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Report of the

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

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TECHNICAL MINUTES

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

ACFM October 2003

For the most part, comment has been made only on the benchmark assessments, although this is not exclusively so. WGNSSK is commended on the thorough approach that it has taken with the benchmark assessments.

General Comments

1. There is a need to move many of the "standard" assessments undertaken by this working group to a more probabilistic approach, specifically towards more appropriate statistical methods with goodness-of-fit diagnostics, to permit a better understanding of the overall quality of the assessment;
2. SURBA is considered to be over-parameterised for use as a mainstream assessment method, but is considered to be useful for exploratory analyses;
3. The non-inclusion of discard data where large-scale discarding exists is problematic. The exploratory analyses that considered the sensitivity of the assessments to the exclusion of discard data is very valuable, but mainly points to the need to measure and include discard data in the assessments;
4. For the update assessments, the review group would have liked more information to be presented on the quality and consistency of the assessment in order to make an informed judgement on it. This does not require a complete evaluation of the data or model settings, just the straightforward presentation of graphical or tabular information. However, the review group recognises that it is for ICES to give clear guidance of its expectations in this respect.
5. Please note the comments on age range truncations under each section. Especially read that for cod and sole.

Cod 347d

There was a lot of discussion relating to the reduction of the age range used in the assessment, particularly with regard to the cascade effects of having to revise biological reference points. It was accepted that a benchmark assessment is the appropriate time to address such issues, but the following points were made:

- The change in age range made no substantive difference to the current or historical perception of the stock development;
- Recent WGNSSK meetings have suggested that mean F should be quantified over ages 4-8 rather than the "traditional" age range of 2-8. This was in part due to the inclusion of partially recruited ages in the estimate of mean F. Truncating the age range in the assessment at this year's meeting has forced WGNSSK to adopt a truncated age range of 2-4. This contradicts the previous view of WGNSSK and gives greater relative weight to the partially recruited ages in the estimate of mean F. WGNSSK is requested to look more closely at the age range included in the assessment and over which mean F is calculated, specifically as it may be used to define the mean F that is taken forward into forecasts, including those used to estimate reference points based on long-term yield – a likely future requirement within ICES. Collapsing the age range in a highly truncated manner may distort the estimates of long-term yields and stock size that contribute to this estimation. Explicitly regarding the use of XSA, a trade-off may be possible in this respect if there is scope to live with shrinkage contributing to the calculation of survivors at the oldest age, as the influence of shrinkage on the stock estimates does not appear to be substantial;
- Calculating mean F over ages 2-4 also means that it is being calculated over a juvenile age range of predominantly immature fish. It would be useful to distinguish whether this is necessitated by the state of the stock and the reduction in age-groups present in the stock, and is therefore an additional diagnostic regarding the state of the stock, or whether it is only a side effect of the exclusion of commercial CPUE data in the calibration of the assessment.

Other points to note are:

- As stock reviewers within ACFM are not always familiar with the assessments that they are reviewing, better explanation and documentation is needed of the reasons behind specific choices. For example, although it is a correct decision to exclude commercial CPUE data from the catch-at-age calibration of this assessment, the reasons for that choice should be better documented, particularly as this is a fundamental to this assessment;
- This benchmark may be considered to establish XSA as the method of choice for assessment until the next benchmark round. However, in line with the General Comments, above, there is a need to consider a more probabilistic approach to the assessment to improve our ability to judge its overall quality;

- The reason for not taking the analysis forward into forecast was queried, as the review group felt that the estimate of stock in the last year was more driven by the surveys than the 2002 catch-at-age data. Greater unease about the wisdom of going forward into a forecast was expressed with regard to uncertainties in the "middle" year of the assessment, 2003, when there were substantially greater grounds for uncertainty over the true level of catches and the appropriate fishing mortality rate and exploitation pattern to use as the basis for forecasting (given direct effort control in 2003 and the scale of "drop-down" of vessels from whitefish gear to *Nephrops* gear that resulted as a consequence of the more generous "*Nephrops*" days at sea allocations).

Haddock 34

- A Working Document for ACFM, October 2003 by Coby Needle, FRS Marine Laboratory, about The effects of technical measures and assumptions about exploitation on short-term forecasts for North Sea haddock (Annex 1), was considered in addition to the WGNSSK report;
- The earlier part of the English groundfish survey series was removed from the assessments of some stocks (due to a perceived step change in Z when the GOV trawl was adopted) but not from this one. WGNSSK is asked to confirm whether such consideration was given to the use of the earlier EGFS data for haddock, and if not, to give it such consideration;
- The age range used in the assessment and calculation of mean F was addressed for haddock as for cod in 347d. Similar considerations apply;
- The trends and patterns in the XSA Ln(q) residuals imply this is not a very good assessment. This may be due to conflicts between the indices used, although this is recognised to be an issues of scale rather than direction (*ie* the relative magnitude of strong year classes as indicated by surveys rather than their qualitative indications of above average year classes). WGNSSK's consideration of a similar inconsistency in scale between the surveys and the catch-at-age data is acknowledged. Although the residual plots imply a poor assessment, this does not seem to be a major problem in terms of the consistency of the assessment from last year to this – it was suggested that an assessment method that gives greater weight minimising the residuals of strong year classes (eg AMCI) could be explored for this stock;
- Unlike the cod assessment, the $\mathbf{F}_{lim}$ and $\mathbf{F}_{pa}$ reference points were not updated in line with the new age-range used to calculate mean F.

Whiting 47d

- A Working Document for ACFM, October 2003 by Coby Needle, FRS Marine Laboratory, about The effects of technical measures and assumptions about exploitation on short-term forecasts for North Sea whiting (Annex 2), was considered in addition to the WGNSSK report;
- This assessment was rejected by ACFM. ICES has previously considered this assessment to be very uncertain due to inconsistent trends in the development of the stock as indicated (i) by conflicts between stock indices, and (ii) the high sensitivity of the catch-at-age analysis to annual updates. In recent years WGNSSK has tried to address this problem by presenting the results of a probabilistic assessment whose error bounds were considered to best encapsulate the overall uncertainty of the assessment. However, even this approach has failed this year to deal adequately with the high sensitivity of the catch-at-age analysis to the addition of a single year's data. As the assessment is very sensitive both to the choice of model (and its specific formulation) and to the data included in the model, it suggests that the fundamental problem is data related and this will initially requires more exploration and evaluation of the data than of the model;
- The same general concerns regarding age ranges to be used in the analysis were made for whiting as for cod in 347d. Similar considerations apply;

Sole Nsea

1. A Working document, ACFM October 2003 on Sole North Sea recruitment update by Sieto Verver, Loes Bolle, Olvin van Keeken, Martin Pastoors, 7/10/2003, Netherlands Institute for Fisheries Research, Ijmuiden, (Annex 3) was considered in addition to the WGNSSK report.
2. When changes are made to the catch-at-age model configuration, it is helpful to provide a clear indication of the impact of that measure on the time-series, for example removing the "power" model on age 2 – although there is an indication of its effect on terminal estimates, there is no indication of its effect on the time-series – if there is no effect on the longer series (and there may not be) then it is helpful to make that clear;
3. The topic of the maturity ogive that is used in this assessment should be revisited when the maturity data that are currently being processed become available;
4. The medium-term forecast program that is used does not generate the distribution of recruitment that has been seen historically for this stock. WGNSSK should consider moving to a medium-term forecast program that does generate an appropriate distribution (eg STPR);

5. The age range truncation caused real problems in the re-evaluation of reference points for this stock in particular. The mechanical repetition of what went before meant that the algorithm for re-estimating $\mathbf{F}_{pa}$ was consistent with the original event, but the biomass values against which simulation outcomes were compared had not been changed (ie if a new $\mathbf{B}_{lim}$ corresponding to current $\mathbf{B}_{loss}$ (21kt) was selected as the reference biomass, then it is unlikely that $\mathbf{F}_{pa}$ would have been revised downwards). Consequently the revision was not accepted, and this meant that none of the F reference value revisions were accepted.

Plaice Nsea

1. A Working document, ACFM October 2003 on Plaice North Sea recruitment update by Sieto Verver, Loes Bolle, Olvin van Keeken, Martin Pastoors, 7/10/2003, Netherlands Institute for Fisheries Research, Ijmuiden, (Annex 4) was considered in addition to the WGNSSK report.
2. Reviewers were unable to follow clearly the discussion of the likely reasons behind the change in perception of the state of this stock and the evaluation of the discard scenario simulations in particular. This required a lot of clarification by the Chair of WGNSSK. This was very important as the ACFM decisions on this stock were based on these aspects of the assessment;
3. The age range used in the assessment and calculation of mean F was addressed for plaice as it was for cod in 347d. Similar considerations apply, and in the case of plaice were it has a dramatic effect on the scaling of historical stock size, it is clearly an insufficient age range to forecast into the medium to long-term future at low fishing mortality without explicit account being taken of the survival and growth into the individual ages comprising the plus-group.

Mixed Fisheries

The review group recognises that WGNSSK is well aware of the problems that it faces in providing mixed fisheries advice. However, it seeks to highlight two of those problems for attention.

- Experience of fisheries-based advice in other parts of the world indicate that such provision is possible, but that it requires well-defined fisheries that are based on complete and reliable catch data. In the ICES case, model development has outstripped the provision of appropriate data both for defining fisheries and providing mixed fishery advice. Specifically, the lack of data on discards for most species is a principal concern. Although this is a weakness of many single-stock forecasts it is accentuated in a mixed fisheries context and may lead to inappropriate advice being given to the extent of mis-informing managers;
- It will not always be possible to provide a framework of analytical forecasts for input into mixed fishery evaluation models such as MTAC. This provides a stimulus for the development of complementary processes that do not require an analytical short-term forecast to proceed.

Sandeel in IV

The WG is asked to evaluate possible in-season indicators of recruiting (1-group) sandeel abundance. The very poor 2003 fishery indicated extremely low abundance of 1-year-olds in 2002 and hence very low SSB in 2004. ACFM struggled greatly to provide appropriate management advice given that the 2004 fishery will be dominated by 1-year-olds from the 2003 year class. Given the likely low SSB in 2004 it was necessary to be adaptive in regard to the 2004 fishery and it advised low exploitation until the strength of the 2004 year class was evaluated. Salmon fisheries in many areas are managed according to escapement policies based on in-season indicators of recruitment. The potential development of this kind of approach should be explored by the WG. However, a pre-requisite to such an approach is a reliable (early) in-season indicator of abundance.

ANNEX 1

Working Document for ACFM, October 2003

The effects of technical measures and assumptions about exploitation on short-term forecasts for North Sea haddock

Coby Needle, FRS Marine Laboratory

Introduction

This document continues the work outlined in the haddock section of the 2003 report of the ICES Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak (in preparation). During the Working Group, time did not permit a full evaluation of the potential effect of recent technical measures and uncertainty regarding forecast exploitation patterns on haddock forecasts, and an undertaking was made to present appropriate results to ACFM at their October 2003 meeting. These results are given below, along with a resumé of the forecast methodology used.

Methods

The salient points for a short-term projection for haddock in this year's assessment are as follows:

1. Mean $F_{2\text{–}4}$ is estimated to have declined during 2000–2002, so that $\boldsymbol{F_{sq}}$ (the mean of the last three years) is likely to be an overestimate of *F* in 2003 and beyond if the trend persists. However, the estimate in the assessment of the strength of the 1999 year class is very uncertain, and terminal *F* is consequently also very uncertain. Hence *F* may not have declined in recent years as much as indicated by the assessment.

2. The large 1999 year class has been observed to be small for its age in the human consumption catch component, indicating density-dependent growth retardation. The use of a standard three-year mean for the weight of age-4 fish in 2003 is likely to bias SSB estimates upwards.

3. Several technical measures have been implemented for the mixed demersal fishery in the North Sea (see the WG report, section 4). These include square-mesh panels, restrictions on lifting bags, mesh-size changes and days-at-sea regulations. There have also been a significant number of vessels decommissioned in 2002 and 2003. These measures will have had (and continue to have) effects on both the exploitation pattern and effort exerted by the international fishery, which need to be accounted for in short-term projections and catch forecasts.

4. The 2003 TAC for North Sea haddock (55 kt) was intended to be restrictive, and have the effect of reducing fishing effort to a level commensurate with measures taken to protect the North Sea cod stock.

The standard forecasts methodology was modified in several ways to address these issues.

1. To allow for uncertainty in terminal-year *F*, three different bases for *F* in forecasts were explored:
   - *F*(scaled), the mean exploitation pattern over the period 2000–2002, scaled to the level of estimated mean $F_{2\text{–}4}$ in 2002.
   - *F*(2002), the estimated exploitation pattern in 2002
   - *F*(sq), the mean exploitation pattern over the period 2000–2002 (the *status quo* estimate).

2. The growth of the 1999 year class was modelled by fitting a logistic curve to observed weights for that year class for ages 1–3, and then projecting forward on the basis of the fitted model. This was done separately for each catch component (human consumption, discards, industrial by-catch). Fitting was done using the Solver package in Excel, and the model formulation used was

$$W = \frac{1}{1 + \exp(a - bA)} \tag{1.1}$$

3. Table 1 gives fitted parameter estimates for each of the catch components, along with the projected weight-at-age and the equivalent value assuming the standard three-year mean. The expected slow growth is only seen in the human consumption component of the catch. Figure 1 shows the weights-at-age for the 1999 year class with the fitted growth curves superimposed.

4. In the forecast presented in the Working Group report, the uptake of the derogation for 110 mm during 2002 (Commission Regulation EC 2056/2001) was taken to be 0%, so that all vessels in the fishery were assumed to have switched to a 120 mm mesh at the start of 2002. This would mean that the exploitation pattern estimated for 2002 in the historical assessment could be carried forward into the forecasts unchanged. However, if (for example) 100% of vessels had taken up the derogation and remained at 110 mm during 2002, then the exploitation pattern for forecasts would have to be altered to reflect the change at the start of 2003 for all vessels from 110 mm to 120 mm. The extent of the change in selectivity that would have to be incorporated depends on the derogation uptake, which is unknown but which clearly lies on a sliding scale between these two extremes. Modifications also have to be made to account for the likely effects of decommissioning and days-at-sea.

Hence, in the following analyses a wider range of alternatives were explored. The following selectivity parameters for haddock were supplied by FRS:

Selectivity	Regulation	L_{50}	L_{25}	S_1	S_2
Sel1	EU 2000	24.8	22.6	12.384357	0.4993692
Sel2	EU 110 mm	28.7	26	11.677842	0.4068934
Sel3	EU 120 mm	32.1	29.05	11.562444	0.3602008

For each catch component, mean weights-at-age were converted to mean lengths-at-age using

$$L = \left(\frac{W}{rf \times a} \right)^{\frac{1}{b}} \qquad (1.2)$$

where $a = 0.0157$, $b = 2.8268$, and the raising factor (gutted to live weight conversion) $rf = 1.16$. Selectivity vectors (Sel1, Sel2, Sel3) relevant to each of the pertinent regulations were calculated using mean lengths-at-age, the selectivity parameters given above, and the following model:

$$S = \frac{1}{1 + \exp(S_1 - S_2 L)}. \qquad (1.3)$$

For each catch component and each *F*-forecast basis (2002, scaled 2002, or *status quo*), three forecast exploitation patterns were calculated. The first assumed 0% derogation uptake, so that the forecast *F* was unchanged. The second assumed 100% derogation uptake, so that the forecast exploitation pattern was multiplied by the ratio of Sel3 (120 mm) to Sel2 (110 mm). The third assumed 50% derogation uptake, and thus used the mean of the forecast *F*s from the first and second patterns. The forecast *F*-at-age in year *y* was modified by the difference between the selection in 2002 (S_{2002}) and that in year *y* (S_y), using $F_y = F_{2002} S_y / S_{2002}$. These *F* vectors were then used in short-term forecast runs, generated using the WGFRANSW program.

The final scenario modification concerned the potential effect of days-at-sea and decommissioning regulations. The days-at-sea regulation of February 2003 limited fishing to 16 effective fishing days per month, implying a ~50% reduction in fishing mortality. In addition, Kunzlik (2003) estimated that 18% of effective fishing mortality on haddock would have been removed during 2002 by decommissioning. If these measures had had the full desired effect, the result would have been a 68% reduction in effective effort. The analyses described above were therefore repeated assuming an effort multiplier of 0.32. This should probably be viewed as an upper limit on the likely effect of the days-at-sea regulation and decommissioning: the actual impact of these measures is still to be evaluated.

The combination of different settings described above produced a total of 18 forecasts. Table 2 gives the input file for run 1, which assumes *F*(scaled) as the forecast basis, 0% derogation uptake, and no effort modification, and which was presented in the WG report. Table 3 gives the corresponding exploitation patterns for each of the alternative runs: these were the input data that were changed between runs.

Results

The key results from each of these are summarised in Table 4, whilst Tables 5–22 give management option and detailed forecast tables for each of these runs. Broadly speaking, *F*(sq) results in the highest catch and lowest SSB, *F*(scaled) gives the lowest catch and the highest SSB, and *F*(2002) lies somewhere in between. Within these categories, 0%

derogation uptake gives lower SSB *and* landings than 100%. Finally, the effort multiplier of 0.32 greatly increases SSB and reduces landings.

All these conclusions would have been expected, given the exploitation patterns in Table 3. The interesting point is the relation between the forecast human consumption landings and the TAC, which is around 55 kt. The forecast presented in the WG report (run 1) indicates landings of 159 kt in 2003, just under three times the TAC. We should reiterate that the TAC was intended to be restrictive, so we would expect landings at the usual forecast *F*s to be higher than the quota. The extent to which predicted landings exceed the TAC is surprising, however. If this was the true level of landings, then the fleets would have exhausted their quotas during the spring. However, there have been no reports (anecdotal or otherwise) to indicate that this has happened: the latest data on the Scottish commercial fleets show that reported quota uptake as of September 2003 was around 70%. There are several possible reasons for this anomaly. For example:

1. The 1999 year class has been overestimated in the assessment, meaning that the starting point for abundance in the forecast is too high.
2. The fish are being caught, but discards have been underestimated and/or landings have been misreported.
3. Recent technical measures have had an effect, so that the basis for the forecast *F* being used (*F*(scaled), *F*(2002) or *F*(sq)) is no longer appropriate.

The WG were unable to determine definitively which of these (or which combination of these) is leading to the apparent overestimation of landings. However, the forecast runs (see Table 2) with *F*(scaled) as a basis and an effort multiplier of 0.32 (thus assuming the full possible impact of decommissioning and days-at-sea regulations) give forecast landings in 2003 of between 49.2 kt and to 58.8 kt, which would be consistent with the agreed TAC. It is unlikely that the effort reduction due to the days-at-sea regulation would be as high as 50%, certainly not in 2003 given that the regulation only commenced in a piecemeal fashion in February, so the effort multiplier used here (0.32) is probably too low. However, the fact that the landings are consistent with the TAC, combined with the perception that the industry have not yet exhausted their haddock quota, implies that the reported effort reduction is of this approximate magnitude. If this is not all due to technical measures, as appears likely, then it is probably due to a combination of the three points listed above.

In conclusion: a standard forecast, making no allowances for recent regulations, results in forecast landings for 2003 that are three times the TAC. The industry have not reported exhausation of quota, so this standard forecast does not appear to be appropriate. Assuming that the regulations have had their full possible effect results in forecast landings for 2003 that are roughly equal to the TAC. However, it is overly optimistic to expect that the regulations have been able to have their full effect yet. Therefore, the estimated landings in 2003 will probably be somewhat higher than the TAC. This could be because of under-reporting, or because the historical estimate of the strength of the 1999 year class was too high, or a combination of both. Given this, it would be inappropriate to present any one of these forecasts as a reliable short-term prognosis of the haddock stock, the future development of which must remain uncertain.

References

Kunzlik, P. (2003) Calculation of potential reduction in fishing mortality of North Sea and west of Scotland cod, haddock and whiting due to decommissioning of UK vessels in 2002. Working Document 6 to the ICES Working Group on the Assessment of Northern Shelf Demersal Stocks.

Table 1 Haddock in Subarea IV and Division IIIa. Fitted growth curve parameter estimates, and projected mean weight-at-age (kg) for age 4 using both the growth model and a simple three-year mean, for the 1999 year class in total catches and three catch components.

Component	*a*	*b*	Growth model	3-year mean
Total catch	2.565	0.616	0.474	0.497
Human consumption	1.060	0.212	0.447	0.524
Discards	2.278	0.430	0.364	0.326
Industrial by-catch	3.575	0.879	0.485	0.366

Table 2 Haddock in Subarea IV and Division IIIa. Input data for catch forecast and linear sensitivity analysis for run 1 (*F*(scaled) basis, 0% derogation uptake, no effort multiplier, as in the WG report).

Label	Value	CV	Label	Value	CV
Number-at-age			Weight in the stock		
N0	6233448	1.22	WS0	0.03	0.61
N1	573688	0.41	WS1	0.11	0.15
N2	45989	0.17	WS2	0.24	0.09
N3	316671	0.14	WS3	0.33	0.09
N4	898062	0.12	WS4	0.47	0.06
N5	5423	0.15	WS5	0.68	0.08
N6	2250	0.19	WS6	0.76	0.16
N7	2098	0.20	WS7	1.17	0.07
H.cons selectivity			Weight in the HC catch		
sH0	0.00	0.00	WH0	0.00	0.00
sH1	0.00	0.64	WH1	0.34	0.12
sH2	0.05	0.83	WH2	0.38	0.11
sH3	0.22	0.65	WH3	0.42	0.05
sH4	0.47	0.28	WH4	0.45	0.05
sH5	0.38	0.08	WH5	0.69	0.08
sH6	0.35	0.83	WH6	0.77	0.15
sH7	0.34	0.83	WH7	1.21	0.11
Discard selectivity			Weight in the discards		
sD0	0.00	1.08	WD0	0.04	0.20
sD1	0.01	0.64	WD1	0.14	0.19
sD2	0.05	0.83	WD2	0.22	0.09
sD3	0.05	0.65	WD3	0.29	0.07
sD4	0.02	0.28	WD4	0.36	0.07
sD5	0.00	0.08	WD5	0.37	0.03
sD6	0.00	0.83	WD6	0.10	1.73
sD7	0.00	0.83	WD7	0.26	0.87
Industrial selectivity			Weight in Ind. by-catch		
sI0	0.01	1.08	WI0	0.03	0.85
sI1	0.03	0.64	WI1	0.07	0.15
sI2	0.02	0.83	WI2	0.14	0.24
sI3	0.04	0.65	WI3	0.19	0.46
sI4	0.01	0.28	WI4	0.48	0.03
sI5	0.00	0.08	WI5	0.36	0.37
sI6	0.00	0.00	WI6	0.00	0.00
sI7	0.00	0.00	WI7	0.00	0.00
Natural mortality			Proportion mature		
M0	2.05	0.03	MT0	0.00	0.10
M1	1.65	0.05	MT1	0.01	0.10
M2	0.40	0.07	MT2	0.32	0.10
M3	0.25	0.19	MT3	0.71	0.10
M4	0.25	0.12	MT4	0.87	0.10
M5	0.20	0.17	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
Relative effort in HC fishery			Year effect for natural mortality		
HF02	1.00	0.22	K02	1.00	0.21
HF03	1.00	0.22	K03	1.00	0.21
HF04	1.00	0.22	K04	1.00	0.21
Relative effort in industrial fishery					
IF02	1.00	0.54			
IF03	1.00	0.54			
IF04	1.00	0.54			
Recruitment in 2004 and 2005					
R03	6233448	1.22			
R04	6233448	1.22			

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

Table 3 Haddock in Subarea IV and Division IIIa. Exploitation patterns for alternative short-term forecasts.

		Forecast exploitation pattern								
	Age	Run 1	Run 2	Run 3	Run 4	Run 5	Run 6	Run 7	Run 8	Run 9
Human consumption landings	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	1	0.002	0.002	0.001	0.006	0.005	0.004	0.002	0.002	0.001
	2	0.049	0.042	0.036	0.032	0.028	0.023	0.118	0.102	0.086
	3	0.220	0.197	0.174	0.096	0.086	0.075	0.480	0.429	0.379
	4	0.474	0.434	0.394	0.615	0.563	0.511	0.842	0.771	0.700
	5	0.382	0.377	0.372	0.577	0.569	0.562	0.624	0.615	0.607
	6	0.350	0.347	0.344	0.395	0.392	0.389	0.708	0.702	0.697
	7	0.336	0.336	0.336	0.354	0.354	0.354	0.696	0.696	0.696
Discards	0	0.000	0.000	0.000	0.001	0.001	0.001	0.001	0.001	0.001
	1	0.024	0.017	0.010	0.033	0.028	0.022	0.040	0.033	0.026
	2	0.123	0.088	0.053	0.113	0.097	0.082	0.240	0.207	0.175
	3	0.114	0.087	0.060	0.111	0.099	0.087	0.223	0.199	0.176
	4	0.058	0.049	0.040	0.045	0.041	0.037	0.111	0.101	0.092
	5	0.008	0.007	0.006	0.002	0.002	0.002	0.016	0.016	0.016
	6	0.001	0.001	0.000	0.000	0.000	0.000	0.003	0.003	0.003
	7	0.014	0.010	0.007	0.041	0.041	0.041	0.015	0.015	0.015
Industrial bycatch	0	0.012	0.012	0.013	0.031	0.033	0.034	0.013	0.014	0.015
	1	0.045	0.037	0.030	0.122	0.101	0.080	0.050	0.042	0.033
	2	0.030	0.026	0.022	0.011	0.009	0.008	0.078	0.068	0.057
	3	0.070	0.062	0.055	0.003	0.003	0.003	0.135	0.121	0.107
	4	0.020	0.019	0.017	0.056	0.051	0.047	0.023	0.021	0.019
	5	0.003	0.003	0.003	0.008	0.008	0.008	0.003	0.003	0.003
	6	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	7	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

		Forecast exploitation pattern								
	Age	Run 10	Run 11	Run 12	Run 13	Run 14	Run 15	Run 16	Run 17	Run 18
Human consumption landings	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	1	0.001	0.001	0.000	0.002	0.001	0.001	0.001	0.001	0.000
	2	0.016	0.014	0.011	0.010	0.009	0.007	0.038	0.033	0.027
	3	0.070	0.063	0.056	0.031	0.027	0.024	0.153	0.137	0.121
	4	0.152	0.139	0.126	0.197	0.180	0.164	0.270	0.247	0.224
	5	0.122	0.121	0.119	0.185	0.182	0.180	0.200	0.197	0.194
	6	0.112	0.111	0.110	0.126	0.125	0.124	0.226	0.225	0.223
	7	0.108	0.108	0.108	0.113	0.113	0.113	0.223	0.223	0.223
Discards	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	1	0.004	0.003	0.002	0.011	0.009	0.007	0.013	0.011	0.008
	2	0.015	0.011	0.007	0.036	0.031	0.026	0.077	0.066	0.056
	3	0.015	0.011	0.008	0.035	0.032	0.028	0.071	0.064	0.056
	4	0.007	0.006	0.005	0.014	0.013	0.012	0.035	0.032	0.029
	5	0.001	0.001	0.001	0.001	0.001	0.001	0.005	0.005	0.005
	6	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.001
	7	0.001	0.001	0.001	0.013	0.013	0.013	0.005	0.005	0.005
Industrial bycatch	0	0.003	0.004	0.004	0.010	0.010	0.011	0.004	0.005	0.005
	1	0.009	0.007	0.006	0.039	0.032	0.026	0.016	0.013	0.011
	2	0.006	0.005	0.004	0.003	0.003	0.002	0.025	0.022	0.018
	3	0.011	0.010	0.009	0.001	0.001	0.001	0.043	0.039	0.034
	4	0.004	0.004	0.003	0.018	0.016	0.015	0.007	0.007	0.006
	5	0.001	0.001	0.001	0.003	0.003	0.002	0.001	0.001	0.001
	6	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	7	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Table 4 Haddock in Subarea IV and Division IIIa. Results from short-term forecasts run under 18 different configurations. All estimates are in thousand tonnes.

Run number	Basis	Derogation uptake	Effort multiplier	SSB 2004	2005	Human cons. landings 2003	2004	Discards 2003	2004	Industrial bycatch 2003	2004
1	F scaled	0%	1.00	368.0	271.0	159.0	116.0	9.0	3.0	7.0	3.0
2	F scaled	50%	1.00	383.0	286.0	148.0	118.0	7.0	3.0	7.0	3.0
3	F scaled	100%	1.00	399.0	302.0	136.0	119.0	6.0	2.0	6.0	3.0
4	F 2002	0%	1.00	322.0	201.0	172.0	133.0	20.0	6.0	21.0	10.0
5	F 2002	50%	1.00	338.0	215.0	161.0	136.0	18.0	6.0	19.0	9.0
6	F 2002	100%	1.00	355.0	230.0	150.0	139.0	16.0	5.0	18.0	9.0
7	F sq	0%	1.00	231.0	133.0	239.0	107.0	36.0	10.0	13.0	4.0
8	F sq	50%	1.00	250.0	147.0	225.0	113.0	34.0	10.0	12.0	4.0
9	F sq	100%	1.00	271.0	162.0	211.0	120.0	31.0	9.0	11.0	4.0
10	F scaled	0%	0.32	499.0	468.0	58.8	57.2	3.2	1.3	2.5	1.1
11	F scaled	50%	0.32	506.0	477.0	54.0	56.3	2.6	1.0	2.3	1.0
12	F scaled	100%	0.32	512.0	485.0	49.2	55.3	2.0	0.7	2.1	1.0
13	F 2002	0%	0.32	476.0	423.0	67.5	76.3	7.2	2.6	7.8	3.9
14	F 2002	50%	0.32	484.0	432.0	62.3	75.5	6.5	2.3	7.3	3.7
15	F 2002	100%	0.32	492.0	442.0	57.1	74.6	5.9	2.1	6.7	3.4
16	F sq	0%	0.32	430.0	369.0	101.0	79.0	15.0	5.0	5.0	2.0
17	F sq	50%	0.32	441.0	381.0	92.9	78.7	13.7	4.8	4.8	1.8
18	F sq	100%	0.32	452.0	394.0	85.1	78.3	12.4	4.4	4.4	1.7

Table 5a Haddock in Subarea IV and Division IIIa. Management option table from run 1.

	Year 2003	2004						
Mean F — Ages								
H.cons — 2 to 4	0.29	0.00	0.11	0.23	0.29	0.34	0.46	0.57
Ind BC — 2 to 4	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Effort relative to 2002								
H.cons	1.00	0.00	0.40	0.80	1.00	1.20	1.60	2.00
Ind BC	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Biomass								
Total 1 January	611	496	496	496	496	496	496	496
SSB at spawning time	457	368	368	368	368	368	368	368
Catch weight (,000t)								
H.cons	159	0	52	96	116	134	167	195
Discards	9	0	1	3	3	4	5	6
Ind BC	7	3	3	3	3	3	3	3
Total Landings	166	3	55	99	119	137	170	198
Total Catch	175	3	56	102	122	141	175	204
Biomass in year.... 2005								
Total 1 January		516	458	410	388	368	333	303
SSB at spawning time		396	340	293	271	252	218	189

	Year 2003	2004						
Effort relative to 2002								
H.cons	1.00	0.00	0.40	0.80	1.00	1.20	1.60	2.00
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	0.11	0.29	0.29	0.29	0.29	0.29	0.29	0.29
SSB at spawning time	0.14	0.21	0.21	0.21	0.21	0.21	0.21	0.21
Catch weight								
H.cons	0.29	0.00	0.54	0.29	0.25	0.23	0.20	0.19
Discards	0.35	0.00	0.69	0.53	0.51	0.50	0.50	0.51
Ind BC	0.64	0.81	0.83	0.84	0.85	0.86	0.87	0.89
Biomass in year.... 2005								
Total 1 January		0.31	0.34	0.36	0.38	0.39	0.42	0.45
SSB at spawning time		0.23	0.25	0.26	0.26	0.26	0.27	0.28

Table 5b Haddock in Subarea IV and Division IIIa. Detailed forecast table from run 1.

Forecast for year 2003
F multiplier H.cons=1.00
F multiplier Indust=1.00

Age	Populations: Stock No.	Catch number: H.Cons	Discards	By-catch	Total
0	6233448	0	772	27837	28609
1	573688	563	3716	7450	11729
2	45989	1761	1692	665	4118
3	316671	53543	11280	8581	73404
4	898062	298242	13016	8214	319472
5	5423	1567	13	7	1587
6	2250	605	1	0	605
7	2098	545	8	0	553
Wt	611	159	9	7	175

Forecast for year 2004
F multiplier H.cons=1.00
F multiplier Indust=1.00

Age	Populations: Stock No.	Catch number: H.Cons	Discards	By-catch	Total
0	6233448	0	772	27837	28609
1	793812	779	5142	10309	16230
2	105602	4044	3884	1527	9456
3	27491	4648	979	745	6372
4	182416	60579	2644	1668	64892
5	421143	121653	1029	556	123238
6	3016	811	1	0	811
7	2520	655	9	0	664
Wt	496	116	3	3	122

Table 6a Haddock in Subarea IV and Division IIIa. Management option table from run 2.

	Year 2003	2004						
Mean F Ages								
H.cons 2 to 4	0.25	0.00	0.10	0.20	0.25	0.30	0.41	0.51
Ind BC 2 to 4	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Effort relative to 2002								
H.cons	1.00	0.00	0.40	0.80	1.00	1.20	1.60	2.00
Ind BC	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Biomass								
Total 1 January	611	513	513	513	513	513	513	513
SSB at spawning time	457	383	383	383	383	383	383	383
Catch weight (,000t)								
H.cons	148	0	52	98	118	136	170	199
Discards	7	0	1	2	3	3	4	5
Ind BC	7	3	3	3	3	3	3	3
Total Landings	154	3	55	100	120	139	173	202
Total Catch	162	3	56	102	123	142	177	206
Biomass in year.... 2005								
Total 1 January		532	475	425	404	383	347	317
SSB at spawning time		412	356	308	286	267	231	201

	Year 2003	2004						
Effort relative to 2002								
H.cons	1.00	0.00	0.40	0.80	1.00	1.20	1.60	2.00
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	0.11	0.28	0.28	0.28	0.28	0.28	0.28	0.28
SSB at spawning time	0.14	0.20	0.20	0.20	0.20	0.20	0.20	0.20
Catch weight								
H.cons	0.30	0.00	0.54	0.29	0.25	0.22	0.20	0.19
Discards	0.35	0.00	0.67	0.49	0.47	0.46	0.46	0.47
Ind BC	0.64	0.83	0.84	0.86	0.87	0.87	0.89	0.90
Biomass in year.... 2005								
Total 1 January		0.30	0.33	0.35	0.36	0.38	0.41	0.44
SSB at spawning time		0.22	0.24	0.25	0.25	0.25	0.26	0.27

Table 6b Haddock in Subarea IV and Division IIIa. Detailed forecast table from run 2.

Forecast for year 2003
F multiplier H.cons=1.00
F multiplier Indust=1.00

Populations		Catch number			
Age	Stock No.	H.Cons	Discards	By-catch	Total
0	6233448	0	600	29533	30133
1	573688	467	2613	6183	9263
2	45989	1537	1225	580	3343
3	316671	48745	8786	7813	65344
4	898062	278479	11245	7670	297393
5	5423	1550	11	7	1568
6	2250	601	0	0	601
7	2098	545	6	0	551
Wt	611	148	7	7	162

Forecast for year 2004
F multiplier H.cons=1.00
F multiplier Indust=1.00

Populations		Catch number			
Age	Stock No.	H.Cons	Discards	By-catch	Total
0	6233448	0	600	29533	30133
1	793352	646	3613	8551	12810
2	106560	3562	2838	1345	7745
3	28117	4328	780	694	5802
4	189422	58738	2372	1618	62727
5	440140	125784	915	575	127274
6	3032	810	1	0	811
7	2525	656	7	0	663
Wt	513	118	3	3	123

Table 7a Haddock in Subarea IV and Division IIIa. Management option table from run 3.

	2003	2004						
Mean F Ages								
H.cons 2 to 4	0.22	0.00	0.09	0.18	0.22	0.27	0.35	0.44
Ind BC 2 to 4	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Effort relative to 2002								
H.cons	1.00	0.00	0.40	0.80	1.00	1.20	1.60	2.00
Ind BC	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Biomass								
Total 1 January	611	530	530	530	530	530	530	530
SSB at spawning time	457	399	399	399	399	399	399	399
Catch weight (,000t)								
H.cons	136	0	53	99	119	138	173	203
Discards	6	0	1	2	2	2	3	3
Ind BC	6	3	3	3	3	3	3	2
Total Landings	142	3	56	101	122	141	175	205
Total Catch	148	3	56	103	124	143	178	208
Biomass in year.... 2005								
Total 1 January		549	492	442	420	400	363	331
SSB at spawning time		429	372	324	302	282	246	215

	2003	2004						
Effort relative to 2002								
H.cons	1.00	0.00	0.40	0.80	1.00	1.20	1.60	2.00
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	0.11	0.27	0.27	0.27	0.27	0.27	0.27	0.27
SSB at spawning time	0.14	0.19	0.19	0.19	0.19	0.19	0.19	0.19
Catch weight								
H.cons	0.30	0.00	0.54	0.29	0.25	0.22	0.20	0.18
Discards	0.35	0.00	0.63	0.44	0.42	0.41	0.40	0.40
Ind BC	0.66	0.85	0.87	0.88	0.89	0.90	0.91	0.93
Biomass in year.... 2005								
Total 1 January		0.29	0.32	0.34	0.35	0.37	0.39	0.42
SSB at spawning time		0.22	0.23	0.24	0.24	0.24	0.25	0.26

Table 7b Haddock in Subarea IV and Division IIIa. Detailed forecast table from run 3.

Forecast for year 2003
F multiplier H.cons=1.00
F multiplier Indust=1.00

Age	Stock No. (Populations)	H.Cons (Catch number)	Discards	By-catch	Total
0	6233448	0	428	31229	31657
1	573688	371	1502	4908	6781
2	45989	1309	748	494	2551
3	316671	43771	6203	7015	56989
4	898062	257870	9400	7102	274372
5	5423	1533	9	7	1549
6	2250	597	0	0	597
7	2098	545	4	0	549
Wt	611	136	6	6	148

Forecast for year 2004
F multiplier H.cons=1.00
F multiplier Indust=1.00

Age	Stock No. (Populations)	H.Cons (Catch number)	Discards	By-catch	Total
0	6233448	0	428	31229	31657
1	792892	513	2076	6783	9372
2	107526	3060	1749	1155	5964
3	28758	3975	563	637	5175
4	196697	56480	2059	1556	60094
5	459994	130032	788	595	131415
6	3049	809	0	0	810
7	2530	658	4	0	662
Wt	530	119	2	3	124

Table 8a Haddock in Subarea IV and Division IIIa. Management option table from run 4.

	Year 2003	2004	2004	2004	2004	2004	2004	2004
Mean F Ages								
H.cons 2 to 4	0.34	0.00	0.13	0.27	0.34	0.40	0.54	0.67
Ind BC 2 to 4	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Effort relative to 2002								
H.cons	1.00	0.00	0.40	0.80	1.00	1.20	1.60	2.00
Ind BC	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Biomass								
Total 1 January	611	445	445	445	445	445	445	445
SSB at spawning time	457	322	322	322	322	322	322	322
Catch weight (,000t)								
H.cons	172	0	62	112	133	152	184	209
Discards	20	0	3	5	6	8	10	12
Ind BC	21	11	11	10	10	10	9	9
Total Landings	193	11	73	122	143	161	193	218
Total Catch	212	11	76	127	149	169	202	230
Biomass in year.... 2005								
Total 1 January		461	391	335	312	291	257	229
SSB at spawning time		346	278	224	201	181	148	121

	Year 2003	2004	2004	2004	2004	2004	2004	2004
Effort relative to 2002								
H.cons	1.00	0.00	0.40	0.80	1.00	1.20	1.60	2.00
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	0.11	0.31	0.31	0.31	0.31	0.31	0.31	0.31
SSB at spawning time	0.14	0.22	0.22	0.22	0.22	0.22	0.22	0.22
Catch weight								
H.cons	0.28	0.00	0.53	0.29	0.26	0.23	0.22	0.21
Discards	0.36	0.00	0.71	0.56	0.54	0.54	0.54	0.55
Ind BC	0.62	0.79	0.81	0.84	0.85	0.86	0.88	0.90
Biomass in year.... 2005								
Total 1 January		0.33	0.37	0.41	0.44	0.46	0.50	0.55
SSB at spawning time		0.24	0.28	0.29	0.29	0.30	0.31	0.32

Table 8b Haddock in Subarea IV and Division IIIa. Detailed forecast table from run 4.

Forecast for year 2003
F multiplier H.cons=1.00
F multiplier Indust=1.00

Populations		Catch number			
Age	Stock No.	H.Cons	Discards	By-catch	Total
0	6233448	0	1547	80500	82047
1	573688	1488	8858	32317	42663
2	45989	1132	3970	379	5480
3	316671	24260	28068	816	53144
4	898062	354090	25887	32322	412298
5	5423	2165	8	30	2203
6	2250	670	0	0	670
7	2098	560	64	0	624
Wt	611	172	20	21	212

Forecast for year 2004
F multiplier H.cons=1.00
F multiplier Indust=1.00

Populations		Catch number			
Age	Stock No.	H.Cons	Discards	By-catch	Total
0	6233448	0	1547	80500	82047
1	777734	2017	12008	43812	57838
2	93793	2308	8097	772	11177
3	26393	2022	2339	68	4429
4	200049	78876	5766	7200	91842
5	341805	136476	508	1889	138873
6	2469	735	0	0	735
7	2399	640	74	0	714
Wt	445	133	6	10	149

Table 9a Haddock in Subarea IV and Division IIIa. Management option table from run 5.

	Year 2003	2004						
Mean F Ages								
H.cons 2 to 4	0.30	0.00	0.12	0.24	0.30	0.37	0.49	0.61
Ind BC 2 to 4	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Effort relative to 2002								
H.cons	1.00	0.00	0.40	0.80	1.00	1.20	1.60	2.00
Ind BC	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Biomass								
Total 1 January	611	462	462	462	462	462	462	462
SSB at spawning time	457	338	338	338	338	338	338	338
Catch weight (,000t)								
H.cons	161	0	63	115	136	156	189	216
Discards	18	0	3	5	6	7	9	11
Ind BC	19	11	10	10	9	9	9	8
Total Landings	181	11	74	124	146	165	198	224
Total Catch	199	11	76	129	151	172	206	235
Biomass in year.... 2005								
Total 1 January		478	407	351	327	305	269	240
SSB at spawning time		363	293	238	215	195	159	132

	Year 2003	2004						
Effort relative to 2002								
H.cons	1.00	0.00	0.40	0.80	1.00	1.20	1.60	2.00
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	0.11	0.30	0.30	0.30	0.30	0.30	0.30	0.30
SSB at spawning time	0.14	0.21	0.21	0.21	0.21	0.21	0.21	0.21
Catch weight								
H.cons	0.29	0.00	0.53	0.29	0.25	0.23	0.21	0.20
Discards	0.36	0.00	0.70	0.54	0.52	0.51	0.51	0.52
Ind BC	0.63	0.79	0.82	0.84	0.85	0.86	0.88	0.90
Biomass in year.... 2005								
Total 1 January		0.32	0.36	0.40	0.42	0.44	0.48	0.53
SSB at spawning time		0.23	0.27	0.27	0.28	0.28	0.29	0.30

Table 9b Haddock in Subarea IV and Division IIIa. Detailed forecast table from run 5.

Forecast for year 2003
F multiplier H.cons=1.00
F multiplier Indust=1.00

Populations		Catch number			
Age	Stock No.	H.Cons	Discards	By-catch	Total
0	6233448	0	1640	85368	87008
1	573688	1243	7401	27001	35645
2	45989	987	3463	330	4780
3	316671	21932	25375	738	48045
4	898062	332657	24320	30366	387343
5	5423	2144	8	30	2182
6	2250	665	0	0	665
7	2098	560	64	0	624
Wt	611	161	18	19	199

Forecast for year 2004
F multiplier H.cons=1.00
F multiplier Indust=1.00

Populations		Catch number			
Age	Stock No.	H.Cons	Discards	By-catch	Total
0	6233448	0	1640	85368	87008
1	776247	1682	10014	36535	48231
2	96438	2070	7262	693	10024
3	26957	1867	2160	63	4090
4	204499	75750	5538	6915	88202
5	363041	143532	534	1987	146052
6	2488	736	0	0	736
7	2403	641	74	0	715
Wt	462	136	6	9	151

Table 10a Haddock in Subarea IV and Division IIIa. Management option table from run 6.

	Year 2003	2004						
Mean F Ages								
H.cons 2 to 4	0.27	0.00	0.11	0.22	0.27	0.33	0.44	0.54
Ind BC 2 to 4	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Effort relative to 2002								
H.cons	1.00	0.00	0.40	0.80	1.00	1.20	1.60	2.00
Ind BC	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Biomass								
Total 1 January	611	480	480	480	480	480	480	480
SSB at spawning time	457	355	355	355	355	355	355	355
Catch weight (,000t)								
H.cons	150	0	65	117	139	159	194	222
Discards	16	0	2	4	5	6	8	9
Ind BC	18	10	9	9	9	9	8	8
Total Landings	168	10	74	126	148	168	202	230
Total Catch	184	10	76	130	153	174	210	239
Biomass in year.... 2005								
Total 1 January		496	425	367	343	321	283	253
SSB at spawning time		380	310	254	230	209	172	143

	Year 2003	2004						
Effort relative to 2002								
H.cons	1.00	0.00	0.40	0.80	1.00	1.20	1.60	2.00
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	0.11	0.29	0.29	0.29	0.29	0.29	0.29	0.29
SSB at spawning time	0.14	0.20	0.20	0.20	0.20	0.20	0.20	0.20
Catch weight								
H.cons	0.29	0.00	0.53	0.29	0.25	0.23	0.20	0.19
Discards	0.36	0.00	0.68	0.51	0.49	0.49	0.48	0.49
Ind BC	0.64	0.80	0.82	0.84	0.86	0.87	0.89	0.90
Biomass in year.... 2005								
Total 1 January		0.31	0.35	0.38	0.40	0.42	0.46	0.51
SSB at spawning time		0.23	0.26	0.26	0.27	0.27	0.28	0.29

Table 10b Haddock in Subarea IV and Division IIIa. Detailed forecast table from run 6.

Forecast for year 2003
F multiplier H.cons=1.00
F multiplier Indust=1.00

Populations		Catch number			
Age	Stock No.	H.Cons	Discards	By-catch	Total
0	6233448	0	1734	90230	91964
1	573688	994	5914	21577	28484
2	45989	840	2946	281	4066
3	316671	19555	22624	658	42837
4	898062	309972	22661	28295	360928
5	5423	2123	8	29	2160
6	2250	661	0	0	661
7	2098	559	64	0	624
Wt	611	150	16	18	184

Forecast for year 2004
F multiplier H.cons=1.00
F multiplier Indust=1.00

Populations		Catch number			
Age	Stock No.	H.Cons	Discards	By-catch	Total
0	6233448	0	1734	90230	91964
1	774762	1342	7987	29139	38468
2	99158	1810	6352	606	8768
3	27533	1700	1967	57	3724
4	209047	72154	5275	6586	84015
5	385597	150927	561	2089	153577
6	2507	737	0	0	737
7	2407	642	74	0	716
Wt	480	139	5	9	153

Table 11a Haddock in Subarea IV and Division IIIa. Management option table from run 7.

	Year 2003	2004						
Mean F Ages								
H.cons 2 to 4	0.67	0.00	0.27	0.54	0.67	0.81	1.07	1.34
Ind BC 2 to 4	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
Effort relative to 2002								
H.cons	1.00	0.00	0.40	0.80	1.00	1.20	1.60	2.00
Ind BC	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Biomass								
Total 1 January	611	348	348	348	348	348	348	348
SSB at spawning time	457	231	231	231	231	231	231	231
Catch weight (,000t)								
H.cons	239	0	52	91	107	121	145	163
Discards	36	0	5	8	10	12	14	17
Ind BC	13	5	5	4	4	4	4	4
Total Landings	252	5	56	96	112	126	149	167
Total Catch	288	5	61	104	122	137	163	184
Biomass in year.... 2005								
Total 1 January		369	308	263	244	228	202	182
SSB at spawning time		253	195	151	133	118	93	74

	Year 2003	2004						
Effort relative to 2002								
H.cons	1.00	0.00	0.40	0.80	1.00	1.20	1.60	2.00
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	0.11	0.40	0.40	0.40	0.40	0.40	0.40	0.40
SSB at spawning time	0.14	0.31	0.31	0.31	0.31	0.31	0.31	0.31
Catch weight								
H.cons	0.25	0.00	0.55	0.35	0.32	0.30	0.29	0.29
Discards	0.32	0.00	0.69	0.55	0.53	0.53	0.53	0.54
Ind BC	0.65	0.81	0.83	0.86	0.87	0.88	0.90	0.91
Biomass in year.... 2005								
Total 1 January		0.41	0.47	0.52	0.55	0.58	0.63	0.69
SSB at spawning time		0.32	0.36	0.37	0.37	0.38	0.39	0.41

Table 11b Haddock in Subarea IV and Division IIIa. Detailed forecast table from run 7.

Forecast for year 2003
F multiplier H.cons=1.00
F multiplier Indust=1.00

Populations		Catch number			
Age	Stock No.	H.Cons	Discards	By-catch	Total
0	6233448	0	1387	35440	36826
1	573688	614	10971	13704	25288
2	45989	3668	7481	2439	13588
3	316671	92585	42988	26088	161661
4	898062	435939	57245	11858	505042
5	5423	2285	60	12	2357
6	2250	1045	5	0	1050
7	2098	959	20	0	979
Wt	611	239	36	13	288

Forecast for year 2004
F multiplier H.cons=1.00
F multiplier Indust=1.00

Populations		Catch number			
Age	Stock No.	H.Cons	Discards	By-catch	Total
0	6233448	0	1387	35440	36826
1	791333	847	15133	18902	34882
2	100379	8005	16328	5324	29658
3	19934	5828	2706	1642	10176
4	106747	51817	6804	1409	60031
5	263619	111055	2920	585	114560
6	2334	1084	5	0	1089
7	1749	799	17	0	816
Wt	348	107	10	4	122

Table 12a Haddock in Subarea IV and Division IIIa. Management option table from run 8.

	Year 2003	2004						
Mean F Ages								
H.cons 2 to 4	0.60	0.00	0.24	0.48	0.60	0.72	0.97	1.21
Ind BC 2 to 4	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
Effort relative to 2002								
H.cons	1.00	0.00	0.40	0.80	1.00	1.20	1.60	2.00
Ind BC	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Biomass								
Total 1 January	611	368	368	368	368	368	368	368
SSB at spawning time	457	250	250	250	250	250	250	250
Catch weight (,000t)								
H.cons	225	0	54	96	113	129	154	174
Discards	34	0	4	8	10	11	14	16
Ind BC	12	5	5	4	4	4	4	4
Total Landings	237	5	59	100	118	133	158	177
Total Catch	271	5	63	108	127	144	171	193
Biomass in year.... 2005								
Total 1 January		389	326	278	259	241	213	191
SSB at spawning time		273	212	166	147	130	103	83

	Year 2003	2004						
Effort relative to 2002								
H.cons	1.00	0.00	0.40	0.80	1.00	1.20	1.60	2.00
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	0.11	0.38	0.38	0.38	0.38	0.38	0.38	0.38
SSB at spawning time	0.14	0.29	0.29	0.29	0.29	0.29	0.29	0.29
Catch weight								
H.cons	0.26	0.00	0.55	0.33	0.30	0.29	0.28	0.27
Discards	0.32	0.00	0.68	0.52	0.50	0.50	0.50	0.50
Ind BC	0.65	0.81	0.83	0.85	0.86	0.87	0.89	0.91
Biomass in year.... 2005								
Total 1 January		0.39	0.45	0.50	0.52	0.55	0.61	0.66
SSB at spawning time		0.30	0.34	0.35	0.35	0.36	0.37	0.39

Table 12b Haddock in Subarea IV and Division IIIa. Detailed forecast table from run 8.

Forecast for year 2003
F multiplier H.cons=1.00
F multiplier Indust=1.00

Populations		Catch number			
Age	Stock No.	H.Cons	Discards	By-catch	Total
0	6233448	0	1471	37596	39067
1	573688	511	9128	11402	21042
2	45989	3251	6631	2162	12045
3	316671	85933	39899	24213	150046
4	898062	412694	54193	11226	478112
5	5423	2263	59	12	2334
6	2250	1039	5	0	1044
7	2098	958	20	0	979
Wt	611	225	34	12	271

Forecast for year 2004
F multiplier H.cons=1.00
F multiplier Indust=1.00

Populations		Catch number			
Age	Stock No.	H.Cons	Discards	By-catch	Total
0	6233448	0	1471	37596	39067
1	790657	704	12581	15715	28999
2	102007	7211	14709	4796	26716
3	21153	5740	2665	1617	10023
4	116568	53568	7034	1457	62059
5	286188	119412	3140	629	123181
6	2353	1087	5	0	1092
7	1754	801	17	0	818
Wt	368	113	10	4	127

Table 13a Haddock in Subarea IV and Division IIIa. Management option table from run 9.

	Year 2003	2004						
Mean F Ages								
H.cons 2 to 4	0.54	0.00	0.21	0.43	0.54	0.64	0.86	1.07
Ind BC 2 to 4	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
Effort relative to 2002								
H.cons	1.00	0.00	0.40	0.80	1.00	1.20	1.60	2.00
Ind BC	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Biomass								
Total 1 January	611	391	391	391	391	391	391	391
SSB at spawning time	457	271	271	271	271	271	271	271
Catch weight (,000t)								
H.cons	211	0	57	101	120	136	163	185
Discards	31	0	4	7	9	10	13	15
Ind BC	11	4	4	4	4	4	4	4
Total Landings	222	4	61	105	124	140	167	188
Total Catch	253	4	65	113	133	150	180	203
Biomass in year.... 2005								
Total 1 January		412	346	295	274	256	226	202
SSB at spawning time		295	231	182	162	144	115	92

	Year 2003	2004						
Effort relative to 2002								
H.cons	1.00	0.00	0.40	0.80	1.00	1.20	1.60	2.00
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	0.11	0.36	0.36	0.36	0.36	0.36	0.36	0.36
SSB at spawning time	0.14	0.27	0.27	0.27	0.27	0.27	0.27	0.27
Catch weight								
H.cons	0.27	0.00	0.54	0.32	0.29	0.27	0.26	0.25
Discards	0.33	0.00	0.65	0.49	0.47	0.46	0.46	0.47
Ind BC	0.65	0.81	0.83	0.86	0.87	0.88	0.90	0.91
Biomass in year.... 2005								
Total 1 January		0.37	0.43	0.47	0.50	0.52	0.58	0.63
SSB at spawning time		0.28	0.32	0.33	0.34	0.34	0.35	0.37

Table 13b Haddock in Subarea IV and Division IIIa. Detailed forecast table from run 9.

Forecast for year 2003
F multiplier H.cons=1.00
F multiplier Indust=1.00

Age	Populations: Stock No.	Catch number: H.Cons	Discards	By-catch	Total
0	6233448	0	1555	39752	41307
1	573688	407	7264	9074	16745
2	45989	2811	5734	1870	10415
3	316671	78707	36544	22177	137429
4	898062	387591	50896	10543	449031
5	5423	2241	59	12	2312
6	2250	1034	5	0	1039
7	2098	958	20	0	978
Wt	611	211	31	11	253

Forecast for year 2004
F multiplier H.cons=1.00
F multiplier Indust=1.00

Age	Populations: Stock No.	Catch number: H.Cons	Discards	By-catch	Total
0	6233448	0	1555	39752	41307
1	789982	560	10003	12495	23058
2	103662	6337	12925	4214	23476
3	22445	5579	2590	1572	9741
4	127293	54938	7214	1494	63647
5	310689	128377	3375	676	132428
6	2373	1090	5	0	1096
7	1759	803	17	0	820
Wt	391	120	9	4	133

Table 14a Haddock in Subarea IV and Division IIIa. Management option table from run 10.

	Year 2003	2004						
Mean F Ages								
H.cons 2 to 4	0.09	0.00	0.04	0.07	0.09	0.11	0.15	0.18
Ind BC 2 to 4	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Effort relative to 2002								
H.cons	1.00	0.00	0.40	0.80	1.00	1.20	1.60	2.00
Ind BC	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Biomass								
Total 1 January	611	637	637	637	637	637	637	637
SSB at spawning time	457	499	499	499	499	499	499	499
Catch weight (,000t)								
H.cons	58.8	0.0	23.7	46.3	57.2	67.8	88.2	107.7
Discards	3.2	0.0	0.5	1.0	1.3	1.5	2.0	2.5
Ind BC	2.5	1.1	1.1	1.1	1.1	1.1	1.1	1.1
Total Landings	61.3	1.1	24.9	47.4	58.3	68.9	89.3	108.7
Total Catch	64.5	1.1	25.4	48.4	59.6	70.4	91.3	111.2
Biomass in year.... 2005								
Total 1 January		652	626	602	590	578	556	534
SSB at spawning time		530	504	480	468	457	435	414

	Year 2003	2004						
Effort relative to 2002								
H.cons	1.00	0.00	0.40	0.80	1.00	1.20	1.60	2.00
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	0.11	0.23	0.23	0.23	0.23	0.23	0.23	0.23
SSB at spawning time	0.14	0.16	0.16	0.16	0.16	0.16	0.16	0.16
Catch weight								
H.cons	0.33	0.00	0.56	0.30	0.26	0.23	0.19	0.18
Discards	0.36	0.00	0.67	0.48	0.46	0.44	0.43	0.43
Ind BC	0.63	0.78	0.78	0.79	0.79	0.79	0.79	0.80
Biomass in year.... 2005								
Total 1 January		0.26	0.26	0.27	0.27	0.28	0.28	0.29
SSB at spawning time		0.19	0.20	0.20	0.20	0.20	0.20	0.20

Table 14b Haddock in Subarea IV and Division IIIa. Detailed forecast table from run 10.

Forecast for year 2003
F multiplier H.cons=1.00
F multiplier Indust=1.00

Populations		Catch number			
Age	Stock No.	H.Cons	Discards	By-catch	Total
0	6233448	0	248	8930	9178
1	573688	182	1202	2409	3793
2	45989	584	561	221	1366
3	316671	18839	3969	3019	25827
4	898062	111523	4867	3071	119462
5	5423	566	5	3	573
6	2250	216	0	0	216
7	2098	194	3	0	197
Wt	611	59	3	3	64

Forecast for year 2004
F multiplier H.cons=1.00
F multiplier Indust=1.00

Populations		Catch number			
Age	Stock No.	H.Cons	Discards	By-catch	Total
0	6233448	0	248	8930	9178
1	799684	254	1675	3358	5287
2	108692	1381	1326	521	3228
3	29718	1768	372	283	2424
4	223936	27809	1214	766	29788
5	594615	62070	525	284	62879
6	3923	377	0	0	377
7	3187	295	4	0	299
Wt	637	57	1	1	60

Table 15a Haddock in Subarea IV and Division IIIa. Management option table from run 11.

	Year 2003	2004						
Mean F Ages								
H.cons 2 to 4	0.08	0.00	0.03	0.06	0.08	0.10	0.13	0.16
Ind BC 2 to 4	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Effort relative to 2002								
H.cons	1.00	0.00	0.40	0.80	1.00	1.20	1.60	2.00
Ind BC	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Biomass								
Total 1 January	611	644	644	644	644	644	644	644
SSB at spawning time	457	506	506	506	506	506	506	506
Catch weight (,000t)								
H.cons	54.0	0.0	23.3	45.5	56.3	66.7	86.9	106.2
Discards	2.6	0.0	0.4	0.8	1.0	1.2	1.6	1.9
Ind BC	2.3	1.1	1.1	1.0	1.0	1.0	1.0	1.0
Total Landings	56.4	1.1	24.4	46.6	57.3	67.8	87.9	107.2
Total Catch	59.0	1.1	24.8	47.4	58.3	69.0	89.5	109.1
Biomass in year.... 2005								
Total 1 January		659	634	610	598	587	565	544
SSB at spawning time		537	512	488	477	465	444	423

	Year 2003	2004						
Effort relative to 2002								
H.cons	1.00	0.00	0.40	0.80	1.00	1.20	1.60	2.00
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	0.11	0.22	0.22	0.22	0.22	0.22	0.22	0.22
SSB at spawning time	0.14	0.16	0.16	0.16	0.16	0.16	0.16	0.16
Catch weight								
H.cons	0.34	0.00	0.56	0.30	0.26	0.23	0.19	0.18
Discards	0.36	0.00	0.65	0.46	0.43	0.41	0.40	0.40
Ind BC	0.64	0.79	0.80	0.80	0.80	0.81	0.81	0.82
Biomass in year.... 2005								
Total 1 January		0.25	0.26	0.27	0.27	0.27	0.28	0.29
SSB at spawning time		0.19	0.20	0.20	0.20	0.20	0.20	0.20

Table 15b Haddock in Subarea IV and Division IIIa. Detailed forecast table from run 11.

Forecast for year 2003
F multiplier H.cons=1.00
F multiplier Indust=1.00

Age	Stock No. (Populations)	H.Cons (Catch number)	Discards	By-catch	Total
0	6233448	0	192	9476	9668
1	573688	151	843	1995	2989
2	45989	506	403	191	1101
3	316671	16955	3056	2717	22729
4	898062	102809	4151	2831	109792
5	5423	559	4	3	566
6	2250	215	0	0	215
7	2098	194	2	0	196
Wt	611	54	3	2	59

Forecast for year 2004
F multiplier H.cons=1.00
F multiplier Indust=1.00

Age	Stock No. (Populations)	H.Cons (Catch number)	Discards	By-catch	Total
0	6233448	0	192	9476	9668
1	799536	210	1175	2781	4166
2	109006	1200	956	453	2610
3	29933	1603	289	257	2148
4	226653	25947	1048	715	27709
5	603069	62177	452	284	62914
6	3930	375	0	0	375
7	3189	295	3	0	298
Wt	644	56	1	1	58

Table 16a Haddock in Subarea IV and Division IIIa. Management option table from run 12.

	2003	2004						
Mean F Ages								
H.cons 2 to 4	0.07	0.00	0.03	0.06	0.07	0.08	0.11	0.14
Ind BC 2 to 4	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Effort relative to 2002								
H.cons	1.00	0.00	0.40	0.80	1.00	1.20	1.60	2.00
Ind BC	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Biomass								
Total 1 January	611	651	651	651	651	651	651	651
SSB at spawning time	457	512	512	512	512	512	512	512
Catch weight (,000t)								
H.cons	49.2	0.0	22.9	44.7	55.3	65.6	85.5	104.6
Discards	2.0	0.0	0.3	0.6	0.7	0.9	1.2	1.4
Ind BC	2.1	1.0	1.0	1.0	1.0	1.0	1.0	0.9
Total Landings	51.4	1.0	23.9	45.7	56.3	66.6	86.5	105.5
Total Catch	53.4	1.0	24.2	46.3	57.0	67.5	87.7	106.9
Biomass in year.... 2005								
Total 1 January		667	642	618	607	596	574	554
SSB at spawning time		544	519	496	485	474	453	433

	2003	2004						
Effort relative to 2002								
H.cons	1.00	0.00	0.40	0.80	1.00	1.20	1.60	2.00
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	0.11	0.22	0.22	0.22	0.22	0.22	0.22	0.22
SSB at spawning time	0.14	0.16	0.16	0.16	0.16	0.16	0.16	0.16
Catch weight								
H.cons	0.34	0.00	0.56	0.30	0.26	0.23	0.20	0.18
Discards	0.36	0.00	0.63	0.42	0.39	0.37	0.35	0.35
Ind BC	0.65	0.82	0.82	0.83	0.83	0.83	0.84	0.84
Biomass in year.... 2005								
Total 1 January		0.25	0.26	0.26	0.27	0.27	0.28	0.28
SSB at spawning time		0.19	0.20	0.20	0.20	0.20	0.20	0.20

Table 16b Haddock in Subarea IV and Division IIIa. Detailed forecast table from run 12.

Forecast for year 2003
F multiplier H.cons=1.00
F multiplier Indust=1.00

Age	Populations: Stock No.	Catch number: H.Cons	Discards	By-catch	Total
0	6233448	0	137	10021	10158
1	573688	119	484	1580	2183
2	45989	428	245	162	834
3	316671	15049	2133	2412	19594
4	898062	93977	3426	2588	99991
5	5423	552	3	3	558
6	2250	213	0	0	213
7	2098	194	1	0	195
Wt	611	49	2	2	53

Forecast for year 2004
F multiplier H.cons=1.00
F multiplier Indust=1.00

Age	Populations: Stock No.	Catch number: H.Cons	Discards	By-catch	Total
0	6233448	0	137	10021	10158
1	799387	166	674	2202	3042
2	109321	1018	582	384	1983
3	30149	1433	203	230	1865
4	229403	24006	875	661	25542
5	611644	62274	378	285	62937
6	3937	373	0	0	373
7	3191	295	2	0	297
Wt	651	55	1	1	57

Table 17a Haddock in Subarea IV and Division IIIa. Management option table from run 13.

	Year 2003	2004						
Mean F Ages								
H.cons 2 to 4	0.11	0.00	0.04	0.09	0.11	0.13	0.17	0.22
Ind BC 2 to 4	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Effort relative to 2002								
H.cons	1.00	0.00	0.40	0.80	1.00	1.20	1.60	2.00
Ind BC	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Biomass								
Total 1 January	611	612	612	612	612	612	612	612
SSB at spawning time	457	476	476	476	476	476	476	476
Catch weight (,000t)								
H.cons	67.5	0.0	32.2	62.1	76.3	89.9	115.8	139.9
Discards	7.2	0.0	1.1	2.1	2.6	3.1	4.0	5.0
Ind BC	7.8	4.1	4.0	4.0	3.9	3.9	3.8	3.7
Total Landings	75.3	4.1	36.2	66.1	80.2	93.8	119.6	143.6
Total Catch	82.5	4.1	37.3	68.2	82.8	96.9	123.7	148.6
Biomass in year.... 2005								
Total 1 January		627	591	558	542	527	499	472
SSB at spawning time		506	471	438	423	408	380	355

	Year 2003	2004						
Effort relative to 2002								
H.cons	1.00	0.00	0.40	0.80	1.00	1.20	1.60	2.00
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	0.11	0.23	0.23	0.23	0.23	0.23	0.23	0.23
SSB at spawning time	0.14	0.16	0.16	0.16	0.16	0.16	0.16	0.16
Catch weight								
H.cons	0.34	0.00	0.55	0.30	0.25	0.22	0.19	0.18
Discards	0.37	0.00	0.71	0.53	0.51	0.50	0.49	0.48
Ind BC	0.62	0.76	0.77	0.78	0.78	0.79	0.79	0.80
Biomass in year.... 2005								
Total 1 January		0.26	0.27	0.28	0.29	0.29	0.30	0.31
SSB at spawning time		0.20	0.20	0.20	0.20	0.20	0.21	0.21

Table 17b Haddock in Subarea IV and Division IIIa. Detailed forecast table from run 13.

Forecast for year 2003
F multiplier H.cons=1.00
F multiplier Indust=1.00

Populations		Catch number			
Age	Stock No.	H.Cons	Discards	By-catch	Total
0	6233448	0	499	25946	26445
1	573688	495	2949	10758	14202
2	45989	380	1333	127	1841
3	316671	8298	9600	279	18177
4	898062	140403	10265	12816	163484
5	5423	830	3	11	844
6	2250	243	0	0	243
7	2098	203	23	0	226
Wt	611	68	7	8	83

Forecast for year 2004
F multiplier H.cons=1.00
F multiplier Indust=1.00

Populations		Catch number			
Age	Stock No.	H.Cons	Discards	By-catch	Total
0	6233448	0	499	25946	26445
1	794465	686	4083	14898	19668
2	104644	865	3034	289	4188
3	29333	769	889	26	1684
4	230647	36059	2636	3292	41987
5	556195	85092	317	1178	86586
6	3680	397	0	0	397
7	3137	303	35	0	338
Wt	612	76	3	4	83

Table 18a Haddock in Subarea IV and Division IIIa. Management option table from run 14.

	Year 2003	2004						
Mean F Ages								
H.cons 2 to 4	0.10	0.00	0.04	0.08	0.10	0.12	0.16	0.19
Ind BC 2 to 4	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Effort relative to 2002								
H.cons	1.00	0.00	0.40	0.80	1.00	1.20	1.60	2.00
Ind BC	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Biomass								
Total 1 January	611	621	621	621	621	621	621	621
SSB at spawning time	457	484	484	484	484	484	484	484
Catch weight (,000t)								
H.cons	62.3	0.0	31.8	61.4	75.5	89.0	114.8	138.8
Discards	6.5	0.0	1.0	1.9	2.3	2.8	3.6	4.4
Ind BC	7.3	3.8	3.8	3.7	3.7	3.6	3.6	3.5
Total Landings	69.6	3.8	35.6	65.1	79.1	92.7	118.3	142.3
Total Catch	76.1	3.8	36.5	67.0	81.4	95.4	122.0	146.7
Biomass in year.... 2005								
Total 1 January		635	600	567	552	537	509	483
SSB at spawning time		514	479	447	432	418	390	364

	Year 2003	2004						
Effort relative to 2002								
H.cons	1.00	0.00	0.40	0.80	1.00	1.20	1.60	2.00
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	0.11	0.23	0.23	0.23	0.23	0.23	0.23	0.23
SSB at spawning time	0.14	0.16	0.16	0.16	0.16	0.16	0.16	0.16
Catch weight								
H.cons	0.34	0.00	0.55	0.30	0.25	0.22	0.19	0.18
Discards	0.37	0.00	0.69	0.51	0.49	0.48	0.47	0.46
Ind BC	0.63	0.77	0.77	0.78	0.78	0.79	0.79	0.80
Biomass in year.... 2005								
Total 1 January		0.26	0.27	0.28	0.28	0.29	0.30	0.31
SSB at spawning time		0.19	0.20	0.20	0.20	0.20	0.20	0.21

Table 18b Haddock in Subarea IV and Division IIIa. Detailed forecast table from run 14.

Forecast for year 2003
F multiplier H.cons=1.00
F multiplier Indust=1.00

Populations		Catch number			
Age	Stock No.	H.Cons	Discards	By-catch	Total
0	6233448	0	529	27527	28056
1	573688	411	2447	8928	11787
2	45989	329	1156	110	1595
3	316671	7450	8620	251	16321
4	898062	129732	9484	11842	151058
5	5423	820	3	11	834
6	2250	241	0	0	241
7	2098	203	23	0	226
Wt	611	62	7	7	76

Forecast for year 2004
F multiplier H.cons=1.00
F multiplier Indust=1.00

Populations		Catch number			
Age	Stock No.	H.Cons	Discards	By-catch	Total
0	6233448	0	529	27527	28056
1	793979	569	3387	12357	16313
2	105580	756	2653	253	3662
3	29532	695	804	23	1522
4	232276	33554	2453	3063	39070
5	567028	85708	319	1186	87213
6	3689	395	0	0	395
7	3139	303	35	0	338
Wt	621	75	2	4	81

Table 19a Haddock in Subarea IV and Division IIIa. Management option table from run 15.

	Year 2003	2004						
Mean F Ages								
H.cons 2 to 4	0.09	0.00	0.03	0.07	0.09	0.10	0.14	0.17
Ind BC 2 to 4	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Effort relative to 2002								
H.cons	1.00	0.00	0.40	0.80	1.00	1.20	1.60	2.00
Ind BC	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Biomass								
Total 1 January	611	629	629	629	629	629	629	629
SSB at spawning time	457	492	492	492	492	492	492	492
Catch weight (,000t)								
H.cons	57.1	0.0	31.4	60.7	74.6	88.1	113.6	137.5
Discards	5.9	0.0	0.8	1.7	2.1	2.4	3.2	3.9
Ind BC	6.7	3.6	3.5	3.4	3.4	3.4	3.3	3.3
Total Landings	63.8	3.6	34.9	64.1	78.0	91.4	116.9	140.8
Total Catch	69.6	3.6	35.7	65.8	80.1	93.9	120.1	144.7
Biomass in year.... 2005								
Total 1 January		643	609	577	562	547	519	493
SSB at spawning time		522	488	457	442	427	400	375

	Year 2003	2004						
Effort relative to 2002								
H.cons	1.00	0.00	0.40	0.80	1.00	1.20	1.60	2.00
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	0.11	0.23	0.23	0.23	0.23	0.23	0.23	0.23
SSB at spawning time	0.14	0.16	0.16	0.16	0.16	0.16	0.16	0.16
Catch weight								
H.cons	0.34	0.00	0.55	0.30	0.25	0.23	0.19	0.18
Discards	0.37	0.00	0.68	0.49	0.47	0.46	0.44	0.44
Ind BC	0.64	0.77	0.78	0.79	0.79	0.79	0.80	0.81
Biomass in year.... 2005								
Total 1 January		0.26	0.27	0.27	0.28	0.28	0.29	0.30
SSB at spawning time		0.19	0.20	0.20	0.20	0.20	0.20	0.20

Table 19b Haddock in Subarea IV and Division IIIa. Detailed forecast table from run 15.

Forecast for year 2003
F multiplier H.cons=1.00
F multiplier Indust=1.00

Populations		Catch number			
Age	Stock No.	H.Cons	Discards	By-catch	Total
0	6233448	0	559	29108	29667
1	573688	326	1942	7087	9355
2	45989	278	977	93	1348
3	316671	6597	7633	222	14452
4	898062	118862	8690	10850	138402
5	5423	810	3	11	824
6	2250	239	0	0	239
7	2098	203	23	0	226
Wt	611	57	6	7	70

Forecast for year 2004
F multiplier H.cons=1.00
F multiplier Indust=1.00

Populations		Catch number			
Age	Stock No.	H.Cons	Discards	By-catch	Total
0	6233448	0	559	29108	29667
1	793492	451	2687	9802	12940
2	106524	645	2262	216	3123
3	29732	619	717	21	1357
4	233917	30960	2263	2826	36049
5	578071	86314	321	1195	87829
6	3698	393	0	0	393
7	3141	303	35	0	338
Wt	629	75	2	3	80

Table 20a Haddock in Subarea IV and Division IIIa. Management option table from run 16.

	Year 2003	2004						
Mean F Ages								
H.cons 2 to 4	0.21	0.00	0.09	0.17	0.21	0.26	0.34	0.43
Ind BC 2 to 4	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Effort relative to 2002								
H.cons	1.00	0.00	0.40	0.80	1.00	1.20	1.60	2.00
Ind BC	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Biomass								
Total 1 January	611	562	562	562	562	562	562	562
SSB at spawning time	457	430	430	430	430	430	430	430
Catch weight (,000t)								
H.cons	101	0	34	64	79	93	119	143
Discards	15	0	2	4	5	6	8	10
Ind BC	5	2	2	2	2	2	2	2
Total Landings	106	2	36	66	81	95	121	144
Total Catch	121	2	38	71	86	101	129	154
Biomass in year.... 2005								
Total 1 January		578	539	504	487	471	441	414
SSB at spawning time		457	419	385	369	353	324	298

	Year 2003	2004						
Effort relative to 2002								
H.cons	1.00	0.00	0.40	0.80	1.00	1.20	1.60	2.00
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	0.11	0.25	0.25	0.25	0.25	0.25	0.25	0.25
SSB at spawning time	0.14	0.18	0.18	0.18	0.18	0.18	0.18	0.18
Catch weight								
H.cons	0.32	0.00	0.55	0.30	0.25	0.22	0.19	0.18
Discards	0.35	0.00	0.65	0.46	0.43	0.42	0.41	0.40
Ind BC	0.65	0.74	0.75	0.75	0.76	0.76	0.77	0.77
Biomass in year.... 2005								
Total 1 January		0.28	0.29	0.31	0.31	0.32	0.34	0.35
SSB at spawning time		0.21	0.22	0.22	0.22	0.22	0.23	0.23

Table 20b Haddock in Subarea IV and Division IIIa. Detailed forecast table from run 16.

Forecast for year 2003
F multiplier H.cons=1.00
F multiplier Indust=1.00

Populations		Catch number			
Age	Stock No.	H.Cons	Discards	By-catch	Total
0	6233448	0	445	11377	11822
1	573688	201	3592	4487	8281
2	45989	1338	2730	890	4959
3	316671	37931	17612	10688	66231
4	898062	185141	24312	5036	214489
5	5423	889	23	5	918
6	2250	415	2	0	417
7	2098	380	8	0	388
Wt	611	101	15	5	121

Forecast for year 2004
F multiplier H.cons=1.00
F multiplier Indust=1.00

Populations		Catch number			
Age	Stock No.	H.Cons	Discards	By-catch	Total
0	6233448	0	445	11377	11822
1	798884	280	5003	6249	11531
2	106942	3112	6348	2070	11531
3	26813	3212	1491	905	5608
4	188650	38891	5107	1058	45056
5	511836	83947	2207	442	86596
6	3614	666	3	0	669
7	2835	514	11	0	525
Wt	562	79	5	2	86

Table 21a Haddock in Subarea IV and Division IIIa. Management option table from run 17.

	Year 2003	2004						
Mean F Ages								
H.cons 2 to 4	0.19	0.00	0.08	0.15	0.19	0.23	0.31	0.39
Ind BC 2 to 4	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Effort relative to 2002								
H.cons	1.00	0.00	0.40	0.80	1.00	1.20	1.60	2.00
Ind BC	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Biomass								
Total 1 January	611	574	574	574	574	574	574	574
SSB at spawning time	457	441	441	441	441	441	441	441
Catch weight (,000t)								
H.cons	92.9	0.0	33.5	64.2	78.7	92.6	118.6	142.6
Discards	13.7	0.0	2.0	3.9	4.8	5.7	7.3	8.9
Ind BC	4.8	1.9	1.9	1.8	1.8	1.8	1.7	1.7
Total Landings	97.7	1.9	35.3	66.1	80.5	94.3	120.4	144.3
Total Catch	111.5	1.9	37.4	70.0	85.3	100.0	127.7	153.2
Biomass in year.... 2005								
Total 1 January		590	552	516	500	484	454	427
SSB at spawning time		469	432	397	381	366	337	310

	Year 2003	2004						
Effort relative to 2002								
H.cons	1.00	0.00	0.40	0.80	1.00	1.20	1.60	2.00
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	0.11	0.25	0.25	0.25	0.25	0.25	0.25	0.25
SSB at spawning time	0.14	0.17	0.17	0.17	0.17	0.17	0.17	0.17
Catch weight								
H.cons	0.32	0.00	0.55	0.30	0.25	0.22	0.19	0.18
Discards	0.35	0.00	0.64	0.44	0.42	0.40	0.39	0.38
Ind BC	0.65	0.74	0.75	0.75	0.76	0.76	0.77	0.77
Biomass in year.... 2005								
Total 1 January		0.28	0.29	0.30	0.31	0.31	0.33	0.34
SSB at spawning time		0.21	0.21	0.22	0.22	0.22	0.22	0.23

Table 21b Haddock in Subarea IV and Division IIIa. Detailed forecast table from run 17.

Forecast for year 2003
F multiplier H.cons=1.00
F multiplier Indust=1.00

Populations		Catch number			
Age	Stock No.	H.Cons	Discards	By-catch	Total
0	6233448	0	472	12072	12544
1	573688	167	2977	3719	6863
2	45989	1166	2379	776	4321
3	316671	34385	15965	9689	60039
4	898062	171593	22533	4667	198793
5	5423	879	23	5	907
6	2250	412	2	0	414
7	2098	380	8	0	388
Wt	611	93	14	5	111

Forecast for year 2004
F multiplier H.cons=1.00
F multiplier Indust=1.00

Populations		Catch number			
Age	Stock No.	H.Cons	Discards	By-catch	Total
0	6233448	0	472	12072	12544
1	798666	232	4145	5178	9555
2	107494	2726	5561	1813	10100
3	27327	2967	1378	836	5181
4	194039	37075	4868	1008	42952
5	525469	85158	2239	449	87846
6	3624	663	3	0	666
7	2838	514	11	0	525
Wt	574	79	5	2	85

Table 22a Haddock in Subarea IV and Division IIIa. Management option table from run 18.

	Year 2003	2004						
Mean F Ages								
H.cons 2 to 4	0.17	0.00	0.07	0.14	0.17	0.21	0.27	0.34
Ind BC 2 to 4	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Effort relative to 2002								
H.cons	1.00	0.00	0.40	0.80	1.00	1.20	1.60	2.00
Ind BC	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Biomass								
Total 1 January	611	586	586	586	586	586	586	586
SSB at spawning time	457	452	452	452	452	452	452	452
Catch weight (,000t)								
H.cons	85.1	0.0	33.2	63.9	78.3	92.2	118.4	142.5
Discards	12.4	0.0	1.8	3.6	4.4	5.2	6.7	8.2
Ind BC	4.4	1.8	1.7	1.7	1.7	1.6	1.6	1.6
Total Landings	89.5	1.8	35.0	65.6	80.0	93.9	120.0	144.1
Total Catch	101.9	1.8	36.8	69.2	84.4	99.1	126.7	152.2
Biomass in year.... 2005								
Total 1 January		603	565	529	513	497	468	440
SSB at spawning time		481	444	410	394	378	349	323

	Year 2003	2004						
Effort relative to 2002								
H.cons	1.00	0.00	0.40	0.80	1.00	1.20	1.60	2.00
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	0.11	0.24	0.24	0.24	0.24	0.24	0.24	0.24
SSB at spawning time	0.14	0.17	0.17	0.17	0.17	0.17	0.17	0.17
Catch weight								
H.cons	0.32	0.00	0.55	0.30	0.25	0.22	0.19	0.18
Discards	0.35	0.00	0.63	0.43	0.40	0.38	0.37	0.36
Ind BC	0.65	0.75	0.75	0.76	0.76	0.77	0.77	0.78
Biomass in year.... 2005								
Total 1 January		0.27	0.28	0.30	0.30	0.31	0.32	0.33
SSB at spawning time		0.20	0.21	0.21	0.21	0.21	0.22	0.22

Table 23b Haddock in Subarea IV and Division IIIa. Detailed forecast table from run 18.

Forecast for year 2003
F multiplier H.cons=1.00
F multiplier Indust=1.00

Populations		Catch number			
Age	Stock No.	H.Cons	Discards	By-catch	Total
0	6233448	0	500	12767	13266
1	573688	132	2360	2948	5440
2	45989	991	2022	659	3672
3	316671	30743	14274	8662	53680
4	898062	157701	20708	4290	182698
5	5423	868	23	5	896
6	2250	409	2	0	411
7	2098	380	8	0	388
Wt	611	85	12	4	102

Forecast for year 2004
F multiplier H.cons=1.00
F multiplier Indust=1.00

Populations		Catch number			
Age	Stock No.	H.Cons	Discards	By-catch	Total
0	6233448	0	500	12767	13266
1	798447	184	3285	4103	7571
2	108049	2329	4750	1549	8628
3	27851	2704	1255	762	4721
4	199582	35047	4602	953	40602
5	539464	86371	2271	455	89097
6	3634	660	3	0	663
7	2841	515	11	0	525
Wt	586	78	4	2	84

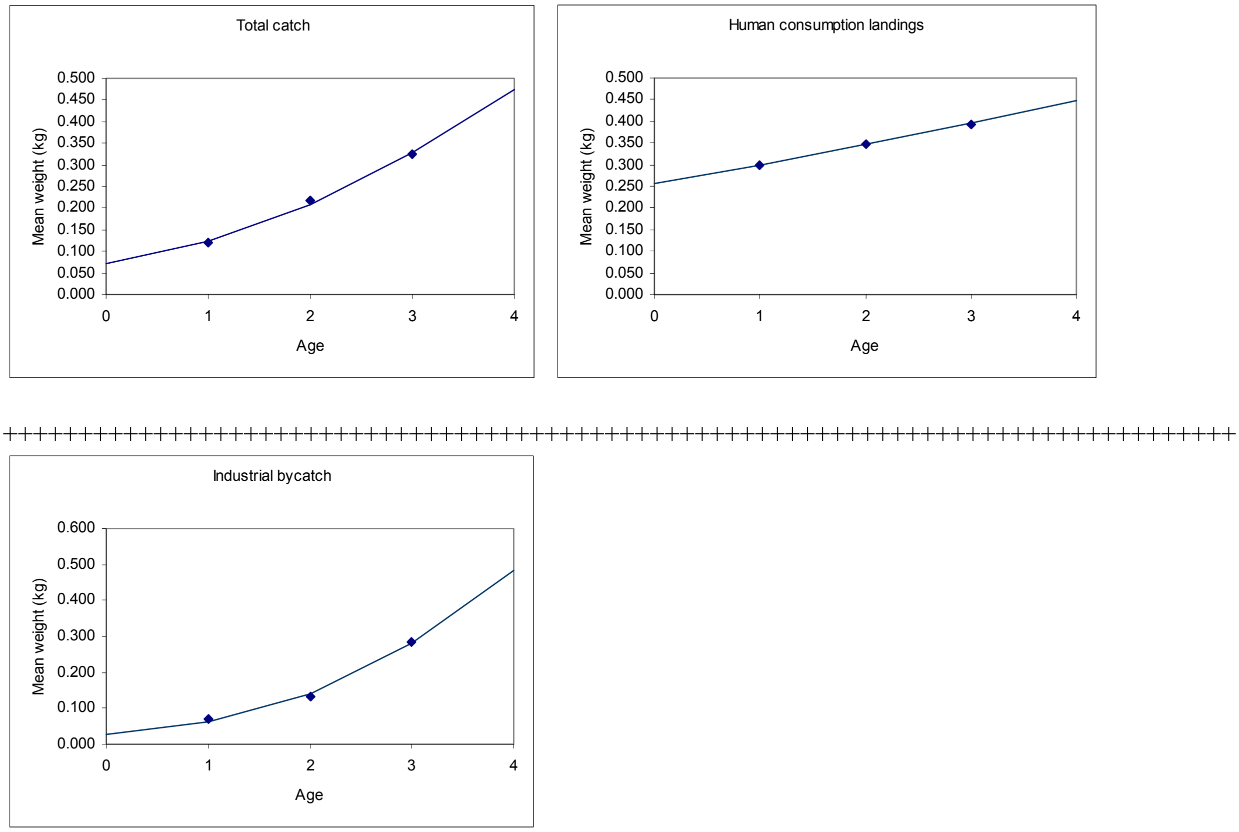

Figure 1 Haddock in Subarea IV and Division IIIa. Mean weights-at-age for the 1999 year class in total catches and three catch components, along with fitted growth curves.

ANNEX 2

Working Document for ACFM, October 2003

The effects of technical measures and assumptions about exploitation on short-term forecasts for North Sea whiting

Coby Needle, FRS Marine Laboratory

Introduction

This document continues the work outlined in the whiting section of the 2003 report of the ICES Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak (in preparation). During the Working Group, time did not permit a full evaluation of the potential effect of recent technical measures and uncertainty regarding forecast exploitation patterns on whiting forecasts, and an undertaking was made to present appropriate results to ACFM at their October 2003 meeting. These results are given below. The methods used for data formulation and forecasting are identical to those in the companion anaylses for haddock (Needle 2003), and the reader is referred to that document for further details. It should be noted that no allowance was made for the possible slow growth of any whiting year class, unlike what was done for haddock.

Results and conclusions

Table 1 gives the input data file for run 1 in the set of scenarios (forecast basis *F*(scaled), 0% derogation uptake, no effort modification). Note that several of the listed CVs in this data file have been corrected from the version given in the 2003 Working Group report. Table 2 shows the selection patterns used for each catch component in each of the 18 runs performed. Table 3 summarises the results of the forecasts, while details of these are given in Tables 4–21.

The forecasts behave much as would be expected. The relationship between *F*(scaled), *F*(2002) and *F*(sq) is complicated, with forecast landings either increasing or decreasing as the forecast basis is changed depending on which catch component is being considered. The full effort multiplier (0.32) reduces whiting catches to a very low level indeed, although this is likely to be an overestimate of the true effect of decommissioning and days-at-sea regulations (see Needle, 2003). The whiting TAC for 2003 is around 38 kt, and in only one forecast is that actually taken in the human consumption landings. This would imply that the recently-imposed technical measures are having a significant effect of the ability of the fleet to catch whiting, an implication supported by anecdotal evidence from skippers.

It should be noted that these forecasts have not allowed for the effects of the ban on lifting bags and the use of square-mesh panels in 110 mm mesh nets, which if used would increase selection. Both of these are unilateral measures which apply only to the Scottish fleet. As this fleet takes only ~50% of the whiting catch, it may be inappropriate to apply Scottish selectivity characteristics to the international fleet as a whole. In any case, analyses accounting for these measures would still only be illustrative, given the caveats about the generakl approach listed in Needle (2003).

References

Needle, C. L. (2003) The effects of technical measures and assumptions about exploitation on short-term forecasts for North Sea haddock. Working Document for ACFM, October 2003.

Table 1 Whiting in Subarea IV and Division VIId. Input data for catch forecast and linear sensitivity analysis for run 1 (F(scaled) basis, 0% derogation uptake, no effort multiplier).

Label	Value	CV	Label	Value	CV
Number-at-age			Weight in the stock		
N1	1459533	0.28	WS1	0.08	0.31
N2	545759	0.26	WS2	0.18	0.10
N3	259221	0.14	WS3	0.23	0.04
N4	170085	0.12	WS4	0.28	0.01
N5	71342	0.11	WS5	0.29	0.08
N6	19022	0.12	WS6	0.31	0.14
H.cons selectivity			Weight in the HC catch		
sH1	0.01	0.35	WH1	0.17	0.12
sH2	0.07	0.37	WH2	0.22	0.02
sH3	0.21	0.35	WH3	0.27	0.01
sH4	0.37	0.21	WH4	0.30	0.03
sH5	0.44	0.29	WH5	0.30	0.10
sH6	0.46	0.29	WH6	0.32	0.13
Discard selectivity			Weight in the discards		
sD1	0.02	0.35	WD1	0.11	0.22
sD2	0.10	0.37	WD2	0.17	0.05
sD3	0.14	0.35	WD3	0.20	0.06
sD4	0.06	0.21	WD4	0.24	0.08
sD5	0.04	0.29	WD5	0.23	0.09
sD6	0.04	0.29	WD6	0.24	0.10
Industrial selectivity			Weight in Ind. by-catch		
sI1	0.08	0.35	WI1	0.04	0.04
sI2	0.08	0.37	WI2	0.14	0.25
sI3	0.11	0.35	WI3	0.19	0.29
sI4	0.10	0.21	WI4	0.30	0.06
sI5	0.05	0.29	WI5	0.37	0.11
sI6	0.02	0.29	WI6	0.28	0.66
Natural mortality			Proportion mature		
M1	0.95	0.10	MT1	0.11	0.10
M2	0.45	0.10	MT2	0.92	0.10
M3	0.35	0.10	MT3	1.00	0.10
M4	0.30	0.10	MT4	1.00	0.00
M5	0.25	0.10	MT5	1.00	0.00
M6	0.25	0.10	MT6	1.00	0.00
Relative effort in HC fishery			Year effect for natural mortality		
HF03	1.00	0.15	K03	1.00	0.10
HF04	1.00	0.15	K04	1.00	0.10
HF05	1.00	0.15	K05	1.00	0.10
Relative effort in industrial fishery					
IF03	1.00	0.63			
IF04	1.00	0.63			
IF05	1.00	0.63			
Recruitment in 2004 and 2005					
R04	1459533	0.38			
R05	1459533	0.38			

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

Stock numbers are XSA are survivors,

Table 2 Whiting in Subarea IV and Division VIId. Exploitation patterns for alternative short-term forecasts.

		Forecast exploitation pattern								
	Age	**Run 1**	**Run 2**	**Run 3**	**Run 4**	**Run 5**	**Run 6**	**Run 7**	**Run 8**	**Run 9**
Human consumption landings	**1**	0.013	0.010	0.008	0.008	0.006	0.004	0.011	0.008	0.006
	2	0.068	0.053	0.039	0.043	0.034	0.025	0.057	0.045	0.033
	3	0.210	0.166	0.122	0.147	0.116	0.085	0.175	0.139	0.102
	4	0.370	0.295	0.220	0.240	0.192	0.143	0.303	0.242	0.180
	5	0.440	0.350	0.261	0.261	0.208	0.155	0.365	0.290	0.216
	6	0.459	0.368	0.278	0.272	0.218	0.165	0.380	0.305	0.230
Discards	**1**	0.021	0.017	0.013	0.018	0.015	0.011	0.025	0.019	0.014
	2	0.099	0.077	0.056	0.094	0.074	0.054	0.124	0.097	0.071
	3	0.138	0.108	0.078	0.144	0.114	0.084	0.172	0.136	0.100
	4	0.062	0.049	0.036	0.060	0.048	0.036	0.075	0.060	0.045
	5	0.038	0.030	0.022	0.033	0.026	0.020	0.046	0.037	0.028
	6	0.036	0.029	0.021	0.032	0.026	0.019	0.045	0.036	0.027
Industrial bycatch	**1**	0.077	0.061	0.044	0.029	0.023	0.016	0.038	0.030	0.022
	2	0.083	0.065	0.047	0.034	0.027	0.019	0.045	0.035	0.026
	3	0.114	0.090	0.066	0.051	0.040	0.030	0.061	0.048	0.036
	4	0.101	0.081	0.060	0.042	0.034	0.025	0.053	0.042	0.031
	5	0.048	0.038	0.028	0.018	0.014	0.011	0.025	0.020	0.015
	6	0.022	0.018	0.013	0.008	0.007	0.005	0.012	0.009	0.007

		Forecast exploitation pattern								
	Age	**Run 10**	**Run 11**	**Run 12**	**Run 13**	**Run 14**	**Run 15**	**Run 16**	**Run 17**	**Run 18**
Human consumption landings	**1**	0.004	0.003	0.002	0.003	0.002	0.001	0.003	0.003	0.002
	2	0.022	0.017	0.012	0.014	0.011	0.008	0.018	0.014	0.010
	3	0.067	0.053	0.039	0.047	0.037	0.027	0.056	0.044	0.033
	4	0.118	0.094	0.070	0.077	0.061	0.046	0.097	0.077	0.058
	5	0.141	0.112	0.083	0.083	0.066	0.050	0.117	0.093	0.069
	6	0.147	0.118	0.089	0.087	0.070	0.053	0.122	0.098	0.074
Discards	**1**	0.007	0.005	0.004	0.006	0.005	0.003	0.008	0.006	0.005
	2	0.032	0.025	0.018	0.030	0.024	0.017	0.040	0.031	0.023
	3	0.044	0.035	0.025	0.046	0.036	0.027	0.055	0.044	0.032
	4	0.020	0.016	0.011	0.019	0.015	0.011	0.024	0.019	0.014
	5	0.012	0.009	0.007	0.011	0.008	0.006	0.015	0.012	0.009
	6	0.012	0.009	0.007	0.010	0.008	0.006	0.014	0.011	0.009
Industrial bycatch	**1**	0.025	0.019	0.014	0.009	0.007	0.005	0.012	0.010	0.007
	2	0.027	0.021	0.015	0.011	0.009	0.006	0.014	0.011	0.008
	3	0.036	0.029	0.021	0.016	0.013	0.010	0.020	0.015	0.011
	4	0.032	0.026	0.019	0.013	0.011	0.008	0.017	0.014	0.010
	5	0.015	0.012	0.009	0.006	0.005	0.003	0.008	0.006	0.005
	6	0.007	0.006	0.004	0.003	0.002	0.002	0.004	0.003	0.002

Table 3 Whiting in Subarea IV and Division VIId. Results from short-term forecasts run under 18 different configurations. All estimates are in thousand tonnes.

		Derogation	**Effort**	**SSB**		**Human cons. landings**		**Discards**		**Industrial bycatch**	
Run number	**Basis**	**uptake**	**multiplier**	**2004**	**2005**	**2003**	**2004**	**2003**	**2004**	**2003**	**2004**
1	F scaled	0%	1.00	224.0	218.0	39.2	37.6	16.0	15.4	15.8	14.6
2	F scaled	50%	1.00	237.0	237.0	32.3	33.5	13.0	13.0	12.9	12.5
3	F scaled	100%	1.00	251.0	260.0	24.9	27.8	9.8	10.2	9.8	9.9
4	F 2002	0%	1.00	246.0	252.0	27.0	29.0	16.3	16.7	6.8	6.8
5	F 2002	50%	1.00	255.0	268.0	22.0	24.9	13.1	13.9	5.5	5.7
6	F 2002	100%	1.00	265.0	285.0	16.8	19.9	9.9	10.7	4.2	4.4
7	F sq	0%	1.00	234.0	233.0	33.4	33.9	20.2	20.0	8.5	8.1
8	F sq	50%	1.00	245.0	251.0	27.4	29.6	16.4	16.8	6.9	6.9
9	F sq	100%	1.00	257.0	271.0	21.0	24.2	12.3	13.1	5.2	5.4
10	F scaled	0%	0.32	269.0	293.0	14.4	17.6	5.7	6.2	5.6	6.1
11	F scaled	50%	0.32	274.0	303.0	11.6	14.6	4.5	5.0	4.5	5.0
12	F scaled	100%	0.32	280.0	313.0	8.7	11.2	3.3	3.8	3.3	3.7
13	F 2002	0%	0.32	278.0	309.0	9.5	12.0	5.6	6.3	2.4	2.6
14	F 2002	50%	0.32	281.0	316.0	7.6	9.8	4.5	5.1	1.9	2.1
15	F 2002	100%	0.32	285.0	323.0	5.7	7.5	3.3	3.8	1.4	1.6
16	F sq	0%	0.32	273.0	301.0	12.0	15.0	7.1	7.9	3.0	3.3
17	F sq	50%	0.32	278.0	309.0	9.6	12.34	5.6	6.34	2.4	2.7
18	F sq	100%	0.32	282.0	317.0	7.2	9.5	4.2	4.8	1.8	2.0

Table 4 Whiting in Subarea IV and Division IIIa. Management option and detailed forecast tables from run 1.

	Year 2003	2004						
Mean F — Ages								
H.cons — 2 to 4	0.32	0.00	0.13	0.25	0.32	0.38	0.50	0.63
Ind BC — 2 to 4	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Effort relative to 2002								
H.cons	1.00	0.00	0.40	0.80	1.00	1.20	1.60	2.00
Ind BC	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Biomass								
Total 1 January	353	341	341	341	341	341	341	341
SSB at spawning time	236	224	224	224	224	224	224	224
Catch weight (,000t)								
H.cons	39.2	0.0	16.6	31.1	37.6	43.8	54.9	64.8
Discards	16.0	0.0	6.6	12.6	15.4	18.1	23.1	27.8
Ind BC	15.8	16.4	15.6	14.9	14.6	14.3	13.7	13.1
Total Landings	55.0	16.4	32.2	46.0	52.3	58.1	68.6	77.9
Total Catch	71.0	16.4	38.8	58.6	67.6	76.1	91.8	105.7
Biomass in year.... 2005								
Total 1 January		380	360	342	334	327	313	301
SSB at spawning time		264	244	226	218	211	197	185

	Year 2003	2004						
Effort relative to 2002								
H.cons	1.00	0.00	0.40	0.80	1.00	1.20	1.60	2.00
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	0.17	0.21	0.21	0.21	0.21	0.21	0.21	0.21
SSB at spawning time	0.13	0.17	0.17	0.17	0.17	0.17	0.17	0.17
Catch weight								
H.cons	0.19	0.00	0.39	0.23	0.21	0.19	0.18	0.17
Discards	0.27	0.00	0.44	0.31	0.29	0.28	0.27	0.26
Ind BC	0.64	0.65	0.65	0.65	0.65	0.65	0.65	0.66
Biomass in year.... 2005								
Total 1 January		0.21	0.22	0.23	0.23	0.23	0.24	0.25
SSB at spawning time		0.20	0.21	0.21	0.22	0.22	0.23	0.23

Table 4 (Cont'd)

Forecast for year 2003
F multiplier H.cons=1.00
F multiplier Indust=1.00

Populations		Catch number			
Age	Stock No.	H.Cons	Discards	By-catch	Total
1	1459533	12016	19293	69357	100666
2	545759	26659	38737	32617	98013
3	259221	37265	24440	20224	81929
4	170085	42709	7160	11699	61568
5	71342	21839	1870	2372	26080
6	19022	6093	481	290	6865
Wt	353	39	16	16	71

Forecast for year 2004
F multiplier H.cons=1.00
F multiplier Indust=1.00

Populations		Catch number			
Age	Stock No.	H.Cons	Discards	By-catch	Total
1	1459533	12016	19293	69357	100666
2	504675	24652	35821	30161	90635
3	271101	38973	25560	21151	85683
4	115150	28915	4848	7921	41683
5	73900	22622	1937	2457	27016
6	41689	13354	1055	636	15045
Wt	341	38	15	15	68

Table 5 Whiting in Subarea IV and Division IIIa. Management option and detailed forecast tables from run 2.

	Year 2003	2004	2004	2004	2004	2004	2004	2004
Mean F — Ages								
H.cons — 2 to 4	0.25	0.00	0.10	0.20	0.25	0.30	0.40	0.50
Ind BC — 2 to 4	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
Effort relative to 2002								
H.cons	1.00	0.00	0.40	0.80	1.00	1.20	1.60	2.00
Ind BC	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Biomass								
Total 1 January	353	354	354	354	354	354	354	354
SSB at spawning time	236	237	237	237	237	237	237	237
Catch weight (,000t)								
H.cons	32.3	0.0	14.5	27.5	33.5	39.1	49.6	59.1
Discards	13.0	0.0	5.5	10.6	13.0	15.3	19.7	23.9
Ind BC	12.9	13.7	13.2	12.7	12.5	12.3	11.8	11.4
Total Landings	45.2	13.7	27.7	40.2	45.9	51.4	61.4	70.5
Total Catch	58.2	13.7	33.2	50.8	58.9	66.7	81.2	94.4
Biomass in year.... 2005								
Total 1 January		395	377	361	354	347	334	322
SSB at spawning time		278	260	245	237	231	218	206

	Year 2003	2004	2004	2004	2004	2004	2004	2004
Effort relative to 2002								
H.cons	1.00	0.00	0.40	0.80	1.00	1.20	1.60	2.00
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	0.17	0.20	0.20	0.20	0.20	0.20	0.20	0.20
SSB at spawning time	0.13	0.16	0.16	0.16	0.16	0.16	0.16	0.16
Catch weight								
H.cons	0.20	0.00	0.39	0.23	0.21	0.19	0.18	0.17
Discards	0.27	0.00	0.44	0.31	0.29	0.28	0.27	0.26
Ind BC	0.65	0.65	0.65	0.66	0.66	0.66	0.66	0.66
Biomass in year.... 2005								
Total 1 January		0.20	0.21	0.22	0.22	0.22	0.23	0.23
SSB at spawning time		0.19	0.20	0.20	0.21	0.21	0.21	0.22

Table 5 (Cont'd)

Forecast for year 2003
F multiplier H.cons=1.00
F multiplier Indust=1.00

Populations		Catch number			
Age	Stock No.	H.Cons	Discards	By-catch	Total
1	1459533	9526	15489	54984	79999
2	545759	21444	31147	26235	78826
3	259221	30769	20006	16698	67473
4	170085	35683	5907	9775	51365
5	71342	18236	1540	1980	21757
6	19022	5118	397	244	5758
Wt	353	32	13	13	58

Forecast for year 2004
F multiplier H.cons=1.00
F multiplier Indust=1.00

Populations		Catch number			
Age	Stock No.	H.Cons	Discards	By-catch	Total
1	1459533	9526	15489	54984	79999
2	516861	20308	29498	24846	74652
3	286030	33951	22075	18425	74451
4	126909	26625	4408	7293	38326
5	82418	21068	1780	2288	25135
6	46365	12474	967	594	14035
Wt	354	33	13	12	59

Table 6 Whiting in Subarea IV and Division IIIa. Management option and detailed forecast tables from run 3.

	Year 2003	2004						
Mean F Ages								
H.cons 2 to 4	0.18	0.00	0.07	0.15	0.18	0.22	0.29	0.37
Ind BC 2 to 4	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
Effort relative to 2002								
H.cons	1.00	0.00	0.40	0.80	1.00	1.20	1.60	2.00
Ind BC	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Biomass								
Total 1 January	353	367	367	367	367	367	367	367
SSB at spawning time	236	251	251	251	251	251	251	251
Catch weight (,000t)								
H.cons	24.9	0.0	11.8	22.7	27.8	32.8	42.0	50.5
Discards	9.8	0.0	4.2	8.3	10.2	12.1	15.7	19.1
Ind BC	9.8	10.7	10.4	10.1	9.9	9.8	9.5	9.3
Total Landings	34.7	10.7	22.2	32.8	37.8	42.6	51.5	59.8
Total Catch	44.5	10.7	26.5	41.1	48.0	54.6	67.2	78.9
Biomass in year.... 2005								
Total 1 January		410	396	383	377	371	359	349
SSB at spawning time		293	279	266	260	254	243	232

	Year 2003	2004						
Effort relative to 2002								
H.cons	1.00	0.00	0.40	0.80	1.00	1.20	1.60	2.00
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	0.17	0.20	0.20	0.20	0.20	0.20	0.20	0.20
SSB at spawning time	0.13	0.16	0.16	0.16	0.16	0.16	0.16	0.16
Catch weight								
H.cons	0.20	0.00	0.39	0.24	0.21	0.19	0.18	0.17
Discards	0.27	0.00	0.44	0.31	0.29	0.28	0.27	0.26
Ind BC	0.65	0.66	0.66	0.66	0.66	0.66	0.66	0.66
Biomass in year.... 2005								
Total 1 January		0.20	0.20	0.21	0.21	0.21	0.22	0.22
SSB at spawning time		0.18	0.19	0.19	0.19	0.20	0.20	0.21

Table 6 (Cont'd)

Forecast for year 2003
F multiplier H.cons=1.00
F multiplier Indust=1.00

Populations		Catch number			
Age	Stock No.	H.Cons	Discards	By-catch	Total
1	1459533	6986	11608	40321	58914
2	545759	15965	23175	19532	58672
3	259221	23656	15152	12838	51647
4	170085	27900	4520	7643	40062
5	71342	14247	1176	1547	16971
6	19022	4042	303	193	4538
Wt	353	25	10	10	45

Forecast for year 2004
F multiplier H.cons=1.00
F multiplier Indust=1.00

Populations		Catch number			
Age	Stock No.	H.Cons	Discards	By-catch	Total
1	1459533	6986	11608	40321	58914
2	529342	15484	22478	18945	56907
3	301780	27540	17640	14946	60127
4	139868	22943	3717	6285	32944
5	91918	18357	1515	1993	21865
6	51565	10958	822	522	12301
Wt	367	28	10	10	48

Table 7 Whiting in Subarea IV and Division IIIa. Management option and detailed forecast tables from run 4.

	Year 2003	2004						
Mean F Ages								
H.cons 2 to 4	0.24	0.00	0.10	0.19	0.24	0.29	0.39	0.49
Ind BC 2 to 4	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
Effort relative to 2002								
H.cons	1.00	0.00	0.40	0.80	1.00	1.20	1.60	2.00
Ind BC	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Biomass								
Total 1 January	353	363	363	363	363	363	363	363
SSB at spawning time	236	246	246	246	246	246	246	246
Catch weight (,000t)								
H.cons	27.0	0.0	12.5	23.8	29.0	34.0	43.3	51.8
Discards	16.3	0.0	7.1	13.6	16.7	19.7	25.4	30.7
Ind BC	6.8	7.5	7.2	6.9	6.8	6.7	6.5	6.2
Total Landings	33.9	7.5	19.7	30.7	35.8	40.7	49.8	58.0
Total Catch	50.2	7.5	26.8	44.4	52.6	60.4	75.2	88.7
Biomass in year.... 2005								
Total 1 January		411	393	376	369	362	348	336
SSB at spawning time		294	276	260	252	245	232	219

	Year 2003	2004						
Effort relative to 2002								
H.cons	1.00	0.00	0.40	0.80	1.00	1.20	1.60	2.00
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	0.17	0.20	0.20	0.20	0.20	0.20	0.20	0.20
SSB at spawning time	0.13	0.16	0.16	0.16	0.16	0.16	0.16	0.16
Catch weight								
H.cons	0.20	0.00	0.39	0.24	0.21	0.20	0.18	0.17
Discards	0.27	0.00	0.44	0.31	0.28	0.27	0.26	0.25
Ind BC	0.66	0.66	0.67	0.67	0.67	0.67	0.67	0.67
Biomass in year.... 2005								
Total 1 January		0.20	0.20	0.21	0.21	0.22	0.22	0.23
SSB at spawning time		0.18	0.19	0.19	0.20	0.20	0.21	0.21

Table 7 (Cont'd)

Forecast for year 2003
F multiplier H.cons=1.00
F multiplier Indust=1.00

Populations			Catch number			
Age	Stock No.		H.Cons	Discards	By-catch	Total
1	1459533		7250	17015	26462	50727
2	545759		17655	38381	13858	69894
3	259221		27433	26959	9559	63951
4	170085		30170	7511	5277	42958
5	71342		14238	1811	988	17037
6	19022		3958	465	120	4543
Wt	353		27	16	7	50

Forecast for year 2004
F multiplier H.cons=1.00
F multiplier Indust=1.00

Populations			Catch number			
Age	Stock No.		H.Cons	Discards	By-catch	Total
1	1459533		7250	17015	26462	50727
2	534201		17281	37569	13564	68414
3	293001		31008	30472	10804	72285
4	129785		23021	5731	4027	32779
5	89478		17858	2272	1239	21369
6	51503		10716	1258	326	12300
Wt	363		29	17	7	53

Table 8 Whiting in Subarea IV and Division IIIa. Management option and detailed forecast tables from run 5.

	Year 2003	2004						
Mean F Ages								
H.cons 2 to 4	0.19	0.00	0.08	0.15	0.19	0.23	0.31	0.39
Ind BC 2 to 4	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Effort relative to 2002								
H.cons	1.00	0.00	0.40	0.80	1.00	1.20	1.60	2.00
Ind BC	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Biomass								
Total 1 January	353	372	372	372	372	372	372	372
SSB at spawning time	236	255	255	255	255	255	255	255
Catch weight (,000t)								
H.cons	22.0	0.0	10.6	20.3	24.9	29.3	37.6	45.3
Discards	13.1	0.0	5.8	11.3	13.9	16.4	21.3	25.9
Ind BC	5.5	6.2	6.0	5.8	5.7	5.6	5.4	5.3
Total Landings	27.6	6.2	16.5	26.1	30.6	34.9	43.1	50.6
Total Catch	40.7	6.2	22.3	37.4	44.5	51.3	64.4	76.5
Biomass in year.... 2005								
Total 1 January		420	405	391	384	378	366	355
SSB at spawning time		303	288	274	268	261	249	238

	Year 2003	2004						
Effort relative to 2002								
H.cons	1.00	0.00	0.40	0.80	1.00	1.20	1.60	2.00
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	0.17	0.19	0.19	0.19	0.19	0.19	0.19	0.19
SSB at spawning time	0.13	0.16	0.16	0.16	0.16	0.16	0.16	0.16
Catch weight								
H.cons	0.20	0.00	0.40	0.24	0.21	0.20	0.18	0.17
Discards	0.27	0.00	0.44	0.31	0.29	0.27	0.26	0.26
Ind BC	0.66	0.67	0.67	0.67	0.67	0.67	0.67	0.67
Biomass in year.... 2005								
Total 1 January		0.19	0.20	0.20	0.21	0.21	0.21	0.22
SSB at spawning time		0.18	0.18	0.19	0.19	0.19	0.20	0.20

Table 8 (Cont'd)

Forecast for year 2003
F multiplier H.cons=1.00
F multiplier Indust=1.00

Populations		Catch number			
Age	Stock No.	H.Cons	Discards	By-catch	Total
1	1459533	5720	13422	20875	40017
2	545759	14099	30651	11066	55816
3	259221	22410	22022	7808	52240
4	170085	24801	6174	4338	35313
5	71342	11674	1485	810	13969
6	19022	3268	384	99	3751
Wt	353	22	13	6	41

Forecast for year 2004
F multiplier H.cons=1.00
F multiplier Indust=1.00

Populations		Catch number			
Age	Stock No.	H.Cons	Discards	By-catch	Total
1	1459533	5720	13422	20875	40017
2	540568	13965	30359	10961	55285
3	304017	26282	25828	9158	61268
4	139380	20324	5060	3555	28938
5	95926	15697	1997	1089	18783
6	54859	9424	1106	287	10817
Wt	372	25	14	6	44

Table 9 Whiting in Subarea IV and Division IIIa. Management option and detailed forecast tables from run 6.

	Year 2003	2004						
Mean F Ages								
H.cons 2 to 4	0.14	0.00	0.06	0.11	0.14	0.17	0.23	0.28
Ind BC 2 to 4	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Effort relative to 2002								
H.cons	1.00	0.00	0.40	0.80	1.00	1.20	1.60	2.00
Ind BC	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Biomass								
Total 1 January	353	382	382	382	382	382	382	382
SSB at spawning time	236	265	265	265	265	265	265	265
Catch weight (,000t)								
H.cons	16.8	0.0	8.3	16.2	19.9	23.6	30.6	37.1
Discards	9.9	0.0	4.4	8.7	10.7	12.7	16.6	20.3
Ind BC	4.2	4.7	4.6	4.5	4.4	4.4	4.3	4.2
Total Landings	20.9	4.7	12.9	20.7	24.4	28.0	34.8	41.3
Total Catch	30.8	4.7	17.4	29.3	35.1	40.7	51.4	61.6
Biomass in year.... 2005								
Total 1 January		430	418	407	402	397	387	377
SSB at spawning time		313	301	290	285	280	270	260

	Year 2003	2004						
Effort relative to 2002								
H.cons	1.00	0.00	0.40	0.80	1.00	1.20	1.60	2.00
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	0.17	0.19	0.19	0.19	0.19	0.19	0.19	0.19
SSB at spawning time	0.13	0.15	0.15	0.15	0.15	0.15	0.15	0.15
Catch weight								
H.cons	0.21	0.00	0.40	0.24	0.22	0.20	0.18	0.17
Discards	0.27	0.00	0.45	0.31	0.29	0.28	0.26	0.26
Ind BC	0.66	0.67	0.67	0.67	0.67	0.67	0.67	0.67
Biomass in year.... 2005								
Total 1 January		0.19	0.19	0.20	0.20	0.20	0.20	0.21
SSB at spawning time		0.18	0.18	0.18	0.18	0.19	0.19	0.19

Table 9 (Cont'd)

Forecast for year 2003
F multiplier H.cons=1.00
F multiplier Indust=1.00

Populations		Catch number			
Age	Stock No.	H.Cons	Discards	By-catch	Total
1	1459533	4174	9794	15232	29200
2	545759	10420	22652	8179	41251
3	259221	17040	16746	5938	39723
4	170085	19068	4747	3335	27150
5	71342	8950	1139	621	10709
6	19022	2536	298	77	2911
Wt	353	17	10	4	31

Forecast for year 2004
F multiplier H.cons=1.00
F multiplier Indust=1.00

Populations		Catch number			
Age	Stock No.	H.Cons	Discards	By-catch	Total
1	1459533	4174	9794	15232	29200
2	547010	10444	22704	8197	41346
3	315447	20736	20378	7225	48340
4	149685	16781	4178	2935	23893
5	102839	12901	1641	895	15437
6	58434	7790	914	237	8941
Wt	382	20	11	4	35

Table 10 Whiting in Subarea IV and Division IIIa. Management option and detailed forecast tables from run 7.

	Year 2003	2004						
Mean F Ages								
H.cons 2 to 4	0.30	0.00	0.12	0.24	0.30	0.36	0.48	0.60
Ind BC 2 to 4	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Effort relative to 2002								
H.cons	1.00	0.00	0.40	0.80	1.00	1.20	1.60	2.00
Ind BC	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Biomass								
Total 1 January	353	351	351	351	351	351	351	351
SSB at spawning time	236	234	234	234	234	234	234	234
Catch weight (,000t)								
H.cons	33.4	0.0	14.8	27.9	33.9	39.5	49.7	58.7
Discards	20.2	0.0	8.5	16.3	20.0	23.5	30.0	36.0
Ind BC	8.5	9.1	8.7	8.3	8.1	8.0	7.6	7.3
Total Landings	41.9	9.1	23.6	36.2	42.0	47.4	57.3	66.1
Total Catch	62.1	9.1	32.1	52.6	62.0	70.9	87.3	102.1
Biomass in year.... 2005								
Total 1 January		399	377	359	350	342	327	314
SSB at spawning time		282	261	242	233	225	210	197

	Year 2003	2004						
Effort relative to 2002								
H.cons	1.00	0.00	0.40	0.80	1.00	1.20	1.60	2.00
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	0.17	0.20	0.20	0.20	0.20	0.20	0.20	0.20
SSB at spawning time	0.13	0.16	0.16	0.16	0.16	0.16	0.16	0.16
Catch weight								
H.cons	0.19	0.00	0.39	0.23	0.21	0.19	0.17	0.17
Discards	0.26	0.00	0.44	0.30	0.28	0.27	0.26	0.25
Ind BC	0.65	0.66	0.66	0.66	0.66	0.66	0.67	0.67
Biomass in year.... 2005								
Total 1 January		0.20	0.21	0.22	0.22	0.22	0.23	0.24
SSB at spawning time		0.19	0.20	0.20	0.21	0.21	0.22	0.22

Table 10 (Cont'd)

Forecast for year 2003
F multiplier H.cons=1.00
F multiplier Indust=1.00

Age	Populations Stock No.	Catch number H.Cons	Discards	By-catch	Total
1	1459533	9610	22553	35075	67238
2	545759	22625	49185	17758	89568
3	259221	31849	31298	11097	74244
4	170085	36576	9106	6397	52079
5	71342	18822	2394	1306	22523
6	19022	5232	614	159	6005
Wt	353	33	20	9	62

Forecast for year 2004
F multiplier H.cons=1.00
F multiplier Indust=1.00

Age	Populations Stock No.	Catch number H.Cons	Discards	By-catch	Total
1	1459533	9610	22553	35075	67238
2	524409	21740	47261	17063	86064
3	277664	34115	33525	11887	79527
4	121391	26104	6499	4566	37169
5	81821	21587	2746	1498	25831
6	45491	12512	1469	381	14361
Wt	351	34	20	8	62

Table 11 Whiting in Subarea IV and Division IIIa. Management option and detailed forecast tables from run 8.

	Year 2003	2004	2004	2004	2004	2004	2004	2004
Mean F Ages								
H.cons 2 to 4	0.24	0.00	0.10	0.19	0.24	0.29	0.38	0.48
Ind BC 2 to 4	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
Effort relative to 2002								
H.cons	1.00	0.00	0.40	0.80	1.00	1.20	1.60	2.00
Ind BC	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Biomass								
Total 1 January	353	362	362	362	362	362	362	362
SSB at spawning time	236	245	245	245	245	245	245	245
Catch weight (,000t)								
H.cons	27.4	0.0	12.8	24.3	29.6	34.7	44.1	52.7
Discards	16.4	0.0	7.1	13.7	16.8	19.8	25.5	30.8
Ind BC	6.9	7.6	7.3	7.0	6.9	6.8	6.5	6.3
Total Landings	34.3	7.6	20.0	31.3	36.5	41.5	50.7	59.0
Total Catch	50.7	7.6	27.1	45.0	53.3	61.3	76.2	89.8
Biomass in year.... 2005								
Total 1 January		410	392	375	368	360	347	334
SSB at spawning time		293	275	259	251	244	230	218

	Year 2003	2004	2004	2004	2004	2004	2004	2004
Effort relative to 2002								
H.cons	1.00	0.00	0.40	0.80	1.00	1.20	1.60	2.00
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	0.17	0.20	0.20	0.20	0.20	0.20	0.20	0.20
SSB at spawning time	0.13	0.16	0.16	0.16	0.16	0.16	0.16	0.16
Catch weight								
H.cons	0.20	0.00	0.39	0.23	0.21	0.19	0.17	0.17
Discards	0.27	0.00	0.44	0.30	0.28	0.27	0.26	0.25
Ind BC	0.66	0.66	0.66	0.66	0.67	0.67	0.67	0.67
Biomass in year.... 2005								
Total 1 January		0.20	0.20	0.21	0.21	0.22	0.22	0.23
SSB at spawning time		0.18	0.19	0.19	0.20	0.20	0.21	0.21

Table 11 (Cont'd)

Forecast for year 2003
F multiplier H.cons=1.00
F multiplier Indust=1.00

Populations		Catch number			
Age	Stock No.	H.Cons	Discards	By-catch	Total
1	1459533	7594	17821	27715	53130
2	545759	18158	39475	14252	71885
3	259221	26168	25716	9118	61002
4	170085	30296	7542	5299	43138
5	71342	15599	1984	1082	18665
6	19022	4365	512	133	5010
Wt	353	27	16	7	51

Forecast for year 2004
F multiplier H.cons=1.00
F multiplier Indust=1.00

Populations		Catch number			
Age	Stock No.	H.Cons	Discards	By-catch	Total
1	1459533	7594	17821	27715	53130
2	532774	17726	38536	13913	70175
3	291446	29421	28913	10252	68586
4	132197	23548	5862	4119	33528
5	89327	19531	2485	1355	23371
6	49686	11401	1338	347	13086
Wt	362	30	17	7	53

Table 12 Whiting in Subarea IV and Division IIIa. Management option and detailed forecast tables from run 9.

	2003	2004						
Mean F Ages								
H.cons 2 to 4	0.18	0.00	0.07	0.14	0.18	0.21	0.28	0.35
Ind BC 2 to 4	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Effort relative to 2002								
H.cons	1.00	0.00	0.40	0.80	1.00	1.20	1.60	2.00
Ind BC	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Biomass								
Total 1 January	353	374	374	374	374	374	374	374
SSB at spawning time	236	257	257	257	257	257	257	257
Catch weight (,000t)								
H.cons	21.0	0.0	10.3	19.8	24.2	28.6	36.7	44.3
Discards	12.3	0.0	5.5	10.6	13.1	15.5	20.2	24.5
Ind BC	5.2	5.8	5.7	5.5	5.4	5.4	5.2	5.1
Total Landings	26.2	5.8	15.9	25.3	29.7	33.9	41.9	49.4
Total Catch	38.6	5.8	21.4	35.9	42.8	49.4	62.1	73.9
Biomass in year.... 2005								
Total 1 January		422	408	394	388	382	370	359
SSB at spawning time		305	291	278	271	265	253	243

	2003	2004						
Effort relative to 2002								
H.cons	1.00	0.00	0.40	0.80	1.00	1.20	1.60	2.00
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	0.17	0.19	0.19	0.19	0.19	0.19	0.19	0.19
SSB at spawning time	0.13	0.16	0.16	0.16	0.16	0.16	0.16	0.16
Catch weight								
H.cons	0.20	0.00	0.40	0.24	0.21	0.19	0.18	0.17
Discards	0.27	0.00	0.44	0.31	0.29	0.27	0.26	0.25
Ind BC	0.66	0.67	0.67	0.67	0.67	0.67	0.67	0.67
Biomass in year.... 2005								
Total 1 January		0.19	0.20	0.20	0.20	0.21	0.21	0.22
SSB at spawning time		0.18	0.18	0.19	0.19	0.19	0.20	0.20

Table 12 (Cont'd)

Forecast for year 2003
F multiplier H.cons=1.00
F multiplier Indust=1.00

Populations		Catch number			
Age	Stock No.	H.Cons	Discards	By-catch	Total
1	1459533	5550	13025	20257	38832
2	545759	13488	29323	10587	53398
3	259221	20018	19671	6975	46664
4	170085	23476	5844	4106	33427
5	71342	12091	1538	839	14468
6	19022	3423	402	104	3930
Wt	353	21	12	5	39

Forecast for year 2004
F multiplier H.cons=1.00
F multiplier Indust=1.00

Populations		Catch number			
Age	Stock No.	H.Cons	Discards	By-catch	Total
1	1459533	5550	13025	20257	38832
2	541273	13377	29082	10500	52959
3	305913	23623	23215	8231	55069
4	143965	19871	4947	3476	28293
5	97521	16528	2103	1147	19777
6	54269	9767	1147	297	11211
Wt	374	24	13	5	43

Table 13 Whiting in Subarea IV and Division IIIa. Management option and detailed forecast tables from run 10.

	Year 2003	2004						
Mean F Ages								
H.cons 2 to 4	0.10	0.00	0.04	0.08	0.10	0.12	0.16	0.20
Ind BC 2 to 4	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Effort relative to 2002								
H.cons	1.00	0.00	0.40	0.80	1.00	1.20	1.60	2.00
Ind BC	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Biomass								
Total 1 January	353	386	386	386	386	386	386	386
SSB at spawning time	236	269	269	269	269	269	269	269
Catch weight (,000t)								
H.cons	14.4	0.0	7.3	14.3	17.6	20.9	27.3	33.4
Discards	5.7	0.0	2.6	5.0	6.2	7.4	9.8	12.0
Ind BC	5.6	6.4	6.2	6.1	6.1	6.0	5.9	5.8
Total Landings	20.0	6.4	13.5	20.4	23.7	27.0	33.3	39.2
Total Catch	25.7	6.4	16.1	25.5	30.0	34.4	43.0	51.3
Biomass in year.... 2005								
Total 1 January		431	423	414	410	406	398	391
SSB at spawning time		315	306	297	293	289	281	274

	Year 2003	2004						
Effort relative to 2002								
H.cons	1.00	0.00	0.40	0.80	1.00	1.20	1.60	2.00
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	0.17	0.19	0.19	0.19	0.19	0.19	0.19	0.19
SSB at spawning time	0.13	0.15	0.15	0.15	0.15	0.15	0.15	0.15
Catch weight								
H.cons	0.21	0.00	0.40	0.24	0.21	0.20	0.18	0.17
Discards	0.27	0.00	0.45	0.31	0.29	0.28	0.27	0.26
Ind BC	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66
Biomass in year.... 2005								
Total 1 January		0.19	0.19	0.19	0.20	0.20	0.20	0.20
SSB at spawning time		0.17	0.18	0.18	0.18	0.18	0.18	0.19

Table 13 (Cont'd)

Forecast for year 2003
F multiplier H.cons=1.00
F multiplier Indust=1.00

Age	Populations: Stock No.	Catch number: H.Cons	Discards	By-catch	Total
1	1459533	3969	6372	22909	33250
2	545759	9207	13378	11264	33849
3	259221	13715	8995	7443	30154
4	170085	16068	2694	4401	23163
5	71342	8209	703	891	9803
6	19022	2285	181	109	2574
Wt	353	14	6	6	26

Forecast for year 2004
F multiplier H.cons=1.00
F multiplier Indust=1.00

Age	Populations: Stock No.	Catch number: H.Cons	Discards	By-catch	Total
1	1459533	3969	6372	22909	33250
2	544597	9187	13349	11240	33777
3	321269	16998	11148	9225	37372
4	157594	14888	2496	4078	21462
5	106224	12223	1047	1327	14597
6	59519	7149	565	340	8054
Wt	386	18	6	6	30

Table 14 Whiting in Subarea IV and Division IIIa. Management option and detailed forecast tables from run 11.

	2003	2004	2004	2004	2004	2004	2004	2004
Mean F Ages								
H.cons 2 to 4	0.08	0.00	0.03	0.06	0.08	0.10	0.13	0.16
Ind BC 2 to 4	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Effort relative to 2002								
H.cons	1.00	0.00	0.40	0.80	1.00	1.20	1.60	2.00
Ind BC	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Biomass								
Total 1 January	353	391	391	391	391	391	391	391
SSB at spawning time	236	274	274	274	274	274	274	274
Catch weight (,000t)								
H.cons	11.6	0.0	6.0	11.8	14.6	17.3	22.7	27.9
Discards	4.5	0.0	2.1	4.1	5.0	6.0	7.9	9.8
Ind BC	4.5	5.1	5.1	5.0	5.0	4.9	4.9	4.8
Total Landings	16.1	5.1	11.0	16.8	19.5	22.3	27.6	32.7
Total Catch	20.6	5.1	13.1	20.8	24.6	28.3	35.5	42.4
Biomass in year.... 2005								
Total 1 January		437	430	423	420	416	410	403
SSB at spawning time		320	313	306	303	299	293	287

	2003	2004	2004	2004	2004	2004	2004	2004
Effort relative to 2002								
H.cons	1.00	0.00	0.40	0.80	1.00	1.20	1.60	2.00
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	0.17	0.19	0.19	0.19	0.19	0.19	0.19	0.19
SSB at spawning time	0.13	0.15	0.15	0.15	0.15	0.15	0.15	0.15
Catch weight								
H.cons	0.21	0.00	0.40	0.24	0.22	0.20	0.18	0.17
Discards	0.27	0.00	0.45	0.31	0.29	0.28	0.27	0.26
Ind BC	0.66	0.66	0.66	0.67	0.67	0.67	0.67	0.67
Biomass in year.... 2005								
Total 1 January		0.19	0.19	0.19	0.19	0.19	0.20	0.20
SSB at spawning time		0.17	0.17	0.18	0.18	0.18	0.18	0.18

Table 14 (Cont'd)

Forecast for year 2003
F multiplier H.cons=1.00
F multiplier Indust=1.00

Populations		Catch number			
Age	Stock No.	H.Cons	Discards	By-catch	Total
1	1459533	3126	5082	18040	26248
2	545759	7288	10586	8917	26791
3	259221	11010	7159	5975	24143
4	170085	13010	2154	3564	18727
5	71342	6644	561	722	7927
6	19022	1862	144	89	2095
Wt	353	12	5	5	21

Forecast for year 2004
F multiplier H.cons=1.00
F multiplier Indust=1.00

Populations		Catch number			
Age	Stock No.	H.Cons	Discards	By-catch	Total
1	1459533	3126	5082	18040	26248
2	548771	7328	10645	8966	26939
3	326827	13881	9026	7533	30440
4	162574	12435	2059	3406	17900
5	109998	10244	865	1112	12222
6	61578	6029	467	287	6784
Wt	391	15	5	5	25

Table 15 Whiting in Subarea IV and Division IIIa. Management option and detailed forecast tables from run 12.

	2003	2004	2004	2004	2004	2004	2004	2004
Mean F Ages								
H.cons 2 to 4	0.06	0.00	0.02	0.05	0.06	0.07	0.09	0.12
Ind BC 2 to 4	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Effort relative to 2002								
H.cons	1.00	0.00	0.40	0.80	1.00	1.20	1.60	2.00
Ind BC	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Biomass								
Total 1 January	353	397	397	397	397	397	397	397
SSB at spawning time	236	280	280	280	280	280	280	280
Catch weight (,000t)								
H.cons	8.67	0.00	4.59	9.05	11.24	13.39	17.62	21.73
Discards	3.33	0.00	1.52	3.02	3.76	4.49	5.93	7.35
Ind BC	3.34	3.84	3.80	3.76	3.74	3.73	3.69	3.65
Total Landings	12.01	3.84	8.39	12.81	14.98	17.12	21.31	25.38
Total Catch	15.34	3.84	9.91	15.83	18.74	21.61	27.24	32.73
Biomass in year.... 2005								
Total 1 January		443	438	432	430	427	422	417
SSB at spawning time		326	321	315	313	310	305	300

	2003	2004	2004	2004	2004	2004	2004	2004
Effort relative to 2002								
H.cons	1.00	0.00	0.40	0.80	1.00	1.20	1.60	2.00
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	0.17	0.18	0.18	0.18	0.18	0.18	0.18	0.18
SSB at spawning time	0.13	0.15	0.15	0.15	0.15	0.15	0.15	0.15
Catch weight								
H.cons	0.21	0.00	0.40	0.25	0.22	0.20	0.18	0.18
Discards	0.27	0.00	0.45	0.31	0.29	0.28	0.27	0.26
Ind BC	0.66	0.67	0.67	0.67	0.67	0.67	0.67	0.67
Biomass in year.... 2005								
Total 1 January		0.19	0.19	0.19	0.19	0.19	0.19	0.19
SSB at spawning time		0.17	0.17	0.17	0.17	0.18	0.18	0.18

Table 15 (Cont'd)

Forecast for year 2003
F multiplier H.cons=1.00
F multiplier Indust=1.00

Populations		Catch number			
Age	Stock No.	H.Cons	Discards	By-catch	Total
1	1459533	2277	3783	13141	19200
2	545759	5339	7750	6532	19621
3	259221	8224	5268	4463	17955
4	170085	9849	1595	2698	14143
5	71342	5027	415	546	5988
6	19022	1427	107	68	1602
Wt	353	9	3	3	15

Forecast for year 2004
F multiplier H.cons=1.00
F multiplier Indust=1.00

Populations		Catch number			
Age	Stock No.	H.Cons	Discards	By-catch	Total
1	1459533	2277	3783	13141	19200
2	552977	5409	7853	6618	19880
3	332482	10548	6756	5725	23029
4	167712	9712	1573	2660	13945
5	113906	8026	662	872	9560
6	63709	4778	358	228	5364
Wt	397	11	4	4	19

Table 16 Whiting in Subarea IV and Division IIIa. Management option and detailed forecast tables from run 13.

	Year 2003	2004						
Mean F Ages								
H.cons 2 to 4	0.08	0.00	0.03	0.06	0.08	0.09	0.12	0.16
Ind BC 2 to 4	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Effort relative to 2002								
H.cons	1.00	0.00	0.40	0.80	1.00	1.20	1.60	2.00
Ind BC	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Biomass								
Total 1 January	353	395	395	395	395	395	395	395
SSB at spawning time	236	278	278	278	278	278	278	278
Catch weight (,000t)								
H.cons	9.48	0.00	4.93	9.69	12.02	14.31	18.78	23.11
Discards	5.61	0.00	2.58	5.09	6.33	7.55	9.94	12.27
Ind BC	2.36	2.72	2.68	2.65	2.63	2.61	2.58	2.55
Total Landings	11.85	2.72	7.61	12.34	14.65	16.92	21.36	25.65
Total Catch	17.46	2.72	10.19	17.43	20.98	24.47	31.30	37.92
Biomass in year.... 2005								
Total 1 January		443	436	430	426	423	417	410
SSB at spawning time		326	319	313	309	306	300	294

	Year 2003	2004						
Effort relative to 2002								
H.cons	1.00	0.00	0.40	0.80	1.00	1.20	1.60	2.00
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	0.17	0.18	0.18	0.18	0.18	0.18	0.18	0.18
SSB at spawning time	0.13	0.15	0.15	0.15	0.15	0.15	0.15	0.15
Catch weight								
H.cons	0.21	0.00	0.41	0.25	0.22	0.21	0.19	0.18
Discards	0.27	0.00	0.45	0.31	0.29	0.28	0.27	0.26
Ind BC	0.66	0.67	0.67	0.67	0.67	0.67	0.67	0.67
Biomass in year.... 2005								
Total 1 January		0.19	0.19	0.19	0.19	0.19	0.19	0.20
SSB at spawning time		0.17	0.17	0.17	0.18	0.18	0.18	0.18

Table 16 (Cont'd)

Forecast for year 2003
F multiplier H.cons=1.00
F multiplier Indust=1.00

Age	Stock No. (Populations)	H.Cons (Catch number)	Discards	By-catch	Total
1	1459533	2357	5531	8602	16490
2	545759	5957	12951	4676	23584
3	259221	9752	9583	3398	22733
4	170085	10736	2673	1878	15287
5	71342	5026	639	349	6014
6	19022	1397	164	43	1604
Wt	353	9	6	2	17

Forecast for year 2004
F multiplier H.cons=1.00
F multiplier Indust=1.00

Age	Stock No. (Populations)	H.Cons (Catch number)	Discards	By-catch	Total
1	1459533	2357	5531	8602	16490
2	554596	6054	13160	4752	23966
3	329355	12390	12176	4317	28883
4	163744	10336	2573	1808	14717
5	112929	7956	1012	552	9520
6	63685	4677	549	142	5368
Wt	395	12	6	3	21

Table 17 Whiting in Subarea IV and Division IIIa. Management option and detailed forecast tables from run 14.

	Year 2003	2004	2004	2004	2004	2004	2004	2004
Mean F Ages								
H.cons 2 to 4	0.06	0.00	0.02	0.05	0.06	0.07	0.10	0.12
Ind BC 2 to 4	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Effort relative to 2002								
H.cons	1.00	0.00	0.40	0.80	1.00	1.20	1.60	2.00
Ind BC	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Biomass								
Total 1 January	353	398	398	398	398	398	398	398
SSB at spawning time	236	281	281	281	281	281	281	281
Catch weight (,000t)								
H.cons	7.59	0.00	4.00	7.89	9.80	11.68	15.38	18.98
Discards	4.46	0.00	2.06	4.09	5.08	6.07	8.01	9.92
Ind BC	1.88	2.17	2.15	2.13	2.12	2.11	2.09	2.07
Total Landings	9.48	2.17	6.15	10.02	11.92	13.79	17.46	21.05
Total Catch	13.94	2.17	8.21	14.11	17.00	19.86	25.48	30.96
Biomass in year.... 2005								
Total 1 January		447	441	436	433	430	425	420
SSB at spawning time		330	324	319	316	313	308	303

	Year 2003	2004	2004	2004	2004	2004	2004	2004
Effort relative to 2002								
H.cons	1.00	0.00	0.40	0.80	1.00	1.20	1.60	2.00
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	0.17	0.18	0.18	0.18	0.18	0.18	0.18	0.18
SSB at spawning time	0.13	0.15	0.15	0.15	0.15	0.15	0.15	0.15
Catch weight								
H.cons	0.21	0.00	0.41	0.25	0.22	0.21	0.19	0.18
Discards	0.27	0.00	0.45	0.31	0.29	0.28	0.27	0.26
Ind BC	0.66	0.67	0.67	0.67	0.67	0.67	0.67	0.67
Biomass in year.... 2005								
Total 1 January		0.19	0.19	0.19	0.19	0.19	0.19	0.19
SSB at spawning time		0.17	0.17	0.17	0.17	0.17	0.18	0.18

Table 17 (Cont'd)

Forecast for year 2003
F multiplier H.cons=1.00
F multiplier Indust=1.00

Populations		Catch number			
Age	Stock No.	H.Cons	Discards	By-catch	Total
1	1459533	1853	4349	6763	12965
2	545759	4704	10227	3692	18624
3	259221	7799	7664	2717	18180
4	170085	8643	2152	1512	12307
5	71342	4042	514	280	4836
6	19022	1132	133	34	1299
Wt	353	8	4	2	14

Forecast for year 2004
F multiplier H.cons=1.00
F multiplier Indust=1.00

Populations		Catch number			
Age	Stock No.	H.Cons	Discards	By-catch	Total
1	1459533	1853	4349	6763	12965
2	556703	4799	10432	3767	18997
3	333268	10026	9853	3494	23373
4	167524	8513	2119	1489	12121
5	115472	6542	832	454	7828
6	64984	3867	454	118	4439
Wt	398	10	5	2	17

Table 18 Whiting in Subarea IV and Division IIIa. Management option and detailed forecast tables from run 15.

	Year 2003	2004						
Mean F Ages								
H.cons 2 to 4	0.05	0.00	0.02	0.04	0.05	0.05	0.07	0.09
Ind BC 2 to 4	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Effort relative to 2002								
H.cons	1.00	0.00	0.40	0.80	1.00	1.20	1.60	2.00
Ind BC	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Biomass								
Total 1 January	353	402	402	402	402	402	402	402
SSB at spawning time	236	285	285	285	285	285	285	285
Catch weight (,000t)								
H.cons	5.67	0.00	3.02	5.99	7.45	8.90	11.75	14.55
Discards	3.29	0.00	1.53	3.05	3.79	4.54	6.00	7.45
Ind BC	1.39	1.62	1.61	1.59	1.59	1.58	1.57	1.56
Total Landings	7.06	1.62	4.63	7.59	9.04	10.48	13.32	16.11
Total Catch	10.36	1.62	6.17	10.63	12.83	15.02	19.33	23.56
Biomass in year.... 2005								
Total 1 January		451	446	442	440	438	434	430
SSB at spawning time		333	329	325	323	321	317	313

	Year 2003	2004						
Effort relative to 2002								
H.cons	1.00	0.00	0.40	0.80	1.00	1.20	1.60	2.00
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	0.17	0.18	0.18	0.18	0.18	0.18	0.18	0.18
SSB at spawning time	0.13	0.15	0.15	0.15	0.15	0.15	0.15	0.15
Catch weight								
H.cons	0.21	0.00	0.41	0.25	0.22	0.21	0.19	0.18
Discards	0.27	0.00	0.45	0.31	0.29	0.28	0.27	0.26
Ind BC	0.66	0.67	0.67	0.67	0.67	0.67	0.67	0.67
Biomass in year.... 2005								
Total 1 January		0.18	0.19	0.19	0.19	0.19	0.19	0.19
SSB at spawning time		0.17	0.17	0.17	0.17	0.17	0.17	0.17

Table 18 (Cont'd)

Forecast for year 2003
F multiplier H.cons=1.00
F multiplier Indust=1.00

Populations		Catch number			
Age	Stock No.	H.Cons	Discards	By-catch	Total
1	1459533	1348	3162	4918	9428
2	545759	3438	7474	2698	13610
3	259221	5803	5703	2022	13529
4	170085	6505	1620	1138	9263
5	71342	3038	386	211	3635
6	19022	862	101	26	989
Wt	353	6	3	1	10

Forecast for year 2004
F multiplier H.cons=1.00
F multiplier Indust=1.00

Populations		Catch number			
Age	Stock No.	H.Cons	Discards	By-catch	Total
1	1459533	1348	3162	4918	9428
2	558817	3520	7652	2763	13935
3	337228	7550	7419	2631	17600
4	171392	6555	1632	1147	9334
5	118072	5028	640	349	6017
6	66310	3004	353	91	3449
Wt	402	7	4	2	13

Table 19 Whiting in Subarea IV and Division IIIa. Management option and detailed forecast tables from run 16.

	Year 2003	2004						
Mean F Ages								
H.cons 2 to 4	0.10	0.00	0.04	0.08	0.10	0.12	0.15	0.19
Ind BC 2 to 4	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Effort relative to 2002								
H.cons	1.00	0.00	0.40	0.80	1.00	1.20	1.60	2.00
Ind BC	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Biomass								
Total 1 January	353	390	390	390	390	390	390	390
SSB at spawning time	236	273	273	273	273	273	273	273
Catch weight (,000t)								
H.cons	12.0	0.0	6.2	12.2	15.0	17.9	23.3	28.6
Discards	7.1	0.0	3.2	6.3	7.9	9.4	12.3	15.1
Ind BC	3.0	3.4	3.4	3.3	3.3	3.3	3.2	3.2
Total Landings	15.0	3.4	9.6	15.5	18.3	21.1	26.5	31.7
Total Catch	22.1	3.4	12.8	21.8	26.2	30.5	38.8	46.9
Biomass in year.... 2005								
Total 1 January		439	430	422	417	413	406	398
SSB at spawning time		322	313	305	301	297	289	281

	Year 2003	2004						
Effort relative to 2002								
H.cons	1.00	0.00	0.40	0.80	1.00	1.20	1.60	2.00
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	0.17	0.19	0.19	0.19	0.19	0.19	0.19	0.19
SSB at spawning time	0.13	0.15	0.15	0.15	0.15	0.15	0.15	0.15
Catch weight								
H.cons	0.21	0.00	0.40	0.24	0.22	0.20	0.18	0.17
Discards	0.27	0.00	0.45	0.31	0.29	0.28	0.27	0.26
Ind BC	0.66	0.67	0.67	0.67	0.67	0.67	0.67	0.67
Biomass in year.... 2005								
Total 1 January		0.19	0.19	0.19	0.19	0.19	0.20	0.20
SSB at spawning time		0.17	0.18	0.18	0.18	0.18	0.18	0.18

Table 19 (Cont'd)

Forecast for year 2003
F multiplier H.cons=1.00
F multiplier Indust=1.00

Age	Stock No. (Populations)	H.Cons (Catch number)	Discards	By-catch	Total
1	1459533	3140	7370	11461	21971
2	545759	7758	16866	6089	30714
3	259221	11545	11345	4023	26913
4	170085	13364	3327	2337	19028
5	71342	6895	877	478	8250
6	19022	1916	225	58	2200
Wt	353	12	7	3	22

Forecast for year 2004
F multiplier H.cons=1.00
F multiplier Indust=1.00

Age	Stock No. (Populations)	H.Cons (Catch number)	Discards	By-catch	Total
1	1459533	3140	7370	11461	21971
2	551322	7837	17038	6151	31027
3	323737	14418	14169	5024	33611
4	160278	12593	3135	2203	17931
5	109742	10606	1349	736	12691
6	61204	6166	724	188	7078
Wt	390	15	8	3	26

Table 20 Whiting in Subarea IV and Division IIIa. Management option and detailed forecast tables from run 17.

	Year 2003	2004						
Mean F Ages								
H.cons 2 to 4	0.08	0.00	0.03	0.06	0.08	0.09	0.12	0.15
Ind BC 2 to 4	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Effort relative to 2002								
H.cons	1.00	0.00	0.40	0.80	1.00	1.20	1.60	2.00
Ind BC	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Biomass								
Total 1 January	353	395	395	395	395	395	395	395
SSB at spawning time	236	278	278	278	278	278	278	278
Catch weight (,000t)								
H.cons	9.64	0.00	5.06	9.96	12.34	14.69	19.27	23.69
Discards	5.63	0.00	2.58	5.10	6.34	7.56	9.96	12.30
Ind BC	2.39	2.74	2.71	2.67	2.65	2.64	2.60	2.57
Total Landings	12.02	2.74	7.77	12.63	15.00	17.33	21.87	26.26
Total Catch	17.66	2.74	10.35	17.73	21.34	24.89	31.83	38.56
Biomass in year.... 2005								
Total 1 January		443	436	429	426	422	416	410
SSB at spawning time		326	319	312	309	306	299	293

	Year 2003	2004						
Effort relative to 2002								
H.cons	1.00	0.00	0.40	0.80	1.00	1.20	1.60	2.00
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	0.17	0.18	0.18	0.18	0.18	0.18	0.18	0.18
SSB at spawning time	0.13	0.15	0.15	0.15	0.15	0.15	0.15	0.15
Catch weight								
H.cons	0.21	0.00	0.40	0.24	0.22	0.20	0.18	0.18
Discards	0.27	0.00	0.45	0.31	0.29	0.28	0.27	0.26
Ind BC	0.66	0.67	0.67	0.67	0.67	0.67	0.67	0.67
Biomass in year.... 2005								
Total 1 January		0.19	0.19	0.19	0.19	0.19	0.19	0.20
SSB at spawning time		0.17	0.17	0.18	0.18	0.18	0.18	0.18

Table 20 (Cont'd)

Forecast for year 2003
F multiplier H.cons=1.00
F multiplier Indust=1.00

Age	Stock No. (Populations)	H.Cons (Catch number)	Discards	By-catch	Total
1	1459533	2470	5797	9016	17284
2	545759	6137	13341	4817	24295
3	259221	9252	9092	3224	21567
4	170085	10787	2685	1887	15359
5	71342	5565	708	386	6659
6	19022	1558	183	47	1789
Wt	353	10	6	2	18

Forecast for year 2004
F multiplier H.cons=1.00
F multiplier Indust=1.00

Age	Stock No. (Populations)	H.Cons (Catch number)	Discards	By-catch	Total
1	1459533	2470	5797	9016	17284
2	554122	6231	13546	4891	24667
3	328795	11735	11532	4089	27355
4	164712	10446	2601	1827	14874
5	112868	8804	1120	611	10535
6	62957	5158	605	157	5920
Wt	395	12	6	3	21

Table 21 Whiting in Subarea IV and Division IIIa. Management option and detailed forecast tables from run 18.

	2003	2004						
Mean F Ages								
H.cons 2 to 4	0.06	0.00	0.02	0.05	0.06	0.07	0.09	0.11
Ind BC 2 to 4	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Effort relative to 2002								
H.cons	1.00	0.00	0.40	0.80	1.00	1.20	1.60	2.00
Ind BC	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Biomass								
Total 1 January	353	399	399	399	399	399	399	399
SSB at spawning time	236	282	282	282	282	282	282	282
Catch weight (,000t)								
H.cons	7.21	0.00	3.85	7.61	9.46	11.28	14.85	18.34
Discards	4.17	0.00	1.93	3.82	4.75	5.67	7.50	9.29
Ind BC	1.77	2.05	2.03	2.01	2.00	1.99	1.97	1.95
Total Landings	8.98	2.05	5.88	9.62	11.46	13.27	16.82	20.29
Total Catch	13.15	2.05	7.81	13.44	16.21	18.94	24.32	29.58
Biomass in year.... 2005								
Total 1 January		448	442	437	434	432	427	422
SSB at spawning time		331	325	320	317	315	310	305

	2003	2004						
Effort relative to 2002								
H.cons	1.00	0.00	0.40	0.80	1.00	1.20	1.60	2.00
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	0.17	0.18	0.18	0.18	0.18	0.18	0.18	0.18
SSB at spawning time	0.13	0.15	0.15	0.15	0.15	0.15	0.15	0.15
Catch weight								
H.cons	0.21	0.00	0.41	0.25	0.22	0.20	0.19	0.18
Discards	0.27	0.00	0.45	0.31	0.29	0.28	0.27	0.26
Ind BC	0.66	0.67	0.67	0.67	0.67	0.67	0.67	0.67
Biomass in year.... 2005								
Total 1 January		0.18	0.19	0.19	0.19	0.19	0.19	0.19
SSB at spawning time		0.17	0.17	0.17	0.17	0.17	0.18	0.18

Table 21 (Cont'd)

Forecast for year 2003
F multiplier H.cons=1.00
F multiplier Indust=1.00

Populations		Catch number			
Age	Stock No.	H.Cons	Discards	By-catch	Total
1	1459533	1797	4218	6560	12576
2	545759	4492	9766	3526	17783
3	259221	6899	6779	2404	16082
4	170085	8141	2027	1424	11591
5	71342	4199	534	291	5025
6	19022	1191	140	36	1367
Wt	353	7	4	2	13

Forecast for year 2004
F multiplier H.cons=1.00
F multiplier Indust=1.00

Populations		Catch number			
Age	Stock No.	H.Cons	Discards	By-catch	Total
1	1459533	1797	4218	6560	12576
2	556935	4584	9965	3598	18148
3	333932	8887	8733	3097	20717
4	169268	8102	2017	1417	11536
5	116083	6832	869	474	8176
6	64759	4054	476	123	4654
Wt	399	9	5	2	16

ANNEX 3

Working document, ACFM October 2003

Sole North Sea recruitment update

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1. BTS index 2003

The Beam trawl survey was carried out between 11 august and 19 September 2003. The survey is carried out by two research vessels and has been used by the WG as two separate calibration indices. The BTS-ISIS survey is available from 1985 onwards, the BTS-Tridens survey from 1996 onwards. Time-series of survey results are shown in table 1.1 and the survey data scaled to the mean survey values for 1996-2002 in table 1.2. Graphs of the spatial results of the 2003 survey by age are shown in figure 1.1.

2. BTS biomass indices

The BTS survey was converted into a proxy of spawning stock biomass by multiplying the numbers per hour by the stock weight-at-age and the maturity ogive of the assessment presented by the WG. For 2003, the weight-at-age was taken as the average over the years 2000-2002. The estimates were then scaled by subtracting the mean over the period 1996-2002 and dividing by the standard deviation over that same period. The resulting proxy for SSB does not take account for differences in catchability between ages, but should be compensated by the standardization process. Results are presented in figure 2.1 and indicate that the biomass index from the BTS-ISIS gives a reasonable reflection of the trends in SSB. The BTS-Tridens survey does not agree with the XSA estimates and was not used in the calibration of the assessment, because the survey area does not correspond with the mayor distribution area of sole.

3. Recruitment estimation

Average recruitment in the period 1957-2000 was 131 million (arithmetic mean) or 97 million (geometric mean) for 1-year-old-fish, and 117 million (arithmetic mean) or 85 million (geometric mean) 2-year-old-fish (VPA estimates).

Recruitment indices were available from pre-recruit surveys carried out in 2003 and previous years. The survey indices available are listed in the RCT3 input table (**Table** 3.1).

The options used in RCT3 are the same as those used in previous years: regression type=C, tapered time weighting not applied, survey weighting not applied, final estimates shrunk towards the mean, the minimum S.E. for any survey is taken as 0.2, and a minimum of 3 points are used for regression. The ´RCT outputs from regressions on ages 1 and 2 are shown in **Tables** 3.2 and 3.3.

The 2001 year class (as age 2 in 2003, in millions) was estimated as 179 in XSA and 179 in RCT3. Both estimates are well above long-term GM (1957-2000) at age 2. The RCT3 estimate of the 2001 year class is based on more independent observations (estimates) of the year class strength than the XSA estimate and, furthermore, the 2001 year class is not yet fully recruited to the fishery. Consequently, the RCT3 is proposed for the predictions. This suggests the 2001 year class being well above long-term average recruitment.

The 2002 year class (as age 1 in 2003, in millions) was estimated as 86 in RCT3 during the WG and 107 in the new RCT3. The latter is slightly higher than the long-term GM (1957-2000) at 97. No XSA estimate for this year class is available. There were two surveys in RCT3. Indices from the Dutch 2003 SNS were not used because this survey was moved from 3rd to 2nd quarter in 2003. The effect of this change in survey time has to be scrutinized before indices for sole forecast is used. Although the year class estimated in RCT3 received substantial weight from the surveys, the final estimate was considered to be close to the GM and the latter is proposed for predictions.

Year class strength used for predictions is in bold and underlined and can be summarized as follows:

Year Class	Age in 2003	XSA Thousands	RCT3 (WG) Thousands	RCT3 (new) Thousands	GM (1957-2000) Thousands
2001	2	178948	179249	**178656**	84585
2002	1		86222	106933	**96762**
2003	Recruits				**96762**

4. Short-term forecast

For the current prediction, population survivors at the start of 2003 for age 1 were from GM, and 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 2000-2002, scaled to the reference $F_{(2-6)}$ in 2002 (0.48). Weight-at-age in the catch and in the stock are averages for the years 2000-2002. Maturity-ogive and natural mortality was the same as in the XSA. The input data are shown in **Table** 4.1.

The management options table is given in Table 4.2 and the detailed predictions for $\mathbf{F}_{sq}$ are presented in Table 4.3. The options are also illustrated in Figure 4.1.

Assuming a *status quo* F results in an expected catch in 2003 of 19,300 t (compared with a TAC of 15,850 t and ACFM advice for a TAC of 14,600 t). The yield in 2004 is expected to be 20,700 t at *status quo* F, which is only marginally lower than the estimated yield in the forecast presented by the WG. The sensitivity of the short-term forecast to the various input parameters are shown in Figures 4.2 and 4.3.

The SSB in 2003 is predicted to be 29,000 compared with 32,300 t in last year's assessment. At *status quo* it is expected to increase to 40,800 t in 2004 ($\mathbf{B}_{lim}$=25,000 t) and to 36,700 in 2005 (Table 7.5.4). There is a 50% probability that the SSB will fall below $\mathbf{B}_{pa}$ in 2005 (Figure 4.3).

5. Conclusion

The 2003 survey information has not substantially changed the perception of recruitment or the short-term forecast compared to the estimates provided by the WG.

Table 1.1 IBTS survey indices and standard deviations for North Sea sole. ISIS (top) and Tridens (bottom)

spec	SOL
ship	Isis

	age	Data																
	1		2		3		4		5		6		7		8		9	
year	Index	Stdev	Index	Stdev	Index	Stdev	Index	Stdev	Index	Stdev	Index	Stdev	Index	Stdev	Index	Stdev	Index	Stdev
1985	2.65	10.16	7.89	11.23	3.54	3.18	1.67	1.74	0.62	0.54	0.28	0.39	0.00	0.00	0.00	0.00	0.00	0.00
1986	7.88	14.55	4.49	4.63	1.73	1.91	0.83	0.91	0.59	0.67	0.22	0.30	0.10	0.15	0.00	0.01	0.02	0.07
1987	6.99	14.70	12.55	13.89	1.83	2.13	0.56	0.61	0.58	0.63	0.22	0.24	0.23	0.37	0.06	0.18	0.03	0.11
1988	81.23	149.52	12.81	21.23	2.78	2.32	1.00	1.13	0.13	0.22	0.15	0.22	0.12	0.25	0.09	0.17	0.01	0.06
1989	9.42	14.37	68.08	85.94	4.19	7.54	4.10	6.71	0.68	1.21	0.13	0.20	0.24	0.33	0.00	0.00	0.14	0.51
1990	22.62	49.22	22.36	34.52	20.09	18.96	0.61	0.47	0.68	0.75	0.51	0.68	0.08	0.23	0.06	0.15	0.01	0.05
1991	3.34	7.06	23.19	29.82	5.84	6.93	6.01	6.90	0.10	0.17	0.14	0.20	0.07	0.18	0.03	0.12	0.01	0.04
1992	74.22	103.11	23.20	53.78	9.88	11.19	2.33	2.87	2.90	2.46	0.06	0.12	0.14	0.19	0.07	0.14	0.02	0.05
1993	4.98	6.53	27.36	23.46	0.99	1.08	4.37	3.30	2.38	2.52	4.30	4.74	0.03	0.09	0.09	0.19	0.06	0.11
1994	5.88	9.62	4.99	4.73	15.42	10.70	0.13	0.30	1.41	1.15	0.10	0.17	0.99	0.85	0.01	0.06	0.00	0.02
1995	27.62	54.00	8.46	10.56	7.04	8.83	6.72	6.24	0.48	0.53	0.91	0.91	0.31	0.49	0.97	1.01	0.05	0.16
1996	3.51	4.63	6.17	5.05	1.91	1.57	1.49	1.10	2.49	1.70	0.31	0.47	0.41	0.60	0.05	0.06	0.29	0.28
1997	173.24	214.62	5.37	4.93	3.23	2.49	0.80	1.05	0.77	0.78	0.40	0.36	0.11	0.15	0.04	0.07	0.05	0.12
1998	14.12	17.30	29.21	26.37	2.00	2.32	1.35	1.25	0.08	0.13	0.02	0.06	0.42	0.51	0.00	0.00	0.00	0.00
1999	11.41	21.98	19.26	25.95	16.63	16.99	0.63	1.12	2.06	2.69	0.33	1.11	0.22	0.34	0.65	0.85	0.00	0.01
2000	12.89	20.86	6.53	8.34	4.09	3.08	1.60	1.35	0.28	0.33	0.16	0.20	0.06	0.13	0.01	0.02	0.16	0.29
2001	7.97	12.48	10.84	10.98	2.35	1.91	1.68	1.32	0.74	0.61	0.08	0.17	0.04	0.11	0.03	0.07	0.00	0.00
2002	21.46	43.54	4.24	4.37	3.41	2.69	0.93	0.73	0.35	0.35	0.35	0.35	0.02	0.04	0.06	0.11	0.00	0.00
2003	12.04	13.85	11.62	14.76	2.62	2.04	1.84	1.62	0.44	0.56	0.21	0.19	0.34	0.37	0.00	0.00	0.02	0.04

spec	SOL
ship	Tridens II

	age	Data																
	1		2		3		4		5		6		7		8		9	
year	Index	Stdev	Index	Stdev	Index	Stdev	Index	Stdev	Index	Stdev	Index	Stdev	Index	Stdev	Index	Stdev	Index	Stdev
1996	0.51	2.18	1.66	5.25	0.45	1.31	0.24	0.60	0.58	1.92	0.15	0.67	0.30	1.04	0.01	0.09	0.15	0.50
1997	0.09	0.38	0.08	0.44	0.16	0.56	0.08	0.47	0.02	0.10	0.00	0.00	0.00	0.00	0.02	0.10	0.00	0.00
1998	0.45	2.22	2.34	7.86	0.60	2.76	0.38	1.58	0.25	0.91	0.18	0.96	0.19	0.93	0.00	0.00	0.08	0.42
1999	0.52	3.10	0.57	2.59	1.26	4.20	0.12	0.64	0.26	1.25	0.03	0.17	0.00	0.03	0.13	0.60	0.02	0.13
2000	0.32	1.60	0.70	2.18	0.48	1.37	0.65	1.56	0.06	0.35	0.04	0.19	0.05	0.16	0.01	0.08	0.08	0.35
2001	1.04	5.76	1.83	10.77	0.82	3.10	0.60	2.26	0.34	1.28	0.01	0.06	0.01	0.07	0.01	0.07	0.00	0.00
2002	0.89	3.90	1.05	4.03	1.88	6.98	1.82	9.11	0.21	1.20	0.80	4.00	0.12	0.61	0.00	0.00	0.00	0.00
2003	1.19	6.29	2.74	12.71	0.35	1.63	0.35	1.54	0.22	1.20	0.04	0.14	0.12	0.43	0.02	0.15	0.01	0.07

Table 1.2 North Sea sole. Relative survey abundances; scaled to the mean over the period 1996-2003.

		1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
BTS-ISIS	1	0.08	0.23	0.20	2.32	0.27	0.65	0.10	2.12	0.14	0.17	0.79	0.10	4.96	0.40	0.33	0.37	0.23	0.61	0.34
	2	0.68	0.39	1.08	1.10	5.84	1.92	1.99	1.99	2.35	0.43	0.73	0.53	0.46	2.51	1.65	0.56	0.93	0.36	1.00
	3	0.74	0.36	0.38	0.58	0.87	4.18	1.22	2.06	0.21	3.21	1.47	0.40	0.67	0.42	3.46	0.85	0.49	0.71	0.55
	4	1.38	0.68	0.47	0.82	3.38	0.51	4.97	1.93	3.61	0.11	5.55	1.23	0.66	1.11	0.52	1.32	1.39	0.77	1.52
	5	0.64	0.61	0.60	0.14	0.70	0.70	0.10	3.00	2.45	1.45	0.49	2.57	0.79	0.08	2.13	0.29	0.76	0.37	0.45
	6	1.18	0.92	0.94	0.65	0.54	2.16	0.57	0.26	18.19	0.41	3.87	1.31	1.71	0.07	1.41	0.66	0.34	1.50	0.89
	7	0.00	0.55	1.25	0.66	1.31	0.42	0.41	0.77	0.15	5.41	1.71	2.22	0.57	2.31	1.22	0.35	0.22	0.12	1.87
	8	0.00	0.01	0.51	0.79	0.00	0.46	0.28	0.54	0.79	0.11	8.05	0.45	0.32	0.00	5.42	0.07	0.25	0.50	0.00
	9	0.00	0.29	0.37	0.19	1.93	0.18	0.17	0.22	0.90	0.06	0.68	4.06	0.64	0.00	0.04	2.26	0.00	0.00	0.28
BTS-TRIDI	1												0.93	0.16	0.83	0.96	0.58	1.91	1.63	2.19
	2												1.41	0.07	1.99	0.48	0.59	1.56	0.90	2.33
	3												0.56	0.20	0.74	1.56	0.60	1.01	2.33	0.44
	4												0.43	0.15	0.68	0.21	1.17	1.08	3.28	0.64
	5												2.35	0.07	1.03	1.05	0.25	1.39	0.87	0.89
	6												0.87	0.00	1.04	0.19	0.21	0.05	4.63	0.21
	7												3.14	0.00	1.97	0.05	0.50	0.10	1.24	1.23
	8												0.55	0.60	0.00	4.97	0.45	0.42	0.00	0.81
	9												3.20	0.00	1.75	0.42	1.64	0.00	0.00	0.28

Table 3.1 Sole in IV. RCT3 input.

Sol-nsea Age 1 recru Age 2 recruitment

8 36 32 2

'yc'	'VPA-1'	'VPA-2'	'DFS-0'	'DFS-1'	'SNS-1'	'SNS-2'	'SNS-3'	'Solea-3'	'BTS-1'	'BTS-2'
1967	99754	89275	-11	-11	-11	-11	-11	-11	-11	-11
1968	50029	44891	-11	-11	-11	745	99	-11	-11	-11
1969	138562	124140	-11	-11	4938	1961	161	-11	-11	-11
1970	41536	37184	-11	-11	613	341	73	-11	-11	-11
1971	76644	69010	-11	-11	1410	905	69	-11	-11	-11
1972	108298	97324	-11	-11	4686	397	174	-11	-11	-11
1973	109736	99197	-11	-11	1924	887	187	31.5	-11	-11
1974	40741	36612	-11	3	597	79	77	16.3	-11	-11
1975	113036	101289	169	7	1413	762	267	34.4	-11	-11
1976	140426	125401	82	10	3724	1379	325	-11	-11	-11
1977	47371	42838	34	2	1552	388	99	41.5	-11	-11
1978	11471	10371	97	2	104	80	51	1.9	-11	-11
1979	151708	136665	392	48	4483	1411	231	76.1	-11	-11
1980	149997	135320	404	14	3739	1124	107	77.1	-11	-11
1981	152918	135836	290	14	5098	1137	307	147.1	-11	-11
1982	142410	128488	330	26	2640	1081	159	78	-11	-11
1983	70844	63921	116	12	2359	709	67	11	-11	7.89
1984	80909	73053	187	3	2151	465	59	30	2.65	4.49
1985	159679	144128	293	14	3791	955	284	25	7.88	12.55
1986	72566	65571	73	6	1890	594	248	20	6.99	12.81
1987	456058	412648	527	38	11227	5369	907	67	81.23	68.08
1988	108347	97925	56	13	3052	1078	527	86	9.42	22.36
1989	178103	160333	63	12	2900	2515	319	54	22.62	23.19
1990	70525	63699	23	9	1265	114	46	11	3.34	23.20
1991	354655	319973	360	18	11081	3489	943	181	74.22	27.36
1992	69380	62726	25	11	1351	475	126	-11	4.98	4.99
1993	57159	51037	25	6	559	234	27	-11	5.88	8.46
1994	97449	83608	74	9	1501	473	231	13	27.62	6.17
1995	49103	44267	19	4	691	143	131	1	3.51	5.37
1996	285745	257040	59	20	10132	1993	381	46	173.24	29.21
1997	126033	113807	53	-11	2875	919	189	14	14.12	19.26
1998	85064	76696	-11	-11	1649	150	99	-11	11.41	6.53
1999			-11	5	1735	645	175	-11	12.89	10.84
2000			16	3	958	361	-11	-11	7.97	4.24
2001			86	18	7093	-11	-11	-11	21.46	11.62
2002			65	-11	-11	-11	-11	-11	12.04	-11

Table 3.2 Sole in IV. RCT3 output (1 year olds)

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

 s4-rct1.txt

 Sol-nsea Age 1 recruitment

 Data for    8 surveys over   36 years :  1967 - 2002

 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.

 Year class =   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

 DFS-0      .89   8.01    .57   .637     23   2.83   10.52     .725     .050
 DFS-1     1.50   7.98    .42   .785     23   1.39   10.07     .597     .074
 SNS-1      .73   6.01    .20   .927     30   6.87   11.01     .242     .448
 SNS-2      .62   7.64    .35   .814     31   5.89   11.31     .403     .162
 BTS-1      .63   9.88    .36   .808     15   2.19   11.27     .416     .152
 BTS-2     1.17   8.52    .54   .648     16   1.66   10.47     .670     .058
                                        VPA Mean =   11.64     .687     .056


 Year class =   2001

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

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

 DFS-0      .90   8.01    .55   .661     23   4.47   12.02     .666     .067
 DFS-1     1.52   7.95    .41   .805     23   2.94   12.42     .526     .108
 SNS-1      .72   6.11    .19   .934     30   8.87   12.45     .241     .510
 BTS-1      .63   9.89    .35   .816     15   3.11   11.83     .410     .177
 BTS-2     1.18   8.53    .54   .651     16   2.54   11.51     .628     .075
                                        VPA Mean =   11.64     .690     .063


 Year class =   2002

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

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

 DFS-0      .92   7.98    .54   .680     23   4.19   11.82     .661     .219
 BTS-1      .61   9.90    .34   .826     15   2.57   11.48     .406     .580
                                        VPA Mean =   11.62     .691     .201


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

 2000        60350     11.01      .16      .15       .90
 2001       196700     12.19      .17      .15       .81
 2002       106933     11.58      .31      .10       .10
```

Table 3.3 Sole in IV. RCT3 output (2 year olds)

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

 s4-rct2.txt

 Sol-nsea Age2 recruitment

 Data for    8 surveys over   36 years :  1967 - 2002

 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.

 Year class =   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

 DFS-0      .89   7.88    .58   .633     23   2.83   10.41     .734     .048
 DFS-1     1.51   7.87    .42   .786     23   1.39    9.95     .597     .073
 SNS-1      .73   5.90    .20   .931     30   6.87   10.90     .236     .466
 SNS-2      .63   7.52    .35   .814     31   5.89   11.21     .404     .159
 BTS-1      .64   9.76    .37   .798     15   2.19   11.16     .431     .140
 BTS-2     1.17   8.43    .53   .656     16   1.66   10.37     .660     .060
                                        VPA Mean =   11.54     .689     .055


 Year class =   2001

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

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

 DFS-0      .90   7.87    .56   .656     23   4.47   11.92     .676     .064
 DFS-1     1.52   7.83    .41   .806     23   2.94   12.31     .525     .106
 SNS-1      .72   5.99    .19   .938     30   8.87   12.35     .234     .531
 BTS-1      .63   9.76    .36   .806     15   3.11   11.73     .425     .162
 BTS-2     1.17   8.43    .53   .660     16   2.54   11.40     .618     .076
                                        VPA Mean =   11.53     .692     .061


 Year class =   2002

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

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

 DFS-0      .92   7.84    .55   .674     23   4.19   11.71     .673     .223
 BTS-1      .62   9.77    .35   .815     15   2.57   11.37     .422     .566
                                        VPA Mean =   11.52     .692     .211
```

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
2000	53890	10.89	.16	.15	.90		
2001	**178656**	**12.09**	**.17**	**.15**	**.81**		
2002	96131	11.47	.32	.10	.10		

Table 4.1 Sole,North Sea
input data for catch forecast and linear sensitivity analysis

Label	Value	CV	Label	Value	CV
Number-at-age			Weight in the stock		
N1	96762	0.79	WS1	0.05	0.00
N2	178656	0.21	WS2	0.14	0.04
N3	40227	0.19	WS3	0.18	0.02
N4	39766	0.15	WS4	0.22	0.01
N5	13844	0.14	WS5	0.26	0.05
N6	14035	0.13	WS6	0.28	0.14
N7	14233	0.14	WS7	0.30	0.09
N8	902	0.15	WS8	0.35	0.21
N9	956	0.14	WS9	0.40	0.02
N10	958	0.16	WS10	0.44	0.18
H.cons selectivity			Weight in the HC catch		
sH1	0.01	0.45	WH1	0.14	0.07
sH2	0.24	0.11	WH2	0.17	0.06
sH3	0.53	0.17	WH3	0.20	0.03
sH4	0.60	0.08	WH4	0.25	0.09
sH5	0.52	0.10	WH5	0.27	0.06
sH6	0.50	0.19	WH6	0.31	0.08
sH7	0.56	0.32	WH7	0.35	0.10
sH8	0.56	0.10	WH8	0.36	0.17
sH9	0.40	0.19	WH9	0.46	0.15
sH10	0.40	0.19	WH10	0.47	0.09
Natural mortality			Proportion mature		
M1	0.10	0.10	MT1	0.00	0.00
M2	0.10	0.10	MT2	0.00	0.10
M3	0.10	0.10	MT3	1.00	0.10
M4	0.10	0.10	MT4	1.00	0.00
M5	0.10	0.10	MT5	1.00	0.00
M6	0.10	0.10	MT6	1.00	0.00
M7	0.10	0.10	MT7	1.00	0.00
M8	0.10	0.10	MT8	1.00	0.00
M9	0.10	0.10	MT9	1.00	0.00
M10	0.10	0.10	MT10	1.00	0.00
Relative effort in HC fishery			Year effect for natural mortality		
HF03	1.00	0.05	K03	1.00	0.10
HF04	1.00	0.05	K04	1.00	0.10
HF05	1.00	0.05	K05	1.00	0.10
Recruitment in 2004 and 2005					
R04	96762	0.79			
R05	96762	0.79			

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

Stock numbers in 2003 are VPA survivors.
These are overwritten at Age 2

Data from file:D:\Working_groups\WGNSSK\2003\post-WG\recruitment\sol-nsea\shortt

Table 4.2 Sole,North Sea
Catch forecast output and estimates of coefficient of variation (CV) from linear analysis.

	Year 2003	2004						
Mean F Ages								
H.cons 2 to 6	0.48	0.00	0.10	0.19	0.29	0.40	0.48	0.57
Effort relative to 2002								
H.cons	1.00	0.00	0.20	0.40	0.60	0.83	1.00	1.20
Biomass								
Total 1 January	58.7	57.6	57.6	57.6	57.6	57.6	57.6	57.6
SSB at spawning time	29.0	40.8	40.8	40.8	40.8	40.8	40.8	40.8
Catch weight (,000t)								
H.cons	19.3	0.0	5.0	9.5	13.6	17.9	20.7	23.8
Biomass in year.... 2005								
Total 1 January		74.7	69.6	65.0	60.8	56.5	53.6	50.5
SSB at spawning time		57.7	52.7	48.1	43.9	39.6	36.7	33.6

	Year 2003	2004						
Effort relative to 2002								
H.cons	1.00	0.00	0.20	0.40	0.60	0.83	1.00	1.20
Est. Coeff. of Variation								
Biomass								
Total 1 January	0.12	0.20	0.20	0.20	0.20	0.20	0.20	0.20
SSB at spawning time	0.08	0.14	0.14	0.14	0.14	0.14	0.14	0.14
Catch weight								
H.cons	0.11	0.00	0.29	0.20	0.18	0.17	0.17	0.17
Biomass in year.... 2005								
Total 1 January		0.22	0.23	0.24	0.25	0.26	0.26	0.27
SSB at spawning time		0.22	0.23	0.24	0.25	0.26	0.27	0.28

Table 4.3 Sole,North Sea
Detailed forecast tables.

Forecast for year 2003
F multiplier H.cons=1.00

Age	Populations: Stock No.	Catch number: H.Cons	Catch number: Total
1	96762	1189	1189
2	178656	36080	36080
3	40227	15727	15727
4	39766	17117	17117
5	13844	5397	5397
6	14035	5285	5285
7	14233	5796	5796
8	902	369	369
9	956	299	299
10	958	300	300
Wt	59	19	19

Forecast for year 2004
F multiplier H.cons=1.00

Age	Populations: Stock No.	Catch number: H.Cons	Catch number: Total
1	96762	1189	1189
2	86423	17453	17453
3	127417	49813	49813
4	21510	9259	9259
5	19787	7713	7713
6	7418	2793	2793
7	7695	3133	3133
8	7393	3027	3027
9	467	146	146
10	1164	364	364
Wt	58	21	21

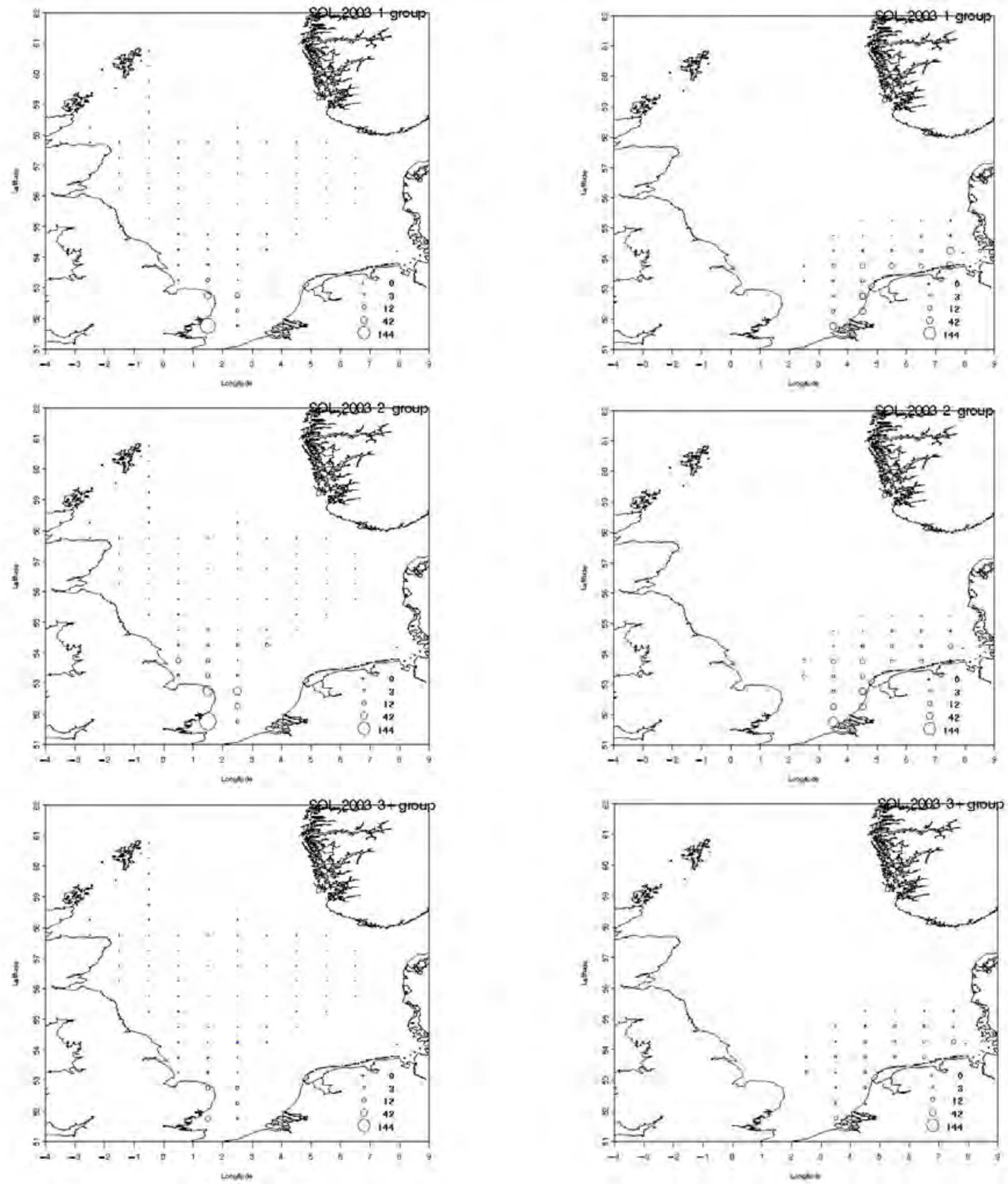

Figure 1.1 North Sea sole. Survey results for 2003 by area and age group for the BTS-ISIS survey (right panels) and the BTS-Tridens survey (left panels).

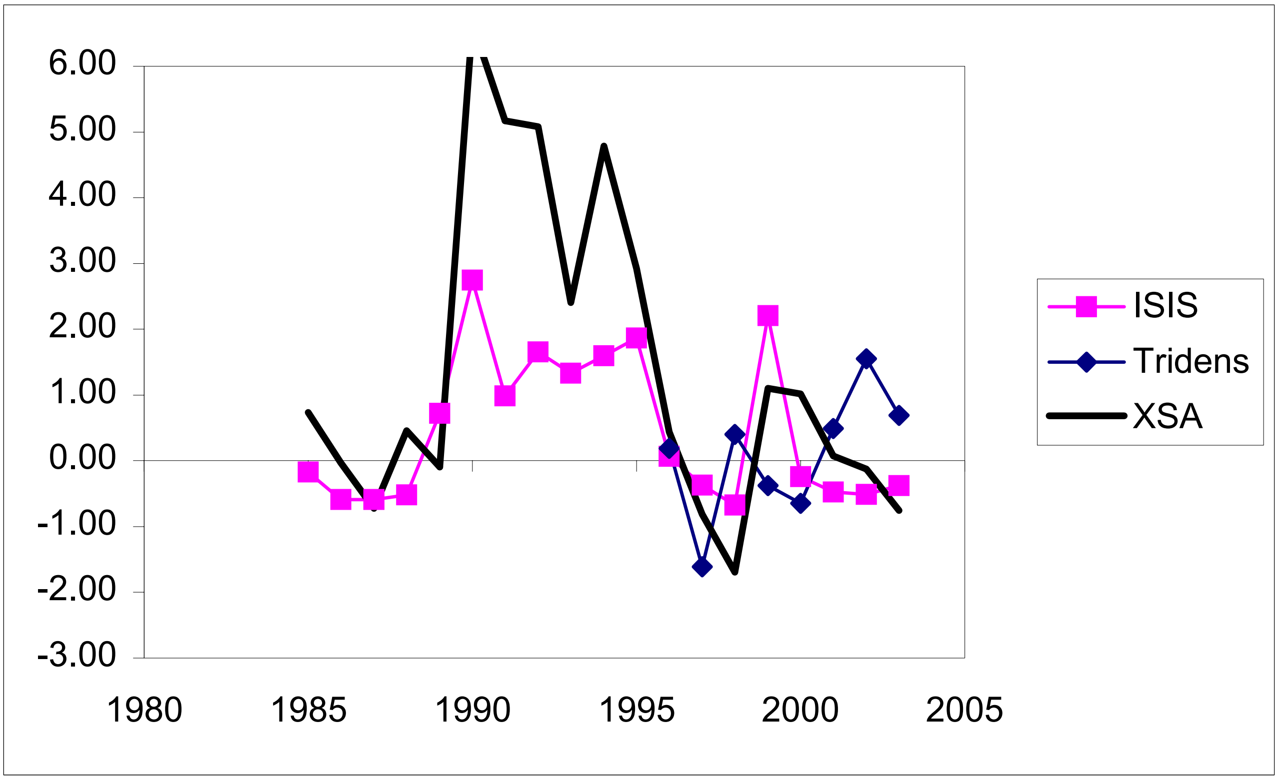

Figure 2.1 North Sea sole. Relative SSB (scaled to the mean of the period 1996-2002) and divided by the standard deviation over that period from the BTS-ISIS and BTS-Tridens survey, in comparison with the SSB estimate from the most recent assessment.

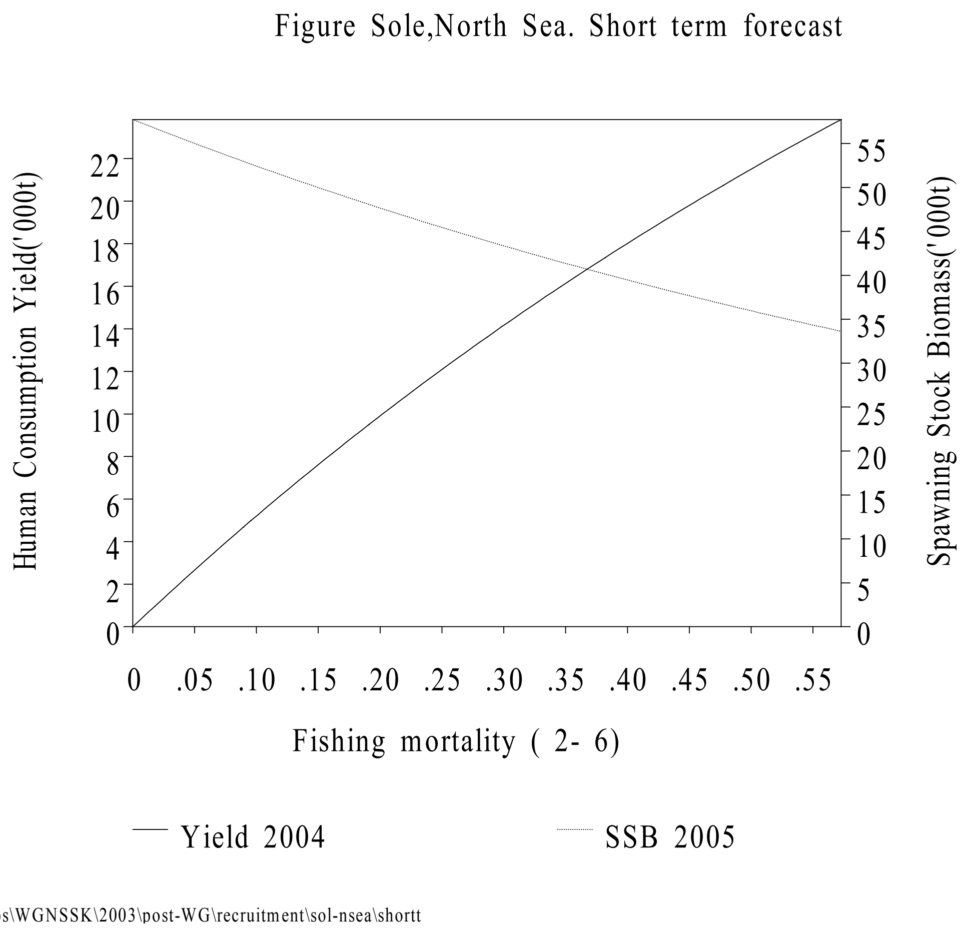

Figure 4.1 Sole North Sea. Short-term forecast

Figure Sole,North Sea. Sensitivity analysis of short term forecast.

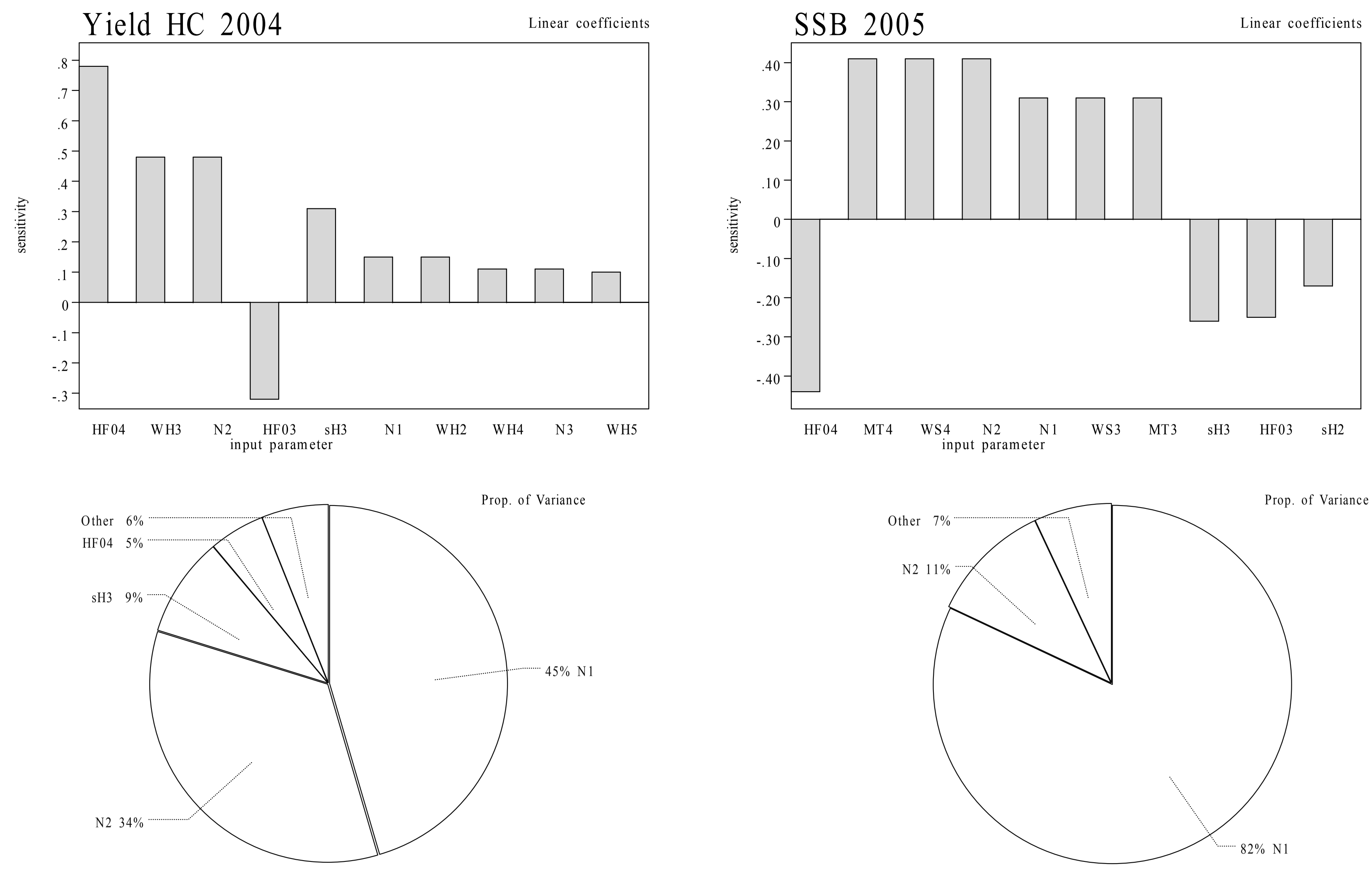

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Figure 4.2 Sole, North Sea. Sensitivity analysis of the short-term forecast.

Figure Sole,North Sea. Probability profiles for short term forecast.

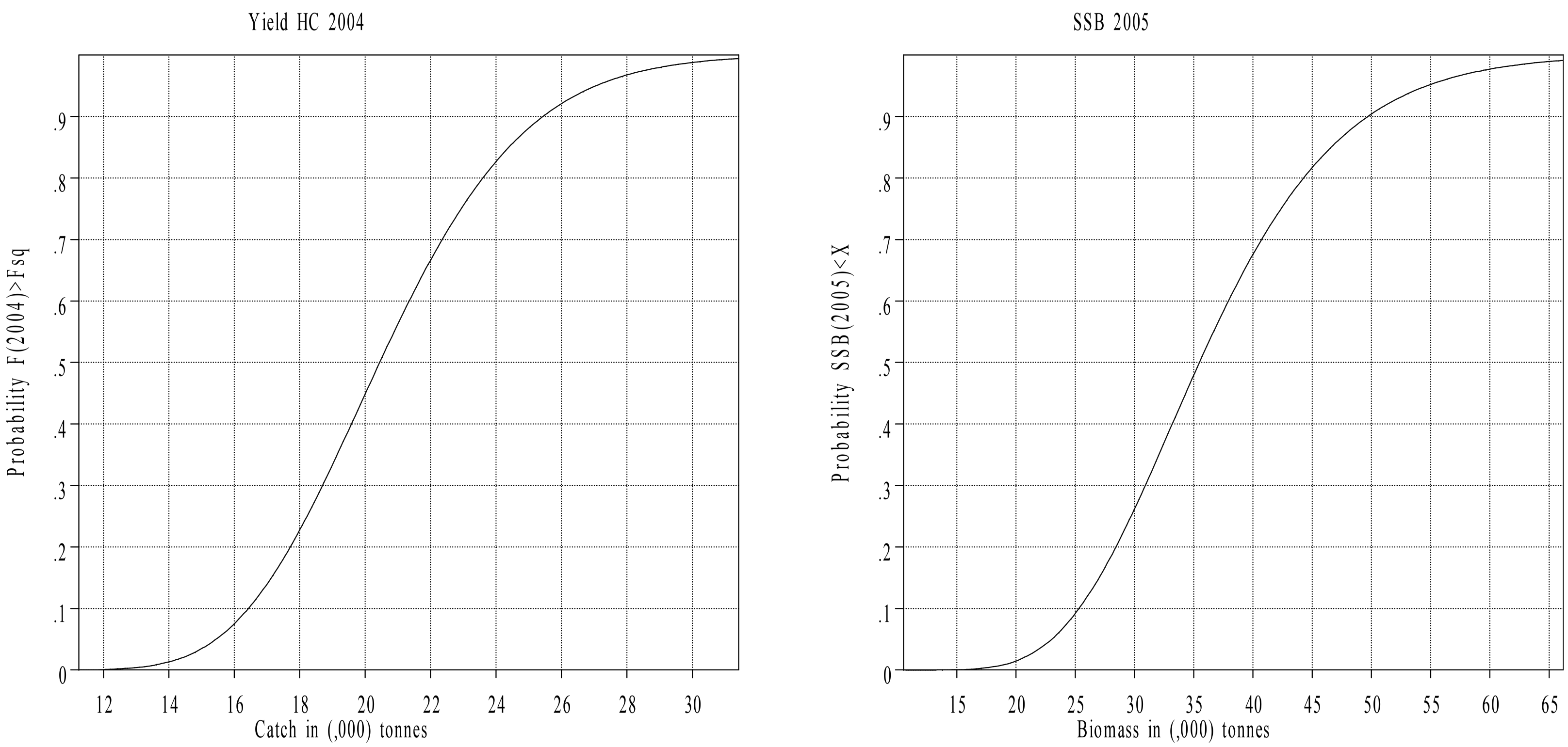

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Figure 4.3 Sole North Sea. Probability profile for the short-term forecast. Left: probability that F(2004) > $\mathbf{F}_{sq}$. Right: probability that SSB(2005)<X.

ANNEX 4

Working document, ACFM October 2003

Plaice North Sea recruitment update

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1. BTS index 2003

The Beam trawl survey was carried out between 11 august and 19 September 2003. The survey is carried out by two research vessels and has been used by the WG as two separate calibration indices. The BTS-ISIS survey is available from 1985 onwards, the BTS-Tridens survey from 1996 onwards. Time-series of survey results are shown in table 1.1 and the survey data scaled to the mean survey values for 1996-2002 in table 1.2. The BTS-Tridens data for 2003 appears to give substantially higher estimates of most age groups in the survey. This could indicate a potential catchability problem in this survey. Graphs of the spatial results of the 2003 survey by age are shown in figure 1.1.

2. BTS biomass indices

The BTS survey was converted into a proxy of spawning stock biomass by multiplying the numbers per hour by the stock weight-at-age and the maturity ogive of the assessment presented by the WG. For 2003, the weight-at-age was taken as the average over the years 2000-2002. The estimates were then scaled by subtracting the mean over the period 1996-2002 and dividing by the standard deviation over that same period. The resulting proxy for SSB does not take account for differences in catchability between ages, but should be compensated by the standardization process. Results are presented in figure 2.1 and indicate that the biomass index from the BTS-ISIS may not reflect the trend in SSB very well. This can be explained by the coastal nature of this survey, which is not dedicated to catching older plaice. The BTS-Tridens survey seems to agree reasonably well with the XSA estimate of SSB. However, this survey indicates that the spawning stock biomass in 2003 may have increased substantially.

3. Recruitment estimation

Input to the RCT3 analysis is presented in **Table** 3.1. Results for ages 1 to 2 are presented in **Tables** 3.2 – 3.3. The Geometric mean recruitment is 395 million and the arithmetic mean is 424 million.

The **2001 year class** in 2003 (at age 2) is estimated at 297 million in XSA and 396 in RCT3 by the WG. Addition of the new BTS index (ISIS) gave an RCT3 estimate of 436 million. There is some discrepancies between the different surveys for this year class. Therefore, the weight attributed to the surveys was only 65% whereas in the RCT3 analysis of the WG (without the BTS 2003 index) the weight was 80%. This year class is estimated to be just above average.

The **2002 year class** in 2003 (at age 1) is poorly estimated by the RCT3 analysis (only two available indices, which gave very different estimates). The long-term GM for this year class was used.

For the **2003** and **subsequent year classes** the long-term GM was used as there were no estimates.

The text table below summarises the year class strength estimates that have been used.

Year class	At age in 2003	**XSA**	**RCT3 (wg)**	**RCT3 (new)**	**GM 57-00**	Accepted Estimate
2001	2	296719	396233	**436063**	353703	RCT3
2002	1	-	350650	354398	**394687**	GM 1957-00
2003 & subsequent	recruits	-	-		**394687**	GM 1957-00

4. Short-term forecast

The input for the short-term forecast is given in **Table** 4.1. Weight-at-age in the stock and weight-at-age in the catch are taken as the average over the last 3 years. The exploitation pattern was taken as the mean value of the last three years and scaled to the average F over 2002 (0.51). Population numbers-at-ages 3 and older are XSA survivor estimates. Numbers-at-age 2 are estimated from the new RCT3. Numbers-at-age 1 and recruitment of the 2003 year class are taken from the long-term geometric mean (1957-2000)

A management option table for status quo fishing mortality in 2003 in presented in **Table** 4.2. Detailed tables for F status quo are given in **Table** 4.3. A detailed deterministic plot of the catch forecast is given in **Figure** 4.1. At status quo fishing mortality in 2003 and 2004 the SSB is expected to be at around 149,000 tonnes in 2004 and 166,000 tonnes in 2005.

The yield at status quo F is expected to be around 72,500 tonnes in 2003, compared to 71,000 tonnes estimated by the WG. The status quo catch prediction for 2003 is slightly lower than the TAC for 2003 (73,250 tonnes). The yield in 2004 is predicted to be 78,000 tonnes at status quo F, compared to 75,200 tonnes estimated by the WG.

A sensitivity analysis has been carried out to identify the different sources of uncertainty underlying the predictions (**Figure** 4.2). Most of the variability (89%) of the SSB in 2005 is explained by the uncertainties of the year classes 2001 to 2003 estimates.

The probability profiles relative to the short-term forecast are given in **Figure** 4.3. At the current yield of around 70,000 tonnes, the probability that F is higher that $\mathbf{F}_{sq}$ is around 35%. The probability that SSB will stay below 210,000 tonnes is predicted to be about 80%.

5. Conclusion

The 2003 survey information has not substantially changed the perception of recruitment or the short-term forecast compared to the estimates provided by the WG. The interpretation of the biomass proxies for the BTS-Tridens and BTS-ISIS surveys are difficult to interpret.

Table 1.1 IBTS survey indices and standard deviations for North Sea plaice. ISIS (top) and Tridens (bottom)

spec	PLA
ship	Isis

	age	Data																
	1		2		3		4		5		6		7		8		9	
year	Index	Stdev	Index	Stdev	Index	Stdev	Index	Stdev	Index	Stdev	Index	Stdev	Index	Stdev	Index	Stdev	Index	Stdev
1985	115.58	251.85	179.90	183.92	38.81	29.79	11.84	9.05	1.37	1.85	1.05	1.43	0.36	0.60	0.17	0.29	0.10	0.19
1986	660.20	896.95	131.77	131.85	51.00	39.86	8.89	7.78	3.29	3.00	0.43	0.67	0.34	0.47	0.13	0.19	0.04	0.14
1987	225.82	355.40	764.29	899.80	33.07	26.64	4.77	3.29	2.04	1.81	1.02	1.17	0.35	0.38	0.09	0.24	0.07	0.21
1988	577.32	782.36	140.10	141.00	173.72	117.31	9.24	6.31	2.59	3.08	0.78	0.88	0.42	0.78	0.04	0.10	0.11	0.22
1989	428.70	810.21	319.27	363.14	38.66	32.02	47.30	45.75	5.85	12.79	0.82	0.77	0.29	0.42	0.66	0.88	0.14	0.24
1990	112.06	146.38	102.64	89.19	55.67	50.66	22.78	22.29	5.57	5.21	0.80	0.91	0.21	0.27	0.38	0.43	0.26	0.43
1991	185.44	343.92	122.05	146.29	28.55	33.37	11.86	10.39	4.26	3.33	5.69	3.97	0.26	0.41	0.23	0.24	0.12	0.22
1992	171.54	236.29	125.93	141.85	27.31	16.35	5.62	4.45	3.18	2.03	2.66	1.86	1.14	1.07	0.26	0.27	0.05	0.17
1993	124.76	211.70	179.10	218.32	38.40	35.98	6.12	4.42	0.93	0.93	0.81	0.70	0.64	0.68	0.44	0.45	0.17	0.27
1994	145.21	200.61	64.22	55.93	35.24	28.79	10.87	11.09	2.86	3.58	0.64	0.69	0.86	0.92	0.96	1.14	0.40	0.53
1995	252.17	391.78	43.62	55.76	14.24	17.59	8.11	9.39	1.20	1.18	0.87	1.09	0.36	0.52	1.13	1.87	0.22	0.35
1996	218.28	408.45	212.13	449.54	22.88	23.93	4.83	5.43	3.72	3.56	0.92	1.02	0.05	0.15	0.17	0.33	0.13	0.23
1997	439.51	373.45	743.57	884.03	19.91	13.37	2.79	2.37	0.22	0.24	0.39	0.54	0.17	0.55	0.12	0.33	0.00	0.00
1998	338.20	373.10	436.20	380.88	47.41	36.73	8.91	8.21	1.44	1.68	0.75	1.17	0.14	0.24	0.08	0.19	0.11	0.21
1999	305.87	528.54	130.00	218.25	182.54	158.66	3.66	1.97	2.11	1.61	0.14	0.33	0.14	0.24	0.03	0.13	0.03	0.10
2000	278.78	270.70	75.22	55.30	31.59	23.88	24.21	15.89	0.61	0.51	0.17	0.32	0.54	1.18	0.03	0.09	0.02	0.07
2001	225.78	255.94	78.90	58.35	19.56	11.14	10.05	6.36	9.52	5.83	0.29	0.33	0.15	0.29	0.04	0.07	0.04	0.18
2002	568.65	491.62	45.46	23.49	15.36	12.41	5.50	3.55	2.68	2.12	1.43	1.20	0.08	0.12	0.14	0.34	0.00	0.00
2003	132.82	113.09	170.90	88.86	9.93	5.49	5.67	3.14	1.43	0.91	1.15	0.88	0.68	0.57	0.12	0.19	0.11	0.16

spec	PLA
ship	Tridens II

	age	Data																
	1		2		3		4		5		6		7		8		9	
year	Index	Stdev	Index	Stdev	Index	Stdev	Index	Stdev	Index	Stdev	Index	Stdev	Index	Stdev	Index	Stdev	Index	Stdev
1996	1.59	5.35	5.58	13.57	4.39	5.74	3.31	3.42	2.39	2.56	1.84	2.27	0.83	1.18	0.48	0.72	0.18	0.54
1997	0.02	0.12	7.21	13.73	10.36	12.51	3.96	4.23	2.84	4.21	1.93	2.36	0.46	0.75	1.12	1.66	0.45	0.87
1998	0.56	1.79	30.79	94.60	9.97	12.76	5.52	6.17	2.70	4.55	1.35	2.00	0.90	1.21	0.78	1.10	0.33	0.64
1999	2.37	9.18	8.29	23.80	36.93	73.73	6.46	7.80	2.65	2.40	2.13	2.90	0.60	0.84	0.76	1.28	0.33	0.64
2000	4.64	15.10	9.45	16.92	12.74	20.73	17.23	21.44	2.94	3.09	1.89	2.40	1.08	1.84	0.95	1.41	0.25	0.34
2001	0.67	2.77	6.93	13.42	9.05	12.59	7.22	8.23	7.65	8.04	1.20	1.27	0.69	1.08	0.48	0.72	0.59	0.89
2002	20.62	39.00	14.41	18.49	10.72	11.85	7.61	5.27	4.26	3.50	4.13	3.48	0.52	0.64	0.63	0.70	0.36	0.56
2003	4.22	18.96	34.35	81.48	11.81	14.32	8.52	9.51	4.79	4.71	3.08	4.41	3.98	3.88	0.70	0.76	0.72	1.11

Table 1.2 North Sea plaice. Relative survey abundances; scaled to the mean over the period 1996-2003.

		1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
BTS-ISIS	1	0.34	1.95	0.67	1.70	1.26	0.33	0.55	0.51	0.37	0.43	0.74	0.64	1.30	1.00	0.90	0.82	0.67	1.68	0.39
	2	0.73	0.54	3.11	0.57	1.30	0.42	0.50	0.51	0.73	0.26	0.18	0.86	3.02	1.77	0.53	0.31	0.32	0.18	0.69
	3	0.80	1.05	0.68	3.58	0.80	1.15	0.59	0.56	0.79	0.73	0.29	0.47	0.41	0.98	3.77	0.65	0.40	0.32	0.20
	4	1.38	1.04	0.56	1.08	5.52	2.66	1.38	0.66	0.71	1.27	0.95	0.56	0.33	1.04	0.43	2.83	1.17	0.64	0.66
	5	0.47	1.13	0.70	0.89	2.02	1.92	1.47	1.10	0.32	0.98	0.41	1.28	0.08	0.50	0.73	0.21	3.28	0.92	0.49
	6	1.79	0.73	1.74	1.33	1.40	1.37	9.73	4.55	1.39	1.09	1.48	1.57	0.67	1.29	0.23	0.30	0.50	2.44	1.96
	7	1.99	1.86	1.93	2.31	1.59	1.13	1.42	6.24	3.49	4.73	1.96	0.26	0.94	0.80	0.77	2.96	0.82	0.46	3.73
	8	1.91	1.48	0.99	0.41	7.56	4.34	2.64	2.97	5.08	10.95	12.98	1.98	1.39	0.90	0.33	0.33	0.47	1.60	1.41
	9	2.07	0.80	1.53	2.43	3.04	5.53	2.49	1.13	3.66	8.48	4.71	2.78	0.00	2.22	0.68	0.40	0.92	0.00	2.29
BTS-TRIDENS	1												0.37	0.00	0.13	0.54	1.07	0.15	4.74	0.97
	2												0.47	0.61	2.61	0.70	0.80	0.59	1.22	2.91
	3												0.33	0.77	0.74	2.75	0.95	0.67	0.80	0.88
	4												0.45	0.54	0.75	0.88	2.35	0.99	1.04	1.16
	5												0.66	0.78	0.74	0.73	0.81	2.11	1.17	1.32
	6												0.89	0.93	0.65	1.03	0.92	0.58	2.00	1.49
	7												1.14	0.64	1.24	0.83	1.48	0.95	0.72	5.49
	8												0.64	1.51	1.05	1.03	1.28	0.64	0.84	0.94
	9												0.50	1.26	0.92	0.94	0.70	1.67	1.01	2.03

Table 3.1 Plaice in IV. RCT3 input.

Ple-nsea	Age 1 recr	Age 2 recruitment									
9	36	32	2								
'yc'	'VPA-1'	'VPA-2'	'SNS-0'	'SNS-1'	'SNS-2'	'SNS-3'	'BTS-1'	'BTS-2'	'BTS-3'	'comb DFS/YFS-0'	'comb DFS/YFS-1'
1967	237193	214621	-11	-11	-11	2813	-11	-11	-11	-11	-11
1968	319318	288928	-11	-11	9450	1008	-11	-11	-11	-11	-11
1969	363590	328917	-11	8032	23848	4484	-11	-11	-11	-11	-11
1970	267742	242245	3678	18101	9584	1631	-11	-11	-11	-11	-11
1971	224217	200756	6705	6437	4191	1261	-11	-11	-11	-11	-11
1972	531194	479438	9242	57238	17985	10744	-11	-11	-11	-11	-11
1973	447210	402538	5451	15648	9171	791	-11	-11	-11	-11	-11
1974	327785	295659	2193	9781	2274	1720	-11	-11	-11	-11	-11
1975	317791	284867	1151	9037	2900	435	-11	-11	-11	-11	-11
1976	463277	416128	11544	19119	12714	1577	-11	-11	-11	-11	-11
1977	420813	379680	4378	13924	9540	456	-11	-11	-11	-11	-11
1978	435541	392840	3252	21681	12084	785	-11	-11	-11	-11	-11
1979	654862	591612	27835	58049	16106	1146	-11	-11	-11	-11	-11
1980	417306	377354	4039	19611	8503	308	-11	-11	-11	-11	154
1981	1021516	921134	31542	70108	14708	2480	-11	-11	-11	633.51	286.65
1982	582796	526181	23987	34884	10413	1584	-11	-11	39	456.51	160.16
1983	600994	543699	36722	44667	13789	1155	-11	180	51	432.42	116.62
1984	523643	473697	7958	27832	7558	1232	116	132	33	263.33	100.94
1985	1247347	1127054	47385	93573	33021	13140	660	764	174	717.73	268.55
1986	539672	488316	8818	33426	14429	3709	226	140	39	345.13	188.55
1987	560224	506911	21270	36672	14952	3248	577	319	56	465.11	105.29
1988	403945	364305	15598	37238	7287	1507	429	103	29	330.73	135.02
1989	392654	353813	24198	24903	11149	2257	112	122	27	462.70	128.61
1990	399455	360052	9559	57349	13742	988	185	126	38	468.23	150.72
1991	401147	359729	17120	48223	9484	884	172	179	35	495.57	131.09
1992	285789	255300	5398	22184	4866	415	125	64	14	356.84	74.09
1993	238966	214900	9226	18225	2786	1189	145	44	23	263.03	30.50
1994	322090	284066	27901	24900	10377	1393	252	212	20	444.90	37.74
1995	249817	224993	13029	24663	-11	5739	218	744	47	184.47	116.73
1996	751423	679067	91713	-11	29431	14347	440	436	183	572.38	152.64
1997	266000	240500	15363	33391	9235	905	338	130	32	156.64	-11
1998	247701	223607	22720	35188	2489	356	306	75	20	-11	-11
1999			39201	23028	2416	263	279	79	15	-11	13.92
2000			24185	10193	1047	-11	226	45	10	184.61	5.21
2001			101291	30265	-11	-11	569	171	-11	499.55	-11
2002			29905	-11	-11	-11	133	-11	-11	-11	-11

Table 3.2 Plaice in IV. RCT3 output (1 year olds)

Analysis by RCT3 ver3.1 of data from file :

p4-rct1.txt

Ple-nseaAge 1 recruitment

Data for 9 surveys over 36 years : 1967 - 2002

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.

Year class = 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	.94	3.61	.60	.360	29	10.09	13.11	.695	.078
SNS-1	1.45	-2.28	.44	.443	29	9.23	11.10	.709	.075
SNS-2	.64	7.06	.27	.735	30	6.95	11.50	.420	.213
BTS-1	1.73	3.34	.83	.225	15	5.42	12.70	.956	.041
BTS-2	1.01	7.68	.79	.240	16	3.83	11.54	1.004	.037
BTS-3	.76	10.07	.35	.622	17	2.40	11.90	.452	.184
comb D	1.28	5.33	.41	.548	17	5.22	12.03	.528	.134
comb D	1.04	8.14	.51	.450	17	1.83	10.03	1.091	.032
					VPA Mean =		12.81	.426	.207

Year class = 2001

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression----------				I	I-----------Prediction---------			I
SNS-0	.88	4.20	.56	.385	29	11.53	14.32	.806	.091
SNS-1	1.43	-2.07	.44	.412	29	10.32	12.66	.528	.213
BTS-1	1.77	3.05	.84	.216	15	6.35	14.31	1.119	.047
BTS-2	1.01	7.66	.82	.225	16	5.15	12.86	.959	.064
comb D	1.22	5.69	.40	.557	17	6.22	13.27	.494	.243
					VPA Mean =		12.79	.416	.342

Year class = 2002

Survey/ Series	**Slope**	**Inter- cept**	**Std Error**	**Rsquare**	**No. Pts**	**Index Value**	**Predicted Value**	**Std Error**	**WAP Weights**
	I-----------Regression----------				**I**	**I-----------Prediction---------**			**I**
SNS-0	**.81**	**4.80**	**.51**	**.419**	**29**	**10.31**	**13.18**	**.628**	**.271**
BTS-1	**1.83**	**2.69**	**.86**	**.206**	**15**	**4.90**	**11.68**	**1.102**	**.088**
					VPA Mean =		**12.76**	**.409**	**.641**

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
2000	165216	12.02	.19	.25	1.66		
2001	486016	13.09	.24	.24	.98		
2002	**354398**	**12.78**	**.33**	**.27**	**.70**		

Table 3.3 Plaice in IV. RCT3 output (2 year olds)

Analysis by RCT3 ver3.1 of data from file :

p4-rct2.txt

Ple-nsea Age 2 recruitment

Data for 9 surveys over 36 years : 1967 - 2002

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.

Year class = 2000

Survey/ Series	Slope (Regression)	Inter-cept (Regression)	Std Error (Regression)	Rsquare (Regression)	No. Pts (Regression)	Index Value (Prediction)	Predicted Value (Prediction)	Std Error (Prediction)	WAP Weights (Prediction)
SNS-0	.95	3.44	.60	.359	29	10.09	13.01	.701	.077
SNS-1	1.45	-2.35	.44	.448	29	9.23	10.99	.704	.077
SNS-2	.64	6.90	.28	.731	30	6.95	11.38	.427	.208
BTS-1	1.72	3.25	.82	.229	15	5.42	12.59	.952	.042
BTS-2	1.02	7.53	.80	.239	16	3.83	11.43	1.011	.037
BTS-3	.76	9.97	.35	.628	17	2.40	11.79	.447	.190
comb D	1.30	5.10	.42	.537	17	5.22	11.91	.544	.128
comb D	1.03	8.03	.51	.459	17	1.83	9.92	1.081	.033
					VPA Mean =		12.71	.428	.208

Year class = 2001

Survey/ Series	**Slope (Regression)**	**Inter-cept (Regression)**	**Std Error (Regression)**	**Rsquare (Regression)**	**No. Pts (Regression)**	**Index Value (Prediction)**	**Predicted Value (Prediction)**	**Std Error (Prediction)**	**WAP Weights (Prediction)**
SNS-0	**.88**	**4.04**	**.56**	**.384**	**29**	**11.53**	**14.22**	**.811**	**.091**
SNS-1	**1.42**	**-2.10**	**.44**	**.419**	**29**	**10.32**	**12.56**	**.522**	**.221**
BTS-1	**1.77**	**2.98**	**.83**	**.220**	**15**	**6.35**	**14.20**	**1.113**	**.049**
BTS-2	**1.02**	**7.52**	**.82**	**.224**	**16**	**5.15**	**12.75**	**.966**	**.064**
combD	**1.24**	**5.46**	**.41**	**.545**	**17**	**6.22**	**13.18**	**.509**	**.232**
					VPA Mean =		**12.68**	**.418**	**.344**

Year class = 2002

Survey/ Series	Slope (Regression)	Inter-cept (Regression)	Std Error (Regression)	Rsquare (Regression)	No. Pts (Regression)	Index Value (Prediction)	Predicted Value (Prediction)	Std Error (Prediction)	WAP Weights (Prediction)
SNS-0	.82	4.66	.52	.418	29	10.31	13.07	.632	.270
BTS-1	1.83	2.64	.85	.210	15	4.90	11.58	1.093	.090
					VPA Mean =		12.65	.410	.640

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
2000	147782	11.90	.19	.25	1.67		
2001	**436063**	**12.99**	**.25**	**.24**	**.98**		
2002	318139	12.67	.33	.27	.70		

Table 4.1 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	394686	0.41	WS1	0.12	0.00
N2	**436063**	0.43	WS2	0.21	0.05
N3	97264	0.24	WS3	0.24	0.04
N4	92730	0.15	WS4	0.28	0.04
N5	59132	0.13	WS5	0.35	0.14
N6	46028	0.12	WS6	0.44	0.08
N7	38896	0.16	WS7	0.56	0.21
N8	4599	0.18	WS8	0.67	0.10
N9	2948	0.20	WS9	0.73	0.08
N10	5159	0.20	WS10	0.87	0.04
H.cons selectivity			Weight in the HC catch		
sH1	0.02	0.97	WH1	0.23	0.04
sH2	0.16	0.40	WH2	0.26	0.05
sH3	0.40	0.30	WH3	0.28	0.04
sH4	0.60	0.20	WH4	0.31	0.03
sH5	0.70	0.17	WH5	0.38	0.14
sH6	0.67	0.12	WH6	0.47	0.09
sH7	0.63	0.19	WH7	0.59	0.16
sH8	0.43	0.09	WH8	0.69	0.04
sH9	0.47	0.38	WH9	0.76	0.04
sH10	0.47	0.38	WH10	0.86	0.06
Natural mortality			Proportion mature		
M1	0.10	0.10	MT1	0.00	0.10
M2	0.10	0.10	MT2	0.50	0.10
M3	0.10	0.10	MT3	0.50	0.10
M4	0.10	0.10	MT4	1.00	0.10
M5	0.10	0.10	MT5	1.00	0.00
M6	0.10	0.10	MT6	1.00	0.00
M7	0.10	0.10	MT7	1.00	0.00
M8	0.10	0.10	MT8	1.00	0.00
M9	0.10	0.10	MT9	1.00	0.00
M10	0.10	0.10	MT10	1.00	0.00
Relative effort in HC fishery			Year effect for natural mortality		
HF03	1.00	0.11	K03	1.00	0.10
HF04	1.00	0.11	K04	1.00	0.10
HF05	1.00	0.11	K05	1.00	0.10
Recruitment in 2004 and 2005					
R04	394687	0.41			
R05	394687	0.41			

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

Stock numbers in 2003 are VPA survivors.
These are overwritten at Age 2

Data from file:D:\Working_groups\WGNSSK\2003\post-WG\recruitment\ple-nsea\shortt

Table 4.2 Plaice,North Sea
Catch forecast output and estimates of coefficient of variation (CV) from linear analysis.

	Year 2003	2004						
Mean F Ages								
H.cons 2 to 6	0.51	0.00	0.10	0.20	0.30	0.40	0.51	0.61
Effort relative to 2002								
H.cons	1.00	0.00	0.20	0.40	0.60	0.80	1.00	1.20
Biomass								
Total 1 January	264	279	279	279	279	279	279	279
SSB at spawning time	157	152	152	152	152	152	152	152
Catch weight (,000t)								
H.cons	72.5	0.0	18.5	35.3	50.8	65.0	78.0	89.9
Biomass in year.... 2005								
Total 1 January		367	349	332	317	303	290	278
SSB at spawning time		242	225	210	196	183	171	161

	Year 2003	2004						
Effort relative to 2002								
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	0.18	0.19	0.19	0.19	0.19	0.19	0.19	0.19
SSB at spawning time	0.15	0.17	0.17	0.17	0.17	0.17	0.17	0.17
Catch weight								
H.cons	0.17	0.00	0.57	0.33	0.26	0.24	0.23	0.22
Biomass in year.... 2005								
Total 1 January		0.17	0.17	0.18	0.18	0.18	0.19	0.19
SSB at spawning time		0.19	0.20	0.20	0.20	0.20	0.21	0.21

Table 4.3 Plaice,North Sea
Detailed forecast tables.

Forecast for year 2003
F multiplier H.cons=1.00

Age	Populations Stock No.	Catch number H.Cons	Catch number Total
1	394686	6701	6701
2	436063	60016	60016
3	97264	30616	30616
4	92730	40208	40208
5	59132	28350	28350
6	46028	21575	21575
7	38896	17391	17391
8	4599	1541	1541
9	2948	1058	1058
10	5159	1851	1851
Wt	264	72	72

Forecast for year 2004
F multiplier H.cons=1.00

Age	Populations Stock No.	Catch number H.Cons	Catch number Total
1	394687	6701	6701
2	350756	48275	48275
3	337575	106260	106260
4	58994	25580	25580
5	45865	21989	21989
6	26703	12516	12516
7	21248	9500	9500
8	18744	6280	6280
9	2702	969	969
10	4580	1644	1644
Wt	279	78	78

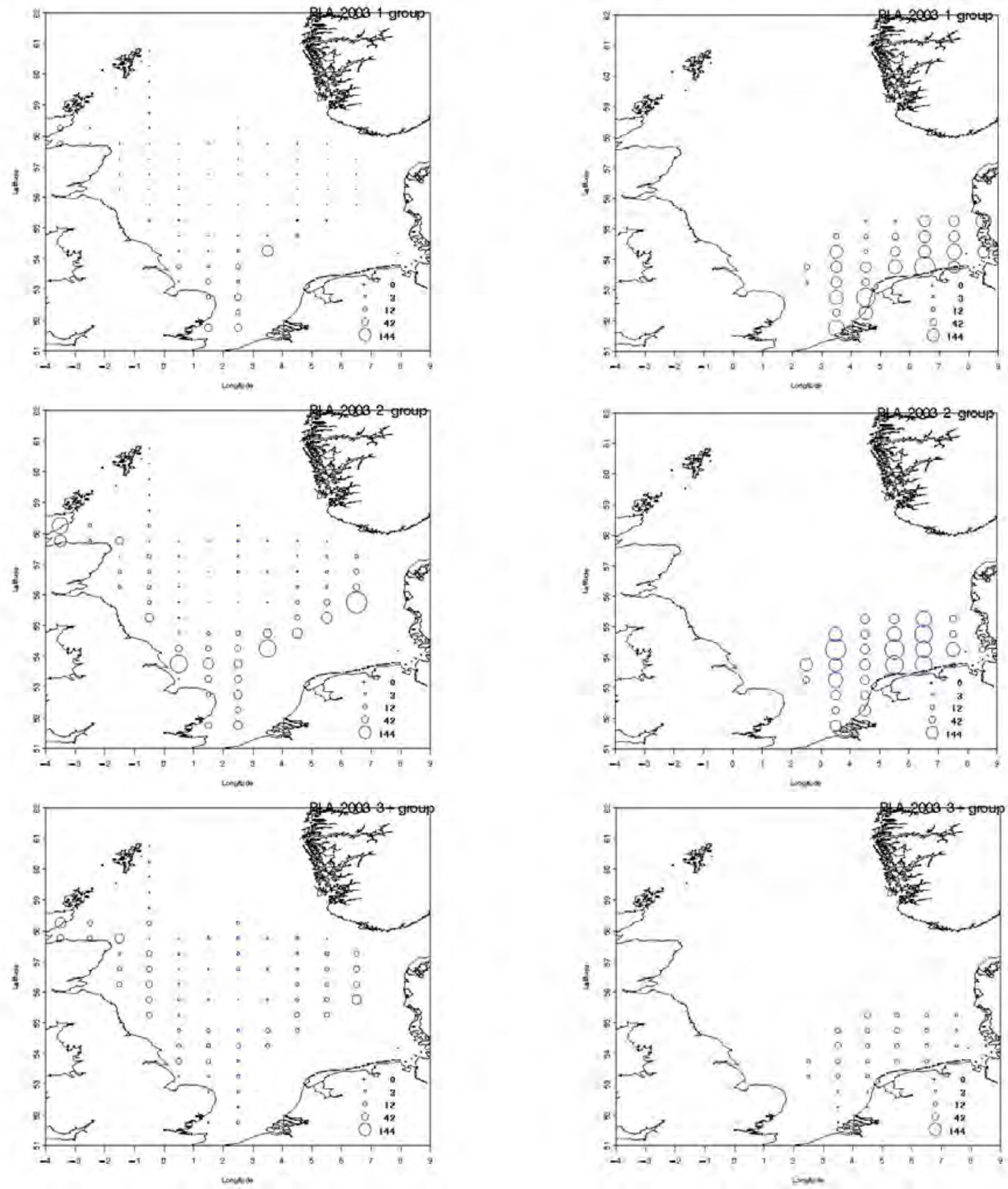


Figure 1.1 North Sea plaice. Survey results for 2003 by area and age group for the BTS-ISIS survey (right panels) and the BTS-Tridens survey (left panels).

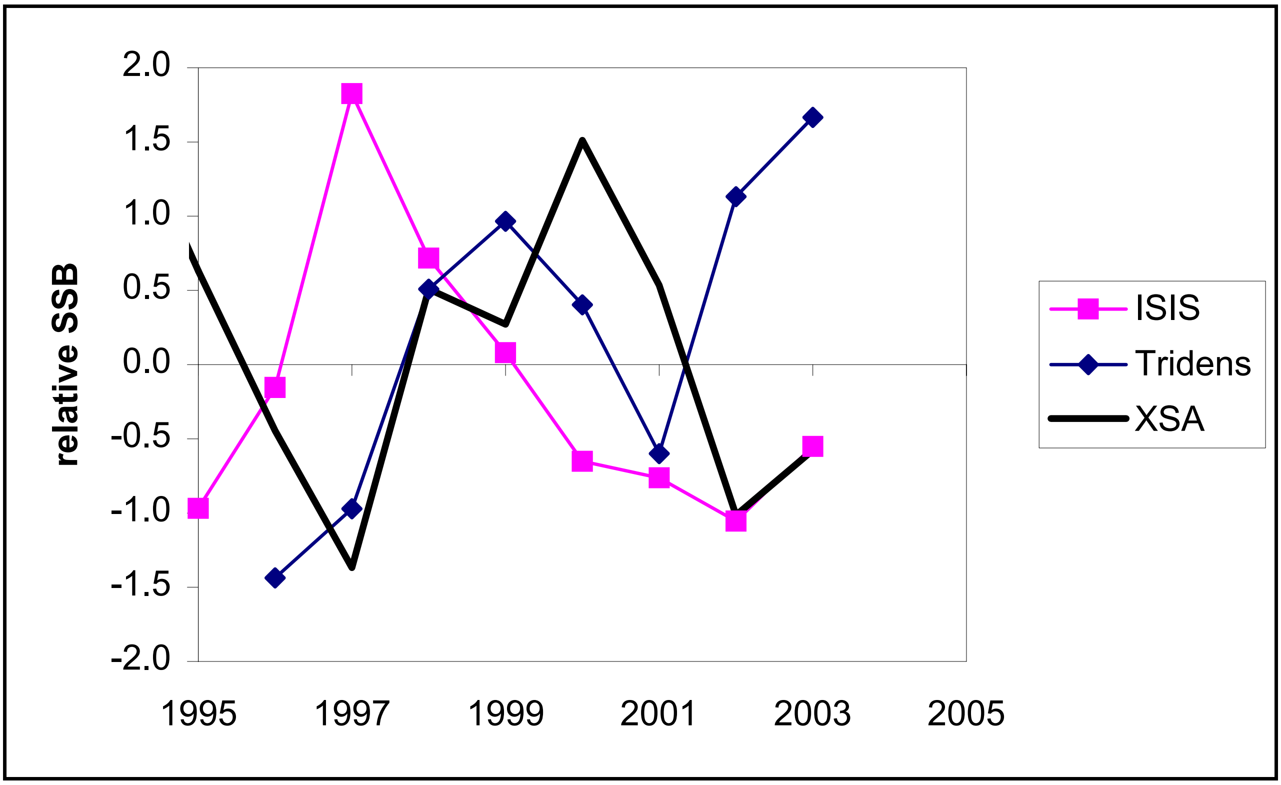


Figure 2.1 North Sea plaice. Relative SSB (scaled to the mean of the period 1996-2002) and divided by the standard deviation over that period from the BTS-ISIS and BTS-Tridens survey, in comparison with the SSB estimate from the most recent assessment.

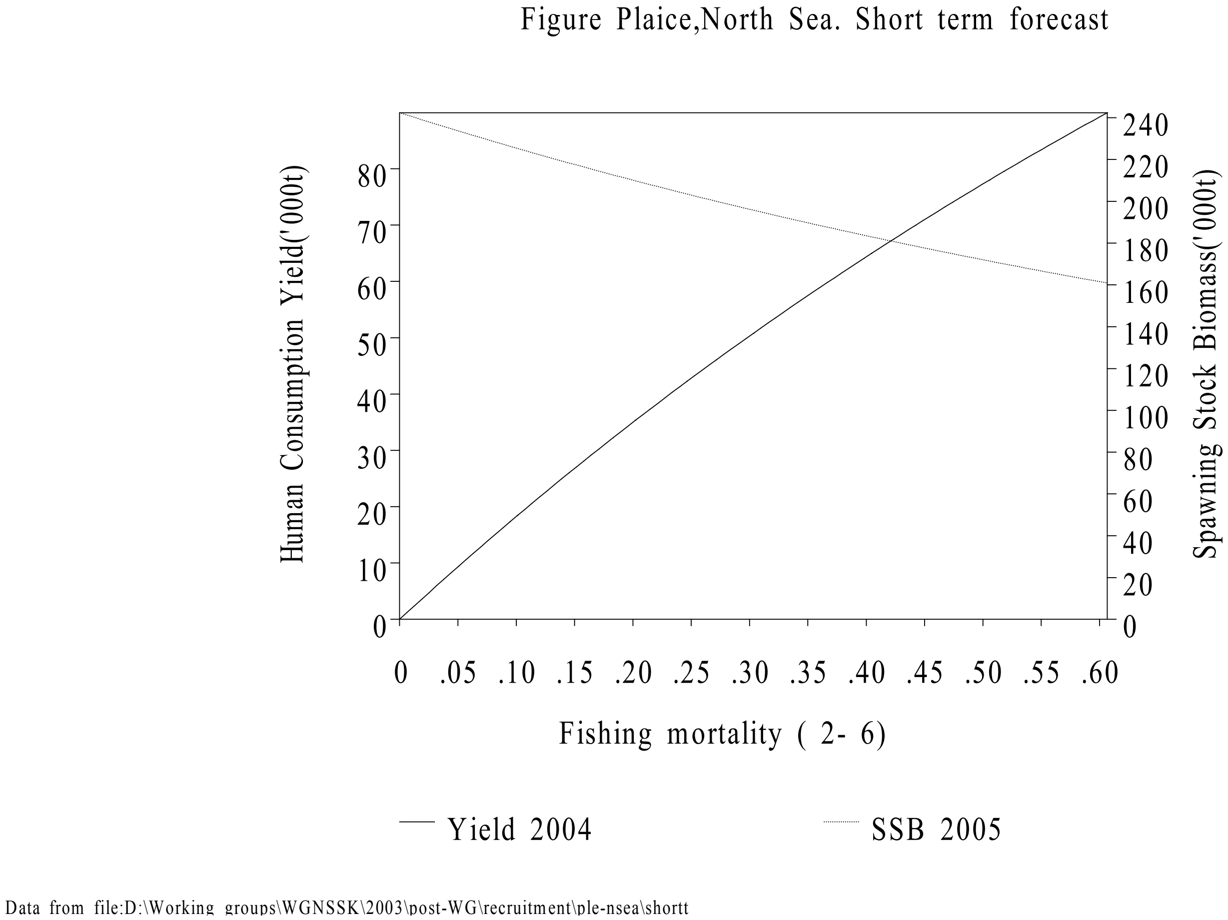


Figure 4.1 Plaice North Sea. Short-term forecast

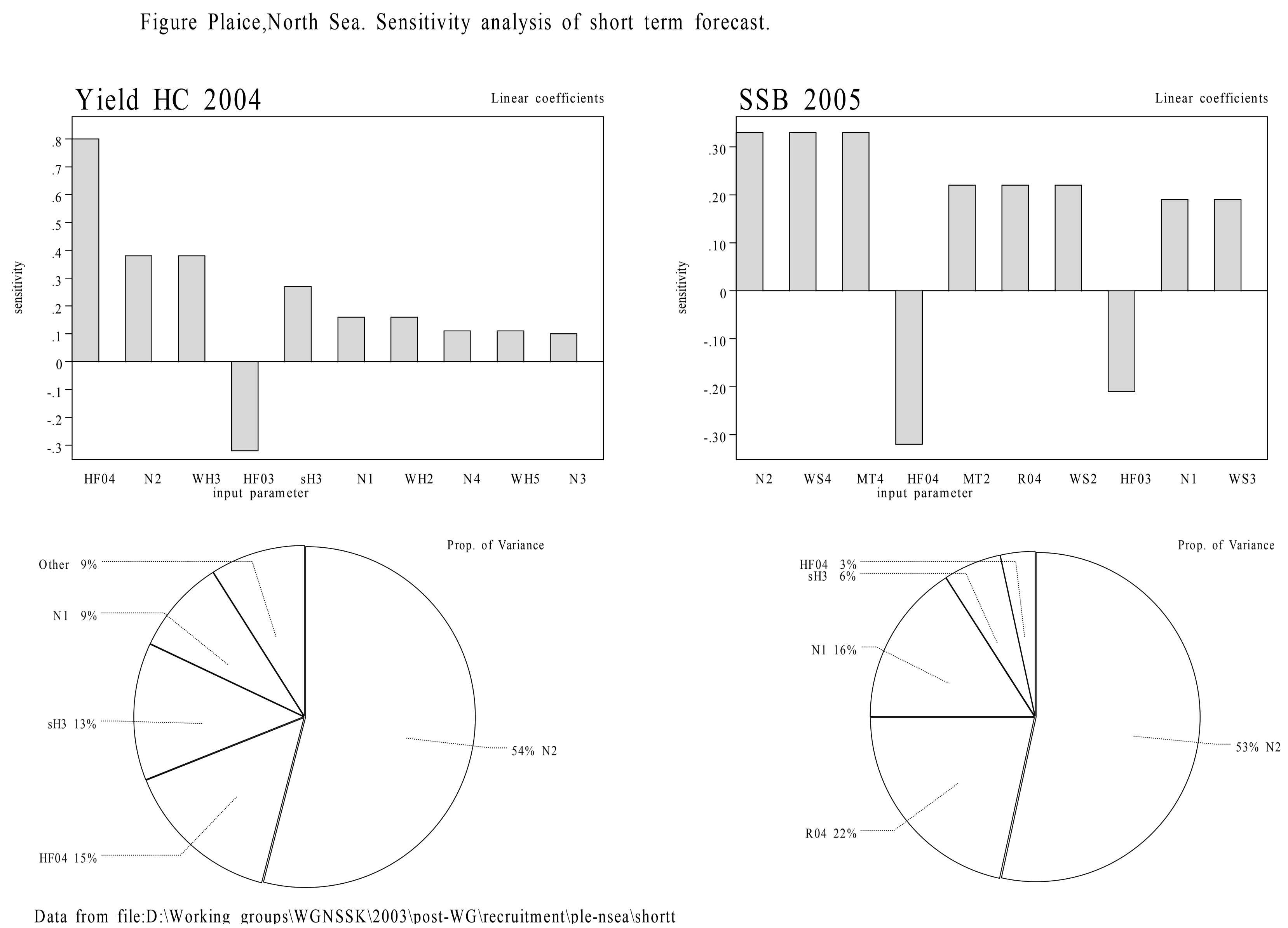
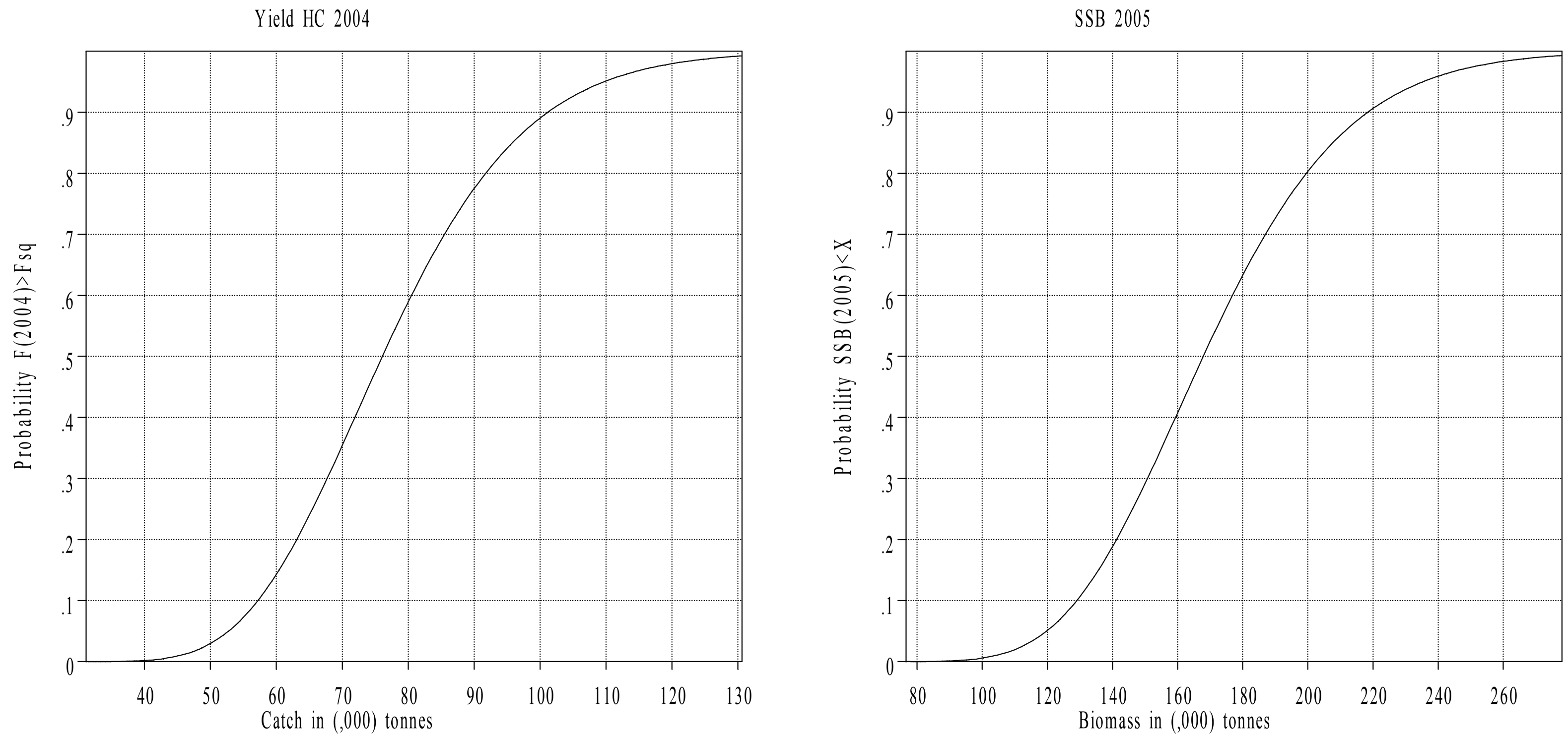


Figure 4.2 Plaice, North Sea. Sensitivity analysis of the short-term forecast.

Figure Plaice,North Sea. Probability profiles for short term forecast.



Data from file:D:\Working groups\WGNSSK\2003\post-WG\recruitment\ple-nsea\shortt

Figure 4.3 Plaice North Sea. Probability profile for the short-term forecast. Left: probability that F(2004) > $\mathbf{F}_{sq}$. Right: probability that SSB(2005)<X.

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0 EXECUTIVE SUMMARY

The Working Group on the Assessment of demersal stocks in the North Sea and Skagerrak met in Boulogne sur Mer, 9-18 September 2003. There were 27 participants. The main terms of reference for the Working group were to carry out stock assessments and to provide catch forecasts for the demersal and industrial stocks in the North Sea, Skagerrak and Eastern Channel, to collate data for mixed fisheries evaluations and to take technical interactions into account in the forecasts, to evaluation of cod recovery plans and to evaluate the proposed new Precautionary Approach reference points.

0.1 Working procedures

The general approach within the WG was changed compared to last year. The stock assessment were distinguished into Benchmark and Update assessments, according to the shortlist agreed by ACFM (October 2002) and according to a rotating cycle over the years. The Working Group carried out benchmark assessments for Cod, Haddock, Plaice in IV and sole in IV. All other stocks were marked for update assessments. From these, the whiting assessment was partly benchmarked during the meeting because problems were encountered with the update assessments. The Quality Control Handbook which specifies the biological background and the default assessment approach for the different stocks is in development. The general approach in benchmark assessments was directed at evaluating the most appropriate model formulation for the benchmark stocks. The benchmark assessments have resulted in new age ranges being used for these stocks.

0.2 State of the stocks

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

Reported landings of cod in 2002 (49,000 t) were the lowest on record, as was the spawning stock. The 1996 year-class was relatively strong, but suffered so heavily from fishing and discarding of immature fish that it did not result in rebuilding the spawning stock. Since 1997, recruitment has been at a low level. Fishing mortality is high but appears to be decreasing. Although the absolute level of the spawning stock cannot be determined accurately, is it clear from all sources of informatio that SSB is low and likely to be well below the current $\mathbf{B}_{\mathrm{lim}}$ (70,000 t).

Historically the stock size of haddock has shown large variation due to the occasional occurrence of a very strong year classes. The strong 1999 year class dominated the human consumption landings in 2002. The maturation of the 1999 year class has also increased the SSB to well above $\mathbf{B}_{\mathrm{pa}}$, but it is likely to decrease again in the near future**.** Fishing mortality is high but appears to be decreasing. Recruitment after 1999 has been low.

The human consumption yield of whiting in 2002 was 16,000t, which is the lowest level observed in the time series. Discard levels observed in 2002 are also low compared to previous years. The spawning stock biomass has overall gradually declined over more than 20 years. Most recent estimates indicate a low level of F and a increase in SSB since 1998. 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 increasing and estimated to be well above $\mathbf{B}_{\mathrm{pa}}$. Landings in 2002 were 112,000 t which is still at a relatively low level. Fishing mortality has declined considerably since 1986 and remains at a low level.

Fishing mortality of sole in the North Sea has fluctuated on a high level since the 1970s but appears to be declining since the late 1990s. The spawning stock was below $\mathbf{B}_{\mathrm{pa}}$ in 2002 and 2003 but is expected to increase due to the relatively strong 2001 year class.

The spawning stock of plaice in the North Sea has been decreasing steadily until arriving at its lowest observed level in 1997. Last year the impression was that the SSB was increasing again but the current assessment indicates that this may have been due to overestimation of the stock size. SSB is not estimated to be at around the same low level as in 1997. Fishing mortality has apparently come down since the late 1990's.

The SSB and fishing mortality of Norway pout is highly fluctuating. However, fishing mortality has appeared to decrease since the 1980s. SSB is estimated to be above $\mathbf{B}_{\mathrm{pa}}$ for this stock.

Over the years, SSB of sandeel has been fluctuating around 1 million t. There is a general pattern of large SSB being followed by a low SSB. The present assessment estimates SSB for 2002 to be below $\mathbf{B}_{lim}$ and the recruitment in 2002 is estimated to extremely low. However, the 2001 yearclass is estimated to rebuild the stock to well above $\mathbf{B}_{pa}$ in 2003.

The landings of cod in Division IIIa were 9.7 thousand tonnes in 2002 in the human consumption fishery, which is a historic low. 75 % was taken in Skagerrak, and the majority of catches were taken by Denmark and Sweden. Cod in Skagerrak is assessed together with the North Sea (Division IV) and Eastern Channel (Division VIId) stock. Cod in Kattegat is assessed as a separate stock by the Baltic Fisheries Assessment Working Group. ICES has since 2002 advised that no fishery should take place on this stock. No recovery plan is implemented yet. By-catches of cod in the Danish small-meshed fishery have been decreasing steadily in the latest decade.

Landings of haddock in Division IIIa, in the human consumption fishery, amounted to 4.6 thousand tonnes. Most of the catches are taken in Skagerrak. Haddock in IIIa is assessed together with the North Sea (Division IV) stock. By-catches of haddock in the Danish small-meshed fishery have been decreasing steadily in the latest decade.

Landings of whiting (for human consumption) in IIIa were 252 tonnes in 2002. Most of the landings are taken in Skagerrak. No analytical assessment of whiting in IIIa was possible. By-catches of whiting in the Danish small-meshed fishery have been slightly increasing in the recent 6 years.

The plaice landings in Division IIIa amounted to 8.7 thousand tonnes in 2002, which is a 25% decrease from 2001. Historically, TAC has not been restrictive for this stock. About 70% of the landings were taken in Skagerrak. Plaice in IIIa is assessed as a separate stock. By-catches of plaice in the Danish small-meshed fishery have been decreasing steadily in the latest decade.

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

The plaice in VIId stock follows the pattern of a general decline in plaice stocks observed in other areas up to 1997. Since then SSB appears to have stabilised at or slightly below $\mathbf{B}_{pa}$. F has increased in 2002 above $\mathbf{F}_{lim}$ (0.54). Recruitment is close to mean levels after the confirmed strong 2000 year class. The state of the plaice stock in VIId is highly dependent on the quality of the recruitment.

0.3 Mixed fisheries modelling

Substantial progress has been on the ToR of collation of fisheries data for mixed fisheries modelling. The MTAC approach takes the (possibly inconsistent) single-species advice for each species in the fishery as a starting point, then attempts to resolve these into consistent catch or effort advice using fishery-disaggregated catch-forecasts in combination with explicitly stated management priorities for each stock. MTAC estimates first a set of fleet effort multipliers for each fleet and species combination to obtain the single species TAC. The estimated fleet-species factors are then combined into a fleet effort factor for each fleet, which afterwards are used to calculate the mixed-fisheries TAC. These calculations require a set of rules or options describing how individual fleet should change effort and how the species specific efforts factors should be combined into a fleet factor. The fleet-factor is determined by the product between three management inputs

a) a species-specific fleet reduction rate

b) a decision weights

c) a fleet target factor

The mixed-fisheries TACs calculated by MTAC were found to be sensitive to both the level of aggregation of the database and the weighting options.

The Working Group concludes that the approach presented here to develop fishery-based forecasts be considered by ACFM as a prototype tool. Due to the data limitations, the group suggests that it may be premature to use this approach for providing fishery-based advice in 2003. The WG considers that there is an urgent need for the ICES SGDFF to collate the appropriate data and for the Methods WG to evaluate the MTAC model.

0.4 Evaluation of cod recovery plans

A summary of the relevant management measures relating to North Sea cod are presented in the report. No evaluation of the effects of reductions in fishing effort could be carried out because reliable effort data on a North Sea scale was (still) not available. The stock assessment of North Sea cod does indicate that there may be a change in the selection pattern which could be attributed to changes in technical measures and reductions in fishing effort although they could also be caused by changes in directivity of the fishery.

The WGNSSK estimated an increase of mean weight at age 1 and 2 in the landings for cod in 2002. It was concluded that this increase could possibly be due to improved size selection but also to high grading or sampling error.

The WG noted that the simultaneous TAC reductions for the closely associated fisheries on cod, haddock and whiting do not necessarily translate into effort reductions. Different assessment methods (including survey only) reveal decreased fishing mortalities. The working group considers that this decrease is mainly driven by low landings in 2001 and 2002. Prediction scenarios applying low fishing mortalities in 2003 and later indicate that the stock has still the potential to recover.

0.5 Evaluation and re-estimation of PA reference points

A sensitivity analysis has been carried out of the segmented regression methodology. In general, it appears from the simulations that systematic departures in the data tend to increase the estimate of the breakpoint. Presumably, this may be because all treatments cause the perceived recent recruitment to decline, recent SSBs are also lower and consequently, the change-point occurs at a higher value of SSB. Discarding had minimal effect presumably because discard mortality in the simulations was less than natural mortality. The following points were clear from the results:

- In contrast to the biomass reference points the fishing mortality reference points are much less sensitive either to bias in the data, to changes in the dynamics, or to the S-R relationships.
- There were only small differences between the estimates of the breakpoint from the Beverton-Holt and from constant stock-recruitment models;
- Simulations of mis-reporting and a decline in recruitment both suggested that $\mathbf{B}_{loss}$ is biased downwards and the breakpoint biased upwards;
- In the case of a recent decline in recruitment the effect is to increase the value of S*, this means that a decline in recruitment and hence the carrying capacity of the stock results in the limit biomass value being increased which is counter-intuitive.

Specific comments about the proposed $\mathbf{B}_{lim}$ values by SGPRP are included in the report, but will be more fully discussed by correspondence. This will result in a annex to this report which will be presented to ACFM in october 2003. Given the revisions in age ranges for the benchmark stocks, the PA points may need immediate revision, which is not yet foreseen in the time-schedule of SGPRP. Therefore, these estimates are likely to be based on the technical basis as described in the ACFM report. This could not be done within the time frame of the working group and will be taken up by correspondence.

1 GENERAL

1.1 Participants

The Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak (WGNSSK) met in Boulogne sur Mer from 9 – 18 september with the following participants:

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The meeting was observed by four scientific observers working under the EC funded research contract on Policy and Knowledge in Fisheries Management (PKFM).

1.2 Terms of Reference

The Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak [WGNSSK] (Chair: M. Pastoors, Netherlands) will meet at Boulogne-sur-Mer (France) from 9–18 September 2003 to:

a) *assess the status of 1) haddock in Sub-area IV and Division IIIa, and 2) sole in Sub-area IV and Division VIId;*

b) *assess the status of the following stocks: 1) cod in Sub-area IV and Division IIIaN (Skagerrak), and Division VIId, 2) whiting and 3) plaice both in Sub-area IV, Division IIIa, and Division VIId, and 4) saithe in Sub-area IV, Sub-area VIa and Division IIIa;*

c) *update recruitment estimates and provide catch options for 2004 using the most recent survey data 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 in Sub-area IV, Division IIIa, and Division VIId, 4) plaice in Sub-area IV, 5) sole in Sub-area IV and 6) Norway Pout in Sub-area IV. The catch options should take into account the technical interactions among the stocks due to the mixed-species fisheries.*

d) *provide catch options for 2004 for saithe in Sub-area IV, Sub-area VIa and Division IIIa;*

e) *assess the status of and provide catch forecasts for 2003 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;*

f) *evaluate the effects of the existing recovery plan for North Sea cod;*

g) *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;*

h) *provide the data required to carry out multispecies assessments (quarterly catches and mean weights at age in the catch and stock for 2002 for all species in the multispecies model that are assessed by this Working Group);*

i) *provide specific information on possible deficiencies in the assessments including at least: Major inadequacies in the data on catches, effort or discards; major inadequacies if any in research vessel surveys data and major difficulties if any in model formulation; including inadequacies in available software. The Group should clarify the consequences from these deficiencies for a) assessment of the status of the stocks and b) for the projection;*

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

k) *comment on the PA reference points proposed by the Study Group on Precautionary Reference Points for Advice on Fishery Management;*

l) *structure the assessment report following the guidelines as adopted by ACFM in October 2002 with special attention to the quality issues;*

m) *provide information on the species compositions by major groups of fisheries/fleets. If possible account for technical interactions in the catch options.*

WGNSSK will report on (a) by 1 July 2003 for the attention of ACFM for presentation to the North Sea Commission Fisheries Partnership on 26-27 August 2003[1] *and will report on the remaining items by 19 September 2003 for the attention of ACFM.*

Terms of reference are mapped onto the sections of the report as follows:

Term of reference	Section(s)
a) Assess status of haddock and sole	4, 7
b) Assess status of cod, whiting, saithe and plaice	3, 5, 6, 9
c) Estimate recruitment and provide catch options	3 -5, 7-11
d) Provide catch options for saithe	6
e) Assess status of Norway pout and sandeel	11-12
f) Evalulate recovery plans for North Sea cod	14
g) Assess by-catches in Norway pout and sandeel fishery	1.7.1
h) Provide quarterly catch data for Multispecies WG	1.7.2
i) Comment on deficiencies in the assessments	3-12, 1.5
j) Compare assessment to last years assessment	3-12
k) Comment on PA reference points	16
l) Structure the report according to guidelines	overall
m) Provide information of catches by fleet. Account for technical interactions	15

[1] Date was afterwards changed to 6-7 October 2003.

1.3 Data Sources and Sampling Levels

1.3.1 Roundfish and flatfish stocks

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: survey indices by age
- data on natural mortality from the MSVPA

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

In a number of cases, 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.

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” in the relevant stock sections. These unallocated landings will in most cases include discrepancies that are due to differences in the calculation procedures. For instance, in some cases national gutted-fresh conversion factors have been changed in the official statistics, but not in the Working Group database. The differences introduced by conversion factors and the difference between SOP and nominal catch are in most cases minor. SOP corrections are usually not applied in the flatfish stocks, but it is a standard procedure for all roundfish stocks. The reason for this is that 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 cases, uncertainties in the landing data can seriously affect the quality of the assessments and catch forecasts. In some cases, the Working Group estimates of the landings include corrections for mis- or unreported landings. Unreported landings for cod in area IV were estimated by the Working Group for part of the fleets, and have been included in the assessment for the year 1998. There are signals that mis- or unreported landings occur in other stocks, especially in the stocks of valuable species, but these could not be verified or quantified.

Historical time-series of age composition, weight-at-age, and length-at-age by fleet, are kept and maintained in databases at national institutes. The roundfish data (cod, haddock, whiting, and saithe) are kept in Aberdeen (FRS). North Sea plaice and sole are kept in IJmuiden (RIVO), VIId sole in Lowestoft (CEFAS), VIId plaice in Port-en-Bessin (IFREMER) and IIIa plaice in Charlottenlund (DIFRES). No major revisions have been made in the catch- and weight-at-age data, any minor revisions are indicated in the relevant stock sections.

The countries that are responsible for the major proportions of the total landings generally provide the age composition data of a stock. In 2001 and previous years each country only sampled national vessels. As a result the vessels landing abroad were never sampled. Therefore, the sampling procedure has been changed and from 2002 onwards each country will sample the landings of fleet components landing in their country (EU regulation 1639/2001).

The mean weights-at-age used for stock biomass are derived from catch-at-age weights. In most stocks the annual mean weight in the catch is set equal to the mean weight in the stock. Exceptions are the North Sea and eastern English Channel plaice and sole stocks for which the weight-at-age in the stock is set equal to the weight-at-age in the first quarter (plaice) or second quarter (sole). The weight-at-age in the catch of the youngest age groups may not accurately represent the stock due to selectivity.

Maturity ogives are 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 has indicated that the age of maturation can change over time. In the case of plaice, the data suggest that the currently used maturity ogive may substantially overestimate the proportion of mature fish at ages 3 and 4. 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 this is examined before revised maturity ogives are implemented. The analyses of maturity ogives are discussed in more detail in Section 1.3.2.1.

1.3.1.2 Discard data used in the assessment

Estimates of discards are used in the 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.

A discards workshop was held under the invitation of the EC in Charlottenlund, Denmark, 2-4 September 2003. The aim of the workshop was to specify the data requirements for discards data that can be used in stock assessment. Furthermore, the workshop intended to identify raising procedures for discards data and to develop method for estimating the uncertainty of raised discards estimates. The draft report of the meeting was available to WGNSSK and has been presented to the group. The Charlottenlund-meeting did not result in concrete products which were of immediate use to WGNSSK but has developed some guidelines which are thought to be useful for further work on aggregating discards data and making these data useful for stock assessment purposes.

WGNSSK considers that there is a distinctive role for PGCCDBS to further develop the proposals by the Charlottenlund meeting and to initiate the data collation and aggregation process for the discards data that is being developed since the EC data directive from 2002 onwards. In the opinion of the WG it is important that all discard data are made available to the WG. Even though the time-series may be too short or otherwise unsuitable to be included in analytical assessments, this information is important for evaluating the quality of the assessment.

1.3.1.3 Natural mortality

The currently used natural mortality estimates are based on historical information (MSVPA for roundfish, ICES, 1989) and, unless specified otherwise, kept constant over the whole time period of the assessment. In the plaice and sole stocks, natural mortality is assumed to be 0.1 for all age groups. The natural mortality of saithe is assumed to be 0.2 for all age groups. The values of M used for the assessments of cod, haddock, and whiting are listed below:

age	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
6	0.20	0.20	0.25
7+	0.20	0.20	0.20

The Study Group on Multispecies Assessment in the North Sea (SGMSNS) has re-estimated the natural mortality of cod, haddock, whiting, sandeel, and Norway pout (1.6.2). The WG explored the effects of using Ms from SGMSMS in the assessments of cod and haddock.

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. The survey indices have become increasingly important as catch data has deteriorated for many stocks. The validity of many of the commercial tuning fleets as indicators of stock size and fishing mortality in recent years has become more uncertain, since the enforcement of national quota, ITQ's, and technical measures are known to have led to changes in directivity of some fleets to other species and in some cases to underreporting and discarding. Therefore the commercial CPUE data has been excluded from the assessments of a number of stocks. In this WG we have re-evaluated the use of commercial CPUE data with the aim of limiting biases potentially introduces by these series.

Since the Working Group now has been moved to September (June last year), most of the survey indices from 2002 were available to the WG. Survey indices from the Dutch beam trawl survey and IBTS Q3 were not available.

1.3.2 Data sources Norway pout and sandeel

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

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

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

In some cases 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.

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°E), D12 (Norway pout, if not sandeel and catch taken east of 0°E). The samples are raised to total landings on the basis of sales slip information on landed categories. Effort is estimated from the total number of trips and an estimate of average days 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.

Historical time-series of market sampling data for sandeel and Norway pout are kept and maintained in Charlottenlund (DIFRES). Any revisions in the catch- and weight-at-age data are indicated in the relevant stock sections.

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

The maturity ogives for Norway pout and sandeel are kept constant over the whole period of assessment. A paper, presented at the WG meeting in 2000, indicates that the age of maturation is higher for sandeel in the central North than observed previously in the southern North Sea and adopted for the assessments of the North Sea sandeel stock. A second paper presented at the same meeting indicated high variability in maturity of 1-group Norway pout.

1.3.2.2 Natural mortality

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

Age 0: M=0.8

Age 1: M=1.2

Age 2+: M=0.6

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

1.3.2.3 Fleet and research vessel data

For Norway pout, time-series of CPUE and effort data from Danish and Norwegian commercial fleets and data from research vessels are available. The research vessel data include first quarter IBTS, third quarter EGFS, and third quarter SGFS. Data from the third quarter IBTS were also available, but not used because the time-series is too short.

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 2001 for each stock.

Since 2002 an EU regulation (1639/2001) has been endorsed which affects the market sampling procedures. Firstly each country is obliged to sample all fleet segments, including foreign vessels, landing in their country. Secondly, a minimum number of market samples per tonnes of landing is required. The national market sampling programmes have been adjusted accordingly.

The Working Group were concerned that for some stocks, the level of sampling specified under the Minimum Programme (MP) was substantially lower than those currently collected by countries contributing to age compositions for North Sea stocks. It was expected that the precision levels required in the MP could not be met at the level of sampling specified for a number of stocks. The sampling levels of cod, whiting and haddock were lower this year compared to last year, while the sampling levels of the other species remained more or less the same.

Table 1.3.3.1 Biological sampling level by assessment stock and country: Preliminary official landings (t) and number of fish measured and aged to analyse commercial landings in 2002.

	Cod in IIIa, IV, VIId			Whiting in IV, VIId		
	Landings (t)	Lengths (No)	Ages (No)	Landings (t)	Lengths (No)	Ages (No)
Belgium	2 667	-	-	328	-	-
Denmark	16 300	6 796	6 636	96	-	-
France	3 118	-	-	8 475	1 655	2 613
Germany	2 101	2 051	450	354	2 691	-
Netherlands	4 713	3 260	2 080	2 444	5 928	1 200
Norway	5 140	3 494	169	41	-	-
Poland	39	-	-	-	-	-
Sweden	2 179	1 101	688	7	-	-
UK (E/W/NI)	3 257	34 712	3 830	1 434	16 868	1 098
UK (Scotland)	15 416	46 306	8 920	7 756	59 270	3 885
UK						
Total	54 930	97 720	22 773	20 935	86 412	8 796

	Haddock in IIIa, IV			Saithe in IV, IIIa,VI		
	Landings (t)	Lengths (No)	Ages (No)	Landings (t)	Lengths (No)	Ages (No)
Belgium	559	-	-	107	-	-
Denmark	8 914	1 684	1 623	5 668	3 621	3 607
France	903	-	-	27 873	5 522	2 425
Germany	1 091	2 138	-	11 466	6 175	3 965
Netherlands	359	-	-	6	-	-
Norway	2 391	7 178	256	59 119	27 984	2 650
Poland	17	-	-	752	-	-
Sweden	965	2 506	505	1 863	-	-
UK (E/W/NI)	3 647	18 407	1 619	2 828	838	-
UK (Scotland)	39 624	127 782	7 083	8 163	15 046	4 610
UK						
Total	58 470	159 695	11 086	117 845	59 186	17 257

(1) data not yet available

	Sole in IV			Sole in VIId		
	Landings (t)	Lengths (No)	Ages (No)	Landings (t)	Lengths (No)	Ages (No)
Belgium	1 437	2 660	400	1 643	3 115	700
Denmark	644	226	2	-	-	-
France	266	-	-	2 770	6 365	1 102
Germany	759	1050	100	-	-	-
Netherlands	12 120	3 968	3 967	-	-	-
UK (E/W/NI)	451	16117	1959	976	18 986	2 183
UK (Scotland)	242	-	-	-	-	-
UK						
Total	15 919	24 021	6 428	5 389	28 466	3 985

(1) VIId age length keys are used for IV

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	4 859	2 870	400	1 204	1 900	700
Denmark	12 552	1 944	1 923	-	-	-
France	548	-	-	3 454	5 676	1 361
Germany	3 927	9 872	78	-	-	-
Netherlands	29 081	7 670	7 670	1	-	-
Norway	1 996	-	-	-	-	-
Sweden	2	-	-	-	-	-
UK (E/W/NI)	8504	19 906	1294	841	10 472	1 667
UK (Scotland)	8 236	5 948	-	-	-	-
UK						
Total	69 705	48 210	11 365	5 500	18 048	3 728

(1) VIId age length keys are used for IV

	Plaice in IIIa			Norway Pout in IV, IIIa		
	Landings (t)	Lengths (No)	Ages (No)	Landings (t)*	Lengths (No)	Ages (No)
Denmark	8 275	5 601	5 366	73 194	3 256	2 138
Germany	29	-	-	-	-	-
Norway	58	-	-	23 753	2 135	251
Sweden	322	3 024	1 167	-	-	-
Total	8 684	8 625	6 533	96 947	5 391	2 389

*includes bycatch

	Sandeel in IV		
	Landings (t)	Lengths (No)	Ages (No)
Denmark	627 208	58 224	23 103
Norway	175 984	3 226	314
Sweden	36 842	-	-
UK (E/W/NI)	-	-	-
UK (Scotland)	2985	-	-
UK			
Total	843 019	61 450	23 417

1.4 Methods and software

1.4.1 General assessment approach: update/benchmark assessments

Following the proposals and decisions made at last year's WGNSSK meeting, and taking account of the guidelines adopted by ACFM in October 2002, the WG structured their work and report as detailed below.

Stock assessments were classified according to the following categories:

Benchmark assessment: as traditionally performed, including data preparation, review of fishery information, data screening, trial assessments, final assessment, catch forecast and medium-term projections. Report section similar to that currently provided in the WG report. ACFM summary sheet provided. Assessments in this category can be initially approached on a full basis , but may be subsequently considered unsuitable for medium-term projections, due to data series length, quality, or forecast concerns. In some cases, the stock perception is so similar that repeated medium-term projections were considered unnecessary.

Update assessment: update and review data sets, carry out a standard assessment and short-term forecast according to the Stock Annex protocol. Report to contain a short text on the the updated data and results of the assessment and forecast only, and associated tables/figures. ACFM summary sheet provided. No trial runs, stock-recruitment relationship fitting or medium-term projections. [This could be upgraded to a full assessment in any year in which concerns over data or the state of the stock, or requests from customers, arose.]

The WGNSSK schedule of assessments (modified at this meeting) is given below:

	2003	2004	2005
Cod in 347d	**Benchmark**	**Benchmark**	**Benchmark**
Haddock in 34	**Benchmark**	Update	Update
Whiting in 47d	Update	**Benchmark**	Update
Saithe in 346	Update	Update	**Benchmark**
Sole in 4	**Benchmark**	Update	Update
Sole in 7d	Update	Update	**Benchmark**
Plaice in 4	**Benchmark**	**Benchmark**	**Benchmark**
Plaice in 3	Update	Update	**Benchmark**
Plaice in 7d	Update	Update	**Benchmark**
Sandeel in 4	Update	**Benchmark**	Update
Norway Pout in 4	Update	**Benchmark**	Update
sandeel in other areas	*Update*	*Update*	*Update*
Norway Pout in other areas	*Update*	*Update*	*Update*
Total Benchmark	**4**	**5**	**6**

Quality control handbook

The WG attempted to provide some stock annexes following the outlines proposed by ICES in the Quality Handbook proposals. Preliminary annexes have been provided for some stocks. These stock annexes are still being developed intersessionally, and it is intended that they will be included with next year's report, along with annexes from any other stocks which should have been completed by then.

1.4.2 Assessment methods

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

XSA

Extended survivors analysis (XSA) has been used as an important tool for catch-at-age analysis for all stocks. Two implementations were used: version 3.1 of the Lowestoft VPA package was used for roundfish and flatfish stocks, while the Seasonal XSA (Skagen 1993, 1994) was used for Norway pout to allow for quarterly seasonal data.

In the last year's WG reports, the general approach to tuning the XSA had been to use a full tuning window with a tricubic 20-year time taper. This option was retained this year for cod and saithe, while the no-downweighting option was used for the other stocks assessed using XSA. For the benchmark assessments the *F*-shrinkage was explored with the aim to reduce the effects of shrinkage on the terminal population estimates..

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 Laurec-Shepherd *ad hoc* tuning or XSA with light shrinkage. These runs were used to explore the consistency of the surveys with the catch-at-age data. In previous assessments, results were used to determine the fleet year and age ranges to be used for the final assessment. In this year's assessment, greater attention was paid to *a priori* reasons for removing surveys, since residual trends in single-fleet Laurec-Shepherd runs can indicate problems with catch-at-age data as well as survey data.

Given a largely predetermined selection of fleets and ages, 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.

The contribution of shrinkage to survivors estimates at older ages from these exploratory XSA runs was used to facilitate decisions on the plus-group to be used (and consequently whether then mean *F* range needed to be changed). These contributions were also used aling with retrospective analyses to determine the correct value of *F*-shrinkage.

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.

TSA

An implementation (time-series analysis or TSA) of the Kalman filter algorithm was used in comparative assessments for cod, haddock and whiting, although it was not selected as the final assessment model for any stock. Its main advantage is that it is thought to encapsulate the uncertainty in terminal-year estimates and that it can be applied to catch data only. It also enabled the exploration of the removal of catch-at-age data for the last two years on the assumption that recent recovery plans for cod may have degraded the quality of such data.

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

The principal benefits of the model are (following Fryer, 2001):

- It gives precision of estimates of numbers-at-age and fishing mortalities-at-age, and avoids over-interpretation of small recent changes in stock trends.
- It allows fishing mortalities-at-age to evolve in a constrained way, thus granting the benefits of both a separable assumption and a fully unconstrained model.
- It partitions the variability in the data into interpretable components (transitory and persistent, year and age, etc.)
- It can predict ahead (and give precision of predictions).
- It can omit catch or survey data or both in some years if the data are suspect.
- It can model landings-at-age, discards-at-age and industrial by-catch separately
- It allows survey catchabilities and discard curves to evolve over time.

The principal disadvantages are:

- It requires normally distributed errors (but constant variance is not a requirement). This is not a particular problem in model fitting, but does impose serious limitations when it comes to predicting in a declining stock..
- It requires linear approximation of non-linear equations.
- The likelihood can be very flat, so it can be difficult to estimate the model parameters. Maximum likelihood estimation can take a long time when there are lots of auxiliary data (and hence lots of parameters).
- It favours the *status quo,* so it can take a number of years for the model to react fully to major changes in the fishery or the stock. It can thus struggle to characterise rapidly those populations which are highly variable.

TSA is undergoing sporadic development at FRS Marine Laboratory, Aberdeen, with the hope of making it generally available at some future time. However, a robust and generally-applicable implementation is proving difficult to specify, and the future of the method is unclear.

SURBA

The WG, and ICES in general, are increasingly concerned over the quality and reliability of catch-at-age data from commercial fisheries, due to more restrictive TACs and the possibility of unrecorded discarding in many fisheries. Much attention was paid during the WG meeting to the evaluation of survey data, and the generation of relative indices of SSB and recruitment (along with absolute estimates of *F*) based solely on such fishery-independent data. The main tool for doing this was SURBA (version 2.10), which is based on a separable model of mortality as indicated by a survey index.

A separable model assumes that fishing mortality $\mathbf{F} = \left[F_{a,y}\right]$ is separable into an age effect $\mathbf{s} = \left[s_a\right]$ and a year effect $\mathbf{f} = \left[f_y\right]$, so that $\mathbf{F} = \mathbf{s} \times \mathbf{f}$. Suppose that the abundance of a particular cohort declines exponentially from one year to the next, so that

$$N_{a+1,y+1} = N_{a,y} \exp\left(-Z_{a,y}\right), \tag{1}$$

where the rate of decline (or total mortality) is given by

$$Z_{a,y} = F_{a,y} + M_{a,y} = s_a f_y + M_{a,y}, \tag{2}$$

and $M_{a,y}$ is the natural mortality rate on age a during year y. Then if a cohort recruits to the stock in at age a in year y with recruiting abundance $r_{a,y}$, we can calculate its abundance at age a as

$$N_{a,a-1+y} = r_{a,y} \exp\left(-\sum_{i=1}^{a-1} Z_{i,i-1+y}\right)$$

$$= r_{a,y} \exp\left(-\sum_{i=1}^{a-1} s_i f_{i-1+y} + M_{i,i-1+y}\right) \tag{3}$$

That is, the abundance at age a is given by the abundance at the recruiting age multiplied by the exponential of the sum of the mortality rates in the intervening years. We will denote the vector of all recruiting abundances by $\mathbf{r} = \left[r_{A,1}, r_{A-1,1}, \ldots, r_{2,1}, r_{1,1}, r_{1,2}, \ldots, r_{1,Y}\right]$ where A is the number of ages and Y is the number of years.

In order to use relative abundance indices $I_{a,y}$ to estimate relative stock size, we assume a time-invariant proportional relationship between stock size and the abundance index. This is given by

$$I_{a,y} = q_a N_{a,y}, \tag{4}$$

where q_a is the *catchability* of the survey at age a. Thus, a survey for which the abundance index was a reliable indicator of stock size at age a would have $q_a = 1.0$, while it could be that $q_a = 0.0$ for a survey which will never catch fish of the age in question (a gill-net survey cannot sample very large fish, for example). Then we can rewrite Equation 3 as

$$I_{a,a-1+y} = \frac{q_a}{q_r} I_{r,y} \exp\left(-\sum_{i=1}^{a-1} s_i f_{i-1+y} + M_{i,i-1+y}\right), \tag{5}$$

where q_r and $I_{r,y}$ are respectively the catchability and the abundance index values for the recruiting age of the cohort.

This expression gives us a model for how the abundance index evolves through time for any given cohort. Estimates can be generated for $\mathbf{s}$, $\mathbf{f}$ and $\mathbf{r}$ by minimising the sum-of-squares difference between natural logs of the observed and fitted survey-derived abundance,

$$SSQ = \sum_{a=1}^{A} \sum_{y=1}^{Y} w_a \left(\ln I_{a,y} - \ln \hat{I}_{a,y} \right)^2, \qquad (6)$$

where $\mathbf{w} = \left[w_a \right]$ are age-weighting factors. The progressive decline in cohort size is modelled using Equation 5. However, the model as it stands is under-specified, since $\mathbf{s}$ and $\mathbf{f}$ are both estimated simultaneously. One solution to this was to fix the terminal value f_Y of the year effect, which is set so that the mean of all the temporal trends is 1.0: thus $f_Y = Y - \sum_{y=1}^{Y-1} f_y$. We can also provide a vector of catchabilities-at-age $\mathbf{q} = \left[q_a \right]$. Summary statistics (total stock biomass, spawning stock biomass, yield) are calculated in the usual manner.

The model fit could be extremely sensitive to noise in the data. One approach to ameliorating this is to introduce a *smoother* λ, which constrains the minimisation by a penalty function:

$$SSQ = \sum_{a=1}^{A} \sum_{y=1}^{Y} w_a \left(\ln I_{a,y} - \ln \hat{I}_{a,y} \right)^2 + \lambda \sum_{y=1}^{Y} \left(\frac{f_y}{f_{y-1}} \right)^2. \qquad (7)$$

Finally, estimates of fishing mortality rates F are obtained from Equation 1, which can be rewritten as

$$F_{a,y} = \ln \left(\frac{N_{a,y}}{N_{a+1,y+1}} \right) - M_{a,y}. \qquad (8)$$

Mortality rate estimates are therefore derived by looking at the ratios of abundances. Since the number of ratios will always be one less than the number of abundances, we can only estimate $A-1$ age effects and $Y-1$ year effects.

Catchability estimation and age weighting

At present, there is no accepted method of determining empirically the catchability $\mathbf{q} = \left[q_a \right]$ of a survey. This has been one of the principal hindrances to the further development of survey-based analysis methods. *Ad hoc* experimentation to determine values of $\mathbf{q}$ which resulted in positive age-effects that looked reasonable has been retained in SURBA 2.10 , but it is now also possible to estimate catchabilities so as to minimise the final model SSQ.

A two-stage fitting algorithm is used. Firstly, the standard SSQ (Equation 6 or 7) is minimised with $\mathbf{q}$ allowed to vary (so that the parameter space is $\left[\mathbf{f}, \mathbf{s}, \mathbf{r}, \mathbf{p} \right]$). Secondly, the model is refitted with $\mathbf{q}$ fixed at the values estimated in the first step (so the parameter space is now $\left[\mathbf{f}, \mathbf{s}, \mathbf{r}, \right]$). The advantage of the two-stage approach is that the model fitted in the first step is likely to be over-parameterised, so that parameter estimates may be unreliable: fixing $\mathbf{q}$ in the second step permits the use of a rough estimate of catchability without compromising the estimates of the remaining parameters. However, because of the potential over-parameterisation, the estimates of $\mathbf{q}$ should be treated with caution, and viewed as indicative only.

In addition to manual definition of age weighting $\mathbf{w} = \left[w_a \right]$, SURBA now allows for inverse-variance age-weighting with

$$w_a = \sum_{y=1}^{Y} \frac{Y-1}{\left(I_{a,y} - \bar{I} \right)^2}. \qquad (9)$$

Constrained parameter estimation

SURBA can be run with no constraints on parameters. However, values of catchabilities q_a which are too large can easily result in negative estimates of the corresponding age-effects s_a, and thus negative fishing mortality F. To circumvent this, parameter estimation can be constrained in SURBA. The bounds used are $\mathbf{f}, \mathbf{s} \in (0,3)$: $\mathbf{r}$ should not be constrained, as $\hat{I}_{1,1...Y}$ or $\hat{I}_{1...A,1}$ can easily be negative on the natural log scale.

Smoothing and uncertainty estimation

Survey data are inherently noisy, due to small sample sizes and natural variation. Because of this, a survey-based analysis without any smoothing will also be very noisy. In particular, fishing mortality F will be very poorly estimated. It is therefore necessary to smooth the separable model fit.

cook97 used a penalty term in the SSQ formulation (Equation 7) to limit interannual variability in the year effect f (a method referred to hereafter as *SSQ smoothing*). This does smooth the fitted estimates, but there are two main problems. Firstly, the value of the smoothing parameter λ, to which the model fit is very sensitive, is entirely arbitrary. Secondly, the penalty term in Equation 7 renders impossible the determination of model uncertainty by residual bootstraps.

An alternative approach is to smooth the survey data themselves before estimating the separable model (*index smoothing*). SURBA does this by fitting cubic splines with fit parameter ρ to the vectors of survey data for each year-class, once missing values are filled in by nearest-neighbour averages. The value of ρ is again arbitrary, but population estimates are not very sensitive to it and values between 2.0 and 5.0 are generally reasonable.

The principal advantage of index smoothing is that it facilitates bootstrap-residual uncertainty estimation. The unpenalised SSQ formulation (Equation 6) represents the sum of squared residuals, so that the residuals themselves are

$$R_{a,y} = \sqrt{w_a}\left(\ln I_{a,y} - \ln \hat{I}_{a,y}\right). \quad (10)$$

Then using Equation 4 and rearranging results in an expression for estimated abundance

$$\hat{N}_{a,y} = \frac{1}{q_a}\exp\left(\ln I_{a,y} - \frac{R_{a,y}}{\sqrt{w_a}}\right). \quad (11)$$

When bootstrapping residuals, SURBA randomly selects (with replacement) a residual R_{a^*,y^*} from the $A \times Y$ residual matrix (where $a^* \in [1,...,A]$ and $y^* \in [1,...Y]$). It then uses R_{a^*,y^*} in Equation 11 to generate a new abundance $\hat{N}^*_{a,y}$. This is done for each age and year, and summary statistics (SSB, mean F, recruitment) are calculated in the usual way. The process is repeated 1000 times, enabling the generation of empirical distributions of the summary statistics. The 50th percentiles (medians) of these distributions are then used as the final smoothed estimates.

Retrospective analysis

Retrospective analysis consists of refitting the model with the data for the final year removed, then with the last two years removed, the last three years, and so on; and comparing summary statistics from these fits to shorter time-series with those from the fit to the full time-series. SURBA generates such model fits automatically, moving back in time until y_0 data points are left ($y_0 = \frac{Y}{2}$ or $\frac{3Y}{4}$, as required). The program also calculates two values of Mohn's ρ statistic, defined as

$$\rho = \sum_{y=y_0}^{Y-1} \frac{S_{Y,y} - S_{y,y}}{S_{Y,y}} \quad (12)$$

where $S_{y,y}$ is the estimate of spawning-stock biomass in year y given by the retrospective model run which spans data from year 1 to year y. Mohn's ρ is therefore the sum of the relative vertical distances between the end points of the retrospective runs and the equivalent estimate from the full time-series run. While Mohn's ρ does not have a formal statistical interpretation, nor a measure of how significant the measured retrospective bias is, it is useful for comparing qualitatively the bias in retrospective analyses using different models or methods.

1.4.3 Recruit estimation

In several cases recruitment estimates have been made with RCT3. This was the case when recruitment indices from 2003 surveys are available or when F-shrinkage in XSA has relatively high weights on the estimation of recruiting survivors. The present implementation of XSA cannot accommodate survey data in the year following the last catch data year, and RCT3 is used for that reason. This creates some inconsistencies in the approaches used. The survey indices may end up being used twice for recruitment estimation – once in the survivors' analysis (and thus in the VPA recruitment) and again with the same survey indices in RCT3. For plaice, haddock, whiting and cod, large discrepancies have been observed in recent Working Groups in the recruitment predicted by RCT3 and the observed recruitment in XSA. In most cases RCT3 seems to overestimate recruitment and WGNSSK considers this may partly explain the overestimation of landings in the short term forecasts for these species

A problem with the use of the power model for recruiting age groups in XSA, is that it cannot be restricted to those tuning fleets for which the use of this model is appropriate. In the present implementation of XSA the use of the power model may solve problems in some fleets while creating problems in other fleets. The fact that the F-shrinkage cannot be turned off for recruiting age groups has in some cases been seen to have an undesirably strong influence on the recruitment estimates originating from XSA.

1.4.4 Short-term forecasts and sensitivity analyses

Short-term forecasts were made for stocks for which a full analytical assessment could be carried out, and which would not feature in late-summer groundfish surveys. Such forecasts 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. Forecasts and corresponding sensitivity analyses were undertaken using the Aberdeen suite of forecast programs. For cod and haddock assessments, forecasts were also carried out that take account of recently-implemented technical measures.

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 Subarea and Division on the basis of the distribution of recent landings.

1.4.5 Stock-recruitment model fitting and medium-term projections

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

1.4.6 Biological reference points

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

1.4.7 Mixed fisheries modeling

Two models aiming at calculating mixed-fisheries forecasts were available to the WG, and these are fully described in WD04 and WD15. One of these two models, MTAC (WD04), was initiated by STECF(2002) and evaluated in several occasions, including SGDFF(2003). The other model was made available during the course of the WG, and the group did not have enough time to evaluate it comprehensively. Therefore, the group approached mixed-fisheries forecasts using MTAC. The methodology underlying MTAC is presented below.

To formalise the problem, the initial stage is to introduce additional subscripts into the conventional catch equation. Thus if k fishing fleets exploit j species at age a, each with partial fishing mortality $F_{k,j,a}$ for each fleet, then the total annual catch numbers (C) and catch weight (CW) are the sum of catches from each fleet such that

$$CW_j = \sum_a \sum_k F_{k,j,a} * N_{j,a} * W_{k,j,a} \frac{(1-\exp(-Z_{j,a}))}{Z_{j,a}} \qquad (1)$$

where N_a represents population abundance on 1st January at age a, and $W_{k,j,a}$ represents the mean weight of fish of age a and species j caught by fleet k. Total mortality Z is conventionally calculated as the sum of natural and fishing mortality, i.e.

$$Z_{j,a} = M_{j,a} + \sum_k F_{k,j,a} \qquad (2)$$

To perform a catch forecast for the purposes of calculating a TAC, we require assumed, '*status quo*' values for fishing mortality and weight at age etc. which would typically be estimated using recent average values. These are here indicated by a 'prime' superscript (e.g. F'). Other variables refer to quantities for the forecast period.

The forecast also requires the implicit assumption that fishing practices will remain unchanged. The TAC can thus be estimated from

$$TAC_j = CW_j = \sum_a \sum_k fac_k * F'_{k,j,a} * N_{j,a} * W'_{k,j,a} \frac{(1-\exp(-Z_{j,a}))}{Z_{j,a}} \qquad (3)$$

where fac is an effort (or F) multiplier for all fleets combined or specified by fleet. Total mortality Z becomes

$$Z_{j,a} = M_{j,a} + \sum_k fac_k * F'_{k,j,a} \qquad (4)$$

Now assume it is desired to alter fishing mortality for one species independently of the other species. A variety of different alterations in fac_k can be used interchangeably to effect modifications in F_j, and the problem is intractable.

In general terms, for a single species in a given year, fisheries management will aim to result in a specified change in the fishing mortality on species j which we will call ΔF_j . This could be achieved through a variety of means including closures or an effort control scheme, but for convenience we will here assume that a TAC is required for this purpose. Assume that F_j for TAC estimation is determined from F'_j and a factor such that $F_j=F'_j*\delta F_j$. The absolute change in F_j thus becomes, $\Delta F_j = F'_j * (1-\delta F_j)$

The contribution which each fleet partial F, $F'_{j,k}$, makes to the total change in F can be defined by

$$\Delta F_j = \alpha_j * \sum_k p_{k,j} * F'_{j,k} \qquad (5)$$

where the 'alpha', α_j is a scaling factor applied for all fleets catching species j, and $p_{k,j}$ represents how the overall effort reduction is allocated across fleets in order to achieve the desired change in fishing mortality for species j. The value of $p_{k,j}$ is a kind of "weighting factor" for effort reduction which could be supplied externally to reflect policy considerations such as e.g. the ecosystem effects of fishing with a particular gear, or could be estimated based on the catch compositions of individual fleets.

As a fleet cannot reduce F to less than zero, the product of alpha and p cannot exceed 1, so (5) must be modified to

$$\Delta F_j = \sum_k \min(\alpha_j * p_{k,j}, 1) * F'_{j,k} \qquad (6)$$

Alternatively, this can be expressed as the effort (or F) factor, $\delta F_{j,k}$, for individual fleets

$$\delta F_{j,k} = 1 - \min(\alpha_j * p_{k,j}, 1) \qquad (7)$$

The $\delta F_{j,k}$ represent the effort modification factor which would be applied to fleet k if management was intended only to apply to species j in isolation of the other species caught in the fishery. For this reason applying $\delta F_{j,k}$ as the effort modification factor, fac_k, in (3) will lead to a unique solution. However, this only applies where management decisions in a multifleet fishery are driven by the conservation needs of a single species. Often this will not be the case and conservation needs for each species give different effort reduction scenarios. This is reflected in the different $\delta F_{j,k}$ estimated for each species within a fleet, and it is necessary to find a way of combining them to produce one single fleet effort modifier for each fleet in the fishery. Multicriterion forecasting can only be developed if an appropriate weight is assigned to each of the conservation criteria. Assume that a decision-weight Θ_j can be developed, representing the importance of the conservation criteria for each of the j species. As noted above, choice of the Θ_j is a policy decision, although it would be possible to develop standardised approaches to deriving values. An overall fleet effort modifier, fac_k, can then be derived as a weighted sum of the $\delta F_{j,k}$. The weightings would include the Θ_j, but if the intention is also to reflect the extent to which the fisheries for the individual species could be prosecuted, (and thus also managed) separately, it would also be necessary to include this in the weightings in some way. If we define $q_{k,j}$ as a fleet target factor, describing the relative importance of species j for fleet k then overall fleet modifier would be :

$$fac_k = \sum_j q_{k,j} \Theta_j \delta F_{j,k} \qquad (8)$$

The simplest way of defining the $q_{k,j}$ would be to use the mean proportion of species j in the catch of fleet k. Use of the catch composition information in the weighting in this way means that greater effort reductions will be applied to those fleets which are targetting the species which are of greater conservation concern.

Having specified such decision weights the calculation for multicriterion TAC setting could be as follows.

A. Specify all relevant decision weights, Θ_j where the sum of $\Theta_j = 1$

B. Specify the effort reduction rates $p_{k,j}$

C. Specify the desired adjustment factor δF_j to status quo fishing mortality for each species, $F_{j,a} = F'_{j,a} * \delta F_j$

D. Calculate individual "single species" TACs (STACs) from $F_{j,a}$

E. Calculate all $\delta F_{j,k}$,the species and fleet specific effort factors required to achieve each $STAC_j$

$$\delta F_{j,k} = 1 - \min(\alpha_j * p_{j,k}, 1) \qquad \text{for } \delta F_j < 1$$
$$\delta F_{j,k} = \delta F_j \qquad \text{for } \delta F_j \geq 1$$

where α_j is estimated by minimization of

$$\left(STAC_j - \sum_a \sum_k \delta F_{j,k} * F'_{k,j,a} * N_{j,a} * W'_{k,j,a} \; \frac{(1 - \exp(-(\sum_k (\delta F_{j,k} * F'_{k,j,a}) + M_{j,a}))}{\sum_k (\delta F_{j,k} * F'_{k,j,a}) + M_{j,a}} \right)^2$$

F. Calculate weighted fleet effort reduction factors, fac_k using equation (8)

G. Calculate each mixed-species TAC using equation (3).

1.4.8 Software versions

Overview of the software versions used:

Software	Purpose	Version
VPA-suite	Historical assessment (e.g. separable VPA, XSA)	Version: VPA95PA. Compiled: 30/04/1998
TSA (Time-series analysis)	Historical assessment. Multiple surveys or none, *n*-year projections	No formal version number. Compiled anew for each run.
GSA	Historical assessment. Seasonal XSA.	Compiled: 09/10/1995
RCT3	Recruitment estimation	Compiled: 02/10/1992
RETVPA	Retrospective analysis	Version: 00-1
SURBA	Survey-driven relative trend estimation	Version 2.10
Insens	Generate input files for predictions and summary files	Compiled: 20/05/2002
Recruit	Estimation of stock recruitment parameters	Compiled: 04/10/1996
RecAn	Estimation of stock recruitment parameters	Version 2.0. Compiled 07/02/2002
WGFRANSW	Short term prediction and sensitivity analysis	Version 1.0, 22/05/2001
WGMTERMC	Medium term analysis	Compiled: 03/11/1999
REFPOINT	Calculation of reference points and yield per recruit	Compiled: 12/06/1997
MTAC	Mixed fisheries forecasts	R-code: september 2003

Table 1.4.1. Overview of biological basis of the stock assessments carried out by WGNSSK 2002

Ch.	Stock	Area	Stock numbers	Mean weight catch	Mean weight stock	Natural mort.	Proportion mature
3	Cod	347d	AC from EW, SC, DK, NL, GER, B, FR. No discards included. SOP correction applied.	Based on AC. No smoothing.	Same as mean weight in the catch	M1=0.8, M2=0.35, M3=0.25, M4-11=0.2	mat1=0.01, mat2=0.05, mat3=0.23, mat4=0.62, mat5=0.86, mat6-11=1.0
4	Haddock	34	AC from SC, EW, DK, FR, B. AC on ind. bycatch from DK and N. AC of discards from SC. Discard and ind. bycatch included in assessment	Based on AC. No smoothing. Calculated separately for different catch components	Same as mean weight in the catch	M0=2.05, M1=1.65, M2=0.4, M3-4=0.25, M4-10=0.2	mat0=0, mat1=0.01, mat2=0.32, mat3=0.71, mat4=0.87, mat5=0.95, mat6-10=1.0
5	Whiting	47d	AC from SC, EW, DK, FR, NL, B. AC on ind. bycatch from DK and N. AC of discards from SC, not applied to 7d. Discard and ind. bycatch included in assessment	Based on AC. No smoothing. Calculated separately for different catch components	Same as mean weight in the catch	M1=0.95, M2=0.45, M3=0.35, M4=0.3, m5-6=0.25, m7-8=0.2	mat1=0.11, mat2=0.92, mat3-8=1.0
6	Saithe	346	AC from N, EW, SC, DK, GER, FR for area IV. AC from SC for area VI. No discards included. SOP corrected.	Based on AC. No smoothing.	Same as mean weight in the catch	M1-10=0.2	mat1-3=0.0, mat4=0.15, mat5=0.70, mat6=0.90, mat7-10=1.0
7	Sole	4	AC from NL, EW, FR, B. No discards included. SOP corrections applied by EW and B	Based on AC. No smoothing.	Second quarter catch weights at age	M1-15=0.1	mat1-2=0.0, mat3-15=1
8	Sole	7d	AC from B, FR and EW (since 1985). No discards included. No SOP correction.	Based on AC. No smoothing.	Second quarter catch weights at age	M1-11=0.1	mat1-2=0.0, mat3-11=1.0
9	Plaice	4	AC from NL, EW, DK, FR, B. No discards included. SOP corrections applied by EW and B	Based on AC. No smoothing.	1st quarter catch weight	0.1 on all ages	mat1=0.0, mat2-3=0.50, mat4-15=1.0
10	Plaice	3	AC from DK only. No discards included. SOP corrected ??	Based on AC. No smoothing.	Same as mean weight in the catch	M2-11=0.1	mat2=0.0, mat3-11=1.0
11	Plaice	7d	AC from FR, B and EW. No discards included. SOP corrected ???	Based on AC. No smoothing.	1st quarter catch weight	M1-10=0.1	mat1=0.00, mat2=0.15, mat3=0.53, mat4=0.96, mat5-10=1.0
12	Norway pout	4	AC from DK and N. No discards in the fishery.	Based on AC. No smoothing.	Fixed mean weight in the stock by quarter and age used	M0-4= 0.4 (per quarter)	mat0=0.0, mat1=0.1, mat2-4=1.0
13	Sandeel	4	AC from DK and N. No discards in the fishery.	Based on AC. No smoothing.	Same as mean weight in the catch	First half year: M1=1.0, M2-3=0.4. Second half year: M0=0.8, M1-4=0.2	mat0-1=0.0, mat2-4=1.0

Table 1.4.2. Overview of model settings used for the stocks assessed by WGNSSK 2003

Chapter	Stock	Area	Assessment Method	Assessment Age Range	Assessment year range	Fbar Age Range	Time taper	Catchability dependent on stock size for ages	Catchability independent of age for ages >=	Survivor estimates shrunk towards mean F	S.E of mean F to which estimates shrunk	Min S.E. for pop. Estimates	Prior weighting	Tuning fleet type	Tuning Fleet Name	Tuning Fleet Year Range	Tuning Fleet Age Range	Tuning Fleet alpha-beta
3	Cod	347d	XSA	**1-7+**	1963-2002	**2-4**	20 yr tricubic	1-3	5	**3yrs/ 3ages**	**1.0**	0.3	No	*S*	*ScoGFS*	*1982-2002*	*1-6*	*0.5-0.75*
														S	*EngGFS*	*1977-2002*	*1-5*	*0.5-0.75*
														S	*IBTS_Q1*	*1976-2002*	*1-5*	*0-0.25*
4	Haddock	34	XSA	**0-7+**	1963-2002	**2-4**	20 yr tricubic	**0**	**2**	5yrs/ **3ages**	**2.0**	0.3	No	*S*	*EngGFS*	*1977-2002*	*0-5*	*0.5-0.75*
														S	*IBTS_Q1*	*1974-2003*	*0.5*	*0.99-1*
5	Whiting	47d	**XSA**	**1-6+**	1980-2002	**2-4**	**15 yr tricubic**	**none**	**4**	**3yrs/ 2ages**	**0.5**	**0.3**	**No**	**S**	***ScoGFS***	***1982-2002***	***1-6***	***0.5-0.75***
														S	***EngGFS***	***1992-2002***	***1-5***	***0.5-0.75***
														S	***IBTS_Q1***	***1982-2003***	***1-5***	***0.99-1.00***
6	Saithe	346	XSA	1-10+	1967-2001	3-6	20 yr tricubic	1-2	7	5yrs/ 5ages	**1.0**	0.3	No	C	FraTRB_IV	1990-2002	2-9	0-1
														C	FraTRF_IV	1990-2002	2-9	0-1
														C	NorTRL_IV	1980-2002	3-9	0-1
														C	GerOTB_IV	1995-2002	3-9	0-1
7	Sole	4	XSA	1-15+	1957-2002	2-8	No	1-2	7	5yrs/ 5ages	0.5	0.3	No	C	NL beam	1990-2002	2-14	0-1
														S	*BTS*	*1990-2002*	*1-4*	*0.67-0.75*
														S	*SNS*	*1990-2002*	*1-4*	*0.67-0.75*
8	Sole	7d	XSA	1-11+	1982-2002	3-8	No	none	7	4yrs/ 4ages	0.5	0.3	No	C	BEL beam	1986-2002	2-9	0-1
														C	UK beam	1986-2002	2-10	0-1
														C	FR OT	1991-2002	3-10	0-1
														S	*UK BTS*	*1988-2002*	*1-6*	*0.5-0.75*
														S	*UK YFS*	*1986-2002*	*1-1*	*0.5-0.75*
														S	*FR YFS*	*1987-2002*	*1-1*	*0.5-0.75*
9	Plaice	4	XSA	1-15+	1957-2002	2-10	No	none	10	5yrs/ 5ages	0.5	0.3	No	*S*	*BTS*	*1985-2002*	*1-4*	*0.66–0.75*
														S	*SNS*	*1982-2002*	*1-3*	*0.66–0.75*
10	Plaice	3	XSA	2-11+	1978-2002	4-8	No	none	8	5yrs/ 5ages	0.5	0.3	No	C	DK seine	1987-2002	2 - 10	0–1
														C	DK trawl	1987-2002	2 - 10	0–1
														C	DK gill net	1987-2002	4-10	0-1
														S	*IBTS_Q1*	*1991-2002*	*4 - 6*	*0.99-1*
														S	*IBTS_Q3*			
														S	*Havfisken Q1*			
														S	*Havfisken Q4*			
11	Plaice	7d	XSA	1-10+	1980-2002	2-6	No	1	7	5yrs/ 3ages	0.5	0.3	No	C	UK Inshore	1988-2002	2-7	0–1
														C	BEL beam	1988-2002	2-7	0–1
														C	FRA TRL	1989-2002	2-7	0–1
														S	*UK BTS*	*1988-2002*	*1-6*	*0.5–0.75*
														S	*FRA GFS*	*1988-2002*	*1-5*	*0.75–1*
12	Norway pout	4	SXSA	0-4+	1983-2002	0-1	No	NA						C	COMB North	1983-2003	0-4+	0.0-0.5
														S	*IBTS_Q1*	*1983-2003*	*1-3*	*0.5-1.0*
														S	*EngGFS*	*1983-2002*	*0-4*	*0.5-0.75*
														S	*ScoGFS*	*1983-2002*	*1-3*	*0.5-0.75*
13	Sandeel	4	SXSA	0-4+	1983-2002	0-1	No	NA						C	COMB North	1983-2002	0-4+	
														C	COMB North	1983-2002	0-4+	0-0.25
														C	COMB South	1983-2002	0-4+	0.0-0.5
														C	COMB South	1983-2002	0-4+	0.5-1.0

1.5 Biological Reference points

Established biological reference points ($\mathbf{F}_{med}$, F_{high}, $F_{0.1}$, F_{max} etc) have been estimated according to standard procedures and given for each stock when it has been benchmarked this year.

In 1998 the Working Group has proposed limit- and precautionary reference points for fishing mortality and SSB ($\mathbf{F}_{lim}$, $\mathbf{F}_{pa}$, $\mathbf{B}_{lim}$ and $\mathbf{B}_{pa}$) 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 $\mathbf{F}_{pa}$ and $\mathbf{B}_{pa}$, the precautionary thresholds which imply a reasonably high probability of remaining below a limit fishing mortality and above a limit spawning stock biomass. $\mathbf{F}_{pa}$ and $\mathbf{B}_{pa}$ 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	$\mathbf{B}_{lim}$	$\mathbf{B}_{pa}$	$\mathbf{F}_{lim}$	$\mathbf{F}_{pa}$
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

During the evaluation of the benchmark assessment this year, changes have been made to the age ranges in some assessments. This affects the biological reference points. Given that the process of revising the biological reference points is still underway, the WG has used the technical basis for the old biological reference points as the guidance to update the BRP's for those stocks. These analysis were not finalized by the end of the meeting and will be circulated by email before being presented to ACFM, October 2003.

The Study Group on Precautionary Reference Points For Advice on Fishery Management used segmented regression to analyse stock-recruit data for most of the stocks assessed by this working group. Our comments to this work are given in section 16 of this report.

1.6 Working Documents and References

1.6.1 Working Documents

WD01
Rätz, H.J., Panten, K. and Ulleweit, J. German Otter Trawl Board Fleet as Tuning Series for the Assessment of Saithe in IV, VI and IIIa, 1995-2002. WGNSSK WD: 1.

The analysed commercial landing and effort data of saithe are derived from the official German logbook statistics, which have been made available in a consistent database for the period 1995-2002. During 1995-2001, otter trawl board catches were considered of 7 vessels continuously being engaged in the directed saithe fishery. In 2002, the German saithe fleet used for tuning in the saithe assessment consisted of 6 vessels as one left by mid year. This fleet accounted for 64-85 % of the entire annual saithe landings officially reported.

The age disaggregated abundance indices derived from CPUE indicated the 1992, 1996 and 1998 year classes as strong, the latter one being the strongest and most important year class for recent catches. Catch curves also revealed that the year classes since 1992 were subject to lower mortality rates at ages 4 to 7 than the previous year classes. This indicates a significant reduction in fishing mortality until 2001. However, the most recent abundance indices display a steep decline for most age groups and thus higher mortalities in 2002, possibly a year effect. It was also concluded that the year class 1998 at age 4 is the strongest year class since 1995. In 2002, the commercially most important age groups 3 and 5 to 8 were about average. The calculated abundance at age 3 (year class 1999) is, however, a poor indicator of the year class strength at age 4. The age group 4 does seem to be a good estimator of year class strength at age 5 explaining about 80 % of the observed variation.

WD02
P.J., Wright, F.M., Gibb, I.M., Gibb, M.R., Heath, and H.A., McLay. North Sea cod spawning grounds. WGNSSK WD: 2.

This review summarises information on cod spawning grounds in the North Sea currently available from i) compilations of historic data (Anon, 1971; Daan, 1978; ICES, 1994). ii) various icthyoplankton and trawl surveys carried out between 1919 and 2003 and iii) interviews with fishermen conducted in 2002.

Cod spawn throughout much of the North Sea but spawning adult and egg survey data and fishermen's observations indicate a number of spawning aggregations.

It is not possible to quantify long-term changes in the use of spawning grounds because of a lack of comprehensive survey data on eggs or spawning adults, and the lack of suitable sampling within ICES bottom trawl surveys.

However, the limited data available do suggest a contraction in significant spawning areas, beginning with the loss of sites at Great Fisher Bank and Aberdeen Bank by the 1980s, and more recently other coastal spawning sites around Scotland and in the Forties area.

The North Sea cod stock may comprise a number of reproductively isolated populations, although further corroboration is needed.

WD03
Weber, W. A new recruitment index for whiting in the North Sea. WGNSSK WD: 3.

German RV "Solea" is carrying out two regular surveys on demersal fish in the German Bight. They are scheduled for the 1st and 4th quarter of the year. Since 1996 the results on cod are reported regularly to the ICES Working Group. The net used as a standard trawl is the so called "Cod hopper". It has a headline of 48.68m. Its standard opening height is 3.5m and the horizontal wing spread is 23m. The ground rope is equipped with rubber disc rollers of 20cm diameter. The cod end has a fine meshed liner with a mesh opening of 20mm.

The survey is carried out during the forth and first quarter of the year, preferably in November and February. For the estimation of year class strengths fife transects are fished with three 60-minutes hauls each. The average catch per transect of 0-gr and 1-gr whiting respectively are taken to calculate the year class indices.

The indices gained in the first quarter are of little predictive value. The fourth quarter survey, however, seems suitable, when comparing the data with the year-class strengths estimated by the Working Group. It has a correlation coefficient of 0.55. In a linear regression, however, the intercept has a rather high value. This confirms the observation, that the whiting year-classes do not vary much: The variation between the smallest and the biggest year-class is only in the order of 1 : 4. The predictive value of this survey for 0-gr whiting coincides with the results of the IBTS Surveys (ICES, 1998, App.1, Fig.8): The German Bight obviously is an important nursery area for the youngest year class during the 3rd and 4th quarter.

WD04
Vinther, M., S., Reeves, and K., Patterson. From single-species advice to mixed-species management: taking the next step. ICES C.M. 2003/V:01. WGNSSK WD: 4.

ICES has traditionally given fishery management advice on a stock by stock basis. Recent problems in implementing this advice, particularly for the demersal fisheries of the North Sea, have highlighted the limitations of this approach. In the long-term it would be desirable to give advice which accounts for such mixed-fishery effects, but in the short-term there is a need for approaches which can resolve the conflicting management advice for different species within the same fishery and generate catch or effort advice which accounts for the mixed-species nature of the fishery. This paper documents a recent approach which has been used to address these problems. The approach takes the single-species advice for each species in the fishery as a starting point, then attempts to resolve these into consistent catch or effort advice using fleet-disaggregated catch-forecasts in combination with explicitly stated management priorities for each stock. Some results are presented for the demersal fisheries of the North Sea and these highlight that the development of such approaches will also require development of the ways in which catch data are collected and compiled.

WD05

Van Keeken,, O., M., Dickey-Collas, S.B.M., Kraak, J.J., Poos, and M.A., Pastoors. The use of simulations of discarding to investigate the potential impact of bias, due to growth, on the stock assessment of North Sea plaice (Pleuronectes platessa). ICES C.M. 2003/X:17. WGNSSK WD: 5.

In many stock assessments, discards are not accounted for in the catch at age data. This could lead to an underestimation of fishing mortality at the youngest ages, which could bias the stock estimates. In this simulation study the effect of discards on the stock assessment of North Sea plaice (*Pleuronectes platessa*) was investigated. North Sea plaice is predominantly caught in a flatfish fishery, where the mesh size used is mostly geared towards sole (*Solea solea*) leading to substantial discarding of plaice. Simulated populations were constructed, derived from mean length at age data obtained from otolith back-calculations and from two distinct surveys. Selection ogives and discarding (sorting) ogives were derived from the literature and used to estimate discards proportions at age, given the simulated populations. Quarterly catch at age numbers were then calculated from the quarterly landings at age using these discard proportions at age. Compared to the (scanty) observer trips, otolith back-calculations gave an apparent underestimation of proportions discards and the surveys an overestimation.

With discards included in the assessment, stock numbers and fishing mortality increased on the youngest ages. This resulted in higher recruitment to the population and to slightly increased estimates of spawning stock biomass The perception of stock trends could be markedly different with the inclusion of discards, especially in periods of high recruitment and associated low growth and high discard rates. In this study, 1-group plaice could not be included in the analysis because the landings of this age group were often zero. This is a serious shortcoming because the 1-group is an important part of the discards and natural mortality is assumed to be relatively low.

WD06

Kraak, S.B.M., M.A., Pastoors, and A.D., Rijnsdorp. Analysis of the ICES short-term forecasts of North Sea plaice and sole: dealing with the “current year” assumption. WGNSSK WD: 6

The F1 working package of the F-project is concerned with the improvement of stock assessment of plaice and sole. The full range of problems of uncertainty and bias in the stock assessment will be analysed through a series of small investigations of single problems. The present report deals with the “current year” assumption in the short-term forecast.

Every year ICES Working Groups produce assessments of fish stocks as well as forecasts for the future of these stocks, which serve as a basis for advice. The short-term forecasts consist of a forward projection based on estimates of the numbers-at-age at the beginning of the current year. The weights-at-age and the relative exploitation-at-age are usually assumed to equal the average of the last three years. An assumption has to be made about the catch of the current year. Usually it is assumed that the catch of the current year corresponds to the catch that would be taken under a status quo F (that is the F estimate of the previous year). The alternative assumption is that the catch taken would equal the TAC that was set for the current year.

In this study on North Sea plaice and sole, we investigate under which of the two assumptions for current year catch the predictions more closely approximate “reality” as estimated by the most recent assessment, and also which of the two assumptions produces more precautionary predictions for the stocks. We also investigate how much each of the input estimates – stock numbers-at-age, weights-at-age, and relative exploitation-at-age – contributes to the inaccuracy of the forecasts.

The comparison of historical forecasts based on alternative catch assumptions shows that, for both plaice and sole, the status quo F assumption leads to less frequent and less severe prediction errors, especially overestimates, of SSB than the TAC assumption. Underestimates as well as overestimates of SSB occurred. In some years the TAC assumption leads to a more accurate forecast, but this is believed to be a spurious result linked to the overestimation of stock size. We can therefore not give any recommendations in what circumstances to use the TAC assumption instead of the usual status quo F assumption.

We simulated the consequences of different catch assumptions in three different situations: one where the assessment of the current year is correct, and two where the assessment is biased, i.e. where last year's fishing mortality has been overestimated and where last year's F has been underestimated. Such biases occur frequently, especially underestimates of F (and, consequently, overestimates of stock size). We found that in the case of bias, the highest catch assumption always results in the lowest catch forecast and the highest surviving SSB; in some years this is the status quo F assumption but in other years it is the TAC assumption. However, the accuracy of the forecasts depends only marginally on the catch assumption; by contrast, it is strongly affected by the inaccuracy of the assessment. For example, overestimation of the stock size leads to the situation that the F corresponding to the advised TAC exceeds the F that was intended and the surviving SSB is lower than predicted; this effect is marginally stronger with the lower catch assumption.

We found that better estimates of number-at-age would improve the forecasts, but better estimates of recruitment, weights-at-age, and relative exploitation-at-age would not improve the quality of the forecasts. The problem of time trends in weights-at-age is therefore of less concern than the estimation of accurate stock numbers. The analyses imply that the inaccuracy of the short-term forecasts is mainly caused by the large error of the number-at-age estimates given by the VPA each year. This finding focuses our concern again on the quality of the outcome of the VPA.

WD08
Quirijns F., Rijnsdorp A. Detailed catch and effort data of Dutch beam trawl vessels. WGNSSK WD: 8

A working document was presented on the trends in CPUE data from a group of beam trawl vessels in the Netherlands that have kept logbooks of haul-by-haul landings by species. The data has been collected under collaborative projects between the Netherlands Institute of Fisheries Research and the Dutch fishing industry in the years 1993-1999. A similar collaboration has been reinstigated in september 2002 and is now still ongoing. The WD describes a method that has been applied with the attempt to remove the potential bias of TAC limited CPUE series by deriving an index of CPUE rather than an average CPUE. The CPUE for the group of vessels in each ICES rectangle and for each month was calculated by dividing total catch by total effort within a rectangle. Then the CPUE was averaged by month over all the rectangles that had been fished in that month. The average CPUE in a year was calculated as the average of CPUE of all months. The assumption of calculating the CPUE as an index is that the catch rate by rectangle are unlikely to be affected by TAC restrictions; restrictive TAC's would rather drive the directivity of the fishery to those rectangles where the catch rates are lower.

Results of the CPUE analysis are presented. The overall trend in CPUE from either the direct division of catch and effort and the index method do not appear to give very different perceptions on the developments of catch rates.

WD09
Turrell, W. R., and Bannister, C. Ocean climate in relation to North Sea cod. WGNSSK WD: 9

The paper does not attempt in-depth studies of climate-related processes, or correlations between climate parameters and stock parameters. Instead it presents a summary of the present knowledge of North Sea ocean climate as a background to how climate may impact cod stocks and the management of those stocks. It also notes areas of potential future research and summarises sources of data and information.

The main points are:

- The North Sea is a complex habitat, divided into the deep northern North Sea, a complex central North Sea and a shallow southern North Sea.
- In each region circulation is determined to a greater or lesser extent by density differences, wind strength and direction, tides, and the shape of the sea bed.
- In at least four regions bottom temperatures in the summer bear no relation to surface temperatures. Rather they are set by the preceding winter. These pools of cold water are isolated at their boundaries by persistent flows of warmer water.
- The North Sea is isolated from deeper waters to the north by a constant flow of warm, saline Atlantic water.
- In the winter there is an inversion of the south-to-north temperature gradient, with the northern boundary of the North Sea warmer (7°C) than the southern North Sea (5°C). In summer this is reversed, with the southern North Sea warmer (14°C) than the north (11°C).
- The northern North Sea therefore has a smaller annual temperature range (4°C) compared to the south (9°C).
- The NAO Winter Index has been a useful measure of North Atlantic atmospheric variability between the years 1960 – 2000. It is not obvious that the simple two point index was a useful measure before 1960, or during the last few years due to departures from the classic 'dipole' pattern of winter sea level pressure anomaly.
- Many physical and oceanographic variables have correlated with the NAO Winter Index during that period. The characteristic change in the NAO Winter Index during the last 4 decades is of a strengthening index, with superimposed decadal variability (peaks 1973, 1983 and 1989).

- This trend, and the classic dipole pattern, has broken down in 2002 and 2003 (Index values of +0.76 and +0.20 respectively), and we do not know how the NAO or the NAO Winter Index will evolve in future years. There is a suggestion that global warming will result in the eastward displacement of the NAO pattern.
- The complex hydrography of the North Sea means that we may get both North Sea-wide and regionally different responses to climate change.
- Winter and summer temperatures are increasing throughout the North Sea, typically at a rate of between 0.5 and 1 °C per decade.
- In the northern North Sea winter temperatures are warming faster (+0.7°C/decade) then summer temperatures (+0.4°C/decade).
- In the southern North Sea summer temperatures are warming faster (+1.0°C/decade) than winter temperatures (+0.5°C/decade).
- In the winter, northern near-bed North Sea temperatures are warming faster (+0.7°C/decade) than in the southern North Sea (+0.5°C/decade).
- In the summer, surface temperatures are warming faster in the southern North Sea (+1.0°C/decade) than in the north (+0.4°C/decade).
- Inter-annually, winter near-bed temperatures vary over a larger range in the southern North Sea (-1°C to 7°C) than the northern North Sea (6°C to 8°C).
- Winter near-bed temperatures are most positively correlated with the NAO Winter Index in the southern North Sea.
- The observed warming in the North Sea region, which is currently of the order of 0.5°C/decade when averaged annually and over the North Sea as a whole, is set to continue for another 2 decades.

WD10

Bell, E. and Dobby, H. Ecosystem considerations for WGNSSK: Multispecies interactions (seals and "industrials"). WGNSSK WD: 10

Multispecies interactions, that is biological rather than fishery (technical) interactions have the potential to mitigate management actions. The North Sea is a biologically complex environment with a vast potential of species interactions, however this paper focusses on two, the position of seals in the ecosystem in relation to cod, and the relationship between so-called industrial species (sandeels and Norway pout) with North Sea whitefish.

- Grey seal population ≈ 75,000 (2001), increasing at 5.6%pa.
- Harbour seals population ≈ 50-60,000 (2001). During 2002 over 21,000 harbour seal carcasses were washed up around the Kattegat/Skagerrak, Waddensea and North sea due to phocine distemper virus.
- Both species consume around 10% cod. MSVPA estimates grey seal consumption of cod to be around 13,000 tonnes, although there is uncertainty regarding some consumption values. Seal induced mortality is estimated to be an order of magnitude lower than fishing mortality on cod ages 2-6.
- New dietary data for grey seals will become available in 2004 and inclusion of harbour seals
- Cod diets are estimated to be 7.7% sandeels and 8.5% Norway pout.
- There is little evidence for a linkage between gadoid growth and sandeel abundance at the North Sea scale, although local effects may occur.
- Local scale investigations into usage of sandeel patches and feeding dependent growth modelling are being undertaken.

WD11

Darby, C. The effect of including discards on the assessment of north sea cod. WGNSSK WD: 11

Discarding, as measured within the EU study is predominantly small juvenile North Sea cod and as such they make up the first ages of the assessment age range. The dominant effect of the inclusion of discards in the cod assessment is an increase in the level of recruitment and in mortality at age 1. Management measures to reduce the level of discards will contribute to faster recovery rates but the consequences were not examined in this paper. Estimates of SSB and reference fishing mortality, based on older mature fish, are unchanged after the inclusion of discards. Since SSB levels and the configuration of recruitment are unchanged by the inclusion of discards, SSB reference points are unaffected by the inclusion of discards. Due to the increase in the level of recruitment, estimates of fishing mortality limit reference points will increase marginally. The increased noise in recruitment at the oldest ages may leave the precautionary reference points unchanged.

The perception of the stock dynamics and the situation relative to management reference points will consequently be largely unaffected by the inclusion of the discarding levels measured in the EU study.

WD12
Panten K.. Discards in Norway lobster fishery. WGNSSK WD: 12

A sampling trip on Norway lobster was carried out at the end of July 2003 in the southern North Sea. The Dutch vessel under German flag used a twin trawl with 80mm mesh opening in the cod end. In 17 hauls discards of plaice, dab, grey gurnad and lemon sole between 79 and 88% in terms of weight were observed. These rates lie between 91 and 95% in terms of numbers. The minimum landing size for these species and the mesh opening do not coincide.

WD13
S. B. M., Kraak, M., Dickey-Collas, B., Rackham, L,. Kell, P., Bromley, D., Bromley, G., Pilling, J., Blanchard. Second meeting of a Workshop on Comprehensive Assessment for North Sea Flatfish (COMPASS); Analysis of maturity data for North Sea plaice and sole. Lowestoft, 30 April – 2 May 2003. WGNSSK WD: 13.

Several national initiatives exist that aim to investigate the quality of stock assessments and the possibilities for their improvement, e.g. The Dutch “F-project”, the English “Fisheries Interactions” and the Danish “TEMAS” project, all of which require international collaboration to achieve their aims. In addition there are several current EU projects, FEMS and EASE and proposals under Priority 8, as well as ICES Working Groups, that have a continuing need for collaboration on an ongoing but informal basis. To facilitate international collaboration an informal group with varying membership has been set up under the name of COMPASS. This report concerns the second meeting of COMPASS. The Terms of Reference of the meeting were:

1. To collate the available data on maturity, growth, and sex ratio, for North Sea flatfish over an as long as possible time period.

2. To develop standard methodology to estimate annual maturity at age, in relation to growth and sex ratio.

3. To explore the consequences of variable maturity on the stock assessments of North Sea flatfish and on the biological reference points.

Data on North Sea plaice and sole from the Dutch and the English market sampling and research sampling programs were combined in one data file, and were described and explored for temporal and spatial coverage and for length and age distributions. About 700 000 records of individual fish have been brought together, sampled from 1951 onwards.

With respect to developing a standard methodology to estimate annual maturity at age, it was noted that population or catch data are required in addition, to raise the calculated ogives to population or catch. This raising is required to assess the consequences of different selectivities in the Dutch and English fleets and their spatial and temporal variation, and to cope with the inherent bias caused by length stratified sampling and category sampling. Because these data were not available, representative population ogives could not be constructed. Further analyses are planned by statistical methods.

For the exploration of the consequences of variable maturity ogives on North Sea plaice stock assessment and biological reference points, preliminary ogives were used. Here, maturity was expressed as the proportion of the fish sampled that were classed as sexually mature or in the process of maturing, by sex, age and year. Sampling bias was not corrected. The WGNSSK stock assessment data set was disaggregated into males and females to allow VPA to be conducted on males and females separately. The VPAs were not calibrated, since it was not possible to derive sex specific catch per unit effort (CPUE) series. It appeared that historically males tend to be exploited more heavily than females at younger ages. Fishing mortality and biomass reference points were calculated, by the method of segmented regression, for females only and for the WG data. In the case of female only data it appeared that recruitment has not been impaired at the observed biomasses, but these results should be treated with caution.

WD14
Anonymous. North Sea Stock Survey 2003. Preliminary Results 9 September 2003. WGNSSK WD: 14.

THE ICES WGNSSK appreciates the important information from the fishing industry about the perception of fish stocks and shellfish stocks that has been made available for the working group.

WD15
Rätz H.J., A programme for multi species/multi fleets stock and catch projections
in Visual Basic for Applications (EXCEL). WGNSSK WD: 15.

The programme calculates mixed fisheries catches constrained by minimum spawning stock biomass values at the start of the year after the TAC year and maximum fishing mortality during the TAC year for up to 6 jointly exploited species. Such constraints could be set to the precautionary reference points in fisheries management or any other values to be defined through mixed fisheries considerations.

The programme is designed to determine weighted fishing mortality factors (effort factors) for up 80 fleets, for which age structured analytical assessments are available (up to 20 age groups). Fleet weighting is based on the contribution of the fleets to the total fishing mortality of the species (F reference) and a relative species weighting factor. Resulting stock parameters, such as exploitation patterns, catch in numbers, catch in weight, stock in numbers, stock in weight, spawning stock in numbers and spawning stock in weight at age will be predicted for each species aggregated over all fleets. Partial exploitation patterns, catch in numbers and in weight at age disaggregated for each fleet will also be determined. These results will be aggregated for each species and given for the 3 projection years, the assessment year (intermediate prediction year), the TAC year (assessment year + 1) and the following year (assessment year +2).

The programme does not account for any assessment error or bias. Such drawbacks could be accounted for when specifying the constraining minimum spawning stock biomass or maximum fishing mortalities.

The programme is written in Visual Basic for Applications and uses Microsoft EXCEL workbooks as in- and output sheets. The code of the programme is attached as Appendix 1 of the working document.

WD16
Tuck, I. Analysis of individual haul data for Scottish *Nephrops* trawlers at the Fladen Ground (2000 – 2001). WGNSSK WG: 16.

Data from confidential tallybooks from over 6000 hauls (19 vessels, 420 voyages) conducted in the North Sea were analysed to investigate the cod and Nephrops component of landings by different gear types. A more detailed analysis of the spatial patterns was also carried out for the Fladen Ground, where most of the activity (3800 hauls in 316 voyages by 16 of the vessels) occurred.

For the full data set, vessels targeting Nephrops caught on average, significantly more Nephrops per haul than the other gears (280 kg compared to < 1kg), and significantly less cod per haul (23 kg compared to 57 – 250 kg). The differences were also apparent in terms of percentage composition of the landings per haul.

Within the Fladen Ground the landings rates show a very similar picture to that of the whole North Sea. The spatial pattern indicated that where activity takes place by the Nephrops targeting vessels, Nephrops landing rates are relatively uniform throughout the area. Cod landings rates are low for these vessels, but do show an increase as the vessels move north. The other gears recorded had higher cod landing rates than the Nephrops targeting vessels, but showed the same spatial pattern, with the highest values in the north. No Nephrops targeted activity took place in the ICES rectangles where the highest cod landing rates were observed.

WD17
Horwood J. Closed areas: The North Sea cod. Working paper to the STECF Working Group 28 April–5 May 2003. WGNSSK WD: 17.

Closed areas have been a feature in the management of North Sea cod for a number of years. In particular, an area in the south-eastern North Sea was closed in the early 1980s to protect juvenile cod, while in 2001, an area in the north-eastern North Sea was closed for several weeks to protect spawning fish. This paper does not review all aspects of closed areas for fisheries. Rather it focuses on those aspects of closed areas as they reveal to conservation measures for North Sea cod. It looks wider at examples of attributed success of closed areas, as these colour the international public debate on the utility of closed areas, and draws some general principles for application of closed areas. It also indicates some of the practical fisheries and environmental problems even when areas could usefully be identified.

WD18
Jennings S. and Rogers S. Note on human impacts on the mortality of fish. WGNSSK WD: 18.

The paper represents the results of a desk study to review the potential effects of human activities in the marine environment on the mortality of fish.

The potential effects of a variety of activities are reviewed including the 2000 OSPAR North Sea Quality status Report which ranked the effects of a range of human activities in the North Sea, and classified them according to severity. Six activities were considered to have the highest impacts on the North Sea ecosystem, and three of the six activities were attributable to fisheries. The removal of target species by fisheries was considered to impact the whole North Sea to varying degrees, with 30-40% of the biomass of most commercially exploited species in the North Sea caught each year. This is a more significant cause of mortality than other human impacts.

The effects of gravel extraction, offshore wind farms, seismic surveys, oil spills and power stations on the mortality of fish is briefly discussed. Each of these is likely to have different effects on fish mortality. Any effects are likely to be localised, and /or temporary although mortality of fish on the cooling water intake screens of coastal powers stations may have a relatively high local impact on juvenile fish of some species compared to fishing in the surrounding area. The potential effect on fish population life history traits of releases of hydrocarbons to the marine environment are not discussed.

The general findings are that fishing is the main source of mortality on fish populations in the North Sea and that the effects of the above at the population level are small in comparison.

1.6.2 Other Documents

OD 01
ICES 2003. Report of EC Expert meeting, April 2003

OD02
ICES 2003. Report of the Study Group on the Development of Fishery-based Forecasts. ICES ACFM:08

OD03
ICES 2003. Report of The Study Group on Precautionary Reference Points For Advice on Fisheries Management. ICES CM 2003/ACFM:15.

OD04
ICES 2003. Report of the Study Group on Multispecies Assessments in the North Sea. ICES CM 2003/D:09

1.7 Data for other working groups

1.7.1 WGECO

Data on species composition of bycatches in the industrial fisheries in the North Sea are given in Tables 2.1.1, 2.1.2 and 2.1.3. The allocation of roundfish bycatches to human consumption or reduction purposes, respectively, for the Danish landings is given in Tables 2.1.4 – 2.1.7.

In addition, data on the age composition of commercial roundfish species from these bycatches are provided for the Danish (cod, haddock, whiting : Table 2.1.9) and Norwegian (cod, haddock, saithe, whiting : Table 2.1.10) fisheries.

1.7.2 WG MSVPA

Data for multispecies assessments (catch numbers and mean weight at age by quarter) are given for sandeel (Table 1.7.2.1) and plaice and sole (Table 1.7.2.2). The respective roundfish data will be provided after the meeting.

Table 1.7.2.1 Numbers (millions) and mean weight (g) by age and quarter for North Sea sandeel, 2002

Numbers

		age					
			0	1	2	3	4+
		No	No	No	No	No	No
Year	Quarter						
2002	0	0	0	0	0	0	0
	1	0	0	3,438	147	1	1
	2	0	432	102,960	11,178	1,462	469
	3	0	0	1,527	478	0	0
	4	0	0	0	0	0	0
	All	0	432	107,925	11,803	1,463	470

Weight

		age					
			0	1	2	3	4+
		W	W	W	W	W	W
Year	Quarter						
2002	0	0	0	0	0	0	0
	1	0	0	2.93	5.79	27.06	33.59
	2	0	1.09	6.26	9.00	14.10	23.83
	3	0	0	8.29	12.60	0	0
	4	0	0	0	0	0	0
	All	0	1.09	6.18	9.11	14.11	23.85

Table 1.7.2.2 North Sea plaice and sole: quarterly landings number ('000) and mean weight (kg) by age for 2002.

Plaice in IV

	Q1		Q2		Q3		Q4	
Age	N	W	N	W	N	W	N	W
1					382.3	0.211	968	0.223
2	1488.6	0.204	1882.2	0.229	4180.6	0.247	9596	0.25
3	10142.3	0.227	16989.1	0.253	17983.5	0.29	16966.3	0.29
4	13347.5	0.271	13937.6	0.287	11684.7	0.321	9020.9	0.33
5	11400.8	0.319	11729.2	0.325	6978.8	0.317	4898.8	0.372
6	15265.3	0.403	12580.5	0.398	5070.7	0.448	4586.3	0.491
7	1779.1	0.446	1152.9	0.474	498.1	0.601	476.1	0.674
8	644.6	0.612	425.2	0.591	251.8	0.753	175.2	0.856
9	332.1	0.685	204.9	0.764	88.5	0.65	38.6	1.044
10	143.1	0.781	39.1	0.637	38.7	1.017	21	1.159
11	251.8	0.932	114.9	0.921	41.1	0.924	16.1	1.078
12	39.3	0.902	49.3	0.693	36.9	0.78	9.6	1.142
13	31.2	0.973	36.3	0.862	18.2	0.915	4.4	1.05
14	67.1	0.886	33.8	1.129	8.1	1.111	1.7	1.516
15+	72.8	0.774	80.3	0.896	47.7	0.915	12.1	1.295

Sole in IV

	Q1		Q2		Q3		Q4	
Age	N	W	N	W	N	W	N	W
1	7.4	0.22			74.1	0.108	1026.5	0.129
2	426.5	0.144	1455.3	0.133	3817.7	0.16	6105.6	0.177
3	8952.8	0.199	9518.2	0.178	7556.6	0.193	6569	0.223
4	2387	0.237	3330.1	0.223	2910	0.214	2118.1	0.255
5	2484.1	0.262	2623.9	0.241	1577.9	0.244	1231.6	0.267
6	2109	0.307	2400.6	0.242	1299.8	0.272	1015	0.312
7	152.2	0.385	312.1	0.274	128.1	0.331	65.4	0.43
8	68.1	0.466	253.8	0.279	187.8	0.247	24.8	0.461
9	14.8	0.743	31.1	0.405	28	0.503	12.4	0.642
10	5.4	0.692	16.2	0.316	27.4	0.447	5.7	0.565
11	40.4	0.567	76.5	0.433	25.2	0.542	14.4	0.72
12	3.3	0.752	19.2	0.355	14.9	0.456	3.9	0.457
13	7.8	0.855	14.7	0.442	9.8	0.558	3.8	0.494
14	0.2	0.767	4.8	0.287	0.3	0.462	0.7	0.552
15+	15.6	0.936	20.1	0.615	4.5	0.619	3.1	0.605

1.8 Recommendations

The Working Group recommends that the ICES secretariat supplies a working paper to the WG in 2004 with details of the calculating procedures of the IBTS indices and the historical extension of the time series. The WG also recommends that the ICES secretariat makes the IBTS maturity data avaialble to the WG and that all species covered by the WG are reported.

The Working Group recommends to all members or data suppliers to provide working documents to the WG when substantial changes in input data or new pieces of information are presented to the WG.

The results of the fishermen's survey were received by the Working Group in due time. The Working Group acknowledges the value of this survey. The WG would like to make suggestions for two possible improvements on the fishermen's survey:

- how was the spatial distribution of the fish: did the fishermen have to travel longer/less to reach the fish concentrations.
- how do the current perceptions relate to last year but also to five years ago. Paragraph on fishermen's survey on how it could be improved.

The Working Group recommends that the ICES Study Group on Fisheries Based Forecasts (SGDFF) meets next year in May and collates all the relevant fisheries data at that meeting.

The Working Group recommends that in the short term better linkages be established between this WG and other working groups that deal with species or fisheries that relate to the North Sea, Eastern Channel and IIIa.

The Working Group recommends the Planninggroup on Commercial Catch, Discards and Biological Sampling to take on the task of collating the available discards data.

The Working Group recommends that the mixed fisheries model (MTAC) be evaluated by the methods WG in it's meeting in 2004. The weighting algorithms used within MTAC are currently based upon catch weights. Two fleets catching the same weight of fish but targetting different age ranges will have a different impact on mortality yet receive the same weighting. The potential impact of weighting by numbers on model outcome should be investigated by the Methods Working Group. The Methods Working Group is also requested to evaluate the potential use of the MTAC model for mixed fisheries forecasts within the ICES advisory framework.

The Working Group recommends that the Working Group on Ecosystem effects of fishing (WGECO) advises the WG on how to incorporate ecosystem characteristics into the process of stock assessment where appropriate. The WG also recommends that any relevant time series be made available by the WGECO.

The Working Group recommends that Coby Needle be appointed as the new chair of WGNSSK.

The Working Group recommends that the 2004 meeting of WGNSSK be held at around the same time of the year at IMR, Bergen (Norway)

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. On average 90% of the landings for reduction are composed of sandeel, Norway pout, blue whiting and sprat. The industrial landings also contain by-catches of various other species (Table 2.1.2). The industrial by-catch of human consumption species landed for consumption and reduction by the Danish small-mash fleet are given for 1994-2002 in Tables 2.1.4 and 2.1.5 respectively. Similar data by quarter for 2002 are shown in Tables 2.1.6 and 2.1.7. Sampling intensity of the Danish industrial by-catch is given in Table 2.1.8.

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. Most demersal effort series are stable or show a downward trend in the recent past. Note that reporting of effort is not a mandatory field on the EU logbook, and therefore the Working Group considers that the data may not representative of the actual deployed fishing effort. Due to reporting problems the Scottish effort data may be underestimates (specific concerns were outlined in the 2000 report of WGNSSK (ICES CM 2001/ACFM:07)). Effort for some fleets may also vary between years because they harvest other areas than the North Sea, as a result of the depletion of the traditional resources of the North Sea.

The trends in the landings (WG estimates) since 1970, of the species assessed by the WG, are shown in Table 2.1.1 and in Figure 2.1.2. The human consumption landings have steadily declined over the last 30 years, with an intermediate high in the early 80's. The landings of the industrial fisheries are fluctuating around 1 million t over the years. These landings show the largest annual variations, probably due to the short life span of the main target species. The total demersal landings from the North Sea reached over 2 million t in 1974, and have been around 1.5 million t in the 1990s. The spatial distribution of reported landings (2000-2002) are shown in figure 2.1.3.

The landings by country and fleet segment for the human consumption fisheries are presented in Section 15 of this report (Table 15.2.1.1 and Figure 15.2.1.2). Most of the human consumption landings are from the Dutch beam-trawl fishery harvesting plaice and sole (> 0000 t) and from the Scottish fishery harvesting cod, haddock and whiting (> 100000 t). This Figure shows clearly the great level of technical interactions between the cod, haddock and whiting fisheries and between the sole and plaice fisheries. The flatfish and roundfish landings are generally taking by different fleet segments, with the exception of gill-netters which may potentially target any of these groups of species. The fisheries landing saithe have a low impact on the others. However, the fisheries non-directed to cod, haddock and whiting may generate discards of saithe. Most of the saithe landings are taken by the Norwegian, French and German offshore trawlers.

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

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 Technical measures

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

Until 2001, the technical measures applicable to the North Sea demersal stocks in EU waters were laid down in the Council Regulation (EC) No 850/98. Additional technical measures have been established in 2001 by the Commission

Regulation (EC) No 2056/2001, for the recovery of the stocks of cod in the North Sea and to the west of Scotland. Their implementation in EU waters is described below.

2.1.2.1 Minimum landing size

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

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

2.1.2.2 Minimum mesh size

Regulations on mesh sizes are more complex than those on landing sizes, as they differ depending on gears used, target species and fishing areas. Many other accompanying measures are implemented simultaneously with mesh sizes. They include regulations on gear dimensions (e.g. number of meshes on the circumference), square-meshed panels, and netting material. The most relevant mesh size regulations of EC 2056/2001 are presented below.

<u>Towed nets except beam-trawls</u>

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

- ***Nephrops* fishing.** It is possible to use a mesh size in range 70-109 mm, provided catches consist of at least 30% of *Nephrops*. However, the net needs to be equipped with a 80 mm square-meshed panel if a mesh size of 70-99 mm is to be used, and with a codend if a mesh size of 70-79 mm is to be used.

- **Saithe fishing.** It is possible to use a mesh size range of 110-119 mm, provided catches consist of at least 70% of saithe and less than 3% of cod. This exemption however does not apply to Norwegian waters, were the minimum mesh size for human consumption fishing is 120 mm.

- **Fishing for other stocks.** It is possible to use a mesh size range of 100-119 mm, provided the net is equipped with a square-meshed panel of at least 90 mm mesh size.

- **2002 exemption.** In 2002 only, it is possible to use a mesh size range of 110-119 mm, provided catches consist of at least 50% of a mixture of haddock, whiting, plaice sole, lemon sole, skates and anglerfish, and no more than 25% of cod.

- **General point.** Unless specified in 1-4, cod catches from demersal towed nets of mesh size 32-119 mm should not exceed 20% of total catch.

<u>Beam-trawls</u>

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

- **Southern North Sea.** It is possible to fish for sole south of 56° N with 80 mm meshes in the cod end, provided that at least 5% of the catch is sole, and no more than 10% of the catch is composed of cod, haddock and saithe.

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

Fixed gears

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

2.1.2.3 Closed areas

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

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

Cod box. A recovery plan for the North Sea Cod has been decided in January 2001 in order to prevent a potential stock collapse and help SSB rebuilding to safe levels. The EU and Norway agreed on a temporary closure of the demersal fishery from February 15 until 30 April 2001. This measure has not been applied in 2002 or 2003.

Sandeel Box

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

A 3 year closure, from 2000 to 2002, was decided and the Commission was requested to produce annual reports to the Council on the effects of the restrictions in the sandeel fishery in the Firth of Forth area. On the basis of these reports the commission can propose appropriate amendments to the limitations on the sandeel fishery in the area. The wording of the Act is stated in article 29a of: "Council Regulation (EC) no 850/98 of 30 March 1998 for the conservation of fishery resources through technical measures for the protection of juveniles of marine organisms".

The closed are is given in Figure 2.1.2.1.

2.1.3 Human consumption fisheries

Data

Data available from scientific sources for the assessment of roundfish and flatfish stocks are relatively good. The volume of biological sampling for most of the stocks in 2001 is close to that 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 is occurring in most human consumption fisheries, particularly when strong year classes are approaching the commercial size limit (e.g. haddock in 2001).

In a number of past years, there are indications that substantial under reporting of roundfish and flatfish landings is likely to had occurred. There are indications that this is likely to have happened for particularly for cod in 2001 and 2002 since the agreed TAC implied a reduction in effort of more than 50% in both years.

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 assessed by this Working Group in this report, whiting used to form a significant by-catch in the industrial fisheries. This by-catch has been reduced in recent years.

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, possibly combined with 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. The trends in Landings, SSB and F from the assessments are presented in Figures 2.1.4-2.1.6. Note that the figure for cod is indicative of stock trends only and the absolute level of spawning stock is uncertain.

Reported landings of cod in 2002 (49,000 t) were the lowest on record, as was the spawning stock. The 1996 year-class was relatively strong, but suffered so heavily from fishing and discarding of immature fish that it did not result in rebuilding the spawning stock. Since 1997, recruitment has been at a low level. Fishing mortality is high but appears to be decreasing. Although the absolute level of the spawning stock cannot be determined accurately, is it clear from all sources of informatio that SSB is low and likely to be well below the current $\mathbf{B}_{lim}$ (70,000 t).

Historically the stock size of haddock has shown large variation due to the occasional occurrence of a very strong year classes. The strong 1999 year class dominated the human consumption landings in 2002. The maturation of the 1999 year class has also increased the SSB to well above $\mathbf{B}_{pa}$, but it is likely to decrease again in the near future. Fishing mortality is high but appears to be decreasing. Recruitment after 1999 has been low.

The human consumption yield of whiting in 2002 was 16,000t, which is the lowest level observed in the time series. Discard levels observed in 2002 are also low compared to previous years. The spawning stock biomass has overall gradually declined over more than 20 years. Most recent estimates indicate a low level of F and a increase in SSB since 1998. 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 increasing and estimated to be well above $\mathbf{B}_{pa}$. Landings in 2002 were 112,000 t which is still at a relatively low level. Fishing mortality has declined considerably since 1986 and remains at a low level.

Fishing mortality of sole has fluctuated on a high level since the 1970s but appears to be declining since the late 1990s. The spawning stock was below $\mathbf{B}_{pa}$ in 2002 and 2003 but is expected to increase due to the relatively strong 2001 year class.

The spawning stock of plaice has been decreasing steadily until arriving at its lowest observed level in 1997. Last year the impression was that the SSB was increasing again but the current assessment indicates that this may have been due to overestimation of the stock size. SSB is not estimated to be at around the same low level as in 1997. Fishing mortality has apparently come down since the late 1990's.

2.1.4 Industrial fisheries

2.1.4.1 Description of fisheries

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

2.1.4.2 Data available

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

2.1.4.3 Trends in landings and effort

The sandeel landings in 1974-1985 fluctuated between 428,000 and 787,000 t with a mean on 611,000 t. In the period 1986-2000 the landings increased to a generally higher level between 591,000 and 1,091,000 t and a mean on 819,000 t. In 1997 the combined Danish and Norwegian landings on more than 1 million t was the highest ever recorded. Landings in 2002 for Norway and Denmark were 804,000 t (Table 2.1.2) which is just above the average on 779.000 tonnes for the period 1980-2002. The majority of the catches in 2002 were taken in the southern fishing area in the second quarter of the year while the landings in the northern fishing area were on low level compared to the previous 6 years. Especially the landings in the north western part of the North Sea were on a low level in 2002 compared to the previous 5 years. The catches were mainly taken in the first half year whereas the landings in the second half year were on a low level compared to the previous 5 years. The catches for 2003 are not included in this assessment, however provisional Danish and Norwegian landings statistics for the period until the end of June 2003 show very small landings. Danish and Norwegian landings were at 221.250 tons compared to a mean value of 494.218 t in the same period for the years 1997-2002..

The Norway pout catches showed a downwards 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 184,000 t based on fishery on the strong 1999 year class. Landings in 2002 were around 73,000 t that is the second lowest landings since 1966 and well below average for the last five years. .

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 sandeel fleet is gradually decreasing from 1989 to 1994, increasing from 1994 to 1998, and decreasing from 1998 to 2002. The development in the effort for the sandeel fleet 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 effort in the Norway pout fleet has been gradually decreasing from1993 and to 2001 where the effort in the Norway pout fishery reached a historic low level (Figure 2.1.1). The effort in the Norway pout fishery in 2002 nearly doubled from effort in 2001 being at the same level as in the previous 8 years before 2001

2.1.4.4 Landings of Blue Whiting

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

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

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

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

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

2.1.4.5 Stock impressions

Trends in Yield, F and SSB for sandeel and Norway pout are given in Figures 2.1.4-2.1.6.

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. SSB in 2001 increased to 340,000 t to reach a similar level as in 1996 because of the strong 1999 year class. In 2002 SSB decreased to 195,000 t and is just above $\mathbf{B}_{pa}$ in 1st quarter of 2003. 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. In 2001 the fishing mortality reached a historically minimum just below 0.2 to increase to about 0.4 in 2002.

Over the years, SSB of sandeel has been fluctuating around 1 million t with an increasing trend from 1989 to 1995 and a decreasing trend from 1998 to 2002. 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 in the period 1989 to 2001. The present assessment estimate SSB for 2002 to be below $\mathbf{B}_{lim}$..The recruitment in 2002 is estimated to 0. The low recruitment of 0-group sandeels in 2002, as estimated in the XSA from commercial CPUE, is confirmed by small landings of the Danish and Norwegian fleets in the first half year of 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)

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

	cod		haddock	haddock	whiting	whiting	saithe	saithe	sole	plaice	Norway pout	sandeel	h cons
Year	hc	ib	hc	ib	hc	ib	hc	ib	hc	hc	ic	ic	total
1970	226	n/a	525	180.0	83	115.0	163	59.0	20	130	238	191	1147
1971	328	n/a	235	32.0	61	72.0	218	35.0	24	114	305	382	980
1972	354	n/a	193	30.0	64	61.0	248	28.0	21	123	445	359	1003
1973	239	n/a	179	11.0	71	90.0	229	31.0	19	130	346	297	867
1974	214	n/a	150	48.0	81	130.0	267	42.0	18	113	736	524	843
1975	205	n/a	147	41.0	84	86.0	271	38.0	21	108	560	428	836
1976	234	n/a	166	48.0	83	150.0	295	67.0	17	114	437	488	909
1977	209	n/a	137	35.0	78	106.0	217	6.0	18	119	390	786	778
1978	297	n/a	86	11.0	97	55.0	163	3.0	20	114	270	787	777
1979	270	n/a	83	16.0	107	59.0	134	2.0	23	145	329	578	762
1980	294	n/a	99	22.0	101	46.0	142		16	140	483	729	792
1981	335	n/a	130	17.0	90	67.0	145	1.0	15	140	239	569	855
1982	303	n/a	166	19.0	81	33.0	185	5.0	22	155	395	611	912
1983	259	n/a	159	13.0	88	24.0	197	1.0	25	144	451	537	872
1984	228	n/a	128	10.0	86	19.0	214	6.0	27	156	393	669	839
1985	215	n/a	159	6.0	62	15.0	222	8.0	24	160	205	622	842
1986	204	n/a	166	3.0	64	18.0	202	1.0	18	165	178	848	819
1987	216	n/a	108	4.0	68	16.0	177	4.0	17	154	149	825	740
1988	184	n/a	105	4.0	56	49.0	140	1.0	22	154	110	893	661
1989	140	n/a	76	2.0	45	36.0	117	1.0	22	170	168	1039	570
1990	125	n/a	51	3.0	47	50.0	100	8.0	35	156	152	591	514
1991	102	n/a	45	5.0	53	38.0	115	1.0	34	148	193	843	497
1992	114	n/a	70	11.0	52	27.0	104		29	125	300	855	494
1993	122	0.66	80	11.0	53	20.0	118	1.0	31	117	184	579	521
1994	111	0.78	80	5.0	49	10.0	115		33	110	182	786	498
1995	136	0.96	75	8.0	46	27.0	124	1.0	30	98	241	918	509
1996	126	0.34	76	5.0	41	5.0	120	0.0	23	82	166	777	468
1997	124	0.79	79	7.0	36	7.0	110	3.0	15	83	170	1137	447
1998	146	0.40	77	5.0	28	3.0	107	3.0	21	71	80	1004	450
1999	96	0.10	66	4.0	30	5.0	114	3.0	25	81	92	735	412
2000	71	0.06	47	9.0	28	8.0	88	6.0	23	81	184	699	338
2001	50	0.10	41	8.0	25	7.0	95	3.0	20	82	66	862	313
2002	54	0.03	57	3.7	22	7.6	117	7.8	17	70	73	804	337

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
2001	810	156	21	59	76	6	7	3	14	1152
2002	804	142	26	73	107	4	8	8	15	1186
Avg 74-02	732	200	63	246	61	13	39	9	34	1382

Year quarter	Sandeel	Sprat	Herring	Norway pout	Blue whiting	Haddock	Whiting	Saithe	Other	Total
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
2001 q1	12	40	2	20	15	1	1	0	3	94
2001 q2	462	1	2	10	32	3	1	2	4	517
2001 q3	314	44	4	4	12	1	2	0	5	386
2001 q4	22	72	13	24	16	1	2	0	2	152
2002 q1	11	5	6	8	18	0	0	0	2	50
2002q2	772	0	3	5	19	1	2	0	4	806
2002q3	21	71	8	31	46	1	3	5	4	189
2002q4	0	66	10	28	24	1	2	3	6	141

0 denotes < 0.5 tonne

Table 2.1.4 Danish by-catch landings of cod, haddock, whiting and saithe in 1993 - 2002 from small meshed fisheries in the North Sea.

Landings in tonnes used for human consumtion purposes (These landings have been counted against the Danish human consumtion quotas and have been included in the estimated catch in numbers of the human consumtion landings reported to ICES).

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

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

Whiting	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
Sandeel fishery	19	3	3	+	+	+	+	+	+	+
Sprat fishery	10	4	3	2	+	+	+	+	+	+
Norway pout fishery	932	307	201	92	33	11	9	19	9	11
Blue whiting fishery	6	+	0	9	3	4	1	1	2	3
"Others" fishery	60	5	2	4	2	1	1	+	+	+
Total	1,027	319	209	107	38	16	11	20	11	14

Saithe	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
Sandeel fishery	52	52	111	88	73	23	44	6	5	1
Sprat fishery	37	48	123	9	1	3	6	1	13	2
Norway pout fishery	589	514	1,057	359	599	264	205	267	245	182
Blue whiting fishery	2	4	0	155	167	356	476	214	186	225
"Others" fishery	21	43	73	43	117	137	108	21	11	83
Total	701	661	1,364	654	957	783	839	509	460	493

Table 2.1.5. Danish by-catch landings of cod, haddock, whiting and saithe in 1993 - 2002 from small meshed fisheries in the North Sea.

Landings in tonnes used for reduction purposes.

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

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

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

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

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

Table 2.1.6

Danish by-catch landings of cod, haddock, whiting and saithe in 2002 from small meshed fisheries in the North Sea.

Landings in tonnes used for human consumtion purposes.
These landings are included in catch in numbers of human consumtion landings.

Cod	**Quarter 1**	**Quarter 2**	**Quarter 3**	**Quarter 4**	**Total**
Sandeel fishery	5.7	5.4	0.0	0.0	11.1
Sprat fishery	0.5	0.0	1.9	0.3	2.7
Norway pout fishery	2.0	0.0	15.4	22.7	40.1
Blue whiting fishery	16.9	3.6	12.8	1.4	34.7
"Others" fishery	8.2	0.0	0.8	1.5	10.5
Total	33.3	9.0	30.9	25.9	99.1

Haddock	**Quarter 1**	**Quarter 2**	**Quarter 3**	**Quarter 4**	**Total**
Sandeel fishery	0.1	10.1	0.2	0.0	10.4
Sprat fishery	0.2	0.0	0.3	0.0	0.5
Norway pout fishery	0.7	0.0	4.3	9.8	14.8
Blue whiting fishery	5.2	0.4	7.7	1.7	15.0
"Others" fishery	3.0	0.0	3.2	9.0	15.2
Total	9.2	10.5	15.7	20.5	55.9

Whiting	**Quarter 1**	**Quarter 2**	**Quarter 3**	**Quarter 4**	**Total**
Sandeel fishery	0.0	0.0	0.0	0.0	0.0
Sprat fishery	0.1	0.0	0.0	0.0	0.1
Norway pout fishery	0.0	0.0	5.4	5.5	10.9
Blue whiting fishery	1.1	0.1	1.1	0.2	2.5
"Others" fishery	0.1	0.0	0.0	0.1	0.2
Total	1.3	0.1	6.5	5.8	13.7

Saithe	**Quarter 1**	**Quarter 2**	**Quarter 3**	**Quarter 4**	**Total**
Sandeel fishery	0.0	0.7	0.1	0.0	0.8
Sprat fishery	1.1	0.0	1.1	0.0	2.2
Norway pout fishery	30.0	0.0	84.3	66.3	180.6
Blue whiting fishery	95.9	26.5	90.0	8.6	221.0
"Others" fishery	57.8	0.0	4.5	16.7	79.0
Total	184.8	27.2	180.0	91.6	483.6

All other human consumtion species	**Quarter 1**	**Quarter 2**	**Quarter 3**	**Quarter 4**	**Total**
Sandeel fishery	0.1	0.9	0.2	0.0	1.2
Sprat fishery	0.4	0.0	1.3	0.8	2.5
Norway pout fishery	10.7	0.0	51.0	32.9	94.6
Blue whiting fishery	40.2	17.9	26.0	2.0	86.1
"Others" fishery	19.2	0.0	1.7	2.8	23.7
Total	70.6	18.8	80.2	38.5	208.1

Table 2.1.7

Danish by-catch landings of cod, haddock, whiting and saithe in 2002 from small meshed fisheries in the North Sea.

Landings in tonnes used for reduction purposes.

Cod	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total
Sandeel fishery	0	12	0	0	12
Sprat fishery	0	0	0	0	0
Norway pout fishery	0	0	0	3	3
Blue whiting fishery	3	0	11	0	14
"Others" fishery	0	0	0	1	1
Total	3	12	11	4	30

Haddock	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total
Sandeel fishery	30	190	0	0	220
Sprat fishery	12	0	1	14	27
Norway pout fishery	0	0	408	1,137	1,545
Blue whiting fishery	57	14	59	3	133
"Others" fishery	119	0	15	49	183
Total	218	204	483	1,203	2,108

Whiting	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total
Sandeel fishery	0	1,350	47	0	1,397
Sprat fishery	43	0	1,496	699	2,238
Norway pout fishery	0	0	239	1,436	1,675
Blue whiting fishery	28	0	80	15	123
"Others" fishery	55	0	19	53	127
Total	126	1,350	1,881	2,203	5,560

Saithe	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total
Sandeel fishery	0	0	0	0	0
Sprat fishery	0	0	0	0	0
Norway pout fishery	0	0	45	201	246
Blue whiting fishery	25	5	41	1	72
"Others" fishery	49	0	4	56	109
Total	74	5	90	258	427

All species	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total
Sandeel fishery	10,297	601,559	16,349		628,205
Sprat fishery	10,386	0	81,345	75,741	167,472
Norway pout fishery	4,511	0	18,582	31,887	54,980
Blue whiting fishery	12,977	2,689	9,905	1,481	27,052
"Others" fishery	4,933	0	1,556	2,014	8,503
Total	43,104	604,248	127,737	111,123	886,212

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

Number of fish measured and aged per species and quarter is given.

	Cod	Haddock	Whiting
Quarter 1	2	74	32
Quarter 2	25	79	143
Quarter 3	35	92	726
Quarter 4	1	337	268
Total	63	582	1169

As the number of specimens in the samples are low, it has been necessary to used all specimens in the samples for the period 1998-2003

Table 2.1.9. Numbers and mean weight at age of commercial roundfishes from the Danish small-meshed fishery sent for reduction, 2002

Species: ***COD*** **Area:** ***IV*** **Numbers (mill.), W (g.)**

Winter Rings		0	1	2	3	4	5	6	7	8+	Total	Nominal catch in t.	SOP in tons
	Numbers			0.02							0.02		
Quarter 1	Mean W			165.5								3	3
	Numbers	0.12	0.25	0.03	0.02						0.42		
Quarter 2	Mean W	3.1	26.3	70.0	155.0							12	12
	Numbers	0.66	0.02								0.68		
Quarter 3	Mean W	6.5	281.0									11	10
	Numbers	0.07									0.07		
Quarter 4	Mean W	60.0										4	4
	Numbers	0.84	0.27	0.05							1.17		
Total Year	Mean W	10.3	44.3	103.4								30	29

Species: ***Haddock*** **Area:** ***IV*** **Numbers (mill.), W (g.)**

Winter Rings		0	1	2	3	4	5	6	7	8+	Total	Nominal catch in t.	SOP in tons
	Numbers		2.77	0.54							3.30		
Quarter 1	Mean W		54.9	123.0								218	218
	Numbers		5.56	0.30							5.86		
Quarter 2	Mean W		29.2	140.5								204	204
	Numbers	13.42	0.96	0.32							14.69		
Quarter 3	Mean W	21.0	118.5	272.5								483	483
	Numbers	35.96	3.90	1.22							41.08		
Quarter 4	Mean W	14.7	102.7	224.8								1,203	1,203
	Numbers	49.38	13.19	2.37							64.94		
Total Year	Mean W	16.4	62.8	197.7								2,108	2,108

Species: ***Whiting*** **Area:** ***IV*** **Numbers (mill.), W (g.)**

Winter Rings		0	1	2	3	4	5	6	7	8+	Total	Nominal catch in t.	SOP in tons
	Numbers		0.17	0.32	0.20	0.10					0.80		
Quarter 1	Mean W		31.3	158.6	244.4	209.0						126	126
	Numbers		11.63	10.43	2.39						24.46		
Quarter 2	Mean W		39.0	60.3	111.7							1,350	1,350
	Numbers	118.11	15.51	1.31	0.37	0.37					135.68		
Quarter 3	Mean W	9.0	34.4	112.6	194.0	179.0						1,881	1,881
	Numbers	16.58	9.68	3.75	1.45	0.85		0.12			32.44		
Quarter 4	Mean W	21.1	61.0	181.6	196.0	294.7		380.0				2,203	2,203
	Numbers	134.69	37.00	15.82	4.42	1.32		0.12			193.37		
Total Year	Mean W	10.5	42.8	95.4	152.3	255.5		380.0				5,560	5,560

Table 2.1.10 . Numbers ('000) and mean weight (g) at age of commercial roundfish species in 2002 in the bycatch of the Norwegian industrial fishery

Saithe	2002									
	1. QUARTER		2. QUARTER		3. QUARTER		4. QUARTER		Year 2002	
AGE	NUMBER	WEIGHT	NUMBER	WEIGHT	NUMBER	WEIGHT	NUMBER	WEIGHT	NUMBER	WEIGHT
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
2	13.4	215.6	34.9	253.6	104.3	271.9	41.0	452.0	193.5	302.8
3	25.1	759.3	65.8	510.0	1762.8	658.9	633.5	656.8	2487.2	655.5
4	140.6	597.6	503.5	651.5	4068.7	765.7	2337.3	769.1	7050.2	755.4
5	16.6	868.9	80.2	805.1	186.6	846.8	114.7	814.3	398.2	830.0
6	8.3	1062.1	17.5	863.2	5.8	1135.3	28.4	863.2	59.9	916.9
7	0.0		0.0		0.0		0.0		0.0	
8	0.0		0.0		0.0		0.0		0.0	
9	0.0		0.0		0.0		0.0		0.0	
10	0.0		0.0		0.0		0.0		0.0	

Cod	2002									
	1. QUARTER		2. QUARTER		3. QUARTER		4. QUARTER		Year 2002	
AGE	NUMBER	WEIGHT	NUMBER	WEIGHT	NUMBER	WEIGHT	NUMBER	WEIGHT	NUMBER	WEIGHT
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	
1	3.2	60.2	13.4	91.4	11.5	136.3	0.0		28.1	106.2
2	4.8	270.6	62.0	174.9	8.5	418.8	0.0		75.4	208.7
3	1.6	331.6	11.1	431.6	0.1	352.8	0.0		12.9	418.4
4	0.0		0.0		0.0		0.0		0.0	
5	0.0		0.0		0.0		0.0		0.0	
6	0.0		0.0		0.0		0.0		0.0	
7	0.0		0.0		0.0		0.0		0.0	
8	0.0		0.0		0.0		0.0		0.0	
9	0.0		0.0		0.0		0.0		0.0	
10	0.0		0.0		0.0		0.0		0.0	

Whiting	2002									
	1. QUARTER		2. QUARTER		3. QUARTER		4. QUARTER		Year 2002	
AGE	NUMBER	WEIGHT	NUMBER	WEIGHT	NUMBER	WEIGHT	NUMBER	WEIGHT	NUMBER	WEIGHT
0	0.0	0.0	0.0	0.0	0.4	16.0	0.0	0.0	0.4	16.0
1	0.0	0.0	851.9	41.6	276.5	135.3	11.9	163.2	1140.3	65.6
2	20.0	140.8	2111.9	96.9	713.5	228.7	89.3	246.2	2934.6	133.8
3	140.6	207.0	2770.5	203.2	1104.1	252.9	160.4	270.2	4175.5	219.0
4	18.2	309.3	405.9	327.1	366.5	382.5	59.2	345.7	849.8	351.9
5	8.0	460.7	139.4	415.4	46.0	407.0	12.1	407.0	205.5	414.8
6	0.0		0.0		0.0		0.0		0.0	
7	0.0		0.0		0.0		0.0		0.0	
8	0.0		0.0		0.0		0.0		0.0	
9	0.0		0.0		0.0		0.0		0.0	
10	0.0		0.0		0.0		0.0		0.0	

Haddock	2002									
	1. QUARTER		2. QUARTER		3. QUARTER		4. QUARTER		Year 2002	
AGE	NUMBER	WEIGHT	NUMBER	WEIGHT	NUMBER	WEIGHT	NUMBER	WEIGHT	NUMBER	WEIGHT
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
1	83.8	54.4	261.3	57.0	225.9	132.2	14.1	179.2	585.1	88.6
2	240.7	116.0	957.5	126.0	765.0	199.3	124.1	213.6	2087.4	156.9
3	118.5	242.9	723.9	252.1	2301.6	291.9	492.8	296.9	3636.8	283.1
4	5.6	397.7	48.0	407.1	368.6	372.4	80.7	360.7	502.9	374.1
5	2.6	430.7	24.0	430.7	0.0		0.0		26.6	430.7
6	0.0		0.0		0.0		0.0		0.0	
7	0.0		0.0		0.0		0.0		0.0	
8	0.0		0.0		0.0		0.0		0.0	
9	0.0		0.0		0.0		0.0		0.0	
10	0.0		0.0		0.0		0.0		0.0	

Figure 2.1.1. Effort in the North Sea.

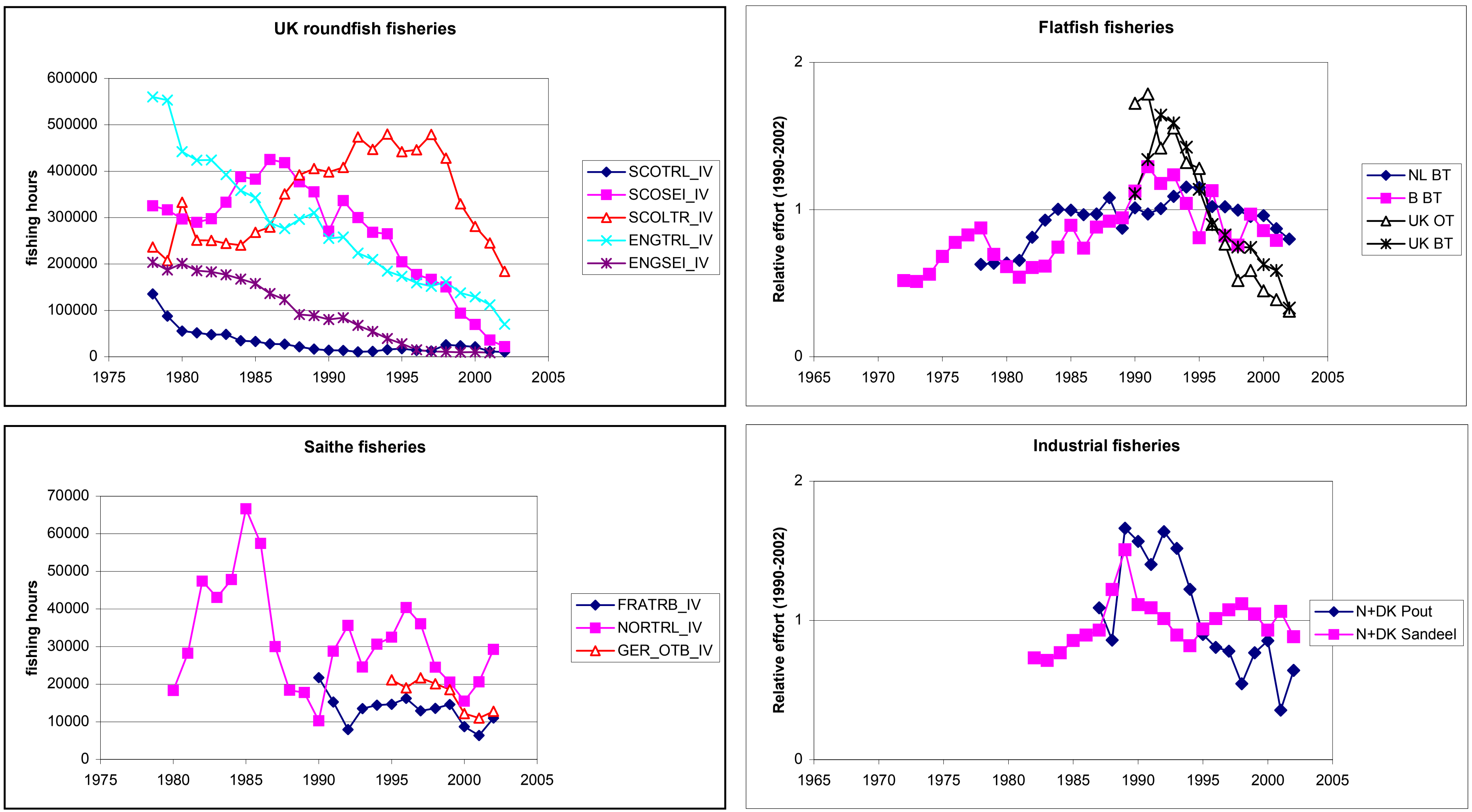


Figure 2.1.2 Demeral landings from the North Sea

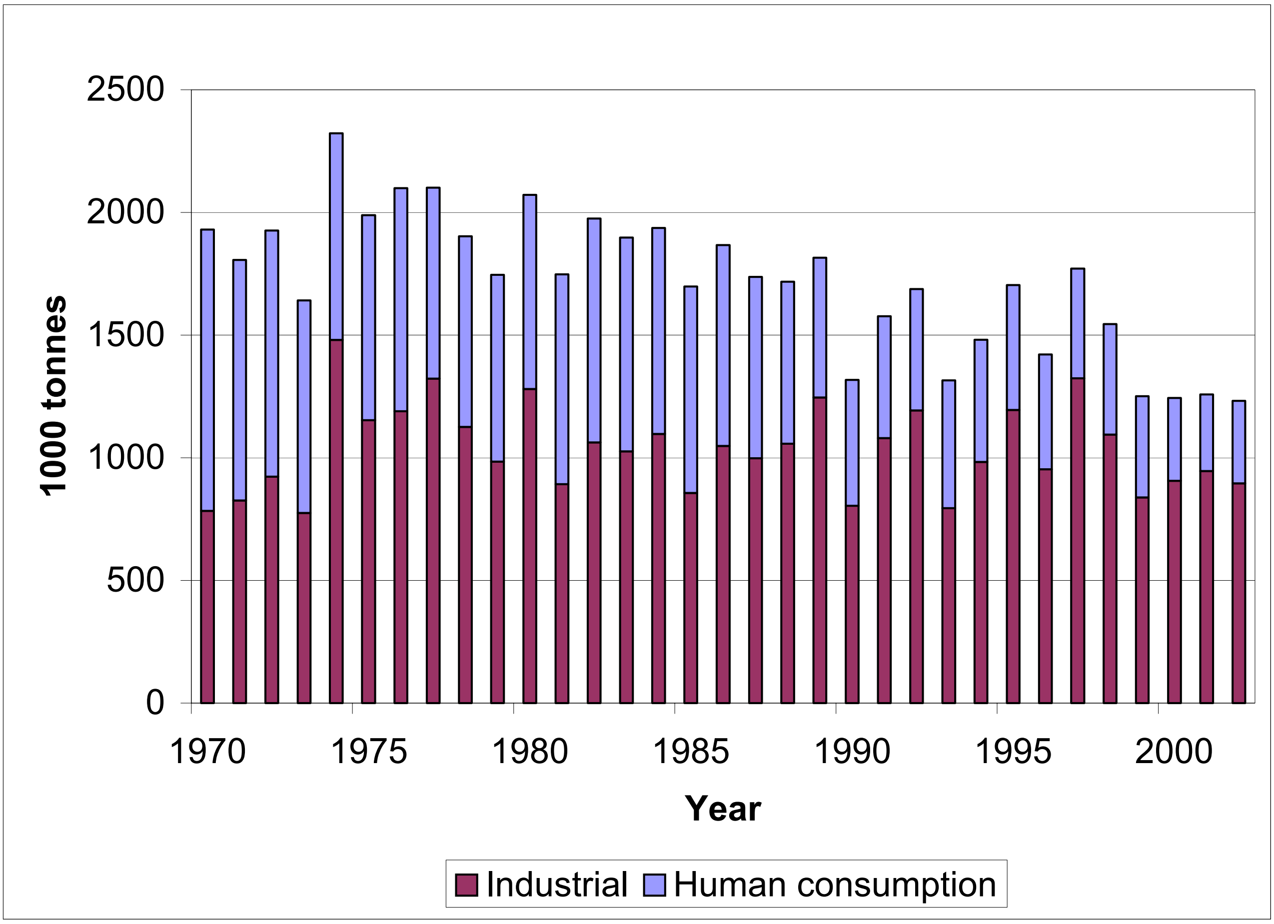
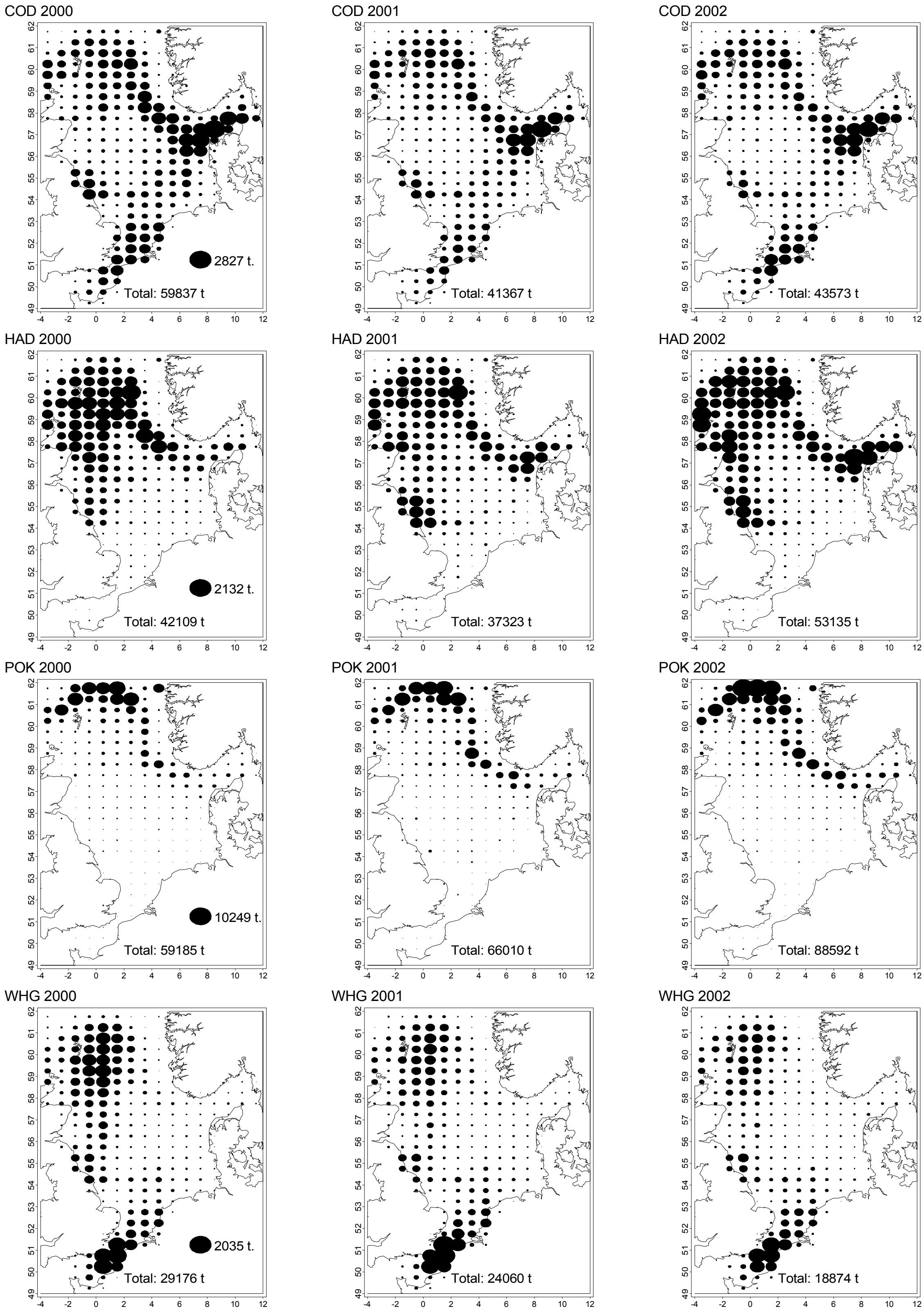
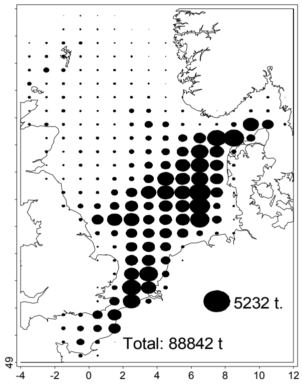


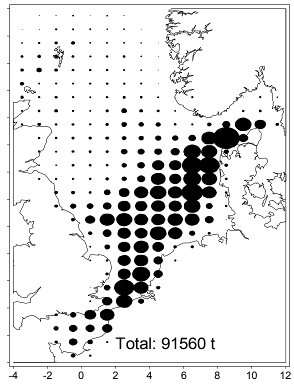
Figure 2.1.3. Distribution of reported landings of cod , haddock, whiting, saithe, plaice, sole and Nephrops from Sub-area IV, IIIa and VIId in 2000-2002. (Belgian, and Norwegian landings are not included).



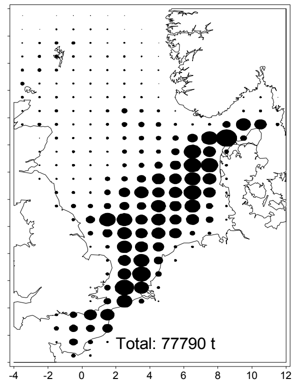
PLE 2000



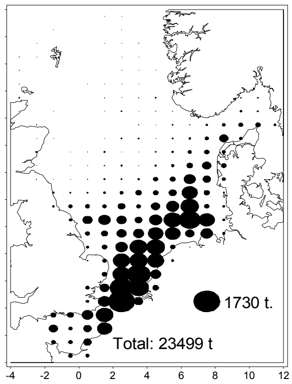
PLE 2001



PLE 2002



SOL 2000



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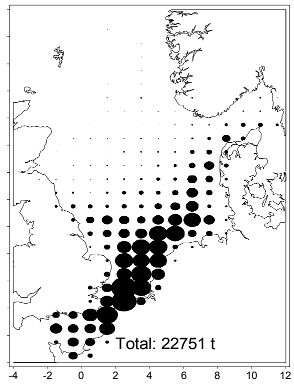
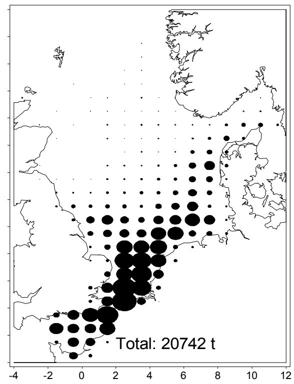
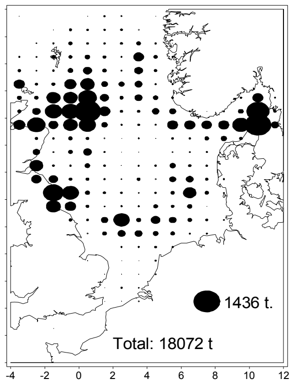


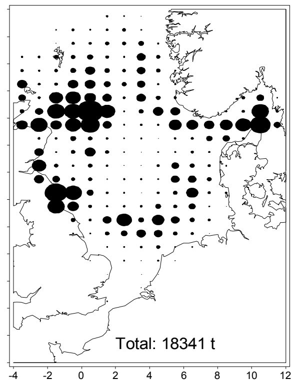
SOL 2002



NEP 2000



NEP 2001



NEP 2002

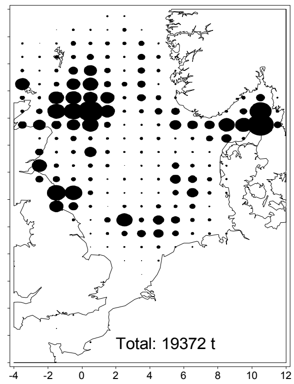


Figure 2.1.4 Yield by species for the main stocks considered by this working group. For Haddock and whiting, yield refers to total catches, for all other species to landings.

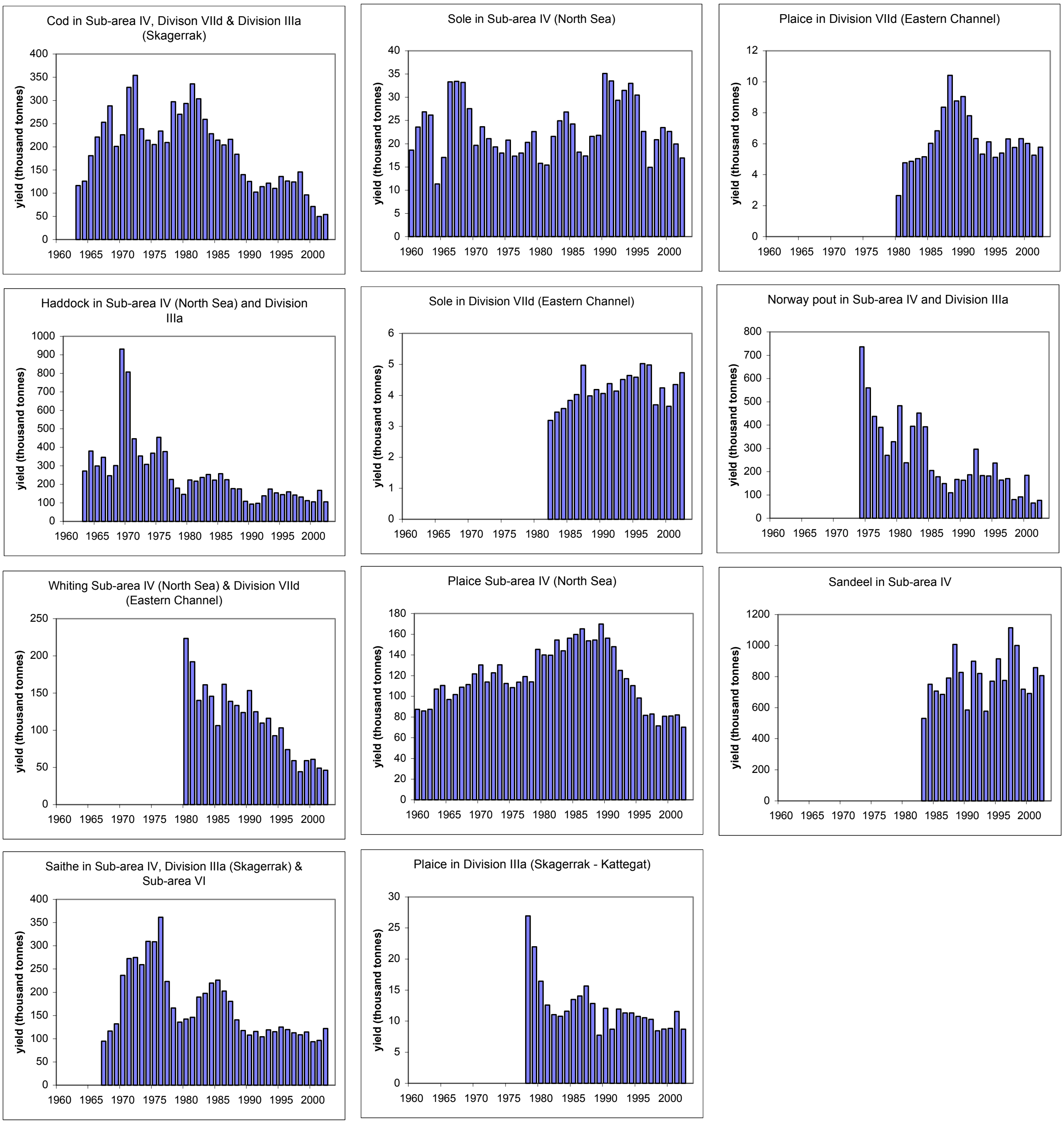
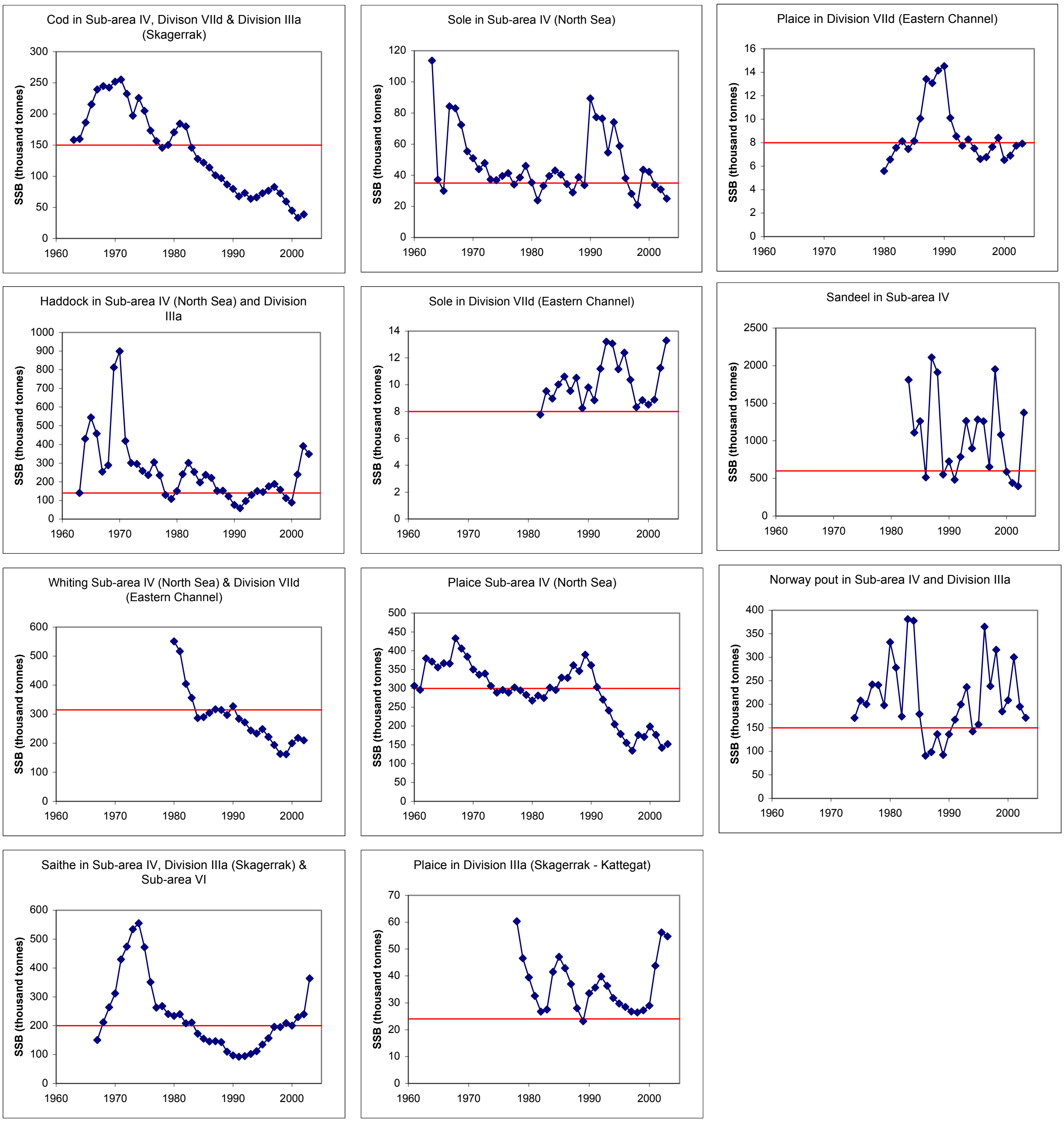
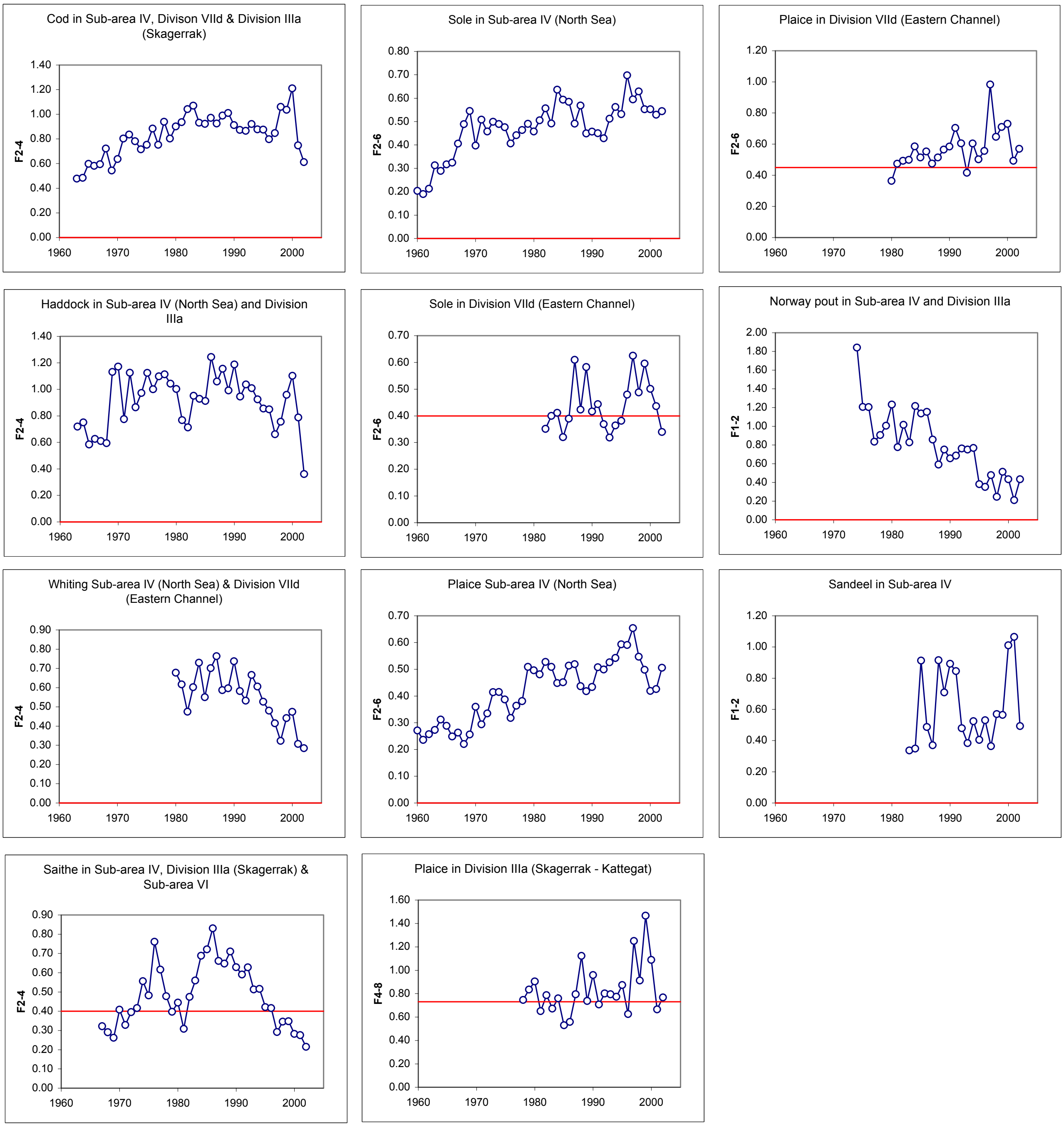


Figure 2.1.5 Trends in SSB for the main stocks considered by this working group. The graph for cod is indicative only.



Note: biological reference points are under revision and may no longer be applicable.

Figure 2.1.6 Trends in mean fishing mortality for the main stocks considered by this working group. The graph for cod is indicative only.



Note: biological reference points are under revision and may no longer be applicable.

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. Effort measures available from the major Danish fleets (Figure 2.2.1) fishing plaice and cod have been stable for nearly a decade. These fleets do however not comprise the entire fishery, but is considered representative for trends in effort.

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

There are important technical interactions between the fleets. This issue was discussed by the WG this year. It was decided to approach the problem by using data for North Sea only and the methodology used is presented in Section 15. Most of the human consumption demersal fleets are involved in mixed fisheries. Norway pout and the mixed clupeoid fishery have by-catches of protected species.

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

Several of the stocks in the Skagerrak may not be separate stocks but are assumed to intermingle with the stocks in the North Sea. This is the case for cod, haddock, whiting, plaice, and Norway pout.

The landings of cod in Division IIIa were 9.7 thousand tonnes in 2002 in the human consumption fishery, which is a historic low. 75 % was taken in Skagerrak, and the majority of catches were taken by Denmark and Sweden. Cod in Skagerrak is assessed together with the North Sea (Division IV) and Eastern Channel (Division VIId) stock. Cod in Kattegat is assessed as a separate stock by the Baltic Fisheries Assessment Working Group. ICES has since 2002 advised that no fishery should take place on this stock. No recovery plan is implemented yet. By-catches of cod in the Danish small-meshed fishery have been decreasing steadily in the latest decade (Table 2.2.2.).

Landings of haddock in Division IIIa, in the human consumption fishery, amounted to 4.6 thousand tonnes. Most of the catches are taken in Skagerrak. Haddock in IIIa is assessed together with the North Sea (Division IV) stock. By-catches of haddock in the Danish small-meshed fishery have been decreasing steadily in the latest decade (Table 2.2.2.).

Landings of whiting (for human consumption) were 252 tonnes in 2002. Most of the landings are taken in Skagerrak. No analytical assessment of whiting in IIIa was possible. By-catches of whiting in the Danish small-meshed fishery have been slightly increasing in the recent 6 years (Table 2.2.2.).

Landings of saithe in Divisions IV and IIIa were about 112 thousand tonnes in 2002, which is above the landings last year. The saithe assessment comprises Divisions IV, IIIa, and VI. No by-catches of saithe occurs in the Danish small-meshed fishery since 1999 (Table 2.2.2.).

The plaice landings in Division IIIa amounted to 8.7 thousand tonnes in 2002, which is a 25% decrease from 2001. Historically, TAC has not been restrictive for this stock. About 70% of the landings were taken in Skagerrak. Plaice in IIIa is assessed as a separate stock. By-catches of plaice in the Danish small-meshed fishery have been decreasing steadily in the latest decade (Table 2.2.2.).

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

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

Most of the landings from the industrial fisheries in IIIa consisted of sandeel, sprat and herring, but also blue whiting and Norway pout were taken (Table 2.2.1). Data was provided by Denmark and Sweden for the years 1999-2002. All other years refer to data provided by Denmark only. The Norway pout assessment comprises Divisions IIIa and IV. Sandeel in Division IIIa was not possible to assess.

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

Year	Sandeel	Sprat[1]	Herring	Norway pout	Blue whiting	Total
1989	18	4	52	5	9	88
1990	16	2	51	27	10	106
1991	24	14	44	39	10	131
1992	39	4	66	45	19	173
1993	45	2	71	8	32	158
1994	55	58	30	7	12	162
1995	12	42	34	50	10	148
1996	53	10	26	36	15	140
1997	82	12	6	32	4	136
1998	11	11	5	15	7	49
1999*	13	26	11	7	16	73
2000*	17	19	18	10	7	71
2001*	25	28	16	9	5	83
2002	49	26	32	3	12	122
Mean 1989-2002	33	18	33	21	12	117

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

[1] Data provided by Working Group members

Table 2.2.2 By-catches of the most important consumption species in the Danish small-meshed fisheries in Division IIIa (t) 1989-2002.

	Whiting	Haddock	Plaice	Saithe	Cod
1989	3,961	64	135	1	399
1990	5,304	297	58	9	131
1991	4,506	400	86	13	421
1992	3,340	513	111	2	293
1993	1,987	415	141	13	153
1994	1,900	138	65	0	181
1995	2,549	247	20	9	304
1996	1,232	302	107	1	234
1997	264	77	16	2	45
1998	354	39	5	1	44
1999	695	89	8	0	53
2000	777	140	30	0	42
2001	970	43	29	0	27
2002	975	12	8	0	32

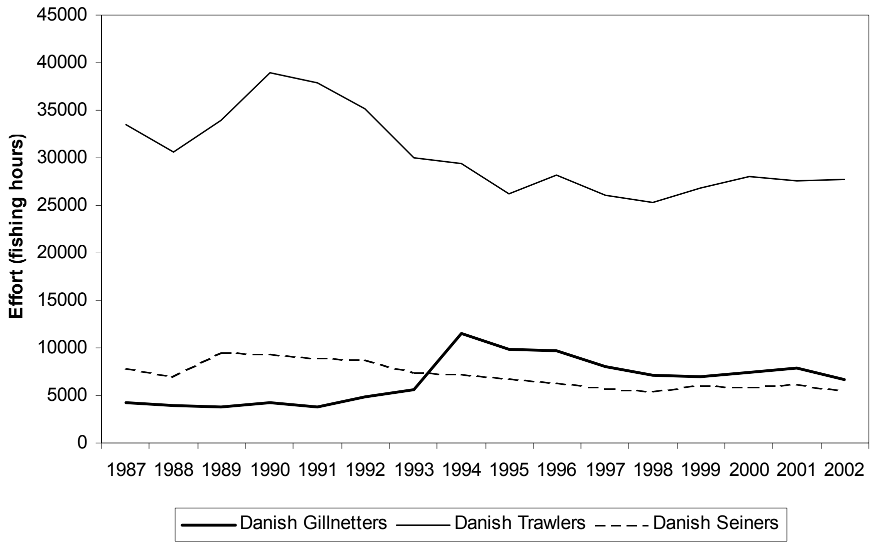


Figure 2.2.1 Effort in the Danish demersal mixed fisheries for plaice and cod in Division IIIa.

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 the English fixed net fleet. No information is available for the important French fixed net fleet which takes about 50% of the French sole landings and less than 20% of the French plaice landings.

2.3.2 Data

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

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.

c) Surveys: There is a 4th quarter research vessel survey (GFS) which is used in tuning for plaice. A research vessel survey using beam trawl which covers most of VIId in August (BTS) is used in tuning sole and plaice. An International Young Fish Survey (YFS) is carried out along the English coast and in the Baie de Somme on the French coast and is used to calculate an index for 0-gp and 1-gp sole and plaice

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 fishing mortality is estimated to be below $\mathbf{F}_{pa}$ The SSB is well above $\mathbf{B}_{pa}$ (8000t) following improved recruitment in recent years particularly of the year classes 1998 to 2000. There is a tendency to underestimate F and overestimate SSB.

Plaice: The stock follows the pattern of a general decline in plaice stocks observed in other areas up to 1997. Since then SSB appears to have stabilised at or slightly below $\mathbf{B}_{pa}$. F has increased in 2002 above $\mathbf{F}_{lim}$ (0.54). Recruitment is close to mean levels after the confirmed strong 2000 year class. The state of the plaice stock in VIId is highly dependent on the quality of the recruitment

2.3.4 Overview of Industrial Fisheries in Division VIa

There are two distinct industrial fisheries operating in Division VIa; a Norway pout fishery and a sandeel fishery. The Norway pout fishery is now exclusively Danish, whereas the sandeel fishery is almost exclusively Scottish and operates in more inshore areas. No information is available on by-catches in the Norway pout fishery. The sandeel fishery has a small by-catch of other species; information from the 1995 and 1996 catches indicates that in excess of 97% of the catch consisted of *Ammodytes marinus*, with the by-catch consisting mostly of other species of sandeel. Landings from both fisheries are small compared to the fisheries in the North Sea. Landings of sandeel from VIa were very low in 2002, reflecting the continued reduced effort in the fishery.

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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 (Subarea IV), and the Eastern Channel (Division VIId). Prior to 1996 cod in these areas were assessed as separate stocks. The present assessment is classified as a benchmark assessment.

3.1 The Fishery

Cod are caught by virtually all the demersal gears in Subarea IV and Divisions IIIa (Skagerrak) and VIId, including beam trawls, otter 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.

3.1.1 ACFM advice applicable to 2002 and 2003

The advice from ICES for 2002 was as follows: ICES recommends a recovery plan that will ensure a safe and rapid recovery of SSB to a level in excess of 150 000 t. If a recovery plan is not implemented ICES recommends that fishing mortality on cod should be reduced to the lowest possible level in 2002. ICES has repeatedly stated that for various reasons, TACs alone are not effective in regulating fishing mortality.

The advice from ICES for 2003 was as follows: **Given the very low stock size, the recent poor recruitments, and continued high fishing mortality despite management efforts to promote stock recovery, ICES recommends a closure of all fisheries for cod as a targeted species or by-catch. In fisheries where cod comprises solely an incidental catch there should be stringent restrictions on the catch and discard rates of cod, with effective monitoring of compliance with those restrictions.**

These and other measures that may be implemented to promote stock recovery should be kept in place until there is clear evidence of the recovery of the stock to a size associated with a reasonable probability of good recruitment and there is evidence that productivity has improved. The current SSB is so far below historic stock sizes that both the biological dynamics of the stock and the behavior of the fleets are unknown, and therefore historic experience and data are not considered a reliable basis for medium- term forecasts of stock dynamics under various rebuilding scenarios.

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

Blim = 70,000 t; **B**pa = 150,000t; **F**lim = 0.86; **F**pa = 0.65.

3.1.2 Management applicable in 2002 and 2003

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

	2002 Agreed TAC (000 t)	2003 Agreed TAC (000 t)
IIIa (Skagerrak)	7.1	3.9
IIa + IV	49.3	27.3

There is no TAC for cod set for Division VIId alone. Landings from Division VIId count against the overall TAC agreed for ICES Divisions VII b-k. The agreed TACs for 2002 and 2003 implied reduction in *status quo* fishing mortality of about 50% for 2002 and 65% in 2003.

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

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

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

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

4. *In order to reduce discarding and to enhance the spawning biomass of cod, the Parties agreed that the exploitation pattern shall, while recalling that other demersal species are harvested in these fisheries, be improved in the light of new scientific advice from, inter alia, ICES.*

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

This agreement has been re-established annually since 1999.

EU technical regulations in force in 2002 and 2003 are contained in regulations Council Regulation (EC) 850/98 and its amendments. The regulation prescribes the minimum target species' composition for different mesh size ranges. In 2001, cod in the whole of NEAFC region 2 were a legitimate target species for towed gears with a minimum codend mesh size of 100 mm. As part of the cod recovery plan, the EU and Norway introduced additional technical measures from 1 January 2002. Details are given in Council regulation (EC) 2056/2001. The basic minimum mesh size for towed gears for cod from 2002 was 120 mm, although a transitional arrangement until 31 December 2002, vessels were allowed to exploit cod with 110 mm codends provided that the trawl is fitted with a 90 mm square mesh panel and the by catch composition of cod retained on board is not greater than 30% by weight of the total catch. From 1 January 2003, the basic minimum mesh size for towed gears for cod was 120 mm. In addition effort restrictions were introduced in 2003. The details are given in Annex XVII of Council Regulation (EC) 2341/2002 and amended in Council Regulation (EC) 671/2003. The minimum mesh size for vessels targeting cod in Norwegian waters is also 120 mm.

Cod form a by-catch in towed-gear fisheries using codend mesh sizes less than 120 mm, and fisheries using other gears.

The emergency measure (Council Regulation (EC) 259/2001) involving the closure of a large area of the North Sea from 14 February to 30 April 2001 to all fishing vessels using gears likely to catch cod, was not extended in 2002 or 2003.

The minimum landing size (mls) for cod in Sub-area IV and Divisions IIIa and VIId is 35 cm, although for Danish vessels the mls is 40 cm.

3.1.3 The fishery in 2002

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. The Working Group estimate for landings from the three areas combined in 2002 is 54.4 thousand t., split as follows for the separate areas.

	2002 Landings 000 t)
IIIa(Skagerrak)	7.5
IV	43.9
VIId	3.1
Total	54.4

Minor revisions for 2000 and 2001 were also reported for landings from some countries.

WG estimates of landings indicate that the TACs for Subarea IV and Division IIIa were not taken in 2002. This is in keeping with previous years. The working group estimate of landings from Division VIId is about double the officially reported landings.

The WG suspects that under-reporting of landings may have been significant in 1998 because of the abundance in the population of the relatively strong 1996 year-class as 2-year-olds. The landed weight and input numbers at age data for 1998 were adjusted to include an estimated 3000 t of under-reported catch. The 1998 catch estimates remain unchanged in the present assessment.

For 1999 and 2000, the WG has no a priori reason to suspect that there was significant under-reporting of landings. However, the reduction in fishing effort implied by the 2001 and 2002 TACs (>50%) may have resulted in an increase in unreported catch in those years. Anecdotal information from the fisheries in some countries, also indicates that this may indeed have been the case, but the extent of the alleged under-reporting of catch varies considerably. Since the WG has no basis to judge the overall extent of under-reported catch, the WG has no alternative than to use its best estimates of landings from market sampling, which in general are in line with the officially reported landings.

The spatial distribution of reported international landings for 2000-2002 are shown in Figure 2.1.3. These represent about 90% of the reported landings for these years and do not include Norwegian or Belgian landings since these are not reported by statistical rectangle. The landings in 2000 to 2002 generally coincide with the areas of highest density of cod aged 2 and older seen in the IBTS Q1 survey (Figure 3.1.1). This is especially apparent for the northern North Sea. However, a significant proportion of the landings in 2000-2002 were reported from the Southern Bight, the eastern central North Sea and entrance to the Skagerrak, where observed IBTS densities of cod aged 2 and older were relatively low. This may be a reflection of the large amount of effort deployed in areas of low cod density.

Estimates of the proportion of cod discarded by age group for the period 1994-2002 from observations aboard English vessels in the North sea are given in Table 3.1.2. International discard estimates for the period 1997-2001 are given in the 2002 report of the SGDBI (www.ices.dk - reports/ACFM/2002/SGDBI/datafiles/ northseaandskagerrak).

The by-catch of cod from the Danish and Norwegian industrial fisheries that was sent for reduction to fishmeal and oil in 2002 was 50 tonnes (Table 1.7.1). An additional 104 t of cod from the Danish Industrial catch was landed for human consumption and was declared against the cod quota for Denmark. The working group had no information on any by-catch of cod in the Norwegian industrial catch that was landed for human consumption.

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

Values for natural mortality and maturity are given in Table 3.2.1, they are applied to all years and are unchanged from those used in recent assessments. The natural mortality values are model estimates from a multi-species VPA fitted by the Multi-species Working Group in 1986. The maturity values were estimated using the International Bottom trawl Survey series 1981-1985. These values were derived for the North Sea and are equally applied to the three stock components. The WG notes that although natural mortality is treated as constant in the assessment, the results of multi-species VPA indicate that this is probably not the case.

Landings in numbers at age for age groups 1-11+ and 1963-2002 are given in Table 3.2.2. SOP corrections have been applied. These data form the basis for the catch at age analysis but do not include industrial fishery by-catches landed for reduction purposes, or discards. By-catch estimates are available for the total Danish and Norwegian small-meshed fishery in Sub-area IV (Table 2.1.3) and separately for the Skagerrak (Table 3.1.1.), but as in previous years, these data were not included in the assessment.

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

Age compositions were provided by Denmark, England, France, 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 3.2.2. Figure 3.2.2 indicates that there have been short-term trends in mean weight at age and that the decline over the recent decade on age groups 3-5 now seems to have stabilised. The data also indicate a slight downward trend in mean weight for age groups 3-6 over time . Age groups 1 and 2 have a slightly increasing long-term trend in mean weight at age in the landings.

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. Note that reporting of effort is not a mandatory field on the EU logbook, and therefore the Working Group considers that the data are not representative of the actual deployed fishing effort. The Report of the 2001 meeting of this WG (ICES CM 2002/ACFM:01), and the ICES advice for 2002 (ICES Co-op. Res. Rep 2001/246) provides arguments for the exclusion of commercial CPUE tuning series from XSA. Such arguments remain valid. Hence in the present assessment using XSA, only survey data have been considered for tuning. Three survey series are used. The English Groundfish Survey (EGFS_Q3) which covers the whole of the North sea in August-September each year to about 200m depth using a fixed station design of 75 standard tows. The survey was conducted using the Granton trawl from 1977-1991 and with the GOV trawl from 1992-2003. The Scottish Groundfish survey (SCOGFS_Q3) is undertaken during August each year using a fixed station design with the GOV trawl. Coverage is restricted to the northern part of the North sea. The International quarter 1 Bottom trawl survey (IBTS Q1), covers the whole of the North Sea using fixed stations of at least two tows per rectangle with the GOV trawl. Trends in survey CPUE at age are given in Figures 3.3.1a-3.3.1c. The data files used for tuning XSA are given in Table 3.3.1. Table 3.3.1 also includes a time series for the IBTS Q3 survey from 1991-2003, although this was not used for tuning XSA because data from the Scottish and English Q3 surveys contribute to this index.

3.4 Exploratory analyses

As part of the benchmark review process a series of analyses have been used to examine each of the sources of information available for the assessment of the North Sea cod stock. Within the following sections, the recorded landings data and survey series are screened for sampling errors; the time series of surveys are examined for correlation between series and used independently of the catch data as indices of the stock dynamics; and finally two catch at age models are fitted to the catch and survey series in order to derive time series of stock and exploitation rate metrics. The review process was used to guide the Working Group in its conclusions with regard to the current state of the stock and its projected dynamics.

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

In a preliminary screening analysis, before the introduction to the assessment process of noise resulting from model fits to tuning series, a Separable VPA model was used to examine the structure of the catch numbers at age data. The model constraints applied when fitting the model were F3(2002) = 1.0 and S(10) = 0.85.

Table 3.4.1 presents the log catch ratio residuals from the fitted Separable VPA, the estimated selection at age and overall fishing mortality effects. Figure 3.4.1 illustrates the average selection pattern estimated for the last 6 years, Figure 3.4.2 the fitted year effects and Figure 3.4.3 the time series of log catch ratio residuals.

It is apparent from the time series of residuals (Table 3.4.1, Figure 3.4.3) that the selection pattern has changed with time. Selection (relative fishing mortality) at the youngest ages increased during the 1960's, following the increases in recruitment that occurred at that time. In recent years selection has declined. This could result from the introduction of larger mesh sizes in the early 1990's or the reduced contribution of younger fish as recruitment to the stock has declined.

The average selection pattern estimated from the last six years of data has full selection at age 3 and is flat topped at older ages. Fishing mortality is estimated to have increased during the 1960's and 1970's and remained relatively constant since then.

The residuals in the most recent years indicate no strong patterns or large values. This indicates that the age structure of the recorded landings has been relatively consistent in recent years and that the landings data are not subject to large random or process errors that would lead to concerns as to the way in which the recorded catch has been processed.

3.4.2 The assessment age range

In previous assessments of this stock an 11+ group has been fitted to the data series. The age range is greater than that for which survey calibration data is available (1-6) and therefore shrinkage to the mean F has a strong influence on the population estimates at the oldest ages. In recent years restrictive management controls have been applied in an attempt to reduce mortality rates on the stock. An assessment that has a large contribution from shrinkage could be biased towards higher fishing mortality rates.

Consistent survey data are available for ages 1 – 6. Few fish are recorded in the reported catch at ages greater than age 7. Therefore a series of the exploratory XSA analyses were carried out using a 7 plus age range. The use of the new plus group reduced the contribution of shrinkage to the estimates in the terminal year to an average value of less than 10% (see text table below). The new age range was accepted and used in all subsequent analyses.

Age	Shrinkage c.v. 0.5 Max age 11+	Shrinkage c.v. 0.5 Max age 11+	Shrinkage c.v. 1.0 Max age 7+
1	15.3	4.2	4.2

2	9.4	2.4	2.4
3	10.3	2.6	2.5
4	21.5	5.5	5.4
5	32.3	10.7	10.6
6	43.1	12.6	8.8
7	81.8	42.9	
8	83.8	52.1	
9	94.6	80.8	
10	97.1	87.5	

The choice of a new age range for the assessment requires a revision to the reference ages used for calculating average fishing mortality, previously ages 2 - 8. In recent years, average fishing mortality at ages 2 – 4 has been used to highlight exploitation rates on the juvenile ages. The age range currently represents ages that are predominant in the landings and was therefore, adopted as the new benchmark for measuring fishing mortality.

English groundfish survey indices

Examination of the EGFS Q3 time series Figure 3.4.4 indicates that there was a step change in Z on age 1 coincident with a change from the Granton to the GOV trawl in 1992. This is despite including a correction factor to convert GOV catch rates to Granton trawl equivalents (Granton cpue = GOV cpue/1.52). This was interpreted as a change in catchability of age 1 with the change of gear. The working group decided it would therefore be appropriate to split the series into two for tuning purposes. The new tuning series are now expressed in their original units (No/100h).

3.4.3 Cod in Subarea IV survey concurrence

Pairwise bivariate scatterplots of survey indices were plotted by age for each survey used in the assessment. The R-squared goodness-of-fit statistic was calculated for each plot, and a linear regression model fitted. The regression lines are plotted with their associated 95% confidence bands. This provides a method of quantitatively assessing the correlation between surveys over a common time period. The following can be gathered from Figure 3.4.5. The English and Scottish groundfish surveys are strongly correlated at ages 1 to 3, with weaker correlation at ages 4 and 5. Age 6 shows no relationship between the surveys. Between the IBTS quarter 1 and Scottish groundfish surveys there is good agreement with significant correlation at ages 1 and 2, weaker association at age 3, and no relationship at ages 4 and 5 (although the 1982 point is highly influential in the lack of correlation). The English groundfish and IBTS quarter1 surveys are well correlated at ages 1, 2 and 3 and moderately correlated at ages 4 and 5 (the 2000 point in age 4 affecting the R-squared value). The three surveys used for the assessment are consistent and well correlated at ages 1, 2 and 3, the dominant ages in the catches, with progressively noisier concurrence at the older ages.

3.4.4 Survey index analysis

3.4.4.1 Survey recruitment

Recruitment indices from the different tuning series are compared in Figures 3.4.6 – 3.4.7. All the series are standardised to zero mean and unit standard deviation. The level of agreement between the different series is quite high, in particular at age 2, with the tuning series picking up the same pattern of yearclass strengths.

3.4.4.2 VPA SSB, survey SSB and immature stock biomass

A spawning stock biomass index was calculated from each of the tuning fleets using the stock weights at age and maturity ogives presented in Table 3.2.1. Each index series and the XSA series of SSB estimates was standardised to zero mean and unit standard deviation. The results are shown in Figure 3.4.8. There are some discrepancies between the survey-based estimates and the VPA. A similar plot was made for the immature part of the stock (Figure 3.4.9). In this figure it seems that the relatively strong 1996 yearclass disappeared more rapidly from the catches than in the surveys indicating an increased under reporting or discarding of this yearclass.

3.4.4.3 Survey based stock and recruitment plots.

Using the standardised survey SSB's and recruitment indices described above, a series of stock and recruit plots were made (Figure 3.4.10). A cubic spline smoother indicates the trend in recruitment relative to SSB indices. The range of

SSB levels is rather narrow and is low compared to historic levels. The trends provide a catch data independent indication that recruitment is declining at lower stock sizes.

3.4.4.4 Survey Z

The log ratios of surveys indices (called survey Z's) was calculated as:

$Z_{a,y} = Log\left(\frac{I_{a-1,y-1}}{I_{a,y}}\right)$ where $I_{a,y}$ is the survey index of age group *a* in year *y*. Since survey Z's could give some indication of trends in the total mortality it was thought useful to calculate mean Z's over several age groups. And since low abundance indices are estimated with higher uncertainty these observations were given a lower weight than the more abundant. The weighting factor was calculated as:

$w_{a,y} = e^{\left(\frac{Log(I_{a-1,y-1})+Log(I_{a,y})}{2}\right)}$ and the average Z at age was calculated as $\overline{Z_a} = \frac{\sum_{y=y1}^{y2} Z_{a,y} \cdot w_{a,y}}{\sum_{y=y1}^{y2} w_{a,y}}$. Average Z at age was subtracted from each $Z_{a,y}$ before averaging over several age groups. This subtraction (standardising) made it easier to compare trends between different surveys. The average Z over the age groups 2 to 5 was calculated using tuning data from the period 1982 to 2003 and the results are shown in Figure 3.4.11. Overall the impression is of an increase in survey Z's over the time period reaching a peak in 2000 followed by a subsequent decline until 2002 with Z's at the same level as in the beginning of the time period. Most of the surveys are conducted in the second half of the year and Z's labelled 2003 represent log ratios between indices from 2003 and 2002. The 2003 observations suggest an increase in overall mortality compared to 2002.

3.4.5 Surba analyses

Surba (see section 1.4) was used as a supplementary analysis tool to explore trends in survey index inferred SSB. Surba is a survey only method that fits survey indices assuming a separable F selection pattern. Prior input of survey index to relative abundance ratios (catchability) is required for each age. Estimation of these parameters was based on exploratory runs, bounded by prior knowledge of likely survey catchability performance for each age. The absolute level and trends in estimated mean F for cod were poorly determined and could not be interpreted.. However, Surba does provide an index of trends in relative SSB. Summary plots are presented in Figures 3.4.12 – 3.4.14 and survey index to relative abundance ratio, q, for each survey fitted (ScoGFS, EngGFS and IBTS Q1) are shown in Table 3.4.2. All three surveys show a declining stock from 1997 with stable SSB in the most recent years.

Table 3.4.2 **Cod in Subarea IV.** User defined survey index to relative abundance ratio, q, for each survey, as used in Surba analysis. $N_{a,y}^{relative} = q_a * I_{a,y}$

	1	2	3	4	5	6	7	8
EngGFS	1.0	1.0	1.0	1.0	1.0			
ScoGFS	0.5	1.0	1.0	1.0	1.0	1.0	1.0	1.0
IBTS Q1	0.5	0.95	1.1	0.9	1.0			

3.4.6 A Laurec – Shepherd based analysis of the North Sea cod tuning data.

The Laurec – Shepherd VPA calibration model was used to screen the survey calibration data. The model makes the assumption that the selection pattern at the oldest ages is constant, a constraint used to reduce the number of estimated parameters.

Figures 3.4.15a – 3.4.15c present the time series of the log catchability residuals from single fleet Laurec – Shepherd tuning models fitted to the English, Scottish and IBTS quarter 1 groundfish surveys. The figures reveal that for some survey ages, catchability is not constant in time, it has been increasing. The increase is more pronounced at ages 1 – 3 of the Scottish ground fish survey and ages 1 and 2 of the IBTS survey. The trend previously observed in the English groundfish catchability has been removed by splitting the time series.

Catchability is derived as the ratio of the survey catch at age to the population calculated from a VPA transformation of the catch data. Reduced levels of catch at age result in low population sizes and positive catchability residuals. Therefore rather than errors or bias in the survey CPUE, the trends could result from bias in the VPA populations induced by mis-reporting, changes in discard practices and or the level of natural mortality. An alternative hypothesis, used previously for this assessment, is that survey catchability is changing with population abundance, a model that has been used previously for this stock and fitted within XSA.

Apart from the trends in the residuals there are no strong outliers that would give rise to concern as to the quality of the tuning series. The series were therefore accepted as being suitable for inclusion in an XSA and TSA analysis of the stock.

3.4.7 Time Series Analysis (TSA)

TSA analyses were carried out using the 'constant cv' version of TSA (see section 1.4). Due to time constraints, last year's TSA settings and input data (updated where possible) were used (Table 3.4.3). Therefore, the combined EngGFS survey data (1977-2002) were used rather than the shortened time series containing data from 1992-2003 only. The only change to the model formulation used last year was that potential outliers in the catch and survey data were not down-weighted.

The base case run consisted of a standard assessment for this year, using catch data from 1963-2002, ScoGFS (1983-2003), EngGFS (1977-2002) and IBTS Q1 (1983-2003). Parameter estimates are given in Table 3.4.4. The predicted catch, mean F (2-4), SSB and recruitment trends for this run (Figure 3.4.16) show similar trajectories to those estimated by XSA. There is a strong increase in mean F from 1997-2000 followed by a decline in recent years. The decrease in recent years is less than the XSA trend. SSB has decreased with only occasional recoveries since the early 1970's. It reached its lowest level in 2000 and has remained at that level subsequently.

Time series analysis has been used previously by this working group in an attempt to estimate the magnitude of missing catch data during the recent period when TAC have been severely reduced. The analysis was repeated by specifying two further TSA models, each with settings and survey indices given in Table 3.4.3, but using reduced time series of catch data from 1963-2000 and from 1963-1995. Thus, in total three scenarios were compared:

- Fitting to the complete catch data time series 1963-2002
- Fitting the model to the catch data from 1963-2000 only
- Fitting the model to the catch data from 1963-1995 only

A comparison of the predicted catch, mean F (2-4), SSB and recruitment time series from these scenarios is presented in Figure 3.4.17. TSA matches the catch data very closely where they are available. Where catch data are missing, TSA predicts larger catches than were actually recorded. This results in higher predicted mean F and SSB in later years than predicted by the TSA analysis including all catch data.

In order to test the predictive ability of the TSA model a retrospective analysis was carried out (Figures 3.4.18 and 3.4.19). This involved stepping back 8 consecutive years in time and fitting the model with two years of missing catch data with surveys extending three years beyond the last year of catch data. In each retrospective model fit, the missing catches are overestimated, usually resulting in overestimation of mean F and underestimation of SSB compared to predictions from models which included the missing catch data.

If the retrospective plots for earlier years had accurately predicted the missing catch, whilst those for later years predicted higher catches than those recorded, then this would suggest the possibility of catches that have not been accounted for in the reported catch for more recent years. However, here we have consistent positive bias in the retrospective plots. This could either be a result of unaccounted-for catch throughout the time series over which the trials were run, or an effect of the smoothing inherent in TSA. The analyses presented here are not sufficient to identify the true cause of the retrospective pattern.

3.4.8 Extended Survivors Analysis (XSA)

As a consequence of the change to the plus group age and the shortening of the English groundfish survey tuning series to the period for which GOV data are available, the XSA model structure was re-examined in a series of exploratory runs. The fitted model diagnostics were used to examine the use of the power model at the youngest ages, the q plateau constraint, the range of ages and years used for shrinkage. Retrospective analysis was used to determine an appropriate value for the weight given to shrinkage.

The tapered time weighting used to down weight historic values of catchability in previous years model fits was retained. No new information, apart from the change to the survey gear used for the English groundfish survey, was available in order to modify the time series weightings.

Exploratory fits of XSA to the survey series were used to determine the catchability models to be applied at each age. The XSA regression diagnostics and catchability values were examined in order to determine the most appropriate catchability model structure for the catch at age analysis. It was established that the settings used for the previous XSA fits to the data for this stock are still appropriate, a power model was applied at ages 1 - 3, because significant slopes were found for the majority of surveys at those ages. Catchability was held constant at the older ages at the values estimated at age 5 because the catchability estimates for the surveys were basically constant from age 5 onwards (Table 3.4.5).

Shrinkage to the mean fishing mortality was calculated over the penultimate 5 years of the assessment and across ages 3 - 5 as a result of the flat topped exploitation pattern at those ages. Retrospective analysis was used to examine the influence of the weight used with shrinkage. Shrinkage weights of 0.5, 1.0 and 1.5 were tested. Figure 3.4.20 presents the retrospective plots for SSB, average fishing mortality at ages 2 - 4 and recruitment. At shrinkage levels of 1.5 the retrospective pattern begins to deteriorate, at 0.5 shrinkage has a strong influence on the estimates of population abundance at the oldest ages (diagnostic output in ICES files). This is not appropriate as management actions are attempting to reduce fishing mortality on this stock. Given these considerations a shrinkage value of 1.0 was selected.

The XSA model structure is listed below with the settings used previously by this group.

Year of assessment	2002	2003
Assessment model	XSA	XSA
Age range	1 - 11+	1 - 7+
SGF Survey	1982 - 2001 1 - 6	1982 - 2002 1 - 6
EGF Survey	1977 - 2001 1 - 5	1992 - 2002 1 - 5
IBTS Q1 Survey	1976 - 2001 1 - 5	1984 - 2002 1 - 5
Time series taper	tri-cubic	tri-cubic
Range	20	20
Power model ages	1 - 3	1 - 3
Catchability plateau	5	5
F shrinkage ages	5	3
Year	5	5
s.e	0.5	1.0
Min s.e	0.3	0.3

The diagnostics from the XSA run are given in Table 3.4.5 and plots of the log-catchability residuals for each fleet from this run are given in Figure 3.4.21. Figure 3.4.22 presents the estimates of spawning stock biomass and average fishing mortality as estimated by single fleet runs of XSA with low (s.e. = 2.0) shrinkage weight. The estimates are consistent between series illustrating the agreement discussed previously in the survey analysis sections 3.4.3 – 3.4.5.

The estimates of fishing mortality rates and population numbers resulting from the tuning procedure and XSA are given in Tables 3.4.6 and 3.4.7 and are summarised in Table 3.4.8. The historic stock and exploitation indices are plotted in Figure 3.4.23 The mean F(2-4) for 2002 is estimated to be 0.61 and the estimate for 2000 has been revised downwards from F = 0.81 to F = 0.75. SSB in 2002 is now estimated to be 39 000 t (Table 3.4.8), compared to 38 000 t predicted from the 2002 assessment. Figure 3.4.24 compares the stock summary time series with the time series estimated in 2002.

There is good agreement between the estimated time series the trends in which are largely unaffected by the change to the new assessment age range.

3.4.9 The sensitivity of the North Sea cod XSA assessment estimates to discards

The data sets used for the North Sea cod stock assessment do not contain information on historic discards and this has raised concerns as to the reliability / quality of the estimated population trends and consequent advice to managers. Darby (WD11) used the results from a recent European Commision (EC Project 98/07) supported discard study to examine the sensitivity of North Sea cod assessment estimates to discarding.

Discarding, as measured within the EU study is predominantly small juvenile North Sea cod and as such they make up the first ages of the assessment age range. The dominant effect of the inclusion of discards in the cod assessment is to increase the level of recruitment and in mortality at age 1. Unfortunately the number of years for which discard data were collected in the study is short (four years) and therefore raising historic catch data time series is complicated by historic changes in mesh and minimum landing size.

At the EU meeting of experts that took place in May 2003 (EC 2003), comparisons were made between the discard ogives recorded in the EU study with those from the Scottish sampling program. The discard ogives were very similar for the available range of overlapping years. In a continuation of the study, Scottish discard observations for the years 1978 – 2002 have been used to raise the complete time series of North Sea cod catch at age data and the effect on the assessment time series of estimates examined. The raising process makes the gross assumption that the Scottish observations of discards from, predominantly, trawl gear can be applied to all gear types used by the fleets fishing in the North Sea.

Table 3.4.9 presents the discard estimates at age used in the assessment time series. Table 3.4.10 presents the proportions discarded at age which are also plotted in Figure 3.4.25 The table of proportions discarded illustrates large variations in the rate of discards between years with a very wide variation in discard proportions. There appears to be a change in the pattern of mis-reporting prior to the period over which the discard data were collected, a shift in the level of discarding at age 1. The pattern would need to be examined before discard data can be included in the assessment regularly and therefore the data can currently only be used for sensitivity analysis of estimates derived from catch at age analysis.

The XSA model fitted to the landings at age data was reapplied to the discard corrected catch data. The fit of the model improved at the youngest ages. The standard errors of the regressions used to estimate catchability parameters were reduced and correlation coefficients increased. Figure 3.4.26 presents the time series of XSA derived assessment estimates of the stock, exploitation trends and the stock and recruitment plot.

The largest change in the assessment estimates when discards were included was to the abundance of the youngest ages. Historic year class strength was estimated to be considerably higher especially during the “gadoid outburst”. There was no major change in the structure of the time series only in the level of the recruitment.

The time series of spawning stock biomass which comprises ages that were unaffected by discarding was unchanged. Since SSB levels and the configuration of recruitment are unchanged by the inclusion of discards, SSB reference points will also be unaffected by the inclusion of discards. Due to the increase in the level of recruitment, estimates of fishing mortality limit reference points will increase marginally.

Fishing mortality is increased as the catch data are increased to include landings, but the trends in the rate of exploitation are unchanged.

There appears to be considerable noise in the estimated discarding rates; this may require smoothing. In addition, further work in developing the data series by use of discard ogives for as many gear types as possible is required before the discards series can be used for a full assessment.

This exercise has shown that the estimates of the historic stock dynamics, the perception that levels of mortality are high and that the stock is low compared to management reference points are robust to the absence of discards in the landings data.

3.4.10 The sensitivity of the North Sea cod XSA assessment estimates to multi-species natural mortality rates

The natural mortality values used for the assessment of the North Sea cod were estimated within runs of the Multi-species assessment model. New estimates were made available to the working group following the meeting of the multi-species study group at which an updated key run of the model was carried out (ICES CM 2003/D:09). The sensitivity of the North Sea cod assessment estimates was examined by replacing the current, constant in time, natural mortality rates with those from the multi-species key run.

Table 3.4.11 presents the multi-species mortality estimates. Figure 3.4.27 presents the results from fitting the XSA model key run for the North Sea cod to the catch at age and tuning data using the MSVPA natural mortality estimates.

The model diagnostics revealed an improvement in the fitted regressions at the younger ages. At the older ages the standard error of the model estimates of catchability increased. Cod natural mortality estimates at the older ages have recently shown an increasing trend resulting from seal predation. The reduced correlation between the XSA population numbers and the survey series would suggest that the estimated increase in mortality is inconsistent with the survey data and may be an area for further investigation of the MSVPA mortality rates.

The results of the assessment (Figure 3.4.27) show that the greatest sensitivity in the model results is in the estimated recruitment values. They are increased during the early period of the time series when the stock was more abundant and predation rates higher. Spawning stock biomass is relatively unaffected by the change to multi-species natural mortality rates. Higher rates of natural mortality at the younger ages result in higher total stock sizes and a reduction in the level of fishing mortality. The trends remain unchanged.

Since SSB levels and the configuration of recruitment are unchanged by the inclusion of multi-species natural mortality, SSB reference points will also be unaffected by the inclusion of multi-species natural mortalities. Due to the increase in the level of recruitment, estimates of fishing mortality limit reference points may increase.

This exercise has shown that the estimates of the historic stock dynamics, the perception that levels of fishing mortality are high and that the stock is low compared to management reference points are robust to the absence of variable multi-species mortality in the assessment model.

3.4.11 The sensitivity of the North Sea cod XSA assessment estimates to multi-species natural mortality rates and discards

A run of the XSA model was made with both the muli-species natural mortalities and the inclusion of discards. The assessment results are plotted in Figure 3.4.28 As with the model fits examining the effect of changes to the assessment inputs in isolation, the effect on the XSA estimates is relatively minor. SSB is increased but does not change its downward trend or the relative low level that it is estimated to have reached. The increase in fishing mortality resulting from the inclusion of discards is cancelled by the reduction resulting from the multi-species natural mortality. There is therefore no change in the perception of high fishing mortality rates. Recruitment is increased throughout the time series especially during the years when stock size and therefore predation rates were high.

As with the results of the single effect sensitivity runs, SSB and exploitation trends are robust to the inclusion of the increased rates of mortality resulting from multi-species effects and discarding.

3.4.12 Conclusions drawn from the exploratory analysis

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

The absolute level of SSB estimated for recent years cannot be determined from the catch at age analysis due to uncertainties in the level of recorded landings. Historically there was less incentive to under report the catch and therefore the historic levels of biomass and their trends are considered to be more representative of the stock abundance at that time. Consequently, the historic estimate of SSB at which recruitment is impaired is considered to be unbiased by recent uncertainty in catches.

Survey indices are in agreement in indicating that the stock has declined to the lowest level in the recorded time series. There are some indications from the recent indices that the decline has been stabilised with some indices indicating a small increase in 2003. This is in agreement with a fishing industry perception of the state of the stock submitted to the working group (WD 14). However, the survey indices also point to another low recruitment (2002 year class) that is about to enter the stock and unless exploitation levels are reduced the stock will decline further.

The results of the catch at age analyses indicate that fishing mortality rates have been too high to maintain a spawning stock biomass above current Precautionary Approach reference levels. Analyses that are independent of the changes in recorded landings from year to year support this conclusion (within year catch curve analysis and survey-only estimates of mortality rates).

For many years recorded landings have followed the TAC, which in 2001 and 2002 implied sever reductions in fishing mortality. Based on the reported landings the catch at age models indicate that the fishing mortality rate has declined. While the working group agrees that recent decommissioning and reductions in the TAC may have reduced exploitation rates, there are frequent anecdotal reports from the fishing industry that the recent reductions in TAC have not been observed. Therefore the working group considers that fishing mortality has **not** been reduced to the extent estimated by the models that rely on recorded catch at age data.

The reduction in survey estimated mortality is less marked and the working group considers that missing catches are biasing the catch at age analysis towards underestimates of mortality.

The catch at age analysis models have a retrospective bias in underestimating F. The retrospective bias is derived from conflicting signals in the survey catch rates and the populations estimated from the recorded catch at age data. The magnitude of any missing catch will influence the degree of bias in the terminal estimates. Hence if TACs are severely restrictive and fishing mortality rates remain constant from one year to the next, F will be underestimated and SSB overestimated in the terminal year. Therefore the F in 2002 is likely to be revised upwards in future years.

Given the uncertainties introduced to the catch at age analyses by under-reporting of the catch, the working group concluded that the catch at age analyses can only be used to indicate the current dynamics of the stock trajectory and not absolute levels of spawning stock biomass or recent exploitation rates.

For the purposes of monitoring the stock the working group recommends a greater reliance on the fishery independent survey indices which are considered to be unbiased.

With regard to the caveats listed above the Working Group presents the results of the XSA model fit only for the purpose of illustrating the dynamic history of the North Sea cod stock. The model results should not be used to provide deterministic catch forecasts for management and should only be used for scenario analysis.

3.5 Historic Stock Trends

The Working Group presents the results of the XSA model fit only for the purpose of illustrating the trends in the North Sea cod stock dynamics.

Historic trends in mean fishing mortality, landings, spawning stock biomass, and recruitment are shown in Table 3.4.8 and Figure 3.4.23

Mean fishing mortality (F2-4) has shown a more or less continuous increase over the whole period up to the early 80’s and remained at a high level ($F \approx 0.9$) throughout the 1990s. The catch at age analyses indicate a sharp increase in F over 1997 to 2000 from about F=0.9 to F=1.2. F is currently estimated to be declining however the rate of decline is uncertain.

Spawning biomass decreased from a peak of 255,000 t in 1971 to a historical low in 2001. In 2002 SSB is estimated to have shown a small increase. However, the absolute level of recent SSB is uncertain due to uncertainties in the reported catch. Recent catch at age analyses of this stock have shown a tendency to over estimate SSB. SSB has remained below $\mathbf{B}_{pa}$ (150,000t) since 1983 and below 100,000 t since the late 1980s. SSB has been below $\mathbf{B}_{lim}$ for four consecutive years.

Recruitment has fluctuated considerably since 1963 and the frequency of poor year classes has increased since 1985. The 1996 year class is still estimated as the largest since the1985 year-class, but the 1997 and subsequent year classes at age 1 have been poor.

Historically, recorded 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, recorded landings have declined in line with TAC reductions to an historical low in 2000 and 2001.

3.6 Recruitment

Three of the last five year classes recruiting to the stock have been the lowest on record (Figure 3.4.23). The 2002 year class indices from all of the survey series (Table 3.6.1) indicate that the incoming year class will be as low as the lowest values in the recent time series. The survey series indices are well correlated with the later recruitment to the fishery.

Table 3.6.1 Recent survey recruitment indices for Cod in Subarea IV and Divisions IIIa and VIId.

Year class	1996	1997	1998	1999	2000	2001	2002
Eng GFS	6147	179	557	1448	264	1199	206
Sco GFS	999	104	440	700	69	274	119
IBTS	4000	270	210	660	280	750	63

3.7 Short-Term Forecast

No short-term forecast is presented in the report. For reasons discussed in Section 3.4 (Exploratory analyses) the Working Group considers that, as a direct result of the uncertainties introduced to the catch at age analysis by mis-reporting and discarding, the XSA results can only be used to examine the recent dynamics of the stock. **The estimates should not be used as a basis for deriving catch options for management.**

In order to illustrate the possible dynamics of the stock under management measures introduced in 2003 the working group ran deterministic projections for two years. The scenarios examined were:

Scenario 1 - An assumption that fishing mortality has been reduced to the levels estimated by the XSA model for 2002 and remains at that level for 2003 and 2004.

Scenario 2 - Constant fishing at the average level of fishing mortality recorded during 2000 – 2002 in 2003 and 2004. The average fishing mortality of recent years is lower than that of the high values observed in the late 1990's but higher than the estimate for 2002. The average allows for some effects of recent regulations and decommissioning to be taken into account in the projection, but not to the same extent as the reduction in fishing mortality estimated for the final year.

Scenario 3 - An assumption that the TAC for 2003 is observed and that the resulting fishing mortality remains at that level in 2004.

Scenario 4 - Fishing mortality is reduced from the value estimated last year by 65%, the working groups estimate of the intended effect of the "Days at sea" regulations.

Scenario 5 - Fishing at the average level of fishing mortality recorded during 2000 – 2002 in 2003 and 2004, with a reduction in mortality at ages 1 and 2 due to the change to 120mm mesh for trawlers in the North Sea. Because the effect of the change in mesh on discard proportions at age could not be predicted it was assumed that all discarding of 1 and 2 group cod was removed by the mesh change. An unlikely event but an assumption that allows the potential benefits of the mesh change to be explored.

The forecasts were calculated using the exploitation patterns described above. Weights at age were taken as the average over 2000 – 2002. Maturity and natural mortality as presented in Table 3.2.1. Recruitment in each year was calculated as the geometric mean of the most recent low year classes, 1997 – 2001.

Section 3.4.9 presents an analysis of the sensitivity of the catch at age analysis model results to the omission of discards. Including discards into the analysis increases recruitment levels. If recent management measures have had an effect on the rate of discarding and reduction in mortality of juveniles then it might be expected that the stock would exhibit faster rates of recovery. Therefore the projection scenarios 1 - 5 were also carried out using the estimates of population abundance and mortality estimated by the catch at age analysis including discards to examine the sensitivity of the projected stock dynamics to the omission.

The Working Group considers that, as a direct result of the uncertainties introduced to the catch at age analysis by mis-reporting and discarding, the projection results can only be used to examine the recent dynamics of the stock not absolute levels of stock abundance. Therefore only SSB trends are presented in terms of relative change from the level of the 2003 spawning stock biomass.

Simulation of the effect of the change to 120mm mesh resulted in an insignificant change to fishing mortality at age when the selection pattern is estimated without discards. Therefore the projections for this scenario are only included in the results of the projections that include discard mortalities. In addition, for the no-discard projections, a 65% reduction from the status quo level of fishing mortality (as estimated last year) resulted in a similar level of mortality to that estimated for 2002. Therefore in the no-discards analysis the results of scenario 1 are repeated in scenario 4.

The results of the stock projections are given in Table 3.7.1. The spawning stock biomass trends of the projections that include discards increase at a marginally faster rate than those without.

If compliance with the new mesh regulations is 100% the improved exploitation pattern has a beneficial effect and the SSB recovers faster. However, the improvement is not as great as the projections with reduced F. The projection examining the effects of mesh change will over-estimate the recovery rate of the stock because it was assumed that all discarding ceased. Taken in isolation the mesh changes will not provide a sufficient rate of recovery to rebuild the stock.

The projections with and without discards have the common result that fishing mortality on the stock has to be reduced substantially in order to rebuild the biomass. The greater the reduction in mortality the faster the rate of rebuilding. A strong reduction in fishing effort for a short time period will have a far greater effect than a lesser reduction over a longer time period. A stock and recruitment relationship has not been used in these projections, only the average of recent low recruitment. Therefore, the rates of recovery show the potential for growth of the remaining stock biomass.

Table 3.7.1 The percentage change in spawning stock biomass relative to the biomass in 2003 for a range of constant fishing mortality scenarios.

Without discards

Scenario		F factor	SSB2004	SSB2005
1	F2002	0.71	21%	40%
2	Fsq	1.00	-6%	-8%
3	FTAC	0.30	72%	172%
4	F65% 99 - 01	0.69	21%	40%

With discards

Scenario		F factor	SSB2004	SSB2005
1	F2002	0.71	28%	56%
2	Fsq	1.00	0%	0%
3	FTAC	0.30	90%	234%
4	F65% 99 - 01	0.76	24%	46%
5	Fsel	0.97	8%	18%

3.8 Medium-Term Projections

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

3.9 Biological Reference Points

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

Reference point:

Blim 70 000 t. **B**pa 150 000 t.
Flim: 0.86 **F**pa 0.65

Technical basis:

Blim Rounded **B**loss. The lowest observed spawning stock biomass.

Bpa The previously agreed MBAL and affords a high probability of maintaining

SSB above **B**lim, taking into account the uncertainty of assessments. Below

this value the probability of below average recruitment increases. Previous

MBAL and signs of impaired recruitment below: 150 000 t.

Flim **F**loss

Fpa Approx. 5th percentile of **F**loss

Changes to the range of ages used for the assessment of this stock resulting from the lack of reliable tuning information at the oldest ages necessitate a recalculation of the PA reference points for this stock. The PA soft program was therefore applied to the stock and exploitation estimates derived from the XSA model fit based on the fit to landings data only. The stock and recruit time series used for the estimation of reference points was 1963 – 2001, that is the 1962 – 2000 year classes. The final year of XSA estimates was removed from the estimation procedure.

The PAsoft diagnostic program was used to examine the appropriate settings for the span of the calculation for Gloss. There is a well-defined minimum value in the Akaike information index at a span of 0.8 (Figure 3.9.1) therefore this value was used in the estimation of the reference point.

Figure 3.9.2 and Table 3.9.1 present the PAsoft output from the reference point estimation procedure.

The revised assessment age range has not significantly altered the level or trend in the estimates of SSB and recruitment. Therefore the structure of the stock and recruitment data pairs is relatively unchanged. This implies that the position of the break point in the stock and recruitment plot is unchanged at about 150,000t. There remains a high probability of poor recruitment at SSB below this value. ACFM has previously recommended that this value should be used as **B**pa but this is currently under review.

Using the previously applied criteria for the selection of fishing mortality reference points (ACFM report 2002) **F**lim = **F**loss, the new value of **F**loss estimated for this stock is 0.91 based on the median of the bootstraped value derived from Gloss. This compares to the value of 0.86 based on the 1 – 11+ age range and Fbar(2-8) used previously by this working group. Using the previous ACFM formulation **F**pa is therefore taken from the 5th percentile of **F**loss and is estimated to be 0.72. This compares with the previous value of 0.65.

The working group notes that the Floss **estimate may be an over-estimate. The PAsoft diagnostic plots indicate that non-parametric smoother is over estimating the recent low recruitment near to the origin of the stock and**

recruitment relationship. Given that region around the origin of the stock and recruitment curve is currently being explored, and that there is a well defined curvature in the pairs of estimates, the working group consider that a parametric model estimate of the slope at the origin may be more robust to random variation in recent recruitment. This should be examined in detail before the Flim **and F**pa **values are revised.**

The results of long-term equilibrium yield and SSB-per-recruit analyses are given in Figure 3.9.2.

The estimates of biological reference points and management reference points for cod are given in the text tables below.

Biological reference point	2002 estimate	2003 Estimate
$\mathbf{F}_{max}$	0.25	0.3
$\mathbf{F}_{0.1}$	0.15	0.18
$\mathbf{F}_{med}$	0.82	0.78
$\mathbf{F}_{high}$	1.19	1.15
Management reference point		
$\mathbf{B}_{lim}$	70,000t	70,000 t
$\mathbf{B}_{pa}$	150,000t	150,000 t
$\mathbf{F}_{lim}$	0.86	0.91
$\mathbf{F}_{pa}$	0.65	0.72

3.10 State of the stock

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

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

Survey indices and results from models fitted to the commercial catch at age data indicate that the spawning stock biomass is at about 20-25% of the level it was in the 1980's. The survey data indicate that the relative decline in spawning biomass is less steep than the commercial catch data suggest. This difference in the estimated trends is considered to be the result of underestimated catch from the commercial fishery. The bias is considered to have been greater in recent years when restrictive TACs have not been accompanied by simultaneous and sufficiently restrictive measures to reduce fishing effort.

Recruitment of 1 year old cod has varied considerably since the 1960s but since 1997 average recruitment has been lower than any other time. Although reduced recruitment is indicated by the survey catch at age data, this may be exaggerated in the model estimates by underestimated commercial catch. There are no indications of a strong year-class of cod since 1996, a year class that was a prominent feature in all surveys and was heavily exploited by the fishery at ages 1-5. The incoming 2002 year class is estimated to be close to the lowest on record.

The comparison of the historic performance of the assessment for North Sea cod is shown in figure 3.10.1. The recent two assessments are very consistent.

3.11 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 exploitation pattern has remained the same since the early 1960s despite various changes to technical regulations (gear modifications and mesh size changes) aimed at improving it.

Cod is a specific target for some fleets, but the majority of cod in the North Sea are caught (landings and discards) in mixed demersal fisheries. This means it is important to take into account the impact of the management of cod on other stocks, especially haddock and whiting, although fishing opportunities for other commercially important stocks will also be affected. The reverse is also true. The linkage is explored elsewhere in Section 15.

Recent measures to protect North Sea cod, such as the 2001 closed area, and proposals to increase mesh size, will most likely have a greater beneficial effect to stocks other than cod. Any benefits for cod by such measures are likely to be through reduced discarding of fish below the minimum landing size. The effects of the 2001 closed area and recent recovery proposals are examined in Section 14.

It is considered that conclusions drawn from the trends in the historic stock dynamics and exploitation rates are robust to the uncertainty in the level of recent recorded catches. A sensitivity analysis has shown that the estimated historic stock trends are largely unaffected by the measured rate of discarding, or the inclusion of variable natural mortality rates from multi-species VPA.

3.11.1 The effect of decommissioning and trends in fishing effort on fishing mortality rates

During the 1990s and again in 2001-2002, successive rounds of decommissioning have resulted in the removal of physical capacity from the fleets of EU member states. This has partly been in response to achieving MAGP targets and also in response to financial incentives offered under the recovery plans for cod and hake.

In addition to decommissioning, effort has been removed from the fishery by boats targeting other species. Trends in reported fishing effort for some of the main fleets exploiting cod are given in section 2.1. However, it should be noted that reporting of effort is not a mandatory field on the EU logbook, and therefore the Working Group considers that the data are not a true representation of the actual deployed fishing effort.

While reported effort appears to have declined and physical capacity has been removed from national fleets, it is not known what effect, if any, this has had on fishing mortality. This is because under relative stability, the national quotas are reallocated to the remaining vessels. If those vessels are still able to catch their share of the quota, this will not result in any reduction in fishing mortality.

If the quota share of the decommissioned vessels was redistributed to the remaining vessels, and the remaining vessels are able to catch the TAC, the most likely effect of decommissioning would be a reduction in the amount of catch unaccounted for by discarding or under-reporting of landings. If discarding is reduced because there is a better match between the capacity of the fleets to catch cod and the available TAC, then a reduction in fishing mortality would be expected.

In 2001 and 2002, TAC reductions implied reductions in fishing mortality of greater than 50%. The WG did not have access to sufficient data to assess the potential reductions in deployed fishing effort over the recent period. However, decommissioning alone would not have resulted in the required reduction in fishing mortality and the reported effort does not show any stepwise change that would be sufficient to effect such large changes in fishing mortality.

Survey data also indicate a reduction in mortality over 2000-2002, however, the reduction does not appear as great as that suggested by the recorded catches.

Table 3.1.1 COD in IIIa (Skagerrak), IV and VIId: Nominal landings (in tonnes) 1984–2002 as officially reported to ICES and as used by the Working Group

Sub-area IV										
Country	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
Belgium	5,804	4,815	6,604	6,693	5,508	3,398	2,934	2,331	3,356	3,374
Denmark	46,751	42,547	32,892	36,948	34,905	25,782	21,601	18,998	18,479	19,547
Faroe Islands	-	71	45	57	46	35	96	23	109	46
France	8,129	4,834	8,402	8,199	8,323	2,578	1,641	975	2,146	1,868
Germany	13,453	7,675	7,667	8,230	7,707	11,430	11,725	7,278	8,446	6,800
Netherlands	25,460	30,844	25,082	21,347	16,968	12,028	8,445	6,831	11,133	10,220
Norway	7,005	5,766	4,864	5,000	3,585	4,813	5,168	6,022	10,476	8,742
Poland	7	-	10	13	19	24	53	15	-	-
Sweden	575	748	839	688	367	501	620	784	823	646
UK (E/W/NI)	35,605	29,692	25,361	29,960	23,496	18,375	15,622	14,249	14,462	14,940
UK (Scotland)	54,359	60,931	45,748	49,671	41,382	31,480	31,120	29,060	28,677	28,197
United Kindom										
Total Nominal Catch	197,148	187,923	157,514	166,806	142,306	110,444	99,025	86,566	98,107	94,380
Unallocated landings	7,723	6,773	11,292	15,288	14,253	5,256	5,726	1,967	-758	10,200
WG estimate of total landings	**204,871**	**194,696**	**168,806**	**182,094**	**156,559**	**115,700**	**104,751**	**88,533**	**97,349**	**104,580**
Agreed TAC	**215,000**	**250,000**	**170,000**	**175,000**	**160,000**	**124,000**	**105,000**	**100,000**	**100,000**	**101,000**
	0.95	0.78	0.99	1.04	0.98	0.93	1.00	0.89	0.97	1.04

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

Division IIIa (Skagerrak)										
Country	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
Denmark	17,443	14,521	18,424	17,824	14,806	16,634	15,788	10,396	11,194	11,997
Sweden	1,981	1,914	1,505	1,924	1,648	1,902	1,694	1,579	2,436	2,574
Norway	311	193	174	152	392	256	143	72	270	75
Germany	-	-	-	-	-	12	110	12	-	-
Others	156	-	-	-	106	34	65	12	102	91
Norwegian coast *	1,187	990	917	838	769	888	846	854	923	909
Danish industrial by-catch *	1,084	1,751	997	491	1,103	428	687	953	1,360	511
Total Nominal Catch	19,891	16,628	20,103	19,900	16,952	18,838	17,800	12,071	14,002	14,737
Unallocated landings	0	0	0	0	0	-141	0	-12	0	0
WG estimate of total landings	**19,891**	**16,628**	**20,103**	**19,900**	**16,952**	**18,697**	**17,800**	**12,059**	**14,002**	**14,737**
Agreed TAC	**28,000**	**29,000**	**29,000**	**22,500**	**21,500**	**20,500**	**21,000**	**15,000**	**15,000**	**15,000**

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

* 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

Division IIIa (Skagerrak) landings not included in the assessment										
Country	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
Norwegian coast *								854.00	923.00	909.00
Danish industrial by-catch								953.00	1,360.00	511.00
Total				**1,807.00**	**2,283.00**	**1,420.00**				

Table 3.1.1(cont) COD in IIIa (Skagerrak), IV and VIId: Nominal landings (in tonnes) 1984–2002 as officially reported to ICES and as used by the Working Group

	1994	1995	1996	1997	1998	1999	2000	2001	2002
Sub-area IV									
Country									
Belgium	2,648	4,827	3,458	4,642	5,799	3,882	3,304	2,470	2,616
Denmark	19,243	24,067	23,573	21,870	23,002	19,697	14,000	8,358	9,022
Faroe Islands	80	219	44	40	102	96			
France	1,868	3,040	1,934	3,451	2,934	1,750	1,222	717	1,777
Germany	5,974	9,457	8,344	5,179	8,045	3,386	1,740	1,810	2,018
Netherlands	6,512	11,199	9,271	11,807	14,676	9,068	5,995	3,574	4,707
Norway	7,707	7,111	5,869	5,814	5,823	7,432	6,353	4,383	4,994
Poland	-	-	18	31	25	19	18	18	39
Sweden	630	709	617	832	540	625	640	661	463
UK (E/W/NI)	13,941	14,991	15,930	13,413	17,745	10,344	6,543	4,087	3,112
UK (Scotland)	28,854	35,848	35,349	32,344	35,633	23,017	21,009	15,640	15,416
United Kindom									
Total Nominal Catch	87,457	111,468	104,407	99,423	114,324	79,316	60,824	41,718	44,164
Unallocated landings	7,066	8,555	2,161	2,746	7,779	-924	-1,057	-745	-303
WG estimate of total landings	**94,523**	**120,023**	**106,568**	**102,169**	**122,103**	**78,392**	**59,767**	**40,973**	**43,861**
Agreed TAC	**102,000**	**120,000**	**130,000**	**115,000**	**140,000**	**132,400**	**81,000**	**48,600**	**49,300**
Division VIId									
Country	1994	1995	1996	1997	1998	1999	2000	2001	2002
Belgium	228	377	321	310	239	172	110	93	51
Denmark	9	-	-	-	-	-	-	-	-
France	2,338	3,261	2,808	6,387	7,788		3,084	1,677	1,341
Netherlands	-	-	+	-	19	3	4	17	6
UK (E/W/NI)	312	336	414	478	618	454	385	249	145
UK (Scotland)	+	+	4	3	1	-	-	-	-
United Kingdom									
Total Nominal Catch	2,887	3,974	3,547	7,178	8,665	629	3,583	2,036	1,543
Unallocated landings	-37	-10	-44	-135	-85	6,229	-1,258	-463	1,554
WG estimate of total landings	**2,850**	**3,964**	**3,503**	**7,043**	**8,580**	**6,858**	**2,325**	**1,573**	**3,097**
Division IIIa (Skagerrak)									
Country	1994	1995	1996	1997	1998	1999	2000	2001	2002
Denmark	11,953	8,948	13,573	12,164	12,340	8,734	7,683	5,901	5,524
Sweden	1,821	2,658	2,208	2,303	1608	1,909	1,350	2,333	1,716
Norway	60	169	265	348	303	345	301	757	643
Germany	301	200	203	81	16	54	9	32	83
Others	25	134	-	-	-	-	-	-	
Norwegian coast *	760	846	748	911	976	788	624	846 n/a	
Danish industrial by-catch *	666	749	676	205	97	62	99	687 n/a	
Total Nominal Catch	14160	12109	16249	14896	14267	11042	9343	9023	7966
Unallocated landings	-899	0	0	50	1,064	-68	-66	-1,937	-498
WG estimate of total landings	**13,261**	**12,109**	**16,249**	**14,946**	**15,331**	**10,974**	**9,277**	**7,086**	**7,468**
Agreed TAC	**15,500**	**20,000**	**23,000**	**16,100**	**20,000**	**19,000**	**11,600**	**7,000**	**7,100**
Sub-area IV, Divisions VIId and IIIa (Skagerrak) combined									
	1994	1995	1996	1997	1998	1999	2000	2001	2002
Total Nominal Catch	104,504	127,551	124,203	121,497	137,256	90,987	73,750	52,777	53,673
Unallocated landings	6,130	8,545	2,117	2,661	8,758	5,238	-2,381	-3,145	753
WG estimate of total landings	**110,634**	**136,096**	**126,320**	**124,158**	**146,014**	**96,225**	**71,369**	**49,632**	**54,426**

* 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

Division IIIa (Skagerrak) landings not included in the assessment									
Country	1994	1995	1996	1997	1998	1999	2000	2001	2002
Norwegian coast *	760.00	846.00	748.00	911.00	976.00	788.00	624.00	846.00	
Danish industrial by-catch	666.00	749.00	676.00	205.00	97.00	62.00	99.00	687.00	
Total	**1,426.00**	**1,595.00**	**1,424.00**	**1,116.00**	**1,073.00**	**850.00**	**723.00**	**1,533.00**	**0.00**

Table 3.1.2 Estimated proportions of cod discarded from observations aboard English vessels in the North Sea 1994-2002

		Year								
Quarter	Age	1994	1995	1996	1997	1998	1999	2000	2001	2002
	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	1	100.0	99.9	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1	2	25.1	30.1	9.2	42.4	48.6	67.1	15.1	50.9	43.9
	3	1.0	0.0	0.0	0.0	0.0	17.8	0.0	0.0	7.2
	4	0.0	0.0	0.0	0.0	0.0	4.9	0.0	0.0	0.0
	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	1	100.0	91.4	100.0	99.8	64.9	0.0	96.7	97.0	93.6
2	2	29.7	8.0	5.1	16.9	33.9	0.0	3.1	20.3	63.6
	3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.8
	4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0
	1	92.3	74.1	58.1	78.8	90.8	77.4	87.0	89.5	32.9
3	2	11.8	6.7	5.3	22.1	20.1	4.5	11.9	13.0	24.8
	3	0.0	0.0	0.0	0.0	0.0	1.4	0.0	0.0	0.0
	4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0	100.0	100.0	100.0	100.0	0.0	100.0	0.0	100.0	0.0
	1	39.7	35.6	72.8	68.3	55.0	75.9	63.8	56.9	60.7
4	2	0.0	0.0	0.0	14.4	1.2	0.0	17.2	3.5	37.3
	3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	18.9	0.0
	4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table 3.2.1 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId: Natural mortality and proportion mature by age-group.

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

Table 3.2.2 COD in IIIa (Skagerrak), IV and VIId: Landings numbers at age.

Run title : North Sea/Skaggerak/Eastern Channel 6/6/2002
At 12/09/2003 12:10

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

AGE\YEAR	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
1	3214	5030	15813	18224	10803	5829	2947	54493	44824	3832
2	42591	22493	51888	62516	70895	83836	22674	33917	155345	187686
3	7030	20113	17645	29845	32693	42586	31578	18488	17219	48126
4	3536	4308	9182	6184	11261	12392	13710	13339	6754	5682
5	2788	1918	2387	3379	3271	6076	4565	6297	7101	2726
6	1213	1818	950	1278	1974	1414	2895	1763	2700	3201
7	81	599	658	477	888	870	588	961	893	1680
8	492	118	298	370	355	309	422	209	458	612
9	13	94	51	126	138	151	147	186	228	390
10	6	12	75	56	40	111	46	98	77	113
+gp	0	4	8	83	17	24	78	40	94	18
TOTAL	60965	56505	98957	122538	132335	153600	79651	129791	235691	254064
TONSLAND	116457	126041	181036	221336	252977	288368	200760	226124	328098	353976
SOP%	100	100	100	100	100	100	100	100	100	100

AGE\YEAR	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
1	25966	15562	33378	5724	75413	29731	34837	62605	20279	66777
2	31755	58920	47143	100283	51118	175727	91697	104708	189007	65299
3	54931	11404	18944	18574	25621	17258	44653	35056	34821	60411
4	14072	15824	4663	6741	4615	9440	4035	12316	9019	9567
5	2206	4624	7563	1741	2294	3003	3395	1965	4118	3476
6	1109	961	2067	3071	836	1108	712	1273	785	2065
7	1060	438	449	924	1144	410	398	495	604	428
8	489	395	196	131	371	405	140	197	134	236
9	80	332	229	67	263	153	158	74	65	78
10	58	81	95	63	26	36	42	55	37	27
+gp	162	189	63	43	96	44	17	25	21	16
TOTAL	131888	108729	114791	137361	161797	237314	180085	218770	258889	208380
TONSLAND	239051	214279	205245	234169	209154	297022	269973	293644	335497	303251
SOP%	100	100	100	100	100	100	101	100	100	99

AGE\YEAR	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	25733	64751	8845	100239	24915	21480	22239	11738	13466	27668
2	129632	66428	118047	32437	128282	55330	36358	54290	23456	32059
3	21662	31276	18995	34109	9800	43955	18193	11906	16776	8682
4	11900	4264	7823	5814	8723	3134	9866	4339	3310	5007
5	2830	3436	1377	2993	1534	2557	1002	2468	1390	1060
6	1258	1019	1265	604	1075	655	1036	310	1053	491
7	595	437	373	556	235	295	251	310	225	329
8	181	244	173	171	215	66	140	54	139	52
9	90	60	79	69	55	63	27	60	28	40
10	28	45	16	44	48	23	31	12	4	17
+gp	23	20	31	23	12	18	10	9	10	9
TOTAL	193932	171978	157022	177058	174895	127577	89153	85496	59857	75415
TONSLAND	259287	228286	214629	204053	216212	184240	139936	125314	102478	114020
SOP%	100	100	100	101	100	100	100	99	100	99

AGE\YEAR	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
1	4783	15557	15717	4938	23769	1255	5941	8294	2217	7392
2	55272	25279	63586	36805	29194	81737	9731	23033	20804	7731
3	11360	21144	12943	23364	18646	16958	32224	6472	6192	13131
4	3190	3083	5301	3169	6499	5967	4034	6697	1141	2450
5	1577	870	802	1860	1238	2402	1445	1021	1078	357
6	435	519	286	399	700	509	626	385	144	345
7	204	142	151	162	153	236	223	139	84	51
8	108	58	42	88	47	41	91	40	27	31
9	18	32	15	43	14	16	14	18	14	13
10	10	7	13	4	15	4	10	5	6	4
+gp	13	16	5	8	10	12	2	1	1	1
TOTAL	76970	66706	98861	70837	80285	109137	54341	46105	31710	31506
TONSLAND	121749	110634	136096	126320	124158	146014	96225	71371	49632	54427
SOP%	99	99	98	100	100	100	100	100	100	100

Table 3.2.3 COD in IIIa (Skagerrak), IV and VIId: Landings weight at age

Run title : North Sea/Skaggerak/Eastern Channel 6/6/2002
At 12/09/2003 12:09

Table 2 Catch weights at age (kg)

AGE\YEAR	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
1	0.538	0.496	0.581	0.579	0.590	0.640	0.544	0.626	0.579	0.616
2	1.004	0.863	0.965	0.994	1.035	0.973	0.921	0.961	0.941	0.836
3	2.657	2.377	2.304	2.442	2.404	2.223	2.133	2.041	2.193	2.086
4	4.491	4.528	4.512	4.169	3.153	4.094	3.852	4.001	4.258	3.968
5	6.794	6.447	7.274	7.027	6.803	5.341	5.715	6.131	6.528	6.011
6	9.409	8.520	9.498	9.599	9.610	8.020	6.722	7.945	8.646	8.246
7	11.562	10.606	11.898	11.766	12.033	8.581	9.262	9.953	10.356	9.766
8	11.942	10.758	12.041	11.968	12.481	10.162	9.749	10.131	11.219	10.228
9	13.383	12.340	13.053	14.059	13.589	10.720	10.384	11.919	12.881	11.875
10	13.756	12.540	14.441	14.746	14.271	12.497	12.743	12.554	13.147	12.530
+gp	0.000	14.998	15.667	15.672	19.016	11.595	11.568	14.367	15.544	14.350
SOP	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

AGE\YEAR	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
1	0.559	0.594	0.619	0.568	0.542	0.572	0.550	0.550	0.723	0.589
2	0.869	1.039	0.899	1.029	0.948	0.937	0.936	1.003	0.837	0.962
3	1.919	2.217	2.348	2.470	2.160	2.001	2.411	1.948	2.189	1.858
4	3.776	4.156	4.226	4.577	4.607	4.146	4.423	4.401	4.615	4.130
5	5.488	6.174	6.404	6.494	6.713	6.531	6.580	6.109	7.045	6.784
6	7.453	8.333	8.691	8.620	8.828	8.667	8.475	9.120	8.884	8.903
7	9.019	9.889	10.107	10.132	10.071	9.686	10.637	9.550	9.934	10.399
8	9.810	10.790	10.910	11.341	11.052	11.099	11.550	11.867	11.519	12.500
9	11.077	12.175	12.339	12.888	11.824	12.427	13.057	12.782	13.338	13.469
10	12.359	12.425	12.976	14.140	13.134	12.778	14.148	14.081	14.897	12.890
+gp	12.886	13.731	14.431	14.557	14.362	13.981	15.478	15.392	16.629	14.608
SOP	1.000	1.000	1.000	1.000	1.000	1.004	1.009	0.996	0.999	0.995

AGE\YEAR	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	0.632	0.594	0.590	0.583	0.635	0.586	0.673	0.737	0.670	0.699
2	0.919	1.007	0.933	0.856	0.976	0.881	1.052	0.976	1.078	1.146
3	1.835	2.156	2.140	1.834	1.955	1.982	1.846	2.176	2.037	2.546
4	3.880	3.972	4.164	3.504	3.650	3.187	3.585	3.791	3.971	4.223
5	6.491	6.190	6.324	6.230	6.052	5.992	5.273	5.932	6.083	6.248
6	8.423	8.362	8.430	8.140	8.307	7.914	7.921	7.889	8.034	8.483
7	9.848	10.317	10.362	9.896	10.242	9.764	9.725	10.235	9.545	10.102
8	11.837	11.352	12.073	11.939	11.461	12.127	11.211	10.924	10.949	10.481
9	12.797	13.505	13.072	12.951	12.447	14.242	12.586	12.802	13.481	11.850
10	12.562	13.408	14.443	13.859	18.691	17.787	15.557	15.525	13.170	13.905
+gp	14.426	13.472	16.588	14.707	16.604	16.477	14.694	23.234	14.989	15.794
SOP	0.997	0.999	0.995	1.010	0.997	1.000	0.995	0.995	0.997	0.993

AGE\YEAR	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
1	0.699	0.678	0.721	0.699	0.656	0.542	0.640	0.621	0.725	0.765
2	1.065	1.075	1.020	1.117	0.960	0.922	0.935	1.030	1.004	1.094
3	2.479	2.201	2.210	2.147	2.120	1.724	1.663	1.737	2.303	1.925
4	4.550	4.471	4.292	4.034	3.821	3.495	3.305	3.196	3.663	3.831
5	6.540	7.167	7.220	6.637	6.228	5.387	5.726	4.830	5.871	5.314
6	8.094	8.436	8.980	8.494	8.394	7.563	7.403	7.411	7.332	7.950
7	9.641	9.536	10.283	9.729	9.979	9.628	8.582	9.532	9.264	9.672
8	10.735	10.323	11.743	11.080	11.424	10.643	10.365	10.952	10.081	9.909
9	12.329	12.224	13.107	12.264	12.300	11.499	11.600	11.914	12.062	11.099
10	13.443	14.247	12.052	12.756	12.761	13.085	12.330	12.437	12.009	13.135
+gp	13.961	12.523	13.954	11.304	13.416	14.921	11.926	15.078	10.195	12.497
SOP	0.995	0.994	0.984	0.999	1.000	1.000	1.003	1.000	1.000	1.000

Table 3.3.1 COD in IIIa (Skagerrak), IV and VIId: Survey tuning data sets

```
"North Sea/Skagerrak/Eastern Channel Cod Tuning data" "Updated 2 Sept 2003"

103
SCOGFS_IV
1982   2003
1   1   0.5 0.75
1   6
100 614 351 572 183 92  59  14  5
100 325 780 181 197 75  23  15  0
100 819 391 253 50  57  16  5   2
100 66  1143    197 112 30  24  6   10
100 801 104 396 57  39  19  6   0
100 219 695 34  92  29  7   2   0
100 162 288 165 25  33  12  4   0
100 561 135 168 95  20  8   5   0
100 114 490 59  74  26  9   8   0
100 303 154 133 13  6   4   2   0
100 642 193 72  67  29  18  12  2
100 347 749 101 25  12  3   0   1
100 1158    334 288 31  12  7   2   0
100 475 1443    130 85  11  7   4   0
100 318 356 542 74  34  4   0   0
100 999 278 224 102 22  10  2   0
100 104 2134    116 57  37  8   2   0
100 440 103 616 27  10  6   3   0
100 700 237 28  44  0   8   3   0
100 69  409 68  3   18  0   0   0
100 274 120 215 11  6   5   0   0
100 119 294 35  51  5   0   0   0
ENGGFS_IV_GOV
1992   2003
1   1   0.5 0.75
1   6
100 3708.60240.98 70.66  54.31  11.97  2.36
100 1128.36988.60 124.95 24.03  24.81  3.02
100 4008.20448.86 233.85 28.41  7.58   9.40
100 1561.811940.76181.19 84.49  2.47   2.47
100 1023.151102.44260.28 29.12  30.35  0.00
100 6147.36431.90 82.50  38.34  2.26   9.04
100 178.75 2122.30125.01 12.65  10.28  7.45
100 557.26 84.00  359.35 19.74  9.46   0.00
100 1448.25299.61 22.94  48.34  0.00   4.52
100 264.39 803.00 49.11  2.83   6.99   2.36
100 1199.47222.01 193.28 25.42  0.00   0.00
100 205.96 270.40867.184 49.248 5.32   5.472
```

Table 3.3.1(cont.) COD in IIIa (Skagerrak), IV and VIId: Survey tuning data sets.

```
IBTS_Q1_IV
1976	2003
1	1	0	0.25
1	5
100	790	1990	-1	-1	-1
100	3670	320	-1	-1	-1
100	1290	2930	-1	-1	-1
100	990	930	-1	-1	-1
100	1690	1480	-1	-1	-1
100	290	2550	-1	-1	-1
100	920	670	-1	-1	-1
100	390	1660	270	180	80
100	1520	800	390	90	100
100	90	1760	350	170	50
100	1700	360	680	230	130
100	880	2880	140	170	60
100	360	610	580	60	90
100	1310	630	500	230	40
100	340	1520	200	100	100
100	240	410	340	80	40
100	1300	450	120	100	30
100	1270	1990	200	70	60
100	1480	440	300	80	50
100	970	2210	280	110	30
100	350	800	600	70	60
100	4000	690	230	110	40
100	270	2640	200	90	50
100	210	160	810	80	50
100	660	380	70	200	40
100	280	870	170	20	40
100	750	320	410	50	10
100	63.3	301.7	102.3	137	39.7
IBTS_Q3
1991	2002
1	1	0.5	0.75
1	5
100	820	250	120	20	10
100	4380	360	70	50	20
100	1000	800	90	20	10
100	4320	620	240	20	10
100	1810	1740	150	80	10
100	1030	530	180	40	20
100	6050	550	170	60	10
100	240	2000	130	40	30
100	1200	100	390	30	10
100	1070	230	20	50	10
100	470	550	80	20	20
100	1150	195.9	154.3	43.9	10
```

Table 3.4.1 COD in IIIa (Skagerrak), IV and VIId: Separable VPA diagnostic output

Title : Cod North Sea/Skaggerak/Eastern Channel 6/6/2002

At 2/09/2003 16:31

Separable analysis
from 1963 to 2002 on ages 1 to 10
with Terminal F of 1.000 on age 3 and Terminal S of .850

Initial sum of squared residuals was   399.640 and
final sum of squared residuals is   49.205 after 148 iterations

Matrix of Residuals

Years Ages	1963/64	1964/65	1965/66	1966/67	1967/68	1968/69	1969/70	1970/71	1971/72
1/ 2	-0.244	-0.721	0.141	0.248	-0.482	0.053	-0.902	0.528	0.167
2/ 3	0.657	0.026	0.223	0.399	0.191	0.493	-0.135	0.35	0.821
3/ 4	-0.08	0.074	0.213	0.221	0.133	0.118	0.004	0.152	0.213
4/ 5	0.04	-0.122	0.163	-0.117	-0.22	-0.017	-0.08	-0.222	0.016
5/ 6	-0.151	-0.014	-0.214	-0.217	0.004	-0.272	0.096	-0.001	-0.084
6/ 7	0.236	0.414	-0.034	-0.275	0.102	-0.014	0.364	-0.05	-0.286
7/ 8	-0.98	-0.041	-0.285	-0.48	0.207	-0.306	0.16	-0.119	-0.508
8/ 9	1.205	0.255	0.164	0.378	0.173	-0.117	0.115	-0.777	-0.548
9/10	-0.201	-0.265	-0.7	0.627	-0.378	0.421	-0.201	0.286	0.087
TOT	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

Years	1972/73	1973/74	1974/75	1975/76	1976/77	1977/78	1978/79	1979/80	1980/81	1981/82
1/ 2	-0.793	0.606	0.419	0.31	-0.704	0.703	0.135	0.439	0.288	0.381
2/ 3	0.567	0.506	0.719	0.38	0.893	0.647	0.62	0.53	0.49	0.672
3/ 4	-0.01	0.174	-0.068	-0.081	0.366	-0.005	0.108	0.298	0.164	0.246
4/ 5	-0.291	0.045	-0.221	-0.125	0.055	-0.568	-0.319	-0.266	-0.094	-0.086
5/ 6	-0.326	-0.23	-0.146	-0.2	-0.28	-0.256	0.111	0.008	-0.257	-0.331
6/ 7	0.008	-0.009	-0.069	-0.171	0.097	-0.147	-0.173	-0.487	-0.301	-0.29
7/ 8	0.003	-0.082	-0.151	0.125	-0.107	0.055	-0.253	-0.274	0.13	-0.078
8/ 9	0.996	-0.5	-0.233	0.15	-1.535	0.088	-0.192	-0.154	0.128	-0.279
9/10	0.964	-0.809	0.559	0.46	0.209	1.279	0.248	0.341	-0.194	0.145
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

Table 3.4.1(cont.) COD in IIIa (Skagerrak), IV and VIId: Separable VPA diagnostic output

Years	1982/83	1983/84	1984/85	1985/86	1986/87	1987/88	1988/89	1989/90	1990/91	1991/92
1/ 2	0.683	0.385	0.729	0.223	1.121	0.587	0.906	0.388	0.743	0.499
2/ 3	0.376	0.7	0.558	0.751	0.509	0.407	0.488	0.335	0.582	0.324
3/ 4	0.277	0.291	0.096	0.116	0.067	-0.128	0.265	0.032	0.098	-0.061
4/ 5	-0.122	-0.085	-0.155	-0.1	0.043	-0.035	-0.081	-0.009	-0.038	-0.126
5/ 6	-0.302	-0.287	-0.27	-0.221	-0.246	-0.392	-0.297	-0.202	-0.307	-0.205
6/ 7	0.061	-0.117	-0.133	-0.096	-0.192	0.184	-0.109	-0.032	-0.709	0.046
7/ 8	-0.447	-0.411	-0.342	-0.261	-0.315	0.033	-0.448	0.163	-0.356	0.226
8/ 9	-0.136	0.01	0.062	0.068	0.073	0.185	-0.089	-0.325	-0.293	0.212
9/10	0.01	-0.313	0.346	-0.191	-0.613	-0.072	-0.192	-0.272	1.795	-0.486
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	1992/93	1993/94	1994/95	1995/96	1996/97	1997/98	1998/99	1999/**	2000/**	2001/**	TOT	WTS
1/ 2	0.743	-0.307	-0.107	0.669	-0.341	0.251	-0.583	-0.014	0.112	0.226	0	0.281
2/ 3	0.442	0.28	-0.038	0.54	0.1	-0.013	0.29	-0.424	0.206	-0.073	0	0.494
3/ 4	-0.186	0.021	0.084	0.383	0.114	-0.011	0.171	0.073	-0.052	-0.185	0	0.982
4/ 5	-0.026	0.022	0.051	0.028	-0.22	-0.147	0.163	-0.113	0.046	0.055	0	1
5/ 6	-0.272	-0.148	-0.169	-0.307	-0.166	-0.234	0.117	-0.131	0.205	0.05	0	0.964
6/ 7	-0.155	-0.008	0.087	-0.31	-0.06	0.095	-0.267	0.192	-0.09	0.074	0	0.655
7/ 8	-0.047	0.005	-0.061	-0.469	0.086	0.201	-0.257	0.28	-0.12	-0.099	0	0.536
8/ 9	0.106	0.159	0.281	-0.842	0.867	0.172	0.046	0.396	-0.434	-0.179	0	0.293
9/10	0.52	0.02	-0.106	0.511	0.203	0.371	-0.463	-0.042	-0.275	0.405	0	0.269
TOT	0	0	0	0	0	0	0	0	0	0	12.196	
WTS	0.001	0.001	0.001	0.001	0.001	1	1	1	1	1		

rtalities (F)

	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
F-values	0.4678	0.5507	0.6035	0.601	0.6674	0.7254	0.6652	0.6997	0.7795	0.9286
	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
F-values	0.8178	0.7892	0.8592	0.8267	0.8653	1.003	0.8381	0.9472	0.9218	1.1001
	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
F-values	1.0683	1.0059	0.9204	1.0556	1.0368	1.0343	1.1008	0.9772	1.0188	0.9836
	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
F-values	1.0278	0.9848	0.8605	0.956	0.9889	1.1129	1.2892	1.3472	0.9281	1

-at-age (S)

	1	2	3	4	5	6	7	8	9	10
S-values	0.0627	0.6328	1	0.9997	0.9601	0.8911	0.9119	0.7931	0.7772	0.85

Table 3.4.3 COD in IIIa (Skagerrak), IV and VIId: TSA settings for all analyses

Parameter	*Setting*	*Justification*
Age above which selection is constant.	*am* = 5	Based on inspection of previous XSA runs.
Multipliers on variance matrices of catch measurements.	$B(a) = 2$ For ages 7, 8+ $B(a) = 1$ Otherwise	Allows extra measurement variability for older ages with fewer catches.
Multipliers on variance matrices of ScoGFS measurements.	$B(a) = 2$ For ages 1,5, 6 $B(a) = 1$ Otherwise	Allows extra measurement variability for older ages with fewer catches.
Multipliers on variance matrices of EngGFS measurements.	$B(a) = 2$ For ages 1, 5 $B(a) = 1$ Otherwise	Allows extra measurement variability for older ages with fewer catches.
Multipliers on variance matrices of IBTS Q1 measurements.	$B(a) = 2$ For ages 1,5 $B(a) = 1$ Otherwise	Allows extra measurement variability for older ages with fewer catches.
Multipliers on variances for fishing mortality estimates.	$H(1) = 2$ $H(a) = 1$ otherwise	Allows for more variable fishing mortalities for age 1 fish.
Downweighting of particular data points (implemented by multiplying the relevant *q* by 3)	None	Large values indicated by exploratory prediction error plots.
Initial standard deviation of state vector of numbers at age	40, 15, 5, 1.5, 0.8, 0.4, 0.2, 0.1 for ages 1-8+ respectively	
Initial standard deviation of state vector of F	3.0	
Recruitment.	Modelled by a Ricker model, with numbers-at-age 1 assumed to be independent and normally distributed with mean $\eta_1 S \exp(-\eta_2 S)$, where *S* is the spawning stock biomass at the start of the previous year. To allow recruitment variability to increase with mean recruitment, a constant coefficient of variation is assumed.	
Large year classes.	1970, 1971, 1977, 1980, 1986	
Survey indices	ScoGFS (1982-2003), ages 1-6 EngGFS (1977-2002), ages 1-5 IBTS Q1 (1983-2003), ages 1-5	

Table 3.4.4 COD in IIIa (Skagerrak), IV and VIId: TSA parameter estimates for the base case run, with starting values and lower and upper estimation bounds: these are not empirical standard errors, but user-defined run-time limits that were used to obtain a converged assessment.

Parameter		Estimate	Starting value	Lower bound	Upper bound
Initial fishing mortality	*F* (1, 1963)	0.0359	0.03	0.01	0.10
	F (2, 1963)	0.4421	0.50	0.20	0.80
	F (5, 1963)	0.5177	0.50	0.40	0.70
Standard deviations:					
fishing mortalities	σ*F*	0.1323	0.10	0.05	0.20
	σ*U*	0.0534	0.10	0.00	0.20
	σ*V*	0.0000	0.001	0.00	0.10
	σ*Y*	0.0692	0.05	0.00	0.50
Measurement	σ*catch*	0.0458	0.45	0.30	0.80
Recruitment	A	2.9654	3.00	2.00	6.00
	B	0.0261	0.3	0.10	0.50
	Cvrec	0.4245	0.4	0.20	0.80
ScoGFS					
	Φ(1)	0.0342	0.05	0.01	0.30
	Φ(2)	0.1119	0.10	0.05	0.70
	Φ(5)	0.1535	0.10	0.05	0.30
	σ*survey*	0.3918	0.30	0.25	0.40
	σΩ	0.0000	0.40	0.00	0.70
	σβ	0.1766	0.10	0.00	0.20
EngGFS					
	Φ(1)	0.0945	0.07	0.01	0.15
	Φ(2)	0.0899	0.08	0.01	0.15
	Φ(5)	0.0455	0.04	0.02	0.10
	σ*survey*	0.3879	0.30	0.10	0.50
	σΩ	0.1286	0.50	0.00	0.80
	σβ	0.0000	0.01	0.00	0.30
IBTS Q1					
	Φ(1)	0.2456	0.35	0.10	1.00
	Φ(2)	0.5551	0.50	0.01	1.00
	Φ(5)	1.1363	1.30	0.05	2.00
	σ*survey*	0.4264	0.25	0.10	0.50
	σΩ	0.0000	0.05	0.00	0.20
	σβ	0.0975	0.01	0.00	0.50

Notation

F(*a*,*y*) Fishing mortality at age *a* in year *y*
σ*F* Transitory changes in overall fishing mortality
σ*U* Persistent changes in selection (age effect in fishing mortality)
σ*V* Transitory changes in the year effect in fishing mortality
σ*Y* Persistent changes in the year effect in fishing mortality
σ*catch* CV of catch-at-age data
α Ricker parameter (slope at the origin)
β Ricker parameter (curve dome occurs at 1/∃)
cvrec Standard error of recruitment data
Φ(a) Age-specific selectivity of survey indices
σ*survey* CV of survey indices
σΩ Transitory changes in survey "catchability"
σβ Persistent changes in survey "catchability"

Table 3.4.5 COD in IIIa (Skagerrak), IV and VIId: The XSA diagnostics file

Lowestoft VPA Version 3.1

11/09/2003 20:28

Extended Survivors Analysis

Cod North Sea/Skaggerak/Eastern Channel 6/6/2002

CPUE data from file CODIVEF3.TUN

Catch data for 40 years. 1963 to 2002. Ages 1 to 7.

Fleet	First year	Last year	First age	Last age	Alpha	Beta
SCOGFS_I\	1982	2002	1	6	0.5	0.75
ENGGFS_I\	1992	2002	1	6	0.5	0.75
IBTS_Q1_I\	1976	2002	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 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 30 iterations

Total absolute residual between iterations
29 and 30 = .00048

Final year F values

Age	1	2	3	4	5	6
Iteration 29	0.0678	0.3124	0.6499	0.8741	1.1303	0.7212
Iteration 30	0.0678	0.3124	0.6499	0.8742	1.1305	0.7213

Table 3.4.5(cont) COD in IIIa (Skagerrak), IV and VIId: The XSA diagnostics file

Regression weights

0.751	0.82	0.877	0.921	0.954	0.976	0.99	0.997	1	1

Fishing mortalities

Age	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
1	0.05	0.074	0.109	0.044	0.091	0.032	0.083	0.078	0.042	0.068
2	0.805	0.648	0.823	0.65	0.636	0.872	0.603	0.912	0.445	0.312
3	1.037	1.017	0.994	1.004	0.985	1.194	1.349	1.36	0.778	0.65
4	0.921	0.965	0.808	0.737	0.921	1.117	1.157	1.358	1.02	0.874
5	0.838	0.7	0.726	0.761	0.735	1.148	0.938	1.122	0.84	1.131
6	1.193	0.75	0.523	1.044	0.744	0.787	1.156	0.705	0.44	0.721

XSA population numbers (Thousands)

	AGE					
YEAR	1	2	3	4	5	6
1993	148000	119000	19900	5860	3070	690
1994	324000	63200	37500	5500	1910	1090
1995	227000	135000	23300	10600	1720	776
1996	172000	91700	41800	6710	3860	680
1997	408000	73900	33700	11900	2630	1470
1998	58800	167000	27600	9800	3890	1030
1999	111000	25600	49300	6500	2620	1010
2000	166000	45900	9870	9960	1670	841
2001	79700	69000	13000	1970	2100	446
2002	168000	34300	31100	4650	583	741

Estimated population abundance at 1st Jan 2003

0	70600	17700	12700	1590	154

Taper weighted geometric mean of the VPA populations:

171000	72200	26100	7100	2310	930

Standard error of the weighted Log(VPA populations) :

0.5772	0.5781	0.5086	0.5252	0.5464	0.3765

1

Table 3.4.5(cont) COD in IIIa (Skagerrak), IV and VIId: The XSA diagnostics file

Fleet : SCOGFS_IV

Age	1976	1977	1978	1979	1980	1981	1982
1	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
3	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
5	99.99	99.99	99.99	99.99	99.99	99.99	99.99
6	99.99	99.99	99.99	99.99	99.99	99.99	99.99

Age	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	-0.66	-0.5	-1.24	-0.67	-0.83	-0.69	-0.05	-0.61	-0.06	-0.05
2	-0.48	-0.4	-0.23	-0.61	-0.71	-0.46	-0.56	-0.1	-0.19	-0.23
3	-0.11	-0.4	-0.13	-0.17	-0.63	-0.85	-0.08	-0.37	-0.25	-0.1
4	0.61	0.1	0.31	0.09	0.19	-0.23	0.24	0.5	-0.86	0.35
5	0.67	0.13	0.23	0.05	0.13	-0.02	0.24	-0.17	-1.35	0.74
6	0.49	0.19	0.26	0.7	-0.47	0.2	-0.2	0.26	-0.61	0.58

Age	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
1	0.14	0.33	-0.01	-0.08	-0.01	0.09	0.64	0.6	-0.54	-0.17
2	0.05	0.09	0.36	-0.24	-0.19	0.42	0.21	0.29	0.05	-0.1
3	0.05	0.06	0.03	0.34	0	-0.13	0.38	0.08	0.13	-0.08
4	-0.16	0.14	0.4	0.67	0.53	0.27	-0.04	0.14	-1.13	-0.78
5	-0.59	-0.2	-0.16	0.18	0.11	0.5	-0.55	99.99	0.2	0.56
6	-0.26	-0.14	0.06	-0.05	-0.09	0.07	0.03	0.22	99.99	-0.11

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	-9.2032	-8.9178	-8.9178
S.E(Log q)	0.5653	0.5193	0.2729

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	0.8	0.902	10.62	0.67	20	0.42	-10.27
2	0.65	2.223	9.95	0.8	20	0.3	-9.3
3	0.62	2.448	9.45	0.8	20	0.26	-9

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	0.54	4.092	9.05	0.89	20	0.2	-9.2
5	1.39	-0.962	9.36	0.4	19	0.72	-8.92
6	1.12	-0.364	9.16	0.52	19	0.32	-8.92

Table 3.4.5(cont) COD in IIIa (Skagerrak), IV and VIId: The XSA diagnostics file

Fleet : ENGGFS_IV_GOV

Age	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	0.04
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	-0.07
4	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	0.42
5	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	0.62
6	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	-0.69

Age	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
1	0.1	0	-0.14	-0.11	0.01	0.02	0.02	0.13	-0.07	0.01
2	-0.14	-0.01	0.13	0.13	-0.2	-0.02	-0.09	0.17	0.16	0.07
3	0.26	0.04	0.34	0	-0.57	0	0.2	-0.04	-0.05	-0.05
4	0.08	0.33	0.68	0.02	-0.17	-0.96	-0.08	0.52	-0.91	0.34
5	0.91	0.11	-0.89	0.83	-1.4	-0.02	0.16	99.99	0.02	99.99
6	0.51	0.92	-0.22	99.99	0.57	0.76	99.99	0.42	0.24	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
Mean Log q	-9.4821	-9.6835	-9.6835
S.E(Log q)	0.5545	0.7683	0.624

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	0.54	9.776	10.41	0.98	11	0.08	-9.04
2	0.57	4.416	9.82	0.93	11	0.17	-8.84
3	0.67	1.998	9.47	0.83	11	0.25	-9.15

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	0.71	1.222	9.29	0.69	11	0.38	-9.48
5	0.52	0.934	8.81	0.39	9	0.41	-9.68
6	0.86	0.288	8.98	0.45	8	0.47	-9.34

Table 3.4.5(cont) COD in IIIa (Skagerrak), IV and VIId: The XSA diagnostics file

Fleet : IBTS_Q1_IV

Age		1976	1977	1978	1979	1980	1981	1982
	1	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
	3	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
	5	99.99	99.99	99.99	99.99	99.99	99.99	99.99
	6	No data for this fleet at this age						

Age		1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
	1	-1.03	-0.56	-1.47	-0.65	-0.25	-0.58	0.09	-0.25	-0.75	-0.02
	2	-0.54	-0.47	-0.47	-0.36	-0.26	-0.51	-0.08	0.14	-0.06	-0.22
	3	-0.27	-0.43	-0.07	-0.02	-0.22	-0.33	0.34	-0.03	0.03	-0.27
	4	-0.34	-0.11	-0.07	0.63	-0.07	-0.18	0.19	-0.01	0.11	-0.09
	5	-0.21	-0.22	-0.12	0.28	-0.01	0.03	0.04	0.2	-0.32	-0.18
	6	No data for this fleet at this age									

Age		1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
	1	0.68	0.02	0.04	-0.48	0.57	0.39	-0.44	0.06	0.11	0.14
	2	0.23	-0.2	0.18	-0.16	-0.05	0.09	-0.01	0.04	0.17	0.16
	3	0.04	-0.26	0.16	0.2	-0.38	-0.27	0.32	-0.1	0.31	0.15
	4	0.02	0.22	-0.13	-0.14	-0.24	-0.22	0.07	0.59	-0.14	-0.09
	5	0.09	0.36	-0.04	-0.15	-0.18	-0.3	0.07	0.32	0.06	-0.01
	6	No data for this fleet at this age									

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

Age	4	5
Mean Log q	-8.9127	-8.4988
S.E(Log q)	0.2397	0.2076

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	0.79	0.95	10.51	0.66	20	0.43	-10.09
2	0.7	3.104	9.73	0.91	20	0.19	-9.1
3	0.83	1.116	9.24	0.81	20	0.26	-9.04

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

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
4	0.94	0.422	8.91	0.85	20	0.23	-8.91
5	1.1	-0.782	8.57	0.86	20	0.23	-8.5

Table 3.4.5(cont) COD in IIIa (Skagerrak), IV and VIId: The XSA diagnostics file

Age 1 Catchability dependent on age and year class strength

Year class = 2001

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
SCOGFS_IV	59666	0.441	0	0	1	0.202	0.08
ENGGFS_IV_GOV	71184	0.3	0	0	1	0.437	0.067
IBTS_Q1_IV	81287	0.452	0	0	1	0.193	0.059
P shrinkage mean	72239	0.58				0.126	0.066
F shrinkage mean	71200	1				0.042	0.067

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
70599	0.2	0.05	5	0.246	0.068

Age 2 Catchability dependent on age and year class strength

Year class = 2000

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
SCOGFS_IV	14002	0.278	0.2	0.72	2	0.226	0.381
ENGGFS_IV_GOV	17775	0.212	0.071	0.33	2	0.384	0.311
IBTS_Q1_IV	20456	0.252	0.021	0.08	2	0.273	0.276
P shrinkage mean	26129	0.51				0.093	0.222
F shrinkage mean	6323	1				0.024	0.706

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
17695	0.13	0.1	8	0.737	0.312

Table 3.4.5(cont) COD in IIIa (Skagerrak), IV and VIId: The XSA diagnostics file

Age 3 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
SCOGFS_IV	13447	0.201	0.16	0.8	3	0.273	0.622
ENGGFS_IV_GOV	13393	0.178	0.07	0.39	3	0.329	0.623
IBTS_Q1_IV	14599	0.197	0.025	0.13	3	0.28	0.584
P shrinkage mean	7103	0.53				0.092	0.967
F shrinkage mean	5364	1				0.025	1.151

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
12658	0.11	0.09	11	0.81	0.65

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

Year class = 1998

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
SCOGFS_IV	1520	0.223	0.269	1.21	4	0.243	0.9
ENGGFS_IV_GOV	1744	0.205	0.091	0.45	4	0.272	0.82
IBTS_Q1_IV	1611	0.197	0.112	0.57	4	0.431	0.865
F shrinkage mean	1061	1				0.054	1.128

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
1586	0.13	0.09	13	0.675	0.874

Table 3.4.5(cont) COD in IIIa (Skagerrak), IV and VIId: The XSA diagnostics file

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

Year class = 1997

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
SCOGFS_IV	179	0.323	0.307	0.95	5	0.209	1.03
ENGGFS_IV_GOV	110	0.23	0.239	1.04	4	0.108	1.367
IBTS_Q1_IV	148	0.211	0.036	0.17	5	0.576	1.157
F shrinkage mean	198	1				0.106	0.967

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
154	0.18	0.09	15	0.536	1.131

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

Year class = 1996

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
SCOGFS_IV	279	0.257	0.058	0.23	6	0.569	0.751
ENGGFS_IV_GOV	346	0.372	0.1	0.27	5	0.066	0.643
IBTS_Q1_IV	352	0.229	0.105	0.46	5	0.278	0.634
F shrinkage mean	216	1				0.088	0.894

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
295	0.18	0.05	17	0.292	0.721

Table 3.4.6 COD in IIIa (Skagerrak), IV and VIId: XSA estimated fishing mortality

Run title : Cod North Sea/Skaggerak/Eastern Channel 6/6/2002

At 11/09/2003 20:29 Terminal Fs derived using XSA (With F shrinkage)

Table 8 Fishing mortality at age

AGE \ YEAR	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
1	0.0253	0.0202	0.0591	0.0562	0.0335	0.0459	0.0215	0.1101	0.0762	0.0338
2	0.5365	0.3844	0.4676	0.5587	0.5096	0.6346	0.3923	0.5884	0.8907	0.89
3	0.3948	0.6026	0.6859	0.6215	0.7514	0.7743	0.5989	0.7522	0.7961	0.9184
4	0.5023	0.4644	0.64	0.5667	0.5228	0.7585	0.6374	0.5689	0.7198	0.6989
5	0.4255	0.566	0.5109	0.5158	0.6783	0.6026	0.7148	0.6935	0.6898	0.7334
6	0.4441	0.5488	0.6177	0.5728	0.6568	0.7186	0.6563	0.6778	0.7424	0.7915
+gp	0.4441	0.5488	0.6177	0.5728	0.6568	0.7186	0.6563	0.6778	0.7424	0.7915
FBAR 2- 4	0.4779	0.4838	0.5978	0.5823	0.5946	0.7225	0.5429	0.6365	0.8022	0.8358

AGE \ YEAR	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
1	0.1301	0.0934	0.1088	0.0357	0.1443	0.0958	0.1044	0.1098	0.1009	0.1759
2	0.7051	0.8219	0.7489	0.9518	0.8584	1.0294	0.8004	0.8863	0.9743	0.9352
3	0.837	0.686	0.8058	0.8986	0.7951	0.9663	0.9602	1.002	1.0222	1.2435
4	0.8012	0.6394	0.7027	0.8028	0.6035	0.822	0.6477	0.8139	0.8105	0.9474
5	0.6532	0.6791	0.7396	0.625	0.7175	1.0743	0.8211	0.7804	0.7199	0.8866
6	0.7714	0.6744	0.7568	0.7833	0.7121	0.9648	0.818	0.8746	0.8599	1.0377
+gp	0.7714	0.6744	0.7568	0.7833	0.7121	0.9648	0.818	0.8746	0.8599	1.0377
FBAR 2- 4	0.7811	0.7158	0.7525	0.8844	0.7523	0.9392	0.8027	0.9007	0.9357	1.0421

AGE \ YEAR	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	0.1257	0.1772	0.0868	0.2351	0.1406	0.1787	0.1287	0.1395	0.1273	0.1447
2	1.0887	0.9527	0.9891	0.8935	0.9229	0.9054	0.8878	0.9056	0.7581	0.8543
3	1.1812	1.0264	0.9539	1.0749	0.8886	1.209	1.0607	0.9996	0.9534	0.8364
4	0.9386	0.8134	0.8232	0.9459	0.9626	0.8519	1.0805	0.8302	0.9111	0.9063
5	0.8453	0.7959	0.6835	0.909	0.7086	0.8664	0.7441	0.9028	0.7058	0.8715
6	0.9958	0.8776	0.7914	0.7457	1.0509	0.7723	1.1456	0.5404	1.4453	0.5836
+gp	0.9958	0.8776	0.7914	0.7457	1.0509	0.7723	1.1456	0.5404	1.4453	0.5836
FBAR 2- 4	1.0695	0.9308	0.9221	0.9714	0.9247	0.9888	1.0097	0.9118	0.8742	0.8657

AGE \ YEAR	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
1	0.0495	0.0744	0.1088	0.0438	0.0909	0.0323	0.0833	0.0775	0.0424	0.0678
2	0.8048	0.6477	0.8229	0.6505	0.6361	0.872	0.6031	0.912	0.4453	0.3124
3	1.0372	1.0173	0.9937	1.0037	0.9855	1.1943	1.3493	1.3596	0.7776	0.6499
4	0.9209	0.965	0.8082	0.7372	0.9214	1.1174	1.1572	1.3583	1.0195	0.8742
5	0.8383	0.7002	0.7264	0.7613	0.7349	1.1484	0.9381	1.1218	0.84	1.1305
6	1.1928	0.7502	0.5234	1.0437	0.7436	0.7875	1.1556	0.7048	0.4405	0.7213
+gp	1.1928	0.7502	0.5234	1.0437	0.7436	0.7875	1.1556	0.7048	0.4405	0.7213
FBAR 2- 4	0.921	0.8767	0.8749	0.7971	0.8476	1.0612	1.0365	1.21	0.7475	0.6122

Table 3.4.7 COD in IIIa (Skagerrak), IV and VIId: XSA estimated fishing population numbers at age

Run title : Cod North Sea/Skaggerak/Eastern Channel 6/6/2002
At 11/09/2003 20:29 Terminal Fs derived using XSA (With F shrinkage)
Table 10 Stock number at age (start of year) Numbers*10**-3

AGE \ YEAR	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
1	191646	375828	410799	497905	489169	193957	206574	779782	911162	172121
2	122193	83958	165499	173984	211507	212556	83243	90845	313851	379365
3	24423	50354	40282	73067	70125	89533	79409	39626	35545	90762
4	9898	12816	21466	15800	30567	25762	32146	33976	14545	12487
5	8891	4904	6595	9267	7340	14837	9879	13914	15748	5798
6	3738	4757	2280	3240	4530	3050	6649	3957	5694	6468
+gp	1808	2138	2584	2787	3260	3117	2906	3312	3639	5600
TOTAL	362597	534755	649505	776049	816497	542811	420806	965412	1300185	672601

AGE \ YEAR	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
1	317476	260316	482839	243756	837303	485694	524217	898279	315222	617721
2	74770	125245	106536	194579	105690	325674	198307	212194	361658	128045
3	109780	26033	38799	35500	52935	31567	81984	62769	61632	96193
4	28215	37021	10210	13498	11256	18615	9354	24443	17948	17270
5	5082	10367	15991	4140	4952	5040	6699	4008	8868	6533
6	2280	2165	4304	6249	1814	1979	1409	2413	1503	3534
+gp	3746	3190	2119	2463	4070	1838	1471	1581	1623	1319
TOTAL	541349	464337	660798	500186	1018020	870408	823442	1205686	768454	870615

AGE \ YEAR	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	325080	594876	158759	713870	283443	195858	274798	134517	168060	306336
2	232798	128819	223891	65406	253571	110658	73606	108567	52574	66488
3	35416	55229	35014	58678	18861	71001	31532	21348	30932	17358
4	21603	8465	15411	10505	15598	6041	16506	8502	6119	9285
5	5483	6919	3073	5539	3340	4877	2110	4587	3035	2014
6	2204	1928	2556	1270	1827	1346	1679	821	1523	1227
+gp	1578	1498	1336	1790	942	942	729	1167	572	1106
TOTAL	624161	797733	440040	857059	577583	390723	400960	279509	262815	403814

AGE \ YEAR	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
1	147701	323776	227493	171819	407879	58833	110926	165854	79691	168150	0
2	119099	63160	135054	91684	73893	167339	25594	45860	68963	34321	70599
3	19940	37529	23288	41793	33713	27565	49307	9867	12982	31133	17695
4	5857	5505	10568	6714	11930	9800	6503	9962	1973	4646	12658
5	3071	1909	1717	3856	2630	3887	2625	1674	2097	583	1586
6	690	1087	776	680	1475	1033	1009	841	446	741	154
+gp	548	525	605	509	498	618	537	438	407	213	380
TOTAL	296907	433491	399500	317055	532018	269075	196500	234495	166559	239787	103073

Table 3.4.8 COD in IIIa (Skagerrak), IV and VIId: XSA summary table

.

Run title : Cod North Sea/Skaggerak/Eastern Channel 6/6/2002
At 11/09/2003 20:29 Table 16 Summary (without SOP correction)

Terminal Fs derived using XSA (With F shrinkage)

	RECRUITS Age 1	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	FBAR 2- 4
1963	191646	452301	158364	116457	0.7354	0.4779
1964	375828	531978	159957	126041	0.788	0.4838
1965	410799	689179	186186	181036	0.9723	0.5978
1966	497905	836682	215447	221336	1.0273	0.5823
1967	489169	906489	239380	252977	1.0568	0.5946
1968	193957	768704	244909	288368	1.1774	0.7225
1969	206574	611930	242463	200760	0.828	0.5429
1970	779782	943822	251748	226124	0.8982	0.6365
1971	911162	1155974	255170	328098	1.2858	0.8022
1972	172121	807908	232159	353976	1.5247	0.8358
1973	317476	641095	197070	239051	1.213	0.7811
1974	260316	614470	225898	214279	0.9486	0.7158
1975	482839	692627	204872	205245	1.0018	0.7525
1976	243756	595421	173382	234169	1.3506	0.8844
1977	837303	813275	156409	209154	1.3372	0.7523
1978	485694	793454	145942	297022	2.0352	0.9392
1979	524217	786082	150216	269973	1.7972	0.8027
1980	898279	1000360	170603	293644	1.7212	0.9007
1981	315222	841731	184428	335497	1.8191	0.9357
1982	617721	828033	179886	303251	1.6858	1.0421
1983	325080	639275	145761	259287	1.7789	1.0695
1984	594876	711369	127851	228286	1.7856	0.9308
1985	158759	498007	122029	214629	1.7588	0.9221
1986	713870	680914	114018	204053	1.7897	0.9714
1987	283443	567772	101617	216212	2.1277	0.9247
1988	195858	422824	96819	184240	1.9029	0.9888
1989	274798	412088	86573	139936	1.6164	1.0097
1990	134517	330394	79756	125314	1.5712	0.9118
1991	168060	293264	67615	102478	1.5156	0.8742
1992	306336	408407	73342	114020	1.5546	0.8657
1993	147701	337528	63817	121749	1.9078	0.921
1994	323776	422925	66227	110634	1.6705	0.8767
1995	227493	424572	72722	136096	1.8714	0.8749
1996	171819	376070	76913	126320	1.6424	0.7971
1997	407879	489659	82729	124158	1.5008	0.8476
1998	58833	302948	72268	146014	2.0205	1.0612
1999	110926	225913	59488	96225	1.6176	1.0365
2000	165854	217959	44693	71371	1.5969	1.21
2001	79691	183730	33264	49632	1.4921	0.7475
2002	168150	255046	38684	54427	1.4069	0.6122
Arith. Mean	355737	587804	140017	193038	1.4833	0.8309
Units	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)		

Table 3.4.9 The estimated numbers of North Sea cod discards at age (thousands) derived from the application of discard rates derived from the Scottish sampling scheme

Run title : Cod North Sea/Skaggerak/Eastern Channel 6/6/2002
At 12/09/2003 14:02

Discard numbers at age Numbers*10**-3

AGE \ YEAR	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
0	50	640	1020	488	274	29	466	2116	527	1028
1	15043	7432	93840	104296	48299	30045	2425	51493	249475	37039
2	18539	5695	6324	21292	23793	22168	9963	8417	35866	57463
3	30	106	86	68	154	190	109	148	45	172
4	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0
TOTALNUM	33662	13873	101270	126144	72520	52432	12963	62174	285913	95702

AGE \ YEAR	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
0	1206	784	100	345	1487	0	86	299	3435	78
1	82279	117784	123776	206340	394689	24353	572445	1156680	153431	178144
2	16651	15064	14687	75277	39853	70934	4963	16294	32166	7755
3	236	67	0	168	417	0	0	0	63	87
4	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0
TOTALNUM	100372	133699	138563	282130	436446	95287	577494	1173273	189095	186064

AGE \ YEAR	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
0	7023	1497	154	618	0	2165	231	438	1429	18
1	51390	533311	56953	501956	22405	14026	170046	31498	46369	90602
2	10560	10953	34916	3937	53130	15876	6938	43623	7390	8439
3	20	4	96	260	0	182	392	55	401	2
4	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0
TOTALNUM	68993	545765	92119	506771	75535	32249	177607	75614	55589	99061

AGE \ YEAR	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
0	459	396	585	696	2	6	2039	87	412	119
1	30155	260406	38594	13410	57334	12854	21523	33629	4472	10930
2	25704	14225	39087	19873	11570	75987	4202	4790	29983	1962
3	9	144	24	656	33	1045	7294	0	609	1434
4	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0
TOTALNUM	56327	275171	78290	34635	68939	89892	35058	38506	35476	14445

Table 3.4.10 The estimated proportions discarded North Sea cod derived from the Scottish sampling scheme

Run title : Cod North Sea/Skaggerak/Eastern Channel 6/6/2002
At 12/09/2003 14:02

Discard proportions at age.

AGE \ YEAR	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
1	82	60	86	85	82	84	45	49	85	91
2	30	20	11	25	25	21	31	20	19	23
3	0	1	0	0	0	0	0	1	0	0
4	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0

AGE \ YEAR	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
1	76	88	79	97	84	45	94	95	88	73
2	34	20	24	43	44	29	5	13	15	11
3	0	1	0	1	2	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0

AGE \ YEAR	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	28	89	33	94	15	20	82	37	66	74
2	33	26	65	10	84	27	28	79	31	49
3	0	0	1	4	0	5	4	1	11	0
4	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0

AGE \ YEAR	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
1	35	91	38	27	66	14	69	59	18	59
2	69	40	75	46	38	82	12	43	83	13
3	0	4	0	17	1	15	64	0	35	37
4	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0

Table 3.4.11 COD in IIIa (Skagerrak), IV and VIId: Estimated multi-species natural mortality rates.

Multi species natural mortality values for cod in 347d

AGE \ YEAR	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
1	0.6640	0.7602	0.9064	0.9699	1.0796	0.9048	1.0014	1.1478	0.9886	0.8875
2	0.3692	0.3849	0.4574	0.5046	0.5314	0.4641	0.5154	0.6122	0.5407	0.4623
3	0.2753	0.2868	0.3014	0.3087	0.3227	0.3047	0.3264	0.3487	0.3233	0.2995
4	0.2107	0.2116	0.2110	0.2111	0.2125	0.2110	0.2142	0.2165	0.2151	0.2110
5	0.2058	0.2051	0.2043	0.2030	0.2015	0.2029	0.2038	0.2038	0.2040	0.2030
6	0.2140	0.2125	0.2125	0.2116	0.2073	0.2103	0.2109	0.2125	0.2130	0.2088
+gp	0.1870	0.1868	0.1873	0.1872	0.1857	0.1859	0.1871	0.1868	0.1860	0.1828

AGE \ YEAR	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
1	1.0441	0.9320	0.7858	0.7621	0.8922	0.9279	0.9721	1.0099	1.1983	0.9891
2	0.5186	0.5577	0.4670	0.4359	0.4895	0.4313	0.4429	0.4445	0.4915	0.4838
3	0.3260	0.3483	0.3153	0.2947	0.3084	0.2948	0.3123	0.3058	0.3420	0.3177
4	0.2145	0.2276	0.2201	0.2172	0.2148	0.2100	0.2212	0.2175	0.2183	0.2201
5	0.2052	0.2180	0.2041	0.2089	0.2062	0.2047	0.2147	0.2107	0.2110	0.2130
6	0.2130	0.2325	0.2139	0.2120	0.2225	0.2145	0.2286	0.2271	0.2278	0.2317
+gp	0.1854	0.2031	0.1837	0.1793	0.1873	0.1770	0.1926	0.1810	0.1794	0.1862

AGE \ YEAR	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	0.9618	0.8430	0.8820	0.8848	0.7959	0.8860	0.8102	0.8375	0.7359	0.7089
2	0.4619	0.4180	0.4108	0.4317	0.3607	0.3921	0.3767	0.3719	0.3519	0.3479
3	0.3441	0.3043	0.3250	0.3403	0.3304	0.3226	0.3376	0.3580	0.3515	0.3630
4	0.2278	0.2193	0.2211	0.2232	0.2252	0.2219	0.2283	0.2389	0.2353	0.2419
5	0.2228	0.2157	0.2190	0.2135	0.2232	0.2221	0.2147	0.2273	0.2310	0.2374
6	0.2430	0.2350	0.2398	0.2230	0.2391	0.2447	0.2579	0.2619	0.2662	0.2930
+gp	0.1964	0.1849	0.1827	0.1743	0.1812	0.1902	0.1832	0.2041	0.1798	0.1830

AGE \ YEAR	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
1	0.6977	0.7285	0.7181	0.7740	0.7175	0.7053	0.7292	0.6322	0.6366	0.6366
2	0.3339	0.3674	0.3617	0.3931	0.4004	0.3919	0.3925	0.3425	0.3066	0.3066
3	0.3754	0.3958	0.4031	0.4319	0.4405	0.4487	0.4817	0.5044	0.4714	0.4714
4	0.2439	0.2530	0.2592	0.2691	0.2792	0.2751	0.2789	0.2988	0.3105	0.3105
5	0.2425	0.2439	0.2576	0.2605	0.2676	0.2765	0.2798	0.2979	0.2980	0.2980
6	0.2851	0.2950	0.3136	0.3287	0.3370	0.3416	0.3503	0.3783	0.3961	0.3961
+gp	0.1815	0.1814	0.1891	0.1794	0.2171	0.1951	0.1888	0.1970	0.1900	0.1874

SSB90%R90%Surv	149763	143224	155932	177399	51.28
SPR%ofVirgin	3.42	3.50	3.99	4.89	
VirginSPR	10.38	10.32	12.41	15.86	
SPRloss	0.36	0.32	0.37	0.44	

	Deterministic	Median	25th percentile	5th percentile	Hist F > ref pt %
FBar	0.86	0.86	0.82	0.76	53.85
Fmax	0.30	0.30	0.27	0.23	100.00
F0.1	0.18	0.19	0.16	0.13	100.00
Flow	0.50	0.53	0.48	0.40	94.87
Fmed	0.78	0.79	0.73	0.63	66.67
Fhigh	1.15	1.14	1.05	0.94	2.56
F35%SPR	0.18	0.18	0.17	0.15	100.00
Floss	0.85	0.91	0.82	0.72	53.85

For estimation of Gloss and Floss:
A LOWESS smoother with a span of 0.8 was used.
Stock recruit data were log-transformed
A point representing the origin was included in the stock recruit data.
For estimation of the stock recruitment relationship used in equilibrium calculations:
A LOWESS smoother with a span of 0.8 was used.
Stock recruit data were log-transformed
A point representing the origin was included in the stock recruit data.

Area 347d North Sea cod

Steady state selection provided as input
FBar averaged from age 2 to 4
Number of iterations = 1000
Random number seed = -99
Stock recruitment data Monte Carloed using residuals from the equilibrium LOWESS fit
Data source:
C:\cod4a\2003\data\pa\Cod4a 2001.sen
C:\cod4a\2003\data\pa\Cod4a 2001.sum
FishLab DLL used
FLVB32.DLL built on Jun 14 1999 at 11:53:37
PASoft 4 October 1999
17/09/03 05:39:38

Figure 3.1.1. Cod in Subarea IV and Divisions IIIa and VIId: IBTS Q1 Relative catch rates by ices rectangle for 1998-2003. Note that No 0-group are in the catches in the first quarter of the year

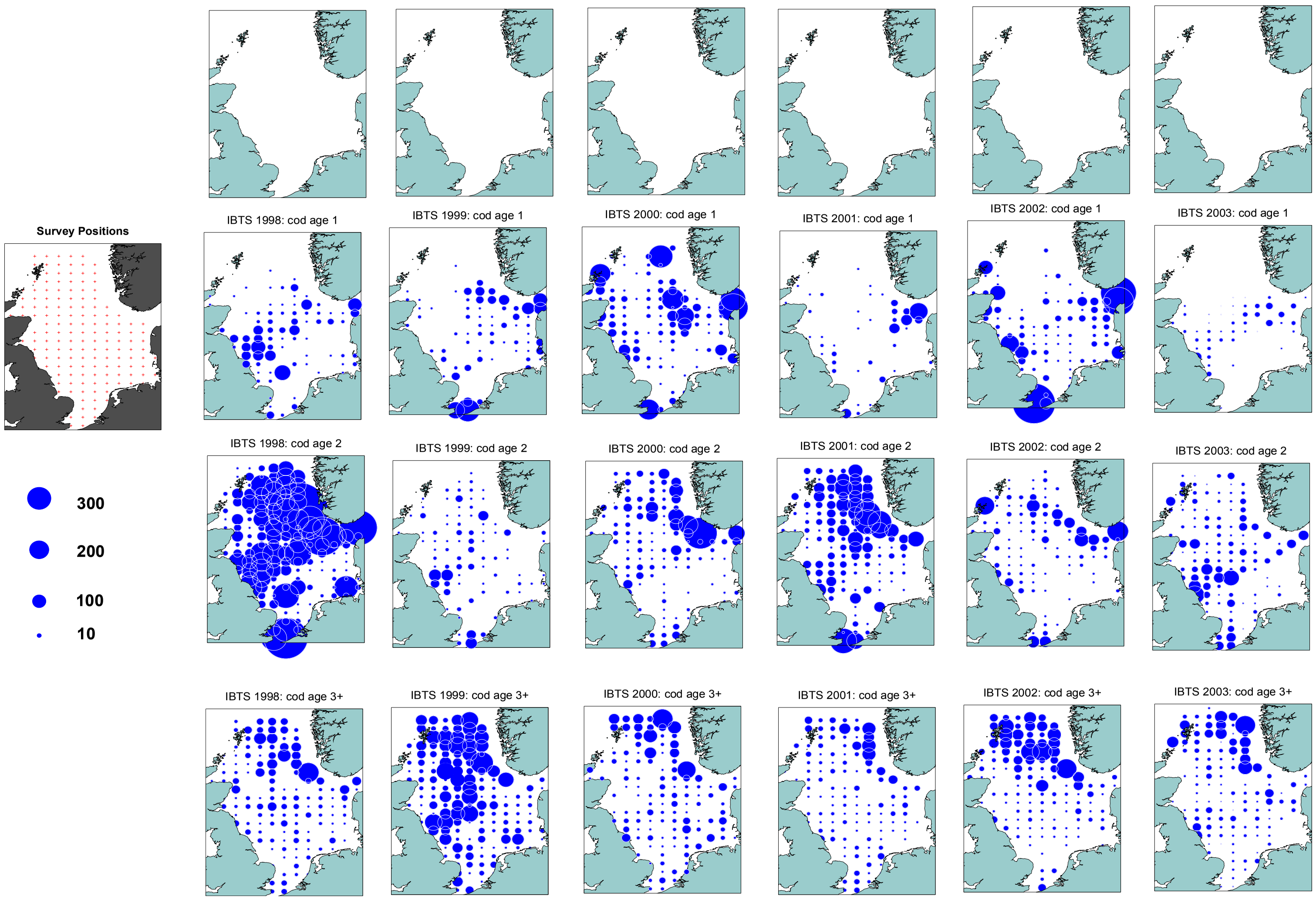


Figure 3.2.2. Cod in IIIa, IV and VIId: mean weight at age in the landings

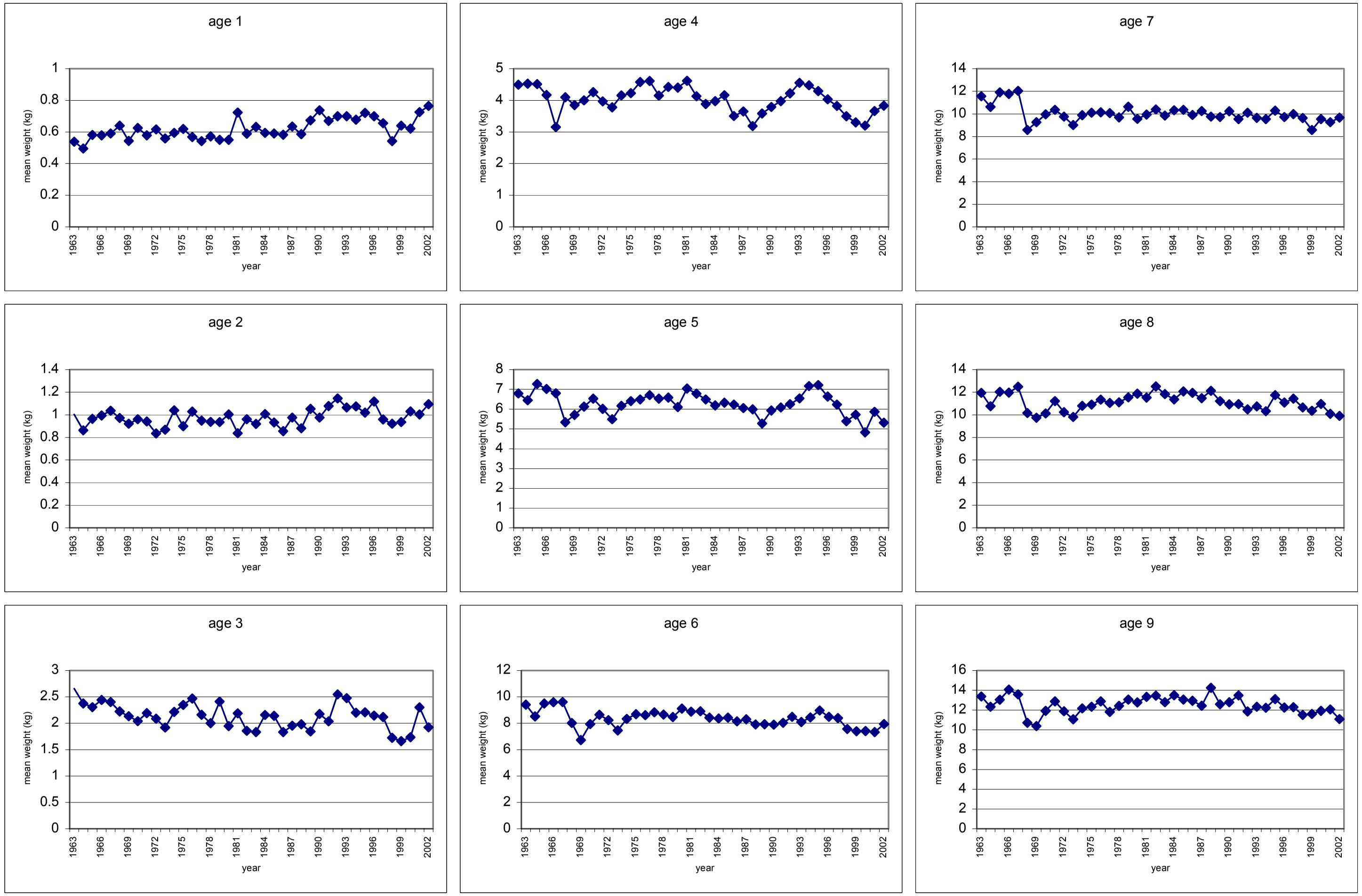


Figure 3.3.1a. Cod in Subarea IV and Divisions IIIa and VIId: IBTS Q1 survey cpue indices by age group

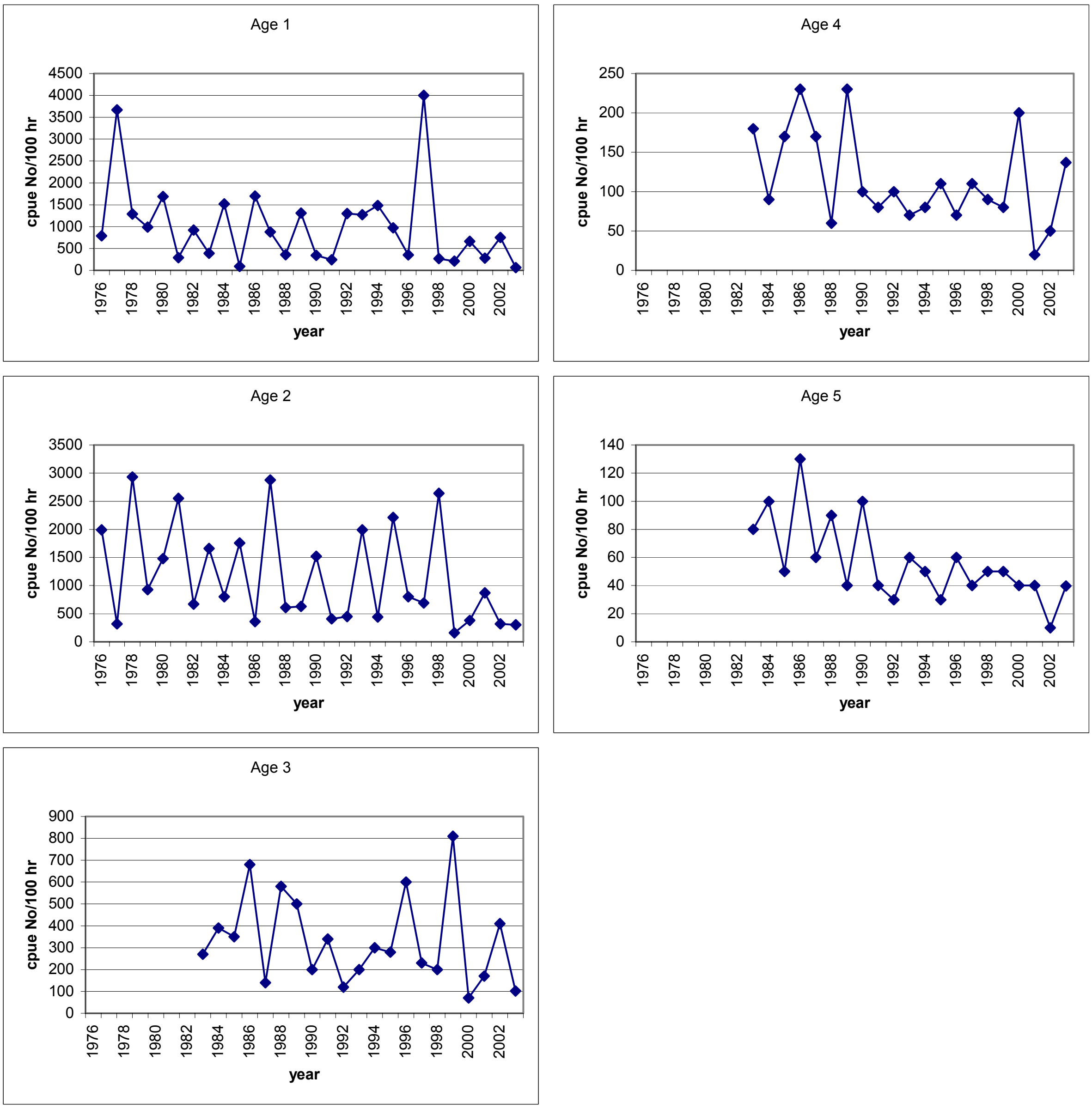


Figure 3.3.1b. Cod in Subarea IV and Divisions IIIa and VIId: EGFS: Survey cpue indices by age group 1977- 1991 = Granton index: 1992-2003 GOV index.

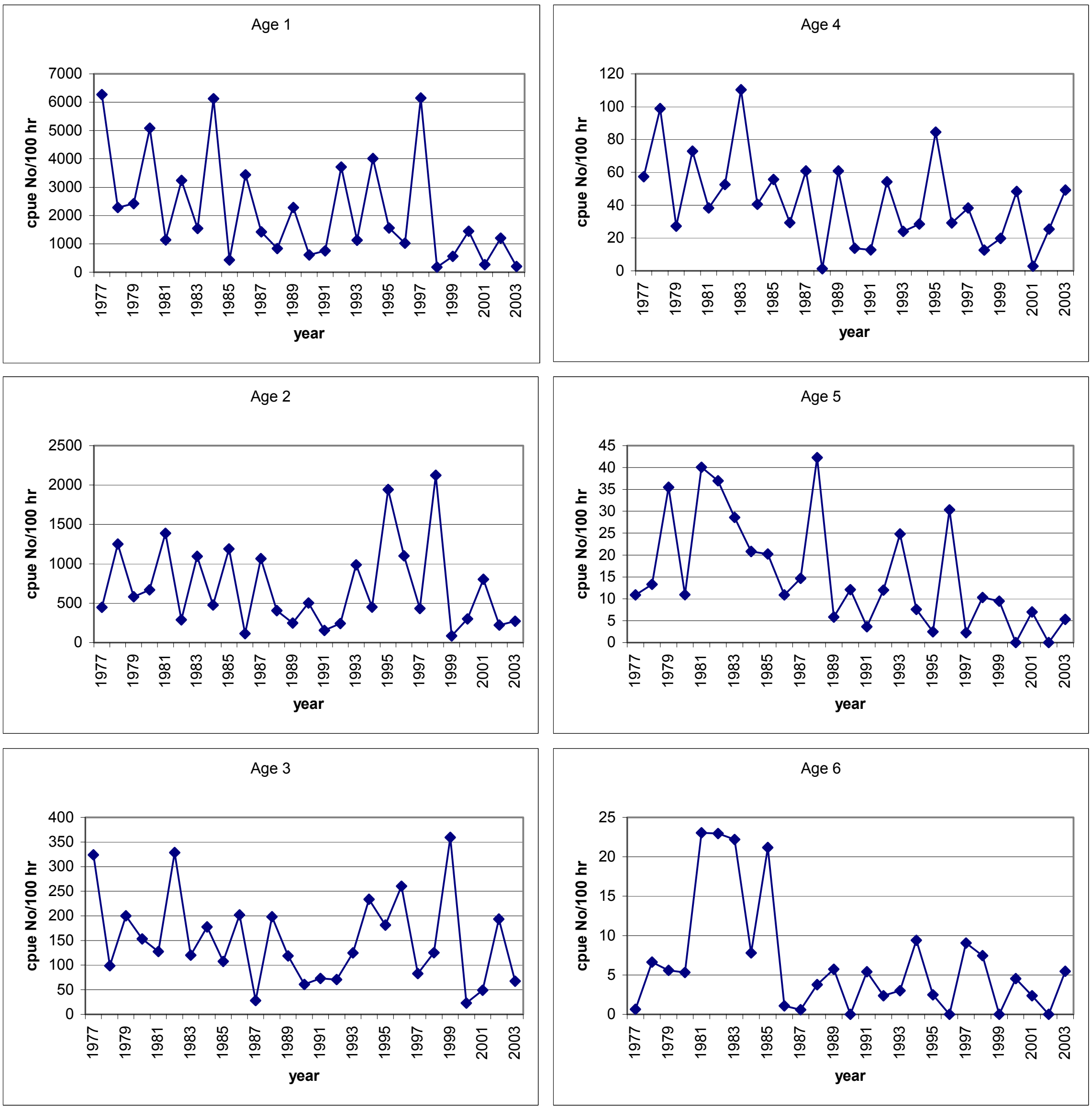


Figure 3.3.1c. Cod in Subarea IV and Divisions IIIa and VIId: SCOGFS: Survey cpue indices by age group

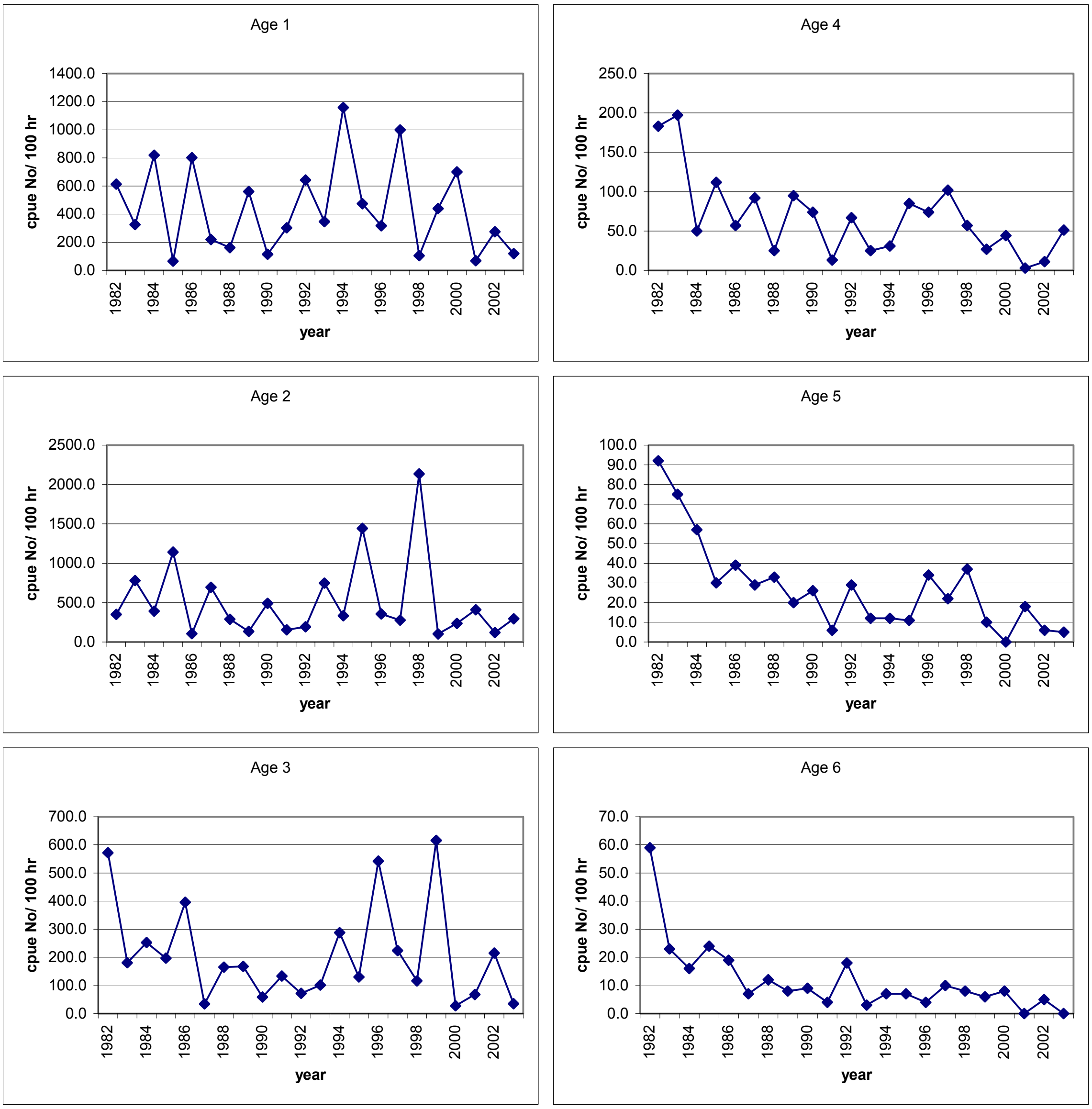


Figure 3.4.1. Cod in Subarea IV and Divisions IIIa and VIId: Selection at age estimated from the catch data for the years 1963 - 2002. The year weights were set to estimate the selection pattern from the log catch ratios of the last 6 years.

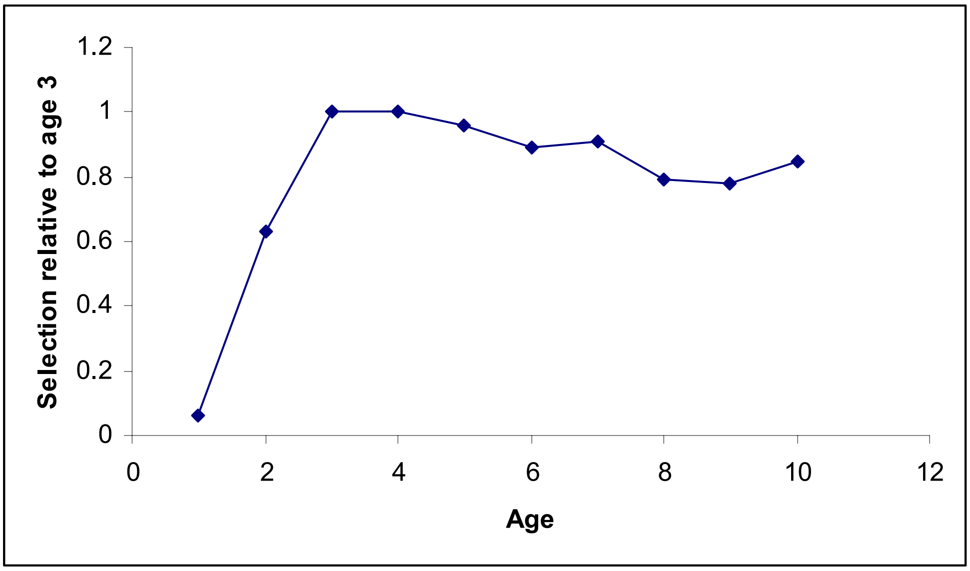


Figure 3.4.2. Cod in Subarea IV and Divisions IIIa and VIId: Overall fishing mortality estimated from the catch data for the years 1963 - 2002. Fishing mortality in 2002 is user-specified. Fishing mortalities for the years prior to 2002 are model estimates.

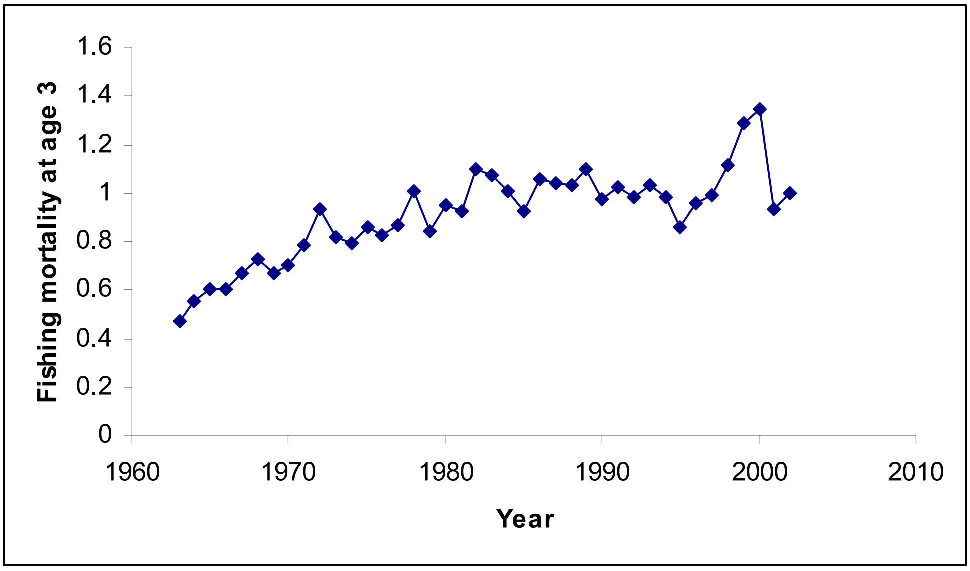


Figure 3.4.3. Cod in Subarea IV and Divisions IIIa and VIId: Separable VPA log catch ratio residuals for the years 1963 - 2002.

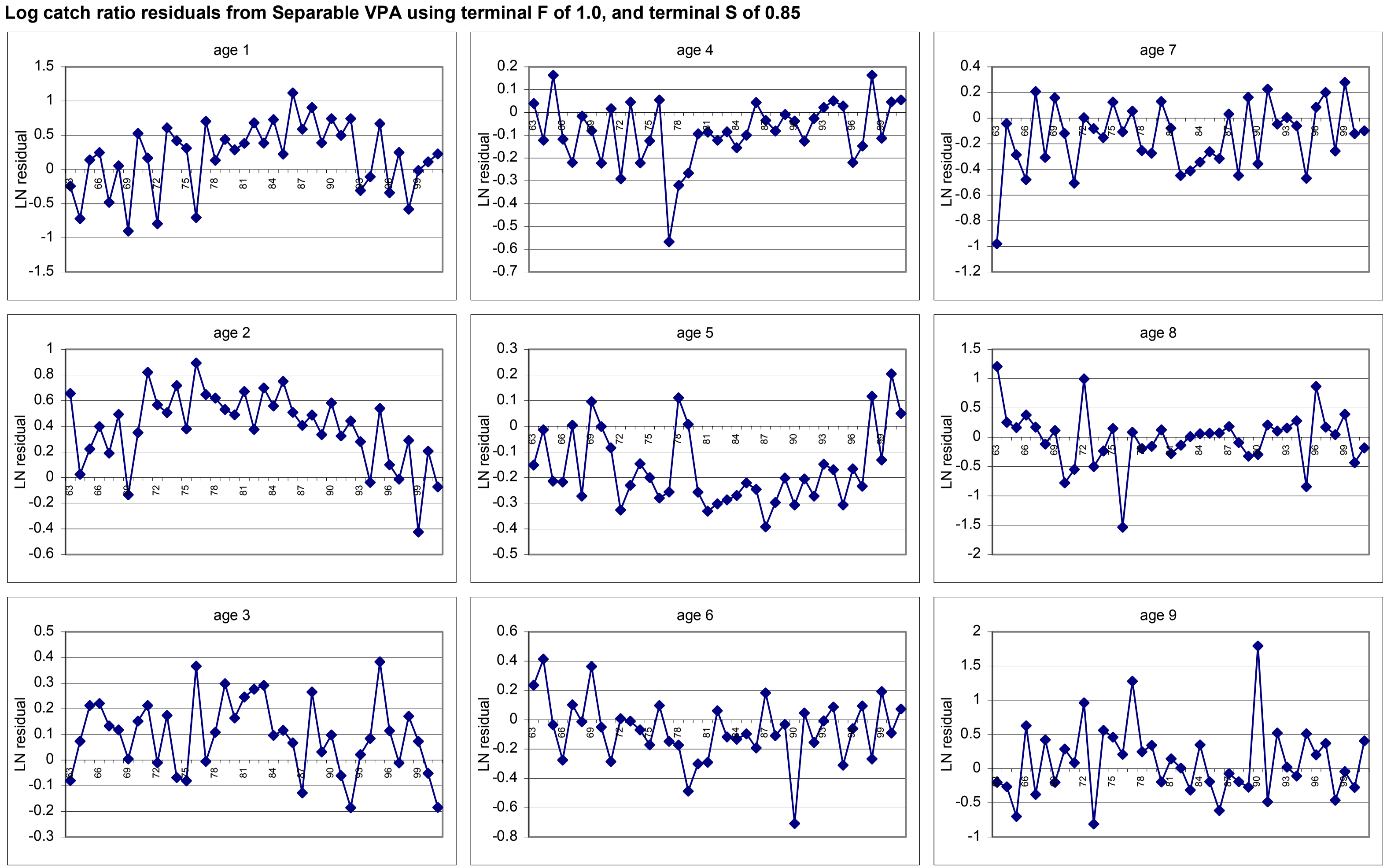


Figure 3.4.4. Cod in Subarea IV and Divisions IIIa and VIId: Trends in Z from the standardised cpue series for the EGFS Q3

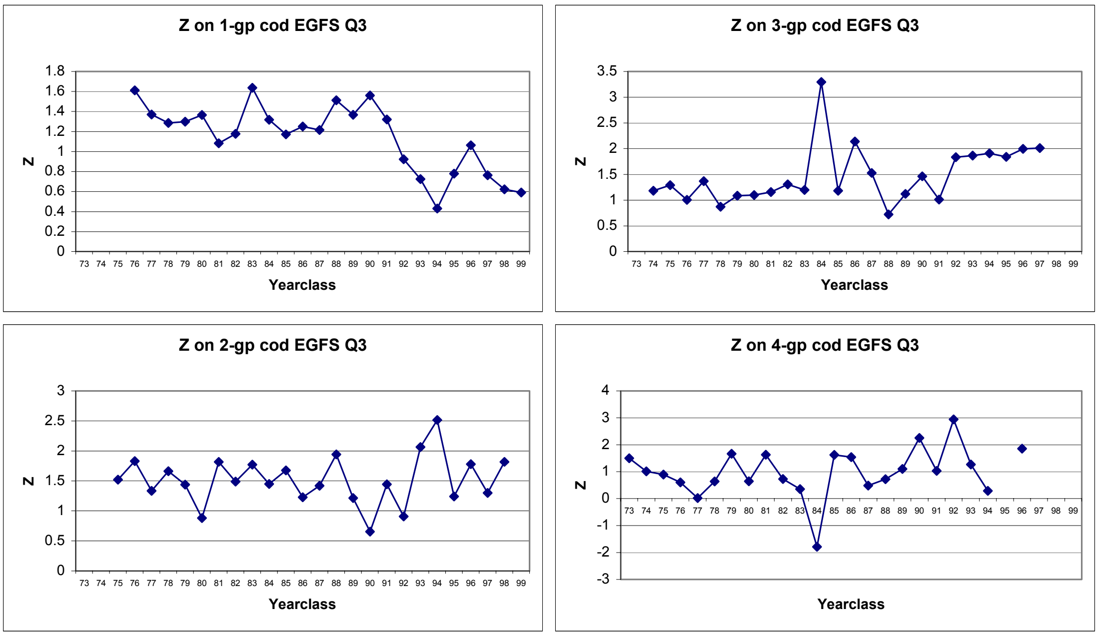


Figure 3.4.5a.Cod in Subarea IV and Divisions IIIa and VIId: Survey concurrence Eng GFS vs Sco GFS

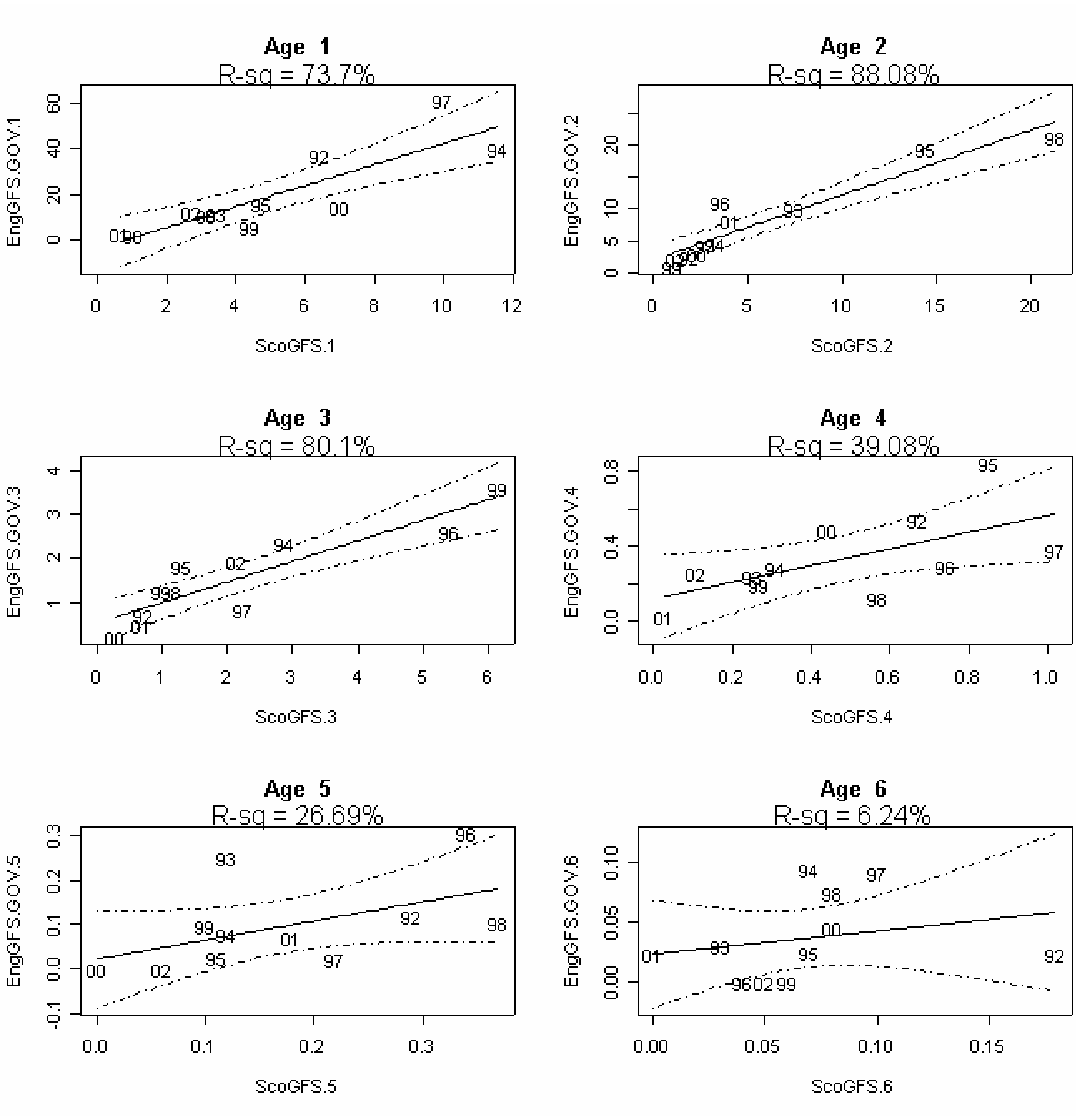


Figure 3.4.5b. Cod in Subarea IV and Divisions IIIa and VIId: Survey concurrence IBTS GFS vs Sco GFS

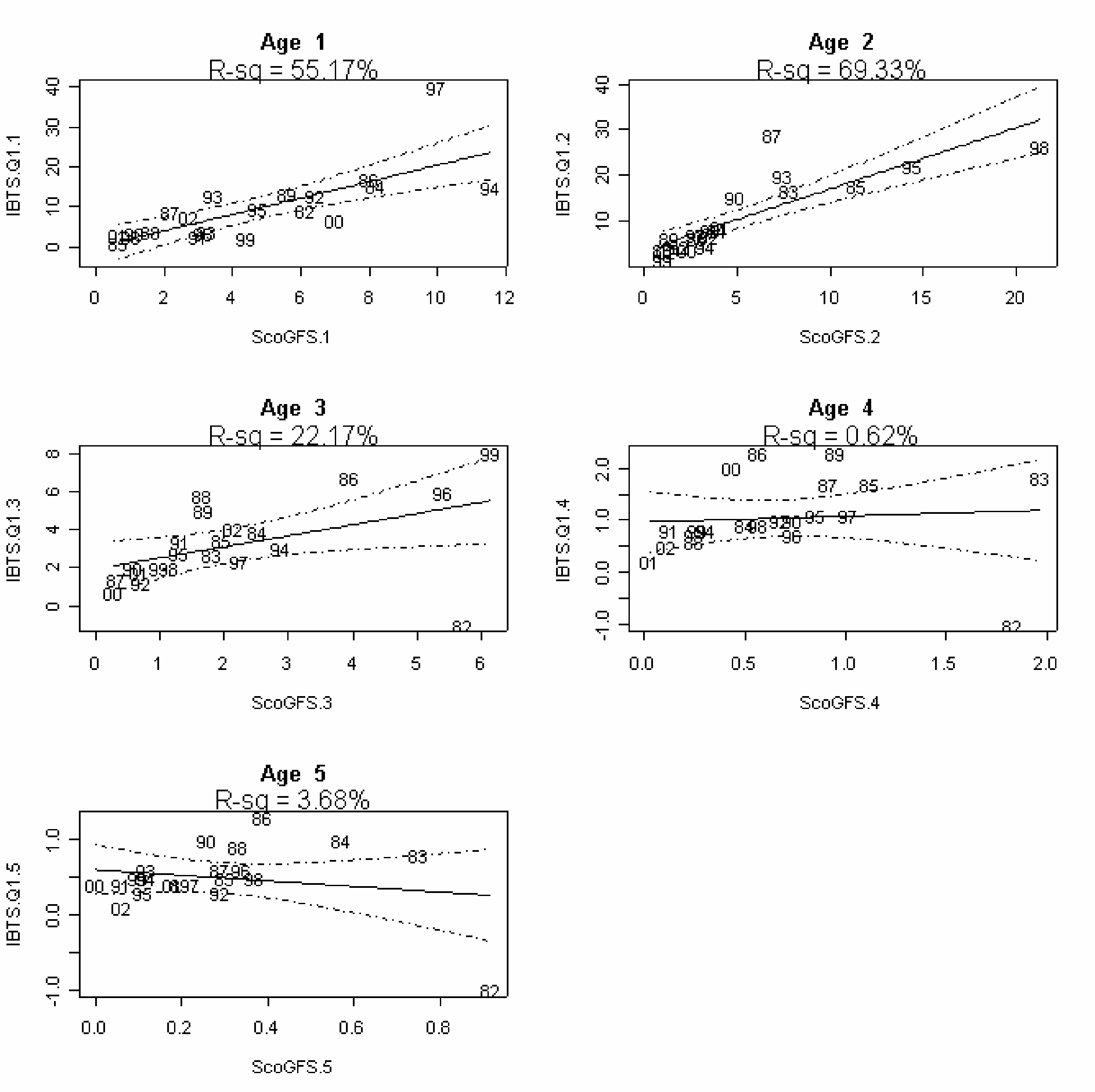


Figure 3.4.5c. Cod in Subarea IV and Divisions IIIa and VIId: Survey concurrence IBTS GFS vs Eng GFS

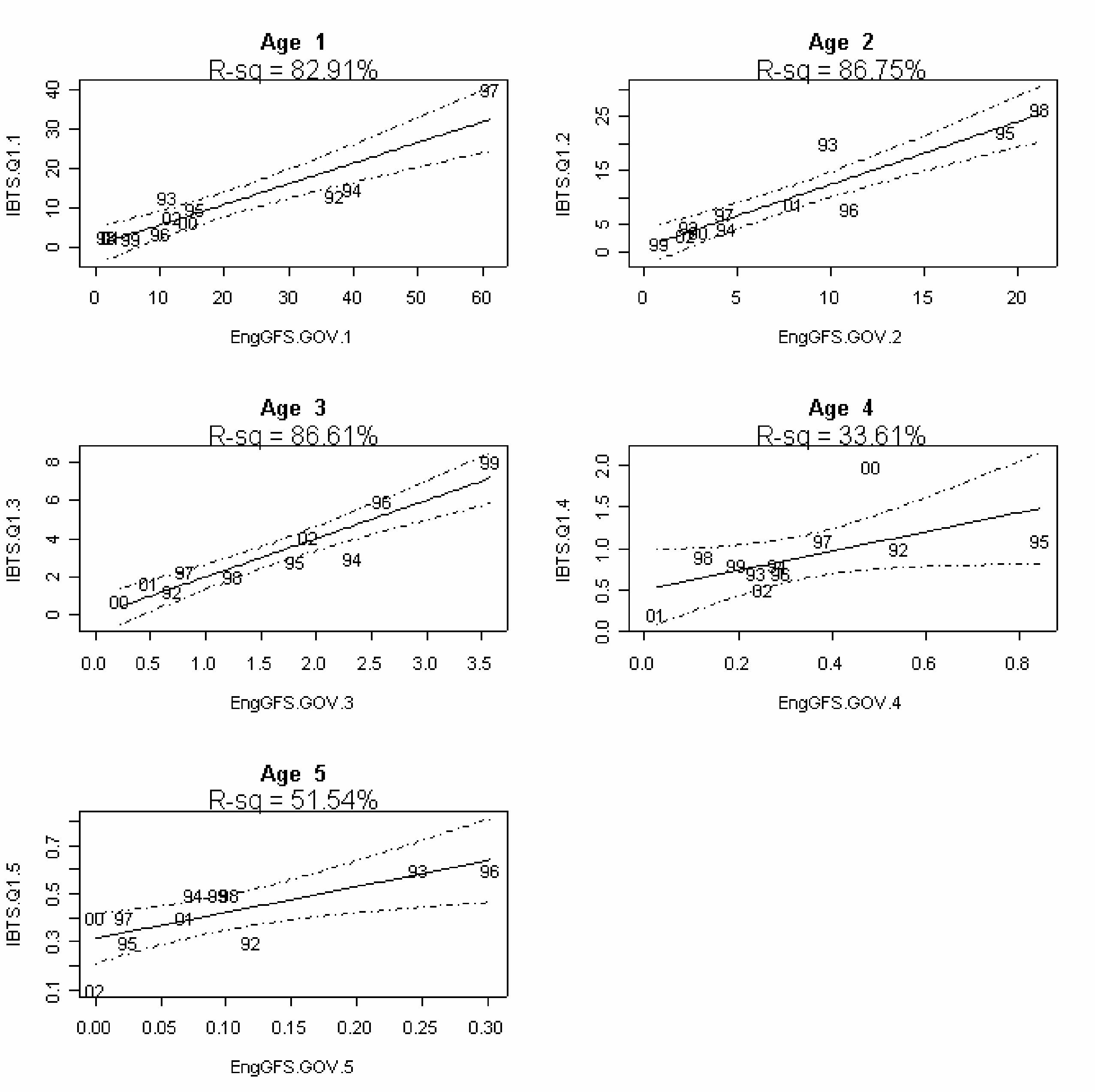


Figure 3.4.6 Cod in Subarea IV and Divisions IIIa and VIId: Standardised recruitment indices age 1.

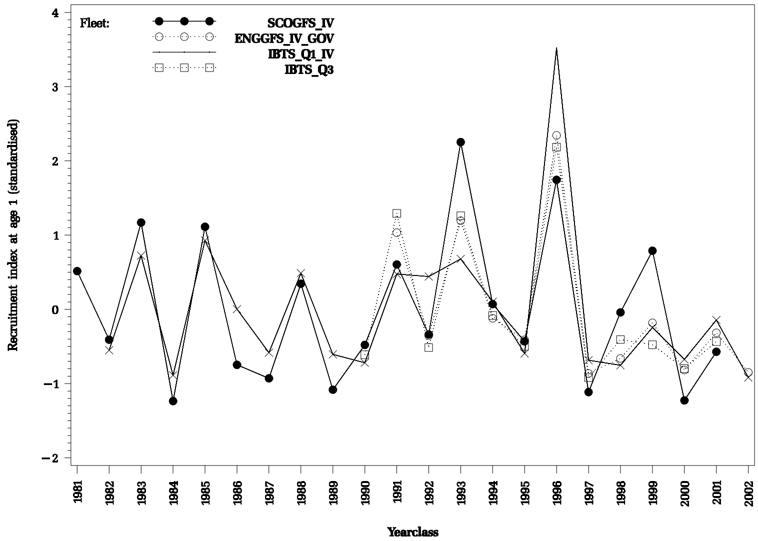


Figure 3.4.7 Cod in Subarea IV and Divisions IIIa and VIId: Standardised recruitment indices age 2.

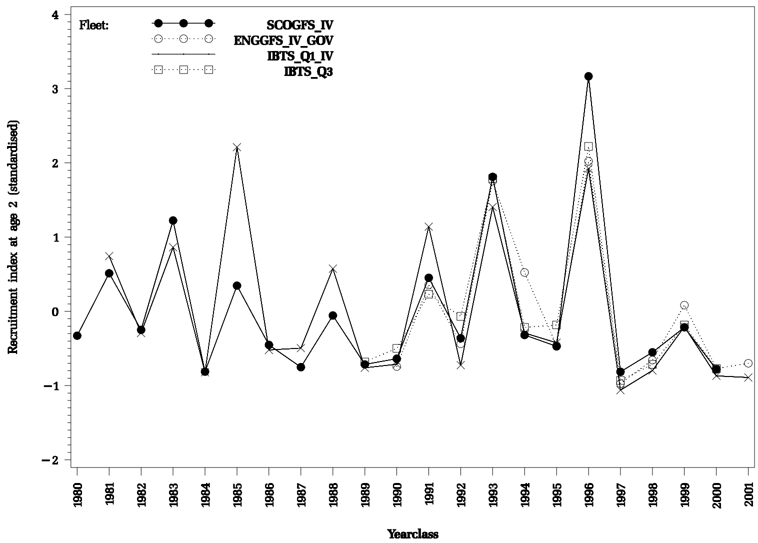


Figure 3.4.8 Cod in Subarea IV and Divisions IIIa and VIId: Comparison of standardised survey indices of SSB with standardised VPA SSB.

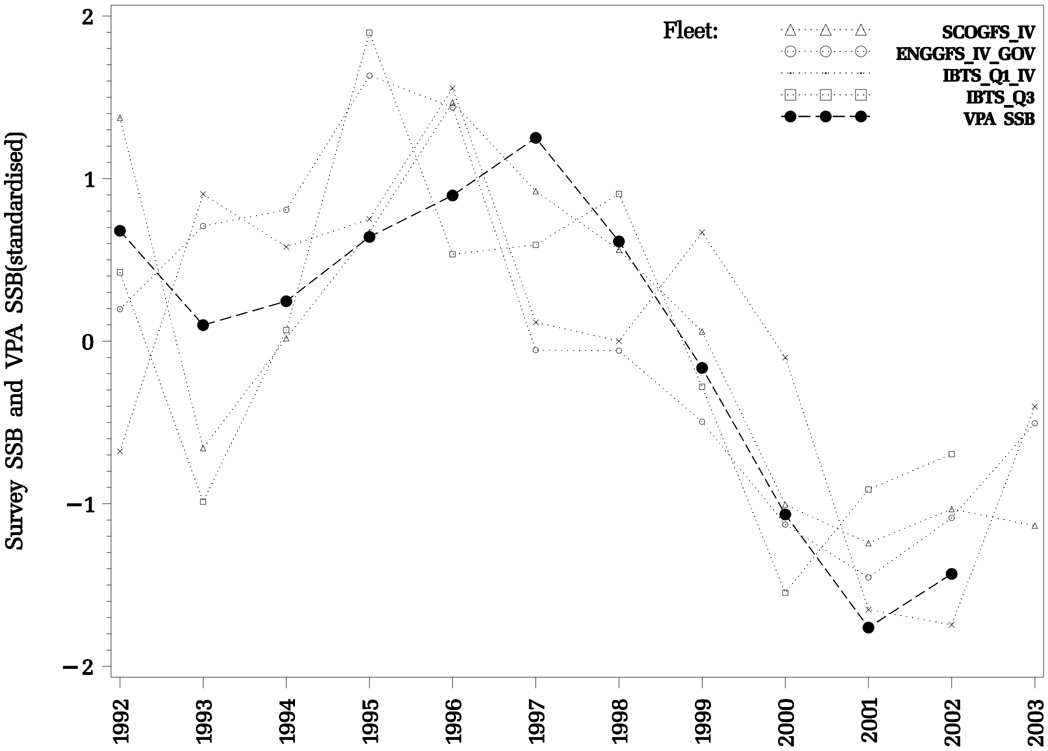


Figure 3.4.9 Cod in Subarea IV and Divisions IIIa and VIId: Comparison of immature stock size indices with standardised VPA estimates of the size of the immature part of the stock

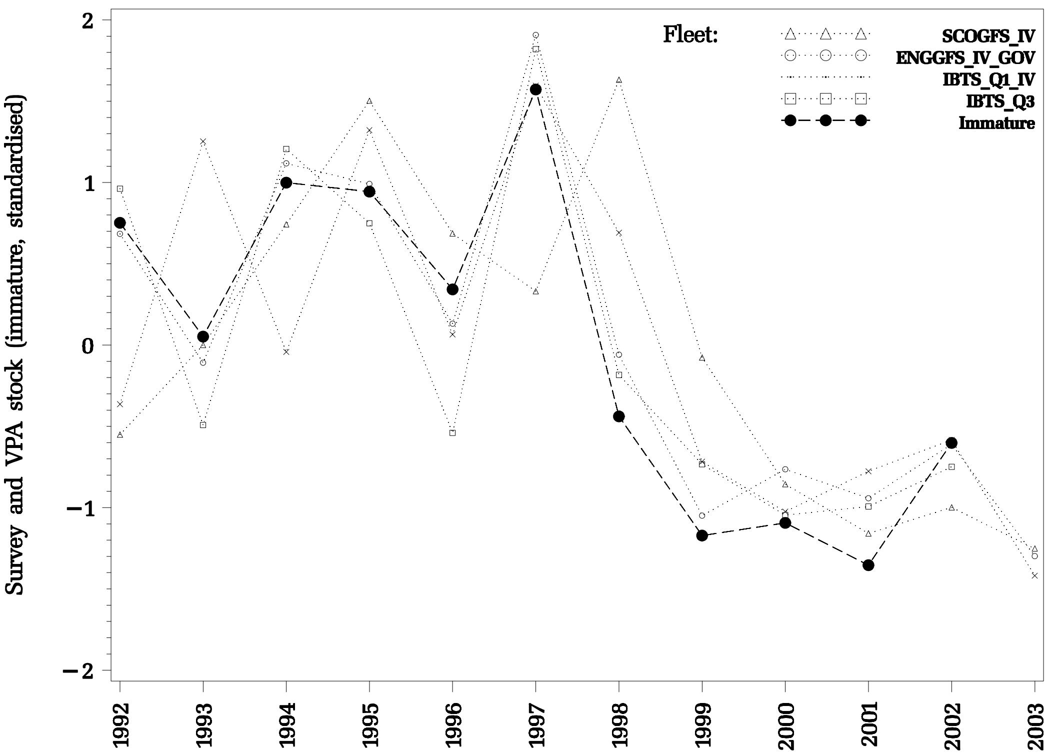


Figure 3.4.10a Cod in Subarea IV and Divisions IIIa and VIId: Scottish GFS stock and recruit plots using survey indices of SSB and recruitment.

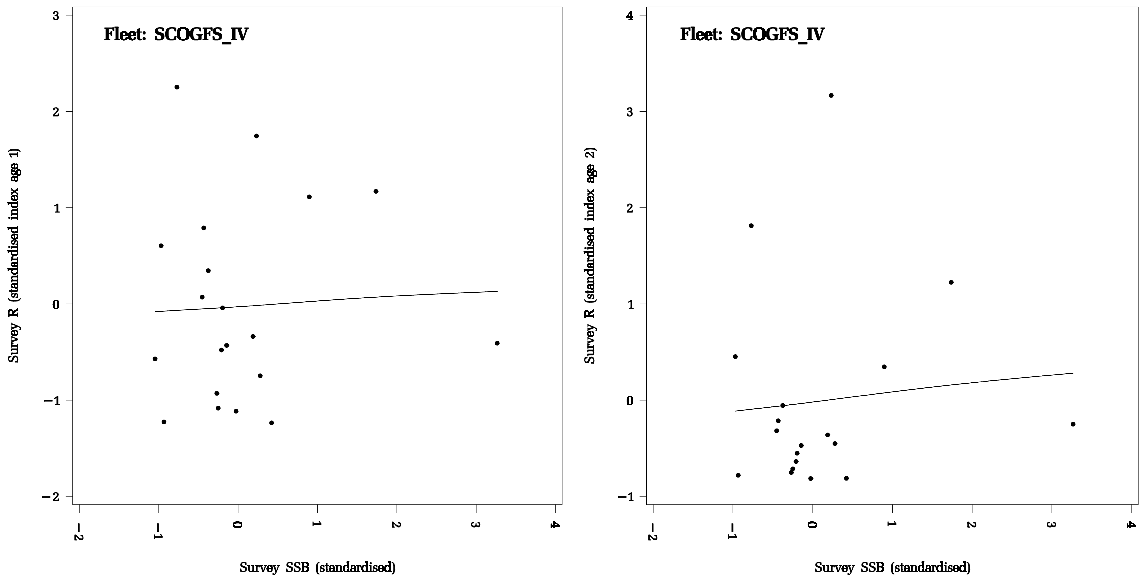


Figure 3.4.10b Cod in Subarea IV and Divisions IIIa and VIId: English GFS stock and recruit plots using survey indices of SSB and recruitment.

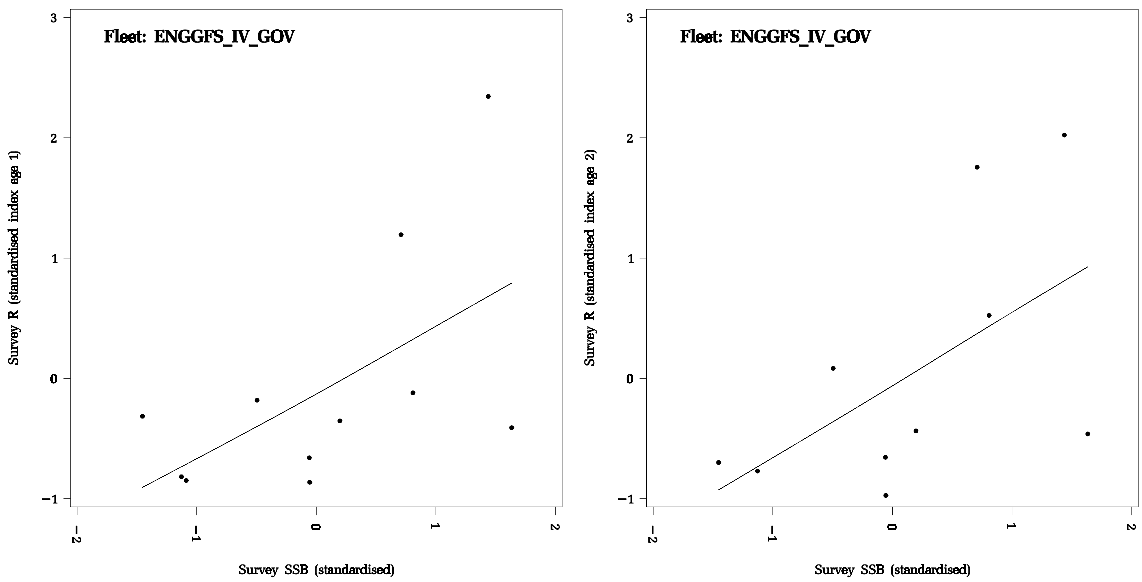


Figure 3.4.10c Cod in Subarea IV and Divisions IIIa and VIId: IBTS stock and recruit plots using survey indices of SSB and recruitment.

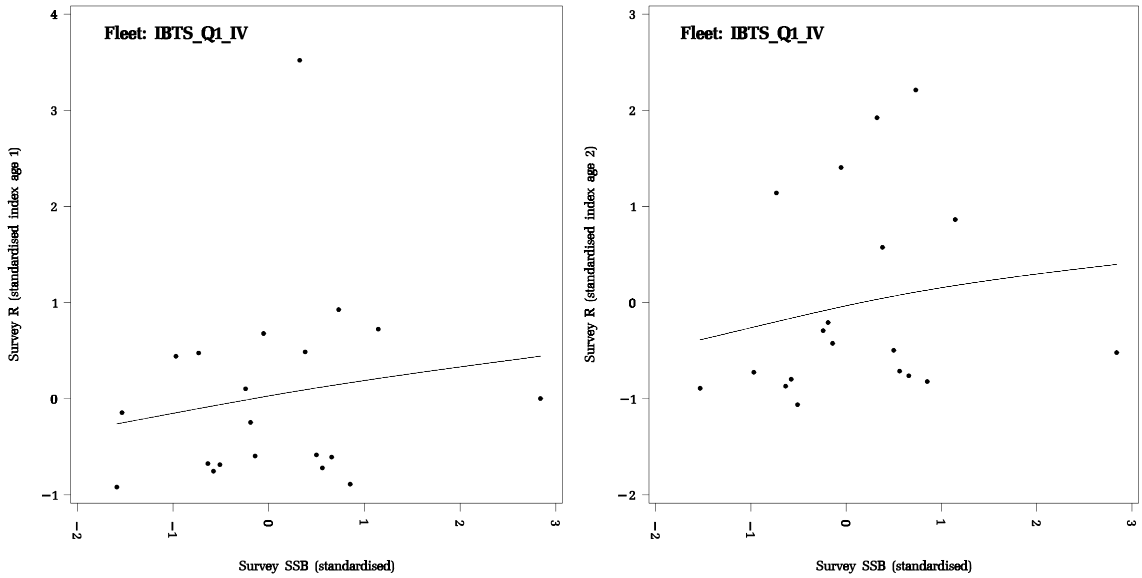


Figure 3.4.11 Cod in Subarea IV and Divisions IIIa and VIId: Weighted survey $\overline{Z}_{2-5}$ for 4 of the available tuning series.

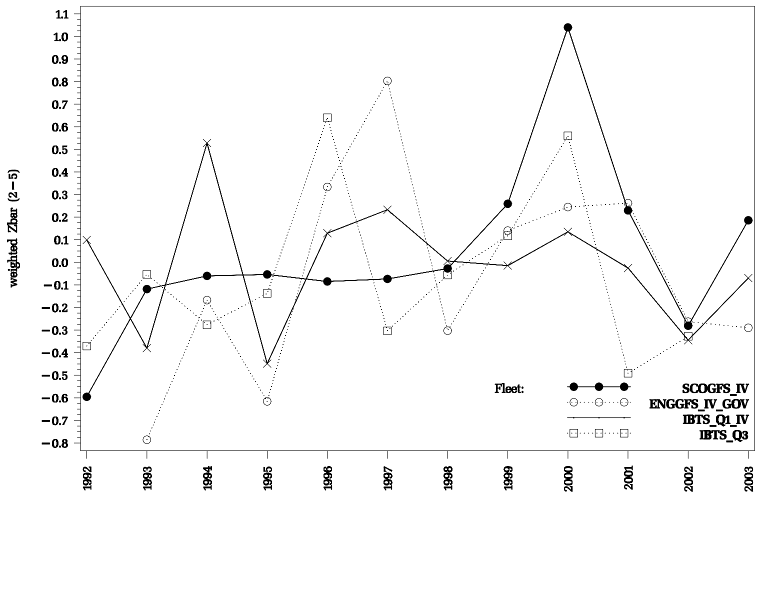


Figure 3.4.12. Cod in Subarea IV and Divisions IIIa and VIId: Summary results of surba runs with the English GFS survey.

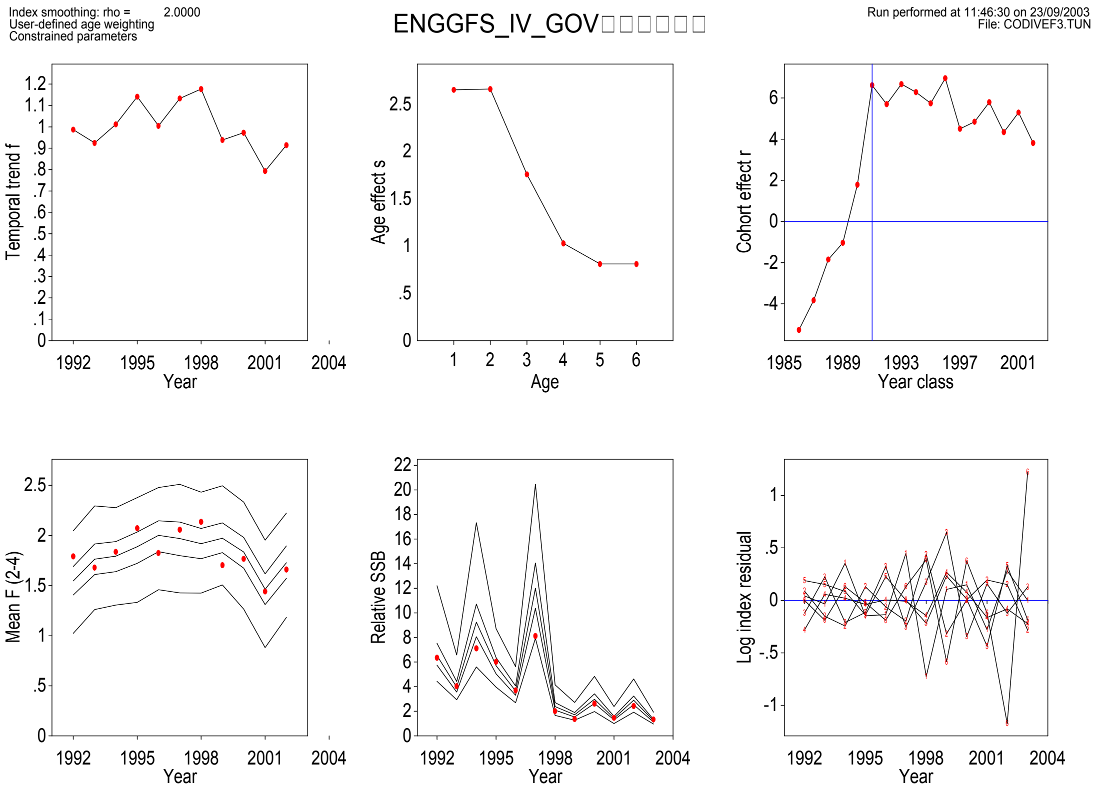


Figure 3.4.13. Cod in Subarea IV and Divisions IIIa and VIId: Summary results of surba runs with Scottish GFS survey.

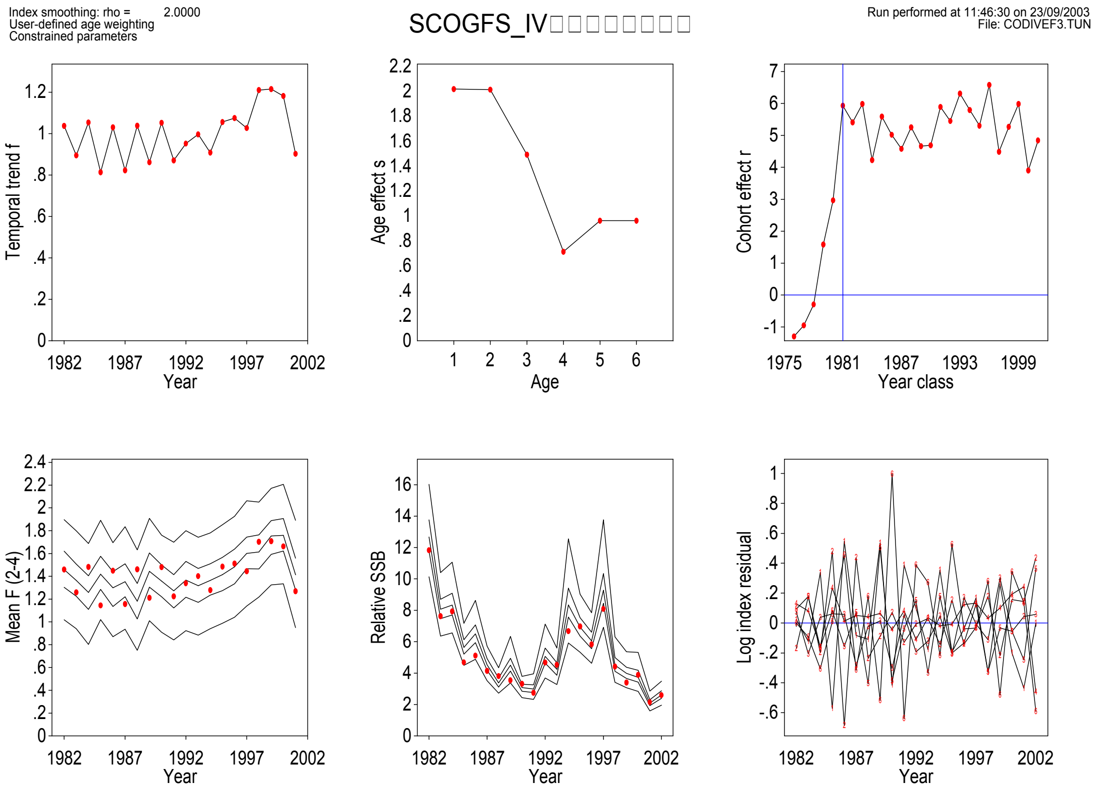


Figure 3.4.14. Cod in Subarea IV and Divisions IIIa and VIId: Summary results of surba runs with IBTS Q1 survey.

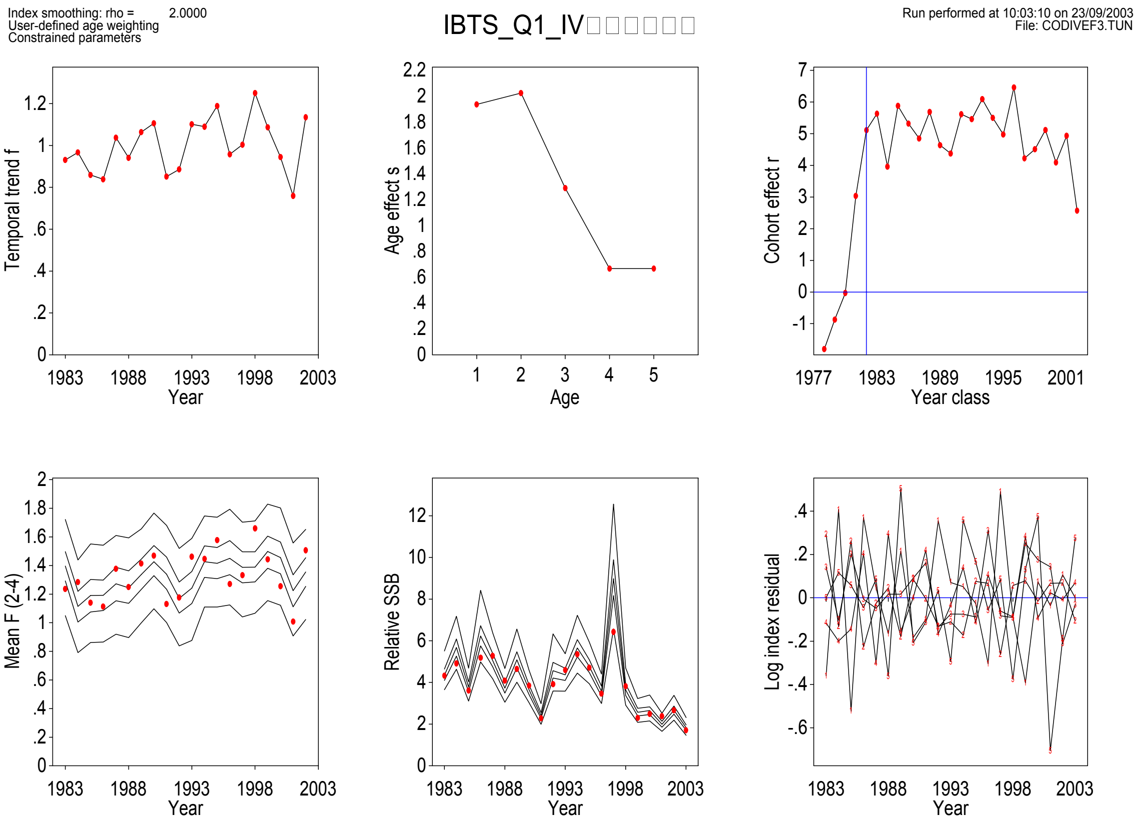


Figure 3.4.15a Cod in Subarea IV and Divisions IIIa and VIId: The log catchability residuals resulting from a fit of the Laurec-Shepherd VPA calibration model to the catch at age data set and the English groundfish survey data for 19993 – 2002.

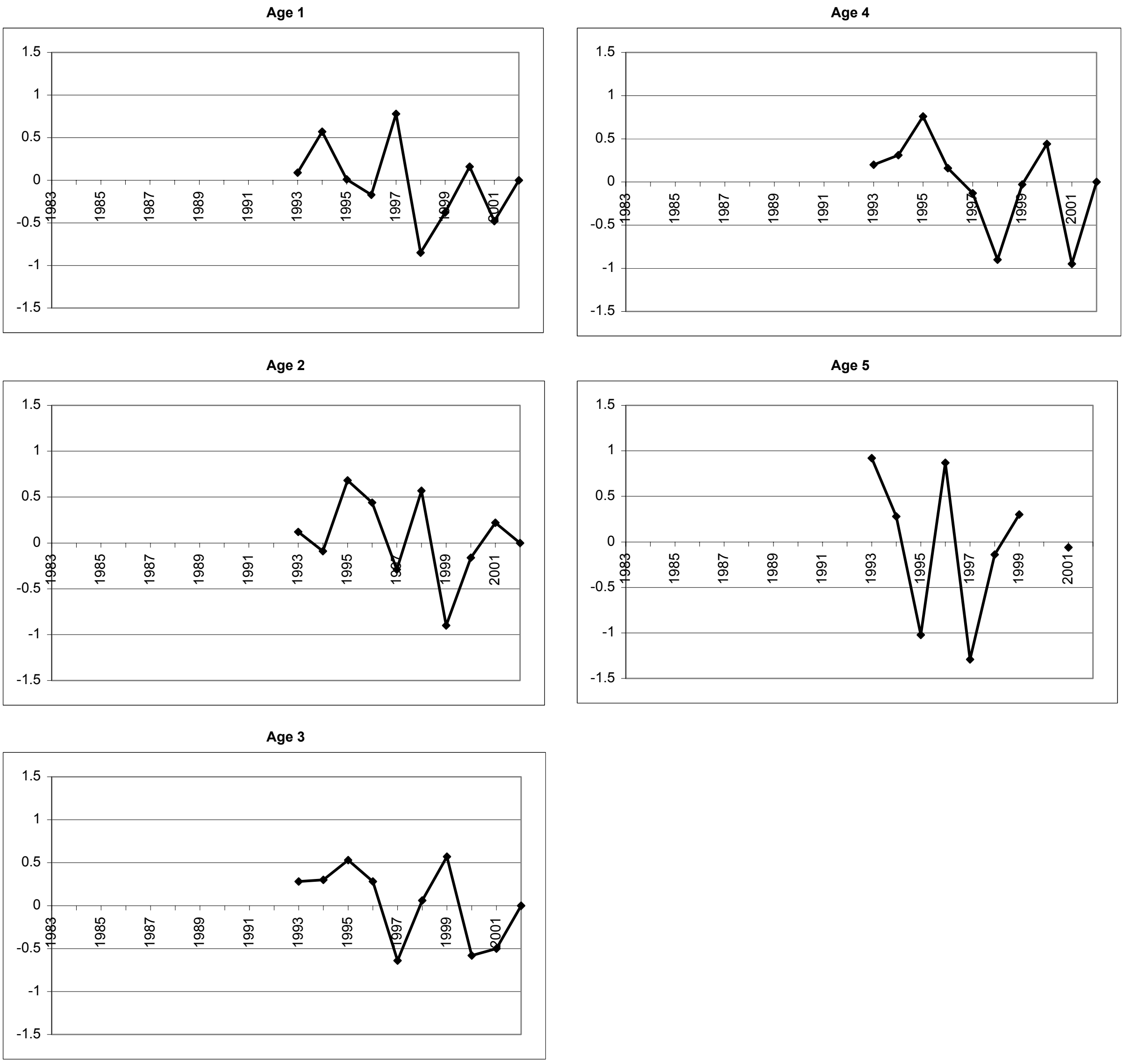


Figure 3.4.15b Cod in Subarea IV and Divisions IIIa and VIId: The log catchability residuals resulting from a fit of the Laurec-Shepherd VPA calibration model to the catch at age data set and the Scottish groundfish survey data for 1983 – 2002.

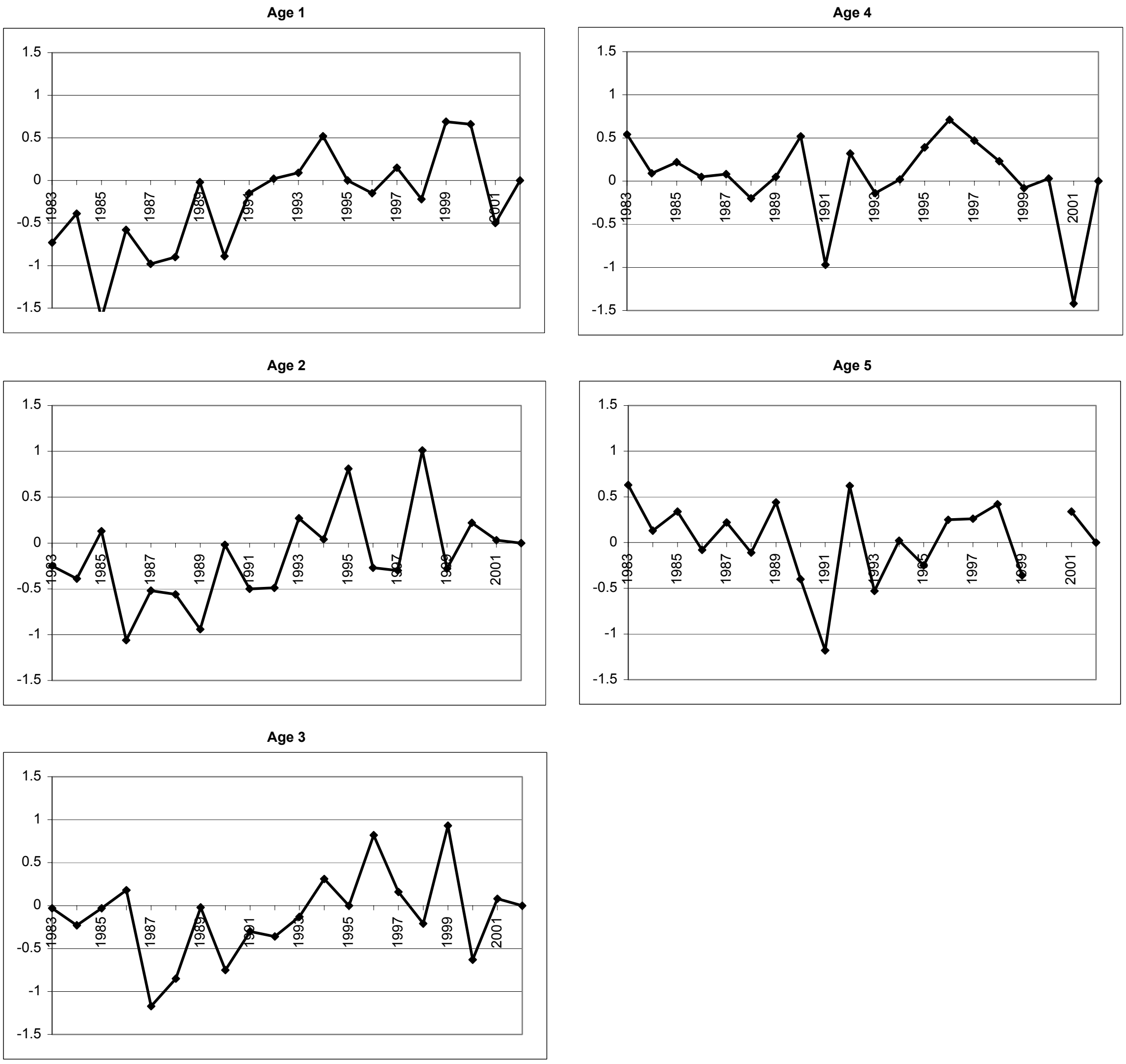


Figure 3.4.15c Cod in Subarea IV and Divisions IIIa and VIId: The log catchability residuals resulting from a fit of the Laurec-Shepherd VPA calibration model to the catch at age data set and the IBTS groundfish survey data for 1993 – 2002.

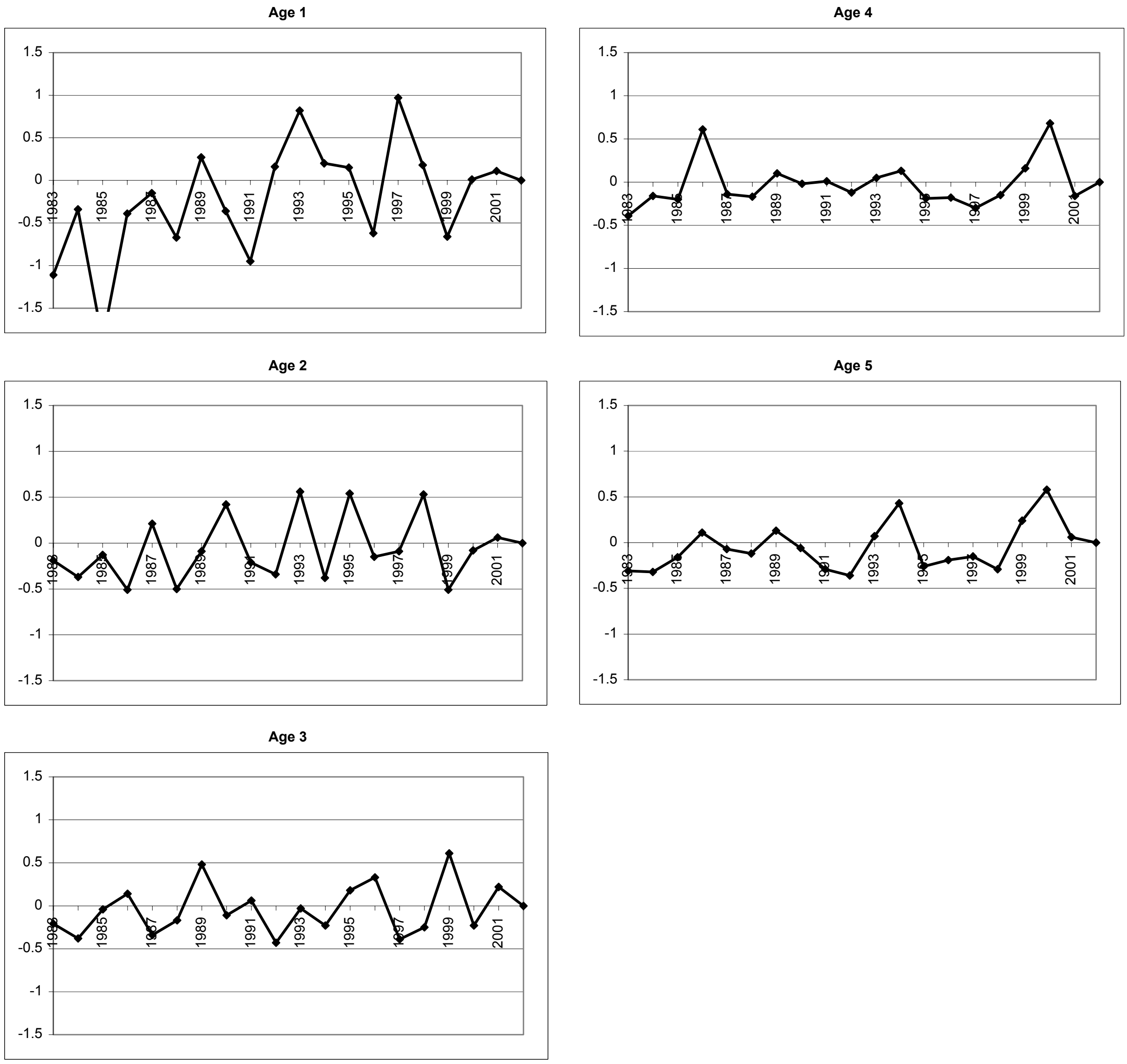


Figure 3.4.16 Cod in Subarea IV and Divisions IIIa and VIId: Stock summary plots for the TSA base case analysis (max catch year = 2002) with approximate 95% pointwise confidence intervals (dashed lines). The vertical dotted lines indicate the last year of catch data, all subsequent estimates are TSA forecasts. Circles on the first graph indicate total reported catches (human consumption, discards and industrial bycatch).

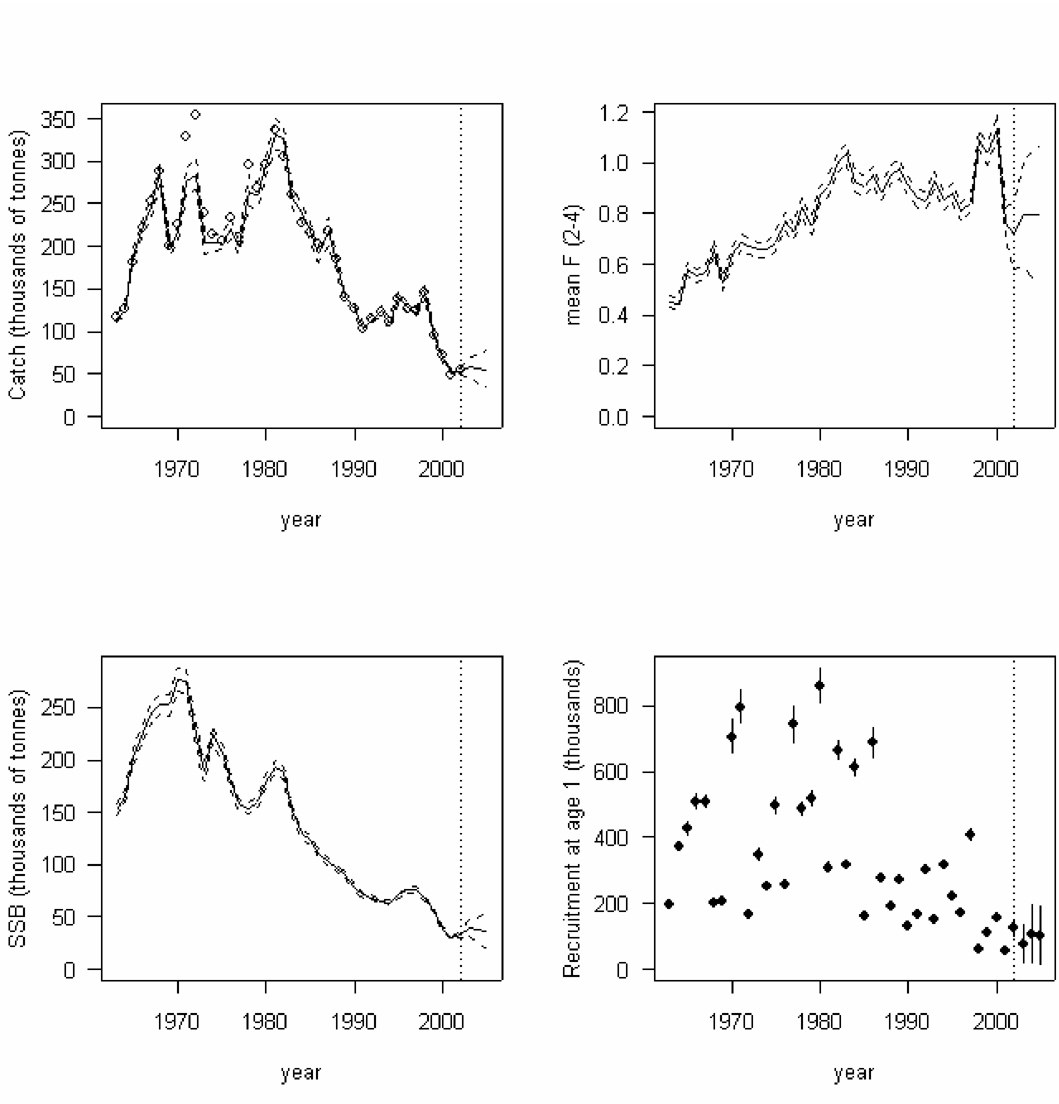


Figure 3.4.17 Cod in Subarea IV and Divisions IIIa and VIId: A comparison of 3 TSA runs, the first using the full set of catch data up to 2002, and survey data up to 2002 (solid line) shown with approximate 95% pointwise confidence intervals (dotted lines), the second having removed the last two years of catch data (dashed line), the third having removed catch data back to 1995 (dashed-dotted lines). The reported catches are shown as circles in the relevant graph.

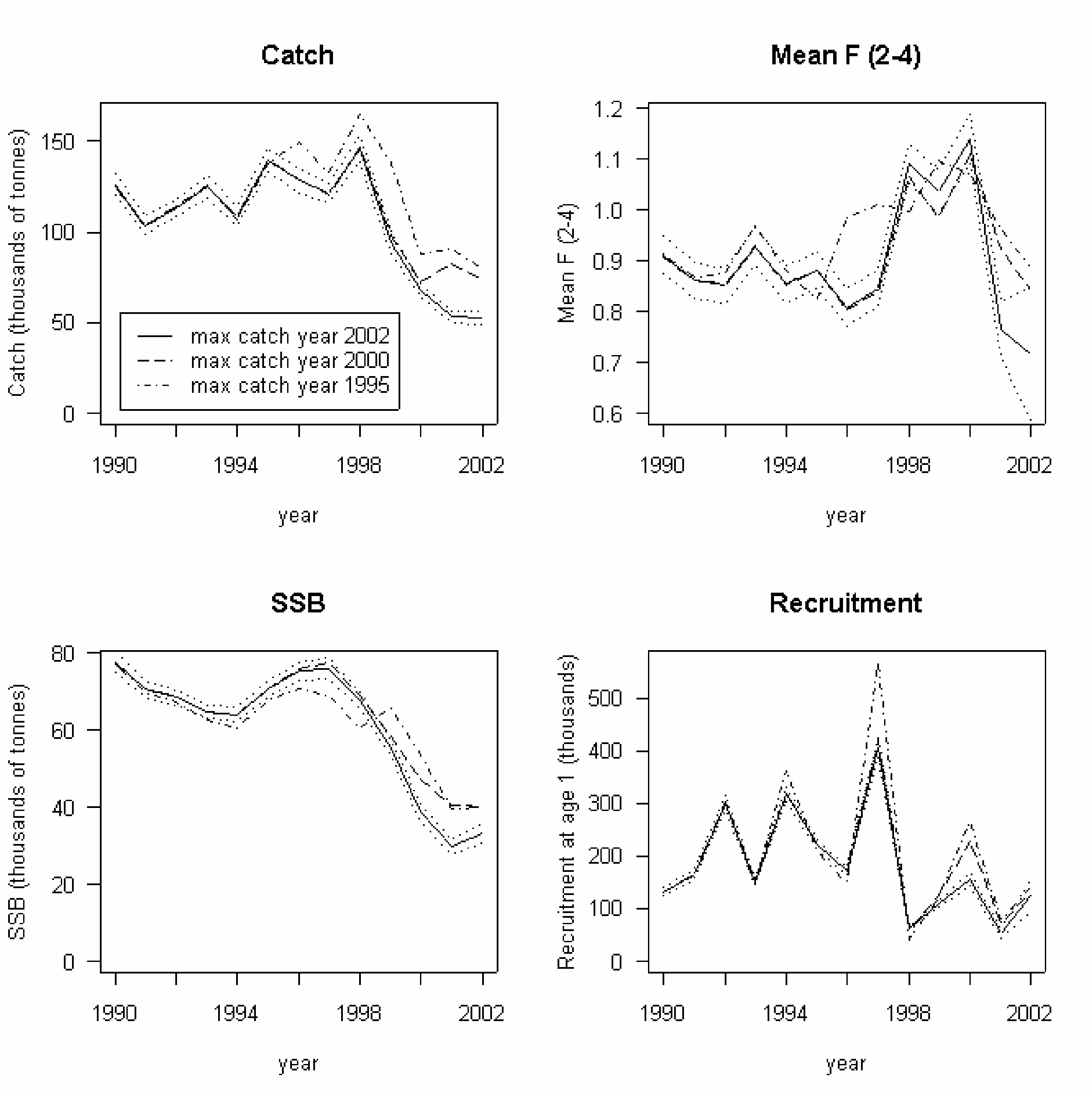


Figure 3.4.18 Cod in Subarea IV and Divisions IIIa and VIId: TSA Retrospectives with two years of catch data removed. The longest lines in each plot are the results from a TSA run using survey data to 2003 but catch data only to 2000, the next longest line is results from a TSA run using survey data to 2002 but catch data only to 1999, etc.

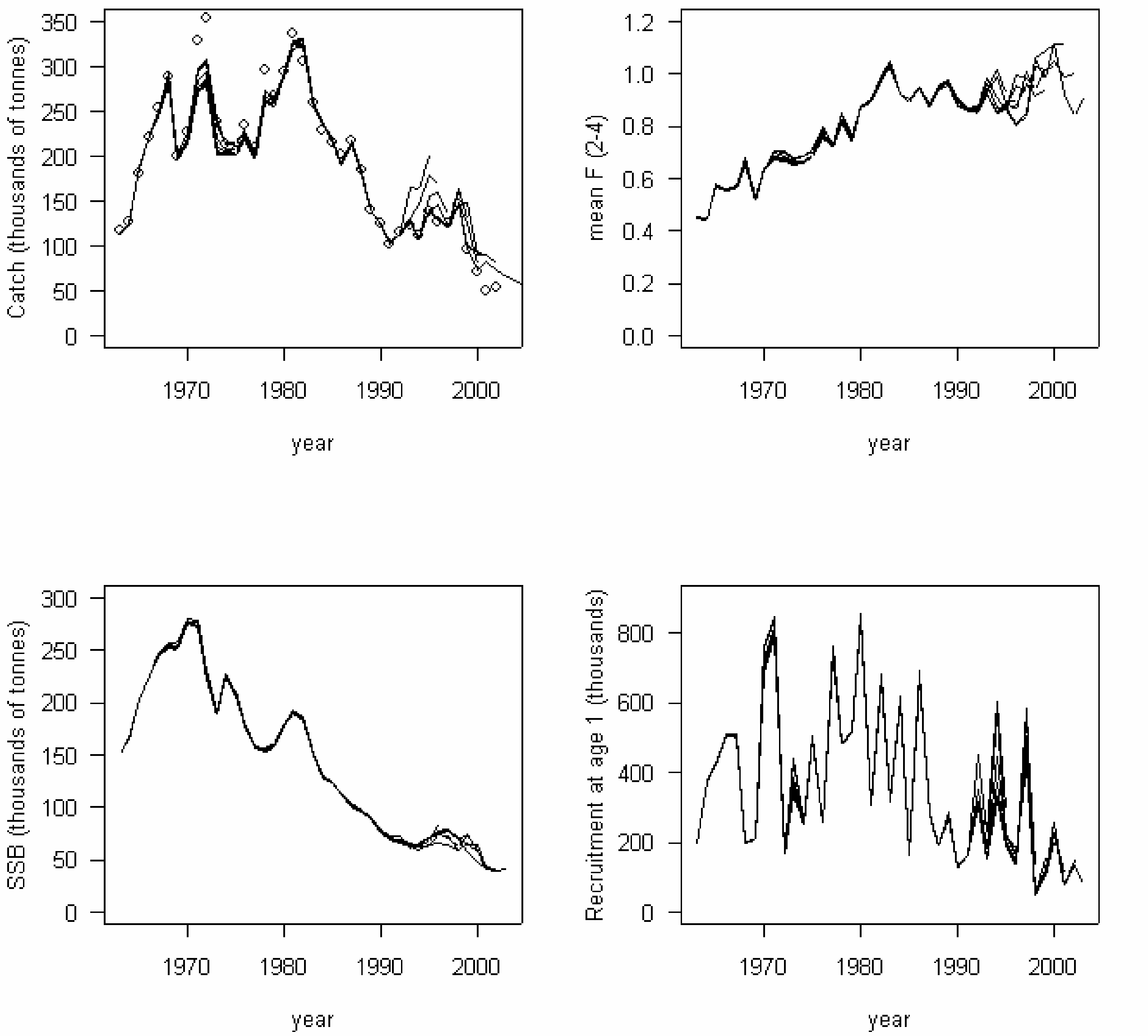
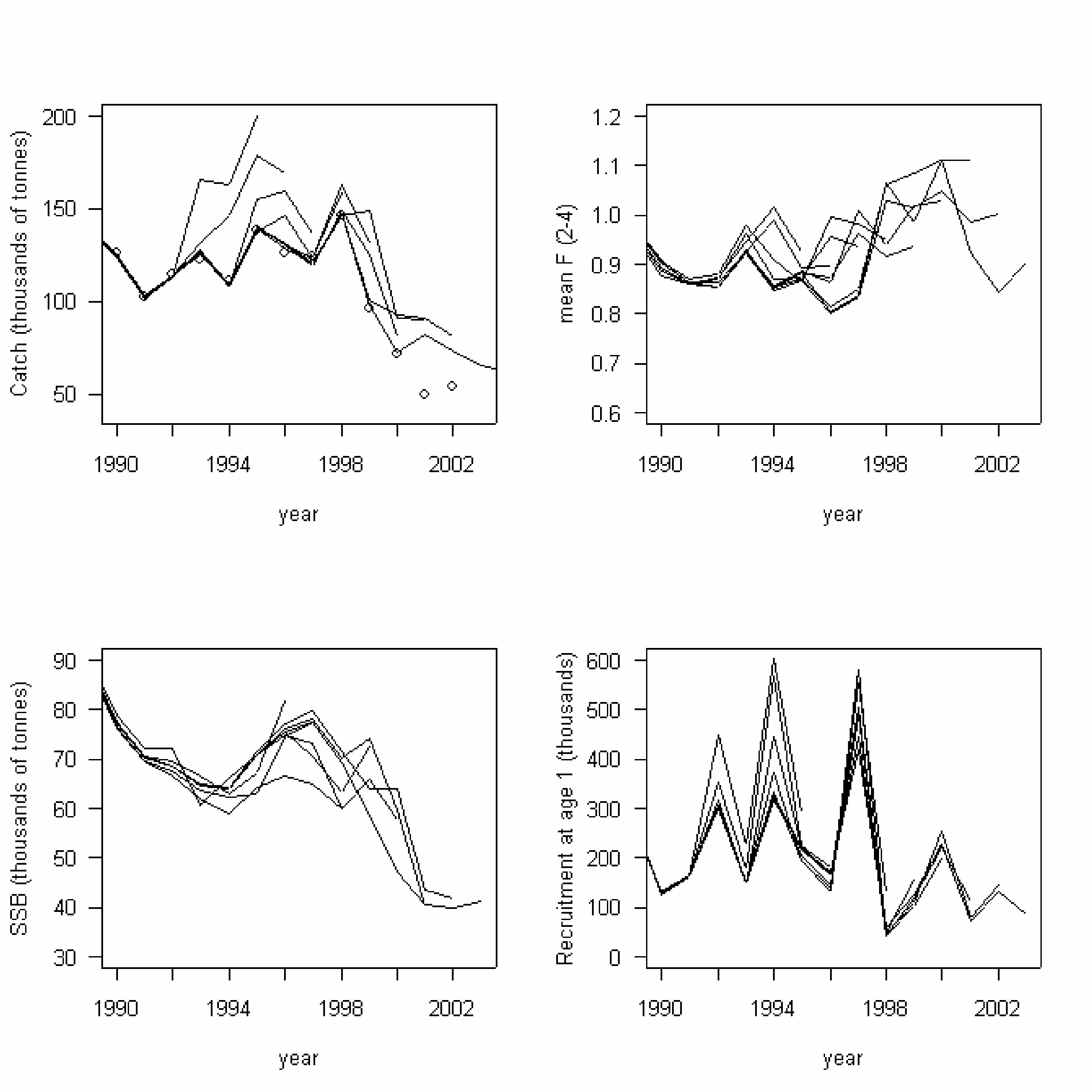


Figure 3.4.19 Cod in Subarea IV and Divisions IIIa and VIId: TSA Retrospectives with two years of catch data removed, enlarging the results for 1990-2003. The longest lines in each plot are results from a TSA run using survey data to 2003 but catch data only to 2000, the next longest line is the results from a TSA run using survey data to 2002



but catch data only to 1999, etc.

Figure 3.4.20 Cod in Subarea IV and Divisions IIIa and VIId: Retrospective XSA plots at a range of shrinkage levels

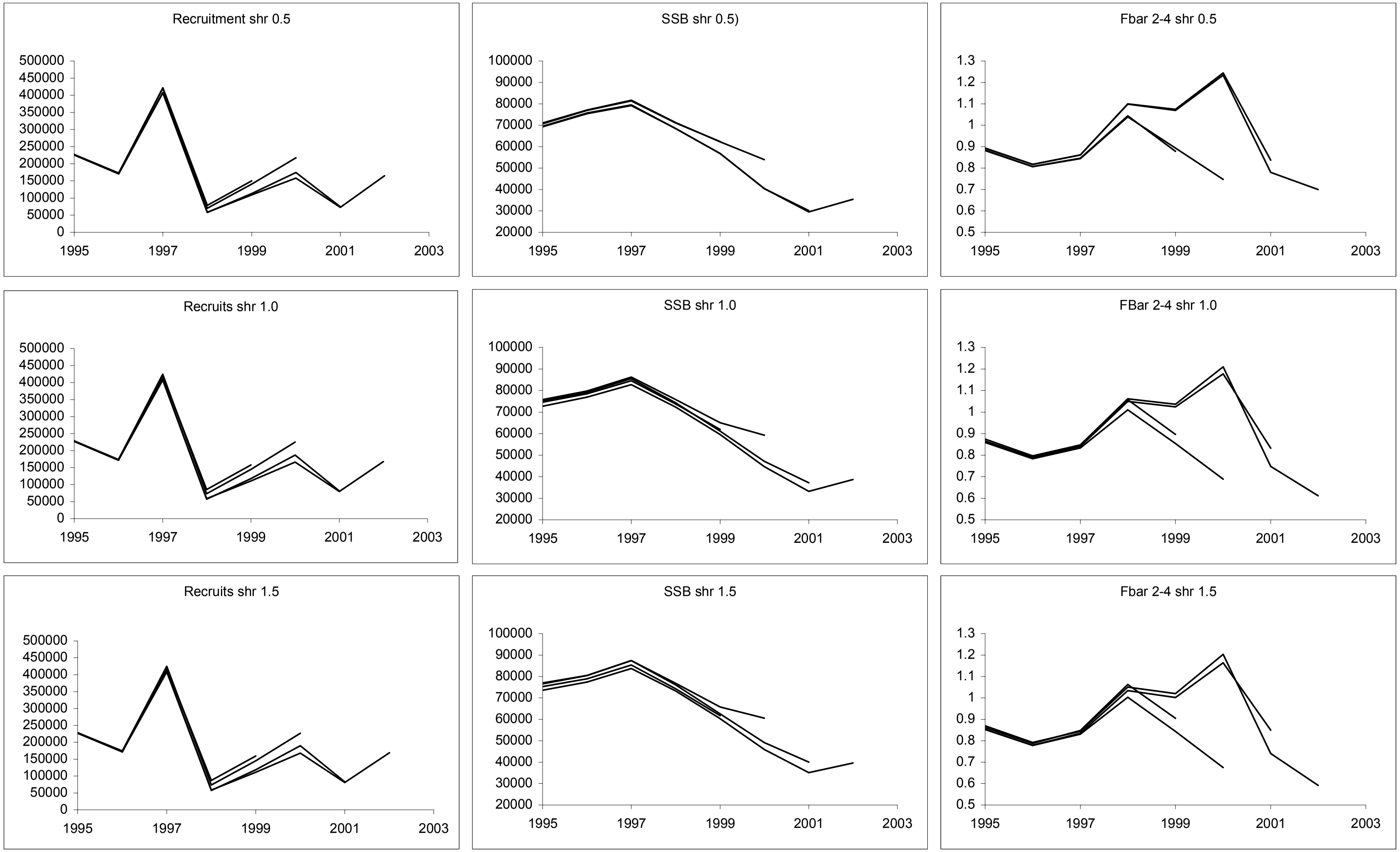


Figure 3.4.21 Cod in Subarea IV and Divisions IIIa and VIId: XSA log catchability residuals for each of the three tuning fleet series.

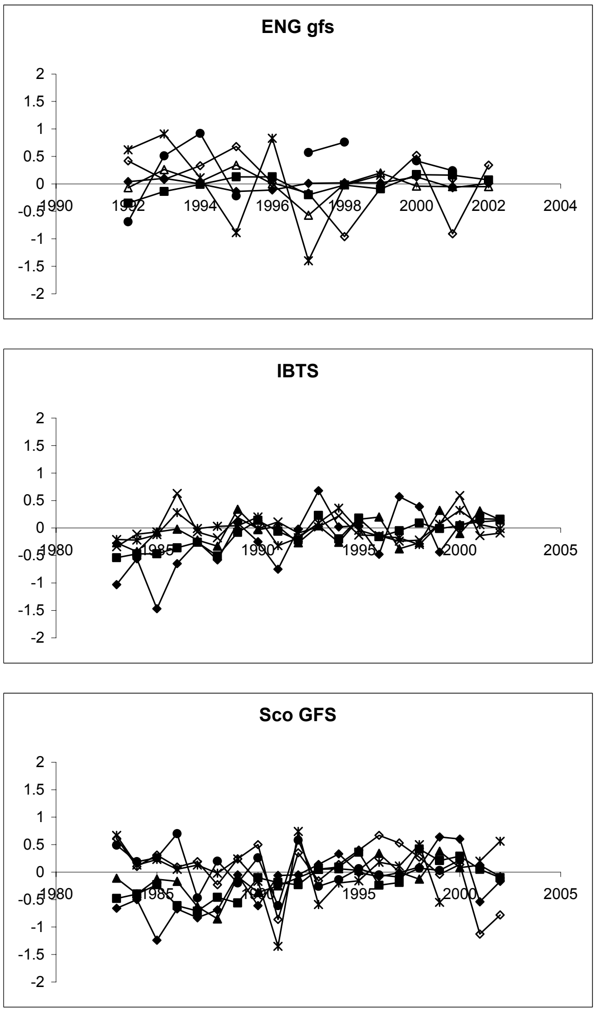


Figure 3.4.22 Cod in Subarea IV and Divisions IIIa and VIId: Spawning stock biomass and average fishing mortality at ages 2 – 4 estimated from XSA models fitted to each of the individual survey seiries with low shrikage weight and the final combined assessment model.

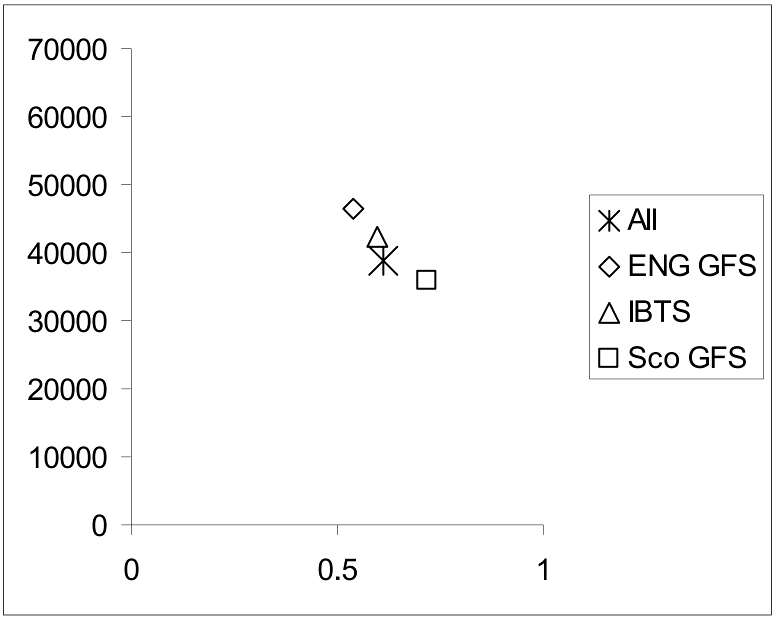


Figure 3.4.23 Cod in Subarea IV and Divisions IIIa and VIId: stock summary plot

North Sea cod: Summary plots for results of XSA using three surveys (EGFS tuning series split), plus group at age 7+, F shrinkage 1.0

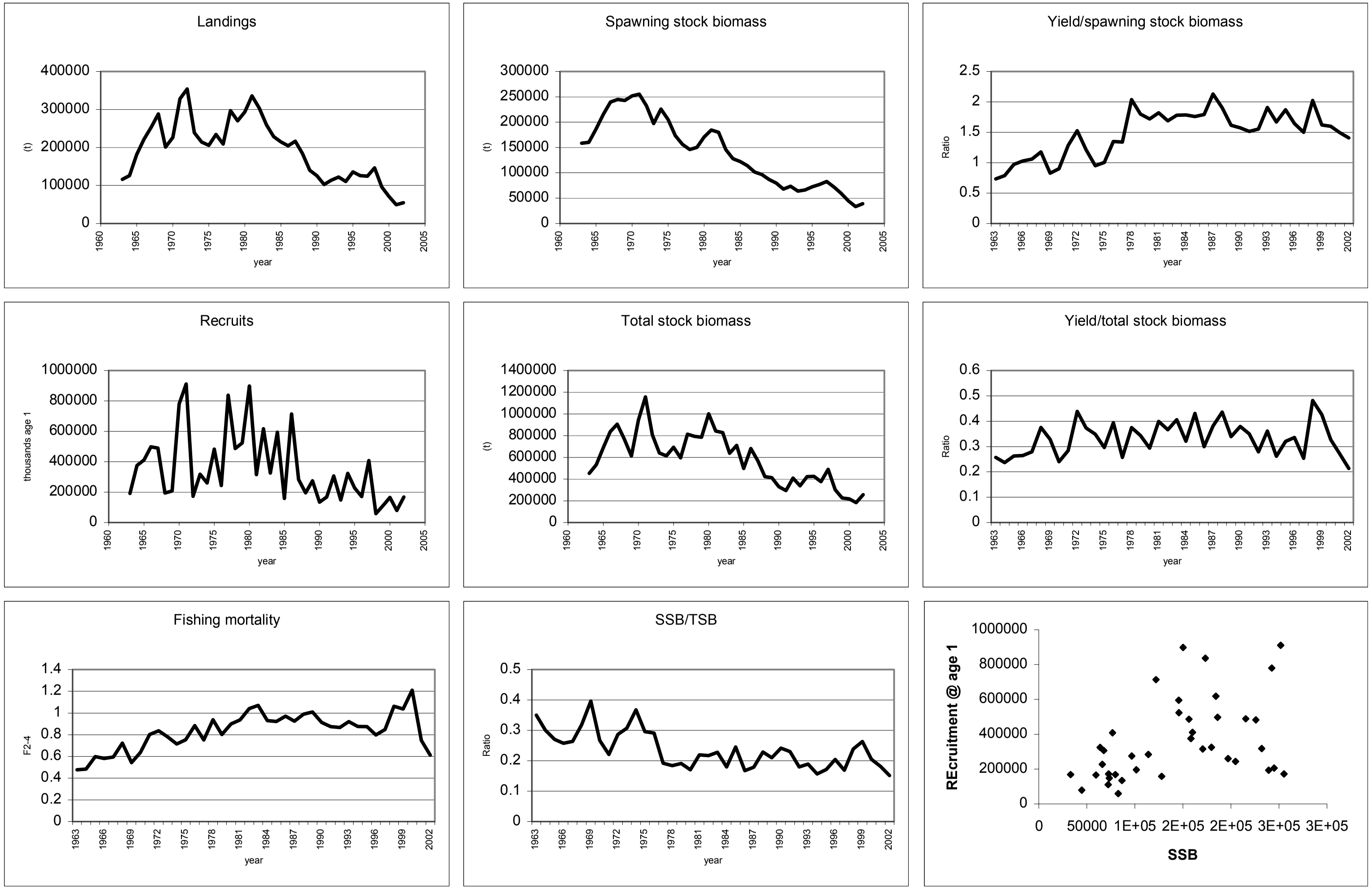


Figure 3.4.24 Cod in Subarea IV and Divisions IIIa and VIId: A comparison of the time series of stock metric as estimated by the XSA fitted models at the 2002 and 2003 North Sea Demersal Working Group.

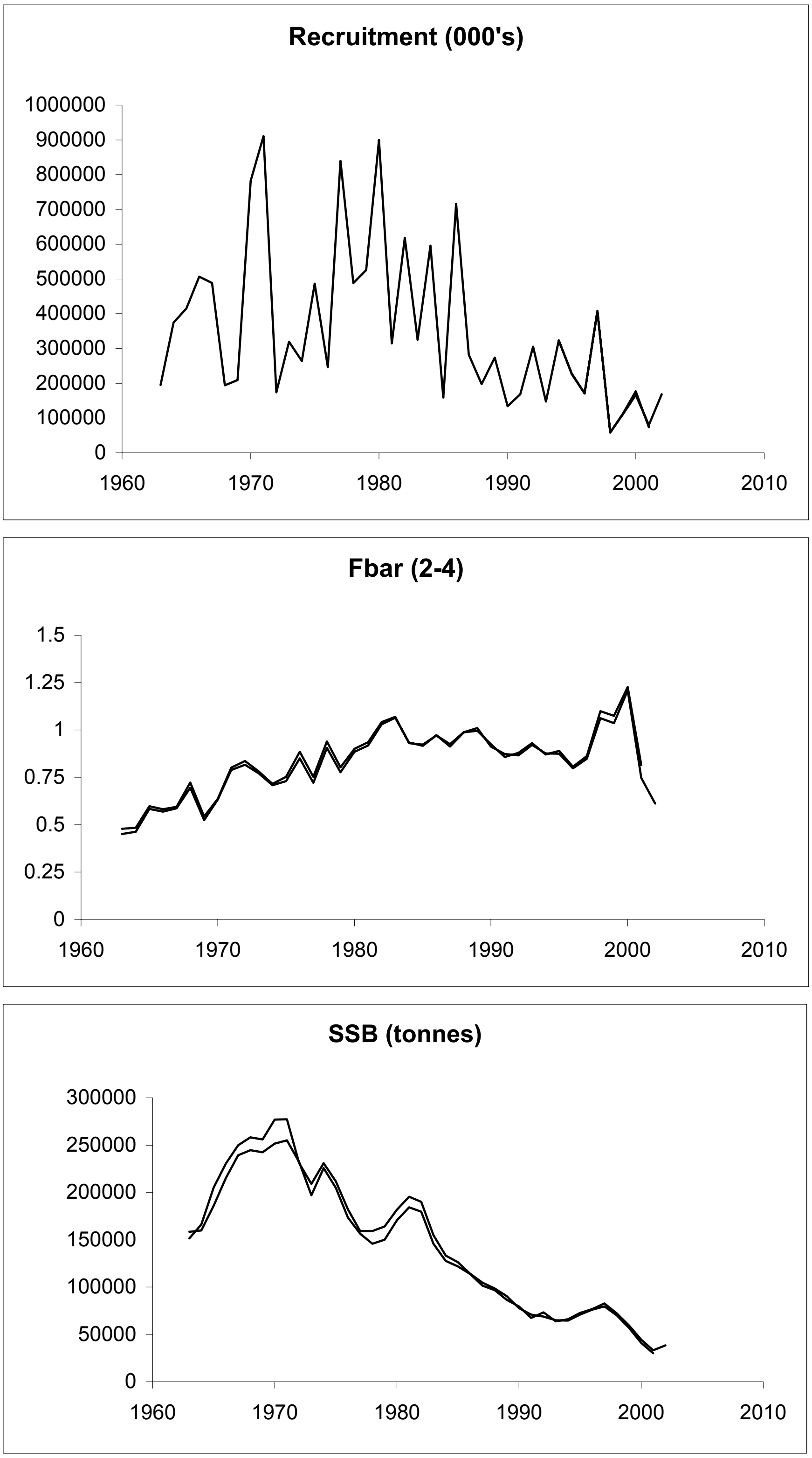
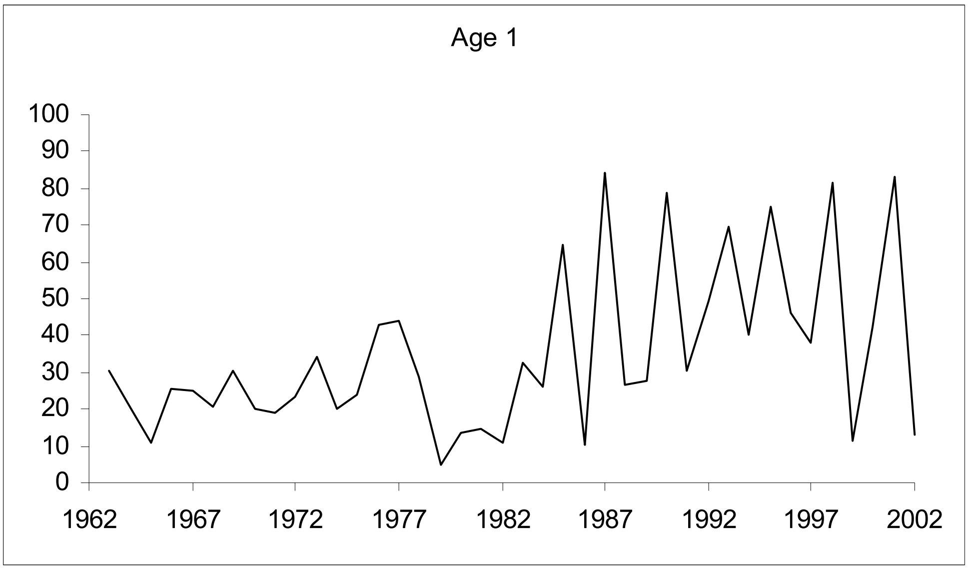


Figure 3.4.25 Cod in Subarea IV and Divisions IIIa and VIId: The proportion of cod discards (numbers) at ages 1 and 2 as estimated from the Scottish sampling scheme.



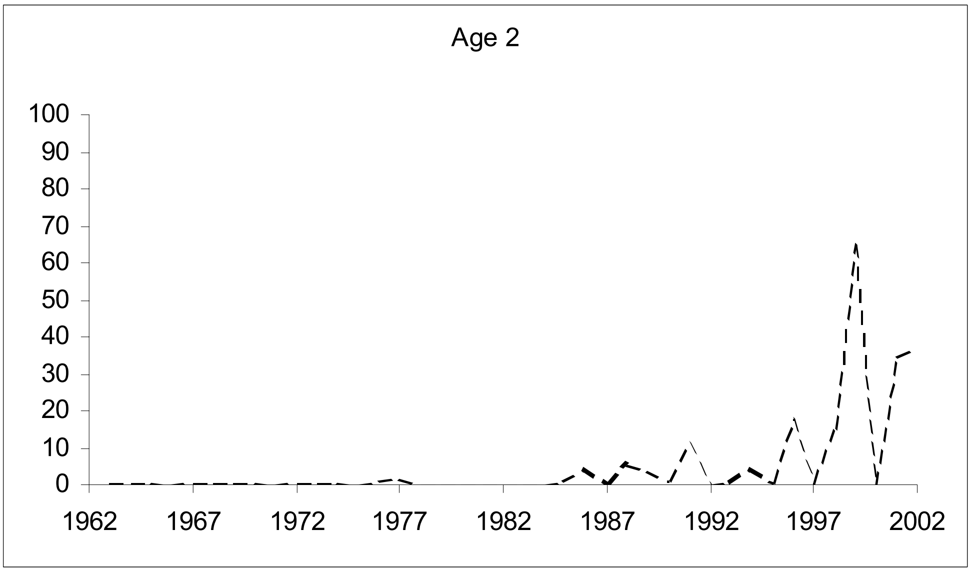


Figure 3.4.26 Cod in Subarea IV and Divisions IIIa and VIId:

North Sea cod: Discard catch summary plots for results of XSA using three surveys (EGFS tuning series shortened), 7+ plus group, F shrinkage 1.0
Solid line - XSA base run without discards and single species natural mortality Fine line - XSA including discards

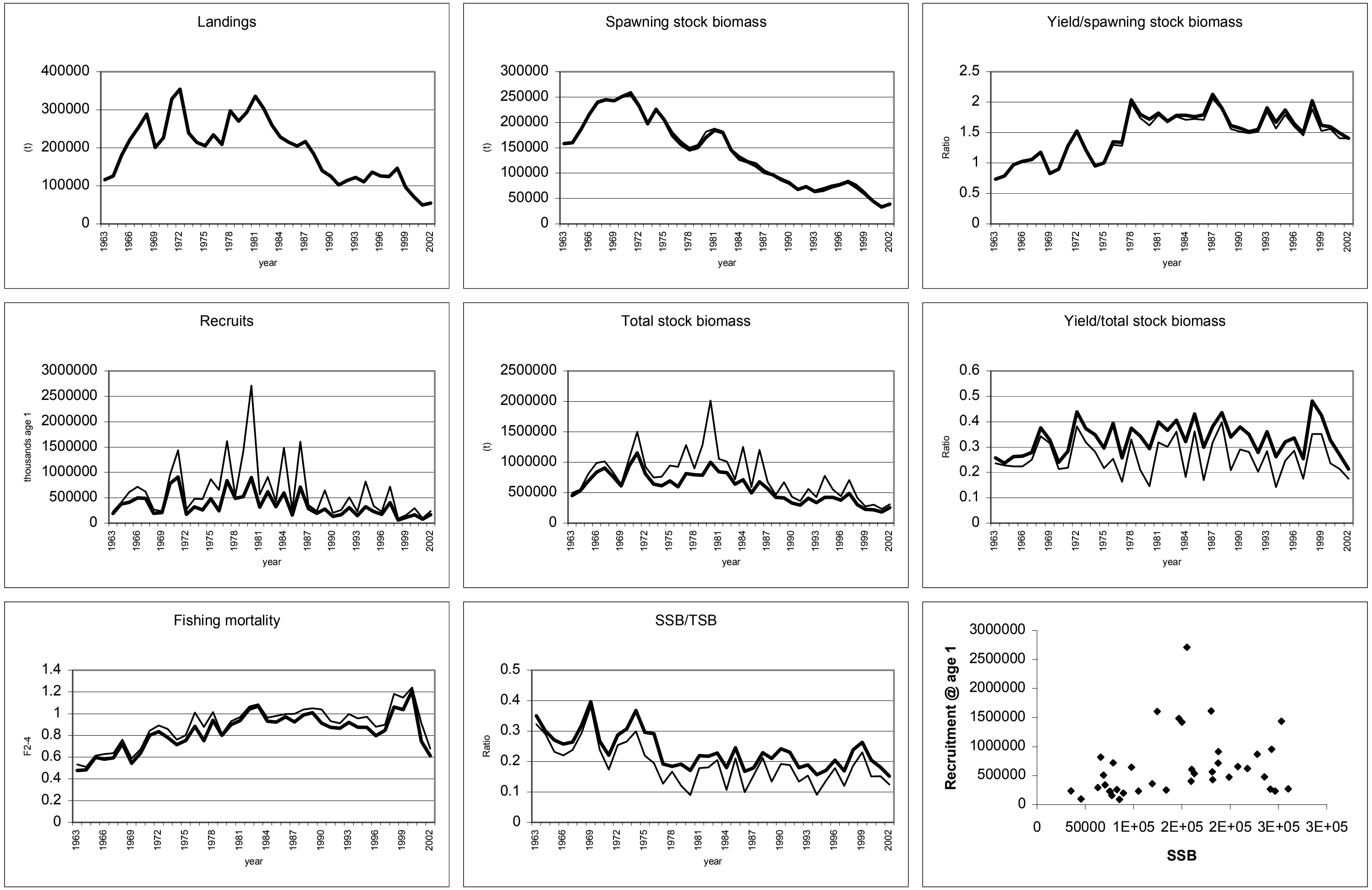


Figure 3.4.27 Cod in Subarea IV and Divisions IIIa and VIId:.

North Sea cod: Multi species M summary plots for results of XSA using three surveys (EGFS tuning series shortened), 7+ plus group, F shrinkage 1.0
Solid line - XSA base run without discards and single species natural mortality. Fine line - XSA including multi-species mortalities

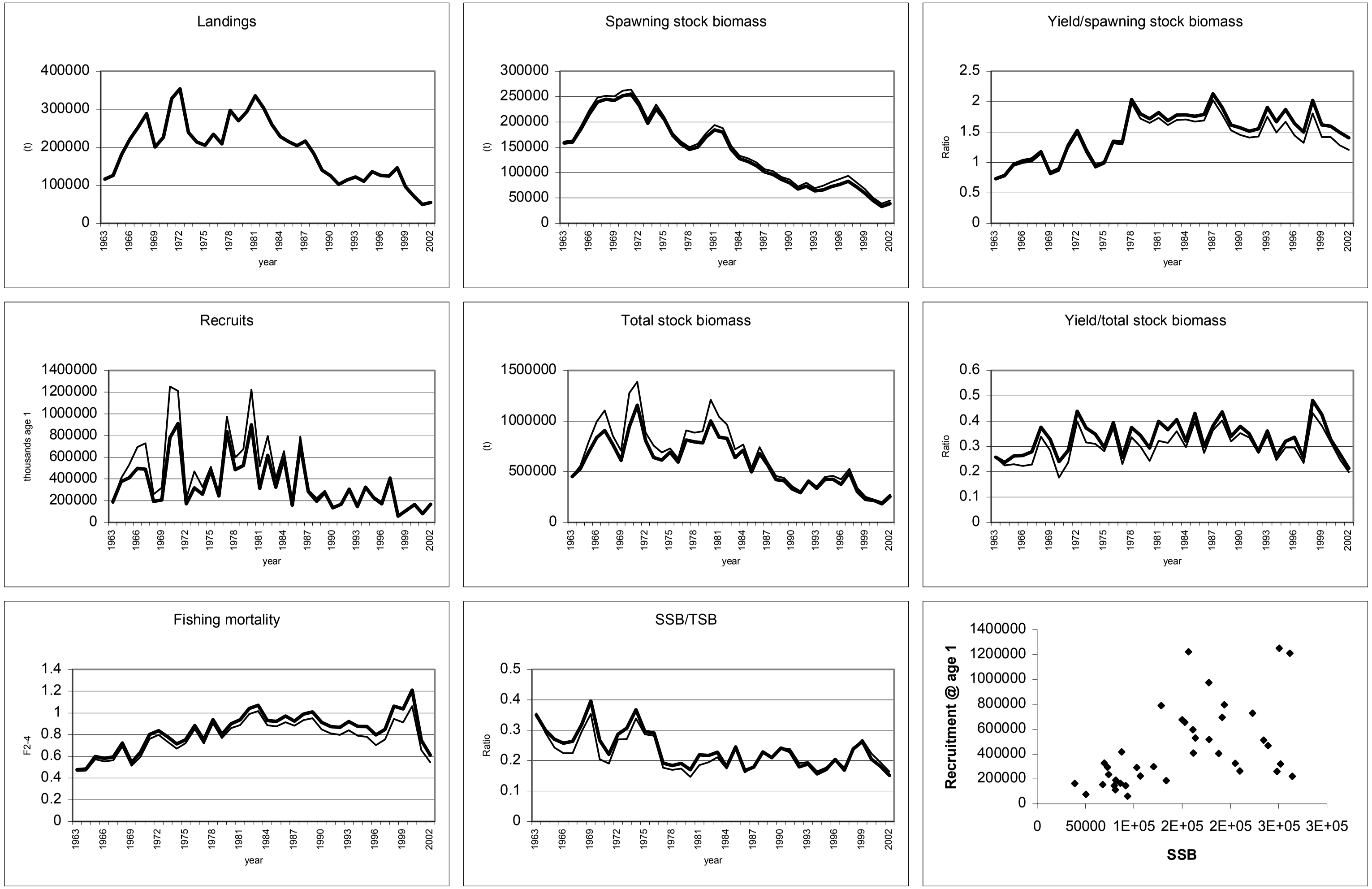


Figure 3.4.28 Cod in Subarea IV and Divisions IIIa and VIId:

North Sea cod: Discard catch and multi species m summary plots. XSA using three surveys (EGFS shortened), 7+ plus group, F shrinkage 1.0
Solid line - XSA base run without discards and single species natural mortality. Fine line - XSA including multi-species mortalities and discards

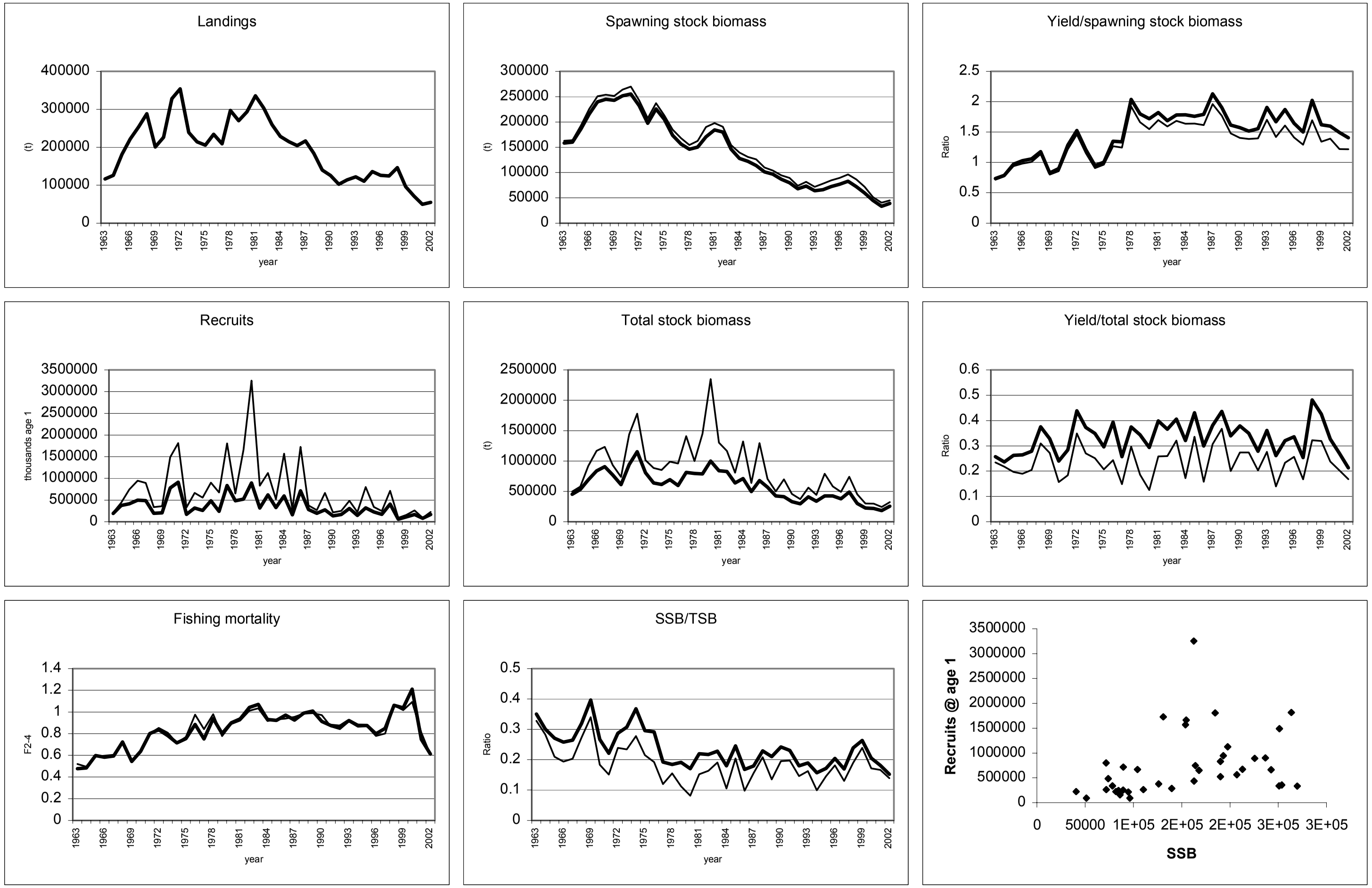


Figure 3.9.1 Cod in Subarea IV and Divisions IIIa and VIId: The PASoft diagnostics plot.

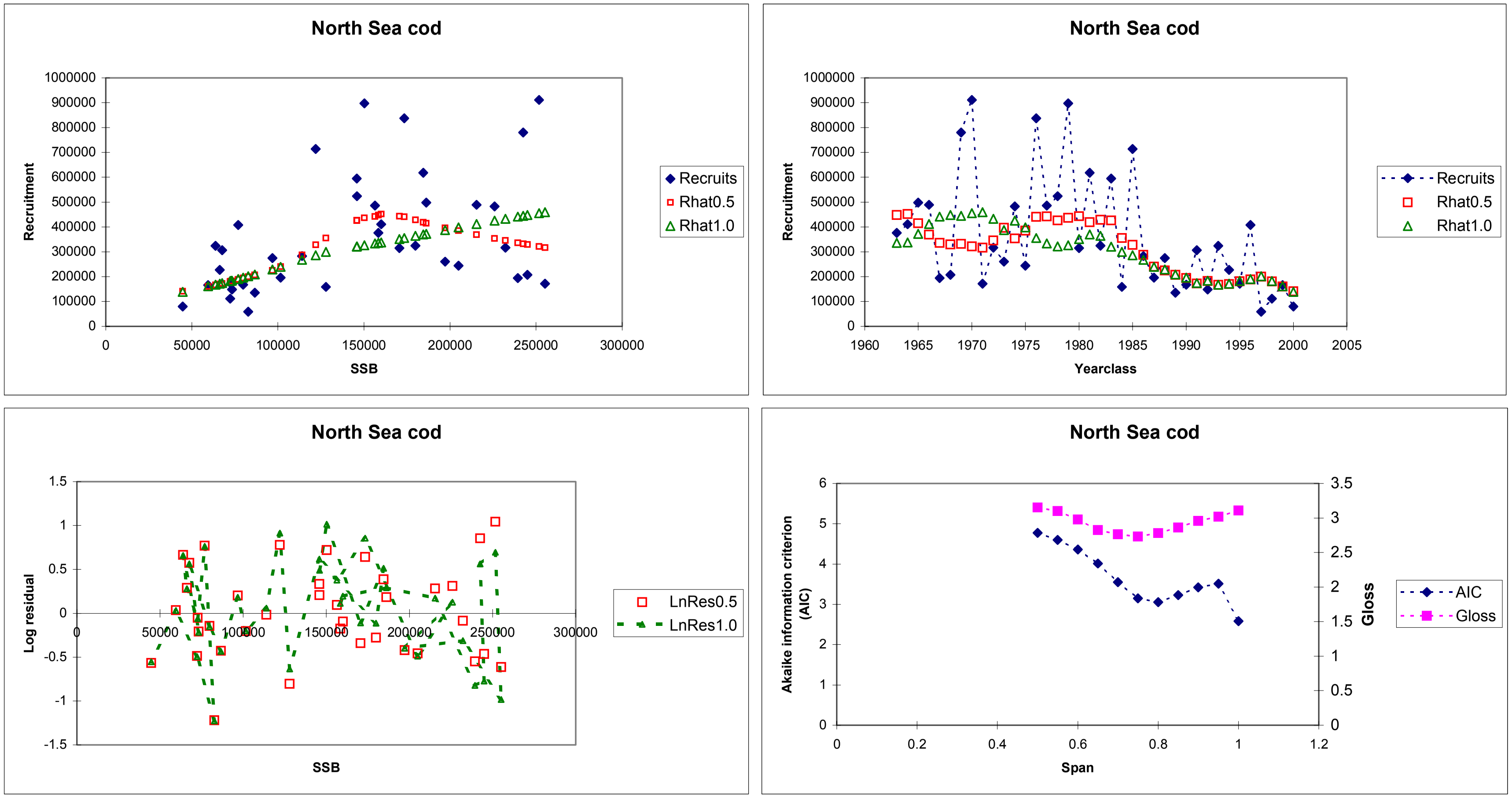


Figure 3.9.2 Cod in Subarea IV and Divisions IIIa and VIId: The PASoft reference point plots

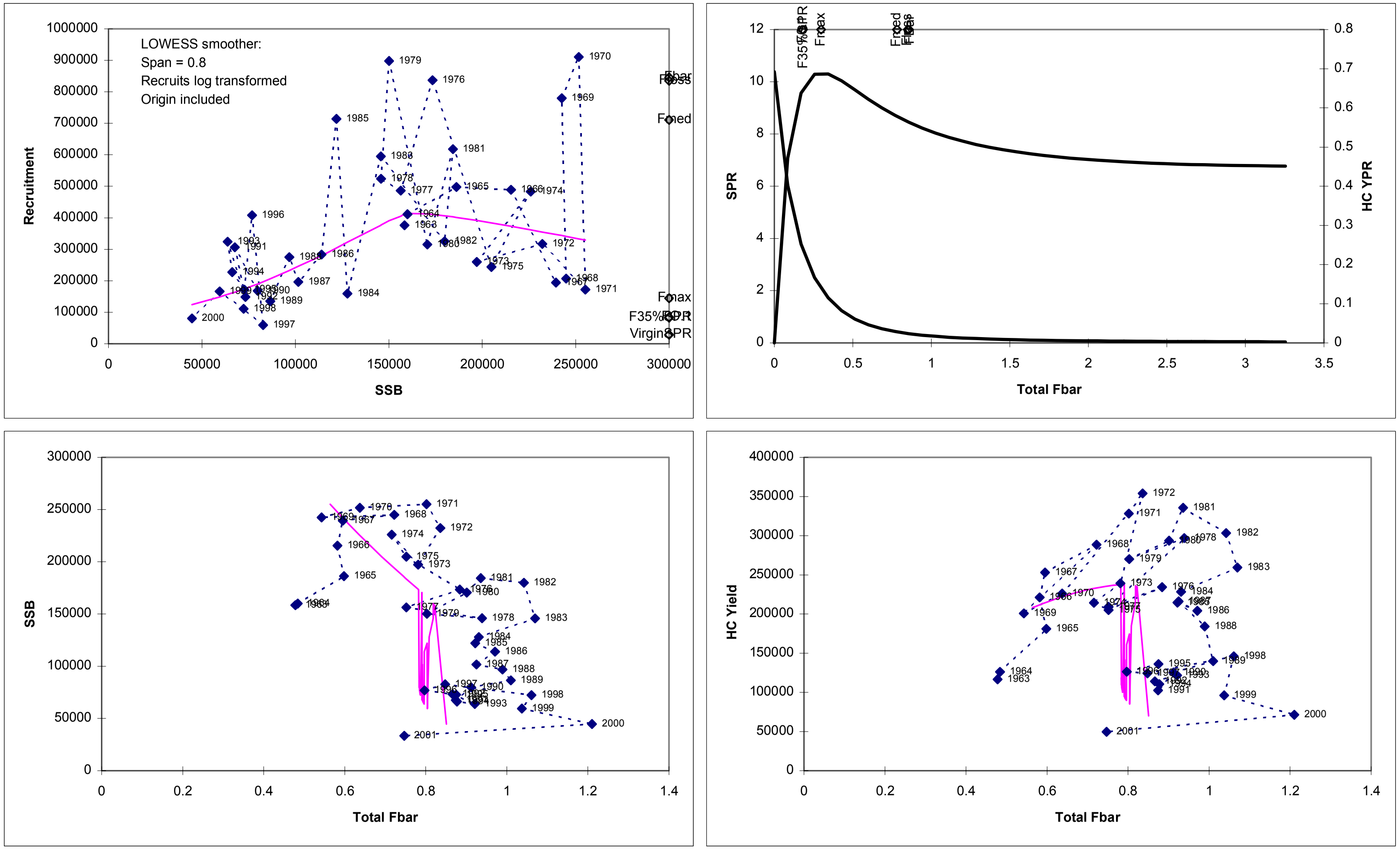
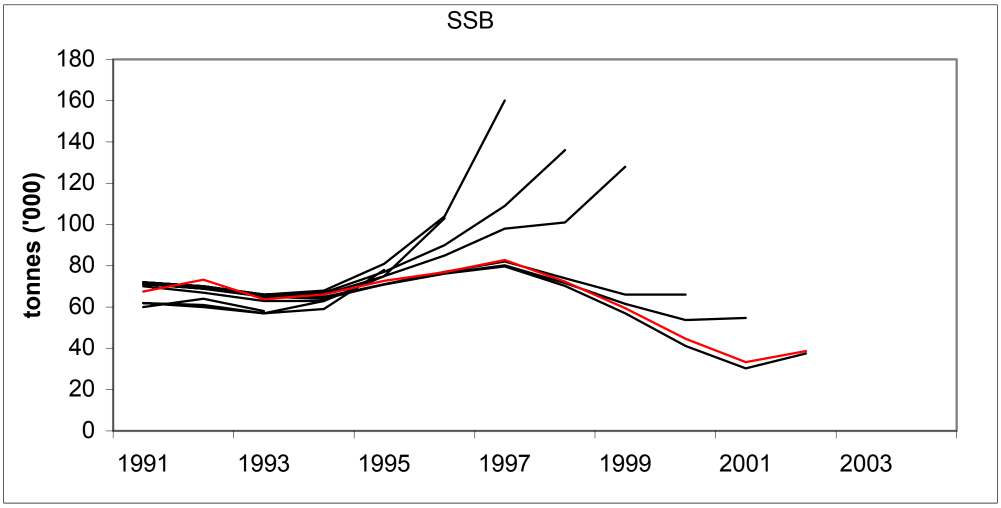
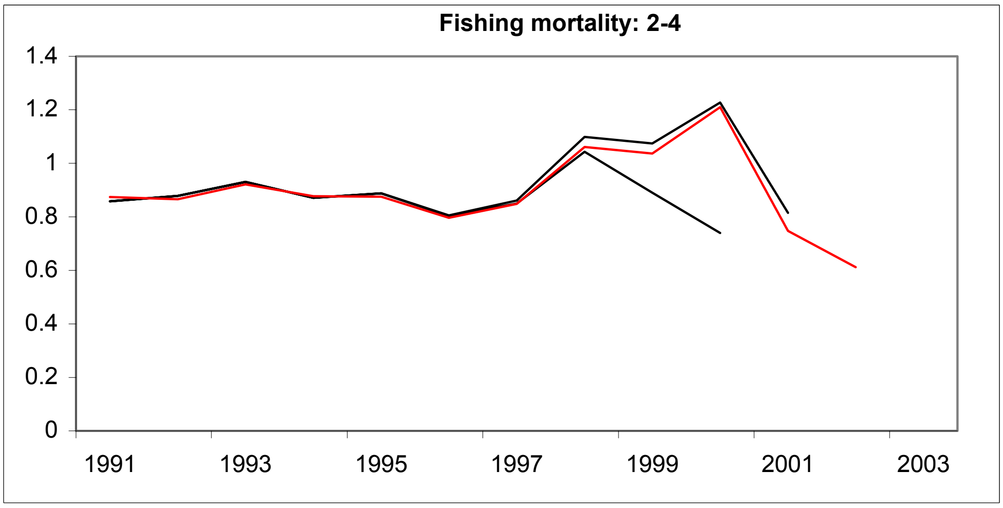


Figure 3.10.1 Cod in Subarea IV and Divisions IIIa and VIId: historical comparison of Cod assessments.





4 HADDOCK IN SUB-AREA IV AND DIVISION IIIA

To attempt to address the issue of increasing workload, the WG proposed in its 2002 report that three stocks per year be subjected to detailed benchmark assessments, with the remaining stocks being analysed in update assessments. The assessment of haddock in Sub-Area IV and Division IIIa in 2003 was selected to be one of the benchmark assessments, because of difficulties encountered previously in dealing with the slow growth of the large 1999 year-class, and because of the strong linkages between the haddock and cod fisheries. In addition, haddock will be the subject of a review by the North Sea Commission Fisheries Partnership in 2003.

4.1 Stock definition and the fishery

Haddock occur in many areas of the central and Northern North Sea and Skagerrak, and are prevalent as far south as the Humber estuary. They usually inhabit depths less than 200 metres. Results from tagging experiments and particle-tracking simulations suggest that there may also be links between the stocks of North Sea haddock and those to the north-west of Scotland. Spawning occurs from March until May and takes place in almost any area around the Scottish coasts to the Norwegian Deeps

In the North Sea, haddock is taken as part of a mixed demersal fishery, with the large majority of the catch being taken by Scottish light trawlers, seiners and pair trawlers. Until 2001, these gears had a minimum legal mesh size of 100 mm, and smaller quantities were taken by other Scottish vessels, including *Nephrops* trawlers which used mesh sizes between 70 and 100mm mesh and hence may have had higher discard rates. New gear regulations were brought in for 2002 as a part of the North Sea cod recovery plan (Commission Regulation (EC) No 2056/2001). Vessels from other countries including England, Denmark and Norway also participate in the fishery, and haddock are also taken as a by-catch by Danish and Norwegian vessels fishing for industrial species. In Division IIIa, haddock are taken as a by catch in a mixed demersal fishery, and in the industrial fishery. Landings from Division IIIa are small compared to those the North Sea.

4.1.1 ICES advice applicable to 2002 and 2003

The ICES advice for 2002 (as formulated at the ACFM meeting in October 2001) recommended a reduction of fishing mortality to below $\boldsymbol{F}_{pa}$ (0.7). ICES also advised that measures should be implemented to reduce discarding of the large 1999 year-class, and that fishing mortality for North Sea haddock may have to be reduced further to retain consistency with the cod recovery plan.

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

4.1.2 Management applicable to 2002 and 2003

Annual management of the fishery operates through TACs. The 2002 and 2003 TACs for haddock in Sub-Area IV and Division IIa (EC waters) were 104,000 t and 51,735 t respectively, while the TACs for Divisions IIIa, IIIb and IIIc were 6,300 t and 3,150 t respectively.

The following table summarises ICES management advice for haddock in Sub-area IV and Division IIIa during 2001–2003:

Year	Catches corresponding to ICES advice (000 t)	Basis	TAC (000 t) for IIa (EC), IV, IIIa,b,c	2003 WG estimate of catches (000 t)
2001	< 60.0	F less than $\boldsymbol{F}_{pa}$	65.0	167.3
2002	< 97.0	F less than $\boldsymbol{F}_{pa}$	110.3	105.2
2003	-	No cod catches	54.9	-

[1]Based on F-multipliers from forecast tables.

The minimum mesh size for vessels fishing for cod in the mixed demersal fishery in EC Zones 1 and 2 (West of Scotland and North Sea excluding Skagerrak) was changed from 100 mm to 120 mm from the start of 2002 under EU regulations regarding the cod recovery plan (Commission Regulation EC 2056/2001), with a one-year derogation of 110 mm for vessels targeting species other than cod. This derogation was not extended beyond the end of 2002. Since mid-2000, UK vessels in this fishery have been required to include a 90 mm square mesh panel (SSI 227/2000), predominantly to reduce discarding of the large 1999 year class of haddock. Further unilateral legislation in 2001 (SSI 250/2001) banned the use of lifting bags in the Scottish fleet.

In 2001, the EU and Norway agreed and implemented emergency measures involving the closure of a large area of the North Sea from 14 February to 30 April 2001 to all fishing vessels using gears likely to catch cod (EC 259/2001). This measure displaced vessels from areas where haddock were commonly fished, and for a brief period a number of vessels remained in port. The closure of the Norway Pout box to industrial fishing is another measure through which by-catches of haddock are limited. The minimum landing size for haddock is 30 cm in the North Sea, and 27 cm in Division IIIa. Vessel decommissioning in several fleets has been underway since 2002. Effort reductions for much of the international fleet to 15 days at sea per month have been imposed since February 2003 (EU 2003/0090).

4.1.3 The fishery in 2002

Official catch data for each country participating in the fishery are presented in Table 4.1.1, together with the corresponding WG estimates. The WG estimate for total international catch in 2002 is 105,194 t, consisting of 56,748 t landed for human consumption, 44,730 t discarded and 3,717 t of industrial bycatch for reduction purposes. The estimates for total, human consumption, discard and industrial bycatch components are all near to the 10-year average, and within the range of recent fluctuations. The increase in human consumption landings and the corresponding decrease in discards in 2002 are due to the large 1999 year-class reaching or exceeding the minimum landing size. No revisions have been made to WG estimates of landings in 2000 and 2001.

The reduction in fishing mortality of *ca.* 35% implied by the TAC set for 2003 necessarily implies a reduction in effort of a similar magnitude, combined with the effective implementation of other technical measures. Reported effort declined in 2002 by 25.0% in the Scottish light trawl fleet, and by 39.6% in the Scottish seine fleet (see Table 4.3.1 and Figure 4.3.1). However, due to reporting problems the Scottish effort data may be underestimates (see Section 4.3).

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

The values of natural mortality and proportion mature at age used in the assessment are unchanged from last year's meeting (Table 4.2.1). The estimates of natural mortality originate from MSVPA (ICES CM 1989/Assess:20). Section 1.3.1.3 of 1999 WG report gives a fuller discussion of the sources of these estimates (ICES CM 2000/ACFM:7). The estimates of proportion mature are based on IBTS data. Both natural mortality and maturity are assumed constant with time. Biomass totals are calculated as at the beginning of the year.

During this year's meeting, the final accepted assessment was re-run using alternative estimates of natural mortality and proportion mature as a sensitivity analysis. These natural mortality estimates were produced by the 2003 meeting of the ICES Study Group on Multispecies Assessments in the North Sea while the maturity estimates were derived from a re-analysis of historical IBTS data (Poulding 1997). The new estimates and the results of the analysis are presented in Section 4.4.1.

Quarterly age composition data for the North Sea (Sub-area IV) human consumption landings were supplied by Denmark, England and Wales, France and Scotland. These nations accounted for 90% of the total human consumption landings. Sampling levels are given in Table 1.3.3.1**.** The procedures used to aggregate national data sets into total international landings are given in Section 1.3. Germany, Norway and Sweden provided quarterly landings, Belgium supplied annual age compositions, and the Faroe Islands, Poland and the Netherlands provided official landings statistics only. Industrial bycatch age compositions for the North Sea were supplied by Denmark and Norway. Age composition data for the human consumption and industrial catches in the Skagerrak (Division IIIa) in 2002 were supplied by Denmark, which accounts for most of the human consumption landings and all of the industrial bycatch in this area.

Discard estimates are derived by raising a mean discard proportion ogive from the Scottish sampling programme to the level of the international fleet landings. The Scottish discard programme follows a stratified random design, with fishing trips stratified by area, gear and quarter. Discards are estimated independently in each stratum and total discards are then estimated by summing across strata. Raising to landings is done for each individual trip. However, when there are few trips per stratum (often there is only one trip per stratum), this *traditional* estimator can be both biased and imprecise. Stratoudakis *et al* (1999) developed an alternative *ratio* estimator that collapses the stratification (i.e. combines strata with similar discard properties) and then estimates discards independently in each collapsed stratum. Total discards are then estimated by summing across collapsed strata. Collapsing strata has the effect of increasing the sample size in each stratum, and results in a collapsed ratio estimator that has negligible bias and greater precision than the traditional estimator. Work is underway to estimate cod, haddock and whiting discards in Sub-Area IV and Divisions VIId and IIIa using the collapsed ratio estimator, to compare these estimates with the traditional estimates, and to compare stock assessments using the two sets of discard estimates. It should also be noted that the method assumes that the Scottish fleet characteristics for haddock are applicable to the international fleet, which may be more tenable for haddock than for other species (given the large Scottish share of the catches). However, further evaluation work on this discard series will be beneficial. No estimates of discards are available for Division IIIa.

Total catch-at-age data are given in Table 4.2.2. while catch-at-age data for each catch component are given in Tables 4.2.3 – 4.2.5. The catch-at-age data for the North Sea are SOP-corrected; numbers-at-age are adjusted in the Scottish and industrial bycatch data, weights-at-age are adjusted in all other data. There are slight SOP discrepancies in the combined data arising from minor discrepancies in the Division IIIa data. The proportions of each catch component in the total catch numbers are shown in Figure 4.2.1. The 1999 year class is still the main component in the 2003 catch composition (Figure 4.2.2).

The mean weight-at-age data for the Division IIIa catches do not cover all years and for earlier years are not split by catch category, so only North Sea weight-at-age data have been used. Weight-at-age data from the total catch (that is, human consumption, discards and industrial bycatch) in the North Sea, which are also used as stock weights-at-age, are given in Table 4.2.6. The mean weights-at-age for the separate catch components are given for all years in Tables 4.2.7 – 4.2.9. Weights-at-age data are summarised in Figure 4.2.3. The mean weight-at-age of discards has remained reasonably consistent over the last decade, whereas there is an indication that for fish older than four in the human consumption landings there has been a reduction in mean weight since the early 1990s. For fish older than one in the industrial bycatch, mean weights appear to have been lower in the latter half of the last decade than to the first half.

Indications from port and market sampling trips suggest that the 1999 year-class might be relatively slow-growing, and therefore under-weight and under-length for its age. The plots of mean weights-at-age for the total catch and the three catch components in Figure 4.2.4 suggest that this assumption only holds with any certainty for the human consumption component. Thus, in the human consumption landings, haddock of the 1999 year-class are consistently lighter than they should be, while they are of normal weight in the discards and industrial bycatch components.

4.3 Catch, effort and research vessel data

Two commercial Scottish CPUE series have been available in recent years for use in assessments of this stock, specifically light trawlers (ScoLTR) and seiners (ScoSEI). However, none have been used in the final assessment presented by the WG during any of its last three meetings, although they have been used in exploratory and comparative analyses. During preparations for the 2000 round of assessment WG meetings it became apparent that the 1999 effort data for the Scottish commercial fleets were not in accord with the historical series and specific concerns were outlined in the 2000 report of WGNSSK (ICES CM 2001/ACFM:07). Effort recording is still not mandatory for these fleets, and concerns remain about the validity of the historical and current estimates.

The commercial CPUE data available for this meeting consisted of the following:

- Scottish seiners (ScoSEI): ages 0–13, years 1978–2002.

- Scottish light trawlers (ScoLTR): ages 0–13, years 1978–2002.

The definitions of these commercial fleets are the same as those given for the equivalent vessels fishing in Division VIa, which are given in the Report of the 1998 Working Group on the Assessment of Northern Shelf Demersal Stocks (ICES CM 1999/ACFM:1, Appendix 2). Three research vessel survey series were also available:

- Scottish third-quarter groundfish survey (ScoGFS): ages 0–8, years 1982–2003. Only ages 0–5 are used for tuning, as there are several missing data points at older ages and very low catch rates. This survey is undertaken during August each year using a fixed station design and the GOV trawl. Coverage was restricted to the northern part of the North Sea corresponding to the more northerly distribution of haddock, but since 1998 it has been extended into the central North Sea. There are two versions of the series available, the first with the new areas ignored to ensure consistent coverage, the second with the new areas included. Both are evaluated in Section 4.4.1. The ScoGFS has also used a new gear and vessel since 1999. The catch rates as presented are corrected for the change in vessel and gear, on the basis of comparative trawl haul data (Zuur *et al* 2001).

- English third-quarter groundfish survey (EngGFS): ages 0–7, years 1977–2002. Only ages 0–5 are used for tuning, as catch rates for older ages are low. The age-composition data for 2003 from this survey were not available at the time of the WG meeting. This survey covers the whole of the North Sea in August-September each year to about 200m depth, using a fixed station design of 75 standard tows and the GOV trawl.

- International bottom-trawl survey (IBTS Q1): ages 1–6+, years 1967–2003. This survey covers the whole of the North Sea using fixed stations of at least two tows per rectangle with the GOV trawl. Previously this series covered only the years from 1982 onwards for ages 3–6+, and from 1973 onwards for ages 1–2. The methodology of the extension of the series for this year's WG was not presented at the meeting, and it is difficult to evaluate them.

The complete data available for catch-at-age analysis tuning are listed in Table 4.3.1.

4.4 Historical stock analyses

Section 1.4.1 outlines the general approach adopted at this year's WG. Rather than begin with an evaluation of catch and survey data as is customary, the following text starts with a discussion of the plus-group and mean *F* age range to be used in the assessment. These settings were determined using a combination of separable VPA and XSA analyses. This issue needs to be addressed first since all the catch and survey evaluations are affected by these decisions.

4.4.1 Exploratory analyses

A number of exploratory runs were performed, each of which was intended to address a specific aspect of the assessment. Separable VPA and XSA runs were done to determine the plus-group and mean *F* age-range to be used. The XSA runs were also used to define XSA parameter settings. Survey data were examined using both empirical and modelling approaches (SURBA) to evaluate the internal and external consistency of the survey data, and to estimate stock trends independently of catch-at-age data. TSA runs were carried out to investigate the utility and consequences of modelling bycatch separately, and also to determine the population dynamics indicated by the catch data alone. Finally, Laurec-Shepherd runs were done to characterise any trend in catchability mismatch between the catch data and the surveys.

Separable VPA and XSA

A separable VPA (Lowestoft assessment suite) was run on the full catch-at-age dataset (years 1963–2002, ages 0–15+). This run used inverse-variance weighting on ages, and equal weighting of 1.0 on all years. Following exploratory runs, terminal *F* (on age 4) was set to 0.7, terminal *S* to 1.0. Log catch residuals were large for age ratio 10:11 and upwards (see Figure 4.4.1). This supported the use of a plus-group at age 10+, as in previous assessments.

Several exploratory XSA runs were conducted before and during the WG meeting on the basis of the 10+ group. Standard diagnostics indicated that a power model at age 0 was appropriate (particularly for the EngGFS series, less so for ScoGFS). A power model on ages 0 and 1 was used in last year's assessment, but this may have been driven by the proximity of the large 1999 year-class which was aged 2 in 2001. These runs also indicated that the catchability plateau should be set at age 2 (see Figure 4.4.2). No time-taper was used in tuning. A time taper would imply greater confidence in the recent catch data than in the historical survey data, and this confidence would be misplaced for haddock.

However, in the course of these exploratory runs, it became clear that a plus-group at age 10+ was unlikely to be appropriate. Table 4.4.1 shows the contribution of *F*-shrinkage to survivors estimates for all combinations of low (SE = 2.0) and high (SE = 0.5) shrinkage, and using a 7+ or 10+ group. The only combination for which *F*-shrinkage was minimal on all ages in the assessment was low shrinkage and a 7+ group. The utility of these settings is supported by the XSA retrospective plots for each combination given in Figure 4.4.3, in which the low shrinkage and 7+ group gives the smallest apparent retrospective bias. The WG therefore decided to use a 7+ group in subsequent analyses. This decision necessitated a change in the mean *F* range, from 2–6 to 2–4. Further separable VPA runs indicated that the number of ages to be used in *F*-shrinkage should be 3 (changed from the 5 ages used when a 10+ group was implemented), because the fitted separable age-effect was relatively flat over ages 3–6.

Mean-standardised indices and catch curves

Figure 4.4.4a gives mean-standardised time-series of the EngGFS series by year-class, which show that year-class strength is well-estimated throughout the lifetime of the cohorts. Catch curves for the EngGFS series are given in

Figure 4.4.4b. The EngGFS survey changed from the Granton gear to the GOV gear in 1992. However, the catch curves do not indicate a substantial change in catchability at this time: the slopes of the curves are comparable throughout the time series, and the reduced catchability on younger ages (the hook at the top of the curve) is equally prevalent before and after 1992. There is therefore no strong evidence for a change in the catchability of haddock in the EngGFS series in 1992, and there no reason to split the survey data in that year.

Figures 4.4.5a and 4.4.5b give the mean-standardised indices by year-class for the ScoGFS (consistent areas) and ScoGFS (full areas), while Figures 4.4.5c and 4.4.5d shows the corresponding catch curves. While these data are less consistent than the EngGFS series in terms of constant catchabilities and ability to follow year-class strength, they are good enough to warrant their re-inclusion in the assessment. In particular, there is very little difference between the consistent-area and full-area series, so the latter should be used to make use of as much data as possible: also, there is no strong evidence of a change in catchability caused by the gear and vessel change in 1998. Hence, there is no reason to split this survey either.

The same information is presented for the IBTS Q1 survey in Figures 4.4.6a–b: the difference between the plots lies in the year range (1967–2003 or 1976–2003). With the former year range, catchability appears to be very inconsistent, and year-class strength poorly determined, in the years 1967–1975. The rest of the series is more acceptable, and the earlier years correspond to the period for which ICES has supplied new undocumented estimates for this year. The WG therefore decided to split to IBTS Q1 series, and to use only the period 1976–2003.

Figure 4.4.7 compares mean-standardised catch numbers at age with the relevant mean-standardised survey indices. Indications of year-class strength are reasonably consistent between surveys, and between surveys and catch data for the most part. The major exception is the 1999 year-class. This appears to be the largest year-class in the time-series for all surveys at ages 0–3, but only appears as a large year-class in the catch data for age 2. This indicates that there may be difficulties in estimating the size of this year-class: either the surveys are measuring it to be too big, or the catch data are measuring it to be too small, or both. One possible explanation for this could be the effect of the technical gear measures imposed on the haddock fishery, which if successful would have reduced commercial catch rates of young haddock.

Catchability mismatch

In previous assessments of this stock, a trend in model catchability residuals has often been interpreted as a trend in survey catchability. The term “catchability” is a misnomer is this context, as what it actually indicates is the mismatch or difference in catchability between the survey and the fishery. Thus, such trends could be due to real changes in survey catchability (arising from distribution changes, for example), or from correspondingly negative changes in fishery catchability.

Trends can be discerned in the basic catch and survey data. Figures 4.4.8 – 4.4.10 show the log ratios of mean-standardised survey index over mean-standardised catch, by year and age, along with a loess smoother fitted through the time series to illustrate the underlying trends. The EngGFS series (Figure 4.4.8) corresponds quite closely with the catch time-series across all ages. However, there are noticeable trends in the relationships between the ScoGFS series and the catch (Figure 4.4.9), and between the IBTS Q1 series and the catch (Figure 4.4.10). For the ScoGFS and IBTS Q1 surveys there is an apparent dissimilarity between the catchability of the survey, and the catchability of the catch. This shows up in residual patterns for catch-at-age assessment models (see below).

External consistency of surveys

Survey indices at age are plotted against each other on a log-log scale in Figure 4.4.11. These show that the surveys are reasonably consistent with each other for haddock, particularly for ages 1–4.

Survey-derived estimates of SSB and recruitment

Survey-based TSB, SSB and recruitment at ages 0 and 1 are shown in Figure 4.4.12. The salient points from these are that all three surveys are estimating a very large year-class in 1999, which results in a correspondingly large SSB in 2002 and 2003. The differences in stock perception arising from each survey are driven by their responses to the 1999 year-class. The ScoGFS series estimates this year-class to be around five times the previous maximum, the EngGFS one-and-a-half times, and the IBTS Q1 around twice the largest observed (discounting the gadoid outburst period). With regards to SSB estimates, the ScoGFS series implies a continuing increase in 2003, and the IBTS series a slight decline from an historic high: the EngGFS estimate for 2003 is not yet available.

Survey-based model analysis using SURBA

SURBA runs (see Section 1.4) were produced for the EngGFS, ScoGFS and IBTS Q1 survey indices. Stock weights, natural mortalities and maturities for 2002 were also used for 2003. Exploratory runs indicated that default values were appropriate for most settings, so that age weights were all set to 1.0, index smoothing with λ = 2.0 was used, and parameter estimates were bounded. The exception to this was catchabilities, which were defined by $\mathbf{q} = (0.01, 0.1, 0.5, 1.0, \ldots)$.

Figures 4.4.13 – 4.4.15 gives graphical outputs and diagnostics for the selected SURBA run for each of the EngGFS, ScoGFS and IBTS Q1 series, while summary statistics from these runs are compared in Figure 4.4.16. All three runs show a peak in the fitted fishing-mortality age-effect at age 2, which suggests disproportionately high mortality on that age. This may be caused by the use of a natural mortality estimate for that age which is too low, or it may be due to an incorrect assumption about catchability. Residuals are generally small and without noticeable trends, with two noticeable exceptions: the EngGFS series seems to be less well fitted by the model in recent years, and the ScoGFS series does not model the 2001 year-class well. Finally, the estimates of SSB from the IBTS Q1 SURBA run in the most recent years are questionable. The SSB suggested directly by the survey data (Figure 4.4.12) does not decline rapidly as the SURBA estimate does, and it is likely that model-fitting problems are responsible for this difference.

TSA

Four TSA runs were performed for this stock (see Section 1.4 for a discussion of the method). The runs were

- Total catch, no surveys.
- Total catch, three surveys.
- Separate industrial bycatch, no surveys.
- Separate industrial bycatch, three surveys.

Due to time constraints, these runs used the plus-group (10+) and mean F range (2–6) from last year's assessment, rather than the revised settings discussed above. Total catch was modelled following Fryer (2002). The only difference was that observed catches and survey indices were assumed to be distributed with constant coefficients of variation cv_{catch} and cv_{survey} respectively (WGMG 2003). A Beverton-Holt stock recruit curve was used.

Human consumption catch and industrial bycatch were modelled by assuming that

$$F_{\text{total}}(a, y) = F_{\text{h. cons. \& disc.}}(a, y) + F_{\text{industrial}}(a, y)$$

and that $F_{\text{h. cons. \& disc}}(a, y)$ and $F_{\text{industrial}}(a, y)$ evolve independently according to the model in Fryer (2002).
Figure 4.4.17 compares summary statistics from these four runs. The key difference lies in the inclusion of surveys, which increases dramatically the estimate of the 1999 year-class. This feeds through to significantly higher estimate of SSB in recent years, and a correspondingly lower estimate of mean $F_{2\text{–}6}$. Persistent trends in log catchability mismatch for the three surveys are shown in Figure 4.4.18 (the plot gives the estimates for TSA run 2: total catch, three surveys). The prevailing impression is confirmed, that there is an increasing trend in catchability mismatch for the ScoGFS and IBTS Q1 series, and a decreasing trend for the EngGFS series.

Single-fleet Laurec-Shepherd

Single-fleet Laurec-Shepherd runs were carried out using each of EngGFS, ScoGFS, and IBTS Q1 in turn, to evaluate further the apparent catchability mismatch between surveys and catch data. The run settings were as follows: no regression weighting, three-age mean for F on the oldest age, $F_{6,2002}$ was set to 0.4 for the IBTS analysis (following the estimate from exploratory XSA runs), no F-shrinkage, minimum five data points for the analysis, and exact VPA for population estimates. Log catchability residuals are plotted in Figure 4.4.19. These analyses confirm the recent increasing catchability mismatch trend between ScoGFS and IBTS Q1 on the one hand, and the catch data on the other. The trend is reversed in the EngGFS residuals.

Run comparisons

Figure 4.4.20 compares the summary statistics from all the exploratory runs described above: three SURBA runs, four TSA runs, three Laurec-Shepherd runs, and three XSA runs. The runs are identified as follows:

TSA.1	TSA with total catch, no surveys
TSA.2	TSA with total catch, three surveys
TSA.3	TSA with separate industrial bycatch, no surveys
TSA.4	TSA with separate industrial bycatch, three surveys
LS.1	Laurec-Shepherd tuned by EngGFS
LS.2	Laurec-Shepherd tuned by ScoGFS
LS.3	Laurec-Shepherd tuned by IBTS Q1
SURBA.1	SURBA on EngGFS
SURBA.2	SURBA on ScoGFS
SURBA.3	SURBA on IBTS Q1
XSA.1	7+ group, low shrinkage
XSA.2	7+ group, high shrinkage
XSA.3	10+ group, low shrinkage
XSA.4	10+ group, high shrinkage

Four of these runs can be disregarded. The sharp downturn in SSB suggested by the IBTS Q1 SURBA run cannot be explained at the moment, and should be considered in more detail. The 2003 data for the EngGFS series are not yet available, so the relevant SURBA run is difficult to evaluate. Finally, the two no-survey TSA runs do not appear to pick up the large 1999 year-class. This is because the year-class has not been appearing in the catch data to the same extent as has been suggested by the surveys. The low year-class estimate from the no-survey TSA is not corroborated by other sources of information.

All other analyses suggest that the 1999 year-class was large, that mean $F_{2\text{–}4}$ has fallen since 2000, and that there has been a commensurate rise in SSB. SURBA only produces relative estimates of abundance and biomass, so the ScoGFS SURBA run should only be used in a comparative role. The TSA with surveys does not include age-0 fish (this is due to a limitation of the current software implementation), so cannot be adopted as a final assessment either. Single-fleet Laurec-Shepherd are also intended for exploratory analyses rather than as final assessments. The four remaining XSA runs have already been discussed in the text above, in which it was concluded that the configuration with a 7+ group and low shrinkage was the most appropriate. This is therefore the model the WG decided to take forward to predictions.

Alternative estimates of natural mortality and proportion mature

The final assessment run from last year's meeting (referred to in Figure 4.4.21. as the SPALY[1] run) was repeated using two different datasets: firstly, the natural mortality estimates produced by the 2003 meeting of the Study Group on Multispecies Assessments in the North Sea, and secondly, maturity estimates derived from a re-analysis of IBTS data by Poulding (1997). Identical XSA settings were used for these runs. Summary statistics are plotted in Figure 4.4.21. Mean *F* is reduced in the most recent years by both new datasets. SSB is most affected by the new maturity estimates, although the natural mortality estimates do increase SSB in the final year. Recruitment estimates are more variable when either of the new sources of information are used. These analyses are only intended to be indicative of the likely effects of such information and should be viewed with caution. However, the relevant ICES Working Groups (see Section 1.8) are to be encouraged to begin or continue providing data to enable a fuller evaluation of their effect.

4.4.2 Final assessment

The WG conducted a full benchmark assessment of haddock, using a number of approaches including XSA, TSA, SURBA, and direct analyses of survey data. On the basis of their findings, the WG produced a new XSA assessment of haddock.

The XSA settings for this year's final assessment are given below, along with the corresponding settings for the three previous assessments. The assessment methodology is a substantial revision from that presented last year. The main

[1] Same Procedure As Last Year

salient changes are as follows: the plus-group was changed to 7+ (from 10+), the mean *F* range was reduced to 2–4 (from 2–6), the Scottish groundfish survey was included as a tuning series, a power catchability model was used for age-0 (ages 0 and 1 last year), a catchability plateau was fixed for ages 2 and older (ages 3 and older last year), historical downweighting of tuning data was not used, and light *F*-shrinkage was implemented (SE = 2.0, compared with SE = 0.5 last year).

Year of assessment	**2000**	**2001**	**2002**	**2003**
Assessment model	XSA	XSA	XSA	XSA
Catch age range	0–10+	0–10+	0–10+	0–7+
Mean *F* range	2–6	2–6	2–6	2–4
ScoLTR	not used	not used	not used	not used
ScoSEI	not used	not used	not used	not used
EngGFS	1990–1999, 0–5	1977–2000, 0–5	1977–2001, 0–5	1977–2002, 0–5
ScoGFS	not used	not used	not used	1982–2003, 0–5
IBTS Q1	1991–2000, 1–6+	1974–2001, 1–6+	1974–2002, 1–6+	1976–2003, 1-6+
Time series weighting	none	tricubic over 20 years	tricubic over 20 years	none
Power model	0	0–1	0–1	0
q plateau	7	3	3	2
***F*-shrinkage**	5 yrs, 5 ages	5 yrs, 5 ages	5 yrs, 5 ages	5 yrs, 3 ages
Shrinkage SE	0.5	0.5	0.5	2
Min SE for pop estimates	0.3	0.3	0.3	0.3
Prior weights	None	None	None	None

The consistency of the XSA was evaluated in a retrospective analysis which is shown in Figure 4.4.3. The retrospective results indicate no consistent bias for either SSB or recruit estimates, although there is an indication that fishing mortality has been underestimated in recent years.

Log catchability residuals are given in Table 4.4.2, and shown in Figure 4.4.22 for the three tuning series. There are clear trends in residuals from the XSA assessment, similar to those observed for exploratory runs (Section 4.4.1). The obvious features are the increase in catchability mismatch for the ScoGFS and IBTS Q1 series, and a decrease in the EngGFS series. A more subtle feature is an apparent change in catchability trend which occurred in the early 1990's. For the older ages this can be seen as a change from decreasing to increasing catchability in the ScoGFS series, and to a lesser extent the EngGFS series. The IBTS Q1 series shows a change from stable to increasing catchability for the older ages and a stabilisation of catchability in the younger ages.

The contribution of the data to the final population estimates is shown in Figure 4.4.23. The contribution of shrinkage is greatly reduced from last year's assessment, due to a combination of lower shrinkage, reduced age-range, and an extra survey.

Estimates of fishing mortalities-at-age and stock numbers-at-age from the final XSA run are given in Table 4.4.3. The present assessment indicates a mean total $F_{2–4}$ in 2002 of 0.36.

4.5 Recruitment estimation

The following table gives the estimates of recent year-class strength from the three surveys used in the assessment, from the final XSA, and from a series of geometric means (GMs): three-year (2000–2002), ten-year (1993–2002), and ten-year (1993–2002) without the 1999 year-class.

	Year-class			
Source	**2000**	**2001**	**2002**	**2003**
EngGFS	31.023	0.372	0.919	
ScoGFS	10375	67	1774	1780
IBTS Q1	888	58	90	
XSA	**24000**	**2195**	**4598**	
GM (00-02)				**6233**

GM (93-02)	15032
GM (93-02 sans 99)	11896

The indications from the surveys are that the 2003 year-class strength is similar or slightly greater than the 2002 year-class strength. The longer-term GMs are considerably higher than the 2002 XSA estimate, which is not supported by the surveys. Therefore the WG used the short-term (three-year) GM of 6.2 millions. This is higher than the previous two years, but still below the long-term (1963-2002) GM (23.2 millions). The values used for year-class estimates are highlighted in bold above.

4.6 **Historical stock trends**

Trends in SSB, recruitment and mean $F_{2–4}$ (by catch component) since 1963 are given in Table 4.6.1 and Figure 4.6.1. Total mean $F_{2–4}$ has fluctuated around a mean of 0.94. Recruitment shows considerable variation as is typical of a spasmodic spawner like haddock, with the current estimate of the 1999 year class indicating that it is the strongest since 1974. The four preceding year classes and the three subsequent ones are all of below-average strength. SSB has fluctuated, with occasional peaks corresponding to the maturation of strong year classes. The 1999 year class has resulted in a rapid increase in SSB in recent years: however, there is no indication of a large incoming year-class.

4.7 Short-term projections

The salient points for a short-term projection for haddock in this year's assessment are as follows:

- Mean $F_{2–4}$ is estimated to have declined in recent years, so that $\boldsymbol{F_{sq}}$ is likely to be an overestimate of F in 2003 and beyond.

- The large 1999 year-class has been observed to be light for its age in the human consumption catch component, indicating density-dependent growth retardation (see Figure 4.2.4). The use of a standard three-year mean for the weight of age-4 fish in 2003 is likely to bias SSB estimates upwards.

- Several technical measures have been implemented for the mixed demersal fishery in the North Sea, as highlighted in Section 4.1.2. These consist of mesh-size changes and days-at-sea regulations. There have also been a significant number of vessels decommissioned in 2002 and 2003. These measures will have had (and continue to have) effects on both the exploitation pattern and effort exerted by the international fishery, with commensurate effects on short-term projections and catch forecasts.

The WG endeavoured to address these issues in the limited time available. The basis for F in forecasts was chosen the mean exploitation pattern over the period 2000–2002, scaled to the level of estimated mean $F_{2–4}$ in 2002. The growth of the 1999 year-class was modelled by fitting a logistic curve to observed weights for that year-class for ages 1–3, and then projecting forward on the basis of the fitted model. Finally, the uptake of the derogation for 110 mm during 2002 (Commission Regulation EC 2056/2001) was assumed to be 0%, so that all vessels in the fishery are assumed to have switched to a 120 mm mesh at the start of 2002. This is unlikely to be true, but the resulting forecast is presented here as an interim position pending further evaluation. Furthermore, no modifications were made to account for the likely effects of decommissioning and days-at-sea. The WG intend to submit a Working Paper to the October 2003 ACFM meeting to explore further the likely effects of such technical measures for haddock.

Population numbers at 1 January 2003 for the catch forecast were taken from XSA predictions for ages 1–7+. CVs for these estimates were approximated by the standard deviations of the log estimates. The short-term GM (2000–2002) recruitment at age 0 of 6.2 millions was assumed for the 2003 and subsequent year classes. CVs on fishing mortalities and weights-at-age were calculated for the period 2000–2002.

Input data are shown in Table 4.7.1. The results of the forecast are shown in Table 4.7.2 (detailed) and Table 4.7.3 (management options).

The proportionate contributions of the 2000–2004 year classes to the landings predictions for 2003 and 2004, and to the corresponding spawning biomass predictions for 2003–2005, are given in Table 4.7.4. The prediction of landings in 2004 is still dominated by the 1999 year-class (74.3%), which is not marked on the plot but which accounts for the unshaded area. This year-class is estimated by TSA. The spawning biomass forecast for 2005 is dominated by the XSA estimate of the 1999 year class (41.3%) and the GM estimate of the 2003 year classes (37%).

Inputs to a sensitivity analysis of the catch prediction are shown in Table 4.7.1 and the results presented in Figure 4.7.1. These indicate that the prediction of landings in 2004 is most sensitive to the year effects on human consumption fishing mortality in 2003, the numbers at age 4 (the 1999 year-class), and the human consumption selectivity and weights for age 5. The majority of the variance of this prediction is provided by multipliers on human consumption fishing mortality. SSB in 2005 is sensitive to the effects of the 1999 year-class, through starting numbers-at-age, weight in the stock and maturity: the variance of this prediction is explained a number of different parameters.

Cumulative probability distributions are presented in Figure 4.7.2. For the probability of *F* in 2004 being below the forecast *F* to be 0.5 or less, landings in 2002 should be *ca*. 105,000 t or less. The probability of SSB remaining above $\boldsymbol{B}_{pa}$ in 2004 is very high (> 95%). Short-term forecasts for landings and spawning stock biomass are presented in **Figure** 4.7.3.

4.8 Medium-term projections

The recruitment dynamics of haddock (with occasional large year-classes) are very uncertain, and future recruitment cannot be projected with any confidence. This means that a medium-term projection for haddock on the basis of the current assessment is unlikely to be informative, and no such projection is presented here.

4.9 Biological reference points

The reduction of the mean *F* age range from 2–6 to 2–4 necessitates a reanalysis of the biological reference points for haddock, particularly those based on *F*. The PASoft program was run on the output from the final-configuration XSA model. A lowess span of 0.8 was chosen on the basis of the AIC minimum shown in Figure 4.9.1. The yield-per-recruit and spawner-per-recruit plots are shown in Figure 4.9.2. New values for $\mathbf{F}_{max}$, $\mathbf{F}_{0.1}$ and $\mathbf{F}_{med}$ are given in the following text table with the 2002 values for comparison.

	$\mathbf{F}_{max}$	$\mathbf{F}_{0.1}$	$\mathbf{F}_{med}$	$\mathbf{F}_{pa}$	$\mathbf{F}_{lim}$	$\mathbf{B}_{pa}$	$\mathbf{B}_{lim}$
2002	0.25*	0.18	0.49	0.7	1	140,000 t	100,000 t
2003	0.32*	0.19	0.57				

*corresponding to HC landings only

The stock-recruit plot with a lowess smoother is shown in Figure 4.9.2. The most obvious feature of this relationship are sporadic large recruitments. Even without these occasional outbreaks there is little in the way of a stock-recruit relationship. For comparison purposes with the 2001 assessment, both stock-recruit scatterplots are overlaid in Figure 4.9.3.

ACFM state that $\mathbf{B}_{lim}$ for this stock is determined as a smoothed estimate of $\mathbf{B}_{loss}$ and $\mathbf{B}_{pa}$ is 1.4*$\mathbf{B}_{lim}$. A new estimate of $\mathbf{B}_{loss}$ was not made in this assessment, hence no updated candidate for $\mathbf{B}_{pa}$ is proposed. The determinsitic estimate of $\mathbf{B}_{loss}$ in 2003 is 58,500t and for the 2002 assessment 63,000t.

Figure 4.9.4 shows the historical performance of the stock in relation to the existing PA reference points. The stock has apparently made a rapid recovery from being outside safe biological limits in 2000 to well inside safe biological limits in 2002.

4.10 Comments on the assessment

In the Technical Minutes of its October 2002 meeting, ACFM commented on several aspects of previous assessments that it would like to see addressed and, if necessary, revised. The general points raised about the WG approach as a whole were:

- A retrospective bias of underestimation of fishing mortality and overestimation of spawning-stock biomass is common to many of the assessments carried out by the WG. It may not be possible to address this problem during the WG meeting, and while ACFM made no specific recommendations, it is clear from the Minutes that the issue should be borne in mind and discussed where necessary.

- Due to concerns about data validity, the WG should continue the recent practice of not using commercial CPUE indices for VPA tuning in those cases where sufficient fishery-independent survey data exist.

- It would be advantageous to express current stock status in probabilistic rather than deterministic terms.

The more specific points relating to the haddock assessment were:

- The WG should investigate the apparent difference in stock-dynamics signals from the surveys used to tune the assessment.

- The Scottish survey data should be re-examined to determine their utility for inclusion in the assessment.

- Adjustments of mean weights-at-age and the selection pattern in forecasts to account for the perceived slow growth of the 1999 year-class should be implemented at the WG.

The retrospective bias in the assessment remains, but now appears to be at a lower level than previously due to the reduction in the number of ages considered in the assessment. Commercial CPUE series were not used for tuning: in addition to ACFM's concerns, the available Scottish effort data is not thought to be reliable. Time has not permitted the generation of a probabilistic statement of stock status, and this is difficult to achieve without modification of the current standard software. Survey data was examined in considerable detail, and appears more consistent than previously. The Scottish survey data were analysed, and no justification for their exclusion could be determined: therefore, they were reinstated. Short-term forecasts were modified to take account of slow growth of the 1999 year-class, and a full investigation of recent possible changes in selectivity will be made available to ACFM.

The uncertainty in the assessment is largely due to uncertainty about the strength of the 1999 year-class. Three independent survey indices indicate that this year-class is very large, but it is not appearing in catch data to the extent expected and this would suggest recording or reporting problems. While all data sources agree that SSB is currently at a relatively high level, it is also clear that the year-classes following 1999 have been weak and are unlikely to contribute to future SSB to any great degree. It is therefore likely that stock biomass will decrease in future.

The results of the fishermen's surveys (WD14) for haddock are broadly in agreement with the perception from the assessment. The majority of respondents report that haddock abundance in 2003 is either the same, more or much more than 2002, which would accord with the 1999 year-class reaching a size where they are fully selected. This also supports the conclusions on discards, with a similar majority reporting that discards were either the same or less than last year.

The quality control chart is given in Figure 4.10.1. Estimates of mean *F* are substantially different in this year's assessment, because a new age range for the mean was used, but the same downwards trend is evident. Estimates of SSB are reasonably consistent from year to year. The estimate of the recruiting strength of the 1999 year-class has been revised upwards in each assessment in which it has appeared.

A number of additional issues were raised during the WG meeting which could not be addressed due to lack of time or necessary data, but which may give valuable insight in the future. Such issues include:

- Documentation and evaluation of the early IBTS dataset (1967–1975).

- Evaluation of the use of Scottish discard ogives to raise international fleets.

- Full exploration of effect of technical measures on forecasts.

The WG intends that these be considered at the earliest opportunity.

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Table 4.1.1 Nominal catch (t) of Haddock from Division IIIa and the North Sea 1990–2001, as officially reported to ICES and estimated by ACFM.

Division IIIa

Country	1996	1997	1998	1999	2000	2001	2002	2003
Belgium	-	-	-	-	-			
Denmark	2,523	2,501	3,168	1,012	1,033	1,590	3,791	
Germany	5	5	11	3	1	128	239	
Norway	115	188	188	168	126*	148	146*	
Sweden	536	835	529	26	377	285	393	
UK (Scotland)	-	-	-	-	-	7	-	
Total reported	3,179	3,529	3,896	1,209	1,537	2,158	4,569	
Unallocated	-37	-128	-137	151	-52	-255	-432	
WG estimate of H.cons. landings	3,142	3,401	3,759	1,360	1,485	1,903	4,137	
WG estimate of industrial by-catch	2,925	610	275	334	617	218	na	
WG estimate of total catch	**6,067**	**4,011**	**4,034**	**1,694**	**2,102**	**2,121**	**4,137**	
TAC	*10,000*	*7,000*	*7,000*	*5,400*	*4,500*	*4,000*	*6,300*	*3,150*

* Preliminary

Subarea IV

Country	1996	1997	1998	1999	2000	2001	2002	2003
Belgium	215	436	724	462	399	606	559	
Denmark	2,520	2,722	2,608	2,104	1,670	2,407	5,123	
Faroe Islands	13	9	43	55	-			
France	369	548	427*	742*1	724*1	485	903	
Germany	1,769	1,462	1,314	565	342	681	852	
Netherlands	110	480	275	110	119	274(2)	359	
Norway	2,295	2,354	3,262	3,830	3,118*	1,901*	2,245*	
Poland	18	8	7	17	13	12	17	
Sweden	689	655	472	686	596	804	572	
UK (Engl. & Wales)	3,379	3,330	3,280	2,398	1,876	3,334	3,647	
UK (N. Ireland)	-	-	-	-	-	-		
UK (Scotland)	63,542	61,098	60,324	53,628	37,772	29,263	39,624	
Total reported	74,919	73,102	72,736	64,597	46,629	39,767	53,901	
Unallocated landings	1,116	5,993	4,575	-388	-545	-809	-1,290	
WG estimate of H.cons. landings	76,035	79,095	77,311	64,209	46,084	38,958	52,611	
WG estimate of discards	72,522	52,105	45,175	42,562	48,841	118,320	44,730	
WG estimate of industrial by-catch	5,048	6,689	5,100	3,834	8,134	7,879	3,717	
WG estimate of total catch	153,605	137,889	127,586	110,605	103,059	165,157	101,058	
TAC	*120,000*	*114,000*	*115,000*	*88,600*	*73,000*	*61,000*	*104,000*	*51,735*

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

Division IIIa and Subarea IV

	1996	1997	1998	1999	2000	2001	2002	2003
WG estimate of total catch	159,672	141,900	131,620	112,299	105,161	167,278	105,195	
TAC	*130,000*	*121,000*	*122,000*	*94,000*	*77,500*	*65,000*	*110,300*	*54,885*

Table 4.1.2. Haddock in Sub-Area IV and Division IIIa. Catch components by weight (tonnes).

Year	Total	Hum. Cons.	Discards	Ind. Bycatch
1963	271531	68779	188969	13783
1964	380158	130944	160318	88896
1965	299464	162307	62236	74921
1966	346726	226335	73572	46819
1967	246589	147778	78056	20755
1968	302043	105830	161886	34327
1969	930538	331419	260232	338887
1970	806674	525325	101380	179969
1971	446634	237340	177482	31812
1972	353606	195494	128130	29983
1973	307688	181518	114719	11451
1974	368797	153116	166786	48895
1975	454536	151386	260424	42726
1976	377118	172607	154265	50246
1977	226411	145083	44347	36982
1978	180144	91674	76878	11592
1979	146001	87094	41732	17175
1980	223610	105071	94743	23796
1981	217151	138731	60115	18306
1982	237842	176635	40549	20658
1983	253594	167353	65925	20316
1984	222563	134505	75294	12764
1985	258117	165672	85444	7001
1986	225697	169157	52209	4331
1987	176880	111779	59212	5889
1988	175516	107978	62062	5475
1989	108772	80288	25713	2770
1990	92720	55558	32603	4559
1991	97021	48731	40276	8014
1992	138001	74614	47967	15420
1993	174296	81539	79601	13156
1994	153864	82730	65392	5741
1995	144773	77503	57360	9909
1996	159671	79176	72522	7973
1997	141900	82496	52105	7299
1998	131621	81070	45175	5376
1999	112299	65569	42562	4168
2000	105161	47569	48841	8751
2001	167278	40861	118320	8097
2002	105194	56748	44730	3717

Table 4.2.1 Haddock in Sub-Area IV and Division IIIa. Maturity ogive and natural mortality values.

Age	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Maturity	0.00	0.01	0.32	0.71	0.87	0.95	1.00	1.00	1.00	1.00	1.00
Natural mortality	2.05	1.65	0.40	0.25	0.25	0.20	0.20	0.20	0.20	0.20	0.20

Table 4.2.2. Haddock in Sub-area IV and Division IIIa. Total catch numbers at age. Ages 0-15, Years 1963-2002.

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1963	1367	1307178	335092	20963	13026	5781	502	653	566	59	18	0	0	0	0	0
1964	140235	7436	1296771	135227	9069	5350	2405	287	236	231	25	0	0	0	0	0
1965	652537	368593	15184	649840	29496	4662	1972	452	107	90	41	0	0	0	0	0
1966	1671205	1007322	25674	6425	412551	9980	1045	601	165	90	23	2	0	0	0	0
1967	306037	838189	89083	4863	3585	177857	2443	215	216	57	34	0	0	0	0	0
1968	11146	1098748	439511	19600	1947	2529	45973	325	40	13	5	0	0	0	0	0
1969	72670	20493	3578611	303489	7596	2411	2515	19129	200	24	7	0	0	0	0	0
1970	925768	266379	218480	1908736	57435	1178	1197	256	5954	67	11	19	0	0	0	0
1971	333396	1815054	71035	47546	400469	10374	462	195	147	1592	160	3	5	0	0	0
1972	244075	679205	587590	40604	21213	158000	3563	190	34	27	408	11	0	0	0	0
1973	60545	366830	570630	240604	6192	4470	39459	1257	108	29	109	49	5	0	0	0
1974	614903	1220855	176342	332967	54314	1875	1351	10922	242	23	32	4	5	0	0	0
1975	46388	2116937	641755	58991	109062	15813	983	620	2714	266	63	11	0	8	0	0
1976	174161	170529	1062943	211544	9952	31311	4996	206	76	759	60	3	0	0	0	0
1977	120798	258923	107675	394175	40185	4318	6275	1300	135	29	200	3	0	1	0	0
1978	305115	463554	146957	30377	113703	8708	1264	2076	402	116	15	64	13	2	0	0
1979	881823	351451	204046	41297	7406	28024	2237	262	483	152	54	12	11	1	0	0
1980	399372	678499	333261	73043	10476	1901	8067	598	121	162	75	31	9	3	1	0
1981	646419	134470	423059	143151	15228	2034	458	2498	125	64	23	30	4	1	3	0
1982	278705	275686	86126	299895	41435	3407	713	279	784	30	15	7	2	2	0	0
1983	639814	157259	252258	73920	127250	16480	1708	297	61	191	53	6	4	4	0	0
1984	95502	432193	168273	122984	22079	32658	3789	596	84	41	112	16	5	1	1	0
1985	139579	178878	534269	78726	37445	5306	7355	965	212	52	21	88	4	0	0	0
1986	56503	160398	178824	323650	27685	9691	1237	1810	237	117	49	32	36	13	4	1
1987	13384	314017	250496	47432	67864	4761	2877	545	778	135	36	50	27	29	5	8
1988	16535	30044	490706	89940	13431	18579	1602	639	166	141	50	18	11	10	15	1
1989	12042	47648	35358	182748	18106	2636	4058	510	200	83	30	13	6	2	2	1
1990	57702	86819	103021	18947	57830	3905	896	1380	210	78	41	11	11	1	4	2
1991	123910	228553	78258	23197	3888	12526	976	401	614	148	54	6	5	1	2	1
1992	270758	209879	253286	32494	6552	1250	4861	454	301	293	124	22	6	2	0	0
1993	141209	359995	262765	108421	7107	1698	450	1138	146	103	144	59	3	2	0	0
1994	85966	99260	296776	100476	29609	1920	573	191	509	115	32	27	25	5	0	0
1995	273689	301733	85925	167801	25875	7645	511	127	45	62	19	8	6	2	1	0
1996	347568	53415	357942	56894	55147	7503	3052	756	52	31	25	5	8	3	1	0
1997	40082	134642	86231	213293	15272	15406	1892	679	62	15	12	4	4	4	2	0
1998	23902	83557	167359	49648	108066	5743	3562	472	140	14	6	5	2	2	1	1
1999	108254	81423	121249	87242	24739	39860	2338	1595	342	41	6	2	1	1	0	0
2000	52181	350998	88624	43351	26356	6026	8707	560	234	32	12	2	1	1	0	0
2001	3510	86744	632880	32343	8886	4122	1561	1305	195	64	17	3	1	0	0	0
2002	50764	18336	64969	236897	6429	1985	1122	524	405	223	13	7	5	0	0	0

Table 4.2.3 Haddock in Sub-area IV and Division IIIa. Human consumption catch numbers at age. Ages 0-15, Years 1963-2002.

1963	0	27353	118185	16692	12212	5644	498	653	566	59	18	0	0	0	0	0
1964	0	48	250523	86368	8166	4689	2283	286	236	231	25	0	0	0	0	0
1965	0	2636	3445	335396	23479	4063	1852	446	107	90	41	0	0	0	0	0
1966	0	12976	6724	4250	372535	9188	1018	599	165	90	23	2	0	0	0	0
1967	0	54953	33894	3845	3345	174011	2421	215	216	57	34	0	0	0	0	0
1968	0	18443	139035	14557	1806	2495	45047	324	40	13	5	0	0	0	0	0
1969	0	139	713860	166997	6542	2014	2381	18876	200	24	7	0	0	0	0	0
1970	0	2259	51861	1133133	50823	1012	1131	254	5954	67	11	19	0	0	0	0
1971	0	34019	25862	35168	369443	10006	455	195	147	1592	160	3	5	0	0	0
1972	0	12778	207267	33215	19853	156344	3550	190	34	27	408	11	0	0	0	0
1973	0	6024	205717	193852	5829	4238	39336	1257	108	29	109	49	5	0	0	0
1974	0	23993	52416	227998	46793	1785	1232	10693	242	23	32	4	5	0	0	0
1975	0	24144	200961	38295	90302	15524	978	620	2709	266	63	11	0	8	0	0
1976	0	2301	223465	142803	9721	28103	4978	206	76	759	60	3	0	0	0	0
1977	0	8484	31741	249285	37092	4057	6021	1300	135	29	200	3	0	1	0	0
1978	0	12883	54630	25305	100036	8568	1152	2070	402	116	15	64	13	2	0	0
1979	0	14009	110008	36486	7284	27543	2219	262	483	152	54	12	11	1	0	0
1980	0	8982	141895	61901	9063	1843	7975	591	121	161	75	31	9	3	1	0
1981	0	1759	153466	112407	14679	2025	455	2498	125	64	23	30	4	1	3	0
1982	0	7373	38819	236209	37728	2913	713	279	784	30	15	7	2	2	0	0
1983	0	7101	109201	52566	117819	15760	1603	297	61	190	53	6	4	4	0	0
1984	0	19501	75963	104651	21372	31874	3788	596	84	41	112	16	5	1	1	0
1985	0	2120	248125	70806	36734	5076	7329	965	212	52	21	88	4	0	0	0
1986	0	12132	62362	261225	27548	9671	1237	1810	237	117	49	32	36	13	4	1
1987	0	6896	113196	37763	66221	4760	2877	545	778	135	36	50	27	29	5	8
1988	0	1524	146403	76925	12024	18310	1602	639	166	141	50	18	11	10	15	1
1989	0	4519	16387	128051	16762	2574	3916	498	199	83	30	13	6	2	2	1
1990	0	5493	43168	14338	45015	3269	775	1242	202	78	41	11	11	1	4	2
1991	0	19482	46902	21841	3812	12337	976	401	614	148	54	6	5	1	2	1
1992	0	2853	117953	28828	6485	1247	4779	454	300	293	124	22	6	2	0	0
1993	0	2488	77820	86806	6976	1686	450	1119	146	103	144	59	3	2	0	0
1994	0	467	69457	70354	27587	1860	524	191	509	115	32	27	25	5	0	0
1995	0	1870	29177	101663	24715	7565	511	127	45	62	19	8	6	2	1	0
1996	0	742	74892	36685	47168	7501	3052	756	52	31	25	5	8	3	1	0
1997	0	1409	23943	123178	14028	15208	1892	679	62	15	12	4	4	4	2	0
1998	0	822	38321	36736	92738	5607	3543	472	140	14	6	5	2	2	1	1
1999	0	994	25856	53192	23301	37630	2155	1595	342	41	6	2	1	1	0	0
2000	0	4750	30316	28653	23407	5873	8644	560	234	32	12	2	1	1	0	0
2001	0	611	67196	16117	7406	3929	1561	1295	191	64	17	3	1	0	0	0
2002	0	640	13414	108143	5521	1951	1122	403	405	223	13	7	5	0	0	0

Table 4.2.4 Haddock in Sub-area IV and Division IIIa. Discard numbers at age. Ages 0-15, Years 1963-2002.

1963	42	1047925	193718	3476	708	51	2	0	0	0	0	0	0	0	0	0
1964	2395	4182	623111	13597	262	21	10	0	0	0	0	0	0	0	0	0
1965	5307	110628	4020	130369	3641	4	1	0	0	0	0	0	0	0	0	0
1966	7880	444111	12388	1166	24114	35	2	0	0	0	0	0	0	0	0	0
1967	6250	389691	49635	863	216	1576	9	0	0	0	0	0	0	0	0	0
1968	39	615649	219022	3006	94	15	186	0	0	0	0	0	0	0	0	0
1969	1732	5152	1158445	37686	420	16	8	0	0	0	0	0	0	0	0	0
1970	51717	92978	77992	289679	2640	13	4	0	0	0	0	0	0	0	0	0
1971	7586	1205838	35117	8960	24590	66	2	0	0	0	0	0	0	0	0	0
1972	4231	424657	322547	6353	1212	1212	13	0	0	0	0	0	0	0	0	0
1973	18540	241423	352310	46740	352	33	123	0	0	0	0	0	0	0	0	0
1974	24758	915157	90904	57011	2814	6	4	0	0	0	0	0	0	0	0	0
1975	630	1478590	353422	15781	13388	143	0	0	0	0	0	0	0	0	0	0
1976	2191	98420	648662	38317	183	137	0	0	0	0	0	0	0	0	0	0
1977	11812	95090	44918	73431	605	9	0	0	0	0	0	0	0	0	0	0
1978	5250	316339	80219	4207	12085	72	106	0	0	0	0	0	0	0	0	0
1979	1824	205555	75517	3232	34	84	0	0	0	0	0	0	0	0	0	0
1980	644	369727	168124	2346	39	0	0	0	0	0	0	0	0	0	0	0
1981	1509	33434	237524	25928	86	3	0	0	0	0	0	0	0	0	0	0
1982	3703	93865	31915	49462	1845	0	0	0	0	0	0	0	0	0	0	0
1983	151108	85338	128171	15966	7112	717	105	0	0	0	0	0	0	0	0	0
1984	2915	314421	80803	13430	327	240	0	0	0	0	0	0	0	0	0	0
1985	17501	165086	267747	6088	149	4	8	0	0	0	0	0	0	0	0	0
1986	23807	108204	114606	61612	31	12	0	0	0	0	0	0	0	0	0	0
1987	1166	188582	133010	9320	1506	0	0	0	0	0	0	0	0	0	0	0
1988	1528	24588	325259	9684	788	67	0	0	0	0	0	0	0	0	0	0
1989	1790	40211	16959	51491	814	20	42	0	0	0	0	0	0	0	0	0
1990	52477	68625	56359	3977	10190	235	77	0	0	0	0	0	0	0	0	0
1991	7001	182162	27942	725	27	145	0	0	0	0	0	0	0	0	0	0
1992	29056	110995	123961	3298	38	0	65	0	0	0	0	0	0	0	0	0
1993	16715	235123	170794	18375	48	3	0	1	0	0	0	0	0	0	0	0
1994	16059	82033	217538	29100	1862	53	48	0	0	0	0	0	0	0	0	0
1995	3228	191807	54448	65250	1095	79	0	0	0	0	0	0	0	0	0	0
1996	3968	35340	275597	16870	7872	2	0	0	0	0	0	0	0	0	0	0
1997	7162	85588	50976	85664	1061	182	0	0	0	0	0	0	0	0	0	0
1998	3132	72793	112075	10165	13766	71	18	0	0	0	0	0	0	0	0	0
1999	14588	69196	90861	31119	1094	2064	180	0	0	0	0	0	0	0	0	0
2000	2474	272894	36568	12614	2764	148	64	0	0	0	0	0	0	0	0	0
2001	545	61878	529908	6100	1446	186	0	10	4	0	0	0	0	0	0	0
2002	957	3807	47066	125116	404	7	0	122	0	0	0	0	0	0	0	0

Table 4.2.5 Haddock in Sub-area IV and Division IIIa. Industrial by-catch (for reduction purposes) catch numbers at age. Ages 0-15, Years 1963-2002.

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

Table 4.2.6 Haddock in Sub-area IV and Division IIIa. Total catch weights at age. Ages 0-15, Years 1963-2002.

1963	0.012	0.123	0.253	0.473	0.695	0.807	1.004	1.131	1.173	1.576	1.825	0	0	0	0	0
1964	0.011	0.118	0.239	0.403	0.664	0.814	0.908	1.382	1.148	1.47	1.781	0	0	0	0	0
1965	0.01	0.069	0.225	0.366	0.648	0.844	1.193	1.173	1.482	1.707	2.239	0	0	0	0	0
1966	0.01	0.088	0.247	0.367	0.533	0.949	1.266	1.525	1.938	1.727	2.963	2.04	0	0	0	0
1967	0.011	0.115	0.281	0.461	0.594	0.639	1.057	1.501	1.922	2.069	2.348	0	0	0	0	0
1968	0.01	0.126	0.253	0.509	0.731	0.857	0.837	1.606	2.26	2.702	2.073	0	0	0	0	0
1969	0.011	0.063	0.216	0.406	0.799	0.891	1.031	1.094	2.04	3.034	3.264	0	0	0	0	0
1970	0.013	0.073	0.222	0.352	0.735	0.873	1.191	1.362	1.437	2.571	3.95	3.869	0	0	0	0
1971	0.011	0.107	0.247	0.362	0.506	0.887	1.267	1.534	1.337	1.275	1.969	4.306	3.543	0	0	0
1972	0.024	0.116	0.242	0.388	0.506	0.606	1	1.366	2.241	2.006	1.651	2.899	0	0	0	0
1973	0.044	0.112	0.24	0.372	0.586	0.649	0.725	1.044	1.302	2.796	1.726	2.02	2.158	0	0	0
1974	0.024	0.128	0.226	0.343	0.548	0.891	0.895	0.952	1.513	2.315	2.508	4.152	2.264	0	0	0
1975	0.02	0.101	0.241	0.356	0.449	0.68	1.245	1.124	1.093	1.72	2.217	2.854	0	3.426	0	0
1976	0.013	0.125	0.224	0.401	0.512	0.588	0.922	1.933	1.784	1.306	2.425	2.528	0	0	0	0
1977	0.019	0.108	0.241	0.345	0.601	0.613	0.802	1.181	1.943	2.322	1.78	3.189	0	4.119	0	0
1978	0.011	0.144	0.253	0.418	0.441	0.719	0.742	0.955	1.398	2.124	2.867	1.849	2.454	4.782	0	0
1979	0.009	0.095	0.29	0.443	0.637	0.664	0.933	1.187	1.187	1.468	2.679	1.624	1.76	1.643	0	0
1980	0.012	0.104	0.283	0.486	0.732	1.046	0.936	1.394	1.599	1.593	1.726	3.328	1.119	3.071	3.111	0
1981	0.009	0.074	0.262	0.476	0.745	1.147	1.479	1.18	1.634	1.764	1.554	1.492	3.389	4.273	1.981	0
1982	0.011	0.1	0.292	0.46	0.784	1.166	1.441	1.672	1.456	2.634	2.164	1.924	1.886	3.179	0	0
1983	0.022	0.135	0.297	0.448	0.651	0.915	1.214	1.162	1.92	1.376	1.395	1.907	2.853	4.689	0	0
1984	0.01	0.141	0.3	0.489	0.67	0.805	1.097	1.1	1.868	2.425	1.972	2.247	2.422	2.822	4.995	0
1985	0.013	0.149	0.279	0.48	0.668	0.857	1.049	1.459	1.833	2.124	2.145	2.003	2.387	2.471	2.721	3.97
1986	0.025	0.124	0.242	0.397	0.613	0.863	1.257	1.195	1.715	1.525	2.484	2.653	2.538	3.075	2.778	2.894
1987	0.008	0.126	0.265	0.406	0.615	1.029	1.276	1.433	1.529	1.877	2.054	1.94	2.471	2.411	2.996	2.638
1988	0.024	0.165	0.217	0.417	0.589	0.748	1.284	1.424	1.551	1.627	1.68	3.068	2.468	2.885	3.337	2.863
1989	0.027	0.197	0.3	0.372	0.605	0.811	0.982	1.364	1.655	1.684	2.249	2.166	2.364	2.389	2.307	1.146
1990	0.044	0.194	0.292	0.43	0.473	0.771	0.967	1.167	1.529	2.037	2.653	2.53	2.392	3.444	1.852	4.731
1991	0.029	0.177	0.32	0.472	0.639	0.65	1.042	1.232	1.481	1.776	1.996	2.253	2.404	1.07	3.509	2.936
1992	0.018	0.107	0.306	0.486	0.748	1.016	0.896	1.395	1.537	1.912	1.997	2.067	2.441	1.781	0	0
1993	0.01	0.115	0.28	0.447	0.68	0.894	1.173	1.102	1.592	1.737	1.92	1.718	2.274	2.516	0	0
1994	0.017	0.116	0.25	0.419	0.597	0.943	1.208	1.57	1.469	1.62	2.418	2.108	2.849	2.403	2.58	0
1995	0.013	0.102	0.297	0.363	0.592	0.763	1.099	1.423	1.685	1.873	1.881	2.508	1.674	1.699	2.243	0
1996	0.019	0.127	0.246	0.388	0.483	0.78	0.87	0.846	1.833	2.025	1.623	2.393	2.369	2.598	3.439	0
1997	0.021	0.133	0.277	0.359	0.579	0.615	0.909	0.966	1.647	2.247	2.146	2.634	2.757	2.262	2.867	2.782
1998	0.023	0.153	0.252	0.392	0.44	0.651	0.76	1.103	1.153	1.825	2.357	2.15	2.824	2.423	2.085	2.509
1999	0.023	0.168	0.243	0.361	0.473	0.498	0.68	0.782	0.749	1.247	1.559	1.913	2.232	2.392	2.912	2.225
2000	0.048	0.119	0.253	0.367	0.498	0.615	0.650	1.100	1.091	1.760	1.959	2.331	2.385	2.315	3.810	1.843
2001	0.021	0.109	0.216	0.309	0.466	0.697	0.754	0.971	1.892	1.198	2.114	2.706	3.237	2.534	1.239	3.425
2002	0.016	0.088	0.252	0.325	0.526	0.725	0.889	0.815	1.399	1.949	2.321	1.988	2.355	2.762	0.000	0.000

Table 4.2.7 Haddock in Sub-area IV and Division IIIa. Human consumption catch weights at age. Ages 0-15, Years 1963-2002.

1963	0	0.233	0.326	0.512	0.715	0.817	1.009	1.131	1.173	1.576	1.825	0	0	0	0	0
1964	0	0.221	0.313	0.459	0.695	0.87	0.934	1.386	1.148	1.47	1.781	0	0	0	0	0
1965	0	0.31	0.357	0.41	0.679	0.907	1.242	1.182	1.482	1.707	2.239	0	0	0	0	0
1966	0	0.301	0.384	0.416	0.553	0.995	1.288	1.529	1.938	1.727	2.963	2.04	0	0	0	0
1967	0	0.26	0.404	0.51	0.614	0.645	1.063	1.501	1.922	2.069	2.348	0	0	0	0	0
1968	0	0.256	0.361	0.591	0.761	0.863	0.846	1.61	2.26	2.702	2.073	0	0	0	0	0
1969	0	0.178	0.302	0.506	0.87	0.984	1.065	1.102	2.04	3.034	3.264	0	0	0	0	0
1970	0	0.242	0.31	0.403	0.786	0.949	1.235	1.37	1.437	2.571	3.95	3.869	0	0	0	0
1971	0	0.256	0.335	0.399	0.524	0.905	1.281	1.534	1.337	1.275	1.969	4.306	3.543	0	0	0
1972	0	0.244	0.329	0.421	0.523	0.609	1.003	1.366	2.241	2.006	1.651	2.899	0	0	0	0
1973	0	0.225	0.315	0.406	0.606	0.663	0.726	1.044	1.302	2.796	1.726	2.02	2.158	0	0	0
1974	0	0.275	0.32	0.389	0.585	0.908	0.954	0.963	1.513	2.315	2.508	4.152	2.264	0	0	0
1975	0	0.258	0.345	0.408	0.487	0.686	1.248	1.124	1.094	1.72	2.217	2.854	0	3.426	0	0
1976	0	0.25	0.344	0.467	0.516	0.614	0.923	1.933	1.784	1.306	2.425	2.528	0	0	0	0
1977	0	0.286	0.362	0.396	0.614	0.63	0.817	1.181	1.943	2.322	1.78	3.189	0	4.119	0	0
1978	0	0.275	0.356	0.457	0.47	0.725	0.789	0.956	1.398	2.124	2.868	1.849	2.454	4.782	0	0
1979	0	0.274	0.361	0.468	0.642	0.668	0.935	1.187	1.187	1.468	2.679	1.624	1.76	1.643	0	0
1980	0	0.299	0.367	0.526	0.75	1.056	0.934	1.392	1.599	1.592	1.726	3.328	1.119	3.071	3.111	0
1981	0	0.339	0.385	0.525	0.754	1.149	1.481	1.18	1.634	1.764	1.554	1.492	3.389	4.273	1.981	0
1982	0	0.3	0.364	0.507	0.818	1.237	1.441	1.672	1.456	2.634	2.164	1.924	1.886	3.179	0	0
1983	0	0.312	0.387	0.482	0.663	0.925	1.243	1.162	1.92	1.376	1.395	1.907	2.853	4.689	0	0
1984	0	0.281	0.376	0.515	0.677	0.81	1.097	1.1	1.868	2.425	1.972	2.247	2.422	2.822	4.995	0
1985	0	0.277	0.359	0.502	0.671	0.871	1.051	1.459	1.833	2.124	2.145	2.003	2.387	2.471	2.721	3.97
1986	0	0.276	0.351	0.433	0.613	0.863	1.257	1.195	1.715	1.525	2.484	2.653	2.538	3.075	2.778	2.894
1987	0	0.274	0.345	0.451	0.622	1.029	1.276	1.433	1.529	1.877	2.054	1.94	2.471	2.411	2.996	2.638
1988	0	0.258	0.324	0.445	0.619	0.752	1.284	1.424	1.551	1.627	1.68	3.068	2.468	2.885	3.337	2.863
1989	0	0.31	0.388	0.415	0.617	0.81	0.982	1.361	1.653	1.684	2.236	2.166	2.364	2.389	2.307	1.146
1990	0	0.308	0.379	0.484	0.516	0.802	1.039	1.191	1.543	2.037	2.653	2.53	2.392	3.444	1.852	4.731
1991	0	0.319	0.377	0.48	0.643	0.653	1.042	1.232	1.481	1.776	1.996	2.253	2.404	1.07	3.509	2.936
1992	0	0.336	0.379	0.51	0.751	1.017	0.904	1.395	1.538	1.912	1.997	2.067	2.441	1.781	0	0
1993	0	0.326	0.393	0.483	0.684	0.896	1.173	1.111	1.592	1.737	1.92	1.718	2.274	2.516	0	0
1994	0	0.288	0.39	0.482	0.617	0.962	1.296	1.57	1.469	1.62	2.418	2.108	2.849	2.403	2.58	0
1995	0	0.312	0.396	0.421	0.603	0.767	1.099	1.423	1.685	1.873	1.881	2.508	1.674	1.699	2.243	0
1996	0	0.342	0.359	0.462	0.515	0.78	0.87	0.846	1.833	2.025	1.623	2.393	2.369	2.598	3.439	0
1997	0	0.333	0.396	0.412	0.601	0.618	0.909	0.966	1.647	2.247	2.146	2.634	2.757	2.262	2.867	2.782
1998	0	0.263	0.361	0.429	0.46	0.657	0.762	1.103	1.153	1.825	2.357	2.15	2.824	2.423	2.085	2.509
1999	0	0.286	0.347	0.416	0.482	0.51	0.717	0.782	0.749	1.247	1.559	1.913	2.232	2.392	2.912	2.225
2000	0	0.298	0.366	0.419	0.520	0.622	0.653	1.100	1.091	1.760	1.959	2.331	2.385	2.315	3.810	1.843
2001	0	0.378	0.348	0.439	0.498	0.714	0.754	0.976	1.922	1.198	2.114	2.706	3.237	2.534	1.239	3.425
2002	0	0.356	0.429	0.394	0.554	0.730	0.889	0.953	1.399	1.949	2.321	1.988	2.355	2.762	0	0

Table 4.2.8 Haddock in Sub-area IV and Division IIIa. Discard catch weights at age. Ages 0-15, Years 1963-2002.

1963	0.064	0.139	0.218	0.327	0.397	0.321	0.321	0	0	0	0	0	0	0	0	0
1964	0.065	0.177	0.249	0.306	0.337	0.321	0.321	0	0	0	0	0	0	0	0	0
1965	0.064	0.131	0.2	0.341	0.613	0.321	0.321	0	0	0	0	0	0	0	0	0
1966	0.063	0.141	0.208	0.244	0.31	0.321	0.321	0	0	0	0	0	0	0	0	0
1967	0.064	0.171	0.209	0.274	0.306	0.321	0.321	0	0	0	0	0	0	0	0	0
1968	0.063	0.186	0.212	0.256	0.318	0.321	0.321	0	0	0	0	0	0	0	0	0
1969	0.064	0.129	0.216	0.237	0.301	0.321	0.321	0	0	0	0	0	0	0	0	0
1970	0.063	0.129	0.21	0.238	0.263	0.321	0.321	0	0	0	0	0	0	0	0	0
1971	0.063	0.134	0.201	0.242	0.263	0.321	0.321	0	0	0	0	0	0	0	0	0
1972	0.063	0.139	0.206	0.237	0.261	0.321	0.321	0	0	0	0	0	0	0	0	0
1973	0.063	0.131	0.201	0.235	0.263	0.321	0.321	0	0	0	0	0	0	0	0	0
1974	0.062	0.145	0.2	0.233	0.259	0.321	0.321	0	0	0	0	0	0	0	0	0
1975	0.05	0.123	0.2	0.257	0.275	0.348	0	0	0	0	0	0	0	0	0	0
1976	0.079	0.176	0.197	0.237	0.292	0.337	0	0	0	0	0	0	0	0	0	0
1977	0.071	0.196	0.197	0.216	0.309	0.347	0	0	0	0	0	0	0	0	0	0
1978	0.037	0.18	0.199	0.222	0.224	0.265	0.284	0	0	0	0	0	0	0	0	0
1979	0.053	0.118	0.219	0.242	0.259	0.34	0	0	0	0	0	0	0	0	0	0
1980	0.051	0.149	0.231	0.274	0.324	0	0	0	0	0	0	0	0	0	0	0
1981	0.073	0.16	0.198	0.29	0.65	0.727	0	0	0	0	0	0	0	0	0	0
1982	0.072	0.197	0.248	0.271	0.264	0	0	0	0	0	0	0	0	0	0	0
1983	0.067	0.187	0.237	0.347	0.476	0.711	0.792	0	0	0	0	0	0	0	0	0
1984	0.046	0.162	0.245	0.317	0.3	0.314	0	0	0	0	0	0	0	0	0	0
1985	0.04	0.155	0.214	0.264	0.336	0.423	0.421	0	0	0	0	0	0	0	0	0
1986	0.045	0.138	0.184	0.245	0.408	0.329	0	0	0	0	0	0	0	0	0	0
1987	0.023	0.159	0.2	0.225	0.287	0	0	0	0	0	0	0	0	0	0	0
1988	0.063	0.172	0.17	0.238	0.254	0.36	0	0	0	0	0	0	0	0	0	0
1989	0.085	0.187	0.229	0.268	0.335	0.708	0.844	0	2.572	0	3.048	0	0	0	0	0
1990	0.046	0.196	0.229	0.249	0.266	0.29	0.333	0	0	0	0	0	0	0	0	0
1991	0.065	0.179	0.243	0.344	0.464	0.493	0	0	0	0	0	0	0	0	0	0
1992	0.043	0.137	0.246	0.286	0.347	0	0.415	0	0	0	0	0	0	0	0	0
1993	0.027	0.142	0.237	0.287	0.344	0.369	0	0.369	0	0	0	0	0	0	0	0
1994	0.044	0.126	0.211	0.269	0.306	0.304	0.27	0	0	0	0	0	0	0	0	0
1995	0.064	0.131	0.251	0.275	0.363	0.384	0	0	0	0	0	0	0	0	0	0
1996	0.046	0.138	0.219	0.279	0.297	0.358	0	0	0	0	0	0	0	0	0	0
1997	0.063	0.161	0.254	0.286	0.321	0.385	0	0	0	0	0	0	0	0	0	0
1998	0.041	0.162	0.231	0.293	0.315	0.391	0.428	0	0	0	0	0	0	0	0	0
1999	0.049	0.183	0.217	0.273	0.307	0.304	0.25	0	0	0	0	0	0	0	0	0
2000	0.030	0.129	0.246	0.281	0.319	0.355	0.287	0	0	0	0	0	0	0	0	0
2001	0.045	0.116	0.205	0.307	0.308	0.364	0	0.411	0.416	0	0	0	0	0	0	0
2002	0.042	0.166	0.222	0.267	0.351	0.377	0	0.357	0	0	0	0	0	0	0	0

Table 4.2.9 Haddock in Sub-area IV and Division IIIa. Industrial by-catch (for reduction purposes) catch weights at age. Ages 0-15, Years 1963-2002.

1963	0.01	0.04	0.18	0.302	0.4	0.42	0.44	0	0	0	0	0	0	0	0	0
1964	0.01	0.04	0.18	0.302	0.4	0.42	0.44	0.5	0	0	0	0	0	0	0	0
1965	0.01	0.04	0.18	0.302	0.4	0.42	0.44	0.5	0	0	0	0	0	0	0	0
1966	0.01	0.04	0.18	0.302	0.4	0.42	0.44	0.5	0	0	0	0	0	0	0	0
1967	0.01	0.04	0.18	0.302	0.4	0.42	0.44	0	0	0	0	0	0	0	0	0
1968	0.01	0.04	0.18	0.302	0.4	0.42	0.44	0.5	0	0	0	0	0	0	0	0
1969	0.01	0.04	0.18	0.302	0.4	0.42	0.44	0.5	0	0	0	0	0	0	0	0
1970	0.01	0.04	0.18	0.302	0.4	0.42	0.44	0.5	0	0	0	0	0	0	0	0
1971	0.01	0.04	0.18	0.302	0.4	0.42	0.44	0	0	0	0	0	0	0	0	0
1972	0.023	0.067	0.136	0.255	0.288	0.231	0	0	0	0	0	0	0	0	0	0
1973	0.035	0.068	0.141	0.246	0.327	0.396	0	0	0	0	0	0	0	0	0	0
1974	0.022	0.058	0.15	0.26	0.359	0.579	0.277	0.447	0	0	0	0	0	0	0	0
1975	0.02	0.039	0.173	0.275	0.267	0.413	0.585	0	0.585	0	0	0	0	0	0	0
1976	0.012	0.046	0.181	0.304	0.473	0.36	0.725	0	0	0	0	0	0	0	0	0
1977	0.013	0.042	0.184	0.307	0.49	0.352	0.442	1.234	1.315	1.319	0	0	0	0	0	0
1978	0.011	0.04	0.174	0.286	0.372	0.473	0.411	0.456	1.315	0	1.4	0	0	0	0	0
1979	0.009	0.039	0.177	0.285	0.384	0.461	0.735	1.234	1.315	0	1.4	0	0	0	0	0
1980	0.012	0.039	0.176	0.268	0.623	0.722	1.102	1.591	0	1.796	0	0	0	0	0	0
1981	0.009	0.04	0.176	0.371	0.467	0.858	1.2	1.234	1.315	1.319	1.4	0	0	0	0	0
1982	0.01	0.04	0.206	0.379	0.636	0.751	1.225	1.233	1.315	1.319	0	0	0	0	0	0
1983	0.008	0.047	0.173	0.428	0.584	1.006	1.225	1.234	1.315	1.319	0	0	0	0	0	0
1984	0.009	0.045	0.211	0.414	0.626	0.751	1.225	1.234	1.315	1.319	1.4	1.4	0	0	0	0
1985	0.009	0.043	0.186	0.371	0.55	0.563	0.565	1.234	1.315	1.319	1.4	0	0	0	0	0
1986	0.01	0.04	0.186	0.375	0.626	1.259	1.225	1.234	1.315	1.319	1.4	0	0	0	0	0
1987	0.006	0.038	0.258	0.442	0.908	1.171	1.225	1.234	1.315	1.319	0	0	0	0	0	0
1988	0.018	0.077	0.196	0.274	0.455	0.549	1.225	1.234	1.315	1.319	1.4	0	0	0	0	0
1989	0.015	0.165	0.251	0.347	0.67	0.923	1.065	1.492	1.315	0	1.4	0	0	0	0	0
1990	0.005	0.104	0.229	0.506	0.609	0.842	0.829	0.796	0.956	1.319	0	0	0	0	0	0
1991	0.027	0.058	0.206	0.357	0.472	0.477	1.225	1.234	1.315	1.319	0	0	0	0	0	0
1992	0.015	0.059	0.217	0.422	0.552	0.615	0.548	1.234	0.621	0.82	0	0	0	0	0	0
1993	0.008	0.053	0.206	0.399	0.521	0.578	1.225	0.582	1.315	0	0	0	0	0	0	0
1994	0.011	0.055	0.155	0.435	0.595	0.698	0.49	0	0	0	0	0	0	0	0	0
1995	0.012	0.045	0.193	0.285	0.387	0	0	0	0	0	0	0	0	0	0	0
1996	0.018	0.077	0.136	0.162	0.264	0	0	0	0	0	0	0	0	0	0	0
1997	0.007	0.076	0.149	0.309	0.419	0.601	0	0	0	0	0	0	0	0	0	0
1998	0.02	0.075	0.166	0.291	0.351	0.453	0	0	0	0	0	0	0	0	0	0
1999	0.018	0.064	0.177	0.304	0.416	0.309	0	0	0	0	0	0	0	0	0	0
2000	0.058	0.070	0.113	0.176	0.370	0.203	0	0	0	0	0	0	0	0	0	0
2001	0.014	0.086	0.133	0.110	0.353	0.431	0	0	0	0	0	0	0	0	0	0
2002	0.016	0.064	0.178	0.283	0.374	0.431	0	0	0	0	0	0	0	0	0	0

Table 4.3.1. Haddock in Sub-area IV and Division IIIa. Landings-effort and survey tuning series made available to the WG. Effort for Scottish seiners (first column) is given as reported hours fished.

ScoSEI Scottish seiners

1978	2002													
1	1	0	1											
0	13													
325246	1665.021	160842.859	69033.234	14339.891	44151.660	2365.977	481.996	672.993	85.999	29.000	3.000	16.000	6.000	0.000
316419	542.986	83630.891	78815.422	17214.719	3039.951	8072.871	647.990	69.999	112.998	24.000	4.000	1.000	1.000	0.000
297227	210.001	131314.297	128306.000	26204.932	3392.990	500.999	2414.993	123.000	20.000	56.000	23.000	13.000	1.000	1.000
289672	344.996	10366.878	134259.797	55726.172	5180.690	701.958	101.994	578.965	14.999	21.999	1.000	9.999	2.000	0.000
297730	1444.967	31143.318	30968.578	118897.859	14296.881	681.995	144.999	39.000	229.998	1.000	9.000	1.000	0.000	0.000
333168	18101.430	29021.006	77288.734	30413.863	50114.895	6394.235	582.521	118.749	14.600	69.108	26.281	0.973	1.947	0.000
388085	422.095	120868.211	63391.047	49285.750	9426.073	14976.844	1593.925	253.625	18.044	8.020	38.094	3.007	2.005	0.000
382910	2052.204	29238.559	164839.219	33202.645	15993.386	2292.755	2846.266	308.427	46.979	19.404	9.192	27.575	2.043	0.000
425017	8265.012	33999.168	72603.500	155836.391	12894.806	4169.091	489.713	620.234	58.473	11.486	19.839	14.618	11.486	3.132
418734	137.900	43645.945	97730.797	19730.920	28882.715	1989.147	1174.107	198.915	284.601	30.602	16.321	15.301	12.241	7.141
377132	498.662	11575.792	201533.422	37421.008	4735.789	7414.681	718.065	290.026	80.007	70.006	27.002	6.001	6.001	7.001
355735	122.757	19003.758	19274.379	91069.766	8388.754	1091.295	1611.435	223.083	88.504	39.511	13.370	5.898	3.555	0.914
300076	712.190	35843.578	46489.320	9055.270	26705.223	1434.486	302.388	407.550	67.207	28.721	5.366	3.083	0.471	0.000
336675	2225.837	66143.555	30754.680	9530.928	1484.518	5028.135	307.511	122.391	183.010	42.406	10.676	1.166	1.469	0.055
300217	1231.550	30384.277	64732.898	8588.196	1511.942	290.016	1179.738	79.037	56.679	53.277	17.957	4.149	0.255	1.183
268413	2912.944	74523.461	88375.047	34996.895	2349.233	445.716	100.011	314.410	28.586	14.710	14.290	3.076	0.306	0.530
264738	3230.533	26626.006	125357.344	34126.902	10522.028	415.035	138.226	41.743	94.732	9.389	6.690	7.342	2.222	0.898
204545	236.434	67772.078	32300.982	70290.070	8734.379	2180.770	116.890	39.103	13.449	9.427	3.759	1.621	3.334	0.570
177092	1333.347	9191.870	123828.508	18532.246	17077.139	2161.283	707.006	83.724	11.556	8.436	11.111	2.525	1.597	0.533
166817	3108.574	30046.252	19165.139	59308.570	3917.753	4082.625	495.431	194.737	9.571	6.679	1.772	0.333	0.385	2.199
150361	38.313	12692.390	36812.770	12002.680	26564.220	1658.977	855.953	68.527	22.136	4.219	1.612	1.706	0.164	0.376
93796	3466.166	23253.381	35101.580	21990.903	6627.722	11164.055	690.476	456.286	56.023	12.211	0.497	0.544	0.148	0.128
69505	109.784	46421.874	13649.786	8497.452	5609.592	1760.584	2356.751	109.619	41.356	3.543	1.124	0.457	0.120	0.026
36135	60.238	3973.356	91164.700	4468.835	1720.130	798.976	272.547	262.936	27.294	17.750	1.445	0.646	0.185	0.017
21817	14.477	653.349	9269.040	42085.780	1125.579	377.031	187.406	55.411	41.627	15.413	1.587	0.565	0.099	0.042

Table 4.3.1. contd. Haddock in Sub-area IV and Division IIIa. Landings-effort and survey tuning series made available to the WG. Effort for Scottish light trawlers (first column) is given as reported hours fished.

ScoLTR Scottish light trawlers

1978	2002													
1	1	0	1											
0	13													
236929	1691.974	45733.129	11470.503	2913.805	12279.115	773.938	109.992	166.987	23.998	4.000	0.000	5.000	1.000	0.000
287494	463.914	44561.961	23134.695	4109.341	713.887	3643.626	202.981	19.998	56.995	19.998	0.000	0.000	1.000	0.000
333197	179.995	92519.258	46282.270	8061.933	754.994	196.998	1014.992	61.000	18.000	8.000	5.000	0.000	0.000	0.000
251504	436.018	7979.309	58146.379	13652.977	1517.987	160.999	20.000	319.997	12.000	6.000	7.000	6.000	0.000	0.000
250870	351.994	24574.580	10169.870	33462.625	3936.959	132.999	66.999	7.000	57.999	0.000	0.000	2.000	0.000	0.000
244349	63675.969	19635.391	48680.480	6954.711	11807.154	1258.171	124.417	27.092	4.014	25.085	7.024	0.000	0.000	2.007
240725	514.080	56768.969	22191.479	13374.796	2074.455	3392.161	402.251	98.036	15.160	7.075	14.150	1.011	0.000	0.000
268136	3547.814	38850.406	57422.219	4912.630	2787.082	414.117	871.881	127.894	27.406	2.030	0.000	18.271	0.000	0.000
279767	4371.354	26322.217	26549.291	32339.221	2796.814	1013.775	123.812	306.884	43.387	37.038	2.116	2.116	2.116	3.175
351128	96.701	26220.209	33647.762	6464.323	7197.125	496.072	377.057	71.620	119.015	27.384	2.106	4.213	3.160	4.213
391988	209.356	2930.596	57588.922	14074.734	2366.963	2923.692	167.036	84.018	28.006	21.005	6.001	0.000	0.000	0.000
405883	1076.998	10415.017	2919.387	24894.512	2753.952	541.324	626.922	108.898	30.131	21.314	6.988	3.810	1.013	0.747
441084	201.380	11886.348	19204.623	2664.623	10237.385	669.340	168.189	264.216	44.836	13.601	5.347	1.618	0.718	0.056
408056	1040.658	44141.125	12393.733	3355.596	564.193	2213.164	226.034	79.589	145.803	38.047	15.861	1.605	1.057	0.407
473955	1838.052	20443.346	31073.281	3889.020	756.982	144.252	765.573	97.505	52.225	57.939	17.465	2.921	1.077	0.055
447064	231.101	39863.391	39175.809	20213.473	1526.971	362.312	83.586	273.529	29.288	26.740	25.521	8.243	2.035	1.210
480400	1482.199	8266.777	49046.742	23557.340	6304.283	474.420	128.143	42.488	63.750	12.916	6.819	7.406	2.389	2.220
442010	143.844	22873.541	13761.645	32063.371	5821.263	1658.212	96.772	14.662	12.648	16.895	2.898	1.597	0.894	1.096
445995	352.525	14280.547	72692.008	9859.966	13958.747	2041.165	955.313	303.994	9.761	13.794	7.004	1.399	1.908	0.686
479449	459.847	15907.054	13450.542	49548.469	3536.682	4510.573	553.205	162.645	12.541	2.170	1.726	0.927	0.755	0.889
427868	156.690	27497.900	33166.450	9596.803	29613.580	1666.356	1228.130	173.209	46.331	4.427	0.827	1.161	0.424	1.405
329750	2100.591	24474.823	36848.743	24426.481	5531.454	11751.876	840.830	578.867	94.400	8.786	2.002	0.490	0.241	0.036
280938	4.881	64710.407	15037.658	11706.879	7060.598	1300.239	2593.344	173.991	82.995	7.893	1.966	0.767	0.467	0.000
245489	87.474	15567.304	173376.240	6323.384	2896.944	1252.629	365.207	443.732	61.520	16.846	8.614	0.423	0.497	0.000
184096	8.327	982.154	11514.146	53313.010	1738.246	663.906	394.788	165.238	217.886	93.785	5.457	3.726	1.947	0.000

Table 4.3.1. contd. Haddock in Sub-area IV and Division IIIa. Landings-effort and survey tuning series made available to the WG. For ScoGFS, numbers are standardised to catch-rate per 10 hours.

EngGFS English groundfish survey

1977	2002							
1	1	0.5	0.75					
0	7							
100	53.480	6.681	3.206	6.163	0.925	0.072	0.091	0.013
100	35.827	13.688	2.617	0.239	2.220	0.214	0.005	0.074
100	87.551	29.554	5.461	0.872	0.109	0.437	0.035	0.004
100	37.402	62.331	16.731	2.570	0.273	0.043	0.142	0.022
100	153.746	17.319	43.910	7.557	0.742	0.064	0.003	0.060
100	28.134	31.547	7.979	11.800	1.026	0.236	0.098	0.014
100	83.193	21.821	10.952	2.143	2.174	0.266	0.041	0.014
100	22.846	59.933	6.159	3.078	0.417	0.478	0.103	0.013
100	24.587	18.656	23.819	2.111	0.698	0.196	0.128	0.041
100	26.600	14.973	4.472	3.383	0.278	0.175	0.038	0.036
100	2.241	28.193	4.310	0.533	0.687	0.048	0.033	0.003
100	6.074	2.856	18.353	1.549	0.160	0.279	0.040	0.012
100	9.429	8.168	1.446	3.968	0.252	0.030	0.060	0.014
100	28.188	6.645	1.983	0.286	0.878	0.048	0.027	0.013
100	26.333	11.505	0.961	0.231	0.048	0.219	0.005	0.006
100	82.774	19.688	9.774	0.584	0.049	0.012	0.084	0.004
100	13.578	24.609	5.859	1.665	0.059	0.017	0.000	0.009
100	94.297	8.066	9.020	0.839	0.283	0.020	0.001	0.001
100	17.993	38.310	4.452	3.403	0.278	0.092	0.007	0.000
100	19.917	8.310	14.570	1.217	0.830	0.071	0.054	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
100	0.372	9.635	32.493	1.023	0.279	0.118	0.045	0.019
100	0.919	1.329	7.596	20.400	0.183	0.033	0.051	0.032

Table 4.3.1. contd. Haddock in Sub-area IV and Division IIIa. Landings-effort and survey tuning series made available to the WG. For ScoGFS, numbers are standardised to catch-rate per 10 hours. The upper table gives indices from a consistent survey area for the whole time-series. The lower table shows indices from the new survey area, instigated in 1999.

ScoGFS (consistent area 1982–2003)

1982	2003					
1	1	0.5	0.75			
0	5					
100	1235.000	2488.000	996.000	1336.000	115.000	7.000
100	2203.000	1813.000	1611.000	372.000	455.000	53.000
100	873.000	4367.000	788.000	336.000	55.000	65.000
100	818.000	1976.000	2981.000	232.000	103.000	14.000
100	1747.000	2329.000	574.000	598.000	36.000	27.000
100	277.000	2393.000	704.000	106.000	128.000	8.000
100	406.000	467.000	1982.000	170.000	27.000	23.000
100	432.000	886.000	214.000	574.000	31.000	4.000
100	3163.000	1002.000	240.000	32.000	103.000	7.000
100	3471.000	1705.000	178.000	21.000	5.000	16.000
100	8270.000	3832.000	963.000	48.000	8.000	3.000
100	859.000	5836.000	1380.000	269.000	6.000	4.000
100	13762.000	1265.000	2080.000	210.000	53.000	2.000
100	1566.000	8153.000	734.000	926.000	74.000	28.000
100	1980.000	2231.000	4705.000	231.000	206.000	22.000
100	972.000	2779.000	849.000	1397.000	66.000	56.000
100	3280.000	6349.000	1924.000	490.000	511.000	24.000
100	66067.310	1907.141	1141.225	688.380	197.127	164.070
100	11902.085	30610.761	460.380	221.282	129.507	72.803
100	78.620	3789.563	11352.408	178.704	65.042	40.239
100	2149.357	674.629	2632.471	6930.857	69.571	37.071
100	2159.063	1171.747	306.57	2091.532	4343.519	22.456

ScoGFS (new area 1999–2003)

1999	2003					
1	1	0.5	0.75			
0	5					
100	54072.000	1556.000	931.000	562.000	161.000	133.000
100	10375.000	25132.000	378.000	181.000	106.000	59.000
100	67.000	3095.000	9267.000	146.000	53.000	33.000
100	1774.000	556.000	2168.000	5709.000	57.000	31.000
100	1780.104	964.250	252.281	1721.365	3574.563	18.688

Table 4.3.1. contd. Haddock in Sub-area IV and Division IIIa. Landings-effort and survey tuning series made available to the WG.

IBTS_Q1

1967	2003					
1	1	0	0.25			
1	6					
1	42.000	3.900	2.800	6.000	0.200	0.300
1	4877.600	29.200	13.100	5.000	1.800	7.400
1	3555.600	1600.900	159.100	46.500	21.700	25.000
1	52.600	148.800	145.900	60.300	7.200	1.200
1	528.500	30.000	31.800	64.800	1.100	0.200
1	395.100	258.100	32.900	4.700	9.700	0.800
1	327.800	876.300	200.100	12.100	2.200	1.000
1	1136.100	136.100	198.400	18.700	0.900	7.400
1	1146.300	355.800	18.600	34.500	6.200	0.900
1	105.000	556.400	182.900	16.500	13.700	3.200
1	139.400	66.500	134.500	16.500	1.200	1.800
1	352.800	105.900	27.900	66.500	10.400	2.900
1	468.200	212.400	52.500	6.700	15.300	2.600
1	863.700	388.600	86.700	10.700	2.400	5.800
1	267.700	637.600	159.700	25.700	4.400	3.100
1	537.600	253.000	421.900	60.300	8.000	2.200
1	308.200	402.600	89.800	115.300	12.700	1.900
1	1067.700	221.300	130.900	20.900	21.200	4.600
1	228.500	828.400	105.100	33.800	4.300	7.200
1	584.500	251.100	285.900	17.200	6.000	2.100
1	917.300	328.800	47.200	61.100	4.700	2.600
1	100.700	671.000	97.000	12.700	13.600	2.000
1	217.600	97.400	273.700	16.800	2.100	4.700
1	217.400	139.100	33.000	50.400	3.200	1.800
1	678.000	133.000	24.800	4.200	8.400	2.400
1	1163.000	344.600	18.100	3.000	0.600	2.000
1	1254.300	540.800	154.500	8.900	1.100	1.000
1	228.700	503.900	98.300	23.300	1.600	0.800
1	1355.500	201.100	176.200	24.300	5.300	0.800
1	267.400	813.300	65.900	46.700	7.700	3.100
1	860.200	366.400	470.600	24.800	15.100	3.400
1	373.600	432.300	105.500	113.700	8.700	5.400
1	211.800	232.900	129.700	48.100	36.600	4.300
1	3702.100	107.800	49.900	25.400	15.600	10.300
1	887.600	2279.000	47.800	10.900	7.200	5.700
1	57.000	471.100	1308.400	8.700	6.700	3.800
1	89.619	40.296	237.85	537.846	2.452	2.402

Table 4.4.1. Haddock in Sub-area IV and Division IIIa. Contribution to survivors' estimates of *F*-shrinkage in exploratory XSA runs.

Model **Low shrinkage, 10+**

Age	F-shrinkage	P-shrinkage
0	0.028	0.09
1	0.013	
2	0.007	
3	0.007	
4	0.028	
5	0.037	
6	0.071	
7	0.072	
8	0.718	
9	0.314	

Model **Low shrinkage, 7+**

Age	F-shrinkage	P-shrinkage
0	0.02	0.064
1	0.009	
2	0.005	
3	0.005	
4	0.02	
5	0.026	
6	0.044	

Model **High shrinkage, 10+**

Age	F-shrinkage	P-shrinkage
0	0.254	0.052
1	0.13	
2	0.079	
3	0.09	
4	0.346	
5	0.549	
6	0.78	
7	0.855	
8	0.974	
9	0.904	

Model **High shrinkage, 7+**

Age	F-shrinkage	P-shrinkage
0	0.254	0.052
1	0.13	
2	0.078	
3	0.088	
4	0.322	
5	0.437	
6	0.534	

Table 4.4.2. Haddock in Sub-Area IV and Division IIIa. XSA tuning output.

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Lowestoft VPA Version 3.1

   16/09/2003   9:26

 Extended Survivors Analysis

 Haddock in the North Sea and Skagerrak, ages 0-10+ (19/08/2003 CLN)

 CPUE data from file hadivef_split.txt

 Catch data for  40 years. 1963 to 2002. Ages  0 to   7.

      Fleet,            First, Last, First, Last, Alpha,  Beta
                   ,     year, year,  age ,  age
 ENGGFS_full (awaitin,   1977, 2002,   0,     5,   .500,   .750
 SCOGFS_new_full (new,   1982, 2002,   0,     5,   .500,   .750
 IBTS_Q1 late (backsh,   1975, 2002,   0,     4,   .990,  1.000


 Time series weights :

      Tapered time weighting not applied


 Catchability analysis :

      Catchability dependent on stock size for ages <    1

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


      Catchability independent of age for ages >=    2


 Terminal population estimation :

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

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

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

      Prior weighting applied :
      Fleet  Weight
      ENGGFS_f  1.00
      SCOGFS_n  1.00
      IBTS_Q1   1.00

 Tuning converged after   20 iterations

1


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



 Fishing mortalities
    Age,  1993,  1994,  1995,  1996,  1997,  1998,  1999,  2000,  2001,  2002

      0,  .032,  .005,  .061,  .048,  .009,  .007,  .002,  .006,  .004,  .031
      1,  .175,  .155,  .106,  .081,  .128,  .135,  .172,  .052,  .067,  .161
      2,  .816,  .579,  .518,  .463,  .479,  .641,  .881,  .842,  .311,  .155
      3, 1.063, 1.103,  .950,  .975,  .665,  .672, 1.046, 1.203, 1.100,  .209
      4, 1.147, 1.093, 1.095, 1.106,  .841,  .954,  .949, 1.261,  .950,  .716
      5, 1.148, 1.296, 1.026, 1.282, 1.229,  .971, 1.338,  .659,  .684,  .587
      6, 2.129, 2.184, 1.987, 2.059, 1.617, 1.149, 1.692, 1.388,  .350,  .395
```

Table 4.4.2. cont. Haddock in Sub-Area IV and Division IIIa. XSA tuning output.

XSA population numbers (Thousands)

YEAR	AGE 0	1	2	3	4	5	6
1993	1.26E+07	5.12E+06	5.75E+05	1.88E+05	1.18E+04	2.75E+03	5.64E+02
1994	5.33E+07	1.58E+06	8.25E+05	1.70E+05	5.05E+04	2.92E+03	7.14E+02
1995	1.29E+07	6.83E+06	2.59E+05	3.10E+05	4.41E+04	1.32E+04	6.54E+02
1996	2.08E+07	1.56E+06	1.18E+06	1.04E+05	9.34E+04	1.15E+04	3.87E+03
1997	1.18E+07	2.56E+06	2.77E+05	4.97E+05	3.04E+04	2.41E+04	2.61E+03
1998	9.20E+06	1.51E+06	4.32E+05	1.15E+05	1.99E+05	1.02E+04	5.76E+03
1999	1.24E+08	1.18E+06	2.53E+05	1.52E+05	4.57E+04	5.97E+04	3.17E+03
2000	2.40E+07	1.59E+07	1.90E+05	7.02E+04	4.17E+04	1.38E+04	1.28E+04
2001	2.19E+06	3.07E+06	2.89E+06	5.49E+04	1.64E+04	9.20E+03	5.84E+03
2002	4.60E+06	2.81E+05	5.52E+05	1.42E+06	1.42E+04	4.94E+03	3.80E+03

Estimated population abundance at 1st Jan 2003

0.00E+00	5.74E+05	4.60E+04	3.17E+05	8.98E+05	5.42E+03	2.25E+03

Taper weighted geometric mean of the VPA populations:

2.33E+07	3.23E+06	5.20E+05	1.62E+05	4.27E+04	1.23E+04	3.60E+03

Standard error of the weighted Log(VPA populations) :

1.0926	1.1125	1.1051	1.1998	1.1507	1.1350	1.1117

1

Table 4.4.2. cont. Haddock in Sub-Area IV and Division IIIa. XSA tuning output.

Log catchability residuals.

Fleet : ENGGFS_full (awaitin

Age	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
0	99.99	99.99	99.99	99.99	.38	-.32	-.30	.66	.89	.18
1	99.99	99.99	99.99	99.99	-.43	-.14	.08	.25	.52	.38
2	99.99	99.99	99.99	99.99	.33	-.19	.05	.44	.67	.50
3	99.99	99.99	99.99	99.99	-.28	-.86	.10	.65	.81	.34
4	99.99	99.99	99.99	99.99	.29	.08	-.26	.31	.67	-.03
5	99.99	99.99	99.99	99.99	-.09	.17	-.14	.15	-.05	.41
6	No data for this fleet at this age									

Age	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
0	-.26	.21	-.07	-.76	.04	.01	.29	-.14	-.16	.23
1	.44	.24	.47	-.13	-.25	-.04	.28	.11	-.55	.02
2	.22	.07	.17	.18	-.35	.28	.16	.02	-.83	.23
3	.28	.13	.18	-.46	-.56	.11	-.01	-.14	-.74	.05
4	-.05	-.04	-.02	-.34	-.60	-.27	-.13	-.13	-.61	-.93
5	-.04	-.09	.41	-.05	-.63	.03	-.52	-.28	-.20	-.73
6	No data for this fleet at this age									

Age	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
0	.17	.04	.35	-.07	.20	-.17	-.26	.08	-.55	-.66
1	-.13	-.08	-.02	-.09	.03	.05	-.15	-.11	-.62	-.16
2	-.21	-.29	.12	-.24	.01	-.07	-.08	-.44	-.43	-.32
3	-.29	-.86	-.15	-.07	-.13	-.26	-.39	-.33	.47	-.34
4	-.81	-.73	-.61	-.26	-.60	-.58	-.32	-.57	.29	-.14
5	-.63	-.44	-.59	-.55	-.21	-.47	-.42	-.65	-.19	-.90
6	No data for this fleet at this age									

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

Age	1	2	3	4	5
Mean Log q	-15.5886	-15.1295	-15.1295	-15.1295	-15.1295
S.E(Log q)	.2908	.3352	.4376	.4654	.4335

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
0	.68	3.929	17.00	.86	26	.38	-17.09

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	1.00	.012	15.59	.90	26	.30	-15.59
2	.96	.491	15.04	.86	26	.33	-15.13
3	.96	.438	15.11	.85	26	.41	-15.24
4	.94	.693	15.11	.87	26	.37	-15.38
5	.91	1.379	14.82	.90	26	.31	-15.39

1

Table 4.4.2. cont. Haddock in Sub-Area IV and Division IIIa. XSA tuning output.

Fleet : SCOGFS_new_full (new

Age	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
0	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	-.42
1	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	-.42
2	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	.19
3	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	-.07
4	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	-.45
5	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	-1.34
6	No data for this fleet at this age									

Age	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
0	-1.13	-.55	-.94	-1.04	-.10	-.48	-.45	.03	.14	.47
1	-.30	-.63	-.03	-.25	-.97	-.11	-.19	-.03	-.71	.13
2	.07	-.22	-.14	-.10	-.39	-.18	.02	-.32	-.75	-.32
3	.30	-.32	-.27	-.42	-.41	-.33	-.18	-.57	-1.37	-.68
4	.15	-.30	-.17	-.62	-.51	-.28	-.46	-.51	-1.11	-.98
5	.11	-.32	-.46	-.16	-.65	-.70	-.77	-.44	-1.04	-.35
6	No data for this fleet at this age									

Age	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
0	-.25	.62	.25	-.04	-.09	1.18	.92	1.18	-.65	1.37
1	.18	-.19	.18	.34	.10	1.46	.32	.43	-.01	.72
2	.11	.01	.09	.40	.14	.62	.58	-.07	.08	.19
3	-.35	-.47	.32	.04	.08	.50	.59	.33	.29	.15
4	-1.33	-.64	-.17	.11	-.07	.17	.48	.35	.39	.46
5	-.31	-.97	-.01	.05	.21	.06	.23	.46	.30	.80
6	No data for this fleet at this age									

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

Age	1	2	3	4	5
Mean Log q	-10.4253	-9.9889	-9.9889	-9.9889	-9.9889
S.E(Log q)	.5194	.3183	.4830	.5792	.5977

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
0	.84	.952	13.22	.64	21	.75	-12.55

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

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
1	1.23	-1.565	9.44	.71	21	.62	-10.43
2	.95	.585	10.14	.88	21	.31	-9.99
3	.87	1.430	10.36	.87	21	.39	-10.12
4	.83	1.760	10.31	.85	21	.40	-10.25
5	.90	.860	10.14	.79	21	.49	-10.24

1

Table 4.4.2. cont. Haddock in Sub-Area IV and Division IIIa. XSA tuning output.

Fleet : IBTS_Q1 late (backsh

Age	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
0	99.99	99.99	-.86	-.91	-.42	-.54	-.50	-.14	-.16	-.30
1	99.99	99.99	-1.01	-.71	-.56	-.28	-.30	-.38	.25	-.03
2	99.99	99.99	-.16	-1.22	-.18	.13	.08	-.10	.05	.02
3	99.99	99.99	.20	-.96	-.62	-.21	-.09	.29	.13	-.18
4	99.99	99.99	-.80	-1.37	.06	-.66	.13	.40	.28	-.29
5	No data for this fleet at this age									
6	No data for this fleet at this age									

Age	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
0	-.21	-.45	.18	-.10	.11	.20	.18	.17	.76	.45
1	-.21	-.11	.12	-.02	-.06	.52	.13	.16	-.11	.36
2	-.11	.11	-.17	-.13	.05	.23	.49	-.08	-.65	.21
3	-.18	-.21	-.47	-.20	-.08	-.11	-.21	-.10	-.89	.12
4	-.44	-.41	-.56	-.08	-.29	-.29	-.23	-.53	-.81	-.53
5	No data for this fleet at this age									
6	No data for this fleet at this age									

Age	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
0	-.13	.24	.04	.75	.42	.08	.43	.60	.18	-.08
1	-.07	.17	.05	.70	.42	.34	-.14	.18	.31	.29
2	-.14	-.16	-.04	.35	.32	.25	.07	.27	.39	.12
3	-.37	-.19	-.29	.20	-.15	.46	-.09	.00	.05	-.10
4	-.22	-.50	.01	-.06	.24	-.08	.53	.16	.82	-.39
5	No data for this fleet at this age									
6	No data for this fleet at this age									

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

Age	1	2	3	4
Mean Log q	-7.3395	-7.3213	-7.3213	-7.3213
S.E(Log q)	.3752	.3332	.3489	.5057

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
0	1.03	-.336	8.49	.82	28	.44	-8.74

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	1.21	-2.492	5.74	.84	28	.42	-7.34
2	1.09	-1.090	6.80	.85	28	.36	-7.32
3	1.07	-1.085	7.14	.89	28	.34	-7.47
4	1.07	-.686	7.32	.80	28	.49	-7.53

1

Table 4.4.2. cont. Haddock in Sub-Area IV and Division IIIa. XSA tuning output.

Terminal year survivor and F summaries :

Age 0 Catchability dependent on age and year class strength

Year class = 2002

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
ENGGFS_full (awaitin,	297297.,	.420,	.000,	.00,	1,	.433,	.000
SCOGFS_new_full (new,	2251520.,	.772,	.000,	.00,	1,	.128,	.000
IBTS_Q1 late (backsh,	527023.,	.464,	.000,	.00,	1,	.355,	.000
P shrinkage mean ,	3227391.,	1.11,,,,				.064,	.006
F shrinkage mean ,	2574011.,	2.00,,,,				.020,	.007

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
573688.,	.28,	.41,	5,	1.497,	.031

1

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

Year class = 2001

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
ENGGFS_full (awaitin,	34793.,	.248,	.181,	.73,	2,	.497,	.208
SCOGFS_new_full (new,	64643.,	.452,	.610,	1.35,	2,	.150,	.117
IBTS_Q1 late (backsh,	58934.,	.298,	.053,	.18,	2,	.344,	.128
F shrinkage mean ,	60524.,	2.00,,,,				.009,	.125

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
45989.,	.17,	.16,	7,	.906,	.161

1

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

Year class = 2000

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
ENGGFS_full (awaitin,	223297.,	.195,	.195,	1.00,	3,	.424,	.214
SCOGFS_new_full (new,	404273.,	.263,	.232,	.88,	3,	.239,	.124
IBTS_Q1 late (backsh,	425251.,	.221,	.132,	.59,	3,	.332,	.118
F shrinkage mean ,	58872.,	2.00,,,,				.005,	.644

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
316671.,	.13,	.14,	10,	1.103,	.155

1

Table 4.4.2. cont. Haddock in Sub-Area IV and Division IIIa. XSA tuning output.

```
Age  3   Catchability constant w.r.t. time and age (fixed at the value for age)  2
Year class = 1999

Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
ENGGFS_full (awaitin,    683920.,   .182,       .075,    .41,   4,  .388,     .267
SCOGFS_new_full (new,   1114116.,   .236,       .128,    .54,   4,  .240,     .172
IBTS_Q1 late (backsh,   1068457.,   .192,       .129,    .67,   4,  .367,     .179

  F shrinkage mean  ,    131721.,   2.00,,,,                       .005,     .951

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
   898062.,       .12,      .09,   13,    .817,   .209


Age  4   Catchability constant w.r.t. time and age (fixed at the value for age)  2
Year class = 1998

Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
ENGGFS_full (awaitin,      5046.,   .246,       .135,    .55,   5,  .375,     .754
SCOGFS_new_full (new,      7494.,   .305,       .128,    .42,   5,  .245,     .564
IBTS_Q1 late (backsh,      4826.,   .246,       .123,    .50,   5,  .360,     .777

  F shrinkage mean  ,      3273.,   2.00,,,,                       .020,    1.006

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
     5423.,       .15,      .08,   16,    .540,   .716


Age  5   Catchability constant w.r.t. time and age (fixed at the value for age)  2
Year class = 1997

Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
ENGGFS_full (awaitin,      1367.,   .283,       .230,    .81,   6,  .498,     .839
SCOGFS_new_full (new,      4316.,   .363,       .114,    .32,   6,  .285,     .348
IBTS_Q1 late (backsh,      3448.,   .256,       .184,    .72,   5,  .191,     .419

  F shrinkage mean  ,      1067.,   2.00,,,,                       .026,     .987

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
     2250.,       .19,      .17,   18,    .880,   .587


Age  6   Catchability constant w.r.t. time and age (fixed at the value for age)  2
Year class = 1996

Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
ENGGFS_full (awaitin,      1656.,   .291,       .074,    .26,   6,  .498,     .478
SCOGFS_new_full (new,      2998.,   .374,       .061,    .16,   6,  .283,     .292
IBTS_Q1 late (backsh,      2507.,   .230,       .115,    .50,   5,  .174,     .340

  F shrinkage mean  ,      1534.,   2.00,,,,                       .045,     .508

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
     2098.,       .20,      .08,   18,    .379,   .395
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Table 4.4.3. Haddock in Sub-Area IV and Division IIIa. XSA summary output.

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Run title : Haddock in the North Sea and Skagerrak, ages 0-10+ (19/08/2003 CLN)

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Terminal Fs derived using XSA (With F shrinkage)

Table 8 Fishing mortality (F) at age

YEAR,	1963,	1964,	1965,	1966,	1967,	1968,	1969,	1970,	1971,	1972,
AGE										
0,	.0016,	.0434,	.0716,	.0701,	.0022,	.0018,	.0168,	.0299,	.0120,	.0322,
1,	.1219,	.0564,	1.3531,	1.3051,	.2633,	.0515,	.0215,	.5028,	.4748,	.1697,
2,	.7914,	.4438,	.4010,	.8143,	1.0863,	.5803,	.6543,	1.0392,	.6646,	.7947,
3,	.6391,	1.1202,	.4901,	.3409,	.4000,	.9110,	1.3932,	1.1454,	.7991,	1.3731,
4,	.7267,	.6871,	.8640,	.7247,	.3440,	.2914,	1.3465,	1.3309,	.8617,	1.2071,
5,	.7652,	.7973,	1.0108,	.8713,	.8544,	.4504,	.7437,	.8033,	.9937,	1.1254,
6,	.7171,	.8775,	.7963,	.6515,	.5371,	.5555,	1.1753,	1.1062,	.8943,	1.2505,
+gp,	.7171,	.8775,	.7963,	.6515,	.5371,	.5555,	1.1753,	1.1062,	.8943,	1.2505,
0 FBAR 2- 4,	.7190,	.7504,	.5850,	.6266,	.6101,	.5943,	1.1313,	1.1718,	.7751,	1.1249,

Table 8 Fishing mortality (F) at age

YEAR,	1973,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,	1982,
AGE										
0,	.0023,	.0130,	.0113,	.0298,	.0131,	.0218,	.0347,	.0735,	.0572,	.0387,
1,	.3747,	.3528,	.3363,	.3087,	.3373,	.3882,	.1757,	.1899,	.1783,	.1739,
2,	.5673,	.9390,	.9669,	.8196,	1.0121,	1.0066,	.8720,	.7088,	.4516,	.4283,
3,	1.1643,	.9587,	1.2767,	1.3606,	1.0546,	1.1515,	1.1248,	1.1697,	.9499,	.8212,
4,	.8607,	1.0183,	1.1282,	.8207,	1.2275,	1.1807,	1.1304,	1.1312,	.9026,	.8897,
5,	.9635,	.7290,	1.0351,	1.3922,	1.1750,	1.0636,	1.1924,	1.1204,	.7145,	.5291,
6,	1.0075,	.9118,	1.1605,	1.2058,	1.3478,	1.6120,	.9039,	1.6445,	.9352,	.5911,
+gp,	1.0075,	.9118,	1.1605,	1.2058,	1.3478,	1.6120,	.9039,	1.6445,	.9352,	.5911,
0 FBAR 2- 4,	.8641,	.9720,	1.1239,	1.0003,	1.0981,	1.1129,	1.0424,	1.0032,	.7681,	.7131,

1

Run title : Haddock in the North Sea and Skagerrak, ages 0-10+ (19/08/2003 CLN)

At 16/09/2003 9:26

Table 4.4.3. cont. Haddock in Sub-Area IV and Division IIIa. XSA summary output.

Terminal Fs derived using XSA (With F shrinkage)

Table 8 Fishing mortality (F) at age

YEAR,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,
AGE										
0,	.0271,	.0157,	.0164,	.0032,	.0090,	.0055,	.0039,	.0058,	.0127,	.0188,
1,	.1527,	.1257,	.2084,	.1287,	.1193,	.1383,	.1064,	.1987,	.1570,	.1483,
2,	.6624,	.6774,	.6190,	1.0372,	.9104,	.8022,	.6668,	1.1283,	.8032,	.7444,
3,	1.0080,	1.0048,	.9870,	1.2680,	1.1045,	1.3398,	1.0056,	1.2140,	1.0540,	1.2324,
4,	1.1832,	1.1008,	1.1296,	1.4272,	1.1632,	1.3231,	1.3037,	1.2189,	.9771,	1.1326,
5,	1.2535,	1.3016,	.9262,	1.1356,	1.1456,	1.4039,	1.1305,	1.2897,	1.0397,	1.1004,
6,	.5570,	1.2131,	1.3316,	.5695,	1.4537,	2.1325,	1.7101,	2.0472,	1.6257,	2.0153,
+gp,	.5570,	1.2131,	1.3316,	.5695,	1.4537,	2.1325,	1.7101,	2.0472,	1.6257,	2.0153,
0 FBAR 2- 4,	.9512,	.9277,	.9119,	1.2441,	1.0594,	1.1550,	.9920,	1.1870,	.9448,	1.0365,

Table 8 Fishing mortality (F) at age

YEAR,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	FBAR **-**
AGE											
0,	.0316,	.0045,	.0609,	.0477,	.0095,	.0073,	.0024,	.0061,	.0045,	.0313,	.0139,
1,	.1750,	.1550,	.1063,	.0812,	.1281,	.1353,	.1719,	.0518,	.0666,	.1610,	.0932,
2,	.8164,	.5787,	.5185,	.4632,	.4787,	.6415,	.8813,	.8418,	.3108,	.1553,	.4360,
3,	1.0634,	1.1028,	.9500,	.9747,	.6654,	.6718,	1.0463,	1.2032,	1.0997,	.2093,	.8374,
4,	1.1465,	1.0933,	1.0951,	1.1060,	.8413,	.9544,	.9487,	1.2607,	.9505,	.7160,	.9757,
5,	1.1478,	1.2959,	1.0258,	1.2816,	1.2294,	.9711,	1.3383,	.6592,	.6836,	.5869,	.6432,
6,	2.1286,	2.1844,	1.9875,	2.0586,	1.6174,	1.1492,	1.6924,	1.3880,	.3500,	.3948,	.7109,
+gp,	2.1286,	2.1844,	1.9875,	2.0586,	1.6174,	1.1492,	1.6924,	1.3880,	.3500,	.3948,	
0 FBAR 2- 4,	1.0088,	.9249,	.8545,	.8480,	.6618,	.7559,	.9588,	1.1019,	.7870,	.3602,	

1

Table 4.4.3. cont. Haddock in Sub-Area IV and Division IIIa. XSA summary output.

Run title : Haddock in the North Sea and Skagerrak, ages 0-10+ (19/08/2003 CLN)

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Terminal Fs derived using XSA (With F shrinkage)

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

YEAR,	1963,	1964,	1965,	1966,	1967,	1968,	1969,	1970,	1971,	1972,
AGE										
0,	24065,	92013,	263162,	688324,	3885069,	170958,	121518,	876972,	780814,	214882,
1,	259949,	3093,	11342,	31537,	82615,	499046,	21968,	15383,	109575,	99322,
2,	7485,	44195,	561,	563,	1642,	12193,	91027,	4129,	1787,	13090,
3,	503,	2274,	19007,	252,	167,	371,	4575,	31718,	979,	616,
4,	286,	207,	578,	9068,	140,	87,	116,	885,	7857,	343,
5,	119,	108,	81,	190,	3422,	77,	51,	24,	182,	2585,
6,	11,	46,	40,	24,	65,	1192,	40,	20,	9,	55,
+gp,	28,	14,	14,	20,	14,	10,	303,	102,	39,	10,
0 TOTAL,	292446,	141949,	294786,	729978,	3973133,	683934,	239598,	929232,	901242,	330904,

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

YEAR,	1973,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,	1982,
AGE										
0,	729676,	1331072,	115087,	165165,	258768,	395055,	719944,	157101,	324165,	204583,
1,	26787,	93718,	169149,	14649,	20638,	32879,	49763,	89518,	18791,	39412,
2,	16098,	3537,	12648,	23208,	2066,	2829,	4283,	8017,	14219,	3020,
3,	3964,	6119,	927,	3224,	6854,	503,	693,	1200,	2645,	6067,
4,	122,	963,	1827,	201,	644,	1859,	124,	175,	290,	797,
5,	80,	40,	271,	460,	69,	147,	445,	31,	44,	92,
6,	687,	25,	16,	79,	94,	17,	42,	110,	8,	18,
+gp,	27,	204,	58,	17,	24,	36,	18,	13,	49,	27,
0 TOTAL,	777440,	1435678,	299984,	207004,	289157,	433327,	775311,	256167,	360212,	254016,

1

Table 4.4.3. cont. Haddock in Sub-Area IV and Division IIIa. XSA summary output.

Run title : Haddock in the North Sea and Skagerrak, ages 0-10+ (19/08/2003 CLN)

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Terminal Fs derived using XSA (With F shrinkage)

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

YEAR,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,
AGE										
0,	666336,	171216,	239390,	496684,	41594,	84149,	85749,	280481,	273304,	405062,
1,	25337,	83485,	21699,	30317,	63738,	5307,	10774,	10996,	35901,	34739,
2,	6361,	4177,	14139,	3383,	5119,	10865,	887,	1860,	1731,	5893,
3,	1319,	2199,	1422,	5104,	804,	1381,	3265,	305,	403,	520,
4,	2079,	375,	627,	413,	1119,	207,	282,	930,	71,	110,
5,	255,	496,	97,	158,	77,	272,	43,	60,	214,	21,
6,	44,	60,	110,	31,	41,	20,	55,	11,	13,	62,
+gp,	16,	13,	20,	58,	23,	13,	11,	21,	16,	15,
0 TOTAL,	701747,	262020,	277504,	536148,	112515,	102213,	101066,	294664,	311654,	446421,

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

YEAR,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003,	GMST 63-**	AMST 63-**
AGE													
0,	126450,	532832,	129088,	208176,	118186,	92035,	1235668,	240005,	21949,	45978,	0,	258871,	445916,
1,	51174,	15772,	68286,	15636,	25552,	15071,	11762,	158685,	30710,	2813,	5737,	34459,	62457,
2,	5752,	8250,	2594,	11792,	2769,	4317,	2528,	1902,	28937,	5518,	460,	4958,	9498,
3,	1877,	1704,	3101,	1035,	4974,	1150,	1524,	702,	549,	14216,	3167,	1574,	3301,
4,	118,	505,	441,	934,	304,	1991,	457,	417,	164,	142,	8981,	451,	999,
5,	27,	29,	132,	115,	241,	102,	597,	138,	92,	49,	54,	126,	305,
6,	6,	7,	7,	39,	26,	58,	32,	128,	58,	38,	22,	35,	88,
+gp,	19,	11,	3,	11,	10,	10,	26,	12,	59,	40,	43,		
0 TOTAL,	185423,	559110,	203650,	237738,	152063,	114734,	1252594,	401989,	82519,	68794,	18464,		

1

Table 4.6.1. Haddock in Sub-Area IV and Division IIIa. Stock summary table.

	Recruitment age 0 '000)	SSB	Fbar(2-4)	Fbar by catch component		
				H. cons	DIS	IB
1963	2406511	140399	0.719	0.490	0.201	0.028
1964	9201303	429454	0.750	0.473	0.115	0.162
1965	26316244	544249	0.585	0.344	0.104	0.137
1966	68832416	458475	0.627	0.364	0.166	0.097
1967	3.89E+08	254254	0.610	0.350	0.232	0.028
1968	17095760	287914	0.594	0.377	0.148	0.070
1969	12151768	812534	1.131	0.686	0.153	0.293
1970	87697192	899973	1.172	0.701	0.202	0.268
1971	78081424	417411	0.775	0.543	0.177	0.055
1972	21488232	300853	1.125	0.844	0.240	0.041
1973	72967600	295866	0.864	0.651	0.208	0.005
1974	1.33E+08	258099	0.972	0.604	0.234	0.134
1975	11508703	235136	1.124	0.689	0.338	0.098
1976	16516503	305197	1.000	0.631	0.254	0.116
1977	25876810	234677	1.098	0.699	0.212	0.186
1978	39505548	129144	1.113	0.791	0.278	0.044
1979	71994400	107800	1.042	0.859	0.139	0.045
1980	15710135	149779	1.003	0.757	0.133	0.113
1981	32416546	246169	0.768	0.593	0.144	0.031
1982	20458344	307943	0.713	0.550	0.111	0.052
1983	66633644	262999	0.951	0.700	0.207	0.045
1984	17121564	199584	0.928	0.742	0.150	0.035
1985	23938964	240147	0.912	0.761	0.130	0.020
1986	49668436	223136	1.244	0.935	0.303	0.006
1987	4159433	149803	1.059	0.809	0.242	0.009
1988	8414860	152320	1.155	0.857	0.251	0.047
1989	8574881	124499	0.992	0.740	0.221	0.031
1990	28048050	76700	1.187	0.780	0.362	0.045
1991	27330430	60786	0.945	0.811	0.109	0.025
1992	40506204	100001	1.037	0.854	0.165	0.017
1993	12644960	129829	1.009	0.740	0.240	0.030
1994	53283160	152913	0.925	0.642	0.271	0.012
1995	12908813	146915	0.855	0.599	0.248	0.007
1996	20817624	175668	0.848	0.557	0.268	0.023
1997	11818640	190031	0.662	0.430	0.203	0.029
1998	9203476	159549	0.756	0.488	0.230	0.039
1999	1.24E+08	112450	0.959	0.573	0.359	0.027
2000	24000498	87664	1.102	0.734	0.277	0.091
2001	2194900	240693	0.787	0.458	0.207	0.122
2002	4597802	399032	0.360	0.248	0.089	0.023
Arithmetic mean	42531814	255001	0.911	0.636	0.208	0.067

Table 4.7.1. Haddock in Sub-Area IV and Division IIIa. Input data for catch forecast.

Label	Value	CV	Label	Value	CV
Number at age			Weight in the stock		
N0	6233448	1.23	WS0	0.03	0.61
N1	573688	0.41	WS1	0.11	0.15
N2	45989	0.17	WS2	0.24	0.09
N3	316671	0.14	WS3	0.33	0.09
N4	898062	0.12	WS4	0.47	0.06
N5	5423	0.15	WS5	0.68	0.08
N6	2250	0.19	WS6	0.76	0.16
N7	2098	0.20	WS7	1.17	0.07
H.cons selectivity			Weight in the HC catch		
sH0	0.00	0.00	WH0	0.00	0.00
sH1	0.00	0.64	WH1	0.34	0.12
sH2	0.05	0.83	WH2	0.38	0.11
sH3	0.22	0.65	WH3	0.42	0.05
sH4	0.47	0.28	WH4	0.45	0.05
sH5	0.38	0.08	WH5	0.69	0.09
sH6	0.35	0.83	WH6	0.77	0.16
sH7	0.34	0.83	WH7	1.21	0.11
Discard selectivity			Weight in the discards		
sD0	0.00	1.08	WD0	0.04	0.20
sD1	0.02	0.64	WD1	0.14	0.19
sD2	0.12	0.83	WD2	0.23	0.09
sD3	0.11	0.65	WD3	0.28	0.07
sD4	0.06	0.28	WD4	0.36	0.07
sD5	0.01	0.08	WD5	0.37	0.03
sD6	0.00	0.83	WD6	0.10	1.73
sD7	0.01	0.83	WD7	0.26	0.87
Industrial selectivity			Weight in Ind. bycatch		
sI0	0.01	1.08	WI0	0.03	0.85
sI1	0.05	0.64	WI1	0.07	0.15
sI2	0.03	0.83	WI2	0.14	0.24
sI3	0.07	0.65	WI3	0.19	0.46
sI4	0.02	0.28	WI4	0.49	0.03
sI5	0.00	0.08	WI5	0.36	0.37
sI6	0.00	0.00	WI6	0.00	0.00
sI7	0.00	0.00	WI7	0.00	0.00
Natural mortality			Proportion mature		
M0	2.05	0.03	MT0	0.00	0.10
M1	1.65	0.05	MT1	0.01	0.10
M2	0.40	0.07	MT2	0.32	0.10
M3	0.25	0.19	MT3	0.71	0.10
M4	0.25	0.12	MT4	0.87	0.10
M5	0.20	0.17	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
Relative effort in HC fishery			Year effect for natural mortality		
HF02	1.00	0.22	K02	1.00	0.21
HF03	1.00	0.22	K03	1.00	0.21
HF04	1.00	0.22	K04	1.00	0.21
Relative effort in industrial fishery					
IF02	1.00	0.54			
IF03	1.00	0.54			
IF04	1.00	0.54			
Recruitment in 2004 and 2005					
R03	6233448	1.23			
R04	6233448	1.23			

Proportion of F before spawning = .00
Proportion of M before spawning = .00
Recruitment in 2003 is the 2000-2002 GM; other stock numbers in 2003 are VPA urvivors.

All catch component Fs are obtained from mean 2000-2002 exploitation pattern, scaled to estimated F(2002). 0% uptake of 110 mm derogation is assumed. Fs are distributed between catch components by the mean proportion retained in 2000-2002. Weights-at-age for 99 yc at age 4 are modified by fitted growth models for each catch component. CVs for weights and Fs are from 3-year ranges.

Table 4.7.2. Haddock in Sub-Area IV and Division IIIa. Catch forecast output and estimates of coefficient of variation (CV) from linear analysis.

	Year 2003	2004						
Mean F Ages								
H.cons 2 to 4	0.35	0.00	0.07	0.14	0.21	0.28	0.35	0.42
Ind BC 2 to 4	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
Effort relative to 2002								
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	611	473	473	473	473	473	473	473
SSB at spawning time	457	348	348	348	348	348	348	348
Catch weight (,000t)								
H.cons	155	0	25	49	70	90	109	126
Discards	22	0	2	3	5	6	7	8
Ind BC	11	5	5	4	4	4	4	4
Total Landings	166	5	30	53	75	95	113	130
Total Catch	189	5	31	56	79	101	120	138
Biomass in year.... 2005								
Total 1 January		491	462	435	410	387	366	347
SSB at spawning time		373	344	318	294	272	252	233

	Year 2003	2004						
Effort relative to 2002								
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	0.11	0.30	0.30	0.30	0.30	0.30	0.30	0.30
SSB at spawning time	0.14	0.21	0.21	0.21	0.21	0.21	0.21	0.21
Catch weight								
H.cons	0.29	0.00	1.07	0.54	0.37	0.30	0.26	0.23
Discards	0.34	0.00	1.14	0.66	0.54	0.49	0.47	0.46
Ind BC	0.63	0.79	0.79	0.80	0.81	0.82	0.82	0.83
Biomass in year.... 2005								
Total 1 January		0.32	0.34	0.35	0.36	0.38	0.39	0.41
SSB at spawning time		0.24	0.25	0.26	0.26	0.26	0.27	0.27

Table 4.7.3. Haddock in Sub-Area IV and Division IIIa. Detailed forecast tables.

Forecast for year 2003
F multiplier H.cons=1.00
F multiplier Indust=1.00

Populations		Catch number			
Age	Stock No.	H.Cons	Discards	By-catch	Total
0	6233448	0	0	31662	31662
1	573688	547	6569	12317	19434
2	45989	1693	4250	1037	6979
3	316671	51136	26498	16271	93905
4	898062	292759	35823	12353	340934
5	5423	1563	33	12	1608
6	2250	605	2	0	607
7	2098	542	23	0	565
Wt	611	155	22	11	189

Forecast for year 2004
F multiplier H.cons=1.00
F multiplier Indust=1.00

Populations		Catch number			
Age	Stock No.	H.Cons	Discards	By-catch	Total
0	6233448	0	0	31662	31662
1	792890	757	9079	17023	26859
2	102625	3778	9484	2313	15575
3	25189	4068	2108	1294	7469
4	164657	53676	6568	2265	62509
5	402719	116049	2430	911	119391
6	2997	806	2	0	809
7	2507	648	27	0	675
Wt	473	109	7	4	120

Table 4.7.4 Haddock in Sub-area IV and Division IIIa

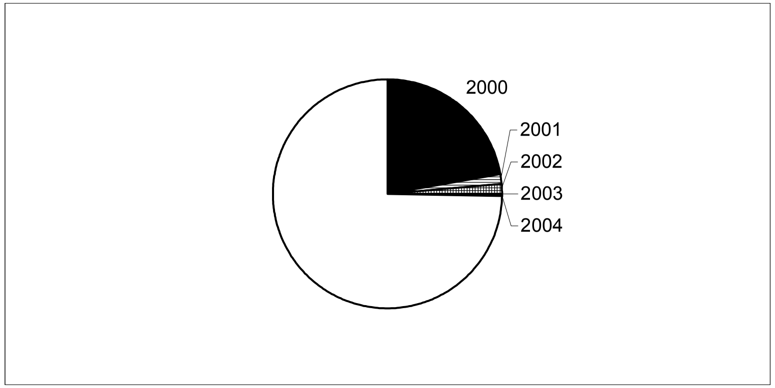
Stock numbers of recruits and their source for recent year classes used in predictions, and the relative (%) contributions to landings and SSB (by weight) of these year classes

Year-class			2000	2001	2002	2003	2004
Stock No. (thousands) of 0 year-olds			24000498	2194900	4597802	6233448	6233448
Source			XSA	XSA	XSA	GM	GM
Status Quo F:							
% in	2003	landings	13.7	0.4	0.1	0.0	-
% in	2004		22.2	1.6	1.3	0.2	0.0
% in	2003	SSB	19.2	2.0	0.0	0.0	-
% in	2004	SSB	19.9	2.1	6.3	0.0	0.0
% in	2005	SSB	13.6	1.8	6.3	37.0	0.0

GM : geometric mean recruitment

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

a) 2004 landings



b) 2005 SSB

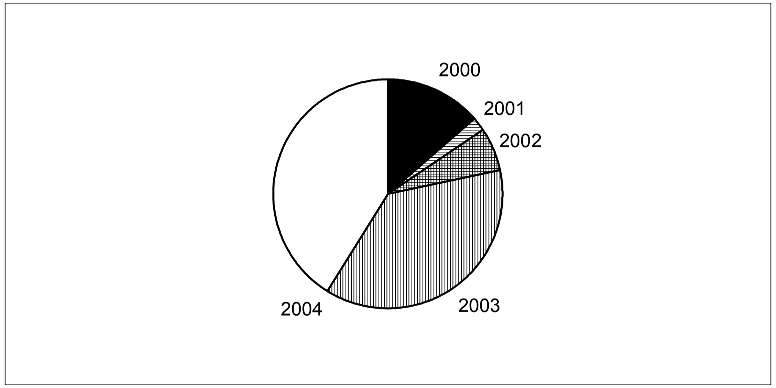


Figure 4.2.1. Haddock in Sub-Area IV and Division IIIa. Proportions of each catch component in the total Working Group numbers-at-age, by age and year.

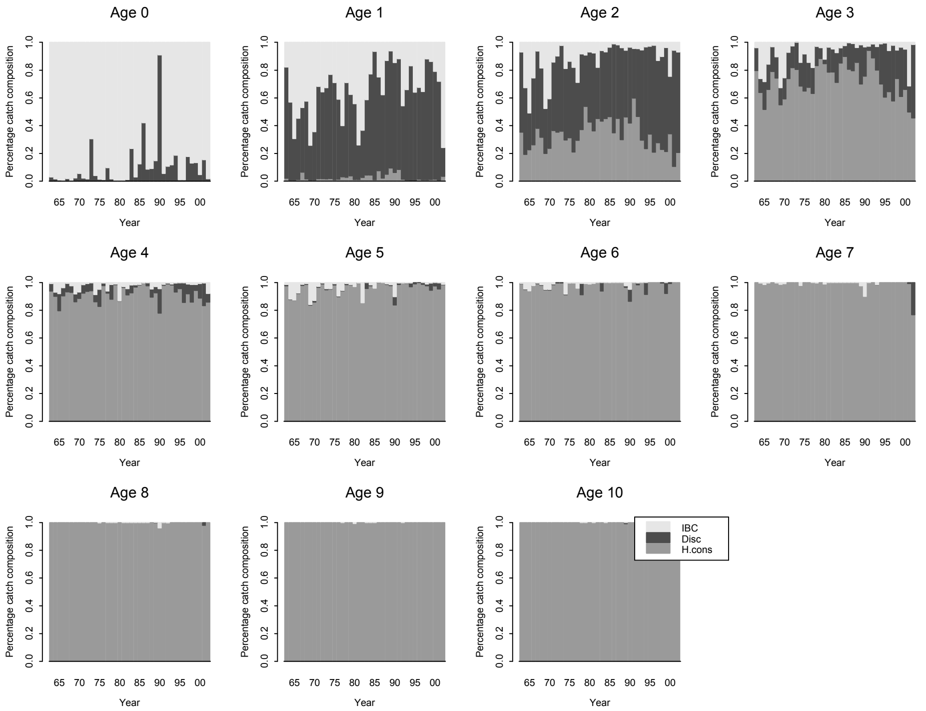


Figure 4.2.2. Haddock in Sub-Area IV and Division IIIa. Percentage age compositions for the catch taken four years after the five largest year-classes in the catch (1966, 1970, 1979, 1965, 1981), and for the 1999 year-class. The percentage contribution of the year-class in question at age-3 is given for each year, and highlighted by the shaded area.

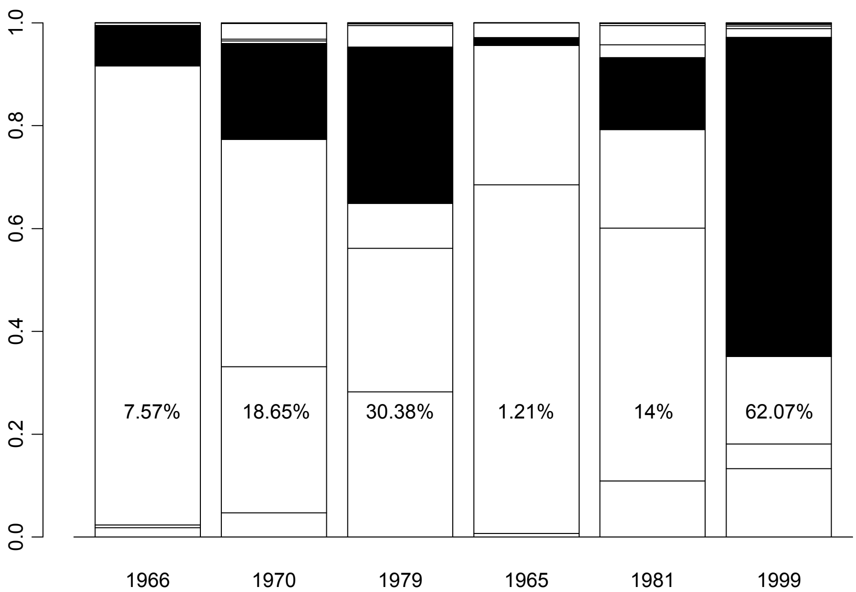


Figure 4.2.3. Haddock in Sub-area IV and Division IIIa. Mean weights-at-age (kg) in total catch (upper plots, which are also used as stock weights), and human consumption landings (lower plot). Dotted lines give loess smoothers fitted to each time-series.

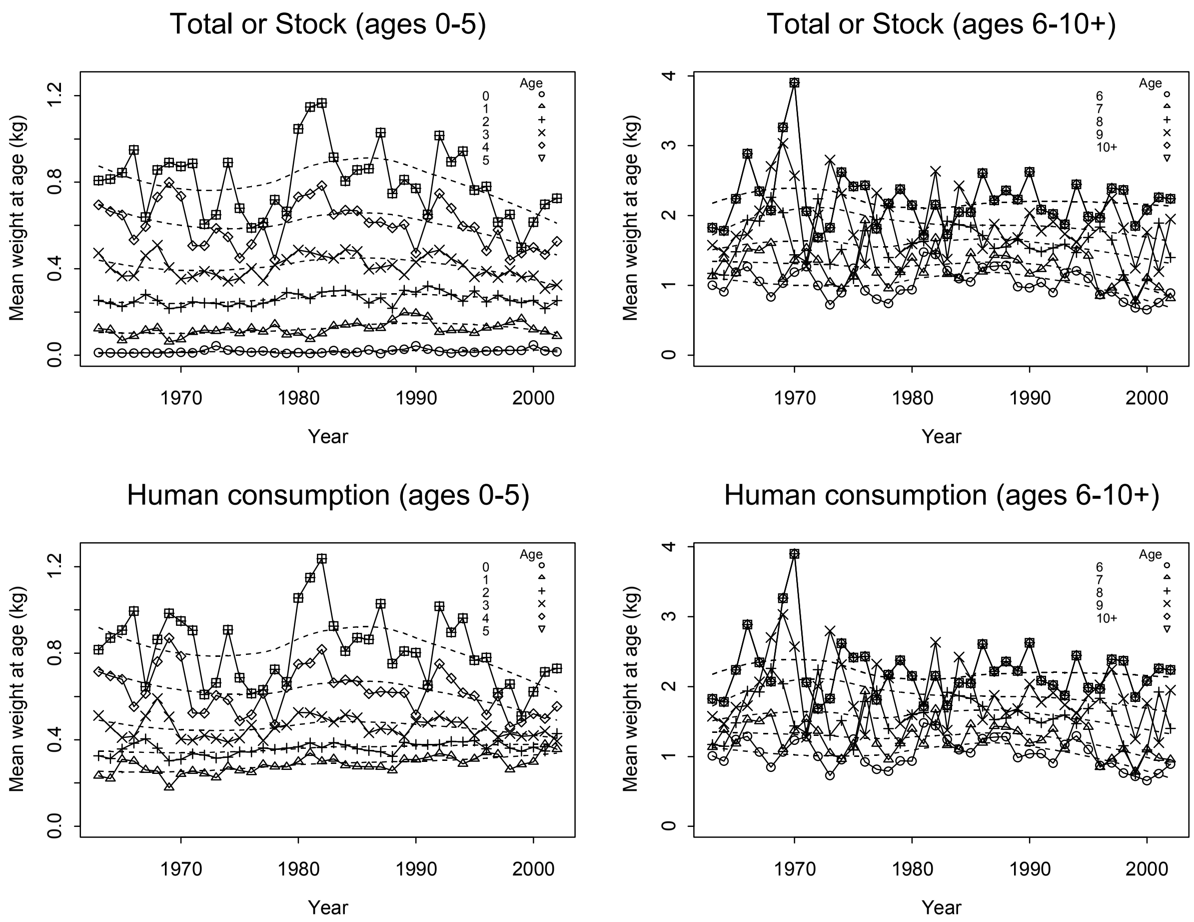


Figure 4.2.3. cont. Haddock in Sub-area IV and Division IIIa. Mean weights-at-age (kg) in discards (upper plots), and industrial bycatch (lower plot). Dotted lines give loess smoothers fitted to each time-series.

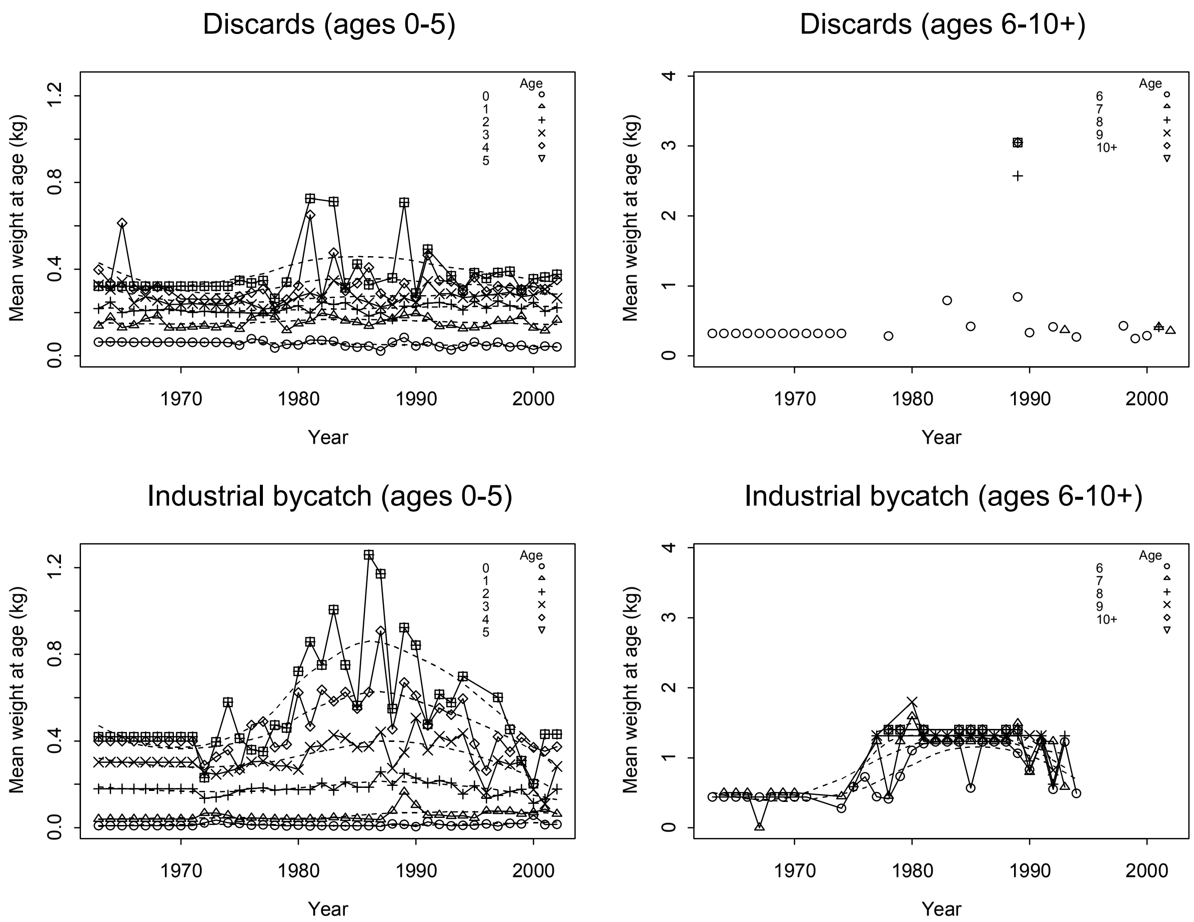


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Figure 4.2.4. Haddock in Sub-area IV and Division IIIa. Mean weights-at-age (kg) in the human consumption landings for ages 0–5, years 1998–2003. The 1999 year-class is highlighted with small circles.

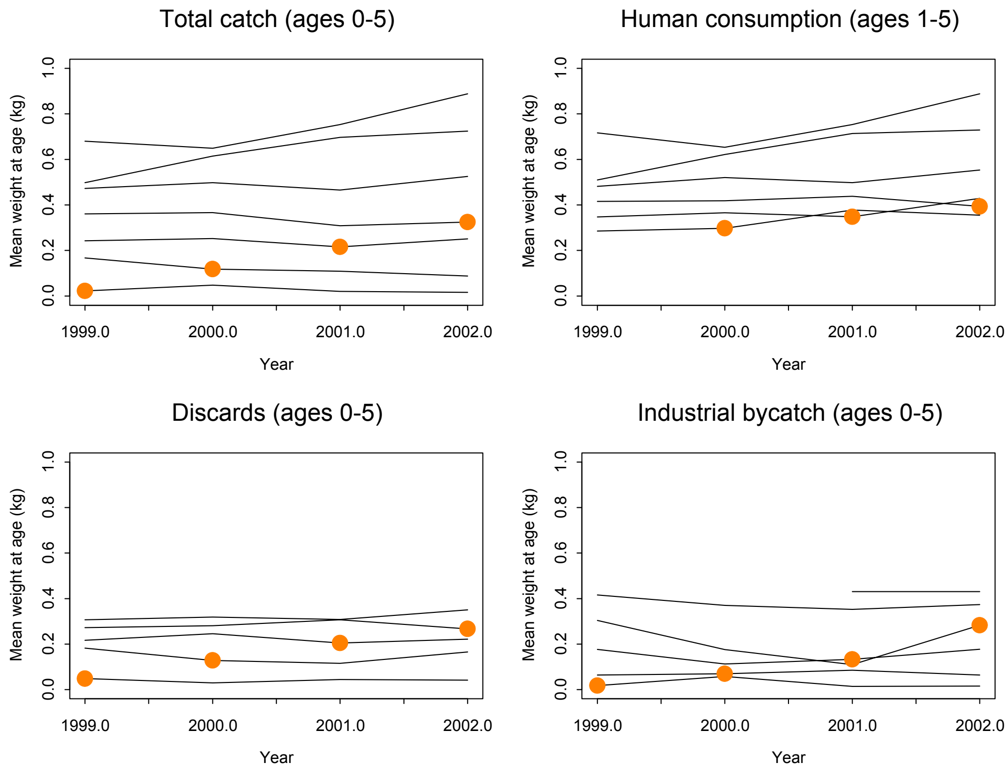


Figure 4.3.1. Haddock in Sub-Area IV and Division IIIa. Time-series of reported commercial effort and landings-per-unit effort (LPUE) for the Scottish seiner (ScoSEI) and light trawler (ScoLTR) fleets.

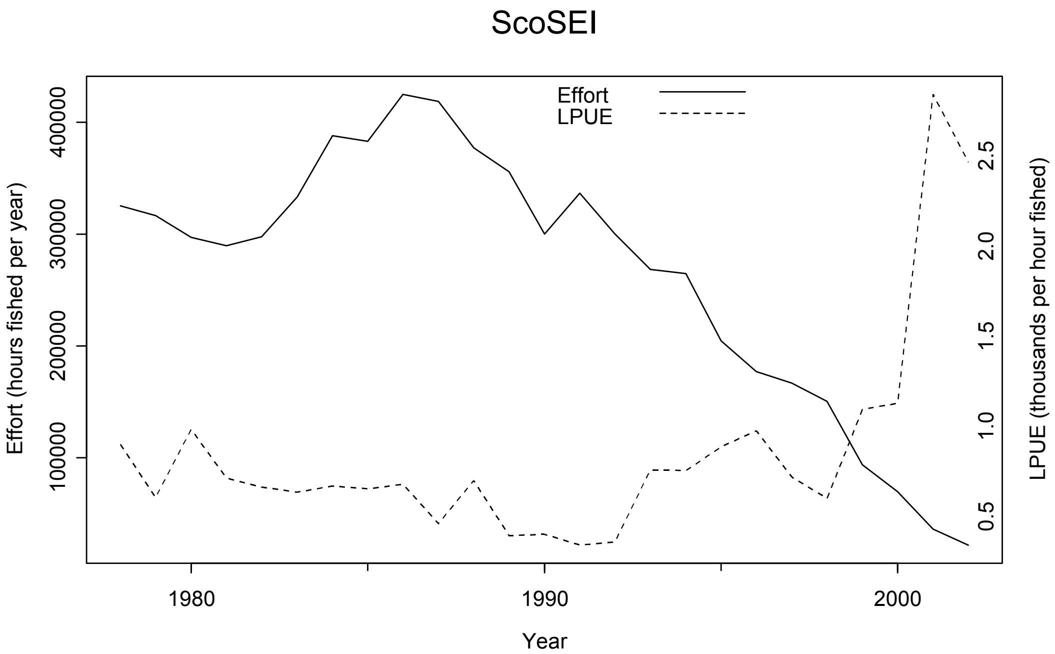


Figure 4.4.1. Haddock in Sub-Area IV and Division IIIa. Model residuals from separable VPA, using full age and year range (0–15+, 1963–2002). See text for model details.

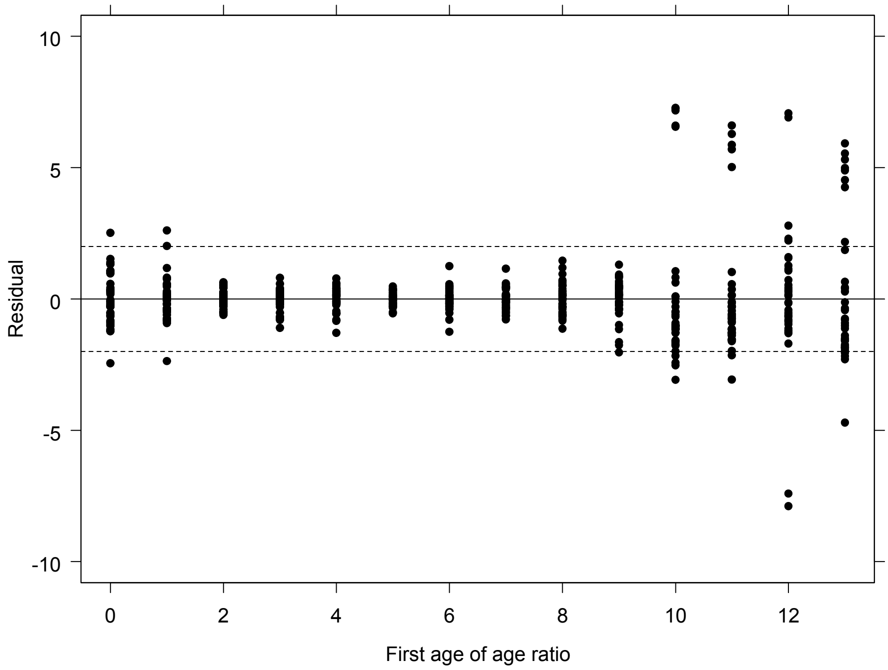


Figure 4.4.2. Haddock in Sub-Area IV and Division IIIa. Mean log catchability for ScoGFS, EngGFS and IBTS Q1 from an exploratory XSA run.

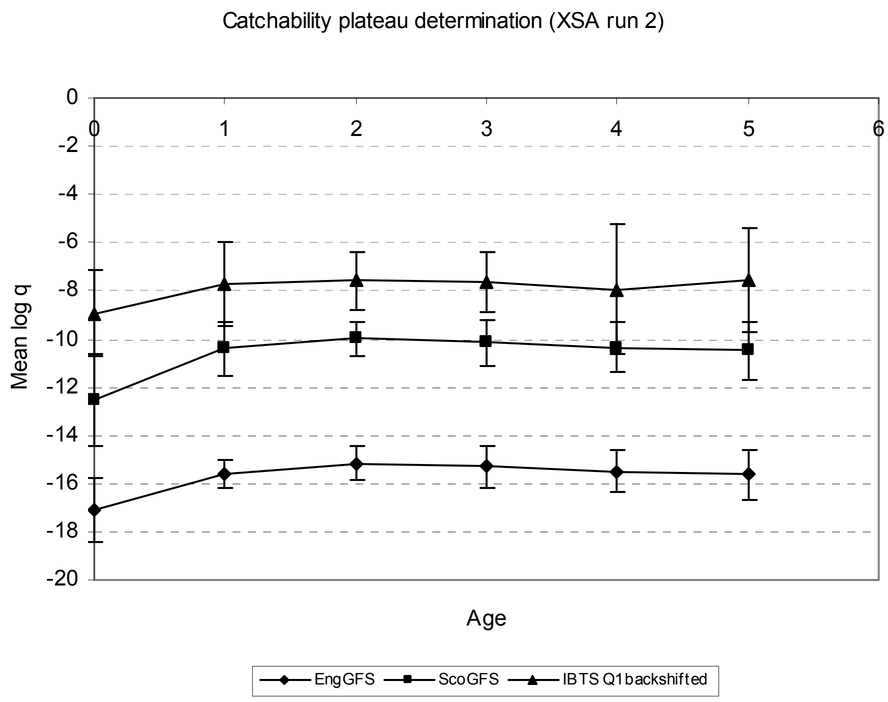
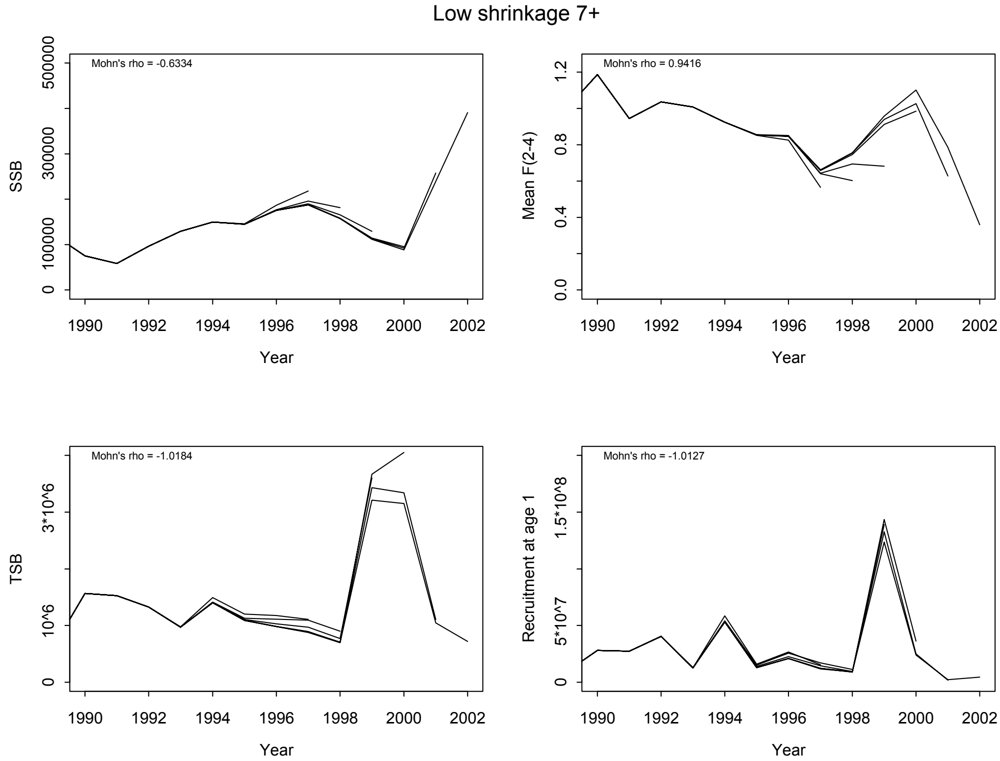


Figure 4.4.3. Haddock in Sub-Area IV and Division IIIa. Retrospective analyses from four exploratory XSA runs, assuming low (SE = 2.0) or high (SE = 0.5) shrinkage, and a 7+ group.



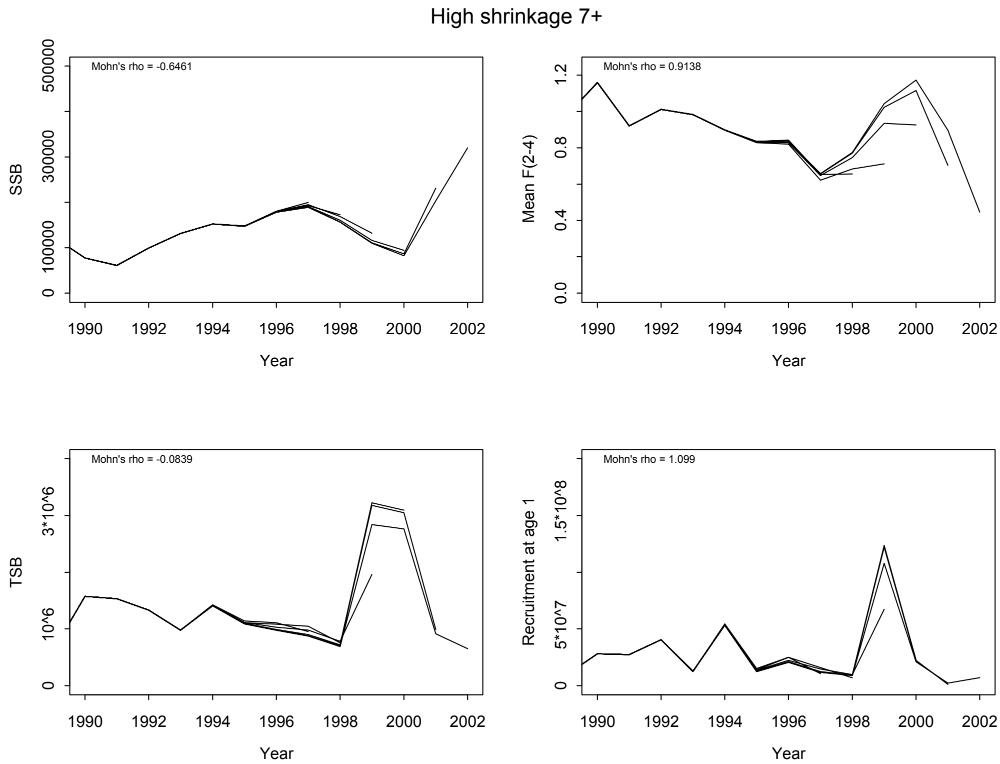
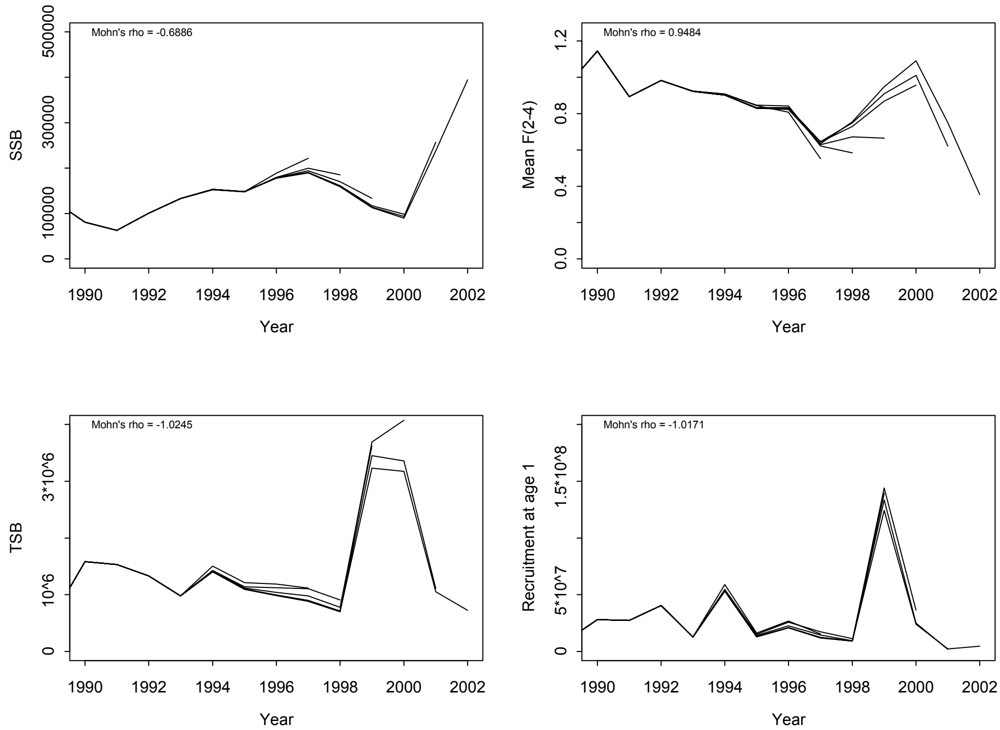


Figure 4.4.3. cont. Haddock in Sub-Area IV and Division IIIa. Retrospective analyses from four exploratory XSA runs, assuming low (SE = 2.0) or high (SE = 0.5) shrinkage, and a 10+ group.

Low shrinkage 10+



High shrinkage 10+

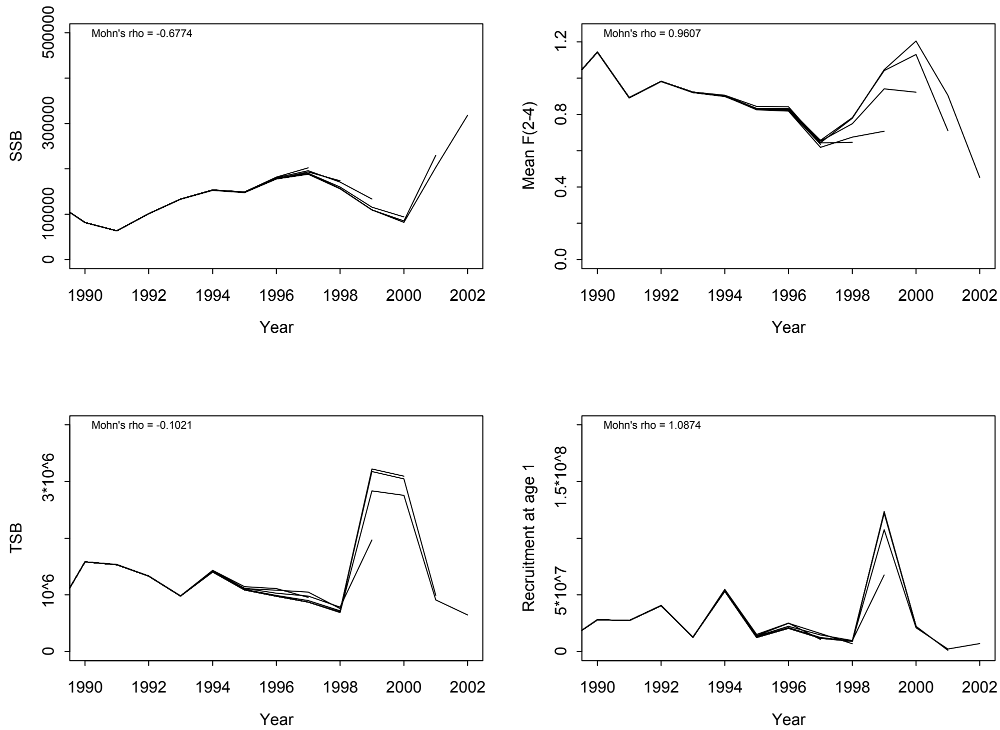
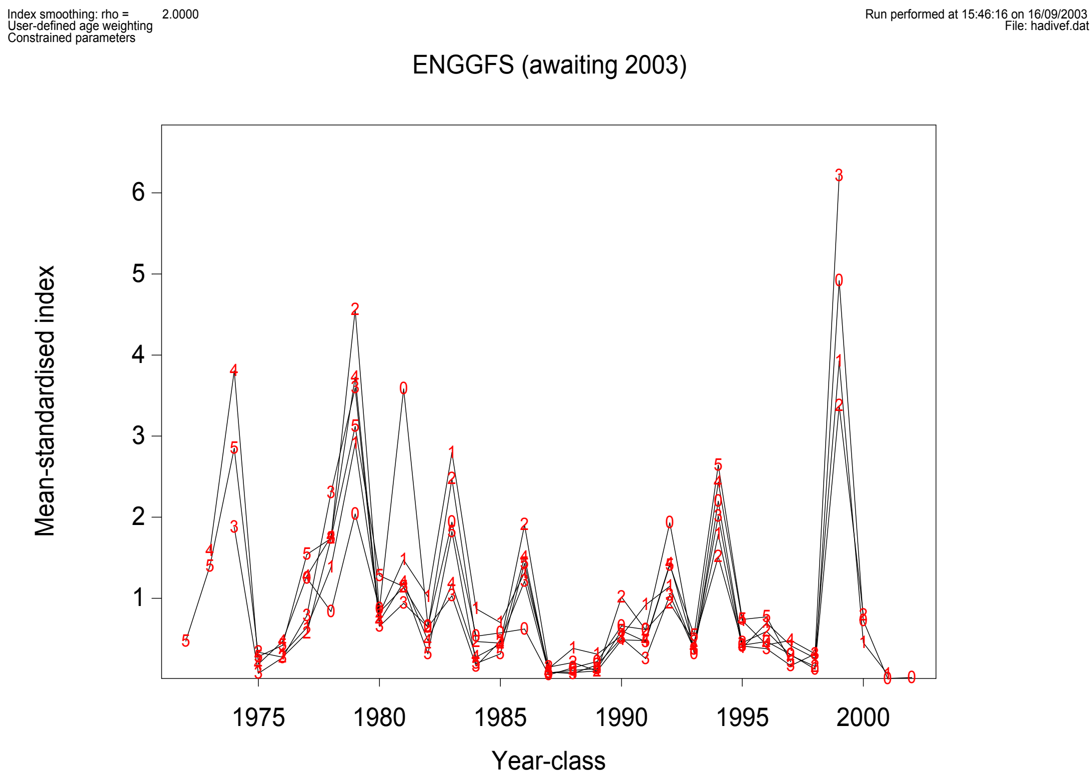


Figure 4.4.4. Haddock in Sub-Area IV and Division IIIa. EngGFS summary plots. **a.** Mean-standardised indices by year-class. Lines are labelled by ages. **b.** Catch curves (log cohort abundance by year-class).



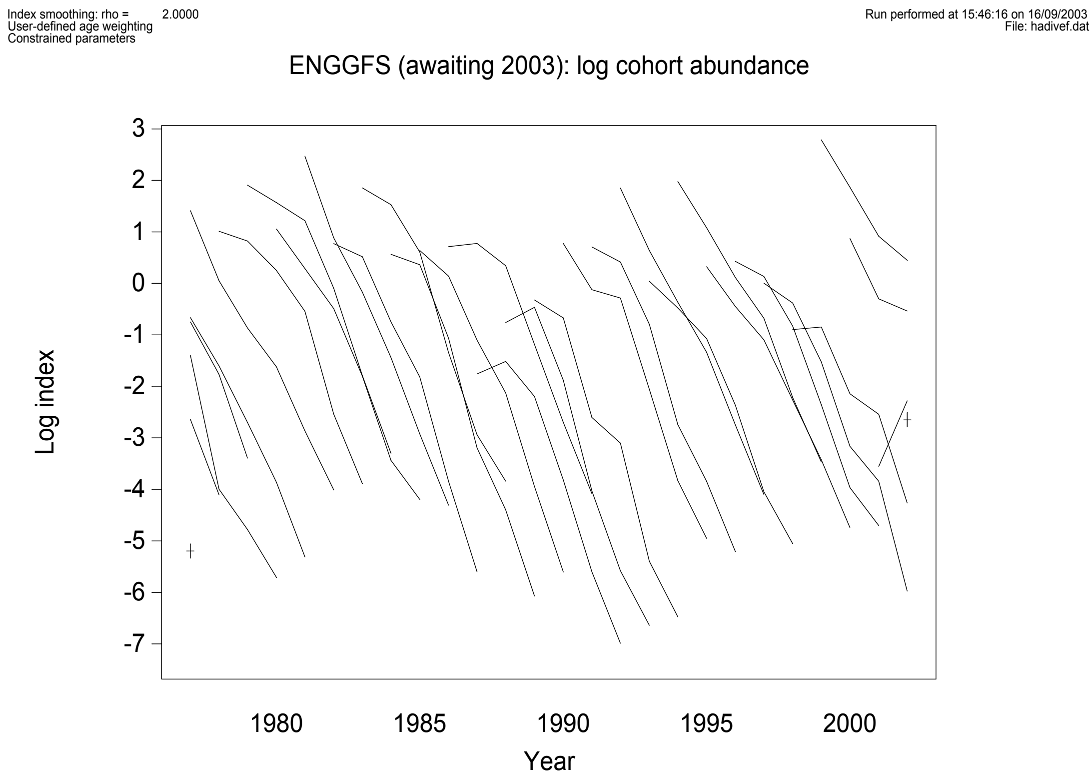
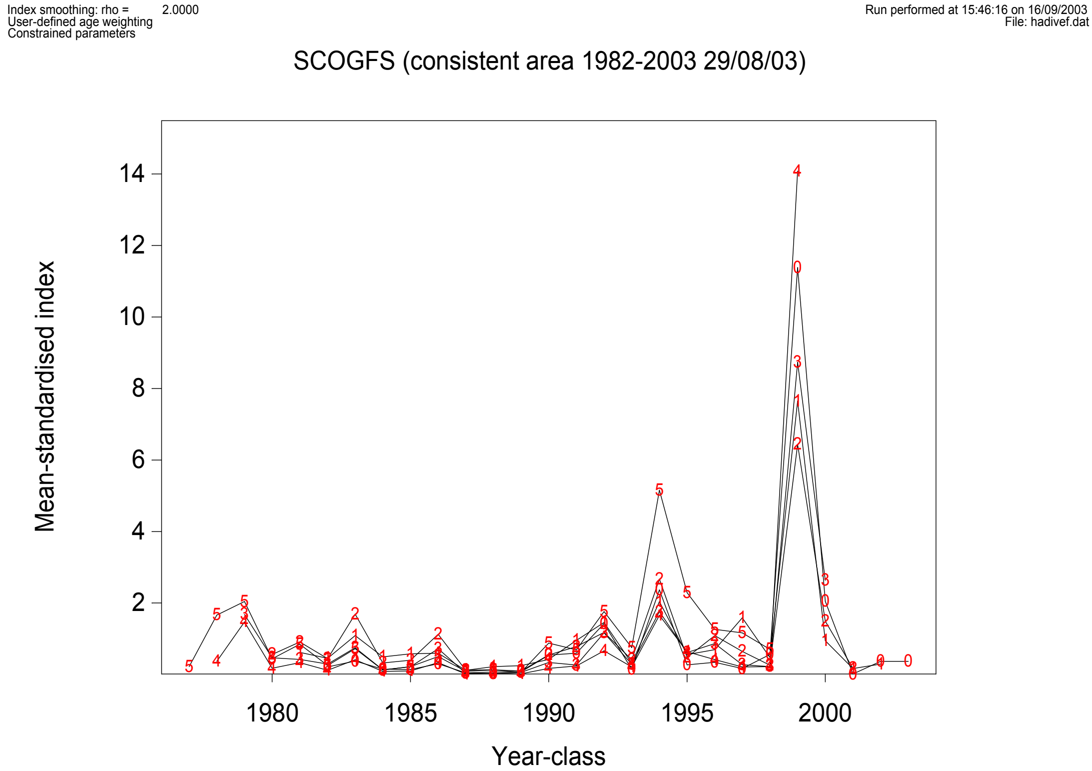


Figure 4.4.5. Haddock in Sub-Area IV and Division IIIa. ScoGFS summary plots. **a.** Mean-standardised indices by year-class for the consistent-area series. **b.** Mean-standardised indices by year-class for the full-area series.



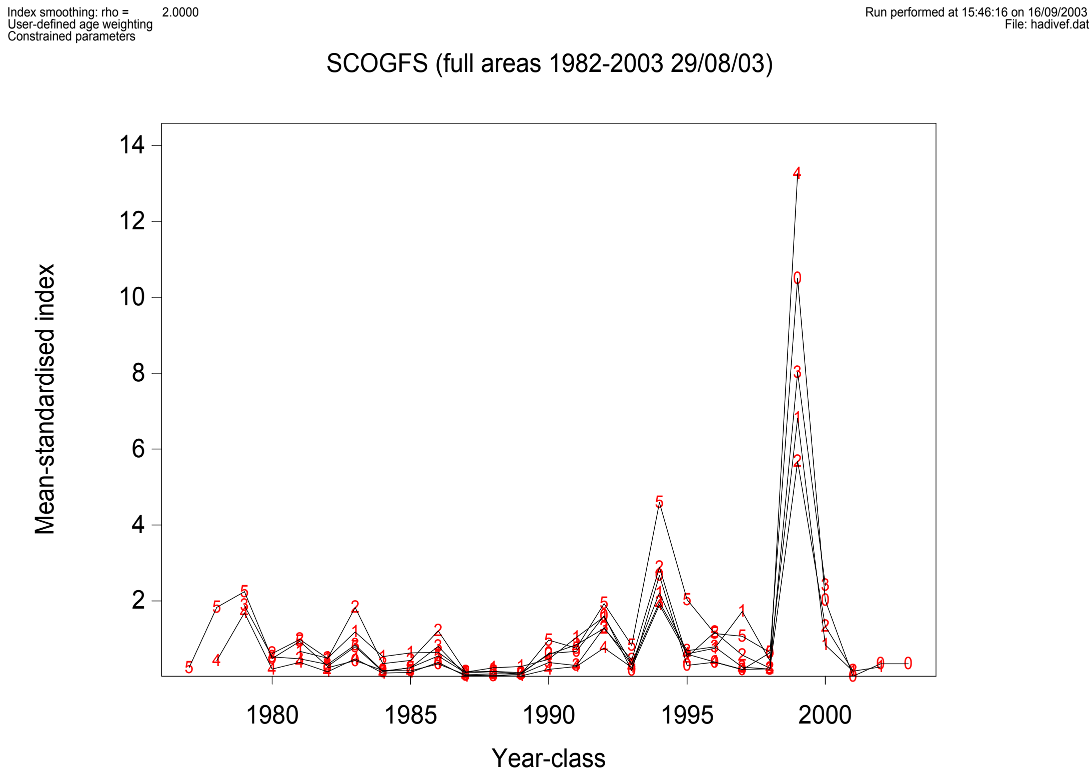
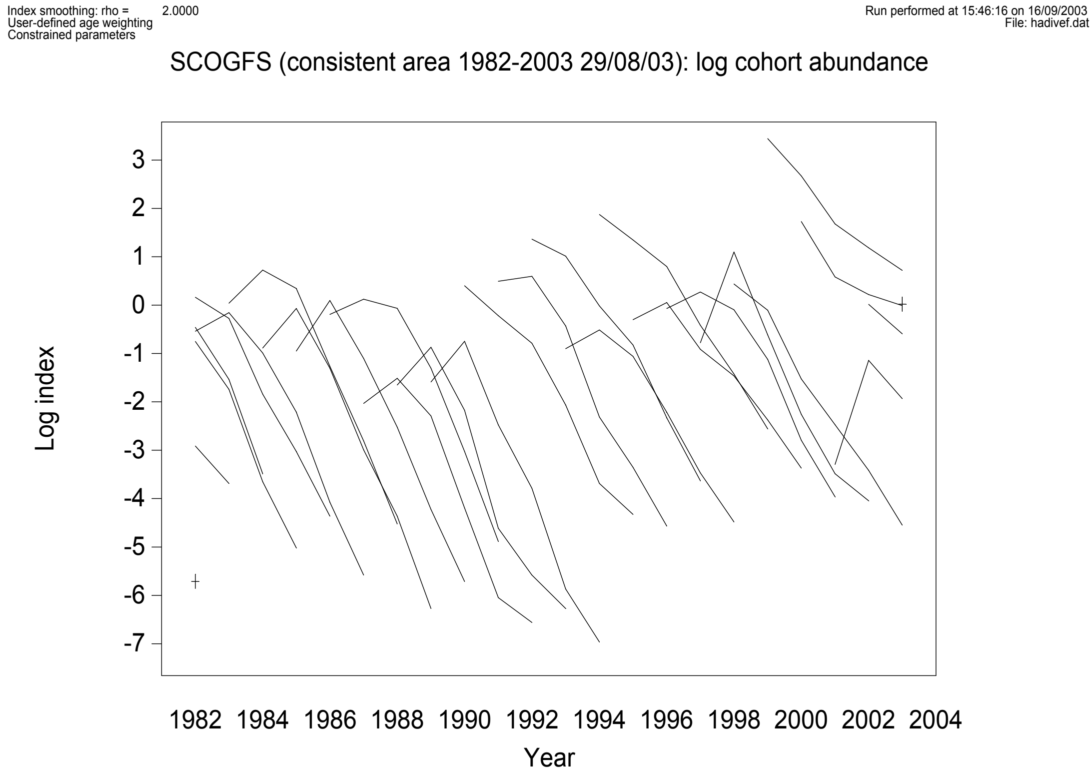


Figure 4.4.5. Haddock in Sub-Area IV and Division IIIa. ScoGFS summary plots. **c.** Catch curves (log cohort abundance by year-class) for the consistent-area series. **d.** Catch curves (log cohort abundance by year-class) for the full-area series.



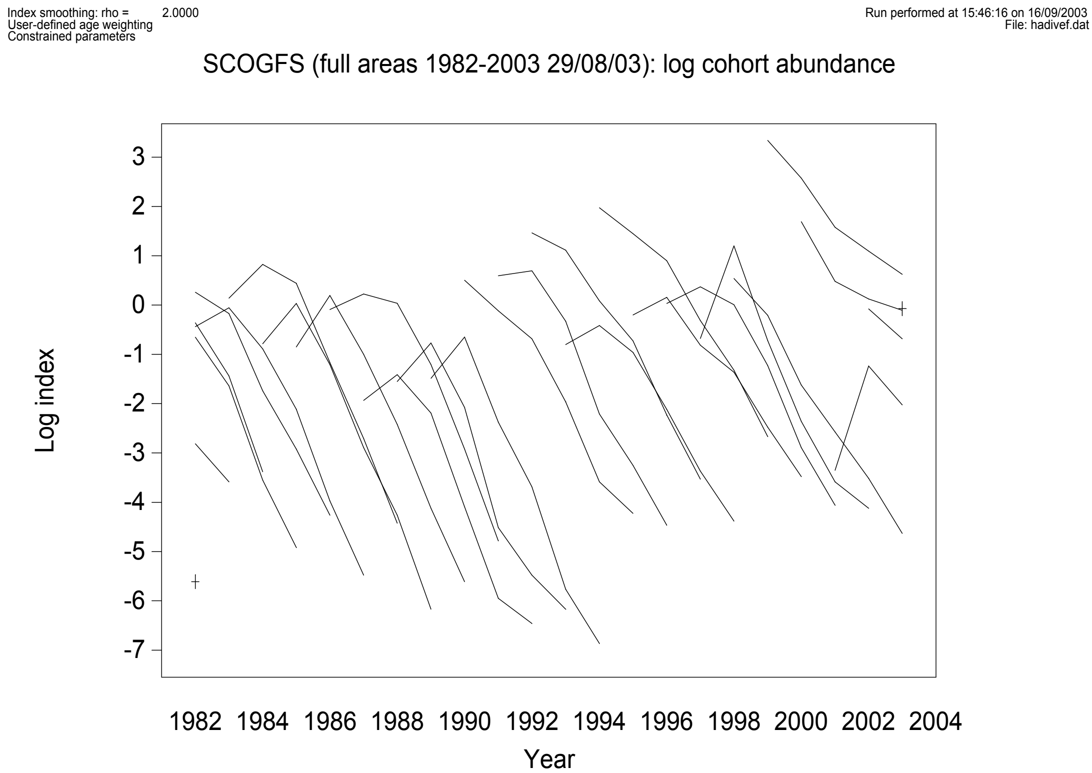
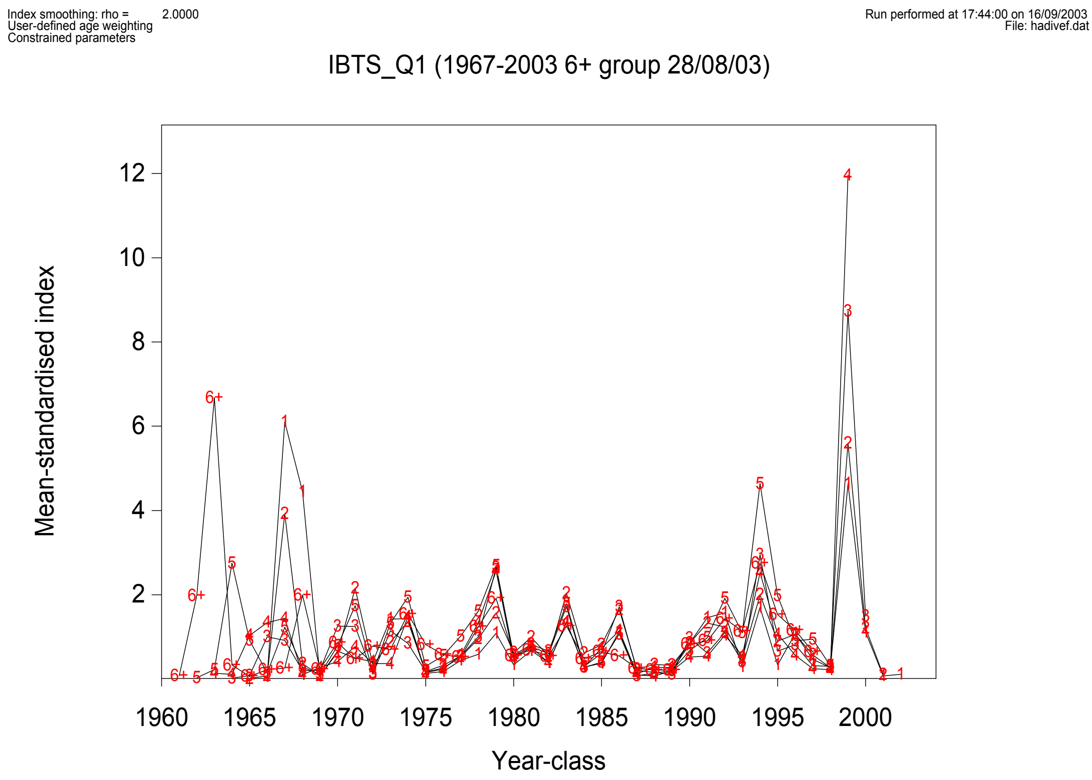


Figure 4.4.6. Haddock in Sub-Area IV and Division IIIa. IBTS Q1 summary plots. **a.** Mean-standardised indices by year-class for the 1967–2003 series. **b.** Mean-standardised indices by year-class for the 1971–2003 series.



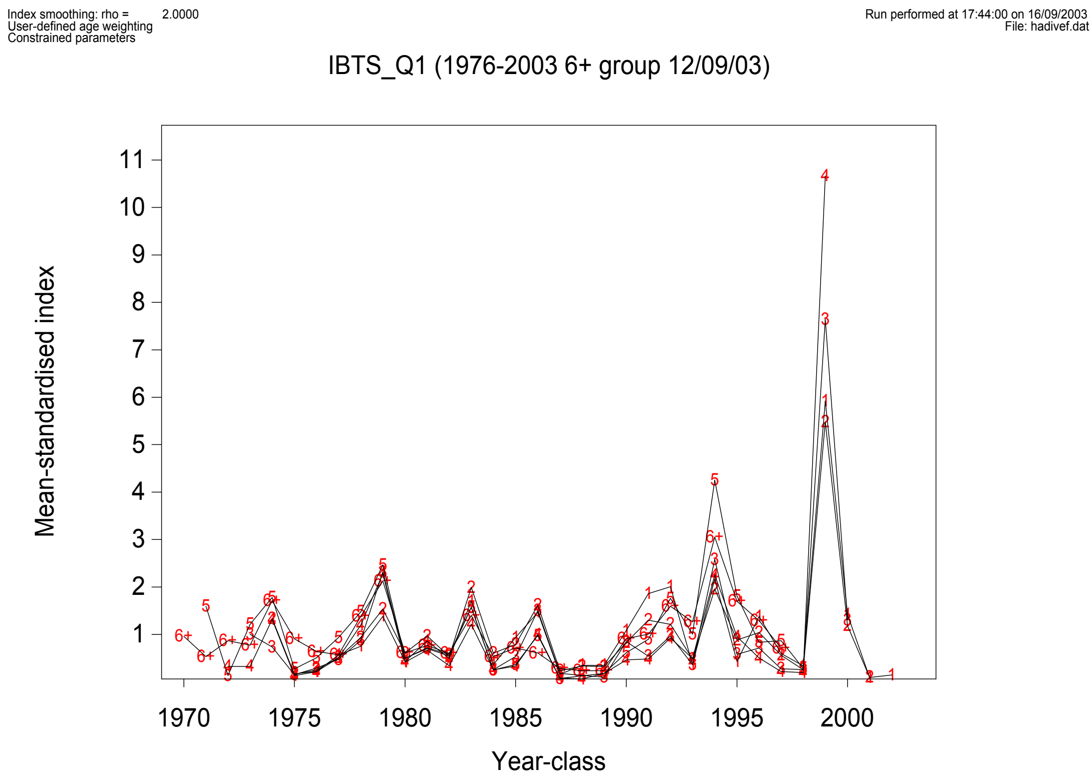
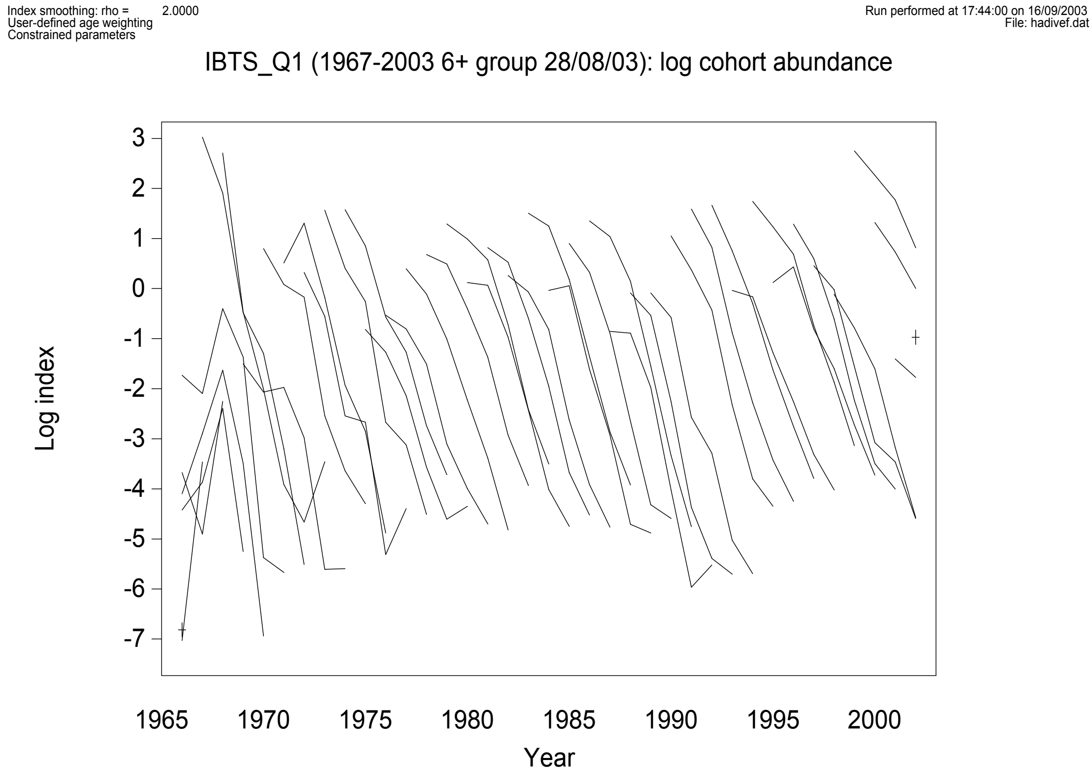


Figure 4.4.6. cont. Haddock in Sub-Area IV and Division IIIa. IBTS Q1 summary plots. **c.** Catch curves (log cohort abundance by year-class) for the 1967-2003 series. **d.** Catch curves (log cohort abundance by year-class) for the 1976–2003 series.



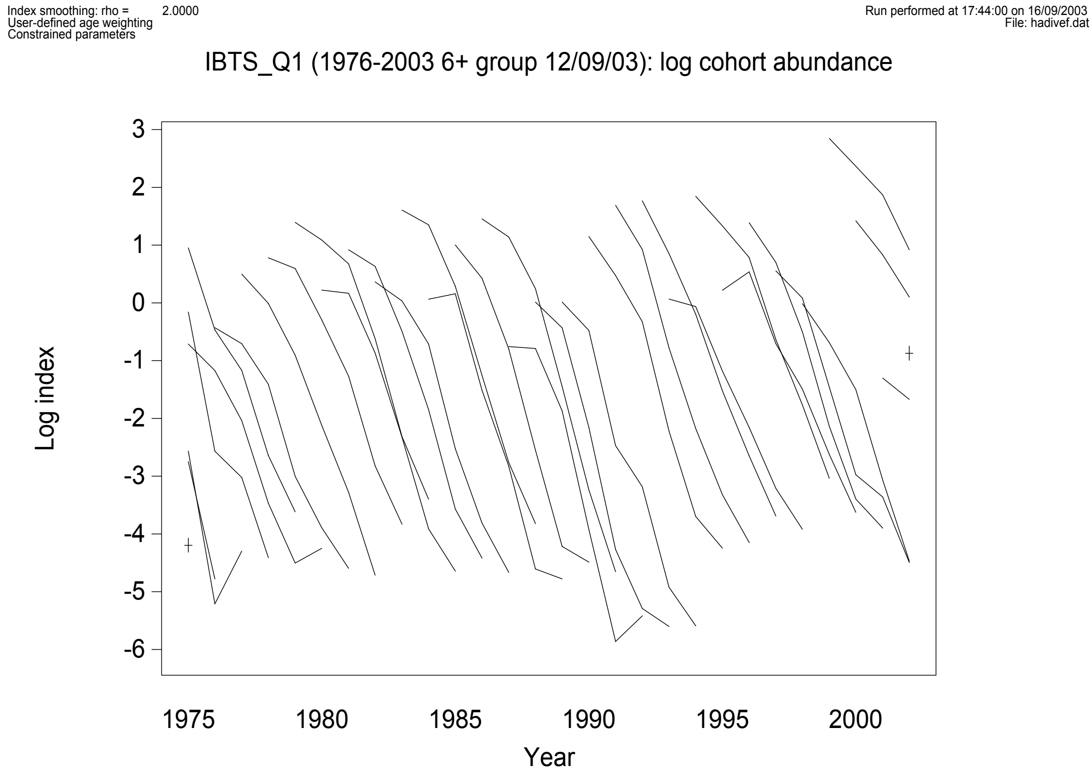


Figure 4.4.7. Haddock in Sub-Area IV and Division IIIa. Time-series plots by age of mean-standardised catch and survey data. Standardisation was performed by dividing through each series by the mean over the year range which all series have in common.

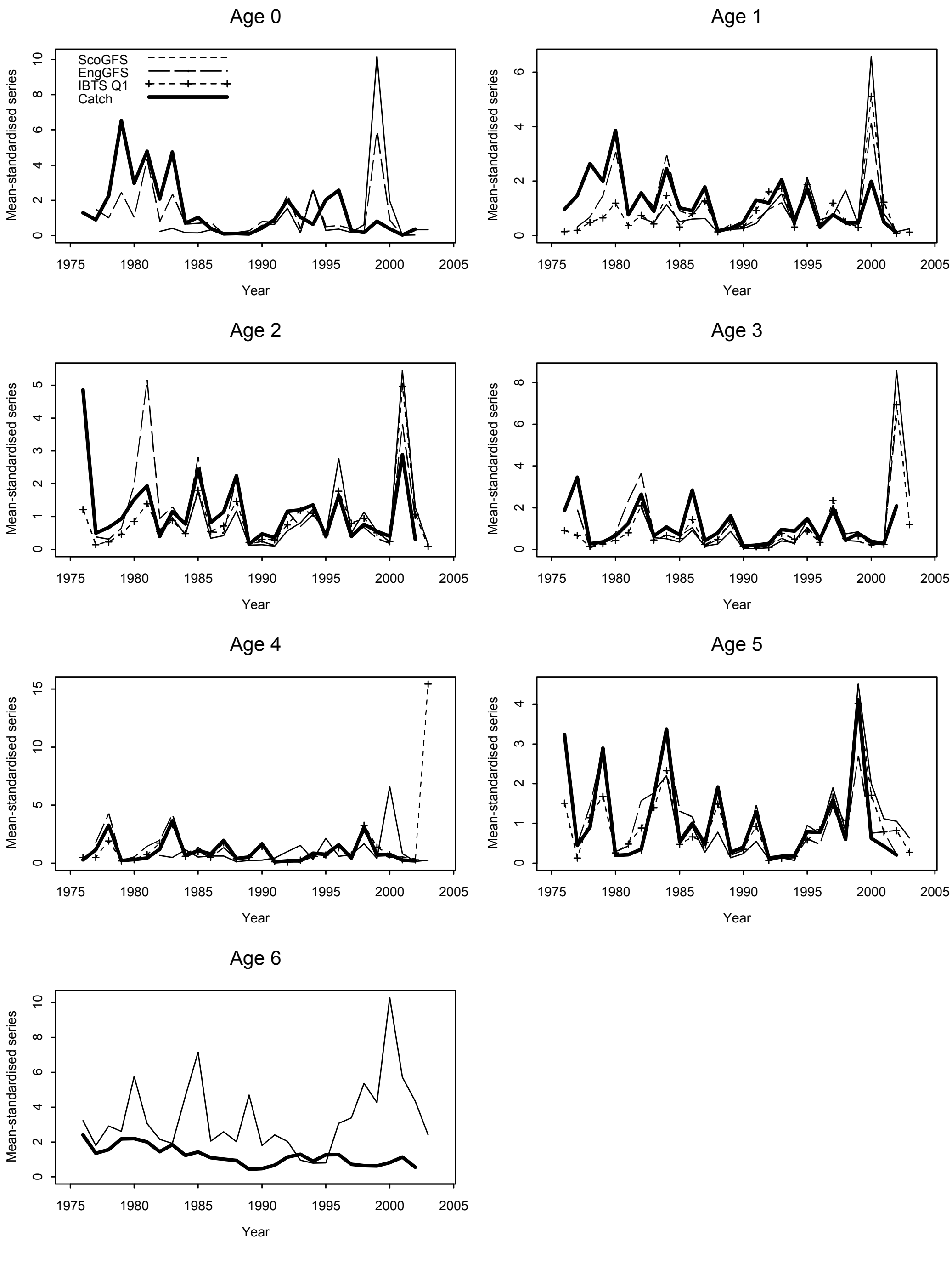


Figure 4.4.8. Haddock in Sub-Area IV and Division IIIa. Time-series of the log ratio of mean-standardised EngGFS survey indices over mean-standardised catch in numbers, by age and year. A loess smoother has been fitted through each time-series.

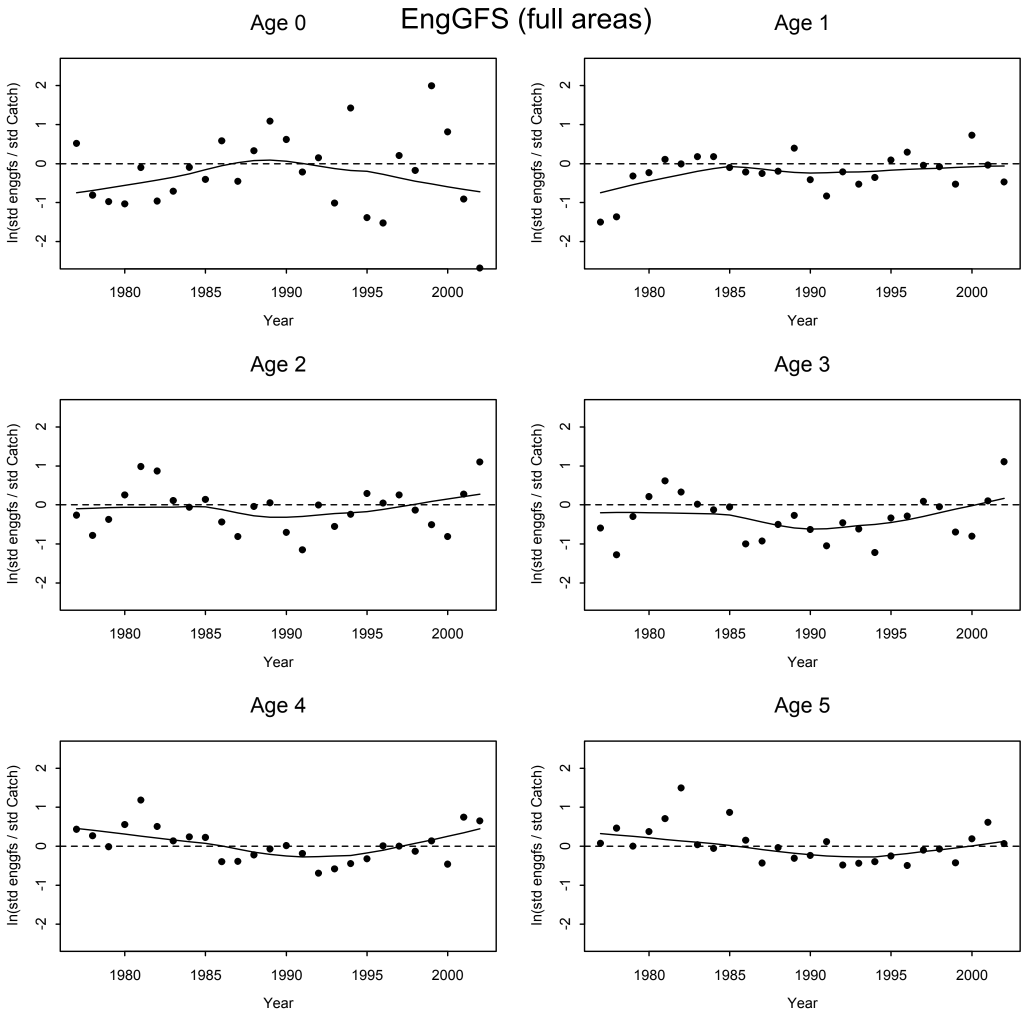


Figure 4.4.9. Haddock in Sub-Area IV and Division IIIa. Time-series of the log ratio of mean-standardised ScoGFS survey indices over mean-standardised catch in numbers, by age and year. A loess smoother has been fitted through each time-series.

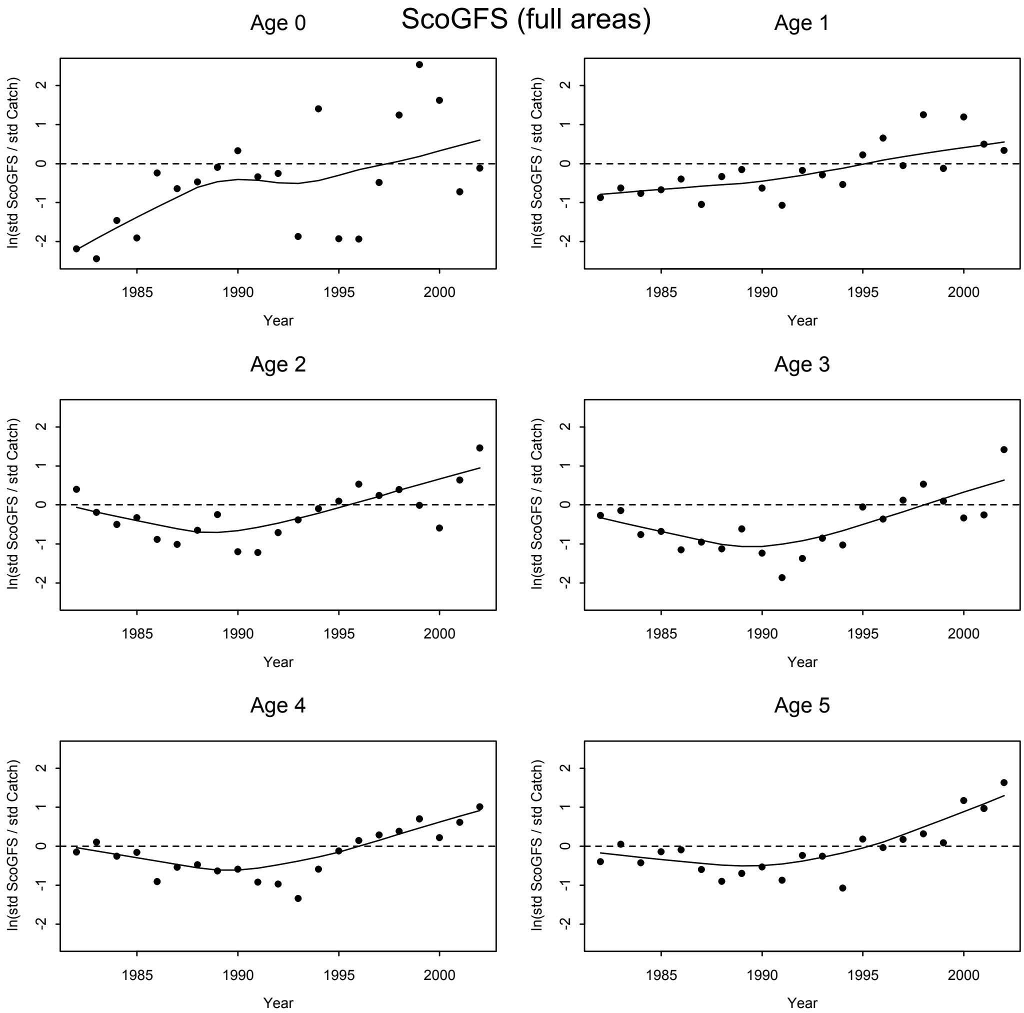


Figure 4.4.10. Haddock in Sub-Area IV and Division IIIa. Time-series of the log ratio of mean-standardised IBTS Q1 survey indices over mean-standardised catch in numbers, by age and year. A loess smoother has been fitted through each time-series.

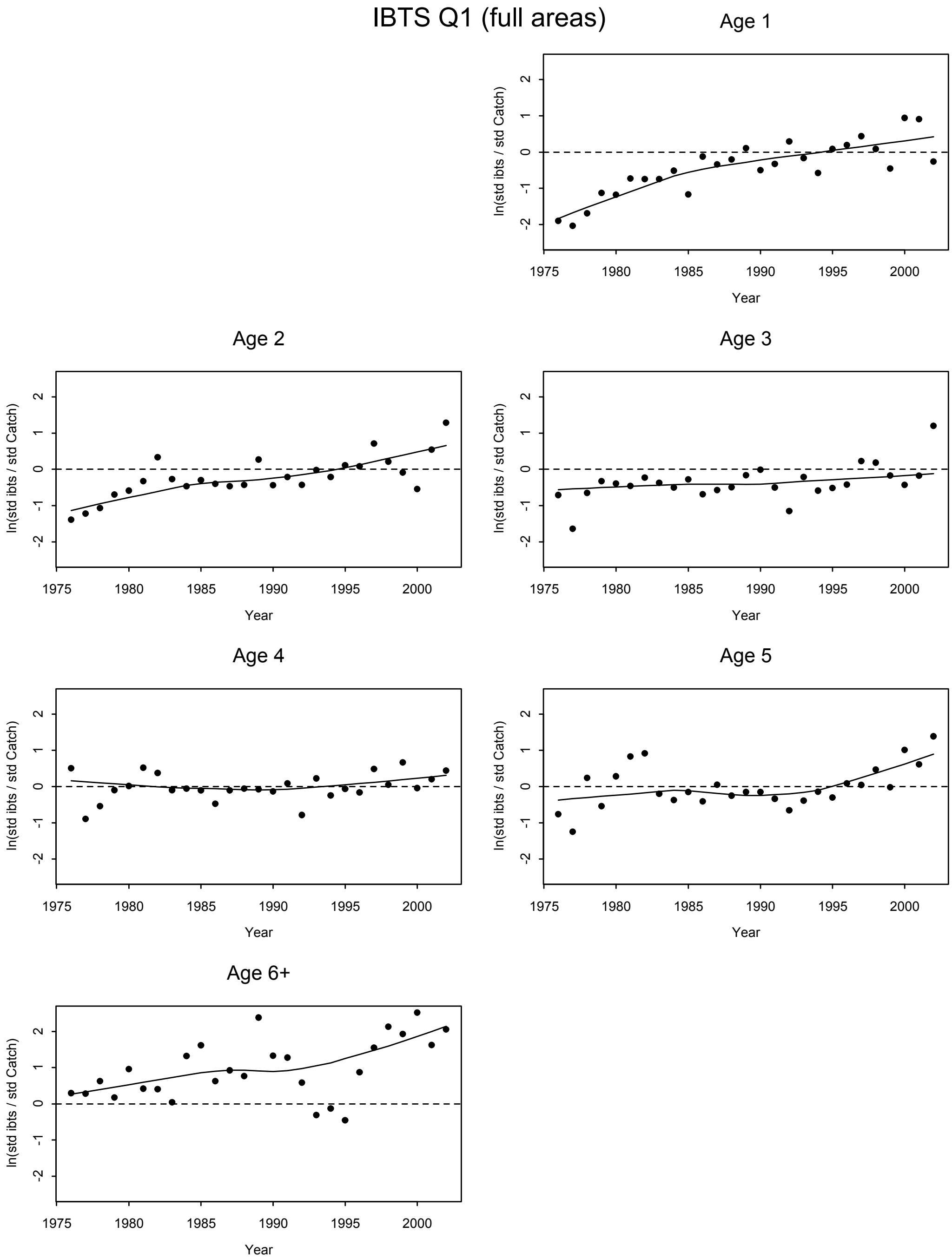


Figure 4.4.11. Haddock in Sub-Area IV and Division IIIa. Log-log bivariate scatterplots of survey indices at age. On each plot the solid line shows a least-squares linear regression fit, the dotted line shows approximate pointwise 95% confidence intervals for the fitted lines. Points are labelled with years.

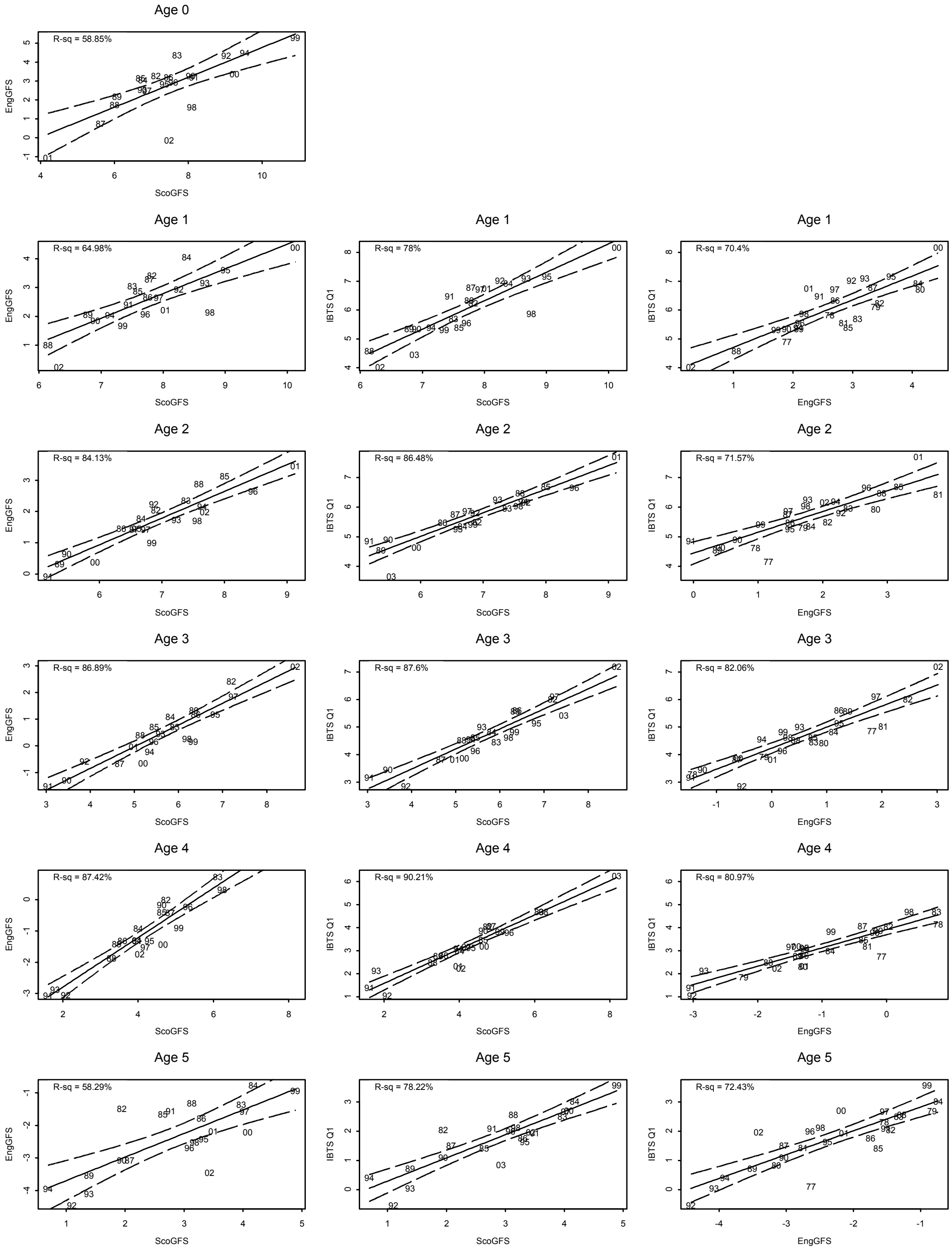


Figure 4.4.12. Haddock in Sub-Area IV and Division IIIa. Estimates of mean-standardised SSB and recruitment derived directly from surveys.

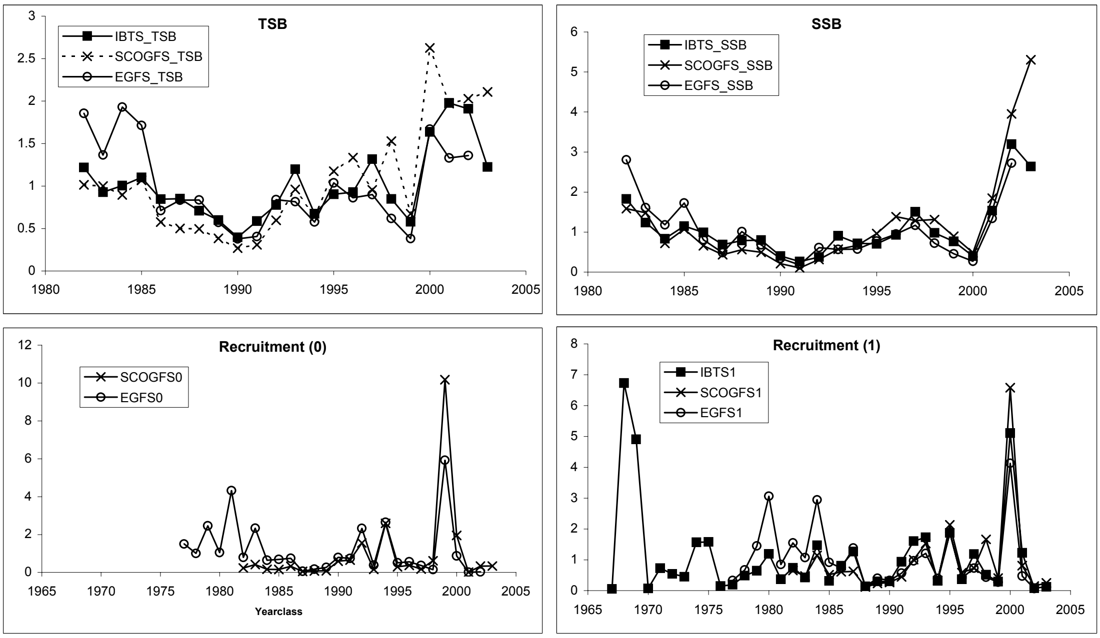
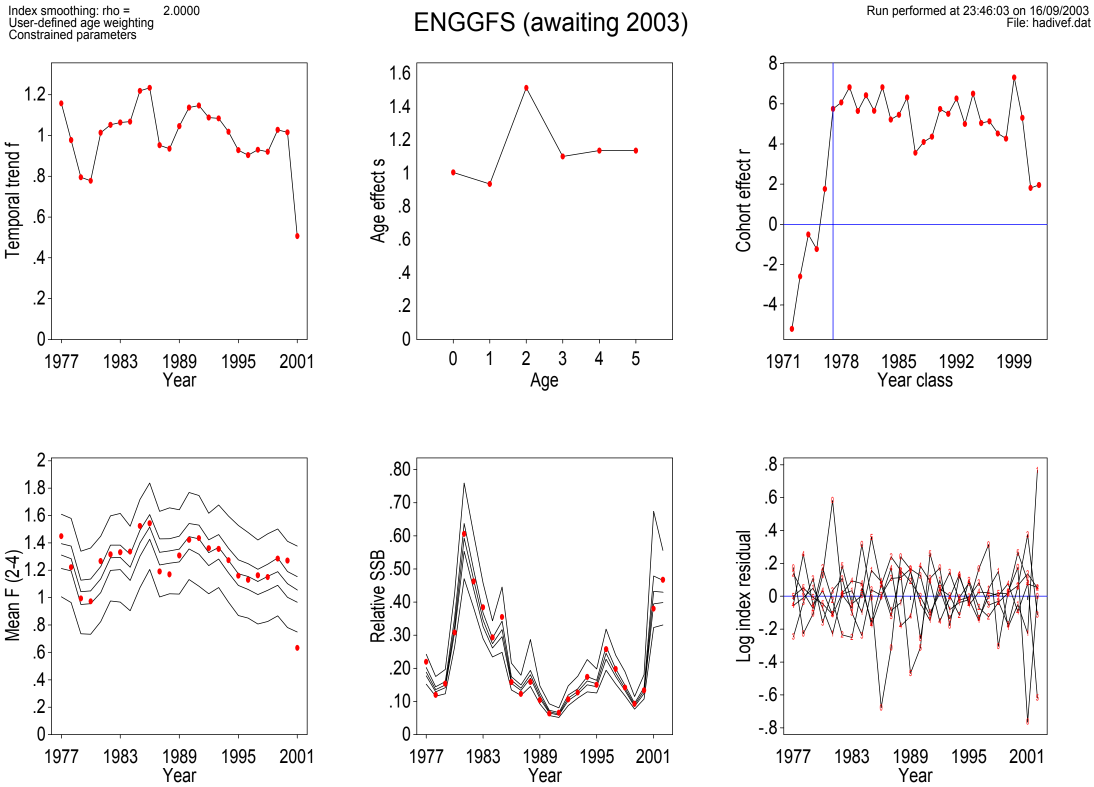


Figure 4.4.13. Haddock in Sub-area IV and Division IIIa. Summary plots from a SURBA run on the EngGFS series.

a. Stock summaries. Top row: fitted temporal trends, age effects and cohort effects. Bottom row: estimated $\bar{F}_{2-4}$ and SSB (both with empirical 2.5%, 25%, 50%, 75% and 97.5% uncertainty estimates), log residuals by age and year.



b. Bubble plot of log residuals to SURBA model fit.

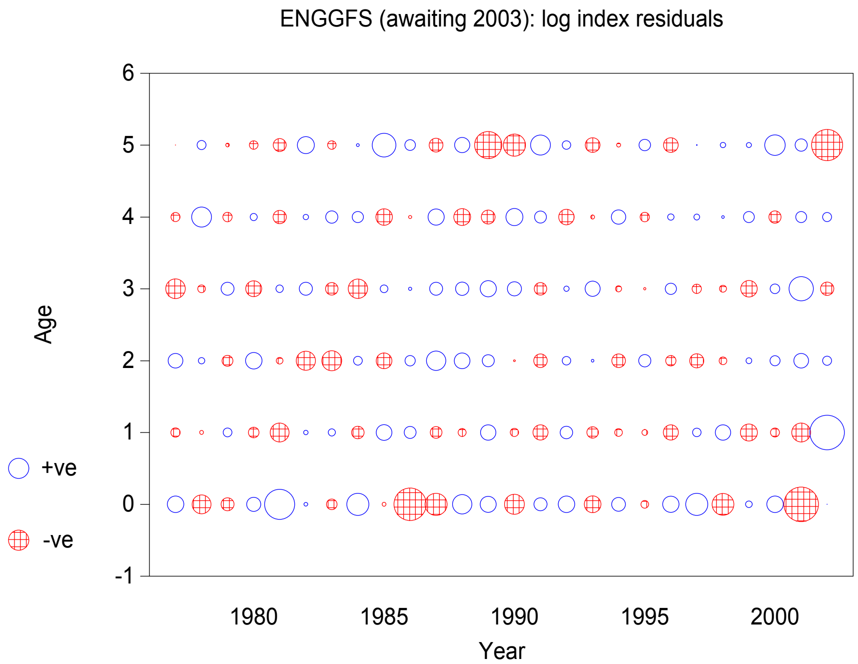
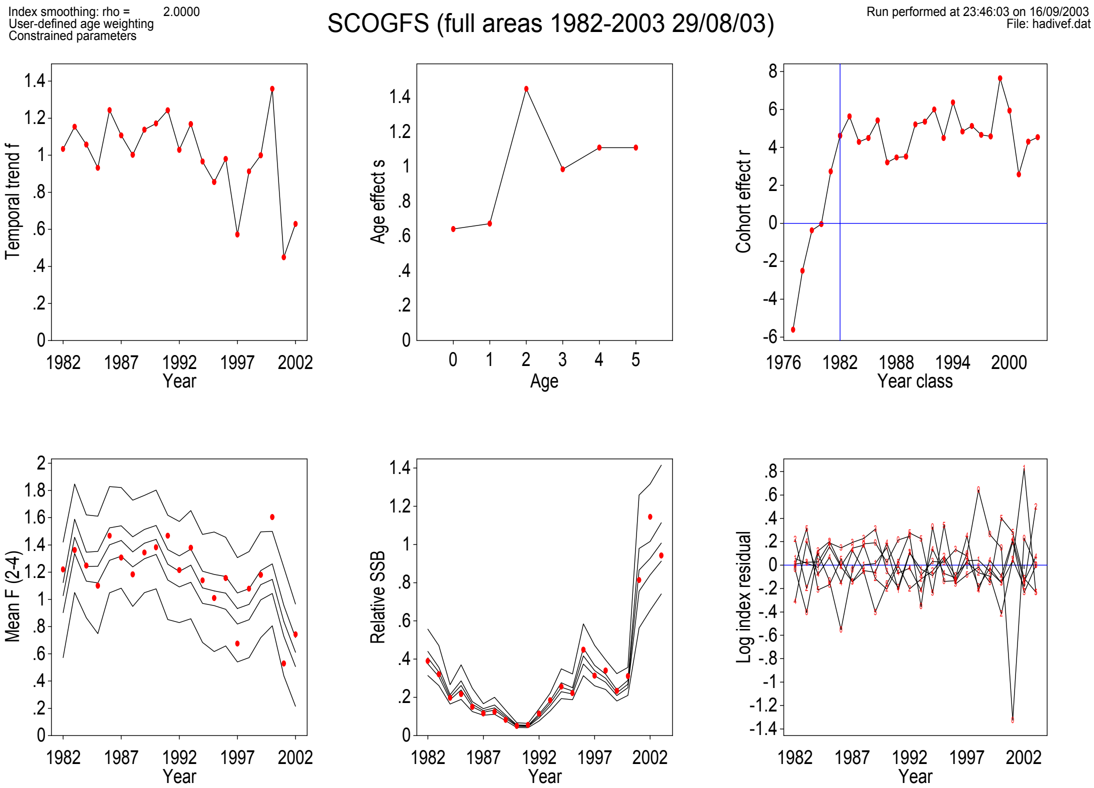


Figure 4.4.14. Haddock in Sub-area IV and Division IIIa. Summary plots from a SURBA run on the ScoGFS series.

a. Stock summaries. Top row: fitted temporal trends, age effects and cohort effects. Bottom row: estimated $\bar{F}_{2-4}$ and SSB (both with empirical 2.5%, 25%, 50%, 75% and 97.5% uncertainty estimates), log residuals by age and year.



b. Bubble plot of log residuals to SURBA model fit.

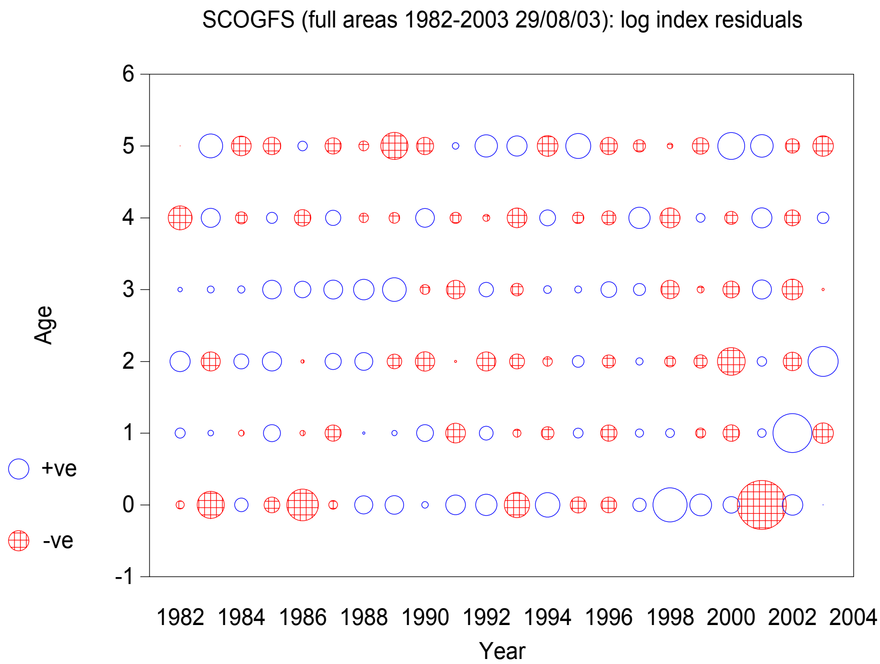
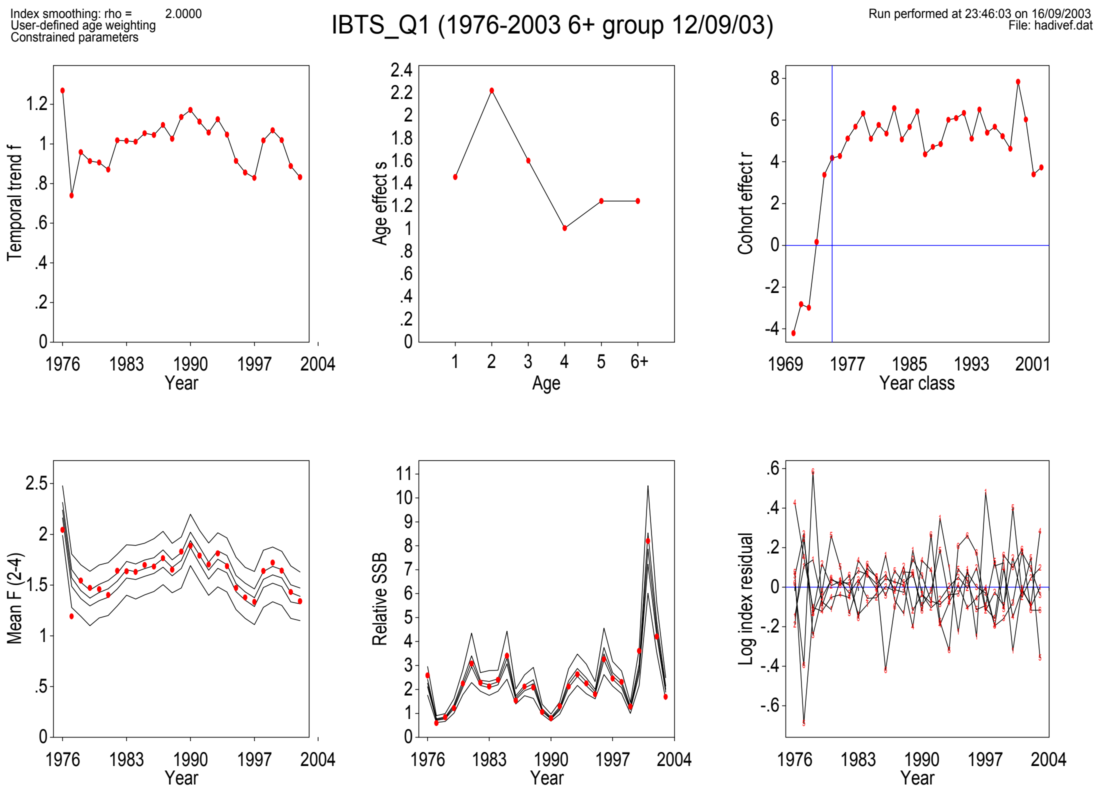


Figure 4.4.15. Haddock in Sub-area IV and Division IIIa. Summary plots from a SURBA run on the IBTS Q1 series.

a. Stock summaries. Top row: fitted temporal trends, age effects and cohort effects. Bottom row: estimated $\bar{F}_{2-4}$ and SSB (both with empirical 2.5%, 25%, 50%, 75% and 97.5% uncertainty estimates), log residuals by age and year.



b. Bubble plot of log residuals to SURBA model fit.

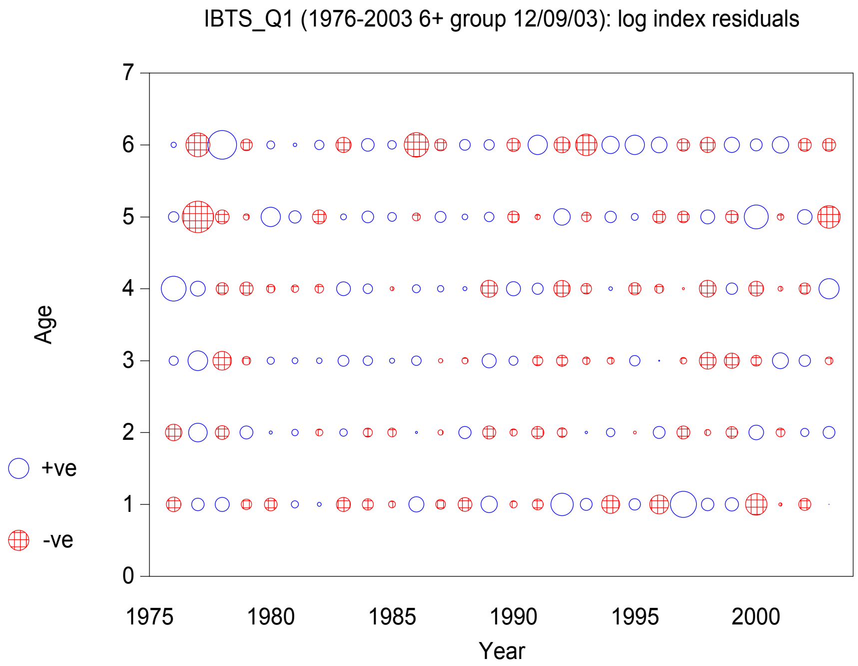


Figure 4.4.16. Haddock in Sub-area IV and Division IIIa. Comparisons of summary plots from SURBA runs on the EngGFS, ScoGFS and IBTS Q1 series.

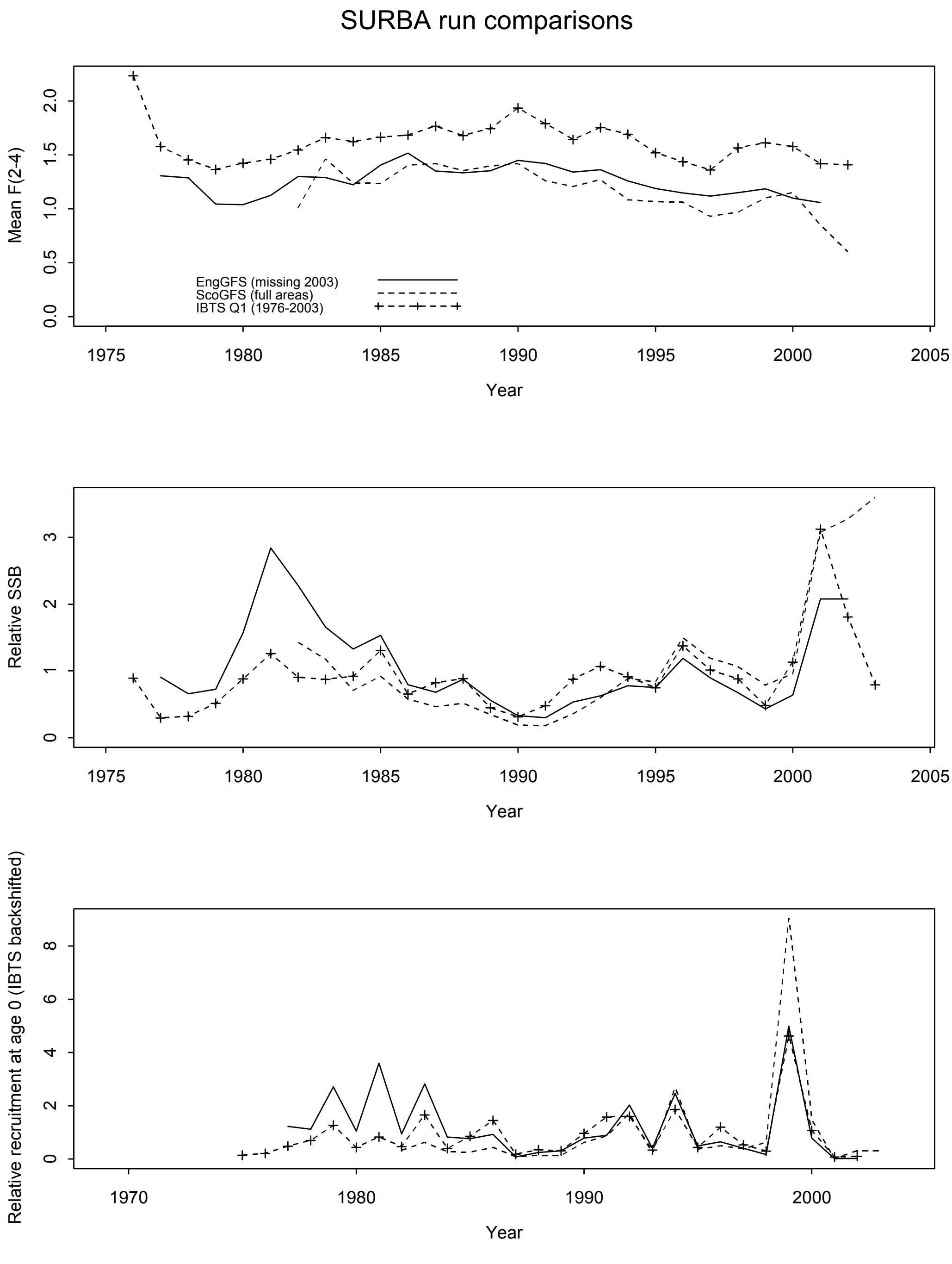


Figure 4.4.17. Haddock in Sub-Area IV and Division IIIa. Comparisons of summary plots from four TSA runs (see text for details). The shaded area shows the approximate pointwise 95% confidence limits about the estimates for TSA run 1 (total catch, no surveys).

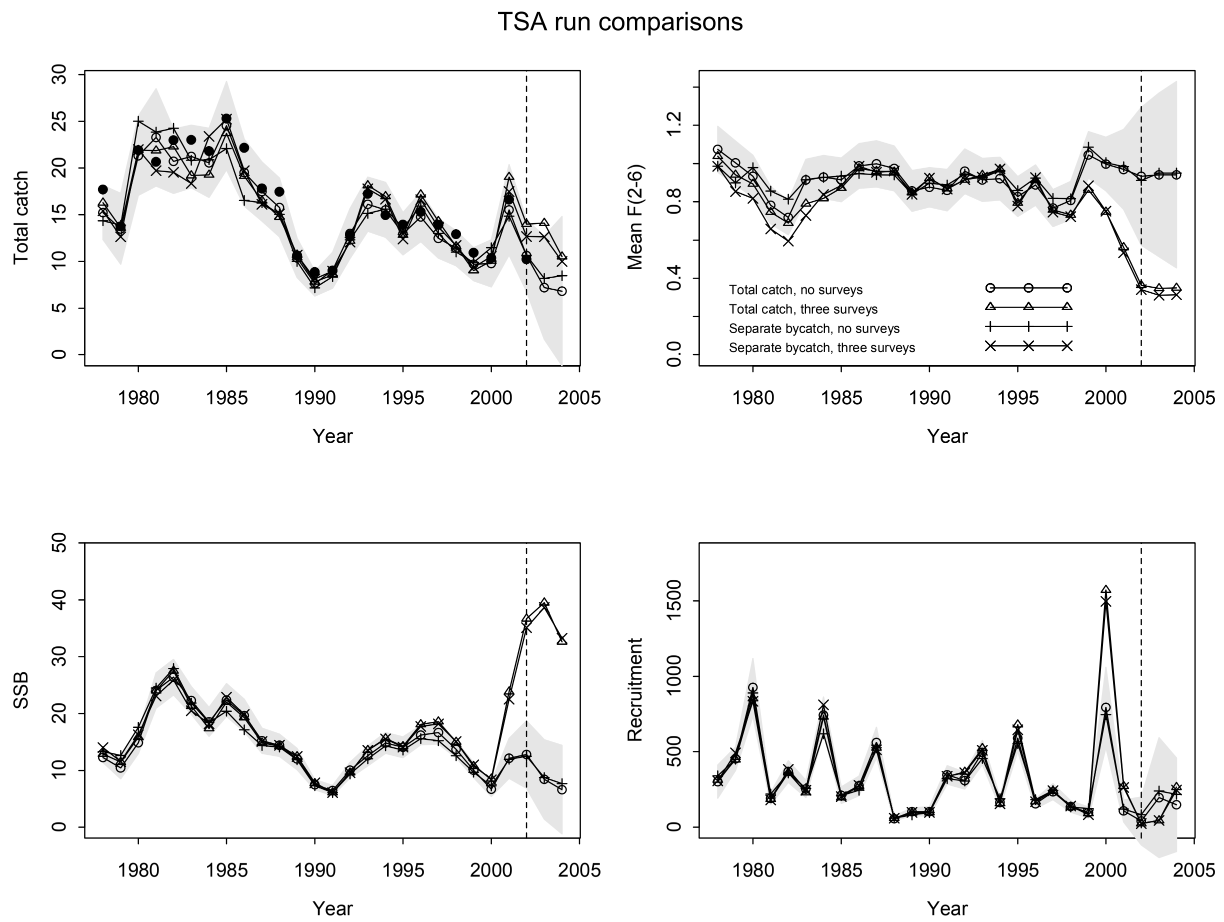
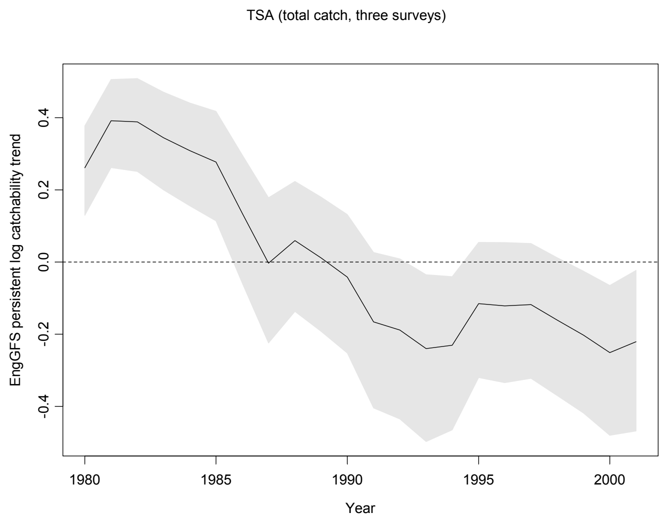
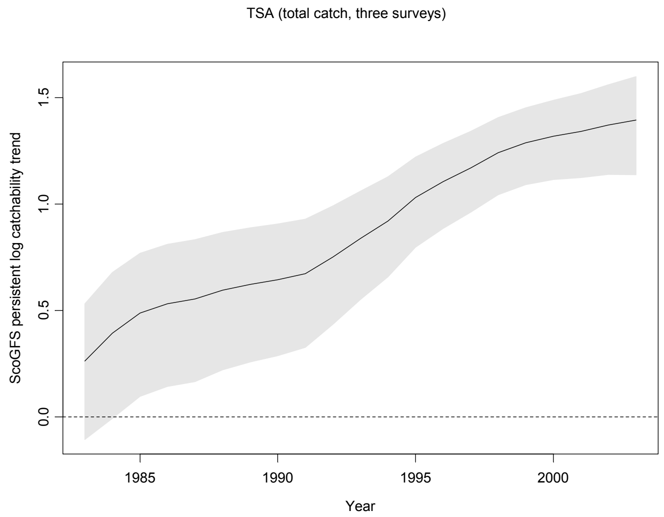


Figure 4.4.18. Haddock in Sub-Area IV and Division IIIa. Fitted estimates (line) with ±2 standard errors (shaded areas) of the persistent trends in EngGFS, ScoGFS and IBTS Q1 log catchability mismatch. These results pertain to TSA run 2 (total catch, three surveys).





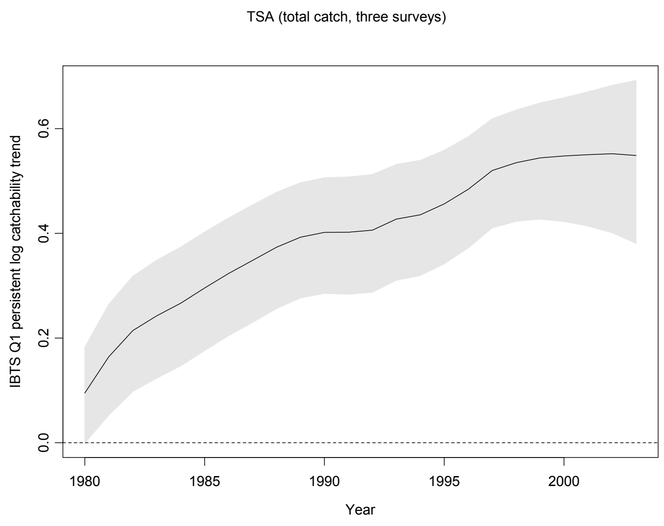
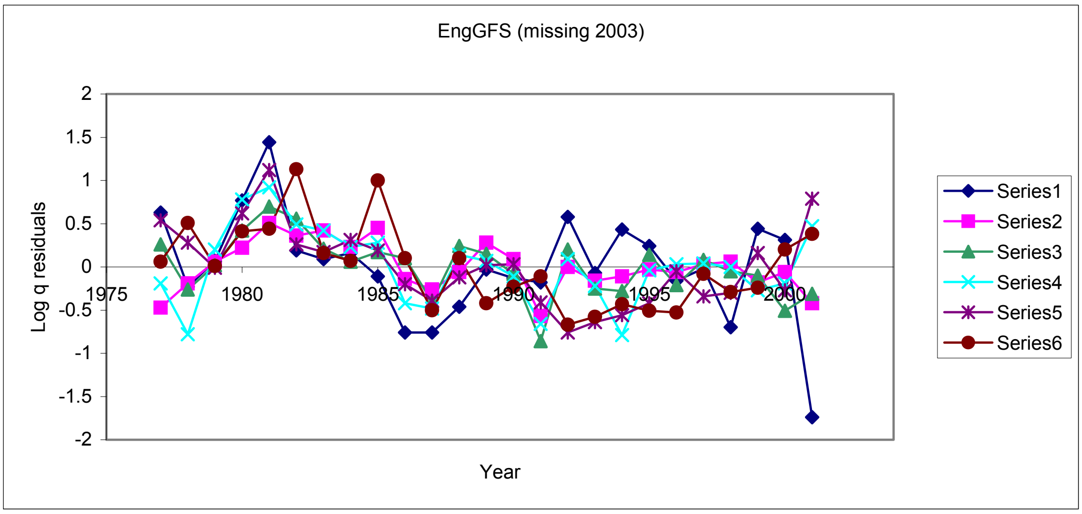
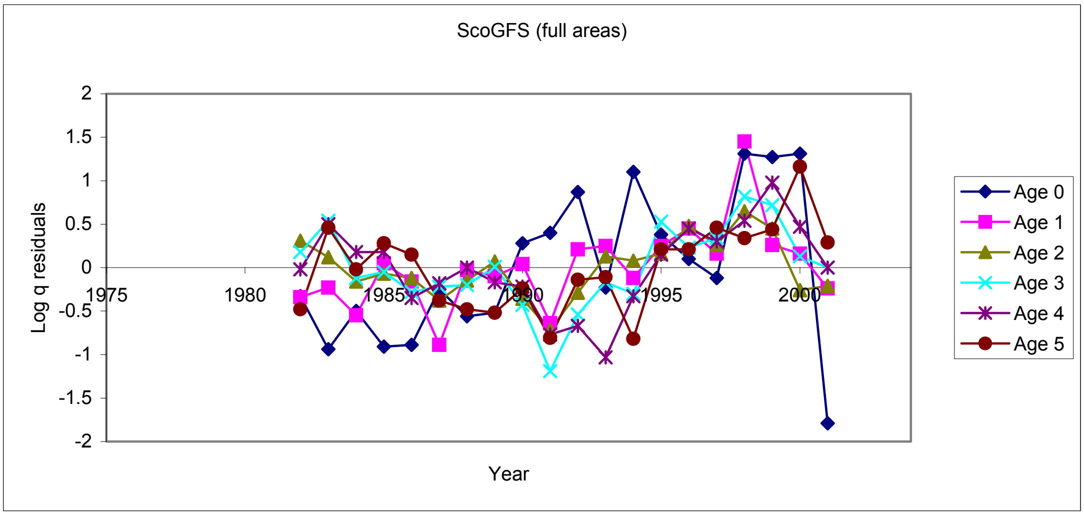


Figure 4.4.19. Haddock in Sub-Area IV and Division IIIa. Log catchability residuals from single-fleet Laurec-Shepherd runs for EngGFS, ScoGFS and IBTS Q1.





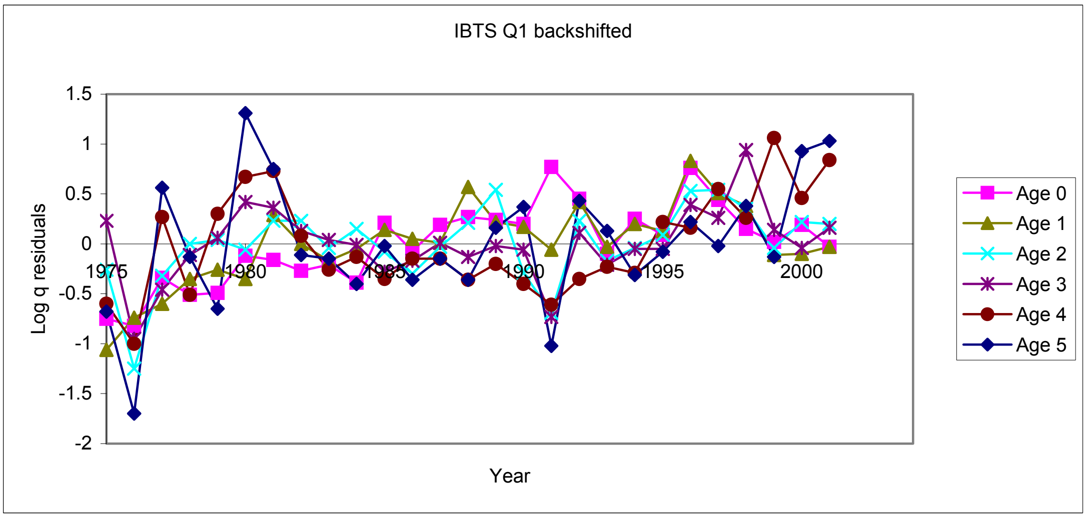
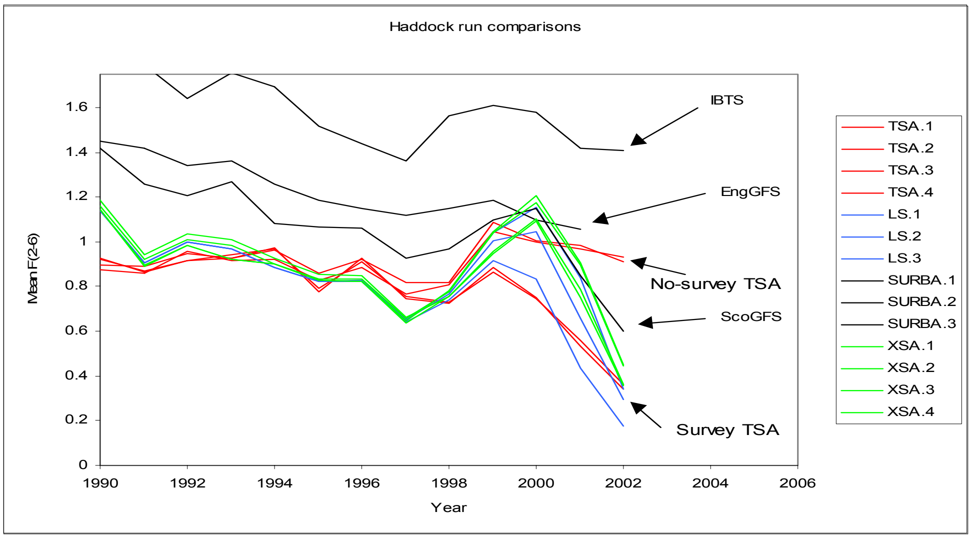
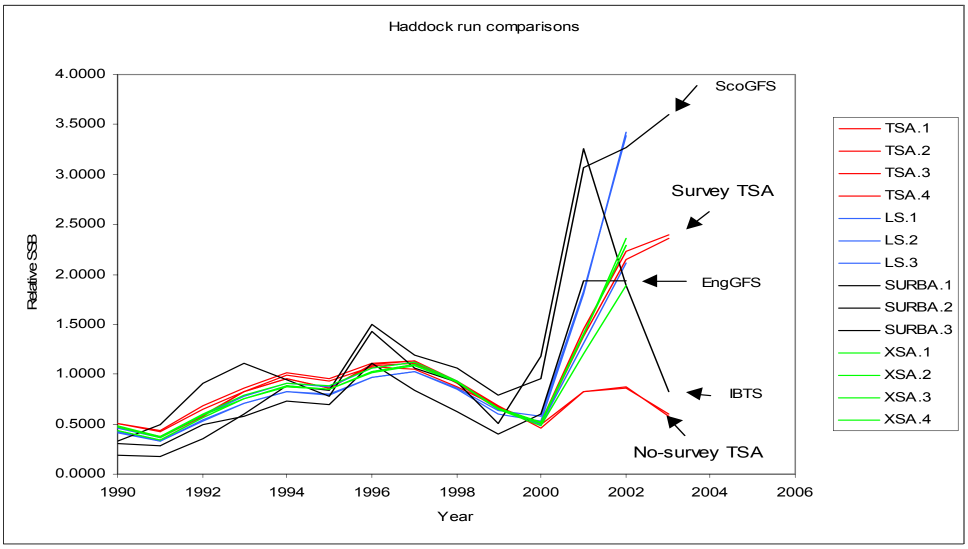


Figure 4.4.20. Haddock in Sub-Area IV and Division IIIa. Comparison of summary statistics from exploratory analyses. Note that the TSA results presented here are based on a 0-10+ age range, and a mean *F* range of 2–6: time did not permit the WG to revisit these analyses.





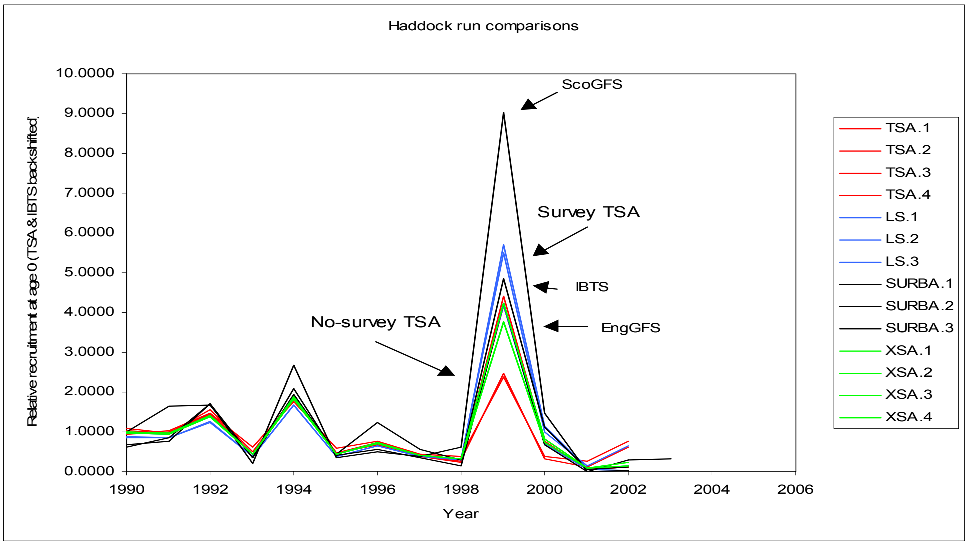


Figure 4.4.21. Haddock in Sub-Area IV and Division IIIa. Summary plots from XSA runs using alternative estimates of natural mortality and maturity.

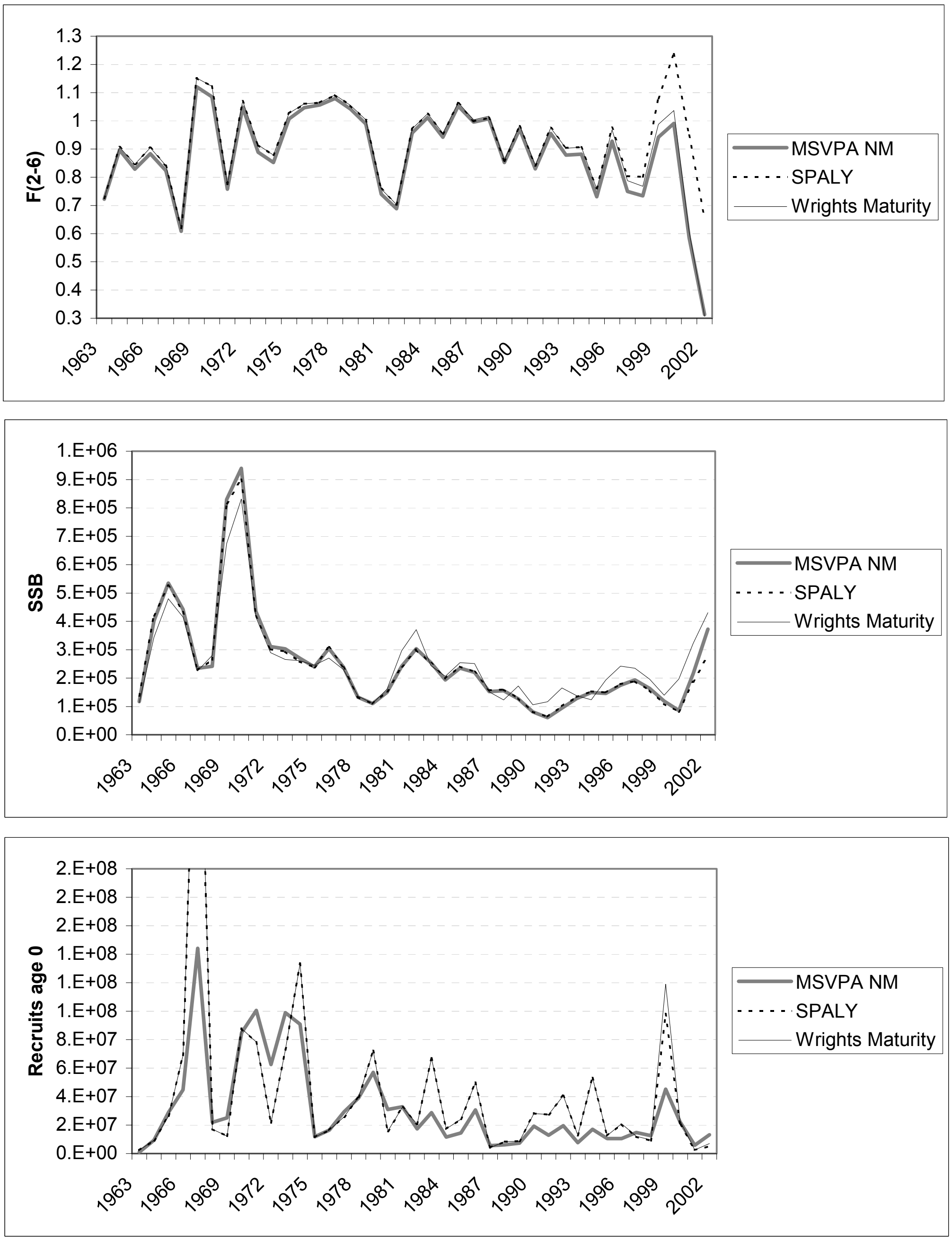


Figure 4.4.22. Haddock in Sub-Area IV and Division IIIa. Log catchability residuals from the final XSA assessment configuration.

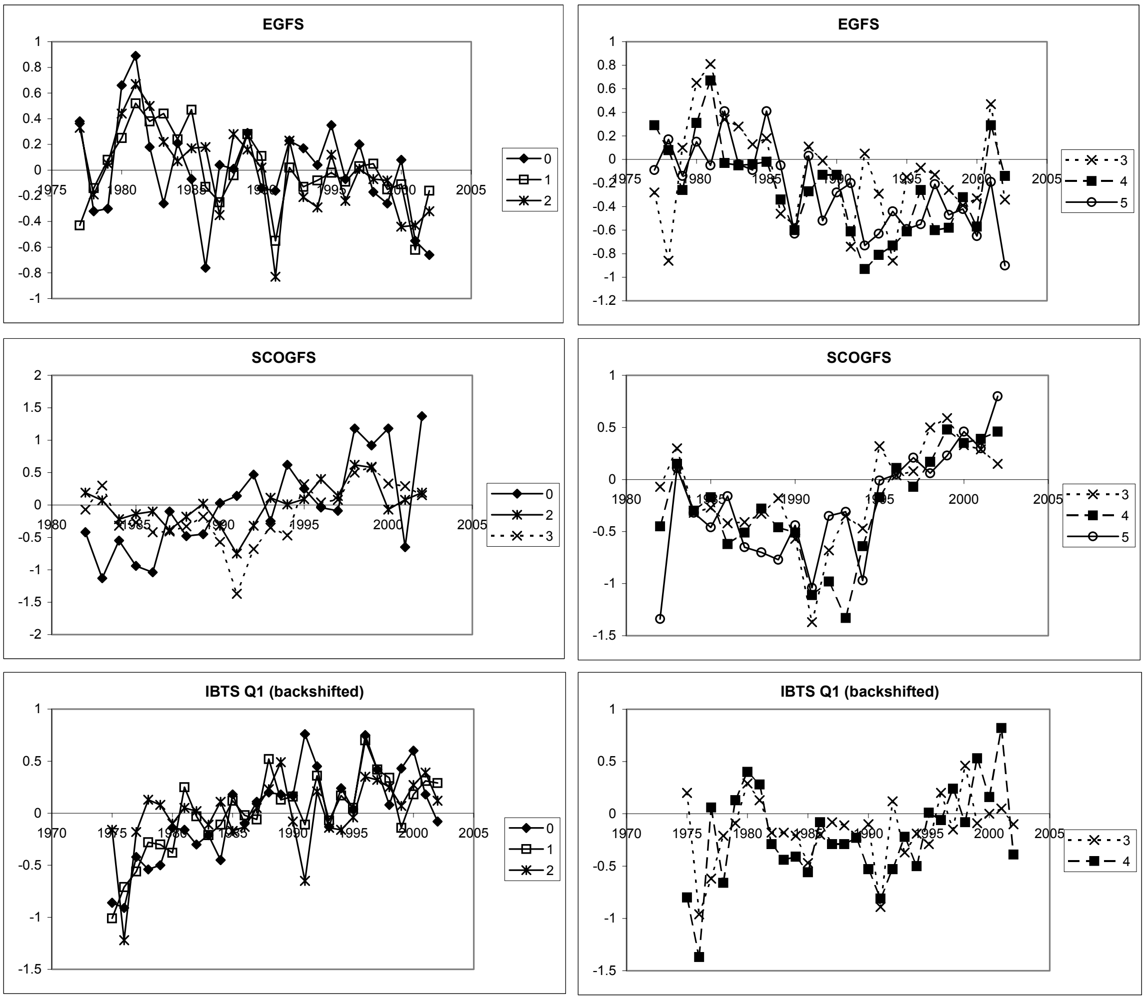
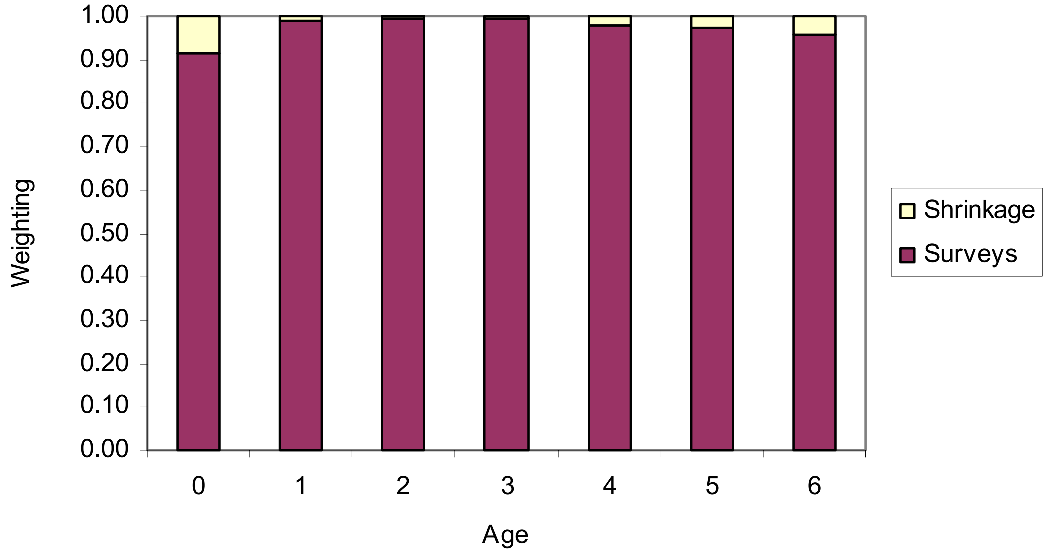


Figure 4.4.23. Haddock in Sub-Area IV and Division IIIa. Relative contribution of surveys and shrinkage to XSA survivors' estimates from the final assessment.

a. Estimates from the 2003 WG assessment.



b. Estimates from the 2002 WG assessment.

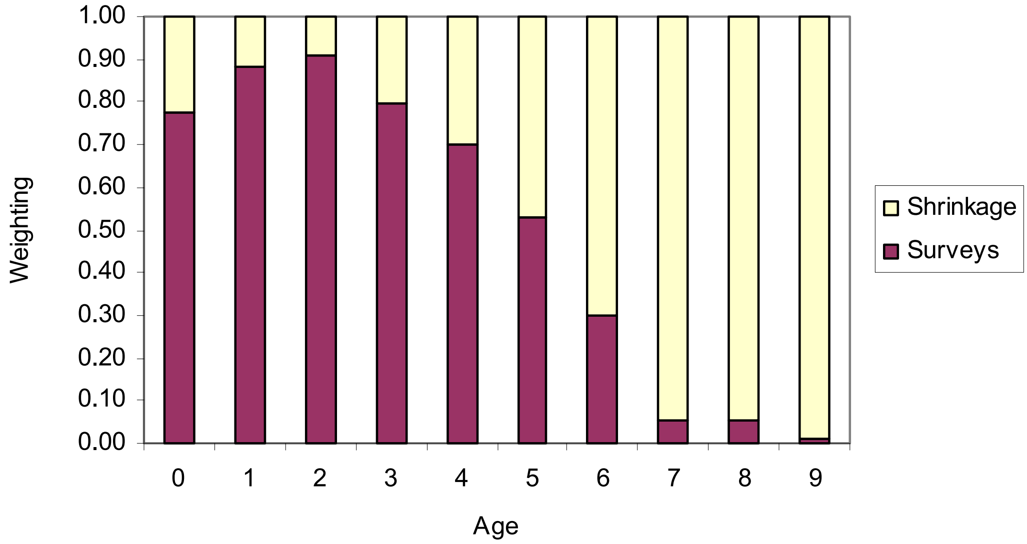


Figure 4.6.1. Haddock in Sub-Area IV and Division IIIa. Stock trends 1963–2002.

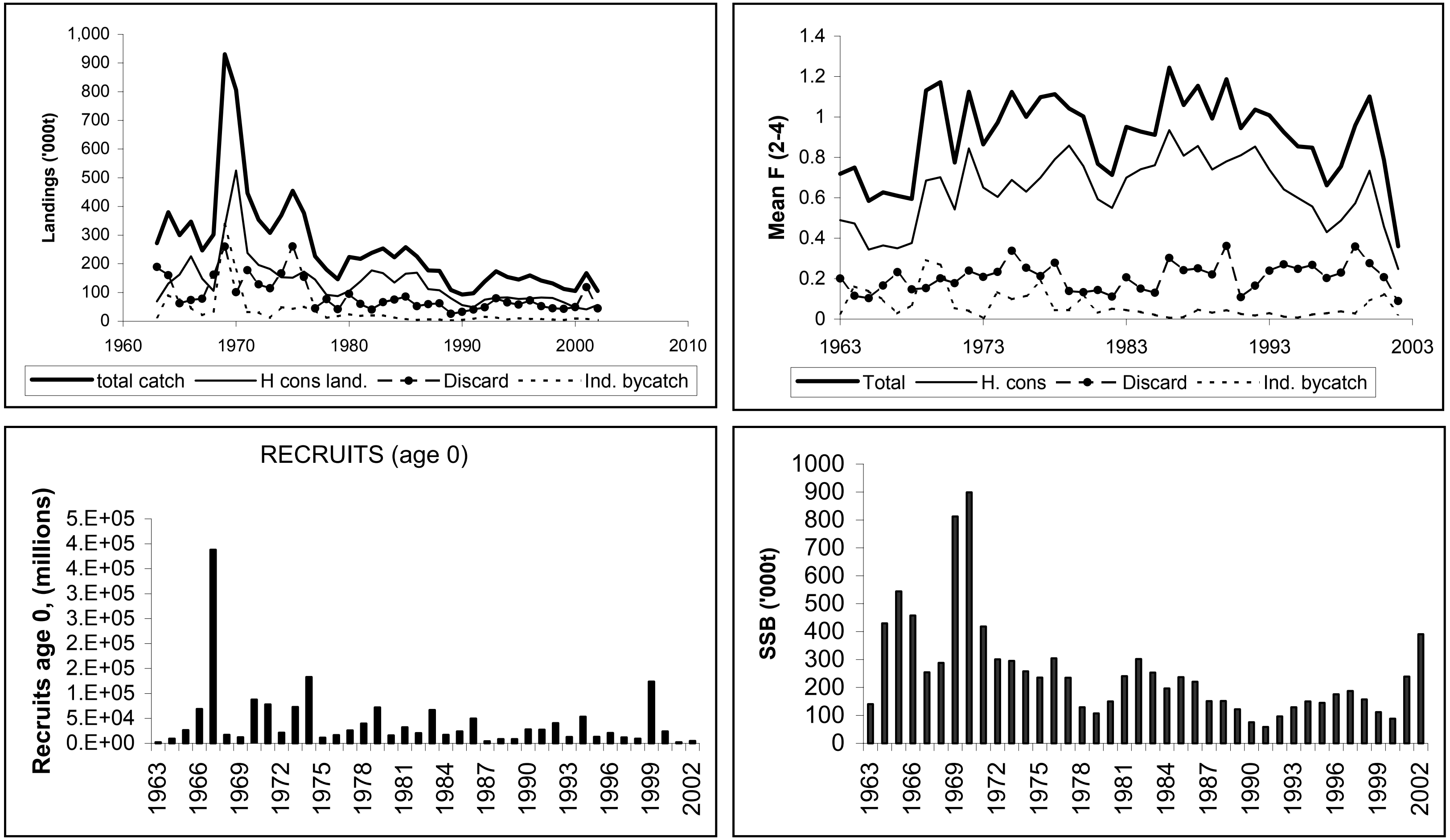
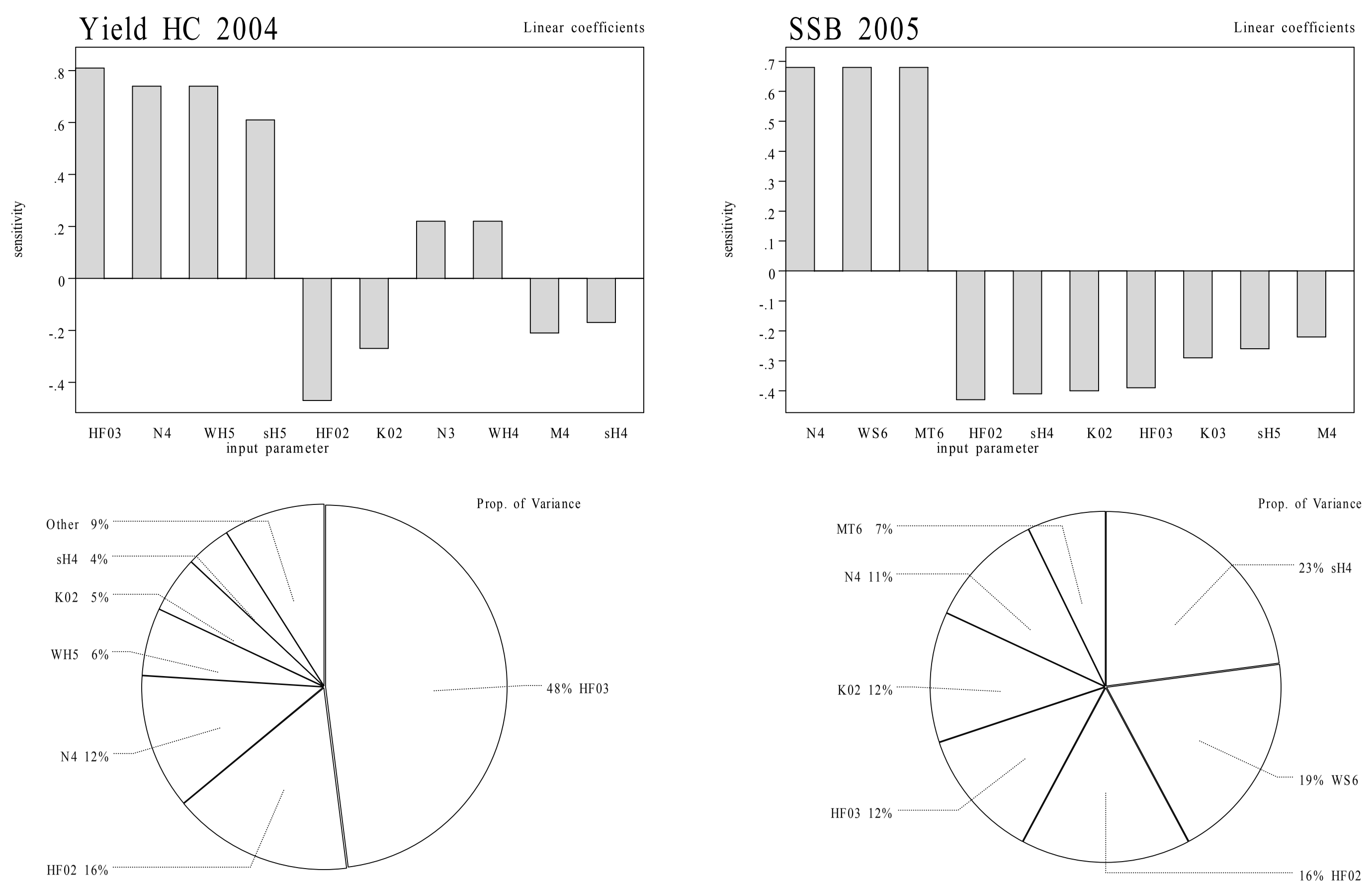


Figure 4.7.1. Haddock in Sub-Area IV and Division IIIa. Sensitivity analysis.of short-term projection.

Haddock, IV and IIIa. Sensitivity analysis of short term forecast.



Data from file:C:\Working Files\NS 2003\haddock\forecasts\hadiv.sen on 18/09/200

Figure 4.7.2. Haddock in Sub-Area IV and Division IIIa. Probability profiles for the short-term projection.

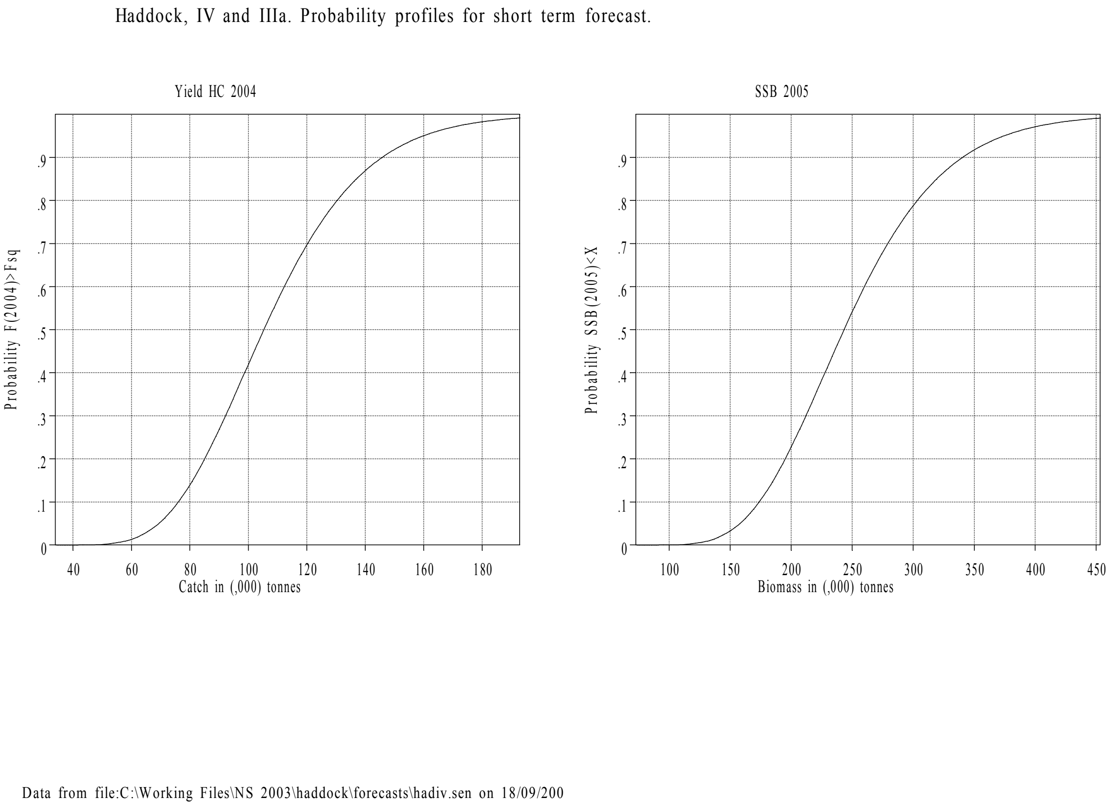


Figure 4.7.3. Haddock in Sub-Area IV and Division IIIa. Short-term forecast.

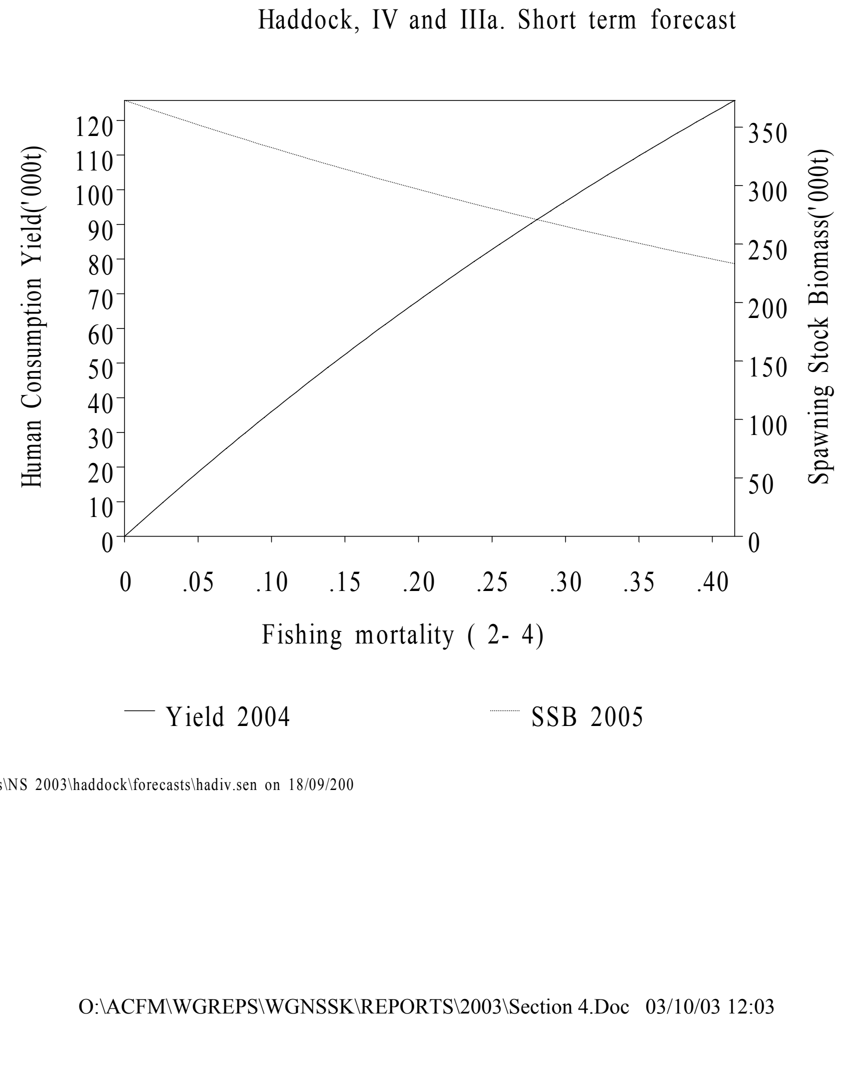


Figure 4.9.1. Haddock in Sub-Area IV and Division IIIa. Diagnostics from PAsoft.

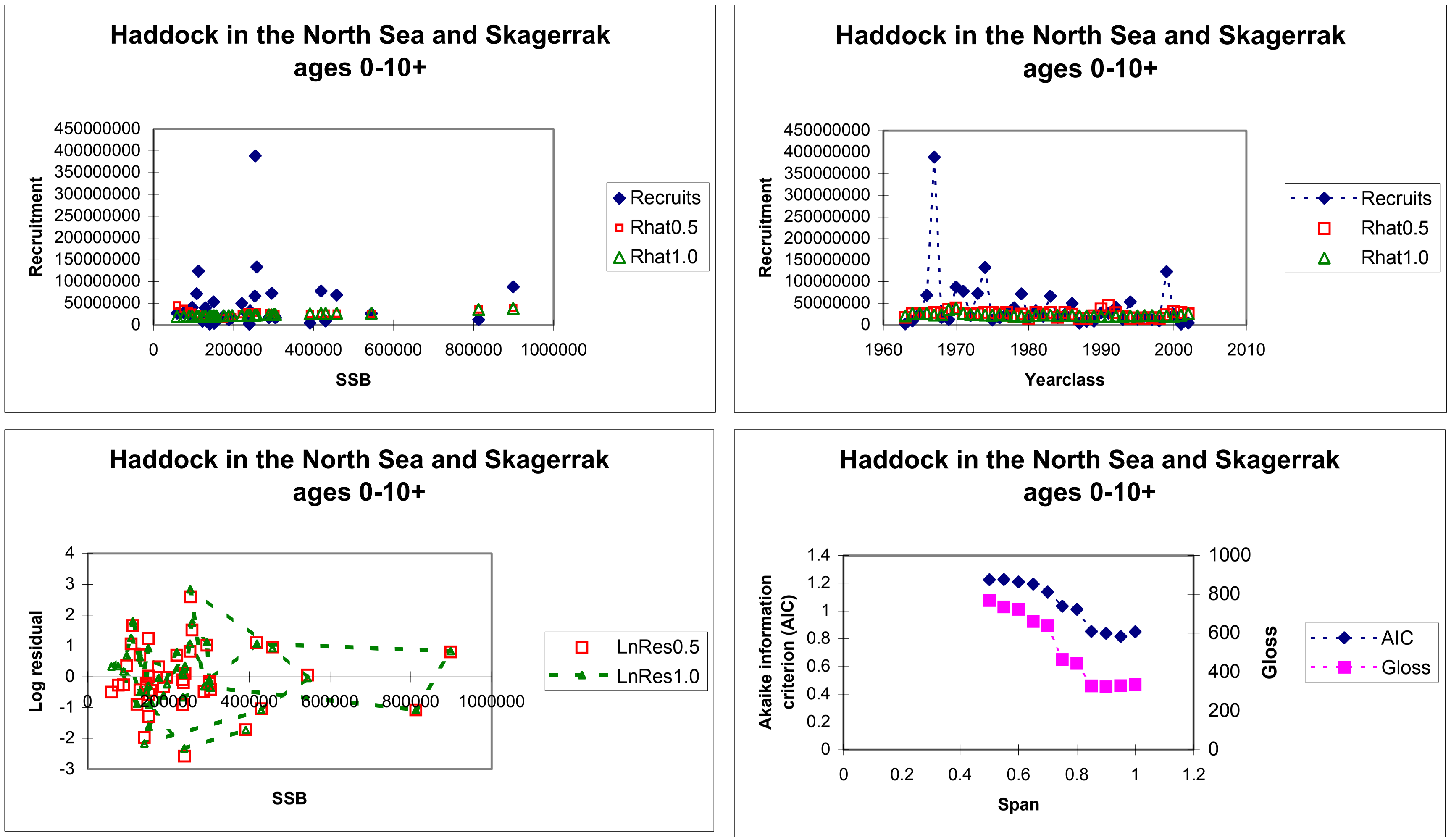


Figure 4.9.2. Haddock in Sub-Area IV and Division IIIa. Output plots from PASoft analysis.

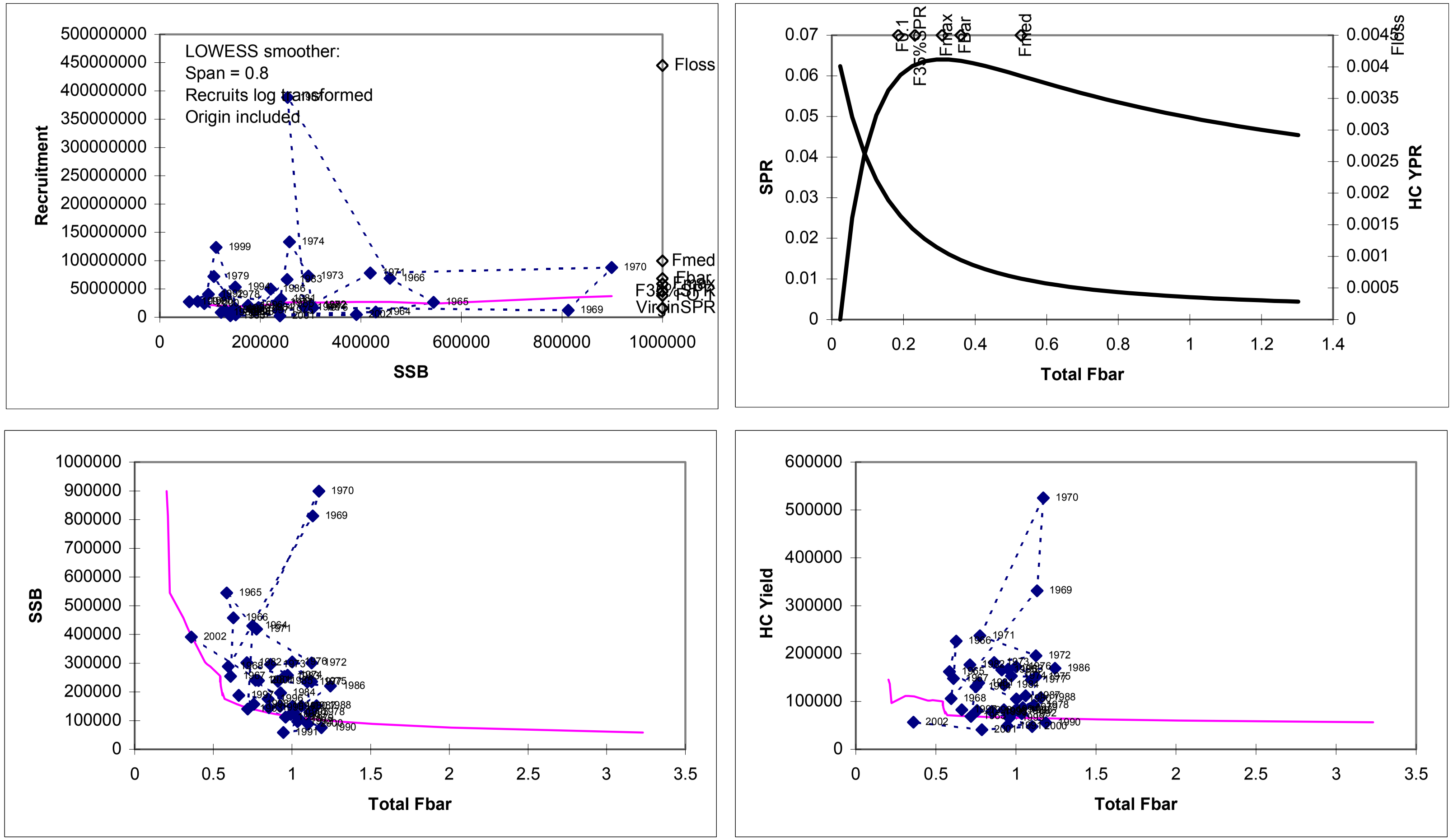


Figure 4.9.3. Haddock in Sub-Area IV and Division IIIa. Stock-recruit comparison plot between 2002 assessment and current 2003 assessment.

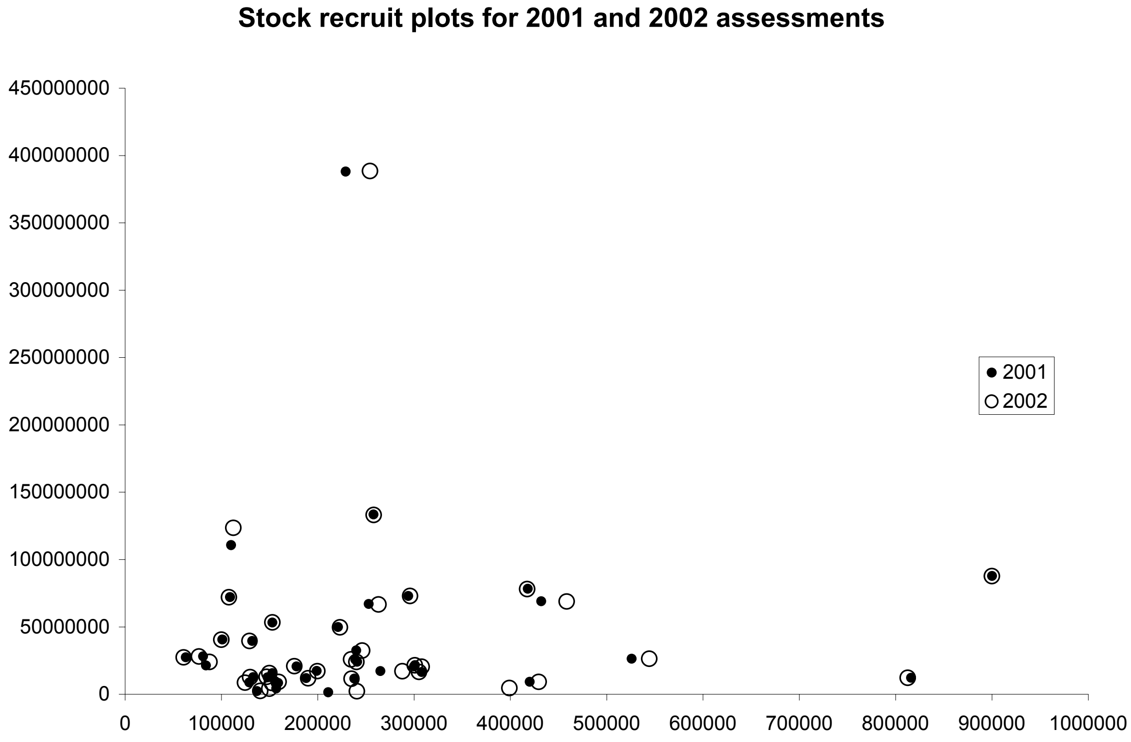


Figure 4.9.4. Haddock in Sub-Area IV and Division IIIa. Historical performance of stock in relation to existing PA reference points. The shaded section corresponds to the stock being outside safe biological limits (SSB<$\mathbf{B}_{lim}$, F>$\mathbf{F}_{lim}$).

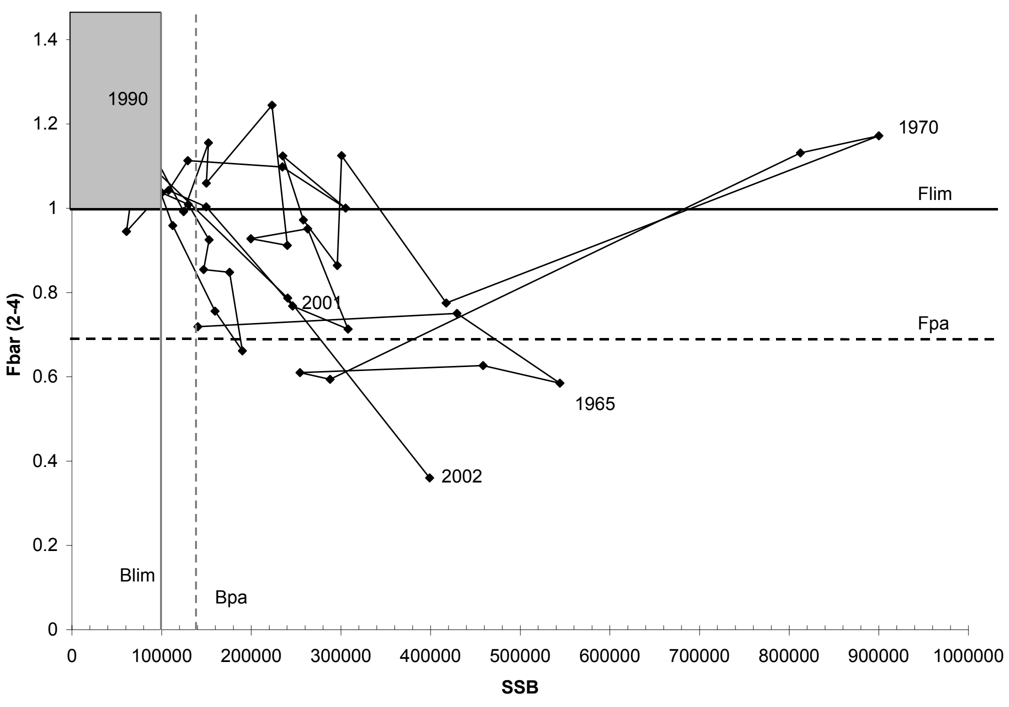
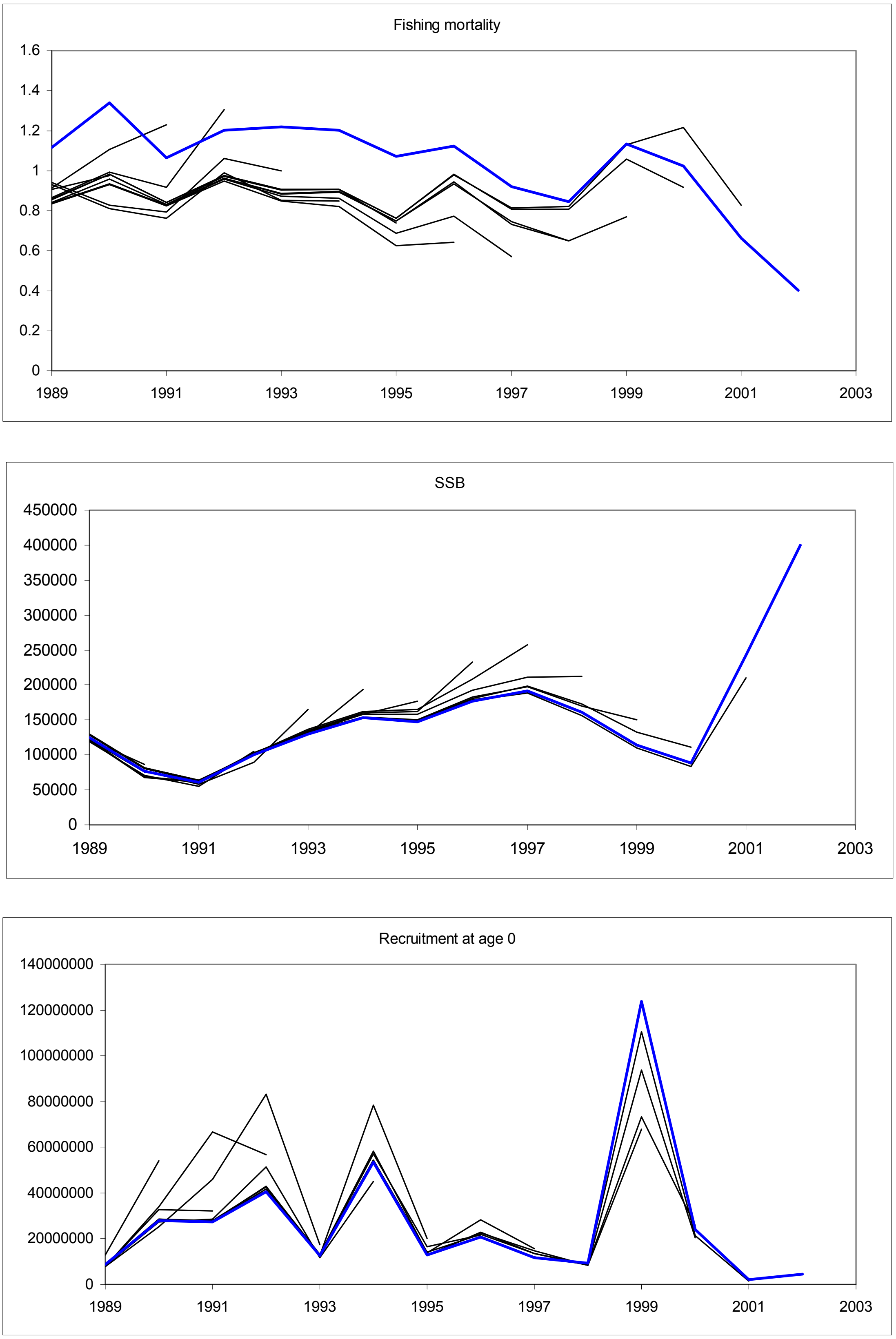


Figure 4.10.1. Haddock in Sub-Area IV and Division IIIa. Quality control charts of assessments generated by successive Working Groups, with the 2003 assessment highlighted in blue. The age range for calculation of mean *F* was 2–6 for the assessments performed during 1989–2002, 2–4 for the current assessment.



5 WHITING

5.1 Whiting in Sub-area IV and Division VIId

The assessment of whiting in sub-area IV and Division VIId was originally tabled as an update assessment, but the Working Group found that additional analyses were required. All the relevant biological and methodological information can be found in the stock annex dealing with this stock.

5.1.1 The Fishery

A brief description of the fishery is given in the stock annex.

5.1.1.1 ACFM advice applicable to 2002 and 2003

The advice in 2001 for the fishery in 2002 was:

> *"To bring SSB above $\boldsymbol{B_{pa}}$ in 2003, fishing mortality in 2002 should be below 0.37, corresponding to human consumption landings of less than 37,000 t. However, due to the mixed nature of the fisheries the fishing mortality for whiting may have to be reduced further to achieve consistency with the recovery plan for cod."*

The advice in 2002 for the fishery in 2003 was:

> "*Since whiting is mostly taken in demersal fisheries with cod and haddock, the advice for cod determines the advice for whiting. Except where it can be demonstrated that whiting can be harvested without by-catch or discards of cod, fishing for whiting should not be permitted.*
>
> *On the status of whiting alone, in order to bring SSB above $\boldsymbol{B_{pa}}$ in 2004, ICES would recommend that fishing mortality in 2002 should be below 0.27, corresponding to human consumption landings of less than 26,000 t. This implies a reduction in fishing mortality of at least 40%. If fishing on whiting is permitted consistent with the advice on cod then total catches should not exceed these values."*

5.1.1.2 Management applicable in 2002 and 2003

Annual management of the fishery operates through TACs. The 2002 and 2003 TACs for whiting in Sub-Area IV and Division IIa (EC waters) were 32,358 t and 16,000 t respectively. The minimum mesh size for vessels fishing for cod in the mixed demersal fishery in EC Zones 1 and 2 (West of Scotland and North Sea excluding Skagerrak) was changed from 100 mm to 120 mm from the start of 2002 under EU regulations regarding the cod recovery plan (Commission Regulation EC 2056/2001), with a one-year derogation of 110 mm for vessels targeting other species such as whiting. This derogation was not extended beyond the end of 2002. Whiting are a by-catch in some Nephrops fisheries that use a smaller mesh size, although landings are restricted through by-catch regulations. Industrial fishing with small-meshed gear is permitted, subject to by-catch limits of protected species including whiting. The minimum landing size of whiting in the human consumption fishery from this area is 27 cm. Regulations applying to the Norway pout box prevent industrial fishing with small meshes in an area where the by-catch limits are likely to be exceeded.

The UK implemented a national regulation in mid 2000, requiring the mandatory fitting of a 90 mm square mesh panel (SSI 227/2000), predominantly to reduce discarding of the large 1999 year class of haddock. Further unilateral legislation in 2001 (SSI 250/2001) banned the use of lifting bags in the Scottish fleet. These measures are likely to affect the selectivity of whiting.

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

There is no separate TAC for Division VIId, landings from this Division are counted against the TAC for Divisions VIIb-k combined (31,700 t in 2002 and 31,700 t in 2003). Minimum mesh size for whiting in Division VIId is 80mm, with a 27 cm minimum landing size.

5.1.1.3 The fishery in 2002

For the North Sea, the total international catches were 40,500 t in 2002, of which 15,900 t were human consumption landings, 17,300 t discards and 7,300 t industrial by-catch. The human consumption landings were the lowest ever recorded, while both discards and industrial by-catch were around 4,000 t above their lowest recorded levels. The total weight of the catch in the human consumption component in the North Sea decreased from 2001 to 2002, whilst those of discards and industrial by-catch were similar to 2001. For the eastern Channel, the total catch in 2002 (5,800 t) was very similar to last year, the highest since 1994. The total North Sea and eastern Channel human consumption landings of 21,700 t in 2002 were 31% of the status quo forecast of 69,000 t from the 2002 assessment.

5.1.2 Data available

5.1.2.1 Landings

Total nominal landings are given in Table 5.1.2.1.1 for the North Sea (Subarea IV) and Eastern Channel (Division VIId). Total international catches as estimated by the Working Group for the combined North Sea and Eastern Channel are shown in Table 5.1.2.1.2. Eastern Channel catches as used by the Working Group are also shown separately in Table 5.1.2.1.3.

5.1.2.2 Age compositions

Total international catch numbers at age (IV and VIId combined) are presented in Table 5.1.2.2.1. Total international human consumption landings, discards and industrial by-catch numbers at age (IV and VIId combined) are presented in Tables 5.1.2.2.2 - 5.1.2.2.4. Scottish discard estimates are used to estimate discarding in all other fleets, which may not be appropriate because of different discarding practices in different fleets.

5.1.2.3 Weight at age

Mean weights at age (IV and VIId combined) in the catch are presented in Table 5.1.2.3.1. Mean weights at age (IV and VIId combined) in human consumption landings, discards and industrial by-catch are presented in Tables 5.1.2.3.2 – 5.1.2.3.4.

5.1.2.4 Maturity and natural mortality

Maturity and natural mortality are assumed at fixed values and are given in Table 5.1.2.4.1. New estimates of natural mortality provided by the Multispecies Study Group have not been explored during the meeting.

5.1.2.5 Catch, effort and research vessel data

A summary of available tuning series is presented in Table 5.1.2.5.1. The full commercial CPUE and survey tuning indices are presented in Table 5.1.2.5.2. Due to non-mandatory reporting of effort, commercial CPUE series are not considered reliable and are therefore not included in the assessment.

5.1.3 Catch at age analysis

Prior to the start of the working group, the whiting assessment had been defined as an update assessment, using the 2002 implementation of TSA (see section 1.4) with catch data from 1980 onwards, and no tuning data. However, due to large differences between the results of the update analysis and last year's assessment, the Working Group considered that additional analyses were required.

5.1.3.1 Exploration of data

At last year's working group it was also decided to truncate the catch data to start from 1980. This was because discard data prior to 1978 were estimated, and there was evidence of a regime shift around 1980. Here we therefore consider analyses using the catch data times series from 1980.

Exploratory analysis of survey data

Previous Working Groups have noted different trends in the signals from the IBTS Q1, ScoGFS, EngGFS and FraGFS survey indices. The 2002 assessment for whiting found that inclusion of survey indices did not make a significant difference to the outcome, so survey indices were not included in the 2002 final assessment.

Comparing trends in mean standardised catch at age (Figure 5.1.3.1.1) indicates an apparent change in catchability over all ages around 1992. There is a consistent downwards trend in most age groups in the 1990s, but the trends in recent years are not consistent over age. The proportions of age 6+ in the catches are very low.

Trends in survey indices agree relatively well in ages 3, 4 and 5 (Figure 5.1.3.1.1) The high 1988 year class is picked up by the surveys from age 1, and also by the catch from age 2.

SURBA (see section 1.4) runs were fitted to ScoGFS, EngGFS and IBTS Q1 surveys, using constant survey index to abundance ratio on all but age 1 for all surveys. A comparison of mean standardised SSB predictions from SURBA show different trends (Figure 5.1.3.1.2). The ScoGFS and EngGFS surveys indicate that the spawning stock has generally increased since the 1980s, and is now at a relatively high level compared to historical values, whereas the IBTS Q1 survey indicates that the stock is at a relatively low level. Relative trends in SSB for the past five years agree well indicating an increase, followed by a decrease in the last three years.

Time series Analysis (TSA)

The settings for the TSA update assessment are those used last year and are given in Tables 5.13.1.1 and 5.1.3.1.2. Parameter estimates for this analysis are very similar to last year's (Table 5.1.3.1.2), the main difference being an increase in σ_F, indicating larger transitory changes in F from year to year, and also an increase in the gradient at the origin in the Ricker recruitment curve (α in Table 5.1.3.1.2). Diagnostics for the update assessment were also similar to those for last year's assessment, and are given in the stock files. The trends in catch, SSB, mean F and recruitment from for this analysis lead to a substantial change in perception of the state of the stock compared to last year's assessment (Figure 5.1.3.1.3).

The retrospective plots for the last 10 years show high retrospective variance and positive bias in the last 3 years (Figure 5.1.3.1.4). TSA analyses were also carried using the same settings as above but including ScoGFS, EngGFS and IBTS Q1 survey indices separately, and then combined. In order to fit the model to all the survey indices, the parameter corresponding to persistent changes in discrepancy between the catch and the survey index was unusually large for the ScoGFS survey, a symptom of the mismatch between the trends in surveys and catch. The stock trends from these analyses are shown in Figure 5.1.3.1.5 . They do not show consistent trends. The output from these runs is included in the stock files.

Extended Survivors Analysis (XSA)

Given the discrepancy between last year's assessment and this year's TSA predictions, the Working Group also considered XSA analyses since, unlike TSA, XSA does not assume separability of F. Exploratory fits of XSA runs were used to determine the choice of power model at the youngest ages, the catchability plateau constraint and the range of ages and years used for shrinkage. Retrospective analyses were used to determine an appropriate value for the weight given to shrinkage. A tricubic taper with a range of 15 years was used to downweight historic information. All ages were fitted with catchability independent of population abundance and catchability was held constant at ages 4 and over. Since the survey data is available only to age 6, the mean F range was set as 2-4. However, ages 6+ account for only a small proportion of the catch (Figure 5.1.3.1.1).

A base case run with the above settings, including the ScoGFS, EngGFS and IBTS Q1 survey indices and catch data from 1980 onwards. The settings for this run are specified in Table 5.1.3.1.3. For this and subsequent runs, the EngGFS series was truncated to 1992–2002, since the gear used on that survey changed in 1992 (see Section 3). Log catchability residuals for this run and runs indicate the model fits well (Figure 5.1.3.1.6), although XSA has similar problems as TSA fitting the ScoGFS survey data. Log catchability residuals for the single fleet runs (Figure 5.1.3.1.7) show the same trends as in the XSA base case run (Figure 5.1.3.1.6). SURBA estimated SSB (Figure 5.1.3.1.2) shows that the ScoGFS series predicts the steepest incline of SSB between the three surveys over recent time. This signal explains the strong trend in the ScoGFS residuals from all presented XSA runs. F-shrinkage weights are low for all ages (Figure 5.1.3.1.8). The base case XSA run has a retrospective positive bias but low variability (Figure 5.1.3.9).

Single fleet XSA runs were also carried out using ScoGFS, EngGFS and IBTS Q1 survey indices. The trends in catch, SSB, mean F and recruitment from all of these analyses agree well (Figure 5.1.3.1.10). The trends from last year's assessment and this year's TSA update analysis are also included (except for mean F, which has a different range) and it can be seen that the update TSA analysis deviates substantially from the other analyses. A TSA run was also performed with all surveys included. This gives a similar result to the XSA base case run, and encapsulates assessment uncertainty. The least consistent result is from the updated TSA (no surveys included). A figure of SSB against F is presented in Figure 5.1.3.1.11.

F(2-6) cannot be estimated for the base case XSA run. Therefore TSA estimates of F(2-4) and F(2-6) were calculated using the TSA run including ScoGFS, EngGFS and IBTS Q1 surveys (for consistency with base XSA run). These show similar trends (Figure 5.1.3.1.12), however, F(2-4) has decreased less rapidly than F(2-6) in recent years.

Conclusion

The Working Group decided to accept the base case XSA run including surveys ScoGFS, EngGFS and IBTS Q1, with shrinkage of 0.5, catchability independent of abundance for all ages, and constant at ages 4 and over, and tricubic tapering over 15 year as the final assessment.

Salient points of the Working Group discussion were as follows:

- Whiting catch-at-age data are thought to be unreliable and therefore including surveys should, in principle, improve the assessment.
- General trends indicated by the survey indices of SSB are different over the whole time series, but trends over the past 5 years agree well.
- The 2002 Working Group excluded survey data from the assessment on the grounds that they made no statistical significant difference to the assessment. The same reasoning could have been used to include survey data. If such a decision had been made, the update TSA assessment would not have resulted in a change in perception of stock. The Working Group therefore decided to include survey indices in the assessment.
- Model predictions from TSA and XSA runs including all surveys were very similar. Model predictions from different XSA runs (single fleet and using all fleets) were relatively consistent whereas those from different TSA runs were less consistent.
- The TSA retrospectives were highly variable, which indicates that the apparent large decrease in SSB predicted by the TSA model this year could be substantially revised upwards next year. However, although a consistent positive bias in the estimation of SSB was apparent in the XSA retrospectives, they showed little retrospective variability. This indicates that whilst the XSA assessment might be overestimating SSB, the magnitude of the annual changes do not substantially change the perception of the recent stock dynamics.
- XSA does not assume separability in F and so does not restrict F-at-age patterns over age and through time. This could provide extra flexibility.
- The Working Group selected XSA for the final assessment, given the reasons indicated above. However, the WG recognized that there is substantial uncertainty in the choice for the most appropriate assessment model for this stock.

5.1.3.2 Final Assessment

Prior to the start of the working group, the whiting assessment had been defined as an update assessment. However, using this run as the final assessment would result in a substantial change in perception of the state of the stock in the last few years compared to the perception last year. Further analyses, described in section 5.1.3.1, were therefore carried out, which led to the acceptance of the XSA specified in Table 5.1.3.1.3 as the final assessment this year. This results in a revision of the mean F range from 2-6 to 2-4.

Results of the analysis are presented in Table 5.1.3.2.1 (diagnostics), 5.1.3.2.2 (fishing mortality at age), 5.1.3.2.3 (population numbers at age), and 5.1.3.2.4 (stock summary). The stock summary is also shown in figure 5.1.3.2.1 and the historical performance of the assessment is shown in figure 5.1.3.2.2. Note that the mean F trajectories for this year's assessment are of F(2-4), not F(2-6) as in the past.

5.1.4 Recruitment estimates

Recruitment estimates for 2003 to 2005 were calculated using a geometric mean over the period 1993 - 2002. RCT3 was run using input data given in Table 5.1.4.1. The RCT3 estimates consisted of >97% shrinkage (output is presented in Table 5.1.4.2). Recruitment has been relatively stable for the period 1990 – 2002 (Figure 5.1.3.2.1), and therefore a geometric mean was considered more favourable.

Therefore the recruitment estimate for 2002 to 2005 was taken to be 1.460 billion..

5.1.5 Short term forecasts

A short term forecast was carried out based on the XSA final assessment. The input is presented in Table 5.1.5.1. Results are presented in Tables 5.1.5.2 and 5.1.5.3, and Figures 5.1.5.1 – 5.1.5.3.

Several technical measures have been implemented for the mixed demersal fishery in the North Sea, as highlighted in Section 4.1.2. These consist of mesh-size changes and days-at-sea regulations. There have also been a significant number of vessels decommissioned in 2002 and 2003. These measures will have affected the exploitation pattern of the fishery, particularly for whiting. Owing to the method of F_{sq} calculation (see Section 1.4.4), recent changes in exploitation will not be reflected in the short-term forecast. This issue was regrettably not addressed due to time constraints.

5.1.6 Comments

Quality of assessment

(a) The Working Group has used the XSA model for the final assessment of this stock in this year. Last year the TSA model was used. Whiting catch-at-age data are thought to be unreliable and therefore including surveys should, in principle, improv the assessment.General trends indicated by the survey indices of SSB are different over the whole time series, but trends over the past 5 years agree well. Model predictions from TSA and XSA runs including all surveys were very similar. Model predictions from different XSA runs (single fleet and using all fleets) were relatively consistent whereas those from different TSA runs were less consistent. The TSA retrospectives were highly variable, which indicates that the apparent large decrease in SSB predicted by the TSA model this year could be substantially revised upwards next year. However, although a consistent positive bias in the estimation of SSB was apparent in the XSA retrospectives, they showed less retrospective variability. XSA does not assume separability in F and so does not restrict F-at-age patterns over age and through time. This could provide extra flexibility. The Working Group selected XSA for the final assessment, given the reasons indicated above. However, the WG recognized that there is substantial uncertainty in the choice for the most appropriate assessment model for this stock.

(b) The historical patterns of stock size and recruitment resulting from this assessment are consistent with those observed in the 2002 assessment. The mean F range has been revised from 2-6 to 2-4, and a qualitative comparison using TSA output showed that trends were similar. F(2-4) trends estimated from the final assessment show a slight decrease from last year.

(c) 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. However the Scottish fleets now account for only about 50% of human consumption landings, and discarding from other fleets could be substantial. Data are also collected by other countries, but have not been made available to data collators.

Suggestions for consideration during benchmark assessment tabled for 2004

(a) Using the XSA model for the final assessment has resulted in a new age range for mean F because survey indices as used give information only to age 6. The effects of this change should be assessed in detail.

(b) 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. These time series need to be assessed in detail.

(c) The effects of a gear change in 1992 in the EngGFS survey were assessed by this Working Group and was found to have affected catchability in age 1 cod, resulting in the formation of two separate time series: EngGFS_GRT and EngGFS_GOV. It is reasonable to assume that the gear change might also affect whiting indices and this should be considered.

(d) A new index for recruitment from 1990 has been provided this year (WD3). Recruitment indices for whiting are very noisy and so new data is very valuable and should also be considered.

(e) A new version of TSA, which uses a different error structure and can also model discards and industrial by-catch, separately has been introduced (see section 1.4). A full exploration of this model should be carried out.

(f) Natural mortality estimates are available from a recent run of MSVPA (ICES, 2003), but these have not been used in this assessment. The maturity ogive is based on North Sea IBTS quarter 1 data, averaged over the period 1981–1985. These should both be addressed.

5.2 Whiting in Division IIIa

Total landings are shown in Table 5.2.1. No analytical assessment of this stock was possible.

Table 5.1.2.1.1 Nominal landings (in tonnes) of Whiting in Sub-area IV and Division VIId, as officially reported to ICES and as estimated by the WG.

Subarea IV

Country	1995	1996	1997	1998	1999	2000	2001	2002*	2003
Belgium	880	843	391	268	529	536	454	270	
Denmark	368	189	103	46	58	105	105	96	
Faroe Islands	21	-	6	1	1	-	-	-	
France	5,963	4,704	3,526	1,908*	4,292*1	2,527	3,455	3,310	
Germany, Fed.Rep.	124	187	196	103	176	424	402	354	
Netherlands	3,640	3,388	2,539	1,941	1,795	1,884	2,478(2)	2,425	
Norway	115	66	75	64	68	33	44	41*	
Poland	-	-	-	1	-	-	-		
Sweden	1	1	1	+	9	4	6	7	
UK (E.&W)3	2,477	2,329	2,638	2,909	2,268	1,782	1,301	1,322	
UK (Scotland)	27,811	23,409	22,098	16,696	17,206	17,158	10,589	7,756	
Total	41,400	35,116	31,573	23,937	26,402	24,453	18,834	15,581	
Unallocated landings	-348	1,006	-276	-71	-421	-409	578	269	
WG est. of H.Cons. landings	41,052	36,122	31,297	23,866	25,981	24,044	19,412	15,850	
WG est. of discards	30,264	28,181	17,217	12,708	23,584	22,360	16,488	17,319	
WG est. of Ind. By-catch	26,561	4,702	5,965	3,141	5,183	8,886	7,357	7,327	
WG est. of total catch	97,877	69,005	54,479	39,715	54,748	55,290	43,257	40,496	
TAC	*81,000*	*67,000*	*74,000*	*60,000*	*44,000*	*30,000*	*30,000*	*32,000*	*16,000*

* Preliminary
1 Includes Division IIa (EC).
2 Not included here are 68 t reported into an unknown area.
3 1989-1994 revised. N. Ireland included with England and Wales.

Division VIId

Country	1995	1996	1997	1998	1999	2000	2001	2002*	2003
Belgium	68	84	98	53	48	65	75	58	
France	5,202	4,771	4,532	4,495*	-	5,875	6,338	5,165	
Netherlands	-	1	1	32	6	14	67	19	
UK (E.&W)	280	199	147	185	135	118	134	112	
UK (Scotland)	1	1	1	+	-	-	-	-	
Total	5,551	5,056	4,779	4,765	189	6,072	6,614	5,354	
Unallocated	-161	-104	-156	-167	4,242	-1,775	-810	446	
W.G. estimate	5,390	4,952	4,623	4,598	4,431	4,297	5,804	5,800	

TAC for VIId is included in TAC for Sub-area VII (except Division VIIa).

* Preliminary.

Sub-area IV and Division VIId

Combined	1995	1996	1997	1998	1999	2000	2001	2002	2003
WG est. of total catch	26,400	4,598	5,809	2,974	9,425	7,111	6,547	7,773	

Table 5.1.2.1.2 Whiting in IV and VIId. Annual weight and numbers caught, years 1980–2002, ages 0–12+.

Year	Weight (thousand tonnes)				Numbers (millions)			
	Total	**H. cons.**	**Disc.**	**Ind. BC**	**Total**	**H. cons.**	**Disc.**	**Ind. BC**
1980	224	101	77	46	1456	340	471	645
1981	192	90	36	67	1439	296	214	929
1982	140	81	27	33	778	271	173	333
1983	161	88	50	24	1358	290	370	697
1984	146	86	41	19	909	285	327	297
1985	106	62	29	15	688	176	231	280
1986	162	64	80	18	1207	225	583	399
1987	139	68	54	16	946	245	416	285
1988	133	56	28	49	1395	212	231	952
1989	124	45	36	43	883	172	280	431
1990	153	47	56	51	1294	177	539	578
1991	125	53	34	38	1611	199	242	1170
1992	110	52	31	27	863	182	216	465
1993	116	53	43	20	1231	174	343	714
1994	93	49	33	10	702	162	235	304
1995	103	46	30	27	2020	147	214	1659
1996	74	41	28	5	448	143	177	128
1997	59	36	17	6	293	131	101	61
1998	44	28	13	3	290	110	83	97
1999	59	30	24	5	456	117	179	160
2000	61	29	23	9	311	114	142	55
2001	49	25	16	7	498	102	114	282
2002	46	22	17	7	377	76	95	205
Min	44	22	13	3	290	76	83	55
GM	103	50	32	17	802	176	227	345
AM	114	55	36	24	933	189	260	484
Max	224	101	80	67	2020	340	583	1659

Table 5.1.2.1.3 Whiting in VIId. Annual weight and numbers caught, year 1980–2002, ages 0–12+.

Year	**Weight (tonnes)**	**Numbers (thousands)**
1980	9167	35509
1981	8932	34279
1982	7911	32952
1983	6936	29470
1984	7373	33413
1985	7390	19561
1986	5498	21143
1987	4671	18208
1988	4428	17922
1989	4156	16869
1990	3483	13648
1991	5718	17884
1992	5745	19398
1993	5215	17842
1994	6625	24049
1995	5390	18492
1996	4952	22360
1997	4623	22556
1998	4598	23047
1999	4431	18867
2000	4297	22087
2001	5804	28560
2002	5800	19697
Min	3483	13648
GM	5607	22195
AM	5789	22948
Max	9167	35509

Table 5.1.2.2.1 Whiting in IV and VIId. Total catch numbers at age (thousands).

Age	1980	1981	1982	1983	1984	1985	1986	1987
1	265359	162899	192640	205646	323408	203321	576731	267051
2	416008	346343	114444	184746	175965	141716	167077	368229
3	286077	266517	245246	118412	124886	82037	169577	122748
4	90718	102295	88137	131508	49505	37847	46517	85240
5	52969	27776	26796	37231	59817	14420	13367	11392
6	10751	12297	6909	8688	13860	17445	3487	4556
7	1152	3540	2082	1780	2964	3328	3975	928
8+	767	326	484	930	613	904	569	1035

Age	1988	1989	1990	1991	1992	1993	1994	1995
1	430344	331672	253745	128507	239792	217539	163609	137481
2	307429	173676	505010	191193	165354	167577	147177	139010
3	179502	191942	129126	187195	89563	124287	90611	111489
4	39635	78464	86324	36830	93636	46543	47533	35728
5	17901	14367	32270	26209	11967	46136	17384	15161
6	2175	5050	2003	5519	6878	3946	17264	5159
7	544	516	735	542	2609	1519	998	4515
8+	168	334	112	273	117	771	460	474

Age	1996	1997	1998	1999	2000	2001	2002
1	72645	53408	71430	178079	66789	84121	49725
2	113956	74200	44697	91355	124365	86178	60926
3	98476	82944	42771	45627	63526	58908	82553
4	48575	42154	36459	34175	23888	20559	33818
5	14235	18492	17756	18528	16232	9177	7893
6	4695	3358	6392	7547	8791	4814	2026
7	1294	1020	1426	2049	4322	2232	1439
8+	1113	460	407	676	1265	1268	751

Table 5.1.2.2.2 Whiting in IV and VIId. Human consumption landings numbers at age (thousands).

Age	1980	1981	1982	1983	1984	1985	1986	1987
1	3656	4240	10890	10568	14388	2288	12879	11074
2	62405	69211	46703	68640	62693	51194	44500	72372
3	152570	104348	124656	67312	99204	57049	111527	70504
4	68422	78253	59393	101342	41277	32340	37287	73742
5	41430	23698	21376	31266	51745	12974	11285	10808
6	9911	12036	5664	8330	12735	16361	3379	4506
7	1135	3530	2058	1730	2813	3238	3912	928
8+	767	326	484	921	613	904	557	1004

Age	1988	1989	1990	1991	1992	1993	1994	1995
1	7462	8636	6949	11610	9603	5980	17126	8832
2	61360	28406	54361	43110	45154	29305	31660	28132
3	94163	77009	45423	91129	48838	64353	46217	58538
4	29147	44307	50603	26169	60806	33514	36814	28013
5	16556	9249	17747	21697	9956	34651	14169	13767
6	2158	3888	1407	4687	6223	2989	14706	4953
7	544	420	622	405	1496	1361	928	4401
8+	164	249	110	273	110	771	446	467

Age	1996	1997	1998	1999	2000	2001	2002
1	12516	6522	17081	16689	15406	12257	2607
2	26768	23543	19894	26966	31989	28499	10351
3	47593	48237	25016	25863	28500	27332	30901
4	36288	31904	24713	23792	14327	17518	22154
5	12023	15824	14717	14708	11841	8640	6599
6	4453	2957	5446	6660	6657	4506	1696
7	1116	1017	1213	1882	3774	2092	1311
8+	1113	443	301	591	1159	1249	635

Table 5.1.2.2.3 Whiting in IV and VIId. Discard numbers at age (thousands).

Age	1980	1981	1982	1983	1984	1985	1986	1987
1	103203	50407	53753	152488	200589	154232	404604	158531
2	250735	96509	26922	85318	82563	48791	120492	202154
3	88399	57403	52349	33325	16815	15117	43479	34824
4	14135	7313	18230	23442	4437	2985	5242	9776
5	10795	1285	2972	4309	4495	761	627	582
6	786	149	343	295	1034	801	108	49
7	0	10	22	25	151	65	63	0
8+	0	0	0	9	0	0	12	31

Age	1988	1989	1990	1991	1992	1993	1994	1995
1	65021	150598	79488	76938	98967	124426	77783	46209
2	87197	36712	245129	77383	57629	101119	97847	77320
3	51135	61442	33194	74005	26527	49064	36762	48601
4	5877	21267	23488	4900	22976	8992	9528	6943
5	846	3276	12012	1828	1199	10709	2856	1318
6	17	103	253	89	350	519	2337	205
7	0	8	87	60	1064	131	7	113
8+	3	12	0	0	2	0	0	6

Age	1996	1997	1998	1999	2000	2001	2002
1	30480	19347	29979	84613	33848	27570	8538
2	82020	28837	18755	51740	75869	44645	31639
3	48240	30616	16361	14422	23590	21930	43013
4	11319	9175	10992	8844	2898	2528	9478
5	2192	2392	2976	3077	2257	385	1089
6	240	399	935	857	1548	268	208
7	179	2	213	166	474	140	129
8+	0	17	106	85	107	19	116

Table 5.1.2.2.4 Whiting in IV and VIId. Industrial bycatch numbers at age (thousands).

Age	1980	1981	1982	1983	1984	1985	1986	1987
1	158500	108252	127998	42591	108431	46801	159249	97446
2	102869	180623	40818	30789	30709	41731	2086	93704
3	45108	104767	68242	17775	8868	9871	14572	17420
4	8162	16729	10514	6723	3790	2522	3987	1722
5	744	2793	2448	1656	3577	685	1456	2
6	55	112	902	63	91	284	0	0
7	18	0	2	25	0	26	0	0
8+	0	0	0	0	0	0	0	0

Age	1988	1989	1990	1991	1992	1993	1994	1995
1	357861	172438	167308	39959	131221	87133	68701	82439
2	158872	108558	205521	70701	62571	37153	17670	33558
3	34205	53491	50508	22062	14198	10870	7632	4351
4	4611	12890	12233	5761	9855	4037	1192	772
5	500	1842	2511	2684	812	776	359	76
6	0	1060	342	743	305	437	222	0
7	0	89	26	78	49	27	64	0
8+	0	72	2	0	6	0	14	0

Age	1996	1997	1998	1999	2000	2001	2002
1	29648	27539	24370	76777	17535	44294	38580
2	5168	21820	6047	12649	16508	13034	18937
3	2643	4091	1395	5342	11436	9646	8638
4	968	1075	754	1539	6663	513	2186
5	21	276	63	743	2134	152	205
6	2	2	12	30	586	40	121
7	0	0	0	0	74	0	0
8+	0	0	0	0	0	0	0

Table 5.1.2.3.1 Whiting in IV and VIId. Total catch mean weights at age (kg).

Age	1980	1981	1982	1983	1984	1985	1986	1987
1	0.075	0.083	0.061	0.107	0.089	0.094	0.105	0.077
2	0.176	0.168	0.184	0.191	0.188	0.192	0.183	0.148
3	0.252	0.242	0.253	0.273	0.271	0.284	0.255	0.247
4	0.328	0.321	0.314	0.325	0.337	0.332	0.318	0.297
5	0.337	0.379	0.376	0.384	0.382	0.402	0.378	0.375
6	0.458	0.411	0.478	0.426	0.391	0.435	0.475	0.379
7	0.458	0.444	0.504	0.452	0.463	0.494	0.468	0.542
8+	0.572	0.72	0.735	0.537	0.567	0.439	0.625	0.584

Age	1988	1989	1990	1991	1992	1993	1994	1995
1	0.054	0.07	0.083	0.103	0.082	0.073	0.08	0.087
2	0.146	0.157	0.137	0.169	0.185	0.175	0.17	0.181
3	0.223	0.225	0.209	0.218	0.257	0.252	0.254	0.258
4	0.301	0.267	0.25	0.29	0.277	0.319	0.323	0.341
5	0.346	0.318	0.279	0.307	0.332	0.329	0.371	0.385
6	0.423	0.391	0.408	0.338	0.346	0.349	0.367	0.43
7	0.506	0.431	0.49	0.365	0.314	0.403	0.414	0.434
8+	0.694	0.394	0.599	0.401	0.503	0.381	0.416	0.42

Age	1996	1997	1998	1999	2000	2001	2002
1	0.093	0.091	0.091	0.076	0.113	0.072	0.066
2	0.167	0.178	0.18	0.174	0.182	0.191	0.156
3	0.236	0.243	0.236	0.233	0.238	0.227	0.222
4	0.302	0.295	0.281	0.256	0.288	0.283	0.281
5	0.387	0.333	0.314	0.289	0.287	0.270	0.314
6	0.406	0.381	0.339	0.303	0.277	0.300	0.361
7	0.428	0.381	0.33	0.309	0.277	0.287	0.359
8+	0.43	0.418	0.367	0.287	0.273	0.294	0.350

Table 5.1.2.3.2 Whiting in IV and VIId. Human consumption landings mean weights at age (kg).

Age	1980	1981	1982	1983	1984	1985	1986	1987
1	0.2038	0.1942	0.1863	0.1990	0.1942	0.1870	0.1886	0.1885
2	0.2391	0.2420	0.2304	0.2396	0.2310	0.2475	0.2297	0.2256
3	0.2733	0.2915	0.2818	0.2825	0.2788	0.3069	0.2788	0.2856
4	0.3351	0.3308	0.3398	0.3317	0.3459	0.3370	0.3271	0.3096
5	0.3580	0.3776	0.3961	0.3829	0.3912	0.4081	0.3760	0.3811
6	0.4733	0.4114	0.4606	0.4290	0.4035	0.4428	0.4837	0.3808
7	0.4566	0.4449	0.5066	0.4522	0.4725	0.4983	0.4725	0.5422
8+	0.5718	0.7198	0.7355	0.5384	0.5674	0.4385	0.6323	0.5928

Age	1988	1989	1990	1991	1992	1993	1994	1995
1	0.1941	0.1783	0.2013	0.2040	0.1954	0.1952	0.1836	0.1718
2	0.2262	0.2260	0.2198	0.2496	0.2479	0.2509	0.2497	0.2554
3	0.2559	0.2528	0.2600	0.2518	0.2903	0.2866	0.2974	0.2981
4	0.3276	0.2878	0.2921	0.3086	0.3068	0.3476	0.3454	0.3670
5	0.3515	0.3448	0.3349	0.3182	0.3425	0.3591	0.3927	0.3977
6	0.4248	0.3700	0.4493	0.3493	0.3577	0.3877	0.3823	0.4373
7	0.5064	0.4397	0.5225	0.3878	0.3828	0.4218	0.4128	0.4369
8+	0.7017	0.4050	0.6012	0.4013	0.5027	0.3804	0.4117	0.4217

Age	1996	1997	1998	1999	2000	2001	2002
1	0.1700	0.1715	0.1642	0.1840	0.1659	0.1600	0.1985
2	0.2220	0.2067	0.2090	0.2365	0.2264	0.2168	0.2226
3	0.2743	0.2607	0.2592	0.2702	0.2714	0.2682	0.2688
4	0.3280	0.3140	0.3041	0.2801	0.3001	0.2857	0.3046
5	0.4067	0.3476	0.3299	0.3024	0.2924	0.2692	0.3257
6	0.4133	0.3977	0.3596	0.3139	0.3153	0.3033	0.3768
7	0.4484	0.3807	0.3444	0.3175	0.2781	0.2909	0.3675
8+	0.4302	0.4205	0.4237	0.2951	0.2737	0.2944	0.3497

Table 5.1.2.3.3 Whiting in IV and VIId. Discard mean weights at age (kg).

Age	1980	1981	1982	1983	1984	1985	1986	1987
1	0.1070	0.1310	0.0910	0.1140	0.1010	0.1050	0.1230	0.0900
2	0.1660	0.1640	0.1820	0.1670	0.1620	0.1690	0.1660	0.1490
3	0.2020	0.1970	0.2110	0.2350	0.2160	0.2130	0.1900	0.2060
4	0.2440	0.2300	0.2250	0.2640	0.2460	0.2380	0.2080	0.2050
5	0.2530	0.2890	0.2410	0.2900	0.2650	0.2420	0.2270	0.2630
6	0.2640	0.2520	0.2440	0.3170	0.2480	0.2530	0.1940	0.2570
7	0.0000	0.2680	0.2610	0.2770	0.2780	0.2550	0.2170	0.0000
8+	0.0000	0.0000	0.0000	0.3650	0.0000	0.0000	0.3110	0.2920

Age	1988	1989	1990	1991	1992	1993	1994	1995
1	0.0630	0.0830	0.0950	0.0890	0.0930	0.0870	0.0900	0.1020
2	0.1460	0.1640	0.1300	0.1540	0.1730	0.1600	0.1510	0.1630
3	0.1810	0.1910	0.1830	0.1770	0.2100	0.2050	0.2030	0.2040
4	0.2100	0.2130	0.1860	0.2130	0.2150	0.2370	0.2300	0.2330
5	0.2190	0.2270	0.1960	0.2300	0.2410	0.2350	0.2440	0.2470
6	0.2350	0.2410	0.2490	0.2530	0.2450	0.2250	0.2540	0.2470
7	0.0000	0.3510	0.3020	0.2680	0.2200	0.2130	0.3320	0.3320
8+	0.2840	0.2210	0.0000	0.0000	1.1830	0.0000	0.0000	0.2900

Age	1996	1997	1998	1999	2000	2001	2002
1	0.0940	0.1250	0.0860	0.1000	0.1272	0.0844	0.1292
2	0.1510	0.1810	0.1730	0.1660	0.1669	0.1828	0.1662
3	0.1980	0.2130	0.2040	0.1970	0.1946	0.2169	0.1958
4	0.2250	0.2250	0.2280	0.2010	0.2262	0.2591	0.2240
5	0.2810	0.2330	0.2340	0.2250	0.2086	0.2482	0.2242
6	0.2650	0.2560	0.2240	0.2310	0.2191	0.2398	0.2249
7	0.3040	0.6170	0.2470	0.2120	0.2223	0.2249	0.2724
8+	0.0000	0.3523	0.2063	0.2266	0.2640	0.2425	0.3520

Table 5.1.2.3.4 Whiting in IV and VIId. Industrial bycatch mean weights at age (kg).

Age	1980	1981	1982	1983	1984	1985	1986	1987
1	0.0510	0.0560	0.0380	0.0580	0.0530	0.0540	0.0540	0.0430
2	0.1640	0.1410	0.1330	0.1480	0.1730	0.1500	0.1500	0.0850
3	0.2810	0.2180	0.2320	0.3110	0.2890	0.2630	0.2620	0.1730
4	0.4120	0.3180	0.3200	0.4310	0.3430	0.3820	0.3810	0.2620
5	0.3800	0.4330	0.3660	0.6510	0.3900	0.4540	0.4550	0.4000
6	0.3890	0.5960	0.6740	0.5650	0.2280	0.5040	0.5000	0.5000
7	0.5610	0.6000	0.2840	0.6020	0.6000	0.5840	0.6000	0.6000
8+	1.0000	0.8000	0.8400	0.8023	0.8959	0.8091	0.8000	0.8216

Age	1988	1989	1990	1991	1992	1993	1994	1995
1	0.0500	0.0530	0.0730	0.1010	0.0660	0.0440	0.0420	0.0690
2	0.1150	0.1370	0.1230	0.1360	0.1500	0.1550	0.1320	0.1590
3	0.1970	0.2240	0.1810	0.2130	0.2280	0.2590	0.2420	0.3100
4	0.2450	0.2850	0.1990	0.2690	0.2420	0.2640	0.3740	0.3730
5	0.3800	0.3440	0.2800	0.2650	0.3350	0.3080	0.5210	0.5110
6	0.5000	0.4820	0.3550	0.2790	0.2190	0.2350	0.5550	0.0000
7	0.6000	0.3960	0.3350	0.3220	0.2550	0.3920	0.4400	0.0000
8+	0.8000	0.3854	0.4730	0.0000	0.2820	0.0000	0.5550	0.0000

Age	1996	1997	1998	1999	2000	2001	2002
1	0.0590	0.0480	0.0450	0.0270	0.0410	0.0402	0.0437
2	0.1430	0.1440	0.1050	0.0770	0.1640	0.1643	0.1010
3	0.2350	0.2500	0.2000	0.1460	0.2420	0.1323	0.1844
4	0.2330	0.3210	0.3040	0.1960	0.2890	0.3200	0.2933
5	0.3470	0.3480	0.2860	0.2860	0.3390	0.3510	0.4150
6	0.2500	0.5880	0.0000	0.0000	0.0000	0.3860	0.3800
7	0.0000	0.0000	0.0000	0.0000	0.5880	0.0000	0.0000
8+	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Table 5.1.2.4.1 Whiting in IV and VIId. Natural mortality and proportion mature by age.

Age	Natural mortality	Maturity
1	0.95	0.11
2	0.45	0.92
3	0.35	1.00
4	0.30	1.00
5	0.25	1.00
6	0.25	1.00
7	0.20	1.00
8+	0.20	1.00

Table 5.1.2.5.1 Whiting in IV and VIId. Summary of available tuning series.

Country	Fleet	Code	Year range	Age Range
Scotland	Groundfish survey	SCOGFS	1982–2003	0-6
	Seiners	SCOSEI	1978–2002	0–10
	Light trawlers	SCOLTR	1978–2002	0–10
England	Groundfish survey	ENGGFS	1977–2002	0-6
France	Trawlers	FRATRB	1978–2002	1–9
		FRATRO_IV	1986–2002	0-8
		FRATRO-7d	1986-2002	1-7
		FRAGFS-7d	1988–2002	0-3
International	Groundfish survey[1]	IBTS_QI	1967–2003	1-6
	Q II survey[2]	IBTS_Q2_SCO	1991–1997	1-6
	Q IV survey[3]	IBTS_Q4-ENG	1991–1996	0-7

[1]Formerly IYFS.
[2] Scottish sub-set of IBTS data – discontinued in 1997.
[3] English sub-set of IBTS data – discontinued in 1996.

Table 5.1.2.5.2 Whiting in IV and VIId. Complete available tuning series (not all are used in the assessment)

SCOSEI_IV											
1978	2002										
1	1	0	1								
0	10										
325246	5345.92	14993.60	29307.94	43710.81	15390.20	1057.94	1408.92	200.99	36.00	0.00	7.00
316419	302.00	90749.85	41091.74	28124.23	14745.01	6083.68	676.92	155.75	3.00	0.00	0.00
297227	668.98	27032.33	73704.44	37657.65	11914.98	9367.98	2556.00	260.00	229.00	27.00	7.00
289672	93.00	8726.79	22243.64	25047.81	10551.99	2402.00	2084.00	374.00	41.00	4.00	1.00
297730	43.00	3720.99	7032.00	26194.14	13117.11	2713.03	539.01	277.00	81.00	5.00	0.00
333168	572.01	11565.39	14957.38	21690.02	34199.11	9830.62	2154.56	406.80	157.78	16.26	0.00
388035	296.72	4922.50	24015.61	20669.76	14985.59	21269.32	4715.24	959.96	87.28	49.59	6.94
381647	773.22	20067.84	20263.32	19695.99	8956.38	4795.86	8013.08	1362.79	333.95	17.89	5.96
425017	137.76	139498.17	48705.18	34509.26	11340.96	2624.40	1097.50	1771.08	215.94	7.27	0.00
418536	1358.85	13793.33	52715.14	38938.77	18440.26	3637.71	1096.91	297.74	348.42	15.88	3.97
377132	26.01	2502.07	28446.11	44869.26	12631.40	4071.61	678.72	63.97	20.99	16.99	2.00
355735	10.13	6878.80	15704.13	41407.43	23710.40	4769.04	1323.23	112.08	43.04	10.72	0.71
252732	184.88	14229.83	124635.82	27694.11	29920.98	14767.80	720.82	206.52	23.23	0.02	0.00
336675	886.65	11951.95	44964.26	63414.28	10436.10	8730.12	1742.93	195.19	93.63	0.00	0.25
300217	426.21	16613.69	19452.01	21217.15	27961.87	2804.54	1958.07	564.87	32.42	3.39	0.00
268413	599.77	9563.69	31623.36	26012.82	12457.88	14446.11	899.25	332.18	153.13	7.51	8.25
264738	82.71	9235.94	21451.65	22570.72	11778.49	5530.94	5611.98	203.91	115.77	14.69	0.00
204545	26.01	8287.88	22152.73	30006.96	9018.67	3874.63	1373.44	1270.02	86.01	14.99	18.13
177092	223.90	5732.24	26020.51	21430.22	10505.52	3483.37	1031.27	295.71	289.16	28.12	1.00
166817	175.60	6627.68	8974.45	16231.23	9922.01	4445.23	575.33	109.85	61.63	37.34	2.35
150361	14.45	3710.69	4694.83	6806.23	6840.32	3669.55	1417.13	243.74	12.81	1.89	12.27
93796	663.34	13384.17	13750.43	7009.42	6068.11	3461.79	1684.05	409.19	77.42	3.15	0.00
69505	2.79	5176.09	11207.84	6458.23	2111.81	1971.96	835.64	297.65	89.60	6.92	0.04
36135	929.75	606.97	6352.27	5592.05	1715.36	485.81	352.94	145.84	65.57	10.54	0.00
21817	1.94	934.97	3156.82	7464.64	2153.75	357.68	138.15	78.65	22.03	5.97	0
SCOLTR_IV											
1978	2002										
1	1	0	1								
0	10										
236944	7158.39	8785.46	19909.95	30722.31	14472.60	956.04	1612.07	635.03	72.00	6.00	0.00
287494	368.00	171147.28	42910.40	23154.59	17995.66	4057.93	376.99	286.00	57.00	5.00	0.00
333197	869.00	20805.96	58381.99	38436.16	9525.06	9430.05	1864.01	144.00	145.00	3.00	0.00
251504	170.99	6576.46	19069.21	21549.75	9706.15	1777.02	1455.03	310.01	9.00	1.00	0.00
250870	6390.16	5214.10	8196.98	26680.54	12944.74	3333.92	646.98	338.99	74.00	16.00	3.00
244349	20191.06	37495.68	17925.87	12535.31	19234.31	6123.52	1216.61	182.80	140.85	25.97	1.00
240775	2553.17	38266.77	16048.09	10784.18	6306.82	9018.98	2371.19	478.59	13.13	30.29	5.05
267393	1221.65	28760.94	9368.37	7616.93	3085.79	1333.19	2901.19	443.13	173.09	13.85	0.00
279727	796.71	8138.43	8571.90	9577.94	4108.82	767.44	425.28	608.60	51.64	2.03	0.00
351131	599.52	18761.18	25933.34	16160.77	5954.48	1182.95	388.46	116.04	128.99	3.93	0.00
391988	60.00	2397.96	15778.77	22525.54	5127.73	1640.63	207.22	31.03	15.02	6.01	6.01
405883	491.80	20318.75	10051.62	21389.72	10836.81	2394.09	448.22	33.08	54.36	2.39	0.61
371493	371.48	3676.88	35321.99	7664.57	8960.09	3423.01	159.54	39.94	5.34	0.07	0.00
408056	688.42	8726.88	11908.03	22145.62	3192.25	2906.40	628.63	49.90	40.87	0.45	0.25
473955	1379.23	17580.58	14551.32	11822.72	15417.66	1500.40	1160.44	304.40	12.75	0.34	0.66
447064	614.45	16438.91	20513.15	14385.55	6590.76	10105.47	574.20	203.58	97.35	24.36	4.59
480400	1259.30	4132.65	15771.00	13004.65	6453.76	2710.23	2997.31	171.83	83.94	13.86	0.00
442010	208.07	9248.04	15886.83	19322.30	6261.60	2982.51	1092.21	1131.71	88.83	3.48	14.19
445995	188.32	6661.92	12461.08	13523.11	9223.33	3012.11	860.73	281.91	242.80	8.93	0.54
479449	100.18	2557.22	6767.92	15603.23	9463.72	4535.19	628.02	181.35	51.94	30.82	0.31
427868	39.44	5096.42	5350.24	8058.40	9506.50	4311.78	1728.79	275.71	57.74	12.20	2.67
329750	1274.23	26518.76	20672.07	9295.36	6705.67	4079.53	2051.46	487.24	40.79	7.35	0.10
280938	1.15	8384.66	16220.42	9287.05	3788.38	2621.24	1469.79	601.84	79.39	7.11	0.17
245489	2221.71	1303.16	11409.11	10419.00	3287.13	745.34	430.51	247.31	65.76	26.77	0.00
184096	5.78	979.79	4680.38	11083.12	3591.95	780.46	234.59	183.36	66.81	12.9	0

Table 5.1.2.5.2 contd. Whiting in IV and VIId. Complete available tuning series.

FRATRB_IV

1978	2001								
1	1	0	1						
1	9								
69739	1153.00	10312.00	14789.00	8544.00	807.00	1091.00	227.00	34.00	4.00
89974	698.00	12272.00	14379.00	10884.00	3789.00	394.00	315.00	45.00	14.00
63577	90.00	5388.00	11298.00	4605.00	4051.00	1004.00	78.00	71.00	10.00
76517	144.00	6591.00	13139.00	8196.00	2090.00	1644.00	314.00	16.00	10.00
78523	173.00	1643.00	16561.00	11241.00	3948.00	1035.00	539.00	119.00	14.00
69720	500.00	4407.00	8188.00	16698.00	5541.00	1061.00	228.00	126.00	19.00
76149	317.00	4281.00	7465.00	4576.00	5999.00	1596.00	308.00	32.00	26.00
25915	314.55	3653.12	2942.09	1225.28	565.55	598.65	117.27	12.32	4.23
28611	890.57	3830.33	3990.71	1202.06	368.64	93.79	160.46	22.28	1.28
28692	431.03	4822.77	3667.48	2151.59	496.97	166.11	47.91	45.81	3.04
25208	150.44	2717.69	4815.08	1124.87	529.69	100.13	31.08	3.11	4.17
25184	447.52	2064.11	4351.49	1877.20	313.54	106.16	9.86	3.52	0.78
21758	163.76	3793.84	2123.86	2009.65	619.55	55.06	13.45	1.07	0.14
19840	292.26	2224.03	3828.93	818.81	657.22	137.59	15.33	3.49	0.08
15656	365.35	1597.81	1685.80	2204.15	248.32	195.02	43.88	2.82	0.06
19076	172.98	1224.59	2633.02	1141.30	1233.36	96.75	37.16	13.84	4.10
17315	107.74	1805.61	1720.52	1466.30	412.54	429.99	29.43	8.24	1.34
17794	114.32	1022.59	3304.45	1536.77	1162.94	240.08	211.60	13.83	6.66
18883	20.89	655.48	1594.39	1438.24	482.20	199.09	37.91	29.82	10.03
15574	39.68	356.96	1406.89	1138.71	606.01	85.94	15.86	9.70	2.25
14949	31.88	125.79	316.62	326.18	191.97	62.83	7.94	2.31	1.19
-9	95.73	489.82	489.30	683.82	451.53	239.35	58.67	13.88	1.21
11747	47.25	1148.44	2968.16	1204.67	319.60	298.20	124.42	53.59	5.27
6771	297.73	648.68	528.07	149.80	36.49	35.62	13.53	6.28	2.11

FRATRO_IV

1986	2001								
1	1	0	1						
0	8								
56099	19.48	1541.94	1891.94	7145.98	3782.82	599.91	157.52	39.03	2.14
71765	12.20	2507.72	4984.96	1271.29	5713.14	412.56	257.90	91.79	69.82
84052	0.31	2536.92	8981.89	3222.83	704.34	1320.59	122.85	55.31	0.54
88397	26.94	2958.16	3739.55	5628.95	1654.27	208.58	280.47	47.27	10.86
71750	37.70	3209.61	6169.85	3780.85	2456.12	365.14	28.65	43.61	1.65
67836	323.02	4464.91	6083.87	2864.37	1412.45	776.93	84.61	5.78	2.53
51340	355.02	3426.92	6498.04	1939.69	635.38	358.08	96.22	4.78	0.12
62553	937.84	3950.46	4586.36	4306.75	877.04	289.87	68.31	39.73	6.21
51241	86.53	7005.88	3298.43	1190.63	612.13	108.28	11.05	8.38	0.98
57823	262.76	6331.03	6125.08	2673.85	543.82	98.58	19.19	0.03	1.79
50163	577.46	5522.73	4742.85	3214.22	890.19	155.83	7.73	12.12	0.03
48904	266.77	1961.14	4676.60	3929.12	1020.11	220.78	18.01	3.07	0.02
38103	566.68	4893.44	1959.25	532.61	161.28	68.00	35.86	0.39	1.55
-9	51.18	7651.96	2885.69	1452.71	960.37	500.08	133.31	45.54	30.71
30082	129.16	7366.57	8191.31	2452.95	1056.07	737.31	454.67	345.11	94.79
50846	3357.15	10766.56	15475.91	6922.60	3226.67	1700.58	637.70	344.65	127.90

Table 5.1.2.5.2 contd. Whiting in IV and VIId. Complete available tuning series.

SCOGFS_IV

1982	2003						
1	1	0.5	0.75				
0	6						
100	102.00	653.00	971.00	972.00	224.00	60.00	16.00
100	210.00	563.00	578.00	407.00	511.00	116.00	17.00
100	442.00	1048.00	371.00	170.00	77.00	92.00	18.00
100	169.00	1577.00	973.00	247.00	63.00	36.00	18.00
100	406.00	1111.00	452.00	224.00	27.00	5.00	5.00
100	120.00	1405.00	1150.00	208.00	77.00	16.00	3.00
100	642.00	967.00	1606.00	452.00	70.00	19.00	2.00
100	427.00	4043.00	741.00	733.00	157.00	13.00	6.00
100	1943.00	2239.00	2053.00	248.00	255.00	47.00	5.00
100	1379.00	1769.00	950.00	759.00	51.00	40.00	9.00
100	2417.00	2925.00	1267.00	553.00	585.00	47.00	26.00
100	247.00	3169.00	1168.00	423.00	156.00	182.00	6.00
100	648.00	2635.00	950.00	254.00	57.00	34.00	23.00
100	1243.00	4176.00	2010.00	903.00	196.00	58.00	22.00
100	440.00	2888.00	3047.00	1215.00	460.00	43.00	15.00
100	317.00	1824.00	1434.00	1191.00	319.00	122.00	17.00
100	12302.00	4141.00	5426.00	649.00	321.00	131.00	62.00
100	15275.68	5409.65	2090.38	614.72	328.51	128.72	58.35
100	17076.44	6645.52	3329.07	675.66	202.25	130.20	81.17
100	116.72	3499.11	2450.75	844.39	207.17	51.32	48.49
100	1606.00	4980.00	2422.00	1608.00	724.00	94.00	44.00
100	5392.60	1890.60	1433.20	1211.30	823.30	276.20	35.70

ENGGFS_IV

1977	2002						
1	1	0.5	0.75				
0	6						
100	28.4280	21.9533	7.4413	1.1092	0.2162	0.0908	0.0801
100	18.4407	24.7136	5.1506	1.0552	0.3447	0.0507	0.0224
100	35.4758	20.0635	7.1169	1.8985	0.8426	0.0572	0.0292
100	19.9030	35.3272	12.5080	4.8104	1.2045	0.3136	0.0576
100	34.9421	18.3141	28.8039	16.0519	0.6176	0.6163	0.0805
100	6.9320	27.7222	7.9339	8.5904	2.2201	0.3404	0.0491
100	71.6727	11.8533	10.8030	1.9061	1.6964	0.2421	0.0671
100	17.2520	50.6135	10.8181	3.0121	0.8888	0.7688	0.3781
100	19.9897	15.8783	17.0426	1.6727	0.9810	0.1817	0.1533
100	16.3337	15.1618	6.5920	3.8469	0.4060	0.1037	0.0144
100	13.7313	22.7627	13.0365	2.6871	2.0086	0.3516	0.1175
100	38.1694	18.8058	13.1596	4.5456	0.6450	0.1737	0.0180
100	116.9483	29.4743	11.7600	7.6937	1.6741	0.3448	0.0185
100	87.5315	19.0085	12.8360	3.8544	2.3182	0.3254	0.0461
100	16.7322	33.3038	7.6653	3.8177	1.0855	0.3710	0.0424
100	45.5048	26.5546	13.0698	3.0455	2.6101	0.4933	0.5888
100	25.2425	25.1038	9.6291	3.7504	1.1614	0.7417	0.1883
100	21.1433	30.5460	10.5944	2.4368	1.1239	0.3333	0.1139
100	36.2817	35.5060	23.7380	7.3607	1.8703	0.2508	0.1443
100	10.2940	12.3787	10.4401	7.3858	3.2250	0.5942	0.1659
100	59.8713	20.2926	9.7191	6.9873	5.4067	1.6755	0.4291
100	204.7684	16.4773	17.8866	4.0113	2.5565	1.2809	0.2800
100	132.5164	47.8886	21.8306	7.8158	3.0348	0.7707	0.7501
100	96.1504	70.2531	28.0310	7.4195	1.6467	0.4657	0.2880
100	99.9000	54.4500	14.7100	5.0800	1.2600	0.3300	0.3800
100	5.3227	62.5700	17.9715	8.0098	2.4482	0.2702	0.0556

Table 5.1.2.5.2 contd. Whiting in IV and VIId. Complete available tuning series.

IBTS_Q1_IV						
1967	2003					
1	1	0	0.25			
1	6					
1	440.360	97.850	21.160	7.210	0.840	1.150
1	1267.710	81.750	25.430	4.740	0.650	0.310
1	504.740	382.300	19.750	7.980	1.090	0.090
1	57.550	132.910	27.440	5.310	0.600	0.180
1	219.740	19.690	10.020	10.170	0.550	0.250
1	263.690	104.310	33.530	10.680	4.150	0.180
1	1460.010	381.800	53.720	33.610	8.360	5.700
1	312.490	485.970	105.660	7.100	0.580	1.300
1	881.190	174.470	91.130	19.690	3.810	0.570
1	676.190	349.440	130.000	31.290	5.030	0.530
1	411.420	232.590	69.080	12.250	11.030	13.000
1	542.890	256.840	88.720	21.120	4.970	7.500
1	440.930	228.840	112.590	33.060	4.890	1.170
1	674.040	403.340	125.750	25.620	9.150	1.960
1	229.260	464.300	228.310	45.930	9.290	2.780
1	151.380	216.140	257.360	68.510	10.140	4.570
1	127.090	126.860	112.570	79.190	33.390	6.360
1	439.010	178.880	89.200	30.250	25.380	10.490
1	339.010	361.760	65.700	18.530	7.030	7.180
1	469.370	268.420	194.600	32.420	6.600	3.850
1	683.380	556.490	90.420	46.170	4.980	1.980
1	450.740	863.720	312.750	34.170	12.280	1.310
1	1446.080	538.560	414.760	109.900	12.050	5.090
1	518.940	862.350	198.160	91.610	16.980	3.620
1	1009.160	686.180	479.410	70.860	37.600	7.590
1	904.610	677.690	250.360	162.890	14.960	14.260
1	1088.200	523.700	244.520	65.480	59.000	11.440
1	720.990	636.970	179.840	66.590	11.560	8.930
1	678.590	448.480	239.450	58.070	11.870	5.580
1	502.360	485.970	244.700	69.740	23.090	9.850
1	287.870	342.070	162.520	60.430	18.010	9.180
1	556.110	161.260	125.490	54.050	15.500	9.260
1	676.270	305.450	94.670	57.450	25.820	11.080
1	756.580	537.390	182.100	53.050	20.010	14.740
1	647.140	594.850	296.080	97.730	25.680	26.050
1	671.110	416.880	275.270	66.640	22.110	10.410
1	145.554	294.908	244.523	127.376	42.230	7.234

Table 5.1.2.5.2 contd. Whiting in IV and VIId. Complete available tuning series.

FRATRO_7D

1986	2001						
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
-9	5536.90	5976.23	2822.66	1672.18	702.49	343.31	69.31
215553	7096.32	7026.28	1733.97	1724.37	1374.95	876.77	674.78
163848	89.05	6101.35	10124.09	3975.55	2563.21	2302.84	1039.71

FRAGFS_7d

1988	2001			
1	1	0.75	1	
0	3			
27	24.7655	-1	-1	-1
27	25.5589	-1	-1	-1
27	17.9188	-1	-1	-1
27	171.8887	26.2471	2.9367	0.4826
27	162.7344	42.7011	7.6562	0.8468
27	67.5271	17.0920	7.2220	1.1432
27	24.2509	68.9305	8.0918	1.4242
27	61.6837	17.8014	2.8242	0.2552
27	30.1222	27.3099	5.5307	1.0228
27	17.7579	50.1070	16.3448	2.5154
27	27.5217	12.3364	8.1936	4.5313
27	8.2441	70.8686	5.8216	0.9928
27	10.8169	64.2548	27.4501	2.5845
27	19.3729	15.1018	14.5698	1.4124

Table 5.1.2.5.2 contd. Whiting in IV and VIId. Complete available tuning series.

IBTS_Q4_ENG_IV Survey discontinued

1991	1996							
1	1	0.75	1					
0	7							
100	46.826	55.276	19.642	15.092	3.255	1.851	1.329	0.030
100	94.233	45.090	26.462	5.379	5.030	0.645	0.534	0.122
100	78.871	54.210	19.474	7.161	2.335	0.827	0.237	0.008
100	69.848	61.335	26.413	4.140	0.842	0.621	0.106	0.079
100	71.328	107.996	41.715	11.186	2.560	0.523	0.204	0.071
100	29.983	36.556	30.330	8.653	4.815	1.626	0.515	0.326

IBTS_Q2_SCO_IV Survey discontinued

1991	1997					
1	1	0.25	0.5			
1	6					
100	94.900	38.560	22.860	3.740	1.230	0.510
100	129.760	47.500	11.420	4.280	1.140	0.450
100	104.670	41.490	20.860	5.170	4.850	0.360
100	65.400	35.710	8.550	2.380	0.900	0.750
100	191.610	77.300	26.190	4.420	2.210	0.410
100	44.020	49.620	22.300	8.330	1.250	0.590
100	14.070	22.600	18.020	6.430	1.400	0.130

Table 5.1.3.1.1 Whiting in IV and VIId. TSA parameters settings for final assessment run.

Parameter	*Setting*	*Justification*
Age above which selection is constant.	$a_m = 5$	Based on inspection of previous XSA runs.
Multipliers on variance matrices of measurements.	$B_{landings}(a) = 2$ for ages 7, 8+	Allows extra measurement variability for older ages with fewer catches.
Multipliers on variances for fishing mortality estimates.	$H(1) = 2$	Allows for more variable fishing mortalities for age 1 fish.
Downweighting of particular data points (implemented by multiplying the relevant q by 3)	Catch values at age 1 in 1986, age 2 in 1990, age 4 in 2001, and age 7 in 2000.	Large values indicated by exploratory prediction error plots.
Recruitment.	Modelled by a Ricker model, with numbers-at-age 1 assumed to be independent and normally distributed with mean $\eta_1 S \exp(-\eta_2 S)$, where S is the spawning stock biomass at the start of the previous year. To allow recruitment variability to increase with mean recruitment, a constant coefficient of variation is assumed.	
Large year classes.	No year classes sufficiently large during 1980–2001 to warrant special modelling treatment.	

Table 5.1.3.1.2 Whiting in IV and VIId. TSA parameter estimates for last year's (left) and this year's (right) assessments. The latter are given with starting values and lower and upper estimation bounds: these are not empirical standard errors, but user-defined run-time limits that were used to obtain a converged assessment.

parameter		Last year's assessment (1980–2001)	This year's assessment (1980–2002)			
		Estimate	Estimate	Starting value	Lower bound	Upper bound
Initial fishing mortality	*F* (1, 1980)	0.1048	0.1061	0.1	0.05	0.4
	F (2, 1980)	0.3637	0.3687	0.4	0.1	0.8
	F (5, 1980)	1.1723	1.1779	1.0	0.3	1.5
Standard deviations:						
fishing mortalities	σ_F	0.1279	0.1401	0.1	0.0	0.2
	σ_U	0.0000	0.0000	0.05	0.0	0.1
	σ_V	0.0259	0.0597	0.05	0.0	0.08
	σ_Y	0.1083	0.0814	0.2	0.0	0.4
Measurement	σ_{catch}	0.0998	0.0914	0.1	0.05	0.2
Recruitment	α	17.9337	14.6477	20.0	10.0	30.0
	β	0.3131	0.2601	0.3	0.1	0.5
	cv_{rec}	0.3751	0.4015	0.4	0.2	0.8

Notation

$F(a,y)$ Fishing mortality at age *a* in year *y*

σ_F Transitory changes in overall fishing mortality
σ_U Persistent changes in selection (age effect in fishing mortality)
σ_V Transitory changes in the year effect in fishing mortality
σ_Y Persistent changes in the year effect in fishing mortality

σ_{catch} Standard error of catch-at-age data

α Ricker parameter (slope at the origin)
β Ricker parameter (curve dome occurs at $1/\beta$)
cv_{rec} Standard error of recruitment data

Table 5.1.3.1.3 Whiting in IV and VIId. XSA input setting for final run.

Catch data range	1980-2002
ScoSEI	Not used
ScoLTR	Not used
FraTRB	Not used
FraTRO	Not used
ScoGFS	1982-2003, 1-6
EngGFS	1992-2002, 1-5
IBTS Q1*	1982-2002, 0-5
FraGFS	Not used
Time series weights	Tricubic over 15 years
Power model used for catchability	None
Catchability plateau	Age 4
Survival estimate shrunk towards mean	Final 3 years or 2 oldest ages
s.e. of other means	0.5
Min std error for pop. estimates	0.3
Prior weighting	None

* The IBTS Q1 Survey was back-shifted to allow incorporation of 2003 survey indices.

Table 5.1.3.2.1 Whiting in IV and VIId. XSA tuning file for final run.

```
Lowestoft VPA Version 3.1

   16/09/2003  15:57
 Extended Survivors Analysis

Whiting in the North Sea and eastern Channel, ages 1-8+
 CPUE data from file EF.dat
 Catch data for  23 years. 1980 to 2002. Ages  1 to   6.

      Fleet,           First, Last, First, Last, Alpha,  Beta
                  ,    year, year,  age ,  age
 IBTS_Q1_IV       ,    1982, 2002,   0,     5,   .990,  1.000
 SCOGFS_IV        ,    1982, 2002,   1,     5,   .500,   .750
 ENGGFS_IV_GOV    ,    1992, 2002,   1,     5,   .500,   .750


 Time series weights :
      Tapered time weighting applied
      Power =    3 over  15 years

 Catchability analysis :
      Catchability independent of stock size for all ages
      Catchability independent of age for ages >=    4

 Terminal population estimation :

      Survivor estimates shrunk towards the mean F
      of the final   3 years or the   2 oldest ages.

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

      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 =     .00043

 Final year F values
 Age          ,     1,      2,      3,      4,      5
 Iteration 39,  .0551,  .1721,  .3419,  .3424,  .3124
 Iteration 40,  .0551,  .1720,  .3418,  .3423,  .3122

Regression weights
       , .482,  .610,  .725,  .820,  .893,  .944,  .976,  .993,  .999, 1.000

 Fishing mortalities
Age,  1993,  1994,  1995,  1996,  1997,  1998,  1999,  2000,  2001,  2002

      1,  .186,  .149,  .142,  .110,  .108,  .109,  .178,  .063,  .103,  .055
      2,  .463,  .327,  .322,  .293,  .273,  .213,  .351,  .321,  .184,  .172
      3,  .731,  .645,  .575,  .514,  .462,  .314,  .448,  .573,  .311,  .342
      4,  .804,  .844,  .682,  .632,  .508,  .442,  .524,  .527,  .426,  .342
      5,  .895,  .933,  .814,  .718,  .583,  .457,  .465,  .564,  .433,  .312

XSA population numbers (Thousands)

                                AGE
 YEAR ,       1,        2,        3,        4,        5,
 1993 ,    2.06E+06, 5.66E+05, 2.86E+05, 9.79E+04, 8.84E+04,
 1994 ,    1.90E+06, 6.61E+05, 2.27E+05, 9.69E+04, 3.25E+04,
 1995 ,    1.67E+06, 6.32E+05, 3.04E+05, 8.40E+04, 3.08E+04,
 1996 ,    1.12E+06, 5.62E+05, 2.92E+05, 1.20E+05, 3.15E+04,
 1997 ,    8.41E+05, 3.89E+05, 2.67E+05, 1.23E+05, 4.74E+04,
 1998 ,    1.11E+06, 2.92E+05, 1.89E+05, 1.19E+05, 5.49E+04,
 1999 ,    1.75E+06, 3.86E+05, 1.50E+05, 9.73E+04, 5.65E+04,
 2000 ,    1.76E+06, 5.67E+05, 1.73E+05, 6.77E+04, 4.27E+04,
 2001 ,    1.38E+06, 6.41E+05, 2.63E+05, 6.89E+04, 2.96E+04,
 2002 ,    1.49E+06, 4.83E+05, 3.40E+05, 1.36E+05, 3.34E+04,

 Estimated population abundance at 1st Jan 2003
    ,     0.00E+00, 5.46E+05, 2.59E+05, 1.70E+05, 7.13E+04,

 Taper weighted geometric mean of the VPA populations:
    ,     1.46E+06, 5.07E+05, 2.44E+05, 1.02E+05, 4.11E+04,

 Standard error of the weighted Log(VPA populations) :
    ,        .2886,    .3045,    .3072,    .3118,    .3274,
```

Log catchability residuals.

Fleet : IBTS_Q1_IV

Age	1982
1	99.99
2	99.99
3	99.99
4	99.99
5	99.99

Age	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	99.99	99.99	99.99	99.99	99.99	.05	-.30	.29	.35	.14
2	99.99	99.99	99.99	99.99	99.99	.10	-.06	.11	.30	.08
3	99.99	99.99	99.99	99.99	99.99	.06	-.15	.37	.21	.12
4	99.99	99.99	99.99	99.99	99.99	-.18	-.50	.36	.20	.39
5	99.99	99.99	99.99	99.99	99.99	-.37	-.31	-.12	.32	.79

Age	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
1	.18	-.11	.07	.09	-.37	-.02	.16	.14	-.13	-.10
2	.00	.02	.06	-.26	-.18	-.22	.28	.36	-.02	-.19
3	.14	.16	-.03	-.21	-.27	.00	.27	.86	-.25	-.71
4	-.20	-.15	.48	-.17	-.44	.02	.04	.67	.28	-.83
5	-.34	.29	.73	.51	-.03	-.10	.19	1.11	.39	-.20

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

Age	1	2	3	4	5
Mean Log q	-14.0372	-14.0547	-14.3315	-14.6156	-14.6156
S.E(Log q)	.1846	.2198	.4339	.4557	.5456

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	.71	2.237	14.08	.89	15	.11	-14.04
2	.83	.778	13.90	.75	15	.19	-14.05
3	9.03	-2.172	29.81	.01	15	3.25	-14.33
4	5.97	-1.856	29.92	.02	15	2.39	-14.62
5	2.53	-1.298	19.98	.09	15	1.10	-14.33

Fleet : SCOGFS_IV

Age	1982
1	99.99
2	99.99
3	99.99
4	99.99
5	99.99

Age	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	99.99	99.99	99.99	99.99	99.99	-1.67	-1.00	-.76	-1.00	-.39
2	99.99	99.99	99.99	99.99	99.99	-.90	-1.10	-.83	-.78	-.60
3	99.99	99.99	99.99	99.99	99.99	-1.08	-.63	-1.01	-.79	-.28
4	99.99	99.99	99.99	99.99	99.99	-1.08	-.95	-.44	-1.31	.05
5	99.99	99.99	99.99	99.99	99.99	-1.66	-1.77	-1.06	-1.27	-.45

Age	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
1	-.45	-.58	.00	.01	-.16	.38	.24	.37	-.01	.24
2	-.49	-.93	-.14	.37	-.03	.12	.41	.47	-.04	.22
3	-.60	-.93	.00	.30	.34	-.02	.24	.27	-.08	.32
4	-.33	-1.30	-.02	.44	-.03	-.02	.25	.13	.07	.59
5	-.05	-.70	-.19	-.57	-.02	-.17	-.21	.14	-.51	-.10

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

Age	1	2	3	4	5
Mean Log q	-9.9236	-9.7336	-9.8498	-10.0303	-10.0303
S.E(Log q)	.3688	.4448	.4179	.5101	.4510

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	1.56	-.783	7.54	.21	15	.59	-9.92
2	3.03	-1.384	2.81	.06	15	1.28	-9.73
3	1.38	-.550	8.89	.23	15	.60	-9.85
4	.79	.435	10.34	.38	15	.43	-10.03
5	.78	.749	10.38	.62	15	.27	-10.31

1

Fleet : ENGGFS_IV_GOV

Age	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	-.41
2	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	-.22
3	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	-.40
4	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	-.26
5	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	.10

Age	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
1	-.60	-.35	-.08	-.33	-.24	-.38	.13	.35	.52	.55
2	-.33	-.47	.37	-.30	-.18	.36	.02	.24	-.20	.27
3	-.24	-.50	.27	.08	.35	-.34	.23	.10	-.12	.10
4	-.13	-.12	.43	-.28	.13	.17	-.09	-.13	.07	.01
5	-.45	-.22	-.53	-.55	.13	-.06	-.21	-.29	-.45	-.84

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

Age	1	2	3	4	5
Mean Log q	-14.6114	-14.6877	-14.9300	-15.1351	-15.1351
S.E(Log q)	.4088	.3001	.2770	.1986	.4582

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	.79	.489	14.52	.44	11	.34	-14.61
2	1.78	-1.154	15.91	.25	11	.52	-14.69
3	.92	.221	14.73	.54	11	.27	-14.93
4	1.14	-.499	15.63	.66	11	.24	-15.14
5	.74	1.106	14.18	.72	11	.22	-15.46

1

Terminal year survivor and F summaries :

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

Year class = 2001

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
IBTS_Q1_IV ,	491796.,	.300,	.000,	.00,	1,	.406,	.061
SCOGFS_IV ,	695254.,	.388,	.000,	.00,	1,	.242,	.044
ENGGFS_IV_GOV ,	948822.,	.431,	.000,	.00,	1,	.197,	.032
F shrinkage mean ,	243028.,	.50,,,,				.155,	.120

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
545759.,	.19,	.26,	4,	1.350,	.055

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

Year class = 2000

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
IBTS_Q1_IV ,	220583.,	.212,	.026,	.12,	2,	.412,	.199
SCOGFS_IV ,	284186.,	.299,	.113,	.38,	2,	.206,	.158
ENGGFS_IV_GOV ,	368688.,	.256,	.116,	.45,	2,	.289,	.124
F shrinkage mean ,	144486.,	.50,,,,				.093,	.290

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
259221.,	.14,	.12,	7,	.888,	.172

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

Year class = 1999

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
IBTS_Q1_IV ,	152970.,	.194,	.228,	1.18,	3,	.343,	.374
SCOGFS_IV ,	216402.,	.249,	.122,	.49,	3,	.214,	.278
ENGGFS_IV_GOV ,	176638.,	.196,	.141,	.72,	3,	.357,	.331
F shrinkage mean ,	121728.,	.50,,,,				.085,	.451

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
170085.,	.12,	.10,	10,	.815,	.342

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

Year class = 1998

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
IBTS_Q1_IV ,	65282.,	.188,	.266,	1.42,	4,	.292,	.369
SCOGFS_IV ,	94758.,	.237,	.157,	.66,	4,	.197,	.268
ENGGFS_IV_GOV ,	73179.,	.170,	.073,	.43,	4,	.422,	.335
F shrinkage mean ,	45016.,	.50,,,,				.089,	.499

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
71342.,	.11,	.10,	13,	.910,	.342

Age 5 Catchability constant w.r.t. time and age (fixed at the value for age) 4

Year class = 1997

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
IBTS_Q1_IV ,	23009.,	.203,	.166,	.82,	5,	.264,	.264
SCOGFS_IV ,	21302.,	.240,	.100,	.42,	5,	.229,	.283
ENGGFS_IV_GOV ,	16222.,	.175,	.191,	1.09,	5,	.395,	.357
F shrinkage mean ,	16914.,	.50,,,,				.112,	.345

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
19022.,	.12,	.09,	16,	.761,	.31

Table 5.1.3.2.2 Whiting in IV and VIId. XSA output: Fishing mortality at age.

Run title : Whiting in the North Sea and eastern Channel, ages 1-8+ (15/09/2003 CPM)

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Terminal Fs derived using XSA (With F shrinkage)

Table 8 Fishing mortality (F) at age

YEAR,	1980,	1981,	1982,
1,	.0990,	.1588,	.1713,
2,	.4261,	.3195,	.2790,
3,	.7572,	.7088,	.5068,
4,	.8493,	.8219,	.6389,
5,	.8139,	.7752,	.5792,
+gp,	.8139,	.7752,	.5792,
0 FBAR 2- 4,	.6776,	.6167,	.4749,

Table 8 Fishing mortality (F) at age

YEAR,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,
1,	.2061,	.2153,	.1812,	.2641,	.1356,	.3489,	.1297,	.2252,	.1151,	.2338,
2,	.4475,	.5015,	.2382,	.3987,	.4920,	.4106,	.4144,	.5525,	.4834,	.3801,
3,	.6866,	.8422,	.6032,	.6541,	.7698,	.6204,	.6403,	.8428,	.5241,	.5698,
4,	.6731,	.8464,	.8080,	1.0491,	1.0285,	.7300,	.7341,	.8174,	.7385,	.6481,
5,	.6880,	.8557,	.7143,	.8632,	.9116,	.6868,	.7195,	.8837,	.7041,	.6302,
+gp,	.6880,	.8557,	.7143,	.8632,	.9116,	.6868,	.7195,	.8837,	.7041,	.6302,
0 FBAR 2- 4,	.6024,	.7300,	.5498,	.7006,	.7634,	.5870,	.5963,	.7376,	.5820,	.5326,

YEAR,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	FBAR (2-4)
1,	.1863,	.1493,	.1417,	.1098,	.1078,	.1088,	.1783,	.0628,	.1029,	.0551,	.0736,
2,	.4632,	.3271,	.3223,	.2932,	.2727,	.2129,	.3510,	.3208,	.1845,	.1720,	.2258,
3,	.7310,	.6448,	.5748,	.5139,	.4619,	.3141,	.4483,	.5732,	.3110,	.3418,	.4087,
4,	.8035,	.8443,	.6816,	.6320,	.5075,	.4418,	.5244,	.5274,	.4256,	.3423,	.4318,
5,	.8952,	.9327,	.8141,	.7184,	.5829,	.4568,	.4647,	.5641,	.4327,	.3122,	.4363,
+gp,	.8952,	.9327,	.8141,	.7184,	.5829,	.4568,	.4647,	.5641,	.4327,	.3122,	
FBAR 2- 4,	.6659,	.6054,	.5262,	.4797,	.4140,	.3229,	.4413,	.4738,	.3070,	.2854,	

Table 5.1.3.2.3 Whiting in IV and VIId. XSA output: Stock numbers at age.

Run title : Whiting in the North Sea and eastern Channel, ages 1-8+ (15/09/2003 CPM)

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Terminal Fs derived using XSA (With F shrinkage)

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

YEAR,	1980,	1981,	1982,
1,	4527870,	1784171,	1967836,
2,	1501584,	1586090,	588708,
3,	641736,	625263,	734775,
4,	184166,	212075,	216886,
5,	107787,	58352,	69063,
+gp,	25211,	33168,	23928,
TOTAL,	6988354,	4299118,	3601195,

YEAR,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,
1,	1775425,	2685199,	1972426,	3995616,	3385703,	2349717,	4385537,	2023262,	1899884,	1849317,
2,	641243,	558741,	837354,	636376,	1186608,	1143315,	641107,	1489806,	624678,	654846,
3,	283992,	261352,	215758,	420758,	272357,	462578,	483523,	270105,	546683,	245642,
4,	311913,	100724,	79335,	83176,	154150,	88885,	175289,	179606,	81944,	228099,
5,	84813,	117881,	32009,	26197,	21581,	40831,	31734,	62323,	58756,	29006,
+gp,	25406,	33539,	47099,	15247,	12016,	6441,	12769,	5359,	13923,	22780,
TOTAL,	3122791,	3757436,	3183982,	5177372,	5032417,	4091767,	5729959,	4030459,	3225869,	3029690,

YEAR,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003,	GM 80-,	AM 80-,
1,	2058234,	1897021,	1673284,	1123578,	840689,	1114114,	1753696,	1763763,	1383552,	1490886,	0,	2039133,	2229825,
2,	566084,	660719,	631910,	561630,	389357,	291916,	386452,	567481,	640585,	482763,	545759,	694233,	768857,
3,	285511,	227138,	303770,	291922,	267116,	189015,	150443,	173465,	262534,	339641,	259221,	316989,	350138,
4,	97917,	96863,	83998,	120472,	123047,	118605,	97292,	67713,	68911,	135554,	170085,	126116,	138198,
5,	88386,	32478,	30846,	31476,	47439,	54873,	56484,	42661,	29603,	33356,	71342,	47846,	53570,
+gp,	11612,	34178,	20044,	15323,	12151,	24991,	30752,	36941,	26266,	17450,	29230,		
TOTAL,	3107743,	2948397,	2743852,	2144401,	1679799,	1793514,	2475119,	2652026,	2411451,	2499649,	1075637,		

Table 5.1.3.2.4 Whiting in IV and VIId. XSA Stock Summary.

Run title : Whiting in the North Sea and eastern Channel, ages 1-8+ (15/09/2003 CPM) ,

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Table 16 Summary (without SOP correction)

Terminal Fs derived using XSA (With F shrinkage)

,	RECRUITS, Age 1	TOTALBIO,	TOTSPBIO,	LANDINGS,	YIELD/SSB,	FBAR 2- 4,
1980,	4527870,	874038,	550660,	223517,	.4059,	.6776,
1981,	1784171,	670133,	517019,	192049,	.3715,	.6167,
1982,	1967836,	520217,	404718,	140195,	.3464,	.4749,
1983,	1775425,	535074,	356202,	161212,	.4526,	.6024,
1984,	2685199,	507559,	286461,	145741,	.5088,	.7300,
1985,	1972426,	467583,	289708,	106363,	.3671,	.5498,
1986,	3995616,	686995,	304288,	161744,	.5315,	.7006,
1987,	3385703,	562689,	316618,	138775,	.4383,	.7634,
1988,	2349717,	440772,	314491,	133470,	.4244,	.5870,
1989,	4385537,	578367,	297096,	123753,	.4165,	.5963,
1990,	2023262,	493116,	327329,	153453,	.4688,	.7376,
1991,	1899884,	467013,	284405,	124975,	.4394,	.5820,
1992,	1849317,	416461,	271806,	109704,	.4036,	.5326,
1993,	2058234,	385829,	244180,	116165,	.4757,	.6659,
1994,	1897021,	377783,	233730,	92606,	.3962,	.6054,
1995,	1673284,	387488,	248776,	103268,	.4151,	.5262,
1996,	1123578,	322083,	221581,	73957,	.3338,	.4797,
1997,	840689,	267486,	193854,	59102,	.3049,	.4140,
1998,	1114114,	257563,	163127,	44312,	.2716,	.3229,
1999,	1753696,	286130,	162130,	59179,	.3650,	.4413,
2000,	1763763,	385836,	200192,	60907,	.3042,	.4738,
2001,	1383552,	316821,	218375,	49062,	.2247,	.3070,
2002,	1490886,	303927,	210328,	46296,	.2201,	.2854,
Arith. Mean ,	2160903,	456998,	287699,	113904,	.3864,	.5510,
0 Units,	(Thousands),	(Tonnes),	(Tonnes),	(Tonnes),		

Table 5.1.4.1. Whiting in IV and VIId. RCT3 input.

RCT3 input values

21	30	2																				
'YC'	'VPA'	'IYFS1'	'IYFS2'	'EGFS0'	'EGFS1'	'EGFS2'	'SGFS0'	'SGFS1'	'SGFS2'	'DGFS0'	'DGFS1'	'DGFS2'	'GGFS1'	'GGFS2'	'IBQ21'	'SCQ21'	'SCQ22'	'IBQ40'	'IBQ41'	'ENQ40'	'ENQ41'	'ENQ42'
1971	-1	332	763	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
1972	-1	1156	496	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
1973	-1	322	153	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
1974	-1	893	535	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
1975	-1	679	219	-1	-1	74	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
1976	-1	418	293	-1	220	52	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
1977	-1	513	183	284	247	71	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
1978	-1	457	391	184	201	125	-1	-1	-1	-1	-1	62	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
1979	-1	692	485	355	353	288	-1	-1	-1	-1	330	131	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
1980	-1	227	232	199	183	79	-1	-1	97	166	205	105	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
1981	-1	161	126	349	277	109	-1	65	58	1393	640	224	-1	15.3	-1	-1	-1	-1	-1	-1	-1	-1
1982	-1	128	179	69	119	108	102	56	37	166	431	141	6.8	12.9	-1	-1	-1	-1	-1	-1	-1	-1
1983	-1	436	359	717	506	170	210	108	97	2649	1330	893	5.7	22.8	-1	-1	-1	-1	-1	-1	-1	-1
1984	-1	341	261	173	159	66	454	158	45	143	783	75	9.6	24.6	-1	-1	-1	-1	-1	-1	-1	-1
1985	-1	456	544	200	152	130	169	111	115	859	384	252	12.2	70.8	-1	-1	-1	-1	-1	-1	-1	-1
1986	-1	669	862	163	228	132	406	141	161	1784	2004	612	91	79.8	-1	-1	-1	-1	-1	-1	-1	-1
1987	-1	394	542	137	188	118	120	97	74	2883	1441	803	15.1	392.3	-1	-1	-1	-1	-1	-1	-1	-1
1988	-1	1465	887	382	295	129	642	404	205	629	1049	196	603.1	248.5	-1	-1	-1	-1	-1	-1	-1	-1
1989	-1	509	675	1170	194	77	427	224	95	1882	963	214	280.2	163.7	-1	-1	3856	-1	-1	-1	-1	19642
1990	-1	1014	748	882	333	131	1943	177	127	5543	1552	310	324.3	73.3	1298	9490	4750	-1	853	-1	55276	26462
1991	-1	916	524	167	266	96	1379	293	117	806	272	61	120.7	-1	816	12976	4149	761	625	46826	45090	19474
1992	-1	1087	637	455	251	106	2417	317	950	453	340	353	-1	79	710	10467	3571	1219	807	94233	54210	26413
1993	-1	721	457	252	305	237	247	2365	2010	2655	660	-1	181.8	74.5	806	6540	7730	1326	1136	78871	61335	41715
1994	-1	679	486	211	355	104	648	4176	3047	1795	-1	-1	104.7	-1	1592	19161	4962	1318	1112	69848	107996	30330
1995	-1	502	342	363	124	97	1243	2888	1434	-1	-1	-1	-1	-1	627	4402	2260	2013	-1	71328	36556	-1
1996	-1	288	162	103	203	179	440	1824	-1	-1	-1	-1	-1	-1	254	1407	-1	-1	-1	29983	-1	-1
1997	-1	556	305	599	165	218	317	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
1998	-1	676	537	2048	479	280	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
1999	-1	757	-1	1325	703	147	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
2000	-1	-1	-1	962	545	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
2001	-1	-1	-1	999	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
2002	-1	-1	-1	53	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
Yclass	VPA	IYFS1	IYFS2	egfs0	egfs1	egfs2	sgfs0	sgfs1	sgfs2	dgfs0	dgfs1	dgfs2	ggfs1	ggfs2	IBQ21	SCQ21	SCQ22	IBQ40	IBQ41	ENQ40	ENQ41	ENQ42
Update ?		Y	Y	Y	Y	Y		** N - see below **		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Table 5.1.4.1 cont. Whiting in IV and VIId. RCT3 input: notes.

KEY

index	Survey	Quarter	Age	
IYFS1	IBTS	1	1	
IYFS2	IBTS	1	2	
EGFS0	English GFS	3	0	
EGFS1	English GFS	3	1	
EGFS2	English GFS	3	2	
SGFS0	Scottish GFS	3	0	
SGFS1	Scottish GFS	3	1	
SGFS2	Scottish GFS	3	2	
DGFS0	Dutch GFS	3	0	Survey discontinued
DGFS1	Dutch GFS	3	1	Survey discontinued
DGFS2	Dutch GFS	3	2	Survey discontinued
GGFS1	German GFS	2	1	Survey discontinued
GGFS2	German GFS	2	2	Survey discontinued
IBQ21	IBTS (provisional, length-based)	2	1	Survey discontinued
SCQ21	IBTS (Scottish, age based)	2	1	Survey discontinued
SCQ22	IBTS (Scottish, age based)	2	2	Survey discontinued
IBQ40	IBTS (provisional, length-based)	4	0	Survey discontinued
IBQ41	IBTS (provisional, length-based)	4	1	Survey discontinued
ENQ40	IBTS (English, age-based)	4	0	Survey discontinued
ENQ41	IBTS (English, age-based)	4	1	Survey discontinued
ENQ42	IBTS (English, age-based)	4	2	Survey discontinued

Below are Scottish GFS indices since change in boat & gear

NB Also expansion of area in 1999 survey, but these indices refer only to old area

Use with care

Yclass	SGFS0	SGFS1	SGFS2
1996			1285
1997		4141	2090
1998	12302	5410	3329
1999	15276	6646	2451
2000	17076	3499	2422
2001	117	4980	1433
2002	1606	1891	-1
2003	5393	-1	-1

Table 5.1.4.2 Whiting in IV and VIId. RCT3 output of final run.

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

 rctwhi_1.in

 "WHITING in IV  RCT3 INPUT VALUES; age 1"

 Data for   21 surveys over   23 years :  1980 - 2002

 Regression type = C
 Tapered time weighting applied
 power =    3 over  15 years
 Survey weighting not applied

 Final estimates shrunk towards mean
 Minimum S.E. for any survey taken as    .50
 Minimum of   3 points used for regression

 Forecast/Hindcast variance correction used.

 Yearclass =   2000

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

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

 EGFS0   ****** ****** ******   .000     20   6.56  ******   ******     .000
 EGFS1     4.82 -12.85   2.27   .034     20   6.30   17.54    3.017     .017
 EGFS2   -18.51 103.58   6.35   .004     20   5.20    7.38    8.100     .002

                                        VPA Mean =   14.29     .399     .981


 Yearclass =   2001

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

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

 EGFS0   -35.81 230.64  35.47   .000     20   6.91  -16.74   45.552     .000
 EGFS1     3.19  -3.73   1.56   .065     20   6.44   16.81    2.215     .029

                                        VPA Mean =   14.25     .380     .971


 Yearclass =   2002

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

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

 EGFS0   -10.14  75.65  10.43   .001     20   3.99   35.22   17.026     .000

                                        VPA Mean =   14.21     .364    1.000


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

 2000     1670241     14.33     .39     .33      .70
 2001     1654574     14.32     .37     .35      .88
 2002     1496007     14.22     .36     .45     1.52
```

Table 5.1.5.1 Whiting in IV and VIId. Input data for catch forecast and linear sensitivity analysis.

Label	Value	CV	Label	Value	CV
Number at age			**Weight in the stock**		
N1	1459533	0.38	WS1	0.08	0.18
N2	545759	0.26	WS2	0.18	0.06
N3	259221	0.14	WS3	0.23	0.02
N4	170085	0.12	WS4	0.28	0.01
N5	71342	0.11	WS5	0.29	0.04
N6	19022	0.12	WS6	0.31	0.08
H.cons selectivity			**Weight in the HC catch**		
sH1	0.01	0.19	WH1	0.17	0.07
sH2	0.06	0.21	WH2	0.22	0.01
sH3	0.17	0.20	WH3	0.27	0.00
sH4	0.30	0.12	WH4	0.30	0.02
sH5	0.36	0.17	WH5	0.30	0.06
sH6	0.38	0.17	WH6	0.32	0.07
Discard selectivity			**Weight in the discards**		
sD1	0.03	0.19	WD1	0.11	0.13
sD2	0.13	0.21	WD2	0.17	0.03
sD3	0.17	0.20	WD3	0.20	0.04
sD4	0.08	0.12	WD4	0.24	0.05
sD5	0.05	0.17	WD5	0.23	0.05
sD6	0.05	0.17	WD6	0.24	0.06
Industrial selectivity			**Weight in Ind. bycatch**		
sI1	0.04	0.19	WI1	0.04	0.03
sI2	0.04	0.21	WI2	0.14	0.15
sI3	0.06	0.20	WI3	0.19	0.17
sI4	0.05	0.12	WI4	0.30	0.03
sI5	0.03	0.17	WI5	0.37	0.06
sI6	0.01	0.17	WI6	0.28	0.38
Natural mortality			**Proportion mature**		
M1	0.95	0.10	MT1	0.11	0.10
M2	0.45	0.10	MT2	0.92	0.10
M3	0.35	0.10	MT3	1.00	0.10
M4	0.30	0.10	MT4	1.00	0.00
M5	0.25	0.10	MT5	1.00	0.00
M6	0.25	0.10	MT6	1.00	0.00
Relative effort in HC fishery			**Year effect for natural mortality**		
HF03	1.00	0.15	K03	1.00	0.10
HF04	1.00	0.15	K04	1.00	0.10
HF05	1.00	0.15	K05	1.00	0.10
Relative effort in industrial fishery					
IF03	1.00	0.63			
IF04	1.00	0.63			
IF05	1.00	0.63			
Recruitment in 2004 and 2005					
R04	1459533	0.38			
R05	1459533	0.38			

Proportion of F before spawning = 0.00
Proportion of M before spawning = 0.00

Stock numbers are XSA are survivors

Table 5.1.5.2 Whiting in IV and VIId. Catch forecast output and estimates of coefficient of variation (CV) from linear analysis.

	Year 2003	2004						
Mean F Ages								
H.cons 2 to 4	0.30	0.00	0.06	0.12	0.18	0.24	0.30	0.37
Ind BC 2 to 4	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Effort relative to 2002								
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	353	351	351	351	351	351	351	351
SSB at spawning time	236	234	234	234	234	234	234	234
Catch weight (,000t)								
H.cons	33.3	0.0	7.6	14.8	21.5	27.8	33.7	39.3
Discards	20.9	0.0	4.5	8.8	12.9	16.9	20.6	24.2
Ind BC	8.3	9.0	8.8	8.6	8.4	8.2	8.0	7.8
Total Landings	41.6	9.0	16.4	23.3	29.8	35.9	41.7	47.1
Total Catch	62.5	9.0	20.9	32.1	42.8	52.8	62.3	71.3
Biomass in year.... 2005								
Total 1 January		399	388	377	367	358	349	341
SSB at spawning time		282	271	260	251	242	233	225

	Year 2003	2004						
Effort relative to 2002								
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	0.17	0.19	0.19	0.19	0.19	0.19	0.19	0.19
SSB at spawning time	0.12	0.18	0.18	0.18	0.18	0.18	0.18	0.18
Catch weight								
H.cons	0.17	0.00	0.74	0.38	0.27	0.22	0.19	0.17
Discards	0.21	0.00	0.77	0.42	0.32	0.28	0.26	0.25
Ind BC	0.64	0.65	0.65	0.65	0.65	0.65	0.65	0.65
Biomass in year.... 2005								
Total 1 January		0.19	0.19	0.20	0.20	0.20	0.21	0.21
SSB at spawning time		0.20	0.20	0.20	0.21	0.21	0.21	0.21

Table 5.1.5.3 Whiting in IV and VIId. Detailed forecast tables.

Forecast for year 2003
F multiplier H.cons=1.00
F multiplier Indust=1.00

Populations		Catch number			
Age	Stock No.	H.Cons	Discards	By-catch	Total
1	1459533	10943	24621	35564	71128
2	545759	23038	49652	15889	88579
3	259221	31116	31844	10736	73696
4	170085	36343	9988	6258	52589
5	71342	18362	2527	1702	22592
6	19022	5160	674	179	6013
Wt	353	33	21	8	62

Forecast for year 2004
F multiplier H.cons=1.00
F multiplier Indust=1.00

Populations		Catch number			
Age	Stock No.	H.Cons	Discards	By-catch	Total
1	1459533	10943	24621	35564	71128
2	522107	22040	47500	15200	84740
3	278433	33422	34204	11532	79158
4	121837	26033	7155	4483	37671
5	81394	20950	2884	1942	25775
6	45425	12321	1610	427	14358
Wt	351	34	21	8	62

Table 5.2.1 Nominal landings (t) of Whiting from Division IIIa as supplied by the Study Group on Division IIIa Demersal Stocks (ICES 1992b) and updated by the Working Group.

Year	Denmark			Norway	Sweden	Others	Total
1975		19,018		57	611	4	19,690
1976		17,870		48	1,002	48	18,968
1977		18,116		46	975	41	19,178
1978		48,102		58	899	32	49,091
1979		16,971		63	1,033	16	18,083
1980		21,070		65	1,516	3	22,654
	Total consumption	Total industrial	Total				
1981	1,027	23,915	24,942	70	1,054	7	26,073
1982	1,183	39,758	40,941	40	670	13	41,664
1983	1,311	23,505	24,816	48	1,061	8	25,933
1984	1,036	12,102	13,138	51	1,168	60	14,417
1985	557	11,967	12,524	45	654	2	13,225
1986	484	11,979	12,463	64	477	1	13,005
1987	443	15,880	16,323	29	262	43	16,657
1988	391	10,872	11,263	42	435	24	11,764
1989	917	11,662	12,579	29	675	-	13,283
1990	1,016	17,829	18,845	49	456	73	19,423
1991	871	12,463	13,334	56	527	97	14,041
1992	555	10,675	11,230	66	959	1	12,256
1993	261	3,581	3,842	42	756	1	4,641
1994	174	5,391	5,565	21	440	1	6,027
1995	85	9,029	9,114	24	431	1	9,570
1996	55	2,668	2,723	21	182	-	2,926
1997	38	568	606	18	94	-	718
1998	35	847	882	16	81	-	979
1999	37	1,199	1,236	15	111	-	1,362
2000	59	386	445	17*	138	1	622
2001	61	n/a	n/a	27*	126	+	214
2002	101	n/a	n/a	23*	127	1	252

*Preliminary.

Figure 5.1.3.1.1 Whiting in VI and VIId. Relative survey indices and catch at ages 0-6. Proportion by number in catch at age.

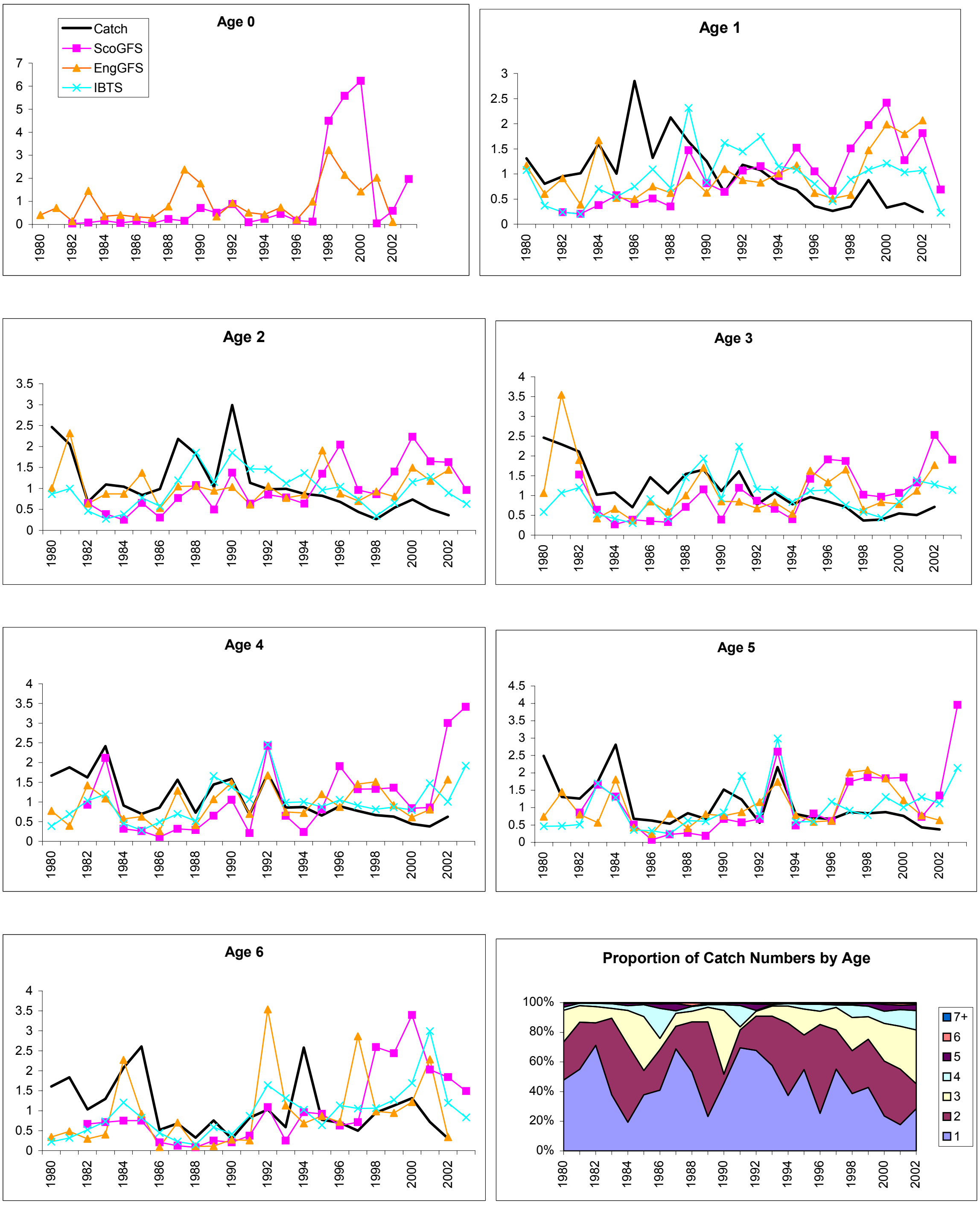


Figure 5.1.3.1.2 Whiting in VI and VIId. Fitted Surba relative SSB for three tuning surveys.

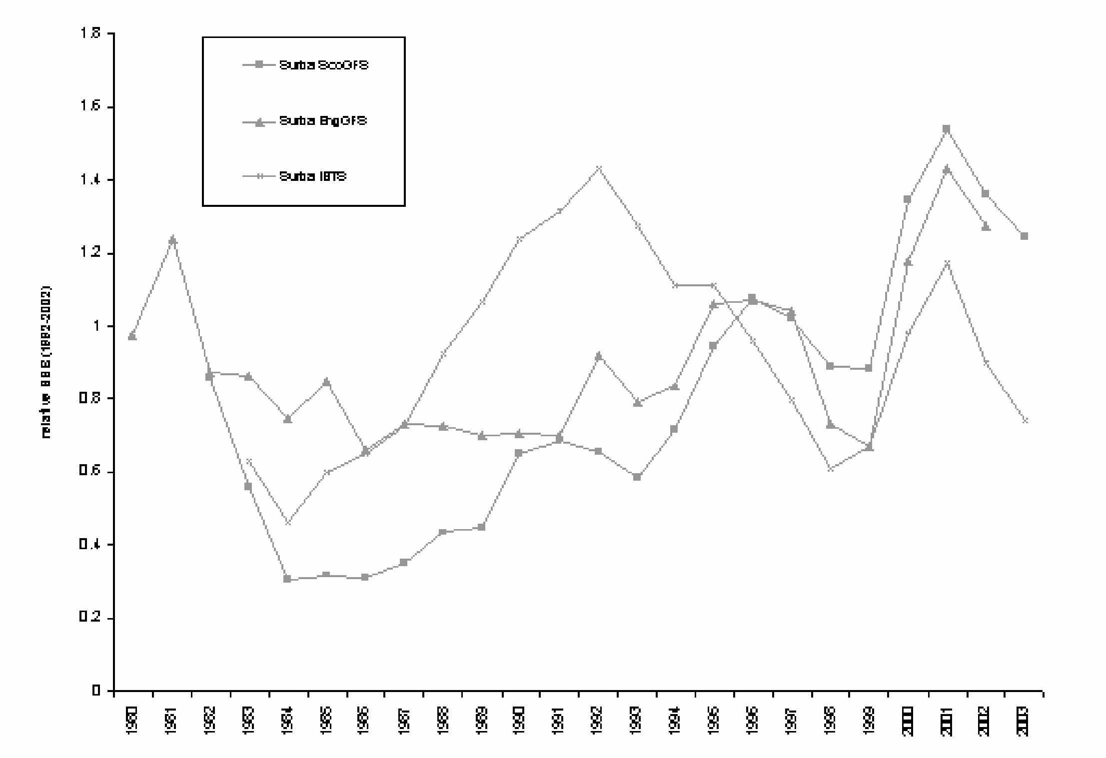


Figure 5.1.3.1.3 Whiting in VI and VIId. Stock summary plots for a TSA update analysis (thick lines) with approximate 95% pointwise confidence intervals (dotted lines). The vertical dotted lines indicate the last year of catch data, all subsequent estimates are TSA forecasts. Thin lines represent last year's WG assessment. Circles on the first graph indicate total reported catches (human consumption, discards and industrial bycatch).

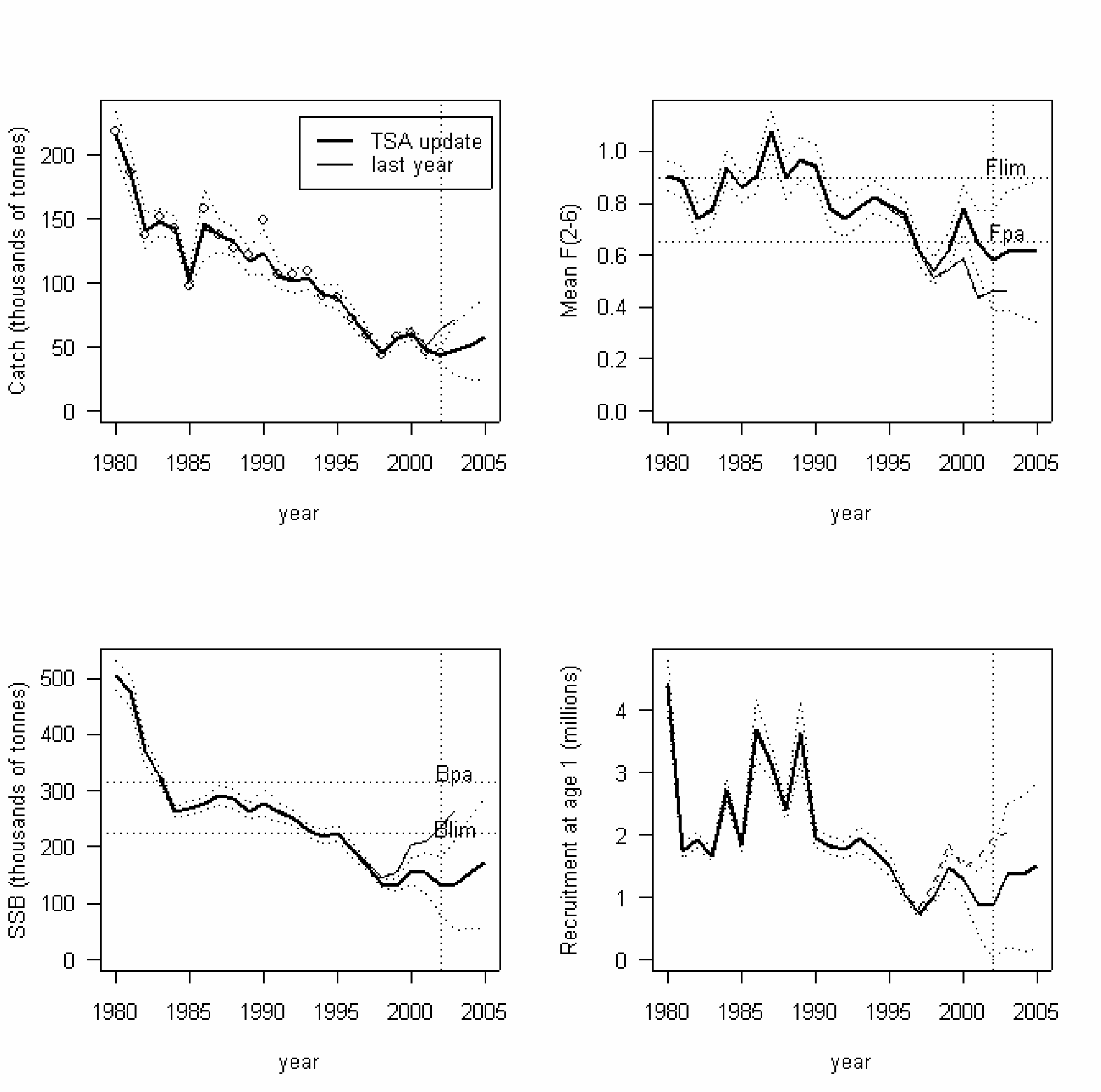


Figure 5.1.3.1.4 Whiting in VI and VIId. TSA update retrospective analyses for 9 years, for mean F (2-6), SSB and recruitment at age 1.

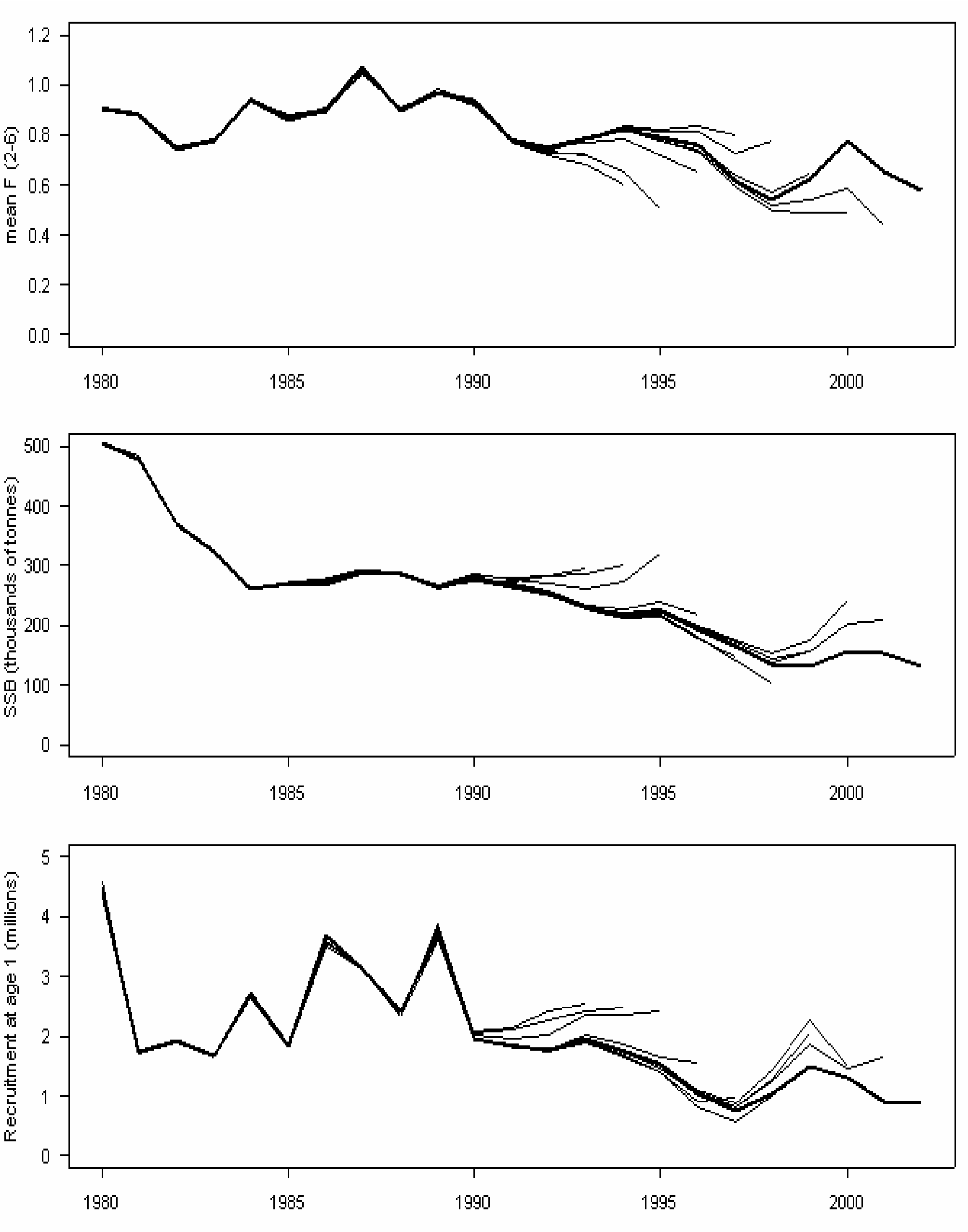


Figure 5.1.3.1.5 Whiting in VI and VIId. A comparison of TSA runs: last year's assessment, the TSA update analysis, a TSA analysis including all ScoGFS, EngGFS and IBTS Q1, and TSA analyses including each survey separately.

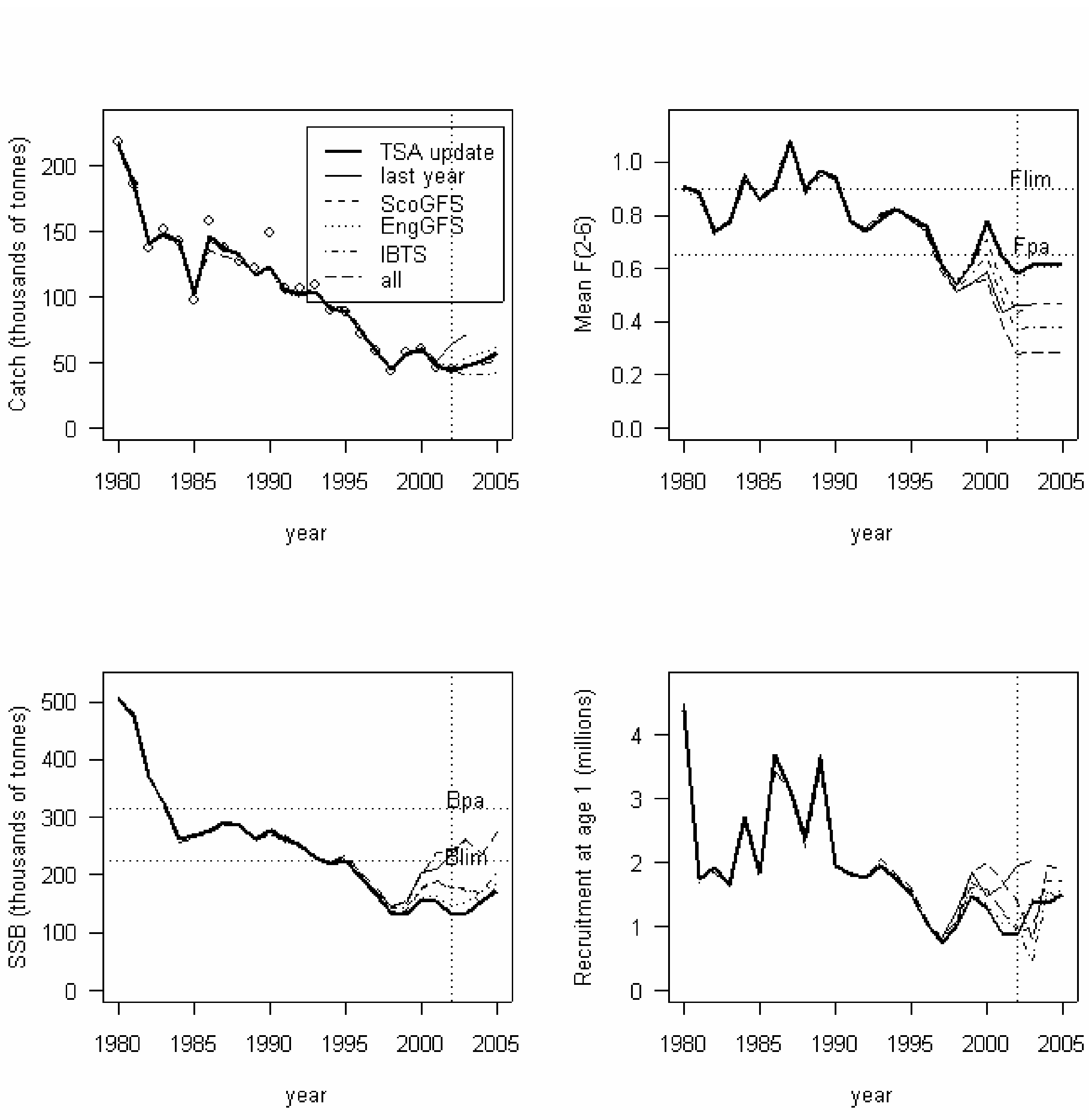


Figure 5.1.3.1.6 Whiting in VI and VIId. Log catchability residuals, from XSA base run.

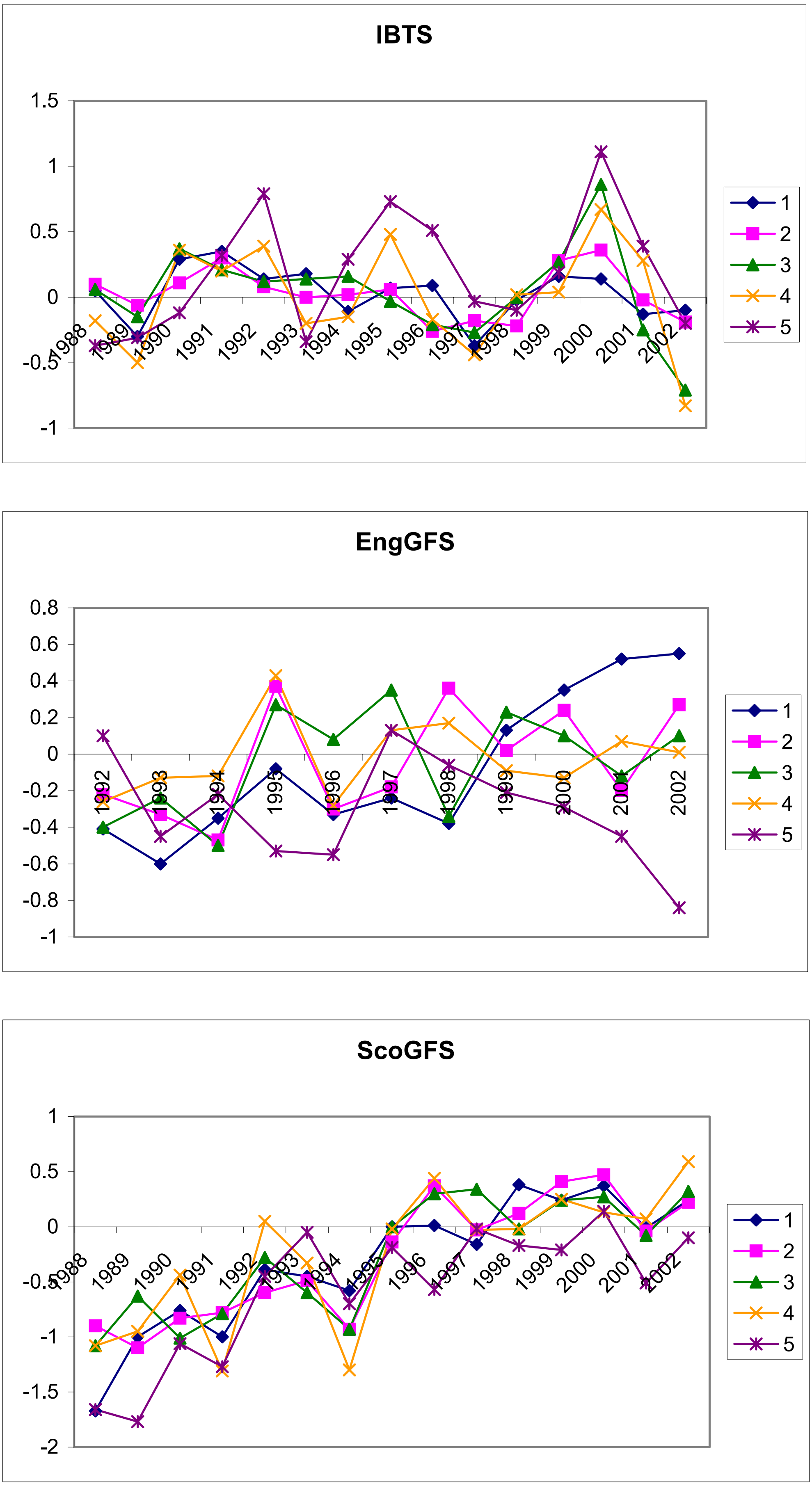
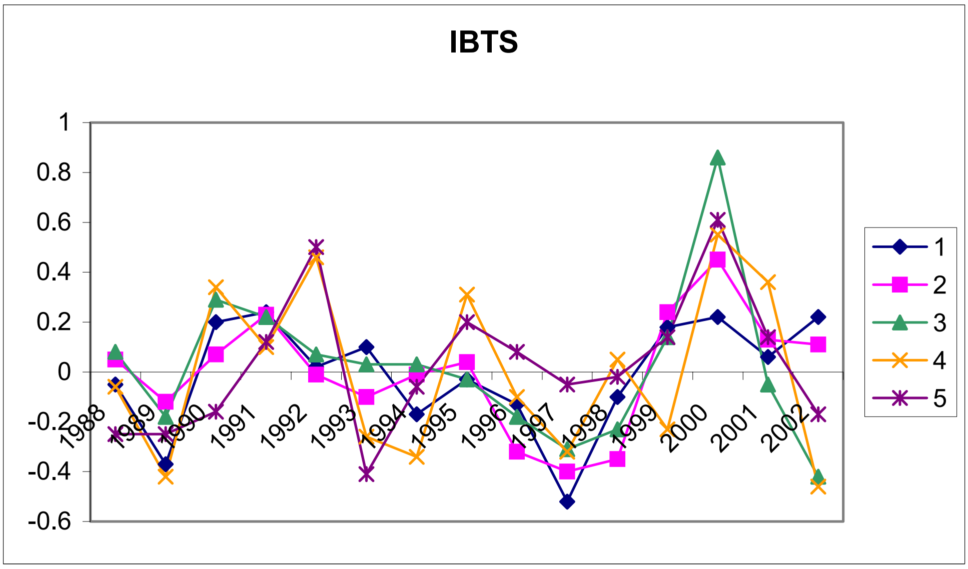
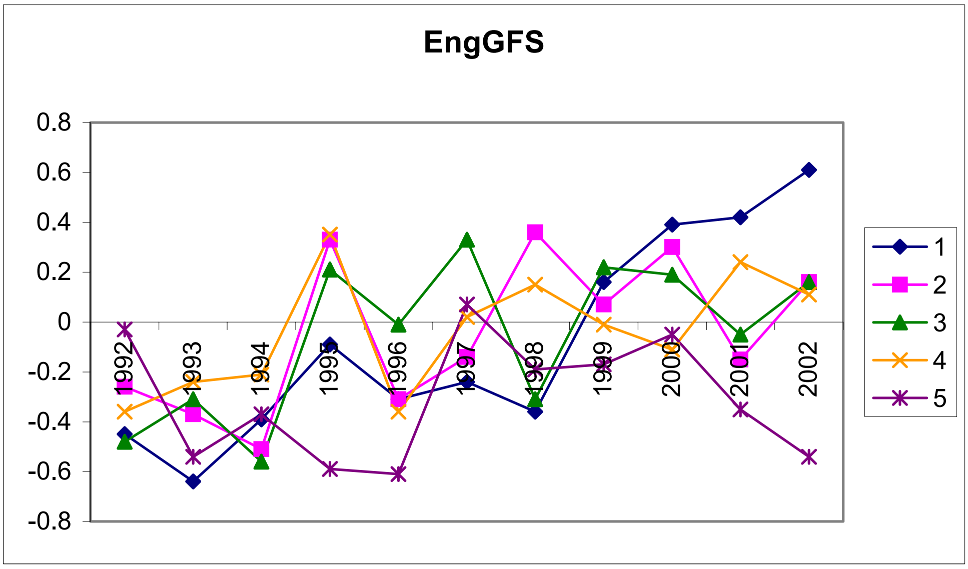


Figure 5.1.3.1.7 Whiting in VI and VIId. Log catchability residuals, from single fleet XSA runs. Using settings as in Table 5.1.3.1.3.





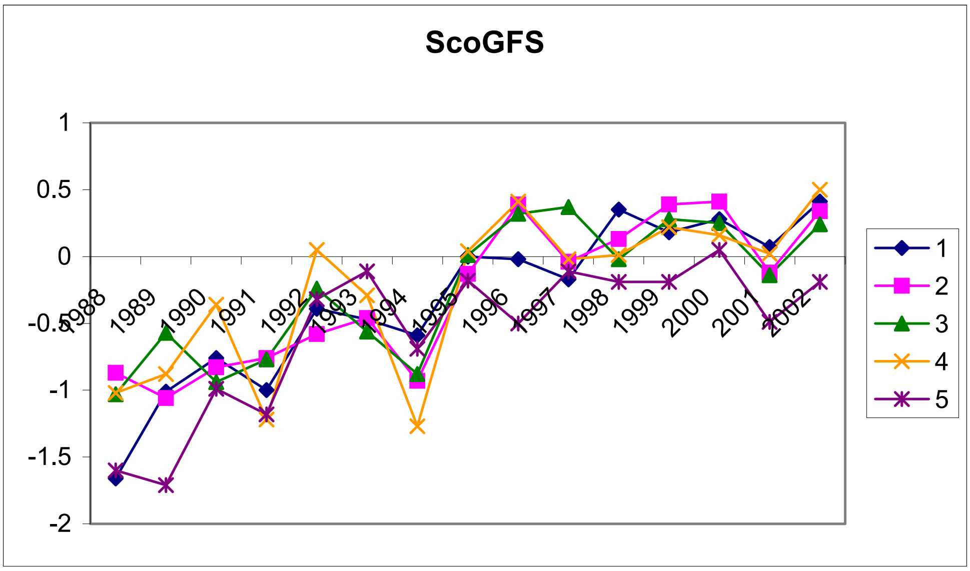


Figure 5.1.3.1.8 Whiting in VI and VIId. Shrinkage contribution in XSA base run.

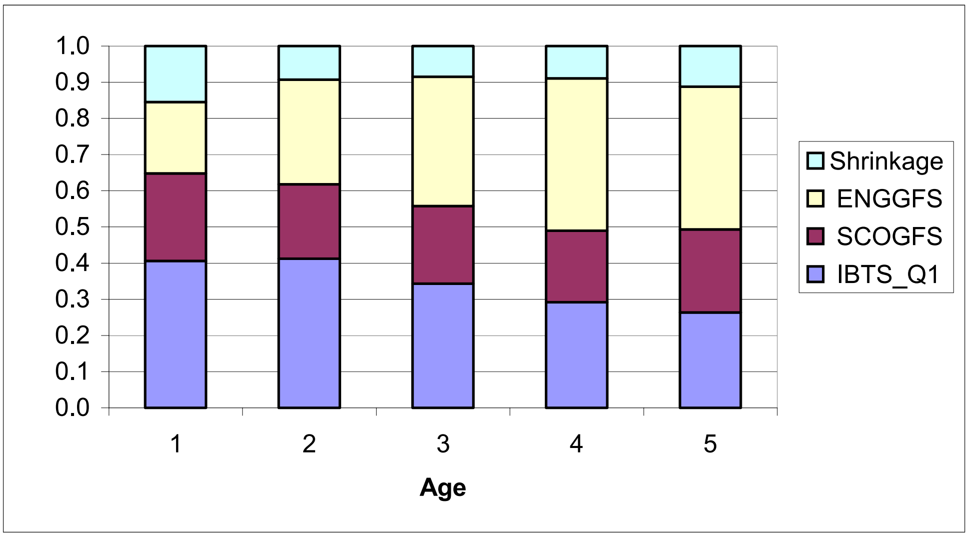
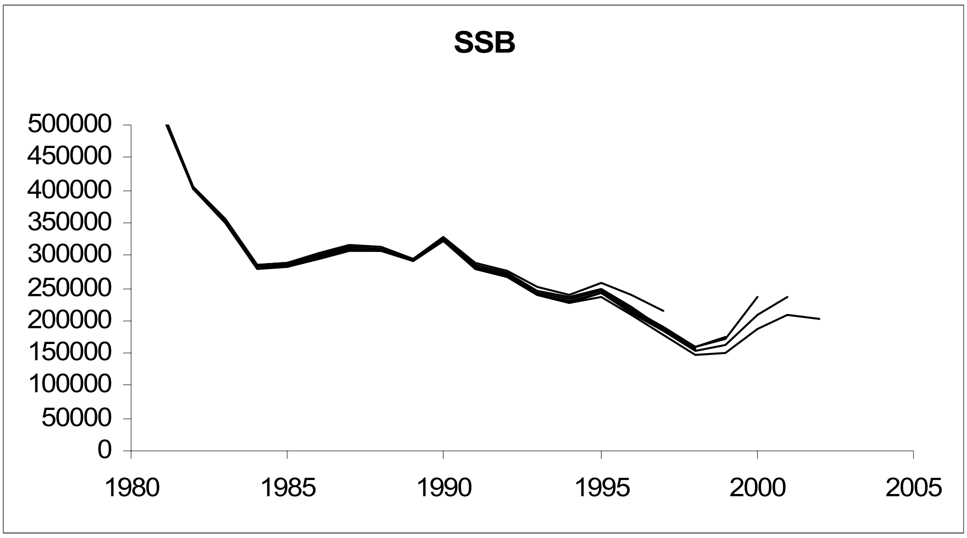


Figure 5.1.3.1.9 Whiting in VI and VIId. Retrospectives for XSA base run.



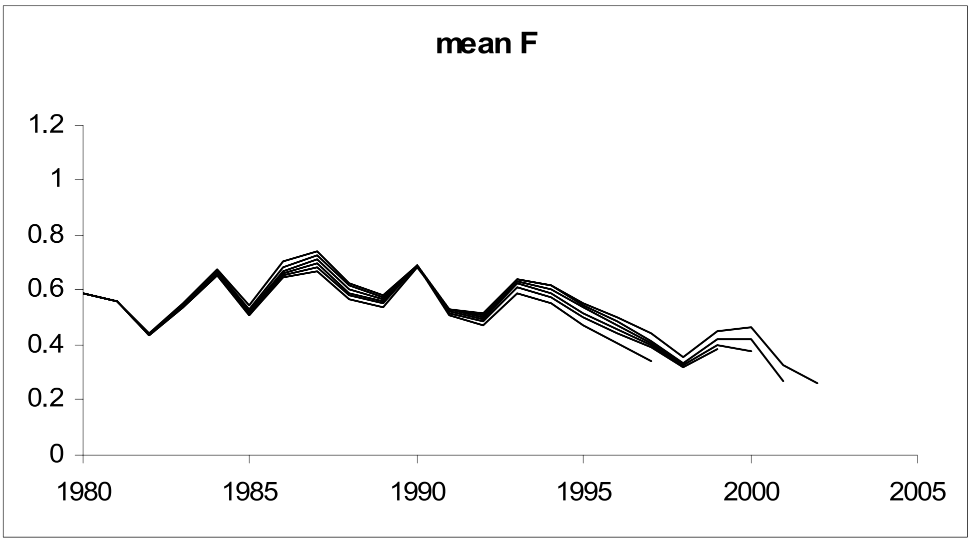
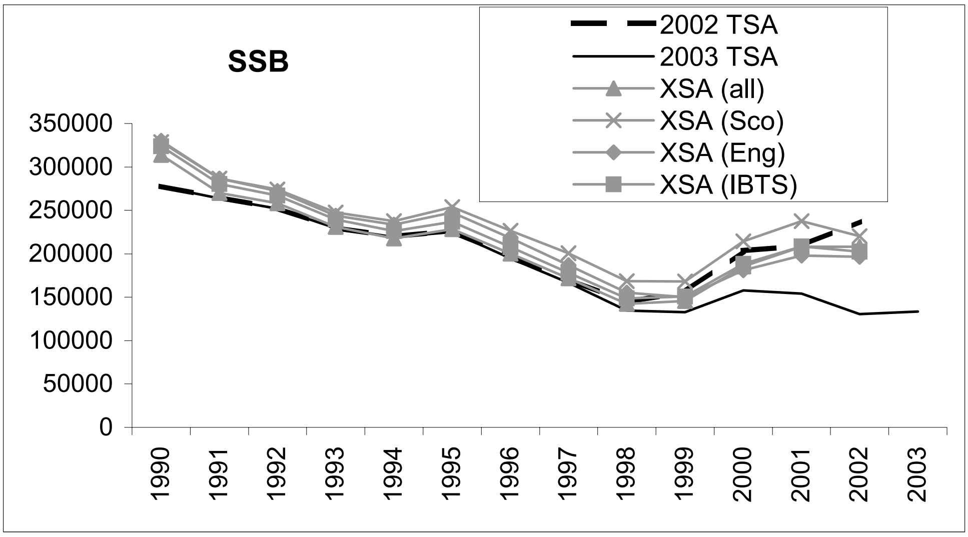
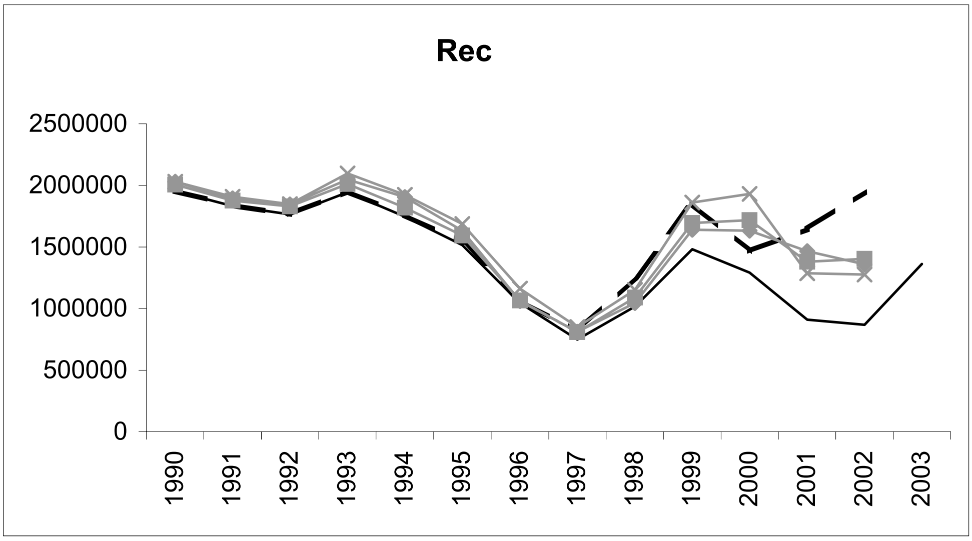


Figure 5.1.3.1.10 Whiting in VI and VIId. Comparison of single fleet XSA runs, base run (XSA all) and the 2002 and 2003 TSA runs.





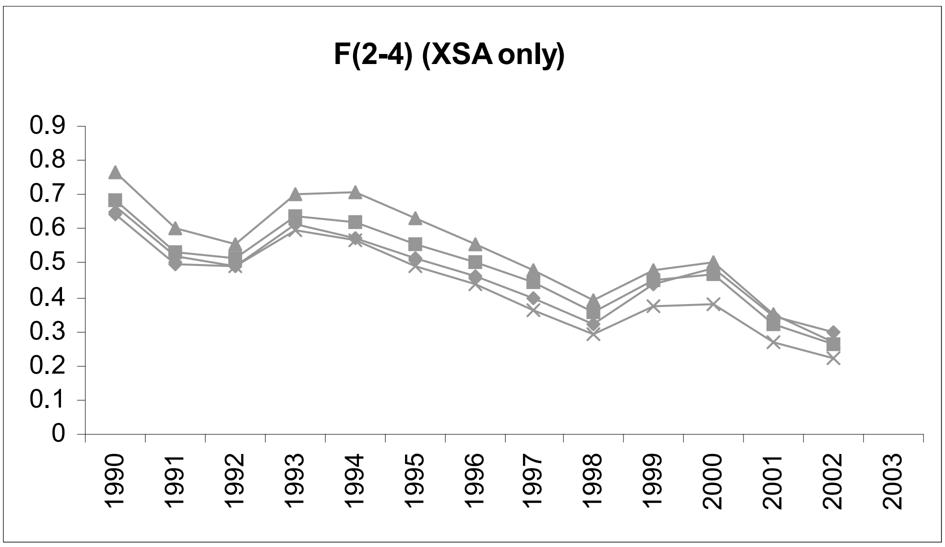
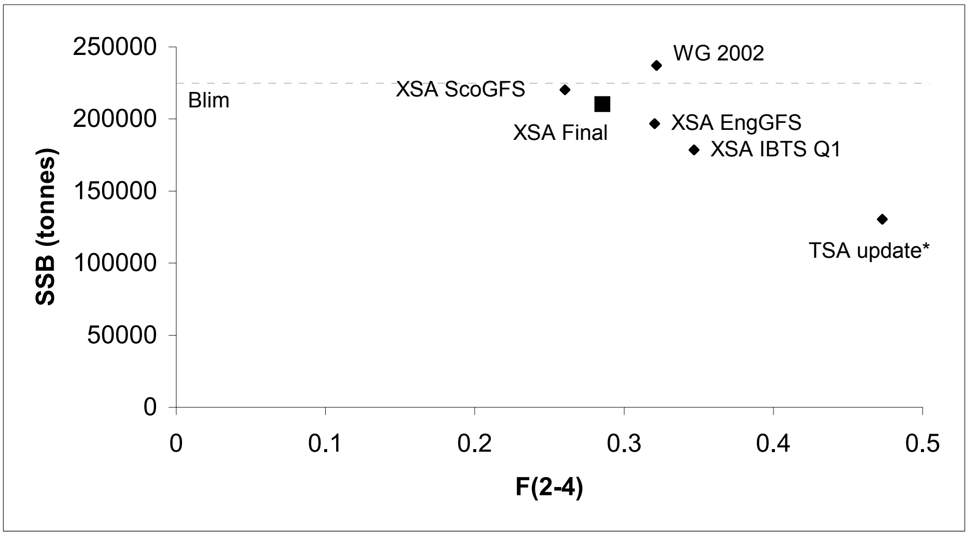


Figure 5.1.3.1.11 Whiting in VI and VIId. Summary plot of SSB against F(2-4).



* Calculated from estimated F at age in 2002 from the update TSA run.

Figure 5.1.3.1.11 Whiting in VI and VIId. A comparison of F(2-4) and F(2-6) trends predicted by the TSA analyses including ScoGFS, EngGFS and IBTSQ1 surveys.

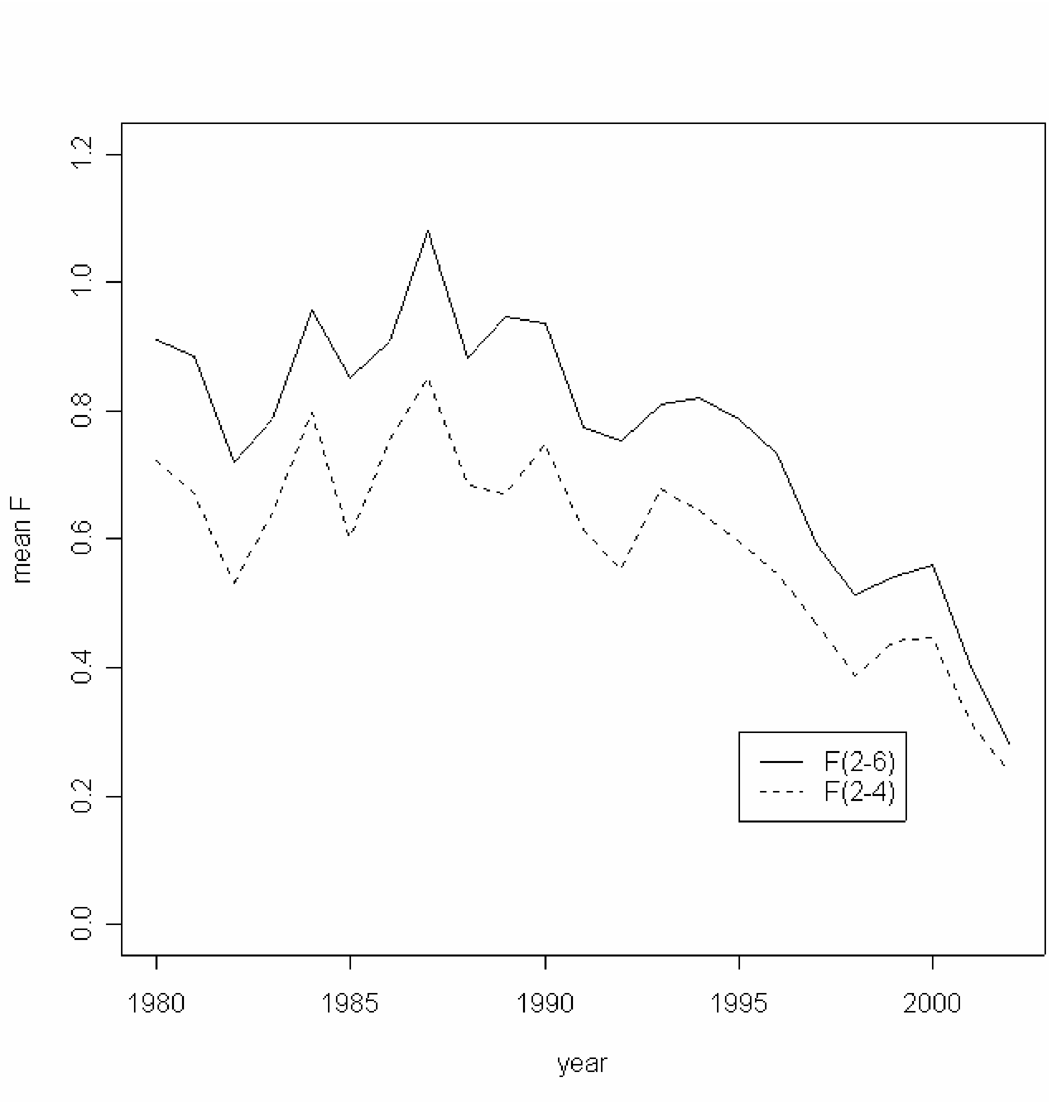


Figure 5.1.3.2.1 Whiting in IV and VIId. Stock summary.

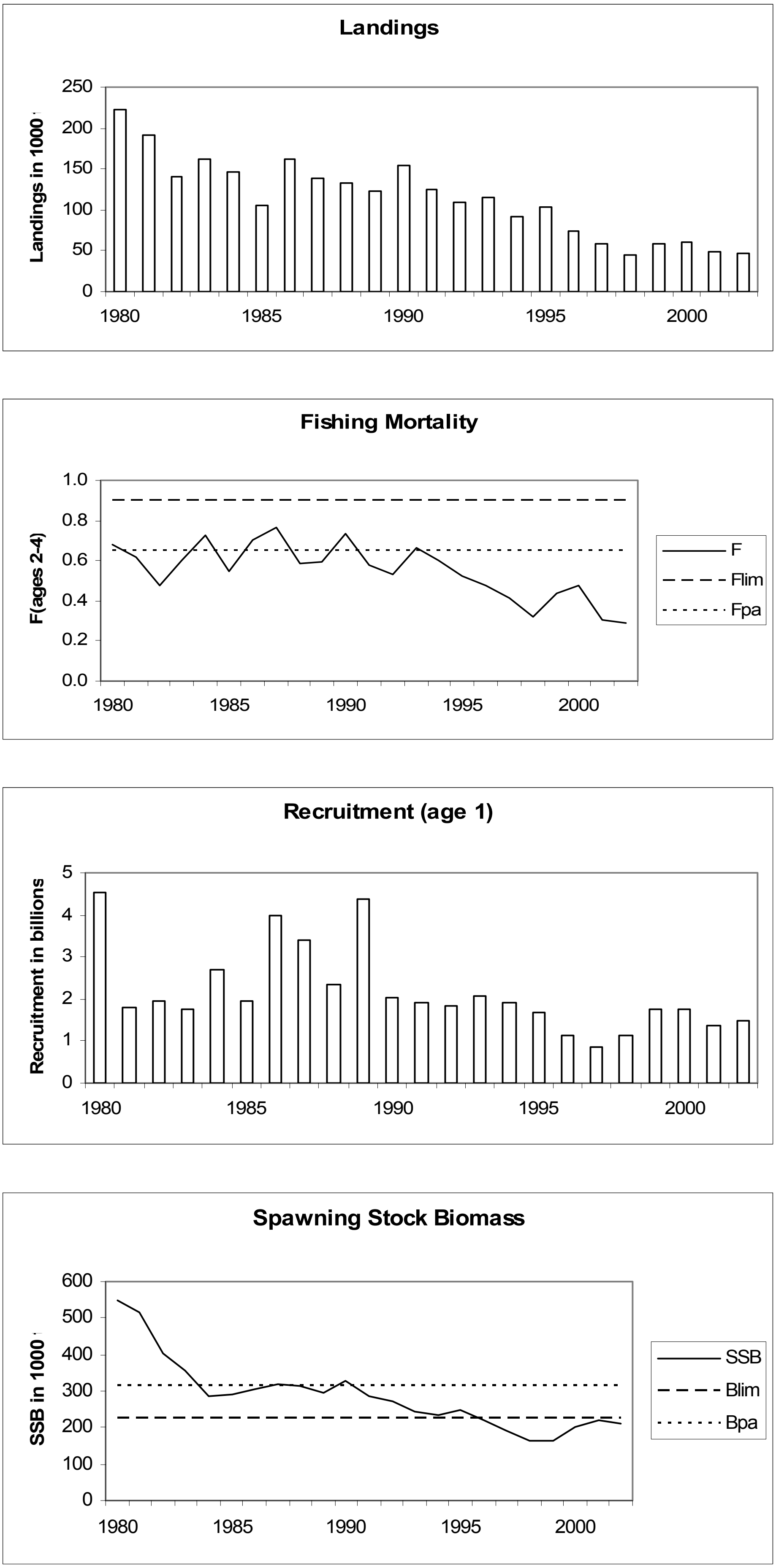
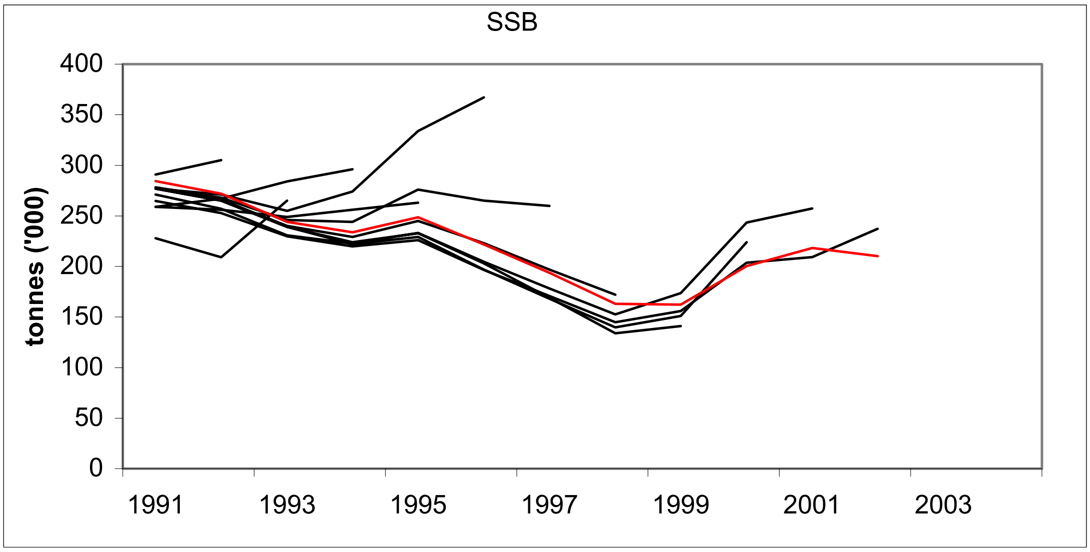
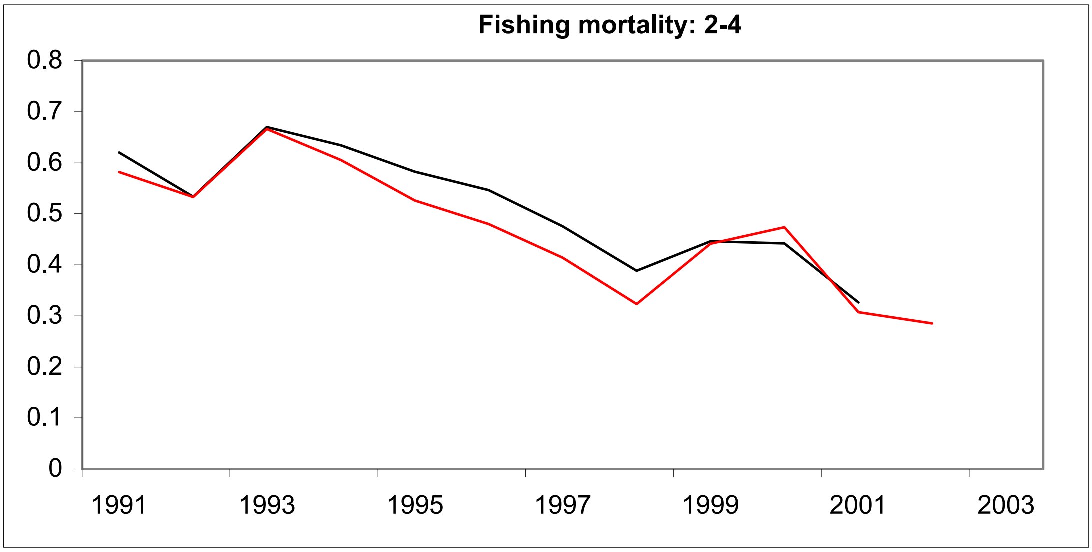


Figure 5.1.3.2.2 Whiting in IV and VIId. Historical performance of the assessment.





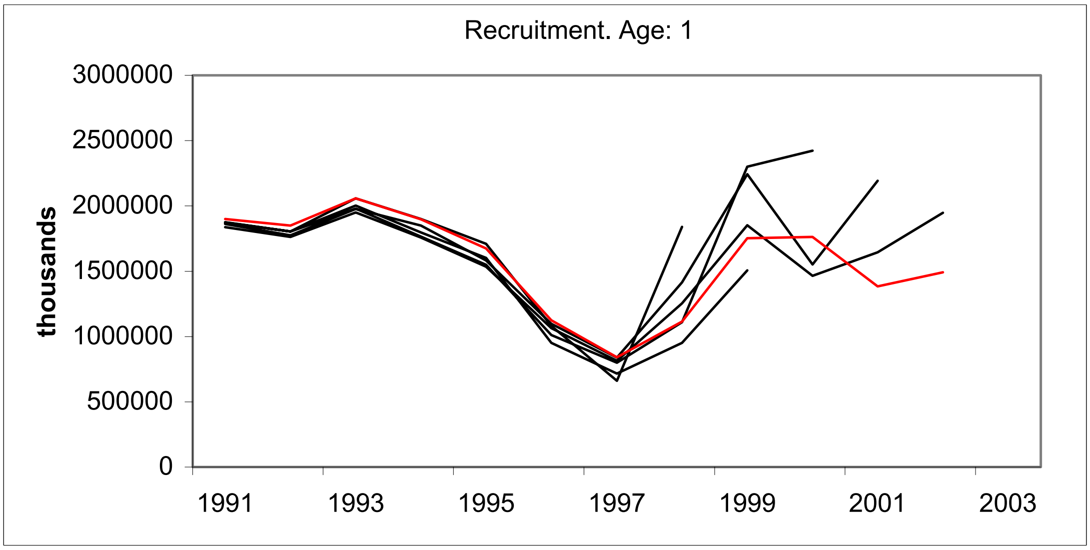
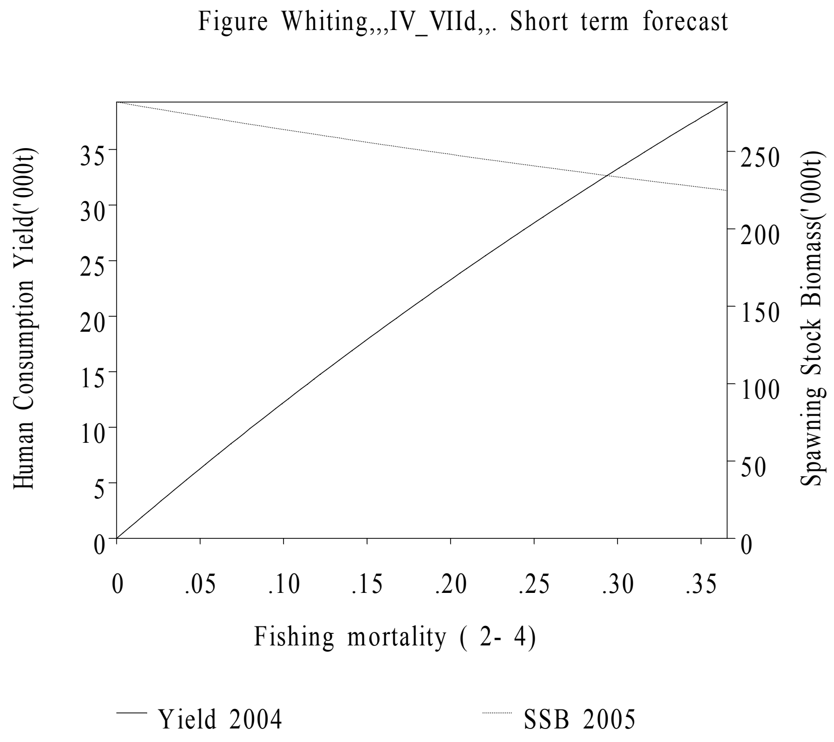
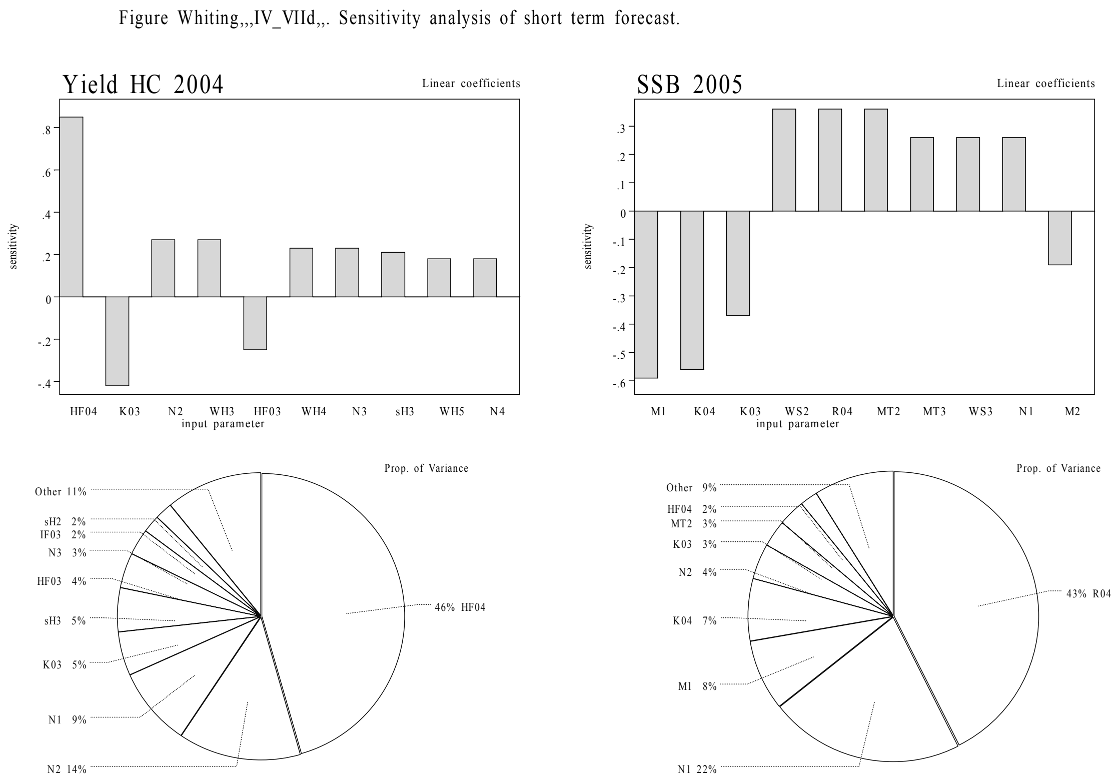


Figure 5.1.5.1 Whiting in IV and VIId. Short term forecast.



Data from file:C:\WGs\WGNSSK\2003\whiivviid.sen on 26/09/2003 at 11:02:55

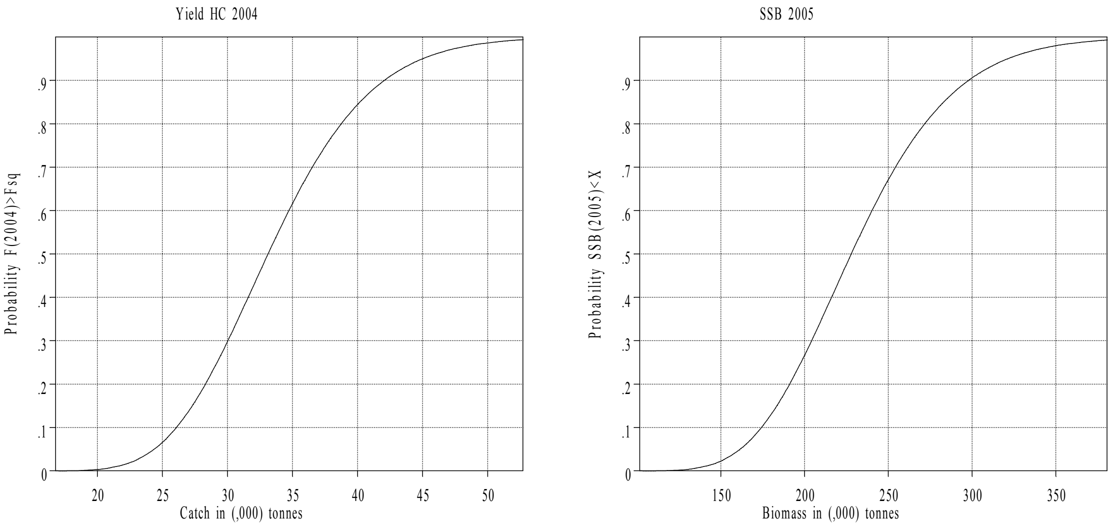
Figure 5.1.5.2 Whiting in IV and VIId. Sensitivity analysis of short term forecast.



Data from file:C:\WGs\WGNSSK\2003\whiivviid.sen on 26/09/2003 at 11:02:30

Figure 5.1.5.3 Whiting in IV and VIId. Probability profiles for short term forecast.

Figure Whiting,,,IV_VIId,,. Probability profiles for short term forecast.



Data from file:C:\WGs\WGNSSK\2003\whiivviid.sen on 26/09/2003 at 11:02:43

6 SAITHE IN SUB-AREA IV, VI AND DIVISION IIIA

The assessment of saithe in sub-area IV, VI and division IIIa is presented here as an update assessment. All the relevant biological and methodological information can be found in the stock annex (Q6) dealing with this stock. Here, only the basic input and output from the assessment model will be presented.

6.1 The Fishery

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

6.1.1 ACFM advice applicable to 2002 and 2003

For 2002 ACFM considered the stock to be inside safe biological limits and advised that fishing mortality in 2002 should be below $\mathbf{F}_{pa}$, corresponding to landings less than 148 000 t (135 000 t in IV and IIIa and 13 000 t in VI).

For 2003 ACFM considered the stock to be inside safe biological limits and advised that fishing mortality in 2003 should be below $\mathbf{F}_{pa}$, corresponding to landings less than 193 000 t.

6.1.2 Management applicable in 2002 and 2003

Management of saithe is by TAC and technical measures. The agreed TAC for saithe in IV and IIIa for 2002 is 135 000 t and in Divisions Vb, VI, XII, and XIV the TAC for 2002 is 14 000 t. For 2003 the TACs were 165 000 t and 17 119 t, respectively. Technical measures are described in Section 2.1.

6.1.3 The fishery in 2002

In 2002 the landings are estimated to be 117 thousand tonnes in Areas IV and IIIa, which is below =the TAC of 135 thousand tonnes.The landings in area VI are estimated to be 5 200 t, which is well below the TAC of 14 000 tonnes. One of the reasons that the TAC not was taken was the very low price for saithe in 2002. Data from SGDBI and Scotland indicate that the discard of saithe may be considerable in the fleets not targeting saithe.

6.2 Data available

6.2.1 Landings

Landings data by country and TACs are presented in Table 6.2.1.

6.2.2 Age compositions

Age compositions of the landings are presented in Table 6.2.2.

6.2.3 Weight at age

Weight at age in the catch is presented in Table 6.2.3. These are also used as stock weights. The procedure for calculating mean weights is described in the stock annex.

6.2.4 Maturity and natural mortality

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

6.2.5 Catch, effort and research vessel data

Fleet data used for calibration of the assessment are presented in Table 6.2.4. Commercial fleets and surveys are described in the stock annex.

6.3 Catch at age analysis

Catch at age analysis was carried out according to the specifications in the stock annex. Results of the analysis are presented in Table 6.3.1 (diagnostics), Table 6.3.2 (fishing mortality at age), Table 6.3.3 (population numbers at age), and Table 6.3.4 (stock summary). The stock summary is also shown in Figure 6.3.1 and the historical performance of the assessment is shown in Figure 6.3.2.

6.4 Recruitment estimates

The calculation of recruitment estimates is described in the stock annex. Year class strength estimates used for short term prognosis are summarized in the text table below.

Year class	Age in 2003	XSA	GM(85-00)
1999	4	**220 604**	
2000	3	139 537	**136 155**
2001	2	257 267	**173 175**
2002	1		**212 194**
2003	1		**212 194**

6.5 Short term prognosis

The short term prognosis was carried out according to the specifications in the stock annex. The input is presented in Table 6.5.1. Results are presented in Tables 6.5.2 and 6.5.3.

6.6 Comments

This assessment agrees well with the fishermen's perception of the stock (WD:14).

The next benchmark assessment for this stock is foreseen in 2005.

This assessment gives an increase in fishing mortalities for the years 2000 and 2001 of about 10%, and a reduction in the SSB for 2000 and 2001 of about 2.5% and 7%, respectively. The general tendency of this assessment to overestimate F and underestimate SSB is no longer apparent.

The historical assessment and catch prediction suffer from the lack of representative data series of recruitment at ages 1-3. At the benchmark assessment, the Working Group should consider to run the assessment with age 3 as recruits. A survey along the Norwegian coast targeting saithe larvae (0-group) started in 1999. The time series from this survey is currently too short to evaluate its potential as a year class strength predictor (i.e. to investigate the correlation between the 0-group indices and the corresponding VPA numbers at age 3).

Data from SGDBI and Scotland indicate that the discard of saithe may be considerable in the fleets not targeting saithe. This is possibly a source of bias in the assessment and should be investigated in the benchmark assessment.

Table 6.2.1 Nominal catch (in tonnes) of Saithe in Subarea IV and Division IIIa and Subarea VI, 1992-2002, as officially reported to ICES.

Subarea IV and Division IIIa

Country	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Belgium	70	113	130	228	157	254	249	200	122	24	107
Denmark	4,669	4,232	4,305	4,388	4,705	4,513	3,967	4,494	3,529	3,575	5,668
Faroe Islands	2,480	2,875	1,780	3,808	617	158	1,298	1,101	-		
France	9,061	15,258	13,612	11,224	12,336	10,932	11,786[1]	24,305[1,2]	19,200	20,472	24,819
Germany	13,177	14,814	10,013	12,093	11,567	12,581	10,117	10,481	9,273	9,479	10,999
Netherlands	180	79	18	9	17	40	7	7	11	20	6
Norway	48,205	47,669	47,042	53,793	55,531	46,424	50,254	56,150	42,735[1]	43,725[1]	58,983[1]
Poland	1,238	937	151	592	365	822	813	862	747	727	752
Sweden	3,302	4,955	5,366	1,891	1,771	1,647	1,857	1,929	1,468	1,627	1,863
UK (E. & W.)	2,893	2,429	2,354	2,522	2,864	2,556	2,293	2,874	1,227	1,186	2,521
UK (Scotland)	6,881	5,929	5,566	6,341	5,848	6,329	5,353	5,420	5,484	5,219	6,596
U.S.S.R.	-	-	-	-	-	-	-	-	67		
Total reported	92,156	99,290	90,337	96,889	95,778	86,256	87,994	107,823	83,863	86,368	112,314
Unallocated	187	5,840	12,098	16,525	14,458	17,006	12,983	-175	3,813	3,305	4,333
W.G. estimate	92,343	105,130	102,435	113,414	110,236	103,322	100,263	107,314	87,676	89,673	116,647
TAC	110,000	93,000	97,000	107,000	111,000	115,000	97,000	110,000	85,000	87,000	135,000

Preliminary values for France (1998-1999), Norway (2000-2002).
Includes IIa (EC), IIIa-d (EC) and IV: France (1999).

Subarea VI

Country	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Belgium	2	2	-	-	-	-	-	-	-	-	-
Denmark	1	2	-	-	1	-	-	-	-	-	-
Faroe Islands	1	-	-	-	3	1	-	-			
France	6,534	10,216	8,423	6,145	4,781	4,662	3,635[1]	3,467[1,2]	3,310	5,157	3,054
Germany	685	222	524	321	1,012	492	506	250	305	466	467
Ireland	278	317	438	530	419	411	216	320	410	399	86
Norway	67	59	74	35	34	26	41	126	58[1]	92[1]	136[1]
Spain	-	-	-	-	-	13	54	23	3	15	
Portugal	-	-	-	-	-	1	-	-	-		
UK (E. & W. & N.I.)	540	799	744	317	708	294	526	503	276	273	307
UK (Scotland)	2,708	2,903	2,828	3,279	2,435	2,659	2,402	2,084	2,463	2,246	1,567
United Kingdom											
Russia	-	-	-	-	-	-	-	3	25	1	1
Total reported	10,816	14,520	13,031	10,627	9,393	8,559	7,380	6,776	6,850	8,649	5,618
Unallocated	988	-577	-210	1,143	40	859	1,056	566	-960	-1,834	-495
W.G. estimate	11,804	13,943	12,821	11,770	9,433	9,418	8,436	7,342	5,890	6,818	5,186
TAC	17,000	14,000	14,000	16,000	13,000	12,000	10,900	7,500	7,000	9,000	14,000

[1]Preliminary values: France (1998-1999), Norway (2000-2002).
[2]Reported by TAC area, Vb (EC), VI, XII and XIV: France (1999).

Subareas IV and VI and Division IIIa

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
W.G. estimate	104,147	119,073	115,256	125,184	119,669	112,740	108,699	114,656	93,566	96,491	121,833

Table 6.2.2. Saithe in IV, VI and IIIa, catch numbers at age.

International catch at age ('000), Total , 1967 to 2002.

Age	1967	1968	1969	1970	1971	1972
1	0	174	36	234	594	430
2	8879	3832	2099	2261	11156	23833
3	17330	23223	30235	37249	69808	48075
4	16220	21231	17681	76661	57792	66095
5	15531	13184	11057	15000	32737	25317
6	2303	6023	7609	12128	4736	21207
7	1594	429	5738	3894	4248	3672
8	292	242	791	1792	2843	2944
9	198	123	626	318	1874	1641
10+	183	145	150	267	774	1607

Age	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
1	4708	4753	335	270	2172	1253	916	1321	5457	1970
2	37832	19206	74231	34111	14125	20551	17756	24100	20644	29570
3	54332	66938	56987	207823	27461	35059	16332	17494	26178	31895
4	37698	33740	25864	53060	54967	27269	14216	12341	8339	40587
5	26849	14123	10319	11696	14755	18062	11182	9015	6739	9174
6	16061	20688	7566	6253	5490	3312	8699	6718	3675	5978
7	8428	14666	13657	3976	3777	1138	2805	5658	3335	2145
8	2000	5199	9357	5362	3447	1033	733	1150	3396	1454
9	1357	1477	3501	3586	3812	768	540	509	657	982
10+	2381	1955	2687	3490	4701	3484	2089	2302	2536	1254

Age	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	312	206	231	322	787	32	3664	355	492	319
2	36824	37387	9415	7227	31017	8762	9871	5764	13091	6679
3	28242	80933	134024	55435	31220	32578	22128	40808	46117	18404
4	20604	32172	55605	91223	97470	26408	30752	19583	29871	33614
5	26013	12957	13281	15186	13990	35323	13187	11322	7467	12753
6	5678	13011	4765	5381	3158	3828	10951	4714	3583	3193
7	4893	1657	3005	2603	1811	1908	1557	2776	1716	1524
8	1494	1252	682	1456	1240	1104	739	745	953	696
9	1036	335	399	445	910	776	419	281	367	518
10+	1327	646	742	900	700	680	488	364	458	422

Age	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
1	160	106	157	354	27	218	64	145	4	913
2	10118	8033	4338	8963	12396	3706	6634	2692	1846	6884
3	37823	19958	26664	11066	15036	10363	9429	7064	17355	20088
4	20828	40194	26034	38861	19299	31017	13872	17295	18565	42857
5	11845	13034	14797	11786	30177	16367	26684	8940	23497	9007
6	3125	4297	3774	7731	3676	16077	8389	12339	3622	9003
7	1568	947	3494	3163	2640	2231	10070	3159	3518	2432
8	1511	346	674	808	1012	1206	2346	3226	1417	2925
9	814	427	552	210	291	567	891	641	1121	1827
10+	1026	794	800	491	288	277	657	441	218	2043

Table 6.2.3 Saithe in IV,VI and IIIa Catch weights at age (kg)

International mean weight at age (kg), Total catch, 1967 to 2002.

Age	1967	1968	1969	1970	1971	1972
1	0.000	0.501	0.451	0.434	0.495	0.328
2	0.697	0.770	0.609	0.695	0.610	0.549
3	0.930	1.278	0.966	0.941	0.840	0.808
4	1.362	1.652	1.557	1.441	1.348	1.196
5	2.104	1.989	2.261	2.059	2.178	1.961
6	3.186	3.009	2.713	2.718	2.936	2.369
7	3.754	4.040	3.559	3.599	3.766	3.794
8	5.316	4.428	4.406	4.463	4.634	4.228
9	5.891	6.136	5.220	5.687	5.172	4.630
10+	7.719	7.406	6.767	6.845	6.163	6.326

Age	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
1	0.164	0.275	0.216	0.459	0.426	0.355	0.435	0.259	0.277	0.253
2	0.432	0.509	0.502	0.516	0.430	0.516	0.406	0.421	0.596	0.508
3	0.821	0.861	0.893	0.702	0.760	0.821	1.107	0.955	0.961	1.086
4	1.406	1.561	1.498	1.309	1.256	1.327	1.623	1.821	1.821	1.575
5	1.641	2.383	2.490	2.260	1.935	2.155	2.238	2.391	2.717	2.529
6	2.571	2.753	3.300	3.071	3.111	3.340	3.095	3.030	3.587	3.220
7	3.357	3.429	3.765	4.035	4.162	4.522	4.050	4.090	4.536	4.207
8	4.684	4.498	4.296	4.383	4.605	4.900	5.274	5.126	5.478	5.125
9	4.814	5.713	5.540	5.112	4.859	5.449	6.308	5.939	6.980	5.905
10+	6.445	7.857	7.562	7.147	6.542	7.400	7.955	8.148	8.724	8.823

Age	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	0.413	0.389	0.149	0.629	0.371	0.517	0.426	0.272	0.479	0.619
2	0.478	0.501	0.555	0.548	0.418	0.638	0.726	0.703	0.557	0.630
3	1.028	0.795	0.663	0.694	0.674	0.779	0.895	0.844	0.791	0.964
4	1.718	1.614	1.265	1.035	0.876	0.981	1.036	1.196	1.158	1.189
5	2.149	2.297	1.950	1.794	1.824	1.386	1.420	1.583	1.752	1.607
6	3.138	2.690	2.772	2.432	3.075	2.791	1.998	2.247	2.365	2.242
7	3.691	3.896	3.407	3.572	4.210	4.024	3.914	3.242	3.165	3.668
8	4.632	4.665	4.950	4.209	5.330	5.254	5.017	4.858	4.222	4.330
9	5.505	6.183	5.865	5.651	6.128	6.322	6.430	6.315	6.066	5.412
10+	8.453	8.474	8.854	8.218	8.603	8.649	8.431	8.416	8.191	7.045

Age	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
1	0.358	0.287	0.502	0.280	0.432	0.603	0.519	0.563	0.508	0.715
2	0.744	0.697	0.759	0.510	0.436	0.659	0.589	0.803	0.730	0.777
3	0.899	0.944	1.002	0.967	0.905	0.892	0.881	1.027	0.796	0.804
4	1.260	1.119	1.294	1.187	1.145	0.966	1.061	1.127	1.071	0.857
5	1.754	1.601	1.816	1.807	1.452	1.393	1.211	1.539	1.303	1.323
6	2.636	2.434	2.562	2.368	2.587	1.744	1.754	1.684	2.057	1.755
7	3.185	3.617	3.555	2.952	3.556	2.949	2.337	2.594	2.569	2.275
8	3.980	4.787	4.767	4.705	4.525	3.883	3.493	3.084	3.523	3.119
9	5.080	6.548	5.267	6.092	6.158	4.996	4.844	4.773	4.173	3.938
10+	6.891	8.326	7.891	8.382	8.866	7.227	6.745	7.461	6.193	4.575

Table 6.2.4. Saithe in IV, VI and IIIa - Combined tuning data

```
Saithe in IV, VI and IIIa - Combined tuning data
104
FRATRB_IV
1990  2002
1     1     0     1
3     9
21758 3379.574    2471.553    1405.54     304.063     290.298     32.728      14.813
15248 1381.383    2538.766    731.379     372.239     130.79      67.67       11.93
7902  717.161     1480.817    498.716     73.572      24.402      7.133       5.741
13527 3917.8      2253.44     1162.23     103.625     8.299       8.648       6.183
14417 1770.754    3652.84     1381.104    434.086     38.895      5.317       2.71
14632 3151.807    1682.869    921.653     225.695     70.393      24.088      13.317
16241 895.031     4286.247    1053.226    535.95      107.63      24.634      15.158
12903 1087.28     1914.745    3175.192    190.091     83.908      16.535      13.738
13559 799.753     2538.413    1870.453    1480.902    52.256      23.023      10.381
14588 852.467     1233.817    2666.699    620.174     399.661     24.212      13.688
8695  889.314     1993.229    1038.898    1195.148    214.774     180.514     31.751
6366  724.1021    1339.454    2372.881    269.951     144.906     25.554      29.28
11022 3275.662    7576.645    1220.435    1242.118    175.302     151.434     40.935
NORTRL_IV
1980  2002
1     1     0     1
3     9
18317 186   1290  658   980   797   261   60
28229 88    844   1345  492   670   699   119
47412 6624  12016 2737  2112  341   234   19
43099 4401  4963  8176  1950  2367  481   357
47803 20576 7328  2207  3358  433   444   106
66607 27088 21401 5307  1569  637   56    46
57468 5297  29612 3589  818   393   122   25
30008 2645  18454 2217  290   235   201   198
18402 3132  2042  2214  141   157   74    134
17781 649   2126  835   694   309   154   65
10249 804   781   924   519   203   63    12
28768 14348 4968  1194  518   203   51    56
35621 3447  9532  4031  1087  465   165   109
24572 7635  4028  2878  1018  526   365   252
30628 3939  16098 4276  926   251   72    203
32489 4347  9366  5412  833   1644  273   203
40400 3790  14429 4414  2765  1144  189   16
36026 2894  5266  9837  1419  892   299   72
24510 1376  8279  5454  5662  977   489   243
20570 783   2527  6741  2333  3573  1162  342
15520 284   1628  2054  4261  1066  1203  221
20593 4554  4982  6332  922   1224  506   388
29278 3173  9667  2808  3061  780   1298  839
GER_OTB_IV
1995  2002
1     1     0     1
3     9
21167 1158  2359  1350  589   152   30    16
19064 510   3167  1081  517   257   148   41
21707 816   2475  3636  292   163   70    24
20153 591   2744  1395  1776  238   100   39
18596 284   1065  2264  943   1015  77    36
12223 542   2185  823   1216  242   325   38
11008 892   1329  2317  372   532   249   155
12789 650   3658  1230  1100  99    140   69
NORACU
1995  2002
1     1     0.5   0.75
3     7
1     56244 4756        1214  174   161
1     21480 29698       6125  4593  1821
1     22585 16188       24939 3002  2472
1     15180 48295       13540 11194 1173
1     16933 21109       27036 4399  3590
1     34551 82338       14213 13842 3018
1     72108 28764       17405 3870  1091
1     82501 163524      17479 4475  2437
```

Table 6.3.1. Saithe in IV, VI and IIIa. XSA diagnostics.

Lowestoft VPA Version 3.1

2/09/2003 9:28

Extended Survivors Analysis

SAITHE IN IV, VI and IIIa : 1967 - 2002

CPUE data from file update.tun

Catch data for 36 years. 1967 to 2002. Ages 1 to 10.

Fleet,	First, year,	Last, year,	First, age ,	Last, age	Alpha,	Beta
FRATRB_IV,	1990,	2002,	3,	9,	.000,	1.000
NORTRL_IV,	1980,	2002,	3,	9,	.000,	1.000
GER_OTB_IV,	1995,	2002,	3,	9,	.000,	1.000
NORACU,	1995,	2002,	3,	7,	.500,	.750

Time series weights :

Tapered time weighting applied
Power = 3 over 20 years

Catchability analysis :

Catchability dependent on stock size for ages < 3

Regression type = C
Minimum of 5 points used for regression
Survivor estimates shrunk to the population mean for ages < 3

Catchability independent of age for ages >= 7

Terminal population estimation :

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

S.E. of the mean to which the estimates are shrunk = 1.000

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

Prior weighting not applied

Tuning converged after 39 iterations

1

Regression weights

.751,	.820,	.877,	.921,	.954,	.976,	.990,	.997,	1.000,	1.000

Fishing mortalities

Age,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002
1,	.001,	.001,	.001,	.003,	.000,	.002,	.000,	.000,	.000,	.003
2,	.085,	.032,	.035,	.046,	.141,	.023,	.060,	.008,	.006,	.044
3,	.322,	.240,	.141,	.118,	.102,	.168,	.073,	.083,	.068,	.079
4,	.490,	.680,	.568,	.313,	.309,	.316,	.355,	.187,	.328,	.240
5,	.623,	.660,	.576,	.549,	.429,	.470,	.495,	.409,	.418,	.261
6,	.617,	.483,	.401,	.686,	.327,	.429,	.470,	.449,	.287,	.278
7,	.683,	.380,	.957,	.704,	.530,	.338,	.527,	.323,	.220,	.319
8,	1.009,	.307,	.514,	.603,	.509,	.494,	.725,	.317,	.235,	.287
9,	1.239,	.921,	1.201,	.295,	.453,	.606,	.860,	.439,	.172,	.538

1

XSA population numbers (Thousands)

AGE YEAR ,	1,	2,	3,	4,	5,	6,	7,	8,	9,
1993 ,	3.46E+05,	1.37E+05,	1.52E+05,	5.94E+04,	2.82E+04,	7.50E+03,	3.50E+03,	2.63E+03,	1.27E+03,
1994 ,	1.71E+05,	2.83E+05,	1.03E+05,	9.01E+04,	2.98E+04,	1.24E+04,	3.31E+03,	1.45E+03,	7.84E+02,
1995 ,	2.68E+05,	1.40E+05,	2.25E+05,	6.64E+04,	3.74E+04,	1.26E+04,	6.27E+03,	1.85E+03,	8.72E+02,
1996 ,	1.28E+05,	2.19E+05,	1.10E+05,	1.60E+05,	3.08E+04,	1.72E+04,	6.92E+03,	1.97E+03,	9.08E+02,
1997 ,	2.25E+05,	1.04E+05,	1.71E+05,	8.03E+04,	9.56E+04,	1.46E+04,	7.09E+03,	2.80E+03,	8.83E+02,
1998 ,	1.55E+05,	1.84E+05,	7.41E+04,	1.27E+05,	4.83E+04,	5.09E+04,	8.61E+03,	3.42E+03,	1.38E+03,
1999 ,	4.37E+05,	1.26E+05,	1.47E+05,	5.13E+04,	7.56E+04,	2.47E+04,	2.72E+04,	5.03E+03,	1.71E+03,
2000 ,	4.38E+05,	3.58E+05,	9.75E+04,	1.12E+05,	2.95E+04,	3.77E+04,	1.26E+04,	1.31E+04,	1.99E+03,
2001 ,	2.17E+05,	3.58E+05,	2.91E+05,	7.34E+04,	7.60E+04,	1.60E+04,	1.97E+04,	7.49E+03,	7.83E+03,
2002 ,	3.15E+05,	1.78E+05,	2.92E+05,	2.22E+05,	4.33E+04,	4.10E+04,	9.84E+03,	1.30E+04,	4.85E+03,

Estimated population abundance at 1st Jan 2003

, 0.00E+00, 2.57E+05, 1.40E+05, 2.21E+05, 1.43E+05, 2.73E+04, 2.54E+04, 5.86E+03, 7.97E+03,

Taper weighted geometric mean of the VPA populations:

, 2.34E+05, 1.84E+05, 1.42E+05, 8.82E+04, 4.01E+04, 1.76E+04, 7.80E+03, 3.57E+03, 1.49E+03,

Standard error of the weighted Log(VPA populations) :

, .4078, .4113, .4600, .4682, .4987, .6226, .6385, .7518, .7423,

1

Log catchability residuals.

Fleet : FRATRB_IV

Age	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
3	99.99	99.99	99.99	99.99	99.99	99.99	99.99	.65	-.03	.27
4	99.99	99.99	99.99	99.99	99.99	99.99	99.99	.30	.37	.31
5	99.99	99.99	99.99	99.99	99.99	99.99	99.99	.01	.00	.14
6	99.99	99.99	99.99	99.99	99.99	99.99	99.99	-.30	.30	-.38
7	99.99	99.99	99.99	99.99	99.99	99.99	99.99	.97	.69	-.41
8	99.99	99.99	99.99	99.99	99.99	99.99	99.99	-.10	.72	-.90
9	99.99	99.99	99.99	99.99	99.99	99.99	99.99	.21	.04	-.26

Age	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
3	.98	.47	.21	-.46	-.48	.03	-.71	.27	-.73	.24
4	.28	.37	-.17	-.33	-.22	-.44	-.31	-.17	.23	.26
5	.12	.19	-.49	-.28	-.13	-.01	-.16	.32	.51	-.21
6	-.53	.28	-.45	.13	-.67	.13	-.07	.67	.28	.31
7	-1.58	-.17	.01	.13	.01	-.79	.11	.68	.10	.48
8	-1.11	-1.37	-.03	-.13	-.69	-.62	-.93	.46	-.66	.05
9	-.63	-1.16	.42	.02	.25	-.46	-.36	.66	-.60	-.17

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	-13.8964	-12.7387	-12.4436	-12.8838	-13.5711	-13.5711	-13.5711
S.E(Log q)	.5245	.3098	.2794	.4145	.6373	.7515	.5328

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	1.40	-.770	14.70	.29	13	.75	-13.90
4	1.12	-.506	12.90	.65	13	.36	-12.74
5	1.01	-.071	12.47	.76	13	.30	-12.44
6	.72	2.159	12.03	.87	13	.26	-12.88
7	.74	1.132	12.39	.68	13	.47	-13.57
8	.77	1.209	12.68	.76	13	.46	-14.00
9	1.13	-.518	14.54	.65	13	.59	-13.73

1

Fleet : NORTRL_IV

Age	1980	1981	1982
3	99.99	99.99	99.99
4	99.99	99.99	99.99
5	99.99	99.99	99.99
6	99.99	99.99	99.99
7	99.99	99.99	99.99
8	99.99	99.99	99.99
9	99.99	99.99	99.99

Age	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
3	.32	1.32	.88	-.70	.25	.89	-.26	.11	1.81	.47
4	-.25	-.02	.58	.85	.49	-.26	-.14	-.23	.28	.54
5	-.05	-.85	-.20	-.26	-.12	-.45	-.68	.09	-.39	.47
6	.34	.04	-.62	-.88	-1.01	-1.28	-.26	.43	-.56	.25
7	.72	-.54	-1.20	-1.31	-.79	-.48	.17	-.04	-.91	-.37
8	.40	.00	-2.19	-2.02	-.59	-.61	.46	-.10	-1.60	-.67
9	.36	-.10	-1.78	-2.09	-.14	.33	.29	-.65	-.45	-.23

Age	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
3	1.18	.65	-.13	.21	-.39	.12	-1.00	-1.32	.08	-.64
4	.14	.97	.62	-.15	-.36	.03	-.07	-1.08	.24	-.60
5	.18	.32	.23	-.01	-.28	.22	.17	.17	.07	-.61
6	.60	-.28	-.49	.30	-.24	.32	.35	.80	-.23	-.32
7	.57	-.46	.97	.18	-.05	.14	.55	.30	-.34	-.40
8	.63	-.92	.20	-.41	-.23	.44	1.20	.38	-.25	-.18
9	1.08	1.00	.94	-2.24	-.52	.70	1.11	.62	-.59	.48

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

Age ,	3,	4,	5,	6,	7,	8,	9
Mean Log q,	-14.0339,	-12.6122,	-12.1906,	-12.3263,	-12.1688,	-12.1688,	-12.1688,
S.E(Log q),	.8064,	.5457,	.3300,	.5053,	.5221,	.7286,	1.0023,

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,	1.26,	-.380,	14.60,	.17,	20,	1.06,	-14.03,
4,	1.63,	-1.117,	13.38,	.24,	20,	.88,	-12.61,
5,	1.09,	-.385,	12.33,	.66,	20,	.37,	-12.19,
6,	.80,	1.013,	11.82,	.72,	20,	.40,	-12.33,
7,	.86,	.643,	11.72,	.68,	20,	.46,	-12.17,
8,	.78,	.943,	11.38,	.66,	20,	.57,	-12.25,
9,	.92,	.214,	11.67,	.40,	20,	.96,	-12.06,

1

Fleet : GER_OTB_IV

Age ,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002
3 ,	99.99,	99.99,	.02,	.01,	-.10,	.52,	-.86,	.62,	.13,	-.34
4 ,	99.99,	99.99,	.34,	-.25,	.06,	-.22,	-.16,	.12,	.21,	-.07
5 ,	99.99,	99.99,	-.06,	.00,	-.10,	-.28,	-.15,	.16,	.35,	.06
6 ,	99.99,	99.99,	.17,	-.04,	-.73,	-.06,	.13,	.37,	.08,	.07
7 ,	99.99,	99.99,	-.03,	.39,	-.29,	-.12,	.35,	.01,	.41,	-.69
8 ,	99.99,	99.99,	-.63,	1.05,	-.22,	.01,	-.46,	.26,	.62,	-.63
9 ,	99.99,	99.99,	-.22,	.41,	-.16,	.02,	-.08,	.05,	.07,	-.24

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,	-15.0866,	-13.2777,	-12.8574,	-12.9109,	-13.1219,	-13.1219,	-13.1219,
S.E(Log q),	.4767,	.2112,	.1994,	.3247,	.3842,	.6063,	.2082,

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,	1.75,	-1.243,	17.41,	.33,	8,	.80,	-15.09,
4,	1.22,	-1.115,	13.67,	.82,	8,	.25,	-13.28,
5,	1.03,	-.177,	12.93,	.82,	8,	.22,	-12.86,
6,	.83,	.870,	12.42,	.82,	8,	.27,	-12.91,
7,	.75,	1.222,	12.18,	.81,	8,	.28,	-13.12,
8,	1.09,	-.256,	13.54,	.59,	8,	.71,	-13.12,
9,	1.03,	-.273,	13.30,	.94,	8,	.23,	-13.14,

1

Fleet : NORACU

Age ,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002
3 ,	99.99,	99.99,	.20,	-.07,	-.47,	.01,	-.62,	.51,	.14,	.28
4 ,	99.99,	99.99,	-1.35,	-.55,	-.48,	.17,	.27,	.74,	.20,	.78
5 ,	99.99,	99.99,	-1.90,	-.11,	.09,	.19,	.45,	.69,	-.05,	.42
6 ,	99.99,	99.99,	-2.44,	.70,	.22,	.35,	.16,	.87,	.35,	-.44
7 ,	99.99,	99.99,	-1.41,	.76,	.94,	-.12,	-.04,	.43,	-1.10,	.46
8 ,	No data for this fleet at this age									
9 ,	No data for this fleet at this age									

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

Age ,	3,	4,	5,	6,	7
Mean Log q,	-1.3703,	-.8089,	-1.0404,	-1.4713,	-1.5351,
S.E(Log q),	.3837,	.7101,	.7796,	1.0167,	.8389,

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,	.95,	.174,	1.91,	.67,	8,	.39,	-1.37,
4,	.66,	.925,	4.47,	.56,	8,	.47,	-.81,
5,	.81,	.331,	2.93,	.34,	8,	.68,	-1.04,
6,	.59,	.936,	5.00,	.48,	8,	.61,	-1.47,
7,	1.53,	-.539,	-2.59,	.15,	8,	1.36,	-1.54,

1

Terminal year survivor and F summaries :

Age 1 Catchability dependent on age and year class strength

Year class = 2001

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
FRATRB_IV,	1.,	.000,	.000,	.00,	0,	.000,	.000
NORTRL_IV,	1.,	.000,	.000,	.00,	0,	.000,	.000
GER_OTB_IV,	1.,	.000,	.000,	.00,	0,	.000,	.000
NORACU,	1.,	.000,	.000,	.00,	0,	.000,	.000
P shrinkage mean ,	184430.,	.41,,,,				.855,	.004
F shrinkage mean ,	1839933.,	1.00,,,,				.145,	.000

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
257267.,	.38,	12.48,	2,	32.819,	.003

1

Age 2 Catchability dependent on age and year class strength

Year class = 2000

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
FRATRB_IV,	1.,	.000,	.000,	.00,	0,	.000,	.000
NORTRL_IV,	1.,	.000,	.000,	.00,	0,	.000,	.000
GER_OTB_IV,	1.,	.000,	.000,	.00,	0,	.000,	.000
NORACU,	1.,	.000,	.000,	.00,	0,	.000,	.000
P shrinkage mean ,	142141.,	.46,,,,				.825,	.043
F shrinkage mean ,	127861.,	1.00,,,,				.175,	.048

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
139537.,	.42,	11.85,	2,	28.344,	.044

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

Year class = 1999

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
FRATRB_IV,	279351.,	.548,	.000,	.00,	1,	.212,	.063
NORTRL_IV,	116877.,	.839,	.000,	.00,	1,	.090,	.145
GER_OTB_IV,	157070.,	.507,	.000,	.00,	1,	.247,	.110
NORACU,	292430.,	.408,	.000,	.00,	1,	.382,	.060
F shrinkage mean ,	174030.,	1.00,,,,				.069,	.099

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
220604.,	.25,	.17,	5,	.660,	.079

1

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

Year class = 1998

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
FRATRB_IV ,	146198.,	.279,	.426,	1.53,	2,	.313,	.235
NORTRL_IV ,	96509.,	.471,	.308,	.65,	2,	.109,	.338
GER_OTB_IV ,	139692.,	.258,	.086,	.33,	2,	.364,	.245
NORACU ,	192221.,	.359,	.269,	.75,	2,	.182,	.184
F shrinkage mean ,	110573.,	1.00,,,,				.031,	.301

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
143168.,	.16,	.12,	9,	.780,	.240

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

 Year class = 1997

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                  Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 FRATRB_IV   ,             27055.,   .207,       .158,    .76,   3,  .328,     .263
 NORTRL_IV   ,             16526.,   .281,       .289,   1.03,   3,  .189,     .401
 GER_OTB_IV         ,      32811.,   .199,       .124,    .62,   3,  .352,     .222
 NORACU     ,              42078.,   .334,       .083,    .25,   3,  .109,     .177

   F shrinkage mean  ,     14449.,   1.00,,,,                        .021,     .447

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
     27313.,       .12,      .11,   13,    .938,   .261


1
 Age  6   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
 FRATRB_IV,                30084.,   .191,       .221,   1.16,   4,  .315,     .240
 NORTRL_IV    ,            19045.,   .252,       .247,    .98,   4,  .187,     .356
 GER_OTB_IV  ,             27834.,   .176,       .179,   1.02,   4,  .383,     .257
 NORACU      ,             19289.,   .325,       .287,    .88,   4,  .093,     .352

   F shrinkage mean  ,     16815.,   1.00,,,,                        .021,     .395

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
     25398.,       .11,      .11,   17,    .974,   .278


 Age  7   Catchability constant w.r.t. time and dependent on age

 Year class = 1995

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                  Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 FRATRB_IV    ,             7037.,   .192,       .135,    .71,   5,  .282,     .272
 NORTRL_IV          ,       5246.,   .240,       .120,    .50,   5,  .207,     .350
 GER_OTB_IV         ,       5179.,   .171,       .183,   1.07,   5,  .400,     .354
 NORACU               ,     7919.,   .338,       .120,    .36,   5,  .087,     .245

   F shrinkage mean  ,      4612.,   1.00,,,,                        .024,     .390

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
      5858.,       .11,      .08,   21,    .718,   .319

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 Age  8   Catchability constant w.r.t. time and age (fixed at the value for age)  7

 Year class = 1994

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                  Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 FRATRB_IV          ,       8150.,   .201,       .174,    .87,   6,  .273,     .281
 NORTRL_IV          ,       8455.,   .245,       .183,    .74,   6,  .219,     .272
 GER_OTB_IV         ,       8365.,   .176,       .166,    .94,   6,  .402,     .275
 NORACU               ,     5952.,   .354,       .341,    .96,   5,  .077,     .368

   F shrinkage mean  ,      4540.,   1.00,,,,                        .029,     .459

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
      7966.,       .11,      .09,   24,    .806,   .287


 Age  9   Catchability constant w.r.t. time and age (fixed at the value for age)  7

 Year class = 1993

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                  Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 FRATRB_IV   ,              2101.,   .212,       .134,    .63,   7,  .250,     .581
 NORTRL_IV          ,       2756.,   .252,       .106,    .42,   7,  .166,     .470
 GER_OTB_IV         ,       2164.,   .169,       .102,    .61,   7,  .499,     .568
 NORACU               ,     2551.,   .358,       .142,    .40,   5,  .050,     .500

   F shrinkage mean  ,      4793.,   1.00,,,,                        .035,     .296

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
      2319.,       .11,      .06,   27,    .548,   .538
```

Table 6.3.2. Saithe in IV, VI and IIIa. Fishing mortality (F) at age

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Run title : SAITHE IN IV, VI and IIIa : 1967 - 2002

At 2/09/2003 9:33

Table 8 Fishing mortality (F) at age

YEAR,	1967,	1968,	1969,	1970,	1971,	1972,
AGE						
1,	.0000,	.0004,	.0001,	.0010,	.0025,	.0017,
2,	.0680,	.0115,	.0065,	.0062,	.0572,	.1320,
3,	.1628,	.2548,	.1178,	.1521,	.2682,	.3711,
4,	.2632,	.3074,	.3145,	.4897,	.3728,	.4397,
5,	.3781,	.3551,	.2599,	.4828,	.3998,	.2768,
6,	.4837,	.2455,	.3574,	.5069,	.2735,	.4925,
7,	.4161,	.1526,	.3912,	.3126,	.3319,	.3537,
8,	.2614,	.1006,	.4641,	.2017,	.3965,	.4053,
9,	.3897,	.1669,	.4070,	.3425,	.3360,	.4201,
+gp,	.3897,	.1669,	.4070,	.3425,	.3360,	.4201,
0 FBAR 3- 6,	.3220,	.2907,	.2624,	.4079,	.3286,	.3950,

Table 8 Fishing mortality (F) at age

YEAR,	1973,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,	1982,
AGE										
1,	.0174,	.0078,	.0017,	.0019,	.0166,	.0112,	.0035,	.0076,	.0276,	.0061,
2,	.2072,	.0916,	.1612,	.2325,	.1296,	.2155,	.2160,	.1196,	.1576,	.2045,
3,	.4990,	.6880,	.4270,	.9115,	.2976,	.5439,	.2659,	.3427,	.1845,	.3889,
4,	.5629,	.6749,	.6294,	.9308,	.6553,	.5454,	.4431,	.3300,	.2718,	.4840,
5,	.3202,	.4243,	.4464,	.6618,	.7380,	.4645,	.4515,	.5653,	.3022,	.5442,
6,	.2838,	.4389,	.4244,	.5385,	.7721,	.3557,	.4274,	.5425,	.4754,	.4817,
7,	.3695,	.4557,	.5874,	.4145,	.7474,	.3493,	.5832,	.5510,	.5741,	.5690,
8,	.3317,	.4107,	.5976,	.4834,	.7850,	.4641,	.3988,	.5049,	.7739,	.5326,
9,	.3303,	.4382,	.5408,	.4825,	.7759,	.3923,	.4733,	.5371,	.6131,	.5321,
+gp,	.3303,	.4382,	.5408,	.4825,	.7759,	.3923,	.4733,	.5371,	.6131,	.5321,
0 FBAR 3- 6,	.4165,	.5565,	.4818,	.7607,	.6158,	.4774,	.3969,	.4451,	.3085,	.4747,

1

Run title : SAITHE IN IV, VI and IIIa : 1967 - 2002

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Table 8 Fishing mortality (F) at age

YEAR,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,
AGE										
1,	.0007,	.0005,	.0014,	.0017,	.0068,	.0002,	.0187,	.0025,	.0023,	.0021,
2,	.1506,	.1033,	.0293,	.0568,	.2196,	.0975,	.0717,	.0370,	.1200,	.0390,
3,	.3075,	.5734,	.6469,	.2405,	.3687,	.3784,	.3796,	.4708,	.4590,	.2470,
4,	.4701,	.6949,	1.0493,	1.4111,	.8770,	.6172,	.7556,	.6913,	.7712,	.7309,
5,	.6682,	.6180,	.7052,	.9649,	.8693,	.9712,	.7355,	.7085,	.6236,	.9318,
6,	.7914,	.8694,	.4848,	.7069,	.5320,	.6217,	.9713,	.6433,	.5083,	.6016,
7,	.9641,	.5621,	.4957,	.5382,	.5490,	.7305,	.5591,	.7096,	.5131,	.4219,
8,	1.0558,	.7073,	.4768,	.4776,	.5358,	.7868,	.7115,	.5758,	.5678,	.4037,
9,	.9472,	.7201,	.5114,	.6673,	.6298,	.7805,	.8088,	.6570,	.6319,	.7083,
+gp,	.9472,	.7201,	.5114,	.6673,	.6298,	.7805,	.8088,	.6570,	.6319,	.7083,
0 FBAR 3- 6,	.5593,	.6889,	.7215,	.8309,	.6618,	.6471,	.7105,	.6285,	.5905,	.6278,

Table 8 Fishing mortality (F) at age

YEAR,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	FBAR **-**	FBAR 98-**
AGE												
1,	.0005,	.0007,	.0006,	.0031,	.0001,	.0016,	.0002,	.0004,	.0000,	.0032,	.0012,	.0011,
2,	.0850,	.0319,	.0350,	.0463,	.1409,	.0225,	.0598,	.0083,	.0057,	.0437,	.0192,	.0280,
3,	.3221,	.2405,	.1407,	.1175,	.1021,	.1679,	.0734,	.0835,	.0683,	.0792,	.0770,	.0944,
4,	.4898,	.6797,	.5677,	.3133,	.3088,	.3158,	.3550,	.1872,	.3277,	.2397,	.2516,	.2851,
5,	.6227,	.6598,	.5755,	.5491,	.4291,	.4696,	.4947,	.4086,	.4180,	.2611,	.3626,	.4104,
6,	.6174,	.4826,	.4011,	.6863,	.3268,	.4289,	.4703,	.4486,	.2874,	.2782,	.3381,	.3827,
7,	.6830,	.3799,	.9570,	.7036,	.5299,	.3376,	.5271,	.3232,	.2196,	.3189,	.2872,	.3453,
8,	1.0092,	.3066,	.5138,	.6034,	.5092,	.4942,	.7251,	.3168,	.2345,	.2869,	.2794,	.4115,
9,	1.2394,	.9208,	1.2013,	.2952,	.4531,	.6057,	.8598,	.4391,	.1722,	.5382,	.3832,	.5230,
+gp,	1.2394,	.9208,	1.2013,	.2952,	.4531,	.6057,	.8598,	.4391,	.1722,	.5382,		
0 FBAR 3- 6,	.5130,	.5156,	.4213,	.4165,	.2917,	.3455,	.3484,	.2820,	.2754,	.2146,		

Table 6.3.3. Saithe in IV, VI and IIIA. Stock number at age (start of year) Numbers*10**-3

Run title : SAITHE IN IV, VI and IIIa : 1967 - 2002

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

YEAR	1967	1968	1969	1970	1971	1972
AGE						
1	453729	438373	492279	270954	260843	273414
2	149192	371482	358752	403012	221626	213023
3	127456	114114	300676	291822	327912	171358
4	77473	88671	72416	218815	205219	205307
5	54514	48753	53387	43291	109785	115727
6	6636	30579	27987	33705	21871	60263
7	5175	3350	19586	16029	16622	13621
8	1403	2795	2354	10844	9600	9765
9	678	884	2069	1212	7257	5287
+gp	622	1038	492	1010	2976	5133
0 TOTAL	876878	1100039	1329998	1290692	1183711	1072897

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

YEAR	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
AGE										
1	301468	678354	222306	157148	145475	124750	289717	192536	221856	357641
2	223464	242561	551088	181706	128417	117139	101003	236371	156440	176702
3	152844	148725	181214	384026	117903	92358	77310	66628	171718	109403
4	96796	75976	61198	96801	126368	71683	43894	48519	38721	116904
5	108286	45139	31675	26702	31244	53725	34015	23074	28557	24157
6	71842	64363	24178	16596	11278	12229	27643	17732	10734	17283
7	30150	44286	33977	12949	7930	4266	7016	14761	8439	5463
8	7829	17059	22988	15460	7004	3075	2463	3206	6966	3891
9	5331	4600	9262	10355	7806	2616	1583	1354	1584	2630
+gp	9287	6035	7034	9981	9489	11769	6065	6057	6043	3324
0 TOTAL	1007295	1327098	1144920	911723	592914	493611	590709	610237	651057	817397

1

Run title : SAITHE IN IV, VI and IIIa : 1967 - 2002

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

YEAR	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
AGE										
1	514731	440437	176947	212723	128199	192542	218411	156718	236028	167948
2	291029	421144	360413	144663	173871	104249	157611	175504	127989	192798
3	117916	204955	310974	286562	111901	114289	77423	120109	138475	92943
4	60711	70987	94571	133334	184458	63368	64094	43367	61413	71645
5	58988	31063	29009	27115	26623	62827	27986	24650	17786	23252
6	11477	24758	13708	11733	8459	9138	19477	10981	9937	7806
7	8741	4259	8497	6912	4737	4068	4018	6037	4725	4894
8	2532	2729	1987	4238	3304	2240	1604	1881	2431	2316
9	1870	721	1101	1010	2152	1583	835	645	866	1128
+gp	2355	1372	2028	2017	1636	1367	958	825	1068	907
0 TOTAL	1070350	1202424	999236	830307	645340	555669	572416	540717	600717	565637

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

YEAR	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	GMST 67-**	GMST 85-**
AGE													
1	345952	170511	267696	127694	224568	154623	437244	437732	217459	315234	0	251511	212194
2	137215	283097	139507	219029	104227	183837	126398	357927	358254	178037	257267	199792	173330
3	151806	103187	224512	110293	171215	74118	147159	97483	290610	291643	139537	144587	133040
4	59443	90065	66424	159688	80287	126574	51305	111952	73420	222228	220604	85301	83853
5	28243	29822	37370	30827	95579	48271	75565	29453	76010	43313	143168	39550	34340
6	7498	12406	12622	17207	14574	50948	24712	37723	16025	40970	27313	18004	14248
7	3502	3311	6269	6919	7093	8606	27165	12642	19720	9843	25398	8422	6333
8	2628	1448	1854	1971	2803	3418	5028	13129	7492	12962	5858	3907	2726
9	1266	784	872	908	883	1379	1707	1993	7831	4852	7966	1759	1124
+gp	1562	1434	1238	2109	866	666	1239	1359	1516	5368	4885		
0 TOTAL	739115	696065	758363	676645	702095	652441	897522	1101394	1068336	1124450	831997		

1

Table 6.3.4. Saithe in IV, VI and IIIa. Summary (without SOP correction)

Run title : SAITHE IN IV, VI and IIIa : 1967 - 2002 ,

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Table 16 Summary (without SOP correction)

,	RECRUITS, Age 1	TOTALBIO,	TOTSPBIO,	LANDINGS,	YIELD/SSB,	FBAR 3- 6,
1967,	453729,	499557,	150821,	94514,	.6267,	.3220,
1968,	438373,	1025991,	211683,	116789,	.5517,	.2907,
1969,	492279,	1134547,	263952,	131882,	.4996,	.2624,
1970,	270954,	1288238,	312029,	236636,	.7584,	.4079,
1971,	260843,	1282669,	429618,	272481,	.6342,	.3286,
1972,	273414,	1110251,	474090,	275098,	.5803,	.3950,
1973,	301468,	993362,	534441,	259602,	.4857,	.4165,
1974,	678354,	1143707,	554846,	309439,	.5577,	.5565,
1975,	222306,	1068000,	471949,	308926,	.6546,	.4818,
1976,	157148,	917779,	351395,	361680,	1.0293,	.7607,
1977,	145475,	626324,	262970,	223395,	.8495,	.6158,
1978,	124750,	568005,	267776,	166199,	.6207,	.4774,
1979,	289717,	585173,	240609,	135967,	.5651,	.3969,
1980,	192536,	544459,	234427,	142395,	.6074,	.4451,
1981,	221856,	646532,	239757,	146092,	.6093,	.3085,
1982,	357641,	687711,	208255,	189861,	.9117,	.4747,
1983,	514731,	814189,	210988,	197774,	.9374,	.5593,
1984,	440437,	843196,	172482,	219642,	1.2734,	.6889,
1985,	176947,	709971,	154943,	226129,	1.4594,	.7215,
1986,	212723,	691943,	145244,	202758,	1.3960,	.8309,
1987,	128199,	496631,	146453,	180776,	1.2344,	.6618,
1988,	192542,	479801,	143202,	140778,	.9831,	.6471,
1989,	218411,	459039,	110022,	117609,	1.0690,	.7105,
1990,	156718,	422665,	97026,	107945,	1.1125,	.6285,
1991,	236028,	458874,	92846,	115576,	1.2448,	.5905,
1992,	167948,	495543,	95155,	104147,	1.0945,	.6278,
1993,	345952,	545419,	102505,	119073,	1.1616,	.5130,
1994,	170511,	558368,	111696,	115255,	1.0319,	.5156,
1995,	267696,	696872,	134990,	125183,	.9273,	.4213,
1996,	127694,	593022,	157006,	119669,	.7622,	.4165,
1997,	224568,	616834,	195883,	112740,	.5755,	.2917,
1998,	154623,	609222,	195735,	108699,	.5553,	.3455,
1999,	437244,	717990,	208908,	114655,	.5488,	.3484,
2000,	437732,	961938,	200768,	93566,	.4660,	.2820,
2001,	217459,	933076,	229909,	96491,	.4197,	.2754,
2002,	315234,	1024350,	239878,	121833,	.5079,	.2146,
Arith. Mean ,	278451,	756979,	232063,	169757,	.8140,	.4786,
0 Units,	(Thousands),	(Tonnes),	(Tonnes),	(Tonnes),		

1

Table 6.5.1. Saithe,IV, VI and IIIa,
input data for catch forecast and linear sensitivity analysis

Label	Value	CV	Label	Value	CV
Number at age			Weight in the stock		
N1	212194	0.38	WS1	0.59	0.18
N2	173175	0.20	WS2	0.77	0.05
N3	136155	0.20	WS3	0.88	0.15
N4	220603	0.20	WS4	1.02	0.14
N5	143167	0.20	WS5	1.39	0.09
N6	27313	0.20	WS6	1.83	0.11
N7	25397	0.20	WS7	2.48	0.07
N8	5858	0.20	WS8	3.24	0.08
N9	7966	0.20	WS9	4.30	0.10
N10	4884	0.20	WS10	6.08	0.24
H.cons selectivity			Weight in the HC catch		
sH1	0.00	1.51	WH1	0.59	0.18
sH2	0.02	1.22	WH2	0.77	0.05
sH3	0.08	0.20	WH3	0.88	0.15
sH4	0.25	0.29	WH4	1.02	0.14
sH5	0.36	0.11	WH5	1.39	0.09
sH6	0.34	0.21	WH6	1.83	0.11
sH7	0.29	0.30	WH7	2.48	0.07
sH8	0.28	0.22	WH8	3.24	0.08
sH9	0.38	0.60	WH9	4.30	0.10
sH10	0.38	0.60	WH10	6.08	0.24
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		
HF03	1.00	0.14	K03	1.00	0.10
HF04	1.00	0.14	K04	1.00	0.10
HF05	1.00	0.14	K05	1.00	0.10
Recruitment in 2004 and 2005					
R04	212194	0.38			
R05	212194	0.38			

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

Stock numbers in 2003 are VPA survivors.
These are overwritten at Age 2 Age 3

Data from file:C:\nsdem03\Data\SAI46.SEN on 11/09/2003 at 14:45:38

Table 6.5.2. Saithe,IV, VI and IIIa Catch forecast output and estimates of coefficient of variation (CV) from linear analysis.

	Year 2003	2004						
Mean F Ages								
H.cons 3 to 6	0.26	0.00	0.13	0.26	0.32	0.40	0.45	0.52
Effort relative to 2002								
H.cons	1.00	0.00	0.50	1.00	1.25	1.54	1.75	2.00
Biomass								
Total 1 January	998	980	980	980	980	980	980	980
SSB at spawning time	364	436	436	436	436	436	436	436
Catch weight (,000t)								
H.cons	161	0	87	162	196	232	256	283
Biomass in year.... 2005								
Total 1 January		1145	1042	955	916	875	847	816
SSB at spawning time		605	516	440	406	371	347	321

	Year 2003	2004						
Effort relative to 2002								
H.cons	1.00	0.00	0.50	1.00	1.25	1.54	1.75	2.00
Est. Coeff. of Variation								
Biomass								
Total 1 January	0.10	0.11	0.11	0.11	0.11	0.11	0.11	0.11
SSB at spawning time	0.11	0.13	0.13	0.13	0.13	0.13	0.13	0.13
Catch weight								
H.cons	0.19	0.00	0.29	0.17	0.16	0.14	0.14	0.13
Biomass in year.... 2005								
Total 1 January		0.11	0.12	0.12	0.12	0.13	0.13	0.13
SSB at spawning time		0.13	0.14	0.14	0.14	0.14	0.15	0.15

Table 6.5.3. Saithe,IV, VI and IIIa
Detailed forecast tables.

Forecast for year 2003
F multiplier H.cons=1.00

Age	Populations: Stock No.	Catch number: H.Cons	Catch number: Total
1	212194	192	192
2	173175	2955	2955
3	136155	9157	9157
4	220603	44725	44725
5	143167	39739	39739
6	27313	7140	7140
7	25397	5770	5770
8	5858	1299	1299
9	7966	2312	2312
10	4884	1417	1417
Wt	998	161	161

Forecast for year 2004
F multiplier H.cons=1.00

Age	Populations: Stock No.	Catch number: H.Cons	Catch number: Total
1	212194	192	192
2	173556	2961	2961
3	139115	9356	9356
4	103213	20925	20925
5	140382	38966	38966
6	81533	21313	21313
7	15948	3624	3624
8	15606	3460	3460
9	3628	1053	1053
10	7173	2082	2082
Wt	980	162	162

Figure. 6.3.1 Saithe in Sub-area IV, Division IIIa (Skagerrak) & Sub-area VI. Stock summary.

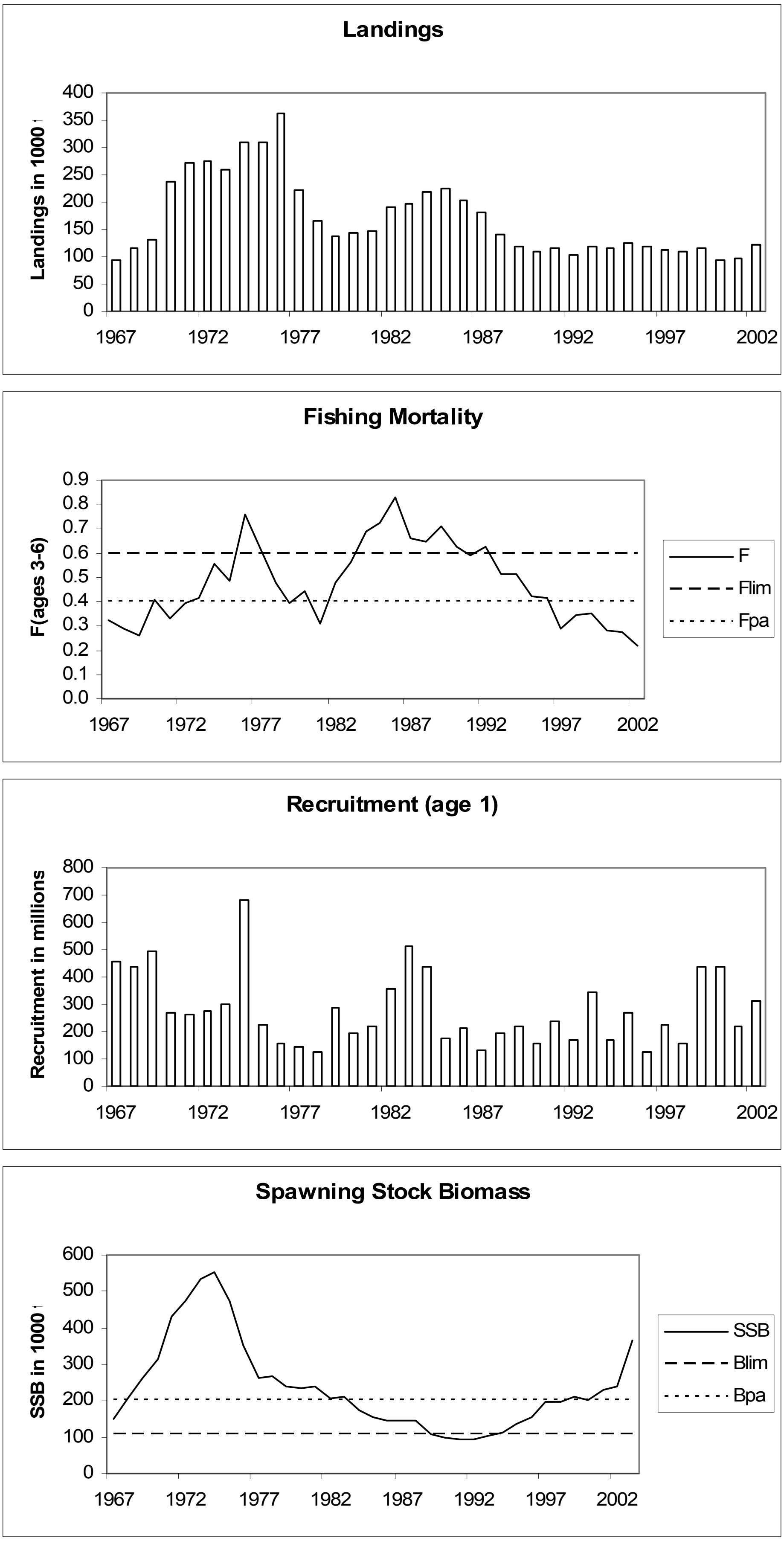
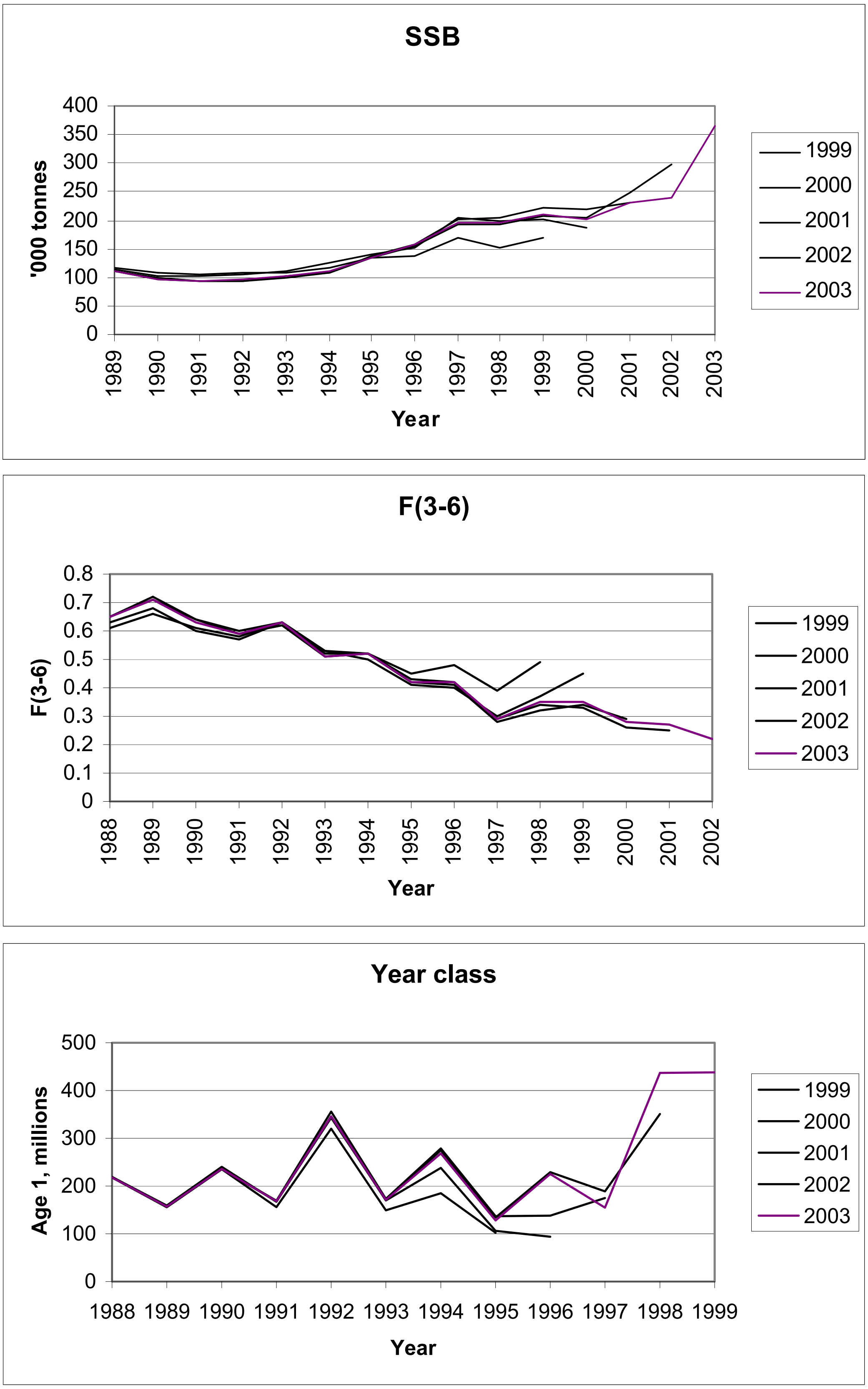


Figure 6.3.2. Saithe in IV, IIIa, and VI. Comparison of historical performance of the assessments.



7 SOLE IN SUB-AREA IV

To attempt to address the issue of increasing workload, the WG proposed in its 2002 report that three stocks per year be subjected to detailed benchmark assessments, with the remaining stocks being analysed in update assessments. The assessment of sole in Sub-Area IV in 2003 was selected to be one of the benchmark assessments. Sole will be the subject of a review by the North Sea Commission Fisheries Partnership in 2003.

7.1 The fishery

Sole is mainly taken by beam trawlers in a mixed fishery with plaice in the southern part of the North Sea. Fishing by different countries is described below:

Belgium: The Belgian fleet operates out of 2 main ports: Oostende and Zeebrugge. The majority of the fleet use beam trawl exclusively and fish for sole an plaice. The fishing grounds change throughout the year depending on catch rates, although the central and southern North Sea (IVb,c) are the preferred fishing area of the Belgian fleet.

Denmark: The main Danish fishery is a directed one for sole using fixed nets although there is also a little effort using beam trawling, and some by-catch in otter trawlers.

Germany: The German sole fishery can be divided into three segments: 7 large beam-trawl vessels >30m, 20-30 Euro-cutters and a varying number of small shrimp beam-trawl vessels catching sole during Q2 & Q3.

The Netherlands: A high proportion of the fishing effort in the North Sea is by Dutch beam trawlers fishing for plaice and sole. The introduction of the Plaice Box in 1989 resulted in a change in the distribution pattern of beam trawl vessels > 300 HP with an increase in activity outside and to the north of the Box.

UK: The English fleet consists of a large number of small otter trawlers fishing in the southern North Sea for sole mainly in the 2nd and 3rd quarters of the year. Prior to 2002, Sole was also taken as by-catch in the English beam trawl fishery (9 vessels) which fished mainly for plaice with 120mm mesh. Since 2002, these vessels do not participate in the fishery any more. These vessels landed the majority of the catch in The Netherlands. In 2001, about 73% of the total UK catch was landed abroad by Dutch vessels fishing on the UK register. Following the decline of the UK beam trawl fleet, in 2002 43% of the UK catches was landed abroad.

7.1.1 ACFM advice applicable to 2002 and 2003

For both 2002 and 2003 ACFM commented that sole was being harvested outside safe biological limits and recommended that fishing mortality should be reduced below the proposed $\mathbf{F}_{pa}$ of 0.4 (based on Fbar age range 2-8). In 2002, the advice was for a reduction in F to 0.37 (20% reduction), corresponding to a catch of 14,800t but the TAC was subsequently set at 16,000t. For 2003, ICES recommended that the fishing mortality should be less than $\mathbf{F}_{pa}$ (0.4), corresponding to landings less that 14,600t. The TAC for 2003 was set at 15,850t. Over the last years TACs have been set above $\mathbf{F}_{pa}$. The stock was expected to decrease just above $\mathbf{B}_{lim}$, but well below $\mathbf{B}_{pa}$ in 2003. For 2004, the stock was expected to increase above $\mathbf{B}_{pa}$, due to a strong 2001 year class. ACFM noted that the the landings over the last years were dominated by the 1996 year class. For 2002 this year class is fished out causing the decrease in SBB. The advice in recent years has been based on the objective to maintain the SSB above a $\mathbf{B}_{pa}$ 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 $\mathbf{F}_{lim}$ is undefined.

ACFM also noted that technical measures which result in a reduction in moratlity on juvenile stocks would benefit the stock as a whole. In the current situation, fishing with 80mm mesh together with a minimum landing size of 24 cm result in a high proportion of age 1 and 2 sole being landed which are immature.

7.1.2 Management applicable to 2003

The TAC for 2003 was set at15,850 t which is about 9% above the maximum value recommended by ACFM.

Technical measures applicable to the sole fishery before 2000 were an exemption to use 80 mm mesh codend when fishing south of 55° North. From January 2000, the exemption area extends from 55° North to 56° North, East of 5° E latitude. Fishing with this mesh size is permitted within that area providing that the landings comprise at least 70% of a mix of species which are defined in the new technical measures of the EU [EU 850/98].

Some additional protection is given to sole 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 technical measures implemented in 2002 to promote the recovery of cod are not likely to have an effect on sole as sole is mainly caught in a directed fishery or as bycatch in the fishery for plaice.

7.1.3 Landings in 2002

The Working Group estimate of landings in 2002 (16,945 t) was around 6% higher than the agreed TAC. Unallocated landings, which represent the difference between the figures reported to ICES and those supplied by WG members, have in general decreased considerably since 1993 (apart from 2000 & 2001) and are mainly caused by 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 1999-2001 for some fleets and indicate that proportions discarded by number amount to 27% by beam trawlers 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 7.1.1. A longer time series of landings is given in Table 7.6.1 and plotted in Figure 7.6.1.

For 2003, the Dutch national uptake rates for sole indicate that around 40% of the national quota was taken by the beginning of September.

7.2 Age composition, weight at age, maturity and natural mortality

Age compositions, mean weight and mean length at age in the catch were available on a quarterly from France, The Netherlands and UK (England and Wales). The Netherlands provide this information by sex. Age compositions for sexes combined on an annual basis were available from Belgium. Due to implementation of the data regulation that came into action in 2002, the number of samples taken by Belgium was no longer sufficient to provide quarterly age compositions by sex. Overall, the samples are thought to be representative of around 85% of the total landings in 2002. However, despite the data regulation, no structural sampling takes place to collect samples from national vessels which land abroad and this constitutes for an substatial part of the total landings by some countries. Some samples are taken but there is no international exchange system for this information available. The age compositions were combined separately by sex on a quarterly basis and then raised to the annual international total. Catch numbers at age are shown in table 7.2.1 & figure 7.2.1b

Revisions since 2002WG:

- For 2000 and 2001, the Danish nominal catches were revised. These catches account for around 5% of the total WG estimate. No age compositions for these landings were available.

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. Weights at age in the catch and stock for all fleets combined are given in Tables 7.2.2 and 7.2.3 and the trend in catch weights at age shown in Figure 7.2.1a. No clear trends are evident over the last years, although age 7 to 13 and older show a slight decline in stock weight at age. This decline is supported by the average decline in length for these ages for the most important fleets over the last years (Figure 7.2.2) The sexratio for quarter 2 over the period 1986 to 2002 do not show an evident change, at most a small increase in the number of males at the older ages that could support the decrease in the stock weight (Figure 7.2.3). This increase is not further explored

In 2002 UK catch weights show a plateau from age 9 onwards (Figure 7.2.4). Further exploration of this data showed that this low average weight was likely to be caused by a bias in the sampling programm that over emphasised the landings over slow growing fish, mainly males in the 2nd quarter. There is no doubt that the age/weight composition is real, otoliths are re-read and recent UK surveys also report catches of these individuals.

As in all previous assessments, a knife-edged maturity-ogive was used in all years, assuming full maturation at age 3 (Table 7.2.4). The maturity-ogive is based on market samples of females from observations in the sixties and seventies. WD13 describes an ongoing international collaboration (under the name of COMPASS) to explore how to determine annually varying maturity ogives for North Sea flatfish from market and research samples, and the consequences of such ogives on the stock assessment and on the biological reference points. The explorations have so far not yet produced results that can be used for assesment purposes. Natural mortality in the period 1957-1999 has been assumed constant over all ages at 0.1 (Table 7.2.4), 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.

7.3 Catch, effort and research vessel data

Catch and effort data, used for tuning the assessment are given in Table 7.3.1. General Catch and effort information is shown in Table 7.3.2 and Figure 7.3.1. Effort in the Netherlands commercial beam trawl is total HP effort days and this has nearly doubled between 1978 and 1994. Since 1996 the effort show a decline and the effort is around the same level as it was in the early 1980's. The English effort is based on the effort from otter trawlers mainly fishing for sole in area IVc. Effort is in HP*hrs and excludes trips directed at cod or shrimps. The 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 the 3th quarter. The BTS (Beam Trawl Survey) is carried out in the southern and south-eastern North Sea in August and September using an 8-m beam trawl. The BTS survey indices were revised in 1998 (ICES,2000) and again examined this year. The procedure to convert length distribution into age distribution was improved and database corrections were carried out. These changes resulted in minimal changes. Figure 9.3.1 (Section North Sea plaice) shows a map of the distribution of the surveys.

The Demersal Young Fish Survey (DFS) is an international survey (The Netherlands, England, Belgium and Germany), which covers the coastal and estuarine areas of the southern North Sea. This survey is directed to 0 and 1-group plaice and sole. The combined international DFS index is only used for RCT3 analysis and not for tuning the VPA. The 2003 indices for the DFS were not available to the WG and will not be available before the ACFM October meeting.

7.4 Catch at age analysis

General approaches and methods are described in section 1.4.

7.4.1 Data exploration

The data exploration for this benchmark assessment of North Sea sole consisted of a number of steps in order to specify the optimal assessment model for this stock. First, the survey and CPUE data were plotted by age so that the consistency between the different sources of calibration could be evaluated. The survey data were also modelled using the Surba model. Then a separable VPA was carried out to inspect the quality of the catch at age data.

The next steps were aimed at evaluating the performance of the calibration-series separately within the XSA model, using a light shrinkage. The explorations with the XSA model were then directed to removing the commercial CPUE series from the calibration process. The potential bias introduced by using commercial CPUE data in the calibration of a VPA model have been described at several occasions (e.g. WGNSSK 2002) and for the North Sea plaice assessment these series were effectively removed from the tuning. Given that the same problems may apply to North Sea sole, an attempt was made to set up the XSA model without commercial CPUE series. This also involved the analysis of the most appropriate plus group and the evaluation of the effects of shrinkage.

It was subsequently shown that the assessment model could not convincinly be set up without the use of commercial CPUE series because the surveys carried too little weight on the older age groups. At that stage the commercial series were reintroduced and the analysis was focussed on finding the appropriate plus group and levels of shrinkage.

Evaluation of survey and CPUE data

The Dutch beam trawl cpue series show a peak in 1990 and reaches its minimum in 1997 (figure 7.3.1) . Over the most recent years the CPUE slightly increased. The UK otter trawl CPUE series also shows a historical low value for 1997, but has increased as the 1996-year class has recruited to the UK fishery, one year later than for the Netherlands fleet. Indices of survey abundance at age are shown in Figure 7.3.2. In general there is good consistency between the two surveys at ages up to 4 but greater variability on the older ages which are, due to the design of the surveys, less well sampled in the surveys.

Surba

Surba (see section 1.4) was used as a supplementary analysis tool to explore trends in survey index inferred SSB. Surba is a survey only method which fits survey indices assuming a separable F selection pattern. Prior input of survey index to relative abundance ratios (q_a) are required for each age. Estimations of these parameters were based on exploratory runs, bounded by prior knowledge of likely survey catchability performance for each age. Estimated mean F cannot reasonably be relied upon due to bootstrap estimation of quantiles from residuals, but this method is especially good at elucidating trends in relative SSB. Summary plots are presented in figures 7.4.1.1a,b – 7.4.1.2,a,b and survey index to relative abundance ratio, q, for each survey fitted (SNS-Tridens, BTS-Isis) are shown in table 7.4.1.1. Both surveys show peaks in relative SSB in 1990, 1994, and 1999, as does SSB in the final run, but the relative height of the peaks differ.

Separable VPA

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. The separable VPA was carried out with last years age range 1-15+ as well as with an age range 1-10+. In both cases log catch ratios did not show any large residuals or trends, except some occasional high residual at ages1-2. Table 7.4.1.2 shows the result of the separable VPA carried out for age range 1-10+.

Single fleet runs

The fleet data were examined for trends in catchability by carrying out XSA for single fleets over the year range available for each fleet. The single fleets XSA runs were carried out with two different settings. One with an age range 1-15+ (setting last year's final run except weakshrinkage of 1.5) and one with an age range 1-10+ (powermodel at age 1, shrinkage 1.5). The results of the last configuration are shown in figure 7.4.1.3. Trends in catchability (Figure 7.4.1.4) were apparent in the Netherlands beam trawl 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 or the effects of technological increase in the fishery. Quick examination of the catch data from The Netherlands, the main fleet influenced by the Plaice Box, showed no clear evidence for the effects of the plaice box. The English otter trawl fleet showed a negative trend from 1990 to 1995 and a positive trend from 1995 for the younger ages. The tuning data was revised this year to exclude data from vessels targeting for shrimp, but this revision did not result in an inprovement of the series. Given the strong trends for this fleet in the single fleet runs, it was decided to remove them from further explorations.

The survey fleets did not show obvious trends in catchability.

XSA without commercial fleets

The XSA model was explored in several runs without commercial CPUE data. In order to run the model without commercial CPUE, the age range of the assessment had to be reduced, because the surveys only have information up to age 9 and the data from ages 7 and higher are already very variable. Several runs with different settings of shrinkage and combination of fleets were performed on the age range 1-10+. With a high shrinkage of 0.5, the weight of the shrinkage on ages 6-9 was still more than 50% (Figure 7.4.1.5). As an experiment the BTS survey indices from the Dutch Tridens survey were made available to explore whether this inclusion would give a lower weight to shrinkage on this ages. The effect if this inclusion was minimal, possibly due to the poor coverage of the distribution area of the older sole. Therefore this survey was excluded again from the model. It was also concluded that a convincing assessment with surveys-only could not be set up for this stock, because the shrinkage on fishing mortality kept determining the survivors at the oldest ages.

XSA with commercial fleets: determining age range, power model, q plateau, shrinkage

After "reintroduction" of the Dutch beamtrawl fleet, the pattern of log catchability residuals for the Netherlands CPUE and the two surveys were not markedly different from single fleet runs (Figure 7.4.1.6).

The sensitivity of the assessment to the tuning fleets was examined by carrying out trial runs with different combinations of fleets. The results are shown in Figures 7.4.1.3. The two commercial fleets run together resulted in lower fishing mortalities and correspondingly higher SSBs than the separate survey fleets or the two surveys taken together.

Age range

In previous assessments, the age range for the analysis was 1 to 15. The survivor estimates on the highest ages (10 and older) were mostly driven by F-shrinkage, which makes the assessment rather insensitive to changes in the fishery on the short term. Several explorations were then carried out, from which it was found that a 10-plus group would limit the contribution of shrinkage on the oldest ages to around 20%. This plus group was used in the subsequent analysis.

Q-plateau

The q-plateau was explored by investigating the estimated catchabilities for the different surveys. Inspection of the catchabilities at age confirmed that age 7 could be used as the q-plateau for at least one of the calibration indices.

Shrinkage

Further explorations with lower levels of shrinkage (1.0 and 2.0) showed that the Dutch commercial fleets gets more weight as the effect of shrinkage reduces. This implies that shrinkage is balanced by the Dutch data series. The retrospective patterns for these settings were very similar as shown **in figure** 7.4.1.7.

The reduction of shrinkage to 2.0 resulted in a slightly lower F in the most recent year. Given the similar retrospective patterns and the fact that shrinkage is driven by the Dutch commercial data no objective reason could be found to decide on the level of shrinkage. As the general intention is to reduce shrinkage as much as possible it was decided to set the shrinkage to 2.0. With this low level of shrinkage the assessment should pick up signals from changes in the fishery.

In previous assessments the Fbar age range was set from age 2 to 8. With the revision of the age range in the model, this age range was no longer suitable. The new Fbar age range was set to a range that covers the catch at age distribution over the last years namely age 2 to 6. Following this change in age range, the biological reference point have to be updated accordingly. Section 7.9 describes this update.

Power model

Over the last years, a power model was applied to age 1 and 2. Explorations were carried out on the influence of the power model. Inspection of the slopes of the regressions when the power model was applied revealed that there were no slopes significantly different from zero at age 2, but that for at least some of the surveys there were significant slopes age age 1. Therefore, the power model was set to age 1 in the final model.

7.4.2 Final run

The final XSA run was accepted with the settings as shown below in comparison with last year.

stock	**Sole**	
area	**North Sea (IV)**	
year of assessment	**2002**	**2003**
Assessment model	XSA	XSA
NL beamtrawl	1990-2001 2-14	1990-2002
UK ottertrawl	1990-2001 2-14	*not used*
BTS Isis	1990-2001 1-9	1985-2002 1-9
SNS	1990-2001 1-4	1970-2002 1-4
Time series weights	none	none
Power model used for catchability	age 1 & 2	age 1
Catchability plateau age	7	7
Surv. Estimates shrunk towards mean F	5 years / 5 ages	5 years / 5 ages
s.e. of the means	0.5	2.0
Min stand. Error for pop estimates	0.3	0.3
Prior weighting	none	none
Number of iterations	22	25
Convergence	yes	yes

Full tuning diagnostics for the final XSA are given in Table 7.4.2. Estimated stocks numbers at age are shown in table 7.4.3 and fishing mortality at age in Table 7.4.4. The stock summary table is shown in table 7.6.1. The weighting given to fleets and to shrinkage is shown in Figure 7.4.2.1. For age 1 (2001 yr class), the two surveys, are given more than 90% of the weight (F-shrinkage and P-shrinkage together only take less than 10%) For age 2, the surveys contribute 88 % to the weight, 10% coming from shrinkage and the remaining percentages from shrinkage At age 3, the surveys together and the NL commercial fleet both take around 50% of the weighting. From age group 5 onwards the commercial fleets start to contribute more than the survey.

Retrospective analyses were run over the full time period to investigate the consistency in estimating F(2-6), SSB and recruitment at age 1. The time series of the tuning limit the retrospective analysis to only three runs. (Figure 7.4.2.2). The results suggest that F has been underestimated in previous years, particularly in 2000, and SSB slightly overestimated.

7.5 Recruitment estimates

Average recruitment in the period 1957-2000 was 131 million (arithmetic mean) or 97 million (geometric mean) for 1-year-old-fish, and 117 million (arithmetic mean) or 85 million (geometric mean) 2-year-old-fish (VPA estimates).

Recruitment indices were available from pre-recruit surveys carried out in 2002 and previous years. The survey indices available are listed in the RCT3 input table (Table 7.5.1).

The options used in RCT3 are the same as those used in previous years: regression type=C, tapered time weighting not applied, survey weighting not applied, final estimates shrunk towards the mean, the minimum S.E. for any survey is taken as 0.2, and a minimum of 3 points are used for regression. The ´RCT outputs from regressions on ages 1 and 2 are shown in Tables 7.5.2a,b.

<u>The 2001 year class</u> (as age 2 in 2003, in millions) was estimated as 179in XSA and 179 in RCT3. Both estimates are well above long term GM (1957-2000) at age 2. The RCT3 estimate of the 2001 year class is based on more independent observations (estimates) of the year class strength than the XSA estimate and, furthermore, the 2001 year class is not yet fully recruited to the fishery. Consequently, the RCT3 result was accepted. This suggests the 2001 year class being well above long term average recruitment.

<u>The 2002 year class</u> (as age 1 in 2003, in millions) was estimated as 86 in RCT3. This is about the same as the long term GM (1957-2000) at 97. No XSA estimate for this year class is available. There was only one survey value available with low weight in RCT3. Indices from the Dutch 2003 SNS were not used because this survey was moved from 3rd to 2nd quarter in 2003. The effect of this change in survey time has to be scrutinized before indices for sole forecast is used. On this basis the GM estimate was accepted.

Year class strength used for predictions is in bold and underlined and can be summarized as follows:

Year Class	Age in 2003	XSA Thousands	RCT3 Thousands	GM (1957-2000) Thousands
2001	2	178948	<u>**179249**</u>	84585
2002	1		86222	<u>**96762**</u>
2003	Recruits			<u>**96762**</u>

7.6 Historical stock trends

Historical trends in landings, recruitment, fishing mortality and SSB are given in Table 7.6.1. and plotted in Figure 7.6.1

Fishing mortality F(2-6) has more than trebled in the period 1957-1984, mainly because of the developing beam trawl fishery. F reached a peak in 1996, possibly as a result of the underestimate in M resulting from the cold winter of 1966. It has decreased since then but remains at a relatively high level compared with the historical pattern.

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, 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 74,000t to a historically low level of 21,000 t in 1998 because of below average recruitment, high fishing mortality and also an estimated additional natural mortality in the 1995/1996 winter. The SSB showed a temporary increase following recruitment of the strong 1996 year class but has declined to below $\mathbf{B}_{pa}$ of 35,000t as this year class has been fished down.

7.7 Short term prognosis

For the current prediction, population survivors at the start of 2003 for age 1 were from GM, and 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 2000-2002, scaled to the reference $F_{(2\text{-}6)}$ in 2002 (0.48). Weight at age in the catch and in the stock are averages for the years 2000-2002. Maturity-ogive and natural mortality was the same as in the XSA. . The input data are shown in Table 7.7.1.

The management options table is given in Table 7.7.2 and the detailed predictions for $\mathbf{F}_{sq}$ are presented in Table 7.7.3. The options are also illustrated in Figure 7.7.1.

Yield and SSB at *status quo* F: Assuming a *status quo* F results in an expected catch in 2003 of 19,300 t (compared with a TAC of 15,850 t and ACFM advice for a TAC of 14,600 t). The yield in 2004 is expected to be 20,800 t at *status quo*. The sensitivity of the short term forecast to the various input parameters are shown in Figures 7.7.2 and 7.7.3.

The SSB in 2003 is predicted to be 29,000 compared with 32,300 t in last year's assessment. At *status quo* it is expected to increase to 40,900 t in 2004 ($\mathbf{B}_{lim}$=25,000 t) and to 40,200 in 2005 (Table 7.5.4). There is a 50% probability that the SSB will fall below $\mathbf{B}_{pa}$ in 2005 (Figure 7.7.3). It should be noted that the dynamics in the SSB is forced by the big variation in recruitment and by the knife edge maturity ogive.

The proportional contributions of recent year classes to catch in 2004 and SSB in 2005 are given in Table 7.7.4. More than half the yield in 2004 is dependent on the 2001 year class estimated by RCT3 and about 10% is depending on the year class for which GM was assumed. 31% of SSB in 2005 is depending on the year class for which GM was assumed.

7.8 Medium term prognosis

Medium term predictions were made for a period of 25 years, to estimate percentiles of the distribution of the predicted yields, SSB and recruitment at a *status quo* level of fishing mortality (program used: WGMTERMC).

The input values for the medium term predictions are presented in Table 7.8.1. Catch and stock weights were the average for the past ten years.

A Ricker stock-recruitment curve was used for medium term projections as in last year's sole assessment (table 7.8.2). The projections were carried out for 3 different settings:

- F=0.4, current reference point
- F=0.56, based on 5th percentile of $\mathbf{F}_{loss}$
- F=0.35 proposed new reference point (see section 7.9)

F=0.4

Figure 7.8.1a shows the trajectory of yield and SBB with associated 10, 25 50,75 and 90 percentiles for the *F=0.40* projection. The medium term yield and SSB are estimated to be around 19,000 t and 40,000t (50% probability)..

F=0.56

Figure 7.8.1b shows the trajectory of yield and SSB for the projection of F at 0.56. The medium term yield and SSB are estimated with a 50% probability to be around 17,000t and 25,000t ($\mathbf{B}_{pa}$=35,000t).

F=0.35

Figure 7.8.1.c shows the trajectory of yield and SBB for the projection of F at 0.35. The medium term yield and SSB are estimated with a 50% probability to be around 18,000t and 48,000t in the medium term.

Conclusion

Figure 7.8.1.d shows the phase plots of F against SSB after 25 years in the medium term simulations. The phase plot is instrumental in evaluating the long term effects of fishing mortality on equilibrium SSB levels.

7.9 Biological reference points

In this benchmark assessment some major changes were made compared to previous assessments. The plus group has been brought down from 15+ to 10+ and the reference F has been brought down from F2-10 to F2-6. For this reason the biological reference points have been revised. In addition, it was requested that the WG comments on the PA reference points proposed by the Study Group on Precautionary Reference Points for Advice on Fishery Management (SGPRP) (ICES 2003).

The estimated biological reference points are in Table7.9.1 and Figure 7.9.1. $\mathbf{B}_{loss}$ is estimated to be 20 941 tonnes (similar to last year: 21 000). $\mathbf{F}_{max}$ is revised upward from 0.25 to 0.34. $\mathbf{F}_{med}$ is revised downward from 0.34 to 0.32. $\mathbf{F}_{high}$ is revised downward from 0.81 to 0.78. Figure 7.9.2 gives respectively a stock recruitment plot with a LOWESS smoother and reference points, a plot of YPR and SPR curves and reference points, a plot of historical SSB against F_{bar} with an equilibrium curve based on the LOWESS stock recruitment relationship, and a plot of historical yield against F_{bar} with an equilibrium curve based on the LOWESS stock recruitment relationship.

In the report of the SGPRP (ICES 2003) North Sea sole was classified as having no S/R signal and a relatively large spread in SSB, and it was stated that the current reference points could be maintained because $\mathbf{B}_{loss}$ (21 000) was close to $\mathbf{B}_{lim}$ (25 000). The current assessment estimates $\mathbf{B}_{loss}$ at 20 941. Therefore, the WG proposes that the current reference points can still be maintained: $\mathbf{B}_{lim}$ at 25 000 and $\mathbf{B}_{pa}$ at 35 000.

$\mathbf{F}_{lim}$ is undefined for this stock (ACFM 2002). $\mathbf{F}_{pa}$, however, needs to be re-established because the current assessment changed the age range for the reference F from 2-8 to 2-6. The technical basis for $\mathbf{F}_{pa}$ was the 5th percentile of $\mathbf{F}_{loss}$ or lower such that it implies $B_{eq} > \mathbf{B}_{pa}$ and a less than 10% probability that $SSB_{MT} < \mathbf{B}_{pa}$ (ACFM 2002). The 5th percentile of $\mathbf{F}_{loss}$ = 0.56 and implies $B_{eq} \sim \mathbf{B}_{pa}$, but $P(SSB_{MT} < \mathbf{B}_{pa}) > 10\%$. F = 0.35 implies $P(SSB_{MT} < \mathbf{B}_{pa}) \sim 10\%$ where MT is run over 25 years only, and implies $B_{eq} > \mathbf{B}_{pa}$. Following this argumentation, the WG proposes 0.35 as the new $\mathbf{F}_{pa}$.

The proposed management reference points are listed below.

	Previous	**Proposed**
$\mathbf{B}_{lim}$	25 000t	25 000t
$\mathbf{B}_{pa}$	35 000t	35 000t
$\mathbf{F}_{lim}$	undefined	undefined
$\mathbf{F}_{pa}$	0.4 (age 2-8)	0.35 (age 2-6)

7.10 Quality of the assessment

This year's benchmark assessment was set up different compared to last years settings. The main differences are listed below:

- UK Ottertrawl CPUE data not used for tuning

- Reduction of age range from 15+ to 10+, followed by an reduction of F age range from 2 - 8 to 2 - 6
- Reduction of shrinkage from 0.5 to 2.0
- Power model applied to age 1 only in stead of age 1 & 2

The reduction of the age range for the assessment and average F match the age range for the landings of the recent years much better as the majority of the landings comprise age 2 to 6. The reduction of shrinkage gives more weight to the dutch commercial fleet. The model should pick up signals from changes in the fishery at an earlier stage. Using the power model at age 1 resulted in a higher weighting of the survey data which cover the age 1 group well.

The input data for sole is well sampled:

- Quarterly catch at age data are available for around 85% of the landings
  - an exploration was carried out on the low average stock weight on te older ages in the UK age composition. This does not affect the calculated international average to such extend that it would be of significant influence on the assessment.
- Discarding is thought to be low (below 30%)
- well sampled commercial tuning fleets
- survey fleets cover main distribution area of the specie
- good historical data series

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

Skippers were asked to compare the state of their catch in January to June 2003 with the same period in 2002. Findings were based upon the catch not the landings. The skippers were asked to describe the catch rates (less, the same or more than last year), the size range (mostly small, all sizes, mostly large) and the discard rates (less, the same or more than last year). Questionnaire returns were received from skippers of vessels registered in Belgium, Denmark, England, the Netherlands, Scotland and Sweden. A total of 299 views were collected on the state of sole catches (all gear types combined). The area covered by this survey was subdivided into 10 zones, 8 within the North Sea and 2 in subdivision IIIa.

The results of this questionaire show a slight increase in abundance for Sole in 2002, possibly due to the last part of the 1996 yearclass that was taken in 2002 (as shown in the catch at age in Figure 7.2.1b). Following this, the majority of the respondants reported catches of all sizes. In zone 3 (Western North Sea) catches of relatively small Sole were reported in 2003. No strong trends in discarding are reported, the discard rates have remained the same or showed a slight decrease. Only zone 8 (roughly the Northern part of ICES Area IIIa) reported a increase in discarding. This possibly reflects an increase in abundance.

Table 7.1.1 Sole in IV. Nominal catch (tonnes) and landings as estimated by the Working Group.

YEAR	1995	1996	1997	1998	1999	2000	2001	2002	2003
Belgium	2624	2555	1519	1844	1919	1806	1874	1437	
Denmark	1673	1018	689	520	828	1069	772	644	
France	640	535	99	510	357	362	411	266	
Germany	1564	670	510	782	1458	1280	958	759	
Neth	20927	15344	10241	15198	16283	15273	13345	12120	
Norway							84	50	
Sweden			2	1					
UK (E/W/NI)	1040	848	479	549	645	600	597	451	
UK (Scotland)		229	202	338	501	346	311	242	
Others	312								
total	28780	21199	13741	19742	21991	20736	18352	15969	
Unallocated	1687	1452	1160	1126	1484	1796	1592	976	
WG estimate	**30467**	**22651**	**14901**	**20868**	**23475**	**22532**	**19944**	**16945**	
TAC	28000	23000	18000	19100	22000	22000	19000	16000	15850

Table 7.2.1 Sole in IV. Catch numbers at age (thousands)

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

YEAR,	1957,	1958,	1959,	1960,	1961,	1962,
AGE						
1,	0,	0,	0,	0,	0,	0,
2,	1415,	1854,	3659,	12042,	959,	1594,
3,	10148,	8440,	12025,	14133,	49786,	6210,
4,	12642,	14169,	10401,	16798,	19140,	59191,
5,	3762,	9500,	8975,	9308,	12404,	15346,
6,	2924,	3484,	5768,	8367,	4695,	10541,
7,	6518,	3008,	1206,	4846,	3944,	4826,
8,	1733,	4439,	2025,	1593,	4279,	4112,
9,	509,	2253,	2574,	1056,	836,	2087,
+gp,	6288,	6557,	5615,	7901,	7254,	7494,
0 TOTALNUM,	45939,	53704,	52248,	76044,	103297,	111401,
TONSLAND,	12067,	14287,	13832,	18620,	23566,	26877,
SOPCOF %,	104,	100,	101,	99,	101,	99,

YEAR,	1963,	1964,	1965,	1966,	1967,	1968,	1969,	1970,	1971,	1972,
AGE										
1,	0,	55,	0,	0,	0,	1037,	396,	1299,	420,	358,
2,	676,	155,	47100,	12278,	3686,	17148,	23922,	6140,	33369,	7594,
3,	8339,	2113,	1089,	133617,	25683,	13896,	21451,	25993,	14425,	36759,
4,	8555,	5712,	1599,	990,	85127,	24973,	5326,	8235,	12757,	7075,
5,	46201,	3809,	5002,	1181,	1954,	48571,	12388,	1784,	4485,	4965,
6,	8490,	17337,	2482,	3689,	536,	462,	25139,	3231,	1442,	1565,
7,	6658,	3126,	12500,	744,	1919,	245,	331,	11960,	2327,	523,
8,	2423,	1810,	1557,	6324,	760,	1644,	244,	246,	7214,	1232,
9,	3393,	818,	1525,	702,	5047,	324,	1190,	140,	192,	4706,
+gp,	8384,	3015,	3208,	2450,	2913,	6523,	5272,	5234,	4594,	2801,
0 TOTALNUM,	93119,	37950,	76062,	161975,	127625,	114823,	95659,	64262,	81225,	67578,
TONSLAND,	26164,	11342,	17043,	33340,	33439,	33179,	27559,	19685,	23652,	21086,
SOPCOF %,	99,	97,	96,	99,	102,	100,	102,	100,	101,	99,

YEAR,	1973,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,	1982,
AGE										
1,	703,	101,	264,	1041,	1747,	27,	9,	637,	423,	2660,
2,	12228,	15380,	22954,	3542,	22328,	25031,	8179,	1209,	29217,	26435,
3,	12783,	21540,	28535,	27966,	12073,	29292,	41170,	12511,	3259,	45746,
4,	16187,	5487,	11717,	14013,	15306,	6129,	16060,	17781,	6866,	1843,
5,	4025,	7061,	2088,	4819,	7440,	6639,	2996,	7297,	8223,	3535,
6,	2324,	1922,	3830,	966,	1779,	4250,	3222,	1450,	3661,	4789,
7,	994,	1585,	790,	1909,	319,	1738,	1747,	2197,	948,	1678,
8,	765,	658,	907,	550,	1112,	611,	816,	1409,	886,	615,
9,	1218,	401,	508,	425,	256,	646,	241,	367,	766,	605,
+gp,	5790,	4814,	3445,	2663,	2115,	1602,	1527,	1203,	908,	1278,
0 TOTALNUM,	57017,	58949,	75038,	57894,	64475,	75965,	75967,	46061,	55157,	89184,
TONSLAND,	19309,	17989,	20773,	17326,	18003,	20280,	22598,	15807,	15403,	21579,
SOPCOF %,	102,	99,	101,	102,	102,	100,	101,	102,	103,	101,

YEAR,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,
AGE										
1,	389,	191,	165,	374,	94,	10,	117,	863,	120,	980,
2,	34408,	30734,	16618,	9363,	29053,	13219,	46387,	11939,	13163,	6832,
3,	41386,	43931,	43213,	18497,	22046,	47182,	18263,	104454,	25420,	44378,
4,	21189,	22554,	20286,	17702,	8899,	15232,	22654,	9767,	77913,	16204,
5,	624,	8791,	9403,	7747,	6512,	4381,	4624,	9194,	6724,	38319,
6,	1378,	741,	3556,	5515,	3119,	3882,	1653,	3349,	3675,	2477,
7,	1950,	854,	209,	2270,	1567,	1551,	1437,	1043,	1736,	3041,
8,	978,	1043,	379,	110,	903,	891,	647,	1198,	719,	741,
9,	386,	524,	637,	283,	81,	524,	458,	554,	730,	399,
+gp,	1176,	894,	975,	1682,	694,	317,	468,	845,	1090,	1180,
0 TOTALNUM,	103864,	110257,	95441,	63543,	72968,	87189,	96708,	143206,	131290,	114551,
TONSLAND,	24927,	26839,	24248,	18201,	17368,	21590,	21805,	35120,	33513,	29341,
SOPCOF %,	100,	100,	99,	99,	99,	100,	98,	99,	98,	99,

YEAR,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,
AGE										
1,	54,	718,	4801,	172,	1590,	244,	287,	2351,	884,	1159,
2,	50451,	7804,	12767,	18824,	6047,	56648,	15762,	15073,	25846,	12196,
3,	16768,	87403,	16822,	16190,	23651,	15141,	72470,	32738,	21595,	36022,
4,	31409,	13550,	68571,	16964,	7325,	14934,	8187,	42803,	19876,	13297,
5,	13869,	18739,	6308,	27257,	5108,	3496,	6111,	3288,	16730,	8980,
6,	24035,	5711,	7307,	3858,	12793,	1941,	1212,	2477,	1427,	7091,
7,	1489,	11310,	1995,	4780,	1201,	4768,	664,	804,	834,	726,
8,	1184,	464,	6015,	943,	2326,	794,	1984,	435,	274,	645,
9,	461,	916,	295,	3305,	333,	1031,	331,	931,	168,	96,
+gp,	842,	908,	668,	988,	1688,	846,	812,	714,	724,	397,
0 TOTALNUM,	140562,	147523,	125549,	93281,	62062,	99843,	107820,	101614,	88358,	80609,
TONSLAND,	31491,	33002,	30467,	22651,	14901,	20868,	23475,	22641,	19944,	16945,
SOPCOF %,	99,	99,	99,	99,	99,	99,	99,	99,	97,	99,

Table 7.2.2 Sole in IV. Catch weight at age (kg)

Table 2 Catch weights at age (kg)

YEAR,	1957,	1958,	1959,	1960,	1961,	1962,
AGE						
1,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
2,	.1540,	.1450,	.1620,	.1530,	.1460,	.1550,
3,	.1770,	.1780,	.1880,	.1850,	.1740,	.1650,
4,	.2040,	.2200,	.2280,	.2350,	.2110,	.2080,
5,	.2480,	.2540,	.2610,	.2540,	.2550,	.2410,
6,	.2790,	.2730,	.3010,	.2770,	.2880,	.2950,
7,	.2900,	.3140,	.3280,	.3010,	.3190,	.3200,
8,	.3350,	.3230,	.3210,	.3090,	.3040,	.3210,
9,	.4360,	.3880,	.3730,	.3810,	.3460,	.3340,
+gp,	.4081,	.4135,	.4262,	.4177,	.4193,	.4119,
0 SOPCOFAC,	1.0402,	1.0050,	1.0095,	.9936,	1.0137,	.9940,

YEAR,	1963,	1964,	1965,	1966,	1967,	1968,	1969,	1970,	1971,	1972,
1,	.0000,	.1530,	.0000,	.0000,	.0000,	.1570,	.1520,	.1540,	.1450,	.1690,
2,	.1630,	.1750,	.1690,	.1770,	.1920,	.1890,	.1910,	.2120,	.1930,	.2040,
3,	.1710,	.2130,	.2090,	.1900,	.2010,	.2070,	.1960,	.2180,	.2370,	.2520,
4,	.2190,	.2520,	.2460,	.1800,	.2520,	.2670,	.2550,	.2850,	.3220,	.3340,
5,	.2580,	.2740,	.2860,	.3010,	.2770,	.3270,	.3110,	.3500,	.3580,	.4340,
6,	.3090,	.3090,	.2820,	.3320,	.3890,	.3420,	.3730,	.4040,	.4250,	.4250,
7,	.3230,	.3270,	.3450,	.4290,	.4190,	.3540,	.5530,	.4410,	.4200,	.5320,
8,	.3870,	.3460,	.3780,	.3990,	.3390,	.4550,	.3980,	.4630,	.4900,	.4850,
9,	.3760,	.3880,	.4040,	.4490,	.4240,	.4650,	.4680,	.4430,	.5340,	.5580,
+gp,	.4846,	.4805,	.4797,	.5015,	.4912,	.5075,	.5227,	.5326,	.5471,	.6291,
0 SOPCOFAC,	.9918,	.9661,	.9592,	.9892,	1.0225,	.9968,	1.0202,	1.0001,	1.0119,	.9890,

YEAR,	1973,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,	1982,
1,	.1460,	.1640,	.1290,	.1430,	.1470,	.1520,	.1370,	.1410,	.1430,	.1410,
2,	.2080,	.1920,	.1820,	.1900,	.1880,	.1960,	.2080,	.1990,	.1870,	.1880,
3,	.2380,	.2330,	.2250,	.2220,	.2360,	.2310,	.2460,	.2440,	.2260,	.2160,
4,	.3460,	.3380,	.3200,	.3060,	.3070,	.3140,	.3230,	.3310,	.3240,	.3070,
5,	.4040,	.4180,	.4060,	.3890,	.3690,	.3700,	.3910,	.3710,	.3780,	.3710,
6,	.4480,	.4480,	.4560,	.4410,	.4240,	.4260,	.4480,	.4180,	.4240,	.4090,
7,	.5520,	.5200,	.5290,	.5120,	.4300,	.4660,	.5340,	.4990,	.4420,	.4370,
8,	.5670,	.5590,	.5950,	.5620,	.5200,	.4170,	.5440,	.5500,	.5160,	.4910,
9,	.5090,	.6090,	.6290,	.6670,	.5620,	.5720,	.6090,	.5980,	.5420,	.5800,
+gp,	.5858,	.6533,	.6693,	.6647,	.6194,	.6663,	.7630,	.6841,	.6302,	.6557,
0 SOPCOFAC,	1.0189,	.9864,	1.0104,	1.0216,	1.0188,	.9956,	1.0124,	1.0201,	1.0262,	1.0138,

YEAR,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,
1,	.1340,	.1530,	.1220,	.1350,	.1390,	.1270,	.1180,	.1240,	.1270,	.1460,
2,	.1820,	.1710,	.1870,	.1790,	.1850,	.1750,	.1730,	.1830,	.1860,	.1780,
3,	.2170,	.2210,	.2160,	.2130,	.2050,	.2170,	.2160,	.2270,	.2100,	.2130,
4,	.3010,	.2860,	.2880,	.2990,	.2770,	.2700,	.2880,	.2920,	.2630,	.2580,
5,	.3890,	.3610,	.3570,	.3570,	.3560,	.3540,	.3360,	.3710,	.3150,	.2980,
6,	.4160,	.3860,	.4270,	.4070,	.3780,	.4280,	.3750,	.4130,	.4360,	.3800,
7,	.4670,	.4650,	.4470,	.4850,	.4280,	.4840,	.4560,	.4150,	.4430,	.4090,
8,	.4890,	.5550,	.5440,	.5430,	.4810,	.5210,	.4920,	.5140,	.4670,	.4600,
9,	.5050,	.5750,	.6120,	.5680,	.3930,	.5590,	.4700,	.4760,	.5070,	.4870,
+gp,	.6422,	.6339,	.6447,	.6096,	.6569,	.7124,	.6111,	.6198,	.5579,	.5557,
0 SOPCOFAC,	1.0040,	1.0034,	.9898,	.9937,	.9946,	.9990,	.9841,	.9897,	.9829,	.9850,

YEAR,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,
1,	.0970,	.1430,	.1510,	.1630,	.1510,	.1280,	.1630,	.1450,	.1430,	.1280,
2,	.1670,	.1800,	.1860,	.1770,	.1800,	.1820,	.1790,	.1700,	.1850,	.1660,
3,	.1960,	.2020,	.1960,	.2020,	.2060,	.1890,	.2120,	.2000,	.2020,	.1920,
4,	.2390,	.2280,	.2470,	.2340,	.2360,	.2520,	.2290,	.2480,	.2700,	.2240,
5,	.2640,	.2570,	.2650,	.2740,	.2670,	.2620,	.2870,	.2900,	.2750,	.2570,
6,	.3000,	.3000,	.3190,	.2850,	.2960,	.2890,	.3240,	.2990,	.3330,	.2840,
7,	.3380,	.3170,	.3440,	.3180,	.3230,	.3360,	.3540,	.3230,	.3910,	.3390,
8,	.4410,	.4320,	.3560,	.3700,	.3060,	.2920,	.3720,	.3680,	.4140,	.2940,
9,	.4960,	.4090,	.4440,	.3900,	.3840,	.3350,	.3720,	.4020,	.4330,	.5290,
+gp,	.6031,	.5101,	.5914,	.5943,	.4396,	.5039,	.4527,	.4274,	.4935,	.5019,
0 SOPCOFAC,	.9885,	.9879,	.9927,	.9886,	.9901,	.9914,	.9898,	.9904,	.9690,	.9924,

Table 7.2.3 Sole in IV. Stock weight at age (kg)

Table 3 Stock weights at age (kg)

YEAR,	1957,	1958,	1959,	1960,	1961,	1962,
AGE						
1,	.0250,	.0250,	.0250,	.0250,	.0250,	.0250,
2,	.0700,	.0700,	.0700,	.0700,	.0700,	.0700,
3,	.1470,	.1640,	.1590,	.1630,	.1480,	.1480,
4,	.1870,	.2050,	.1980,	.2070,	.2060,	.1920,
5,	.2080,	.2260,	.2390,	.2340,	.2350,	.2400,
6,	.2530,	.2280,	.2710,	.2400,	.2320,	.3010,
7,	.2620,	.2970,	.2920,	.2680,	.2590,	.2930,
8,	.3550,	.3180,	.2760,	.2420,	.2740,	.2820,
9,	.3900,	.3930,	.3030,	.3600,	.2810,	.2730,
+gp,	.3652,	.4215,	.4258,	.4313,	.3964,	.4414,

YEAR,	1963,	1964,	1965,	1966,	1967,	1968,	1969,	1970,	1971,	1972,
1,	.0250,	.0250,	.0250,	.0250,	.0250,	.0250,	.0250,	.0250,	.0340,	.0380,
2,	.0700,	.0700,	.1400,	.0700,	.1770,	.1220,	.1370,	.1370,	.1480,	.1550,
3,	.1480,	.1590,	.1980,	.1600,	.1640,	.1710,	.1740,	.2010,	.2130,	.2180,
4,	.1930,	.2140,	.2230,	.1490,	.2350,	.2480,	.2520,	.2750,	.3130,	.3130,
5,	.2430,	.2400,	.2510,	.3890,	.2420,	.3120,	.3240,	.3410,	.3610,	.4190,
6,	.2750,	.2910,	.2970,	.3100,	.3990,	.2800,	.3640,	.3670,	.4100,	.4430,
7,	.3110,	.3050,	.3370,	.4060,	.3620,	.6290,	.5790,	.4230,	.4320,	.4430,
8,	.3630,	.3060,	.3580,	.3770,	.2830,	.4160,	.4150,	.4580,	.4740,	.4430,
9,	.3290,	.3650,	.5260,	.3850,	.3810,	.4100,	.4690,	.3900,	.4830,	.5080,
+gp,	.4654,	.4739,	.4605,	.5045,	.4591,	.4856,	.5211,	.5544,	.5325,	.6018,

YEAR,	1973,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,	1982,
1,	.0390,	.0350,	.0350,	.0350,	.0350,	.0350,	.0450,	.0390,	.0500,	.0500,
2,	.1490,	.1460,	.1480,	.1420,	.1470,	.1390,	.1480,	.1570,	.1370,	.1300,
3,	.2260,	.2180,	.2060,	.2010,	.2020,	.2110,	.2110,	.2000,	.2000,	.1930,
4,	.3220,	.3290,	.3110,	.3010,	.2910,	.2900,	.3000,	.3040,	.3050,	.2700,
5,	.3710,	.4080,	.4030,	.3790,	.3650,	.3650,	.3520,	.3450,	.3640,	.3590,
6,	.4330,	.4290,	.4460,	.4580,	.4090,	.4290,	.4290,	.3940,	.4020,	.4110,
7,	.4520,	.4990,	.5080,	.5080,	.4780,	.4270,	.5210,	.4890,	.4540,	.4290,
8,	.4720,	.5650,	.5820,	.5170,	.4870,	.3850,	.5620,	.5370,	.5220,	.4760,
9,	.4460,	.5420,	.5800,	.6440,	.5310,	.5420,	.5670,	.5790,	.5610,	.5830,
+gp,	.5355,	.6180,	.6501,	.6648,	.6443,	.6444,	.7434,	.6451,	.6221,	.6422,

YEAR,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,
1,	.0500,	.0500,	.0500,	.0500,	.0500,	.0500,	.0500,	.0500,	.0500,	.0500,
2,	.1400,	.1330,	.1270,	.1330,	.1540,	.1330,	.1330,	.1480,	.1390,	.1560,
3,	.2000,	.2030,	.1850,	.1910,	.1910,	.1930,	.1950,	.2030,	.1840,	.1940,
4,	.2850,	.2680,	.2670,	.2780,	.2620,	.2600,	.2900,	.2940,	.2540,	.2570,
5,	.3290,	.3480,	.3240,	.3450,	.3570,	.3350,	.3500,	.3570,	.3010,	.3070,
6,	.4350,	.3860,	.3810,	.4230,	.3810,	.4090,	.3400,	.4470,	.4130,	.3980,
7,	.4640,	.4880,	.3800,	.4950,	.4060,	.4170,	.4110,	.3990,	.4470,	.4060,
8,	.4830,	.5910,	.6260,	.4870,	.4540,	.4740,	.4750,	.4940,	.5220,	.4720,
9,	.5100,	.5670,	.5540,	.5870,	.3320,	.4860,	.4190,	.4810,	.5480,	.5000,
+gp,	.6362,	.6636,	.6423,	.6863,	.6196,	.6543,	.5946,	.6528,	.5733,	.5401,

YEAR,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,
1,	.0500,	.0500,	.0500,	.0500,	.0500,	.0500,	.0500,	.0500,	.0500,	.0500,
2,	.1280,	.1430,	.1510,	.1470,	.1500,	.1400,	.1310,	.1390,	.1440,	.1330,
3,	.1840,	.1740,	.1790,	.1780,	.1900,	.1730,	.1870,	.1850,	.1850,	.1780,
4,	.2290,	.2090,	.2400,	.2080,	.2250,	.2340,	.2160,	.2260,	.2230,	.2200,
5,	.2650,	.2570,	.2530,	.2740,	.2520,	.2670,	.2590,	.2640,	.2630,	.2410,
6,	.2930,	.3260,	.3210,	.2680,	.3030,	.2810,	.2960,	.2750,	.3190,	.2420,
7,	.3440,	.3490,	.3650,	.3210,	.3190,	.3280,	.3400,	.2870,	.3270,	.2740,
8,	.4820,	.4020,	.3570,	.3750,	.3250,	.2730,	.3220,	.3370,	.4210,	.2790,
9,	.4370,	.4940,	.5450,	.4020,	.3600,	.3360,	.3690,	.3910,	.4100,	.4050,
+gp,	.5833,	.4589,	.5452,	.5465,	.4240,	.4548,	.4639,	.3762,	.5302,	.4111,

Table 7.2.4 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 7.3.1 North Sea sole tuning fleets

```
North Sea Sole
103
FLT01:NL BTS-ISIS
1985    2002
1       1       0.67    0.75
1       9
1       2.651   7.893   3.541   1.669   0.620   0.279   0.000   0.000   0.000   0.000
1       7.880   4.494   1.726   0.826   0.590   0.216   0.101   0.002   0.021   0.099
1       6.993   12.548  1.834   0.563   0.583   0.223   0.230   0.061   0.026   0.009
1       81.230  12.807  2.776   0.997   0.131   0.154   0.121   0.095   0.013   0.116
1       9.419   68.084  4.191   4.096   0.677   0.128   0.242   0.000   0.138   0.034
1       22.623  22.363  20.090  0.611   0.682   0.511   0.078   0.055   0.013   0.010
1       3.344   23.187  5.843   6.011   0.100   0.135   0.075   0.033   0.012   0.034
1       74.220  23.200  9.879   2.332   2.903   0.061   0.142   0.065   0.016   0.066
1       4.980   27.359  0.987   4.367   2.376   4.295   0.027   0.094   0.064   0.051
1       5.879   4.992   15.422  0.134   1.407   0.097   0.995   0.014   0.004   0.013
1       27.622  8.456   7.039   6.718   0.476   0.913   0.314   0.966   0.049   0.000
1       3.511   6.166   1.909   1.488   2.493   0.309   0.408   0.054   0.290   0.063
1       173.238 5.367   3.234   0.800   0.769   0.403   0.105   0.038   0.045   0.060
1       14.122  29.211  1.998   1.346   0.079   0.016   0.424   0.000   0.000   0.000
1       11.413  19.257  16.626  0.629   2.061   0.334   0.224   0.651   0.003   0.323
1       12.888  6.527   4.093   1.597   0.284   0.155   0.064   0.008   0.162   0.074
1       7.973   10.837  2.350   1.681   0.740   0.081   0.040   0.030   0.000   0.184
1       21.457  4.238   3.412   0.930   0.354   0.355   0.022   0.060   0.000   0.068
FLT02:NL SNS
1970    2002
1       1       0.67    0.75
1       4
        1       4938    745     204     31
        1       613     1961    99      7
        1       1410    341     161     0.1
        1       4686    905     73      35
        1       1924    397     69      0.1
        1       597     887     174     44
        1       1413    79      187     70
        1       3724    762     77      85
        1       1552    1379    267     27
        1       104     388     325     60
        1       4483    80      99      45
        1       3739    1411    51      13
        1       5098    1124    231     7
        1       2640    1137    107     43
        1       2359    1081    307     102
        1       2151    709     159     59
        1       3791    465     67      30
        1       1890    955     59      15
        1       11227   594     284     81
        1       3052    5369    248     50
        1       2900    1078    907     100
        1       1265    2515    527     607
        1       11081   114     319     194
        1       1351    3489    46      166
        1       559     475     943     10
        1       1501    234     126     365
        1       691     473     27      48
        1       10132   143     231     51
        1       2876    1993    131     52
        1       1649    919     381     12.3
        1       1735    150     189     95.7
        1       949     638     99      32
        1       7093    361     174     0
FLT03:NL Comm BT
1990    2002
1       1       0       1
2       15
71.4    9071.1  84629.7 7242    6586.7  1669.1  634.6   819.2   375.9   137.6   134.1   42.5    10.1    12.6    138.2
68.5    7336.6  17182.4 59754   4638.3  2137.6  682.7   312.1   392.3   156.6   98.4    180.5   6.3     6       48.1
71.1    5046.7  33880.5 11131   29835.9 1457.9  2081.2  446.1   218.6   274.8   75.7    164.1   66.4    3.9     109
76.9    39284.5 10948   24132   9625.4  18624   887.1   811.5   236.1   66.4    186.3   50.2    41.6    59.1    21.8
81.4    5389.9  69878.8 7411.7  13010.4 3104.8  8932.9  190     524.2   175.9   25.9    158.5   25.2    20.1    149.5
81.2    9778    11329.4 53488.8 2839.2  5128.8  896.5   4682.4  147.4   204.8   24.4    22.4    34.7    6.4     108.6
72.1    15843.4 9093.9  11170.8 21211.9 1570    3173.4  471.9   2773.8  160     190.5   85.7    23.3    62.4    99.5
72      4505.9  18426.8 4503.6  3329    9771.1  497.2   1800.4  94.6    1155.3  5.7     76.9    11.1    14.3    43.5
70.2    50570.7 9023.1  11123.1 1826.2  1145.6  3395    210.7   337     21.4    286.6   5.2     37.2    4.9     42.9
67.3    11820.5 55177.2 4152.6  4458.8  730.2   335.7   1526.8  133.4   362.5   6       126.7   2       21.5    30.1
67.7    12308.6 29559.5 21746.8 2046.1  1579.9  454.8   322.4   640.8   209.8   115.4   23.2    53.6    2.9     44
61.4    18723.6 13660.3 14969   13081   721     506     136     93      369     8       33.9    6.8     40.3    17.3
56.4    9997.1  27727   8809.1  6697.3  5639.3  470.1   426.3   59.7    32.9    77.5    13      19.2    0       23.5
```

Table 7.3.1 (cont.) North Sea sole tuning fleets (not used in the assessment)

```
FLT02:    UK Comm OT (Division IVc)                     effort hphr's (000's)
1990      2002
1         1        0        1
2         15
          6409.1   123.5    552.6    71.9     96.2     62.1     34       24.8     14.2     11.3     10.3     0.8      0.5      5.1      4.3
          6643.4   144      229.6    364.8    21.2     60.9     33.9     18.8     8.1      7.7      10.6     10.1     0.6      0.1      8.7
          5279.3   59.9     223.5    88.9     94.9     10.2     21.9     13.3     8.4      7.8      3.9      2.6      3.7      0        6.5
          5787.2   114.9    181.5    187.1    83.6     95.9     8.5      13.8     9.9      5.8      4.2      2.2      2.5      2.6      4.6
          4913.3   14.1     2008.9   105.8    99.1     29.3     32.3     2.5      7.6      5.9      4.7      2.7      2.4      1.7      4.3
          4766.3   39.9     128.8    144.1    134.3    38.6     26.8     17       1        6        3        3.2      0.5      0.2      1.7
          3352.8   38.3     65.7     73.3     75.5     43.7     23.6     11       13.6     0.6      3        1.6      1.1      1.5      1.9
          2852.8   30.8     78.3     54.8     36.4     31.5     31.7     13.3     8.4      4.5      0.6      1.7      0.7      1        2.2
          1933.4   51.4     43.6     29.5     18.8     18.5     14.6     25.1     9.5      3.4      2.6      0.6      0.6      0.4      1.5
          2184.1   17.9     89.7     33.1     13.4     10.2     9.8      11.8     12.3     3.8      1.9      2        0.3      0.6      1.4
          1667.6   19.7     36.9     81.4     27.8     8.6      8        6.2      4.1      9        2.4      1.1      0.2      0.1      0.8
          1446.0   25.2     44.6     16.9     30.9     9.7      3.2      3.7      1.7      2.4      2.6      0.7      0.2      0.3      0.5
          1153.5   6.3      34.2     39.6     7.7      16.9     7.7      3.1      1.4      1.7      2.2      2.2      1        0.5      0.9

FLT03:BTS TRIDENS
1996 2002
1    1    0.67 0.75
1    9
     1    0.5061.6590.4540.2370.5790.1510.3040.0150.1480.048
     1    0.0850.0800.1580.0830.0160.0000.0000.0160.0000.000
     1    0.4532.3420.5960.3760.2520.1790.1900.0000.0810.023
     1    0.5200.5691.2600.1180.2580.0340.0040.1340.0190.207
     1    0.3170.6960.4800.6480.0610.0370.0480.0120.0760.018
     1    1.0351.8290.8170.6010.3420.0090.0100.0110.0000.027
     1    0.8881.0541.8801.8180.2130.8000.1200.0000.0000.206
```

Table 7.3.2 North Sea sole : indices of effort and CPUE

	Effort			CPUE		
	B beam	**UK otter**	**NL beam**	**B beam**	**UK otter**	**NL beam**
year	1000 HP hour[1]	1000 HP hour	1000000 HP day	kg/1000 HP h[1]	kg/HP h	kg/1000 HP d
1972	29.8			33.5		
1973	29.4			33.1		
1974	32.2			23.7		
1975	39.2			26.2		
1976	44.7			24.5		
1977	47.6			27.2		
1978	50.3		44.3	25.9		375.8
1979	40.0		44.9	38.7		423.2
1980	35.2		45.0	30.9		282.1
1981	31.1		46.3	35.2		267.8
1982	34.9		57.3	44.7		309.8
1983	35.4		65.6	42.8		319.9
1984	42.8		70.8	35.2		307.3
1985	51.4		70.3	40.8		276.3
1986	42.5		68.2	38.8		213.4
1987	50.7		68.5	28.9		204.5
1988	53.0		76.3	19.2		235.9
1989	54.3		61.6	22.7		272.7
1990	64.7	6409.1	71.4	24.8	35.5	378.1
1991	74.3	6643.4	68.5	33.5	30.3	350.9
1992	67.7	5279.3	71.1	22.5	25.3	307.1
1993	71.1	5787.2	76.9	27.2	27.4	306.4
1994	60.0	4913.3	81.4	32.5	25.4	295.6
1995	46.5	4766.3	81.2	34.9	25.5	275.1
1996	64.9	3352.8	72.1	29.0	23.9	227.1
1997	47.2	2852.8	72.0	24.2	23.6	151.7
1998	43.6	1933.4	70.2	25.0	25.9	230.7
1999	55.7	2184.1	67.3	24.3	24.9	257.9
2000	49.3	1667.6	67.7	24.0	25.7	240.6
2001	45.5	1446.0	61.4	27.7	22.6	220.1
2002	51.6	1153.5	56.4	23.0	24.9	229.0

[1] corrected for fishing power

Table 7.4.1.1. Sole in Subarea IV. Survey to relative abundance ratio, q, for each survey

$$N_{a,y}^{relative} = q_a * I_{a,y}$$

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
SNS - Tridens	1.0	1.0	1.0	1.0					
BTS	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0

Table 7.4.1.2 North Sea Sole, Separable XSA output

Title : Sole in IV
At 18/09/2003 15:17

Separable analysis
from 1957 to 2002 on ages 1 to 9
with Terminal F of .500 on age 4 and Terminal S of .800

Initial sum of squared residuals was 1659.565 and
final sum of squared residuals is 305.113 after 150 iterations

Matrix of Residuals

Years	1982/83	1983/84	1984/85	1985/86	1986/87	1987/88	1988/89	1989/90	1990/91	1991/92
1/ 2	0.75	-0.8	-1.154	-0.618	-1.061	-1.456	-5.233	-1.1	0.754	-0.589
2/ 3	0.025	0.478	0.127	0.482	-0.376	0.2	0.106	-0.057	-0.056	-0.544
3/ 4	0.202	0.303	0.191	0.456	0.196	0.062	0.172	0.423	0.024	0.147
4/ 5	0.175	0.246	-0.05	0.193	0.132	0.08	0.306	0.39	-0.209	0.092
5/ 6	-0.035	-0.87	-0.088	-0.304	-0.03	-0.183	0.011	-0.265	0.259	0.306
6/ 7	0	-0.144	0.353	-0.314	0.39	0.065	0.095	-0.07	0.059	-0.442
7/ 8	-0.12	0.233	0.139	0.114	0.292	0.164	0.215	-0.116	0.007	0.454
8/ 9	-0.474	-0.038	-0.461	-0.511	-0.603	-0.128	-0.273	-0.412	-0.14	-0.08
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

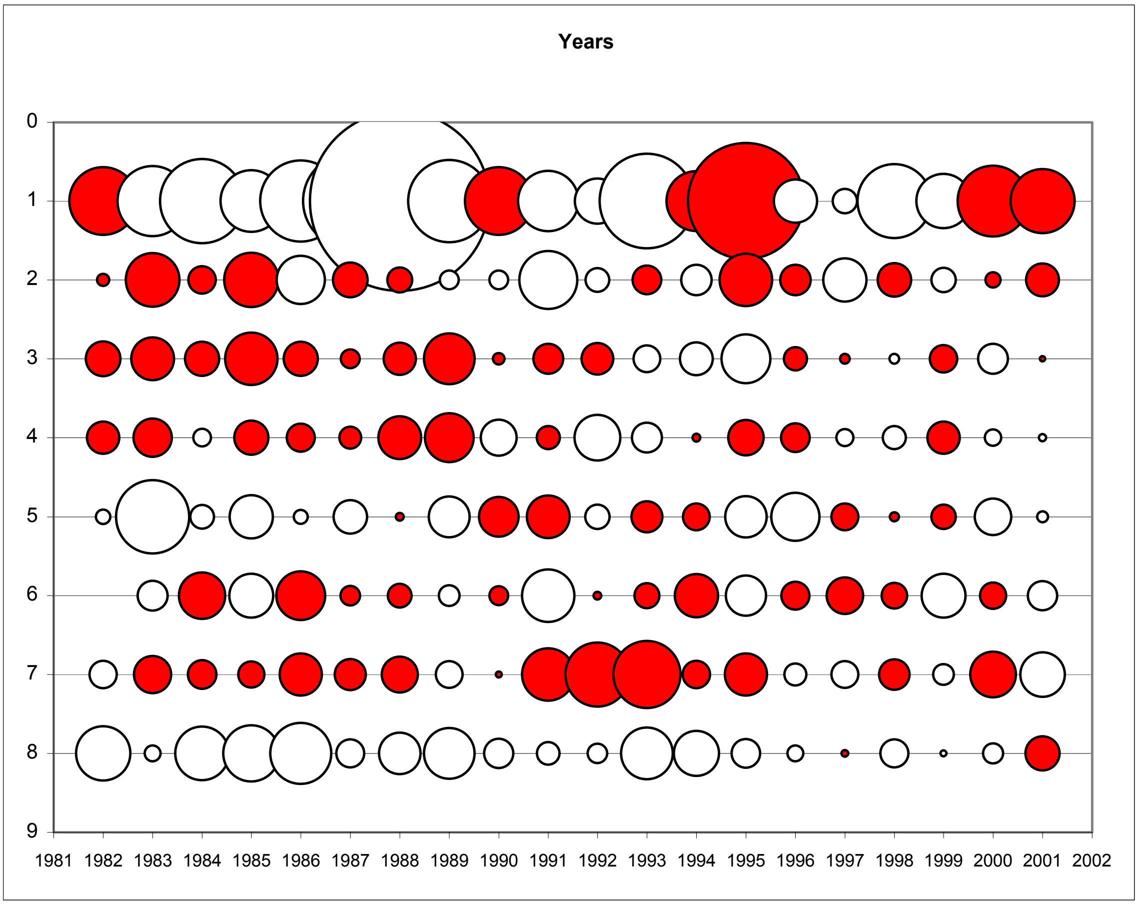


Table 7.4.2 North Sea sole XSA tuning output

Lowestoft VPA Version 3.1

18/09/2003 2:14

Extended Survivors Analysis
Sole in IV
CPUE data from file fleet02z.txt
Catch data for 46 years. 1957 to 2002. Ages 1 to 10.

Fleet,	First, year,	Last, year,	First, age ,	Last, age	Alpha,	Beta
FLT01:NL BTS-ISIS ,	1985,	2002,	1,	9,	.670,	.750
FLT02:NL SNS ,	1970,	2002,	1,	4,	.670,	.750
FLT03:NL Comm BT ,	1990,	2002,	2,	9,	.000,	1.000

Time series weights :
Tapered time weighting not applied

Catchability analysis :

Catchability dependent on stock size for ages < 2

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

Catchability independent of age for ages >= 7

Terminal population estimation :

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

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

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

Prior weighting not applied

Tuning converged after 25 iterations

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

Fishing mortalities

Age,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002
1,	.001,	.013,	.053,	.004,	.006,	.002,	.004,	.019,	.015,	.006
2,	.181,	.140,	.305,	.270,	.155,	.264,	.157,	.231,	.263,	.253
3,	.423,	.479,	.444,	.693,	.563,	.624,	.556,	.496,	.532,	.621
4,	.553,	.634,	.760,	.975,	.693,	.750,	.729,	.664,	.564,	.649
5,	.825,	.667,	.609,	.693,	.797,	.750,	.704,	.646,	.523,	.475
6,	.558,	.876,	.526,	.835,	.732,	.717,	.559,	.611,	.572,	.388
7,	.856,	.492,	.778,	.694,	.596,	.588,	.505,	.796,	.376,	.568
8,	.519,	.627,	.468,	.954,	.774,	.906,	.459,	.646,	.614,	.495
9,	.785,	.873,	.950,	.451,	.975,	.849,	1.136,	.359,	.490,	.397

XSA population numbers (Thousands)

	AGE								
YEAR ,	1,	2,	3,	4,	5,	6,	7,	8,	9,
1993 ,	6.94E+04,	3.20E+05,	5.11E+04,	7.77E+04,	2.60E+04,	5.91E+04,	2.72E+03,	3.07E+03,	8.91E+02,
1994 ,	5.72E+04,	6.27E+04,	2.42E+05,	3.03E+04,	4.05E+04,	1.03E+04,	3.06E+04,	1.05E+03,	1.65E+03,
1995 ,	9.74E+04,	5.10E+04,	4.93E+04,	1.35E+05,	1.45E+04,	1.88E+04,	3.88E+03,	1.69E+04,	5.06E+02,
1996 ,	4.91E+04,	8.36E+04,	3.40E+04,	2.86E+04,	5.73E+04,	7.16E+03,	1.00E+04,	1.61E+03,	9.58E+03,
1997 ,	2.86E+05,	4.43E+04,	5.77E+04,	1.54E+04,	9.78E+03,	2.59E+04,	2.81E+03,	4.54E+03,	5.62E+02,
1998 ,	1.26E+05,	2.57E+05,	3.43E+04,	2.98E+04,	6.96E+03,	3.99E+03,	1.13E+04,	1.40E+03,	1.89E+03,
1999 ,	8.51E+04,	1.14E+05,	1.79E+05,	1.66E+04,	1.27E+04,	2.98E+03,	1.76E+03,	5.67E+03,	5.13E+02,
2000 ,	1.32E+05,	7.67E+04,	8.80E+04,	9.28E+04,	7.26E+03,	5.69E+03,	1.54E+03,	9.61E+02,	3.24E+03,
2001 ,	6.42E+04,	1.18E+05,	5.51E+04,	4.85E+04,	4.32E+04,	3.45E+03,	2.80E+03,	6.28E+02,	4.56E+02,
2002 ,	1.99E+05,	5.73E+04,	8.18E+04,	2.93E+04,	2.50E+04,	2.32E+04,	1.76E+03,	1.74E+03,	3.08E+02,

Estimated population abundance at 1st Jan 2003

,	0.00E+00,	1.79E+05,	4.02E+04,	3.98E+04,	1.38E+04,	1.40E+04,	1.42E+04,	9.02E+02,	9.57E+02,

Taper weighted geometric mean of the VPA populations:

, 9.74E+04, 8.45E+04, 6.39E+04, 3.50E+04, 1.80E+04, 9.42E+03, 5.19E+03, 3.07E+03, 1.71E+03,

Standard error of the weighted Log(VPA populations) :

, .7797, .8157, .8441, .8840, .9270, .9341, .9903, 1.0200, 1.0965,

1

Log catchability residuals.

Fleet : FLT01:NL BTS-ISIS

Age	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	99.99	99.99	-.64	-.62	.09	-.18	-.12	-.05	-.36	.02
2	99.99	99.99	.11	-.71	-.30	.51	.26	.59	.10	1.05
3	99.99	99.99	-.13	-.20	-.52	-.59	.51	.04	.27	.26
4	99.99	99.99	.30	-.41	-.23	.01	.94	-.41	-.20	.28
5	99.99	99.99	-.17	.14	-.01	-.89	.35	-.05	-1.33	-.24
6	99.99	99.99	.25	-.17	.15	-.40	-.03	1.03	-.80	-.77
7	99.99	99.99	99.99	-.24	.21	-.10	.33	-.21	-.40	-.32
8	99.99	99.99	99.99	-1.59	.03	-.21	99.99	-.55	-.38	.16
9	99.99	99.99	99.99	-.16	1.75	-.59	.56	-1.22	-1.33	-.25

Age	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
1	-.09	.22	.70	.04	.78	-.01	.24	-.11	.30	-.20
2	-.36	-.46	.39	-.44	-.03	-.02	.31	-.33	-.23	-.45
3	-1.10	.14	.92	.16	.07	.15	.57	-.16	-.22	-.18
4	.44	-2.05	.46	.66	.46	.36	.17	-.67	-.04	-.07
5	1.21	.13	.03	.37	1.04	-.93	1.69	.23	-.68	-.90
6	1.08	-.74	.66	.76	-.34	-1.70	1.52	.14	-.04	-.60
7	-.96	-.03	1.09	.34	.18	.18	1.35	.43	-.93	-.93
8	-.07	-.82	.52	.33	-1.18	99.99	1.21	-1.28	.44	.04
9	.97	-2.36	1.39	-.13	1.22	99.99	-1.29	.31	99.99	99.99

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

Age	2	3	4	5	6	7	8	9
Mean Log q	-8.8093	-9.3885	-9.7600	-9.8518	-10.1441	-9.8855	-9.8855	-9.8855
S.E(Log q)	.4564	.4630	.6569	.7884	.8036	.6394	.7935	1.1999

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
1	.64	2.489	9.98	.75	18	.38	-9.04

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

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
2	1.04	-.202	8.71	.65	18	.49	-8.81
3	.94	.383	9.51	.69	18	.44	-9.39
4	.97	.118	9.78	.54	18	.66	-9.76
5	1.01	-.051	9.85	.45	18	.82	-9.85
6	.91	.373	10.05	.52	18	.75	-10.14
7	.97	.156	9.83	.60	17	.64	-9.89
8	.72	2.059	9.41	.80	15	.49	-10.11
9	1.83	-1.368	12.46	.18	14	2.12	-9.97

1

Fleet : FLT02:NL SNS

Age	1970	1971	1972
1	.31	-.07	-.05
2	.77	.85	.24
3	.39	.13	-.16
4	.34	-1.37	-5.25
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	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
1	.52	-.17	-.07	-.43	.09	.50	-.13	.15	.02	.24
2	.57	-.62	.24	-1.30	.06	.41	.21	-.01	.37	.13
3	.20	-.59	-.08	.10	.03	.42	.44	.24	.89	.06
4	-.12	-4.75	.55	.45	.87	.48	.51	.03	-.25	.43
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	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	-.19	.42	.22	-.03	.23	-.26	.19	-.34	-.05	-.02
2	.19	.19	.48	-.20	-.09	.22	.51	.35	.67	-1.48
3	-.80	.42	-.19	-.41	-.92	.17	.73	-.02	.90	-.13
4	.05	.75	.48	-.20	-.33	1.03	.06	1.31	1.04	1.32
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	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
1	.02	-.45	-.22	-.15	.13	-.01	-.03	-.43	-.17	.23
2	.37	-.03	-.41	-.23	-.87	.09	.05	-1.31	-.27	-.13
3	-1.12	.38	-.07	-1.06	.47	.46	-.17	-.20	-.35	-.12
4	.69	-1.12	1.07	.75	1.23	.63	-.24	.04	-.47	99.99
5	No data for this fleet at this age									
6	No data for this fleet at this age									
7	No data for this fleet at this age									
8	No data for this fleet at this age									
9	No data for this fleet at this age									

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

Age	2	3	4
Mean Log q	-4.6869	-5.5181	-6.3770
S.E(Log q)	.5743	.5079	1.4625

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
1	.76	3.687	5.64	.88	33	.26	-3.77

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

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
2	.80	1.828	6.06	.72	33	.44	-4.69
3	1.09	-.599	5.04	.61	33	.56	-5.52
4	.60	1.896	7.97	.43	32	.84	-6.38

Fleet : FLT03:NL Comm BT

Age	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	No data for this fleet at this age									
2	99.99	99.99	99.99	99.99	99.99	99.99	99.99	-.31	-1.00	-.47
3	99.99	99.99	99.99	99.99	99.99	99.99	99.99	-.11	-.21	-.10
4	99.99	99.99	99.99	99.99	99.99	99.99	99.99	-.10	-.02	-.30
5	99.99	99.99	99.99	99.99	99.99	99.99	99.99	-.06	.21	-.16
6	99.99	99.99	99.99	99.99	99.99	99.99	99.99	-.19	-.36	.00
7	99.99	99.99	99.99	99.99	99.99	99.99	99.99	-.19	-.27	.25
8	99.99	99.99	99.99	99.99	99.99	99.99	99.99	.06	-.20	.00
9	99.99	99.99	99.99	99.99	99.99	99.99	99.99	.06	.08	.21

Age	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
1	No data for this fleet at this age									
2	-.08	-.52	.37	.46	-.22	.52	-.13	.34	.44	.61
3	-.36	-.09	-.34	.04	.16	.02	.20	.25	.06	.49
4	-.09	-.35	.18	.38	-.03	.27	-.10	-.20	.13	.23
5	.19	-.08	-.60	.19	.15	-.10	.21	-.04	.08	.02
6	.08	.12	-.13	-.10	.40	.15	-.03	.11	-.10	.06
7	.29	-.04	-.14	.25	-.37	.18	-.27	.29	-.28	.28
8	-.07	-.45	-.10	.29	.52	-.37	.06	.36	.00	.16
9	.05	.21	.16	.06	-.26	-.23	.31	-.30	-.11	-.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
Mean Log q	-6.2192	-5.2698	-5.1092	-5.0924	-5.2678	-5.3128	-5.3128	-5.3128
S.E(Log q)	.4957	.2416	.2239	.2244	.1879	.2620	.2747	.1970

Regression statistics :

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

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
2	1.03	-.133	6.04	.59	13	.53	-6.22
3	.99	.120	5.34	.90	13	.25	-5.27
4	1.01	-.112	5.06	.92	13	.24	-5.11
5	1.00	.047	5.11	.93	13	.23	-5.09
6	.95	.842	5.46	.96	13	.18	-5.27
7	.96	.484	5.44	.92	13	.26	-5.31
8	.96	.436	5.39	.92	13	.27	-5.29
9	1.02	-.336	5.27	.96	13	.21	-5.30

1

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Terminal year survivor and F summaries :

Age  1   Catchability dependent on age and year class strength

Year class = 2001

Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
FLT01:NL BTS-ISIS   ,    146711.,   .396,       .000,    .00,   1,  .332,     .007
FLT02:NL SNS        ,    224110.,   .300,       .000,    .00,   1,  .577,     .005
FLT03:NL Comm BT    ,         1.,   .000,       .000,    .00,   0,  .000,     .000

  P shrinkage mean  ,     84474.,    .82,,,,                        .078,     .013

  F shrinkage mean  ,    122240.,   2.00,,,,                        .013,     .009

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
   178948.,       .23,      .18,    4,    .774,   .006

1
Age  2   Catchability constant w.r.t. time and dependent on age

Year class = 2000

Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
FLT01:NL BTS-ISIS   ,     39624.,   .302,       .371,   1.23,   2,  .376,     .257
FLT02:NL SNS        ,     34309.,   .267,       .016,    .06,   2,  .482,     .291
FLT03:NL Comm BT    ,     74225.,   .514,       .000,    .00,   1,  .131,     .145

  F shrinkage mean  ,     48505.,   2.00,,,,                        .011,     .214

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
    40228.,       .19,      .15,    6,    .812,   .253

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

Year class = 1999

Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
FLT01:NL BTS-ISIS   ,     33601.,   .257,       .033,    .13,   3,  .307,     .703
FLT02:NL SNS        ,     28725.,   .239,       .094,    .39,   3,  .346,     .785
FLT03:NL Comm BT    ,     64468.,   .261,       .022,    .08,   2,  .336,     .426

  F shrinkage mean  ,     46054.,   2.00,,,,                        .011,     .556

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
    39766.,       .15,      .13,    9,    .879,   .621

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

Year class = 1998

Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
FLT01:NL BTS-ISIS   ,     12914.,   .249,       .130,    .52,   4,  .257,     .683
FLT02:NL SNS        ,     10090.,   .238,       .319,   1.34,   3,  .227,     .813
FLT03:NL Comm BT    ,     16571.,   .205,       .065,    .32,   3,  .503,     .567

  F shrinkage mean  ,     12910.,   2.00,,,,                        .012,     .683

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
    13844.,       .14,      .10,   11,    .754,   .649
```

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

Year class = 1997

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
FLT01:NL BTS-ISIS ,	11841.,	.255,	.199,	.78,	5,	.209,	.543
FLT02:NL SNS ,	13175.,	.236,	.073,	.31,	4,	.158,	.500
FLT03:NL Comm BT ,	15236.,	.181,	.056,	.31,	4,	.621,	.445
F shrinkage mean ,	8650.,	2.00,,,,				.011,	.687

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
14035.,	.13,	.07,	14,	.494,	.475

Age 6 Catchability constant w.r.t. time and dependent on age

Year class = 1996

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
FLT01:NL BTS-ISIS ,	11755.,	.311,	.260,	.84,	6,	.161,	.454
FLT02:NL SNS ,	14933.,	.239,	.072,	.30,	4,	.085,	.373
FLT03:NL Comm BT ,	14904.,	.172,	.062,	.36,	5,	.743,	.373
F shrinkage mean ,	7510.,	2.00,,,,				.012,	.641

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
14234.,	.14,	.07,	16,	.517,	.388

Age 7 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:NL BTS-ISIS ,	606.,	.353,	.206,	.58,	7,	.164,	.761
FLT02:NL SNS ,	799.,	.238,	.233,	.98,	4,	.042,	.623
FLT03:NL Comm BT ,	988.,	.171,	.080,	.47,	6,	.778,	.530
F shrinkage mean ,	889.,	2.00,,,,				.015,	.575

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
902.,	.15,	.08,	18,	.534,	.568

Age 8 Catchability constant w.r.t. time and age (fixed at the value for age) 7

Year class = 1994

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
FLT01:NL BTS-ISIS ,	824.,	.360,	.262,	.73,	8,	.145,	.557
FLT02:NL SNS ,	959.,	.240,	.191,	.80,	4,	.023,	.495
FLT03:NL Comm BT ,	989.,	.161,	.084,	.52,	7,	.819,	.483
F shrinkage mean ,	627.,	2.00,,,,				.013,	.682

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
957.,	.14,	.08,	20,	.534,	.495

Age 9 Catchability constant w.r.t. time and age (fixed at the value for age) 7

Year class = 1993

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
FLT01:NL BTS-ISIS ,	297.,	.402,	.178,	.44,	8,	.077,	.268
FLT02:NL SNS ,	114.,	.242,	.296,	1.22,	4,	.010,	.589
FLT03:NL Comm BT ,	182.,	.172,	.050,	.29,	8,	.898,	.407
F shrinkage mean ,	135.,	2.00,,,,				.015,	.517

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
187.,	.16,	.05,	21,	.331,	.397

Table 7.4.3 North Sea sole XSA: fishing mortality at age

Run title : Sole in IV
At 18/09/2003 2:14

Terminal Fs derived using XSA (With F shrinkage)

Table 8 Fishing mortality (F) at age

YEAR	1957	1958	1959	1960	1961	1962
1	.0000	.0000	.0000	.0000	.0000	.0000
2	.0207	.0169	.0336	.0290	.0182	.0188
3	.1272	.1487	.1299	.1577	.1446	.1411
4	.2547	.2349	.2464	.2410	.2952	.2287
5	.2592	.2756	.2050	.3234	.2515	.3629
6	.2283	.3608	.2395	.2671	.2393	.3128
7	.2922	.3448	.1818	.2893	.1738	.3669
8	.1671	.2949	.3657	.3440	.3967	.2468
9	.2408	.3030	.2482	.2937	.2719	.3044
+gp	.2408	.3030	.2482	.2937	.2719	.3044
0 FBAR 2- 6	.1780	.2074	.1709	.2036	.1898	.2129
FBAR 2- 8	.1928	.2395	.2003	.2359	.2170	.2397

YEAR	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
1	.0000	.0001	.0000	.0000	.0000	.0110	.0084	.0099	.0107	.0049
2	.0525	.0198	.1071	.1244	.1136	.3081	.3309	.1552	.3321	.2417
3	.1787	.3257	.1689	.4375	.3657	.6957	.6908	.6366	.5728	.6530
4	.4218	.2497	.3886	.2044	.4884	.6433	.5547	.5487	.6593	.5432
5	.4015	.4865	.3208	.4904	.6825	.5060	.6830	.3209	.5798	.5134
6	.5092	.3649	.6000	.3686	.3819	.2954	.4728	.3319	.4124	.3609
7	.4819	.5159	.4321	.3180	.2961	.2678	.3176	.3824	.3759	.2289
8	.4572	.3251	.4647	.3599	.5492	.3948	.4126	.3668	.3718	.3106
9	.4792	.3896	.4427	.3492	.4813	.4228	.4899	.3913	.4816	.3926
+gp	.4792	.3896	.4427	.3492	.4813	.4228	.4899	.3913	.4816	.3926
0 FBAR 2- 6	.3128	.2893	.3171	.3250	.4064	.4897	.5464	.3987	.5113	.4624
FBAR 2- 8	.3576	.3268	.3546	.3290	.4110	.4444	.4946	.3918	.4720	.4074

YEAR	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
1	.0068	.0010	.0068	.0097	.0132	.0006	.0008	.0044	.0030	.0185
2	.2061	.1817	.2787	.1073	.2636	.2355	.2240	.1307	.2546	.2299
3	.7105	.5900	.5251	.5671	.5560	.5751	.6592	.5526	.5380	.6964
4	.5949	.6754	.6603	.4697	.6192	.5400	.6367	.5896	.5932	.5894
5	.6044	.4974	.5204	.5537	.4336	.5294	.4890	.5925	.5286	.6176
6	.4263	.5764	.4883	.4294	.3592	.4196	.4689	.4115	.5947	.5948
7	.3640	.5120	.4372	.4258	.2178	.6285	.2703	.5993	.4587	.5303
8	.5376	.3875	.5496	.5481	.4182	.7238	.6050	.3238	.4554	.5400
9	.5073	.5318	.5172	.4770	.4707	.4055	.6219	.5331	.2610	.5715
+gp	.5073	.5318	.5172	.4770	.4707	.4055	.6219	.5331	.2610	.5715
0 FBAR 2- 6	.5085	.5042	.4946	.4254	.4463	.4599	.4956	.4554	.5018	.5456
FBAR 2- 8	.4920	.4886	.4942	.4430	.4097	.5217	.4790	.4571	.4890	.5426

YEAR	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	.0029	.0028	.0021	.0025	.0014	.0000	.0011	.0051	.0018	.0029
2	.3096	.2896	.3193	.1447	.2381	.2382	.1258	.1372	.0903	.1196
3	.5927	.7177	.7382	.6211	.5196	.6590	.5287	.4057	.4245	.4338
4	.7242	.6678	.7672	.6821	.6121	.7344	.6831	.5307	.5319	.4662
5	.3573	.6683	.5757	.6674	.5068	.6150	.4522	.5791	.7606	.4807
6	.4590	.8293	.5536	.7023	.5488	.5706	.4374	.6119	.4255	.6235
7	.4552	.5092	.5153	.7376	.3853	.5138	.3780	.4823	.6607	.6635
8	.5989	.4167	.3940	.4977	.6531	.3501	.3706	.5503	.6390	.5826
9	.6864	.6648	.4291	.5082	.7442	.8939	.2721	.5525	.6815	.7956
+gp	.6864	.6648	.4291	.5082	.7442	.8939	.2721	.5525	.6815	.7956
0 FBAR 2- 6	.4886	.6346	.5908	.5635	.4851	.5634	.4454	.4529	.4466	.4248
FBAR 2- 8	.4996	.5855	.5519	.5790	.4948	.5259	.4251	.4710	.5046	.4814

YEAR	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	FBAR 00-02
1	.0008	.0133	.0532	.0037	.0059	.0020	.0036	.0188	.0146	.0061	.0132
2	.1812	.1402	.3051	.2701	.1550	.2636	.1574	.2314	.2627	.2534	.2492
3	.4227	.4787	.4439	.6933	.5631	.6237	.5557	.4962	.5316	.6215	.5498
4	.5531	.6345	.7601	.9749	.6934	.7501	.7285	.6638	.5640	.6490	.6256
5	.8250	.6674	.6085	.6934	.7970	.7503	.7036	.6459	.5226	.4754	.5480
6	.5583	.8756	.5261	.8353	.7318	.7173	.5590	.6114	.5716	.3879	.5236
7	.8557	.4924	.7779	.6941	.5963	.5876	.5050	.7964	.3764	.5684	.5804
8	.5195	.6273	.4684	.9540	.7740	.9057	.4585	.6457	.6136	.4954	.5849
9	.7846	.8732	.9496	.4507	.9753	.8495	1.1362	.3591	.4899	.3975	.4155
+gp	.7846	.8732	.9496	.4507	.9753	.8495	1.1362	.3591	.4899	.3975	
0 FBAR 2- 6	.5081	.5593	.5287	.6934	.5881	.6210	.5408	.5298	.4905	.4774	
FBAR 2- 8	.5594	.5595	.5557	.7307	.6158	.6569	.5240	.5844	.4918	.4930	

1

Table 7.4.3 North Sea sole XSA: fishing mortality at age

Run title : Sole in IV

At 18/09/2003 2:14

Terminal Fs derived using XSA (With F shrinkage)

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

YEAR,	1957,	1958,	1959,	1960,	1961,	1962,
1,	128909,	128643,	488760,	61713,	99480,	22895,
2,	72454,	116641,	116401,	442248,	55840,	90013,
3,	89307,	64213,	103778,	101843,	388708,	49614,
4,	59106,	71155,	50074,	82464,	78708,	304360,
5,	17318,	41456,	50906,	35415,	58637,	53011,
6,	15057,	12092,	28474,	37524,	23191,	41258,
7,	27046,	10843,	7627,	20278,	25994,	16518,
8,	11836,	18272,	6950,	5754,	13738,	19769,
9,	2500,	9062,	12311,	4362,	3691,	8361,
+gp,	30811,	26295,	26788,	32546,	31943,	29933,
0 TOTAL,	454344,	498671,	892068,	824147,	779931,	635731,

YEAR,	1963,	1964,	1965,	1966,	1967,	1968,	1969,	1970,	1971,	1972,
1,	20428,	538986,	121937,	39877,	75140,	99754,	50029,	138562,	41536,	76644,
2,	20716,	8305,	487642,	110333,	36082,	67989,	89275,	44891,	124140,	37184,
3,	79931,	7991,	7367,	396434,	88154,	29142,	45207,	58024,	34779,	80585,
4,	38986,	27180,	5221,	5630,	231608,	55335,	13150,	20501,	27777,	17747,
5,	219092,	10395,	19160,	3203,	4153,	128592,	26314,	6833,	10716,	12999,
6,	33369,	59617,	5783,	12579,	1775,	1899,	70153,	12026,	4486,	5430,
7,	27305,	8153,	37452,	2872,	7873,	1096,	1279,	39564,	7808,	2687,
8,	10355,	6856,	4404,	21998,	1891,	5298,	759,	842,	24422,	4852,
9,	13976,	2665,	4482,	2504,	13889,	988,	3230,	454,	528,	15236,
+gp,	32249,	9788,	9390,	8709,	7981,	19810,	14246,	16929,	12581,	9035,
0 TOTAL,	496406,	679938,	702839,	604139,	468545,	409904,	313643,	338626,	288774,	262400,

YEAR,	1973,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,	1982,
1,	108298,	109736,	40741,	113036,	140426,	47371,	11471,	151708,	149997,	152918,
2,	69010,	97324,	99197,	36612,	101289,	125401,	42838,	10371,	136665,	135320,
3,	26421,	50811,	73432,	67923,	29759,	70411,	89657,	30981,	8234,	95867,
4,	37950,	11748,	25486,	39301,	34857,	15443,	35847,	41963,	16132,	4351,
5,	9329,	18941,	5410,	11916,	22231,	16981,	8143,	17159,	21056,	8066,
6,	7039,	4612,	10422,	2909,	6198,	13039,	9049,	4518,	8585,	11230,
7,	3425,	4159,	2345,	5787,	1713,	3916,	7755,	5123,	2709,	4286,
8,	1934,	2153,	2255,	1370,	3421,	1247,	1890,	5355,	2546,	1550,
9,	3218,	1022,	1323,	1178,	717,	2037,	547,	934,	3505,	1461,
+gp,	15227,	12211,	8927,	7347,	5896,	5033,	3447,	3046,	4144,	3070,
0 TOTAL,	281851,	312717,	269538,	287380,	346507,	300878,	210645,	271158,	353573,	418119,

YEAR,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,
1,	142410,	70844,	80909,	159679,	72566,	456058,	108347,	178103,	70525,	354655,
2,	135836,	128488,	63921,	73053,	144128,	65571,	412648,	97925,	160333,	63699,
3,	97297,	90180,	87026,	42031,	57194,	102776,	46757,	329255,	77249,	132554,
4,	43229,	48670,	39809,	37639,	20436,	30781,	48115,	24935,	198563,	45718,
5,	2183,	18960,	22585,	16724,	17218,	10026,	13362,	21987,	13272,	105554,
6,	3935,	1382,	8793,	11491,	7764,	9385,	4905,	7692,	11149,	5613,
7,	5606,	2250,	546,	4574,	5152,	4058,	4799,	2866,	3775,	6592,
8,	2282,	3218,	1224,	295,	1980,	3171,	2196,	2976,	1601,	1764,
9,	817,	1134,	1919,	747,	162,	932,	2021,	1372,	1553,	765,
+gp,	2474,	1924,	2926,	4417,	1381,	560,	2060,	2082,	2305,	2245,
0 TOTAL,	436070,	367050,	309658,	350649,	327980,	683317,	645211,	669193,	540323,	719159,

YEAR,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003,	GMST 57-**	AMST 57-**
1,	69380,	57159,	97449,	49103,	285745,	126033,	85064,	132431,	64233,	198986,	0,	96762,	130806,
2,	319973,	62726,	51037,	83608,	44267,	257040,	113807,	76696,	117592,	57279,	178948,	84585,	116567,
3,	51139,	241533,	49333,	34036,	57746,	34302,	178694,	87984,	55059,	81816,	40228,	63714,	90129,
4,	77726,	30322,	135408,	28637,	15397,	29753,	16635,	92753,	48470,	29278,	39766,	34916,	52650,
5,	25954,	40453,	14547,	57295,	9775,	6964,	12716,	7265,	43211,	24951,	13844,	17480,	28506,
6,	59059,	10291,	18778,	7162,	25915,	3986,	2975,	5693,	3446,	23185,	14035,	9440,	14734,
7,	2722,	30576,	3879,	10040,	2811,	11280,	1760,	1539,	2795,	1760,	14234,	5394,	8874,
8,	3072,	1047,	16908,	1612,	4538,	1401,	5671,	961,	628,	1736,	902,	3229,	5401,
9,	891,	1653,	506,	9577,	562,	1894,	513,	3244,	456,	308,	957,	1837,	3283,
+gp,	1617,	1627,	1136,	2851,	2825,	1542,	1245,	2480,	1956,	1268,	958,		
0 TOTAL,	611533,	477387,	388981,	283923,	449580,	474195,	419081,	411046,	337847,	420567,	303872,		

Tabel 7.5.1 North Sea Sole Input RCT3 – age 1

Sole	North	Sea	-	Age1.					
8	35	2							
'yc'	'VPA-1'	'DFS-0'	'SNS-1'	'DFS-1'	'SNS-2'	'SNS-3'	'Solea-3'	'BTS-1'	'BTS-2'
1968	50029	-11	-11	-11	745	99	-11	-11	-11
1969	138562	-11	4938	-11	1961	161	-11	-11	-11
1970	41536	-11	613	-11	341	73	-11	-11	-11
1971	76644	-11	1410	-11	905	69	-11	-11	-11
1972	108298	-11	4686	-11	397	174	-11	-11	-11
1973	109736	-11	1924	-11	887	187	31.5	-11	-11
1974	40741	-11	597	2.86	79	77	16.3	-11	-11
1975	113036	168.84	1413	6.95	762	267	34.4	-11	-11
1976	140426	82.28	3724	9.69	1379	325	-11	-11	-11
1977	47371	33.8	1552	2.13	388	99	41.5	-11	-11
1978	11471	96.87	104	2.27	80	51	1.9	-11	-11
1979	151708	392.08	4483	48.21	1411	231	76.1	-11	-11
1980	149997	404	3739	13.9	1124	107	77.1	-11	-11
1981	152918	289.72	5098	14.06	1137	307	147.1	-11	-11
1982	142410	330.38	2640	25.87	1081	159	77.8	-11	-11
1983	70844	115.96	2359	12.45	709	67	10.8	-11	7.89
1984	80909	187.17	2151	3.32	465	59	29.8	2.65	4.49
1985	159679	292.92	3791	13.66	955	284	24.6	7.88	12.55
1986	72566	72.97	1890	6.19	594	248	20.3	6.99	12.81
1987	456058	527.45	11227	38.02	5369	907	66.9	81.23	68.08
1988	108347	56.08	3052	12.62	1078	527	86.4	9.42	22.36
1989	178103	62.77	2900	12.3	2515	319	54.1	22.62	23.19
1990	70525	22.54	1265	8.52	114	46	11.3	3.34	23.2
1991	354655	360.44	11081	17.66	3489	943	180.7	74.22	27.36
1992	69380	25.38	1351	10.6	475	126	-11	4.98	4.99
1993	57159	25.01	559	6.12	234	27	-11	5.88	8.46
1994	97449	74.25	1501	9.46	473	231	12.9	27.62	6.17
1995	49103	18.82	691	3.64	143	131	0.9	3.51	5.37
1996	285745	58.51	10132	19.92	1993	381	45.7	173.24	29.21
1997	126033	53.35	2875	-11	919	189	13.6	14.12	19.26
1998	85064	-11	1649	-11	150	99	-11	11.41	6.53
1999	-11	-11	1735	4.56	645	175	-11	12.89	10.84
2000	-11	16.15	958	3.07	361	-11	-11	7.97	4.24
2001	-11	86.41	7093	18.35	-11	-11	-11	21.46	-11
2002	-11	64.71	-11	-11	-11	-11	-11	-11	-11

Tabel 7.5.1 (cont.) North Sea Sole Input RCT3 – age 2

Sole North Sea - Age2.
8 35 2

'yc'	'VPA-2'	'DFS-0'	'SNS-1'	'DFS-1'	'SNS-2'	'SNS-3'	'Solea-3'	'BTS-1'	'BTS-2'
1968	44891	-11	-11	-11	745	99	-11	-11	-11
1969	124140	-11	4938	-11	1961	161	-11	-11	-11
1970	37184	-11	613	-11	341	73	-11	-11	-11
1971	69010	-11	1410	-11	905	69	-11	-11	-11
1972	97324	-11	4686	-11	397	174	-11	-11	-11
1973	99197	-11	1924	-11	887	187	31.5	-11	-11
1974	36612	-11	597	2.86	79	77	16.3	-11	-11
1975	101289	168.84	1413	6.95	762	267	34.4	-11	-11
1976	125401	82.28	3724	9.69	1379	325	-11	-11	-11
1977	42838	33.8	1552	2.13	388	99	41.5	-11	-11
1978	10371	96.87	104	2.27	80	51	1.9	-11	-11
1979	136665	392.08	4483	48.21	1411	231	76.1	-11	-11
1980	135320	404	3739	13.9	1124	107	77.1	-11	-11
1981	135836	289.72	5098	14.06	1137	307	147.1	-11	-11
1982	128488	330.38	2640	25.87	1081	159	77.8	-11	-11
1983	63921	115.96	2359	12.45	709	67	10.8	-11	7.89
1984	73053	187.17	2151	3.32	465	59	29.8	2.65	4.49
1985	144128	292.92	3791	13.66	955	284	24.6	7.88	12.55
1986	65571	72.97	1890	6.19	594	248	20.3	6.99	12.81
1987	412648	527.45	11227	38.02	5369	907	66.9	81.23	68.08
1988	97925	56.08	3052	12.62	1078	527	86.4	9.42	22.36
1989	160333	62.77	2900	12.3	2515	319	54.1	22.62	23.19
1990	63699	22.54	1265	8.52	114	46	11.3	3.34	23.2
1991	319973	360.44	11081	17.66	3489	943	180.7	74.22	27.36
1992	62726	25.38	1351	10.6	475	126	-11	4.98	4.99
1993	51037	25.01	559	6.12	234	27	-11	5.88	8.46
1994	83608	74.25	1501	9.46	473	231	12.9	27.62	6.17
1995	44267	18.82	691	3.64	143	131	0.9	3.51	5.37
1996	257040	58.51	10132	19.92	1993	381	45.7	173.24	29.21
1997	113807	53.35	2875	-11	919	189	13.6	14.12	19.26
1998	76696	-11	1649	-11	150	99	-11	11.41	6.53
1999	-11	-11	1735	4.56	645	175	-11	12.89	10.84
2000	-11	16.15	958	3.07	361	-11	-11	7.97	4.24
2001	-11	86.41	7093	18.35	-11	-11	-11	21.46	-11
2002	-11	64.71	-11	-11	-11	-11	-11	-11	-11

Table 7.5.2a North Sea Sole. Output RCT3 Age 1

Analysis by RCT3 ver3.1 of data from file :

S4RCT-1.TXT

SoleNorthSea - Age1.

Data for 8 surveys over 35 years : 1968 - 2002

Regression type = C

Tapered time weighting not applied
Survey weighting not applied

Final estimates shrunk towards mean
Minimum S.E. for any survey taken as .20
Minimum of 3 points used for regression

Forecast/Hindcast variance correction used.

Yearclass = 2000

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression			----------I		I-----------Prediction			---------I
DFS-0	1.39	5.15	1.24	.286	23	2.84	9.09	1.409	.016
SNS-1	.77	5.63	.26	.890	30	6.87	10.89	.271	.438
DFS-1	1.33	8.36	.59	.649	23	1.40	10.23	.660	.074
SNS-2	.80	6.29	.45	.723	31	5.89	11.01	.473	.144
SNS-3									
Solea-									
BTS-1	.66	9.92	.38	.771	15	2.19	11.36	.428	.175
BTS-2	1.14	8.62	.52	.643	16	1.66	10.51	.600	.089
					VPA Mean =		11.48	.712	.063

Yearclass = 2001

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression			----------I		I-----------Prediction			---------I
DFS-0	1.39	5.15	1.24	.286	23	4.47	11.35	1.326	.024
SNS-1	.77	5.63	.26	.890	30	8.87	12.42	.275	.560
DFS-1	1.33	8.36	.59	.649	23	2.96	12.30	.644	.102
SNS-2									
SNS-3									
Solea-									
BTS-1	.66	9.92	.38	.771	15	3.11	11.96	.428	.231
BTS-2									
					VPA Mean =		11.48	.712	.083

Yearclass = 2002

Survey/ Series	**Slope**	**Inter- cept**	**Std Error**	**Rsquare**	**No. Pts**	**Index Value**	**Predicted Value**	**Std Error**	**WAP Weights**
	I-----------Regression			**----------I**		**I-----------Prediction**			**---------I**
DFS-0	**1.39**	**5.15**	**1.24**	**.286**	**23**	**4.19**	**10.95**	**1.330**	**.223**
SNS-1									
DFS-1									
SNS-2									
SNS-3									
Solea-									
BTS-1									
BTS-2									
					VPA Mean =		11.48	.712	.777

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
2000	54906	10.91	.18	.16	.83		
2001	198412	12.20	.21	.16	.60		
2002	**86222**	**11.36**	**.63**	**.22**	**.12**		

Table 7.5.2a North Sea Sole. Output RCT3 Age 2

Analysis by RCT3 ver3.1 of data from file :

S4RCT-2.TXT

SoleNorthSea - Age2.

Data for 8 surveys over 35 years : 1968 - 2002

Regression type = C

Tapered time weighting not applied
Survey weighting not applied

Final estimates shrunk towards mean
Minimum S.E. for any survey taken as .20
Minimum of 3 points used for regression

Forecast/Hindcast variance correction used.

Yearclass = 2000

Survey/ Series	Slope (Regression)	Inter- cept	Std Error	Rsquare	No. Pts	Index Value (Prediction)	Predicted Value	Std Error	WAP Weights
DFS-0	1.38	5.05	1.24	.286	23	2.84	8.99	1.406	.016
SNS-1	.77	5.53	.25	.892	30	6.87	10.78	.269	.445
DFS-1	1.33	8.26	.59	.650	23	1.40	10.12	.659	.074
SNS-2	.80	6.19	.45	.724	31	5.89	10.90	.472	.145
SNS-3									
Solea-									
BTS-1	.66	9.79	.40	.762	15	2.19	11.25	.441	.166
BTS-2	1.14	8.52	.51	.649	16	1.66	10.40	.594	.091
					VPA Mean =		11.38	.712	.063

Yearclass = 2001

Survey/ Series	**Slope (Regression)**	**Inter- cept**	**Std Error**	**Rsquare**	**No. Pts**	**Index Value (Prediction)**	**Predicted Value**	**Std Error**	**WAP Weights**
DFS-0	**1.38**	**5.05**	**1.24**	**.286**	**23**	**4.47**	**11.24**	**1.322**	**.024**
SNS-1	**.77**	**5.53**	**.25**	**.892**	**30**	**8.87**	**12.31**	**.273**	**.571**
DFS-1	**1.33**	**8.26**	**.59**	**.650**	**23**	**2.96**	**12.19**	**.643**	**.103**
SNS-2									
SNS-3									
Solea-									
BTS-1	**.66**	**9.79**	**.40**	**.762**	**15**	**3.11**	**11.86**	**.440**	**.219**
BTS-2									
					VPA Mean =		**11.38**	**.712**	**.084**

Yearclass = 2002

Survey/ Series	Slope (Regression)	Inter- cept	Std Error	Rsquare	No. Pts	Index Value (Prediction)	Predicted Value	Std Error	WAP Weights
DFS-0	1.38	5.05	1.24	.286	23	4.19	10.85	1.327	.224
SNS-1									
DFS-1									
SNS-2									
SNS-3									
Solea-									
BTS-1									
BTS-2									
					VPA Mean =		11.38	.712	.776

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
2000	49095	10.80	.18	.16	.82		
2001	**179249**	**12.10**	**.21**	**.16**	**.60**		
2002	77492	11.26	.63	.22	.12		

Table 7.6.1 North Sea sole VPA summary table

NOTE: 2 Fbar ranges, age 2 - 6 and 2 - 8

Run title : Sole in IV ,

At 18/09/2003 2:14
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 2- 8,
1957,	128909,	63402,	55107,	12067,	.2190,	.1780,	.1928,
1958,	128643,	72300,	60919,	14287,	.2345,	.2074,	.2395,
1959,	488760,	85947,	65580,	13832,	.2109,	.1709,	.2003,
1960,	61713,	105898,	73398,	18620,	.2537,	.2036,	.2359,
1961,	99480,	123494,	117099,	23566,	.2012,	.1898,	.2170,
1962,	22895,	123703,	116830,	26877,	.2301,	.2129,	.2397,
1963,	20428,	115587,	113626,	26164,	.2303,	.3128,	.3576,
1964,	538986,	51182,	37126,	11342,	.3055,	.2893,	.3268,
1965,	121937,	101347,	30029,	17043,	.5676,	.3171,	.3546,
1966,	39877,	92951,	84231,	33340,	.3958,	.3250,	.3290,
1967,	75140,	91204,	82939,	33439,	.4032,	.4064,	.4110,
1968,	99754,	83066,	72277,	33179,	.4591,	.4897,	.4444,
1969,	50029,	68716,	55235,	27559,	.4989,	.5464,	.4946,
1970,	138562,	60342,	50728,	19685,	.3880,	.3987,	.3918,
1971,	41536,	63499,	43714,	23652,	.5411,	.5113,	.4720,
1972,	76644,	56168,	47492,	21086,	.4440,	.4624,	.4074,
1973,	108298,	51257,	36751,	19309,	.5254,	.5085,	.4920,
1974,	109736,	54091,	36041,	17989,	.4991,	.5042,	.4886,
1975,	40741,	55063,	38956,	20773,	.5332,	.4946,	.4942,
1976,	113036,	49777,	40622,	17326,	.4265,	.4254,	.4430,
1977,	140426,	53273,	33469,	18003,	.5379,	.4463,	.4097,
1978,	47371,	56715,	37626,	20280,	.5390,	.4599,	.5217,
1979,	11471,	51252,	44396,	22598,	.5090,	.4956,	.4790,
1980,	151708,	42085,	34540,	15807,	.4576,	.4554,	.4571,
1981,	149997,	51009,	24786,	15403,	.6214,	.5018,	.4890,
1982,	152918,	57825,	32588,	21579,	.6622,	.5456,	.5426,
1983,	142410,	66042,	39904,	24927,	.6247,	.4886,	.4996,
1984,	70844,	64032,	43401,	26839,	.6184,	.6346,	.5855,
1985,	80909,	53476,	41312,	24248,	.5869,	.5908,	.5519,
1986,	159679,	52700,	35000,	18201,	.5200,	.5635,	.5790,
1987,	72566,	55107,	29283,	17368,	.5931,	.4851,	.4948,
1988,	456058,	70574,	39050,	21590,	.5529,	.5634,	.5259,
1989,	108347,	94803,	34503,	21805,	.6320,	.4454,	.4251,
1990,	178103,	113488,	90090,	35120,	.3898,	.4529,	.4710,
1991,	70525,	103756,	77943,	33513,	.4300,	.4466,	.5046,
1992,	354655,	104878,	77208,	29341,	.3800,	.4248,	.4814,
1993,	69380,	99566,	55141,	31491,	.5711,	.5081,	.5594,
1994,	57159,	86598,	74770,	33002,	.4414,	.5593,	.5595,
1995,	97449,	71963,	59384,	30467,	.5131,	.5287,	.5557,
1996,	49103,	53615,	38869,	22651,	.5828,	.6934,	.7307,
1997,	285745,	49450,	28523,	14901,	.5224,	.5881,	.6158,
1998,	126033,	63583,	21296,	20868,	.9799,	.6210,	.6569,
1999,	85064,	63537,	44375,	23475,	.5290,	.5408,	.5240,
2000,	132431,	60972,	43690,	22641,	.5182,	.5298,	.5844,
2001,	64233,	56006,	35861,	19944,	.5561,	.4905,	.4918,
2002,	**198412**[1],	51808,	34241,	16945,	.4949,	**.4774,**	.4930,
2003,	97000[2],		**29000**[3]				
Arith. Mean ,	130841,	72111,	52390,	22481,	.4768,	.4498,	.4570,
0 Units,	(Thousands),	(Tonnes),	(Tonnes),	(Tonnes),			

---

[1] RCT3
[2] GM
[3] Assuming mean weights at age in 2003 as the average over 2000-2002.

Table 7.7.1 Sole,North Sea - input data for catch forecast and linear sensitivity analysis

Label	Value	CV	Label	Value	CV
Number at age			Weight in the stock		
N1	96762	0.79	WS1	0.05	0.00
N2	179249	0.21	WS2	0.14	0.04
N3	40227	0.19	WS3	0.18	0.02
N4	39766	0.15	WS4	0.22	0.01
N5	13844	0.14	WS5	0.26	0.05
N6	14035	0.13	WS6	0.28	0.14
N7	14233	0.14	WS7	0.30	0.09
N8	902	0.15	WS8	0.35	0.21
N9	956	0.14	WS9	0.40	0.02
N10	958	0.16	WS10	0.44	0.18
H.cons selectivity			Weight in the HC catch		
sH1	0.01	0.45	WH1	0.14	0.07
sH2	0.24	0.11	WH2	0.17	0.06
sH3	0.53	0.17	WH3	0.20	0.03
sH4	0.60	0.08	WH4	0.25	0.09
sH5	0.52	0.10	WH5	0.27	0.06
sH6	0.50	0.19	WH6	0.31	0.08
sH7	0.56	0.32	WH7	0.35	0.10
sH8	0.56	0.10	WH8	0.36	0.17
sH9	0.40	0.19	WH9	0.46	0.15
sH10	0.40	0.19	WH10	0.47	0.09
Natural mortality			Proportion mature		
M1	0.10	0.10	MT1	0.00	0.00
M2	0.10	0.10	MT2	0.00	0.10
M3	0.10	0.10	MT3	1.00	0.10
M4	0.10	0.10	MT4	1.00	0.00
M5	0.10	0.10	MT5	1.00	0.00
M6	0.10	0.10	MT6	1.00	0.00
M7	0.10	0.10	MT7	1.00	0.00
M8	0.10	0.10	MT8	1.00	0.00
M9	0.10	0.10	MT9	1.00	0.00
M10	0.10	0.10	MT10	1.00	0.00
Relative effort in HC fishery			Year effect for natural mortality		
HF03	1.00	0.05	K03	1.00	0.10
HF04	1.00	0.05	K04	1.00	0.10
HF05	1.00	0.05	K05	1.00	0.10
Recruitment in 2004 and 2005					
R04	96762	0.79			
R05	96762	0.79			

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

Stock numbers in 2003 are VPA survivors.
These are overwritten at Age 2

Data from file:E:\wgnssk\Sole IV\FINAL_Truncated_yearrange_NL_CPUE\SOLIV.SEN on

Table 7.7.2 North Sea Sole

Table_____.Sole,North Sea

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

	Year 2003	2004						
Mean F Ages								
H.cons 2 to 6	0.48	0.00	0.10	0.19	0.35	0.40	0.48	0.56
Effort relative to 2002								
H.cons	1.00	0.00	0.20	0.40	0.73	0.83	1.00	1.17
Biomass								
Total 1 January	58.8	57.7	57.7	57.7	57.7	57.7	57.7	57.7
SSB at spawning time	29.0	40.9	40.9	40.9	40.9	40.9	40.9	40.9
Catch weight (,000t)								
H.cons	19.3	0.0	5.0	9.5	16.1	17.9	20.8	23.4
Biomass in year.... 2005								
Total 1 January		74.8	69.7	65.1	58.4	56.5	53.6	50.9
SSB at spawning time		57.8	52.7	48.1	41.5	39.7	36.8	34.1

	Year 2003	2004						
Effort relative to 2002								
H.cons	1.00	0.00	0.20	0.40	0.73	0.83	1.00	1.17
Est. Coeff. of Variation								
Biomass								
Total 1 January	0.12	0.20	0.20	0.20	0.20	0.20	0.20	0.20
SSB at spawning time	0.08	0.14	0.14	0.14	0.14	0.14	0.14	0.14
Catch weight								
H.cons	0.11	0.00	0.29	0.20	0.18	0.17	0.17	0.17
Biomass in year.... 2005								
Total 1 January		0.22	0.23	0.24	0.25	0.26	0.26	0.27
SSB at spawning time		0.22	0.23	0.24	0.25	0.26	0.27	0.28

Table 7.7.3 North Sea Sole Detailed forecast tables.

Table_____.Sole,North Sea
Detailed forecast tables.

Forecast for year 2003
F multiplier H.cons=1.00

Age	Populations: Stock No.	Catch number: H.Cons	Catch number: Total
1	96762	1189	1189
2	179249	36200	36200
3	40227	15727	15727
4	39766	17117	17117
5	13844	5397	5397
6	14035	5285	5285
7	14233	5796	5796
8	902	369	369
9	956	299	299
10	958	300	300
Wt	59	19	19

Forecast for year 2004
F multiplier H.cons=1.00

Age	Populations: Stock No.	Catch number: H.Cons	Catch number: Total
1	96762	1189	1189
2	86423	17453	17453
3	127840	49979	49979
4	21510	9259	9259
5	19787	7713	7713
6	7418	2793	2793
7	7695	3133	3133
8	7393	3027	3027
9	467	146	146
10	1164	364	364
Wt	58	21	21

Table 7.7.4 North Sea Sole Proportional contributions in the short term forecast

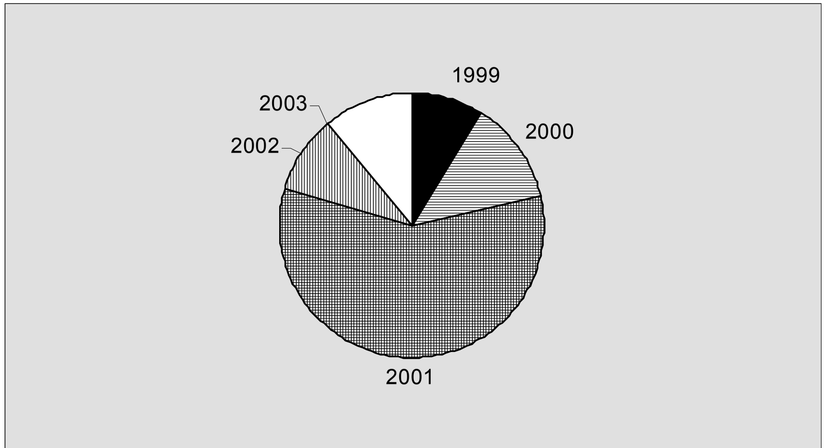
Stock numbers of recruits and their source for recent year classes used in predictions, and the relative (%) contributions to landings and SSB (by weight) of these year classes

Year-class	1999	2000	2001	2002	2003
Stock No. (thousands) of 1 year-olds	132431	64233	198412	96762	96762
Source	XSA	XSA	RCT3	GM	GM
Status Quo F:					
% in 2003 landings	28.2	22.8	23.8	0.0	-
% in 2004	9.0	12.3	58.3	9.2	0.0
% in 2003 SSB	30.6	25.3	0.0	0.0	-
% in 2004 SSB	12.4	11.8	57.2	0.0	0.0
% in 2005 SSB	8.2	7.5	41.8	30.9	0.0

GM : geometric mean recruitment

Sole in IV : Year-class % contribution to

a) 2004 landings



b) 2005 SSB

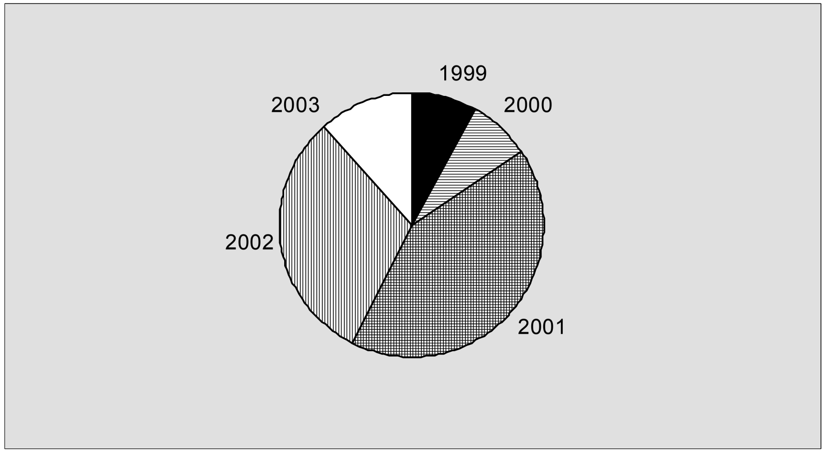


Table 7.8.1 North Sea sole. Input to medium term forecasts

```
Input to sensitivity analysis, SOL,IV
  1, 10, 2003,  3
  1, 0, 0
 'N1'  ,     96762, 0.79
 'N2'  ,    179249, 0.21
 'N3'  ,     40227, 0.19
 'N4'  ,     39766, 0.15
 'N5'  ,     13844, 0.14
 'N6'  ,     14035, 0.13
 'N7'  ,     14233, 0.14
 'N8'  ,       902, 0.15
 'N9'  ,       956, 0.14
 'N10' ,       958, 0.16
 'sH1' ,     0.013, 0.45
 'sH2' ,     0.238, 0.11
 'sH3' ,     0.526, 0.17
 'sH4' ,     0.598, 0.08
 'sH5' ,     0.524, 0.10
 'sH6' ,     0.501, 0.19
 'sH7' ,     0.555, 0.32
 'sH8' ,     0.559, 0.10
 'sH9' ,     0.397, 0.19
 'sH10',     0.397, 0.19
 'WH1' ,     0.141, 0.14
 'WH2' ,     0.177, 0.04
 'WH3' ,     0.200, 0.03
 'WH4' ,     0.241, 0.06
 'WH5' ,     0.270, 0.04
 'WH6' ,     0.303, 0.06
 'WH7' ,     0.338, 0.07
 'WH8' ,     0.364, 0.15
 'WH9' ,     0.419, 0.14
 'WH10',     0.512, 0.13
 'WS1' ,     0.050, 0.00
 'WS2' ,     0.141, 0.06
 'WS3' ,     0.181, 0.03
 'WS4' ,     0.223, 0.05
 'WS5' ,     0.259, 0.04
 'WS6' ,     0.292, 0.09
 'WS7' ,     0.325, 0.08
 'WS8' ,     0.357, 0.18
 'WS9' ,     0.415, 0.15
 'WS10',     0.479, 0.14
 'M1'  ,      0.10, 0.10
 'M2'  ,      0.10, 0.10
 'M3'  ,      0.10, 0.10
 'M4'  ,      0.10, 0.10
 'M5'  ,      0.10, 0.10
 'M6'  ,      0.10, 0.10
 'M7'  ,      0.10, 0.10
 'M8'  ,      0.10, 0.10
 'M9'  ,      0.10, 0.10
 'M10' ,      0.10, 0.10
 'MT1' ,      0.00, 0.00
 'MT2' ,      0.00, 0.10
 'MT3' ,      1.00, 0.10
 'MT4' ,      1.00, 0.00
 'MT5' ,      1.00, 0.00
 'MT6' ,      1.00, 0.00
 'MT7' ,      1.00, 0.00
 'MT8' ,      1.00, 0.00
 'MT9' ,      1.00, 0.00
 'MT10',      1.00, 0.00
 'R04' ,     96762, 0.79
 'R05' ,     96762, 0.79
 'HF03',         1, 0.05
 'HF04',         1, 0.05
 'HF05',         1, 0.05
 'K03' ,         1, 0.10
 'K04' ,         1, 0.10
 'K05' ,         1, 0.10
Sole
North Sea
 1
  1 10  1
 1
H.cons.
```

```
  2  6
 1957      2002
 Stock numbers in 2003 are VPA survivors.
 These are overwritten at   Age  2
-1
```

Table 7.8.2 North Sea sole. Stock recruitment parameters and residuals as input to the medium term forecast.

```
5
       12.497477365975280
    2.154233404279291E-002
        1.000000000000000
    0.000000000000000E+000
    0.000000000000000E+000
           45
    2.052662546702059E-001
        1.562678481134551
   -4.756431239142150E-001
    4.802439103647679E-002
   -9.373051098788598E-001
       -1.080964555487997
        2.171862802576497
    1.572454349758395E-001
   -8.984272158556442E-001
   -1.342210072227557E-001
    1.410158760807869E-001
   -6.436692265071371E-001
    2.802687807962195E-001
   -9.284390430180494E-001
   -3.245218446343638E-001
    1.228326198175615E-002
    5.536117702997963E-002
   -9.268020911887506E-001
    7.159798758098417E-002
    2.801139226987012E-001
   -7.721089185872758E-001
       -2.251496245335633
    3.547415283898164E-001
    3.805072334043742E-001
    5.214647868929940E-001
    3.414155774317137E-001
   -3.965365215256408E-001
   -2.734521542639474E-001
    4.116305233321461E-001
   -3.432861845897172E-001
        1.543716363815717
    2.593480961236422E-002
    5.516554896002036E-001
   -1.296546526944599E-001
        1.362460864773927
   -2.816035656264791E-001
   -6.114948818569160E-001
    3.888085278175250E-002
   -7.452382791000617E-001
        1.000615140712567
    2.679550141518288E-001
    1.041649560532061E-002
    2.136629301299109E-001
   -5.094441831283758E-001
    6.535580753121363E-001
```

Table 7.9.1. North Sea sole. Estimated biological reference points.

Reference point	Deterministic	Median	75th percentile	95th percentile	Hist SSB < ref pt %
MedianRecruits	104026	104026	109042	126033	
MBAL	0				0.00
Bloss	21296				
SSB90%R90%Surv	46599	41242	46502	56659	58.70
SPR%ofVirgin	9.80	9.78	10.93	12.83	
VirginSPR	3.05	3.07	3.49	4.18	
SPRloss	0.19	0.18	0.21	0.24	
	Deterministic	**Median**	**25th percentile**	**5th percentile**	**Hist F > ref pt %**
FBar	0.48	0.48	0.46	0.43	52.17
Fmax	0.34	0.34	0.29	0.24	78.26
F0.1	0.13	0.13	0.12	0.10	100.00
Flow	0.10	0.06	0.03	0.00	100.00
Fmed	0.33	0.31	0.28	0.24	78.26
Fhigh	0.74	0.84	0.69	0.58	0.00
F35%SPR	0.13	0.13	0.12	0.10	100.00
Floss	0.75	0.76	0.67	0.56	0.00

For estimation of Gloss and Floss:
A LOWESS smoother with a span of 1 was used.
Stock recruit data were log-transformed
A point representing the origin was included in the stock recruit data.
For estimation of the stock recruitment relationship used in equilibrium calculations:
A LOWESS smoother with a span of 1 was used.
Stock recruit data were log-transformed
A point representing the origin was included in the stock recruit data.

Sole in IV

Steady state selection averaged over 3 years.
FBar averaged from age 2 to 6

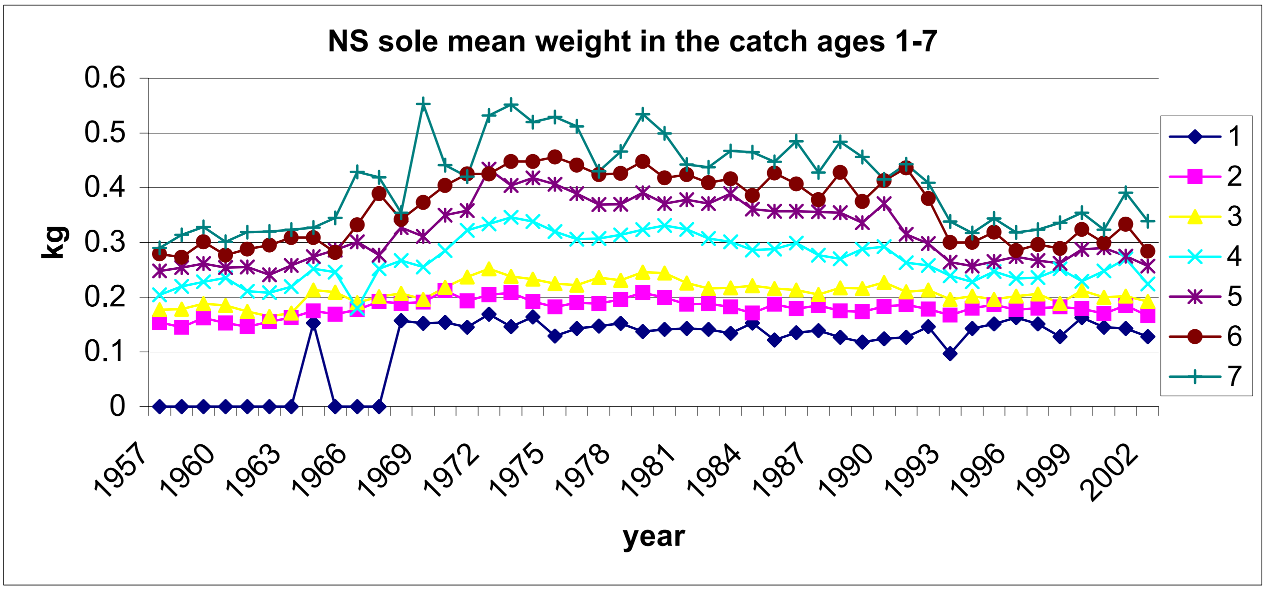
Number of iterations = 1000
Random number seed = -99
Stock recruitment data Monte Carloed using residuals from the equilibrium LOWESS fit

Data source:
W:\Personal\Sarah\ref points sol4\pa_out_final.csv

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

18-9-2003 14:50:08

Figure 7.2.1a North Sea sole trends in mean weight in the catches



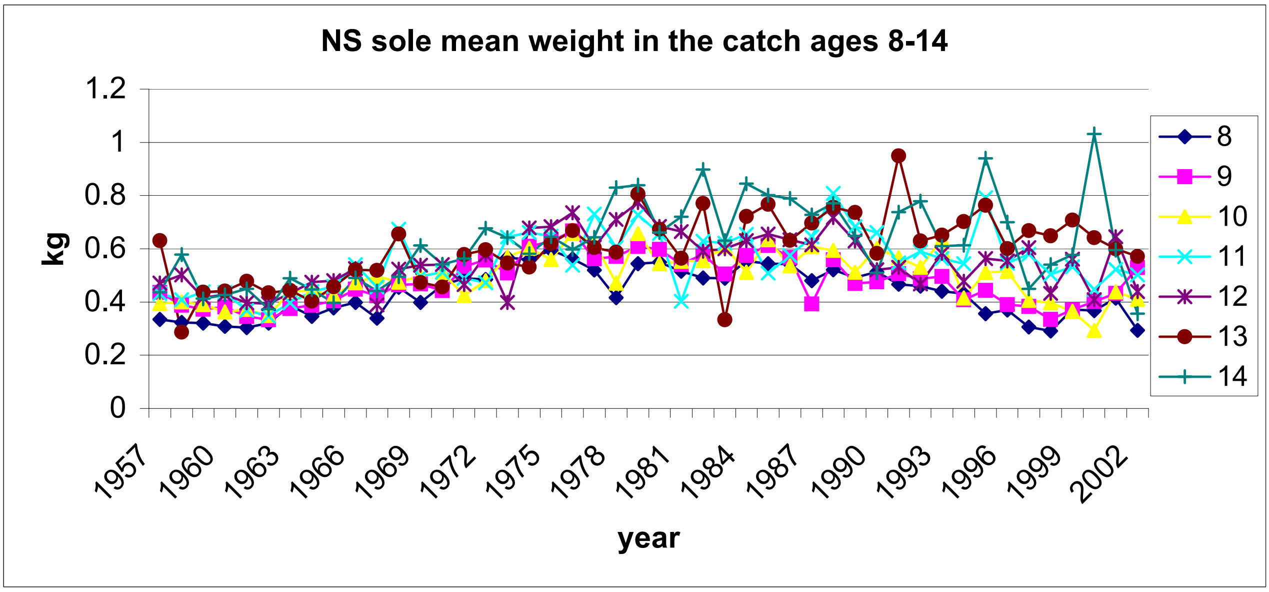


Figure 7.2.1b North Sea Sole Catch Number at age

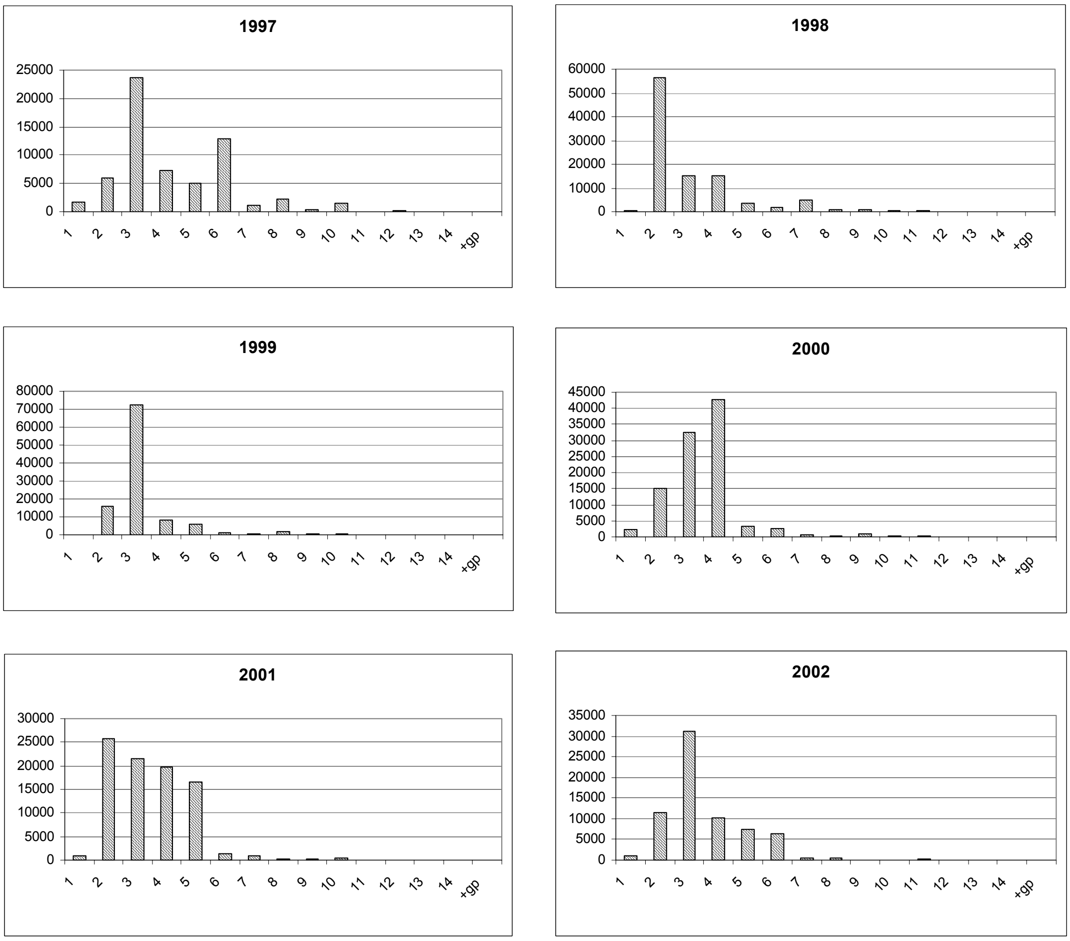


Figure 7.2.2 North Sea sole length at age by sex NOTE: Graph titles should be read as quarter 2 in stead of quarter 1.

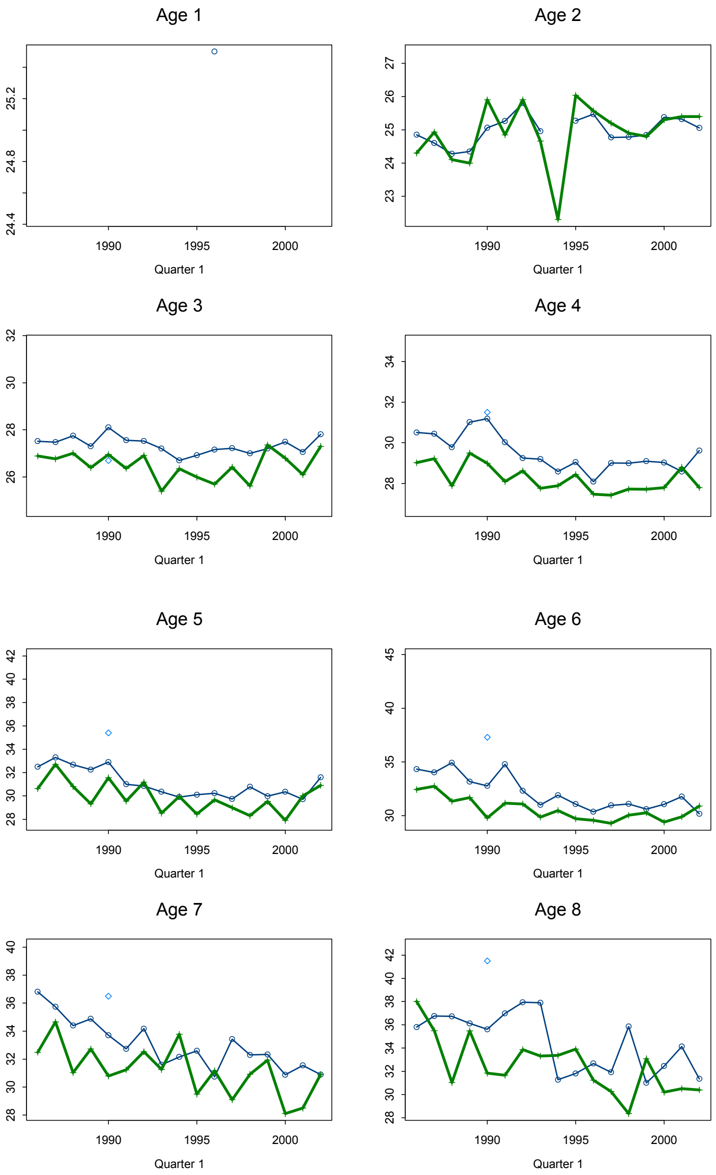


Figure 7.2.2 (cont.)

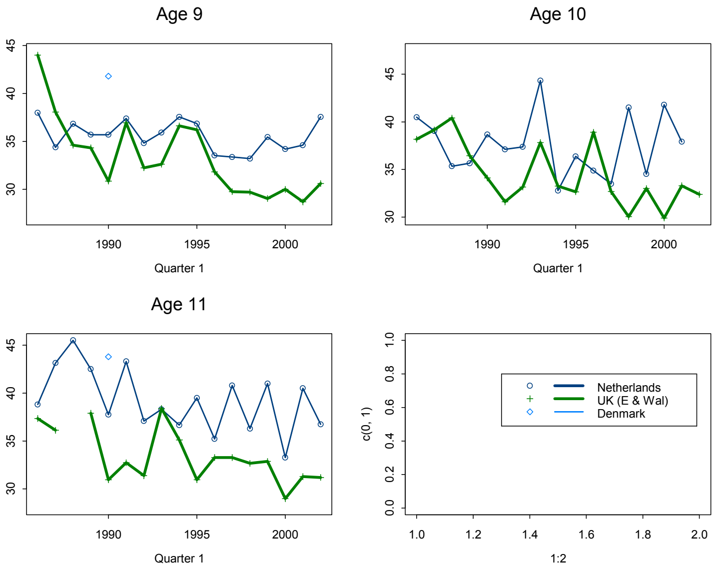
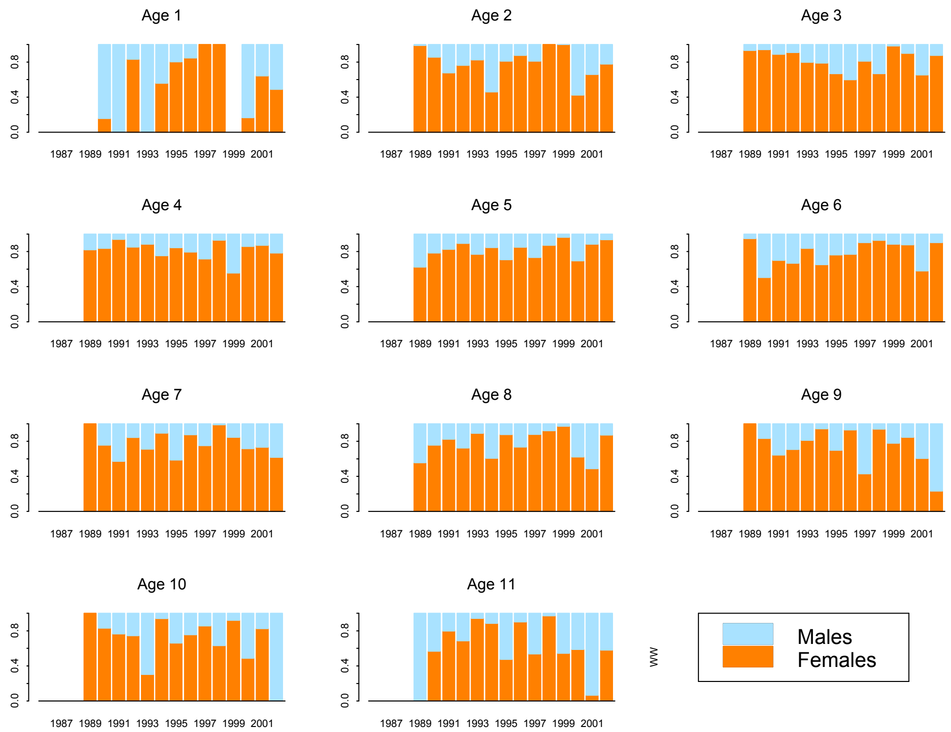


Figure 7.2. 3 North Sea sole sex ratio
Yearly Sex-ratio from 1986 to 2002 – all fleets



Quarter 2 Sex-ratio from 1986 to 2002 – all fleets

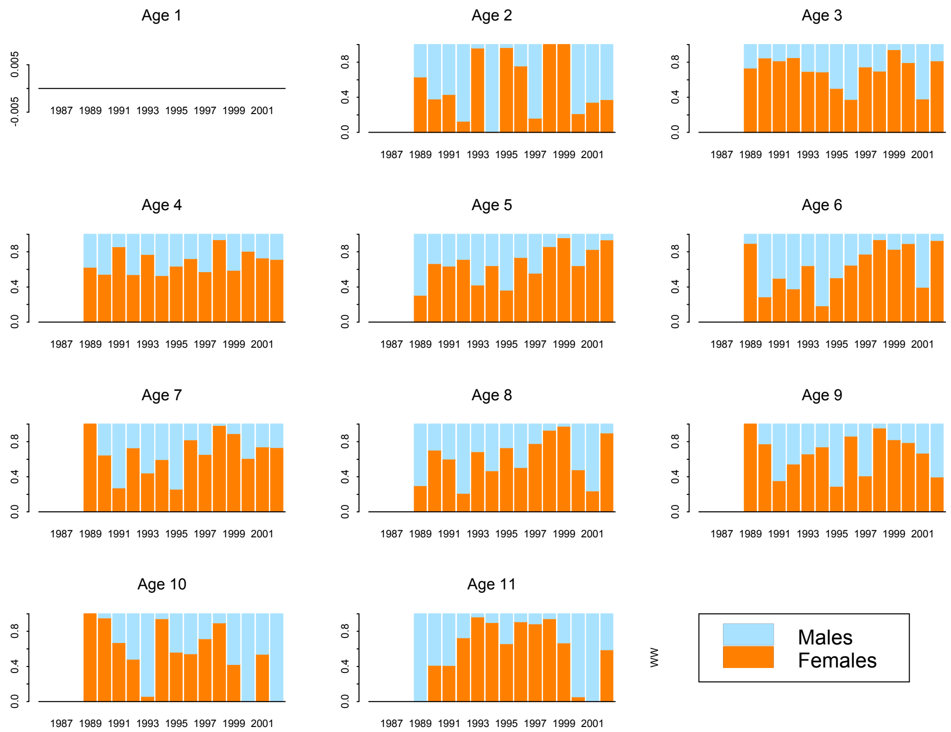


Figure 7.2.4 North Sea Sole. Catch weights at age in 2002 by country.

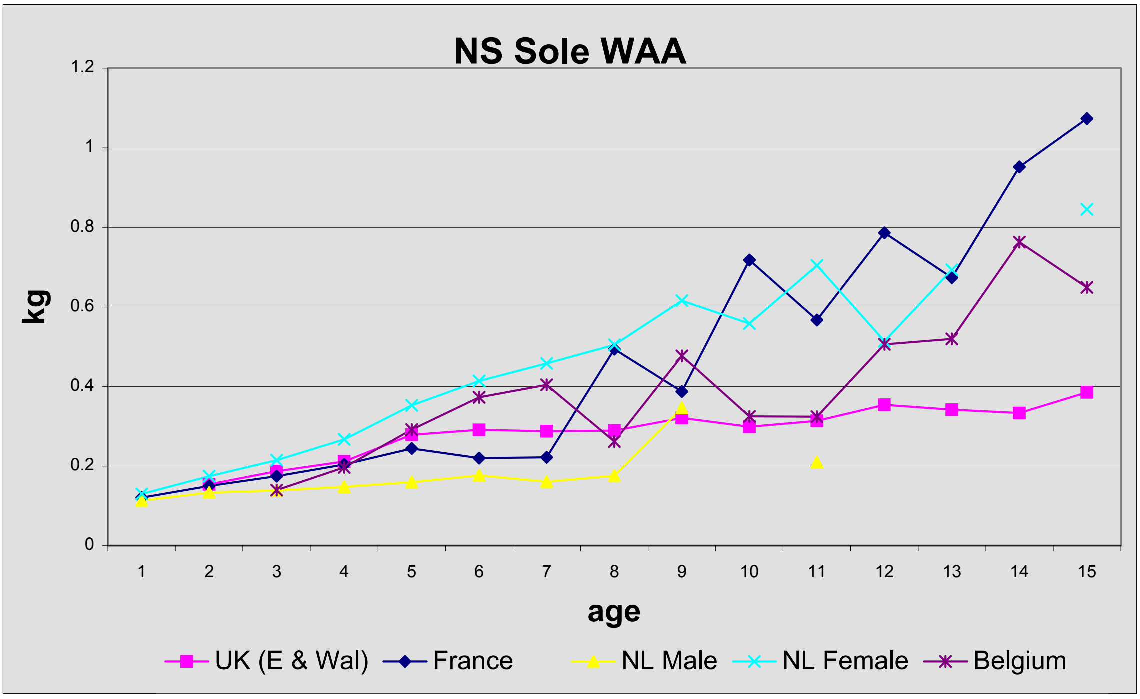
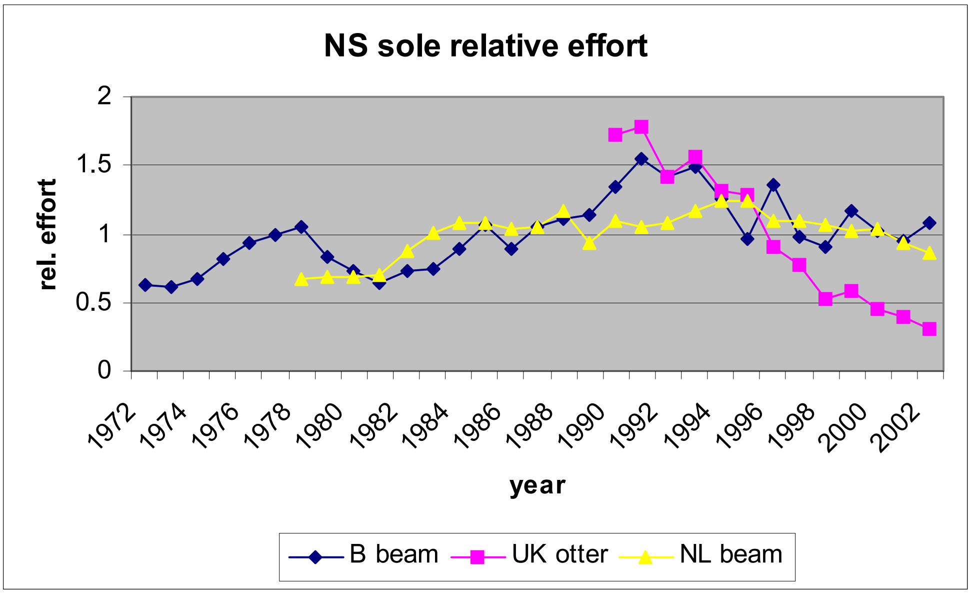


Figure 7.3.1 North Sea sole relative effort and cpue



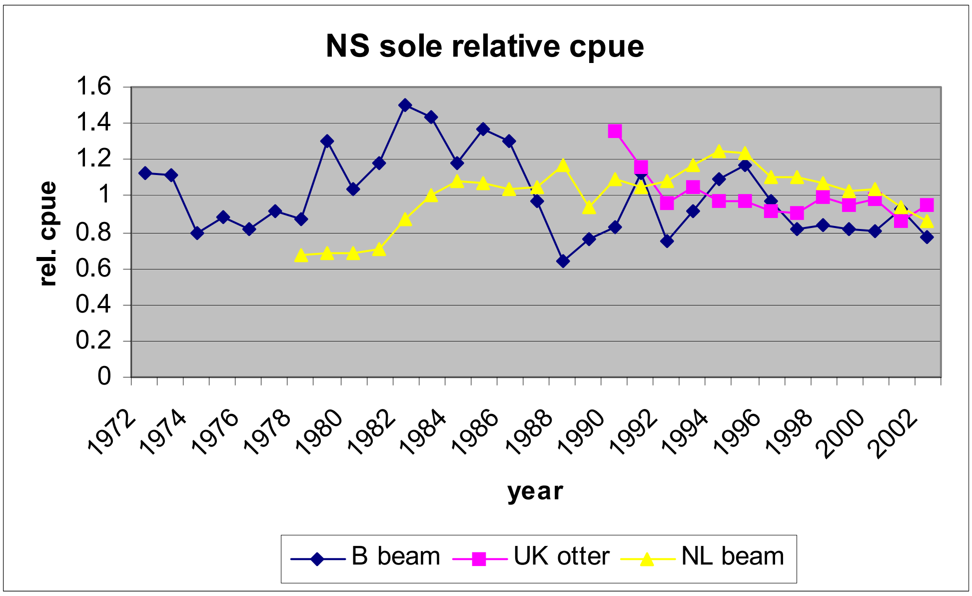


Figure 7.3.2 North Sea sole: standardized survey indices

Figure 3.7.2 North Sea sole standardized survey indices

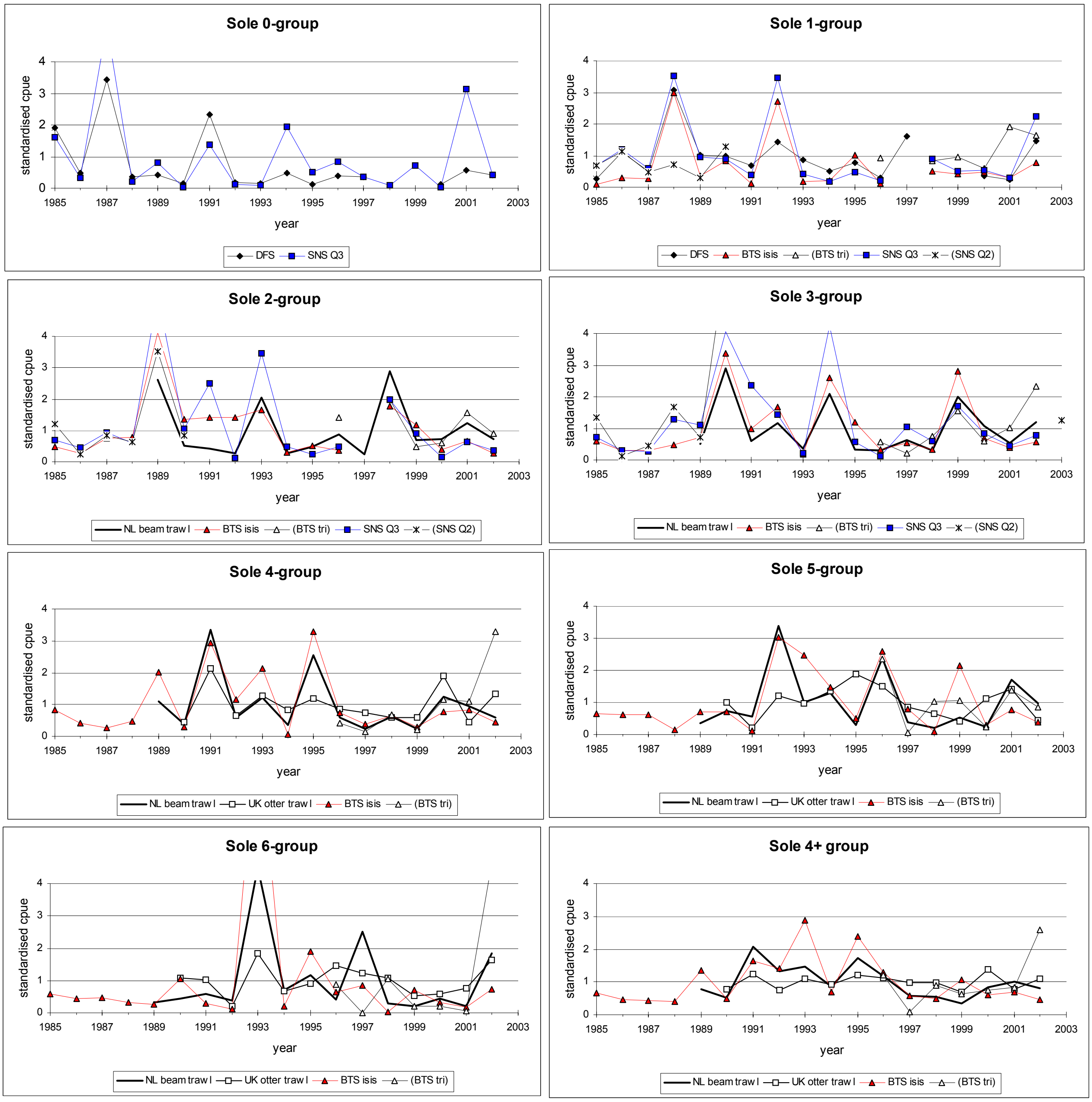


Figure 7.4.1.1a. Sole in Subarea IV, SNS Tridens.

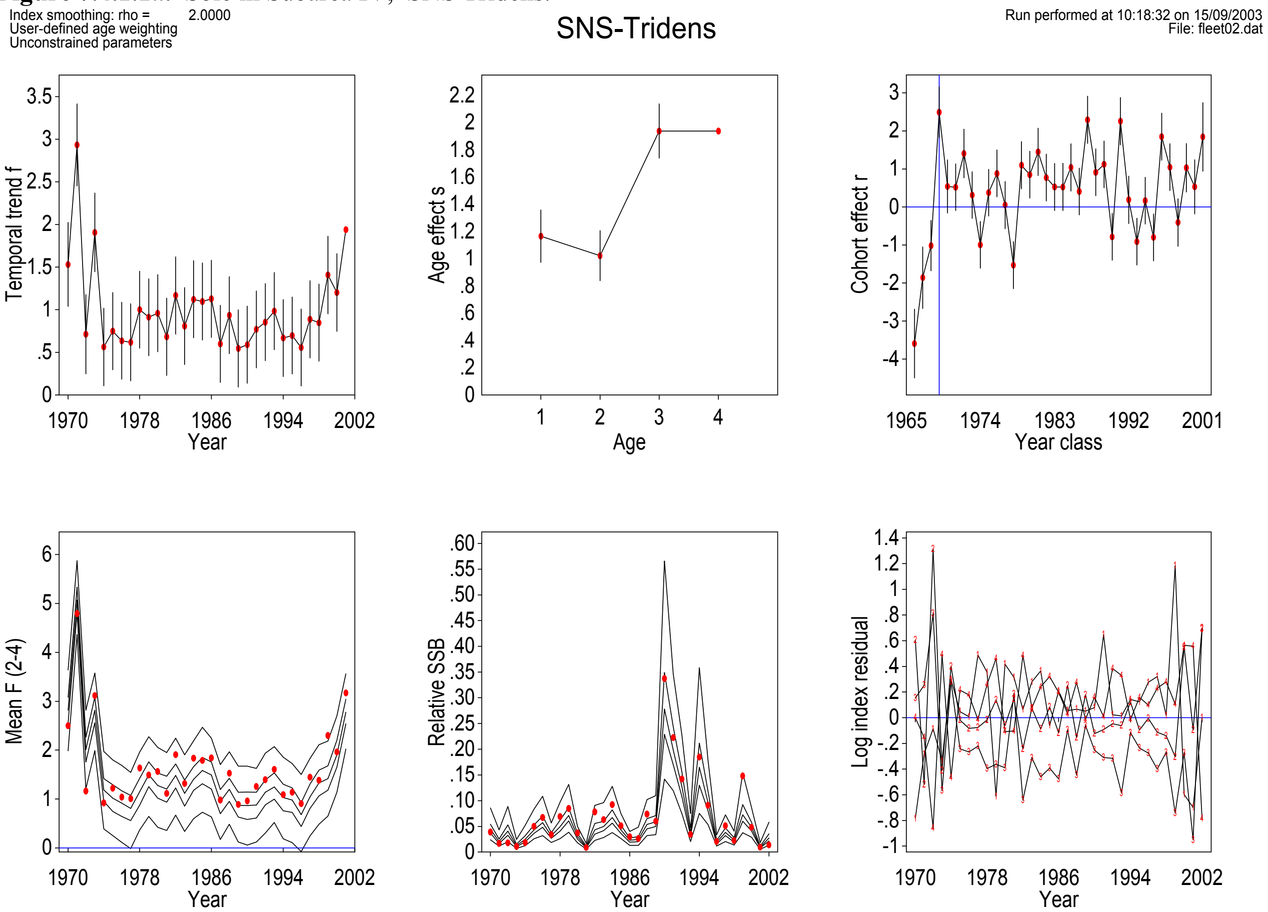


Figure 7.4.1.1.1b. Sole in Subarea IV. SNS Tridens.

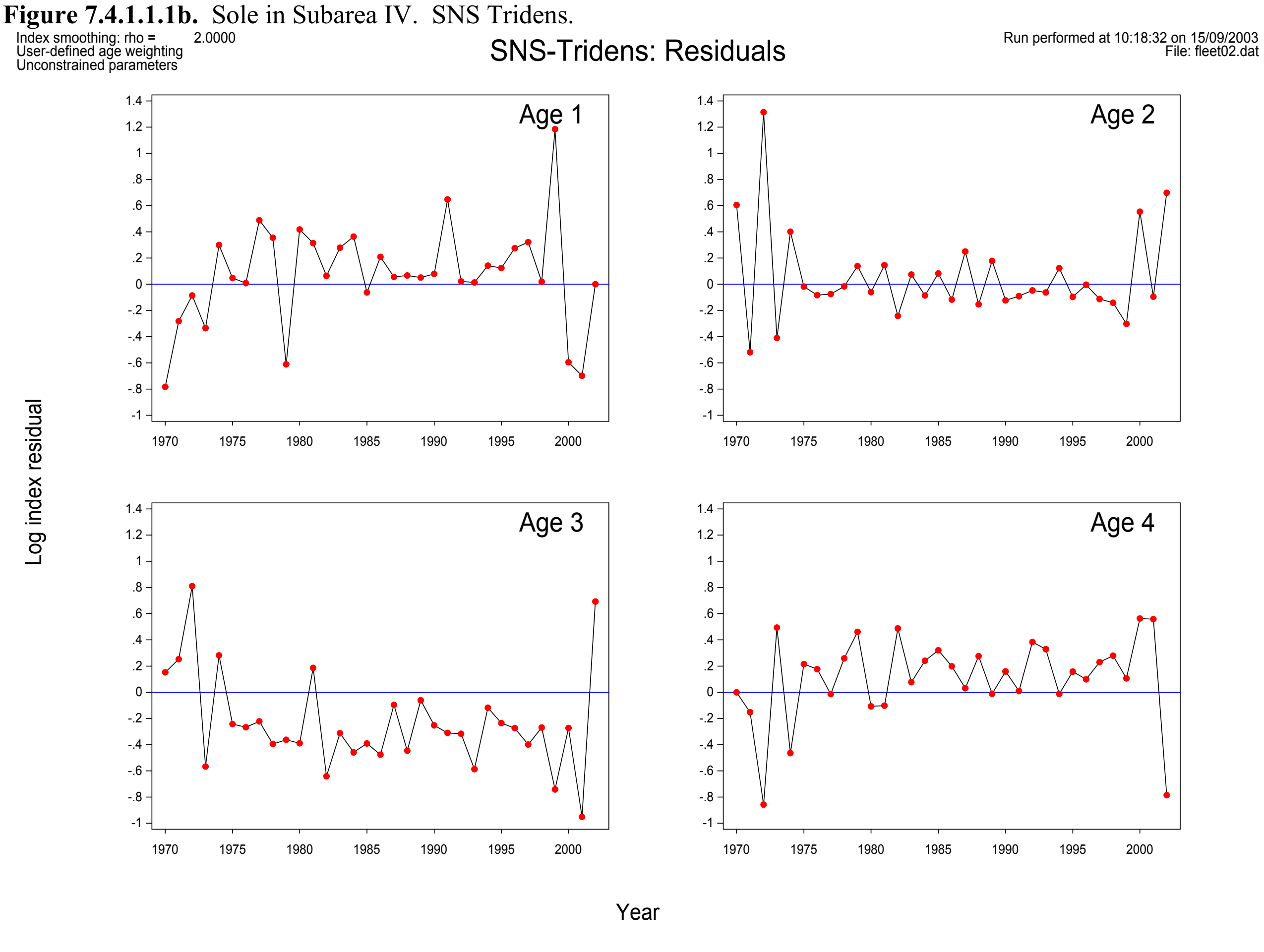


Figure 7.4.1.2a. Sole in Subarea IV. BTS.

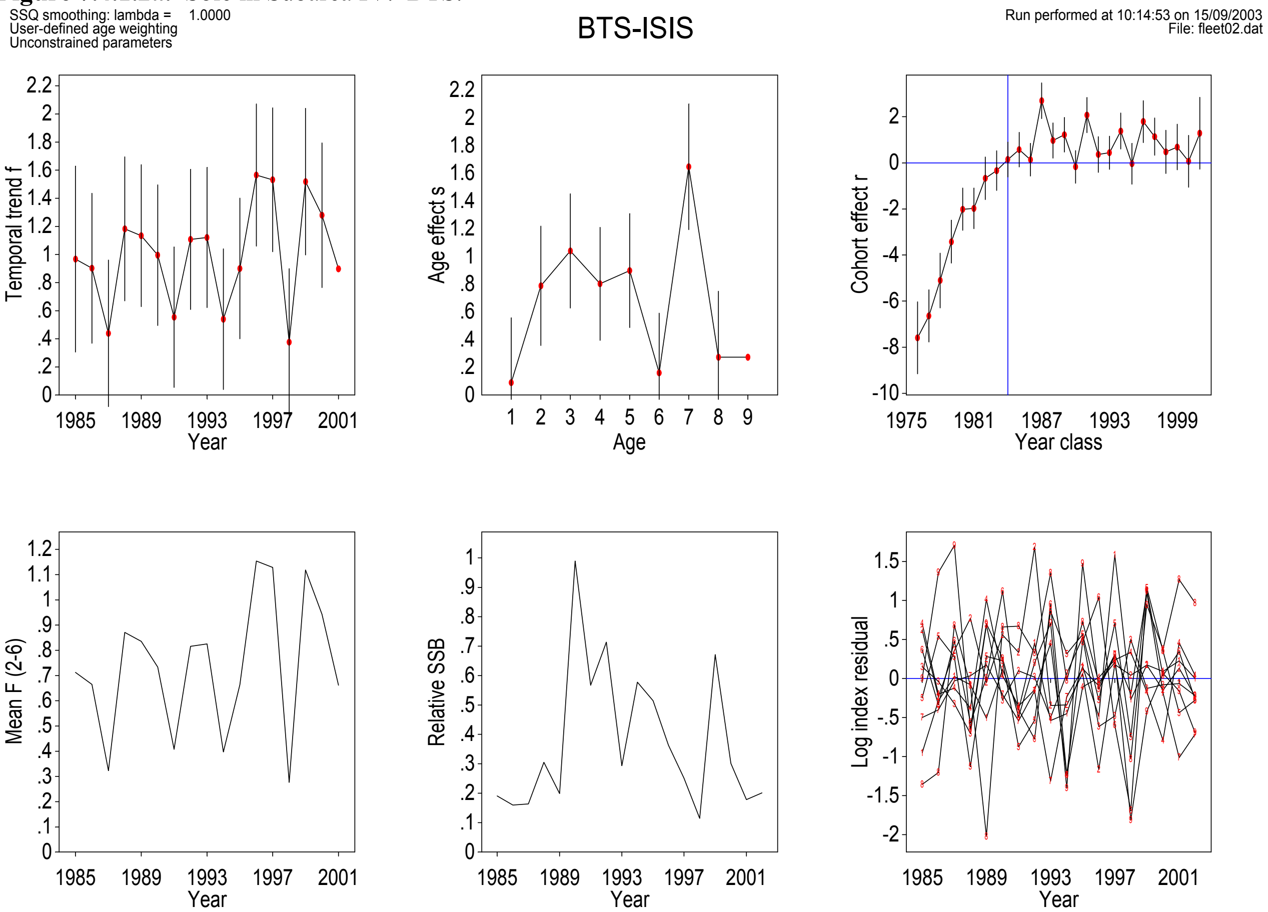


Figure 7.4.1.2b. Sole in Subarea IV. BTS.

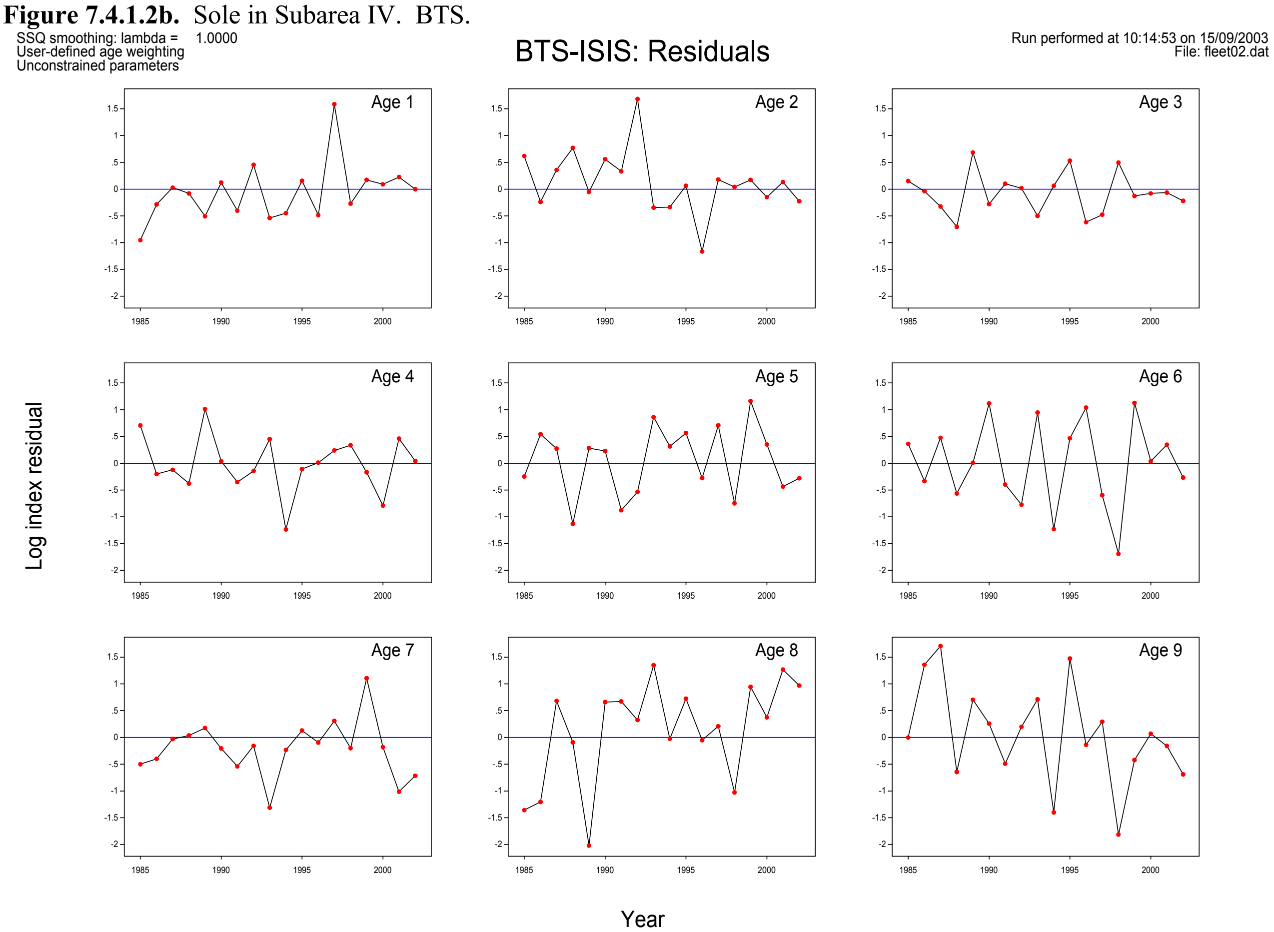
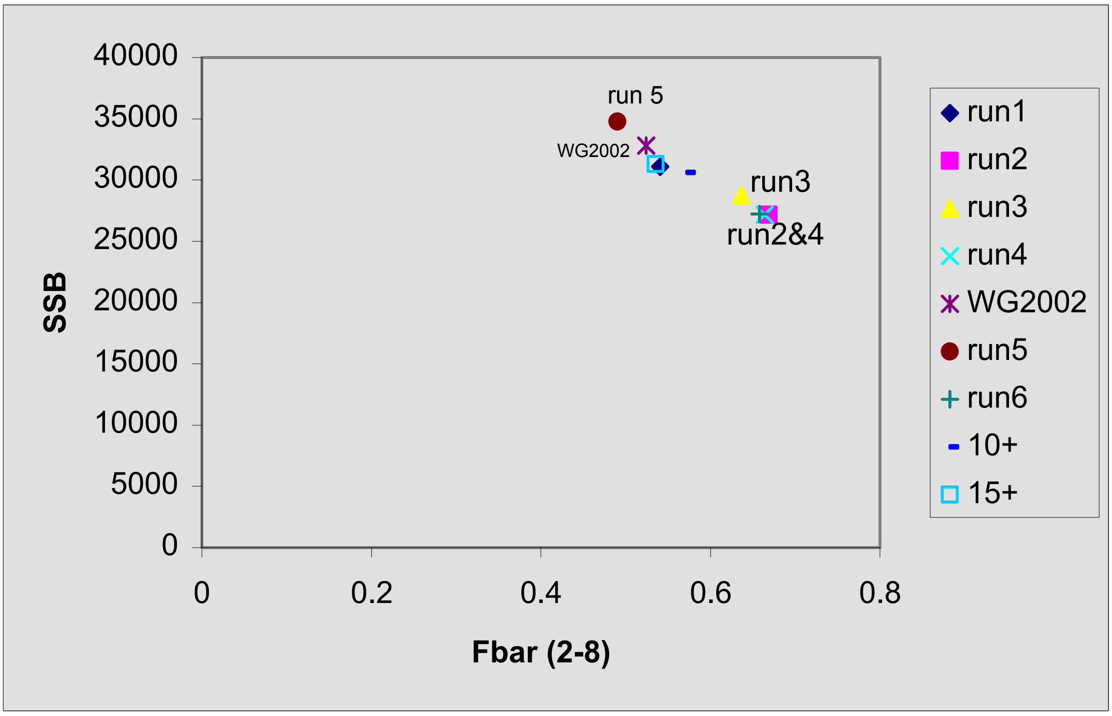


Figure 7.4.1.3 North Sea sole: F and SSB in 2002.



LEGEND:

WG2002 final assessment

run 1: All fleets in full age/year range

run 2: Survey fleets only full age/year range

run 3: BTS only full year/age range

run 4: SNS only full year/age range

run 5: Commercial fleets only

run 6: Survey only age range 1-11

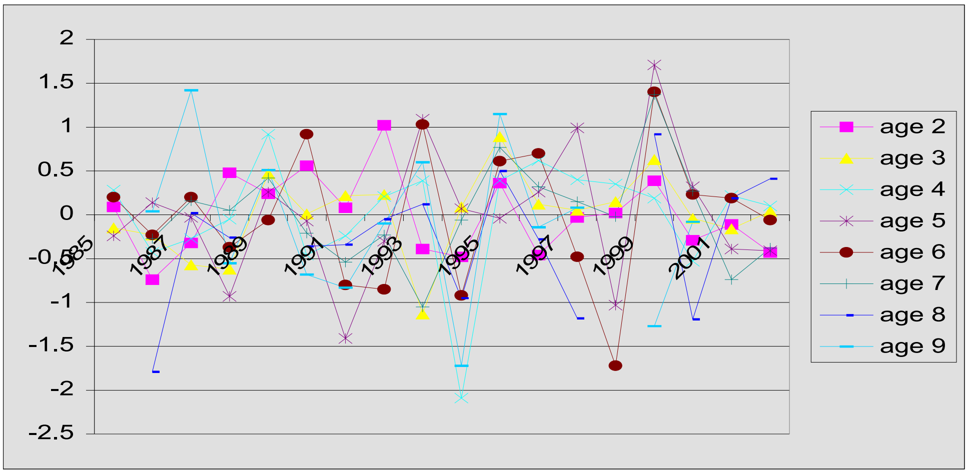
run 7: Survey only 10+ group

10+: NL comm, 10+ group, power age 1

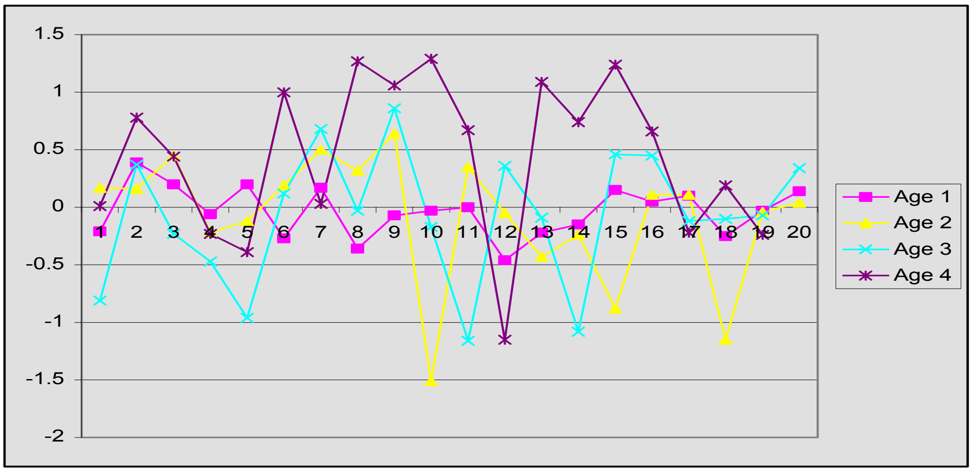
15+: NL comm, 15+, power age 1

Figure 7.4.1.4 North Sea sole catchability plots single fleet XSA runs, shrinkage 1.5.

Fleet 1 BTS Isis



Fleet 2 SNS Tridens



Fleet 3 NL commercial CPUE

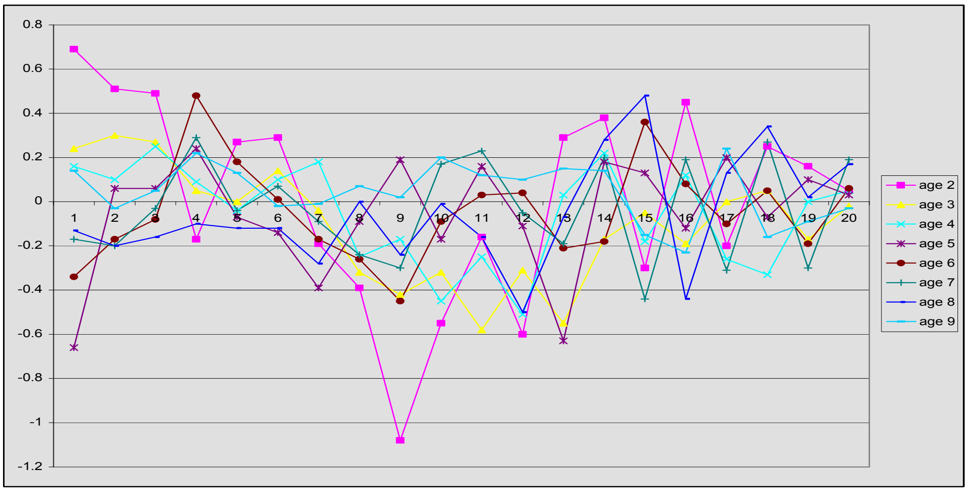


Figure 7.4.1.5 Weighting of the tuning fleets (XSA without commercial fleets)

10+group q independent >=7
shrinkage=0.5 over 5 years last 5 ages

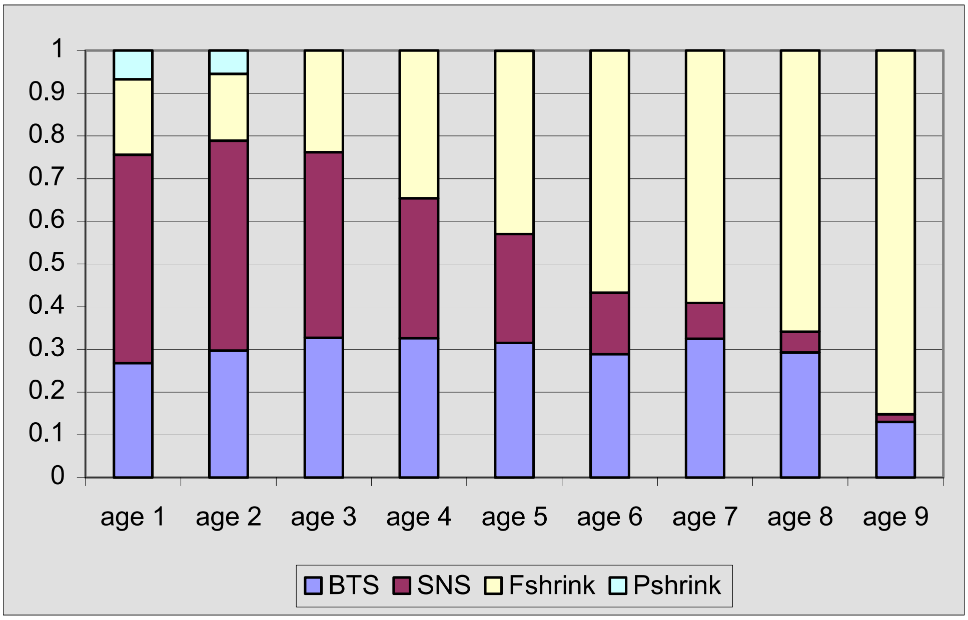
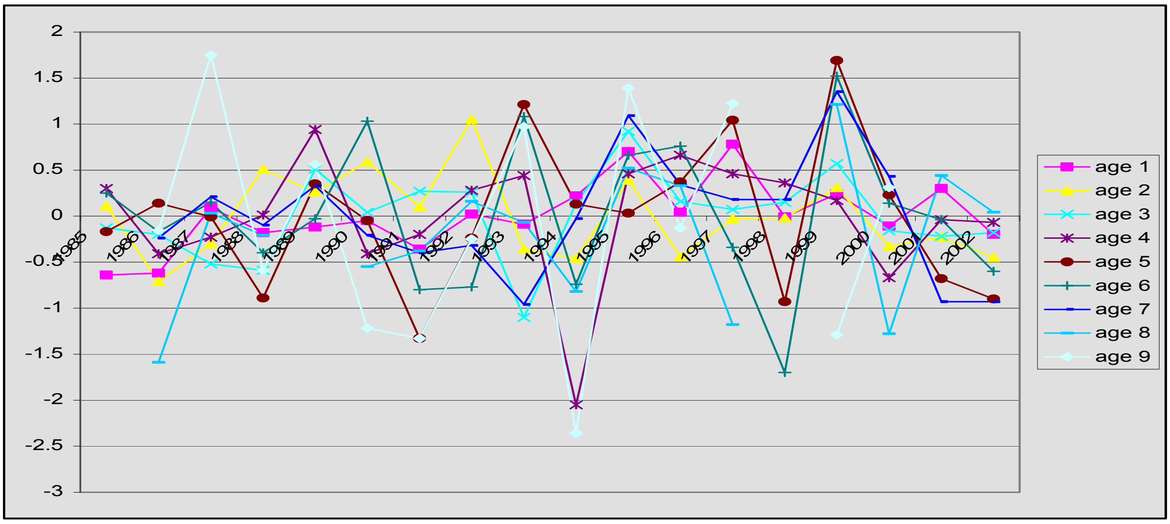
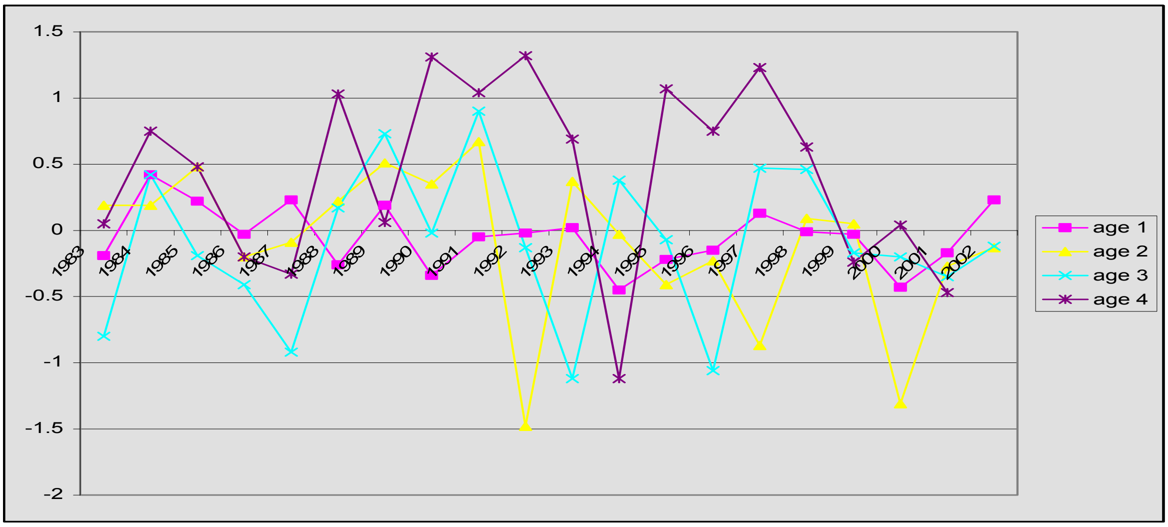


Figure 7.4.1.6 North Sea sole combined fleet XSA catchability residuals

Fleet 1 BTS – Isis



Fleet 2 SNS Tridens



Fleet 3 NL commercial CPUE

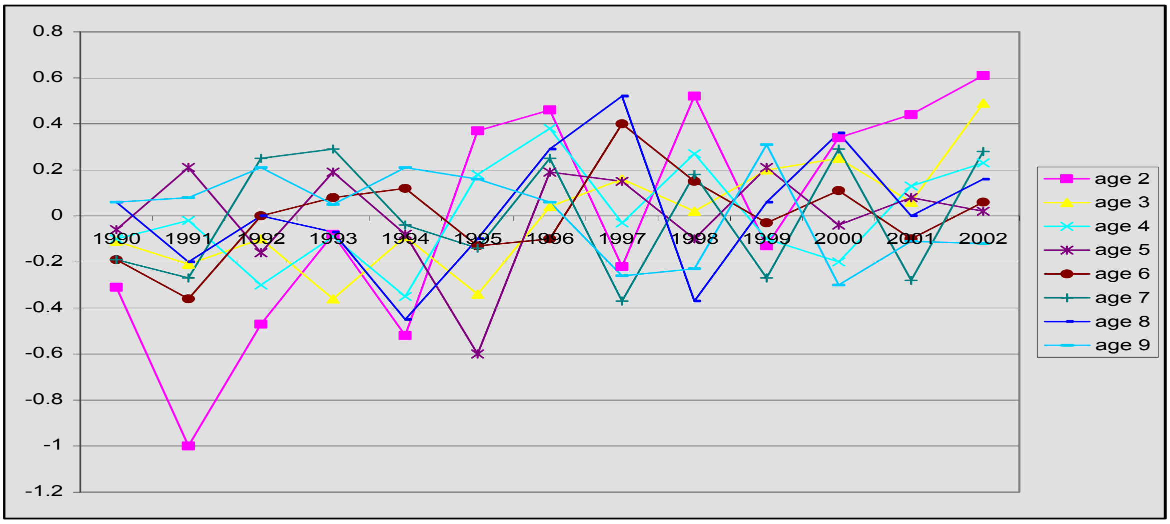
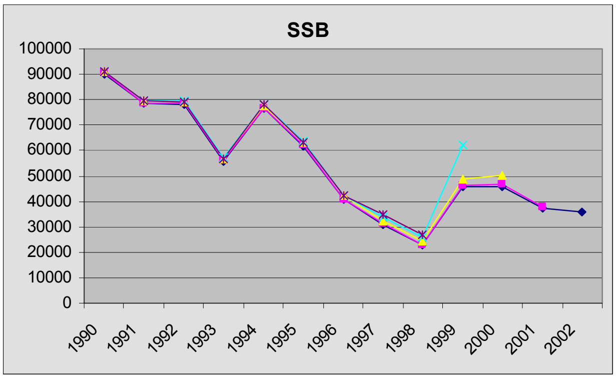
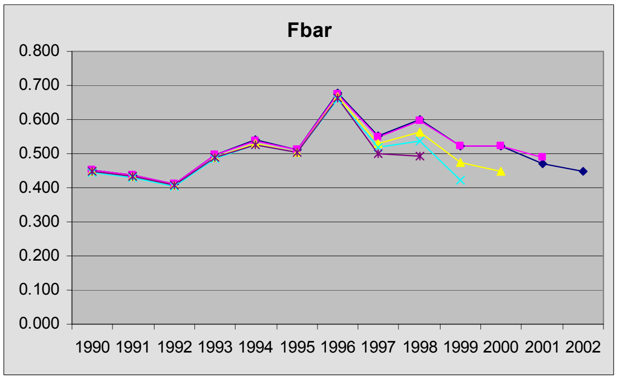


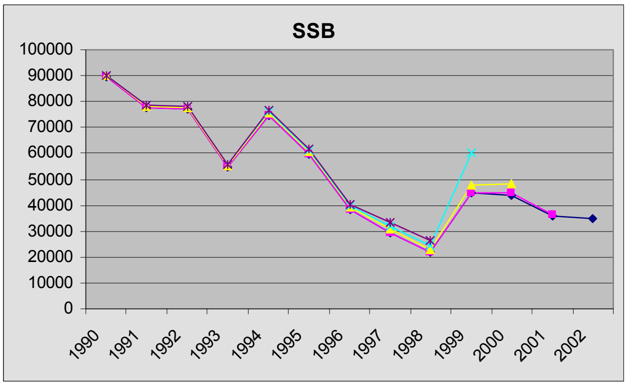
Figure 7.4.1.7 North Sea Sole Restospective patterns different setting shrinkage

Shrinkage 2.0 Fbar 2-6





Shrinkage 1.0 Fbar 2-6



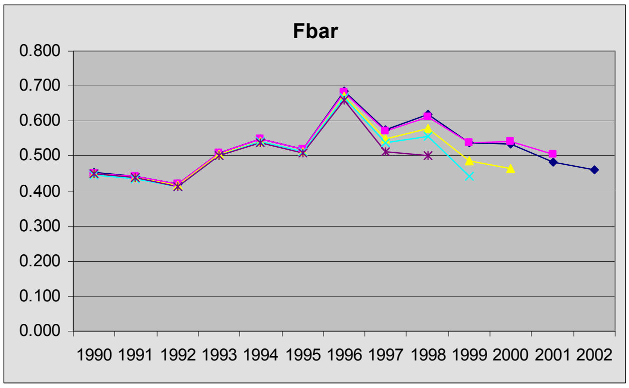


Figure 7.4.2.1 North Sea sole weighting of survey fleets and shrinkage in final XSA.

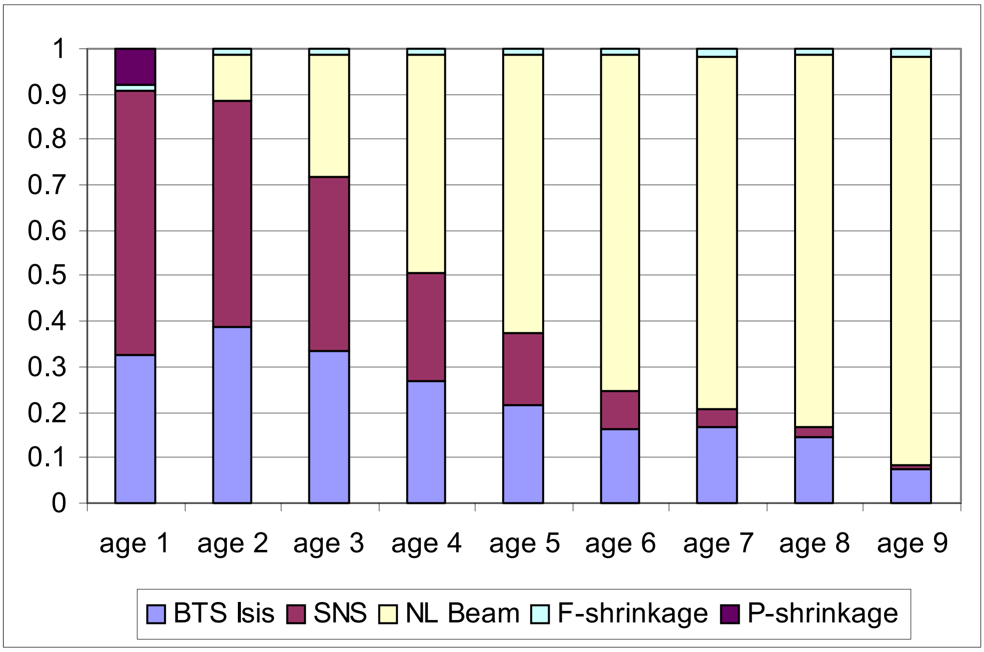
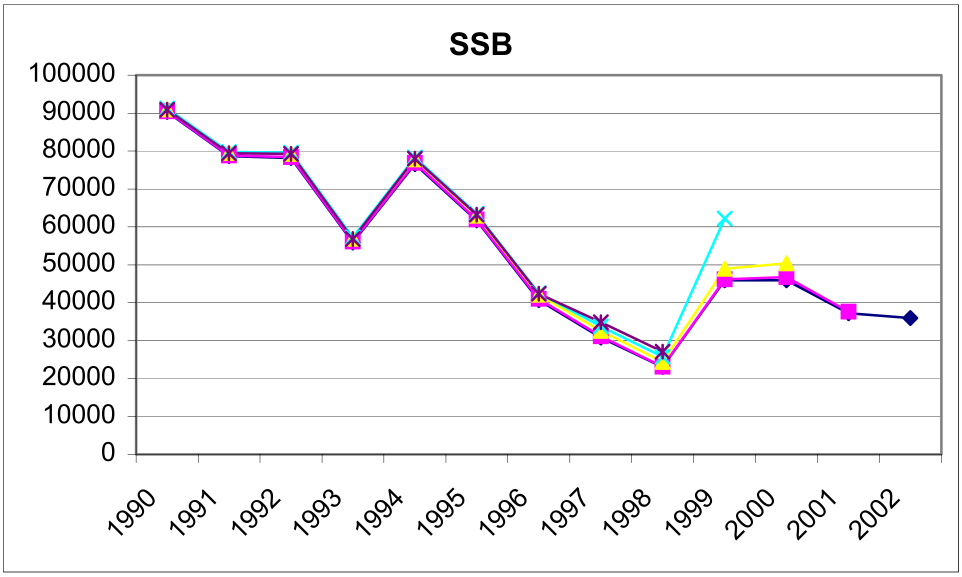
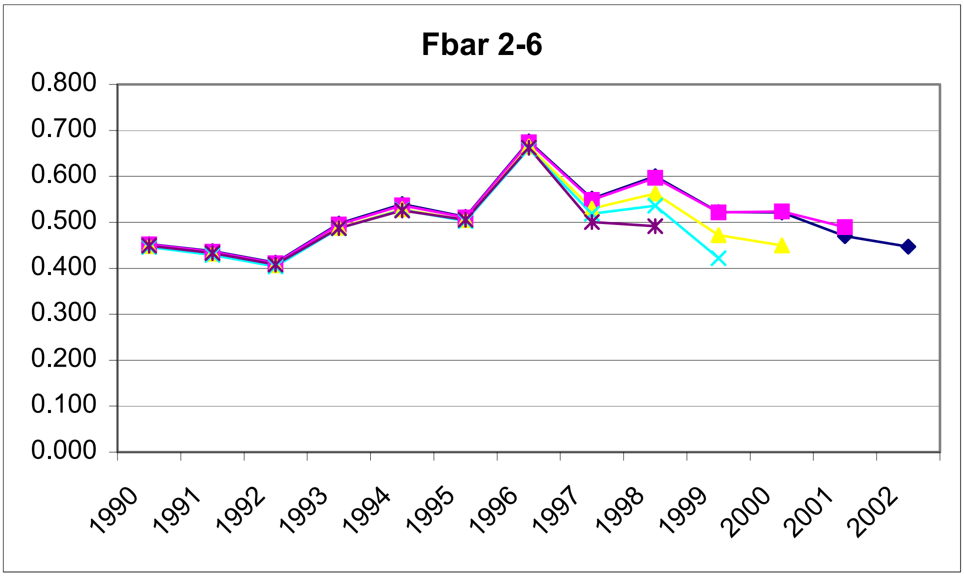


Figure 7.4.2.2 North Sole Retrospective analysis





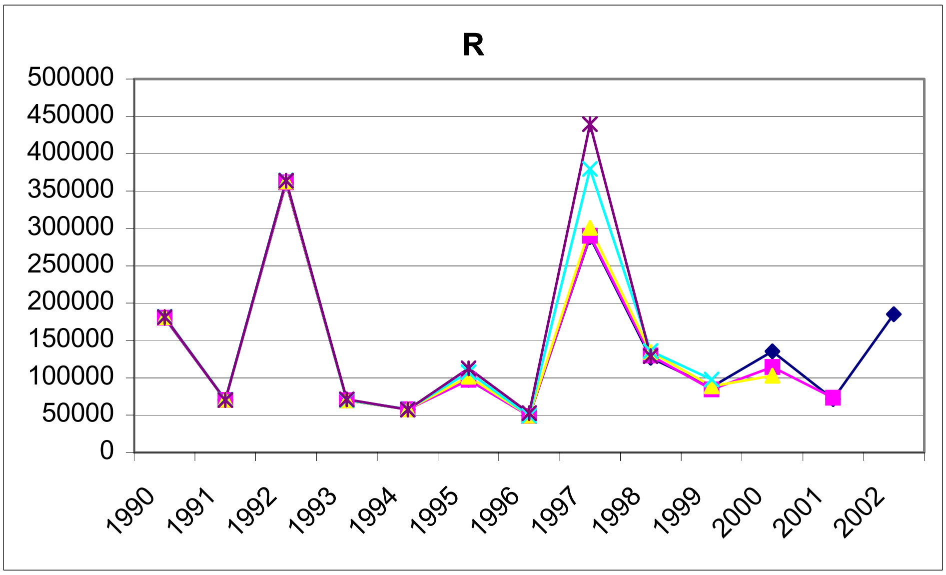
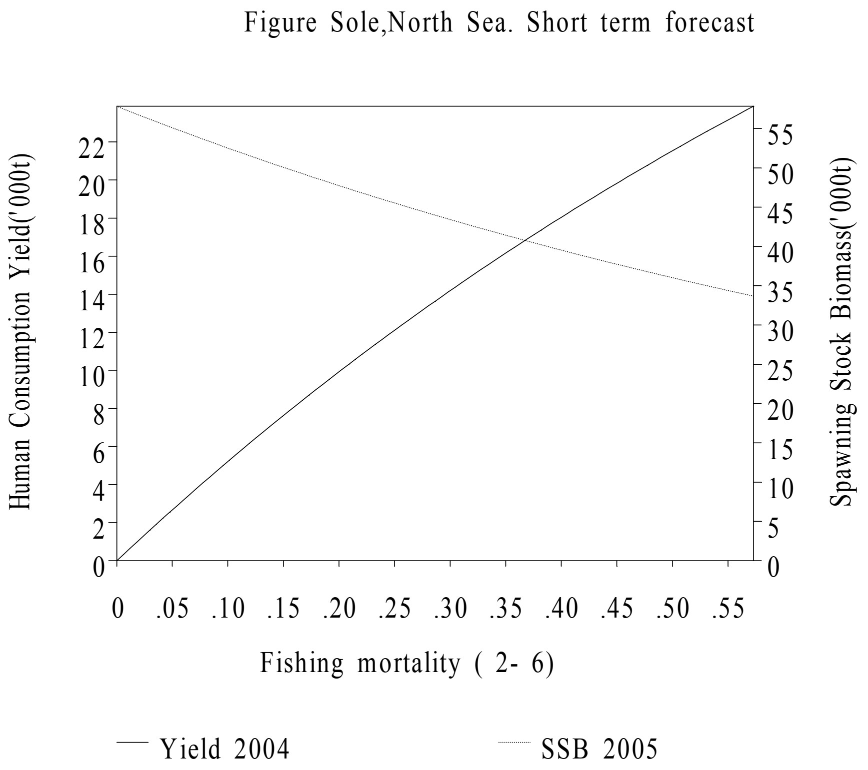
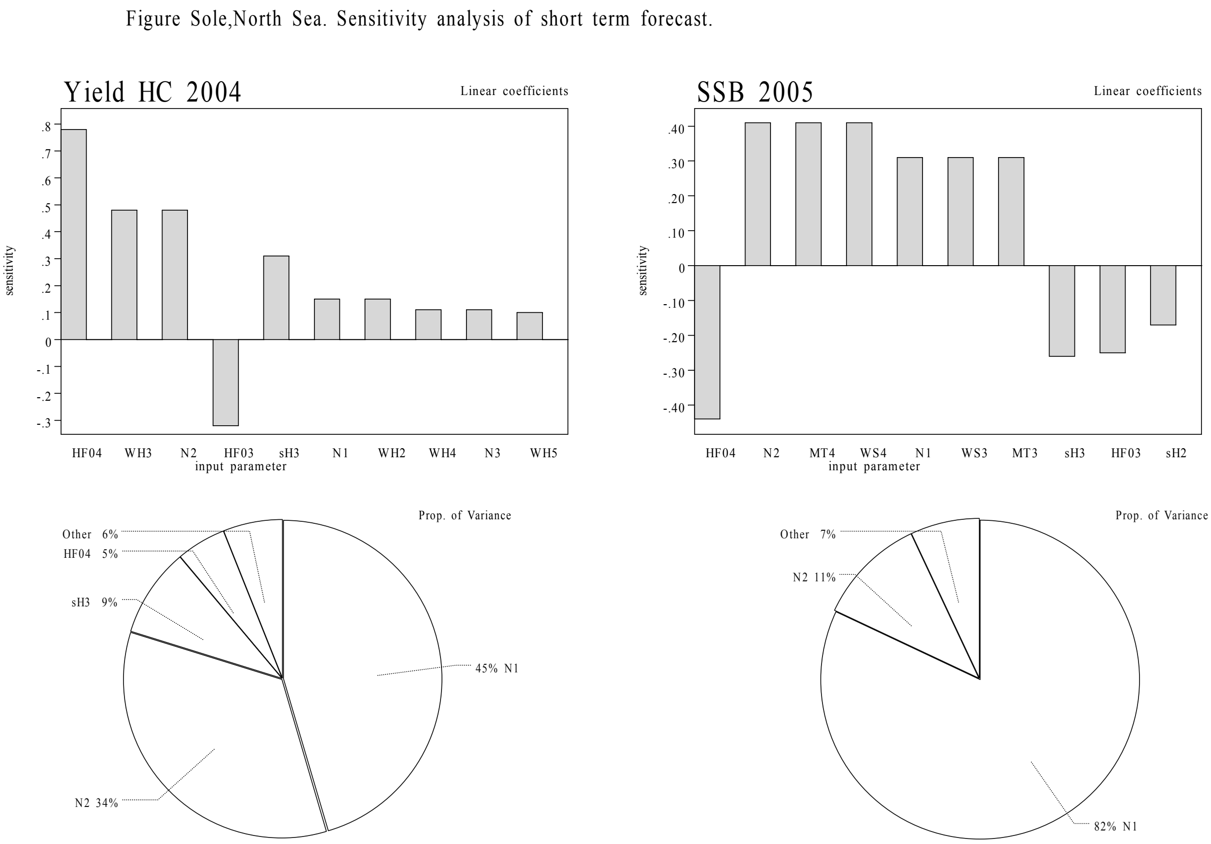


Figure 7.7.1 North Sea Sole Short term forecast



Data from file:E:\wgnssk\Sole IV\FINAL_Truncated_yearrange_NL_CPUE\SOLIV.SEN on

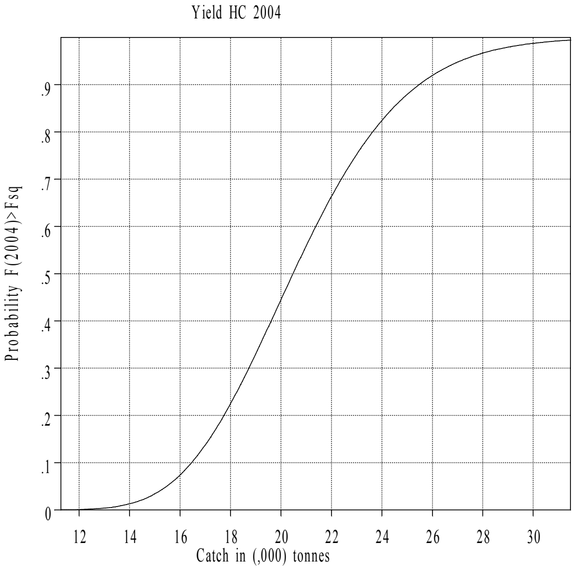
Figure 7.7.2 North Sea Sole sensitivity analysis

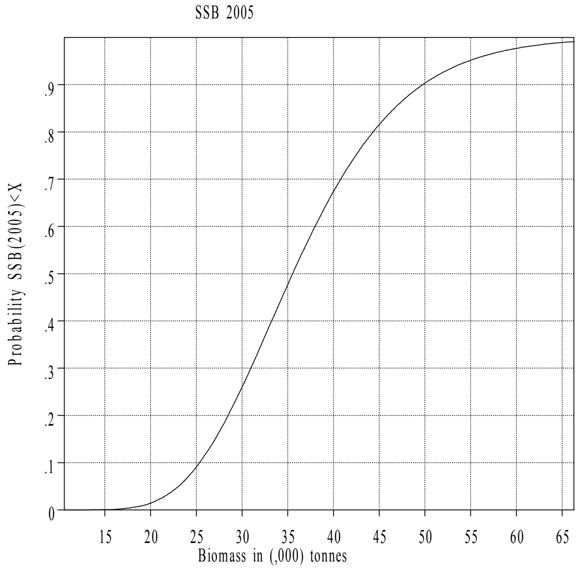


Data from file:E:\wgnssk\Sole IV\FINAL_Truncated_yearrange_NL_CPUE\SOLIV.SEN on

Figure 7.7.3 North Sea Sole probability profiles

Figure Sole,North Sea. Probability profiles for short term forecast.





Data from file:E:\wgnssk\Sole IV\FINAL_Truncated_yearrange_NL_CPUE\SOLIV.SEN on

Figure 7.8.1a North Sea Sole Medium term plots at F=0.40

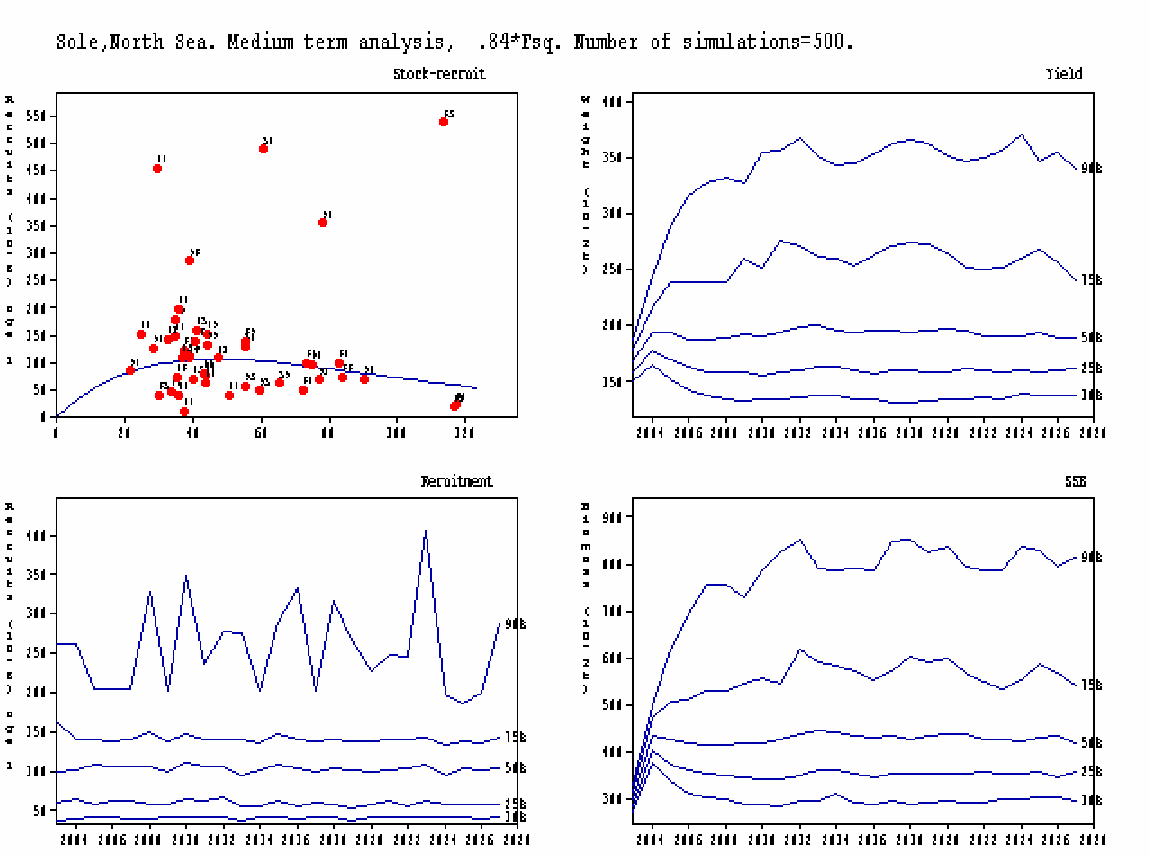


Figure 7.8.1b North Sea Sole Medium term plots at F=0.56

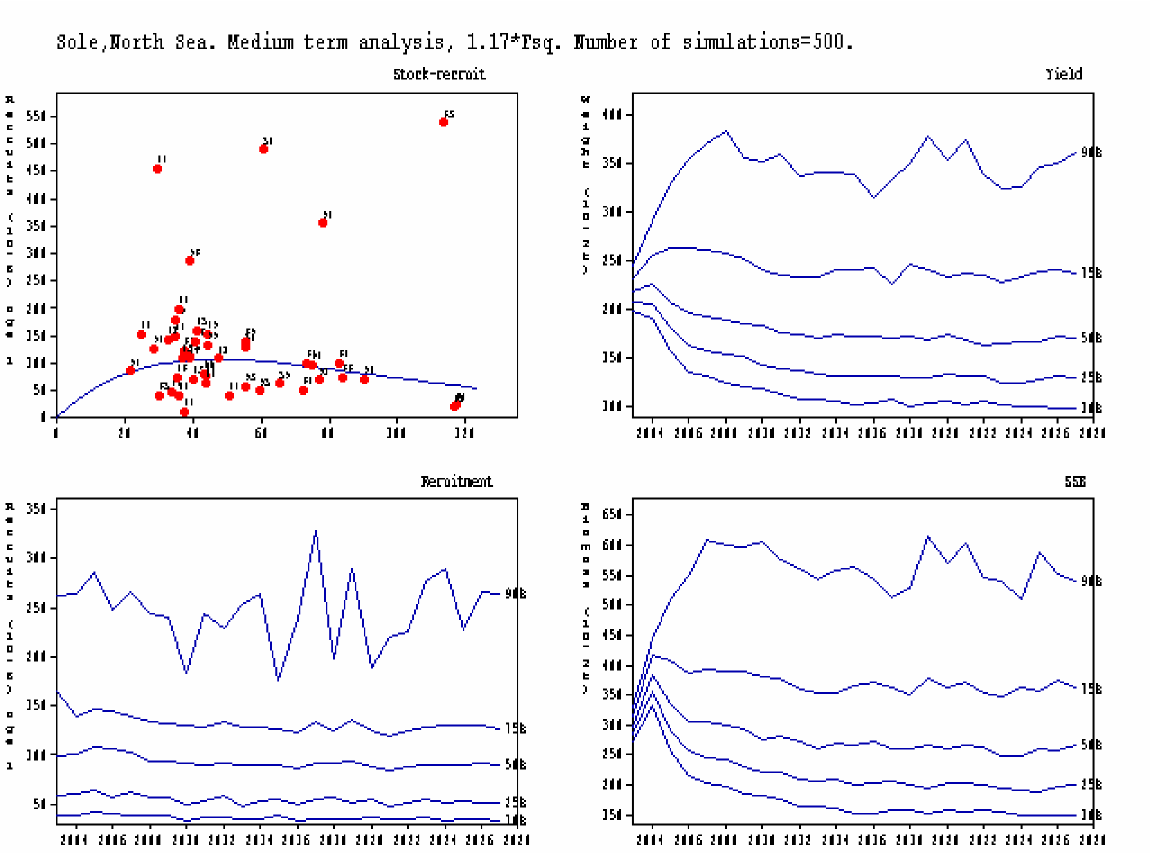


Figure 7.8.1c North Sea Sole Medium term plots at F=0.35.

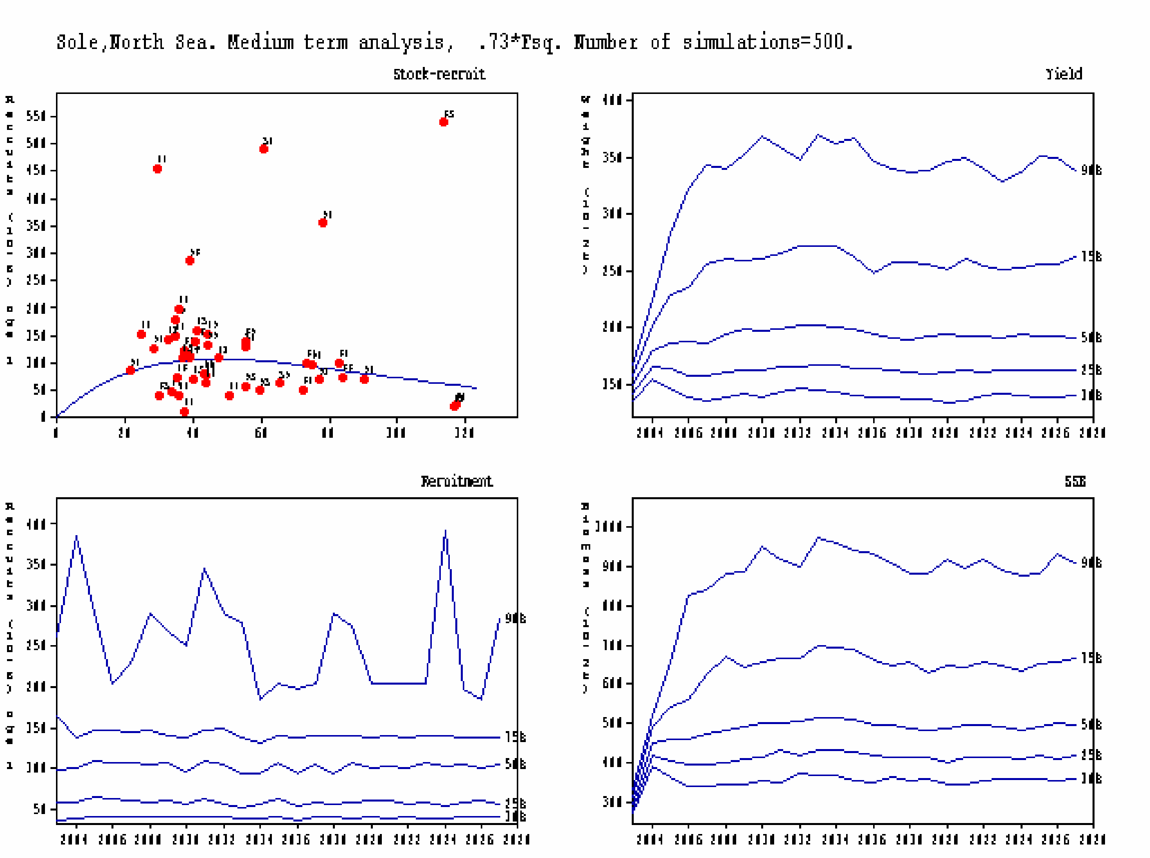


Figure 7.8.1d North Sea Sole Medium term fase plot after 25 years.

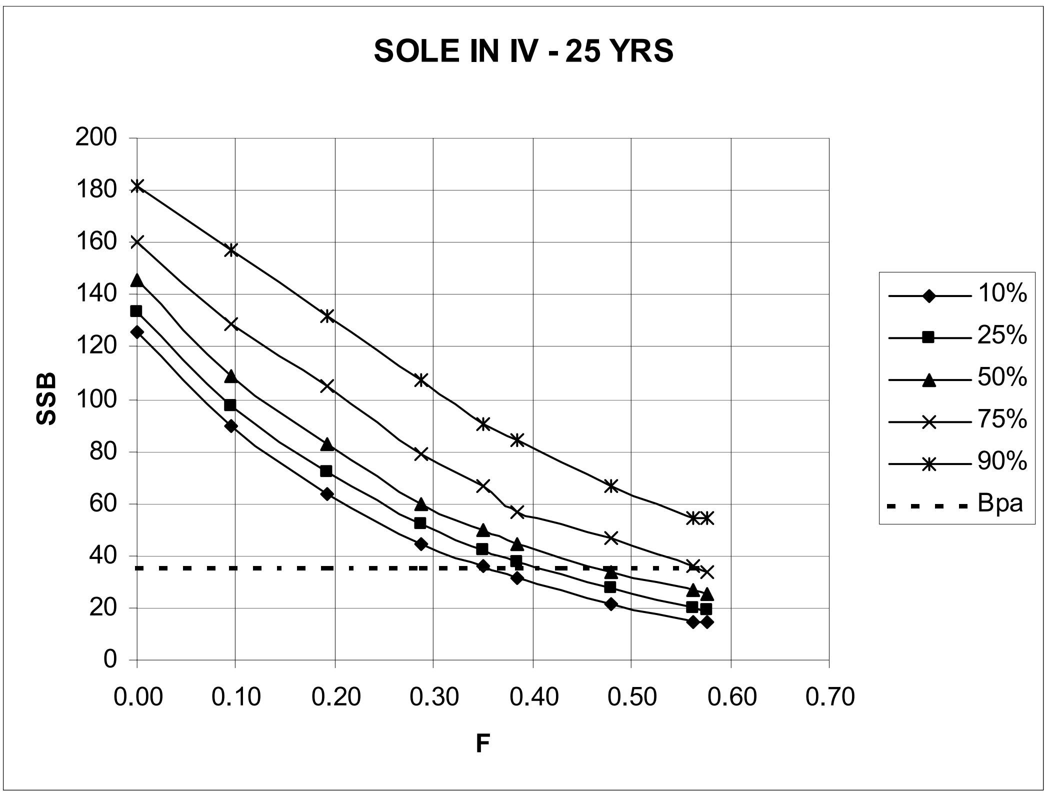


Figure 7.9.1. North Sea sole. Biological reference points.

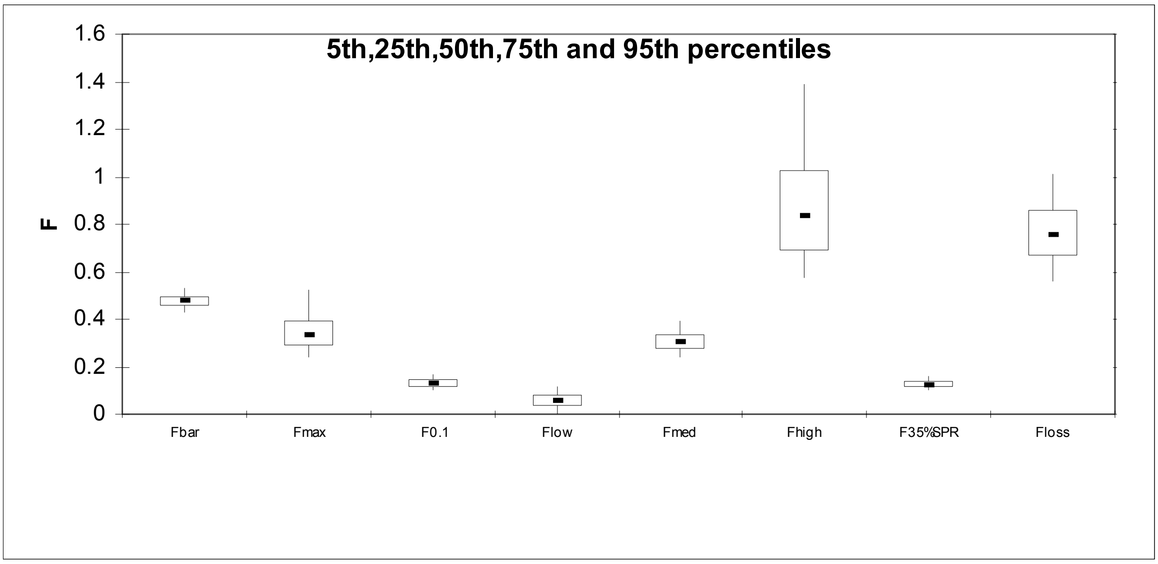
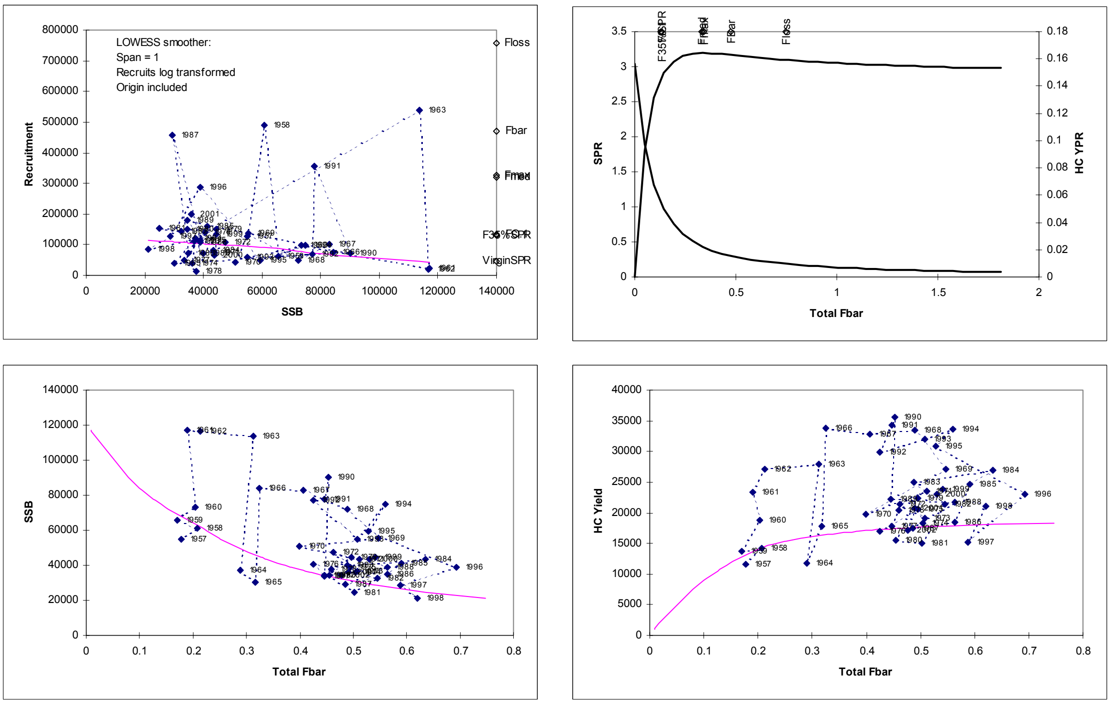


Figure 7.9.2. North Sea sole. Basis for estimation of biological reference points.



8 SOLE IN SUB-AREA VIID

The assessment of sole in sub-area VIId is presented here as an update assessment. All the relevant biological and methodological information can be found in the Stock Annex dealing with this stock. Here, only the basic input and output from the assessment model will be presented.

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. In addition there is a directed fishery by English and Belgian beam trawlers. A third fleet is made up of French offshore trawlers fishing for mixed demersal species and taking sole as a by-catch.

A more detailed description of the fishery can be found in the Stock Annex

8.1.1 ACFM advice applicable to 2002 and 2003

Both in 2001 and in 2002, ACFM considered the stock to be within safe biological limits. ACFM recommended that fishing mortality should be maintained below the proposed $F_{pa,}$ corresponding to landings of less than 5200t in 2002 and of less than 5400t in 2003.

8.1.2 Management applicable in 2002 and 2003

The TAC for sole was set at 5200t in 2002 and 5400 t in 2003.

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.

The MLS for sole is 24 cm.

8.1.3 The fishery in 2002

The 2002 landings used by the Working Group were 4730t which is 9% below the agreed TAC of 5200t and around the catch predicted at status quo fishing mortality in 2002 (4860t). The contribution of Belgium, France and the UK to the landings in 2002 is 30%, 51% and 18% respectively (Table 8.2.1).

8.2 Data available

8.2.1 Landings

Landing data reported to ICES are shown in Table 8.2.1 together with the total landings estimated by the Working Group. There is misreporting by beam trawlers fishing from adjacent areas. This has been taken into account for the year 2002 and a correction for a longer time series will be made next year (See also the section on sole in VIIe in the WGSSDS for this matter). There is also a considerable under-reporting by small vessels, which take up to 60% of the landings in the eastern Channel, however, it has not been possible to quantify the level of these for inclusion in the assessment.

There are no discards included in the assessment, but in general discards for sole are minor.

8.2.2 Age compositions

Age compositions of the landings are presented in Table 8.2.2.

8.2.3 Weight at age

Weight at age in the catch is presented in Table 8.2.3 and weight at age in the stock in Table 8.2.4. The procedure for calculating mean weights is described in the Stock Annex.

8.2.4 Maturity and natural mortality

Maturity and natural mortality are assumed at fixed values and are described in the Stock Annex.

8.2.5 Catch, effort and research vessel data

Survey and commercial data used for calibration of the assessment are presented in Table 8.2.5. Additional information that is used for recruitment estimation is presented in Table 8.4.1.

8.3 Catch at age analysis

Catch at age analysis was carried out according to the specifications in the Stock Annex. The model used was XSA. Results of the analysis are presented in Table 8.3.1 (diagnostics), 8.3.2 (fishing mortality at age), 8.3.3 (population numbers at age), and 8.3.4 (stock summary). The stock summary is also shown in Figure 8.3.1 and the historical performance of the assessment is shown in Figure 8.3.2 (a very noisy pattern!).

8.4 Recruitment estimates

Recruitment estimation was carried out according to the specifications in the Stock Annex. The model used was RCT3. Input to the RCT3 model is presented in Table 8.4.1. Results are presented in Table 8.4.2 and Table 8.4.3. Average recruitment in the period 1982-2000 was 23 million (geometric mean) 1-year-old-fish. Year class strength estimates used for short term prognosis are summarized in the text table below.

Year class	At age in 2003	XSA	GM 82-99	RCT3	Accepted Estimate
2001	2	107294	20090	36025	RCT3
2002	1	-	23267	23830	GM 1982-00
2003 & subsequent	recruits	-	23267	-	GM 1982-00

8.5 Short term prognosis

The short term prognosis was carried out according to the specifications in the stock annex. Input to the WGFRANSW model is presented in Table 8.5.1. Results are presented in Tables 8.5.2 and 8.5.3.

8.6 Comments

- This is an update assessment, using the same parameters as last year.
- The year classes 1998 to 2000 are estimated to be above average and explain the increase in SSB.
- There is a tendency to underestimate fishing mortality and overestimate SSB.
- The discrepancy between the high XSA estimate and the RCT3 estimate of the 2001 year class is partly caused by F shrinkage pulling up the XSA estimate.
- The historical performance of this assessment is very noisy (Figure 8.3.2).
- Uncertainties in the current assessment are the under-reporting by important segments of the inshore fleet, since this fleet takes a major part of the landings of sole in VIId, and the misreporting of beam trawl fleets fishing in adjacent areas (it is expected that the latter will be taken into account for the next assessment)

Workplan for benchmark.

- Analyse the consistency of the tuning fleets by individual retrospective analysis

- Consider redefinition of the current tuning fleets (prior to the Working Group) and/or the integration of new ones like the UK beam trawlers that have been provided for this assessment but not used.

- In depth analysis of possible effects of under- and misreporting

The next benchmark assessment for this stock is foreseen in 2005

Table 8.2.1 Sole in VIId. Nominal landings (tonnes) as officially reported to ICES and used by the Working Group

Year	Belgium	France	UK(E+W)	others	reported	Unallocated*	Total used by WG	TAC
1974	159	469	309	3	940	-56	884	
1975	132	464	244	1	841	41	882	
1976	203	599	404	.	1206	99	1305	
1977	225	737	315	.	1277	58	1335	
1978	241	782	366	.	1389	200	1589	
1979	311	1129	402	.	1842	373	2215	
1980	302	1075	159	.	1536	387	1923	
1981	464	1513	160	.	2137	340	2477	
1982	525	1828	317	4	2674	516	3190	
1983	502	1120	419	.	2041	1417	3458	
1984	592	1309	505	.	2406	1169	3575	
1985	568	2545	520	.	3633	204	3837	
1986	858	1528	551	.	2937	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	2322	877	.	4098	927	5025	3500
1997	1306	1702	933	.	3941	1042	4983	5230
1998	541	1703	** 803	.	3047	647	3694	5230
1999	880	2239	** 769	.	3888	350	4238	4700
2000	1021	2190	621	.	3832	-183	3649	4100
2001	1313	2482	822		4617	-267	4350	4600
2002	1643	2770	976		5389	-659	4730	5200

* Unallocated mainly due misreporting
** Preliminary

Table 8.2.2 Sole in VIId. Catch numbers at age (kg)

Run title : Sole in VIId (run 09/2003)

At 11/09/2003 11:50

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

YEAR	1982
AGE	
1	155
2	2625
3	5256
4	1727
5	570
6	653
7	549
8	240
9	122
10	83
+gp	202
TOTALNUM	12182
TONSLAND	3190
SOPCOF %	97

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

YEAR	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
AGE										
1	0	24	49	49	9	95	163	1271	383	106
2	852	1977	3693	1264	3284	2227	3704	3092	7381	4082
3	3452	3157	5211	5377	3827	7393	3424	6326	3796	8967
4	3930	2610	1646	3273	3417	1648	4842	1257	4316	1886
5	897	1900	1027	925	2166	1219	1530	1654	585	2065
6	735	742	1860	790	1064	910	943	329	1003	295
7	627	457	144	1087	1110	400	651	432	256	382
8	333	317	158	156	828	268	218	293	257	140
9	108	136	156	192	114	280	181	138	272	184
10	89	99	69	216	163	84	270	139	95	98
+gp	193	238	128	381	469	284	329	556	395	237
TOTALNUM	11216	11657	14141	13710	16451	14808	16255	15487	18739	18442
TONSLAND	3458	3575	3837	4024	4974	3982	4187	4060	4382	4142
SOPCOF %	99	99	100	100	100	100	100	99	100	100

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

YEAR	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
AGE										
1	85	34	683	11	30	41	182	145	184	707
2	5225	783	2974	2055	1740	1814	3512	3787	6488	6985
3	6716	6660	4558	7934	6444	5929	9126	5368	6615	7536
4	5735	6152	5003	3081	5228	2890	3543	4914	1760	3777
5	1057	3514	3090	3381	2157	1760	1406	1227	2671	1418
6	645	613	2052	1896	1840	651	945	577	798	659
7	171	613	394	1332	992	654	379	376	319	298
8	206	112	310	288	841	494	731	163	159	131
9	123	154	95	351	255	394	379	380	65	97
10	67	94	111	112	199	251	209	170	102	57
+gp	145	278	247	375	298	354	389	292	304	197
TOTALNUM	20175	19007	19517	20816	20024	15232	20801	17399	19465	21862
TONSLAND	4511	4643	4583	5025	4983	3694	4238	3649	4350	4730
SOPCOF %	100	100	100	100	98	100	93	94	100	100

Table 8.2.3 Sole in VIId. Catch weights at age (kg)

Run title : Sole in VIId (run 09/2003)

At 11/09/2003 11:50

Table 2 Catch weights at age (kg)

YEAR	1982
AGE	
1	0.102
2	0.171
3	0.225
4	0.312
5	0.386
6	0.428
7	0.439
8	0.509
9	0.502
10	0.463
+gp	0.673
SOPCOFAC	0.971

Table 2 Catch weights at age (kg)

YEAR	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
AGE										
1	0.000	0.100	0.090	0.135	0.095	0.102	0.106	0.121	0.114	0.103
2	0.173	0.178	0.182	0.179	0.176	0.152	0.156	0.180	0.161	0.153
3	0.230	0.234	0.230	0.212	0.236	0.226	0.193	0.240	0.211	0.202
4	0.302	0.314	0.281	0.306	0.295	0.278	0.274	0.291	0.267	0.267
5	0.404	0.380	0.368	0.362	0.353	0.358	0.295	0.351	0.349	0.291
6	0.436	0.436	0.394	0.385	0.407	0.407	0.357	0.343	0.390	0.399
7	0.435	0.417	0.516	0.435	0.412	0.458	0.391	0.469	0.415	0.386
8	0.524	0.538	0.543	0.519	0.479	0.509	0.469	0.463	0.426	0.455
9	0.537	0.529	0.594	0.501	0.463	0.551	0.516	0.489	0.433	0.445
10	0.583	0.565	0.595	0.524	0.538	0.559	0.538	0.519	0.477	0.461
+gp	0.628	0.714	0.801	0.603	0.619	0.666	0.705	0.567	0.559	0.558
SOPCOFAC	0.991	0.988	0.998	1.004	1.000	0.997	0.997	0.995	1.000	1.001

Table 2 Catch weights at age (kg)

YEAR	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
AGE										
1	0.085	0.099	0.127	0.142	0.139	0.133	0.133	0.146	0.111	0.120
2	0.148	0.151	0.174	0.167	0.155	0.160	0.153	0.143	0.154	0.162
3	0.197	0.188	0.180	0.179	0.189	0.174	0.193	0.175	0.211	0.203
4	0.245	0.236	0.233	0.230	0.233	0.236	0.219	0.223	0.280	0.252
5	0.331	0.290	0.257	0.272	0.291	0.285	0.264	0.335	0.286	0.316
6	0.374	0.354	0.332	0.323	0.341	0.341	0.285	0.379	0.329	0.374
7	0.528	0.380	0.356	0.360	0.385	0.379	0.295	0.426	0.361	0.376
8	0.540	0.505	0.380	0.403	0.401	0.412	0.347	0.431	0.361	0.390
9	0.505	0.492	0.480	0.436	0.495	0.480	0.363	0.387	0.480	0.467
10	0.742	0.496	0.490	0.461	0.469	0.432	0.379	0.461	0.488	0.420
+gp	0.647	0.616	0.642	0.585	0.643	0.604	0.545	0.684	0.535	0.530
SOPCOFAC	1.001	1.000	1.000	1.000	0.978	1.000	0.935	0.940	1.000	1.000

Table 8.2.4 Sole in VIId. Stock weights at age (kg)

Run title : Sole in VIId (run 09/2003)

At 11/09/2003 11:50

Table 3 Stock weights at age (kg)

YEAR	1982
AGE	
1	0.059
2	0.114
3	0.167
4	0.217
5	0.263
6	0.306
7	0.347
8	0.384
9	0.418
10	0.450
+gp	0.530

Table 3 Stock weights at age (kg)

YEAR	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
AGE										
1	0.070	0.067	0.065	0.070	0.072	0.050	0.050	0.050	0.050	0.050
2	0.135	0.131	0.129	0.136	0.139	0.145	0.115	0.139	0.138	0.144
3	0.197	0.192	0.192	0.198	0.203	0.223	0.184	0.231	0.224	0.199
4	0.255	0.249	0.254	0.256	0.262	0.268	0.272	0.302	0.278	0.275
5	0.309	0.304	0.315	0.309	0.318	0.365	0.324	0.390	0.377	0.301
6	0.359	0.355	0.376	0.358	0.370	0.424	0.336	0.363	0.382	0.448
7	0.406	0.403	0.436	0.403	0.417	0.476	0.469	0.464	0.408	0.398
8	0.448	0.448	0.495	0.443	0.461	0.494	0.494	0.515	0.441	0.449
9	0.487	0.490	0.554	0.480	0.500	0.566	0.559	0.561	0.468	0.416
10	0.522	0.529	0.611	0.512	0.536	0.636	0.519	0.497	0.444	0.524
+gp	0.601	0.627	0.780	0.576	0.616	0.754	0.712	0.559	0.610	0.521

Table 3 Stock weights at age (kg)

YEAR	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
AGE										
1	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050
2	0.131	0.111	0.126	0.155	0.141	0.141	0.131	0.123	0.125	0.138
3	0.188	0.159	0.128	0.175	0.167	0.160	0.159	0.148	0.179	0.190
4	0.243	0.217	0.220	0.259	0.221	0.233	0.191	0.209	0.235	0.237
5	0.356	0.278	0.234	0.286	0.265	0.296	0.275	0.402	0.263	0.289
6	0.363	0.325	0.338	0.308	0.318	0.368	0.305	0.438	0.277	0.335
7	0.531	0.371	0.365	0.367	0.372	0.353	0.366	0.395	0.324	0.364
8	0.543	0.536	0.335	0.395	0.402	0.351	0.340	0.552	0.327	0.336
9	0.546	0.483	0.633	0.435	0.559	0.440	0.448	0.444	0.423	0.479
10	0.782	0.476	0.381	0.467	0.492	0.365	0.348	0.417	0.408	0.498
+gp	0.548	0.631	0.635	0.636	0.647	0.559	0.494	0.685	0.539	0.585

Table 8.2.5. Sole in VIId. Tuning fleets

SOLE 7d,TUNING														
104	1													
BEL BT														
1980	2002													
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	640.7	161.4	82.1	312.8	229.6	44.7	32.9	33.1	6.9	9	18.4	9.3	0.8	51.9
23.9	148.7	980.9	128	93.4	155.9	112.6	38.8	60.1	15.2	14	7.4	12.5	5.9	54.3
23.6	190.4	373	818.9	65.5	54	81.7	73.2	23.5	20.2	27	5	1	7.1	33
28	603.8	347.2	311.2	436	53.7	38.5	104.9	59.9	25.4	23.2	25.3	9	8.2	42.4
25.3	382.9	612.1	213	209.1	260.2	58.2	34.1	48	31	16.9	19.6	9.2	7.7	21.3
23.4	215	1522.3	675	233.7	170.6	194	30.1	53.1	64.2	32.6	12.7	2.6	43	29.3
27.1	843.6	451	739.3	724.4	344.5	232.4	152.7	25.3	86.5	56	56.1	54.5	9.3	109
38.5	131.6	990.4	243.3	362.9	216.7	111.8	41.8	73.8	47	9.8	22.3	35.8	8.6	25.3
35.7	47.5	512.6	543.6	748	276.6	225	53.1	36.4	12.7	4.7	0	0	4.7	27
30.3	1011.4	1375.2	218.1	366.2	85.3	198.2	65.5	39	22.4	22.2	25.4	2.8	24	18.2
24.3	320.2	1358.6	710.1	125.6	283.9	60.6	56.2	21	19.8	22.2	18	5.6	0.3	21.4
22	499.3	1613.7	523.3	477.7	36.9	67.9	28.2	31.7	11.2	11.4	6	5.7	3.2	16.7
20	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	22.4
22.2	196.9	1183.2	1598.5	912.9	201	160	39.5	33.8	46.2	16	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	11.9	3.4	8
25	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	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	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	26.9	7.6	6.6	0.3	1.9
32.4	1055.5	1385.4	375	617.9	351.1	105.4	31.6	15.2	18.7	35.5	11.6	6.9	12.3	4.6
33.7	1267.7	1612.6	804.3	286.3	122.4	95.7	45.2	24.8	28.6	15.8	13.8	8	6	2.6
UK BT														
1981	2002													
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	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	0.1	0.1	2.3
2.7	18.5	38.4	118.6	2	2.8	6.9	4.4	0.3	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	43.8	21.9	79.8	0.3	0.1	4.9	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	2.2	6.8
24.3	362	152.3	206.4	142.6	26.8	21	54.1	2.1	0.6	4.8	1.5	2.2	4.7	3.5
19	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	0.3
33.3	310	186.9	369.7	44	81.7	60.5	12.7	10.8	42.6	2.5	1.1	5	6.8	34.5
33.4	199.8	662.3	97.2	146.7	29.1	34.2	34.7	8.7	15	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	16.3	4.1	2.7	12.7	0.4	0	7.4
37.1	332.3	684.6	105.6	215.2	15	26.1	8.2	19	6.6	3	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	5.5	1.9	2.1	3.5	4.6
28.1	49.6	394	217.4	170	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	376	118.1	251.3	127.7	101.8	26.3	50.5	6.3	13.5	6.3	8	5.4	18.2
39.6	427.3	504.4	239.9	64.2	180.2	75.3	71	16.6	33.1	4	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	10.8	22.9	4	10.2	2.8	17.5
27.2	350.3	613.7	214.2	87.8	64.8	25.3	54	26.7	14.8	7.1	7.7	1.4	5.1	8.5
29	298.9	342	320.9	102.1	47.5	33.1	12.7	39.8	17.9	10.6	4.4	7.6	1.1	14.3
26	722.3	631.1	219.6	236.2	92.8	39.5	42	12.5	29.7	25.8	10.8	3	6.6	10
33.8	732.3	964.9	479.4	154.5	117	49.9	39.6	13	7	11.1	5.1	5.2	1	6.2
UK BTS														
1988	2002													
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	10	0.7	1.1	0.3								
1	0.5	17.5	8.4	7	0.8	1								
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	7.3	3.2	1.3	0.2	0.5								
1	2	21.2	2.5	1	0.9	0.1								
1	28.1	9.4	13.2	2.5	1.7	1.3								
1	10.49	22.03	4.15	4.24	1.03	0.58								
1	9.09	21.01	8.36	1.2	1.91	0.54								
1	31.76	11.42	5.42	3.45	0.27	0.71								
YFS														
1987	2002													
1	1	0.5	0.75											
1	1													
1	0.66													
1	0.94													
1	0.36													
1	1.15													
1	1.87													
1	0.8													
1	0.62													
1	1.59													
1	1.46													
1	0.34													
1	0.52													
1	0.56													
1	0.85													
1	1.28													
1	0.84													
1	1.93													

Table 8.3.1 Sole in VIId. Diagnostics

Lowestoft VPA Version 3.1

12/09/2003 13:53

Extended Survivors Analysis

Sole in VIId (run 09/2003)

CPUE data from file e:\wgnssk\tun2.txt

Catch data for 21 years. 1982 to 2002. Ages 1 to 11.

Fleet	First year	Last year	First age	Last age	Alpha	Beta
BEL BT	1986	2002	2	10	0	1
UK BT	1986	2002	2	10	0	1
UK BTS	1988	2002	1	6	0.5	0.75
YFS	1987	2002	1	1	0.5	0.75

Time series weights :

Tapered time weighting not applied

Catchability analysis :

Catchability independent of stock size for all ages

Catchability independent of age for ages >= 7

Terminal population estimation :

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

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

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

Prior weighting not applied

Tuning converged after 36 iterations

Regression weights

	1	1	1	1	1	1	1	1	1	1

Fishing mortalities

Age	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
1	0.005	0.001	0.035	0.001	0.001	0.002	0.006	0.004	0.005	0.006
2	0.191	0.054	0.136	0.128	0.105	0.073	0.243	0.156	0.218	0.215
3	0.33	0.352	0.441	0.56	0.638	0.539	0.544	0.626	0.395	0.375
4	0.416	0.503	0.431	0.535	0.792	0.584	0.638	0.563	0.379	0.364
5	0.335	0.429	0.451	0.515	0.793	0.597	0.556	0.418	0.605	0.528
6	0.246	0.295	0.424	0.488	0.52	0.517	0.662	0.412	0.467	0.257
7	0.274	0.346	0.279	0.477	0.452	0.311	0.571	0.532	0.373	0.282
8	0.309	0.259	0.263	0.301	0.556	0.377	0.6	0.456	0.398	0.23
9	0.351	0.356	0.324	0.471	0.422	0.486	0.492	0.64	0.294	0.4
10	0.272	0.439	0.416	0.689	0.474	0.845	0.457	0.378	0.309	0.403

Table 8.3.1 Sole in VIId. Continued

XSA population numbers (Thousands)

YEAR \ AGE	1	2	3	4	5	6	7	8	9	10
1993	1.74E+04	3.16E+04	2.51E+04	1.77E+04	3.90E+03	3.11E+03	7.51E+02	8.14E+02	4.37E+02	2.95E+02
1994	2.72E+04	1.57E+04	2.36E+04	1.64E+04	1.06E+04	2.52E+03	2.20E+03	5.17E+02	5.40E+02	2.78E+02
1995	2.06E+04	2.46E+04	1.34E+04	1.50E+04	8.96E+03	6.24E+03	1.70E+03	1.41E+03	3.61E+02	3.43E+02
1996	2.03E+04	1.80E+04	1.94E+04	7.82E+03	8.83E+03	5.16E+03	3.69E+03	1.16E+03	9.82E+02	2.36E+02
1997	3.01E+04	1.84E+04	1.44E+04	1.00E+04	4.14E+03	4.77E+03	2.87E+03	2.07E+03	7.79E+02	5.55E+02
1998	1.89E+04	2.72E+04	1.50E+04	6.87E+03	4.12E+03	1.70E+03	2.57E+03	1.65E+03	1.08E+03	4.63E+02
1999	3.06E+04	1.71E+04	2.29E+04	7.90E+03	3.46E+03	2.05E+03	9.15E+02	1.70E+03	1.03E+03	5.99E+02
2000	3.86E+04	2.75E+04	1.21E+04	1.20E+04	3.77E+03	1.80E+03	9.58E+02	4.68E+02	8.45E+02	5.68E+02
2001	4.22E+04	3.48E+04	2.13E+04	5.87E+03	6.19E+03	2.25E+03	1.08E+03	5.09E+02	2.68E+02	4.03E+02
2002	1.19E+05	3.80E+04	2.53E+04	1.30E+04	3.63E+03	3.06E+03	1.27E+03	6.71E+02	3.09E+02	1.81E+02

Estimated population abundance at 1st Jan 2003

0.00E+00	1.07E+05	2.77E+04	1.58E+04	8.17E+03	1.94E+03	2.14E+03	8.70E+02	4.83E+02	1.88E+02

Taper weighted geometric mean of the VPA populations:

2.59E+04	2.13E+04	1.61E+04	8.63E+03	4.55E+03	2.65E+03	1.54E+03	9.20E+02	5.69E+02	3.50E+02

Standard error of the weighted Log(VPA populations) :

0.5216	0.3899	0.3681	0.4327	0.43	0.4489	0.4699	0.4577	0.4253	0.3871

Log catchability residuals.

Fleet : BEL BT□□□□□□□□□□□□□□□

Age	1986	1987	1988	1989	1990	1991	1992
1	No data for this fleet at this age						
2	0.17	0.71	-0.6	-2.43	1.29	-0.61	0.12
3	0.65	-0.3	-0.52	-0.1	0.03	0.77	0.04
4	0.13	0.29	-0.82	-0.46	-0.21	0.06	0.31
5	-0.22	0.47	-0.35	0.84	-0.15	-0.17	0.21
6	-0.15	0.84	-0.25	0.24	-0.29	0.69	-0.57
7	-0.12	0.49	-0.14	0.27	0.48	-0.15	-0.21
8	-0.23	0.09	-0.87	-0.28	-0.25	-0.06	-0.42
9	0.26	-0.06	-0.39	-0.43	0.1	-0.55	-0.01
10	0.19	1.2	0.79	-1.49	-0.14	0.22	-0.38

Age	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
1	No data for this fleet at this age									
2	1.45	-0.15	-0.6	-0.01	-0.62	-0.23	0.52	0.08	0.43	0.49
3	0.19	-0.09	-0.36	-0.12	0.28	-0.32	-0.06	0.37	-0.19	-0.26
4	-0.08	0.52	-0.38	0.22	0.3	0.18	0.43	0.27	-0.34	-0.42
5	-0.2	0.19	-0.16	-0.2	0.35	-0.24	0.31	-0.44	0.03	-0.28
6	-0.76	0.31	0.09	0.13	0.18	-0.29	-0.04	0.02	0.68	-0.82
7	-0.17	0.1	-0.23	0.2	0.18	-0.19	-0.08	-0.15	0.03	-0.32
8	-0.19	0.11	-0.96	-0.26	-0.18	0.09	-0.06	0.5	-0.41	-0.45
9	0.38	-0.05	-0.03	0.12	-0.2	0.08	0.11	0.1	-0.55	-0.2
10	-0.47	0.97	-0.52	0.82	-0.49	-0.48	-0.25	-0.1	-0.75	0.48

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	-7.2516	-5.7812	-5.6593	-5.4848	-5.7452	-5.6042	-5.6042	-5.6042	-5.6042
S.E(Log q)	0.8824	0.3525	0.3767	0.344	0.4797	0.2481	0.4215	0.2839	0.706

Table 8.3.1 Sole in VIId. 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	0.89	0.218	7.56	0.21	17	0.81	-7.25
3	1.22	-0.759	4.93	0.45	17	0.43	-5.78
4	0.86	0.759	6.15	0.65	17	0.33	-5.66
5	0.98	0.123	5.56	0.62	17	0.35	-5.48
6	0.86	0.596	6.04	0.54	17	0.42	-5.75
7	0.85	1.481	5.88	0.86	17	0.2	-5.6
8	1.04	-0.232	5.79	0.65	17	0.38	-5.83
9	0.88	0.893	5.76	0.78	17	0.24	-5.68
10	5.8	-2.235	4.37	0.01	17	3.66	-5.63

Fleet : UK BT

Age	1986	1987	1988	1989	1990	1991	1992
1	No data for this fleet at this age						
2	-0.58	0.35	0.58	-0.11	-0.06	-0.03	-0.44
3	0.27	-0.15	0.42	0.09	0.33	-0.24	-0.21
4	0.25	0.31	-0.02	0.41	0.07	0.12	-0.63
5	-0.05	0.39	0.44	-0.48	0.27	-1.28	0.33
6	0.06	-0.46	0.34	0.24	-0.32	-0.21	-0.85
7	0.48	-0.45	-0.2	0.38	-0.02	-1.11	-0.34
8	-1.28	0.52	0.32	-0.29	0.37	-0.57	-0.82
9	-0.64	-1.09	0.61	-0.22	-0.15	0.33	0.3
10	-0.13	-2.31	-0.05	1.14	0.71	-0.23	-0.08

Age	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
1	No data for this fleet at this age									
2	-0.36	-1.39	-0.29	0.37	0.29	0.26	0.6	-0.14	0.65	0.31
3	-0.51	-0.3	-0.78	-0.39	0.23	-0.09	0.29	0.32	0.37	0.35
4	-0.19	-0.53	-0.2	-0.71	-0.16	0.05	0.28	0.17	0.53	0.25
5	-0.47	-0.29	-0.32	-0.01	-0.51	0.25	0.26	0.19	0.73	0.54
6	0.1	-0.36	-0.13	-0.2	0.23	-0.04	0.49	0.13	0.71	0.28
7	-0.71	0.36	-0.46	-0.03	-0.1	0.33	0.38	0.52	0.62	0.38
8	-0.05	-0.55	0.46	-0.31	0.21	0.26	0.53	0.25	1.44	0.76
9	-0.29	0.3	-0.11	0.59	-0.32	0.5	0.28	0.88	0.82	0.5
10	-0.32	-0.16	0.58	0.03	0.73	0.12	0.22	0.36	1.28	0.42

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

Age	2	3	4	5	6	7	8	9	10
Mean Log q	-7.626	-6.9103	-6.8445	-6.9242	-6.8886	-6.9536	-6.9536	-6.9536	-6.9536
S.E(Log q)	0.5203	0.3622	0.3603	0.5043	0.3839	0.4926	0.6598	0.5542	0.7999

Regression statistics :

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

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
2	0.89	0.35	7.88	0.42	17	0.48	-7.63
3	0.99	0.059	6.95	0.53	17	0.37	-6.91
4	1.14	-0.595	6.52	0.53	17	0.42	-6.84
5	0.74	1.204	7.32	0.59	17	0.37	-6.92
6	0.82	1.01	7.06	0.68	17	0.32	-6.89
7	0.82	0.862	7.03	0.6	17	0.41	-6.95
8	0.75	1.037	6.86	0.52	17	0.49	-6.88
9	0.74	1.159	6.7	0.58	17	0.39	-6.82
10	0.74	0.77	6.57	0.36	17	0.59	-6.82

Table 8.3.1 Sole in VIId. Continued

Fleet : UK BTS

Age		1986	1987	1988	1989	1990	1991	1992
	1	99.99	99.99	0.46	-0.23	0.34	0.26	-1.57
	2	99.99	99.99	1.07	0.26	-0.66	0.19	-0.28
	3	99.99	99.99	0.66	0.62	-0.44	-0.35	0.15
	4	99.99	99.99	-0.29	0	0.07	0.14	-0.62
	5	99.99	99.99	0.44	0.12	-0.07	-0.24	0.02
	6	99.99	99.99	0.12	-0.79	-0.35	0.17	0.29
	7	No data for this fleet at this age						
	8	No data for this fleet at this age						
	9	No data for this fleet at this age						
	10	No data for this fleet at this age						

Age		1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
	1	-1.9	-0.09	-0.11	-0.11	1.19	-0.6	1.56	0.35	0.12	0.33
	2	0.14	-0.94	-0.15	-0.21	-0.25	0.41	0.16	0.48	0.24	-0.46
	3	0.08	0.15	-0.94	-0.31	-0.13	-0.48	0.76	0.29	0.28	-0.34
	4	0.67	0.05	-0.27	-0.74	-0.22	-0.23	0.58	0.65	-0.01	0.24
	5	-0.03	0.45	-0.38	-0.25	-1.19	0.2	0.98	0.31	0.55	-0.92
	6	0.45	-0.92	0.27	-0.01	-0.5	-1.08	1.39	0.56	0.3	0.13
	7	No data for this fleet at this age									
	8	No data for this fleet at this age									
	9	No data for this fleet at this age									
	10	No data for this fleet at this age									

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

Age	1	2	3	4	5	6
Mean Log q	-8.4925	-7.4556	-7.8181	-8.1819	-8.193	-8.2754
S.E(Log q)	0.887	0.5008	0.4843	0.4211	0.5575	0.6411

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	0.63	1.268	9.17	0.47	15	0.54	-8.49
2	1.04	-0.095	7.36	0.36	15	0.54	-7.46
3	0.93	0.21	7.95	0.41	15	0.47	-7.82
4	0.75	1.462	8.42	0.72	15	0.3	-8.18
5	0.93	0.231	8.21	0.44	15	0.54	-8.19
6	1.02	-0.055	8.28	0.34	15	0.68	-8.28

Fleet : YFS

Age		1986	1987	1988	1989	1990	1991	1992
	1	99.99	0.63	0.14	-0.36	-0.16	0.55	-0.28
	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						

Table 8.3.1 Sole in VIId. Continued

Age		1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
1		0.16	0.66	0.87	-0.59	-0.56	-0.02	-0.08	0.09	-0.42	-0.62
2	No data for this fleet at this age										
3	No data for this fleet at this age										
4	No data for this fleet at this age										
5	No data for this fleet at this age										
6	No data for this fleet at this age										
7	No data for this fleet at this age										
8	No data for this fleet at this age										
9	No data for this fleet at this age										
10	No data for this fleet at this age										

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

Age	1
Mean Log q	-10.3415
S.E(Log q)	0.4771

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	1.62	-1.775	10.39	0.37	16	0.72	-10.34

Terminal year survivor and F summaries :

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

Year class = 2001

Fleet	Estimate Survivor	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
BEL BT	1	0	0	0	0	0	0
UK BT	1	0	0	0	0	0	0
UK BTS	148868	0.916	0	0	1	0.127	0.005
YFS	57476	0.492	0	0	1	0.442	0.012
F shrinkage mean	184917	0.5				0.43	0.004

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
107294	0.33	0.49	3	1.5	0.006

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

Year class = 2000

Fleet	Estimate Survivor	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
BEL BT	45140	0.908	0	0	1	0.065	0.137
UK BT	37808	0.535	0	0	1	0.187	0.162
UK BTS	20145	0.45	0.245	0.54	2	0.263	0.285
YFS	18272	0.492	0	0	1	0.22	0.31
F shrinkage mean	38478	0.5				0.265	0.159

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
27739	0.24	0.18	6	0.743	0.215

Table 8.3.1 Sole in VIId. Continued

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

Year class = 1999

Fleet	Estimate Survivor	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
BEL BT	13113	0.338	0.221	0.65	2	0.24	0.436
UK BT	24300	0.307	0.133	0.43	2	0.281	0.259
UK BTS	15198	0.337	0.214	0.64	3	0.223	0.386
YFS	17261	0.492	0	0	1	0.093	0.347
F shrinkage mean	9764	0.5				0.163	0.551

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
15752	0.17	0.13	9	0.799	0.375

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

Year class = 1998

Fleet	Estimate Survivor	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
BEL BT	6066	0.26	0.1	0.39	3	0.274	0.465
UK BT	10325	0.242	0.114	0.47	3	0.31	0.299
UK BTS	11966	0.273	0.185	0.68	4	0.237	0.263
YFS	7508	0.492	0	0	1	0.052	0.391
F shrinkage mean	4433	0.5				0.126	0.594

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
8170	0.14	0.12	12	0.887	0.364

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

Year class = 1997

Fleet	Estimate Survivor	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
BEL BT	1648	0.223	0.159	0.71	4	0.345	0.598
UK BT	3180	0.235	0.055	0.23	4	0.271	0.354
UK BTS	1501	0.267	0.242	0.91	5	0.209	0.641
YFS	1895	0.492	0	0	1	0.026	0.538
F shrinkage mean	1655	0.5				0.149	0.596

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
1940	0.14	0.11	15	0.806	0.528

Table 8.3.1 Sole in VIId. Continued

Age 6 Catchability constant w.r.t. time and dependent on age

Year class = 1996

Fleet	Estimate Survivor	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
BEL BT□□□□□□□	1701	0.225	0.217	0.97	5	0.321	0.314
UK BT	2983	0.232	0.09	0.39	5	0.334	0.191
UK BTS□□□□□□□	3404	0.279	0.118	0.42	6	0.189	0.169
YFS□□□□□□□□□	1221	0.492	0	0	1	0.018	0.414
F shrinkage mean	925	0.5				0.137	0.517

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
2139	0.14	0.13	18	0.967	0.257

Age 7 Catchability constant w.r.t. time and dependent on age

Year class = 1995

Fleet	Estimate Survivor	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
BEL BT□□□□□□□	746	0.195	0.173	0.89	6	0.459	0.322
UK BT	1316	0.223	0.107	0.48	6	0.29	0.195
UK BTS□□□□□□□	1092	0.273	0.147	0.54	6	0.115	0.231
YFS□□□□□□□□□	481	0.492	0	0	1	0.011	0.464
F shrinkage mean	500	0.5				0.125	0.449

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
870	0.13	0.11	20	0.809	0.282

Age 8 Catchability constant w.r.t. time and age (fixed at the value for age) 7

Year class = 1994

Fleet	Estimate Survivor	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
BEL BT□□□□□□□	454	0.188	0.108	0.57	7	0.492	0.243
UK BT	718	0.228	0.111	0.49	7	0.281	0.16
UK BTS□□□□□□□	673	0.283	0.22	0.78	6	0.086	0.17
YFS□□□□□□□□□	1151	0.492	0	0	1	0.007	0.103
F shrinkage mean	203	0.5				0.133	0.479

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
483	0.13	0.11	22	0.829	0.23

Table 8.3.1 Sole in VIId. Continued

Age 9 Catchability constant w.r.t. time and age (fixed at the value for age) 7

Year class = 1993

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
BEL BT	152	0.184	0.044	0.24	8	0.574	0.475
UK BT	340	0.264	0.165	0.63	8	0.227	0.24
UK BTS	296	0.298	0.316	1.06	6	0.035	0.271
YFS	361	0.492	0	0	1	0.003	0.227
F shrinkage mean	155	0.5				0.16	0.468

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
188	0.15	0.09	24	0.623	0.4

Age 10 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
BEL BT	94	0.184	0.156	0.85	9	0.54	0.455
UK BT	151	0.264	0.168	0.63	9	0.239	0.307
UK BTS	39	0.287	0.097	0.34	6	0.032	0.869
YFS	129	0.492	0	0	1	0.003	0.351
F shrinkage mean	134	0.5				0.186	0.34

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
109	0.15	0.1	26	0.655	0.403

Table 8.3.2. Sole in VIId. Fishing mortality (F) at age

Run title : Sole in VIId (run 09/2003)

At 12/09/2003 13:54

Terminal Fs derived using XSA (With F shrinkage)

Table 8 Fishing mortality (F) at age

YEAR	1982
AGE	
1	0.0126
2	0.1848
3	0.3221
4	0.4712
5	0.2095
6	0.2427
7	0.4620
8	0.3984
9	0.3377
10	0.3309
+gp	0.3309
FBAR 3- 8	0.3510

Table 8 Fishing mortality (F) at age

YEAR	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
AGE										
1	0.0000	0.0011	0.0038	0.0019	0.0008	0.0037	0.0101	0.0299	0.0113	0.0032
2	0.0804	0.1115	0.2157	0.1156	0.1531	0.2533	0.1742	0.2380	0.2167	0.1436
3	0.3495	0.4198	0.4210	0.4898	0.5279	0.5302	0.6728	0.4449	0.4535	0.3928
4	0.3770	0.4302	0.3575	0.4516	0.5868	0.4018	0.7056	0.4933	0.5490	0.3784
5	0.4239	0.2805	0.2662	0.3105	0.5404	0.3779	0.7081	0.4894	0.3975	0.4891
6	0.4037	0.6591	0.4313	0.3002	0.6215	0.4046	0.4986	0.2808	0.5500	0.3175
7	0.3445	0.4182	0.2233	0.4282	0.7846	0.4432	0.5014	0.3964	0.3268	0.3691
8	0.5002	0.2611	0.2211	0.3560	0.5978	0.3827	0.4093	0.3913	0.3855	0.2660
9	0.2789	0.3467	0.1771	0.4040	0.4237	0.3650	0.4277	0.4367	0.6759	0.4654
10	0.3914	0.3943	0.2644	0.3516	0.6293	0.5614	0.6337	0.6032	0.5389	0.4855
+gp	0.3914	0.3943	0.2644	0.3516	0.6293	0.5614	0.6337	0.6032	0.5389	0.4855
FBAR 3- 8	0.3998	0.4115	0.3201	0.3894	0.6098	0.4234	0.5826	0.4160	0.4437	0.3688

Table 8 Fishing mortality (F) at age

YEAR	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	FBAR 00-02
AGE											
1	0.0051	0.0013	0.0354	0.0006	0.0010	0.0023	0.0063	0.0040	0.0046	0.0062	0.0049
2	0.1911	0.0540	0.1358	0.1276	0.1049	0.0728	0.2433	0.1561	0.2180	0.2147	0.1963
3	0.3296	0.3519	0.4413	0.5603	0.6380	0.5390	0.5442	0.6261	0.3948	0.3751	0.4653
4	0.4156	0.5028	0.4311	0.5351	0.7919	0.5842	0.6382	0.5628	0.3789	0.3645	0.4354
5	0.3353	0.4291	0.4505	0.5151	0.7929	0.5966	0.5563	0.4182	0.6050	0.5279	0.5171
6	0.2456	0.2948	0.4244	0.4876	0.5196	0.5167	0.6620	0.4118	0.4672	0.2570	0.3787
7	0.2736	0.3459	0.2791	0.4769	0.4516	0.3115	0.5714	0.5323	0.3730	0.2821	0.3958
8	0.3094	0.2585	0.2626	0.3012	0.5558	0.3771	0.6004	0.4563	0.3982	0.2297	0.3614
9	0.3509	0.3560	0.3237	0.4713	0.4216	0.4859	0.4917	0.6400	0.2941	0.4001	0.4447
10	0.2725	0.4385	0.4165	0.6893	0.4736	0.8450	0.4569	0.3781	0.3092	0.4026	0.3633
+gp	0.2725	0.4385	0.4165	0.6893	0.4736	0.8450	0.4569	0.3781	0.3092	0.4026	
FBAR 3- 8	0.3182	0.3639	0.3815	0.4794	0.6250	0.4875	0.5954	0.5013	0.4362	0.3394	

Table 8.3.3. Sole in VIId. Stock numbers at age

Run title : Sole in VIId (run 09/2003)

At 12/09/2003 13:54

Terminal Fs derived using XSA (With F shrinkage)

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

YEAR	1982
AGE	
1	12977
2	16356
3	20065
4	4832
5	3170
6	3186
7	1560
8	768
9	447
10	310
+gp	751
TOTAL	64423

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

YEAR	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
AGE										
1	21769	22144	13502	26934	11574	27023	17133	45359	35860	35006
2	11595	19698	20014	12170	24324	10464	24361	15348	39833	32083
3	12303	9681	15943	14596	9810	18886	7350	18519	10946	29022
4	13156	7848	5757	9469	8092	5236	10056	3394	10739	6294
5	2729	8165	4619	3643	5454	4072	3170	4493	1875	5612
6	2326	1616	5581	3202	2417	2875	2525	1413	2492	1140
7	2262	1406	756	3281	2146	1175	1736	1388	965	1301
8	889	1450	837	548	1934	886	682	951	845	630
9	467	488	1011	607	347	963	547	410	582	520
10	289	319	312	766	367	206	605	323	240	268
+gp	624	765	578	1347	1050	691	733	1284	992	645
TOTAL	68409	73581	68909	76563	67516	72476	68897	92881	105370	112520

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

YEAR	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	GMST 82-00	AMST 82-00
AGE													
1	17403	27241	20649	20304	30059	18936	30633	38630	42190	119320	0[a]	23267	24902
2	31574	15666	24616	18034	18361	27170	17095	27545	34816	38000	107294[b]	20090	21385
3	25147	23599	13430	19445	14363	14959	22859	12127	21321	25331	27739	15496	16476
4	17730	16366	15018	7817	10047	6867	7895	12002	5867	13000	15752	8617	9401
5	3901	10588	8956	8830	4142	4118	3464	3774	6186	3634	8170	4527	4988
6	3114	2524	6238	5165	4774	1696	2052	1797	2248	3057	1940	2655	2954
7	751	2204	1701	3692	2870	2569	915	958	1077	1275	2139	1585	1770
8	814	517	1411	1164	2074	1653	1702	468	509	671	870	965	1064
9	437	540	361	982	779	1076	1026	845	268	309	483	611	654
10	295	278	343	236	555	463	599	568	403	181	188	360	386
+gp	637	820	759	787	827	648	1110	972	1198	623	486		
TOTAL	101803	100342	93482	86455	88850	80153	89351	99685	116083	205400	165060		

[a] replaced by GM in the prediction

[b] replaced by RCT3 estimate (36025)

Table 8.3.4. Sole in VIId. Summary

Run title : Sole in VIId (run 09/2003)

At 12/09/2003 13:54

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
1982	12977	10399	7769	3190	0.4106	0.3510
1983	21769	12616	9526	3458	0.3630	0.3998
1984	22144	13037	8972	3575	0.3984	0.4115
1985	13502	13481	10022	3837	0.3829	0.3201
1986	26934	14151	10610	4024	0.3793	0.3894
1987	11574	13758	9543	4974	0.5212	0.6098
1988	27023	13382	10513	3982	0.3788	0.4234
1989	17133	11914	8255	4187	0.5072	0.5826
1990	45359	14211	9809	4060	0.4139	0.4160
1991	35860	16136	8846	4382	0.4953	0.4437
1992	35006	17570	11200	4142	0.3698	0.3688
1993	17403	18221	13214	4511	0.3414	0.3182
1994	27241	16173	13072	4643	0.3552	0.3639
1995	20649	15296	11162	4583	0.4106	0.3815
1996	20304	16206	12396	5025	0.4054	0.4794
1997	30059	14471	10379	4983	0.4801	0.6250
1998	18936	13106	8328	3694	0.4436	0.4875
1999	30633	12622	8851	4238	0.4788	0.5954
2000	38630	13841	8522	3649	0.4282	0.5013
2001	42190	15346	8884	4350	0.4896	0.4362
2002	40212[a]	22470	11260	4730	0.4201	0.3394
2003	23267[b]		13300			
Arith. Mean	30221	14686	10054	4201	0.4225	0.4402
0 Units	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)		

[a] RCT3 estimate

[b] GM (82-00)

Table 8.4.1. Sole in VIId. RCT3 input.

Yearclass	XSA (Age 1)	XSA (age 2)	yfs0	yfs1	ebts1	ebts2
1981	11595	12977	1.881	0.2005	-11	-11
1982	19698	21769	2.6555	0.695	-11	-11
1983	20014	22144	11.887	-11	-11	-11
1984	12170	13502	-11	-11	-11	-11
1985	24324	26934	-11	-11	-11	-11
1986	10464	11574	-11	0.6595	-11	14.2
1987	24361	27023	7.995	0.935	8.2	15.4
1988	15348	17133	1.1875	0.356	2.6	3.7
1989	39833	45359	12.588	1.152	12.1	22.8
1990	32083	35860	3.3285	1.8695	8.9	12
1991	31574	35006	1.3865	0.796	1.4	17.5
1992	15666	17403	1.281	0.615	0.5	3.2
1993	24616	27241	6.534	1.591	4.8	10.6
1994	18034	20649	8.1035	1.4635	3.5	7.4
1995	18361	20304	5.3135	0.339	3.5	7.3
1996	27170	30059	0.9865	0.5205	19	21.23
1997	17095	18936	1.942	0.559	2	9.44
1998	27545	30633	9.3725	0.854	28.14	22.03
1999	-11	-11	2.7455	1.282	10.49	21.01
2000	-11	-11	1.8475	0.8365	9.09	-11
2001	-11	-11	4.5135	1.93	31.76	28.48
2002	-11	-11	2.52	-11	6.47	-11

Table 8.4.2. Sole in VIId. RCT3 output (1 year olds)

Analysis by RCT3 ver3.1 of data from file :

S7DREC.TXT

7D Sole (1year olds),,,,,

Data for 4 surveys over 22 years : 1981 - 2002

Regression type = C

Tapered time weighting not applied
Survey weighting not applied

Final estimates shrunk towards mean
Minimum S.E. for any survey taken as .20
Minimum of 3 points used for regression

Forecast/Hindcast variance correction used.

Yearclass = 2000

	I-----------Regression----------I					I-----------Prediction---------I			
Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
yfs0,,	1.29	8.05	.86	.140	15	1.05	9.39	.976	.070
yfs1,,	2.59	8.55	.55	.348	15	.61	10.12	.607	.180
ebts1,	.58	9.10	.43	.378	12	2.31	10.45	.491	.275
ebts2,									
					VPA Mean =		10.03	.374	.475

Yearclass = 2001

	I-----------Regression----------I					I-----------Prediction---------I			
Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
yfs0,,	1.29	8.05	.86	.140	15	1.71	10.25	.957	.067
yfs1,,	2.59	8.55	.55	.348	15	1.08	11.33	.681	.132
ebts1,	.58	9.10	.43	.378	12	3.49	11.13	.552	.201
ebts2,	1.07	7.43	.50	.382	13	3.38	11.05	.615	.162
					VPA Mean =		10.03	.374	.438

Yearclass = 2002

	I-----------Regression----------I					**I-----------Prediction---------I**			
Survey/ Series	**Slope**	**Inter- cept**	**Std Error**	**Rsquare**	**No. Pts**	**Index Value**	**Predicted Value**	**Std Error**	**WAP Weights**
yfs0,,	**1.29**	**8.05**	**.86**	**.140**	**15**	**1.26**	**9.67**	**.963**	**.087**
yfs1,,									
ebts1,	**.58**	**9.10**	**.43**	**.378**	**12**	**2.01**	**10.27**	**.486**	**.340**
ebts2,									
					VPA Mean =		**10.03**	**.374**	**.574**

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
2000	24722	10.12	.26	.15	.35		
2001	40212	10.60	.25	.28	1.28		
2002	**23830**	**10.08**	**.28**	**.12**	**.18**		

Table 8.4.3 Sole in VIId. RCT3 output (2 year olds)

Analysis by RCT3 ver3.1 of data from file :

S7DREC2.TXT

7D Sole (2year olds),,,,,

Data for 4 surveys over 22 years : 1981 - 2002

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

Final estimates shrunk towards mean
Minimum S.E. for any survey taken as .20
Minimum of 3 points used for regression

Forecast/Hindcast variance correction used.

Yearclass = 2000

Survey/ Series	Regression: Slope	Inter- cept	Std Error	Rsquare	No. Pts	Prediction: Index Value	Predicted Value	Std Error	WAP Weights
yfs0,,	1.32	7.89	.89	.132	15	1.05	9.27	1.002	.066
yfs1,,	2.61	8.43	.55	.339	15	.61	10.02	.615	.175
ebts1,	.58	9.00	.42	.379	12	2.31	10.33	.488	.279
ebts2,									
						VPA Mean =	9.92	.372	.479

Yearclass = 2001

Survey/ Series	**Regression: Slope**	**Inter- cept**	**Std Error**	**Rsquare**	**No. Pts**	**Prediction: Index Value**	**Predicted Value**	**Std Error**	**WAP Weights**
yfs0,,	**1.32**	**7.89**	**.89**	**.132**	**15**	**1.71**	**10.14**	**.983**	**.063**
yfs1,,	**2.61**	**8.43**	**.55**	**.339**	**15**	**1.08**	**11.24**	**.690**	**.128**
ebts1,	**.58**	**9.00**	**.42**	**.379**	**12**	**3.49**	**11.01**	**.548**	**.202**
ebts2,	**1.05**	**7.36**	**.49**	**.388**	**13**	**3.38**	**10.93**	**.603**	**.168**
						VPA Mean =	**9.92**	**.372**	**.439**

Yearclass = 2002

Survey/ Series	Regression: Slope	Inter- cept	Std Error	Rsquare	No. Pts	Prediction: Index Value	Predicted Value	Std Error	WAP Weights
yfs0,,	1.32	7.89	.89	.132	15	1.26	9.55	.989	.082
yfs1,,									
ebts1,	.58	9.00	.42	.379	12	2.01	10.16	.483	.343
ebts2,									
						VPA Mean =	9.92	.372	.576

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
2000	22234	10.01	.26	.15	.35		
2001	**36025**	**10.49**	**.25**	**.28**	**1.27**		
2002	21421	9.97	.28	.12	.18		

Table 8.5.1 Sole in VIId
input data for catch forecast and linear sensitivity analysis

Label	Value	CV	Label	Value	CV
Number at age			Weight in the stock		
N1	23267	0.38	WS1	0.05	0.00
N2	36025	0.28	WS2	0.13	0.06
N3	27739	0.24	WS3	0.17	0.13
N4	15752	0.17	WS4	0.23	0.07
N5	8169	0.14	WS5	0.32	0.23
N6	1939	0.14	WS6	0.35	0.23
N7	2139	0.14	WS7	0.36	0.10
N8	870	0.13	WS8	0.41	0.31
N9	482	0.13	WS9	0.45	0.06
N10	187	0.15	WS10	0.44	0.11
N11	486	0.15	WS11	0.47	0.18
H.cons selectivity			Weight in the HC catch		
sH1	0.00	0.44	WH1	0.13	0.14
sH2	0.16	0.34	WH2	0.15	0.06
sH3	0.37	0.16	WH3	0.20	0.10
sH4	0.35	0.13	WH4	0.25	0.11
sH5	0.41	0.30	WH5	0.31	0.08
sH6	0.30	0.19	WH6	0.36	0.08
sH7	0.32	0.14	WH7	0.39	0.09
sH8	0.29	0.16	WH8	0.39	0.09
sH9	0.36	0.31	WH9	0.45	0.11
sH10	0.29	0.30	WH10	0.46	0.08
sH11	0.29	0.30	WH11	0.50	0.13
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
Relative effort in HC fishery			Year effect for natural mortality		
HF03	1.00	0.19	K03	1.00	0.10
HF04	1.00	0.19	K04	1.00	0.10
HF05	1.00	0.19	K05	1.00	0.10
Recruitment in 2004 and 2005					
R04	23267	0.38			
R05	23267	0.38			

Table 8.5.2 Sole in VIId.
Catch forecast output and estimates of coefficient of variation (CV) from linear analysis.

	Year 2003	2004						
Mean F Ages 3 to 8								
H.cons	0.34	0.14	0.20	0.27	0.34	0.37	0.40	0.41
Effort relative to 2002								
H.cons	1.00	0.40	0.60	0.80	1.00	1.10	1.18	1.20
Biomass								
Total 1 January	19.1	19.2	19.2	19.2	19.2	19.2	19.2	19.2
SSB at spawning time	13.3	15.3	15.3	15.3	15.3	15.3	15.3	15.3
Catch weight (,000t)								
H.cons	4.93	2.28	3.31	4.27	5.17	5.60	**5.93**	6.01
Biomass in year.... 2005								
Total 1 January		21.8	20.6	19.6	18.6	18.1	17.8	17.7
SSB at spawning time		17.9	16.8	15.7	14.7	14.3	13.9	13.8

	Year 2003	2004						
Effort relative to 2002								
H.cons	1.00	0.40	0.60	0.80	1.00	1.10	1.18	1.20
Est. Coeff. of Variation								
Biomass								
Total 1 January	0.11	0.13	0.13	0.13	0.13	0.13	0.13	0.13
SSB at spawning time	0.13	0.15	0.15	0.15	0.15	0.15	0.15	0.15
Catch weight								
H.cons	0.21	0.47	0.32	0.25	0.22	0.20	0.19	0.19
Biomass in year.... 2005								
Total 1 January		0.15	0.15	0.15	0.15	0.15	0.15	0.15
SSB at spawning time		0.17	0.17	0.17	0.17	0.17	0.17	0.17

Table 8.5.3 Sole in VIId.
Detailed forecast tables.

Forecast for year 2003
F multiplier H.cons=1.00

	Populations	Catch number	
Age	Stock No.	H.Cons	Total
1	23267	88	88
2	36025	4988	4988
3	27739	8207	8207
4	15752	4408	4408
5	8169	2634	2634
6	1939	482	482
7	2139	553	553
8	870	208	208
9	482	137	137
10	187	45	45
11	486	117	117
Wt	19	5	5

Forecast for year 2004
F multiplier H.cons=1.00

	Populations	Catch number	
Age	Stock No.	H.Cons	Total
1	23267	88	88
2	20969	2903	2903
3	27861	8243	8243
4	17320	4846	4846
5	10074	3248	3248
6	4896	1217	1217
7	1297	335	335
8	1411	337	337
9	590	168	168
10	306	73	73
11	456	109	109
Wt	19	5	5

Figure 8.3.1. Sole in Division VIId. Summary plots.

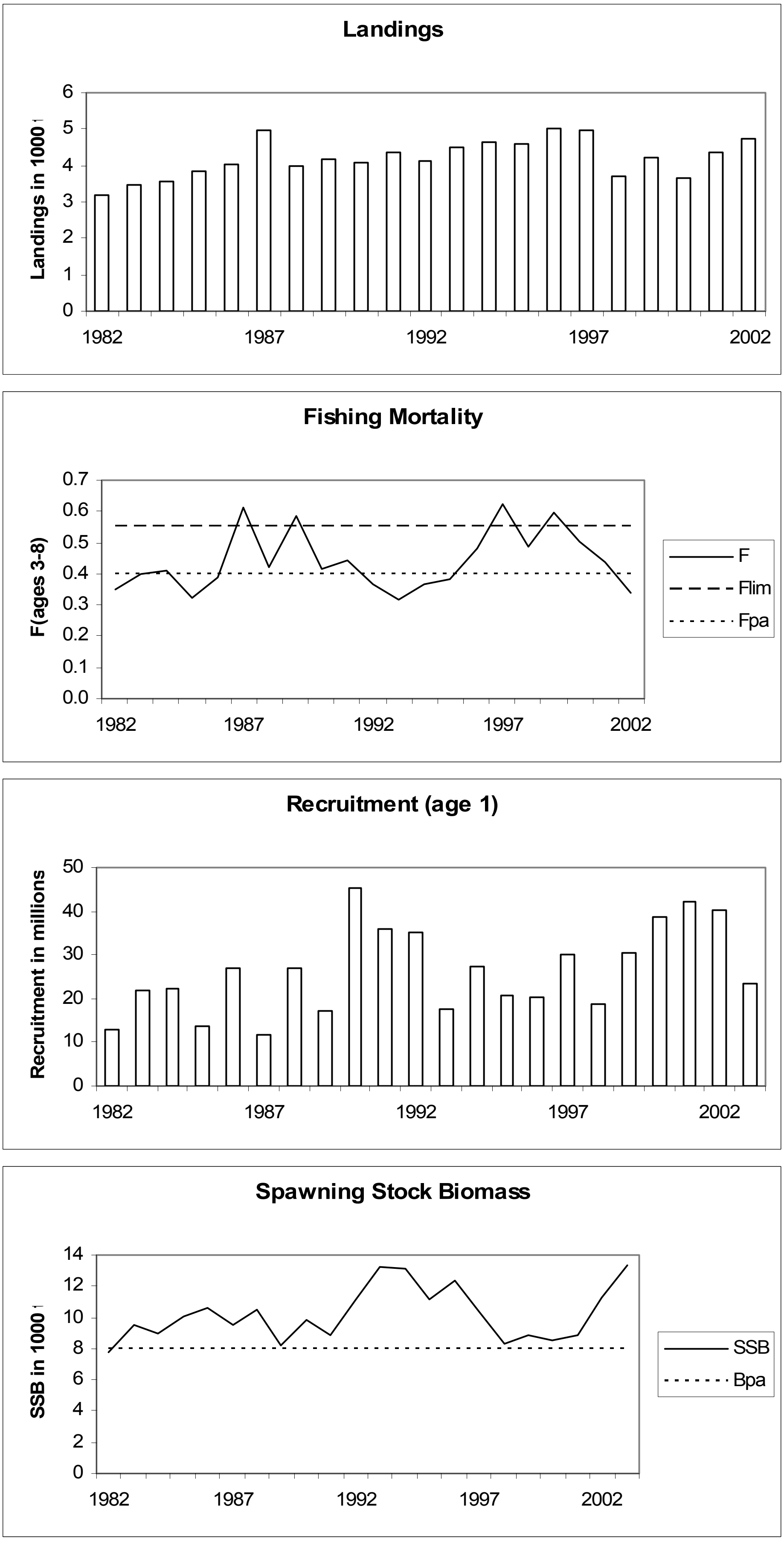
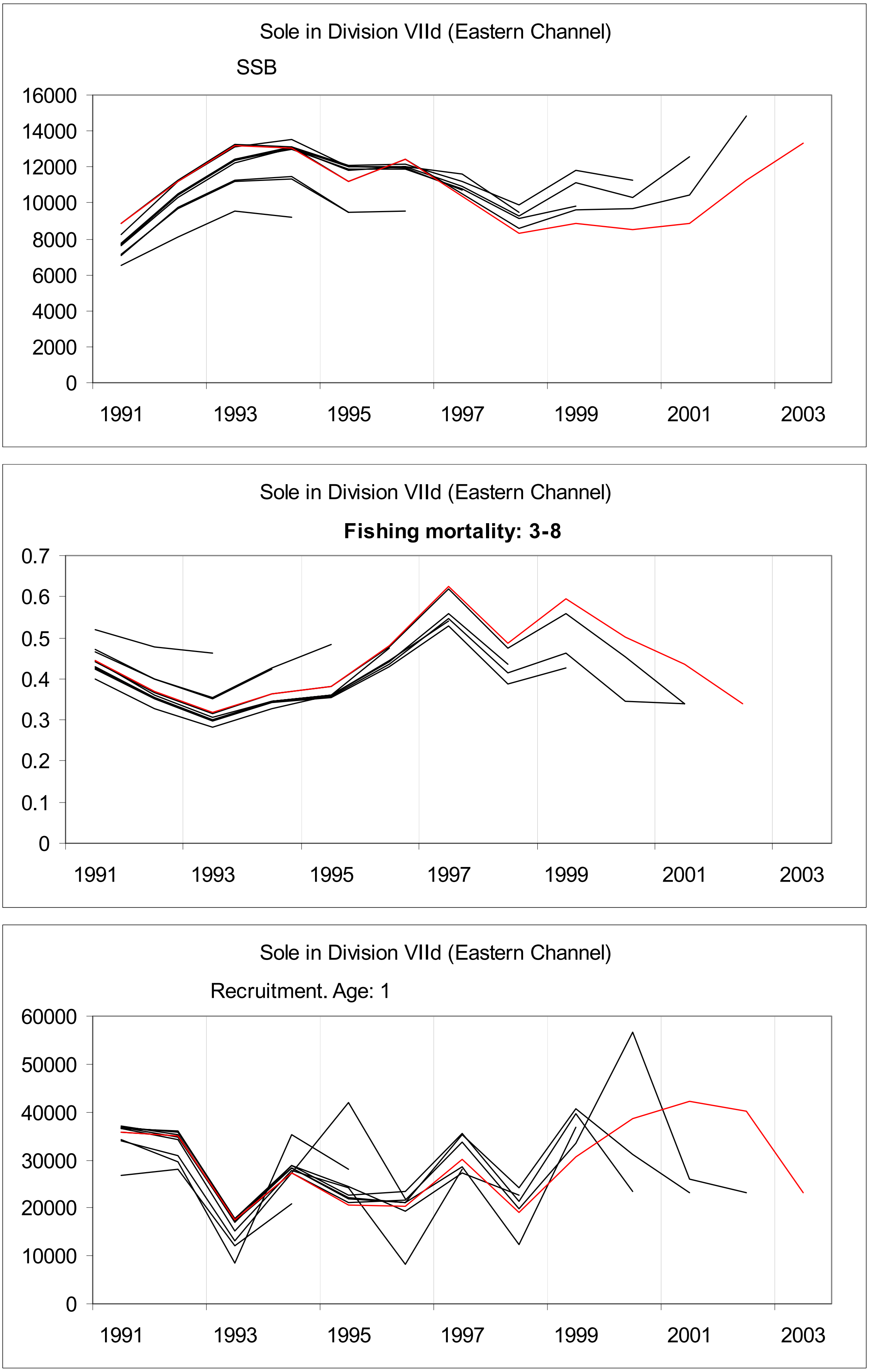


Figure 8.3.2 Sole in VIId. Historical performance



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 9.4.3).

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. The Dutch beam trawl fleet, one of the major operators in the mixed flatfish fishery in the North Sea, has seen a reduction in the number of vessels and also a shift towards two categories of vessels: 2000HP (the maximum engine power allowed) and 300 HP (the maximum engine power for vessels that are allowed to fish within the 12 mile coastal zone and the plaice box).

Approximately 70% of plaice landings from the UK (England and Scotland) quota is landed into the Netherlands by Dutch vessels fishing on the UK register. Vessels fishing under foreign registry are referred to as ‘flag’ vessels. As described in the 2001 report of this working group (ICES CM 2002/ACFM:01), the fishing pattern of flag vessels can be very different from that of other fleet segments.

9.1.1 ACFM advice applicable to 2002 and 2003

In the 2001 autumn session, ACFM 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 corresponding with a value below 0.3, which would correspond to a catch of less than 77,000 t in 2002.

In 2002 ACFM stated that the stock is still outside safe biological limits. SSB in 2002 is below $\mathbf{B}_{pa}$ and fishing mortality in 2001 was above $\mathbf{F}_{pa}$. ICES recommends that the fishing mortality be less than F = 0.23 in order to bring SSB above $\mathbf{B}_{pa}$ in 2004. This corresponds to landings of less than 60 000 t in 2003. This implies a reduction in fishing mortality of at least 40%. Management of fisheries taking plaice must respect the stringent restrictions on the catch and discard rates advised for cod, with effective monitoring of compliance with those restrictions**.**

9.1.2 Management applicable to 2002 and 2003

The TAC in 2002 was agreed at 77,000 tonnes, which was in line with the ACFM recommendation. For 2003 the TAC was set at 73,250, which is substantially higher than 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 is re-instigated every year and consists of the following elements:

1. *Every effort shall be made to maintain a minimum level of SSB greater than 210,000 tonnes ($\mathbf{B}_{lim}$)*

2. *For 2000 and subsequent years the Parties agreed to restrict their fishing on the basis of a TAC consistent with a fishing mortality of 0.3 for appropriate age groups as defined by ICES.*

3. *Should the SSB fall below a reference point of 300,000 tonnes ($\mathbf{B}_{pa}$), the fishing mortality referred to under paragraph 2, shall be adapted in the light of scientific estimates of the conditions then prevailing. Such adaptation shall ensure a safe and rapid recovery of SSB to a level in excess of 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 2001 included mesh size regulations, minimum landing size, gear restrictions and a closed area (the plaice box). Mesh size regulations for towed gears require that vessels fishing North of 55°N (or 56°N east of 5°E, since January 2000) should have a minimum mesh size of 100 mm, while to the south of this limit, where the majority the plaice fishery takes place, an 80 mm mesh is allowed. In the fishery with fixed gears a minimum mesh size of 100mm is required. In addition to this, since 2002 a small part of North Sea plaice fishery is affected by the additional cod recovery plan (EU regulation 2056/2001) that prohibits trawl fisheries with a mesh size <120mm in the area to the north of 56°N.

The minimum landing size of North Sea plaice is 27 cm. A closed area has been in operation since 1989 (the plaice box). Since 1995 this area was closed in all quarters. The closed area applies to vessels using towed gears, but vessels smaller than 300 HP are exempted from the regulation. An additional technical measure concerning the fishing gear is the restriction of the aggregated beam length of beam trawlers to 24 m. In the 12 nautical mile zone and in the plaice box the maximum aggregated beam-length is 9m.

9.1.3 The fishery in 2002

Landings

Total landings of North Sea plaice in 2002 (Table 9.1.1) were estimated by the WG to be just over 70 thousand tonnes, which is approximately 10 thousand tonnes lower than in the previous 3 years. The TAC was not taken in 2002.

The national uptake rates by the Netherlands (main plaice landing country) indicate that approximately 53% of the national quota was taken by the beginning of September 2003.

Discards

There are indications that the North Sea plaice stock has been subject to increased discarding in recent years. It has been suggested that the slow growth of the strong 1996 year class contributed to changes in discard patterns. This would have an impact on the catch at age matrix, thereby giving rise to an underestimate of fishing mortality. In 1999 a discard sampling programme was started to obtain discard estimates from the Dutch beam trawl fleet. However, the time series is too short to be incorporated in the assessment. Therefore, catch at age will be equated to landings at age in subsequent analyses. A qualitative assessment of the effects of discarding is presented in section 9.4.3.

9.2 Natural mortality, maturity, age compositions and mean weight at age

Natural mortality and maturity at age were the conventional values as used in previous assessments (Table 9.2.1). Maturity 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. Maturity at age is not likely to be constant over time. A recent study (Grift *et al.* 2003) has found that in North Sea plaice the age and length at maturation have decreased over the past half century. WD13 describes an ongoing international collaboration (under the name of COMPASS) to explore how to determine annually varying maturity ogives for North Sea flatfish from market and research samples, and the consequences of such ogives on the stock assessment and on the biological reference points. The explorations are preliminary and cannot yet be used for assessment purposes.

Market sampling programmes supplied age distributions representative for 68% of the official total landings in 2002. Age compositions by sex and quarter were available for the English and Dutch landings. Combined age compositions by quarter were available from Belgium, Denmark and France. The age composition of the landings is presented in Table 9.2.2 and Figure 9.2.1. No SOP-correction was applied to the results of the assessment.

The landings of the flag vessels were not sampled prior to 2002. From 2002 onwards, following EU regulation (1639/2001), each country is obliged to sample landings from foreign vessels that land in their country. However, as the market category data are not available, these catch data cannot be converted to age compositions. These landings and the landings from countries that do not provide age compositions, were raised to the international age composition.

Mean weights at age in the catch were estimated from market samples taken throughout the year (Table 9.2.3). Weights-at-age in the stock were first quarter weights (Table 9.2.4). Weight at age has varied considerably over time. For the most important age groups (4-6), weights appear to have decreased strongly (25 to 32%) in the past five years (Figure 9.2.2). A decrease in weights is also observed in the older age groups since 2000. These changes in weight at age in the older age groups affect the SSB estimates and the catch forecasts. The patterns clearly show a year effect as opposed to a year-class effect. The mean weight at age is mainly determined by the Dutch market sampling programme, but the decrease was observed in the Danish and English market samples as well (see Figure 9.2.3). Length at age data, which are only available for the English and Dutch samples, also indicate a decline since 1998. No apparent trends in the sex ratio clarify the observed changes in weight at age (Figure 9.2.4). These recent changes in weight at age can indicate a change in growth pattern. However, they may also be caused by a shift in the distribution of the fisheries.

9.3 Catch, effort and survey data

9.3.1 Commercial CPUE data

At the ACFM meeting in October 2001 the validity of the information provided by commercial tuning fleets was discussed and it was decided to exclude commercial tuning fleets from the assessment. A working document presented to ACFM October 2001 showed that *"The CPUE series of the Dutch beam trawl fleet and the new English beam trawl fleet (excluding flag vessels) are reasonably consistent, and show a decreasing trend in CPUE in the early 1990s. However, the time series of the English flag vessels show a different pattern of a more or less flat CPUE trend. The observed differences can be due to different spatial coverages by the different fleets or to different management measures applicable to the fleets. Therefore, CPUE data may rather reflect trends in management rather than trends in the stock."* (Pastoors *et al*. 2002). Poos *et al*. (2001) showed that the CPUE of individual vessels indeed declined when quota restrictions were more severe. The commercial CPUE data was again excluded from the assessment that is presented by this WG.

Although the commercial CPUE series are not included in the assessment as tuning fleets they are presented in this section to provide a full overview of the available data. The WG acknowledges that it may be important to monitor the developments in the fishery as they are shown by trends in CPUE from different fleet segments. One reason for this is that the perceptions of the fishermen will be driven by their catch rates. Discrepancies between the stock assessment results and their perceptions do need to be addressed by working groups and ACFM so that the overall results of the group can be understood by a wider group of people. Therefore the WG has evaluated a method to derive spatial based indices from commercial CPUE series in an attempt to remove the potential bias of TAC limited CPUE series. Furthermore the WG has examined the CPUE data of a subgroup of the flag vessels for which market-category data are available.

CPUE series that have previously been used for North Sea plaice assessment:

- NL commercial beam trawl CPUE
- UK commercial beam-trawl CPUE, excluding all flag vessels

CPUE series that have been made available to this WG:

- A spatial based CPUE index for a subgroup vessels within the NL beam trawl fleet (4-16 vessels)
- The CPUE of a subgroup of the Dutch flag vessels under UK registry (approx. 35 vessels)

The Dutch commercial beam-trawl CPUE consists of the total catch at age by the Dutch (beam trawl) fleet and the effort in horsepower days (days absent from port times the horsepower of the vessel). The effort series are estimated by the Agricultural Economics Institute (LEI-DLO), except for the final year, which is a preliminary estimate by the WG. The series are available for 1980 onwards and for the age 2 to 9.

The UK commercial beam-trawl CPUE is derived from the catch at age of the beam trawlers registered in England and Wales but excluding Scottish registered vessels and Dutch flag vessels. Effort was calculated on a trip basis as hours fishing multiplied by the horsepower (HP) of the vessel. The series is available for 1990 onwards and for the age 4 to 12.

For this WG, a working document was presented on the trends in CPUE data from a group of Dutch beam trawl vessels (NL registry) that have kept logbooks of haul-by-haul landings by species (WD 08). The data has been collected under collaborative projects between the Netherlands Institute of Fisheries Research and the Dutch fishing industry in the years 1993-1999. A similar collaboration has been re-instigated in September 2002 and is now still ongoing. The WD describes a method that has been applied with the attempt to remove the potential bias of TAC limited CPUE series by deriving an index of CPUE rather than an average CPUE. The CPUE for the group of vessels in each ICES rectangle and for each month was calculated by dividing total catch by total effort within a rectangle. Then the CPUE was averaged by month over all the rectangles that had been fished in that month. The average CPUE in a year was calculated as the average of CPUE of all months. The assumption of calculating the CPUE as an index is that the catch rate by rectangle are unlikely to be affected by TAC restrictions; restrictive TAC's would rather drive the directivity of the fishery to those rectangles where the catch rates are lower.

Results of the CPUE analysis are shown in Figure 9.3.1.1. The overall trend in CPUE from either the direct division of catch and effort and the index method do not appear to give very different perceptions on the developments of catch rates. The WG considers that the index method could be improved by defining index areas, which are covered by the fleet in most years.

A consultation with the Dutch fishing industry has also resulted in data being made available on catch rates of a group of so-called flag vessels. This information is based on all vessels that have landed in two major ports in the north of the Netherlands (Urk and Harlingen) and included data by market category. A preliminary analysis of the data has been carried out during the WG and is briefly summarized here. The group of vessels consists of around 35 vessels with engine powers of around 2000 HP. Figure 9.3.1.2 shows the trends in CPUE for the vessels based on the auction data. The data is compared to the official logbook data in the Netherlands and are found to be in close agreement. This fleet segment – which is directed towards plaice – has been able to keep relatively high catch rates over the whole period (1992-2002). In Figure 9.3.1.3, the same information is shown by market category. This figure indicates the overall contribution of the strong 1996 year-class to the CPUE in the different market categories. Furthermore, the CPUE of the largest plaice appears to have decreased over the course of the time series.

From the above information it appears that the conclusion from the working document presented to the ACFM meeting in October 2001 (=WD08 to WGNSSK2002) still holds: the signal in commercial CPUE is different for different fleet segments. The additional information of CPUE by market category does add to the possibility of interpreting the CPUE signal, notably the decrease in CPUE for the largest market category. The method of deriving an indexed CPUE does not appear to be successful at present. This could be improved by incorporating fixed index areas.

9.3.2 Survey data

CPUE series that have previously been used for North Sea plaice assessment:

- Beam Trawl Survey RV 'Isis' (BTS)
- Sole Net Survey in September-Oktober (SNS)
- Demersal Young Fish Survey (DFS)

New survey series available to the working group

- Beam Trawl Survey RV 'Tridens' (BTS-tri)
- Sole Net Survey in April-May (SNSQ2)

The Beam Trawl Survey (BTS & BTS-tri) was initiated in 1985 and was set up to obtain indices of the younger age groups of plaice and sole. However, due to its spatial distribution the BTS survey also catches considerable numbers of older plaice and sole. Initially, the survey only covered the south-eastern part of the North Sea (RV Isis). Since 1996 the survey area of the BTS has been extended. The RV Tridens now covers the north-western part of the North Sea (Figure 9.3.2.1). Both vessels use an 8-m beam trawl with 40 mm stretched mesh cod-end, but the Tridens beam trawl is rigged with a modified net. The BTS-Isis survey is used as a tuning series for the plaice assessment and consists of average catches in numbers by fishing hour. Previously age groups 1 to 4 were used for tuning the North Sea plaice assessment, but the age range has been extended to 1 to 9 in the revision done by ACFM in October 2001. This year the BTS-isis series was revised. The procedure to convert length distributions into age distributions was improved and database corrections were carried out. The changes in the indices series are minimal (Figure 9.3.2.2). The 2003 indices of the BTS and BTS-tri were not available to the working group, but preliminary indices will be made available to the ACFM meeting in October 2003.

The Sole Net Survey (SNS & SNSQ2) was carried out with RV Tridens until 1995 and then continued with the RV Isis. The gear used is a 6 m beam trawl with 40 mm stretched mesh cod-ends. The stations fished are on transects along or perpendicular to the coast (Figure 9.3.2.1). This survey is directed to juvenile plaice and sole. Ages 1 to 3 are used for tuning the North Sea plaice assessment, the 0-group index is used in the RCT3. Due to the timing of the working group the SNS was moved to spring in 2003. Until 1990 this survey was carried out in both spring and autumn. However, because of the gap in the spring series these data cannot be used in the plaice assessment or in RCT3.

The Demersal Young Fish Survey (DFS) is an international survey (The Netherlands, England, Belgium and Germany), which covers the coastal and estuarine areas of the southern North Sea. This survey is directed to 0 and 1-group plaice and sole. The area sampled by the Dutch survey is shown in Figure 9.3.2.1. In the Wadden Sea and Scheldt estuaries a light 3 meter beam trawl is used with a 20 mm cod-end and one light tickler chain. The coastal area is fished with a 6 m beam trawl rigged with a similar net as the 3 meter beam trawl. The combined index is calculated as mean of the national indices with a weighting by country, based on the size of the nursery area. In 1998 and 1999 no estimates of the DFS were available due to bad weather conditions during the period of the survey and technical problems with one of the Dutch research vessels. The combined DFS index is only used for the RCT3 analysis and not for tuning the VPA. The 2003 indices of the DFS were not available to the working group and will not be available before the ACFM meeting in October 2003.

The standardised CPUE of the commercial fleets and all surveys are plotted by age in Figure 9.3.2.3. All fleets indicate at some age that the 1996 and 1985 year classes are strong. The 2001 year class appears to be strong based on the SNSQ3 survey at age 0 and the BTS surveys at age 1. However the DFS survey at age 1 suggests that this year-class is one of the weakest year-classes on record. There are some indications that nowadays plaice move offshore at younger ages and smaller sizes compared to some years ago. Furthermore the increased visibility in estuarine waters may have affected the catchability of the larger fish. This will need further investigation to find out if the DFS is still suitable to estimate 1-group abundances.

For reasons previously discussed only the BTS(isis), BTS-tri and the SNS(Q3) are used as tuning fleets in the final assessment (Tabel 9.3.1).

9.4 Catch at age analyses

9.4.1 Data explorations

International catches-at-age data were examined using a separable VPA, with a reference age of 5, terminal F = 0.6 and terminal selectivity set to 0.5. The age range was set at 1-14 and the year range at 1993-2002. The diagnostics are presented in Table 9.4.1.1 and Figure 9.4.1.1. A dome-shaped selection pattern is apparent for plaice in the North Sea, with S declining from age 5 to approximately age 10, and thereafter remaining at more or less the same level. Residuals in log-catch ratios were low apart from age 1/2 in some years. No consistent trends could be detected.

Single fleet XSA runs were carried out for the BTS, BTS-tri and SNS, using a low F-shrinkage (1.5), no power model, no tuning window and no time taper. The age range was set at 1-15+ and the q-plateau at age 10, as in last years assessment. The tuning fleets provide information for ages 1-3 (SNS) and 1-9 (BTS and BTS-tri). Log-catchability residuals derived from these analyses are presented in Figure 9.4.1.2. No obvious trends were observed in the catchability residuals for the BTS and SNS. These surveys have high log-q residuals indicating noisy data. The new tuning fleet, BTS tridens, has high log-q residuals at age 1, because the survey area does not cover the mayor areas of distribution of 1-group plaice. Therefore age 1 is removed from this tuning fleet. The residuals at the older ages are relatively low compared to the other 2 tuning fleets.

The results of the single fleet XSA runs are presented in Figure 9.4.1.3 and compared to a high shrinkage multi-fleet run. The multi-fleet run includes all 3 surveys and F-shrinkage is set at 0.5, all other settings are the same as in the single fleet runs. Although the single fleet runs generate different signals on the overall pattern of SSB and Fbar(2-10), they all suggest a decrease in SSB and an increase in Fbar in the last 3 years. Note that tuning the VPA using only the SNS is not very reliable because only ages 1-3 are included in this survey. The low shrinkage single fleet runs all suggest a higher SSB and lower Fbar in the most recent years compared to a high shrinkage multi-fleet run.

Surba was used as a supplementary analysis tool to explore trends in survey index inferred SSB. Surba is a survey only method, which fits survey indices assuming a separable F selection pattern. Prior input of survey index to relative abundance ratios (q_a) are required for each age. Estimations of these parameters were based on exploratory runs, bounded by prior knowledge of likely survey catchability performance for each age. Estimated mean F cannot reasonably be relied upon due to bootstrap estimation of quantiles from residuals, but this method is especially good at elucidating trends in relative SSB. Summary plots are presented in Figure 9.4.1.4 and q_a values for each survey fitted (BTS-tri, BTS, SNS) are shown in Table 9.4.1.2. In Figure 9.4.1.5, the (fitted) relative SSB estimates are compared to the multi-fleet XSA run described above. Evidently estimating relative SSB using the SNS survey is useless because the SNS survey only includes indices for ages 1 to 3, comprising only a small proportion of the spawning stock. Although the BTS and BTS-tri include indices for the older ages, the relative SSB estimates appear to be driven by indices of the strong 1996 year class at younger ages. This indicates that the BTS and BTS-tri do not sample all ages sufficiently well to be able to produce survey only SSB estimates.

9.4.2 Model explorations

In previous years assessments the plus-group was set at 15+. However, since the commercial fleets have been removed from the assessment (in 2001) the survivor and F estimates at the older ages is mainly determined by F-shrinkage, because the survey provide poor (variable) information at the older ages and no information above age=9. The top panel in Figure 9.4.2.1 shows the relative weight of the fleets and shrinkage if an 'update' assessment would have been carried out. From age 8 upwards more than 50% of the estimation is based on F-shrinkage.

From the single fleet runs it became apparent that the new fleet (BTS tridens) is suitable tuning fleet to include in a multi-fleet XSA, despite the short time range. The middle panel in Figure 9.4.2.1 shows the relative weight of the fleets and shrinkage in the case that this new fleet is included and all other model settings remain unchanged. This change to the model brings down the weight of shrinkage in ages 6 to 10 to approximately 20%. In the older age groups the weight of shrinkage is still high, because the BTS-tridens series does not provide data for ages over 9.

High shrinkage in older ages is generally considered to be undesirable because the model outcome for these ages is then closer to a mean value than a VPA estimate, which makes the model insensitive to changes in fishing mortality (Fbar is set at 2-10). Therefore it was decided to decrease the age of the plus group. The most obvious choice is to set the plus group at age 10, as this corresponds to the age range covered by the BTS and the BTS-tridens surveys. But because the reliability of the survey indices at older ages declines due to small sample sizes, it can be argued that the plus group should be brought down further. Another aspect that should be taken into account is the position of the plus group in relation to the dome-shaped selection curve (see Figure 9.4.1.1). If the plus group is set close to the breakpoint in the selection curve than the estimated F may be biased by F-shrinkage at the oldest ages. In the 10+ scenario, little difference between the level of F was observed in a comparison between low shrinkage and high shrinkage runs, whereas a distinct difference was observed in the 9+ scenario. Therefore it was decided to set the plus-group at age 10 and to reduce the age range of F-shrinkage to 2.

The major changes in the model up to this point required re-evaluating the age at which catchability is related to year-class strength (power model) and the age at which catchabilty is constant (q-plateau). The appropriateness of the power model was tested (stepwise reduction of the ages using the power model) and it was decided that that there is no relationship between catchability of the recruiting ages and year-class strength. The slope seems to deviate from 1 at age 1 in the BTS, but this was considered to be doubtful due to high discarding of 1-group fish. To define the q-plateau, the mean log catchability based on a model with the q-plateau set at highest possible age was plotted (Figure 9.4.2.2). This plot shows that catchability increases with age to a plateau at the age of 6. Therefore the q-plateau was set at 6 in the final XSA run.

Finally, we examined the retrospective pattern to investigate if the level of shrinkage could be brought down. Figure 9.4.2.3 shows the retrospective pattern at a high (0.5) and low (2.0) level of F-shrinkage. The retrospective analysis can only be run for 3 years due to the short time series of the BTS-tridens fleet. F-shrinkage improves the retrospective pattern. It was concluded that F-shrinkage of 0.5 is required due to the noise in the survey indices, which are used to tune the XSA.

After these explorations we arrived at the final model described in section 9.4.4. For this model (at a F-shrinkage level of 0.5) the relative weight of shrinkage was less than 30 % at all ages (see bottom panel in Figure 9.4.2.1). As a consequence of reducing the age of the plus group to 10, Fbar 2-10 can no longer be estimated. We propose to set the new reference F at Fbar 2-6, so only the ages that are predominant in the catch are included.

In Figure 9.4.2.4 the results of the final run are compared to the results of last years assessment and some of the exploratory runs. Lowering the age of the plus group has an effect on the level of F and especially on the level of SSB (Figure 9.4.2.4 top right and bottom left panel). However the difference in levels does not appear to be constant over time. This is more evident when if the full year range is plotted (Figure 9.4.2.5 top panel and middle panel). Changing the reference F has an effect on both the level and the pattern of Fbar (Figure 9.4.2.4 top left panel and Figure 9.4.2.5 bottom panel).

Addition of the 2002 data has drastically changed our perception of the stock. The SSB in 2002 is now estimated at 142,300 tonnes which is slightly higher than the lowest point ever observed, whereas in last years catch forecast the SSB in 2002 was estimated at 250,000 tonnes. The conclusion that the SSB has decreased in the last 3 years to a level slightly above the lowest SSB ever observed is independent of which model is chosen, all models show very similar trends in the most recent years.

9.4.3 Sensitivity analysis

9.4.3.1 The effect of discarding on the stock assessment of North Sea plaice.

The catch numbers do not include discard data due to lack of sufficiently long time series of discard sampling programmes. We however do know that the level of discarding is high in plaice and may have increased in recent years. The sensitivity of the XSA results to discarding has been examined using 2 different modelling approaches.

Kraak *et al.* (2002) carried out a simulation study based on very simplified assumptions. Discard scenarios were compared to the assessment of North Sea plaice that was performed in 2002, one in which a constant level of discarding was assumed (50% by numbers), and one in which discarding increased over the last three years (from 50% to 80% by numbers). Accounting for discarding at a constant level, as expected, only re-scales the estimates. However, accounting for a recent increase in discarding does not only change the absolute values of the estimates but also the relative values: R, SSB, and F strongly increase towards the end of the time series.

An update of this study is presented in Figure 9.4.3.1. Two crude assumptions concerning discards are made: (1) in 1999 discarding has step-wise increased from a level of 50% to a level of 80% (percentage of the catch by numbers); (2) The age composition of discards is constant throughout the time series. The results are compared to the final XSA-run. The age composition is derived from a discard sampling programme carried out in 1999-2001 (Storbeck & Pastoors 2002). It is however unlikely that the age composition of discards has remained unchanged through time (see below). The assumption of 80% discarding since 1999 is realistic (Storbeck & Pastoors 2002), as is the assumption of 50% discarding in the 1970s and 80s (Van Beek 1998), but discard rates in other periods are unknown. Although this simulation is crude it clearly shows increased discard rates will have affected our perception of SSB and F. Increased discarding will result in an underestimation SSB and F compared to a period with lower discard rates. However the magnitude of the bias cannot be estimated due to lack of sufficiently long time series of discard data.

Van Keeken *et al.* (2003, WD05) investigated the hypothesis that variability in annual and cohort growth rates affects the potential to be selected by the fishery and the potential to be discarded, and thereby causes a variable bias in the assessment. Simulated populations were constructed, derived from mean length at age data obtained from otolith back-calculations and from two distinct surveys (BTS and SNS). Selection ogives and discarding (sorting) ogives were derived from the literature. Two different selection ogives were explored: for 80 mm and for 60 mm mesh size. The minimum mesh size allowed for beam trawling in the southern North Sea is 80 mm. The selection by 60 mm mesh size was explored because there are indications that liners are regularly used by commercial beam trawlers, which may substantially reduce the effective mesh size. The selection and discarding ogives were used to estimate discard proportions at age, given the simulated populations. Quarterly catch at age numbers were then calculated from the quarterly landings at age using these discard proportions at age. Unfortunately, 1-group plaice could not be included in the analysis because the landings of this age group were often zero. This is a serious shortcoming because the 1-group is an important part of the discards and natural mortality is assumed to be relatively low. Compared to the (scanty) observer trips, otolith back-calculations give an apparent underestimation of proportions discarded and the surveys an overestimation (Figure 9.4.3.2). Figure 9.4.3.3 shows the simulated proportion discarded assuming a 80mm mesh size fishery. The inclusion of estimated discards in the assessment increases the perceived values of F on young ages, but this increase is not constant over all years, reflecting the variable bias in the assessment. The variability in discarding affects estimates of recruitment and SSB mainly when recruitment is high. The effects are much stronger with the 60 mm than with the 80 mm mesh size simulations (Figure 9.4.3.4). Discarding mainly appears to impact on our perception of F, SSB, and R, during periods of high recruitment. This can be understood because high recruitment (associated with slow growth) causes more young fish to be vulnerable to the fishery and an extension of the discard phase.

Both studies point in the same direction: variable discarding causes a variable bias in the assessment. The second study shows that variable discarding may be a function of variable growth. The magnitude of the bias appears to be lower in the second study, but this is due to the fact that 1-group discarding is not included. Although these simulation studies clearly show that the absence of discard data may have a serious effect on the plaice assessment, they cannot substitute the final assessment, because the magnitude of the bias in each year cannot yet be determined. However when evaluating the quality of the assessment the potential effect of discarding should be taken into account.

9.4.3.2 ICA analyses including SBB indices from commercial fleet segments.

The commercial CPUE data have been removed from the assessment because of potential bias caused by TAC constraints (see section 9.3.1). This however leaves us with survey indices, which are noisy and less reliable for the older age groups. The coverage of the older age groups has improved after including the new survey fleet (BTS tridens), and the model has been adjusted to the age range covered by the surveys (10+ group in stead of a 15+ group). Nevertheless, unbiased CPUE series, which target older age groups would certainly improve the North Sea plaice assessment.

Three commercial CPUE series have been made available to the WG as aggregated biomass indices: a spatial based CPUE index for a subgroup vessels within the NL beam trawl fleet (4-16 vessels), and two CPUE series of a subgroup of the Dutch flag vessels under UK registry (approx. 35 vessels): either for the whole year or for the first half year only. All three CPUE series were not been included in the final assessment for reasons discussed in detail in section 9.3.1. Furthermore, both CPUE series are not age structured (which is required for a XSA analysis), although in future it should be possible to convert the flag vessel data to age structured data because of the additional information on CPUE by market category.

ICA allows tuning by SBB indices, besides age-structured indices. To test the sensitivity of the final XSA run, an ICA analyses was carried out using these CPUE series and the (age structured) indices obtained from the BTS, BTS-tri and SNS. The number of years for separable analysis was set at 6, the age range was set at 1-15+, the reference at 4 and manual weighting of the indices was applied.

The SSB estimates of the ICA assessment are presented in Figure 9.4.3.5 and compared to the results of 3 XSA runs: last years assessment, this years final run (age range 1-10+) and an exploratory run called ‘fleet addition’(age range 1-15+, see section 9.4.2). The ICA results are very similar to the comparable ‘fleet addition’ XSA run. Figure 9.4.3.5b shows the residual patterns of the commercial fleets as SSB indices. All three commercial indices show similar patterns in residuals indicating that the catching opportunities in the commercial fleets appear to be different from the stock reconstruction. The positive residuals in recent years suggest that the commercial fleets experiences larger stock sizes than in the assessment. However, in 2003 only the flagvessels still showed positive residuals where the other fleets show negative residuals.

9.4.3.3 Fishermen’s survey

Skippers were asked to compare the state of their catch in January to June 2003 with the same period in 2002. Findings were based upon the catch not the landings. The skippers were asked to describe the catch rates (less, the same or more than last year), the size range (mostly small, all sizes, mostly large) and the discard rates (less, the same or more than last year). Questionnaire returns were received from skippers of vessels registered in Belgium, Denmark, England, the Netherlands, Scotland and Sweden. A total of 348 views were collected on the state of plaice catches (all gear types combined). The area covered by this survey was subdivided into 10 zones, 8 within the North Sea and 2 in subdivision IIIa. Figure 9.4.3.6 shows the overall results of the fishermen’s survey and the results segregated into 3 regions.

Overall the catch rates appear to have remained unchanged: 40% catch the same, 30% catch less and 30% catch more than last year. However if these results are split up by region, a clear increase in catch rates in subdivion IIIa is observed. In the south-eastern North Sea the average catch rates appear have declined slightly, whereas in the rest of the North Sea the average catches rates remain unchanged. These results correspond to the CPUE data presented in section 9.3.1. The Dutch beam trawl vessels mainly fish in the south-eastern North Sea and these vessels observe a decline in their CPUE (Figure 9.3.1.1), whereas the flag vessels fish further north-west and have been able to maintain a relatively stable CPUE (Figure 9.3.1.2).

The views of the skippers on the size range of plaice indicate the larger specimens are scarce in all regions. This corresponds to the age composition observed in the market samples (Figure 9.2.1). The majority of the catch consists of 2 to 6 year old fish.

In the North Sea, there appears to be a tendency towards less discarding in 2003 compared to 2002. This may be related to the fact that the strong (slow growing) 1996 year class no longer dominates the discards. The subsequent year classes have been much weaker, resulting in lower numbers of under-sized fish. We however do not have the 2003 discard sampling data available yet to compare with the fishermen’s survey.

9.4.4 Final assessment

The settings of the final XSA assessment are given in the text table below.

North Sea Plaice final assessment settings

year of assessment	2002 (sub-group)					2003				
		years	age	alpha	beta		years	age	alpha	beta
fleets	BTS	1985-2001	1-9	0.660	0.750	BTS	1985-2002	1-9	0.660	0.750
	SNS	1982-2001	1-3	0.660	0.750	SNS	1982-2002	1-3	0.660	0.750
						BTS-tri	1996-2002	1-9	0.660	0.750
plus group	15					10				
first tuning year	1982					1982				
last data year	2001					2002				
time series weights	no taper					no taper				
Catchability dependent on stocksize for age<	1					1				
Catchability independent of age for ages >=	10					6				
Survivor estimates shrunk towards the mean F	3 years / 5 ages					5 years / 2 ages				
s.e. of the mean	0.5					0.5				
Minumum standard error for pop Estimates	0.3					0.3				
Prior weighting	not applied					not applied				
Number of iterations	28					49				
Convergence	Yes					Yes				

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 will not be used in RCT3, due to age reading problems in that year.

Diagnostics of the final run are presented in Table 9.4.4.1. Figure 9.4.4.1 shows the log catchability residuals for the tuning fleets in the final run. Fishing mortality and stock numbers are shown in Tables 9.4.4.2 and 9.4.4.3. Weighting of the different data sources in the assessment is shown in Figure 9.4.2.1 (bottom panel). The surveys account for most of the weight on all ages.

The retrospective analysis is shown in Figure 9.4.2.3 (left panels) and was carried out by chopping off one year at the end and without a tuning window. The retrospective analysis can only be run for 3 years due to the short time series of the BTS-tridens fleet. The analysis does not show a clear retrospective pattern in fishing mortality, but a systematic overestimation of SSB seems to occur,

9.5 Recruitment estimates

Input to the RCT3 analysis is presented in Table 9.5.1. Results for ages 1 to 2 are presented in Tables 9.5.2 – 9.5.3. The Geometric mean recruitment is 395 million and the arithmetric mean is 424 million.

The 2001 year class in 2003 (at age 2) is estimated at 297 million in XSA and 396 in RCT3. All but the international DFS (‘comb’) at age 1 survey indices estimate this year class to be above average (354 million), and therefore the RCT3 estimate was used for further analysis (80% of the weight is coming from the surveys).

The 2002 year class in 2003 (at age 1) is poorly estimated by the RCT3 analysis (only two available indices, which gave very different estimates). The long term GM for this year class was used for further analysis.

For the 2003 and subsequent year classes the long term GM was used as there were no estimates.

The text table below summarises the year class strength estimates that have been used.

Year class	At age in 2003	XSA	RCT3	GM 57-00	Accepted Estimate
2001	2	296719	396233	353703	RCT3
2002	1	-	350650	394687	GM 1957-00
2003 & subsequent	recruits	-	-	394687	GM 1957-00

9.6 Historical stock trends

Figure 9.6.1 shows the trends in landings, mean Fbar(2-6), SSB and recruitment since 1957. The landings have gradually increased up to the late 1980s and rapidly declined until 1996, in line with the decrease in TAC. The landings have levelled off in the most recent years.

Fishing mortality increased until the late 1990s and reached its highest observed estimate in 1997. Current fishing mortality (0.53) remains high and is estimated to be well 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 around 270 kt in the early 1980s. Due to the recruitment of the strong year classes 1981 and 1985, SSB again increased to a peak in 1989 followed by a rapid decline (up to 1997). SSB remains low in the most recent years.

Except for the occurrence of strong year classes (1963, 1981, 1985 and 1996), 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 is estimated to be strong, while the 2000 year class is one of the lowest observed.

9.7 Short term prognosis

The input for the short term forecast is given in Table 9.7.1. Weight at age in the stock and weight at age in the catch are taken as the average over the last 3 years. The exploitation pattern was taken as the mean value of the last three years and scaled to the average F over 2002 (0.51). Population numbers at ages 3 and older are XSA survivor estimates. Numbers at age 2 are estimated from RCT3. Numbers at age 1 and recruitment of the 2003 year class are taken from the long term geometric mean (1957-2000)

A management option table for status quo fishing mortality in 2003 in presented in Table 9.7.2. Detailed tables for F status quo are given in Table 9.7.3. A detailed deterministic plot of the catch forecast is given in Figure 9.7.1. At status quo fishing mortality in 2003 and 2004 the SSB is expected to be at around 149,000 tonnes in 2004 and 166,000 tonnes in 2005.

The yield at status quo F is expected to be around 71,000 tonnes in 2003, about 24% lower than the predicted value for 2003 from last years status quo forecast. The status quo catch prediction for 2003 is slightly lower than the TAC for 2003 (73,250 tonnes). The yield in 2004 is predicted to be 75,200 tonnes at status quo F.

A sensitivity analysis has been carried out to identify the different sources of uncertainty underlying the predictions (Figure 9.7.2). Most of the variability (89%) of the SSB in 2005 is explained by the uncertainties of the year classes 2001 to 2003 estimates.

The probability profiles relative to the short term forecast are given in Figure 9.7.3. At the current yield of around 70,000 tonnes, the probability that F is higher that $\mathbf{F}_{sq}$ is around 35%. The probability that SSB will stay below 210,000 tonnes is predicted to be about 80%.

9.8 Medium term prognoses

A 10 year average was used for the catch weight at age and stock weight at age. A constrained Shepherd stock recruit curve was used to fit the model. The estimated parameters and the residuals from the fit were exported to the input-file for the WGTERMC program. Figure 9.8.1 shows the stock-recruitment fit and the medium term forecasts at $\mathbf{F}_{sq}$. There is a high probability (90%) that the SSB remains under 240,000 tonnes over the medium time period.

Figure 9.8.2 shows the probability of SSB to remain below 300,000 tonnes over the next 10 years. At F=0.3, the probability of remaining below 300,000 tonnes is around 35% in 2012.

9.9 Reference points

9.9.1 Biological reference points

In this benchmark assessment some major changes were made compared to previous assessments. The plus group has been brought down from 15+ to 10+ and the reference F has been changed from F_{bar}(2-10) to F_{bar}(2-6). Therefore the reference points are likely to have changed (see Figure 9.4.2.5). The estimated biological reference points are presented in the text table below and Figure 9.9.1.

Reference point	Deterministic	Median	75th percentile	95th percentile	Hist SSB < ref pt %	
MedianRecruits	372349	369554	396055	404123		
MBAL	0				0.00	
Bloss	134383					
SSB90%R90%Surv	283254	284006	305869	338111	32.61	
SPR%ofVirgin	8.39	8.46	9.42	10.90		
VirginSPR	5.57	5.56	6.20	7.46		
SPRloss	0.55	0.51	0.57	0.65		
	Deterministic	Median	25th percentile	5th percentile	Hist F > ref pt %	
FBar	0.51	0.50	0.48	0.44	26.09	
Fmax	0.23	0.23	0.21	0.17	95.65	
F0.1	0.11	0.11	0.10	0.08	100.00	
Flow	0.18	0.20	0.18	0.16	100.00	
Fmed	0.33	0.30	0.28	0.25	67.39	
Fhigh	0.53	0.56	0.48	0.42	10.87	
F35%SPR	0.11	0.12	0.10	0.09	100.00	
Floss	0.43	0.46	0.41	0.36	45.65	

$\mathbf{B}_{loss}$ (SSB in 1997) is now estimated to be 134 383 tonnes, whereas in last year's assessment it was estimated at 144,440 tonnes. Note that $\mathbf{B}_{loss}$ was the basis for setting $\mathbf{B}_{lim}$ at 210,000 tonnes.

$\mathbf{F}_{max}$ is revised downwards from 0.24 to 0.23. $\mathbf{F}_{med}$ is revised downwards from 0.35 to 0.33. $\mathbf{F}_{high}$ is revised downwards from 0.68 to 0.53.

Figures 9.9.2-5 give respectively a stock recruitment plot with a LOWESS smoother and reference points, a plot of YPR and SPR curves and reference points, a plot of historical SSB against F_{bar} with an equilibrium curve based on the LOWESS stock recruitment relationship, and a plot of historical yield against F_{bar} with an equilibrium curve based on the LOWESS stock recruitment relationship.

9.9.2 PA reference points

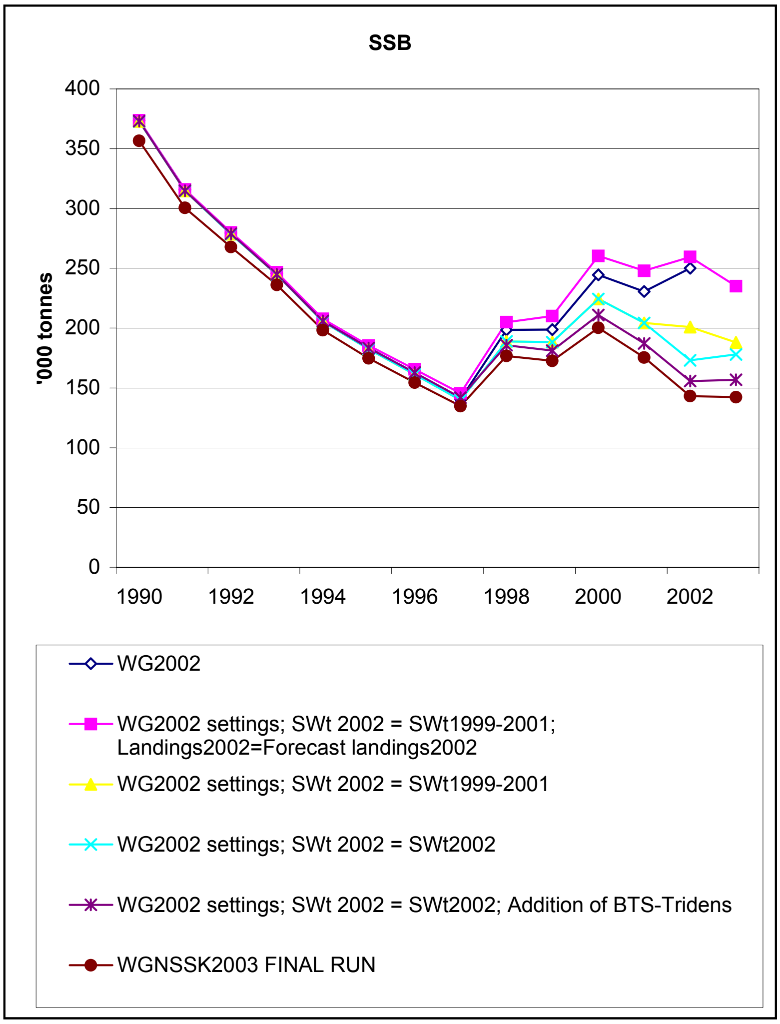
In the report of the SGPRP (ICES 2003) North Sea plaice was classified as having no S/R signal and a distinct plateau (wide range of SSB). The segmented regression for North Sea plaice presented by SGPRP (ICES 2003) is not significant, and "the WG is requested to evaluate a change in reference points for North Sea plaice based on an updated version of $\mathbf{B}_{loss}$".

Furthermore, $\mathbf{F}_{lim}$ and $\mathbf{F}_{pa}$ need to be re-established because the current assessment changed the age range for the reference F from 2-10 to 2-6.

The revision of PA reference points is discussed in section 16 of this report.

9.10 Quality of the assessment

9.10.1 Comparison between WG2002 assessment with the new WG2003 assessment for North Sea plaice



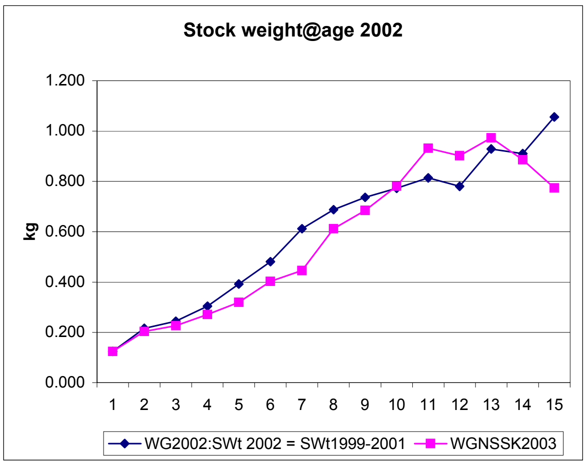
The current assessment gives a rather different perspective of stock development compared to the ACFM advice from October 2002. The SSB in 2002 is now estimated at 142,300 tonnes, which is slightly higher than the lowest point ever observed, whereas in last years catch forecast the SSB in 2002 was estimated at 250,000 tonnes. In this section, the contribution of different sources of data and model assumptions to this difference in perception are investigated by adjusting the input data and model settings of the assessment. Four main elements are explored: landings in 2002, weights at age, inclusion of the BTS-Tridens survey and model formulation.

- landings in 2002

In the ACFM 2002 forecast for plaice in the North Sea, a status quo fishing mortality was assumed for 2002. This gave predicted landings in 2002 of around 95,000 tonnes. The TAC in 2002 was 77,000 tonnes and the WG estimate of landings was 70,000 tonnes. In a first scenario, the WG estimate of landings at age in 2002 was multiplied by a factor of 1.3 in order to generate total landings of around 95,000 tonnes. In this scenario we used the average stock weight at age of 1999-2001 for 2002. The results in terms of SSB are very close to the WG2002 assessment. This indicates that the stock may have been overestimated by a factor of 30%.

- weights at age

In the second scenario, we used the observed landings in 2002, however, we still used the mean weights at age of 1999-2001 instead of the mean weights of 2002. This is because the forecast provided in 2002 was based on an average weight at age of 1999-2001. This provides an estimate of SSB in 2002 of 200,000 tonnes, which is 50,000 tonnes below the estimate of ACFM 2002. When instead we used the observed mean weight at age in 2002, the estimate is further reduced to 173,000 tonnes. The declining trend in mean weight at age has continued and this has a noticeable effect on the SSB estimates.



- incorporation of BTS-Tridens survey

The next scenario used the observed 2002 weight at age, but we here introduced the BTS-Tridens index as an additional source of calibration data. The reason for including the BTS-Tridens survey are explained more fully in section 9.4.2. The inclusion of the BTS-Tridens survey gave an estimate of SSB in 2002 of 155,000 tonnes.

- model formulation

The last scenario is actually the final run proposed by the WG in 2003. Here the model formulation has been substantially changed to remove the undesirable effects of shrinkage. This has been achieved by reducing the plusgroup to age 10, application of a catchability plateau at age 6 and the usage of shrinkage over 2 ages (instead of 5). In this case the SSB estimate for 2002 is 143,000 tonnes.

From the above analysis it is shown that the largest effect on the SSB estimates is generated by the addition of the 2002 catch at age data (46%). The second largest effect was generated by the (low) mean weights at age in 2002 (26%). Finally, the addition of the new BTS-Tridens (16%) and the new model formulation (12%) have a relatively low contribution to the re-estimate of the SSB in 2002. The main features of the new stock estimates are the strength of the 1996 yearclass and the low estimates of fishing mortality on the youngest ages.

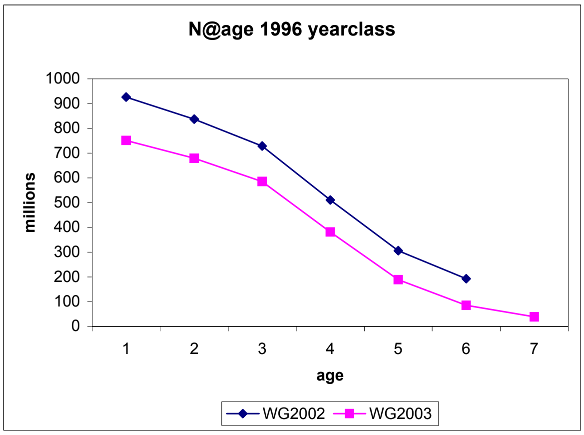
The strength of the 1996 yearclass was initially estimated from the research surveys only. When the landings at age from this yearclass were lower than expected from the abundance, this was interpreted by the model as a low fishing mortality on the youngest ages and the most recent years (see text table below). So the model predicted high stock-numbers of the 1996 yearclass and low F's.

Run title : Plaice in IV
At 30/09/2002 15:35
Terminal Fs derived using XSA (With F shrinkage)

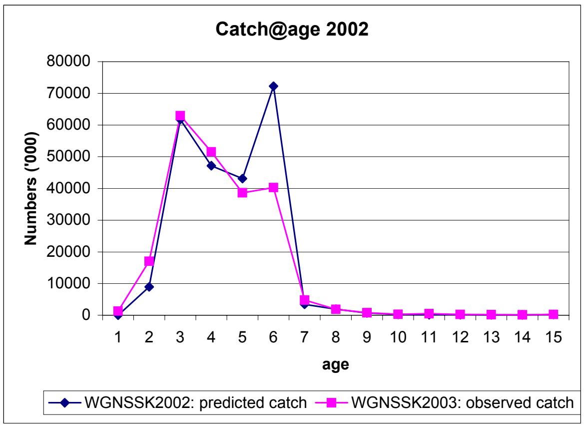
Table 8 Fishing mortality (F) at age

YEAR	1996	1997	1998	1999	2000	2001
1	0.005	0.001	0.001	0.002	0.009	0.017
2	0.170	0.223	0.039	0.033	0.080	0.153
3	0.553	0.544	0.587	0.255	0.184	0.362
4	0.755	0.808	0.729	0.714	0.413	0.299
5	0.752	0.932	0.746	0.708	0.567	0.361
6	0.669	0.737	0.665	0.694	0.581	0.516
7	0.674	0.622	0.588	0.601	0.424	0.541
8	0.550	0.453	0.471	0.508	0.411	0.385
9	0.517	0.494	0.367	0.517	0.366	0.427
10	0.528	0.442	0.350	0.397	0.311	0.372
11	0.360	0.386	0.281	0.304	0.197	0.264
12	0.364	0.452	0.362	0.319	0.356	0.362
13	0.326	0.471	0.366	0.322	0.250	0.348
14	0.423	0.458	0.350	0.360	0.280	0.333
15	0.423	0.458	0.350	0.360	0.280	0.333
F2-10	0.574	0.584	0.505	0.492	0.371	0.380

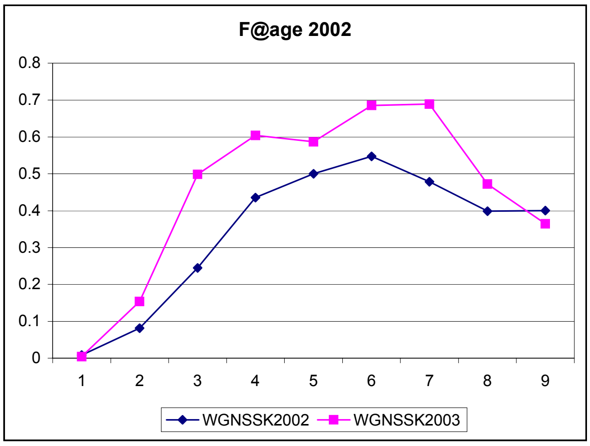
In the most recent assessment, additional catch at age data has become available (2002) in which the 1996 yearclass (at age 6) was again lower than expected from the surveys. The catches of this yearclass have now for a number of years been lower than expected from the surveys. As additional data is available on the catches, the effects of the catches on the perception of the cohort becomes more important compared to the survey information. Therefore the strength of the 1996 yearclass has been brought more in line with the signal from the catches and therefore this yearclass is now estimated substantially lower than in previous years. Consequently, the fishing mortality on the youngest ages and recent years is estimated to be higher compared to the estimates from last year.



The comparison of the catch at age in 2002 from the ACFM forecast of 2002 and WG2003 are shown in the graph below. This graph indicates that the forecast was based on a high contribution of the 1996 yearclass in the catches which has not materialized in the data that was available to WGNSSK in 2003.



Also the fishing mortality at age in 2002 is substantially higher than assumed by ACFM in it's 2002 advice.



Conclusion

It is shown above that the difference in perception between this year's assessment SSB estimates. and last year's assessment is mainly driven by the addition of the 2002 catch data. The second largest effect was caused by the decrease in mean weight at age. The catch data of 2002 has caused a re-evaluation of the strength of the important 1996 yearclass, which is now estimated to be substantially lower than estimated last year.

9.10.2 Other remarks concerning the quality of the assessment

The observed decrease in SSB in the last 3 years appears to be robust to the use of different models. Essentially this means that the 2002 data included in this years assessment all point in the same direction. Despite the similarity of the outcome of the different model settings, the WG thinks the XSA model settings used in this years assessment are an improvement compared to previous years settings (see section 9.4.2).

The North Sea plaice stock assessment generally shows a retrospective pattern in which the SSB is overestimated and F underestimated in the current year. This pattern clearly still exists for SSB but is less evident for F when F-shrinkage is used. At low F-shrinkage both SSB and F show a strong retrospective pattern.

The quality of the catch-at-age data are questionable. The catch numbers do not include discard data due to lack of a sufficiently long time series of discard sampling programmes. Discarding is known to be high in plaice and may have increased in recent years. In this years assessment, the sensitivity of the XSA results to the lack of discard data was tested using simulated discard data. It was shown that in periods slow growth, discarding may increase, and this may impact the estimates of fishing mortality, recruitment and to a lesser extend SSB (see section 9.4.3.1).

The commercial CPUE data have been removed from the assessment because of potential bias caused by TAC constraints (see section 9.3.1). This however leaves us with survey indices, which are noisy and less reliable for the older age groups (see section 9.4.1). The coverage of the older age groups has improved after including a new survey fleet, and the model has been adjusted to the age range covered by the surveys (see section 9.4.2). But because of the noise in the survey-tuning fleets, F-shrinkage is set at a relatively high value (0.5). The disadvantage of choosing a high level of shrinkage is that the assessment will react slowly to changes in the fishery. Therefore, additional information on the older fish would improve the North Sea plaice assessment.

Table 9.1.1 North Sea plaice. Nominal landings (tonnes) in Sub-area IV as officially reported to ICES

YEAR	1995	1996	1997	1998	1999	2000	2001	2002	2003
Belgium	7093	5765	5223	5592	6160	7260	6369	4859	
Denmark	13358	11776	13940	10087	13468	13408	13797	12552	
France	442	379	254	489	624	547	429	548	
Germany	6329	4780	4159	2773	3144	4310	4739	3927	
Netherlands	44263	35419	34143	30541	37513	35030	33290	29081	
Norway	527	917	1620	965	643	883	1926	1996	
Sweden	3	5	10	2	4	3	3	2	
UK (E/W/NI)	15801	13541	13789	11473	9743	13131	11025	8504	
UK (Scotland)	8594	7451	8345	8442	7318	7579	8122	8236	
Others				1					
Total	96410	80033	81483	70365	78617	82151	79700	69705	
Unallocated	1946	1640	1565	1169	2045	-1001	2263	512	
WG estimate	**98356**	**81673**	**83048**	**71534**	**80662**	**81150**	**81963**	**70217**	
TAC	115000	81000	91000	87000	102000	97000	78000	77000	73250

Table 9.2.1 North Sea plaice: natural mortality and maturity at age

Age	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Natural mortality	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Maturity	0	0.5	0.5	1	1	1	1	1	1	1	1	1	1	1	1

Table 9.2.2 North Sea plaice, catch numbers at age

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

YEAR	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
AGE										
1	0	0	0	0	0	0	3	76	19	2233
2	4340	14708	9858	4144	5982	9474	15017	17294	29591	36528
3	21471	40486	42202	65009	30304	40698	45187	51174	48282	62199
4	76926	64735	53188	51488	112917	38140	36084	56153	33475	52906
5	54364	57408	43674	36667	41383	123619	35585	40686	26059	23043
6	31799	37091	30151	27370	22053	17139	102014	35074	22903	16998
7	12848	15819	18361	16500	16175	10341	10410	78886	16913	14380
8	6833	6595	8554	10784	8004	10102	6086	6311	29730	10903
9	7047	3980	4213	6467	6728	3925	8192	4185	6414	18585
+gp	16592	16886	17587	14928	11175	13365	16092	14840	16910	15651
0 TOTALNUM	232220	257708	227788	233357	254721	266803	274670	304679	230296	253426
TONSLAND	107118	110540	97143	101834	108819	111534	121651	130342	113944	122843
SOPCOF %	102	101	101	102	102	103	106	97	103	103

YEAR	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
AGE										
1	1268	2223	981	2820	3220	1143	1318	979	253	3334
2	31733	23120	28124	33643	56969	60578	58031	64904	100927	47776
3	59099	55548	61623	77649	43289	62343	118863	133741	122296	209007
4	73065	42125	31262	96398	66013	54341	48962	77523	57604	69544
5	42255	41075	25419	13779	83705	50102	47886	24974	35745	28655
6	13817	19666	21188	9904	9142	35510	39932	17982	12414	16726
7	8885	8005	11873	9120	5912	5940	24228	13761	9564	7589
8	9848	6321	5923	6391	5022	3352	4161	8458	8092	5470
9	6084	5568	4106	2947	4061	2419	2807	1864	4874	4482
+gp	23978	21980	19695	12552	9191	7468	9288	5377	5903	8653
0 TOTALNUM	270032	225631	210194	265203	286524	283196	355476	349563	357672	401236
TONSLAND	130429	112540	108536	113670	119188	113984	145347	139951	139747	154547
SOPCOF %	105	104	106	103	100	96	100	101	102	101

YEAR	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
AGE										
1	1214	108	121	1674	0	0	1261	1550	1461	3410
2	119695	63252	73552	67125	85123	15146	46757	32533	43266	43954
3	115034	274209	144316	163717	115951	250675	105929	97766	83603	85120
4	99076	53549	185203	93801	111239	74335	231414	110997	116155	72494
5	29359	37468	32520	84479	64758	47380	52909	159814	72961	72703
6	12906	13661	15544	24049	34728	25091	19247	26757	77557	33406
7	8216	6465	6871	9299	11452	16774	10567	8129	14910	29547
8	4193	5544	3650	4490	4341	5381	7561	4216	5233	6970
9	3013	2720	2698	2733	2154	3162	2120	3451	3141	3200
+gp	8287	6565	5798	6950	5478	6233	5580	3808	5591	6928
0 TOTALNUM	400993	463541	470273	458317	435224	444177	483345	449021	423878	357732
TONSLAND	144038	156147	159838	165347	153670	154475	169818	156240	148004	125190
SOPCOF %	99	98	98	99	99	98	99	98	96	98

YEAR	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
AGE										
1	3461	1394	7751	1104	892	196	549	2634	4509	1323
2	53949	45148	36575	42496	42855	30401	8689	15819	35886	16998
3	98375	101617	81398	64382	86948	68920	155971	39550	52480	62996
4	72286	80236	78370	46359	43669	56329	39857	164330	48238	51544
5	51405	38542	36499	32130	22541	16713	24112	14993	89949	38625
6	29001	20388	17953	14460	13518	6432	6829	9343	6836	40247
7	13472	15323	9772	10605	6362	4986	2783	2130	4418	4796
8	11272	6399	4366	4528	3632	2506	2246	1030	1127	1870
9	3645	5368	2336	2624	2179	1761	1521	940	637	765
+gp	5883	5433	3753	4892	4181	3119	3093	2097	2309	1628
0 TOTALNUM	342749	319848	278773	223580	226777	191363	245650	252866	246389	220792
TONSLAND	117113	110392	98356	81673	83048	71534	80662	81148	81963	70217
SOPCOF %	98	97	99	98	99	98	99	97	99	98

Table 9.2.3 North Sea plaice, catch weights at age (kg)

Table 2 Catch weights at age (kg)

YEAR		1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
AGE											
	1	0	0	0	0	0	0	0.217	0.315	0.256	0.246
	2	0.253	0.25	0.242	0.232	0.232	0.267	0.294	0.286	0.318	0.296
	3	0.286	0.273	0.282	0.27	0.279	0.298	0.31	0.318	0.356	0.352
	4	0.319	0.312	0.321	0.348	0.322	0.331	0.333	0.356	0.403	0.428
	5	0.399	0.388	0.385	0.436	0.425	0.366	0.359	0.419	0.448	0.493
	6	0.533	0.487	0.471	0.484	0.547	0.517	0.412	0.443	0.514	0.541
	7	0.624	0.628	0.539	0.559	0.597	0.59	0.573	0.499	0.542	0.608
	8	0.667	0.7	0.663	0.624	0.662	0.596	0.655	0.672	0.607	0.646
	9	0.715	0.737	0.726	0.69	0.738	0.686	0.658	0.744	0.699	0.674
+gp		1.0281	1.0049	0.8866	0.9332	0.9781	0.9109	0.8934	0.8916	0.8906	0.9388
SOPCOFAC		1.0193	1.0075	1.0057	1.0182	1.0198	1.0291	1.0582	0.9744	1.0331	1.0283

YEAR		1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
AGE											
	1	0.272	0.285	0.249	0.265	0.254	0.244	0.235	0.238	0.237	0.279
	2	0.316	0.311	0.3	0.295	0.323	0.315	0.311	0.286	0.274	0.262
	3	0.344	0.354	0.33	0.338	0.353	0.369	0.349	0.344	0.329	0.311
	4	0.405	0.405	0.42	0.375	0.38	0.397	0.388	0.401	0.416	0.424
	5	0.486	0.476	0.495	0.513	0.418	0.438	0.429	0.473	0.505	0.514
	6	0.539	0.554	0.587	0.594	0.556	0.491	0.474	0.545	0.558	0.608
	7	0.605	0.609	0.636	0.641	0.647	0.609	0.55	0.588	0.604	0.664
	8	0.627	0.693	0.703	0.705	0.721	0.687	0.675	0.662	0.642	0.712
	9	0.677	0.707	0.783	0.741	0.715	0.776	0.796	0.772	0.725	0.738
+gp		0.8417	0.9256	1.0187	0.9802	0.9781	0.9498	0.9603	1.013	1.0072	0.9838
SOPCOFAC		1.0508	1.0369	1.0624	1.0254	1.0016	0.9643	0.9983	1.0136	1.0175	1.0062

YEAR		1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
AGE											
	1	0.2	0.233	0.247	0.221	0.221	0.221	0.236	0.271	0.227	0.251
	2	0.25	0.263	0.264	0.269	0.249	0.254	0.28	0.285	0.286	0.263
	3	0.3	0.283	0.29	0.304	0.3	0.278	0.309	0.298	0.294	0.29
	4	0.383	0.375	0.337	0.347	0.351	0.352	0.332	0.317	0.306	0.318
	5	0.515	0.491	0.462	0.425	0.402	0.453	0.392	0.366	0.365	0.341
	6	0.604	0.613	0.577	0.488	0.504	0.512	0.533	0.447	0.455	0.425
	7	0.677	0.684	0.678	0.675	0.583	0.608	0.603	0.597	0.528	0.531
	8	0.771	0.725	0.729	0.751	0.728	0.699	0.67	0.692	0.671	0.605
	9	0.815	0.837	0.804	0.853	0.829	0.813	0.792	0.761	0.747	0.715
+gp		0.9838	1.0347	1.0213	1.0132	0.9901	1.0144	0.9427	1.004	0.9206	0.891
SOPCOFAC		0.9938	0.9844	0.9799	0.9877	0.9875	0.9848	0.9854	0.9846	0.9634	0.9818

YEAR		1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
AGE											
	1	0.249	0.229	0.272	0.24	0.208	0.152	0.245	0.228	0.238	0.22
	2	0.273	0.263	0.277	0.28	0.271	0.26	0.253	0.267	0.267	0.243
	3	0.289	0.286	0.301	0.307	0.313	0.31	0.28	0.284	0.292	0.268
	4	0.326	0.339	0.338	0.355	0.364	0.394	0.355	0.314	0.309	0.297
	5	0.356	0.397	0.402	0.42	0.457	0.497	0.455	0.432	0.365	0.33
	6	0.423	0.449	0.454	0.486	0.524	0.607	0.547	0.5	0.482	0.419
	7	0.518	0.502	0.528	0.499	0.603	0.633	0.63	0.684	0.592	0.496
	8	0.631	0.611	0.611	0.589	0.616	0.695	0.682	0.71	0.708	0.662
	9	0.721	0.732	0.734	0.72	0.683	0.7	0.752	0.751	0.795	0.74
+gp		0.8558	0.9066	0.9081	0.8576	0.9242	0.9141	0.813	0.8873	0.8006	0.8781
SOPCOFAC		0.9767	0.9738	0.9935	0.9846	0.992	0.9842	0.986	0.9711	0.9901	0.9775

Table 9.2.4 North Sea plaice, stock weights at age derived from first quarter catch weights

Table 3 Stock weights at age (kg)

YEAR	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
AGE										
1	0.141	0.141	0.141	0.141	0.141	0.141	0.175	0.175	0.175	0.175
2	0.2	0.2	0.2	0.2	0.203	0.2	0.203	0.25	0.248	0.274
3	0.232	0.228	0.246	0.243	0.246	0.265	0.258	0.261	0.305	0.321
4	0.29	0.276	0.274	0.301	0.281	0.301	0.297	0.311	0.363	0.401
5	0.378	0.373	0.333	0.403	0.442	0.344	0.344	0.369	0.413	0.473
6	0.54	0.477	0.43	0.455	0.528	0.532	0.39	0.41	0.489	0.534
7	0.663	0.645	0.516	0.503	0.585	0.592	0.565	0.468	0.512	0.579
8	0.788	0.673	0.601	0.565	0.65	0.362	0.621	0.636	0.583	0.606
9	0.882	0.845	0.722	0.581	0.703	0.667	0.679	0.732	0.696	0.655
+gp	1.2523	1.2325	0.9089	0.9844	0.9848	0.8873	0.8575	0.8964	0.8769	0.9293

YEAR	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
AGE										
1	0.175	0.17	0.17	0.17	0.16	0.15	0.15	0.15	0.15	0.15
2	0.264	0.234	0.275	0.217	0.25	0.242	0.243	0.229	0.25	0.242
3	0.322	0.304	0.294	0.281	0.309	0.336	0.303	0.307	0.282	0.265
4	0.38	0.375	0.417	0.332	0.364	0.367	0.363	0.372	0.378	0.381
5	0.468	0.437	0.483	0.484	0.405	0.411	0.414	0.444	0.473	0.49
6	0.521	0.524	0.544	0.55	0.551	0.467	0.459	0.524	0.536	0.589
7	0.566	0.57	0.61	0.593	0.627	0.547	0.543	0.582	0.57	0.631
8	0.583	0.629	0.668	0.658	0.69	0.63	0.667	0.651	0.624	0.679
9	0.617	0.652	0.704	0.694	0.667	0.704	0.764	0.778	0.707	0.726
+gp	0.8036	0.8519	0.9429	0.9307	0.9384	0.9431	1.0044	1.0582	1.0328	0.9809

YEAR	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
AGE										
1	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.131	0.131
2	0.211	0.203	0.208	0.195	0.194	0.212	0.215	0.245	0.208	0.262
3	0.248	0.242	0.243	0.253	0.265	0.238	0.248	0.272	0.263	0.266
4	0.329	0.338	0.31	0.336	0.33	0.315	0.282	0.281	0.275	0.3
5	0.494	0.464	0.452	0.44	0.401	0.426	0.362	0.342	0.34	0.316
6	0.559	0.571	0.536	0.533	0.503	0.467	0.484	0.421	0.4	0.402
7	0.624	0.649	0.635	0.692	0.573	0.547	0.553	0.555	0.463	0.501
8	0.712	0.692	0.656	0.779	0.711	0.644	0.616	0.648	0.64	0.575
9	0.754	0.787	0.764	0.888	0.747	0.706	0.759	0.713	0.658	0.696
+gp	0.9173	1.0288	1.0114	1.0919	0.9843	0.9732	0.8836	0.991	0.853	0.8739

YEAR	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
AGE										
1	0.131	0.131	0.124	0.124	0.124	0.124	0.124	0.124	0.124	0.124
2	0.257	0.222	0.245	0.245	0.217	0.205	0.211	0.224	0.213	0.204
3	0.264	0.249	0.265	0.282	0.254	0.269	0.251	0.236	0.247	0.227
4	0.301	0.302	0.311	0.329	0.342	0.362	0.346	0.29	0.273	0.271
5	0.328	0.366	0.401	0.39	0.442	0.471	0.436	0.409	0.331	0.319
6	0.391	0.41	0.451	0.464	0.491	0.578	0.524	0.468	0.452	0.403
7	0.491	0.467	0.52	0.49	0.563	0.588	0.591	0.687	0.56	0.446
8	0.595	0.548	0.607	0.572	0.586	0.657	0.68	0.742	0.641	0.612
9	0.646	0.679	0.705	0.689	0.684	0.676	0.696	0.707	0.798	0.685
+gp	0.86	0.871	0.8496	0.8782	0.9032	0.8698	0.8274	0.8971	0.8297	0.8729

Table 9.3.1 North Sea plaice: tuning fleets

Plaice in the North Sea (Area IV)

	103										
BTS											
		1985	2002								
		1	1	0.66	0.75						
		1	9								
	1	115.577	179.898	38.813	11.843	1.371	1.048	0.362	0.167	0.098	0.246
	1	660.199	131.772	51.003	8.886	3.285	0.428	0.338	0.129	0.038	0.211
	1	225.822	764.285	33.065	4.773	2.039	1.017	0.352	0.087	0.072	0.314
	1	577.319	140.105	173.719	9.241	2.594	0.775	0.421	0.036	0.115	0.22
	1	428.699	319.272	38.66	47.305	5.85	0.822	0.289	0.661	0.144	0.096
	1	112.063	102.639	55.674	22.78	5.572	0.801	0.205	0.379	0.261	0.165
	1	185.442	122.051	28.553	11.86	4.264	5.691	0.259	0.231	0.118	0.102
	1	171.538	125.93	27.314	5.62	3.184	2.662	1.136	0.259	0.053	0.091
	1	124.762	179.103	38.399	6.116	0.931	0.812	0.636	0.444	0.173	0.085
	1	145.212	64.217	35.242	10.875	2.857	0.638	0.861	0.957	0.401	0.032
	1	252.168	43.622	14.235	8.106	1.195	0.868	0.357	1.135	0.223	0.119
	1	218.284	212.134	22.882	4.834	3.717	0.919	0.047	0.173	0.131	0.118
	1	-11	-11	19.914	2.788	0.219	0.39	0.171	0.121	0	0.034
	1	338.198	436.197	47.413	8.906	1.44	0.755	0.145	0.078	0.105	0.087
	1	305.874	130.001	182.54	3.656	2.109	0.137	0.139	0.029	0.032	0.085
	1	278.776	75.219	31.594	24.21	0.613	0.174	0.539	0.029	0.019	0.055
	1	225.784	78.903	19.557	10.049	9.525	0.294	0.15	0.041	0.043	0.192
	1	568.654	45.463	15.365	5.501	2.683	1.427	0.083	0.14	0	0.113
SNS											
		1982	2002								
		1	1	0.66	0.75						
		1	3								
		1	70108	8503	1146						
		1	34884	14708	308						
		1	44667	10413	2480						
		1	27832	13789	1584						
		1	93573	7558	1155						
		1	33426	33021	1232						
		1	36672	14430	13140						
		1	37238	14952	3709						
		1	24903	7287	3248						
		1	57349	11149	1507						
		1	48223	13742	2257						
		1	22184	9484	988						
		1	18225	4866	884						
		1	24900	2786	415						
		1	24663	10377	1189						
		1	-11	-11	1393						
		1	33391	29431	5739						
		1	35188	9235	14347						
		1	23028	2489	905						
		1	10193	2416	356						
		1	30265	1047	264						
BTS	Tridens										
	1996	2002									
	1	1	0.66	0.75							
	2	9									
	1	5.576	4.39	3.307	2.388	1.841	0.83	0.479	0.177	0.495	
	1	-11	10.355	3.96	2.837	1.927	0.463	1.123	0.447	0.59	
	1	30.786	9.969	5.521	2.705	1.349	0.899	0.782	0.327	0.448	
	1	8.292	36.931	6.462	2.649	2.133	0.6	0.764	0.333	0.169	
	1	9.453	12.736	17.227	2.936	1.893	1.076	0.954	0.247	0.621	
	1	6.926	9.051	7.224	7.646	1.204	0.691	0.48	0.593	0.605	
	1	14.405	10.724	7.611	4.262	4.132	0.519	0.629	0.358	0.779	

Table 9.3.1 (cont.) North Sea plaice: tuning fleets (not used in the assessment)

NL Beam Trawl
1989 2002
1 1 0.0 1.0
2 9

72.5	40443	73696	131915	23064	9634	5240	2715	947
71.1	21956	60038	49862	76521	12187	3682	1790	1161
68.5	27501	42376	53152	30697	34092	6879	1954	1137
71.1	24271	44306	31854	27165	12219	9485	2464	993
76.9	27552	46536	31333	19705	10984	6040	3611	1025
81.4	30194	48106	35901	15371	7938	6174	2866	1929
81.2	22519	43505	33883	14453	6575	3418	1549	931
72.1	26600	27628	20922	13980	5313	3644	1366	944
72	23098	45655	18156	6884	4337	2016	975	460
70.3	15288	32486	26751	6389	2290	1359	669	314
67.3	4341	76295	18251	11058	2999	998	833	506
67.7	8973	16995	72228	5789	3880	735	336	214
61.4	16227	22535	19715	40807	2745	1759	390	196
56.4	10034	32616.3	21689.5	14223.1	16567	1047.7	565.2	156.2

FLT02: English Beam trawl excl Flag vessel landings
1990 2002
1 1 0.00 1.00
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
105.0	3574	1657	1475	1020	620	332	378	287	143
82.9	1105	1579	890	836	543	388	207	274	163
76.3	1253	844	1066	599	686	505	211	148	229
68.8	1623	892	617	598	347	415	317	134	110
68.6	1011	1045	457	327	367	258	224	193	98
57.8	3655	865	575	255	141	201	108	103	146
54.1	794	2436	481	336	134	93	112	49	91
30.6	716.3	636.8	906.2	156.7	125.5	42.8	52.9	46.2	41.2

Table 9.4.1.1 North Sea Plaice: Separable VPA output

Title : Plaice in IV

At 17/09/2003 9:23

Separable analysis
from 1993 to 2002 on ages 1 to 14
with Terminal F of .600 on age 5 and Terminal S of .500

Initial sum of squared residuals was 159.581 and
final sum of squared residuals is 13.641 after 60 iterations

Matrix of Residuals

Years	1993/94	1994/95	1995/96	1996/97	1997/98	1998/99	1999/2000	2000/2001	2001/2002
1/ 2	0.47	-0.493	1.343	-0.676	-0.731	-0.783	-0.581	0.439	1.655
2/ 3	0.484	0.293	0.588	0.372	0.456	-0.488	-0.571	0.018	0.585
3/ 4	-0.001	-0.171	0.439	0.185	0.093	0.455	-0.331	-0.178	-0.038
4/ 5	-0.201	-0.278	0.17	-0.091	0.013	0.179	0.123	0.075	-0.389
5/ 6	-0.114	-0.522	-0.005	-0.158	0.087	0.014	-0.126	0.046	-0.02
6/ 7	-0.255	-0.406	-0.273	-0.067	-0.038	0.077	0.207	0.116	-0.361
7/ 8	-0.142	0.114	-0.037	0.18	-0.115	0.018	0.01	-0.027	0.114
8/ 9	0.126	0.142	-0.037	0.105	-0.058	-0.028	0.14	0.058	-0.113
9/10	-0.259	0.194	-0.304	0.014	-0.016	-0.232	0.188	-0.024	0.085
10/11	0.042	0.076	-0.235	0.202	0.077	-0.021	0.296	0.106	-0.457
11/12	0.449	0.344	0.379	0.054	0.161	0.135	-0.069	-0.215	-0.013
12/13	-0.235	0.071	-0.15	-0.471	-0.164	-0.073	-0.214	-0.008	0.46
13/14	0.391	0.251	-0.498	-0.387	0.113	0.027	-0.121	-0.2	0.182

Table 9.4.1.2 North Sea Plaice: Input values to Surba: Survey to relative abundance ratio (q) for each survey.

$$N_{a,y}^{relative} = q_a * I_{a,y}$$

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
BTS - Tridens	1.0	1.0	1.0	1.0	1.0	1.0	1.0	*	*			
BTS	1.0	1.0	1.0	1.0	1.0	1.0	0.99	0.78	0.5			
SNS	1.0	1.0	1.0									

* ages 8 and 9 removed due to inherent noise in signal

Table 9.4.4.1 North Sea Plaice: Final XSA output

Lowestoft VPA Version 3.1

15/09/2003 22:31

Extended Survivors Analysis

Plaice in IV

CPUE data from file fleet

Catch data for 46 years. 1957 to 2002. Ages 1 to 10.

Fleet	First year	Last year	First age	Last age	Alpha	Beta
BTS	1985	2002	1	9	.660	.750
SNS	1982	2002	1	3	.660	.750
BTS Tridens	1996	2002	2	9	.660	.750

Time series weights :

Tapered time weighting not applied

Catchability analysis :

Catchability independent of stock size for all ages

Catchability independent of age for ages >= 6

Terminal population estimation :

Survivor estimates shrunk towards the mean F
of the final 5 years or the 2 oldest ages.
S.E. of the mean to which the estimates are shrunk = .500
Minimum standard error for population
estimates derived from each fleet = .300
Prior weighting not applied

Tuning converged after 49 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	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
1	.013	.006	.026	.005	.001	.001	.002	.011	.034	.004
2	.172	.206	.197	.171	.223	.048	.039	.077	.184	.154
3	.453	.494	.607	.552	.548	.589	.329	.221	.349	.498
4	.586	.726	.785	.746	.802	.740	.718	.603	.407	.604
5	.737	.633	.769	.778	.904	.735	.730	.574	.695	.587
6	.684	.649	.606	.707	.793	.623	.673	.617	.496	.685
7	.614	.850	.662	.786	.693	.679	.534	.402	.590	.689
8	.572	.590	.548	.656	.602	.572	.662	.340	.342	.472
9	.619	.522	.392	.664	.680	.584	.728	.569	.324	.365

XSA population numbers (Thousands)

	AGE								
YEAR	1	2	3	4	5	6	7	8	9
1993	2.86E+05	3.60E+05	2.84E+05	1.71E+05	1.04E+05	6.16E+04	3.09E+04	2.72E+04	8.31E+03
1994	2.39E+05	2.55E+05	2.74E+05	1.63E+05	8.64E+04	4.49E+04	2.81E+04	1.51E+04	1.39E+04
1995	3.22E+05	2.15E+05	1.88E+05	1.51E+05	7.15E+04	4.15E+04	2.12E+04	1.09E+04	7.58E+03
1996	2.50E+05	2.84E+05	1.60E+05	9.27E+04	6.25E+04	3.00E+04	2.05E+04	9.89E+03	5.68E+03
1997	7.51E+05	2.25E+05	2.17E+05	8.32E+04	3.98E+04	2.60E+04	1.34E+04	8.44E+03	4.64E+03
1998	2.66E+05	6.79E+05	1.63E+05	1.13E+05	3.38E+04	1.46E+04	1.06E+04	6.05E+03	4.19E+03
1999	2.48E+05	2.41E+05	5.86E+05	8.18E+04	4.89E+04	1.47E+04	7.08E+03	4.88E+03	3.09E+03
2000	2.51E+05	2.24E+05	2.09E+05	3.81E+05	3.61E+04	2.13E+04	6.76E+03	3.75E+03	2.28E+03
2001	1.43E+05	2.24E+05	1.87E+05	1.52E+05	1.89E+05	1.84E+04	1.04E+04	4.09E+03	2.42E+03
2002	3.29E+05	1.25E+05	1.69E+05	1.20E+05	9.15E+04	8.53E+04	1.01E+04	5.22E+03	2.63E+03

Estimated population abundance at 1st Jan 2003

0.00E+00	2.97E+05	9.73E+04	9.27E+04	5.91E+04	4.60E+04	3.89E+04	4.60E+03	2.95E+03

Taper weighted geometric mean of the VPA populations:

3.85E+05	3.42E+05	2.85E+05	1.85E+05	1.03E+05	5.38E+04	2.91E+04	1.68E+04	1.00E+04

Standard error of the weighted Log(VPA populations) :

.4244	.4395	.4217	.4560	.5245	.5860	.6335	.6776	.7331

Log catchability residuals.

Fleet : BTS

Age	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	99.99	99.99	-1.17	-.29	-.53	.37	.41	-.91	-.42	-.50
2	99.99	99.99	-.14	-.31	.52	-.37	.46	-.34	-.11	-.10
3	99.99	99.99	-.27	.04	-.33	.33	-.40	-.02	-.32	-.26
4	99.99	99.99	-.39	-.29	-.72	-.24	.42	.46	-.14	-.54
5	99.99	99.99	-.61	-.23	-.32	.13	.59	-.32	.18	-.01
6	99.99	99.99	.25	-.76	-.34	-.16	.03	-.42	.88	.83
7	99.99	99.99	.02	-.24	-.20	-.52	-.42	-.73	-.85	.10
8	99.99	99.99	-.08	-.31	-1.00	-1.70	.58	.45	.07	-.15
9	99.99	99.99	-.19	-.72	-.15	.01	.36	.20	-.03	-.51

Age	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
1	-.48	-.15	.12	.21	99.99	.59	.56	.46	.82	.89
2	.28	-.38	-.60	.68	99.99	.45	.27	-.18	-.06	-.05
3	.10	.08	-.37	.23	-.21	.97	.85	.05	-.23	-.26
4	-.30	.43	.25	.19	-.21	.60	.02	.29	.19	-.03
5	-.92	.31	-.28	1.00	-1.30	.63	.64	-.40	.77	.15
6	-.26	-.21	.15	.60	-.05	1.07	-.61	-.79	-.20	-.02
7	.14	.70	-.03	-1.93	-.28	-.23	.04	1.34	-.24	-.73
8	-.12	1.25	1.72	.01	-.23	-.36	-1.07	-1.03	-.77	.30
9	.15	.41	.34	.29	99.99	.32	-.47	-.80	-.21	99.99

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

Age	1	2	3	4	5	6	7	8	9
Mean Log q	-7.1820	-7.6913	-8.6235	-9.4602	-10.1077	-10.4263	-10.4263	-10.4263	-10.4263
S.E(Log q)	.6083	.3745	.3955	.3770	.6095	.5476	.7106	.8458	.4000

Regression statistics :

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

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
1	2.65	-2.178	-2.06	.10	17	1.45	-7.18
2	.79	1.494	8.74	.78	17	.29	-7.69
3	.91	.505	8.99	.65	18	.37	-8.62
4	1.02	-.107	9.41	.68	18	.40	-9.46
5	.98	.092	10.14	.52	18	.61	-10.11
6	.90	.551	10.45	.63	18	.50	-10.43
7	1.30	-.846	10.89	.33	18	.88	-10.65
8	.63	1.661	10.05	.55	18	.50	-10.56
9	.67	2.895	9.87	.84	16	.22	-10.49

1

Fleet : SNS

Age	1982
1	-.19
2	.03
3	-.43
4	No data for this fleet at this age
5	No data for this fleet at this age
6	No data for this fleet at this age
7	No data for this fleet at this age
8	No data for this fleet at this age
9	No data for this fleet at this age

Age	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	-.33	-.11	-.45	-.10	-.30	-.24	.10	-.27	.55	.37
2	-.31	-.10	.16	-.30	.25	.23	.27	-.12	.37	.56
3	-1.47	-.28	-.22	-.50	-.37	1.00	.50	.38	-.01	.49
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	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
1	-.06	-.08	-.06	.17	99.99	.41	.53	.11	-.14	.10
2	.21	-.09	-.48	.54	99.99	.62	.49	-.72	-.67	-.95
3	-.31	-.36	-.66	.52	.37	2.10	1.55	-.26	-.99	-1.08
4	No data for this fleet at this age									
5	No data for this fleet at this age									
6	No data for this fleet at this age									
7	No data for this fleet at this age									
8	No data for this fleet at this age									
9	No data for this fleet at this age									

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

Age	1	2	3
Mean Log q	-2.4138	-3.6556	-4.9617
S.E(Log q)	.2881	.4557	.8534

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	1.28	-1.809	-.51	.70	20	.35	-2.41
2	.72	2.210	6.27	.77	20	.30	-3.66
3	.76	.806	6.80	.38	21	.66	-4.96

1

Fleet : BTS Tridens

Age	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
1	No data for this fleet at this age									
2	99.99	99.99	99.99	-.69	99.99	.06	-.22	.01	-.23	1.07
3	99.99	99.99	99.99	-.55	.00	.28	.13	.01	-.13	.25
4	99.99	99.99	99.99	-.30	.03	.01	.48	-.16	-.25	.18
5	99.99	99.99	99.99	-.34	.37	.37	-.03	.27	-.35	-.28
6	99.99	99.99	99.99	-.20	.05	.15	.64	.10	-.29	-.45
7	99.99	99.99	99.99	-.56	-.78	.10	.00	.54	-.21	-.39
8	99.99	99.99	99.99	-.47	.50	.45	.70	.96	.19	.31
9	99.99	99.99	99.99	-.91	.23	-.05	.38	.27	.91	.35

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	-9.9575	-9.4946	-9.3487	-9.2089	-8.9281	-8.9281	-8.9281	-8.9281
S.E(Log q)	.5855	.2810	.2708	.3312	.3583	.4874	.6083	.5858

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	1.94	-1.019	7.62	.23	6	1.13	-9.96
3	.88	.497	9.82	.78	7	.27	-9.49
4	1.27	-1.030	8.71	.75	7	.34	-9.35
5	1.80	-3.328	7.78	.78	7	.36	-9.21
6	1.73	-2.305	8.07	.67	7	.47	-8.93
7	10.60	-2.711	7.68	.02	7	3.28	-9.12
8	5.81	-1.952	8.08	.03	7	2.17	-8.55
9	-4.05	-2.937	5.55	.06	7	1.49	-8.76

1

Terminal year survivor and F summaries :

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

Year class = 2001

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
BTS	725420.	.626	.000	.00	1	.144	.002
SNS	328004.	.300	.000	.00	1	.628	.004
BTS Tridens	1.	.000	.000	.00	0	.000	.000
F shrinkage mean	127431.	.50				.227	.010

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
296719.	.24	.42	3	1.747	.004

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

Year class = 2000

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
BTS	116771.	.328	.388	1.18	2	.290	.130
SNS	66568.	.252	.374	1.48	2	.484	.217
BTS Tridens	282152.	.632	.000	.00	1	.079	.056
F shrinkage mean	133244.	.50				.147	.115

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
97264.	.18	.24	6	1.366	.154

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

Year class = 1999

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
BTS	86610.	.256	.171	.67	3	.288	.526
SNS	75029.	.243	.308	1.27	3	.299	.587
BTS Tridens	110694.	.272	.175	.64	2	.276	.433
F shrinkage mean	118784.	.50				.138	.408

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
92731.	.15	.12	9	.828	.498

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

Year class = 1998

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
BTS	55621.	.217	.127	.58	4	.303	.632
SNS	63565.	.243	.447	1.84	3	.199	.572
BTS Tridens	62267.	.205	.104	.51	3	.367	.581
F shrinkage mean	52804.	.50				.131	.657

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
59132.	.13	.10	11	.804	.604

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

Year class = 1997

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
BTS ,	56642.,	.208,	.069,	.33,	5,	.280,	.500
SNS ,	67242.,	.242,	.135,	.56,	3,	.164,	.436
BTS Tridens ,	38090.,	.181,	.071,	.39,	4,	.422,	.675
F shrinkage mean ,	34111.,	.50,,,,				.134,	.731

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
46028.,	.12,	.08,	13,	.670,	.587

Age 6 Catchability constant w.r.t. time and dependent on age

Year class = 1996

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
BTS ,	55099.,	.251,	.167,	.67,	5,	.254,	.528
SNS ,	89797.,	.412,	.393,	.95,	2,	.033,	.355
BTS Tridens ,	29324.,	.193,	.101,	.52,	5,	.481,	.835
F shrinkage mean ,	42425.,	.50,,,,				.232,	.643

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
38896.,	.16,	.11,	13,	.684,	.685

Age 7 Catchability constant w.r.t. time and age (fixed at the value for age) 6

Year class = 1995

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
BTS ,	3663.,	.290,	.208,	.72,	6,	.226,	.809
SNS ,	7008.,	.285,	.647,	2.27,	2,	.033,	.501
BTS Tridens ,	4358.,	.204,	.171,	.84,	5,	.466,	.716
F shrinkage mean ,	5777.,	.50,,,,				.276,	.582

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
4599.,	.18,	.11,	14,	.611,	.689

Age 8 Catchability constant w.r.t. time and age (fixed at the value for age) 6

Year class = 1994

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
BTS ,	2971.,	.323,	.191,	.59,	8,	.228,	.469
SNS ,	3399.,	.243,	.190,	.78,	3,	.028,	.421
BTS Tridens ,	3095.,	.235,	.081,	.35,	7,	.432,	.454
F shrinkage mean ,	2706.,	.50,,,,				.312,	.505

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
2948.,	.20,	.07,	19,	.338,	.472

Age 9 Catchability constant w.r.t. time and age (fixed at the value for age) 6

Year class = 1993

Fleet,		Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
BTS	,	1677.,	.317,	.323,	1.02,	8,	.189,	.360
SNS	,	1446.,	.243,	.191,	.79,	3,	.022,	.408
BTS Tridens	,	2363.,	.239,	.100,	.42,	7,	.491,	.268
F shrinkage mean	,	920.,	.50,,,,				.298,	.583

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
1653.,	.20,	.15,	19,	.746,	.365

Table 9.4.4.2 North Sea Plaice: F derived from final XSA run

Run title : Plaice in IV
At 15/09/2003 22:37

Terminal Fs derived using XSA (With F shrinkage)

Table 8 Fishing mortality (F) at age

YEAR,	1957,	1958,	1959,	1960,	1961,	1962,
1,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
2,	.0273,	.0303,	.0468,	.0173,	.0069,	.0070,
3,	.2311,	.1711,	.1569,	.2208,	.1142,	.1298,
4,	.2959,	.3538,	.2701,	.3781,	.3561,	.3112,
5,	.3356,	.3429,	.3721,	.3378,	.3937,	.4285,
6,	.2010,	.3172,	.3623,	.4023,	.3090,	.4100,
7,	.2532,	.2568,	.3454,	.3544,	.3482,	.3343,
8,	.2673,	.2626,	.2924,	.3513,	.3901,	.3331,
9,	.2608,	.2603,	.3197,	.3538,	.3702,	.3346,
+gp,	.2608,	.2603,	.3197,	.3538,	.3702,	.3346,
0 FBAR 2- 6,	.2182,	.2430,	.2416,	.2713,	.2360,	.2573,
FBAR 2- 8,	.2302,	.2478,	.2637,	.2946,	.2740,	.2791,

YEAR,	1963,	1964,	1965,	1966,	1967,	1968,	1969,	1970,	1971,	1972,
1,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0002,	.0001,	.0105,
2,	.0176,	.0553,	.0119,	.0155,	.0234,	.0410,	.0764,	.0650,	.0994,	.1726,
3,	.0807,	.2018,	.1986,	.0911,	.1351,	.1960,	.2490,	.3553,	.2322,	.2779,
4,	.3981,	.3287,	.3925,	.3514,	.2023,	.2246,	.2385,	.4914,	.3687,	.3805,
5,	.3982,	.5163,	.3427,	.4561,	.4683,	.3165,	.3006,	.4090,	.3938,	.4143,
6,	.4709,	.4602,	.4981,	.3328,	.4847,	.3194,	.4149,	.4812,	.3774,	.4275,
7,	.4291,	.4015,	.3852,	.4950,	.2983,	.3904,	.2911,	.5789,	.3995,	.3829,
8,	.4017,	.3624,	.3499,	.3639,	.4206,	.2743,	.3719,	.2567,	.3954,	.4305,
9,	.4167,	.3831,	.3686,	.4308,	.3605,	.3332,	.3324,	.4191,	.3986,	.4080,
+gp,	.4167,	.3831,	.3686,	.4308,	.3605,	.3332,	.3324,	.4191,	.3986,	.4080,
0 FBAR 2- 6,	.2731,	.3124,	.2888,	.2494,	.2628,	.2195,	.2559,	.3604,	.2943,	.3346,
FBAR 2- 8,	.3138,	.3323,	.3113,	.3008,	.2904,	.2517,	.2775,	.3768,	.3237,	.3552,

YEAR,	1973,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,	1982,
1,	.0025,	.0052,	.0032,	.0094,	.0073,	.0029,	.0032,	.0016,	.0006,	.0034,
2,	.1817,	.0520,	.0763,	.1274,	.2360,	.1661,	.1752,	.1908,	.1977,	.1428,
3,	.4107,	.4870,	.1712,	.2769,	.2147,	.3885,	.4973,	.6686,	.5758,	.6935,
4,	.5378,	.5110,	.4947,	.3897,	.3563,	.4039,	.5313,	.6244,	.6033,	.6719,
5,	.5254,	.5843,	.5885,	.3736,	.6112,	.4449,	.6628,	.5029,	.5831,	.6074,
6,	.4158,	.4393,	.6024,	.4231,	.4037,	.5026,	.6803,	.4947,	.4447,	.5266,
7,	.3684,	.4007,	.4589,	.4994,	.4269,	.4419,	.6780,	.4638,	.4719,	.4753,
8,	.4356,	.4310,	.5159,	.4254,	.5012,	.4060,	.5623,	.4688,	.4837,	.4799,
9,	.4032,	.4172,	.4891,	.4640,	.4657,	.4253,	.6228,	.4679,	.4795,	.4793,
+gp,	.4032,	.4172,	.4891,	.4640,	.4657,	.4253,	.6228,	.4679,	.4795,	.4793,
0 FBAR 2- 6,	.4143,	.4147,	.3866,	.3182,	.3644,	.3812,	.5094,	.4963,	.4809,	.5284,
FBAR 2- 8,	.4108,	.4151,	.4154,	.3594,	.3929,	.3934,	.5410,	.4877,	.4800,	.5139,

YEAR,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,
1,	.0022,	.0002,	.0002,	.0014,	.0000,	.0000,	.0033,	.0042,	.0039,	.0090,
2,	.1469,	.1351,	.1534,	.1613,	.0827,	.0332,	.1020,	.0986,	.1376,	.1374,
3,	.5252,	.5118,	.4537,	.5240,	.4067,	.3295,	.3018,	.2852,	.3485,	.3868,
4,	.7428,	.4391,	.6908,	.5318,	.7282,	.4394,	.5077,	.5242,	.5680,	.5101,
5,	.5922,	.6171,	.4621,	.6967,	.7670,	.7017,	.5693,	.7030,	.6945,	.7529,
6,	.5378,	.5370,	.4965,	.6540,	.6117,	.6810,	.6101,	.5598,	.7917,	.7080,
7,	.4720,	.5013,	.5028,	.5535,	.6652,	.5984,	.6055,	.4982,	.6201,	.7098,
8,	.4646,	.5976,	.5211,	.6384,	.4804,	.6747,	.5244,	.4572,	.6151,	.5868,
9,	.4699,	.5516,	.5795,	.8346,	.6418,	.6861,	.5439,	.4273,	.6486,	.8540,
+gp,	.4699,	.5516,	.5795,	.8346,	.6418,	.6861,	.5439,	.4273,	.6486,	.8540,
0 FBAR 2- 6,	.5090,	.4480,	.4513,	.5136,	.5193,	.4370,	.4182,	.4342,	.5081,	.4990,
FBAR 2- 8,	.4974,	.4770,	.4686,	.5371,	.5346,	.4940,	.4601,	.4466,	.5394,	.5417,

YEAR,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	FBAR 00-02
1,	.0128,	.0062,	.0256,	.0047,	.0012,	.0008,	.0023,	.0111,	.0336,	.0042,	.0163,
2,	.1716,	.2057,	.1971,	.1711,	.2234,	.0482,	.0387,	.0773,	.1843,	.1538,	.1384,
3,	.4528,	.4937,	.6070,	.5515,	.5482,	.5888,	.3286,	.2214,	.3490,	.4985,	.3563,
4,	.5855,	.7263,	.7854,	.7456,	.8021,	.7396,	.7184,	.6031,	.4065,	.6039,	.5378,
5,	.7370,	.6330,	.7692,	.7781,	.9044,	.7348,	.7300,	.5744,	.6947,	.5868,	.6186,
6,	.6835,	.6494,	.6064,	.7072,	.7928,	.6231,	.6733,	.6169,	.4961,	.6853,	.5994,
7,	.6144,	.8504,	.6624,	.7860,	.6932,	.6793,	.5336,	.4022,	.5903,	.6891,	.5605,
8,	.5723,	.5895,	.5484,	.6561,	.6018,	.5717,	.6620,	.3402,	.3418,	.4722,	.3847,
9,	.6186,	.5217,	.3916,	.6640,	.6796,	.5839,	.7284,	.5694,	.3243,	.3648,	.4195,
+gp,	.6186,	.5217,	.3916,	.6640,	.6796,	.5839,	.7284,	.5694,	.3243,	.3648,	
0 FBAR 2- 6,	.5261,	.5416,	.5930,	.5907,	.6542,	.5469,	.4978,	.4186,	.4261,	.5056,	
FBAR 2- 8,	.5453,	.5926,	.5966,	.6280,	.6523,	.5694,	.5263,	.4051,	.4375,	.5271,	

Table 9.4.4.3 North Sea Plaice: stock numbers at age derived from the final XSA run

Run title : Plaice in IV
At 15/09/2003 22:37
Terminal Fs derived using XSA (With F shrinkage)

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

YEAR	1957	1958	1959	1960	1961	1962
1	277333	420311	404123	381108	357999	289524
2	168598	250941	380313	365665	344841	323931
3	304822	148449	220280	328373	325199	309871
4	183554	218913	113200	170374	238266	262489
5	117158	123549	139060	78182	105627	150998
6	51294	75788	79343	86732	50461	64471
7	51837	37961	49937	49976	52482	33522
8	40466	36413	26569	31989	31726	33524
9	22772	28027	25338	17945	20371	19434
+gp	49596	60156	61964	53276	49633	47171
0 TOTAL	1267429	1400509	1500128	1563620	1576606	1534935

YEAR	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
1	317895	969692	312825	300504	274279	237193	319318	363590	267742	224217
2	261972	287644	877413	283056	271907	248178	214621	288928	328917	242245
3	291063	232914	246280	784539	252177	240341	215548	179913	244982	269469
4	246257	242941	172238	182700	648042	199353	178757	152053	114113	175742
5	173988	149648	158244	105253	116337	478962	144103	127422	84169	71412
6	89010	105718	80799	101641	60358	65901	315793	96540	76594	51371
7	38714	50291	60375	44429	65933	33637	43327	188703	53989	47519
8	21714	22809	30458	37164	24506	44273	20599	29301	95707	32764
9	21739	13148	14365	19423	23370	14560	30450	12850	20510	58319
+gp	50987	55582	59757	44655	38684	49422	59626	45388	53871	48926
0 TOTAL	1513339	2130386	2012753	1903363	1775593	1611820	1542141	1484686	1340594	1221982

YEAR	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
1	531194	447210	327785	317791	463277	420813	435541	654862	417306	1021516
2	200756	479438	402538	295659	284867	416128	379680	392840	591612	377354
3	184446	151466	411821	337479	235521	203568	318904	288348	293718	439308
4	184660	110677	84213	314013	231501	171931	124893	175491	133690	149435
5	108692	97586	60074	46462	192434	146678	103879	66434	85048	66173
6	42697	58154	49227	30178	28933	94499	85061	48443	36356	42953
7	30313	25490	33913	24388	17885	17484	51728	38982	26728	21088
8	29318	18977	15450	19392	13392	10559	10170	23759	22182	15087
9	19274	17161	11158	8346	11467	7341	6366	5244	13453	12374
+gp	75678	67481	53284	35395	25843	22573	20948	15062	16221	23785
0 TOTAL	1407029	1473640	1449464	1429104	1505122	1511573	1537170	1709464	1636315	2169072

YEAR	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	582796	600994	523643	1247347	539672	560224	403945	392654	399455	401147
2	921134	526181	543699	473697	1127054	488316	506911	364305	353813	360052
3	295998	719619	415941	421994	364767	938829	427439	414196	298690	278988
4	198689	158406	390303	239081	226104	219759	611038	286000	281782	190740
5	69062	85537	92394	176990	127103	98773	128137	332763	153200	144477
6	32618	34563	41757	52668	79788	53408	44305	65614	149076	69218
7	22955	17238	18279	22997	24780	39161	24458	21780	33918	61115
8	11862	12956	9448	10004	11963	11528	19478	12079	11975	16508
9	8448	6745	6449	5077	4781	6695	5313	10433	6919	5858
+gp	23135	16198	13787	12816	12089	13118	13915	11466	12245	12588
0 TOTAL	2166697	2178436	2055699	2662671	2518102	2429812	2184938	1911289	1701075	1540691

YEAR	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	GMST 57-**	AMST 57-**
1	285789	238966	322090	249817	751423	266000	247701	250524	143288	329316	0	394687	432253
2	359729	255300	214900	284066	224993	679067	240500	223607	224178	125363	296719	353703	388804
3	283978	274179	188059	159658	216610	162817	585527	209348	187280	168709	97264	291609	320805
4	171470	163377	151426	92735	83222	113290	81765	381442	151805	119538	92731	187206	209548
5	103631	86392	71507	62468	39812	33764	48927	36071	188828	91473	59132	101970	117922
6	61571	44871	41508	29983	25961	14581	14653	21335	18376	85296	46028	54579	64677
7	30855	28125	21207	20481	13375	10631	7076	6762	10417	10125	38896	30547	36723
8	27193	15103	10873	9894	8444	6051	4877	3755	4093	5223	4599	17831	21642
9	8307	13883	7579	5685	4645	4186	3091	2276	2418	2631	2948	10694	13436
+gp	13333	13985	12132	10536	8859	7375	6245	5052	8737	5580	5159		
0 TOTAL	1345855	1134182	1041281	925323	1377345	1297761	1240360	1140173	939420	943255	643476		

Table 9.5.1 North Sea Plaice: inputs to RCT3 analysis

'yc'	'VPA-1'	'VPA-2'	'SNS-0'	'SNS-1'	'SNS-2'	'SNS-3'	'BTS-1'	'BTS-2'	'BTS-3'	mb DFS/YFS	'comb DFS/YFS-1'
1967	237193	214621	-11	-11	-11	2813	-11	-11	-11	-11	-11
1968	319318	288928	-11	-11	9450	1008	-11	-11	-11	-11	-11
1969	363590	328917	-11	8032	23848	4484	-11	-11	-11	-11	-11
1970	267742	242245	3678	18101	9584	1631	-11	-11	-11	-11	-11
1971	224217	200756	6705	6437	4191	1261	-11	-11	-11	-11	-11
1972	531194	479438	9242	57238	17985	10744	-11	-11	-11	-11	-11
1973	447210	402538	5451	15648	9171	791	-11	-11	-11	-11	-11
1974	327785	295659	2193	9781	2274	1720	-11	-11	-11	-11	-11
1975	317791	284867	1151	9037	2900	435	-11	-11	-11	-11	-11
1976	463277	416128	11544	19119	12714	1577	-11	-11	-11	-11	-11
1977	420813	379680	4378	13924	9540	456	-11	-11	-11	-11	-11
1978	435541	392840	3252	21681	12084	785	-11	-11	-11	-11	-11
1979	654862	591612	27835	58049	16106	1146	-11	-11	-11	-11	-11
1980	417306	377354	4039	19611	8503	308	-11	-11	-11	-11	-11
1981	1021516	921134	31542	70108	14708	2480	-11	-11	-11	634	287
1982	582796	526181	23987	34884	10413	1584	-11	-11	39	457	160
1983	600994	543699	36722	44667	13789	1155	-11	180	51	432	117
1984	523643	473697	7958	27832	7558	1232	116	132	33	263	101
1985	1247347	1127054	47385	93573	33021	13140	660	764	174	718	269
1986	539672	488316	8818	33426	14429	3709	226	140	39	345	189
1987	560224	506911	21270	36672	14952	3248	577	319	56	465	105
1988	403945	364305	15598	37238	7287	1507	429	103	29	331	135
1989	392654	353813	24198	24903	11149	2257	112	122	27	463	129
1990	399455	360052	9559	57349	13742	988	185	126	38	468	151
1991	401147	359729	17120	48223	9484	884	172	179	35	496	131
1992	285789	255300	5398	22184	4866	415	125	64	14	357	74
1993	238966	214900	9226	18225	2786	1189	145	44	23	263	31
1994	322090	284066	27901	24900	10377	1393	252	212	20	445	38
1995	249817	224993	13029	24663	-11	5739	218	-11	47	184	117
1996	751423	679067	91713	-11	29431	14347	-11	436	183	572	153
1997	266000	240500	15363	33391	9235	905	338	130	32	157	-11
1998	247701	223607	22720	35188	2489	356	305	75	20	-11	-11
1999	-11	-11	39201	23028	2416	263	279	79	15	-11	14
2000	-11	-11	24185	10193	1047	-11	226	45	-11	185	5
2001	-11	-11	101291	30265	-11	-11	569	-11	-11	500	19
2002	-11		29905	-11	-11	-11	-11	-11	-11	212	-11

Table 9.5.2 Plaice in IV. RCT3 output (1 year olds)

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

 P4RCT-1.TXT

 Plaice North Sea - 1-Y-Rcr.

 Data for    9 surveys over   36 years :  1967 - 2002

 Regression type = C

 Tapered time weighting not applied
 Survey weighting not applied

 Final estimates shrunk towards mean
 Minimum S.E. for any survey taken as    .20
 Minimum of   3 points used for regression

 Forecast/Hindcast variance correction used.

 Yearclass =   2000

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

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

 SNS-0    .83   5.17    .72   .266   29  10.09   13.59   .765   .055
 SNS-1    .96   3.14    .50   .415   29   9.23   12.03   .542   .110
 SNS-2    .83   5.35    .40   .526   30   6.95   11.13   .484   .138
 SNS-3
 BTS-1   1.74   3.38    .92   .203   14   5.42   12.80    1.031   .030
 BTS-2    .72   9.34    .27   .747   15   3.83   12.10   .330   .297
 BTS-3
 comb D    1.54   3.88    .43   .568   17   5.23   11.92   .511   .124
 comb D    1.05   8.07    .41   .585   16   1.79    9.94   .732   .060

                       VPA Mean =   12.93   .420   .184

 Yearclass =   2001

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

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

 SNS-0    .83   5.17    .72   .266   29  11.53   14.79   .819   .078
 SNS-1    .96   3.14    .50   .415   29  10.32   13.08   .524   .190
 SNS-2
 SNS-3
 BTS-1   1.74   3.38    .92   .203   14   6.35   14.40    1.116   .042
 BTS-2
 BTS-3
 comb D    1.54   3.88    .43   .568   17   6.22   13.44   .474   .232
 comb D    1.05   8.07    .41   .585   16   3.00   11.20   .567   .162

                       VPA Mean =   12.93   .420   .296

 Yearclass =   2002

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

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

 SNS-0    .83   5.17    .72   .266   29  10.31   13.77   .770   .148
 SNS-1
 SNS-2
 SNS-3
 BTS-1
 BTS-2
 BTS-3
 comb D    1.54   3.88    .43   .568   17   5.36   12.13   .497   .355
 comb D

                       VPA Mean =   12.93   .420   .498
```

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

 2000    173096   12.06   .18   .31   2.99
 2001    443058   13.00   .23   .42   3.46
 2002    350650   12.77   .30   .39   1.75
```

Table 9.5.3 Plaice in IV. RCT3 output (2 year olds)

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

P4RCT-2.TXT

Plaice North Sea - 2-Y-Rcr.

Data for    9 surveys over   36 years :  1967 - 2002

Regression type = C

Tapered time weighting not applied
Survey weighting not applied

Final estimates shrunk towards mean
Minimum S.E. for any survey taken as    .20
Minimum of   3 points used for regression

Forecast/Hindcast variance correction used.

Yearclass =   2000

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

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

SNS-0    .84   5.00    .72   .264   29  10.09   13.49   .772   .056
SNS-1    .97   2.99    .50   .415   29   9.23   11.92   .544   .112
SNS-2    .83   5.22    .40   .527   30   6.95   11.02   .485   .140
SNS-3
BTS-1   1.74   3.26    .92   .204   14   5.42   12.70    1.033   .031
BTS-2    .73   9.20    .28   .742   15   3.83   11.99   .337   .292
BTS-3
comb D    1.56   3.66    .44   .561   17   5.23   11.80   .522   .121
comb D    1.05   7.95    .41   .590   16   1.79    9.83   .729   .062

                       VPA Mean =   12.82   .421   .186

Yearclass =   2001

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

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

SNS-0    .84   5.00    .72   .264   29  11.53   14.70   .826   .078
SNS-1    .97   2.99    .50   .415   29  10.32   12.97   .526   .191
SNS-2
SNS-3
BTS-1   1.74   3.26    .92   .204   14   6.35   14.30    1.117   .042
BTS-2
BTS-3
comb D    1.56   3.66    .44   .561   17   6.22   13.34   .484   .225
comb D    1.05   7.95    .41   .590   16   3.00   11.09   .565   .166

                       VPA Mean =   12.82   .421   .298

Yearclass =   2002

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

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

SNS-0    .84   5.00    .72   .264   29  10.31   13.67   .776   .148
SNS-1
SNS-2
SNS-3
BTS-1
BTS-2
BTS-3
comb D    1.56   3.66    .44   .561   17   5.36   12.01   .508   .347
comb D

                       VPA Mean =   12.82   .421   .505


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

2000    154630   11.95   .18   .32   3.01
2001    396233   12.89   .23   .43   3.48
2002    31703
```

Table 9.6.1 North Sea Plaice: summary table derived from the final XSA run

Run title : Plaice in IV
At 15/09/2003 22:37
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 2- 8,
1957,	277333,	401921,	305111,	70563,	.2313,	.2182,	.2302,
1958,	420311,	398437,	299457,	73354,	.2450,	.2430,	.2478,
1959,	404123,	403722,	297611,	79300,	.2665,	.2416,	.2637,
1960,	381108,	429624,	306999,	87541,	.2852,	.2713,	.2946,
1961,	357999,	401258,	296210,	85984,	.2903,	.2360,	.2740,
1962,	289524,	491008,	379924,	87472,	.2302,	.2573,	.2791,
1963,	317895,	475793,	371009,	107118,	.2887,	.2731,	.3138,
1964,	969692,	548060,	356017,	110540,	.3105,	.3124,	.3323,
1965,	312825,	528951,	366809,	97143,	.2648,	.2888,	.3113,
1966,	300504,	531869,	365871,	101834,	.2783,	.2494,	.3008,
1967,	274279,	530320,	433031,	108819,	.2513,	.2628,	.2904,
1968,	237193,	496103,	405995,	111534,	.2747,	.2195,	.2517,
1969,	319318,	489955,	384485,	121651,	.3164,	.2559,	.2775,
1970,	363590,	473744,	350521,	130342,	.3719,	.3604,	.3768,
1971,	267742,	461739,	336739,	113944,	.3384,	.2943,	.3237,
1972,	224217,	454828,	339153,	122843,	.3622,	.3346,	.3552,
1973,	531194,	455588,	306433,	130429,	.4256,	.4143,	.4108,
1974,	447210,	444026,	288884,	112540,	.3896,	.4147,	.4151,
1975,	327785,	467514,	295904,	108536,	.3668,	.3866,	.4154,
1976,	317791,	422308,	288788,	113670,	.3936,	.3182,	.3594,
1977,	463277,	448616,	302495,	119188,	.3940,	.3644,	.3929,
1978,	420813,	442411,	294738,	113984,	.3867,	.3812,	.3934,
1979,	435541,	442382,	282605,	145347,	.5143,	.5094,	.5410,
1980,	654862,	455049,	267578,	139951,	.5230,	.4963,	.4877,
1981,	417306,	458918,	280956,	139747,	.4974,	.4809,	.4800,
1982,	1021516,	531486,	274391,	154547,	.5632,	.5284,	.5139,
1983,	582796,	523266,	301963,	144038,	.4770,	.5090,	.4974,
1984,	600994,	526202,	295572,	156147,	.5283,	.4480,	.4770,
1985,	523643,	514523,	328895,	159838,	.4860,	.4513,	.4686,
1986,	1247347,	614725,	328056,	165347,	.5040,	.5136,	.5371,
1987,	539672,	600154,	361547,	153670,	.4250,	.5193,	.5346,
1988,	560224,	593580,	346064,	154475,	.4464,	.4370,	.4940,
1989,	403945,	557575,	389488,	169818,	.4360,	.4182,	.4601,
1990,	392654,	521325,	361469,	156240,	.4322,	.4342,	.4466,
1991,	399455,	432052,	303649,	148004,	.4874,	.5081,	.5394,
1992,	401147,	406985,	270163,	125190,	.4634,	.4990,	.5417,
1993,	285789,	362698,	241549,	117113,	.4848,	.5261,	.5453,
1994,	238966,	298627,	204849,	110392,	.5389,	.5416,	.5926,
1995,	322090,	270191,	179009,	98356,	.5494,	.5930,	.5966,
1996,	249817,	243246,	154959,	81673,	.5271,	.5907,	.6280,
1997,	751423,	279481,	134383,	83048,	.6180,	.6542,	.6523,
1998,	266000,	300803,	176315,	71534,	.4057,	.5469,	.5694,
1999,	247701,	300545,	170974,	80662,	.4718,	.4978,	.5263,
2000,	250524,	279488,	198676,	81148,	.4084,	.4186,	.4051,
2001,	143288,	241662,	176891,	81963,	.4634,	.4261,	.4375,
2002,	329316,	215041,	142271,	70217,	.4935,	.5056,	.5271,
2003,	395000,		152000				
Arith. Mean ,	423733,	438430,	294445,	115148,	.4067,	.4055,	.4263,
0 Units,	(Thousands),	(Tonnes),	(Tonnes),	(Tonnes),			

Table 9.7.1 North Sea Plaice: Input data for catch forecast and linear sensitivity analysis

Label	Value	CV	Label	Value	CV
Number at age			Weight in the stock		
N1	394686	0.41	WS1	0.12	0.00
N2	396233	0.43	WS2	0.21	0.05
N3	97264	0.24	WS3	0.24	0.04
N4	92730	0.15	WS4	0.28	0.04
N5	59132	0.13	WS5	0.35	0.14
N6	46028	0.12	WS6	0.44	0.08
N7	38896	0.16	WS7	0.56	0.21
N8	4599	0.18	WS8	0.67	0.10
N9	2948	0.20	WS9	0.73	0.08
N10	5159	0.20	WS10	0.87	0.04
H.cons selectivity			Weight in the HC catch		
sH1	0.02	0.97	WH1	0.23	0.04
sH2	0.16	0.40	WH2	0.26	0.05
sH3	0.40	0.30	WH3	0.28	0.04
sH4	0.60	0.20	WH4	0.31	0.03
sH5	0.70	0.17	WH5	0.38	0.14
sH6	0.67	0.12	WH6	0.47	0.09
sH7	0.63	0.19	WH7	0.59	0.16
sH8	0.43	0.09	WH8	0.69	0.04
sH9	0.47	0.38	WH9	0.76	0.04
sH10	0.47	0.38	WH10	0.86	0.06
Natural mortality			Proportion mature		
M1	0.10	0.10	MT1	0.00	0.10
M2	0.10	0.10	MT2	0.50	0.10
M3	0.10	0.10	MT3	0.50	0.10
M4	0.10	0.10	MT4	1.00	0.10
M5	0.10	0.10	MT5	1.00	0.00
M6	0.10	0.10	MT6	1.00	0.00
M7	0.10	0.10	MT7	1.00	0.00
M8	0.10	0.10	MT8	1.00	0.00
M9	0.10	0.10	MT9	1.00	0.00
M10	0.10	0.10	MT10	1.00	0.00
Relative effort in HC fishery			Year effect for natural mortality		
HF03	1.00	0.11	K03	1.00	0.10
HF04	1.00	0.11	K04	1.00	0.10
HF05	1.00	0.11	K05	1.00	0.10
Recruitment in 2004 and 2005					
R04	394687	0.41			
R05	394687	0.41			

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

Stock numbers in 2003 are VPA survivors.
These are overwritten at Age 2

Table 9.7.2 North Sea Plaice. Catch forecast output and estimates of coefficient of variation (CV) from linear analysis.

	Year 2003	2004						
Mean F Ages 2 to 6								
H.cons	0.51	0.00	0.10	0.20	0.30	0.40	0.51	0.61
Effort relative to 2002								
H.cons	1.00	0.00	0.20	0.40	0.60	0.80	1.00	1.20
Biomass								
Total 1 January	255	271	271	271	271	271	271	271
SSB at spawning time	152	149	149	149	149	149	149	149
Catch weight (,000t)								
H.cons	71.1	0.0	17.8	34.1	49.0	62.7	75.2	86.8
Biomass in year.... 2005								
Total 1 January		359	342	325	311	297	285	274
SSB at spawning time		235	218	203	190	177	166	156

	Year 2003	2004						
Effort relative to 2002								
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	0.17	0.18	0.18	0.18	0.18	0.18	0.18	0.18
SSB at spawning time	0.14	0.17	0.17	0.17	0.17	0.17	0.17	0.17
Catch weight								
H.cons	0.16	0.00	0.56	0.32	0.26	0.23	0.22	0.21
Biomass in year.... 2005								
Total 1 January		0.17	0.17	0.18	0.18	0.18	0.19	0.19
SSB at spawning time		0.18	0.19	0.19	0.20	0.20	0.20	0.21

Table 9.7.3 North Sea Plaice. Detailed forecast tables.

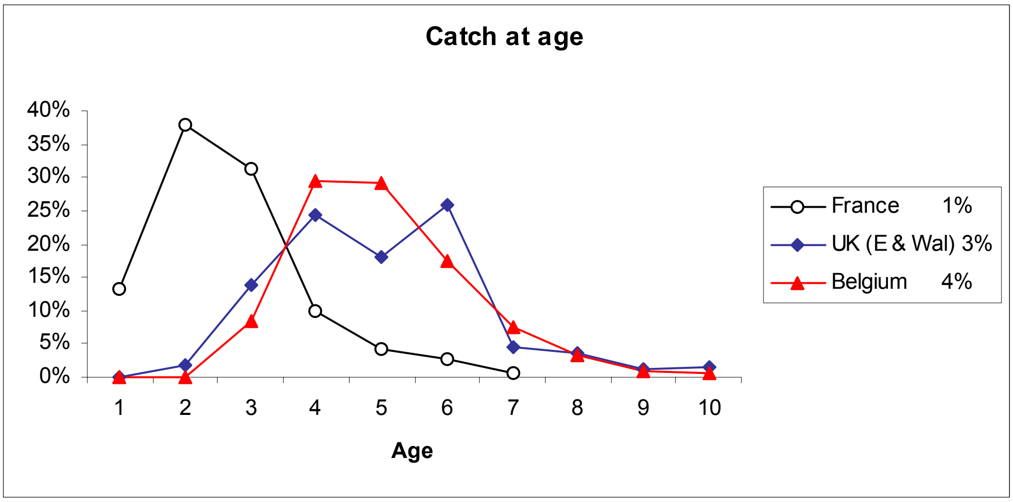
Forecast for year 2003
F multiplier H.cons=1.00

Populations		Catch number	
Age	Stock No.	H.Cons	Total
1	394686	6701	6701
2	396233	54534	54534
3	97264	30616	30616
4	92730	40208	40208
5	59132	28350	28350
6	46028	21575	21575
7	38896	17391	17391
8	4599	1541	1541
9	2948	1058	1058
10	5159	1851	1851
Wt	255	71	71

Forecast for year 2004
F multiplier H.cons=1.00

Populations		Catch number	
Age	Stock No.	H.Cons	Total
1	394687	6701	6701
2	350756	48275	48275
3	306741	96554	96554
4	58994	25580	25580
5	45865	21989	21989
6	26703	12516	12516
7	21248	9500	9500
8	18744	6280	6280
9	2702	969	969
10	4580	1644	1644
Wt	271	75	75

Figure 9.2.1 North Sea plaice: Relative age compositions of the catches by country in 2002. The percentages in the legend indicate the proportion of the total landings for each country.



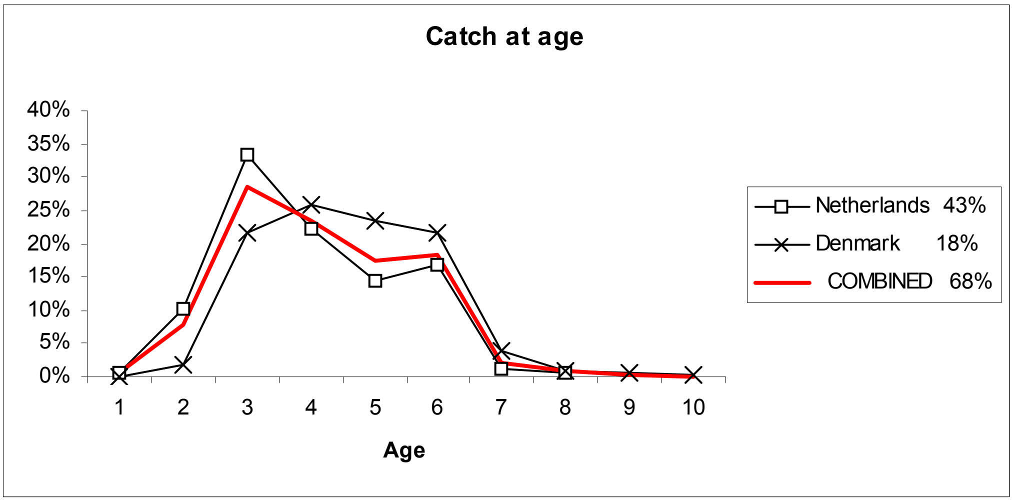
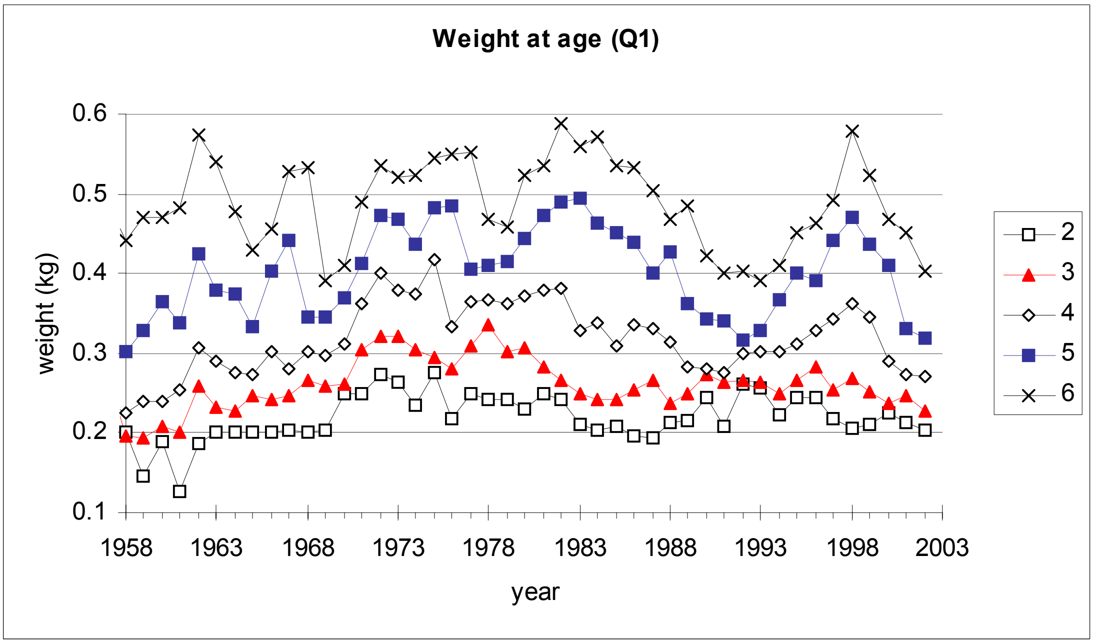


Figure 9.2.2 North Sea plaice: mean weights in the stock



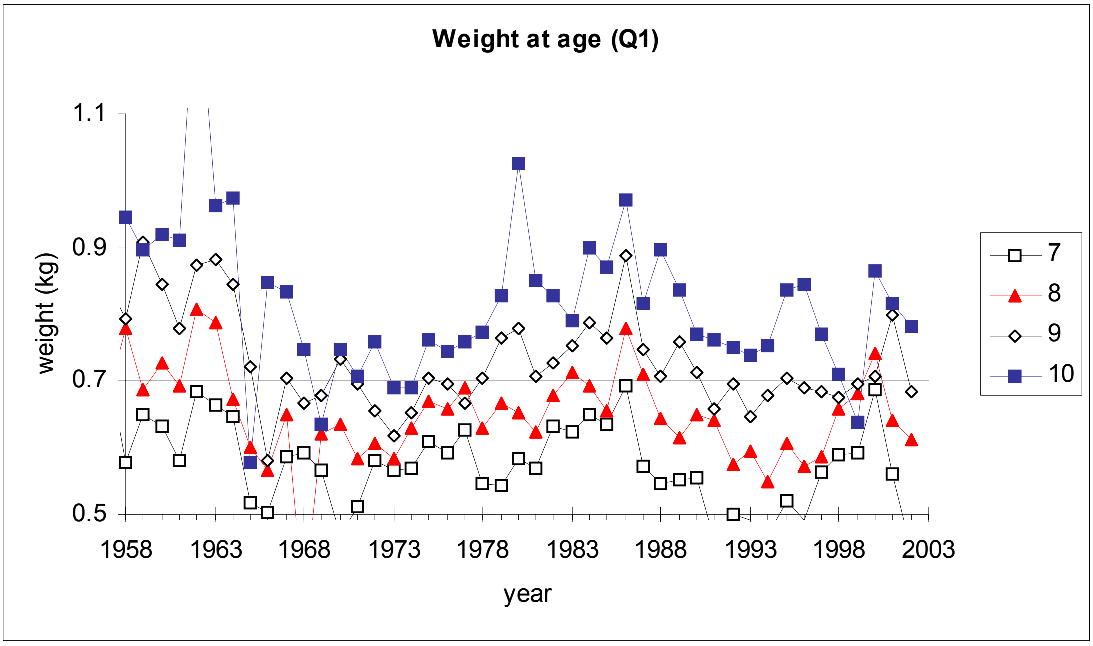


Figure 9.2.3 North Sea plaice: Weight at age (top panels) and length at age (bottom panels) at ages 4 to 6 in the first quarter.

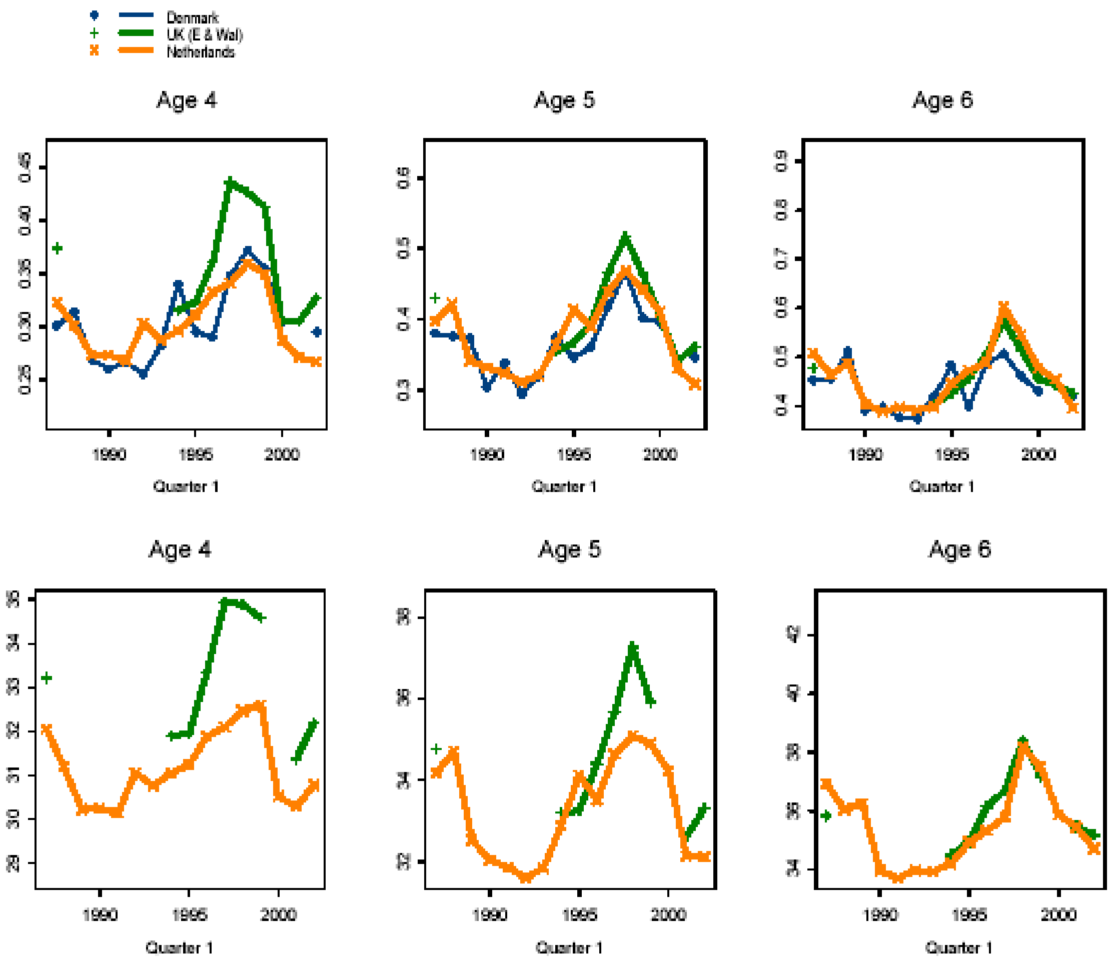


Figure 9.2.4 North Sea plaice: Sex-ratio by age.

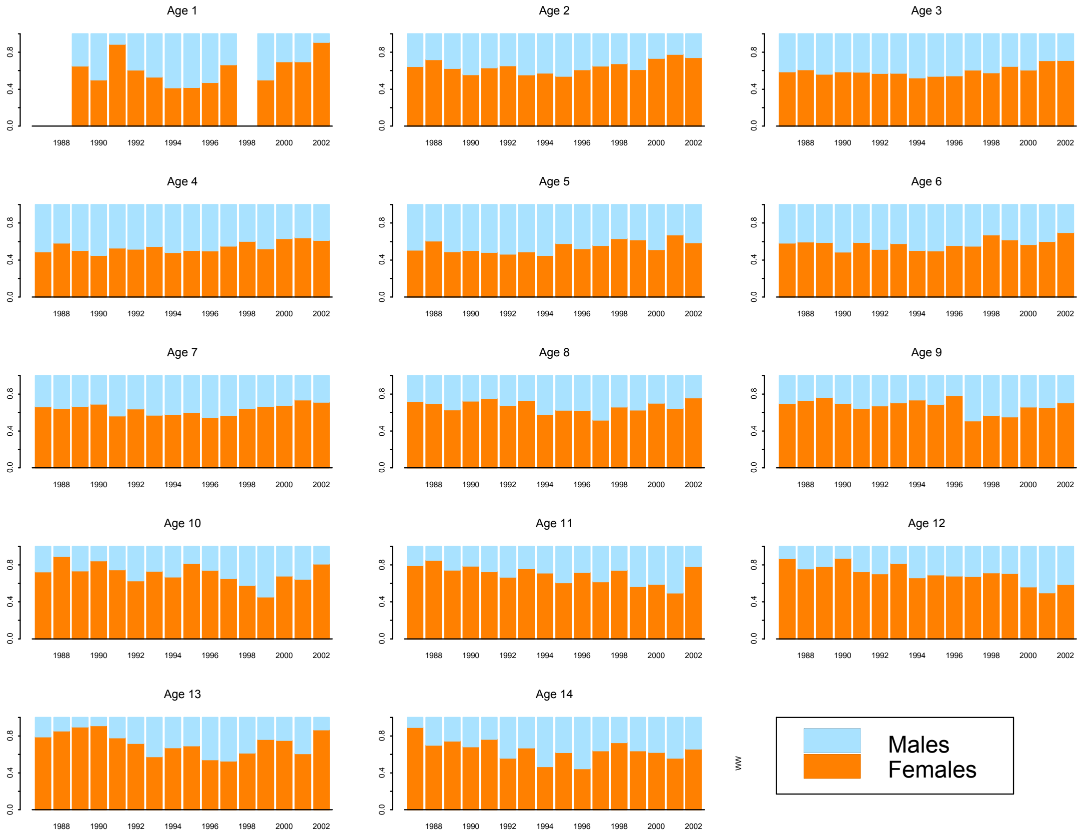


Figure 9.3.1.1 North Sea plaice: Trends in CPUE from a group of Dutch beam trawl vessels (>300 HP) based on haul-by-haul data. CPUE is calculated either directly from the catch and effort data ("raw") or as an index by first averaging over the rectangles and months ("index"). The estimates for 2003 are based on the first half year only.

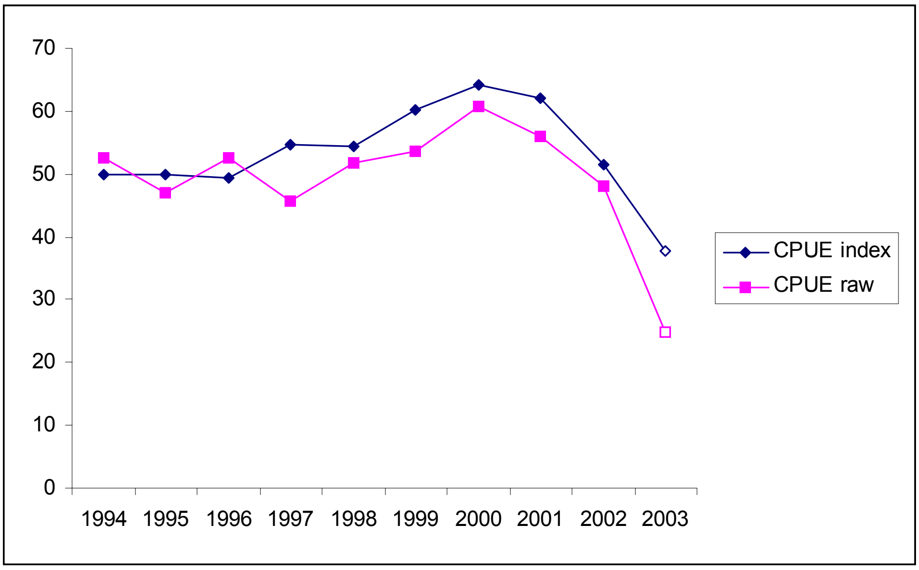


Figure 9.3.1.2 North Sea plaice: Trends in CPUE (kg/HPday) for a group of flagvessels landing in the ports of Urk and Harlingen. The estimates for 2003 are based on the first half year only.

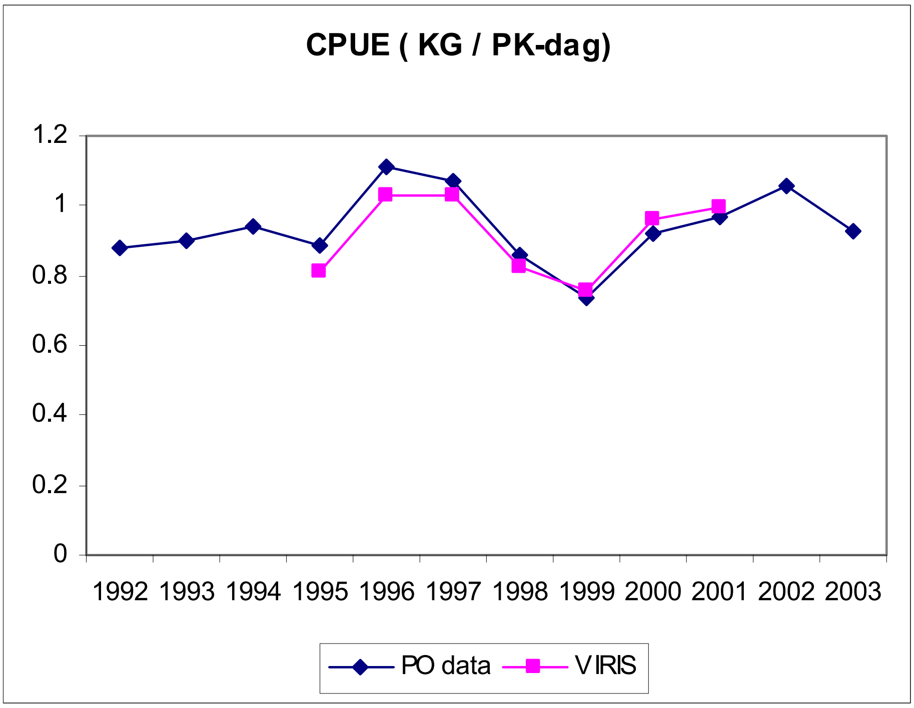


Figure 9.3.1.3 North Sea plaice: Trends in CPUE (kg/HPday) for a group of flagvessels landings in the ports of Urk and Harlingen. The estimates for 2003 are based on the first half year only.

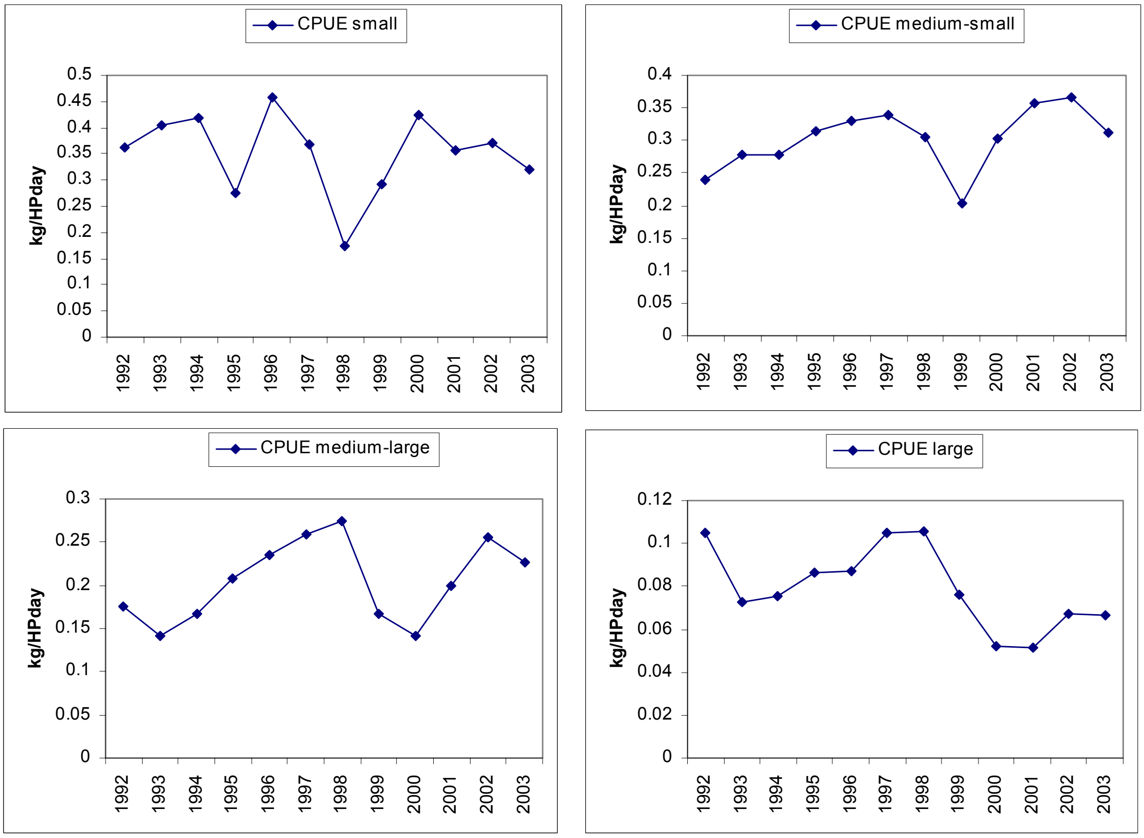


Figure 9.3.2.1 North Sea plaice: Survey areas of the BTS (left panel), SNS (middle panel) and Dutch DFS (right panel)

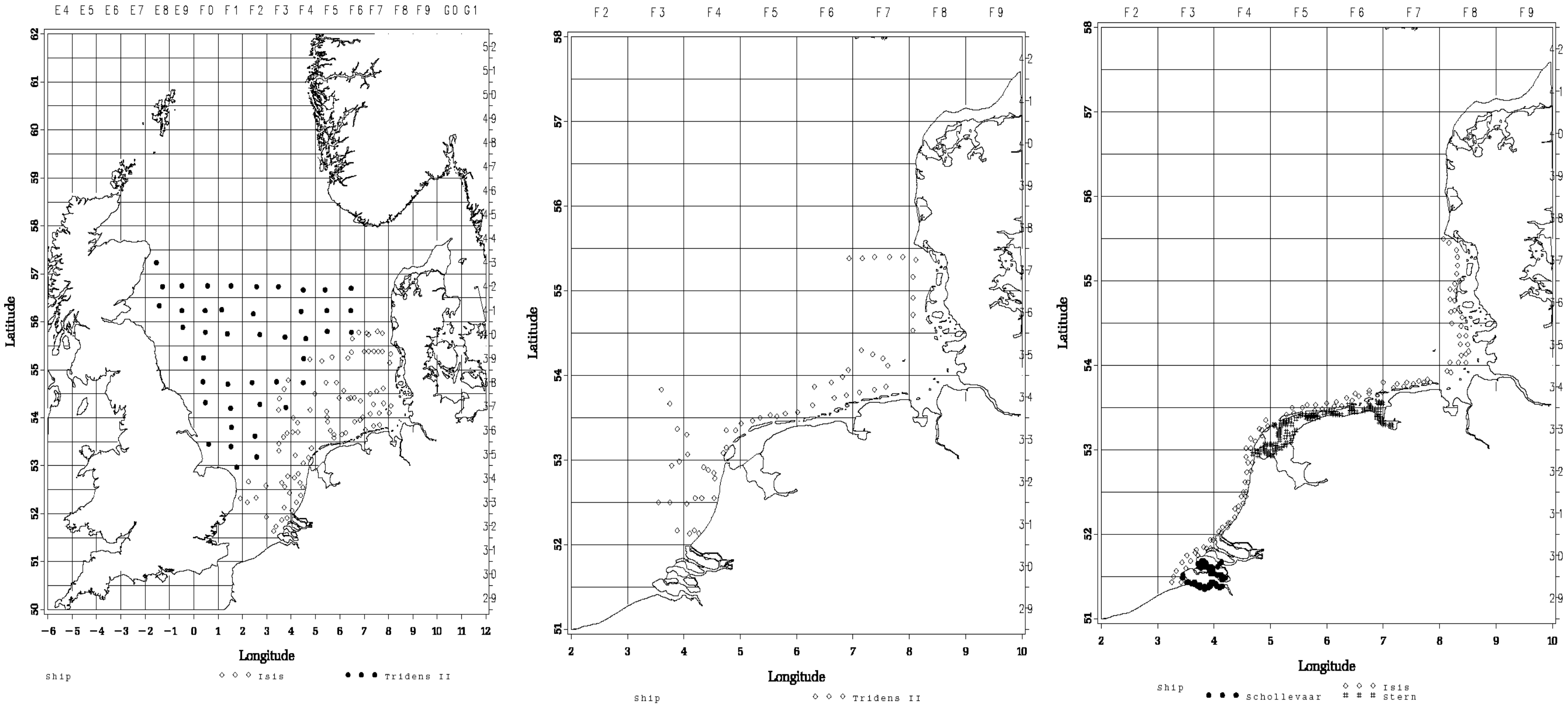


Figure 9.3.2.2 North Sea plaice: Comparison of the BTS indices before and after revision.

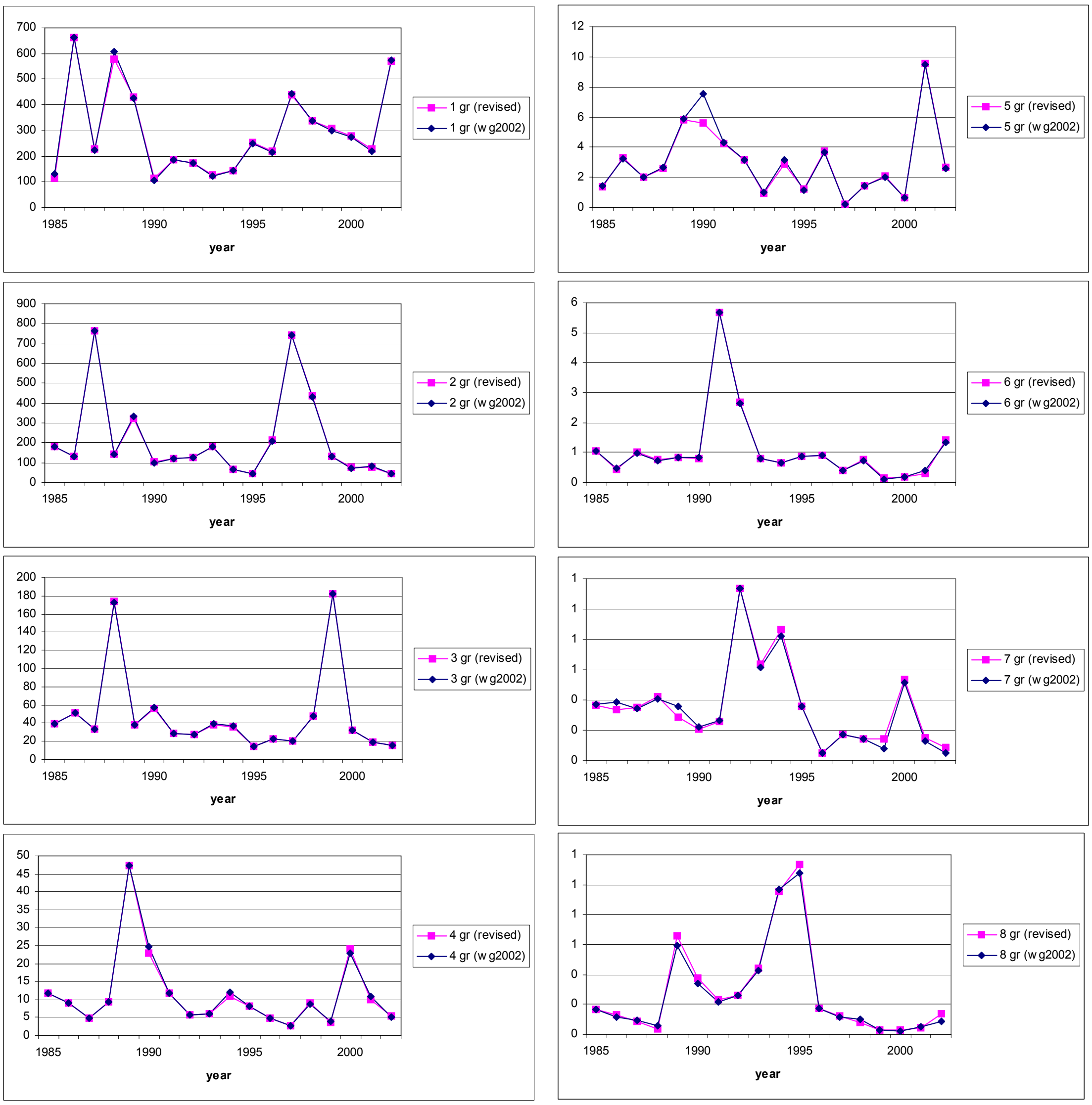


Figure 9.3.2.3 North Sea plaice: Standardised CPUE for commercial fleets and surveys by age group. The fleets between brackets have not been used in the assessments of previous years.

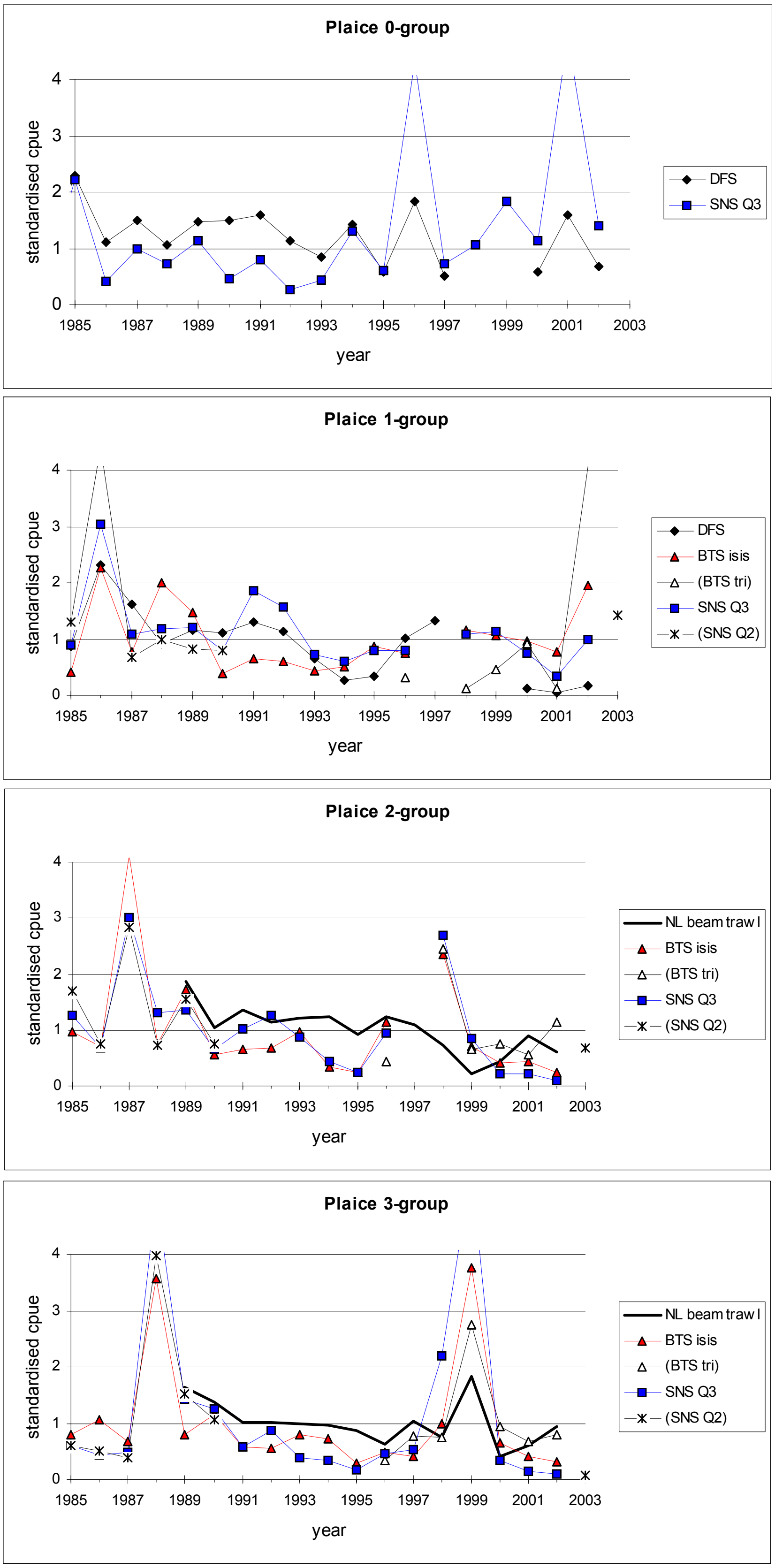
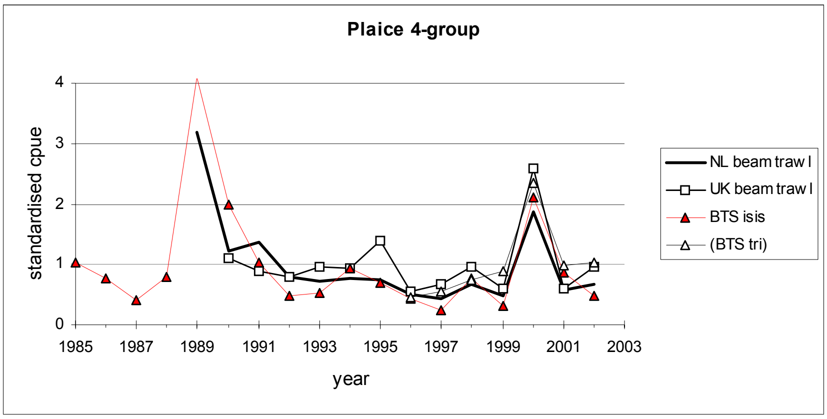
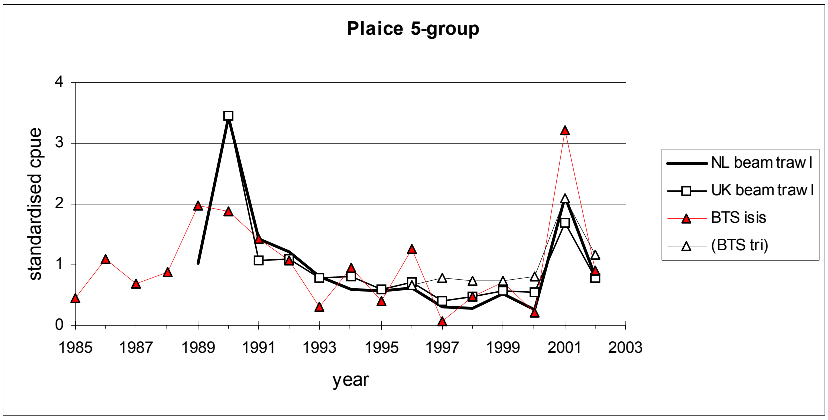
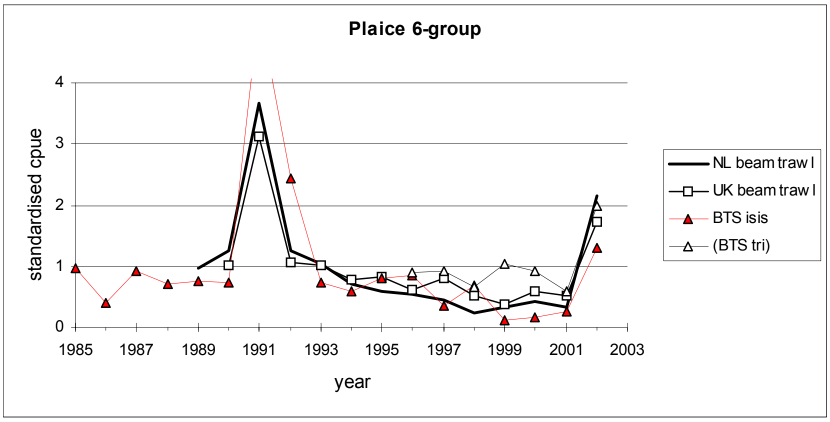


Figure 9.3.2.3 (cont'd) North Sea plaice: Standardised CPUE for commercial fleets and surveys by age group. The fleets between brackets have not been used in the assessments of previous years.







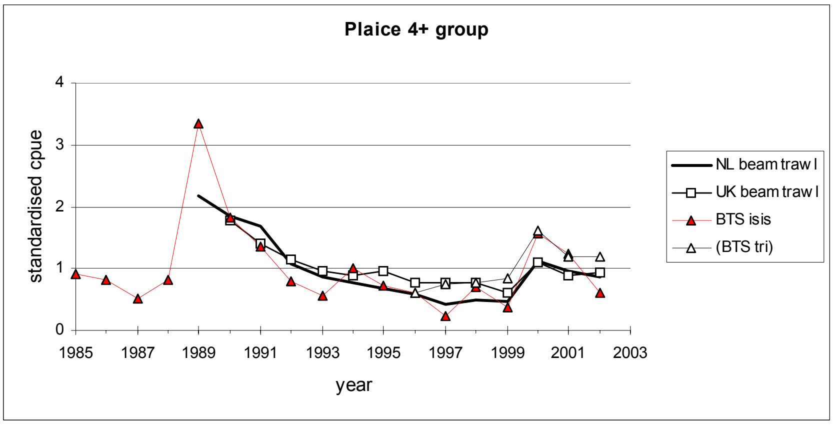
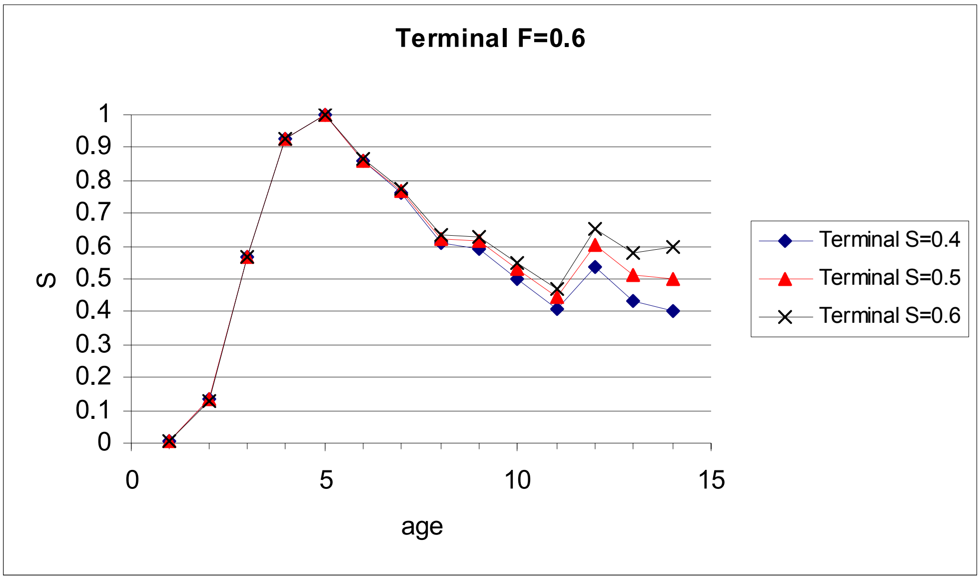


Figure 9.4.1.1 North Sea Plaice: Separable VPA output



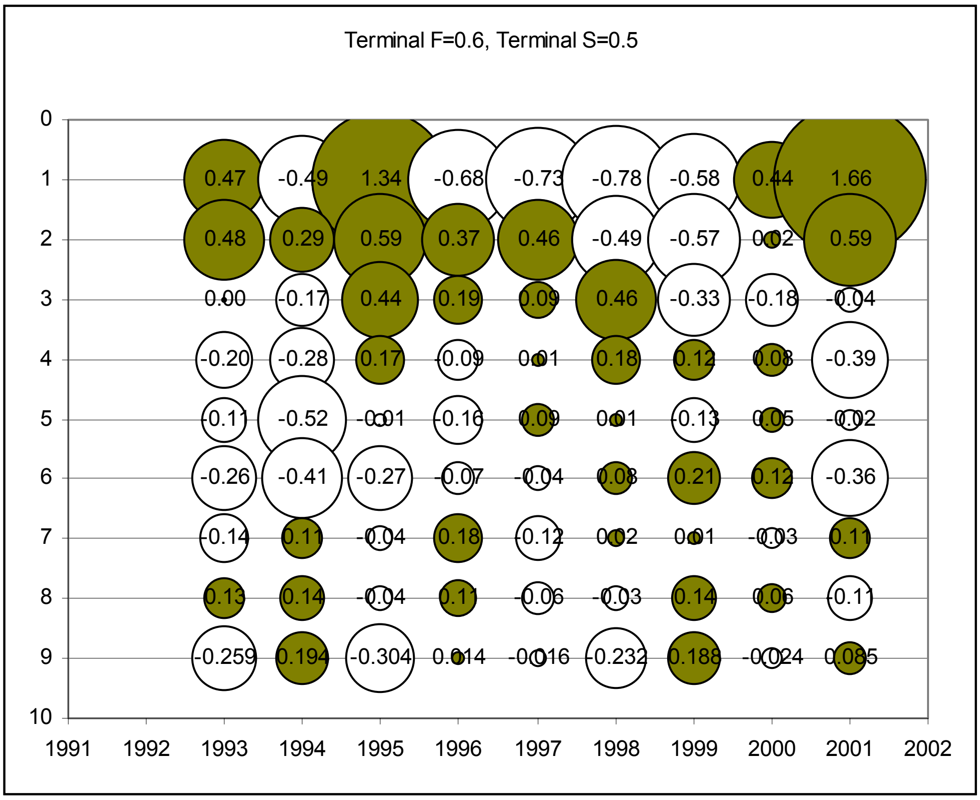


Figure 9.4.1.2 North Sea plaice: Log-catchability residuals derived from single-fleet XSA (F-shrinkage=1.5)

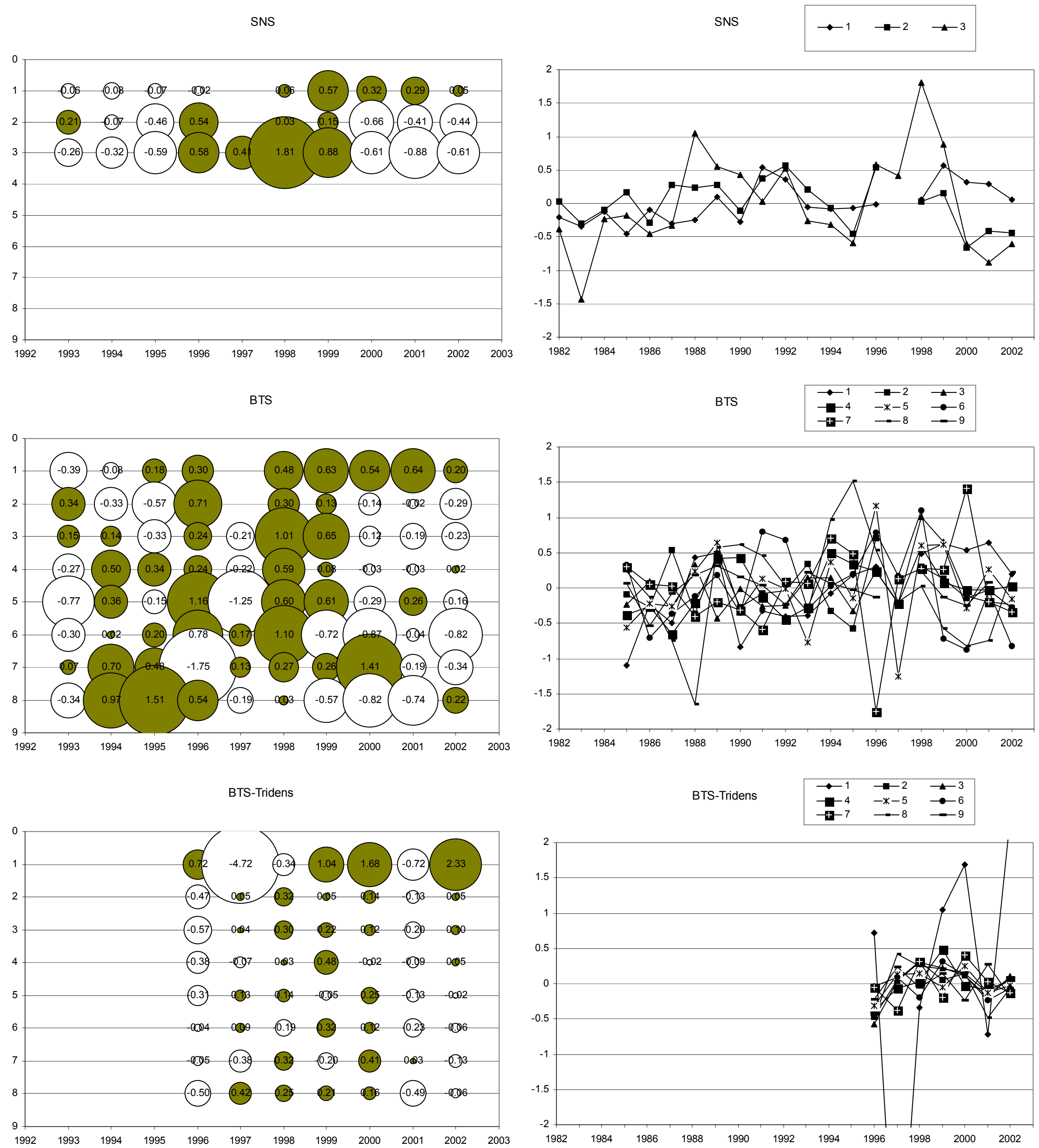


Figure 9.4.1.3 North Sea plaice: The results of single fleet XSA runs (F-shrinkage=1.5) compared to the results of a multi-fleet XSA run (F-shrinkage=0.5).

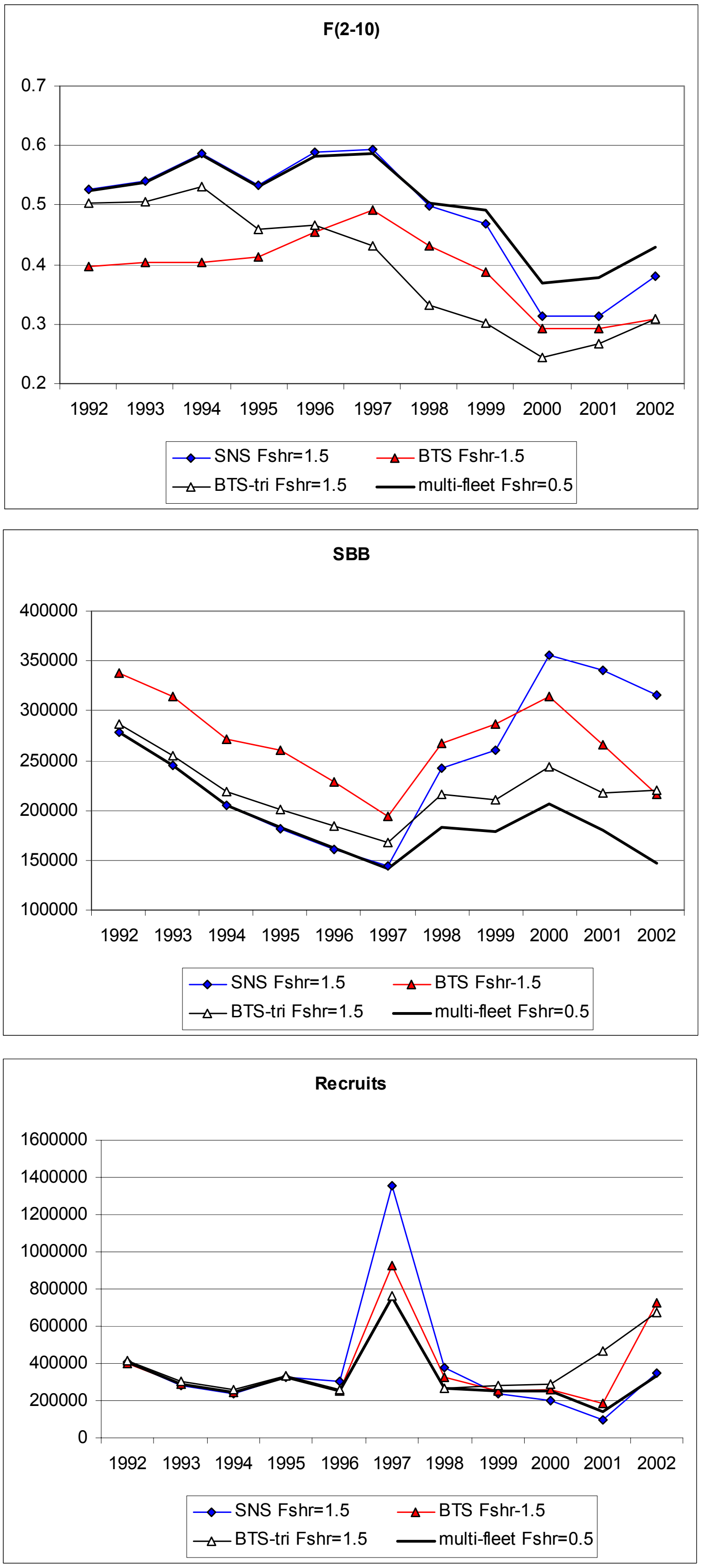


Figure 9.4.1.4 North Sea plaice: Surba output for the BTS-tridens, BTS and SNS survey

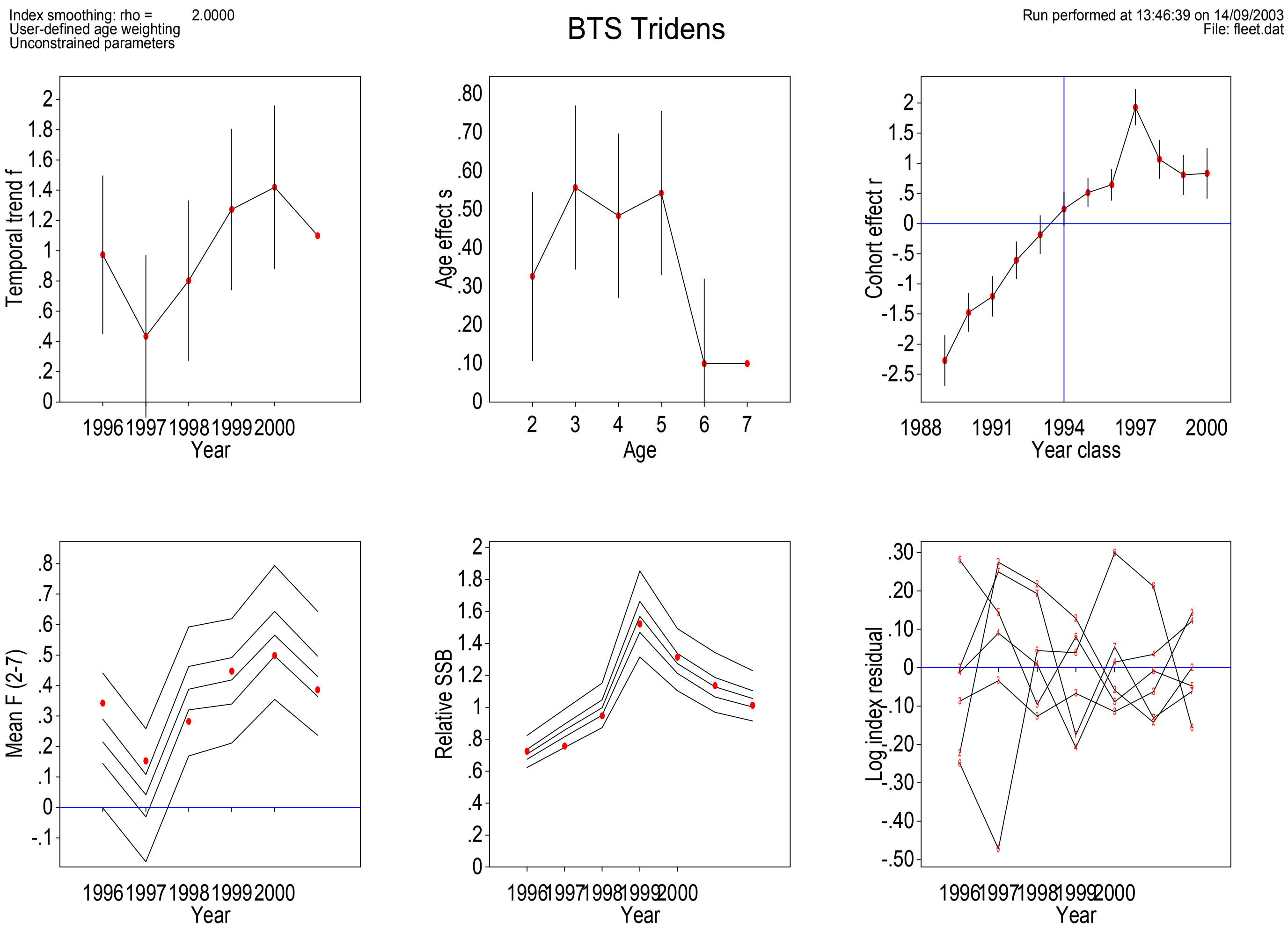


Figure 9.4.1.4 (continued) North Sea plaice: Surba output for the BTS-tridens, BTS and SNS survey.

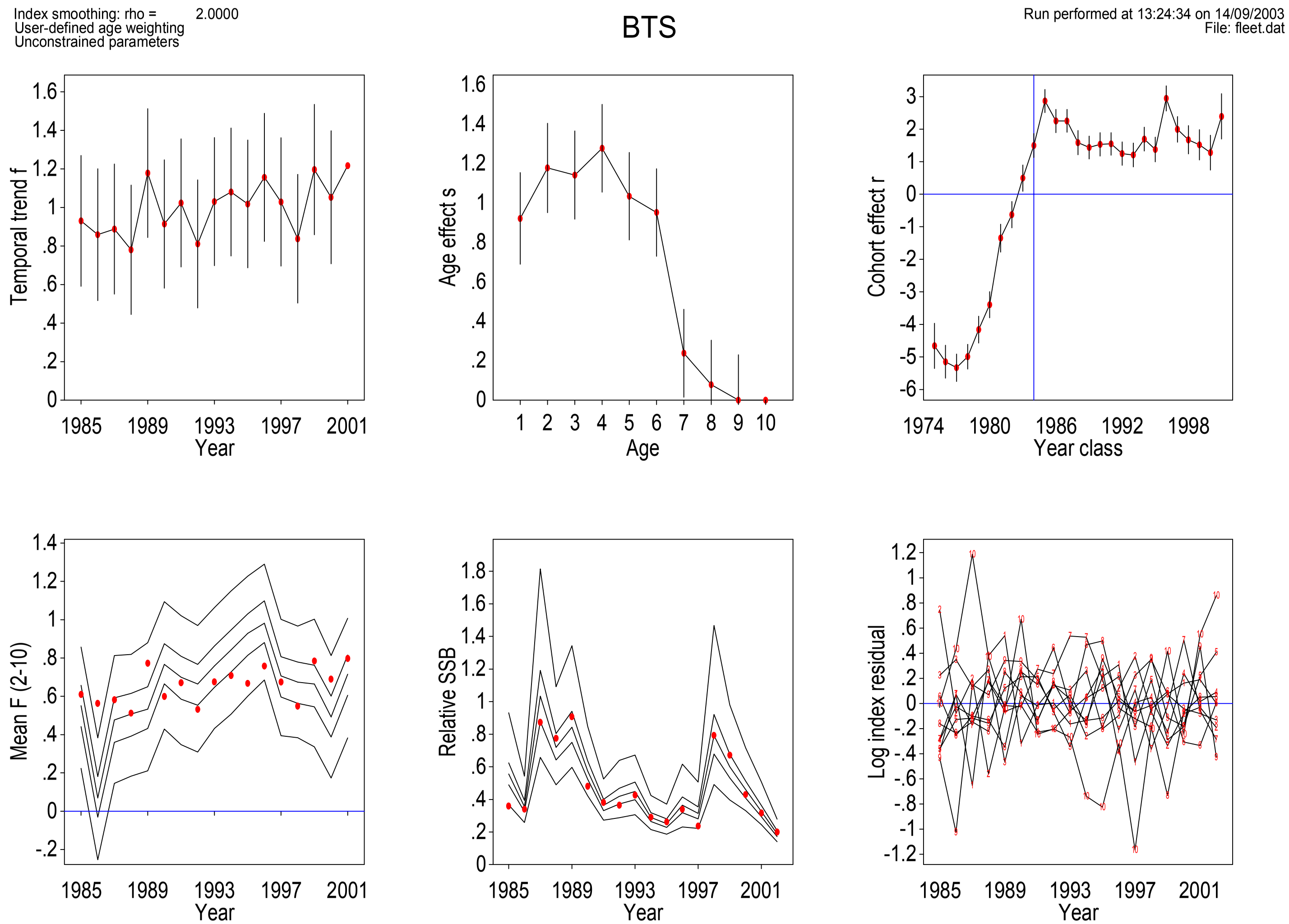


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Figure 9.4.1.4 (continued) North Sea plaice: Surba output for the BTS-tridens, BTS and SNS survey.

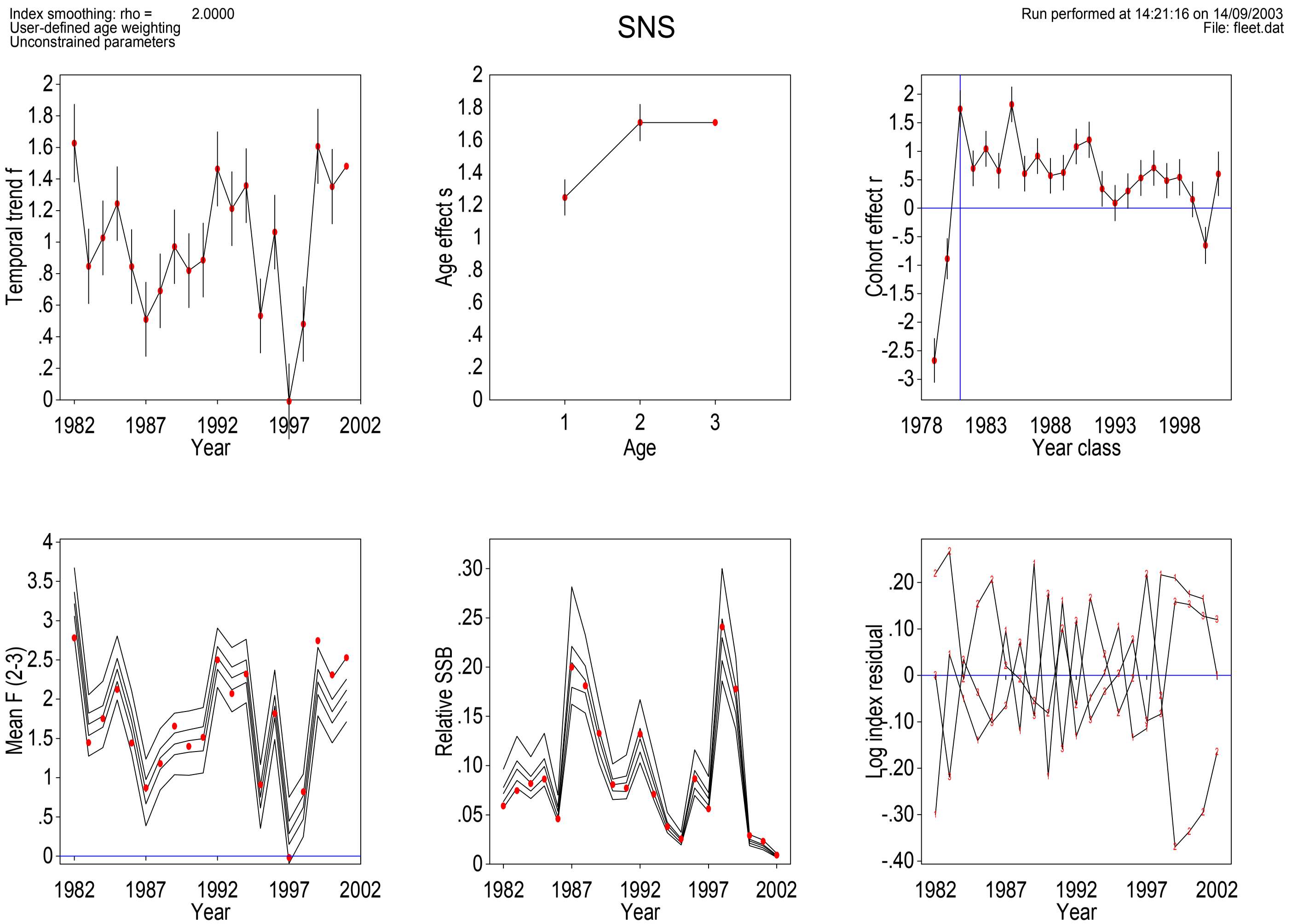


Figure 9.4.1.5 North Sea plaice: Surba estimates of relative SSB compared to the results of a multi-fleet XSA run (F-shrinkage=0.5).

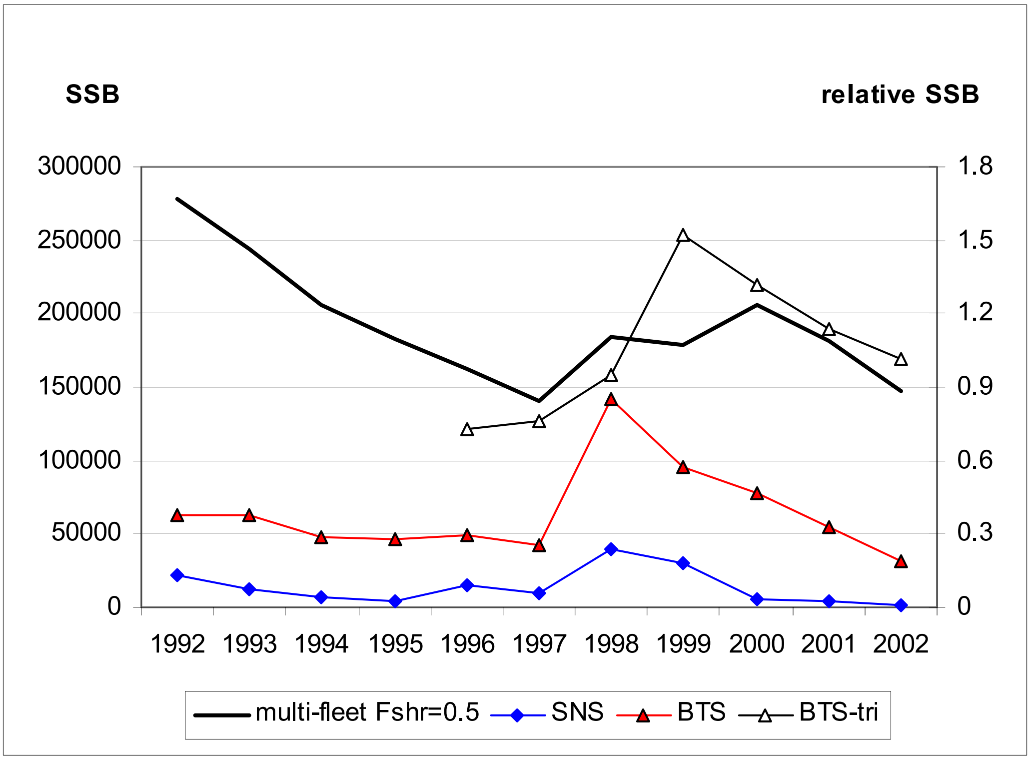
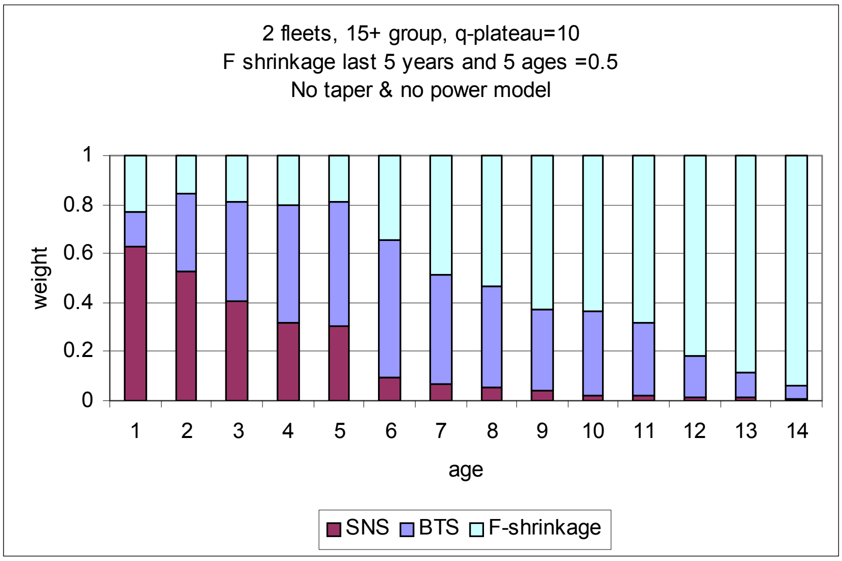
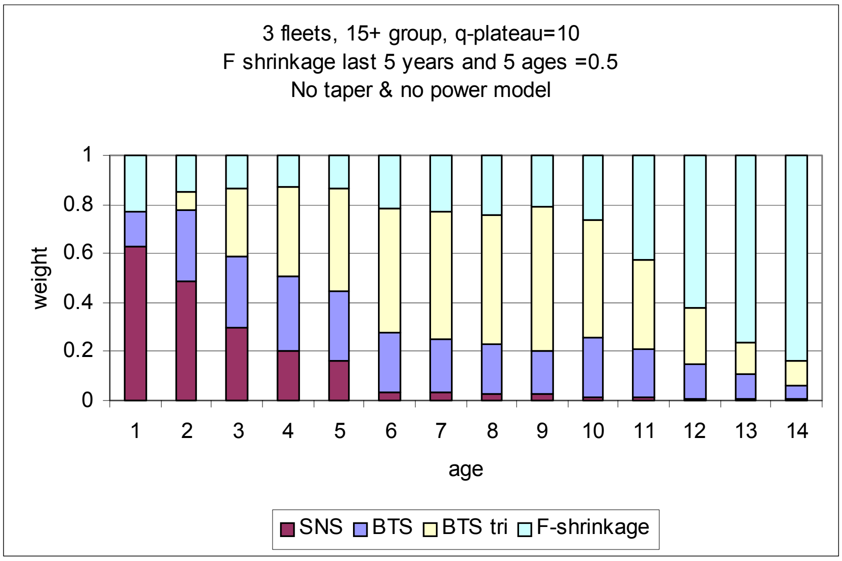


Figure 9.4.2.1 North Sea plaice: relative weighting of the tuning fleets and shrinkage.





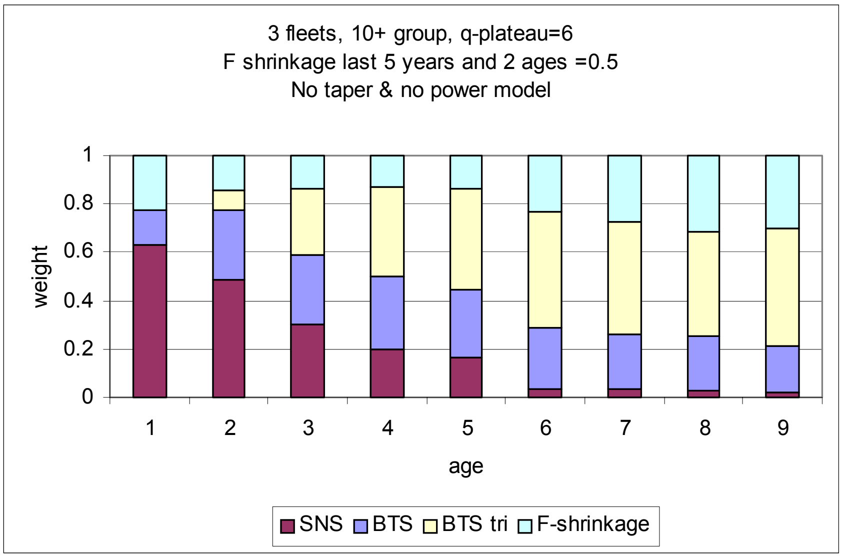


Figure 9.4.2.2 North Sea plaice: Catchability at age plot

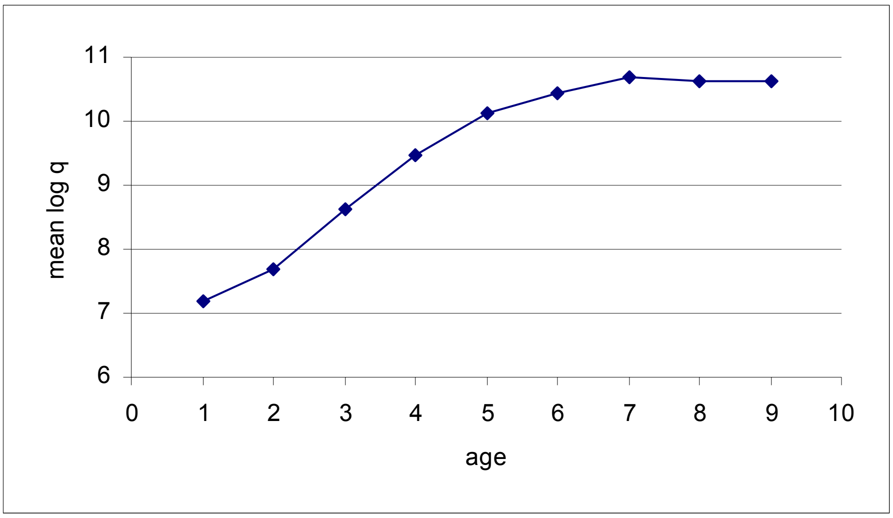


Figure 9.4.2.3 North Sea plaice: retrospective pattern at high and low F-shrinkage.

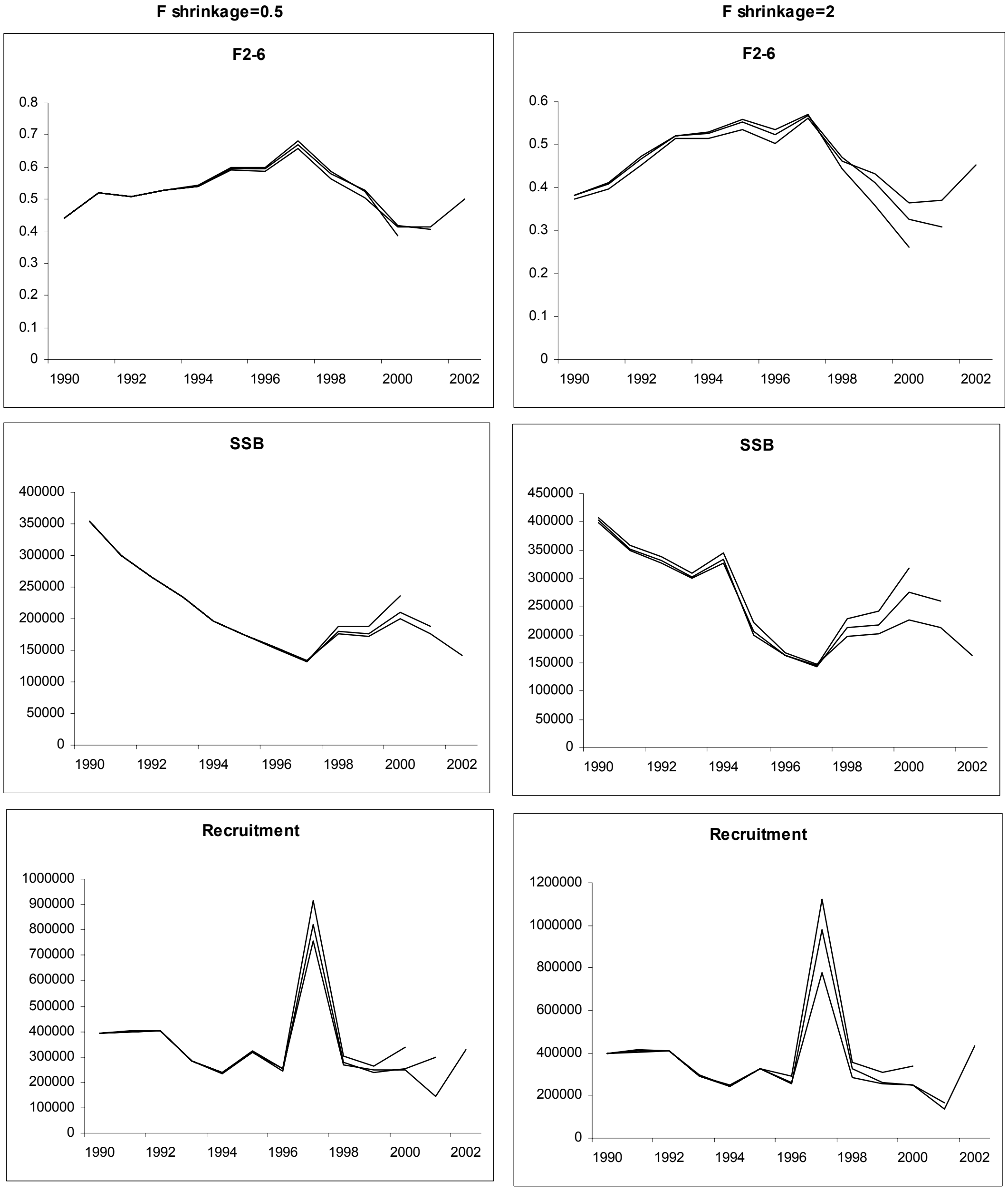


Figure 9.4.2.4 North Sea plaice: The results of the final model compared to the results of last years assessment (ACFM 2002) and some exploratory models.

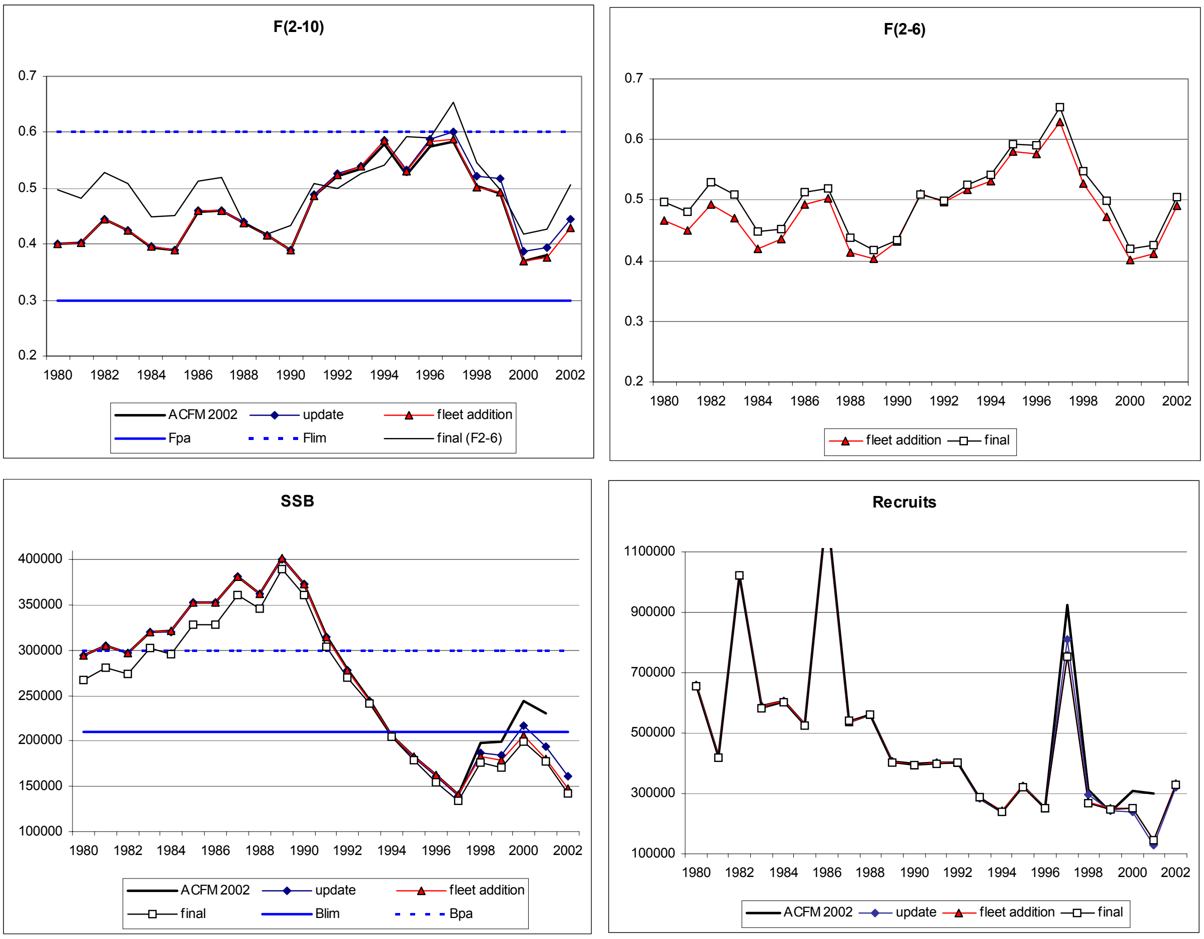
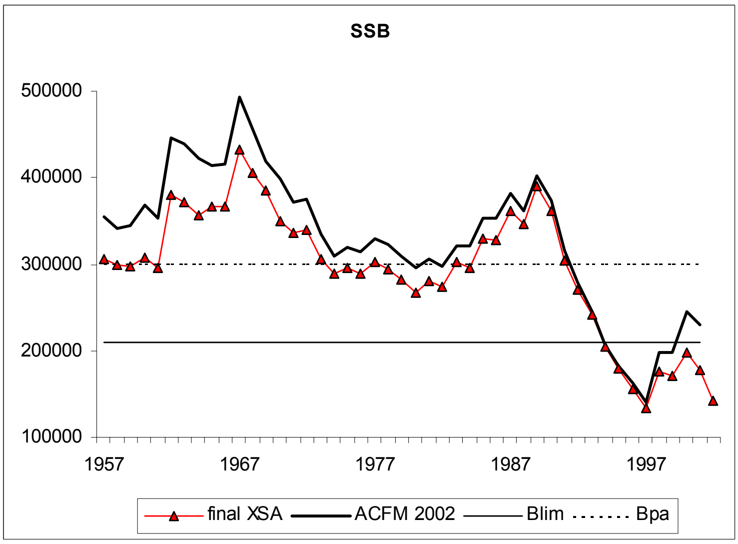
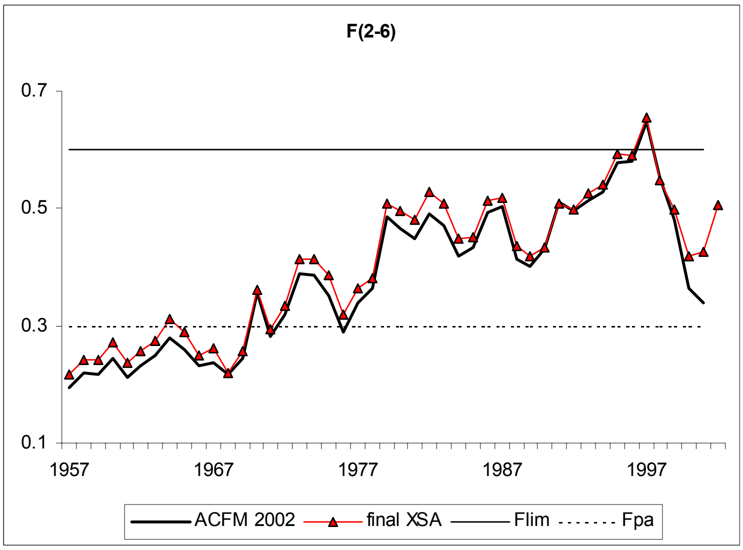


Figure 9.4.2.5 North Sea plaice: The results of the final model compared to the results of last years assessment (ACFM 2002) for the full time scale.





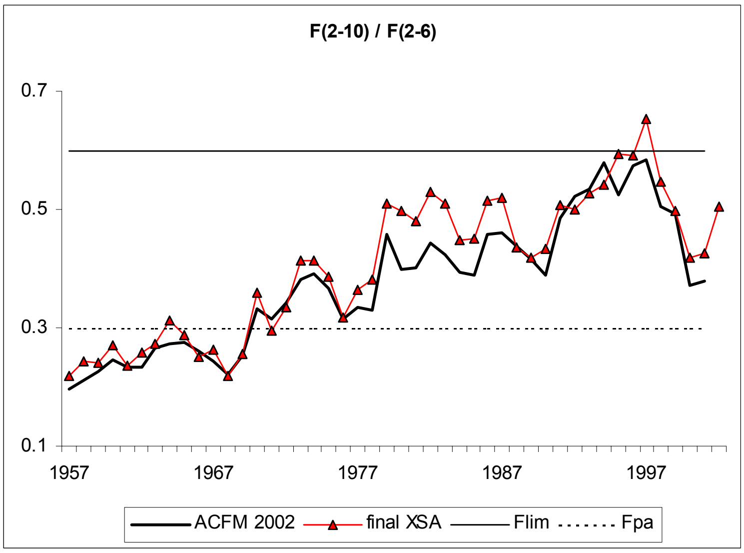
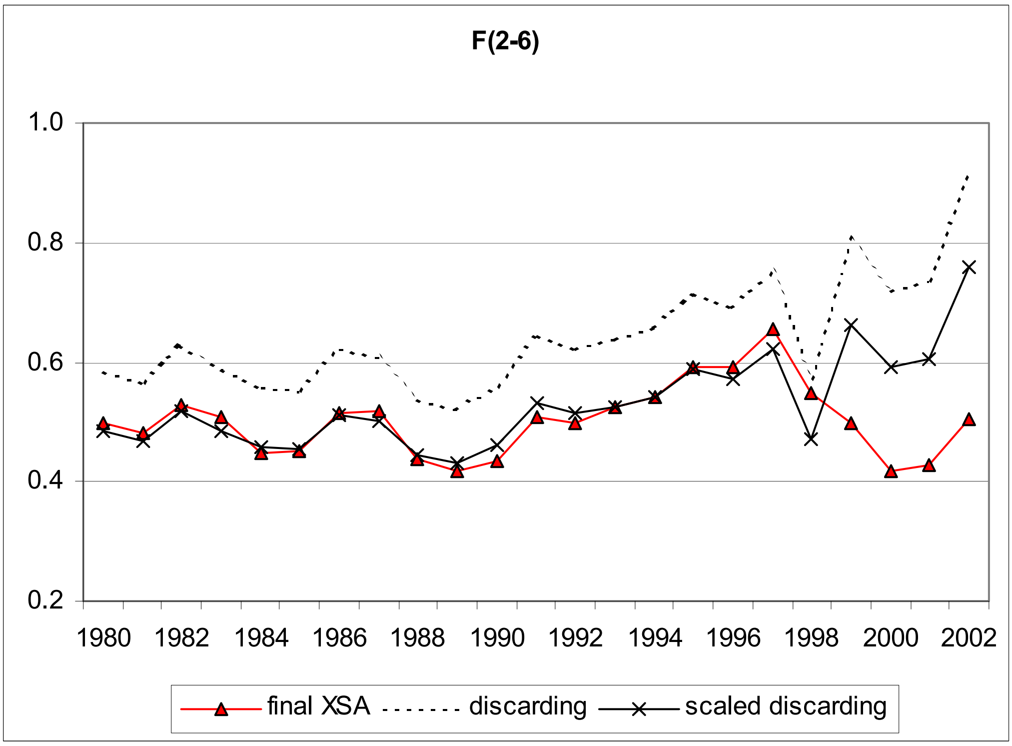


Figure 9.4.3.1 North Sea plaice: The effect of (increased) discarding on the estimation of SSB and Fbar2-6.



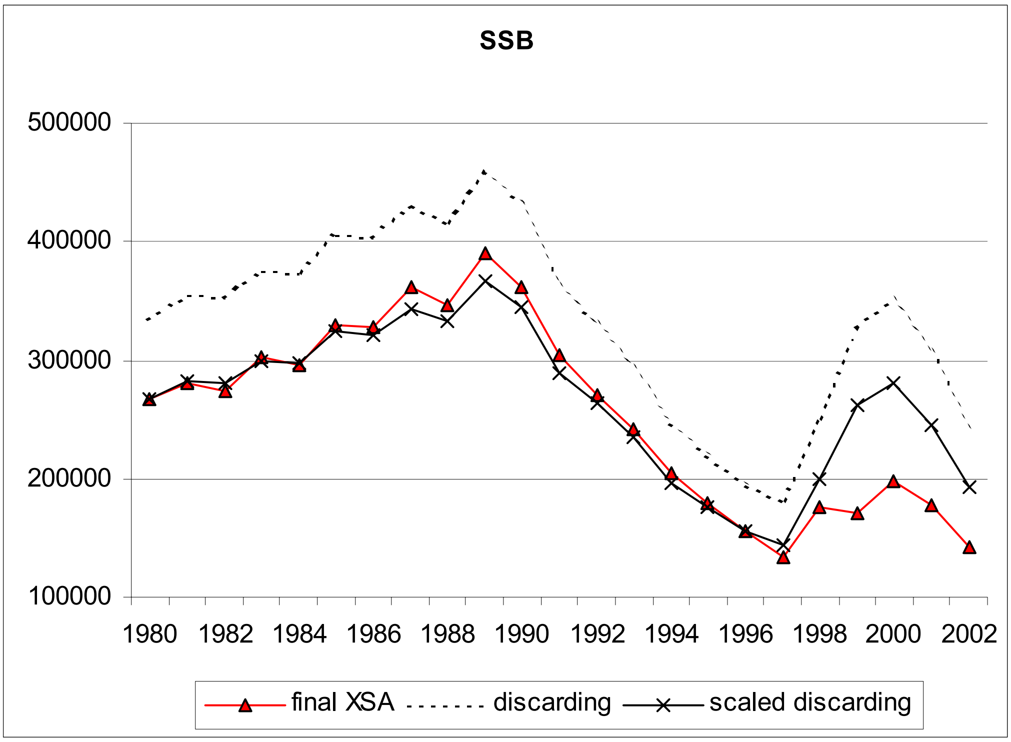


Figure 9.4.3.2 North Sea plaice: Comparison of observed discards proportions from onboard sampling of Dutch beam trawl vessels (1999-2001) with simulated discards proportions based on growth data from otolith back-calculations and BTS and SNS surveys respectively by quarter.

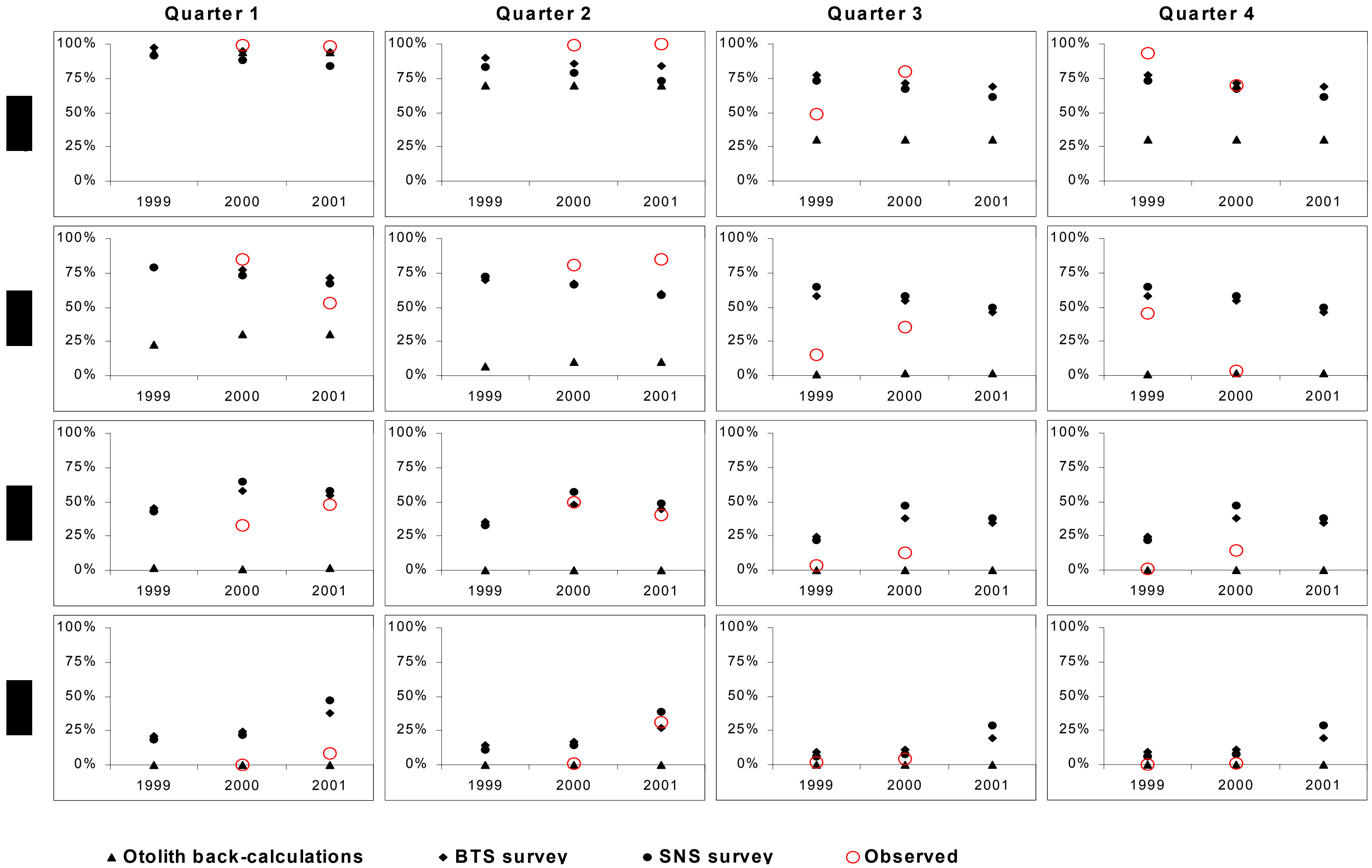


Figure 9.4.3.3 North Sea plaice: Simulated proportion discarded assuming a 80 mm mesh size fishery.

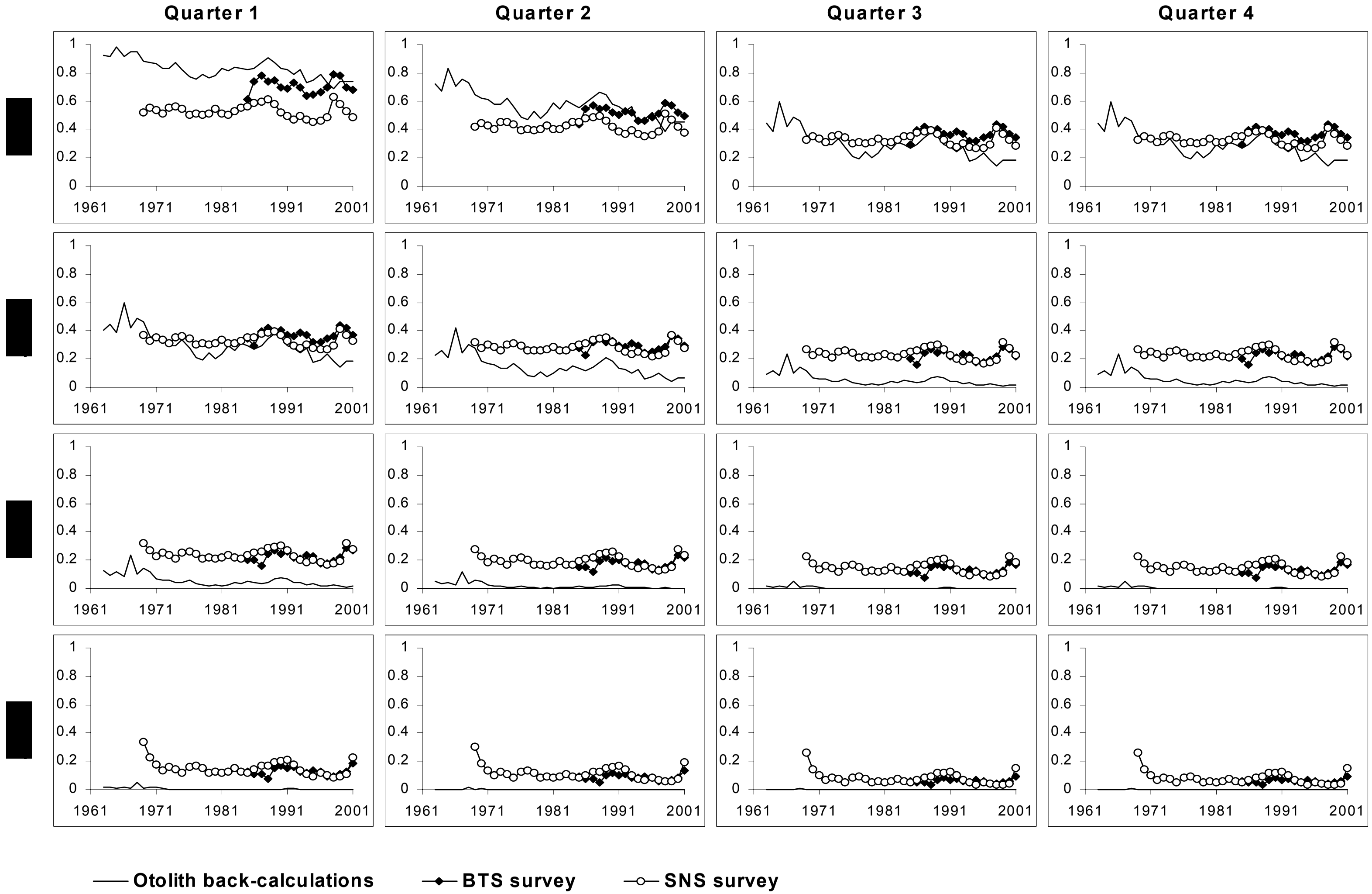


Figure 9.4.3.4 Stock assessment results (SSB, recruitment at age 2 and mean fishing mortality for ages 2 and 3) for three different catch scenario's (landings only, landings and discards assuming 80 mm and 60 mm gear) and using three different data sources to generate the discards information (otolith back-calculations and BTS and SNS surveys respectively).

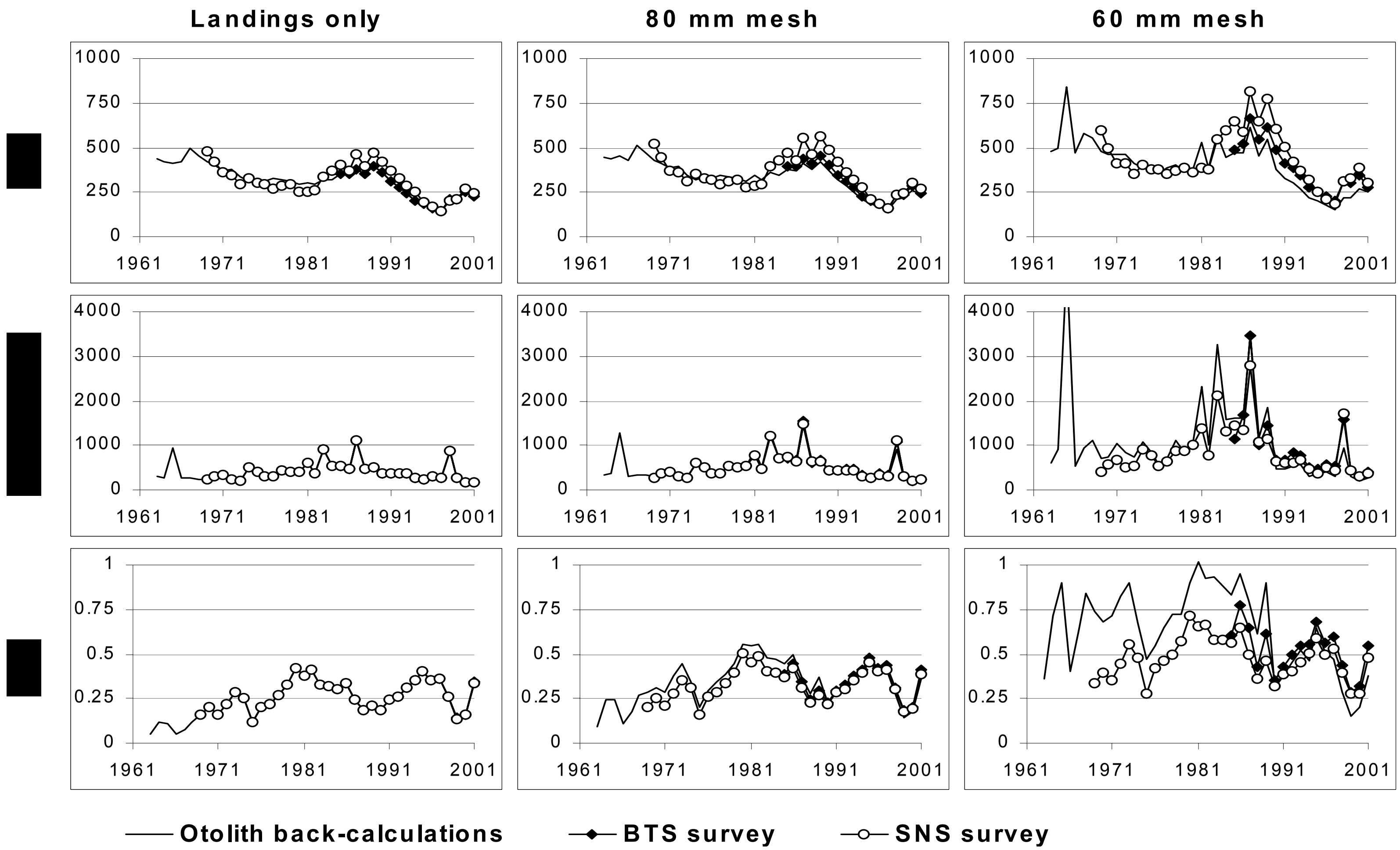
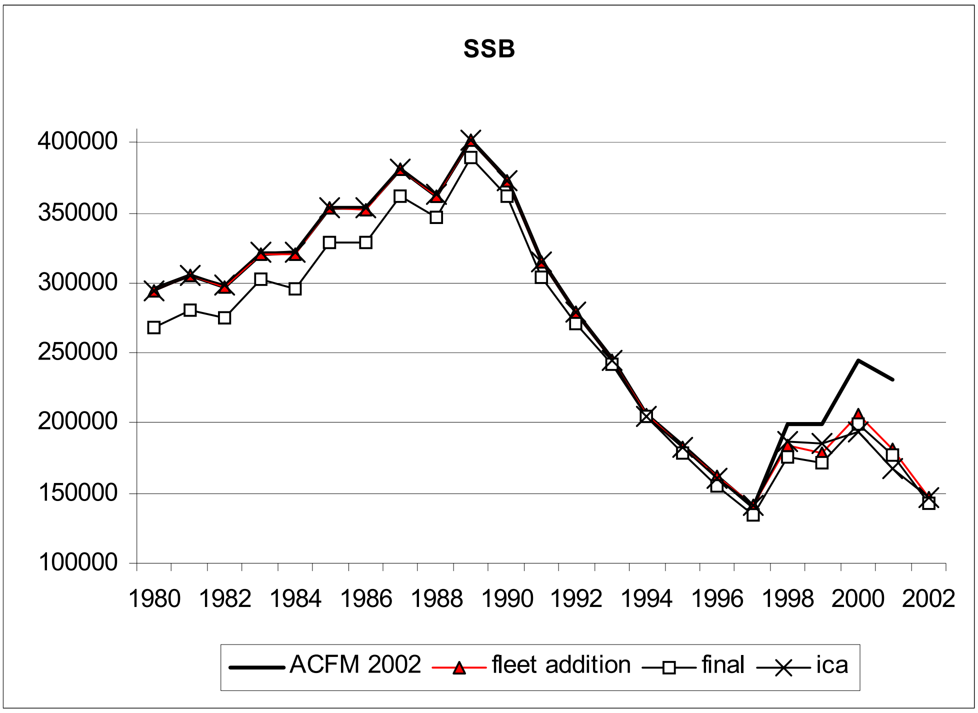


Figure 9.4.3.5 North Sea plaice: (a)The results of the ICA model compared to the results of last years assessment (ACFM 2002), this years final run and an exploratory XSA run (fleet addition). (b) residuals of SSB indices from commercial fleets in an ICA assessment of North Sea plaice.

(a)



(b)

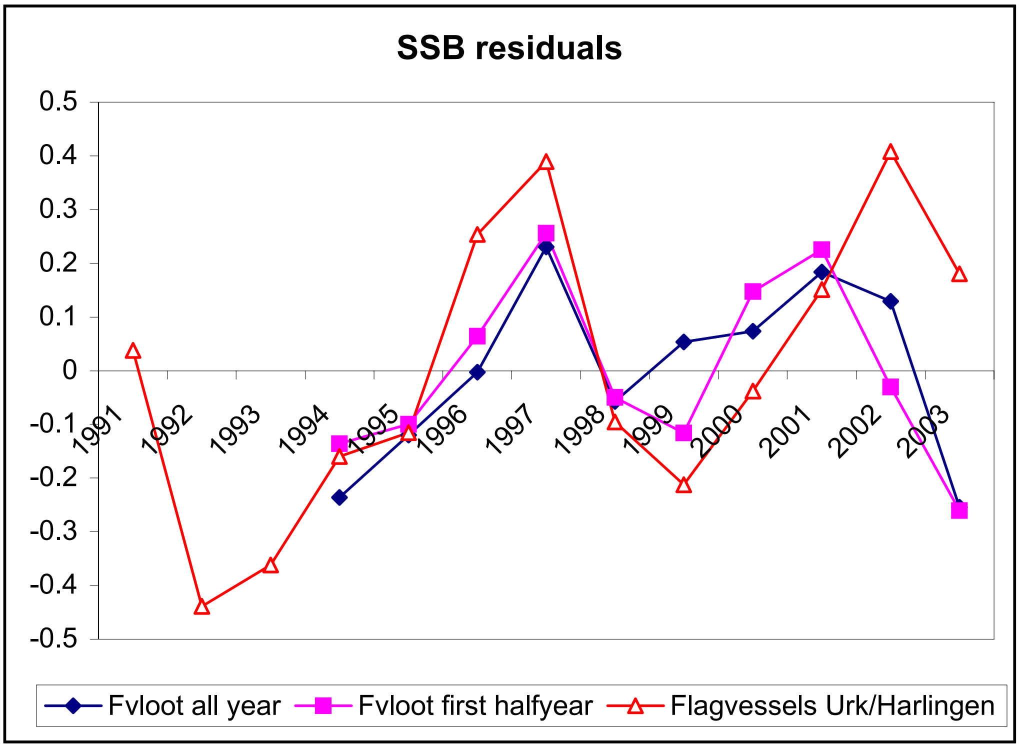


Figure 9.4.3.5 North Sea plaice: The results of the Fishermen's survey.

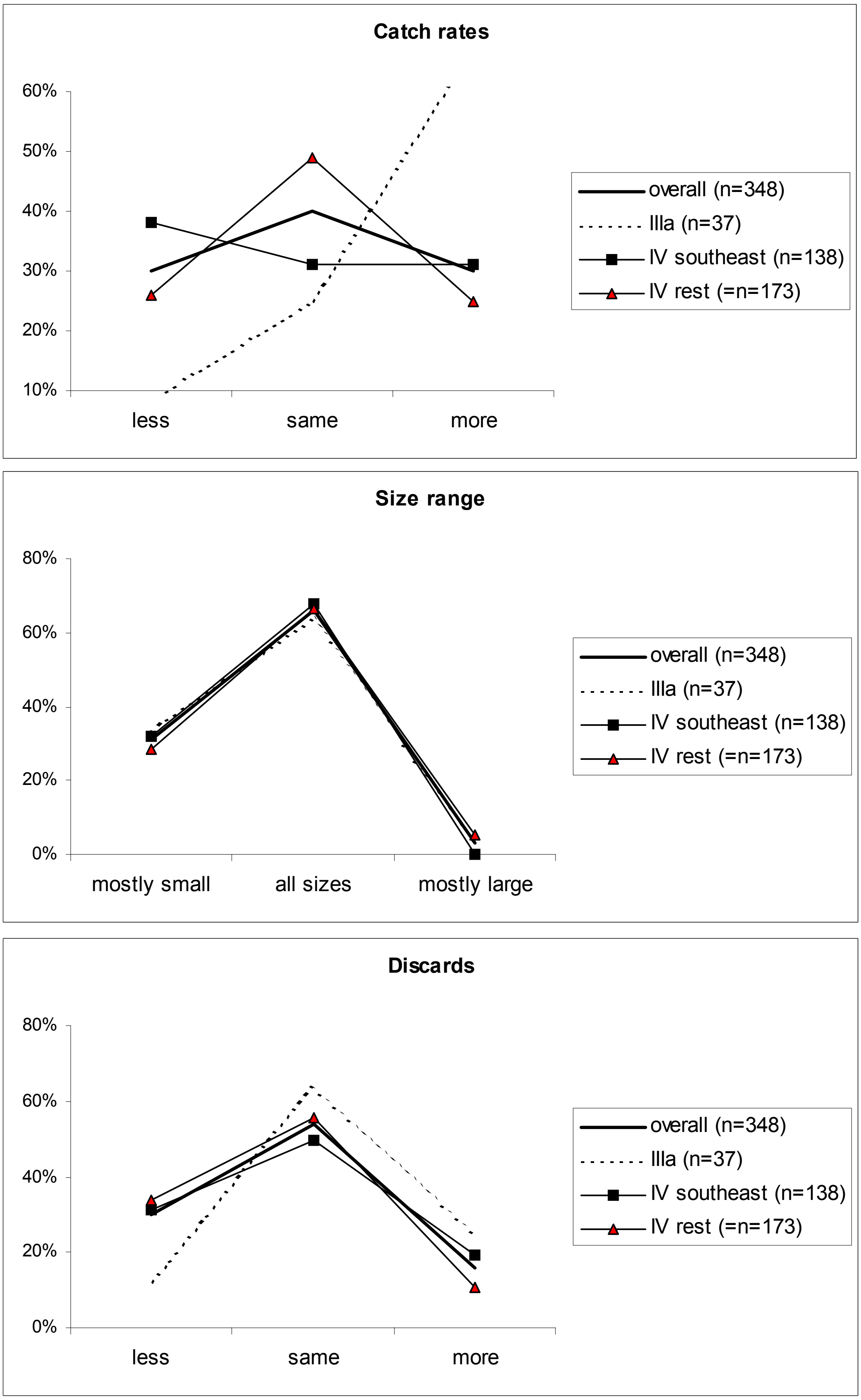


Figure 9.4.4.1 North Sea plaice: Log catchability residuals of final run.

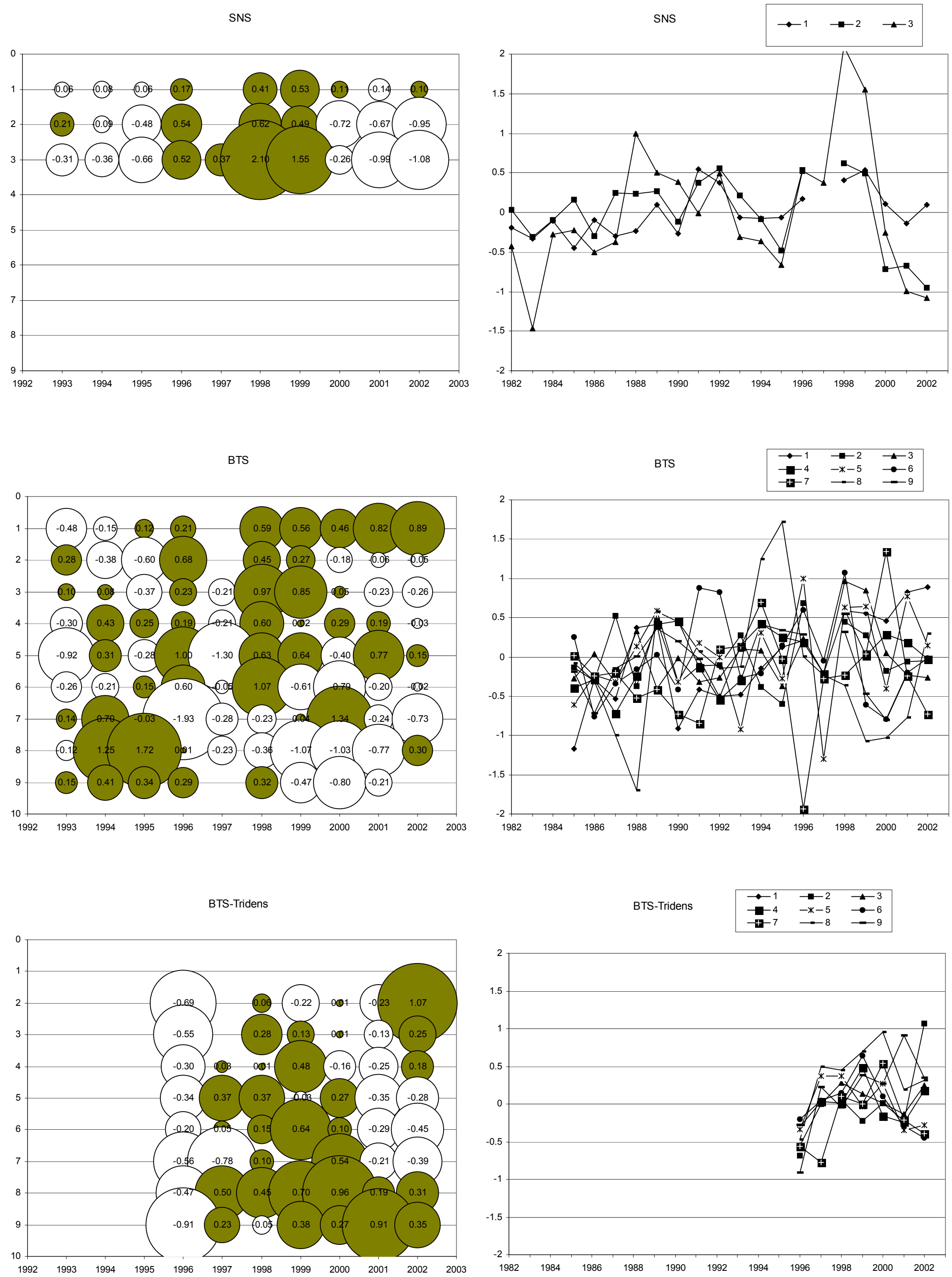


Figure 9.6.1 North Sea Plaice: Overview of the final assessment

Figure 9.7.1 North Sea plaice, short term forecast

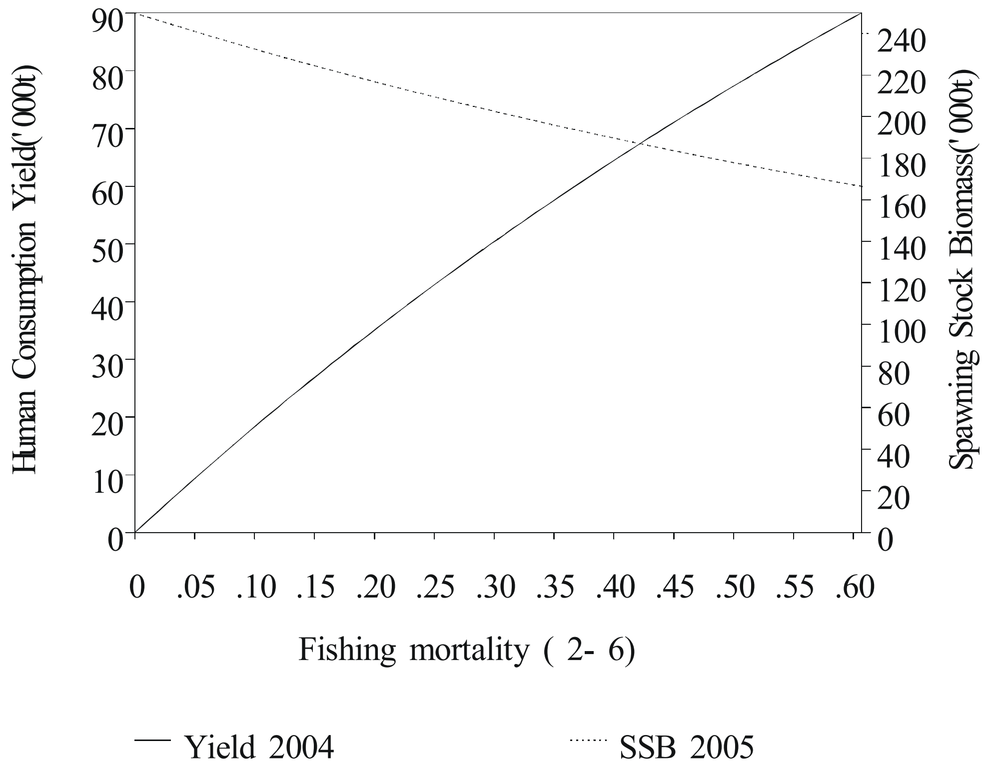


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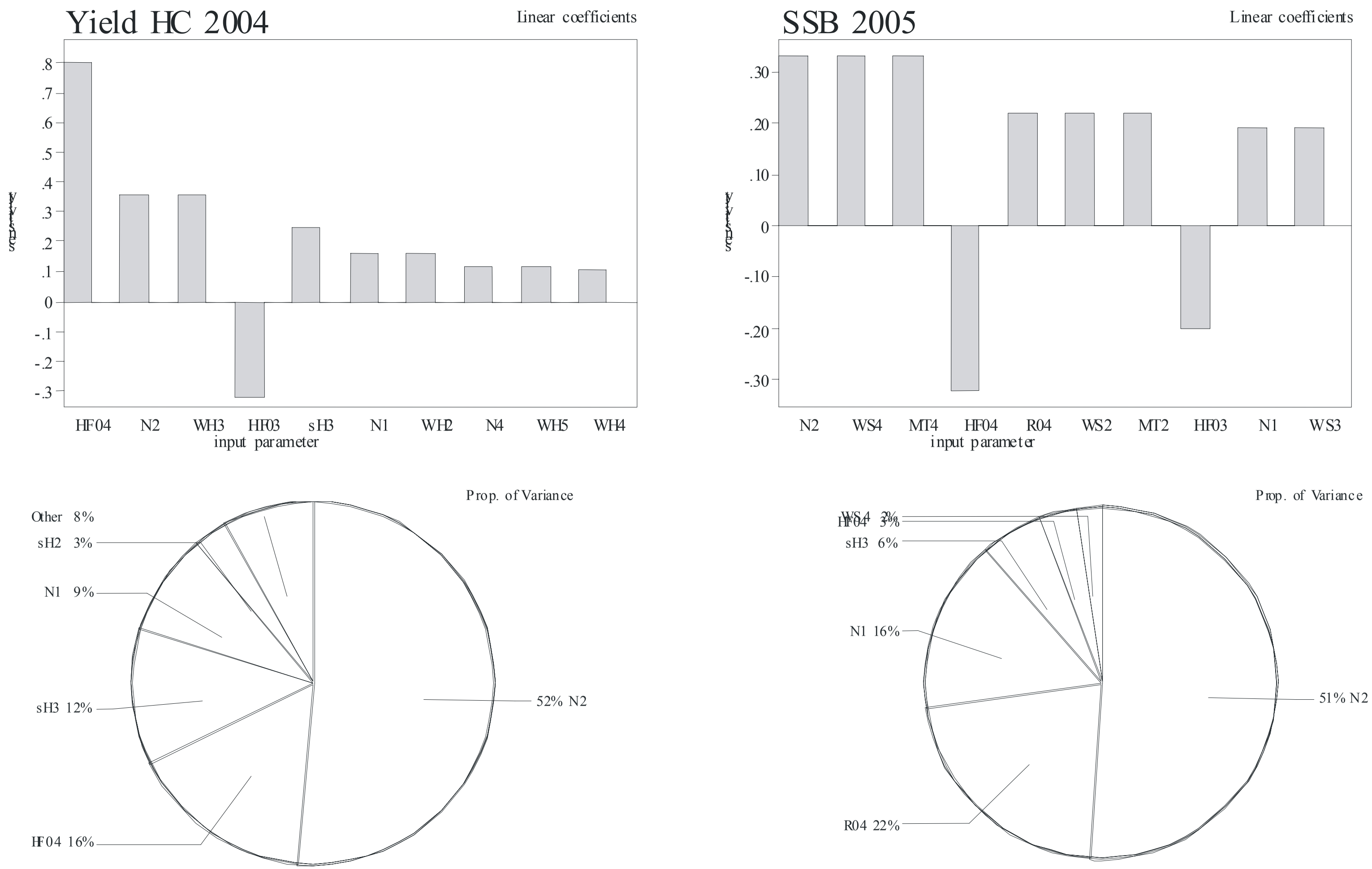
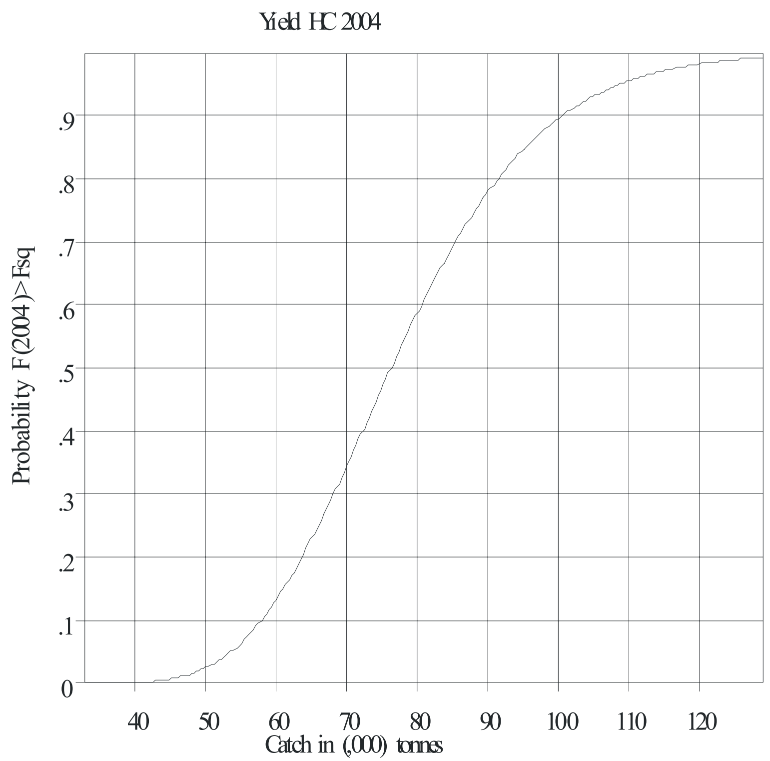
Figure 9.7.2 North Sea plaice, sensitivity analysis of short term forecast



Data from file:W:\Personal\Joel\sec9_ple\projection\PLEIV_MT.SEN on 17/09/2003 a

Figure 9.7.3 North Sea Plaice: Probability profiles for short-term forecast



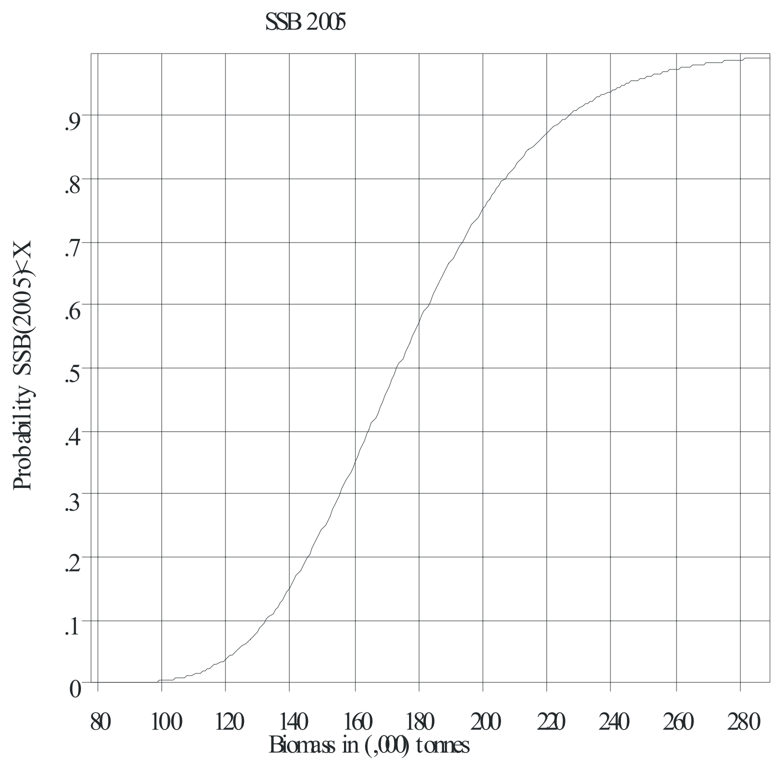


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Figure 9.8.1 North Sea Plaice: Medium term analysis

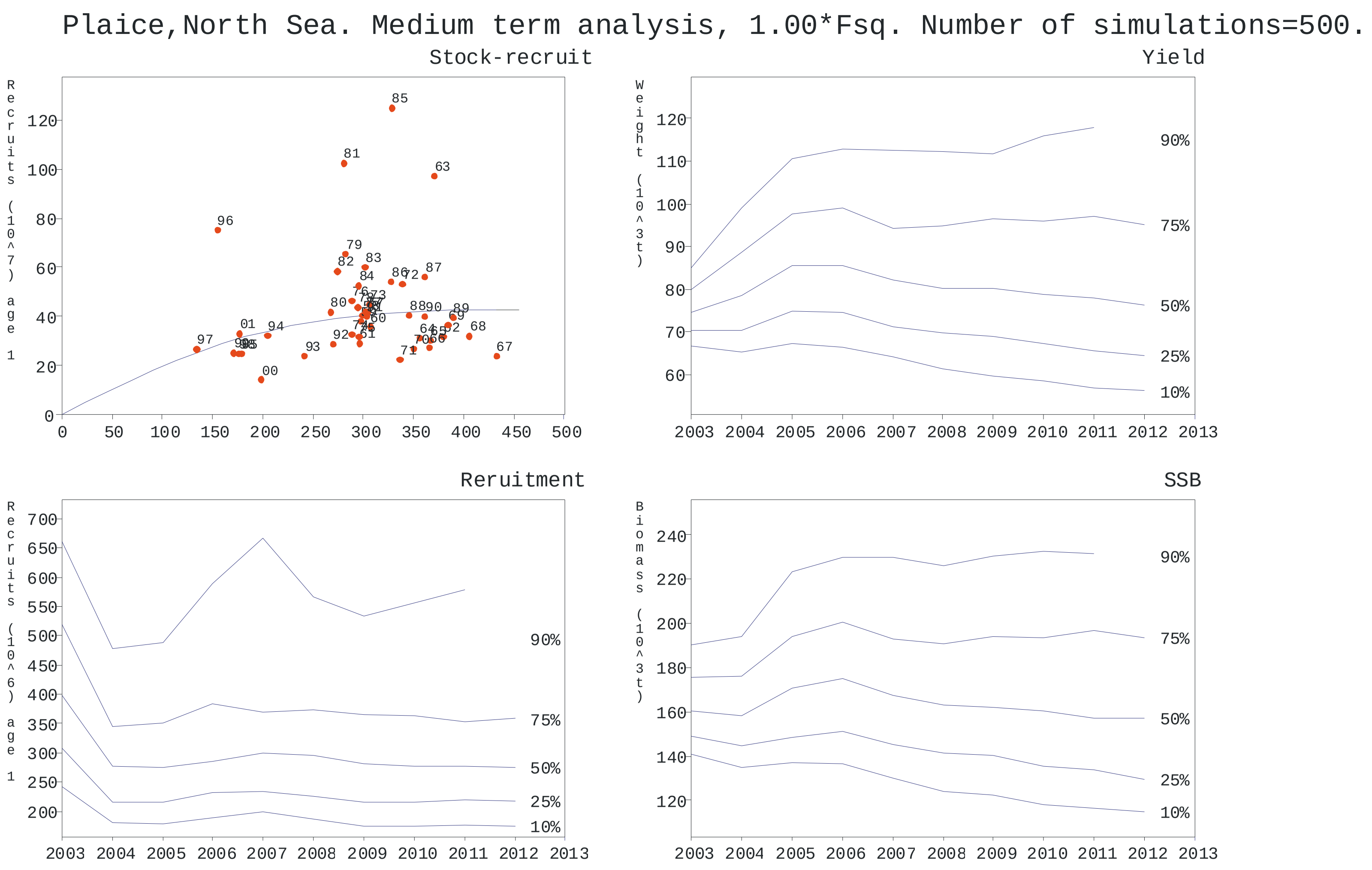

Figure 9.8.2 North Sea plaice. Summary of medium-term analysis. Contours show the probability that SSB will be below $\mathbf{B}_{PA}$ for any combination of year and fishing mortality.

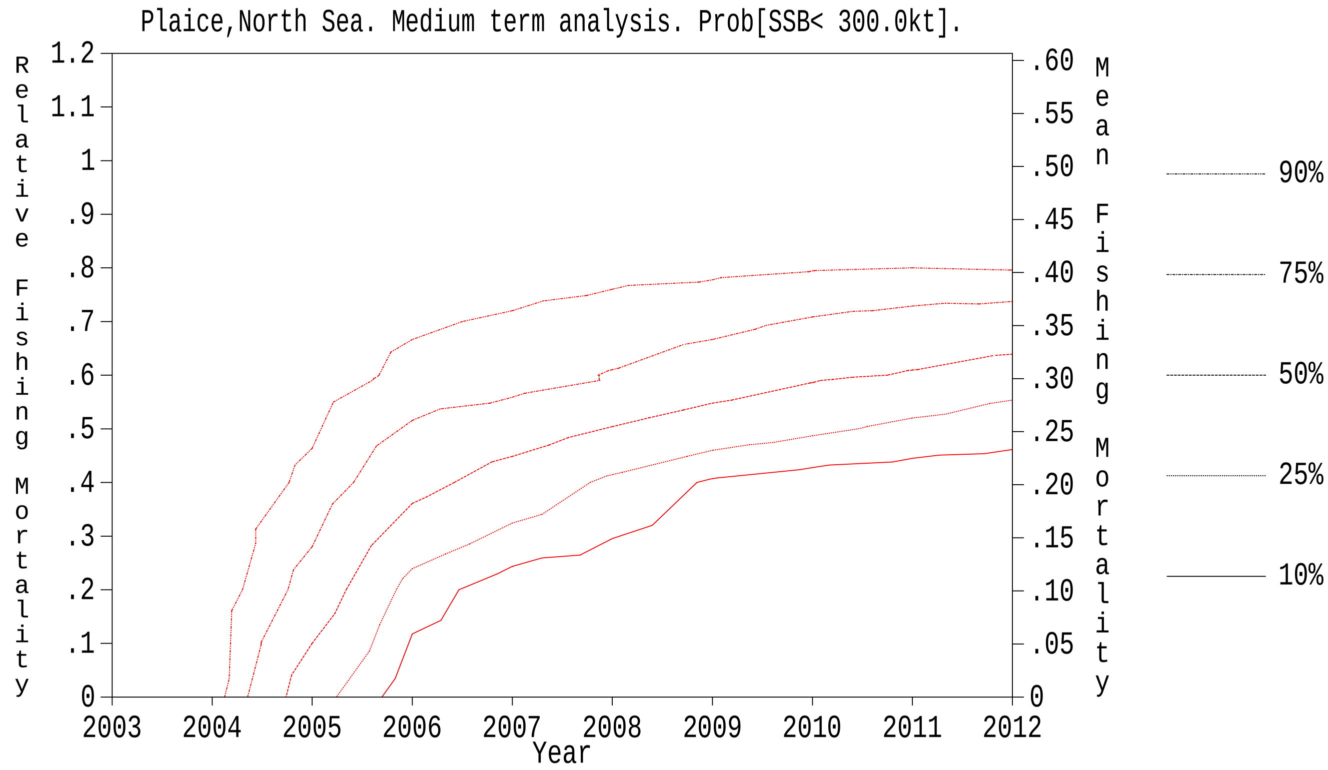

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Figure 9.9.1. North Sea plaice. Estimated reference points.

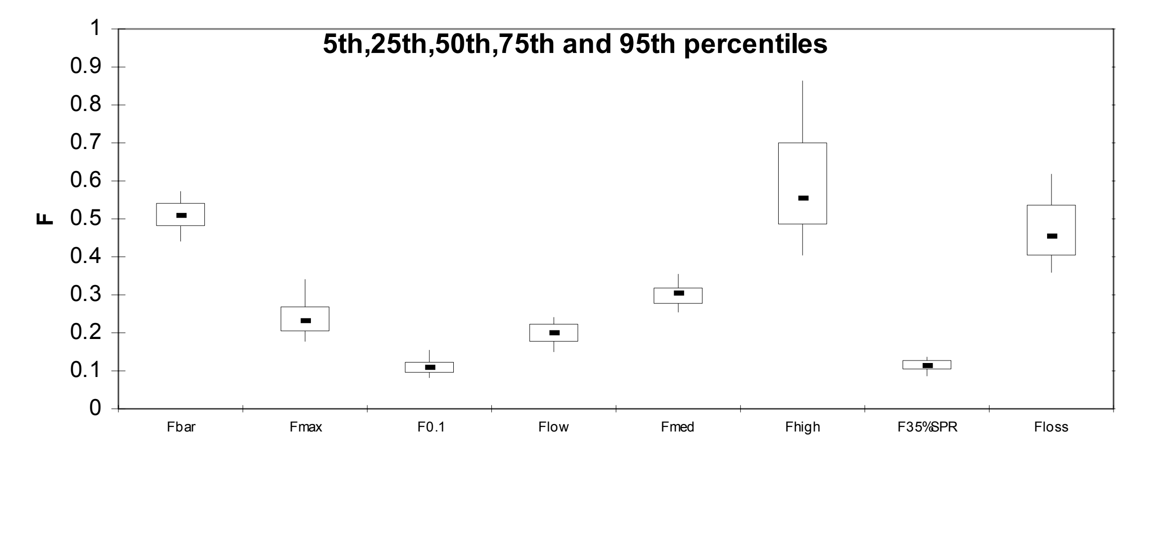


Figure 9.9.2. North Sea plaice. Stock and recruitment relationship

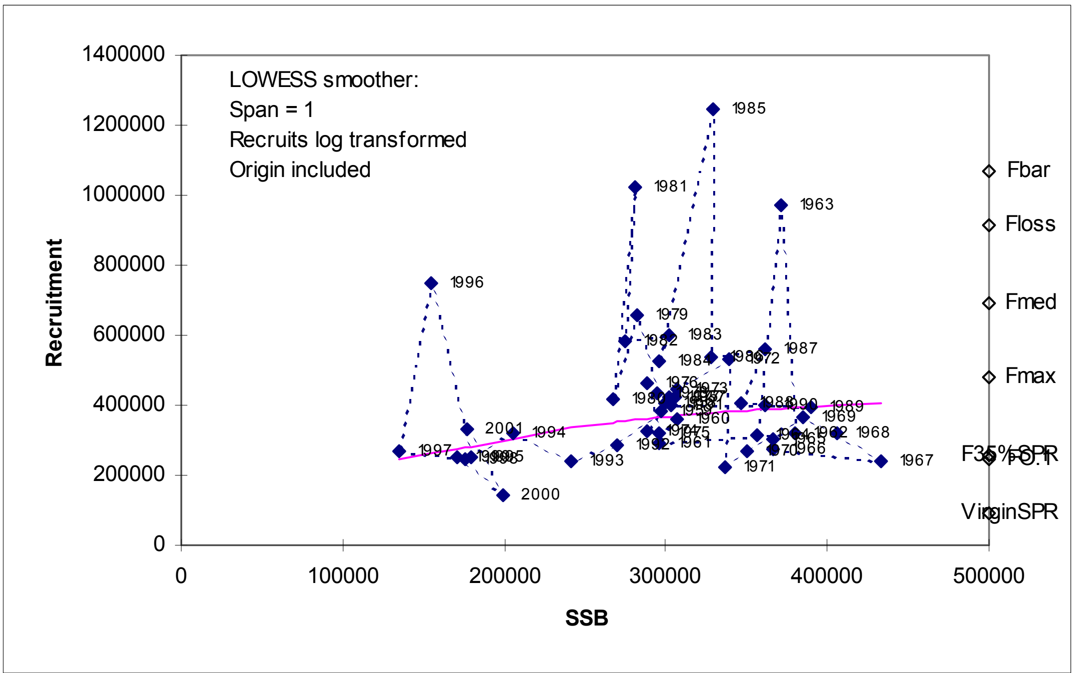


Figure 9.9.3 North Sea Plaice. Long-term projections of stock and yield per recruit, including BRP.

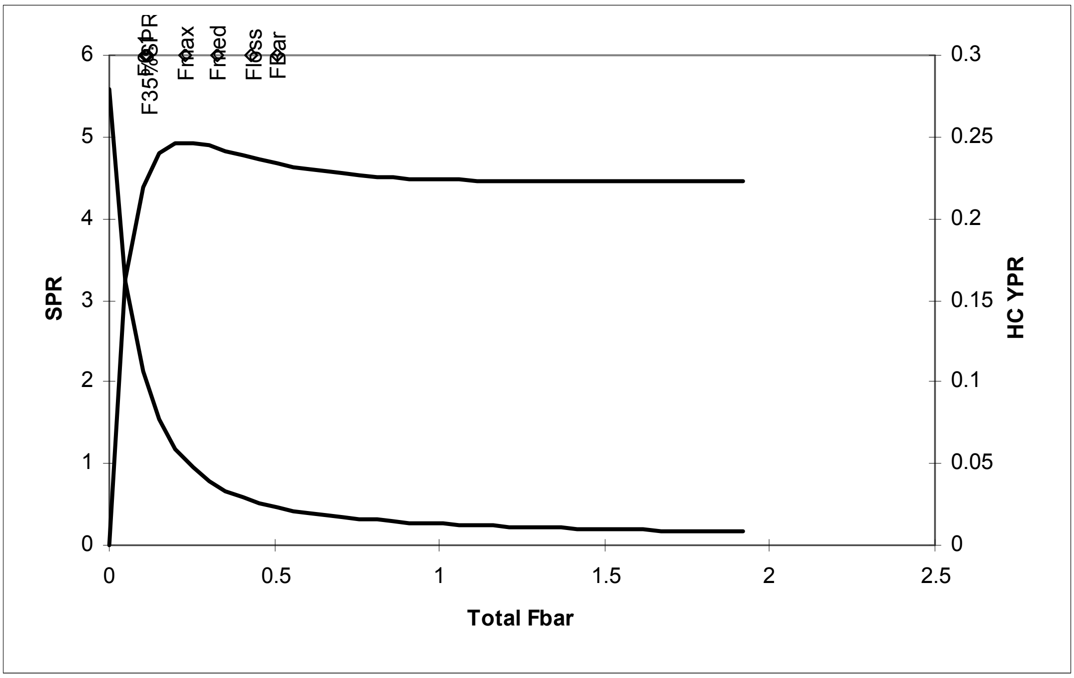


Figure 9.9.4 North Sea Plaice. Stock and fishing mortality relationship.

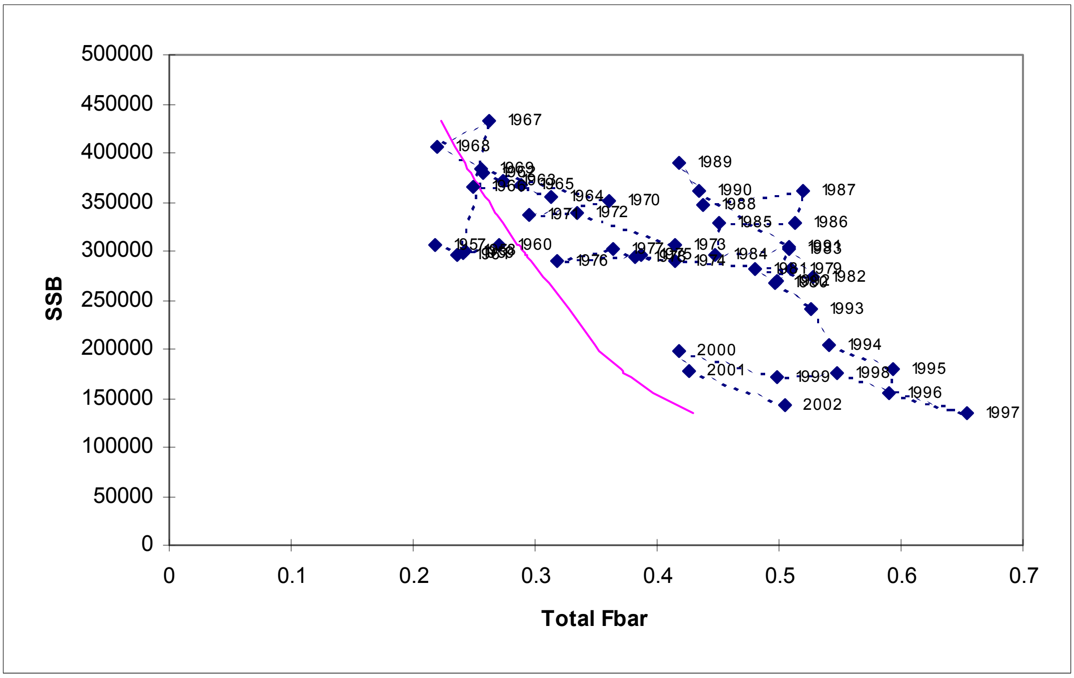
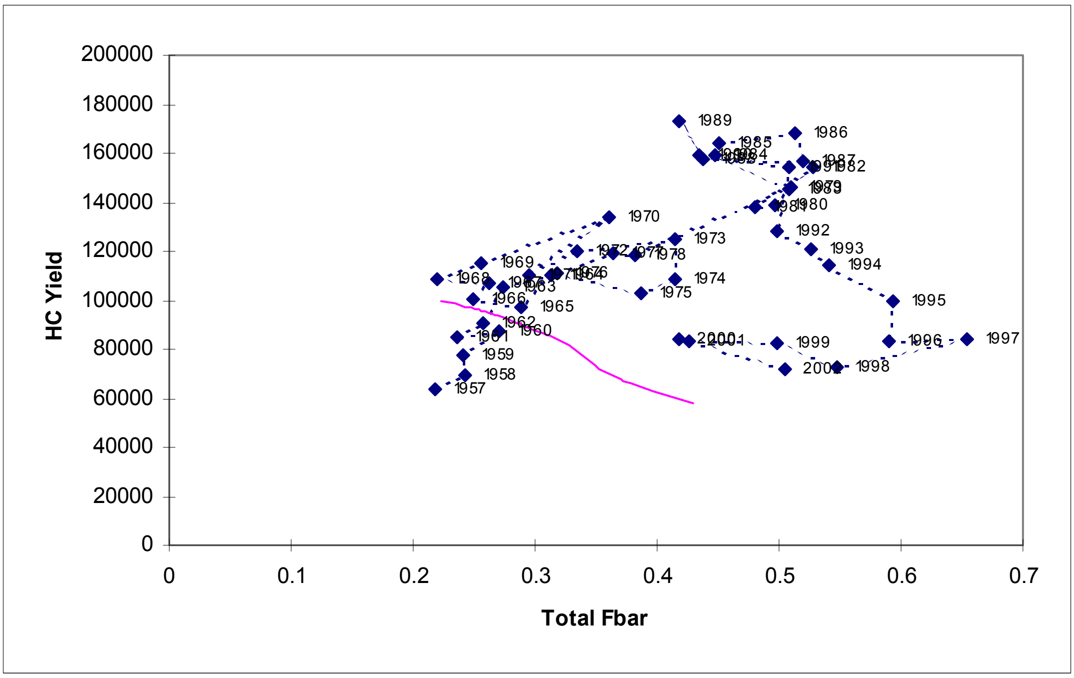


Figure 9.9.5 North Sea Plaice. Yield and fishing mortality relationship.



10 PLAICE IN DIVISION IIIA

The assessment of plaice in Division IIIa is presented here as an update assessment. All the relevant biological and methodological information can be found in the stock annex dealing with this stock. Here, only the basic input and output from the assessment model will be presented.

10.1 The Fishery

The fishery is dominated by Denmark, with Danish landings accounting for more than 90% of the total. A directed plaice fishery is carried out during summer by Danish seiners. Plaice is also an important catch to otter-trawlers and gillnetters, within a mixed cod-plaice fishery.

10.1.1 ACFM advice applicable to 2002 and 2003

ACFM recommended for 2002 to reduce fishing mortality below the proposed $\mathbf{F}_{pa}$ ($\mathbf{F}_{pa}$ = 0.73), corresponding to landings in 2002 of less than 8,500 t, and also to maintain spawning stock biomass above $\mathbf{B}_{pa}$ ($\mathbf{B}_{pa}$ = 24,000 t). $\mathbf{F}_{pa}$ was set to the value of $\mathbf{F}_{med}$ in 1998. $\mathbf{B}_{pa}$ was set to a smoothed value of $\mathbf{B}_{loss}$. Neither $\mathbf{F}_{lim}$ nor $\mathbf{B}_{lim}$ are defined. A re-evaluation of the advice was requested in April 2002. At the re-evaluation ACFM noted that "the re-evaluation is based on preliminary data and the uncertainty on the estimates is larger than in an assessment based on the full dataset. The fishing mortality to be used for a possible adjustment of the TAC should be below=0.94*$\mathbf{F}_{sq}$ ($\mathbf{F}_{pa}$ = 0.73). The TAC 2002 should be set below 11,600 t."

ACFM recommended for 2003 to reduce fishing mortality below the proposed $\mathbf{F}_{pa}$ ($\mathbf{F}_{pa}$ = 0.73), corresponding to landings in 2003 of less than 18,400 t.

10.1.2 Management applicable in 2002 and 2003

TAC in 2002 was 8 000 t and in 2003 16 700 t.

The use of beam trawl in the Kattegat is prohibited. Minimum mesh size is 90 mm for towed gears, and 100 mm for fixed gears. The minimum landing size is 27 cm.

10.1.3 The fishery in 2002

The official landings reported to ICES are given in Table 10.1.3.1. The annual landings used by the Working Group, available since 1972, are given by country for Kattegat and Skagerrak separately in Tables 10.1.3.2 and 10.1.3.3. In the start of this period, landings were mostly taken in Kattegat but from the mid-1970s, the major proportion of the landings has been taken in Skagerrak. In 2002, around 80% of the landings were taken in Skagerrak.

According to ICES official tables (Belgian, Norwegian and German landings) and national statistics (Danish and Swedish landings) total landings in 2002 were estimated to be 25% less than in 2001. No quantitative information on mis-reporting is available, but it is not suspected to be major in this fishery.

10.2 Data available

10.2.1 Landings

Landings data by country and TACs are presented in table 10.1.3.1-3.

10.2.2 Age compositions

Age compositions of the landings are presented in table 10.2.2.1.

Age disaggregated discard data from the Swedish trawl fishery was made available in 2003 and should be included in future assesments. Some discard estimates in the Skagerrak (Report of the Study Group on Discards and By-Catch Information, ICES CM 2002/ACFM:9) indicate that the otter trawlers catch and discard the highest amount of small fish. However, these data are not related to the number of fish retained, nor are they age-disaggregated. Therefore, at present these discard estimates cannot be included in the assessment

10.2.3 Weight at age

Weights at age in the stock were assumed equal to those in the catch. Weight at age data is presented in Table 10.2.3.1. The procedure for calculating mean weights is described in the stock annex.

10.2.4 Maturity and natural mortality

Maturity and natural mortality are assumed constant for all years. Natural mortality is set at 0.1 for all ages. A knife-edge maturity distribution was employed: age group 2 was assumed to be immature whereas age 3 and older plaice were assumed mature.

10.2.5 Catch, effort and research vessel data

Survey data used for calibration of the assessment are presented in Tables 10.2.5.1. The tuning fleets consist of three commercial tuning fleets and the four survey tuning series that were added in the 2002 stock assessment.

10.3 Catch at age analysis

Catch at age analysis was carried out according to the specifications in the stock annex. The model used was XSA. Results of the analysis are presented in table 10.3.1 (diagnostics), 10.3.2 (fishing mortality at age), 10.3.3 (population numbers at age), and 10.4.4 (stock summary). The stock summary is also shown in Figure 10.3.1 and the historical performance of the assessment is shown in Figure 10.3.2.

SSB in 2003 is well above $\mathbf{B}_{pa}$ and fishing mortality is about $\mathbf{F}_{pa}$. Stock and recruitment indices are indicated in Figure 10.3.3.

10.4 Recruitment estimates

Recruitment estimation was carried out according to the specifications in the stock annex. Average recruitment in the period 1978-2001 was 47 million (geometric mean) 2-year-old-fish used as recruitment in 2003-2005.

Year Class	Age in 2003	XSA Thousands	GM (1978-2002) Thousands
1999	4	81108	
2000	3	34161	
2001	2		47356
2002	Recr. age 2		47356

10.5 Short term prognosis

The short-term prognosis was carried out according to the specifications in the stock annex. The model used was MFDP. Input parameters are presented in Table 10.5.1. Results are presented in Table 10.5.2. The strong 1998 and 1999 year-classes will comprise 75% of the landings and 54% of SSB in 2004. Their proportion will decrease to 31% in SSB in 2005.

10.6 Comments

10.6.1 Compilation of commercial tuning series

During its October 2002 meeting ACFM appreciated the inclusion of new survey tuning series, and recommended that WGNSSK reconsidered using the commercial tuning series in the assessment. The data exploration in 2003 was deliberately limited as assessment of the plaice stock in Div. IIIa was regarded as subject to the effort category "update assessment" only. Some comments are, however, provided on this issue for a forthcoming benchmark assessment.

Present commercial tuning series as measures for stock abundance are considered questionable due to the aggregated level of information provided in the logbooks, where catch and effort, are provided by statistical square and fishing trip only. Consequently, fishing effort is defined as standardised days fishing calculated from duration of total trip. Furthermore, catch composition is available as market weight categories only and a common ALK, obtained from the market sorting categories irrespective of geartype and fishing area, is applied to the catch by market categories of the fleets. The poor information on catch length composition (only 4 market weight categories) from the fisheries, results in poor precision of calculated age composition of catches. In addition, application of a common ALK results in a smoothen calculated age composition. The procedure also causes an auto-correlation between the commercial tuning fleets and the catch-at-age matrix.

The commercial tuning series are therefore considered of poor quality as stock abundance measures and further inclusion in calibration of assessment in their present format should be evaluated in a forthcoming benchmark assessment.

10.6.2 Issues to be addressed in a forthcoming benchmark assessment

Although discard in the plaice fishery in Div. IIIa is not supposed to be significant, inclusion of available discard data from Sweden (per age, length and quarter) for otter trawlers, should be attempted in a benchmark assessment.

Use of weight at age and maturity data available from Swedish IBTS, quarter 1 and 3, should be attempted in future assessments. Also inclusion of Danish maturity data available for the recent years. Inclusion of those data will improve the overall quality of the assessment significantly, as only a knife-edge assumption is used presently.

The present indices for stock abundance do not convey the same trend and thus results in a wide range of stock perceptions if used individually. In addition to the validity of commercial tuning series as described in Sec. 10.6.1, all indices should be explored properly in order to justify the different signals.

Abundance indices from a Danish 0-group survey with R/V "Havkatten" since 1957 should be explored for possible inclusion as a recruitment estimator.

A benchmark assessment for this stock is foreseen in 2005

Table 10.1.3.1 Plaice in IIIa. Official landings in tonnes as reported to ICES and WG estimates, 1972-2002

Year	Denmark		Sweden		Germany		Belgium		Norway		Total			
	Official	WG est.	Official	WG est.	Official	WG est.	Official	WG est.	Official	WG est.	Official	Unalloc.	WG est.	TAC
1972		20,599		418		77				3			21,097	
1973		13,892		311		48				6			14,257	
1974		14,830		325		52				5			15,212	
1975		15,046		373		39				6			15,464	
1976		18,738		228		32		717		6			19,721	
1977		24,466		442		32		846		6			25,792	
1978		26,068		405		100		371		9			26,953	
1979		20,766		400		38		763		9			21,976	
1980		15,096		384		40		914		11			16,445	
1981		11,918		366		42		263		13			12,602	
1982		10,506		384		19		127		11			11,047	
1983		10,108		489		36		133		14			10,780	
1984		10,812		699		31		27		22			11,591	
1985		12,625		699		4		136		18			13,482	
1986		13,115		404		2		505		26			14,052	
1987		14,173		548		3		907		27			15,658	19,250
1988		11,602		491		0		716		41			12,850	19,750
1989		7,023		455		0		230		33			7,741	19,000
1990		10,559		981		2		471		69			12,082	13,000
1991		7,546		737		34		315		68			8,700	11,300
1992		10,582		589		117		537		106			11,931	14,000
1993		10,419		462		37		326		79			11,323	14,000
1994		10,330		542		37		325		91			11,325	14,000
1995	9,722	9,722	470	470	48	48	302	302	224	224	10,766	0	10,766	14,000
1996	9,593	9,641	465	465	31	11			428	428	10,517	28	10,545	14,000
1997	9,505	9,504	499	499	39	39			249	249	10,292	-1	10,291	14,000
1998	7,918	7,918	393	393	22	21			98	98	8,431	-1	8,430	14,000
1999	7,983	7,983	373	394	27	27			336	336	8,719	21	8,740	14,000
2000	8,324	8,324	401	414	15	15			67	67	8,807	13	8,820	14,000
2001	11,112	11,114	385	385	1	0			61	61	11,559	1	11,560	11,750
2002	8,275	8,276	322	338	29	29			58	58	8,684		8,701	12,800

Table 10.1.3.2 Plaice in Kattegat. Landings in tonnes Working Group estimates, 1972-2002

Year	Denmark	Sweden	Germany	Belgium	Norway	Total
1972	15,504	348	77			15,929
1973	10,021	231	48			10,300
1974	11,401	255	52			11,708
1975	10,158	296	39			10,493
1976	9,487	177	32			9,696
1977	11,611	300	32			11,943
1978	12,685	312	100			13,097
1979	9,721	333	38			10,092
1980	5,582	313	40			5,935
1981	3,803	256	42			4,101
1982	2,717	238	19			2,974
1983	3,280	334	36			3,650
1984	3,252	388	31			3,671
1985	2,979	403	4			3,386
1986	2,470	202	2			2,674
1987	2,846	307	3			3,156
1988	1,820	210	0			2,030
1989	1,609	135	0			1,744
1990	1,830	202	2			2,034
1991	1,737	265	19			2,021
1992	2,068	208	101			2,377
1993	1,294	175	0			1,469
1994	1,547	227	0			1,774
1995	1,254	133	0			1,387
1996	2,337	205	0			2,542
1997	2,198	255	25			2,478
1998	1,786	185	10			1,981
1999	1,510	161	20			1,691
2000	1,644	184	10			1,838
2001	2,069	260				2,329
2002	1,806	198	26			2,030

* years 1972-1990 landings refers to IIIA

Table 10.1.3.3 Plaice in Skagerrak. Landings in tonnes. Working Group estimates, 1972-2002

Year	Denmark	Sweden	Germany	Belgium	Norway	Total
1972	5,095	70			3	5,168
1973	3,871	80			6	3,957
1974	3,429	70			5	3,504
1975	4,888	77			6	4,971
1976	9,251	51		717	6	10,025
1977	12,855	142		846	6	13,849
1978	13,383	94		371	9	13,857
1979	11,045	67		763	9	11,884
1980	9,514	71		914	11	10,510
1981	8,115	110		263	13	8,501
1982	7,789	146		127	11	8,073
1983	6,828	155		133	14	7,130
1984	7,560	311		27	22	7,920
1985	9,646	296		136	18	10,096
1986	10,645	202		505	26	11,378
1987	11,327	241		907	27	12,502
1988	9,782	281		716	41	10,820
1989	5,414	320		230	33	5,997
1990	8,729	779		471	69	10,048
1991	5,809	472	15	315	68	6,679
1992	8,514	381	16	537	106	9,554
1993	9,125	287	37	326	79	9,854
1994	8,783	315	37	325	91	9,551
1995	8,468	337	48	302	224	9,379
1996	7,304	260	11		428	8,003
1997	7,306	244	14		249	7,813
1998	6,132	208	11		98	6,449
1999	6,473	233	7		336	7,049
2000	6,680	230	5		67	6,982
2001	9,045	125			61	9,231
2002	6,470	140	3		58	6,671

Table 10.2.2.1 Plaice in IIIa. Catch numbers at age Numbers*10-3**

YEAR	1978	1979	1980	1981	1982
AGE					
2	489	1105	362	190	526
3	15692	9789	4772	4048	2067
4	39531	29655	16353	13098	9204
5	24919	20807	12575	10970	10602
6	8011	7646	6033	4306	5554
7	620	2514	2393	1427	1851
8	63	170	949	546	758
9	63	75	203	213	301
10	48	50	54	119	113
+gp	60	55	50	97	48
0 TOTALNUM	89496	71866	43744	35014	31024
TONSLAND	26953	21976	16445	12602	11047
SOPCOF %	102	104	106	103	102

YEAR	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
AGE										
2	1481	2154	1400	375	623	101	1012	3147	2309	904
3	9715	12620	8641	4366	4227	3052	3844	8748	8611	3858
4	8630	11140	21798	14749	12400	12037	7102	8623	9583	11759
5	8026	4463	6232	19193	17710	13783	6255	9718	4663	17427
6	2673	2183	1715	4477	10205	6860	2708	3222	2893	4297
7	925	985	698	633	2089	2745	1171	981	892	1033
8	531	904	260	274	373	946	549	481	306	296
9	257	695	197	154	242	322	254	349	156	115
10	96	337	168	141	125	136	136	155	87	27
+gp	106	120	156	98	190	156	236	273	137	115
0 TOTALNUM	32440	35601	41265	44460	48184	40138	23267	35697	29637	39831
TONSLAND	10780	11591	13482	14052	15658	12850	7741	12082	8700	11931
SOPCOF %	101	100	100	100	100	100	100	100	100	100

YEAR	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
AGE										
2	1038	1411	446	4527	529	563	687	1223	3981	364
3	3505	6919	2277	5353	4733	6710	2704	3937	9172	5008
4	10088	8016	6606	7971	6379	8219	8432	8302	9399	8861
5	13233	9859	11530	5283	9465	6856	8520	11212	11001	7528
6	6891	8002	6622	4751	5104	2971	7419	3599	4744	4843
7	1657	2780	4929	1812	3072	791	1301	888	410	1766
8	376	448	853	1355	1369	385	380	139	102	448
9	104	111	137	151	849	234	77	17	19	51
10	47	38	65	23	114	170	106	7	14	17
+gp	69	55	51	45	36	64	43	29	33	12
0 TOTALNUM	37008	37639	33516	31271	31650	26963	29669	29353	38875	28898
TONSLAND	11323	11325	10766	10545	10291	8430	8740	8820	11560	8701
SOPCOF %	100	100	100	101	100	100	100	101	100	102

Table 10.2.3.1. Plaice in IIIa. Catch and stock weights at age (kg)

	YEAR	1978	1979	1980	1981	1982
	AGE					
	2	0.236	0.222	0.261	0.23	0.27
	3	0.248	0.255	0.274	0.263	0.301
	4	0.268	0.267	0.306	0.296	0.286
	5	0.322	0.297	0.345	0.357	0.318
	6	0.417	0.378	0.414	0.432	0.386
	7	0.598	0.451	0.579	0.537	0.544
	8	0.752	0.655	0.64	0.671	0.704
	9	0.818	0.922	0.753	0.813	0.813
	10	0.914	1.02	0.811	0.912	0.912
	+gp	0.843	1.044	0.91	0.999	0.986
0	SOPCO	1.0159	1.039	1.0625	1.0268	1.0184

	YEAR	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
	AGE										
	2	0.285	0.282	0.278	0.25	0.322	0.252	0.274	0.292	0.263	0.309
	3	0.274	0.299	0.282	0.277	0.28	0.267	0.263	0.288	0.27	0.31
	4	0.293	0.304	0.308	0.284	0.281	0.268	0.282	0.294	0.259	0.272
	5	0.356	0.372	0.354	0.31	0.292	0.29	0.32	0.337	0.274	0.28
	6	0.423	0.403	0.437	0.384	0.363	0.35	0.376	0.397	0.365	0.336
	7	0.483	0.406	0.544	0.531	0.527	0.475	0.466	0.498	0.492	0.5
	8	0.531	0.383	0.68	0.707	0.711	0.567	0.635	0.684	0.584	0.646
	9	0.647	0.36	0.737	0.85	0.904	0.755	0.741	0.775	0.67	0.817
	10	0.986	0.443	0.755	0.903	1.036	0.833	0.825	0.951	0.882	0.804
	+gp	1.184	1.061	0.914	1.099	1.084	1.193	1.002	1.15	1.08	0.976
0	SOPCO	1.006	1.0009	1.0012	0.9997	0.9996	1.0002	0.9999	1.0004	1.0006	0.9999

	YEAR	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
	AGE										
	2	0.267	0.275	0.263	0.266	0.3	0.26	0.271	0.257	0.257	0.25
	3	0.272	0.263	0.301	0.268	0.294	0.25	0.271	0.262	0.272	0.279
	4	0.271	0.272	0.303	0.294	0.283	0.28	0.29	0.276	0.29	0.274
	5	0.295	0.289	0.289	0.384	0.299	0.327	0.29	0.302	0.322	0.278
	6	0.338	0.33	0.328	0.399	0.341	0.398	0.294	0.355	0.31	0.317
	7	0.441	0.381	0.368	0.436	0.41	0.464	0.336	0.388	0.425	0.391
	8	0.566	0.516	0.499	0.43	0.465	0.515	0.37	0.517	0.589	0.462
	9	0.712	0.658	0.736	0.561	0.445	0.587	0.656	0.857	0.836	0.752
	10	0.802	0.766	0.752	0.87	0.531	0.641	0.567	0.97	0.679	1.037
	+gp	1.168	0.979	1.022	0.957	0.76	0.863	0.831	0.967	0.818	1.014
0	SOPCO	0.9991	1.0001	1.0015	1.0113	1.0003	1.0016	1	1.0061	1.0014	1.0225

Table 10.2.5.1. Plaice IIIa. Tuning data by fleet

Danish Gillnetters										
1987	2002									
1	1	0	1							
2	11									
4168	20592	169059	650916	1071313	803165	286784	58777	33991	18818	24877
3988	27444	168504	529771	606818	410016	309311	134000	55393	19492	23977
3795	18882	63447	175206	186617	129661	111415	85514	44764	24564	43810
4208	64308	246880	272984	362432	157274	62094	42383	38230	20604	41001
3805	43034	181507	242271	148622	168826	68492	32399	14923	11663	17809
4879	67456	350855	854331	1065380	260669	108795	39021	18755	5675	21064
5639	4846	80411	339540	652443	591404	199282	42122	12860	3774	2597
11463	93332	788950	992744	1280086	1145581	443000	78443	26304	7859	14155
9905	93997	320239	744931	1661991	911912	979462	185418	30434	13976	10309
9655	431700	632571	858288	762350	711940	291167	215022	22193	3298	8388
8048	67268	468037	544401	912161	684171	509591	271094	101874	19323	7745
7109	52000	481000	803000	854000	380000	112000	63000	42000	31000	15000
6997	62000	183000	698000	841000	1001000	206000	70000	21000	13000	9000
7351	44000	250000	847000	1044000	439000	93000	19000	4000	1000	6000
7816	257408	421089	734508	1514962	901478	101935	32356	4397	3983	4543
6643	36711	451342	573342	561560	555556	336972	105617	16792	4906	5391
Danish Trawlers										
1987	2002									
1	1	0	1							
2	11									
33443	255915	1177661	2468347	2379126	1046122	215078	50415	32514	24420	37438
30661	108178	839066	1906117	1819047	700988	226895	75481	23885	20953	22426
33982	430316	927355	1291748	1026225	456678	165557	71803	37576	18121	35819
38873	1181442	2311097	2020630	2065160	631904	200416	85590	45586	22634	42975
37884	660031	2459249	2424238	1085399	580774	151470	52786	31364	18475	27441
35126	324054	1244765	2463167	3594631	910595	232058	62318	14226	3014	12454
30062	172192	866648	2265364	2200206	1312213	455227	82231	15921	12071	15309
29412	506609	1815439	1886714	2177012	1785146	732729	113303	17909	12336	11983
26141	262364	791718	1217689	2119319	1052643	706432	144496	23084	11096	8823
28119	1044742	1432920	1503021	1053244	772862	329651	235696	24501	4352	9874
26062	166014	1234787	1637715	1843447	841073	352324	143468	96237	15809	6255
25274	210000	1613000	1953000	1285000	495000	120000	54000	36000	23000	9000
26802	223000	761000	1739000	1403000	1024000	212000	58000	10000	11000	8000
28039	514000	1392000	2182000	2529000	762000	168000	25000	6000	3000	6000
27579	1213134	2297369	2297400	2241237	982424	99667	19672	6921	4216	5405
27736	132625	1517394	2419247	1910112	1210114	368511	82071	7932	3153	1656
Danish Seiners										
1987	2002									
1	1	0	1							
2	11									
7897	97426	1157332	4050596	5227390	2536790	426009	72398	40925	20944	22943
6959	466750	1343996	3116463	3368983	1446989	521283	158464	47106	16431	19006
9579	334835	1483241	3030013	2733969	1193297	477612	171227	76749	33563	39868
9369	1116082	3542256	3431384	3748325	1097119	299716	116328	81119	32922	60674
8911	515012	2426848	3289407	1838074	1057052	265606	88516	42174	17972	28587
8767	106267	791895	4199036	6819566	1725235	324760	77400	27070	4686	17868
7367	139121	509253	1721085	2800822	1649545	413535	89601	21958	5718	3978
7249	336892	1620907	1883228	2514844	1977352	552285	69993	19937	4536	4288
6802	195908	569871	1348638	2282155	1664669	1118605	153081	23915	11391	8384
6384	949342	1363113	1878662	980782	913661	327089	230807	22762	3019	6502
5769	165538	1193786	1794123	2572264	1359436	909634	392850	278160	26736	5420
5508	144000	2251000	2489000	2044000	884000	231000	109000	61000	49000	14000
6041	173000	721000	2487000	2755000	2425000	367000	103000	16000	36000	9000
5893	286000	1240000	2954000	4300000	1202000	334000	46000	3000	1000	3000
6138	1534686	3619758	3159809	3377381	1347729	137169	33892	5948	4204	4928
5518	109606	1732101	3339718	2960753	1745554	566533	131577	11847	3376	2136

Table 10.2.5.1. con't. Plaice IIIa. Tuning data by fleet

Havfisken_q4						
1994	2002					
1	1	1	1			
1	6					
1	0.87	10.51	5.88	0.37	0.99	
1	1.67	10.33	3.77	0.19	1.10	
1	2.48	37.87	11.07	0.36	0.42	
1	11.14	11.27	4.32	1.25	0.64	
1	17.85	14.80	5.19	3.50	0.00	
1	89.27	33.15	7.70	0.27	0.60	
1	99.71	121.08	15.63	0.00	0.47	
1	52.84	99.58	29.67	1.70	0.49	
1	46.10	18.36	25.18	12.40	1.23	
Havfisken_q1_shifted						
1995	2002					
1	1	0.99	1			
1	5					
1	23.26	26.79	7.00	1.69	0.81	
1	11.52	20.47	4.77	1.03	0.67	
1	-9.00	-9.00	-9.00	-9.00	-9.00	
1	25.82	22.27	2.92	1.25	0.15	
1	196.46	47.55	9.06	1.88	1.64	
1	127.68	74.02	6.68	1.71	1.41	
1	45.73	78.31	32.05	2.30	0.44	
1	134.21	36.87	34.79	8.27	0.16	
IBTSQ1_Shifted						
1991	2002					
1	1	0.99	1			
1	6					
1	4.17	9.29	6.44	1.62	0.38	0.08
1	6.50	6.02	5.78	5.11	2.03	0.22
1	8.50	6.48	1.89	1.09	1.19	0.25
1	4.48	10.40	4.20	1.13	0.85	0.40
1	17.05	13.35	4.90	1.54	0.46	0.13
1	6.86	12.90	3.26	1.14	0.12	0.04
1	8.06	8.00	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
1	11.71	46.89	31.90	9.37	1.71	1.27
1	31.80	16.42	17.02	11.59	2.59	0.59
IBTSQ3						
1995	2002					
1	1	0.83	0.92			
1	6					
1	7.52	9.71	10.01	2.93	1.62	0.86
1	8.78	16.62	6.60	2.04	0.73	0.35
1	15.15	18.42	9.22	2.54	0.88	0.54
1	18.51	20.86	5.13	3.77	0.47	0.00
1	46.59	46.17	13.90	1.50	1.51	0.28
1	-9.00	-9.00	-9.00	-9.00	-9.00	-9.00
1	7.75	81.52	49.97	7.53	2.72	0.95
1	11.97	30.14	33.41	26.65	7.68	1.26

Table 10.3.1 Plaice in IIIa. Diagnostic from XSA tuning

Lowestoft VPA Version 3.1
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Extended Survivors Analysis

Plaice IIIa VPA data,2003 WG,ANON,COMBSEX,PLUSGROUP
CPUE data from file ple3aFL1.dat
Catch data for 25 years. 1978 to 2002. Ages 2 to 11.

Fleet,	First, year,	Last, year,	First, age ,	Last, age	Alpha,	Beta
Danish Gillnetters ,	1987,	2002,	2,	10,	.000,	1.000
Danish Trawlers ,	1987,	2002,	2,	10,	.000,	1.000
Danish Seiners ,	1987,	2002,	2,	10,	.000,	1.000
Havfisken_q4 ,	1994,	2002,	1,	6,	.830,	.920
Havfisken_q1_shifted,	1995,	2002,	1,	5,	.990,	1.000
IBTSQ1_Shifted ,	1991,	2002,	1,	6,	.990,	1.000
IBTSQ3 ,	1995,	2002,	1,	6,	.830,	.920

Time series weights :
Tapered time weighting applied
Power = 3 over 20 years

Catchability analysis :
Catchability independent of stock size for all ages
Catchability independent of age for ages >= 8

Terminal population estimation :
Survivor estimates shrunk towards the mean F
of the final 5 years or the 5 oldest ages.

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

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

Prior weighting not applied

Tuning converged after 23 iterations

Regression weights
, .751, .820, .877, .921, .954, .976, .990, .997, 1.000, 1.000

Fishing mortalities

Age,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002
2,	.031,	.043,	.012,	.125,	.012,	.014,	.015,	.013,	.039,	.010
3,	.096,	.268,	.082,	.180,	.167,	.183,	.078,	.099,	.118,	.057
4,	.350,	.294,	.392,	.401,	.302,	.430,	.327,	.324,	.320,	.144
5,	.542,	.602,	.786,	.551,	1.045,	.541,	.955,	.841,	.822,	.406
6,	.924,	.656,	.949,	.785,	1.536,	1.020,	1.961,	1.371,	.959,	.970
7,	1.202,	1.131,	.997,	.652,	1.909,	.979,	1.953,	1.648,	.462,	1.084
8,	.956,	1.188,	1.244,	.734,	1.457,	1.591,	2.138,	1.254,	.762,	1.235
9,	.954,	.739,	1.473,	.660,	1.386,	.972,	1.994,	.462,	.475,	.997
10,	1.148,	1.033,	1.231,	.978,	1.511,	1.090,	1.732,	1.016,	.765,	.921

XSA population numbers (Thousands) AGE

YEAR ,	2,	3,	4,	5,	6,	7,	8,	9,	10,
1993 ,	3.53E+04,	4.02E+04,	3.59E+04,	3.32E+04,	1.20E+04,	2.49E+03,	6.42E+02,	1.78E+02,	7.24E+01,
1994 ,	3.51E+04,	3.10E+04,	3.30E+04,	2.29E+04,	1.75E+04,	4.32E+03,	6.77E+02,	2.23E+02,	6.20E+01,
1995 ,	3.81E+04,	3.04E+04,	2.14E+04,	2.23E+04,	1.14E+04,	8.21E+03,	1.26E+03,	1.87E+02,	9.65E+01,
1996 ,	4.05E+04,	3.41E+04,	2.53E+04,	1.31E+04,	9.18E+03,	3.98E+03,	2.74E+03,	3.29E+02,	3.88E+01,
1997 ,	4.72E+04,	3.23E+04,	2.58E+04,	1.53E+04,	6.84E+03,	3.79E+03,	1.88E+03,	1.19E+03,	1.54E+02,
1998 ,	4.22E+04,	4.22E+04,	2.47E+04,	1.72E+04,	4.88E+03,	1.33E+03,	5.08E+02,	3.96E+02,	2.69E+02,
1999 ,	4.94E+04,	3.77E+04,	3.18E+04,	1.46E+04,	9.08E+03,	1.59E+03,	4.53E+02,	9.37E+01,	1.35E+02,
2000 ,	9.67E+04,	4.40E+04,	3.15E+04,	2.07E+04,	5.07E+03,	1.16E+03,	2.04E+02,	4.83E+01,	1.15E+01,
2001 ,	1.09E+05,	8.63E+04,	3.61E+04,	2.06E+04,	8.09E+03,	1.16E+03,	2.01E+02,	5.28E+01,	2.75E+01,
2002 ,	3.81E+04,	9.49E+04,	6.94E+04,	2.37E+04,	8.20E+03,	2.81E+03,	6.64E+02,	8.50E+01,	2.97E+01,

Estimated population abundance at 1st Jan 2003
, 0.00E+00, 3.42E+04, 8.11E+04, 5.44E+04, 1.43E+04, 2.81E+03, 8.58E+02, 1.75E+02, 2.84E+01,

Taper weighted geometric mean of the VPA populations:
, 4.99E+04, 4.44E+04, 3.26E+04, 1.93E+04, 7.88E+03, 2.34E+03, 6.75E+02, 1.99E+02, 7.49E+01,

Standard error of the weighted Log(VPA populations) :
, .3849, .3906, .3350, .3076, .3932, .6039, .7799, .9657, .9914,

Log catchability residuals.

Fleet : Danish Gillnetters

Age	1987	1988	1989	1990	1991	1992
2	-.24	.13	-.88	.15	.22	.52
3	.19	.29	-.59	.00	-.29	.46
4	.56	.77	-.38	.08	-.70	.24
5	.50	.50	-.38	.03	-.80	.20
6	.28	.22	-.36	-.28	-.18	-.35
7	.19	.41	.04	-.39	-.11	-.10
8	-.45	.25	.02	-.14	-.10	-.08
9	-.09	.26	.18	.12	.28	.11
10	.14	.42	.47	.31	.25	.45

Age	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
2	-2.00	.26	.31	1.86	-.03	-.05	-.01	-1.08	.52	-.23
3	-1.07	.85	.02	.66	.59	.48	-.41	-.29	-.50	-.39
4	-.49	-.07	.27	.28	-.06	.55	.13	.28	-.06	-.88
5	-.63	-.27	.25	-.08	.33	.06	.41	.18	.48	-.67
6	-.20	-.73	-.26	-.34	.40	.07	.78	.28	.31	-.02
7	.14	-.35	-.10	-.71	.57	-.13	.68	.05	-.41	.34
8	-.38	-.42	-.02	-.83	.25	.27	.70	-.17	.11	.46
9	-.28	-.59	.17	-1.01	-.30	-.12	1.02	-.62	-.67	.58
10	-.53	-.40	-.04	-.65	.13	.01	.09	-.34	.01	.37

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	-8.5536	-6.7768	-5.6884	-4.7248	-4.0755	-3.8173	-3.5949	-3.5949	-3.5949
S.E(Log q)	.8762	.5594	.4397	.4268	.4062	.4067	.4112	.5849	.3532

Regression statistics :

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

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
2	1.24	-.271	8.01	.11	16	1.14	-8.55
3	2.97	-1.650	-.93	.07	16	1.54	-6.78
4	12.31	-3.025	-47.45	.01	16	4.09	-5.69
5	1.20	-.378	3.68	.26	16	.54	-4.72
6	1.45	-.987	1.87	.33	16	.59	-4.08
7	1.01	-.058	3.77	.69	16	.43	-3.82
8	1.19	-.995	3.05	.74	16	.49	-3.59
9	1.04	-.208	3.63	.72	16	.63	-3.69
10	.88	1.217	3.69	.92	16	.31	-3.61

1

Fleet : Danish Trawlers

Age	1987	1988	1989	1990	1991	1992
2	-.10	-.84	-.25	.54	.35	-.19
3	.02	-.17	-.13	-.02	-.01	-.27
4	.10	.30	-.28	.15	-.40	-.38
5	-.17	.17	-.25	.16	-.50	.05
6	-.60	-.34	-.35	-.18	-.31	-.13
7	-.97	-.74	-.55	-.23	-.41	-.11
8	-1.24	-.92	-.89	-.22	-.47	-.13
9	-.77	-1.17	-.74	-.48	.17	-.70
10	-.23	-.09	-.58	-.38	-.14	-.70

Age	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
2	-.41	.71	.07	1.37	-.60	-.22	-.38	-.26	.51	-.67
3	-.39	.71	-.07	.38	.36	.39	-.35	.06	-.09	-.63
4	.03	-.07	.09	.06	.16	.47	-.01	.18	.11	-.58
5	-.48	-.07	.13	-.21	.48	-.19	.19	.33	.23	-.26
6	-.13	-.29	-.15	-.39	.37	.00	.40	.43	.07	.27
7	.50	.42	-.19	-.45	.23	-.12	.57	.51	-.48	.20
8	.07	.45	.21	-.36	-.11	.30	.62	.21	-.20	.22
9	-.29	-.47	.37	-.53	-.08	-.10	.39	-.11	-.03	-.15
10	.41	.56	.21	.01	.21	-.11	.02	.87	.25	-.06

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	-8.2553	-6.7496	-5.9819	-5.3367	-5.0151	-5.0232	-5.0429	-5.0429	-5.0429
S.E(Log q)	.6098	.3761	.2864	.2949	.3072	.4362	.4223	.4292	.4121

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	.85	.363	8.65	.36	16	.54	-8.26
3	1.96	-1.875	2.94	.28	16	.67	-6.75
4	3.25	-4.229	-3.94	.26	16	.58	-5.98
5	1.13	-.376	4.74	.45	16	.35	-5.34
6	1.32	-1.031	3.73	.51	16	.41	-5.02
7	1.07	-.277	4.84	.63	16	.49	-5.02
8	1.22	-1.142	4.71	.72	16	.51	-5.04
9	1.17	-1.248	5.22	.84	16	.44	-5.23
10	1.27	-1.876	5.13	.83	16	.46	-4.95

1

Fleet : Danish Seiners

Age	1987	1988	1989	1990	1991	1992
2	-.86	.87	-.47	.67	.31	-1.15
3	-.03	.31	.13	.35	-.05	-.81
4	.31	.55	.11	.38	-.38	-.19
5	.18	.39	.12	.30	-.41	.20
6	-.21	-.08	-.07	-.14	-.20	-.05
7	-.75	-.32	-.13	-.31	-.30	-.29
8	-1.30	-.56	-.63	-.36	-.37	-.40
9	-.97	-.88	-.63	-.35	.05	-.53
10	-.81	-.72	-.57	-.45	-.59	-.74

Age	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
2	-.45	.46	-.11	1.52	-.33	-.31	-.38	-.52	1.01	-.49
3	-1.00	.52	-.53	.34	.35	.77	-.40	.03	.39	-.36
4	-.57	-.40	-.19	.04	.03	.50	.11	.32	.21	-.37
5	-.71	-.40	-.33	-.68	.44	-.08	.48	.55	.26	-.09
6	-.44	-.73	-.29	-.68	.41	.17	.81	.51	-.05	.30
7	-.09	-.36	-.29	-.88	.78	.15	.71	.86	-.57	.35
8	-.31	-.50	-.25	-.77	.54	.66	.81	.51	-.02	.44
9	-.43	-.83	-.11	-.99	.62	.09	.48	-1.11	-.55	-.01
10	-.80	-.91	-.29	-.74	.37	.30	.83	-.54	-.12	-.24

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	-7.0197	-5.2718	-4.2541	-3.4591	-3.0724	-3.1208	-3.1731	-3.1731	-3.1731
S.E(Log q)	.7391	.5255	.3364	.4326	.4626	.5655	.5671	.6487	.6121

Regression statistics :

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

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
2	.77	.484	7.88	.32	16	.59	-7.02
3	1.05	-.118	4.99	.34	16	.58	-5.27
4	2.08	-1.875	-2.37	.23	16	.63	-4.25
5	1.25	-.448	1.83	.24	16	.56	-3.46
6	2.38	-1.772	-5.07	.14	16	1.01	-3.07
7	1.34	-.884	1.56	.41	16	.76	-3.12
8	1.41	-1.387	1.80	.54	16	.77	-3.17
9	.86	.932	3.74	.81	16	.48	-3.49
10	.83	1.236	3.60	.85	16	.44	-3.46

1

Fleet : Havfisken_q4

Age	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
2	99.99	-.54	-.67	.67	-.79	-.41	.24	.86	.57	-.10
3	99.99	.00	-.59	.46	-.44	-.51	-.09	.48	.46	.15
4	99.99	-1.06	-1.21	-.73	.41	1.59	-1.31	99.99	.40	1.57
5	99.99	.04	.33	-.31	.39	99.99	.30	-.40	-.37	.05
6	99.99	-3.08	-1.69	-1.11	1.12	-.18	1.80	1.54	1.27	-.43
7	No data for this fleet at this age									
8	No data for this fleet at this age									
9	No data for this fleet at this age									
10	No data for this fleet at this age									

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

Age	2	3	4	5	6
Mean Log q	-7.4465	-8.2483	-9.9901	-9.4741	-9.5391
S.E(Log q)	.6253	.4321	1.2168	.3297	1.6291

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	.50	2.295	9.13	.77	9	.25	-7.45
3	.68	1.375	9.03	.74	9	.28	-8.25
4	.40	1.195	10.21	.42	8	.48	-9.99
5	1.19	-.261	9.41	.26	8	.42	-9.47
6	-.53	-2.349	8.72	.26	9	.69	-9.54

1

Fleet : Havfisken_q1_shifted

Age	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
2	99.99	99.99	-.04	-.26	99.99	-.33	.28	.04	.01	.27
3	99.99	99.99	.13	-.27	99.99	-.98	.17	-.27	.64	.57
4	99.99	99.99	.28	-.37	99.99	-.13	-.07	-.16	.00	.45
5	99.99	99.99	.31	.42	99.99	-1.36	1.61	1.00	-.18	-1.75
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	2	3	4	5
Mean Log q	-7.1063	-8.3208	-9.2403	-9.6554
S.E(Log q)	.2360	.5656	.2773	1.2290

Regression statistics :

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

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
2	.94	.248	7.32	.81	7	.24	-7.11
3	.57	1.695	9.39	.76	7	.28	-8.32
4	.71	1.568	9.58	.86	7	.17	-9.24
5	-.68	-1.099	9.94	.08	7	.82	-9.66

1

Fleet : IBTSQ1_Shifted

Age	1987	1988	1989	1990	1991	1992
2	99.99	99.99	99.99	99.99	-.52	-.87
3	99.99	99.99	99.99	99.99	-.36	-.16
4	99.99	99.99	99.99	99.99	-.84	.26
5	99.99	99.99	99.99	99.99	-.48	.69
6	99.99	99.99	99.99	99.99	-.70	-.01
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	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
2	-.54	-.05	.09	.11	-.64	-.39	.68	.86	.32	.29
3	-1.19	.04	.02	-.40	-.10	-.84	.55	.91	.89	.11
4	-.92	-.85	-.01	-.47	-.33	.29	.22	.17	1.20	.58
5	-.22	-.12	-.53	-1.57	-.26	-1.78	1.38	.94	.90	.76
6	-.43	-.61	-1.01	-2.14	.00	-.71	.49	1.83	1.62	.85
7	No data for this fleet at this age									
8	No data for this fleet at this age									
9	No data for this fleet at this age									
10	No data for this fleet at this age									

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	-7.9344	-8.5757	-9.0388	-9.3807	-9.3265
S.E(Log q)	.5440	.6428	.6421	1.0410	1.1784

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	.59	1.645	9.10	.66	12	.30	-7.93
3	.67	.928	9.28	.48	12	.44	-8.58
4	.69	.721	9.47	.38	12	.45	-9.04
5	.49	.908	9.64	.27	12	.52	-9.38
6	21.77	-.940	16.13	.00	12	25.81	-9.33

1

Fleet : IBTSQ3

Age	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
2	99.99	99.99	-.76	-.18	-.33	-.10	.54	99.99	.34	.37
3	99.99	99.99	.09	-.35	.02	-.82	.20	99.99	.69	.14
4	99.99	99.99	.10	-.42	-.31	.24	-1.02	99.99	.46	.91
5	99.99	99.99	-.10	-.57	-.11	-1.30	.40	99.99	.53	1.06
6	99.99	99.99	-.16	-.99	.39	99.99	-.17	99.99	.29	.56
7	No data for this fleet at this age									
8	No data for this fleet at this age									
9	No data for this fleet at this age									
10	No data for this fleet at this age									

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	-7.4171	-7.9503	-8.5657	-8.6536	-8.4100
S.E(Log q)	.4577	.4775	.6478	.7853	.5638

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	.67	.986	8.55	.65	7	.31	-7.42
3	.68	1.160	8.84	.74	7	.32	-7.95
4	.52	1.473	9.42	.67	7	.31	-8.57
5	.37	1.219	9.36	.44	7	.28	-8.65
6	-1.20	-1.238	9.85	.08	6	.64	-8.41

1

Terminal year survivor and F summaries :

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

Year class = 2000

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
Danish Gillnetters ,	27109.,	.912,	.000,	.00,	1,	.040,	.013
Danish Trawlers ,	17406.,	.635,	.000,	.00,	1,	.083,	.020
Danish Seiners ,	21017.,	.770,	.000,	.00,	1,	.056,	.016
Havfisken_q4 ,	31037.,	.661,	.000,	.00,	1,	.076,	.011
Havfisken_q1_shifted,	44942.,	.300,	.000,	.00,	1,	.370,	.008
IBTSQ1_Shifted ,	45816.,	.569,	.000,	.00,	1,	.103,	.008
IBTSQ3 ,	49471.,	.491,	.000,	.00,	1,	.138,	.007
F shrinkage mean ,	18387.,	.50,,,,				.134,	.019

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
34161.,	.18,	.16,	8,	.854,	.010

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

Year class = 1999

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
Danish Gillnetters ,	71014.,	.491,	.407,	.83,	2,	.074,	.065
Danish Trawlers ,	58526.,	.333,	.505,	1.51,	2,	.160,	.078
Danish Seiners ,	88447.,	.446,	.644,	1.44,	2,	.089,	.052
Havfisken_q4 ,	107615.,	.376,	.194,	.52,	2,	.126,	.043
Havfisken_q1_shifted,	91400.,	.269,	.225,	.84,	2,	.241,	.051
IBTSQ1_Shifted ,	101988.,	.435,	.106,	.24,	2,	.093,	.046
IBTSQ3 ,	103137.,	.354,	.102,	.29,	2,	.141,	.045
F shrinkage mean ,	34492.,	.50,,,,				.076,	.129

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
81108.,	.13,	.12,	15,	.932,	.057

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

Year class = 1998

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
Danish Gillnetters ,	24759.,	.336,	.145,	.43,	3,	.097,	.293
Danish Trawlers ,	36720.,	.223,	.159,	.71,	3,	.219,	.207
Danish Seiners ,	44200.,	.276,	.238,	.86,	3,	.144,	.175
Havfisken_q4 ,	106949.,	.361,	.233,	.64,	3,	.079,	.076
Havfisken_q1_shifted,	73327.,	.201,	.158,	.79,	3,	.267,	.109
IBTSQ1_Shifted ,	118622.,	.366,	.096,	.26,	3,	.079,	.069
IBTSQ3 ,	117798.,	.413,	.110,	.27,	2,	.063,	.069
F shrinkage mean ,	20708.,	.50,,,,				.053,	.341

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
54363.,	.10,	.13,	21,	1.272,	.144

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

Year class = 1997

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
Danish Gillnetters ,	9857.,	.272,	.163,	.60,	4,	.114,	.546
Danish Trawlers ,	13058.,	.184,	.109,	.59,	4,	.250,	.437
Danish Seiners ,	14747.,	.239,	.101,	.42,	4,	.144,	.396
Havfisken_q4 ,	17197.,	.257,	.106,	.41,	4,	.134,	.348
Havfisken_q1_shifted,	14653.,	.199,	.214,	1.08,	4,	.179,	.398
IBTSQ1_Shifted ,	34758.,	.350,	.122,	.35,	4,	.060,	.187
IBTSQ3 ,	27400.,	.368,	.171,	.46,	3,	.057,	.232
F shrinkage mean ,	5391.,	.50,,,,				.061,	.845

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
14282.,	.09,	.09,	28,	.963,	.406

Age 6 Catchability constant w.r.t. time and dependent on age

Year class = 1996

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
Danish Gillnetters ,	3096.,	.258,	.128,	.50,	5,	.141,	.911
Danish Trawlers ,	3332.,	.180,	.094,	.52,	5,	.275,	.868
Danish Seiners ,	3458.,	.243,	.115,	.48,	5,	.141,	.847
Havfisken_q4 ,	2062.,	.266,	.071,	.27,	4,	.080,	1.174
Havfisken_q1_shifted,	2313.,	.200,	.084,	.42,	4,	.103,	1.096
IBTSQ1_Shifted ,	3859.,	.376,	.248,	.66,	5,	.043,	.786
IBTSQ3 ,	3989.,	.341,	.155,	.45,	4,	.075,	.768
F shrinkage mean ,	1553.,	.50,,,,				.141,	1.378

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
2813.,	.11,	.07,	33,	.623,	.970

Age 7 Catchability constant w.r.t. time and dependent on age

Year class = 1995

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
Danish Gillnetters ,	1165.,	.271,	.035,	.13,	6,	.199,	.893
Danish Trawlers ,	1003.,	.209,	.069,	.33,	6,	.262,	.984
Danish Seiners ,	1098.,	.288,	.110,	.38,	6,	.142,	.928
Havfisken_q4 ,	581.,	.265,	.227,	.85,	5,	.046,	1.359
Havfisken_q1_shifted,	737.,	.267,	.306,	1.15,	3,	.035,	1.187
IBTSQ1_Shifted ,	1051.,	.387,	.470,	1.21,	5,	.024,	.955
IBTSQ3 ,	710.,	.347,	.302,	.87,	4,	.043,	1.214
F shrinkage mean ,	550.,	.50,,,,				.248,	1.399

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
858.,	.15,	.07,	36,	.467,	1.084

Age 8 Catchability constant w.r.t. time and dependent on age

Year class = 1994

Fleet,	Estimated,	Int,	Ext,	Var,	N,	Scaled,	Estimated
,	Survivors,	s.e,	s.e,	Ratio,	,	Weights,	F
Danish Gillnetters ,	205.,	.267,	.168,	.63,	7,	.239,	1.125
Danish Trawlers ,	189.,	.244,	.149,	.61,	7,	.254,	1.182
Danish Seiners ,	206.,	.332,	.196,	.59,	7,	.140,	1.123
Havfisken_q4 ,	238.,	.275,	.260,	.95,	5,	.018,	1.027
Havfisken_q1_shifted,	158.,	.218,	.268,	1.23,	3,	.018,	1.306
IBTSQ1_Shifted ,	361.,	.422,	.393,	.93,	5,	.009,	.779
IBTSQ3 ,	191.,	.314,	.126,	.40,	4,	.009,	1.173
F shrinkage mean ,	131.,	.50,,,,				.313,	1.449

Weighted prediction :

Survivors,	Int,	Ext,	N,	Var,	F
at end of year,	s.e,	s.e,	,	Ratio,	
175.,	.19,	.07,	39,	.372,	1.235

Age 9 Catchability constant w.r.t. time and age (fixed at the value for age) 8

Year class = 1993

Fleet,	Estimated,	Int,	Ext,	Var,	N,	Scaled,	Estimated
,	Survivors,	s.e,	s.e,	Ratio,	,	Weights,	F
Danish Gillnetters ,	39.,	.337,	.092,	.27,	8,	.203,	.802
Danish Trawlers ,	25.,	.305,	.065,	.21,	8,	.281,	1.073
Danish Seiners ,	30.,	.428,	.088,	.21,	8,	.136,	.961
Havfisken_q4 ,	40.,	.390,	.411,	1.05,	4,	.001,	.800
Havfisken_q1_shifted,	24.,	.282,	.237,	.84,	3,	.002,	1.114
IBTSQ1_Shifted ,	22.,	.372,	.328,	.88,	5,	.002,	1.180
IBTSQ3 ,	18.,	.306,	.184,	.60,	5,	.003,	1.314
F shrinkage mean ,	26.,	.50,,,,				.373,	1.064

Weighted prediction :

Survivors,	Int,	Ext,	N,	Var,	F
at end of year,	s.e,	s.e,	,	Ratio,	
28.,	.22,	.04,	42,	.178,	.997

Age 10 Catchability constant w.r.t. time and age (fixed at the value for age) 8

Year class = 1992

Fleet,	Estimated,	Int,	Ext,	Var,	N,	Scaled,	Estimated
,	Survivors,	s.e,	s.e,	Ratio,	,	Weights,	F
Danish Gillnetters ,	12.,	.286,	.141,	.49,	9,	.296,	.834
Danish Trawlers ,	11.,	.282,	.037,	.13,	9,	.281,	.928
Danish Seiners ,	9.,	.412,	.118,	.29,	9,	.129,	1.065
Havfisken_q4 ,	11.,	.282,	.226,	.80,	5,	.001,	.899
Havfisken_q1_shifted,	8.,	.282,	.190,	.67,	2,	.001,	1.101
IBTSQ1_Shifted ,	8.,	.437,	.146,	.33,	5,	.001,	1.131
IBTSQ3 ,	10.,	.398,	.149,	.38,	3,	.000,	.987
F shrinkage mean ,	10.,	.50,,,,				.290,	.943

Weighted prediction :

Survivors,	Int,	Ext,	N,	Var,	F
at end of year,	s.e,	s.e,	,	Ratio,	
11.,	.19,	.04,	43,	.224,	.921

Table 10.3.2. Plaice in IIIa. Fishing mortality (F) at age.

Table 8 Fishing mortality (F) at age

YEAR		1978	1979	1980	1981	1982
AGE						
	2	0.0084	0.0257	0.0111	0.0078	0.0115
	3	0.2335	0.2058	0.1326	0.1487	0.0988
	4	0.7571	0.7969	0.5479	0.5626	0.5156
	5	1.0753	1.0747	0.8465	0.7786	1.1259
	6	1.0199	1.0636	0.9627	0.7009	1.0771
	7	0.5951	0.9543	1.0673	0.5502	0.6587
	8	0.2824	0.2829	1.0973	0.6559	0.5633
	9	0.4844	0.5608	0.5648	0.6834	0.8317
	10	0.6945	0.791	0.9124	0.6767	0.8556
+gp		0.6945	0.791	0.9124	0.6767	0.8556
0 FBAR 4- 8		0.746	0.8345	0.9043	0.6497	0.7881

Table 8 Fishing mortality (F) at age

YEAR		1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
AGE											
	2	0.0166	0.0326	0.0305	0.0107	0.0191	0.0032	0.0162	0.0462	0.049	0.0212
	3	0.2684	0.1721	0.1591	0.113	0.1434	0.1103	0.1454	0.1697	0.1543	0.0972
	4	0.6524	0.4946	0.4438	0.3936	0.4706	0.6639	0.3565	0.4911	0.2535	0.2901
	5	1.0501	0.7463	0.5035	0.7843	1.0215	1.34	0.7792	1.0436	0.4763	0.8671
	6	0.8685	0.8176	0.6369	0.7332	1.2031	1.4309	0.9471	1.1134	0.9292	0.9712
	7	0.4406	0.8286	0.5925	0.4514	0.8159	1.1801	0.9173	0.9993	0.9825	0.9283
	8	0.3503	0.9114	0.4721	0.4319	0.4645	0.9976	0.6899	1.146	0.8957	0.9489
	9	0.3333	0.9336	0.4437	0.5025	0.7492	0.8302	0.7092	1.1973	1.4657	0.9208
	10	0.6111	0.8517	0.5317	0.583	0.8811	1.18	0.9262	1.1916	1.0125	1.0135
+gp		0.6111	0.8517	0.5317	0.583	0.8811	1.18	0.9262	1.1916	1.0125	1.0135
0 FBAR 4- 8		0.6724	0.7597	0.5297	0.5589	0.7951	1.1225	0.738	0.9587	0.7074	0.8011
	1										

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Table 8 Fishing mortality (F) at age

YEAR		1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	FBAR **-**
AGE												
	2	0.0314	0.0432	0.0124	0.1251	0.0119	0.0141	0.0147	0.0134	0.0391	0.0101	0.0209
	3	0.0961	0.2678	0.082	0.1804	0.1672	0.1831	0.0784	0.0988	0.1184	0.0571	0.0914
	4	0.3498	0.2944	0.3916	0.4015	0.3016	0.4298	0.3271	0.3241	0.3201	0.1441	0.2628
	5	0.5423	0.6019	0.7858	0.551	1.0449	0.5414	0.9548	0.841	0.8225	0.4064	0.69
	6	0.9239	0.6561	0.949	0.7848	1.5358	1.02	1.9609	1.3708	0.9588	0.9698	1.0998
	7	1.2019	1.131	0.9975	0.6516	1.9094	0.9789	1.9534	1.6485	0.462	1.0841	1.0649
	8	0.956	1.1881	1.2437	0.7338	1.4566	1.591	2.1385	1.254	0.7616	1.235	1.0835
	9	0.9536	0.739	1.4731	0.6596	1.3863	0.9723	1.9945	0.4623	0.4754	0.9965	0.6447
	10	1.1477	1.033	1.2305	0.978	1.5109	1.0902	1.7317	1.0157	0.7654	0.9208	0.9006
+gp		1.1477	1.033	1.2305	0.978	1.5109	1.0902	1.7317	1.0157	0.7654	0.9208	
0 FBAR 4- 8		0.7948	0.7743	0.8735	0.6245	1.2497	0.9122	1.4669	1.0877	0.665	0.7679	

Table 10.3.3. Plaice in IIIa. Stock number at age (start of year) Numbers*10**-3

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

	YEAR	1978	1979	1980	1981	1982
	AGE					
	2	61661	45792	34421	25726	48501
	3	79225	55328	40383	30801	23097
	4	78264	56759	40751	32001	24020
	5	39763	33213	23149	21318	16496
	6	13172	12276	10260	8984	8854
	7	1453	4298	3834	3545	4033
	8	269	725	1497	1193	1850
	9	173	184	495	452	560
	10	101	96	95	254	207
	+gp	125	105	87	206	87
0	TOTAL	274206	208776	154973	124481	127705

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

	YEAR	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
	AGE										
	2	94317	70513	48963	37162	34608	33107	66184	73275	50799	45379
	3	43385	83933	61754	42972	33269	30722	29860	58923	63309	43768
	4	18933	30015	63941	47657	34730	26082	24895	23362	44995	49093
	5	12979	8922	16562	37121	29092	19629	12150	15771	12937	31597
	6	4842	4109	3827	9058	15332	9478	4651	5044	5026	7270
	7	2729	1838	1641	1832	3937	4166	2050	1632	1499	1796
	8	1889	1589	726	821	1055	1575	1158	741	544	508
	9	953	1204	578	410	483	600	526	526	213	201
	10	221	618	428	336	224	206	237	234	144	45
	+gp	242	218	396	232	338	234	408	408	224	188
0	TOTAL	180488	202959	198817	177601	153069	125800	142119	179916	179688	179844

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

	YEAR	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	GMST 78-**	AMST 78-**
	AGE													
	2	35310	35082	38149	40467	47155	42238	49354	96701	109068	38136	0	47356	50211
	3	40201	30962	30402	34094	32310	42164	37683	44004	86335	94902	34161	41634	44024
	4	35933	33041	21434	25343	25758	24733	31769	31525	36071	69394	81108	33453	35871
	5	33236	22918	22272	13111	15349	17239	14561	20725	20628	23698	54363	19722	21309
	6	12013	17485	11359	9185	6838	4885	9077	5071	8088	8201	14282	7850	8613
	7	2491	4315	8210	3979	3791	1332	1594	1156	1165	2805	2813	2562	2920
	8	642	677	1260	2740	1876	508	453	204	201	664	858	885	1065
	9	178	223	187	329	1190	396	94	48	53	85	175	342	444
	10	72	62	97	39	154	269	135	12	28	30	28	138	186
	+gp	105	89	75	75	48	100	54	47	64	21	18		
0	TOTAL	160181	144856	133443	129360	134469	133865	144774	199493	261701	237936	187807		

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Table 10.3.4. Plaice in IIIa Summary table (without SOP correction) .

Year	Recruitment Age 2 thousands	SSB tonnes	Landings tonnes	Mean F Ages 4-8
1978	61661	60329	26953	0.746
1979	45792	46558	21976	0.835
1980	34421	39476	16445	0.904
1981	25726	32575	12602	0.650
1982	48501	26712	11047	0.788
1983	94317	27545	10780	0.672
1984	70513	41489	11591	0.760
1985	48963	47142	13482	0.530
1986	37162	42884	14052	0.559
1987	34608	36996	15658	0.795
1988	33107	27979	12850	1.123
1989	66184	23194	7741	0.738
1990	73275	33575	12082	0.959
1991	50799	35693	8700	0.707
1992	45379	39821	11931	0.801
1993	35310	36307	11323	0.795
1994	35082	31799	11325	0.774
1995	38149	29744	10766	0.874
1996	40467	28490	10545	0.625
1997	47155	26784	10291	1.250
1998	42238	26419	8430	0.912
1999	49354	27203	8740	1.467
2000	96701	28942	8820	1.088
2001	109068	43822	11560	0.665
2002	38136	56199	8701	0.768
2003	47356	54750		
Average	52083	35907	12336	0.831

	Fish Mort Ages 4-8	Yield/R	SSB/R
Average last 3 years	0.840	0.234	0.664
$\mathbf{F}_{max}$	0.199	0.267	1.714
$\mathbf{F}_{0.1}$	0.096	0.243	2.796
$\mathbf{F}_{med}$	0.684	0.238	0.740

Table 10.5.1. Plaice IIIa. Input to short-term prediction

2003

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
2	47356	0.1	0	0	0	0.255	0.019	0.255
3	34161	0.1	1	0	0	0.271	0.084	0.271
4	81108	0.1	1	0	0	0.280	0.240	0.280
5	54363	0.1	1	0	0	0.301	0.631	0.301
6	14282	0.1	1	0	0	0.327	1.005	0.327
7	2813	0.1	1	0	0	0.401	0.973	0.401
8	858	0.1	1	0	0	0.523	0.990	0.523
9	175	0.1	1	0	0	0.815	0.589	0.815
10	28	0.1	1	0	0	0.895	0.823	0.895
11	18	0.1	1	0	0	0.933	0.823	0.933

2004

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
2	47356	0.1	0	0	0	0.255	0.019	0.255
3	.	0.1	1	0	0	0.271	0.084	0.271
4	.	0.1	1	0	0	0.280	0.240	0.280
5	.	0.1	1	0	0	0.301	0.631	0.301
6	.	0.1	1	0	0	0.327	1.005	0.327
7	.	0.1	1	0	0	0.401	0.973	0.401
8	.	0.1	1	0	0	0.523	0.990	0.523
9	.	0.1	1	0	0	0.815	0.589	0.815
10	.	0.1	1	0	0	0.895	0.823	0.895
11	.	0.1	1	0	0	0.933	0.823	0.933

2005

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
2	47356	0.1	0	0	0	0.255	0.019	0.255
3	.	0.1	1	0	0	0.271	0.084	0.271
4	.	0.1	1	0	0	0.280	0.240	0.280
5	.	0.1	1	0	0	0.301	0.631	0.301
6	.	0.1	1	0	0	0.327	1.005	0.327
7	.	0.1	1	0	0	0.401	0.973	0.401
8	.	0.1	1	0	0	0.523	0.990	0.523
9	.	0.1	1	0	0	0.815	0.589	0.815
10	.	0.1	1	0	0	0.895	0.823	0.895
11	.	0.1	1	0	0	0.933	0.823	0.933

Input units are thousands and kg - output in tonnes

Table 10.5.2. Plaice in IIIa. Management options table

2003 Biomass	SSB	FMult	FBar	Landings
66810	54750	1	0.7679	16731

2004 Biomass	SSB	FMult	FBar	Landings	2005 Biomass	SSB
60071	48011	0	0	0	71932	59872
.	48011	0.1	0.0768	2315	69389	57329
.	48011	0.2	0.1536	4470	67028	54968
.	48011	0.3	0.2304	6478	64836	52776
.	48011	0.4	0.3072	8351	62798	50738
.	48011	0.5	0.3839	10098	60903	48843
.	48011	0.6	0.4607	11730	59138	47078
.	48011	0.7	0.5375	13256	57493	45433
.	48011	0.8	0.6143	14684	55960	43900
.	48011	0.9	0.6911	16020	54528	42468
	48011	**0.95**	**0.73**	**16708**	**53852**	**41792**
.	48011	1	0.7679	17273	53191	41131
.	48011	1.1	0.8447	18448	51941	39881
.	48011	1.2	0.9215	19552	50771	38711
.	48011	1.3	0.9982	20589	49675	37615
.	48011	1.4	1.075	21565	48647	36587
.	48011	1.5	1.1518	22483	47683	35623
.	48011	1.6	1.2286	23349	46778	34718
.	48011	1.7	1.3054	24166	45926	33866
.	48011	1.8	1.3822	24937	45125	33065
.	48011	1.9	1.459	25666	44370	32310
.	48011	2	1.5358	26356	43658	31598

Input units are thousands and kg - output in tonnes

Figure 10.3.1. Plaice in IIIa. Stock summary plots

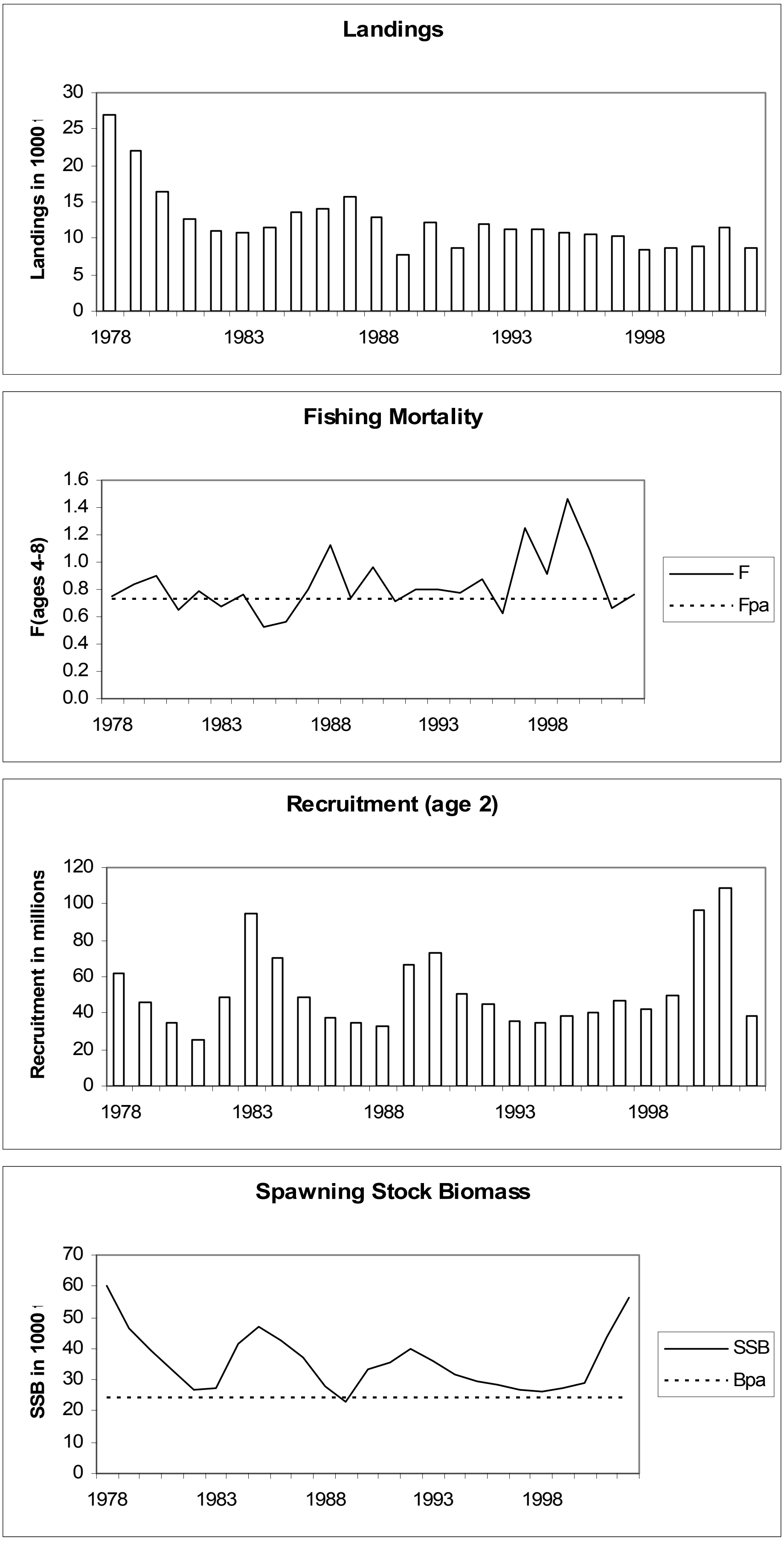
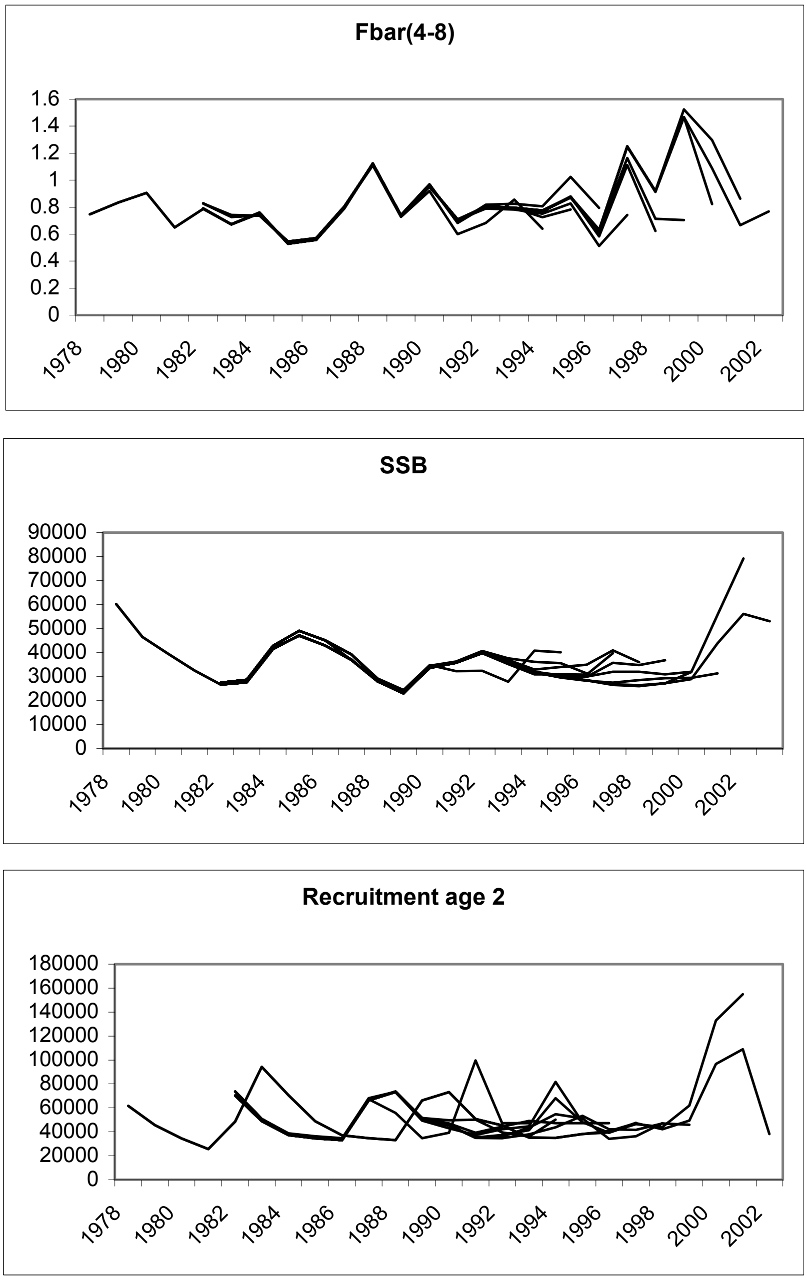


Figure 10.3.2. Plaice in IIIa. Historic performance of assessments.



11 PLAICE IN DIVISION VIID

The assessment of plaice in Division VIId is presented here as an update assessment. All the relevant biological and methodological information can be found in the stock annex dealing with this stock. Here, only the basic input and output from the assessment model will be presented.

11.1 The fishery

Plaice is caught all year in a mixed fishery with sole by Belgian and UK offshore beam trawlers and French inshore trawlers. During the winter plaice in VIId is a seasonal target for some French offshore trawlers and the Belgium beam trawlers

11.1.1 ACFM advice applicable to 2002 and 2003

ACFM advice for 2002 and 2003 was that the stock was harvested outside safe biological limits.

The fishing mortality in 2002 should be reduced to less than the proposed $\mathbf{F}_{pa}$ (0.45), corresponding to landings in 2002 of less than 5800t.

The fishing mortality in 2003 should be reduced to less than the proposed $\mathbf{F}_{pa}$ (0.45), corresponding to landings in 2003 of less than 5300t.

The precautionary fishing mortality and biomass reference points proposed by ACFM are as follows :

$\boldsymbol{B}_{lim}$ *= 5600 t;* $\boldsymbol{B}_{pa}$ *= 8000 t,* $\boldsymbol{F}_{lim}$ *= 0.54,* $\boldsymbol{F}_{pa}$*= 0.45.*

11.1.2 Management applicable in 2002 and 2003

There is no separate TAC for VIId plaice which at present is managed together with area VIIe. The TAC in 2002 and 2003 were set respectively to 6690 t and 5970 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 2002

Landings data as reported to ICES together with the total landings estimated by the Working Group are shown in Table 11.1.1. Since 1992, the landings remained steady between 5100 t. to 6300 t. The 2002 landing of 5777 t. (Figure 11.6.1) was still between these boundaries and was at the same magnitude as the 5800 t predicted at status quo F from last year's assessment. France contributed to 63 % of the official landings in 2002 followed by Belgium (22 %) and UK (15 %).

The first quarter is the most important for the fisheries and the landings (in weights) in 2002 for this period was 35% of the annual total, compared to 44% in 2000 and 41% in 2001.

11.2 Data available

11.2.1 Landings

Landings data by country and TACs are presented in table 11.1.1. No correction was made for SOP discrepancies which have been very low since 1992.

11.2.2 Age compositions

Age compositions of the landings are presented in table 11.2.1

11.2.3 Weight at age

Weight at age in the catch is presented in table 11.2.2 and weight at age in the stock in table 11.2.3. The procedure for calculating mean weights is described in the stock annex.

11.2.4 Maturity and natural mortality

Maturity and natural mortality are assumed at fixed values and are presented in table 11.2.4.

11.2.5 Catch, effort and research vessel data

Survey data used for calibration of the assessment are presented in tables 11.2.5. Additional information that is used for recruitment estimation is presented in table 11.4.1.

11.3 Catch at age analysis

Catch at age analysis was carried out according to the specifications in the stock annex. The model used was XSA. Results of the analysis are presented in table 11.3.1 (diagnostics), 11.3.2 (fishing mortality at age), 11.3.3 (population numbers at age), and 11.3.4 (stock summary). The stock summary is also shown in figure 11.3.1 and the historical performance of the assessment is shown in figure 11.3.2.

11.4 Recruitment estimates

Recruitment estimation was carried out according to the specifications in the stock annex. The model used was RCT3. Input to the RCT3 model is presented in table 11.4.1. Results are presented in table 11.4.2 and table 11.4.3.

Average recruitment in the period 1980-2002 was 23.275 millions (geometric mean) 1-year-old-fish. Year class strength estimates used for short term prognosis are summarised in the text table below.

Year Class	Age in 2003	XSA Thousands	RCT3 Thousands	GM (1980-2002) Thousands
2000	3	**17125**		13898
2001	2	23135	**22556**	20261
2002	1		18198	**23275**
2003	0			**23275**

11.5 Short term prognosis

The short term prognosis was carried out according to the specifications in the stock annex. Input to the WGFRANSW model is presented in table 11.5.1. Results are presented in tables 11.5.2 and 11.5.3.

11.6 Comments

- This assessment has been carried out with exactly the same parameters as last year
- The strong 2000 year class (32 millions at age 1 in 2001) is confirmed and has contributed to 29% of the 2002 total catch numbers. The increase landings in 2002 and SSB at the start of 2003 can be partly explained by the strength of this 2000 year class
- The age readings of Eastern channel plaice otoliths have been the object of investigation in an International workshop. This workshop was held in Ostend in may 2003 and has permitted to increase the ability of the age readers. Samples from the 2002 age sampling program has been read by all the specialists and therefore, the 2002 age-length keys can be considered as very reliable.
- All the commercial fleets have slightly increased their effort from last year coming back to the 2000 level.
- The fleets used for tuning this assessment give very unstable signals from the stock one to each others and from one year to another.
- This assessment doesn't include discards

Workplan for benchmark.

- Analyse the consistency of the tuning fleets by individual retrospective analysis

- Investigate the reliability of the number at ages estimation by each tuning fleet (log catchabilities residuals, standardised CPUE, …)

- Consider redefinition of the current tuning fleets (prior to the Working Group) and/or the integration of new ones. UK have provided beam trawlers data for this assessment but this new tuning fleet has not been used given that this was an update assessment.

- Integrate the ongoing discard estimation into the assessment

The next benchmark assessment for this stock is foreseen in 2005

Table 11.1.1.- Plaice in VIId. Nominal landings (tonnes) as officially reported to ICES, 1976–2001.

Year	Belgium	Denmark	France	UK(E+W)	Others	Total reported	Un-allocated	Total as used by WG
1976	147	1(1)	1439	376	-	1963	-	1963
1977	149	81(2)	1714	302	-	2246	-	2246
1978	161	156(2)	1810	349	-	2476	-	2476
1979	217	28(2)	2094	278	-	2617	-	2617
1980	435	112(2)	2905	304	-	3756	-1106	2650
1981	815	-	3431	489	-	4735	34	4769
1982	738	-	3504	541	22	4805	60	4865
1983	1013	-	3119	548	-	4680	363	5043
1984	947	-	2844	640	-	4431	730	5161
1985	1148	-	3943	866	-	5957	65	6022
1986	1158	-	3288	828	488 (2)	5762	1072	6834
1987	1807	-	4768	1292	-	7867	499	8366
1988	2165	-	5688 (2)	1250	-	9103	1317	10420
1989	2019	+	3265 (1)	1383	-	6667	2091	8758
1990	2149	-	4170 (1)	1479	-	7798	1249	9047
1991	2265	-	3606 (1)	1566	-	7437	376	7813
1992	1560	1	3099	1553	19	6232	105	6337
1993	877	+(2)	2792	1075	27	4771	560	5331
1994	1418	+	3199	993	23	5633	488	6121
1995	1157	-	2598 (2)	796	18	4569	561	5130
1996	1112	-	2630 (2)	856	+	4598	795	5393
1997	1161	-	3077	1078	+	5316	991	6307
1998	854	-	3276 (23)	700	+	4830	932	5762
1999	1306	-	3259 (23)	743	+	5437	889	6326
2000	1298	-	3183	752	+	5233	781	6014
2001	1346	-	2962	655	+	4963	303	5266
2002	1204	-	3454	841		5499	278	5777

[1]Estimated by the Working Group from combined Division VIId+e
[2]Includes small landings in Division VIIe
[3]Provisional

Table 11.2.1.- 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
2001	2682	4159	4380	2141	1985	310	87	22	13	78
2002	902	7204	5191	1907	1565	888	234	62	25	92

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Table 11.2.2.- Plaice in VIId. Weight in the catch

	1	2	3	4	5	6	7	8	9	10+
1980	0.309	0.312	0.499	0.627	0.787	1.139	1.179	1.293	1.475	1.557
1981	0.239	0.299	0.373	0.464	0.712	0.87	0.863	0.897	0.992	1.174
1982	0.245	0.271	0.353	0.431	0.64	0.795	1.153	1.067	1.504	1.355
1983	0.266	0.296	0.349	0.42	0.542	0.822	0.953	1.144	0.943	1.591
1984	0.233	0.295	0.336	0.402	0.508	0.689	0.703	0.945	1.028	1.427
1985	0.254	0.278	0.301	0.427	0.502	0.57	0.557	1.081	0.849	1.421
1986	0.226	0.306	0.331	0.406	0.546	0.486	0.629	0.871	1.446	1.579
1987	0.251	0.282	0.36	0.477	0.577	0.783	0.735	1.142	1.268	1.515
1988	0.292	0.268	0.321	0.432	0.56	0.657	0.77	0.908	1.218	1.328
1989	0.201	0.268	0.321	0.37	0.473	0.648	0.837	0.907	1.204	1.519
1990	0.201	0.256	0.326	0.378	0.483	0.61	0.781	0.963	1.159	1.31
1991	0.225	0.277	0.311	0.39	0.454	0.556	0.745	1.087	0.924	1.602
1992	0.182	0.277	0.352	0.429	0.509	0.585	0.701	0.837	0.85	1.195
1993	0.22	0.272	0.336	0.432	0.507	0.591	0.741	0.82	0.934	1.156
1994	0.243	0.27	0.288	0.356	0.466	0.576	0.686	0.928	0.969	1.287
1995	0.218	0.271	0.313	0.39	0.485	0.688	0.612	0.806	1.15	1.298
1996	0.221	0.3	0.29	0.396	0.475	0.643	0.764	0.934	1.057	1.312
1997	0.199	0.252	0.298	0.332	0.442	0.577	0.801	0.894	1.055	1.395
1998	0.159	0.244	0.267	0.381	0.502	0.762	0.839	0.981	0.986	1.379
1999	0.197	0.245	0.235	0.306	0.461	0.751	0.768	0.868	0.885	1.508
2000	0.182	0.256	0.314	0.37	0.44	0.607	0.768	0.972	0.975	1.193
2001	0.215	0.252	0.303	0.37	0.447	0.642	0.876	1.008	1.144	1.223
2002	0.254	0.256	0.309	0.376	0.438	0.562	0.627	0.880	0.909	1.330

Table 11.2.3.- Plaice in VIId. Weight in the stock

	1	2	3	4	5	6	7	8	9	10+
1981	0.11	0.216	0.317	0.414	0.506	0.594	0.677	0.756	0.83	1.042
1982	0.105	0.208	0.308	0.406	0.502	0.596	0.687	0.776	0.862	1.118
1983	0.097	0.192	0.286	0.379	0.47	0.56	0.648	0.735	0.821	1.169
1984	0.082	0.164	0.248	0.333	0.42	0.507	0.596	0.686	0.777	1.086
1985	0.084	0.171	0.259	0.348	0.44	0.533	0.628	0.725	0.824	1.206
1986	0.101	0.205	0.311	0.42	0.532	0.646	0.763	0.882	1.004	1.313
1987	0.122	0.242	0.361	0.479	0.596	0.712	0.826	0.939	1.051	1.306
1988	0.084	0.168	0.254	0.34	0.427	0.514	0.603	0.692	0.783	0.952
1989	0.079	0.162	0.25	0.342	0.439	0.541	0.648	0.759	0.874	1.211
1990	0.085	0.23	0.322	0.346	0.465	0.549	0.748	0.899	0.979	1.766
1991	0.065	0.219	0.275	0.335	0.375	0.472	0.633	1.057	1.022	1.502
1992	0.088	0.241	0.336	0.421	0.477	0.521	0.634	0.713	0.741	1.229
1993	0.108	0.258	0.296	0.379	0.493	0.539	0.573	0.699	0.787	1.056
1994	0.165	0.198	0.276	0.331	0.383	0.493	0.603	0.903	0.781	1.15
1995	0.058	0.257	0.286	0.354	0.442	0.707	0.531	0.703	1.092	1.194
1996	0.178	0.229	0.263	0.347	0.354	0.474	0.536	0.907	0.958	1.126
1997	0.059	0.202	0.256	0.266	0.417	0.53	0.665	0.686	0.972	1.364
1998	0.072	0.203	0.273	0.361	0.53	0.67	0.629	0.656	0.915	1.107
1999	0.072	0.172	0.213	0.351	0.429	0.644	0.76	0.782	0.593	1.166
2000	0.068	0.184	0.204	0.246	0.355	0.554	0.693	0.817	0.89	1.131
2001	0.093	0.206	0.274	0.338	0.404	0.624	0.844	0.989	1.153	1.405
2002	0.102	0.206	0.281	0.379	0.467	0.558	0.610	0.759	1.053	1.250

Table 11.2.4 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 11.2.5- Plaice in VIId. Tuning fleets

```
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 2002
1 1 0.00 1.00
2 10
    2520   618.3   419.7   221.1    18.8     0.0     0.0     0.0    19.0     0.0
    1804   237.9   300.2   132.9    51.6     6.5     4.7     2.9     0.0     0.0
    2556   456.0   430.2   153.2    48.0    25.1     5.0     6.3     4.3     0.0
    2500   382.4   856.1   141.7    57.8    30.1    14.1     2.8     4.0     5.2
    2131    47.4   221.7   465.4    97.1    41.3    19.0     5.5     1.2     6.2
    1094    34.3    92.1    52.6    56.9    18.0     7.5     5.5     3.6     3.1
    2349   240.2   229.7   166.6    76.6    64.9    10.7     4.3     2.1     1.3
    2527   298.0   225.5   140.4    77.8    55.3    44.2    14.6     2.9     2.4
    2503   309.3   181.4    66.6    40.5    30.1    21.5    25.1     8.5     3.8
    2635   176.0   240.2    99.7    37.8    21.0    17.0     8.9    17.9     3.5
    1531   124.1    70.7    54.6    23.5     8.5     5.0     5.5     3.9     6.8
    1659   274.4    63.8    16.9    19.1    10.0     2.5     3.1     2.5     2.5
    2024   317.1   223.8    20.4     7.7    10.2     8.0     4.9     2.8     4.0
     813   104.3    77.7    27.6     3.7     1.7     3.9     1.4     1.2     0.3
     861    53.4   222.2    27.0     8.7     1.2     0.4     1.4     0.5     0.4
     652    75.0    46.0    81.3    13.8     4.5     1.1     0.5     1.0     0.4
     493    29.5    21.4    13.8    17.6     3.3     0.9     0.6     0.2     0.2
     608    36.4   120.3    77.2    17.2     8.5    14.7     2.2     1.5     0.3
```

FLT02: BELGIAN BEAM TRAWL(HP corr) all gears age comp [rev: 05/09/03-WD] (Catch: Unknown) (Effort: Unknown)

```
1981 2002
1 1 0.00 1.00
2 10
   24.4    285.9   1126.5    593.3     67.3     21.6      8.3      7.1     13.3     14.1
   29.8    147.8   1065.4    688.2    187.2     55.1     21.1      6.5      4.6      4.0
   26.4    476.7    654.3   1384.5    165.0     52.2     23.0     31.6      1.3      1.4
   35.4     92.0   1570.4    712.1    467.5    134.3     61.0     28.2      5.4      6.8
   33.4    557.2   1125.3   1115.1     93.9    197.2     52.9     31.9      5.3      6.1
   30.8    700.6   1141.8    667.8    269.9    145.9     60.3     11.3      5.6      6.4
   49.3   1944.8   1639.7    889.0    343.1     92.7    154.5     41.1     28.0     14.1
   48.9    773.0   4264.6   1301.8    237.1    109.9    113.2     35.8     25.4     24.0
   43.8     73.6   1733.7   2950.5    973.4    212.8    113.1     61.1     21.7      0.1
   38.5    372.1   2687.5   1942.8   1007.0    184.8     43.9     50.5     13.1     14.0
   32.8    595.4   1689.2   1149.4   1089.5    698.4     86.9     36.0     58.9      1.7
   30.9    889.8   1031.7    403.8    277.6    282.1    159.7     58.2     60.7      6.7
   28.2    488.8    684.2    274.3    197.6    121.6     74.7     62.8     10.6     19.3
   32.8    424.6   1259.2   1426.5    268.0    132.6    109.5     75.5     90.0     37.6
   31.7     39.8    591.9    925.2    396.5     82.0    140.1     82.6     26.1      0.7
   32.6    259.3    689.3    541.5    503.7    137.6     46.4     49.9     38.4     44.4
   39.7      0.0    287.3    931.8    570.2    295.7    143.7     37.3     27.7     11.2
   23.6    164.6    900.7    616.6    122.0     39.0     40.0     18.2     18.4     13.7
   27.6     40.7   1687.7   1366.6    370.5     67.5     25.4     13.5     14.0     12.7
   37.0     60.4    369.7    529.0    235.4     43.4     12.1      5.9     10.4      1.5
   40.2    422.6   1759.9   1085.0    705.3    119.4     26.5      9.3      7.6     26.9
   41.11   412.7   1361.3    641.0    578.0    138.7     62.7      9.6      5.0     26.1
```

FLT03: FRENCH TRAWLERS (EFFORT H*KW*10-4) 1989-90 DERAISED 1991-98 TRUE (Catch: Unknown) (Effort: Unknown)

```
1989 2002
1 1 0.00 1.00
2 10
     6983   1190.1   1635.9   1643.2    466.2     73.5     34.3     34.1     19.3     16.1
     8395    698.2   1876.1   1289.5    728.3    153.7     42.6     33.1     46.5     14.4
    10689   1938.7   1474.1   1430.0    399.5    255.2     41.0     17.6     11.9      9.9
    10519   1802.9   1396.1    370.2    269.4    230.7    143.5     21.2     12.1     11.6
    10217   2124.4   1118.2    268.4     56.0     73.4     48.7     32.3     14.3      4.6
    10609   1034.2   2271.2    476.4    177.6     69.5     48.2     48.3     32.0     25.0
    12384   1354.7    686.5    578.5     95.4     21.4     19.5     27.5     21.8     28.2
    14476   1133.3   1283.9    352.7    317.5     98.8     43.6     33.3     34.6     36.9
    10921   1396.2   3536.0   1155.4    139.0    170.7     88.3     50.8     22.4     28.2
    11707   1446.0   3541.9   1534.4    205.4     29.8     20.2     17.8      6.9      8.2
    10625   1139.1   5654.6   2456      254.4     36.1     24.8     23.5      4.4     16.6
    13779   2757.4   1634     3110.4    781.5    130.9     21.2      6.1     12.9     19.9
    11376   2113.6   1726.3    663.1    642.5     81.3     21.6      1.4      1.2     16.4
    13489   3130.4   1134.9    336.6    230.9    186.2     36.7      9.5      2.9     13.1
```

Table 11.2.5-(continued) Plaice in VIId. Tuning fleets

FLT04: UK BEAM TRAWL SURVEY true age 6 [rev: 15/06/03-RM] (Catch: Unknown) (Effort: Unknown)

```
1988 2002
1 1 0.50 0.75
1 6
   1   26.5   31.3   43.8    7.0    4.6    1.5
   1    2.3   12.1   16.6   19.9    3.3    1.5
   1    5.2    4.9    5.8    6.7    7.5    1.8
   1   11.8    9.1    7.0    5.3    5.4    3.2
   1   16.5   12.5    4.2    4.2    5.6    4.9
   1    3.2   13.4    5.0    1.7    1.9    1.6
   1    8.3    7.5    9.2    5.6    1.9    0.8
   1   11.3    4.1    3.0    3.7    1.5    0.6
   1   13.2   11.9    1.3    0.7    1.3    0.9
   1   33.1   13.5    4.2    0.6    0.3    0.3
   1   11.4   27.3    7.0    3.1    0.3    0.2
   1   11.3   14.1   15.9    2.9    1.0    0.2
   1   13.2   21.0   14.4   13.8    3.5    0.9
   1   17.9   13.0   10.0    7.1   10.9    1.9
   1   20.7   15.9    7.7    3.5    1.8    3.5
```

FLT05: French GFS [option 2] true age 5 [rev: 06/09/03-JV] (Catch: Unknown) (Effort: Unknown)

```
1988 2002
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    2.7    0.8    1.8    1.3    1.1
   1    1.7    1.4    0.6    0.4    0.3
   1   23.8    2.5    1.3    0.2    0.2
   1   19.2    8.9    4.2    0.9    0.4
   1    5.2    2.2    0.8    0.2    0.1
   1    4.9    3.0    1.1    0.7    0.2
   1    4.5    2.6    0.3    0.1    0.2
   1   35.5    8.4    4.5    0.3    0.1
   1   12.5   14.0    3.1    0.5    0.0
   1    8.5    4.6    7.6    1.3    0.2
   1   10.3   12.8    3.5    3.1    0.8
   1    7.4    3.5    1.2    0.8    0.3
   1   11.3    9.3    4.3    0.4    0.2
```

FLT06: Intl YFS [rev: 06/09/03-JV] (Catch: Unknown) (Effort: Unknown)

```
1987 2002
1 1 0.50 0.75
1 1
   1   1.44
   1   1.32
   1   0.58
   1   0.71
   1   0.62
   1   1.78
   1   0.84
   1   0.79
   1   1.68
   1   0.66
   1   0.82
   1   0.8
   1   0.76
   1   0.48
   1   0.83
   1   0.92
```

Table 11.3.1- Plaice in VIId. Tuning diagnostic

```
Lowestoft VPA Version 3.1

   12/09/2003  12:45

 Extended Survivors Analysis

 PLaice in VIId (run 09/2003)

 CPUE data from file e:\wgnssk\fleet.dat

 Catch data for  23 years. 1980 to 2002. Ages  1 to  10.

      Fleet,            First, Last, First, Last, Alpha,  Beta
                  ,       year, year,  age ,  age
 FLT01: UK INSHORE TR,   1988, 2002,   2,     9,   .000,  1.000
 FLT02: BELGIAN BEAM ,   1988, 2002,   2,     9,   .000,  1.000
 FLT03: FRENCH TRAWLE,   1989, 2002,   2,     9,   .000,  1.000
 FLT04: UK BEAM TRAWL,   1988, 2002,   1,     6,   .500,   .750
 FLT05: French GFS [o,   1988, 2002,   1,     5,   .750,  1.000
 FLT06: Intl YFS [rev,   1988, 2002,   1,     1,   .500,   .750


 Time series weights :

      Tapered time weighting not applied


 Catchability analysis :

      Catchability independent of stock size for all ages

      Catchability independent of age for ages >=    7


 Terminal population estimation :

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

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

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

      Prior weighting not applied


 Tuning had not converged after   30 iterations


 Total absolute residual between iterations
 29 and  30 =     .00030

 Final year F values
 Age         ,      1,      2,      3,      4,      5,      6,      7,      8,      9
 Iteration 29,  .0364,  .3366,  .5656,  .6092,  .7621,  .5771,  .4917,  .5697,  .6324
 Iteration 30,  .0364,  .3366,  .5656,  .6092,  .7620,  .5771,  .4917,  .5696,  .6323


1
 Regression weights
       , 1.000, 1.000, 1.000, 1.000, 1.000, 1.000, 1.000, 1.000, 1.000, 1.000


 Fishing mortalities
    Age,  1993,  1994,  1995,  1996,  1997,  1998,  1999,  2000,  2001,  2002

      1,  .061,  .078,  .115,  .039,  .015,  .032,  .041,  .069,  .092,  .036
      2,  .412,  .415,  .378,  .290,  .183,  .146,  .144,  .485,  .272,  .337
      3,  .478,  .726,  .614,  .548,  .803,  .601,  .652,  .542,  .667,  .566
      4,  .495,  .803,  .684,  .681, 1.464, 1.044, 1.144,  .937,  .507,  .609
      5,  .343,  .649,  .517,  .758, 1.395,  .853,  .969,  .929,  .635,  .762
      6,  .352,  .430,  .316,  .504, 1.070,  .588,  .643,  .758,  .382,  .577
      7,  .385,  .373,  .499,  .389, 1.166,  .482,  .758,  .650,  .439,  .492
      8,  .340,  .536,  .447,  .606,  .879,  .556,  .524,  .501,  .317,  .570
      9,  .440,  .559,  .444,  .610,  .907,  .522,  .486,  .503,  .424,  .632
```

Table 11.3.1 (continued)- Plaice in VIId. Tuning diagnostic

1

XSA population numbers (Thousands)

YEAR	AGE 1	2	3	4	5	6	7	8	9
1993	1.32E+04	2.37E+04	1.06E+04	3.39E+03	1.96E+03	1.66E+03	1.10E+03	1.05E+03	3.01E+02
1994	1.73E+04	1.13E+04	1.42E+04	5.92E+03	1.87E+03	1.26E+03	1.05E+03	6.76E+02	6.75E+02
1995	2.51E+04	1.45E+04	6.72E+03	6.22E+03	2.40E+03	8.85E+02	7.41E+02	6.57E+02	3.58E+02
1996	3.06E+04	2.02E+04	8.98E+03	3.29E+03	2.84E+03	1.30E+03	5.84E+02	4.07E+02	3.80E+02
1997	3.81E+04	2.67E+04	1.37E+04	4.70E+03	1.51E+03	1.20E+03	7.09E+02	3.58E+02	2.01E+02
1998	1.57E+04	3.40E+04	2.01E+04	5.55E+03	9.83E+02	3.38E+02	3.74E+02	2.00E+02	1.34E+02
1999	1.96E+04	1.37E+04	2.66E+04	9.96E+03	1.77E+03	3.79E+02	1.70E+02	2.09E+02	1.04E+02
2000	2.17E+04	1.70E+04	1.08E+04	1.25E+04	2.87E+03	6.07E+02	1.80E+02	7.21E+01	1.12E+02
2001	3.21E+04	1.83E+04	9.46E+03	5.66E+03	4.44E+03	1.03E+03	2.57E+02	8.51E+01	3.95E+01
2002	2.65E+04	2.65E+04	1.26E+04	4.39E+03	3.09E+03	2.13E+03	6.33E+02	1.50E+02	5.61E+01

Estimated population abundance at 1st Jan 2003

0.00E+00	2.31E+04	1.71E+04	6.49E+03	2.16E+03	1.30E+03	1.08E+03	3.51E+02	7.68E+01

Taper weighted geometric mean of the VPA populations:

2.37E+04	2.04E+04	1.36E+04	6.36E+03	2.53E+03	1.08E+03	5.34E+02	2.83E+02	1.35E+02

Standard error of the weighted Log(VPA populations) :

.3506	.3600	.4450	.5120	.5117	.6629	.7147	.7636	1.0739

1

Log catchability residuals.

Fleet : FLT01: UK INSHORE TR

Age	1988	1989	1990	1991	1992
1	No data for this fleet at this age				
2	.18	-1.60	-.69	.52	.47
3	.20	-.42	-.39	.41	.49
4	-.24	.56	-.50	.32	.68
5	.17	.41	-.06	-.05	.32
6	.07	.69	.28	.05	.35
7	-.34	.30	.26	-.40	.25
8	-.78	-.56	.29	-.55	.38
9	-.11	-.82	.30	-.80	-.44

Age	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
1	No data for this fleet at this age									
2	.24	.37	.29	.63	.25	-.21	-.03	.53	-.30	-.63
3	-.09	-.05	-.03	-.53	.22	-.40	.33	-.11	-.41	.77
4	.05	-.02	-.17	-.79	-.84	.04	-.58	.48	-.40	1.41
5	.05	.11	-.13	-.48	-.69	-.30	-.04	.19	.15	.34
6	-.05	-.15	-.21	-.43	-.29	-.10	-.60	.58	-.14	-.05
7	.03	-.22	-.49	-1.08	.03	.57	-.86	.33	-.04	1.66
8	.21	-.35	-.30	-.40	.10	.20	.09	.39	.60	1.24
9	.42	.36	-.04	-.55	.13	.43	-.26	.65	.32	1.87

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	-12.1554	-11.5237	-11.5276	-11.5407	-11.5659	-11.5561	-11.5561	-11.5561
S.E(Log q)	.6045	.3926	.6144	.3074	.3534	.6481	.5348	.6819

Table 11.3.1 (continued)- Plaice in VIId. Tuning diagnostic

Regression statistics :

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

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
2,	1.91,	-.937,	14.23,	.08,	15,	1.16,	-12.16,
3,	.99,	.030,	11.51,	.61,	15,	.40,	-11.52,
4,	.93,	.214,	11.35,	.45,	15,	.60,	-11.53,
5,	.80,	1.694,	10.83,	.85,	15,	.23,	-11.54,
6,	.86,	1.126,	10.95,	.84,	15,	.30,	-11.57,
7,	.94,	.247,	11.25,	.57,	15,	.63,	-11.56,
8,	1.54,	-2.153,	14.61,	.55,	15,	.73,	-11.52,
9,	1.64,	-1.773,	15.39,	.37,	15,	1.03,	-11.46,

1

Fleet : FLT02: BELGIAN BEAM

Age	1988,	1989,	1990,	1991,	1992
1	No data for this fleet at this age				
2	.38,	-1.71,	.60,	1.26,	1.53
3	-.07,	-.29,	.52,	.86,	.60
4	-.47,	-.09,	.07,	.14,	-.24
5	-.96,	.12,	-.33,	.39,	-.49
6	-.84,	.08,	-.19,	.56,	.24
7	-.36,	-.06,	-.66,	-.06,	-.10
8	-.33,	-.30,	-.17,	-.19,	.14
9	-.36,	-.08,	-1.09,	.77,	.98

Age	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002
1	No data for this fleet at this age									
2	.75,	1.20,	-1.40,	.07,	99.99,	-.65,	-1.30,	-1.25,	.44,	.06
3	-.09,	.18,	.16,	-.03,	-1.42,	-.22,	-.01,	-.97,	.69,	.08
4	-.43,	.65,	.15,	.22,	.53,	.30,	.40,	-1.16,	.09,	-.16
5	-.36,	-.03,	.09,	.24,	1.06,	.25,	.66,	-.58,	-.13,	.07
6	-.31,	-.06,	-.21,	-.01,	.87,	.43,	.73,	-.42,	-.19,	-.70
7	-.27,	.00,	.69,	-.26,	.81,	.41,	.70,	-.44,	-.19,	-.22
8	-.42,	.14,	.26,	.27,	.03,	.28,	-.24,	-.30,	-.18,	-.62
9	-.90,	.33,	-.29,	.08,	.32,	.67,	.48,	-.17,	.43,	-.27

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

Age ,	2,	3,	4,	5,	6,	7,	8,	9
Mean Log q,	-7.7230,	-5.7111,	-5.1448,	-5.0571,	-5.4275,	-5.5245,	-5.5245,	-5.5245,
S.E(Log q),	1.0816,	.5982,	.4542,	.5088,	.4961,	.4461,	.3016,	.5953,

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,	1.98,	-.509,	5.65,	.02,	14,	2.20,	-7.72,
3,	1.32,	-.718,	4.50,	.28,	15,	.80,	-5.71,
4,	1.28,	-.924,	4.13,	.46,	15,	.58,	-5.14,
5,	1.44,	-1.224,	3.79,	.37,	15,	.72,	-5.06,
6,	1.19,	-.788,	5.11,	.56,	15,	.60,	-5.43,
7,	1.13,	-.666,	5.40,	.66,	15,	.52,	-5.52,
8,	.92,	.963,	5.65,	.91,	15,	.26,	-5.63,
9,	1.16,	-.657,	5.49,	.56,	15,	.70,	-5.46,

1

Table 11.3.1 (continued)- Plaice in VIId. Tuning diagnostic

Fleet : FLT03: FRENCH TRAWLE

Age	1988	1989	1990	1991	1992
1	No data for this fleet at this age				
2	99.99	-.11	-.26	.55	.30
3	99.99	-.21	-.02	.14	.28
4	99.99	.04	.06	.36	-.37
5	99.99	.50	.16	-.21	-.15
6	99.99	.07	.38	-.10	.34
7	99.99	-.09	.17	-.36	.20
8	99.99	.28	.26	-.45	-.46
9	99.99	.97	1.03	-.38	-.23

Age	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
1	No data for this fleet at this age									
2	.22	.20	.05	-.66	-.50	-.79	-.03	.54	.29	.18
3	-.28	.20	-.45	-.30	.68	.15	.45	-.19	.24	-.69
4	-.55	-.44	-.50	-.52	.91	.80	.82	.48	-.26	-.81
5	-1.32	-.02	-1.11	-.12	.22	.76	.53	.89	.32	-.45
6	-.57	-.36	-1.39	-.31	.83	.08	.28	.89	-.09	-.07
7	-.35	-.37	-1.02	-.18	.95	-.25	.96	.44	.20	-.31
8	-.74	.15	-.57	.01	.96	.29	.60	.05	-1.48	-.19
9	-.26	-.25	-.20	.12	.73	-.28	-.39	.36	-.82	-.37

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	-11.6141	-10.9181	-10.9309	-11.2507	-11.5572	-11.7618	-11.7618	-11.7618
S.E(Log q)	.4188	.3741	.5815	.6408	.5778	.5374	.6245	.5606

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	2.76	-1.882	14.73	.09	14	1.06	-11.61
3	.76	1.193	10.57	.68	14	.28	-10.92
4	.68	1.654	10.24	.69	14	.37	-10.93
5	1.02	-.069	11.33	.42	14	.68	-11.25
6	1.11	-.404	12.05	.53	14	.66	-11.56
7	1.53	-1.751	14.60	.48	14	.76	-11.76
8	.94	.303	11.48	.66	14	.60	-11.86
9	.81	1.203	10.53	.77	14	.45	-11.76

1

Fleet : FLT04: UK BEAM TRAWL

Age	1988	1989	1990	1991	1992
1	.67	-1.26	-.56	.10	.18
2	.49	-.31	-.65	.05	.16
3	.70	.27	-.50	.36	.02
4	.04	.55	-.08	.14	.46
5	.64	-.08	.09	.25	.69
6	.02	.18	.12	-.05	.91
7	No data for this fleet at this age				
8	No data for this fleet at this age				
9	No data for this fleet at this age				

Table 11.3.1 (continued)- Plaice in VIId. Tuning diagnostic

Age	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
1	-.72	-.02	-.06	-.15	.53	.37	.14	.21	.14	.44
2	-.05	.12	-.76	-.09	-.30	.13	.38	.78	.09	-.04
3	-.24	.23	-.21	-1.38	-.47	-.47	.10	.84	.68	.07
4	-.35	.47	-.07	-1.10	-1.12	.10	-.49	.71	.57	.18
5	-.05	.18	-.38	-.55	-.99	-.89	-.20	.54	1.06	-.30
6	-.05	-.43	-.43	-.29	-.96	-.40	-.48	.63	.61	.62
7	No data for this fleet at this age									
8	No data for this fleet at this age									
9	No data for this fleet at this age									

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

Age	1	2	3	4	5	6
Mean Log q	-7.5096	-7.1078	-7.0558	-6.8732	-6.6093	-6.6053
S.E(Log q)	.5084	.4019	.5751	.5650	.5820	.5214

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	.51	2.538	8.75	.67	15	.22	-7.51
2	.88	.376	7.43	.45	15	.37	-7.11
3	.80	.804	7.56	.54	15	.46	-7.06
4	.69	1.684	7.48	.69	15	.36	-6.87
5	.63	2.314	7.10	.75	15	.32	-6.61
6	.79	1.267	6.71	.74	15	.40	-6.61

1

Fleet : FLT05: French GFS [o

Age	1988	1989	1990	1991	1992
1	-.18	-.48	-.84	-1.47	.91
2	.86	.13	-1.52	-.81	-.45
3	.47	-.34	-.40	-.80	.14
4	.48	-.47	.15	-.54	-.74
5	.78	-1.32	.37	-.42	-.47
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	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
1	1.44	-.12	-.52	-.87	.96	.81	.22	.33	-.37	.19
2	.53	-.12	-.10	-.65	.15	.39	.18	1.29	-.27	.39
3	.80	-.94	.03	-1.62	.89	-.04	.62	.65	-.18	.72
4	.82	-.97	.13	-1.18	.24	.22	.68	1.14	.20	-.15
5	.52	-.56	-.23	-.19	.31	99.99	.47	1.34	-.33	-.27
6	No data for this fleet at this age									
7	No data for this fleet at this age									
8	No data for this fleet at this age									
9	No data for this fleet at this age									

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

Age	1	2	3	4	5
Mean Log q	-7.8335	-7.9683	-8.1224	-8.5361	-8.6262
S.E(Log q)	.8007	.6935	.7294	.6697	.6701

Table 11.3.1 (continued)- Plaice in VIId. Tuning diagnostic

```
 Regression statistics :
 Ages with q independent of year class strength and constant w.r.t. time.

 Age, Slope , t-value , Intercept, RSquare, No Pts, Reg s.e,  Mean Q

  1,    1.60,    -.511,      6.52,     .05,     15,    1.32,   -7.83,
  2,     .50,    1.836,      8.91,     .51,     15,     .32,   -7.97,
  3,     .75,     .819,      8.47,     .45,     15,     .55,   -8.12,
  4,     .74,    1.054,      8.61,     .55,     15,     .49,   -8.54,
  5,    1.65,    -.996,      9.03,     .16,     14,    1.11,   -8.63,
1
```

Fleet : FLT06: Intl YFS [rev

```
  Age  ,  1988,  1989,  1990,  1991,  1992
     1 ,   .24,  -.06,   .03,  -.26,   .53
     2 , No data for this fleet at this age
     3 , No data for this fleet at this age
     4 , No data for this fleet at this age
     5 , No data for this fleet at this age
     6 , No data for this fleet at this age
     7 , No data for this fleet at this age
     8 , No data for this fleet at this age
     9 , No data for this fleet at this age

  Age  ,  1993,  1994,  1995,  1996,  1997,  1998,  1999,  2000,  2001,  2002
     1 ,   .53,   .20,   .61,  -.57,  -.59,   .29,   .02,  -.53,  -.35,  -.10
     2 , No data for this fleet at this age
     3 , No data for this fleet at this age
     4 , No data for this fleet at this age
     5 , No data for this fleet at this age
     6 , No data for this fleet at this age
     7 , No data for this fleet at this age
     8 , No data for this fleet at this age
     9 , No data for this fleet at this age


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

    Age ,         1
 Mean Log q,  -10.0886,
 S.E(Log q),     .4028,

 Regression statistics :


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

 Age, Slope , t-value , Intercept, RSquare, No Pts, Reg s.e,  Mean Q

  1,    2.79,   -1.957,     10.21,     .08,     15,    1.03,  -10.09,
1

 Terminal year survivor and F summaries :

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

 Year class = 2001

 Fleet,                Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
      ,                Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 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,    35902.,   .525,       .000,    .00,   1,  .242,     .024
 FLT05: French GFS [o,    28035.,   .827,       .000,    .00,   1,  .097,     .030
 FLT06: Intl YFS [rev,    21037.,   .416,       .000,    .00,   1,  .385,     .040

   F shrinkage mean  ,    16806.,    .50,,,,                       .276,     .050

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
     23135.,       .26,      .18,    4,    .693,   .036
```

Table 11.3.1 (continued)- Plaice in VIId. Tuning diagnostic

1

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

Year class = 2000

Fleet,	Estimated,	Int,	Ext,	Var,	N,	Scaled,	Estimated
,	Survivors,	s.e,	s.e,	Ratio,	,	Weights,	F
FLT01: UK INSHORE TR,	9078.,	.624,	.000,	.00,	1,	.080,	.562
FLT02: BELGIAN BEAM ,	18098.,	1.120,	.000,	.00,	1,	.025,	.321
FLT03: FRENCH TRAWLE,	20479.,	.434,	.000,	.00,	1,	.167,	.289
FLT04: UK BEAM TRAWL,	17567.,	.326,	.085,	.26,	2,	.285,	.329
FLT05: French GFS [o,	18598.,	.542,	.378,	.70,	2,	.103,	.314
FLT06: Intl YFS [rev,	12012.,	.416,	.000,	.00,	1,	.165,	.451
F shrinkage mean ,	24469.,	.50,,,,				.175,	.247

Weighted prediction :

Survivors,	Int,	Ext,	N,	Var,	F
at end of year,	s.e,	s.e,	,	Ratio,	
17125.,	.18,	.11,	9,	.632,	.337

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

Year class = 1999

Fleet,	Estimated,	Int,	Ext,	Var,	N,	Scaled,	Estimated
,	Survivors,	s.e,	s.e,	Ratio,	,	Weights,	F
FLT01: UK INSHORE TR,	10851.,	.342,	.459,	1.34,	2,	.170,	.375
FLT02: BELGIAN BEAM ,	7536.,	.544,	.140,	.26,	2,	.068,	.504
FLT03: FRENCH TRAWLE,	4735.,	.291,	.476,	1.63,	2,	.227,	.714
FLT04: UK BEAM TRAWL,	7280.,	.288,	.041,	.14,	3,	.208,	.518
FLT05: French GFS [o,	8602.,	.445,	.304,	.68,	3,	.091,	.454
FLT06: Intl YFS [rev,	3840.,	.416,	.000,	.00,	1,	.087,	.827
F shrinkage mean ,	5328.,	.50,,,,				.149,	.656

Weighted prediction :

Survivors,	Int,	Ext,	N,	Var,	F
at end of year,	s.e,	s.e,	,	Ratio,	
6493.,	.15,	.13,	14,	.885,	.566

1

Age 4 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,	3270.,	.325,	.598,	1.84,	3,	.157,	.441
FLT02: BELGIAN BEAM ,	2120.,	.375,	.307,	.82,	3,	.150,	.618
FLT03: FRENCH TRAWLE,	2023.,	.286,	.397,	1.39,	3,	.192,	.640
FLT04: UK BEAM TRAWL,	3301.,	.293,	.164,	.56,	4,	.179,	.438
FLT05: French GFS [o,	2395.,	.419,	.298,	.71,	4,	.099,	.564
FLT06: Intl YFS [rev,	2208.,	.416,	.000,	.00,	1,	.043,	.600
F shrinkage mean ,	1016.,	.50,,,,				.180,	1.025

Weighted prediction :

Survivors,	Int,	Ext,	N,	Var,	F
at end of year,	s.e,	s.e,	,	Ratio,	
2162.,	.15,	.16,	19,	1.054,	.609

Table 11.3.1 (continued)- Plaice in VIId. Tuning diagnostic

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

Year class = 1997

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
FLT01: UK INSHORE TR,	1555.,	.240,	.151,	.63,	4,	.269,	.672
FLT02: BELGIAN BEAM ,	1184.,	.317,	.234,	.74,	4,	.141,	.814
FLT03: FRENCH TRAWLE,	1016.,	.271,	.087,	.32,	4,	.148,	.902
FLT04: UK BEAM TRAWL,	1669.,	.268,	.205,	.77,	5,	.157,	.638
FLT05: French GFS [o,	1459.,	.368,	.188,	.51,	5,	.093,	.703
FLT06: Intl YFS [rev,	1738.,	.416,	.000,	.00,	1,	.032,	.619
F shrinkage mean ,	922.,	.50,,,,				.161,	.961

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
1303.,	.13,	.08,	24,	.593,	.762

1

Age 6 Catchability constant w.r.t. time and dependent on age

Year class = 1996

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
FLT01: UK INSHORE TR,	1150.,	.228,	.072,	.32,	5,	.327,	.551
FLT02: BELGIAN BEAM ,	607.,	.320,	.174,	.54,	5,	.162,	.872
FLT03: FRENCH TRAWLE,	1160.,	.331,	.174,	.53,	5,	.133,	.547
FLT04: UK BEAM TRAWL,	2082.,	.315,	.121,	.38,	6,	.155,	.341
FLT05: French GFS [o,	1344.,	.416,	.315,	.76,	5,	.047,	.488
FLT06: Intl YFS [rev,	602.,	.416,	.000,	.00,	1,	.012,	.877
F shrinkage mean ,	848.,	.50,,,,				.164,	.691

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
1082.,	.14,	.09,	28,	.633,	.577

Age 7 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,	478.,	.240,	.322,	1.34,	6,	.283,	.383
FLT02: BELGIAN BEAM ,	280.,	.296,	.089,	.30,	5,	.235,	.585
FLT03: FRENCH TRAWLE,	325.,	.334,	.175,	.52,	6,	.174,	.522
FLT04: UK BEAM TRAWL,	527.,	.353,	.174,	.49,	6,	.103,	.352
FLT05: French GFS [o,	838.,	.439,	.326,	.74,	5,	.025,	.236
FLT06: Intl YFS [rev,	198.,	.416,	.000,	.00,	1,	.006,	.753
F shrinkage mean ,	219.,	.50,,,,				.174,	.702

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
351.,	.15,	.11,	30,	.726,	.492

1

Table 11.3.1 (continued)- Plaice in VIId. Tuning diagnostic

Age 8 Catchability constant w.r.t. time and age (fixed at the value for age) 7

Year class = 1994

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
FLT01: UK INSHORE TR,	145.,	.268,	.221,	.82,	7,	.217,	.341
FLT02: BELGIAN BEAM ,	48.,	.235,	.114,	.49,	7,	.393,	.805
FLT03: FRENCH TRAWLE,	91.,	.341,	.161,	.47,	7,	.152,	.501
FLT04: UK BEAM TRAWL,	108.,	.363,	.171,	.47,	6,	.043,	.435
FLT05: French GFS [o,	107.,	.448,	.184,	.41,	5,	.010,	.438
FLT06: Intl YFS [rev,	142.,	.416,	.000,	.00,	1,	.002,	.348
F shrinkage mean ,	79.,	.50,,,,				.183,	.558

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
77.,	.15,	.10,	34,	.639,	.570

Age 9 Catchability constant w.r.t. time and age (fixed at the value for age) 7

Year class = 1993

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
FLT01: UK INSHORE TR,	47.,	.273,	.342,	1.25,	8,	.212,	.411
FLT02: BELGIAN BEAM ,	23.,	.228,	.098,	.43,	8,	.360,	.713
FLT03: FRENCH TRAWLE,	18.,	.320,	.272,	.85,	8,	.188,	.844
FLT04: UK BEAM TRAWL,	14.,	.368,	.117,	.32,	6,	.030,	.977
FLT05: French GFS [o,	20.,	.404,	.428,	1.06,	4,	.002,	.779
FLT06: Intl YFS [rev,	33.,	.416,	.000,	.00,	1,	.001,	.541
F shrinkage mean ,	33.,	.50,,,,				.206,	.548

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
27.,	.16,	.11,	36,	.704,	.632

Table 11.3.2 - Plaice in VIId. Fishing mortality at age

Run title : PLaice in VIId (run 09/2003)

At 12/09/2003 12:47

Table 8 Fishing mortality (F) at age

YEAR		1980	1981	1982
AGE				
	1	0.0022	0.0013	0.0111
	2	0.1674	0.1183	0.1344
	3	0.2789	0.729	0.4974
	4	0.3373	0.8858	0.8586
	5	0.6175	0.2719	0.6939
	6	0.4144	0.3658	0.2815
	7	0.399	0.4875	0.3492
	8	0.2537	0.7048	1.8579
	9	0.3567	0.5213	0.8336
+gp		0.3567	0.5213	0.8336
0 FBAR 2- 6		0.3631	0.4742	0.4932

YEAR		1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
AGE											
	1	0.0049	0.0148	0.005	0.0119	0.0008	0.0006	0.0548	0.0956	0.0776	0.0647
	2	0.1524	0.116	0.3135	0.2137	0.1816	0.2064	0.174	0.2206	0.5077	0.4433
	3	0.4541	0.5777	0.598	0.6949	0.5189	0.6679	0.4546	0.703	0.8333	0.8101
	4	0.9393	0.8181	0.861	0.7655	0.7927	0.6744	0.7499	0.7478	0.8746	0.6078
	5	0.5512	0.7901	0.2299	0.599	0.573	0.5628	0.8683	0.6357	0.6946	0.5198
	6	0.3979	0.626	0.5699	0.4922	0.3111	0.4588	0.5783	0.6127	0.6126	0.644
	7	0.1749	0.8301	0.3508	0.4344	0.8046	0.5306	0.4194	0.4426	0.4059	0.4909
	8	0.8841	0.2638	0.9157	0.2174	0.4534	0.4983	0.379	0.5206	0.3622	0.4892
	9	0.4874	0.5756	0.6147	0.3825	0.525	0.5661	0.6074	0.706	0.5451	0.6278
+gp		0.4874	0.5756	0.6147	0.3825	0.525	0.5661	0.6074	0.706	0.5451	0.6278
0 FBAR 2- 6		0.499	0.5856	0.5145	0.5531	0.4755	0.5141	0.565	0.584	0.7046	0.605

YEAR		1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	FBAR **-*
AGE												
	1	0.0607	0.0784	0.115	0.0392	0.0153	0.0316	0.0407	0.0693	0.0919	0.0364	0.0659
	2	0.4119	0.4147	0.3782	0.2903	0.1832	0.1463	0.1445	0.4854	0.2724	0.3366	0.3648
	3	0.478	0.7257	0.6135	0.5483	0.8032	0.6009	0.6522	0.5423	0.6669	0.5656	0.5916
	4	0.4947	0.803	0.6835	0.6806	1.4637	1.0438	1.1445	0.9366	0.5069	0.6092	0.6842
	5	0.3431	0.6492	0.5168	0.7585	1.3955	0.8535	0.9685	0.929	0.6349	0.762	0.7753
	6	0.3525	0.4303	0.316	0.5039	1.0698	0.5877	0.6431	0.7584	0.3823	0.5771	0.5726
	7	0.3852	0.373	0.4991	0.3893	1.1661	0.4824	0.7585	0.6505	0.4391	0.4917	0.5271
	8	0.3396	0.5363	0.4468	0.606	0.8791	0.5556	0.5244	0.5006	0.3171	0.5696	0.4624
	9	0.4396	0.5591	0.4438	0.6097	0.9072	0.5223	0.4865	0.5027	0.4242	0.6323	0.5197
+gp		0.4396	0.5591	0.4438	0.6097	0.9072	0.5223	0.4865	0.5027	0.4242	0.6323	
0 FBAR 2- 6		0.416	0.6046	0.5016	0.5563	0.9831	0.6465	0.7105	0.7303	0.4927	0.5701	

Table 11.3.3 - Plaice in VIId. Stock numbers at age

Run title : PLaice in VIId (run 09/2003)

At 12/09/2003 12:47

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

YEAR	1980	1981	1982
AGE			
1	25533	12890	25189
2	18032	23053	11648
3	6267	13801	18533
4	1983	4290	6024
5	1118	1280	1601
6	232	546	883
7	144	139	342
8	206	87	77
9	14	145	39
+gp	360	515	162
0 TOTAL	53889	56746	64498

YEAR	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
AGE										
1	19943	25040	29639	60170	31251	26486	16287	18816	21715	27926
2	22540	17957	22324	26683	53798	28253	23950	13951	15473	18182
3	9214	17512	14469	14764	19498	40594	20798	18211	10125	8426
4	10197	5295	8892	7199	6668	10501	18836	11944	8158	3982
5	2310	3607	2114	3401	3030	2731	4840	8051	5117	3078
6	724	1204	1481	1520	1691	1546	1408	1838	3858	2311
7	603	440	583	758	841	1121	884	714	901	1892
8	219	458	174	371	444	340	597	526	415	543
9	11	82	318	63	270	255	187	370	283	262
+gp	274	239	114	112	197	421	452	477	311	265
0 TOTAL	66033	71833	80107	115042	117688	112248	88239	74898	66355	66866

YEAR	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	GMST 80-**	AMST 80-
AGE													
1	13212	17318	25076	30639	38131	15672	19555	21716	32106	26516	0	23275	24867
2	23684	11251	14489	20224	26659	33979	13739	16989	18334	26499	23135	20261	21755
3	10561	14195	6724	8982	13689	20083	26560	10759	9461	12633	17125	13898	15417
4	3392	5925	6216	3294	4697	5548	9964	12519	5660	4394	6493	6509	7406
5	1962	1871	2402	2840	1509	983	1767	2870	4440	3085	2162	2436	2785
6	1656	1260	885	1296	1203	338	379	607	1026	2129	1303	1053	1279
7	1098	1054	741	584	709	374	170	180	257	633	1082	548	680
8	1048	676	657	407	358	200	209	72	85	150	351	309	385
9	301	675	358	380	201	134	104	112	40	56	77	149	217
+gp	447	762	754	795	535	484	302	260	236	205	126		
0 TOTAL	57361	54987	58301	69440	87690	77794	72748	66085	71645	76302	51853		

Table 11.3.4 – Plaice in VIId. Stock summary

Run title : PLaice in VIId (run 09/2003)

At 12/09/2003 12:46

Table 16 Summary (without SOP correction)

Terminal Fs derived using XSA (With F shrinkage)

	RECR Age 1	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	FBAR 2- 6
1980	25533	16509	5585	2650	0.4745	0.3631
1981	12890	14337	6560	4769	0.727	0.4742
1982	25189	15061	7577	4865	0.6421	0.4932
1983	19943	15133	8127	5043	0.6205	0.499
1984	25040	14129	7461	5161	0.6917	0.5856
1985	29639	15760	8140	6022	0.7398	0.5145
1986	60170	23070	10064	6834	0.6791	0.5531
1987	31251	31727	13412	8366	0.6238	0.4755
1988	26486	24325	13077	10420	0.7968	0.5141
1989	16287	21431	14145	8758	0.6191	0.565
1990	18816	21768	14520	9047	0.6231	0.584
1991	21715	17516	10113	7813	0.7726	0.7046
1992	27926	16125	8545	6337	0.7416	0.605
1993	13212	15880	7739	5331	0.6889	0.416
1994	17318	14951	8280	6121	0.7392	0.6046
1995	25076	14789	7523	5130	0.6819	0.5016
1996	30639	17151	6605	5393	0.8165	0.5563
1997	38131	15298	6774	6307	0.9311	0.9831
1998	15672	17284	7635	5762	0.7547	0.6465
1999	19555	14633	8418	6326	0.7515	0.7105
2000	21716	11875	6521	6015	0.9224	0.7303
2001	32106	13707	6890	5266	0.7643	0.4927
2002	26516	16903	7744	5777	0.746	0.5701
Arith. Mean	25253	17364	8759	6240	0.7195	0.5714
0 Units	(Thousands	(Tonnes)	(Tonnes)	(Tonnes)		

Table 11.4.1 - Plaice in VIId. Input to RCT3

7D PLAICE - ' AGES 1/ indices all * per 100
5 17 2

'YEARCLASS	VPA age 1'	VPA age 2'	VPA age 3'	'yfs0'	'yfs1'	'bts1'	'gfs0'	'gfs1'
1986	31251	28253	20798	-11	144	-11	-11	-11
1987	26486	23950	18211	1168	132	2647	-11	1033
1988	16287	13951	10125	556	58	231	19	408
1989	18816	15473	8426	397	71	516	16	270
1990	21715	18182	10561	342	62	1175	10	173
1991	27926	23684	14195	436	178	1653	10	2379
1992	13212	11251	6724	404	84	322	66	1916
1993	17318	14489	8982	370	79	833	438	517
1994	25076	20224	13689	869	168	1132	362	491
1995	30639	26659	20083	687	66	1320	136	447
1996	38131	33979	26560	407	82	3310	2360	3549
1997	15672	13739	10759	223	80	1140	890	1253
1998	19555	16989	-11	530	76	1130	768	848
1999	21716	-11	-11	381	48	1319	103	1026
2000	-11	-11	-11	514	83	1791	1590	738
2001	-11	-11	-11	374	92	2066	461	1134
2002	-11	-11	-11	67	-11	-11	54	-11

Table 11.4.2 – Plaice in VIId. RCT3 ouput for Age 1

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

recpl7d1.in

7D PLAICE - VPA AGE 1 / indices all * per 100

Data for    5 surveys over   17 years :  1986 - 2002

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

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

Forecast/Hindcast variance correction used.

Yearclass =   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

yfs0      1.70   -.47    .69   .169     13   6.24   10.11     .784     .056
yfs1      1.91   1.46    .74   .156     14   4.43    9.91     .823     .051
bts1       .50   6.54    .23   .650     13   7.49   10.26     .264     .494
gfs0       .84   5.93   1.61   .038     12   7.37   12.13    1.976     .009
gfs1      1.43    .44   1.27   .057     13   6.61    9.90    1.436     .017

                                       VPA Mean =   10.01     .304     .373


Yearclass =   2001

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

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

yfs0      1.70   -.47    .69   .169     13   5.93    9.57     .792     .056
yfs1      1.91   1.46    .74   .156     14   4.53   10.10     .823     .052
bts1       .50   6.54    .23   .650     13   7.63   10.33     .268     .488
gfs0       .84   5.93   1.61   .038     12   6.14   11.09    1.873     .010
gfs1      1.43    .44   1.27   .057     13   7.03   10.51    1.446     .017

                                       VPA Mean =   10.01     .304     .378


Yearclass =   2002

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

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

yfs0      1.70   -.47    .69   .169     13   4.22    6.68    1.259     .054
yfs1
bts1
gfs0       .84   5.93   1.61   .038     12   4.01    9.30    1.848     .025
gfs1

                                       VPA Mean =   10.01     .304     .921


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

2000       25520     10.15     .19     .10      .30
2001       25916     10.16     .19     .10      .30
2002       18198      9.81     .29     .53     3.34
```

Table 11.4.3 – Plaice in VIId. RCT3 ouput for Age 2

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

recpl7d2.in

7D PLAICE - VPA AGE 2 / indices all * per 100

Data for    5 surveys over   17 years :  1986 - 2002

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

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

Forecast/Hindcast variance correction used.

Yearclass =   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

yfs0      1.76  -1.06    .74   .172     12   6.24    9.93     .850     .052
yfs1      2.10    .33    .76   .171     13   4.43    9.65     .862     .050
bts1       .50   6.36    .23   .688     12   7.49   10.11     .266     .526
gfs0       .72   6.31   1.45   .054     11   7.37   11.65    1.800     .012
gfs1      1.24   1.56   1.14   .082     12   6.61    9.78    1.299     .022

                                       VPA Mean =    9.86     .332     .339


Yearclass =   2001

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

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

yfs0      1.76  -1.06    .74   .172     12   5.93    9.37     .861     .051
yfs1      2.10    .33    .76   .171     13   4.53    9.86     .860     .051
bts1       .50   6.36    .23   .688     12   7.63   10.18     .270     .520
gfs0       .72   6.31   1.45   .054     11   6.14   10.76    1.707     .013
gfs1      1.24   1.56   1.14   .082     12   7.03   10.32    1.309     .022

                                       VPA Mean =    9.86     .332     .343


Yearclass =   2002

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

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

yfs0      1.76  -1.06    .74   .172     12   4.22    6.37    1.381     .053
yfs1
bts1
gfs0       .72   6.31   1.45   .054     11   4.01    9.22    1.686     .035
gfs1

                                       VPA Mean =    9.86     .332     .912


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

2000       22094     10.00     .19     .10      .28
2001       22556     10.02     .19     .10      .29
2002       15510      9.65     .32     .55     3.05
```

Table 11.5.1 – Plaice in VIId. Input for short term prediction

input data for catch forecast and linear sensitivity analysis

Label	Value	CV	Label	Value	CV
Number at age			Weight in the stock		
N1	23275	0.36	WS1	0.08	0.23
N2	22556	0.19	WS2	0.20	0.06
N3	17124	0.18	WS3	0.25	0.17
N4	6493	0.15	WS4	0.32	0.21
N5	2162	0.16	WS5	0.41	0.14
N6	1303	0.13	WS6	0.58	0.07
N7	1081	0.14	WS7	0.72	0.17
N8	350	0.15	WS8	0.86	0.14
N9	77	0.15	WS9	1.03	0.13
N10	125	0.16	WS10	1.26	0.11
H.cons selectivity			Weight in the HC catch		
sH1	0.06	0.55	WH1	0.22	0.17
sH2	0.35	0.09	WH2	0.26	0.01
sH3	0.56	0.30	WH3	0.31	0.02
sH4	0.65	0.12	WH4	0.37	0.01
sH5	0.74	0.03	WH5	0.44	0.01
sH6	0.55	0.15	WH6	0.60	0.07
sH7	0.50	0.02	WH7	0.76	0.16
sH8	0.44	0.25	WH8	0.95	0.07
sH9	0.50	0.24	WH9	1.01	0.12
sH10	0.50	0.24	WH10	1.25	0.06
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		
HF03	1.00	0.20	K03	1.00	0.10
HF04	1.00	0.20	K04	1.00	0.10
HF05	1.00	0.20	K05	1.00	0.10
Recruitment in 2004 and 2005					
R04	23275	0.36			
R05	23275	0.36			

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

Stock numbers in 2003 are VPA survivors.
These are overwritten at Age 2

Table 11.5.2 – Plaice in VIId. Short term prediction (management option table)

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

	Year							
	2003	2004						
Mean F Ages								
H.cons 2 to 6	0.57	0.00	0.11	0.23	0.34	0.45	0.57	0.68
Effort relative to 2002								
H.cons	1.00	0.00	0.20	0.40	0.60	0.79	1.00	1.20
Biomass								
Total 1 January	15.79	15.48	15.48	15.48	15.48	15.48	15.48	15.48
SSB at spawning time	7.92	8.38	8.38	8.38	8.38	8.38	8.38	8.38
Catch weight (,000t)								
H.cons	6.50	0.00	1.57	2.99	4.27	5.37	6.47	7.41
Biomass in year.... 2005								
Total 1 January		21.75	20.13	18.68	17.38	16.26	15.15	14.20
SSB at spawning time		13.96	12.55	11.29	10.17	9.22	8.28	7.48

	Year							
	2003	2004						
Effort relative to 2002								
H.cons	1.00	0.00	0.20	0.40	0.60	0.79	1.00	1.20
Est. Coeff. of Variation								
Biomass								
Total 1 January	0.11	0.15	0.15	0.15	0.15	0.15	0.15	0.15
SSB at spawning time	0.11	0.17	0.17	0.17	0.17	0.17	0.17	0.17
Catch weight								
H.cons	0.20	0.00	0.96	0.47	0.32	0.25	0.21	0.18
Biomass in year.... 2005								
Total 1 January		0.15	0.17	0.17	0.17	0.17	0.18	0.18
SSB at spawning time		0.16	0.19	0.20	0.20	0.20	0.20	0.21

Table 11.5.3 – Plaice in VIId. Short term prediction (detailed output)

Detailed forecast tables.

Forecast for year 2003
F multiplier H.cons=1.00

Populations / Catch number

Age	Stock No.	H.Cons	Total
1	23275	1353	1353
2	22556	6327	6327
3	17124	7057	7057
4	6493	2979	2979
5	2162	1081	1081
6	1303	524	524
7	1081	408	408
8	350	119	119
9	77	29	29
10	125	47	47
Wt	16	7	7

Forecast for year 2004
F multiplier H.cons=1.00

Populations / Catch number

Age	Stock No.	H.Cons	Total
1	23275	1353	1353
2	19774	5547	5547
3	14411	5939	5939
4	8815	4044	4044
5	3058	1529	1529
6	934	376	376
7	683	258	258
8	591	201	201
9	204	76	76
10	111	42	42
Wt	15	6	6

Figure 11.3.1. Plaice in Division VIId. Stock summary.

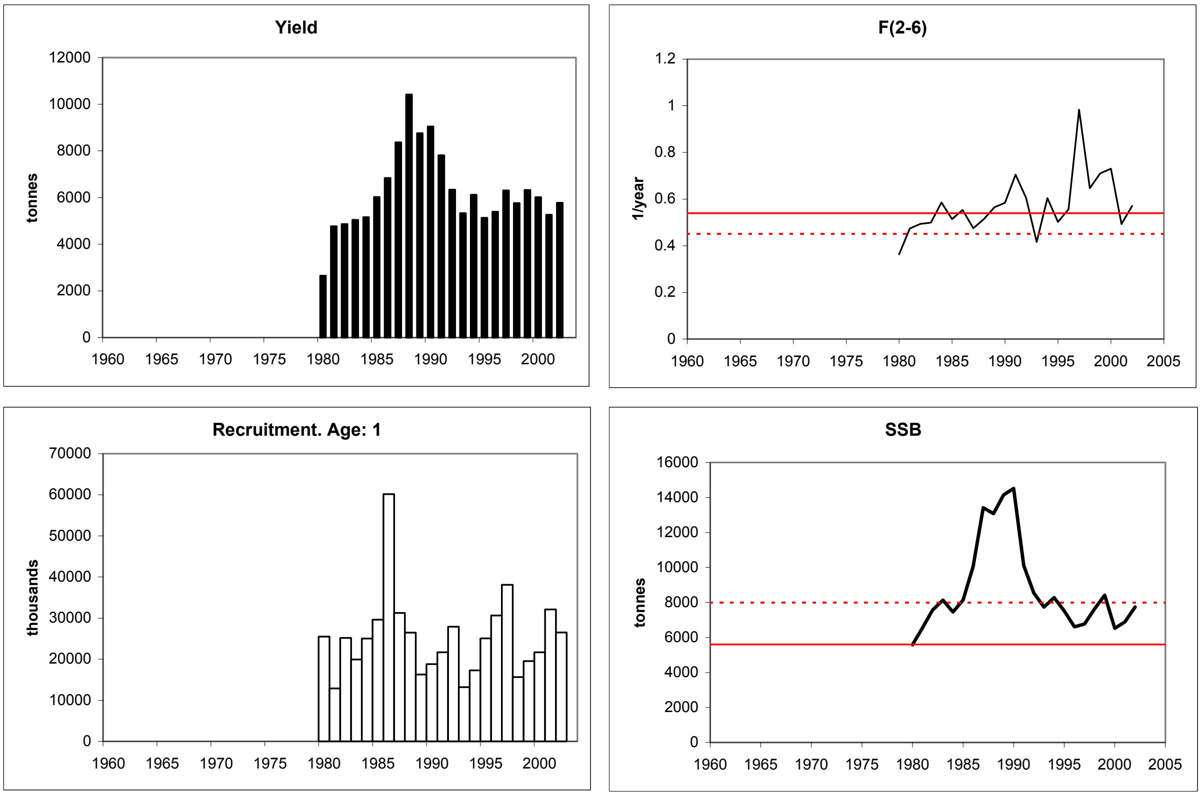
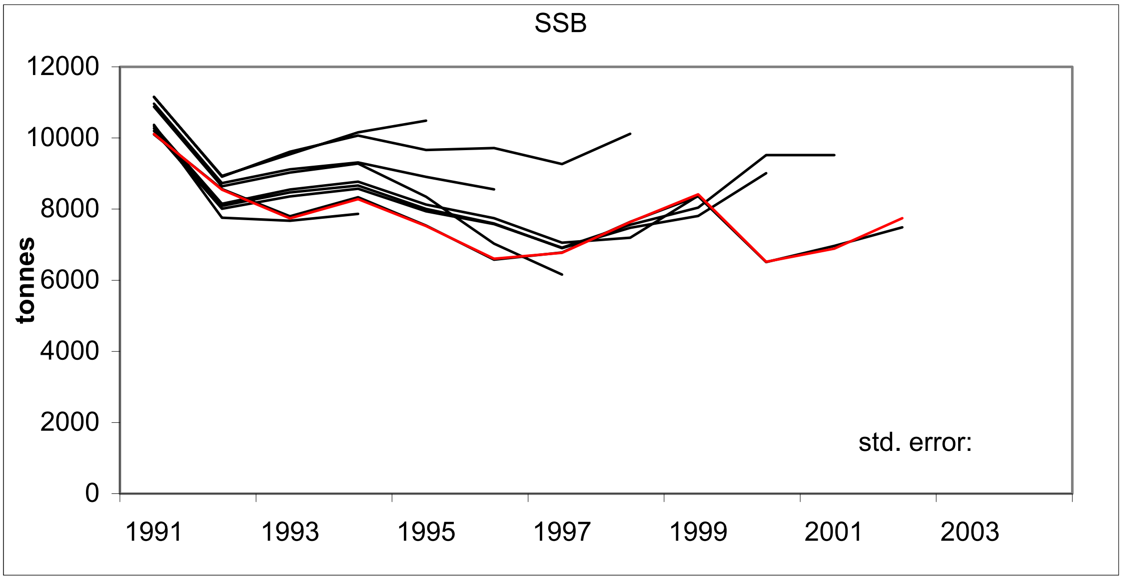
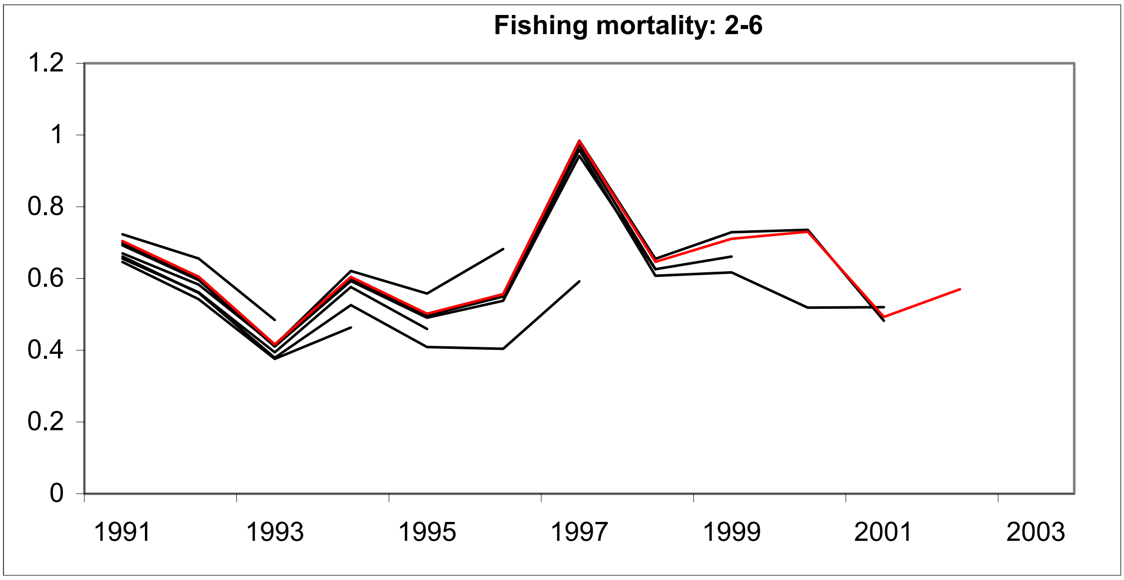


Figure 11.3.2. Plaice in Division VIId. Comparison of historical performance of the assessments





12 NORWAY POUT IN ICES SUB-AREA IV AND DIVISION IIIA

The 2003 assessment of Norway pout in the North Sea and Skagerrak is an update assessment. Relevant information on the biology of the stock and general assessment methodological information can be found in the stock quality control handbook.

12.1 The fishery

The fishery is mainly performed by Danish and Norwegian (large) vessels using small mesh trawls in the northern North Sea at Fladen Ground and along the edge of the Norwegian Trench. Main fishing seasons are 1st, 3rd, and 4th quarters of the year.

12.1.1 ACFM advice applicable to 2002 and 2003

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 2002 and 2003 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.

Biological reference points for the stock have been set by ICES at $\mathbf{B}_{lim}$ = 90,000 t as the lowest observed biomass and $\mathbf{B}_{pa}$ = 150,000 t which should be maintained. Advised TAC was 220,000 t.

12.1.2 Management applicable to 2002 and 2003

In 1996-2003 the TAC was set to 220,000 t. In managing this fishery by-catches of other species have been taken into account. Existing technical measures such as the closed Norway pout box, minimum mesh size in the fishery, and by-catch regulations to protect other species have been maintained.

12.1.3 The Fishery in 2002 and 2003

Nominal landings of Norway pout as officially reported to ICES are given in Table 12.1.1. Annual landings as provided by Working Group members are shown in Tables 12.1.2-3 and trends in yield are shown in Figures 12.3.2-3.

While landings in year 2000 were high (185,000 t mainly based on fishery on the strong 1999 year class as age 1) then landings in 2001 were the lowest observed since 1966 (66,000 t), and landings only slightly increased in 2002 to 77,000 t being well below average for the last five years for all quarters of the year (Table 12.1.3; see also Table 12.2.1 under section 12.2).

The effort in the Norway pout fishery in 2002 nearly doubled from effort in 2001 being at the same level as in the previous 8 years before 2001.

Landings in the 1st and 2nd quarter of 2003 were below average within the last 5 year period (as shown in section 12.2, Table 12.2.1), and also effort for Norway pout was historically low in 2003 compared to previous years.

12.2 Data available

12.2.1 Landings

Data for annual nominal landings of Norway pout as officially reported to ICES are shown in Table 12.1.1. Data for annual landings as provided by Working Group members are presented in Table 12.1.2, and data for national landings by quarter of year and by geographical area are given in Table 12.1.3

12.2.2 Age compositions in Landings

Age compositions were available from Norway and Denmark. Catch at age by quarter of year is shown in Table 12.2.1.

12.2.3 Weight at age

Mean weight at age in the catch is shown in Table 12.2.2 and mean weight at age in the stock is given in Table 12.2.3. The estimation of mean weights at age in the catches and in the used mean weights in the stock in the assessment is described in the stock quality handbook.

12.2.4 Maturity and natural mortality

Proportion mature and natural mortality by age and quarter used in the assessment is given in Table 12.2.3. Maturity and natural mortality used in the assessment is described in the stock quality handbook.

In the 2001 and 2002 assessment exploratory runs were made with revised input data for natural mortality based on the results from two papers presented to the working group in 2001, *Sparholt, Larsen and Nielsen 2002a,b (both published in ICES J. Mar. Sci.).* This has not been explored further in the 2003 up-date assessment but should be investigated in future benchmark assessment of the stock.

12.2.5 Catch, Effort and Research Vessel Data

Description of catch, effort and research vessel data used in the assessment is given in the stock quality control handbook. Data used in the present assessment is given in Tables 12.2.4-10 as described below.

Effort standardization:

The method for effort standardization of the commercial fishery tuning fleet is described in the stock quality control handbook. Results and parameter estimates from the yearly regression analyses on CPUE versus GRT for the different Danish vessel size categories used in the effort standardization of both the Norwegian and Danish commercial fishery are shown in Table 12.2.5.

Norwegian effort data

Observed average GRT and effort for the Norwegian commercial fleets are given in Table 12.2.6.

Danish effort data

Table 12.2.4 shows CPUE data by vessel size category and year for the Danish commercial fishery in area IVa. The basis for these data is described in the stock quality handbook.

Standardized effort data

The resulting combined and standardized Danish and Norwegian effort for the commercial fishery used in the assessment is presented in Table 12.2.7, and combined CPUE indices by age and quarter for the commercial fishery tuning fleet are shown in Table 12.2.8.

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 12.2.9. The use of survey data in the assessment is described in the stock quality control handbook.

As age data from the EGFS performed in 3rd quarter of 2003 were not available to the working group the catch per length group of Norway pout caught in this survey was applied to age-length keys from the commercial Danish fishery performed in 2nd quarter of 2003 in area IV in order to obtain age disaggregated CPUE indices. The results of this are shown in Table

12.2.10. Even if the age dis-aggregation of data is uncertain the CPUE indices from this survey indicate under all circumstances a relatively small 0-group recruiting to fishery in 2003 compared to the previous 5 years EGFS 0-group indices (Table 12.2.9). In comparison the SGFS 0-group index in 3rd quarter of 2003 was only reduced to around half compared to the 2002 3rd quarter 0-group index.

Research vessel indices from the 3rd quarter IBTS are also presented in Table 12.2.9 but for comparison purposes only. These survey data are not used in the assessment.

12.3 Catch at Age Analyses

The SXSA (Seasonal Extended Survivors Analysis) was used to estimate quarterly stock numbers and fishing mortalities for Norway pout in the North Sea and Skagerrak in 2003. The catch at age analysis was carried out according to the specifications in the stock quality control handbook. The parameter settings and options of the SXSA were the same this year as in the last year's assessment (Table 12.3.1).

Results of the analysis are presented in Table 12.3.2 (population numbers at age, SSB and TSB), Table 12.3.3 (partial fishing mortalities by fleet), Table 12.3.4 and Figure 12.3.1 (diagnostics), as well as Table 12.3.2 (stock summary). The stock summary is also shown in Figures 12.3.2-3, and the historical performance of the assessment is shown in Figure 12.3.4. In the stock summary 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 three surveys and the seasonally (by quarter) divided commercial fleets were all used in the tuning (Table 12.3.1). The data time series for the tuning fleets used in the SXSA are given in Tables 12.2.7-12.2.9. 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.

Fishing mortality has generally been lower than the natural mortality and has decreased in recent years well below the long term average (0.8). It has increased in 2002 to a level around 0.4-0.5 similar to that in 1999-2000, but has been relatively low in 1st and 2nd quarter of the year 2003. However, the main fishery is usually in 3rd and 4th quarter of the year therefore giving only little indication of total fishing mortality in 2003.

Stock biomass (SSB) is just above $\mathbf{B}_{pa}$ in 1st quarter of 2003.

12.4 Recruitment Estimates

The long-term average recruitment (age 0, 3rd quarter) is 129 billions (arithmetic mean) and 109 billions (geometric mean) for the period 1974-2002 (Table 12.3.5). Recruitment is highly variable and influences SSB and TSB rapidly due to the short life span of the species.

Recruitment in 2000-2002 was low. The SXSA show that recruitment of 0-group Norway pout in 3rd quarter of the year 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, and also in 2001-2002 rrecruitment was well below long term average. Recruitment in 2003 will probably also be low according to the EGFS and SGFS 0-group survey indices in 3rd quarter of 2003 (Table 12.2.9).

There is a change in the recruitment estimate for the 2001 year class from the 2002 assessment to the 2003 assessment because of revised Danish catch numbers in 1st quarter of the year 2002.

12.5 Short-Term Predictions (Forecasts)

No forecast is given for this stock. The reason for this is described in the stock quality control handbook.

Short term developments in the stock:

Recruitment has been low in the whole period 2000-2002, and recent 2003 3rd quarter survey indices also indicate low recruitment of 0-group Norway pout as well in 2003 (Table 12.3.5 and Table 12.2.9). Stock biomass (SSB) is just above

$\mathbf{B}_{pa}$ in 1st quarter of 2003 (Table 12.3.5), and well below long term average because the majority of the strong 1999 year class is dead now. Fishing mortality has increased in 2002 to a level around 0.4-0.5 similar to that in 1999-2000 (Table 12.3.5). The fishing mortality of the first half year in 2003 has been low however, the main Norway pout fishery is usually in 3rd and 4th quarter of the year therefore giving only little indication of total fishing mortality in 2003. Taking all this into consideration it can be expected that the SSB in the second half of 2003 and in 1st quarter of 2004 will decrease further from the 1st quarter 2003 level (172,000 t). Consequently, in the first half year 2003 the stock seems still to be within safe biological limits ($\mathbf{B}_{pa}$ = 150,000 t), however the stock are in risk of decreasing below $\mathbf{B}_{pa}$ in second half of 2003 and in 1st quarter of 2004. This should be taken into consideration when setting a TAC for the stock.

12.6 Comments

It appears from the quality control diagrams made from the results of the assessment (Figure 12.3.4) that the estimates of the SSB, recruitment and the average fishing mortality of the 1- and 2-group are consistent with the estimates of previous years assessment. Only the standardization procedure introduced in 2001-2002 has resulted in slightly higher estimates of SSB and slightly lower estimates of F in the latest years of the assessment period. Furthermore, there can be observed a change in the recruitment estimate for the 2001 year class from the 2002 assessment to the 2003 assessment because of revised Danish catch numbers in 1st quarter of the year 2002.

Future benchmark assessment of the stock:

The next benchmark assessment for this stock is foreseen to be in 2004.

Potential workplan and suggestions for investigations to be included in this benchmark assessment:

1. Test of assessment output and improvements in assessment performance in relation to single fleet assessment runs for both the commercial and survey tuning fleets.

2. Test of assessment output and improvements in assessment performance by making runs where the combined (and effort standardized) Danish and Norwegian commercial tuning fleet is divided into two national tuning fleet components. It should among other be taken into consideration that there are some geographical differences in the distribution of the between the national fisheries.

3. Test of assessment output and improvements in assessment performance by including the combined 3rd quarter IBTS time series as a tuning fleet replacing the 3rd quarter EGFS and SGFS tuning fleets. Future exploratory assessment runs should be made using the 3Q IBTS fleet as tuning fleet instead of 3Q EGFS and 3Q EGFS independently, as the 3Q IBTS is now beginning to contribute with a relatively long data time series from 1991 and onwards.

   For the SXSA recruitment estimates are available from the EGFS and SGFS surveys carried out in August as well as the 3rd quarter IBTS and the commercial fishery in 3rd and 4th quarter of the year. The SGFS recruitment indices from 1998-2003 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. 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 1991-2003. 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 should also be taken into consideration that 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. The 0-group are recruited to the 4th quarter commercial fishery that tends to predict strong year classes well as 0-group.

4. Scrutinize available age-disaggregated catch data in the historical commercial fleet databases in order to obtain longer time series in the tuning fleets and expand number of tuning fleets available. Investigate this in relation to background for decisions made in early ICES working group reports dealing with this stock.

5. Scrutinize CPUE indices per cohort and raw data for all survey tuning fleets. Investigate with respect to this the potential for real time monitoring of the stock only based on catch rates indices from surveys (maybe combined with data from commercial fleets). Can the surveys based on estimation of total mortality (slope of catch curve) with given natural mortality describe the trends in fishing mortality in the stock over years?

Possible test of whether it is more appropriate to formulate reference points based on total stock biomass (TSB) based on estimates of total mortality from surveys for use within management of this stock.

6. Evaluate the effect of assessment runs with new natural mortality estimates for the stock published in *Sparholt, Larsen and Nielsen (2002a,b*). (See also stock quality control handbook under natural mortality). This will be a continuation of the analyses (and provisional runs) made during the 2001 and 2002 assessments.

7. Possibly include revised maturity at age estimates for the stock based on the results from another paper presented to the working group in 2000, (*Larsen, Lassen, Nielsen and Sparholt, 2001*).

8. Run the assessment with and without cosine time taper applied as a continuation of the analyses (and provisional runs) made during the 2001 assessment.

9. There seems to be two levels of the stock-recruitment-relationship for the stock, a level well above and well below recruitment around 125 billions. 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.

10. Possible evaluation of the Norway pout in Division VIa. ACFM (October 2001) asked the Working Group to verify the justification of treating Division VIa as a management area for Norway pout and sandeel separately from IV and IIIa. Preliminary results from an analysis of regionalized survey data on Norway pout maturity, presented in a Working Document to the 2000 meeting of the Working Group (*Larsen, Lassen, Nielsen and Sparholt,2001* in ICES C.M.2001/ACFM:07), gave no evidence for a stock separation in the whole northern area.

    Possible evaluation of availability of data necessary for performing assessment of the VIa stock.

12.7 Norway Pout in Division VIa

12.7.1 Catch trends and assessment

Landings of Norway pout from Division VIa as reported to ICES are given in Table 12.7.1 and Figure 12.7.1. Reported landings in 2002 were 4,800 t. This level of landings is well below the series average of nearly 11,000 t (1974-2002). No data are available on by-catches in this fishery. Since no age compositions are available, data are insufficient for an assessment of this stock.

12.7.2 Stock identity

ACFM (October 2001) asked the Working Group to verify the justification of treating Division VIa as a management area for Norway pout and sandeel separately from IV and IIIa. Preliminary results from an analysis of regionalized survey data on Norway pout maturity, presented in a Working Document to the 2000 meeting of the Working Group (*Larsen, Lassen, Nielsen and Sparholt,2001* in ICES C.M.2001/ACFM:07), gave no evidence for a stock separation in the whole northern area.

The WG considers that the extent of the data that is available on VIa Norway pout is assessed before the discussion on the merging of the VIa stock with the North Sea stock is finalized.

Table 12.1.1 Nominal landings (tonnes) of Norway pout from the North Sea and Skagerrak / Kattegat, ICES areas IV and IIIa in the period 1995-2002, as officially reported to ICES.

Norway pout
Division IIIa

Country	1995	1996	1997	1998	1999	2000	2001	2002**
Denmark	67.841	57.529	34.746	11.080	7.194	14.545	13.619	3.780
Sweden	68	237	2			133	780	0
Norway								96
Total IIIa	67.909	57.766	34.748	11.080	7.194	14.678	14.399	3.876

Norway pout
Division IVa

Country	1995	1996	1997	1998	1999	2000	2001	2002**
Denmark	141687	95708	106.958	42.154	39.319	133.149	44.818	68.858
Faroe Islands	7669	5717	7.033	4.707	2.534			
Germany	34							
Netherlands	114		35					
Norway	110017	90042	39.006	22.213	44.841	48061*	17.158	23.657
Sweden			+					
UK (Scotland)		74						
Total IVa	259.521	191.541	153.032	69.074	86.694	181.210	61.976	92.515

Norway pout Division IVb

Country	1995	1996	1997	1998	1999	2000	2001	2002**
Denmark	28.584	3.531	1.794	3.258	5.299	158	632	556
Faroe Islands	1.180	1.857						
Germany						2		
Netherlands	17	5	50	2		3		
Norway	14	139		57		34		
UK (E/W/NI)						+		
UK (Scotland)	+	+	+					
United Kingdom							+	
Total IVb	29795	5532	1844	3317	5299	197	632	556

Norway pout Division IVc

Country	1995	1996	1997	1998	1999	2000	2001	2002**
Denmark					514	182	304	
Netherlands					+			
UK (E/W/NI)								
UK (Scotland)		+						
United Kingdom							+	
Total IVc	0	0	0	0	514	182	304	0

Sub-area IV and IIIa (Skagerrak) combined

Country	1995	1996	1997	1998	1999	2000	2001	2002**
Denmark	238112	156768	143498	56492	52326	148034	59.373	73194
Faroe Islands	8849	7574	7033	4707	2534			
Norway	110031	90181	39006	22270	44841	48095	17.158	23753
Sweden	68	237	2			133	780	
Netherlands	131	5	85	2		3		
Germany	34					2		
UK		74						
Total nominal landings	357225	254839	189624	83471	99701	196267	77311	96947
By-catch of other species and other	-120425	-91039	-19924	-3671	-7701	-11867	-11711	-19747
WG estimate of total landings (IV+IIIaN)	236800	163800	169700	79800	92000	184400	65600	77200
Agreed TAC	180000	220000	220000	220000	220000	220000	220000	220000

* provisional
** provisional
+ Landings less than 1
n/a not available

Table 12.1.2 Norway pout annual landings ('000 t) in the North Sea and Skagerrak (not incl. Kattegat, IIIaS) by country, for 1961-2002 (Data provided by Working Group members). (Norwegian landing data include landings of by-catch of other species).

Year	Denmark		Faroes	Norway	Sweden	UK (Scotland)	Others	Total
	North Sea	Skagerrak						
1961	20.5	-	-	8.1	-	-	-	28.6
1962	121.8	-	-	27.9	-	-	-	149.7
1963	67.4	-	-	70.4	-	-	-	137.8
1964	10.4	-	-	51.0	-	-	-	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	95.7	4.2	0.8	65.3	+	0.1	0.3	166.4
1990	61.5	23.8	0.9	77.1	+	-	-	163.3
1991	85.0	32.0	1.3	68.3	+	-	+	186.6
1992	146.9	41.7	2.6	105.5	+	-	0.1	296.8
1993	97.3	6.7	2.4	76.7	-	-	+	183.1
1994	97.9	6.3	3.6	74.2	-	-	+	182.0
1995	138.1	46.4	8.9	43.1	0.1	+	0.2	236.8
1996	74.3	33.8	7.6	47.8	0.2	0.1	+	163.8
1997	94.2	29.3	7.0	39.1	+	+	0.1	169.7
1998	39.8	13.2	4.7	22,1	-	-	+	79.8
1999	41.0	6.8	-	44.2	+	-	-	92.0
2000	127.0	9.3	-	48.0	0.1	-	+	184.4
2001	40.6	7.5	-	16.8	0.7	+	+	65.6
2002	50.2	2.8	-	23.6	-	-	-	76.7

Table 12.1.3 Norway Pout, North Sea and Skagerak. National landings (t) by quarter of year 1992-2003. (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
1992	1	2.330	619	2.950	29.701	8.862	1.096	-	39.659	41.989			
	2	9.235	1.684	10.919	1.610	264	1.529	-	3.403	12.638			
	3	22.586	817	23.402	9.908	34.053	6.465	-	50.426	73.012			
	4	7.561	263	7.824	4.102	47.704	1.630	2	53.439	61.000			
	Total	41.713	3.383	45.095	45.321	90.883	10.720	2	146.926	188.639			
1993	1	319	30	350	16.471	6.581	151	-	23.203	23.522			
	2	1.052	77	1.129	594	102	802	-	1.498	2.550			
	3	3.629	531	4.161	7.461	25.072	409	-	32.941	36.570			
	4	1.728	406	2.133	10.685	28.994	9	-	39.688	41.416			
	Total	6.729	1.044	7.773	35.210	60.748	1.371	-	97.330	104.058			
1994	1	568	75	643	18.660	3.588	533	-	22.781	23.350			
	2	4	0	4	511	170	-	-	681	685			
	3	2.137	74	2.211	5.674	12.604	493	-	18.772	20.908			
	4	3.623	116	3.739	5.597	49.935	91	-	55.622	59.246			
	Total	6.332	265	6.598	30.442	66.298	1.117	-	97.857	104.189			
1995	1	576	9	585	19.421	1.336	7	-	20.764	21.339	15521	15521	36.860
	2	10.495	290	10.793	2.841	30	3.670	-	6.540	17.035	10639	10639	27.674
	3	20.563	976	21.540	13.316	17.681	11.445	-	42.442	63.004	5790	5790	68.794
	4	14.748	2.681	17.430	10.812	56.159	1.426	-	68.396	83.145	11131	11131	94.276
	Total	46.382	3.956	50.347	46.390	75.205	16.547	-	138.142	184.524	43.081	43081	227.605
1996	1	1.231	164	1.395	6.133	3.149	658	2	9.943	11.174	10604	10604	21.778
	2	7.323	970	8.293	1.018	452	1.476	-	2.946	10.269	4281	4281	14.550
	3	20.176	836	21.012	7.119	17.553	1.517	-	26.188	46.364	27466	27466	73.830
	4	5.028	500	5.528	9.640	25.498	42	-	35.180	40.208	5466	5466	45.674
	Total	33.758	2.470	36.228	23.910	46.652	3.692	2	74.257	108.015	47.817	47817	155.832
1997	1	2.707	460	3.167	6.203	2.219	7	-	8.429	11.137	4183	4183	15.320
	2	5.656	200	5.857	141	-	45		185	5.842	8466	8466	14.308
	3	16.432	649	17.081	19.054	21.024	740	-	40.818	57.250	21546	21546	78.796
	4	4.464	1.042	5.505	6.555	38.202	7		44.765	49.228	4884	4884	54.112
	Total	29.259	2.351	31.610	31.953	61.445	799	-	94.197	123.456	39.079	39079	162.535
1998	1	1.117	317	1.434	7.111	2.292	-	-	9.403	10.520	8913	8913	19.433
	2	3.881	103	3.984	131	5	124	-	259	4.140	7885	7885	12.025
	3	6.011	406	6.417	7.161	1.763	2.372	-	11.297	17.308	3559	3559	20.867
	4	2.161	677	2.838	1.051	17.752	77	-	18.880	21.041	1778	1778	22.819
	Total	13.171	1.503	14.673	15.454	21.811	2.573	-	39.838	53.009	22.135	22135	75.144
1999	1	4	12	15	2.769	1.246	1	-	4.016	4.020	3021	3021	7.041
	2	1.568	36	1.605	953	361	418	-	1.731	3.300	10321	10321	13.621
	3	3.094	109	3.203	7.500	3.710	2.584	-	13.794	16.887	24449	24449	41.336
	4	2.156	517	2.673	3.577	16.921	928	1	21.426	23.583	6385	6385	29.968
	Total	6.822	674	7.496	14.799	22.237	3.931	1	40.968	47.790	44.176	44176	91.966
2000	1	0	11	12	3.726	1.038	-	-	4.764	4.765	5440	5440	10.205
	2	929	15	944	684	22	227	-	933	1.862	9779	9779	11.641
	3	7.380	139	7.519	1.708	5.613	515	-	7.836	15.216	28428	28428	43.644
	4	947	209	1.157	1.656	111.732	76	-	113.464	114.411	4334	4334	118.745
	Total	9.257	375	9.631	7.774	118.406	818	-	126.998	136.255	47.981	47981	184.236
2001	1			302	7.341	9.734	103	72	17.250	17.250	3838	3838	21.088
	2			2.174	31	30	269	-	330	330	9268	9268	9.598
	3			2.006	15	154	191	-	360	360	2263	2263	2.623
	4			3.059	2.553	19.826	329	-	22.708	22.708	1426	1426	24.134
	Total			7.541	9.940	29.744	892	72	40.648	40.648	16.795	16795	57.443
2002	1	-	1	1	4.869	1.660	114	-	6.643	6.643	1896	1896	8.539
	2	883	161	1.045	56	9	22	-	87	970	5563	5563	6.533
	3	1.567	213	1.778	2.234	14.739	104	-	17.077	18.644	14147	14147	32.791
	4	393	100	492	1.787	24.273	335	-	26.395	26.788	2033	2033	28.821
	Total	2.843	475	3.316	8.946	40.681	575	-	50.202	53.045	23.639	23639	76.684
2003	1	-	1	1	1.109	87	22	-	1.218	1.218	1927	1927	3.145
	2	246	160	405	64	-	33	-	97	343	2763	2763	3.106

Table 12.2.1 NORWAY POUT in the North Sea and Skagerrak. Catch in numbers at age by quarter (millions). SOP is given in tons. Data for 1990 were estimated within the SXSA program used in the 1996 assessment.

Age	Year	1984				1985				1986			
			2	3	4		2	3	4		2	3	4
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			
			2	3	4		2	3	4		2	3	4
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			
			2	3	4		2	3	4		2	3	4
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			
			2	3	4		2	3	4		2	3	4
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			
			2	3	4		2	3	4		2	3	4
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			
			2	3	4		2	3	4		2	3	4
0		0	0	41	1127	0	0	73	302	0	0	32	368
1		202	318	1298	576	653	280	1368	4616	220	133	122	267
2		128	220	338	160	185	207	266	245	845	246	27	439
3		73	93	35	23	3	48	20	6	35	100	1	1
4+		1	0	0	0	0	0	0	0	0	0	0	0
SOP		7833	12535	41445	30497	10207	11589	44173	119001	21400	11778	4630	26565
Age	Year	2002				2003							
			2	3	4		2						
0		0	0	340	290	0	0						
1		485	351	621	473	58	70						
2		148	24	284	347	75	51						
3		17	5	24	26	22	25						
4+		0	0	0	0	0	0						
SOP		8553		32922	28947	3145	3263						
			6686										

Table 12.2.2 Norway pout in North Sea and Skagerrak. Mean weights (grams) at age in catch, by quarter, 1983-2003, from Danish and Norwegian catches combined. Data for 1974 to 1982 are assumed to be the same as 1983.

Year	1983				1984				1985			
Quarter of year	1	2	3	4	1	2	3	4	1	2	3	4
Age 0			4,00	6,00			6,54	6,54			8,37	6,23
1	7,00	15,00	25,00	23,00	6,55	8,97	17,83	20,22	7,86	12,56	23,10	26,97
2	22,00	34,00	43,00	42,00	24,04	22,66	34,28	35,07	22,7	28,81	36,52	40,90
3	40,00	50,00	60,00	58,00	39,54	37,00	34,10	46,23	45,26	43,38	58,99	
4									41,80			
Year	1986				1987				1988			
Quarter of year	1	2	3	4	1	2	3	4	1	2	3	4
Age 0				7,20			5,80	7,40			9,42	7,91
1	6,69	14,49	28,81	26,90	8,13	12,59	20,16	23,36	9,23	11,61	26,54	30,60
2	29,74	42,92	43,39	44,00	28,26	31,51	34,53	37,32	27,31	33,26	39,82	43,31
3	44,08	55,39	47,60		52,93			46,60	38,38			
4	82,51				63,09				69,48			
Year	1989				1990				1991			
Quarter of year	1	2	3	4	1	2	3	4	1	2	3	4
Age 0			7,48	6,69			6,40	6,67			6,06	6,64
1	7,98	13,49	26,58	26,76	6,51	13,75	20,29	28,70	7,85	12,95	30,95	30,65
2	26,74	28,70	35,44	34,70	25,47	25,30	32,92	38,90	20,54	28,75	44,28	43,10
3	39,95	44,39		46,50	37,72	40,35	39,40	52,94	35,43	49,87	67,25	59,37
4					68,00				44,30			
Year	1992				1993				1994			
Quarter of year	1	2	3	4	1	2	3	4	1	2	3	4
Age 0		8,00	6,70	8,14			4,40	8,14			5,40	8,81
1	8,78	11,71	26,52	27,49	9,32	14,76	25,03	26,24	8,56	15,22	29,26	31,23
2	25,73	31,25	42,42	44,14	24,94	30,58	35,19	36,44	25,91	29,27	38,91	49,59
3	41,80	49,49	50,00	50,30	46,50	48,73	55,40	70,80	42,09	46,88	53,95	
4	43,90											
Year	1995				1996				1997			
Quarter of year	1	2	3	4	1	2	3	4	1	2	3	4
Age 0			5,01	7,19			3,88	5,95			3,61	10,18
1	7,70	10,99	25,37	24,6	8,95	12,06	27,81	28,09	7,01	11,69	20,14	22,11
2	24,69	22,95	33,40	39,57	21,47	25,72	40,90	38,81	23,11	26,40	31,13	32,69
3	50,78	37,69	45,56	57,00	37,58	37,94	50,44	56,00	39,11	34,47	44,03	38,62
4												
Year	1998				1999				2000			
Quarter of year	1	2	3	4	1	2	3	4	1	2	3	4
Age 0			4,82	8,32			2,84	7,56			7,21	13,86
1	8,76	12,55	23,82	24,33	8,98	12,40	22,16	25,60	10,05	15,65	23,76	22,98
2	22,16	25,27	31,73	30,93	25,84	24,15	32,66	37,74	19,21	25,14	38,90	34,48
3	34,84	32,18	44,92	33,24	36,66	35,24	43,98	51,63	32,10	41,30	39,61	50,04
4	42,40	40,00			46,57	46,57						
Year	2001				2002				2003			
Quarter of year	1	2	3	4	1	2	3	4	1	2		
Age 0			6,34	7,90			7,28	7,20				
1	8,34	16,79	27,00	30,01	8,59	16,40	27,13	27,47	11,62	13,33		
2	21,50	23,57	39,54	35,51	25,98	30,39	43,37	36,87	22,80	26,58		
3	39,84	37,63	54,20	55,70	32,30	40,10	54,11	41,28	34,80	39,79		
4												

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 12.2.4 Danish CPUE data (tonnes/day fishing) and fishing activities by vessel category for 1987-2002. Non-standardized CPUE-data for the Danish part of the commercial tuning fleet. (Logbook information).

Vessel GRT	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
51-100	11.73	20.27	14.58	10.03	12.56	31.75	31.00	24.80	29.53	-	20.00	-	-	-	-	-
101-150	20.70	18.83	19.59	17.38	24.14	26.42	23.72	26.76	38.96	20.48	22.68	-	-	-	-	-
151-200	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	-	20.45
201-250	25.63	30.44	26.10	24.87	29.74	36.00	27.76	40.59	39.34	24.96	30.59	19.68	26.69	48.55	25.35	17.09
251-300	26.10	23.29	26.14	21.30	28.15	31.90	32.05	36.98	38.84	31.43	32.55	17.48	23.98	45.92	20.02	21.73
301-	32.73	38.81	28.58	24.96	36.48	42.60	34.89	44.91	57.90	39.14	43.01	32.32	31.00	64.33	52.95	46.36

Table 12.2.5 Results of regression of Danish CPUE-data used for effort standardization of the Danish and Norwegian fishery (com-mercial) tuning fleet. 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. Data for 1994-2003 combined.

Regression models: CPUE=b*GRTa => 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	0,17	14,13	0,78	32,73
1995	0,17	14,13	0,78	32,73
1996	0,17	14,13	0,78	32,73
1997	0,17	14,13	0,78	32,73
1998	0,17	14,13	0,78	32,73
1999	0,17	14,13	0,78	32,73
2000	0,17	14,13	0,78	32,73
2001	0,17	14,13	0,78	32,73
2002	0,17	14,13	0,78	32,73
2003	0,17	14,13	0,78	32,73

Table 12.2.6 Effort in days fishing and average GRT of Norwegian vessels fishing for Norway pout by quarter, 1983-2003.

	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	252	203,4	297	192,9	130	165,0	65	219,4
2002	90	208,6	246	189,1	1022	211,7	205	197,9
2003	140	155,5	215	160,0				

Table 12.2.7 Norway pout. Combined Danish and Norwegian fishing effort (standardized number of fishing days per year) to be used in 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	1124	1565	547	31	578	197	1191	1387	355	1633	1988	1540	3978	5518
1988	315	880	1195	144	13	156	75	416	491	617	1890	2506	1150	3198	4348
1989	146	776	922	485	196	680	1093	1745	2838	1701	2279	3980	3424	4996	8420
1990	406	989	1394	2002	87	2089	1162	462	1623	1185	1648	2833	4754	3186	7940
1991	824	1315	2139	833	33	866	1027	483	1510	869	1719	2588	3553	3551	7104
1992	866	2087	2953	354	17	371	1051	1526	2577	1154	1239	2392	3424	4869	8294
1993	483	1231	1714	1056	37	1094	1145	1555	2701	508	1666	2175	3193	4490	7683
1994	463	1262	1725	476	74	550	1362	615	1977	717	1223	1940	3019	3174	6193
1995	577	807	1384	253	99	352	164	850	1014	313	1482	1795	1307	3237	4544
1996	478	577	1054	143	184	328	570	757	1327	137	1235	1373	1329	2753	4081
1997	137	393	529	203	17	220	617	1239	1856	220	1116	1336	1177	2765	3941
1998	509	444	953	285	34	319	264	560	823	208	455	663	1265	1492	2758
1999	266	304	570	740	56	796	1184	385	1570	226	730	956	2417	1475	3892
2000	302	302	604	351	74	425	965	220	1184	207	1895	2102	1825	2491	4316
2001	261	439	701	304	15	319	128	48	176	69	539	607	762	1041	1803
2002	94	386	480	251	21	271	1069	674	1742	207	549	756	1620	1630	3250
2003	136	211	347	210	15	226									

Table 12.2.8 CPUE indices (´000s per fishing day) by age and quarter from Danish and Norwegian commercial fishery (CF) in the North Sea (Area IV, commercial tuning fleet).

Year	CF, 1st quarter				CF, 2nd quarter				CF, 3rd quarter				CF, 4th quarter			
	0-group	1-group	2-group	3-group	0-group	1-group	2-group	3-group	0-group	1-group	2-group	3-group	0-group	1-group	2-group	3-group
1982	.	2144,5	169,0	87,9	.	1705,7	144,3	12,1	30,3	1320,2	86,5	12,4	368,4	1050,5	16,0	0
1983	.	1524,2	470,0	5,4	.	1044,9	706,5	5,5	74,3	969,6	262,0	2,8	604,9	972,9	85,9	1,7
1984	.	1137,9	566,8	59,1	.	1518,0	784,9	181,1	0,2	990,2	314,9	1,5	462,0	723,1	152,1	0
1985	.	877,1	528,2	74,3	.	1310,5	221,5	20,3	2,6	599,0	339,0	8,3	183,6	809,5	47,2	0
1986	.	108,5	292,9	19,8	.	267,9	89,3	3,0	0,0	531,1	109,7	2,7	892,9	277,1	5,9	0
1987	.	1702,9	254,3	7,7	.	1856,4	103,8	0,0	5,8	1142,8	119,0	0,0	111,2	1075,5	115,7	2,5
1988	.	205,7	584,5	16,4	.	525,6	457,7	0,0	48,3	373,1	510,0	0,0	1176,0	252,1	161,6	0
1989	.	1862,8	52,1	7,6	.	1019,8	214,9	9,6	2,4	386,4	69,7	0,0	1186,1	488,7	22,7	3,2
1990	.	1065,9	451,8	25,8	.	865,0	258,2	14,7	9,5	571,7	126,7	7,2	444,9	395,2	39,7	2,3
1991	.	694,2	624,1	43,4	.	484,3	458,2	22,0	50,3	669,1	44,1	1,0	1007,3	398,0	71,7	6,6
1992	.	1130,9	361,3	39,7	.	2686,5	619,9	53,4	13,1	1012,0	144,2	0,4	190,6	1105,0	106,1	1,0
1993	.	1123,0	404,0	7,9	.	689,2	431,6	52,7	4,0	385,0	329,0	6,9	427,3	475,0	203,3	0,8
1994	.	1102,7	341,5	32,7	.	677,0	518,0	52,5	94,1	520,4	203,5	35,7	1955,6	591,6	69,0	0
1995	.	2852,2	171,4	4,0	.	3188,5	728,3	90,3	117,9	1866,0	38,6	3,0	198,8	1706,6	33,0	1,7
1996	.	366,0	732,7	13,2	.	121,1	408,5	115,7	122,0	346,9	716,0	27,5	1067,3	473,8	242,6	0,2
1997	.	992,5	481,1	147,1	.	435,0	593,0	540,5	1,9	1257,3	154,4	56,5	75,3	1349,1	153,1	25,9
1998	.	150,2	724,2	49,4	.	182,8	756,7	54,8	31,1	319,9	350,5	1,1	233,1	775,7	322,9	20,0
1999	.	351,6	225,0	128,2	.	280,3	230,0	116,8	0,0	726,4	213,8	22,0	1087,9	516,8	167,1	24,2
2000	.	1081,1	305,8	4,5	.	576,7	427,9	113,9	20,0	896,4	207,2	17,2	122,3	2182,4	115,0	2,8
2001	.	300,7	1198,6	50,1	.	216,0	662,1	312,0	30,5	369,2	142,7	6,3	560,1	323,2	721,9	1,5
2002	.	1010,9	308,4	34,8		1144,1	59,2	18,1	194,6	321,7	158,0	13,6	383,7	602,8	455,5	34,9
2003		166,7	216,2	63,1		257,4	208,6	110,1								

Table 12.2.9 Research vessel indices (CPUE in catch in number per trawl hour) of abundance for Norway pout.

Year	IBTS/IYFS[1] February			EGFS[2,3] August				SGFS[4] August				IBTS 3rd Quarter[1]			
	1-group	2-group	3-group	0-group	1-group	2-group	3-group	0-group	1-group	2-group	3-group	0-group	1-group	2-group	3-group
1970	35	6	-	-	-		-	-	-	-	-	-	-		-
1971	1,556	22	-	-	-	-	-	-	-	-	-	-	-	-	-
1972	3,425	653	-	-	-	-	-	-	-	-	-	-	-	-	-
1973	4,207	438	-	-	-	-	-	-	-	-	-	-	-	-	-
1974	25,626	399	-	-	-	-	-	-	-	-	-	-	-	-	-
1975	4,242	2,412	-	-	-	-	-	-	-	-	-	-	-	-	-
1976	4,599	385	-	-	-	-	-	-	-	-	-	-	-	-	-
1977	4,813	334	-	-	-	-	-	-	-	-	-	-	-	-	-
1978	1,913	1,215	-	-	-	-	-	-	-	-	-	-	-	-	-
1979	2,690	240	-	-	-	-	-	-	-	-	-	-	-	-	-
1980	4,081	611	-	-	-	-	-	-	1,928	346	12	-	-	-	-
1981	1,375	557	-	-	-	-	-	-	185	127	9	-	-	-	-
1982	3,315	403	-	6,594	2,609	39	77	8	991	44	22	-	-	-	-
1983	2,331	663	9	6,067	1,558	114	0.4	13	490	91	1	-	-	-	-
1984	3,925	802	58	457	3,605	359	14	2	615	69	9	-	-	-	-
1985	2,109	1,423	71	362	1,201	307	0	5	636	173	5	-	-	-	-
1986	2,043	384	23	285	717	150	80	38	389	54	9	-	-	-	-
1987	3,023	469	65	8	552	122	0.9	7	338	23	1	-	-	-	-
1988	127	760	13	165	102	134	21	14	38	209	4	-	-	-	-
1989	2,079	260	178	1,530	1,274	621	20	2	382	21	14	-	-	-	-
1990	1,320	773	46	2,692	917	158	23	58	206	51	2	-	-	-	-
1991	2,497	677	129	1,509	683	399	6	10	732	42	6	7,383	1,105	222	3
1992	5,121	902	33	2,885	6,193	1,069	157	12	1,715	221	24	2,588	4,366	640	48
1993	2,681	2,644	259	5,699	3,278	1,715	0	2	580	329	20	3,953	1,861	597	53
1994	1,868	375	67	7,764	1,305	112	7	136	387	106	6	3,196	704	102	14
1995	5,941	785	77	7,546	6,174	387	14	37	2,438	234	21	1,762	4,527	317	42
1996	912	2,635	234	3,274	1,262	303	2	127	412	321	8	4,554	763	362	12
1997	9,752	1,474	670	1,103	5,579	364	32	1	2,154	130	32	490	3,521	169	40
1998	1,006	5,343	300	2,684	411	248	0	2,628	938	1,027	5	2,931	806	743	11
1999	3,527	597	667	6,358	1,930	88	26	3,603	1,784	180	37	7,844	2,367	201	94
2000	8,097	1,533	65	2,005	6,261	141	2	2,094	6,656	207	23	1,644	7,868	282	11
2001	1,304	2,861	235	3,547	970	667	5	756	727	710	26	2,084	1,279	860	27
2002	1,791	809	880	3,677	780	40	11	2,559	1,192	151	123	-	-	-	-
2003	1,243	573	92	389	594	168	0	1,767	779	126	1		-	-	-

[1]International Bottom Trawl Survey, arithmetic mean catch in no./h in standard area.
[2]English groundfish survey, arithmetic mean catch in no./h, 22 selected rectangles within Roundfish areas 1, 2, and 3.
[3]1982-91 EGFS numbers adjusted from Granton trawl to GOV trawl by multiplying by 3.5.
[4]Scottish groundfish surveys, arithmetic mean catch no./h. Survey design changed in 1998 and 2000. 0-group indices not used from this survey.
[5]English groundfish survey, arithmetic 2003: Data provisional. Data are evaluated number per age based on sampled number per length group in EGFS 3rd quarter 2003. See Table 12.3.7.

Table 12.2.10 Provisional Norway pout index from English Groundfish Survey (EGFS) 3rd quarter 2003. Evaluated number per age group based on sampled number per length group of Norway pout from EGFS 3rd quarter 2003, and based on age length estimates of Norway pout from Danish landings in 2nd quarter 2003 in area IV. Length groups obtained from IBTS manual.

Length (cm)	Number sampled EGFS Q3 2003	Evaluated age EGFS	Age	Mean length (cm); Danish fishery IV Q2 2003
< 13	389	0	0	
13-15	594	1	1	12,7
> 15	168	2	2	13,7
			3	16,2

Table 12.3.1 Seasonal extended survivor analysis (SXSA) of Norway pout in the North Sea and Skagerrak. Parameters, settings and the options of the SXSA as well as the input data used in the SXSA.

```
SURVIVORS ANALYSIS OF: Norway pout stock in 2003
Run: npns3a03 (Summary from NPNS3A03)

The following parameters were used:
Year range:                                                    1983 - 2003
Seasons per year:                                                     4
The last season in the last year is season :                          2
Youngest age:  0;            Oldest age:  3;             (Plus age:  4)
Recruitment in season:                                                3
Spawning in season:                                                   1

The following fleets were included:
Fleet  1:                                                commercial
Fleet  2:                                                ibts-1q
Fleet  3:                                                egfs
Fleet  4:                                                sgfs

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

Factor (between 0 and 1) for weighting the inverse catchabilities
at the oldest age versus the second oldest age (factor 1 means that
the catchabilities for the oldest age are used as they are):          0


Specification of minimum value for the survivor number (this is
Used instead of the estimate if the estimate becomes very low):       0

Iteration until convergence (setting 0):                              0


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
```

Table 12.3.2 Seasonal extended survivor analysis (SXSA) of Norway pout in the North Sea and Skagerrak. Stock numbers, SSB and TSB at start of season

Year		1983				1984				1985			
Season		1	2	3	4	1	2	3	4	1	2	3	4
AGE													
	0	*	*	153867.	102775.	*	*	79134.	53044.	*	*	57283.	38393.
	1	108966.	69597.	45157.	25501.	66705.	42455.	26614.	13509.	33730.	20756.	13212.	7709.
	2	13623.	8070.	4399.	1660.	13576.	7975.	4392.	1567.	6196.	3037.	1917.	636.
	3	114.	64.	35.	10.	802.	420.	62.	35.	449.	144.	86.	42.
	4+	6.	3.	0.	0.	0.	0.	0.	0.	23.	15.	10.	7.
SSN		24640.				21049.				10042.			
SSB		380904.				377471.				179200.			
TSN		122709.	77734.	203458.	129945.	81084.	50850.	110203.	68154.	40399.	23952.	72508.	46787.
TSB		1067388.	1321685.	1935650.	1273441.	797713.	928991.	1174462.	696777.	391699.	422642.	647004.	436809.

Year		1986				1987				1988			
Season		1	2	3	4	1	2	3	4	1	2	3	4
AGE													
	0	*	*	110802.	74273.	*	*	32308.	21650.	*	*	88738.	58876.
	1	25180.	16554.	10884.	6325.	45225.	28115.	17965.	10711.	14327.	9400.	6223.	4022.
	2	2719.	947.	564.	177.	2773.	1531.	977.	515.	5419.	3059.	1990.	1129.
	3	284.	131.	85.	52.	87.	48.	32.	21.	155.	87.	58.	39.
	4+	32.	19.	13.	9.	41.	27.	18.	12.	18.	12.	8.	6.
SSN		5553.				7424.				7024.			
SSB		90612.				98446.				136449.			
TSN		28216.	17652.	122347.	80835.	48126.	29720.	51300.	32909.	19918.	12559.	97018.	64072.
TSB		249248.	288150.	744672.	601587.	383362.	477672.	622313.	399128.	226707.	250059.	599614.	495460.

Year		1989				1990				1991			
Season		1	2	3	4	1	2	3	4	1	2	3	4
AGE													
	0	*	*	99450.	66534.	*	*	94022.	63008.	*	*	166464.	110983.
	1	36890.	23307.	15068.	8731.	40625.	25725.	15787.	9787.	41423.	26538.	17268.	10331.
	2	2178.	1421.	844.	347.	4428.	2490.	1201.	653.	5594.	2656.	1450.	796.
	3	425.	280.	183.	119.	157.	89.	44.	25.	343.	154.	88.	40.
	4+	30.	20.	13.	9.	75.	42.	28.	19.	26.	12.	8.	6.
SSN		6323.				8722.				10105.			
SSB		92443.				136320.				167224.			
TSN		39524.	25028.	115558.	75740.	45285.	28346.	111082.	73493.	47385.	29360.	185278.	122156.
TSB		324853.	413051.	821745.	621505.	392258.	477328.	825022.	632021.	428188.	496756.	1165160.	939270.

Table 12.3.2 (Cont´d.).

Year		1992				1993				1994			
Season		1	2	3	4	1	2	3	4	1	2	3	4
AGE													
	0	*	*	77002.	50896.	*	*	60801.	40677.	*	*	234740.	156821.
	1	71540.	45043.	28947.	16573.	33336.	20756.	13247.	7941.	26305.	16016.	10431.	6149.
	2	6067.	3178.	1890.	948.	8830.	5347.	3197.	1396.	4463.	2508.	1448.	626.
	3	380.	159.	90.	59.	417.	268.	132.	73.	572.	337.	202.	78.
	4+	16.	8.	6.	4.	41.	27.	18.	12.	55.	37.	25.	17.
SSN		13618.				12622.				7721.			
SSB		199673.				236571.				142571.			
TSN		78004.	48388.	107935.	68481.	42624.	26398.	77395.	50099.	31395.	18898.	246846.	163691.
TSB		650377.	792086.	1118356.	729852.	446587.	508042.	719771.	489563.	308290.	344448.	1274118.	1113153.

Year		1995				1996				1997			
Season		1	2	3	4	1	2	3	4	1	2	3	4
AGE													
	0	*	*	72961.	48334.	*	*	177868.	118636.	*	*	50999.	34097.
	1	101650.	64870.	41924.	26019.	31014.	20352.	13183.	7983.	77463.	51375.	34356.	20500.
	2	3182.	1937.	1088.	691.	14700.	9221.	6017.	3213.	4819.	2964.	1879.	955.
	3	310.	203.	110.	71.	415.	267.	148.	69.	1881.	1196.	705.	386.
	4+	63.	42.	28.	19.	58.	39.	26.	18.	58.	39.	26.	17.
SSN		13720.				18274.				14504.			
SSB		157095.				364956.				238712.			
TSN		105206.	67052.	116112.	75135.	46187.	29879.	197242.	129918.	84220.	55573.	87966.	55956.
TSB		797493.	1051428.	1393351.	921618.	560346.	634317.	1308638.	1034379.	726729.	933363.	1185994.	738624.

Year		1998				1999				2000			
Season		1	2	3	4	1	2	3	4	1	2	3	4
AGE													
	0	*	*	77005.	51541.	*	*	180827.	121179.	*	*	56204.	37615.
	1	22575.	14919.	9828.	6251.	34272.	22808.	15028.	9011.	80306.	53296.	35496.	22674.
	2	12168.	7591.	4835.	2969.	3756.	2413.	1437.	687.	5568.	3581.	2231.	1278.
	3	471.	277.	171.	113.	1814.	1156.	699.	440.	330.	219.	107.	55.
	4+	242.	156.	85.	57.	103.	69.	46.	31.	297.	199.	133.	89.
SSN		15139.				9100.				14225.			
SSB		315896.				184943.				208509.			
TSN		35457.	22943.	91924.	60931.	39945.	26445.	198037.	131347.	86500.	57294.	94171.	61710.
TSB		458122.	504469.	771878.	584286.	400856.	485788.	1202743.	988688.	714437.	943260.	1214552.	804038.

Year		2001				2002				2003	
Season		1	2	3	4	1	2	3	4	1	2
AGE											
	0	*	*	69564.	46604.	*	*	64686.	43082.	*	*
	1	24967.	16556.	10989.	7267.	30938.	20341.	13348.	8439.	28641.	19151.
	2	11419.	6963.	4466.	2971.	4652.	2997.	1989.	1101.	5270.	3471.
	3	656.	411.	194.	129.	1632.	1080.	720.	463.	454.	287.
	4+	92.	62.	41.	28.	104.	70.	47.	31.	310.	208.
SSN		14664.				9483.				8898.	
SSB		300088.				195132.				171512.	
TSN		37134.	23991.	85254.	56999.	37327.	24489.	80790.	53117.	34675.	23117.
TSB		457380.	509069.	756647.	579028.	390044.	464963.	721195.	525704.	351952.	431249.

Table 12.3.3 Seasonal extended survivor analysis (SXSA) of Norway pout in the North Sea and Skagerrak. Partial fishing mortalities by fleet.

Partial fishing mortality for fleet: 1
commercial

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	0.168	0.225	0.051	0.066	0.271	0.366	0.085	0.051	0.137	0.598
2	0.122	0.203	0.541	0.317	0.130	0.193	0.589	0.766	0.304	0.059	0.649	0.392
3	0.170	0.197	0.796	1.602	0.241	1.197	0.171	0.000	0.677	0.118	0.314	0.000
4+	0.000	1.807	*	*	0.000	0.000	0.000	0.000	0.038	0.000	0.000	0.000
F (1- 2)	0.085	0.117	0.355	0.271	0.091	0.129	0.430	0.566	0.194	0.055	0.393	0.495

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	0.141	0.407	0.075	0.047	0.116	0.274	0.021	0.012	0.036	0.209
2	0.609	0.117	0.693	0.303	0.191	0.049	0.234	0.731	0.169	0.030	0.164	0.542
3	0.359	0.027	0.089	0.000	0.183	0.000	0.012	0.324	0.170	0.000	0.000	0.000
4+	0.119	0.000	0.000	0.000	0.030	0.000	0.000	0.000	0.000	0.000	0.000	0.000
F (1- 2)	0.314	0.068	0.417	0.355	0.133	0.048	0.175	0.502	0.095	0.021	0.100	0.375

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	0.039
1	0.059	0.036	0.143	0.272	0.056	0.087	0.077	0.157	0.045	0.029	0.112	0.130
2	0.027	0.120	0.464	0.381	0.173	0.319	0.204	0.239	0.333	0.201	0.196	0.327
3	0.017	0.026	0.031	0.141	0.167	0.295	0.179	0.218	0.387	0.161	0.361	0.712
4+	0.000	0.000	0.000	0.000	0.174	0.000	0.000	0.000	0.323	0.000	0.000	0.000
F (1- 2)	0.043	0.078	0.304	0.326	0.114	0.203	0.141	0.198	0.189	0.115	0.154	0.229

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	0.033
1	0.062	0.042	0.155	0.225	0.073	0.049	0.110	0.173	0.095	0.029	0.127	0.252
2	0.241	0.118	0.282	0.404	0.100	0.113	0.411	0.468	0.173	0.147	0.420	0.294
3	0.453	0.164	0.014	0.042	0.043	0.299	0.190	0.034	0.126	0.109	0.527	0.000
4+	0.252	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)	0.151	0.080	0.218	0.314	0.087	0.081	0.261	0.321	0.134	0.088	0.273	0.273

Year	1995				1996				1997			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	*	0.012	0.043	*	*	0.005	0.026	*	*	0.003	0.012
1	0.049	0.036	0.076	0.168	0.021	0.034	0.100	0.103	0.011	0.002	0.115	0.120
2	0.095	0.173	0.053	0.109	0.066	0.027	0.222	0.133	0.085	0.055	0.269	0.299
3	0.022	0.208	0.034	0.052	0.041	0.187	0.347	0.005	0.052	0.128	0.197	0.114
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)	0.072	0.105	0.065	0.139	0.043	0.030	0.161	0.118	0.048	0.029	0.192	0.210

Year	1998				1999				2000			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	*	0.001	0.008	*	*	0.000	0.011	*	*	0.002	0.010
1	0.014	0.017	0.052	0.108	0.007	0.017	0.110	0.080	0.010	0.006	0.048	0.278
2	0.071	0.051	0.087	0.092	0.042	0.116	0.328	0.324	0.041	0.073	0.155	0.260
3	0.128	0.083	0.011	0.152	0.050	0.102	0.062	0.066	0.010	0.306	0.258	0.139
4+	0.041	0.207	0.000	0.000	0.006	0.003	0.000	0.000	0.000	0.000	0.000	0.000
F (1- 2)	0.043	0.034	0.069	0.100	0.025	0.067	0.219	0.202	0.025	0.039	0.101	0.269

Year	2001				2002				2003	
Season	1	2	3	4	1	2	3	4	1	2
AGE										
0	*	*	0.001	0.010	*	*	0.006	0.008	*	*
1	0.011	0.010	0.014	0.045	0.019	0.021	0.058	0.070	0.002	0.004
2	0.094	0.044	0.007	0.195	0.039	0.010	0.188	0.462	0.017	0.018
3	0.067	0.340	0.007	0.008	0.012	0.006	0.041	0.071	0.060	0.111
4+	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
F (1- 2)	0.052	0.027	0.011	0.120	0.029	0.015	0.123	0.266	0.010	0.011

Table 12.3.4 Seasonal extended survivor analysis (SXSA) of Norway pout in the North Sea and Skagerrak.Diagnostics from the SXSA.

Log inverse catchabilities, fleet no: 1 (commercial)

Year 1983-2003 (all quarters of year); (The same for all years; estimated and held constant by year as option in SXSA)

Season	1	2	3	4
AGE				
0	*	*	15.269	11.617
1	10.775	10.400	9.979	9.382
2	9.387	8.932	8.996	8.808
3	9.387	8.932	8.996	8.808

Log inverse catchabilities, fleet no: 2 (ibts-1q)

Year 1983-2003 (first quarter of year); (The same for all years; estimated and held constant by year as option in SXSA)

Season	1	2	3	4
AGE				
0	*	*	*	*
1	2.711	*	*	*
2	1.562	*	*	*
3	1.562	*	*	*

Log inverse catchabilities, fleet no: 3 (egfs)

Year 1983-2003 (third quarter of year); (The same for all years; estimated and held constant by year as option in SXSA)

Season	1	2	3	4
AGE				
0	*	*	3.767	*
1	*	*	2.257	*
2	*	*	1.753	*
3	*	*	1.753	*

Log inverse catchabilities, fleet no: 4 (sgfs)

Year 1983-2003 (third quarter of year); (The same for all years; estimated and held constant by year as option in SXSA)

Season	1	2	3
AGE			
0	*	*	*
1	*	*	2.985
2	*	*	2.368
3	*	*	2.368

Table 12.3.4 (Cont´d.).

Weighting factors for computing survivors:
Fleet no: 1 (commercial)

Year 1983-2003 (all quarters of year); (The same for all years; estimated and held constant by year as option in SXSA)

Season	1	2	3	4
AGE				
0	*	*	0.579	1.666
1	1.455	1.280	3.159	2.669
2	2.103	1.535	1.593	1.491
3	1.119	0.767	0.658	0.598

Weighting factors for computing survivors:
Fleet no: 2 (ibts-1q)

Year 1983-2003 (first quarter of year); (The same for all years; estimated and held constant by year as option in SXSA)

Season	1	2	3	4
AGE				
0	*	*	*	*
1	1.657	*	*	*
2	1.825	*	*	*
3	1.132	*	*	*

Weighting factors for computing survivors:
Fleet no: 3 (egfs)

Year 1983-2003 (third quarter of year); (The same for all years; estimated and held constant by year as option in SXSA)

Season	1	2	3	4
AGE				
0	*	*	0.814	*
1	*	*	1.349	*
2	*	*	0.956	*
3	*	*	0.622	*

Weighting factors for computing survivors:
Fleet no: 4 (sgfs)

Year 1983-2003 (third quarter of year); (The same for all years; estimated and held constant by year as option in SXSA)

Season	1	2	3	4
AGE				
0	*	*	*	*
1	*	*	1.170	*
2	*	*	1.313	*
3	*	*	1.410	*

Table 12.3.5 Norway pout in Sub-area IV and Division IIIa. Trends in Recruitment (0-group beginning of 3rd quarter), SSB (beginning of the year), Yield and average fishing mortality for 1- and 2-group. Values from 1974-1982 are based on previous assessments and is the same as given in previous years reports.

Year	RECRUITS Age 0; Q3	TSB Q3	SSB Q1	LANDINGS (Yearly)	YIELD / SSB	FBAR 1-2 (Mean F Ages 1-2)
1974	176000000		171000	735800	4,3029	1,840
1975	212000000		208000	559700	2,6909	1,206
1976	198000000		200000	437400	2,1870	1,204
1977	102000000		242000	389900	1,6112	0,835
1978	201000000		241000	270100	1,1207	0,907
1979	233000000		198000	329200	1,6626	1,006
1980	61000000		332000	482700	1,4539	1,233
1981	306000000		278000	238500	0,8579	0,777
1982	238000000		174000	395300	2,2718	1,016
1983	153867000	1935650	380904	451400	1,1851	0,828
1984	79134000	1174462	377471	393000	1,0411	1,216
1985	57283000	647004	179200	205100	1,1445	1,137
1986	110802000	744672	90612	178400	1,9688	1,154
1987	32308000	622313	98446	149300	1,5166	0,858
1988	88738000	599614	136449	109500	0,8025	0,591
1989	99450000	821745	92443	166400	1,8000	0,751
1990	94022000	825022	136320	163300	1,1979	0,656
1991	166464000	1165160	167224	186600	1,1159	0,687
1992	77002000	1118356	199673	296800	1,4864	0,763
1993	60801000	719771	236571	183100	0,7740	0,750
1994	234740000	1274118	142571	182000	1,2766	0,768
1995	72961000	1393351	157095	236800	1,5074	0,381
1996	177868000	1308638	364956	163800	0,4488	0,352
1997	50999000	1185994	238712	169700	0,7109	0,479
1998	77005000	771878	315896	79800	0,2526	0,246
1999	180827000	1202743	184943	92000	0,4975	0,513
2000	56204000	1214552	208509	184400	0,8844	0,434
2001	69564000	756647	300088	65600	0,2186	0,210
2002	64686000	721195	195132	76700	0,3931	0,433
2003			171512			
Average	128680172	1010144	213958	261114	1,3235	0,801
Units	No in '000	Tonnes	Tonnes	Tonnes		

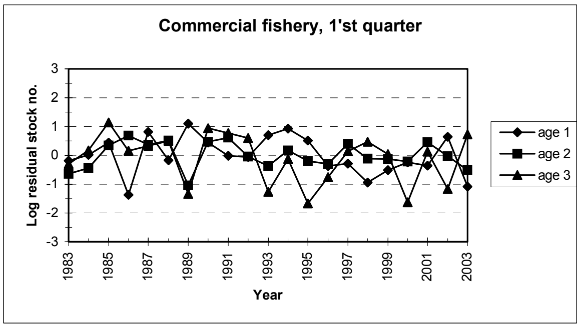
Table 12.7.1 Norway pout in Division VIa.

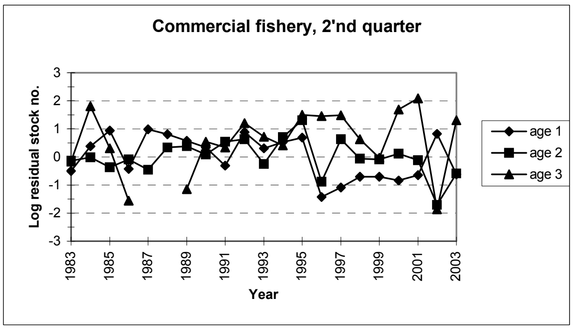
Officially reported landings (tonnes)

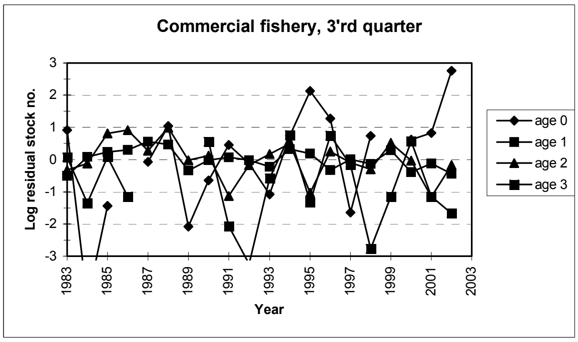
Country	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Denmark	5849	28180	3316	4348	5147	7338	14147	24431	6175	9549
Faroes	376	11	-	-	-	-	-	-	-	-
Germany	-	-	-	-	-	-	-	1	-	-
Netherlands	-	-	-	-	10	-	-	7	7	-
Norway	-	-	-	-	-	-	-	-	-	-
Poland	-	-	-	-	-	-	-	-	-	-
UK (E+W)	-	-	-	-	1	-	1	-	-	-
UK (Scotland)	517	5	-	-	-	-	+	-	140	13
Total	6742	28196	3316	4348	5158	7338	14148	24439	6322	9562

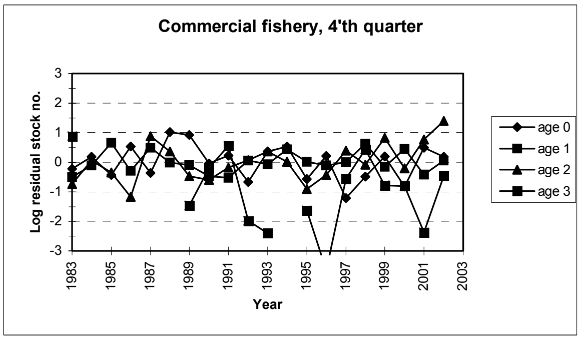
Country	1998	1999	2000	2001	2002
Denmark	7186	4624	2005	3214	4815
Faroes	-	-	-	-	-
Germany	-	-	-	-	-
Netherlands	-	1	-	-	-
Norway	-	-	-	-	-
Poland	-	-	-	-	-
UK (E+W)	-	-	-	-	-
UK (Scotland)	-	-	-	-	-
Total	7186	4625	2005	3214	4815

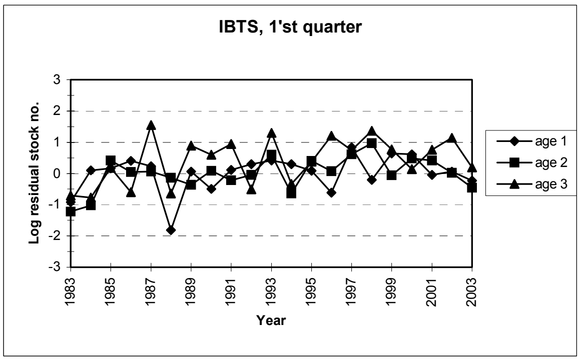
Figure 12.3.1 Log residual stock numbers (log (Nhat/N)) per age group divided by fleet and season. SXSA-Norway pout in the North Sea and Skagerak.

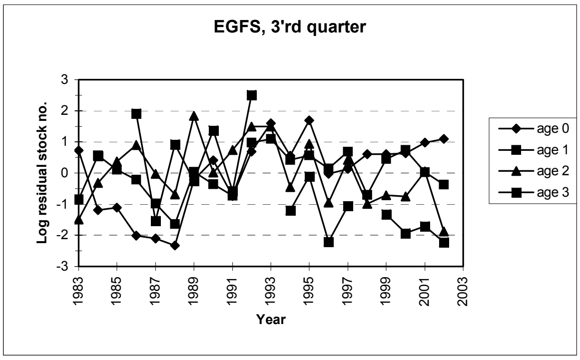












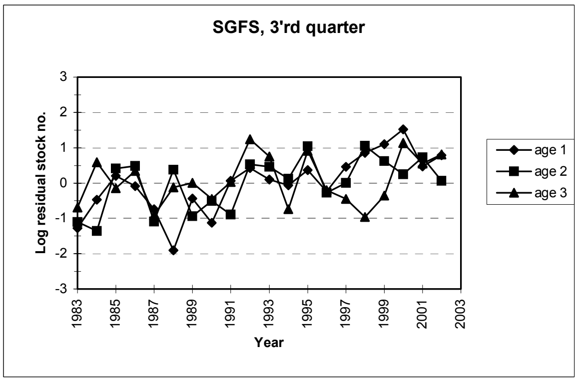


Figure 12.3.2 Norway pout in Sub-area IV and Division IIIa. Historical trends in landings yield, annual fishing mortality, recruitment and spawning stock biomass.

Figure 12.3.3 Trends in yield, SSB and TSB for Norway pout in the North Sea and Skagerrak during the period 1983-2002.

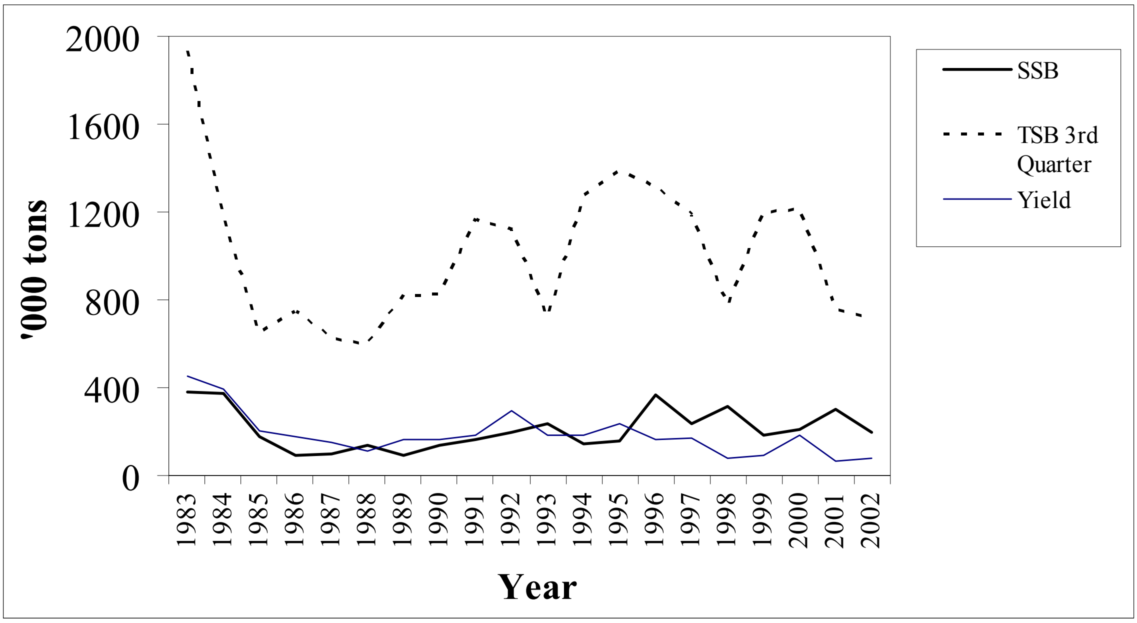
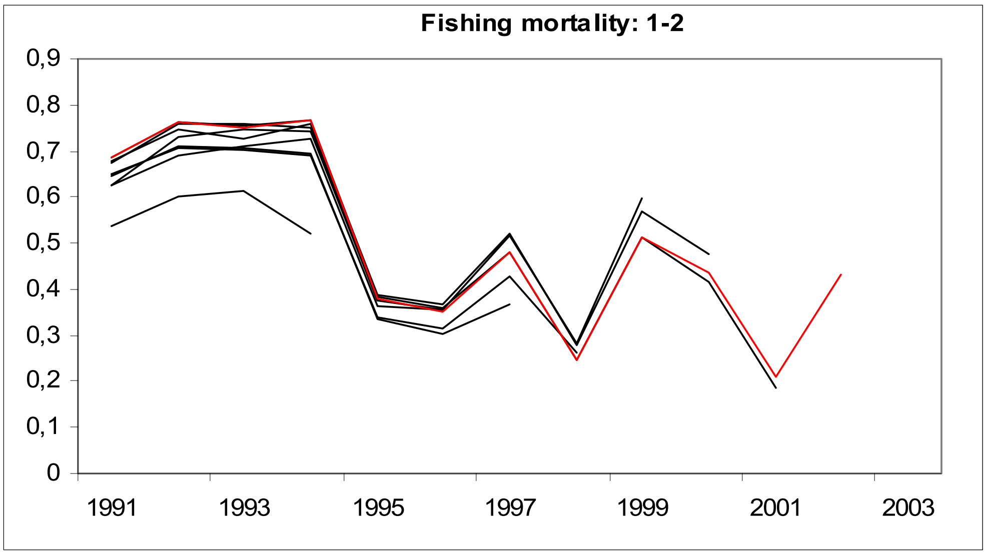


Figure 12.3.4 Quality Control Diagram for Norway pout in the North Sea and Skagerrak covering the present assessment period 1983-2003.



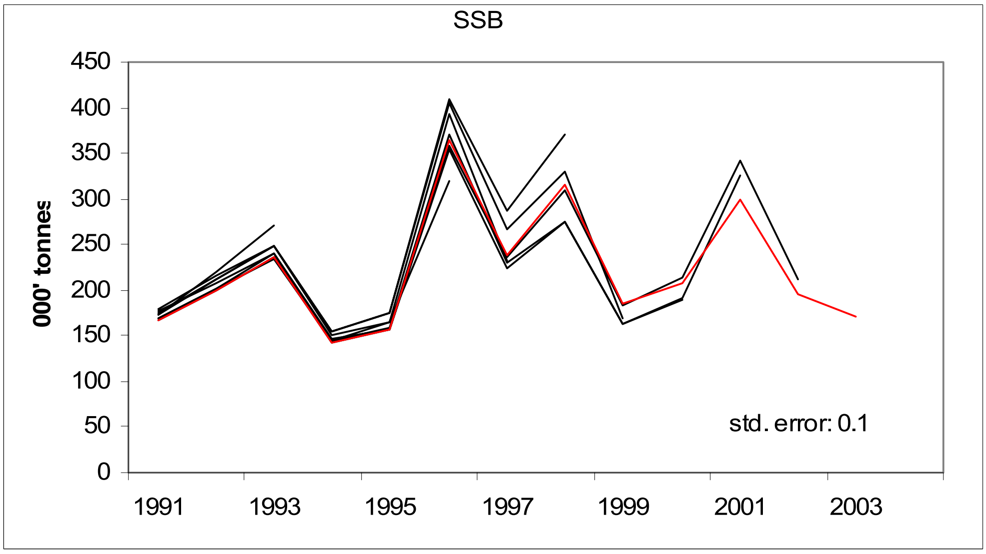
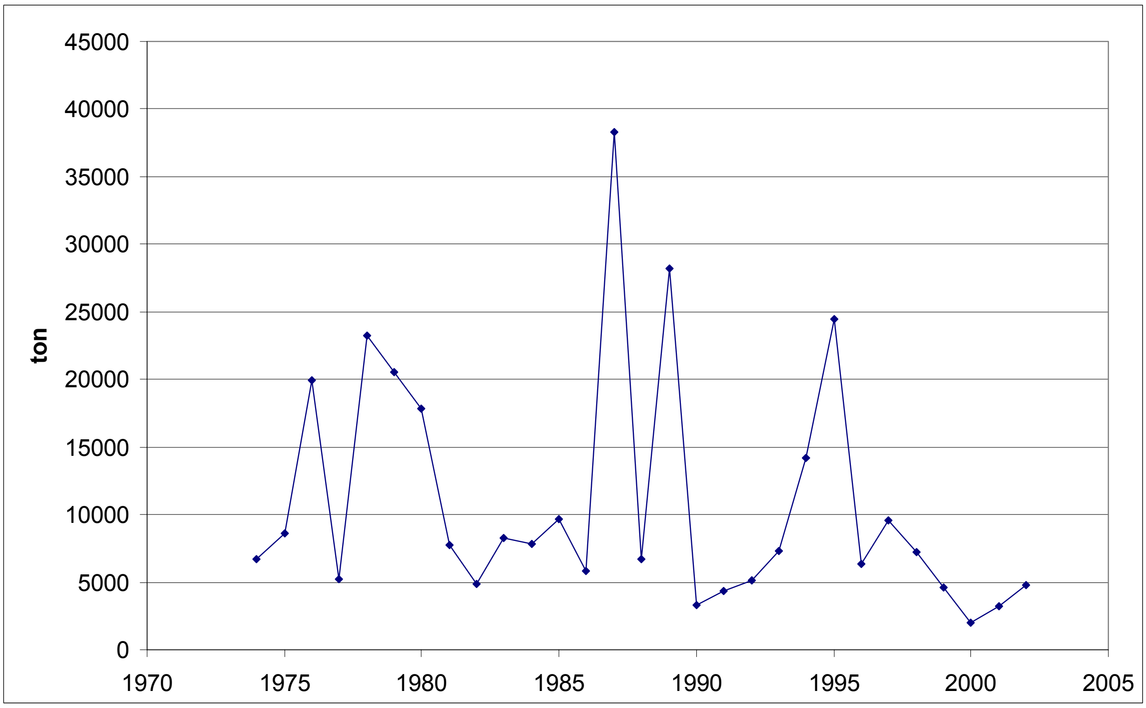


Figure 12.7.1 Trends in catches of Norway pout in ICES Division VIa



13 SANDEEL

13.1 Sandeel in IV

The assessment of sandeel in sub-area IV is presented here as an update assessment. All the relevant biological and methodological information can be found in the stock annex dealing with this stock. Here, only the basic input and output from the assessment model will be presented.

13.1.1 The Fishery

13.1.1.1 ACFM advice applicable to 2002 and 2003

There is no management objective set for this stock. However, there is a need to develop management objectives that ensure that the stock remains high enough to provide food for a variety of predator species. The fishing mortality should not increase because of the consequences of removing a larger fraction of the food-biomass for other biota is unknown. Further, local depletion of sandeel aggregations should be prevented, particularly in areas where predators congregate.

13.1.1.2 Management applicable in 2002 and 2003

The TAC was set to 1,020,000 tonnes for 2002 and 918.000 tonnes in 2003.

Technical measures for the sandeel fishery include a minimum percentage of the target species at 95% for meshes < 16 mm. Sandeels are only fished using mesh sizes < 16 mm.

13.1.2 The fishery in 2002

Official landings statistics of sandeel by country and area of the North Sea are presented in Table 13.1.2.1. Total official landings of sandeels in area IV was 848.000 tonnes in 2002 which is just above the average on 779.000 tonnes for the period 1980-2002. The majority of the catches were taken in the southern fishing area in the second quarter of the year while the landings in the northern fishing area were on a low level compared to the previous 6 years. Especially the landings in the north western part of the North Sea were on a low level in 2002 compared to the previous 5 years.

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

13.1.3 Data available

13.1.3.1 Landings

Official landings data by country and TACs are presented in table 13.1.2.1.

13.1.3.2 Age compositions

Age compositions of the landings are presented in table 13.1.3.1. No 0-group sandeels was recorded in the catches in the second half of 2002 which is unusual. Most of the sandeels in the catches in 2002 were 1-group of the very large 2001 year class.

13.1.3.3 Weight at age

Weight at age in the catch is presented in table 13.1.3.2 and weight at age in the stock in table 13.1.3.3.

13.1.3.4 Maturity and natural mortality

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

13.1.3.5 Catch, effort and research vessel data

Commercial tuning fleets used for calibration of the assessment are presented in tables 13.1.3.4.

Total international standardised effort was for the years prior to 1987 estimated as described in the WG report from 1996 (ICES, 1996/Assess:6). For the time period from 1987 to 2002 a slightly different method was applied for the Danish CPUE. This change in the estimation of effort was not found to have any effect on F, SSB and recruitment.

13.1.4 Catch at age analysis

Catch at age analysis was carried out using the XSA with the same settings as last year and the settings specified in the stock annex. Results of the analysis are presented in table 13.1.4.1 (diagnostics), 13.1.4.2 (fishing mortality at age), 13.1.4.3 (population numbers at age), and 13.1.4.4 (stock summary). The stock summary is also shown in figure 13.1.4.1 and the historical performance of the assessment is shown in figure 13.1.4.2.

The present assessment estimate SSB for 2002 to be below $\mathbf{B}_{\mathrm{lim}}$. Fishing mortality in 2002 is below the average F in the assessment period (Table 13.1.4.4).

A tendency of underestimation of Fbar is observed in recent years (Figure 13.1.4.2). The same tendencies of mean F as in the quality control plot were seen in the retrospective analysis. This confirms that there is no effect of changing methodology for the estimation of effort (section 13.1.3.5). An additional runs was carried out with the XSA to explore the reason for the retrospective pattern observed for mean F. In this run the minimum standard error for population estimates derived from each fleet was changed from 0.3 to 0.5 to evaluate the effect of down weighting the influence of the fleet in the southern part of the North Sea in the first half year, as this fleet has far the highest tuning weight for age 3 sandeels. However, this change did only improve the patterns of Fbar in the quality control plot and in the retrospective pattern very little. As far the largest proportion of age 3 sandeels are caught in the southern part of the North Sea during the first half year changing minimum standard error for population estimates seems inappropriate.

13.1.5 Recruitment estimates

As no recruitment estimates from surveys are available, recruitment estimates are based exclusively on commercial catch-at-age data. The tuning diagnostics indicate that the 0-group CPUE is a rather poor predictor of recruitment. Very small landings in the period up to August 2003 confirm however a small 2002 recruitment well below average (section 13.1.4).

The recruitment in 2001 is estimated as the second highest in the time series. The 2002 recruitment is estimated to 0. Very small landings in the first half year of 2003 (section 13.1.6) confirm a low 2002 recruitment. However, these landings are not used in this years assessment.

13.1.6 Short term prognosis

The high natural mortality of sandeel and the few year classes in the fishery make the stock size and catch opportunities largely dependent on the size of the incoming year classes. Although recruits (age 0) have appeared in the fishery at the time of the WG the biological samples from the fishery has not been processed to a stage where number of 0-sandeels caught can be estimated. 0-group CPUE is a poor predictor of recruitment (ICES C.M. 2003/ACFM:2) and traditional deterministic forecasts are therefore not considered appropriate.

Provisional Danish and Norwegian landings statistics for the period until the end of June 2003 show very small landings. Danish and Norwegian landings were at 221.250 tons compared to a mean value of 494.218 t in the same period for the years 1997-2002. In 2003 the 2002-year class contributed with only 38% in numbers and 15% in weight in the Norwegian landings in the northern assessment area, underlining an extraordinary poor 2002 year-class. The results from 2003 also suggest that the strong 2001 year-class was mainly exploited at the 0- and 1-group stage in the northern assessment area, with 35.5 billion 0-groups, 10 billion 1-groups and 0.5 billion 2-groups (estimates from Norwegian landings).

Landings of sandeel are normally composed of large numbers of 1 year olds and have no relationship with SSB. The lack of sandeels observed by the fishery in 2003 can therefore largely be attributed to the very low recruitment of 2002. There are, however, conflicting signs of the size of the remaining 2001 year class as age 2 in 2003 from the Danish and Norwegian fisheries indicating some uncertainty as to their survivorship to age 2.

SSB in 2003 is estimated to 1.374.357 tons, which is above the average on 1.054.131 tonnes in the period 1983-2002 (Table 13.1.4.4). The increase in SSB in 2003 is due to a relative high estimate of age 2 sandeels in 2003 from the large 2001 year class, and the knife-edge assumption about age at maturity, i.e. all sandeel are assumed to mature at age-2 and all sandeels of age-0 and age-1 are assumed immature.

13.1.7 Comments

The next benchmark assessment for this stock is foreseen in 2004. Terms of tasks for this assessment may include:

- Exploration of the effect on the sandeel assessment of changing natural mortality values with update estimates from the MSVPA.
- Review the procedure for estimating catch at age data used in the sandeel assessment.
- Estimate the uncertainty in catch at age figures using boot strap analyses.
- Evaluate the effect of changing the tuning fleets from being combined Danish and Norwegian fleets to being separate fleets for each of the countries.
- Evaluate the effect of changing area definition of the tuning fleets.
- Exploring the possibilities for carrying out area based assessments based on the newest knowledge about sandeel population structure.
- Evaluate the effect of including sandeel in IIIa in the assessment of sandeel in IV.
- The fishery in the northern area assessment area is usually carried out in a very limited area. Hence, the possibility of growth over-fishing should be evaluated for the benchmark assessment in 2004.
- It should be evaluated if the catch of the first half year of the assessment year could be used in the assessment.

13.2 Sandeel in Subarea IIIa

Sandeels in IIIa are considered to include a number of species of Ammodytoidei spp. as for the North Sea. The dominance of *Ammodytes marinus* in the North Sea is, however, not that pronounced in IIIa, so that traditionally one-species assessment is not feasible.

The catches in 2002 were 48.879 t, which is higher than the average of 31.598 t for the period 1996-2002.

13.3 Sandeel at Shetlands

13.3.1 Catch trends

The sandeel population adjacent to the Shetlands 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 2002 were 543 t, which is far less than the 7000 t TAC.

13.3.2 Management in 2001-2003

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 the possibility of the fishery having an 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. The regime agreed to cover the period 2001-2003 is effectively the same as the one for 1998-2000.

ACFM (October 2001) suggested that the management plan be evaluated before the agreed end date. The evaluation has been carried out and all interest groups have agreed to the continuation of the current measures.

13.3.3 Assessment

In the current WG no attempt was made to update the assessment, as this is only done every third year.

13.4 Sandeel in Division VIa

13.4.1 Catch trends

Landings of sandeel in Division VIa as officially reported to ICES are given in Table 13.4.1.1. In 2002 landings were 706 t, which is an insignificant quantity compared to the long-term average of 11 000 t (1981-2001).

13.4.2 Assessment

As with the fishery at Shetland, management of this fishery is on a three-yearly basis, with the management measure that effort is being agreed and then kept in place for a three-year period. No age composition samples were obtained from the fishery since 1999, so it is not possible to provide an updated assessment for this stock. However, it can be seen from the catch and effort data (Figure 13.4.1.1) that the catch trends in former years 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 13.1.2.1 Sandeel in IV. Official landings (tonnes) reported to ICES

SANDEELS IVa

Country	1996	1997	1998	1999	2000	2001	2002
Denmark	12,367	26,498	23,138	3,388	4,742	1,058	111
Faroe Islands	15	11,221	11,000	6,582			
Norway	61,593	98,386	172,887	44,620	11,522*	4,121*	185*
Sweden	-	-	55	495	55	-	-
UK (E/W/NI)	550	-	-	-	-	-	-
UK (Scotland)	1,311	3,463	5,742	4,195	4,781	970	543
Total	75,836	139,568	212,822	59,280	21,100	6,149	839

*Preliminary.

SANDEELS IVb

Country	1996	1997	1998	1999	2000	2001	2002
Denmark	607,290	731,184	603,491	503,572	533,905	638,657	627,097
Faroe Islands	5,008	-	-	-			
Ireland	-	-	-	389	-	-	
Norway	99,109	252,177	170,737	142,969	107,493*	183,329*	175,799*
Sweden	-	-	8,465	21,920	27,867	47,080	36,842
UK (E/W/NI)	1,130	2,575	-	-	-	-	
UK (Scotland)	6,688	20,554	18,008	7,280	5,978	-	2,442
United Kingdom						-	
Total	719,225	1,006,490	800,701	676,130	675243	869066	842180

*Preliminary.

SANDEELS IVc

Country	1996	1997	1998	1999	2000	2001	2002
Denmark	1,481	3,163	9,674	10,356	11,993	7,177	4,996
Netherlands	-	-	+	+	1	-	+
UK (E/W/NI)	-	-	-	-	+	-	-
Total	1,481	3,163	9,674	10,356	11,994	7,177	4,996

*Preliminary.

Summary table official landings

	1996	1997	1998	1999	2000	2001	2002
Total IV tones	796,542	1,149,221	1,023,197	745,766	708,337	882,392	848,015
TAC						1,020,000	1,020,000

By-catch and other landings

	1996	1997	1998	1999	2000	2001	2002
Area IV tones: official - WG	19,598	11,439	18,797	10,628	9,188	20,781	37,315

Summary table - landing data provided by Working Group members

	1996	1997	1998	1999	2000	2001	2002
Total IV - tonnes	776,944	1,137,782	1,004,400	735,138	699,149	861,611	810,700

Table 13.1.3.1. Sandeel in IV. Catch numbers at age

Run title : Sandeel in IV

At 9/09/2003 19:18

Catch numbers at age — Numbers*10**-5

YEAR,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,
AGE										
0,	172090,	0,	122890,	72170,	7530,	131960,	33810,	127040,	257310,	69310,
1,	84590,	848389,	124830,	799900,	394500,	134870,	1067620,	363880,	741900,	741590,
2,	393660,	41160,	460610,	106990,	404880,	365700,	71830,	213960,	119380,	144620,
3,	15550,	140443,	58150,	20450,	17040,	214360,	43770,	31670,	23470,	16450,
+gp,	4010,	4904,	10540,	480,	3710,	28800,	34910,	9560,	7750,	9600,
0 TOTALNUM,	669900,	1034896,	777020,	999990,	827660,	875690,	1251940,	746110,	1149810,	981570,
TONSLAND,	530640,	750040,	707105,	685950,	791050,	1007304,	826835,	584912,	898959,	820140,
SOPCOF %,	100,	100,	100,	100,	100,	100,	100,	100,	100,	100,

Catch numbers at age — Numbers*10**-5

YEAR,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,
AGE										
0,	277980,	4569,	40460,	339055,	26290,	363618,	349749,	66590,	1198280,	0,
1,	213900,	581087,	823630,	254537,	1459804,	269557,	349646,	625678,	721083,	1081042,
2,	183590,	113528,	130940,	272518,	84569,	772782,	105984,	153626,	160264,	117943,
3,	50300,	92017,	29790,	78361,	80900,	55151,	196854,	36079,	17643,	14614,
+gp,	17670,	30324,	15300,	25481,	20265,	27362,	21358,	53733,	34237,	4692,
0 TOTALNUM,	743440,	821526,	1040120,	969952,	1671828,	1488470,	1023591,	935706,	2131507,	1218291,
TONSLAND,	576932,	770747,	915043,	776126,	1114044,	1000375,	718668,	692498,	858619,	806921,
SOPCOF %,	100,	100,	100,	100,	100,	100,	100,	100,	100,	100,

1

Table 13.1.3.2. Sandeel in IV. Catch weight at age (kg)

Run title : Sandeel in IV

At 9/09/2003 19:18

Catch weights at age (kg)

	YEAR,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,
	AGE										
	0,	.0027,	.0000,	.0024,	.0030,	.0023,	.0030,	.0050,	.0029,	.0030,	.0054,
	1,	.0059,	.0059,	.0059,	.0064,	.0070,	.0061,	.0055,	.0053,	.0077,	.0073,
	2,	.0103,	.0117,	.0103,	.0115,	.0116,	.0130,	.0131,	.0129,	.0159,	.0131,
	3,	.0149,	.0140,	.0166,	.0151,	.0187,	.0165,	.0161,	.0180,	.0188,	.0180,
	+gp,	.0177,	.0172,	.0297,	.0172,	.0291,	.0191,	.0181,	.0243,	.0229,	.0249,
0	SOPCOFAC,	.9997,	.9999,	.9998,	.9995,	1.0001,	1.0000,	1.0002,	1.0001,	1.0005,	.9999,

Catch weights at age (kg)

	YEAR,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,
	AGE										
	0,	.0027,	.0066,	.0051,	.0029,	.0019,	.0025,	.0032,	.0017,	.0027,	.0000,
	1,	.0064,	.0067,	.0074,	.0073,	.0061,	.0045,	.0057,	.0065,	.0045,	.0062,
	2,	.0131,	.0149,	.0150,	.0113,	.0098,	.0087,	.0089,	.0088,	.0086,	.0091,
	3,	.0172,	.0166,	.0198,	.0150,	.0120,	.0121,	.0137,	.0136,	.0132,	.0141,
	+gp,	.0211,	.0194,	.0210,	.0261,	.0214,	.0164,	.0216,	.0172,	.0152,	.0238,
0	SOPCOFAC,	1.0000,	1.0000,	1.0002,	1.0000,	1.0002,	1.0004,	1.0000,	.9997,	1.0004,	.9995,

1

Table 13.1.3.3. Sandeel in IV. Stock weight at age (kg)

Run title : Sandeel in IV

At 9/09/2003 19:18

Stock weights at age (kg)

YEAR,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,
AGE										
0,	.0010,	.0010,	.0010,	.0010,	.0010,	.0010,	.0010,	.0010,	.0010,	.0010,
1,	.0050,	.0041,	.0042,	.0042,	.0047,	.0044,	.0044,	.0043,	.0043,	.0041,
2,	.0129,	.0138,	.0128,	.0131,	.0128,	.0148,	.0135,	.0133,	.0132,	.0131,
3,	.0169,	.0163,	.0188,	.0163,	.0160,	.0158,	.0196,	.0176,	.0170,	.0172,
+gp,	.0248,	.0210,	.0221,	.0278,	.0212,	.0192,	.0183,	.0193,	.0206,	.0212,

Stock weights at age (kg)

YEAR,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,
AGE										
0,	.0010,	.0010,	.0010,	.0010,	.0010,	.0010,	.0010,	.0010,	.0010,	.0010,
1,	.0045,	.0063,	.0071,	.0068,	.0056,	.0050,	.0056,	.0064,	.0044,	.0061,
2,	.0127,	.0130,	.0154,	.0100,	.0094,	.0085,	.0088,	.0086,	.0085,	.0090,
3,	.0164,	.0146,	.0200,	.0145,	.0118,	.0120,	.0134,	.0133,	.0135,	.0141,
+gp,	.0213,	.0187,	.0209,	.0211,	.0216,	.0163,	.0222,	.0170,	.0152,	.0238,

1

Table 13.1.3.4. Sandeel in IV. Tuning fleets

```
Sandeel IV
104
North IV 1.half year
1976  2002
1 1 0.25 0.50
1 4
      5.90   5697.20   1130.00    445.00    155.10
     11.30  24306.50   2350.50    516.30    144.00
      4.30   6126.90   2337.80    572.50    143.50
      2.30   2335.20   1327.60    242.20     11.80
      5.40  13394.10   8865.00   1049.60    827.30
      3.90   5505.00   4109.00    904.00    174.00
      2.40   3518.00   2132.00    556.00     85.00
      2.00   5684.00   1215.00     89.00     12.00
      1.80  11692.20   1646.70    152.70      4.50
      1.60   2688.00   3292.00   1002.00    480.00
      4.40  23934.00   2600.00    200.00      0.00
      6.79  26236.00  10855.00    350.00    155.00
      8.41   9855.00  25922.00   1319.00     26.00
     12.43  56661.00   2219.00   3385.00      0.00
      5.94  13101.00   3907.00    578.00    175.00
      7.24  41855.00   2342.00    908.00    318.00
      4.06   9871.00   4056.00    486.00    305.00
      5.03  15768.00   2635.00   1023.00    646.00
      7.69  28490.20   7225.30   5953.50   2155.50
      6.42  36140.00   3360.00   1091.00    145.00
      5.05  11523.60   5384.60    760.80    300.70
      7.15  67037.80   3640.30   5254.30   1205.70
      5.43   6667.10  33215.80   2038.90    410.10
      4.01   2117.70   3490.80   5086.00   1022.70
      6.40  22887.20   8809.90   1419.80   1469.70
      1.74   6433.80   2407.80    472.00   1034.60
      1.89  21718.80   2649.00    401.50    219.20
South IV 1.half year
1982  2002
1 1 0.25 0.50
1 4
      8.90  56545.00   6224.00   3277.00   1939.00
      8.40   2232.00  35029.00    934.00    387.00
      9.10  62517.00   2257.10  13271.70    442.10
     10.00   7790.00  39301.00   2490.00    265.00
      7.20  43629.00   7333.00   1604.00     30.00
      5.19   4351.00  22771.00   1158.00    165.00
      9.89   2349.00  10074.00  17914.00   2769.00
     11.54  44444.00   4525.00    957.00   3368.00
     11.03  20179.00  16670.00   2467.00    745.00
      6.95  20058.00   9224.00   1320.00    454.00
     11.31  60337.00  10021.00   1002.00    621.00
      6.94   3581.00  14659.00   3707.00   1012.00
      4.24  24697.10   2594.20   2654.40    715.30
      7.56  39060.00   6503.00   1531.00   1226.00
      7.05  10193.90  16015.30   6403.40   1169.10
      6.55  52358.70   3647.90   2404.60    683.30
      9.61   9545.80  39552.90   3188.00   2260.30
     10.56  31950.90   6498.70  13149.80    946.70
      8.36  35612.80   5972.90   1825.30   3528.00
     11.20  64084.00  13530.70   1158.00   2389.10
     12.70  84858.00   8666.70   1059.90    250.00
North IV 2.half year
1976  2002
1 1 0.5 0.75
0 4
      2.40   6125.60    648.00     83.50    367.80     36.60
      4.20   3067.20   2855.70    913.30    141.90    141.10
      1.90   7820.20   1001.00    307.30     38.90      1.90
      4.80  44202.90   1310.10    433.10     66.20      9.50
      2.40   8348.80   1172.70    213.90     19.40      7.50
      2.30   9128.00    346.00     94.00     14.00      6.00
      0.40   6530.00     65.00      0.00      0.00      0.00
      0.60   7911.00    303.00    316.00     19.00      0.00
      0.60      0.00   1207.20    120.60     42.60      0.00
      0.40    349.00    109.00    239.00     89.00     11.00
      2.70   7105.00   7077.00    473.00      0.00      0.00
      1.82    455.00   5768.00    198.00      0.00      0.00
      2.43  13196.00   1283.00    340.00    119.00     17.00
      2.36   3380.00   4038.00    274.00      0.00      0.00
      2.26  12107.00   1670.00    342.00     51.00     15.00
      2.47  13616.00    866.00     28.00      8.00      3.00
      0.71   6797.00     48.00      3.00      0.00      0.00
      2.95  26960.00   1004.00    112.00     34.00     22.00
      1.73    457.00    828.60   1211.00    396.30     24.70
      1.49   4046.00   3374.00    338.00     26.00      2.00
      3.25  31817.40   1705.70   1771.50    135.80     55.30
      2.18   2431.00  11345.60    633.20     24.90      1.90
      3.34  35220.00  10005.30   1837.00     78.80      0.60
      3.02  33652.80    693.50    550.70     57.80      0.00
      0.30      0.00    467.20     83.90     23.60     46.10
      2.10  46385.40    771.20     72.80    134.30      0.00
      0.34      0.00    157.00      6.40      0.00      0.00
```

```
South IV 2.half year
1982  2002
1 1 0.5 0.75
0 4
      1.50   5039.00   4718.00    490.00    344.00     40.00
      1.80   9298.00    240.00   2806.00    513.00      2.00
      2.20      0.00   9422.50     91.60    577.30     43.80
      3.30  11940.00   1896.00   3229.00   2234.00    298.00
      1.70    112.00   5350.00    293.00    241.00     18.00
      2.83    298.00   3095.00   6664.00    196.00     51.00
      1.11      0.00      0.00    234.00   2084.00     68.00
      0.63      1.00   1619.00    165.00     35.00    123.00
      0.67    597.00   1438.00    477.00     71.00     21.00
      2.84  12115.00  11411.00    344.00    111.00      0.00
      2.02    134.00   3903.00    382.00    157.00     34.00
      1.07    838.00   1037.00    953.00    266.00     87.00
      0.97      0.00   4092.90    322.30    197.60    136.90
      1.30      0.00   3166.00   2789.00    307.00    157.00
      2.77   2088.10   2030.50   4080.40    536.10   1023.00
      3.36    198.00  15238.30    535.50    406.20    135.60
      1.64   1141.80    737.50   2672.50    209.40     65.20
      1.13   1322.10    202.50     58.20   1391.80    166.40
      1.59   6659.00   3600.60    495.90    339.20    329.50
      3.98  73442.60    819.30     15.10      0.00      0.00
      0.86      0.00   1370.40    472.20      0.00      0.00
```

Table 13.1.4.1 Sandeel in IV. XSA diagnostics

```
Lowestoft VPA Version 3.1

   15/09/2003  18:07

 Extended Survivors Analysis

 Sandeel in IV

 CPUE data from file fleet.dat

 Catch data for  20 years. 1983 to 2002. Ages  0 to   4.

      Fleet,            First, Last, First, Last, Alpha,  Beta
                    ,    year, year,  age ,  age
 North IV 1.half year,   1983, 2002,   1,     3,   .250,   .500
 South IV 1.half year,   1983, 2002,   1,     3,   .250,   .500
 North IV 2.half year,   1983, 2002,   0,     3,   .500,   .750
 South IV 2.half year,   1983, 2002,   0,     3,   .500,   .750


 Time series weights :

      Tapered time weighting not applied


 Catchability analysis :

      Catchability independent of stock size for all ages

      Catchability independent of age for ages >=    2


 Terminal population estimation :

      Survivor estimates shrunk towards the mean F
      of the final   5 years or the   2 oldest ages.

      S.E. of the mean to which the estimates  are shrunk =   1.500

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

      Prior weighting not applied


 Tuning converged after   26 iterations

1


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



 Fishing mortalities
    Age,  1993,  1994,  1995,  1996,  1997,  1998,  1999,  2000,  2001,  2002

      0,  .056,  .001,  .016,  .024,  .012,  .141,  .106,  .018,  .119,  .000
      1,  .312,  .398,  .492,  .332,  .340,  .392,  .505,  .781,  .762,  .370
      2,  .454,  .650,  .316,  .728,  .388,  .748,  .624, 1.240, 1.367,  .615
      3,  .509,  .745,  .576,  .520,  .867,  .830,  .727,  .772,  .721,  .666



1
 XSA population numbers (Thousands)

                               AGE
 YEAR ,           0,            1,            2,            3,

 1993 ,    7.59E+08, 1.45E+08, 6.79E+07, 1.70E+07,
 1994 ,    8.60E+08, 3.22E+08, 3.21E+07, 2.36E+07,
 1995 ,    3.71E+08, 3.86E+08, 6.52E+07, 9.18E+06,
 1996 ,    2.11E+09, 1.64E+08, 7.11E+07, 2.61E+07,
 1997 ,    3.41E+08, 9.24E+08, 3.55E+07, 1.88E+07,
 1998 ,    4.12E+08, 1.51E+08, 1.98E+08, 1.32E+07,
 1999 ,    5.20E+08, 1.61E+08, 3.08E+07, 5.14E+07,
 2000 ,    5.58E+08, 2.10E+08, 2.92E+07, 9.06E+06,
 2001 ,    1.60E+09, 2.46E+08, 2.90E+07, 4.64E+06,
 2002 ,    2.23E-06, 6.37E+08, 3.46E+07, 4.06E+06,

 Estimated population abundance at 1st Jan 2003

    ,     0.00E+00, 1.00E-06, 1.33E+08, 1.03E+07,

 Taper weighted geometric mean of the VPA populations:

    ,     6.10E+08, 2.52E+08, 4.87E+07, 1.19E+07,
```

Standard error of the weighted Log(VPA populations) :

,	4.8086,	.6343,	.6375,	.8117,

1

Log catchability residuals.

Fleet : North IV 1.half year

Age	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
0	No data for this fleet at this age									
1	.64	.22	.04	-.50	.02	-.16	.23	.22	.45	-.63
2	-1.52	.36	.63	.07	-.73	1.23	-1.00	-.04	-.24	-.07
3	-.84	-2.35	1.12	-1.42	-1.18	-1.88	1.00	-.35	-.13	.32

Age	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
0	No data for this fleet at this age									
1	.47	-.12	.15	.04	-.27	-.47	-1.34	.41	.28	.32
2	-1.03	.38	-1.04	-.26	-.43	.47	.33	1.07	1.13	.69
3	-.57	.53	-.11	-1.29	.75	.42	.23	.24	1.10	.97

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

Age	1	2	3
Mean Log q	-10.6581	-10.3523	-10.3523
S.E(Log q)	.4658	.7845	1.0496

Regression statistics :

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

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
1	1.08	-.407	10.00	.62	20	.51	-10.66
2	1.54	-1.260	6.39	.23	20	1.19	-10.35
3	2.24	-2.048	3.36	.13	20	2.15	-10.52

1

Fleet : South IV 1.half year

Age	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
0	No data for this fleet at this age									
1	-1.39	.61	-.39	-.05	-1.16	-1.42	.40	.38	.10	.50
2	.17	-1.18	1.04	.38	.05	-.11	-.45	.55	.94	-.43
3	-.16	.26	-.03	-.07	.06	.33	-.43	.25	.05	-.22

Age	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
0	No data for this fleet at this age									
1	-.99	.67	.40	-.07	-.09	-.35	.75	.92	1.05	.12
2	.13	-.28	-.78	.26	-.58	-.16	-.25	.18	.76	-.26
3	.16	.08	-.17	.27	-.18	.06	-.02	-.01	-.10	-.20

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

Age	1	2	3
Mean Log q	-10.9987	-10.1183	-10.1183
S.E(Log q)	.7490	.5666	.1952

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,	.68,	1.838,	13.67,	.65,	20,	.48,	-11.00,
2,	.95,	.273,	10.53,	.59,	20,	.55,	-10.12,
3,	.87,	3.242,	10.91,	.97,	20,	.14,	-10.12,

1

Fleet : North IV 2.half year

Age ,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992
0 ,	.91,	99.99,	-2.26,	-.31,	-1.65,	.23,	-.27,	.31,	.16,	1.63
1 ,	.26,	.47,	-.41,	.15,	1.21,	.42,	.78,	.59,	-.89,	-2.78
2 ,	.23,	.67,	1.56,	.80,	-1.54,	.29,	.47,	.55,	-1.55,	-3.65
3 ,	.72,	-.62,	2.12,	99.99,	99.99,	-1.09,	99.99,	.17,	-1.88,	99.99

Age ,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002
0 ,	.78,	-2.93,	.25,	-.20,	-.56,	1.58,	1.38,	99.99,	.95,	99.99
1 ,	-.36,	-.76,	.67,	-.03,	.54,	1.83,	-.73,	1.08,	-.53,	-1.49
2 ,	-1.77,	2.01,	-.03,	1.01,	.87,	.01,	.69,	1.55,	-.45,	-1.70
3 ,	-1.55,	1.26,	-.48,	-.68,	-1.44,	-.38,	-2.01,	1.16,	1.60,	99.99

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

Age ,	0,	1,	2,	3
Mean Log q,	-11.5687,	-11.6686,	-11.9662,	-11.9662,
S.E(Log q),	1.2886,	1.0418,	1.4003,	1.3362,

Regression statistics :

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

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
0,	1.31,	-.443,	8.89,	.12,	17,	1.73,	-11.57,
1,	1.41,	-.759,	8.54,	.16,	20,	1.48,	-11.67,
2,	1.52,	-.671,	8.97,	.08,	20,	2.16,	-11.97,
3,	4.48,	-1.943,	-2.92,	.02,	15,	5.40,	-12.17,

1

Fleet : South IV 2.half year

Age ,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992
0 ,	1.85,	99.99,	1.05,	-2.12,	-.63,	99.99,	-5.19,	.41,	1.79,	-1.46
1 ,	-1.52,	.78,	-.11,	-.12,	-.30,	99.99,	.74,	1.21,	1.10,	.12
2 ,	.41,	-1.82,	1.14,	-.12,	.63,	-.21,	.38,	1.19,	-.09,	-.76
3 ,	2.01,	-.22,	2.33,	.67,	.07,	1.65,	.68,	.81,	-.29,	.92

Age ,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002
0 ,	.20,	99.99,	99.99,	-.87,	-1.61,	.75,	1.01,	2.16,	2.66,	99.99
1 ,	.24,	.97,	.30,	-.15,	-.05,	-.52,	-1.43,	1.01,	-1.56,	-.70
2 ,	.47,	.36,	1.31,	1.10,	-.64,	.19,	-1.48,	.75,	-3.57,	.76
3 ,	.61,	.23,	1.22,	-.06,	.01,	.40,	1.24,	1.26,	99.99,	99.99

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

Age ,	0,	1,	2,	3
Mean Log q,	-13.4544,	-11.2203,	-11.0589,	-11.0589,
S.E(Log q),	2.0461,	.8699,	1.1960,	1.0836,

Regression statistics :

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

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
0,	.40,	1.949,	17.57,	.45,	15,	.74,	-13.45,
1,	.79,	.780,	12.92,	.45,	19,	.70,	-11.22,
2,	.59,	1.725,	13.81,	.49,	20,	.67,	-11.06,
3,	1.14,	-.493,	9.48,	.45,	18,	.88,	-10.31,

1

Terminal year survivor and F summaries :

Age 0 Catchability constant w.r.t. time and dependent on age

Year class = 2002

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
North IV 1.half year,	1.,	.000,	.000,	.00,	0,	.000,	.000
South IV 1.half year,	1.,	.000,	.000,	.00,	0,	.000,	.000
North IV 2.half year,	1.,	.000,	.000,	.00,	0,	.000,	.000
South IV 2.half year,	1.,	.000,	.000,	.00,	0,	.000,	.000
F shrinkage mean ,	0.,	1.50,,,,				.000,	.000

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
0.,	.00,	.00,	0,	.000,	.000

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

Year class = 2001

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
North IV 1.half year,	182085500.,	.477,	.000,	.00,	1,	.459,	.282
South IV 1.half year,	148845600.,	.767,	.000,	.00,	1,	.177,	.335
North IV 2.half year,	72741920.,	.833,	1.178,	1.41,	2,	.145,	.596
South IV 2.half year,	103876500.,	.823,	1.155,	1.40,	2,	.152,	.452
F shrinkage mean ,	71297700.,	1.50,,,,				.067,	.605

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
132656600.,	.33,	.30,	7,	.919,	.370

1

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

Year class = 2000

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
North IV 1.half year,	16180410.,	.440,	.204,	.46,	2,	.345,	.432
South IV 1.half year,	10412700.,	.486,	.538,	1.11,	2,	.360,	.609
North IV 2.half year,	3197237.,	.919,	.584,	.64,	2,	.086,	1.317
South IV 2.half year,	8970833.,	.733,	.915,	1.25,	3,	.130,	.680
F shrinkage mean ,	5911917.,	1.50,,,,				.079,	.907

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
10274490.,	.29,	.25,	10,	.883,	.615

Age 3 Catchability constant w.r.t. time and age (fixed at the value for age) 2

Year class = 1999

Fleet,	Estimated,	Int,	Ext,	Var,	N,	Scaled,	Estimated
,	Survivors,	s.e,	s.e,	Ratio,	,	Weights,	F
North IV 1.half year,	2652641.,	.572,	.200,	.35,	3,	.116,	.342
South IV 1.half year,	1010742.,	.279,	.191,	.68,	3,	.787,	.728
North IV 2.half year,	1851067.,	.780,	.581,	.75,	3,	.019,	.461
South IV 2.half year,	318713.,	.738,	1.620,	2.20,	3,	.022,	1.481
F shrinkage mean ,	1635808.,	1.50,,,,				.056,	.508

Weighted prediction :

Survivors,	Int,	Ext,	N,	Var,	F
at end of year,	s.e,	s.e,	,	Ratio,	
1144599.,	.25,	.17,	13,	.683,	.666

1
1

Table 13.1.4.2. Sandeel in IV. Fishing mortality at age

Run title : Sandeel in IV

At 15/09/2003 18:07

Terminal Fs derived using XSA (With F shrinkage)

Fishing mortality (F) at age

YEAR	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
AGE										
0	0.0276	0	0.0125	0.0171	0.005	0.0262	0.0154	0.0277	0.0467	0.0315
1	0.1575	0.4693	0.2181	0.2528	0.2969	0.2767	0.878	0.6025	0.5909	0.4699
2	0.5166	0.2284	1.6076	0.7211	0.4433	1.5526	0.5405	1.1813	1.0997	0.4882
3	0.5525	0.5793	1.0805	0.3899	0.3662	0.7724	1.6716	0.8579	0.6005	0.6992
+gp	0.5525	0.5793	1.0805	0.3899	0.3662	0.7724	1.6716	0.8579	0.6005	0.6992
FBAR 1-2	0.33705	0.34885	0.91285	0.48695	0.3701	0.91465	0.70925	0.8919	0.8453	0.47905

YEAR	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
AGE										
0	0.0562	0.0008	0.0164	0.0243	0.0116	0.1413	0.1057	0.018	0.1187	0
1	0.3121	0.3983	0.492	0.3321	0.3397	0.3922	0.5053	0.7807	0.7619	0.3696
2	0.4545	0.6503	0.3163	0.7284	0.3884	0.7481	0.6243	1.2399	1.3675	0.6154
3	0.5089	0.7453	0.5762	0.5204	0.8668	0.8301	0.7269	0.7717	0.7212	0.6657
+gp	0.5089	0.7453	0.5762	0.5204	0.8668	0.8301	0.7269	0.7717	0.7212	0.6657
FBAR 1-2	0.3833	0.5243	0.40415	0.53025	0.36405	0.57015	0.5648	1.0103	1.0647	0.4925

Table 13.1.4.3. Sandeel in IV. Stock numbers at age (millions)

Run title : Sandeel in IV

At 15/09/2003 18:07

Terminal Fs derived using XSA (With F shrinkage)

Stock number at age (start of year) Numbers*10**-6

YEAR	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
AGE										
0	944245	258325	1470523	633458	227399	760517	331113	693244	840514	333929
1	105746	412741	116073	652511	279794	101672	332877	146512	302979	360419
2	131699	27208	77755	28110	152633	62622	23221	41668	24158	50539
3	4945	43115	11883	8550	7501	53773	7276	7423	7018	4415
+gp	1223	1442	2015	194	1580	6855	5290	2117	2217	2453
TOTAL	1187858	742830	1678248	1322823	668907	985438	699776	890965	1176885	751755

YEAR	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	GMST 83-02	AMST 83-02
AGE													
0	758748	860122	371327	2105872	340877	411669	520393	558329	1597383	0	Na	578511	690034
1	145398	322294	386171	164136	923502	151404	160601	210383	246410	637427	Na	240092	293067
2	67857	32054	65182	71111	35467	198038	30808	29183	29028	34643	132657	51093	63851
3	17023	23640	9181	26073	18838	13200	51436	9056	4635	4058	10274	13271	18019
+gp	5746	7401	4516	8142	4457	6197	5306	12798	8555	1243	1495		
TOTAL	994772	1245511	836378	2375332	1323141	780507	768545	819749	1886011	677371	144426		

1

Table 13.1.4.4 Sandeel in IV. Assessment summary

Run title : Sandeel in IV

At 15/09/2003 18:07

Table 16 Summary (without SOP correction)

Terminal Fs derived using XSA (With F shrinkage)

Year	RECRUITS Age 0	TOTALBIO	SSB	Landings	YIELD/SSB	Mean F Ages 1-2
1983	944244928	3287694	1811547	530640	0.2929	0.3371
1984	258324672	3058503	1107940	750040	0.6770	0.3489
1985	1470523264	3218631	1261763	707105	0.5604	0.9129
1986	633458432	3874114	513159	685950	1.3367	0.4870
1987	227399264	3652744	2110316	791050	0.3748	0.3701
1988	760517248	3118729	1910853	1007304	0.5271	0.9147
1989	331112704	2348179	552408	826835	1.4968	0.7093
1990	693243712	2043341	725955	584912	0.8057	0.8919
1991	840513728	2624390	484097	898959	1.8570	0.8453
1992	333929312	2592706	788267	820140	1.0404	0.4791
1993	758748288	2676268	1263228	576932	0.4567	0.3833
1994	860121728	3777208	899525	770747	0.8568	0.5243
1995	371326848	4407518	1282790	915043	0.7133	0.4042
1996	2105871488	4474545	1260757	776126	0.6156	0.5303
1997	340877152	6193049	652858	1114044	1.7064	0.3641
1998	411668736	3121493	1951291	1000375	0.5127	0.5702
1999	520393024	2498615	1080464	718668	0.6651	0.5648
2000	558328576	2493280	588499	692498	1.1767	1.0103
2001	1597382656	3123648	439599	858619	1.9532	1.0647
2002	0	4311107	397303	806921	2.0310	0.4925
2003			1374357*			
Average	700899277	3344788	1054131	791645	0.9828	0.6102
Units	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)		

*Calculated using the 2002 weight in the stock

Figure 13.4.1.1 Sandeel in VIa, Trends in landings (tonnes) and effort (days absent)

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
Total effort	-	-	447	446	475	530	290	455	315	281

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
Total effort	116	83	134	162	131	203	203	60	17	-

Country	2001	2002
Denmark		
UK, Scotland		
United Kingdom	295	706
Total	295	706
Total effort	-	-

Figure 13.1.4.1. Sandeel in IV. Stock summary

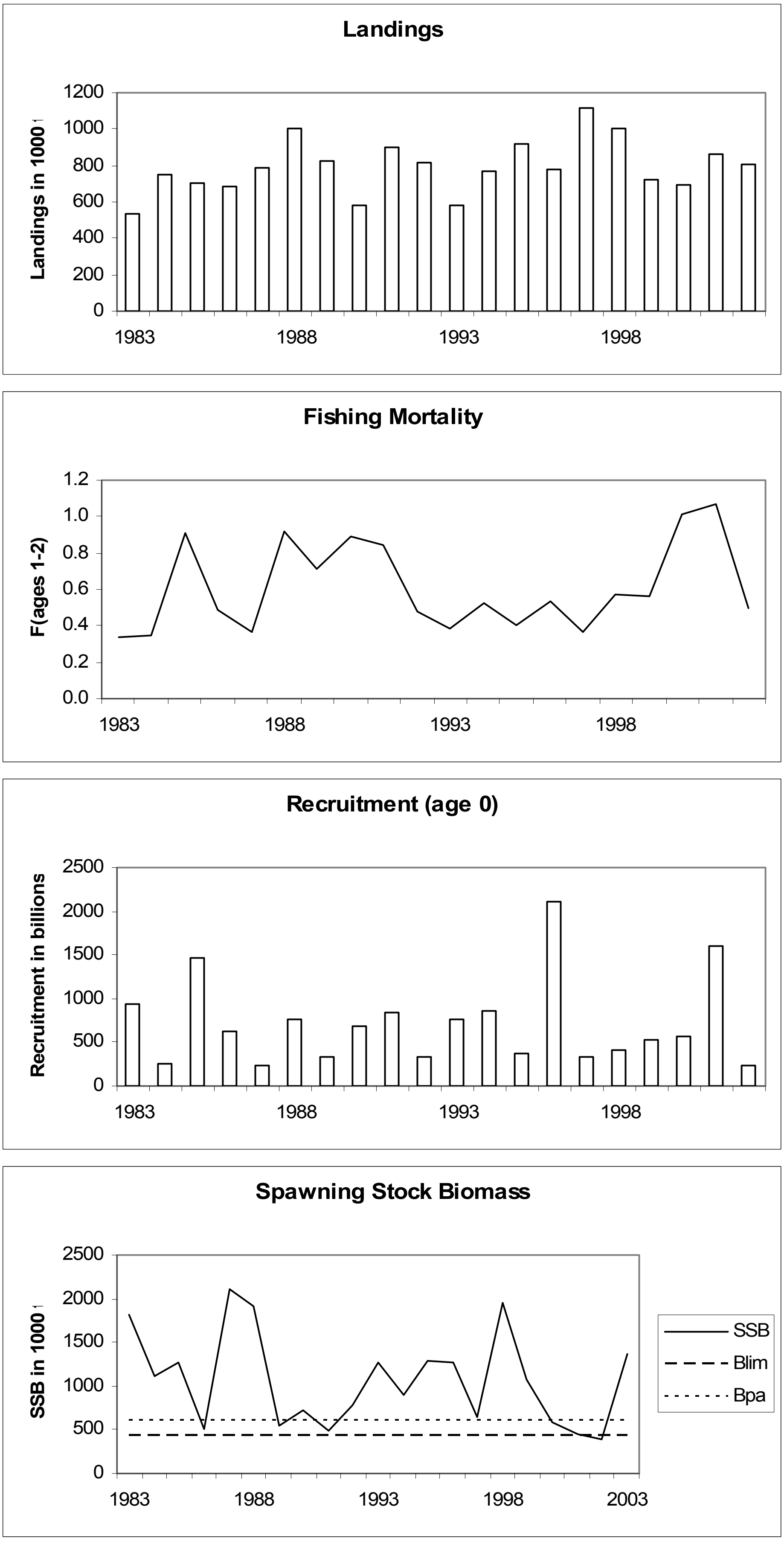
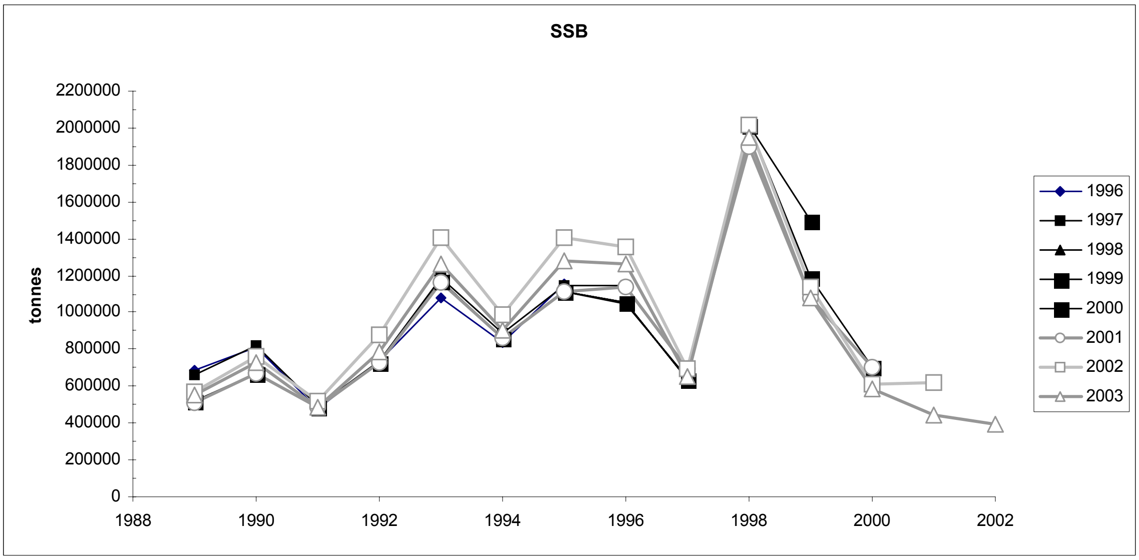
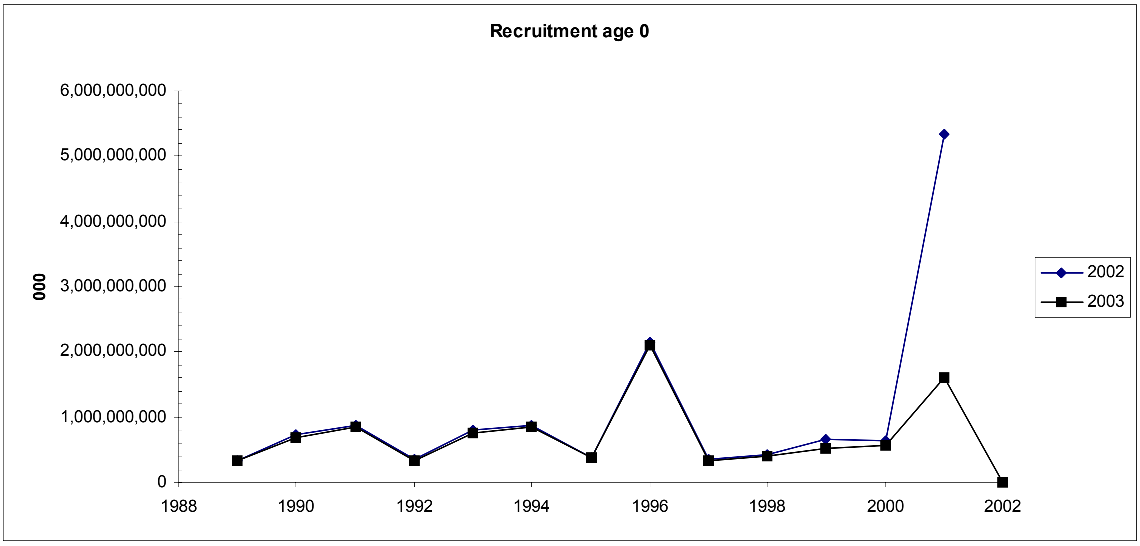
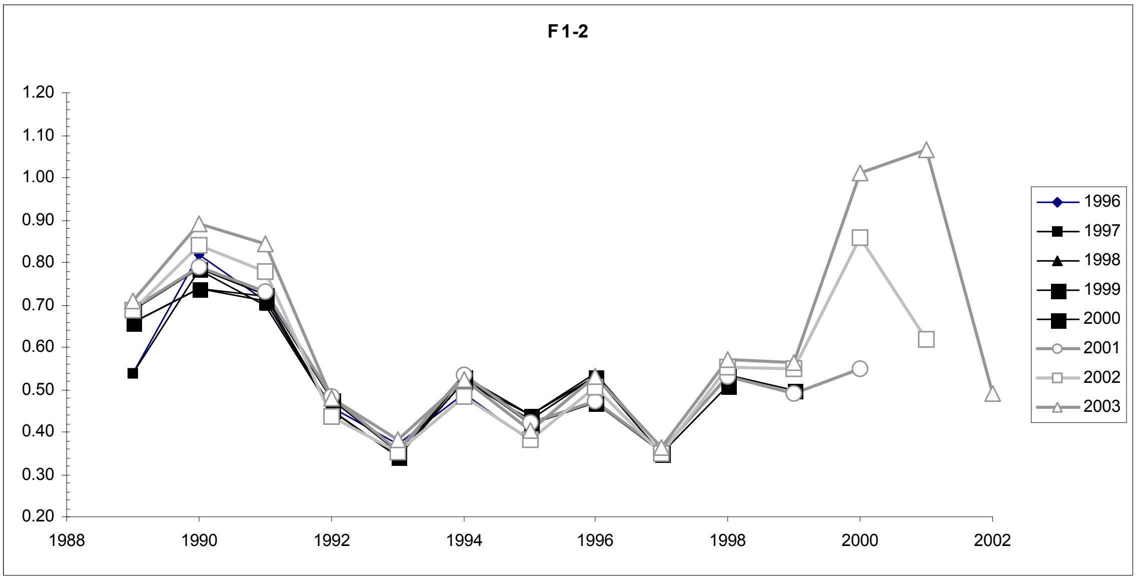


Figure 13.1.4.2. Sandeel in IV. Comparison of historical performance of the assessments







14 COD RECOVERY PLAN

14.1 Expired regulations and proposals

14.1.1 COMMISSION REGULATION (EC) No 259/2001 establishing measures for the recovery of the stock of cod in the North Sea (ICES subarea IV) and associated conditions for the control of activities of fishing vessels of 7 February 2001

14.1.1.1 Description

It must be noted that this emergency measure enforced by the COM is not considered to be a part of the long term cod recovery plan but is mentioned here as an accompanying measure. The area closed from 14 February to 30 April 2001 was defined on the basis of the ICES statistical rectangles which represented the top 80% landings of cod from the first 6 months of 1999 and was intended to protect mature fish while they spawned. The closed area and the resulting fishing effort distributions before, during and after the closure as well cumulative landings during the first months of 2001 are illustrated in the report of the expert group meeting in Brussels, 28 April – 7 May 2003 (EC 2003).

14.1.1.2 Evaluation

The measure was evaluated during an expert meeting in Brussels, 28 April – 7 May 2003 and WGNSSK endorses the results elaborated during that meeting. Details can be taken from its report while main findings were that

- from the quarterly catch at age analysis it is concluded that the apparent reduction in catch rates of mature fish in the first quarter 2001 is part of a general shift in exploitation pattern and can not be solely attributed to the closure.

- the closure had an insignificant effect upon the spawning potential for cod in 2001. The redistribution of the fishery, especially along the edges of the box coupled to the increases in proportional landings from January and February appear to have been able to negate the potential benefits of the box. The conclusion from this study is therefore that the box would have to be extended in both space and time to be more effective.

From more detailed simulations about the application of closed areas as a management tool the expert group concluded that

- Closed areas can be used to beneficial effects in the management of fish stocks.

- If effort is removed from the fishery at the time of closure (and not reallocated) the effects on the reduction in fishing mortality are generally of significantly greater magnitude.

- Redistributed effort can lead to no beneficial and sometimes significant negative effects on unprotected age groups and species. Discussions with fishers with regard to the potential changes in effort distribution would be required before a full modelling evaluation of any box can be carried out.

- Cod spawn throughout much of the North Sea but the adult and egg data do indicate a number of spawning aggregations.

- However, the limited data does suggest a contraction in significant spawning areas, beginning with the loss of sites at Great Fisher bank and Aberdeen bank by the 1980s, and more recently further coastal spawning sites around Scotland and the Forties area.

14.1.2 Proposal of a COUNCIL REGULATION establishing measures for the recovery of cod and hake stocks COM (2001) 724 final of 11 December 2001

This proposal is no longer relevant as the proposal for the cod recovery plan has been revised on 6 May 2003 (COM (2003) 237 final) and separated from the proposal of the northern hake recovery plan published on 27 June 2003 (COM(2003) 374 final).

14.2 Regulations in force or proposed

14.2.1 COMMISSION REGULATION (EC) No 2056/2001 establishing additional technical measures for the recovery of the stocks of cod in the North Sea and to the west of Scotland of 19 October 2001 and unilateral measures

14.2.1.1 Description

Table 14.2.1 provides an overview about changes in the technical gear properties according to new regulations since 2000. Apart from the technical measures set by the Commission additional unilateral measures are in force in the UK. In August and December 2000 Scottish Statutory Instruments (SI) 227 and 405 introduced additional measures on square mesh panels and multiple rigs (equivalent Westminster Statutory Instruments 649 and 650 followed in April 2001). These also implemented, in March 2001, a further restriction on twine size in both whitefish and Nephrops gears. In August 2001, Scottish SI 250 banned lifting bags and limited extension length for whitefish gear.

14.2.1.2 Evaluation

There are analyses in the experts group report presented which are endorsed by the WGNSSK. The experts demonstrated only the potential effects of the technical regulations as their actual uptake is unknown. Based on newly estimated selection parameters of the amended gear configurations and assuming full compliance with the regulations the expert group concluded that

- For whiting, the effects of the gear regulations alone, result in immediate and short term (ca 2-3 years) losses in consumption landings that do not revert to gains in the medium term (ca 10 years). Discards are substantially reduced over both the short and medium terms.

- For haddock there are also immediate losses, but these revert to small gains within the short term, and to greater gains over the medium term. As with whiting, discards are substantially reduced over both the short and medium terms.

- For cod there is little noticeable effect on consumption landings or spawning biomass if discards are excluded from the analysis. Using a series of "derived" discard data produces a moderate benefit to the medium term consumption yield and spawning biomass.

- For cod, a substantially greater benefit accrues to the spawning biomass in the medium term if fishing mortality is reduced in addition to the effects of the gear measures. This also applies to a lesser extent for haddock and whiting. Similarly, there are substantially greater gains in the medium term consumption landings of cod in these circumstances, whilst those for haddock are little affected by the additional reduction in mortality. Losses to the consumption landings of whiting are greater in these circumstances.

The conclusions of the experts group were also reviewed during a second expert meeting with a Norwegian delegation during 30 June-1 July 2003 in Bergen. The results of the first meeting were generally endorese and are also in line with agreements and findings elaborated during a series of meetings between delegations from the European Community and Norway during 2001 (WGNSSK 2001).

The WGNSSK estimated an increase of mean weight at age 1 and 2 in the catch for cod in 2002. It was concluded that this increase could be due to improved size selection but also to high grading or sampling error (Figure 14.1).

The most recent cod assessment also revealed significant changes in exploitation patterns. Fishing mortalities of ages 2, 3 and 4 decreased since 2001 (Figure 14.2). The WGNSSK concludes that the apparent changes are likely to be an effect of directed fishing on the 1996 year class at ages 1 to 4. Is could be an effect improved selectivity due to technical gear changes, of the low landings in 2001 and 2002 or high grading. The working group also emphasise that the final year estimates in the XSA are uncertain.

14.2.2 COUNCIL REGULATION (EC) No 2341/2002 of 20 December 2002

14.2.2.1 Description

The quota regulation for 2003 includes interim measures that could be interpreted as accompanying measures of the cod recovery plan, i.e. multi fisheries TAC settings for the demersal fishery in the North Sea and Skagerrak are considered for the first time. This can be seen when comparing the actual TAC changes from 2002 to 2003 leading to much lower fishing possibilities for haddock and whiting than those that would be expected when adopting ACFM single species advice. Haddock and whiting fisheries are closely associated with cod fisheries and their TAC reductions amount to about 50 %. However, ACFM advice on a closure for those fisheries was not adopted by the management. It must also be noted, that the TACs of the stocks of saithe, plaice, sole and nephrops, which are also associated with the cod fishery, remained relatively unaffected by the cod crises.

As a new and interim element, the quota regulation includes a detailed effort regulation described in its Annex XVII in terms of days at sea by area and by each licensed vessel, classified by the gear type exerted. The new interim effort regulation for 2003 is no longer relevant as it was updated in Council Regulation 671/2003 (see 14.2.3).

14.2.2.2 Evaluation

The simultaneous TAC reductions for the closely associated fisheries on cod, haddock and whiting do not necessarily translate into effort reductions. Different assessment methods (including survey only) reveal decreased fishing mortalities. The working group considers that this decrease is mainly driven by low landings in 2001 and 2002. Prediction scenarios applying low fishing mortalities in 2003 and later indicate that the stock has still the potential to recover.

14.2.3 COUNCIL REGULATION (EC) No 671/2003 of 10 April 2003 amending Council Regulation (EC) No 2341/2002 fixing for 2003 the fishing opportunities and associated conditions for certain fish stocks and groups of fish stocks, applicable in Community waters and, for Community vessels, in waters where catch limitations are required

14.2.3.1 Description

The revised regulations mainly consider amendments in the area definition, for which the effort reductions apply. 10 previously included rectangles are no longer considered part of the regulatory area, namely 52F3, 52F4, 51F3, 51F4, 50F3, 50F4, 48F3, 48F4, 47F4, 47F5 and 2 additional foot notes describe the way of cutting some rectangles. The effort regulatory area is shown in Figure 14.3.

The effort regulation defines days at sea by area and month for each licensed vessel, classified by the gear type exerted. According to the distinguished gear types, the six classes of fisheries are

4a) demersal trawls, seines or similar towed gears of mesh size equal to or greater than 100 mm except beam trawls; refers to the towed gear mixed demersal fishery for cod, haddock, whiting, saithe and plaice as main targets.

4b) beam trawls of mesh size equal to or greater than 80 mm; refers to towed gear mixed fishery for plaice and sole as main targets.

4c) static demersal nets including gill nets, trammel nets and tangle nets; refers to mixed static gear fishery for cod, plaice and sole as main targets.

4d) demersal longlines; refers to mixed fishery mainly for cod.

4e) demersal trawls, seines or similar towed gears of mesh size between 70 and 99 mm except beam trawls; refers to mixed fishery for nephrops, cod, haddock, whiting, plaice and sole as main targets.

4f) demersal trawls, seines or similar towed gears of mesh size between 16 mm and 31 mm except beam trawls; industrial fisheries for sandeel, Norway pout and sprat as main targets.

14.2.3.2 Evaluation

Paragraphs regulating the possible allocation of additional days at sea through permission by the EC in relation of steaming time or progress made in implementing decommissioning programmes and the allowances of transferring days at sea between months and vessels will complicate the effort control and any analyses of the potential effects on effort changes. Paragraph 7 defines any trip of a vessel to only one gear category (one net rule).

The working group is not aware of any suitable data base from which information about days at sea by area, month, vessel and gear type could be obtained. These data are required for the analyses of the effect of the effort restrictions on the exploitation rates. Several recent approaches to collate these aggregated effort data through scientific frame works (ICES SGDDF, STECF, expert meeting) are still ongoing. The WG express concerns about the quality of the fishing effort data included in these data bases. Effort was given by fleet, using various measures, and was not standardised (e.g. to KW*hours). Scottish effort data are based on the voluntary effort information from logbooks and might be biased. Other nations have derived effort from days absent from harbour and allocated to rectangles according to catch distributions from logbook data. Thus, the working group is again not in the position to estimate the effect of the effort restrictions on exploitation rates.

14.2.4 Proposal of a COUNCIL REGULATION establishing measures for the recovery of cod stocks COM (2003) 237 final of 6 May 2003

14.2.4.1 Description

The proposed regulations define multi-annual TAC setting rules (harvest control rules) for 4 cod stocks, including the cod stock in North Sea, the Skagerrak and Eastern Channel (3a47d). TAC settings are subject to the status of the spawning stock (SSB).

In the case that the stock is below the recommended level (150000 t) but above the minimum level (70000 t), the stock is subject to the recovery plan and will not been harvested at higher rates than F=0.65. Furthermore, TAC should be set to achieve an increase of the SSB by 30 % at the start of the following year. TAC changes should not be set in excess of ± 15 % after the first year of its implementation.

In the case that the SSB is below the minimum level, the TAC with a maximum annual variation of ± 15 % should be set at a level to allow for an increase in the SSB by 30 % leading to a SSB in excess of the minimum level at the start of the following year. If this goal is not achieved by a maximum annual reduction in the TAC of -15 %, the TAC reduction should be set in the order to achieve the annual increase in SSB of 30 %.

The second main issue of the proposed cod recovery plan considers a calculation of maximum permissible fishing effort in terms of kilowatt days. The regulation of the effort is by member state and aimed at being proportional to the required reduction in fishing mortality overall to avoid discarding. It requests 2 data sets listing all fishing vessels that have landed cod, and secondly, that have landed sandeel or Norway pout but no cod in a reference period 2000-2002 and thereafter, to allow a calculation of kilowatt days at sea (product) by member states. The allocated kilowatt days should be managed by the member states and not be transferred between areas or vessels included in lists 1 or 2.

The reduction of effort by member states is proportional to required reduction in fishing mortality and to the cod landed by member state and will be applied only to its vessels that are authorised to land cod (list 1). Vessels that are not authorised to land cod but sandeel or Norway pout have to decrease their effort by 10 % in general.

The stock should be subject to the recovery plan until it has reached $\mathbf{B}_{pa}$ for 2 consecutive years.

14.2.4.2 Evaluation

The proposed rules to derive a TAC for cod stocks under the recovery plan have been evaluated by STECF, during an EU-Norway expert meeting and ACFM in 2002.

The results produced at the three meetings indicate that

- none of the cod stocks are likely to recover within a five-year period for any of the scenarios evaluated.

- the simulations presented assume complete compliance with the management measures implemented to obtain the required reductions in fishing mortality and thereby the recovery of the stocks.

- in general, it should be remembered that predictions and simulations of this kind have had a tendency to be overly optimistic (bias and error in the assessments).

The working group is not in the position to evaluate the proposed regulations of maximum permissible fishing effort in kilowatt days. Proposed dead lines for the required effort data by vessel for an analysis are set as 15 November 2003 for the years 2000-2002 and 30 July for future years, respectively. However, a reduction of effort proportional to the reduction in fishing mortality in accordance with the required TAC change could enhance the achievement of the aimed SSB level at the start of the following year through expected discard reductions in the mixed fisheries.

The multi species working group simulated the cod recovery plan assuming single and multi species interactions. In cases where multi species (biological) interactions are taken into account, recovery periods will last only about one year longer. Again, it should be remembered that such medium term simulations may be overly optimistic.

Table 14.2.1 Changes in Technical Measures relating to gear design in force in 2001(Council Regulation (EC) No 850/98), and in 2002 (Council Regulation (EC) No 2056/2001) in the North Sea (ICES Sub-area IV and IIIa). Technical Measures for which no changes occurred are not enclosed. This includes ICES Division VIId but no changes in gear related technical measures took place in the period considered.

	Year	Mesh size (mm)	Twine thickness (mm)	Cod-end: max number of meshes round	Square mesh panel	Large mesh panel	Others
Demersal towed gears - whitefish	2001	100	8 S / 2x6 D	100	No	No	
	2002	110 (2002 only)	8 S / 2x5 D	100	YES – 90mm	No	
		120	8 S / 2x5 D	100	No	No	
Demersal towed gears - saithe	2001	100	8 S / 2x6 D	100	No	No	
	2002	110	8 S / 2x5 D	100	No	No	
Demersal towed gears - Nephrops	2001	70	8 S / 2x6 D	No	Yes – 80mm	No	
	2002	70 (2002 only)	8 S / 2x5 D	120	Yes – 80mm	Yes – 140 mm	Square mesh cod-end
		80	8 S / 2x5 D	120	Yes – 80mm	Yes – 140 mm	
		100	8 S / 2x5 D	100	Yes – 90mm	No	
Beam trawl - Sth 56°N-5°E	2001	80	8 S / 2x6 D	N/A	No	No	
	2002	80	8 S / 2x5 D	N/A	No	Yes – 180 mm	
Beam trawl - Nth 56°N-5°E (sole)	2001	100	8 S / 2x6 D	N/A	No	No	
	2002	120	8 S / 2x5 D	N/A	No	Yes – 180 mm	
Fixed gears	2001	120	N/A				
	2002	140	N/A				

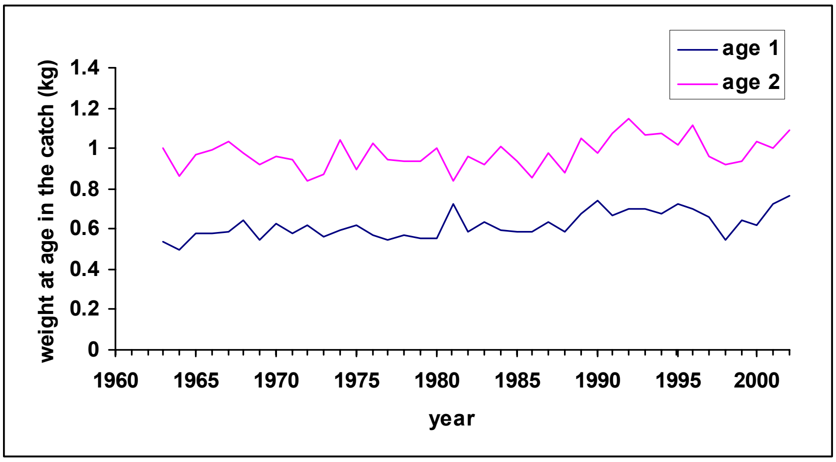


Figure 14.1 Trends in weight at ages 2 and 3 in the catch of cod in the North Sea, Skagerrak and Eastern Channel.

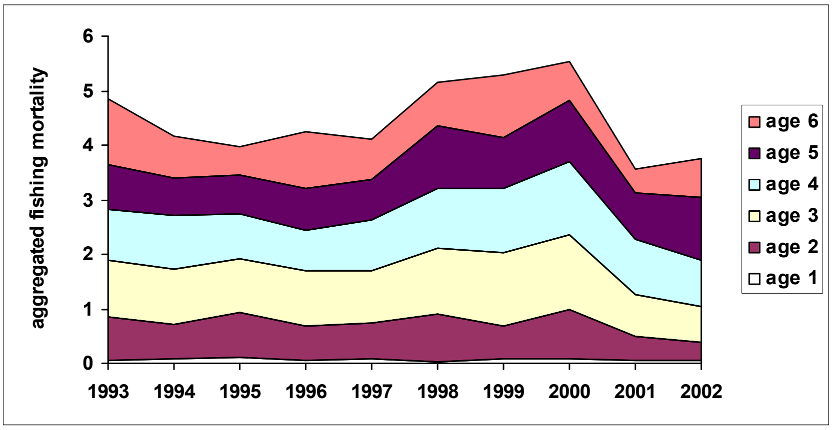


Figure 14.2 Trends in fishing mortality at ages 1 to 6 as derived from the final XSA for cod in the North Sea, Skagerrak and Eastern Channel.

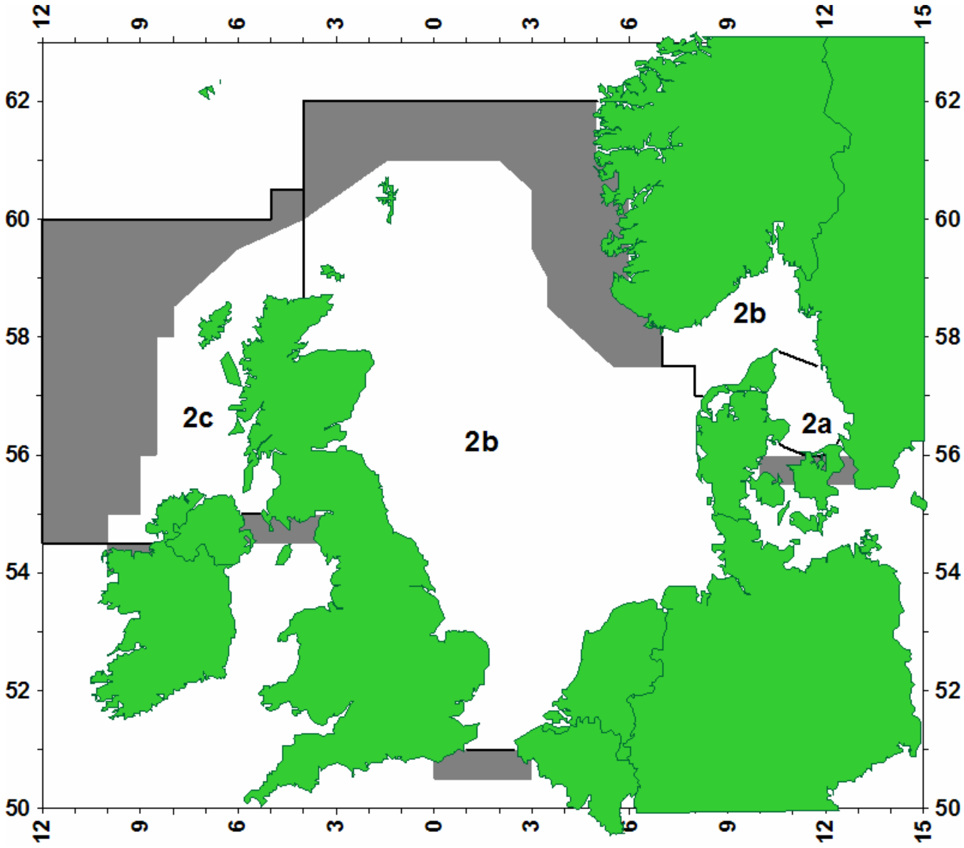


Figure 14.3 Definitions of the effort regulated areas 2a-c in the North Sea, Skagerrak and West of Scotland as defined in COUNCIL REGULATION (EC) No 671/2003 of 10 April 2003.

15 MIXED FISHERIES

15.1 Background

In 1992, assessment working groups were re-organised on to an area-basis in order to facilitate the provision of advice on an area and fishery basis. Although some progress was made (ICES; 1992a,b), the ultimate goal of providing fishery-based advice has not been achieved. In 2001, the European Commission sent to ICES a request for provision of advice in a fisheries context rather than on an individual stock basis (EC, 2001). The Commission suggested that ICES should prepare plans for developing a database, which would collate catch at age data disaggregated by fleet and by area.

At the Fisheries Council of December 2001, the Council and the Commission emphasized the need to further develop the scientific basis for management that takes appropriate account of the mixed nature of the fisheries, and stressed the importance that objective information about the consequences of fisheries interactions be available when TACs are being considered for the year 2003. This issue resulted in the Commission sending to ICES a more explicit request regarding scientific advice on mixed fisheries (EC, 2002). In the short term, ICES should, (i) propose appropriate definitions of operational fishing units and, (ii) provide the STECF (SGRST sub-group) with catch data, disaggregated by species, fleet and ICES rectangle. For the longer term, EC(2002) recommended that ICES should establish a working group to address a number of questions, including fleet definitions, age-structured data assembly, development of multi-fleet and multi-species short term projection software, collation of datasets including partial and total fishing mortalities at age.

In 2002, the WGNSSK responded to the request of EC(2002) by providing fleet-disaggregated landings data over recent years for the North Sea. The SGRST/STECF used these to calculate fishery-based forecasts.

In 2003, ICES initiated the Study Group for the Development of Fishery-based Forecasts (ICES, 2003). ICES(2003), (i) investigated the definition of appropriate fishing units, (ii) established a framework for collating catch and effort disaggregated by fishing unit, ICES rectangle and age group and , (iii) evaluated software developed to calculate mixed-fisheries forecasts.

WGNSSK03 has given a high priority to the development of mixed-fisheries forecasts applicable to the North Sea demersal fisheries. The progress made by the WG are reported in this section.

15.2 Data

15.2.1 Description of the data available

The group produced two different databases. These databases were used to derive the inputs to the MTAC model (section 1.4.6).

The first database provides landings or catch data disaggregated by country, fishery, ICES rectangle and species. This database covers the period 2000-2002, and ICES divisions IV, VIId and IIIaN (Skagerrak). A fishery was defined as a combination of engine power category, gear and mesh size. The species investigated are cod, whiting, haddock, saithe, sole, plaice and *Nephrops*. In order to simplify the case study being investigated, pelagic and industrial species (e.g. herring, sandeel, Norway pout), as well as the fisheries exploiting them, were excluded from the database. The selection criterion was mesh size, and only fisheries with a mesh size exceeding 70 mm were retained in the database. The coverage of information was uneven across countries. Thus, not all countries provided landings disaggregated by ICES rectangle and not all countries provided *Nephrops* landings. Fisheries with low catches of any of the species under investigation (e.g. dredges or pots) were removed. In the end, 77 fisheries were included in the database. Table 15.2.1.1 shows the international catch by fishery and by species in the database for 2002. Figures 15.2.1.1 and 15.2.1.2 show the same information by country and by gear respectively.

The second database provides catch numbers at age and catch weight at age by country and by species. Data have been calculated on the basis of the age-disaggregated information from countries that provided it, and then raised to the total international catches. No discard data were available for cod, saithe, plaice and sole, so catches were equated to landings for these species. International discards of haddock and whiting were calculated based on the Scottish discards monitoring programme. Landings/Catch at age data were provided by country and not by fishery. Again here, the coverage of information was uneven across countries. Thus, only one country provided discards data, and not all countries provided landings at age data. Figure 15.2.1.3 shows the derived international catch at age data for 2002.

15.2.2 Inputs to modeling

As explained in section 1.4.6, while the group is aware that several on-going approaches to mixed-fisheries forecasts are being developed (WD4, WD15), it decided to make in-depth exploratory runs of the MTAC model. The data inputs to MTAC include catch at age by fishery providing such data, and total catch for the other fisheries. As stated in section 15.2.1, catch at age data were only available by country. Therefore, the same exploitation pattern was applied as a first proxy to all the fisheries belonging to the same country. This assumption has been debated in section 15.4.

Other model requirements include the usual VPA input data and outputs, including stock numbers at age and F*sq*. However, the most up-to-date stock numbers at age for cod, haddock, whiting, saithe, plaice and sole were only made available late during the WG, so they could not be used in the final runs of MTAC. The 2003 stock predictions from WGNSSK02 were used instead as a first proxy. Stock numbers at age of *Nephrops* could not be derived in a simple way, as several *Nephrops* functional units are defined and assessed in the North Sea, and these could not be used as inputs to MTAC.

15.3 Model explorations

15.3.1 Sensitivity analyses

A revised version of MTAC (model section) and a sensitivity test is presented in section 1.4.6 and in WD04. In this section, MTAC will be further tested and the effects of the different options that can be chosen in MTAC will be illustrated. For this exercise a data set was chosen that is suitable for illustration only. It is based on one of the datasets used at the SGRST/STECF meeting (STECF, 2002), namely the country based catch at age data of 1999-2001. For this exercise two countries with minor catches are left out so that we arrive at 9 fleets, and the country names are replaced by the first nine letters of the alphabet respectively. The scenario that is investigated is the one that was proposed by the Commission at the SGRST meeting (Tab. 15.3.1.1).

The model contains three options for weighting the species-specific fleet effort reduction.

- p=0: Equal for all fleets.
- p=1: In proportion to the catch (in weight) of the species within the catch of the fleet.
- p=2: In proportion to the catch (in weight) of the species by the fleet of the total catch of that species.

The model contains an option for modifying the decision weights through multiplication by a fleet target factor q (see description of MTAC in WD04), which can be switched off (q=0) and on (q=1). The fleet target factor describes the relative importance of a given species for a given fishery. When q = 1, greater effort reductions will be applied to those fleets which are targeting the species which are of greater conservation concern (i.e. which have a high decision weight).

All combinations of options p and q are tested (six combinations). The influence of the decision weight on cod (priority given to cod) is explored by running MTAC with all six combinations of options while the decision weights vary (from 2 for cod vs 1 for all other species to 40 for cod vs 1 for all other species) with the scenario above.

The influence of the value of the target F multiplier on cod is explored by running MTAC with all six options while the target F multiplier for cod varies from 0.1 to 1 (all other F multiplier as in the scenario above) with decision weights of 40 for cod vs 1 for all other species.

Figures 15.3.1.1-15.3.1.4 below show respectively the catch weight by species, the catch weight by species and fleet, the catch composition of the fleets, and the allocation of species catches to the fleets (average of 1999-2001). From figures 15.3.1.3 and 15.3.1.4, the following points can be noted:

- Fleet A takes the largest proportion of the cod catch.

- Fleets E and H take the smallest proportion of the cod catch; however, the two fleets contrast in that their respective cod catches represent a higher proportion of the catch of fleet H than of the catch of fleet E.

- Fleets D and I are quite similar with respect to their share in the cod catch and the proportion of cod in their catch, but are highly contrasting in that fleet D takes no saithe whereas fleet I catches mainly saithe.

The results of the twelve runs are given in figures 15.3.1.5-15.3.1.16.

Run 1 is set so the fleet-specific effort reduction is consistent across fleets (p = 0), while the decision weight is not weighted by a fleet target factor (q = 0).The outcome of run 1 (figure 15.3.1.5) is straightforward: all fleets catch cod and have to reduce effort equally, and the more so when higher decision weight is put on cod.

Run 2 is set so the fleet-specific fleet effort reduction is still the same across fleet (p = 0), but the decision weight is weighted by a fleet target factor (q = 1). By contrast with run 1, the decrease in the fleet factor is different across fleets (figure 15.3.1.6). In particular, fleets E and I are favoured, due to the low proportion of cod in the catch. Fleet E suffers the least from restricting cod catches, and only when decision weight is high, because it has the lowest proportion of cod in its catch. Although both fleets D and I have similar cod proportions in their catch composition, only fleet I is favoured because it targets saithe, for which Fsq does not have to be reduced.

Run 3 is set so the fleet-specific effort reduction is in proportion to the species proportions in the fleets catches (p = 1), while the decision weight is not weighted by a fleet target factor (q = 0). Given these settings, the fleet factor profiles differentiate only slightly between the fleets (figure 15.3.1.7).

Run 4 is set so the fleet-specific effort reduction is in proportion to the species proportions in the fleets catches (p = 1), while the decision weight is weighted by a fleet target factor (q = 1). Compared to run 3, the fleet factor profile differs between fleets, as the decision weight is weighted by a fleet target factor (q = 1). Again, modifying the decision weight by fleet target factors favours fleets E and I, which take small proportion of cod (figure 15.3.1.8).

Run 5 is set so the fleet-specific effort reduction is in proportion to fleets' contribution to the total catch of that species (p = 2), while the decision weight is not weighted by a fleet target factor (q = 0). Choosing these settings differentiates only slightly between the fleets, and slightly favours all fleets except fleet A which takes most of the cod (figure 15.3.1.9).

Run 6 is set so the fleet-specific effort reduction is in proportion to fleets' contribution to the total catch of that species (p = 2), while the decision weight is weighted by a fleet target factor (q = 1). Choosing these settings differentiates most between the fleets (figure 15.3.1.10).. This differentiation appears to be driven as much by the distribution of saithe catches as by the distribution of cod catches. Fleets that suffer take a high proportion of cod and/or take a low proportion of saithe. Similarly, fleets that benefit take little cod and/or target saithe. Note that this effect comes about because the Fsq for saithe does not have to be reduced whereas the Fsq for cod has to be reduced to 0. Reduction of Fsq for the other species is intermediate.

Run 7 is set so the fleet-specific effort reduction is consistent across fleets (p = 0), while the decision weight is not weighted by a fleet target factor (q = 0). The outcome of run 7 (figure 15.3.1.11) is straightforward: all fleets have to reduce effort equally. Their level of effort linearly increases with the level of the chosen F multiplier for cod.

Run 8 is set so the fleet-specific fleet effort reduction is still the same across fleet (p = 0), but the decision weight is weighted by a fleet target factor (q = 1). Modifying the decision weights by fleet target factors (q = 1) discriminates between the fleets (figure 15.3.1.12). In particular, fleets, such as fleet E, suffer less as they take little cod (in terms of proportion within the fleets' catch).

Run 9 is set so the fleet-specific effort reduction is in proportion to the species proportions in the fleets catches (p = 1), while the decision weight is not weighted by a fleet target factor (q = 0). When species-specific fleet effort has to be reduced in proportion to the species composition within the fleet (p = 1), fleets such as fleet E suffer less due to their low proportion of cod in their catch (figure 15.3.1.13). Fleets such as fleets B, C and G, which have a high proportion of cod in their catches, have to limit their effort when the F multiplier for cod is low, but can gradually increase their effort at higher F multipliers. Note that the plateau at low F multipliers for these fleets are due to the fact that species-specific fleet effort cannot be below zero.

Run 10 is set so the fleet-specific effort reduction is in proportion to the species proportions in the fleets catches (p = 1), while the decision weight is weighted by a fleet target factor (q = 1). Modifying the decision weights by fleet target factors (q = 1) does not bring about much change compared to run 9, except that most fleets seem to suffer a bit more at the highest F multipliers for cod (figure 15.3.1.14).

Run 11 is set so the fleet-specific effort reduction is in proportion to fleets' contribution to the total catch of that species (p = 2), while the decision weight is not weighted by a fleet target factor (q = 0). The contrast between run 11 (figure 15.3.1.15) and run 9 (figure 15.3.1.13) is quite clear. In the run 11, fleets such as G and H are favoured compared to run 9 because they contribute little to the total cod catch (although within these fleets' catches cod represents a high proportion as compared to the other fleets). For similar reasons, fleet A, taking a high proportion of total cod catch, is disadvantaged with run 11's setting compared to run 9's setting.

Run 12 is set so the fleet-specific effort reduction is in proportion to fleets' contribution to the total catch of that species (p = 2), while the decision weight is weighted by a fleet target factor (q = 1). Modifying the decision weights by fleet target factors does not bring about much change (figure 15.3.1.16).

To conclude, the exercise of varying decision weights on the x-axis of the figures (runs 1-6) illustrates the difference between choosing to modify the decision weights by fleet target factors or not (q=1 or q=0). The choice of modification differentiates well between the fleets. On the other hand, the exercise of varying the F multiplier for cod on the x-axis (runs 7-12) illustrates the difference between choosing reducing species-specific fleet effort in proportion to a fleet's proportion of a species catch within the catch of that fleet or among fleets within the catch of that species (p=0, p=1, p=2). Choosing between these options (p) allows managers to either 'penalize' fleets when the proportion of cod within the fleet's catch is high, or when they take a high proportion of the total cod catch.

15.3.2 Mixed-fisheries forecasts using MTAC

15.3.2.1 Preliminary MTAC investigations

MTAC has been applied to the 2002 catch data collated during the WG. The data have been aggregated at two different levels: by fishery and by country. The fleet code names may be found in Table 15.3.2.1. A simple scenario set up, with arbitrary F-multipliers, has been used to evaluate the forecasts based on the different levels of aggregation (Table 15.3.2.2).

Figures 15.3.2.1-15.3.2.4 show the outcomes of MTAC using fisheries-aggregated data. When the species-specific fleet effort reduction is in proportion to the catch of the species within the catch of the fleet (p = 1, figure 15.3.2.1), most fisheries are penalized as the decision weight on cod increases. This results from these fisheries having a substantial proportion of cod in their catches. With this setting, the decrease in the F-multiplier of cod when the cod decision weight increases is of the same order of magnitude than that of haddock, whiting and *Nephrops*. (figure 15.3.2.2). By contrast, the decrease in the saithe F-multiplier when the cod decision weight increases is modest relative to that of cod. The change in the F-multipliers of sole and plaice is intermediate between that of cod, haddock, whiting, *Nephrops* on the one hand, and that of saithe on the other hand. These results stress the level of technical interaction between the cod fishery and the fishery for the other species: strong in the case of haddock, whiting and *Nephrops*, moderate in the case of sole and plaice, weak in the case of saithe.

When the species-specific fleet effort reduction is in proportion to the catch of the species by the fleet of the total catch of that species (figure 15.3.2.3), fewer fisheries are penalized as the decision weight on cod increases. The fisheries penalised are those which contribute most to the international cod landings. However, the distance between the F-multipliers profiles of cod and of the other species (figure 15.3.2.4) is comparable to that observed when the species-specific fleet effort reduction is in proportion to the catch of the species within the catch of the fleet (figure 15.3.2.2).

Figures 15.3.2.5-15.3.2.8 show the outcomes of MTAC using country-aggregated data. When the species-specific effort reduction is in proportion to the catch of the species within the catch of the country (p = 1, figure 15.3.2.5), all countries are penalized as the decision weight on cod increases. The changes of the F-multiplier of cod when the cod decision weight increases are almost confounded with those of the other species, except saithe (figure 15.3.2.6). This suggests that aggregating data by country does not provide sufficient information to identify technical interactions. When the species-specific fleet effort reduction is in proportion to the catch of the species by the country of the total catch of that species (p = 2, figure 15.3.2.7), the Swedish fisheries are less penalized as the decision weight on cod increases. The Swedish fleet has the smallest cod landings such that the reduction effort rate for this fleet is modest. The sharp decrease in the fleet factor for the Belgian fleet was not expected, as this country contributes only little to the international cod catches. However, the cod F-multiplier was set to 0.01 from which the Swedish fleet benefited. All other countries will get a cod-specific fleet effort factor at zero so that the reduction becomes independent of the size of the national cod landings. The different rates for the fleet effort reduction factor are due to the q-option. Countries with a large proportion of cod in their landings (e.g. Belgium and Denmark) are penalized more than countries (e.g. France and Norway) with a low proportion of cod The distance between the F-multipliers profiles of cod and of the other species (figure 15.3.2.8) is comparable to that observed when the species-specific fleet effort reduction is in proportion to the catch of the species within the catch of the fleet (p = 1, figure 15.3.2.6).

Summary of the results of the scenarios presented in Figure 15.3.2.1-15.3.2.8

When the species-specific effort reduction is in proportion to the catch of the species within the catch of the country (p = 1), most fisheries are penalised since most fisheries catch a substantial proportion of cod in their total catch. When the species-specific fleet effort reduction is in proportion to the catch of the species by the country of the total catch of that species (p = 2), the only fisheries penalised are those contributing most to the international cod landings. However, setting the p-option to 1 or 2 hardly affects the F-multiplier profiles for the species under consideration.

The outcomes of MTAC are dependent on the level of aggregation of the landings data. With the highest level of desegregation available (by fishery), the reduction in the fleet factor are well differentiated across fisheries. With the lowest level of desegregation (by country), there is overall little discrepancy between the fleet factors across countries. In order to make use of all the information available, further investigations will be based on the data broken down by fishery.

15.3.2.2 Further MTAC investigations using F-multipliers as proposed by ACFM in 2002.

MTAC was investigated using the fleet database for 2002 in its most dis-aggregated form and the scenario configuration shown below:

Species	F multiplier (as proposed by ACFM in 2002)	Decision weight (relative numbers)
Cod	0 or 0.2	0-1000
Haddock	0.60	1
Whiting	1.00	1
Saithe	1.61	1

Plaice	0.60	1
Sole	0.77	1
Nephrops	1	0

One groups of runs used a cod F-multiplier on 0.0 and another group of scenarios used a F-multiplier of 0.2. For both groups of scenarios, the decision weight on cod was varying from zero to very close to one. The remaining fish species receive the remaining decision weight equally splitted between species. The decision valued on Nephrops was set to zero in all runs, because it was not possible to make a real age-based forecast for that species. By having a decision weight on zero, the actually values of the F-multiplier on Nephrops will not influence the mixed-species TAC on other species. However, F-multipliers on other species will influence the TAC for Nephrops.

The scenarios were made using combinations of the p-option (1 or 2) and q-option (0 or 1) and the values given in the table above.

Figure 15.3.2.9 shows the effect of varying cod decision weight when p-option=1 (the rate of the species specific effort decrease is proportional to the relative catch of the species within the fleet), q-option=0 (no weighting of individual species specific fleet effort factors) and a cod F multiplier at 0.0 is applied. The individual fleet factors as function of the cod decision weight are show in the upper part of the figure. There is a linear relation between the fleet factors and the decision weight on cod. As the F-multiplier on cod is set to 0.0 the cod specific fleet factor will become 0.0 for all values of cod decision weight. The absolute value of the species specific fleet factor for the other species depend of the cod decision weight, but the relative value is the same for all the non-cod species. This will create the linear relation between the fleet factor and the cod decision weight as the F-multipliers are fixed. The intercept for all the fleet factors - cod decision weight relations are in this case close to one. The intercept value of approximately one is close to the average of the input F-multiplier for the non-cod fish species, however as some fleets do not catch all species the value is not the exact average.

The lower left part of figure 15.3.2.9 shows the resulting mixed fisheries F-multiplier for by species together with the F-multiplier for cod for varying decision weight on cod. The individual species F-multipliers is almost identical to the F-multiplier for cod, even though the individual species F-multipliers varies from 0.60 to 1.61. The lower right part of Figure 15.3.2.9 shows the mixed species TAC and the "single species TAC (horizontal line) for varying cod decision weight. As the mixed fisheries F-multipliers are closed to 1 for all species at a cod decision weight equal 0.0, the mixed fisheries TAC at that point will simply be higher for species with an input F-multiplier smaller than one and lower for the rest.

Figure 15.3.2.10 presents runs with p-option=2 (rate of effort decrease proportional to the species catch compared to the total international species catch) and q-option=0. As the F-multiplier on cod is set to 0.0 all the cod specific fleet factor will become 0.0 for all values of cod decision weight. The effect of choosing a different value for the p-option is therefore limited and the results presented in Figure 15.3.2.9 and 15.3.2.10 become very similar

The effect of using p-option=1 and q-option=1 is presented in Figure 15.3.2.11. As for the two previous configurations all the cod specific fleet factor will become 0.0 for all values of cod decision weight. As the fleet species proportion is used (q-option=1) to find the weighted average of the species specific fleet factors, fleet with a relatively high proportion of cod will get a concave shape of the fleet factor – cod decision weight plot (e.g. fleet F017, F018 and F019 all with more than 80% cod). The intercept of the relation is highest for the fleets having a large proportion of saithe in their catch (e.g. F034 with 89% saithe). Fleet F074 catch 58% saithe, which gives it a high intercept, however its catch of 35% cod makes the curve concave. With saithe as the exception, the F-multipliers for cod follows the F-multipliers for the other species rather close.

A p-option=2 has be used to create the results presented in Figure 15.3.2.12. This figure is very similar to Figure 15.3.2.11 which indicate that the value of the p-option has little impact for the chosen configuration. For fleets with a very low total cod catch (e.g. fleets F045 and F073) there are however, a clear differences in the fleet factor plot, where the "small" fleet in general have a higher intercept when p-option=2 is used

15.3.3 Summary of the results of the scenarios presented in Figure 15.3.2.9-15.3.2.12

The F-multiplier for cod was 0.0, which made the estimated fleet factors almost independent of the p-option when q-option=0 was applied. The q-option=0 produces mixed species F-multipliers close to the average value of the input F-multipliers of non-cod species, when the decision weight for cod was zero. For q-option=1 the fleet factors were highly dependent on the choice of the P-option, but the resulting mixed-fisheries F-multipliers or TAC were quite similar for the two values of the p-option

To investigate further the effect of having an F-multiplier on cod at 0.0 this F-multiplier is raised to 0.2 in the following scenarios.

Figure 15.3.2.13 shows the results of applying p-option=1 and q-option=0. The Fleet factor plots show now a linear dependence of the cod decision weight as seen in Figure 15.3.2.9 and 15.3.2.10 as well. The intercept of the fleet factor curves is almost constant at one as seen previously for q-option=0, but the slopes vary now with the proportion of cod in the fleet catch. As the intercept is of the F-multipliers plots is the same, the resulting mixed species TAC is almost similar to the one seen in for the cod runs using F-multiplier at 0 (Figure 15.3.2.9), when the cod decision weight is low. The mixed-species F-multipliers for cod and other species has now a different slope, with the smallest slope for species (saithe, plaice and sole) less associated with cod. The same intercept at the F-multiplier plot for all species and smaller slopes give in general a higher mixed species TAC for saithe and flatfish, compared to the single species TAC.

When the p-option is changed to 2 the fleet factors changes a lot. (Figure 15.3.2.14). Fleets with a low absolute cod landing (e.g the Swedish fleets F074-F077) get as expected the smallest reduction. As seen before, using q-option=0 the F-multiplier plots have the same intercept but variable slopes. The slopes are closer to the slope for cod, compared to Figure 15.3.2.13 , where the p-option=1 was used. .

For p-option=1 and q-option=1 the fleet factors plot has changed (Figure 15.3.2.15) compared to Figure 15.3.2.11 which uses the same option, but has a F-multiplier on 0.0. The difference is biggest for fleets with a relatively small proportion of cod catches due to the p-option=1. As an example, Fleet F072 and F073 have a 2% cod in their landings and they both have a convex curve in the fleet effort plot when F-multiplier on cod was 0.0 (Figure 15.3.2.11). When the F-multiplier on cod is raised to 0.2 their fleet factors get higher and the shape of the curve is now concave. For cod decision weight at 0.0 the mixed species F-multiplier is close to the input values, however increased for plaice and decreased for the associated species sole. The same happens for haddock and whiting.

The effect of changing the p-option from 1 to 2 is presented in Figure 15.3.2.16.

With p = 2, fleets taking a small part of the total international landings receive the smallest effort reduction. In some cases these fleets have a high proportion of cod in their landings but they can remain at a relatively high effort. Fleet F046 is an example for such a fleet. It has a total catch of 1700 t of which 51% was cod.

By contrast, other fleets taking a large part of the total international landings suffer large effort cuts, although the proportion of cod in their catch is small. The beam-trawl fleet F062 is an example of such a fleet. Fleet F062 targets flatfish with a 5% catch of cod, and it overall takes the largest total catch. The input F-multiplier for all species but saithe is substantially lower than 1. Given the saithe catches by this fleet are negligible, it has to reduce its effort drastically. For p-option=1 the fleet factor curve for F062 is almost horizontal (Figure 15.3.2.15). Using p-option=2 this fleet reduces half its effort for a low decision weight on cod, and its effort is decreased to almost zero for a high decision weight on cod. Fleet F062 takes most of the international landings of sole and has a high share of the plaice catches as well.

Overall, these contrasting examples illustrate why the choice of p-option gives a rather big difference in mixed species TAC for flat fish. The choice of p-option effects less the mixed species TAC for roundfish.

Summary of the results of the scenarios presented in Figure 15.3.2.13 to 15.3.2.16

A F-multiplier for cod at 0.2 gives a much higher difference between the fleet factors derived when using a p-option at 1 or 2 compared to the scenarios where the cod F-multiplier was 0.0. The increase in Cod F-multiplier did not change the effect of using q-option=0 very much, so in both cases the q-option=0 produces mixed species F-multipliers close to the average value of the input F-multipliers of non-cod species, when the decision weight for cod is relatively low. Therefore q-option=1 is the only option that allows integrating technical interactions in the calculation of the F-multiplier. The use of p-option=2 decreases effort for fleets having the highest international catch. However, when the fleet database includes very few large fleets targeting only few species the mixed-fishery TAC depends much on the actual species composition of the large fleets and on the choice of p-option.

15.4 Discussion

ICES has traditionally given fishery management advice on a stock by stock basis. Recent problems in implementing this advice, particularly for the demersal fisheries of the North Sea, have highlighted the limitations of this approach. In the long-term it would be desirable to give advice which accounts for such mixed-fishery effects, but in the short-term there is a need for approaches which can resolve the conflicting management advice for different species within the same fishery and generate routine advice which accounts for the mixed-species nature of the fishery.

The MTAC approach takes the (possibly inconsistent) single-species advice for each species in the fishery as a starting point, then attempts to resolve these into consistent catch or effort advice using fishery-disaggregated catch-forecasts in combination with explicitly stated management priorities for each stock.

MTAC estimates first a set of fleet effort multipliers for each fleet and species combination to obtain the single species TAC. The estimated fleet-species factors are then combined into a fleet effort factor for each fleet, which afterwards are used to calculate the mixed-fisheries TAC. These calculations require a set of rules or options describing how individual fleet should change effort and how the species specific efforts factors should be combined into a fleet factor. The fleet-factor is determined by the product between three management inputs

a) a species-specific fleet reduction rate

b) a decision weights

c) a fleet target factor

and these are described below

Species-specific fleet reduction rate

The rules to be used for the calculation of species-specific fleet effort are given by the so-called p-option used in MTAC. The rate of effort change can be:

- p-option=0: Equal for all fleets.
- p-option=1: In proportion (weight) to the catch of the species within the catch of the fleet.
- p-option=2: In proportion (weight) to the catch of the species by the fleet of the total catch of that species.

The choice of the p-options is a policy decision. p-option=1 will require a higher effort reduction from fleets having a high proportion of the species in their landings and p-option=2 will penalize fleets which take a large proportion of the total international species landings. The sensitivity analysis has shown that the choice of p-option as a large influence on the fleet effort reduction. The mixed fisheries TAC also depends on the choice of p-option. In the special case where a TAC is set to zero for a species the influence of the p-option is quite low, as all fleets catching the species are penalized equally.

Decision weight

The choice of the decision weight is a policy decision. A high decision weight for a species implies that it is very important that the mixed-species TAC is close to the single species TAC for that species.

Fleet target factor

The value of the fleet target factor ($q_{k,j}$) is determined by the so-called q-option, which can have two values:

- q-option=0: $q_{k,j}$ is set to a constant 1
- q-option=1: $q_{k,j}$ is set to the proportion the catch weight of the species within the fleet.

A q-option=0 will change the effort factors proportionally to the decision weight applied for the species. That means that a species, which contributes very little to a fleets catch can have a major impact of the effort reduction for the fleet. If for example the single species TAC for cod is set to zero, all fleets catching cod will be penalized the same way irrespective of their proportion of cod in their catches. When q-option=1 is used fleets having just a small proportion of cod in their catch will get a relatively small effort reduction. In general, q-option=1 will favour fisheries with a limited catch of species for which stock rebuilding is needed, and q-option=0 will penalize all fisheries equally.

The sensitivity analyses did not reveal programming bugs in the MTAC. Output was not always as first expected. Further analysis did however confirm that MTAC responded reasonable, given the input values and options.

The mixed-fisheries TACs calculated by MTAC are sensitive to both the level of aggregation of the database and the options.

Level of aggregation of the fleet database:

The output of MTAC are dependent on the level of aggregation of the landings data. With the highest level of desegregation available (by fishery), the reduction in the fleet factor are well differentiated across fisheries. With the lowest level of desegregation, there is overall little discrepancy between the fleet factors across fleets. The most disaggregated database is the best way to integrate technical interactions in the calculation of the mixed fisheries F-multiplier.

q-option:

A q-option=0 produces mixed species F-multipliers close to the average value of the input F-multipliers when decision weights were not highly differentiated between species. q-option=1 that allows better integrating technical interactions in the calculation of the F-multiplier.

p-option

The choice of p-option should be left to managers. As an example, using p-option=2 decreases effort for fleets having the highest international catch and not necessarily the highest proportion of a species at risk. From a technical view some guidance can however be given. When the fleet database includes few large fleets targeting only few species the mixed-fishery TAC depends much on the actual species composition of the large fleets and on the choice of p-option.

15.5 Recommendations

The group has investigated the issue of mixed-fisheries forecasts using the case study of the North Sea demersal fisheries. A mixed-fisheries database has been set up and the model MTAC initiated by STECF(2002) has been further developed and tested by the WG. This approach may be considered as a step forward towards providing routine, fishery-based, advice. However, the group recommends that further developments be needed before this approach be considered as an operational framework for providing routine, fishery-based, forecasts. These developments could consist in, (i) improving the mixed-fisheries database, (ii) further evaluating MTAC and also, (iii) restructuring the current assessment working groups to accommodate more fully the fishery interactions. These points are elaborated below.

A major limitation of developing mixed-fishery forecasts is the lack of an appropriate mixed-fishery database. A number of critical assumptions have been made in order to create input data for MTAC, based on the data available to the group. These assumptions are presented below.

- The database collated by the group did not include all the information required to run the model. Thus, discards data were only estimated for haddock and whiting, and it was assumed that for the other species, catch would equate landings. However, substantial discards are thought to happen for other species such as cod and plaice. In addition, landings or catch at age data were provided by country and not by fishery. Therefore, the same exploitation pattern was applied to all the fisheries belonging to the same country. This extrapolation is likely to be a poor proxy, given the high desegregation level of the fisheries under investigation. E.g. an otter-trawler of mesh size 100-109 mm is unlikely to have the same exploitation pattern than an otter-trawler of mesh size 120 mm or than any gill-netter. A structure and format for an appropriate mixed-fishery database has been suggested by ICES(2003). The WG recommends that future collation of mixed-fisheries data should be made according to the framework proposed by SGDFF, and that the SGDFF should initiate the compilation of these data.

- The WG focused on a selection of species living in the North Sea: cod, haddock, whiting, saithe, plaice, sole and *Nephrops*. In the case of *Nephrops*, only the total landings by fishery could be used, and even not all countries supplied landings data for this species. However, the fleets harvesting any of these species may also catch some species, which have not been dealt with here because they are evaluated by other assessment WGs. For example, vessels targeting saithe in VIa may take by-catches of some of the species evaluated by either the WGNSDS, the WGDEEP or the WGHMM. Ideally, any mixed-fishery advice provided for the WGNSSK stocks should account for the stocks and fisheries evaluated by other relevant WGs. The group was not in a position to carry out this exercise, which lies beyond the scope of an area- and stock-specific group such as WGNSSK.

- The most up-to-date stock numbers at age for cod, haddock, whiting, saithe, plaice and sole were only made available the last day of the WG, so they could not be used in the final runs of MTAC. Stock predictions from WGNSSK02 were used instead as a first proxy. Besides, no stock numbers at age could be made available for *Nephrops*.

- The fisheries were defined on a rather *ad hoc* basis. Besides, the fishery definitions were sometimes different between countries. Given some outcomes of MTAC proved sensitive to the fisheries definition, the basis for defining fisheries should be further investigated, possibly along the lines suggested by ICES(2003).

There is scope for further testing and possibly developing the current mixed-fishery forecasts model. First, it was investigated the extent to which the outcomes of MTAC were sensitive to input parameters. No errors could be detected in the MTAC program. However, the group recommends MTAC be thoroughly examined by the ICES Methods WG, which is entitled to evaluate whether MTAC could be used as a tool to provide routine fishery-based advice. Second, a critical assumption underlying MTAC is that the fishery-, species- and age-dependent exploitation pattern used in the forecasts is estimated from the last years average. However, this assumption is likely to be violated in the case of shifts in fishing tactics, as a result of e.g. changes in management regulations. There are a number of on-going approaches aiming at modeling fishermen's adaptation to management changes, which could at a later stage be incorporated in the mixed-fisheries model. Nevertheless, MTAC is seen as a step further towards providing mixed-fisheries forecasts.

Within the current working group framework, stock assessments (including forecasts) are undertaken on a stock by stock basis with little consideration of fisheries and the linkage between the two. Using the North Sea demersal fisheries as an example, assessment working groups do not deal well with linkages between cod, haddock, whiting, plaice and *Nephrops* at various levels, such as the overall change in forecast fishing mortality on haddock, whiting, plaice and *Nephrops* that corresponds to a given percentage change in fishing mortality on cod. At a more detailed level, they cannot currently consider how such changes are distributed over different fisheries within the region. In this example it is not sufficient simply to argue that data need to be provided to the working groups in a fisheries-based format rather than a stock-based format. This is because *Nephrops* assessments and forecasts are undertaken in an entirely separate working group (WGNEPH) and currently it assesses functional units within the geographical domain of three ICES demersal assessment working groups (WGNSSK, WGNSDS, WGSSDS). ICES(2003) considered three separate solutions to this sort of problem:

- To maintain the current working group structure whilst improving interchanges between working groups

- To create a permanent ICES fishery-based forecast group, corresponding to the current STECF sub-group on resource status (SGRST)
- To restructure the current assessment working groups to accommodate more fully the fishery interactions. This could involve the assimilation of, for example, Nephrops assessments into the area-based demersal working groups including WGNSSK.

ICES groups that are currently considering the working practices and structure of the assessment and advisory process need to consider these points when considering the appropriate framework under which fishery-based forecasts are to be undertaken. WGNNSSK suggests that the first option is the easiest to implement in the short term.

To conclude, the group suggests that the approach presented here to develop fishery-based forecasts be considered by ACFM as a prototype tool. Due to the limitations identified above, the group suggests that it may be premature to use this approach for providing fishery-based advice in 2003. The WG considers that there is an urgent need for the ICES SGDFF to collate the appropriate data and for the Methods WG to evaluate the MTAC model.

Table 15.2.1.1. International catches(t) in ICES division IV for year 2002.

Catch(t)	species						
fleet	COD	HAD	NEP	PLE	POK	SOL	WHG
B___OTB________	229.9	17.1	0.0	96.3	77.7	26.9	126.7
B___Other______	302.0	21.1	0.0	182.3	1.5	43.7	268.9
B___TBB________	2002.0	1104.2	0.0	4285.3	27.4	1543.5	320.2
DK__GNS____<140	284.2	40.9	3.4	515.0	2.5	309.4	3.2
DK__GNS_140-200	3984.4	231.3	3.3	2827.7	204.7	173.3	4.5
DK__LL_________	325.0	235.9	0.0	0.7	18.4	1.6	0.0
DK__OTB_070-099	261.8	106.6	931.3	567.7	222.5	18.2	51.4
DK__OTB_100-109	85.3	140.7	91.6	968.6	38.8	5.7	14.2
DK__OTB_110-119	65.5	332.5	26.8	523.3	20.5	3.0	2.5
DK__OTB_120-___	2034.9	5871.7	813.4	1683.0	1834.8	10.4	103.8
DK__Other______	497.5	236.6	267.4	635.7	56.0	108.3	8.8
DK__SDN_070-099	0.4	0.2	1.1	2.6	0.0	0.0	35.0
DK__SDN_100-109	12.7	82.5	0.0	29.5	1.0	0.0	4.6
DK__SDN_110-119	79.6	712.0	0.0	1144.6	3.4	1.2	2.0
DK__SDN_120-___	1059.0	2012.8	0.0	1550.6	141.0	1.9	3.1
DK__TBB_100-___	91.6	54.9	0.0	1884.5	3.1	5.6	0.2
ENG_GNS________	147.6	35.6	0.0	10.1	0.1	68.8	54.0
ENG_GNS____<140	48.7	0.0	0.0	0.6	0.1	3.3	4.7
ENG_GNS_140-200	397.9	1.0	0.0	2.1	0.3	3.2	4.2
ENG_GNS_200-___	5.8	0.0	0.0	0.0	0.0	0.0	0.0
ENG_LL_________	224.8	52.5	0.0	0.1	0.3	0.6	17.1
ENG_OTB_070-099	163.5	690.7	1410.9	39.5	0.5	67.0	599.6
ENG_OTB_100-109	219.0	1362.2	287.0	330.3	4.5	7.4	755.1
ENG_OTB_110-119	281.3	2526.1	224.3	418.6	2039.2	1.4	1311.1
ENG_OTB_120-___	1257.4	2545.7	32.7	121.6	470.9	5.5	786.0
ENG_Other______	1.2	3.5	0.0	0.0	0.0	0.4	0.2
ENG_TBB_080-099	61.2	45.9	0.7	2316.9	0.0	142.2	25.6
ENG_TBB_100-___	244.3	172.2	0.7	5205.1	5.0	87.5	10.3
FR__GNS________	14.4	0.0	0.0	3.1	0.0	13.0	8.5
FR__GNS____<140	76.2	0.0	0.0	110.2	0.0	455.6	31.5
FR__GNS_140-200	53.8	0.0	0.0	41.4	0.0	5.5	16.1
FR__OTB_070-099	1088.0	12.6	0.0	174.5	0.0	24.6	6807.7
FR__OTB_100-109	48.7	35.0	0.0	3.6	696.1	0.1	70.3
FR__OTB_110-119	71.8	1755.7	0.0	0.0	23779.0	0.0	1008.4
FR__OTB_120-___	322.2	22.1	0.0	22.1	247.4	0.8	597.4
FR__TBB_080-099	11.1	0.0	0.0	123.7	0.0	59.7	25.9
FR__TBB_100-___	23.9	0.0	0.0	9.0	0.0	0.1	5.0
GER_GNS____<140	5.0	0.1	0.0	6.1	0.0	74.4	0.7
GER_GNS_140-200	12.7	0.1	0.0	0.9	0.0	1.0	0.0
GER_OTB_070-099	64.1	47.1	84.0	531.5	0.0	8.1	551.7
GER_OTB_100-109	102.5	213.1	8.8	1141.9	4401.8	2.8	81.1
GER_OTB_110-119	2.9	1.4	0.0	28.8	0.0	0.1	0.0
GER_OTB_120-___	746.2	738.2	0.3	111.4	6197.7	0.3	60.6
GER_SDN_070-099	1.1	0.3	0.0	33.6	0.0	0.0	52.5
GER_SDN_100-109	1.1	0.8	0.7	53.6	3.2	0.0	4.2
GER_SDN_120-___	903.8	500.6	0.0	26.3	331.0	0.0	4.5
GER_TBB_080-099	64.1	4.7	31.7	1642.8	0.0	633.8	113.3
GER_TBB_100-___	27.2	32.0	0.1	358.3	0.5	41.0	8.2

Table 15.2.1.1. (cont'd) International catches(t) in ICES division IV for year 2002.

Catch(t)	species						
fleet	COD	HAD	NEP	PLE	POK	SOL	WHG
N___GNS________	1876.4	996.3	1.7	17.7	5910.2	0.0	8.0
N___LL_________	1310.4	1285.2	0.1	6.7	427.0	0.0	1.8
N___OTB________	919.1	1408.7	92.7	1015.3	45806.7	0.5	55.4
N___Other______	38.6	1.3	17.3	0.1	6079.0	0.0	0.0
N___SDN________	226.7	502.2	0.0	49.3	54.1	0.0	11.9
N___TBB________	23.8	10.3	1.8	891.5	0.4	49.2	5.5
NL__OTB________	23.9	8.8	3.4	7.2	0.2	1.1	24.5
NL__OTB_070-099	219.6	16.2	406.6	506.1	0.0	12.8	1740.2
NL__OTB_100-109	72.9	31.5	6.4	153.4	0.2	0.9	234.5
NL__OTB_110-119	2.3	0.0	0.0	0.0	0.0	0.0	2.7
NL__OTB_120-___	1837.4	250.0	0.1	45.5	3.4	1.3	1145.1
NL__Other______	183.1	58.2	47.5	61.6	1.6	57.5	148.4
NL__TBB________	26.3	5.7	4.7	136.8	0.0	34.4	29.9
NL__TBB_080-099	2196.8	337.4	494.5	26814.0	0.0	11949.2	3226.6
NL__TBB_100-___	64.3	32.3	1.1	1091.3	0.2	26.4	16.4
SCO_OTB_070-099	453.4	1924.2	4625.8	57.2	102.7	0.1	1356.8
SCO_OTB_100-109	131.3	445.1	944.8	234.6	24.2	1.3	309.8
SCO_OTB_110-119	5356.2	25920.0	1047.1	363.3	2435.9	0.1	6621.1
SCO_OTB_120-___	5356.2	25920.0	1047.1	363.3	2435.9	0.1	6621.1
SCO_Other______	542.6	2176.9	957.8	35.9	156.5	0.0	822.2
SCO_SDN_110-119	1263.5	10425.1	5.3	113.2	364.5	0.0	2029.9
SCO_SDN_120-___	1263.5	10425.1	5.3	113.2	364.5	0.0	2029.9
SCO_TBB________	3.9	2.3	0.0	29.9	0.0	4.1	3.2
SCO_TBB_080-099	75.9	66.6	0.1	2845.5	0.0	160.5	66.0
SCO_TBB_100-___	75.6	70.7	2.5	3349.2	0.4	48.8	12.0
SWE_OTB_070-099	1.9	0.1	0.3	0.0	3.2	0.0	0.1
SWE_OTB_100-109	1.3	7.8	0.0	0.0	1.4	0.0	0.0
SWE_OTB_110-119	0.9	0.2	0.0	0.0	5.2	0.0	0.0
SWE_OTB_120-___	394.3	866.7	12.1	2.1	1324.5	0.0	8.5
TOTAL	**41951**	**105195**	**13946**	**68069**	**106333**	**16309**	**40496**

Table 15.3.1.1. Target F multiplier for the sensitivity analysis of MTAC

species	16 TARGET F MULTIPLIER
COD	0.0
HAD	0.60
PLE	0.60
POK	1.0
SOL	0.77
WHG	0.60

Table 15.3.2.1. Fleet code and name

F001 B___OTB________
F002 B___Other______
F003 B___TBB________
F004 DK__GNS____<140
F005 DK__GNS_140-200
F006 DK__LL_________
F007 DK__OTB_070-099
F008 DK__OTB_100-109
F009 DK__OTB_110-119
F010 DK__OTB_120-___
F011 DK__Other______
F012 DK__SDN_070-099
F013 DK__SDN_100-109
F014 DK__SDN_110-119
F015 DK__SDN_120-___
F016 DK__TBB_100-___
F017 ENG_GNS________
F018 ENG_GNS____<140
F019 ENG_GNS_140-200
F020 ENG_GNS_200-___
F021 ENG_LL_________
F022 ENG_OTB_070-099
F023 ENG_OTB_100-109
F024 ENG_OTB_110-119
F025 ENG_OTB_120-___
F026 ENG_Other______
F027 ENG_TBB_080-099
F028 ENG_TBB_100-___
F029 FR__GNS________
F030 FR__GNS____<140
F031 FR__GNS_140-200
F032 FR__OTB_070-099
F033 FR__OTB_100-109
F034 FR__OTB_110-119
F035 FR__OTB_120-___
F036 FR__TBB_080-099
F037 FR__TBB_100-___
F038 GER_GNS____<140
F039 GER_GNS_140-200
F040 GER_OTB_070-099
F041 GER_OTB_100-109
F042 GER_OTB_110-119
F043 GER_OTB_120-___
F044 GER_SDN_070-099
F045 GER_SDN_100-109
F046 GER_SDN_120-___
F047 GER_TBB_080-099
F048 GER_TBB_100-___
F049 N___GNS________
F050 N___LL_________
F051 N___OTB________
F052 N___Other______
F053 N___SDN________
F054 N___TBB________
F055 NL__OTB________
F056 NL__OTB_070-099
F057 NL__OTB_100-109
F058 NL__OTB_110-119
F059 NL__OTB_120-___
F060 NL__Other______
F061 NL__TBB________
F062 NL__TBB_080-099
F063 NL__TBB_100-___
F064 SCO_OTB_070-099
F065 SCO_OTB_100-109
F066 SCO_OTB_110-119
F067 SCO_OTB_120-___
F068 SCO_Other______
F069 SCO_SDN_110-119
F070 SCO_SDN_120-___
F071 SCO_TBB________
F072 SCO_TBB_080-099
F073 SCO_TBB_100-___
F074 SWE_OTB_070-099
F075 SWE_OTB_100-109
F076 SWE_OTB_110-119
F077 SWE_OTB_120-___

Table 15.3.2.2. Scenario setup for the MTAC runs

Species	F multiplier	Decision weight (relative numbers)
Cod	0	0-50
Haddock	1	1
Whiting	1	1
Saithe	1	1
Plaice	1	1
Sole	1	1
Nephrops	1	0

Figure 15.2.1.1. International catches(t) in area IV by country and by species for year 2002.

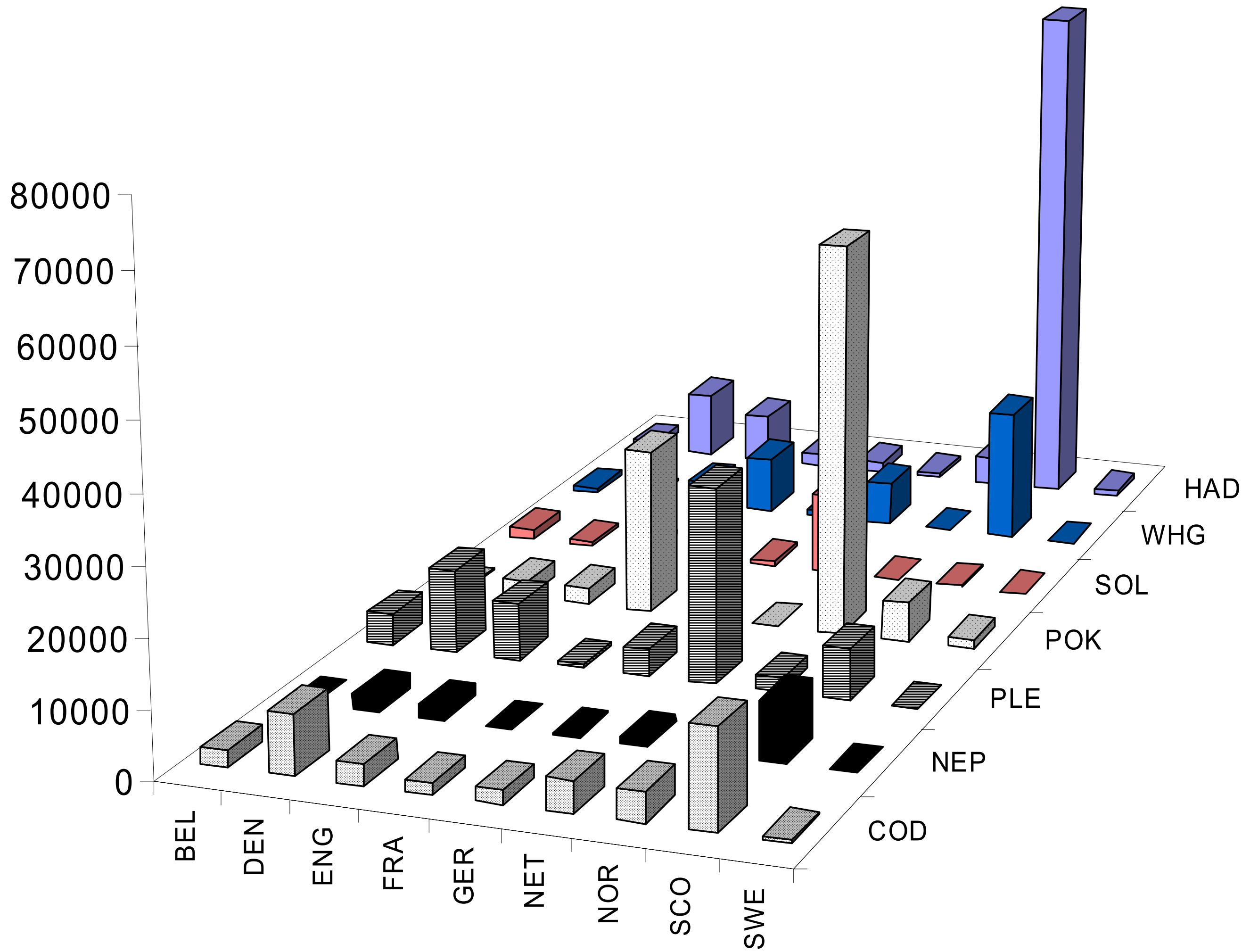


Figure 15.2.1.2. International catches(t) in area IV by species and by fishing gear for year 2002.

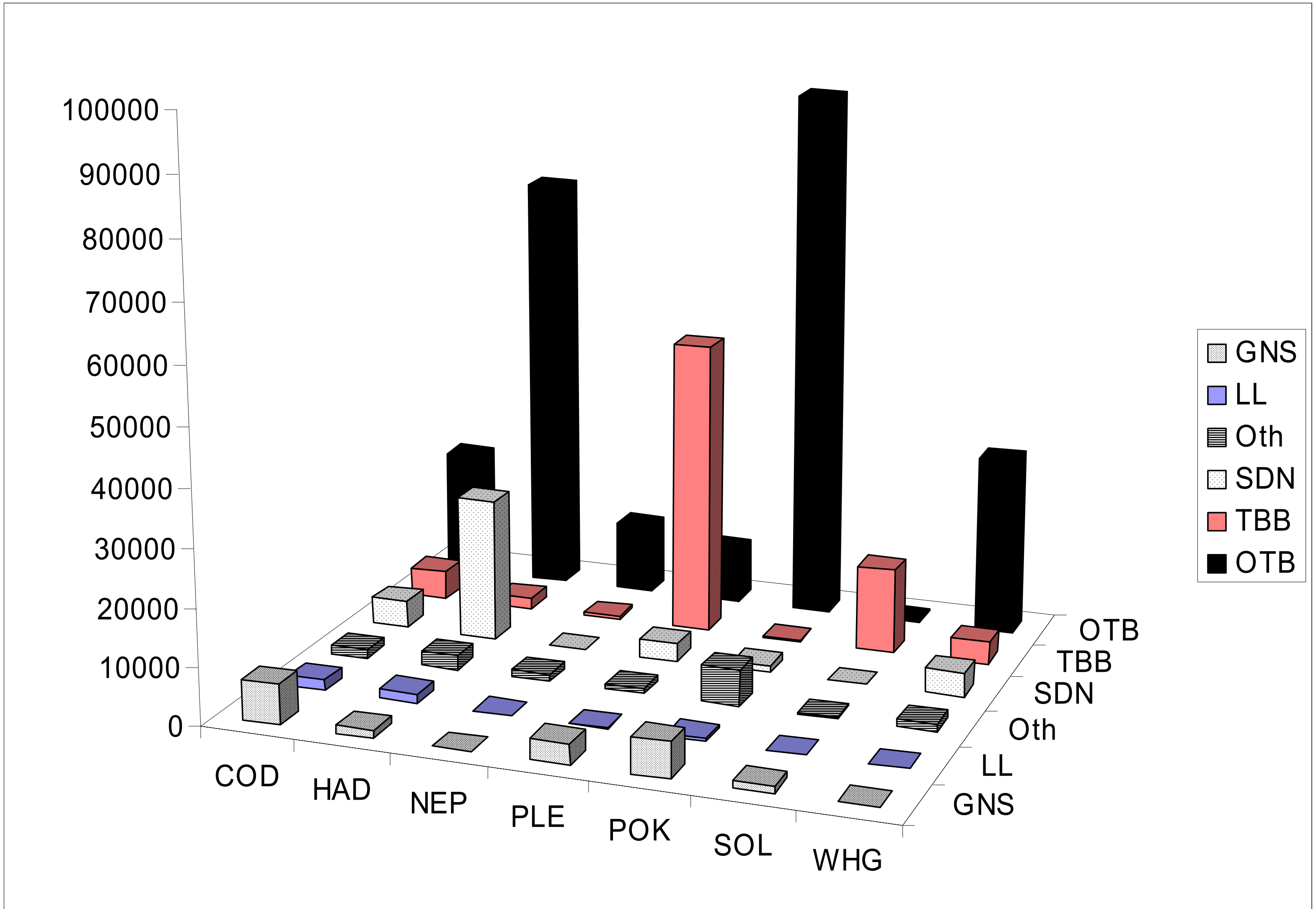


Figure 15.2.1.3. International catches(t) at age in area IV by species and by country for year 2002.

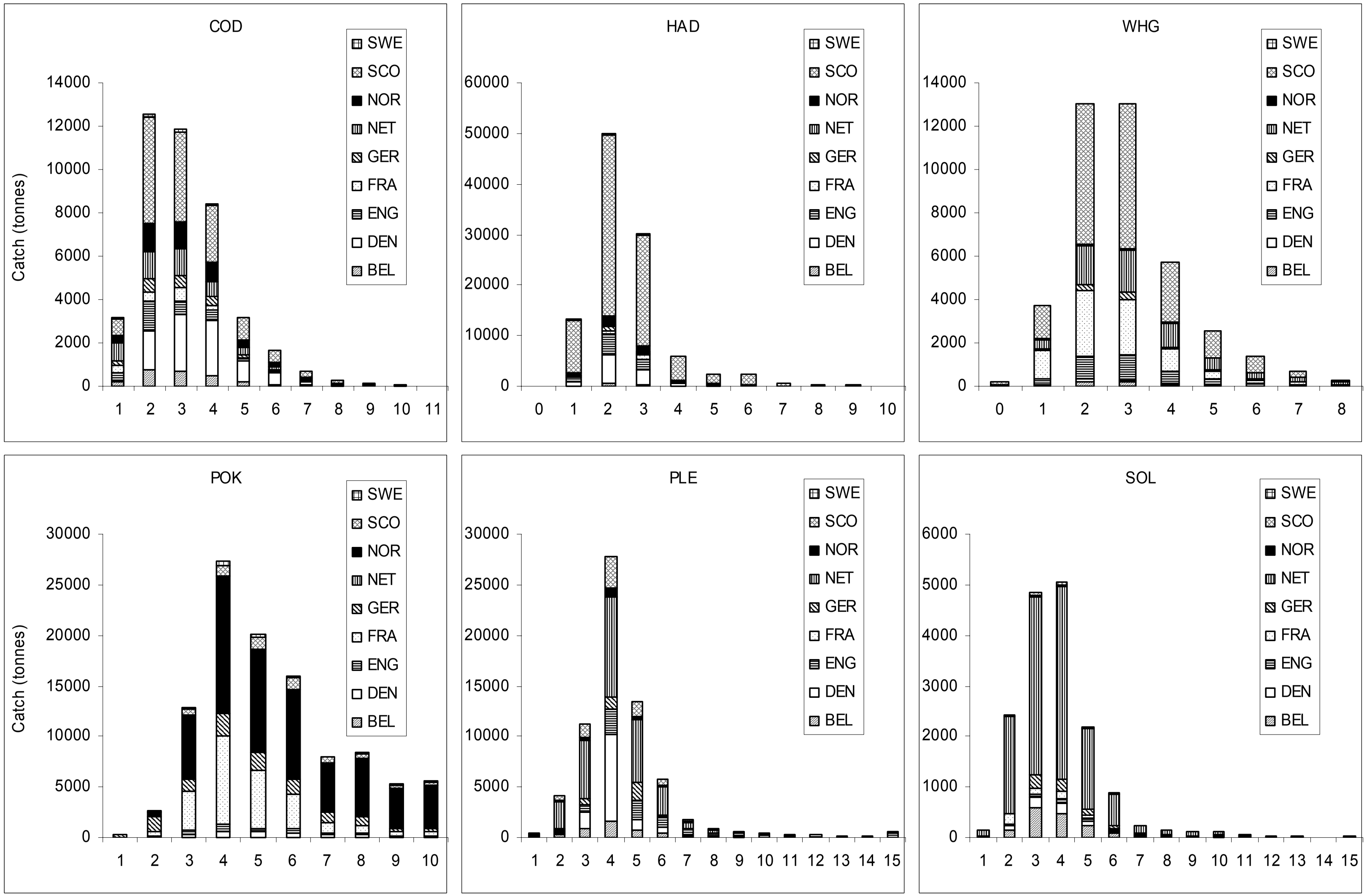


Figure 15.3.1.1. Catch weight by species and fleet used to test MTAC

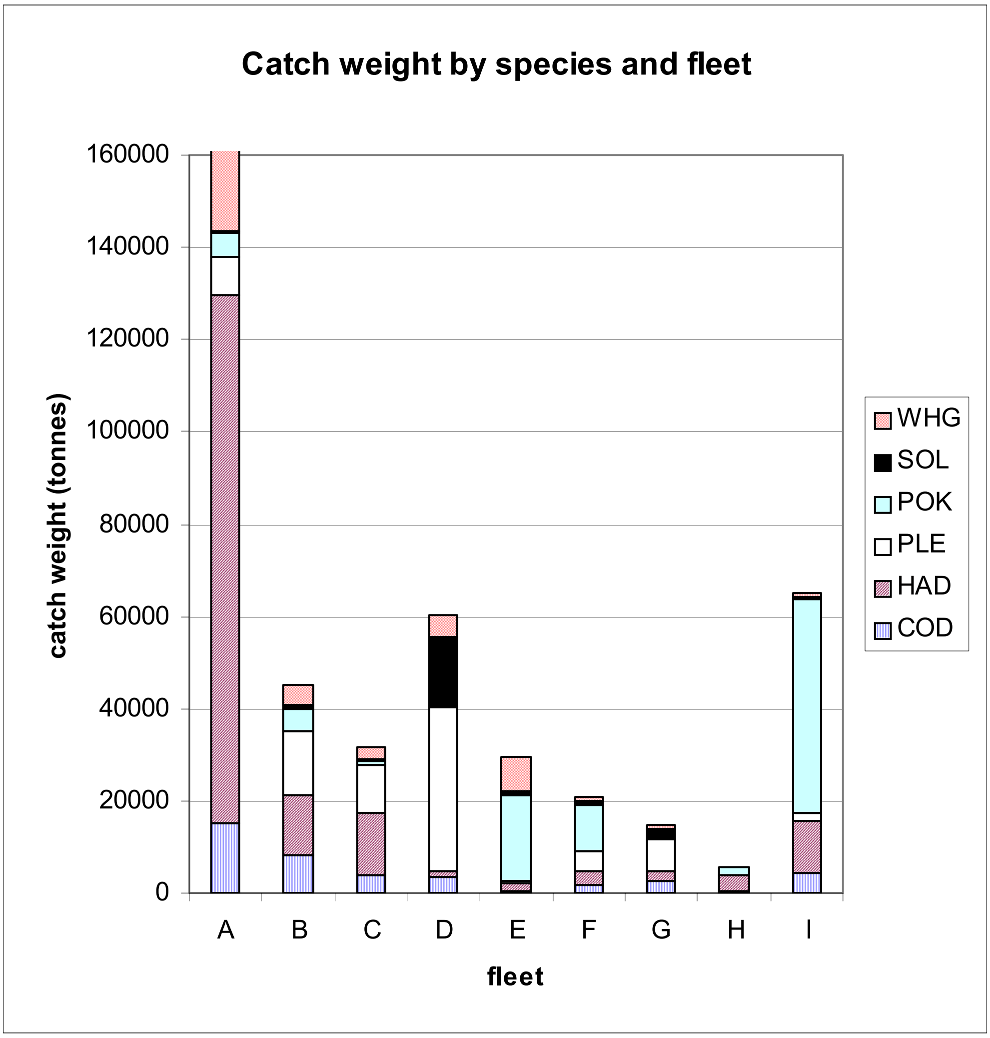


Figure 15.3.1.2. Catch weight by species used to test MTAC

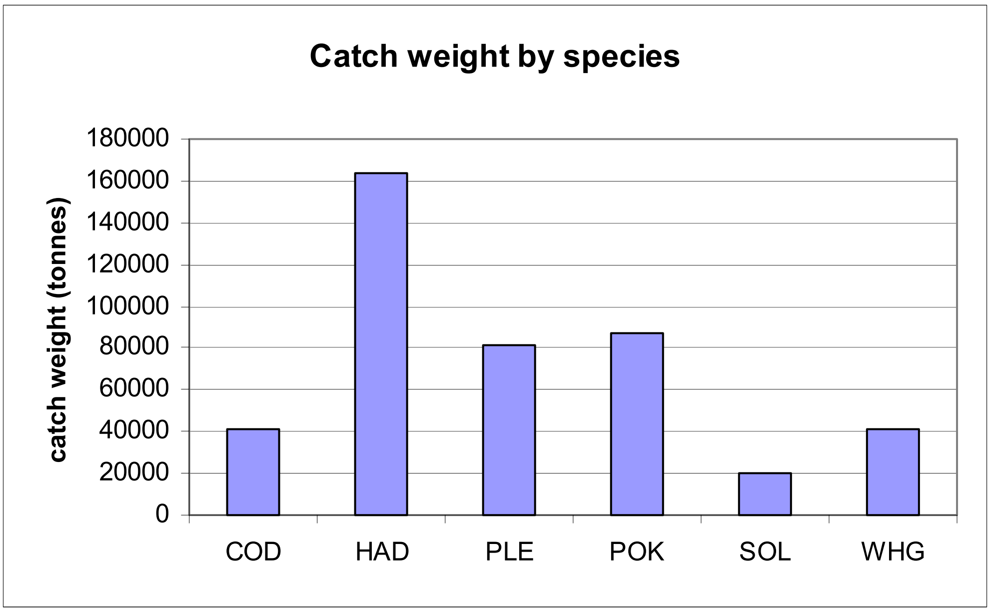


Figure 15.3.1.3. Catch percentages of species by fleet used to test MTAC

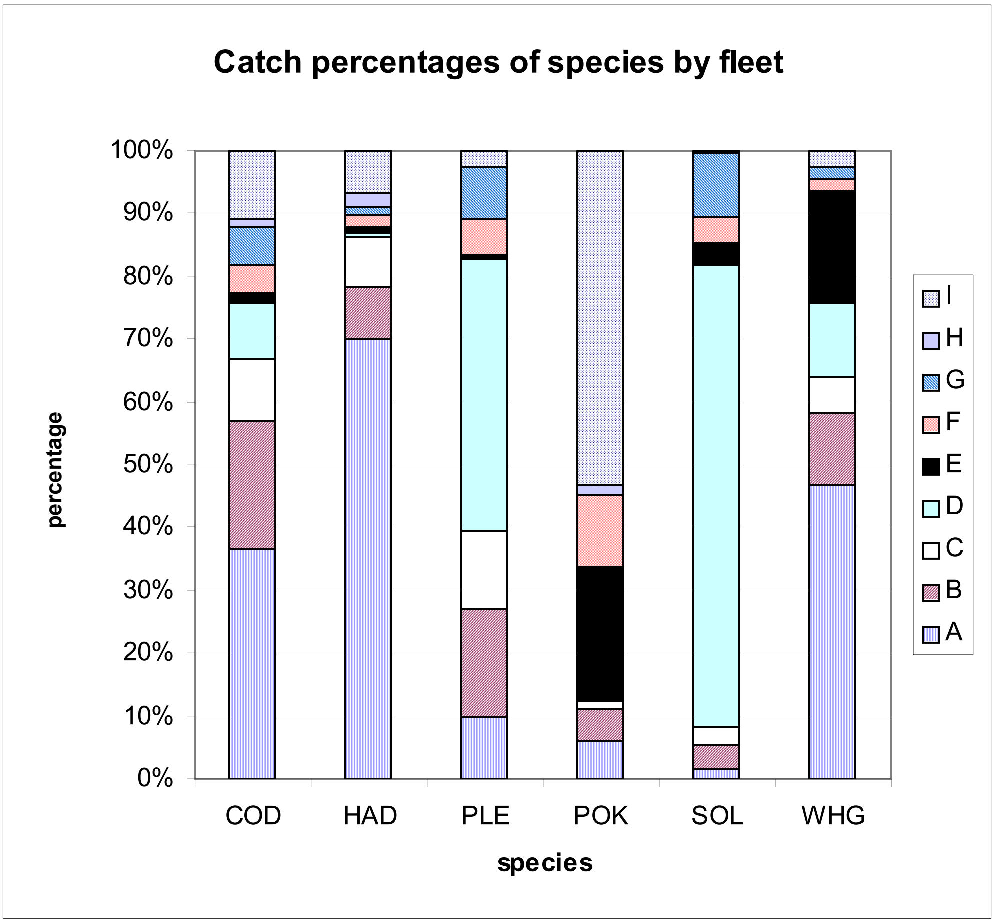


Figure 15.3.1.4. Catch percentages of species within fleet used to test MTAC

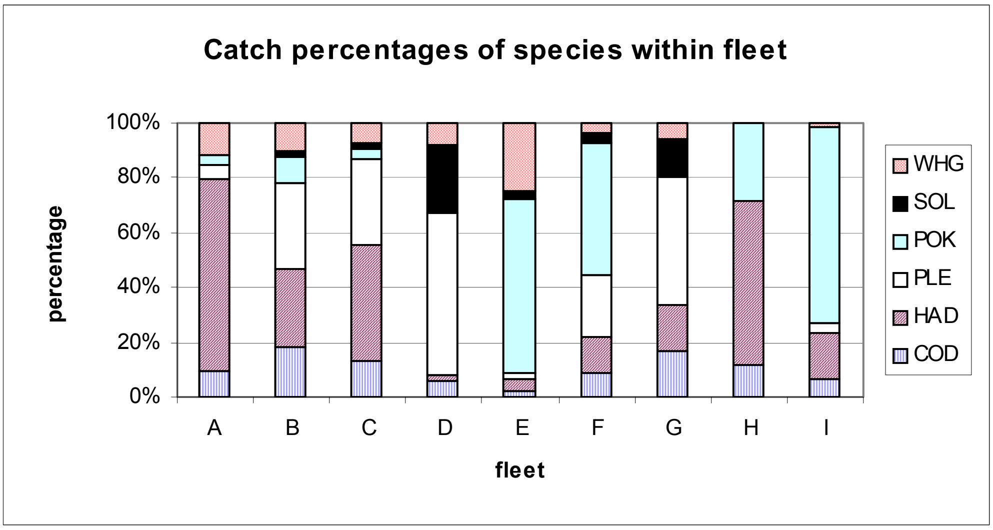


Figure 15.3.1.5. Sensitivity analysis of MTAC. Run 1: the species-specific fleet effort reduction is equal for all fleets (p = 0); the fleet target factor is switched off (q = 0); decision weights vary.

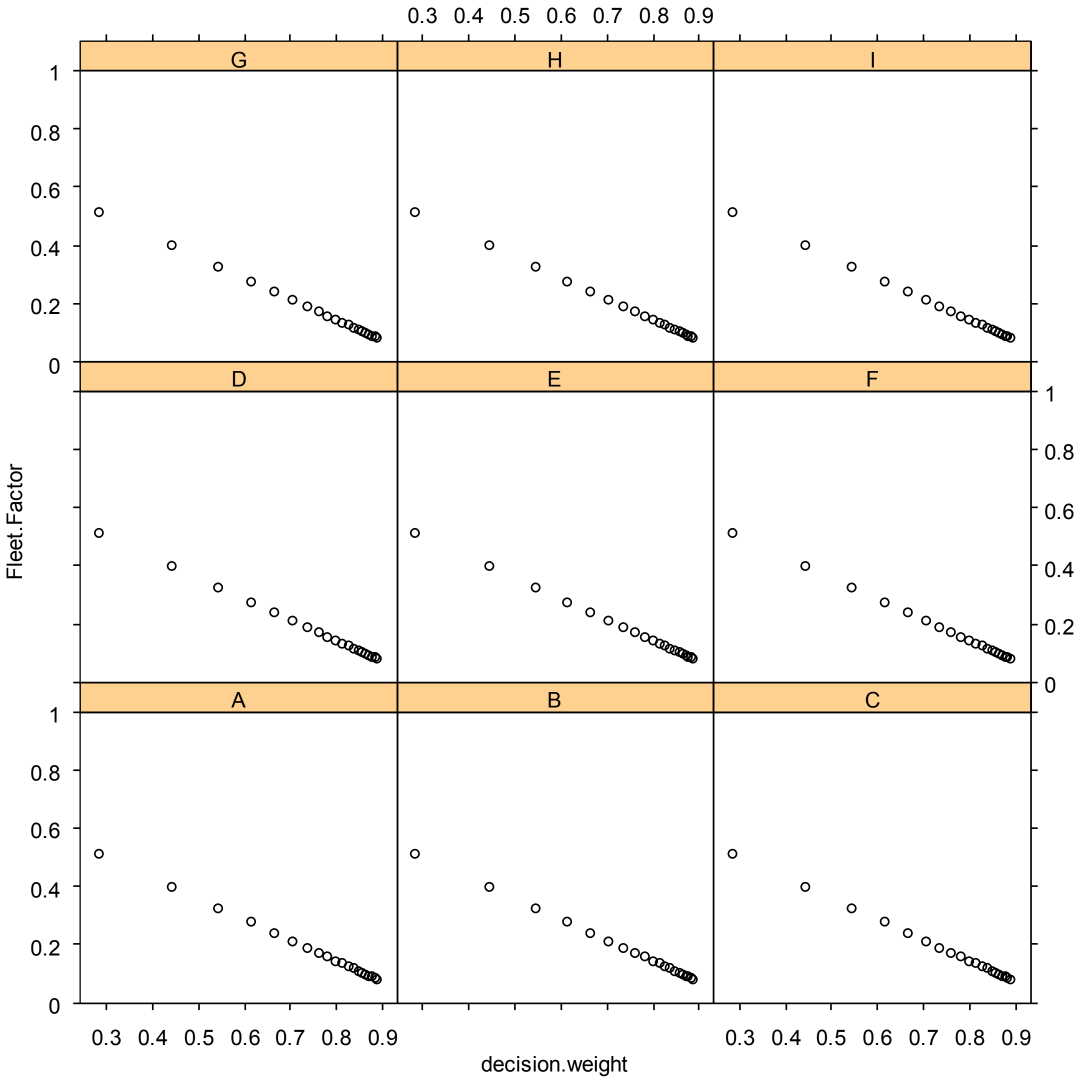


Figure 15.3.1.6. Sensitivity analysis of MTAC. Run 2: the species-specific fleet effort reduction is equal for all fleets (p = 0); the fleet target factor is switched on (q = 1); decision weights vary.

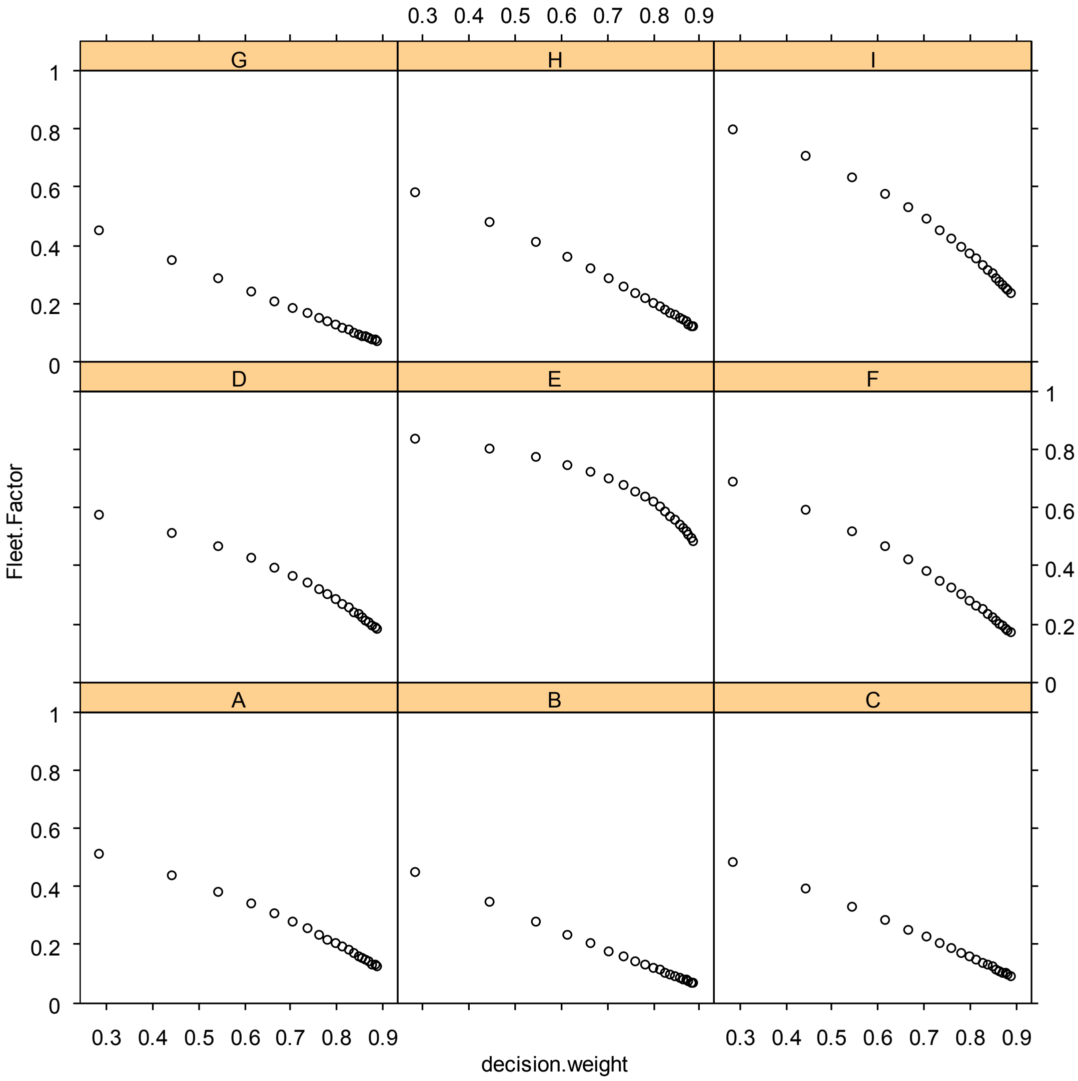


Figure 15.3.1.7. Sensitivity analysis of MTAC. Run 3: the species-specific fleet effort reduction is in proportion to the catch of the species within the catch of the fleet (p = 1); the fleet target factor is switched off (q = 0); decision weights vary.

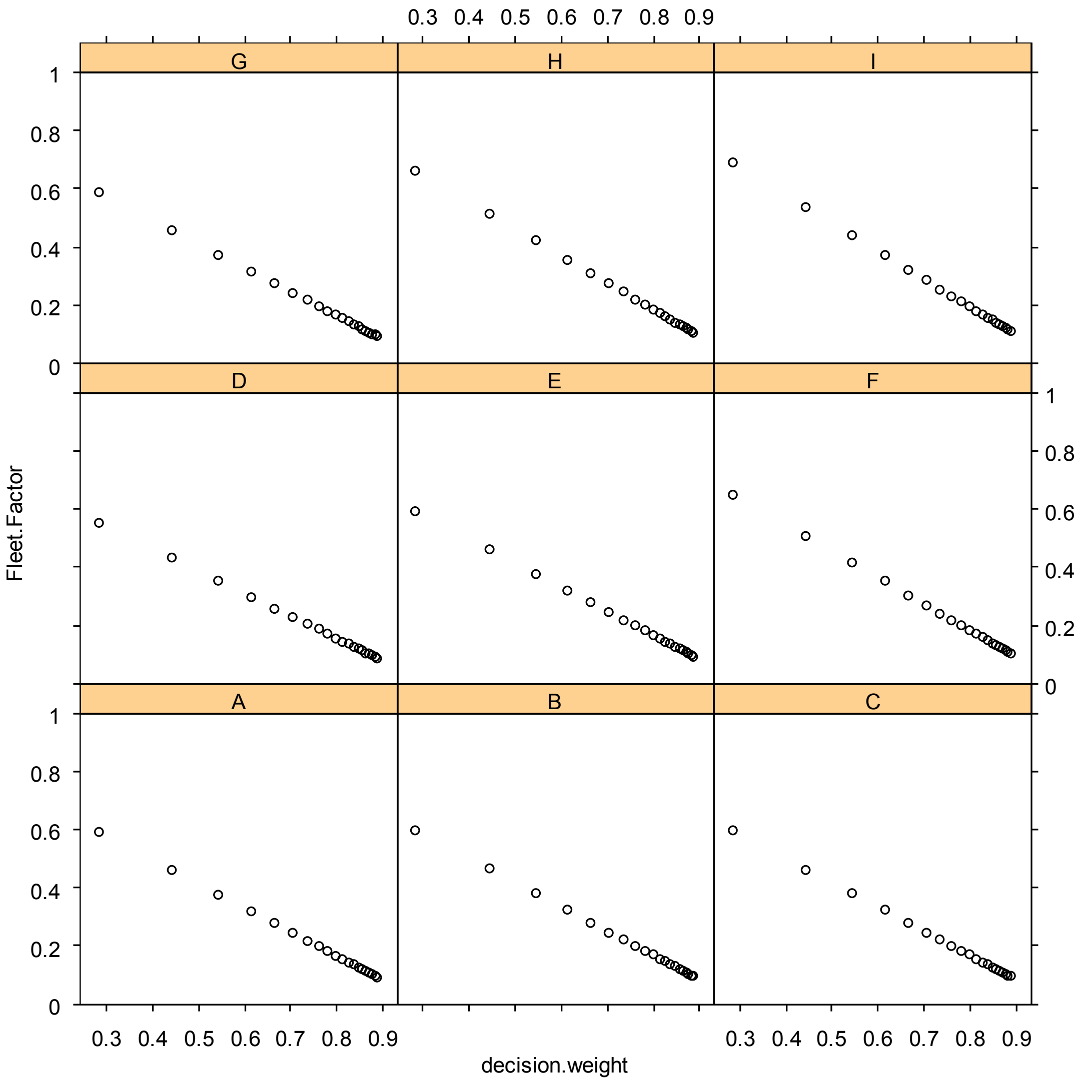


Figure 15.3.1.8. Sensitivity analysis of MTAC. Run 4: the species-specific fleet effort reduction is in proportion to the catch of the species within the catch of the fleet (p = 1); the fleet target factor is switched on (q = 1); decision weights vary.

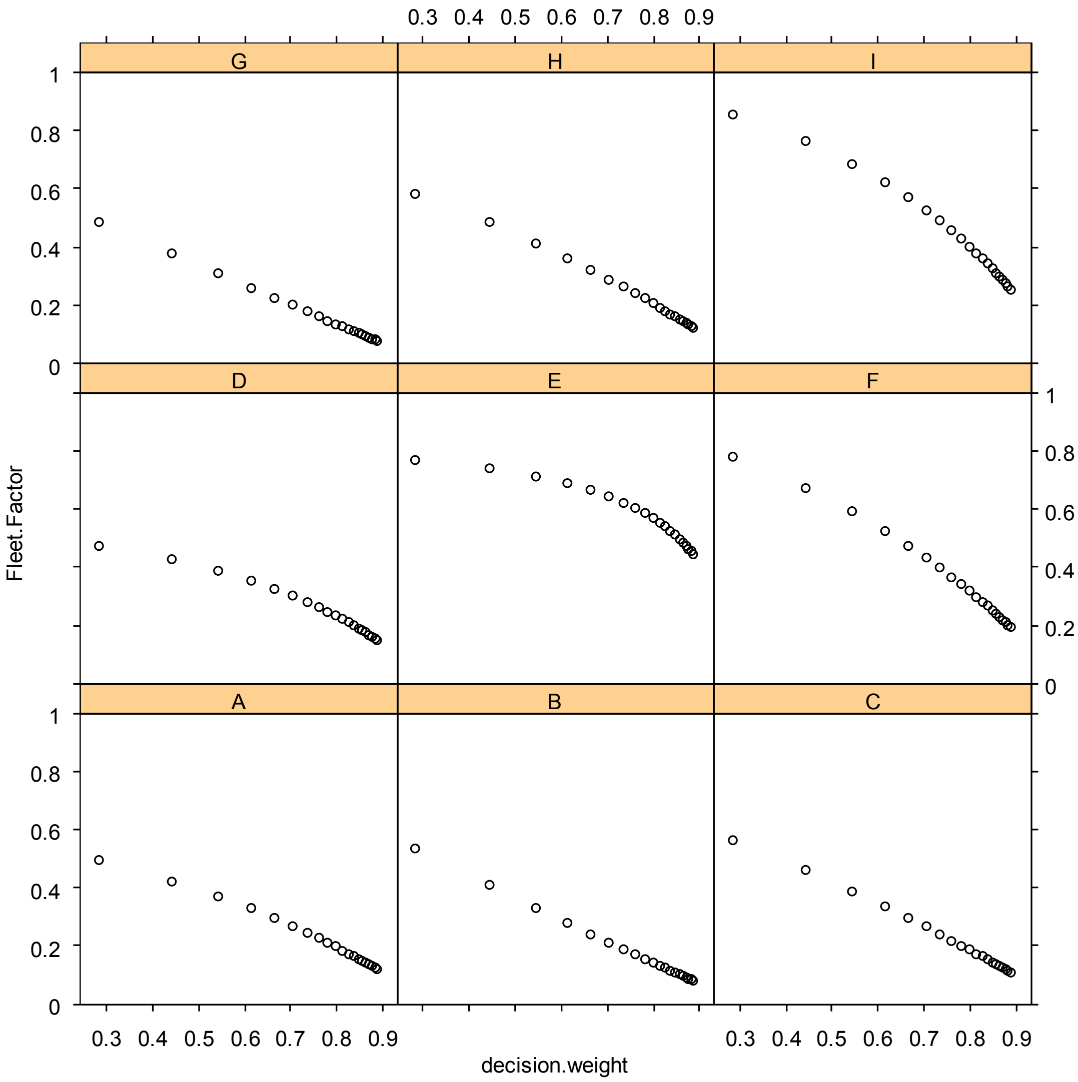


Figure 15.3.1.9. Sensitivity analysis of MTAC. Run 5: the species-specific fleet effort reduction is in proportion to the catch of the species by the fleet of the total catch of that species (p = 2); the fleet target factor is switched off (q = 0); decision weights vary.

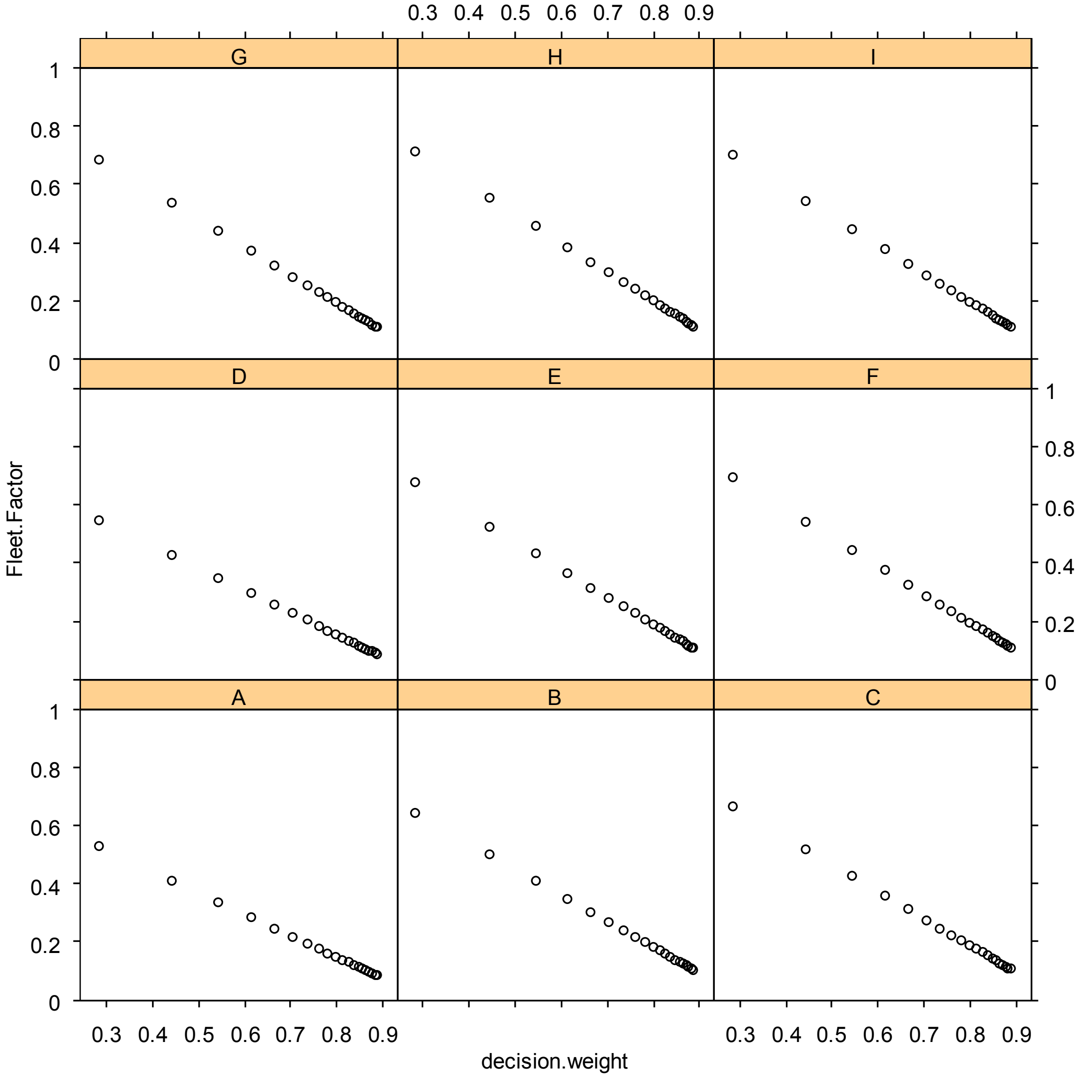


Figure 15.3.1.10. Sensitivity analysis of MTAC. Run 6: the species-specific fleet effort reduction is in proportion to the catch of the species by the fleet of the total catch of that species (p = 2); the fleet target factor is switched on (q = 1); decision weights vary.

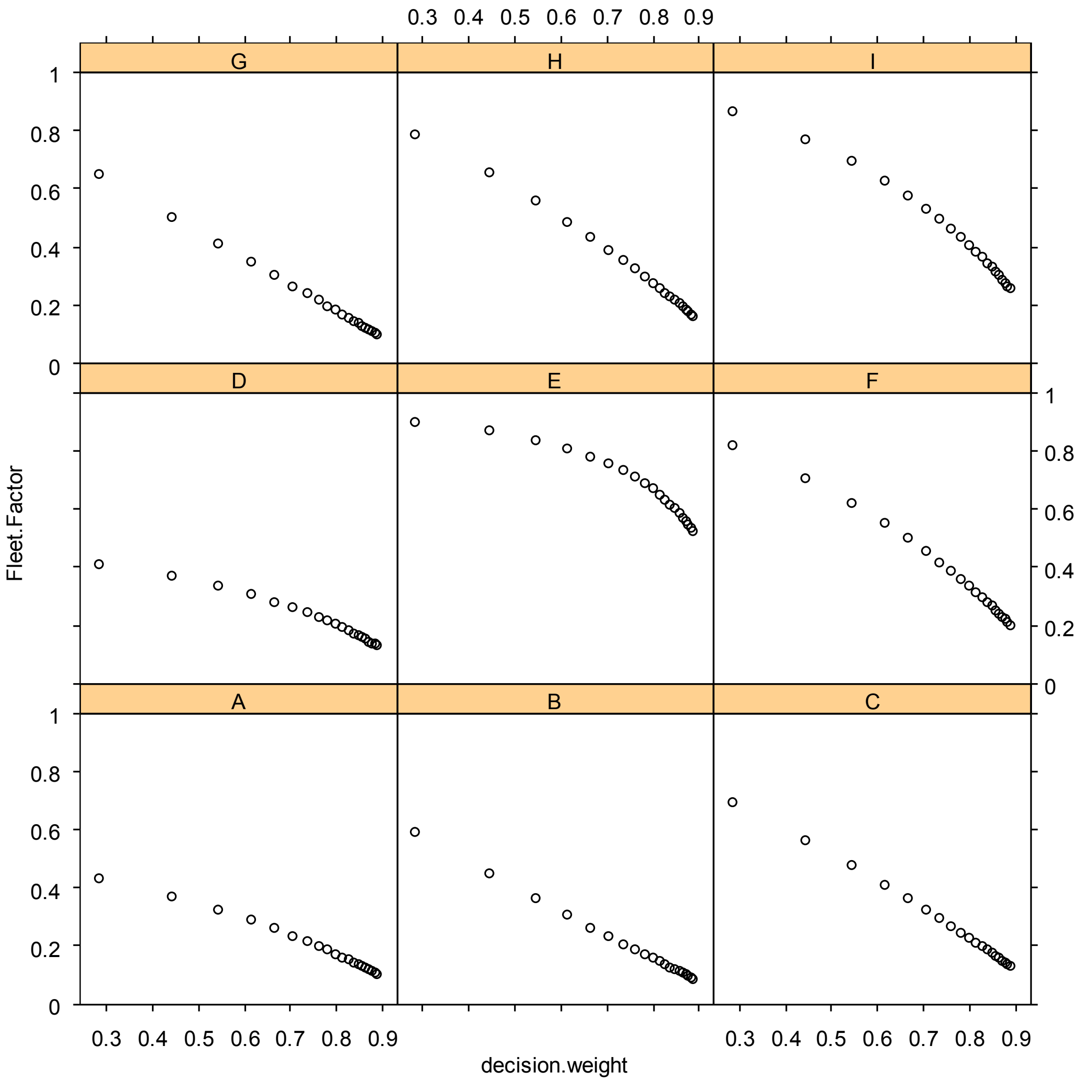


Figure 15.3.1.11. Sensitivity analysis of MTAC. Run 7: the species-specific fleet effort reduction is equal for all fleets (p = 0); the fleet target factor is switched off (q = 0); F multiplier for cod varies.

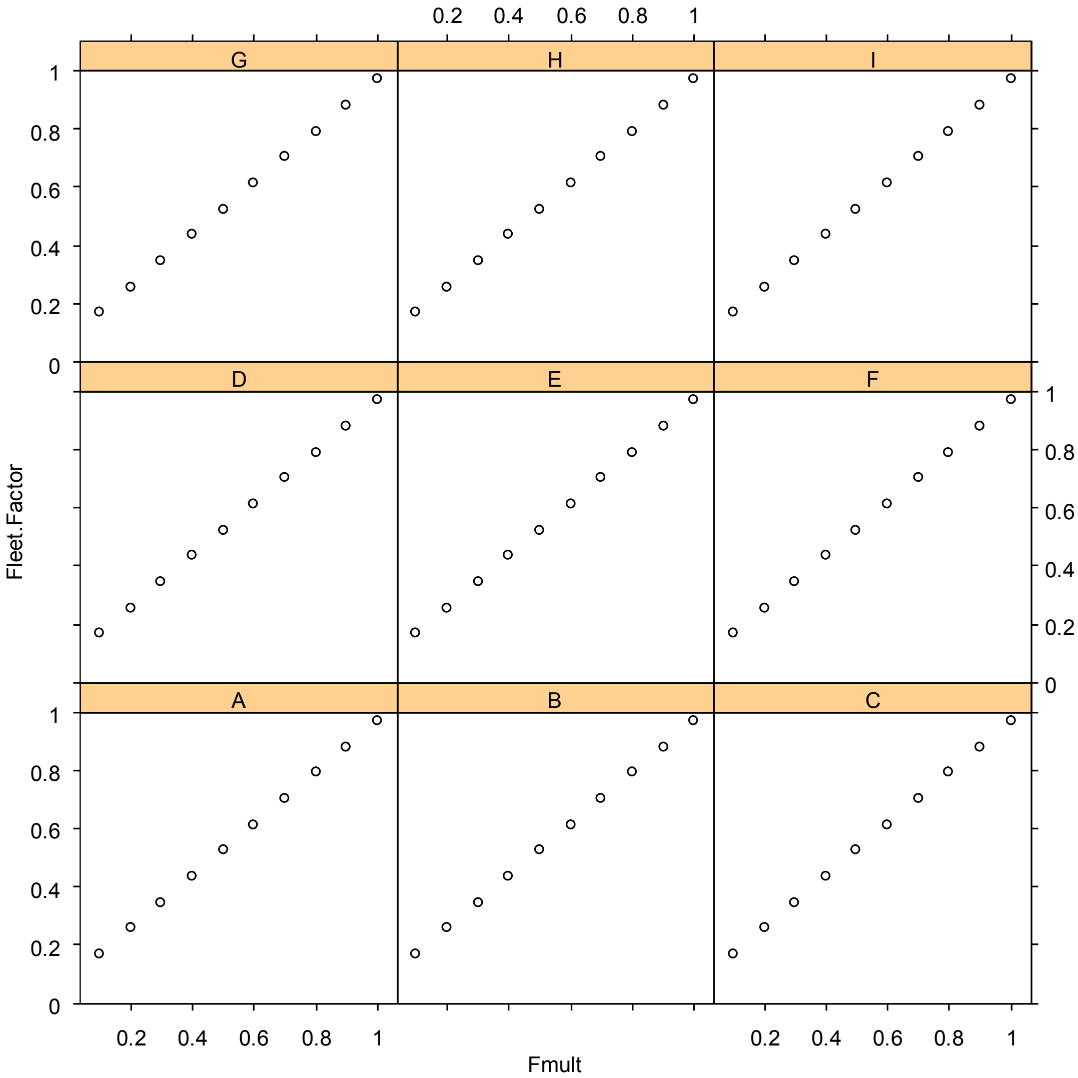


Figure 15.3.1.12. Sensitivity analysis of MTAC. Run 8: the species-specific fleet effort reduction is equal for all fleets (p = 0); the fleet target factor is switched on (q = 1); F multiplier for cod varies.

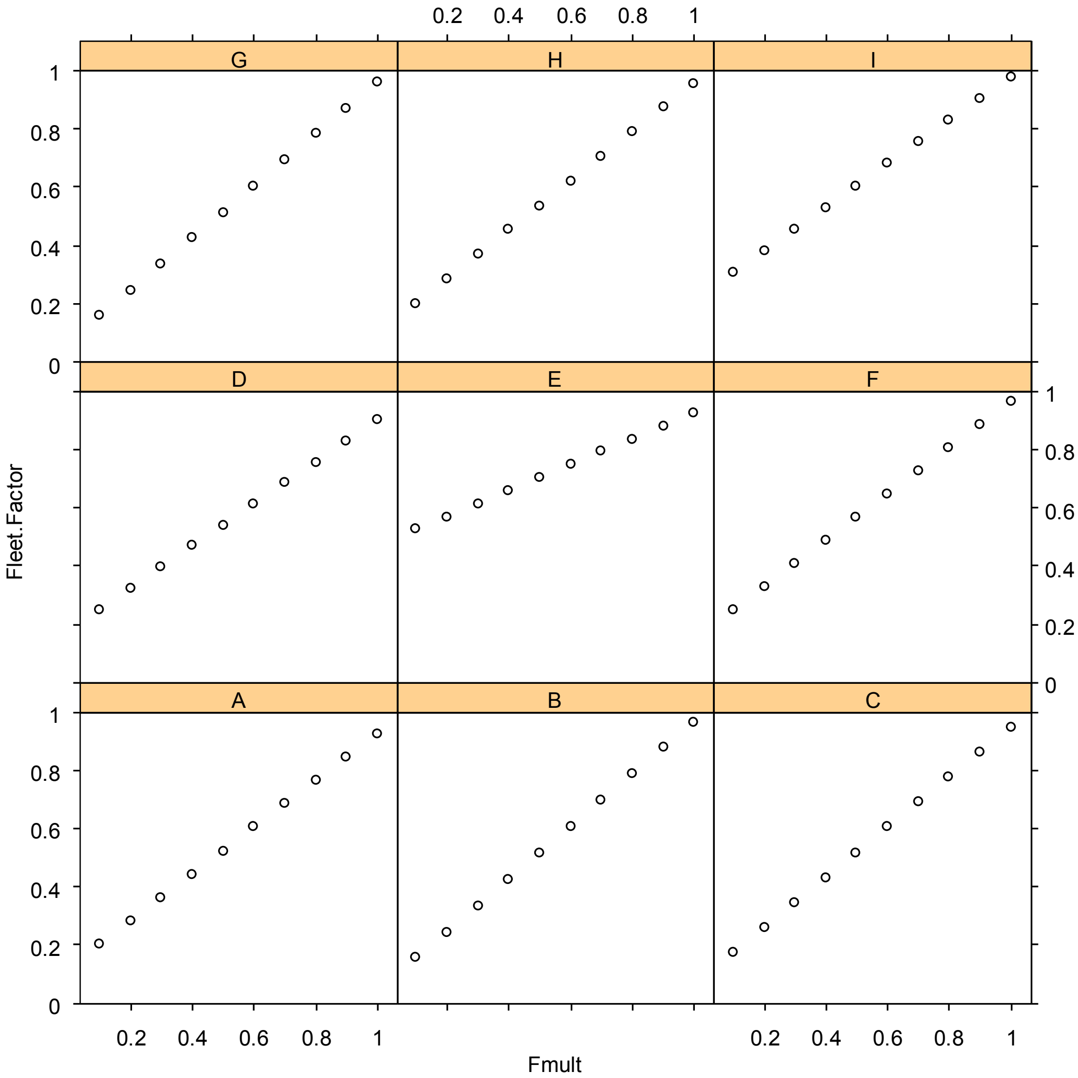


Figure 15.3.1.13. Sensitivity analysis of MTAC. Run 9: the species-specific fleet effort reduction is in proportion to the catch of the species within the catch of the fleet (p = 1); the fleet target factor is switched off (q = 0); F multiplier for cod varies

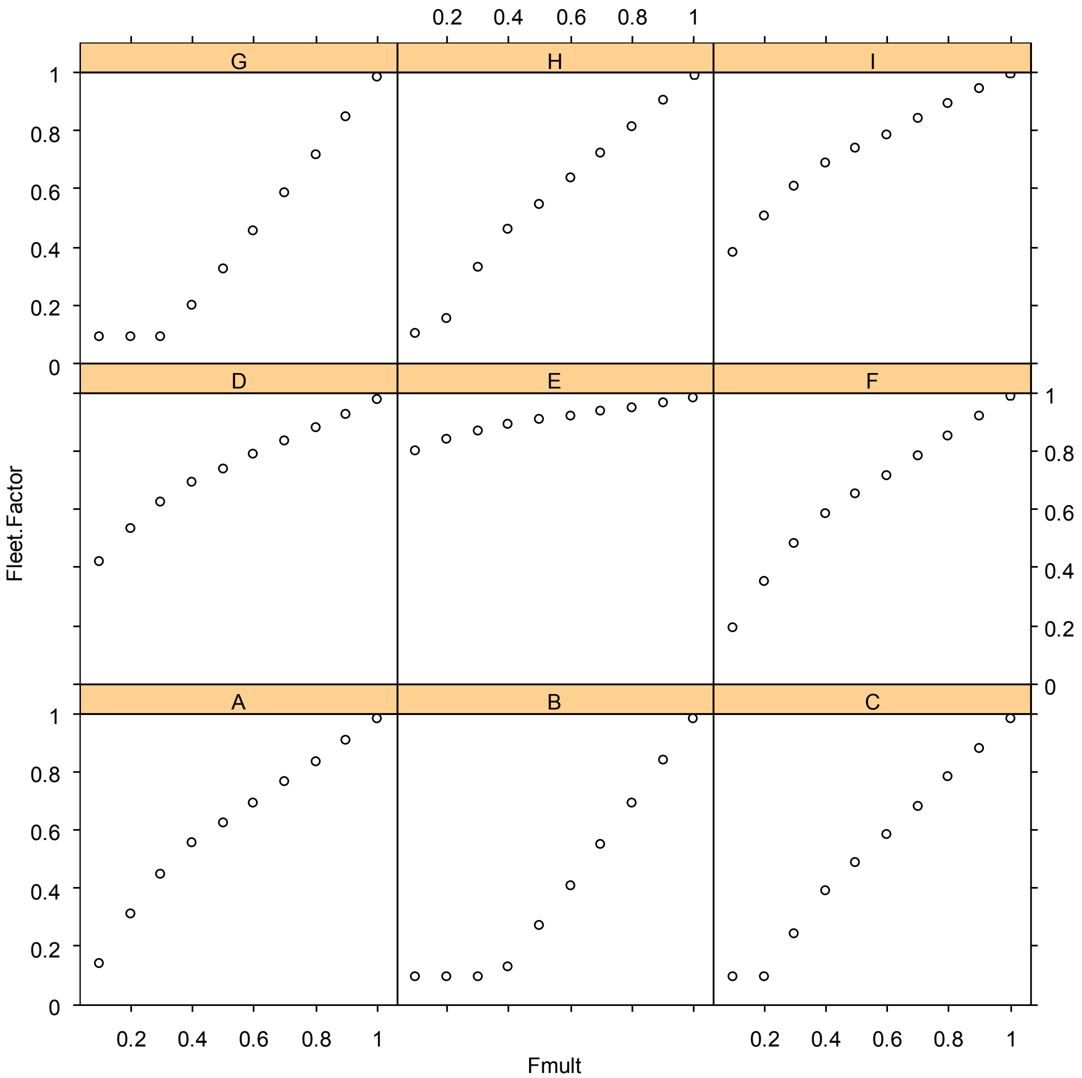


Figure 15.3.1.14. Sensitivity analysis of MTAC. Run 10: the species-specific fleet effort reduction is in proportion to the catch of the species within the catch of the fleet (p = 1); the fleet target factor is switched on (q = 1); F multiplier for cod varies.

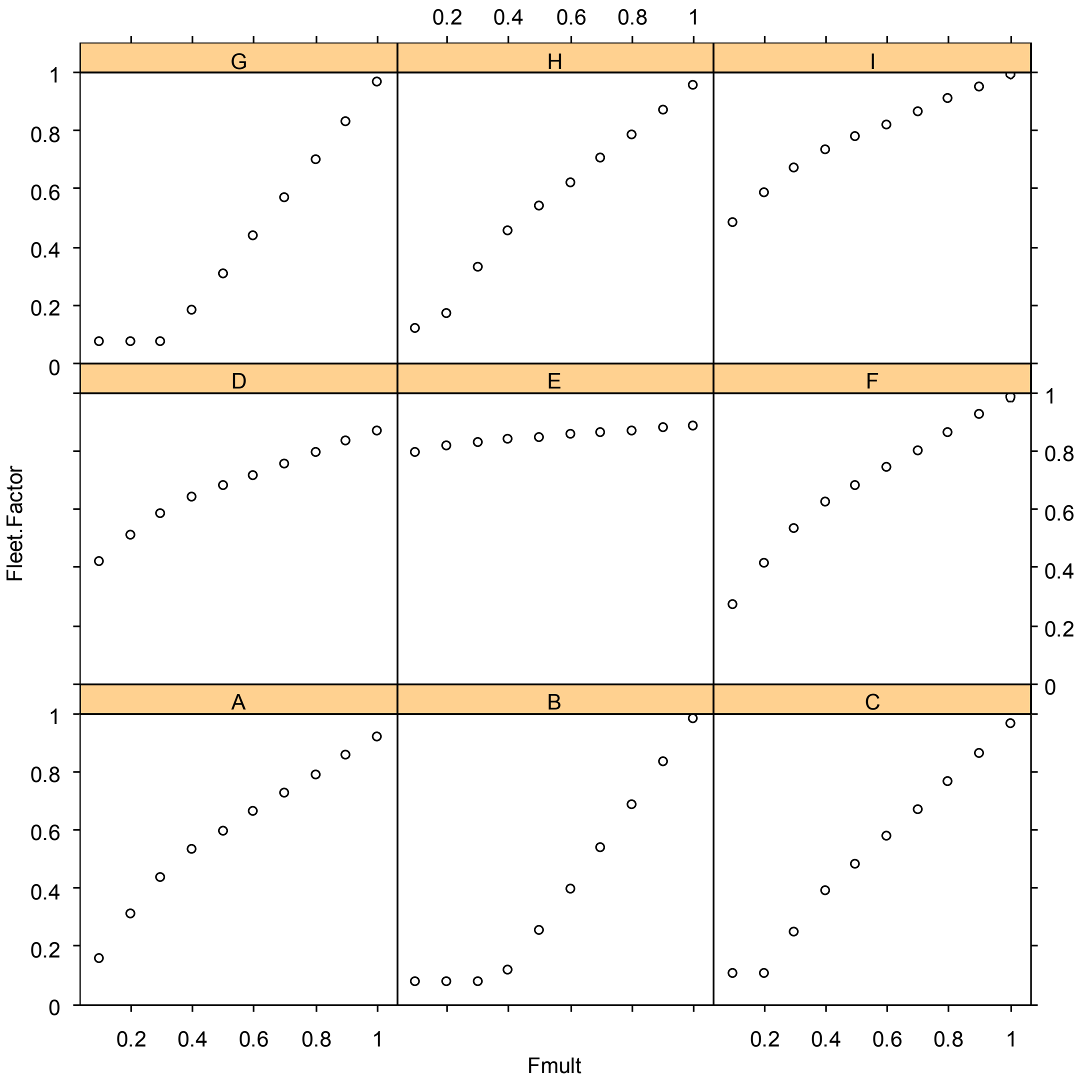


Figure 15.3.1.15. Sensitivity analysis of MTAC. Run 11: the species-specific fleet effort reduction is in proportion to the catch of the species by the fleet of the total catch of that species (p = 2); the fleet target factor is switched off (q = 0); F multiplier for cod varies.

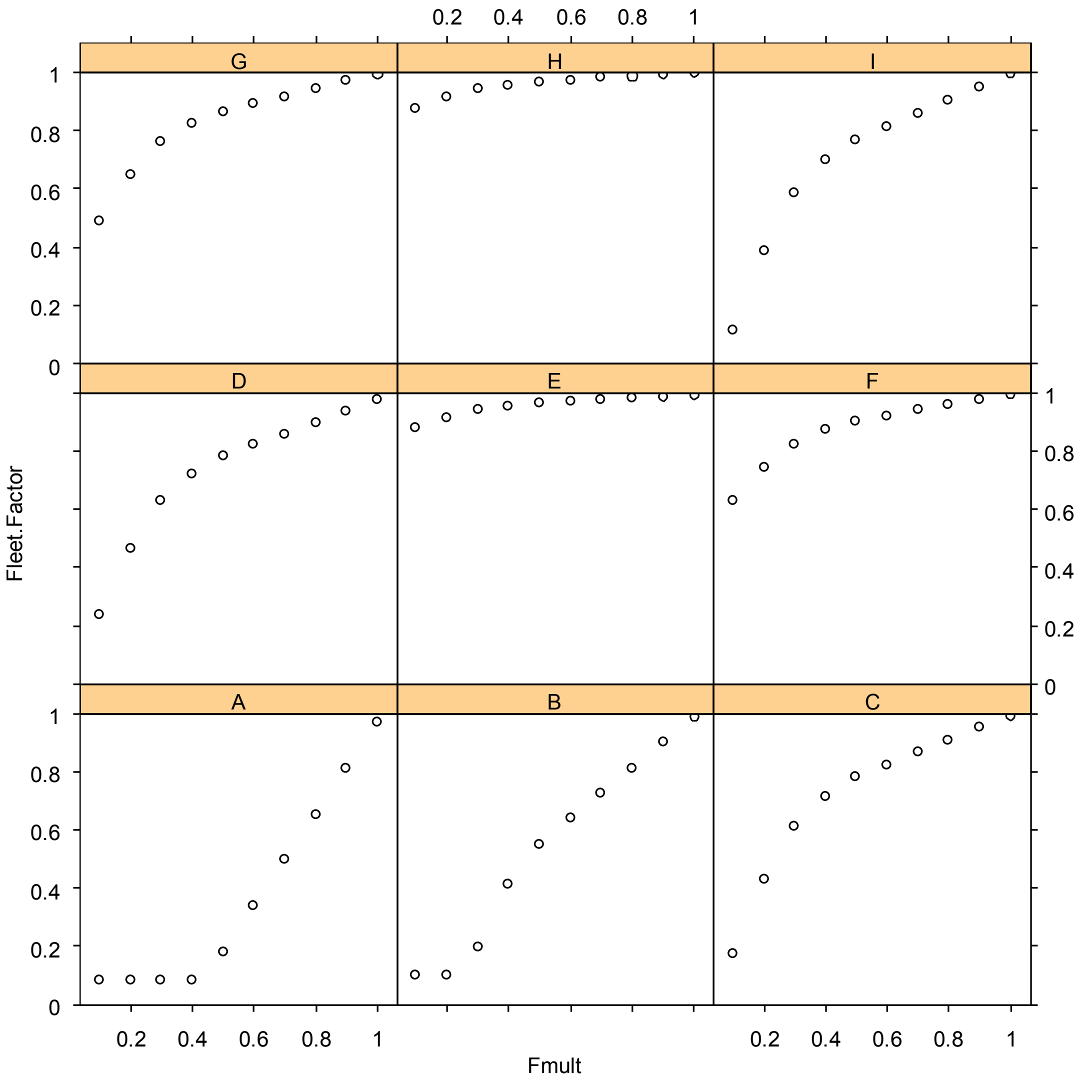


Figure 15.3.1.16. Sensitivity analysis of MTAC. Run 12: the species-specific fleet effort reduction is in proportion to the catch of the species by the fleet of the total catch of that species (p = 2); the fleet target factor is switched on (q = 1); F multiplier for cod varies.

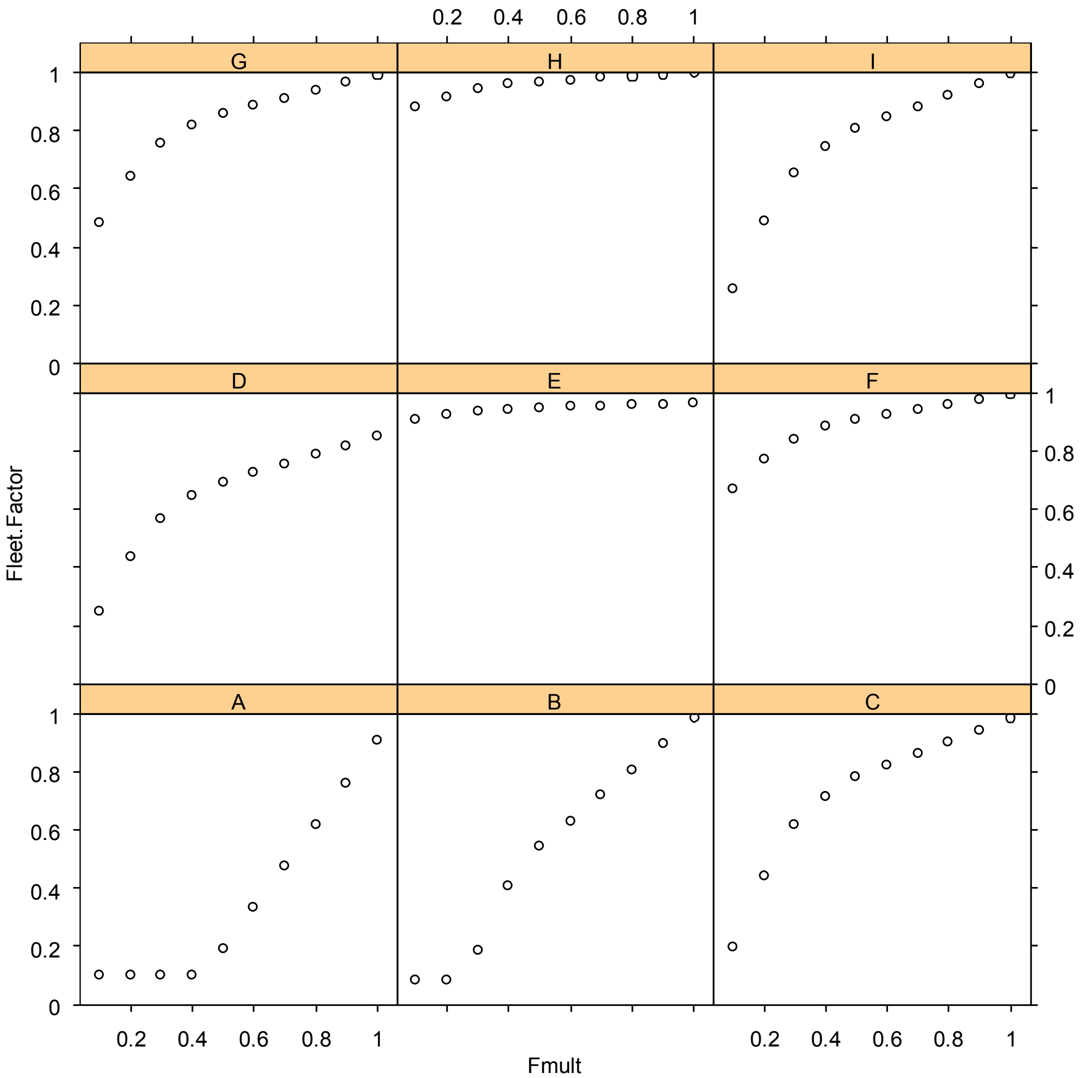


Figure 15.3.2.1. Fleet effort factor as function of the decision weight on cod. the species-specific fleet effort reduction is in proportion to the catch of the species within the catch of the fleet (p = 1); the fleet target factor is switched on (q = 1).

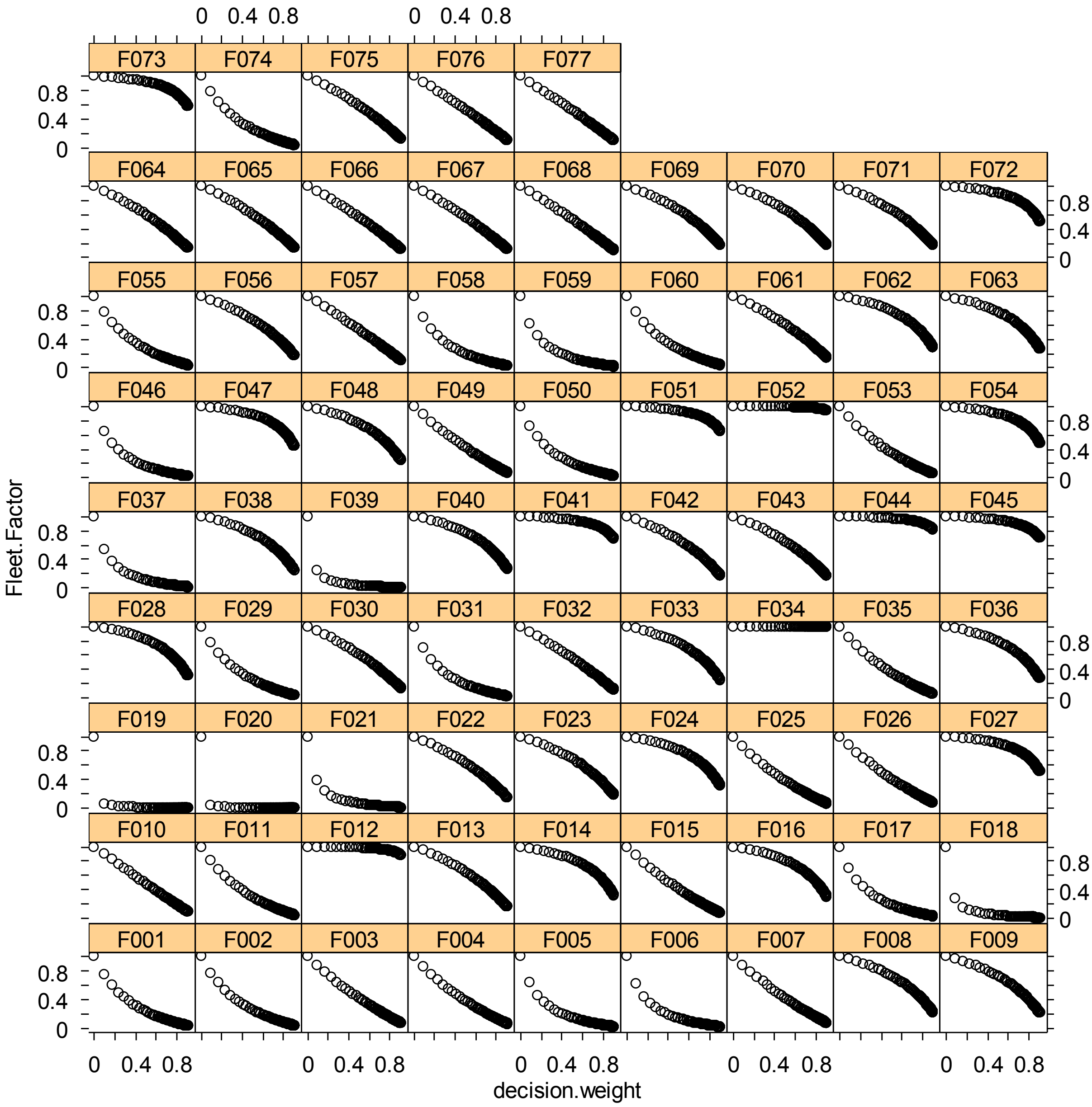


Figure 15.3.2.2. F multipliers by species as a function of the decision weight on cod. F multipliers by species are presented by dots. F multipliers for cod are presented by the line. the species-specific fleet effort reduction is in proportion to the catch of the species within the catch of the fleet (p = 1); the fleet target factor is switched on (q = 1).

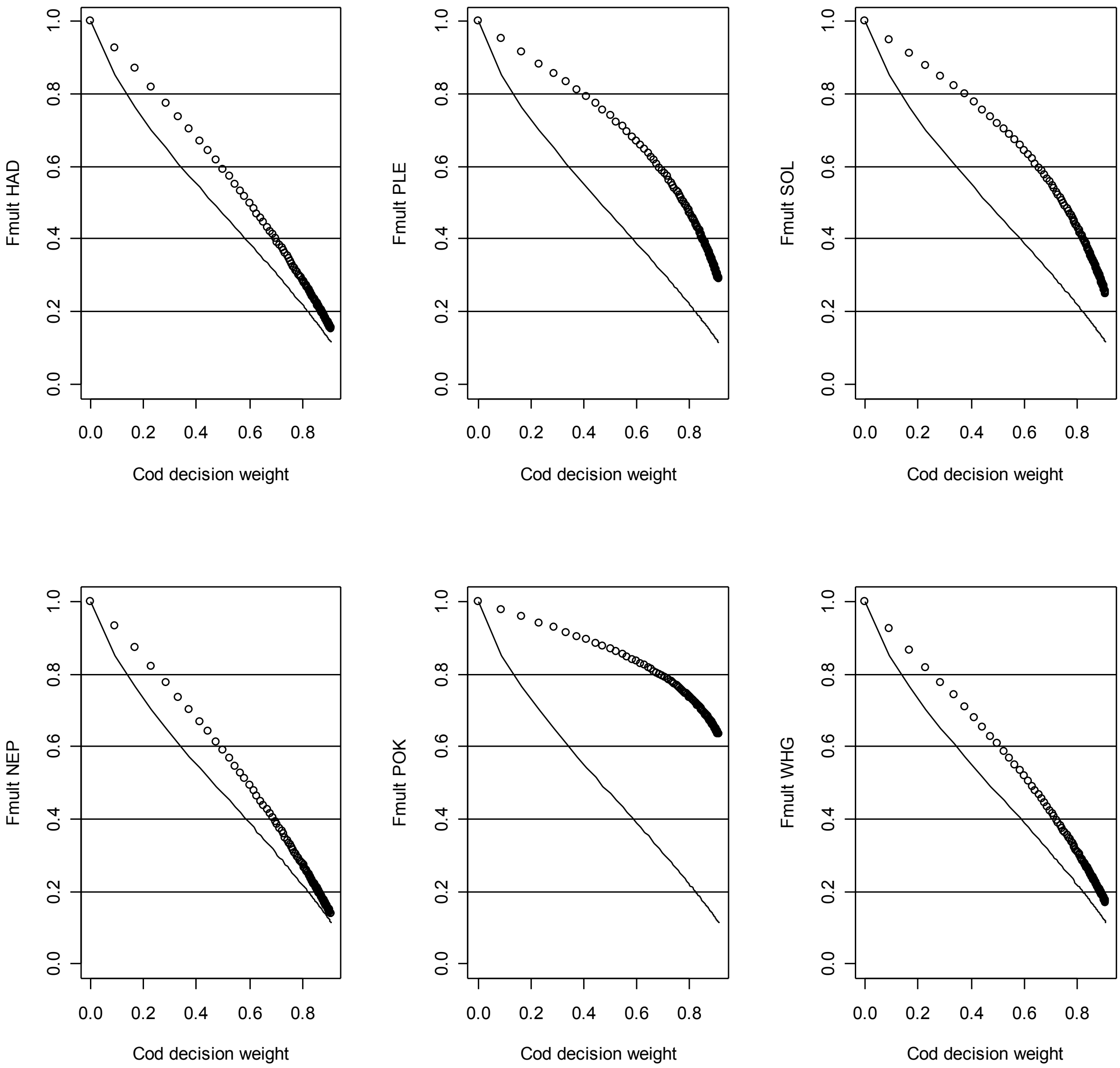


Figure 15.3.2.3. Fleet effort factor as function of the decision weight on cod. the species-specific fleet effort reduction is in proportion to the catch of the species by the fleet of the total catch of that species (p = 2); the fleet target factor is switched on (q = 1).

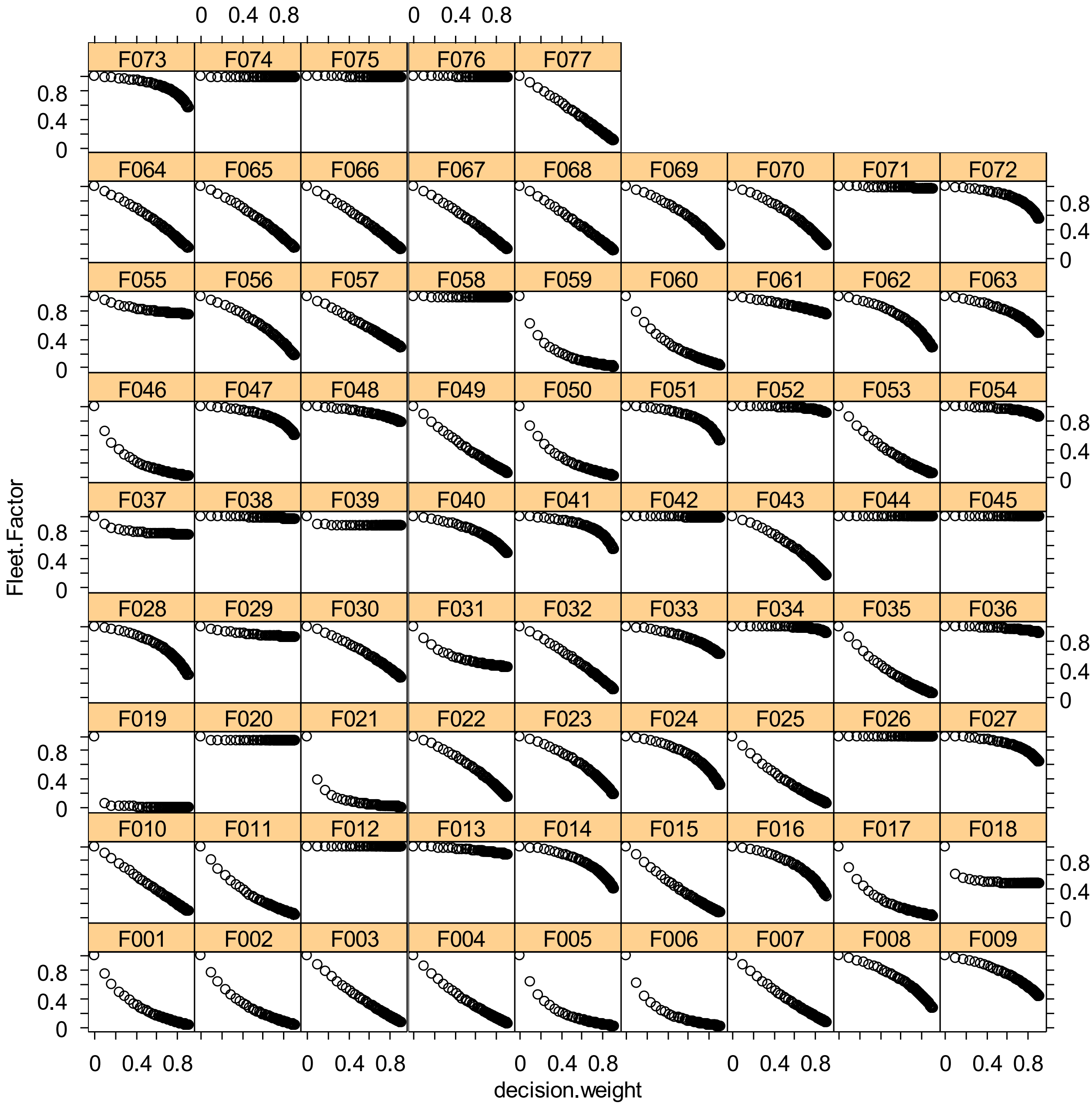


Figure 15.3.2.4. F multipliers by species as a function of the decision weight on cod. F multipliers by species are presented by dots. F multipliers for cod are presented by the line. the species-specific fleet effort reduction is in proportion to the catch of the species by the fleet of the total catch of that species (p = 2); the fleet target factor is switched on (q = 1).

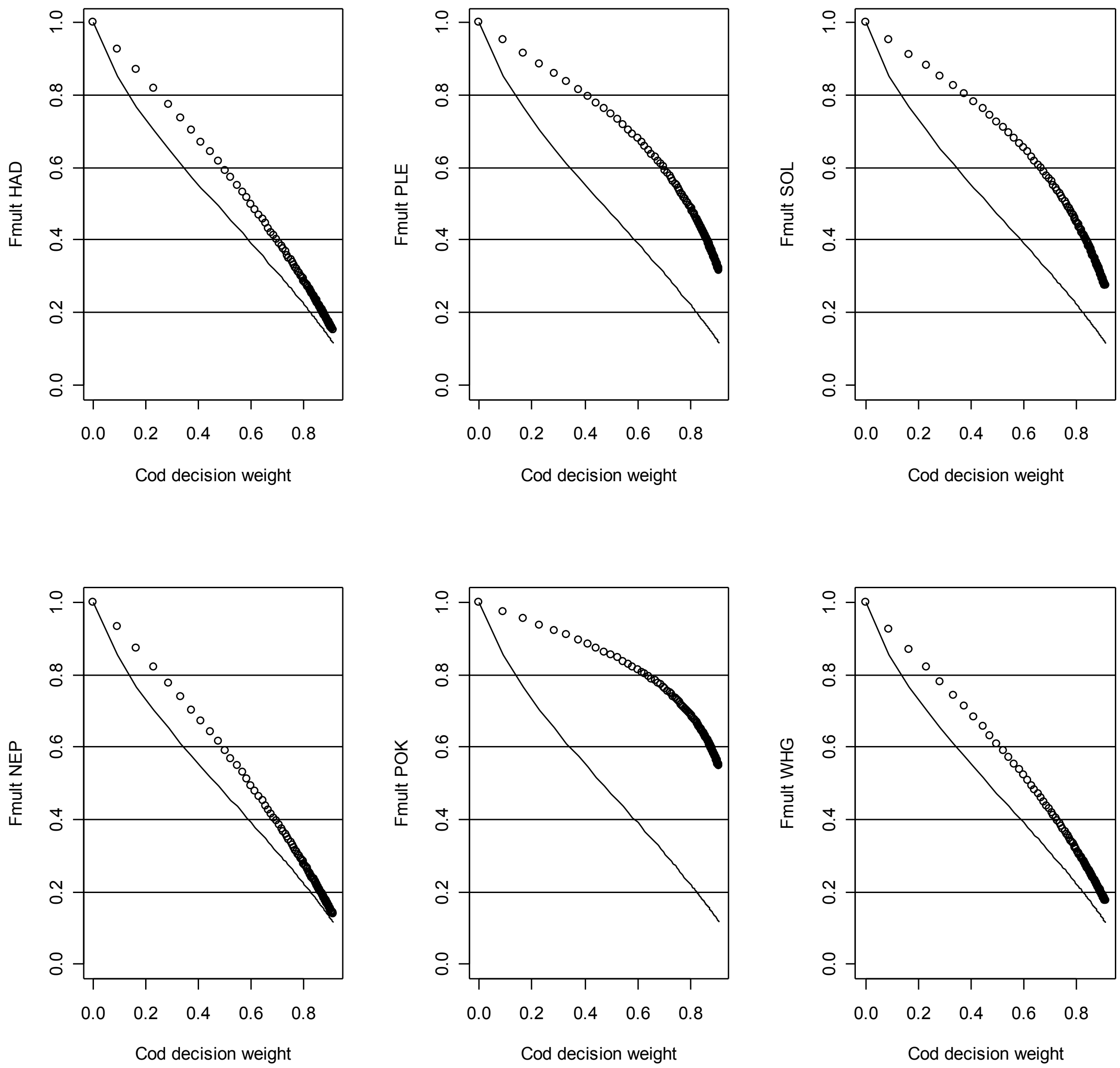


Figure 15.3.2.5. Fleet effort factor as function of the decision weight on cod. the species-specific fleet effort reduction is in proportion to the catch of the species within the catch of the fleet (p = 1); the fleet target factor is switched on (q = 1).

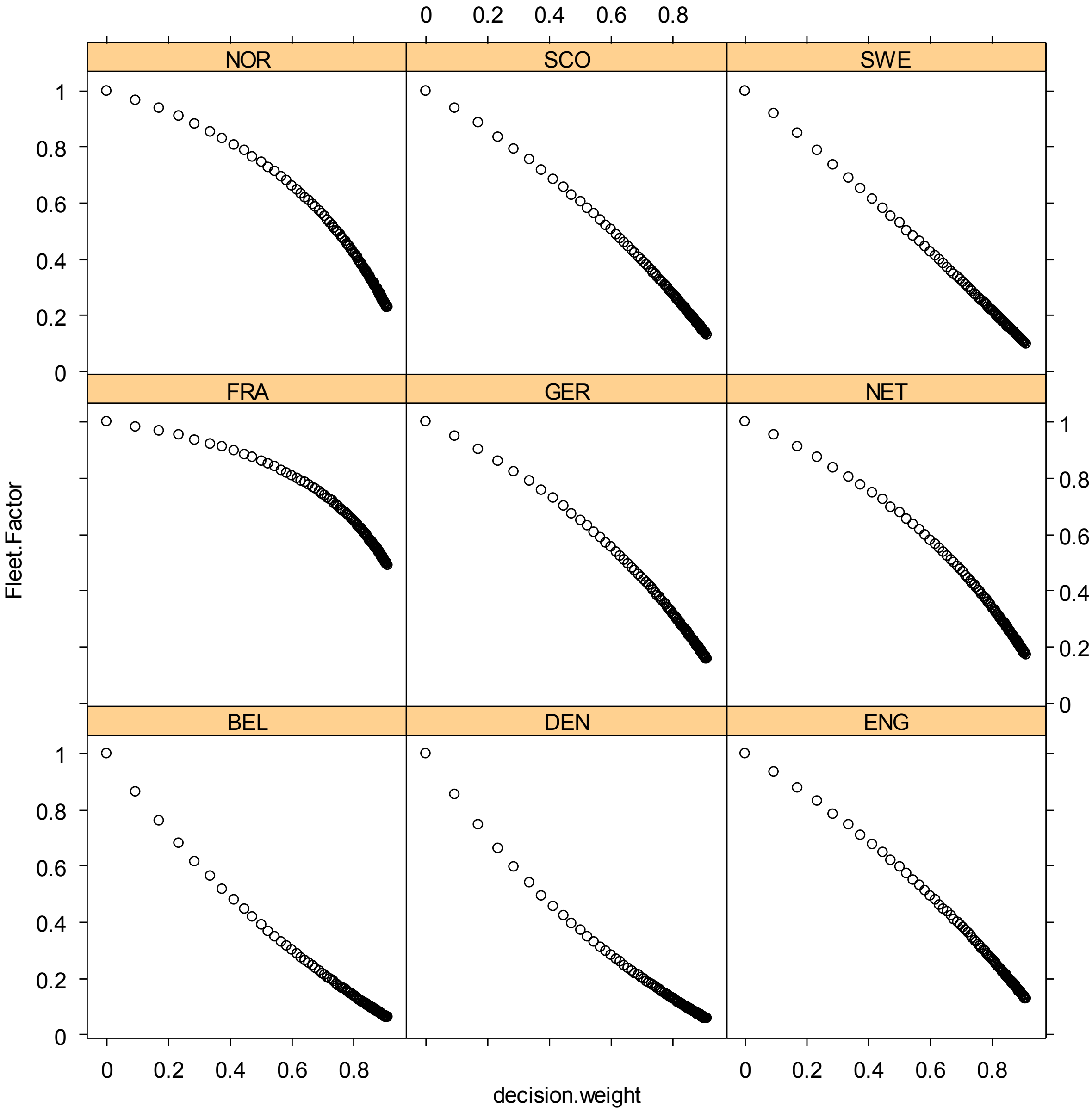


Figure 15.3.2.6. F multipliers by species as a function of the decision weight on cod. F multipliers by species are presented by dots. F multipliers for cod are presented by the line. the species-specific fleet effort reduction is in proportion to the catch of the species within the catch of the fleet (p = 1); the fleet target factor is switched on (q = 1).

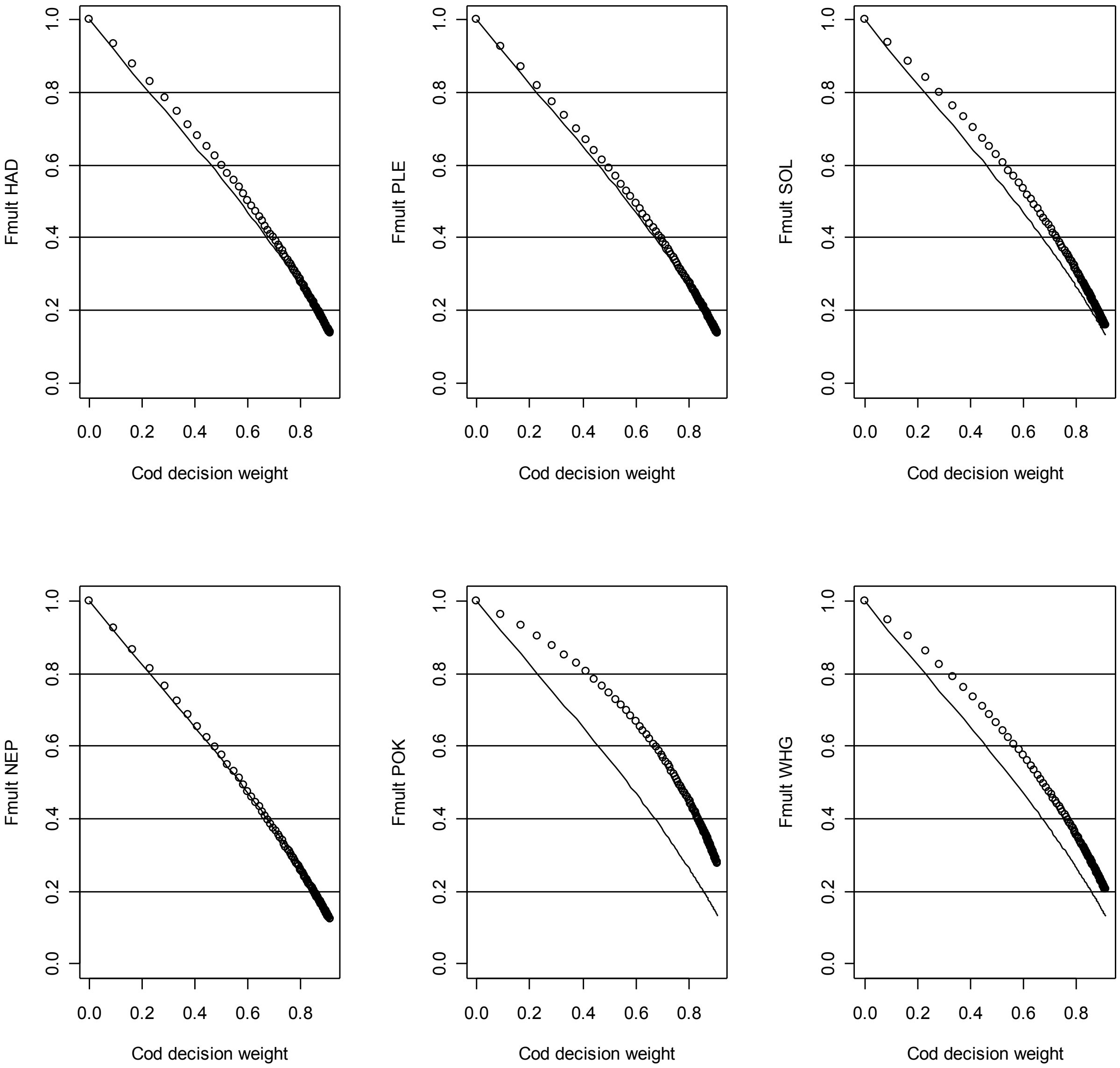


Figure 15.3.2.7. Fleet effort factor as function of the decision weight on cod. the species-specific fleet effort reduction is in proportion to the catch of the species by the fleet of the total catch of that species (p = 2); the fleet target factor is switched on (q = 1).

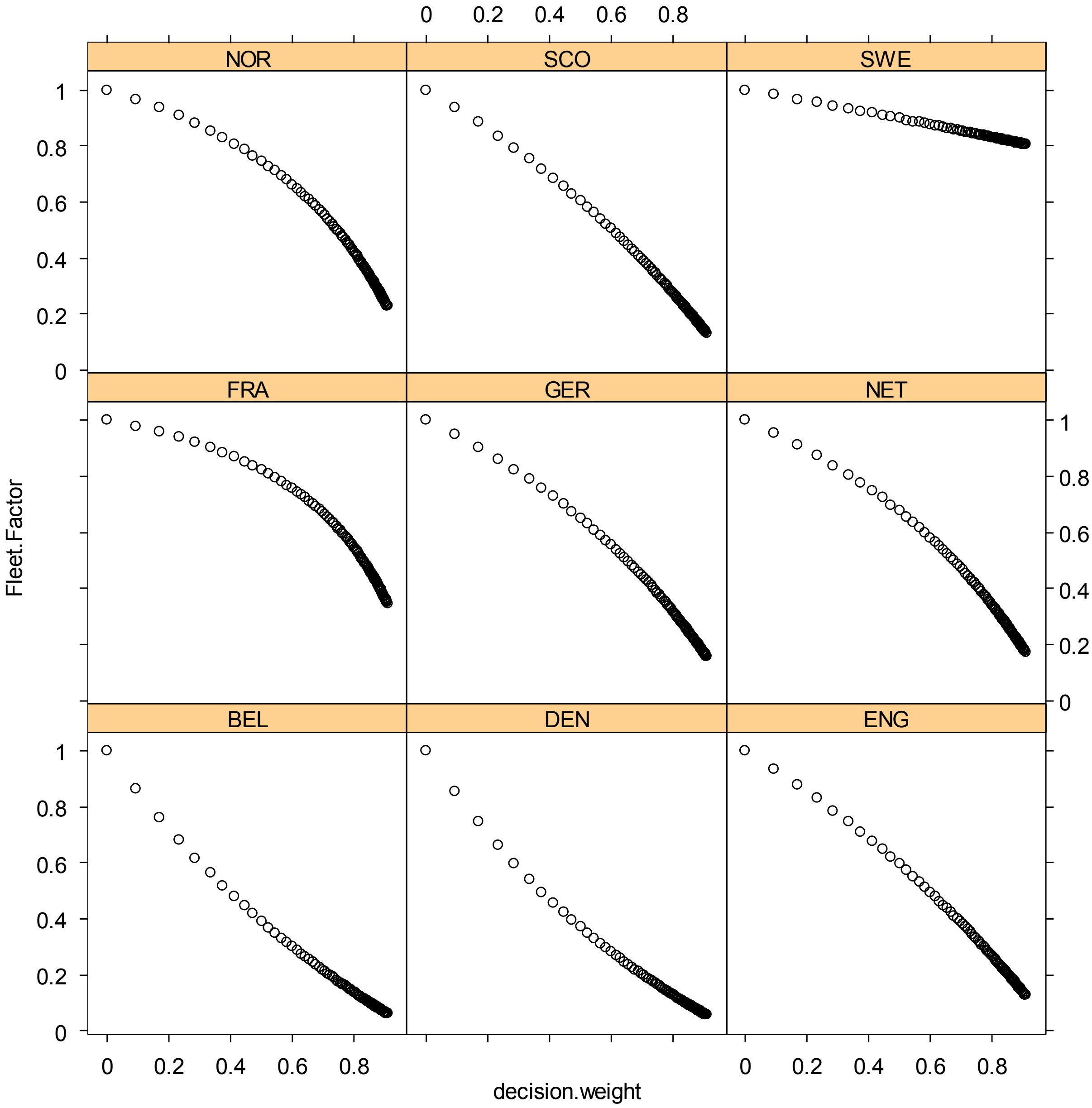


Figure 15.3.2.8. F multipliers by species as a function of the decision weight on cod. F multipliers by species are presented by dots. F multipliers for cod are presented by the line. the species-specific fleet effort reduction is in proportion to the catch of the species by the fleet of the total catch of that species (p = 2); the fleet target factor is switched on (q = 1).

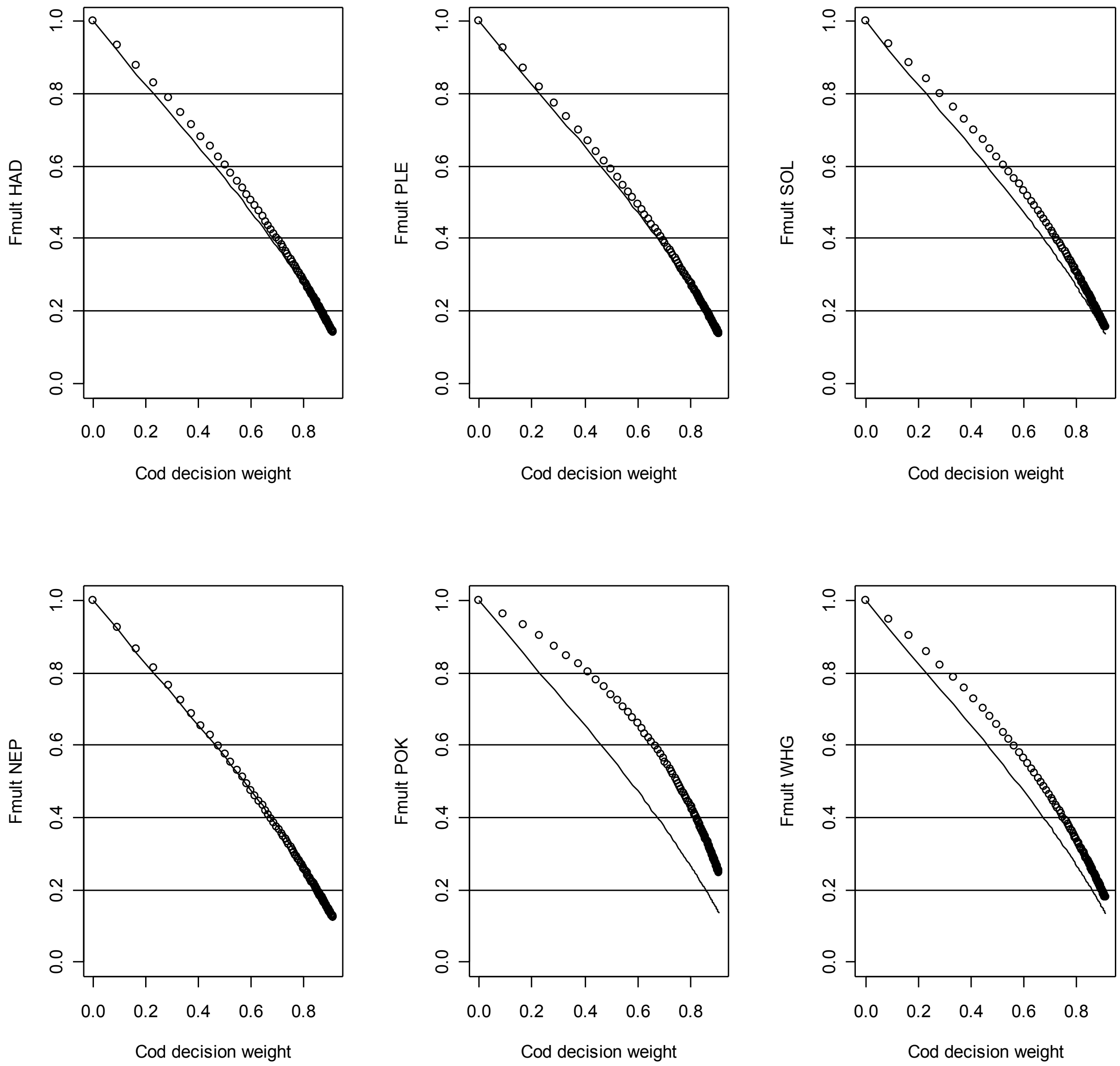
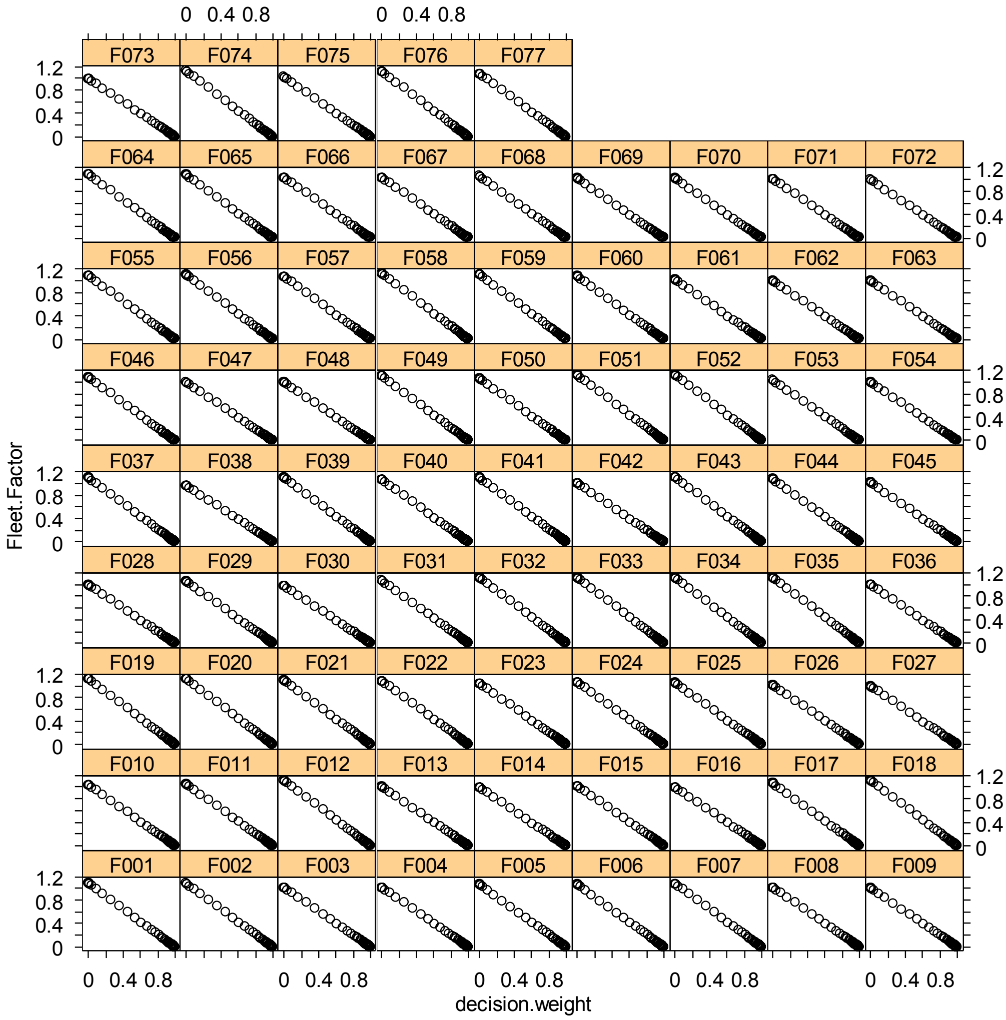


Figure 15.3.2.9. Sensitivity analysis of MTAC. The species-specific fleet effort reduction is in proportion to the catch of the species within the catch (p=1); the fleet target factor is switched of (q = 0); cod F-mult=0; decision weights vary.

Fleet factor plot:



F-multiplier plot:

TAC plot:

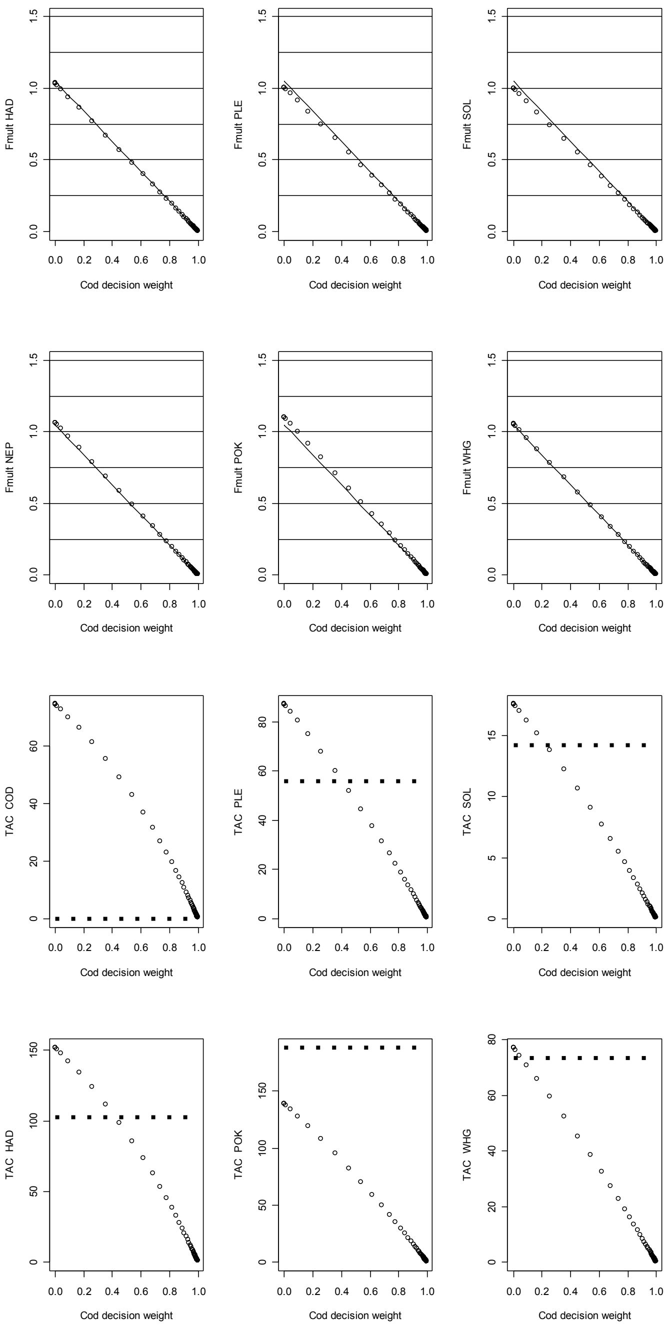
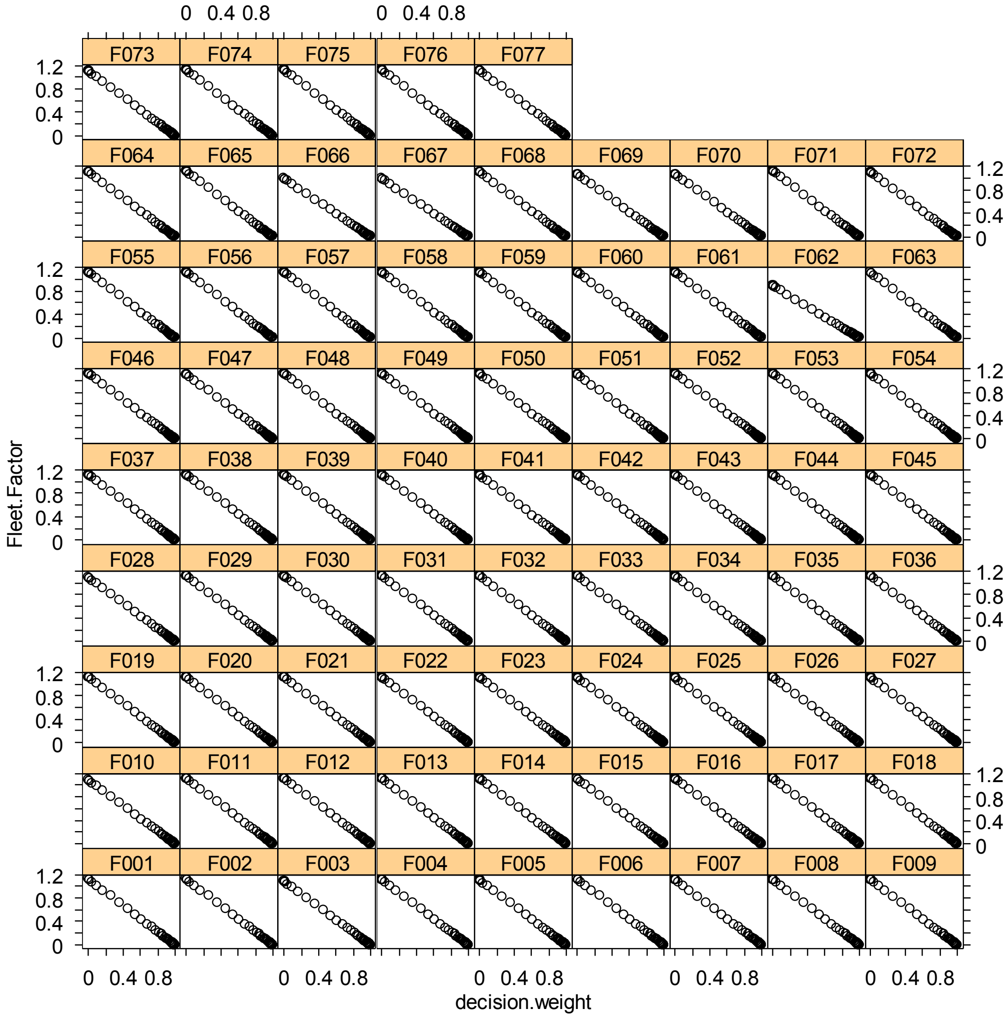

Fmult HAD
Fmult PLE
Fmult SOL
Fmult NEP
Fmult POK
Fmult WHG
TAC COD
TAC PLE
TAC SOL
TAC HAD
TAC POK
TAC WHG
Cod decision weight

Figure 15.3.2.10. Sensitivity analysis of MTAC. The species-specific fleet effort reduction is in proportion to the catch of the species by the fleet of the total catch of that species (p = 2); the fleet target factor is switched of (q = 0); cod F-mult=0; decision weights vary.

Fleet factor plot:



F-multiplier plot: TAC plot:

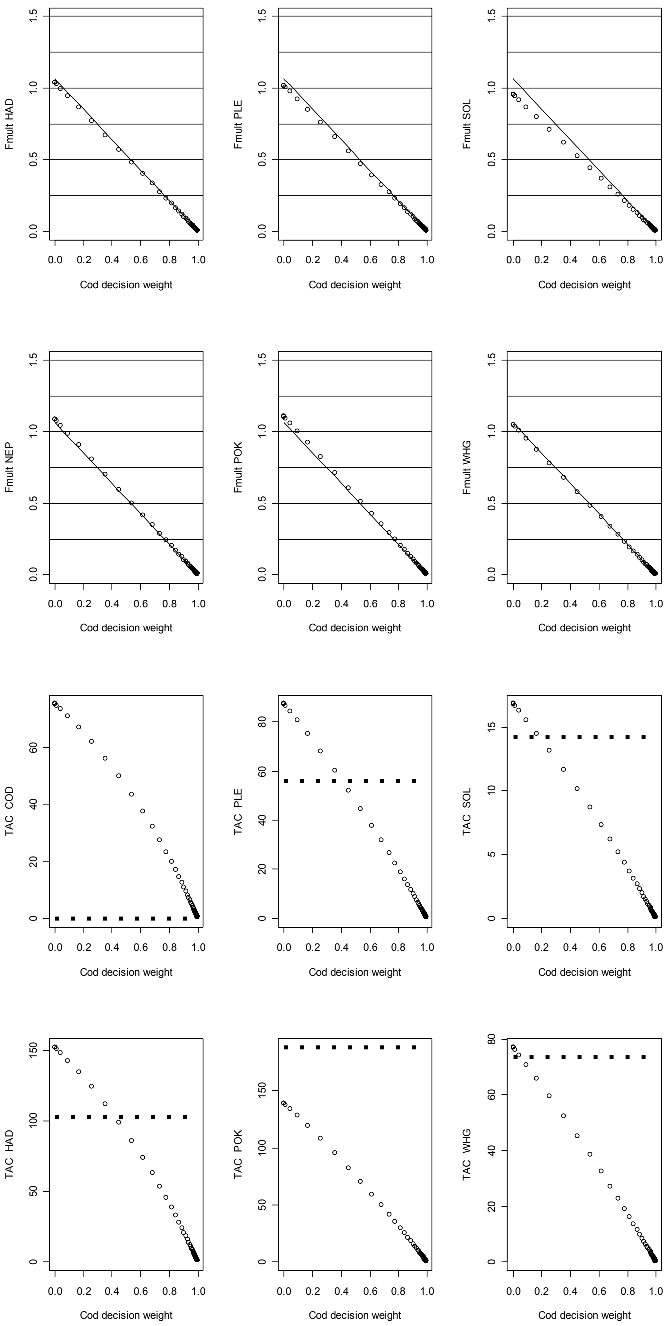
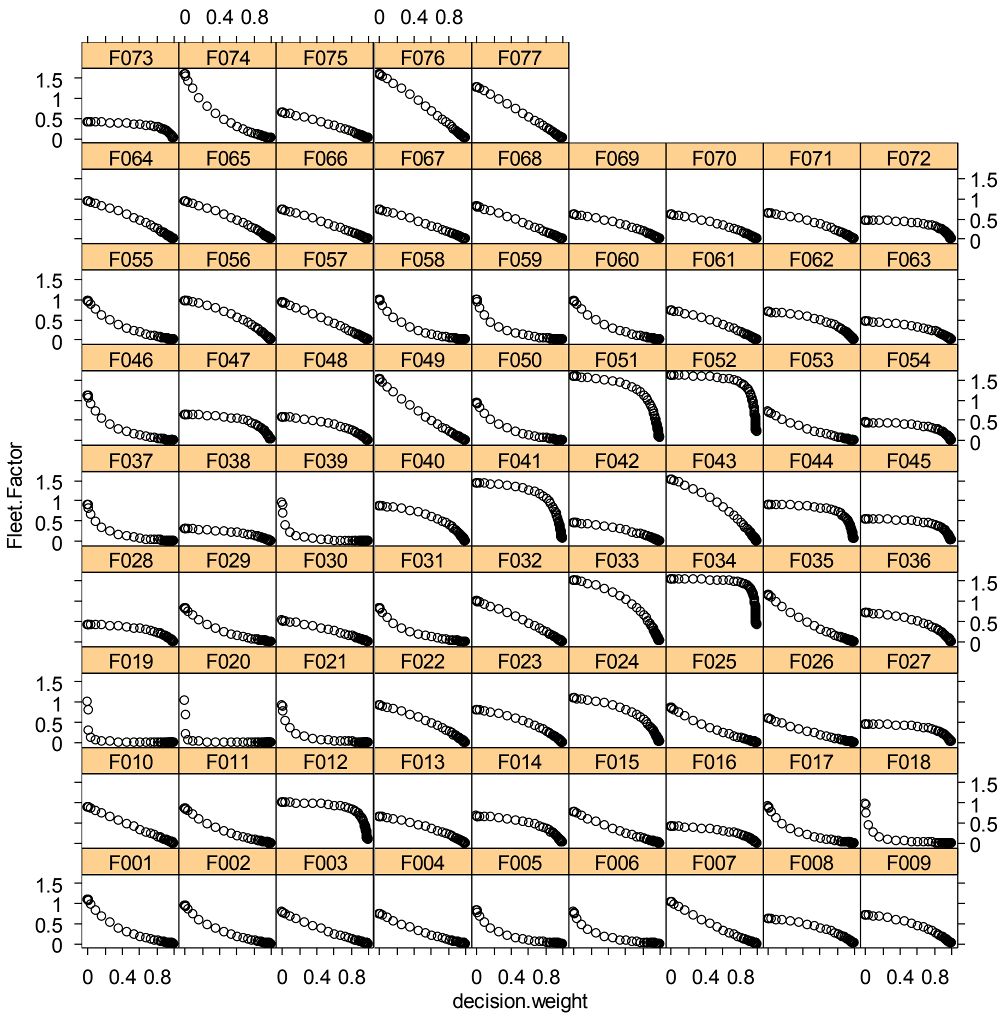

Fmult HAD
Fmult PLE
Fmult SOL
Fmult NEP
Fmult POK
Fmult WHG
TAC COD
TAC PLE
TAC SOL
TAC HAD
TAC POK
TAC WHG
Cod decision weight

Figure 15.3.2.11. Sensitivity analysis of MTAC. The species-specific fleet effort reduction is in proportion to the catch of the species within the catch (p=1); the fleet target factor is switched on (q = 1); cod F-mult=0; decision weights vary.

Fleet factor plot:



F-multiplier plot:

TAC plot:

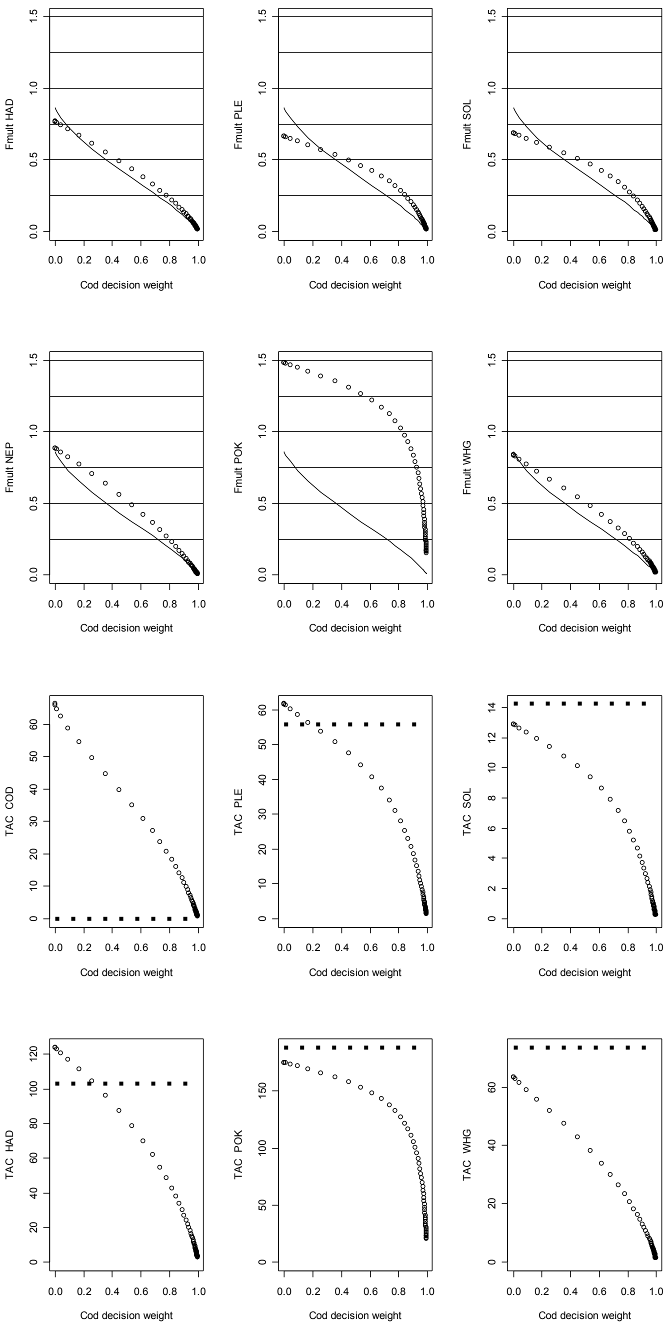
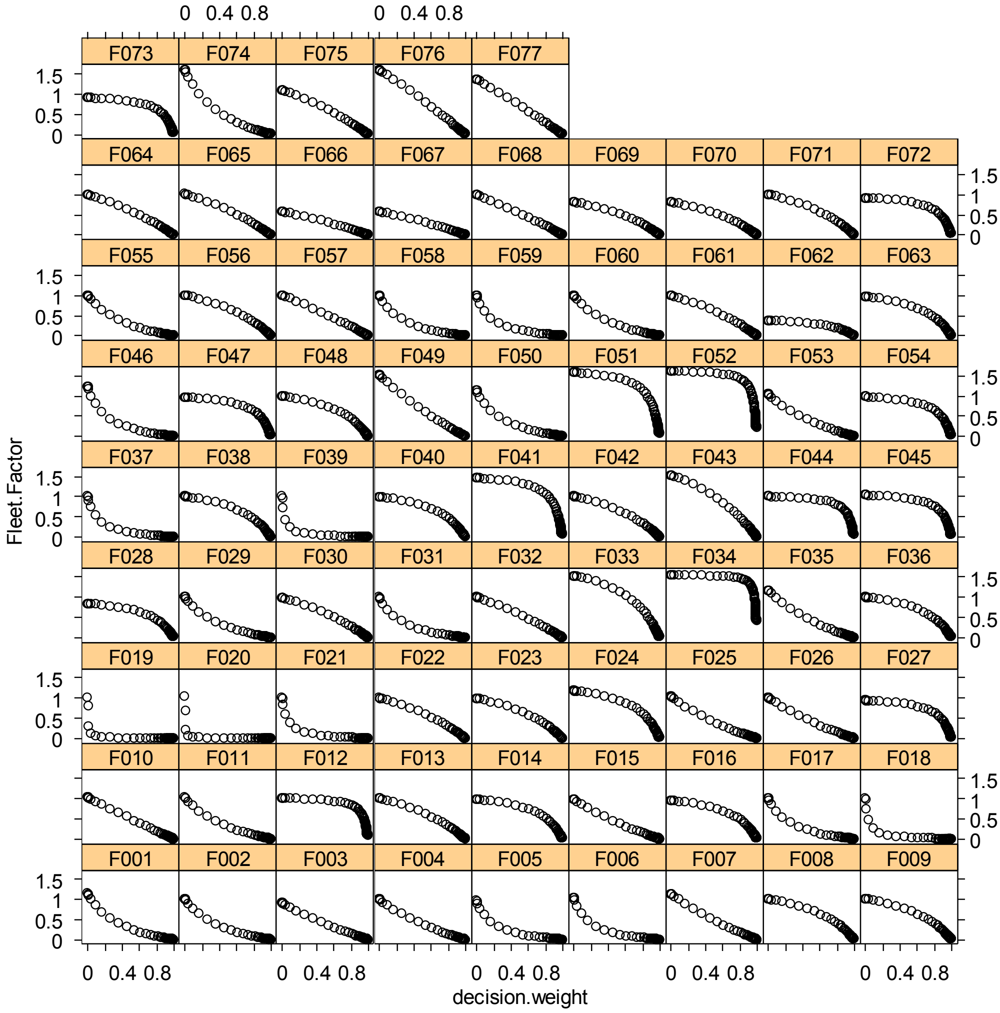

Fmult HAD
Fmult PLE
Fmult SOL
Fmult NEP
Fmult POK
Fmult WHG
TAC COD
TAC PLE
TAC SOL
TAC HAD
TAC POK
TAC WHG
Cod decision weight

Figure 15.3.2.12. Sensitivity analysis of MTAC. The species-specific fleet effort reduction is in proportion to the catch of the species by the fleet of the total catch of that species (p = 2); the fleet target factor is switched on (q = 1); cod F-mult=0; decision weights vary.

Fleet factor plot:



F-multiplier plot:

TAC plot:

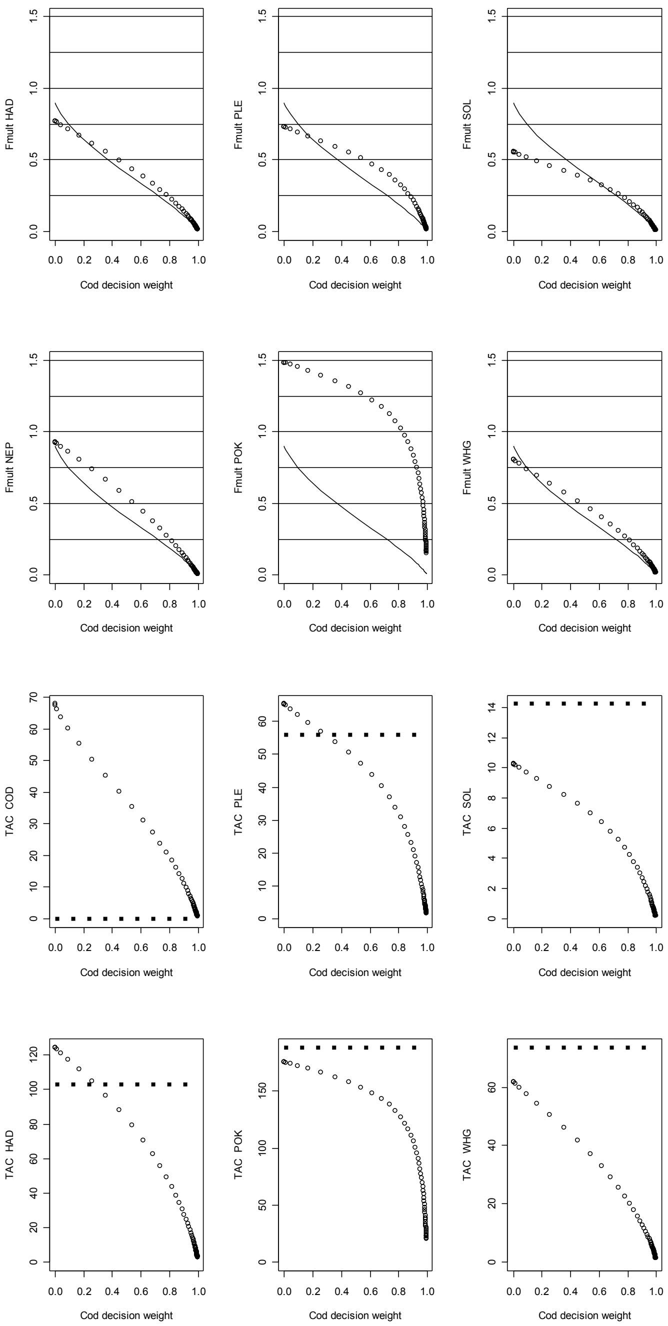
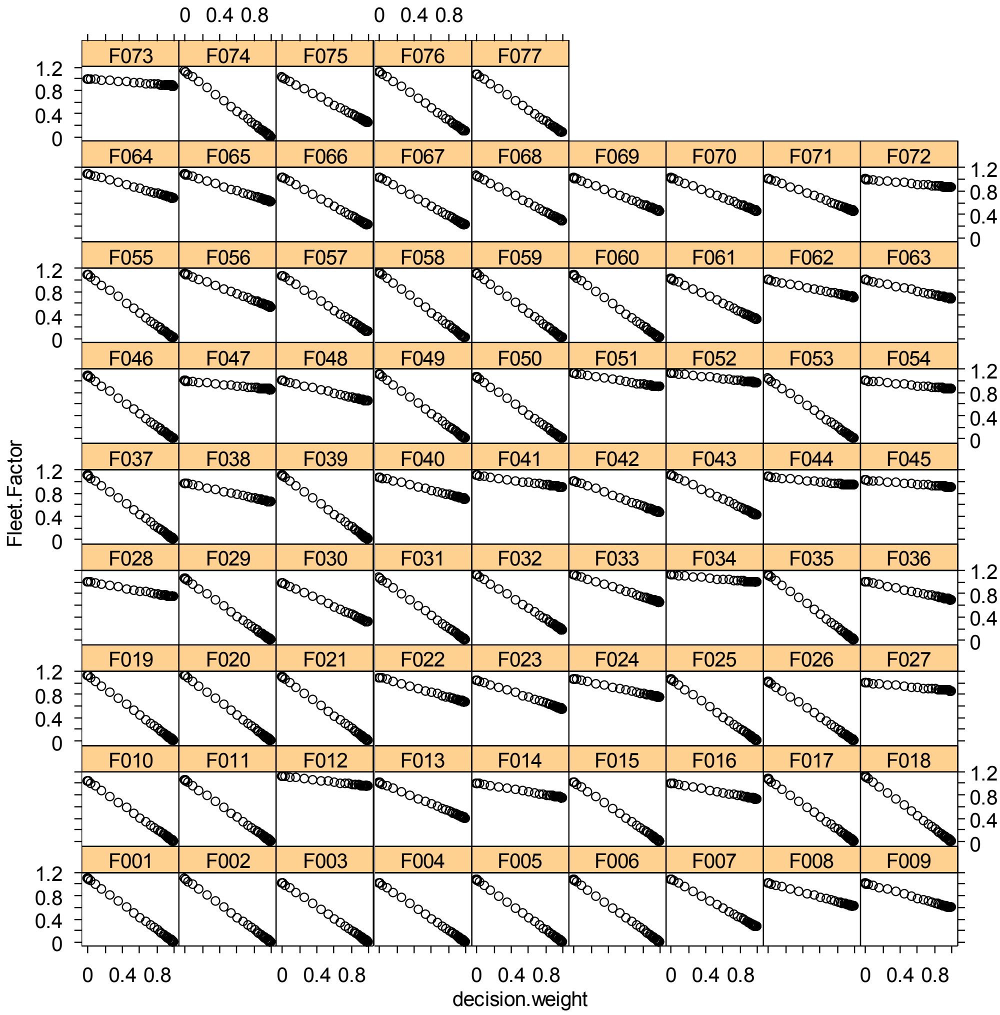

Fmult HAD
Fmult PLE
Fmult SOL
Fmult NEP
Fmult POK
Fmult WHG
TAC COD
TAC PLE
TAC SOL
TAC HAD
TAC POK
TAC WHG
Cod decision weight

Figure 15.3.2.13. Sensitivity analysis of MTAC. The species-specific fleet effort reduction is in proportion to the catch of the species within the catch (p=1); the fleet target factor is switched of (q = 0); cod F-mult=0.2; decision weights vary.

Fleet factor plot:



F-multiplier plot:

TAC plot:

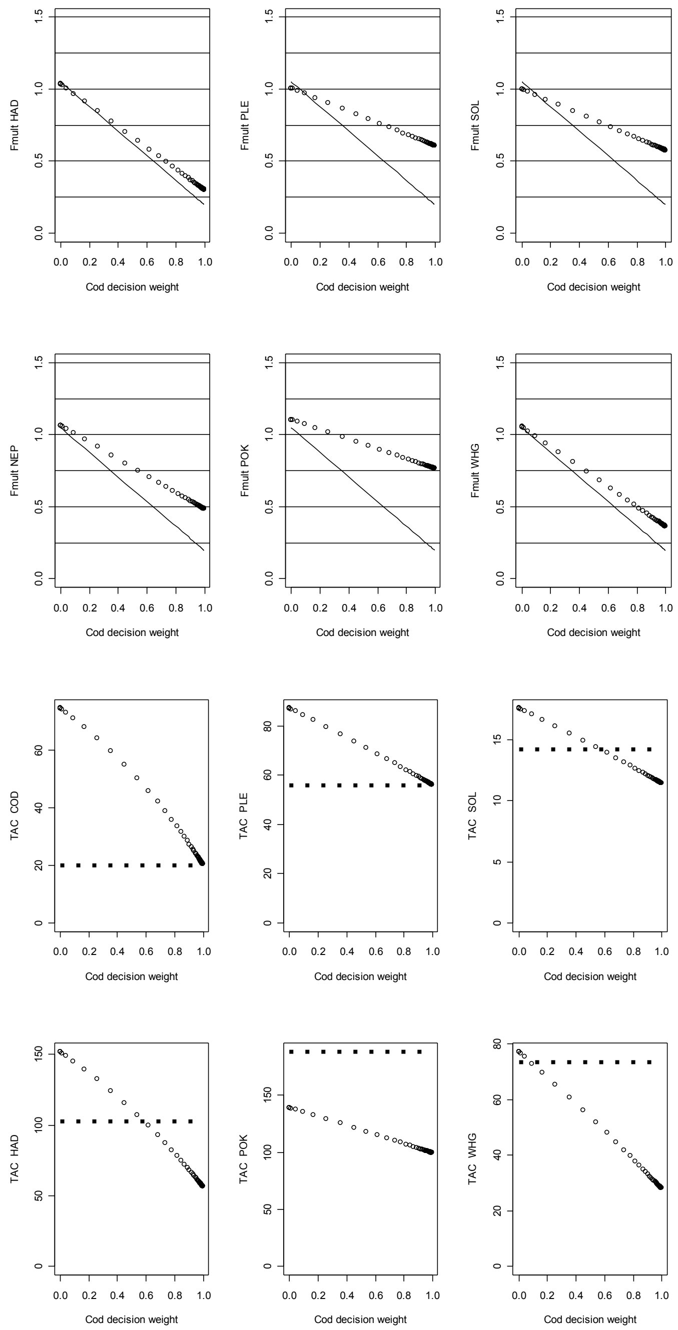
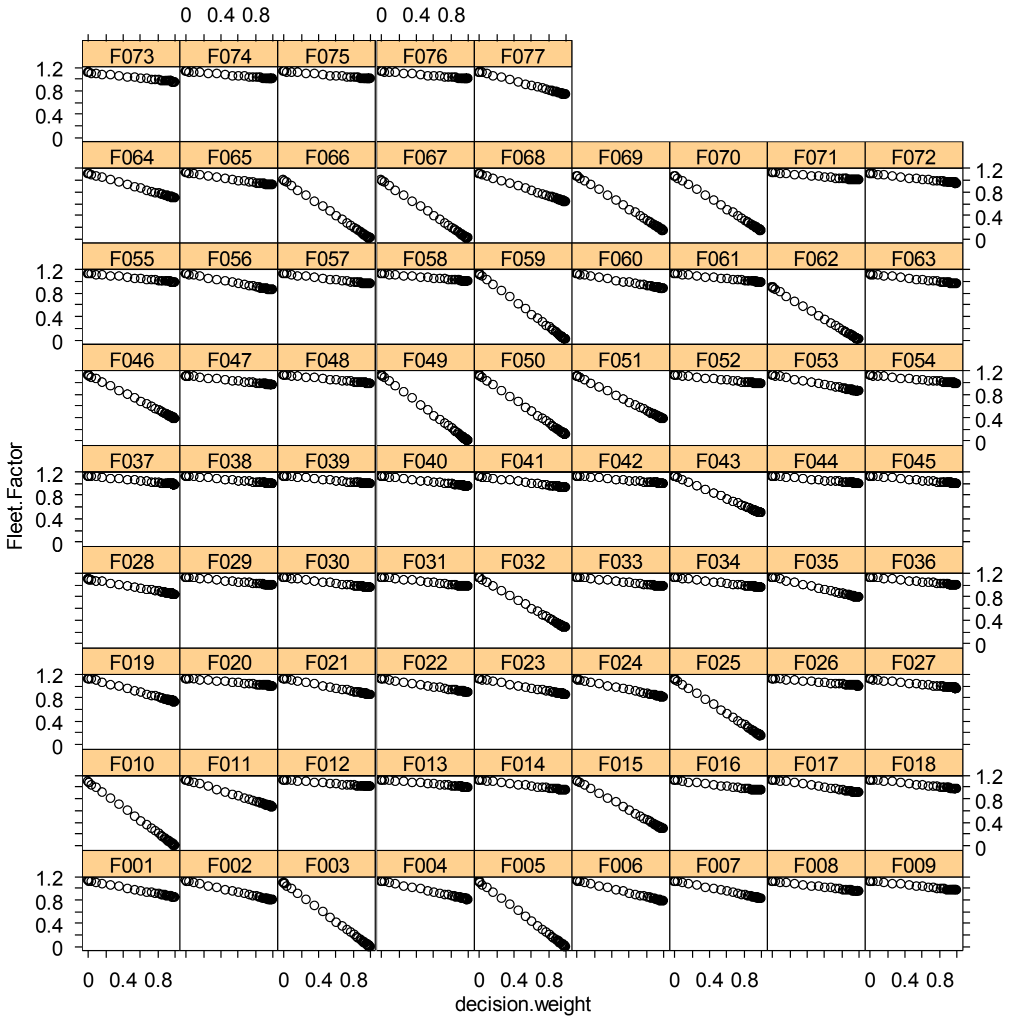

Fmult HAD
Fmult PLE
Fmult SOL
Fmult NEP
Fmult POK
Fmult WHG
TAC COD
TAC PLE
TAC SOL
TAC HAD
TAC POK
TAC WHG
Cod decision weight

Figure 15.3.2.14. Sensitivity analysis of MTAC. The species-specific fleet effort reduction is in proportion to the catch of the species by the fleet of the total catch of that species (p = 2); the fleet target factor is switched of (q = 0); cod F-mult=0.2; decision weights vary.

Fleet factor plot:



F-multiplier plot:

TAC plot:

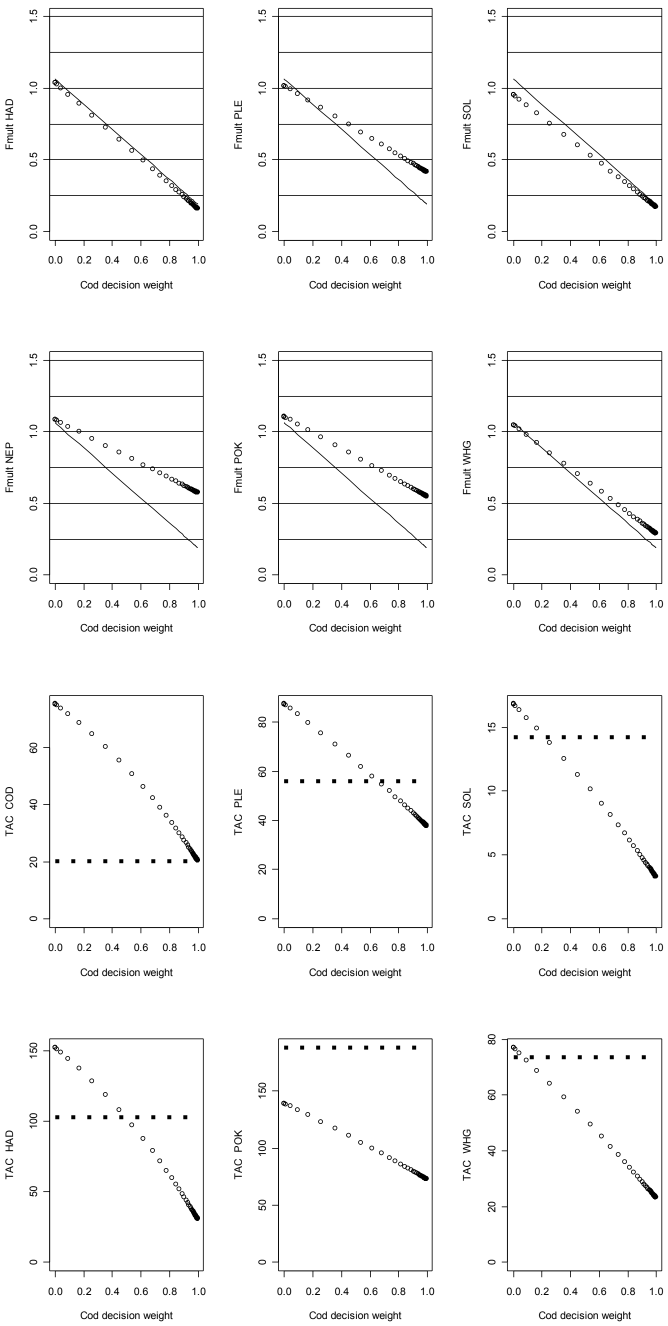
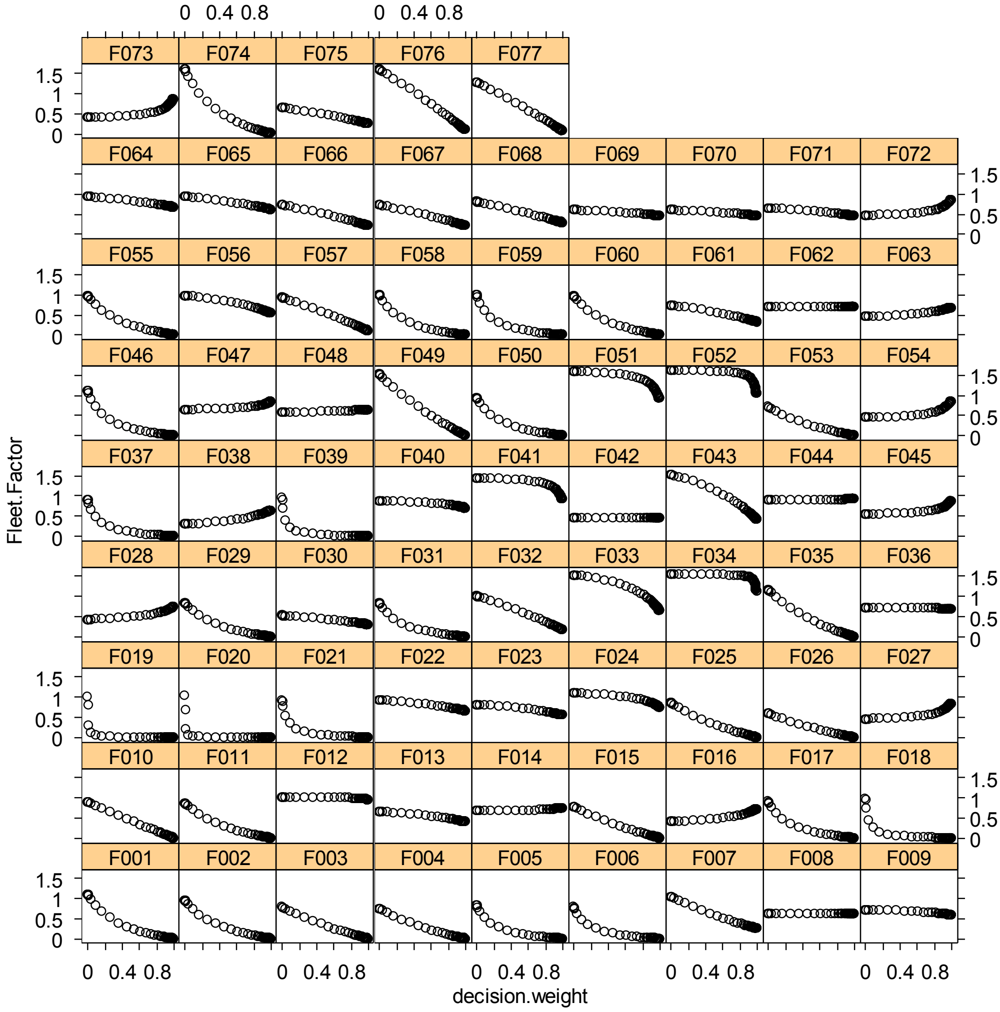

Fmult HAD
Fmult PLE
Fmult SOL
Fmult NEP
Fmult POK
Fmult WHG
TAC COD
TAC PLE
TAC SOL
TAC HAD
TAC POK
TAC WHG
Cod decision weight

Figure 15.3.2.15. Sensitivity analysis of MTAC. The species-specific fleet effort reduction is in proportion to the catch of the species within the catch (p=1); the fleet target factor is switched on (q = 1); cod F-mult=0.2; decision weights vary.

Fleet factor plot:



F-multiplier plot:

TAC plot:

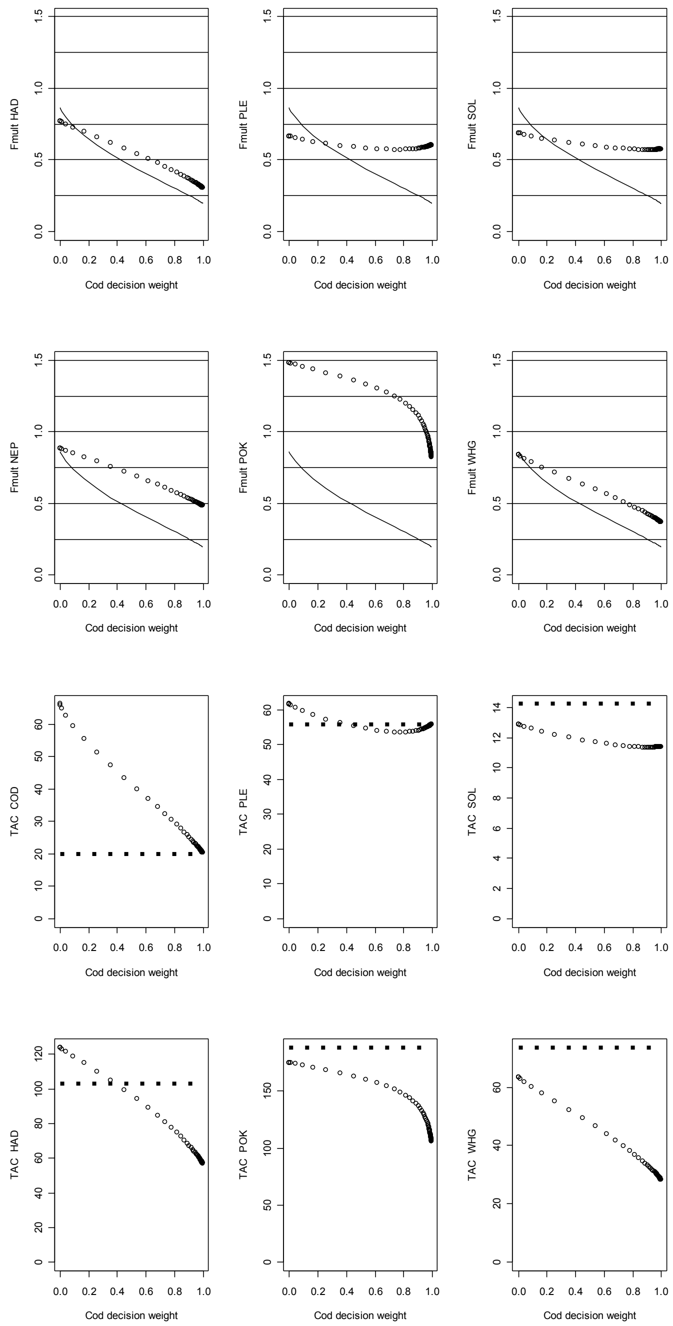
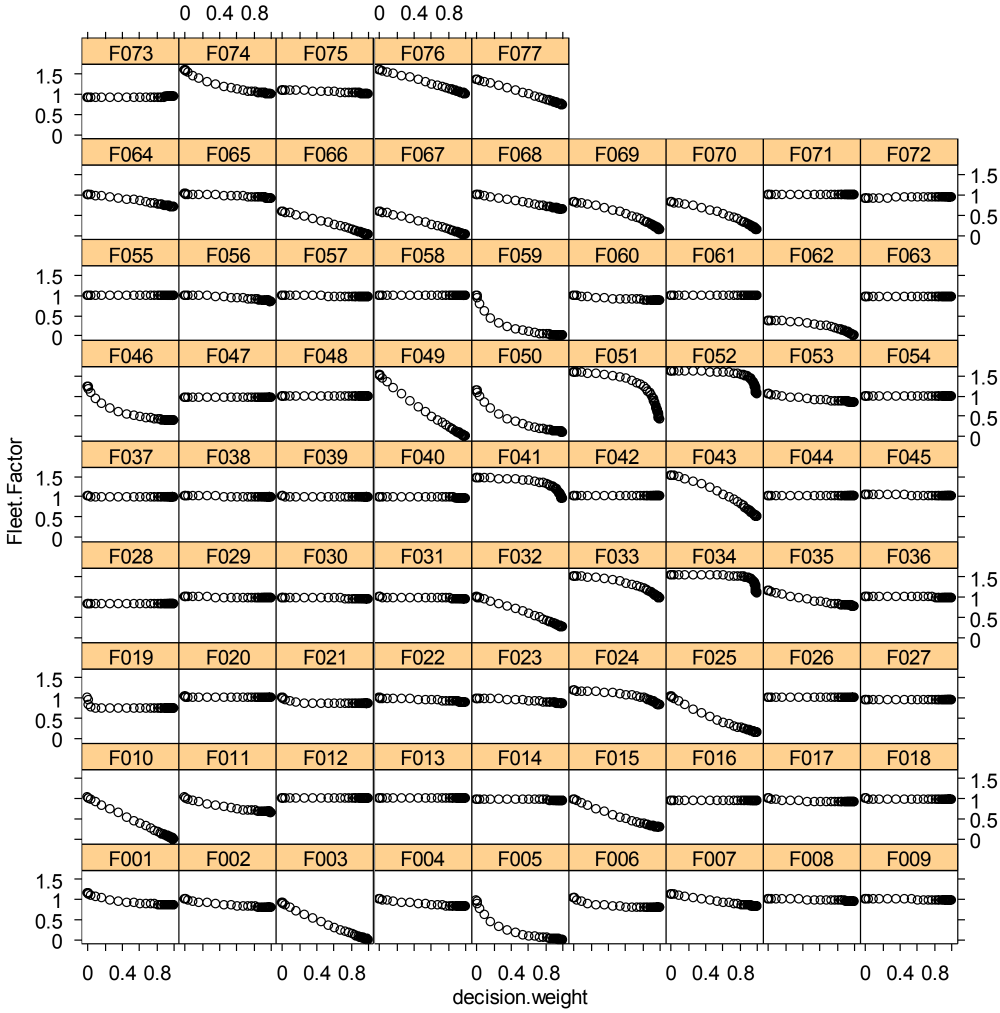

Fmult HAD
Fmult PLE
Fmult SOL
Fmult NEP
Fmult POK
Fmult WHG
TAC COD
TAC PLE
TAC SOL
TAC HAD
TAC POK
TAC WHG
Cod decision weight

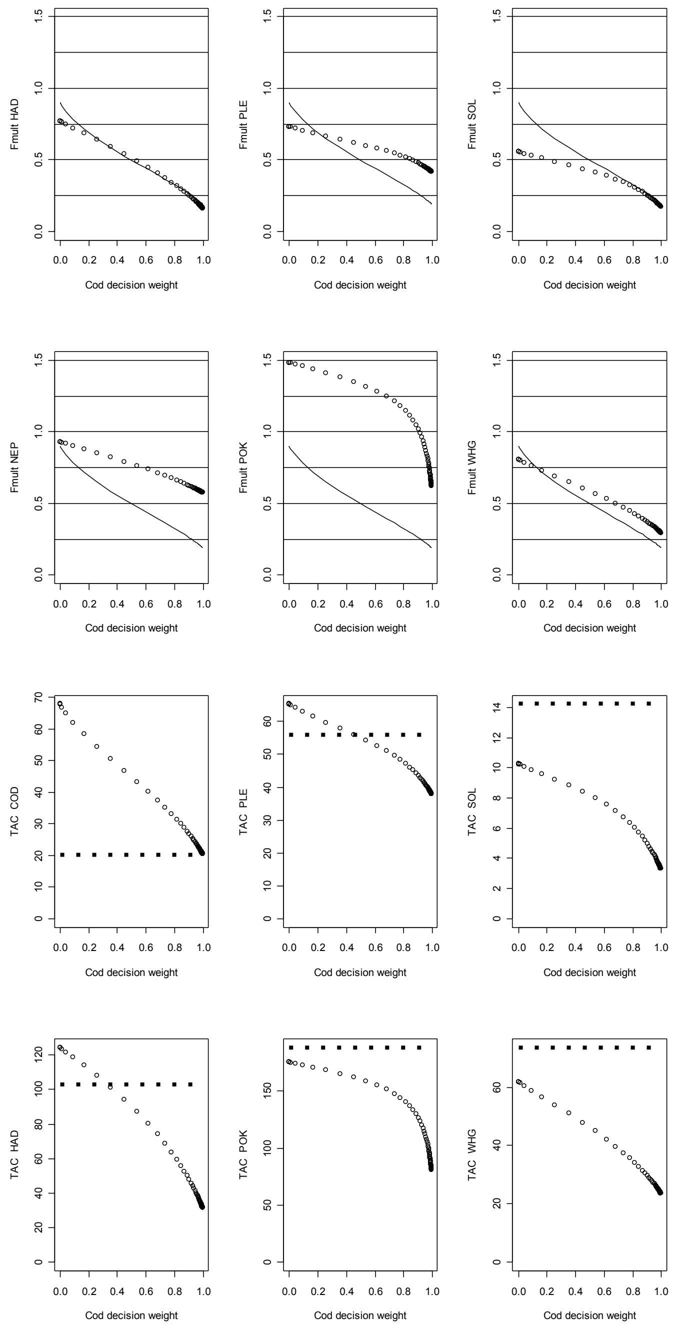
Figure 15.3.2.16. Sensitivity analysis of MTAC. The species-specific fleet effort reduction is in proportion to the catch of the species by the fleet of the total catch of that species (p = 2); the fleet target factor is switched on (q = 1); cod F-mult=0.2; decision weights vary.

Fleet factor plot:



F-multiplier plot:

TAC plot:


Fmult HAD
Fmult PLE
Fmult SOL
Fmult NEP
Fmult POK
Fmult WHG
TAC COD
TAC PLE
TAC SOL
TAC HAD
TAC POK
TAC WHG
Cod decision weight

16 PA REFERENCE POINTS

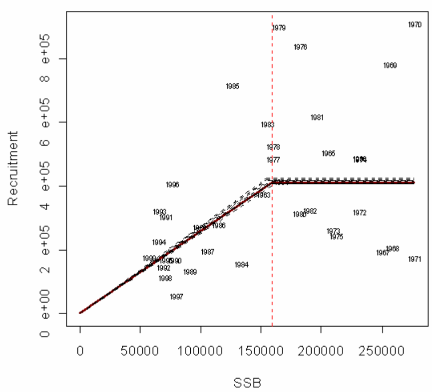
This section consists of three parts:

- comments on SGPRP suggestions
- general comments on the SGPA/SGPRP approach (including simulations of segmented regression)
- updating reference points when the assessment setup has changed

16.1 Stock specific comments on the PA reference points proposed by the Study Group on Precautionary Reference Points for Advice on Fishery Management.

16.1.1 Cod in the North Sea, VIId and Skagerrak (cod-347d)

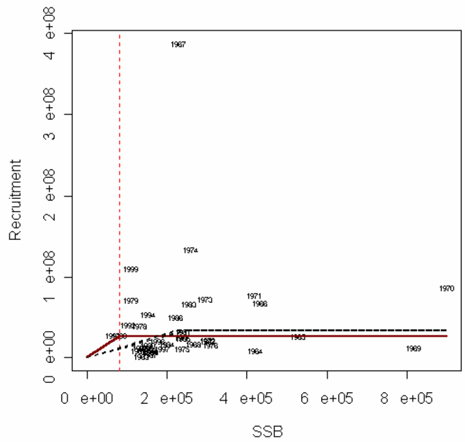
SGPRP: "For cod in the North Sea, the segemented regression was significant ($p<0.01$). The change point was around 160 thousand tonnes and was not very sensitive to the addition of years in the retrospective analysis. See the conclusions sections for a more detailed discussion of the results for North Sea cod. The WG is requested to evaluate a change in reference points for North Sea cod."



WGNSSK: the WG agrees with SGPRP that S*=160 000 tonnes is a candidate for $\mathbf{B}_{lim}$. Section 16.1 describes different sources of estimation bias. The S* is close to the previous MBAL (where recruitment was thought to be impaired). Using the proposed value as a new $\mathbf{B}_{lim}$ and an associated new $\mathbf{B}_{pa}$ (not estimated yet) as basis for advice would have a rather large impact on the perception of recovery plans. See also the subsection on biological reference points in section 3 of this report.

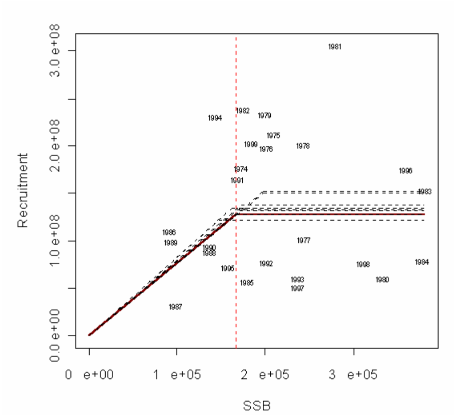
16.1.2 North Sea Haddock (had-34)

SGPRP: "This stock shows a very high recruitment variation. There is one exceptional and two extremely high yearclasses. The segmented regression is not significant. There appear to be two different states of the change point which is dependent on the number of years included in the analysis. This stock is categorized as a spasmodic stock that merits special consideration for the estimation of $\mathbf{F}_{loss}$ rather than biomass reference points directly. The WG is requested to evaluate a change in reference points for North Sea haddock based on F reference points primarily."



WGNSSK: The most obvious feature of this SRR relationship are sporadic large recruitments. Even without these occasional outbreaks there is little in the way of a stock-recruit relationship. The WG has not commented on the suggestion to work with F reference points primarily.

16.1.3 Norway pout



SGPRP: "The segmented regression is not significant. The regression is sensitive to individual years being removed. There exists a trend in SSQ in the retrospective analysis. Classification: no S/R relationship and relatively narrow spread in SSB (use $\mathbf{B}_{loss}$ as proxy for $\mathbf{B}_{lim}$). $\mathbf{B}_{loss}$ is close to the current $\mathbf{B}_{lim}$. Therefore the current reference points can be maintained. "

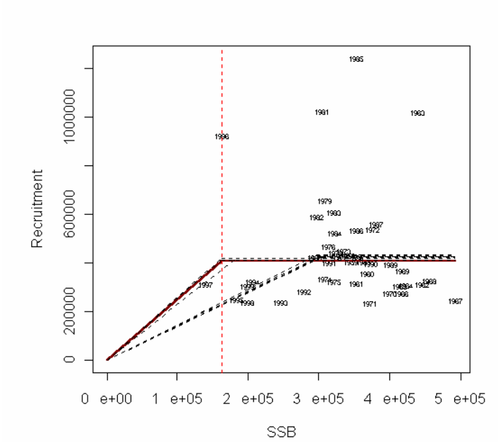
WGNSSK: There seems to be two levels of the stock-recruitment-relationship for the stock, a level well above and well below recruitment around 125 billions. There seems not to be periodical and historical trends to explain these two levels.

Historically, there has been no high recruitments below 150,000 t which indicates at least some relationship between R and SSB even if the segmented regression was not significant.

Evaluation of the stock-recruitment relationship should be carried out, taking into account biological processes and fisheries interactions. This will allow medium term simulations to be carried out which are needed before decisions on limit reference points are taken.

The working group recommends that either $\mathbf{B}_{pa}$ should be set at the breakpoint of the segmented regression OR that $\mathbf{B}_{loss}$ should be used as the $\mathbf{B}_{lim}$.

16.1.4 Plaice North Sea



SGPRP: "The segmented regression is not significant. There appear to be two different states of the change point which is dependent on the number of years included in the analysis. The regression is sensitive to the addition of the 1996 data and onwards in the retrospective analysis. Classification: no S/R relationship and relatively large spread in SSB (use $\mathbf{B}_{loss}$ as proxy for $\mathbf{B}_{lim}$). Assessment has been substantially revised compared to the assessment that gave rise to the original estimate of $\mathbf{B}_{lim}$ (as $\mathbf{B}_{loss}$). The WG is requested to evaluate a change in reference points for North Sea plaice based on an updated value of $\mathbf{B}_{loss}$."

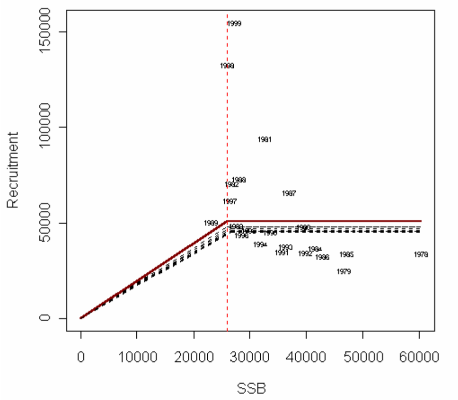
WGNSSK: The WG discussed how to estimate $\mathbf{B}_{lim}$, in which process three possible bases for $\mathbf{B}_{lim}$ estimates came up:

- Using $\mathbf{B}_{lim}$ with an updated value of $\mathbf{B}_{loss}$ (134 000 tonnes)
- Keep $\mathbf{B}_{lim}$ at current level (210 000 tonnes)
- Set $\mathbf{B}_{lim}$ is at S*, given by segmented regression, at 154 000 tonnes

The WG did not make a choice between these three options but has explored the consequences of the three options. This is further discussed in section 16.3.3.

16.1.5 Plaice Skagerrak

SGPRP: "The segmented regression is not significant. The regression is sensitive to the addition of the 1998 data and onwards in the retrospective analysis. Classification: Inverse relationship between SSB and R (use $\mathbf{B}_{loss}$ as proxy for $\mathbf{B}_{pa}$). The WG is requeste to evaluate the $\mathbf{B}_{loss}$ as a potential $\mathbf{B}_{pa}$ for this stock."



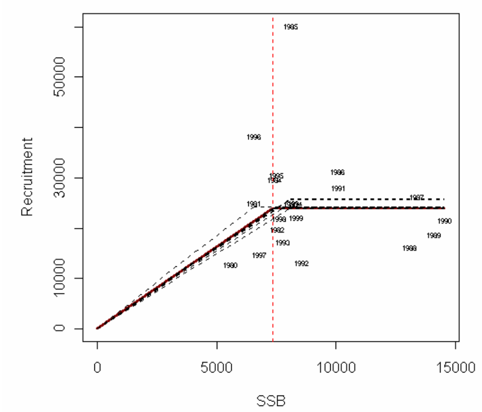
WGNSSK: This stock was up for an update assessment during this working group. The working group does not agree with the study group proposal of $\mathbf{B}_{loss}$ as a candidate for $\mathbf{B}_{pa}$.

- The reason for the inverse relationship between the stock and recruits are not known. Can the linkage with the North Sea explain this?
- The performance of the stock forecasts has not been evaluated.

Not setting a biomass reference point should be considered.

16.1.6 Plaice VIId

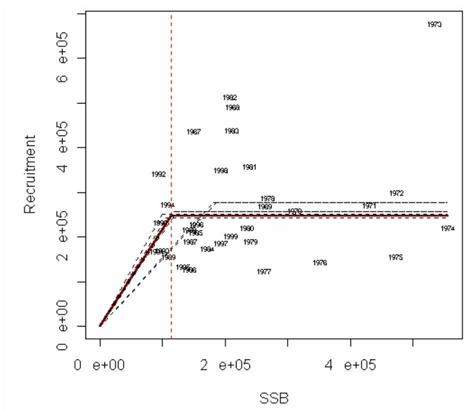
SGPRP: "The segmented regression is not significant. Classification: no S/R relationship and relatively narrow spread in SSB (use $\mathbf{B}_{loss}$ as proxy for $\mathbf{B}_{pa}$?). $\mathbf{B}_{loss}$ is close to the current $\mathbf{B}_{lim}$. The working group should review the situation."



WGNSSK: This stock was up for an update assessment during this working group. The working group does not agree with the study group proposal of $\mathbf{B}_{loss}$ as a candidate for $\mathbf{B}_{pa}$. This stock has experienced fishing mortalities well above $\mathbf{F}_{0.1}$ for a long number of years. Therefore, the WG suggests to use $\mathbf{B}_{loss}$ as the $\mathbf{B}_{lim}$, in line with the reasoning by SGPRP.

16.1.7 Saithe North Sea and VIa

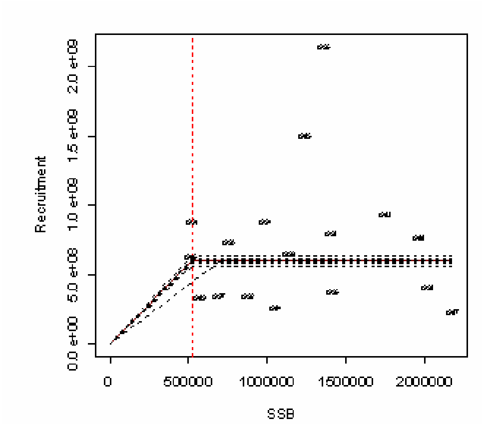
SGPRP: "The segmented regression is not significant. The analysis is also considered invalid because recruitment has been included up to the 1999 yearclass which is taken as a mean recruitment in the assessment. The analysis was sensitive to the addition of 1992 data and onwards in the retrospective analysis. There appear to be two different states of the change point which is dependent on the number of years included in the analysis. Classification: no S/R relationship and relatively large spread in SSB (use $\mathbf{B}_{\text{loss}}$ as proxy for $\mathbf{B}_{\text{lim}}$). However, because of the problems in the analysis mentioned above, a new analysis should be carried out with fewer years included. The WG is requested to carry out a new segmented regression analysis with the appropriate number of years included. The WG is requested to analyse a potential update of the $\mathbf{B}_{\text{lim}}$ reference point based on the $\mathbf{B}_{\text{loss}}$."



WGNSSK: The reference points for saithe in sub-area IV, VI and division IIIa have not been evaluated since 1999. The SGPAFM then used the MBAL concept to define the $\mathbf{B}_{\text{pa}}$. Following this rationality an appropriate $\mathbf{B}_{\text{pa}}$ for the combined stock in the North Sea, Skagerrak and West of Scotland was set to 200,000 t. There are indications of increased probability of impaired recruitment for SSB values below 200,000 t from the SSB-recruitment plot. However, the SSB-recruitment plot is scattered. $\mathbf{B}_{\text{loss}}$ amounts to 106,000 t and $\mathbf{B}_{\text{lim}}$ is set at $\mathbf{B}_{\text{loss}}$.

16.1.8 Sandeel

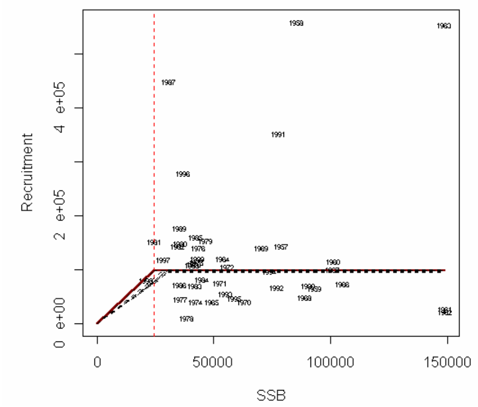
SGPRP: "The segmented regression is not significant. The regression is sensitive to two individual years being removed; for all other years the change point appears to be constant (this could be a bug in the program?). There is a clear upward trend in the residual SSQ in the retrospective analysis. Classification: no S/R relationship and relatively large spread in SSB (use $\mathbf{B}_{\text{loss}}$ as proxy for $\mathbf{B}_{\text{lim}}$). The WG is requested to evaluate a change in reference points for North Sea sandeel based on an updated value of $\mathbf{B}_{\text{loss}}$".



WGNSSK: Using the new $\mathbf{B}_{\text{loss}}$ as a reference point, instead as previously $\mathbf{B}_{\text{lim}}$ (430.000 t) and $\mathbf{B}_{\text{pa}}$ (600.000 t), will only lead to a minor change in the perception of the stock situation for sandeels in IV. Given the uncertainties in the stock assessment the previously proposed $\mathbf{B}_{\text{lim}}$ at 430.000 t seems appropriate.

16.1.9 Sole North Sea

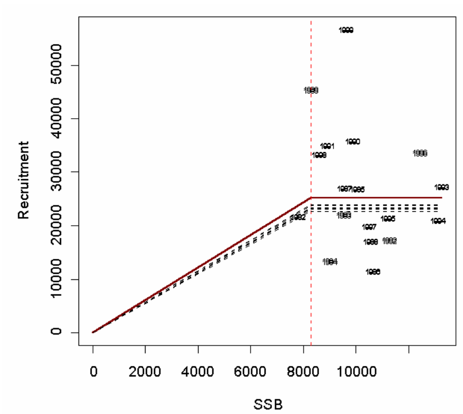
SGPRP: "The segmented regression is not significant. There appear to be two different states of the change point which is dependent on the number of years included in the analysis. The regression is sensitive to the addition of the 1997 data and onwards in the retrospective analysis. Classification: no S/R relationship and relatively large spread in SSB (use $\mathbf{B}_{loss}$ as proxy for $\mathbf{B}_{lim}$). Given that the new $\mathbf{B}_{loss}$ is close to the old $\mathbf{B}_{lim}$, the current reference points can be maintained."



WGNSSK: In the report of the SGPRP (ICES 2003) North Sea sole was classified as having no S/R signal and a relatively large spread in SSB, and it was stated that the current reference points could be maintained because $\mathbf{B}_{loss}$ (21 000) was close to $\mathbf{B}_{lim}$ (25 000). The current assessment estimates $\mathbf{B}_{loss}$ at 20 941. Therefore, the WG proposes that the current reference points can still be maintained: $\mathbf{B}_{lim}$ at 25 000 and $\mathbf{B}_{pa}$ at 35 000.

16.1.10 Sole Eastern Channel

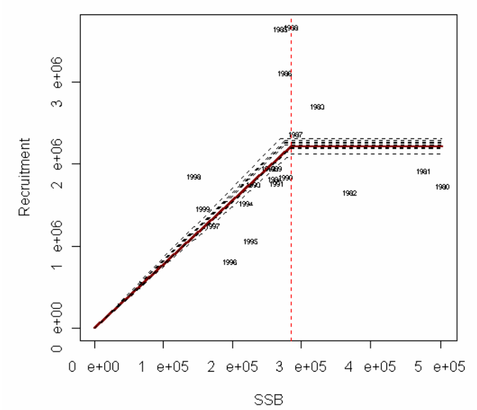
SGPRP: "The segmented regression is not significant. There appears to be only one state of the change point but with different slopes dependent on the number of years included in the analysis. The regression is insensitive to the addition of the data in the retrospective analysis. Classification: no S/R relationship and relatively narrow spread in SSB (use $\mathbf{B}_{loss}$ as proxy for $\mathbf{B}_{pa}$). The WG is requested to evaluate the $\mathbf{B}_{loss}$ as a potential $\mathbf{B}_{pa}$ for this stock."



WGNSSK: See the comments for Plaice in in VIId.

16.1.11 Whiting North Sea

SGPRP: "The segmented regression was considered significant ($p<0.01$). The change point was around 285 thousand tonnes. There is a clear upward trend in the residual SSQ in the retrospective analysis. If the change point would be interpreted as a $\mathbf{B}_{lim}$ point, this would imply a substantial revision of the reference point from 225,000 to 285,000 tonnes. See the conclusions sections for a more detailed discussion of the results for North Sea whiting. The WG is requested to evaluate a change in reference points for North Sea whiting."



WGNSSK: Given the ICES definition of Blim, the segmented regression gives satisfactory results for whiting. The WG notes that using the proposed value as a new Blim, with an associated new Bpa (still to be estimated) as basis for advice would have a substantial impact on the advice.

16.2 Generic comments on the new PA reference point system

16.2.1 Simulations on segmented regressions

If S* is a stable estimate of the level of biomass at which recruitment is impaired then it would be expected, in contrast to $\mathbf{B}_{loss}$ (the lowest observed biomass), that there should be a point at which additional S-R pairs from low SSBs will no longer affect the estimate of S*. Therefore simulations were performed for North Sea cod, haddock, plaice and sole to determine the stability of S* and in particular the relationship between S* and the availability of observations from low SSBs.

In addition for North Sea cod the sensitivity of S* (and the associated limit fishing mortality reference point derived from) it to changes in data quality and the environment was evaluated. The intention was to determine how robust the estimate is relative to assumed underlying stock dynamics and data quality.

Evaluation of the relationship between S and data points from low SSBs*

A time series of SSB that linearly declined from half of Virgin to zero biomass was generated for 50 years. This was then used to generate recruitments residuals drawn from a lognormal distribution for two CVs (30% or 50%) assuming a Ricker stock recruitment relationship for the roundfish and Beverton and Holt for the flatfish stocks (see Table 16.1. and Figure 16.1).

Figure 16.2 evaluates how estimates of S* are influenced by the availability of data from low SSB levels. In the first panel (North Sea cod with a CV of 30%) it can be seen that S* linearly declines for the first 40 years. The lowest estimate is equal to the lowest observed SSB ($\mathbf{B}_{loss}$). After 40 years the linear decline in S* as indicated by box plots is less pronounced, indicating that S* is less influenced by additional data points when data are available from SSBs at about 5% of Virgin SSB. For an assumed CV of 50% levelling off is even less pronounced. A similar result is seen for haddock but the levelling off occurs slightly earlier. A CV of 50% results in more variability in the observed relationship between S* and number of data points than a CV of 30%. For the flatfish stocks S* declines linearly with SSB for all stock sizes and there is no evidence of a stabilisation in the estimate of S*. Increasing the CV increases the variance of the relationship.

Since S* is intended to indicate a level of biomass at which recruitment is impaired the ratio of the expected recruitment at S* to maximum recruitment is shown in figure 16.3. For North Sea cod and haddock expected recruitment when S-R pairs are available in this simulation from low SSBs is about 80% of the maximum level. However for the flatfish stocks expected recruitment declines sharply as more data points are obtained from S-R pairs obtained from low SSB levels.

In conclusion it appears that where the underlying stock recruitment relationship is of the Ricker form then there is no point at which the estimate of S* stops changing as additional data points from low SSBs are obtained, but the rate of change to the S* estimate is reduced. However for an underlying Beverton and Holt relationship the reduction in the estimate of S* continues.

These results are conditional on the assumed stock recruitment relationship. However, alternative equally plausible stock recruitment relationship could also have been evaluated. The assumed stock recruitment relationships assume that recruitment declines to the origin although there is evidence that recruitment can fail at SSBs greater than 0. Also occasional high recruitments are seen even at low biomass. The impact of such behaviour could also be explored.

Evaluation of impact on S of discarding, mis-reporting and regime change*

A more detailed evaluation of S* for North Sea cod was performed by O'Brien et al (2003) and the results are summarised in figures 4 and 5. These shows the results from simulations of a North Sea cod like stock, using three underlying stock recruitment relationships, two treatments evaluated the effect of bias in the stock assessment data (due to discarding and misreporting) and a regime shift where the expected recruitment declined in the recent period.

Figures 16.4 compare S* to $\mathbf{B}_{loss}$ and Figure 5 compares $\mathbf{F}_{lim}$ (derived from S*) to $\mathbf{F}_{loss,}$ O'Brien et al (op. cit.). In Figure 16.4 for each S-R relationship *times* treatment *panel*, the assumed S-R relationship is shown; the points represent R*-S* (blue) or the expected recruitment at $\mathbf{B}_{loss}$ (red). The grey and pink points represent the estimates without systematic departures in the data. The marginal empirical distributions of S* and $\mathbf{B}_{loss}$ are shown.

It can be seen that for a Ricker S-R model S* tends to occur at higher values of SSB and the empirical distribution is more markedly peaked than those for a Beverton-Holt S-R or constant S-R relationships. Also S* tends to occur at higher SSBs than $\mathbf{B}_{loss}$ for the Ricker S-R model, slightly higher for the Beverton-Holt S-R model and at $\mathbf{B}_{loss}$ for constant recruitment model. Discarding appears to have little affect on the estimates of the biomass reference points.

When increasing mis-reporting occurs S* occurs at higher SSB levels whilst $\mathbf{B}_{loss}$ occurs at lower values. However, the effect is much less pronounced for S* than it is for $\mathbf{B}_{loss}$. The consequences for a change in the recent recruitment levels are very similar to those produced by mis-reporting and might imply that in reality it will not be possible to distinguish between the two cases.

In Figure 16.5 the first sub-plot shows the expected slope at the origin and contrasts it with the assumed S-R relationship. The lower sub-plots show the empirical distributions of $\mathbf{F}_{lim}$ (derived from S*) and $\mathbf{F}_{loss}$. In contrast to the biomass reference points the fishing mortality reference points are much less sensitive either to bias in the data, to changes in the dynamics, or to the S-R relationships.

Discussion

S*, the estimate of the biomass at which recruitment is impaired, is only one of a number of candidate approaches that might be employed and has been adopted by ICES for the revision of the reference points for North-east Arctic cod (ICES 2003) at the May 2003 meeting of ACFM. Ultimately, the choice of method and estimation procedure will depend upon specific stock dynamics, knowledge of fisheries and management objectives. However, in reality our knowledge of the stock and fishery dynamics will always be incomplete and it may be difficult to choose between alternative hypotheses about the dynamics. There will also be confounding between changes in the dynamics and the response to management so that it might not be possible to distinguish between real effects and biases in the data. The provision of advice, in respect of management objectives, cannot be postponed until we have full knowledge of the relevant processes. It is therefore important, that any advice is robust to our uncertainty in the dynamic processes and our ability to monitor and control them. Therefore, the simulation approach is important in that it allows the robustness of the change-point method for estimating S* and its corresponding fishing mortality to be evaluated.

		Ricker	**Beverton & Holt**	**Constant**
Discarding	**S***	**No noticeable effect**	**No noticeable effect**	**No noticeable effect**
	$\mathbf{F}_{lim}$	**No noticeable effect**	**No noticeable effect**	**No noticeable effect**
Misreporting	**S***	**Positively biases S***	**Positively biases S***	**Positively biases S***
	$\mathbf{F}_{lim}$	**Little effect**	**Little effect**	**Little effect**
Decline in R	**S***	**Positively biases S***	**Positively biases S***	**Positively biases S***
	$\mathbf{F}_{lim}$	**Little effect**	**Little effect**	**Little effect**

In general, it appears from the simulations that systematic departures in the data tend to increase the estimate of S* (see text table above). Presumably, this may be because all treatments cause the perceived recent recruitment to decline, recent SSBs are also lower and consequently, the change-point occurs at a higher value of SSB. However, note that the opposite effect is seen for $\mathbf{B}_{loss}$. Discarding had minimal effect presumably because discard mortality was less than natural mortality. The fishing mortality corresponding to S* is similar in magnitude to that estimated by $\mathbf{F}_{loss}$.

The following points are clear from the results:

- In contrast to the biomass reference points the fishing mortality reference points are much less sensitive either to bias in the data, to changes in the dynamics, or to the S-R relationships.
- minimal difference between estimates of S* from the Beverton-Holt and constant stock-recruitment models;
- minimal effect of discards on biomass reference points;
- the other treatments (mis-reporting and a decline in recruitment) both suggest that $\mathbf{B}_{loss}$ is biased downwards and S* biased upwards;
- In the case of a recent decline in recruitment the effect is to increase the value of S*, this means that a decline in recruitment and hence the carrying capacity of the stock results in the limit biomass value being increased which is counter-intuitive.

- F corresponding to S* tends to be slightly biased downwards in the mis-reporting and decline in recruitment treatments;

- $\mathbf{F}_{loss}$ tends to be slightly larger than the F corresponding to S*. The latter is not unexpected since both these estimates of F are linear proxies for $\mathbf{F}_{crash}$ but $\mathbf{F}_{loss}$ is estimated at the lower extreme range of the data margin and hence, nearer to the origin. Both of the estimates of fishing mortality seem less affected by the systematic departures explored.

The next step will be to identify appropriate pa-values for biomass and fishing mortality that avoid the lim-values with a specified probability, and take into account the management regime.

Previously, it has been demonstrated that two different ways to formulate advice – one based on a TAC constraint and the other based upon status quo F – could imply different precautionary reference values for fishing mortality and biomass if there is an tendency for an overall assessment bias. (Anon 2002). One should note that any future change to the current basis for advice is most likely to change the corresponding precautionary reference values. Before recommendations can be made for specific target levels or harvesting strategies scenario modelling should be used for the investigation of candidate reference points and their incorporation within a management procedure. Such methodological investigations fall within the remit of the ICES Working Group on Methods on Fish Stock Assessments [WGMG] and further research is planned for presentation at their next meeting in 2004.

16.2.2 Comments on the proposed method to derive PA reference points.

The Study Group on Precautionary Reference Points for Advice on Fishery Management stated in their 2003 report that: "… the distance between LIMIT points and PA point (the distance between $\mathbf{B}_{lim}$ and $\mathbf{B}_{pa}$ and between $\mathbf{F}_{lim}$ and $\mathbf{F}_{pa}$ respectively) relate to our ability to measure the present spawning stock biomass and fishing mortality and are thus related to data quality and estimation methodology."

The Study Group stated later in the report that: "SGPA 02b noted that the comparison between the observed SSB and the true SSB can be made in either the assessment year, or in the forecast year, and concluded that the assessment year should be used since that was the value that was used to compare with the reference point value in giving the advice. However, at the present meeting SGPRP concluded that to be consistent with the estimation of assessment uncertainty, the observed SSB should be that forecast for the end of the TAC year."

WGNSSK agrees with the Study Group that the prediction error of the SSB after fishing could be used as the basis for calculating the distance between $\mathbf{B}_{lim}$ and $\mathbf{B}_{pa}$.

Some important issues to adress:

1) Assuming status quo F in the intermediate year would give a different estimate of $\mathbf{B}_{pa}$ than using a TAC constraint if the assessment has a tendency to be biased. The Study Group on Biological Reference Points for Northeast Arctic Cod estimated one $\mathbf{B}_{pa}$ for assuming status quo F in the intermediate year and one $\mathbf{B}_{pa}$ assuming a TAC constraint. (Anon 2003).

2) The prediction error brought forward from the assessment error is much larger than the assessment error and also depending on F. This means that the estimation of $\mathbf{B}_{pa}$ must rely on assumptions regarding the level of F or possibly even different $\mathbf{B}_{pa}$'s for different F levels. (If you climb higher you need a bigger safety net.)

3) If $\mathbf{B}_{pa}$ is estimated assuming F= $\mathbf{F}_{pa}$ in the prediction year then aiming at F> $\mathbf{F}_{pa}$ should be evaluated relative to an increased (F dependent) $\mathbf{B}_{pa}$. A not so uncommon wish from managers is to aim at $\mathbf{B}_{pa}$ allowing for F> $\mathbf{F}_{pa}$. And the opposite case: If managers (?) are rebuilding the stock and aiming at F< $\mathbf{F}_{pa}$ then the safety margin represented by the distance between $\mathbf{B}_{lim}$ and $\mathbf{B}_{pa}$ could be reduced.

4) Fishing at higher F's (above 0.7) makes it almost impossible to use a deterministic forecast for a single yearclass if the assessment error has overestimated the yearclass with 20% or more. The predicted catch of the yearclass in the TAC year will easily be higher than the yearclass size after the intermediate year. A stock completely dominated by one yearclass could easily demonstrate such effects. General symptoms of overestimation would be that the fishery was unable to take the TAC or there is a change in fishing pattern (compensating the unexpected low level of one or more yearclasses with fishing on younger agegroups).

5) The WG urges the WGMG or SGPRP to come forward with practicle software solutions to implement the estimation of prediction error without having to go down the detailed route that was followed for North East Arctic cod.

16.3 Update of reference points for "changed" assessments

16.3.1 North Sea Cod (cod-347d)

Changes to the range of ages used for the assessment of this stock resulting from the lack of reliable tuning information at the oldest ages necessitated a recalculation of the PA reference points for this stock. The PA soft program was therefore applied to the stock and exploitation estimates derived from the XSA model fit based on the fit to landings data only. The stock and recruit time series used for the estimation of reference points was 1963 – 2001, that is the 1962 – 2000 year classes. The final year of XSA estimates was removed from the estimation procedure. Figure 3.9.2 and Table 3.9.1 present the PAsoft output from the reference point estimation procedure.

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

Using the previously applied criteria for the selection of fishing mortality reference points (ACFM report 2002) $\mathbf{F}_{lim}$ = $\mathbf{F}_{loss}$, the new value of $\mathbf{F}_{loss}$ estimated for this stock is 0.91 based on the median of the bootstraped value derived from Gloss. This compares to the value of 0.86 based on the 1 – 11+ age range and Fbar(2-8) used previously by this working group. Using the previous ACFM formulation $\mathbf{F}_{pa}$ is therefore taken from the 5th percentile of $\mathbf{F}_{loss}$ and is estimated to be 0.72. This compares with the previous value of 0.65.

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

The estimates of biological reference points and management reference points for cod are given in the text tables below.

Management reference point	1998 choice	2003 proposal
$\mathbf{B}_{lim}$	70,000t	70,000 t
$\mathbf{B}_{pa}$	150,000t	150,000 t
$\mathbf{F}_{lim}$	0.86	0.91
$\mathbf{F}_{pa}$	0.65	0.72

16.3.2 North Sea Haddock (had-34)

The reduction of the mean *F* age range from 2–6 to 2–4 necessitated a reanalysis of the biological reference points for haddock, particularly those based on *F*. The PASoft program was run on the output from the final-configuration XSA model. A lowess span of 0.8 was chosen on the basis of the AIC minimum shown in **Figure** 4.9.1.

The stock-recruit plot with a lowess smoother is shown in Figure 4.9.2. The most obvious feature of this relationship are sporadic large recruitments. Even without these occasional outbreaks there is little in the way of a stock-recruit relationship.

ACFM state that $\mathbf{B}_{lim}$ for this stock is determined as a smoothed estimate of $\mathbf{B}_{loss}$ and $\mathbf{B}_{pa}$ is 1.4*$\mathbf{B}_{lim}$. A new estimate of $\mathbf{B}_{loss}$ was not made in this assessment, but there appears to be no compelling reason to change the current $\mathbf{B}_{lim}$ and $\mathbf{B}_{pa}$. The average scaling factor between F2-6 and F2-4 is 0.97 over the whole time-series. The differences between the two average fishing mortalities may have been slightly larger in recent years. Nevertheless, the WG proposes that in the first instance the fishing mortality reference points with the new age range can be kept at the old values: $\mathbf{F}_{pa}$ =0.7 and $\mathbf{F}_{lim}$=1.0.

	F_{max}	$F_{0.1}$	F_{med}	F_{pa}	F_{lim}	B_{pa}	B_{lim}
2002	0.25*	0.18	0.49	0.7	1.0	140,000 t	100,000 t
2003	0.32*	0.19	0.57	0.7	1.0	140,000 t	100,000 t

*corresponding to HC landings only

16.3.3 Plaice North Sea

In the report of the SGPRP (ICES 2003) North Sea plaice was classified as having no S/R signal and a distinct plateau (wide range of SSB), and it was suggested that $\mathbf{B}_{lim}$ should be estimated according to standard method. The segmented regression for North Sea plaice presented by SGPRP (ICES 2003) is not significant, and "the WG is requested to evaluate a change in reference points for North Sea plaice based on an updated version of $\mathbf{B}_{loss}$". Up to now $\mathbf{B}_{lim}$ was set at 210 000 tonnes.

The WG discussed how to estimate $\mathbf{B}_{lim}$, in which process three possible bases for $\mathbf{B}_{lim}$ estimates came up:

- Using $\mathbf{B}_{lim}$ with an updated value of $\mathbf{B}_{loss}$ (134 000 tonnes); this is the SSB in 1997 which was the basis for setting the current $\mathbf{B}_{lim}$. The original estimate of 210,000 t. has been revised over subsequent assessment and is now estimated to be 134,000 tonnes.

  - This choice is consistent with the previous choice of $\mathbf{B}_{lim}$ set at $\mathbf{B}_{loss}$.
  - Since there is no significant S/R relation, no impaired recruitment is observed at any observed SSB.

  However:

  - The Lowess smoother through the SSR plot shows a breakpoint around 270,000 tonnes.
  - There are now six years of low recruitment at relatively low SSB. This may point to recruitment impairment.

- Keep $\mathbf{B}_{lim}$ at current level (210 000 tonnes)

  - The Lowess smoother through the SSR plot shows are breakpoint around 270,000 tonnes.
  - There are now six years of low recruitment at relatively low SSB. This may point to recruitment impairment.

  However:

  - The change in age range for the reference F necessitates re-establishment of $\mathbf{F}_{lim}$ and $\mathbf{F}_{pa}$. Following the technical basis (ACFM 2002) for these reference points will result in them being inconsistent with $\mathbf{B}_{lim}$ and $\mathbf{B}_{pa}$ remaining at their current values.
  - The technical basis for the present $\mathbf{B}_{lim}$ was $\mathbf{B}_{lim} = \mathbf{B}_{loss}$. Keeping it at 210 000 has no basis.

- Set $\mathbf{B}_{lim}$ is at S*, given by segmented regression, at 154 000 tonnes

  - Although the segmented regression is not significant, it may still give the best estimate of SSB below which recruitment is impaired.
  - S* corresponds to the lowest observed SSB at which a strong year class can still be produced (this argument is used as a basis for spasmodic spawners).

However:

  - The segmented regression is not significant, hence spurious. Therefore, it gives no estimate of SSB below which recruitment is impaired.
  - Based on visual inspection of the S/R plot, the SSB at which recruitment is impaired does not correspond with S*.
  - The segmented regression is very sensitive to the exclusion of single data points, e.g. those corresponding to strong year classes.

To conclude: the WG cannot choose between two alternative lines of reasoning. One line of reasoning is that the old technical basis for the estimation of $\mathbf{B}_{lim}$ should be re-applied because the current assessment gives a very different estimate of the SSB in 1997 which was the basis for setting the $\mathbf{B}_{lim}$. Given that the segmented regression is not significant this would mean that the $\mathbf{B}_{lim}$ would be updated from 210,000 to 134,000 tonnes. The second line of reasoning is that a strict application of the technical basis from ACFM 2002 is no longer valid because additional information has now shown that recruitment may have been impaired since the low biomasses from 1997 onwards. This suggests that we should preferably change the technical basis for estimating $\mathbf{B}_{lim}$.

$\mathbf{F}_{lim}$ and $\mathbf{F}_{pa}$ needed to be re-established because the current assessment changed the age range for the reference F from 2-10 to 2-6.

- The technical basis for $\mathbf{F}_{lim}$ was $\mathbf{F}_{loss}$ (ACFM 2002) and is maintained. This sets $\mathbf{F}_{lim}$ at 0.43.

- The technical basis for $\mathbf{F}_{pa}$ was the 5th percentile of $\mathbf{F}_{loss}$ or lower such that it implies Beq > $\mathbf{B}_{pa}$ and a less than 10% probability that SSB_{MT} < $\mathbf{B}_{pa}$ (ACFM 2002).

The different scenario's for estimating $\mathbf{B}_{lim}$ result in the following calculated refernce points.

$\mathbf{B}_{lim}$	$\mathbf{B}_{pa}$	$\mathbf{F}_{lim}$=$\mathbf{F}_{loss}$	$\mathbf{F}_{pa}$[1]
134,000 t	190,000 t.	0.43 ??	0.40
155,000 t.	220,000 t.	0.43 ?	0.37
210,000 t.	300,000 t.	0.43	0.30

16.3.4 Sole North Sea

$\mathbf{F}_{lim}$ is undefined for this stock (ACFM 2002). $\mathbf{F}_{pa}$ needs to be re-established because the current assessment changed the age range for the reference F from 2-8 to 2-6.

The technical basis for $\mathbf{F}_{pa}$ was the 5th percentile of $\mathbf{F}_{loss}$ or lower such that it implies Beq > $\mathbf{B}_{pa}$ and a less than 10% probability that SSB_{MT} < $\mathbf{B}_{pa}$ (ACFM 2002).

The 5th percentile of $\mathbf{F}_{loss}$ = 0.55 and implies Beq ~ $\mathbf{B}_{pa}$, but P(SSB_{MT} < $\mathbf{B}_{pa}$) > 10%.

F = 0.35 implies P(SSB_{MT} < $\mathbf{B}_{pa}$) ~ 10% where MT is run over 25 years, and implies Beq > $\mathbf{B}_{pa}$.

Following this argumentation, the WG proposes 0.35 as the new $\mathbf{F}_{pa}$.

Management reference point	1998 choice	2003 proposal
$\mathbf{B}_{lim}$	25,000 t.	25,000 t.
$\mathbf{B}_{pa}$	35,000 t	35,000 t
$\mathbf{F}_{lim}$	undefined	undefined
$\mathbf{F}_{pa}$	0.40	0.35

[1] P(SSB_{MT} < Bpa) ~ 10% where MT is run over 25 years

Table 16.1 Assumed stock recruitment relationships, with corresponding virgin biomass and maximum recruitment (at virgin biomass for the Beverton and Holt and $\mathbf{B}_{MSY}$ for the Ricker relationships)

Stock	*Relationship*	*Alpha*	*Beta*	*V. Biomass*	*Max R*
Cod	**Ricker**	**3.73**	**3.18E-06**	**1192121**	**431646**
Haddock	**Ricker**	**211.0**	**2.15E-06**	**1265851**	**36140995**
Plaice	**Beverton & Holt**	**1.85E-06**	**0.1853**	**3024427**	**523022**
Sole	**Beverton & Holt**	**8.18E-06**	**0.1105**	**467557**	**118781**

Figure 16.1. SSB and expected recruitment, from the stock recruitment relationship, by data year.

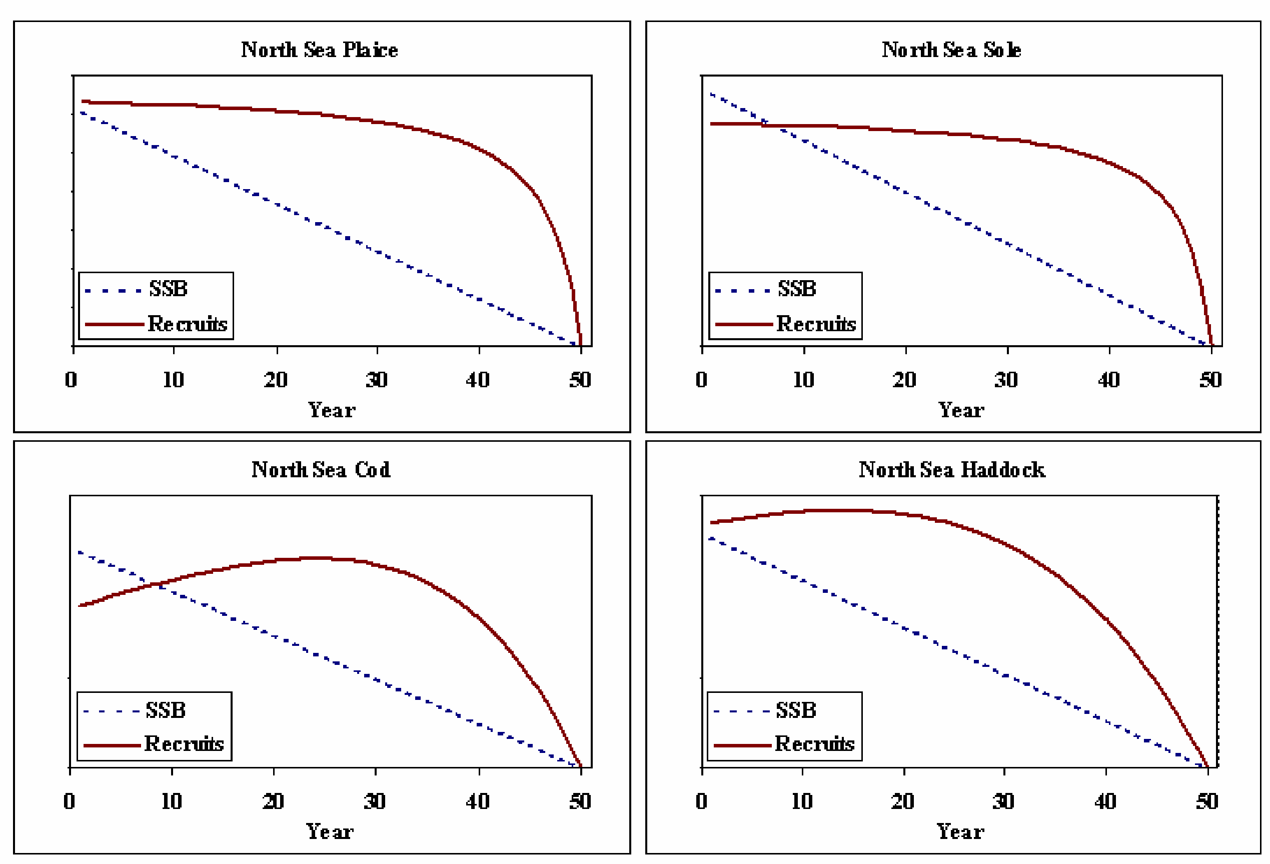


Figure 16.2. Plots showing S* as a ratio of Virgin SSB for each stock, top row for a CV of 30% and bottom row a CV of 50%. Boxes show the inter-quartile range, the whiskers extend to the most extreme data point but not more than 1.5 times the inter-quartile range from the box.

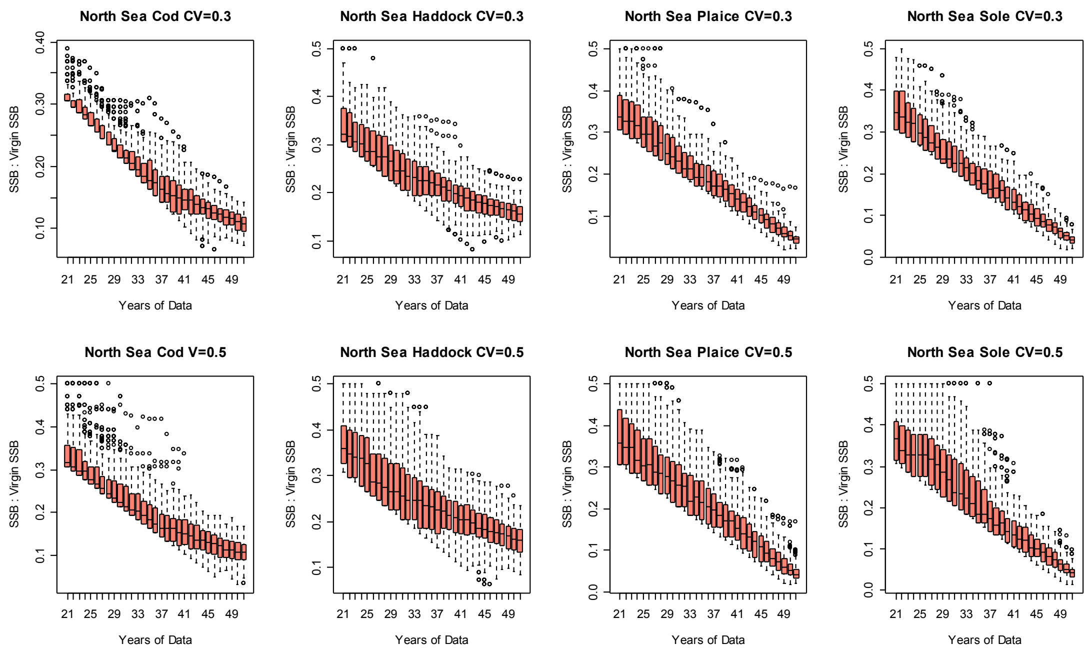


Figure 16.3. Plots showing expected recruitment, given by the assumed stock recruitment relationship, at S* as a ratio of maximum recruitment for each stock, top row for a CV of 30% and bottom row a CV of 50% Boxes show the inter-quartile range, the whiskers extend to the most extreme data point but not more than 1.5 times the inter-quartile range from the box.

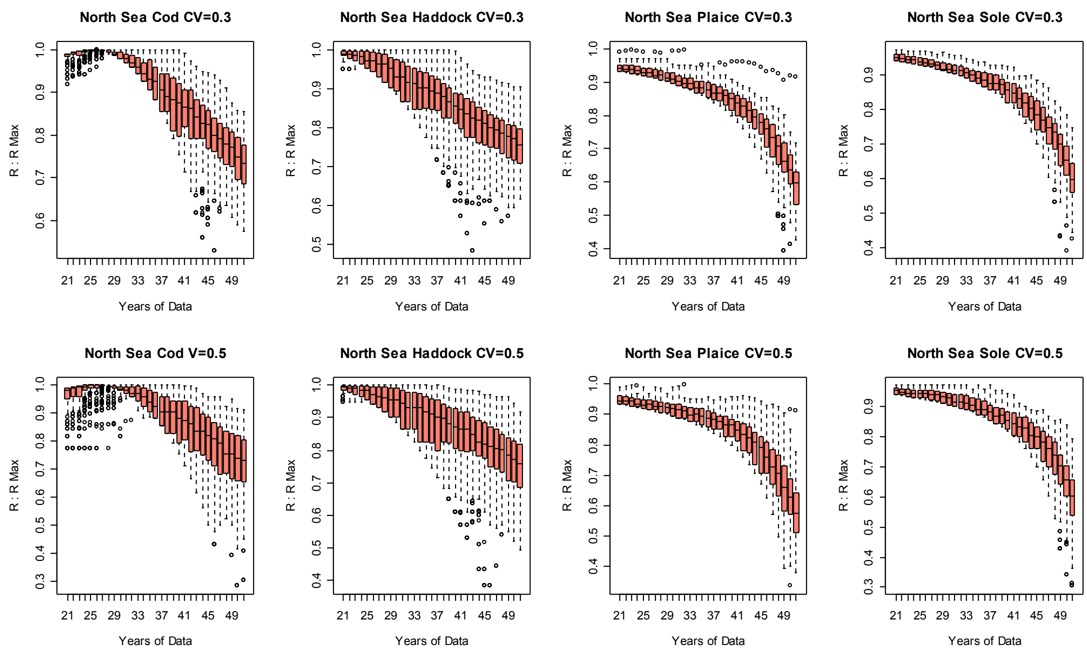


Figure 16.4. Plots show the simulated values for each stock-recruitment relationship along with the marginal density for S* (blue) and $\mathbf{B}_{loss}$ (red). The thick lines are for estimates with systematic departures in the data; namely, discarding, mis-reporting and a decline in recruitment; the thin lines (grey and pink) show the distribution without these systematic departures. Pair wise comparisons may only be made between the grey and blue points/curves and between the pink and red points/curves as their simulations are linked.

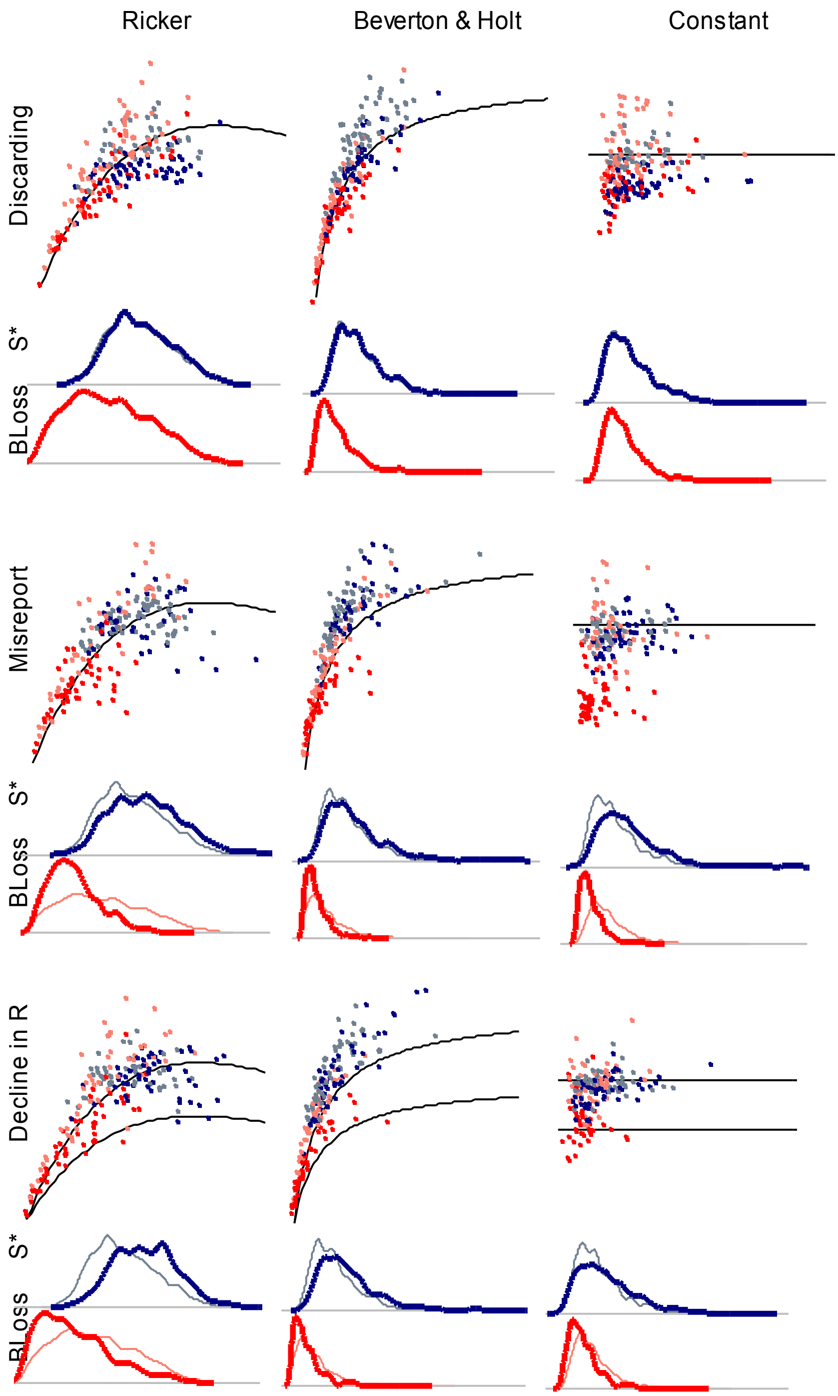
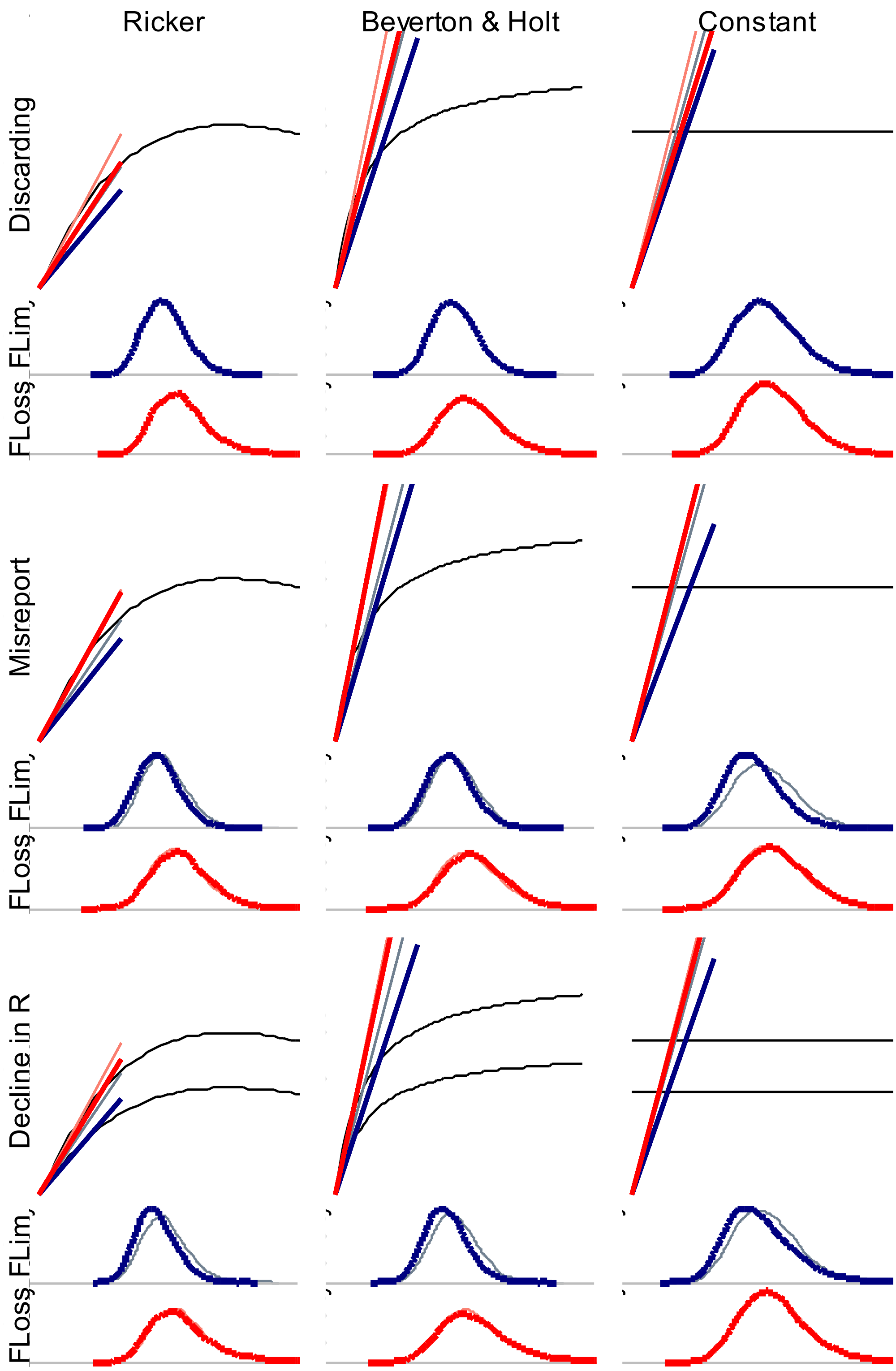


Figure 16.5. Plots show the expected values of the slope at the origin for each stock-recruitment relationship along with the marginal density for $\mathbf{F}_{lim}$ (blue) and $\mathbf{F}_{loss}$ (red). The thick lines are for estimates with systematic departures in the data; namely, discarding, mis-reporting and a decline in recruitment; the thin lines (grey and pink) show the distribution without systematic departures. Pair wise comparisons may only be made between the grey and blue points/curves and between the pink and red points/curves as their simulations are linked.



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Annex - Quality Handbook

Stock specific documentation of standard assessment procedures used by the ICES WGNSSK

1 INTRODUCTION

Text to be written

2 METHODS

Text to be written

3 COD IN AREAS IIIA (SKAGERRAK), IV AND VIID

Text to be written

4 HADDOCK IN SUB-AREA IV AND DIVISION IIIA

Text to be written

5 IV & VIID WHITING

Stock specific documentation of standard assessment procedures used by ICES.

Stock: Whiting in Division IV
Working Group: Assessment of Demersal Stocks in the North Sea and Skagerrak
Date: 29 August 2003
Last updated: 29 August 2003

5.1 General

5.1.1 Stock definition

Whiting is known to occur exclusively in some localised areas, but for the most part it is caught as part of a mixed fishery operating throughout the entire year. Adult whiting are widespread in the North Sea, while high numbers of immature fish occur off the Scottish coast, in the German Bight and along the coast of the Netherlands.

Tagging experiments, and the use of a number of fish parasites as markers, have shown that the whiting found to the north and south of the Dogger Bank form two virtually separate populations (Hislop & MacKenzie, 1976). It is also possible that the whiting in the northern North Sea may contain 'inshore' and 'offshore' populations.

5.1.2 Fishery

5.1.3 Ecosystem aspects

Results from key runs of the North Sea MSVPA in 2002 and 2003 indicate three major sources of mortality. For ages two and above, the primary source of mortality is the fishery, followed by predation by seals, which increases with fish age. For ages 0-1, though more notable on 0-group, there is evidence for cannibalism. This is corroborated by Bromley et al. (1997), who postulate that multiple spawings over a protracted period may provide continued resources for earlier spawned 0-group whiting.

Results from key runs of the North Sea MSVPA in 2002 and 2003 indicate that, as a predator, whiting tend to feed on (in order of importance): whiting, sprat, Norway pout, sandeel and haddock.

5.2 Data

5.2.1 Commercial catch

For North Sea catches, human consumption landings data and age compositions were provided by Scotland, the Netherlands, England, and France. Discard data were provided by Scotland and used to estimate total international discards. Other discard estimates do exist (Section 1.11.4, 2002 WG), but were not made available to Working Group data collators. Since 1991 the age composition of the Danish industrial by-catch has been directly sampled, whereas it was calculated from research vessel survey data during the period 1985–1990. Norway provides age composition data for its industrial by-catch.

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

5.2.2 Biological

Weight at age in the stock is assumed to the same as weight at age in the catch. Further paragraphs.

Natural mortality values are rounded averages of estimates produced by previous key runs of the North Sea MSVPA (see Section 1.3.1.3 of the 1999 WG report: ICES CM 2000/ACFM:7). The values used in both the assessment and the forecast are :

Age	1	2	3	4	5	6	7	8+
Natural Mortality	0.95	0.45	0.35	0.30	0.25	0.25	0.20	0.20

The maturity ogive is based on North Sea IBTS quarter 1 data, averaged over the period 1981-1985. The maturity ogive used in both the assessment and forecast is:

Age	1	2	3	4	5	6	7	8+
Maturity Ogive	0.11	0.92	1.00	1.00	1.00	1.00	1.00	1.00

Both the proportion of natural mortality before spawning (Mprop) and the proportion of fishing mortality before spawning (Fprop) are set to zero.

5.2.3 Surveys

The Scottish Groundfish Survey (SCOGFS) is carried out in August each year, and covers depths of roughly 35 m to 200 m in the North Sea to the north of the Dogger Bank. It samples at most one survey station per statistical rectangle. In 1998 the coverage of this survey was extended into the central North Sea, but the index available to the Working Group has been modified so as to cover a consistent area throughout the time-series.

The English Groundfish Survey (ENGGFS) is carried out in August each year, and samples at most one station per rectangle. It covers depths of roughly 35 m to 200 m in the whole of the North Sea basin.

The time-series of the survey indices of whiting supplied by the French Channel Groundfish Survey (FRAGFS) was revised in 2002. In 2001, the Eastern Channel was split into five zones. Abundance indices were first calculated for each zone, and then averaged to obtain the final FRAGFS index. This procedure was not thought to be entirely satisfactory, as the level of sampling was inconsistent across geographical strata. In 2002, it was thought more appropriate first to raise abundance indices to the level of ICES rectangles, and then to average those to calculate the final abundance index. Previous to the 2002 WG, only the hauls in which whiting were caught were used to derive abundance indices. This procedure biased estimates, and therefore, the indices supplied from 2002 are calculated on the basis of all hauls.

The first quarter International Bottom Trawl Survey (IBTS Q1) is undertaken in February and March of each year, and covers depths of roughly 35 m and 200 m in the whole of the North Sea basin. It uses a higher density of survey stations than either the SCOGFS or the ENGGFS, with several hauls per statistical rectangle.

5.2.4 Commercial CPUE

Effort data are available for two Scottish commercial fleets: seiners (SCOSEI) and light trawlers (SCOLTR). Non-mandatory reporting of fishing effort for these fleets means that they cannot strictly be used for catch-at-age tuning.

French commercial fleets….

5.2.5 Other relevant data

None

5.3 Historical Stock Development

5.3.1 Weight at age

5.4 Short-term Projection

Model used:
Software used:
Initial stock size:
XSA terminal population numbers
Natural mortality:
XSA input
Maturity:
XSA input
F and M before spawning:
XSA input
Weight at age in stock:

Mean of last three years by age
Weight at age in catch:
Mean of last three years by age
Exploitation pattern:
Mean of last three years. Level of exploitation defined $\mathbf{F}_{sq}$. Exploitation pattern was scaled by to mean of last two years.
F at age * [$\mathbf{F}_{sq}$ / Fbar(Fexplotation)
Intermediate year assumptions:
Stock recruitment model used:
Ricker with parameters : alpha = , Beta = .
Procedures used for splitting projected catches:
Mean proportion over last three years

5.5 Medium-Term Projections

N/A for the time being

5.6 Yield and Biomass per Recruit / Long-Term Projections

5.7 Biological Reference Points

5.8 Other Issues

5.9 References

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6 SAITHE IN SUB-AREA IV, VI, AND DIVISION IIIA

6.1 General

6.1.1 STOCK DEFINITION

The geographical distribution of juveniles (< age 3) and adults differs. Typical for all saithe stocks are the inshore nursery grounds. Juveniles are therefore mainly distributed along the west and south coast of Norway, the coast of Shetland and the coast of Scotland. Around age 3 the individuals gradually migrate from the costal areas to the northern part of the North Sea (57°N - 62°N), where the feeding grounds of the adult part of the stock are situated. The age at maturity is between 4 and 6 years, and spawning takes place in January-March at about 200 m depth along the Northern Shelf edge and the western edge of the Norwegian deeps. Mature fish migrate during the season between the feeding grounds (summer) and spawning grounds (winter).

Before 1999 saithe in Sub-area IV and Division IIIa and saithe in Sub-area VI was treated as a separate stock units. These stock boundaries were more for management purposes than a biological basis for stock separation. Present biological knowledge shows no evidence that saithe in Division IVa and Via belong to separate stock units. There seems to be a similar recruitment pattern and the spawning areas in these divisions are not separated (ICES 1995).

Tagging experiments by various countries have shown that exchange between all saithe stock components in the north-east Atlantic takes place to a variable extent (ICES 1995). For example, a substantial migration of immature saithe from the Norwegian coast between 62°N and 66°N to the North Sea has been shown to occur (Jakobsen 1981). 0-group saithe, on the other hand, drifts from the northern North Sea to the coast of Norway north of 62°N.

6.1.2 FISHERY

Saithe in the North Sea are mainly taken in a direct trawl fishery in deep water near the Northern Shelf edge and the Norwegian deeps. The majority of the catches are taken by Norwegian, French, and German trawlers. In the first half of the year the fishery are directed towards mature fish, while immature fish dominate in the catches the rest of the year. In recent years the French fishery deployed less effort along the Norwegian deeps, while the German and Norwegian fisheries have maintained their effort there. The main fishery developed in the beginning of the 1970s. Recently trawlers have also been targeting deep sea fish, and it is necessary to take account of that when tuning series are established. The fishery in Area VI consists largely of a directed French, German, and Norwegian deep-water fishery operating on the shelf edge, and a Scottish fishery operating inshore. In both areas most of the saithe do not enter the main fishery before age 3, because the younger ages are staying in inshore waters. A small proportion of the total catch is taken in a limited purse seine fishery along the west coast of Norway targeting juveniles (age 2 and 3). Minimum landing size for saithe is currently 35 cm in the EU zone and 32 cm in the Norwegian zone (south of 62°N). Since the fish are distributed inshore until they are 2-3 years old, discarding of young fish is assumed to be a small problem in this fishery. Problems with by-catches in other fisheries when saithe quotas are exceeded may cause discarding. Data from SGDBI and Scotland indicate that the discard in the UK fleets in 2000 and 2001 was about 22 000 t and 15 000 t, respectively, mainly age 3 and age 4. French and German trawlers are targeting saithe and they have larger quotas, so the problem may be less in these fleets. The Norwegian trawlers move out of the area when the boat quotas are reached, and in addition the fishery is closed if the seasonal quota is reached.

6.1.3 ECOSYSTEM ASPECTS

Saithe in the North Sea mainly preys on krill and Norway pout.

6.2 Data

6.2.1 COMMERCIAL CATCH

Catch at age data by fleet are supplied by Denmark, Germany, France, Norway, UK (England), and UK (Scotland) for Area IV and only UK(Scotland) for Area VI. Aberdeen (FRS) is responsible for the database with catch at age data from the different countries.

6.2.2 BIOLOGICAL

Average weights at age in the stock are assumed to be equal to average weights at age in the catches. Average weights at age by fleet are supplied by Denmark, Germany, France, Norway, UK (England), and UK (Scotland) for Area IV and only UK(Scotland) for Area VI.

Aberdeen (FRS) is responsible for the database with weights at age in the catches from the different countries.

A natural mortality rate of 0.2 is used for all ages in all years. A constant maturity ogive based on historic biological sampling is used for all years:

Age	1	2	3	4	5	6	7+
Proportion mature	0.0	0.0	0.0	0.15	0.7	0.9	1.0

6.2.3 SURVEYS

A Norwegian acoustic survey is conducted in conjunction with the IBTS Q3 survey, covering the area north of 56°30′ N up to 62° N and directed towards saithe. The time series of indices from this survey is the only survey data used for tuning, and it extends back to 1995.

Time series from the English and Scottish Groundfish surveys are also available for tuning but since saithe is not well represented they are, at the time being, excluded.

A survey along the Norwegian coast targeting saithe larvae (0-group) started in 1999. The time series from this survey is currently too short to evaluate its potential as a year class strength predictor (i.e. to investigate the correlation between the 0-group indices and the corresponding VPA numbers at age 3).

6.2.4 COMMERCIAL CPUE

Three time series of CPUE are used in the tuning: Norwegian bottom trawl, German bottom trawl and French fresh fish trawlers. All fleets are targeting saithe along the Northern Shelf edge and along the western edge of the Norwegian deep, primarily at depths between 150 - 250 m. A more detailed description of the CPUE time series follows.

Norwegian bottom trawl: This time series extends back to 1980. The resolution of the logbook data is day-by-day (i.e. a record comprises total daily catch and total hours trawled for each vessel). Only records where the weight proportion of saithe exceeds 50 % and records from vessels larger than 30 m are used to calculate CPUE (kg/h). Samples of age compositions in commercial trawl catches are used to age disaggregated the CPUE time series.

German bottom trawl: This age disaggregated CPUE time series extends back to 1995, and it is described in (Rätz et al. 2002)

French fresh fish trawlers: This time series extends back to 1990. The French saithe fishery has developed in the seventies, during the gadoid outburst. At the beginning of the nineties, the saithe stock reached its lowest historical level. Part of the French vessels reacted by fishing in different areas and in deeper waters. The remaining vessels have been harvesting saithe, almost exclusively in the North Sea, and with by-catches of deep-water species (blue ling) west of Scotland. The French fleet targeting saithe is now made up of large trawlers and freezer trawlers over 50 m. The vessels are registered in Boulogne and Lorient.

Series of CPUE (kg/h) at age were not supplied for the French freezers after 2002, as the landings from this fleet were neither length- nor age-sampled. The French tuning fleet is therefore made up of the non-freezer trawlers. Data are restricted to the fishing trips with more than 10% of saithe landings.

6.2.5 OTHER RELEVANT DATA

None.

6.3 Historical Stock Development

6.3.1 DETERMINISTIC MODELLING

Modell used: XSA (Darby and Flatman 1994)

Software used: Lowstoft VPA suite.

The settings of the final run in 2003 are given in the following table.

Year of assessment	**2003**	
Assessment model	XSA	
French trawlers (TRB) IV	1990-2002	**3-9**
Norwegian trawlers IV	1980-2002	3-9
German trawlers IV	1995-2002	3-9
SGFS	not used	
EGFS	not used	
Norwegian acoustic survey IV	**1995-2002**	**3-7**
Time-series weights	tricubic over 20 yrs	
Power model used for catchability	1-2	
Catchability plateau age	7	
Surv. est. shrunk towards mean F	5 years / 3 ages	
s.e. of the means	1.0	
Min. stand. error for pop. estimates	0.3	
Prior weighting	none	

6.3.2 UNCERTAINTY ANALYSIS

Nothing here yet.

6.3.3 RETROSPECTIVE ANALYSIS

6.4 Short-Term Projection

Model used:

WGFRANSW (Reeves and Cook 1994)

Recruitment at age 1:

The geometric mean of historic XSA numbers at age 1 (in 2003 the geometric mean from the period 1985-00 was used).

Initial stock structure:

The number at age 2 are found by applying natural mortality (0.2) and XSA fishing mortality at age 1 from the last year to the number of recruits at age 1 (geometric mean). The number at age 3 are found by first applying natural mortality (0.2) and XSA fishing mortality at age 1 from the second last year (i.e. for the 2003-assessment F_1 from 2001) to the number of recruits at age 1 (geometric mean) and, second, apply natural mortality (0.2) and XSA fishing mortality at age 2 from the last year to this number (i.e. for the 2003-assessment F_2 from 2002). For ages older than 3, XSA-numbers for the current year are used.

Mortality:

Natural mortality is 0.2 for all ages. Fishing mortalities at age is the mean of the XSA fishing mortalities at age for the 3 last years. (The fishing pattern is not scaled to F_{3-6} for the last year.)

Maturity:

The constant maturity ogive used (see section 2.2).

Mean weights at age in the stock and catch:

The average of mean weights at age for the last three years.

6.5 Medium-Term Projections

Initial stock size, maturity at age, natural mortality, fishing mortality and mean weights at age in the stock/catch are the same as in the short-term projection.

Recruitment:

A Ricker stock-recruitment curve is fitted to the historic data (SSB and age 1 from XSA).

6.6 Long-Term Projections, yield per recruit

Nothing here yet.

6.7 Biological reference points

$\mathbf{F}_{0.1}$	0.09	$\mathbf{F}_{lim}$	0.60
$\mathbf{F}_{max}$	0.17	$\mathbf{F}_{pa}$	0.40
$\mathbf{F}_{med}$	0.49	$\mathbf{B}_{lim}$	106 000 t
$\mathbf{F}_{high}$	>0.49	$\mathbf{B}_{pa}$	200 000 t

6.8 Other Issues

None

6.9 References

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7 SOLE IN SUB-AREA IV

Text to be written

8 EASTERN CHANNEL SOLE (SOLE_ECHE)

DRAFT TEXT – to be completed by next WG

Stock specific documentation of standard assessment procedures used by the ICES WGNSSK.

Working group: North Sea Demersal Working Group

Updated: 3/9//2003

By: Richard Millner (r.s.millner@cefas.co.uk) and Wim Demaré (wim.demare@dvz.be)

8.1 General

8.1.1 Stock definition

The sole in the eastern English Channel (VIId) are considered to be a separate stock from the larger North Sea stock to the east and the smaller geographically separate stock to the west in VIIe. There is some movement of juvenile sole from the North Sea into VIId (ICES CM 1989/G:21) and from VIId into the western Channel (VIIe) and into the North Sea. Adult sole appear to largely isolated from other regions except during the winter, when sole from the southern North Sea may enter the Channel temporarily (Pawson, 1995).

8.1.2 Fishery

There is a directed fishery for sole by small inshore vessels using trammel nets and trawls, who fish mainly along the English and French coasts and possibly exploit different coastal populations. Sole represents the most important species for these vessels in terms of the annual value to the fishery. The fishery for sole by these boats occurs throughout the year with small peaks in landings in spring and autumn. There is also a directed fishery by English and Belgian beam trawlers who are able to direct effort to different ICES divisions. These vessels are able to fish for sole in the winter before the fish move inshore and become accessible to the local fleets. In cold winters, sole are particularly vulnerable to the offshore beamers when they aggregate in localised areas of deeper water. Effort from the beam trawl fleet can change considerably depending on whether the fleet moves to other areas or directs effort at other species such as scallops and cuttlefish. A third fleet is made up of French offshore trawlers fishing for mixed demersal species and taking sole as a by-catch.

The minimum landing size for sole is 24cm. Demersal gears permitted to catch sole are 80mm for beam trawling and 90mm for otter trawlers. Fixed nets are required to use 100mm mesh since 2002 although an exemption to permit 90mm has been in force since that time.

8.1.3 Ecosystem aspects

No information is available.

8.2 Data

8.2.1 Commercial catch

The landings are taken by three countries France (50%), Belgium (30%) and England (20%). Age sampling for the period before 1980 was poor, but between 1981 and 1984 quarterly samples were provided by both Belgium and England. Since 1985, quarterly catch and weight-at-age compositions were available from Belgium, France, and England.

8.2.1.1 Belgium

Belgian commercial landings and effort information by quarter, area and gear are derived from log-books (CHECK).

Sampling for age and length occurs for the beam trawl fleet (main fleet operating in Belgium).

Quarterly sampling of landings takes place at the auctions of Zeebrugge and Oostende (main fishing ports in Belgium). Length is measured to the cm below. Samples are raised per market category to the catches of both harbours.

Quarterly otolith samples are taken throughout the length range of the landings (sexes separated). These are aged and combined to the quarterly level. The ALK is used to obtain the quarterly age distribution from the length distribution.

In 2003 a pilot study started on on-board sampling with respect to discarded and retained catch.

8.2.1.2 France

French commercial landings in tonnes by quarter, area and gear are derived from log-books for boats over 10m and from sales declaration forms for vessels under 10m. These self declared production are then linked to the auction sales in order to have a complete and precise trip description.

The collection of discard data has begun in 2003 within the EU Regulation 1639/2001. This first year of collection will be incomplete in term of time coverage, therefore the use of these data should be investigated only from 2005.

The length measurements are done by market commercial categories and by quarter into the principal auctions of Grandcamp, Port-en-Bessin, Dieppe and Boulogne. Samplings from Grandcamp and Port-en-Bessin are used for raising catches from Cherbourg to Fecamp and samplings from Dieppe and Boulogne are used to raise the catches from Dieppe to Dunkerque

Otoliths samples are taken by quarter throughout the length range of the landed catch for quarters 1 to 3 and from the october GFS survey in quarter 4. These are aged and combined to the quarterly level and the age-length key thus obtained is used to transform the quarterly length compositions. The length not sampled during one quarter are derived from the same year close quarter.

Weight, sex and maturity at length and at age are obtained from the fish sampled for the age-length keys.

8.2.1.3 England

English commercial landings in tonnes by quarter, area and gear are derived from the sales notes statistics for vessels under 12m who do not complete logbooks. For those over 12m (or >10m fishing away for more than 24h), data is taken from the EC logbooks. Effort and gear information for the vessels <10m is not routinely collected and is obtained by interview and by census. .No information is collected on discarding from vessels <10m but it is known to be low. Discarding from vessels >10m has been obtained since 2002 under the EU Data Collection Regulation and is also relatively low.

Length samples are combined and raised to monthly totals by port and gear group for each stock. Months and ports are then combined to give quarterly total length compositions by gear group; unsampled port landings are added in at this stage. Quarterly length compositions are added to give annual totals by gear. These are for reference only, as ALK conversion takes place at the quarterly level. Age structure from otolith samples are combined to the quarterly level, and generally include all ports, gears and months. For sole the sex ratio from the randomally collected otolih samples are used to spli the unsexed length composition into sex-separate length compositions. The quarterly ses separate age-length-keys are used to transform quarterly length compositions by gear group to quarterly age compositions. At this stage the age compositions by gear group are combined to give total quarterly age compositions.

A minimum of 24 length samples are collected per gear category per quarter. Age samples are collected by sexes separately and the target is 300 otoliths per sex per quarter. If this is not reached, the 1st and 2nd or 3rd and 4th quarters are combined.

Weight at age is derived from the length samples using:
to be completed

1.2.1.4 The text table below shows which country supply which kind of data:

	Kind of data supplied quarterly

Country	Caton (catch in weight)	Canum (catch at age in numbers)	Weca (weight at age in the catch)	Matprop (proportion mature by age)	Length composition in catch
Belgium	x	x	x		x
England	x	x	x		x
France	x	x	x		x

Data are supplied as FISHBASE files containing quarterly numbers at age, weight at age, length at age and total landings. The files are aggregated by the stock coordinator to derive the input VPA files in the Lowestoft format. No SOP corrections are applied to the data because individual country SOPs are usually better than 95%. The quarterly data files by country can be found with the stock co-ordinator

The resulting files (FAD data) can be found at ICES and with the stock co-ordinator, either in the IFAP system as SAS datasets or as ASCII files on the Lowestoft format, either under **w:\acfm\nsskwg\2002\data\sol_eche** or **w:\ifapdata\eximport\nsskwg\sol_eche**.

8.2.2 Biological

Natural mortality was assumed constant over ages and years at 0.1, and the maturity ogive used was knife-edged with sole regarded as fully mature at age 3 and older as in the North Sea.

Prior to 2001 WG, stock weights were calculated from a smoothed curve of the catch weights interpolated to the 1st January. Since the 2002 WG, second quarter catch weights were used as stock weights in order to be consistent with North Sea sole.

Both the proportion of natural mortality before spawning (Mprop) and the proportion of fishing mortality before spawning (Fprop) are set to 0.

8.2.3 Surveys

A dedicated 4m beam trawl survey for plaice and sole has been carried out by England using the RV Corystes since 1988. The survey covers the whole of VIId and is a depth stratified survey with most samples allocated to the shallower inshore stations where the abundance of sole is highest. In addition, inshore small boat surveys using 2m beam trawls are undertaken along the English coast and in a restricted area of the Baie de Somme on the French coast. In 2002, The English and French Young Fish Surveys were combined into an International Young Fish Survey. The dataset was revised for the full period back to 1981. The two surveys operate with the same gear (beam trawl) during the same period (September) in two different nursery areas. Previous analysis (Riou *et al*, 2001) has shown that asynchronous spawning occurs for flatfish in Division VIId. Therefore both surveys were combined based on weighting of the individual index with the area nursery surface sampled. Taking into account the low, medium, and high potential area of recruitment, the French YFS got a weight index of 55% and the English YFS of 45%.

8.2.4 Commercial CPUE

Three commercial fleets have been used in tuning. The Belgian beam trawl fleet (BEL BT), the UK Beam Trawl fleet (UK BT) and a French otter trawl fleet (FR OT). The two beam trawl fleets carry out fishing directed towards sole but can switch effort between ICES areas. The UK BT CPUE data is derived from trips where landings of sole from VIId exceeded 10% of the total demersal catch by weight on a trip basis. Effort from both the BT fleets is corrected for HP. The French otter trawl fleet is description needed.

8.2.5 Other relevant data

None.

8.3 Historical Stock Development

8.3.1 Deterministic modelling

Model used: XSA

Software used: IFAP / Lowestoft VPA suite

Model Options chosen:
Tapered time weighting not applied
Catchability independent of stock size for all ages
Catchability independent of age for ages >= 7
Survivor estimates shrunk towards the mean F of the final 5 years or the 5 oldest ages
S.E. of the mean to which the estimate are shrunk = 0.500
Minimum standard error for population estimates derived from each fleet = 0.300
Prior weighting not applied

Input data types and characteristics:

Catch data available for 1982-present year. However, there was no French age compositions before 1986 and large catchability residuals were observed in the commercial data before 1986. In the final analyses only data from 1986-present were used in tuning

Type	Name	Year range	Age range	Variable from year to year Yes/No
Caton	Catch in tonnes	1982 – last data year	2 – 11+	Yes
Canum	Catch at age in numbers	1982 – last data year	2 – 11+	Yes
Weca	Weight at age in the commercial catch	1982 – last data year	2 – 11+	Yes
West	Weight at age of the spawning stock at spawning time.	19682 – last data year	2 – 11+	Yes - assumed to be the same as weight at age in the Q2 catch
Mprop	Proportion of natural mortality before spawning	1982 – last data year	2 – 11+	No – set to 0 for all ages in all years
Fprop	Proportion of fishing mortality before spawning	1982 – last data year	2 – 11+	No – set to 0 for all ages in all years
Matprop	Proportion mature at age	1982 – last data year	2 – 11+	No – the same ogive for all years
Natmor	Natural mortality	1982 – last data year	2 – 11+	No – set to 0.2 for all ages in all years

Tuning data:

Type	Name	Year range	Age range
Tuning fleet 1	Belgian commercial BT	1986 – last data year	2-10
Tuning fleet 2	English commercial BT	1986 – last data year	2-10
Tuning fleet 3	English BT survey	1988 – last data year	1-6
Tuning fleet 4	International YFS	1994 – last data year	1-1

8.3.2 uncertainty analysis

8.3.3 Retrospective analysis??

8.4 Short-Term Projection

Model used: Age structured

Software used: WGFRANSW

Initial stock size is taken from the XSA for age 3 and older and from RCT3 for age 2. The long-term geometric mean recruitment is used for age 1 in all projection years.

Natural mortality: Set to 0.1 for all ages in all years

Maturity: The same ogive as in the assessment is used for all years

F and M before spawning: Set to 0 for all ages in all years

Weight at age in the stock: Average weight over the last three years

Weight at age in the catch: Average weight over the three last years

Exploitation pattern: Average of the three last years, scaled to the level of Fbar (3-8) in the last year

Intermediate year assumptions: F *status quo*

Stock recruitment model used: None, the long term geometric mean recruitment at age 1 is used

Procedures used for splitting projected catches: Not relevant

8.5 Medium-Term Projections

Model used: Age structured

Software used: WGMTERMc

Settings as in short term projection except for the weights in the catch and in the stock which are averaged over the last 10 years

8.6 Long-Term Projections, yield per recruit

Model used: Age structured

Software used: WGMTERMc

Settings as in short term projection except for the weights in the catch and in the stock which are averaged over the last 10 years

8.7 Biological Reference Points

Biological reference points

B_{pa}	F_{pa}	F_{lim}
8,000 t	0.4	0.55

8.8 Other Issues

None.

8.9 References

CEFAS 1999. PA software users guide. The Centre for Environment, Fisheries and Aquaculture Science, CEFAS, Lowestoft, United Kingdom, 22 April 1999.

9 PLAICE IN SUB-AREA IV

Text to be written

10 PLAICE IIIA

Stock specific documentation of standard assessment procedures used by the ICES WGNSSK.

Working group: North Sea Demersal Working Group

Updated: 15/09/2003

By:

10.1 General

10.1.1 Stock definition

The stock boundaries are arbitrary and more for management purposes than based on a biological recognised stock separation. Electrophoresis and meristic character indicated that the plaice in IIIa is a mixed population of the Kattegat and the Skagerrak component, which is dominating and a Belt Sea component (Simonsen et al., 1988).

The influence of the North Sea stock component, especially via the transport of eggs or larvae could also contribute to the IIIa plaice stock abundance (see Ecosystem aspects).

10.1.2 Fishery

The fishery is dominated by Denmark, with Danish landings accounting for more than 90% of the total. A directed plaice fishery is carried out during summer by Danish seiners. Plaice is also an important catch for otter trawlers and gillnetters, often within a mixed cod-plaice fishery. Plaice is also caught as by-catch in the directed Nephrops fishery. Since 1978, landings have declined from 27 000 to 9 000 tonnes in the late nineties. However, landings in 2001 were the highest since 1992. The fishery exploits traditionally three age classes (ages 4 to 6).

The use of beam trawl in the Kattegat is prohibited. Minimum mesh size is 90 mm for towed gears, and 100 mm for fixed gears. The minimum landing size is 27 cm.

10.1.3 Ecosystem aspects

The large scale circulation pattern in the Northern Kattegat depends mainly on interaction between Baltic runoffs and local variation due to win stress. Nielsen et al., (1998) demonstrated that the abundance of settled 0-group plaice along the Danish coast of the Kattegat depends on transport from the Skagerrak. The 0-group abundance measured in July-August was significantly higher in years when wind conditions during the larval development period (March-April) were moderate to strong. This might imply that larval plaice are food-limited in years when calm conditions prevail during the larval drift period (Nielsen et al., 1998).

10.2 Data

10.2.1 Commercial catch

Data from three Danish fleets, i.e., trawlers, gillnetters, and Danish seiners, are available. The age-disaggregated indices were derived by merging logbook statistics supplying catch weight per market category with the age distribution within these categories available from the market sampling. Catch-at-age and mean weight-at-age in the catch information are provided by Denmark only. The sampling scheme is broken down by quarter, landing harbours, and fishing area. The total international catches-at-age have been estimated for Kattegat and Skagerrak separately since 1984.

10.2.2 Biological

Weights-at-age in the stock were assumed equal to those of the catch.

Both the proportion of natural mortality before spawning (Mprop) and the proportion of fishing mortality before spawning (Fprop) are set to 0.

A fixed natural mortality of 0.1 per year was assumed for all years and ages.

A knife-edge maturity distribution was employed: age group 2 was assumed to be immature, whereas age 3 and older plaice were assumed mature.

10.2.3 Surveys

Data from four surveys are available. IBTS survey data for Kattegat and Skagerrak for the first and third quarter are provided by Sweden as numbers-per-age and hour on a haul-by-haul basis for the period 1992–2002 and 1995-2002 respectively (no survey was performed in third quarter 2000). Two Danish bottom trawl surveys are conducted by the vessel 'Havfisken' in Kattegat, Belt Sea, and Western Baltic in the first and fourth quarter of each year. The indices available from these surveys cover the period 1996-2002 for the first quarter survey (except 1998), and 1994-2001 for the fourth quarter survey. The survey indices of the IBTS and 'Havfisken' surveys first quarter is shifted from February to the preceding December to allow for full use of the available data.

Very few plaice aged 7–9 were caught during the surveys and these ages were removed from the analysis.

10.2.4 Commercial CPUE

Three Danish fleets, i.e., trawlers, gillnetters, and Danish seiners, are available. The age-disaggregated indices were derived by merging logbook statistics supplying catch weight per market category with the age distribution within these categories available from the market sampling. Fishing effort has been defined as standardised days fishing. The fishing effort appears to have been fairly stable over the last decade. There has been a decrease in the fishing effort of towed-geared fleets since 1990, but this trend has been reversing since 1998. The fishing effort of gillnetters has steeply increased over 1990-1994, and steadily decreased since then. All commercial fleets show increase in both the yield and the CPUE in 2001. Highest values and increases are observed for the Danish seiners.

10.2.5 Other relevant data

None.

10.3 Historical Stock Development

10.3.1 Deterministic modelling

Model used: XSA

Software used: IFAP / Lowestoft VPA suite

Model Options chosen:
Tapered time weighting applied, power = 3 over 20 years
Catchability independent of stock size for all ages
Catchability independent of age for ages >= 8
Survivor estimates shrunk towards the mean F of the final 5 years or the 5 oldest ages
S.E. of the mean to which the estimate are shrunk = 0.500
Minimum standard error for population estimates derived from each fleet = 0.300
Prior weighting not applied

Input data types and characteristics:

Type	Name	Year range	Age range	Variable from year to year

				Yes/No
Caton	Catch in tonnes	1978 – last data year	2 – 11+	Yes
Canum	Catch at age in numbers	1978 – last data year	2 – 11+	Yes
Weca	Weight at age in the commercial catch	1978 – last data year	2 – 11+	Yes
West	Weight at age of the spawning stock at spawning time.	1978 – last data year	2 – 11+	Yes/No - assumed to be the same as weight at age in the catch
Mprop	Proportion of natural mortality before spawning	1978 – last data year	2 – 11+	No – set to 0 for all ages in all years
Fprop	Proportion of fishing mortality before spawning	1978 – last data year	2 – 11+	No – set to 0 for all ages in all years
Matprop	Proportion mature at age	1978 – last data year	2 – 11+	No – the same ogive for all years
Natmor	Natural mortality	1978 – last data year	2 – 11+	No – set to 0.1 for all ages in all years

Tuning data:

Type	Name	Year range	Age range
Tuning fleet 1	Danish Gillnetters	1987 – last data year	2 – 10
Tuning fleet 2	Danish Trawlers	1987 – last data year	2 – 10
Tuning fleet 3	Danish seiners	1987 – last data year	2 – 10
Tuning fleet 4	IBTS Q1	1991 – last data year	1 – 6
Tuning fleet 5	Havsfisken Q4	1994 – last data year	1 – 6
Tuning fleet 6	Havsfisken Q1	1995 – last data year	1 – 5
Tuning fleet 6	IBTS Q3	1995 – last data year	1 – 6

10.3.2 Uncertainty analysis

10.3.3 Retrospective analysis??

10.4 Short-Term Projection

Model used: Age structured

Software used: MFDP

Initial stock size. Stock sizes for age 3 and older are taken from the estimated number of survivors from the XSA. The age 2 recruitments are taken as the geometric average over the entire period.

Natural mortality: Set to 0.1 for all ages in all years

Maturity: The same ogive as in the assessment is used for all years

F and M before spawning: Set to 0 for all ages in all years

Weight at age in the stock: Assumed to be the same as weight at age in the catch

Weight at age in the catch: Average weight of the three last years

Exploitation pattern: Average of the three last years, scaled by the Fbar (3-6) to the level of the last year

Intermediate year assumptions: TAC constraint

Stock recruitment model used: None, the long term geometric mean recruitment at age 2 is used

Procedures used for splitting projected catches: Not relevant

11 EASTERN CHANNEL PLAICE (PLE-ECHE)

Stock specific documentation of standard assessment procedures used by the ICES WGNSSK.

Working group: North Sea Demersal Working Group

Updated: 5/9//2003

By: Richard Millner (r.s.millner@cefas.cu.uk) and Joel Vigneau (joel.vigneau@ifremer.fr)

11.1 General

11.1.1 Stock definition

There is mixing of plaice between the North Sea and VIId both as adults and juveniles. Analysis of tagging data shows that around 40% of the juvenile plaice in VIId come from nursery grounds in the North Sea. The eastern Channel supplies very few recruits to the North Sea. There is also an adult migration between the North Sea and Channel with 20-30% of the plaice caught in the winter in VIId were from migratory North Sea fish. Separation between VIId and the western Channel (VIIe) is much clearer. VIId does not receive significant numbers of juvenile plaice from VIIe but contributes around 20% of the recruits to VIIe. Similarly, around 20% of the adult plaice spawning in VIId may have spent part of the year in VIIe but few plaice tagged in VIIe during the spawning period are recaptured in VIId. It can be concluded that there is considerable interchange of plaice from the North Sea into VIId but a much smaller interchange between VIId and VIIe. Since the exploitation patterns between the three areas are very different, it has been concluded that separate assessments should be carried out.

The management area for channel plaice is a combined one between VIId and VIIe. TACs are obtained by combining the agreed TAC from each area.

11.1.2 Fishery

Plaice is mainly caught in beam trawl fisheries for sole or in mixed demersal fisheries using otter trawls. There is also a directed fishery during parts of the year by inshore trawlers and netters on the English and French coasts. The main fleet segments are the English and Belgian beam trawlers. The Belgian beam trawlers fish mainly in the 1st and 4th quarters and their area of activity covers almost the whole of VIId south of the 6 mile contour from the English coast. There is only light activity by this fleet between April and September. The second offshore fleet is mainly large otter trawlers from Boulogne, Dieppe and Fecamp. The target species of these vessels are cod, whiting, plaice mackerel, gurnards and cuttlefish and the fleet operates throughout VIId. The inshore trawlers and netters are mainly vessels <10m operating on a daily basis within 6 miles of the coast. There are a large number of these vessels (in excess of 400) operating from small ports along the French and English coast. These vessels target sole, plaice, cod and cuttlefish.

The minimum landing size for plaice is 27cm. Demersal gears permitted to catch plaice are 80mm for beam trawling and 100mm for otter trawlers. Fixed nets are required to use 100mm mesh since 2002 although an exemption to permit 90mm has been in force since that time.

There is widespread discarding of plaice, especially from beam trawlers. The 25 and 50% retention lengths for plaice in an 80mm beam trawl are16.4cm and 17.6cm respectively which are substantially below the MLS. Routine data on discarding is not available but comparison with the North Sea suggests that discarding levels in excess of 40% by weight are likely. Discard survival from small otter trawlers can be in excess of 50% (Millner et al., 1993). In comparison discard mortality from large beam trawlers has been found to be between less than 20% after a 2h haul and up to 40% for a one-hour tow (van Beek et al 1989).

11.1.3 Ecosystem aspects

No information is available.

11.2 Data

11.2.1 Commercial catch

The landings are taken by three countries France (55% of combined TAC), England (29%) and Belgium (16%). Quarterly catch numbers and weights were available for a range of years depending on country; the availability is presented in the text table below. Levels of sampling prior to 1985 were poor and these data are considered to be less reliable. In 2001 international landings covered by market sampling schemes represented the majority of the total landings.

11.2.1.1 Belgium

Belgian commercial landings and effort information by quarter, area and gear are derived from log-books (CHECK).

Sampling for age and length occurs for the beam trawl fleet (main fleet operating in Belgium).

Quarterly sampling of landings takes place at the auctions of Zeebrugge and Oostende (main fishing ports in Belgium). Length is measured to the cm below. Samples are raised per market category to the catches of both harbours.

Quarterly otolith samples are taken throughout the length range of the landings (sexes separated). These are aged and combined to the quarterly level. The ALK is used to obtain the quarterly age distribution from the length distribution.

In 2003 a pilot study started on on-board sampling with respect to discarded and retained catch.

11.2.1.2 France

French commercial landings in tonnes by quarter, area and gear are derived from log-books for boats over 10m and from sales declaration forms for vessels under 10m. These self declared production are then linked to the auction sales in order to have a complete and precise trip description.

The collection of discard data has begun in 2003 within the EU Regulation 1639/2001. This first year of collection will be incomplete in term of time coverage, therefore the use of these data should be investigated only from 2005.

The length measurements are done by market commercial categories and by quarter into the principal auctions of Grandcamp, Port-en-Bessin, Dieppe and Boulogne. Samplings from Grandcamp and Port-en-Bessin are used for raising catches from Cherbourg to Fecamp and samplings from Dieppe and Boulogne are used to raise the catches from Dieppe to Dunkerque

Otoliths samples are taken by quarter throughout the length range of the landed catch for quarters 1 to 3 and from the october GFS survey in quarter 4. These are aged and combined to the quarterly level and the age-length key thus obtained is used to transform the quarterly length compositions. The length not sampled during one quarter are derived from the same year close quarter.

Weight, sex and maturity at length and at age are obtained from the fish sampled for the age-length keys.

11.2.1.3 England

English commercial landings in tonnes by quarter, area and gear are derived from the sales notes statistics for vessels under 12m who do not complete logbooks. For those over 12m (or >10m fishing away for more than 24h), data is taken from the EC logbooks. Effort and gear information for the vessels <10m is not routinely collected and is obtained by interview and by census. . No information is collected on discarding from vessels <10m. Discarding from vessels >10m has been obtained since 2002 under the EU Data Collection Regulation.

The gear group used for length measurements are beam trawl, otter trawl and net.

Separate-sex length measurements are taken from each of the gear groupings by trip. Trip length samples are combined and raised to monthly totals by port and gear group. Months and ports are then combined to give quarterly total length compositions by gear group; unsampled port landings are added in at this stage. Quarterly length compositions are added to give annual totals by gear. These are for reference only, as ALK conversion takes place at the quarterly level.

Otoliths samples are taken by 2cm length groups separately for each sex throughout the length range of the landed catch. These are aged and combined to the quarterly level, and include all ports, gears and months. The quarterly sex-separate age-length-keys are used to transform quarterly length compositions by gear group to quarterly age compositions.

A minimum of 24 length samples are collected per gear category per quarter. Age samples are collected by sexes separately and the target is 300 otoliths per sex per quarter. If this is not reached, the 1st and 2nd or 3rd and 4th quarters are combined.

1.2.1.4 The text table below shows which country supplies which kind of data:

Country	Numbers	Weights-at-age
Belgium	1981-present	1986-present
France	1989- present	1989- present
UK	1980- present	1989- present

Data are supplied as FISHBASE files containing quarterly numbers at age, weight at age, length at age and total landings. The files are aggregated by the stock co-ordinator to derive the input VPA files in the Lowestoft format. No SOP corrections are applied to the data because individual country SOPs are usually better than 95%. The quarterly data files by country can be found with the stock co-ordinator

The resulting files (FAD data) can be found at ICES and with the stock co-ordinator, either in the IFAP system as SAS datasets or as ASCII files on the Lowestoft format, either under **w:\acfm\nsskwg\2002\data\ple_eche** or **w:\ifapdata\eximport\nsskwg\ple_eche**.

11.2.2 Biological

Natural mortality was assumed constant over ages and years at 0.1 as in the North Sea. The maturity ogive used assumes that 15% of age 2, 53% of age 3 and 96% of age 4 are mature and 100% for ages 5 and older.

Prior to 2001, stock weights were calculated from a smoothed curve of the catch weights interpolated to the 1st January. From 2001, second quarter catch weights were used as stock weights in order to be consistent with North Sea sole. The database was revised back to 1990.

Both the proportion of natural mortality before spawning (Mprop) and the proportion of fishing mortality before spawning (Fprop) are set to 0.

11.2.3 Surveys

A dedicated 4m beam trawl survey for plaice and sole has been carried out by England using the RV Corystes since 1988. The survey covers the whole of VIId and is a depth stratified survey with most samples allocated to the shallower inshore stations where the abundance of sole is highest. In addition, inshore small boat surveys using 2m beam trawls are undertaken along the English coast and in a restricted area of the Baie de Somme on the French coast. In 2002, The English and French Young Fish Surveys were combined into an International Young Fish Survey. The dataset was revised for the period back to 1987. The two surveys operate with the same gear (beam trawl) during the same period (September) in two different nursery areas. Previous analysis (Riou *et al*, 2001) has shown that asynchronous spawning occurs for flatfish in Division VIId. Therefore both surveys were combined based on weighting of the individual index with the area nursery surface sampled. Taking into account the low, medium, and high potential area of recruitment, the French YFS got a weight index of 55% and the English YFS of 45%.

A third survey consists of the French otter trawl groundfish survey (FR GFS) in October. Prior to 2002, the abundance indices were calculated by splitting the survey area into five zones, calculating a separate index for each zone each zone, and then averaging to obtain the final GFS index. This procedure was not thought to be entirely satisfactory, as the level of sampling was inconsistent across geographical strata. A new procedure was developed based on raising abundance indices to the level of ICES rectangles, and then by averaging those to calculate the final abundance index. Although there are only minor differences between the two indices, the revised method was used in 2002 and subsequently.

11.2.4 Commercial CPUE

Three commercial fleets have been used in tuning. UK inshore trawlers, Belgian beam trawl fleet and French otter trawlers as well as three survey fleets.
The effort of the French otter trawlers is obtained by the log-books information on the duration of the fishing time weighted by the engine power (in KW) of the vessel. Only trips where sole and/or plaice have been caught is accounted for.

11.2.5 Other relevant data

None.

11.3 Historical Stock Development

11.3.1 Deterministic modelling

Model used: XSA

Software used: IFAP / Lowestoft VPA suite

Model Options chosen:
Tapered time weighting not applied
Catchability independent of stock size for all ages
Catchability independent of age for ages >= 7
Survivor estimates shrunk towards the mean F of the final 5 years or the 3 oldest ages
S.E. of the mean to which the estimate are shrunk = 0.500
Minimum standard error for population estimates derived from each fleet = 0.300
Prior weighting not applied

Input data types and characteristics:

Catch data available for 1982-present year. However, there was no French age compositions before 1986 and large catchability residuals were observed in the commercial data before 1986. In the final analyses only data from 1986-present were used in tuning

Type	Name	Year range	Age range	Variable from year to year Yes/No
Caton	Catch in tonnes	1980 – last data year	2 – 10+	Yes
Canum	Catch at age in numbers	1980 – last data year	2 – 10+	Yes
Weca	Weight at age in the commercial catch	1980 – last data year	2 – 10+	Yes
West	Weight at age of the spawning stock at spawning time.	1980 – last data year	2 – 10+	Yes - assumed to be the weight at age in the Q1 catch
Mprop	Proportion of natural mortality before spawning	1980 – last data year	2 – 10+	No – set to 0 for all ages in all years
Fprop	Proportion of fishing mortality before spawning	1980 – last data year	2 – 10+	No – set to 0 for all ages in all years
Matprop	Proportion mature at age	1980 – last data year	2 – 10+	No – the same ogive for all years
Natmor	Natural mortality	1980 – last data	2 – 10+	No – set to 0.2 for

		year		all ages in all years

Tuning data:

Type	Name	Year range	Age range
Tuning fleet 1	English commercial Inshore trawl	1985 – last data year	2 – 10
Tuning fleet 2	Belgian commercial Beam trawl	1981 – last data year	2-10
Tuning fleet 3	French trawlers	1989 – last data year	2 - 10
Tuning fleet 4	English BT survey	1988 – last data year	1 – 6
Tuning fleet 5	French GFS	1988 – last data year	1 - 5
Tuning fleet 6	International YFS	1987 – last data year	1 - 1

11.3.2 Uncertainty analysis

11.3.3 Retrospective analysis

11.4 Short-Term Projection

Model used: Age structured

Software used: IFAP prediction with management option table and yield per recruit routines

Initial stock size: Taken from XSA for age 3 and older. The number at age 2 in the last data year is estimated using RCT3. The recruitment at age 1 in the last data year is estimated using the geometric mean over a long period (1980 – last data year)

Natural mortality: Set to 0.1 for all ages in all years

Maturity: The same ogive as in the assessment is used for all years

F and M before spawning: Set to 0 for all ages in all years

Weight at age in the stock: Average weight of the three last years

Weight at age in the catch: Average weight of the three last years

Exploitation pattern: Average of the three last years, scaled by the Fbar (2-6) to the level of the last year

Intermediate year assumptions:

Stock recruitment model used: None, the long term geometric mean recruitment at age 1 is used

Procedures used for splitting projected catches: Not relevant

11.5 Medium-Term Projections

The segmented stock/recruitment relationship is considered not significant (ICES, 2003a). There is therefore no consistent basis to build a medium term projection

11.6 Long-Term Projections

11.7 Biological Reference Points

$\mathbf{B}_{lim}$ = 5400 t.

$\mathbf{B}_{pa}$ =	8000 t.
$\mathbf{F}_{lim}$ =	0.54
$\mathbf{F}_{pa}$ =	0.45

11.8 Other Issues

None.

11.9 References

Beek, F.A. van, Leeuwen, P.I. van and Rijnsdorp, A.D. 1989. On the survivalof plaice and sole discards in the otter trawl and beam trawl fisheries in the North Sea. ICES C.M. 1989/G:46, 17pp

ICES 2003a. Report of the Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak, October 2002. ICES CM 2003/ACFM:02

ICES 2003b. Report of the Study Group on Precautionary Reference Points For Advice on Fishery Management ICES CM 2003/ACFM:15

Millner, R.S., Whiting, C.L and Howlett, G.J. 1993. Estimation of discard mortality of plaice from small otter trawlers using tagging and cage survival studies. ICES C.M. 1993/G:24, 6pp

Riou *et al.* 2001. Relative contributions of different sole and plaice nurseries to the adult population in the Eastern Channel : application of a combined method using generalized linear models and a geographic information system. Aquatic Living Resources. 14 (2001) 125-135

12 NORWAY POUT

Stock specific documentation of standard assessment procedures used by ICES.

Stock: Norway pout in North Sea and Skagerrak (ICES Area IV and IIIa)

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

Date: 10.9.03

12.1 General

12.1.1 Stock definition

Norway pout is a small, short-lived gadoid species, which rarely gets older than 5 years (Sparholt, Larsen and Nielsen 2002a). It is mainly distributed in the northern North Sea (>57°N) and in Skagerrak at depths between 50 and 250 m (Raitt 1968, Sparholt, Larsen and Nielsen 2002b).

ICES ACFM (October 2001) asked the ICES WGNSSK to verify the justification of treating ICES Division VIa as a management area for Norway pout (and sandeel) separately from ICES areas IV and IIIa. Preliminary results from an analysis of regionalized survey data on Norway pout maturity, presented in a Working Document to the 2000 meeting of the WGNSSK (*Larsen, Lassen, Nielsen and Sparholt,2001* in ICES C.M.2001/ACFM:07), gave no evidence for a stock separation in the whole northern area.

12.1.2 Fishery

The fishery is mainly by Danish and Norwegian (large) vessels using small mesh trawls in the northern North Sea at Fladen Ground and along the edge of the Norwegian Trench. Main fishing seasons are 1st, 3rd, and 4th quarters of the year. Norway pout is caught in small meshed trawls (16-31 mm) in a mixed fishery with blue whiting. The fishery is mainly carried out by Denmark (~70%) and Norway (~30%) at fishing grounds in the northern North Sea at Fladen Ground and along the edge of the Norwegian Trench. Norway pout is landed for reduction purposes (fish meal and fish oil).

With present fishing mortality levels the status of the stock is more determined by natural processes and less by the fishery.

12.1.3 Ecosystem aspects

There is a need to ensure that the stock remains high enough to provide food for a variety of predator species. By-catches of other species should also be taken into account in management of the fishery. Existing technical measures such as the closed Norway pout box, minimum mesh size in the fishery, and by-catch regulations to protect other species have been maintained.

Recruitment in Norway pout is highly variable and influences spawning stock biomass (SSB) and total stock biomass (TSB) rapidly due to the short life span of the species. The fishing mortality is lower than the natural mortality, and this stock is important as food source for other species, which means that the population dynamics for Norway pout in the North Sea and in Skagerrak are very dependent on changes caused by recruitment variation and predation mortality (or other natural mortality causes) and less by the fishery

12.2 Data

12.2.1 Commercial catch and effort data

The assessment uses the combined catch and effort data from the commercial Danish and Norwegian small meshed trawler fleets fishing mainly in the northern North Sea.

For the Danish and Norwegian commercial landings sampling procedures of the commercial landings, which vary between the countries, were described in detail in the report of the WGNSSK meeting in 1998 (ICES 1999).

From 2002 onwards, an EU regulation (1639/2001) was endorsed which affects the market sampling procedures. First, each country is obliged to sample all fleet segments, including foreign vessels landing in their country. Second, a minimum number of market samples per tonnes of landing are required. The national market sampling programmes have been adjusted accordingly.

Method of effort standardization of the commercial fishery tuning fleet

Background descriptions of the commercial fishery tuning series used and methods of effort standardization of the commercial fishery between different vessel size categories and national commercial fleets are given in the 1996 working group report (ICES CM 1997/Assess:6). Previous to the 2001 assessment the effort has been standardized by vessel category (to a standard 175 GRT vessel) only using the catch rate proportions between vessel size categories within the actual year.

In the 2003 (as well as in the 2001 and 2002) assessments the output of the regression analyses using time series from 1987-2003 has been applied to the Danish and Norwegian commercial fishery as well. Effort standardization of both the Danish and the Norwegian part of the commercial fishery tuning series is performed by applying standardization factors to reported catch and effort data for the different vessel size categories. The standardization factors are obtained from regression of CPUE indices by vessel size category over years of the Danish commercial fishery tuning fleet. The number of small vessels in the Danish Norway pout fishing fleet has decreased significantly and the relative number of large vessels has increased in the latest years. Furthermore, there was found no trends in CPUE between vessel categories over time. For these reasons the CPUE indices used in the regression has been obtained from pooled catch and effort data over the years 1994-present assessment year by vessel category in order to obtain and include estimates for all vessel categories also for the latest years where no observations exists for the smallest vessels groups. Results and parameter estimates from the yearly regression analyses on CPUE versus GRT for the different Danish vessel size categories used in the effort standardization of both the Norwegian and Danish commercial fishery are yearly updated and shown in the input data to the yearly performed assessment.

In 2002 the assessment was run both with and without the new standardization method (regression). The differences in results of output SSB, TSB and F between the two assessment runs were small.

Norwegian effort data

In 1997, Norwegian effort data were revised as described in sections 13.1.3.1 and 1.3.2 of the 1997 working group report (ICES CM 1998/Assess:7). Furthermore, in the 2000 assessment Norwegian average GRT and Effort data for 1998-99 were corrected because data from ICES area IIa were included for these years in the 1998-99 assessments. Observed average GRT and effort for the Norwegian commercial fleets are given in the input data to the yearly performed assessment.

Danish effort data

In each yearly assessment the input data as CPUE data by vessel size category and year for the Danish commercial fishery in area IVa is given. This is based on fishing trips where total catch included at least 70 % Norway pout and blue whiting per trip, and where Norway pout was reported as main species in catch in the logbook per fishing day and fishing trip. There has been a relative reduction in the number and effort of small vessels and an increase for the larger vessels in the fleet in the latest years. Minor revisions (up-dating) of the Danish effort and catch data used in the effort standardization and as input to the tuning fleets have been made for the 2001 assessment.

Standardized effort data

The resulting combined and standardized Danish and Norwegian effort for the commercial fishery used in the assessment is presented in the input data to the yearly performed assessment, as well as the combined CPUE indices by age and quarter for the commercial fishery tuning fleet. The seasonal variation in effort data is one reason for performing a seasonal VPA.

12.2.2 Biological data

Weight at age

Mean weight at age in the catch is estimated as a weighted average of Danish and Norwegian data. In general, 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 is used for all years. Mean weight in catch is not used as estimator of weight in the stock partly because the smallest 0-group fish are not fully recruited to the fishery in 3rd quarter of the year.

Maturity and natural mortality
The same proportion mature and natural mortality are used for all years in the assessment. The natural mortality is set to 0.4 for all age groups in all seasons that result in an annual natural mortality of 1.6 for all age groups. The proportion mature used is 0% for the 0-group, 10% of the 1-group and 100% of the 2+-group independent of sex.

In the 2001 and 2002 assessment exploratory runs were made with revised input data for natural mortality based on the results from two papers presented to the working group in 2001, *Sparholt, Larsen and Nielsen 2002a,b (both published in ICES J. Mar. Sci.).* This has not been explored further in the 2003 up-date assessment but should be investigated in future benchmark assessment of the stock.

Research results on population dynamics parameters (e.g. natural mortality and maturity)

Investigations on population dynamics (natural mortality, distribution, and spawning and maturity as well as growth patterns) of Norway pout in the North Sea are ongoing. Exploratory runs of the SXSA model was presented in the 2002 assessment report with revised input data for natural mortality by age based on the results from two papers presented to the working group in 2001, (*Sparholt, Larsen and Nielsen, 2002a,b*). The resulting SSB, TSB (3rd quarter of year), TSB (1st quarter of year) and F for the final exploratory run was compared to those for the accepted run with standard settings. It appears that the implications of these revised input data are very significant. Year 2002 was the second assessment year where exploratory runs with revised natural mortality values were made. The working group in 2002 suggested that an assessment with partly the traditional settings (constant M) and a new assessment with the revised values for M were made for at least a 3 year period in order to compare the output and the performance of the assessments before the working group decided on final adoption of the revised values for M to be used in the assessment.

Preliminary results from an analysis of regionalized survey data on Norway pout maturity is presented in a Working Document to the 2000 meeting of the Working Group (*Larsen, Lassen, Nielsen and Sparholt,2001* in ICES C.M.2001/ACFM:07).

12.2.3 Survey data

Survey indices series of abundance of Norway pout by age and quarter are for the assessment period available from the IBTS (1. and 3. quarter) and the EGFS (English Ground Fish Survey, 3. quarter) and SGFS (Scottish Ground Fish Survey, 3. quarter) The SGFS data from 1998 onwards are used with caution due to new survey design (new vessel from 1998 and new gear and extended survey area from 1999). The 0-group indices from this survey are not used in the assessment. 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 are included in the SXSA. Research vessel indices from the 3rd quarter IBTS are used for comparison purposes only due to relatively short time series (since 1991). Furthermore, the 3rd quarter IBTS is not an independent tuning fleet of the separate SGFS and EGFS tuning fleets.

12.2.4 Commercial CPUE data

Combined CPUE indices by age and quarter for the Danish and Norwegian commercial fishery tuning fleet is calculated from effort data obtained from the method of effort standardization of the commercial fishery tuning fleet described under section B.1 and vessel category specific catches by area. CPUE is estimated on a quarterly basis for the Danish and Norwegian commercial fleets.

12.3 Historical Stock Development

The SXSA (Seasonal Extended Survivors Analysis: Skagen (1993)) was used to estimate quarterly stock numbers and fishing mortalities for Norway pout in the North Sea and Skagerrak. The catch at age analysis is carried out according to the specifications given in the present stock quality handbook.

Model used: SXSA

The SXSA (Seasonal Extended Survivors Analysis: Skagen (1993)) is used to estimate quarterly stock numbers and fishing mortalities for Norway pout in the North Sea and Skagerrak. The assessment is analytical using catch-at-age analysis based on quarterly catch and CPUE data. The assessment is considered appropriate to indicate trends in the stock and immediate changes in the stock because of the seasonal assessment taking into account the seasonality in fishery. The seasonal variation in effort data is one reason for performing a seasonal VPA.

In the SXSA the catchability, r, per age and quarter and fleet is assumed to be constant within the period 1983-2003 where the estimated catchability, rhat, is a geometric mean over years by age, quarter and tuning fleet. Tuning is performed over the period 1983 to present producing log residual (log(Nhat/N)) stock numbers and survivor estimates by year, quarter, age and tuning fleet. The contributions from the various age groups to the survivor estimates by year and quarter and fleet are in the SXSA combined to an overall survivors estimate, shat, estimated as the geometric mean over years of log(shat) weighted by the exponential of the inverse cumulated fishing mortality as described in Skagen (1993).

Software used:
SXSA program available from ICES.

Model Options chosen:
The parameter settings and options of the SXSA has been the same in all recent years assessments. No time taper or shrinkage is used in the catch at age analysis. The three surveys and the seasonally (by quarter) divided commercial fleets are all used in the tuning.

```
The following parameters were used:
Year range:                                            1983 - present
Seasons per year:                                                   4
The last season in the last year is season :                        2
Youngest age:  0;            Oldest age:  3;            (Plus age:  4)
Recruitment in season:                                              3
Spawning in season:                                                 1

The following fleets were included:
Fleet  1:                                                  commercial
Fleet  2:                                                  ibts-1q
Fleet  3:                                                  egfs
Fleet  4:                                                  sgfs

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

Factor (between 0 and 1) for weighting the inverse catchabilities
at the oldest age versus the second oldest age (factor 1 means that
the catchabilities for the oldest age are used as they are):        0

Specification of minimum value for the survivor number (this is
Used instead of the estimate if the estimate becomes very low):     0

Iteration until convergence (setting 0):                            0
```

Input data types and characteristics:

Type	Name	Year range	Age range	Variable from year to year Yes/No
Caton	Catch in tonnes	1983-present	0-3+	Yes
Canum	Catch at age in numbers	1983-present|	0-3+	Yes
Weca	Weight at age in the commercial catch	1983-present|	0-3+	Yes
West	Weight at age of the spawning stock at spawning time.	1983-present|	0-3+	No
Mprop	Proportion of natural mortality before spawning	Not relevant in SXSA|		
Fprop	Proportion of fishing mortality before spawning	1983-present|	0-1	Yes
Matprop	Proportion mature at age	1983-present|	1-3+	No, 10%age 1, 100% 2+
Natmor	Natural mortality	1983-present|	0-3+	No, 0.4 per quarter per age group

Tuning data:

Type	Name	Year range	Age range
Tuning fleet 1	Commercial fleet	1983-present	0-3+
Tuning fleet 2	IBTS	1983-present	0-3+
Tuning fleet 3	EGFS	1983-present	0-3+
Tuning fleet 4	SGFS	1983-present	0-3+

12.4 Short-Term Projection

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. Survey indices in the 3rd quarter seems to predict strong 0-group year classes relatively well when comparing with 0-group indices from commercial fishery (4th quarter) and to 1-group survey indices the following spring. The 0-group are recruited to the 4th quarter commercial fishery which tends to predict strong year classes well as 0-group. Deterministic catch forecasts are uncertain due to the catch possibilities are largely dependent on the size of a few year classes, the large dependence on the strength of the recruiting 0-group year class, and the added uncertainty in the assessment and forecast arising from variations in natural mortality (*Sparholt, Larsen and Nielsen. 2002a,b*).

12.5 Medium-Term Projection

12.6 Long-Term Projection

12.7 Biological Reference Points

$\mathbf{B}_{lim}$ is 90 000 t $\mathbf{B}_{pa}$= 150 000 t $\mathbf{F}_{low}$ =0.23 $\mathbf{F}_{med}$ =0.67 $\mathbf{F}_{high}$ =1.21

$\mathbf{B}_{lim}$ is 90.000 t, the lowest observed biomass

$\mathbf{B}_{pa}$ be established at 150,000 t. This affords a high probability of maintaining SSB above $\mathbf{B}_{lim}$, taking into account the uncertainty of assessments. Below this value the probability of below average recruitment increases.

$\mathbf{F}_{lim}$ None advised.

$\mathbf{F}_{pa}$ None advised.

12.8 Other Issues

There is no management objective set for this stock. With present fishing mortality levels the status of the stock is more determined by natural processes and less by the fishery. There is a need to ensure that the stock remains high enough to provide food for a variety of predator species. In managing this fishery by-catches of other species have been taken into account. Technical measures such as the closed Norway pout box, minimum mesh size in the fishery, and by-catch regulations to protect other species have been used in managing this stock and the fishery.

12.9 References

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13 SANDEEL IN IV

Stock specific documentation of standard assessment procedures used by ICES.

Working group: North Sea Demersal Working Group

Updated: 13/9//2003 by: Henrik Jensen (hj@dfu.min.dk)

13.1 General

13.1.1 Stock definition

For assessment of sandeels the European continental shelf has been divided into four regions until 1995: Division IIIa (Skagerrak), northern North Sea, southern North Sea, Shetland Isl. and Division IVa. 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. The Shetland sandeel stock was kept as a separate stock unit. ICES assessments have used these stock definitions since 1995.

Sandeels are largely stationary after settlement and the North Sea sandeel fishery must be considered as exploiting a complex of local populations. However, recruitment to local areas may not only be related to the local stock, as interchange between areas seems to take place during the early phases of life before settlement. Based on the distribution and simulated dispersal of larval stages, Wright et *al.* (1998) suggest that the North Sea stock could be split into six areas including the Shetland population. Assessments have tentatively been made for some of the areas (Pedersen et *al*. 1999) and there were high correlation between the results from the study and the one-area assessment made by the WG.

13.1.2 Fishery

Sandeel is taken by trawlers using small meshed trawls with mesh sizes < 16 mm. The fishery is seasonal, taking place mostly in the spring and summer. Most of the sandeel catch consists of the lesser sandeel *Ammodytes marinus*, although small quantities of other Ammodytoidei spp. are caught as well. There is little by-catch of protected species (ICES 2004).

Technical measures for the sandeel fishery include a minimum percentage in weight of sandeel at 95% for meshes < 16 mm.

13.1.3 Ecosystem aspects

ACFM consider that there is a need to ensure that the sandeel stock remains high enough to provide food for a variety of predator species.

In 1999 the U.K called for a moratorium on sandeel fishing adjacent to seabird colonies along the U.K. coast and in response the EU requested advice from ICES. An ICES Study Group, was convened in 1999 to assess whether removal of sandeel by fisheries has a measurable effect on sandeel, whether establishment of closed areas and seasons for sandeel fisheries could ameliorate any effects, and to identify possible spatial and/or temporal restrictions of the fishery as specifically as possible. The ICES Advisory committees (ACFM and ACE) accepted the advice from the study group. STECF (1999) agreed with this ICES advice and the EU advised to close the fishery whilst maintaining a commercial monitoring. A 3-year closure, from 2000 to 2002, was decided. All commercial fishing was excluded, except for a maximum of 10 boat days in each of May and June for stock monitoring purposes. The closure was maintained for three years (see e.g. Wright et *al.* 2002) and has been extended until 2006, with a small increase in the effort of the monitoring fishery, after which the effect of the closure will be evaluated.

13.2 Data

13.2.1 Commercial catch

In the last 20 years the landings of sandeels in IV have been taken by 5 countries: Denmark (78%), Norway (19%) UK/Scotland (1%), Sweden (1%) and Faroes Isl. (1%). In the 1950's also Germany and the Netherlands participated in this fishery, but since the start of the 1970's no landings have been recorded for these countries.

Age, length and weight at age data are available for Denmark and Norway to estimate numbers by age in the landings. Prior to 1996, the Norwegian age composition data were based on Danish ALK's. Catch numbers and weight at age for the southern North Sea are based only on Danish age compositions.

Denmark More details to be included in this section

Industrial species are not sorted by species before processing and it is assumed that the landings consist of one species only in the calculation of the official landings. The WG estimate of landings is based on samples for species composition taken by the Fishery Inspectors for control of the by-catch regulation. At least one sample (10-15 kg) per 1000 tons landings is taken and these samples are used to estimate average species composition by area (ICES rectangles) and month. This species/area/period key, logbook data (spatial distribution) and landings slip data (quantity) are used to derive the Danish WG estimates of landings of sandeel and by-catch of other species (further information can be found in ICES, 1994/Assess:7; Dalskov, 2002).

Norway Text to be inserted by Norway

For Norway and Sweden, the official landings and the WG estimated landings are the same.

UK/Scotland Text to be inserted by UK/Scotland

Sweden Text to be inserted by Sweden

The text table below shows which country supplies which kind of data:

	Data				
Country	Caton (catch in weight)	Canum (catch at age in numbers)	Weca (weight at age in the catch)	Matprop (proportion mature by age)	Length composition in catch
Denmark	x	x	x		x
Norway	x	x	x		x
UK/Scotland	x				
Sweeden	x				
Farao Islands	x				

All input files are Excel spreadsheet files.

The national data sets have been imported in a database aggregated to international data by DIFRES.

The combined Danish and Norwegian age composition data and weight at age data are applied on the landings of UK, Sweeden and Farao Isl., assuming catches from these countries have the same age composition and weight at age as the Danish and Norwegian landings. Excel spreadsheet files can be found with the Danish stock co-ordinator and in the ICES computer system under **w:\acfm\WGNSSK****.

The result files can be found at ICES and with the stock co-ordinator as ASCII files on the Lowestoft format under **w:\acfm\WGNSSK****.

13.2.2 Biological

Historically, assessments were done separately for the Northern and Southern North Sea. In recent years, the assessment has been done for the whole North Sea, but data are still compiled separately for the two areas. The catch numbers and weight at age data for the Northern North Sea are constructed by combining Danish and Norwegian data by half-year.

The mean weight at age in the catch used in the assessment is the mean weights at age in the catch for the Southern and Northern North Sea weighted by catch numbers. The mean weight at age in the stock is copied from the mean weight in the catch first half-year, and an arbitrary chosen weight at 1 gram was used for the 0-group.

Both the proportion of natural mortality before spawning (Mprop) and the proportion of fishing mortality before spawning (Fprop) are set to 0.

Values for natural mortalities are the same as used since 1989 (ICES CM 1989/Asssess:13). MSVPA (ICES CM 2002/D:04) estimates of natural mortalities are relatively stable in the period covered by this assessment. The values used in this assessment are quite similar to the MSVPA M, except for the 0-group where MSVPA estimates a value of approximately 1.2 for the second half of the year. This assessment uses a value of 0.8 for the whole year for the 0-group, 1.2 for the 1-group, and 0.6 for the 3-group and 4+-group.

The proportion mature is assumed constant over the whole period with 100% mature from age 2 and 0% of age 0 and 1. Recent research indicates however, that there are large regional variations in age at maturity of *Ammodytes marinus* in the North Sea (see e.g. Jensen et al. 2001). Whilst sandeels in some areas seem to spawn at age 2 or older, sandeels in other regions seem to mature and spawn at age 1. As the decision to spawn at age 1 or 2 is an annual event, it is likely that there are large regional and annual variations in the fraction of the populations of the sandeels that contribute to the spawning. The age at maturity keys used in the assessment might thus considerably underestimate the spawning biomass of sandeels in the North Sea.

The fishing fleet catch sandeels in different parts of the North Sea during the year, and the fishing pattern changes from year to year. Because sandeels, *Ammodytes marinus*, in the North Sea possibly consist of a number of sub populations (see section **) the industrial fishery target different part of the sandeel populations during the year and between years. There seem to be significant spatial and temporal variations in emergence behaviour (e.g. Rindorf *et al*. 2000) and growth (e.g. Pedersen et al. 1999; Wright et al. 1998) of sandeels in the North Sea. Further, there are age/length dependent variations in the burrowing behaviour of sandeels (Kvist et al. 2001). The information about age compositions in the catches and the age and weight relationships thus represent average values over time and space and reflect the variability in emergence behaviour and growth. For example, weight at age of sandeels seems to vary both between years and between Danish and Norwegian catches.

The effect of variations in the biological data on the performance of the assessments has not yet been analysed. Such an analysis requires information about spatial and temporal variations in emergence and growth. A new sampling programme for such data for the Danish industrial fleet was initiated in 1999 in which a part of the fleet is monitored in detail (Jensen *et al*. 2001). In 1999, information about catches of sandeel was collected on a trawl haul basis from 17 Danish vessels. In total 231 samples was taken from 49 grounds, corresponding to 2.6% of the Danish landings of sandeel in the North Sea in 1999. This sampling programme was continued in 2000 to 2003 with about the same sampling level. Basic analysis of the data from 1999-2003 is not completed. However, the data have been used for estimation of assessment catch at age numbers. Due to the new sampling program, the number of fish measured and aged has since 1999 increased by a factor of around 10 compared to previous years.

13.2.3 Surveys

There are no survey time series available for this stock.

13.2.4 Commercial CPUE

Four commercial tuning fleets are used in the assessment. One fleet in the northern North Sea in first half year and one in the same area the second half year, one fleet in the southern North Sea first half year, and one in the same area in the second half year. The effort data for the Southern North Sea prior to 1999 are only available for Danish vessels. Since 1999 Norwegian vessels have also provided effort data. The tuning fleet used for 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 (see section **).

Total international standardised effort used in the assessment is calculated from CPUE and total catch. CPUE is standardized to a vessel size of 200 Gross Register tones (GRT) using the relationship:

$CPUE = a * GRT^{b}$ (1)

where a and b are constants and GRT is vessel size in GRT

The constants a and b are estimated for each year by performing the regression analysis:

$Ln(C/e)=\ln(a)+b*\ln(GRT)$ (2)

where C=catch in ton, e=effort in days spend fishing, and the rest of the parameters are as in (1).

The parameters in (2) are from 2003 estimated using catch and effort data on single trip level. Prior to 2003 average values of catch and effort for each vessel size categories were used in the estimation (ICES, 1996/Assess:6). This change in the estimation procedure of effort was not found to have any effect on F, SSB and recruitment.

As no recruitment estimates from surveys are available, recruitment estimates are based exclusively on commercial catch-at-age data. The tuning diagnostics indicate that the 0-group CPUE is a poor predictor of recruitment.

There is a relatively poor correlation between the tuning indices and the stock, which may be due to the fact that several sub-stocks are assessed as a single unit.

13.2.5 Other relevant data

None.

13.3 Estimation of Historical Stock Development

The Seasonal XSA (SXSA) developed by Skagen (1993) was from 19** to 2002 used for stock assessment of sandeel in IV. Annual XSA was tried in 2002 WG where it was concluded that the two approaches gave similar results. For a standardization of methodology, it was decided to shift to XSA in 2003. For analysis of alternative procedures see WG reports from previous years (ICES 1986, … 2003 **to be updated with references prior to 1986).

The assessment of sandeels in IV now use the XSA method with the following settings for tuning:

stock	Sandeel	
area	IV	
Assessment model	**XSA**	
Combined Northern 1st half-year	1983-2001	0-4+
Combined Northern 2nd half-year	1983-2001	0-4+
Combined Southern 1st half-year	1983-2001	0-4+
Combined Southern 2nd half-year	1983-2001	0-4+
Time series weights	**none**	
Power model used for catchability	**not used**	
Catchability plateau age	**2**	
Surv. est. shrunk towards mean F	**5 years / 2 ages**	
s.e. of the means	**1.5**	
Min. stand. error for pop. estimates	**0.3**	
Prior weighting	**none**	

Input data types and characteristics:

Type	Name	Year range	Age range	Variable from year to year Yes/No
Caton	Catch in tonnes	1974 – last data year	0 – 4+	Yes
Canum	Catch at age in numbers	1974 – last data year	0 – 4+	Yes
Weca	Weight at age in the commercial catch	1974 – last data year	0 – 4+	Yes
West	Weight at age of the spawning stock at spawning time.	1974 – last data year	0 – 4+	Yes
Mprop	Proportion of natural mortality before spawning	1974 – last data year	0 – 4+	No – set to 0 for all ages in all years
Fprop	Proportion of fishing mortality before spawning	1974 – last data year	0 – 4+	No – set to 0 for all ages in all years
Matprop	Proportion mature at age	1974 – last data year	0 – 4+	No (see section **)
Natmor	Natural mortality	1974 – last data year	0 – 4+	No (see section **)

Tuning data:

Type	Name	Year range	Age range
Tuning fleet 1	Northern North Sea first half year	1976 – last data year	1 – 4+
Tuning fleet 2	Northern North Sea second half year	1976 – last data year	0 – 4+
Tuning fleet 3	Southern North Sea first half year	1982 – last data year	1 – 4+
Tuning fleet 4	Southern North Sea second half year	1982 – last data year	0 – 4+

The low number of age groups makes the assessment highly sensitive to estimated terminal fishing mortalities for the oldest age (age 3). This in combination with an assumed constant and poorly determined proportion mature makes the SSB estimate highly uncertain.

13.4 Short-Term Projection

Not done

The high natural mortality of sandeel and the few year classes in the fishery make the stock size and catch opportunities largely dependent on the size of the incoming year classes. Quantitative estimates of recruits (age 0) in the year of the assessment are not available at the time of the WG. Traditional deterministic forecasts are therefore not considered appropriate.

13.5 Medium-Term Projections

Not done

13.6 Long-Term Projections

Not done

13.7 Biological Reference Points

There is no management objective set for this stock. There is a need to ensure that the stock remains high enough to provide food for a variety of predator species. Management of fisheries should try to prevent local depletion of sandeel aggregations, particularly in areas where predators congregate.

In 1998 ACFM proposed that $\mathbf{B}_{lim}$ be set at 430,000 t, the lowest observed SSB. The $\mathbf{B}_{pa}$ was estimated at 600,000 t, approximately $\mathbf{B}_{lim}$ * 1.4. This corresponds to that if SSB is estimated to be at $\mathbf{B}_{pa}$ then the probability that the true SSB is less than $\mathbf{B}_{lim}$ will be less than 5% (assuming that estimated SSB is log normal distributed with a CV of 0.2). No fishing mortality reference points are given. These reference points are based on an assessment using another tuning method than used from 2002 (see section 1.2.4). Due to the few age-groups, SSB is highly dependent on the terminal F and thereby tuning method. Even though the previously used SXSA and XSA give similar results, an update of the reference points is needed.

The TAC was set to 1,020,000 tonnes for 2002 and 918.000 t for 2003. The ACFM advice for 2003 was that the stock can sustain the current fishing mortality and that the fishing mortality should not be allowed to increase because the consequences of removing a larger fraction of the food-biomass for other biota are unknown.

13.8 Other Issues

None

13.9 References

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