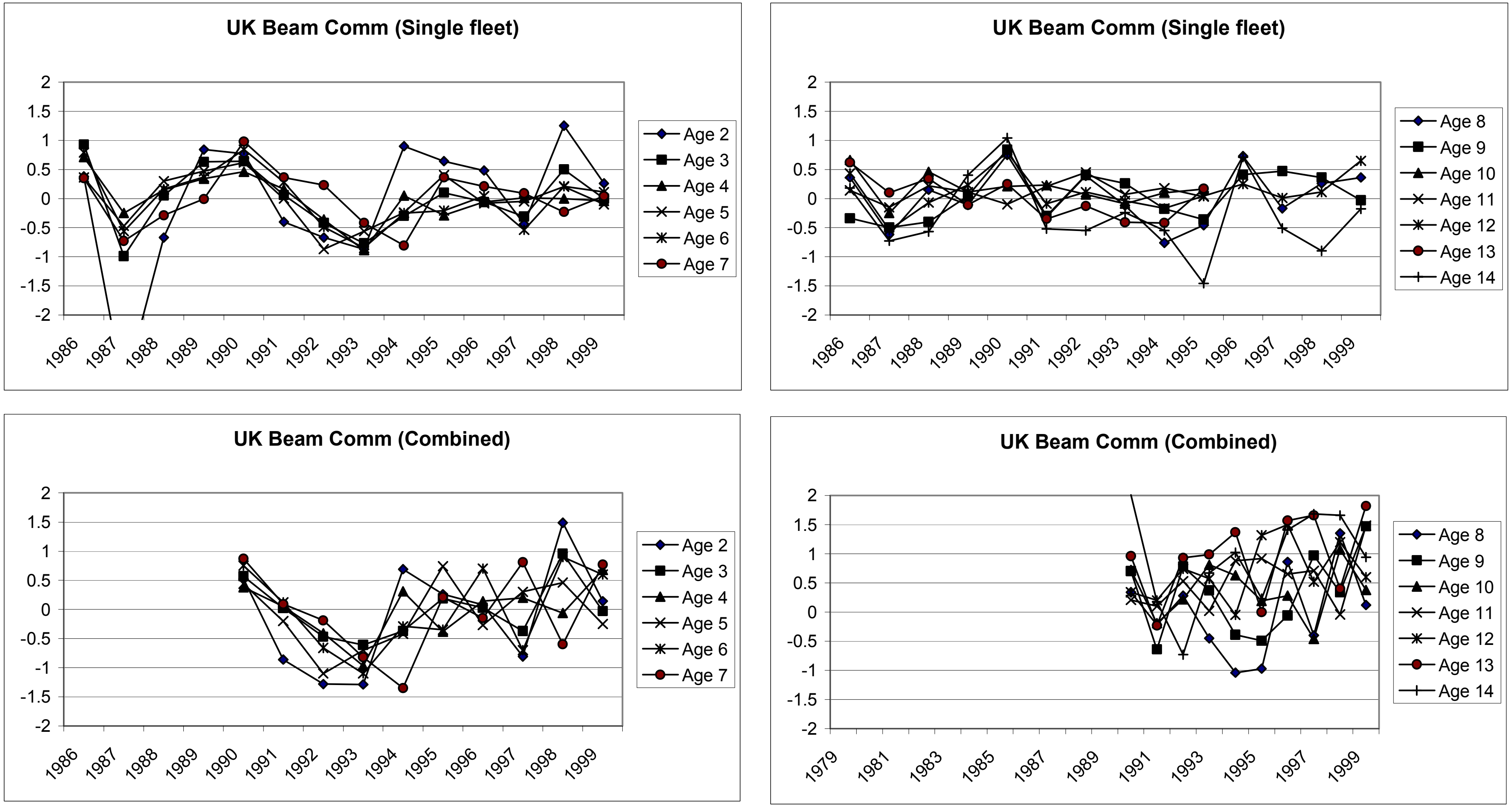


Figure 7.2c Comparison between single fleet XSA-runs and combined runs by fleet

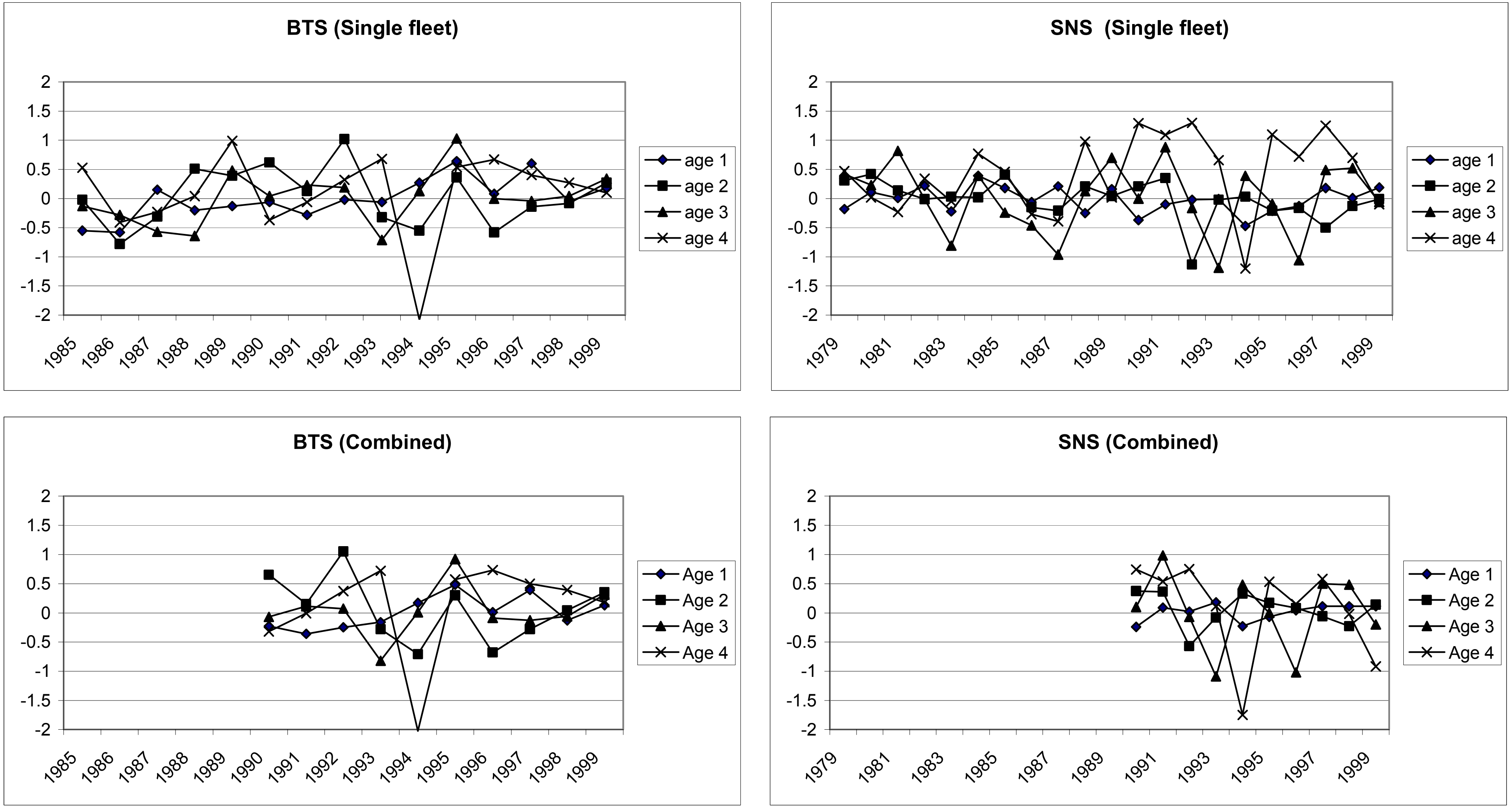
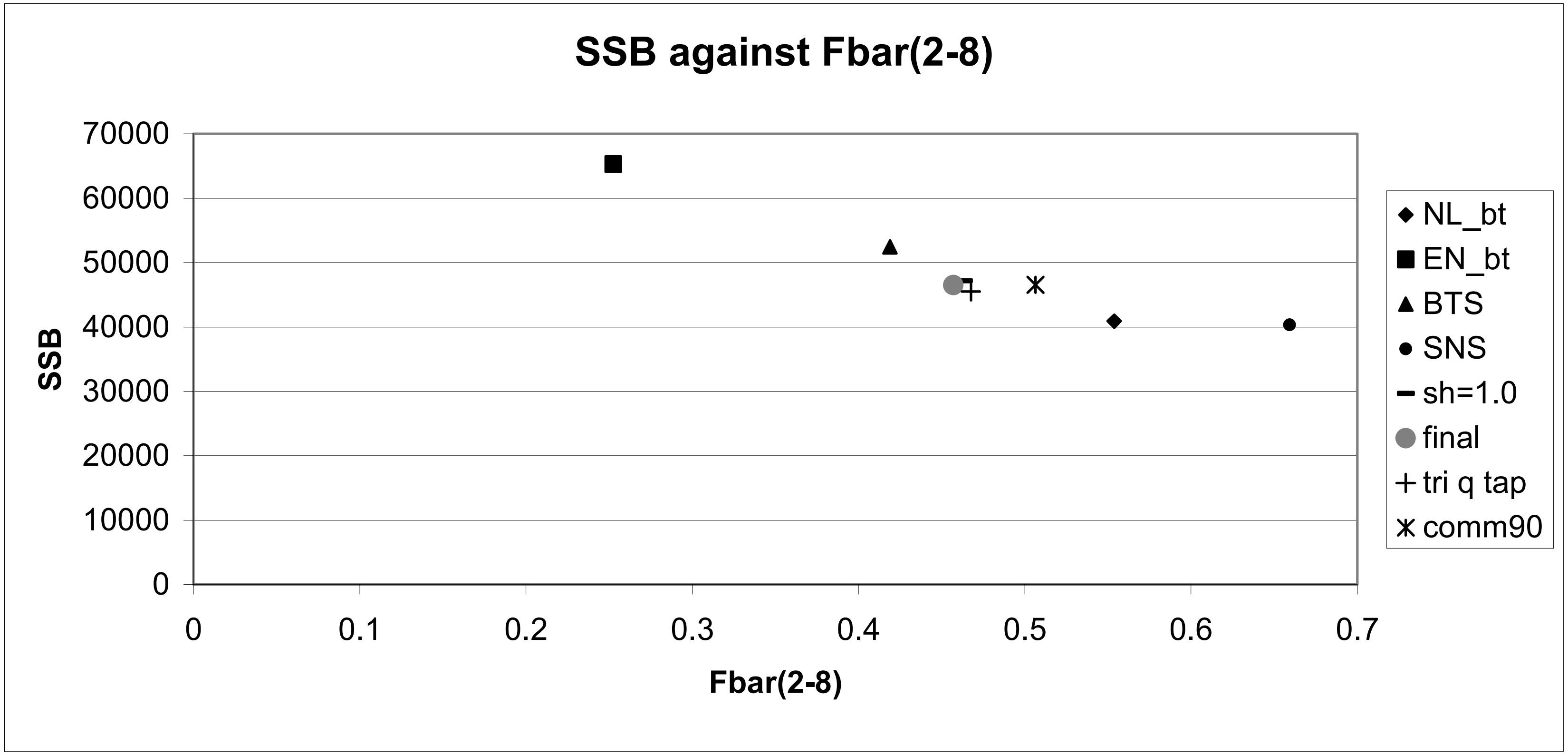


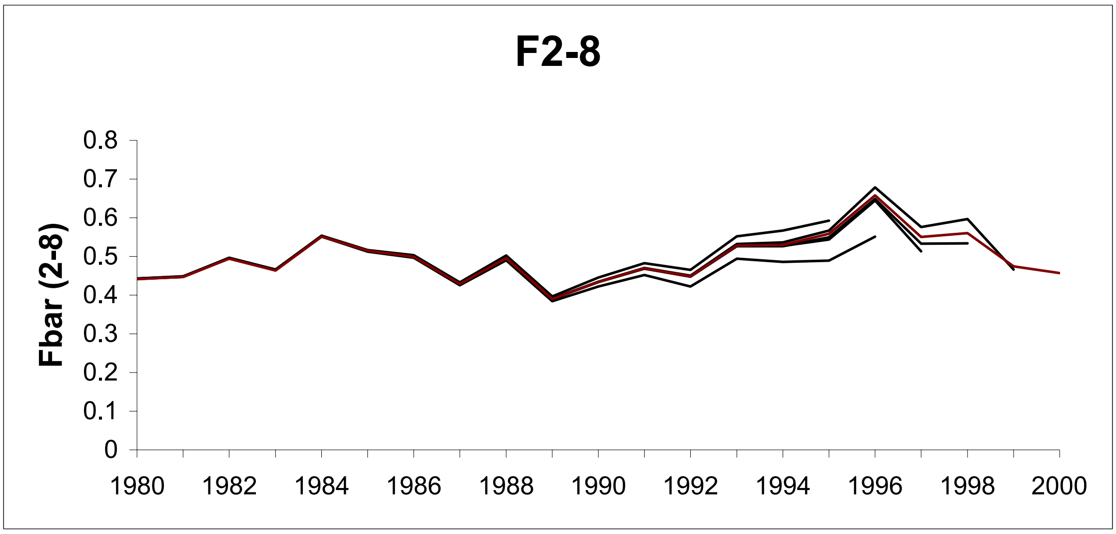
Figure 7.3a North Sea sole Estimates of SSB and $F_{2\text{-}8}$ in 2000 from various tuning options

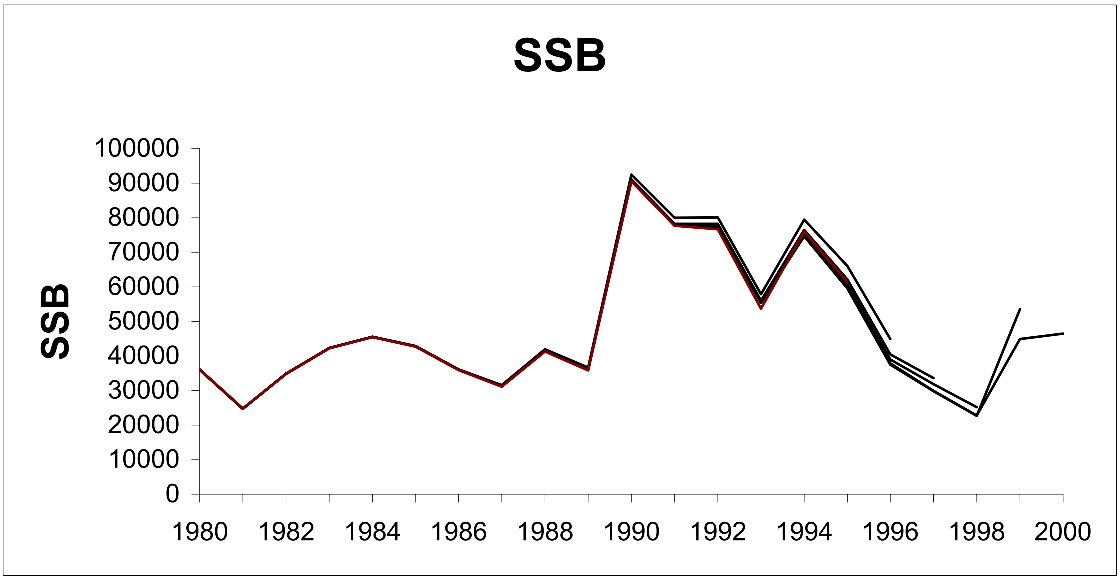


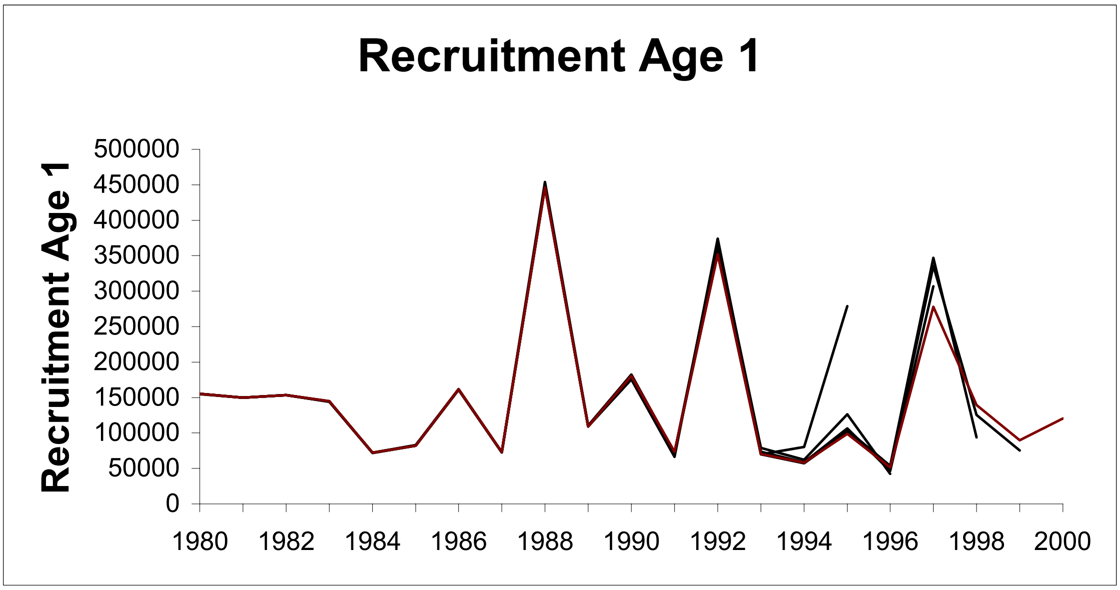
1. Single fleet runs: NL_bt - Netherlands commercial BT ; En_bt - English commercial BT; BTS - Netherlands BT survey; SNS - Netherlands Sole net survey

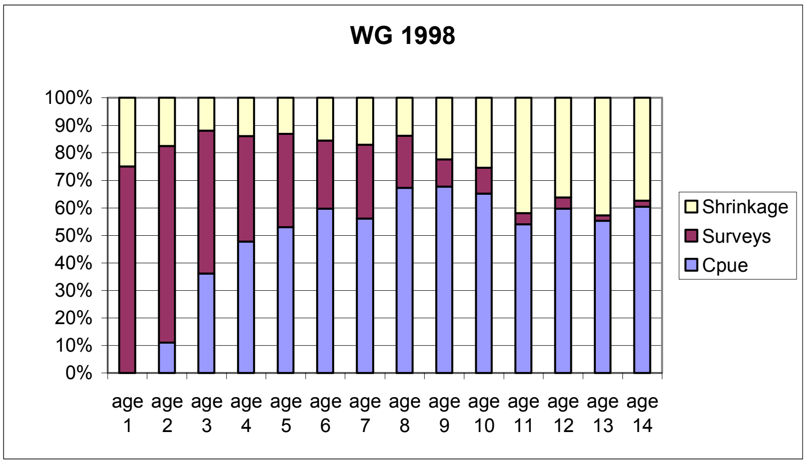
2. Combined fleets runs with all 4 fleets: Final - final configuration; sh=1.0 - shrinkage set to 1.0; tri q tap - 20 year tricubic taper on al fleets; comm90 - commercial fleets year range starts at 1990, surveys full year range

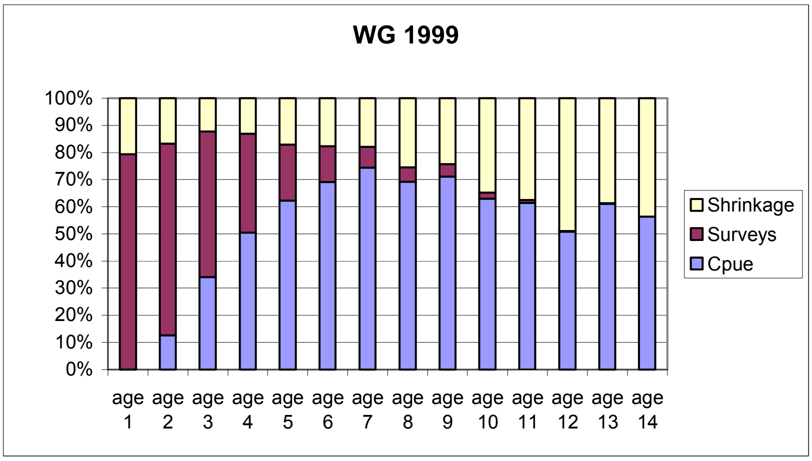
Figure 7.3b - North Sea sole
Retrospective Analysis with shrinkage F= 0.5

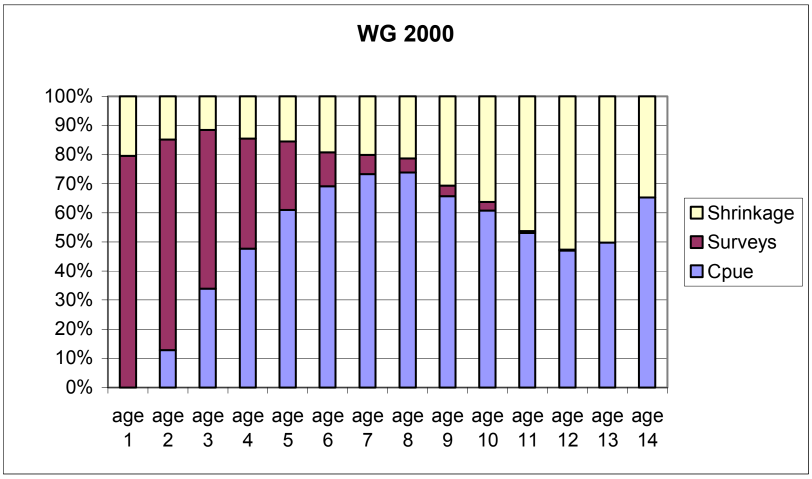












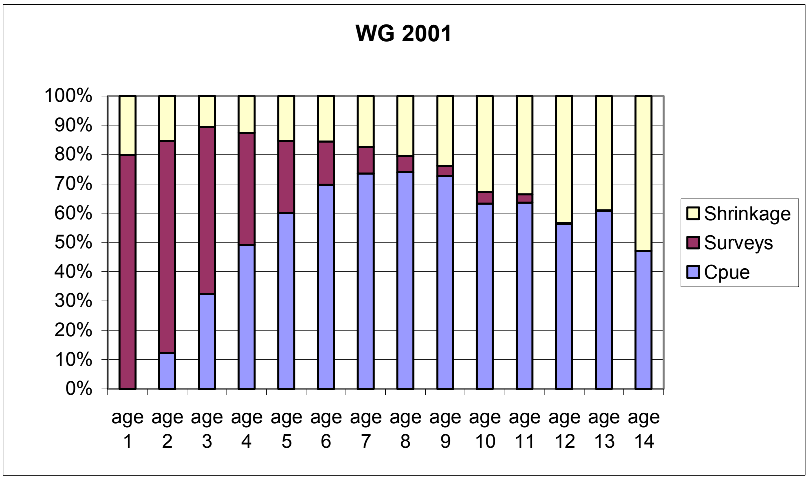


Figure 7.3c Weighting of tuning fleets in the 1999 (top), 2000 (middle) and 2001 Wg (bottom) assessments

Figure 7.4 North Sea sole Summary plots

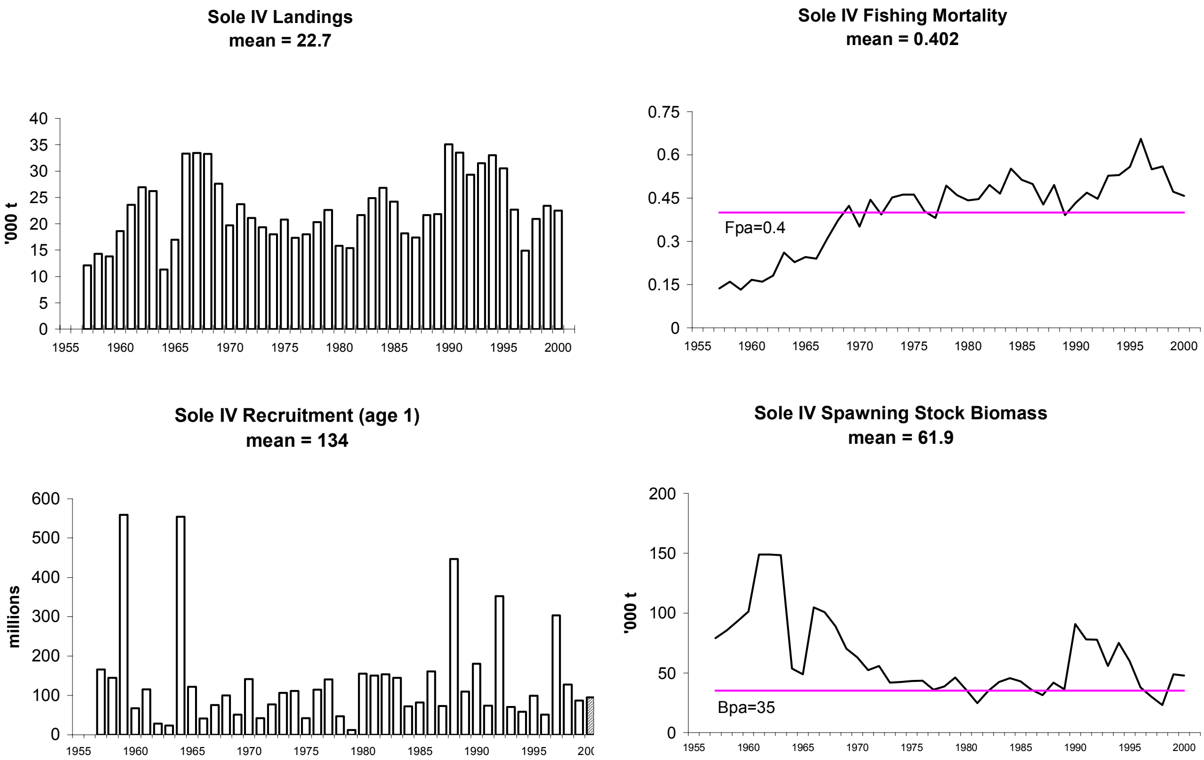


Figure 7.5 North Sea sole: Sensitivity analysis of short-term forecast

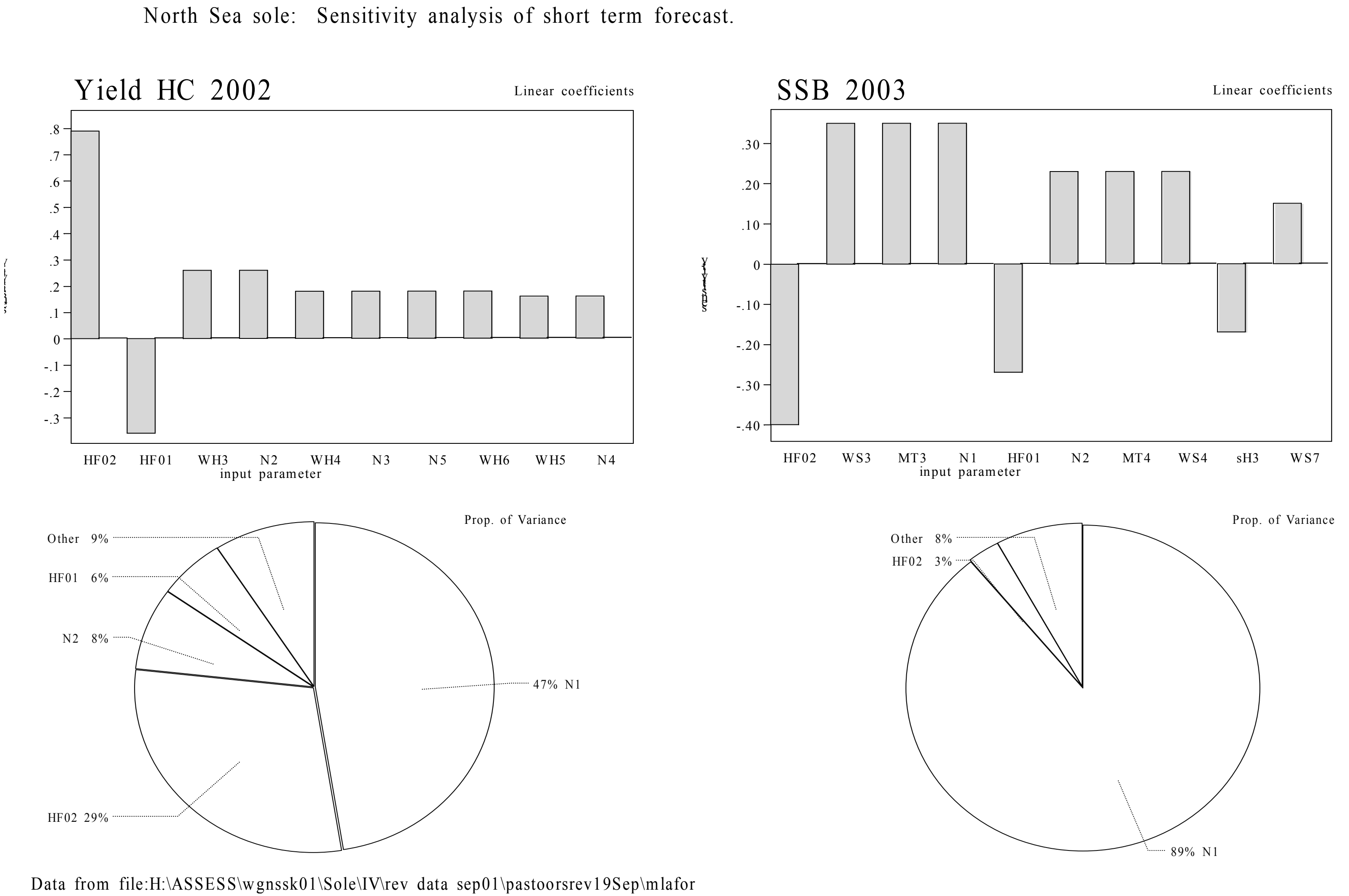
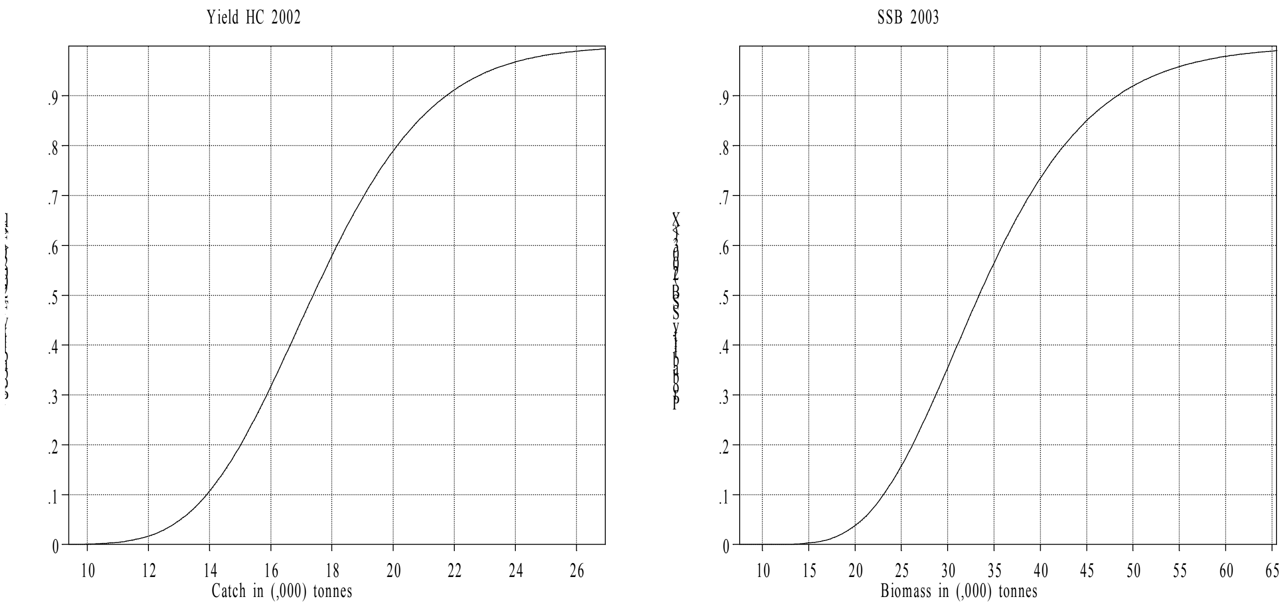


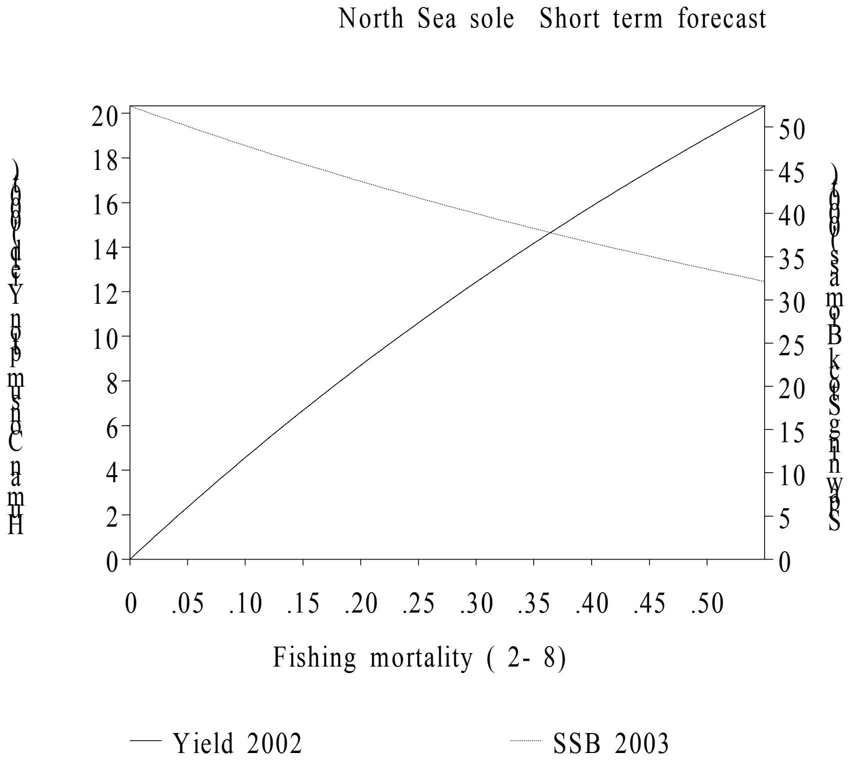
Figure 7.6 North Sea sole: Probability profile for short term forecast.

North Sea sole: Probability profiles for short term forecast.



Data from file:H:\ASSESS\wgnssk01\Sole\IV\rev data sep01\pastoorsrev19Sep\mlafor

Figure 7.7 North Sea sole: Short term forecast



Data from file:H:\ASSESS\wgnssk01\Sole\IV\rev data sep01\pastoorsrev19Sep\mlafor

Figure 7.8a North Sea sole: Medium term analysis using Ricker stock-recruit model at SQ F

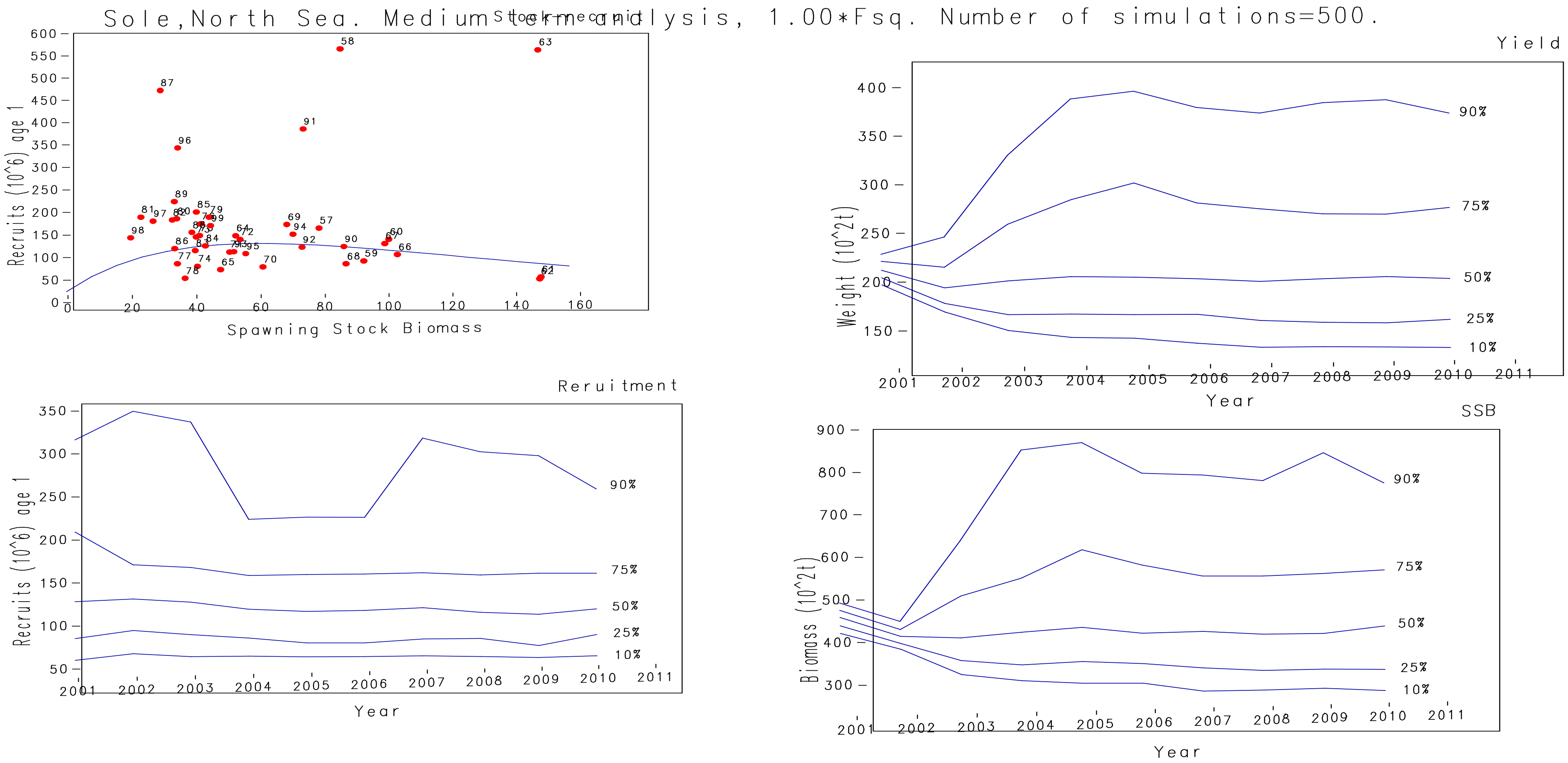


Figure 7.8b North Sea sole: Probability contours of SSB being less than Bpa at different levels of F

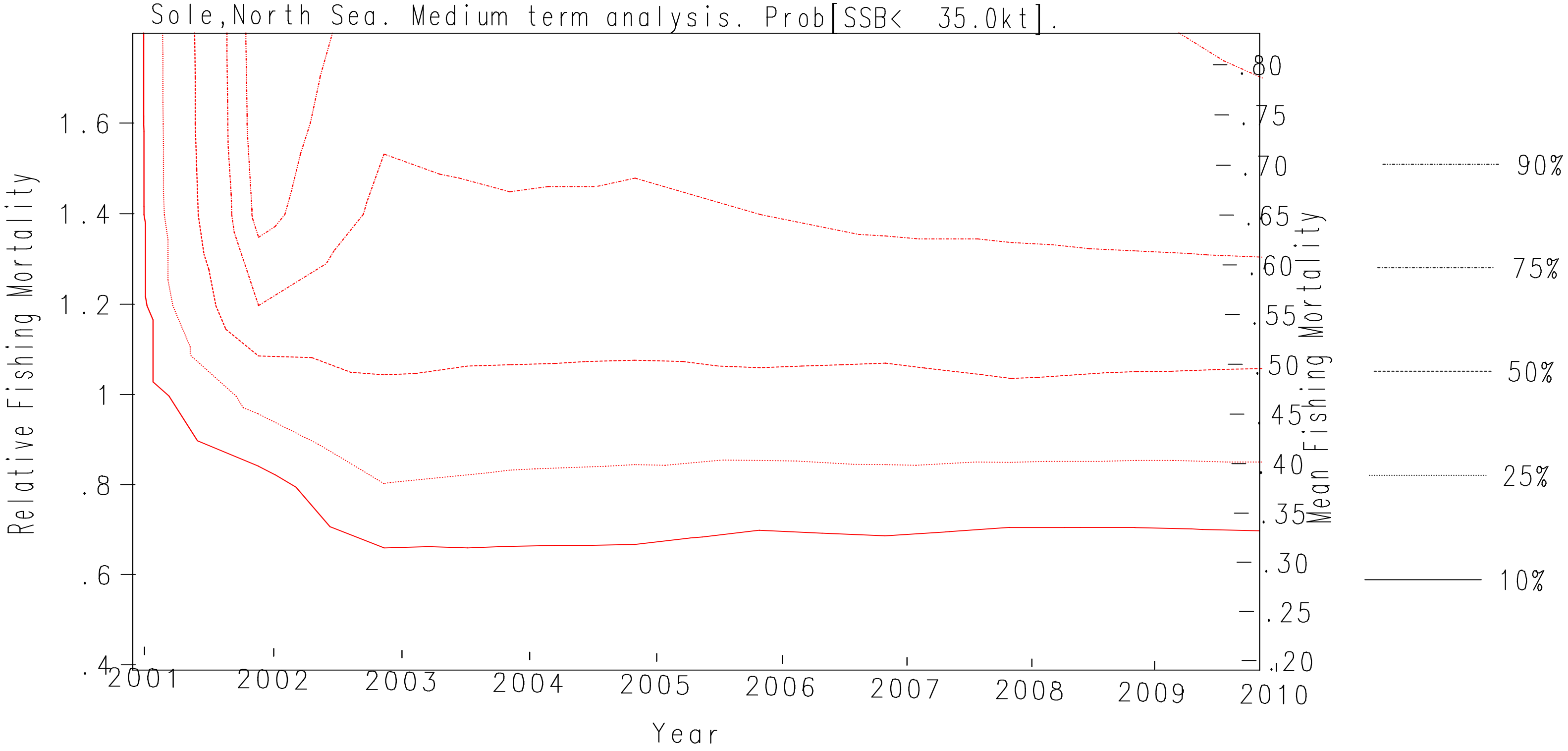


Figure 7.9 North Sea sole: Yield per recruit

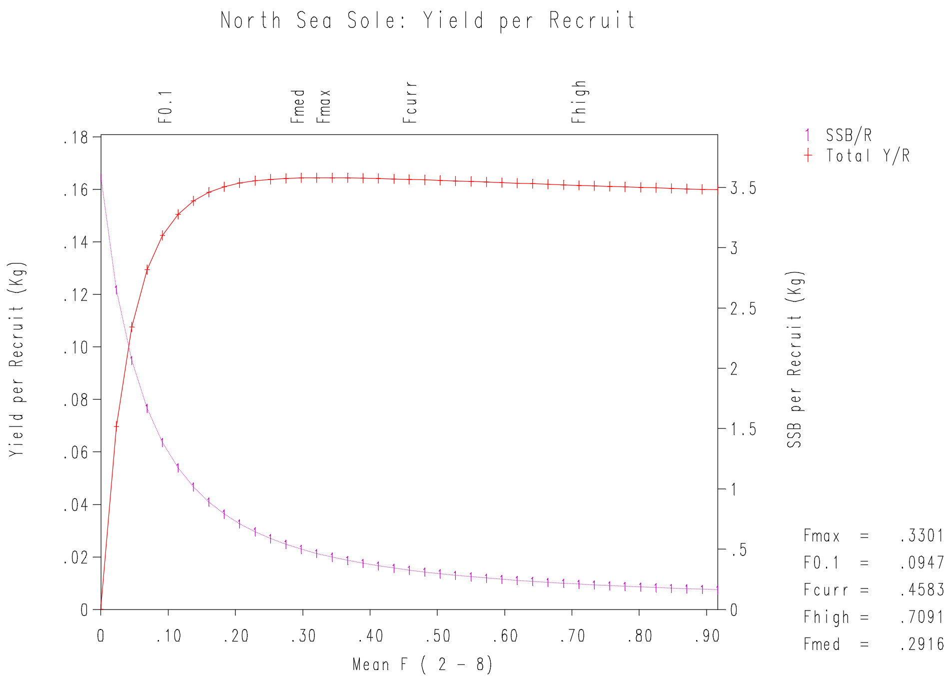


Figure 7.10 North Sea sole: Spawning stock biomass per recruit

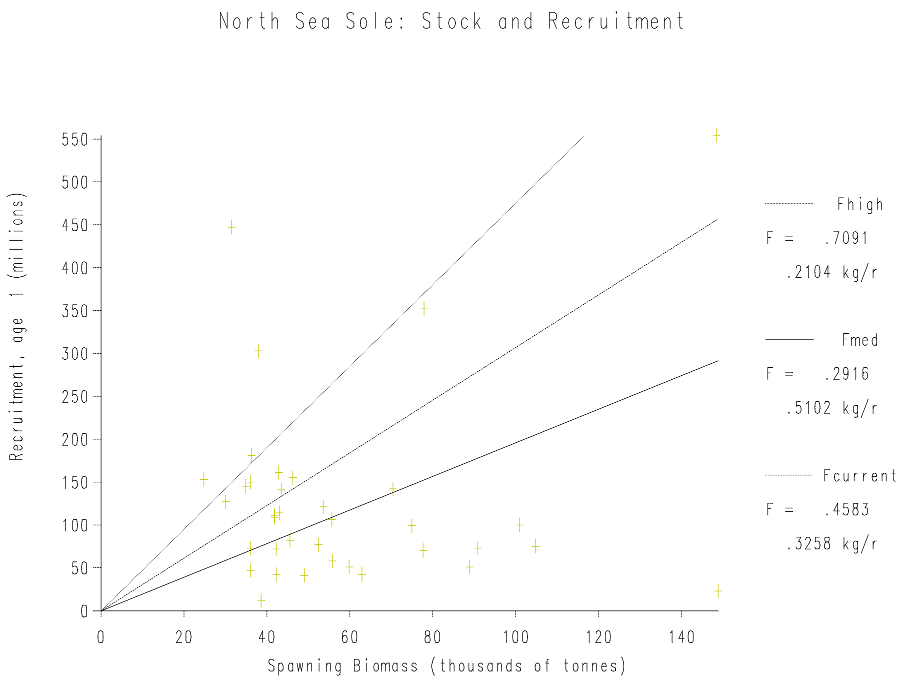
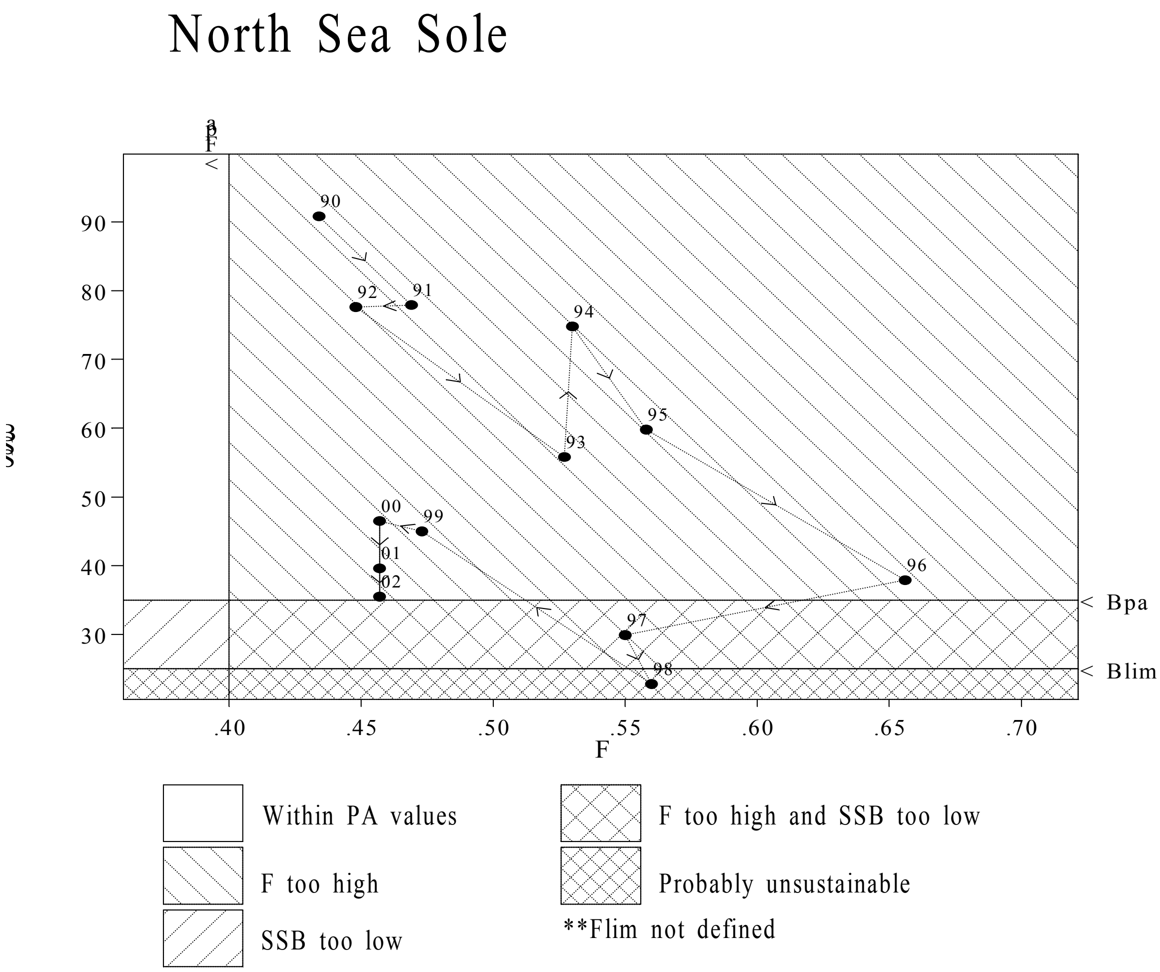
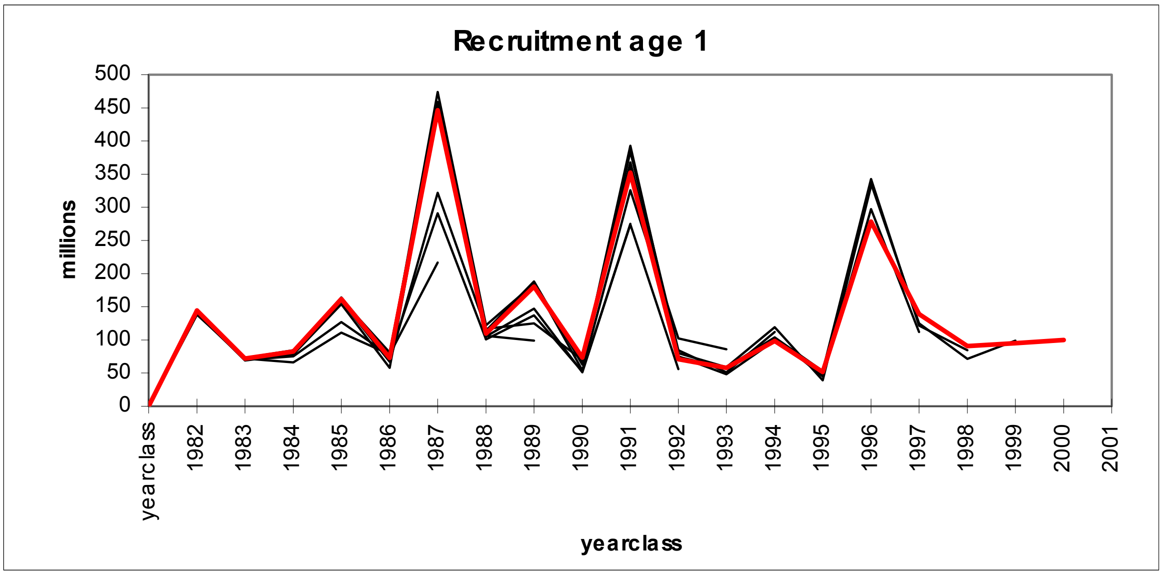


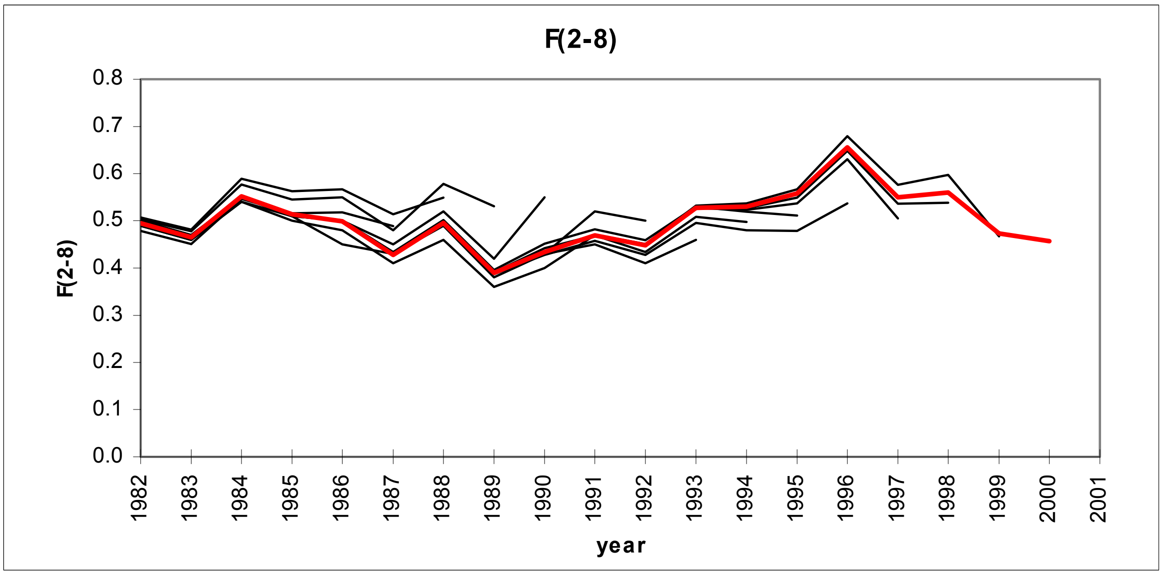
Figure 7.11 North Sea sole Precautionary Approach plot

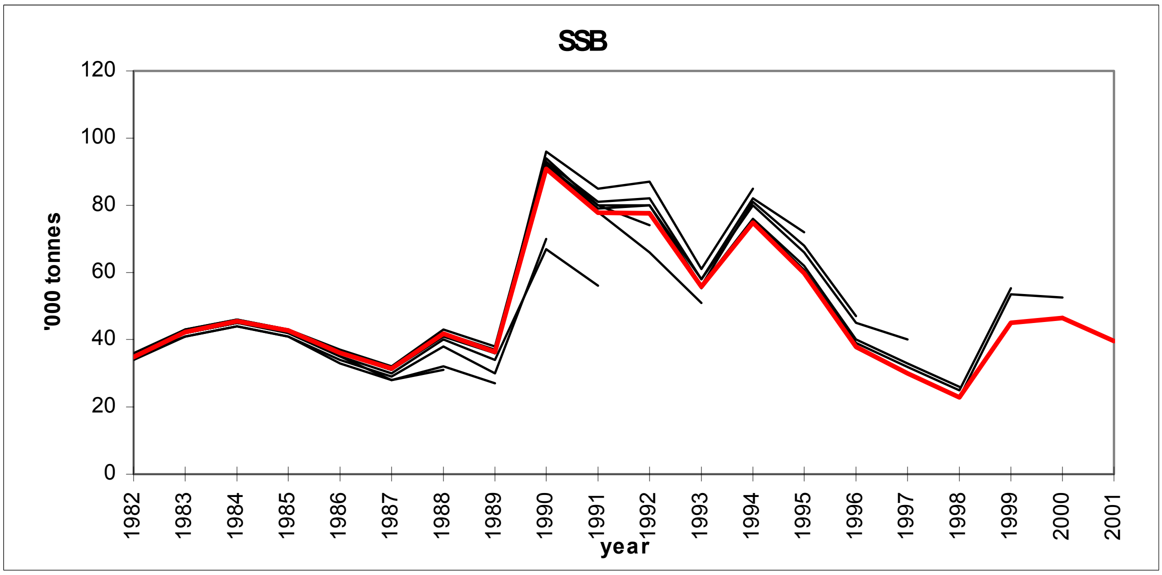


Data file(s):W:\2001\data\sole_nsea\mterm\Soliv.pa;W:\2001\data\sole_nsea\mterm\Soliv.sum
Plotted on 25/06/2001 at 14:53:25

Figure 7.12 North Sea Sole Assessments generated in successive Working Groups







8 SOLE IN DIVISION VIID

8.1 The 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. 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 metier 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 metier is made up of French offshore trawlers fishing for mixed demersal species and taking sole as a by-catch.

8.1.1 ACFM advice applicable to 2001

In 2000 ACFM considered the stock to be harvested outside safe biological limits. Although the SSB in 2000 was estimated to be above the proposed $\mathbf{B}_{pa}$, the level of fishing mortality in 1999 was higher than $\mathbf{F}_{pa}$ of 0.4. ACFM recommended that F be reduced to less than the proposed $\mathbf{F}_{pa}$ corresponding to landings in 2001 of 4700t.

8.1.2 Management applicable to 2000 and 2001

Minimum mesh size for trawling is 80 mm. Under the EU legislation, for fisheries targeting sole in NEACF Regions 1 and 2 with static gears, the minimum mesh size should be 100 mm. Derogation for fisheries targeting sole in ICES division VIId and IVc permit to use static gears with a minimum mesh size of 90 mm.

TAC's for 2000 and 2001 were 4100t and 4600t respectively.

8.1.3 Landings in 2000

Landing data reported to ICES are shown in Table 8.1.1 together with the total landings estimated by the Working Group. The unallocated landings are mainly due to the late- and misreporting of data by some countries. There is thought to be a considerable under-reporting by small vessels, which take up to 60% of the landings in the eastern Channel, as well as some misreporting by beam trawlers fishing from adjacent areas. However, it has not been possible to quantify the level of these for inclusion in the assessment. Because of problems with the national database, the precise level of the 1999 French landings was uncertain. However from 2000 onwards these problems are solved. The 2000 landings used by the Working Group were 3649t, which is 10% below the agreed TAC of 4100t and 20% below the catch predicted at *status quo* fishing mortality in 2000 (4600t).

Year	TAC	WG Landings
1999	4700	4238
2000	4100	3649
2001	4600	-

8.2 Natural mortality maturity, age compositions and weight at age

As in previous assessments natural mortality was assumed constant over ages and years at 0.1 and the maturity ogive used was knife-edged with sole regarded as fully mature at age 3 and older. 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. In 1999 and 2000 there were age reading problems in France. Therefore it was decided to use the English ALK to calculate French age compositions. Stock weights were calculated from a smoothed curve of the catch weights interpolated to 1st January (Figure 8.2.1a). It should be considered to use first quarter catch weights to calculate stock weights in the future.

The age composition data and the mean weight at age in the catch and stock are shown in Tables 8.2.1-8.2.3 and Figures 8.2.1b,c. No significant trends in mean weight at age can be noticed.

Discarding is expected to be similar as for North Sea sole.

8.3 Catch, effort and research vessel data

Catch per unit effort and effort data is shown for 4 main commercial fleets in Table 8.3.1. and Figure 8.3.1. Effort increased from 1975 to reach a peak during 1988-90, followed by a decline in the early 1990's and a fluctuation around the same level until 1995. CPUE has been more or less constant over the time series.

CPUE from the English beam trawl survey is shown in Table 8.3.2. In 1999 a large increase in cpue for the 3+ fish was noticed as the strong 1996 year class recruited to the SSB. The cpue for the 3+ fish decreases again in 2000 but remains above the cpue of the previous years.

8.4 Catch at age analysis

8.4.1 Data screening

Year range and age range: A separable analysis was run to examine the consistency of the age composition. The results are shown in Table 8.4.1a. As last year, the residuals on ages 1/2 were high as expected from the low catch and poor sampling of these ages. There were also increased anomalies at ages older than 11 and these ages were subsequently combined into an 11+ group.

8.4.2 Exploratory XSA runs

a) Three commercial fleets, i.e. the Belgian Beam Trawl fleet (BEL BT), the UK Beam Trawl fleet (UK BT), the French Otter Trawl fleet (FR OT) and three surveys, i.e. the UK Beam Trawl Survey (UK BTS), the UK Young Fish Survey (UK YFS), the French Young Fish Survey (FR YFS), were available for the tuning (Table 8.4.1b).

b) Trends in catchability. Each fleet was initially run separately, over the full year range and with low shrinkage (s.e. 1.5). The log catchability residuals were plotted to examine trends across years (Figure 8.4.1.a). No explicit trends could be detected.

   Trends in log catchability residuals for the final XSA are plotted in Figure 8.4.1b.

c) Time taper. An XSA run, with taper was explored using the full time series. The results were similar as compared to the results of the truncated XSA run (from 1986 onwards). As last year, it was decided to use the truncated series, as French age composition data became available from 1986 onwards and French landings take half of the catch.

Final SSB vs. F estimates for the single fleets, the final XSA and last years prediction is shown in Figure 8.4.1c. The UK Beam Trawl and the French Otter Trawl predict low values of F and high values of SSB whereas the Young Fish Surveys predict the opposite. The other year estimates lie in between.

8.4.3 Final XSA run

The input parameters for the final runs used in the 2000 and 2001 assessment are compared below:

	2000 assessment			**2001 assessment**		
Fleets	Years	Ages	α-β	Years	Ages	α-β
Belgian Beam Trawl (BEL BT)	86-99	2-9	0-1	86-00	2-9	0-1
Uk Beam Trawl (UK BT)	86-99	2-10	0-1	86-00	2-10	0-1
French Otter Trawl (FR OT)*	91-98	3-10	0-1	91-00	3-10	0-1
UK Beam Trawl Survey (UK BTS)	86-99	1-6	0.5-0.75	86-00	1-6	0.5-0.75
UK Young Fish Survey (UK YFS)	86-99	1	0.5-0.75	86-00	1	0.5-0.75
French Young Fish Survey (FR YFS)	87-99	1	0.5-0.75	87-00	1	0.5-0.75
-First tuning year	1986			1986		
-Last data year	1999			2000		
Time series weights	None			None		
-Catchability dependent on stock size for age <	1			1		
-Catchability independent of age for ages >=	7			7		
-Survivors estimates shrunk towards mean F	4 years / 4 ages			4 years / 4 ages		
-s.e. of the means	0.5			0.5		
-Min s.e. for pop. estimates	0.3			0.3		
-Prior weighting	None			None		

*No data for 1999

The input fleets used in the final XSA run are given in Table 8.4.1b and tuning results using the selected parameters, in Table 8.4.1c. Fishing mortality and stock number at age are presented in Table 8.4.2 and 8.4.3. Log survivor estimates and fishing mortality at age predicted by the different fleets together with the scaled weights are shown in Figure 8.4.2. The FR YFS gives high fishing mortalities for ages 4 and 8, but low weights are given to the FR YFS estimates at these ages. The same applies for fishing mortality at age 8, estimated by the UK YFS.

A retrospective analysis using F shrinkage (s.e. 0.5) was taken over the full year range. Results are shown in Figure 8.4.3. The retrospective pattern is similar to the pattern in 2000. There is no explicit tendency to over- or underestimate SSB and fishing mortality.

8.5 Recruitment estimates

Recruit indices were available for 1 and 2-gp sole from the English 4m beam trawl survey which covers most of VIId in August and for 0 and 1-gp from English and French coastal young fish surveys (Tables 8.3.2 and 8.5.1). In 2000, the area covered by English inshore survey index (EYFS) has changed to reflect the distribution of plaice and sole more effectively. This year pushnet stations were also excluded from the tuning series. As a result, the full time series of the index has been revised in 2001. The input file to RCT3 is given in Table 8.5.1 and the output in Tables 8.5.2a,b.

1999 year class: The 1999 year class at age 2 was estimated at 52.5 million by XSA and 28.0 million by RCT3. The survey estimates in RCT3 received 53% weighting. Since no power model was used in XSA and there is variable information on catch at age 1 together with high F shrinkage (which increased the XSA estimate) and indications that the 1999 year class is not the highest in the time series (as estimated by VPA) the RCT3 estimate for the 1999 year class at age 2 was accepted.

2000 year class: Two survey estimates were available (UK and French young fish surveys) for the estimation of the 2000 year class at age 1. Estimates from the English beam trawl survey covering the whole of VIId were not available (as the survey is carried out in august), but they will become accessible before the ACFM meeting. The surveys gave conflicting information for the RCT3 estimate at age 1 and the VPA mean got more than 90% of the weight. For these reasons it was decided to use the GM 82-98 (23.2 million) as an estimate for this year class.

The table below gives an overview of the estimates for year classes 1999-2000 obtained by the different methods.

Year class	At age in 2001	**XSA**	**GM 82-98**	**RCT3**	Accepted Estimate
1999	2	52532	20462	27971	RCT3
2000	1	-	23152	22011	GM 1982-98
2001 & 2002	recruits	-	23152	-	GM 1982-98

8.6 Historical Stock trends

Trends in yield, fishing mortality, SSB and recruitment are shown in Table 8.6.1 and Figure 8.6.1. Landings have been rather constant over the time series. Fishing mortality has been variable over the period and peaked in the periods 1987-89 and 1996-99 to decrease again in 2000. Following a relatively strong recruitment in 1996, there appears to be another very good year class in 1998, which comes into the spawning stock this year.

8.7 Short term forecast and sensitivity analysis

The input data for the catch forecasts are given in Table 8.7.1. Stock numbers in 2000 were taken from the XSA output for age 3 and older, from RCT3 for age 2, and from the GM for age 1 and the recruits in 2002 and 2003. An exploitation pattern for the period 1998-2000 scaled to F_{bar} (3-8) in 2000 was used ($F_{3\text{-}8} = 0.34$). The rescaled F values are presented in Table 8.4.2. Catch and stock weights at age were the mean for the period 1998-2000 and the proportions of M and F before spawning were set to zero.

Figure 8.7.1 shows the sensitivity of the predicted yields in 2002 and the predicted biomasses in 2003 to the input parameters. They also show the partial variances (proportions), and how the variability in the input parameters contributes to the variance of the predicted yield and biomasses. The variability of the exploitation pattern in 2002 has a major influence on the variance and sensitivity of the yield in 2002. Spawning stock biomass in 2003 is most sensitive to the variability of the exploitation pattern in 2002. The variability of the estimates at age 1 have a major influence on the variance of SSB in 2003.

Probability profiles of SSB in 2003 assuming status quo F, and the probability that F in 2002 will exceed status quo F at different 2002 catch levels are given in Figure 8.7.2. The probability that SSB in 2003 will fall below the $\mathbf{B}_{pa}$ (8 kt) is small at $\mathbf{F}_{sq}$.

Table 8.7.4 shows the contribution of different year classes to the landings and SSB under *status quo* assumptions. The 1998 and 1999 year classes contribute more than 50% to the landings in 2002. SSB in 2003 mainly consists of the 1998 and 1999 and 2000 year classes.

The results of the *status quo* catch prediction are given in Table 8.7.2 and a detailed output by age in Table 8.7.3. The predicted *status quo* landings in 2001 are estimated to be 4430t compared with a TAC of 4600 t. The predicted *status quo* landings in 2002 are estimated to be 4550 t. At $\mathbf{F}_{sq}$ spawning stock biomass is forecast to stay at the same level (from 12600 t in 2001 to 12300 t in 2003).

The input data of short-term yield and SSB is shown in Table 8.7.1.

8.8 Medium Term Projections

Last year, no medium term prediction was carried out and the prediction for 1999 was considered to be representative for 2000. This year medium term predictions were carried out for a period of 10 years, based on a Ricker relationship between SSB and recruitment. It must be emphasized that the left hand side of the Ricker curve is not well defined. However, as the current SSB lies above 10 kt this is thought to be of minor importance. Analysis of the Shepherd curve showed an analogous relationship on the right hand side of the curve and an even less realistic relationship on the left hand side (results not shown).

WGMTERMC was run for a range of F multipliers. Results over the entire 10 year projection are given in Figure 8.8.1a for the F *status quo*. The contour plot (Figure 8.8.1b) suggests a low probability of SSB falling below $\mathbf{B}_{pa}$ (8 kt) at $\mathbf{F}_{pa}$ (0.4). The median yield in 2010 is around 4000 t (which is the average landing over the time series).

8.9 Biological Reference Points

The input data for the yield per recruit analysis are given in Table 8.7.1. Mean weights were the recent three year average (1998-2000). Figure 8.9.1 shows the yield and SSB per recruit assuming *status quo* F in 2001. Figure 8.9.2 shows the relationship between stock and recruitment and gives the calculated reference points. The current level of $F_{3\text{-}8}$ is close to $\mathbf{F}_{med}$ and above $\mathbf{F}_{max}$.

The precautionary reference points were not reviewed in this assessment. The management reference points proposed by ACFM are shown below together with the estimated reference points calculated from the recent assessment:

Management			Estimated			
$\mathbf{B}_{pa}$	$\mathbf{F}_{pa}$	$\mathbf{F}_{lim}$	$\mathbf{F}_{sq}$	$\mathbf{F}_{med}$	$\mathbf{F}_{0.1}$	$\mathbf{F}_{max}$
8,000 t	0.4	0.55	0.34	0.36	0.11	0.26

Historical SSBs and F values are plotted in Figure 8.9.3 into zones according to the proposed precautionary reference points. Sole in VIId is considered to be within safe biological limits.

8.10 Comments on the Assessment

Quality of landing statistics and catch at age data do not always appear to be sufficient and this will lead to uncertainty in estimates of fishing mortality. Uncertainties in the current assessment are (1) under-reporting by important segments of the inshore fleet, since this fleet takes a major part of the landings of sole in VIId, (2) misreporting of beamtrawl fleets fishing in adjacent areas, (3) the poor quality of data at the youngest ages (because of a low sampling level) and (4) the use of an English ALK to raise French length compositions.

Fishing mortality in 2000 is estimated to be considerably lower than in 1999 (Table and Figure 8.6.1), mainly driven be by the estimates of the French and English trawl fleets. It remains the question if this corresponds to reality.

The 2001 assessment was consistent with previous assessments. (Figure 8.10.1)

8.11 Management considerations

According to the ICES criteria the stock is considered within safe biological limits, although this does not fully correspond with the perceptions in the fishery which indicate that the catch rates have declined over the recent years

The cumulative probability distribution from the sensitivity analysis indicates that the probability of the spawning biomass being below $\mathbf{B}_{pa}$ in 2003 is small.

The *status quo* F medium term predictions show that the probability of SSB being below $\mathbf{B}_{pa}$ in 2002 and 2010 is less than 10%.

Sole is mainly taken in fisheries with plaice as a by-catch.

Table 8.1.1 Sole in VIId. Nominal landings (tonnes)
as officially reported to ICES and used by the WG.

Year	Belgium	France	UK (E&W)	others	Total 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	1087	4024	
1987	1100	2086	655	.	3841	1133	4974	3850
1988	667	2057	578	.	3302	680	3982	3850
1989	646	1610	689	.	2945	1242	4187	3850
1990	996	1255	742	.	2993	1067	4060	3850
1991	904	2054	825	.	3783	599	4382	3850
1992	891	2187	706	10	3794	348	4142	3500
1993	917	1907	610	13	3447	1064	4511	3200
1994	940	2001	701	15	3657	984	4641	3800
1995	817	2248	669	9	3743	840	4583	3800
1996	899	2335	877	.	4111	914	5025	3500
1997	1306	1609	933	.	3848	1135	4983	5230
1998	541	1703**	803	.	3047	647	3694	5230
1999	880	2239**	769	.	3888	350	4238	4700
2000	1021	2171	615	.	3807	-158	3649	4100

* Unallocated mainly due to late reporting by some countries;
also includes minor unreported landings estimated by the WG
** Preliminary

Table 8.2.1 Sole in VIId. Catch Numbers at age (Numbers*103)**

YEAR	1982	1983	1984	1985	1986	1987	1988	1989	1990
AGE									
1	155	0	24	49	49	9	95	163	1271
2	2625	852	1977	3693	1264	3284	2227	3704	3092
3	5256	3452	3157	5211	5377	3827	7393	3424	6326
4	1727	3930	2610	1646	3273	3417	1648	4842	1257
5	570	897	1900	1027	925	2166	1219	1530	1654
6	653	735	742	1860	790	1064	910	943	329
7	549	627	457	144	1087	1110	400	651	432
8	240	333	317	158	156	828	268	218	293
9	122	108	136	156	192	114	280	181	138
10	83	89	99	69	216	163	84	270	139
+gp	202	193	238	128	381	469	284	329	556
TOTALNUM	12182	11216	11657	14141	13710	16451	14808	16255	15487
TONSLAND	3190	3458	3575	3837	4024	4974	3982	4187	4060
SOPCOF %	97	99	99	100	100	100	100	100	99

YEAR	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
AGE										
1	383	106	85	34	683	11	30	41	182	145
2	7381	4082	5225	783	2974	2055	1740	1814	3512	3787
3	3796	8967	6716	6660	4558	7934	6444	5929	9126	5368
4	4316	1886	5735	6152	5003	3081	5228	2890	3543	4914
5	585	2065	1057	3514	3090	3381	2157	1760	1406	1227
6	1003	295	645	613	2052	1896	1840	651	945	577
7	256	382	171	613	394	1332	992	654	379	376
8	257	140	206	112	310	288	841	494	731	163
9	272	184	123	154	95	351	255	394	379	380
10	95	98	67	94	111	112	199	251	209	170
+gp	395	237	145	278	247	375	298	354	389	292
TOTALNUM	18739	18442	20175	19007	19517	20816	20024	15232	20801	17399
TONSLAND	4382	4142	4511	4643	4583	5025	4983	3694	4238	3649
SOPCOF %	100	100	100	100	100	100	98	100	93	94

Table 8.2.2 Sole in VIId.   Catch Weights at age (kg)

YEAR	1982	1983	1984	1985	1986	1987	1988	1989	1990
AGE									
1	0.102	0	0.1	0.09	0.135	0.095	0.102	0.106	0.121
2	0.171	0.173	0.178	0.182	0.179	0.176	0.152	0.156	0.18
3	0.225	0.23	0.234	0.23	0.212	0.236	0.226	0.193	0.24
4	0.312	0.302	0.314	0.281	0.306	0.295	0.278	0.274	0.291
5	0.386	0.404	0.38	0.368	0.362	0.353	0.358	0.295	0.351
6	0.428	0.436	0.436	0.394	0.385	0.407	0.407	0.357	0.343
7	0.439	0.435	0.417	0.516	0.435	0.412	0.458	0.391	0.469
8	0.509	0.524	0.538	0.543	0.519	0.479	0.509	0.469	0.463
9	0.502	0.537	0.529	0.594	0.501	0.463	0.551	0.516	0.489
10	0.463	0.583	0.565	0.595	0.524	0.538	0.559	0.538	0.519
+gp	0.6729	0.6283	0.7135	0.8005	0.6029	0.6192	0.6662	0.7047	0.5667
SOPCOFAC	0.9713	0.991	0.9884	0.998	1.0044	1.0003	0.997	0.9974	0.9949

YEAR	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
AGE										
1	0.114	0.103	0.085	0.099	0.127	0.142	0.139	0.133	0.133	0.146
2	0.161	0.153	0.148	0.151	0.174	0.167	0.155	0.16	0.153	0.143
3	0.211	0.202	0.197	0.188	0.18	0.179	0.189	0.174	0.193	0.175
4	0.267	0.267	0.245	0.236	0.233	0.23	0.233	0.236	0.219	0.223
5	0.349	0.291	0.331	0.29	0.257	0.272	0.291	0.285	0.264	0.335
6	0.39	0.399	0.374	0.354	0.332	0.323	0.341	0.341	0.285	0.379
7	0.415	0.386	0.528	0.38	0.356	0.36	0.385	0.379	0.295	0.426
8	0.426	0.455	0.54	0.505	0.38	0.403	0.401	0.412	0.347	0.431
9	0.433	0.445	0.505	0.492	0.48	0.436	0.495	0.48	0.363	0.387
10	0.477	0.461	0.742	0.496	0.49	0.461	0.469	0.432	0.379	0.461
+gp	0.559	0.5576	0.6467	0.6155	0.6419	0.5852	0.6428	0.6043	0.5452	0.6841
SOPCOFAC	1.0004	1.0006	1.0009	0.9997	1.0001	0.9999	0.978	0.9995	0.9348	0.9397

Table 8.2.3 Sole in VIId. Stock Weights at Age (kg)

YEAR	1982	1983	1984	1985	1986	1987	1988	1989	1990
AGE									
1	0.059	0.07	0.067	0.065	0.07	0.072	0.073	0.06	0.07
2	0.114	0.135	0.131	0.129	0.136	0.139	0.141	0.119	0.135
3	0.167	0.197	0.192	0.192	0.198	0.203	0.206	0.175	0.196
4	0.217	0.255	0.249	0.254	0.256	0.262	0.267	0.23	0.253
5	0.263	0.309	0.304	0.315	0.309	0.318	0.324	0.283	0.305
6	0.306	0.359	0.355	0.376	0.358	0.37	0.377	0.335	0.353
7	0.347	0.406	0.403	0.436	0.403	0.417	0.426	0.385	0.396
8	0.384	0.448	0.448	0.495	0.443	0.461	0.471	0.433	0.435
9	0.418	0.487	0.49	0.554	0.48	0.5	0.512	0.479	0.47
10	0.45	0.522	0.529	0.611	0.512	0.536	0.549	0.523	0.5
+gp	0.53	0.6008	0.6265	0.7798	0.5761	0.6156	0.6297	0.675	0.5501

YEAR	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
AGE										
1	0.061	0.084	0.067	0.068	0.097	0.103	0.06	0.121	0.153	0.16
2	0.119	0.132	0.087	0.118	0.134	0.139	0.106	0.149	0.164	0.171
3	0.175	0.178	0.161	0.165	0.172	0.175	0.154	0.179	0.179	0.186
4	0.228	0.223	0.23	0.211	0.21	0.212	0.203	0.211	0.198	0.206
5	0.278	0.267	0.293	0.254	0.248	0.248	0.253	0.246	0.221	0.23
6	0.326	0.309	0.352	0.296	0.287	0.284	0.305	0.282	0.248	0.258
7	0.371	0.349	0.405	0.335	0.326	0.32	0.358	0.321	0.279	0.29
8	0.413	0.388	0.454	0.372	0.366	0.357	0.413	0.362	0.314	0.327
9	0.453	0.425	0.497	0.407	0.406	0.393	0.469	0.405	0.353	0.368
10	0.49	0.461	0.535	0.44	0.446	0.429	0.526	0.45	0.396	0.413
+gp	0.5759	0.5459	0.6102	0.532	0.575	0.5337	0.6985	0.5846	0.5342	0.5617

Table 8.3.1 Sole in VIId

Catch per unit effort

Year	Belgium	UK		France*
	Beam trawl (kg/10hr) HP corr	Trammel (kg/day)	Beam trawl (kg/hr) GRT corr	Trawl (kg/h*kw*10-4)
1972			15.2	
1973			12.1	
1974			11.6	
1975	24.1		11.5	
1976	27.3		10.5	
1977	30.0		11.0	
1978	26.3		9.1	
1979	37.4		8.3	
1980	23.3		15.2	
1981	24.5		13.7	
1982	23.6		11.2	
1983	22.4		21.4	
1984	21.6		13.3	
1985	22.9	33.8	12.8	
1986	33.5	38.9	10.9	
1987	36.6	31.6	11.0	
1988	15.9	33.8	11.3	
1989	16.8	28.2	10.6	
1990	25.9	20.2	11.9	
1991	22.6	31.8	8.1	18.5
1992	29.1	30.1	8.0	18.1
1993	34.8	18.7	8.4	21.6
1994	27.9	21.1	9.2	17.8
1995	24.7	21.8	9.0	18.5
1996	29.8	31.2	10.3	19.8
1997	32.6	32.8	9.9	14.4
1998	23.5	21.1	11.1	17.3
1999	26.4	35.1**	12.0	-
2000	24.5	28.1	10.1	0.2

*no data available for France in 1999
** revised

Effort

Year	Belgium	UK		France*
	Beam trawl ('000 hr) HP corr	Trammel (days at sea)	Beam trawl ('000 hr)	Trawl (h*kw*10-4)
1975	5.0			
1976	6.6			
1977	6.9			
1978	8.2			
1979	7.3			
1980	12.8		2.7	
1981	19.0		2.3	
1982	23.9		4.2	
1983	23.6		2.7	
1984	28.0		2.9	
1985	25.3	6243	9.1	
1986	23.5	5863	12.9	
1987	27.1	7192	24.3	
1988	38.5	6943	19.0	
1989	35.7	8380	33.3	
1990	30.3	13541	33.4	
1991	24.3	12188	30.4	10689
1992	22.0	8547	37.1	10519
1993	20.0	9062	29.3	10217
1994	25.2	10756	28.1	10609
1995	24.2	10571	28.6	12384
1996	25.0	8531	39.1	14088
1997	30.9	10066	39.6	10921
1998	18.1	10307	33.5	11707
1999	21.4	7862	27.2	-
2000	30.5	6398.0	29.0	11703

Table 8.3.2 Sole in VIId. English beam trawl survey numbers per hr raised to 8m beam trawl equivalent

(mean no/rectangle, averaged across rectangles).

Age	1	2	3	4	5	6	7	8	9	10+	1+	3+
1988	8.2	14.2	9.9	0.8	1.3	0.6	0.1	0.1	0.2			
1989	2.6	15.4	3.4	1.7	0.6	0.2	0.2	0.0	0.0	0.6	25.6	8.2
1990	12.1	3.7	3.4	0.7	0.8	0.2	0.1	0.2	0.0	0.2	25.2	6.4
1991	8.9	22.8	2.2	2.3	0.3	0.5	0.1	0.2	0.1	0.4	40.3	6.3
1992	1.4	12.0	10.0	0.7	1.1	0.3	0.5	0.1	0.2	0.8	28.9	14.2
1993	0.5	17.5	8.4	7.0	0.8	1.0	0.3	0.2	0.0	0.3	36.0	18.1
1994	4.8	3.2	8.3	3.3	3.3	0.2	0.6	0.1	0.3	0.3	24.2	16.3
1995	3.5	10.6	1.5	2.3	1.2	1.5	0.2	0.3	0.2	0.2	20.5	7.2
1996	3.5	7.3	3.8	0.7	1.3	0.9	1.1	0.1	0.5	0.4	19.5	8.8
1997	19.0	7.3	3.2	1.3	0.2	0.5	0.4	0.9	0.0	0.6	33.5	7.0
1998	2.0	21.2	2.5	1.0	0.9	0.1	0.3	0.0	0.1	0.3	28.4	5.2
1999	28.1	9.4	13.2	2.5	1.7	1.3	0.2	0.9	1.1	0.5	58.9	21.3
2000	10.5	22.0	4.1	4.2	1.0	0.6	0.3	0.0	0.2	1.2	44.3	11.8
mean	7.8	11.9	5.4	2.1	1.1	0.6	0.4	0.3	0.2	0.4	31.0	10.8

Table 8.4.1.a Sole in VIId. Separable Analysis

At 19/06/2001 18:53

Separable analysis
from 1982 to 2000 on ages 1 to 14
with Terminal F of .450 on age 3 and Terminal S of .500

Initial sum of squared residuals was 474.120 and
final sum of squared residuals is 88.792 after 69 iterations

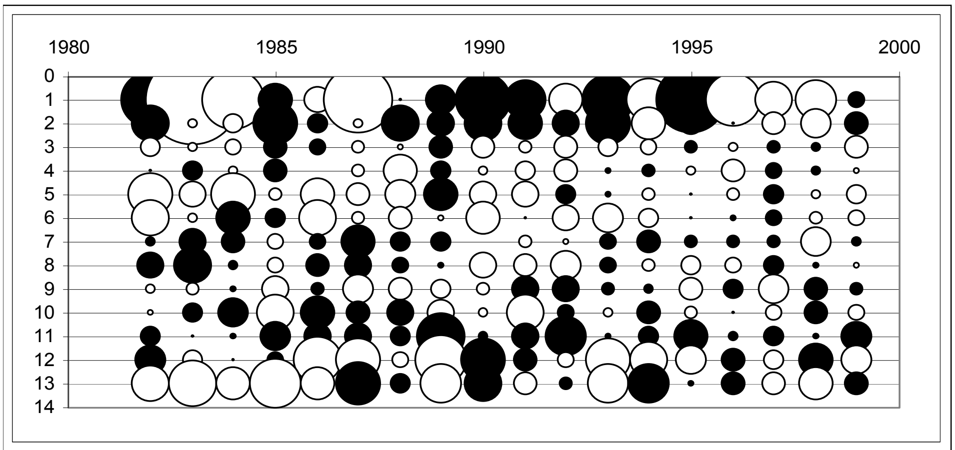
Years	1982/83	1983/84	1984/85	1985/86	1986/87	1987/88	1988/89	1989/90	1990/91	1991/92	1992/93	1993/94	1994/95	1995/96	1996/97	1997/98
Ages																
1/ 2	1.813	-4.406	-1.826	0.619	-0.333	-2.256	-0.002	0.555	1.729	0.947	-0.602	1.455	-0.887	2.673	-1.416	-0.674
2/ 3	0.828	-0.053	-0.158	1.064	0.253	-0.038	0.743	0.47	0.8	0.675	0.401	1.031	-0.59	0.34	0.016	-0.276
3/ 4	-0.18	-0.033	-0.131	0.363	0.211	-0.07	-0.022	0.356	-0.256	-0.062	-0.235	-0.18	-0.104	0.141	-0.045	0.102
4/ 5	0.01	0.242	-0.031	0.306	0.004	-0.064	-0.543	0.253	-0.05	-0.204	-0.282	0.05	0.125	-0.028	-0.278	0.211
5/ 6	-0.954	-0.345	-0.999	-0.062	-0.579	-0.258	-0.395	0.685	-0.348	-0.3	0.244	0.045	-0.082	0.022	-0.06	0.287
6/ 7	-0.636	-0.031	0.644	0.233	-0.729	-0.086	-0.268	-0.016	-0.545	0.022	-0.353	-0.434	-0.157	-0.003	0.029	0.175
7/ 8	0.085	0.437	0.333	-0.129	0.154	0.646	0.278	0.283	0.003	-0.064	-0.018	0.192	0.342	0.141	0.115	0.119
8/ 9	0.49	0.756	0.088	-0.14	0.299	0.419	0.169	0.049	-0.335	-0.225	-0.397	0.165	-0.069	-0.192	-0.117	0.288
9/10	-0.025	-0.085	0.025	-0.301	0.114	-0.398	-0.223	-0.181	-0.072	0.427	0.451	0.113	0.062	-0.265	0.293	-0.491
10/11	-0.007	0.232	0.586	-0.652	0.652	0.359	0.475	-0.379	-0.048	-0.612	0.159	-0.053	0.369	-0.085	0.015	-0.142
11/12	0.288	0.021	0.043	-0.43	0.417	-0.347	0.28	-1.154	0.055	0.458	0.879	0.04	-0.197	-0.496	0.061	-0.214
12/13	0.574	-0.213	0.023	0.163	-1.092	-0.925	-0.129	-1.23	1.072	0.326	-0.103	-0.944	-0.646	-0.436	0.381	-0.212
13/14	-0.651	-1.136	-0.505	-1.267	-0.545	1.063	0.235	-0.827	0.791	-0.241	0.109	-0.877	0.924	0.037	0.312	-0.226
TOT	0.008	0.007	0.006	0.004	0.003	0.003	0.002	0.001	0.001	0	-0.001	-0.003	-0.004	-0.004	-0.005	-0.004
WTS	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	1	1	1

Fishing Mortalities (F)

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
F-values	0.4097	0.3991	0.4677	0.3331	0.4648	0.6657	0.5058	0.5815	0.5664	0.5455	0.4354	0.3376	0.3848	0.4013	0.5122	0.5808

Selection-at-age (S)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
S-values	0.0058	0.2309	1	1.0779	0.9735	0.7856	0.6016	0.5715	0.6038	0.6246	0.6099	0.7116	0.516	0.5



8.4.1.b Sole in VIId. Tuning Fleets.

SOLE 7d,TUNING
106 1
BELGIAN BT
1980 2000
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

UK BT
1981 2000
1 1 0 1
2 15

2.3	41.5	31.2	6.7	25.7	8.5	1.9	2.3	1.6	0.3	0.4	0.8	0.1	0.0	2.8
4.2	17.2	137.2	10.1	3.3	14.1	1.8	1.8	1.9	4.5	1.1	0.0	0.1	0.1	2.3
2.7	18.5	38.4	118.6	2.0	2.8	6.9	4.4	0.3	0.0	0.0	0.0	0.0	1.7	1.3
2.9	42.6	34.8	26.1	30.1	2.6	1.1	0.7	0.6	0.4	0.1	0.1	0.1	0.3	1.5
9.1	12.8	295.0	43.8	21.9	79.8	0.3	0.1	4.9	0.0	0.1	0.5	1.8	0.5	0.5
12.9	38.4	185.4	128.7	35.9	36.9	50.5	1.5	3.1	6.7	3.3	3.6	2.0	2.2	6.8
24.3	362.0	152.3	206.4	142.6	26.8	21.0	54.1	2.1	0.6	4.8	1.5	2.2	4.7	3.5
19.0	145.2	402.6	81.8	94.4	61.4	13.4	17.6	25.6	2.6	0.4	6.7	7.1	0.0	0.3
33.3	310.0	186.9	369.7	44.0	81.7	60.5	12.7	10.8	42.6	2.5	1.1	5.0	6.8	34.5
33.4	199.8	662.3	97.2	146.7	29.1	34.2	34.7	8.7	15.0	48.6	4.1	1.1	6.8	17.7
30.4	488.9	200.3	287.8	12.3	45.9	7.5	11.0	16.3	4.1	2.7	12.7	0.4	0.0	7.4
37.1	332.3	684.6	105.6	215.2	15.0	26.1	8.2	19.0	6.6	3.0	1.9	4.2	0.1	3.3
29.3	272.1	358.5	357.3	56.9	86.8	8.6	17.7	7.4	5.0	5.5	1.9	2.1	3.5	4.6
28.1	49.6	394.0	217.4	170.0	41.6	68.3	6.7	15.8	4.9	5.9	5.5	3.6	2.4	13.9
28.6	229.9	136.3	291.6	140.5	124.3	24.4	51.3	7.2	13.1	2.6	5.9	6.1	1.2	10.8
39.1	446.0	376.0	118.1	251.3	127.7	101.8	26.3	50.5	6.3	13.5	6.3	8.0	5.4	18.2
39.6	427.3	504.4	239.9	64.2	180.2	75.3	71.0	16.6	33.1	4.0	10.4	1.7	5.4	12.1
33.5	527.5	337.9	185.8	125.1	41.7	94.1	54.3	43.0	10.8	22.9	4.0	10.2	2.8	17.5
27.2	350.3	613.7	214.2	87.8	64.8	25.3	54.0	26.7	14.8	7.1	7.7	1.4	5.1	8.5
29.0	298.9	342.0	320.9	102.1	47.5	33.1	12.7	39.8	17.9	10.6	4.4	7.6	1.1	14.3

FR OT*
1991 2000
1 1 0 1
3 15

10689	121.1	138.9	26.8	32.3	9.8	7.9	9.2	3.4	3.8	3.5	0.5	0.9	4.1
10519	528.1	57.4	43.0	10.5	13.5	5.3	4.5	3.2	3.9	1.7	1.3	0.5	2.1
10217	397.8	243.6	36.8	12.0	5.4	4.8	3.3	1.7	0.6	0.3	0.2	0.0	0.2
10609	328.0	288.0	142.7	22.4	14.9	4.5	5.0	2.5	1.6	0.9	0.8	1.2	3.2
12384	292.0	223.2	138.0	87.6	18.1	6.4	3.6	3.9	3.2	3.2	0.8	0.4	6.6
14088	558.6	189.7	141.3	108.8	62.5	16.4	8.7	7.8	4.0	5.6	3.1	2.9	8.2
10921	164.6	164.1	79.6	42.6	30.8	31.5	12.6	2.9	4.3	2.7	0.7	1.4	3.2
11707	497.5	136.2	81.3	41.5	21.3	21.6	20.7	16.8	3.7	3.5	0.7	1.1	2.3
-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
11703	367.5	289.1	71.7	29.4	22.2	4.9	20.4	5.8	5.0	1.5	2.5	0.2	4.4

Table 8.4.1b (Continued)

UK BTS

1988	2000					
1	1	0.5	0.75			
1	6					
1	8.2	14.2	9.9	0.8	1.3	0.6
1	2.6	15.4	3.4	1.7	0.6	0.2
1	12.1	3.7	3.4	0.7	0.8	0.2
1	8.9	22.8	2.2	2.3	0.3	0.5
1	1.4	12.0	10.0	0.7	1.1	0.3
1	0.5	17.5	8.4	7.0	0.8	1.0
1	4.8	3.2	8.3	3.3	3.3	0.2
1	3.5	10.6	1.5	2.3	1.2	1.5
1	3.5	7.3	3.8	0.7	1.3	0.9
1	19.0	7.3	3.2	1.3	0.2	0.5
1	2.0	21.2	2.5	1.0	0.9	0.1
1	28.1	9.4	13.2	2.5	1.7	1.3
1	10.5	22.0	4.1	4.2	1.0	0.6

UK YFS**

1985	2000		
1	1	0.5	0.75
1	1		
1	2.94		
1	1.45		
1	1.38		
1	1.87		
1	0.62		
1	1.9		
1	3.69		
1	1.5		
1	1.33		
1	2.68		
1	2.91		
1	0.57		
1	1.12		
1	1.12		
1	1.47		
1	2.47		

FR YFS

1987	2000		
1	1	0.5	0.75
1	1		
1	0.07		
1	0.17		
1	0.14		
1	0.54		
1	0.38		
1	0.22		
1	0.03		
1	0.70		
1	0.28		
1	0.15		
1	0.03		
1	0.10		
1	0.35		
1	0.31		

* No data available for the French Otter Trawl Fleet in 1999

** Revised, Indexbased on reduced sample area worked in 2000, excludes pushnet stations

Table 8.4.1c Sole in VIId Tuning diagnostics

Lowestoft VPA Version 3.1

22/06/2001 9:51

Extended Survivors Analysis

Sole in VIId (run: XSARIC07/X07)

CPUE data from file c:\wgnssk\2001\vpa\tun.txt

Catch data for 19 years. 1982 to 2000. Ages 1 to 11.

Fleet	First year	Last year	First age	Last age	Alpha	Beta
BEL BT	1986	2000	2	9	0	1
UK BT	1986	2000	2	10	0	1
FR OT	1991	2000	3	10	0	1
UK BTS	1988	2000	1	6	0.5	0.75
UK YFS	1986	2000	1	1	0.5	0.75
FR YFS	1987	2000	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 4 years or the 4 oldest ages.

S.E. of the mean to which the estimates are shrunk = .500

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

Prior weighting not applied

Tuning converged after 57 iterations

Regression weights

1	1	1	1	1	1	1	1	1	1

Fishing mortalities

Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	0.011	0.003	0.005	0.001	0.033	0.001	0.001	0.002	0.005	0.003
2	0.211	0.141	0.185	0.053	0.13	0.12	0.1	0.062	0.185	0.115
3	0.441	0.378	0.321	0.337	0.433	0.527	0.583	0.505	0.437	0.42
4	0.545	0.363	0.393	0.484	0.404	0.518	0.704	0.498	0.57	0.395
5	0.39	0.483	0.316	0.394	0.424	0.465	0.746	0.478	0.426	0.348
6	0.517	0.309	0.242	0.272	0.374	0.444	0.44	0.461	0.452	0.276
7	0.328	0.335	0.264	0.338	0.251	0.393	0.39	0.245	0.473	0.289
8	0.347	0.267	0.271	0.247	0.255	0.261	0.41	0.304	0.419	0.339
9	0.463	0.398	0.352	0.297	0.305	0.451	0.346	0.304	0.359	0.355
10	0.447	0.267	0.219	0.441	0.322	0.625	0.442	0.597	0.234	0.241

Table 8.4.1c (continued)

XSA population numbers (Thousands)

YEAR	AGE 1	2	3	4	5	6	7	8	9	10
1991	3.65E+04	4.08E+04	1.12E+04	1.08E+04	1.90E+03	2.61E+03	9.64E+02	9.21E+02	7.71E+02	2.77E+02
1992	3.61E+04	3.27E+04	2.99E+04	6.52E+03	5.66E+03	1.17E+03	1.41E+03	6.28E+02	5.89E+02	4.39E+02
1993	1.77E+04	3.26E+04	2.57E+04	1.86E+04	4.11E+03	3.16E+03	7.74E+02	9.13E+02	4.35E+02	3.58E+02
1994	2.84E+04	1.59E+04	2.45E+04	1.69E+04	1.13E+04	2.71E+03	2.25E+03	5.38E+02	6.30E+02	2.77E+02
1995	2.18E+04	2.56E+04	1.36E+04	1.58E+04	9.40E+03	6.92E+03	1.87E+03	1.45E+03	3.80E+02	4.24E+02
1996	2.12E+04	1.91E+04	2.04E+04	8.01E+03	9.56E+03	5.56E+03	4.31E+03	1.32E+03	1.02E+03	2.53E+02
1997	3.52E+04	1.92E+04	1.53E+04	1.09E+04	4.31E+03	5.44E+03	3.23E+03	2.63E+03	9.17E+02	5.85E+02
1998	2.42E+04	3.18E+04	1.57E+04	7.75E+03	4.87E+03	1.85E+03	3.17E+03	1.98E+03	1.58E+03	5.87E+02
1999	4.06E+04	2.19E+04	2.71E+04	8.58E+03	4.26E+03	2.73E+03	1.06E+03	2.24E+03	1.32E+03	1.05E+03
2000	5.82E+04	3.66E+04	1.65E+04	1.58E+04	4.39E+03	2.52E+03	1.57E+03	5.95E+02	1.34E+03	8.35E+02

Estimated population abundance at 1st Jan 2001

0.00E+00	5.25E+04	2.95E+04	9.78E+03	9.65E+03	2.81E+03	1.73E+03	1.07E+03	3.84E+02	8.47E+02

Taper weighted geometric mean of the VPA populations:

2.50E+04	2.12E+04	1.62E+04	9.04E+03	4.78E+03	2.86E+03	1.74E+03	1.06E+03	6.93E+02	4.17E+02

Standard error of the weighted Log(VPA populations) :

0.4392	0.3918	0.3771	0.4596	0.4581	0.4836	0.5073	0.5076	0.484	0.4903

Log catchability residuals.

Fleet : BEL BT

Age	1986	1987	1988	1989	1990
1	No data for this fleet at this age				
2	0.3	0.84	-0.48	-2.3	1.39
3	0.67	-0.26	-0.49	-0.06	0.06
4	0.11	0.29	-0.8	-0.46	-0.21
5	-0.17	0.47	-0.32	0.91	-0.13
6	-0.09	0.91	-0.25	0.3	-0.18
7	-0.17	0.54	-0.07	0.24	0.54
8	-0.09	-0.06	-0.87	-0.23	-0.36
9	0.48	0.08	-0.68	-0.49	0.1
10	No data for this fleet at this age				

Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	No data for this fleet at this age									
2	-0.51	0.23	1.54	-0.03	-0.52	0.06	-0.54	-0.27	0.37	-0.09
3	0.78	0.04	0.2	-0.1	-0.34	-0.14	0.23	-0.34	-0.24	0.01
4	0.07	0.29	-0.12	0.5	-0.42	0.21	0.2	0.04	0.34	-0.06
5	-0.12	0.26	-0.19	0.17	-0.15	-0.24	0.36	-0.4	0.11	-0.56
6	0.73	-0.5	-0.68	0.33	0.06	0.14	0.12	-0.3	-0.31	-0.28
7	-0.02	-0.19	-0.08	0.2	-0.21	0.14	0.16	-0.31	-0.14	-0.64
8	-0.04	-0.29	-0.19	0.19	-0.87	-0.27	-0.36	0	-0.3	0.33
9	-0.8	-0.04	0.51	-0.1	0.03	0.2	-0.27	-0.26	-0.08	-0.36
10	No data for this fleet at this age									

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

Age	2	3	4	5	6	7	8	9
Mean Log	-7.3811	-5.8186	-5.6804	-5.55	-5.8488	-5.7295	-5.7295	-5.7295
S.E(Log q)	0.9155	0.3579	0.3513	0.3814	0.4367	0.3117	0.4024	0.3941

Table 8.4.1c (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
2	1.11	-0.154	7.1	0.14	15	1.05	-7.38
3	1.14	-0.5	5.26	0.48	15	0.42	-5.82
4	0.88	0.687	6.11	0.7	15	0.31	-5.68
5	1.05	-0.211	5.4	0.56	15	0.42	-5.55
6	0.84	0.798	6.19	0.64	15	0.37	-5.85
7	0.93	0.474	5.86	0.76	15	0.3	-5.73
8	1.21	-1.132	5.73	0.68	15	0.39	-5.96
9	1.62	-2.148	5.37	0.48	15	0.55	-5.84

Fleet : UK BT

Age	1986	1987	1988	1989	1990
1	No data for this fleet at this age				
2	-0.45	0.48	0.7	0.02	0.05
3	0.37	-0.03	0.52	0.2	0.44
4	0.33	0.41	0.11	0.51	0.18
5	0.09	0.49	0.58	-0.31	0.4
6	0.19	-0.32	0.42	0.37	-0.14
7	0.51	-0.32	-0.05	0.43	0.12
8	-1.06	0.45	0.4	-0.16	0.34
9	-0.33	-0.86	0.4	-0.2	-0.06
10	0.09	-1.93	0.19	0.74	0.62

Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	No data for this fleet at this age									
2	0.07	-0.33	-0.27	-1.27	-0.2	0.44	0.37	0.23	0.46	-0.31
3	-0.15	-0.14	-0.42	-0.23	-0.68	-0.33	0.25	-0.04	0.19	0.03
4	0.23	-0.55	-0.12	-0.44	-0.14	-0.62	-0.15	0.01	0.29	-0.06
5	-1.13	0.48	-0.37	-0.21	-0.22	0.05	-0.4	0.19	0.16	0.18
6	-0.1	-0.7	0.26	-0.27	-0.08	-0.11	0.24	0.03	0.29	-0.09
7	-0.9	-0.23	-0.54	0.55	-0.36	-0.01	-0.04	0.3	0.4	0.12
8	-0.46	-0.61	0.02	-0.39	0.64	-0.24	0.12	0.25	0.38	0.16
9	0.16	0.36	-0.07	0.33	0.04	0.76	-0.31	0.24	0.18	0.5
10	-0.2	-0.47	-0.33	0.05	0.54	0.14	0.87	-0.01	-0.24	0.12

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

Age	2	3	4	5	6	7	8	9	10
Mean Log	-7.7581	-7.0261	-6.9679	-7.0906	-7.0674	-7.1645	-7.1645	-7.1645	-7.1645
S.E(Log q)	0.4977	0.3378	0.3455	0.4508	0.3014	0.4146	0.47	0.4097	0.6653

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	1.1	-0.275	7.52	0.35	15	0.57	-7.76
3	1.12	-0.44	6.71	0.52	15	0.39	-7.03
4	1.16	-0.668	6.62	0.58	15	0.41	-6.97
5	0.74	1.35	7.45	0.68	15	0.33	-7.09
6	0.79	1.669	7.25	0.83	15	0.22	-7.07
7	0.72	1.951	7.26	0.79	15	0.27	-7.16
8	0.64	3.16	7.11	0.86	15	0.24	-7.17
9	0.67	2.764	6.93	0.85	15	0.22	-7.09
10	0.76	0.893	6.91	0.52	15	0.51	-7.15

Table 8.4.1c (continued)

Fleet : FR OT

Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	No data for this fleet at this age									
2	No data for this fleet at this age									
3	-0.43	0.04	-0.08	-0.26	0.1	0.26	-0.4	0.58	99.99	0.19
4	-0.07	-0.51	-0.07	0.2	-0.19	0.25	0.14	0.13	99.99	0.12
5	0.09	-0.47	-0.35	-0.01	0	-0.1	0.5	0.21	99.99	0.13
6	0.28	-0.12	-0.98	-0.23	0.09	0.43	-0.23	0.76	99.99	0.02
7	0.15	0.11	-0.21	-0.27	-0.09	0.26	0.09	-0.4	99.99	0.37
8	-0.01	-0.05	-0.49	-0.08	-0.87	0.04	0.33	0.12	99.99	-0.15
9	0.37	-0.09	-0.09	-0.11	-0.08	-0.24	0.44	0.3	99.99	0.48
10	0.39	-0.2	-0.62	0.09	-0.1	1.11	-0.54	1.21	99.99	-0.37

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

Age	3	4	5	6	7	8	9	10
Mean Log	-13.1125	-13.2564	-13.3961	-13.6546	-13.8059	-13.8059	-13.8059	-13.8059
S.E(Log q)	0.3303	0.241	0.2893	0.4912	0.2556	0.3794	0.3031	0.6828

Regression statistics :

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

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
3	0.9	0.28	12.79	0.55	9	0.32	-13.11
4	0.88	0.597	12.79	0.78	9	0.22	-13.26
5	1.11	-0.523	13.94	0.75	9	0.34	-13.4
6	1.05	-0.146	13.93	0.55	9	0.55	-13.65
7	1	0.008	13.8	0.83	9	0.27	-13.81
8	0.88	0.603	13.07	0.77	9	0.32	-13.94
9	0.74	1.946	11.89	0.89	9	0.18	-13.7
10	2.08	-0.874	21.98	0.09	9	1.42	-13.7

Fleet : UK BTS

Age	1986	1987	1988	1989	1990
1	99.99	99.99	0.6	-0.11	0.46
2	99.99	99.99	1.13	0.32	-0.62
3	99.99	99.99	0.73	0.7	-0.37
4	99.99	99.99	-0.19	0.08	0.16
5	99.99	99.99	0.46	0.18	-0.06
6	99.99	99.99	0.18	-0.67	-0.17
7	No data for this fleet at this age				
8	No data for this fleet at this age				
9	No data for this fleet at this age				
10	No data for this fleet at this age				

Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	0.38	-1.46	-1.77	-0.01	-0.02	-0.01	1.17	-0.73	1.42	0.08
2	0.22	-0.24	0.17	-0.9	-0.13	-0.2	-0.23	0.31	-0.06	0.24
3	-0.3	0.19	0.14	0.18	-0.88	-0.29	-0.15	-0.49	0.61	-0.07
4	0.23	-0.56	0.71	0.11	-0.24	-0.67	-0.25	-0.31	0.56	0.36
5	-0.21	0.06	-0.04	0.41	-0.4	-0.31	-0.99	0.02	0.74	0.14
6	0.27	0.44	0.6	-0.83	0	0.06	-0.51	-0.85	1.14	0.34
7	No data for this fleet at this age									
8	No data for this fleet at this age									
9	No data for this fleet at this age									
10	No data for this fleet at this age									

Table 8.4.1c (continued)

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	-8.6339	-7.5178	-7.9008	-8.2858	-8.2429	-8.4488
S.E(Log q)	0.9099	0.4978	0.4856	0.415	0.4339	0.5943

Regression statistics :

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

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
1	0.48	1.613	9.49	0.47	13	0.41	-8.63
2	0.96	0.114	7.62	0.41	13	0.5	-7.52
3	0.85	0.457	8.17	0.47	13	0.43	-7.9
4	0.77	1.279	8.49	0.74	13	0.31	-8.29
5	1.02	-0.066	8.24	0.54	13	0.46	-8.24
6	1.04	-0.12	8.47	0.41	13	0.65	-8.45

Fleet : UK YFS

Age	1986	1987	1988	1989	1990
1	-0.04	0.75	0.21	-0.45	-0.3
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	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	0.6	-0.3	0.3	0.52	0.89	-0.73	-0.56	-0.19	-0.43	-0.27
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	-9.7286
S.E(Log q)	0.5112

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	1.84	-1.466	9.31	0.19	15	0.9	-9.73

Table 8.4.1c (continued)

Fleet : FR YFS

Age	1986	1987	1988	1989	1990
1	99.99	-0.04	0	0.25	0.63
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	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	0.51	-0.03	-1.3	1.37	0.74	0.12	-2	-0.42	0.32	-0.16
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	-11.9165
S.E(Log q)	0.8391

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	0.87	0.27	11.7	0.27	14	0.76	-11.92

Terminal year survivor and F summaries :

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

Year class = 1999

Fleet	I S	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
FR OT	1	0	0	0	0	0	0
UK BTS	56768	0.944	0	0	1	0.112	0.002
UK YFS	39908	0.528	0	0	1	0.357	0.003
FR YFS	44659	0.869	0	0	1	0.132	0.003
F shrinka	69357	0.5				0.399	0.002

Weighted prediction :

Survivors at end of y	Int s.e	Ext s.e	N	Var Ratio	F
52532	0.32	0.18	4	0.567	0.003

Table 8.4.1c (continued)

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

Year class = 1998

Fleet	I :	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
BEL BT	26848	0.946	0	0	1	0.058	0.126
UK BT	21621	0.514	0	0	1	0.198	0.154
FR OT	1	0	0	0	0	0	0
UK BTS	49043	0.453	0.499	1.1	2	0.254	0.071
UK YFS	19137	0.528	0	0	1	0.186	0.172
FR YFS	40626	0.869	0	0	1	0.069	0.085
F shrinka	29063	0.5				0.234	0.117

Weighted prediction :

Survivors at end of y	Int s.e	Ext s.e	N	Var Ratio	F
29501	0.23	0.18	7	0.77	0.115

Age 3 Catchability constant w.r.t. time and dependent on age

Year class = 1997

Fleet	I :	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
BEL BT	10260	0.345	0.115	0.33	2	0.179	0.404
UK BT	11386	0.29	0.19	0.66	2	0.247	0.371
FR OT	11852	0.348	0	0	1	0.179	0.358
UK BTS	8479	0.338	0.151	0.45	3	0.174	0.471
UK YFS	8093	0.528	0	0	1	0.065	0.489
FR YFS	6443	0.869	0	0	1	0.024	0.584
F shrinka	7580	0.5				0.132	0.515

Weighted prediction :

Survivors at end of y	Int s.e	Ext s.e	N	Var Ratio	F
9779	0.15	0.07	11	0.484	0.42

Age 4 Catchability constant w.r.t. time and dependent on age

Year class = 1996

Fleet	I :	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
BEL BT	8412	0.256	0.066	0.26	3	0.219	0.442
UK BT	10335	0.23	0.093	0.4	3	0.26	0.373
FR OT	10914	0.3	0	0	1	0.187	0.356
UK BTS	15246	0.273	0.125	0.46	4	0.183	0.267
UK YFS	5486	0.528	0	0	1	0.037	0.616
FR YFS	1310	0.869	0	0	1	0.014	1.519
F shrinka	6019	0.5				0.1	0.575

Weighted prediction :

Survivors at end of y	Int s.e	Ext s.e	N	Var Ratio	F
9648	0.12	0.11	14	0.872	0.395

Table 8.4.1c (continued)

Age 5 Catchability constant w.r.t. time and dependent on age

Year class = 1995

Fleet	I !	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
BEL BT	2215	0.231	0.23	1	4	0.233	0.423
UK BT	3384	0.223	0.077	0.34	4	0.224	0.296
FR OT	3506	0.252	0.182	0.72	2	0.233	0.287
UK BTS	3209	0.254	0.169	0.67	5	0.186	0.31
UK YFS	1347	0.528	0	0	1	0.019	0.624
FR YFS	3161	0.869	0	0	1	0.007	0.314
F shrinka	1667	0.5				0.097	0.531

Weighted prediction :

Survivors at end of y	Int s.e	Ext s.e	N	Var Ratio	F
2805	0.12	0.09	18	0.794	0.348

Age 6 Catchability constant w.r.t. time and dependent on age

Year class = 1994

Fleet	I !	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
BEL BT	1680	0.218	0.096	0.44	5	0.237	0.283
UK BT	1764	0.197	0.073	0.37	5	0.322	0.271
FR OT	1715	0.243	0.136	0.56	3	0.169	0.278
UK BTS	2198	0.249	0.19	0.76	6	0.166	0.223
UK YFS	4203	0.528	0	0	1	0.012	0.123
FR YFS	3606	0.869	0	0	1	0.004	0.142
F shrinka	964	0.5				0.089	0.451

Weighted prediction :

Survivors at end of y	Int s.e	Ext s.e	N	Var Ratio	F
1728	0.11	0.07	22	0.648	0.276

Age 7 Catchability constant w.r.t. time and dependent on age

Year class = 1993

Fleet	I !	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
BEL BT	680	0.203	0.112	0.55	6	0.276	0.423
UK BT	1222	0.197	0.08	0.41	6	0.259	0.257
FR OT	1436	0.198	0.05	0.25	4	0.287	0.222
UK BTS	1394	0.26	0.259	1	6	0.087	0.228
UK YFS	1802	0.528	0	0	1	0.006	0.181
FR YFS	4198	0.869	0	0	1	0.002	0.082
F shrinka	783	0.5				0.083	0.376

Weighted prediction :

Survivors at end of y	Int s.e	Ext s.e	N	Var Ratio	F
1066	0.11	0.08	25	0.78	0.289

Table 8.4.1c (continued)

Age 8 Catchability constant w.r.t. time and age (fixed at the value for age) 7

Year class = 1992

Fleet	I :	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
BEL BT	407	0.199	0.107	0.54	7	0.319	0.323
UK BT	399	0.201	0.145	0.72	7	0.278	0.328
FR OT	438	0.235	0.171	0.73	5	0.225	0.303
UK BTS	159	0.262	0.079	0.3	6	0.062	0.682
UK YFS	518	0.528	0	0	1	0.005	0.262
FR YFS	104	0.869	0	0	1	0.002	0.911
F shrinka	370	0.5				0.109	0.35

Weighted prediction :

Survivors at end of y	Int s.e	Ext s.e	N	Var Ratio	F
384	0.12	0.07	28	0.632	0.339

Age 9 Catchability constant w.r.t. time and age (fixed at the value for age) 7

Year class = 1991

Fleet	I :	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
BEL BT	647	0.177	0.069	0.39	8	0.288	0.444
UK BT	1133	0.182	0.083	0.46	8	0.26	0.277
FR OT	903	0.175	0.174	1	6	0.312	0.337
UK BTS	643	0.239	0.137	0.57	6	0.05	0.446
UK YFS	630	0.528	0	0	1	0.004	0.453
FR YFS	824	0.869	0	0	1	0.002	0.364
F shrinka	818	0.5				0.083	0.366

Weighted prediction :

Survivors at end of y	Int s.e	Ext s.e	N	Var Ratio	F
847	0.1	0.06	31	0.649	0.355

Age 10 Catchability constant w.r.t. time and age (fixed at the value for age) 7

Year class = 1990

Fleet	I :	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
BEL BT	624	0.179	0.057	0.32	8	0.282	0.23
UK BT	611	0.186	0.072	0.39	9	0.297	0.235
FR OT	619	0.18	0.081	0.45	7	0.265	0.232
UK BTS	548	0.24	0.107	0.44	6	0.048	0.259
UK YFS	1081	0.528	0	0	1	0.004	0.139
FR YFS	992	0.869	0	0	1	0.002	0.151
F shrinka	436	0.5				0.104	0.316

Weighted prediction :

Survivors at end of y	Int s.e	Ext s.e	N	Var Ratio	F
594	0.1	0.04	33	0.369	0.241

Table 8.4.2 Sole in VIId. Fishing mortality (F) at age

Run title : Sole in VIId (run: XSARIC07/X07)

At 22/06/2001 9:53

Terminal Fs derived using XSA (With F shrinkage)

YEAR	1982	1983	1984	1985	1986	1987	1988	1989	1990
AGE									
1	0.0125	0.0000	0.0011	0.0038	0.0019	0.0008	0.0037	0.0099	0.0292
2	0.1825	0.0798	0.1093	0.2140	0.1157	0.1519	0.2522	0.1736	0.2332
3	0.3084	0.3439	0.4158	0.4100	0.4844	0.5281	0.5243	0.6684	0.4430
4	0.4723	0.3545	0.4200	0.3525	0.4335	0.5758	0.4021	0.6909	0.4875
5	0.2147	0.4254	0.2579	0.2575	0.3045	0.5057	0.3666	0.7089	0.4713
6	0.2432	0.4174	0.6631	0.3832	0.2872	0.6022	0.3647	0.4758	0.2813
7	0.4577	0.3456	0.4400	0.2254	0.3590	0.7271	0.4205	0.4276	0.3689
8	0.4147	0.4929	0.2622	0.2372	0.3605	0.4519	0.3359	0.3781	0.3084
9	0.3362	0.2952	0.3390	0.1780	0.4456	0.4316	0.2402	0.3537	0.3878
10	0.3640	0.3889	0.4275	0.2565	0.3540	0.7481	0.5791	0.3416	0.4465
+gp	0.3640	0.3889	0.4275	0.2565	0.3540	0.7481	0.5791	0.3416	0.4465
FBAR 3- 8	0.3518	0.3966	0.4098	0.3110	0.3715	0.5651	0.4023	0.5583	0.3934

YEAR	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	FBAR 98-00	Frescaled
AGE												
1	0.0111	0.0031	0.0051	0.0013	0.0334	0.0005	0.0009	0.0018	0.0047	0.0026	0.003	0.0025
2	0.2107	0.1408	0.1848	0.0532	0.1301	0.1200	0.1002	0.0618	0.1849	0.1152	0.1206	0.1020
3	0.4407	0.3782	0.3214	0.3367	0.4327	0.5269	0.5830	0.5054	0.4372	0.4201	0.4543	0.3841
4	0.5452	0.3625	0.3928	0.4841	0.4039	0.5184	0.7036	0.4980	0.5696	0.3951	0.4876	0.4123
5	0.3903	0.4834	0.3156	0.3943	0.4241	0.4648	0.7457	0.4779	0.4262	0.3479	0.4173	0.3528
6	0.5166	0.3094	0.2416	0.2716	0.3738	0.4435	0.4398	0.4613	0.4518	0.2758	0.3963	0.3351
7	0.3276	0.3351	0.2643	0.3382	0.2506	0.3933	0.3897	0.2446	0.4734	0.2892	0.3358	0.2839
8	0.3472	0.2669	0.2708	0.2472	0.2548	0.2615	0.4098	0.3042	0.4191	0.3394	0.3542	0.2995
9	0.4631	0.3981	0.3524	0.2970	0.3050	0.4513	0.3459	0.3042	0.3587	0.3554	0.3394	0.2870
10	0.4470	0.2673	0.2191	0.4414	0.3222	0.6248	0.4421	0.5970	0.2337	0.2407	0.3571	0.3019
+gp	0.4470	0.2673	0.2191	0.4414	0.3222	0.6248	0.4421	0.5970	0.2337	0.2407		
FBAR 3- 8	0.4279	0.3559	0.3011	0.3453	0.3567	0.4347	0.5453	0.4152	0.4629	0.3446		
											factor	0.845471274

Table 8.4.3 Sole in VIId. Stock number at age (start of year) Numbers*10-3**

Run title : Sole in VIId (run: XSARIC07/X07)

At 22/06/2001 9:53

Terminal Fs derived using XSA (With F shrinkage)

YEAR	1982	1983	1984	1985	1986	1987	1988	1989	1989
AGE									
1	13069	22191	22298	13498	27134	11616	27099	17439	46478
2	16541	11678	20079	20153	12167	24505	10502	24430	15625
3	20822	12470	9756	16288	14722	9807	19049	7384	18582
4	4823	13841	8000	5825	9781	8207	5233	10204	3425
5	3102	2721	8786	4756	3705	5737	4175	3168	4627
6	3180	2264	1609	6142	3326	2472	3130	2618	1411
7	1571	2256	1350	750	3788	2258	1225	1967	1472
8	743	900	1445	787	542	2394	988	728	1161
9	449	444	497	1006	561	342	1378	639	451
10	286	290	299	321	762	325	201	981	406
+gp	694	627	716	593	1339	930	676	1191	1616
TOTAL	65281	69684	74835	70118	77827	68593	73657	70749	95253

YEAR	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	GMST 82-98	AMST 82-98
AGE													
1	36519	36098	17660	28363	21835	21223	35223	24216	40624	58209 [3]	23152 [1]	23152	24821
2	40846	32679	32562	15899	25632	19107	19193	31843	21872	36585	52532 [2]	20462	21967
3	11197	29938	25687	24493	13641	20364	15334	15712	27087	16450	29501	15725	16779
4	10796	6520	18559	16854	15827	8007	10879	7745	8577	15828	9779	8770	9678
5	1903	5663	4106	11338	9398	9562	4314	4870	4259	4390	9648	4837	5408
6	2613	1165	3160	2710	6916	5564	5436	1852	2733	2516	2805	2890	3269
7	964	1411	774	2246	1869	4306	3231	3168	1056	1574	1728	1797	2036
8	921	628	913	538	1449	1316	2629	1980	2245	595	1066	1051	1180
9	771	589	435	630	380	1016	917	1579	1322	1336	384	642	711
10	277	439	358	277	424	253	585	587	1054	835	847	380	416
+gp	1147	1059	773	816	940	844	873	823	1957	1432	1613		
TOTAL	107954	116190	104986	104162	98310	91563	98616	94376	112786	139752	109903		

[1] Replaced by GM
[2] Replaced by 27971,RCT3 estimate (2 year olds in 2001)
[3] Replaced by 31277,RCT3 estimate (1 year olds in 2000)

Table 8.5.1 Sole in VIId. Input data for RCT3

Year class	VPA-1	VPA-2	enyfs0	enyfs1	fyfs0	fyfs1	ebts1	ebts2
1981	13069	11678	0.11	0.36	3.33	0.07	-11	-11
1982	22191	20079	4.63	1.52	1.04	0.02	-11	-11
1983	22298	20153	25.45	4.04	0.79	-11	-11	-11
1984	13498	12167	4.33	2.94	-11	-11	-11	-11
1985	27134	24505	7.65	1.45	-11	-11	-11	-11
1986	11616	10502	6.45	1.38	-11	0.07	-11	14.2
1987	27099	24430	16.85	1.87	0.75	0.17	8.2	15.4
1988	17439	15625	2.59	0.62	0.04	0.14	2.6	3.7
1989	46478	40846	6.67	1.9	17.43	0.54	12.1	22.8
1990	36519	32679	6.7	3.69	0.57	0.38	8.9	12
1991	36098	32562	1.81	1.5	1.04	0.22	1.4	17.5
1992	17660	15899	2.26	1.33	0.48	0.03	0.5	3.2
1993	28363	25632	14.19	2.68	0.27	0.7	4.8	10.6
1994	21835	19107	13.07	2.91	4.04	0.28	3.5	7.4
1995	21223	19193	7.53	0.57	3.5	0.15	3.5	7.3
1996	35223	31843	1.85	1.12	0.28	0.03	19	21.23
1997	24216	21872	4.23	1.12	0.07	0.1	2	9.44
1998	-11	-11	7.97	1.47	10.52	0.35	28.14	22.03
1999	-11	-11	2.63	2.47	2.84	0.31	10.49	-11
2000	-11	-11	1.16	-11	2.41	-11	-11	-11

Table 8.5.2a Sole in VIId. RCT3 estimates at age 1

Analysis by RCT3 ver3.1 of data from file :

S7DREC1.CSV

7D Sole (1year olds),,,,,,,

Data for 6 surveys over 20 years : 1981 - 2000

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 = 1999

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression----------I					I-----------Prediction---------I			
enyfs0	2.19	5.97	1.74	.050	17	1.29	8.80	1.938	.019
enyfs1	3.58	6.57	1.33	.083	17	1.24	11.03	1.482	.032
fyfs0,	2.26	8.27	1.84	.037	14	1.35	11.31	2.087	.016
fyfs1,	4.61	9.27	.63	.308	14	.27	10.51	.708	.140
ebts1,	.62	9.16	.38	.438	11	2.44	10.68	.461	.330
ebts2,									
					VPA Mean =		10.05	.389	.463

Yearclass = 2000

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression----------I					I-----------Prediction---------I			
enyfs0	2.19	5.97	1.74	.050	17	.77	7.66	2.013	.035
enyfs1									
fyfs0,	2.26	8.27	1.84	.037	14	1.23	11.04	2.074	.033
fyfs1,									
ebts1,									
ebts2,									
					VPA Mean =		10.05	.389	.932

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
1999	31277	10.35	.26	.18	.44		
2000	22011	10.00	.38	.34	.81		

Table 8.5.2b Sole in VIId. RCT3 estimates at age 2

Analysis by RCT3 ver3.1 of data from file :

S7DREC2.CSV

7D Sole (2 year olds),,,,,,,

Data for 6 surveys over 20 years : 1981 - 2000

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 = 1999

Survey/ Series	Regression: Slope	Inter- cept	Std Error	Rsquare	No. Pts	Prediction: Index Value	Predicted Value	Std Error	WAP Weights
enyfs0	2.18	5.88	1.73	.050	17	1.29	8.70	1.929	.019
enyfs1	3.60	6.45	1.34	.082	17	1.24	10.92	1.492	.032
fyfs0,	2.54	7.93	2.07	.029	14	1.35	11.35	2.348	.013
fyfs1,	4.66	9.15	.64	.299	14	.27	10.41	.720	.136
ebts1,	.62	9.05	.38	.435	11	2.44	10.57	.462	.330
ebts2,									
						VPA Mean =	9.94	.387	.470

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
1999	27971	10.24	.27	.18	.45		

Table 8.6.1 Sole in VIId. Stock summary

Run title : Sole in VIId (run: XSARIC07/X07)

At 22/06/2001 9:53

Table 16 Summary (without SOP correction)

Terminal Fs derived using XSA (With F shrinkage)

	RECRUITS (Age 1)	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	FBAR 3- 8
1980						
1981						
1982	13069	10484	7827	3190	0.4075	0.3518
1983	22191	12834	9704	3458	0.3564	0.3966
1984	22298	13274	9149	3575	0.3907	0.4098
1985	13498	13824	10346	3837	0.3709	0.311
1986	27134	14506	10952	4024	0.3674	0.3715
1987	11616	14086	9843	4974	0.5053	0.5651
1988	27099	13542	10083	3982	0.3949	0.4023
1989	17439	12062	8108	4187	0.5164	0.5583
1990	46478	14172	8810	4060	0.4609	0.3934
1991	36519	14774	7686	4382	0.5701	0.4279
1992	36098	17768	10422	4142	0.3974	0.3559
1993	17660	16343	12327	4511	0.3660	0.3011
1994	28363	16849	13044	4643	0.3560	0.3453
1995	21835	17561	12009	4583	0.3816	0.3567
1996	21223	16861	12019	5025	0.4181	0.4347
1997	35223	15058	10910	4983	0.4567	0.5453
1998	24216	16961	9286	3694	0.3978	0.4152
1999	40624	20898	11095	4238	0.3820	0.4629
2000	31277*	25841	10271	3649	0.3553	0.3446
2001	23152**		12600***			
Arith. Mean	27410	15668	10205	4165	0.4132	0.4079
0 Units	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)		

* RCT3 estimate
** GM 82-97
*** SSB estimated using the average weight at age over the years 1998-2000

Table 8.7.1 Sole in VIId

Input data for catch forecast and linear sensitivity analysis.

Populations in 2001			Stock weights			Nat.Mortality			Prop.mature		
Labl	Value	CV	Labl	Value	CV	Labl	Value	CV	Labl	Value	CV
N1	23151	.39	WS1	.14	.14	M1	.10	.10	MT1	.00	.00
N2	27970	.27	WS2	.16	.07	M2	.10	.10	MT2	.00	.10
N3	29499	.23	WS3	.18	.02	M3	.10	.10	MT3	1.00	.10
N4	9778	.15	WS4	.20	.03	M4	.10	.10	MT4	1.00	.00
N5	9647	.12	WS5	.23	.05	M5	.10	.10	MT5	1.00	.00
N6	2804	.12	WS6	.26	.07	M6	.10	.10	MT6	1.00	.00
N7	1727	.11	WS7	.30	.07	M7	.10	.10	MT7	1.00	.00
N8	1066	.11	WS8	.33	.07	M8	.10	.10	MT8	1.00	.00
N9	382	.12	WS9	.38	.07	M9	.10	.10	MT9	1.00	.00
N10	846	.10	WS10	.42	.07	M10	.10	.10	MT10	1.00	.00
N11	1612	.10	WS11	.56	.04	M11	.10	.10	MT11	1.00	.00

HC selectivity			HC.catch wt		
Labl	Value	CV	Labl	Value	CV
sH1	.00	.40	WH1	.14	.05
sH2	.10	.44	WH2	.15	.06
sH3	.38	.14	WH3	.18	.06
sH4	.41	.04	WH4	.23	.04
sH5	.35	.11	WH5	.30	.12
sH6	.34	.16	WH6	.34	.14
sH7	.28	.27	WH7	.37	.18
sH8	.30	.15	WH8	.40	.11
sH9	.29	.19	WH9	.41	.15
sH10	.30	.56	WH10	.42	.10
sH11	.30	.56	WH11	.61	.11

Year effect M			HC relative eff		
Labl	Value	CV	Labl	Value	CV
K01	1.00	.10	HF01	1.00	.15
K02	1.00	.10	HF02	1.00	.15
K03	1.00	.10	HF03	1.00	.15

Recruitment		
Labl	Value	CV
R02	23152	.39
R03	23152	.39

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

Table 8.7.2 Sole in VIId. Prediction with management option table

	Year 2001	2002						
Mean F Ages								
H.cons 3 to 8	.34	.00	.10	.21	.28	.34	.40	.45
Effort relative to 2000								
H.cons	1.00	.00	.30	.60	.80	1.00	1.17	1.30
Biomass at start of year								
Total	20.5	19.8	19.8	19.8	19.8	19.8	19.8	19.8
Spawning	12.6	13.1	13.1	13.1	13.1	13.1	13.1	13.1
Catch weight (,000t)								
H.cons	4.43	.00	1.54	2.92	3.76	4.55	5.18	5.64
Biomass at start of 2003								
Total		23.4	21.9	20.6	19.8	19.0	18.4	18.0
Spawning		16.7	15.2	13.9	13.1	12.3	11.7	11.2

Table 8.7.3 Sole in VIId. Single option prediction, detailed tables

Forecast for year 2001
F multiplier H.cons=1.00

	Populations	Catch number	
Age	Stock No.	H.Cons	Total
1	23151	66	66
2	27971	2583	2583
3	29500	8980	8980
4	9778	3153	3153
5	9648	2739	2739
6	2804	762	762
7	1727	407	407
8	1066	263	263
9	383	91	91
10	847	211	211
11	1612	401	401
Wt	20	4	4

Forecast for year 2002
F multiplier H.cons=1.00

	Populations	Catch number	
Age	Stock No.	H.Cons	Total
1	23152	66	66
2	20885	1929	1929
3	22855	6957	6957
4	18181	5862	5862
5	5860	1663	1663
6	6133	1666	1666
7	1815	428	428
8	1176	290	290
9	715	170	170
10	260	65	65
11	1645	409	409
Wt	20	5	5

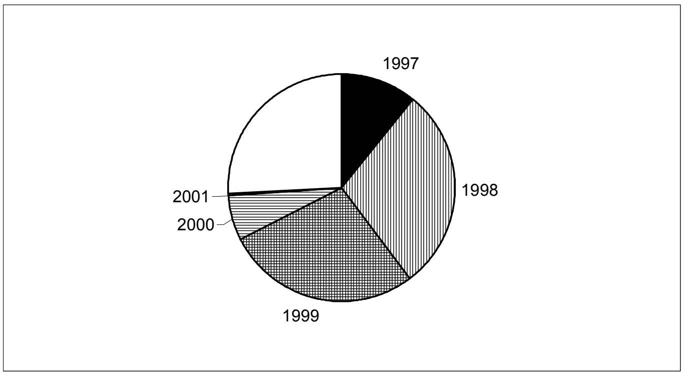
Table 8.7.4 Sole in VIId
Stock numbers of recruits and their source for recent year classes used in predictions, and the relative (%) contributions to landings and SSB (by weight) of these year classes

Year-class			1997	1998	1999	2000	2001
Stock No. (thousands) of 1 year-olds			24216	40624	31277	23152	23152
Source			VPA	VPA	RCT3	GM	GM
Status Quo F:							
% in	2001	landings	16.1	36.7	8.9	0.2	-
% in	2002		10.8	29.1	27.6	6.4	0.2
% in	2001	SSB	17.1	45.7	0.0	0.0	-
% in	2002	SSB	11.2	30.7	34.1	0.0	0.0
% in	2003	SSB	8.5	21.9	24.9	26.7	0.0

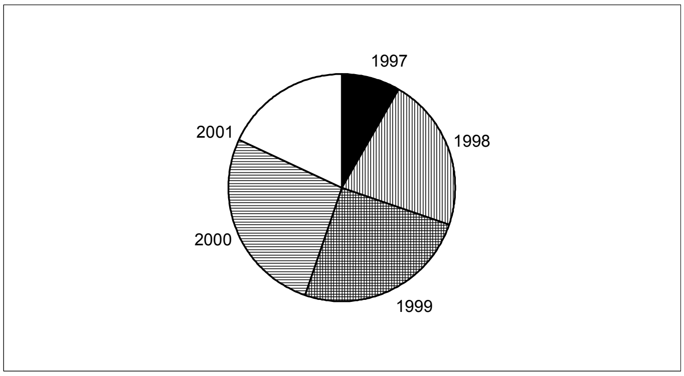
GM : geometric mean recruitment

Sole in VIId : Year-class % contribution to

a) 2002 landings



b) 2003 SSB



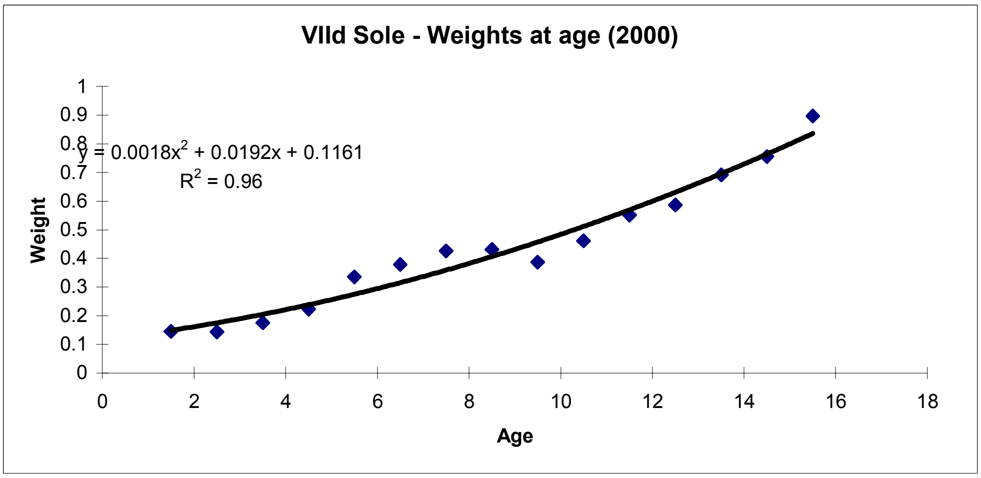


Figure 8.2.1a Sole in VIId. Smoothed curve of the catch weights interpolated to 1st January, to calculate the stock weights

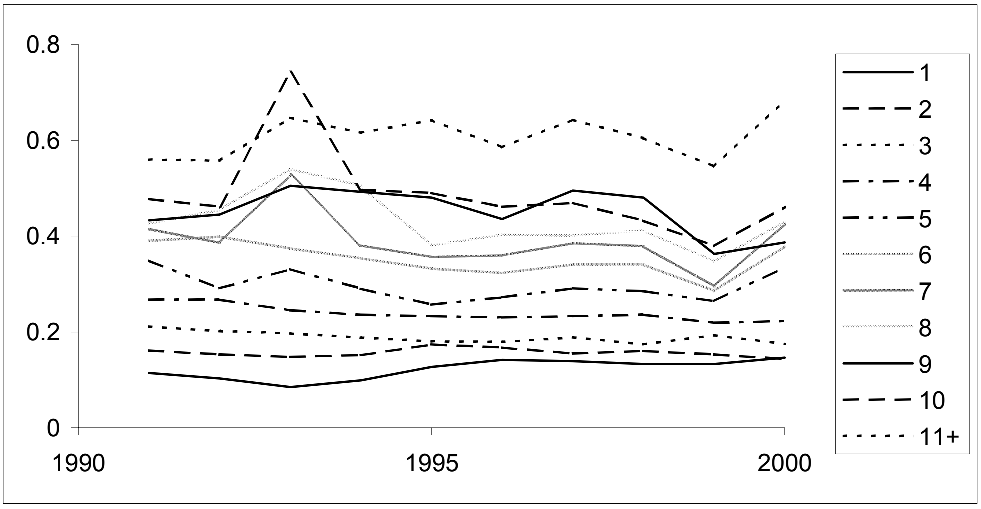
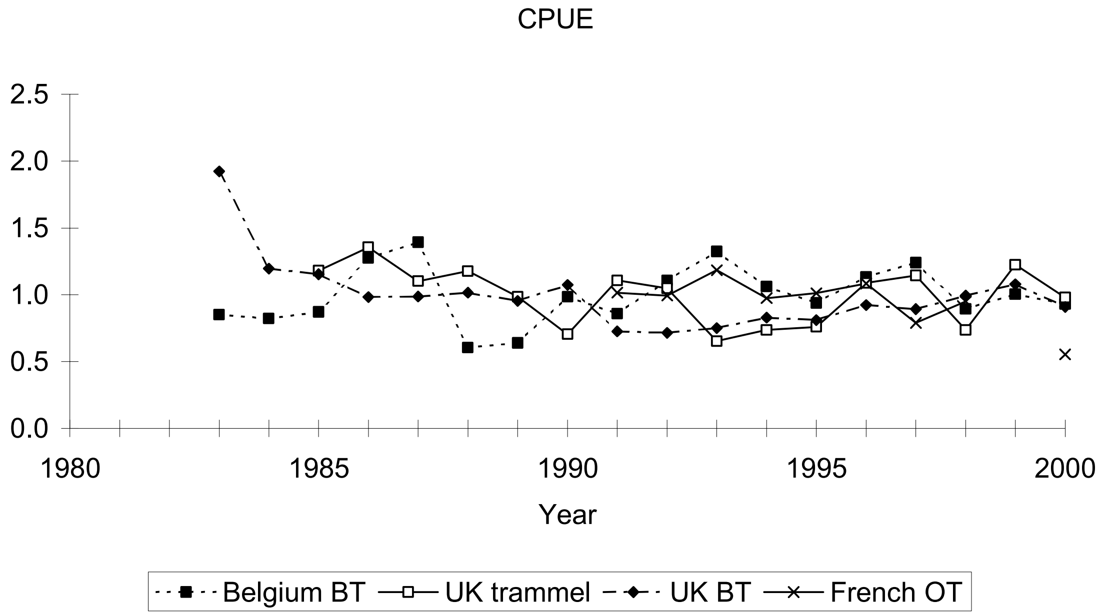


Figure 8.2.1b Sole in VIId. Catch weights at age

Figure 8.2.1c Sole in VIId. Stock weights at age



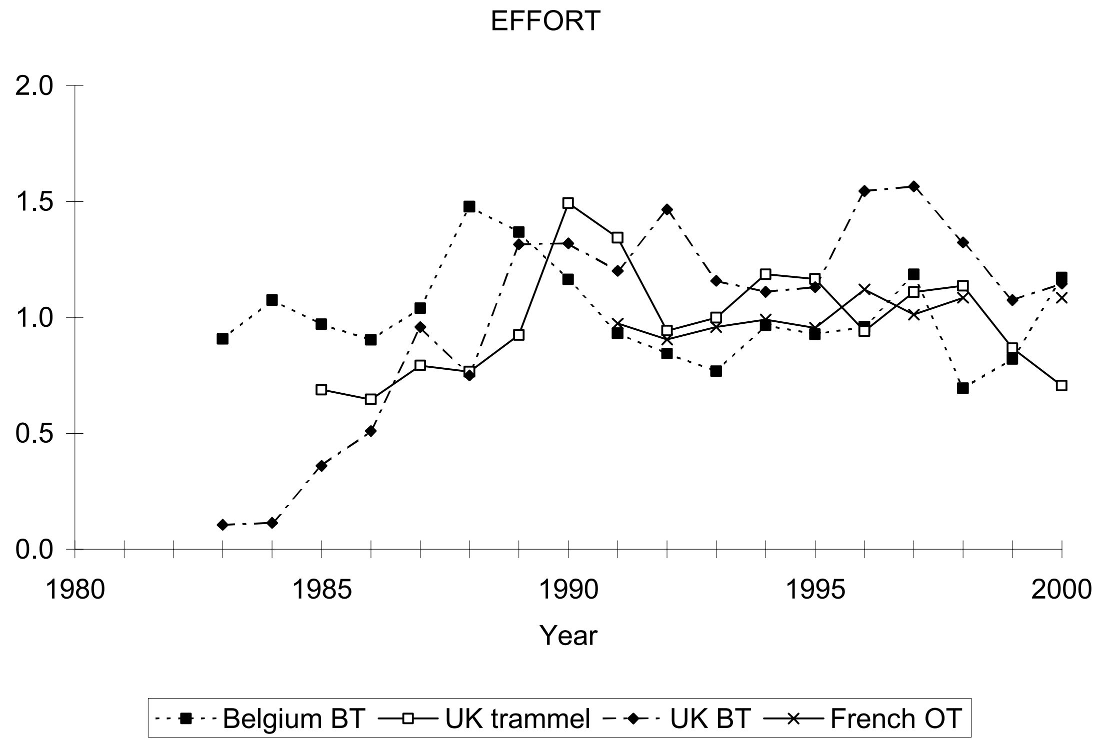


Figure 8.3.1 Sole in VIId. Trends in cpue and effort for the main commercial fleets

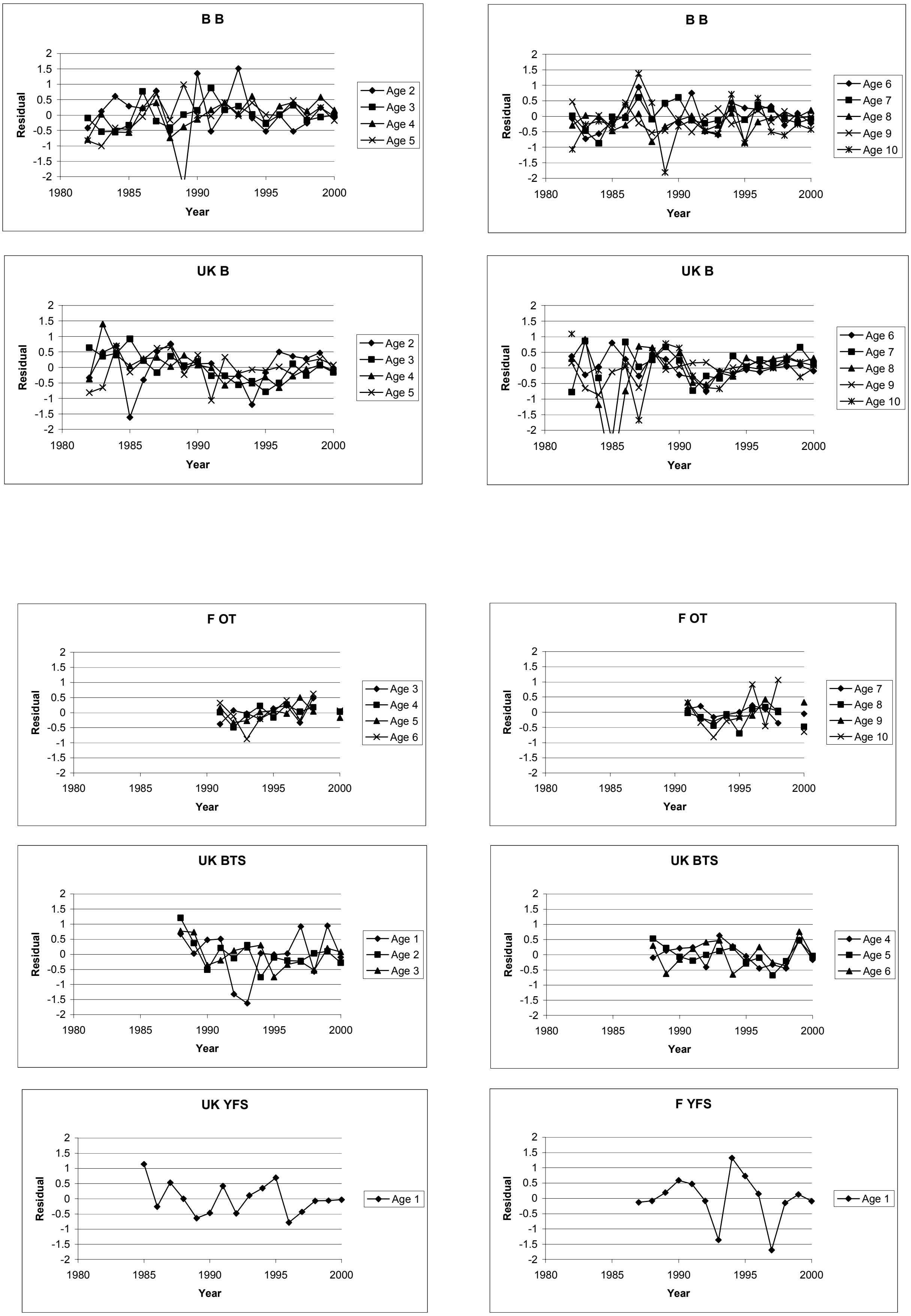


Figure 8.4.1a Sole in VIId. Trends in log catchability residuals (single fleets)

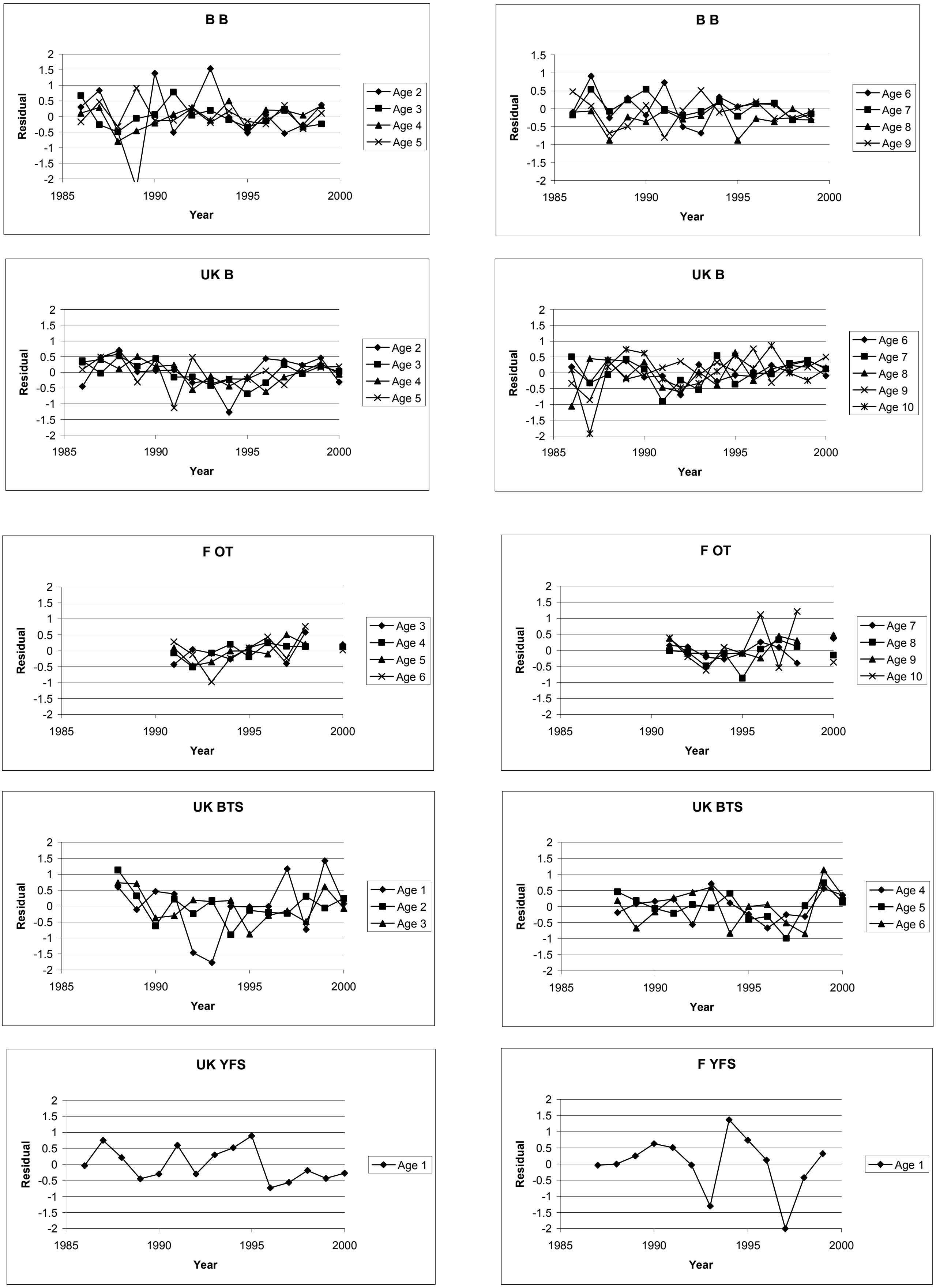


Figure 8.4.1b Sole in VIId. Trends in log catchability residuals final XSA (combined fleets)

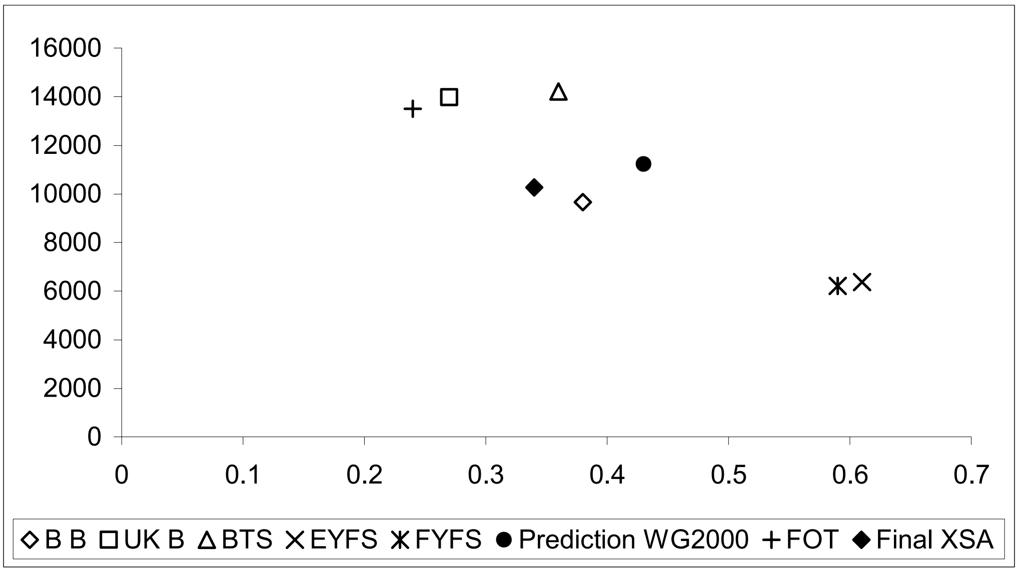


Figure 8.4.1c Sole in VIId. Year estimates.

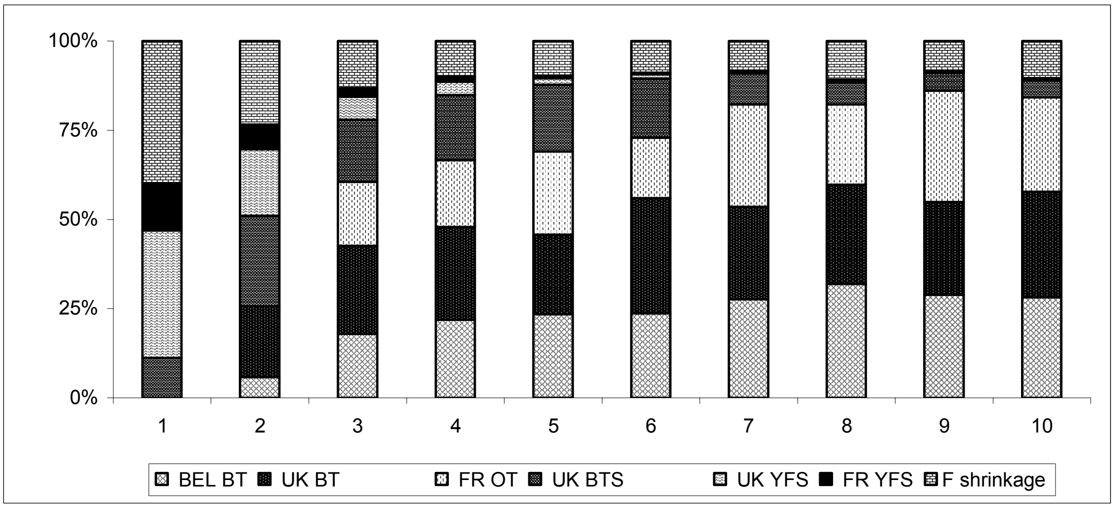


Figure 8.4.2a Sole VIId. Scaled weights of the tuning fleets

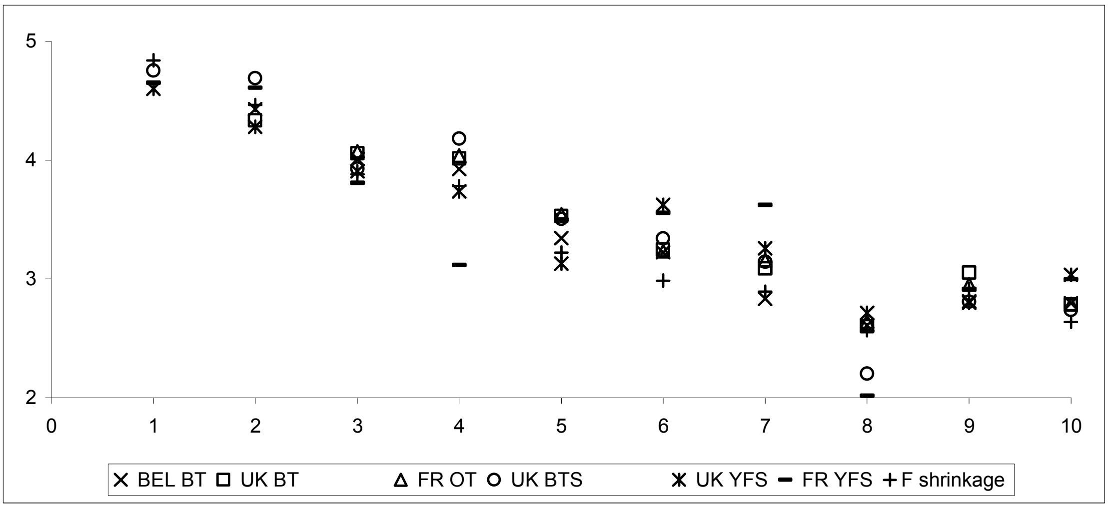


Figure 8.4.2b Sole VIId. Log survivor estimates of the tuning fleets

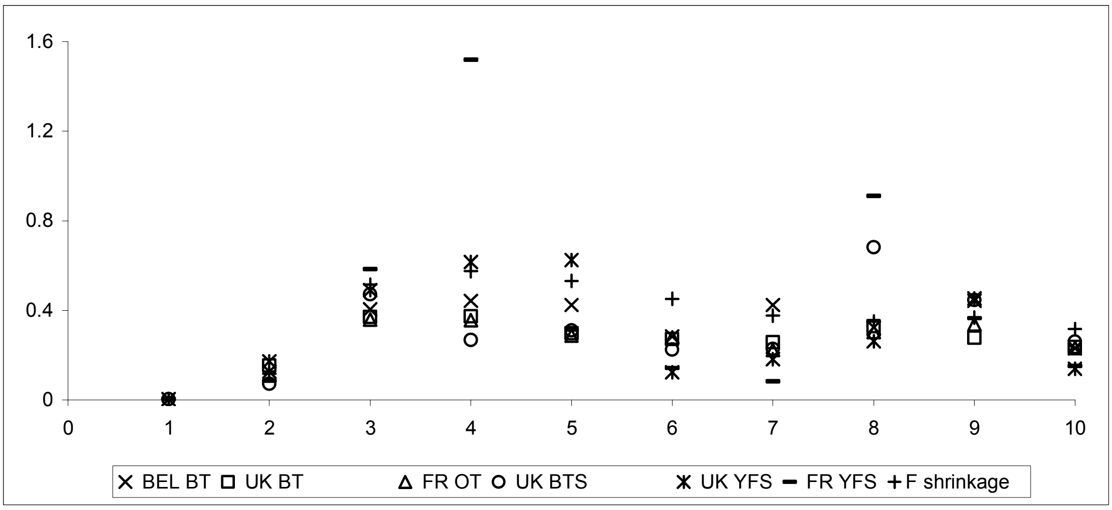


Figure 8.4.2c Sole VIId. Exploitation pattern of the tuning fleets

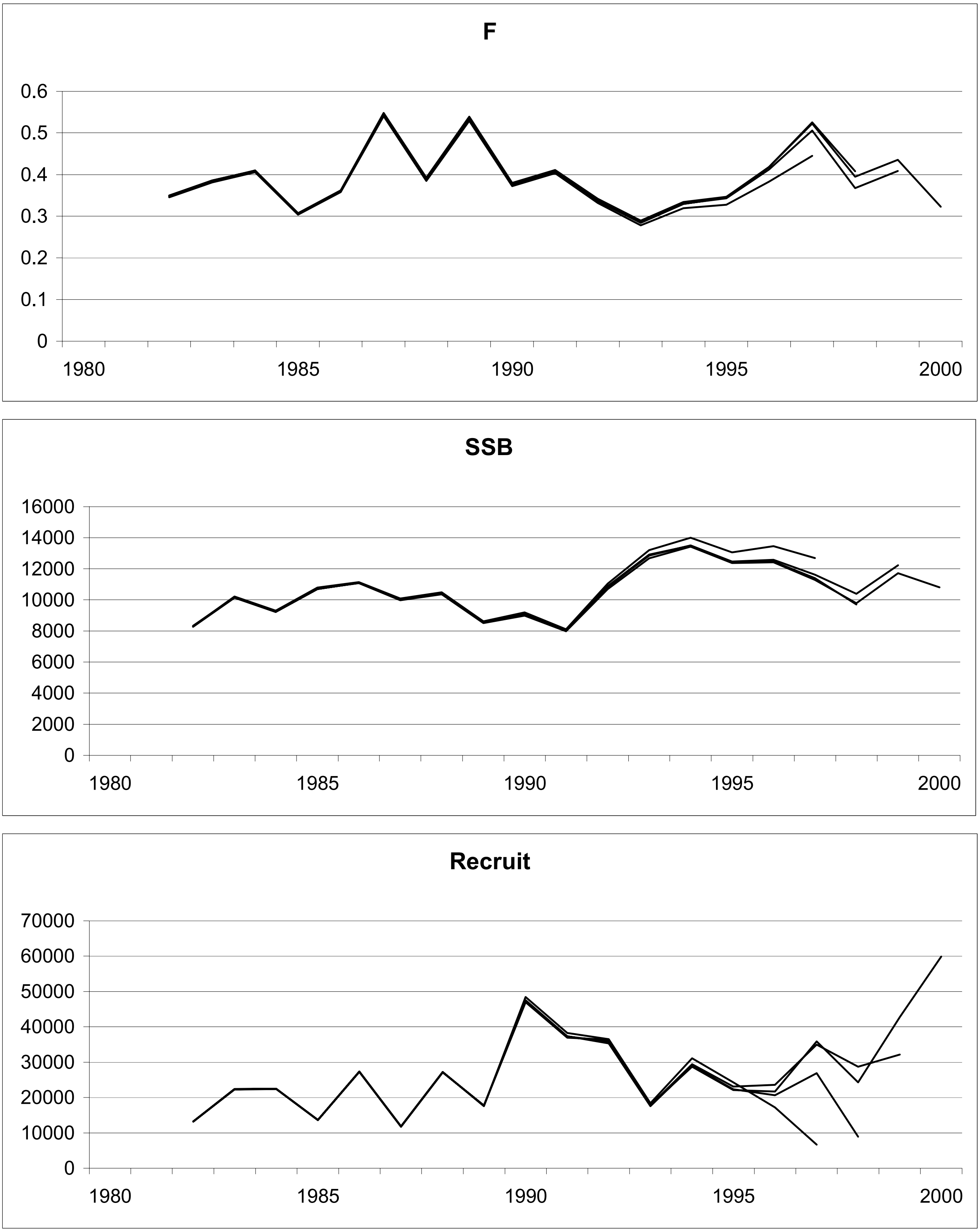
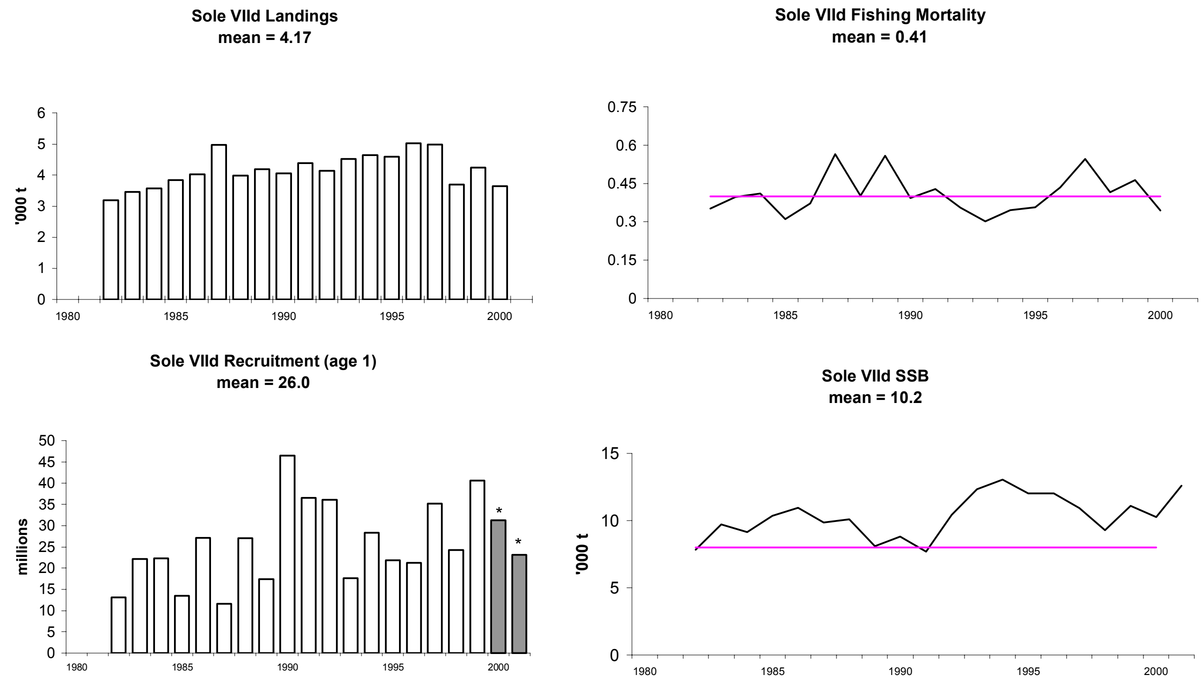


Figure 8.4.3 Sole in VIId. Retrospective analysis (shrinkage 0.5)

Figure 8.6.1 Sole in VIId. Stock summary



* The 1999 and 2000 year classes are replaced by the RCT3 estimate and GM (82-00) respectively

Figure 8.7.1 SOLE,VIID. Sensitivity analysis of short term forecast.

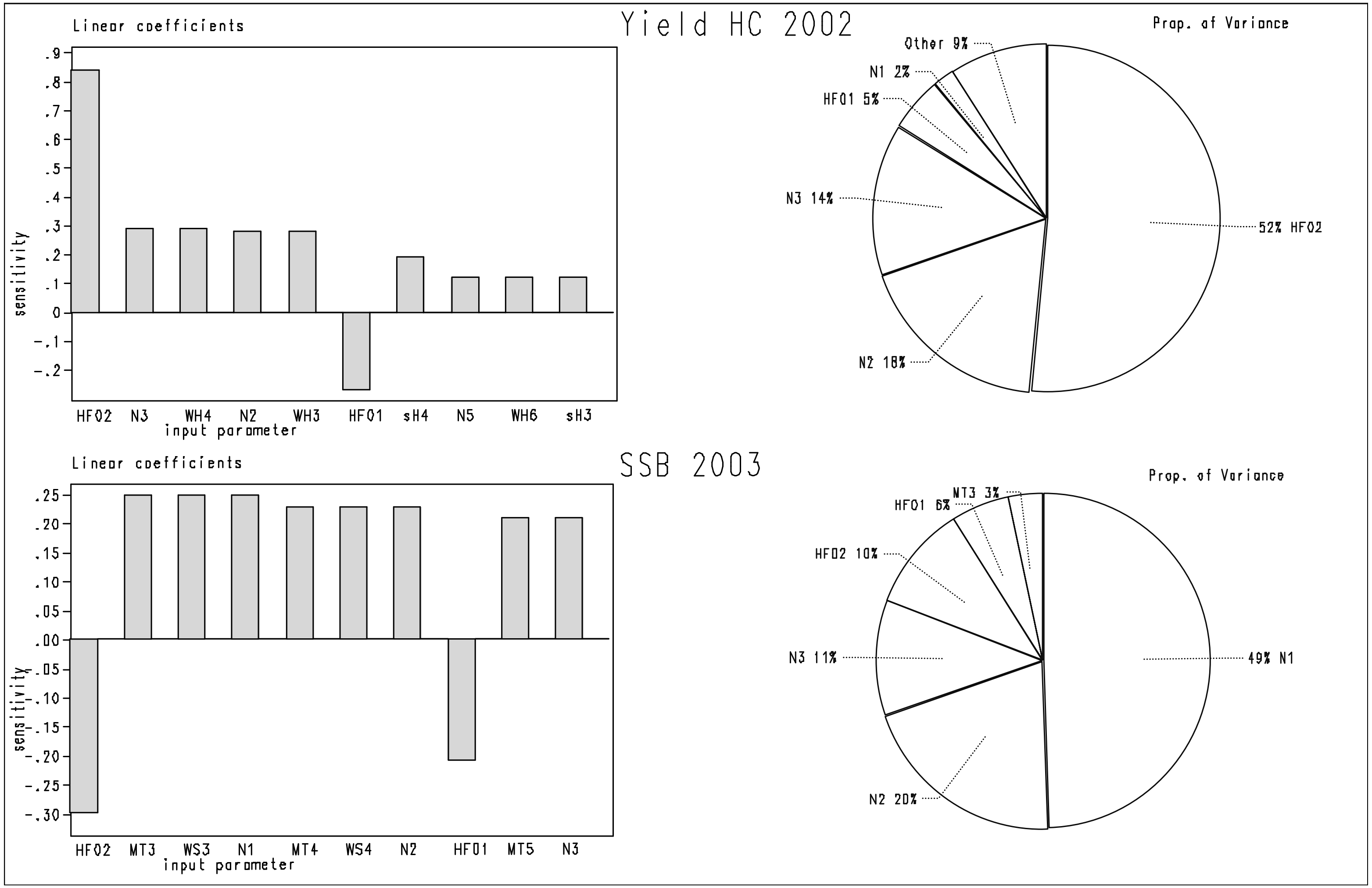


Figure 8.7.1 Sole in VIId. Sensitivity plot

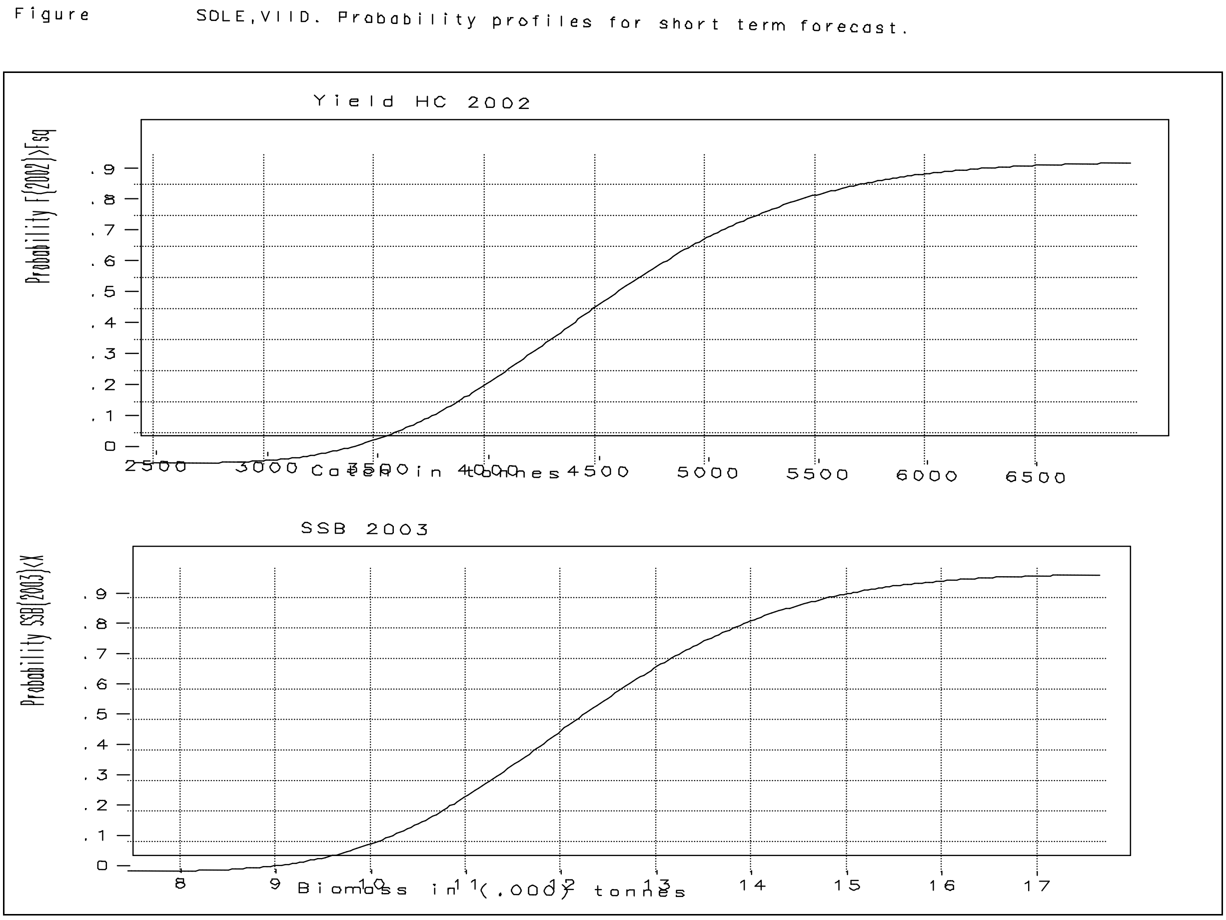


Figure 8.7.2 Sole in VIId. Probability plot

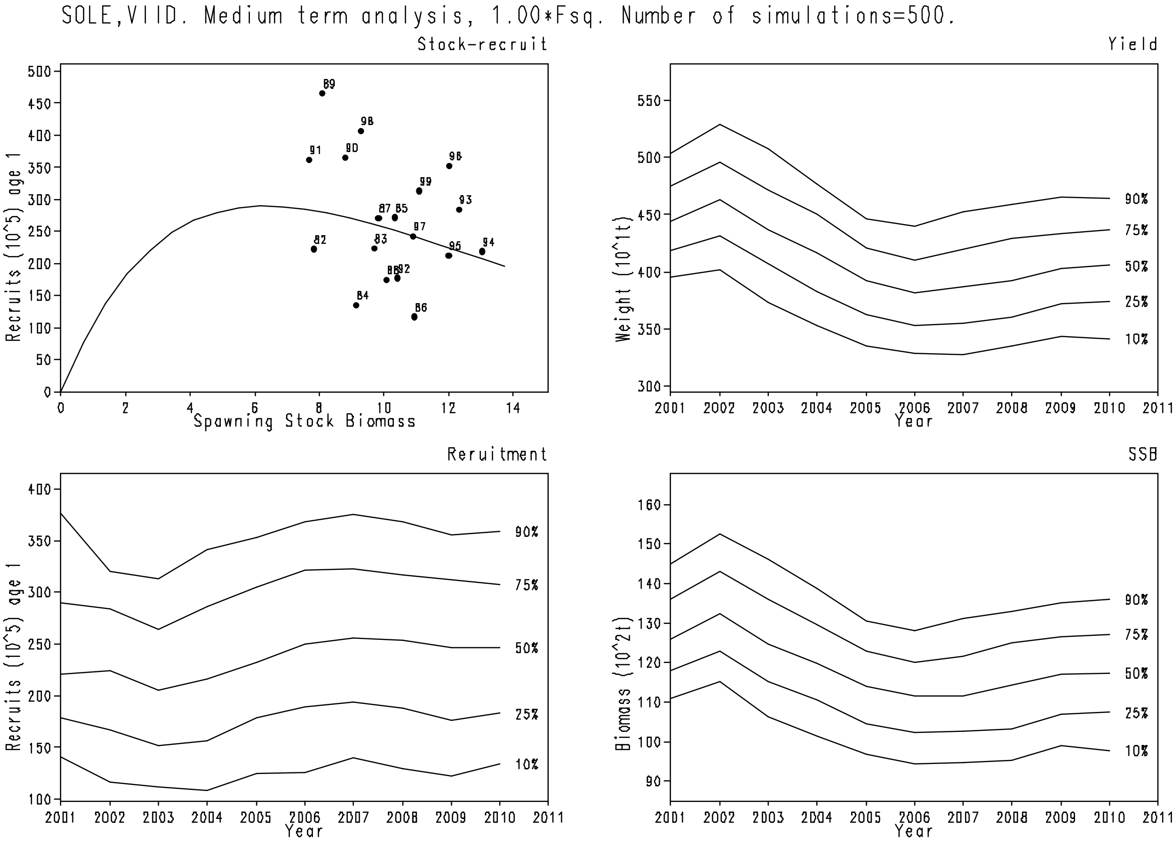


Figure 8.8.1a Sole in VIId. Medium term predictions (Ricker curve)

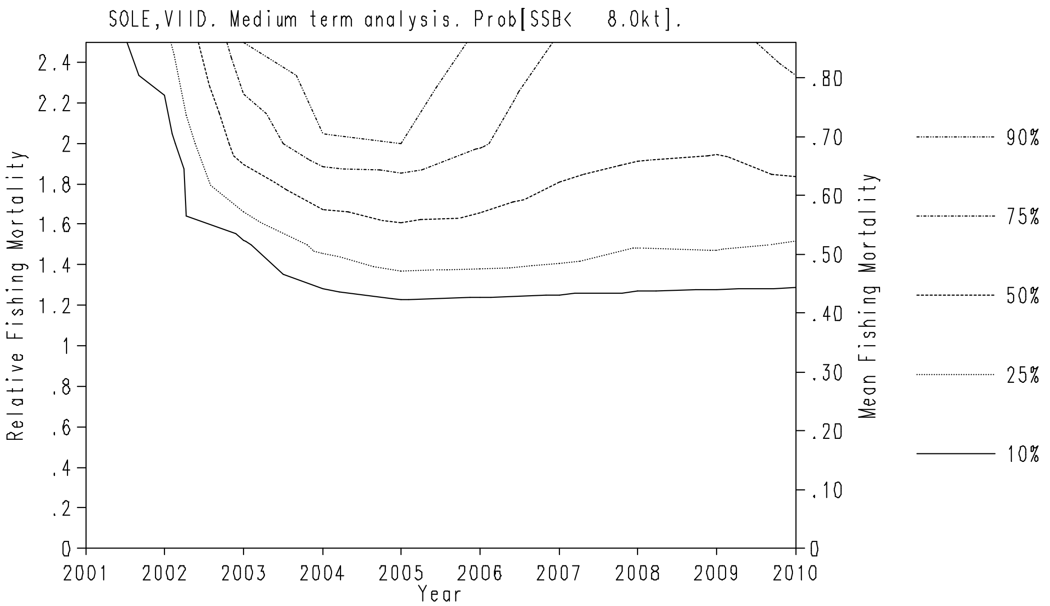


Figure 8.8.1b Sole in VIId. Medium term analysis, contour plot.

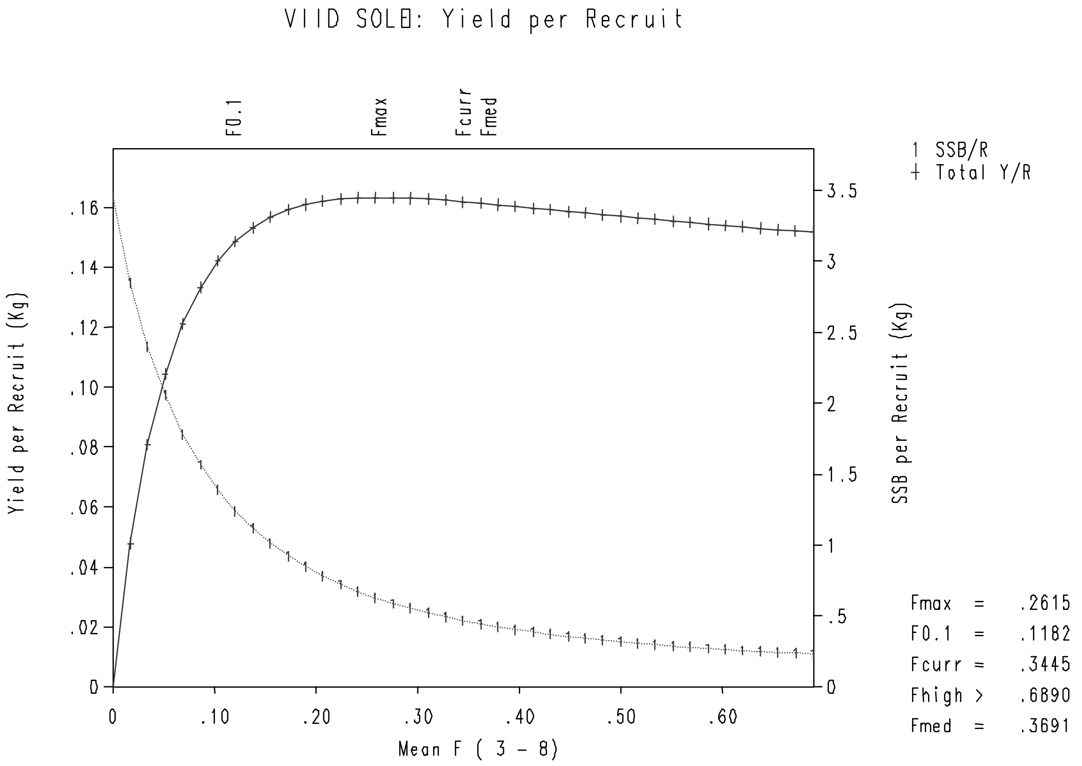


Figure 8.9.1 Sole in VIId. Yield per recruit

Figure 8.9.2 Sole in VIId

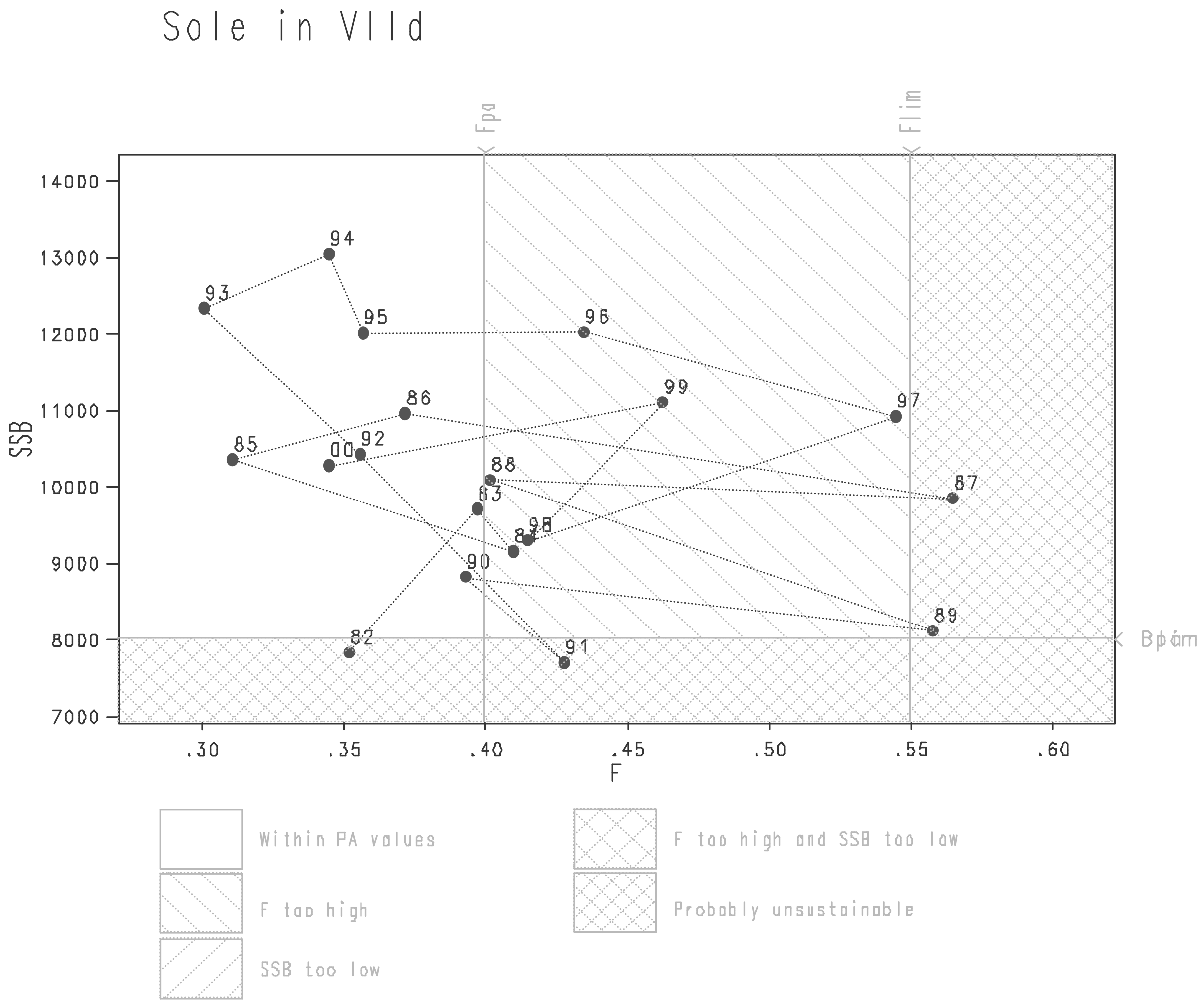
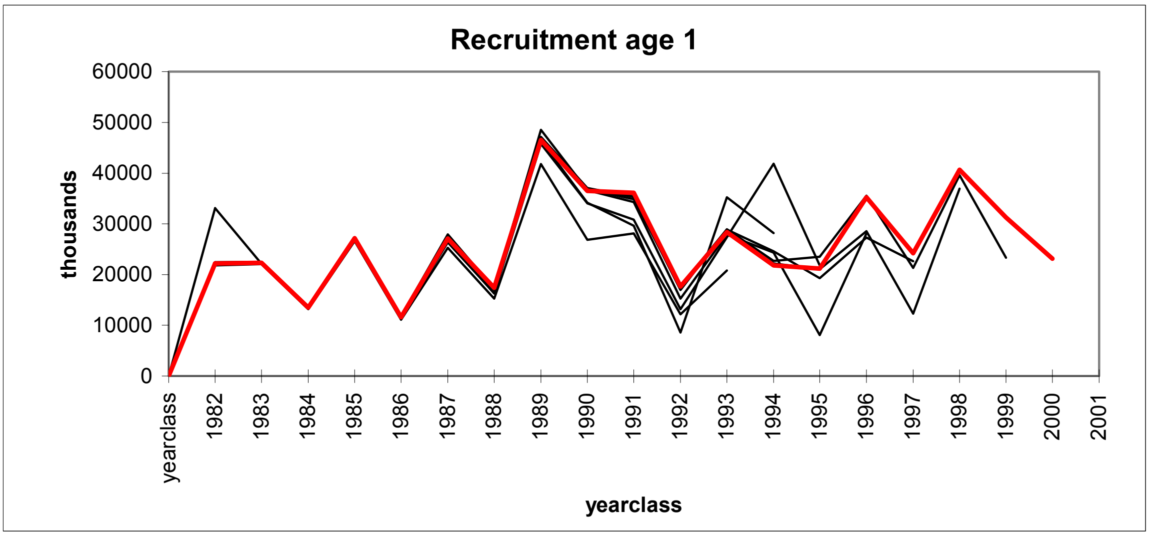
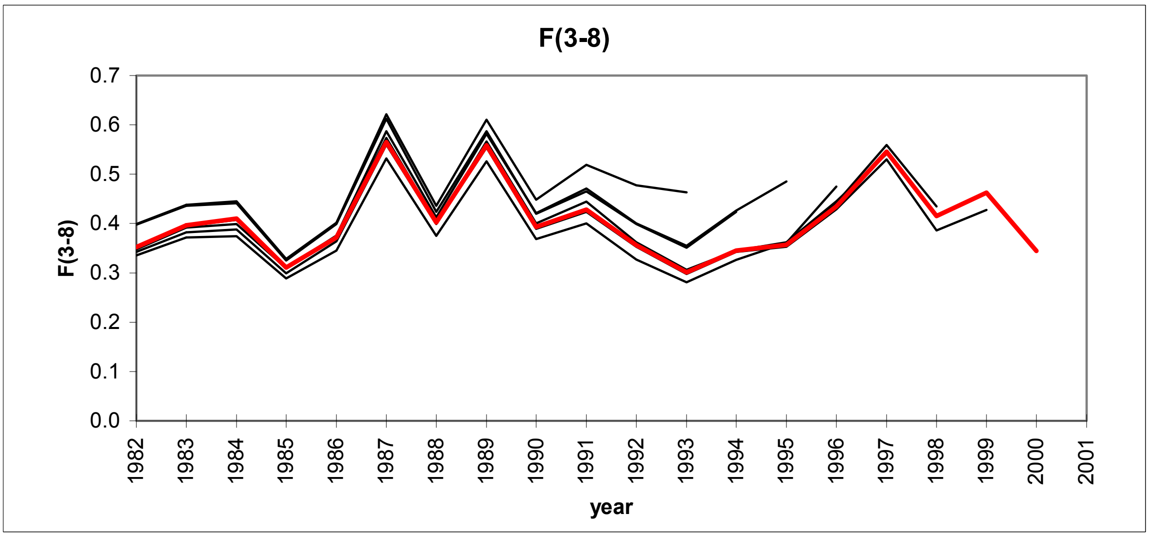


Figure 8.9.3 Sole in VIId. PA plot

SOLE VIId Quality Control Diagram





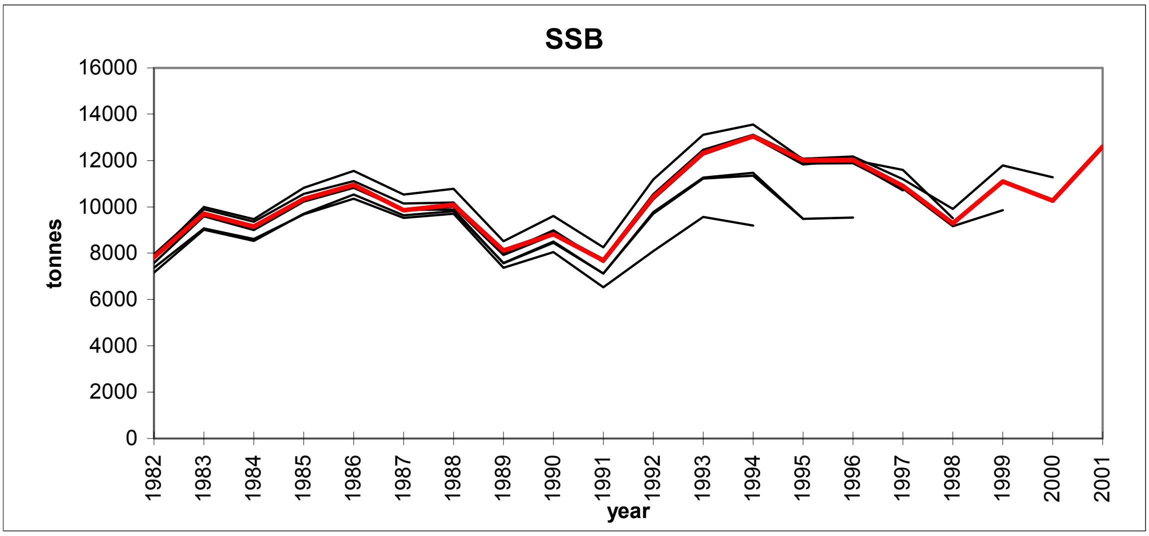


Figure 8.10.1 Sol in VIId
SOLE VIId. Assessments generated in subsequent Working Groups.

9 NORTH SEA PLAICE

9.1 The fishery

North Sea plaice is taken mainly in a mixed flatfish fishery by beam trawlers in the southern and south-eastern North Sea. Directed fisheries are also carried out with seine and gill net, and by beam trawlers in the central North Sea. Due to the minimum mesh size (80 mm) in the mixed beam trawl fishery, large numbers of (undersized) plaice are discarded (see Section 9.2.2).

Fleets exploiting North Sea plaice have generally decreased in number of vessels in the last 10 years, partly due to the MAGP policy. However, in some instances these reductions have been compensated by reflagging vessels to other countries (see Section 9.3). The Dutch beam trawl fleet, one of the major operators in the mixed flatfish fishery in the North Sea, has seen a reduction in the number of vessels and also a shift towards two categories of vessels: 2000 HP (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). The overall effort level (expressed as HP days) has remained relatively constant.

9.1.1 ACFM advice applicable to 2000 and 2001

In October 1999 ACFM considered the North Sea plaice stock to be outside safe biological limits. SSB was below the proposed $\mathbf{B}_{pa}$ and fishing mortality was above the proposed $\mathbf{F}_{pa}$. The advice provided by ACFM was based on the Agreed Record of the EC/Norway consultation. ACFM considered that the agreed fishing mortality of F = 0.30 was consistent with the precautionary approach and advised a reduction in fishing mortality in 2000 to F = 0.3 corresponding to landings of 95,000 t in 2000. ACFM noted that the observed reduced growth rate of the strong 1996 year class resulted in this year class becoming available to the fishery (in marketable size) one year later than normally expected. This could result in additional discard mortality.

In the 2000 autumn session, ACFM again stated that the stock is outside safe biological limits, with respect to both biomass and fishing mortality. In regard of the EU/Norway agreement, as a rebuilding measure a reduction of at least 20% for F was recommended in order to achieve a value below 0.26, which would correspond to a catch of less than 78,000 t in 2001. ACFM stressed that the slow growth of the strong 1996 year class, resulting in additional discard mortality, and the delayed maturation of this year class, could adversely affect the rebuilding of the SSB.

9.2 Management applicable to 2000 and 2001

The North Sea plaice TAC for 2000 was agreed at 97,000 tonnes, 2,000 tonnes above the maximum catch implied by the ACFM advice. The 2001 TAC was agreed at 78,000 tonnes, which is the maximum quantity being in line with the ACFM recommendation.In 1999, the EU and Norway have "agreed to implement a long-term management plan for the plaice stock, which is consistent with the precautionary approach and is intended to constrain harvesting within safe biological limits and designed to provide for sustainable fisheries and greater potential yield. The plan shall consist of the following elements:

1. *Every effort shall be made to maintain a minimum level of SSB greater than 210,000 tonnes (*$\boldsymbol{B}_{lim}$*)*

2. *For 2000 and subsequent years the Parties agreed to restrict their fishing on the basis of a TAC consistent with a fishing mortality of 0.3 for appropriate age groups as defined by ICES.*

3. *Should the SSB fall below a reference point of 300,000 tonnes (*$\boldsymbol{B}_{pa}$*), the fishing mortality referred to under paragraph 2, shall be adapted in the light of scientific estimates of the conditions then prevailing. Such adaptation shall ensure a safe and rapid recovery of SSB to a level in excess of 300,000 tonnes.*

4. *In order to reduce discarding and to enhance the spawning biomass of plaice, the Parties agreed that the exploitation pattern shall, while recalling that other demersal species are harvested in these fisheries, be improved in the light of new scientific advice from, inter alia, ICES.*

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

The current Multi-annual guidance program (MAGP-IV) has defined national targets for EU fleet reductions in fleet capacity and/or days at sea.

Technical measures applicable to the plaice fishery in the North Sea in 2000 included mesh size regulations, minimum landing size, gear restrictions and a closed area (the plaice box). Mesh size regulations for towed gears required that vessels fishing North of 55°N (or 56°N east of 5°E, since January 2000) should have a minimum mesh opening of 100 mm, while to the south of this limit an 80 mm mesh is allowed. The minimum landing size of North Sea plaice is of 27 cm. A closed area has been in operation since 1989 (the plaice box). Since 1995 this area was closed for all quarters. The closed area is only applicable for towed gears but vessels smaller than 300 HP using towed gears have been exempted from the regulation. An additional technical measure concerning the fishing gear is the restriction of the aggregate beam length of beam trawlers to 24 m. Finally, the North Sea plaice fishery is affected by the cod recovery plan (sub-section 3.1).

9.2.1 Landings in 2000

Total landings of North Sea plaice in 2000 (Table 9.1) were estimated by the WG to be just over 80 thousand tonnes, which is at the same level as in the years 1996 and 1997.

The text table below contrasts recent total landings (estimated by the WG) with the agreed TAC.

Year	Total WG landings	TAC
1996	81,673	81,000
1997	83,048	91,000
1988	71,534	87,000
1999	80,662	102,000
2000	83,058	97,000
2001		78,000

Like in most of the recent years, in 2000 the TAC was not taken (86%). The national uptake rates reported by the WG members indicated that for 2001, about 28% of the national quota was taken by April 2001. 2001.

Approximately 60% of plaice from the UK (England and Scotland) quota is landed into the Netherlands by Dutch vessels fishing on the UK register. Such vessels are from now on referred to as 'flag' vessels. The pattern of fishing activity of vessels from England is very different between the two fleets (Figure 9.1). The English vessels fish mainly in the northern part of IVb and the Norwegian sector of the North Sea using 110mm mesh cod-ends. The Dutch flag vessels fish mainly to the south of the English vessels. The differences in fishing pattern result in a higher proportion of older plaice being taken by the English fleet. These fish also have a different age/length relationship because growth tends to be slower in fish from the colder deeper water in the north of the fishing area. Like last year, the WG explored the effects of treating the landings data from the two fleet components separately (see Section 9.3).

9.2.2 Discards in 2000

Discard data have been made available to the WG in 1999 (third and fourth quarters) and 2000 (all quarters). Data relative to year 2000 are reported in Figure 9.2. Figure 9.2 indicates that overall, the discarding rate is high. Fleets 1 and 3 discard all 1-year old, the majority of 2-3-year old, and more than 20% of 4-year old fish. The discarding patterns of fleets 2 and 3 are peculiar. The amount of 1-year old fish discarded by fleet 2 is low, compared to 2-year old fish. This feature might result from insufficient sampling. Fleet 3 discards a substantial amount of old fish. This feature might result from high-grading, since plaice is not a target species for this fleet. Data in 1999 only cover two quarters and do not allow contrasting discarding practices in 1999 and 2000. However, there is increasing evidence that plaice discarding has increased in recent years, as a result of the reduced growth rate observed for this species.

9.3 Age composition, natural mortality, maturity, weight at age

Natural mortality and maturity at age were the conventional numbers used in previous assessments (Table 9.2). Maturation is taken as a step function representing the difference in maturation of males and females and is assumed constant over time. Estimation of maturation was originally based on biological sampling of maturity and sex ratio; however, a working document (**WD:6**) was presented on a time series of maturity data which showed considerable discrepancies to the conventional values, which are overestimating the mature stock. A summary of the working document is presented in Section 1.6. In the absence of a validated model describing the time trends in the maturity ogive, it was decided to postpone the evaluation of the effects of using the new estimates in this assessment.

As the landings of the Dutch flag vessels are not sampled by the UK, there is no complete ALK to apply to the landings, and the English ALK has previously been used to raise the data to a total age composition for English plus flag vessel landings. This was defined as the English beam trawl age composition. However, the effect of adding the Dutch flag landings to the English age composition leads to an over-estimation in the numbers of older fish. In order to correct this, revised age composition data series were calculated for the English landings by using the ratio of landings made in England to landings made abroad. It had been previously established that this approximates closely to the landings by each fleet. This was done on a quarterly basis for all years from 1990 to 2000. The landings from the Dutch flag vessels were used to raise the international age composition also on a quarterly basis. Figures 9.3 and 9.4 show the differences in total catch numbers at age calculated by splitting (raising procedure 1) or not (raising procedure 0) the English beam-trawlers into its two fleet components, over 1990-2000. It can be seen that the catch at age matrix derived from raising procedure 1 includes more young fish (1-4 year old) and less old fish (7-15 year old), compared to the one derived from raising procedure 0. This discrepancy has increased since 1990, as a result of the increased number of flag vessels. The implications of both raising procedures for the assessment have been contrasted. Raising procedure 1 has been used to provide inputs to the final assessment run.

Age distributions were available from countries, contributing together to more than 70% of the official total landings in 2000. The age composition of the landings is presented in Table 9.3. SOP corrections were used in the calculations of the English and Belgian age compositions. The SOP-discrepancy was small (2%). Age compositions by sex and quarter were available from Belgium, England and the Netherlands. Combined age compositions by quarter were available from Denmark and France. All other landings were raised to the total international age composition (either by quarter or by year).

No time series of discards estimates are available to incorporate in the assessment. There are however indications that the discard pattern may have increased in recent years (section 9.1.5). Therefore, catch at age will be equated to landings at age in subsequent analyses.

Mean weights at age in the catch were estimated from the market samples taken throughout the year (Table 9.4). Weights-at-age in the stock were first quarter weights (Table 9.5). Weight at age has varied considerably over time. Weight at age of the most important age groups (age 3-6) appear to have decreased in the past three years (Figure 9.5)

9.4 Catch, effort and research vessel data

The following tuning data were available for North Sea plaice assessment:

- NL commercial beam trawl CPUE
- UK commercial beam trawl CPUE, including all UK registered vessels
- UK commercial beam-trawl CPUE, excluding all flag vessels
- Three Danish commercial CPUE series
- Beam Trawl Survey (BTS)
- Sole Net Survey (SNS)
- Demersal Young Fish Survey (DFS)

The Dutch commercial beam trawl CPUE consists of the total catch at age by the Dutch (beam trawl) fleet and the effort in horsepower days (days absent from port times the horsepower of the vessel). The effort series are estimated by the Agricultural Economics Institute (LEI-DLO). The series are available for 1980 onwards and for the age 2 to 14. Only the years 1989 onwards have been used in the recent assessments because of strong patterns in log catchability residuals in the earlier years.

Two English commercial beam-trawl CPUE series were available to the WG.

- English commercial beam trawl (including flag vessels)
- English commercial beam trawl (excluding flag vessels)

The first one is derived from the catch at age of all beam trawlers registered in England and Wales but excluding Scottish registered vessels. The fleets landings and effort include landings into England and Wales as well as landings abroad. Effort was calculated on a trip basis as hours fishing times the horsepower (HP) of the vessel. The latter is derived from the catch at age of the beam trawlers registered in England and Wales but excluding Scottish registered vessels and Dutch flag vessels. New catch at age and effort series were calculated over the period 1990-2000 for this fleet, based on the trips by English vessels only. The WG decided this year to use the tuning information provided by the English fleet excluding the flag vessels, since vessels belonging to this fleet are expected to harvest the same part of the stock.

Three Danish commercial CPUE series were available to the WG:

- Gill-net
- Trawlers
- Danish seiners

All Danish series consist of total effort, total yield and catch numbers at age. The age range is 1-14 and the year range 1987-2000. Effort is expressed as number of days fishing standardized by the vessel length. A directed plaice fishery is carried out by Danish seiners. Plaice is also a by-catch to otter-trawlers (which target cod or nephrops, but also go for industrial fishing) and gill-netters (which target cod and sole). Only Danish trawlers were used in last year's WG. This year, the WG considered removing the Danish tuning fleet from the final assessment, due to the difficulties encountered to provide a consistent effort definition, plaice not being a target species for this fleet.

The Beam Trawl Survey (BTS) was initiated in 1985 and aims at obtaining pre-recruit indices for 1- and 2-group plaice and sole. However, due to its spatial distribution the BTS survey also catches considerable numbers of older plaice and sole. The survey is carried out in international cooperation and covers both inshore and offshore areas throughout the North Sea, Channel and western waters of the UK. The Dutch survey is carried out using the RV ISIS. The fishing gear used is a pair of 8-m beam trawls with 40 mm stretched mesh cod-ends. The Dutch participation in the survey is used as a tuning series for the plaice assessment and consists of average catches in numbers by fishing hour.

The Sole Net Survey (SNS) was carried out with RV Tridens until 1995. Since 1996 the RV ISIS is used for this survey. The gear used is a pair of 6 m beam trawls with 40 mm stretched mesh cod-ends. The stations fished are in lines perpendicular to the coast. The index has a year range of 1977 to 2000 and an age range of 0 to 3. Only the ages 1 to 3 are used for tuning North Sea plaice assessment, the 0-group index is used in the RCT3.

The Demersal Young Fish Survey (DFS) is an international survey carried out by The Netherlands, England, Belgium and Germany. In the Wadden Sea and Scheldt Estuaries a single light 3 meter beam trawl is used with a 20 mm cod-end and one light tickler chain from the shoes. The coastal area are fished with a pair of 6 m beam trawls rigged with a similar net as the 3 meter beam trawl. The combined index is calculated as a mean of the international indices with a fixed weighting by country, which refers to the area, covered. In 1998 and 1999 no estimate of the DFS were available due to bad weather conditions during the period of the survey and technical problems with one of the Dutch research vessels. The DFS survey is only used for the RCT3 analysis and not for tuning the VPA..

The tuning fleets used for the final XSA analysis are presented in Table 9.6. Table 9.7, Figures 9.6 and 9.7 summarize the trends in CPUE for the indices relevant to the estimation of the adult population. It can be seen that the fishing effort of all fleets has decreased slightly between 1999 and 2000 (Figure 9.6). The CPUE series are generally consistent across tuning fleets at ages 5-8, but not so for the younger ages. In particular, the CPUE of Danish trawlers and surveys are much higher at ages 2 and 4 than the CPUE of other fleets (Figure 9.7).

9.5 Assessment

9.5.1 Data exploration

International catches-at-age were preliminarily examined using separable VPA, with a reference age of 4, terminal F = 0.65 and terminal selectivity set to 0.65 (Table 9.8). Residuals in Log-catch ratios were low apart from age 1/2 in some years, but no consistent trends could be detected for these ages. The other residuals showed little variability and trends. As in previous years, the age range for the analyses was set to 1-15+.

Initial exploratory assessment runs were performed using the same configuration as last year. The 10-year tuning window previously used did not appear appropriate as the assessment was fundamentally changed compared to last year, just by the addition of one year of data (2000) and removal of the first year (1990). In particular, large residuals associated to the Log-catchability of the Dutch beam-trawlers were observed for all ages in the final year. The WG therefore suggested using the whole range of observation to perform the calibration. A number of exploratory XSA runs have then been carried out and are summarized in the table below:

Run	Fleets	Shrinkage	Power model
1	Dutch BT	1.5	none
2	English BT (all)	1.5	none
3	English BT (no flag)	1.5	none
4	DK trawlers	1.5	none
5	BTS	1.5	none
6	SNS	1.5	none
7	Dutch BT, English BT (all), DK trawlers, BTS, SNS	0.5	none
8	Dutch BT, English BT (no flag), BTS, SNS **(final run)**	0.5	none
9	Dutch BT, English BT (no flag), BTS, SNS	0.5	Age 1
10	BTS, SNS	1.0	none
11	BTS, SNS	0.01	none

Single-fleet XSAs (Runs 1-6) were carried out for all available commercial fleets separately, with a low shrinkage of 1.5, a tuning window made up of the whole range of observations and no taper. Log-catchability residuals derived from these analyses are presented in Figure 9.8.

For the Dutch beam trawl CPUE (Run 1), the Log-catchability residuals for 2-year olds are strongly negative in 1998 and 1999. This may indicate that catch numbers at age 2 are particularly underestimated in these years, possibly as a result of increased discarding (Section 9.2.2). However, this pattern appeared to be more a year effect rather than a consistent trend, and it was decided to keep age 2 in subsequent multi-fleet assessments. The standard error associated to ages 3-9 were lower than 0.5, which indicates that the quality of the data is not problematic for these ages.

Both UK beam trawl CPUE (Runs 2 and 3) showed low and similar log catchability residuals. The positive trend observed over 1991-1997 was followed by a downward trend (1998-2000).

The Danish seiners and gill-netters all showed very high log catchability residuals (not shown here). These fleets were again excluded from subsequent analyses. The Danish trawler fleet had statistics which performed slightly better, but the residuals were substantially higher than those of the English and Dutch (Run 4).

Both surveys showed high residuals but no consistent trend (Runs 5 and 6). The age range for these fleets was kept the same as last year, 1-4 and 1-3 for the BTS and the SNS respectively.

The conclusion regarding the single-fleet analyses of commercial tuning fleets is that the Dutch beam-trawlers (age 2-9), both English beam trawlers (age 4-12), BTS (age 1-4), SNS (age 1-3) are useable tuning fleets. The Danish trawlers tuning series (age 4-9) is only kept for comparative purposes in subsequent analyses.

Multi-fleet XSAs (Runs 7-11) have been carried out for selected combinations of tuning fleets, with or without a power model, using the whole range of observations for tuning, and no taper. The Log-catchability residuals derived from runs 7-9 showed similar properties to those derived from runs 1-6. A retrospective pattern was consistently identified in both SSB and F trajectories, even when a power model was introduced. From the diagnostics there were no clear indications that catchability could be considered dependent on year class strength for ages 2-3, as there were no consistent significant slopes over different fleets. A slope was discovered for the BTS, in relation to age 1. It was however decided this year not to use a power model, for two reasons. First, the catch numbers at age 1 are uncertain, due to the high level of discards generated by the commercial fishery at that age (section 9.1.5). Second, using a power model lead to a high shrinkage for age 1, making it difficult to provide an estimate of recruitment. A comparison between the diagnostics of runs 9 and 10 suggests in any case that introducing a power model does not alter much the stock and F trajectories (Figure 9.9).

Runs 10 and 11 were carried out so as to evaluate whether the retrospective pattern identified in all other runs could be driven by flawed information (e.g. trends in catchability) provided by the commercial fleets. A strong retrospective pattern was still observed with run 10 (using surveys only). These results suggest that the retrospective pattern is probably not caused by catchability trends. It could be due to the input information provided by the total catch numbers at age. In particular, discards at young ages could lead to an underestimate of catch numbers, an underestimate of fishing mortality, and a overestimate of stock numbers for the youngest ages. The retrospective pattern only disappeared by operating run 11, where a strong shrinkage was imposed. Run 8 was kept as the final run.

Figure 9.9 shows the recruitment, SSB and F trajectories derived from the different runs. There are discrepancies between the trajectories derived from runs 1-6. The highest SSB and the lowest F are estimated using the Dutch fleet (run 1). The lowest SSB and the highest F are estimated using the Danish and the English (including flag vessels) fleet. The power model does not alter the trajectories. The final run, excluding the Danish trawlers and including English (no flag) beam trawlers provides higher estimates of F and lower estimates of SSB over the whole time period.

9.5.2 Final assessment

The settings of the final XSA assessment are given in the text table below. The new tuning series now starts in 1982 (starting date of the SNS).

stock	**plaice**							
area	North Sea							
year of assessment	**2000**				**2001**			
		years	ages	alpha-beta		years	ages	alpha-beta
Fleets	NL BT	90-99	2-9	0-1	NL BT	89-00	2-9	0-1
	UK BT (all)	90-99	4-12	0-1	UK BT (noflag)	90-00	4-12	0-1
	DK trawl	90-99	2-9	0-1	-			
	BTS	90-99	1-4	0.66-0.75	BTS	85-00	1-4	0.66-0.75
	SNS	90-99	1-3	0.66-0.75	SNS	82-00	1-3	0.66-0.75
First tuning year	1990				**1982**			
Last datayear	1999				**2000**			
Time series weights	none				none			
Catchability dependent on stock size for age <	4				**1**			
Catchability independent of age for ages >=	10				10			
Survivor estimates shrunk towards mean F	5 years / 5 ages				5 years / 5 ages			
s.e. of the means	0.5				0.5			
Minimum standard error for pop. Estimates	0.3				0.3			
Prior weighting	none				none			
Number of iterations	50				30			
Convergence	no				no			

As last year, the 1997 survey results for the year classes 1995 and 1996 in the BTS and SNS surveys were not used in the assessment and inRCT3, due age reading problems in that year.

Diagnostics of the final run are presented in Table 9.9. Figure 9.10 shows the log catchability residuals for the tuning fleets in the final run. Fishing mortality and stock numbers are shown in Tables 9.10 and 9.11. Weighting of the different data sources in the assessment is shown in Figure 9.11. The surveys have regained most of the weight on ages 1-3 (at the expense of the commercial fleets and shrinkage). The commercial fleets are the dominant source for tuning from ages 4 and upwards. A summary of the assessment results is presented in Table 9.12 and Figure 9.12.

The retrospective analysis is shown in Figure 9.13, by chopping off one year. The analysis shows a retrospective pattern in both fishing mortality and SSB with a marked difference between the assessments ending in 2000 and in 1999. Increased discarding, not included in the assessment, may cause underestimation of fishing mortality at the youngest age groups and also contribute to the retrospective pattern.

9.6 Recruitment

The GM recruitment at age 1 is of 412 million. No data were available on the 2001 third quarter BTS and SNS, due to the rescheduling of the WG. The DFS indices for ages 0-1 in 2000 were made available during the WG. RCT3 runs were carried out for ages 1, 2 and 3. Inputs for the runs including the DFS updates are presented in Table 9.13, while the associated results are in Tables 9.14-9.16.

Year class 2000 (at age 1 in 2001). The surveys used in RCT3 received a low weight (47%), and were hence not considered useable. This year class was hence estimated using the GM recruitment.

Year class 1999. The surveys used in RCT3 had a weight of 71%. The RCT3 estimate (304 million) was very close to the XSA estimate (307 million). The XSA value was selected because it was associated with a low F shrinkage.

Year class 1998. The surveys used in RCT3 received a high weight (82%). The RCT3 estimate (240 million) was substantially higher than the XSA estimate (167 million). The F shrinkage associated to this year class was low, so the WG decided to use the XSA estimate.

The following text table summarizes the recruitment estimates. Estimates selected for further use in the analysis are denoted in bold and underlined print. All estimates are expressed as yearclass strength at the respective ages in 2001.

Year class	Age in 2001	XSA	RCT3	GM(57-98)
1997	4	**133**		194
1998	3	**167**	240	296
1999	2	**307**	304	370
2000	1		438	**412**

9.7 Historical stock trends

Figure 9.12 shows the trends in yield, mean F (2-10), SSB and recruitment since 1957. Yield has gradually increased up to the late 1980s and rapidly declined.

Fishing mortality increased until the early 1980s, and levelled off in the 1980s after which there have been slight fluctuations in fishing mortality. Current fishing mortality (0.34) is estimated to be substantially lower than in previous years. It is now estimated a little above $\mathbf{F}_{pa}$ (0.3)

The SSB increased to a peak in 1967 when the strong 1963 year class became mature. Since then, SSB declined to a level of 300 kt in the early 1980s. Due to the recruitment of the strong year classes 1981 and 1985, SSB again increased to a peak in 1989 and rapidly declined since then. The 2000 SSB is estimated to be at 222,000 tonnes, just above $\mathbf{B}_{lim}$ (210,000 tonnes), but SSB in 2001 is thought to be around 237,000 tonnes. SSB is well below $\mathbf{B}_{pa}$ (300,000 tonnes).

Except for the occurrence of strong year classes (1963, 1981 and 1985), which coincided with cold winters, inter-annual variability in recruitment is relatively small. VPA estimates of recruitment show a periodic change with relative poor recruitment in the 1960s and relatively strong recruitment in the 1980s. The recruitment level in the early 1990s appears to be somewhat lower than in the 1980s. The 1996 year class appears to be rather strong and is currently estimated at 815 million.

9.8 Short term forecast

The input data to the short term forecast are given in Table 9.17. Weight at age in the stock and in the catch were taken as a mean over the last three years. The exploitation pattern was taken as the mean value of the last three years and scaled to the average F for 2000 (0.34). Population numbers were taken from the final XSA. Recruitment of year classes 2000-2002 were taken as the long term geometric mean (1957-1998).

A management option table for status quo fishing mortality in 2000 is presented in Table 9.19. Detailed tables for F *status quo* are given in Table 9.20. A detailed deterministic plot of the catch forecasts is given in Figure 9.14. At *status quo* fishing mortality in 2001 and 2002 the SSB is expected to remain stable at around 235,000 tonnes in 2002, which is a lower level than the predicted 2002 SSB estimated last year (270,000 tonnes). SSB is expected to increase to 249,000 tonnes in 2003. The yield at *status quo* F is expected to be around 83,000 tonnes in 2001, which is lower than the 94,000 tonnes predicted last year, but which is also more consistent with recent landing trends. The discrepancy between the predictions made during successive WGs is likely to be one of the consequences of the retrospective pattern observed in the assessment of this stock.

In Table 9.18 the results of a detailed *status-quo* prediction are shown. The 1997-1999 year classes are expected to contribute equally to the landings (in weight) in 2002, and to the SSB in 2003. The strong year class 1996 (included in the "other" year classes) is also expected to contribute substantially to landings (2002) and SSB (2003).

A sensitivity analysis has been made to identify the different sources of uncertainty underlying the predictions (Figure 9.15). It may be seen that the landings in 2002 are not expected to be much sensitive to factors other than exploitation rate.. About 50% of variability of the SSB in 2003 is explained by recruitments in 2001 and 2002. The probability profiles relative to the short-term forecasts are given in Figure 9.16. At the current yield of 80,000 tonnes, the probability that F is higher than Fsq is around 45%. The probability that SSB will fall below $\mathbf{B}_{lim}$ (210,000 tonnes) is predicted to be lower than 10%, but the risk that SSB will stay below $\mathbf{B}_{pa}$ (300,000 tonnes) is of 90%.

9.9 Medium term forecast

A 3 year average was used for the catch weight and stock weight at age. The exploitation pattern was averaged over three years (1998-2000) and scaled to the average of 2000. Last year, a constrained Shepherd stock recruitment curve was used so as to obtain qualitatively the same model as the Butterworth-Berg model. This year, the WG decided to use one of the traditional stock and recruitment relationships (BH, Ricker, Shepherd), to be more consistent with the other stocks. The BH curve did not fit at all. Both the Ricker and the S curves explained some of the variability in recruitment (5-10%). It was decided to keep the Shepherd curve as it better fitted the last years recruitment values (apart from year class 1996), where stocks have been at low levels. The estimated parameters and the residuals from the fit were exported to the input file for the WGMTERMC program. Figure 9.17 shows the stock-recruitment fit and the medium-term forecasts at $\mathbf{F}_{sq}$. Both landings and SSB are predicted to increase over the next 10 years at current F, while average recruitment is expected to remain stable. Figure 9.18 shows the probability of SSB to fall below $\mathbf{B}_{pa}$ over the next 10 years. At $\mathbf{F}_{pa}$ the probability of remaining below $\mathbf{B}_{pa}$ decreases from more than 90% in 2001 and 2002 to less than 10% after 2007. The medium-term forecasts are probably too optimistic, due to the persistent overestimation of the SSB derived from the assessment, and the uncertainty on future recruitments.

9.10 Biological reference points

Biological reference points have been calculated and are shown in the text table below and also in Figures 9.19 and 9.20. $\mathbf{F}_{max}$ is revised slightly downwards (0.29 against 0.31 last year), while $\mathbf{F}_{med}$ is adjusted upwards (0.35 against 0.29 last year). $\mathbf{F}_{0.1}$ stays at the same level (0.15). Figure 9.21 indicates that SSB was below $\mathbf{B}_{lim}$ in the previous 5 years, to exceed this threshold only this year.

Management point	Value	Reference point	Value
$\mathbf{F}_{pa}$	0.3	$\mathbf{F}_{max}$	0.29
$\mathbf{F}_{lim}$	0.6	$\mathbf{F}_{high}$	0.59
$\mathbf{B}_{pa}$	300,000 tonnes	$\mathbf{F}_{med}$	0.35
$\mathbf{B}_{lim}$	210,000 tonnes	$\mathbf{F}_{0.1}$	0.15

9.11 Comments on the assessment

Figure 9.22 shows the comparison of SSB, F(2-10) and recruitment as estimated in the most recent working groups. Overall, the SSB time series have been revised downwards, while the F time series have been reevaluated upwards. This difference is related to the retrospective pattern observed in the assessment, but also to the changes in the tuning configuration. Thus, Figure 9.9 suggests that removing the Danish trawlers and excluding the flag vessels from the assessment lead to an upward revision of F, and a downwards shift of SSB. The selection of tuning fleets was made based on a priori arguments made before the assessment. The major feature of this assessment is the retrospective pattern, which is indicative of persistent underestimation of F and overestimation of SSB. An important consequence of this retrospective pattern is that short- and medium-term predicted SSB and yield have proved optimistic so far, and are persistently revised downwards every year. It appears from the present analysis that the retrospective pattern is probably not caused by catchability trends, since it still exists when the calibration is carried out with surveys only. As stated before, the retrospective pattern could be due to the input information provided in the total catch numbers at age matrix. In particular, discards at young ages could lead to an underestimate of catch numbers, an underestimate of fishing mortality, and a overestimate of stock numbers for the youngest ages. A time series of discards is building up, and figure 9.2 provides evidence that discarding is high for ages 1-5. The phenomenon has also probably worsened by the strong slow growing 1996 year class. It is worrying that the retrospective pattern would only disappear by performing an assessment with high shrinkage (i.e. F estimated as historical average). This suggests that new information hardly improves the quality of the assessment, in its present configuration.

Overall, this assessment should still be considered uncertain. The short term prediction seems however to be more in line with the catch possibilities for the stock. Last year, the yield in 2000 corresponding to the status quo fishing mortality (93 kt.) was consistent with the agreed TAC for that year (97 kt.) which was again based on $\mathbf{F}_{pa}$=0.3. In this year's WG, the yield in 2001 at status quo fishing mortality is predicted to be 85 kt. which is again lower than last year's estimate (93 kt.), but which is more consistent with recent landing trends.

The word "discards" has been used in several occasions in this report. As stated above, adjusting catch numbers at age for discards may contribute to improve the quality of this assessment and the precision of advised TACs. Although the collection of discards information is under way, time series are so far too short to attempt any adjustment of the catch data.

9.12 Management considerations

The perception of stock trends is obscured by the uncertainty in the North Sea plaice assessment. Thus, although the SSB has apparently slightly increased in the past two years, the new assessment now suggests that SSB was below $\mathbf{B}_{lim}$ during the past five years. The bias in the assessment adversely affects the predictions.

The amounts of discards is a major problem for the plaice fishery, and an improvement to the exploitation pattern would be a major benefit for this stock.Plaice is mainly caught in a mixed beam trawl fishery with sole using 80mm mesh in the southern North Sea. This means it is important to stress that management measures intended for plaice will affect sole and vice versa. In relation to this, new technical measures introduced in January 2000 may affect the exploitation of the sole and plaice. The area where fishing with 80 mm is allowed has extended from 55ºN to 56ºN east of 5ºE. The expansion will mainly affect plaice by increasing the level of discarding from 80mm mesh nets but may also increase the mortality on sole. Finally, closure of the cod box in the spring of 2001 may also affect the pattern of fishing for plaice.

Table 9.1 North Sea plaice. Nominal landings (tonnes) in Sub-Area IV as officially reported to ICES, 1993-2000

	1993	1994	1995	1996	1997	1998	1999	2000
Belgium	10,814	7,951	7,093	5,765	5,223	5,592	6,160	7,620
Denmark	16,452	17,056	13,358	11,776	13,940	10,087	13,468	13,408
France	603	407	442	379	254	489	624	836
Germany	6,895	5,697	6,329	4,780	4,159	2,773	3,144	4,310
Netherlands	48,552	50,289	44,263	35,419	34,143	30,541	37,513	35,030
Norway	827	524	527	917	1,775	1,004	913	835
Sweden	7	6	3	5	10	2	4	3
UK (E/W/NI)	20,586	17,806	15,801	13,541	13,789	11,473	9,743	
UK (Scotland)	10,542	9,943	8,594	7,451	8,345	8,442	7,318	
UK								20,711
Others						1		
Total	115,278	109,679	96,410	80,033	81,638	70,404	78,887	82,753
Unallocated	1,835	713	1,946	1,640	1,410	1,130	1,775	305
WG estimate	**117,113**	**110,392**	**98,356**	**81,673**	**83,048**	**71,534**	**80,662**	**83,058**
TAC	175,000	165,000	115,000	81,000	91,000	87,000	102,000	97,000

Table 9.2 North Sea plaice: natural mortality and maturity at age

Age	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Natural mortality	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Maturity	0	0.5	0.5	1	1	1	1	1	1	1	1	1	1	1	1

Table 9.3. North Sea plaice, catch numbers at age (thousands)

Table 1 Catch numbers at age Numbers*10**-3

YEAR	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
AGE										
1	0	0	0	0	0	0	0	0	3	76
2	2264	2147	4340	14708	9858	4144	5982	9474	15017	17294
3	33392	35876	21471	40486	42202	65009	30304	40698	45187	51174
4	67906	66779	76926	64735	53188	51488	112917	38140	36084	56153
5	32699	50060	54364	57408	43674	36667	41383	123619	35585	40686
6	12759	20628	31799	37091	30151	27370	22053	17139	102014	35074
7	14680	9060	12848	15819	18361	16500	16175	10341	10410	78886
8	9748	9035	6833	6595	8554	10784	8004	10102	6086	6311
9	5996	5257	7047	3980	4213	6467	6728	3925	8192	4185
10	3446	3428	3863	3804	4015	3336	3045	4891	3739	4778
11	3621	2659	3591	3066	2807	1843	2033	2273	4760	2202
12	2887	2266	2117	1905	2221	2552	968	1556	1796	2871
13	1743	2001	2089	1518	1745	1624	1303	607	1223	1150
14	1345	1061	1536	1300	1338	1032	783	1007	703	939
+gp	1618	1386	3396	5293	5461	4541	3043	3031	3871	2900
0 TOTALNUM	194104	211643	232220	257708	227788	233357	254721	266803	274670	304679
TONSLAND	85984	87472	107118	110540	97143	101834	108819	111534	121651	130342
SOPCOF %	102	97	102	101	101	102	102	103	106	97

YEAR	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
AGE										
1	19	2233	1268	2223	981	2820	3220	1143	1318	979
2	29591	36528	31733	23120	28124	33643	56969	60578	58031	64904
3	48282	62199	59099	55548	61623	77649	43289	62343	118863	133741
4	33475	52906	73065	42125	31262	96398	66013	54341	48962	77523
5	26059	23043	42255	41075	25419	13779	83705	50102	47886	24974
6	22903	16998	13817	19666	21188	9904	9142	35510	39932	17982
7	16913	14380	8885	8005	11873	9120	5912	5940	24228	13761
8	29730	10903	9848	6321	5923	6391	5022	3352	4161	8458
9	6414	18585	6084	5568	4106	2947	4061	2419	2807	1864
10	4602	3467	13829	3931	3337	2020	1927	2176	2333	1326
11	3377	2841	1680	10118	1741	2111	1301	1145	1849	952
12	2213	2538	1995	1634	7935	911	1357	603	1113	1173
13	1910	1553	1516	1686	1080	4478	489	689	707	433
14	929	1591	1355	1242	1424	388	2290	330	707	284
+gp	3879	3661	3603	3369	4178	2644	1827	2525	2579	1209
0 TOTALNUM	230296	253426	270032	225631	210194	265203	286524	283196	355476	349563
TONSLAND	113944	122843	130429	112540	108536	113670	119188	113984	145347	139951
SOPCOF %	103	103	105	104	106	103	100	96	100	101

YEAR	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
AGE										
1	253	3334	1214	108	121	1674	0	0	1261	1550
2	100927	47776	119695	63252	73552	67125	85123	15146	46757	32533
3	122296	209007	115034	274209	144316	163717	115951	250675	105929	97766
4	57604	69544	99076	53549	185203	93801	111239	74335	231414	110997
5	35745	28655	29359	37468	32520	84479	64758	47380	52909	159814
6	12414	16726	12906	13661	15544	24049	34728	25091	19247	26757
7	9564	7589	8216	6465	6871	9299	11452	16774	10567	8129
8	8092	5470	4193	5544	3650	4490	4341	5381	7561	4216
9	4874	4482	3013	2720	2698	2733	2154	3162	2120	3451
10	1406	3706	2947	2088	1543	2026	1743	1671	1692	1097
11	1097	1134	2144	1307	1030	1178	1033	932	927	716
12	830	712	1219	1143	1070	1084	663	932	630	456
13	796	575	581	455	727	806	529	505	446	293
14	468	519	344	310	371	628	296	516	328	208
+gp	1306	2007	1052	1262	1057	1228	1214	1677	1557	1038
0 TOTALNUM	357672	401236	400993	463541	470273	458317	435224	444177	483345	449021
TONSLAND	139747	154547	144038	156147	159838	165347	153670	154475	169818	156240
SOPCOF %	102	101	99	98	98	99	99	98	99	98

YEAR	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
AGE										
1	1461	3410	3461	1394	7751	1104	892	196	549	2756
2	43266	43954	53949	45148	36575	42496	42855	30401	8689	16047
3	83603	85120	98375	101617	81398	64382	86948	68920	155971	40213
4	116155	72494	72286	80236	78370	46359	43669	56329	39857	167145
5	72961	72703	51405	38542	36499	32130	22541	16713	24112	15202
6	77557	33406	29001	20388	17953	14460	13518	6432	6829	9487
7	14910	29547	13472	15323	9772	10605	6362	4986	2783	2140
8	5233	6970	11272	6399	4366	4528	3632	2506	2246	1045
9	3141	3200	3645	5368	2336	2624	2179	1761	1521	953
10	2325	2240	1888	2319	1682	1659	1252	912	1180	553
11	956	1516	1241	942	864	1170	690	500	515	395
12	592	925	932	646	427	511	889	403	381	387
13	356	524	743	580	229	260	396	431	230	206
14	289	490	215	300	209	238	224	176	267	136
+gp	1073	1233	864	646	342	1054	730	697	520	427
0 TOTALNUM	423878	357732	342749	319848	278773	223580	226777	191363	245650	257092
TONSLAND	148004	125190	117113	110392	98356	81673	83048	71534	80662	83058
SOPCOF %	96	98	98	97	99	98	99	98	99	98

Table 9.4. North Sea plaice, catch weights at age (kg)

Table 2 Catch weights at age (kg)

YEAR	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
AGE										
1	0	0	0	0	0	0	0	0	0.217	0.315
2	0.191	0.211	0.253	0.25	0.242	0.232	0.232	0.267	0.294	0.286
3	0.233	0.248	0.286	0.273	0.282	0.27	0.279	0.298	0.31	0.318
4	0.302	0.3	0.319	0.312	0.321	0.348	0.322	0.331	0.333	0.356
5	0.412	0.4	0.399	0.388	0.385	0.436	0.425	0.366	0.359	0.419
6	0.509	0.541	0.533	0.487	0.471	0.484	0.547	0.517	0.412	0.443
7	0.604	0.57	0.624	0.628	0.539	0.559	0.597	0.59	0.573	0.499
8	0.671	0.692	0.667	0.7	0.663	0.624	0.662	0.596	0.655	0.672
9	0.812	0.777	0.715	0.737	0.726	0.69	0.738	0.686	0.658	0.744
10	0.87	0.959	0.86	0.841	0.615	0.813	0.837	0.75	0.694	0.762
11	0.942	0.995	0.92	0.89	0.792	0.858	0.87	0.817	0.81	0.78
12	1.033	1.1	1.033	0.954	0.857	0.843	0.902	0.939	0.838	0.892
13	1.224	1.187	1.004	0.938	0.974	0.943	0.95	0.936	1.022	0.941
14	1.239	1.41	1.182	1.098	0.878	1.018	1.032	0.973	0.863	1.021
+gp	1.553	1.54	1.276	1.204	1.121	1.08	1.214	1.201	1.179	1.128
0 SOPCOFAC	1.0156	0.9665	1.0193	1.0075	1.0057	1.0182	1.0198	1.0291	1.0582	0.9744

YEAR	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
AGE										
1	0.256	0.246	0.272	0.285	0.249	0.265	0.254	0.244	0.235	0.238
2	0.318	0.296	0.316	0.311	0.3	0.295	0.323	0.315	0.311	0.286
3	0.356	0.352	0.344	0.354	0.33	0.338	0.353	0.369	0.349	0.344
4	0.403	0.428	0.405	0.405	0.42	0.375	0.38	0.397	0.388	0.401
5	0.448	0.493	0.486	0.476	0.495	0.513	0.418	0.438	0.429	0.473
6	0.514	0.541	0.539	0.554	0.587	0.594	0.556	0.491	0.474	0.545
7	0.542	0.608	0.605	0.609	0.636	0.641	0.647	0.609	0.55	0.588
8	0.607	0.646	0.627	0.693	0.703	0.705	0.721	0.687	0.675	0.662
9	0.699	0.674	0.677	0.707	0.783	0.741	0.715	0.776	0.796	0.772
10	0.724	0.785	0.729	0.779	0.853	0.813	0.791	0.781	0.871	0.931
11	0.818	0.841	0.978	0.849	0.854	0.851	0.898	0.886	0.818	0.943
12	0.848	0.901	0.907	0.971	0.983	0.928	0.97	0.983	0.894	0.848
13	0.922	0.9	0.942	1.002	0.953	1.019	0.855	1.039	1.083	1.015
14	1.004	0.964	0.983	1.04	1.138	1.009	1.063	0.933	1.044	1.308
+gp	1.133	1.192	1.079	1.224	1.264	1.159	1.165	1.094	1.115	1.248
0 SOPCOFAC	1.0331	1.0283	1.0508	1.0369	1.0624	1.0254	1.0016	0.9643	0.9983	1.0136

YEAR	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
AGE										
1	0.237	0.279	0.2	0.233	0.247	0.221	0.221	0.221	0.236	0.271
2	0.274	0.262	0.25	0.263	0.264	0.269	0.249	0.254	0.28	0.285
3	0.329	0.311	0.3	0.283	0.29	0.304	0.3	0.278	0.309	0.298
4	0.416	0.424	0.383	0.375	0.337	0.347	0.351	0.352	0.332	0.317
5	0.505	0.514	0.515	0.491	0.462	0.425	0.402	0.453	0.392	0.366
6	0.558	0.608	0.604	0.613	0.577	0.488	0.504	0.512	0.533	0.447
7	0.604	0.664	0.677	0.684	0.678	0.675	0.583	0.608	0.603	0.597
8	0.642	0.712	0.771	0.725	0.729	0.751	0.728	0.699	0.67	0.692
9	0.725	0.738	0.815	0.837	0.804	0.853	0.829	0.813	0.792	0.761
10	0.869	0.84	0.893	0.916	0.9	0.921	0.826	0.936	0.819	0.826
11	0.95	0.983	0.913	0.981	1.001	0.948	0.996	0.964	0.923	1.044
12	0.931	1.045	0.984	1.026	0.95	1.063	1.015	1.041	0.952	1.098
13	0.933	1.174	1.24	1.112	1.071	1.078	1.045	1.137	1.157	1.117
14	1.179	0.97	1.209	1.25	1.139	1.074	1.127	1.115	1.084	0.991
+gp	1.236	1.177	1.167	1.214	1.215	1.11	1.15	1.038	0.994	1.094
0 SOPCOFAC	1.0175	1.0062	0.9938	0.9844	0.9799	0.9877	0.9875	0.9848	0.9854	0.9846

YEAR	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
AGE										
1	0.227	0.251	0.249	0.229	0.272	0.24	0.208	0.152	0.245	0.228
2	0.286	0.263	0.273	0.263	0.277	0.28	0.271	0.26	0.253	0.267
3	0.294	0.29	0.289	0.286	0.301	0.307	0.313	0.31	0.28	0.284
4	0.306	0.318	0.326	0.339	0.338	0.355	0.364	0.394	0.355	0.313
5	0.365	0.341	0.356	0.397	0.402	0.42	0.457	0.497	0.455	0.432
6	0.455	0.425	0.423	0.449	0.454	0.486	0.524	0.607	0.547	0.5
7	0.528	0.531	0.518	0.502	0.528	0.499	0.603	0.633	0.63	0.686
8	0.671	0.605	0.631	0.611	0.611	0.589	0.616	0.695	0.682	0.71
9	0.747	0.715	0.721	0.732	0.734	0.72	0.683	0.7	0.752	0.749
10	0.843	0.755	0.775	0.787	0.881	0.854	0.803	0.8	0.608	0.83
11	0.93	0.843	0.806	0.936	0.865	0.928	0.907	0.975	0.75	0.843
12	0.944	0.945	0.903	0.948	0.923	0.933	0.957	1.078	0.933	0.749
13	1	0.994	0.846	1.034	0.918	0.923	0.884	0.888	1.031	0.85
14	0.976	0.928	0.919	0.92	0.943	0.829	1.1	0.907	0.936	1.007
+gp	1.026	1.098	1.046	1.131	1.104	0.739	1.076	0.943	1.093	1.092
0 SOPCOFAC	0.9634	0.9818	0.9767	0.9738	0.9935	0.9846	0.992	0.9842	0.986	0.9801

Table 9.5. North Sea plaice, stock weights at age derived from first quarter catch weights

Table 3 Stock weights at age (kg)

YEAR	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
AGE										
1	0.141	0.141	0.141	0.141	0.141	0.141	0.141	0.141	0.175	0.175
2	0.126	0.187	0.2	0.2	0.2	0.2	0.203	0.2	0.203	0.25
3	0.202	0.258	0.232	0.228	0.246	0.243	0.246	0.265	0.258	0.261
4	0.254	0.306	0.29	0.276	0.274	0.301	0.281	0.301	0.297	0.311
5	0.337	0.424	0.378	0.373	0.333	0.403	0.442	0.344	0.344	0.369
6	0.483	0.573	0.54	0.477	0.43	0.455	0.528	0.532	0.39	0.41
7	0.579	0.684	0.663	0.645	0.516	0.503	0.585	0.592	0.565	0.468
8	0.691	0.806	0.788	0.673	0.601	0.565	0.65	0.362	0.621	0.636
9	0.779	0.873	0.882	0.845	0.722	0.581	0.703	0.667	0.679	0.732
10	0.911	1.335	0.961	0.973	0.578	0.848	0.833	0.746	0.635	0.747
11	0.947	1.074	1.097	0.999	0.79	0.949	0.907	0.791	0.772	0.771
12	1.079	1.24	1.261	1.255	0.843	0.704	1.007	0.919	0.741	0.898
13	1.184	1.141	1.246	1.201	1.072	1.052	0.898	0.81	0.995	0.839
14	1.186	1.8	1.403	1.62	0.721	1.056	0.976	0.938	0.907	1.155
+gp	1.424	1.619	1.678	1.46	1.234	1.216	1.221	1.17	1.179	1.175

YEAR	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
AGE										
1	0.175	0.175	0.175	0.17	0.17	0.17	0.16	0.15	0.15	0.15
2	0.248	0.274	0.264	0.234	0.275	0.217	0.25	0.242	0.243	0.229
3	0.305	0.321	0.322	0.304	0.294	0.281	0.309	0.336	0.303	0.307
4	0.363	0.401	0.38	0.375	0.417	0.332	0.364	0.367	0.363	0.372
5	0.413	0.473	0.468	0.437	0.483	0.484	0.405	0.411	0.414	0.444
6	0.489	0.534	0.521	0.524	0.544	0.55	0.551	0.467	0.459	0.524
7	0.512	0.579	0.566	0.57	0.61	0.593	0.627	0.547	0.543	0.582
8	0.583	0.606	0.583	0.629	0.668	0.658	0.69	0.63	0.667	0.651
9	0.696	0.655	0.617	0.652	0.704	0.694	0.667	0.704	0.764	0.778
10	0.707	0.759	0.69	0.69	0.762	0.743	0.759	0.773	0.826	1.025
11	0.817	0.815	0.926	0.774	0.83	0.784	0.818	0.848	0.894	0.947
12	0.847	0.869	0.899	0.932	0.886	0.875	0.909	0.939	0.88	0.838
13	0.941	0.849	0.961	1.017	0.874	0.972	0.838	0.959	1.127	1.209
14	0.936	0.971	0.977	0.962	1.07	1.158	1.055	1.024	1.041	1.194
+gp	1.102	1.237	0.998	1.113	1.217	1.107	1.116	1.119	1.255	1.31

YEAR	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
AGE										
1	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
2	0.25	0.242	0.211	0.203	0.208	0.195	0.194	0.212	0.215	0.245
3	0.282	0.265	0.248	0.242	0.243	0.253	0.265	0.238	0.248	0.272
4	0.378	0.381	0.329	0.338	0.31	0.336	0.33	0.315	0.282	0.281
5	0.473	0.49	0.494	0.464	0.452	0.44	0.401	0.426	0.362	0.342
6	0.536	0.589	0.559	0.571	0.536	0.533	0.503	0.467	0.484	0.421
7	0.57	0.631	0.624	0.649	0.635	0.692	0.573	0.547	0.553	0.555
8	0.624	0.679	0.712	0.692	0.656	0.779	0.711	0.644	0.616	0.648
9	0.707	0.726	0.754	0.787	0.764	0.888	0.747	0.706	0.759	0.713
10	0.849	0.828	0.791	0.898	0.869	0.971	0.817	0.897	0.837	0.769
11	0.91	0.981	0.824	0.932	0.955	0.953	1.009	0.937	0.791	1.051
12	0.866	1.066	1.011	1.042	0.906	1.107	1.018	1.009	0.968	1.154
13	1.114	1.182	1.13	1.235	1.068	1.153	1.019	1.065	1.215	1.022
14	1.218	0.897	1.257	1.127	1.108	1.126	1.214	1.135	0.899	1.09
+gp	1.324	1.197	1.124	1.235	1.308	1.354	1.114	0.972	0.857	1.084

YEAR	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
AGE										
1	0.131	0.131	0.131	0.131	0.124	0.124	0.124	0.124	0.124	0.124
2	0.208	0.262	0.257	0.222	0.245	0.245	0.217	0.205	0.211	0.224
3	0.263	0.266	0.264	0.249	0.265	0.282	0.254	0.269	0.251	0.236
4	0.275	0.3	0.301	0.302	0.311	0.329	0.342	0.362	0.346	0.29
5	0.34	0.316	0.328	0.366	0.401	0.39	0.442	0.471	0.436	0.409
6	0.4	0.402	0.391	0.41	0.451	0.464	0.491	0.578	0.524	0.468
7	0.463	0.501	0.491	0.467	0.52	0.49	0.563	0.588	0.591	0.687
8	0.64	0.575	0.595	0.548	0.607	0.572	0.586	0.657	0.68	0.742
9	0.658	0.696	0.646	0.679	0.705	0.689	0.684	0.676	0.696	0.707
10	0.762	0.751	0.737	0.752	0.836	0.845	0.771	0.709	0.639	0.864
11	0.855	0.844	0.805	0.912	0.739	0.906	0.913	1.004	0.764	0.872
12	0.99	0.886	0.942	0.961	0.885	0.973	0.865	1.092	0.898	0.744
13	0.982	0.998	0.866	1.027	0.827	0.9	0.898	0.788	1.185	0.818
14	0.86	0.859	0.912	0.846	0.913	0.781	1.287	1.175	0.839	1.082
+gp	0.928	1.078	1.101	1.02	1.128	0.87	1.052	0.829	1.102	1.081

Table 9.6. North Sea plaice: tuning fleets

Plaice	Sub-area IV									
104										
NL Beam Trawl (1)										
1989	2000									
1	1	0	1							
2	9									
72.5	40443	73696	131915	23064	9634	5240	2715	947		
71.1	21956	60038	49862	76521	12187	3682	1790	1161		
68.5	27501	42376	53152	30697	34092	6879	1954	1137		
71.1	24271	44306	31854	27165	12219	9485	2464	993		
76.9	27552	46536	31333	19705	10984	6040	3611	1025		
81.4	30194	48106	35901	15371	7938	6174	2866	1929		
81.2	22519	43505	33883	14453	6575	3418	1549	931		
72.1	26600	27628	20922	13980	5313	3644	1366	944		
72	23098	45655	18156	6884	4337	2016	975	460		
70.3	15288	32486	26751	6389	2290	1359	669	314		
67.3	4335	76190	18227	11044	2995	997	832	505		
65	8973	16995	72228	5789	3880	735	336	214		
English Beam Trawl (excluding flag vessels landings) (2)										
1990	2000									
1	1	0	1							
4	12									
	102.3	2764	9488	1786	1133	722	842	251	170	98
	123.6	2711	3538	6599	1325	837	427	610	226	183
	151.5	2909	4446	2787	3674	968	558	485	497	166
	146.6	3436	3060	2530	923	1876	635	400	357	255
	131.4	3038	2890	1772	1252	593	850	431	189	160
	105	3574	1657	1475	1020	620	332	378	287	143
	82.9	1105	1579	890	836	543	388	207	274	163
	76.3	1253	844	1066	599	686	505	211	148	229
	68.8	1623	892	617	598	347	415	317	134	110
	68.6	1011	1045	457	327	367	258	224	193	98
	57.8	3355	734	491	217	113	165	83	85	119

BTS (3)				
1985	2000			
1	1	0.66	0.75	
1	4			
1	130	180	38.8	11.8
1	660.2	131.8	50.9	8.9
1	225.1	765	33.1	4.8
1	605.1	139.9	173.2	9.2
1	426.6	332.6	38.6	47.3
1	107	99.8	57.7	24.8
1	184.4	122.1	28.5	11.9
1	172.8	125.7	27.3	5.6
1	122.6	181	38.8	6.1
1	141.7	65.7	37.4	11.9
1	249.4	43.6	14.2	8.3
1	215.8	206.8	22.8	4.8
1	-11	-11	19.9	2.8
1	337	433.1	47.3	8.9
1	298.9	133.1	181.8	4
1	276.4	72.9	32.4	23
SNS (3)				
1982	2000			
1	1	0.66	0.75	
1	3			
1	70108	8503	1146	
1	34884	14708	308	
1	44667	10413	2480	
1	27832	13789	1584	
1	93573	7558	1155	
1	33426	33021	1232	
1	36672	14430	13140	
1	37238	14952	3709	
1	24903	7287	3248	
1	57349	11149	1507	
1	48223	13742	2257	
1	22184	9484	988	
1	18225	4866	884	
1	24900	2786	415	
1	24663	10377	1189	
1	-11	-11	1393	
1	33391	29431	5739	
1	35188	9235	14347	
1	23028	2489	905	

1) Effort is specified in HP days (*100,000), catch numbers in thousands. Source: RIVO-DLO
2) Effort is specified in HP fishing hours (million), catch numbers in thousands. Source: CEFAS
3) Source: RIVO-DLO

Table 9.7. North Sea plaice: effort and CPUE trends for the NL, UK and DKK commercial fleets

Effort Unit	NL beam-trawlers HP days * 100000	English beam-trawlers* HP days *million	DK Danish seiners Standardized effort	DK Gill-netters Standardized effort	DK Trawlers Standardized effort
1979	44.3				
1980	45				
1981	46.3				
1982	57.3				
1983	65.6				
1984	70.8				
1985	70.3				
1986	68.2				
1987	68.4		13356.0	6424.1	9219.4
1988	76.2		14418.9	7131.6	6553.3
1989	72.5		15216.1	7021.2	7886.4
1990	71.1	102.3	12945.7	7429.2	10274.2
1991	68.5	123.6	14303.7	11374.8	9703.1
1992	71.1	151.5	12644.5	13158.1	6170.7
1993	76.9	146.6	11150.8	14190.2	5202.9
1994	81.4	131.4	8206.5	18486.3	5537.4
1995	81.2	105.0	7600.4	16395.1	4579.0
1996	72.1	82.9	6630.4	14398.5	4542.9
1997	72	76.3	4720.2	12446.8	4036.7
1998	70.3	68.8	4330.7	11457.1	4572.1
1999	67.3	68.6	5266.4	12764.3	6145.1
2000	65	57.8	4619.0	10606.0	5582.0

CPUE	NL beam-trawlers	English beam-trawlers	DK Danish seiners	DK Gill-netters	DK Trawlers
1979	1693				
1980	1729				
1981	1853				
1982	1707				
1983	1441				
1984	1439				
1985	1511				
1986	1651				
1987	1440		0.677	0.324	0.469
1988	1194		0.828	0.226	0.449
1989	1379		0.898	0.183	0.626
1990	1104	86	0.939	0.179	0.709
1991	1022	70	0.544	0.387	0.594
1992	745	59	0.601	0.408	0.449
1993	656	51	0.543	0.314	0.431
1994	626	47	0.527	0.341	0.4
1995	565	49	0.457	0.315	0.296
1996	510	46	0.515	0.349	0.339
1997	492	55	1.002	0.352	0.684
1998	451	55	0.741	0.205	0.533
1999	577	45	0.771	0.146	0.734
2000	558	47	0.874	0.189	0.726

*Excluding flag vessels

Table 9.8. North Sea plaice: separable VPA outputs

Title : Plaice in IV

At 23/06/2001 9:09

Separable analysis
from 1991 to 2000 on ages 1 to 14
with Terminal F of .650 on age 4 and Terminal S of .450

Initial sum of squared residuals was 179.667 and
final sum of squared residuals is 10.235 after 68 iterations

Matrix of Residuals

Years	1991/92	1992/93	1993/94	1994/95	1995/96	1996/97	1997/98	1998/99	1999/**	TOT
1/ 2	0.022	0.543	0.726	-0.237	1.601	-0.406	-0.444	-0.482	-0.268	0.001
2/ 3	0.519	0.242	0.386	0.2	0.498	0.29	0.389	-0.547	-0.629	0.001
3/ 4	0.003	-0.171	-0.184	-0.356	0.266	0.016	-0.07	0.297	-0.508	0.001
4/ 5	-0.156	-0.502	-0.283	-0.364	0.093	-0.163	-0.058	0.106	0.024	0.001
5/ 6	0.062	-0.02	-0.078	-0.486	0.032	-0.113	0.136	0.055	-0.109	0.001
6/ 7	0.347	0.081	-0.246	-0.396	-0.261	-0.046	-0.012	0.099	0.221	0.001
7/ 8	0.099	0.105	-0.164	0.091	-0.056	0.17	-0.12	0.015	-0.008	0
8/ 9	0.067	0.041	0.091	0.105	-0.071	0.08	-0.077	-0.044	0.112	0
9/10	-0.096	-0.085	-0.2	0.252	-0.245	0.083	0.061	-0.153	0.255	0.001
10/11	-0.099	-0.106	-0.035	-0.006	-0.313	0.134	0.016	-0.076	0.24	0.001
11/12	-0.116	0.177	0.312	0.195	0.233	-0.081	0.026	0.005	-0.182	0.001
12/13	-0.175	-0.24	-0.016	0.287	0.054	-0.252	0.06	0.145	-0.005	0.001
13/14	-0.474	0.575	0.56	0.418	-0.337	-0.213	0.293	0.206	0.051	0.001
TOT	0.002	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	1.227
WTS	0.001	0.001	0.001	0.001	1	1	1	1	1	

Fishing Mortalities (F)

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
F-values	0.6604	0.7993	0.8606	0.9226	0.7492	0.8015	0.8168	0.6969	0.7479	0.65

Selection-at-age (S)

	1	2	3	4
S-values	0.0055	0.1663	0.6868	1

	5	6	7	8	9	10	11	12	13	14
S-values	1.0082	0.8909	0.8102	0.647	0.6086	0.5469	0.4182	0.4512	0.4196	0.45

Table 9.9 North Sea Plaice. Final XSA output

```
Lowestoft VPA Version 3.1
  22/06/2001  17:00
Extended Survivors Analysis
Plaice in IV

CPUE data from file fleet_nodk.txt

Catch data for  44 years. 1957 to 2000. Ages  1 to  15.

     Fleet,            First, Last, First, Last, Alpha,  Beta
                  ,     year, year,  age ,  age
NL Beam Trawl      ,    1989, 2000,   2,     9,   .000,  1.000
FLT02: English Beam ,   1990, 2000,   4,    12,   .000,  1.000
BTS                ,    1985, 2000,   1,     4,   .660,   .750
SNS                ,    1982, 2000,   1,     3,   .660,   .750


Time series weights :

     Tapered time weighting not applied

Catchability analysis :

     Catchability independent of stock size for all ages

     Catchability independent of age for ages >=   10

Terminal population estimation :

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

     S.E. of the mean to which the estimates  are shrunk =    .500

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

     Prior weighting not applied


Tuning converged after   63 iterations


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


Fishing mortalities
   Age,  1991,  1992,  1993,  1994,  1995,  1996,  1997,  1998,  1999,  2000

     1,  .004,  .009,  .013,  .006,  .025,  .005,  .001,  .001,  .003,  .009
     2,  .136,  .136,  .170,  .206,  .197,  .167,  .215,  .044,  .043,  .087
     3,  .340,  .380,  .447,  .486,  .606,  .551,  .527,  .557,  .297,  .253
     4,  .559,  .491,  .569,  .710,  .762,  .744,  .799,  .687,  .648,  .528
     5,  .690,  .729,  .687,  .601,  .733,  .729,  .900,  .729,  .630,  .484
     6,  .789,  .699,  .640,  .567,  .552,  .642,  .691,  .616,  .663,  .481
     7,  .546,  .705,  .600,  .742,  .518,  .656,  .575,  .521,  .523,  .394
     8,  .428,  .471,  .564,  .565,  .426,  .428,  .432,  .413,  .416,  .336
     9,  .383,  .448,  .427,  .509,  .366,  .435,  .334,  .341,  .421,  .277
    10,  .370,  .459,  .459,  .470,  .261,  .426,  .338,  .202,  .359,  .236
    11,  .287,  .389,  .441,  .387,  .283,  .261,  .280,  .196,  .151,  .174
    12,  .364,  .439,  .390,  .384,  .271,  .241,  .288,  .234,  .201,  .145
    13,  .258,  .562,  .671,  .398,  .203,  .235,  .266,  .197,  .182,  .143
    14,  .333,  .595,  .419,  .556,  .216,  .299,  .290,  .162,  .161,  .139
```

Table 9.9 (Cont'd) North Sea Plaice. Final XSA output

XSA population numbers (Thousands)

YEAR	AGE 1	2	3	4	5	6	7	8	9	10
1991	4.03E+05	3.58E+05	3.05E+05	2.85E+05	1.54E+05	1.49E+05	3.72E+04	1.58E+04	1.04E+04	7.91E+03
1992	4.05E+05	3.63E+05	2.83E+05	1.96E+05	1.48E+05	6.98E+04	6.14E+04	1.95E+04	9.32E+03	6.40E+03
1993	2.86E+05	3.63E+05	2.87E+05	1.75E+05	1.09E+05	6.45E+04	3.14E+04	2.75E+04	1.10E+04	5.39E+03
1994	2.39E+05	2.55E+05	2.78E+05	1.66E+05	8.97E+04	4.95E+04	3.07E+04	1.56E+04	1.41E+04	6.51E+03
1995	3.30E+05	2.15E+05	1.88E+05	1.55E+05	7.38E+04	4.45E+04	2.54E+04	1.32E+04	8.01E+03	7.69E+03
1996	2.58E+05	2.91E+05	1.60E+05	9.29E+04	6.53E+04	3.21E+04	2.32E+04	1.37E+04	7.83E+03	5.03E+03
1997	8.15E+05	2.32E+05	2.23E+05	8.34E+04	3.99E+04	2.85E+04	1.53E+04	1.09E+04	8.07E+03	4.59E+03
1998	2.41E+05	7.36E+05	1.70E+05	1.19E+05	3.39E+04	1.47E+04	1.29E+04	7.78E+03	6.40E+03	5.23E+03
1999	2.23E+05	2.18E+05	6.37E+05	8.79E+04	5.42E+04	1.48E+04	7.18E+03	6.94E+03	4.66E+03	4.12E+03
2000	3.42E+05	2.01E+05	1.89E+05	4.28E+05	4.16E+04	2.61E+04	6.91E+03	3.85E+03	4.14E+03	2.77E+03

Estimated population abundance at 1st Jan 2001

, 0.00E+00, 3.07E+05, 1.67E+05, 1.33E+05, 2.29E+05, 2.32E+04, 1.46E+04, 4.21E+03, 2.49E+03, 2.84E+03,

Taper weighted geometric mean of the VPA populations:

, 4.04E+05, 3.60E+05, 2.99E+05, 1.94E+05, 1.08E+05, 5.98E+04, 3.51E+04, 2.22E+04, 1.49E+04, 1.03E+04,

Standard error of the weighted Log(VPA populations) :

, .4060, .4200, .4187, .4580, .5190, .5656, .6065, .6151, .6185, .6553,

YEAR	AGE 11	12	13	14
1991	4.03E+03	2.04E+03	1.64E+03	1.07E+03
1992	4.95E+03	2.74E+03	1.28E+03	1.15E+03
1993	3.66E+03	3.03E+03	1.60E+03	6.61E+02
1994	3.08E+03	2.13E+03	1.86E+03	7.39E+02
1995	3.68E+03	1.89E+03	1.31E+03	1.13E+03
1996	5.36E+03	2.51E+03	1.31E+03	9.69E+02
1997	2.97E+03	3.73E+03	1.78E+03	9.36E+02
1998	2.96E+03	2.03E+03	2.53E+03	1.24E+03
1999	3.87E+03	2.20E+03	1.46E+03	1.88E+03
2000	2.60E+03	3.01E+03	1.63E+03	1.10E+03

Estimated population abundance at 1st Jan 2001

, 1.98E+03, 1.98E+03, 2.35E+03, 1.28E+03,

Taper weighted geometric mean of the VPA populations:

, 7.13E+03, 5.02E+03, 3.41E+03, 2.36E+03,

Standard error of the weighted Log(VPA populations) :

, .6828, .6896, .7105, .7488,

1

Log catchability residuals.

Fleet : NL Beam Trawl

Age	1982	1983	1984	1985	1986	1987	1988	1989	1990
1	No data for this fleet at this age								
2	99.99	99.99	99.99	99.99	99.99	99.99	99.99	.21	-.06
3	99.99	99.99	99.99	99.99	99.99	99.99	99.99	.02	-.15
4	99.99	99.99	99.99	99.99	99.99	99.99	99.99	.03	-.16
5	99.99	99.99	99.99	99.99	99.99	99.99	99.99	-.13	.24
6	99.99	99.99	99.99	99.99	99.99	99.99	99.99	.10	.00
7	99.99	99.99	99.99	99.99	99.99	99.99	99.99	.17	-.11
8	99.99	99.99	99.99	99.99	99.99	99.99	99.99	.10	-.05
9	99.99	99.99	99.99	99.99	99.99	99.99	99.99	.17	.03
10	No data for this fleet at this age								
11	No data for this fleet at this age								
12	No data for this fleet at this age								

Table 9.9 (Cont'd) North Sea Plaice. Final XSA output

Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	No data for this fleet at this age									
2	.26	.08	.14	.55	.43	.39	.50	-1.12	-1.12	-.26
3	-.11	-.01	-.03	.00	.34	.15	.31	.28	-.27	-.54
4	-.04	-.24	-.19	.00	.04	.18	.17	.18	.13	-.10
5	.13	.02	-.09	-.24	-.04	.16	.02	.06	.14	-.27
6	.41	.07	-.06	-.21	-.29	-.02	-.08	-.07	.26	-.10
7	.26	.12	.21	.26	-.24	.10	-.11	-.34	-.02	-.31
8	.13	.13	.13	.41	-.10	-.14	-.24	-.27	.11	-.21
9	.24	.20	-.02	.34	.12	.30	-.49	-.61	.26	-.51
10	No data for this fleet at this age									
11	No data for this fleet at this age									
12	No data for this fleet at this age									

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

Age	2	3	4	5	6	7	8	9
Mean Log q	-6.9345	-5.8740	-5.5573	-5.5961	-5.7060	-5.8722	-6.1918	-6.4409
S.E(Log q)	.5732	.2541	.1496	.1590	.1922	.2176	.2026	.3431

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	1.78	-.981	2.48	.14	12	1.02	-6.93
3	1.34	-1.475	3.60	.65	12	.32	-5.87
4	1.15	-2.134	4.56	.95	12	.15	-5.56
5	.94	.970	5.97	.96	12	.15	-5.60
6	.93	.901	6.06	.94	12	.18	-5.71
7	.82	2.670	6.60	.96	12	.14	-5.87
8	.83	2.025	6.74	.94	12	.15	-6.19
9	.70	1.590	7.20	.74	12	.23	-6.44

1

Fleet : FLT02: English Beam

Age	1982	1983	1984	1985	1986	1987	1988	1989	1990
1	No data for this fleet at this age								
2	No data for this fleet at this age								
3	No data for this fleet at this age								
4	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	-.44
5	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	.10
6	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	-.36
7	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	-.05
8	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	-.15
9	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	.16
10	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	-.30
11	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	-.04
12	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	-.35

Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	No data for this fleet at this age									
2	No data for this fleet at this age									
3	No data for this fleet at this age									
4	-.63	-.42	-.07	.04	.52	.08	.42	.38	.19	-.07
5	-.31	-.23	-.28	-.07	-.15	.16	.18	.43	.08	.09
6	.11	-.23	-.24	-.26	-.12	-.02	.38	.57	.29	-.12
7	-.37	.01	-.71	-.21	-.10	.09	.22	.47	.45	.19
8	-.13	-.38	.01	-.46	-.10	-.02	.52	.27	.45	-.01
9	-.52	-.32	-.33	-.14	-.36	.09	.36	.50	.39	.16
10	.12	-.06	-.05	-.05	-.22	-.09	.07	.38	.35	-.13
11	-.24	.19	.21	-.17	.25	.05	.12	.09	.17	-.08
12	.27	-.30	.04	.04	.21	.28	.33	.28	.08	.10

Table 9.9 (Cont'd) North Sea Plaice. Final XSA output

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

Age	4	5	6	7	8	9	10	11	12
Mean Log q	-8.5361	-7.9117	-7.6348	-7.4756	-7.3685	-7.2584	-7.2692	-7.2692	-7.2692
S.E(Log q)	.3735	.2273	.3004	.3486	.3097	.3487	.2152	.1699	.2481

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
4	1.89	-2.723	5.45	.51	11	.55	-8.54
5	1.23	-2.077	7.13	.90	11	.24	-7.91
6	1.35	-2.319	6.58	.83	11	.34	-7.63
7	1.52	-2.705	6.18	.75	11	.42	-7.48
8	1.37	-1.606	6.62	.68	11	.39	-7.37
9	1.97	-1.938	5.55	.31	11	.61	-7.26
10	1.11	-.428	7.12	.61	11	.25	-7.27
11	.84	.825	7.37	.75	11	.14	-7.22
12	1.02	-.044	7.17	.45	11	.25	-7.18

1

Fleet : BTS

Age	1982	1983	1984	1985	1986	1987	1988	1989	1990
1	99.99	99.99	99.99	-.93	-.16	-.40	.54	.51	-.84
2	99.99	99.99	99.99	-.17	-.33	.52	-.38	.49	-.40
3	99.99	99.99	99.99	-.31	.00	-.37	.31	-.43	-.02
4	99.99	99.99	99.99	-.37	-.29	-.72	-.23	.46	.58
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								
11	No data for this fleet at this age								
12	No data for this fleet at this age								

Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	-.30	-.37	-.36	-.04	.21	.30	99.99	.81	.77	.27
2	-.13	-.12	.27	-.37	-.61	.62	99.99	.35	.38	-.11
3	-.37	-.31	.08	.10	-.39	.20	-.28	.88	.72	.18
4	-.12	-.55	-.30	.53	.27	.22	-.17	.55	.03	.11
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									
11	No data for this fleet at this age									
12	No data for this fleet at this age									

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

Age	1	2	3	4
Mean Log q	-7.3118	-7.6832	-8.6017	-9.4979
S.E(Log q)	.5428	.3987	.3960	.4075

Table 9.9 (Cont'd) North Sea Plaice. Final XSA output

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,	1.86,	-1.487,	2.51,	.19,	15,	.97,	-7.31,
2,	.78,	1.278,	8.81,	.73,	15,	.31,	-7.68,
3,	.97,	.131,	8.71,	.62,	16,	.40,	-8.60,
4,	1.03,	-.133,	9.43,	.66,	16,	.43,	-9.50,

Fleet : SNS

Age	1982	1983	1984	1985	1986	1987	1988	1989	1990
1	-.18,	-.33,	-.11,	-.45,	-.09,	-.29,	-.24,	.10,	-.27
2	-.07,	-.40,	-.20,	.06,	-.40,	.17,	.14,	.18,	-.22
3	-.54,	-1.59,	-.38,	-.33,	-.61,	-.48,	.90,	.40,	.28
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								
11	No data for this fleet at this age								
12	No data for this fleet at this age								

Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	.55,	.37,	-.05,	-.07,	-.07,	.15,	99.99,	.52,	.65,	-.19
2	.26,	.46,	.11,	-.18,	-.57,	.42,	99.99,	.45,	.51,	-.69
3	-.13,	.38,	-.42,	-.47,	-.75,	.43,	.23,	1.95,	1.35,	-.22
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									
11	No data for this fleet at this age									
12	No data for this fleet at this age									

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

Age ,	1,	2,	3
Mean Log q,	-2.4270,	-3.5671,	-4.8687,
S.E(Log q),	.3253,	.3651,	.8078,

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,	1.52,	-2.341,	-3.02,	.56,	18,	.44,	-2.43,
2,	.89,	.635,	4.56,	.69,	18,	.33,	-3.57,
3,	.93,	.197,	5.44,	.30,	19,	.77,	-4.87,

1

Table 9.9 (Cont'd) North Sea Plaice. Final XSA output

```
 Terminal year survivor and F summaries :

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

 Year class = 1999

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                  Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 NL Beam Trawl       ,          1.,   .000,      .000,     .00,   0,  .000,     .000
 FLT02: English Beam ,          1.,   .000,      .000,     .00,   0,  .000,     .000
 BTS                 ,     400972.,   .561,      .000,     .00,   1,  .197,     .007
 SNS                 ,     252571.,   .334,      .000,     .00,   1,  .554,     .010

   F shrinkage mean  ,     382863.,    .50,,,,                        .250,     .007

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
    306885.,       .25,      .16,    3,    .652,   .009


1
 Age  2   Catchability constant w.r.t. time and dependent on age

 Year class = 1998

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                  Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 NL Beam Trawl       ,     128912.,   .597,      .000,     .00,   1,  .087,     .112
 FLT02: English Beam ,          1.,   .000,      .000,     .00,   0,  .000,     .000
 BTS                 ,     203595.,   .332,      .418,    1.26,   2,  .281,     .072
 SNS                 ,     176472.,   .250,      .669,    2.68,   2,  .497,     .083

   F shrinkage mean  ,     106970.,    .50,,,,                        .135,     .133

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
    167055.,       .18,      .25,    6,   1.433,   .087


 Age  3   Catchability constant w.r.t. time and dependent on age

 Year class = 1997

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                  Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 NL Beam Trawl       ,      69185.,   .268,      .231,     .86,   2,  .273,     .440
 FLT02: English Beam ,          1.,   .000,      .000,     .00,   0,  .000,     .000
 BTS                 ,     195725.,   .258,      .165,     .64,   3,  .291,     .179
 SNS                 ,     208322.,   .239,      .147,     .61,   3,  .333,     .169

   F shrinkage mean  ,      57558.,    .50,,,,                        .102,     .510

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
    132728.,       .14,      .21,    9,   1.487,   .253


1
 Age  4   Catchability constant w.r.t. time and dependent on age

 Year class = 1996

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                  Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 NL Beam Trawl       ,     176307.,   .202,      .203,    1.01,   3,  .387,     .643
 FLT02: English Beam ,     212574.,   .390,      .000,     .00,   1,  .119,     .558
 BTS                 ,     330435.,   .242,      .181,     .75,   3,  .260,     .393
 SNS                 ,     420308.,   .342,      .345,    1.01,   2,  .111,     .321

   F shrinkage mean  ,     147522.,    .50,,,,                        .123,     .731
```

Table 9.9 (Cont'd) North Sea Plaice. Final XSA output

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
228654.,	.13,	.15,	10,	1.108,	.528

Age 5 Catchability constant w.r.t. time and dependent on age

Year class = 1995

Fleet, ,		Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
NL Beam Trawl	,	22084.,	.187,	.144,	.77,	4,	.418,	.504
FLT02: English Beam	,	26108.,	.247,	.042,	.17,	2,	.290,	.441
BTS	,	32665.,	.273,	.272,	1.00,	3,	.110,	.367
SNS	,	36557.,	.311,	.671,	2.16,	2,	.052,	.333
F shrinkage mean	,	13004.,	.50,,,,				.130,	.748

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
23198.,	.13,	.12,	12,	.893,	.484

Age 6 Catchability constant w.r.t. time and dependent on age

Year class = 1994

Fleet, ,		Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
NL Beam Trawl	,	15254.,	.177,	.075,	.43,	5,	.422,	.465
FLT02: English Beam	,	14538.,	.208,	.110,	.53,	3,	.340,	.483
BTS	,	19988.,	.231,	.213,	.92,	4,	.070,	.373
SNS	,	17140.,	.239,	.164,	.69,	3,	.045,	.423
F shrinkage mean	,	10164.,	.50,,,,				.123,	.635

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
14623.,	.12,	.06,	16,	.509,	.481

Age 7 Catchability constant w.r.t. time and dependent on age

Year class = 1993

Fleet, ,		Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
NL Beam Trawl	,	3954.,	.178,	.114,	.64,	6,	.468,	.415
FLT02: English Beam	,	5541.,	.204,	.051,	.25,	4,	.351,	.313
BTS	,	3622.,	.232,	.161,	.70,	4,	.032,	.446
SNS	,	3376.,	.239,	.225,	.94,	3,	.020,	.472
F shrinkage mean	,	2706.,	.50,,,,				.128,	.561

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
4215.,	.13,	.08,	18,	.593,	.394

Age 8 Catchability constant w.r.t. time and dependent on age

Year class = 1992

Fleet, ,		Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
NL Beam Trawl	,	2253.,	.170,	.051,	.30,	7,	.478,	.365
FLT02: English Beam	,	3085.,	.192,	.122,	.64,	5,	.384,	.279
BTS	,	2218.,	.234,	.172,	.73,	4,	.016,	.370
SNS	,	2095.,	.239,	.143,	.60,	3,	.010,	.388
F shrinkage mean	,	1882.,	.50,,,,				.112,	.424

Table 9.9 (Cont'd) North Sea Plaice. Final XSA output

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
2489.,	.12,	.06,	20,	.475,	.336

Age 9 Catchability constant w.r.t. time and dependent on age

Year class = 1991

Fleet, ,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
NL Beam Trawl ,	2331.,	.164,	.104,	.63,	8,	.472,	.328
FLT02: English Beam ,	3925.,	.182,	.063,	.35,	6,	.402,	.208
BTS ,	3311.,	.229,	.118,	.51,	4,	.012,	.242
SNS ,	3428.,	.239,	.176,	.73,	3,	.008,	.235
F shrinkage mean ,	1959.,	.50,,,,				.105,	.380

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
2844.,	.12,	.08,	22,	.642,	.277

Age 10 Catchability constant w.r.t. time and dependent on age

Year class = 1990

Fleet, ,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
NL Beam Trawl ,	1936.,	.164,	.082,	.50,	8,	.339,	.240
FLT02: English Beam ,	2136.,	.169,	.091,	.54,	7,	.533,	.220
BTS ,	2324.,	.227,	.180,	.79,	4,	.010,	.204
SNS ,	3018.,	.239,	.194,	.81,	3,	.007,	.161
F shrinkage mean ,	1404.,	.50,,,,				.111,	.318

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
1978.,	.12,	.05,	23,	.448,	.236

Age 11 Catchability constant w.r.t. time and age (fixed at the value for age) 10

Year class = 1989

Fleet, ,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
NL Beam Trawl ,	1452.,	.162,	.095,	.58,	8,	.253,	.230
FLT02: English Beam ,	2382.,	.155,	.096,	.62,	8,	.626,	.146
BTS ,	1425.,	.225,	.117,	.52,	4,	.010,	.234
SNS ,	1989.,	.239,	.197,	.83,	3,	.007,	.173
F shrinkage mean ,	1421.,	.50,,,,				.104,	.235

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
1979.,	.12,	.07,	24,	.608,	.174

Age 12 Catchability constant w.r.t. time and age (fixed at the value for age) 10

Year class = 1988

Fleet, ,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
NL Beam Trawl ,	1787.,	.158,	.058,	.37,	8,	.217,	.187
FLT02: English Beam ,	2769.,	.137,	.061,	.45,	9,	.685,	.125
BTS ,	1699.,	.224,	.192,	.86,	4,	.009,	.196
SNS ,	2231.,	.239,	.109,	.46,	3,	.007,	.153
F shrinkage mean ,	1312.,	.50,,,,				.082,	.247

Table 9.9 (Cont'd) North Sea Plaice. Final XSA output

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
2354.,	.11,	.06,	25,	.578,	.145

Age 13 Catchability constant w.r.t. time and age (fixed at the value for age) 10

Year class = 1987

Fleet, ,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
NL Beam Trawl ,	1425.,	.169,	.071,	.42,	8,	.174,	.129
FLT02: English Beam ,	1341.,	.145,	.031,	.22,	9,	.700,	.136
BTS ,	1477.,	.223,	.165,	.74,	4,	.006,	.125
SNS ,	1249.,	.239,	.154,	.65,	3,	.004,	.146
F shrinkage mean ,	809.,	.50,,,,				.116,	.217

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
1278.,	.12,	.04,	25,	.355,	.143

Age 14 Catchability constant w.r.t. time and age (fixed at the value for age) 10

Year class = 1986

Fleet, ,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
NL Beam Trawl ,	1065.,	.170,	.060,	.35,	7,	.158,	.115
FLT02: English Beam ,	894.,	.149,	.095,	.63,	9,	.680,	.135
BTS ,	807.,	.222,	.270,	1.22,	4,	.006,	.149
SNS ,	818.,	.239,	.173,	.73,	3,	.004,	.147
F shrinkage mean ,	600.,	.50,,,,				.152,	.195

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
864.,	.13,	.06,	24,	.472,	.139

1

Table 9.10. North Sea plaice: F derived from final XSA run

Run title : Plaice in IV

At 22/06/2001 17:01

Table 8 Fishing mortality (F) at age

YEAR / AGE	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
1	0	0	0	0	0	0	0	0	0	0.0002
2	0.007	0.007	0.0159	0.0557	0.0113	0.0157	0.023	0.0405	0.0737	0.0633
3	0.106	0.122	0.0804	0.1811	0.2006	0.0862	0.1366	0.1925	0.2458	0.3399
4	0.344	0.284	0.3654	0.327	0.3401	0.3561	0.1898	0.2276	0.2332	0.4825
5	0.344	0.407	0.3498	0.4523	0.3403	0.3692	0.4779	0.2915	0.306	0.3964
6	0.263	0.337	0.4344	0.3794	0.4034	0.3296	0.3521	0.3291	0.3691	0.4942
7	0.279	0.27	0.3221	0.3554	0.2909	0.3574	0.2943	0.2468	0.3032	0.4806
8	0.297	0.247	0.2985	0.2428	0.2944	0.2474	0.2618	0.2695	0.201	0.271
9	0.26	0.231	0.277	0.2534	0.2157	0.3369	0.2151	0.177	0.3246	0.1854
10	0.199	0.208	0.2365	0.2113	0.388	0.2366	0.2338	0.2142	0.2279	0.2839
11	0.241	0.208	0.311	0.2666	0.213	0.2751	0.1982	0.245	0.297	0.1823
12	0.248	0.209	0.2278	0.2406	0.2805	0.2725	0.2031	0.205	0.2776	0.262
13	0.258	0.243	0.2704	0.2265	0.3221	0.3034	0.1945	0.1697	0.2203	0.2567
14	0.242	0.22	0.2652	0.2402	0.2846	0.2856	0.2093	0.2026	0.2701	0.2346
+gp	0.242	0.22	0.2652	0.2402	0.2846	0.2856	0.2093	0.2026	0.2701	0.2346
0 FBAR 2-10	0.233	0.235	0.2645	0.2732	0.2761	0.2594	0.2427	0.221	0.2538	0.333

Table 8 Fishing mortality (F) at age

YEAR / AGE	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
1	1E-04	0.01	0.0025	0.0052	0.0031	0.0092	0.0072	0.0028	0.0031	0.0016
2	0.097	0.167	0.1729	0.051	0.0755	0.1242	0.2304	0.163	0.1711	0.1869
3	0.225	0.271	0.394	0.4543	0.1673	0.2733	0.2083	0.376	0.4843	0.6447
4	0.346	0.365	0.5189	0.4787	0.4426	0.378	0.35	0.3875	0.5045	0.5962
5	0.383	0.378	0.4929	0.5492	0.5267	0.3164	0.5814	0.4331	0.618	0.4618
6	0.361	0.41	0.3628	0.397	0.54	0.3547	0.3186	0.4615	0.6491	0.4384
7	0.416	0.358	0.3461	0.3286	0.3932	0.4165	0.3297	0.314	0.5838	0.4278
8	0.297	0.459	0.3949	0.3932	0.3828	0.3377	0.3774	0.2806	0.3363	0.3651
9	0.43	0.273	0.4449	0.3603	0.4244	0.2963	0.3315	0.2798	0.3564	0.2205
10	0.284	0.387	0.2987	0.5111	0.3387	0.3389	0.2867	0.2649	0.4219	0.253
11	0.296	0.254	0.292	0.3305	0.3953	0.3311	0.3384	0.2459	0.3353	0.2701
12	0.251	0.338	0.2543	0.4533	0.4147	0.329	0.3269	0.231	0.356	0.3275
13	0.249	0.25	0.3079	0.3153	0.5429	0.3864	0.2628	0.2446	0.4106	0.2032
14	0.303	0.301	0.3204	0.3953	0.4246	0.3373	0.31	0.2538	0.3772	0.2554
+gp	0.303	0.301	0.3204	0.3953	0.4246	0.3373	0.31	0.2538	0.3772	0.2554
0 FBAR 2-10	0.316	0.341	0.3807	0.3915	0.3657	0.3151	0.3349	0.3289	0.4584	0.3994

Table 8 Fishing mortality (F) at age

YEAR / AGE	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
1	6E-04	0.003	0.0022	0.0002	0.0002	0.0014	0	0	0.0032	0.0041
2	0.196	0.14	0.1462	0.1332	0.1513	0.1593	0.0827	0.0331	0.1011	0.0967
3	0.558	0.684	0.5123	0.5085	0.4452	0.5139	0.4	0.3293	0.3012	0.2821
4	0.564	0.635	0.7227	0.4219	0.6828	0.5156	0.7021	0.4285	0.5073	0.5225
5	0.537	0.539	0.5339	0.5852	0.4343	0.6807	0.7231	0.6524	0.5461	0.7018
6	0.389	0.458	0.4387	0.4508	0.4536	0.588	0.5853	0.6056	0.5329	0.5209
7	0.391	0.388	0.3789	0.3637	0.3806	0.4771	0.5468	0.5528	0.49	0.3983
8	0.426	0.36	0.3415	0.4209	0.3197	0.4073	0.379	0.4746	0.4583	0.3269
9	0.329	0.393	0.3059	0.3451	0.3305	0.3736	0.31	0.4636	0.3071	0.3471
10	0.23	0.397	0.431	0.3203	0.2989	0.3931	0.3846	0.3733	0.4289	0.2302
11	0.306	0.262	0.3737	0.3067	0.2305	0.3481	0.3166	0.3246	0.325	0.2883
12	0.355	0.296	0.4408	0.3106	0.3926	0.3588	0.2998	0.4642	0.3376	0.2342
13	0.343	0.395	0.3723	0.2594	0.2957	0.5114	0.2649	0.3485	0.3746	0.2312
14	0.314	0.35	0.3859	0.3092	0.3104	0.3982	0.316	0.3961	0.3556	0.2668
+gp	0.314	0.35	0.3859	0.3092	0.3104	0.3982	0.316	0.3961	0.3556	0.2668
0 FBAR 2-10	0.402	0.444	0.4235	0.3944	0.3886	0.4565	0.4571	0.4348	0.4081	0.3807

Table 8 Fishing mortality (F) at age

YEAR / AGE	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	FBAR 98-00
1	0.004	0.009	0.0128	0.0061	0.025	0.0045	0.0012	0.0009	0.0026	0.0085	0.004
2	0.136	0.136	0.1696	0.2055	0.1969	0.1665	0.2154	0.0444	0.0428	0.0874	0.0582
3	0.34	0.38	0.4472	0.4859	0.6063	0.5505	0.5272	0.5572	0.2974	0.2532	0.3693
4	0.559	0.491	0.5691	0.7098	0.7619	0.7439	0.7992	0.6871	0.6476	0.5279	0.6209
5	0.69	0.729	0.6871	0.601	0.7332	0.729	0.8998	0.7291	0.63	0.4845	0.6145
6	0.789	0.699	0.6405	0.5674	0.5519	0.6417	0.691	0.6164	0.6629	0.4807	0.5866
7	0.546	0.705	0.6002	0.7424	0.5184	0.6555	0.5753	0.5207	0.5234	0.394	0.4794
8	0.428	0.471	0.5643	0.5651	0.4257	0.4276	0.4316	0.4133	0.4158	0.3361	0.3884
9	0.383	0.448	0.4272	0.5093	0.366	0.4346	0.3337	0.3414	0.4206	0.2767	0.3462
10	0.37	0.459	0.459	0.4696	0.2613	0.426	0.3383	0.2024	0.3586	0.2358	0.2656
11	0.287	0.389	0.4412	0.3874	0.2834	0.2608	0.2799	0.1956	0.1509	0.1738	0.1734
12	0.364	0.439	0.3902	0.3842	0.2706	0.241	0.288	0.2338	0.2009	0.1453	0.1933
13	0.258	0.562	0.671	0.3979	0.2028	0.2346	0.2658	0.197	0.1817	0.1426	0.1738
14	0.333	0.595	0.4188	0.5563	0.2164	0.2987	0.2899	0.162	0.1615	0.1395	0.1543
+gp	0.333	0.595	0.4188	0.5563	0.2164	0.2987	0.2899	0.162	0.1615	0.1395	
0 FBAR 2-10	0.471	0.502	0.5071	0.5396	0.4913	0.5306	0.5346	0.4569	0.4443	0.3418	

Table 9.11. North Sea plaice: stock numbers at age derived from the final XSA run

Run title : Plaice in IV

At 22/06/2001 18:45

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

AGE \ YEAR	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
1	359381	318800	315181	1021880	309565	305370	277225	245503	327474	370438
2	366751	325182	288462	285187	924635	280106	276311	250843	222141	296308
3	349199	329697	292194	256883	244057	827267	249509	244326	217960	186717
4	245432	284205	264196	243965	193926	180689	686704	196939	182362	154235
5	118250	157482	193637	165880	159170	124877	114517	513945	141918	130684
6	57940	75893	94877	123498	95486	102479	78115	64254	347447	94563
7	63324	40290	49049	55600	76463	57719	66692	49704	41837	217344
8	39905	43334	27838	32160	35261	51721	36531	44959	35137	27953
9	27537	26835	30616	18689	22826	23769	36541	25441	31071	26004
10	20057	19213	19281	20999	13124	16646	15355	26664	19286	20322
11	17761	14871	14124	13772	15382	8056	11889	10998	19474	13894
12	13828	12626	10926	9364	9545	11248	5536	8824	7789	13093
13	8072	9766	9269	7873	6661	6524	7750	4089	6504	5339
14	6587	5646	6933	6400	5679	4367	4358	5773	3122	4721
+gp	7904	7359	15288	25995	23116	19163	16900	17341	17147	14547
0 TOTAL	1701929	1671197	1631869	2288142	2134898	2020001	1883932	1709603	1620669	1576164

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

AGE \ YEAR	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
1	275478	234584	541889	451919	335732	324585	471354	430024	443809	659903
2	335114	249244	210136	489115	406799	302850	291014	423436	388015	400321
3	251660	275076	190779	159954	420577	341334	242028	209130	325517	295890
4	120270	181784	189734	116407	91893	321937	234990	177818	129926	181474
5	86144	76982	114159	102176	65259	53411	199604	149834	109206	70988
6	79546	53158	47737	63101	53381	34870	35221	100986	87917	53263
7	52201	50190	31930	30051	38390	28147	22130	23173	57598	41566
8	121623	31145	31735	20440	19577	23442	16793	14401	15318	29070
9	19290	81769	17810	19347	12482	12080	15132	10418	9842	9902
10	19549	11353	56309	10328	12210	7389	8127	9829	7125	6235
11	13843	13311	6975	37796	5606	7874	4764	5521	6824	4228
12	10477	9314	9342	4713	24574	3416	5116	3073	3906	4416
13	9116	7375	6013	6555	2710	14688	2224	3339	2207	2476
14	3737	6432	5196	3999	4327	1425	9030	1548	2366	1324
+gp	15559	14757	13774	10807	12647	9678	7183	11811	8599	5624
0 TOTAL	1413606	1296473	1473518	1526709	1506165	1487125	1564711	1574340	1598173	1766680

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

AGE \ YEAR	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
1	424238	1025826	590479	608707	529685	1247920	540636	564989	411573	397584
2	596174	383626	925034	533133	550678	479164	1127572	489188	511224	371207
3	300487	443435	301673	723148	422231	428309	369714	939298	428228	418098
4	140514	155560	202423	163542	393496	244773	231818	224235	611463	286714
5	90462	72347	74604	88916	97041	179879	132254	103944	132187	333147
6	40476	47852	38205	39578	44814	56872	82403	58068	48983	69279
7	31089	24816	27388	22293	22817	25764	28584	41527	28675	26013
8	24521	19033	15236	16966	14022	14110	14466	14971	21619	15895
9	18258	14490	12019	9797	10078	9215	8496	8960	8427	12369
10	7187	11885	8848	8009	6278	6553	5739	5638	5100	5609
11	4380	5165	7228	5202	5261	4212	4002	3535	3512	3005
12	2920	2920	3595	4501	3464	3780	2691	2638	2312	2296
13	2880	1853	1965	2093	2985	2117	2389	1804	1501	1492
14	1828	1849	1130	1225	1461	2010	1148	1659	1152	934
+gp	5086	7125	3442	4973	4151	3915	4696	5371	5451	4647
0 TOTAL	1690501	2217782	2213269	2232084	2108463	2708594	2556609	2465826	2221407	1948290

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

AGE \ YEAR	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	AMST 57-98	
1	402941	405305	285978	239231	330003	258095	814830	241100	223262	342057	0*	411518	450098
2	358275	363206	363491	255471	215140	291226	232484	736440	217970	201494	306885	369564	405326
3	304936	283025	286832	277583	188214	159875	223088	169595	637440	188962	167055	296412	324501
4	285312	196392	175123	165959	154506	92875	83419	119151	87897	428415	132728	194218	215289
5	153846	147671	108744	89697	73843	65255	39938	33941	54231	41619	228654	112119	127786
6	149424	69803	64461	49498	44499	32097	28482	14696	14813	26134	23198	63038	72880
7	37234	61430	31384	30740	25394	23187	15288	12913	7179	6908	14623	37935	43805
8	15805	19508	27478	15582	13239	13682	10892	7781	6941	3849	4215	23809	27744
9	10372	9323	11022	14141	8012	7826	8073	6401	4657	4144	2489	15836	18852
10	7910	6397	5392	6506	7689	5028	4586	5232	4117	2767	2844	10872	13315
11	4032	4945	3657	3083	3681	5357	2971	2958	3866	2603	1978	7410	9338
12	2038	2739	3033	2129	1894	2508	3734	2032	2201	3008	1979	5180	6557
13	1644	1281	1598	1857	1312	1307	1784	2533	1455	1629	2354	3540	4504
14	1072	1149	661	739	1129	969	936	1237	1882	1098	1278	2417	3147
+gp	3966	2876	2644	1584	1843	4279	3040	4891	3660	3442	3574		
0 TOTAL	1738805	1575049	1371497	1153800	1070397	963566	1473545	1360903	1271572	1258130	893853		

* replaced by GM = 411518

Table 9.12. North Sea plaice: summary table derived from the final XSA run

Run title : Plaice in IV

At 22/06/2001 17:01

Table 16 Summary (without SOP correction)

Terminal Fs derived using XSA (With F shrinkage)

	RECRUITS Age 1	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	FBAR 2-10
1957	296164	457372	354624	70563	0.199	0.1973
1958	429984	443678	340636	73354	0.2153	0.2118
1959	433436	457566	345187	79300	0.2297	0.2266
1960	405323	497694	368311	87541	0.2377	0.2469
1961	359381	461925	352877	85984	0.2437	0.2331
1962	318800	564457	446570	87472	0.1959	0.2345
1963	315181	547156	439975	107118	0.2435	0.2645
1964	1021880	624822	422933	110540	0.2614	0.2732
1965	309565	580484	414353	97143	0.2344	0.2761
1966	305370	587966	416386	101834	0.2446	0.2594
1967	277225	590830	493006	108819	0.2207	0.2427
1968	245503	548174	456101	111534	0.2445	0.221
1969	327474	526249	418277	121651	0.2908	0.2538
1970	370438	525804	399572	130342	0.3262	0.333
1971	275478	500493	372352	113944	0.306	0.3156
1972	234584	495151	375802	122843	0.3269	0.341
1973	541889	488008	334724	130429	0.3897	0.3807
1974	451919	467188	308823	112540	0.3644	0.3915
1975	335732	494875	320041	108536	0.3391	0.3657
1976	324585	450517	314520	113670	0.3614	0.3151
1977	471354	478419	329233	119188	0.362	0.3349
1978	430024	473495	322622	113984	0.3533	0.3289
1979	443809	472395	309364	145347	0.4698	0.4584
1980	659903	485291	295050	139951	0.4743	0.3994
1981	424238	485731	305205	139747	0.4579	0.4023
1982	1025826	556624	297576	154547	0.5194	0.4438
1983	590479	544476	320905	144038	0.4488	0.4235
1984	608707	554425	321505	156147	0.4857	0.3944
1985	529685	541704	353680	159838	0.4519	0.3886
1986	1247920	642261	354173	165347	0.4669	0.4565
1987	540636	622338	382881	153670	0.4014	0.4571
1988	564989	612780	364401	154475	0.4239	0.4348
1989	411573	574228	404435	169818	0.4199	0.4081
1990	397584	539234	377262	156240	0.4141	0.3807
1991	402941	449930	319786	148004	0.4628	0.4712
1992	405305	422434	284117	125190	0.4406	0.502
1993	285978	373740	251706	117113	0.4653	0.5071
1994	239231	306809	212554	110392	0.5194	0.5396
1995	330003	283146	190933	98356	0.5151	0.4913
1996	258095	261116	170895	81673	0.4779	0.5306
1997	814830	304314	149718	83048	0.5547	0.5346
1998	241100	327536	199344	71534	0.3588	0.4569
1999	223262	322595	191916	80662	0.4203	0.4443
2000	342057	309310	222030	83058	0.3741	0.3418
2001	411519*		237000**			
Arith. Mean	442487	483062	332417	116966	0.3685	0.3662
0 Units	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)		

* equated to GM(57-98)
** predicted using average stock weights

Table 9.13. North Sea plaice: inputs to RCT3.

Plaice North Sea - 1-Y-Rcr.

9	34	34	34	2								
'yc'	'VPA-1'	'VPA-2'	'VPA-3	'SNS-0'	'SNS-1'	'SNS-2'	'SNS-3	'BTS-1'	'BTS-2'	'BTS-3	'com-0	'com-1
1967	246	222	187	-11	-11	-11	2813	-11	-11	-11	-11	-11
1968	327	296	252	-11	-11	9450	1008	-11	-11	-11	-11	-11
1969	370	335	275	-11	8032	23848	4484	-11	-11	-11	-11	-11
1970	275	249	191	3678	18101	9584	1631	-11	-11	-11	-11	-11
1971	235	210	160	6708	6437	4191	1261	-11	-11	-11	-11	-11
1972	542	489	421	9242	57238	17985	10744	-11	-11	-11	-11	-11
1973	452	407	341	5451	15648	9171	791	-11	-11	-11	-11	-11
1974	336	303	242	2193	9781	2274	1720	-11	-11	-11	112.6	84.8
1975	325	291	209	1151	9037	2900	435	-11	-11	-11	71.9	81.5
1976	471	423	326	11544	19119	12714	1577	-11	-11	-11	243.0	159.0
1977	430	388	296	4378	13924	9540	456	-11	-11	-11	171.7	83.5
1978	444	400	300	3252	21681	12084	785	-11	-11	-11	223.9	176.3
1979	660	596	443	27835	58049	16106	1146	-11	-11	-11	366.9	252.1
1980	424	384	302	4039	19611	8503	308	-11	-11	-11	167.1	154.3
1981	1026	925	723	31542	70108	14708	2480	-11	-11	-11	615.3	285.3
1982	590	533	422	23987	34884	10413	1584	-11	-11	38.8	460.1	160.8
1983	609	551	428	36722	44667	13788	1155	-11	180.0	50.9	475.4	115.7
1984	530	479	370	7958	27832	7557	1232	130.0	131.8	33.1	259.0	106.0
1985	1248	1128	939	47385	93573	33021	13140	660.2	765.0	173.2	719.1	267.6
1986	541	489	428	8818	33426	14429	3709	225.1	139.9	38.6	357.7	190.3
1987	565	511	418	21270	36672	14952	3248	605.1	332.6	57.7	471.7	105.5
1988	412	371	305	15598	37238	7287	1507	426.6	99.8	28.5	347.0	131.5
1989	398	358	283	24198	24903	11148	2257	107.0	122.1	27.3	462.0	126.6
1990	403	363	287	9559	57349	13742	988	184.4	125.7	38.8	450.8	153.9
1991	405	363	278	17120	48223	9484	884	172.8	181.0	37.4	496.5	130.5
1992	286	255	188	5398	22184	4866	415	122.6	65.7	14.2	365.1	75.3
1993	239	215	160	9226	18225	2786	1189	141.7	43.6	22.8	267.9	30.1
1994	330	291	223	27901	24900	10377	1393	249.4	206.8	19.9	461.3	34.8
1995	258	232	170	13029	24663	-11	5739	215.8	-11	47.3	182.4	117.7
1996	815	736	637	91713	-11	29431	14347	-11	433.1	181.8	548.2	157.8
1997	-11	-11	-11	15363	33391	9235	905	337.0	133.1	32	160.7	-11
1998	-11	-11	-11	22720	35188	2489	-11	298.9	73	-11	-11	-11
1999	-11	-11	-11	39201	23028	-11	-11	276	-11	-11	-11	15.8
2000	-11	-11	-11	24185	-11	-11	-11	-11	-11	-11	178.5	-11

Table 9.14 North Sea plaice: outputs of RCT3 (age 1)

Analysis by RCT3 ver3.1 of data from file :

rct1.csv

Plaice North Sea - 1-Y-Rcr.,,,,,,,,,,

Data for 9 surveys over 34 years : 1967 - 2000

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 = 1997

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression----------I					I-----------Prediction---------I			
SNS-0	.67	-.11	.55	.373	27	9.64	6.34	.579	.062
SNS-1	.81	-2.12	.39	.518	27	10.42	6.29	.415	.121
SNS-2	.84	-1.63	.39	.524	28	9.13	6.04	.408	.125
SNS-3	1.02	-1.53	.92	.170	30	6.81	5.44	.977	.022
BTS-1	1.15	-.20	.57	.397	12	5.82	6.52	.664	.047
BTS-2	.65	2.83	.24	.786	13	4.90	6.03	.270	.285
BTS-3	.78	3.20	.32	.672	15	3.50	5.94	.355	.165
com-0	1.24	-.99	.59	.340	23	5.09	5.31	.645	.050
com-1									
						VPA Mean =	6.07	.411	.123

Yearclass = 1998

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression----------I					I-----------Prediction---------I			
SNS-0	.67	-.11	.55	.373	27	10.03	6.60	.584	.084
SNS-1	.81	-2.12	.39	.518	27	10.47	6.34	.415	.167
SNS-2	.84	-1.63	.39	.524	28	7.82	4.94	.439	.149
SNS-3									
BTS-1	1.15	-.20	.57	.397	12	5.70	6.38	.658	.066
BTS-2	.65	2.83	.24	.786	13	4.30	5.64	.281	.364
BTS-3									
com-0									
com-1									
						VPA Mean =	6.07	.411	.170

Yearclass = 1999

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression----------I					I-----------Prediction---------I			
SNS-0	.67	-.11	.55	.373	27	10.58	6.96	.595	.135
SNS-1	.81	-2.12	.39	.518	27	10.04	5.99	.414	.280
SNS-2									
SNS-3									
BTS-1	1.15	-.20	.57	.397	12	5.62	6.29	.655	.112
BTS-2									
BTS-3									
com-0									
com-1	1.00	1.32	.38	.555	23	2.82	4.15	.504	.189
						VPA Mean =	6.07	.411	.284

Table 9.14 (Continued)

Yearclass = 2000

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression----------I					I-----------Prediction---------I			
SNS-0	.67	-.11	.55	.373	27	10.09	6.64	.585	.259
SNS-1									
SNS-2									
SNS-3									
BTS-1									
BTS-2									
BTS-3									
com-0	1.24	-.99	.59	.340	23	5.19	5.44	.640	.216
com-1									
VPA Mean =							6.07	.411	.525

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
1997	423	6.05	.14	.09	.36		
1998	349	5.86	.17	.22	1.75		
1999	341	5.83	.22	.43	3.92		
2000	438	6.08	.30	.29	.95	1	.00

Table 9.15 North Sea plaice: outputs from RCT3 (age 2)

Analysis by RCT3 ver3.1 of data from file :

rct2.csv

Plaice North Sea - 2-Y-Rcr.,,,,,,,,,,

Data for 9 surveys over 34 years : 1967 - 2000

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 = 1997

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression	-----------	----------	----------I	I-----------	Prediction	----------	----------	---------I
SNS-0	.68	-.28	.55	.369	27	9.64	6.23	.588	.062
SNS-1	.81	-2.29	.39	.515	27	10.42	6.19	.419	.122
SNS-2	.84	-1.77	.39	.525	28	9.13	5.94	.409	.128
SNS-3	1.03	-1.65	.92	.171	30	6.81	5.34	.978	.022
BTS-1	1.17	-.37	.58	.395	12	5.82	6.41	.671	.048
BTS-2	.66	2.67	.25	.778	13	4.90	5.92	.279	.274
BTS-3	.79	3.08	.32	.674	15	3.50	5.84	.356	.169
com-0	1.26	-1.19	.60	.335	23	5.09	5.20	.656	.050
com-1									
					VPA Mean =		5.97	.413	.126

Yearclass = 1998

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression	-----------	----------	----------I	I-----------	Prediction	----------	----------	---------I
SNS-0	.68	-.28	.55	.369	27	10.03	6.50	.592	.085
SNS-1	.81	-2.29	.39	.515	27	10.47	6.23	.419	.169
SNS-2	.84	-1.77	.39	.525	28	7.82	4.83	.441	.153
SNS-3									
BTS-1	1.17	-.37	.58	.395	12	5.70	6.27	.665	.067
BTS-2	.66	2.67	.25	.778	13	4.30	5.53	.290	.352
BTS-3									
com-0									
com-1									
					VPA Mean =		5.97	.413	.174

Yearclass = 1999

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression	-----------	----------	----------I	I-----------	Prediction	----------	----------	---------I
SNS-0	.68	-.28	.55	.369	27	10.58	6.87	.604	.133
SNS-1	.81	-2.29	.39	.515	27	10.04	5.89	.418	.278
SNS-2									
SNS-3									
BTS-1	1.17	-.37	.58	.395	12	5.62	6.18	.662	.111
BTS-2									
BTS-3									
com-0									
com-1	1.01	1.20	.38	.560	23	2.82	4.04	.503	.192
					VPA Mean =		5.97	.413	.285

Table 9.15 (Continued)

Yearclass = 2000

Survey/ Series	Slope	Intercept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression----------I					I-----------Prediction---------I			
SNS-0	.68	-.28	.55	.369	27	10.09	6.54	.593	.257
SNS-1									
SNS-2									
SNS-3									
BTS-1									
BTS-2									
BTS-3									
com-0	1.26	-1.19	.60	.335	23	5.19	5.33	.650	.213
com-1									
					VPA Mean =		5.97	.413	.530

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
1997	380	5.94	.15	.09	.36		
1998	314	5.75	.17	.23	1.75		
1999	304	5.72	.22	.44	3.94		
2000	394	5.98	.30	.29	.95		

Table 9.16. North Sea plaice: outputs from RCT3 (age 3)

Analysis by RCT3 ver3.1 of data from file :

rct3.csv

Plaice North Sea - 3-Y-Rcr.,,,,,,,,,,

Data for 9 surveys over 34 years : 1967 - 2000

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 = 1997

Survey/ Series	Regression: Slope	Inter- cept	Std Error	Rsquare	No. Pts	Prediction: Index Value	Predicted Value	Std Error	WAP Weights
SNS-0	.72	-.95	.59	.371	27	9.64	6.01	.626	.062
SNS-1	.87	-3.14	.43	.503	27	10.42	5.96	.455	.118
SNS-2	.86	-2.18	.38	.562	28	9.13	5.70	.402	.151
SNS-3	.96	-1.42	.84	.215	30	6.81	5.14	.895	.030
BTS-1	1.25	-1.08	.61	.408	12	5.82	6.21	.714	.048
BTS-2	.73	2.12	.28	.768	13	4.90	5.68	.313	.249
BTS-3	.86	2.57	.35	.672	15	3.50	5.58	.391	.160
com-0	1.31	-1.76	.61	.353	23	5.09	4.91	.676	.053
com-1									
						VPA Mean =	5.73	.434	.129

Yearclass = 1998

Survey/ Series	Regression: Slope	Inter- cept	Std Error	Rsquare	No. Pts	Prediction: Index Value	Predicted Value	Std Error	WAP Weights
SNS-0	.72	-.95	.59	.371	27	10.03	6.29	.631	.085
SNS-1	.87	-3.14	.43	.503	27	10.47	6.01	.456	.164
SNS-2	.86	-2.18	.38	.562	28	7.82	4.57	.433	.181
SNS-3									
BTS-1	1.25	-1.08	.61	.408	12	5.70	6.06	.707	.068
BTS-2	.73	2.12	.28	.768	13	4.30	5.25	.325	.322
BTS-3									
com-0									
com-1									
						VPA Mean =	5.73	.434	.180

Yearclass = 1999

Survey/ Series	Regression: Slope	Inter- cept	Std Error	Rsquare	No. Pts	Prediction: Index Value	Predicted Value	Std Error	WAP Weights
SNS-0	.72	-.95	.59	.371	27	10.58	6.68	.643	.135
SNS-1	.87	-3.14	.43	.503	27	10.04	5.64	.454	.271
SNS-2									
SNS-3									
BTS-1	1.25	-1.08	.61	.408	12	5.62	5.96	.704	.113
BTS-2									
BTS-3									
com-0									
com-1	1.09	.56	.41	.549	23	2.82	3.63	.551	.184
						VPA Mean =	5.73	.434	.296

Table 9.16 (Continued)

Yearclass = 2000

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression----------I					I-----------Prediction---------I			
SNS-0	.72	-.95	.59	.371	27	10.09	6.34	.632	.250
SNS-1									
SNS-2									
SNS-3									
BTS-1									
BTS-2									
BTS-3									
com-0	1.31	-1.76	.61	.353	23	5.19	5.05	.671	.222
com-1									
					VPA Mean =		5.73	.434	.529

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
1997	298	5.70	.16	.09	.37		
1998	240	5.48	.18	.25	1.78		
1999	238	5.47	.24	.47	3.92		
2000	308	5.73	.32	.31	.97		

Table 9.17. Plaice,North Sea

input data for catch forecast and linear sensitivity analysis

Label	Value	CV	Label	Value	CV
Number at age			Weight in the stock		
N1	411518	0.40	WS1	0.12	0.00
N2	306884	0.25	WS2	0.21	0.05
N3	167054	0.25	WS3	0.25	0.07
N4	132728	0.21	WS4	0.33	0.11
N5	228653	0.15	WS5	0.44	0.07
N6	23198	0.13	WS6	0.52	0.11
N7	14623	0.12	WS7	0.62	0.09
N8	4214	0.13	WS8	0.69	0.06
N9	2488	0.12	WS9	0.69	0.02
N10	2843	0.12	WS10	0.74	0.16
N11	1977	0.12	WS11	0.88	0.14
N12	1978	0.12	WS12	0.91	0.19
N13	2353	0.11	WS13	0.93	0.24
N14	1278	0.12	WS14	1.03	0.17
N15	3573	0.13	WS15	1.00	0.15
Fishing Mortality			Weight in the HC catch		
F1	0.00	1.12	WH1	0.21	0.24
F2	0.05	0.61	WH2	0.26	0.03
F3	0.31	0.34	WH3	0.29	0.06
F4	0.51	0.03	WH4	0.35	0.11
F5	0.51	0.07	WH5	0.46	0.07
F6	0.48	0.05	WH6	0.55	0.10
F7	0.40	0.02	WH7	0.65	0.05
F8	0.32	0.04	WH8	0.70	0.02
F9	0.29	0.12	WH9	0.73	0.04
F10	0.22	0.29	WH10	0.75	0.16
F11	0.14	0.20	WH11	0.86	0.13
F12	0.16	0.10	WH12	0.92	0.18
F13	0.14	0.03	WH13	0.92	0.10
F14	0.13	0.08	WH14	0.95	0.05
F15	0.13	0.08	WH15	1.04	0.08
Natural mortality			Proportion mature		
M1	0.10	0.10	MT1	0.00	0.10
M2	0.10	0.10	MT2	0.50	0.10
M3	0.10	0.10	MT3	0.50	0.10
M4	0.10	0.10	MT4	1.00	0.10
M5	0.10	0.10	MT5	1.00	0.00
M6	0.10	0.10	MT6	1.00	0.00
M7	0.10	0.10	MT7	1.00	0.00
M8	0.10	0.10	MT8	1.00	0.00
M9	0.10	0.10	MT9	1.00	0.00
M10	0.10	0.10	MT10	1.00	0.00
M11	0.10	0.10	MT11	1.00	0.00
M12	0.10	0.10	MT12	1.00	0.00
M13	0.10	0.10	MT13	1.00	0.00
M14	0.10	0.10	MT14	1.00	0.00
M15	0.10	0.10	MT15	1.00	0.00
Relative effort in HC fishery			Year effect for natural mortality		
HF01	1.00	0.15	K01	1.00	0.10
HF02	1.00	0.15	K02	1.00	0.10
HF03	1.00	0.15	K03	1.00	0.10
Recruitment in 2002 and 2003					
R02	411519	0.40			
R03	411519	0.40			

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

Stock numbers in 2001 are VPA survivors.

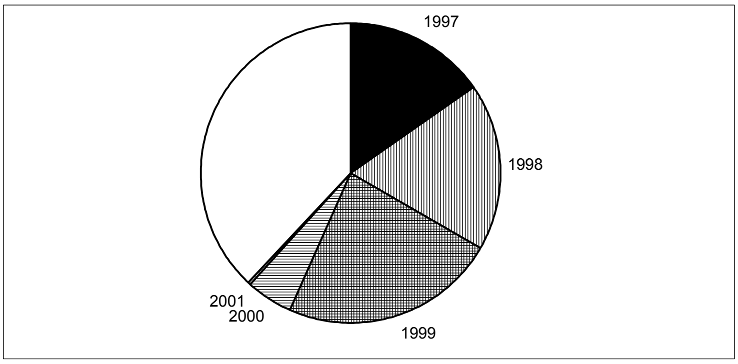
Table 9.18 Plaice (IV)
Stock numbers of recruits and their source for recent year classes used in predictions, and the relative (%) contributions to landings and SSB (by weight) of these year classes

Year-class			1997	1998	1999	2000	2001
Stock No. (thousands) of 1 year-olds			241100	223262	342057	411518	411518
Source			VPA	VPA	VPA	GM	GM
Status Quo F:							
% in	2001	landings	21.1	14.4	4.2	0.3	-
% in	2002		15.2	18.1	23.3	5.2	0.3
% in	2001	SSB	42.6	18.6	8.8	13.7	-
% in	2002	SSB	13.6	15.8	14.2	16.7	0.0
% in	2003	SSB	8.2	10.8	23.4	16.1	15.8

GM : geometric mean recruitment

Plaice (IV) : Year-class % contribution to

a) 2002 landings



b) 2003 SSB

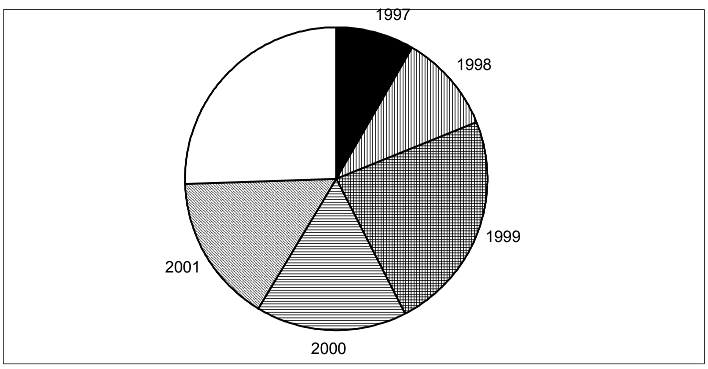


Table 9.19. Plaice, North Sea

Catch forecast output and estimates of coefficient of variation (CV) from linear analysis.

	Year 2001	Year 2002						
Mean F Ages								
H.cons 2 to10	0.34	0.00	0.07	0.14	0.21	0.27	0.34	0.41
Effort relative to 2000								
H.cons	1.00	0.00	0.20	0.40	0.60	0.80	1.00	1.20
Biomass								
Total 1 January	342	358	358	358	358	358	358	358
SSB at spawning time	237	235	235	235	235	235	235	235
Catch weight (,000t)								
H.cons	84.6	0.0	19.4	37.3	53.7	68.9	83.0	95.9
Biomass in year.... 2003								
Total 1 January		470	449	429	412	395	380	366
SSB at spawning time		337	316	297	280	264	249	236

	Year 2001	Year 2002						
Effort relative to 2000								
H.cons	1.00	0.00	0.20	0.40	0.60	0.80	1.00	1.20
Est. Coeff. of Variation								
Biomass								
Total 1 January	0.10	0.13	0.13	0.13	0.13	0.13	0.13	0.13
SSB at spawning time	0.10	0.12	0.12	0.12	0.12	0.12	0.12	0.12
Catch weight								
H.cons	0.17	0.00	0.73	0.37	0.26	0.20	0.18	0.16
Biomass in year.... 2003								
Total 1 January		0.13	0.14	0.14	0.14	0.15	0.15	0.15
SSB at spawning time		0.12	0.13	0.13	0.14	0.14	0.14	0.15

Table 9.20.Plaice,North Sea
Detailed forecast tables.

Forecast for year 2001
F multiplier H.cons=1.00

Age	Populations Stock No.	Catch number H.Cons	Catch number Total
1	411518	1173	1173
2	306884	13692	13692
3	167054	41896	41896
4	132728	50827	50827
5	228653	86901	86901
6	23198	8504	8504
7	14623	4556	4556
8	4214	1101	1101
9	2488	590	590
10	2843	533	533
11	1977	251	251
12	1978	277	277
13	2353	299	299
14	1278	145	145
15	3573	406	406
Wt	342	85	85

Forecast for year 2002
F multiplier H.cons=1.00

Age	Populations Stock No.	Catch number H.Cons	Catch number Total
1	411519	1173	1173
2	371241	16564	16564
3	264666	66377	66377
4	111421	42668	42668
5	71974	27354	27354
6	124612	45682	45682
7	12937	4030	4030
8	8914	2329	2329
9	2769	657	657
10	1691	317	317
11	2067	262	262
12	1551	217	217
13	1527	194	194
14	1845	210	210
15	3866	439	439
Wt	358	83	83

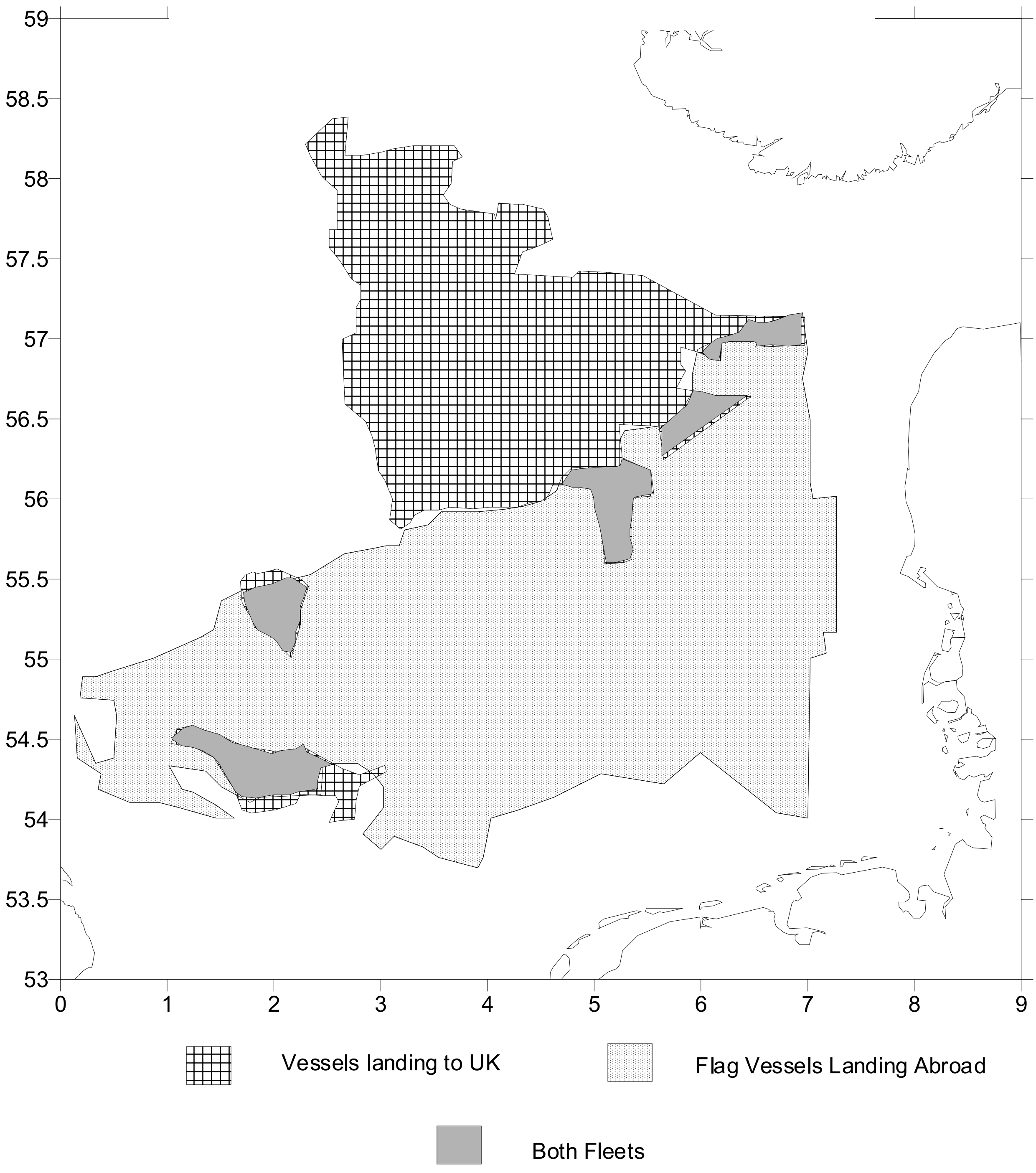


Figure 9.1 North Sea Plaice. Distribution of fishing activity of English vessels landing into the UK and 'flag' vessels landing abroad.

Figure 9.2. North Sea plaice. Age distribution (%) of international discards of plaice, as estimated from a selection of fleets and countries fishing in the North Sea in 2000

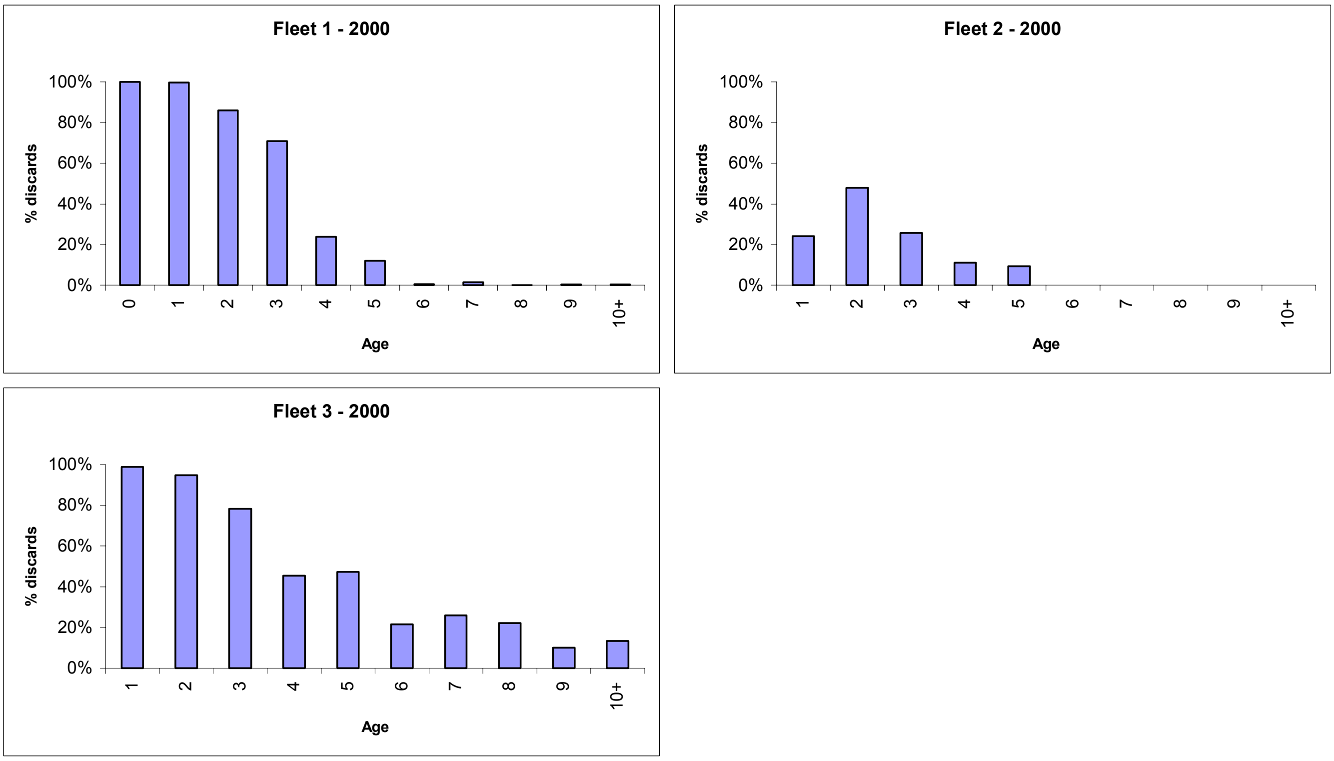
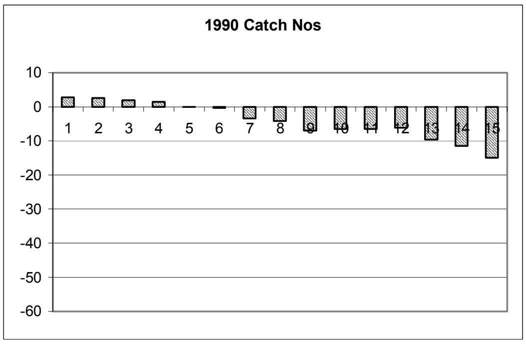
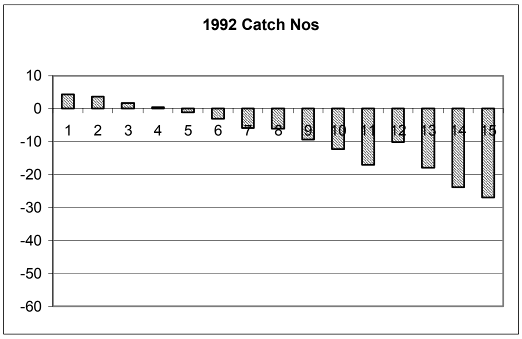
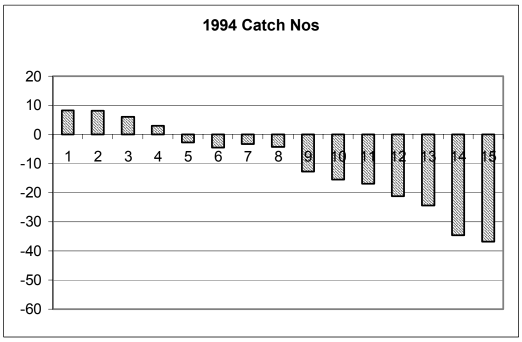
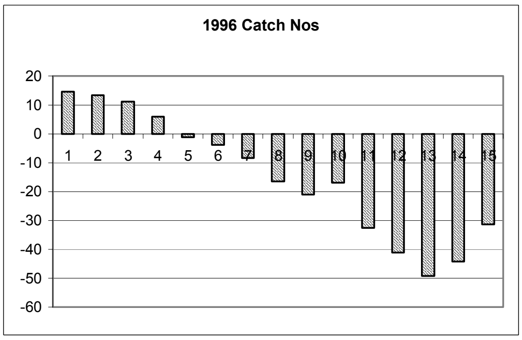


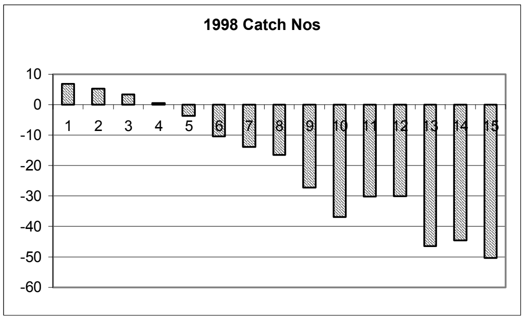
Figure 9.3. North Sea plaice. % difference between catch nos at age calculated with raising procedure 1 relative to raising procedure 0.











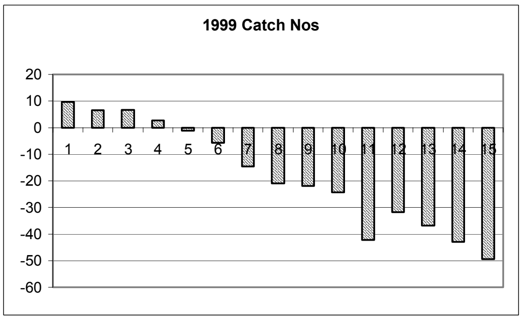
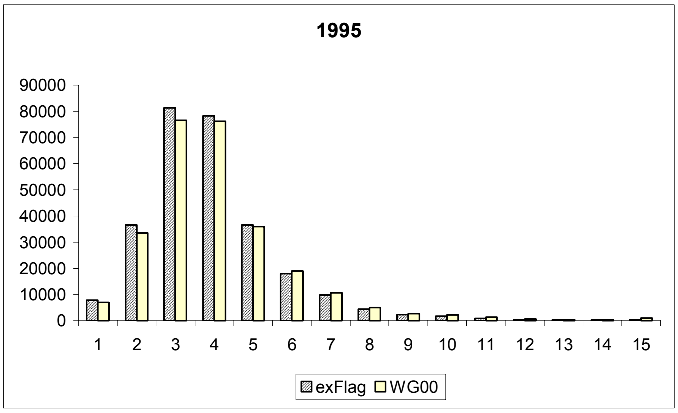
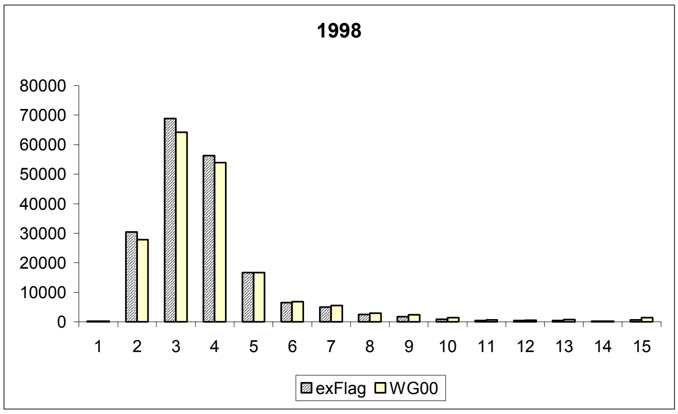
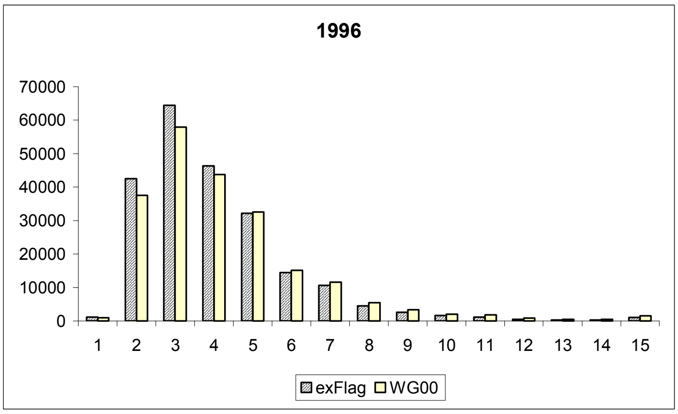
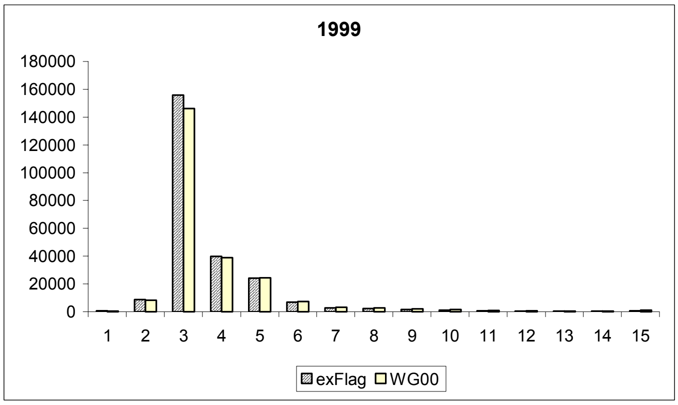


Figure 9.4. North Sea plaice. Comparison between catch numbers from WG00 and English landings excluding Flag vessels









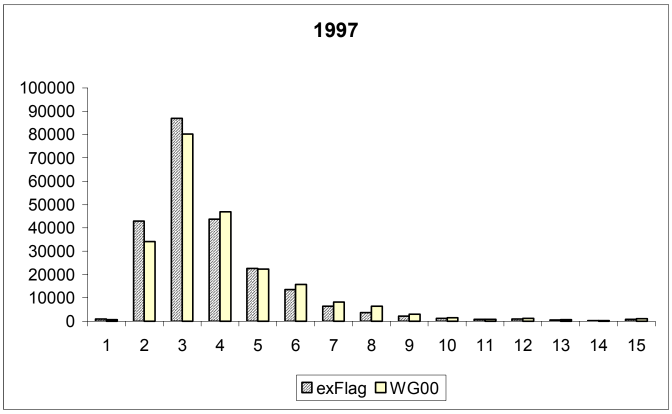


Figure 9.5. North Sea plaice mean weights in the catch

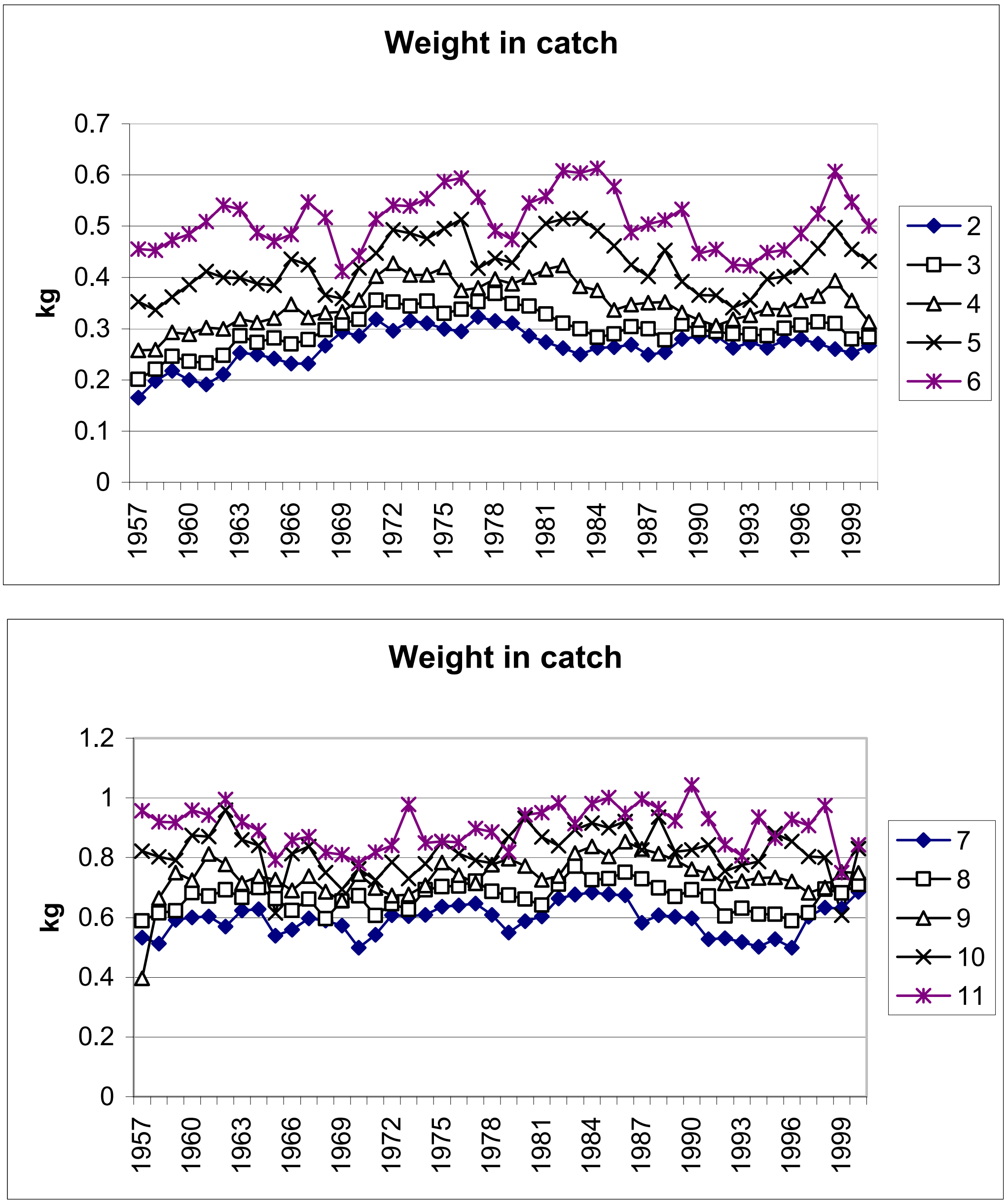
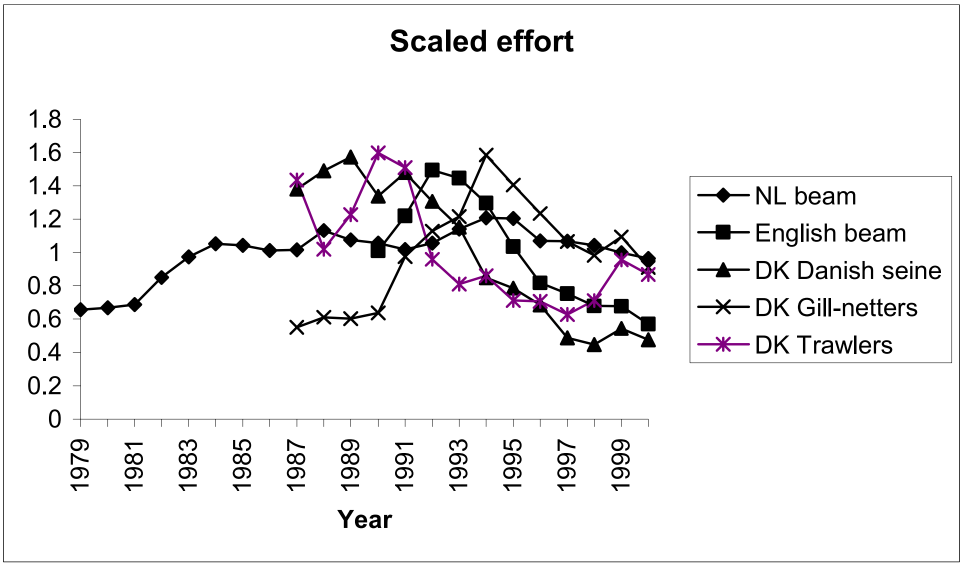


Figure 9.6. North Sea plaice: relative effort and CPUE (scaled to the average for each fleet)



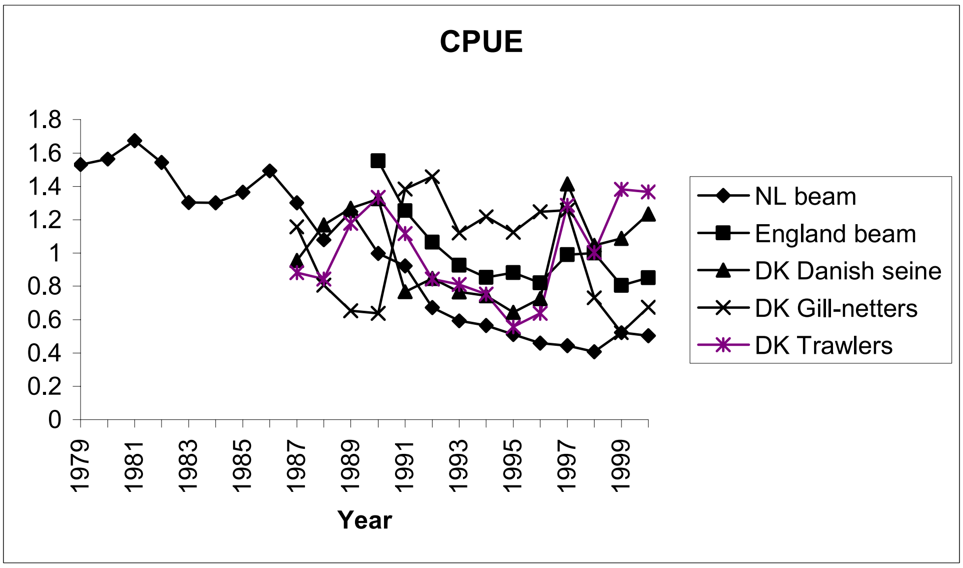


Figure 9.7. North Sea plaice. CPUE at age of the tuning fleets.

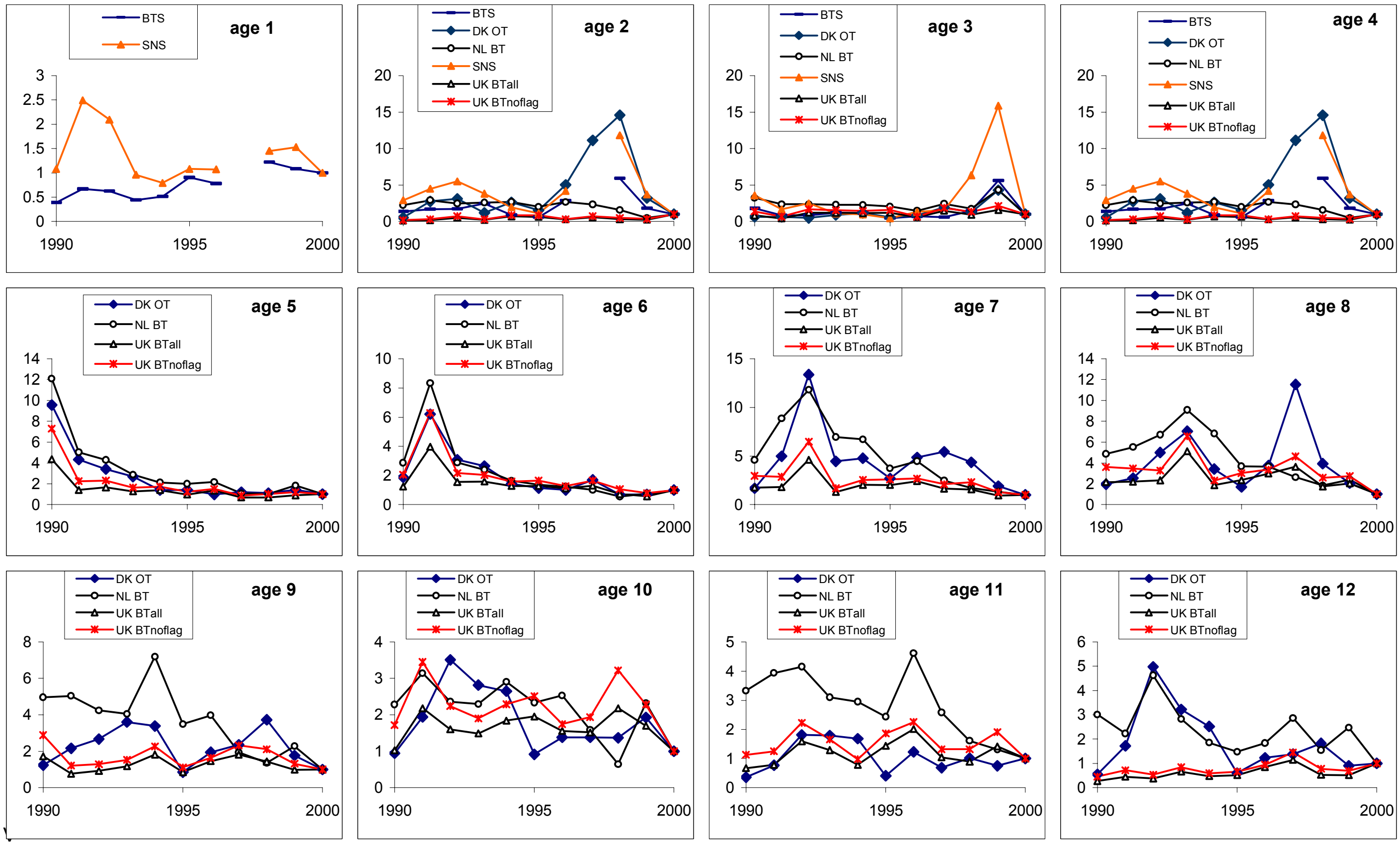


Figure 9.8. North Sea plaice. Log-catchability residuals derived from single-fleet XSA, shrinkage=1.5

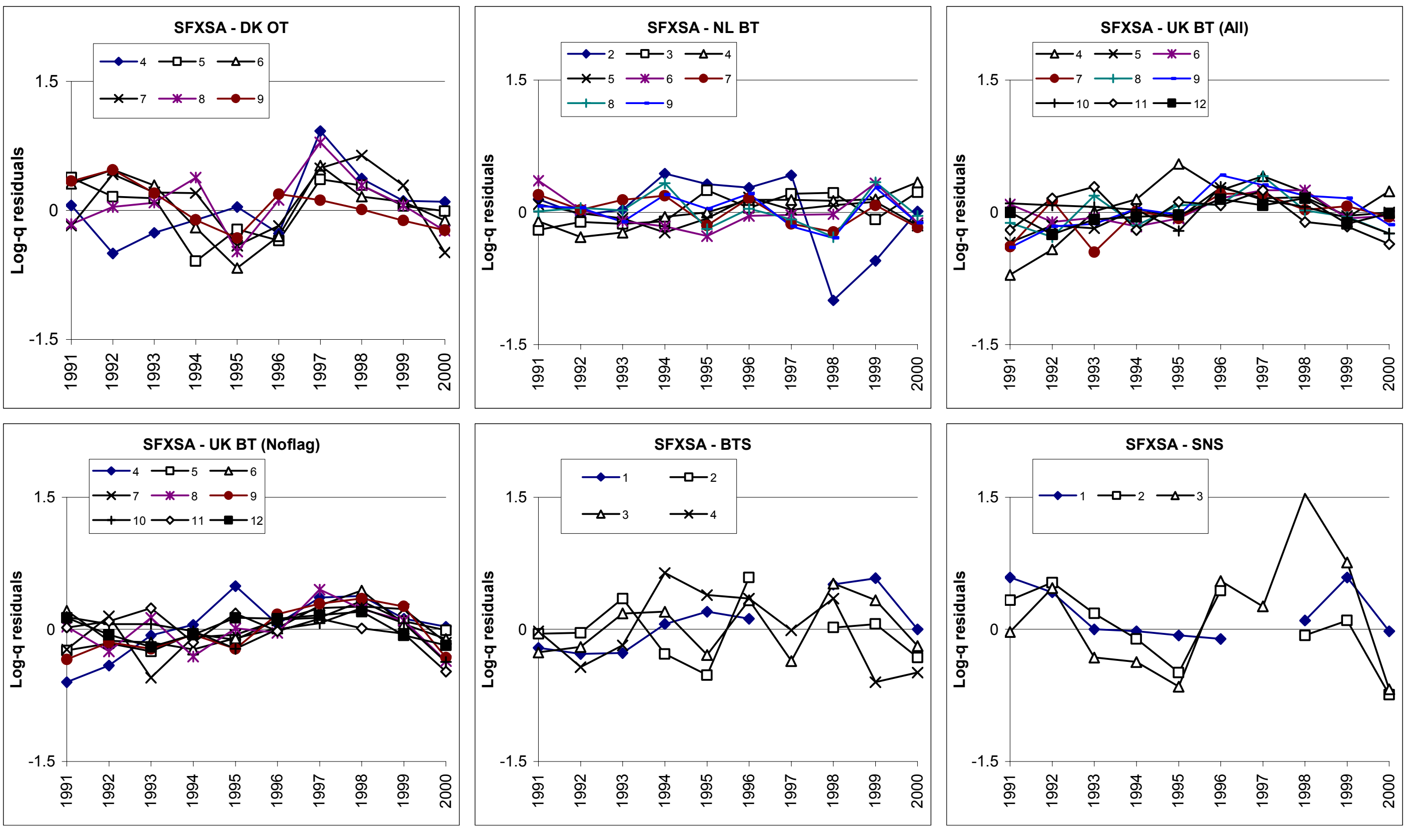


Figure 9.9. North Sea plaice. Recruitment, SSB and F trajectories estimated by the different exploration runs. Runs 10 and 11 are not represented.

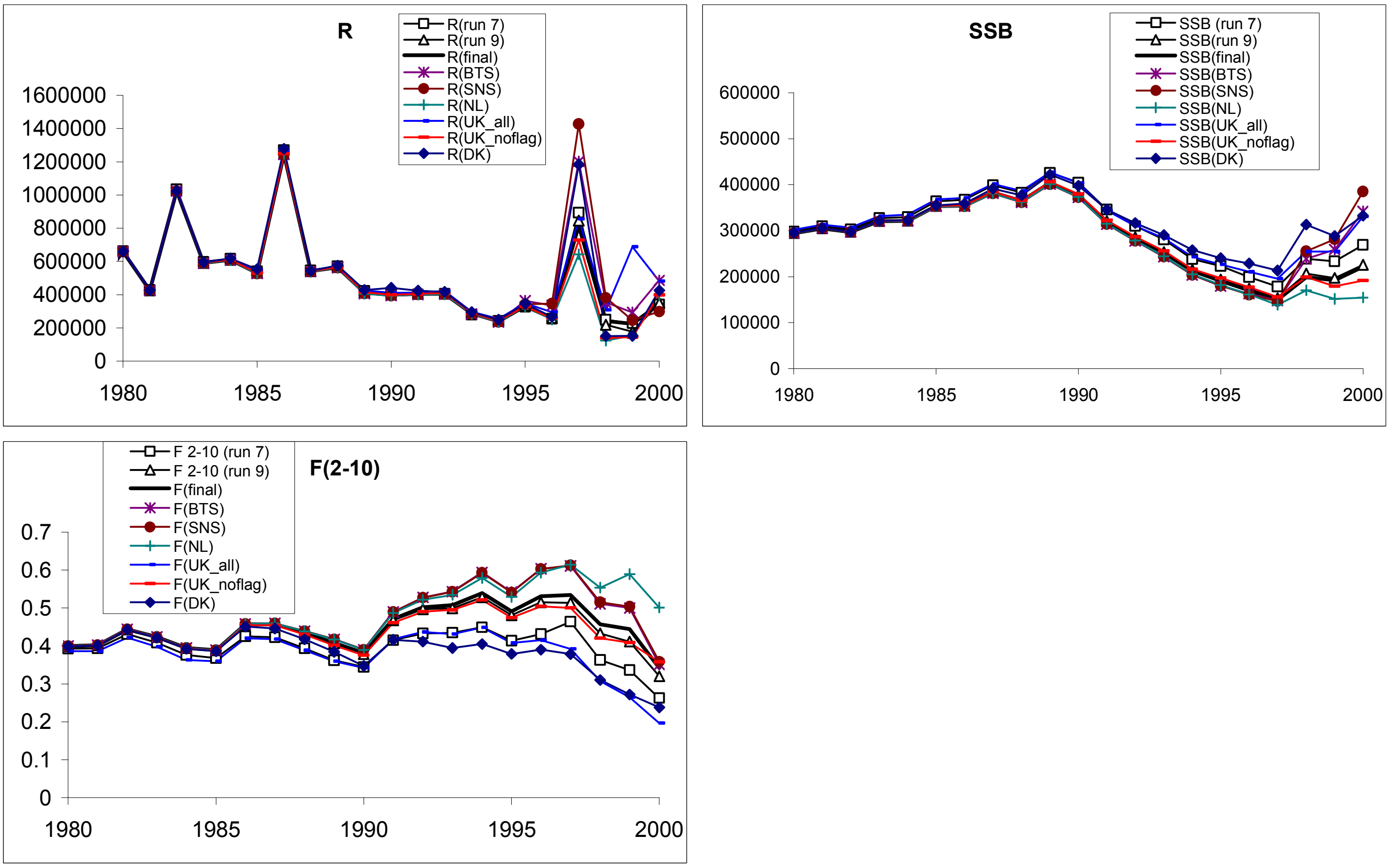


Figure 9.10. North Sea plaice : log catchability derived from the final combined fleets run

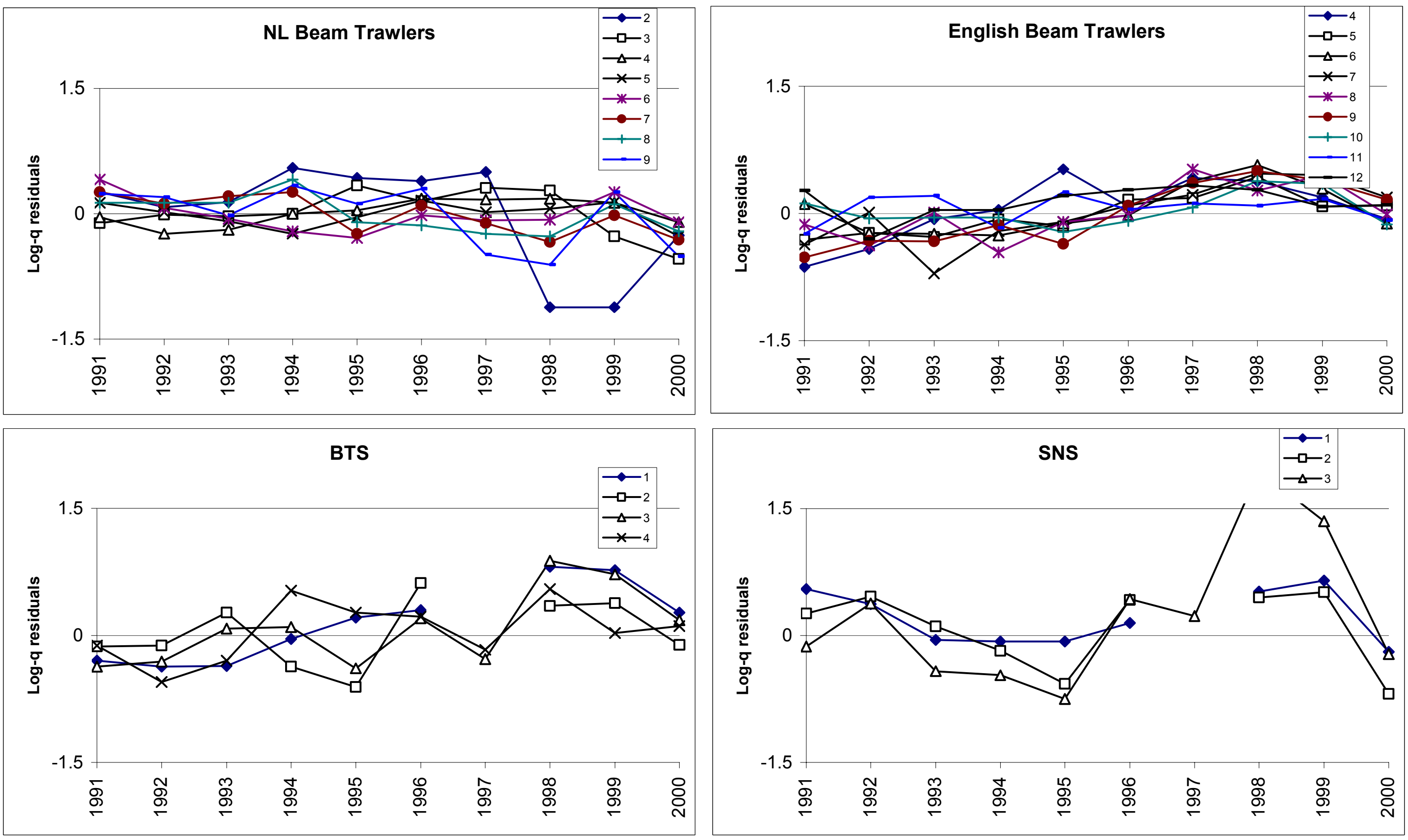


Fig. 9.11. North Sea plaice : scaled weights of the tuning fleets in the final XSA run

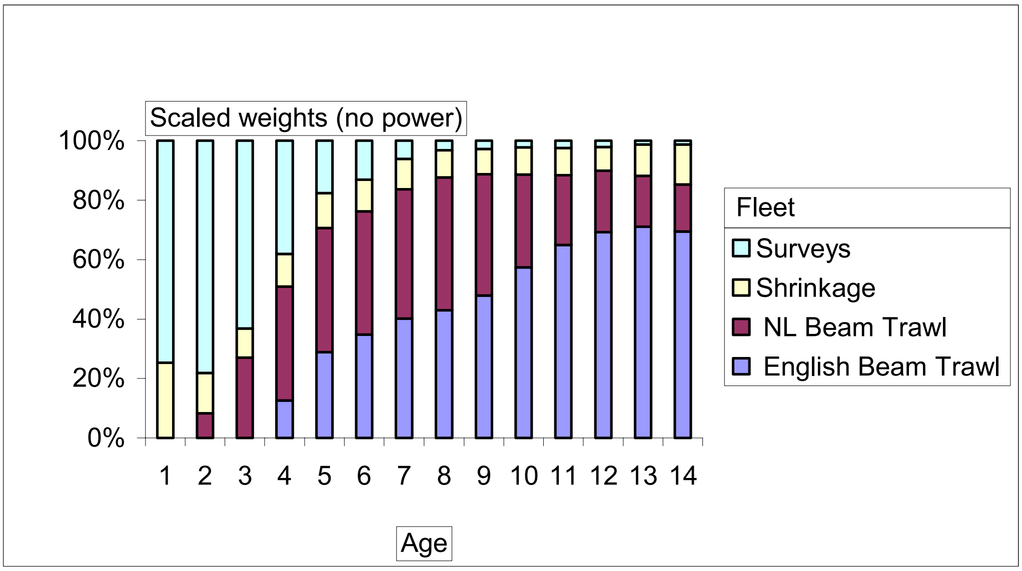


Figure 9.12. North Sea plaice: stock summary

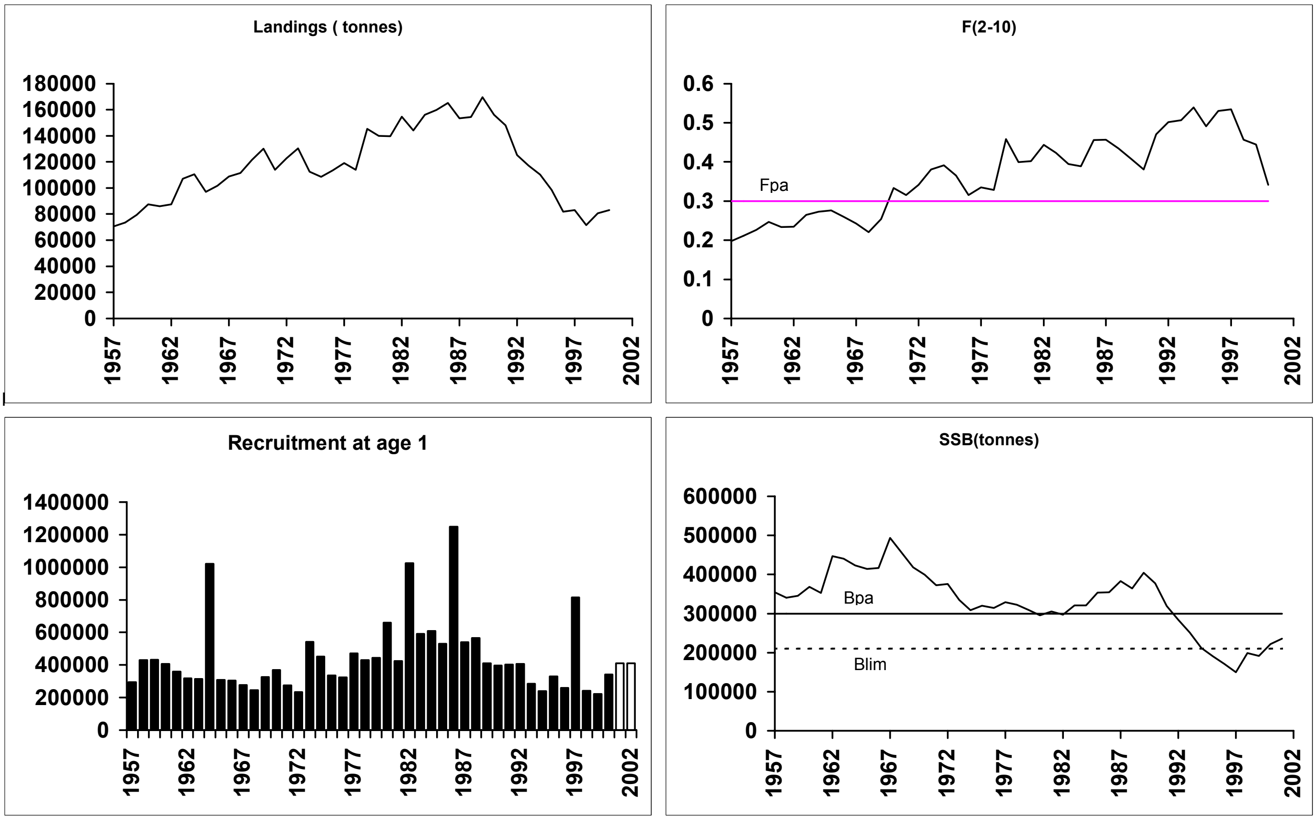


Fig. 9.13. North Sea plaice : retrospective analysis derived from the final XSA run

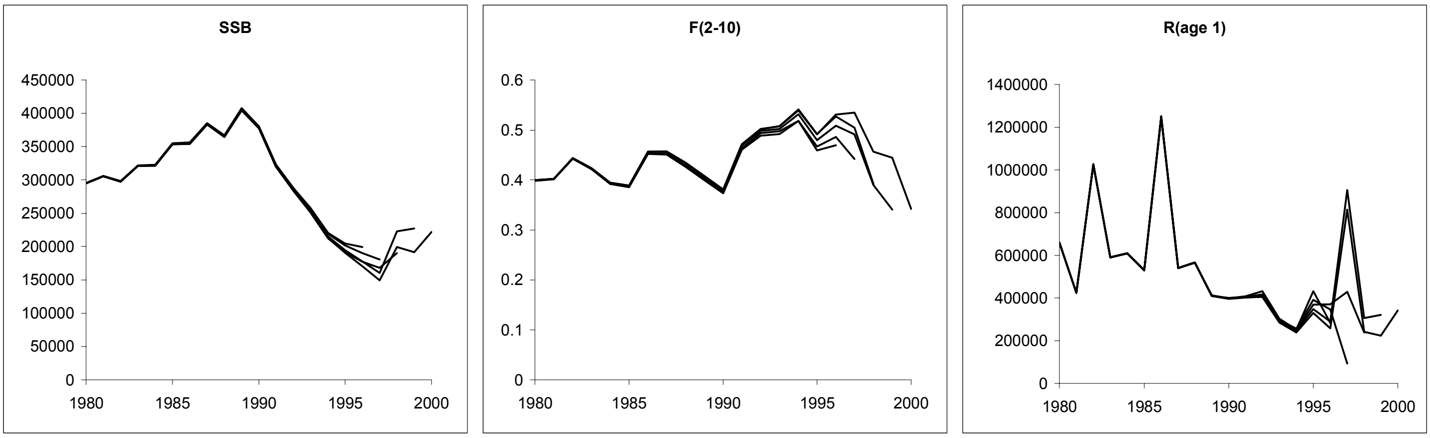


Figure 9.14. North Sea plaice: short-term forecasts

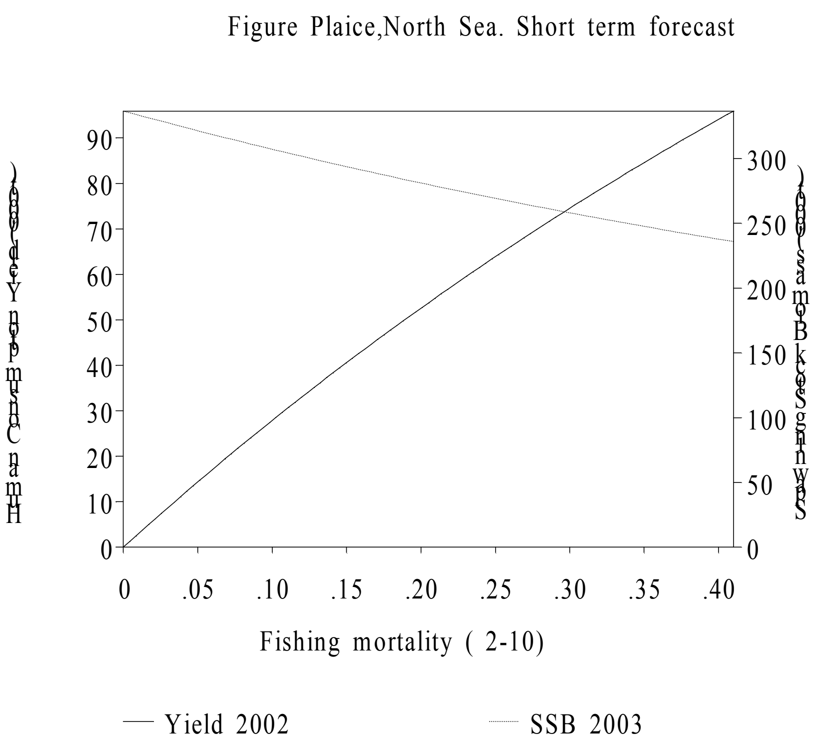


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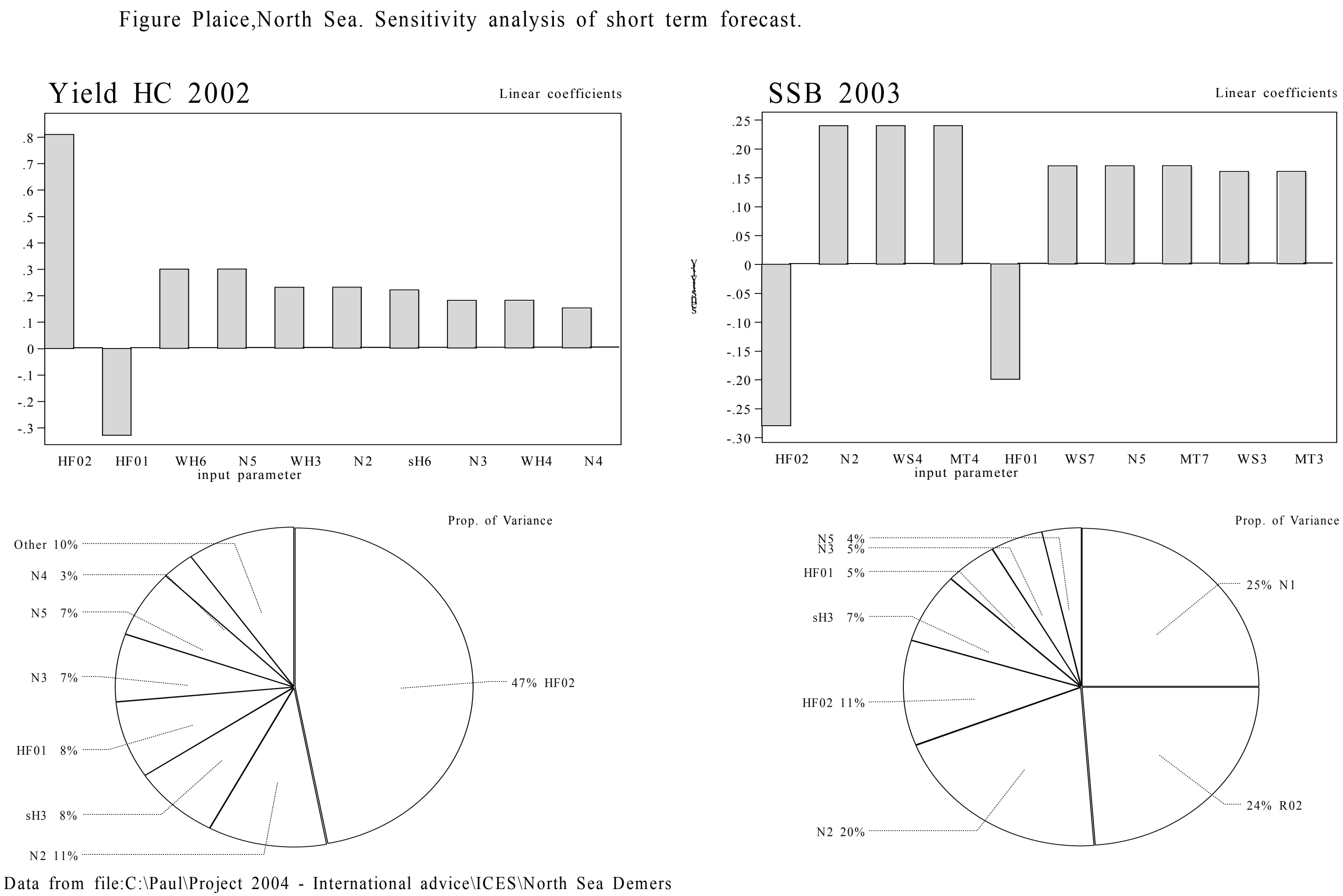
Figure 9.15. North Sea plaice: sensitivity analysis of short-term forecasts



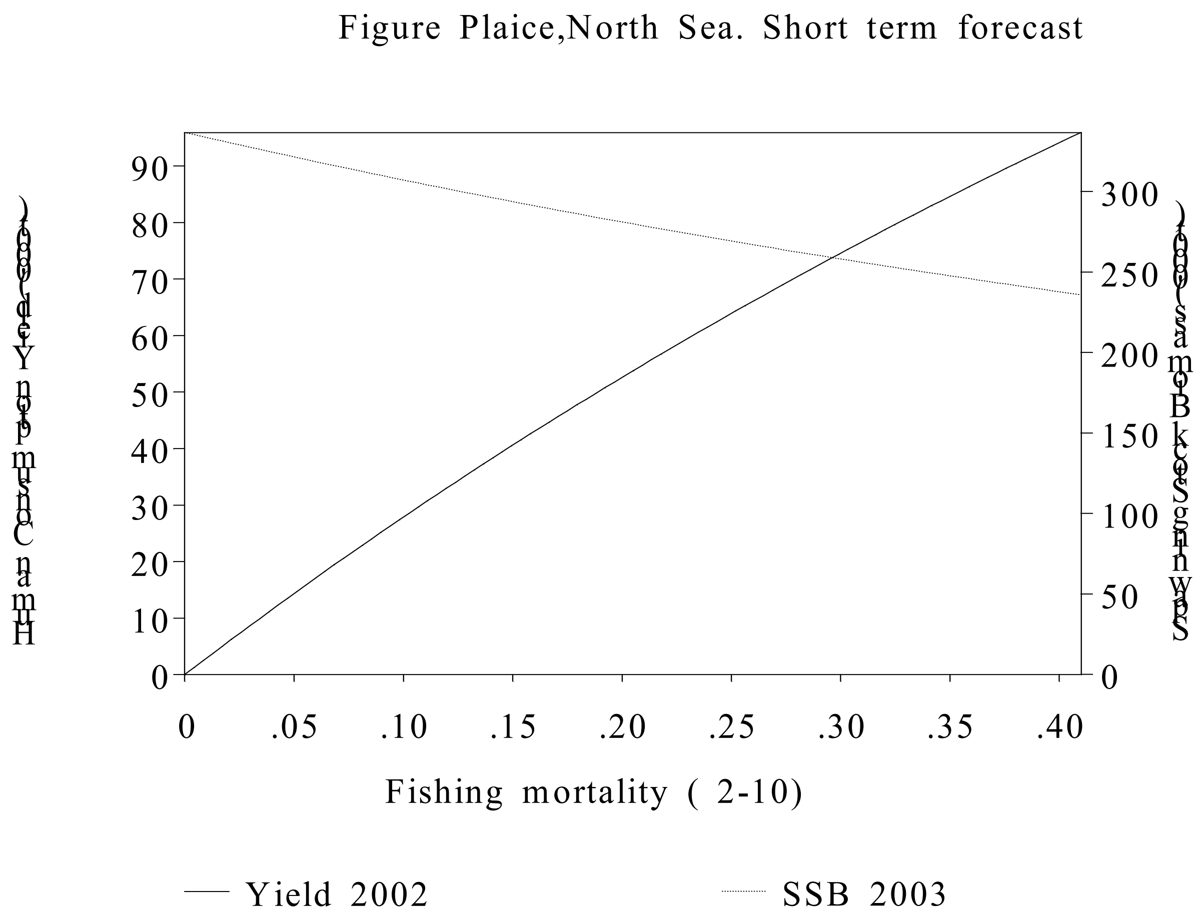


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Figure 9.16. North Sea plaice: probability profiles for short-term forecasts. Left: probability hat given a certain catch in 2002, F in 2002 is larger than Fsq. Right: probability that SSB om 2003 is below the value on the x-axis.

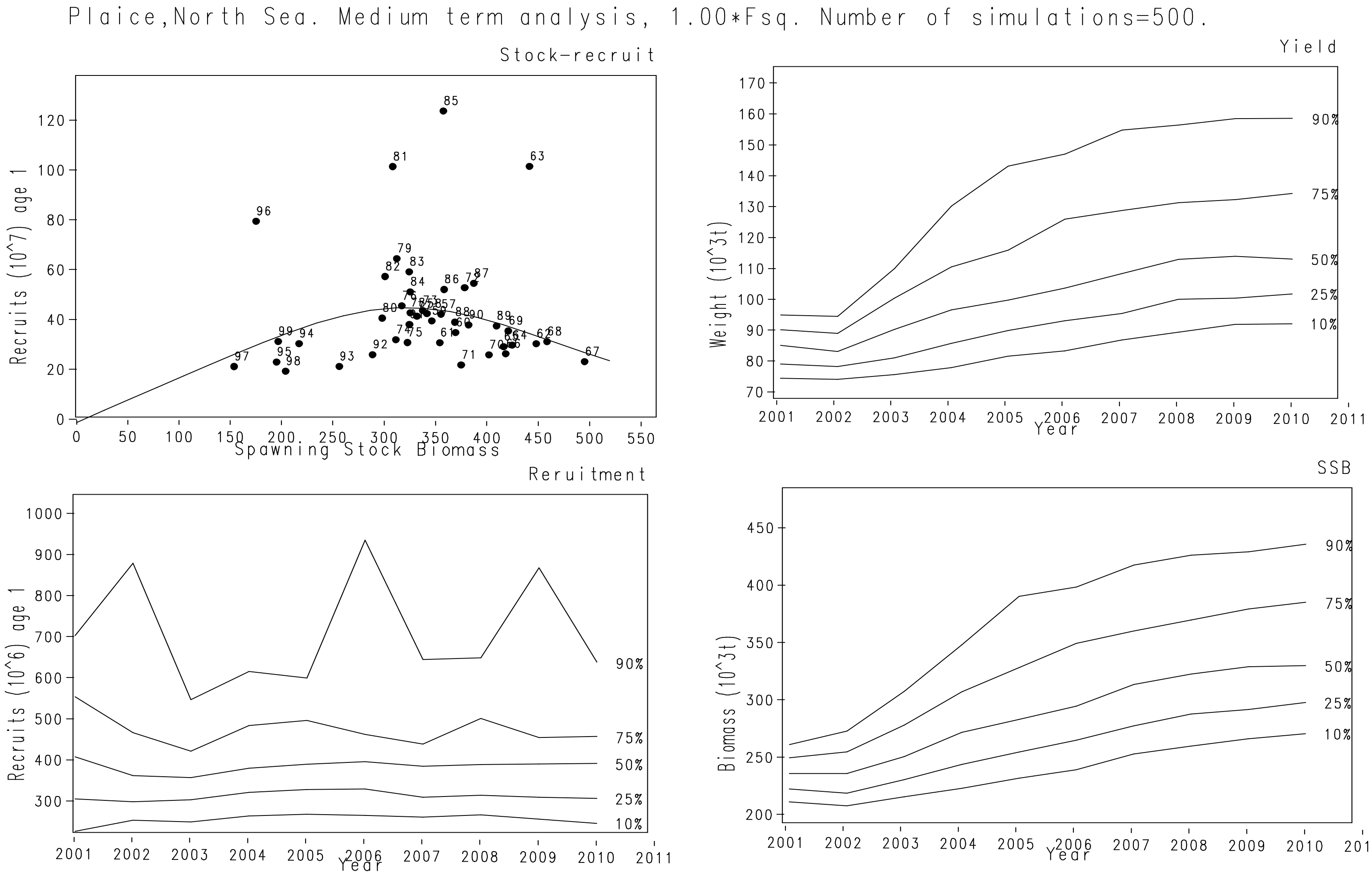


Figure 9.17. North Sea plaice: medium-term forecasts, using a Shepherd stock and recruitment curve.

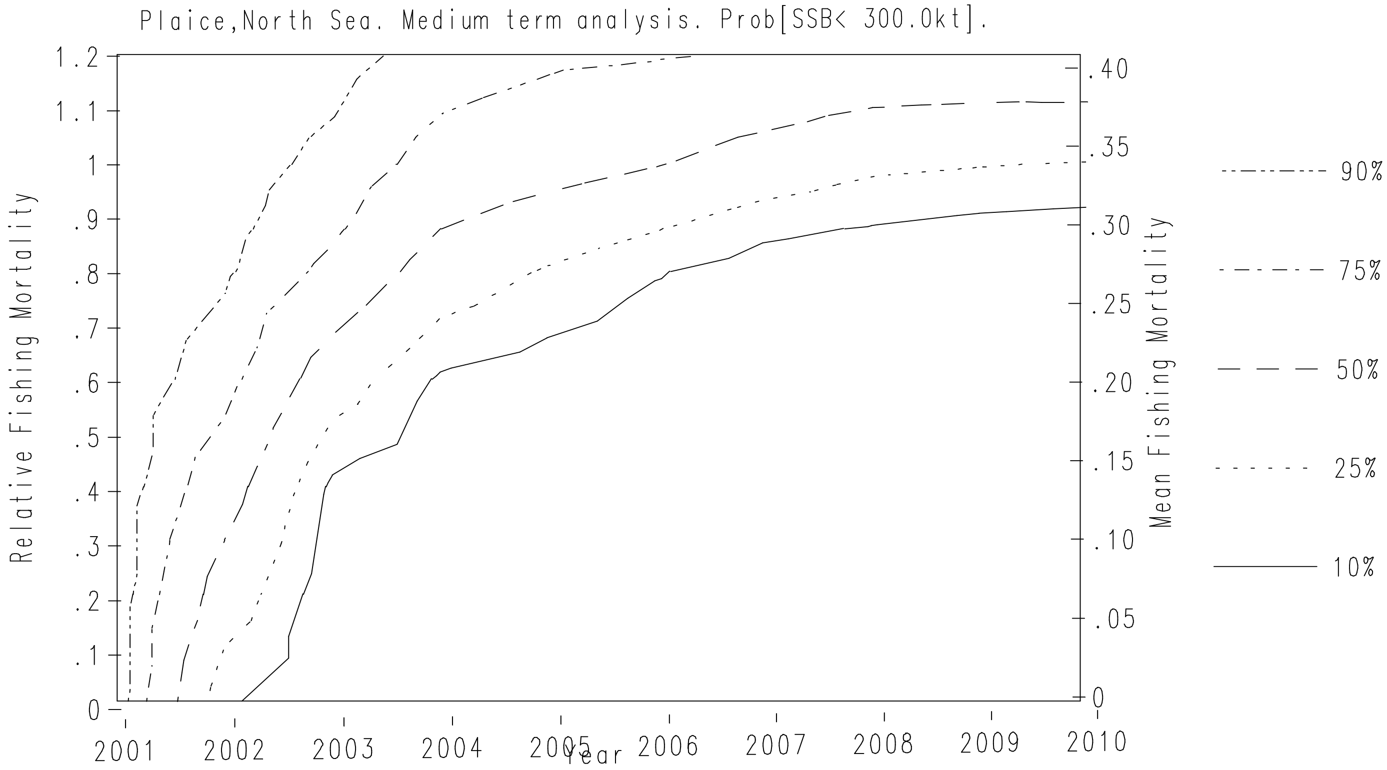


Figure 9.18. North Sea plaice: probability profiles relative to medium-term forecasts, using a Shepherd stock and recruitment curve.

Figure 9.19. North Sea plaice: stock and recruitment

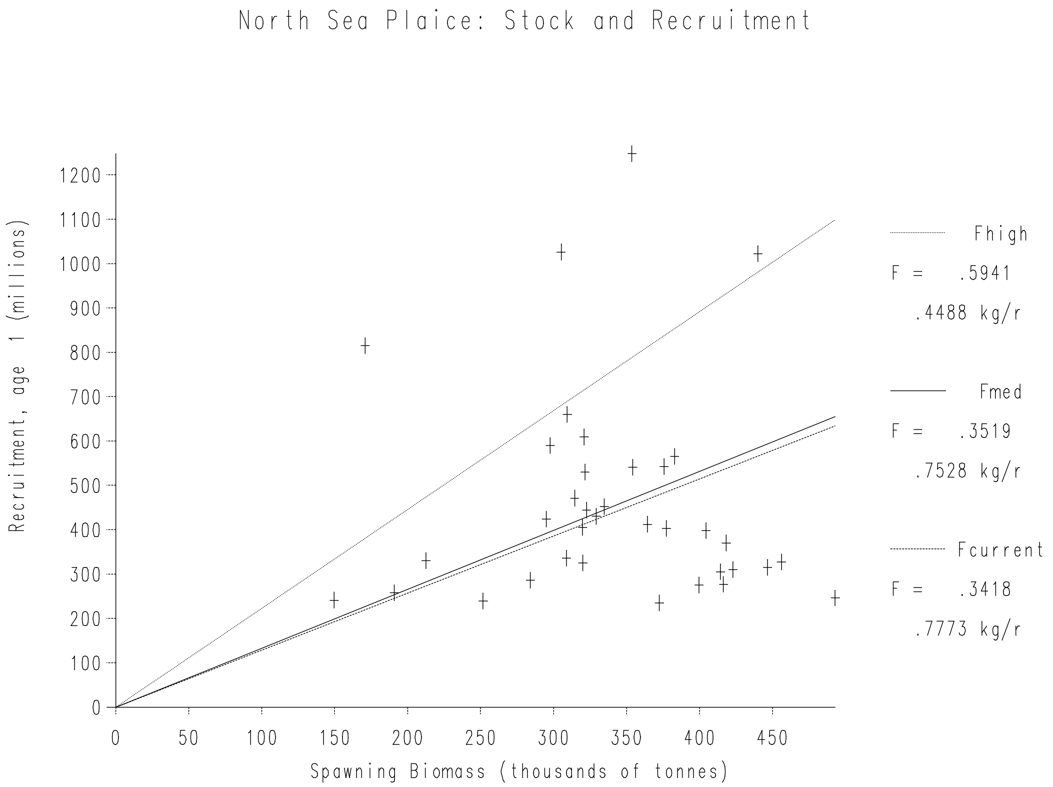


Figure 9.20. North Sea plaice: Yield per Recruit

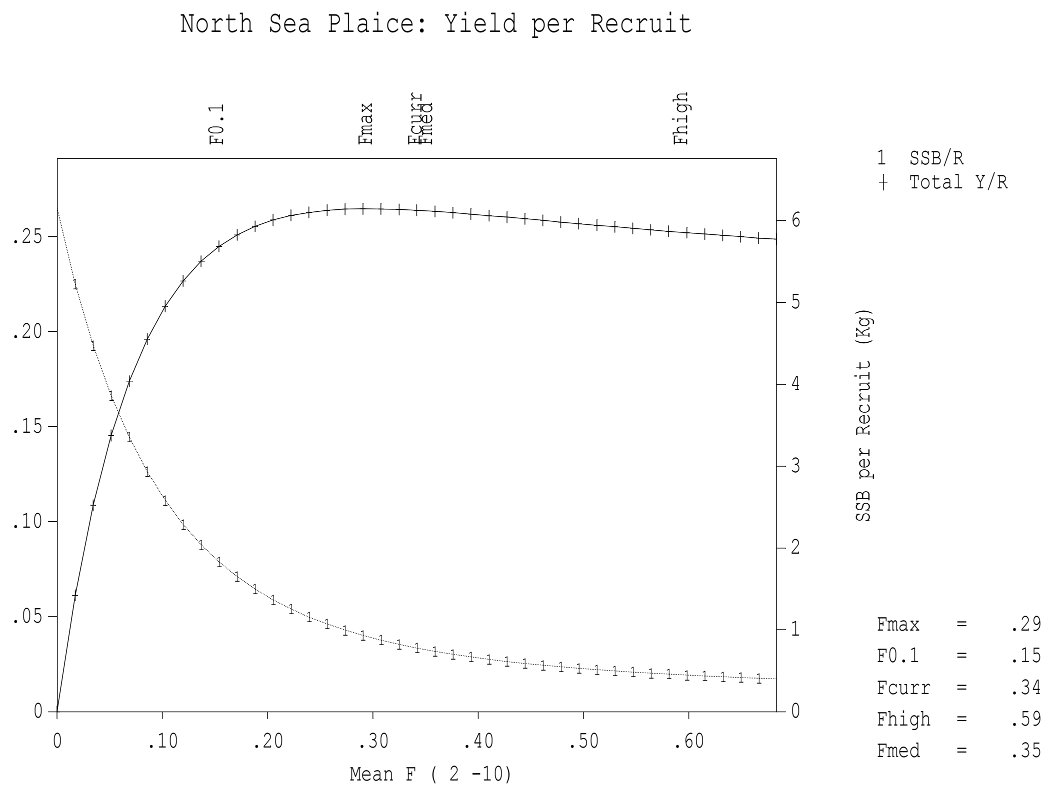
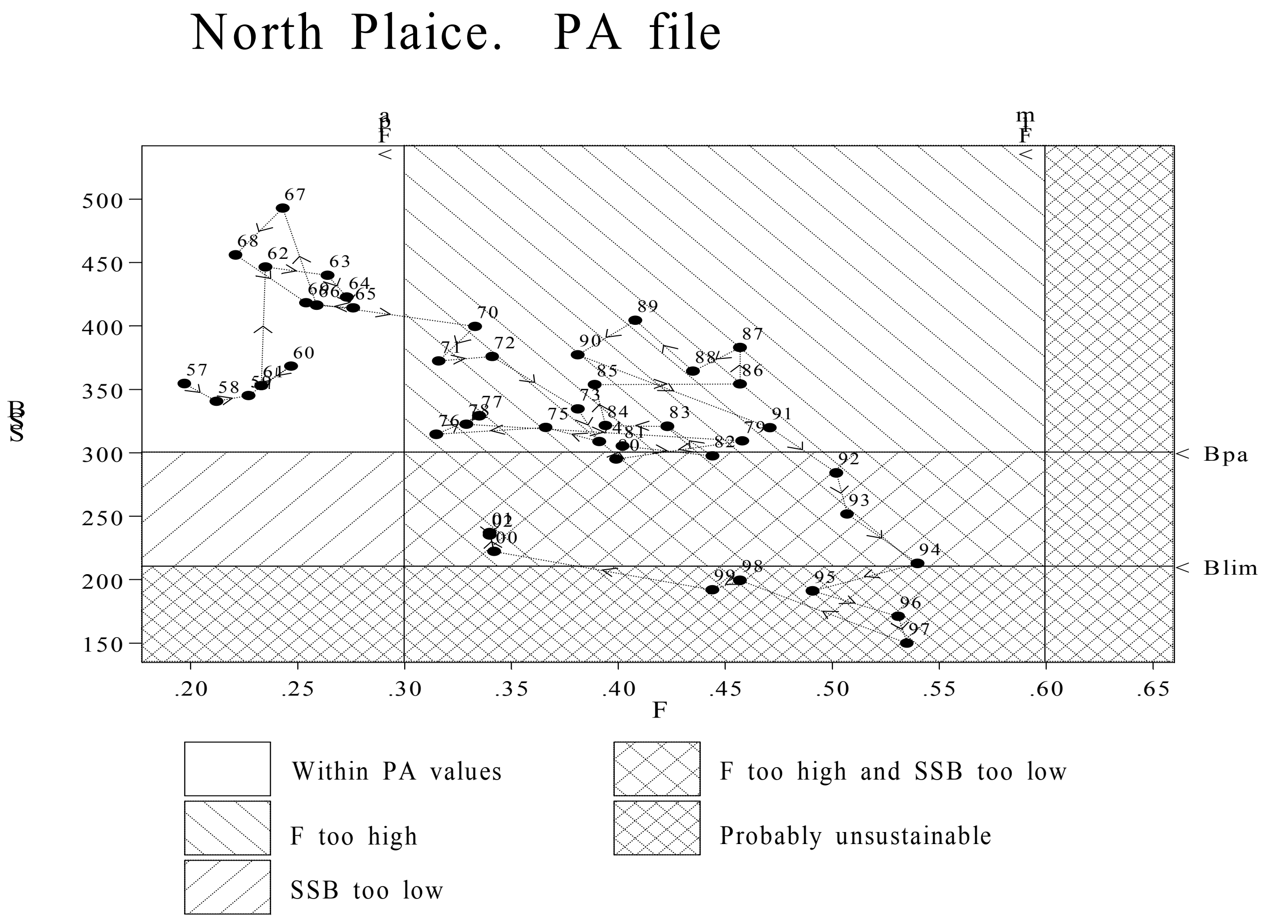


Figure 9.21. North Sea plaice. PA plot.



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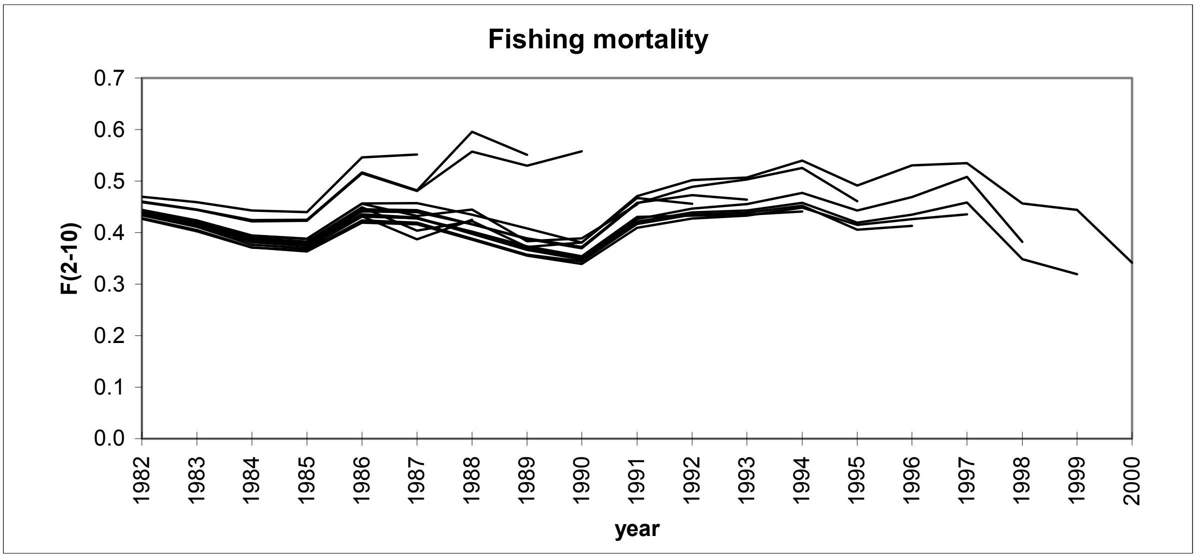
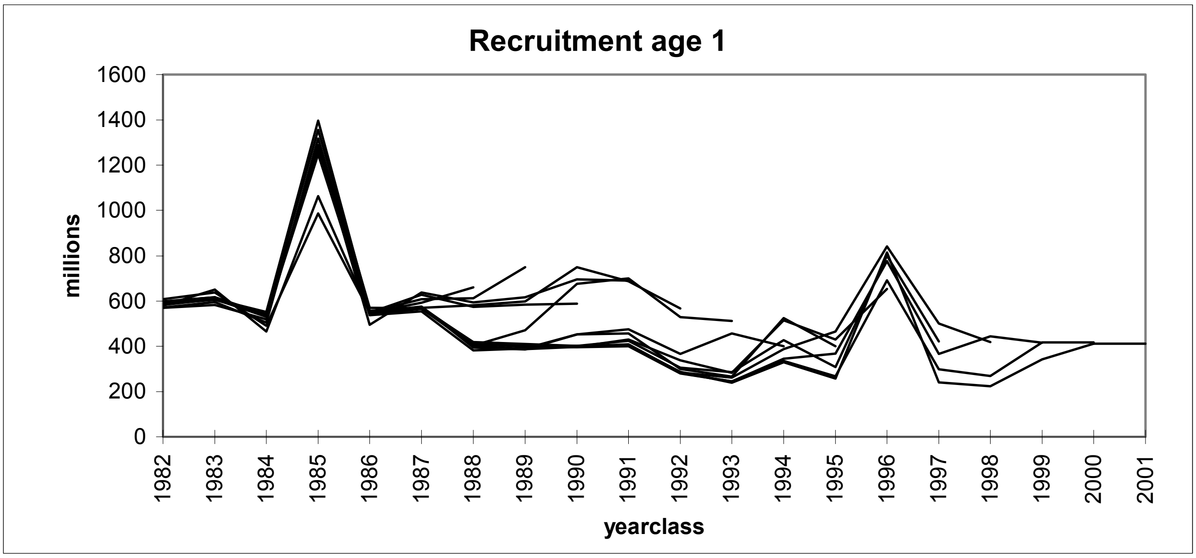
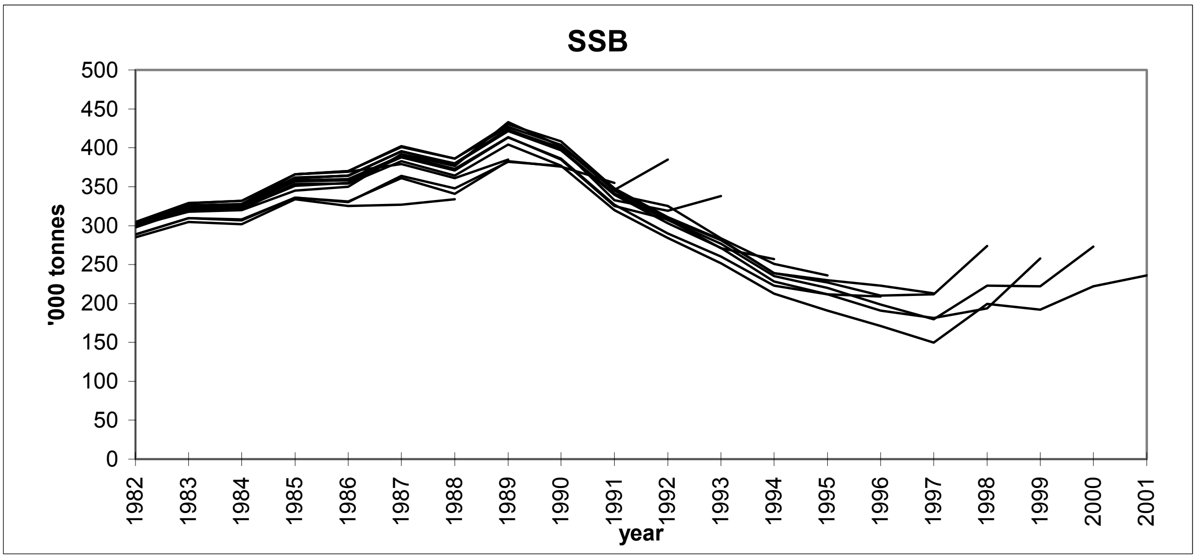
Plotted on 28/06/2001 at 09:50:21

Figure 9.22
NORTH SEA PLAICE Quality Control Diagrams







NORTH SEA PLAICE. Assessments generated in subsequent Working Groups.

10 PLAICE IN DIVISION IIIA

10.1 The fishery

10.1.1 ACFM advice applicable to 2000 and 2001

ACFM recommended for 2000 to reduce or maintain fishing mortality below the proposed F_{pa} (F_{pa} = 0.73), corresponding to landings in 2000 of 11 800 t, and also to increase or maintain spawning stock biomass above B_{pa} (B_{pa} = 24 000 t). F_{pa} was set to the value of F_{med} in 1998. Neither F_{lim} nor B_{lim} were defined.

ACFM recommendations for 2001 corresponded to landings in 2001 of less than 9 400 t.

10.1.2 Management applicable to 2000 and 2001

The 2000 TACs was 14 000 tonnes (11 200 t in Skagerrak and 2 800 t in Kattegat). The same TAC had been implemented since 1992. The 2001 TAC was reduced to 11 750 tonnes (9 400t in Skagerrak and 2 350t in Kattegat).

10.1.3 Landings in 2000

A directed plaice fishery is carried out by Danish seiners. Plaice is also an important by-catch to otter-trawlers and gill-netters. The total landings have been estimated for 2000 according to ICES official tables (Belgian, Norwegian and German landings) and national statistics (Danish and Swedish landings). Few minor revisions on historical data have been made. No information on mis-reporting were available.

Plaice landings in 2000 were slightly higher than in the two previous years (8 800 t), but remained far lower than the historical mean (12 500 t). The fishery is dominated by Denmark with Danish catches accounting for 90% of the total. The annual landings, available since 1972, are given by country for Kattegat and Skagerrak separately in Table 10.1.1. In the start of this period, catches were mostly taken in Kattegat but from the mid-1970s, the major proportion of the catch has been taken in Skagerrak. In 2000, around 80% of the catches were taken in Skagerrak.

10.2 Natural mortality, Maturity, Age Compositions and Mean Weight at Age

As in previous years catch at age and mean weight at age information were provided by Denmark only and are available over period 1978-2000. The sampling scheme was broken down by quarter, landing harbours and fishing area. The total international catches at age were estimated for Kattegat and Skagerrak separately. The procedures being used to derive the distribution of fish length from market size categories and age from length are the same as in last year's assessment. The catch numbers at age and the mean catch weight at age are presented in Figures 10.2.1 and 10.2.2, and in Tables 10.2.1 and 10.2.2.

In 2000 the fishery has mainly exploited two year classes (1995 and 1996). The fishery used to exploit mainly three year classes (Figure 10.2.1). Mean catch weights at age of Kattegat plaice have remained stable over years for all age groups (Figure 10.2.2). By contrast, decreasing trends in weights at age have been observed in the Skagerrak for age groups 8-11+ since 1978, with a historical minimum reached in 1997. However, the low values perceived in year 1997 for plaice aged 8+ could be due to the low number of large fish being sampled in the most recent years. Weight at age in the stock was assumed equal to that of the catch.

As in previous assessments, a natural mortality of 0.1 per year was assumed for all years and ages. A knife-edge maturity distribution was employed: age group 2 was assumed to be fully immature whereas all age 3 and older plaice were assumed fully mature. Some discards estimates in the Skagerrak (Danish seiners 1999-2000, Otter trawlers 2000) were available to this assessment (Report on Discards - EC PROJECT 98/097). Discarding is higher in the otter trawl fishery (50%) than in the seine fishery (15-30%), particularly on the young ages. However, the time series has been considered too short to be included yet in the analysis.

10.3 Catch, Effort and Research Vessel Data

Three Danish fleets, i.e., trawlers, gill-netters and Danish seiners, are available for tuning. The age dis-aggregated indices were derived by merging logbook statistics supplying catch weight per market category with the age distribution within these categories available from the market sampling.

Fishing effort has been defined as standardised days fishing. The standardisation of effort by vessel length is obtained by modelling Log-CPUE using a GLM approach, with (Log-) vessel length (continuous variable), year (discrete variable) and quarter (discrete variable) taken as external factors. A 15 m vessel is used as the reference fishing unit. This procedure explicitly splits some important sources of variability that underlie CPUE dynamics, and is therefore preferred to simple linear regression of Log-CPUE versus Log-Length. The coefficients associated to the vessel length effect are very close to the ones estimated last year. They indicate that plaice is essentially a by-catch to both trawlers and gill-netters, but is a target species to the Danish seiners.

The trends in fishing effort and CPUE of the tuning fleets are presented in Figure 10.3.1 There has been a general decrease in the fishing effort of towed-geared fleets since 1990, but this trend has been reversing since 1998. The fishing effort of gill-netters has steeply increased over 1990-1994, and steadily decreased since then. But variation in the beginning of the decade is more likely due to an extend of the log-book database to cover also the small boats of the fishery, than to a real increase of fishing effort. The CPUE time series do not reveal consistent trends for any fleet, but both the Danish seiners and trawlers fleets show higher yield and CPUE values in 2000 than in 1999. The Danish seiners have the highest CPUE. The tuning fleet data are provided in Table 10.3.1.

Three surveys data were available this year. IBTS survey data for Kattegat and Skagerrak for the first quarter were provided by Sweden for the period 1992–2001, as numbers-per-age and hour on a haul by haul basis. This survey is hereby referred to as "Argos". The survey indices were shifted from February to the preceding December to allow for a full use of the available data. In addition, two new Danish surveys data were included. These come from the BTS survey operated in spring and fall by the ship "Havfisken". These surveys are currently used for the tuning of the cod IIIa stock by the ICES Baltic Fisheries Assessment Working group ((ICES CM 2001/ACFM:18). Data were provided by Denmark for the period 1996-2000 for the fall survey, and for the period 1997-2000 for the spring survey. The survey fleet data are provided in Table 10.3.1, and the fleet CPUE are displayed in Figure 10.3.1. All surveys show increasing CPUE over the last few years, with a particularly high value in 2000.

10.4 Catch at Age Analysis

10.4.1 Data exploration

As in previous years, the catch information in the age groups used in the VPA were restricted to ages 2–11+ as age 1 plaice rarely accounted for more than 1% of the total catch number. International catches-at-age were preliminarily examined using separable VPA, with a reference age of 6, terminal F = 1.05 (corresponding to the mean 97-99 F at age 6 estimated in last year's assessment) and terminal selectivity set to unity (Figure 10.4.1). Large residuals in Log-catch ratios were detected for ages 2/3 and 3/4, in some years (94/95 to 97/98), but no consistent trends could be detected for these ages. The other residuals showed little variability and trends. In particular, no evidence could be seen for decreasing the age of the plus-group, in spite of the low amount of catches of ages 8 and over.

Tuning was carried out by using the CPUE information from the three commercial fleets and the three surveys indices. Very few plaice aged 7–9 were caught during the surveys and these ages were removed from the IBTS tuning fleet.

A number of assessment runs have been carried out, in order to define the final run configuration and investigate the sensitivity of results to the various XSA options. Single-fleet XSA assessments with low shrinkage (1.5) were firstly carried out over the whole CPUE time series (Run 1), to prevent the potential year-effect of high CPUE historical values (e.g. as in 1990). The log-catchability residuals are presented in the Figure 10.4.2. High residuals were observed for the youngest ages caught by gill netters, and for the oldest ages sampled by Argos survey, but no significant trends were observed for the four fleets used for tuning in the last year's assessment. The whole age-range was thus kept for each of these fleets. Conversely, the log-catchability residuals derived for both Havfisken surveys were high for most ages. A trend was observed for age 2 in the spring survey, and the R-squares associated with the analysis of young ages with the fall survey were very low. Given the shortness of both time series and the poor fit of the models, both surveys have been removed from the subsequent runs.

Run 2 was a combined-fleet XSA analysis, using the whole age-range and CPUE time series of the three commercial fleets and the Argos survey data. A tricubic weighting over 20 years was used. Run 3 used exactly the same configuration as last year (using a ten-years tuning window without weighting, and excluding the ages 2 and 3 for the Argos and gill netters fleets). Poor fits of tuning data and high weight of F-shrinkage for ages 2 and 3 in both runs 2 and 3 raised the issue of the validity of the stock size-dependant catchability model (power model) on recruiting ages. Run 4 used thus the same configuration as run 2, but with no power model. The plot of log-catchability residuals versus log-XSA abundance by fleet and age showed no significant trends, justifying the removal of the power model (Figure 10.4.3). However, the survivors estimated by the Argos survey for the ages 2 and 3 were not consistent with the commercial fleets estimates, and contributed at a very low level to the final estimates. Consistently with last year's assessment, these ages have thus been removed in the final run (Run 5), which is presented below. The comparison of the 2000 spawning stock biomass and mean fishing mortality estimated by the various single and combined fleets analyses is displayed in the Figure 10.4.4. Most estimates are consistent, and only the estimates based on survey data only seem too optimistic compared to the others.

10.4.2 Final assessment

As explained above, the configuration of the final XSA assessment was changed from last year concerning time taper, tuning window and catchability independent of stock size given in text table below.

	XSA (2000)	XSA (2001)
Argos survey (1991-1999) DK gill-netters (1987-1999) DK trawlers (1987-1999) DK seiners (1987-1999) Havfisken spring (1997-2000) Havfisken fall (1996-2000)	4-6 4-11+ 2-11+ 2-11+ Excluded Excluded	4-6 2-11+ 2-11+ 2-11+ Excluded Excluded
Fishing effort	Standardised days fishing	Standardised days fishing
Taper	Uniform over10 years	Tricubic over 20 years
Tuning window	10 years	all years included
First age of independent q	4	2
q plateau age	8	8
Shrinkage	F(0.5); P(0.3)	F(0.5); P(0.3)

Plots of the log catchability residuals, derived from the run 5 show little trend over time, despite a year effect in 1997 for the oldest age groups caught by the Danish seine fleet, and a high residual for the age 2 in all commercial fleets (Figure 10.4.5). Figure 10.4.6 shows the weighting in tuning fleets and shrinkage, as derived from the assessment. Overall, the weight of shrinkage is slightly higher than in last year's assessment. It is always lower than 50%, the maximum occurring for the oldest ages. Retrospective VPA runs are carried back to 1995, by chopping off one year for each retrospective run (Figure 10.4.7). Both the recruitment and the fishing mortality are generally underestimated, while the SSB is mostly overestimated, except for the 1996 assessment. The SSB pattern is the less variable, with little difference between estimates. The fishing mortality pattern is less stable and major differences occur between consecutive years, and particularly in comparison with last year's assessment.

The VPA results are given in Tables 10.4.1-10.4.4. The fishing mortality (age 4–8) estimated for 2000 is 0.82, which is above F_{pa} (0.73) but below F_{1999}. The exploitation pattern increases up to age 8. Total and spawning stock biomass in 2000 are estimated to be at about the same level as in 1999 (41 000 t and 30 000t respectively). The current XSA run has revised the estimate of F in 1999 from 0.70 to 1.46. This change appears to be the result of the additional catch at age data since all exploratory runs resulted in inflated estimates of F in 1999. It arises likely from the low catches of older ages in 2000, inducing high mortality estimates in 1999 on the 1998 survivors.

Main features regarding the validity of the assessment are: All combined-fleets runs show very close estimates of mean F and SSB (Figure 10.4.4). The R-squares associated to the estimation of Log-catchability of the commercial fleets are high (40%-90%) for the age range 5–10 for the commercial fleets, even if these R-squares are somewhat lower for the Argos survey (Table 10.4.1). The estimation of survivors differed only slightly between the fleets except for age 6, where the estimation of survivors from Argos survey was about the double than average from the other fleets. The contribution of shrinkage is acceptable. However, the fishing mortality coefficients appear overall very high, and the retrospective pattern is not consistent from year to year.

10.5 Recruitment estimates

The abundance indices from the Argos surveys in Kattegat and Skagerrak and from the surveys conducted in spring and fall by Havfisken are given in Table 10.3.1. The three time series indicate that the year classes 1997 and 1998 are the highest in the time series. Also the year class 1999 appears to be strong. Despite the short time span available, RCT3 analysis was operated this year, based on the Argos, Havfisken spring and Havfisken fall survey indices. The contribution of the surveys to the predicted value of age 2 group was lower than 5% for year classes 1996–2000 except from a 30% contribution of the Havfisken fall survey for year classes 1997 and 1998. However, these values had negative slopes, which could be an effect of the short time series the analysis is based on. The estimations of recruitment at age 2 were consistent across the commercial tuning fleets for all ages except for age 2 (Table 10.4.1). As a result, the estimates of recruitment carried out by the XSA were retained. The geometric mean of 46.0 million, calculated over period 1978–1998, was used to estimate the size of the 1999 and 2000 year classes (recruitments 2001-2002). Given the poor results obtained with the RCT3 method, the output tables are not presented in this report.

Year class strength used for predictions are underlined in the following summary table

Year class	Age	RCT3 (Thousand)	XSA (Thousand)	GM (78-98) (Thousand)
1998	3	N/A	41 278	42 089
1999	2	N/A	N/A	46 053
2000	2	N/A	N/A	46 053

10.6 Historical trends

The historical trends in the fisheries are presented in Tables 10.1.1-10.4.4 and in Figure 10.6.1.

Since 1978, landings have declined from 27 000 to 9 000 tonnes. Landings in 2000 were slightly higher than the year before. The fishing mortality has consistently remained at a rather high level of 0.6-1.0 over the period of assessment, with extreme values observed in 1988, 1997 and 1999. SSB and recruitment have oscillated around a stable mean since 1980. SSB has varied in the range 25 000–45 000 tonnes, while recruitment has fluctuated between 25 and 95 million per year.

10.7 Short-term forecast

The inputs used for the predictions are given in Table 10.7.1. Stock sizes for age 3 and older are taken from the estimated number of survivors from the XSA. The age 2 recruitments in 2001, 2002 and 2003 (year classes 1999-2001) are taken as the geometric average over the 1978–1998 period. The mean weights at age are taken as the average for the years 1998–2000. The exploitation pattern is calculated as the average F over 1998-2000, and then rescaled to the 2000 value of F(4-8) = 0.82.

The *status quo* predictions result in catches of 8 600 and 9 200 tonnes in 2001 and 2002, respectively (Table 10.7.2). These values are very close from those derived last year. The landings predicted this year are consistent with recent trends. Estimate of SSB over 2001-2003, at *status quo* F, remains in the range 31 000-34 000 tonnes. The short-term yield and SSB are shown in Figure 10.7.1. The sensitivity coefficients and the probability distribution of the forecast and are shown in Figures 10.7.2 and 10.7.3. The prediction of yield is sensitive to the estimated abundance and mean weight at age of year classes 1997 and 1998, whereas the prediction of biomass relies mostly on the predicted abundance of year classes to come (Figure 10.7.2). Overall, the probability of falling below B_{pa} (24 000 t) in 2003, fishing at status quo is less than 5 % (Figure 10.7.3).

The contribution of the various year classes in a status quo short-term forecast are shown in Table 10.7.3. Year classes 1996 and 1997 are expected to provide the largest contribution to landings predicted in year 2002 (50%). Year classes 1999 and 2000, which have been set to the geometric mean calculated over 1978-1998, contribute to around 60% of SSB predicted in 2003.

10.8 Medium-term forecast

No medium term analyses were performed last year. Projections have been undertaken this year using both a Beverton-Holt and a Ricker stock recruitment curves (Tables 10.8.1 and 10.8.2) and using the same input values as were used in the short term forecast (Table 10.7.1). The Ricker curve gives a better fit to the data, but it appears particularly domed and is likely to be over optimistic at low SSB values. The results of the projections for status quo F are shown in Figure 10.8.1. Yield and SSB trajectories do not show large differences, suggesting that medium term forecasts are rather robust to the choice of the stock recruitment relationship. At the current level of fishing mortality, the SSB is expected to stay above B_{pa} during the next decade.

10.9 Biological reference points

A yield per recruit analysis was carried out. (Figure 10.9.1). The stock and recruitment relationship is given in Figure 10.9.2. The values of the biological and precautionary reference points are presented in the following table.

$F_{0.1}$	0.10	F_{lim}	N/A
F_{max}	0.21	F_{pa}	0.73
F_{med}	0.88	B_{lim}	N/A
F_{high}	> 1.5	B_{pa}	24 000 t

F_{max} and $F_{0.1}$ remain at the same level as last year. F_{med} has increased by 20% compared to last year. It is remarkable that for this stock F_{med} is much higher than F_{max}. Figure 10.9.3 shows historical and projected trends in F and SSB, in relation to F_{pa} and B_{pa}. It may be observed that the current F is above F_{pa}, while SSB is above B_{pa}.

10.10 Comments on the assessment

- The landings are decreasing in Kattegat, in comparison to Skagerrak, since 1978. This could result from either reduced recruitments in Kattegat, or shifts in fishing strategies. The weights at age observed in Skagerrak are decreasing since 1984. This trend has also been observed for other stocks in the area, including cod. However, the mean weights at age in 2000 were above the 1999 estimates.

- As in previous years, the inclusion of survey data in the assessment has not proven to improve the quality of the tuning, and their contribution is low compared to commercial data. Two new surveys time series were tested this year, but due to their shortness they couldn't be included in the analysis. However, they should be reconsidered regularly in future assessments, as they have proven to be of interest for the tuning of other stocks in IIIa (cod in Kattegat).

- The short-term predictions, and in particular those dealing with SSB, should be interpreted cautiously, as a result of the high contribution of recruitments in 2001 and 2002, which have been extrapolated using the geometric mean average (Table 10.7.3). The working group noted last year that the assessment of Plaice in Kattegat and Skagerrak had become more consistent over the years, but that it was still noisy (Figure 10.10.1). This is also the case for this year's assessment, and particularly regarding the estimation of fishing mortality.

- A remarkable result of the assessments of plaice in IIIa is the continuously high levels of mean fishing mortality, almost twice as high as the one estimated for plaice in the North Sea (Division IV). The difference may be caused by the difference of exploitation patterns, the fishing mortality of young ages (2-3) being much higher in the North Sea. It may also be caused by older, mature, plaice emigrating from the Skagerrak to the North Sea for spawning, or by higher natural mortality (e.g. due to possible parasitic infection). Taking these factors into account would lead to an increase in the natural mortality at the old ages, and thus to lower estimates of fishing mortality. This issue is particularly important in 2000, where the catches of old ages are much lower than during all previous years.

- The fluctuations of the mean fishing mortality are thus significantly driven by these high mortality coefficients on old ages, biasing potentially the real fluctuations of the fishing mortality for the most exploited ages. To limit this potential bias, it has been proposed during the Working Group to decrease the range of ages considered as fully exploited, and used in the calculation of the mean fishing mortality estimate, from ages 4-8 to ages 3-7. Such a change would require an revision of reference points.

- Although F has mostly been above F_{pa}, the SSB has always been estimated above B_{pa} since 1978 (Figure 10.9.3). The yield, the recruitment and the biomass have shown very stable patterns during the last decade. This stability is also confirmed by the short- and medium-term forecasts.

10.11 Management considerations

At the current level of exploitation, the stock of plaice in Kattegat and Skagerrak appears relatively stable. In particular, the exploitation pattern on the young ages (less than 4) seems favourable.

The estimation of fishing mortality might be biased by unaccounted natural mortality or migration for the oldest ages. This suggests that the estimation of F is not very precise, and is probably overestimated.

A TAC has been implemented on this stock since 1987. The 2001 TAC is the lowest TAC since the beginning. However, TACs have always higher than the landings, and thus have never been restrictive.

Table 10.1.1 Plaice landings (tonnes) used by the Working Group, Division IIIa, Kattegat and Skagerrak, 1972-2000.

Year	Denmark		Sweden		Germany		Belgium	Norway	Netherlands	Correction	Total WG		
	Kattegat	Skagerrak	Kattegat	Skagerrak	Kattegat	Skagerrak	Skagerrak	Skagerrak	Skagerrak	Skagerrak	Kattegat	Skagerrak	Div. IIIa
1972	15,504	5,095	348	70	77			3			15,929	5,168	21,097
1973	10,021	3,871	231	80	48			6			10,300	3,957	14,257
1974	11,401	3,429	255	70	52			5			11,708	3,504	15,212
1975	10,158	4,888	296	77	39			6			10,493	4,971	15,464
1976	9,487	9,251	177	51	32		717	6			9,696	10,025	19,721
1977	11,611	12,855	300	142	32		846	6			11,943	13,849	25,792
1978	12,685	13,383	312	94	100		371	9			13,097	13,857	26,953
1979	9,721	11,045	333	67	38		763	9			10,092	11,884	21,976
1980	5,582	9,514	313	71	40		914	11			5,935	10,510	16,445
1981	3,803	8,115	256	110	42		263	13			4,101	8,501	12,602
1982	2,717	7,789	238	146	19		127	11			2,974	8,073	11,047
1983	3,280	6,828	334	155	36		133	14	594	-594	3,650	7,130	10,780
1984	3,252	7,560	388	311	31		27	22	1,580	-1,580	3,671	7,920	11,591
1985	2,979	9,646	403	296	4		136	18	2,225	-2,225	3,386	10,096	13,482
1986	2,470	10,645	202	202	2		505	26	4,024	-4,024	2,674	11,378	14,052
1987	2,846	11,327	307	241	3		907	27	2,209	-2,209	3,156	12,502	15,658
1988	1,820	9,782	210	281	0		716	41	2,087	-2,087	2,030	10,820	12,850
1989	1,609	5,414	135	320	0		230	33			1,744	5,997	7,741
1990	1,830	8,729	202	779	2		471	69			2,034	10,048	12,082
1991	1,737	5,809	265	472	19	15	315	68			2,021	6,679	8,700
1992	2,068	8,514	208	381	101	16	537	106			2,377	9,554	11,931
1993	1,294	9,125	175	287	0	37	326	79			1,469	9,854	11,323
1994	1,547	8,783	227	315	0	37	325	91			1,774	9,551	11,325
1995	1,254	8,468	133	337	0	48	302	224			1,387	9,379	10,766
1996	2,337	7,304	205	260	0	11		428			2,542	8,003	10,545
1997	2,198	7,306	255	244	25	14		93			2,478	7,657	10,135
1998	1,786	6,132	185	208	10	11		59			1,981	6,410	8,391
1999	1,510	6,473	161	233	20	7		66			1,691	6,779	8,470
2000	1,644	6,680	184	230	10	5		67			1,838	6,982	8,820

Table 10.2.1 Plaice IIIa. Catch numbers at age ('000)

	2	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11+**
1978	489	15692	39531	24919	8011	620	63	63	48	60
1979	1105	9789	29655	20807	7646	2514	170	75	50	55
1980	362	4772	16353	12575	6033	2393	949	203	54	50
1981	190	4048	13098	10970	4306	1427	546	213	119	97
1982	526	2067	9204	10602	5554	1851	758	301	113	48
1983	1481	9715	8630	8026	2673	925	531	257	96	106
1984	2154	12620	11140	4463	2183	985	904	695	337	120
1985	1400	8641	21798	6232	1715	698	260	197	168	156
1986	375	4366	14749	19193	4477	633	274	154	141	98
1987	623	4227	12400	17710	10205	2089	373	242	125	190
1988	101	3052	12037	13783	6860	2745	946	322	136	156
1989	1012	3844	7102	6255	2708	1171	549	254	136	236
1990	3147	8748	8623	9718	3222	981	481	349	155	273
1991	2309	8611	9583	4663	2893	892	306	156	87	137
1992	904	3858	11759	17427	4297	1033	296	115	27	115
1993	1038	3505	10088	13233	6891	1657	376	104	47	69
1994	1411	6919	8016	9859	8002	2780	448	111	38	55
1995	446	2277	6606	11530	6622	4929	853	137	65	51
1996	4527	5353	7971	5283	4751	1812	1355	151	23	45
1997	529	4722	6287	9290	5007	3012	1343	833	112	35
1998	562	6681	8187	6820	2954	786	383	233	169	64
1999	687	2660	8195	8234	7142	1254	367	75	103	42
2000	1223	3937	8302	11212	3599	888	139	17	7	29

Table 10.2.2 IIIa. Mean weight in catch and in stock (kg)

	2	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11+**
1978	0.236	0.248	0.268	0.322	0.417	0.598	0.752	0.818	0.914	0.843
1979	0.222	0.255	0.267	0.297	0.378	0.451	0.655	0.922	1.020	1.044
1980	0.261	0.274	0.306	0.345	0.414	0.579	0.640	0.753	0.811	0.910
1981	0.230	0.263	0.296	0.357	0.432	0.537	0.671	0.813	0.912	0.999
1982	0.270	0.301	0.286	0.318	0.386	0.544	0.704	0.813	0.912	0.986
1983	0.285	0.274	0.293	0.356	0.423	0.483	0.531	0.647	0.986	1.184
1984	0.282	0.299	0.304	0.372	0.403	0.406	0.383	0.360	0.443	1.061
1985	0.278	0.282	0.308	0.354	0.437	0.544	0.680	0.737	0.755	0.914
1986	0.250	0.277	0.284	0.310	0.384	0.531	0.707	0.850	0.903	1.099
1987	0.322	0.280	0.281	0.292	0.363	0.527	0.711	0.904	1.036	1.084
1988	0.252	0.267	0.268	0.290	0.350	0.475	0.567	0.755	0.833	1.193
1989	0.274	0.263	0.282	0.320	0.376	0.466	0.635	0.741	0.825	1.002
1990	0.292	0.288	0.294	0.337	0.397	0.498	0.684	0.775	0.951	1.150
1991	0.263	0.270	0.259	0.274	0.365	0.492	0.584	0.670	0.882	1.080
1992	0.309	0.310	0.272	0.280	0.336	0.500	0.646	0.817	0.804	0.976
1993	0.267	0.272	0.271	0.295	0.338	0.441	0.566	0.712	0.802	1.168
1994	0.275	0.263	0.272	0.289	0.330	0.381	0.516	0.658	0.766	0.979
1995	0.263	0.301	0.303	0.289	0.328	0.368	0.499	0.736	0.752	1.022
1996	0.266	0.268	0.294	0.384	0.399	0.436	0.430	0.561	0.870	0.957
1997	0.300	0.294	0.283	0.300	0.341	0.410	0.465	0.445	0.532	0.764
1998	0.260	0.250	0.280	0.327	0.398	0.464	0.515	0.587	0.641	0.864
1999	0.271	0.271	0.290	0.290	0.294	0.336	0.371	0.656	0.567	0.834
2000	0.257	0.262	0.276	0.302	0.355	0.388	0.517	0.857	0.970	0.967

Table 10.3.1. Plaice IIIa. Tuning data by fleet

106										
FLT01:	ARGOS	1st	Q	(IBTS)						
1991	2000									
1	1	0.99	1							
1	6									
1	4.17	9.29	6.44	1.62	0.38	0.08				
1	6.5	6.02	5.78	5.11	2.03	0.22				
1	8.5	6.48	1.89	1.09	1.19	0.25				
1	4.48	10.4	4.2	1.13	0.85	0.4				
1	17.05	13.35	4.9	1.54	0.46	0.13				
1	6.86	12.9	3.26	1.14	0.12	0.04				
1	8.06	8	4.24	1.48	0.32	0.12				
1	17.31	9.14	2.59	2.32	0.13	0.07				
1	57.85	30.98	10.31	3.08	1.71	0.17				
1	42.45	73.24	16.92	2.91	1.76	0.65				
FLT02:	Danish	gill-netters								
1987	2000									
1	1	0	1							
2	11									
4215	20592	169059	650916	1071313	803165	286784	58777	33991	18818	24877
4026	27444	168504	529771	606818	410016	309311	134000	55393	19492	23977
3821	18882	63447	175206	186617	129661	111415	85514	44764	24564	43810
4223	64308	246880	272984	362432	157274	62094	42383	38230	20604	41001
3831	43034	181507	242271	148622	168826	68492	32399	14923	11663	17809
4918	67456	350855	854331	1065380	260669	108795	39021	18755	5675	21064
5697	4846	80411	339540	652443	591404	199282	42122	12860	3774	2597
11787	93332	788950	992744	1280086	1145581	443000	78443	26304	7859	14155
10167	93997	320239	744931	1661991	911912	979462	185418	30434	13976	10309
9897	431700	632571	858288	762350	711940	291167	215022	22193	3298	8388
8230	67268	468037	544401	912161	684171	509591	271094	101874	19323	7745
7281	52000	481000	803000	854000	380000	112000	63000	42000	31000	15000
7160	62000	183000	698000	841000	1001000	206000	70000	21000	13000	9000
7510	44000	250000	847000	1044000	439000	93000	19000	4000	1000	6000
FLT03:	Danish	trawlers								
1987	2000									
1	1	0	1							
2	11									
33391	255915	1177661	2468347	2379126	1046122	215078	50415	32514	24420	37438
30602	108178	839066	1906117	1819047	700988	226895	75481	23885	20953	22426
33925	430316	927355	1291748	1026225	456678	165557	71803	37576	18121	35819
38754	1181442	2311097	2020630	2065160	631904	200416	85590	45586	22634	42975
37772	660031	2459249	2424238	1085399	580774	151470	52786	31364	18475	27441
35003	324054	1244765	2463167	3594631	910595	232058	62318	14226	3014	12454
29955	172192	866648	2265364	2200206	1312213	455227	82231	15921	12071	15309
29386	506609	1815439	1886714	2177012	1785146	732729	113303	17909	12336	11983
26104	262364	791718	1217689	2119319	1052643	706432	144496	23084	11096	8823
28078	1044742	1432920	1503021	1053244	772862	329651	235696	24501	4352	9874
26026	166014	1234787	1637715	1843447	841073	352324	143468	96237	15809	6255
25228	210000	1613000	1953000	1285000	495000	120000	54000	36000	23000	9000
26738	223000	761000	1739000	1403000	1024000	212000	58000	10000	11000	8000
28922	514000	1392000	2182000	2529000	762000	168000	25000	6000	3000	6000

Table 10.3.1 (Continued)

FLT04:		Danish	seiners								
	1987	2000									
	1	1	0	1							
	2	11									
	7919	97426	1157332	4050596	5227390	2536790	426009	72398	40925	20944	22943
	6981	466750	1343996	3116463	3368983	1446989	521283	158464	47106	16431	19006
	9646	334835	1483241	3030013	2733969	1193297	477612	171227	76749	33563	39868
	9441	1116082	3542256	3431384	3748325	1097119	299716	116328	81119	32922	60674
	8984	515012	2426848	3289407	1838074	1057052	265606	88516	42174	17972	28587
	8842	106267	791895	4199036	6819566	1725235	324760	77400	27070	4686	17868
	7411	139121	509253	1721085	2800822	1649545	413535	89601	21958	5718	3978
	7276	336892	1620907	1883228	2514844	1977352	552285	69993	19937	4536	4288
	6825	195908	569871	1348638	2282155	1664669	1118605	153081	23915	11391	8384
	6417	949342	1363113	1878662	980782	913661	327089	230807	22762	3019	6502
	5791	165538	1193786	1794123	2572264	1359436	909634	392850	278160	26736	5420
	5534	144000	2251000	2489000	2044000	884000	231000	109000	61000	49000	14000
	6065	173000	721000	2487000	2755000	2425000	367000	103000	16000	36000	9000
	5926	286000	1240000	2954000	4300000	1202000	334000	46000	3000	1000	3000
FLT05:		Havfisken	spring	1st	Q						
	1997	2000									
	1	1	0	0.25							
	1	7									
	1	0	7.502	13.76	3.878	1.254	0.147	0.116			
	1	3.427	9.876	7.375	14.022	3.912	1.089	0.3			
	1	4.285	37.263	20.471	4.09	0.976	0.4	0.043			
	1	34.633	165.998	54.522	10.366	1.74	1.513	0.076			
FLT06:		Havfisken	fall	3rd	Q						
	1996	2000									
	1	1	0.5	0.75							
	1	6									
	1	5.851	31.705	8.066	0.89	0.201	0.18				
	1	9.822	7.855	5.796	2.003	0.991	0.676				
	1	50.874	26.331	5.785	3.339	0.109	0.063				
	1	111.801	59.898	9.31	1.259	0.637	0.487				
	1	96.01	73.006	16.464	0.419	0.208	0.486				

Table 10.4.1 Plaice in IIIa. Diagnostics from the XSA run5

Lowestoft VPA Version 3.1
22/06/2001 9:54
Extended Survivors Analysis

Plaice IIIa VPA data 2001 W ANON MBSEX
CPUE data from file ple3afl_run5.dat
Catch data for 23 years. 1978 to 2000. Ages 2 to 11.

Fleet	First year	Last year	First age	Last age	Alpha	Beta
FLT01: ARGOS 1st Q	1991	2000	4	6	.990	1.000
FLT02: Danish gillnetters	1987	2000	2	10	.000	1.000
FLT03: Danish trawlers	1987	2000	2	10	.000	1.000
FLT04: Danish seiner	1987	2000	2	10	.000	1.000

Time series weights :

Tapered time weighting applied
Power = 3 over 20 years

Catchability analysis :

Catchability independent of stock size for all ages
Catchability independent of age for ages >= 8

Terminal population estimation :

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

S.E. of the mean to which the estimates are shrunk = .500

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

Prior weighting not applied

Tuning converged after 24 iterations

Regression weights

.751	.820	.877	.921	.954	.976	.990	.997	1.000	1.000

Table 10.4.1 (Con´t)

Fishing mortalities

Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
2	.049	.021	.032	.044	.012	.115	.010	.014	.017	.028
3	.154	.097	.096	.270	.083	.182	.152	.159	.077	.118
4	.253	.290	.350	.295	.396	.407	.299	.378	.266	.325
5	.476	.867	.543	.603	.790	.561	1.044	.541	.713	.617
6	.929	.971	.924	.657	.955	.795	1.548	1.040	1.775	.698
7	.980	.927	1.201	1.132	1.001	.660	1.898	1.029	1.953	1.118
8	.890	.943	.954	1.184	1.248	.741	1.450	1.596	2.631	1.352
9	1.468	.907	.939	.735	1.455	.666	1.369	.983	1.902	1.079
10	1.001	1.018	1.101	.992	1.212	.940	1.494	1.070	1.701	.887

XSA population numbers (Thousands)

YEAR	AGE 2	3	4	5	6	7	8	9	10
1991	50,700	63,300	45,000	12,900	5,030	1,500	546	213	145
1992	45,300	43,700	49,100	31,600	7,270	1,800	510	203	44
1993	35,100	40,100	35,900	33,200	12,000	2,490	643	180	74
1994	34,700	30,800	33,000	22,900	17,500	4,310	679	224	64
1995	37,900	30,100	21,200	22,200	11,300	8,190	1,260	188	97
1996	43,700	33,900	25,000	12,900	9,110	3,940	2,720	327	40
1997	53,400	35,200	25,600	15,100	6,680	3,720	1,840	1,170	152
1998	42,100	47,800	27,400	17,200	4,800	1,290	505	391	270
1999	41,700	37,500	36,900	17,000	9,040	1,540	416	93	132
2000	46,900	37,100	31,400	25,600	7,530	1,390	197	27	13

Estimated population abundance at 1st Jan 2001

0	41,300	29,800	20,500	12,500	3,390	410	46	8

Taper weighted geometric mean of the VPA populations:

44500	39100	31000	19400	7980	2480	778	255	102

Standard error of the weighted Log(VPA populations) :

.2289	.2495	.2742	.3517	.4230	.5792	.7196	.9797	.9481

Log catchability residuals.

Fleet : FLT01: ARGOS 1st Q (

Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
2	this age									
3	this age									
4	-.58	.52	-.65	-.59	.26	-.19	-.06	.40	.27	.44
5	-.20	.97	.06	.16	-.24	-1.27	.04	-1.49	1.27	.79
6	-.26	.42	.00	-.17	-.56	-1.68	.48	-.24	.75	1.20
7	this age									
8	this age									
9	this age									
10	this age									

Table 10.4.1 (Con´t)

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

Age	4	5	6
Mean Log q	-9.3017	-9.6622	-9.7633
S.E(Log q)	.4521	.9130	.8199

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
4	1.28	-.341	9.01	.17	10	.61	-9.30
5	.44	1.437	9.79	.47	10	.38	-9.66
6	1.46	-.413	10.09	.10	10	1.26	-9.76

Fleet : FLT02: Danish gill-n

Age	1987	1988	1989	1990
2	-.26	.11	-.90	.14
3	.12	.22	-.66	-.07
4	.49	.71	-.44	.03
5	.55	.54	-.33	.08
6	.39	.33	-.25	-.17
7	.22	.43	.07	-.36
8	-.40	.29	.07	-.09
9	-.04	.31	.23	.16
10	.19	.48	.54	.36

Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
2	.20	.50	-2.02	.23	.28	1.74	-.18	-.08	.12	-.38
3	-.36	.40	-1.14	.77	-.05	.58	.41	.26	-.49	-.19
4	-.76	.18	-.55	-.14	.21	.22	-.13	.35	-.12	.21
5	-.76	.24	-.59	-.24	.28	-.04	.38	.09	.18	-.10
6	-.07	-.24	-.09	-.64	-.16	-.23	.52	.19	.82	-.29
7	-.08	-.07	.17	-.33	-.09	-.69	.60	-.06	.73	-.32
8	-.06	-.03	-.33	-.40	.02	-.79	.30	.31	.97	-.06
9	.33	.14	-.25	-.57	.19	-.97	-.26	-.07	1.04	.25
10	.29	.51	-.52	-.41	-.02	-.65	.18	.03	.13	-.44

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

Age	2	3	4	5	6	7	8	9	10
Mean Log q	-8.5466	-6.7176	-5.6386	-4.7766	-4.1959	-3.8542	-3.6509	-3.6509	-3.6509
S.E(Log q)	.8552	.5393	.3760	.3712	.4092	.4156	.4502	.5110	.4051

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	.82	.175	8.93	.09	14	.74	-8.55
3	1.86	-.629	3.40	.05	14	1.04	-6.72
4	2.24	-1.224	-.17	.09	14	.82	-5.64
5	.94	.162	5.06	.48	14	.37	-4.78
6	1.24	-.617	3.04	.41	14	.52	-4.20
7	1.05	-.216	3.65	.65	14	.46	-3.85
8	1.26	-1.084	2.88	.65	14	.56	-3.65
9	1.24	-1.238	3.18	.74	14	.62	-3.63
10	.78	2.418	3.85	.93	14	.26	-3.66

Table 10.4.1 (Con´t)

Fleet : FLT03: Danish trawle

Age	1987	1988	1989	1990
2	-.18	-.91	-.32	.47
3	-.04	-.23	-.18	-.07
4	.09	.29	-.29	.15
5	-.11	.23	-.20	.22
6	-.47	-.22	-.23	-.05
7	-.93	-.69	-.51	-.19
8	-1.20	-.88	-.86	-.18
9	-.73	-1.13	-.71	-.45
10	-.19	-.05	-.53	-.34

Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
2	.28	-.25	-.47	.64	.00	1.22	-.80	-.29	-.28	.37
3	-.06	-.32	-.44	.66	-.12	.33	.21	.20	-.40	.15
4	-.41	-.39	.02	-.08	.09	.06	.16	.33	-.19	.14
5	-.44	.11	-.42	-.01	.19	-.14	.55	-.12	-.01	.05
6	-.18	.00	.00	-.17	-.02	-.25	.52	.16	.47	-.14
7	-.37	-.07	.55	.47	-.15	-.39	.29	-.02	.66	.14
8	-.44	-.10	.10	.48	.25	-.32	-.06	.34	.89	.29
9	.21	-.67	-.27	-.44	.40	-.49	-.04	-.05	.40	.74
10	-.11	-.66	.40	.55	.23	.01	.25	-.09	.07	.74

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

Age	2	3	4	5	6	7	8	9	10
Mean Log q	-8.1806	-6.6929	-5.9698	-5.3928	-5.1402	-5.0658	-5.0755	-5.0755	-5.0755
S.E(Log q)	.5951	.3258	.2336	.2714	.2746	.4391	.5286	.5365	.4056

Regression statistics :

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

Age	Slope	t-value	ntercept	RSquare	No Pts	Reg s.e	Mean Q
2	.85	.205	8.56	.16	14	.53	-8.18
3	1.39	-.633	5.18	.22	14	.47	-6.69
4	2.76	-2.902	-1.69	.22	14	.49	-5.97
5	1.04	-.133	5.23	.59	14	.30	-5.39
6	1.16	-.657	4.52	.64	14	.33	-5.14
7	1.14	-.508	4.68	.59	14	.52	-5.07
8	1.54	-1.723	4.22	.52	14	.75	-5.08
9	1.51	-2.562	5.08	.73	14	.63	-5.22
10	1.28	-1.797	5.14	.81	14	.46	-5.01

Fleet : FLT04: Danish seiner

Age	1987	1988	1989	1990
2	-.87	.86	-.49	.65
3	-.02	.32	.14	.36
4	.32	.55	.11	.38
5	.25	.46	.18	.36
6	-.10	.03	.03	-.04
7	-.70	-.28	-.09	-.27
8	-1.22	-.49	-.56	-.28
9	-.89	-.79	-.56	-.28
10	-.73	-.64	-.47	-.37

Table 10.4.1 (Con´t)

Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
2	.30	-1.16	-.46	.46	-.12	1.43	-.47	-.32	-.22	.19
3	-.05	-.81	-.99	.54	-.51	.35	.27	.65	-.38	.22
4	-.38	-.19	-.56	-.39	-.18	.06	.04	.38	-.06	.32
5	-.35	.26	-.65	-.33	-.26	-.60	.52	-.01	.28	.30
6	-.10	.05	-.34	-.62	-.17	-.56	.55	.30	.86	-.06
7	-.26	-.25	-.05	-.32	-.24	-.82	.84	.26	.79	.52
8	-.31	-.33	-.24	-.43	-.17	-.68	.63	.74	1.13	.66
9	.12	-.48	-.37	-.76	-.05	-.91	.70	.18	.53	-.19
10	-.53	-.67	-.77	-.87	-.23	-.71	.45	.36	.92	-.60

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	-7.0102	-5.2861	-4.2635	-3.5267	-3.1841	-3.1709	-3.2542	-3.2542	-3.2542
S.E(Log q)	.6958	.5236	.3300	.4038	.4317	.5237	.6522	.5674	.6567

Regression statistics :

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

Age	Slope	t-value	ntercept	₹Square	No Pts	Reg s.e	Mean Q
2	.96	.041	7.16	.10	14	.70	-7.01
3	1.01	-.010	5.25	.16	14	.55	-5.29
4	2.52	-1.589	-4.94	.10	14	.78	-4.26
5	1.08	-.179	3.05	.37	14	.46	-3.53
6	1.85	-1.512	-1.75	.25	14	.75	-3.18
7	1.53	-1.299	.71	.39	14	.78	-3.17
8	1.77	-1.724	.64	.35	14	1.06	-3.25
9	.99	.047	3.47	.78	14	.55	-3.45
10	.78	1.535	3.77	.84	14	.43	-3.54

Terminal year survivor and F summaries :
Age 2 Catchability constant w.r.t. time and dependent on age

Year class = 1998

Fleet	stimated urvivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	stimated F
FLT01: ARGOS 1st Q (	1.	.000	.000	.00	0	.000	.000
FLT02: Danish gill-n	28281.	.892	.000	.00	1	.127	.040
FLT03: Danish trawle	59492.	.621	.000	.00	1	.263	.019
FLT04: Danish seiner	50125.	.726	.000	.00	1	.192	.023
F shrinkage mean	33636.	.50				.417	.034

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
41278.	.32	.18	4	.569	.028

Table 10.4.1 (Con´t)

Age 3 Catchability constant w.r.t. time and dependent on age

Year class = 1997

Fleet	stimated urvivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	stimated F
FLT01: ARGOS 1st Q (	1.	.000	.000	.00	0	.000	.000
FLT02: Danish gill-n	26914.	.476	.142	.30	2	.174	.130
FLT03: Danish trawle	31493.	.298	.181	.61	2	.443	.112
FLT04: Danish seiner	31664.	.436	.209	.48	2	.206	.112
F shrinkage mean	26813.	.50				.178	.131

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
29815.	.20	.07	7	.372	.118

Age 4 Catchability constant w.r.t. time and dependent on age

Year class = 1996

Fleet	stimated urvivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	stimated F
FLT01: ARGOS 1st Q (	31817.	.476	.000	.00	1	.080	.222
FLT02: Danish gill-n	20303.	.303	.217	.72	3	.191	.329
FLT03: Danish trawle	18424.	.212	.186	.88	3	.389	.357
FLT04: Danish seiner	22153.	.271	.233	.86	3	.240	.305
F shrinkage mean	18839.	.50				.100	.350

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
20539.	.14	.10	11	.713	.325

Age 5 Catchability constant w.r.t. time and dependent on age

Year class = 1995

Fleet	stimated urvivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	stimated F
FLT01: ARGOS 1st Q (	18641.	.429	.221	.51	2	.065	.452
FLT02: Danish gill-n	11755.	.242	.076	.31	4	.211	.646
FLT03: Danish trawle	11924.	.176	.140	.79	4	.391	.639
FLT04: Danish seiner	14366.	.231	.174	.75	4	.225	.555
F shrinkage mean	9862.	.50				.108	.733

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
12504.	.12	.07	15	.619	.617

Table 10.4.1 (Con´t)

Age 6 Catchability constant w.r.t. time and dependent on age

Year class = 1994

Fleet	stimated urvivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	stimated F
FLT01: ARGOS 1st Q (	7996.	.432	.288	.67	3	.057	.356
FLT02: Danish gill-n	3589.	.235	.198	.84	5	.206	.670
FLT03: Danish trawle	3524.	.170	.134	.78	5	.397	.679
FLT04: Danish seiner	4187.	.231	.156	.68	5	.203	.598
F shrinkage mean	1414.	.50				.136	1.230

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
3389.	.12	.12	19	1.012	.698

Age 7 Catchability constant w.r.t. time and dependent on age

Year class = 1993

Fleet	stimated urvivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	stimated F
FLT01: ARGOS 1st Q (	405.	.412	.528	1.28	3	.018	1.126
FLT02: Danish gill-n	370.	.310	.174	.56	6	.216	1.189
FLT03: Danish trawle	494.	.250	.079	.32	6	.260	.997
FLT04: Danish seiner	641.	.336	.120	.36	6	.160	.841
F shrinkage mean	309.	.50				.346	1.316

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
410.	.20	.09	22	.422	1.118

Age 8 Catchability constant w.r.t. time and dependent on age

Year class = 1992

Fleet	stimated urvivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	stimated F
FLT01: ARGOS 1st Q (	38.	.479	.065	.14	3	.005	1.491
FLT02: Danish gill-n	49.	.372	.111	.30	7	.197	1.305
FLT03: Danish trawle	64.	.373	.067	.18	7	.168	1.125
FLT04: Danish seiner	85.	.479	.080	.17	7	.106	.936
F shrinkage mean	36.	.50				.524	1.543

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
46.	.28	.09	25	.313	1.352

Table 10.4.1 (Con´t)

Age 9 Catchability constant w.r.t. time and age (fixed at the value for age) 8

Year class = 1991

Fleet	stimated urvivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	stimated F
FLT01: ARGOS 1st Q (	9.	.427	.438	1.03	3	.001	1.025
FLT02: Danish gill-n	11.	.465	.081	.17	8	.179	.890
FLT03: Danish trawle	17.	.486	.067	.14	8	.162	.673
FLT04: Danish seiner	7.	.535	.114	.21	8	.140	1.153
F shrinkage mean	6.	.50				.518	1.283

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
8.	.29	.10	28	.342	1.079

Age 10 Catchability constant w.r.t. time and age (fixed at the value for age) 8

Year class = 1990

Fleet	stimated urvivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	stimated F
FLT01: ARGOS 1st Q (	2.	.447	.422	.94	3	.000	1.577
FLT02: Danish gill-n	3.	.378	.149	.39	9	.253	1.070
FLT03: Danish trawle	9.	.382	.045	.12	9	.250	.537
FLT04: Danish seiner	3.	.557	.163	.29	9	.107	1.124
F shrinkage mean	4.	.50				.390	.978

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
5.	.24	.09	31	.372	.887

Table 10.4.2 Plaice in IIIa. Fishing mortalities from XSA run5

Run title : Plaice IIIa VPA data 2001 WG ANON COMBSEX PLUSGROUP

At 22/06/2001 9:55

Terminal Fs derived using XSA (With F shrinkage)

Table 8 Fishing mortality (F) at age

YEAR		1978	1979	1980
AGE				
	2	.0084	.0257	.0111
	3	.2335	.2058	.1327
	4	.7572	.7969	.5480
	5	1.0753	1.0747	.8465
	6	1.0200	1.0636	.9628
	7	.5951	.9543	1.0674
	8	.2824	.2829	1.0973
	9	.4844	.5608	.5648
	10	.6945	.7910	.9125
+gp		.6945	.7910	.9125
0 FBAR 4- 8		.7460	.8345	.9044

Table 8 Fishing mortality (F) at age

YEAR		1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
AGE											
	2	.0078	.0115	.0166	.0326	.0305	.0107	.0191	.0032	.0162	.0462
	3	.1487	.0988	.2684	.1721	.1591	.1129	.1434	.1103	.1454	.1697
	4	.5627	.5156	.6527	.4946	.4438	.3936	.4705	.6638	.3565	.4910
	5	.7787	1.1262	1.0503	.7470	.5035	.7842	1.0216	1.3396	.7789	1.0434
	6	.7010	1.0772	.8691	.8179	.6380	.7332	1.2029	1.4310	.9463	1.1125
	7	.5503	.6588	.4408	.8300	.5928	.4528	.8160	1.1794	.9174	.9969
	8	.6559	.5635	.3505	.9119	.4736	.4324	.4668	.9979	.6889	1.1465
	9	.6835	.8318	.3335	.9342	.4441	.5051	.7507	.8383	.7097	1.1926
	10	.6768	.8558	.6113	.8524	.5324	.5838	.8904	1.1865	.9483	1.1939
+gp		.6768	.8558	.6113	.8524	.5324	.5838	.8904	1.1865	.9483	1.1939
0 FBAR 4- 8		.6497	.7883	.6726	.7603	.5303	.5592	.7956	1.1224	.7376	.9581

1

Run title : Plaice IIIa VPA data 2001 WG ANON COMBSEX PLUSGROUP

At 22/06/2001 9:55

Terminal Fs derived using XSA (With F shrinkage)

Table 8 Fishing mortality (F) at age

YEAR		1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	FBAR 98
AGE												
	2	.0490	.0212	.0316	.0437	.0124	.1154	.0105	.0141	.0175	.0278	.0198
	3	.1544	.0974	.0964	.2698	.0830	.1816	.1520	.1588	.0774	.1183	.1182
	4	.2535	.2903	.3503	.2954	.3958	.4075	.2990	.3776	.2658	.3253	.3229
	5	.4762	.8672	.5428	.6035	.7902	.5606	1.0437	.5409	.7131	.6168	.6236
	6	.9289	.9709	.9243	.6572	.9545	.7945	1.5485	1.0400	1.7748	.6983	1.1710
	7	.9803	.9274	1.2008	1.1323	1.0014	.6599	1.8980	1.0290	1.9533	1.1185	1.3669
	8	.8904	.9434	.9537	1.1842	1.2485	.7407	1.4503	1.5955	2.6313	1.3523	1.8597
	9	1.4678	.9074	.9393	.7349	1.4549	.6659	1.3685	.9833	1.9021	1.0787	1.3214
	10	1.0010	1.0184	1.1012	.9920	1.2119	.9399	1.4943	1.0697	1.7010	.8865	1.2191
+gp		1.0010	1.0184	1.1012	.9920	1.2119	.9399	1.4943	1.0697	1.7010	.8865	
0 FBAR 4- 8		.7058	.7998	.7944	.7745	.8781	.6326	1.2479	.9166	1.4677	.8222	

Table 10.4.3 Plaice in IIIa. Estimated population abundance from XSA run5

Run title : Plaice IIIa VPA data 2001 W ANON COMBSEX PLUSGROUP

At 22/06/2001 9:55

Terminal Fs derived using XSA (With F shrinkage)

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

	YEAR	1978	1979	1980
	AGE			
	2	61660	45789	34420
	3	79224	55327	40380
	4	78263	56758	40751
	5	39763	33212	23148
	6	13172	12276	10260
	7	1453	4298	3834
	8	269	725	1497
	9	173	184	495
	10	101	96	95
	+gp	125	105	87
0	TOTAL	274204	208770	154967

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

	YEAR	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
	AGE										
	2	25718	48500	94319	70512	48967	37165	34610	33109	66180	73244
	3	30800	23090	43384	83935	61753	42975	33272	30724	29862	58919
	4	31998	24018	18926	30015	63943	47657	34733	26085	24897	23364
	5	21317	16494	12978	8916	16562	37123	29092	19632	12152	15772
	6	8984	8854	4839	4108	3822	9058	15333	9478	4653	5046
	7	3545	4033	2728	1836	1641	1827	3937	4167	2050	1634
	8	1193	1850	1888	1589	725	821	1051	1575	1159	741
	9	452	560	953	1203	578	408	482	596	525	527
	10	254	207	221	618	428	335	223	206	233	234
	+gp	206	87	242	218	395	232	336	234	402	408
0	TOTAL	124468	127693	180479	202951	198813	177601	153069	125805	142114	179889
	1										

Run title : Plaice IIIa VPA data

At 22/06/2001 9:55

Terminal Fs derived using XSA (With F shrinkage)

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

	YEAR	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	GMST 78-98	AMST 78-98
	AGE													
	2	50740	45269	35082	34712	37926	43674	53406	42067	41712	46905	0*	46053	48432
	3	63280	43715	40101	30756	30067	33893	35211	47820	37529	37089	41278	42089	44690
	4	44991	49067	35885	32951	21247	25040	25575	27369	36915	31427	29815	33741	36359
	5	12938	31594	33213	22874	22190	12942	15075	17161	16977	25606	20539	19922	21626
	6	5027	7271	12010	17464	11319	9111	6685	4803	9041	7529	12504	7940	8742
	7	1501	1797	2492	4312	8191	3943	3725	1286	1536	1387	3389	2713	3059
	8	546	510	643	679	1258	2723	1844	505	416	197	410	979	1133
	9	213	203	180	224	188	327	1175	391	93	27	46	399	478
	10	145	44	74	63	97	40	152	270	132	13	8	156	197
	+gp	226	188	108	91	76	77	47	101	53	51	24		
0	TOTAL	179607	179658	159787	144128	132559	131767	142894	141774	144403	150232	108014		

Table 10.4.4 Plaice in IIIa. Historical trends in SSB, recruitment and F-bar from XSA run5

Run title : Pl 2001 WG ANON COMBSEX PLUSGROUP

At 22/06/2001 9:55

Table 16 Summary (without SOP correction)

Terminal Fs derived using XSA (With F shrinkage)

	RECRUITS Age 2	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	FBAR 4- 8
1978	61660	74881	60329	26953	.4468	.7460
1979	45789	56723	46558	21976	.4720	.8345
1980	34420	48458	39475	16445	.4166	.9044
1981	25718	38488	32573	12602	.3869	.6497
1982	48500	39803	26708	11047	.4136	.7883
1983	94319	54422	27541	10780	.3914	.6726
1984	70512	61370	41486	11591	.2794	.7603
1985	48967	60750	47137	13482	.2860	.5303
1986	37165	52171	42880	14052	.3277	.5592
1987	34610	48134	36990	15658	.4233	.7956
1988	33109	36321	27977	12850	.4593	1.1224
1989	66180	41322	23189	7741	.3338	.7376
1990	73244	54964	33576	12082	.3598	.9581
1991	50740	49034	35690	8700	.2438	.7058
1992	45269	53788	39799	11931	.2998	.7998
1993	35082	45632	36265	11323	.3122	.7944
1994	34712	41250	31704	11325	.3572	.7745
1995	37926	39519	29544	10766	.3644	.8781
1996	43674	39848	28231	10545	.3735	.6326
1997	53406	43438	27416	10135	.3697	1.2479
1998	42067	39427	28489	8391	.2945	.9166
1999	41712	40611	29307	8470	.2890	1.4677
2000	46905	41577	29522	8820	.2988	.8222
2001	46053*		31427			
Arith. Mean	48073	47910	34886	12507	.3565	.8304
0 Units	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)		

*GM (1978-98)
SSB estimated using average wt at age in the stock (1998-2000)

Table 10.7.1 plaice,IIIa

input data for catch forecast and linear sensitivity analysis

Label	Value	CV	Label	Value	CV
Number at age			Weight in the stock		
N2	46053	0.32	WS2	0.26	0.03
N3	41278	0.32	WS3	0.26	0.04
N4	29814	0.20	WS4	0.28	0.03
N5	20539	0.14	WS5	0.31	0.06
N6	12504	0.12	WS6	0.35	0.15
N7	3389	0.12	WS7	0.40	0.16
N8	410	0.20	WS8	0.47	0.18
N9	46	0.28	WS9	0.70	0.20
N10	8	0.29	WS10	0.73	0.30
N11	23	0.24	WS11	0.89	0.08
H.cons selectivity			Weight in the HC catch		
sH2	0.02	0.58	WH2	0.26	0.03
sH3	0.09	0.51	WH3	0.26	0.04
sH4	0.25	0.39	WH4	0.28	0.03
sH5	0.48	0.22	WH5	0.31	0.06
sH6	0.90	0.18	WH6	0.35	0.15
sH7	1.05	0.10	WH7	0.40	0.16
sH8	1.43	0.04	WH8	0.47	0.18
sH9	1.02	0.11	WH9	0.70	0.20
sH10	0.94	0.04	WH10	0.73	0.30
sH11	0.94	0.04	WH11	0.89	0.08
Natural mortality			Proportion mature		
M2	0.10	0.10	MT2	0.00	0.10
M3	0.10	0.10	MT3	1.00	0.10
M4	0.10	0.10	MT4	1.00	0.00
M5	0.10	0.10	MT5	1.00	0.00
M6	0.10	0.10	MT6	1.00	0.00
M7	0.10	0.10	MT7	1.00	0.00
M8	0.10	0.10	MT8	1.00	0.00
M9	0.10	0.10	MT9	1.00	0.00
M10	0.10	0.10	MT10	1.00	0.00
M11	0.10	0.10	MT11	1.00	0.00
Relative effort in HC fishery			Year effect for natural mortality		
HF01	1.00	0.33	K01	1.00	0.10
HF02	1.00	0.33	K02	1.00	0.10
HF03	1.00	0.33	K03	1.00	0.10
Recruitment in 2002 and 2003					
R02	46053	0.32			
R03	46053	0.32			

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

Stock numbers in 2001 are VPA survivors.

Data from file\\ish_sdc\workgrp\2001\data\plaiceIIIa\predictions\pleiiia.sen

Table 10.7.2. plaice,IIIa

Catch forecast output and estimates of coefficient of variation (CV) from linear analysis.

	Year							
	2001	2002						
Mean F Ages								
H.cons 4 to 8	0.82	0.00	0.16	0.33	0.49	0.73	0.82	0.99
Effort relative to 2000								
H.cons	1.00	0.00	0.20	0.40	0.60	0.89	1.00	1.20
Biomass								
Total 1 January	43.5	45.3	45.3	45.3	45.3	45.3	45.3	45.3
SSB at spawning time	31.4	33.2	33.2	33.2	33.2	33.2	33.2	33.2
Catch weight (,000t)								
H.cons	8.61	0.00	2.32	4.36	6.18	8.48	9.26	10.57
Biomass in year.... 2003								
Total 1 January		56.4	53.9	51.6	49.7	47.2	46.4	45.0
SSB at spawning time		44.3	41.7	39.5	37.6	35.1	34.3	32.9

	Year							
	2001	2002						
Effort relative to 2000								
H.cons	1.00	0.00	0.20	0.40	0.60	0.89	1.00	1.20
Est. Coeff. of Variation								
Biomass								
Total 1 January	0.13	0.15	0.15	0.15	0.15	0.15	0.15	0.15
SSB at spawning time	0.13	0.17	0.17	0.17	0.17	0.17	0.17	0.17
Catch weight								
H.cons	0.28	0.00	1.56	0.75	0.49	0.34	0.30	0.26
Biomass in year.... 2003								
Total 1 January		0.14	0.16	0.16	0.16	0.16	0.16	0.16
SSB at spawning time		0.15	0.18	0.18	0.18	0.18	0.18	0.18

Forecast for year 2001
F multiplier H.cons=1.00

Age	Populations: Stock No.	Catch number: H.Cons	Catch number: Total
2	46053	653	653
3	41278	3419	3419
4	29814	6244	6244
5	20539	7481	7481
6	12504	7119	7119
7	3389	2117	2117
8	410	300	300
9	46	28	28
10	8	5	5
11	23	13	13
Wt	44	9	9

Forecast for year 2002
F multiplier H.cons=1.00

Age	Populations: Stock No.	Catch number: H.Cons	Catch number: Total
2	46053	653	653
3	41050	3400	3400
4	34101	7142	7142
5	21052	7667	7667
6	11500	6547	6547
7	4595	2870	2870
8	1071	784	784
9	89	54	54
10	15	9	9
11	11	6	6
Wt	45	9	9

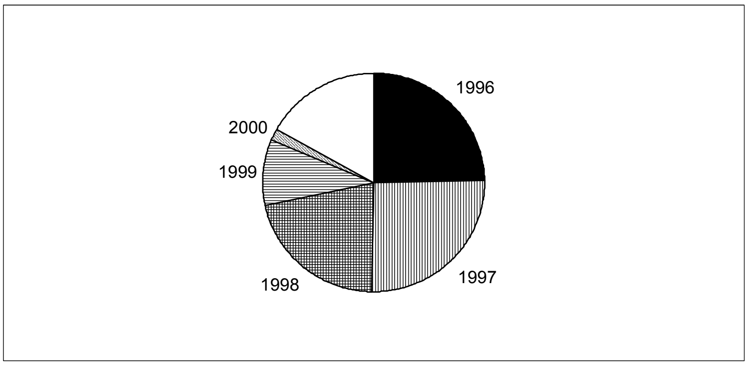
Table 10.7.3. **Plaice (IIIa)**
Stock numbers of recruits and their source for recent year classes used in predictions, and the relative (%) contributions to landings and SSB (by weight) of these year classes

Year-class			1996	1997	1998	1999	2000
Stock No. (thousands)			42067	41712	46905	46053	46053
of	2 year-olds						
Source			VPA	VPA	VPA	GM	GM
Status Quo F:							
% in	2001	landings	26.8	20.2	10.3	2.0	-
% in	2002		24.7	25.6	21.5	9.5	1.8
% in	2001	SSB	20.3	26.6	34.1	0.0	-
% in	2002	SSB	12.1	19.7	28.8	32.2	0.0
% in	2003	SSB	4.9	12.0	21.7	27.7	31.1

GM : geometric mean recruitment

Plaice (IIIa) : Year-class % contribution to

a) 2002 landings



b) 2003 SSB

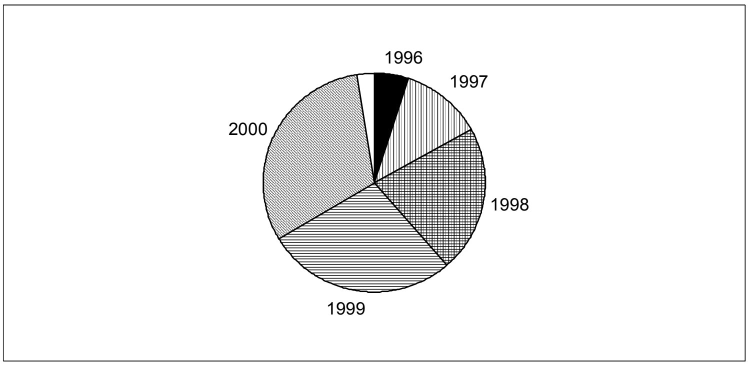


Table 10.8.1

plaice IIIa

Data read from file
\\Ish_sdc\workgrp\2001\data\plaiceIIIa\predictions\pleiiia.rec

Beverton-Holt curve
Moving average term NOT fitted

IFAIL on exit from E04FDF =, 2

Residual sum of squares=, 1.9353

Number of observations=, 21

Number of parameters =, 2

Residual mean square =, .1019

Coefficient of determination =, -.0021

Adj. coeff. of determination =, -.0548

IFAIL from E04YCF=, 0

Parameter Correlation matrix

, 1.0000,
, -1.0000, 1.0000,

Parameter,s.d.

525.7329,65340.0316,
.0863, 10.7573,

Y/Class,SSB,Recruits,Fit. rct,residuals,residuals,wt

Y/Class	SSB	Recruits	Fit. rct	residuals	residuals	wt
1978,	60.30,	34.00,	45.32,	-.2874,	-.2874,	1.0000
1979,	46.60,	26.00,	45.30,	-.5553,	-.5553,	1.0000
1980,	39.50,	49.00,	45.29,	.0788,	.0788,	1.0000
1981,	32.60,	94.00,	45.27,	.7307,	.7307,	1.0000
1982,	26.70,	71.00,	45.24,	.4507,	.4507,	1.0000
1983,	27.50,	49.00,	45.25,	.0797,	.0797,	1.0000
1984,	41.50,	37.00,	45.29,	-.2022,	-.2022,	1.0000
1985,	47.10,	35.00,	45.30,	-.2581,	-.2581,	1.0000
1986,	42.90,	33.00,	45.30,	-.3167,	-.3167,	1.0000
1987,	37.00,	66.00,	45.28,	.3767,	.3767,	1.0000
1988,	28.00,	73.00,	45.25,	.4783,	.4783,	1.0000
1989,	23.20,	51.00,	45.22,	.1203,	.1203,	1.0000
1990,	33.60,	45.00,	45.27,	-.0060,	-.0060,	1.0000
1991,	35.70,	35.00,	45.28,	-.2575,	-.2575,	1.0000
1992,	39.80,	35.00,	45.29,	-.2577,	-.2577,	1.0000
1993,	36.30,	38.00,	45.28,	-.1753,	-.1753,	1.0000
1994,	31.70,	44.00,	45.26,	-.0283,	-.0283,	1.0000
1995,	29.50,	53.00,	45.26,	.1580,	.1580,	1.0000
1996,	28.20,	42.00,	45.25,	-.0745,	-.0745,	1.0000
1997,	27.40,	42.00,	45.25,	-.0744,	-.0744,	1.0000
1998,	28.50,	47.00,	45.25,	.0379,	.0379,	1.0000

Table 10.8.2

Plaice IIIa

Data read from file
\\Ish_sdc\workgrp\2001\data\plaiceIIIa\predictions\pleiiia.rec

Ricker curve
Moving average term NOT fitted

IFAIL on exit from E04FDF =, 0

Residual sum of squares=, 1.3323

Number of observations=, 21

Number of parameters =, 2

Residual mean square =, .0701

Coefficient of determination =, .3101

Adj. coeff. of determination =, .2738

IFAIL from E04YCF=, 0

Parameter Correlation matrix

,	1.0000,	
,	.9713,	1.0000,

Parameter,s.d.

6.8111,	1.6541,
.0464,	.0067,

Y/Class	SSB	Recruits	Fit. rct	residuals	residuals	wt
1978,	60.30,	34.00,	24.96,	.3091,	.3091,	1.0000
1979,	46.60,	26.00,	36.45,	-.3377,	-.3377,	1.0000
1980,	39.50,	49.00,	42.96,	.1315,	.1315,	1.0000
1981,	32.60,	94.00,	48.85,	.6545,	.6545,	1.0000
1982,	26.70,	71.00,	52.62,	.2995,	.2995,	1.0000
1983,	27.50,	49.00,	52.22,	-.0637,	-.0637,	1.0000
1984,	41.50,	37.00,	41.13,	-.1059,	-.1059,	1.0000
1985,	47.10,	35.00,	35.99,	-.0279,	-.0279,	1.0000
1986,	42.90,	33.00,	39.84,	-.1884,	-.1884,	1.0000
1987,	37.00,	66.00,	45.20,	.3786,	.3786,	1.0000
1988,	28.00,	73.00,	51.95,	.3402,	.3402,	1.0000
1989,	23.20,	51.00,	53.80,	-.0534,	-.0534,	1.0000
1990,	33.60,	45.00,	48.06,	-.0659,	-.0659,	1.0000
1991,	35.70,	35.00,	46.32,	-.2803,	-.2803,	1.0000
1992,	39.80,	35.00,	42.69,	-.1986,	-.1986,	1.0000
1993,	36.30,	38.00,	45.81,	-.1868,	-.1868,	1.0000
1994,	31.70,	44.00,	49.53,	-.1184,	-.1184,	1.0000
1995,	29.50,	53.00,	51.05,	.0375,	.0375,	1.0000
1996,	28.20,	42.00,	51.84,	-.2105,	-.2105,	1.0000
1997,	27.40,	42.00,	52.27,	-.2188,	-.2188,	1.0000
1998,	28.50,	47.00,	51.67,	-.0946,	-.0946,	1.0000

Figure 10.2.1 Plaice IIIa. Distribution of catch in numbers (%) by age and by year.

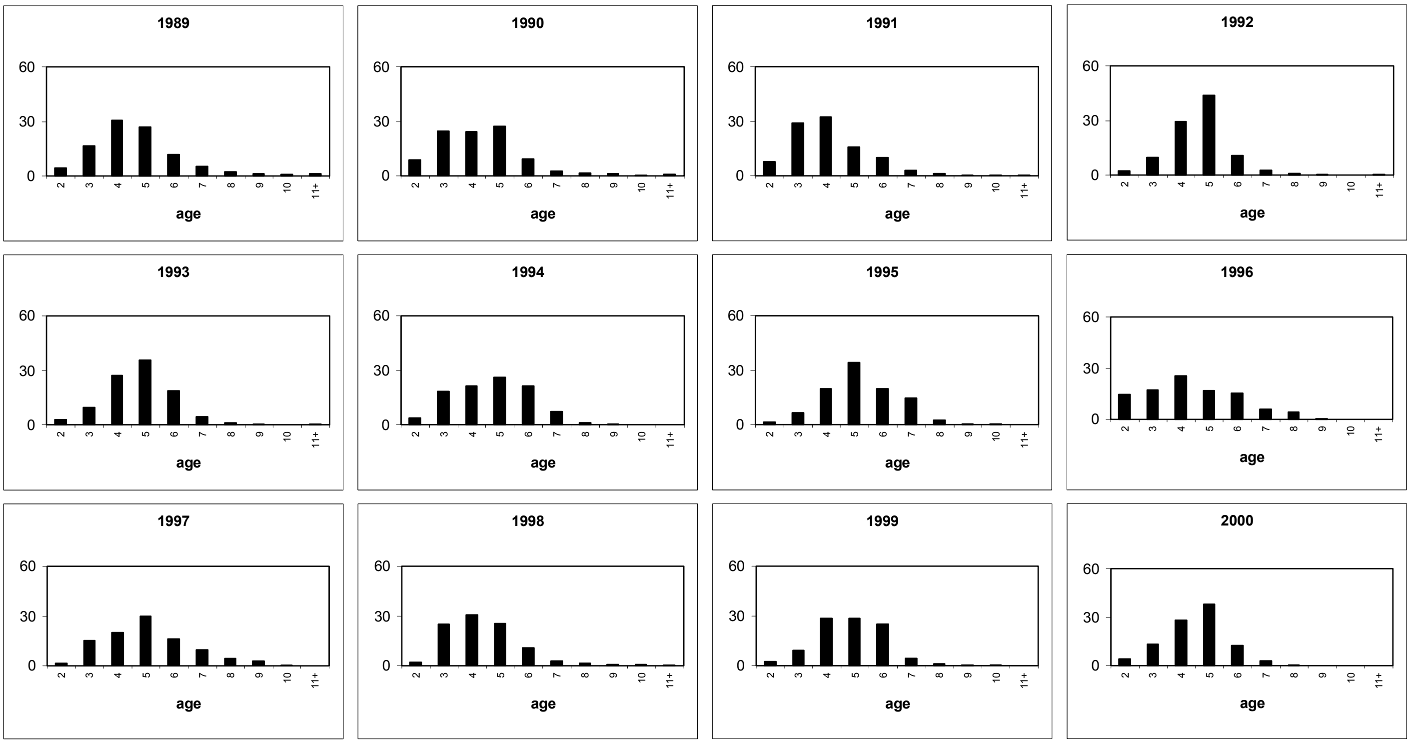


Figure 10.2.2. Time series of catch weight at age for plaice in Kattegat and Skagerrak.

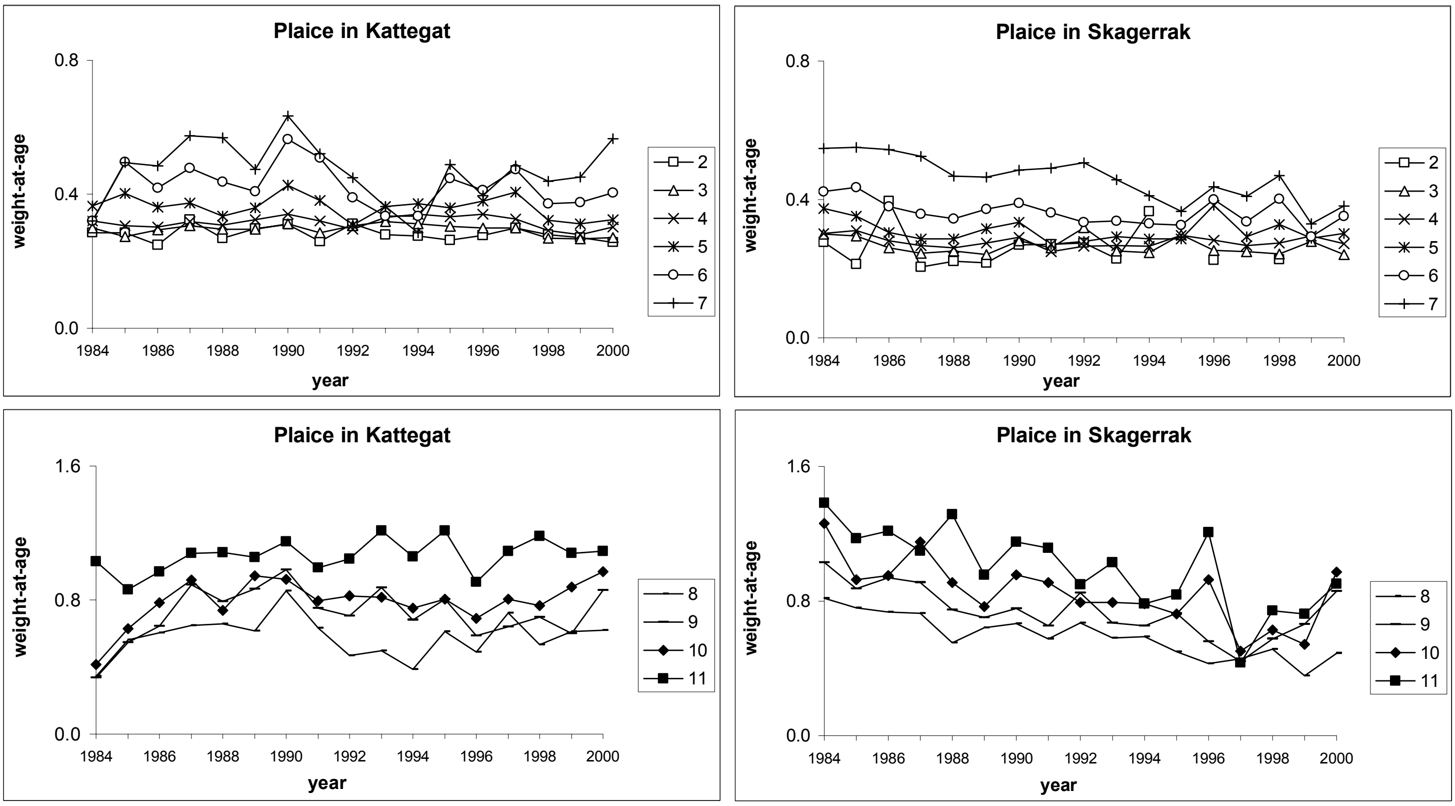


Figure 10.3.1 Plaice in IIIa. Time series of fishing effort (days standardised by vessel length), yield and CPUE from commercial fleets and from surveys.

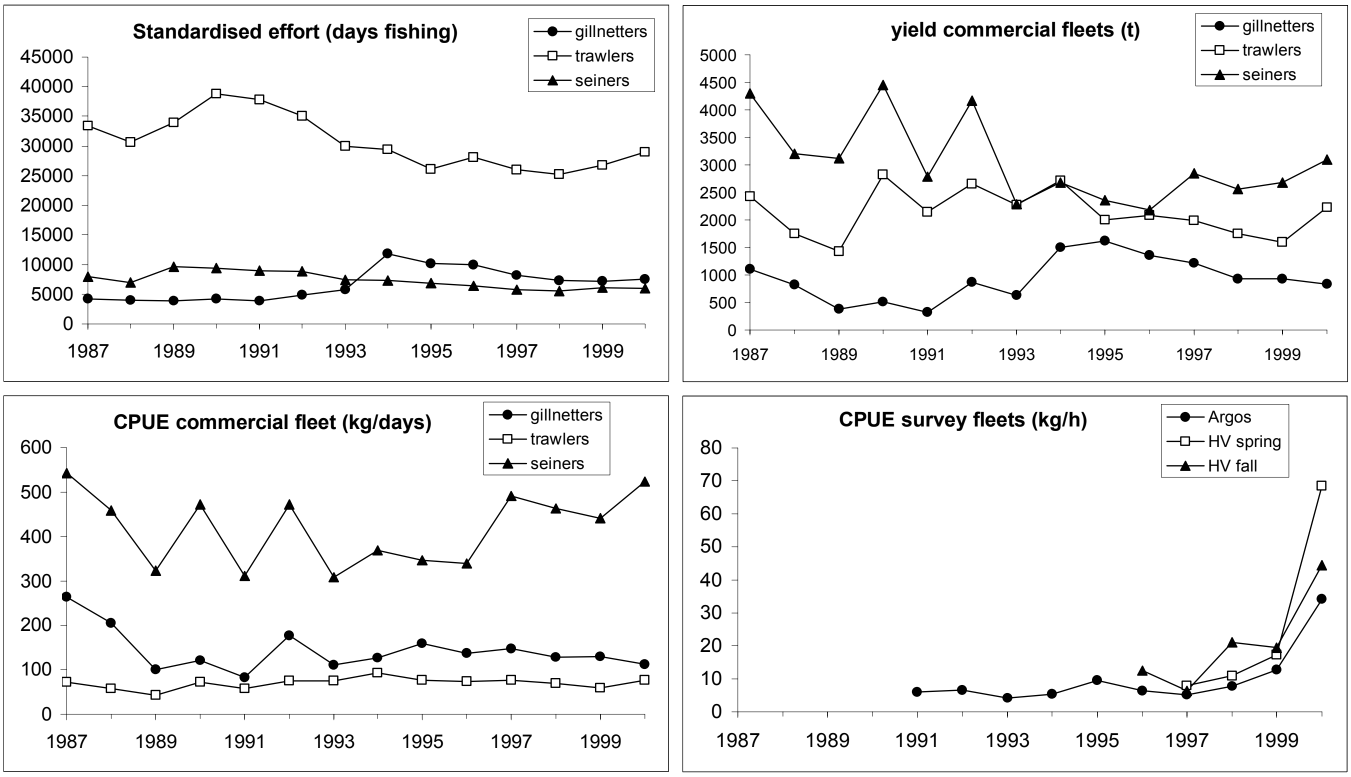


Figure 10.4.1 Plaice in IIIa. Separable VPA log residuals by age.

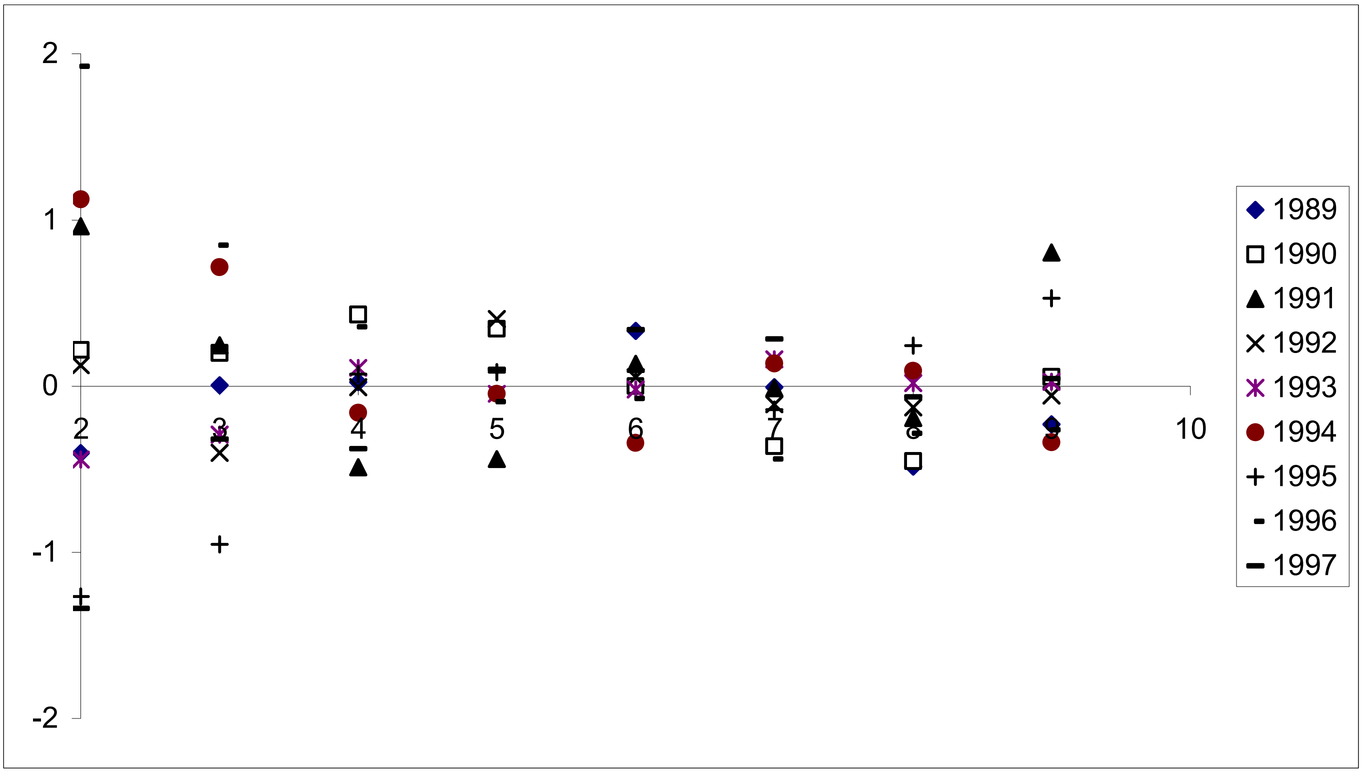


Figure 10.4.2. Plaice IIIa. log residuals by fleet and age (Single fleet XSA runs. Shrinkage 1.5)

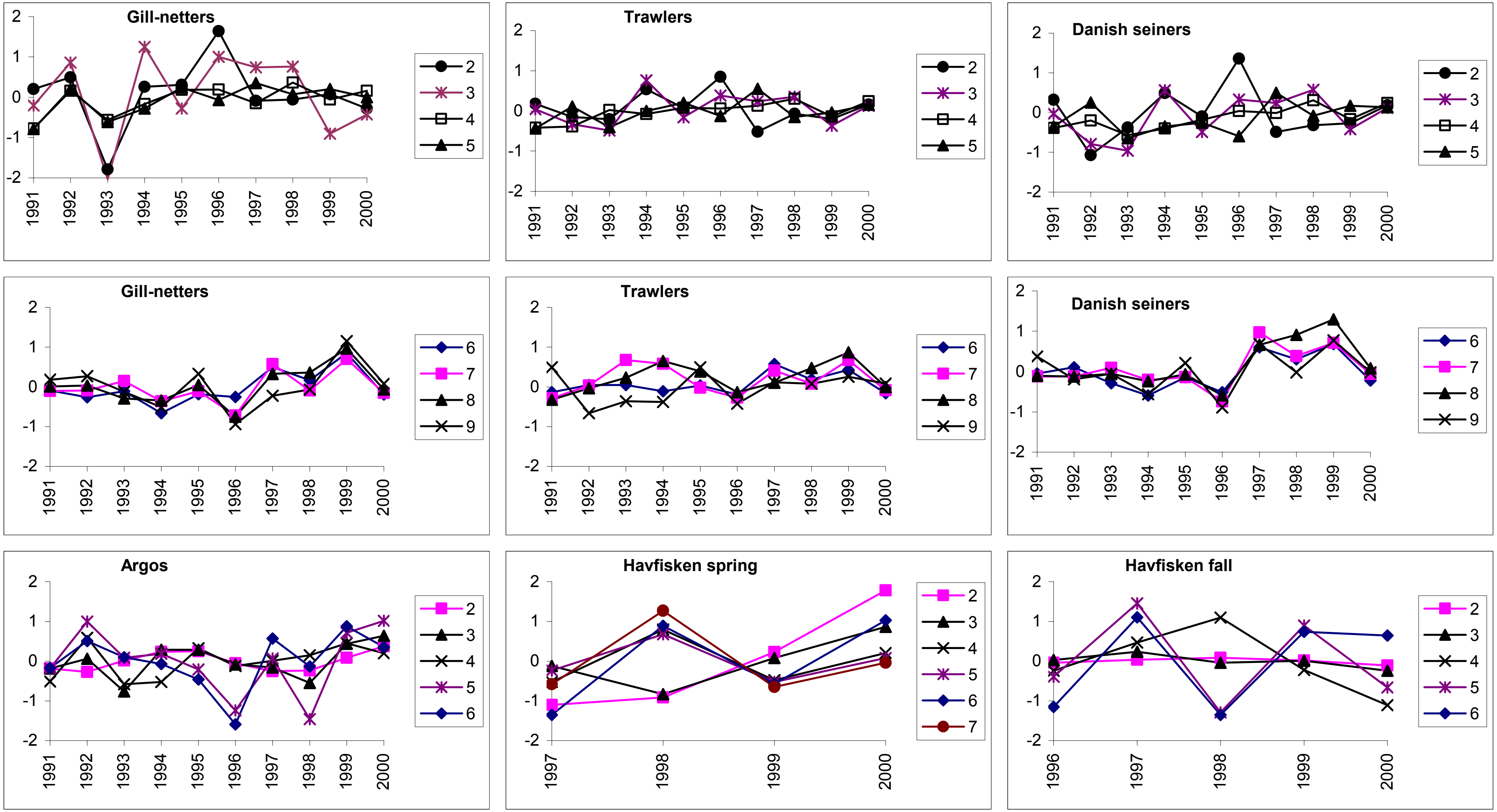


Figure 10.4.3. Plaice in IIIa. Combined fleet run with no power model applied on age 2 and 3 (XSA run 4)

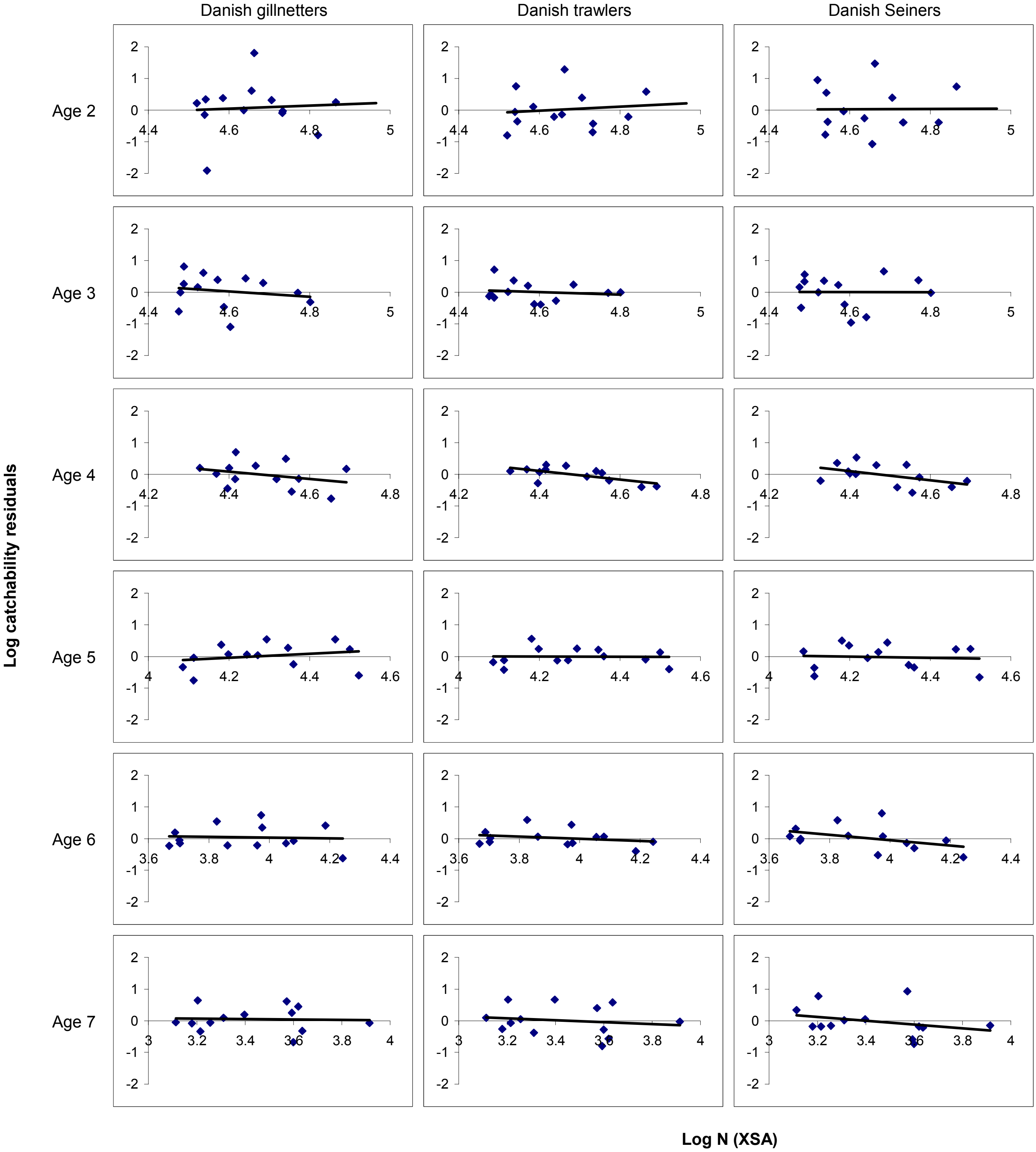


Figure 10.4.4 Plaice in IIIa. SSB versus F 4-8 for different XSA runs.

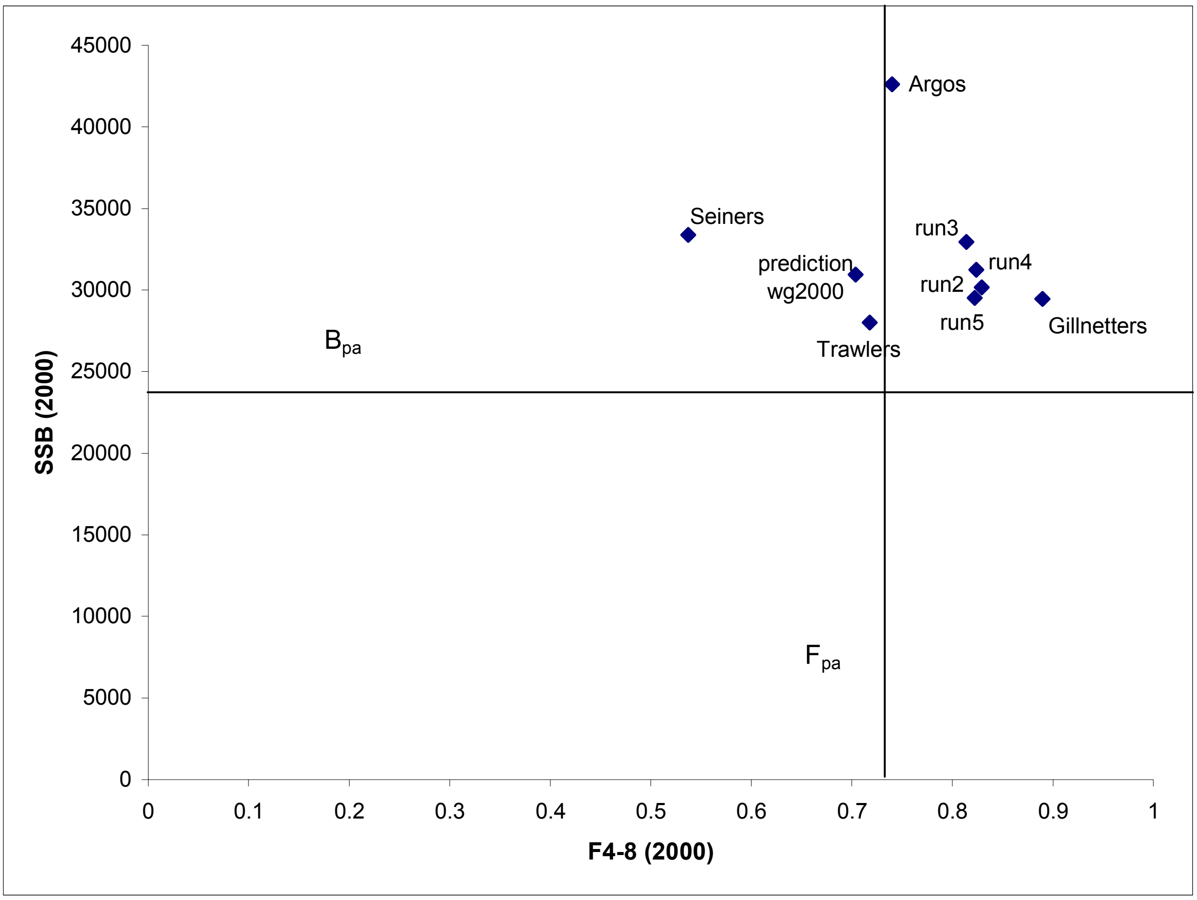


Figure 10.4.5 Plaice IIIa. log residuals by fleet and age (combined fleet XSA run5)

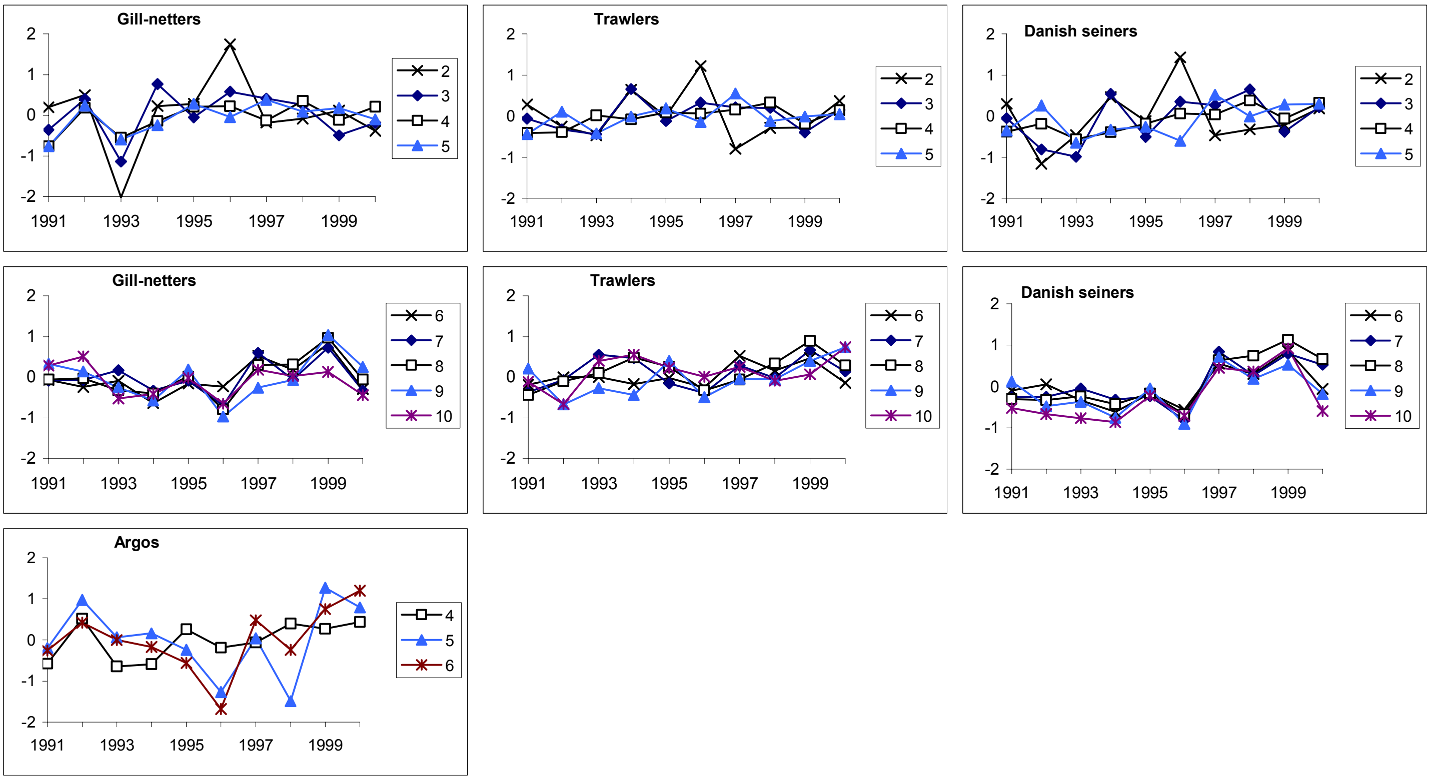


Figure 10.4.6 Plaice in IIIa. Weighting in tuning fleets in 2001 XSA assessment

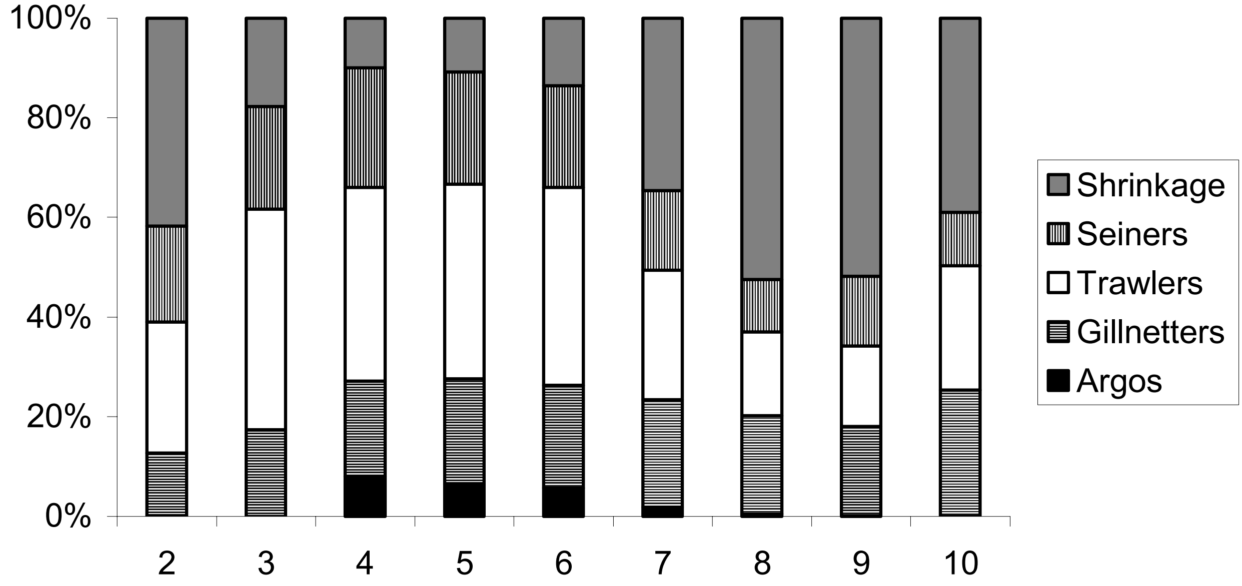


Figure 10.4.7 Plaice in IIIa. Retrospective analysis (1995-2000), XSA run5

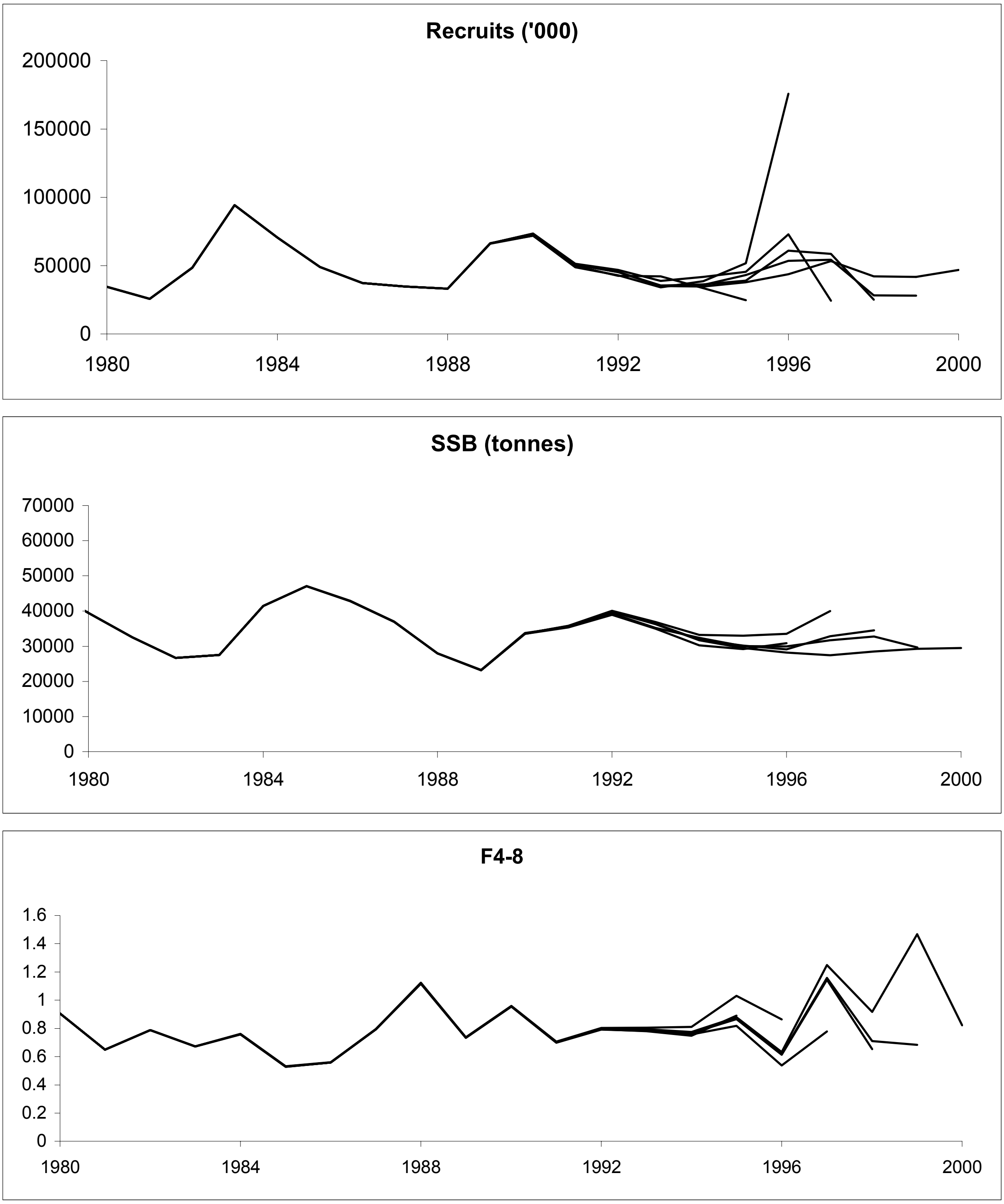


Figure 10.6.1 Stock trends for plaice in IIIa. (Values of Fpa and Bpa inserted)

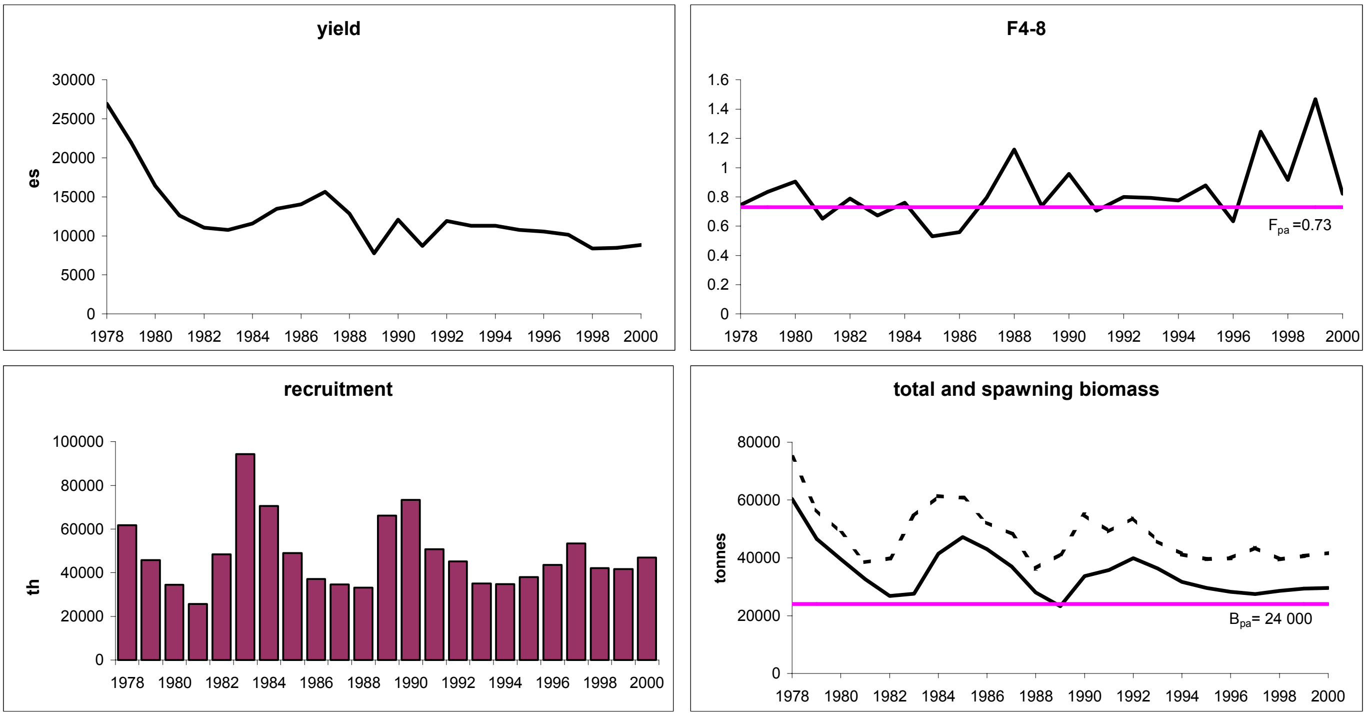
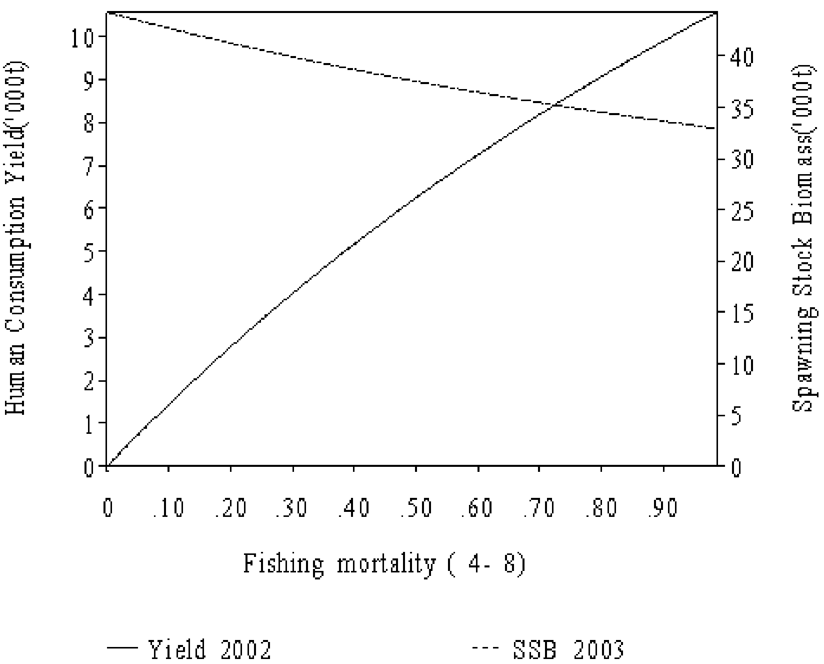
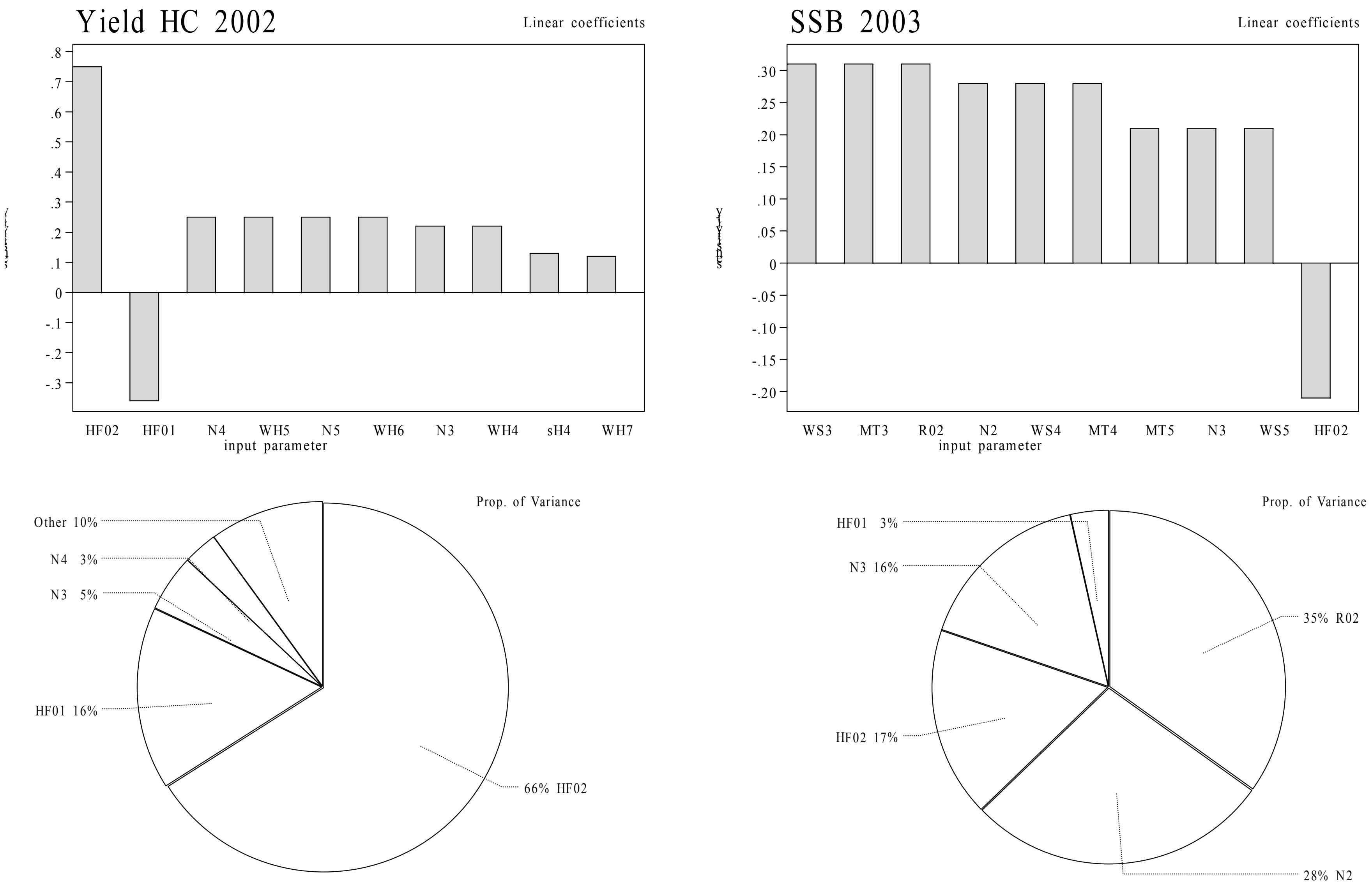


Figure 10.7.1. Plaice,IIIa. Short term forecast



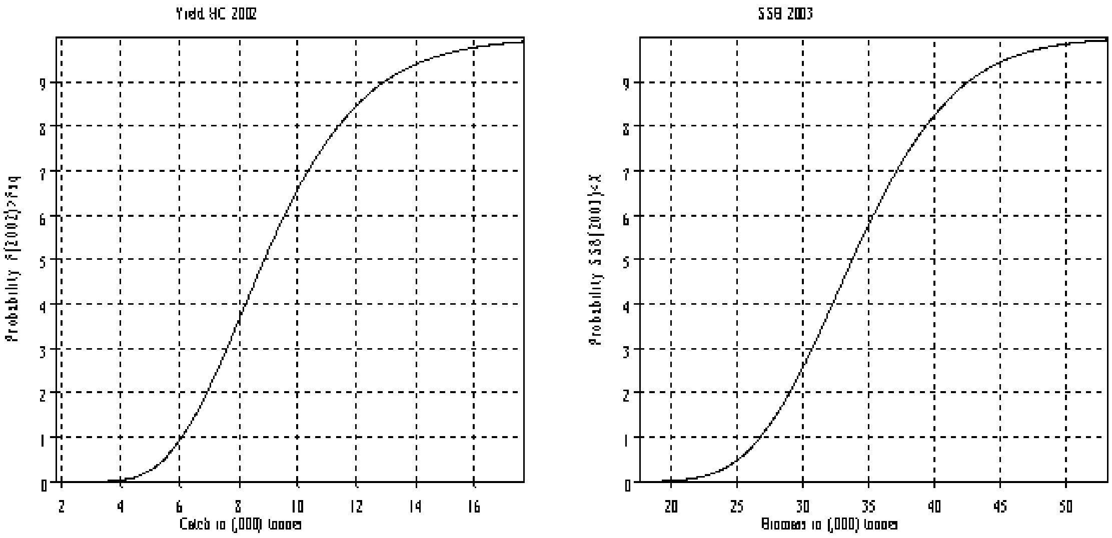
Data from file:\\lh_sdc\Worlgrp\2001\data\plaiceIIIa\prediction\PLEIIIA.SEN on

Figure 10.7.2. Plaice,IIIa. Sensitivity analysis of short term forecast.



Data from file:\\Ish_sdc\Workgrp\2001\data\plaiceIIIa\predictions\PLEIIIA.SEN on

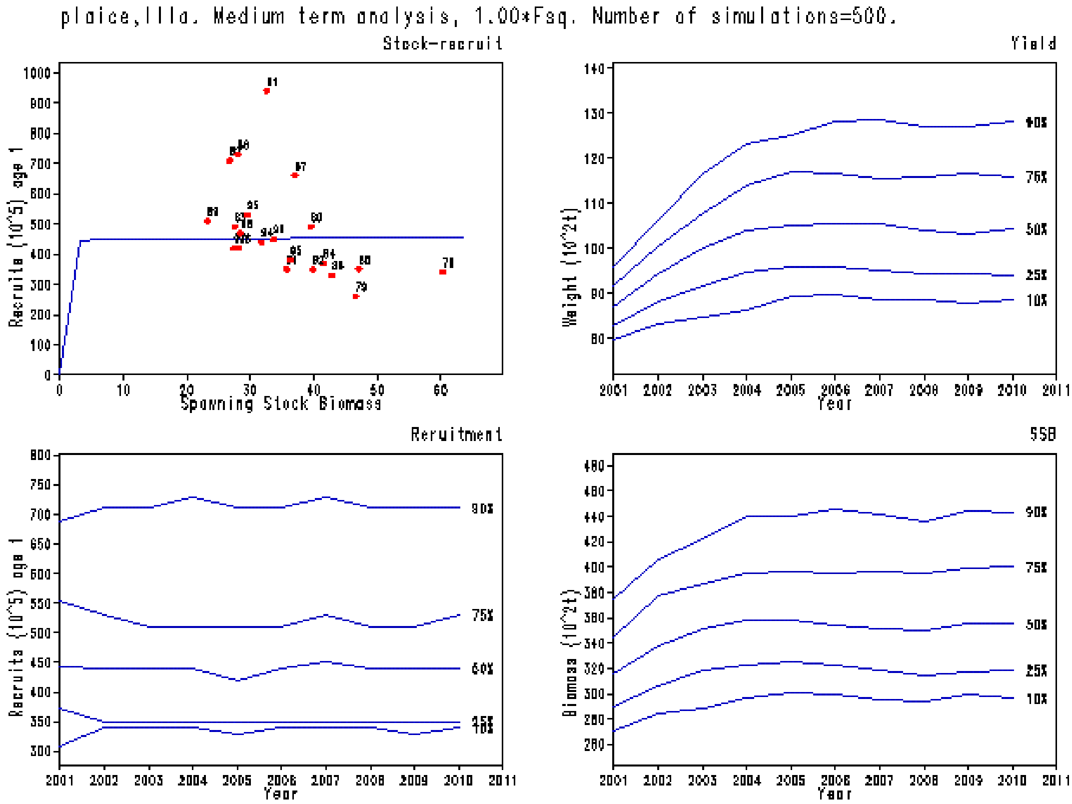
Figure 10.7.3. Plaice,IIIa. Probability profiles for short term forecast.



Data from file:\\Ish_sdc\Workgrp\2001\data\plaiceIIIa\predictions\PLEIIIASEN on

Figure 10.8.1. Plaice IIIa. Medium/term projections using a a) Beverton/Holt and b) Ricker stock/recruitment relationship.

a)



b)

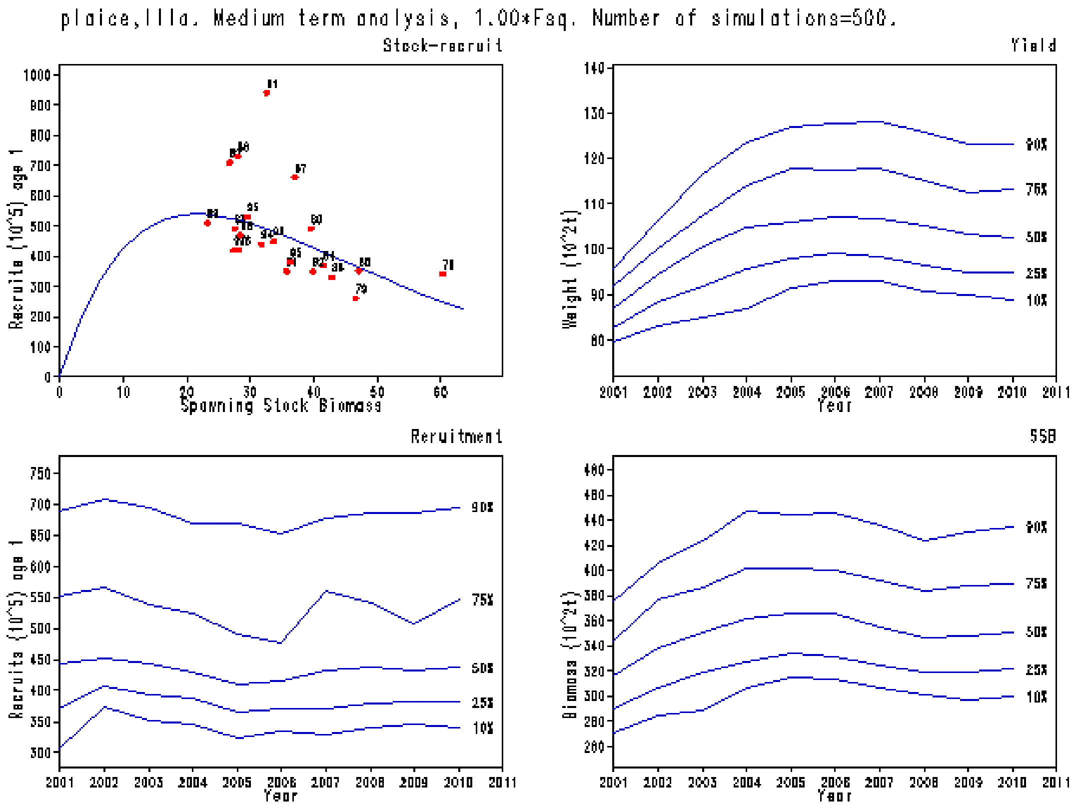


Figure 10.9.1.

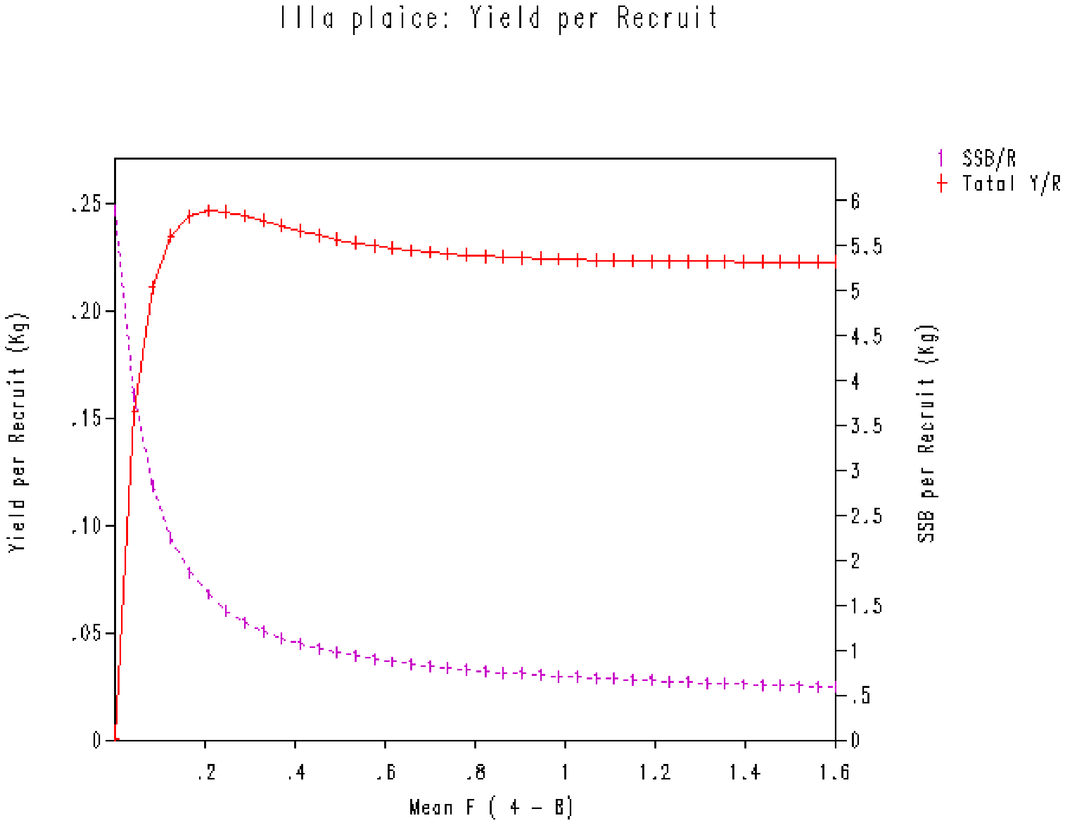
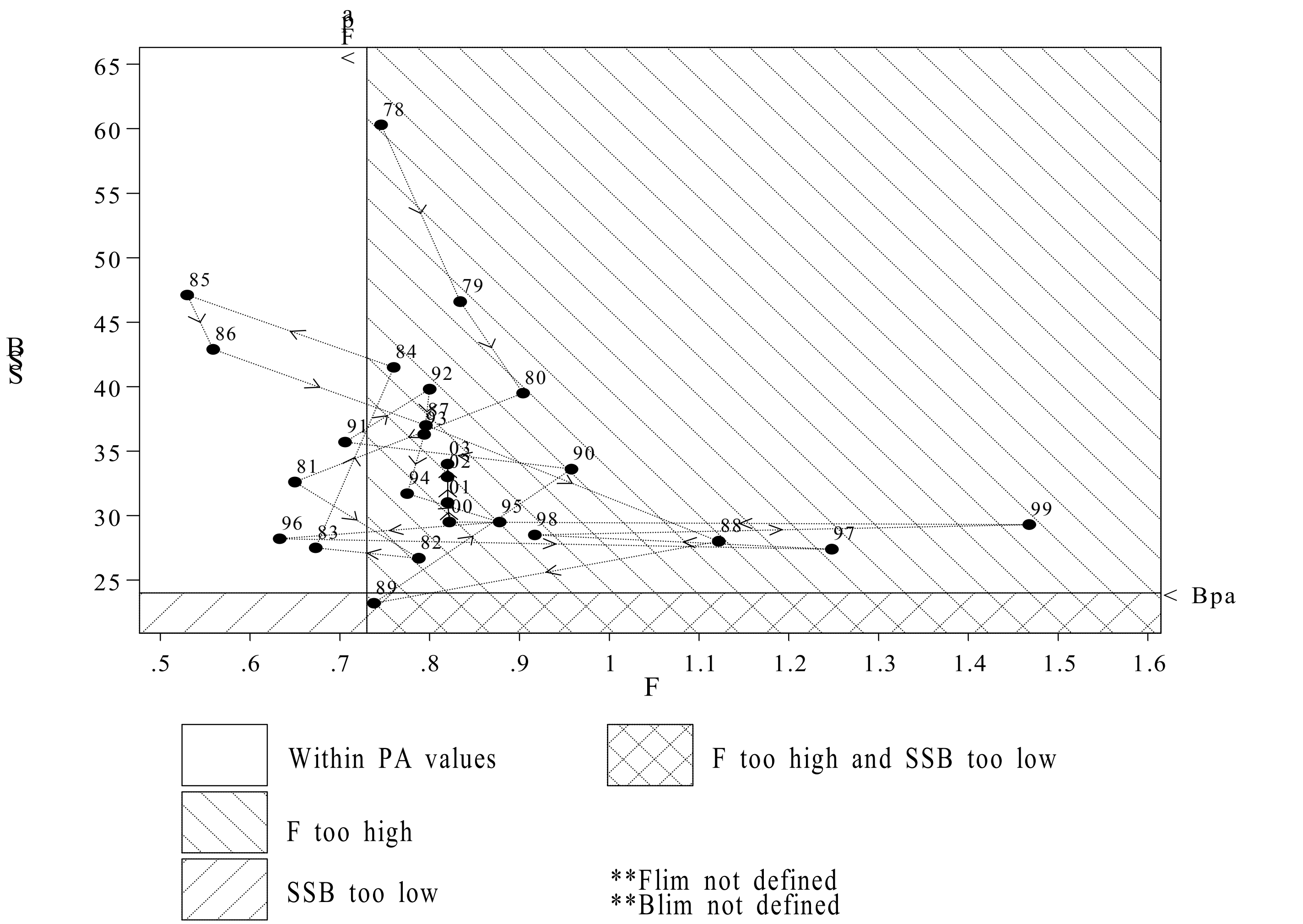


Figure 10.9.2

Figure 10.9.3. Plaice IIIa. Precautionary Approach plot showing historical F and SSB in relation to Bpa and Fpa.



Data file(s):\\Ish_sdc\Workgrp\2001\data\plaiceIIIa\predictions\pleiiia.pa;\\Ish_sdc\Workgrp\2001\data\plaiceIIIa\predictions\PLEIIIA.SUM
Plotted on 26/06/2001 at 15:55:20

11 PLAICE IN DIVISION VIID

11.1 The fishery

11.1.1 ACFM advice applicable to 2000 and 2001

Advice for 2000 : the stock was considered as harvested outside safe biological limits and fishing mortality in 1998 was estimated to be well above $\mathbf{F}_{pa}$. ICES recommended that fishing mortality in 2000 was reduced to less than the proposed $\mathbf{F}_{pa}$ corresponding to landings in 2001 of less than 4900 t.

ACFM advice for 2001 was that the stock was harvested outside safe biological limits and the fishing mortality in 2001 should be reduced to less than the proposed F_{pa} (0.45), corresponding to landings in 2001 of less than 4400t.

The precautionary fishing mortality and biomass reference points proposed by ACFM are as follows :

$\mathbf{B}_{\mathbf{lim}}$ = 5600 t, $\mathbf{B}_{\mathbf{pa}}$ = 8000 t, $\mathbf{F}_{\mathbf{lim}}$ = 0.54, F_{pa}= 0.45.

11.1.2 Management applicable in 2000 and 2001

There is no separate TAC for VIId plaice which at present is managed together with area VIIe. The TAC in 2001 was set to 6000 t for the combined areas. Technical conservation measures include a minimum mesh size of 80 mm for trawling and minimum landing size (27 cm).

11.1.3 The fishery in 2000

Plaice is caught all year in a mixed fishery with sole by Belgian and UK offshore beam trawlers and French inshore trawlers. It's also a seasonal target in winter for some French offshore otter trawlers. There appears to have been a displacement of effort from the Irish Sea in reaction to the Cod Recovery Plan in force there. This lead to an increase in fishing effort by Belgian beam trawlers during the first quarter of 2000 in area VIId. The catch (in numbers) in the 1st quarter of 2000 was 47% of the annual total, compared to 42% in 1999.

Landings data as reported to ICES together with the total landings estimated by the Working Group are shown in Table 11.1.1. No correction was made for SOP discrepancies which have been very low since 1992.

Landings peaked at 10400 t in 1988 and have declined to 6015 t in 2000 (Figure 11.1.1). This was significantly below the 6590 t predicted at status quo F from last year's assessment. France contributed 63 % of the official landings in 2000 followed by Belgium (23 %) and UK (13 %).

11.2 Natural mortality, maturity, age compositions and mean weight at age

The natural mortality was assumed to be constant over ages and years at 0.10 as for the North Sea (table 11.2.1). The maturity ogive used is similar to that for VIIe plaice and is the same for all years (table 11.2.1).

Quarterly catch numbers and weights were available for a range of years depending on country, and are given in the following text table. Levels of sampling prior to 1985 were poor and these data are considered to be less reliable.

Country	Numbers	Weights
Belgium	1981-2000	1986-2000
France	1989-2000	1980-2000
UK	1980-2000	1989-2000

[1] It is considered that the VIId part of the French landings is 90 %

The age-composition data and the mean weight at age in the catch are shown in Tables 11.2.2 and 11.2.3 and Figure 11.2.1. In 2000 international landings covered by market sampling schemes represented the majority of the total landings. Stock weights for VIId plaice on the 1st of January have normally been estimated from smoothed catch weights (Table 11.2.4) and back predicted by 6 months.

This method produces poor estimates of stock weight for 2000, under predicting ages 1-2 and ages 6-10+, whilst over predicting ages 3-5 (Figure 11.2.2). This is probably a product of the seasonal nature of the fishery as described previously. The over-estimation of stock weight for the 4 year old fish is critical as this is the large 1996 year class which comprises the bulk of the spawning stock.

It would be preferable to take stock weights as the catch weights from the 1st quarter, but these data were only available to the WG for 1999 and 2000. It was decided that for the 2002 WG, the historical stock weights should all be reworked as the 1st quarter weights. This procedure may also require revision of the PA reference points. In order to maintain consistency with the basis of previous stock weight estimates, and the PA reference points (which were calculated using this method of stock weight production), the estimates for 2000 were taken as the mean of the preceeding 3 years. Stock weights at age are given in table 11.2.4.

The data do not include discards (they are not sampled for this stock) although they are probably quite substantial.

11.3 Catch, effort and research vessel data

Commercial effort and CPUE data are available from four commercial fleets covering inshore and offshore trawlers. Due to problems with the French data base in 1999, effort data are still unavailable for the commercial fleet for that year. Trends in effort and CPUE are shown in Table 11.3.1 and Figure 11.3.1 (see also overview section 2.3). All fleets show a steep decline in CPUE from 1988/89 to 1996. Since then the French CPUE has remained stable whilst the Belgian and UK CPUEs have increased. Effort increased in all fleets from 1983 to 1989. The UK effort has been declining since 1994, French effort has remained stable and the Belgian effort has increased sharply over the last 3 years.

Effort and age compositions were available for three commercial fleets except FRENCH TRAWLERS in 1999. Survey data were obtained since 1988 from two trawls surveys covering most of VIId. These were the English beam trawl survey in August (Table 11.3.2) and French otter trawl ground fish survey (CGFS) in October. Recruit survey estimates for 0 and 1-group fish were also available from coastal research surveys in VIId, the English and French YFS (Table 11.3.3).

In 2000, the working group rejected the English YFS for plaice in VIId. After preliminary analysis the French YFS was also removed from the tuning fleets. All remaining tuning fleets were used in the analysis. The range of ages and years used in each fleet is shown in the input file for tuning (Table 11.3.4).

11.4 Catch at age analyses

11.4.1 Exploration of data

As previously the analysis was carried out with XSA. A number of trial runs were made to select the most appropriate model for the data and a multi-stage process was used to select the final tuning options:

a) <u>Trends in catchability</u> were examined for residual trends by fleet and age. Trends were examined from exploratory runs using XSA with single fleet tuning runs with low (1.5) shrinkage (Figure 11.4.1). The French YFS (age 1) shows a long term decline in log catchability residuals. This survey only covers a very small area and was therefore removed from the final assessment. A combined fleet run gave very little weight to the FYFS and the residuals were very similar to those in figure 11.4.2. Catchability residuals of the fleets from final XSA are presented in Figure 11.4.2. French YFS residuals in figure 11.4.2 are given for illustrative purposes only and were not included in the tuning.

b) <u>Choice of age to be treated as recruits:</u> A run was made with the combined fleets where all ages were not treated as recruits (constant catchabitity). There is borderline evidence for negative slopes at age 1 from the UK beam trawl survey and age 2 from the French Trawlers. The other two series with data for 1 year old fish (French GFS and YFS) have very low R^2 values and non-significant slopes. Figure 11.4.3 shows log catchability vs log VPA numbers. There are no consistent trends over all fleets for a given age. It is recommended for XSA to use a power model unless there is strong evidence to the contrary, therefore the power model for age 1 was retained

c) Time series. As the tuning data were relatively poor before 1989, therefore this period was excluded from the tuning. This date correspond also to the beginning of the UK BTS which has an important weight in this assessment.

d) Choice of age for which catchability can be assumed to be constant: age 7 was taken as an acceptable value (as in 2000 WG.).

e) Survival estimates were shrunk towards the mean F of the final 5 years or the 3 oldest ages in the final run (as in 2000 WG).

The SSB and Fbar(2-6) estimates for 2000 for a selection of exploratory runs are given in figure 11.4.6. The scatter of points from the tuning fleets reflects the conflicting information provided by the assessments in 2000. The use of a taper makes no difference to the assessment confirming the belief that the data are historically consistent.

The following table summarises the final XSA configuration used this year, in comparison to that used last year.

	2000 assessment		2001 assessment	
Calibration period, no taper	12 years		**13** years	
Age range	1-10+		1-10+	
Catchability model	Power model for Age 1		Power model for Age 1	
Catchability plateau	Age 7		Age 7	
F shrinkage : SE Year range Age range	 0.5 5 3		 0.5 5 3	
Fleets used :	Ages	Years	Ages	Years
FLT01: UK INSHORE TRAWL	2-9	1988-99	2-9	1988-00
FLT02: BELGIAN BEAM	2-9	1988-99	2-9	1988-00
FLT03: FRENCH TRAWLERS	2-9	1989-99	2-9	1989-00(*)
FLT04: UK BTS	1-6	1988-99	1-6	1988-00
FLT05: French GFS	1-5	1988-99	1-5	1988-00
FLT06: French YFS	1	1988-99	**Not included**	Not included
FLT07: UK YFS	Not included	Not included	Not included	Not included

(*) no data for 1999

11.4.2 Final Assessment

The list of tuning fleets, input parameters and output from the final run are shown in Table 11.4.1. Fishing mortality and stock numbers are in Tables 11.4.2 and 11.4.3 respectively. The weights of tuning categories are presented in Figure 11.4.7. Surveys dominate the tuning weighting for younger ages whilst commercial fleet dominate for older ages. The weight of F shrinkage is nearly the same for all ages.

There is a high degree of consistency between the current assessment and the preceding two years (Figure 11.10.1). Estimates of SSB and F, in particular the very high estimate of F in 1997 have been repeated.

Retrospective analysis was carried out using final XSA options with a strong shrinkage of 0.5. Unlike the 2000 WG which used an 8 year tuning window, the full (1988-) year range was used, thus maintaining consistency with the final run. There is no consistent trend in retrospective patterns (Figure 11.4.5).

11.5 Recruitment estimates

Research vessel survey indices of 0, 1 and 2 year olds were available and are shown in tables 11.3.2 and 11.3.3. The English YFS and French YFS recruitment indices for the 0 group are uncorrelated, and estimates for the 2000 year class are contradictory (EYFS=0.59, the lowest on record, FYFS= 9.10, the third highest on record). Given the conflicting signals from the surveys, and the removal of both the YFS series from the VPA tuning, the young fish surveys were removed from the RCT3 input files (Table 11.5.1). The only remaining survey information for the 2000 year class is therefore the French CGFS which RCT3 gives very low weight (6.1%), attributing the remaining 93.9% to the mean. RCT3 outputs are given in Tables 11.5.2 and 11.5.3

RCT3 estimates of 2 year olds in 2001 are largely influenced by the UK BTS, getting 64% of the weight and having an R^2 value of 0.755. The French CGFS get very little weight. The resulting estimates of recruitment from RCT3, XSA and the GM are relatively close. For consistency with the approach taken for recruits at age 1, the RCT3 value was rejected, and the XSA value was accepted.

The recruitment estimate for the 2000 year class (1 year old in 2001) is therefore taken as the GM recruitment (23946). XSA recruitments were taken for all other ages.

		RCT3	XSA	GM_{80-98}	AM_{80-98}
Year-Class	Age in 2001	Weighted average			
1998	3	14763	18969	13671	15147
1999	2	21444	22928	21042	22683
2000	1	24639	-	23946	25725

- numbers are * 10^{-3}. Underlined values are those accepted by working group.

11.6 Historical Stock Trends

Trends in fishing mortality, SSB and recruitment are shown in Table 11.6.1 and Figure 11.1.1. Fishing mortality has fluctuated widely in the past 10 years. After a peak in 1997 (0.96) there has been a sharp decrease to the current year (0.52). This recent trend in F can be explained by the evolution of the effort made by the various fleets. SSB increased rapidly in 1987 following recruitment of the strong 1985 year class. Since 1990 SSB has declined steeply until 1992 and now is at a plateau near 8000 t. The recent rise in SSB can be attributed to the large 1996 year class entering the spawning stock. Recruitment has been close to the GM level of 24.3 million of 1 yr. olds since 1987.

11.7 Short term forecast

The input data for the catch forecasts are given in Table 11.7.1. Stock numbers in 2000 were taken from the VPA for age 2 and older and the GM of 23.9 million was used for age 1 in 2000, 2001 and 2002. The exploitation pattern used was the mean F(2-6) over 3 years rescaled to mean F(2-6) in 2000. Catch and stock weights at age were the mean for the period 1998-2000 and proportions of M and F before spawning were set to zero. The results of the *status quo* catch prediction are given in Table 11.7.2 and Figure 11.7.1. Figure 11.7.2 shows the sensitivity analysis of the short term prediction. There is no single parameter which dominates the uncertainty surrounding the estimate of landings in 2002, uncertainty in the F multiplier taking the largest share (25%). Uncertainty in the estimate of SSB in 2003 is largely driven by uncertainty in the estimates of 1 and 2 year olds in the current assessment. Figure 11.7.3 shows the probability profiles for the *status quo* short term prediction, the left panel shows the probability that $F_{2001}>F_{2000}$ for a given catch, while the right panel shows the probability that SSB in 2003 will be above a certain point. The probability that SSB 2003 will be below Bpa (8000t) is less than 10%.

The predicted catch in 2001 is estimated to be 6210 t with a SSB of 8700 t for the same year. This compares with a figure of 6600 t forecast for the catch and 9000 t for the SSB made last year. Continuing with the same level of F implies an increase in catch with 6350 t in 2002 and a predicted SSB to 8990 t in 2002. A detailed prediction output by age is shown in table 11.7.3. Figure 11.7.4 shows the contribution to yield in 2002 and SSB in 2003 by year class, both of which are dominated by the 1999 and 2000 year classes.

11.8 Medium term predictions

A new medium term prediction was carried out this year using the same configuration as the previous prediction (WG 1999). A Shepherd stock recruit curve was fitted, and 500 projections made over 10 years. Mean weights in the catch and stock are as for the short term prediction (3 year average). The fishing mortality pattern is the mean F over the last 3 years, scaled to the terminal F. The results are shown in figure 11.8.1. SSB is predicted to increase until 2007 after which it declines slightly, but with a high probability of being above B_{pa}(8000t). The contour plot is not presented as the probability of being below B_{pa} is very low (<5%).

11.9 Biological reference points

A stock-recruitment scatter plot is shown in Figure 11.9.1. The catch and stock weights used for the yield per recruit were the average for 1998-2000 as for the short term prediction. The YPR curve is shown in Figure 11.9.2. The PA plot (SSB vs F) is given in figure 11.9.3. The current estimate is that the stock is above Bpa, but fished well above Fpa.

The available reference points are :

Management reference points.				
F_{lim}	F_{pa}	B_{lim}	B_{pa}	
0.54	0.45	5 600 t	8 000 t	
Estimated reference points				
F_{max}	$F_{0.1}$	F_{low}	F_{high}	F_{med}
.19	.11	0.35	.87	0.57

The current assessment has made minor changes to the estimated reference points.

11.10 Comments on the assessment

Given the problems identified with estimation of stock weights for this year, in particular the probable over-estimation of the 4 year old fish, the estimate of SSB and subsequent predictions are uncertain. In terms of stock numbers, the current assessment appears to be consistent with previous assessments for years prior to 2000 (Figure 11.10.1). The spawning stock is currently being supported by the large 1996 year class.

The surveys in 2000 (UKBTS, FGFS) give more optimitstic perspectives (larger stock size and lower F) on the state of the stock in the terminal year when compared to the commercial fleets and shrinkage to the mean. Consultation with UK and French fishermen concerning the fishery in 2001 indicates that catches of plaice in VIId have been lower than for the beginning of 2000. Given this information, the estimate of an increase in SSB seems even more uncertain.

The rejection of the English YFS in 2000 and the French YFS in 2001 in the assessment and recruitment estimates should not be considered as definitive. These surveys explicitly target young fishes in known nursery areas at the same period of the year, and should, in some combination, give a relevant value for the recruitment index. Studies to investigate the combination of these indices should be undertaken in order to reinstate the information in future assessments.

11.11 Management considerations

The current estimate of SSB and subsequent predictions are uncertain, due in particular to the problems with stock weight highlighted this year. Overestimation of stock weights, particularly the weight of 4 year old fish (the large 1996 year class) is probably creating an overly optimistic view for this stock.

The level of any discarding of Plaice in VIId is an unknown but is considered likely to be significant. A reduction in the minimum landing size to reduce the unknown mortality on small fish was recently proposed but was not acceptable to some sections of the industry who feared it would lead to increased mortality on this section of the stock. There was also concern that there would be no market for such small fish.

Table 11.1.1.- Plaice in VIId. Nominal landings (tonnes) as officially reported to ICES, 1976–2000.

Year	Belgium	Denmark	France	UK (E+W)	Others	Total reported	Un-allocated	Total as used by WG
1976	147	1 [1]	1,439	376	-	1,963	-	1,963
1977	149	81 [2]	1,714	302	-	2,246	-	2,246
1978	161	156 [2]	1,810	349	-	2,476	-	2,476
1979	217	28 [2]	2,094	278	-	2,617	-	2,617
1980	435	112 [2]	2,905	304	-	3,756	-1,106	2,650
1981	815	-	3,431	489	-	4,735	34	4,769
1982	738	-	3,504	541	22	4,805	60	4,865
1983	1,013	-	3,119	548	-	4,680	363	5,043
1984	947	-	2,844	640	-	4,431	730	5,161
1985	1,148	-	3,943	866	-	5,957	65	6,022
1986	1,158	-	3,288	828	488 [2]	5,762	1,072	6,834
1987	1,807	-	4,768	1,292	-	7,867	499	8,366
1988	2,165	-	5,688 [2]	1,250	-	9,103	1,317	10,420
1989	2,019	+	3,265 [1]	1,383	-	6,667	2,091	8,758
1990	2,149	-	4,170 [1]	1,479	-	7,798	1,249	9,047
1991	2,265	-	3,606 [1]	1,566	-	7,437	376	7,813
1992	1,560	1	3,099	1,553	19	6,232	105	6,337
1993	0,877	+ [2]	2,792	1,075	27	4,771	560	5,331
1994	1,418	+	3,199	993	23	5,633	488	6,121
1995	1,157	-	2,598 [2]	796	18	4,569	561	5,130
1996	1,112	-	2,630 [2]	856	+	4,598	795	5,393
1997	1,161	-	3,077	1,078	+	5,316	991	6,307
1998	854	-	3,276 [23]	700	+	4,830	932	5,762
1999	1,306	-	3,388 [23]	743	+	5,437	889	6,326
2000	1,315	-	3,513 [2]	752	+	5,580	434	6,014

[1]Estimated by the Working Group from combined Division VIId+e
[2]Includes Division VIIe
[3]Provisional

Table 11.2.1. -Plaice in VIId. Natural mortality and proportion mature.

Age	Natural Mortality	Maturity
1	0.100	0.000
2	0.100	0.150
3	0.100	0.530
4	0.100	0.960
5	0.100	1.000
6	0.100	1.000
7	0.100	1.000
8	0.100	1.000
9	0.100	1.000
10+	0.100	1.000

Table 11.2.2. -Plaice in VIId. Catch numbers at age

	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

Table 11.2.3. -Plaice in VIId. Catch weights-at-age

	1	2	3	4	5	6	7	8	9	10+
1980	0.309	0.312	0.499	0.627	0.787	1.139	1.179	1.293	1.475	1.557
1981	0.239	0.299	0.373	0.464	0.712	0.87	0.863	0.897	0.992	1.174
1982	0.245	0.271	0.353	0.431	0.64	0.795	1.153	1.067	1.504	1.355
1983	0.266	0.296	0.349	0.42	0.542	0.822	0.953	1.144	0.943	1.591
1984	0.233	0.295	0.336	0.402	0.508	0.689	0.703	0.945	1.028	1.427
1985	0.254	0.278	0.301	0.427	0.502	0.57	0.557	1.081	0.849	1.421
1986	0.226	0.306	0.331	0.406	0.546	0.486	0.629	0.871	1.446	1.579
1987	0.251	0.282	0.36	0.477	0.577	0.783	0.735	1.142	1.268	1.515
1988	0.292	0.268	0.321	0.432	0.56	0.657	0.77	0.908	1.218	1.328
1989	0.201	0.268	0.321	0.37	0.473	0.648	0.837	0.907	1.204	1.519
1990	0.201	0.256	0.326	0.378	0.483	0.61	0.781	0.963	1.159	1.31
1991	0.225	0.277	0.311	0.39	0.454	0.556	0.745	1.087	0.924	1.602
1992	0.182	0.277	0.352	0.429	0.509	0.585	0.701	0.837	0.85	1.195
1993	0.22	0.272	0.336	0.432	0.507	0.591	0.741	0.82	0.934	1.156
1994	0.243	0.27	0.288	0.356	0.466	0.576	0.686	0.928	0.969	1.287
1995	0.218	0.271	0.313	0.39	0.485	0.688	0.612	0.806	1.15	1.298
1996	0.221	0.3	0.29	0.396	0.475	0.643	0.764	0.934	1.057	1.312
1997	0.199	0.252	0.298	0.332	0.442	0.577	0.801	0.894	1.055	1.395
1998	0.159	0.244	0.267	0.381	0.502	0.762	0.839	0.981	0.986	1.379
1999	0.197	0.245	0.235	0.306	0.461	0.751	0.768	0.868	0.885	1.508
2000	0.182	0.256	0.314	0.37	0.44	0.607	0.768	0.972	0.975	1.193

Table 11.2.4. -Plaice in VIId. Stock weights-at-age

	1	2	3	4	5	6	7	8	9	10+
1981	0.11	0.216	0.317	0.414	0.506	0.594	0.677	0.756	0.83	1.042
1982	0.105	0.208	0.308	0.406	0.502	0.596	0.687	0.776	0.862	1.118
1983	0.097	0.192	0.286	0.379	0.47	0.56	0.648	0.735	0.821	1.169
1984	0.082	0.164	0.248	0.333	0.42	0.507	0.596	0.686	0.777	1.086
1985	0.084	0.171	0.259	0.348	0.44	0.533	0.628	0.725	0.824	1.206
1986	0.101	0.205	0.311	0.42	0.532	0.646	0.763	0.882	1.004	1.313
1987	0.122	0.242	0.361	0.479	0.596	0.712	0.826	0.939	1.051	1.306
1988	0.084	0.168	0.254	0.34	0.427	0.514	0.603	0.692	0.783	0.952
1989	0.079	0.162	0.25	0.342	0.439	0.541	0.648	0.759	0.874	1.211
1990	0.085	0.172	0.262	0.355	0.451	0.549	0.651	0.755	0.862	1.125
1991	0.065	0.141	0.227	0.324	0.432	0.55	0.679	0.819	0.969	1.404
1992	0.088	0.177	0.268	0.361	0.456	0.552	0.651	0.751	0.853	1.116
1993	0.108	0.214	0.315	0.414	0.509	0.601	0.69	0.776	0.858	1.038
1994	0.165	0.215	0.274	0.344	0.422	0.511	0.609	0.716	0.834	1.147
1995	0.058	0.172	0.284	0.396	0.506	0.615	0.723	0.83	0.935	1.189
1996	0.178	0.238	0.307	0.385	0.473	0.569	0.675	0.79	0.915	1.223
1997	0.059	0.151	0.246	0.343	0.443	0.545	0.649	0.756	0.865	1.147
1998	0.072	0.163	0.256	0.352	0.45	0.55	0.654	0.759	0.868	1.199
1999	0.072	0.101	0.198	0.295	0.392	0.49	0.587	0.684	0.782	1.035
2000*	0.068	0.138	0.233	0.33	0.428	0.528	0.63	0.733	0.838	1.127

*** data for 2000 are 3 year averages of previous stock weight estimates.**

Table 11.3.1.- Plaice in VIId. Catch per unit effort

Year	United Kingdom Beam trawl (kg/hr)	United Kingdom Inshore trawl (kg/day)	Belgium Beam trawl (kg/hr)	France Otter trawl (kg/(hr*kw*10-4))
1980			24.4	
1981			31.2	
1982			24.5	
1983	21.6		36.2	
1984	18.5		25.9	
1985	19.9	165.3	31.8	
1986	27.7	147.4	34.9	
1987	15.5	178.7	33.7	
1988	8.9	212.8	40.7	
1989	17.6	157.4	42.8	
1990	17.4	117.4	48.8	
1991	18.3	123.0	45.5	181.9
1992	14.2	129.7	34.9	155.6
1993	11.9	105.0	24.2	125.9
1994	11.1	98.2	32.4	136.5
1995	9.3	76.4	25.7	100.8
1996	10.0	86.8	26.2	97.2
1997	13.9	103.2	21.2	183.7
1998	6.1	86.2	25.9	181.9
1999	8.4	108.8	37.6	-
2000	8.3	112.5	35.6	186.1

Plaice in VIId. Effort data

Year	United Kingdom Beam trawl(1) ('000 hr)	United Kingdom Inshore trawl ('000 days)	Belgium Beam trawl(1) ('000 hr)	France Otter trawl(1) hr*kw*10-4
1980			29.8	
1981			24.4	
1982			29.8	
1983	2.9		26.4	
1984	2.3		35.4	
1985	7.9	2.520	33.4	
1986	7.3	1.804	30.8	
1987	24.3	2.556	49.3	
1988	19.7	2.500	48.9	
1989	24.6	2.131	43.8	
1990	32.8	1.094	38.5	
1991	29.5	2.349	32.8	10689
1992	35.0	2.527	30.9	10519
1993	29.2	2.503	28.2	10217
1994	26.8	2.635	32.8	10609
1995	28.1	1.531	31.7	12384
1996	37.1	1.659	32.6	14476
1997	36.0	2.024	39.7	10921
1998	34.1	0.813	23.6	11707
1999	28.6	0.861	27.6	-
2000	28.8	0.652	37	11703

1. Corrected for HP

Table 11.3.2.- Plaice in VIId. English beam trawl survey numbers per hr raised to 8m beam trawl equivalent (mean no/rectangle, average across rectangles).

Age	1	2	3	4	5	6	7	8	9	10+	1+	3+
1988	26.5	31.3	43.8	7.0	4.6	1.5	0.8	0.7	0.6	1.2	117.9	60.1
1989	2.3	12.1	16.6	19.9	3.3	1.5	1.3	0.5	0.3	1.7	59.6	45.2
1990	5.2	4.9	5.8	6.7	7.5	1.8	0.7	1.0	0.8	0.4	34.5	24.5
1991	11.8	9.1	7.0	5.3	5.4	3.2	1.2	1.0	0.1	1.2	45.2	24.4
1992	16.5	12.5	4.2	4.2	5.6	4.9	3.4	0.7	0.5	0.7	53.2	24.1
1993	3.2	13.4	5.0	1.7	1.9	1.6	2.0	2.8	0.4	0.6	32.6	15.9
1994	8.3	7.5	9.2	5.6	1.9	0.8	0.9	1.8	1.2	0.8	38.0	22.2
1995	11.3	4.1	3.0	3.7	1.5	0.6	0.6	1.3	0.8	0.8	27.6	12.3
1996	13.2	11.9	1.3	0.7	1.3	0.9	0.4	0.3	0.4	2.8	33.3	8.1
1997	33.1	13.5	4.2	0.6	0.3	0.3	0.2	0.2	0.2	1.9	54.6	8.0
1998	11.4	27.3	7.0	3.1	0.3	0.2	0.2	0.1	0.0	1.0	50.6	11.9
1999	11.3	14.1	15.9	2.9	1.0	0.2	0.1	0.3	0.1	0.9	46.8	21.4
2000	13.2	21.0	14.4	13.8	3.5	0.9	0.6	0.2	0.4	1.5	69.4	35.2

Table 11.3.3.- Plaice in VIId. Survey indices of recruitment

	English YFS		English BTS			French YFS		French CGFS		
Year class	0 gp	1 gp	1 gp	2 gp	3 gp	0 gp	1 gp	0 gp	1 gp	2 gp
1978						-	0.50			
1979						8.40	0.77			
1980		0.36				2.53	0.09	-		
1981	3.37	0.45				11.97	0.54	-		
1982	2.45	1.14				3.37	0.07	-		
1983	14.47	0.73				5.47	-	-		
1984	6.29	1.71				-	-	-		
1985	10.90	2.08			43.75	-	-	-		
1986	20.14	2.38		31.33	16.63	-	1.75	-	-	26.46
1987	22.33	1.61	26.47	12.13	5.76	9.82	1.74	-	10.33	8.79
1988	12.98	1.47	2.31	4.86	6.98	2.50	0.49	0.19	4.08	1.27
1989	3.71	0.76	5.16	9.06	4.19	5.36	0.87	0.16	3.95	0.91
1990	6.45	0.64	11.75	12.54	4.96	2.34	0.77	0.16	1.95	6.05
1991	2.68	1.45	16.53	13.40	9.17	6.83	2.35	0.15	33.61	6.79
1992	4.27	0.85	3.22	7.46	3.00	4.95	1.00	0.98	11.68	3.45
1993	7.64	0.83	8.33	4.06	1.30	2.00	0.96	2.41	9.02	4.38
1994	17.23	3.27	11.32	11.90	4.20	5.47	1.03	7.39	5.42	4.06
1995	12.04	1.42	13.20	13.50	7.00	6.42	0.61	0.99	6.15	8.57
1996	2.48	0.42	33.10	27.30	15.9	6.40	1.28	17.33	37.56	13.34
1997	2.38	0.42	11.40	14.1	14.4	3.07	1.22	9.83	10.67	5.62
1998	7.19	0.2	11.3	21.0		5.36	1.25	5.92	12.98	16.22
1999	6.46	1.71	13.2			2.98	0.29	1.06	9.6	
2000	0.59					9.1		4.11		

Table 11.3.4.- Plaice in VIId. Tuning input file.

Plaice in Division VIId (Eastern English Channel) (run name: XSAEDB01)
106
FLT01: UK INSHORE TRAWL METIER <40 trawl lands all trawl age comps fleet (Catch: Unknown) (Effort: Unknown)
1985 2000
1 1 0.00 1.00
2 10

2520	618.3	419.7	221.1	18.8	0.0	0.0	0.0	19.0	0.0
1804	237.9	300.2	132.9	51.6	6.5	4.7	2.9	0.0	0.0
2556	456.0	430.2	153.2	48.0	25.1	5.0	6.3	4.3	0.0
2500	382.4	856.1	141.7	57.8	30.1	14.1	2.8	4.0	5.2
2131	47.4	221.7	465.4	97.1	41.3	19.0	5.5	1.2	6.2
1094	34.3	92.1	52.6	56.9	18.0	7.5	5.5	3.6	3.1
2349	240.2	229.7	166.6	76.6	64.9	10.7	4.3	2.1	1.3
2527	298.0	225.5	140.4	77.8	55.3	44.2	14.6	2.9	2.4
2503	309.3	181.4	66.6	40.5	30.1	21.5	25.1	8.5	3.8
2635	176.0	240.2	99.7	37.8	21.0	17.0	8.9	17.9	3.5
1531	124.1	70.7	54.6	23.5	8.5	5.0	5.5	3.9	6.8
1659	274.4	63.8	16.9	19.1	10.0	2.5	3.1	2.5	2.5
2024	317.1	223.8	20.4	7.7	10.2	8.0	4.9	2.8	4.0
813	104.3	77.7	27.6	3.7	1.7	3.9	1.4	1.2	0.3
861	53.4	222.2	27.0	8.7	1.2	0.4	1.4	0.5	0.4
652	75.0	46.0	81.3	13.8	4.5	1.1	0.5	1.0	0.4

FLT02: BELGIAN BEAM TRAWL(HP corr) all gears age comp [rev: 15/06/00-EB] (Catch: Unknown) (Effort: Unknown)
1981 2000
1 1 0.00 1.00
2 10

24.4	285.9	1126.5	593.3	67.3	21.6	8.3	7.1	13.3	14.1
29.8	147.8	1065.4	688.2	187.2	55.1	21.1	6.5	4.6	4.0
26.4	476.7	654.3	1384.5	165.0	52.2	23.0	31.6	1.3	1.4
35.4	92.0	1570.4	712.1	467.5	134.3	61.0	28.2	5.4	6.8
33.4	557.2	1125.3	1115.1	93.9	197.2	52.9	31.9	5.3	6.1
30.8	700.6	1141.8	667.8	269.9	145.9	60.3	11.3	5.6	6.4
49.3	1944.8	1639.7	889.0	343.1	92.7	154.5	41.1	28.0	14.1
48.9	773.0	4264.6	1301.8	237.1	109.9	113.2	35.8	25.4	24.0
43.8	73.6	1733.7	2950.5	973.4	212.8	113.1	61.1	21.7	0.1
38.5	372.1	2687.5	1942.8	1007.0	184.8	43.9	50.5	13.1	14.0
32.8	595.4	1689.2	1149.4	1089.5	698.4	86.9	36.0	58.9	1.7
30.9	889.8	1031.7	403.8	277.6	282.1	159.7	58.2	60.7	6.7
28.2	488.8	684.2	274.3	197.6	121.6	74.7	62.8	10.6	19.3
32.8	424.6	1259.2	1426.5	268.0	132.6	109.5	75.5	90.0	37.6
31.7	39.8	591.9	925.2	396.5	82.0	140.1	82.6	26.1	0.7
32.6	259.3	689.3	541.5	503.7	137.6	46.4	49.9	38.4	44.4
39.7	0.0	287.3	931.8	570.2	295.7	143.7	37.3	27.7	11.2
23.6	164.6	900.7	616.6	122.0	39.0	40.0	18.2	18.4	13.7
27.6	40.7	1687.7	1366.6	370.5	67.5	25.4	13.5	14.0	12.7
37.0	241.2	1365.5	1791.3	410.3	62.8	37.1	12.7	11.8	34.9

FLT03: FRENCH TRAWLERS (EFFORT H*KW*10-4) 1989-90 DERAISED 1991-98 TRUE (Catch: Unknown) (Effort: Unknown)
1989 2000
1 1 0.00 1.00
2 10

6983	1190.1	1635.9	1643.2	466.2	73.5	34.3	34.1	19.3	16.1
8395	698.2	1876.1	1289.5	728.3	153.7	42.6	33.1	46.5	14.4
10689	1938.7	1474.1	1430.0	399.5	255.2	41.0	17.6	11.9	9.9
10519	1802.9	1396.1	370.2	269.4	230.7	143.5	21.2	12.1	11.6
10217	2124.4	1118.2	268.4	56.0	73.4	48.7	32.3	14.3	4.6
10609	1034.2	2271.2	476.4	177.6	69.5	48.2	48.3	32.0	25.0
12384	1354.7	686.5	578.5	95.4	21.4	19.5	27.5	21.8	28.2
14476	1133.3	1283.9	352.7	317.5	98.8	43.6	33.3	34.6	36.9
10921	1396.2	3536.0	1155.4	139.0	170.7	88.3	50.8	22.4	28.2
11707	1446.0	3541.9	1534.4	205.4	29.8	20.2	17.8	6.9	8.2
1	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
11703	1594.7	1364.9	2762.2	716.4	98.4	14.7	3.2	7.8	6.5

Table 11.3.4 . - Plaice in VIId. Tuning input file (continued)

```
FLT04: UK BEAM TRAWL SURVEY  true age 6 [rev: 23/8/00-RM] (Catch: Unknown) (Effort: Unknown)
1988 2000
1 1 0.50 0.75
1 6
   1   26.5   31.3   43.8    7.0    4.6    1.5
   1    2.3   12.1   16.6   19.9    3.3    1.5
   1    5.2    4.9    5.8    6.7    7.5    1.8
   1   11.8    9.1    7.0    5.3    5.4    3.2
   1   16.5   12.5    4.2    4.2    5.6    4.9
   1    3.2   13.4    5.0    1.7    1.9    1.6
   1    8.3    7.5    9.2    5.6    1.9    0.8
   1   11.3    4.1    3.0    3.7    1.5    0.6
   1   13.2   11.9    1.3    0.7    1.3    0.9
   1   33.1   13.5    4.2    0.6    0.3    0.3
   1   11.4   27.3    7.0    3.1    0.3    0.2
   1   11.3   14.1   15.9    2.9    1.0    0.2
   1   13.2   21.0   14.4   13.8    3.5    0.9

FLT05: French GFS [option 2]  true age 5 [rev: 28/9/00-AT] (Catch: Unknown) (Effort: Unknown)
1988 2000
1 1 0.75 1.00
1 5
   1    8.0   17.6    9.9    1.7    0.6
   1    3.5    7.4    2.7    1.1    0.1
   1    3.3    0.9    2.3    1.4    1.3
   1    1.6    0.6    0.4    0.2    0.2
   1   37.7    3.2    0.5    0.2    0.1
   1   10.0    5.4    2.0    0.4    0.2
   1    6.3    2.4    0.9    0.3    0.2
   1    4.0    3.8    1.5    1.0    0.2
   1    4.9    3.0    0.4    0.2    0.2
   1   33.1    6.8    4.2    0.3    0.1
   1   10.0   11.6    2.6    0.5    0.0
   1   10.1    4.3    7.6    1.2    0.2
   1    6.9   12.4    4.1    3.6    0.8
```

Table 11.4.1.- Plaice in VIId. Tuning diagnostics.

```
Lowestoft VPA Version 3.1

   25/06/2001  17:01

 Extended Survivors Analysis

 Plaice in VIId (run: XSAAEDB01/X01)

 CPUE data from file fleet

 Catch data for  21 years. 1980 to 2000. Ages  1 to  10.

      Fleet,           First, Last, First, Last, Alpha,  Beta
                  ,    year, year,  age ,  age
 FLT01: UK INSHORE TR,   1988, 2000,   2,     9,   .000,  1.000
 FLT02: BELGIAN BEAM ,   1988, 2000,   2,     9,   .000,  1.000
 FLT03: FRENCH TRAWLE,   1989, 2000,   2,     9,   .000,  1.000
 FLT04: UK BEAM TRAWL,   1988, 2000,   1,     6,   .500,   .750
 FLT05: French GFS [o,   1988, 2000,   1,     5,   .750,  1.000
 FLT06: French YFS [r,   1988, 2000,   1,     1,   .500,   .750


 Time series weights :

      Tapered time weighting not applied


 Catchability analysis :

      Catchability dependent on stock size for ages <    2

         Regression type = C
         Minimum of   5 points used for regression
         Survivor estimates shrunk to the population mean for ages <  2


      Catchability independent of age for ages >=    7


 Terminal population estimation :

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

      S.E. of the mean to which the estimates  are shrunk =    .500

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

      Prior weighting applied :
      Fleet  Weight
      FLT01: U  1.00
      FLT02: B  1.00
      FLT03: F  1.00
      FLT04: U  1.00
      FLT05: F  1.00
      FLT06: F   .00

 Tuning had not converged after   30 iterations


 Total absolute residual between iterations
 29 and  30 =     .00011

 Final year F values
 Age          ,      1,      2,      3,      4,      5,      6,      7,      8,      9
 Iteration 29,  .0558,  .2713,  .4339,  .6905,  .7201,  .4782,  .5574,  .4156,  .4149
 Iteration 30,  .0558,  .2713,  .4339,  .6905,  .7200,  .4782,  .5574,  .4155,  .4149


1


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

Table 11.4.1.cont - Plaice in VIId. Tuning diagnostics.

Fishing mortalities

Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	.077	.065	.061	.078	.113	.038	.014	.027	.025	.056
2	.506	.442	.411	.414	.377	.284	.178	.132	.123	.271
3	.832	.805	.476	.723	.611	.546	.775	.576	.562	.434
4	.875	.606	.489	.798	.679	.676	1.443	.955	1.035	.690
5	.688	.521	.341	.636	.511	.748	1.365	.819	.774	.720
6	.592	.633	.353	.427	.306	.494	1.032	.557	.591	.478
7	.379	.464	.374	.374	.493	.372	1.111	.448	.683	.557
8	.362	.441	.312	.513	.449	.593	.808	.500	.465	.416
9	.526	.627	.374	.491	.413	.615	.865	.445	.409	.415

1

XSA population numbers (Thousands)

	AGE								
YEAR	1	2	3	4	5	6	7	8	9
1991	2.17E+04	1.55E+04	1.01E+04	8.15E+03	5.15E+03	3.95E+03	9.53E+02	4.15E+02	2.90E+02
1992	2.80E+04	1.82E+04	8.46E+03	3.99E+03	3.07E+03	2.34E+03	1.98E+03	5.90E+02	2.62E+02
1993	1.32E+04	2.37E+04	1.06E+04	3.42E+03	1.97E+03	1.65E+03	1.12E+03	1.13E+03	3.44E+02
1994	1.74E+04	1.13E+04	1.42E+04	5.95E+03	1.90E+03	1.27E+03	1.05E+03	7.00E+02	7.46E+02
1995	2.55E+04	1.45E+04	6.74E+03	6.25E+03	2.42E+03	9.09E+02	7.48E+02	6.54E+02	3.79E+02
1996	3.14E+04	2.06E+04	9.01E+03	3.31E+03	2.87E+03	1.32E+03	6.05E+02	4.14E+02	3.78E+02
1997	4.18E+04	2.74E+04	1.40E+04	4.73E+03	1.52E+03	1.23E+03	7.27E+02	3.78E+02	2.07E+02
1998	1.82E+04	3.73E+04	2.07E+04	5.84E+03	1.01E+03	3.52E+02	3.96E+02	2.17E+02	1.52E+02
1999	3.12E+04	1.60E+04	2.96E+04	1.05E+04	2.03E+03	4.03E+02	1.83E+02	2.29E+02	1.19E+02
2000	2.68E+04	2.75E+04	1.28E+04	1.53E+04	3.38E+03	8.49E+02	2.02E+02	8.35E+01	1.30E+02

Estimated population abundance at 1st Jan 2001

	0.00E+00	2.29E+04	1.90E+04	7.50E+03	6.92E+03	1.49E+03	4.76E+02	1.05E+02	4.99E+01

Taper weighted geometric mean of the VPA populations:

	2.44E+04	2.10E+04	1.41E+04	6.62E+03	2.48E+03	1.08E+03	5.60E+02	3.17E+02	1.54E+02

Standard error of the weighted Log(VPA populations) :

	.3637	.3765	.4648	.5448	.5187	.6647	.7226	.7302	1.0816

1

Log catchability residuals.

Fleet : FLT01: UK INSHORE TR

Age	1988	1989	1990
1	No data for this fleet at this age		
2	.17	-1.60	-.70
3	.26	-.35	-.32
4	-.13	.67	-.38
5	.26	.48	.01
6	.11	.74	.28
7	-.18	.46	.43
8	-.54	-.41	.44
9	.04	-.53	.44

Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	No data for this fleet at this age									
2	.51	.46	.23	.36	.29	.61	.22	-.31	-.20	-.05
3	.47	.55	-.03	.01	.03	-.47	.24	-.38	.25	-.26
4	.44	.80	.16	.10	-.06	-.68	-.74	.07	-.56	.30
5	.03	.41	.13	.18	-.05	-.40	-.63	-.26	-.18	.03
6	.07	.38	.00	-.11	-.20	-.40	-.28	-.11	-.64	.17
7	-.29	.36	.17	-.04	-.33	-.95	.15	.67	-.79	.35
8	-.38	.45	.30	-.22	-.12	-.25	.19	.27	.14	.38
9	-.67	-.27	.43	.40	.06	-.37	.26	.44	-.26	.63

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

Age	2	3	4	5	6	7	8	9
Mean Log q	-12.1535	-11.5885	-11.6484	-11.6277	-11.6120	-11.7279	-11.7279	-11.7279
S.E(Log q)	.6046	.3388	.4919	.3132	.3556	.4918	.3537	.4284

Table 11.4.1.cont - Plaice in VIId. Tuning diagnostics.

Regression statistics :

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

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
2,	1.51,	-.660,	13.30,	.13,	13,	.94,	-12.15,
3,	1.04,	-.186,	11.66,	.69,	13,	.37,	-11.59,
4,	.85,	.701,	11.23,	.66,	13,	.43,	-11.65,
5,	.80,	1.618,	10.89,	.86,	13,	.24,	-11.63,
6,	.79,	1.887,	10.66,	.88,	13,	.25,	-11.61,
7,	.88,	.629,	11.11,	.72,	13,	.44,	-11.73,
8,	1.11,	-.603,	12.31,	.75,	13,	.40,	-11.71,
9,	.94,	.275,	11.29,	.63,	13,	.41,	-11.68,

1

Fleet : FLT02: BELGIAN BEAM

Age	1988	1989	1990
1	No data for this fleet at this age		
2	.38	-1.71	.60
3	-.08	-.30	.52
4	-.54	-.16	.01
5	-.96	.10	-.34
6	-.88	.04	-.26
7	-.44	-.15	-.73
8	-.33	-.39	-.27
9	-.45	-.02	-1.19

Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	No data for this fleet at this age									
2	1.26	1.53	.75	1.20	-1.40	.05	99.99	-.75	-1.46	-.45
3	.85	.59	-.10	.18	.15	-.04	-1.46	-.27	-.16	.11
4	.09	-.30	-.49	.59	.09	.16	.46	.16	.24	-.30
5	.38	-.48	-.37	-.04	.08	.23	1.04	.21	.44	-.28
6	.49	.19	-.34	-.10	-.27	-.07	.80	.34	.61	-.55
7	-.20	-.22	-.37	-.07	.60	-.37	.70	.26	.53	.46
8	-.26	-.03	-.57	.03	.19	.18	-.12	.10	-.42	.21
9	.67	.90	-1.14	.13	-.43	.02	.21	.44	.24	-.31

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

Age	2	3	4	5	6	7	8	9
Mean Log q	-7.7221	-5.7069	-5.0883	-5.0582	-5.3918	-5.4539	-5.4539	-5.4539
S.E(Log q)	1.1369	.5582	.3430	.5022	.4804	.4588	.2961	.6302

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,	12.53,	-.937,	-17.27,	.00,	12,	14.32,	-7.72,
3,	1.41,	-.935,	4.11,	.32,	13,	.79,	-5.71,
4,	1.12,	-.576,	4.65,	.69,	13,	.39,	-5.09,
5,	1.37,	-1.039,	3.99,	.41,	13,	.69,	-5.06,
6,	1.12,	-.488,	5.19,	.60,	13,	.56,	-5.39,
7,	1.60,	-2.204,	4.81,	.55,	13,	.64,	-5.45,
8,	1.18,	-1.338,	5.51,	.84,	13,	.30,	-5.58,
9,	1.42,	-.836,	5.51,	.27,	13,	.90,	-5.53,

1

Table 11.4.1.cont - Plaice in VIId. Tuning diagnostics.

Fleet : FLT03: FRENCH TRAWLE

Age	1988	1989	1990
1	No data for this fleet at this age		
2	99.99	.04	-.12
3	99.99	-.18	.02
4	99.99	.04	.07
5	99.99	.55	.21
6	99.99	.16	.42
7	99.99	.04	.31
8	99.99	.40	.38
9	99.99	1.24	1.14

Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	No data for this fleet at this age									
2	.69	.44	.36	.34	.19	-.54	-.38	-.75	99.99	-.28
3	.17	.31	-.26	.23	-.42	-.27	.68	.13	99.99	-.40
4	.37	-.36	-.55	-.43	-.49	-.51	.91	.72	99.99	.24
5	-.15	-.08	-1.26	.02	-1.05	-.07	.27	.78	99.99	.78
6	-.05	.41	-.48	-.28	-1.33	-.24	.88	.12	99.99	.40
7	-.29	.29	-.24	-.22	-.89	-.08	1.04	-.18	99.99	.23
8	-.31	-.43	-.68	.25	-.43	.13	1.02	.32	99.99	-.48
9	-.27	-.09	-.28	-.23	-.13	.27	.82	-.30	99.99	-.03

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

Age	2	3	4	5	6	7	8	9
Mean Log q	-11.7571	-10.9493	-10.9444	-11.3177	-11.6435	-11.9027	-11.9027	-11.9027
S.E(Log q)	.4513	.3423	.5183	.6613	.5895	.4827	.5175	.6247

Regression statistics :

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

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
2	5.58	-2.579	20.24	.03	11	2.01	-11.76
3	.82	.768	10.67	.66	11	.28	-10.95
4	.79	.967	10.49	.70	11	.41	-10.94
5	.95	.154	11.14	.48	11	.66	-11.32
6	.91	.293	11.26	.57	11	.57	-11.64
7	1.05	-.176	12.17	.58	11	.53	-11.90
8	1.04	-.162	12.13	.62	11	.57	-11.89
9	1.26	-.546	13.32	.32	11	.77	-11.71

Fleet : FLT04: UK BEAM TRAWL

Age	1988	1989	1990
1	.35	-.43	-.13
2	.57	-.23	-.57
3	.80	.36	-.40
4	.14	.65	.02
5	.75	.01	.18
6	.17	.35	.24
7	No data for this fleet at this age		
8	No data for this fleet at this age		
9	No data for this fleet at this age		

Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	.15	.07	-.04	.19	-.02	-.17	.01	.29	-.25	-.01
2	.12	.24	.02	.19	-.69	-.03	-.26	.11	.29	.24
3	.46	.11	-.14	.32	-.12	-1.29	-.41	-.42	.04	.70
4	.25	.56	-.26	.57	.04	-1.00	-1.03	.10	-.51	.47
5	.36	.80	.06	.28	-.28	-.45	-.90	-.82	-.35	.36
6	.08	1.06	.11	-.27	-.30	-.15	-.85	-.30	-.41	.28
7	No data for this fleet at this age									
8	No data for this fleet at this age									
9	No data for this fleet at this age									

Table 11.4.1.cont - Plaice in VIId. Tuning diagnostics.

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

Age ,	2,	3,	4,	5,	6
Mean Log q,	-7.1846,	-7.1538,	-6.9820,	-6.7246,	-6.7675,
S.E(Log q),	.3546,	.5609,	.5597,	.5377,	.4631,

Regression statistics :

Ages with q dependent on year class strength

Age,	Slope ,	t-value ,	Intercept,	RSquare,	No Pts,	Reg s.e,	Mean Log q
1,	.52,	2.347,	8.79,	.69,	13,	.23,	-7.63,

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,	.78,	.984,	7.80,	.64,	13,	.28,	-7.18,
3,	.73,	1.201,	7.81,	.64,	13,	.40,	-7.15,
4,	.68,	1.795,	7.59,	.74,	13,	.35,	-6.98,
5,	.65,	2.159,	7.14,	.78,	13,	.31,	-6.72,
6,	.74,	1.873,	6.86,	.83,	13,	.31,	-6.77,

1

Fleet : FLT05: French GFS [o

Age ,	1988,	1989,	1990
1 ,	-.09,	-.30,	-.46
2 ,	1.02,	.29,	-1.24
3 ,	.65,	-.16,	.03
4 ,	.53,	-.42,	.28
5 ,	.88,	-1.25,	.61
6 ,	No data for this fleet at this age		
7 ,	No data for this fleet at this age		
8 ,	No data for this fleet at this age		
9 ,	No data for this fleet at this age		

Age ,	1991,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000
1 ,	-1.27,	1.29,	.85,	.18,	-.58,	-.67,	.73,	.51,	-.02,	-.19
2 ,	-1.50,	-.04,	.19,	.13,	.30,	-.36,	.08,	.26,	.11,	.75
3 ,	-1.02,	-.64,	.23,	-.65,	.51,	-1.16,	.95,	-.09,	.61,	.72
4 ,	-1.17,	-.69,	.05,	-.52,	.53,	-.44,	.27,	.15,	.50,	.93
5 ,	-.75,	-1.07,	-.09,	.21,	-.15,	-.11,	.37,	99.99,	.26,	1.09
6 ,	No data for this fleet at this age									
7 ,	No data for this fleet at this age									
8 ,	No data for this fleet at this age									
9 ,	No data for this fleet at this age									

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

Age ,	2,	3,	4,	5
Mean Log q,	-8.1340,	-8.3038,	-8.5936,	-8.7221,
S.E(Log q),	.6966,	.6953,	.6026,	.7305,

Table 11.4.1.cont - Plaice in VIId. Tuning diagnostics.

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
1,	.89,	.162,	8.16,	.17,	13,	.74,	-7.93,

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,	.49,	1.976,	9.04,	.58,	13,	.31,	-8.13,
3,	.65,	1.424,	8.75,	.61,	13,	.44,	-8.30,
4,	.75,	1.080,	8.67,	.63,	13,	.45,	-8.59,
5,	1.41,	-.621,	9.02,	.19,	12,	1.06,	-8.72,

1

Fleet : FLT06: French YFS [r

Age	1988	1989	1990
1	1.93	-1.96	.02
2	No data for this fleet at this age		
3	No data for this fleet at this age		
4	No data for this fleet at this age		
5	No data for this fleet at this age		
6	No data for this fleet at this age		
7	No data for this fleet at this age		
8	No data for this fleet at this age		
9	No data for this fleet at this age		

Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	-.60	3.08	.79	.41	.36	-1.88	.41	1.11	.65	-4.32
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									

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
1,	3.55,	-1.446,	9.92,	.03,	13,	1.96,	-10.02,

Terminal year survivor and F summaries :

Age 1 Catchability dependent on age and year class strength

Year class = 1999

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
FLT01: UK INSHORE TR,	1.,	.000,	.000,	.00,	0,	.000,	.000
FLT02: BELGIAN BEAM ,	1.,	.000,	.000,	.00,	0,	.000,	.000
FLT03: FRENCH TRAWLE,	1.,	.000,	.000,	.00,	0,	.000,	.000
FLT04: UK BEAM TRAWL,	22710.,	.300,	.000,	.00,	1,	.453,	.056
FLT05: French GFS [o,	19002.,	.764,	.000,	.00,	1,	.070,	.067
FLT06: French YFS [r,	1.,	.000,	.000,	.00,	0,	.000,	.000
P shrinkage mean ,	21035.,	.38,,,,				.304,	.061
F shrinkage mean ,	29529.,	.50,,,,				.173,	.044

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
22928.,	.20,	.08,	4,	.367,	.056

Table 11.4.1.cont - Plaice in VIId. Tuning diagnostics.

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

Year class = 1998

Fleet,	Estimated,	Int,	Ext,	Var,	N,	Scaled,	Estimated
,	Survivors,	s.e,	s.e,	Ratio,	,	Weights,	F
FLT01: UK INSHORE TR,	18025.,	.627,	.000,	.00,	1,	.073,	.284
FLT02: BELGIAN BEAM ,	12154.,	1.183,	.000,	.00,	1,	.021,	.396
FLT03: FRENCH TRAWLE,	14366.,	.471,	.000,	.00,	1,	.129,	.345
FLT04: UK BEAM TRAWL,	17992.,	.233,	.241,	1.04,	2,	.524,	.284
FLT05: French GFS [o,	28135.,	.526,	.387,	.74,	2,	.103,	.191
FLT06: French YFS [r,	1.,	.000,	.000,	.00,	0,	.000,	.000
F shrinkage mean ,	24095.,	.50,,,,				.151,	.219

Weighted prediction :

Survivors,	Int,	Ext,	N,	Var,	F
at end of year,	s.e,	s.e,	,	Ratio,	
18969.,	.17,	.11,	8,	.649,	.271

Age 3 Catchability constant w.r.t. time and dependent on age

Year class = 1997

Fleet,	Estimated,	Int,	Ext,	Var,	N,	Scaled,	Estimated
,	Survivors,	s.e,	s.e,	Ratio,	,	Weights,	F
FLT01: UK INSHORE TR,	5843.,	.307,	.028,	.09,	2,	.199,	.529
FLT02: BELGIAN BEAM ,	6382.,	.521,	.598,	1.15,	2,	.069,	.494
FLT03: FRENCH TRAWLE,	5023.,	.357,	.000,	.00,	1,	.150,	.594
FLT04: UK BEAM TRAWL,	10699.,	.216,	.104,	.48,	3,	.366,	.323
FLT05: French GFS [o,	11849.,	.426,	.185,	.43,	3,	.097,	.296
FLT06: French YFS [r,	1.,	.000,	.000,	.00,	0,	.000,	.000
F shrinkage mean ,	4780.,	.50,,,,				.119,	.617

Weighted prediction :

Survivors,	Int,	Ext,	N,	Var,	F
at end of year,	s.e,	s.e,	,	Ratio,	
7501.,	.14,	.13,	12,	.898,	.434

1

Age 4 Catchability constant w.r.t. time and dependent on age

Year class = 1996

Fleet,	Estimated,	Int,	Ext,	Var,	N,	Scaled,	Estimated
,	Survivors,	s.e,	s.e,	Ratio,	,	Weights,	F
FLT01: UK INSHORE TR,	8439.,	.274,	.141,	.51,	3,	.185,	.597
FLT02: BELGIAN BEAM ,	5185.,	.302,	.072,	.24,	3,	.190,	.845
FLT03: FRENCH TRAWLE,	5934.,	.376,	.482,	1.28,	2,	.108,	.770
FLT04: UK BEAM TRAWL,	7950.,	.211,	.101,	.48,	4,	.263,	.624
FLT05: French GFS [o,	14215.,	.378,	.144,	.38,	4,	.101,	.395
FLT06: French YFS [r,	1.,	.000,	.000,	.00,	0,	.000,	.000
F shrinkage mean ,	4255.,	.50,,,,				.152,	.963

Weighted prediction :

Survivors,	Int,	Ext,	N,	Var,	F
at end of year,	s.e,	s.e,	,	Ratio,	
6925.,	.13,	.10,	17,	.784,	.690

Table 11.4.1.cont - Plaice in VIId. Tuning diagnostics.

Age 5 Catchability constant w.r.t. time and dependent on age

Year class = 1995

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
FLT01: UK INSHORE TR,	1377.,	.250,	.125,	.50,	4,	.292,	.762
FLT02: BELGIAN BEAM ,	1386.,	.309,	.181,	.58,	3,	.161,	.758
FLT03: FRENCH TRAWLE,	2122.,	.361,	.312,	.87,	3,	.100,	.554
FLT04: UK BEAM TRAWL,	1444.,	.260,	.171,	.66,	5,	.179,	.736
FLT05: French GFS [o,	2703.,	.413,	.279,	.67,	5,	.082,	.458
FLT06: French YFS [r,	1.,	.000,	.000,	.00,	0,	.000,	.000
F shrinkage mean ,	1178.,	.50,,,,				.187,	.848

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
1490.,	.15,	.09,	21,	.592,	.720

1

Age 6 Catchability constant w.r.t. time and dependent on age

Year class = 1994

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
FLT01: UK INSHORE TR,	504.,	.234,	.088,	.37,	5,	.326,	.457
FLT02: BELGIAN BEAM ,	385.,	.304,	.243,	.80,	5,	.183,	.565
FLT03: FRENCH TRAWLE,	728.,	.403,	.168,	.42,	4,	.103,	.337
FLT04: UK BEAM TRAWL,	516.,	.298,	.116,	.39,	6,	.189,	.449
FLT05: French GFS [o,	583.,	.425,	.170,	.40,	5,	.040,	.406
FLT06: French YFS [r,	1.,	.000,	.000,	.00,	0,	.000,	.000
F shrinkage mean ,	357.,	.50,,,,				.159,	.598

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
476.,	.14,	.07,	26,	.498,	.478

Age 7 Catchability constant w.r.t. time and dependent on age

Year class = 1993

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
FLT01: UK INSHORE TR,	86.,	.240,	.194,	.81,	6,	.307,	.646
FLT02: BELGIAN BEAM ,	166.,	.299,	.069,	.23,	6,	.232,	.385
FLT03: FRENCH TRAWLE,	139.,	.403,	.122,	.30,	5,	.143,	.446
FLT04: UK BEAM TRAWL,	62.,	.322,	.130,	.41,	6,	.110,	.813
FLT05: French GFS [o,	100.,	.382,	.340,	.89,	4,	.008,	.578
FLT06: French YFS [r,	1.,	.000,	.000,	.00,	0,	.000,	.000
F shrinkage mean ,	90.,	.50,,,,				.199,	.624

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
105.,	.16,	.08,	28,	.537,	.557

Table 11.4.1.cont - Plaice in VIId. Tuning diagnostics.

Age 8 Catchability constant w.r.t. time and age (fixed at the value for age) 7

Year class = 1992

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
FLT01: UK INSHORE TR,	52.,	.240,	.186,	.78,	7,	.312,	.402
FLT02: BELGIAN BEAM ,	66.,	.238,	.065,	.27,	7,	.364,	.328
FLT03: FRENCH TRAWLE,	35.,	.408,	.116,	.28,	6,	.117,	.547
FLT04: UK BEAM TRAWL,	35.,	.328,	.132,	.40,	6,	.047,	.554
FLT05: French GFS [o,	58.,	.388,	.212,	.55,	5,	.008,	.368
FLT06: French YFS [r,	1.,	.000,	.000,	.00,	0,	.000,	.000
F shrinkage mean ,	34.,	.50,,,,				.151,	.565

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
50.,	.15,	.07,	32,	.499,	.416

Age 9 Catchability constant w.r.t. time and age (fixed at the value for age) 7

Year class = 1991

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
FLT01: UK INSHORE TR,	108.,	.224,	.129,	.58,	8,	.354,	.316
FLT02: BELGIAN BEAM ,	63.,	.227,	.129,	.57,	8,	.318,	.492
FLT03: FRENCH TRAWLE,	77.,	.368,	.117,	.32,	7,	.127,	.418
FLT04: UK BEAM TRAWL,	47.,	.280,	.182,	.65,	6,	.032,	.614
FLT05: French GFS [o,	89.,	.400,	.233,	.58,	5,	.007,	.372
FLT06: French YFS [r,	1.,	.000,	.000,	.00,	0,	.000,	.000
F shrinkage mean ,	64.,	.50,,,,				.162,	.485

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
78.,	.14,	.07,	35,	.486,	.415

Table 11.4.2.- Plaice in VIId. F at age.

Run title : Plaice in VIId (run: XSAAEDB01/X01)
At 25/06/2001 17:01

Fishing mortality (F) at age

YEAR,	1980,
AGE	
1,	.0022,
2,	.1675,
3,	.2790,
4,	.3374,
5,	.6177,
6,	.4144,
7,	.3991,
8,	.2538,
9,	.3567,
+gp,	.3567,
0 FBAR 2- 6,	.3632,
FBAR 3- 6,	.4121,

YEAR,	1981,	1982,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,
AGE										
1,	.0013,	.0111,	.0049,	.0148,	.0050,	.0119,	.0008,	.0006,	.0547,	.0954,
2,	.1182,	.1348,	.1522,	.1159,	.3135,	.2130,	.1811,	.2060,	.1740,	.2204,
3,	.7294,	.4972,	.4559,	.5770,	.5973,	.6948,	.5162,	.6649,	.4535,	.7032,
4,	.8860,	.8597,	.9384,	.8244,	.8590,	.7635,	.7927,	.6681,	.7431,	.7446,
5,	.2721,	.6942,	.5526,	.7883,	.2328,	.5960,	.5701,	.5627,	.8507,	.6243,
6,	.3660,	.2817,	.3982,	.6288,	.5674,	.5013,	.3087,	.4550,	.5782,	.5877,
7,	.4875,	.3494,	.1751,	.8314,	.3533,	.4312,	.8340,	.5244,	.4139,	.4425,
8,	.7049,	1.8586,	.8852,	.2641,	.9191,	.2195,	.4482,	.5338,	.3721,	.5099,
9,	.5214,	.8340,	.4879,	.5770,	.6158,	.3851,	.5323,	.5553,	.6877,	.6839,
+gp,	.5214,	.8340,	.4879,	.5770,	.6158,	.3851,	.5323,	.5553,	.6877,	.6839,
0 FBAR 2- 6,	.4743,	.4935,	.4995,	.5869,	.5140,	.5537,	.4738,	.5113,	.5599,	.5760,
FBAR 3- 6,	.5634,	.5832,	.5863,	.7046,	.5641,	.6389,	.5469,	.5877,	.6564,	.6650,

YEAR,	1991,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	FBAR 98-**
AGE											
1,	.0775,	.0646,	.0606,	.0782,	.1131,	.0382,	.0139,	.0272,	.0253,	.0558,	.0361,
2,	.5062,	.4424,	.4111,	.4138,	.3771,	.2844,	.1782,	.1323,	.1229,	.2713,	.1755,
3,	.8319,	.8053,	.4764,	.7232,	.6112,	.5457,	.7749,	.5763,	.5620,	.4339,	.5241,
4,	.8753,	.6057,	.4892,	.7978,	.6788,	.6756,	1.4435,	.9548,	1.0353,	.6905,	.8936,
5,	.6885,	.5206,	.3413,	.6364,	.5105,	.7478,	1.3653,	.8191,	.7740,	.7200,	.7710,
6,	.5925,	.6330,	.3533,	.4269,	.3062,	.4937,	1.0321,	.5566,	.5913,	.4782,	.5420,
7,	.3793,	.4636,	.3744,	.3743,	.4928,	.3722,	1.1113,	.4481,	.6831,	.5574,	.5629,
8,	.3620,	.4407,	.3120,	.5129,	.4491,	.5928,	.8077,	.4996,	.4654,	.4155,	.4602,
9,	.5262,	.6274,	.3742,	.4906,	.4131,	.6152,	.8653,	.4445,	.4095,	.4149,	.4230,
+gp,	.5262,	.6274,	.3742,	.4906,	.4131,	.6152,	.8653,	.4445,	.4095,	.4149,	
FBAR 2- 6,	6989,	.6014,	.4142,	.5996,	.4967,	.5494,	.9588,	.6078,	.6171,	.5188,	
FBAR 3- 6,	7470,	.6412,	.4150,	.6461,	.5267,	.6157,	1.1539,	.7267,	.7407,	.5807,	

1

Table 11.4.3.- Plaice in VIId. N at age.

Run title : Plaice in VIId (run: XSAAEDB01/X01)

At 25/06/2001 17:01

Terminal Fs derived using XSA (With F shrinkage)

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

	YEAR,	1980,	1981,	1982,	1983,
	AGE				
	1,	25542,	12855,	25207,	19960,
	2,	18026,	23061,	11616,	22556,
	3,	6266,	13796,	18539,	9186,
	4,	1982,	4290,	6019,	10203,
	5,	1118,	1280,	1600,	2305,
	6,	232,	545,	882,	723,
	7,	144,	139,	342,	602,
	8,	206,	87,	77,	218,
	9,	14,	145,	39,	11,
	+gp,	360,	515,	162,	274,
0	TOTAL,	53890,	56712,	64485,	66039,

	YEAR,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	
	AGE											
	1,	25040,	29732,	60327,	31298,	26480,	16300,	18856	21749,	27966,	13235,	,
	2,	17973,	22324,	26768,	53940,	28296,	23945,	13963	15509,	18212,	23721,	,
	3,	17527,	14483,	14764,	19575,	40723,	20837,	18206	10135,	8459,	10588,	,
	4,	5268,	8906,	7212,	6668,	10570,	18952,	11979	8154,	3991,	3421,	,
	5,	3612,	2090,	3414,	3041,	2731,	4903,	8157	5148,	3075,	1971,	,
	6,	1200,	1486,	1499,	1702,	1556,	1408,	1895	3953,	2340,	1653,	,
	7,	439,	579,	762,	821,	1131,	893,	714	953,	1978,	1124,	,
	8,	457,	173,	368,	448,	323,	606,	534	415,	590,	1126,	,
	9,	82,	318,	62,	267,	259,	171,	378	290,	262,	344,	,
	+gp,	239,	114,	111,	195,	427,	414,	487	320,	265,	510,	,
0	TOTAL,	71838,	80205,	115287,	117957,	112496,	88429,	75170	66627,	67138,	57693,	,
1												

	YEAR,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,		GMST 80-98	AMST 80-98
	AGE											
	1,	17357,	25475,	31404,	41838,	18156,	31167,	26793,	0,		23946,	25725,
	2,	11271,	14524,	20585,	27351,	37333,	15987,	27496,	22928,		21042,	22683,
	3,	14229,	6743,	9014,	14015,	20710,	29595,	12793,	18969,		13671,	15147,
	4,	5950,	6246,	3311,	4726,	5843,	10531,	15265,	7501,		6180,	7036,
	5,	1898,	2424,	2867,	1525,	1010,	2035,	3384,	6925,		2469,	2851,
	6,	1268,	909,	1317,	1228,	352,	403,	849,	1490,		1154,	1376,
	7,	1051,	748,	605,	727,	396,	183,	202,	476,		626,	745,
	8,	700,	654,	414,	378,	217,	229,	83,	105,		346,	421,
	9,	746,	379,	378,	207,	152,	119,	130,	50,		157,	237,
	+gp,	842,	798,	790,	551,	548,	346,	302,	258,			
0	TOTAL,	55311,	58901,	70684,	92546,	84717,	90594,	87298,	58701,			
1												

Table 11.5.1.- Plaice in VIId. RCT3 input files.

7D PLAICE - VPA AGE 1 / indices all * per 100

3	20	2		
'YEARCLASS	'VPA'	'ebt1'	'fbt0'	'fbt1'
1981	25207	-11	-11	-11
1982	19960	-11	-11	-11
1983	25040	-11	-11	-11
1984	29732	-11	-11	-11
1985	60327	-11	-11	-11
1986	31298	-11	-11	-11
1987	26480	2647	-11	1033
1988	16300	231	19	408
1989	18856	516	16	395
1990	21749	1175	16	195
1991	27966	1653	15	3361
1992	13235	322	98	1168
1993	17357	833	241	902
1994	25475	1132	739	542
1995	31404	1320	99	615
1996	41838	3310	1733	3756
1997	18156	1140	983	1067
1998	-11	1130	592	1298
1999	-11	1319	106	960
2000	-11	-11	401	-11

Table 11.5.2 – Plaice in VIId. RCT3 output for Age 1

Analysis by RCT3 ver3.1 of data from file : rct3.cfg
7D PLAICE - VPA **AGE 1** / indices all * per 100,,,,
Data for 3 surveys over 20 years : 1981 - 2000
Regression type = C
Tapered time weighting applied
power = 3 over 20 years
Survey weighting not applied
Final estimates shrunk towards mean
Minimum S.E. for any survey taken as .20
Minimum of 3 points used for regression

Forecast/Hindcast variance correction used.
Yearclass = 1998

	I-----------Regression----------I					I-----------Prediction---------I				
Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index	Predicted Value	Std Value	WAP Error	Weights
ebt1	.51	6.52	.22	.733	11	7.03	10.08	.258	.635	
fbt0	.62	7.00	1.16	.095	10	6.39	10.98	1.435	.021	
fbt1	.91	3.86	.78	.178	11	7.17	10.38	.929	.049	
						VPA Mean =	10.09	.378	.296	

Yearclass = 1999

	I-----------Regression----------I					I-----------Prediction---------I				
Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index	Predicted Value	Std Value	WAP Error	Weights
ebt1	.51	6.46	.22	.736	11	7.19	10.16	.263	.627	
fbt0	.63	6.93	1.18	.094	10	4.67	9.88	1.417	.022	
fbt1	.92	3.78	.80	.177	11	6.87	10.10	.943	.049	
						VPA Mean =	10.08	.379	.303	

Yearclass = 2000

	I-----------Regression----------I					I-----------Prediction---------I				
Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index	Predicted Value	Std Value	WAP Error	Weights
ebt1										
fbt0	.64	6.85	1.21	.093	10	6.00	10.70	1.489	.061	
fbt1										
						VPA Mean =	10.07	.378	.939	

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
1998	24692	10.11	.21	.08	.16		
1999	24975	10.13	.21	.03	.02		
2000	**24639**	10.11	.37	.15	.16		

Table 11.5.3 – Plaice in VIId. RCT3 output for Age 2

```
Analysis by RCT3 ver3.1 of data from file : rct3.cfg
 7D PLAICE - VPA AGE 2 / indices all * per 100,,,,
 Data for    3 surveys over   20 years :  1981 - 2000
 Regression type = C
 Tapered time weighting applied
 power =    3 over  20 years
 Survey weighting not applied
 Final estimates shrunk towards mean
 Minimum S.E. for any survey taken as    .20
 Minimum of   3 points used for regression

 Forecast/Hindcast variance correction used.

Yearclass =   1998

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

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

 ebt1        .52       6.28      .22      .752       11     7.03        9.92       .255        .652
 fbt0        .60       6.93     1.12      .108      10      6.39      10.79    1.380       .022
 fbt1        .88       3.90       .75      .205      11      7.17      10.21       .885       .054

                                                                VPA  Mean  =     9.94          .396
.271

Yearclass =   1999

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

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

 ebt1         .53      6.21      .22     .755       11      7.19       10.00      .260      .644
 fbt0          .61     6.87     1.14     .107      10      4.67          9.73   1.362      .024
 fbt1          .89     3.83       .76     .204      11      6.87          9.94      .897      .054

                                                                 VPA  Mean  =      9.93         .396
.278

Yearclass =   2000

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

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

 ebt1
 fbt0           .62      6.79      1.16    .106       10     6.00      10.52      1.431      .071
 fbt1
                                                                  VPA Mean  =     9.92          .396
.929


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

 1998      21198       9.96     .21     .08      .16
 1999      21444       9.97     .21     .03      .02
 2000      21252       9.96     .38     .15      .16
```

Table 11.6.1 - Plaice in VIId. Historical stock data

Run title : Plaice in VIId (run: XSAAEDB01/X01)
At 25/06/2001 17:01

Table 16 Summary (without SOP correction)
Terminal Fs derived using XSA (With F shrinkage)

	RECRUITS, Age 1	TOTALBIO,	TOTSPBIO,	LANDINGS,	YIELD/SSB,	FBAR 2- 6,	FBAR 3- 6,
1980,	25542,	16507,	5584,	2650,	.4746,	.3632,	.4121,
1981,	12855,	14333,	6558,	4769,	.7272,	.4743,	.5634,
1982,	25207,	15056,	7574,	4865,	.6423,	.4935,	.5832,
1983,	19960,	15129,	8123,	5043,	.6209,	.4995,	.5863,
1984,	25040,	14126,	7454,	5161,	.6924,	.5869,	.7046,
1985,	29732,	15765,	8136,	6022,	.7402,	.5140,	.5641,
1986,	60327,	23101,	10064,	6834,	.6791,	.5537,	.6389,
1987,	31298,	31792,	13429,	8366,	.6230,	.4738,	.5469,
1988,	26480,	24396,	13126,	10420,	.7938,	.5113,	.5877,
1989,	16300,	21461,	14169,	8758,	.6181,	.5599,	.6564,
1990,	18856,	19488,	13432,	9047,	.6735,	.5760,	.6650,
1991,	21749,	14658,	10199,	7813,	.7661,	.6989,	.7470,
1992,	27966,	14336,	8011,	6337,	.7910,	.6014,	.6412,
1993,	13235,	15727,	8359,	5331,	.6378,	.4142,	.4150,
1994,	17357,	15410,	8572,	6121,	.7141,	.5996,	.6461,
1995,	25475,	12537,	7937,	5130,	.6463,	.4967,	.5267,
1996,	31404,	18683,	7577,	5393,	.7117,	.5494,	.6157,
1997,	41838,	14581,	6916,	6307,	.9119,	.9588,	1.1539,
1998,	18156,	16612,	7558,	5762,	.7623,	.6078,	.7267,
1999,	31167,	14535,	8040,	6326,	.7868,	.6171,	.7407,
2000,	26793,	16169,	9519,	6015,	.6319,	.5188,	.5807,
2001,	23946 (*)		9520 (**)				
Arith. Mean	26035,	17353,	9064,	6308,	.6974,	.5557,	.6334,
0 Units,	(Thousands),	(Tonnes),	(Tonnes),	(Tonnes),			

(*) geometric mean (1980-2000)
(**) short-term prediction at Fsq

Table 11.7.1 - Plaice in VIId (Eastern English Channel)
input data for catch forecast and linear sensitivity analysis

Label	Value	CV	Label	Value	CV
Number at age			Weight in the stock		
N1	23945	0.38	WS1	0.07	0.03
N2	22928	0.2	WS2	0.13	0.23
N3	18969	0.17	WS3	0.23	0.13
N4	7501	0.14	WS4	0.33	0.09
N5	6924	0.13	WS5	0.42	0.07
N6	1490	0.15	WS6	0.52	0.06
N7	475	0.14	WS7	0.62	0.05
N8	104	0.16	WS8	0.73	0.05
N9	49	0.15	WS9	0.83	0.05
N10	258	0.14	WS10	1.12	0.07
H.cons selectivity			Weight in the HC catch		
sH1	0.03	0.54	WH1	0.18	0.11
sH2	0.17	0.56	WH2	0.25	0.03
sH3	0.50	0.05	WH3	0.27	0.15
sH4	0.84	0.10	WH4	0.35	0.11
sH5	0.74	0.07	WH5	0.47	0.07
sH6	0.54	0.06	WH6	0.71	0.12
sH7	0.59	0.27	WH7	0.79	0.05
sH8	0.47	0.14	WH8	0.94	0.07
sH9	0.41	0.11	WH9	0.95	0.06
sH10	0.41	0.11	WH10	1.36	0.12
Natural mortality			Proportion mature		
M1	0.10	0.10	MT1	0.00	0.10
M2	0.10	0.10	MT2	0.15	0.10
M3	0.10	0.10	MT3	0.53	0.10
M4	0.10	0.10	MT4	0.96	0.10
M5	0.10	0.10	MT5	1.00	0.10
M6	0.10	0.10	MT6	1.00	0.00
M7	0.10	0.10	MT7	1.00	0.00
M8	0.10	0.10	MT8	1.00	0.00
M9	0.10	0.10	MT9	1.00	0.00
M10	0.10	0.10	MT10	1.00	0.00
Relative effort in HC fishery			Year effect for natural mortality		
HF01	1	0.08	K01	1	0.1
HF02	1	0.08	K02	1	0.1
HF03	1	0.08	K03	1	0.1
Recruitment in 2002 and 2003					
R02	23946	0.38			
R03	23946	0.38			

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

Stock numbers age 1 in 2001 are GM
Stock numbers age 2 - 10 in 2001 are VPA survivors.

Data from file:E:\2001\data\plaiceviid\final\PLEVIID.SEN on 25/06/2

Table 11.7.2 plaice,viid Catch forecast output and estimates of coefficient of variation (CV) from linear analysis.

	Year 2001	2002						
Mean F Ages								
H.cons 2 to 6	0.52	0.00	0.10	0.21	0.31	0.42	0.52	0.62
Effort relative to 2000								
H.cons	1.00	0.00	0.20	0.40	0.60	0.80	1.00	1.20
Biomass								
Total 1 January	15.97	15.99	15.99	15.99	15.99	15.99	15.99	15.99
SSB at spawning time	9.52	9.85	9.85	9.85	9.85	9.85	9.85	9.85
Catch weight (,000t)								
H.cons	6.37	0.00	1.59	3.02	4.30	5.45	6.48	7.42
Biomass in year.... 2003								
Total 1 January		22.52	20.85	19.37	18.05	16.87	15.81	14.87
SSB at spawning time		16.10	14.53	13.14	11.91	10.82	9.85	8.98

	Year 2001	2002						
Effort relative to 2000								
H.cons	1.00	0.00	0.20	0.40	0.60	0.80	1.00	1.20
Est. Coeff. of Variation								
Biomass								
Total 1 January	0.10	0.12	0.12	0.12	0.12	0.12	0.12	0.12
SSB at spawning time	0.10	0.11	0.11	0.11	0.11	0.11	0.11	0.11
Catch weight								
H.cons	0.13	0.00	0.44	0.23	0.17	0.15	0.14	0.13
Biomass in year.... 2003								
Total 1 January		0.12	0.13	0.14	0.14	0.15	0.15	0.16
SSB at spawning time		0.12	0.13	0.13	0.14	0.14	0.15	0.15

Detailed forecast tables.

Forecast for year 2001
F multiplier H.cons=1.00

Age	Populations: Stock No.	Catch number: H.Cons	Catch number: Total
1	23945	718	718
2	22928	3174	3174
3	18969	6773	6773
4	7501	3950	3950
5	6924	3296	3296
6	1490	546	546
7	475	179	179
8	104	33	33
9	49	15	15
10	258	78	78
Wt	16	6	6

Forecast for year 2002
F multiplier H.cons=1.00

Age	Populations: Stock No.	Catch number: H.Cons	Catch number: Total
1	23946	718	718
2	20984	2905	2905
3	17732	6331	6331
4	10749	5661	5661
5	3056	1455	1455
6	3149	1154	1154
7	831	313	313
8	260	84	84
9	62	19	19
10	190	57	57
Wt	16	6	6

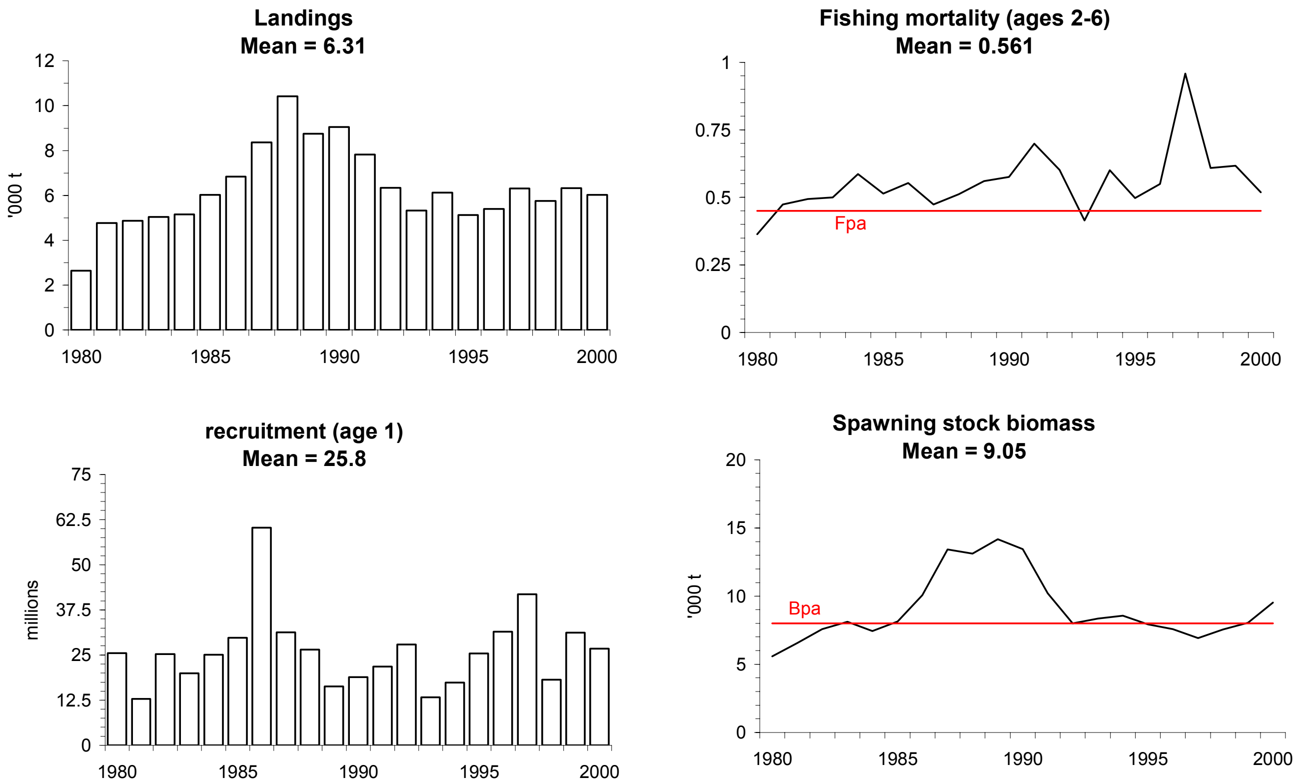


Figure 11.1.1. Plaice in VIId (Eastern English Channel)

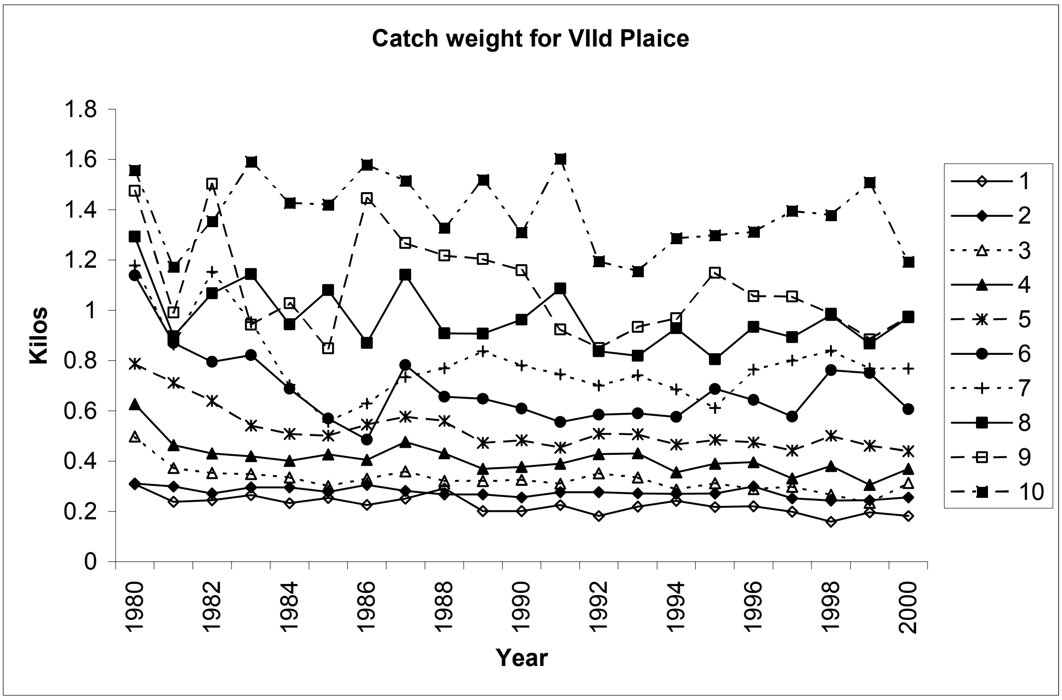


Fig 11.2.1 Plaice VIId. Catch weights at age

Figure 11.2.2 Plaice VIId. Polynomial curve fitted to catch weight data for the production of stock weight data

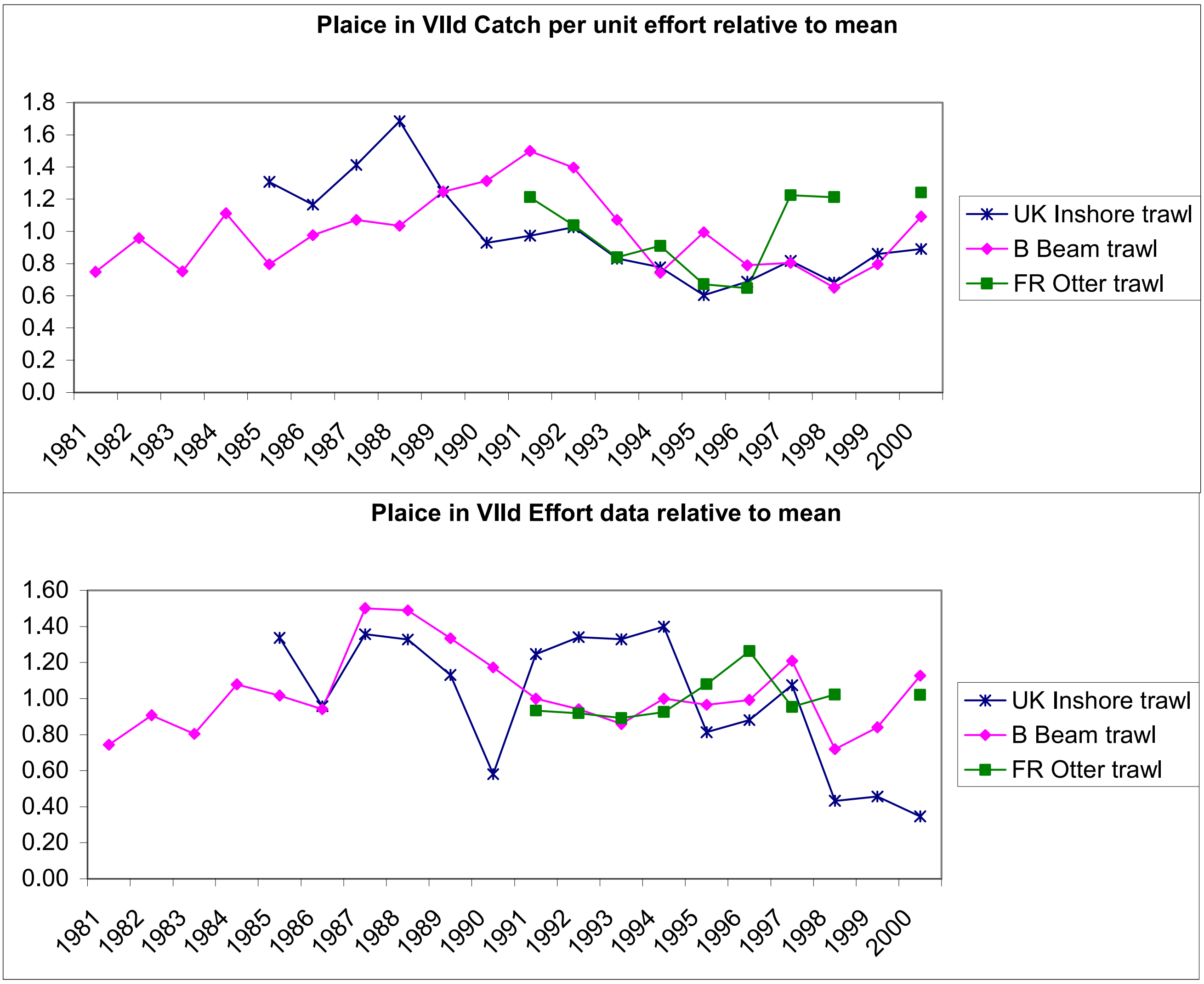


Figure 11.3.1 - Plaice in VIId. CPUE and effort

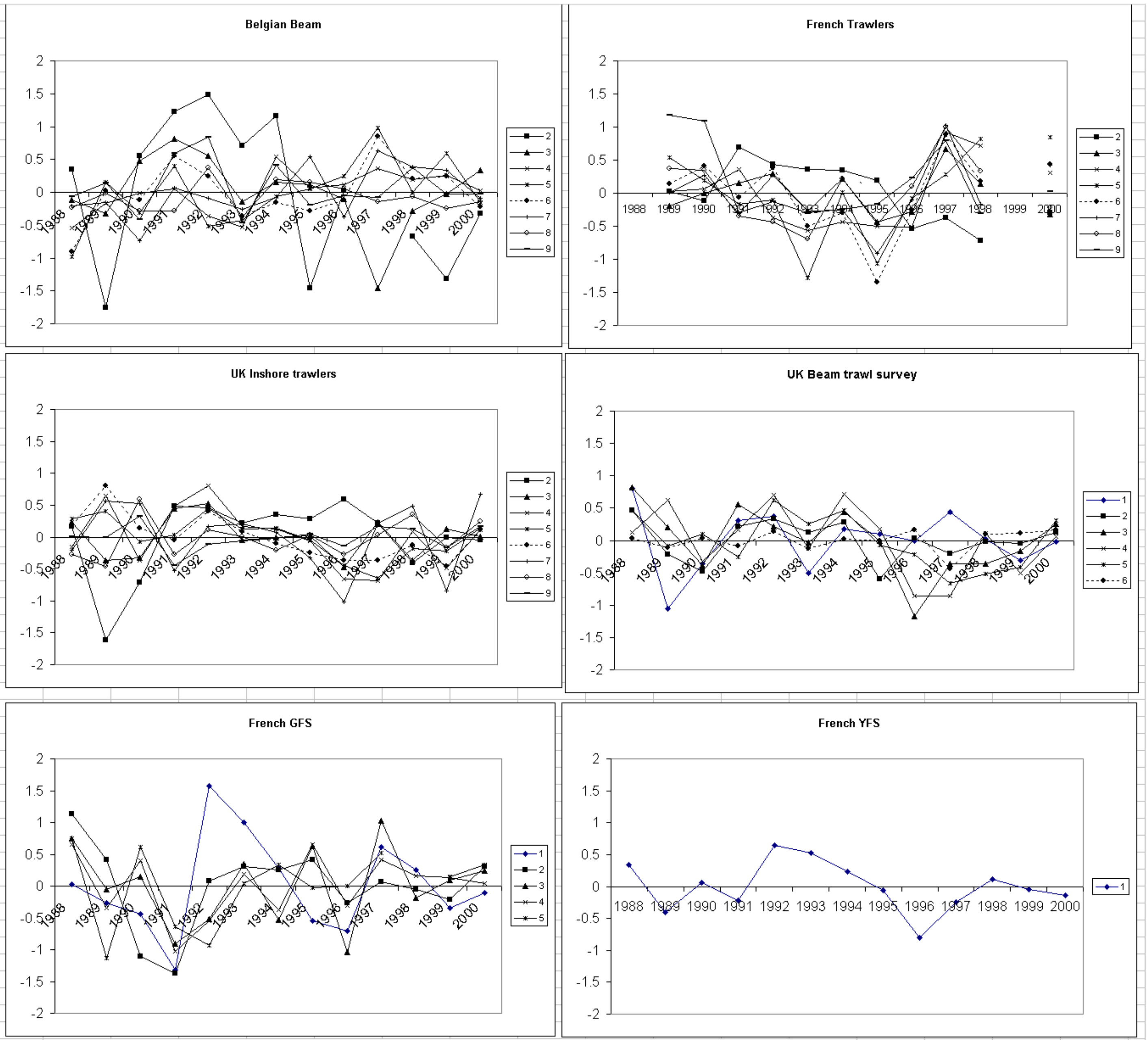


Figure 11.4.1 - Plaice in VIId. Log q residual per fleet and age (XSA, single fleet runs, F shrinkage = 1.5, no taper)

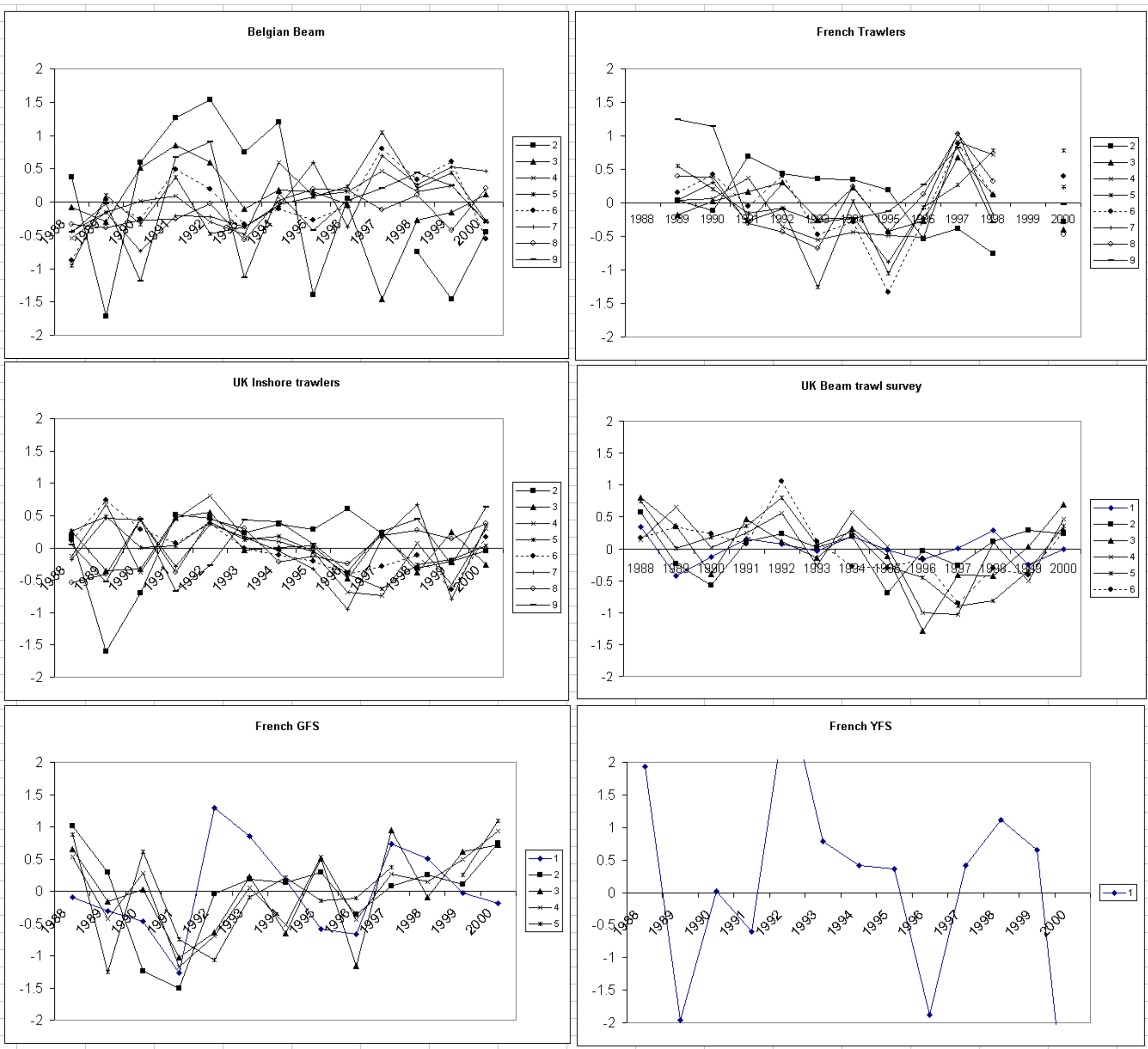


Figure 11.4.2 - Plaice in VIId. Log q residual per fleet and age (XSA, final run, fleet together, F shrinkage = 0.5, no taper)

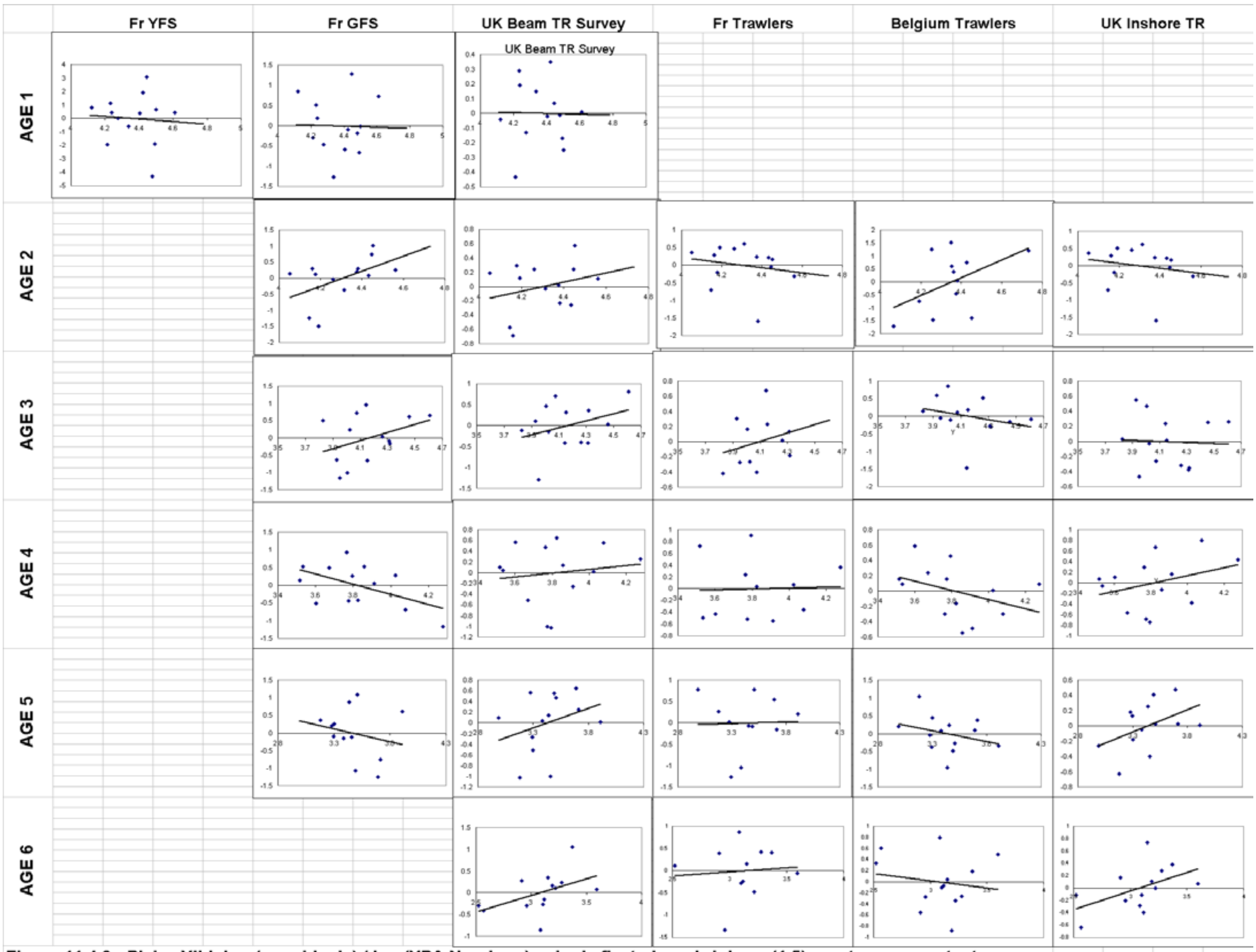


Figure 11.4.3 - Plaice VIId. Log(q residuals) / log (VPA Numbers) - single fleet - low shrinkage (1.5) - no taper - constant q

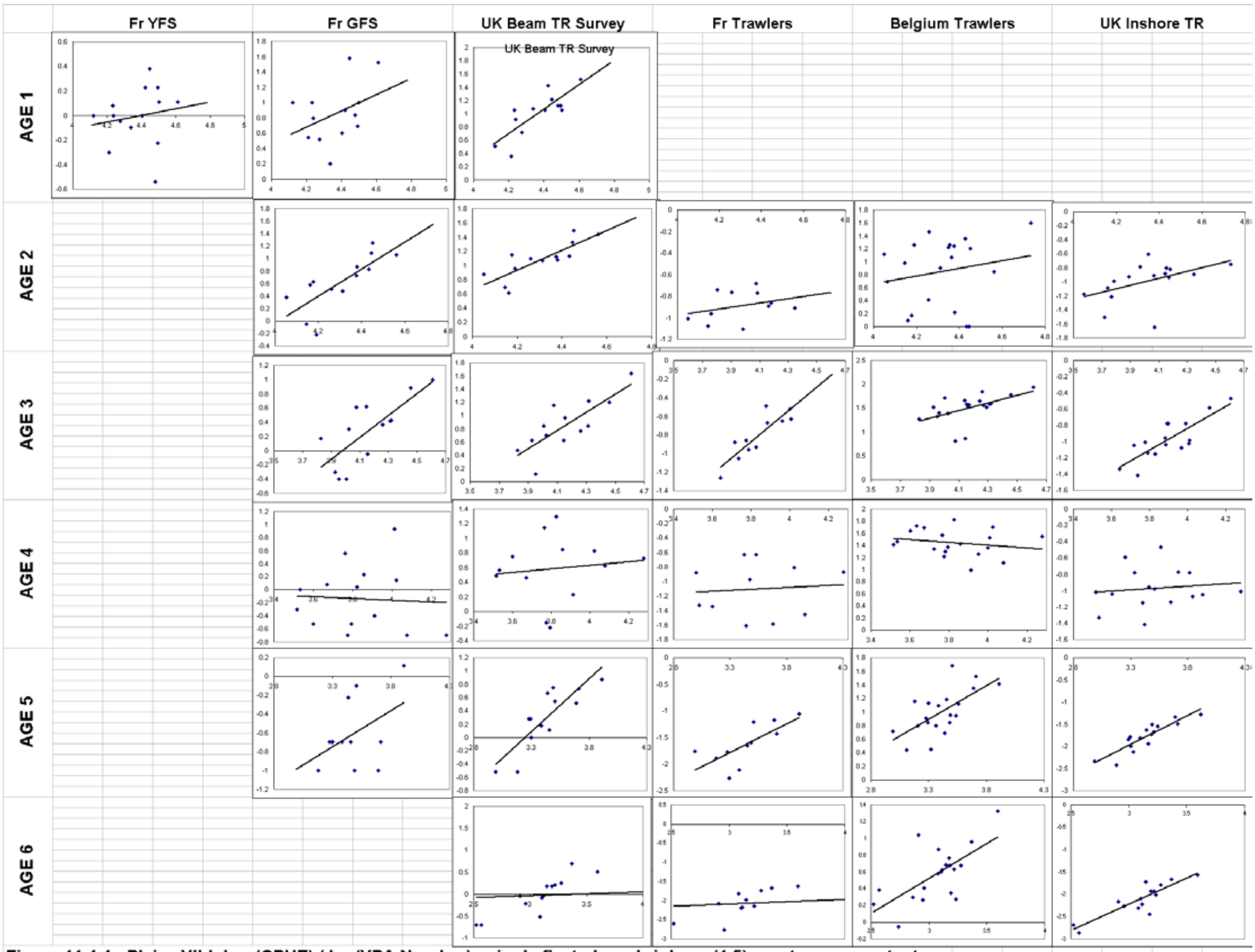
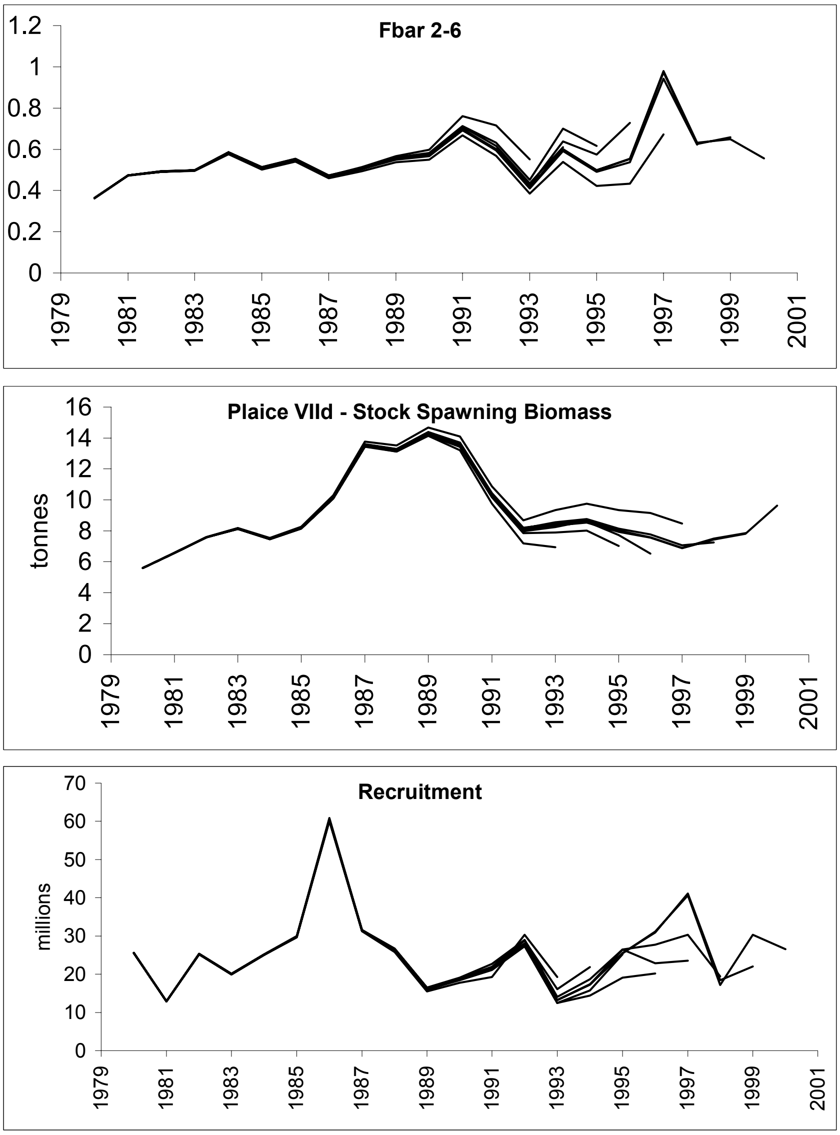


Figure 11.4.4 - Plaice VIId. Log(CPUE) / log(VPA Number) - single fleet - low shrinkage (1.5) - no taper - constant q



Retrospective patterns.

Truncation of year range.

Tuning range 1988 - 2000, no taper.

Power model on age 1

F shrinkage = 0.5

Figure 11.4.5 - Plaice in VIId. Retrospective analysis with final run

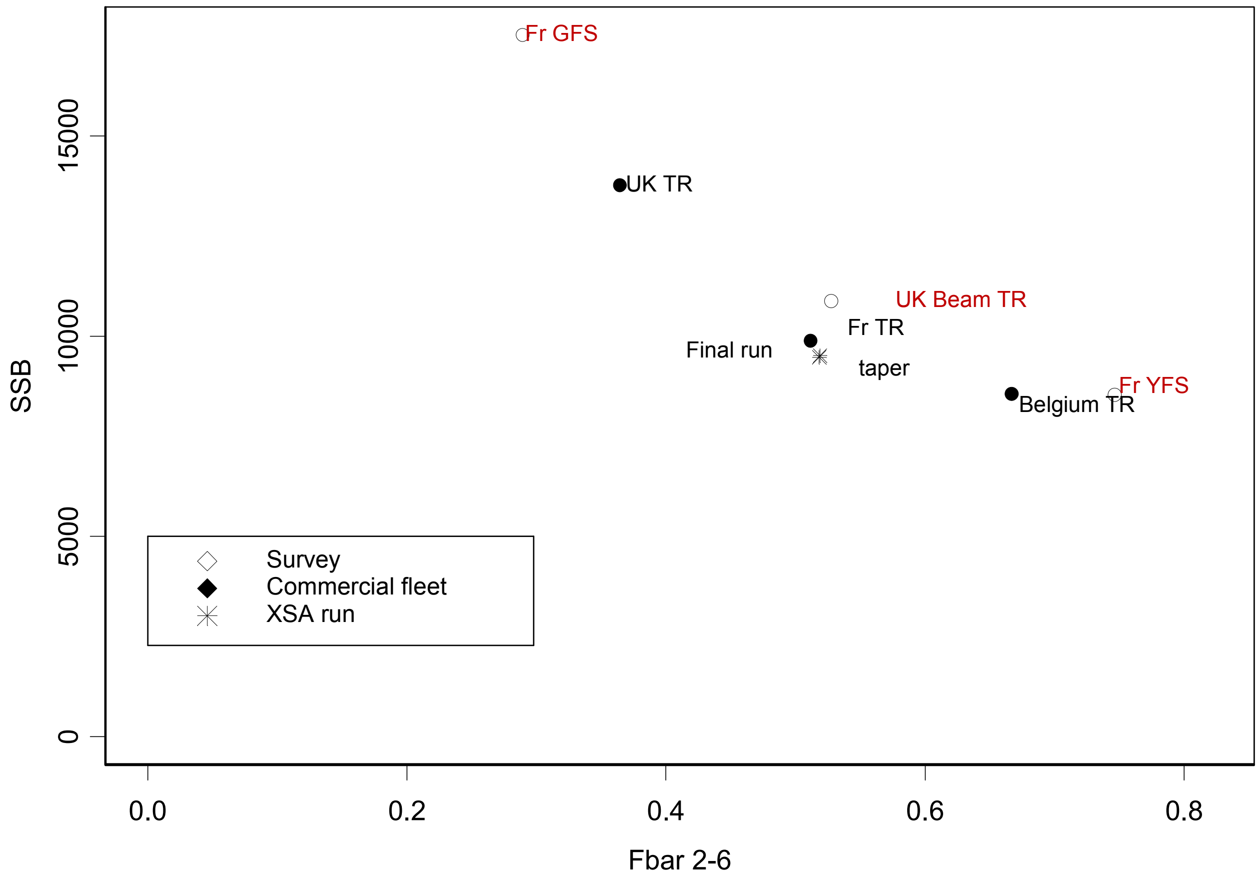


Figure 11.4.6. Plaice in VIId. Estimates of terminal Fbar (2-6) against estimates of terminal SSB for a range of XSA tuning configurations.

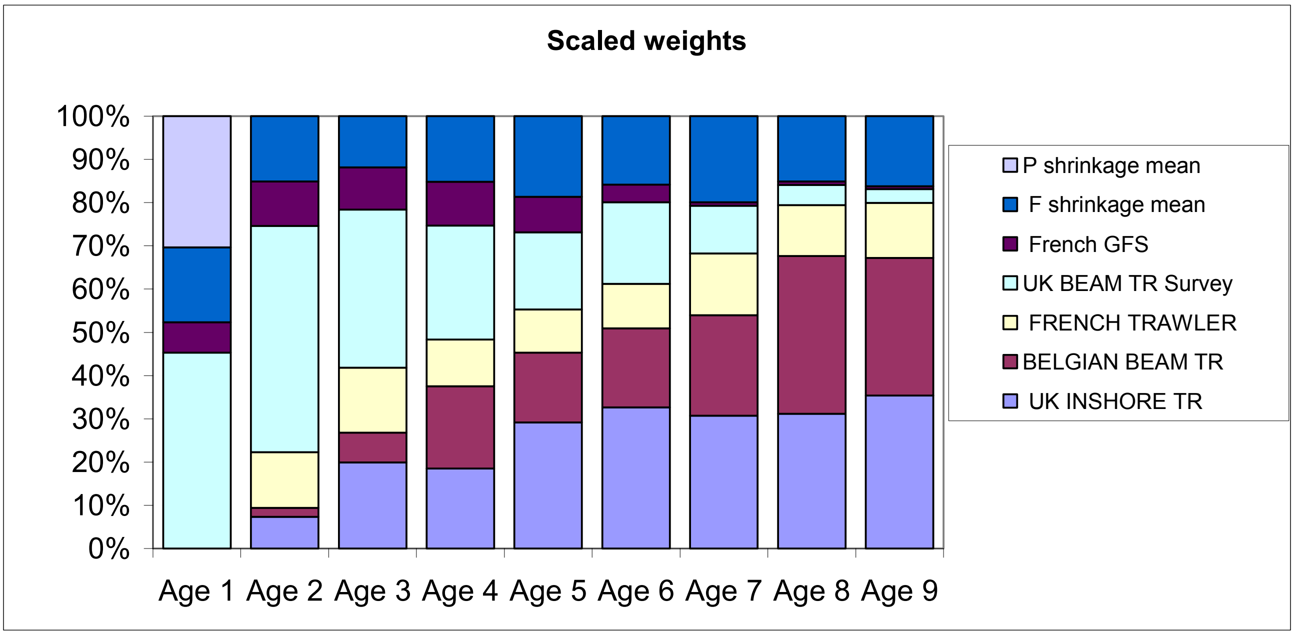
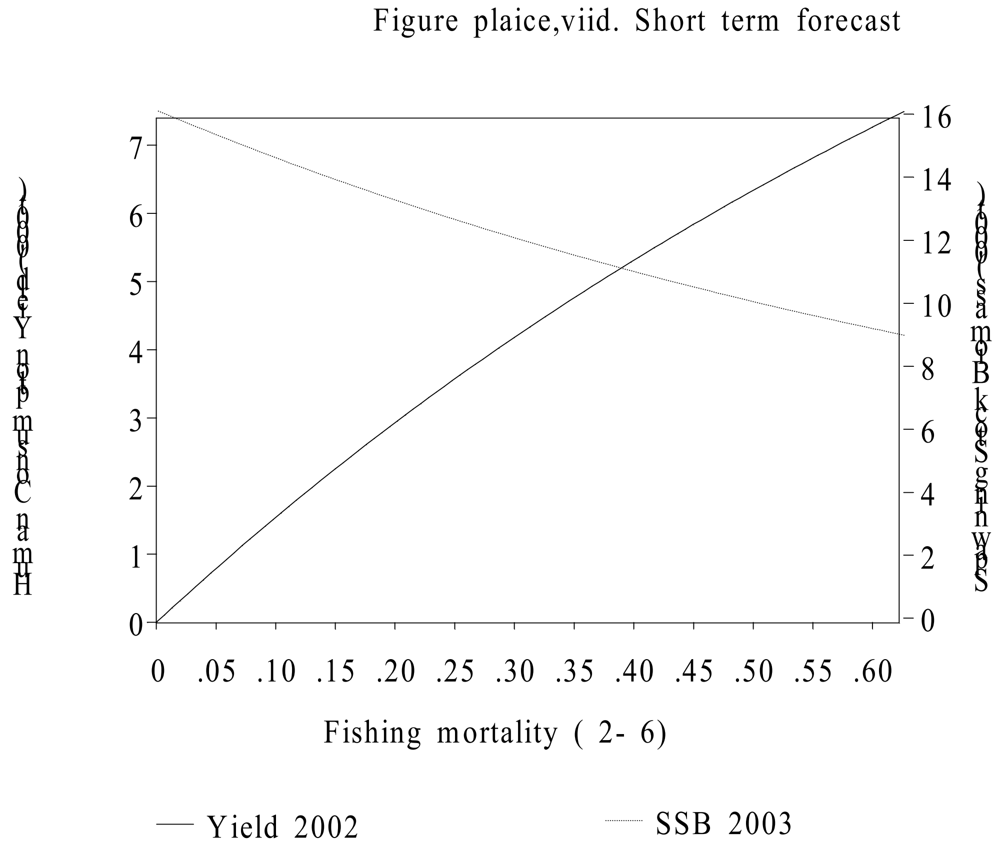


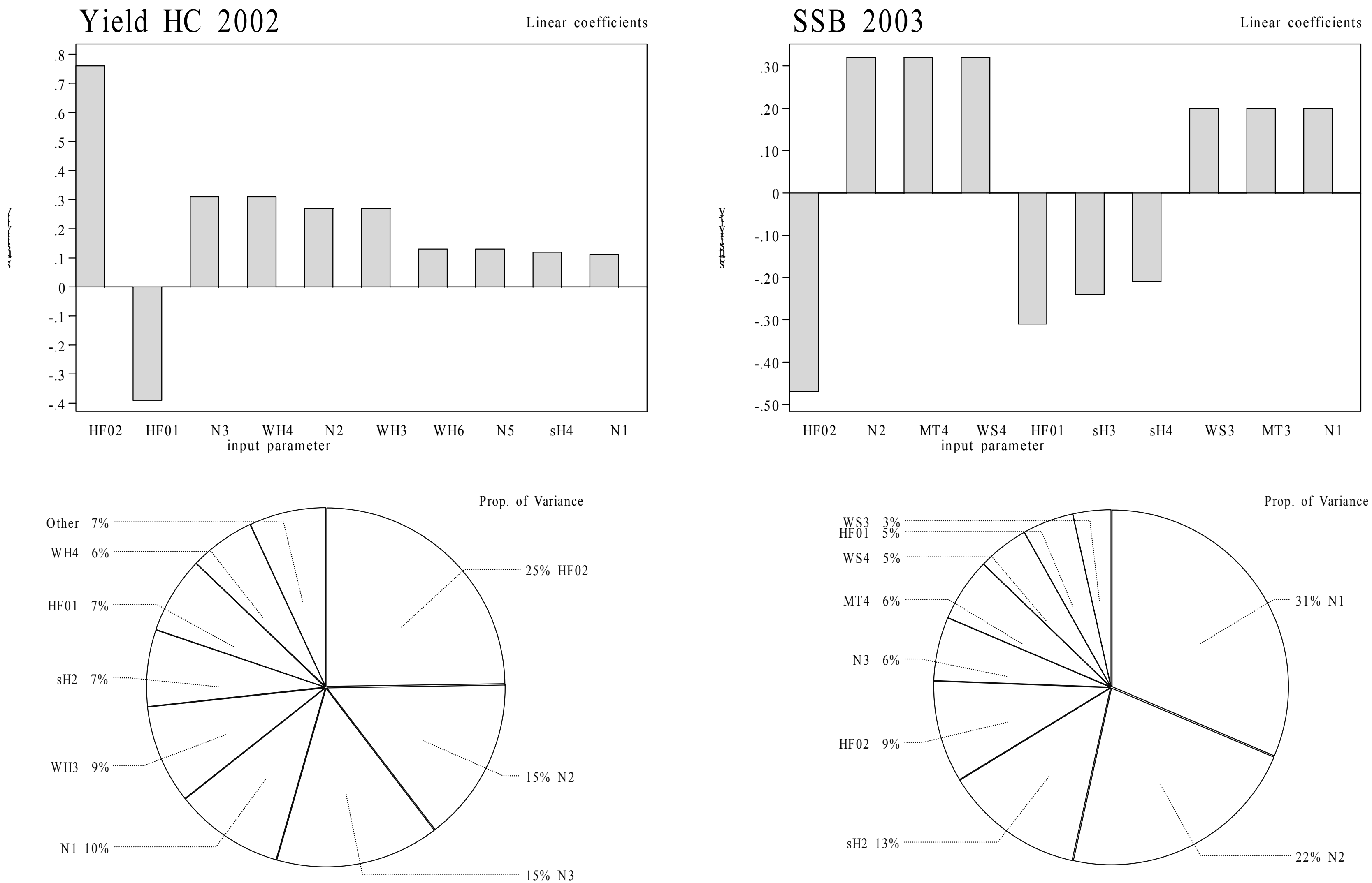
Figure 11.4.7 - Plaice in VIId. Weights of tuning categories in final assessments



Data from file:E:\2001\personal\ewen\2000_data\vpa\mean_3\PLEVIID.SEN on 26/06/2

Figure 11.7.1 Plaice in VIId Short term forecasts for yield and SSB under a range of Fs.

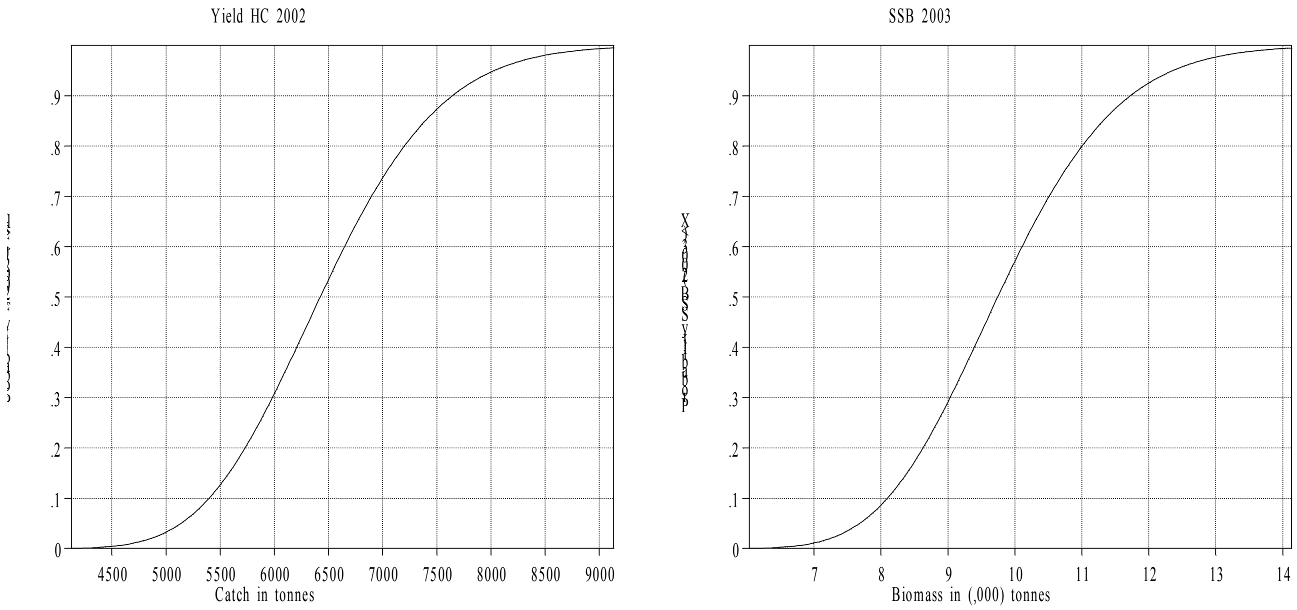
Figure plaice,viid. Sensitivity analysis of short term forecast.



Data from file:E:\2001\personal\ewen\2000_data\vpa\mean_3\PLEVIID.SEN on 26/06/2

Figure 11.7.2

Figure plaice,viid. Probability profiles for short term forecast.



Data from file:E:\2001\personal\ewen\2000_data\vpa\mean_3\PLEVIID.SEN on 26/06/2

Figure 11.7.3. Plaice in VIId Probability profiles for yield in 2002 and SSB in 2003 from short term forecast. The left panel shows the probability of an increase in *status quo* fishing mortality for given levels of catches. The right hand plot shows the probability of a decrease in SSB in 2002 for a given biomass in 2001 under *status quo* fishing mortality..

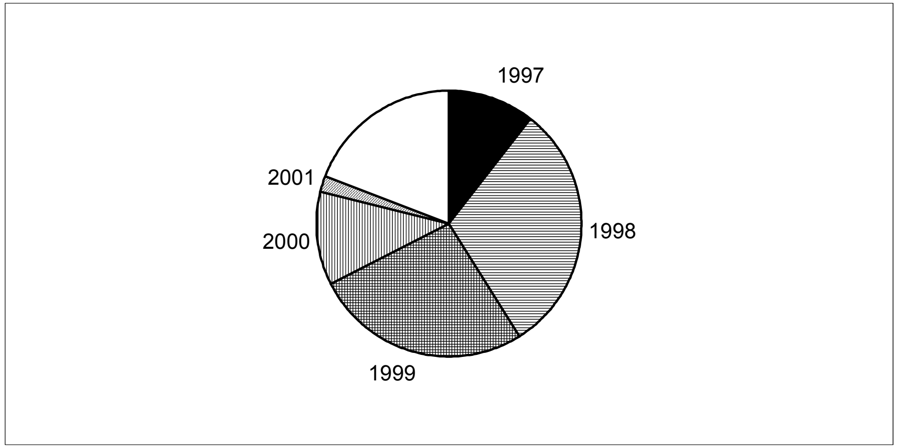
Figure 11.7.4. **Plaice in VIId**
Stock numbers of recruits and their source for recent year classes used in predictions, and the relative (%) contributions to landings and SSB (by weight) of these year classes

Year-class			1997	1998	1999	2000	2001
Stock No. (thousands)			18156	31167	23945	23945	23945
of	1 year-olds						
Source			VPA	VPA	GM	GM	GM
Status Quo F:							
% in	2001	landings	21.7	28.7	12.5	2.0	-
% in	2002		10.6	30.6	26.4	11.2	2.0
% in	2001	SSB	25.0	24.3	4.7	0.0	-
% in	2002	SSB	13.0	34.5	21.9	4.1	0.0
% in	2003	SSB	7.3	18.8	32.8	20.8	4.4

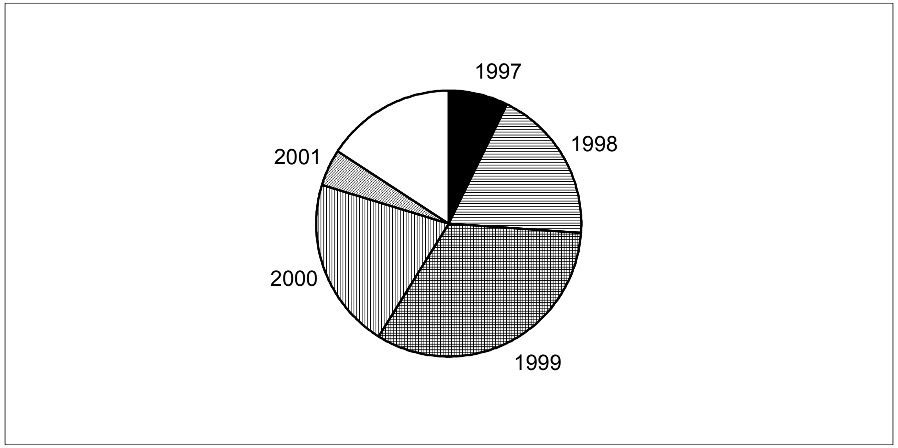
GM : geometric mean recruitment

Plaice in VIId : Year-class % contribution to

a) 2002 landings



b) 2003 SSB



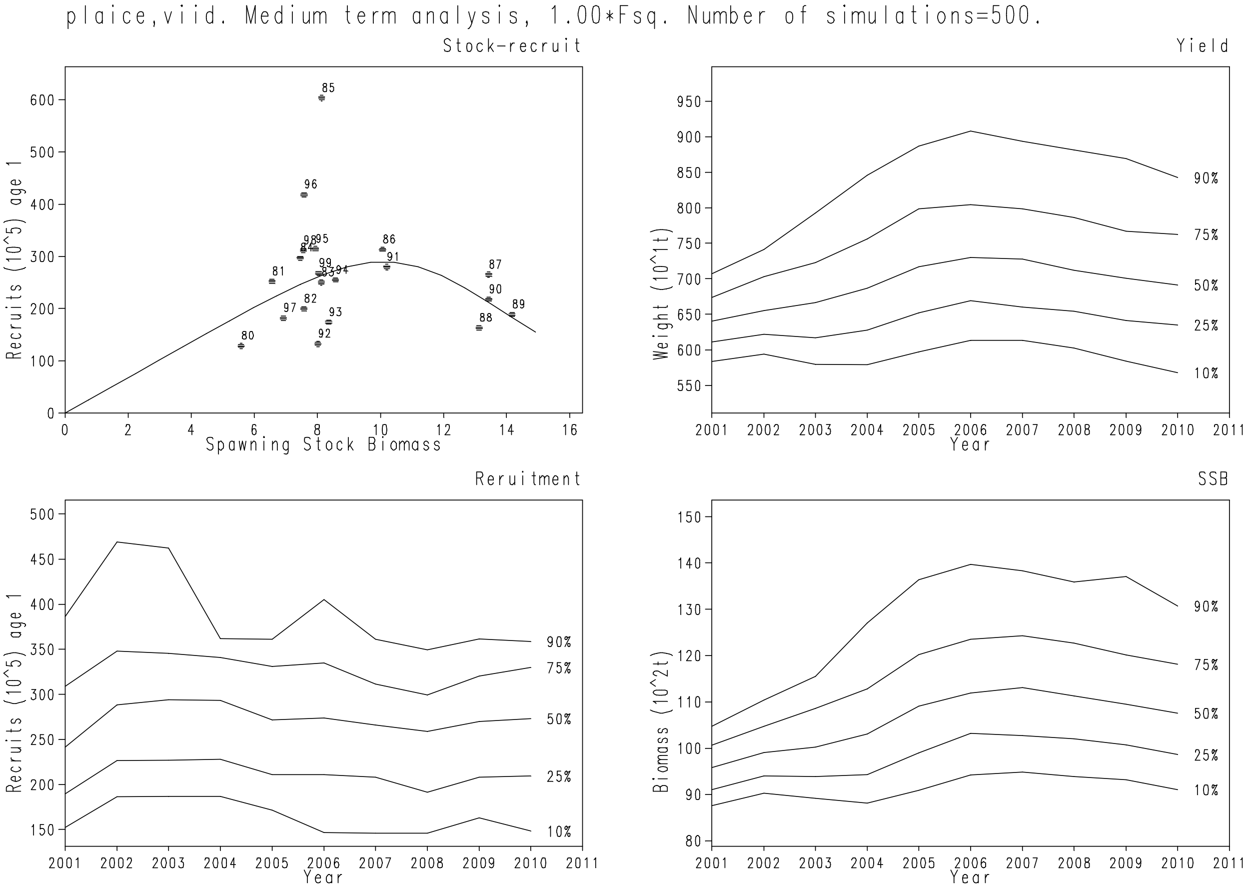


Figure 11.8.1 Plaice in VIId Results of the medium term forecast

Figure 11.9.1 Plaice in VIId Stock recruit plot for plaice in VIId.

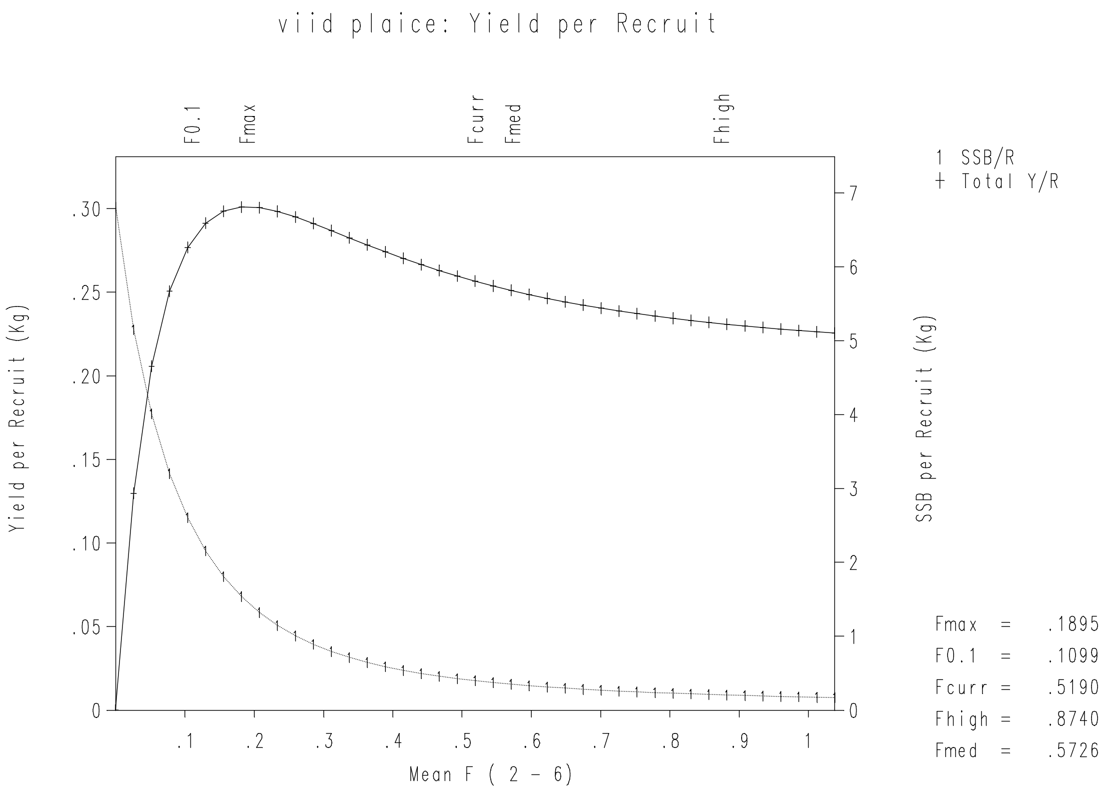
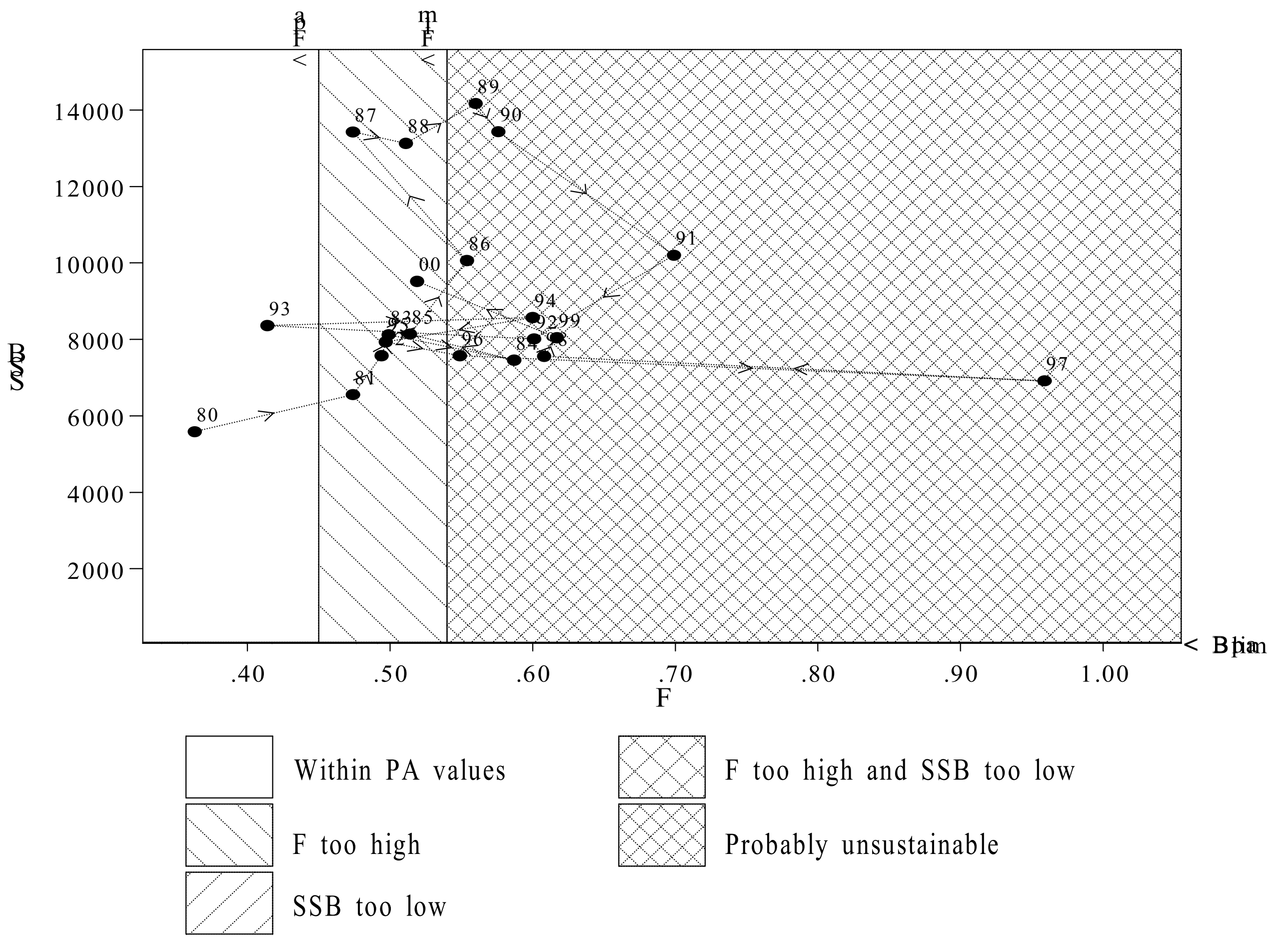


Figure 11.9.2 Plaice in VIId Yield per recruit plot

VIId Plaice



Data file(s):E:\2001\data\plaiceVIId\final\pleviid.pa;E:\2001\data\plaiceVIId\final\PLEVIID.SUM
Plotted on 27/06/2001 at 11:27:19

Figure 11.9.3. Plaice in VIId PA plot showing F vs SSB for the years 1980-2000.

PLAICE VIId Quality Control Diagram

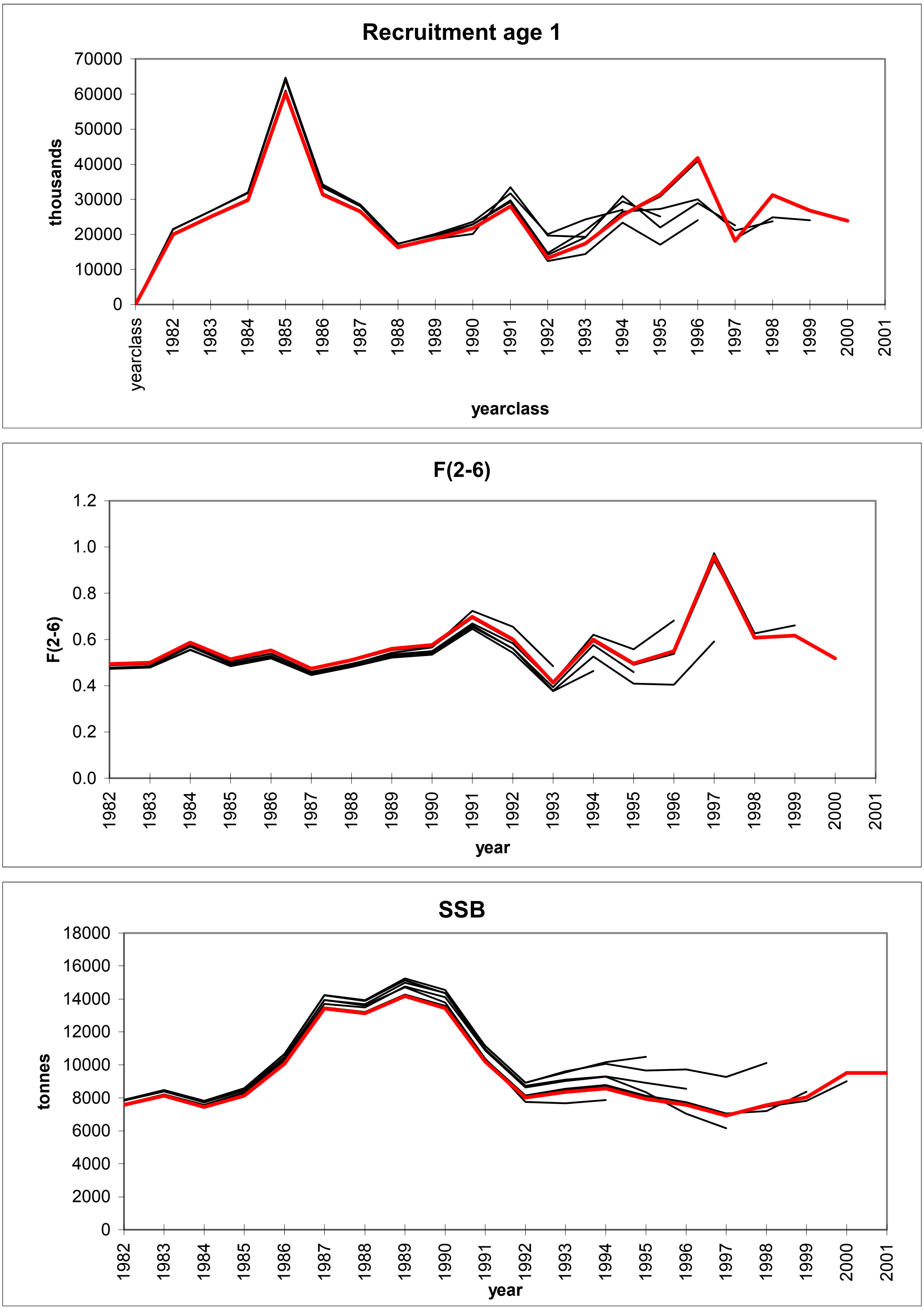


Figure 11.10.1
PLAICE VIId. Assessments generated in subsequent Working Groups.

12 NORWAY POUT IN ICES SUB-AREA IV AND DIVISION IIIA

12.1 The fishery

12.1.1 ICES advice applicable to 2001 and 2002

There is no management objective set for this stock. With present fishing mortality levels the status of the stock is more determined by natural processes and less by the fishery. The ACFM advice for 2001 was that the stock was considered to be within safe biological limits and the stock could on average sustain current fishing mortality.

There is a need to ensure that the stock remains high enough to provide food for a variety of predator species. By-catches of other species should also be taken into account in management of the fishery. Existing measures to protect other species should be maintained.

Reference points for the stock have been set by ICES at $\mathbf{B}_{lim}$ = 90,000 t as the lowest observed biomass and $\mathbf{B}_{pa}$ = 150,000 t which should be maintained.

12.1.2 Management applicable to 2000 and 2001

In 1996-2001 the TAC was set to 220,000 t. In managing this fishery by-catches of other species have been taken into account. Existing technical measures such as the closed Norway pout box, minimum mesh size in the fishery, and by-catch regulations to protect other species have been maintained.

12.1.3 Fishery in 2000 and 2001

Annual landings as provided by Working Group members are shown in Table 12.1.1 and trends in yield are shown in Figure 12.6.1.The total yearly landings in 1998-99 were between 80-100,000 t increasing in year 2000 to nearly 200,000 t mainly based on fishery on the strong 1999 year class (age 1), Table 12.2.1. Highest catches were in general taken in the 1^{st}, 3^{rd} and 4^{th} quarter of the year (Table 12.1.2). Landings in the 1^{st} quarter of 2001 were above average within the last 5 year period based on fishery on the 1999 year class (Table 12.2.1).

12.1.4 Fleet developments

The fishing effort and number of vessels as well as the catch rates per vessel size category of the Danish trawlers participating in the Norway pout fishery for the years 1986-2001 are shown in Figure 12.3.2. The number of small vessels in the fleet is reduced and the relative number of large vessels has increased in the latest years. There was not found any trends in CPUE between vessel categories over time.

12.2 Natural Mortality, Maturity, Age Composition and Mean Weight at Age

Age compositions were available from Norway and Denmark. Catch at age is shown in Table 12.2.1. Mean weight at age in the catch was estimated as a weighted average of Danish and Norwegian data, Table 12.2.2. Norwegian input data of catch number and mean weight by age have been revised for 1998 and 1999. However, this had no significant effect on the assessment output. The mean weights at age in the catches are very variable between years and seasons, and also between countries, for the same age groups in the same year. The same mean weight at age in the stock, proportion mature and natural mortality are used for all years, Table 12.2.3. Mean weight in catch is not used as estimator of weight in the stock partly because the smallest 0-group fish are not fully recruited to the fishery in 3^{rd} quarter of the year. The natural mortality is set to 0.4 for all age groups in all seasons that results in an annual natural mortality of 1.6 for all age groups. Exploratory runs were made with revised input data for natural mortality based on the results presented in WD 2 and WD 3 of this working group. This is further described in sections 12.4 and 12.11.

12.3 Catch, Effort and Research Vessel Data

The assessment uses the combined catch and effort data from the commercial Danish and Norwegian small meshed trawler fleets fishing mainly in the northern North Sea.

Background descriptions of the commercial fishery tuning series used and the method of effort standardization of the commercial fishery between different vessel size categories and national commercial fleets are given in Section 1.3 (describing sampling procedures) of this report.

In 1997, Norwegian effort data were revised as described in sections 13.1.3.1 and 1.3.2 of the 1997 working group report (ICES CM 1998/Assess:7). Furthermore, in the 2000 assessment Norwegian average GRT and Effort data for 1998-99 were corrected because data from ICES area IIa were included for these years in the 1998-99 assessments. Input data for average GRT and effort for the Norwegian commercial fleets to be effort standardized is given in Table 12.3.3.

Table 12.3.1 gives CPUE data by vessel size category and year for the Danish commercial fishery in area IVa for fishing trips where total catch included at least 70 % Norway pout and blue whiting per trip. The comparative trends in effort, vessel number and CPUE for different vessel size categories for the Danish commercial fishery given in Figure 12.3.2 shows a relative reduction in the number of small vessels and increase in the larger vessels in the fleet in the latest years. No trends in CPUE between vessel size categories were found. Parameter estimates from yearly regression analyses on CPUE versus GRT for the different Danish vessel size categories used in the effort standardization of both the Norwegian and Danish commercial fishery are shown in Table 12.3.2. Minor revisions (up-dating) of the Danish catch and effort data used in the effort standardization and as input to the tuning fleets have been made for the present assessment. In previous years the Danish effort has been standardized by vessel category (to a standard Danish 175 GRT vessel) only using the catch rate proportions between vessel size categories within the actual year. In the present assessment the output of the regression analyses using time series from 1987-2001 has been applied to the Danish commercial fishery as well.

The resulting combined and standardized Danish and Norwegian effort for the commercial fishery used in the assessment is presented in Table 12.3.4, and combined CPUE indices by age and quarter for the commercial tuning fleet are shown in Table 12.3.7 and Figure 12.3.1. Seasonal trends in effort and landings of the combined tuning fleet are shown in Figures 12.3.3-4. Research vessel data: Survey indices series of abundance of Norway pout by age and quarter were available from the IBTS and the EGFS and SGFS, Table 12.3.5 and Figure 12.3.1

Furthermore, research vessel indices from the 3rd quarter IBTS are given, Table 12.3.6, in order to follow abundance indices by age (not used in the assessment).

12.4 Catch-at-Age Analysis

The SXSA (Seasonal Extended Survivors Analysis: Skagen (1993)) was used to estimate quarterly stock numbers and fishing mortalities for Norway pout in the North Sea and Skagerrak. The settings and options of the SXSA were the same this year as in the last year's assessment, Table 12.4.1. In the SXSA the catchability, r, per age and quarter and fleet was assumed to be constant within the period 1983-2001 where the estimated catchability, rhat, is a geometric mean over years by age, quarter and tuning fleet. Tuning was performed over the period 1983 to 2001 producing log residual (log(Nhat/N)) stock numbers and survivor estimates by year, quarter, age and tuning fleet. The contributions from the various age groups to the survivor estimates by year and quarter and fleet were in the SXSA combined to an overall survivors estimate, shat, estimated as the geometric mean over years of log(shat) weighted by the exponential of the inverse cumulated fishing mortality as described in Skagen (1993). The three surveys and the seasonally (by quarter) divided commercial fleets were all used in the tuning, Table 12.4.1. The data time series for the tuning fleets used in the SXSA are given in Tables 12.3.4-12.3.7. The 3rd quarter IBTS was not used in tuning as it contains shorter time series than the SGFS and the EGFS and because it is not an independent tuning fleet of the separate SGFS and EGFS tuning fleets. No time taper or shrinkage was used in the catch at age analysis.

Table 12.4.1 contains the SXSA options used as well as the estimated stock numbers, fishing mortalities and additional output from the SXSA, and a summary of the results is shown in Table 12.6.1 and in Figures 12.6.1-12.6.3. Total stock biomass is given for 3rd quarter of the year because this is the biomass including 0-groups available for the commercial fishery.

The log residual stock numbers by year for each tuning fleet are least variable for 1- and 2-year-old fish as the precision in the estimated catch is higher for these age groups (Fig. 12.4.1). There are no apparent trends in the residuals with time in for the commercial tuning fleets. Estimated SSQ Residuals by tuning fleet and season, Figure 12.4.2, indicate large inter-annual variations with large sum of squared residuals for commercial fishery in some years for 3rd and 4th quarter. The surveys, especially the EGFS, show large variations in SSQ while the values for SGFS and 1Q IBTS are lower and more stable. There might be a slight trend in the residuals for the 1Q IBTS and existence of two slightly different levels for the 3Q SGFS over time. In order to investigate this an exploratory run of the SXSA was made using the cosine time taper option in the SXSA down weighting the period 1983 to 1991 (both years included; 12 cohorts). The trends in the log residual stock numbers for the 1Q IBTS and the 3Q SGFS disappeared and no trends were introduced in the other tuning fleets (not shown) in the output from this run. The resulting SSB and F for this run compared to those for the run with standard settings are shown in Figure 12.4.4. It appears that SSB and F for the latest years are different. The full methodological aspects and implications of using the time taper in SXSA are not described in Skagen (1983) and could not immediately be explored by the working group. On this basis the working group decided to use the assessment with standard settings (without time taper) as in previous years.

The estimated weighting factors for computing survivors by tuning fleet used in the tuning process in the final run were evenly distributed over the different CPUE series with a general tendency towards most weight given to the CPUE data from the commercial fishery, Figure 12.4.2. The commercial fishery was used in tuning in each quarter of the year while survey weighting was only used for the 1st and 3rd quarter of the year. For several age groups and seasons approximately the same weight were given to the IBTS and SGFS surveys as the weight given to the commercial fishery. Relatively high weight is given to SGFS age 3.

Retrospective analyses have been made for SSB, recruitment and fishing mortality estimated by the SXSA, Figure 12.4.3. The method used was running the SXSA by sequential exclusion of the more recent assessment year. The analyses revealed no tendencies in over- or under-estimating the SSB, recruitment and fishing mortality in the last year. In nearly all cases the estimates converged rapidly. The SXSA seems to estimate recruitment well.

An exploratory run of the SXSA was made with revised input data for natural mortality based on the results presented in WD 2 and WD 3 of this working group. The results of this are shown in Figure 12.4.5. This will be further commented in section 12.10.

12.5 Recruitment Estimates

The long-term average recruitment (age 0, 3rd quarter) is 132 billions (arithmetric mean) and 112 billions (geometric mean) for the period 1974-2000 (Table 12.6.1). Recruitment is highly variable and influences SSB and TSB rapidly due to the short life span of the species.

Recruitment estimates are available from the EGFS and SGFS surveys carried out in August (Table 12.3.5) as well as the 3rd quarter IBTS (Table 12.3.6) and the commercial fishery in 3rd and 4th quarter of the year (Table 12.3.7). The SGFS recruitment indices from 1998-2000 should be used with caution as a new survey design (new vessel from 1998 and new gear and extended survey area from 1999) was introduced. The 0-group indices from this survey were not used. The same trends for the 1+-group is observed for the SGFS as for the EGFS for which reason the SGFS survey index for the age groups 1-3 was included in the SXSA. Historically, the EGFS estimates the strong year classes as 1-group better than as 0-group. Recruitment indices are also available for the IBTS 3rd quarter survey for the period 1991-2000. This new time series seems to estimate 0-groups better than the EGFS alone and it gives a longer time series than the new SGFS alone, however, it contains shorter time series than the EGFS and the full time series of the SGFS used as separate tuning time series and, furthermore, it is not independent of EGFS and SGFS (see 12.4). On this basis the IBTS 3rd quarter survey has not this year been included in the assessment. The 0-group are recruited to the 4th quarter commercial fishery that tends to predict strong year classes well as 0-group. However, no information on the strength of the 2001 year class is available at the time of the assessment, i.e. the recruitment in 2001 is unknown.

The SXSA show that recruitment in 1997-98 was well below the long term averages while the 1996 and 1999 year classes were well above average. Recruitment in 2000 was historically low within the last 12 years period and much below the long term average.

12.6 Historical Stock Trends

Historical trends in stock biomass (SSB, TSB), landings, recruitment and fishing mortality of Norway pout for the period 1974–2000 (2001) are presented in Table 12.6.1 and Figures 12.6.1-12.6.3. The present assessment covers the period 1983-2001.

Trends in annual landings are also shown in Table 12.1.1 for the period 1960-2000. The total yearly landings in 1998-99 between 80-100,000 t are a decrease in yield from the 1989-1997-level between 150,000 and 300,000 t. However, the yield increased in 2000 to the previous years level (to around 200,000 t) due to extensive fishery on the strong 1999 year class in 2000 as well as in the 1st quarter 2001. The long term averages in landings were in the period 1959-66 below 100,000 t raising to a level around 375,000 t in the period 1967-84 and falling again to approximately 170,000 t in the period 1985-97. The seasonal distribution of the landings by country, Table 12.1.2, show that catches in all years are highest in 1st, 3rd and 4th quarter of the year.

In the mid-1970'ies the fishing mortality for ages 1-2 was well above 1.0, and average fishing mortality was at a level of around 1.0 in the early 1980's up to 1986 but then declined to the a level of approximately 0.7 until 1994 and then again to a level around 0.4 in 1995 to 1997. In 1998 the fishing mortality was historically low (0.28) but in 1999-2000 it has increased to the level around 0.5-0.6. Also total effort increased in 1999-2000 compared to 1998 as well as compared to 1995-97 (Tab. 12.3.4).

Spawning stock biomass decreased in the mid-1980s after having reached peaks at above 350,000 t in 1983-84, but has since slowly increased again with a smaller drop in 1994 and 1995 to peak again at above 350.000 t in 1996. The SSB was low in 1999 however, because of the strong 1999 year class the SSB in 2000 and in the first quarter of 2001 has increased to 200,000 t and 325,000 t, respectively.

12.7 Short-Term Predictions (Forecasts)

No forecast is given for this stock. Catch predictions for 0- and 1-groups are important as the fishery target the 0-group already in 3rd and (especially in) 4th quarter of the year as well as the 1-group in the 1st quarter of the following year. Deterministic catch forecasts are uncertain due to the few year classes contributing to the catch, the large dependence on the strength of the recruiting 0-group year class that is unknown for 2001, and the added uncertainty in the assessment and forecast arising from variations in natural mortality (WD 2 and WD 3 of this working group meeting).

Recruitment data has not been used for separate forecast. There are several reasons for that. The catch possibilities are largely dependent on the size of a few year classes. The unknown 2001 year class (at the time of assessment) will according to the traditional fishing pattern on Norway pout be exposed to extensive fishery already in (3rd and) 4th quarter of 2001 as 0-group. Furthermore, an important part of the 2000 year class have already been fished as 0-group in 4th quarter 2000 and the 1-group in the 1st quarter 2001. Traditional catch prediction for traditional TAC based management for 2001 will therefore be uncertain and will not cover the important year classes in the future fishery.

12.8 Medium-Term Predictions

No medium term predictions are given for this stock (see also section 12.9 and 12.10).

12.9 Biological Reference Points

Figures 12.9.1 and 12.9.2 shows recruitment-SSB-plots and pa-plots for Norway pout in the North Sea and Skagerrak.

$\mathbf{B}_{lim}$ is 90.000 t.
$\mathbf{B}_{pa}$= 150,000 t.
$\mathbf{F}_{low}$ =0.23
$\mathbf{F}_{med}$ =0.66
$\mathbf{F}_{high}$ =1.21

In 1997-2000 a precautionary limit reference point for SSB was proposed based on the lowest observed level of SSB where the stock has produced strong year classes, i.e. the level of below average recruitment. $\mathbf{F}_{med}$=0.66, which represents the exploitation level where the stock has a 50 % chance of replacing itself (Fig. 12.9.1), is a little above the F-level in 1999-2000 around 0.5-0.6.

12.10 Comments to the Assessment

The reasons for performing seasonal VPA are that there are seasonal differences in the fishery and in the fishing pattern (and most likely also in the natural mortality). If the ratio between F and M varies between seasons, then seasonal and annual VPAs will produce different results. Comparisons between annual and seasonal assessments were performed for Norway pout in 1997 (ICES CM 1998/Assess:7). The annual VPA had a tendency to estimate the lower stock numbers.

It should be noted that there seems to be two levels of the stock-recruitment-relationship for the stock, Figure 12.9.1, a level well above and well below recruitment around 125 billion. There are no periodical and historical trends to explain these two levels. Evaluation of the stock-recruitment relationship for this stock and the factors and biological processes affecting it, as well as fisheries interactions should be performed in order to investigate the possibilities for producing a realistic stock-recruitment-model and realistic medium term predictions for this stock. Recruitment is highly variable and influences SSB and TSB rapidly due to the short life span of the species.

The assessment indicates strong 1996 and 1999 year classes and weak 1997, 1998 and 2000 year classes. Recruitment in 2000 was historically low within the last 12 years period and much below the long term average. The assessment indicates a low SSB in 1999 however, because of the strong 1999 year class the SSB and TSB in 2000 and in the first quarter of 2001 were high. Consequently, the relatively high spawning stock biomass level in recent years (except for 1999) will probably be maintained in the first part of 2001 based on the strong 1999 year class. However, because of the very low recruitment in 2000 and the high mortality of the 2-group the stock biomass is expected to decrease significantly during 2001 and reach a low level in 2002.

Investigations on population dynamics (natural mortality, distribution, and spawning and maturity) of Norway pout in the North Sea are ongoing (Section 1.6, WD 2 and WD 3of this report). An exploratory run of the SXSA model was made with revised input data for natural mortality by age based on the results presented in WD 2 and WD 3 of this working group. The resulting SSB and F for this run compared to those for the run with standard settings are shown in Figure 12.4.5. It appears that the implications of these revised input data are very significant. The results in WD2 and WD3 are now in the process of being evaluated and peer reviewed for publication. The working group suggests that for the next 2 to 3 years an assessment with partly the traditional settings (constant M) and a new assessment with the revised values are made in order to compare the output and the performance of the assessment before finally deciding on which values for M to use in the assessment.

It appears from the quality control diagrams made from the results of the performed assessment on the Norway pout stock in the North Sea and Skagerrak (Figure 12.10.1) that the estimates of the SSB, recruitment and the average fishing mortality of the 1- and 2-group are consistent with the estimates of previous years assessment.

12.11 Management Considerations

There is no management objective set for this stock. With present fishing mortality levels the status of the stock is more determined by natural processes and less by the fishery. However, there is a need to ensure that the stock remains high enough to provide food for a variety of predator species. The stock can on average sustain current F. However, because of the low recruitment in 2000 and high mortality of the 2-group, i.e. of the strong 1999 year class, a significant decrease in the stock biomass during 2001 and in 2002 is expected. Recruitment in 2001 is unknown at the time of assessment. This should be taken into account when setting a TAC. In managing this fishery, by-catches of other species should be taken into account. Existing measures to protect other species should be maintained.

It may be more appropriate to formulate reference points based on total stock biomass (TSB) or based on estimates of total mortality from surveys for use within management.

Table 12.1.1 Norway pout annual landings ('000 t) in the North Sea and Skagerrak, by country, for 1960–2000. (Data provided by Working Group members). (Norwegian landing data include landings of by-catch of other species).

Year	Denmark		Faroes	Norway	Sweden	UK (Scotland)	Others	Total
	North Sea	Skagerrak						
1960	17.2	-	-	13.5	-	-	-	30.7
1961	20.5	-	-	8.1	-	-	-	28.6
1962	121.8	-	-	27.9	-	-	-	149.7
1963	67.4	-	-	70.4	-	-	-	137.8
1964	10.4	-	-	51.0	-	-	-	61.4
1965	8.2	-	-	35.0	-	-	-	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	-	32.0	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	63.0	2.9	13.0	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	1.0	559.7
1976	244.9	-	64.6	108.9	+	17.3	1.7	437.4
1977	232.2	-	50.9	98.3	2.9	4.6	1.0	389.9
1978	163.4	-	19.7	80.8	0.7	5.5	-	270.1
1979	219.9	9.0	21.9	75.4	-	3.0	-	329.2
1980	366.2	11.6	34.1	70.2	-	0.6	-	482.7
1981	167.5	2.8	16.6	51.6	-	+	-	238.5
1982	256.3	35.6	15.4	88.0	-	-	-	395.3
1983	301.1	28.5	24.5	97.3	-	+	-	451.4
1984	251.9	38.1	19.1[1]	83.8	-	0.1	-	393.0
1985	163.7	8.6	9.9	22.8	-	0.1	-	205.1
1986	146.3	4.0	6.6	21.5	-	-	-	178.4
1987	108.3	2.1	4.8	34.1	-	-	-	149.3
1988	79.0	7.9	1.5	21.1	-	-	-	109.5
1989	95.6	5.4	0.8	65.3	+	0.1	0.3	167.5
1990	61.5	12.1	0.9	77.1	+	-	-	151.6
1991	85.0	38.3	1.3	68.3	+	-	+	192.9
1992	146.9	44.7	2.6	105.5	+	-	0.1	299.8
1993	97.3	7.8	2.4	76.7	-	-	+	184.2
1994	97.9	6.6	3.6	74.2	-	-	+	182.3
1995	138.4	50.3	8.9	43.1	0.1	+	0.2	241.0
1996	74.3	36.2	7.6	47.8	0.2	0.1	+	166.2
1997	94.2	29.3	7.0	39.1	+	+	0.1	169.7
1998	39.8	13.2	4.7	22,1	-	-	+	79.8
1999	41.0	7.5	-	44.2	+	-	-	92.7
2000	127.0	9.6	-	48.0	0.1	-	+	184.7

Table 12.1.2 **Norway Pout, North Sea and Skagerak. National landings (t) by quarter of year 1989-2001.**
(Data provided by Working Group members. Norwegian landing data include landings of by-catch of other species).

Year	Quarter	Denmark									Norway		Total
	Area	IIIaN	IIIaS	Div. IIIa	IVaE	IVaW	IVb	IVc	Div. IV	Div. IV + IIIaN	IVaW	Div. IV	Div. IV + IIIaN
1989	1	194	67	261	6,213	6,058	8	-	12,279	12,473			
	2	301	21	322	793	47	725	-	1,566	1,867			
	3	1,917	303	2,220	13,876	16,361	3,479	-	33,717	35,634			
	4	1,772	910	2,681	7,802	31,892	8,403	-	48,097	49,869			
	Total	4,184	1,300	5,484	28,684	54,359	12,615	-	95,659	99,842			
1990	1	323	33	356	16,171	4,613	594		21,377	21,700			
	2	6,770	366	7,136	2,682	283	3,768	-	6,732	13,502			
	3	12,616	2,696	15,312	6,253	2,041	138	-	8,432	21,048			
	4	4,059	466	4,525	7,341	17,506	81	-	24,928	28,987			
	Total	23,768	3,561	27,329	32,446	24,443	4,580	-	61,469	85,237			
1991	1	139	53	191	17,007	10,331	37	-	27,375	27,514			
	2	1,918	694	2,613	183	231	92	-	506	2,424			
	3	23,467	4,101	27,568	3,119	11,042	299	-	14,460	37,927			
	4	6,571	1,719	8,290	14,584	27,693	332	-	42,609	49,180			
	Total	32,094	6,567	38,662	34,894	49,297	760	-	84,950	117,044			
1992	1	2,330	619	2,950	29,701	8,862	1,096	-	39,659	41,989			
	2	9,235	1,684	10,919	1,610	264	1,529	-	3,403	12,638			
	3	22,586	817	23,402	9,908	34,053	6,465	-	50,426	73,012			
	4	7,561	263	7,824	4,102	47,704	1,630	2	53,439	61,000			
	Total	41,713	3,383	45,095	45,321	90,883	10,720	2	146,926	188,639			
1993	1	319	30	350	16,471	6,581	151	-	23,203	23,522			
	2	1,052	77	1,129	594	102	802	-	1,498	2,550			
	3	3,629	531	4,161	7,461	25,072	409	-	32,941	36,570			
	4	1,728	406	2,133	10,685	28,994	9	-	39,688	41,416			
	Total	6,729	1,044	7,773	35,210	60,748	1,371	-	97,330	104,058			
1994	1	568	75	643	18,660	3,588	533	-	22,781	23,350			
	2	4	0	4	511	170	-	-	681	685			
	3	2,137	74	2,211	5,674	12,604	493	-	18,772	20,908			
	4	3,623	116	3,739	5,597	49,935	91	-	55,622	59,246			
	Total	6,332	265	6,598	30,442	66,298	1,117	-	97,857	104,189			
1995	1	576	9	585	19,421	1,336	7	-	20,764	21,339	15521	15521	36,860
	2	10,495	290	10,793	2,841	30	3,670	-	6,540	17,035	10639	10639	27,674
	3	20,563	976	21,540	13,316	17,681	11,445	-	42,442	63,004	5790	5790	68,794
	4	14,748	2,681	17,430	10,812	56,159	1,426	-	68,396	83,145	11131	11131	94,276
	Total	46,382	3,956	50,347	46,390	75,205	16,547	-	138,142	184,524	43,081	43081	227,605
1996	1	1,231	164	1,395	6,133	3,149	658	2	9,943	11,174	10604	10604	21,778
	2	7,323	970	8,293	1,018	452	1,476	-	2,946	10,269	4281	4281	14,550
	3	20,176	836	21,012	7,119	17,553	1,517	-	26,188	46,364	27466	27466	73,830
	4	5,028	500	5,528	9,640	25,498	42	-	35,180	40,208	5466	5466	45,674
	Total	33,758	2,470	36,228	23,910	46,652	3,692	2	74,257	108,015	47,817	47817	155,832
1997	1	2,707	460	3,167	6,203	2,219	7	-	8,429	11,137	4183	4183	15,320
	2	5,656	200	5,857	141	-	45		185	5,842	8466	8466	14,308
	3	16,432	649	17,081	19,054	21,024	740	-	40,818	57,250	21546	21546	78,796
	4	4,464	1,042	5,505	6,555	38,202	7		44,765	49,228	4884	4884	54,112
	Total	29,259	2,351	31,610	31,953	61,445	799	-	94,197	123,456	39,079	39079	162,535
1998	1	1,117	317	1,434	7,111	2,292	-	-	9,403	10,520	8913	8913	19,433
	2	3,881	103	3,984	131	5	124	-	259	4,140	7885	7885	12,025
	3	6,011	406	6,417	7,161	1,763	2,372	-	11,297	17,308	3559	3559	20,867
	4	2,161	677	2,838	1,051	17,752	77	-	18,880	21,041	1778	1778	22,819
	Total	13,171	1,503	14,673	15,454	21,811	2,573	-	39,838	53,009	22,135	22135	75,144
1999	1	4	12	15	2,769	1,246	1	-	4,016	4,020	3021	3021	7,041
	2	1,568	36	1,605	953	361	418	-	1,731	3,300	10321	10321	13,621
	3	3,094	109	3,203	7,500	3,710	2,584	-	13,794	16,887	24449	24449	41,336
	4	2,156	517	2,673	3,577	16,921	928	1	21,426	23,583	6385	6385	29,968
	Total	6,822	674	7,496	14,799	22,237	3,931	1	40,968	47,790	44,176	44176	91,966
2000	1	0	11	12	3,726	1,038	-	-	4,764	4,765	5440	5440	10,205
	2	929	15	944	684	22	227	-	933	1,862	9779	9779	11,641
	3	7,380	139	7,519	1,708	5,613	515	-	7,836	15,216	28428	28428	43,644
	4	947	209	1,157	1,656	111,732	76	-	113,464	114,411	4334	4334	118,745
	Total	9,257	375	9,631	7,774	118,406	818	-	126,998	136,255	47,981	47981	184,236
2001	1			302	3,976	13,243	175	-	17,394	17,696	3839	3839	21,535

Table 12.2.1 NORWAY POUT in the North Sea and Skagerrak. Catch in numbers at age by quarter (millions). + represents less than half a million. SOP is given in tons. Data for 1990 were estimated within the SXSA program used in the 1996 assessment.

Age Year	1981				1982				1983			
0	0	0	78	36,926	0	0	156	1,090	0	0	446	2,671
1	2,245	1,083	1,329	1,048	5,425	3,349	6,773	3,108	4,207	1,826	5,825	4,296
2	1,705	627	953	304	427	283	444	47	1,297	1,234	1,574	379
3	77	78	17	3	222	24	64	0	15	10	17	7
4+	6	2	0	0	0	0	0	0	0	2	0	0
SOP									58587	69964	216106	131207
Age Year	**1984**				**1985**				**1986**			
0	0	0	1	2,231	0	0	6	678	0	0	0	5,572
1	2,759	2,252	5,290	3,492	2,264	857	1,400	2,991	396	260	1,186	1,791
2	1,375	1,165	1,683	734	1,364	145	793	174	1,069	87	245	39
3	143	269	8	0	192	13	19	0	72	3	6	0
4+	0	0	0	0	1	0	0	0	3	0	0	0
SOP	56790	56532	152291	110942	57464	15509	62489	92017	37889	7657	45085	89993
Age Year	**1987**				**1988**				**1989**			
0	0	0	8	227	0	0	741	3,146	0	0	151	4,854
1	2,687	1,075	1,627	2,151	249	95	183	632	1,736	678	1,672	1,741
2	401	60	171	233	700	73	250	405	48	133	266	93
3	12	0	0	5	20	0	0	0	6	6	5	13
4+	1	0	0	0	0	0	0	0	0	0	0	0
SOP	33894	15435	38729	60847	22181	3559	21793	61762	15379	13234	55066	82880
Age Year	**1990**				**1991**				**1992**			
0	0	0	20	993	0	0	734	3,486	0	0	879	954
1	1,840	1,780	971	1,181	1,501	636	1,519	1,048	3,556	1,522	3,457	2,784
2	584	572	185	116	1,336	404	215	187	1,086	293	389	267
3	20	19	6	4	93	19	22	18	118	20	1	2
4+	10	0	0	0	6	0	0	0	3	0	0	0
SOP	28287	39713	26156	45242	42776	20786	62518	64380	64224	27973	114122	96177
Age Year	**1993**				**1994**				**1995**			
0	0	0	96	1,175	0	0	647	4,238	0	0	700	1,692
1	1,942	813	1,147	1,050	1,975	372	1,029	1,148	3,992	1,905	2,545	3,348
2	699	473	912	445	591	285	421	134	240	256	47	59
3	15	58	19	2	56	29	71	0	6	32	3	3
4+	0	0	0	0	0	0	0	0	0	0	0	0
SOP	36206	29291	62290	53470	34575	15373	53799	79838	36942	28019	69763	97048
Age Year	**1996**				**1997**				**1998**			
0	0	0	724	2,517	0	0	109	343	0	0	94	339
1	535	560	1,043	650	672	99	3,090	1,922	261	210	411	531
2	772	201	1,002	333	325	131	372	207	690	310	332	215
3	14	38	37	0	79	119	105	35	47	18	2	13
4+	0	0	0	0	0	0	0	0	8	24	0	0
SOP	21888	13366	74631	46194	15320	8708	78809	54100	19562	12026	20866	22830
Age Year	**1999**				**2000**				**2001**			
0	0	0	41	1127	0	0	73	302	0			
1	202	318	1298	576	653	280	1368	4616	243			
2	128	220	338	160	185	207	266	245	935			
3	73	93	35	23	3	48	20	6	12			
4+	1	0	0	0	0	0	0	0	0			
SOP	7833	12535	41445	30497	10207	11589	44173	119001	21091			

Table 12.2.2 Norway pout in North Sea and Skagerrak. Mean weights (grams) at age in catch, by quarter, 1983-2001, from Danish and Norwegian catches combined. Data for 1974 to 1982 are assumed to be the same as 1983.

		Age-Group							Age-Group				
Year	Qtr	0	1	2	3	4	Year	Qtr	0	1	2	3	4
1983	1	.00	7.00	22.00	40.00	56.00	1992	1	.00	8.78	25.73	41.80	43.90
1983	2	.00	15.00	34.00	50.00	56.00	1992	2	8.00	11.71	31.25	49.49	.00
1983	3	4.00	25.00	43.00	60.00	.00	1992	3	6.70	26.52	42.42	50.00	.00
1983	4	6.00	23.00	42.00	58.00	.00	1992	4	8.14	27.49	44.14	50.30	.00
1984	1	.00	6.55	24.04	39.54	.00	1993	1	.00	9.32	24.94	46.50	.00
1984	2	.00	8.97	22.66	37.00	.00	1993	2	.00	14.76	30.58	48.73	.00
1984	3	6.54	17.83	34.28	34.10	.00	1993	3	4.40	25.03	35.19	55.40	.00
1984	4	6.54	20.22	35.07	46.23	.00	1993	4	8.14	26.24	36.44	70.80	.00
1985	1	.00	7.86	22.70	45.26	41.80	1994	1	.00	8.56	25.91	42.09	.00
1985	2	.00	12.56	28.81	43.38	.00	1994	2	.00	15.22	29.27	46.88	.00
1985	3	8.37	23.10	36.52	58.99	.00	1994	3	5.40	29.26	38.91	53.95	.00
1985	4	6.23	26.97	40.90	.00	.00	1994	4	8.81	31.23	49.59	.00	.00
1986	1	.00	6.69	29.74	44.08	82.51	1995	1	.00	7.70	24.69	50.78	.00
1986	2	.00	14.49	42.92	55.39	.00	1995	2	.00	10.99	22.95	37.69	.00
1986	3	.00	28.81	43.39	47.60	.00	1995	3	5.01	25.37	33.40	45.56	.00
1986	4	7.20	26.90	44.00	.00	.00	1995	4	7.19	24.60	39.57	57.00	.00
1987	1	.00	8.13	28.26	52.93	63.09	1996	1	.00	8.95	21.47	37.58	.00
1987	2	.00	12.59	31.51	.00	.00	1996	2	.00	12.06	25.72	37.94	.00
1987	3	5.80	20.16	34.53	.00	.00	1996	3	3.88	27.81	40.90	50.44	.00
1987	4	7.40	23.36	37.32	46.60	.00	1996	4	5.95	28.09	38.81	56.00	.00
1988	1	.00	9.23	27.31	38.38	69.48	1997	1	.00	7.01	23.11	39.11	.00
1988	2	.00	11.61	33.26	.00	.00	1997	2	.00	11.69	26.40	34.47	.00
1988	3	9.42	26.54	39.82	.00	.00	1997	3	3.61	20.14	31.13	44.03	.00
1988	4	7.91	30.60	43.31	.00	.00	1997	4	10.18	22.11	32.69	38.62	.00
1989	1	.00	7.98	26.74	39.95	.00	1998	1	.00	8.76	22.16	34.84	42.40
1989	2	.00	13.49	28.70	44.39	.00	1998	2	.00	12.55	25.27	32.18	40.00
1989	3	7.48	26.58	35.44	.00	.00	1998	3	4.82	23.82	31.73	44.92	.00
1989	4	6.69	26.76	34.70	46.50	.00	1998	4	8.32	24.33	30.93	33.24	.00
1990	1	.00	6.51	25.47	37.72	68.00	1999	1	.00	8.98	25.84	36.66	46.57
1990	2	.00	13.75	25.30	40.35	0.00	1999	2	.00	12.40	24.15	35.24	46.57
1990	3	6.40	20.29	32.92	39.40	0.00	1999	3	2.84	22.16	32.66	43.98	.00
1990	4	6.67	28.70	38.90	52.94	0.00	1999	4	7.56	25.60	37.74	51.63	.00
1991	1	.00	7.85	20.54	35.43	44.30	2000	1	.00	10.05	19.21	32.10	.00
1991	2	.00	12.95	28.75	49.87	.00	2000	2	.00	15.65	25.14	41.30	.00
1991	3	6.06	30.95	44.28	67.25	.00	2000	3	7.21	23.76	38.90	39.61	.00
1991	4	6.64	30.65	43.10	59.37	.00	2000	4	13.86	22.98	34.48	50.04	.00
							2001	1	.00	7.47	20.13	36.99	00.00

Table 12.2.3 Norway pout. Mean weight at age in the stock, proportion mature and natural mortality.

Age	Weight (g)				Proportion mature	M (per quarter)
	Q1	Q2	Q3	Q4		
0	-	-	4.0	6.0	0.0	0.4
1	7.0	15.0	25.0	23.0	0.1	0.4
2	22.0	34.0	43.0	42.0	1.0	0.4
3	40.0	50.0	60.0	58.0	1.0	0.4
4	56.0	56.0	-	-	1.0	0.4

Table 12.3.1 Danish CPUE data (tonnes/day fishing) and fishing activities by vessel category for 1985-2000. (Commercial fleet used for tuning. Logbook information).

Vessel GRT	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
51-100	11.60	10.83	11.73	20.27	14.58	10.03	12.56	31.75	31.00	24.80	29.53	-	20.00	-	-	-
101-150	17.98	19.49	20.70	18.83	19.59	17.38	24.14	26.42	23.72	26.76	38.96	20.48	22.68	-	-	-
151-200	20.76	22.97	22.26	22.71	23.17	25.60	28.22	34.20	27.36	31.52	34.73	22.05	27.45	16.85	12.43	29.13
201-250	24.80	25.20	25.63	30.44	26.10	24.87	29.74	36.00	27.76	40.59	39.34	24.96	30.59	19.68	6.69	8.55
251-300	22.86	25.12	26.10	23.29	26.14	21.30	28.15	31.90	32.05	36.98	38.84	31.43	32.55	7.48	23.98	5.92
301-	26.86	26.63	32.73	38.81	28.58	24.96	36.48	42.60	34.89	44.91	57.90	39.14	3.01	2.32	1.00	64.33

Table 12.3.2 Danish CPUE-data. Parameter estimates from regressions of ln(CPUE) versus ln(Aver. GRT) by year together with estimates of standardized CPUE to the group of Danish 175 GRT industrial trawlers.

Regression models: $CPUE=b*GRT^a$ => ln(CPUE)=ln(b)+a*ln((GRT-50))

Year	Slope	Intercept	R-Square	CPUE(175 tonnes)
1987	0,39	3,51	0,98	22,75
1988	0,22	8,81	0,71	25,27
1989	0,28	5,91	1,00	22,91
1990	0,37	3,32	0,91	20,24
1991	0,40	3,79	0,96	25,98
1992	0,10	20,74	0,56	33,69
1993	0,05	23,23	0,31	29,33
1994	0,24	10,48	0,92	34,05
1995	0,19	15,44	0,77	39,55
1996	0,48	2,36	0,92	23,89
1997	0,29	7,33	0,92	29,03
1998	0,65	0,68	0,74	15,74
1999	1,05	0,09	0,88	14,22
2000	0,90	0,41	0,93	30,79
2001	1,33	0,02	0,52	11,63

Table 12.3.3 Effort in days fishing and average GRT of Norwegian vessels fishing for Norway pout by quarter, 1983-2001.

	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	113.7	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	238	209.1						

Table 12.3.4 Norway pout. Combined Danish and Norwegian fishing effort (standardised) to be used in the assessment.

	Quarter 1			Quarter 2			Quarter 3			Quarter 4			Year total		
Year	Norway	Denmark	Total	Norway	Denmark	Total	Norway	Denmark	Total	Norway	Denmark	Total	Norway	Denmark	Total
1987	441	1169	1610	547	7	554	197	1333	1530	355	1946	2301	1540	4455	5995
1988	315	910	1225	144	3	147	75	464	539	617	1957	2574	1150	3334	4484
1989	146	536	681	485	37	521	1093	1320	2412	1701	1732	3433	3424	3624	7048
1990	406	1027	1433	2002	146	2148	1162	410	1571	1185	1228	2413	4754	2811	7565
1991	824	1052	1876	833	16	849	1027	545	1572	869	1627	2496	3553	3241	6793
1992	866	1145	2011	354	56	409	1051	1305	2355	1154	1538	2692	3424	4043	7467
1993	483	786	1269	1056	24	1080	1145	1109	2254	508	1353	1861	3193	3271	6465
1994	474	653	1128	487	20	507	1387	537	1924	730	1631	2361	3079	2841	5920
1995	581	525	1106	255	73	328	165	784	949	315	1693	2008	1316	3075	4391
1996	519	388	907	158	62	219	613	1033	1645	147	1471	1618	1436	2953	4390
1997	140	290	430	210	5	215	627	1380	2007	222	1542	1763	1198	3217	4415
1998	542	598	1139	324	9	333	265	567	833	222	1195	1417	1354	2368	3722
1999	263	282	545	766	92	859	1287	788	2075	213	1441	1655	2529	2604	5133
2000	340	155	495	362	23	385	1129	238	1366	257	3682	3939	2088	4097	6186
2001	328	401	729										328	401	729

Table 12.3.5 Research vessel indices (CPUE in catch in number per trawl hour) of abundance for Norway pout.

Year	IBTS/IYFS[1] February			EGFS[2,3] August				SGFS[4] August			
	1-group	2-group	3-group	0-group	1-group	2-group	3-group	0-group	1-group	2-group	3-group
1970	35	6	-	-	-	-	-	-	-		-
1971	1,556	22	-	-	-	-	-	-	-	-	-
1972	3,425	653	-	-	-	-	-	-	-	-	-
1973	4,207	438	-	-	-	-	-	-	-	-	-
1974	25,626	399	-	-	-	-	-	-	-	-	-
1975	4,242	2,412	-	-	-	-	-	-	-	-	-
1976	4,599	385	-	-	-	-	-	-	-	-	-
1977	4,813	334	-	-	-	-	-	-	-	-	-
1978	1,913	1,215	-	-	-	-	-	-	-	-	-
1979	2,690	240	-	-	-	-	-	-	-	-	-
1980	4,081	611	-	-	-	-	-	-	1,928	346	12
1981	1,375	557	-	-	-	-	-	-	185	127	9
1982	3,315	403	-	6,594	2,609	39	77	8	991	44	22
1983	2,331	663	9	6,067	1,558	114	0.4	13	490	91	1
1984	3,925	802	58	457	3,605	359	14	2	615	69	9
1985	2,109	1,423	71	362	1,201	307	0	5	636	173	5
1986	2,043	384	23	285	717	150	80	38	389	54	9
1987	3,023	469	65	8	552	122	0.9	7	338	23	1
1988	127	760	13	165	102	134	21	14	38	209	4
1989	2,079	260	178	1,530	1,274	621	20	2	382	21	14
1990	1,320	773	46	2,692	917	158	23	58	206	51	2
1991	2,497	677	129	1,509	683	399	6	10	732	42	6
1992	5,121	902	33	2,885	6,193	1,069	157	12	1,715	221	24
1993	2,681	2,644	259	5,699	3,278	1,715	0	2	580	329	20
1994	1,868	375	67	7,764	1,305	112	7	136	387	106	6
1995	5,941	785	77	7,546	6,174	387	14	37	2,438	234	21
1996	912	2,635	234	3,274	1,262	303	2	127	412	321	8
1997	9,752	1,474	670	1,103	5,579	364	32	1	2,154	130	32
1998	1,006	5,343	300	2,684	411	248	0	2,628	938	1,027	5
1999	3,527	597	667	6,358	1,930	88	26	3,603	1,784	180	37
2000	8,097	1,533	65	2,110	5,710	123	2	2,094	6,656	207	23
2001	1,304	2,861	235	-	-	-	-	-	-	-	-

[1]International Bottom Trawl Survey, arithmetic mean catch in no./h in standard area.
[2]English groundfish survey, arithmetic mean catch in no./h, 22 selected rectangles within Roundfish areas 1, 2, and 3.
[3]1982-91 EGFS numbers adjusted from Granton trawl to GOV trawl by multiplying by 3.5.
[4]Scottish groundfish surveys, arithmetic mean catch no./h. Survey design changed in 1998 and 2000. 0-group indices not used from this survey.

Table 12.3.6 Research vessel indices of abundance of Norway pout. CPUE-data (kg/trawl hour). IBTS 3rd quarter of the year 1991-2000.

Year / Age	0	1	2	3	4	5	6+
1991	7382.9	1104.9	222.2	2.6	0	0	0
1992	2587.8	4365.8	640.2	48.2	2.8	0	0.1
1993	4103.9	1831.5	608.5	52.6	3.3	0	0
1994	3195.8	704.4	101.6	13.5	0.3	0	0
1995	2859.6	4440.2	597.4	68.6	1.7	0	0
1996	4542.6	745.6	388.2	14.7	0.8	0	0
1997	491.2	3398	235.1	46.4	1.6	0	0
1998	2931.4	800.9	747.5	12.1	3	0	0
1999	7832.2	2562.5	204.3	114.8	1.6	0	0.3
2000	1643.5	7868.3	281.7	11.3	5.3	0	0

Table 12.4.1 Seasonal extended survivor analysis (SXAS) of Norway Pout in the North Sea and Skagerrak.

SURVIVORS ANALYSIS OF: Norway Pout 2001
The following parameters were used:

```
Year range: 1983 - 2001
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 (1983 - 2001)
Fleet  2:  ibts_1q    (1983 - 2001)
Fleet  3:  egfs       (1983 - 2000)
Fleet  4:  sgfs       (1983 - 2000)
```

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):     tuning.xsa
Weighting for rhats:    rweigh.xsa
```

Stock numbers (at start of season)

Year	1983				1984				1985			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	*	152811.	102067.	*	*	78787.	52812.	*	*	56954.	38172.
1	108735.	69443.	45054.	25431.	66230.	42136.	26401.	13366.	33574.	20652.	13142.	7662.
2	13594.	8050.	4385.	1651.	13530.	7944.	4371.	1553.	6101.	2973.	1874.	607.
3	115.	65.	36.	10.	796.	416.	59.	33.	440.	138.	81.	39.
4+	6.	3.	0.	0.	1.	0.	0.	0.	22.	14.	10.	6.
SSN	24589.				20949.				9920.			
SSB	380133.				375887.				176541.			
TSN	122450.	77560.	202285.	129159.	80557.	50497.	109619.	67763.	40137.	23776.	72061.	46487.
TSB	1065164.	1318726.	1928289.	1267238.	793139.	922965.	1166682.	691400.	388059.	418532.	641831.	433028.

Year	1986				1987				1988			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	*	110421.	74018.	*	*	32607.	21851.	*	*	88997.	59050.
1	25032.	16455.	10817.	6280.	45054.	28000.	17889.	10659.	14461.	9490.	6284.	4062.
2	2688.	926.	550.	168.	2744.	1510.	963.	506.	5384.	3036.	1975.	1119.
3	264.	118.	77.	47.	81.	44.	30.	20.	148.	83.	56.	37.
4+	30.	18.	12.	8.	37.	24.	16.	11.	16.	11.	7.	5.
SSN	5486.				7366.				6995.			
SSB	88923.				97172.				135422.			
TSN	28015.	17517.	121877.	80520.	47915.	29579.	51504.	33046.	20010.	12620.	97318.	64273.
TSB	246626.	285216.	740358.	598295.	381011.	474897.	620843.	398659.	226528.	250342.	601332.	496892.

Year	1989				1990				1991			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	*	99823.	66783.	*	*	94964.	63640.	*	*	168334.	112237.
1	37007.	23385.	15120.	8766.	40792.	25838.	15862.	9838.	41846.	26821.	17458.	10459.
2	2206.	1439.	856.	355.	4451.	2506.	1211.	660.	5627.	2679.	1465.	806.
3	419.	276.	180.	117.	162.	92.	46.	26.	348.	157.	90.	42.
4+	28.	19.	13.	9.	73.	41.	27.	18.	27.	13.	9.	6.
SSN	6353.				8766.				10186.			
SSB	92751.				137076.				168496.			
TSN	39659.	25118.	115991.	76031.	45479.	28476.	112111.	74183.	47848.	29670.	187356.	123549.
TSB	325894.	414545.	824878.	624031.	394068.	479665.	831272.	637362.	432126.	501969.	1178176.	950235.

Table 12.4.1 (Continued)

Year	1992				1993				1994			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	*	77784.	51421.	*	*	60302.	40343.	*	*	229731.	153464.
1	72381.	45606.	29324.	16827.	33687.	20991.	13405.	8047.	26081.	15866.	10330.	6082.
2	6153.	3235.	1929.	974.	9000.	5461.	3273.	1447.	4534.	2555.	1479.	647.
3	387.	163.	93.	62.	434.	279.	140.	78.	606.	360.	218.	88.
4+	17.	9.	6.	4.	42.	28.	19.	13.	59.	40.	27.	18.
SSN	13795.				12846.				7807.			
SSB	202477.				241329.				145558.			
TSN	78938.	49014.	109137.	69287.	43164.	26759.	77139.	49928.	31280.	18821.	241785.	160299.
TSB	658475.	802753.	1132759.	740019.	453559.	516080.	725469.	492441.	309867.	345105.	1253862.	1092952.

Year	1995				1996				1997			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	*	70470.	46664.	*	*	158694.	105782.	*	*	48519.	32434.
1	99400.	63362.	40913.	25341.	29895.	19601.	12680.	7646.	68847.	45599.	30485.	17905.
2	3137.	1906.	1068.	678.	14245.	8917.	5812.	3076.	4593.	2812.	1778.	887.
3	324.	213.	117.	76.	406.	261.	144.	66.	1789.	1135.	663.	359.
4+	71.	48.	32.	21.	63.	42.	28.	19.	57.	38.	26.	17.
SSN	13472.				17703.				13323.			
SSB	155529.				354059.				223986.			
TSN	102932.	65528.	112599.	72780.	44608.	28820.	177358.	116590.	75286.	49584.	81471.	51603.
TSB	781747.	1028537.	1357614.	895684.	542395.	612564.	1210337.	943596.	657723.	838472.	1072449.	664501.

Year	1998				1999				2000			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	*	68486.	45831.	*	*	199149.	133460.	*	*	43194.	28894.
1	21461.	14172.	9328.	5916.	30444.	20242.	13308.	7858.	88538.	58814.	39195.	25153.
2	10429.	6425.	4053.	2445.	3531.	2262.	1336.	619.	4795.	3063.	1883.	1045.
3	425.	246.	150.	99.	1463.	921.	541.	334.	284.	188.	87.	41.
4+	224.	143.	76.	51.	90.	60.	40.	27.	223.	150.	100.	67.
SSN	13223.				8128.				14156.			
SSB	273974.				162538.				191335.			
TSN	32538.	20987.	82093.	54342.	35527.	23484.	214374.	142298.	93841.	62215.	84459.	55201.
TSB	409178.	451386.	690442.	519500.	354335.	429912.	1219213.	1026876.	749126.	1004138.	1238832.	798174.

Year	2001
Season	1
AGE	
0	*
1	19121.
2	13081.
3	500.
4+	68.
SSN	15561.
SSB	324975.
TSN	32770.
TSB	445440.

Partial fishing mortality for fleet: 1
Commercial fisheries

Year	1983				1984				1985			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	*	0.004	0.032	*	*	0.000	0.052	*	*	0.000	0.022
1	0.048	0.032	0.169	0.226	0.052	0.067	0.273	0.370	0.085	0.052	0.137	0.603
2	0.122	0.203	0.543	0.319	0.131	0.193	0.592	0.775	0.309	0.061	0.669	0.414
3	0.169	0.194	0.782	1.522	0.243	1.215	0.180	0.000	0.696	0.123	0.332	0.000
4+	0.000	1.807	*	*	0.000	0.000	0.000	0.000	0.040	0.000	0.000	0.000
F (1- 2)	0.085	0.118	0.356	0.273	0.091	0.130	0.433	0.573	0.197	0.056	0.403	0.508

Year	1986				1987				1988			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	*	0.000	0.095	*	*	0.000	0.013	*	*	0.010	0.067
1	0.019	0.019	0.142	0.410	0.075	0.048	0.116	0.275	0.021	0.012	0.036	0.206
2	0.618	0.120	0.716	0.322	0.193	0.049	0.238	0.748	0.170	0.030	0.165	0.548
3	0.390	0.030	0.099	0.000	0.198	0.000	0.014	0.360	0.177	0.000	0.000	0.000
4+	0.128	0.000	0.000	0.000	0.034	0.000	0.000	0.000	0.000	0.000	0.000	0.000
F (1- 2)	0.319	0.070	0.429	0.366	0.134	0.048	0.177	0.512	0.095	0.021	0.101	0.377

Year	1989				1990				1991			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	*	0.002	0.092	*	*	0.000	0.019	*	*	0.005	0.038
1	0.058	0.036	0.143	0.270	0.056	0.087	0.077	0.156	0.044	0.029	0.111	0.129
2	0.027	0.118	0.456	0.370	0.172	0.317	0.202	0.236	0.331	0.199	0.194	0.322
3	0.018	0.027	0.032	0.144	0.160	0.281	0.169	0.203	0.380	0.157	0.351	0.680
4+	0.000	0.000	0.000	0.000	0.179	0.000	0.000	0.000	0.312	0.000	0.000	0.000
F (1- 2)	0.043	0.077	0.299	0.320	0.114	0.202	0.140	0.196	0.188	0.114	0.152	0.226

Table 12.4.1 (Continued)

Year	1992				1993				1994			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	*	0.014	0.023	*	*	0.002	0.036	*	*	0.003	0.034
1	0.061	0.041	0.153	0.221	0.072	0.048	0.109	0.171	0.096	0.029	0.128	0.256
2	0.237	0.116	0.275	0.392	0.098	0.110	0.399	0.449	0.170	0.144	0.409	0.283
3	0.443	0.159	0.013	0.040	0.042	0.285	0.178	0.032	0.118	0.102	0.482	0.000
4+	0.234	0.000	0.000	0.000	0.005	0.000	0.000	0.000	0.000	0.000	0.000	0.000
F (1- 2)	0.149	0.078	0.214	0.306	0.085	0.079	0.254	0.310	0.133	0.087	0.268	0.269

Year	1995				1996				1997			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	*	0.012	0.045	*	*	0.006	0.029	*	*	0.003	0.013
1	0.050	0.037	0.078	0.173	0.022	0.035	0.105	0.108	0.012	0.003	0.130	0.138
2	0.097	0.176	0.054	0.111	0.068	0.028	0.231	0.140	0.089	0.058	0.287	0.325
3	0.021	0.198	0.032	0.049	0.042	0.192	0.358	0.005	0.055	0.135	0.210	0.124
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)	0.073	0.107	0.066	0.142	0.045	0.031	0.168	0.124	0.051	0.030	0.208	0.232

Year	1998				1999				2000			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	*	0.002	0.009	*	*	0.000	0.010	*	*	0.002	0.013
1	0.015	0.018	0.055	0.115	0.008	0.019	0.125	0.093	0.009	0.006	0.043	0.248
2	0.083	0.060	0.104	0.112	0.045	0.124	0.357	0.365	0.048	0.085	0.186	0.326
3	0.143	0.093	0.013	0.175	0.062	0.130	0.080	0.087	0.012	0.363	0.328	0.189
4+	0.044	0.227	0.000	0.000	0.007	0.003	0.000	0.000	0.000	0.000	0.000	0.000
F (1- 2)	0.049	0.039	0.079	0.113	0.027	0.072	0.241	0.229	0.028	0.046	0.114	0.287

Year	2001
Season	1
AGE	
0	*
1	0.016
2	0.090
3	0.030
4+	0.000
F (1- 2)	0.053

Log inverse catchabilities, fleet no: 1
Commercial fisheries

Year 1983 – 2001 (first quarter of year). (Same for all years, held constant by year by the SXSA).

Season	1	2	3	4
AGE				
0	*	*	15.464	11.764
1	10.612	10.316	9.956	9.483
2	9.228	8.725	8.914	9.027
3	9.228	8.725	8.914	9.027

Table 12.4.1 (Continued)

Weighting factors for computing survivors:
Fleet no: 1
Commercial fishery

Year 1983 – 2001 (first quarter of year). (Same for all years and quarters, held constant by year as option in the SXSA).

Season	1	2	3	4
AGE				
0	*	*	0.605	1.335
1	1.358	1.322	3.089	3.142
2	2.203	1.968	1.746	1.872
3	1.188	0.898	0.648	0.630

Weighting factors for computing survivors:
Fleet no: 2
ibts_1q

Year 1983 – 2001 (first quarter of year). (Same for all years, held constant by year as option in the SXSA).

Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	*	*	*	*	*	*	*	*	*	*	*
1	1.545	*	*	*	1.545	*	*	*	1.545	*	*	*
2	1.689	*	*	*	1.689	*	*	*	1.689	*	*	*
3	1.093	*	*	*	1.093	*	*	*	1.093	*	*	*

Weighting factors for computing survivors:
Fleet no: 3
egfs

Year 1983 – 2000 (Same for all years, held constant by year as option in the SXSA).

Season	1	2	3	4
AGE				
0	*	*	0.791	*
1	*	*	1.279	*
2	*	*	1.024	*
3	*	*	0.659	*

Weighting factors for computing survivors:
Fleet no: 4
sgfs

Year 1983 – 2000 (Same for all years, held constant by year as option in the SXSA).

Season	1	2	3
AGE			
0	*	*	*
1	*	*	1.132
2	*	*	1.229
3	*	*	1.397

Table 12.6.1 Trends in Yield, Average fishing mortality for 1- and 2-group, SSB (beginning of the year), TSB (beginning of 3rd quarter) and Recruitment (0-group beginning of 3rd quarter) for Norway Pout in the North Sea and Skagerrak. Values from 1974-1982 are based on previous assessments and is the same as given in previous years reports.

Year	Yield ('000 tonnes)	Fav(1-2)	SSB ('000 tonnes)	TSB ('000 tonnes)	Recruitment, 3Q ('000 millions)
1974	735.8	1.84	171		176
1975	559.7	1.206	208		212
1976	437.4	1.204	200		198
1977	389.9	0.835	242		102
1978	270.1	0.907	241		201
1979	329.2	1.006	198		233
1980	482.7	1.233	332		61
1981	238.5	0.777	278		306
1982	395.3	1.016	174		238
1983	451.4	0.832	380	1928	153
1984	393.0	1.227	376	1167	79
1985	205.1	1.164	177	642	57
1986	178.4	1.184	89	740	110
1987	149.3	0.871	97	621	33
1988	109.5	0.594	135	601	89
1989	167.5	0.739	93	825	100
1990	151.6	0.652	137	831	95
1991	192.9	0.680	168	1178	168
1992	299.8	0.747	202	1133	78
1993	184.2	0.728	241	725	60
1994	182.3	0.757	146	1254	230
1995	241.0	0.388	156	1358	70
1996	166.2	0.368	354	1210	159
1997	169.7	0.521	224	1072	49
1998	79.8	0.280	274	690	68
1999	92.7	0.569	163	1219	199
2000	184.7	0.475	191	1239	43
2001			325		
Average, Arithm. (1974-2000)	275.5	0.844	209	1024	132
Average, Geom. (1974-2000)					112

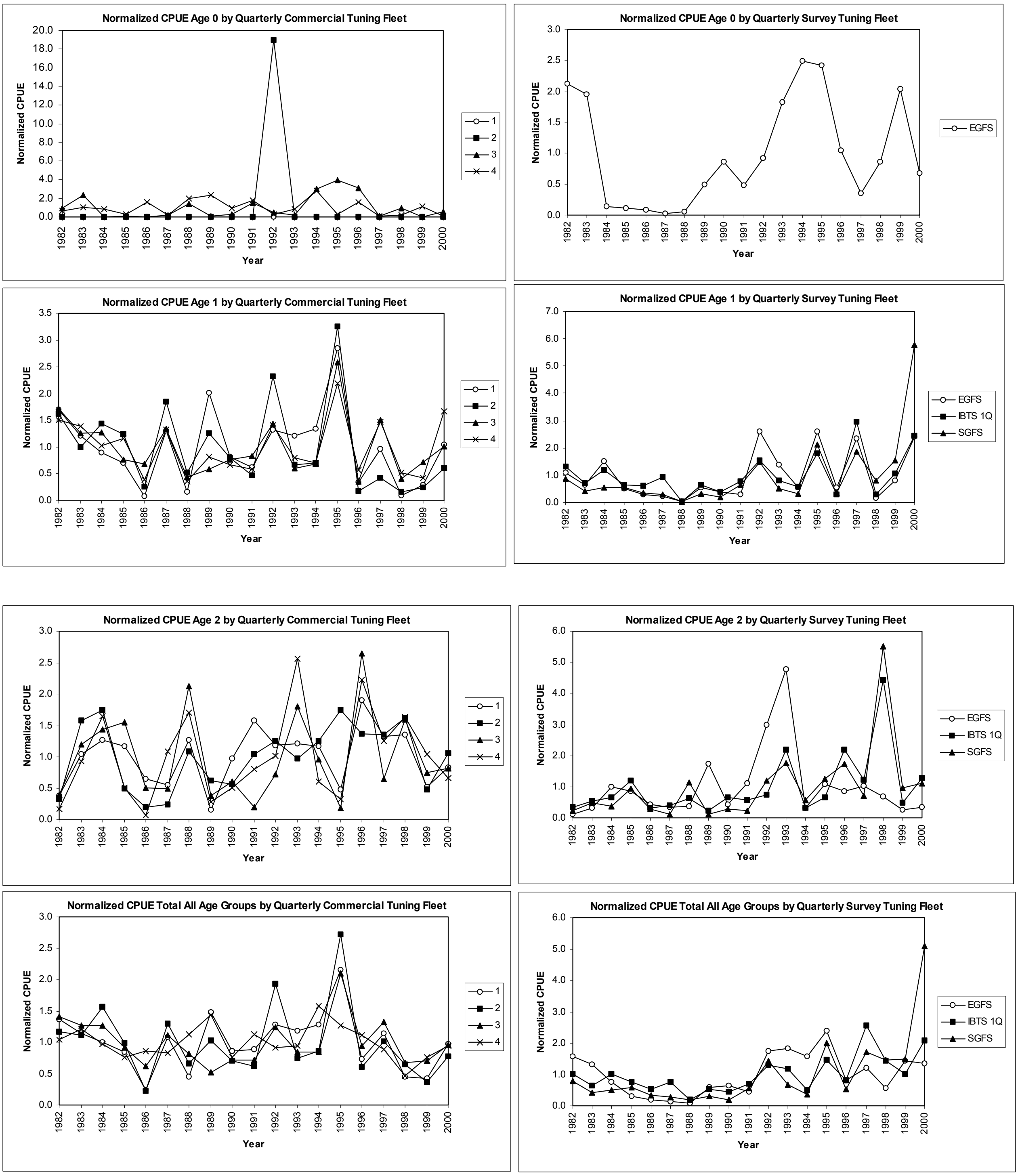
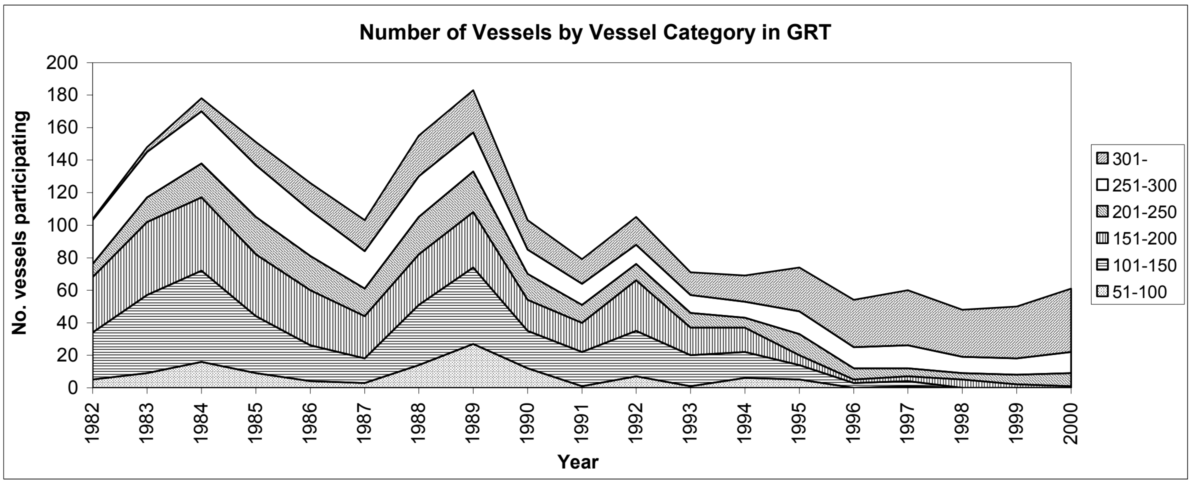
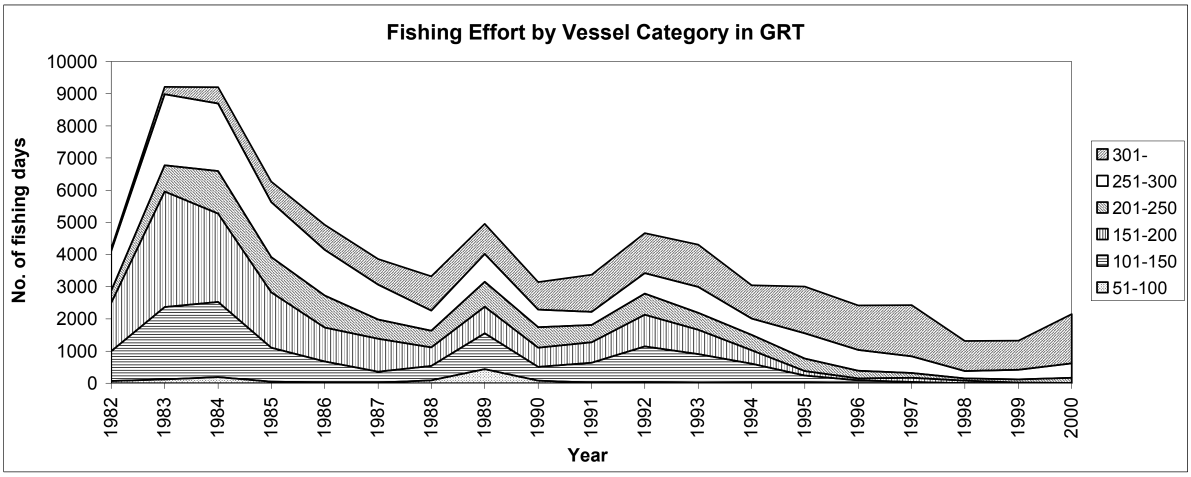
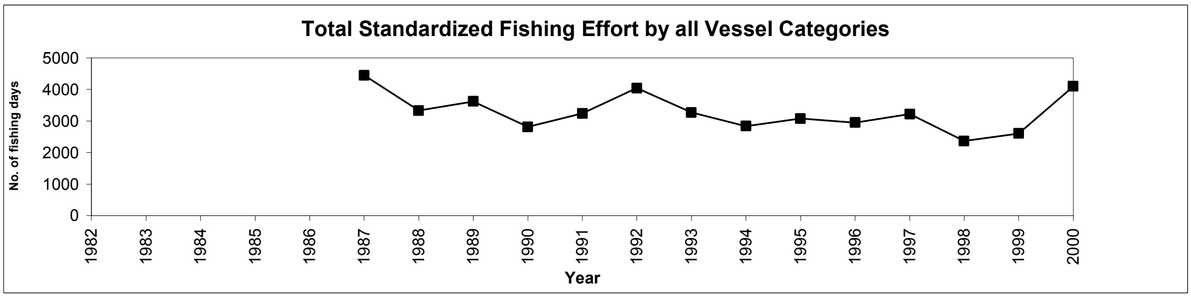


Figure 12.3.1 Norway Pout. Trends in CPUE (normalized) by quarterly commercial tuning fleet and survey tuning fleet used in the Norway pout SXSA Assessment for each age group and all age groups together.

Figure 12.3.2 **Development in the fleet structure and effort and catch rates by vessel category in GRT participating in the Danish Norway pout fishery during the last 20 years (1982-2000).**
(Logbook Data provided by the Working Group).







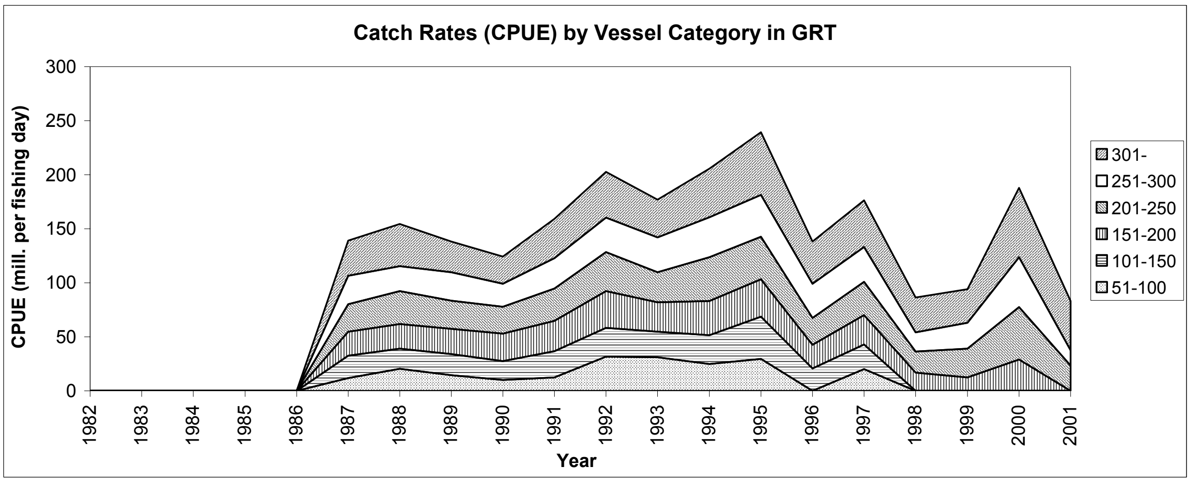


Figure 12.3.3 Development in seasonal and yearly fishing effort for the combined Danish and Norwegian commercial tuning fleet included in the Norway Pout assessment. Standardized fishing effort.

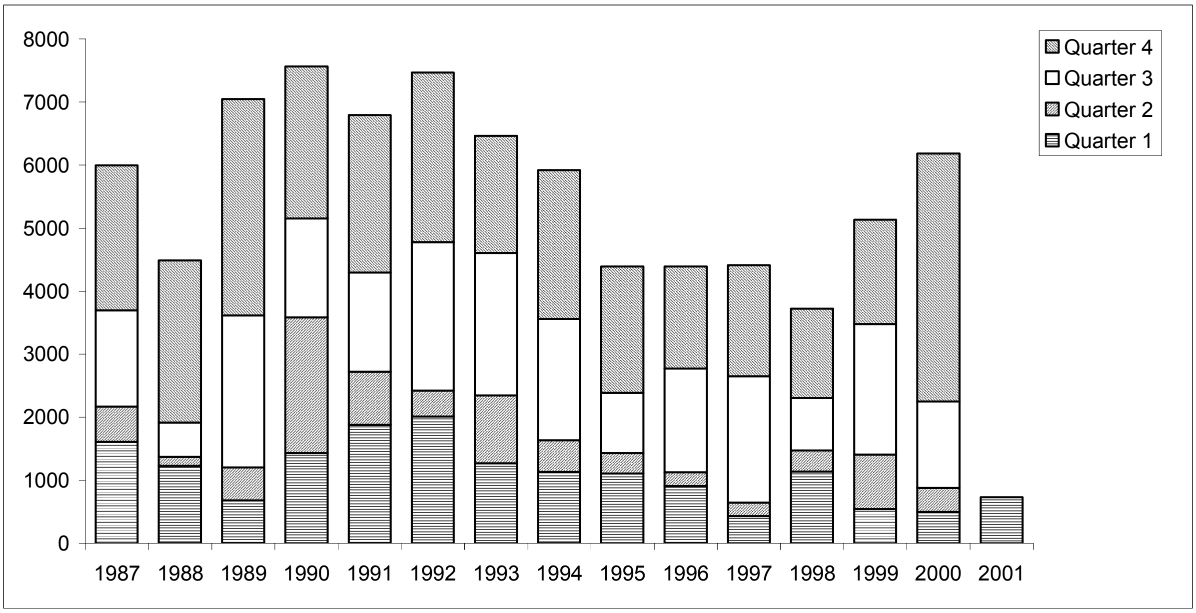


Figure 12.3.4 Development in seasonal and yearly landings of the Danish commercial fleet participating in the Danish Norway Pout fishery in the North Sea and Skagerrak.

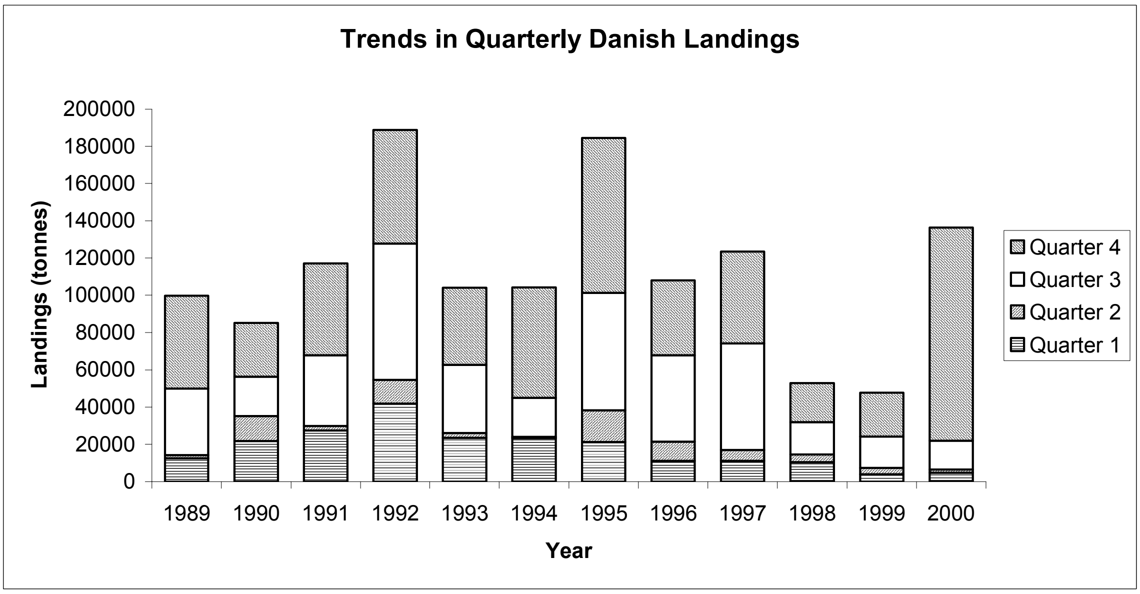


Figure 12.4.1 Log residual stock numbers (log (Nhat/N)) per age group divided by fleet and season.

SXSA-Norway pout in the North Sea and Skagerak.

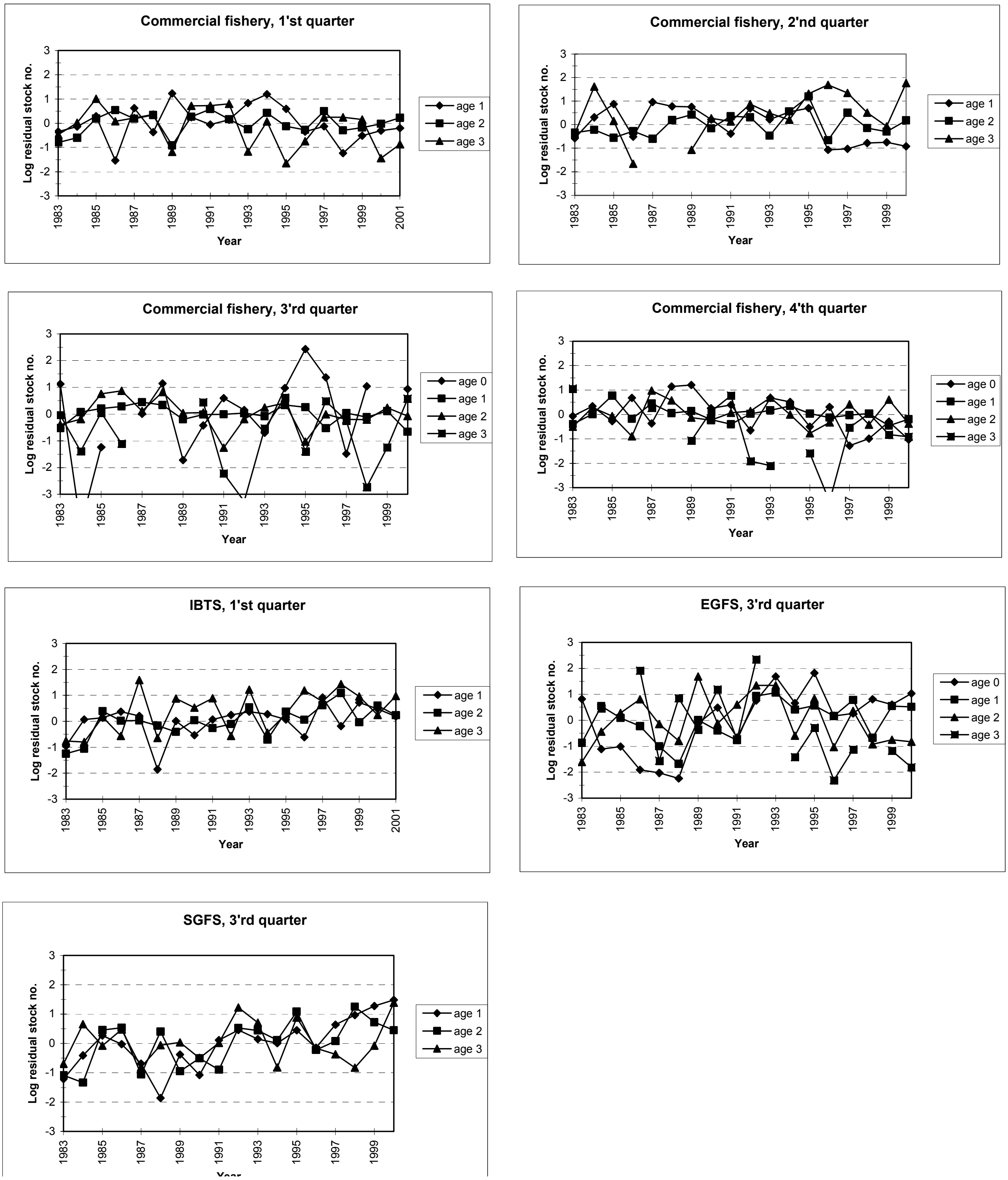
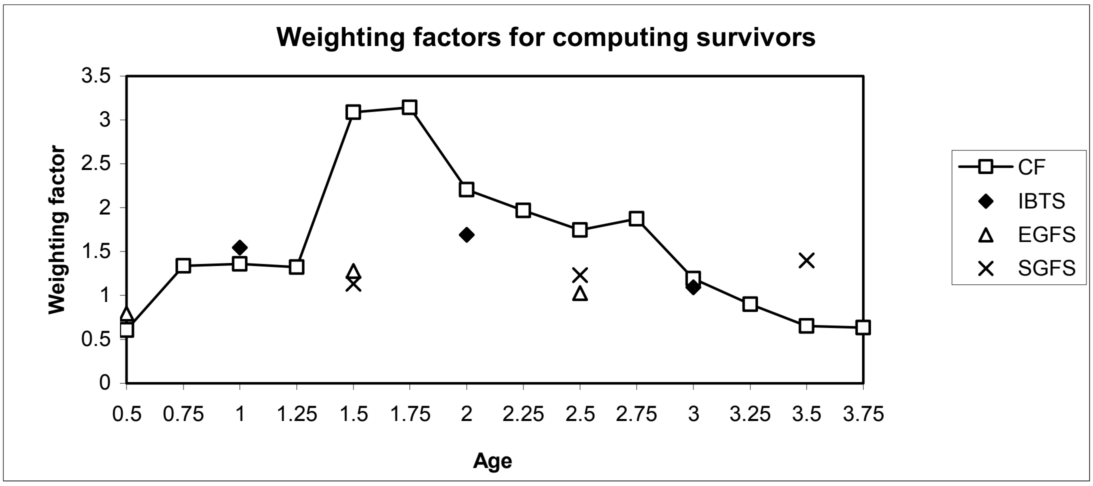
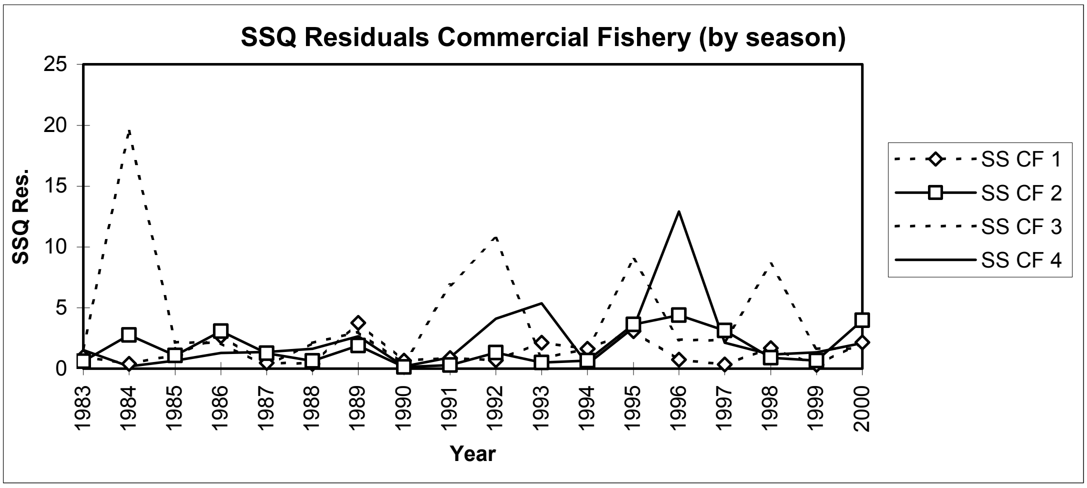


Figure 12.4.2 **Weighting factors for computing survivors and summed of squared (SSQ) residual stock number for commercial fishery (by season) and for the survey series summed for all age groups. Output from seasonal extended survivors analysis (SXSA). Commercial fishery fleet (CF), IBTS, EGFS, SGFS.** (For comparison it should be noticed that only some of the fleets include SSQ for the 0-group).





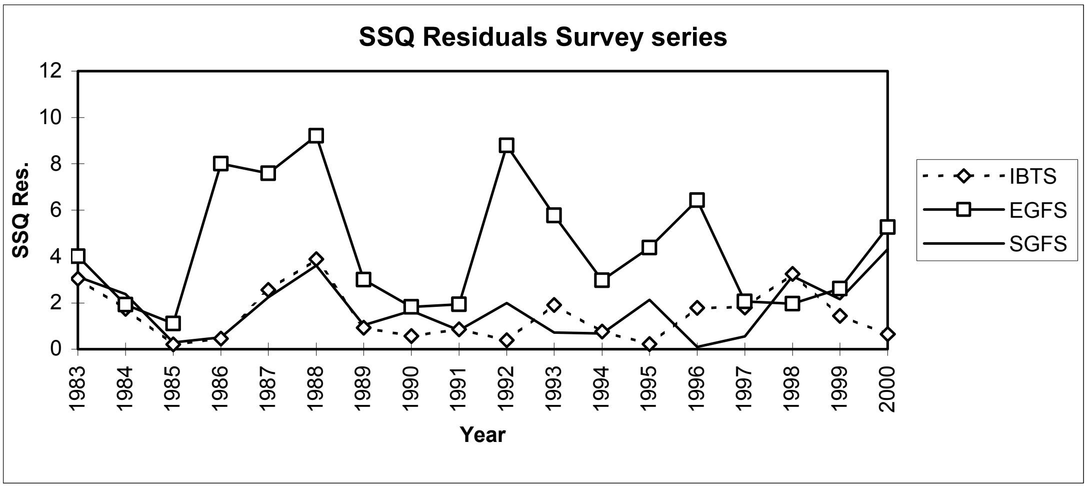
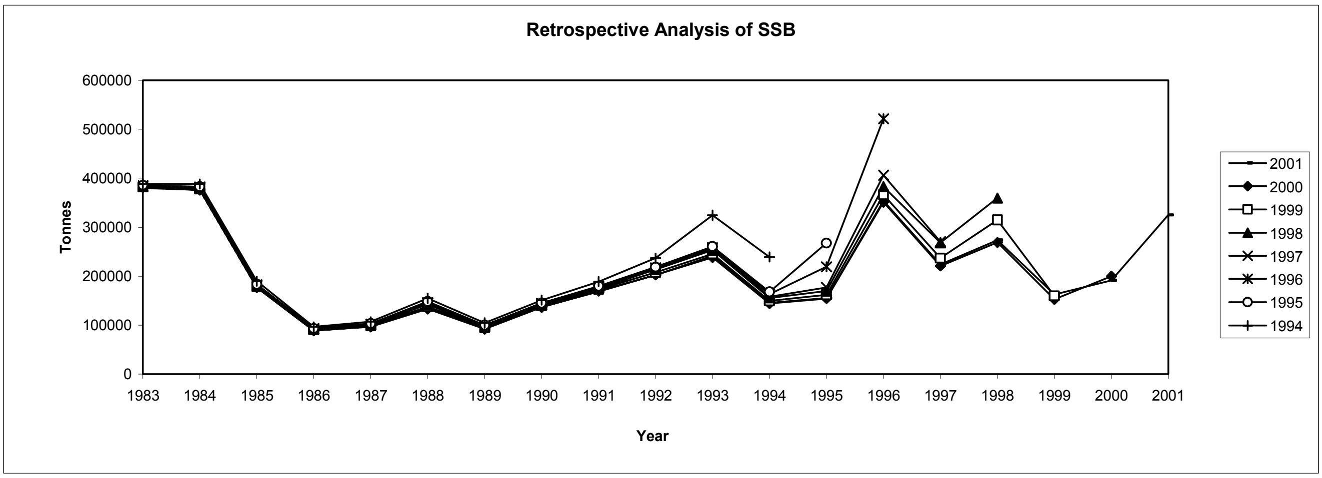
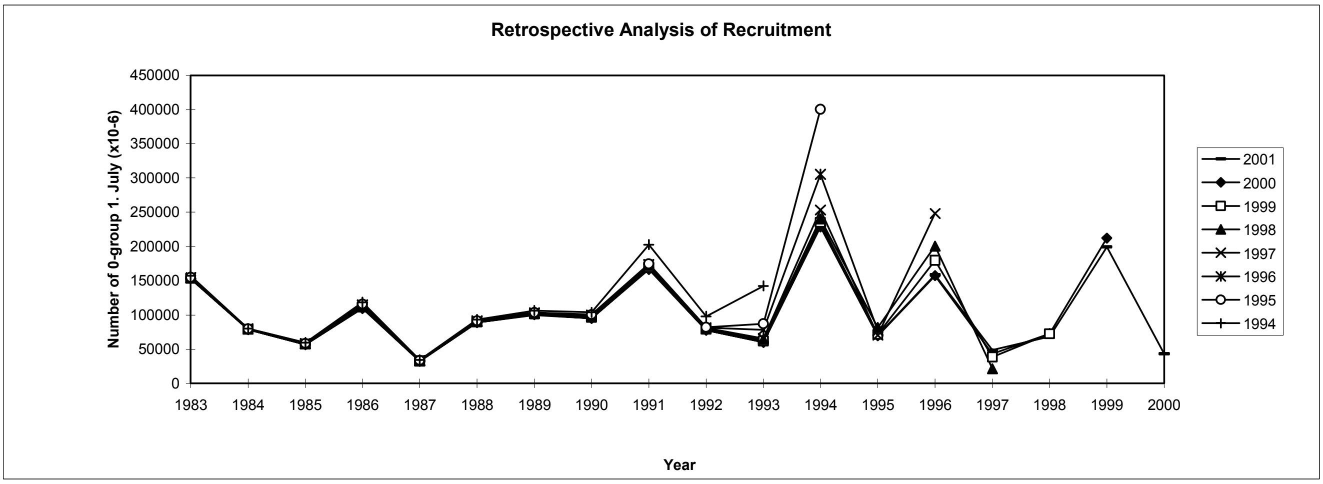


Figure 12.4.3 **Retrospective analyses of SSB and Recruitment and $F_{ann(1-2)}$. No shrinkage used.**

SXSA - Norway pout in the North Sea and Skagerrak





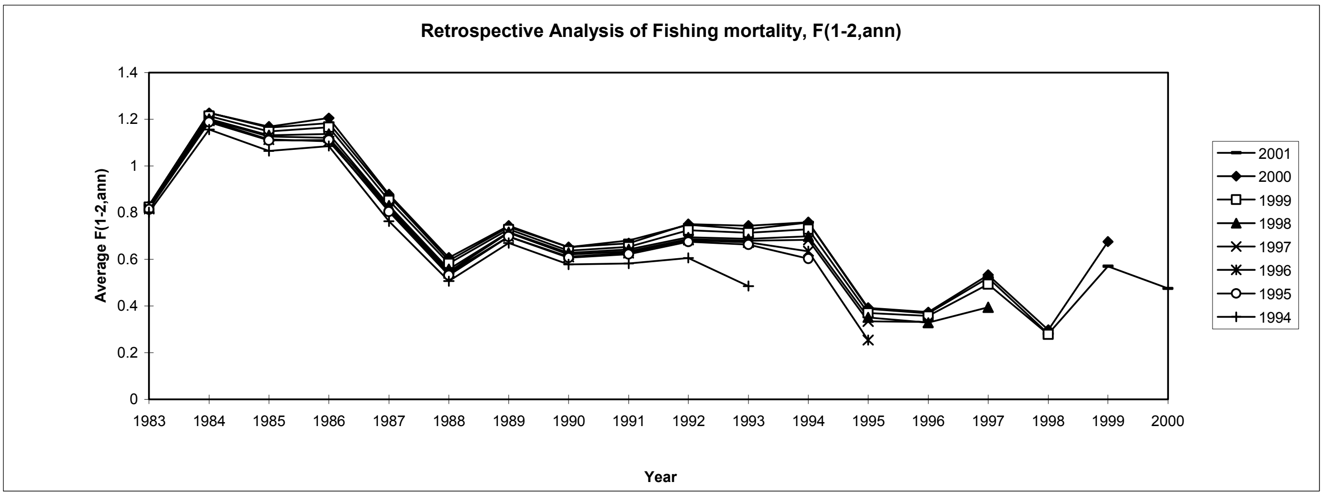


Figure 12.4.4 Difference in trends in annual fishing mortality as average for age 1 and 2, and spawning stock biomass, in assessment partly with settings as in previous years (accepted assessment in 2001) and with a cosine time taper applied (TT) for 12 cohorts within the period 1983-1991(both years included).

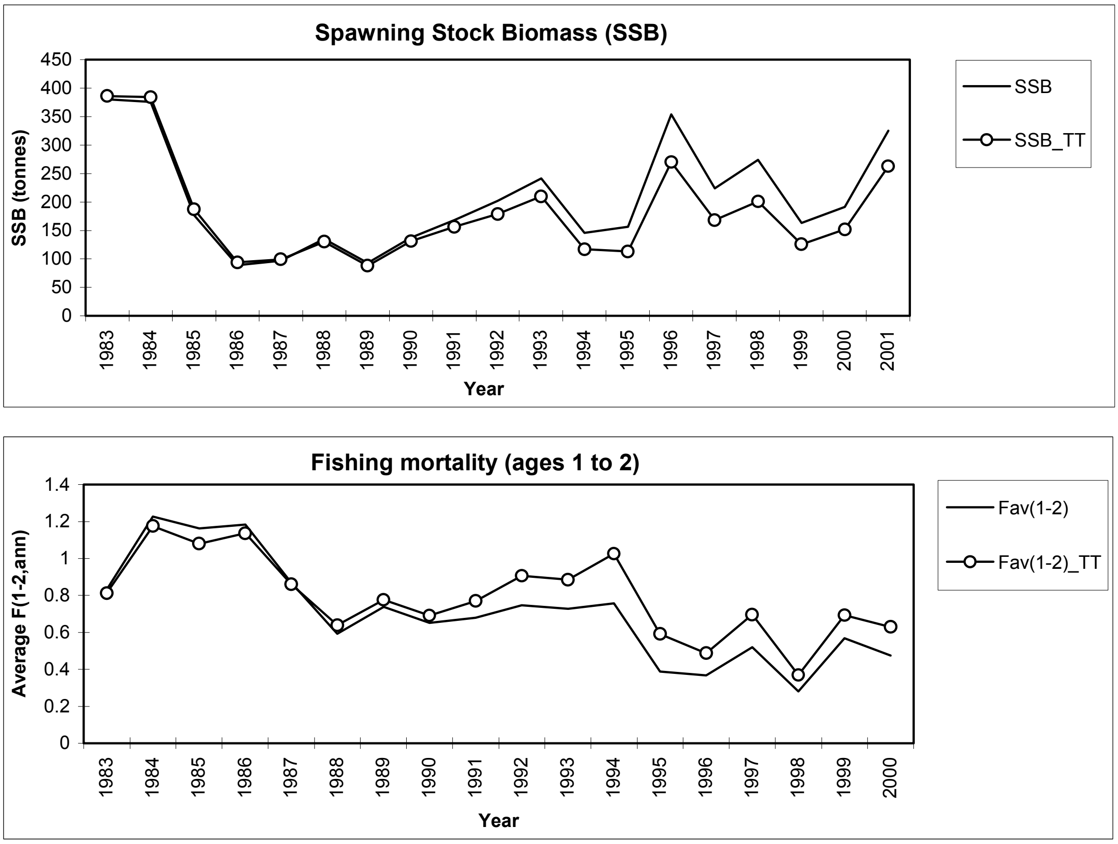


Figure 12.4.5 Difference in trends in annual fishing mortality as average for age 1 and 2, and stock biomass, in assessment partly with natural mortalities as in previous years (accepted assessment in 2001) and with revised natural mortalities applied (NM=new mortalities).

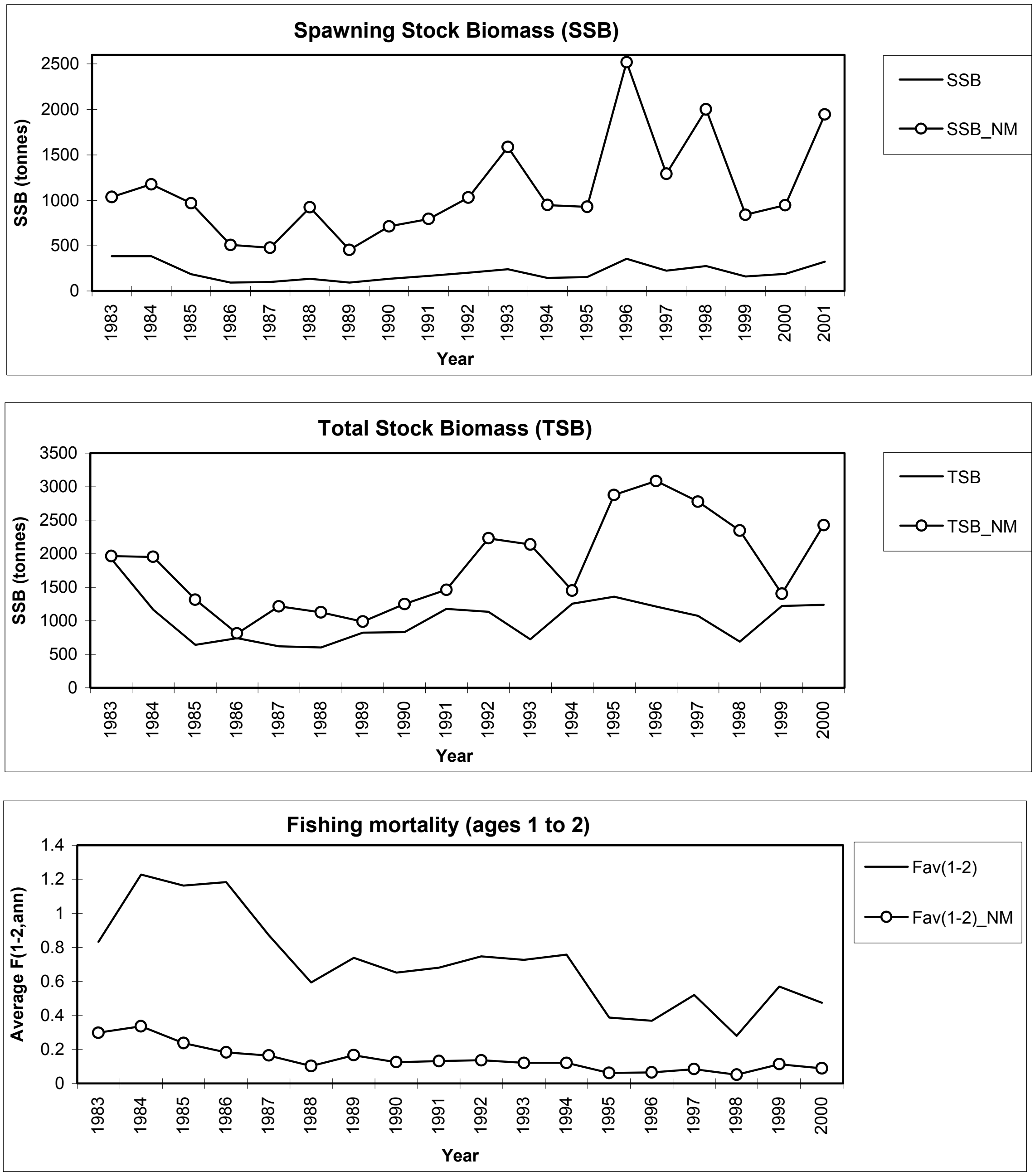


Figure 12.6.1 Historical trends in landings (yield), recruitment at age 0 in 3rd quarter of the year, annual fishing mortality as average for age 1 and 2, and spawning stock biomass.

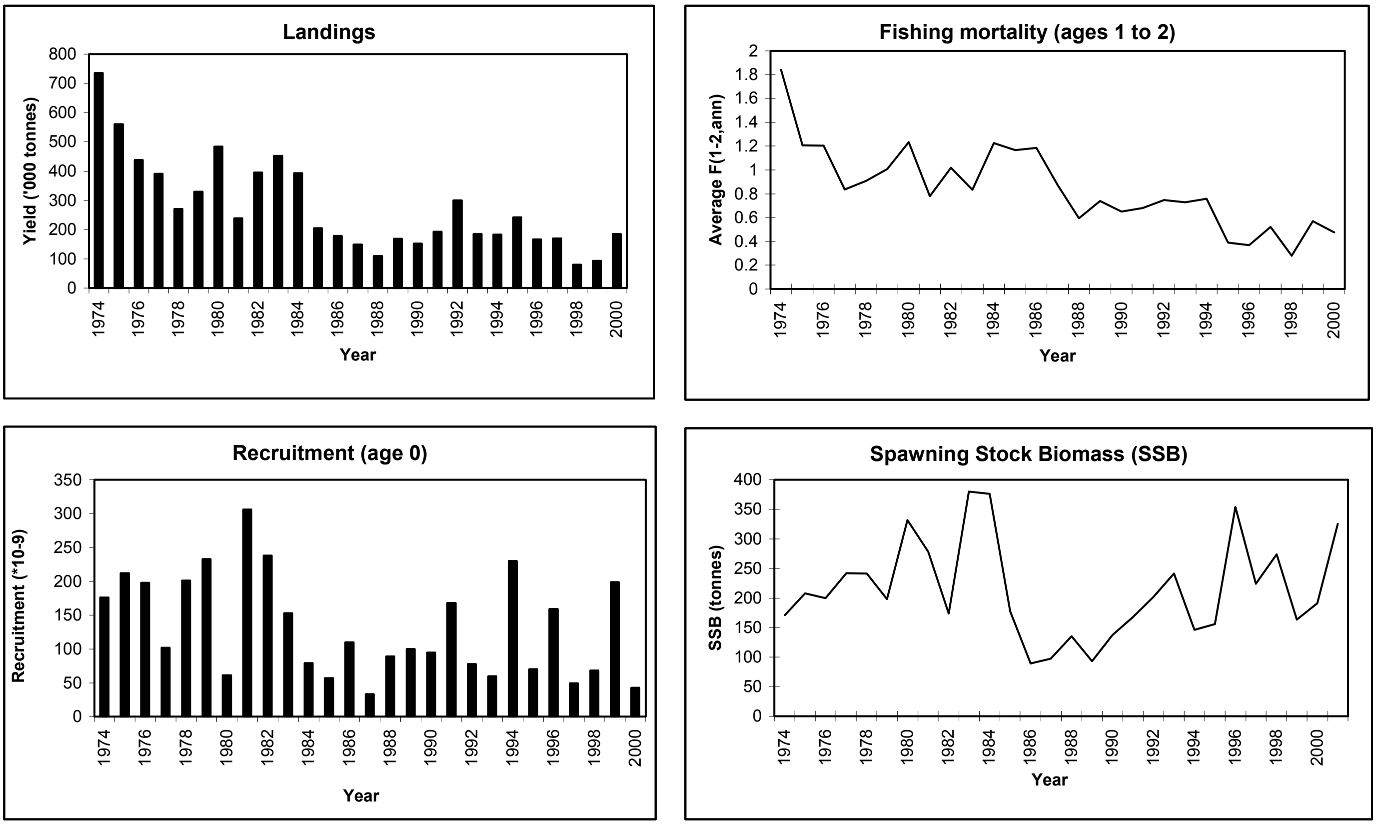


Figure 12.6.2 Historical trends in fishing mortality for 1- and 2-group Norway pout.

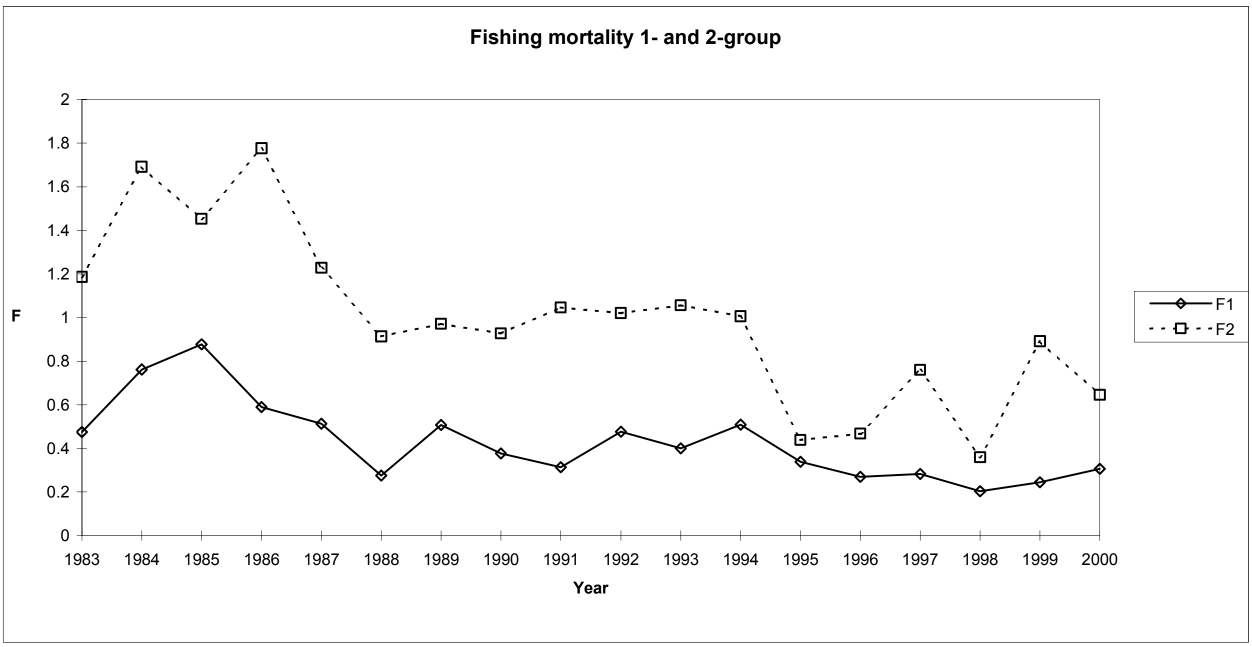


Figure 12.6.3 Trends in yield, SSB and TSB for Norway pout in the North Sea and Skagerrak during the period 1983-2000.

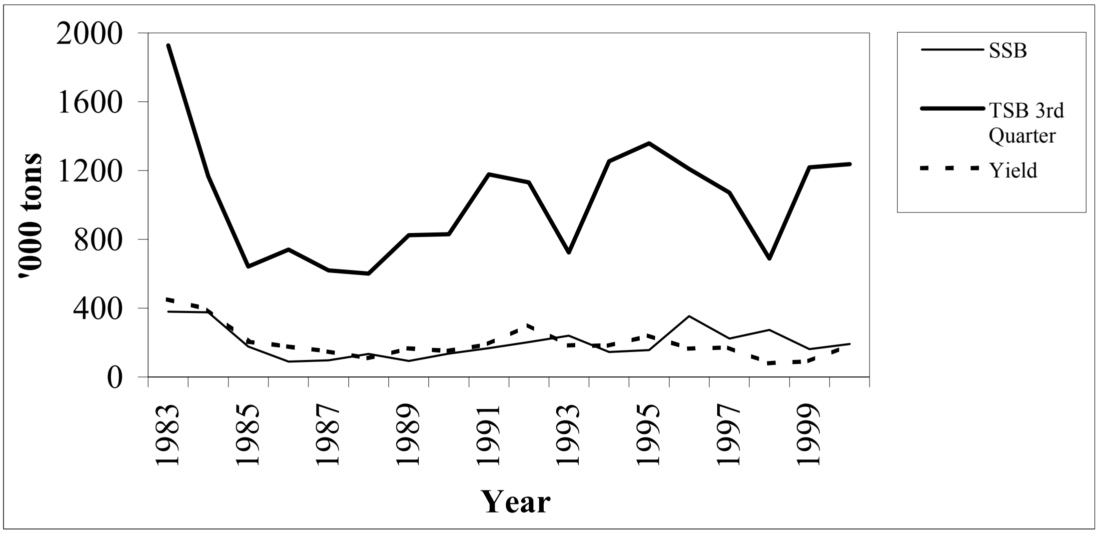


Figure 12.9.1 Recruitment / SSB plot used to calculate F(pa). SXSA - Norway pout in the North Sea and Skagerak. Period: 1974-2000.

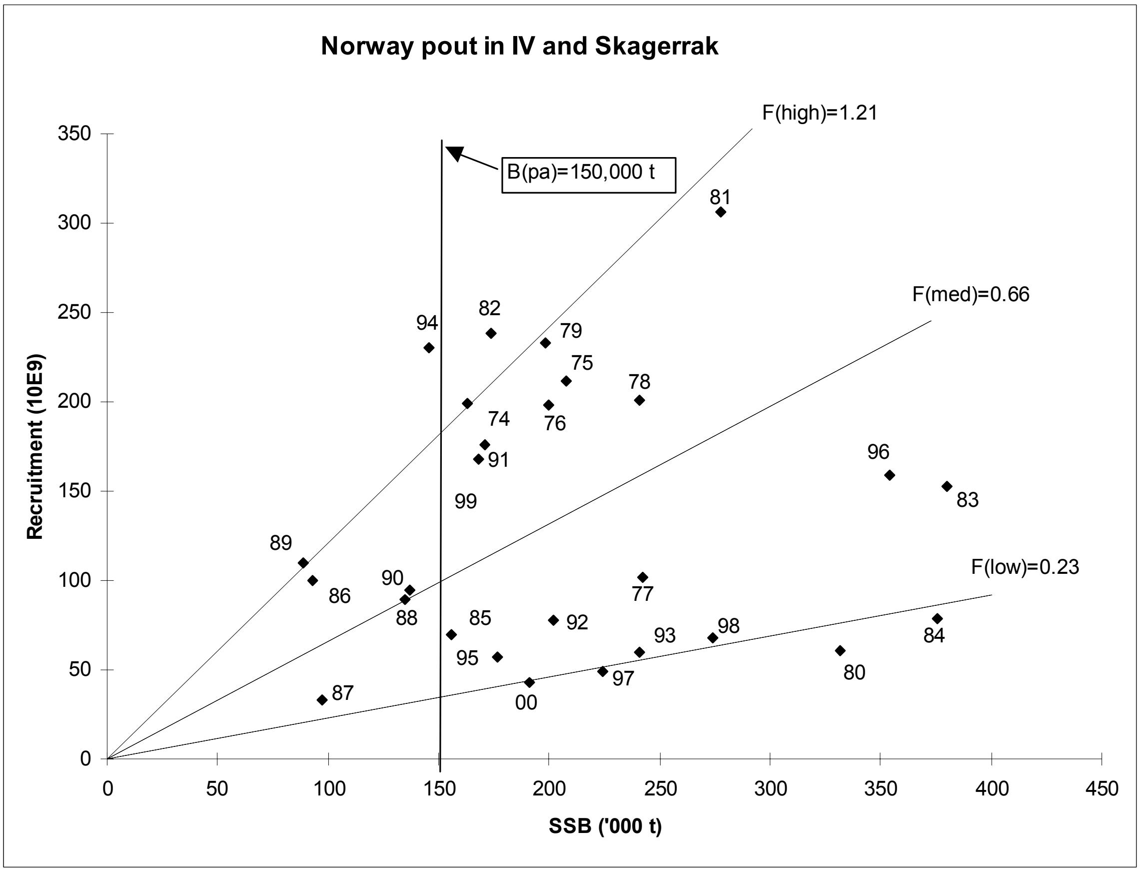
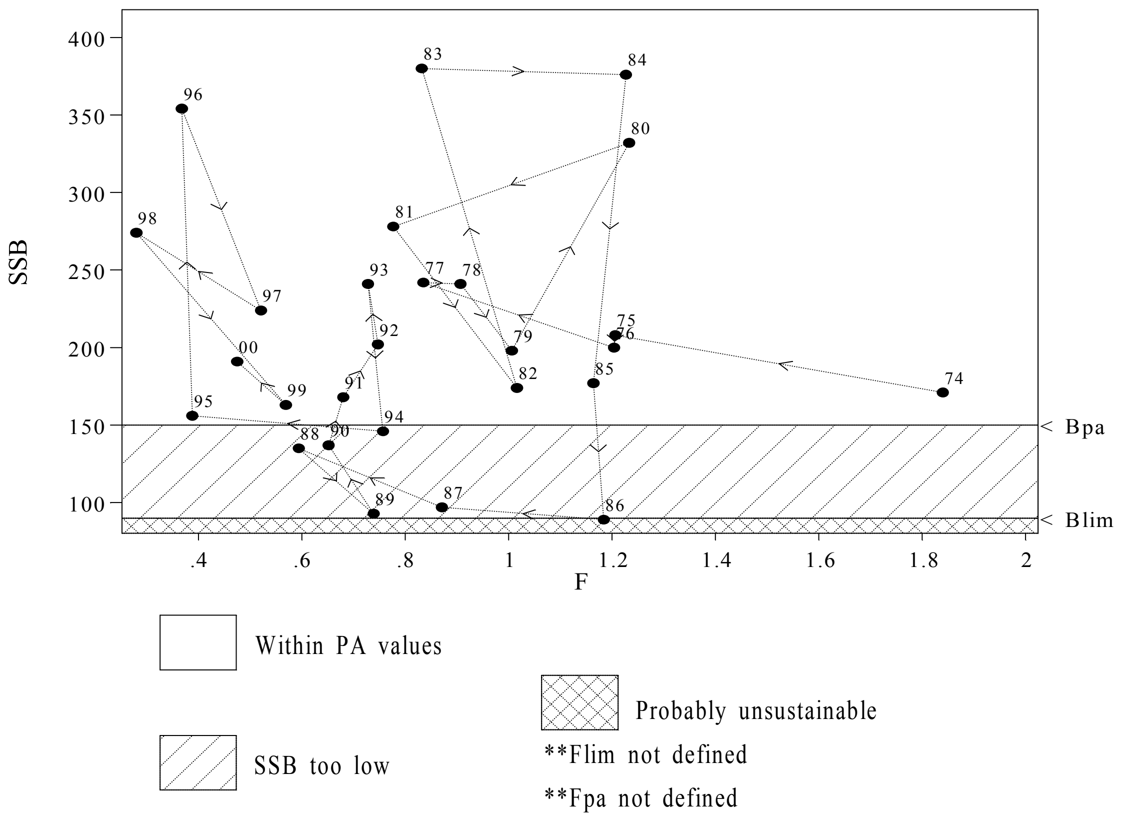


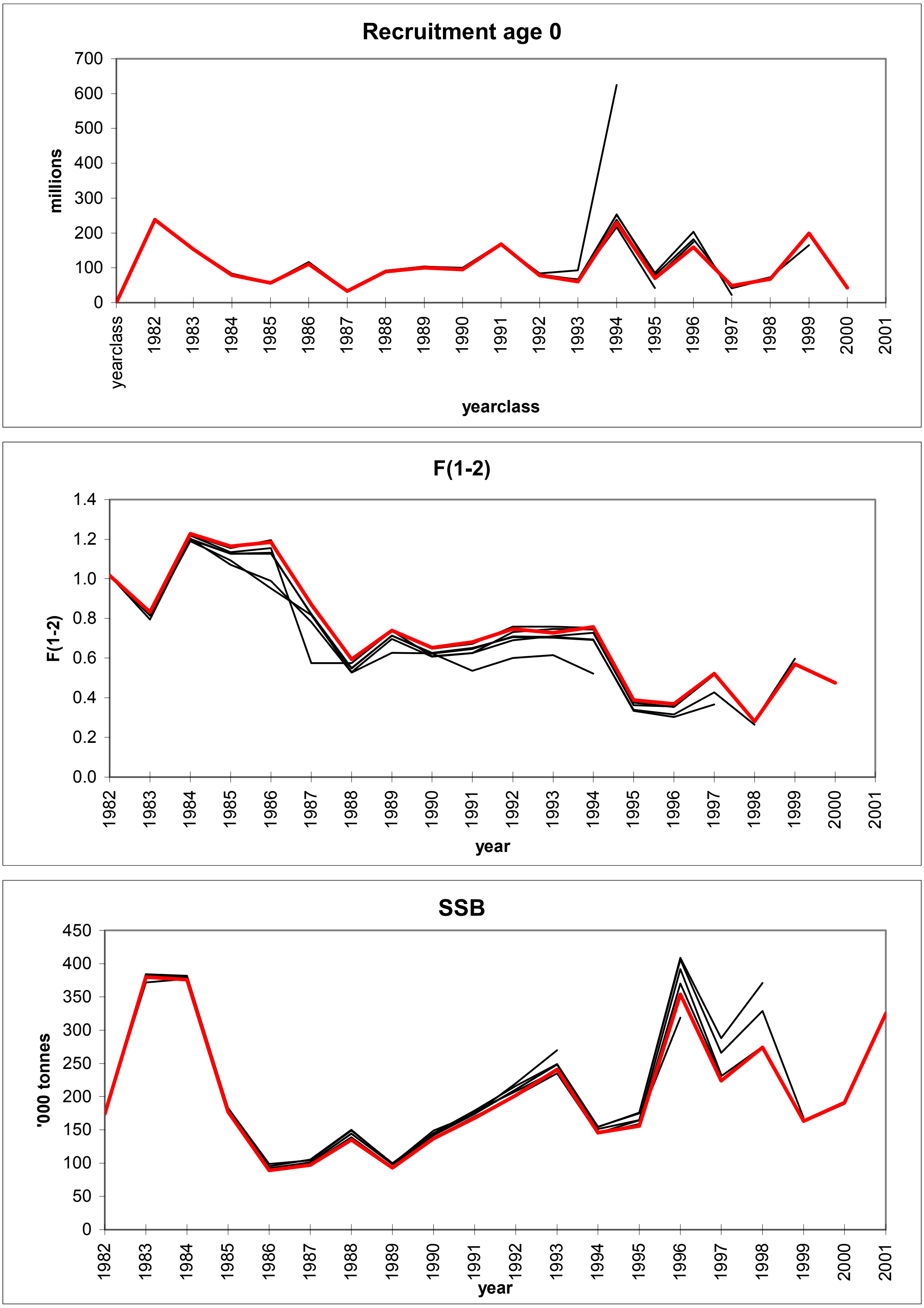
Figure 12.9.2 SSB vs. annual fishing mortality, $F_{ann, 1-2}$, for Norway pout in the North Sea and the Skagerrak[1].



[1] Results and data previous to 1983 do not include Skagerrak.

Figure 12.10.1. Quality Control Diagram for Norway pout in the North Sea and Skagerrak covering the present assessment period from 1983-2001.

NORWAY POUT IV Quality Control Diagram



13 SANDEEL

Sandeel in Sub-area IV

13.1 Fishery and stock definition

Sandeel is taken by trawlers using small mesh gear. The fishery is seasonal, taking place mostly in the spring and summer. Most of the sandeel catch consists of *Ammodytes marinus*, although small quantities of other Ammodytoidei spp. are caught as well. There is little by-catch of protected species.

Sandeels are largely stationary after settlement and the North Sea sandeel fishery must be considered as exploiting a complex of local populations. Recruitment to local areas may not only be related to the local stock, as interchange between areas seems to take place during the early phases of life before settlement. For assessment purposes, the European continental shelf was divided into four regions for sandeel assessment purposes up to 1995: Divison IIIa (Skagerrak), northern North Sea, southern North Sea and Division IVa (Shetland Isl.). 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 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.

Based on the distribution and simulated dispersal of larval stages, Wright *et al*. (1998) suggest that the North Sea stock could be further subdivided into three local populations, broadly comprising the region east of 4°E, the region west of 4°E and south of 55°30'N, and the region north of 55°30'N. With the additional definition of distinct stock units at the Viking Bank, the Moray Firth and the Scottish west coast grounds, sandeel stocks should number seven. Assessments have been tentatively made based on these revised stock divisions (Pedersen et al. 1999) and there were high correlation between the results from the study and the one-area assessment made by the WG.

13.1.1 ACFM advice applicable to 2001

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. The ACFM advice for 2001 was that the stock could sustain the current fishing mortality and that the fishing mortality should not be allowed to increase because the consequences of removing a larger fraction of the food-biomass for other biota are unknown. Management of fisheries should try to prevent local depletion of sandeel aggregations, particularly in areas where predators congregate.

In the light of studies linking low sandeel availability to poor breeding success of kittiwake, ICES advised for 2000 that a closure of the sandeel fisheries east of Scotland (Figure 13.1.1). All commercial fishing were excluded, except for a maximum of 10 boat days in each of May and June for stock monitoring purposes. The closed area will be maintained for three years with evaluation every year.

$\mathbf{B}_{lim}$ is determined as 430,000 t and $\mathbf{B}_{pa}$ 600,000 t . There in no F reference points given.

13.1.2 Management applicable to 2001

The TAC was set to 1,020,000 tonnes for 2000 and 2001.

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 .

13.1.3 Catch and effort trends

The overall landings of sandeel in the North Sea in 2000 were 699,000 t, of which 77% was landed by the Danish fishery, (Table 13.1.1). The catch history is shown in Figure 13.1.2. The sandeel fishery was developed in the beginning of the fifties, rose to a peak in 1997 (1.1 million t) and has steadily declined since. The catch in 2000 is smaller than the arithmetic mean of the period 1983-1999 (803,000 tonnes).

Total international standardized effort (see sec. 13.3) peaked in 1989, decreased until 1994 and was followed by an increase until 1998 (Figure 13.1.2). The effort in 2000 is 67% of the highest observed effort. CPUE has fluctuated without a clear trend throughout the period.

The catches for 2001 are not included in this assessment, however provisional Danish landings statistics for the period until mid June shows catches a little below the landings in 2000 for the same period. By the end of May Norwegian landings in 2001 have been low with less than half of landings at the same time in 2000.

Figure 13.1.1 shows the areas for which catches are tabulated in Tables 13.1.2 and 13.1.3. Compared to the average of the 5 previous years, a larger fraction of the catch in 2000 was taken from area 3, while the fraction from area 2B are below average (Table 13.1.3). The fishery stopped relatively early in 2000, with very low catches in August-November (Table 13.1.2 and Table 13.1.4). The catch of 10,000 t for the second half of 2000 in the northern North Sea, is the lowest observed in the available time series 1976-2000.

Figure 13.1.3 shows the distribution of catches for 2000 by quarter and ICES statistical rectangle based on log book data from Danish, Norwegian and Scottish vessels. A catch of "0.0" in a rectangle indicates a very small catch or, for Danish data, that no sandeel was found in a sample from an industrial catch in the rectangle.

13.2 Natural mortality, maturity, age composition, mean weight at age

Estimates of natural mortality and maturity at age used in the assessment are given in Table 13.2.1. Values for natural mortalities are the same as used since 1989 (ICES CM 1989/Asssess:13). Natural mortalities estimated by MSVPA (ICES CM 1997/Assess:16; Vinther 2001) indicate however, that the present used M-value for the 0-group, second half-year is approximately 50% lower than the MSVPA estimate. The present M-value for the first half-year for the 1-group is slightly higher than the MSVPA values. The M-values used in the assessment were left unchanged, as the overall differences between the present used natural mortalities, the average values estimated by MSVPA are limited.

The mean weight at age in the stock by half-year (Table 13.2.2) was constructed as a weighted average of the mean weight at age in the catch weighted by catch in numbers. The catch and weight at age data for the southern and northern North Sea were worked up separately and are given in Tables 13.2.3-13.2.4.

The catch and weight at age data for the northern North Sea were constructed by combining Danish and Norwegian data. Prior to 1996, the Norwegian age composition data were based on Danish ALK's. Since 1997 the Norwegian age compositions are based on samples from their own fishery. Weights at age prior to 1987 are assumed to be constant in the absence of observations. Mean weights by country are highly variable for the older ages. Parts of this variation might be caused by inclusion of other Ammodytoidei species than *Ammodytes marinus.*

Catch numbers and weight at age for the southern North Sea were based on Danish age compositions and weight at age values prior to 1989 are average values.

13.3 Catch, effort and research vessel data

Effort data from the southern and northern North Sea were treated as two independent fleets. The effort data for the southern North Sea prior to 1999 is only available for Danish vessels, although since 1999 Norwegian vessels have also provided effort data. The fleet in the northern North Sea is a mixture of Danish and Norwegian vessels, even though separate national fleets would have been preferable. Such separation is however not suitable due to the use of a common Danish ALK for the period before 1996. Total international standardised effort was estimated as described in the WG report from 1996, a résumé is provided in section 1.3.2. Input data for these calculations are given in the Tables 13.3.1, Table 13.3.2 and Table 13.3.3. The results of the regressions used to standardise effort to a 200 GRT vessel are given in Table 13.3.4. Total international effort is given in Tables 13.3.5 and 13.3.6 by area and combined in Figure 13.1.4.

The CPUE given as total catch weight per effort show a high correlation between the fleets over the years (Figure 13.3.1). CPUE by age group (Figure 13.3.2) shows a weak correlation between the fleets for the 0-group and a strong correlation for the age 1 and 2.

There are no survey time series available for this stock.

13.4 Catch-at-age analysis

Compared to the assessment made in October 2000 by the WG, the assessment this year has just additional data from the second half-year of 2000. As 90% of the catch were taken in the first half-year, the two assessments are quite similar.

13.4.1 Data exploration

The Seasonal XSA (SXSA) developed by Skagen (1993) was used to estimate fishing mortalities and stock numbers at age by half year. The options used were the same as in the 2000 report (Table 13.4.1), except that data from the second half-year of 2000 were included. Weighting of catchability and survivor estimates was set manually (Table 13.4.1). Tuning data for the years 1983-2000 were used (Table 13.4.2 and Figure 13.3.2). Catch at age data are presented in Table 13.4.3.

The log stock number residuals (Figure 13.4.1), which are equivalent to the XSA log catchability residuals, were examined and no long-term trends were identified. For the first half-year the pattern of residuals is almost identical with the pattern observed in the previous assessment, as no new data are added and the second half-year of the last data year data are down weighted. The VPA stock estimates are given in Table 13.4.4 and fishing mortalities in Tables 13.4.6 and 13.4.7.

Additional explorative runs were made in the previous year's assessment, where it was shown that the used of tuning data from a shorter period (1990-2000 1st half-year) had no effect on the residual pattern, and that the estimated terminal stock numbers from such tuning differed by only 1% compared to the full tuning time series. The normally used "backward extension" method for estimation of F on the oldest age without tuning will not work properly due to the very limited number of age groups and no options for F-shrinkage. Therefore the full tuning time series are used.

13.4.1.1 Automatically weighting of survivors

SXSA weights the estimated survivors from manually entered data or according to the variance of the estimated log catchability. The working group has used manual entered weighting factors for many years. A lower weighting are given to estimates of survivors in the second half of the year 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 for this period. The number of samples taken from the fisheries is related to the size of landings. In years with a limited fishery in the second half-year (like year 2000) a very limited number of samples are taken which influence the accuracy of the catch at age data. Down weighting the survivor estimates permits an increase in the range of log residuals for the 2nd half-year. To explore the effect of the weighting method a run was made where the survivors were weighted by the inverse variance of the log catchability. The residual plot (Figure 13.4.2) looks quite similar to one produced with fixed weights. The estimated weighting factors in the new run show a relatively higher weighting of the first half-year fleets, but the difference between the two season is not that big as for the manually set weighting factors (Table 13.4.8), A comparison of the fishing mortalities (Figure 13.4.3) from the two runs shows that fishing mortality are quite similar for the younger ages and rather different for age 3, especially in the beginning of the period (with a lower quality of the catch at age data). Overall, the two assessments are very similar, indicating that the present choice has been reasonable, and that the choice of options has a limited effect

13.4.1.2 Annual XSA

The sandeel assessment has traditionally been done with time step of half-years, using Seasonal XSA. The choice of time step excludes the use of most of the standard assessment software, and in addition the WGs' expertise cannot fully be utilized. Seasonal, contra annual, assessment is preferable for stocks with highly seasonal fishing mortality and a high and variable natural mortality. The sandeel fishery is highly seasonal with approximately 75% of the catch taken in the second quarter. However, the catch distribution within the year is relative stable from year to year, such that the need for a seasonal assessment is reduced. According to the MSVPA results natural mortality is age dependent and approximately a factor 3-6 higher in quarter 2+3 (summer), compared to quarter 1+4 (winter). This seasonality is not taken into account very well in the present SXSA, as it operates by half years that go across the seasonality of the natural mortality. With WG meetings in October, data for the first half-year have been available and used in the SXSA. However, having the WG in June makes this impossible. The reasons in support of SXSA seem weak and the annual XSA method was tried as an alternative.

Data for XSA were produced from the available SXSA data. four fleets were defined For tuning from, first and second half-year of both the north end southern SXSA fleets. The tuning fleets were assumed to take the catch in the second or third quarter, and the alfa and beta values for defining fishing period in XSA were set accordingly. Annual natural mortality was calculated as a simple sum of the half-year values. The tried XSA options were similar the one used in SXSA (Table 13.4.9)

Both XSA and SXSA are Extended Survivor Analysis and they give, as expected, similar results. The weighting of the individual fleets for estimation of terminal year F in XSA (Table 13.4.10) is not comparable directly to the weights estimated in SXSA (Table 13.4.8), however, the pattern with the highest weight on the first half-year fleet is found for both SXSA and XSA. Within an age-class the relative weighting of the North south fleets is similar for both methods. F shrinkage gives a higher terminal F for the 0-group than the SXSA and XSA without shrinkage. This is due to the relatively high F, age 0 in 1998. For age 2, the shrinkage brings the F to the level estimated by SXSA. The various methods and options give very similar F values (Figure 13.4.3) and XSA or other methods using annual data seems to be a valid alternative to SXSA for future assessments. More explorative runs must however be done before such a change can be implemented.

13.4.2 Final assessment

The final run used the same settings (Table 13.4.1) as in the previous WG.

The VPA stock estimates are given in Table 13.4.4 and fishing mortalities in Tables 13.4.6 and 13.4.7.

The retrospective analysis, Figure 13.4.4, shows that the SXSA estimates SSB converge rapidly and show no sign of a bias in the most recent estimates. The retrospective average F is more variable and shows no consistent bias, even though F has been overestimated the last two years. Recruitment to the fishery takes place the third quarter and the stock number estimate is based on commercial fishing data only, which makes the estimate of recruits unreliable in the terminal year. Previously catch data for the 1-group in the first half-year were available for the estimation of recruitment, but the timing of the WG meeting excludes such data.

SXSA estimates recruitment in 2000 to be the highest ever seen (Figure 13.4.4). XSA without shrinkage gives similar results, while XSA with F-shrinkage estimates a very low recruitment. The high recruitment estimate is in sharp contrast to the very poor fishery in the northern North Sea, second half-year, where the 0-group often is a major age-class. In the southern North Sea catches were at an average level in the second half-year with a relatively high CPUE of the 0-group (Figure 13.3.2). The mean weigh of these 0-groups was estimated well below average (Table 13.2.4). The conflicting signals, combined with relative modest provisional catches in 2001, makes is hard to accept the SXSA estimate and a geometric mean was used instead for recruitment (Table 13.4.11 and Figure 13.4.5).

Figure 13.4.6 shows the relationship between log stock numbers and log CPUE by age of the tuning fleets. Ages 1-3 give correlation coefficients in the range 0.39-0.63, but the 0 group and 4+ groups are quite poor although this is not unexpected given the increased variability in log residuals of 0 groups and the low numbers of the oldest ages.

The stock-recruitment scatter plot is shown in Figure 13.4.7 indicating that there is no clearly defined relationship between stock and recruitment over the observed stock sizes.

13.5 Recruitment estimates

As no recruitment estimates from surveys are available, recruitment estimates are based exclusively on commercial catch-at-age data. The estimation of the 2000 year-class in the present SXSA assessment is based on a limited landings and sampling and is not considered reliable.

13.6 Historical stock trends

Average fishing mortality, recruitment at age 0 in the 2^{nd} half and SSB in the 1^{st} half for the period 1976-1999 are shown in Table 13.4.11 and Figure 13.4.5

Fishing mortality in the period 1976-1991 appears to have been at a higher level (average 0.67) compared to the more recent period 1992-2000 (average 0.47).

Recruitment appears to fluctuate with either a 2 or 3 years period. High recruitment is generally followed by one year of poor recruitment. Very good recruitment is generally followed by two years of low recruitment. The 1996-year class is estimated to have been the largest in the time series while the 1997 and 1998-year classes were low. The 1999 recruitment value was above average. The recruitment estimate for 2000 is uncertain and a GM was used. Low catches in the second half-year of 2000 in the northern North Sea may indicate poor recruitment in that area.

Spawning stock biomass has fluctuated around a level of 1 million t. After the peak in 1998 (due to the 1996 year-class) the SSB at the start of 2000 (707,000t) has fallen below the average level (Arithmetic mean 1983-1999 = 998,000t).

13.7 Catch Forecasts

Because of the high natural mortality of sandeel and few year classes in the fishery, the stock size and catch opportunities are largely dependent on the size of the incoming year classes. Traditional deterministic forecasts are therefore not considered appropriate.

13.8 Biological reference points

In 1998 ACFM proposed that $\mathbf{B}_{\mathrm{lim}}$ be set at 430,000 t, the lowest observed SSB. The $\mathbf{B}_{\mathrm{pa}}$ was estimated at 600,000 t, approximately $\mathbf{B}_{\mathrm{lim}}$ * 1.4. This corresponds to that if SSB is estimated to be at $\mathbf{B}_{\mathrm{pa}}$ then the probability that the true SSB is less than $\mathbf{B}_{\mathrm{lim}}$ 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.

Figure 13.8.1 shows the relationship between Fbar(1-2) and SSB in relation to $\mathbf{B}_{\mathrm{pa}}$ for the period 1976-2000. SSB in 2000 is estimated to be 18% above the $\mathbf{B}_{\mathrm{pa}}$.

13.9 Comments on the assessment

The assessment for this year appears to be internally consistent. Similar results were obtained from both SXSA and XSA. No seriously bias was seen in the retrospective analysis for F and SSB. The assessment this year indicates that fishing mortality is at an average level. SSB is below average, but slightly above $\mathbf{B}_{\mathrm{pa}}$. Yield has decreased since 1997.

The total stock biomass estimated for the second half of each year (Table 13.4.4) should be treated with caution. Weight at age of the 0 group is taken as weight at age from the catch and this is likely to over estimate the biomass of the 0 group. However the higher value of natural mortality given by the latest MSVPA run indicates that the stock size of the 0 group is underestimated. Total stock biomass and spawning stock biomass, 1. January (Table 13.4.11) are in the same way estimated from stock numbers in the start of the season and the mean weights in the catch during the season.

The relatively poor correlation between the tuning indices and the stock size is perhaps a reflection of the fact that we are assessing several sub-stocks as a single unit. In addition, the mobility of the sandeel fleet is such that vessels will rapidly change grounds to optimise CPUE.

The recruitment, average F and SSB estimated in the assessment carried out since 1995 are presented in Figure 13.9.1. Recruitment in the figure is given for the age one, 1. Jan, where this assessment normally defines recruits as the 0-group, 1. July. The present timing of the working group meeting makes it impossible to include data for the first half of the year, such that the recruitment estimate for the 0-group is very uncertain. Both recruitment, F and SSB have been quit consistently estimated in the assessments over the period.

The explorative runs with annual XSA and the traditionally used seasonal XSA gave very similar results, the WG propose to use annual XSA assessment in future assessments. The present practice of presenting catches at age data by half-year and for the Northern and Southern North Sea separately should be kept unchanged.

13.10 Management considerations

There is a need to ensure that the stock remains high enough to provide food for a variety of predator species. Fishing mortality should not be allowed to increase because the consequences of removing a larger fraction of the food-biomass for other biota are unknown. Management of fisheries should try to prevent local depletion of sandeel aggregations, particularly in areas where predators congregate.

The sandeel fishery in the first half of the year consists mainly of age 1 and older fish. The 0-group recruits to the fishery in the third quarter, even though a few are caught before, however they are left out of the assessment. There is a marked difference in the exploitation pattern in the southern and northern assessment area in the second half-year. 31% of the catch (by number) comes from the 0-group in the southern area, while 77% of the catch numbers in the northern area belong to the 0-group. These percentages are calculated from catch numbers over the last 20 years. The fishery in the northern area has been carried out in a relative small area during the last years and the implication of such 0-group fishery should be evaluated.

A group of Danish fishermen have expressed concern about the exploitation pattern of sandeel and they have asked for a regulation to protect small sandeel (Fiskeritidende, 2001). There has now (24 June) been made an agreement between the Danish Fishermens Association and the fishing industry to decrease catches of sandeels less than 9cm (recruits). For landing with 10-20% (weight) recruits, the payment is reduced proportionally to the percentage. The reduction is twice the percentage for landings with more than 20%. Such an agreement may have a positive effect on both the exploitation pattern and stock size. The changes in fishing practice and stock development should be followed with interest.

13.11 Sandeel in Sub-area IIIa

Sandeels in IIIa are considered to include a number of species as for the North Sea. The one-species dominance, like Ammodytes *marinus* in the North Sea, is however not that pronounced in IIIa, such that traditionally one-species assessment is not feasible.

The catches in 2000 were 16,500 t, which is a small increase compared to the values in 1998-1999, however well below the average of 32,000 t for the period 1989-2000 (Table 2.2.1).

13.12 Sandeel in Shetland

13.12.1 Catch trends

The sandeel population adjacent to Shetland has been exploited since the early 1970s. The grounds fished are close inshore and the vessels involved are generally small and local. Seasonal closures were introduced in 1989 following a decline in SSB and recruitment and poor breeding success of sandeel-dependent seabird populations, and the fishery was closed completely from 1991–1994. A restricted fishery has operated since 1995. Landings in 1999 were 4157 tonnes (Table 13.1.3.2), which is the slightly lower than in 1998, and short of the 7,000t TAC. Figures for 2000 indicate landings of 4781 t.

13.12.2 Management in 2000-2001

The fishery re-opened at the start of the 1998 season with a TAC of 7,000 t, limited licensing and seasonal closures. The fishery is closed during the months of June and July to avoid any possibility of the fishery having any impact on the availability of 0-group sandeels to Shetlands seabird populations during their chick-rearing season.

Management of the Shetland fishery is based on a three-year multi-annual regime, which is agreed among the main stakeholders. These include the Scottish Executive, fishing industry representatives, local government authorities and NGOs. A new regime was agreed to cover the period 2001-2003, which is effectively, the same regime as operated from 1998-2000.

13.12.3 Assessment

The previous assessment of this stock was done by the 1997 WG (ICES CM 1998/Assess:7). The main problem in trying to assess the stock using traditional catch-at-age analyses is that the fishing mortality is very low and as a result such methods tend to fail. The last assessment suggested that the fishing mortality since about 1985 has been less than 0.1 which is considerably lower than the assumed natural mortality which range from 0.8 at age 0, 1.2 at age 1 to 0.6 for all other ages. As a result the dynamics of the stock is driven almost entirely by natural events and VPA methods do not converge.

The principal source of data is from trawl surveys carried out in August each year. These data have been used in the past to tune a separable VPA but in recent years the analytical method did not produce plausible results. In order to avoid these difficulties, and noting the predominance of natural mortality in determining stock dynamics, a different approach has been adopted here. A model which estimates total mortality rather than fishing mortality has been applied. This makes the assumption that Z is separable into an age and year effect, i.e.:

$$Z_{a,y} = z_a k_y$$

Given that F is very small for this stock, in applying this formulation, the model is in effect estimating natural mortality. The particular model implementation is the program RCRV1a which is fully described in Cook (1997).

Input data showing assumed maturity and weights at age are shown in Table 13.12.1. The table also shows the survey index. Results from fitting the model are given in Table 13.12.2 which gives the fitted year effects (k_y) and age effects (z_a), estimated Z at age and fitted survey indices. The age effects indicate that mortality is high on the youngest ages but decreases to a minimum at age 2 and then increases again on the older ages. Biologically this is the kind of relationship with age which is expected, although the very high value at age 4 seems anomalous.

Table 13.12.3 shows the time series of biomass, Z and recruitment estimated from the model. In Figure 13.12.1 the time series of Z, SSB and recruitment are shown. Z appears to show a cyclical change, possibly with an increasing trend. For comparison, SSB and recruitment are plotted with the estimated values from the last assessment in 1997. Although the present assessment only shows values on a relative scale, the trends for the last VPA assessment and the current one are very similar and provides some reason to believe the results. If correct, the present assessment suggests that the SSB is at a relatively low level and that recent recruitment has been poor. This would mean that the SSB is likely to decrease in the short term.

Table 13.1.1. SANDEEL in the North Sea. Landings ('000 t), 1952-2000.
(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

+ = less than half unit.
- = no information or no catch.

Table 13.1.2 Monthly landings (ton) of sandeels by Denmark, Norway and Scotland from each area in Figure 13.1.1

	1A	1B	1C	2A	2B	2C	3	4	5	6	Shetland
1995											
Mar	0	3769	0	317	14428	0	94	0	0	18	
Apr	64640	29155	17990	10529	26818	248	123	751	0	171	
May	105246	9646	25901	62345	47201	340	27795	2267	293	3539	
Jun	139864	1308	68056	3874	58920	369	16343	12261	4424	18676	
Jul	12612	0	104	8811	9605	0	7541	11301	367	25548	
Aug	0	0	34151	867	3242	0	6507	0	193	7801	
Sep	0	0	1234	4	1683	0	615	0	0	85	
Oct	0	0	0	0	7555	0	410	0	0	4	
Total	322362	43878	147436	86747	169452	957	59428	26580	5277	55842	1160
1996											
Mar	0	28	10	0	2379	0	0	0	0	0	
Apr	8792	35	1551	3944	21184	0	5438	247	0	534	
May	78847	13217	4595	13739	54993	611	18817	2509	455	3064	
Jun	112059	81	20441	12692	32264	489	25078	7097	1711	35186	
Jul	108624	1976	59	1282	9565	1	22477	2885	802	6034	
Aug	1313	461	3679	7153	8849	125	34315	0	0	5441	
Sep	875	43	767	1256	12586	3307	19781	0	0	2262	
Oct	0	2671	0	726	10252	0	8156	0	0	0	
Nov	0	48	0	0	879	0	0	0	0	0	
Total	310510	18560	31102	40792	152951	4533	134062	12738	2968	52521	1000
1997											
Mar	17	7562	2326	1402	25821		1220				0
Apr	23736	35036	5800	11404	42308	535	21745	588		180	892
Mai	117700	6326	584	24309	76216	487	36499	3074	1768	13636	503
Jun	132631	2751		37848	142941		36966	1121	51	29935	442
Jul	58429	1235	197	14212	42478		11632	11057	1278	31738	534
Aug	1660	293		1552	24113	15	3497	83	1602	12211	503
Sep				1024	23859	156	1230			666	0
Okt		140		859	12513		134			61	0
Total	334173	53343	8907	92610	390249	1193	112923	15923	4699	88427	2874
1998											
Mar	5631	6378	322	1176	8431	150	697	1275	0	0	0
Apr	55616	12943	589	34884	73929	351	11619	482	225	843	1073
May	80124	30002	1103	41509	85448	481	13613	8688	1173	10151	1224
Jun	129065	6115	0	7693	86544	0	9248	14485	1488	27392	0
Jul	6172	396	0	1675	43587	0	2490	6750	1188	23786	50
Aug	149	1477	0	964	55421	0	1852	642	0	473	2362
Sept	0	676	0	733	37012	0	1094	0	0	212	503
Oct	0	26	4	0	4472	0	0	0	0	16	0
Total	276757	58013	2018	88634	394844	982	40613	32322	4074	62873	5212
1999											
Mar	1448	2587	136	1047	9371	0	466	73	218	0	479
Apr	52710	3030	0	64860	17779	0	644	80	55	1360	1080
May	151806	15520	0	42635	45709	0	7299	1567	82	1271	461
Jun	52943	9427	0	6199	8224	0	3304	12744	1097	18254	6
Jul	7816	1883	0	15142	13918	0	14841	2434	1270	5274	0
Aug	1	0	0	1770	29621	0	15376	0	0	99	2043
Sept	1	155	0	930	26486	0	4129	0	0	883	88
Oct	0	0	0	42	16440	0	1754	0	0	68	0
Dec	0	0	0	181	358	0	198	0	0	0	0
Total	266725	32603	136	132807	167905	0	48011	16898	2722	27208	4157
2000											
Mar	800	42	0	3257	5618	0	739	0	0	393	687
Apr	30931	19012	0	15259	71384	281	33583	479	0	595	1436
May	110128	6843	0	24941	42647	0	53911	6685	3089	662	1651
Jun	73632	3262	26	18564	16440	0	17287	11240	2503	29205	0
Jul	10610	33	4	25193	3286	11	5996	2024	2692	12201	0
Aug	0	0	0	3	113	0	117	0	1	127	560
Sept	0	0	0	21	393	0	18	0	0	145	0
Oct	0	0	0	0	0	0	2	0	0	1	0
Total	226102	29192	30	87238	139882	292	111652	20428	8285	43329	4334
%	34%	4%	0%	13%	21%	0%	17%	3%	1%	6%	1%
Average 1995-1999											
	34%	5%	4%	10%	29%	0%	9%	2%	0%	6%	0%
	302105	41279	37920	88318	255080	1533	79007	20892	3948	57374	2881

Table 13.1.3 Annual landings ('000 t) of Sandeels by area of the North Sea (Denmark, Norway and Scotland). Data provided by Working Group members.

	Area										Assessment 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

Assessment areas: Northern - Areas 1B, 1C, 2B, 2C, 3.
Southern - Areas 1A, 2A, 4, 5, 6.

Table 13.1.4 Sandeel North Sea. Monthly landings (t) by Denmark, Norway and Scotland, 1996-2000 (Data provided by Working Group members).

Year	Month	Denmark	Norway	Scotland	Total
1996	Mar	1,202	829		2,031
	Apr	30,651	7,720		38,371
	May	137,629	45,637	2,742	186,008
	Jun	184,507	50,912	3,740	239,159
	Jul	131,018	17,610	68	148,696
	Aug	67,913	11,829		79,742
	Sep	34,257	11,955		46,212
	Oct	13,222	12,480		25,702
	Nov		927		927
	Total	600,399	159,899	6,550	766,848
1997	Mar	15,343	23,005		38,348
	Apr	88,690	52,642		141,332
	May	208,647	71,951	8,029	288,627
	Jun	276,974	107,270	11,581	395,825
	Jul	136,708	35,369	2,396	174,473
	Aug	22,394	22,811		45,205
	Sept	2,490	24,448		26,938
	Oct	640	13,067		13,707
	Nov	0			0
	Total	751,886	350,563	22,007	1,124,456
1998	Mar	14,729	9,332		24,061
	Apr	130,629	60,852	2,359	193,840
	May	191,407	80,885	8,246	280,538
	Jun	204,102	77,929	7,933	289,964
	Jul	56,586	29,457		86,043
	Aug	17,894	43,084		60,978
	Sept	2,395	37,331		39,726
	Oct	17	4,503		4,520
	Nov				0
	Total	617,759	343,373	18,538	979,670
1999	Mar	6,851	8,496	479	15,826
	Apr	115,596	24,149	1,854	141,599
	May	202,813	56,961	6,578	266,352
	Jun	97,284	14,478	434	112,197
	Jul	49,333	13,245	0	62,578
	Aug	19,044	27,823	2,043	48,910
	Sept	6,217	26,366	88	32,672
	Oct	2,567	15,738	0	18,305
	Nov	405	332		737
	Total	500,110	187,589	11,476	699,175
2000	Mar	7,524	3,325	687	11,536
	Apr	126,644	44,879	1,436	172,959
	May	195,866	48,292	6,400	250,558
	Jun	150,394	20,089	1,677	172,160
	Jul	60,126	1,923		62,049
	Aug	247	113	560	921
	Sept	184	393		577
	Oct	3			3
	Total	540,988	119,015	10,759	670,763

Table 13.2.1 SANDEEL North Sea. Natural mortality and proportion mature.

Age	Proportion mature	Natural mortality	
		Jan-Jun	Jul-Dec
0	0.0	-	0.8
1	0.0	1.0	0.2
2	1.0	0.4	0.2
3	1.0	0.4	0.2
4+	1.0	0.4	0.2

Table 13.2.2 SANDEEL North Sea, Mean weight (g) in the stock.

		Half-year	
Year	Age	1	2
1996	0	-	2.90
	1	6.75	10.33
	2	9.99	16.13
	3	14.52	20.52
	4+	21.10	32.88
1997	0	-	1.94
	1	5.63	8.04
	2	9.44	11.70
	3	11.77	15.27
	4+	21.61	18.86
1998	0	-	2.49
	1	5.01	3.84
	2	8.54	12.03
	3	12.03	13.92
	4+	16.34	17.11
1999	0	-	3.15
	1	5.59	8.29
	2	8.85	10.49
	3	13.42	17.14
	4+	22.15	15.68
2000	0	-	1.66
	1	6.40	7.56
	2	8.57	14.29
	3	13.30	15.96
	4+	17.03	18.87

Table 13.2.3 SANDEEL, Northern North Sea. Mean weight (g) in the catch by country and combined (as used in the assessment). 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
1996	0	-	2.92	-	2.98	-	2.94
	1	6.57	8.31	10.31	14.94	7.80	10.85
	2	12.09	13.61	18.20	23.34	14.98	14.92
	3	21.54	15.59	30.79	-	25.93	15.59
	4	33.11	20.72	40.78	-	36.29	20.72
	5	37.00	25.81	-	-	37.00	25.81
	5+	-	-	48.56	-	48.56	-
	4++	33.89	23.58	42.46	-	37.49	23.58
1997	0	-	4.63	-	1.58	-	1.71
	1	4.20	9.12	5.97	7.69	4.94	8.11
	2	6.23	23.93	8.77	9.86	7.95	10.15
	3	10.67	10.65	12.25	28.06	11.76	23.96
	4	14.73	14.02	16.97	-	15.53	14.02
	5	17.94	17.94	-	-	17.94	17.94
	5+	-	-	30.90	-	30.90	-
	6	19.26	18.56	-	-	19.26	18.56
	7	21.57	18.55	-	-	21.57	18.55
	4++	18.07	17.19	29.36	-	24.64	17.19
1998	0	-	2.84	-	2.23	-	2.48
	1	4.03	10.31	4.89	3.82	4.24	3.91
	2	8.11	18.33	9.24	10.56	8.73	11.13
	3	12.72	20.33	14.42	20.14	14.21	20.15
	4	15.41	26.40	31.00	12.75	28.60	13.39
	5	19.90	-	-	-	19.90	-
	5+	-	-	49.94	-	49.94	-
	6	16.62	-	-	-	16.62	-
	7	18.37	-	-	-	18.37	-
	4++	16.59	26.40	36.61	12.75	33.61	13.39
1999	0	-	4.08	-	2.67	-	3.07
	1	6.72	18.52	3.87	2.90	6.53	7.78
	2	10.89	-	7.12	10.43	8.08	10.43
	3	17.47	24.15	11.65	-	13.20	24.15
	4	20.07	-	20.72	-	20.57	-
	5	22.23	-	-	-	22.23	-
	5+	-	-	37.82	-	37.82	-
	6	26.11	-	-	-	26.11	-
	7	27.00	-	-	-	27.00	-
	8+	30.33	-	-	-	30.33	-
	4++	21.30	-	27.14	-	25.68	-
2000	0	-	-	-	-	-	-
	1	6.41	14.92	8.46	-	6.78	14.92
	2	7.44	17.95	8.05	-	7.90	17.95
	3	12.68	19.18	11.17	-	11.86	19.18
	4	18.49	22.62	-	-	18.49	22.62
	4+	-	-	21.92	-	21.92	-
	5	19.37	25.37	-	-	19.37	25.37
	6	18.41	18.41	-	-	18.41	18.41
	4++	18.60	22.67	21.92	-	19.66	22.67

Table 13.2.4 SANDEEL, Southern North Sea. Mean weight (g) in the catch (Denmark)
Age group 4++ is the 4-plus group used in assessment

		Half-year	
Year	Age	1	2
1996	0	-	2.34
	1	5.57	9.90
	2	8.31	16.66
	3	13.16	21.77
	4	15.88	31.49
	5	17.95	33.31
	6	17.99	36.78
	7	-	43.83
	4++	16.89	33.39
1997	0	-	4.72
	1	6.52	7.99
	2	10.92	13.54
	3	11.81	14.73
	4	16.19	16.74
	5	-	23.33
	6	17.05	20.01
	4++	16.27	18.88
1998	0	-	2.79
	1	5.54	3.01
	2	8.38	12.65
	3	10.64	11.57
	4	12.05	17.23
	5	15.59	14.87
	6	17.82	-
	7	18.28	-
	4++	13.21	17.14
1999	0	-	5.42
	1	5.52	10.02
	2	9.27	11.05
	3	13.50	16.85
	4	16.84	15.59
	5	22.23	9.16
	6	20.95	21.38
	7	-	21.38
	4++	18.33	15.68
2000	0	-	1.66
	1	6.16	6.61
	2	9.56	13.68
	3	14.42	15.74
	4	15.41	18.06
	5	16.66	19.60
	6	19.82	19.75
	7	18.69	19.75
	8+	19.88	-
	4++	15.93	18.34

Table 13.3.1 SANDEEL. Northern North Sea. Danish CPUE data (t/day fishing) by half year

First half year

	Vessel size (GRT)						
Year	0-50	50-100	100-150	150-200	200-250	250-300	>300
1982	11.2	17.2	31.8	26.7	47.6	40.8	25.8
1983	11.1	17.1	23.6	23.9	31.6	36.4	41.3
1984	14.6	24.8	33.4	32.1	44.4	55.5	19.7
1985	12.1	17.2	35.7	51.2	57.9	67.2	55.8
1986	21.0	32.0	45.5	50.2	63.9	57.4	71.8
1987	23.7	37.8	67.0	66.5	78.6	79.9	113.0
1988	19.0	25.6	34.4	42.5	48.0	47.8	75.3
1989	16.3	25.2	36.7	41.0	49.6	51.4	76.2
1990	14.5	21.6	27.3	27.8	29.5	27.4	39.7
1991	16.7	25.5	38.4	42.5	47.6	47.5	72.2
1992	16.6	24.6	36.3	34.7	60.6	46.9	76.9
1993	14.9	19.3	33.6	36.5	47.2	51.1	51.8
1994	26.9	32.0	53.9	61.8	75.0	87.9	102.5
1995	19.6	29.5	49.5	57.8	61.0	66.9	73.6
1996	16.5	21.1	35.9	39.1	36.7	40.0	56.2
1997	24.9	34.9	51.4	56.1	76.8	58.9	90.4
1998	16.9	24.4	28.7	44.6	52.8	54.3	64.8
1999	24.2	27.3	22.7	34.9	35.2	47.3	67.4
2000	17.5	33.2	32.8	40.0	50.7	54.5	71.2

Second half year

	Vessel size (GRT)						
Year	0-50	50-100	100-150	150-200	200-250	250-300	>300
1982	-	17.7	33.6	46.7	19.9	-	-
1983	17.9	25.7	31.0	32.9	44.5	34.3	57.1
1984	113.2	22.0	21.5	35.2	-	28.3	24.0
1985	21.6	23.5	25.8	39.6	60.7	33.3	-
1986	17.1	27.5	50.2	50.0	77.9	74.0	80.7
1987	21.3	31.8	23.9	24.3	42.6	25.4	46.3
1988	16.8	21.3	30.0	32.4	38.0	33.1	43.9
1989	16.6	22.3	23.6	27.3	28.3	35.6	25.0
1990	17.6	32.5	29.4	34.1	40.4	32.6	53.3
1991	15.1	26.3	40.8	44.8	54.4	51.3	72.5
1992	20.4	25.4	35.2	38.2	53.6	50.9	52.1
1993	18.5	21.4	26.5	27.5	38.8	47.9	59.0
1994	24.3	31.5	42.7	53.5	59.8	65.8	74.6
1995	21.9	34.6	46.1	53.8	58.6	62.7	68.6
1996	15.3	30.6	41.9	37.8	47.4	44.9	47.3
1997	14.1	26.2	32.5	34.1	40.2	33.6	43.3
1998	12.4	18.9	14.9	27.8	33.1	31.1	38.5
1999	17.4	29.5	17.3	31.9	39.8	37.3	42.3
2000	22.4	20.4	22.4	30.1	50.2	42.3	54.5

Table 13.3.2 SANDEEL North Sea. Norwegian effort data.

Northern area

Year	Fishing days		Mean gross register tonnage (Av. GRT pr. trip)	
	Jan-Jun	Jul-Dec	Jan-Jun	Jul-Dec
1976	595		199	
1977	2212	457	172	185
1978	1747	806	203	204
1979	1407	1720	214	189
1980	2642	1099	216	210
1981	1740	404	217	191
1982	1206		209	
1983	304	66	255	191
1984	145		183	
1985	366		220	
1986	1562	567	201	187
1987	2123	1584	219	201
1988	3571	925	203	198
1989	4292	588	192	202
1990	2275	731	208	189
1991	1749	958	200	194
1992	1202	23	205	213
1993	1462	971	231	201
1994	2559	742	222	227
1995	3305	980	216	218
1996	1935	724	224	219
1997	3354	1484	218	221
1998	2479	2176	222	219
1999	2030	1540	240	241
2000	2045	n/a (very low)	254	n/a

Southern area

Year	Fishing days		Mean gross register tonnage (Av. GRT pr. trip)	
	Jan-Jun	Jul-Dec	Jan-Jun	Jul-Dec
1999	521	10	262	316
2000	111	n/a	259	n/a

Table 13.3.3 SANDEEL. Southern North Sea. Danish CPUE data (t/day fishing) by half year

First half year

Year	Vessel size (GRT) 0-50	50-100	100-150	150-200	200-250	250-300	>300
1982	16.1	26.9	43.1	47.2	59.2	53.2	59.6
1983	17.0	20.6	36.3	44.4	49.1	51.2	50.9
1984	19.9	26.3	42.6	50.4	60.9	56.4	60.1
1985	13.8	21.2	35.5	43.4	49.8	49.1	56.3
1986	23.2	31.4	41.1	49.8	58.9	58.4	69.4
1987	23.9	33.9	53.9	67.4	76.1	76.4	115.5
1988	19.2	26.8	42.9	52.3	60.0	56.6	82.8
1989	19.4	24.5	43.3	52.3	58.9	55.2	74.3
1990	20.0	20.8	30.4	33.7	39.8	35.7	49.1
1991	27.0	30.0	49.5	50.3	62.8	60.7	92.8
1992	18.4	23.4	53.1	63.2	83.8	82.4	115.9
1993	17.2	18.1	38.1	40.2	58.6	60.9	89.5
1994	24.6	29.0	59.1	59.5	75.2	78.9	96.6
1995	23.6	33.2	63.7	63.5	68.0	80.0	100.8
1996	23.4	25.3	40.9	48.4	58.8	56.4	84.1
1997	32.2	36.7	60.1	55.9	86.5	90.3	124.9
1998	20.0	27.1	40.7	44.7	58.0	60.9	87.7
1999	19.7	28.2	38.2	43.5	55.0	52.3	66.0
2000	21.6	26.9	33.9	36.1	56.7	59.1	74.9

Second half year

Year	Vessel size (GRT) 0-50	50-100	100-150	150-200	200-250	250-300	>300
1982	-	20.3	37.5	40.5	-	27.9	-
1983	15.1	21.3	25.1	32.4	45.4	34.0	34.7
1984	12.7	16.4	26.9	34.2	36.5	40.2	40.9
1985	13.2	19.5	26.0	35.8	36.2	38.2	39.4
1986	18.4	25.2	32.5	44.5	45.8	51.8	55.5
1987	16.2	22.6	41.4	45.8	49.3	45.6	75.4
1988	18.8	29.3	29.9	31.1	38.6	31.1	44.0
1989	26.7	26.2	27.0	38.3	38.0	29.3	40.4
1990	27.9	32.8	36.4	41.3	48.3	45.2	42.7
1991	21.4	26.8	41.8	49.4	65.1	53.7	98.3
1992	21.3	28.7	36.7	42.6	44.8	39.1	58.3
1993	20.2	22.7	30.8	35.6	45.3	39.3	51.8
1994	28.6	38.9	50.4	54.3	60.7	56.9	65.2
1995	28.6	42.2	50.2	53.3	72.4	60.8	73.9
1996	22.9	23.3	56.3	69.4	81.0	87.5	123.6
1997	22.9	25.9	35.5	41.7	54.8	51.0	74.9
1998	12.8	17.9	19.1	36.5	36.5	32.7	40.0
1999	-	-	-	26.2	34.3	33.9	37.2
2000	18.7	19.6	30.6	29.4	38.1	36.9	53.0

CPUE data for the 0-150 GRT groups in 1999, second half year have not been used as effort has been less than totally 7 fishing days

Table 13.3.4 SANDEEL North Sea, Danish CPUE data. Parameter estimates from regressions of ln(CPUE) versus ln(Av. GRT) by year together with estimates of standardized CPUE (200 GRT)

$$CPUE = b * GRT^{a}$$

Northern North Sea

	Jan-Jun				Jul-Dec			
Year	**SLOPE**	**INTERCEPT**	**R-square**	**CPUE**	**SLOPE**	**INTERCEPT**	**R-square**	**CPUE**
1987	0.57	3.60	0.98	75.2	0.20	11.22	0.58	31.9
1988	0.48	3.58	0.95	46.4	0.36	5.06	0.96	33.9
1989	0.55	2.54	0.98	47.5	0.23	8.11	0.87	27.3
1990	0.33	5.13	0.95	29.4	0.33	6.37	0.89	37.3
1991	0.52	2.99	0.97	46.5	0.58	2.31	0.99	49.4
1992	0.55	2.55	0.94	47.0	0.41	5.05	0.96	43.7
1993	0.54	2.40	0.97	40.9	0.43	3.86	0.90	37.4
1994	0.54	4.02	0.96	70.3	0.45	5.20	0.98	56.1
1995	0.54	3.36	0.99	57.8	0.45	5.15	1.00	55.5
1996	0.44	3.72	0.95	38.9	0.43	4.30	0.96	42.3
1997	0.47	5.11	0.95	62.6	0.40	4.24	0.96	35.6
1998	0.54	2.66	0.97	45.9	0.44	2.73	0.89	27.7
1999	0.33	6.78	0.76	39.3	0.33	5.75	0.79	33.2
2000	0.49	3.49	0.97	47.9	0.37	5.26	0.80	37.2

Southern North Sea

	Jan -Jun				Jul-Dec			
Year	**SLOPE**	**INTERCEPT**	**R-square**	**CPUE**	**SLOPE**	**INTERCEPT**	**R-square**	**CPUE**
1987	0.58	3.28	0.97	71.7	0.55	2.54	0.95	47.4
1988	0.55	3.00	0.97	54.7	0.27	8.17	0.91	34.4
1989	0.53	3.18	0.96	52.6	0.15	15.33	0.69	33.7
1990	0.34	5.93	0.92	35.8	0.20	14.18	0.94	41.8
1991	0.45	5.54	0.93	58.8	0.54	3.23	0.93	56.3
1992	0.74	1.41	0.96	70.6	0.34	6.85	0.95	42.5
1993	0.64	1.67	0.93	51.0	0.37	5.56	0.94	38.5
1994	0.55	3.60	0.96	67.8	0.32	10.23	0.99	55.6
1995	0.55	3.71	0.97	69.6	0.36	8.88	0.97	60.1
1996	0.48	4.14	0.93	53.3	0.68	1.97	0.93	73.8
1997	0.51	5.17	0.92	76.7	0.44	4.67	0.93	48.3
1998	0.54	3.06	0.96	54.1	0.47	2.61	0.93	30.9
1999	0.46	4.19	0.98	48.5	0.52	1.86	0.91	29.4
2000	0.47	3.99	0.93	48.7	0.38	4.81	0.91	35.4

Table 13.4.1 Options for the Seasonal survivors analysis (SXSA)

```
Dankert Skagens SXSA program
   last updated 5/9 - 1995
```

The following values will be used:

```
 1: First VPA year            1983
 2: Last VPA year             2000
 3: Youngest age                 0
 4: Oldest true age              3
 5: Number of seasons            2
 6: Recruiting season            2
 7: Last season in last year    2
 8: Spawning season              1
 9: Number of fleets             2
```

The Following fleets were included

```
Fleet:  1: Fishery in the Northern North Sea
Fleet:  2: Fishery in the Southern North Sea
```

The Following options were used

```
 1: Inv. catchability:                   2
    (1: Linear; 2: Log; 3: Cos. filter)
 2: Indiv. shats:                             2
   (1: Direct; 2: Using z)
 3: Comb. shats:                                   2
   (1: Linear; 2: Log.)
 4: *Fit catches:                                 0
   (0: No fit; 1: No SOP corr; 2: SOP corr.)
5: *Est. unknown catches                                0
   (0: No; 1: No SOP corr; 2: SOP corr.; 3: Sep. F)
 6: *Weighting of r                                     0
   (0: Manual; (1: not available at present).)
 7: *Weighting of shats                            0
   (0: Manual; 1: Linear; 2: Log.)
 8: Handling of the plus group                     1
   (1: Dynamic; 2: Extra age group)
```

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

Minimum value for the survivor number. This is used instead of the estimate if the estimate becomes very low
Present value: 1.0

The iteration will carry on until convergence

Data were input from the following files:

```
 Catch in numbers:       CANUM4.hyr
 Weight in catch:        WECA4.hyr
 Weight in stock:        WEST4.hyr
 Natural mortalities:    natmor.hyr
 Maturity ogive:         matprop.hyr
 Tuning data (CPUE):     Tuning4.hyr
 Weighting for rhats:    tweq.new
 Weighting for shats:    twred.xsa
```

Weighting factors for computing catchability for both fleets (Weighting for rhats)

```
Year 1983-1999                Year 2000
Season  1    2                     Season  1          2
Age                                        Age
0       1    1                0    0.5  0.1
1       1    1                0    0.5  0.1
2       1    1                2    0.5  0.1
3       1    1                3    0.5  0.1
```

Weighting factors for computing survivors in all years (Weighting for shats)

```
Season  1    2
AGE
0       *  0.02
1       1  0.1
2       1  0.1
3       1  0.1
```

Table 13.4.2. Tuning data for the North Sea sandeel.
Total international standadized effort and catch at age numbers (millions).

Year	Effort	Age 0	Age 1	Age 2	Age 3	Age 4+	Effort	Age 0	Age 1	Age 2	Age 3	Age 4+
Northen North Sea, 1st half-year							**Southern North Sea, 1st half-year**					
1976	5.90	237	5697	1130	445	155						
1977	11.27	3686	24307	2351	516	144						
1978	4.30	0	6127	2338	573	144						
1979	2.34	0	2335	1328	242	12						
1980	5.35	17	13394	8865	1050	827						
1981	3.94	17	5505	4109	904	174						
1982	2.38	2	3518	2132	556	85	8.85	242	56545	6224	3277	1939
1983	1.96	0	5684	1215	89	12	8.41	955	2232	35029	934	387
1984	1.84	0	11692	1647	153	5	9.13	20	62517	2257	13272	442
1985	1.63	1	2688	3292	1002	480	9.95	6573	7790	39301	2490	265
1986	4.41	7	23934	2600	200	0	7.20	0	43629	7333	1604	30
1987	5.32	0	26236	10855	350	155	4.15	0	4351	22771	1158	165
1988	7.66	2453	9855	25922	1319	26	8.45	1420	2349	10074	17914	2769
1989	10.11	6124	56661	2219	3385	0	9.62	29	44444	4525	957	3368
1990	5.34	0	13101	3907	578	175	9.54	0	20179	16670	2467	745
1991	6.33	0	41855	2342	908	318	5.55	0	20058	9224	1320	454
1992	3.28	137	9871	4056	486	305	8.80	2	60337	10021	1002	621
1993	4.48	1112	15768	2635	1023	646	5.25	0	3581	14659	3707	1012
1994	6.50	398	28490	7225	5954	2156	3.34	0	24697	2594	2654	715
1995	5.86	0	36140	3360	1091	145	6.17	0	39060	6503	1531	1226
1996	4.61	0	11524	5385	761	301	5.49	0.0	10194	16015	6403	1169
1997	6.68	2434	67038	3640	5254	1206	5.49	0.0	52359	3648	2405	683
1998	5.28	2278	6667	33216	2039	410	8.28	56.6	9546	39553	3188	2260
1999	3.68	265	2118	3491	5086	1023	8.91	0.0	31951	6499	13150	947
2000	5.77	0	22887	8810	1420	1470	7.36	1126	35613	5973	1825	3528
Northern North Sea, 2nd half-year							**Southern North Sea, 2nd half-year**					
1976	2.43	6126	648	84	368	36.6						
1977	4.15	3067	2856	913	142	141.1						
1978	1.92	7820	1001	307	39	1.9						
1979	4.78	44203	1310	433	66	9.5						
1980	2.41	8349	1173	214	19	7.5						
1981	2.26	9128	346	94	14	6						
1982	0.36	6530	65	0	0	0	1.47	5039	4718	490	344	40
1983	0.64	7911	303	316	19	0	1.75	9298	240	2806	513	2
1984	0.59	0	1207	121	43	0	2.16	0	9423	92	577	43.8
1985	0.43	349	109	239	89	11	3.29	11940	1896	3229	2234	298
1986	2.68	7105	7077	473	0	0	1.71	112	5350	293	241	18
1987	1.83	455	5768	198	0	0	2.22	298	3095	6664	196	51
1988	2.23	13196	1283	340	119	17	0.97	0	0	234	2084	68
1989	2.23	3380	4038	274	0	0	0.55	1	1619	165	35	123
1990	1.97	12107	1670	342	51	15	0.57	597	1438	477	71	21
1991	2.00	13616	866	28	8	3	2.35	12115	11411	344	111	0
1992	0.58	6797	48	3	0	0	1.72	134	3903	382	157	34
1993	2.46	26960	1004	112	34	22	0.89	838	1037	953	266	87
1994	1.44	457	829	1211	396	24.7	0.86	0	4093	322	198	137
1995	1.34	4046	3374	338	26	2	1.12	0	3166	2789	307	157
1996	3.00	31817	1706	1772	135.8	55.3	1.88	2088	2031	4080	536	1023
1997	2.16	2431	11346	633	24.9	1.9	2.86	198	15238	536	406	136
1998	3.28	35220	10005	1837	78.8	0.6	1.39	1142	738	2673	209	65
1999	2.96	33653	694	551	57.8	0.0	1.22	1322	203	58	1392	166
2000	0.27	0	467	84	23.6	46.1	1.50	6659	3601	496	339	330

Table 13.4.3 North Sea Sandeel. Catch at age numbers

Catch in numbers (millions) for fleet: 1
Fishery in the Northern North Sea

Year	1983		1984		1985		1986		1987		1988	
Season	1	2	1	2	1	2	1	2	1	2	1	2
AGE												
0	*	7911.	*	0.	*	349.	*	7105.	*	455.	*	13196.
1	5684.	303.	11692.	1207.	2688.	109.	23934.	7077.	26236.	5768.	9855.	1283.
2	1215.	316.	1647.	121.	3292.	239.	2600.	473.	10855.	198.	25922.	340.
3	89.	19.	153.	43.	1002.	89.	200.	0.	350.	0.	1319.	119.
4+	12.	0.	5.	0.	480.	11.	0.	0.	155.	0.	26.	17.
SOP	50871.	37464.	91792.	20871.	106279.	12946.	174378.	128325.	305979.	83202.	430970.	71479.

Year	1989		1990		1991		1992		1993		1994	
Season	1	2	1	2	1	2	1	2	1	2	1	2
AGE												
0	*	3380.	*	12107.	*	13616.	*	6797.	*	26960.	*	457.
1	56661.	4038.	13101.	1670.	41855.	866.	9871.	48.	15768.	1004.	28490.	829.
2	2219.	274.	3907.	342.	2342.	28.	4056.	3.	2635.	112.	7225.	1211.
3	3385.	0.	578.	51.	908.	8.	486.	0.	1023.	34.	5954.	396.
4+	0.	0.	175.	15.	318.	3.	305.	0.	646.	22.	2155.	25.
SOP	437540.	57222.	148411.	70806.	374465.	55536.	115957.	38189.	188264.	86785.	413536.	83222.

Year	1995		1996		1997		1998		1999		2000	
Season	1	2	1	2	1	2	1	2	1	2	1	2
AGE												
0	*	4046.	*	31817.	*	2431.	*	35220.	*	33653.	*	0.
1	36140.	3374.	11524.	1706.	67038.	11346.	6667.	10005.	2118.	694.	22887.	467.
2	3360.	338.	5385.	1772.	3640.	633.	33216.	1837.	3491.	551.	8810.	84.
3	1091.	26.	761.	136.	5254.	25.	2039.	79.	5086.	58.	1420.	24.
4+	145.	2.	301.	55.	1206.	2.	410.	1.	1023.	0.	1470.	46.
SOP	348280.	71351.	201546.	141902.	451606.	103226.	360999.	148508.	135432.	115849.	270507.	9974.

Catch in numbers for fleet: 2
Fishery in the Southern North Sea

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

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

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

Table 13.4.4 Sandeel in the North Sea, Stock numbers

Stock numbers (millions) 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	*	868905.	*	227548.	*	1205497.	*	629639.	*	200747.	*	723430.
1	98695.	31507.	378888.	94375.	102244.	31258.	533427.	155258.	278077.	83747.	89697.	25595.
2	88219.	29461.	25304.	13766.	67650.	10475.	23778.	7806.	115870.	50139.	60547.	11115.
3	3418.	1454.	21295.	3284.	11078.	4567.	5438.	2168.	5698.	2585.	34842.	7608.
4+	498.	6.	712.	111.	2179.	851.	2054.	1352.	2648.	1513.	3132.	0.
SSN	92135.		47311.		80907.		31270.		124216.		98520.	
SSB	1207311.		711092.		1121073.		457320.		1632839.		1509388.	
TSN	190830.	931331.	426200.	339084.	183151.	1252648.	564697.	796223.	402293.	338731.	188216.	767748.
TSB	1703748.	1799126.	2264534.	1564111.	1549475.	2046085.	2687045.	2930170.	2939801.	2016102.	1904054.	1650054.

Year	1989		1990		1991		1992		1993		1994	
Season	1	2	1	2	1	2	1	2	1	2	1	2
AGE												
0	*	332257.	*	650848.	*	830125.	*	325133.	*	633813.	*	877414.
1	316212.	55005.	147026.	33903.	283929.	66900.	355751.	88290.	141446.	40299.	266157.	65654.
2	19795.	7747.	39915.	9909.	24945.	7252.	43664.	17744.	68711.	31899.	31147.	12839.
3	8580.	2197.	5946.	1493.	7372.	3117.	5601.	2536.	14179.	5632.	25153.	9813.
4+	4235.	82.	1767.	431.	1432.	328.	2710.	1058.	2770.	499.	4649.	766.
SSN	32611.		47628.		33749.		51975.		85660.		60950.	
SSB	512463.		669888.		484292.		724225.		1163988.		858328.	
TSN	348823.	397287.	194654.	696584.	317678.	907721.	407726.	434761.	227105.	712142.	327107.	966487.
TSB	1903798.	1178586.	1296220.	1439790.	1702348.	1801813.	2175689.	1766404.	1800493.	1916323.	2524471.	7312676.

Year	1995		1996		1997		1998		1999		2000	
Season	1	2	1	2	1	2	1	2	1	2	1	2
AGE												
0	*	357747.	*	2069785.	*	358073.	*	448990.	*	879523.	*	6853171.
1	393941.	98934.	158034.	44965.	907287.	261355.	159130.	48707.	177370.	44587.	371751.	101277.
2	49300.	24886.	75083.	32809.	33434.	16444.	189925.	67732.	30158.	12037.	35694.	11823.
3	9124.	3950.	17546.	5896.	21566.	8186.	12406.	4036.	51374.	19507.	9304.	3580.
4+	7978.	4225.	6248.	2985.	5687.	2265.	8042.	3204.	5608.	2147.	16266.	6811.
SSN	66402.		98876.		60687.		210373.		87140.		61263.	
SSB	1109356.		1136672.		692343.		1902607.		1080551.		706641.	
TSN	460343.	489742.	256910.	2156439.	967974.	646323.	369503.	572670.	264510.	957800.	433014.	6976663.
TSB	3918158.	3320964.	2203400.	7215189.	5800369.	3156073.	2699850.	2230855.	2072049.	3634398.	3085846.	12496538.

Table 13.4.5 Sandeel in the North Sea, log inverse catchabilities

Log inverse catchabilities, fleet no: 1
Fishery in the Northern North Sea

Season	1	2
AGE		
0	*	4.764
1	3.700	4.104
2	3.464	4.478
3	3.464	4.478

Log inverse catchabilities, fleet no: 2
Fishery in the Southern North Sea

Season	1	2
AGE		
0	*	6.968
1	4.032	3.468
2	3.073	3.325
3	3.073	3.325

Table 13.4.6 Sandeel in the North Sea, Partial fishing mortality

Partial fishing mortality for fleet: 1
Fishery in the Northern North Sea

Year	1983		1984		1985		1986		1987		1988	
Season	1	2	1	2	1	2	1	2	1	2	1	2
AGE												
0	*	0.013	*	0.000	*	0.000	*	0.017	*	0.003	*	0.027
1	0.096	0.011	0.056	0.015	0.044	0.004	0.077	0.052	0.160	0.080	0.190	0.057
2	0.022	0.013	0.086	0.010	0.090	0.030	0.172	0.070	0.135	0.005	0.772	0.035
3	0.038	0.018	0.013	0.016	0.133	0.029	0.055	0.000	0.087	0.000	0.066	0.020
4+	0.051	0.000	0.012	0.000	0.329	0.018	0.000	0.000	0.076	0.000	0.031	*
F (1- 2)	0.059	0.012	0.071	0.012	0.067	0.017	0.125	0.061	0.148	0.043	0.481	0.046

Year	1989		1990		1991		1992		1993		1994	
Season	1	2	1	2	1	2	1	2	1	2	1	2
AGE												
0	*	0.015	*	0.027	*	0.024	*	0.031	*	0.063	*	0.001
1	0.354	0.086	0.164	0.057	0.270	0.016	0.050	0.001	0.193	0.028	0.193	0.014
2	0.167	0.040	0.166	0.040	0.153	0.004	0.137	0.000	0.054	0.004	0.340	0.111
3	0.663	0.000	0.164	0.039	0.179	0.003	0.123	0.000	0.107	0.007	0.354	0.046
4+	0.000	*	0.168	0.040	0.383	0.010	0.168	0.000	0.422	0.055	0.852	0.040
F (1- 2)	0.261	0.063	0.165	0.048	0.211	0.010	0.094	0.000	0.123	0.016	0.267	0.063

Year	1995		1996		1997		1998		1999		2000	
Season	1	2	1	2	1	2	1	2	1	2	1	2
AGE												
0	*	0.017	*	0.023	*	0.010	*	0.120	*	0.057	*	0.000
1	0.165	0.039	0.126	0.044	0.127	0.051	0.071	0.256	0.021	0.017	0.108	0.005
2	0.093	0.016	0.103	0.066	0.150	0.044	0.269	0.031	0.172	0.052	0.388	0.008
3	0.173	0.008	0.068	0.027	0.367	0.003	0.260	0.022	0.149	0.003	0.229	0.008
4+	0.024	0.001	0.067	0.025	0.315	0.001	0.076	0.000	0.274	0.000	0.132	0.008
F (1- 2)	0.129	0.028	0.115	0.055	0.139	0.047	0.170	0.144	0.097	0.035	0.248	0.007

Partial fishing mortality for fleet: 2
Fishery in the Southern North Sea

Year	1983		1984		1985		1986		1987		1988	
Season	1	2	1	2	1	2	1	2	1	2	1	2
AGE												
0	*	0.016	*	0.000	*	0.014	*	0.000	*	0.002	*	0.000
1	0.038	0.008	0.297	0.117	0.129	0.069	0.140	0.040	0.027	0.043	0.045	0.000
2	0.622	0.111	0.118	0.007	1.078	0.412	0.486	0.044	0.284	0.158	0.300	0.024
3	0.397	0.482	1.157	0.215	0.330	0.736	0.438	0.130	0.289	0.087	0.896	0.356
4+	1.655	0.487	1.151	0.546	0.182	0.478	0.018	0.015	0.081	0.038	3.291	*
F (1- 2)	0.330	0.060	0.208	0.062	0.603	0.240	0.313	0.042	0.155	0.101	0.173	0.012

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	0.278	0.034	0.253	0.049	0.129	0.208	0.306	0.050	0.044	0.029	0.168	0.072
2	0.341	0.024	0.707	0.056	0.602	0.054	0.338	0.024	0.300	0.034	0.122	0.030
3	0.187	0.018	0.701	0.055	0.261	0.040	0.254	0.071	0.388	0.054	0.158	0.023
4+	1.714	*	0.717	0.056	0.547	0.000	0.342	0.036	0.661	0.217	0.283	0.222
F (1- 2)	0.309	0.029	0.480	0.052	0.366	0.131	0.322	0.037	0.172	0.031	0.145	0.051

Year	1995		1996		1997		1998		1999		2000	
Season	1	2	1	2	1	2	1	2	1	2	1	2
AGE												
0	*	0.000	*	0.001	*	0.001	*	0.004	*	0.002	*	0.001
1	0.181	0.037	0.112	0.052	0.099	0.068	0.101	0.019	0.324	0.005	0.168	0.040
2	0.183	0.132	0.307	0.151	0.150	0.037	0.320	0.045	0.320	0.005	0.263	0.048
3	0.246	0.090	0.571	0.107	0.168	0.056	0.406	0.059	0.386	0.082	0.295	0.110
4+	0.206	0.042	0.261	0.467	0.178	0.068	0.417	0.023	0.254	0.089	0.317	0.055
F (1- 2)	0.182	0.084	0.209	0.102	0.125	0.053	0.211	0.032	0.322	0.005	0.215	0.044

Table 13.4.7 Sandeel in the North Sea, annual fishing mortality

Annual F at age (second half-year only for age 0)

Year/age	1983	1984	1985	1986	1987	1988	1989	1990	1991
0	0.029	0.000	0.015	0.017	0.005	0.027	0.015	0.029	0.046
1	0.156	0.463	0.231	0.291	0.275	0.289	0.768	0.519	0.568
2	0.819	0.239	1.690	0.827	0.596	1.270	0.616	1.062	0.894
3	0.890	1.526	1.143	0.652	0.486	1.393	0.973	1.052	0.521
4	4.205	1.949	0.989	0.032	0.203	0.000	0.000	1.129	1.119
F (1-2)	0.488	0.351	0.961	0.559	0.435	0.780	0.692	0.791	0.731

Year/age	1992	1993	1994	1995	1996	1997	1998	1999	2000
0	0.031	0.066	0.001	0.017	0.024	0.011	0.124	0.059	0.001
1	0.419	0.291	0.445	0.423	0.315	0.316	0.346	0.390	0.328
2	0.546	0.421	0.627	0.424	0.630	0.397	0.717	0.591	0.771
3	0.474	0.598	0.623	0.542	0.821	0.643	0.809	0.663	0.677
4	0.602	1.573	1.650	0.288	0.772	0.609	0.571	0.667	0.552
F (1-2)	0.482	0.356	0.536	0.423	0.473	0.357	0.531	0.491	0.549

Table 13.4.8 Factors for weighting of the survivor estimated from each fleet set manually, or estimated from the inverse variance of the log catchability.

Fixed weights

	Northern and Southern	
Age	1st half-year	2nd half-year
0		0.02
1	1	0.1
2	1	0.1
3	1	0.1

Weighting according to the inverse variance of log catchability

	Northern		Southern	
Age	1st half-year	2nd half-year	1st half-year	2nd half-year
0		0.78		0.53
1	1.97	1.03	1.34	1.29
2	1.54	0.74	1.80	1.14
3	1.05	0.82	2.31	1.39

Table 13.4.9. North Sea SANDEEL. Overview of tuning options used for explorative runs.

	VPA run			
Options	SXSA fixed weighting	SXSA auto weighting	XSA	XSA shrunk
Tapered time weighting	No	no	no	no
Catchability dependent of stock size (”recruits”)	no	no	no	no
Catchability independent of age for ages	>= 2	>= 2	>=2	>= 2
Survivor estimates shrunk to the population mean (”recruits”)	no	no	no	no
Survivor estimates shrunk towards the mean F	no	no	no	Yes, towards the mean F of the final 5 years or the 2 oldest ages.
Prior weighting applied	Second half year survivor estimatet downweighted, all years	no	no	no

Table 13.4.10. Fleet weighting for terminal year F estimation in XSA runs.

	XSA		XSA shrunk	
Age and fleet	Scaled Weights	Estimated F	Scaled Weights	Estimated F
Age 0				
North IV 1.half year	0	0	0	0
South IV 1.half year	0	0	0	0
North IV 2.half year	0	0	0	0
South IV 2.half year	1	0	0.053	0
F shrinkage mean			0.947	0.045
Age 1				
North IV 1.half year	0.433	0.427	0.251	0.409
South IV 1.half year	0.206	0.276	0.136	0.264
North IV 2.half year	0.168	0.238	0.106	0.226
South IV 2.half year	0.193	0.314	0.111	0.310
F shrinkage mean			0.396	0.384
Age 2				
North IV 1.half year	0.344	1.353	0.213	0.972
South IV 1.half year	0.354	0.923	0.211	0.659
North IV 2.half year	0.117	0.851	0.075	0.593
South IV 2.half year	0.184	1.419	0.108	1.136
F shrinkage mean			0.393	0.486
Age 3				
North IV 1.half year	0.159	0.732	0.123	0.591
South IV 1.half year	0.665	0.759	0.484	0.652
North IV 2.half year	0.064	0.372	0.049	0.306
South IV 2.half year	0.112	0.860	0.086	0.697
F shrinkage mean			0.258	0.527

Table 13.12.1 Sandeel at Shetland. Input data used in the assessment.

Source data

Age	Proportion mature	catch weight	stock weight
0	.00	1.0245	1.0245
1	.00	5.6361	5.6361
2	1.00	8.4852	8.4852
3	1.00	11.9519	11.9519
4	1.00	13.8657	13.8657
5	1.00	16.9572	16.9572
6	1.00	20.5006	20.5006

Abundance index data

Age	1985	1986	1987	1988	1989	1990
0	121905.0	681869.0	n/a	73371.0	813752.0	90148.0
1	74509.0	49816.0	n/a	898.0	9059.0	30118.0
2	38843.0	11399.0	n/a	7189.0	977.0	3771.0
3	23455.0	15376.0	n/a	4843.0	3820.0	1346.0
4	10872.0	7049.0	n/a	4612.0	3893.0	1736.0
5	1959.0	2893.0	n/a	3031.0	2017.0	1142.0
6	962.0	1210.0	n/a	1619.0	462.0	444.0

Age	1991	1992	1993	1994	1995	1996
0	1009024.0	199301.0	635331.0	98653.0	n/a	589368.0
1	10001.0	465958.0	18180.0	135158.0	n/a	23056.0
2	1925.0	1215.0	73176.0	14272.0	n/a	12513.0
3	1694.0	347.0	2176.0	41299.0	n/a	1836.0
4	750.0	168.0	361.0	3369.0	n/a	1185.0
5	53.0	43.0	150.0	296.0	n/a	1387.0
6	21.0	10.0	72.0	12.0	n/a	524.0

Age	1997	1998	1999	2000
0	2953350.0	559203.0	1165594.0	7915.0
1	88582.0	222137.0	6410.0	26166.0
2	6519.0	18583.0	10766.0	2740.0
3	8938.0	2841.0	10377.0	6213.0
4	1211.0	1840.0	1351.0	1997.0
5	1353.0	227.0	360.0	301.0
6	1159.0	607.0	365.0	239.0

Table 13.12.2. Sandeel at Shetland. Results of fitting the separable mortality model to survey index data in Table. The year effects are in effect multipliers on natural mortality and measure the annual change in M. The age effects measure the relative natural mortality at age. Year class effects measure relative abundance of 0-group sandeel each year.

	Parameter	s.d.
year effects		
	1.0286	.2267
	1.0650	.2014
	.9062	.2444
	.4320	.1877
	.8875	.1822
	1.5393	.1830
	1.0433	.1812
	.8873	.1814
	.6686	.1954
	1.2044	.2020
	1.0675	.2431
	.8311	.1862
	1.0081	.1820
	1.3883	.1823
age effects		
	2.0977	.3928
	1.7852	.1749
	.5765	.1728
	.6744	.3642
	1.7287	.4871
	.8377	.5221
year class effects		
	6.8690	1.3938
	7.7701	1.0256
	9.5211	1.0378
	10.0722	.4072
	10.3763	.3217
	11.1968	.3795
	12.8936	.6906
	12.4280	.7168
	9.6407	.7329
	10.4488	.5259
	11.8800	.5807
	12.7300	.7256
	14.9225	.6021
	12.2053	.5878
	12.4842	.5785
	13.8162	.7416
	12.3646	.7570
	13.3414	.5815
	14.1037	.5990
	12.2338	.7009
	12.5059	.6959
	8.9765	1.3938

Table 13.12.2 cont.

Estimated Z-at-age

Age	1985	1986	1987	1988	1989	1990
0	2.1578	2.2342	1.9010	.9062	1.8618	3.2289
1	1.8363	1.9013	1.6178	.7712	1.5844	2.7478
2	.5930	.6140	.5225	.2491	.5117	.8874
3	.6937	.7183	.6112	.2913	.5986	1.0381
4	1.7782	1.8411	1.5666	.7468	1.5343	2.6609
5	.8617	.8922	.7592	.3619	.7435	1.2895
6	.8617	.8922	.7592	.3619	.7435	1.2895

Age	1991	1992	1993	1994	1995	1996
0	2.1885	1.8613	1.4025	2.5265	2.2394	1.7435
1	1.8624	1.5840	1.1935	2.1501	1.9057	1.4837
2	.6015	.5115	.3854	.6944	.6154	.4792
3	.7036	.5984	.4509	.8122	.7199	.5605
4	1.8035	1.5338	1.1558	2.0820	1.8454	1.4368
5	.8740	.7433	.5601	1.0090	.8943	.6963
6	.8740	.7433	.5601	1.0090	.8943	.6963

Age	1997	1998	1999
0	2.1147	2.9123	2.1873
1	1.7996	2.4784	1.8614
2	.5812	.8004	.6011
3	.6798	.9363	.7032
4	1.7426	2.4000	1.8025
5	.8445	1.1630	.8735
6	.8445	1.1630	.8735

Fitted survey index

Age	1985	1986	1987	1988	1989	1990
0	397769.7	249703.9	15377.4	34503.4	144346.9	337738.5
1	72894.3	45974.3	26737.9	2297.6	13941.0	22429.5
2	32090.0	11619.9	6867.3	5303.1	1062.5	2858.8
3	23675.4	17734.6	6288.3	4072.7	4134.0	637.0
4	13644.4	11831.1	8647.3	3412.8	3043.4	2272.0
5	2368.8	2305.2	1876.9	1805.2	1617.3	656.2
6	962.0	1000.7	944.5	878.5	1257.0	768.9

Age	1991	1992	1993	1994	1995	1996
0	3025151.6	199842.1	264129.4	1000699.3	234357.4	622415.7
1	13374.2	339075.8	31069.5	64970.7	79992.2	24965.0
2	1437.0	2077.0	69564.0	9418.6	7567.4	11896.1
3	1177.0	787.5	1245.3	47313.6	4703.6	4089.4
4	225.6	582.4	432.9	793.3	21000.6	2289.6
5	158.8	37.2	125.6	136.3	98.9	3317.3
6	180.7	66.3	17.7	71.8	49.7	40.4

Age	1997	1998	1999	2000
0	1333990.0	205613.9	269912.6	7915.0
1	108866.3	160977.4	11174.7	30287.9
2	5661.9	18002.8	13502.1	1737.1
3	7367.3	3166.4	8086.0	7401.6
4	2334.7	3733.0	1241.5	4002.5
5	544.2	408.7	338.7	204.7
6	1653.5	233.9	127.7	141.4

Table 13.12.2 cont.

Log Population residuals

Age	1985	1986	1987	1988	1989	1990
0	-.3740	.3177	.0000	.2386	.5469	-.4177
1	.0219	.0803	.0000	-.9395	-.4311	.2947
2	.1910	-.0192	.0000	.3043	-.0839	.2769
3	-.0094	-.1427	.0000	.1732	-.0790	.7482
4	-.0718	-.1638	.0000	.0952	.0779	-.0851
5	-.0601	.0718	.0000	.1639	.0698	.1752
6	.0000	.0601	.0000	.1933	-.3165	-.1737

Age	1991	1992	1993	1994	1995	1996
0	-.3472	-.0009	.2776	-.7327	.0000	-.0173
1	-.2906	.3179	-.5359	.7325	.0000	-.0795
2	.2924	-.5362	.0506	.4156	.0000	.0506
3	.3641	-.8195	.5581	-.1360	.0000	-.8008
4	.3799	-.3931	-.0574	.4573	.0000	-.2083
5	-.3470	.0462	.0561	.2453	.0000	-.2758
6	-.6807	-.5980	.4442	-.5655	.0000	.8100

Age	1997	1998	1999	2000
0	.2513	.3164	.4626	.0000
1	-.2062	.3220	-.5558	-.1463
2	.1410	.0317	-.2265	.4557
3	.1933	-.1084	.2495	-.1751
4	-.2076	-.2237	.0267	-.2199
5	.2880	-.1860	.0193	.1219
6	-.1124	.3016	.3320	.1660

Table 13.12.3. Sandeel at Shetland. Stock summary estimated from August survey. Biomass and recruitment values are relative and are scaled to the time series mean. Z(1-4) is the mean total mortality over ages 1 to 4 estimated from the model. Z should be an estimate of M since fishing mortality is likely to be in the region of 0.05.

Year	Total stock biomass	Spawning stock biomass	Z(1-4)	Recruitment Age 0
1985	1.277	2.525	1.225	.716
1986	.826	1.677	1.269	.449
1987	.371	.956	1.079	.028
1988	.187	.595	.515	.062
1989	.299	.483	1.057	.260
1990	.443	.283	1.834	.608
1991	2.526	.112	1.243	5.444
1992	1.694	.116	1.057	.360
1993	.834	1.926	.796	.475
1994	1.615	2.072	1.435	1.801
1995	.870	1.300	1.272	.422
1996	.800	.749	.990	1.120
1997	1.725	.664	1.201	2.401
1998	1.080	.798	1.654	.370
1999	.454	.743	1.242	.486
2000	.271	.518	N/A	.014

Figure 13.1.1 Danish Sandeel sampling areas and assessments areas used by the Working Group

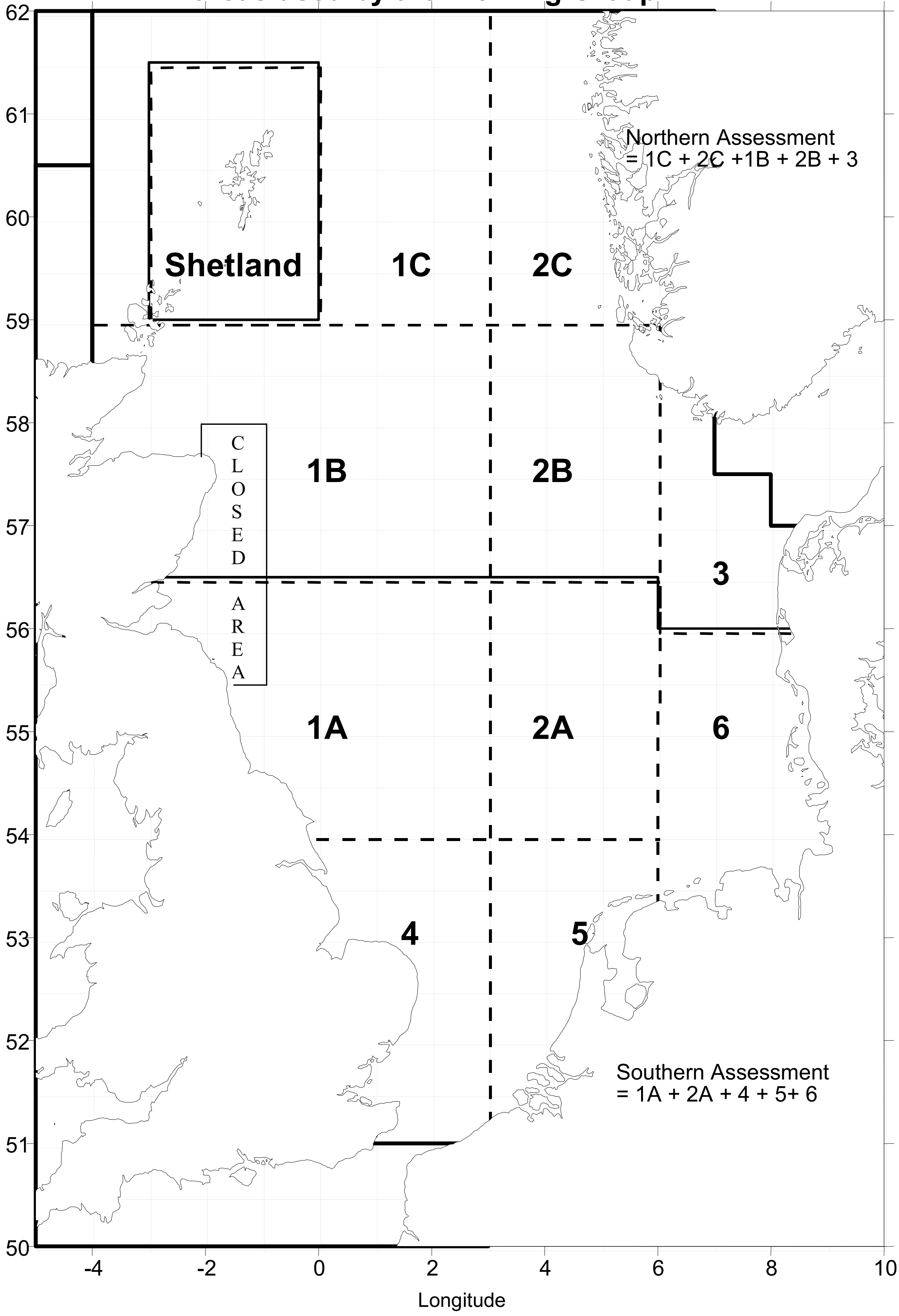
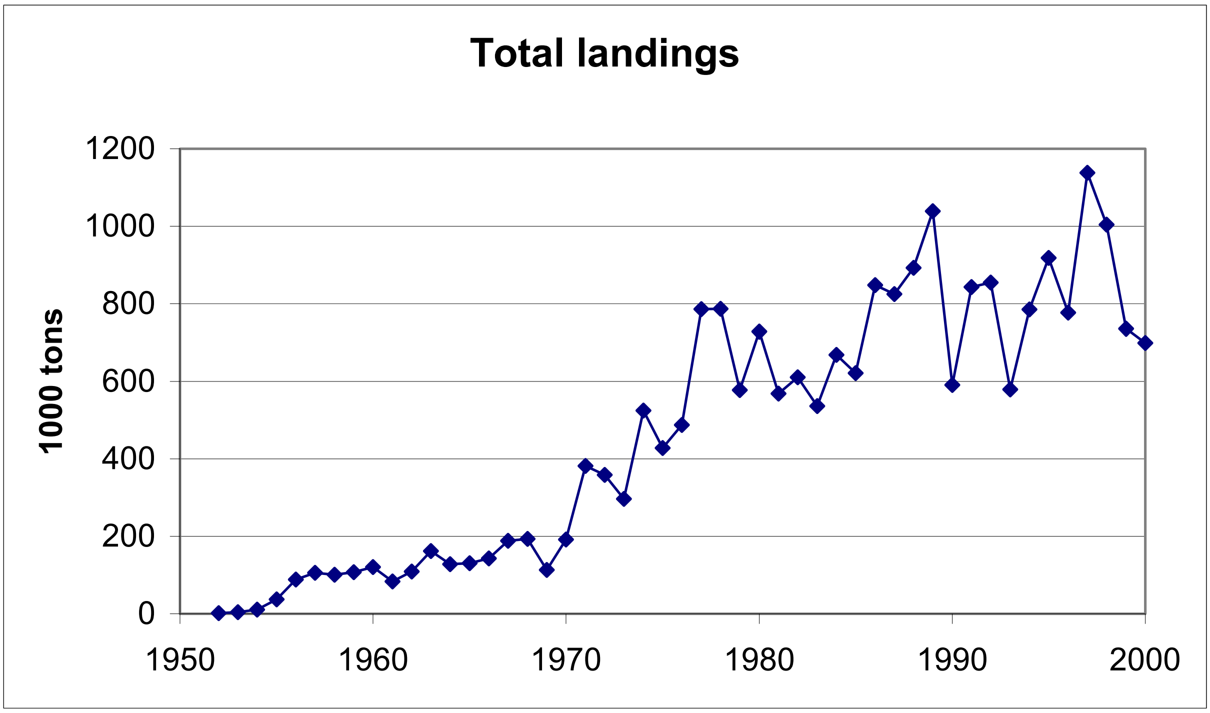


Figure 13.1.2. SANDEEL North Sea, Total international landings, effort and CPUE.



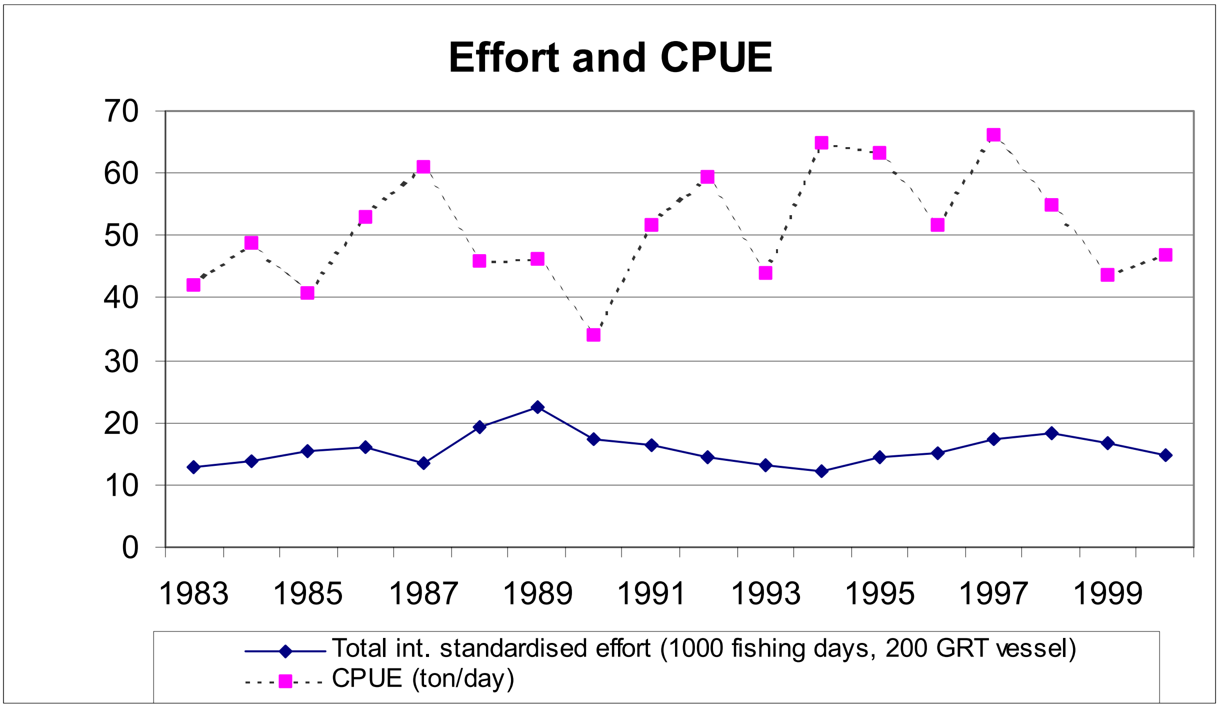
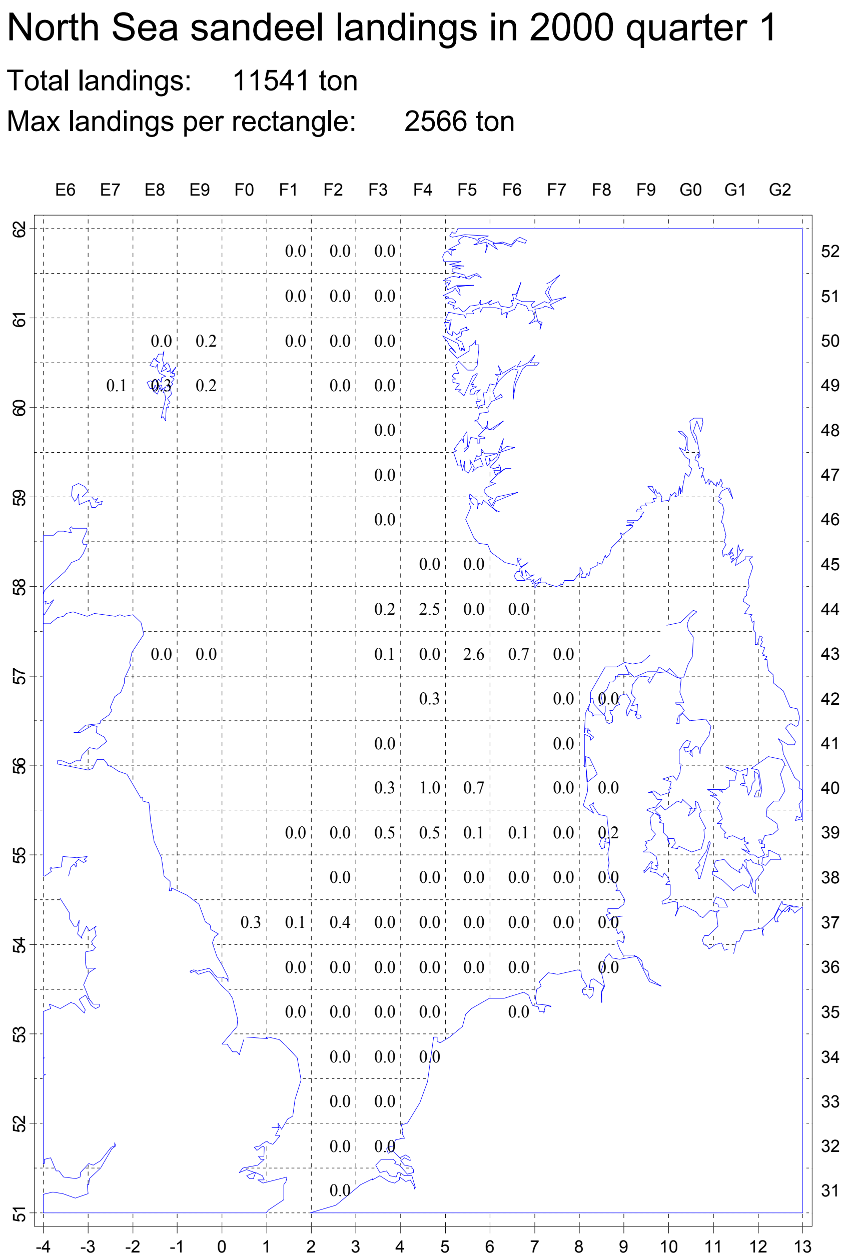


Figure 13.1.3 Quarterly catches (Denmark, Norway and Scotland) of Sandeel by ICES rectangle (**'**000 tonnes).



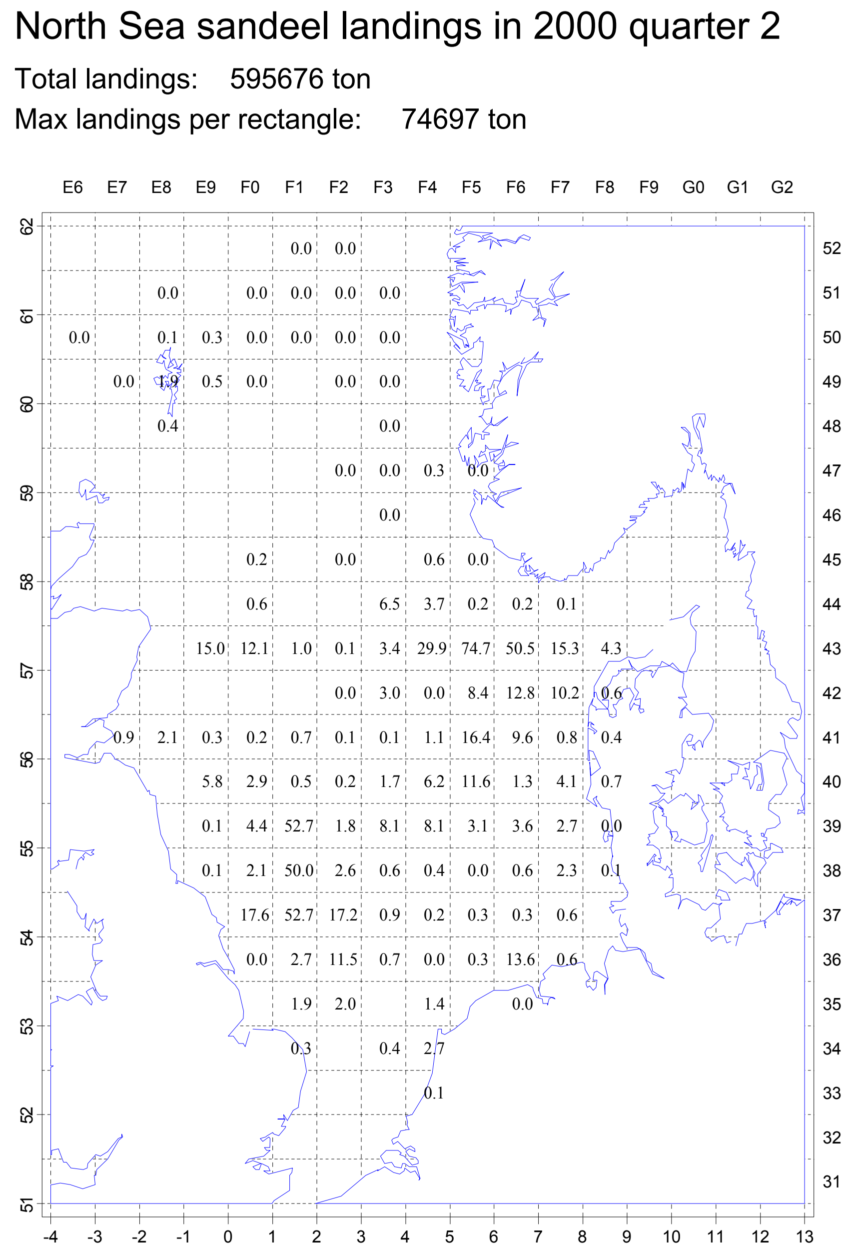
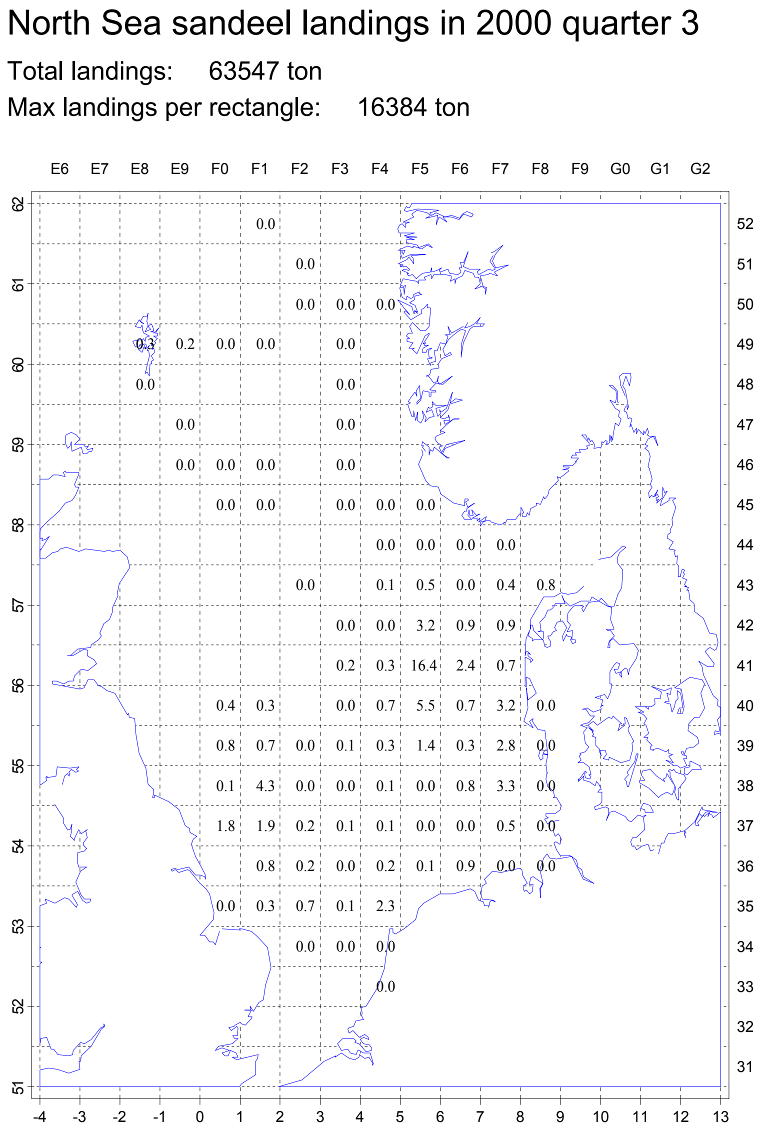


Figure 13.1.3 (continued) Quarterly catches of Sandeel by ICES rectangle ('000 tonnes).



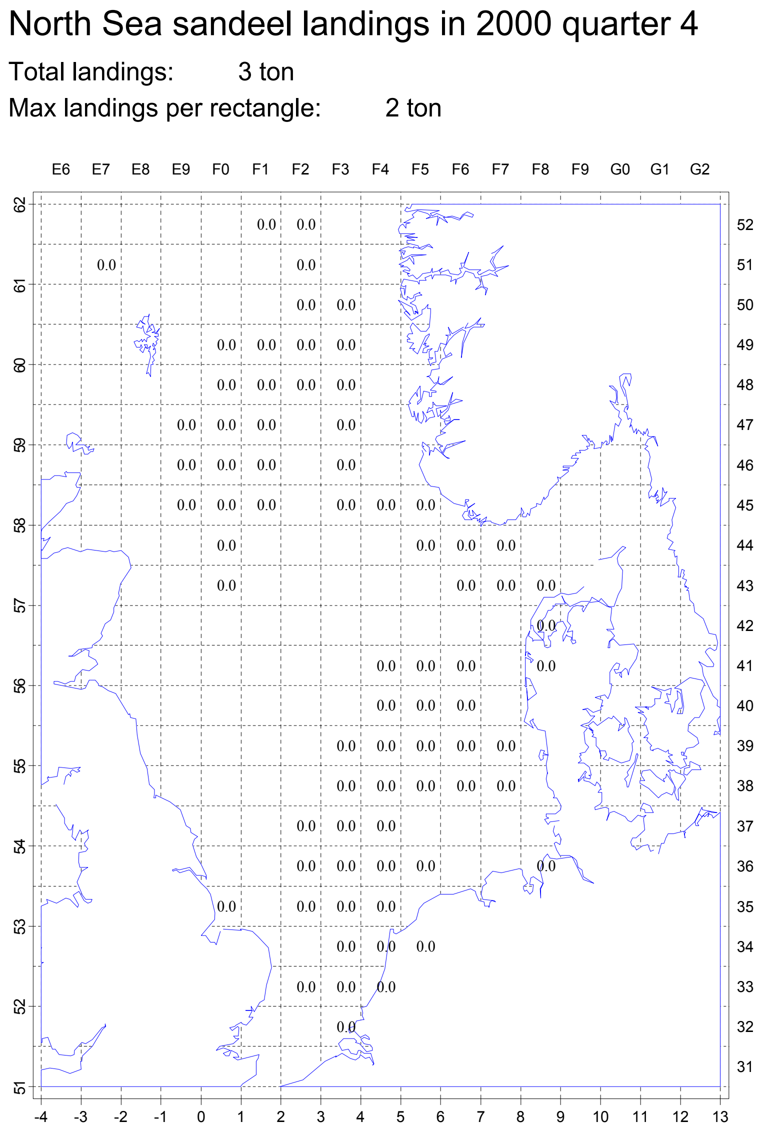
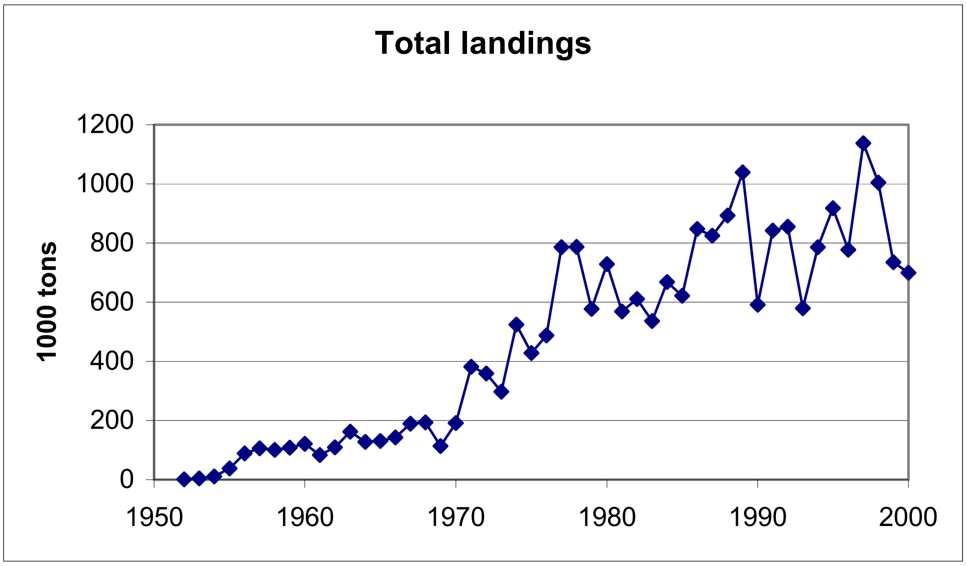


Figure 13.1.4. SANDEEL North Sea, Total international landings, effort and CPUE.



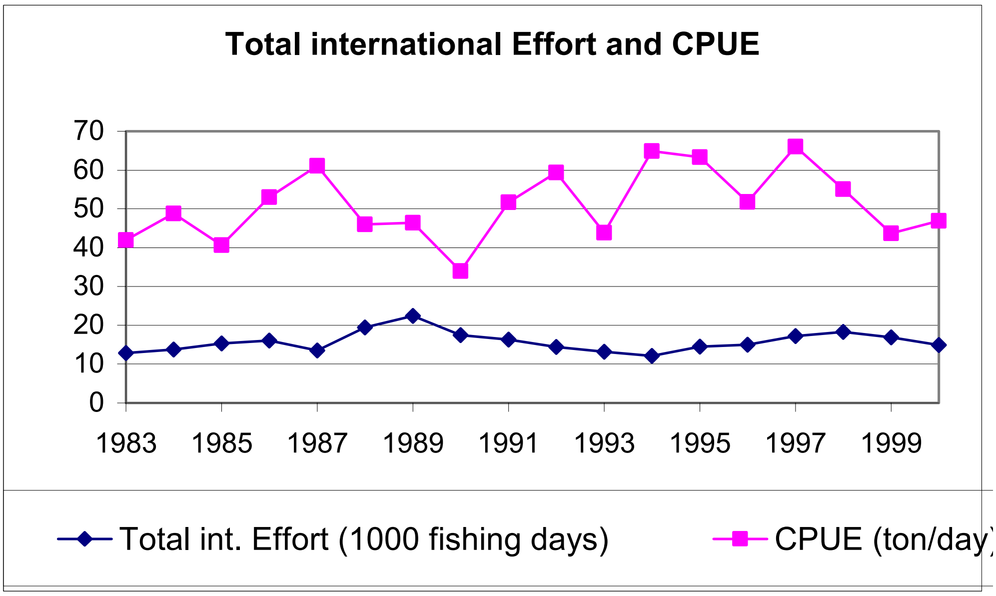


Figure 13.3.1 SANDEEL North Sea, CPUE (ton/day) by fleet

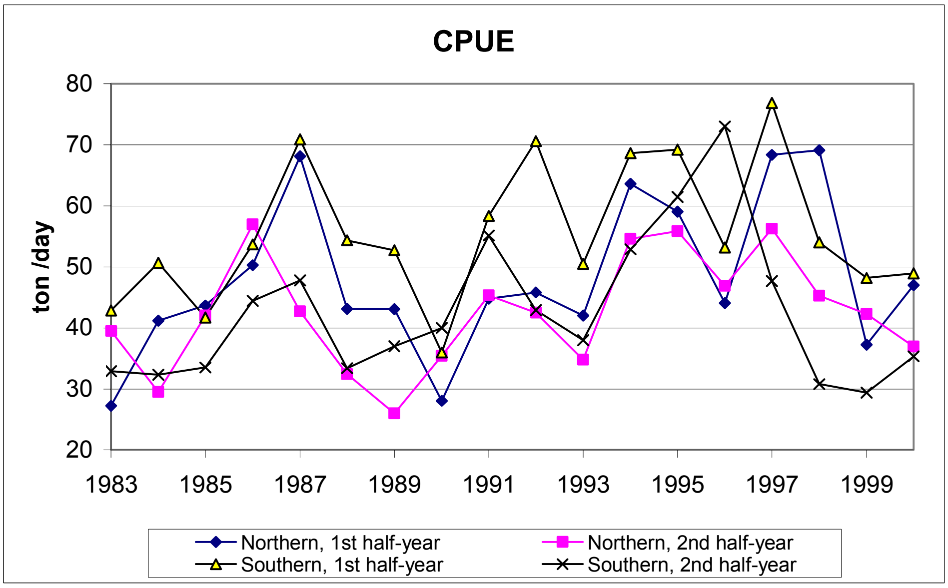


Figure 13.3.2 SANDEEL North Sea, Normalized CPUE by age group and year

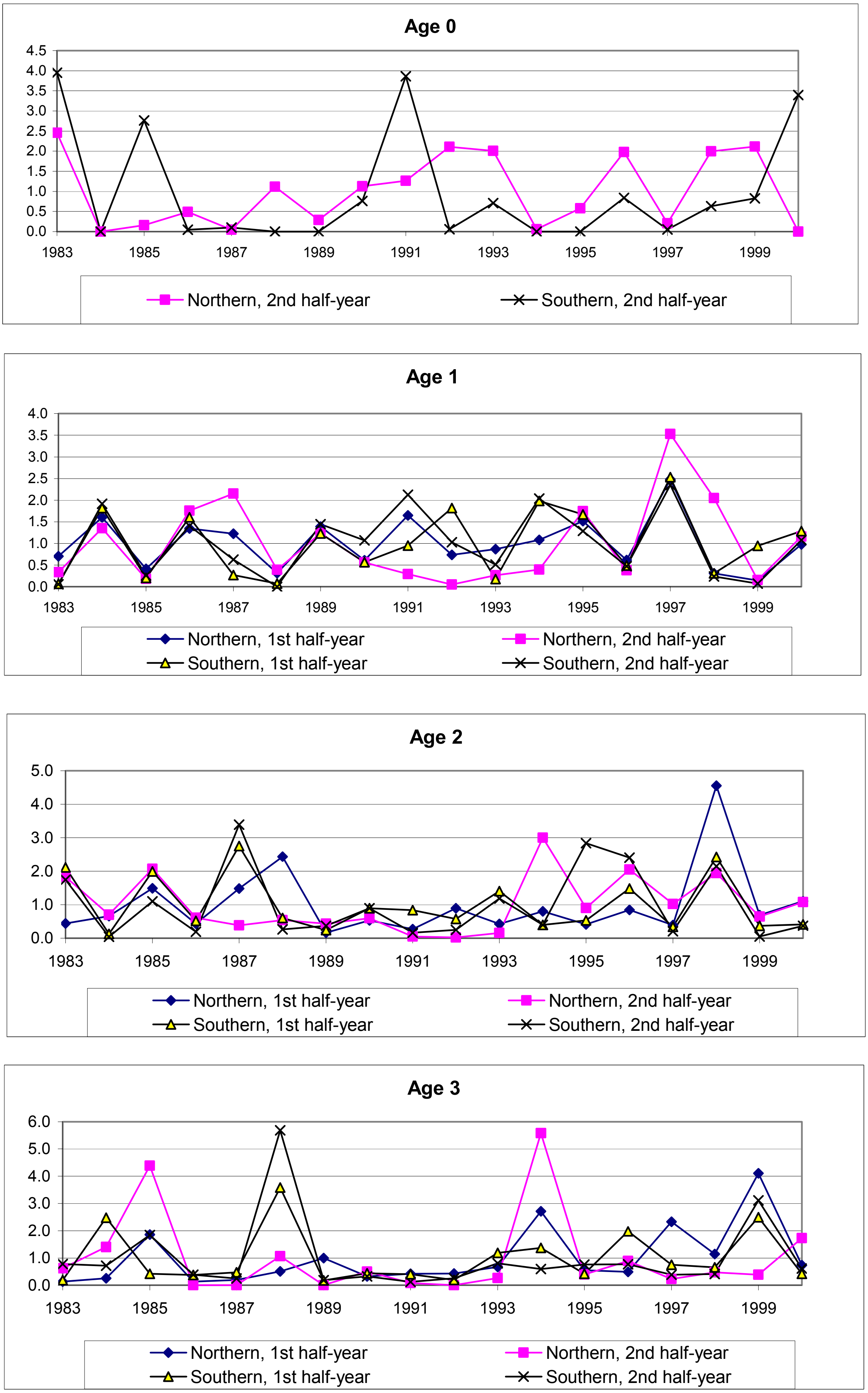


Figure 13.4.1 North Sea SANDEEL. Log stock number residuals by fleet and season

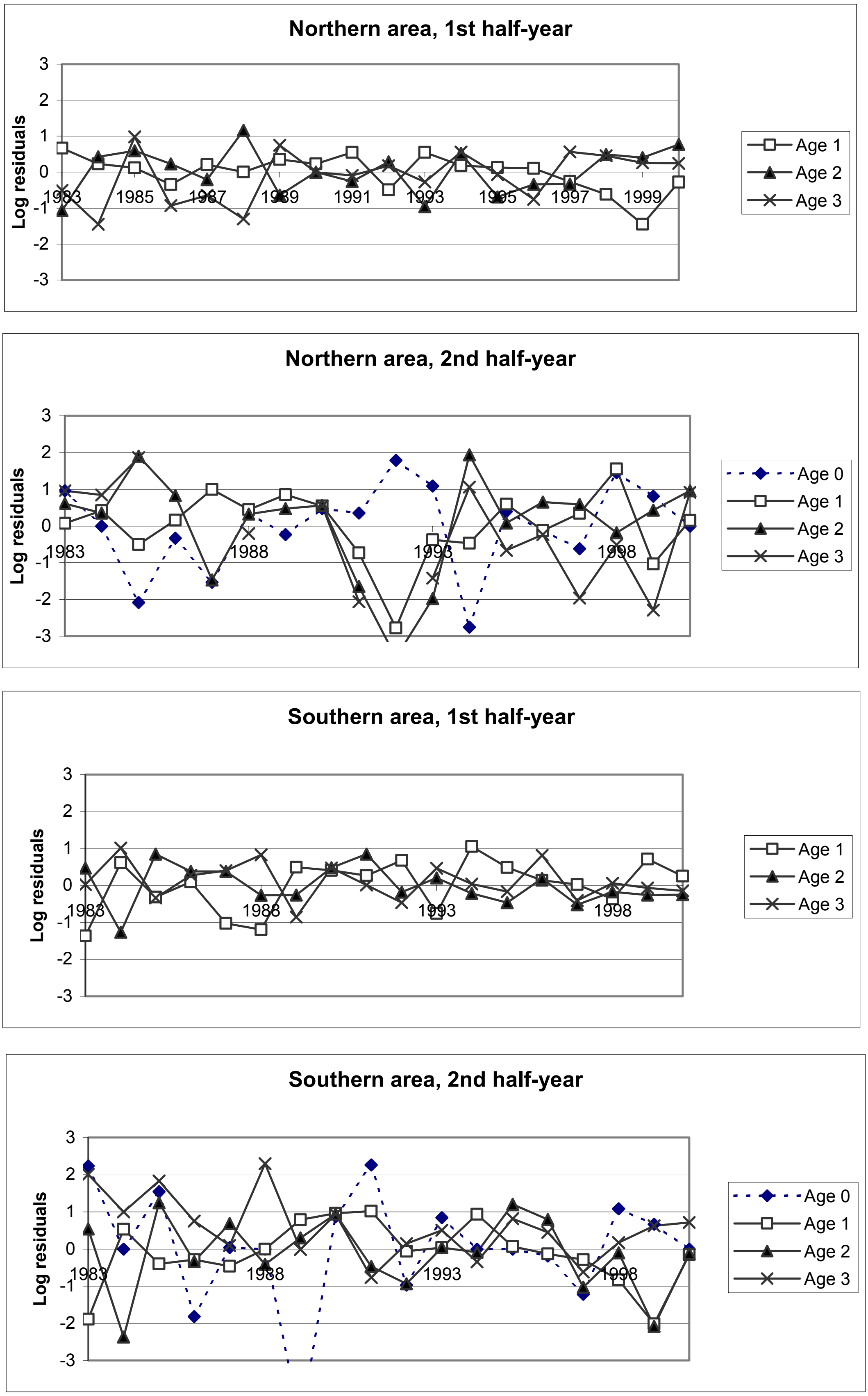
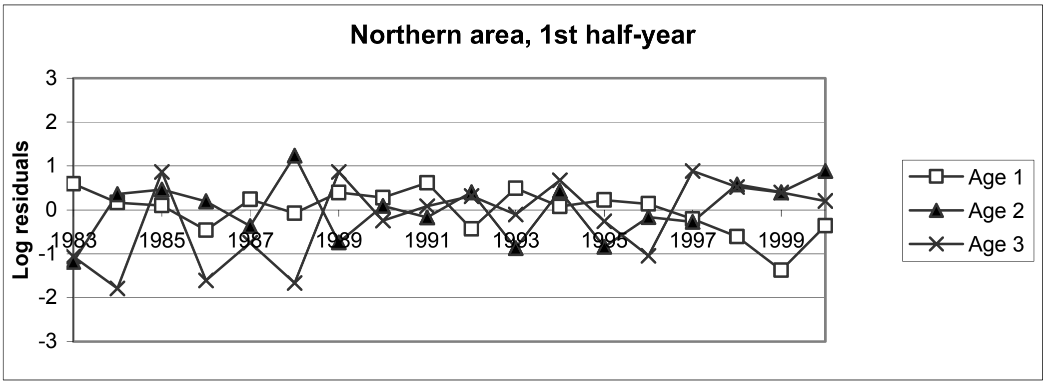
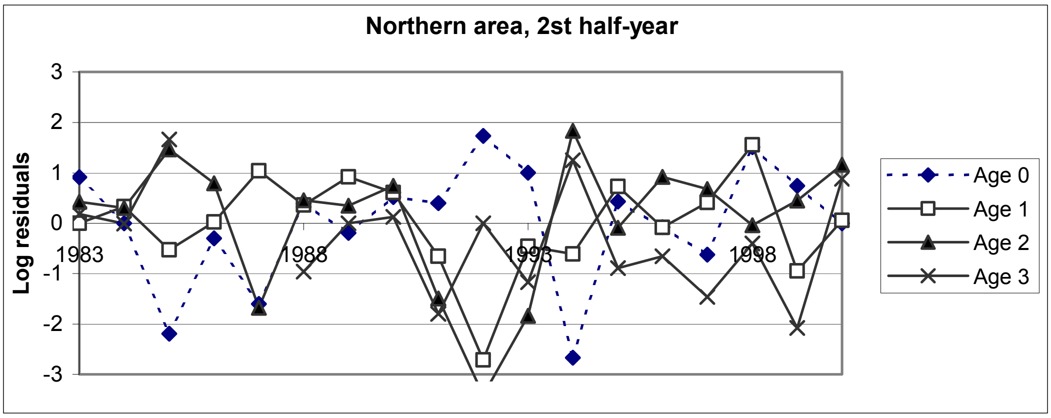
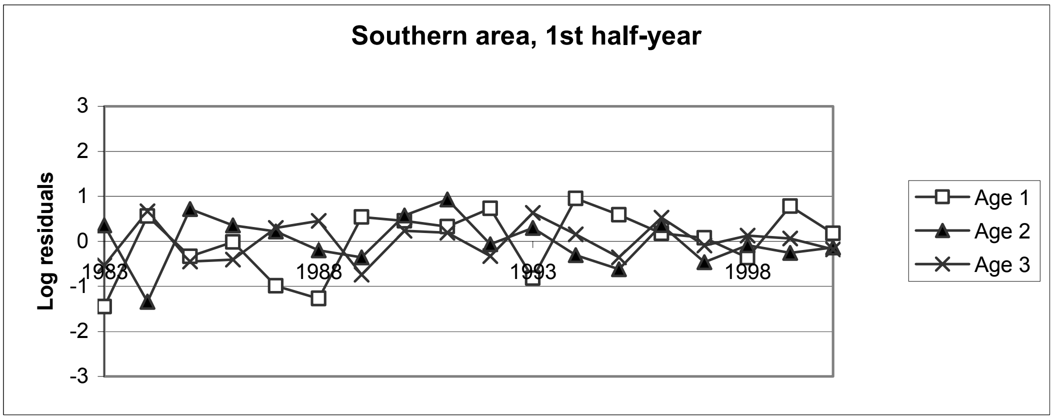


Figure 13.4.2. North Sea SANDEEL. Log stock number residuals by fleet and season.
Weighting of survivors according to the inverse of the variance of log catchability







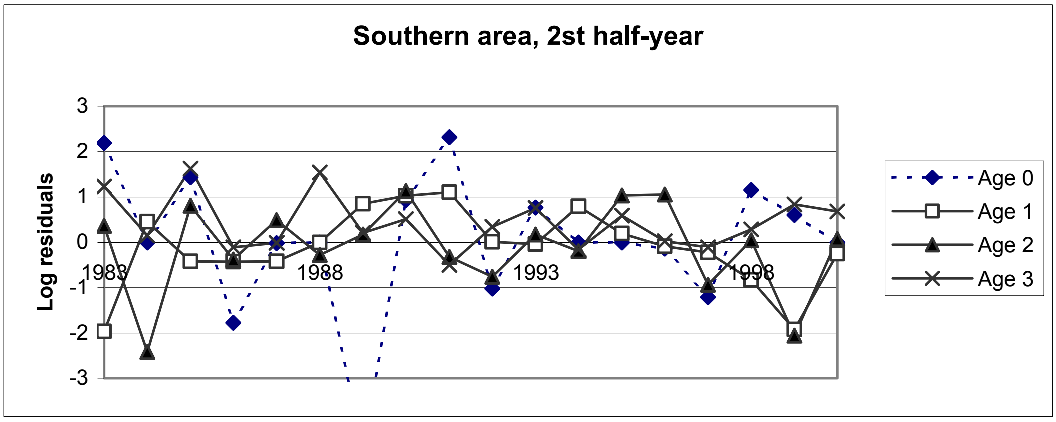


Figure 13.4.3 SANDEEL North Sea. F at age for various SXSA and XSA tunings options. See the text for details

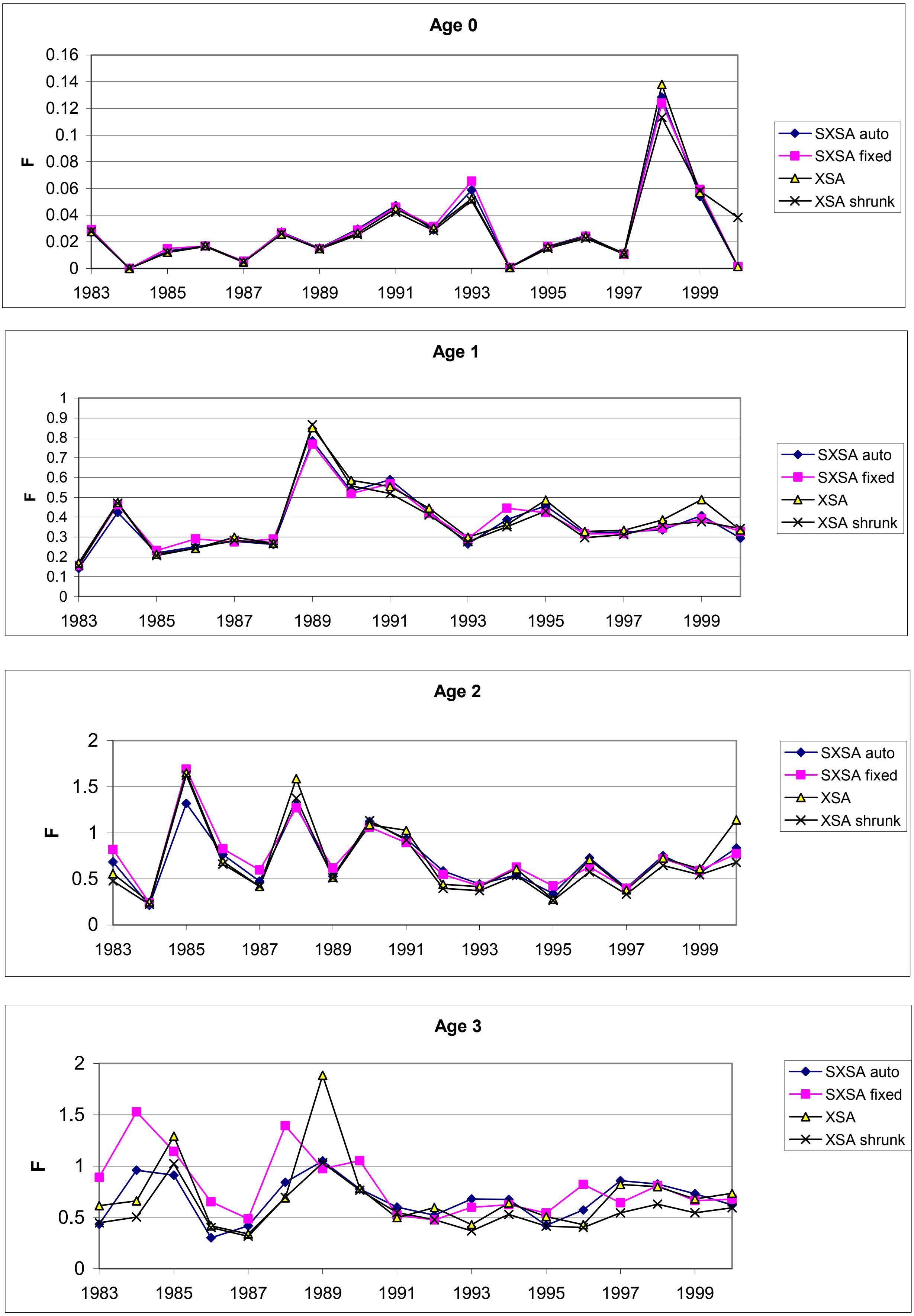
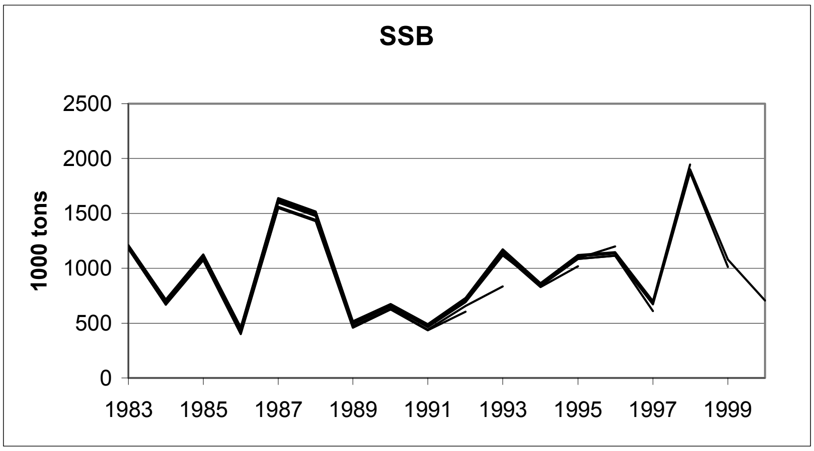
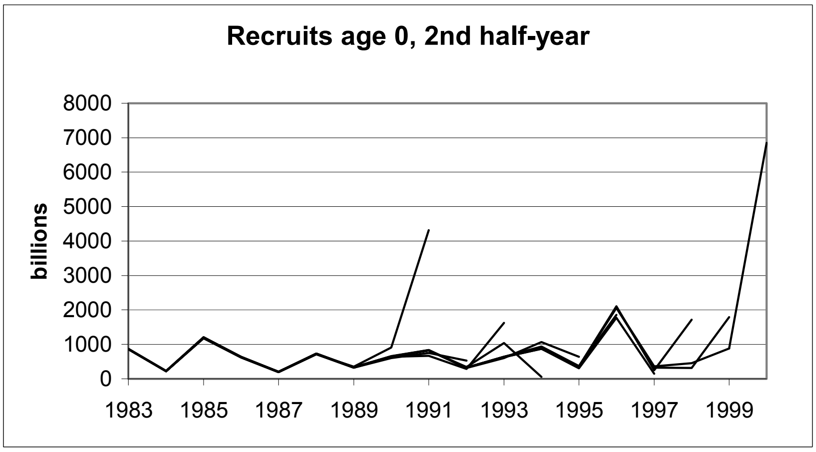


Figure 13.4.4 Nort Sea SANDEEL. Retrospective analysis of SSB, recruitment and Fbar (1-2), 1991-2000





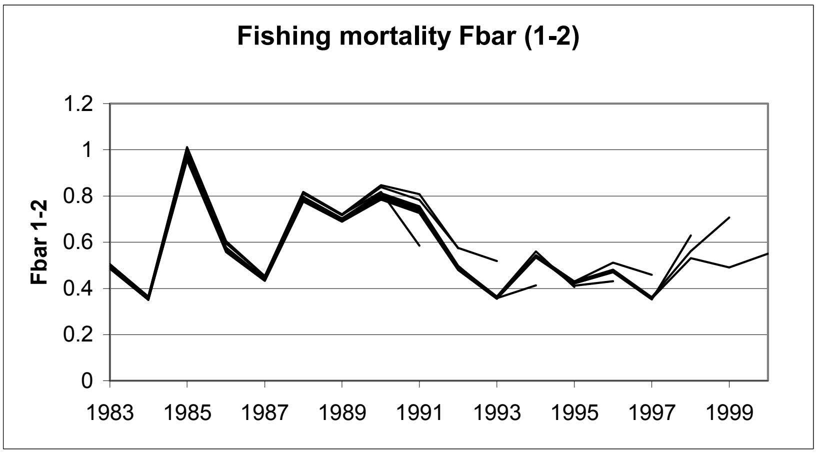


Figure 13.4.5 Sandeels in the North Sea. Trends in Yield, F, TSB, SSB and recruitment
The present assessment includes values for the years 1983-2000
recritment year 2000 is a geometric mean

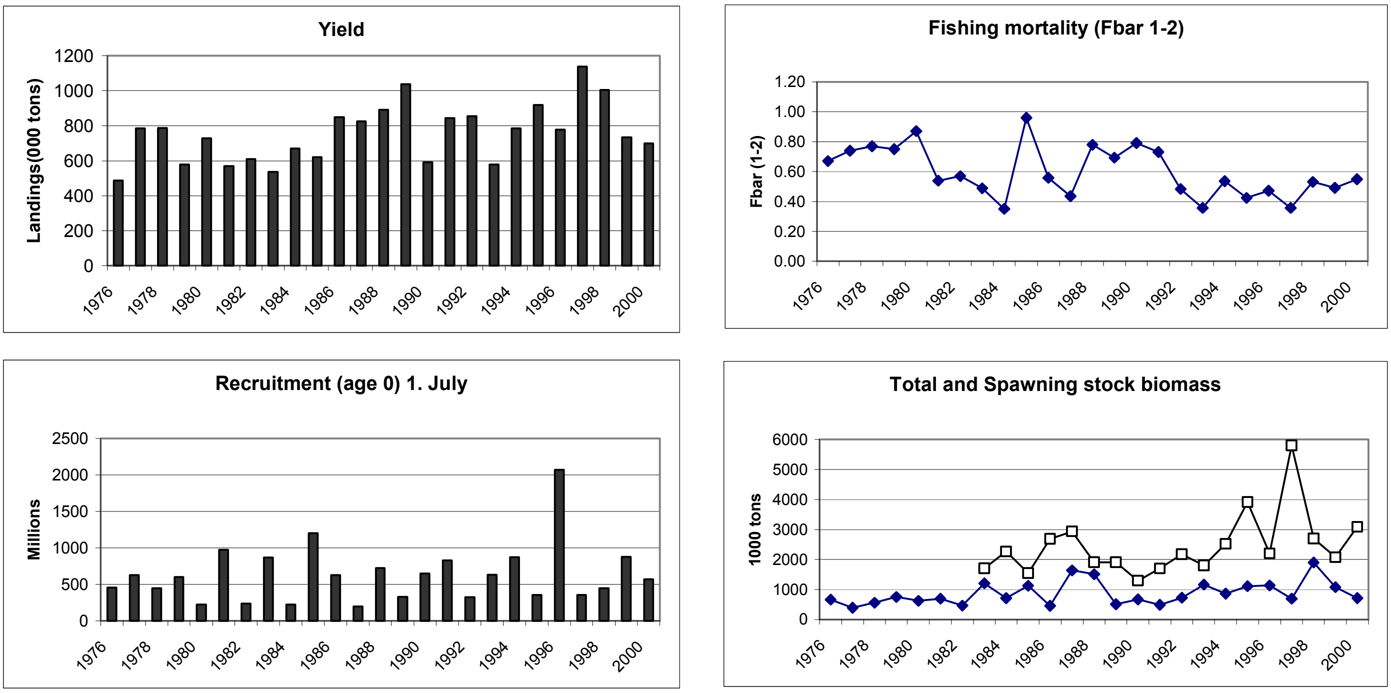


Figure 13.4.6 North Sea sandeel. Relation between stock numbers estimated by SXSA and CPUE of tuning fleets

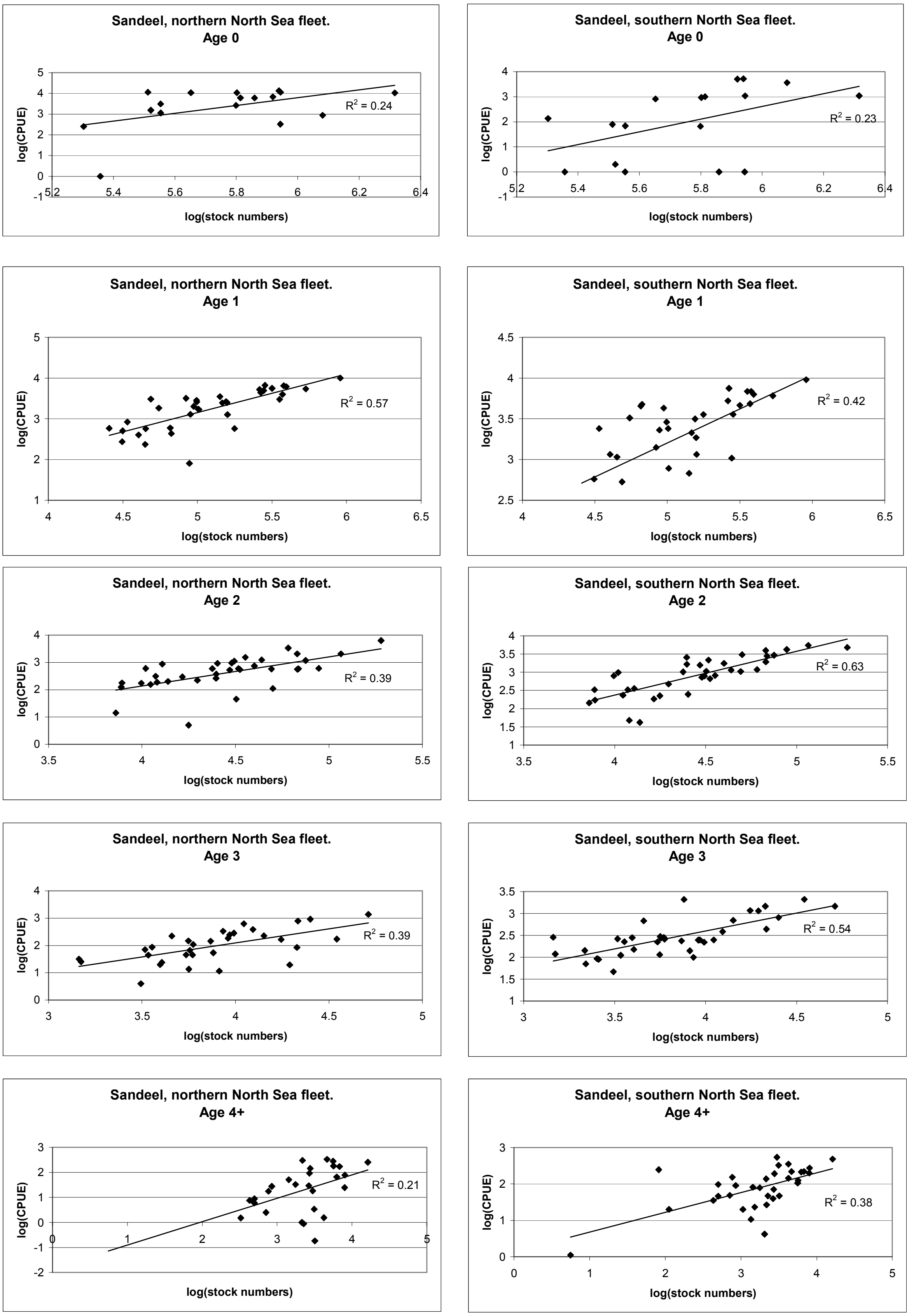


Figure 13.4.7 North Sea SANDEEL. Stock recruitement relation.

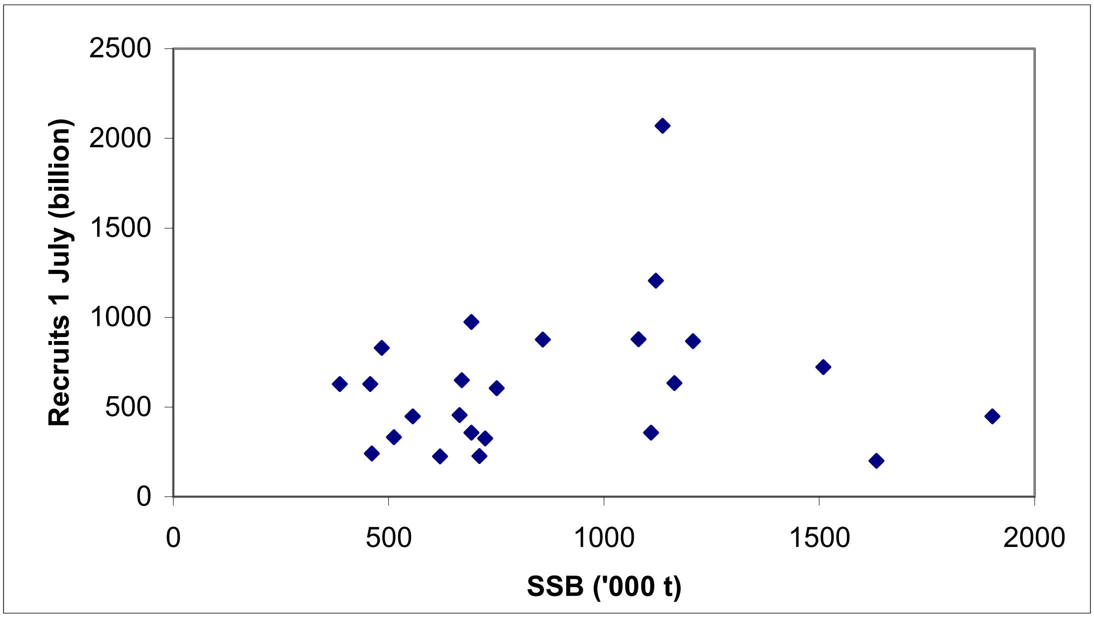
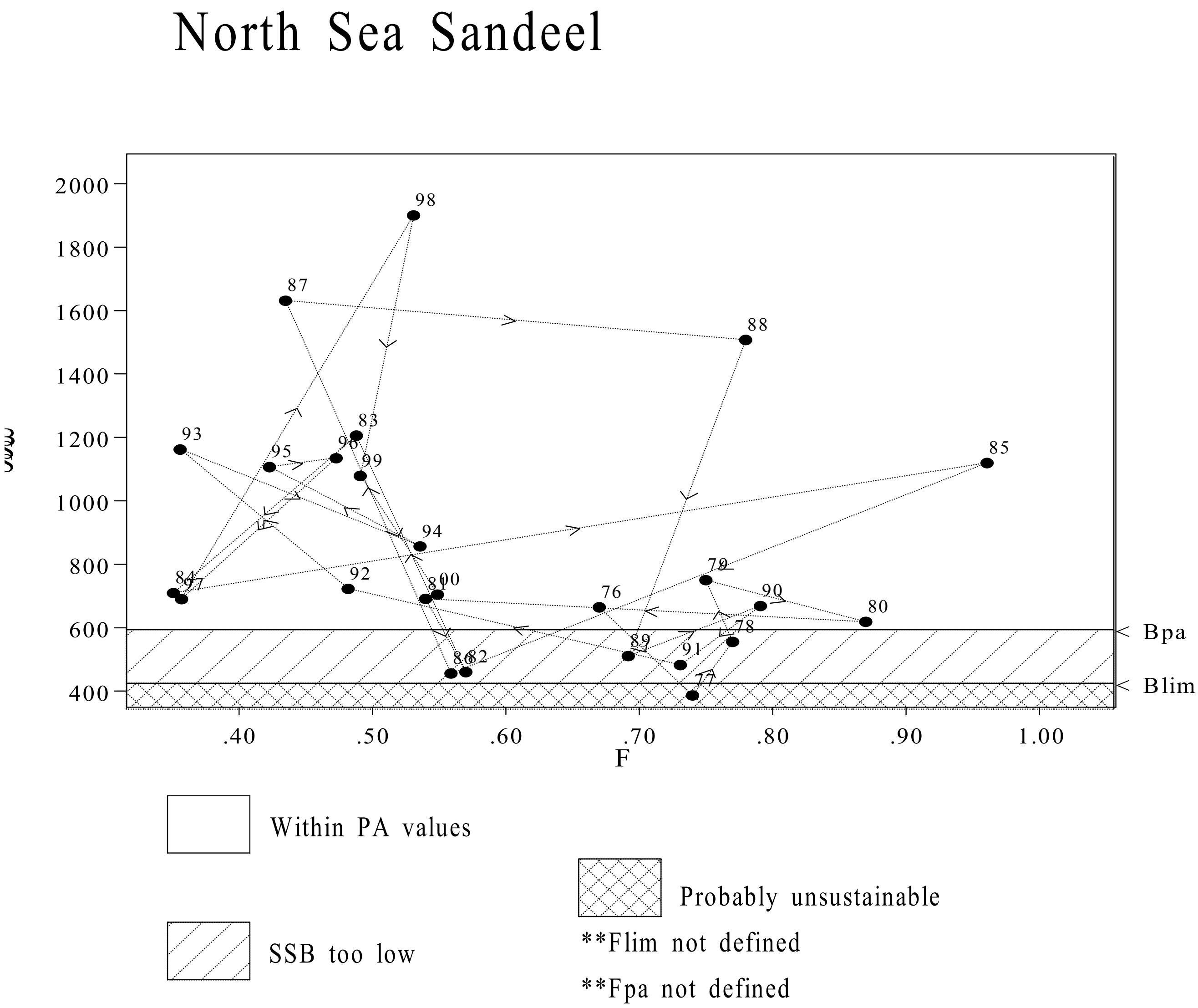
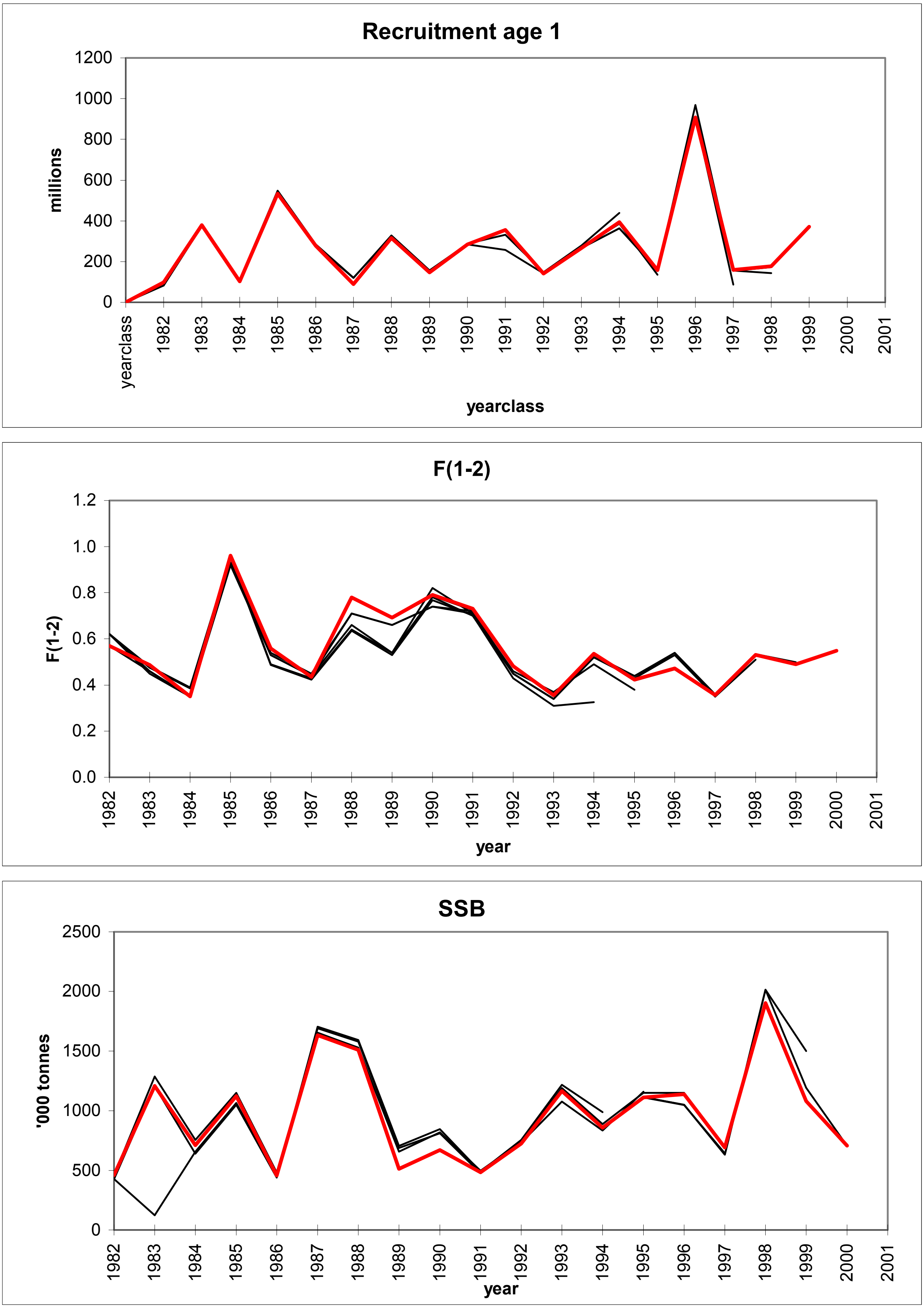


Figure 13.8.1 North Sea sandeel, SSB versus average ishing mortality (age 1-2)

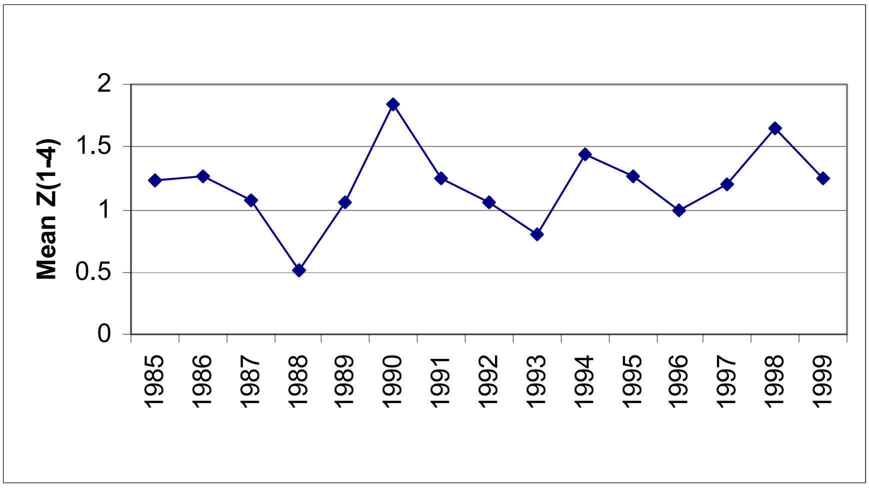


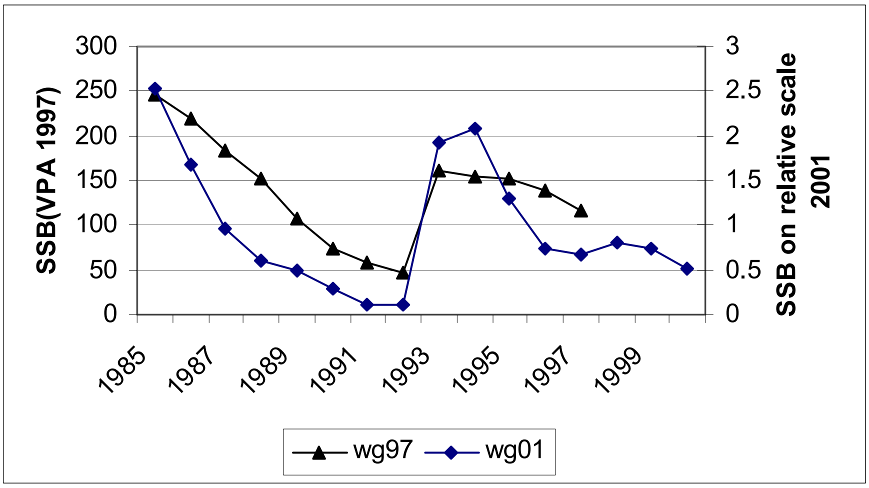
Data file(s):D:\Sandeel\San01\WPA-plot\SAN.pa;D:\Sandeel\San01\WPA-plot\SAN.sum
Plotted on 18/06/2001 at 14:17:21

Figure 13.9.1 SANDEEL IV Quality Control Diagram



SANDEEL IV. Assessments generated in subsequent Working Groups.





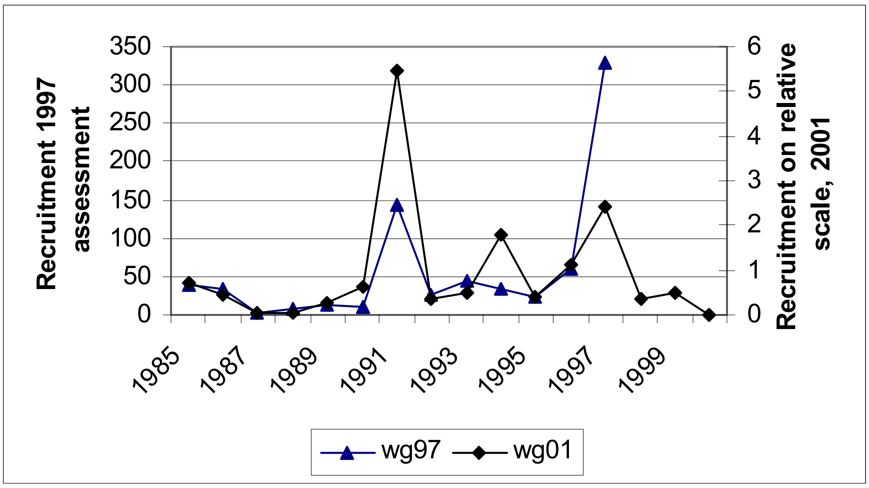


Figure 13.12.1. Shetland sandeel. Trends in Z, SSB and recruitment at age 0 estimated from research vessel surveys. The trends can be compared with the last VPA assessment carried out in 1997.

14 NORWAY POUT AND SANDEEL IN DIVISION VIA

14.1 Overview of Industrial Fisheries in Division VIa

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

14.2 Norway Pout in Division VIa

Landings of Norway pout from Division VIa as reported to ICES are given in Table 14.2.1 and Figure 14.2.1. Reported landings in 2000 were 2005 t, which is well below the series average of 11,500 t (1974-2000). No data are available on by-catches in this fishery. In addition, no age composition date are available so there are insufficient data available to assess this stock.

14.3 Sandeel in Division VIa

14.3.1 Catch trends

Landings of sandeel in Division VIa as officially reported to ICES are given in Table 14.3.1, and trends in landings are given in Figure 14.3.1. In 2000 landings were 5,700 t which is well below the long term average of 12,000 t (1981-2000).

14.3.2 Assessment

As with the fishery at Shetland, management of this fishery is on a three-yearly basis, with management measures effort being agreed and then kept in place for a three-year period. Unfortunately, no age composition samples were obtained from the fishery during 1999 or 2000-2001, so it is not possible to provide an updated assessment for this stock. This means that it is not possible to provide quantitative information on the current state of the stocks. However, it can be seen from the catch and effort data (Figure 14.3.1) that the catch trends are closely related to the amount of annual effort, and the recent decrease in landings corresponds to a similar reduction in fishing effort. On this basis it seems likely that recent exploitation of this stock has been at a very low level.

Table 14.2.1 Norway Pout. Annual landings (t) in Division VIa (Data officially reported to ICES)

Country	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Denmark	37714	5849	28180	3316	4348	5147	7338	14147	24431	6175	9549	7186	4624	2005
Faroes	-	376	11	-	-	-	-	-	-	-	-	-	-	-
Germany	-	-	-	-	-	-	-	-	1	-	-	-	-	-
Netherlands	-	-	-	-	-	10	-	-	7	7	-	-	1	-
Norway	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Poland	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UK (E+W)	-	-	-	-	-	1	-	1	-	-	-	-	-	-
UK (Scotland)	553	517	5	-	-	-	-	+	-	140	13	-	-	-
Total	38267	6742	28196	3316	4348	5158	7338	14148	24439	6322	9562	7186	4625	2005

Table 14.3.1, Sandeel, Division VIa
Landings (tonnes), 1981-2000, as officially reported to ICES.

Country	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Denmark	-	-	-	-	-	-	-	-	-	-
UK, Scotland	5972	10786	13051	14166	18586	24469	14479	24465	18785	16515
Total	5972	10786	13051	14166	18586	24469	14479	24465	18785	16515

Country	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Denmark	-	-	80	-	-	-	-	-	-	-
UK, Scotland	8532	4935	6156	10627	7111	13257	12679	5320	2627	-
United Kingdom										5771
Total	8532	4935	6236	10627	7111	13257	12679	5320	2627	5771

Preliminary data for 2000

Figure 14.2.1; Norway Pout in Division VIa
Catch trends

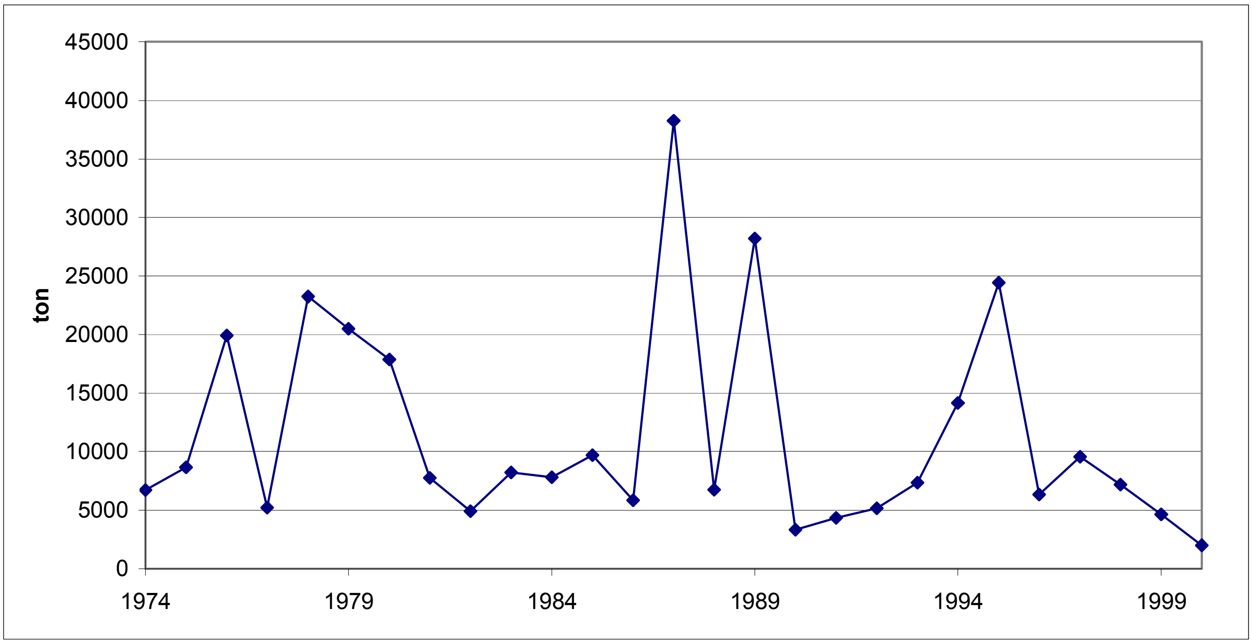
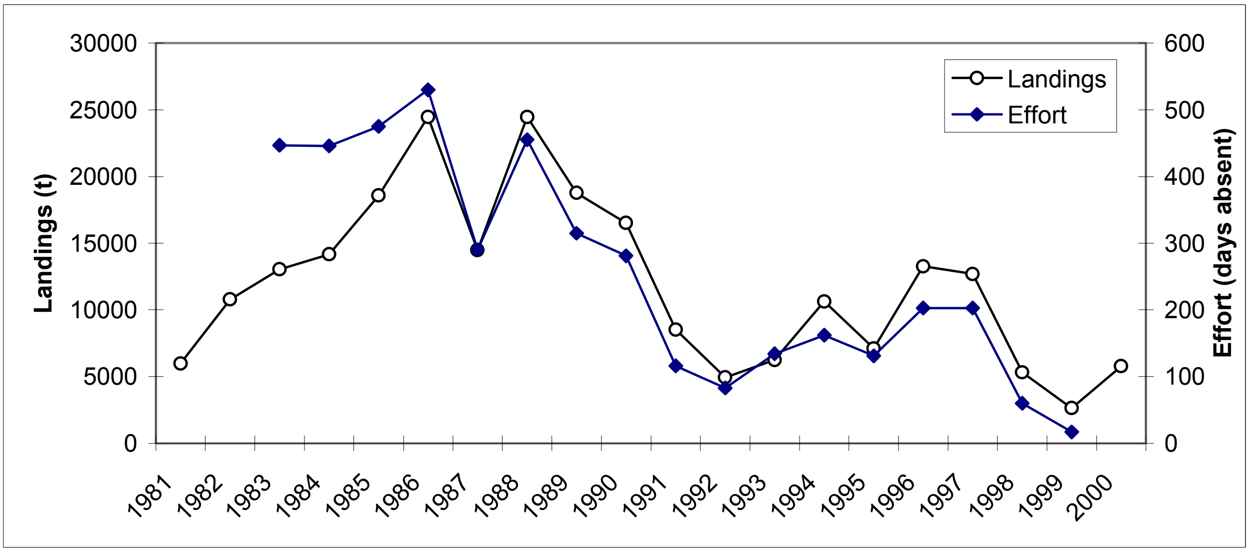


Figure 14.3.1. Sandeel in Division VIa.
Trends in landings and effort



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