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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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Palægade 2–4 DK–1261 Copenhagen K Denmark

TECHNICAL MINUTES

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

ACFM October 2002

General

The WGNSSK was complimented on the completeness and standardised format of the report, which facilitated review of the assessments. In particular, the "Synthesis" and "Management considerations" sections of the report proved helpful as a starting point in formulating management advice.

One aspect of the WGNSSK terms of reference was to "take into account the technical interactions among the stocks due to the mixed-species fisheries and the new management measures coming into force in 2000." The WG lacked the resources to address this issue in all of the current assessments. Instead, the WG conducted a case study using the North Sea flatfish fisheries (two species, two fleets) to demonstrate an approach that might be expanded and employed for more complex fisheries (WGNSSK report section 1.4.6).

In reference to the workload issue, the WGNSSK proposed that in the future a detailed, "review" level of assessment be provided to ACFM for three stocks per year, and simpler update, or "roll-over," assessment be provided for the remaining stocks.

A retrospective pattern of underestimation of fishing mortality and overestimation of spawning stock biomass (SSB) is apparent in many of the North Sea and Eastern Channel assessments. The suspected cause of this retrospective pattern is some combination of unreported landings and the lack of discards in many of the assessments (e.g., North Sea cod and plaice).

Commercial fishery CPUE tuning indices are excluded from many, but not all, of the assessments. Given the problematic assumption that commercial CPUE is an accurate index of stock abundance (due to unaccounted for changes in the efficiency of commercial fishing operations over time or restrictions on retention due to TAC), it is currently preferable to exclude these indices from VPA tuning if sufficient fishery independent survey indices are available (e.g., North Sea cod). In some cases, however, (e.g., North Sea saithe) it is still necessary to rely mainly on commercial CPUE indices for VPA tuning.

The evaluation of current stock status is generally expressed in deterministic terms (e.g., VPA terminal year point estimates of fishing mortality and SSB). Presentation of confidence intervals for these estimates would be helpful to managers in evaluating the risk of management decisions. Currently, expression of the precision of the terminal year estimates of fishing mortality and SSB is difficult due to XSA software limitations. It is anticipated that this situation will improve in the near future, allowing a probabilistic expression of terminal year estimates of fishing mortality and SSB (i.e., bootstrap estimates).

ACFM undertook an evaluation of the impact of technical conservation measures for cod, haddock and whiting in the North Sea according to a simplified regimen of gear measures introduced by EU and UK national legislation. See Appendix 1.

North Sea cod

There was considerable discussion about the internal (current assessment) and historical (between assessments) retrospective patterns of severe underestimation of fishing mortality and overestimation of SSB in the assessment. There was general agreement that the likely cause is some combination of unreported landings and the absence of discards in the fishery catch at age input to the VPA.

It was noted that there are recent estimates of discards available that indicate that discarding may be high, but as most programs began in 1999, there is no time series of discards available for inclusion in the VPA. The availability of discard sample data will be critical in the coming years to evaluate the effectiveness of the recently implemented technical measures. As discarding of North Sea cod appears to be related to minimum size regulations, rather than due to the restrictions of TAC, there may be some potential to develop a time series of discard estimates using historical survey catch at length and mesh selective ogives.

A TSA assessment of North Sea cod using landings only, however, indicated it was likely that substantial under-reporting of landings did occur in 2000 and 2001.

There was consensus that while the terminal year estimates of fishing mortality and SSB are somewhat uncertain, there is little doubt that the current status of the North Sea cod is very poor.

North Sea haddock

It was noted that while the internal retrospective pattern is not severe, the historical retrospective pattern indicates that the apparent recent decline in fishing mortality may not be as large as currently estimated. There is little evidence of unreported landings that might account for the historical underestimation of fishing mortality, however, and estimates of discards are included in the assessment. There have been no recent major structural changes in the assessment. Therefore, the cause of the retrospective pattern remains unclear.

Residual patterns from the VPA indicate, however, that the model is balancing conflicting signals about current stock status from the two surveys available for tuning (English Groundfish and IBTS).

ACFM notes that the Scottish Groundfish survey indices have been excluded from VPA tuning in the current and three previous assessments due to survey gear changes that occurred in 1998. ACFM recommends that the Scottish survey data be re-examined to determine the potential to again include those data in VPA tuning in future assessments.

Adjustment of mean weights and/or selection pattern in forecasts for slow growth of 1999 year class – not accounted for in WG, but done during ACFM. In the time available this could not be fully addressed but indicated that the WG "got away with it"

North Sea whiting

The comparative analyses examining the differing trends in fishing mortality and SSB provided by the survey and commercial fishery VPA tuning indices were useful in illustrating the degree of uncertainty of this assessment. The different impressions provided by the four survey series (English Groundfish, Scottish Groundfish, French Groundfish, and IBTS) may be due to real differences in the spatial and temporal abundance of the stock. The fishermen's survey (North Sea Stock Summary, Scottish Fishermen's Association) reflects such differential impressions of stock abundance over geographic regions.

North Sea saithe

The evaluation of current status is uncertain, in part because the assessment is based mainly on fishery dependent data (commercial fishery landings at age and commercial CPUE tuning indices). The increasing use of more sophisticated echo sounders over the time series of the commercial CPUE tuning indices, which has not been explicitly accounted for, may provide an optimistic indication of stock abundance. There is also uncertainty in the assessment because a time series of discards is not included. In single index VPA runs, the Norwegian acoustic survey provided a lower estimate of biomass in 2001 than the commercial fishery CPUE indices, although the 2002 acoustic survey is expected to indicate an increase in biomass.

The assessment of current status, relatively low fishing mortality and relatively high SSB, generally agrees with fishermen's perception of the stock.

North Sea plaice

The terminal year estimates of fishing mortality and SSB are sensitive to VPA model assumptions. Further, an alternative assessment based on the ICA model indicates higher recent fishing mortality rates and lower SSB than the VPA, reinforces the uncertainty of the state of the stock.

High levels of discards area known to have occurred in the plaice fisheries in recent years, but these have not been included in the assessment because a full and representative time series is not available. This situation further contributes to the uncertainty of the assessment.

Commercial CPUE indices have been excluded from the VPA tuning because of concerns about possible bias due to changing fishery practices that have not been explicitly accounted for. This has resulted in a loss of information about the abundance of older age classes, and as a result the estimates of the abundance of the older ages are influenced mainly by shrinkage to the mean estimates in the VPA.

The survey indices currently used in the assessment are mainly from inshore areas, and therefore the abundance of older age fish occurring mainly in offshore areas may not be well characterised. Recent surveys over the full range of the stock indicate that may be different recent trends in the abundance of plaice in different depths and areas of the North Sea.

North Sea sole

An historical review of assessments indicates that the management measures implemented to date have not been successful in reducing fishing mortality sufficiently to maintain SSB above Bpa.

A new commercial fishery tuning index was developed that was intended to more representative of the fishing activities of the UK commercial otter trawlers actually based in the UK. This new tuning fleet did not match the other tuning and catch information very well, and so exerted a relatively low influence on the estimates of stock size.

Commercial CPUE indices have been retained in the assessment because of the impression that TAC restrictions have not resulted in bias. However, the influence of possible bias in the commercial CPUE indices due to unaccounted for increases in commercial fishing efficiency has not been explored in detail.

ACFM recommends that the WGNSSK consider the following in developing next year's assessment: 1) consider whether inclusion of the UK commercial OT index is still appropriate, given the lack of fit and large residuals, 2) consider whether truncation of the fishery landings at age matrix used in the VPA might be appropriate, given the large tuning residuals for the older ages, 3) if substantial revision to the configuration to the VPA are made, consider recalculation of the biological reference points, and 4) consider whether continued use of commercial CPUE indices in the VPA tuning is appropriate.

Plaice IIIa

There have been major structural changes in the assessment, due to the addition of three new survey tuning series. These new survey indices now receive the majority of the tuning weighting for ages 2-4. This is a major change from previous assessments in which the stock sizes at these ages were determined by commercial CPUE indices and shrinkage to the mean estimates. The addition of these surveys to the VPA tuning is perceived to be a major improvement in the assessment.

The assessment exhibits significant internal and historical retrospective patterns of underestimation of fishing mortality, and therefore the recent estimates of fishing mortality are uncertain. It is not clear if this retrospective pattern is caused by absence of discards estimates in the assessment, high and variable levels of natural mortality, emigration of adult fish from the assumed unit stock, the use of commercial CPUE indices in the VPA tuning, or some other factor.

There are trends in tuning residuals evident for some of the commercial CPUE tuning indices, even in the single index runs, that are difficult to reconcile with a constant catchability assumption.

ACFM recommends that the WGNSSK consider if the continued inclusion of the commercial CPUE indices in the VPA tuning is appropriate.

The fishing mortality reference point of Fpa = 0.73 is unusually high for a flatfish stock with assumed natural mortality rate (M) of 0.1 for all ages. ACFM recommends that the reference points for this stock be re-evaluated, especially since major structural changes have been made in the assessment since the reference points were established.

Sole VIId

There is no decline in fishing effort that corresponds to the apparent recent decline in fishing mortality. Rather, the decline appears due to recruitment to the fishery of the strong 1999 year class.

The retrospective pattern of underestimation of fishing mortality and the wide range of recent fishing mortality rates indicated by the various tuning indices suggest that the terminal year estimates of fishing mortality and SSB are uncertain. In this case, the retrospective pattern appears to be caused by misreporting of the landings to other areas, rather than by the absence of discards.

ACFM recommends that the WGNSSK consider an additional VPA diagnostic exercise for this assessment. Single index VPA retrospective runs should be run to explore the consistency of the different tuning indices with the fishery landings at age over time. Tuning indices that provide stable indications of stock trends (limited retrospective bias) would be identified as candidates for retention in the full VPA tuning, conditional on reasonable performance of the other usual diagnostics.

Plaice VIId

The retrospective pattern of underestimation of fishing mortality and the wide range of recent fishing mortality rates indicated by the various tuning indices suggest that the terminal year estimates of fishing mortality and SSB are uncertain. Given these factors, the apparent 35% reduction in fishing mortality from 2000 to 2001 (0.74 to 0.48) may prove to be transient.

The short-term forecast is sensitive to the assumption of the size of the 2000 year class, which accounts for 45% of the variance of the estimated SSB in 2004.

A revised forecast was put forward by ACFM. This is contingent on the recruitment estimates from RCT3 at age 2, which were made available to ACFM:

Survey series	Slope	Inter-cept	Std Error	Rsquare	No. Points	Index Value	Predicted value	Std Error	WAP Weights
yfs0	1.68	-0.57	0.74	0.194	11	6.24	9.94	0.855	0.046
yfs1	2.38	-0.78	0.94	0.131	12	4.14	9.06	1.108	0.027
bts1	0.51	6.27	0.25	0.674	11	7.49	10.13	0.298	0.376
bts2	0.78	4.38	0.31	0.578	12	7.38	10.11	0.363	0.254
gfs0	0.75	6.34	1.5	0.058	10	7.37	11.85	1.93	0.009
gfs1	1.29	1.26	1.25	0.078	11	6.61	9.79	1.443	0.016
VPA mean							9.86	0.351	0.272

The BTS 2002 data in the RCT3 estimate at age 2 increases the influence of BTS survey in the analysis, getting 63% of the total weight. Moreover, the two BTS estimates (age 1 in 2001 and age 2 in 2002) are consistent in their estimates of the 2001 year class. The RCT3 estimate of the 2000 year class is 22.5 million which is much lower than the XSA estimate (32 million). The XSA estimate is for a large part driven by F-shrinkage and is therefor suspect. ACFM considered that the 2 year olds in 2002 should be replaced by the RCT3 estimate.

Recruitment is then summarized as follows (underlined, bold numbers are used in the assessment.

Year class	Age in 2002	XSA	RCT3 (WGNSSK)	RCT3 (updated)	GM_{80-99}
2000	2	31628	22160	<u>**22552**</u>	20378
2001	1		21455	25899	<u>**23427**</u>
2002	Recruit	-			<u>**23427**</u>

The updated short-term forecast is given in the tables below:

Table_____Plaice,VIId

input data for catch forecast and linear sensitivity analysis

Label	Value	CV	Label	Value	CV
Number at age			Weight in the stock		
N1	23426	0.37	WS1	0.08	0.16
N2	22500	0.36	WS2	0.19	0.09
N3	13125	0.18	WS3	0.23	0.17
N4	6239	0.14	WS4	0.31	0.18
N5	2512	0.13	WS5	0.40	0.10
N6	2238	0.14	WS6	0.61	0.08
N7	547	0.15	WS7	0.77	0.10
N8	148	0.16	WS8	0.86	0.13
N9	38	0.15	WS9	0.88	0.32
N10	162	0.15	WS10	1.23	0.12
H.cons selectivity			Weight in the HC catch		
sH1	0.05	0.56	WH1	0.20	0.08
sH2	0.21	0.45	WH2	0.25	0.02
sH3	0.43	0.14	WH3	0.28	0.15
sH4	0.67	0.15	WH4	0.35	0.11
sH5	0.64	0.03	WH5	0.45	0.02
sH6	0.47	0.07	WH6	0.67	0.11
sH7	0.49	0.08	WH7	0.80	0.08
sH8	0.35	0.16	WH8	0.95	0.08
sH9	0.34	0.18	WH9	1.00	0.13
sH10	0.34	0.18	WH10	1.31	0.13
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		
HF02	1.00	0.22	K02	1.00	0.10
HF03	1.00	0.22	K03	1.00	0.10
HF04	1.00	0.22	K04	1.00	0.10
Recruitment in 2003 and 2004					
R03	23427	0.37			
R04	23427	0.37			

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

Stock numbers in 2002 are VPA survivors. Except for age 1 which is GM and age 2 which is taken from RCT3 (october 2002)

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Table_____.Plaice,VIId

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

	2002	2003						
Mean F Ages								
H.cons 2 to 6	0.48	0.00	0.05	0.10	0.14	0.19	0.24	0.29
Effort relative to 2001								
H.cons	1.00	0.00	0.10	0.20	0.30	0.40	0.50	0.60
Biomass								
Total 1 January	14.16	15.20	15.20	15.20	15.20	15.20	15.20	15.20
SSB at spawning time	7.23	8.25	8.25	8.25	8.25	8.25	8.25	8.25
Catch weight (,000t)								
H.cons	4.78	0.00	0.65	1.27	1.86	2.43	2.97	3.48
Biomass in year.... 2004								
Total 1 January		21.37	20.69	20.04	19.43	18.84	18.28	17.74
SSB at spawning time		13.98	13.37	12.78	12.22	11.70	11.19	10.72

	2002	2003						
Effort relative to 2001								
H.cons	1.00	0.00	0.10	0.20	0.30	0.40	0.50	0.60
Est. Coeff. of Variation								
Biomass								
Total 1 January	0.14	0.17	0.17	0.17	0.17	0.17	0.17	0.17
SSB at spawning time	0.10	0.17	0.17	0.17	0.17	0.17	0.17	0.17
Catch weight								
H.cons	0.23	0.00	2.16	1.06	0.70	0.53	0.43	0.36
Biomass in year.... 2004								
Total 1 January		0.16	0.17	0.17	0.17	0.17	0.17	0.18
SSB at spawning time		0.18	0.20	0.20	0.21	0.21	0.21	0.21

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

	2002	2003						
Mean F Ages								
H.cons 2 to 6	0.48	0.34	0.39	0.43	0.45	0.48	0.53	0.58
Effort relative to 2001								
H.cons	1.00	0.70	0.80	0.90	0.93	1.00	1.10	1.20
Biomass								
Total 1 January	14.16	15.20	15.20	15.20	15.20	15.20	15.20	15.20
SSB at spawning time	7.23	8.25	8.25	8.25	8.25	8.25	8.25	8.25
Catch weight (,000t)								
H.cons	4.78	3.98	4.45	4.90	5.03	5.33	5.75	6.14
Biomass in year.... 2004								
Total 1 January		17.23	16.75	16.28	16.15	15.84	15.41	15.01
SSB at spawning time		10.26	9.83	9.42	9.30	9.03	8.66	8.31

	2002	2003						
Effort relative to 2001								
H.cons	1.00	0.70	0.80	0.90	0.93	1.00	1.10	1.20
Est. Coeff. of Variation								
Biomass								
Total 1 January	0.14	0.17	0.17	0.17	0.17	0.17	0.17	0.17
SSB at spawning time	0.10	0.17	0.17	0.17	0.17	0.17	0.17	0.17
Catch weight								
H.cons	0.23	0.32	0.28	0.26	0.25	0.24	0.23	0.22
Biomass in year.... 2004								
Total 1 January		0.18	0.18	0.18	0.18	0.18	0.18	0.18
SSB at spawning time		0.21	0.21	0.21	0.21	0.21	0.21	0.21

Table_____.Plaice,VIId

Detailed forecast tables.

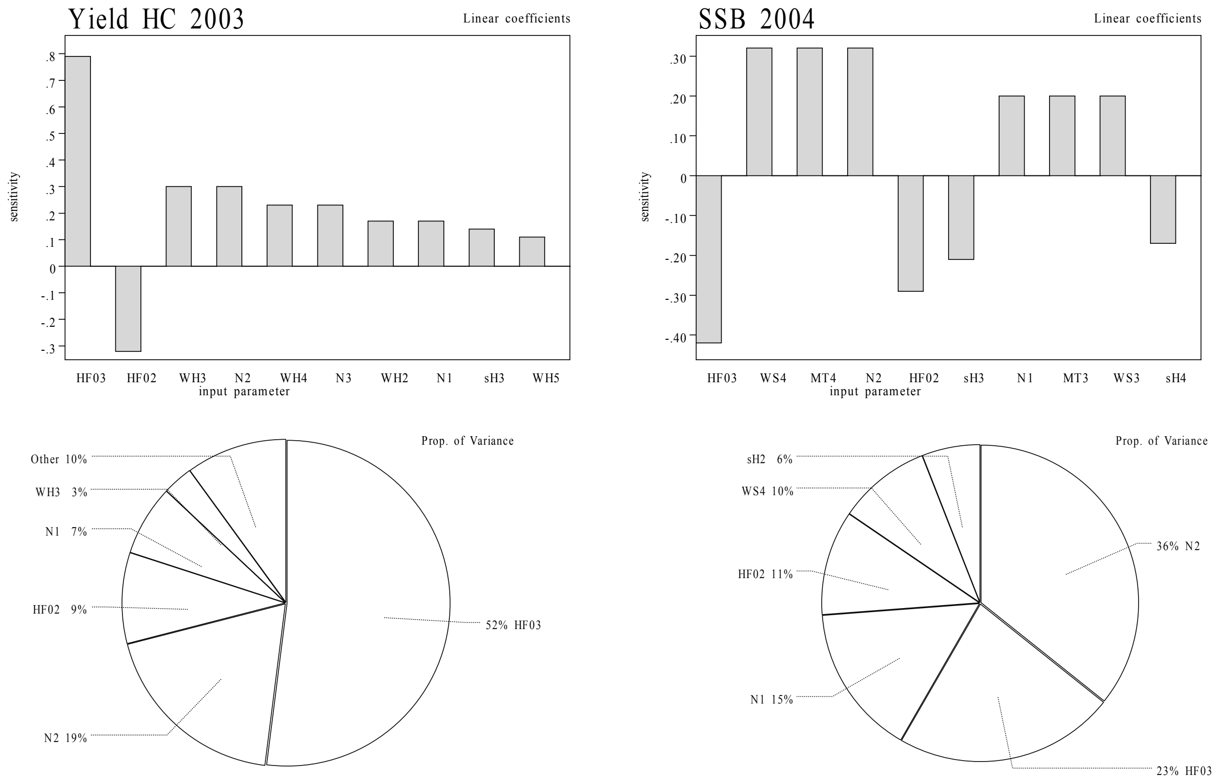
Forecast for year 2002
F multiplier H.cons=1.00

	Populations	Catch number	
Age	Stock No.	H.Cons	Total
1	23426	981	981
2	22500	3993	3993
3	13125	4413	4413
4	6239	2900	2900
5	2512	1132	1132
6	2238	800	800
7	547	202	202
8	148	42	42
9	38	11	11
10	162	45	45
Wt	14	5	5

Forecast for year 2003
F multiplier H.cons=1.00

	Populations	Catch number	
Age	Stock No.	H.Cons	Total
1	23427	981	981
2	20264	3596	3596
3	16569	5571	5571
4	7695	3576	3576
5	2903	1308	1308
6	1202	430	430
7	1267	469	469
8	303	86	86
9	94	26	26
10	129	36	36
Wt	15	5	5

Figure Plaice,VIId. Sensitivity analysis of short term forecast.



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Norway pout IV

The assessment was accepted with limited comment.

Sandeel IV

The assessment was accepted with limited comment.

APPENDIX 1

Impact of recent technical conservation measures

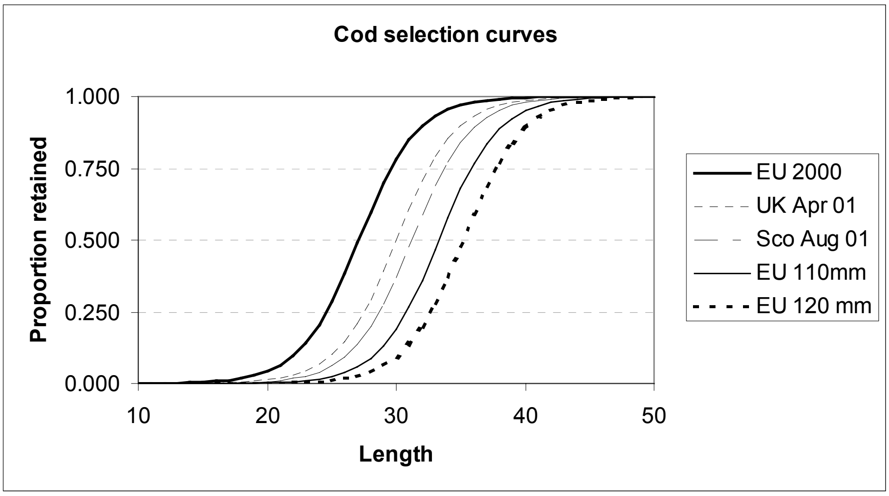
A number of regulations affecting the design and construction of cod-ends have been enacted in recent years. Based on information with regard to UK national legislation and EU legislation, an evaluation of their potential impacts is given below. This evaluation necessarily includes a number of simplifying assumptions due to the restricted availability of gear selection data and the appropriately disaggregated dataset. Nevertheless, the results are considered to be indicative of the potential impacts of the measures.

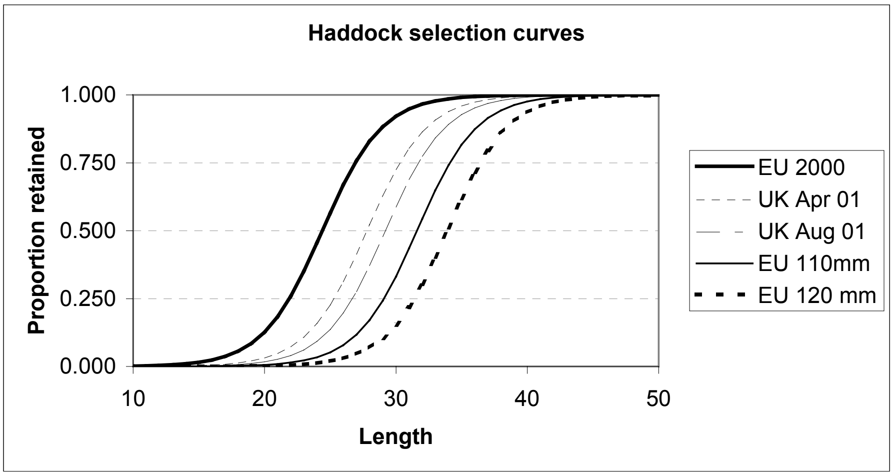
A truncated overview of the regulations are given below in regard to their effects on the construction of towed demersal gears targeting gadoids in the North Sea:

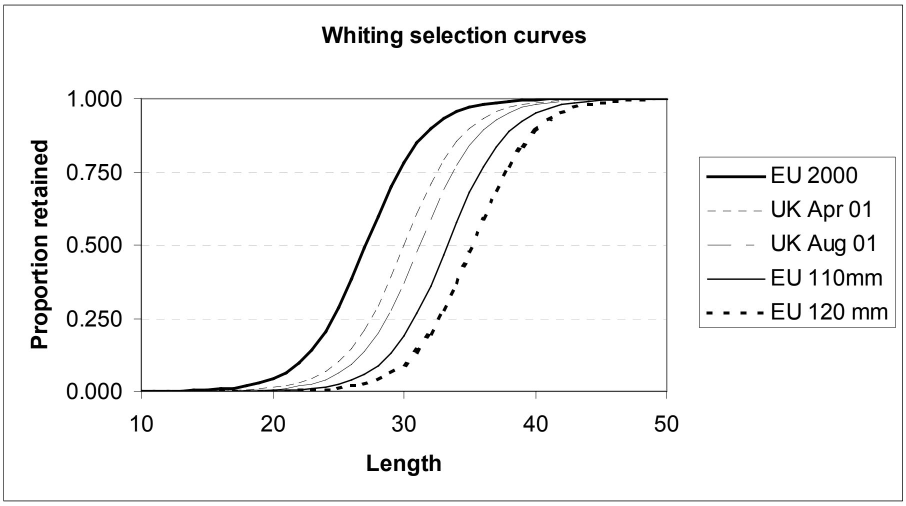
Label	Regulation	Applicability	Constraint or additional constraint on gear design
EU 2000	EU 850/98	EU	100 mm minimum mesh size
UK 2000	SSI 227/2000	UK (Scotland)	90 mm square mesh panel with restrictions on its placement
UK 2001	SI 649/2001	UK	Maximum twine diameter in cod-end and 90 mm square mesh panel with restrictions on its placement
Scotland 2001	SSI 250/2001	UK (Scotland)	Ban on lifting bags and maximum number of meshes along the length of the extension piece
EU 110 or EU 120	EU 2056/2001	EU	120 mm minimum mesh size and a maximum length for the extension piece. Derogation for vessels targeting a mixed demersal gadoid fishery of 110 mm minimum mesh size in 2002, subject to rules on catch composition

For the purposes of this evaluation, selectivity based on the joint effects of EU 2000 and UK 2000 was taken as the baseline case and considered to run from January 2000. For the evaluation of effects, UK 2001 selectivity was initiated at April 2001 and applied to UK fleets only; Scotland 2001 selectivity was initiated at August 2001 and applied to Scotland only; and EU 110 and EU120 measures were initiated at January 2002 subject to the uptake of the 110 mm derogation and applied to all fleets. All UK demersal vessels and 20% of non-UK demersal vessels were assumed to adopt the 110 mm derogation in 2002. These values reflect the predominance of the mixed demersal gadoid fishery to the UK fleet compared to the non-UK fleet, but are, nevertheless, uncertain. For 2003 and subsequent years, the 110 mm derogation is assumed to lapse.

The selection curves generated by these measures is shown below for cod, haddock and whiting:


Cod selection curves
1.000
0.750
0.500
0.250
0.000
Proportion retained
10
20
30
40
50
Length
EU 2000
UK Apr 01
Sco Aug 01
EU 110mm
EU 120 mm


Haddock selection curves
1.000
0.750
0.500
0.250
0.000
Proportion retained
10
20
30
40
50
Length
EU 2000
UK Apr 01
UK Aug 01
EU 110mm
EU 120 mm


Whiting selection curves
1.000
0.750
0.500
0.250
0.000
Proportion retained
10
20
30
40
50
Length
EU 2000
UK Apr 01
UK Aug 01
EU 110mm
EU 120 mm

The parameters of these selection curves are as estimated from a number of selectivity experiments conducted onboard commercial fishing vessels by FRS Marine Laboratory staff in recent years using, in the case of haddock, the model based on Ferro and Graham (ICES CM1998/OPEN:3) with an extra "panel factor" built in. Lifting bags are assumed to reduce the L_{50} by 5%. For cod and whiting, selection parameters were estimated from only limited data and required extrapolations to be made on the basis of regressions relating cod and whiting retention to that of haddock. The selection range in all cases was assumed to be 5cm.

In the schedule of regulations under evaluation, the effect of EU vessels fishing in Norwegian waters is disregarded to the extent that they are assumed to meet EU but not Norwegian regulations. This is a technical adjustment because disaggregated data to allow for the calculation of partial fishing mortalities on cod, haddock and whiting by EU vessels in Norwegian waters was not available at the time of analysis. Similarly, all fishing mortality on cod, haddock and whiting in the EU zone of the North Sea is assumed to stem from vessels with the selection characteristics defined above. In doing so, the differences in the selection characteristics of, for example, *Nephrops* trawlers and gill-netters is explicitly ignored. This is again due to the lack of available disaggregated data at the time of the analysis.

Within the analysis, three "fleets" were examined: UK Scotland, UK England and Others. Where other catch categories were available, *ie*., discard data and information on industrial bycatch, they were also applied in this evaluation. Gear selectivity changes to fishing mortality acted upon the mean length of fish at age by "fleet" and catch category. The gear regulations were also assumed to be fully and effectively implemented.

Baseline forecasts were run using ICES' most recent estimates of stock size at age in 2000, 2001 and 2002 and of weight at age and fishing mortality at age for 2000 and 2001. Fishing mortality in 2002 and mean weight at age in 2002 was taken as the current ICES *status quo* estimates. These were also the values used in subsequent years for the purpose of this analysis. Recruitment in 2003 and 2004 was as used in the current ICES short term forecasts. Subsequent recruitments were generated from deterministic stock and recruitment relationships defined under the EU MATES contract awarded to CEFAS, Lowestoft, and partners.

At the same time, a scenario forecast was run using the same input data as the baseline forecast, but with fishing mortality rates modified by the effects of the technical regulations as discussed above. Results are presented as the percentage deviation of the scenario from the baseline forecast. When interpreting these results, it is important to remember that a large percentage increase of a small absolute number can still yield a small number!

It should also be noted that these results are based on single species forecasts in which biological interactions, *i*.e., predation, are excluded. Previous analyses of the effects of technical conservation measures have shown that when such interactions are taken into consideration, there can be a reduction in the increase in yields and biomass that may be expected under single species assumptions – gains may even be turned into losses. (Discussion of this point during ACFM indicated that the effect of increased predation is seen particularly where future stock size assumes constant recruitment, and that where future recruitment is determined through stock and recruitment relationships, then the impact of predatory interactions on analyses such as this is reduced). Results are presented below:

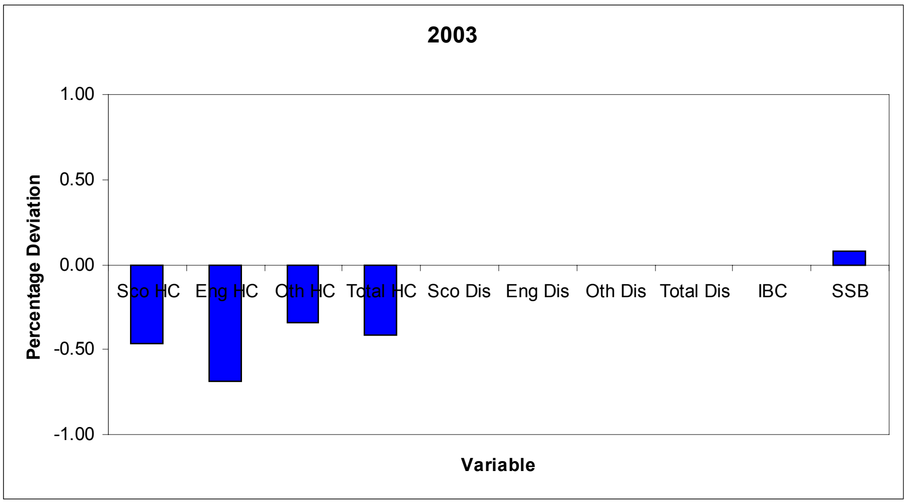
Comparison of results
Percentage deviation from baseline

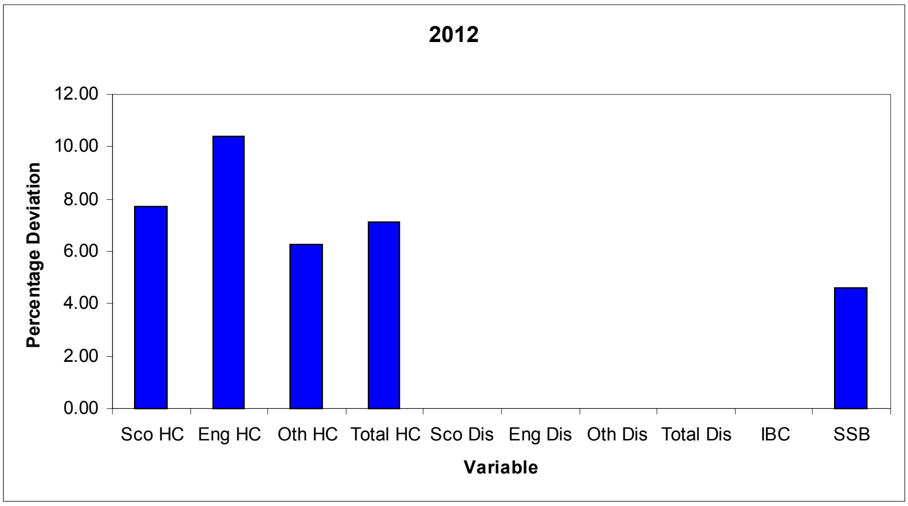
Yield by "fleet" and category

Year	Sco HC	Sco Dis	Eng HC	Eng Dis	Oth HC
2000	0.00		0.00		0.00
2001	-0.06		-0.01		0.00
2002	-0.29		-0.37		-0.45
2003	-0.47		-0.69		-0.34
2012	7.69		10.41		6.29

Total yield by category / Population size

Year	Total HC	Total Dis	IBC	TSB
2000	0.00			0.00
2001	-0.02			0.00
2002	-0.40			0.00
2003	-0.42			0.15
2012	7.13			69.58



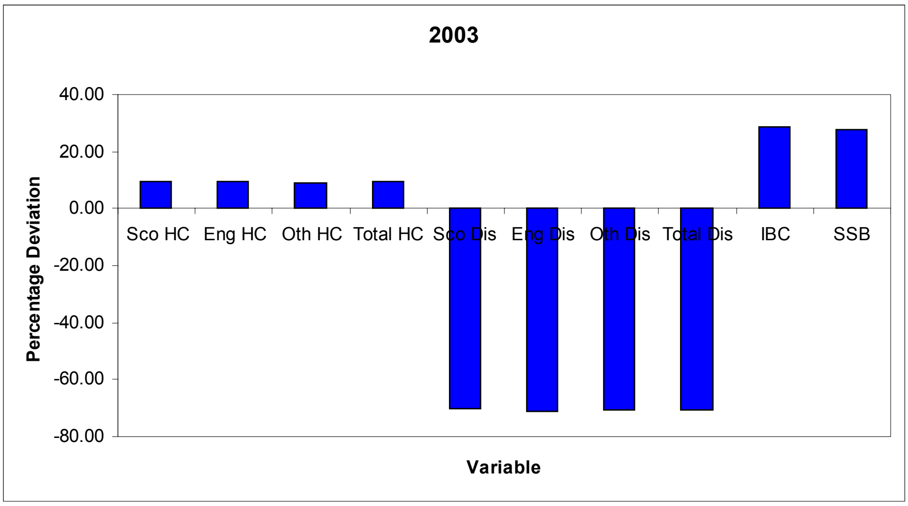


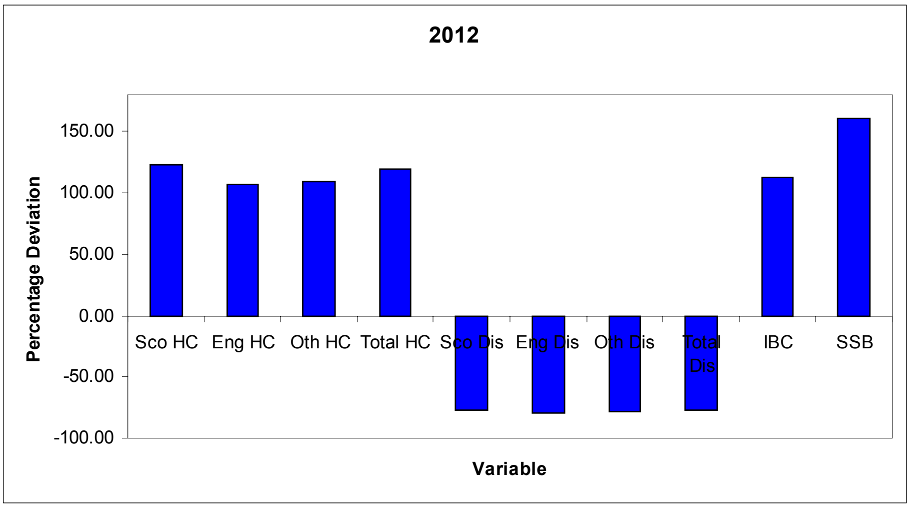
The lack of discard data in the cod assessment influences these results markedly. Points to note are that it is fish at age 1 that are discarded due to minimum landing size (MLS) restrictions. Any conservation benefit through reduced discarding would be anticipated through their subsequent development in the cohort. Notwithstanding that, the absolute growth of cod in the North Sea is such that they are not exposed to discarding due to MLS requirements for long compared to whiting and, to a lesser extent, haddock. There is no effect on spawning biomass until 2003, as stock numbers prior to this are "hard-wired" in the evaluation from the ICES stock estimates. Yield is permitted to change from the implementation of the first non-baseline regulation, *i.*e., UK 2001 (April). The EU 120 mm regulation shifts the selection curve so that the L_{50} for cod corresponds to the cod MLS. Although from a purely technical standpoint this is coherent, from a biological perspective in terms of the growth and maturity schedule of cod this is still less than optimal.

Comparison of results
Percentage deviation from baseline

			Yield by "fleet" and category		
Year	Sco HC	Sco Dis	Eng HC	Eng Dis	Oth HC
2000	0.00	0.00	0.00	0.00	0.00
2001	-5.21	-36.68	-0.79	-14.48	0.75
2002	-8.82	-61.00	-10.42	-64.47	-26.16
2003	9.29	-70.33	9.59	-71.30	9.11
2012	122.39	-76.60	106.40	-78.94	108.83

	Total yield by category				Population size
Year	Total HC	Total Dis	IBC		TSB
2000	0.00	0.00	0.00		0.00
2001	-3.56	-27.81	0.53		0.00
2002	-11.41	-63.86	10.47		0.00
2003	9.28	-70.44	28.90		6.90
2012	119.71	-76.94	112.99		79.40





The general form of the results for haddock fit to expectation given what is known about its growth schedule and the gear measures under evaluation. In general, increased gear selectivity results in a short term loss in landings followed by an increase in landings as the conservation benefits of the measure kick-in through the survival and growth of fish that previously would have been caught and in many cases discarded. The reduction in discards according to this evaluation is immediate and ultimately substantial in percentage terms. The net long-term effect on spawning biomass is also large in percentage terms.

It should also be noted that the EU 120 mm selection curve is shifted substantially to the right of the MLS for haddock. This means that a very large proportion of legally marketable haddock entering the net will not be retained. Under such circumstances there is a strong incentive to rig the fishing gear in a way that will retain a greater proportion of the marketable fish.

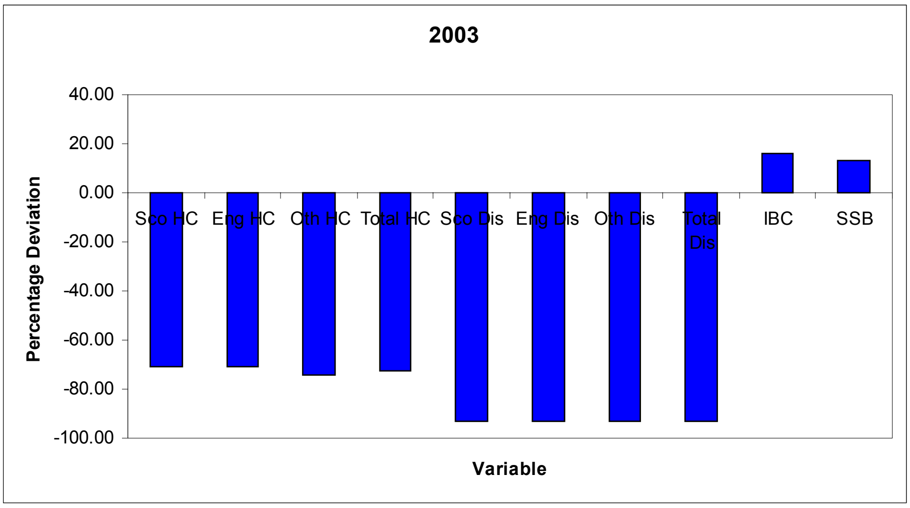
Whiting

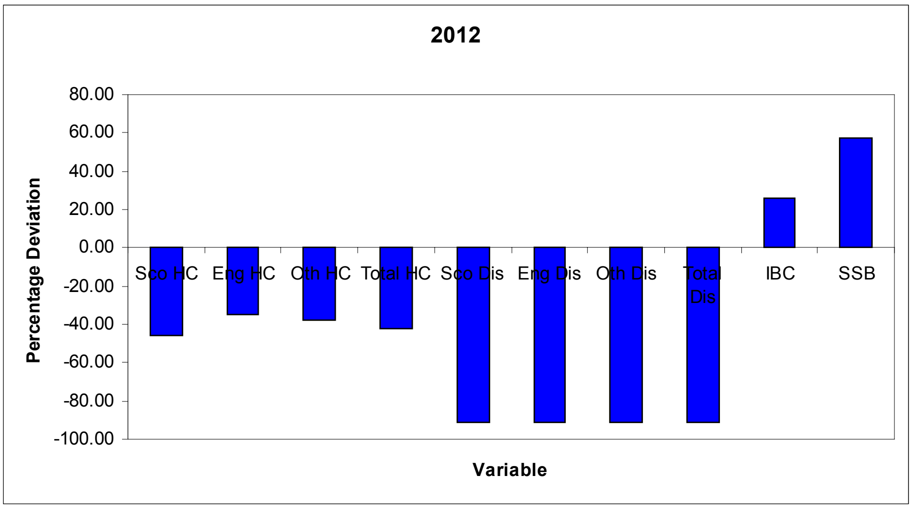
Comparison of results
Percentage deviation from baseline

Yield by "fleet" and category

Year	Sco HC	Sco Dis	Eng HC	Eng Dis	Oth HC
2000	0.00	0.00	0.00	0.00	0.00
2001	-11.97	-41.27	-8.87	-17.30	0.29
2002	-58.49	-86.08	-58.31	-86.10	-76.69
2003	-71.14	-92.89	-71.07	-92.90	-74.30
2012	-46.22	-91.25	-35.21	-91.26	-37.84

	Total yield by category weight (tonnes)				Population size weight (tonnes)
Year	Total HC	Total Dis	IBC		TSB
2000	0.00	0.00	0.00		0.00
2001	-5.35	-23.27	0.35		0.00
2002	-66.06	-87.78	6.31		0.00
2003	-72.45	-92.88	15.89		8.08
2012	-41.89	-91.28	25.93		37.37





As with haddock, the general form of these results fits in with expectation given the growth schedule of whiting and the gear measures under consideration. Discarding is rapidly reduced by a substantial percentage, but the short-term losses in landings are more severe than for haddock and, although modified in the long term, they are not turned around into gains. There is a substantial percentage increase in spawning biomass in the long term.

Again, as for haddock, it should also be noted that the EU 120 mm selection curve is shifted substantially to the right of the whiting MLS. This means that a very large proportion of legally marketable whiting that enter the net will not be retained. Under such circumstances there is a strong incentive to rig the fishing gear in a way that will retain a greater proportion of the marketable fish.

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1 GENERAL

1.1 Participants

The Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak (WGNSSK) met in Copenhagen at the ICES headquarters from 11–20 June 2002 with the following participants:

Martin Pastoors (chair)	Netherlands
Wim Demaré	Belgium
Clara Ulrich	Denmark
Henrik Jensen	Denmark
Morten Vinther	Denmark
J. Rasmus Nielsen	Denmark
Ewen Bell	England
John Casey	England
Richard Millner	England
Joël Vigneau	France
Paul Marchal	France
Hans-Joachim Rätz	Germany
Uli Damm	Germany
Loes Bolle	Netherlands
Sieto Verver	Netherlands
Knut Korsbrekke	Norway
Odd M. Smedstad	Norway
Anne McLay	Scotland
Coby Needle	Scotland
Phil Kunzlik	Scotland
Maria Hansson	Sweden

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 ICES Headquarters from 11–20 June 2002 to:

a) assess the status of and provide catch options for 2003 for the following stocks:

1) **cod** in Subarea IV and Division IIIaN (Skagerrak), and Division VIId,
2) **haddock** in Subarea IV and Division IIIa,
3) **whiting** and **plaice** in Subarea IV, Division IIIa, and Division VIId,
4) **sole** in Subarea IV and Division VIId,
5) **saithe** in Subarea IV, Subarea VIa and Division IIIa.

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

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

c) evaluate the effects of the existing **recovery plans**;

d) 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;

e) **review forecast procedures** for catches of haddock and whiting in the industrial fisheries. Explain why these forecasts appear to systematically overshoot the realised catches;

f) provide the **data required to carry out multispecies assessments** (quarterly catches and mean weights-at-age in the catch and stock for 2001 for all species in the multispecies model that are assessed by this Working Group);

g) 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;

h) 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;

i) consider the results presented in the reports of the **WGMG and the SGPA** with a view to applying these in the assessments.

Terms of reference *a* and *b* will be dealt with in the separate stock sections 3 to 14. The group attempted to devote more attention than last year to the issue of technical interactions in mixed fisheries. Results of these analyses for the North Sea human consumption fishery are presented in Section 2. The terms of reference *g* and *h* are addressed in the sections on quality of the assessment of the different species. The terms of reference *c-f* and *i* are dealt with in different sub-sections of Section 1 (see below).

The overall mapping of the terms of reference to the report sections is as follows:

Term of reference	**Section(s)**
a) Assess status of cod, haddock, whiting, saithe, sole, and plaice	3-11
b) Assess status of sandeel and pout	12-13
c) Evaluate existing recovery plans	1.9
d) quantify species and size composition in Norway pout and sandeel fisheries for WGECO	1.7
e) review forecast procedures for industrial by-catch of haddock and whiting	1.10
f) Provide quarterly catch data needed for multispecies assessments	1.8
g) Provide information of possible deficiencies in the assessments	3-13 (comments on the assessment)
h) Compare this year's assessments with last year	3-13 (comments on the assessment)
i) Consider the results of WGMT and SGPA	1.11
j) Review the draft Quality Handbook	1.12

Because the WG is now scheduled in June, whereas for a number of stocks the important surveys are carried out in August and September, the WG decided to have a second meeting just prior to ACFM. This meeting will be used to update the recruitment estimates, prepare short-term and medium-term predictions and in some cases update the time-series analysis models. This will be done for cod, haddock, whiting, plaice, and sole in the North Sea. The meeting is likely to be held on 7 and 8 October 2002 at a venue still to be decided.

For these stocks, recruitment estimates or predictions will not be presented in this report. The additional analysis will be published in an annex to the WG report.

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 1.13.1.

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.

The discard data available for other stocks has been examined by the Study Group on Discard and By-catch Information (SGDBI 2002) and is reviewed in Section 1.11.4. In the opinion of 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 ICES Workshop on MSVPA in the North Sea (WKNSMS) has re-estimated the natural mortality of cod, haddock, whiting, sandeel, and Norway pout (WD-3). The WG discussed how to use this new information and decided to evaluate the effect of changes in M by comparing the results of multi-species VPA and single-species VPA. The results of these comparisons are presented in 1.11.3.

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.

Because of the change in timing of the Working Group from October to June, most of the important recruitment indices for 2001 were not available to the WG. These included the English and Scottish Q3 Groundfish surveys, the BTS and SNS flatfish surveys in the North Sea, English and French groundfish surveys in VIId, the international Demersal young Fish Survey in the North Sea (DFS), and the French and English Young Fish surveys. These data will be made available to a subgroup of the WG who will meet in October.

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 (1.3.1.2), the WKNSMS has re-estimated natural mortality of cod, haddock, whiting, sandeel, and Norway pout (WD-3). The effect of changes in natural mortality will be evaluated by means of comparison between multi-species and single-species VPAs (Section 1.11.3).

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.

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 2001.

	Cod in IIIa, IV, VIId			Whiting in IV, VIId		
	Landings (t)	Lengths (No)	Ages (No)	Landings (t)	Lengths (No)	Ages (No)
Belgium	2,563	4,011	935	529	5,179	956
Denmark	17,008	4384	4379	105	1,523	635
France	1,350	-	-	3,460	2,587	2,587
Germany	1,842	1,466	292	402	-	-
Netherlands	3,591	7,141	1,978	2,545	9,243	1,200
Norway	5,126	7,157	784	44	6,948	265
Poland	18	-	-	0	-	-
Sweden	2,827	-	-	1	-	-
UK (E/W/NI)	(UK)	41,419	4,405	(UK)	16,951	1,258
UK (Scotland)	(UK)	58,874	9,898	(UK)	81,312	4,474
UK	19,931	-	-	12,009	-	-
Total	54,256	124,452	22,671	19,095	123,743	11,375

	Haddock in IIIa, IV			Saithe in IV, IIIa,VI		
	Landings (t)	Lengths (No)	Ages (No)	Landings (t)	Lengths (No)	Ages (No)
Belgium	606	4,029	828	24	-	-
Denmark	3,997	5,479	5,470	3,575	1,622	1,615
France	576	-	-	26,423	+ (1)	+ (1)
Germany	809	-	-	9,945	24,330	3,472
Netherlands	274	-	-	20	-	-
Norway	2,025	27,134	851	43,596	43,637	2,620
Poland	12	-	-	727	-	-
Sweden	1,097	-	-	1,510	-	-
UK (E/W/NI)	(UK)	19,527	1,439	(UK)	779	0
UK (Scotland)	(UK)	145,389	8,661	(UK)	13,253	4,267
UK	32,551	-	-	8,804	-	-
Total	41,947	201,558	17,249	94,624	83,621	11,974

(1) data not yet available

	Sole in IV			Sole in VIId		
	Landings (t)	Lengths (No)	Ages (No)	Landings (t)	Lengths (No)	Ages (No)
Belgium	1,874	5,147	908	1,313	3,718	437
Denmark	772	612	0	0	-	-
France	370	5,473	(1) 1035	2,436	8,230	1,035
Germany	958	2728	1,547	0	-	-
Netherlands	11,547	3,749	3,749	0	-	-
UK (E/W/NI)	(UK)	14140	1682	(UK)	17,292	2,315
UK (Scotland)	(UK)	-	-	(UK)	-	-
UK	906	-	-	816	-	-
Total	16,427	31,849	7,886	4,565	29,240	3,787

(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	6,369	4,145	835	1,346	2,526	426
Denmark	13,797	3,566	3,471	0	-	-
France	429	3,397	(1) 1281	3,265	4,719	1,281
Germany	4,739	5,240	904	0	-	-
Netherlands	33,290	4,844	4,844	0	-	-
Norway	1,926	-	-	0	-	-
Sweden	3	-	-	0	-	-
UK (E/W/NI)	(UK)	32,978	2139	(UK)	7,903	1,971
UK (Scotland)	(UK)	-	-	(UK)	-	-
UK	19,111	-	-	655	-	-
Total	79,664	54,170	12,193	5,266	15,148	3,678

(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	11,114	1,745	1,699	58,437	4,070	2,366
Germany	1	-	-	0	-	-
Norway	61	-	-	16,835	1,777	396
Sweden	385	-	-	744	-	-
Total	11,561	1,745	1,699	76,016	5,847	2,762

	Sandeel in IV		
	Landings (t)	Lengths (No)	Ages (No)
Denmark	646,892	86,667	24,293
Norway	187,500	3,532	713
Sweden	46,537	-	-
UK (E/W/NI)	(UK)	-	-
UK (Scotland)	(UK)	2,765	777
UK	970	-	-
Total	881,899	92,964	25,783

1.4 Methods and Software

1.4.1 Assessment

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

1.4.1.1 XSA

Extended survivors analysis (XSA) has been used as the main tool for catch-at-age analysis for all stocks, except for whiting in IV and VIId (see Section 1.4.1.2). 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, haddock, and saithe, while the no-downweighting option was used for the other stocks assessed using XSA. *F*-shrinkage was generally set to a high level (SE = 0.5), essentially for consistency with previous assessments.

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

A separable analysis was carried out to explore the internal consistency of the catch-at-age data and also to judge whether the plus group was appropriately chosen.

For all available tuning series, single fleet runs were carried out using XSA with a low shrinkage (SE = 1.0 to 2.0) and no time taper over the whole time period. These runs were used to explore the consistency of the surveys with the catch-at-age data. 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 XSA 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.

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.

1.4.1.2 TSA

An implementation (time-series analysis or TSA) of the Kalman filter algorithm was used for the assessment of whiting in IV and VIId, as it was thought that it best encapsulated the uncertainty in terminal-year estimates (see Section 5.1.4). It was also used as a supplementary assessment method for cod in IV, IIIa, and VIId, as it enabled 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), and in Fryer *et al* (1998) and Fryer (2001). In brief, the Kalman filter TSA algorithm is a recursive procedure that represents the variables of interest (stock numbers and fishing mortalities at age) as unobserved state variables that evolve forward over time. Each year, observed catches-at-age are used to update the estimates of the state variables. Year-class strength is assumed (in this implementation) to be distributed according to a Ricker stock-recruitment model. Model fitting proceeds by examination of standardised catch prediction errors (equivalent to model-fit residuals) and inflation of permitted variance on year-age pairs for which such errors are high. Each estimate of historical mean *F* and stock numbers is produced with an associated standard error, allowing a statistical evaluation of the uncertainty in the assessment. A number of research-vessel tuning series can be incorporated. The model is also able to roll forward and produce estimates for all parameters for as many years as required following the last historical year.

The 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 in theory model landings-at-age, discards-at-age, and industrial by-catch separately, although the latter has not yet been implemented.
- 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.

1.4.1.3 Relative trends from survey indices

The assessment of whiting in IV and VIId is causing increasing concern to ACFM (see Section 5 and WD 2). Doubts over the quality and validity of catch-at-age data have led to the conclusion that relative-trend assessment of population dynamics using models based on survey data only might be an appropriate alternative. This possibility was investigated by the Working Group using RCRV1A (Cook, 1997), an implementation of a simple survey separable model. It estimates model parameters by minimising the sum-of-squares differences between observed and fitted survey-derived abundance, using an assumed fixed vector of catchabilities-at-age which must be supplied by the user. Since these abundances are relative indices only, the model cannot be used to estimate absolute population numbers, but only relative values. The principal drawbacks of the method are that weights-at-age and proportion mature-at-age are assumed fixed at constant values throughout the time-series, and that the definition of catchabilities is currently extremely *ad hoc*. However, the underlying principles are sound and the method is worthy of further attention.

A spreadsheet implementation of the Cook (1997) model was used to evaluate relative trends for cod in IV, IIIa, and VIId, in order to enable the use of natural mortality estimates from MSVPA (see Section 3).

1.4.2 Recruit estimation

In several cases recruitment estimates have been made with RCT3. This will be the case when recruitment indices from 2002 surveys are available. 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. The XXSA program may solve this problem, but it has not been fully tested yet.

The TSA model used for whiting in IV and VIId produces predictions of recruitment for as many years as required, based on a fitted Ricker stock-recruitment model and with estimates of associated standard errors. These can be used as recruitment estimates for that stock, although the final definition of such estimates has been deferred until after the completion of late-summer groundfish surveys. The assumption of normal errors in TSA can lead to problems in using it to forecast into the medium-term, particularly in a declining stock.

1.4.3 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.

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.

1.4.4 Stock-recruitment model fitting, medium-term projections, and biological reference points

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. The CS4 and STPR3 programs were applied to evaluate medium-term effects of terminal year stock size, recruitment models, assessment bias, and applied software on cod recovery plans. Two programs were used 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. RecAn 2.2 is currently under development and will offer better modelling facilities and a more streamlined user interface. This will be closely linked with MedAn, a new version of WGMTERMC also under development which will allow for structured variation in growth parameters, along with the possibility to model fecundity and condition if data are available.

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 and are given for each stock where possible and appropriate. No additional work was carried out to evaluate the management reference points ($\mathbf{F}_{pa}$, $\mathbf{B}_{pa}$, $\mathbf{F}_{lim}$, $\mathbf{B}_{lim}$).

1.4.5 Software

Overview of the versions used:

Software	**Purpose**	**Version**
VPA-suite	Historical assessment (e.g. separable VPA, XSA)	Version: VPA95PA. Compiled: 30/04/1998
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 VPA)	Retrospective analysis	Version: 00-1
RCRV1A	Survey-driven relative trend estimation	Compiled: 04/04/1996
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
CS4	Medium-term analysis	Version 4
STPR3	Medium-term analysis	Version 3
REFPOINT	Calculation of reference points and yield per recruit	Compiled: 12/06/1997

1.4.6 Technical interactions and stock predictions

Introduction

Current advice provided by ICES is mainly given in the form of fishing mortality limits and associated catch options, which are derived separately for individual fish stocks. This form of advice has two major disadvantages. First, it takes little account of biological interactions. Second, the stocks being analysed are often caught together in mixed-species fisheries, so the catches of species harvested by a given fleet are not independent of each other. This process is traditionally referred to as technical interactions. If, as currently, TAC are set independently for each stock, fishing for one species may lead to discards and/or misreporting of another species, for which the TAC has already been reached. In consequence, technical interactions should be taken into account as much as possible when giving advice. The Commission has on several occasions acknowledged the need to deal with technical interactions in ICES advice. This year, a request has been made to ICES to compile age-structured catch and effort data by fleet as appropriate, and to initiate multifleet multispecies short-term forecasts based on these data. This request is addressed in this section of the report.

Methods

In single-species predictions, levels of F and catch consistent with the precautionary approach for the species under consideration are investigated. In the present analysis, we investigate levels of single-species F which are consistent with the precautionary approach for this species, but also for other species which may be caught in the same mixed fishery.

In a mixed-species, multi-fleet fishery, the partial fishing mortality of species s, of age a, harvested by fleet f in year t may be approached by

$$F(t,f,s,a) = \left(\frac{C(t,f,s,a)}{C(t,s,a)} \right) F(t,s,a) \qquad (1)$$

where C represents the catch in weight. In this analysis, F will be divided between two sets of fleets. The first set (f_1) is made up of the fleets targeting all the *n* species under consideration. The main characteristic of this first fleet set is that its exploitation rate E (i.e. the F multiplier) is the same for all targeted species. The second set is made up of the other fleets, which are not particularly targeting any of the species under consideration. The exploitation of the “other fleets” group defined for one species (e.g. f_{oth}^1) is assumed to vary independently from that of the “other fleets” groups (e.g. $f_{oth}^2, ..., f_{oth}^n$) defined for the *n*-1 remaining species. To proceed with calculations, we make the assumption that the fishing pattern in short-term forecasts will be the same as at status quo. This implies for instance that a fleet does not switch target species in the forecasts compared to the status quo. Fishing mortality (F) in year t may then be represented by

$$\begin{cases} F(t,s_1,a) = E(t,f_1)\,F(SQ,f_1,s_1,a) + E(t,f_{oth}^1)\,F(SQ,f_{oth}^1,s_1,a) \\ F(t,s_2,a) = E(t,f_1)\,F(SQ,f_1,s_2,a) + E(t,f_{oth}^2)\,F(SQ,f_{oth}^2,s_2,a) \\ \ldots \\ F(t,s_n,a) = E(t,f_1)\,F(SQ,f_1,s_n,a) + E(t,f_{oth}^n)\,F(SQ,f_{oth}^n,s_n,a) \end{cases} \qquad (2)$$

where $E(SQ, f)$ = 1 for any fleet f.

The scope of this analysis is to evaluate the extent to which fixing the short-term total F for one species (e.g. s_1) will perturb the short-term predicted F, SSB, and catch levels for all species being examined. For species s_1, whose F is fixed, we assume that variations in F(t,s_1,a) are brought about by equal changes in the exploitation rate of both fleets: $E(t,f_{oth}^1) = E(t,f_1)$. The exploitation rate of the "other fleets" group $E(t,f_{oth}^i)$ fishing species s_i is independent of $E(t,f_1)$ and $E(t,f_{oth}^1)$, and it varies hereby within the range [0.0-1.0].

Let t_0 be the year of the assessment (i.e. 2002 for WGNSSK02). The reference $\mathbf{F}_{sq}$ to be used in the short-term predictions is calculated as the mean F over the last three years of assessment (i.e. $t_0 - 3$, $t_0 - 2$, $t_0 - 1$), scaled to average F over ages for the last year being assessed (i.e. $t_0 - 1$). $\mathbf{F}_{sq}$ may then be formulated as

$$F(SQ,s,a) = SC(s) \times \left[\sum_{t_0-3}^{t_0-1} \left(F(t,s,a) \right) \right]$$

where SC is the scaling factor defined as

$$SC(s) = \frac{\sum_a \left(F(t_0 - 1, s, a) \right)}{\sum_a \sum_{t_0-3}^{t_0-1} \left(F(t,s,a) \right)}$$

The same scaling factor is used to calculate the status quo partial Fs for all fleets.

$$F(SQ,f,s,a) = SC(s) \times \left[\sum_{t_0-3}^{t_0-3} \left(F(t,f,s,a) \right) \right]$$

So we have:

$$F(SQ,s,a) = \left[\sum_f \left(F(SQ,f,s,a) \right) \right]$$

It is assumed that, consistent with short-term predictions usually carried out by ICES, the current fishing mortality in year t_0 is $\mathbf{F}_{sq}$, so the short-term predictions investigate F and catches during year t_0+1, and SSB at the beginning of year t_0+2, using equation (2).

Case study

The methodology developed above has been applied to a relatively simple case study: the North Sea flatfish fisheries. This fishery includes two species, sole and plaice, and two fleet groups. The main fleet group includes both Dutch and English beam-trawlers, while the remaining fleets have been aggregated in an "other fleets" group. The data required to carry out this analysis are catch-at-age by fleet and the outputs from XSA runs, and these have been made available.

Figure 1.4.6.1. represents the changes over time of the partial F of plaice and sole, for Dutch and English beam-trawlers, and for the "other fleets" groups. The beam-trawlers contribute to about 40% of the total F of plaice, and about 60% of the total F of sole. The relative allocation of F across fleets has remained almost constant over 1992-2001, which probably reflects the principle of quota share stability.

As new recruitment estimates were not available for these stocks, recruitment was set to geometric mean for both sole and plaice.

Results

Figure 1.4.6.2a-c shows the short-term predictions of F(2003), SSB(2004), and catch(2003) of both species, resulting from F changes for sole, for different rates of exploitation by other fleets fishing plaice. When F(sole) is set to $\mathbf{F}_{pa}$ = 0.40, corresponding to a reduction of 30% in the exploitation rate of beam trawlers, F(plaice) ranges between [0.15, 0.35], for the different multipliers used in the other fleets (Figure 1.4.6.2a). Given these F values, SSB for both plaice and sole are below $\mathbf{B}_{pa}$ (Figure 1.4.6.2b). Sole landings are around 13000 tonnes, which is below recent catches, while plaice landings fluctuate widely within the range [35 000 – 90 000 tonnes], depending on the assumptions on the other fleets (Figure 1.4.6.2.c).

Figure 1.4.6.3a-c shows the short-term predictions of F(2003), SSB(2004), and catch(2003) of both species, resulting from F changes for plaice, for different rates of exploitation of the other fleets fishing sole. When F(plaice) is set to $\mathbf{F}_{pa}$ = 0.30, corresponding to a reduction of 50% in the exploitation rate of beam-trawlers, F(sole) ranges between [0.25, 0.45] for the different multipliers used in the other fleets (Figure 1.4.6.3a). Given these F values, SSB for both plaice and sole are about or below their respective $\mathbf{B}_{pa}$ (Figure 1.4.6.3b). Plaice landings are about 70 000 tonnes, while sole landings fluctuate within a narrow range [9 000 – 14 000 tonnes], depending on the assumptions on the other fleets (Figure 1.4.6.3c).

Discussion

This analysis provides a possible basis to build up short-term predictions for mixed fisheries. It could be expanded for the intention of future working groups in several ways. First, the predictions derived here were performed for various scenarios corresponding to different values of the exploitation rate of one "other fleets" group.

An important assumption underlying this analysis is that the fishing pattern of fleets harvesting sole and plaice remain the same in the short-term forecasts as at *status quo*. This assumption could be violated, for instance if a fleet shifts areas and/or target species in the forecast year. Only a sensitivity analysis would allow evaluating the relative impact of this assumption on predictions, and this has not been performed in this session. It is therefore unclear which relative weight this hypothesis would have compared to the other traditional assumptions relevant to short-term forecasts (e.g. constant weight-at-age, status quo F in the year the assessment is performed). This issue could be addressed in forthcoming working groups.

Future developments could include exploring changes in exploitation rate values of several "other fleets" groups. Second, multi-species multi-fleet predictions could be applied to more complex case studies, including the North Sea roundfish fisheries, which include more combinations of fleets and stocks than those dealt with in the present analysis. Such analyses could incorporate changes in mesh size, discarding patterns. However, it should be reminded that such developments would require higher parameterisation, and could hence be less robust. Finally, a software program could be developed, especially if such complex case studies are to be addressed in future working groups.

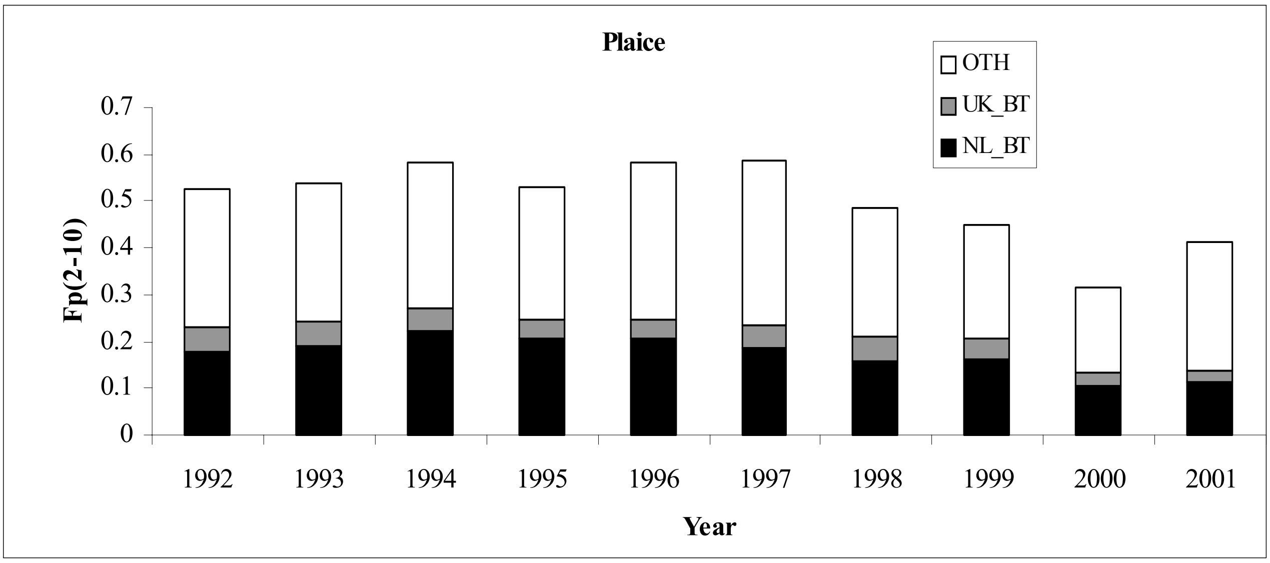
Table 1.4.1. Overview of the biological basis for the stock assessments carried out by WGNSSK 2002.

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. by-catch from DK and N. AC of discards from SC. Discard and ind. by-catch 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. by-catch from DK and N. AC of discards from SC, not applied to 7d. Discard and ind. by-catch 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. No SOP correction.	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 2002

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	1-11+	1963-2001	2-8	20 yr tricubic	1-3	5	5yrs/ 5ages	0.5	0.3	No	*S*	*ScoGFS*	*1982-2001*	*1-6*	*0.5-0.75*
														S	*EngGFS*	*1977-2001*	*1-5*	*0.5-0.75*
														S	*IBTS_Q1*	*1976-2001*	*1-5*	*0-0.25*
4	Haddock	34	XSA	0-10+	1963-2001	2-6	20 yr tricubic	1	3	5yrs/ 5ages	0.5	0.3	No	*S*	*EngGFS*	*1977-2001*	*0-5*	*0.5-0.75*
														S	*IBTS_Q1*	*1974-2002*	*0.5*	*0.99-1*
5	Whiting	47d	**TSA**	1-8+	1980-2001	2-6	na	na	na	na	na	na	na		none	na	na	na
6	Saithe	346	XSA	1-10+	1967-2001	3-6	20 yr tricubic	1-2	7	5yrs/ 3ages	1.0	0.3	No	C	FraTRB_IV	1990-2001	**3-9**	0-1
														C	FraTRF_IV	1990-2001	**3-9**	0-1
														C	NorTRL_IV	1980-2001	3-9	0-1
														C	GerOTB_IV	1995-2001	3-9	0-1
														S	**NorAco**	**1995-2001**	**3-7**	**0.5-0.75**
7	Sole	4	XSA	1-15+	1957-2001	2-8	No	1-2	7	5yrs/ 5ages	0.5	0.3	No	C	NL beam	1990-2001	2-14	0-1
														C	UK beam	1990-2001	2-14	0-1
														S	*BTS*	*1990-2001*	***1-9***	*0.67-0.75*
														S	*SNS*	*1990-2001*	*1-4*	*0.67-0.75*
8	Sole	7d	XSA	1-11+	1982-2001	3-8	No	none	7	**5yrs/ 5ages**	0.5	0.3	No	C	BEL beam	1986-2001	**2-10**	0-1
														C	UK beam	1986-2001	2-10	0-1
														S	*UK BTS*	*1988-2001*	*1-6*	*0.5-0.75*
														S	*INT YFS*	*1986-2001*	*1*	*0.5-0.75*
9	Plaice	4	XSA	1-15+	1957-2001	2-10	No	none	10	5yrs/ 5ages	0.5	0.3	No	*S*	*BTS*	*1985-2001*	***1-9***	*0.66–0.75*
														S	*SNS*	*1982-2001*	*1-3*	*0.66–0.75*
10	Plaice	3	XSA	2-11+	1978-2001	4-8	No	none	8	5yrs/ 5ages	0.5	0.3	No	C	DK seine	1987-2001	**2-10**	0–1
														C	DK trawl	1987-2001	2-10	0–1
														C	DK gill net	1987-2001	2-10	0-1
														S	*IBTS_Q1*	*1992-2002*	***1-6***	*0.99-1*
														S	***IBTS_Q3***	***1995-2001***	***1-6***	***0.83-0.92***
														S	***Havfisken Q1***	***1996-2002***	***1-5***	***0.99-1***
														S	***Havfisken Q4***	***1994-2001***	***1-6***	***0.83-0.92***
11	Plaice	7d	XSA	1-10+	1980-2001	2-6	No	**none**	7	5yrs/ **3ages**	0.5	0.3	No	C	UK Inshore	1988-2001	2-7	0–1
														C	BEL beam	1988-2001	2-7	0–1
														C	FRA TRL	1989-2001	2-7	0–1
														S	*UK BTS*	*1988-2001*	*1-6*	*0.5–0.75*
														S	*FRA GFS*	*1988-2001*	*1-5*	*0.75–1*
														S	***INT YFS***	***1988-2001***	***1***	***0.5-0.75***
12	Norway pout	4	SXSA	0-4+	1983-2001	0-1	No	NA						C	COMB North	1983-2002	0-4+	0.0-0.5
														S	*IBTS_Q1*	*1983-2002*	*1-3*	*0.5-1.0*
														S	*EngGFS*	*1983-2001*	*0-4*	*0.5-0.75*
														S	*ScoGFS*	*1983-2001*	*1-3*	*0.5-0.75*
13	Sandeel	4	**XSA**	0-4+	1983-2001	1-2	No	none	3	5yrs/ 3ages				C	COMB North	1983-2001	0-4+	0.25-0.5
														C	COMB North	1983-2001	0-4+	0.5-0.75
														C	COMB South	1983-2001	0-4+	0.25-0.5
														C	COMB South	1983-2001	0-4+	0.5-0.75

Figure 1.4.6.1 North Sea flatfish fisheries. Changes in the distribution of partial fishing mortality over period 1992-2001.



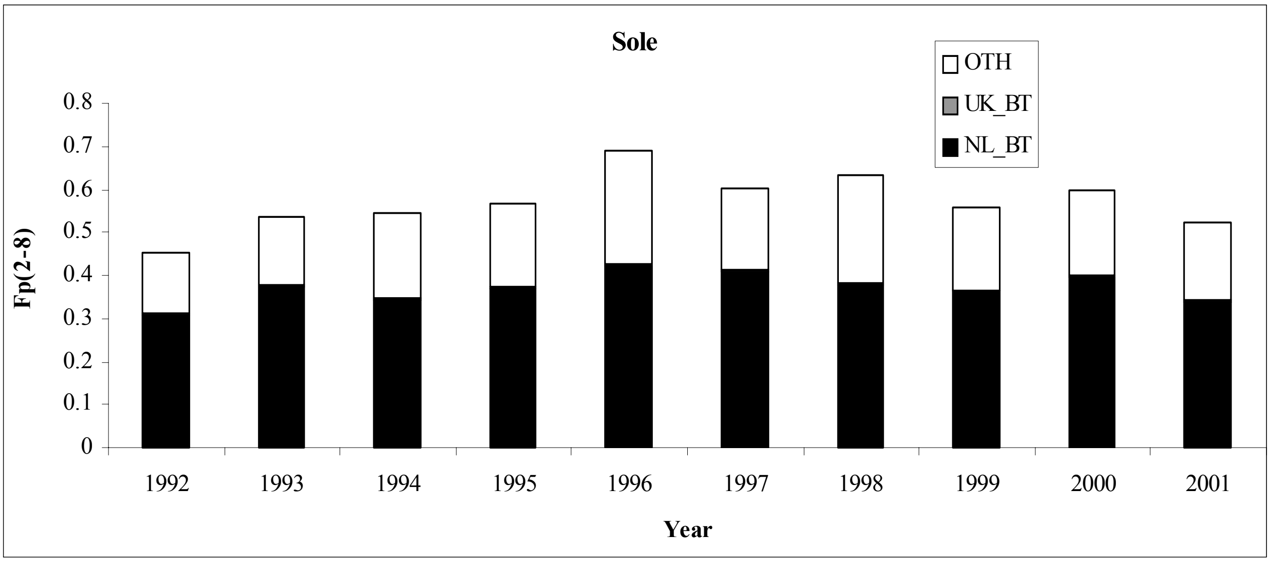


Figure 1.4.6.2 North Sea flatfish fisheries. Short-term predictions of F (a), relative SSB (b), and catch (c) of plaice, resulting from F changes for sole, for different rates of exploitation of the other fleets fishing plaice.

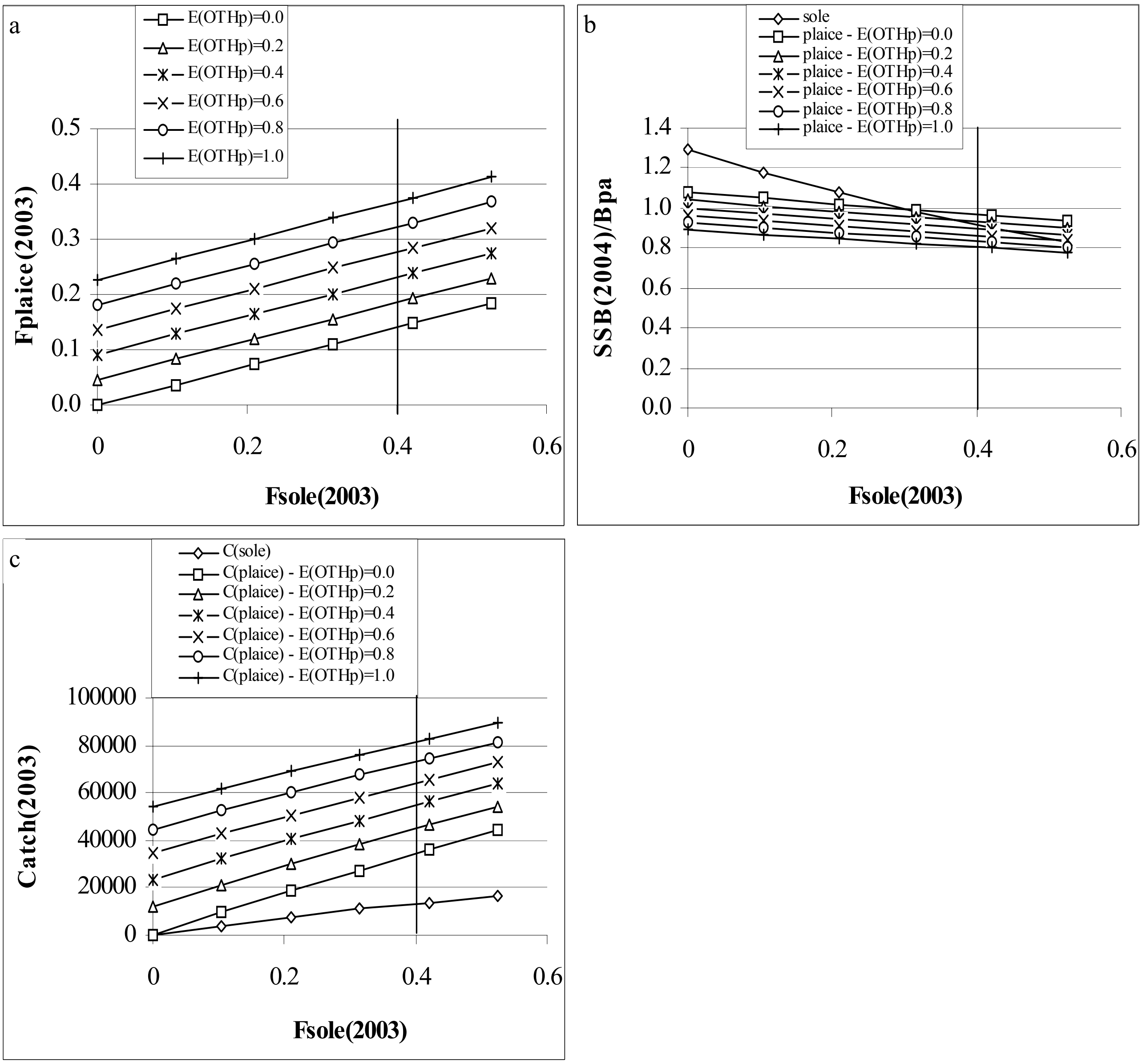
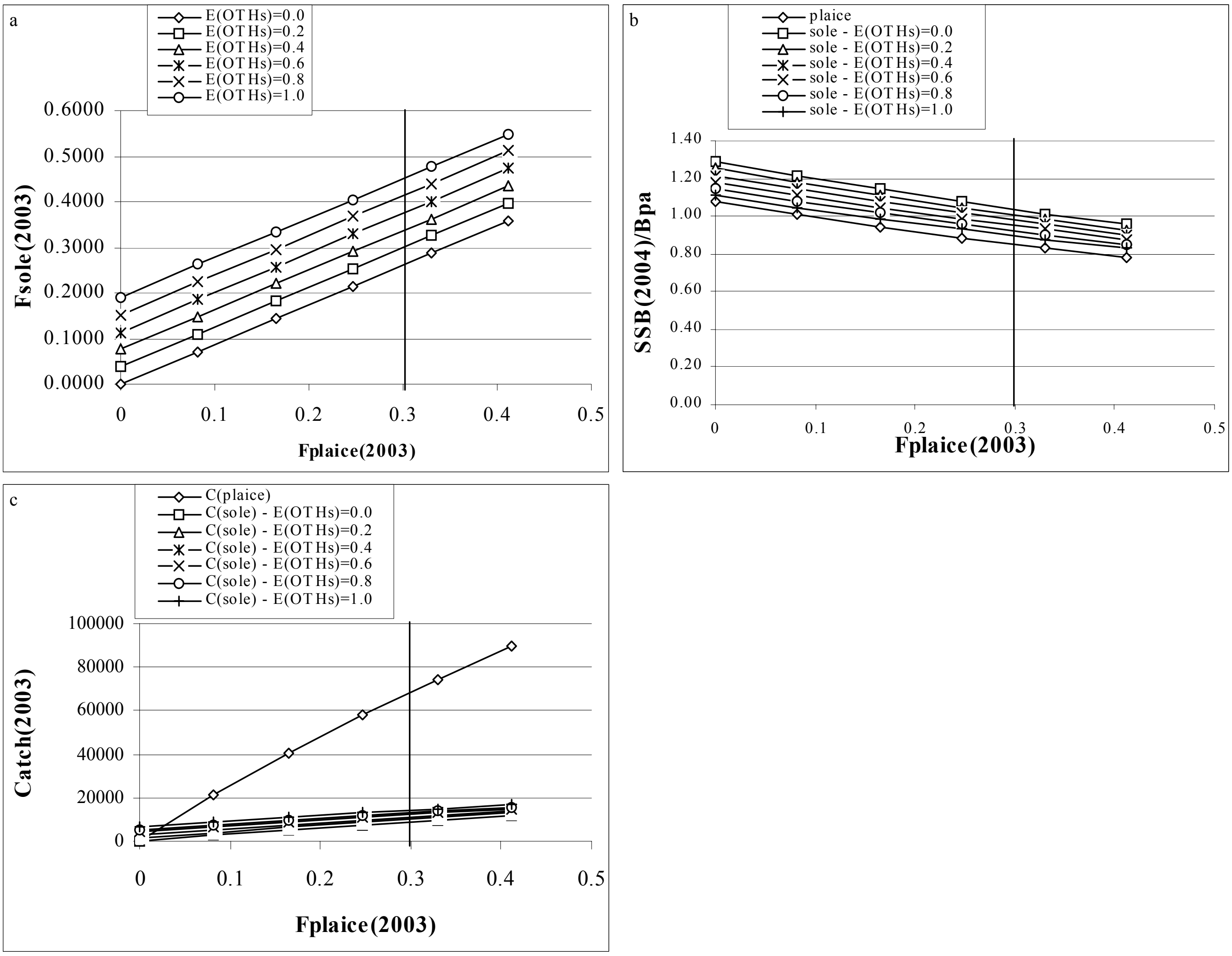


Figure 1.4.6.3 North Sea flatfish fisheries. Short-term predictions of F (a), relative SSB (b), and catch (c) of sole, resulting from F changes for plaice, for different rates of exploitation of the other fleets fishing sole.



1.5 Biological Reference Points

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

Three years ago, the Working Group proposed limit- and precautionary reference points for fishing mortality and SSB ($\mathbf{F}_{lim}$, $\mathbf{F}_{pa}$, $\mathbf{B}_{lim}$, and $\mathbf{B}_{pa}$) for all stocks based on guidelines by the ICES Study Group on 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

1.6 Working Documents and Reports

1.6.1 German otter trawl board fleet as tuning series for the assessment of saithe in IV, VI, and IIIa, 1995-2001.

The WD was presented in the subgroup. The analysed commercial catch 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 1995-2001. Only otter trawl board catches were considered from 7 vessels continuously being engaged in the directed saithe fishery. During 1995-2001, this fleet, consisting of 7 vessels, accounted for 74 % of the entire saithe catch officially reported. They reveal a fairly constant fishing pattern in the northern part of the North Sea mainly along the Norwegian trench. CPUE was a highly variable estimate throughout the time-series with CVs in excess of 1.0. Compared with the relatively stable period 1995-1999 the catch rates in 2000 and 2001 almost doubled.

The samples of length measurements collected on board the vessels or on the fish market at Cuxhaven have been quarterly aggregated and converted to the age compositions based on quarterly age-length keys. This material is the basis for the computation of the age composition of the quarterly aggregated catches, which have been summed to represent the annual age composition of the catches of the 7 vessels. Both information on age group representation in the annual catch and the effort was used to calculate abundance indices for the various age groups. The age-disaggregated abundance indices derived from CPUE indicated the 1992, 1994, and 1996 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. It can also be concluded that the recruiting year class 1998 at age 3 is the strongest year class since 1995. The calculated abundance at age 3 is, however, a poor indicator of the year-class strength at age 4. The age group 4 does, however, seem to be a good estimator of year-class strength at age.

1.6.2 Preliminary analyses of whiting in IV and VIId

Recent ICES assessments of whiting in IV and VIId have been the cause of some concern to ACFM. It is a characteristic of the assessment of this whiting stock that it is extremely uncertain, due partly to fisheries aspects such as suspected misreporting and discarding, and partly to perceived inconsistencies between the different research-vessel surveys used to tune the assessment; and this uncertainty can be difficult to accommodate fully in a management context. It is therefore imperative that the whiting assessment be analysed in greater detail than is usually possible within the constraints of an assessment Working Group.

With this in mind, WD 2 presented a series of preliminary analyses of the stock, concentrating on relative trends in mean $F_{2–6}$, SSB, and recruitment derived using research-vessel survey indices only. Along with simple bivariate scatterplots of the data, the specific methods employed were two separable analyses generating relative stock trends from survey data alone, namely RCRV1A (Cook, 1997) and RVS (Shepherd and Nicholson 1991). The known inadequacies of these methods were summarised. The conclusions of the analyses were that there are two main clusters of information for whiting in IV and VIId, within which data are fairly consistent but between which there is little in common. Broadly speaking, on the one hand there are the Scottish and English groundfish surveys, on the other there are the IBTS Q1 survey and the reported catch-at-age data. The reasons for these patterns of similarity and dissimilarity are unclear at present, and until the dichotomy is resolved it is difficult to see how to proceed. Without a more detailed analysis of the methodology and characteristics of these surveys, it is difficult to know which is the most representative of whiting population dynamics: there are no empirical diagnostics on which to base such a decision.

1.6.3 Stock overviews and natural mortalities estimated by the ICES workshop on MSVPA in the North Sea

The WD is incorporated in the discussion in Section 1.11.3.

1.6.4 Restrictive TACs: how do they affect ICES assessments and what do we do about it?

The WD discusses highlights many of the concerns that have been aired in discussions in assessment working groups in relation to deteriorating data.

Under the current system of management using TACs and quotas if TACs and hence national quotas are restrictive, and effort is not restricted, this implies that there is an unknown level of under-reporting of catch and possibly under-reporting of landings in order to keep within quota allocations. Some potential effects of the TAC and Quota system on commercial CPUE are discussed and the paper argues that increased reliance of survey data for assessments should be a priority.

The paper points out that the use of VPA as an assessment method may not be appropriate for stocks where the quality of the basic catch-at-age data is questionable.

The paper also argues that assessment working groups should have *a priori* reasons for including tuning series in assessments, rather than adopting an approach which excludes potential tuning fleets on the grounds that they do not fit well to the catch data.

1.6.5 Reflections about maturity stages and stock unit composition for plaice in IIIa

The WD was presented in the subgroup. IBTS maturity data from 1993-2002 was used to present maturity stage at length for plaice in IIIa. Also a comparison of collected maturity data with the WG using maturity ogive was presented.

A 4-scale maturity key was used in the IBTS survey (1=immature; 2=ripening; 3=spawning; 4=spent). Hardly any spawning females (maturity stage 3) were present in Skagerrak, while a small proportion of spawning female were found in Kattegat in the same time period. A comparison of the collected maturity data with the knife-edge maturity ogive was presented. Depending on what maturity stage is considered to actually spawn within that season the spawning stock biomass (SSB) could consequently be overestimated. General conclusions and recommendations, see Section 1.13.1.

1.6.6 Trends in cpue of plaice and the effort of three groups of beam trawl vessels since 1995

There is a widespread feeling within the Dutch fishing industry that the plaice stock is in a better condition than suggested by ICES assessment. Dutch fishermen reported high catch rates in 2001 and especially during the first months of 2002. Based on these observations they criticise the assessments of ICES and challenge the fisheries biologist to critically evaluate the assessment results in the light of the information from the fishing industry.

The working document presents an evaluation of trends in cpue of two selected groups of UK vessels landing in the Netherlands, and a mixed group of UK and Dutch vessels with a large ITQ for plaice. The first group mainly fished in the western North Sea (Doggerbank and Flamborough area), while the second group mainly fished in the German Bight.

The analysis indicates that the plaice cpue has increased in 2000 and 2001 to a level that is higher than observed since 1995. As the engine power of the UK vessels is not available, no correction was made. However, the UK vessels landing in the Netherlands are all large vessels with engine powers around 2000 hp and the time trend in cpue is believed not to be affected by changes in engine power.

1.6.7 Some further explorations into the assessment of North Sea plaice. Working document presented to ACFM 2001

An exploration was presented to ACFM 2001 on different methods and assumptions underlying the traditional XSA assessment of North Sea plaice. The commercial cpue data that is used appeared to be suspect because different fleet segments realized different trends in cpue. It is hypothesized that this may be caused by quota restrictions. Therefore, the use of commercial cpue data for this stock was considered to be undesirable.

Explorations have been carried out using XSA assessments without commercial cpue data, ICA assessments without commercial cpue data, and a Time-series Analysis (TSA) using only catch-at-age data. Results indicated that the state of the stock was very dependent on the model and the assumptions used, on the quality of the catch-at-age matrix, and on the inclusion or exclusion of commercial cpue data. It was concluded that the spawning stock biomass of North Sea plaice was likely to be between 240 and 300 thousand tonnes.

1.7 Data for WGECO

TOR d) asks to “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”. While by-catch quantities by weight used to be routinely provided by this WG and its respective predecessor, length compositions for selected by-catch species are included here for the first time (Note that data are from the ‘small-meshed’ fisheries, i.e. including the sprat fishery).

Weight of by-catches of the species haddock, whiting, and saithe in the industrial fisheries of Denmark and Norway are presented in Table 2.1.2 for the years 1974-2001, including a quarterly breakdown for the last five years.

Detailed catches of the “other” species mentioned in Table 2.1.2 for the period 1985-2001 are given in Table 1.7.1.

Length compositions of selected species (cod, haddock, whiting, saithe) from the landings of the Norwegian industrial fishery in 2001 can be found in Table 1.7.2. Corresponding data for the Danish fisheries can be obtained from DIFRES.

Table 1.7.1 Sum of Danish and Norwegian North Sea by-catch (ton) landed for industrial reduction in the small-mesh fisheries by year and species (excluding saithe, haddock, and whiting accounted for in Table 2.1.2) .

Species	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Gadus morhua	544	710	1092	1404	2988	2948	570	1044	1052	876	955	366	1688	1281	532	383	192
Scomber scombrus	4	534	2663	6414	8013	5212	7466	4631	4386	3576	2331	2019	3153	1934	2728	2443	1749
Trachurus trachurus	22789	16658	7391	18104	22723	14918	5704	6651	6169	4886	2746	2369	3332	2576	5116	5312	1159
Trigla sp.	0	888[2]	45342[2]	5394[2]	9391[2]	2598[2]	5622[2]	4209	1593	1139	2091	897	2618	1015	2566	1343	2293
Limanda limanda	187	3209	4632	3781	7743	4706	5578	3986	4871	528	1028	1065	2662	6620	4317	441	1441
Argentina spp.	8714	5210	3033	1918	778	2801	3434	2024	2874	2209	292	3101	2604	5205	3580	333	397
Hippoglossoides platessoides	59	718	1173	946	2160	1673	1024	1694	1428	529	617	339	1411	2229	1272	493	431
Pleuronectes platessa	34	119	109	372	582	566	1305	218	128	143	33	90	73	91	88	64	56
Merluccius merluccius[4]	349	165	261	242	290	429	28	359	109	10	-	3625	2364	33	211	231	167
Trisopterus minutus	0	68[3]	0	5[2]	48[2]	121[2]	79[2]	111	36	0	9	30	181	261	922	518	0
Molva molva[3]	51	1	40	39	37	13	65	10	28	0	-	0	31	31	125	19	49
Glyptocephalus cynoglossus	236[3]	132	341	44	255[3]	251[3]	1439[3]	195[3]	246	40	-	97	394	860	437	154	246
Gadiculus argenteus[3]	1210	729	3043	2494	741	476	801	0	0	0	-	7	248	248	387	532	942
Others	31715[1]	3853	3604	3670	3528	3154	4444	4553	4106	5141	5158	50	749	5405	17931	8927	301
Total	65892	32994	72724	44827	59277	39866	37559	29685	27026	19077	15260	14055	21508	27787	40211	21192	12523

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

Table 1.7.2 Numbers at length (thousands) for selected species landed in the Norwegian industrial fishery

Norway	2001			
cm	Cod	Haddock	Whiting	Saithe
5	0	0	0	0
6	0	41	0	0
7	138	0	0	0
8	0	0	10	0
9	0	0	10	0
10	15	14	20	0
11	15	0	61	0
12	0	0	30	0
13	0	0	67	0
14	15	20	10	0
15	0	299	10	0
16	0	448	64	0
17	0	794	20	0
18	0	894	156	0
19	0	1346	54	0
20	0	1573	370	0
21	0	1550	544	0
22	0	1896	377	0
23	0	1767	249	0
24	0	1664	200	0
25	0	896	202	0
26	0	1175	165	0
27	0	1977	195	0
28	0	1332	150	0
29	0	675	537	0
30	16	604	355	0
31	0	264	364	0
32	138	200	258	0
33	0	69	164	91
34	0	108	185	34
35	34	56	62	236
36	0	0	105	101
37	0	20	53	202
38	51	53	12	236
39	0	12	26	385
40	0	0	23	430
41	0	0	0	340
42	0	0	12	260
43	0	0	0	135
44	0	0	12	169
45	0	0	0	396
46	0	0	0	135
47	0	0	0	260
48	0	0	0	68
49	0	0	0	68
50	0	0	0	169
51	0	0	0	0
52	0	0	0	0
53	0	0	0	0
54	0	0	0	0
55	0	0	0	34
56	0	0	0	0
57	0	0	0	0
58	0	0	0	0
59	0	0	0	0
60	0	0	0	68
Sum	422	19745	5134	3818

1.8 Data for Multispecies Assessments

Data for the MSVPA WG (quarterly numbers caught and mean weights-at-age from Subarea IV, 2001) are given in Tables 1.8.1 – 1.8.8.

Table 1.8.1 Quarterly catch numbers and mean weight at age for North Sea cod, 2001

Data could not be made available in time for the final report. Therefore this table will be added to an appendix of the report which will be generated from the subgroup meeting just prior to ACFM 2002.

Table 1.8.2 Quarterly catch numbers and mean weight at age for North Sea haddock, 2001

Data could not be made available in time for the final report. Therefore this table will be added to an appendix of the report which will be generated from the subgroup meeting just prior to ACFM 2002.

Table 1.8.3 Quarterly catch numbers and mean weight at age for North Sea whiting, 2001

Data could not be made available in time for the final report. Therefore this table will be added to an appendix of the report which will be generated from the subgroup meeting just prior to ACFM 2002.

Table 1.8.4 Quarterly catch numbers and mean weight at age for North Sea saithe, 2001

Data could not be made available in time for the final report. Therefore this table will be added to an appendix of the report which will be generated from the subgroup meeting just prior to ACFM 2002.

Table 1.8.5 Quarterly catch numbers and mean weight-at-age for North Sea sole, 2001

age composition (thousands)

quarter age	1	2	3	4	
1			159.0	736.9	
2	1579.2	1623.8	10215.6	12701.1	
3	3243.4	4899.7	6128.5	6875.7	
4	5824.6	5437.4	4828.2	3526.2	
5	3621.5	5189.8	5116.1	3072.1	
6	245.0	504.7	329.8	276.2	
7	205.2	395.4	138.1	91.9	
8	71.4	122.0	41.8	35.8	
9	57.9	81.5	25.4	9.0	
10	97.4	117.8	202.3	84.7	
11	7.3	37.0	12.1	8.2	
12	19.4	16.1	17.6	8.4	
13	0.3	10.7	0.8	0.3	
14	11.8	12.0	26.4	2.4	
15+	11.3	8.3	3.0	10.7	
reference NC	3829.1	4163.4	5691.6	6164.8	19848.9
total NC					22532.0

weight-at-age (kg)

quarter age	1	2	3	4
1			0.120	0.148
2	0.153	0.144	0.180	0.199
3	0.207	0.185	0.200	0.216
4	0.250	0.223	0.235	0.429
5	0.306	0.263	0.245	0.300
6	0.412	0.319	0.284	0.352
7	0.472	0.327	0.430	0.387
8	0.325	0.421	0.446	0.434
9	0.497	0.410	0.286	0.521
10	0.610	0.502	0.333	0.403
11	1.106	0.396	0.536	0.497
12	0.680	0.600	0.585	0.779
13	0.602	0.604	0.542	0.615
14	1.020	0.568	0.408	0.663
15+	1.055	1.016	0.518	0.543

Table 1.8.6 Quarterly catch numbers and mean weight-at-age for North Sea plaice, 2001

age composition (thousands)					
quarter	1	2	3	4	
Age					
0					
1		57.9	909.4	2571.3	
2	670.6	4503.4	11569.4	12080.4	
3	6208.4	6858.3	16949.3	15551	
4	10065.2	9735.6	17013.2	11935.2	
5	30904.4	26867.3	19589.9	13403	
6	4659.2	8462	2012.1	2131.3	
7	3126.3	1519.3	545	582.7	
8	941.5	476.2	161.7	123.2	
9	365.5	292.6	53.1	58.6	
10	362	204.6	53.8	50	
11	201.3	61	75.5	11.3	
12	289.2	74.8	53.2	13.7	
13	103.6	44.6	19	21.4	
14	43.3	54.6	19.4	30.7	
15+	176.8	165	45.9	59.5	
reference NC	19854	19328	22324	20339	81845.0
total NC					81846

weight-at-age (kg)				
quarter	1	2	3	4
Age				
0				
1		0.167	0.213	0.247
2	0.213	0.237	0.261	0.285
3	0.247	0.256	0.288	0.32
4	0.273	0.28	0.304	0.336
5	0.331	0.33	0.388	0.434
6	0.406	0.377	0.436	0.473
7	0.519	0.536	0.644	0.626
8	0.615	0.67	0.782	0.935
9	0.772	0.659	0.755	1.056
10	0.801	0.667	0.857	1.056
11	0.792	0.833	0.73	0.938
12	0.767	0.775	0.704	1.227
13	0.826	0.938	1.136	0.807
14	0.957	0.675	0.87	1.025
15+	0.986	0.783	1.043	0.799

Table 1.8.7 Quarterly catch numbers and mean weight-at-age for North Sea Norway pout, 2001 (see Tables 12.2.1 and 12.2.2)

Table 1.8.8 Quarterly catch numbers and mean weight-at-age for North Sea sandeel, 2001

Sandeel in IV, mean weight in the catch by quarter for year 2001

		age				
		0	1	2	3	4+
Year	Quarter					
2001	1	0	2.81	9.10	15.73	18.58
	2	1.74	4.50	8.51	13.49	15.16
	3	2.67	9.57	17.52	8.91	-
	4	2.77	9.42	17.15	9.22	-
	All	2.67	4.53	8.56	13.17	15.19

Sandeel catch in IV, numbers*10^6 by age and quarter for year

		age				
		0	1	2	3	4+
Year	Quarter					
2001	1	0	3,442	181	15	33
	2	669	66,801	15,786	1,619	3,395
	3	112,649	1,476	63	63	-
	4	7,163	115	25	71	-
	All	120,480	71,834	16,055	1,768	3,428

1.9 Evaluation of Existing Recovery Plans

The WG was requested to evaluate the effects of the existing recovery plans (ToR c). The evaluation will be presented below.

1.9.1 Introduction

The values referred to in the presentation and discussion of the likely outcomes of the different medium-term projections should NOT be interpreted as absolute. They are presented as values which are conditional on a number of assumptions made within the forecast models that have been used, and are better considered to be relative values to be compared one to another. It cannot be emphasised too greatly that the results presented here permit only the COMPARATIVE performance to be evaluated.

Two meetings have provided medium-term forecast runs to evaluate the EU Commission's proposal (COM(2001) 724 final) for stock rebuilding of the 3an47d cod stock, the meeting among Norwegian and EU scientists (Anon., 2002 a) and the STECF subgroup meeting (Anon. 2002 b); both were held in Brussels. Four different assessment software programs were presented in that meeting, and it was decided to run the test simulations of the proposed rebuilding plans using the "CS4"-module, mainly because it allows both assessment error and bias to be considered. 18 various scenarios were investigated, based on the 2001 assessment results as updated during the ACFM October 2001 meeting, and the pros and cons of SSB versus F controlled management under the option of different annual TAC change constraints (buffers) were considered. The results of the meetings have been reviewed and endorsed by STECF (Anon. 2002 c) and ACFM (May 2002, ICES 2002).

However, the following effects have not yet been analysed and are considered worth looking in to:

- The medium-term simulations were sensitive to the size of the starting population and should be updated if the stock status has changed significantly in 2002.
- Different recruitment models are to be considered.
- The assessment bias has been fixed at 10 percent overestimation of stock size, the effects of no and of higher bias are to be determined.
- Software effects are to be considered.

The base run scenario definitions (Sc01-base) are in accordance with the EU-proposal of the rebuilding plan and deploy the 2001 assessment results as updated during the ACFM October 2001 meeting. The common specifics of the compared runs are that the stock, fishing mortality, and catch predictions are controlled by a 30% annual increase in SSB, a maximum annual change in TAC by ±50%, and a maximum fishing mortality of $\mathbf{F}_{pa}$=0.65. The following text table specifies the deviations from the base run in order to investigate terminal assessment year, recruitment model, assessment bias, and software effects. The evaluation defines stock recovery as two consecutive years of SSB exceeding $\mathbf{B}_{pa}$ as applied in earlier exercises.

Specific settings for the seven comparative medium-term projections for North Sea cod (3an47d) and resulting median recovery time (estimated over 20 years) and recovery probability after 10 years:

Run Name	Terminal year of assessment	Recruitment model	Bias factor	Software used	Median recovery time (years)	Prob. Of recovery after 10 years
Sc01-base	2001	Shepherd	1.1	CS4	8.05	89.8
Sc02	2002	Shepherd	1.1	CS4	8.51	82.0
Sc03	2001	Beverton&Holt	1.1	CS4	8.20	88.8
Sc04	2001	Ricker	1.1	CS4	8.06	87.8
Sc05	2001	Shepherd	1.0	CS4	6.65	100.0
Sc06	2001	Shepherd	1.2	CS4	10.45	37.2
Sc07	2001	Shepherd	1.1	STPR3	6.35*	91.9

*) estimated over 10 years only due to software limitation

1.9.2 Terminal year effect

Comparative medium-term projections revealed that the estimated stock parameters are sensitive to the size of the starting population. Given that the updated stock assessment indicated a further significant reduction in stock size, scenario runs 01 and 02 are defined to investigate the effect of the change in stock size. The updated input considers the new estimates of stock size in numbers in 2002, including a short-term GM (1992-2001) amounting to 170 mill. for age group 1 (Tables 1.9.1 and 1.9.2), and the updated exploitation pattern as derived from the 1999-2001 average values by age rescaled to the 2001 Fbar 2-8. SSB in 2002 was estimated to amount to 41 815 t and the catch in 2002 was defined through the status quo F.

The results of the base run scenario 1 and the updated run scenario 2 are given in the text table and illustrated in Figures 1.9.1 and 1.9.2. The updated cod assessment results indicated a prolongation of the recovery period from 8.05 to 8.51 years and the recovery probability after 10 years was reduced from 89.8 to 82 percent.

1.9.3 Recruitment model effect

In comparison with the Shepherd recruitment model used in the base run scenario 1 (Table 1.9.1), the Beverton & Holt and Ricker functions were applied in the scenario runs 3 and 4, respectively (Tables 1.9.3 and 1.9.4). Recruitment model parameters were estimated using the recruit.exe program with the 2001 WGNSSK input file. All three recruitment models are illustrated in Fig. 1.9.3. The recruitment models are almost identical over the range of SSB to 150 000 t.

The resulting yield, SSB, fishing mortality, and recruitment projections for the three recruitment model scenarios are illustrated in Figures 1.9.1, 1.9.4, and 1.9.5. There is no model effect in the three medium-term predictions, as can be derived from the low variation in the estimated recovery times (8.05-8.2 years) and recovery probabilities after 10 years (87.8-89.8 %) given in the text table.

1.9.4 Assessment bias effect

In addition to base run scenario 1 with a consistent bias of 10% stock size overestimation, two medium-term projections were defined with no bias and a 20% stock size overestimation as scenarios 5 and 6, respectively. Bias is taken into account when the program CS4 predicts catches (and TAC) for the following year. In addition to noise, bias is put on the program's simulated assessment, such that the TAC is set consistently too high (or low) compared to the real stock status. The input parameters of the 3 comparative runs are given in Tables 1.9.1, 1.9.5, and 1.9.6.

The medium-term scenarios 1, 4, and 5 are illustrated in Figures 1.9.1, 1.9.6, and 1.9.7. They reveal a major bias effect on the estimated recovery periods and recovery probability (text table). Under the assumption of no assessment bias, the estimated recovery period lasts 6.65 years and the recovery probability after 10 years amounts to almost 100%. Both values changed substantially in the base run scenario 1 and amounted to 8.05 years and 89.8%. The increased bias to a factor of 1.2 stock size overestimation as applied in scenario run 6 results in a further delay in the recovery to 10.45 years and a reduced recovery probability after 10 years of 37.2%.

1.9.5 Software effect

In order to validate the scenario results as estimated by the CS4 program, the base run scenario 1 settings were also used as inputs to the program STPR3 in scenario run 7. Both scenario inputs are listed in Tables 1.9.1 and 1.9.7, respectively.

The observed differences in the calculated recovery periods of 8.05 versus 6.35 years (text table) are believed to be due to internal program properties. 500 iterations are calculated in the CS4 program, while STPR3 outputs are based on 1000 iterations. However, the main difference might be due to the generated recruitment, which is calculated by applying a normal frequency distribution in the STPR3 program, while it appears to be a flat random selection in the CS4 program within the range of the model value plus minus the CV (Figures 1.9.1 and 1.9.8). Thus the results are highly affected by the variation defined to generate future recruitment. However, the determined probabilities of recovery after 10 years of both programs are very similar and amounted to 89.8 and 91.9 percent.

1.9.6 Summary of the sensitivity analyses of medium-term projections

The resulting recovery periods and recovery probabilities of the various medium-term projections of yield, SSB, fishing mortality, and recruitment should not be interpreted as face values, but rather as representative of the effects of different *a priori* assumptions. However, all formulations of the medium-term projections do indicate that, even with very strong reductions in fishing mortality as implied by the EU Commission's proposal for the cod rebuilding plan (COM(2001) 724 final), short-term recovery of the North Sea cod to $\mathbf{B}_{pa}$ within the coming 5 years is unlikely. The effect of discards could not be investigated due to lack of representative discard data. Results of the sensitivity analyses can be summarised as follows:

- The medium-term projections were found sensitive to the terminal assessment year since the starting population in 2002 was found significantly reduced compared with 2001. The reduction in the starting population of North Sea cod resulted in a reduced probability of recovery after 10 years from 90 to 82 percent.

- The main effect on the estimated recovery time and recovery probability was due to assessment bias. Assuming a consistent 20 % stock size overestimation caused a substantial prolongation of the recovery time by almost 4 years.

- Yield, SSB, fishing mortality, and recruitment projections were also found to differ with different software programs used. Properties of the used CS4 and STPR3 programs did generate dissimilar recruitment variation.

- As the fitted Shepherd, Beverton & Holt, and Ricker functions were found almost identical over the SSB range up to $\mathbf{B}_{pa}$, no effect on the medium-term stock parameters could be detected.

Table 1.9.1 Input of Sc01-base run. Terminal year: 2001; Rec. model: Shepherd; Bias factor: 1.1; Software: CS4

```
Starting year,Last year, first age,lastage
2002, 2011, 1, 11
N, se log(N hat), Bias(N hat), M,  Mat, Expl,    WEST,     WECA
151000     0.61      1.1     0.8    0.00  0.05     0.663   0.663
 37016     0.19      1.1     0.35   0.05  0.66     1.035   1.035
 36929     0.13      1.1     0.25   0.23  1.08     2.086   2.086
  7059     0.12      1.1     0.2    0.62  1.04     3.937   3.937
  1601     0.15      1.1     0.2    0.86  1.03     6.207   6.207
  1700     0.18      1.1     0.2    1.0   1.00     8.130   8.130
   244     0.23      1.1     0.2    1.0   1.12     9.655   9.655
    84     0.37      1.1     0.2    1.0   1.06    10.870  10.870
    26     0.42      1.1     0.2    1.0   0.83    12.259  12.259
     9     0.46      1.1     0.2    1.0   1.03    13.020  13.020
     6     0.48      1.1     0.2    1.0   1.03    13.773  13.773
SRR parameters (if the last no. is -1 then use Ockham, otherwise Shepherd/Ricker)
2.7672  259867.9  5.0524   0.0  0.53038  0.0
HCR % change (up, down), Fpa, SSBincr%
50, 50, 0.65, 30
Spawning Time as fraction  of year
0.0
Catch in StartingYear-1
55600
Catch in the starting year, or (if negative) F constraint -0.83
Ages for calculating reference F 2    8
Reference Biomass to calculate probabilities
150000
SSB  in StartingYear-1 54700

COMMENTS

RUN id         : NScod1
Stock          : North Sea Cod
Starting Point : As WG Medium-term projections, as modified by ACFM, Nov. 2001
Constraint     : Catch Constraint in 2002 = 56400t
```

Table 1.9.2 Input of Sc02 run. Terminal year: 2002; Rec. model: Shepherd; Bias factor: 1.1; Software: CS4

```
Starting year,Last year, first age,lastage
2003, 2012, 1, 11
N, se log(N hat), Bias(N hat), M,  Mat, Expl,    WEST,     WECA
170000     0.61      1.1     0.8    0.00  0.05     0.663   0.663
 31659     0.19      1.1     0.35   0.05  0.52     1.035   1.035
 34713     0.13      1.1     0.25   0.23  0.97     2.086   2.086
  5200     0.12      1.1     0.2    0.62  1.08     3.937   3.937
   386     0.15      1.1     0.2    0.86  0.96     6.207   6.207
   751     0.18      1.1     0.2    1.0   0.96     8.130   8.130
    81     0.23      1.1     0.2    1.0   1.01     9.655   9.655
    40     0.37      1.1     0.2    1.0   0.88    10.870  10.870
    13     0.42      1.1     0.2    1.0   0.78    12.259  12.259
     8     0.46      1.1     0.2    1.0   0.93    13.020  13.020
     4     0.48      1.1     0.2    1.0   0.93    13.773  13.773
SRR parameters (if the last no. is -1 then use Ockham, otherwise Shepherd/Ricker)
2.7672  259867.9  5.0524   0.0  0.53038  0.0
HCR % change (up, down), Fpa, SSBincr%
50, 50, 0.65, 30
Spawning Time as fraction  of year
0.0
Catch in StartingYear-1
49300
Catch in the starting year, or (if negative) F constraint -0.91
Ages for calculating reference F - 2    8
Reference Biomass to calculate probabilities
150000
SSB  in StartingYear-1 41815

COMMENTS
See text
```

Table 1.9.3 Input of Sc03 run. Terminal year: 2001; Rec. model: Beverton&Holt; Bias factor: 1.1; Software: CS4

```
Starting year,Last year, first age,lastage
2002, 2011, 1, 11
N, se log(N hat), Bias(N hat), M,  Mat, Expl,    WEST,     WECA
151000     0.61      1.1     0.8    0.00  0.05     0.663   0.663
 37016     0.19      1.1     0.35   0.05  0.66     1.035   1.035
 36929     0.13      1.1     0.25   0.23  1.08     2.086   2.086
  7059     0.12      1.1     0.2    0.62  1.04     3.937   3.937
  1601     0.15      1.1     0.2    0.86  1.03     6.207   6.207
  1700     0.18      1.1     0.2    1.0   1.00     8.130   8.130
   244     0.23      1.1     0.2    1.0   1.12     9.655   9.655
    84     0.37      1.1     0.2    1.0   1.06    10.870  10.870
    26     0.42      1.1     0.2    1.0   0.83    12.259  12.259
     9     0.46      1.1     0.2    1.0   1.03    13.020  13.020
     6     0.48      1.1     0.2    1.0   1.03    13.773  13.773
SRR parameters (if the last no. is -1 then use Ockham, otherwise Shepherd/Ricker)
4.0303  192705.1  0.0   0.0  0.53038  0.0
HCR % change (up, down), Fpa, SSBincr%
50, 50, 0.65, 30
Spawning Time as fraction  of year 0.0
Catch in StartingYear-1 55600
Catch in the starting year, or (if negative) F constraint -0.83
Ages for calculating reference F 2 8
Reference Biomass to calculate probabilities 150000
SSB  in StartingYear-1 54700

COMMENTS

RUN id         : NScod1
Stock          : North Sea Cod
Starting Point : As WG Medium-term projections, as modified by ACFM, Nov. 2001
Constraint     : Catch Constraint in 2002 = 56400t
```

Table 1.9.4 Input of Sc04 run. Terminal year: 2001; Rec. model: Ricker; Bias factor: 1.1; Software: CS4

```
Starting year,Last year, first age,lastage
2002, 2011, 1, 11
N, se log(N hat), Bias(N hat), M,  Mat, Expl,    WEST,     WECA
151000     0.61      1.1     0.8    0.00  0.05     0.663   0.663
 37016     0.19      1.1     0.35   0.05  0.66     1.035   1.035
 36929     0.13      1.1     0.25   0.23  1.08     2.086   2.086
  7059     0.12      1.1     0.2    0.62  1.04     3.937   3.937
  1601     0.15      1.1     0.2    0.86  1.03     6.207   6.207
  1700     0.18      1.1     0.2    1.0   1.00     8.130   8.130
   244     0.23      1.1     0.2    1.0   1.12     9.655   9.655
    84     0.37      1.1     0.2    1.0   1.06    10.870  10.870
    26     0.42      1.1     0.2    1.0   0.83    12.259  12.259
     9     0.46      1.1     0.2    1.0   1.03    13.020  13.020
     6     0.48      1.1     0.2    1.0   1.03    13.773  13.773
SRR parameters (if the last no. is -1 then use Ockham, otherwise Shepherd/Ricker)
3.7272  312500.0  0.0   0.0  0.53038  0.0
HCR % change (up, down), Fpa, SSBincr%
50, 50, 0.65, 30
Spawning Time as fraction  of year 0.0
Catch in StartingYear-1 55600
Catch in the starting year, or (if negative) F constraint -0.83
Ages for calculating reference F 2 8
Reference Biomass to calculate probabilities 150000
SSB  in StartingYear-1 54700

COMMENTS
RUN id         : NScod1
Stock          : North Sea Cod
Starting Point : As WG Medium-term projections, as modified by ACFM, Nov. 2001
Constraint     : Catch Constraint in 2002 = 56400t
```

Table 1.9.5 Input of Sc05 run. Terminal year: 2001; Rec. model: Shepherd; Bias factor: 1.0; Software: CS4

Starting year,Last year, first age,lastage

2002, 2011, 1, 11

N	se log(N hat)	Bias(N hat)	M	Mat	Expl	WEST	WECA
151000	0.61	1.0	0.8	0.00	0.05	0.663	0.663
37016	0.19	1.0	0.35	0.05	0.66	1.035	1.035
36929	0.13	1.0	0.25	0.23	1.08	2.086	2.086
7059	0.12	1.0	0.2	0.62	1.04	3.937	3.937
1601	0.15	1.0	0.2	0.86	1.03	6.207	6.207
1700	0.18	1.0	0.2	1.0	1.00	8.130	8.130
244	0.23	1.0	0.2	1.0	1.12	9.655	9.655
84	0.37	1.0	0.2	1.0	1.06	10.870	10.870
26	0.42	1.0	0.2	1.0	0.83	12.259	12.259
9	0.46	1.0	0.2	1.0	1.03	13.020	13.020
6	0.48	1.0	0.2	1.0	1.03	13.773	13.773

SRR parameters (if the last no. is -1 then use Ockham, otherwise Shepherd/Ricker)

2.7672 259867.9 5.0524 0.0 0.53038 0.0

HCR % change (up, down), $\mathbf{F}_{pa}$, SSBincr%

50, 50, 0.65, 30

Spawning Time as fraction of year 0.0

Catch in StartingYear-1 55600

Catch in the starting year, or (if negative) F constraint -0.83

Ages for calculating reference F 2 8

Reference Biomass to calculate probabilities 150000

SSB in StartingYear-1 54700

COMMENTS

RUN id : NScod1

Stock : North Sea Cod

Starting Point : As WG Medium-term projections, as modified by ACFM, Nov. 2001

Constraint : Catch Constraint in 2002 = 56400t

Table 1.9.6 Input of Sc06 run. Terminal year: 2001; Rec. model: Shepherd; Bias factor: 1.2; Software: CS4

Starting year,Last year, first age,lastage

2002, 2011, 1, 11

N	se log(N hat)	Bias(N hat)	M	Mat	Expl	WEST	WECA
151000	0.61	1.2	0.8	0.00	0.05	0.663	0.663
37016	0.19	1.2	0.35	0.05	0.66	1.035	1.035
36929	0.13	1.2	0.25	0.23	1.08	2.086	2.086
7059	0.12	1.2	0.2	0.62	1.04	3.937	3.937
1601	0.15	1.2	0.2	0.86	1.03	6.207	6.207
1700	0.18	1.2	0.2	1.0	1.00	8.130	8.130
244	0.23	1.2	0.2	1.0	1.12	9.655	9.655
84	0.37	1.2	0.2	1.0	1.06	10.870	10.870
26	0.42	1.2	0.2	1.0	0.83	12.259	12.259
9	0.46	1.2	0.2	1.0	1.03	13.020	13.020
6	0.48	1.2	0.2	1.0	1.03	13.773	13.773

SRR parameters (if the last no. is -1 then use Ockham, otherwise Shepherd/Ricker)

2.7672 259867.9 5.0524 0.0 0.53038 0.0

HCR % change (up, down), $\mathbf{F}_{pa}$, SSBincr%

50, 50, 0.65, 30

Spawning Time as fraction of year 0.0

Catch in StartingYear-1 55600

Catch in the starting year, or (if negative) F constraint -0.83

Ages for calculating reference F 2 8

Reference Biomass to calculate probabilities 150000

SSB in StartingYear-1 54700

COMMENTS

RUN id : NScod1

Stock : North Sea Cod

Starting Point : As WG Medium-term projections, as modified by ACFM, Nov. 2001

Constraint : Catch Constraint in 2002 = 56400t

Table 1.9.7 Input of Sc07 run. Terminal year: 2001; Rec. model: Shepherd; Bias factor: 1.1; Software: STPR3

```
1 11                youngest and oldest (+age)
1               years betw. spawn. and recr.
2 8             ref. age. interv. fleet 1
2 8               ref. age. interv. fleet 2
2002                intermediate year (year 0)
C               constraint fleet1 (C=catch, F=f.mort)
1000                value of constraint.
C               constraint fleet2 (C=catch, F=f.mort)
 0              value of constraint.
 0  0.65 0.0 1000 1000  min SSB; max F fl 1,2; max catch fl 1,2
 0  0.65 0.0 1000 1000  same, level 2
 150    0.65 0.0 1000 1000  same, level 3
 1              1=linear increase of F in level 2
 1.5 0 0        both, fleet1, fleet2   max year to year increase in catches (>1)
 0.5 0 0        (0=no constraint)   max year to year decrease in catches (<1)
 1.3 0              min increase in SSB, which fleet (0=both)
 0.83 0.0           max possible fish mort by fleet
 0.65 0.0           max permitted fish mort by fleet
 5 2.7672 259.8679 5.0524 0.6 0 recr. model + 3 pars + sigma + trunc
 0              number of AR terms
 0 0 0 0 0  AR coeffisients
 0              1=apply the S-R relation in year 0
 1.10000000 0.20000000      assessment bias multiplier (mean,sd)
 1.00000000 0.10000000      TAC deviation multiplier (mean,sd)
 2  initial numbers (0=determ, 1=lognorm, 2=norm, 3=bootstrap)
```

Figure 1.9.1 Results of Sc01-base run. Terminal year: 2001; Rec. model: Shepherd; Bias factor: 1.1; Software: CS4.

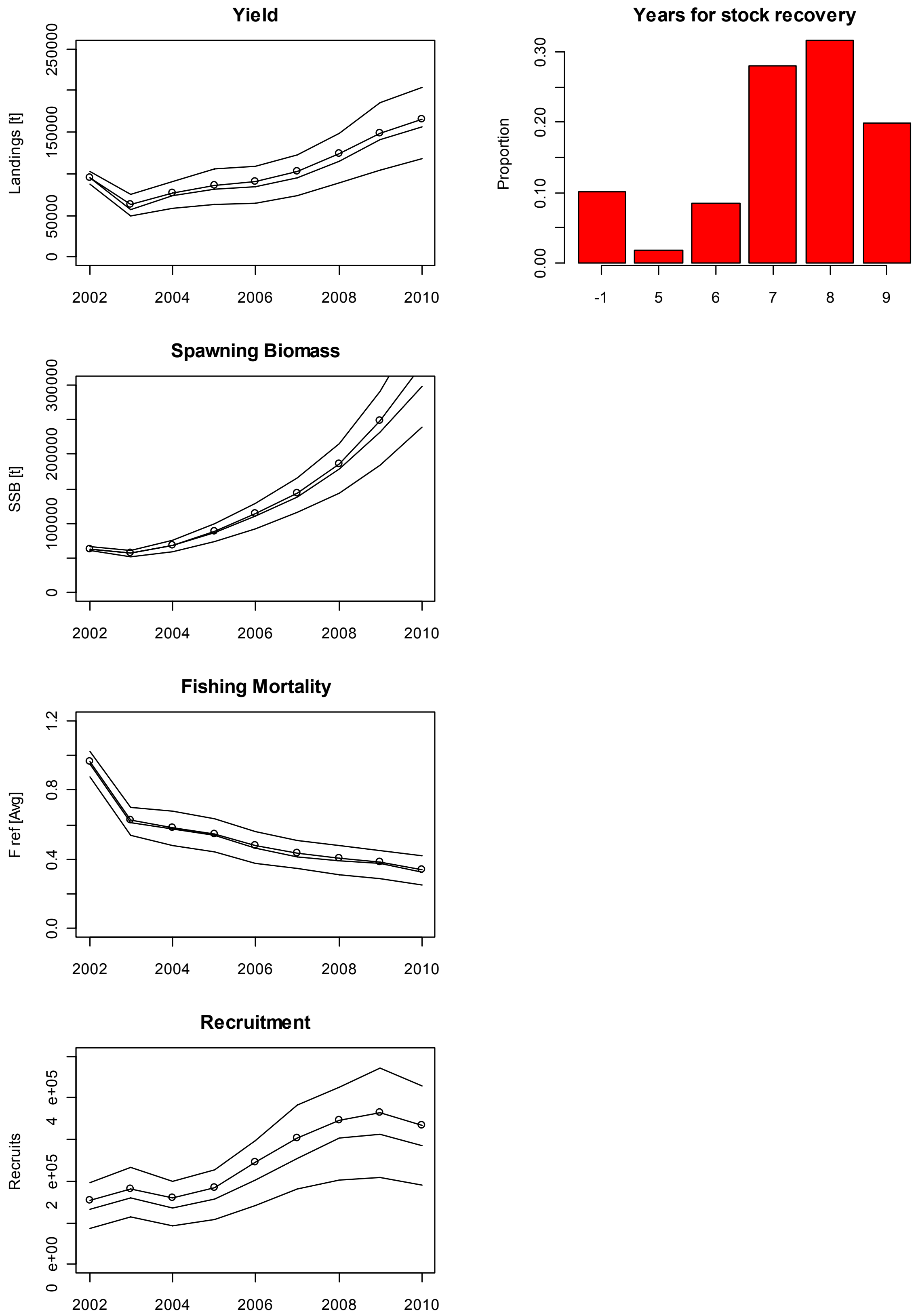


Figure 1.9.2 Results of Sc02 run. Terminal year: 2002; Rec. model: Shepherd; Bias factor: 1.1; Software: CS4.

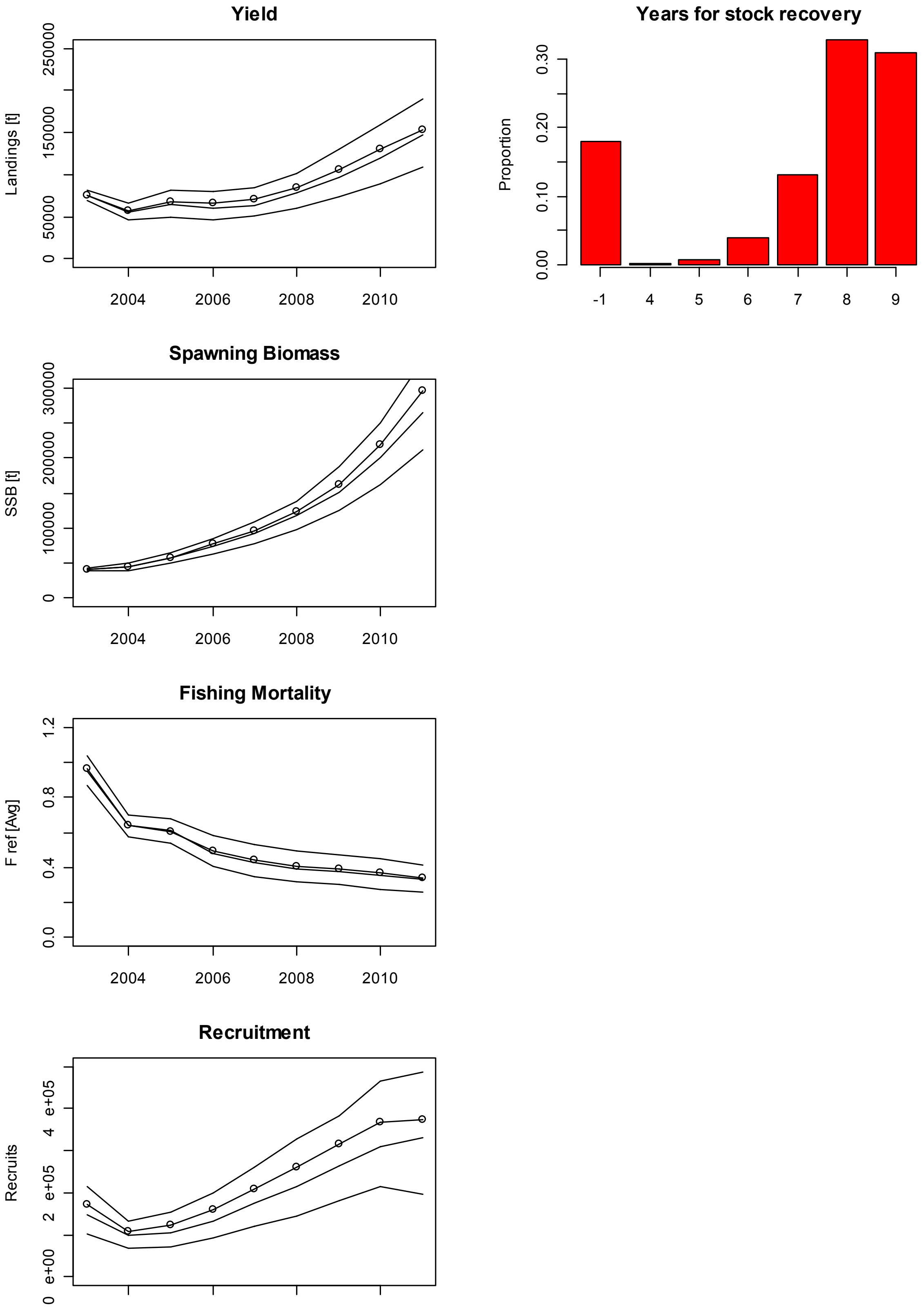


Figure 1.9.3 Recruitment models for North Sea cod as used in the medium-term projections. Various parameters are given in Tables 1.9.2, 1.9.4, and 1.9.5.

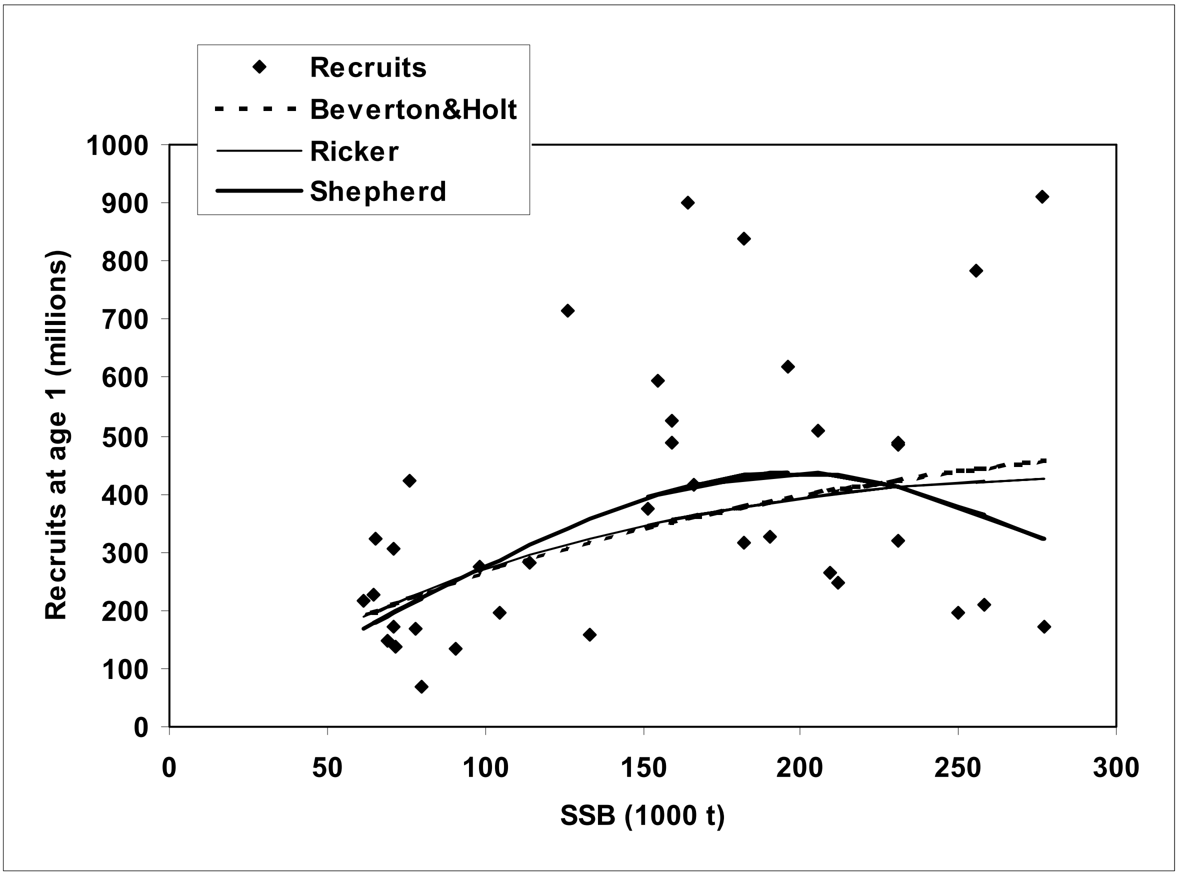


Figure 1.9.4 Results of Sc03 run. Terminal year: 2001; Rec. model: Beverton&Holt; Bias factor: 1.1; Software: CS4.

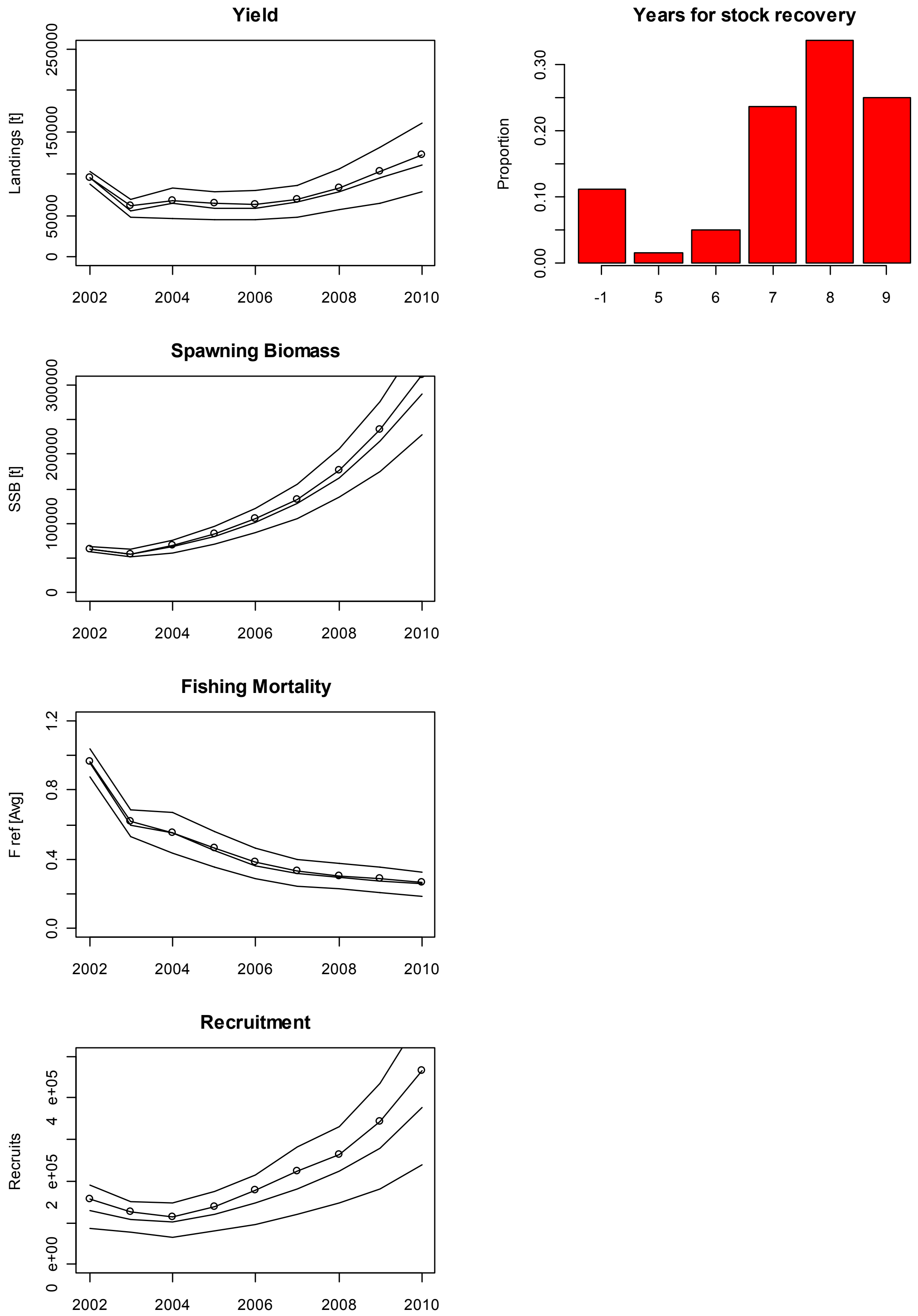


Figure 1.9.5 Results of Sc04 run. Terminal year: 2001; Rec. model: Ricker; Bias factor: 1.1; Software: CS4.

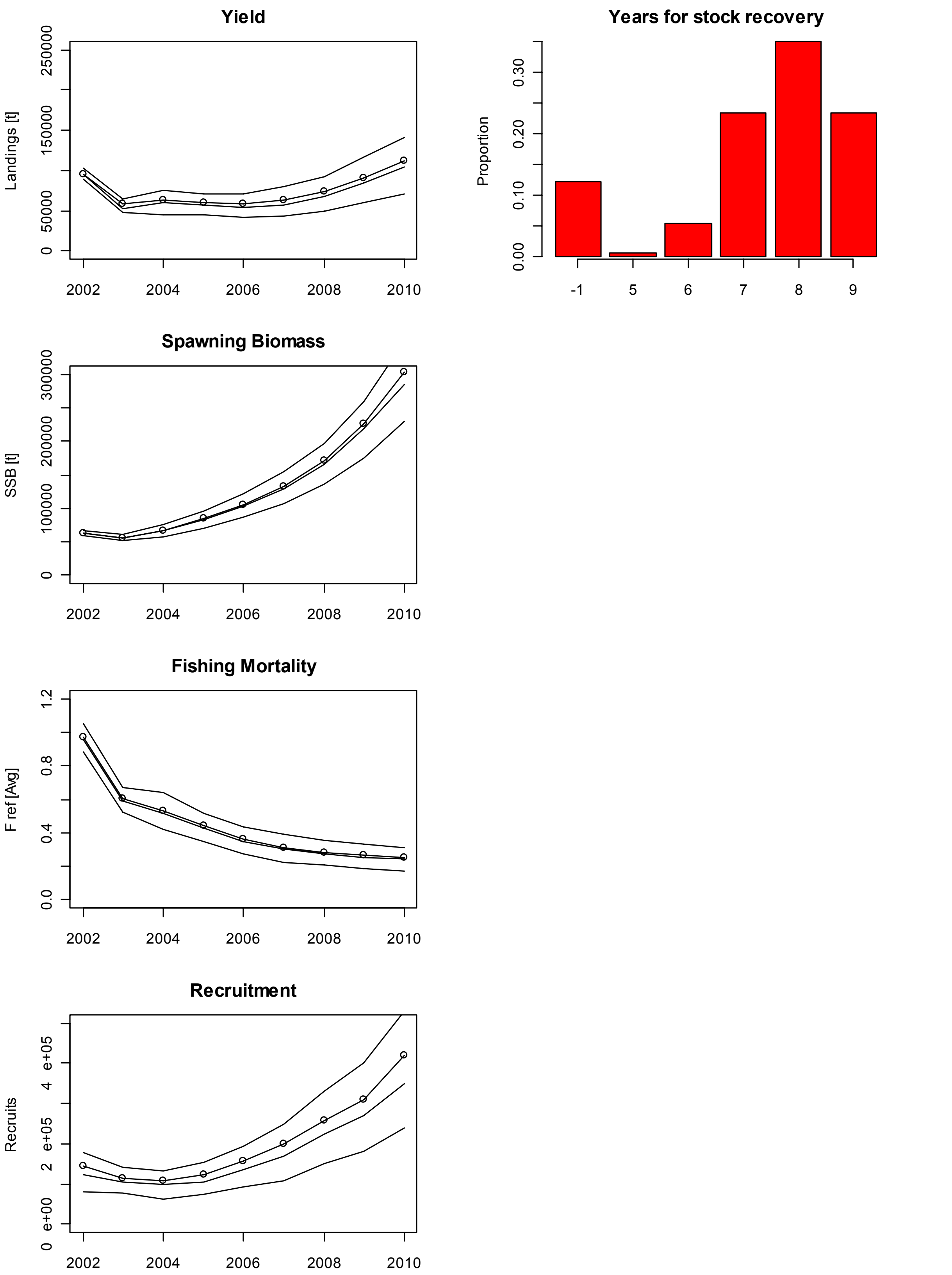


Figure 1.9.6 Results of Sc05 run. Terminal year: 2001; Rec. model: Shepherd; Bias factor: 1.0; Software: CS4.

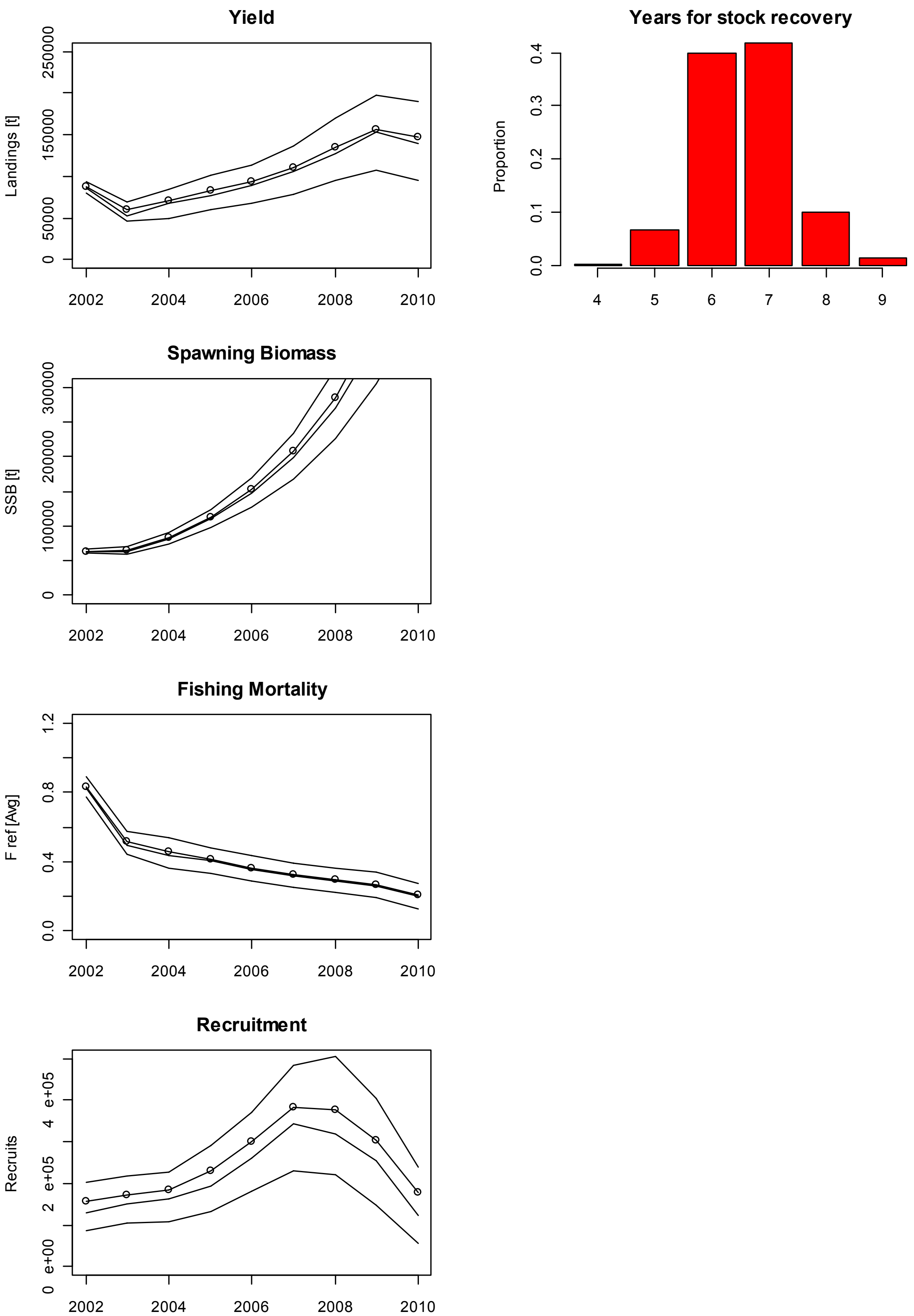


Figure 1.9.7 Results of Sc06 run. Terminal year: 2001; Rec. model: Shepherd; Bias factor: 1.2; Software: CS4.

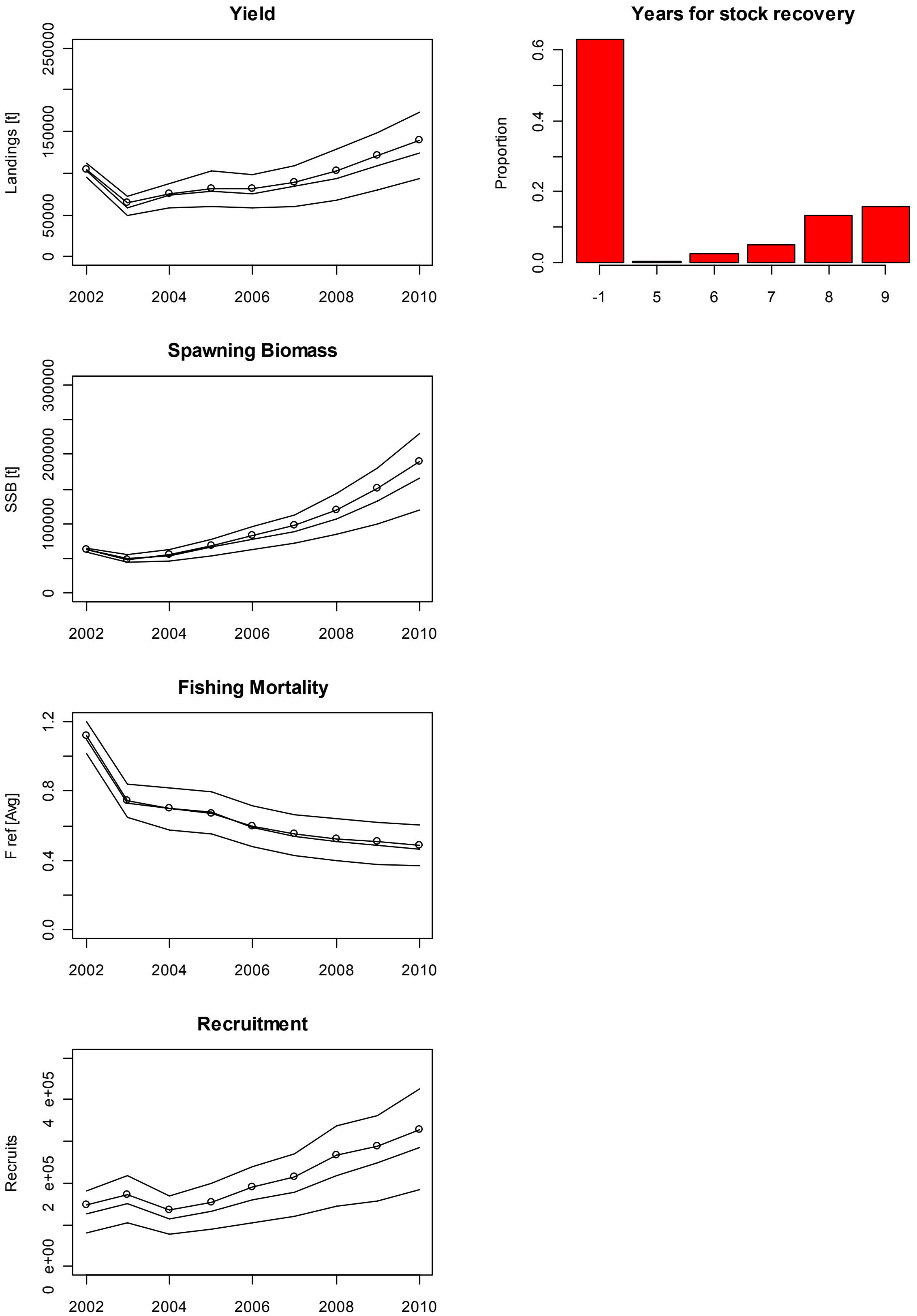
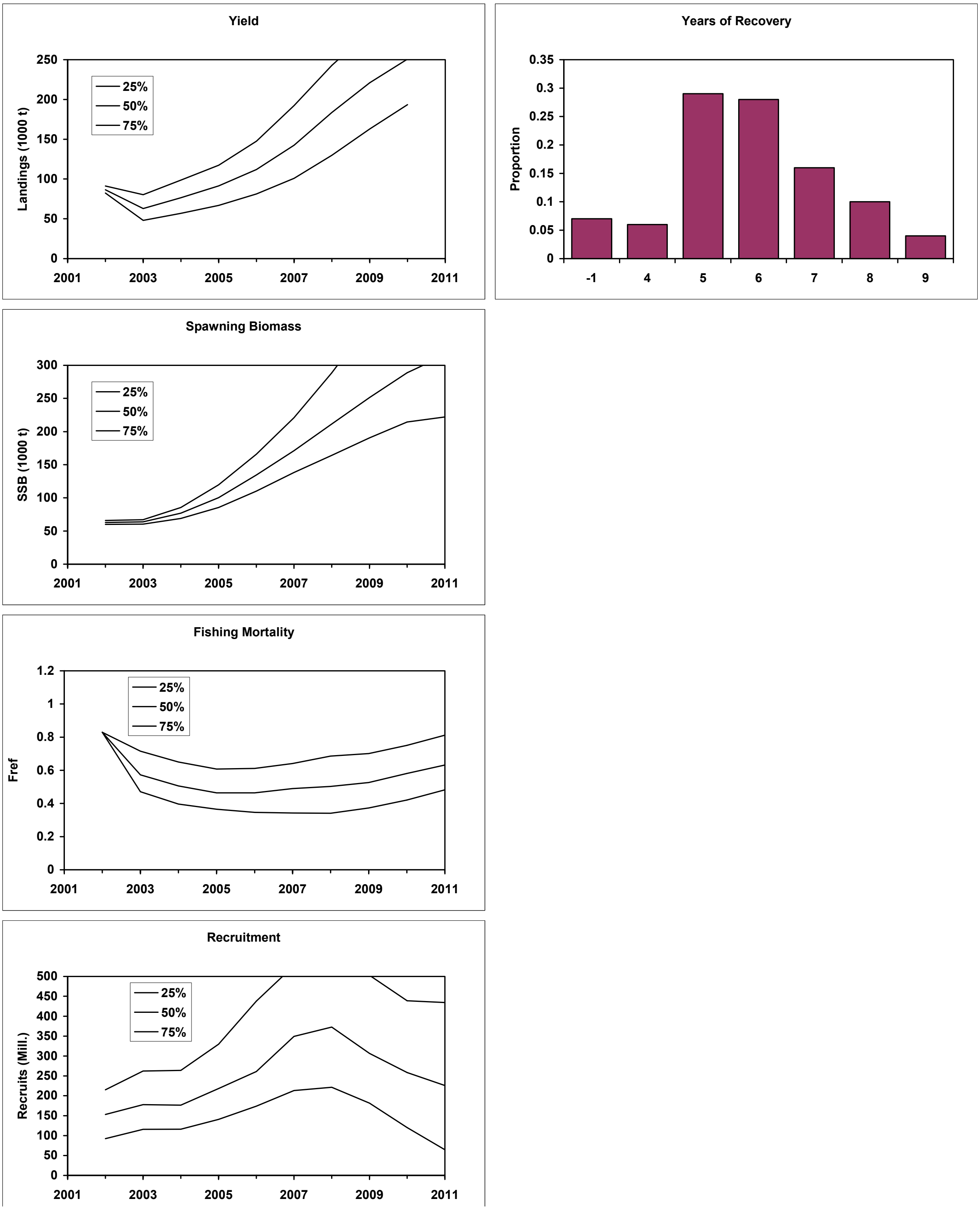


Figure 1.9.8 Results of Sc07 run. Terminal year: 2001; Rec. model: Shepherd; Bias factor: 1.1; Software: STPR3.



1.10 Overestimation in the Forecasting of Haddock and Whiting By-catch in the Industrial Fisheries

This section is a response to the following term of reference:

e) review forecast procedures for catches of haddock and whiting in the industrial fisheries. Explain why these forecasts appear to systematically overshoot the realised catches;

The amount of "overshoot" mentioned in the terms of reference is largest for the predicted by-catch of whiting and was more than 350% for the year 1997. The forecast suggested 28 thousand tonnes by-catch of whiting in the industrial fishery, while the estimated by-catch was as low as 6 thousand tonnes. The forecast for haddock by-catch in 1996 was more than 200% higher than the estimated by-catch that year (16 thousand tonnes compared to 5 thousand tonnes). The degree of overestimation has been decreasing in later years and the forecast of whiting by-catch for 2000 was an underestimate. Table 1.10.1 shows predicted (as given in the ACFM advice) and observed by-catches of haddock and whiting in the industrial fisheries. Subsection 1.10.1 gives a brief overview of the forecast procedure, while subsections 1.10.2 to 1.10.5 aim at explaining the overestimation of the by-catches of whiting and haddock in the industrial fisheries for the time period 1995 to 2000.

1.10.1 The forecast procedure

The forecasts of the haddock and whiting by-catch in the industrial fisheries are similar to the forecast of human consumption landings and discards. The deterministic forecast uses three types of input:

- Weight-at-age (average weight-at-age during the forecast period, separate weights used for human consumption landings, discards, and industrial by-catch)
- The mortality, including natural mortality (partial fishing mortalities in the industrial by-catch, the discards, and the human consumption landings add up to the total fishing mortality)
- Initial stock size (numbers-at-age)

All inputs are estimates and can be subject to uncertainty (stocastic noise) and/or bias.

Predicted weight-at-age in the by-catches is calculated as the mean over the three latest years. Separate forecasts are made for weights-at-age in the human consumption landings, in the discards, and in the by-catch in the industrial fisheries.

The partial fishing mortalities at each age are calculated using the proportion of catch in numbers-at-age multiplied with the total fishing mortality. Mean exploitation pattern in the by-catch is then calculated using the industrial by-catch mortality from the three latest years, and the predicted industrial fishing mortality is found by scaling this exploitation pattern to the unweighted mean of industrial by-catch fishing mortality (ages 2 to 6) in the most recent year. For human consumption landings and discards, a similar procedure is used.

The initial stock size is estimated in the assessment of the stock and has typically been XSA estimates with the size of the latest year classes replaced with RCT3 estimates for the haddock forecast and with short-term GM recruitment for the whiting forecast.

The predicted forecast of haddock by-catch in 2001 was made similar to earlier forecasts, but the relative proportions of human consumption and discards for age 2 was replaced with proportions predicted from a linear regression using stock weights as an explanatory variable. This was done due to the large size of the 1999 year class and the experience that larger year classes are slower growing than others.

A bias could be caused from any of the three sources of input used in the forecast: The initial stock size could be an overestimate, the mean weight-at-age could be lower than the predicted three-year mean and the partial fishing mortality could be lower than predicted.

1.10.2 Trends in mean weight-at-age in the by-catch

Whiting: A decreasing trend in mean weight-at-age in the by-catches can be seen in the industrial fisheries by-catch. Observed mean weight-at-age in the by-catches and the relative prediction error at age are shown in Figure 1.10.1. The by-catch of whiting represents a rather "flat" exploitation pattern across ages 1 to 5. Within the period of forecasts examined for prediction errors (1995-2000), weights were at their highest around 1995 and declined until 1999. Weights-at-age then rose in 2000. This had the result that the predicted weights-at-age were generally higher than the values observed in the period 1996-1999, while the opposite occurred in 2000 (which coincided with the prediction being an underestimate of whiting by-catch that year).

Haddock: There has also been a decreasing trend in mean weight-at-age in the by-catches of haddock (Figure 1.10.2). The by-catches contain mainly fish of ages 1 to 4 with the 2- and 3-year-olds being the most dominant. The weight-at-age for 3-year-olds in the haddock by-catches fluctuated slightly above 0.40 kg in the period 1990-1994, but has been lower, around 0.20-0.30 kg, since then. The observed weight-at-age of 2-year-olds in the catches has also declined from 0.25 kg in 1990 to less than 0.15 kg (in 2000). The trends in the relative prediction errors (right hand side of Figure 1.10.2) are not as clear as for whiting, but an overestimation was obvious for 1996 and 2000.

1.10.3 Trends in the industrial by-catch fishing mortality

Whiting: The partial fishing mortality by cohort together with the unweighted mean of partial fishing mortalities ($\overline{F}_{2-6}$) is shown in Figure 1.10.3. The fishing mortality of whiting by-catches in the industrial fisheries peaked around 1989-1990. The fishing mortality was gradually reduced, but has risen since 1998.

Haddock: The partial fishing mortality by cohort together with the unweighted mean of partial fishing mortalities ($\overline{F}_{2-6}$) is shown in Figure 1.10.4. The partial fishing mortality of haddock also peaked in 1990 and decreased until 1995, after which there has been an increase. The unweighted average of fishing mortalities for ages 2 to 6 ($\overline{F}_{2-6}$) are to some extent misleading in the years 2000 and 2001. There may be some problems in the age readings making a kind of "spillover" from the 1999 year class to the 1998 year class, causing the estimated partial fishing mortality for the 1998 year class to be above 0.3 (not shown in the graph due to a maximum fishing mortality of 0.12 on the vertical axis) and lifting the $\overline{F}_{2-6}$ to an artificial level higher than 0.05.

1.10.4 Possible overestimation of the haddock and whiting stocks

Whiting: The overall impression of fishing mortality of whiting is a decrease since the end of the 1980's. Why this has not lead to a similar increase in stock size is not known. There was only enough data to reproduce assessments back to 1995 due to the use of a 20-year tuning window and limiting the number of tuning data years available. Previous assessments have probably used different settings, so the results presented here should be treated as indicative of the magnitude of the problem. In the retrospective pattern (Figure 1.10.5) of numbers (stock size)-at-age there is a strong tendency to overestimate the 1994 year class and older in the 1995 assessment and onwards. The problem of overestimating could possibly be linked both to assessment years and to specific cohorts corresponding to changes to tuning series and specific cohort displaying a different behaviour (like different geographical distribution) than others.

Haddock: Previous assessments of haddock are known to have overestimated the stock quite strongly. Most of this was due to the contribution from commercial CPUE series. These have been excluded from the XSA tuning and the size of the problem is now believed to be reduced. See also Section 4.10.

The current study evaluates to what extent the current way of estimating stock size of haddock would have been a source of bias in previous years. The retrospective assessments are run back to 1992 and the retrospective pattern of numbers-at-age (Figure 1.10.6) show only minor deviations (ages 2 to 4). The XSA estimates of numbers-at-age 1 in the current (assessment year) are replaced by other recruitment estimates that are not evaluated here. Figure 1.10.7 shows the retrospective pattern in $\overline{F}_{2-6}$. The pattern of underestimation of F in the period 1996-1999 is almost entirely driven by the F of 6-year-olds and can possibly be an example on how the use of such an age range can be the source of bias.

1.10.5 Conclusions

The results are summarized in the following table:

	Whiting	*Haddock*
Weight-at-age prediction	A clear source for overestimating the industrial by-catch in some years. Contributes towards an underestimate in 1995 and 2000, but towards an overestimate in the years between.	Contributes to an overestimate in 1996 and 2000. No clear picture for the years between.
Partial fishing mortality	The use of a status quo fishing mortality would contribute to an overestimate in the period 1991 to 1996 during the time that the fishing mortality of whiting in the industrial by-catches decreased. The small increase in F the last year contributes towards an underestimate in 2000 (which also occurred).	The use of a *status quo* fishing mortality would contribute to an overestimate in the period 1991 to 1995, but possibly to an underestimate in some the years following. The problem with the estimation of the partial fishing mortality of the 1998 year class contributes strongly towards an overestimate of the by-catch of haddock.
Stock size	The overestimation of stock size in 1995 and 1996 could possibly have contributed to an overestimate of the industrial by-catch those years. The effect is not straightforward to assess because the estimate of stock size is closely linked to the estimate of fishing mortality, which again is linked to the perception of the status quo partial fishing mortality (in the by-catches).	A relatively small overestimation of fishing mortality in the period 1992-1995, followed by a (still small) underestimation of fishing mortality in the years 1996-1999. There are clear signs of autocorrelation in this pattern. Previous assessments used commercial cpue data, and the tendency to overestimate the stock was larger and could have been the major source of the prediction error in at least some years.
Conclusions	**The sources of error described above are quite likely to have produced the large discrepancies between predicted and observed by-catch of whiting in the industrial fishery.**	**The picture is not as clear as for whiting. Future studies could go more into detail to see if there are any systematic differences between small and large year classes. The use of the age range 2 to 6 in calculating mean fishing mortality should be compared with the use of other age ranges (in the prediction of partial fishing mortality in the by-catch).**

Additional comment	*It should be noted that problems in forecasting catches occur for a number of stocks advised upon by ICES. In addition such problems exist for other components of the haddock and whiting forecasts, ie. for both the human consumption landings and for the discards. Additional intersessional work is required to evaluate whether the problem is particularly severe for the industrial by-catch component, or whether it is of equivalent severity across all sources of the catch.*

Table 1.10.1 Comparison of predicted and observed bycatches of whiting and haddock in the industrial fisheries.

Assessment	Year	Haddock bycatch (1000 't)		Whiting bycatch (1000 't)	
		Predicted	Observed	Predicted	Observed
October 1990	1991	7	5	70	38
October 1991[1]	1992		11		27
October 1992	1993	16	11	50	20
October 1993	1994	13	4	47	10
October 1994	1995	14	8	28	27
October 1995	1996	16	5	19	5
October 1996	1997	7	7	28	6
October 1997	1998	10	5	9	3
October 1998	1999	8	4	11	5
October 1999	2000	13	8	6	9
October 2000	2001	10	8	10	7

[1] No prediction of bycatches given in the ACFM advice

Figure 1.10.1 Whiting: Trends in weight-at-age (left) and predicted divided by observed weights-at-age (right).

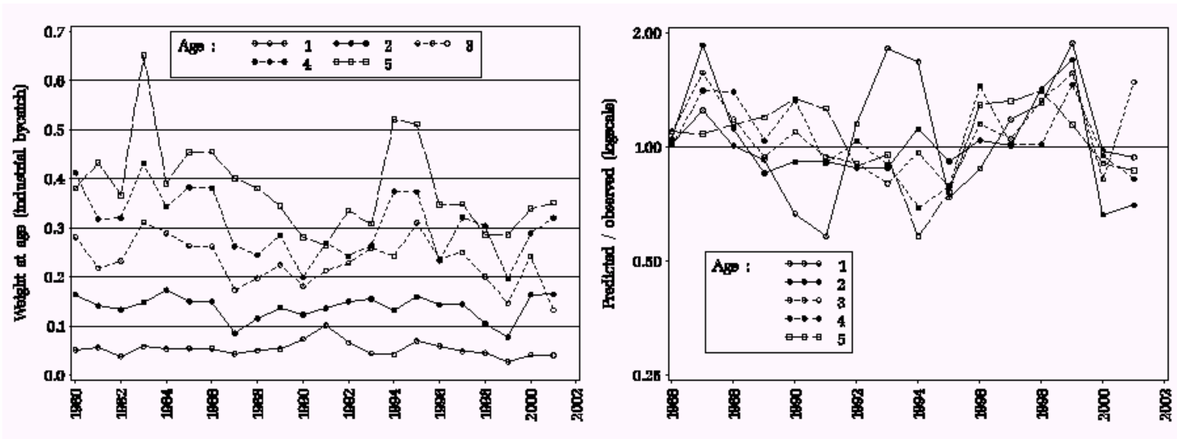


Figure 1.10.2 Haddock: Trends in weight-at-age (left) and predicted divided by observed weights-at-age (right). The 1999 year class is not treated separately as in the assessment.

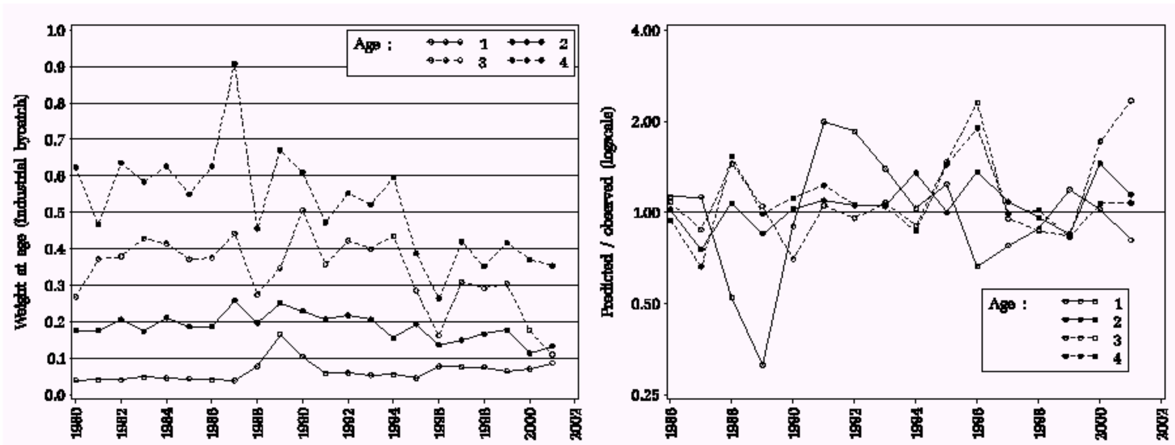


Figure 1.10.3 Partial fishing mortality of whiting taken as by-catch in the industrial fisheries. F's are plotted by cohort (age 1 to 6), shown with solid lines. $\overline{F}_{2-6}$ is shown as dots connected with a dotted line.

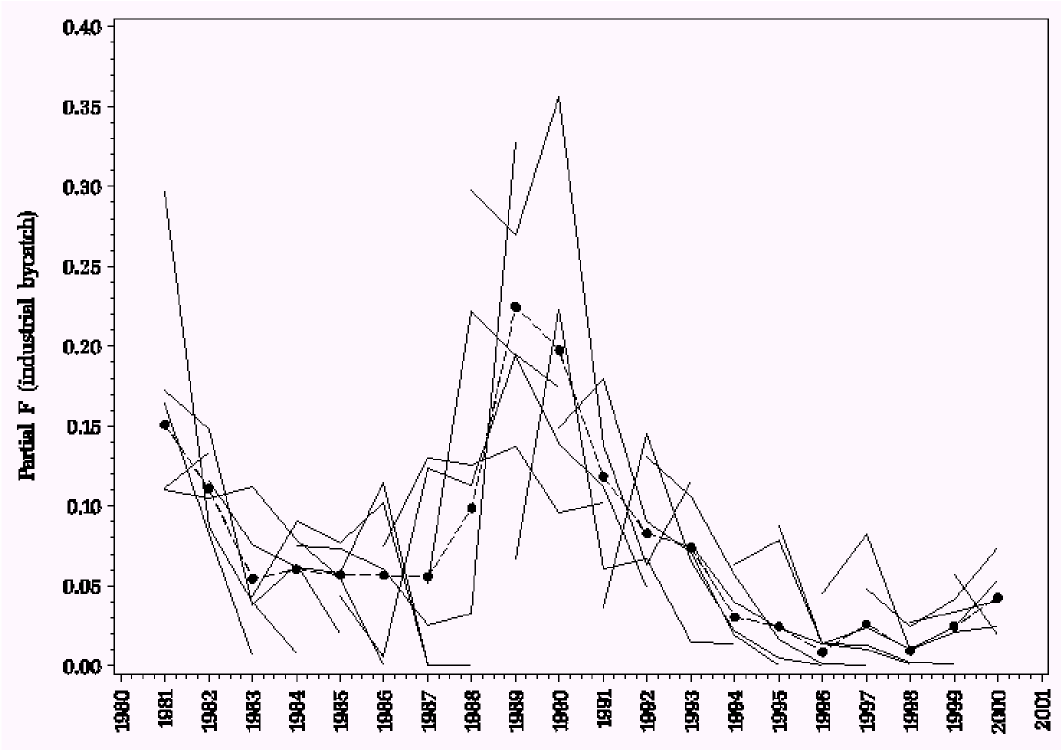


Figure 1.10.4 Partial fishing mortality of haddock taken as by-catch in the industrial fisheries. F's are plotted by cohort (age 1 to 6), shown with solid lines. $\overline{F}_{2-6}$ is shown as dots connected with a dotted line.

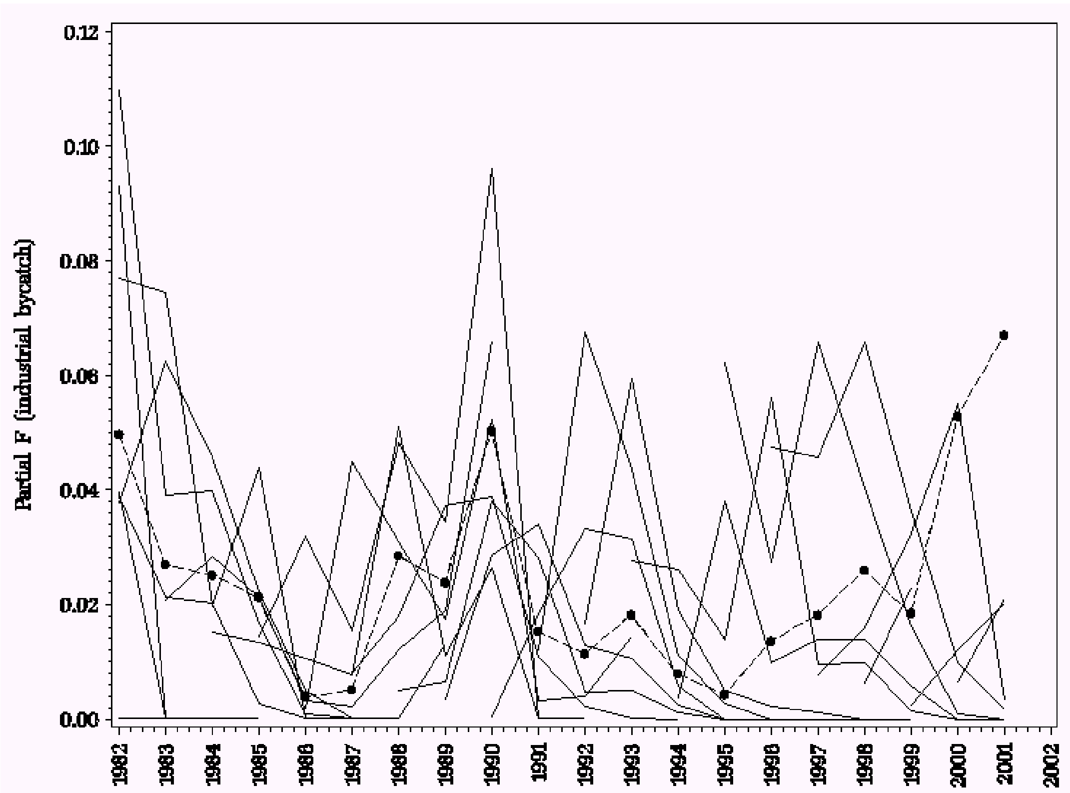


Figure 1.10.5 Retrospective pattern of stock size-at-age of whiting. Since there is no XSA estimate of number at age 1 in the current years the endpoints represent the estimate from the current year + 1.

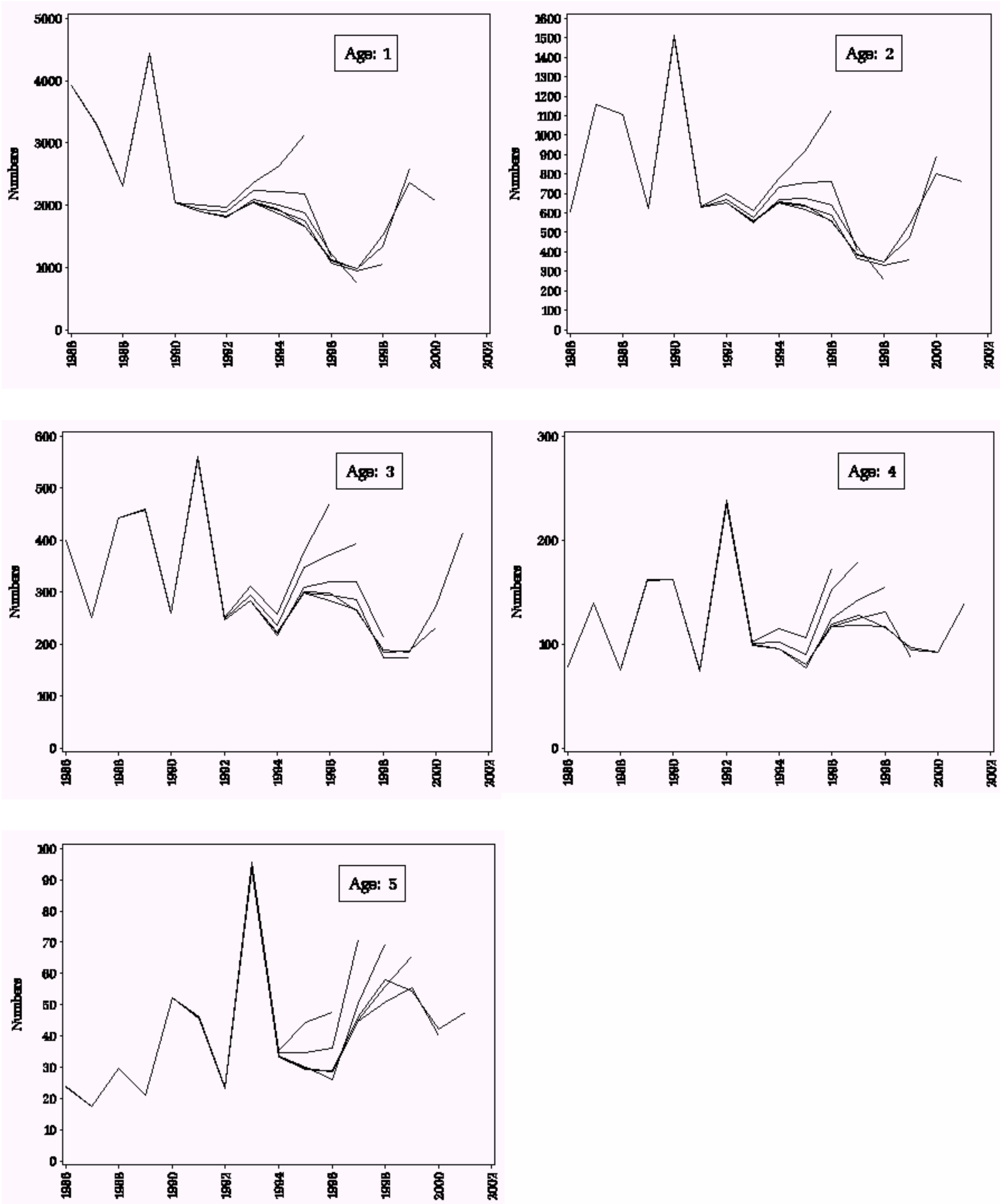


Figure 1.10.6 Retrospective pattern of stock size-at-age of haddock.

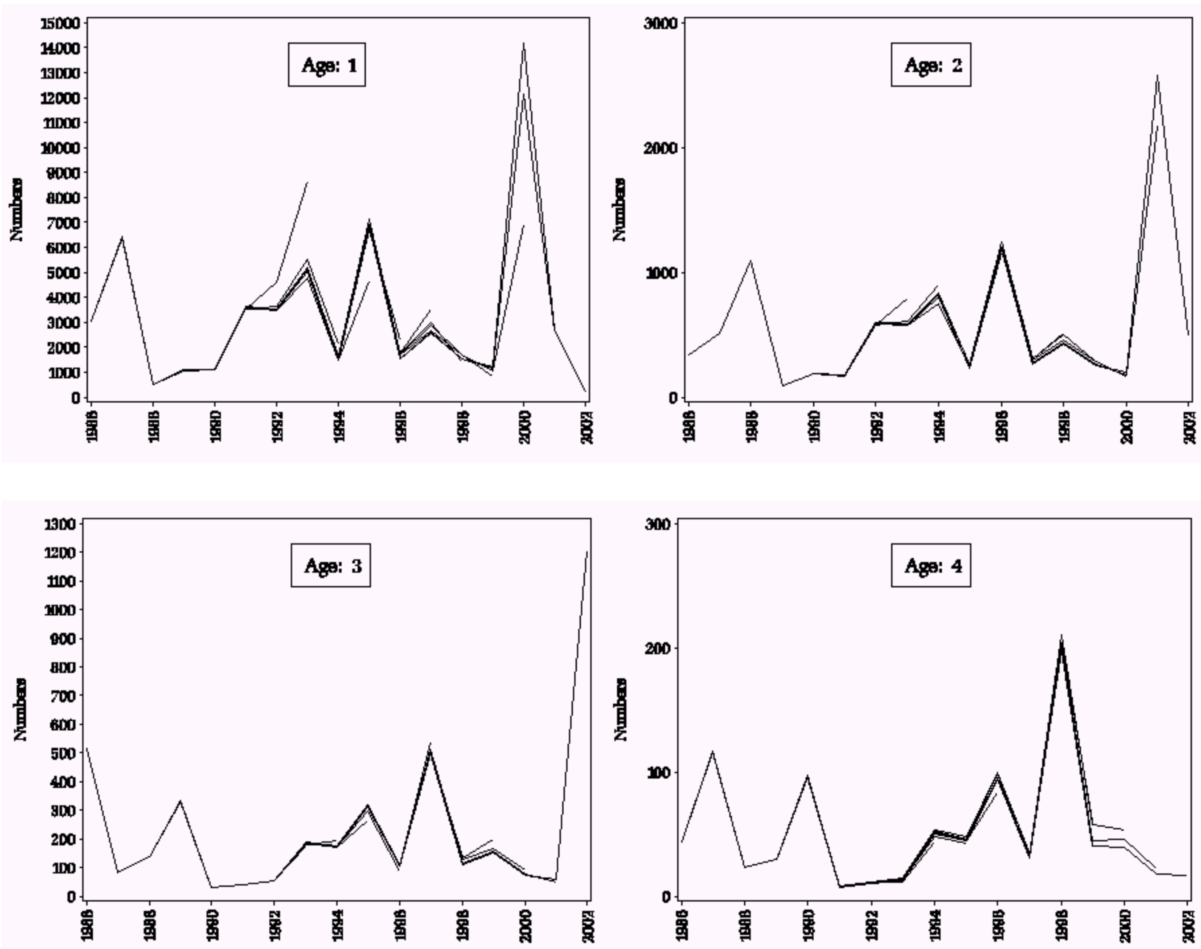
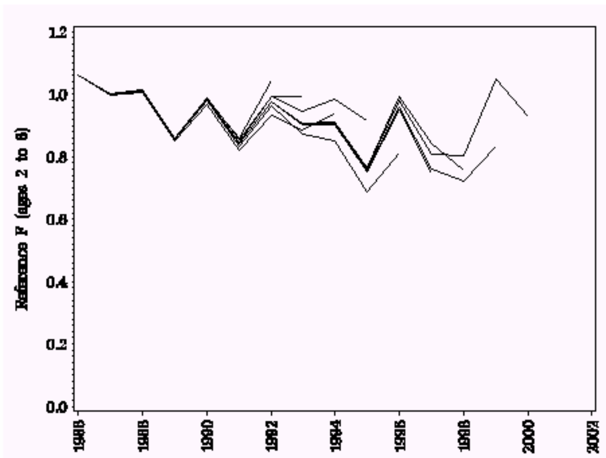


Figure 1.10.7 Retrospective pattern of unweighted mean fishing mortalities ($\overline{F}_{2-6}$) of haddock.



1.11 Evaluation of Reports of Relevant ICES Working Groups and Study Groups

1.11.1 Working Group on Methods of Fish Stock Assessments (WGMG)

WGMG was reconvened in 2002, having last met in 1995, and was set up to develop and evaluate assessment methodologies and forecasting techniques. Chapters 2, 3, 4, and 6 cover background material and general discussion of the issues surrounding bias in assessments and projections, the precautionary approach, and data quality. Much of the discussion is pertinent to this Working Group (WGNSSK) and highlights the need to be aware of the strengths and limitations of the tools being used. Chapters 5 and 7 discuss more technical details of assessment methodologies and the procedures for "certification" of new assessment tools. WGNSSK looks forward to the development of new, more robust assessment packages.

Some phrases, which the WGMG felt the need to highlight and which are of particular relevance include:

"This Group therefore recommends that effort data be corrected for changes in efficiency by specific analysis prior to setting up the tuning data for assessment."

"A message to assessment working groups is that they should favour fewer data of good quality (as evaluated independently of the assessment model) instead of large quantities of data of unknown properties."

"The definition of fleets for tuning purposes should be improved, and stricter criteria should be used to select the catch and effort data retained for each fleet."

With respect to medium-term forecasts, the WGMG concluded that:

"the extreme percentiles (5^{th} and 95^{th} percentiles) or predicted SSB and catch cannot be considered to be reliable – the 25^{th} and 75^{th} percentiles are better behaved, but their use may be overly prescriptive."

"it is proposed that a series of candidate stock-recruitment models are fitted to historically-estimated stock-recruitment pairs, and that a final model is chosen based on consideration of statistical fit, parsimony, biological appropriateness, and robustness (including sensitivity to the addition of new data)."

"Current Working Group practice does not generally stipulate that quality control procedures should be carried out on medium-term projections..… Substantial annual changes in starting population numbers-at-age and assumed stock-recruitment formulations lead to medium-term projections that vary widely from year to year. Plotting the projection from this year's assessment alongside that from last year's (and indeed, several years prior to that) would serve to highlight such variation, and focus Working Group attention on determining the reasons for it. It should be noted that such comparisons would have to be based on the same projected fishing mortality, so that there would be a need to re-run previous projections using the current status quo F."

With respect to short-term forecasts, WGMG concluded that:

"Working groups should be encouraged to produce more detailed catch forecast tables. These were generated automatically by the IFAP system, but with its recent demise the provision of detailed tables has become inconsistent.

The WGMG will be investigating the modelling of weights, maturity, and condition factors for incorporation into stock forecasts and await the results of the Study Group on Growth and Maturity (SGGROMAT) with much anticipation.

WGNSSK would like guidance from the WGMG on how to assess the quality of data and criteria for the acceptance/rejection of data series. This particularly applies to the choice of tuning data, for instance the ability to assess the reliability of using a tuning fleet which provides the majority of the catch data.

The WGNSSK has, this year, investigated a number of alternative stock-recruitment relationships and will further these investigations in future years. In addition, the WG has changed the percentiles presented in medium-term projections in line with the recommendations of WGMG.

In response to the comment regarding lack of standardisation within assessments, WGNSSK has, for several years, universally used the Aberdeen suite of forecasting programs as it has a consistent way of treating assessment data.

1.11.2 Study Group on the Further Development of the Precautionary Approach to Fishery Management (SGPA)

This group met to further develop ICES strategy concerning the Precautionary Approach (PA) and for the subsequent provision of advice with particular reference to rebuilding plans, reference points, and short-lived and deepwater species. The group were also to study the calculation of $\mathbf{B}_{MSY}$ and $\mathbf{F}_{MSY}$ and consider initiatives for the harmonisation of approaches between NAFO and ICES. A final report of this meeting was not available at the time of the WG, therefore the discussions were based on a draft version.

Chapter 3 of the report deals with the determination of reference points for stocks undergoing analytical assessments and presents the segmented regression methodology. This method fits 2 straight lines to the stock recruit data, one passing through the origin and the other horizontal. The data are statistically analysed to locate the SSB at which the stock recruit data should be split, this SSB being referred to as the change point. As the method is fully statistical, estimates of error surrounding this point may be calculated, and biomass reference points can then be chosen to reflect the degree of risk which managers are prepared to accept surrounding this point. Change point models are presented for a large number of stocks, and the limitations of the methodology are acknowledged. Chapter 3 also contains an investigation into the problems encountered when SSB and F reference points are not compatible (i.e. fishing at the F reference point resulting in an equilibrium biomass quite different to the reference biomass). Finally there is a discussion of structural uncertainty in assessment methodology and its impact on the determination of reference points.

Chapter 4 deals with reference points and environmental influences, concluding that attempts to identify periods of differing environmental conditions (or regime shifts) are problematical. Potential solutions include the setting of biomass reference points conservatively to be commensurate with the harshest environmental conditions, or a stronger reliance on F reference points.

Chapter 5 considers the PA in respect to deepwater and short-lived species, of which the latter is pertinent to this WG. It is suggested that F reference points for short-lived stocks within the ICES area could be set in line with other short-lived pelagic species (Northern anchovy, Pacific sardine, Peruvian anchovy, etc.). F reference points may overlook the potential for increased catchability at low stock sizes, and thus biomass reference points, including a minimum escapement level, may be more suitable.

A presentation was made to the SGPA on the implementation of the PA within NAFO. A system of three reference points was set up: limit, buffer (which maps to ICES PA points), and target. For many stocks, the target has been set to reflect correspondence to MSY, although problems have been encountered with the ratification and acceptance of these points. It should be noted that several stocks within the NAFO region are subject to fishery closure.

The Study Group proposed that ICES commits itself to reviewing the current range of reference points and that this should be undertaken by the Assessment Working Groups, using guidelines to be set down by ACFM. The Study Group also awaits the findings of the SGGROMAT, and proposes that these will assist the Assessment Working Groups in the determination of reference points. It is proposed that these reviews of reference points would occur in 2003.

WGNSSK considers that the lack of specific target reference points within ICES is one of the biggest problems facing the application of a precautionary approach to fisheries management. Current practice by fishery managers appears to be the use of the precautionary reference points as targets. These points were originally determined as a boundary to biologically critical values and unless alternative target values are set by management, many stocks will continue to remain around or be driven to these minimum biological levels. These issues are probably of much greater importance than relatively minor updates to reference points.

The Working Group would welcome software which enables fitting of the change point model as an alternative stock-recruit modelling tool.

1.11.3 Workshop on Multispecies in the North Sea (WKNSMS)

This workshop was convened to produce a new key run of MSVPA (now 4M) and to provide an overview of progress regarding multispecies work undertaken for the North Sea. The latest 4M key run covers the period 1963 to 2000.

Unlike previous versions of MSVPA, multispecies tuning is possible within 4M. A full account is given in Vinther (2001), but essentially multispecies tuning is an iterative process, which exchanges estimates of F and M between single-species XSA runs and multispecies runs until some convergence criteria are met. The multispecies VPA section generates natural mortalities (M1+M2), which are used by following single-species tunings (XSA, SXSA, or ICA) that produce new estimates of terminal F. These are used by the multispecies part and the procedure is repeated until convergence is achieved. Parameter settings for maturity, weight-at-age, tuning options, etc. were the same as for the most recent XSA assessment (2001 for cod, haddock, sandeel, and Norway pout, 2000 for whiting).

The results of the key run for cod, haddock, whiting, Norway pout, and sandeels are summarised in Figures 1.11.3.1-1.11.3.5. Single-species runs are presented for comparison. These are also performed within 4M and are XSA assessments using the most recent settings, but using the single-species constant M values.

The trends in SSB and mean F are highly correlated between single- and multispecies assessments, differences largely being a scaling effect. The differences between single- and multispecies SSBs (Figure 1.11.3.1) for predators are small due to predation mortality generally affecting the younger ages. Correspondingly, the mean Fs (Figure 1.11.3.2) have greater differences as they generally encompass some of the more vulnerable ages.

The ratio of multispecies to single-species numbers by age are shown in Figure 1.11.3.3. The general pattern of reducing differences with increasing age is reversed for sandeels and warrants further investigation.

Stock-recruit scatter-plots are shown in Figure 1.11.3.4. Natural mortalities (M1 + M2)-at-age are shown in Figures 1.11.3.5, note that the scales are not the same.

Table 1.11.3.1 shows mean M-at-age for decades within the modelled time period and it can be seen that for some species-at-age, considerable changes are estimated to have occurred. Older ages of sandeels are estimated to have a reduced predation mortality through time, whist younger ages of most fish appear to have increased predation mortalities. A detailed examination of the partial predation mortalities reveals different causes for these increases.

While the differences between the single- and multi-species runs are generally small, the presence of trends in differences of recruitment estimates has implications for medium- and long-term projections. Comparisons of single- and multispecies forecasts should be made. Field studies designed to provide new estimates of predation rates, in particular for seals, are being undertaken. The Group (WGNSSK) is therefore deferring use of new natural mortality estimates until they have been further evaluated.

1.11.4 Information on discards in the North Sea and Skagerrak

The WG considered the 2002 report of the Study Group on Discard and By-Catch Information (SGDBI) and the data compiled by the group to date. The data are mainly from towed-gear fisheries for cod, haddock, whiting, saithe, sole, and plaice in IIIa and IV as collected by Germany, England, Denmark, and Sweden between 1999 and 2001 under EC project 98/097. Some data from other projects going back to 1997 were also available to the SGBDI. Data compilations, as tables of raised and unraised, quarterly length distributions, raised numbers, mean weights-at-age of discards for various fleet sectors, and estimates of the raised tonnes discarded by all gears, all available on the ICES SGDBI website[2], are summarised in Table 1.11.4.1. Data are raised on the basis of fishing effort, in most cases hours fished.

The Netherlands, Belgium, and France also collected discard data as part of the EC project, but these data were not available to the SGDBI. The Dutch data were withdrawn from the Study Group because of disagreement with the Dutch fishing industry about whether the results were representative. The WG considered that it is very undesirable to withhold scientific data required for analytical purposes and regrets that it is not able to evaluate the discard pattern of an important fleet in the North Sea. The WG understands, however, that discard data collected for EC project 98/097 by participating countries have been reported to the Commission.

Data on discarding of haddock, whiting, cod, and saithe by Scottish vessels from the mid-1970s onwards are derived from an observer program. Numbers- and weights-at-age of haddock and whiting discarded are raised to national (Scottish) and then to international fleet level on the basis of landings. These data are compiled annually and are used by this WG. Data on discards of cod and saithe are not treated in this way because it is considered that patterns of discarding by Scottish vessels are unlikely to reflect those across the fisheries. Scotland was not involved in 98/097 and discard data from the Scottish fleets were not reported to the SGDBI.

From the point of view of the WG, the utility of the SGDBI discard data are limited by:

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[2] (www.ices.dk - /reports/ACFM/2002/SGDBI/datafiles/northseaandskagerrak)

- lack of equivalent information on the quantities and length distribution and age of fish retained or landed

- lack of information on discarding from national fleets which are important components of particular fisheries, for example, discarding of saithe by French and Norwegian fleets, of cod by Scottish fleets, and plaice, whiting, and cod by the Dutch beam trawl fishery

- the length of the data series

In some cases, information on weight-at-age in the SGBDI files is missing. The WG was advised that age-disaggregated data and mean weights-at-age from Denmark's discard sampling programme are available, and have been compiled and reported to the EC. These data and other data on discards in Danish gillnet fisheries in the IV and IIIa were, however, not on the ICES SGDBI site at the time of the meeting.

The SGDBI report addresses the question of inclusion of information on fish retained noting a number of reasons why the quantities retained, as observed at sea, may not be the same as the reported quantities landed. These include non-declaration of catch, high grading of fish in the hold, and errors in raising factors. Because of these and possible influences on raised estimates of quantities retained, the SGDBI indicate that they do not think the inclusion of quantities retained would be a good way of allowing readers to assess the significance of discard data. The SGDBI indicate, however, that where possible, information of the proportion of the catch discarded as observed onboard has been added to the discarding data tables and that these proportions could be applied in stock assessment to raise total declared landings to total catch. However, only a few of the SGBDI data tables include this information.

In an attempt to produce indicative estimates of the extent of discarding for saithe, plaice, and cod in IV, the WG examined data on the SGDBI database, data from Scotland's discard sampling programme, and data summaries from EC project 98/097 as reported to the EC. The latter present estimates of tonnage and numbers-at-age discarded and retained. The WG also examined disaggregated data (SGDBI and Scotland) from which it is evident that, depending on species, patterns of discarding vary among fleets, seasonally, and from year to year, often in relation to year-class strength. It is likely that discard patterns and quantities are also influenced by quota allocation and technical conservation measures.

Saithe

For saithe, the SGDBI provides estimates of discard percentages between 66% and 77% by number, and 66% by weight for the English beam and otter trawl fleets in 2000, and an estimate of the total weight discarded of 2,459 tonnes in 2000. Discards of saithe by Scottish vessels were estimated to be in excess of 19 500 and 13 100 tonnes in 2000 and 2001, respectively, and were 2.6 and 1.8 times the total reported landings. Discarded saithe were predominately 3 and 4 years old, but fish of all ages were discarded.

Plaice

Estimates of the tonnage of plaice discarded and retained by the combined towed gear fleet in IV, in the EC project report, indicate that 38.3% and 42.7% of the catch by weight was discarded in 2000 and 2001, respectively. In numerical terms many more fish are discarded than retained. Estimates for beam trawlers indicate that 1 612 million and 457.5 million plaice were discarded in 2000 and 2001, respectively, as compared to 713.6 million and 59.6 million retained. Fish discarded were predominately younger fish. Discard rates in 2001 of 0- and 1-group fish were 100%, and 96%, 86%, and 64% for fish aged 2, 3, and 4, respectively. The SGDBI data indicate that patterns of discards vary seasonally and between fleets.

Cod

For North Sea cod, estimates of tonnage discarded and retained, reported to the EC, indicate discard rates of 11.8% and 12.1% for the combined towed gear fleet in 2000 and 2001, respectively. Scottish vessels discarded an estimated 4 100 and 4 400 tonnes of cod in 2000 and 2001, 20.1% and 31% of total reported landings and 16.8% and 25.1% of the catch by weight. Although the tonnage of cod discarded is low compared to other species, as with plaice the numbers of fish are substantial, relative to both the numbers landed and of numbers-at-age in the stock. It is estimated that the combined Scottish fleet discarded 13.2 and 13 million cod in 2000 and 2001 respectively, as compared with 15 and 11 million fish landed. Discard rates were 100%, 97.9%, and 15.1% for 1-, 2-, and 3-year-old fish in 2001.

WG Conclusions

Not considering discard catches in stock assessments may introduce bias and affect estimates of F and stock biomass, particularly when discard patterns vary over time. Good estimates of discard catches are, however, difficult and costly to obtain. The WG considers that assessments of plaice and cod in IV should take discards into account.

The collection and collation of data as undertaken by the SGDBI has not been useful for assessment purposes. The data collected and reported under EC project 98/097 when and if available might prove so. For North Sea cod and plaice there is currently insufficient information on discard catches to include them in assessments. The EU data collection regulation, which requires countries to collect and report on discard catches from 2002, should improve this. There is a need to ensure that national discard sampling programmes target representative components of the fleet and that differences in discard patterns are considered when extrapolating to the total catch.

Table 1.11.3.1 Average natural mortality (M1+M2) as estimated by MSVPA

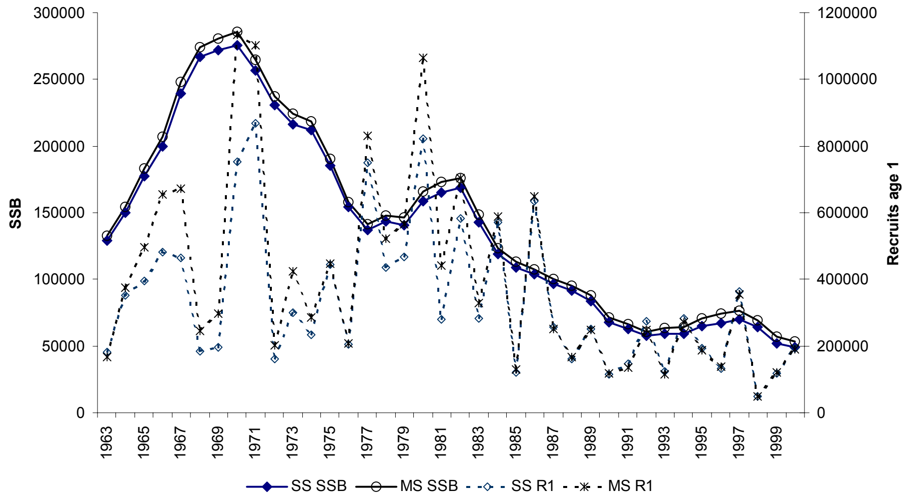
		Age group								
		0	1	2	3	4	5	6	7	8
Species	Period									
Cod	1963-1969	1.90	0.88	0.45	0.31	0.22	0.21	0.22	0.20	0.20
	1970-1979	1.57	0.89	0.46	0.32	0.22	0.21	0.23	0.20	0.20
	1980-1989	2.11	0.85	0.39	0.32	0.23	0.22	0.25	0.20	0.20
	1990-2000	3.21	0.70	0.34	0.40	0.26	0.26	0.32	0.20	0.20
	All	2.25	0.82	0.41	0.34	0.23	0.23	0.26	0.20	0.20
	Used	*N/A*	*0.8*	*0.35*	*0.25*	*0.2*	*0.2*	*0.2*	*0.2*	*0.2*
Haddock	Period									
	1963-1969	2.10	1.29	0.33	0.26	0.25	0.25	0.23	0.20	0.20
	1970-1979	2.12	1.78	0.34	0.27	0.26	0.26	0.23	0.20	0.20
	1980-1989	2.23	1.32	0.31	0.25	0.24	0.28	0.23	0.20	0.20
	1990-2000	2.19	1.29	0.27	0.24	0.23	0.36	0.25	0.20	0.20
	All	2.16	1.43	0.31	0.25	0.24	0.29	0.24	0.20	0.20
	Used	*2.05*	*1.65*	*0.4*	*0.25*	*0.2*	*0.2*	*0.2*	*0.2*	*0.2*
Norway pout	Period									
	1963-1969	1.13	1.66	1.17	1.17	_	_	_	_	_
	1970-1979	1.00	1.95	1.49	1.60	_	_	_	_	_
	1980-1989	1.37	1.76	1.33	1.38	_	_	_	_	_
	1990-2000	1.54	1.77	1.34	1.42	_	_	_	_	_
	All	1.28	1.80	1.34	1.41	_	_	_	_	_
	Used	*1.6*	*1.6*	*1.6*	*1.6*					
Sandeel	Period									
	1963-1969	1.03	1.21	0.87	1.12	0.99	_	_	_	_
	1970-1979	1.04	1.10	0.64	0.69	0.54	_	_	_	_
	1980-1989	1.21	0.98	0.66	0.71	0.51	_	_	_	_
	1990-2000	1.36	0.87	0.61	0.67	0.45	_	_	_	_
	All	1.18	1.02	0.68	0.77	0.59	_	_	_	_
	Used	*0.8*	*1.2*	*0.8*	*0.8*	*0.8*				
Whiting	Period									
	1963-1969	1.80	1.06	0.47	0.36	0.36	0.34	0.33	0.20	0.20
	1970-1979	1.56	1.03	0.47	0.37	0.37	0.37	0.35	0.20	0.20
	1980-1989	2.00	1.22	0.43	0.34	0.36	0.40	0.35	0.20	0.20
	1990-2000	2.51	1.26	0.36	0.34	0.40	0.56	0.42	0.20	0.20
	All	1.99	1.15	0.43	0.35	0.37	0.43	0.37	0.20	0.20
	Used	*N/A*	*0.95*	*0.45*	*0.35*	*0.3*	*0.25*	*0.25*	*0.2*	*0.2*

Table 1.11.4.1 Summary of discard data available in SGDBI data files

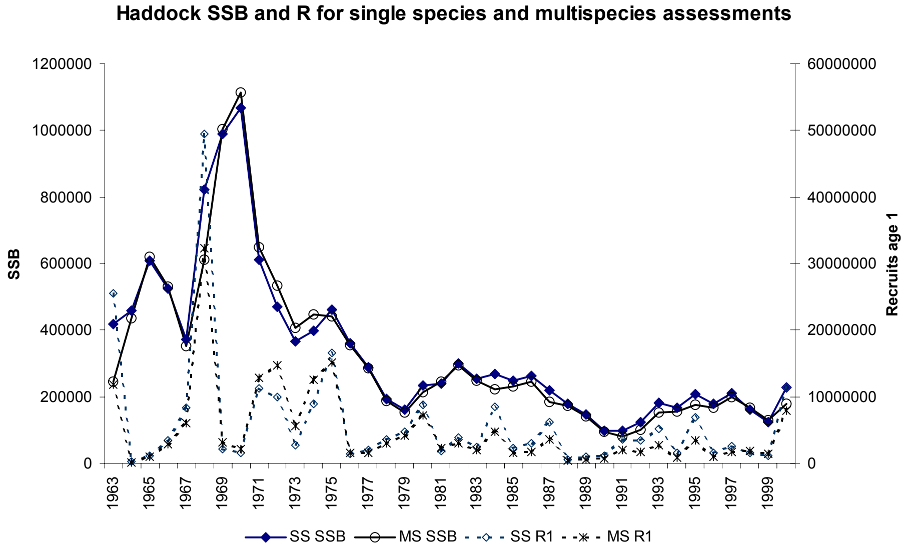
Country & Subarea, Division	Species	Discard data available	Fleets[1]	Years
Germany IV	Cod haddock whiting saithe plaice Sole	Raised quarterly length distributions Raised numbers, mean lengths and weights-at-age Raised tonnes discarded, all gears	Beam trawl, pair trawl, otter trawl	1999 – 2001[2]
England IV	Cod, haddock Whiting Saithe Sole Plaice	Raised quarterly length distributions Raised numbers, mean lengths and weights-at-age Raised tonnes discarded, all gears	Beam trawl, Nephrops trawl, otter trawl, pair trawl, seine trawl	1997 – 2001[3]
Denmark IIIa & IV	Cod haddock plaice	Raised and quarterly length distributions Unraised and raised quarterly length distributions (2001 only)	Otter trawl, anchor seine, beam trawl	1999 – 2001
Sweden IIIa & IV	Cod	Raised quarterly length distributions Raised numbers, mean lengths and weights-at-age Raised tonnes discarded, all gears	Otter trawl, Nephrops trawl, shrimp trawl, Danish seines	1999 - 2001
Sweden IIIa	Haddock Plaice saithe sole whiting	Raised quarterly length distributions raised numbers, mean lengths and weights-at-age Raised tonnes discarded, all gears	Nephrops trawl, otter trawl	2001

[1] In some cases data are from different fleets in different years
[2] Only data for 2001 available on website
[3] Not all data available for all species in all years

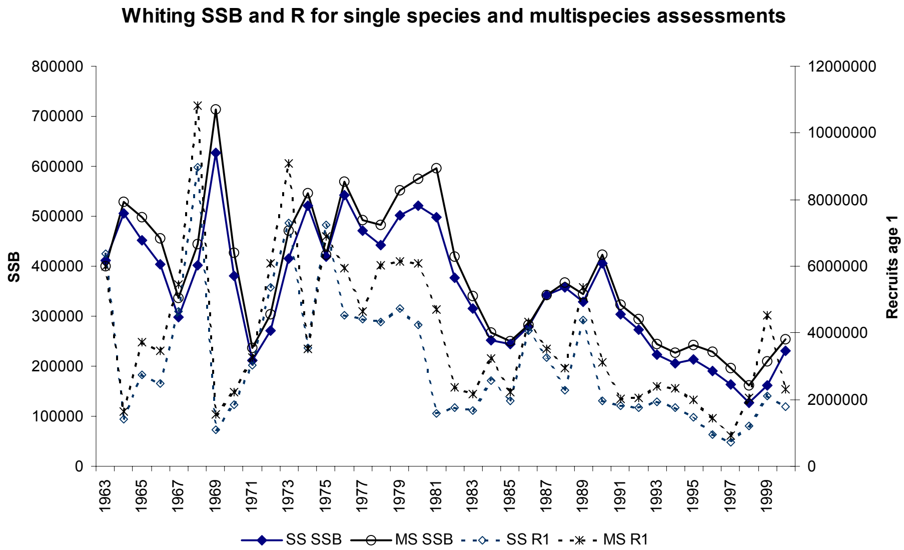
Figure 1.11.3.1 SSB and recruitment for single- and multispecies runs for a) cod, b) haddock, c) whiting, d) sandeel, and e) Norway pout.



a)

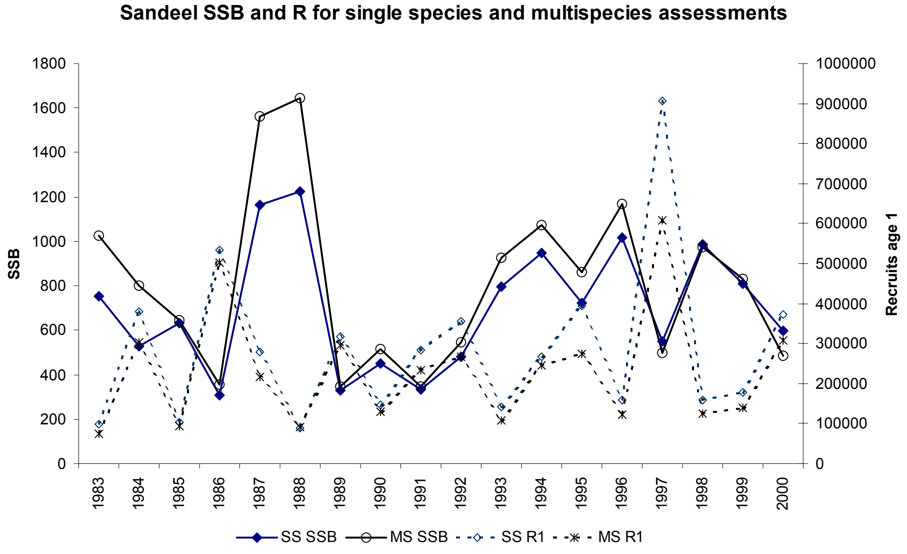


b)

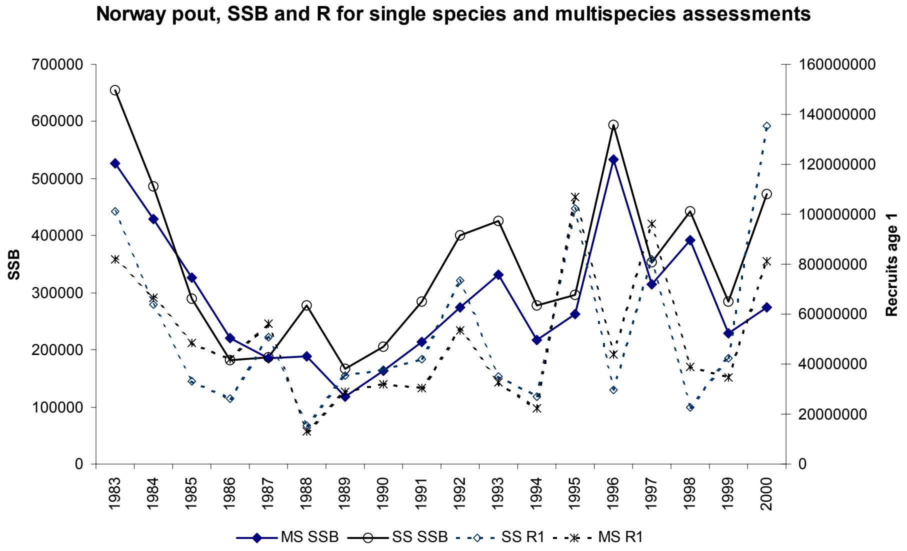


c)

Figure 1.11.3.1. ..continued

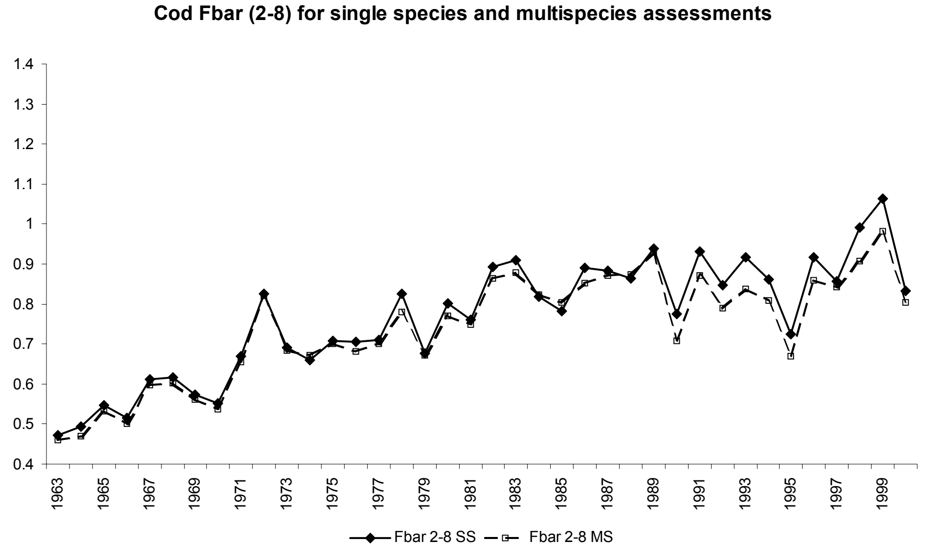


d)

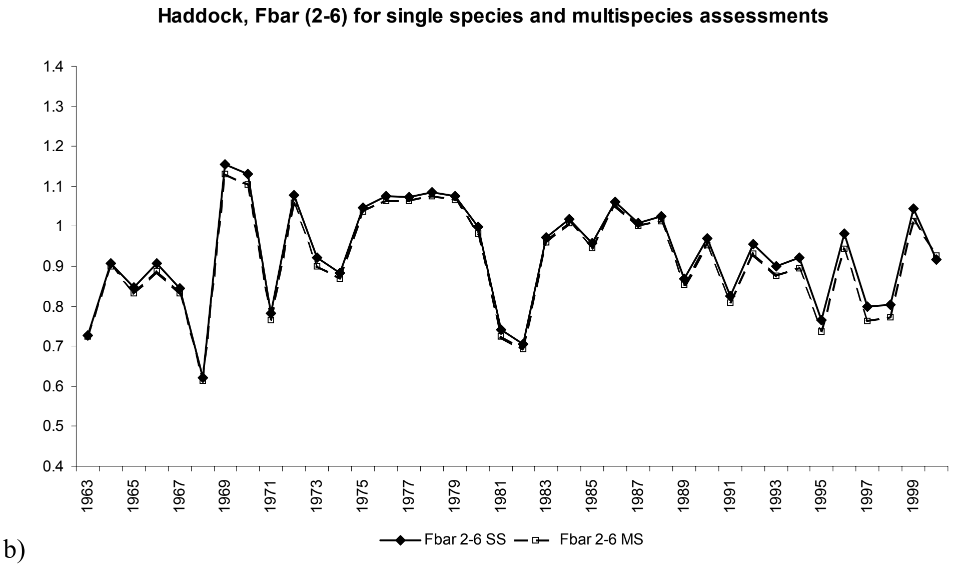


e)

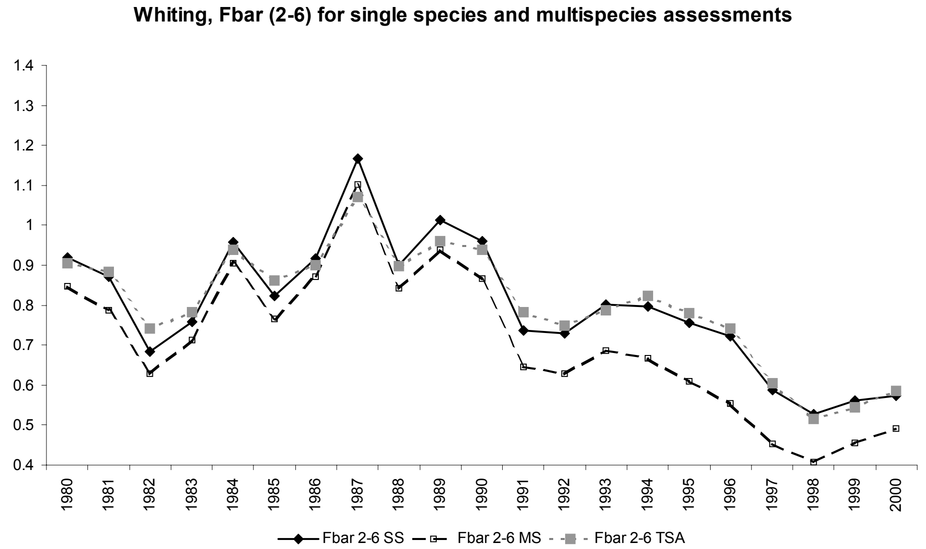
Figure 1.11.3.2 Fbar for single- and multispecies runs for a) cod, b) haddock, c) whiting, d) sandeel, and e) Norway pout.



a)

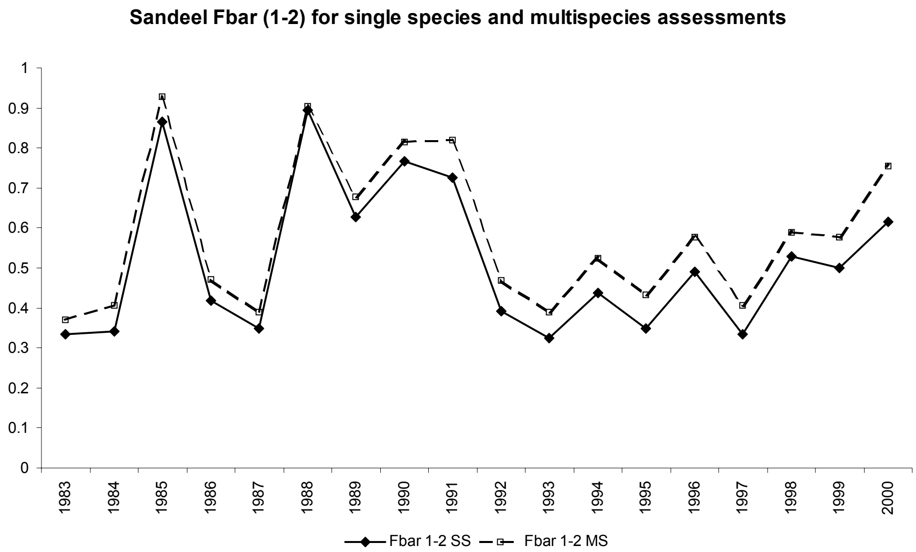


b)

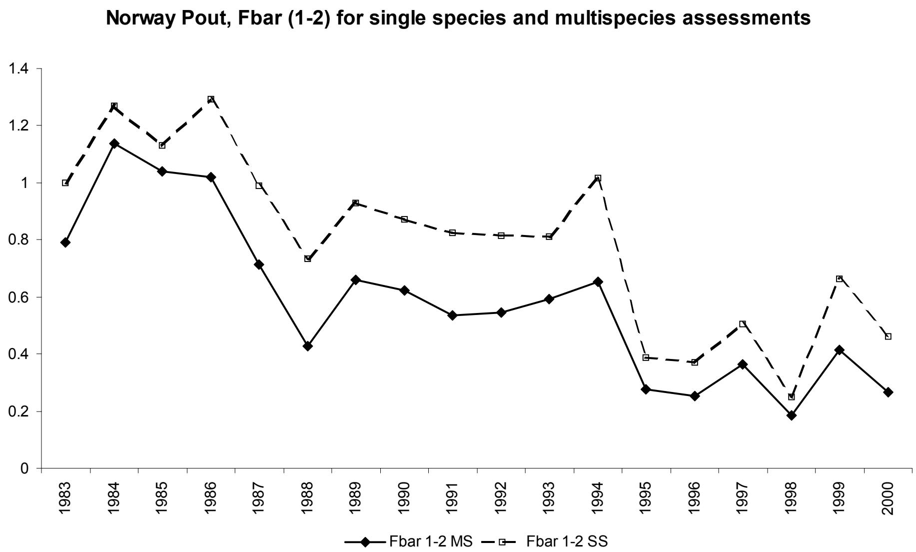


c)

Figure 1.11.3.2. ..continued



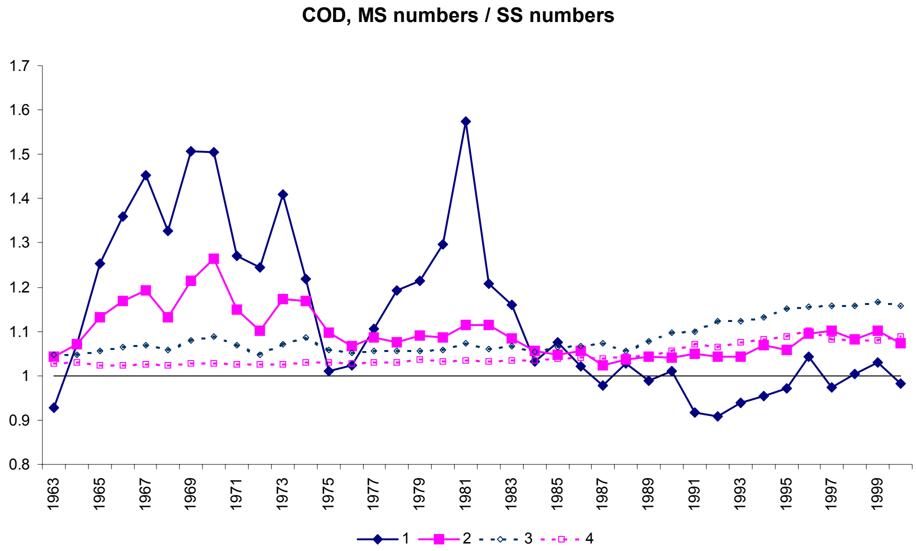
d)

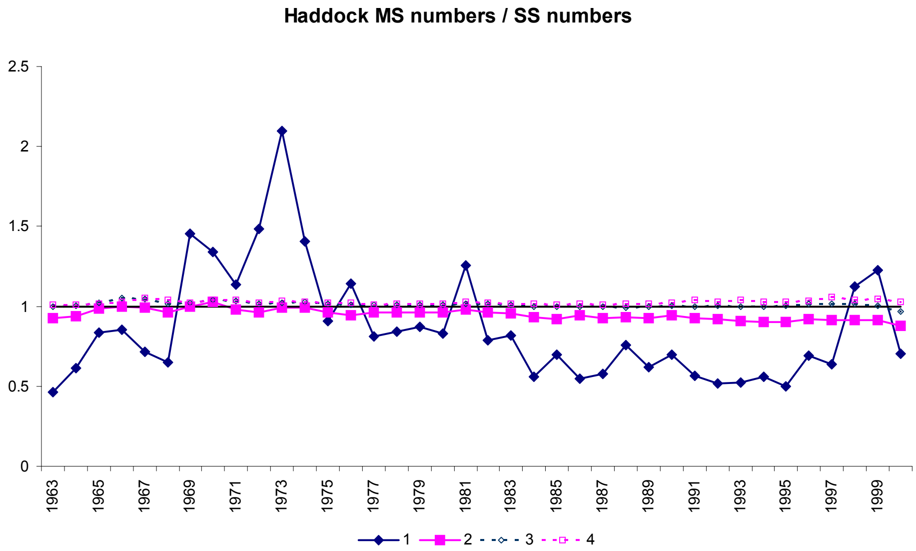


e)

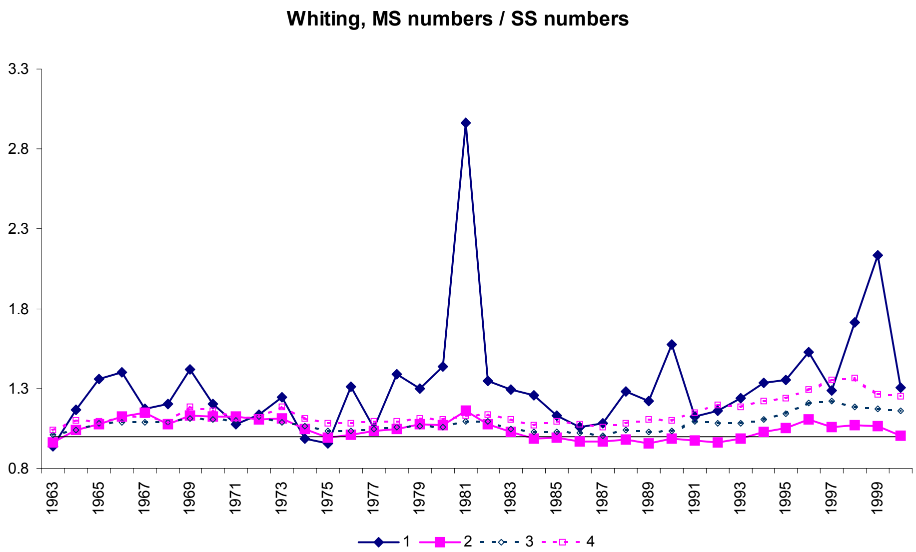
Figure 1.11.3.3. Ratio of numbers between multispecies and single-species assessments for a) cod, b) haddock, c) whiting, d) sandeel and e) Norway pout.

a)



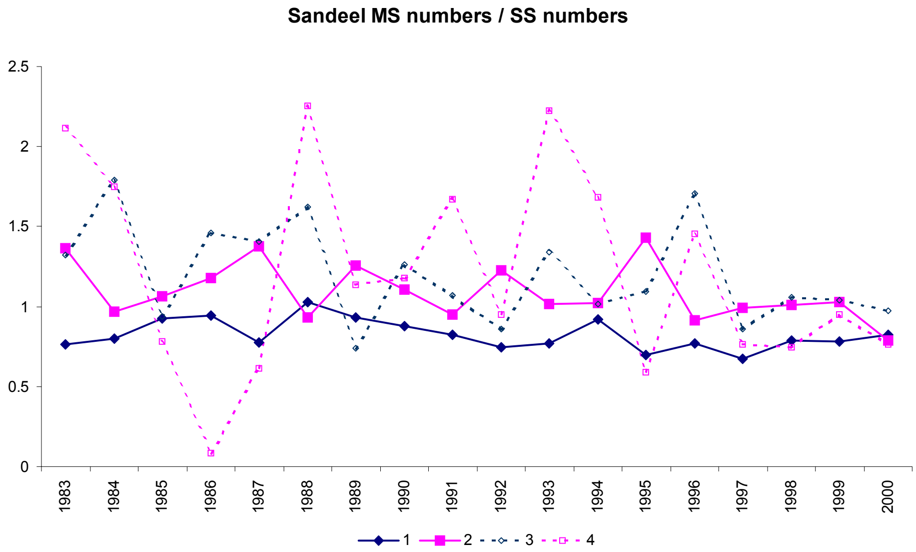


b)

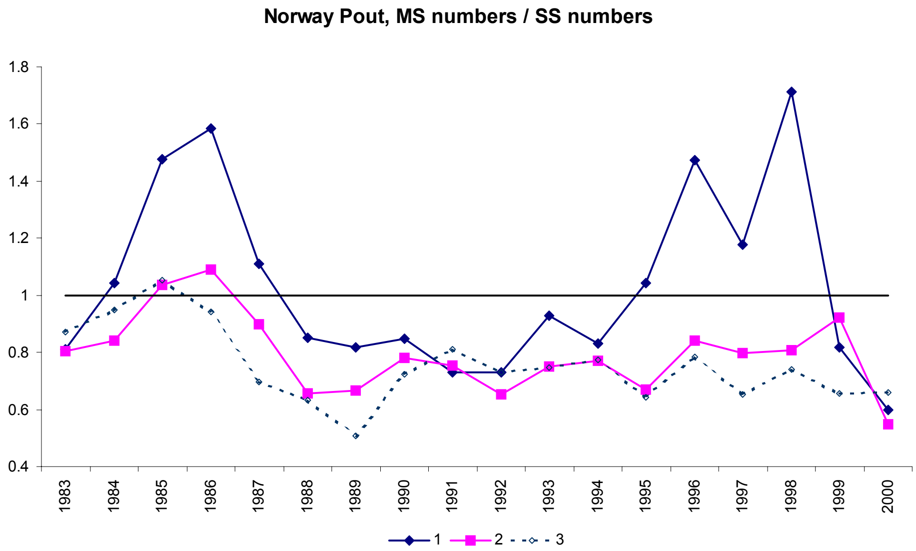


c)

Figure 1.11.3.3. ..continued

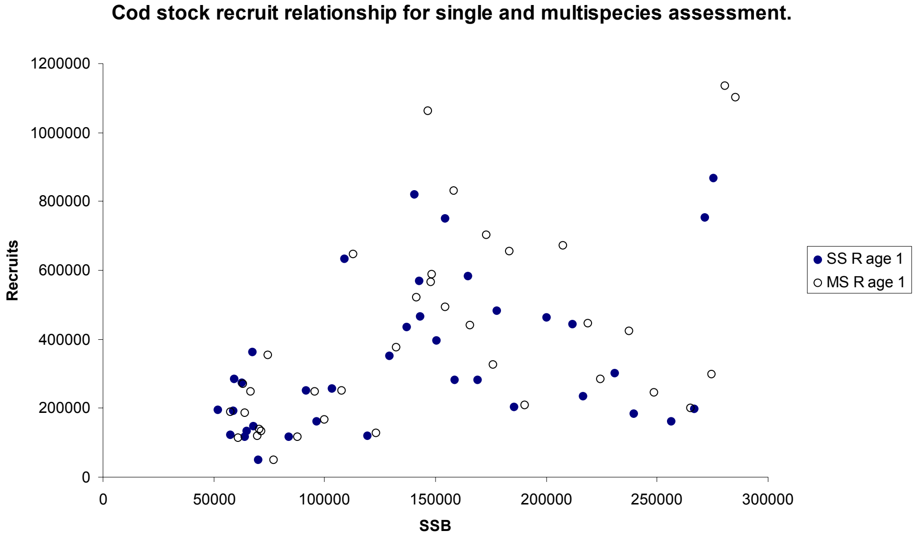


d)

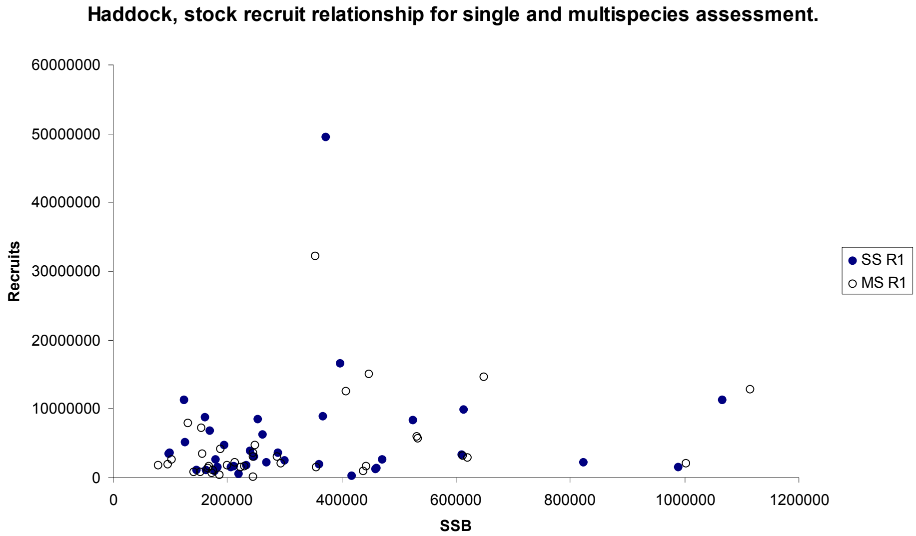


e)

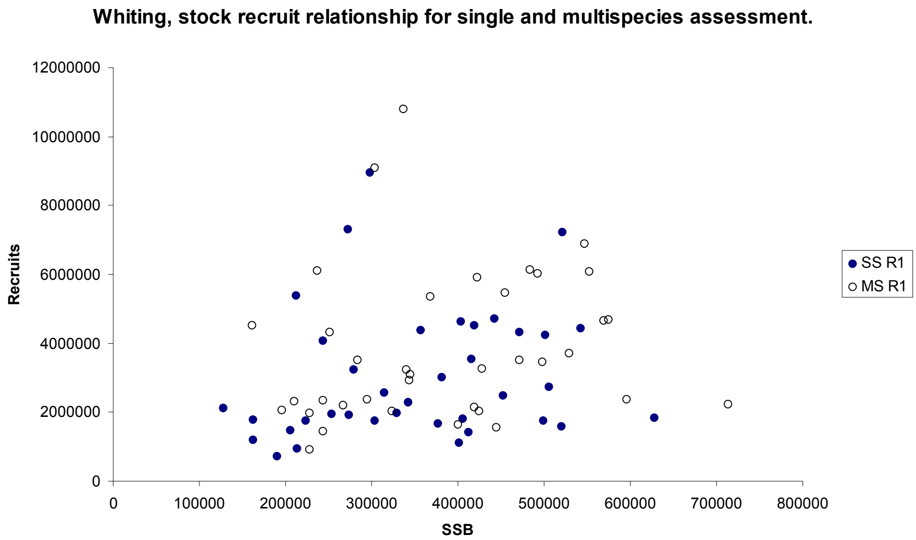
Figure 1.11.3.4. Stock recruit plots for single- and multi-species assessments for a) cod, b) haddock, c) whiting, d) sandeel, and e) Norway pout.



a)

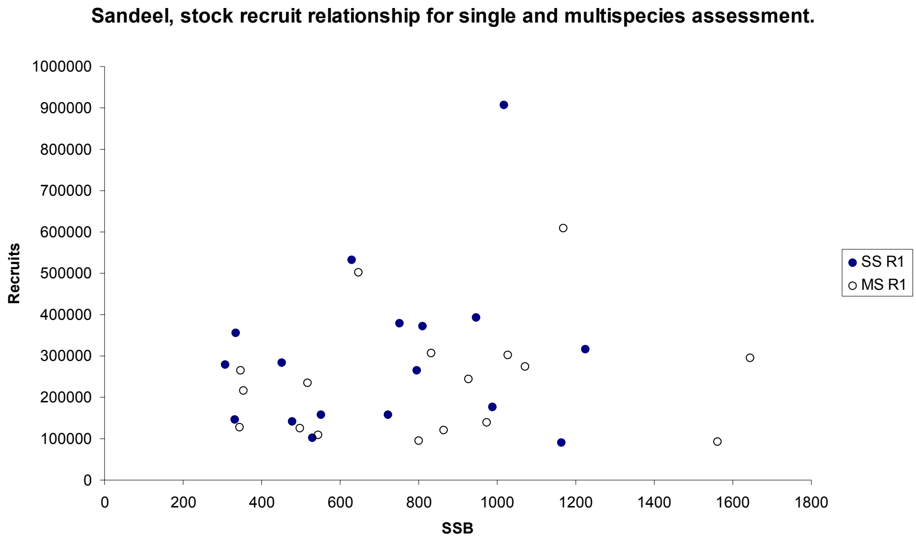


b)

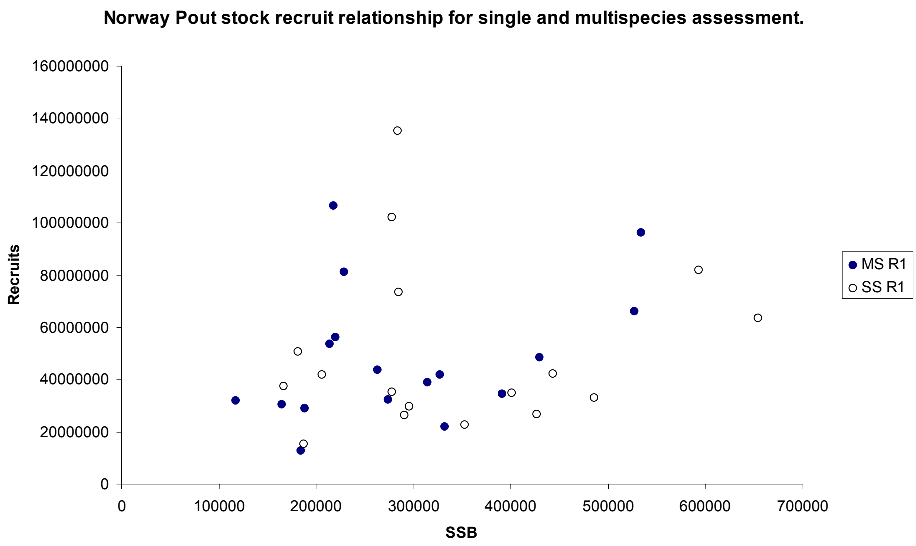


c)

Figure 1.11.3.4..continued.



d)



e)

Figure 1.11.3.5 Annual natural mortality (M1+M2) as estimated by MSVPA and loess smoother fit of observations. a) Cod, b) haddock, c) whiting, d) sandeel, e) Norway pout.

a)

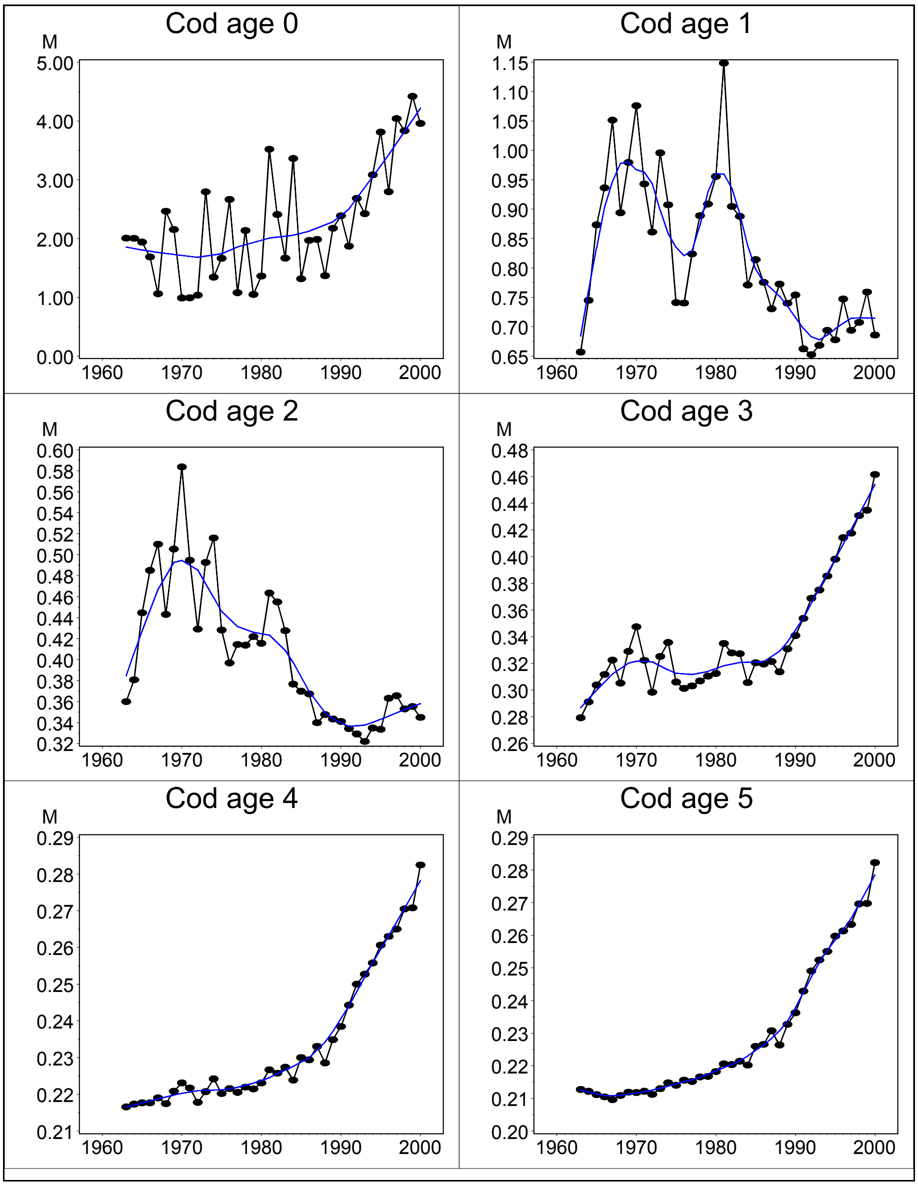


Figure 1.11.3.5..continued

b)

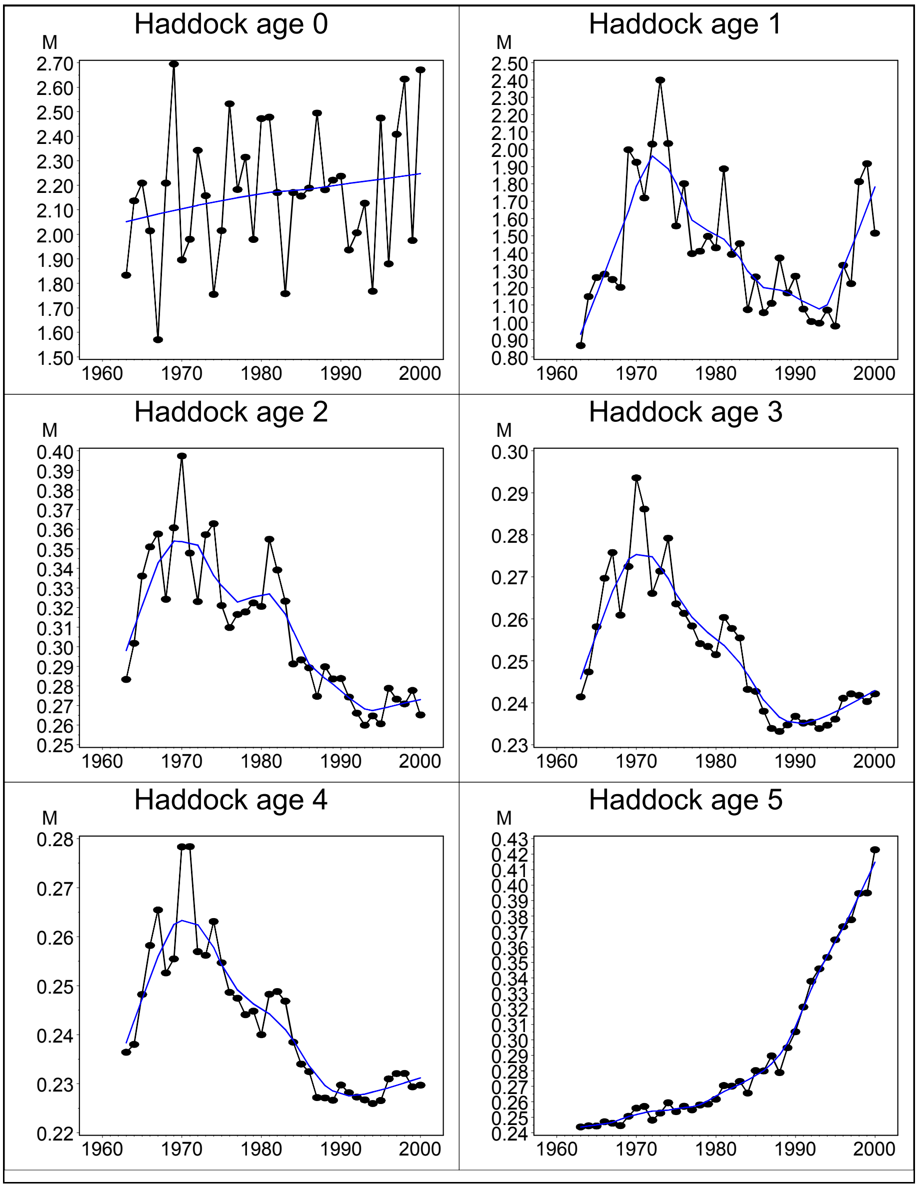


Figure 1.11.3.5. continued

c)

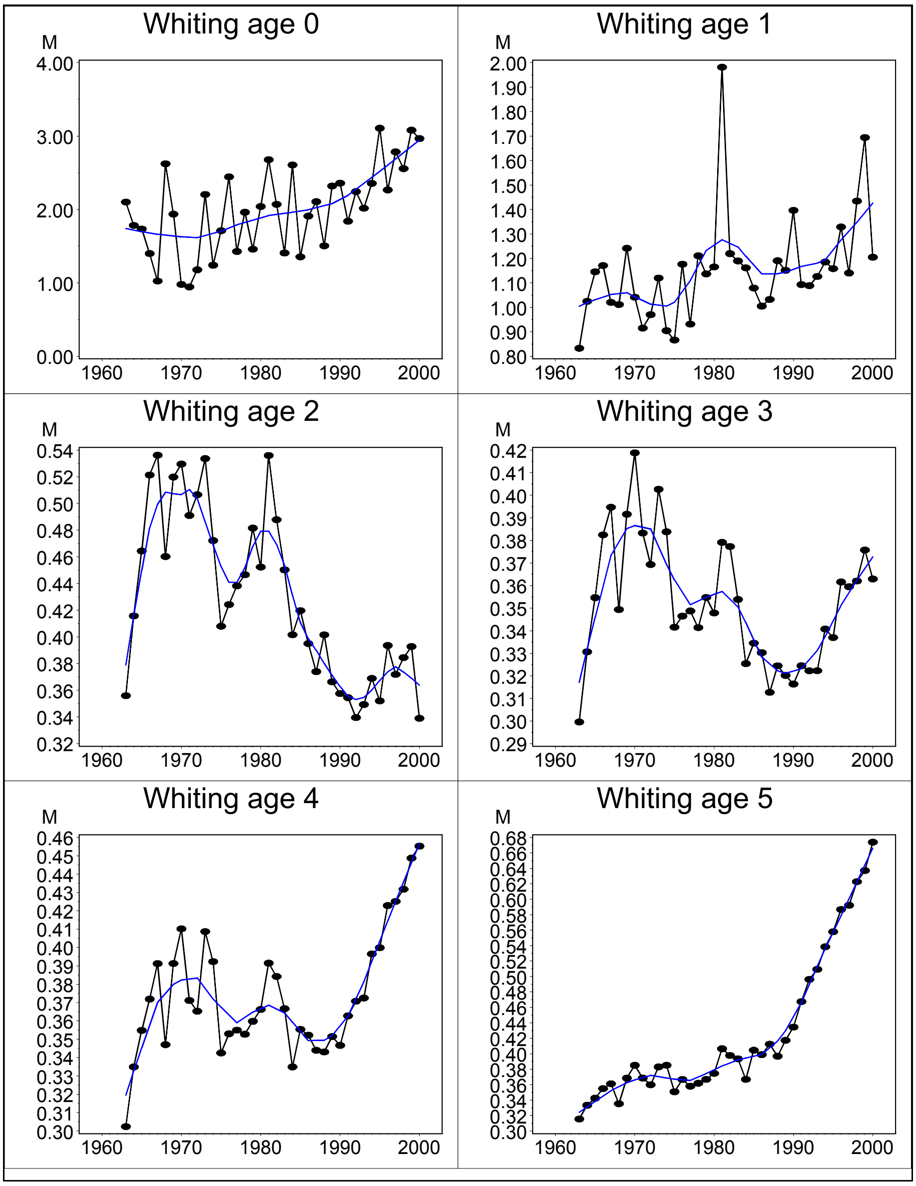


Figure 1.11.3.5..continued

d)

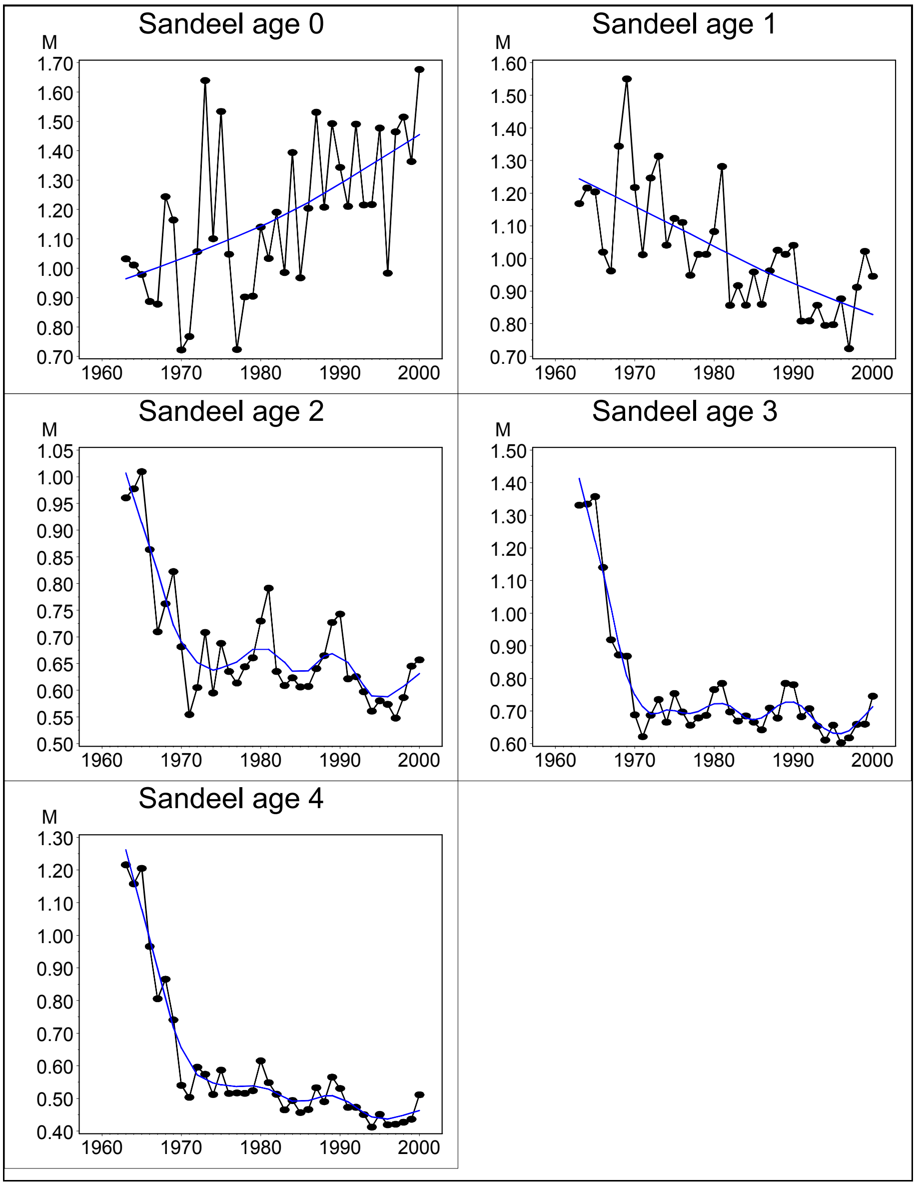
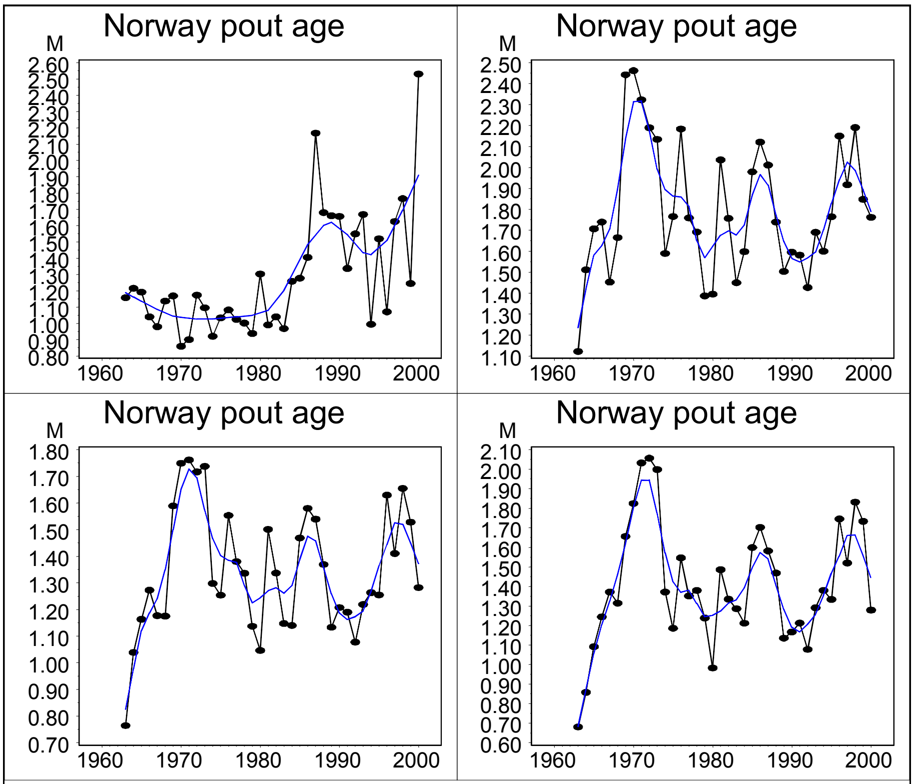


Figure 1.11.3.5 continued

e)



1.12 Quality Control

The WG recognised the need for improved management of procedures for the aggregation of international data for assessments and for developing quality control procedures to assist in this. It was also recognised that there was an increased need to document procedures to allow external scrutiny and peer review of procedures used in preparing data and in running assessments. These requirements have already been widely discussed by a number of groups:

- ICES Study Group on ACFM Working Procedures (SGWP, 2002)
- ICES Planning Group on Commercial Catch, Discards and Biological Sampling (PGCCDBS, 2002)
- ICES Working Group on Southern Shelf Stocks of Hake, Megrim and Monk (WGHMM, 2002)

The WG considered that improvement in the quality control of the WG procedures should be investigated and noted that there are four major areas for improvement:

- Dissemination and documentation of input data
- Standard raising software and data storage
- More time available during WG meetings for in-depth reviews of input data and assessment methodology
- Description of standard methodologies

1.12.1 Quality control of input data

Quality control of input data refers to the first two areas mentioned above. One of the terms of references of the PGCCDBS was to evaluate the need for developing sampling methodology, calculation methodology, data storage procedures, and software for aggregating national catch-at-age data to international catch-at-age data in a form suitable for assessment working groups.

Several recommendations were made by PGCCDBS; the ones relevant for this WG are the following:

- That ACFM was asked to establish PGCCDBS as an annual planning group, to support stock assessment WGs.

- To evaluate sampling in the previous year in terms of:

    - -Spatial & Temporal Coverage

    - -Precision levels (including age reading)

- To establish quality assurance protocols for assessment data.

- That ICES Assessment Working Groups participate in the attempts to secure adequate data for stock assessment by highlighting any particular weaknesses in the quality of the data.

- To support the WG stock co-ordinators in the aggregation of national data sets to provide age compositions and estimates of precision for use in stock assessment. At the same time, records of the procedures used in terms of data aggregation and decisions on allocations should also be derived.

- To provide a tool for the analysis of international sampling results in order to review coverage and sampling effort allocation on a stock basis.

- Software on data storage and raising procedures were presented during the meeting. Software on data storage (BALTCOM) was suggested to be implemented for storage of discard sampling data. Software on raising procedure (VPABase) was suggested to be distributed to the stock co-ordinators to be tested in 2003.

The WG supported the initiatives of PGCCDBS and other groups to establish protocols and software for the aggregation of national and international data. In the meantime it was recognised that there is a need for stock coordinators to develop clearly documented procedures for data aggregation and preparation of international age compositions. The documentation would make the whole process clearer for peer review and would ensure that changes to procedures are clearly identified and documented. It was felt that this approach could be best developed by reviewing the approach to assessing stocks as described in Section 1.12.2.

The computer system to handle fish stock assessment data is part of the ICES quality assurance system and should facilitate the work of the assessment working groups, ACFM, and the ICES Secretariat. This work is part of the advisory process to provide information to the Fisheries Commissions and national and regional governments.

At present, fish stock assessment data held at the ICES Secretariat are aggregates related to total annual catch on a stock level. These stored data are the input data to catch-at-age analysis. The aggregation of national data submitted for fish stock assessment is not documented in the present database system.

There are two main requirements to remedy the current ad-hoc solutions to the age-disaggregated catch data:

1. to develop a database to store the exchanged data
2. to develop software to aggregate data to the appropriate level.

These requirements are also of relevance to the European Commission, whereby the first requirement deals with the issue of evaluating sampling programs, and the latter for application of the data in, e.g., specialists groups meeting in Brussels or elsewhere. However, the range of data types to be exchanged under the EC Regulation is wider than what is foreseen to be the needs of ICES, e.g. the EC Regulation includes economic data. The general aim of the data collection process is to enhance the assessment of changes in fish stocks and in the fisheries. Therefore, data collected under the EC regulation are also of high relevance to ICES for the work on assessing the state of the stocks and to advice on management. Clearly, EC and ICES have common interests in this field.

In 2001 the European Commission (EC) (DG Fish) requested ICES to initiate analysis on a fishery basis as a supplement to the currently used stock basis. The data currently collected and stored at the ICES Secretariat are not in sufficient detail to allow ICES to meet the EC request, and data disaggregated by fleet and season will need to become part of the international assessment data. But analysis on a fishery basis also requires enlargement of the database with new data types (effort and geographical distribution of fleet by season).

Data need to be aggregated nationally before they can be useful for international stock assessment. This was the overall conclusion from the EC-funded project EMAS (Pastoors et al., 2001). The reason is that the sampling procedures in different countries have very different characteristics, adapted to the local circumstances, the availability of sampling options and the behaviour of the fishery. The project also concluded that there is no obvious method available for standardization of sampling procedures.

FAO is developing a system called Fisheries Global Information System (FIGIS). The objective of this system is to create a web portal that presents information on fisheries on a worldwide scale. FIGIS includes a module called Fisheries Information Resource Management System (FIRMS) that focus on presentation of information on status and trends in fish stocks (resources). ICES participates in FIRMS and plans that fish stock assessment results and fisheries management advice shall be presented on both the ICES website and on the FIGIS portal.

1.12.2 Quality control of assessments

The WG considered that it is desirable to split the workload of the group up into two different types of assessments:

- Benchmark assessments: in-depth review of the basic input data and assessment methodology for a given stock.

- Update assessments: rolling over the benchmark assessments by updating with new data.

For example, some stocks could be fully-assessed once every three years. The year for benchmark assessment could be planned and agreed by the WG and ACFM. For other years, the stock would be updated. Clearly any stocks under recovery plans, or those with particular data or model problems, would need more frequent benchmark assessments.

Benchmark assessment: as now, 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 similar to present. Much of this information could be used to develop quality documentation. Once a benchmark assessment has been carried out, a description would be prepared of the standard procedures which should be used for that stock. These would include a description of the input data and the way they are collected and collated, and a description of the standard assessment settings. The standard procedures will be documented in an appendix to the WG report.

Update assessment: update data sets, carry out a standard assessment and short-term forecast according to protocols agreed in the bench marks. Report to contain a short text on the updated data and results of the assessment and forecast only, and associated tables/figures. So no data screening, trial runs, stock-recruitment relationship fitting, or medium-term projections.

This would require a different approach to the WG which would be more in line with the kind of working procedures in the ACFM subgroups. Members of the WG would be reviewers of data and assessment methodology and not be uniquely linked to certain stocks.

1.12.3 Feasibility

The WG considered that in it's current meeting, the following stocks would be acceptable for interim assessments:

- Sole in IV
- Haddock in IV
- Sole in VIId
- Plaice in VIId

However, it is recognized that many of the fisheries considered by this WG are recruitment fisheries, whereby the incoming year classes can have a very big impact on the stock perception. This implies that all stocks would require recruitment estimates and forecasts to be made annually, but it would not be necessary to make a detailed review of the input data and trial assessments for the benchmarked stocks. The time saved could be used to look in depth at a restricted number of stocks each year and review, update, or develop quality handbooks for all stocks.

The WG proposes to start the new working procedures at its meeting in June 2003.

1.13 Recommendations

1.13.1 Analysis of maturity data

In WGNSSK maturity ogives are generally based on historical biological information and kept constant over the whole time period of the assessment. For a number of stocks a knife-edge maturity ogive has been assumed.

Maturity data are sampled for most stocks every year, but new information on maturity has not been considered in the assessment procedure. The maturity stage of individual fish is evaluated by visual inspection of the gonads for most stocks by using a four-stage maturity key (1=immature; 2=ripening; 3=spawning; 4=spent). However, a correct classification of fish maturity by visual inspection is often difficult and the interpretation could vary between observers, especially if the gonads are sampled some months prior to spawning (Kjesbu, 1991). Fish classified as maturing (stage 2 in the ICES maturity key) during the spawning period are supposed to spawn in the current reproductive season, although it has never been demonstrated. If not all these individuals will spawn within that season the spawning stock biomass (SSB) will be overestimated.

ICES provides advice on the management of fish stocks on the basis of biological reference points which are defined for the fishing mortality (F) and spawning stock biomass (SSB). The reference points for SSB have been estimated assuming fixed maturity ogives. However, if maturity can be shown to change over time, it may be more appropriate to revisit the biological reference points and to incorporate this information, as this may give a different perspective of the stock developments.

The Working Group therefore recommends:

- Currently available information on maturity from market sampling and research surveys be collated and made available to SGGROMAT.

- A research program be formulated with the aim to study seasonal development of gonads for different species and ages.

- A maturity scale for classifying gonads into a number of maturity stages based on histological criteria be developed. The results of such research would be used to revise the macroscopic maturity scale and help to define the proportion of the maturing individuals likely to reproduce in the current spawning season and thus contribute to the reproductive potential of the stock.

- An ICES workshop be held to calibrate the interpretation of the different maturity stages and to provide estimates of maturity-at-age for different stocks. The consequences for stock assessments should be explored in the workshop.

It is envisioned that the new maturity estimates could be taken further by SGGROMAT in order to evaluate, e.g., the effects on biological reference points.

1.13.2 Analysis of survey data for North Sea whiting

It has been observed that there are different population-trend signals in the available North Sea whiting surveys. The English and Scottish groundfish surveys (and, to a lesser extent, the French groundfish survey) appear to be in accord, while the IBTS Q1 survey is more consistent with the catch-at-age data. Without a more detailed analysis of the methodology and characteristics of these surveys, it is difficult to know which is the most representative of whiting population dynamics: there are no empirical diagnostics on which to base such a decision.

The Working Group recommends that an intersessional group should try to resolve the apparent conflict between surveys.

1.13.3 Formatting of the report

The WG has made tried hard to prepare a readable and clear report. This took a lot of work which could be classified as secretarial rather than scientific. The WG recommends that more secretarial assistance be given, notably on the formatting of the report and the conversion of Excel tables and figures into Word.

1.13.4 Meeting room

The WG considers that the meeting room (Castle room) is not suitable for a meeting with over 20 persons when microphones are not available. The WG recommends that a microphone installation be acquired for the ICES meeting rooms.

1.13.5 Photo-copying

The Working Group recommends that ICES changes its organization of printers and photo-copying machines. The amount of time spent on waiting for and debugging the copying machines is considered to be disproportionate. Also it was noted that as soon as the ICES staff left, the machines would invariably stop functioning properly.

Therefore, the WG recommends ICES to make high volume printers available that could be operated as photocopying machines at the same time. If these allow printing of double-sided stapled documents, the waiting time would be reduced, the environment would be enhanced (less paper), and the WG members would be less frustrated.

2 OVERVIEW

2.1 Stocks in the North Sea (Subarea IV)

2.1.1 Description of the fisheries

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

Each fishery uses a variety of gears. Human consumption fisheries: otter trawls, pair trawls, seines, gillnets, 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. It is not clear to what extent this stagnation is caused by adverse economic results or effort reduction programmes. Effort in some fleets may vary between years because they harvest areas other than the North Sea, as a result of the depletion of the traditional resources of the North Sea.

The trends in landings of the most important species landed by all fleets during the last 30 years, as compiled by the WG, are shown in Table 2.1.1 and in Figure 2.1.2. The human consumption landings have steadily declined over the last 30 years, with an intermediate high in the early 80's. The landings of the industrial fisheries are fluctuating around 1 million t over the years. These landings show the largest annual variations, probably due to the short life span of the species. The total demersal landings from the North Sea reached over 2 million t in 1974, and have been around 1.5 million t in the 1990s.

Figure 2.1.3. shows the landings by country and fleet segment for the human consumption fisheries. Fleet and gear codes are given in Table 2.1.4. Most of the human consumption landings are from the Dutch beam-trawl fishery harvesting plaice and sole (> 140 000 t) and from the Scottish fishery harvesting cod, haddock, and whiting (> 100 000 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 taken by different fleet segments, with the exception of gill-netters which may potentially target any of these groups of species. The fisheries landing saithe have a low impact on the others. However, the fisheries non-directed at 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 comprise other regions adjacent to Subarea IV. Thus, combined assessments were made: for cod including IIIaN (Skagerrak) and VIId, for haddock and Norway pout including IIIa, for whiting including VIId, and for saithe including IIIa and VI. Sandeel stocks at Shetlands and in IIIa are dealt with separately.

Biological interactions are not 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 values for demersal stocks are 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.

Towed nets except beam trawls

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

- ***Nephrops* fishing.** It is possible to use a mesh size in range 70-109 mm, provided catches 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. However, this exemption does not apply to Norwegian waters, where 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 at least 50% of the catches consist of a mixture of haddock, whiting, plaice sole, lemon sole, skates, and anglerfish, and no more than 25% consist of cod.

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

Beam trawls

- **Northern North Sea.** It is prohibited to use any beam trawl of mesh size range 32 to 119 mm in that part of ICES Subarea IV which is 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 % 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 140 mm when targeting cod, that is when the proportion of cod catches exceeds 30% of the total catches.

2.1.2.3 Closed areas

Twelve-mile-zone. Beam trawling is not allowed in a 12 nm-wide zone along the British coast, except for vessels 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 8 m 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-mile-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 an 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.

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 have been 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 occurs in most human consumption fisheries, particularly when strong year classes approach the commercial size limit (e.g. haddock in 2001).

In a number of the recent years, there are indications that substantial underreporting of roundfish and flatfish landings is likely to have occurred. There are indications that this is likely to have happened for cod in 2001.

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

Of the species considered in this report, only whiting used to be subject to a significant by-catch in the industrial fisheries. This 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 SSB and F are presented in Figures 2.1.4 and 2.1.5.

Reported landings of cod in 2001 (50 000 t) were the lowest on record, as was the spawning stock with 30 000 t. 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 is fluctuating at a low level. Fishing mortality is very high. The scarcity of the stock resulted in the implementation of a recovery plan in 2001.

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 resulted in the highest level of discarding observed since 1976, which dominated the human consumption landings (41 000 t). Nevertheless, the spawning stock could recover to 211 000 t in 2001, due to the maturation of the 1999 year class. Fishing mortality is at a high level.

The human consumption yield of whiting in 2001 was 50 000t, which is the lowest level observed in the time-series. Discard levels observed in 2001 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 rise 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 at a low level compared to the seventies when recruitment was higher. Landings in 2001 were 98 000 t, slightly more than the record low of the previous year, but still on a low level. The restricting TAC may have resulted in discards in 2001. Fishing mortality has declined considerably since 1986 and remains at a low level, while the spawning stock is on an upward trend since 1990. The decrease observed in F is due to the reallocation of fishing effort towards other areas and species (e.g. deep-water species in VI and VII).

Landings of sole were at high levels in the early 90’s but decreased to a historic low of 15 000 t in 1997, rising to 23 000 t in 1999 and 2000. The 20 000 t landings in 2001 thus constitute another decline. Fishing mortality varies on a historically high level and is recently lower than the record peak in 1996. The spawning stock was at a record low of 25 000 t in 1998 but went up thereafter. All the recovery signals are due to the entry into the fishery of the strong 1996 year class, the effect of which tends to fade out now.

The spawning stock of plaice has been decreasing steadily until arriving at its lowest observed level in 1997, but it has appeared to rise since then. Landings have fallen since 1990 to 71 000 t in 1998, and are still low with 82 000 t in 2001. Fishing mortality in the most recent three years is lower than the record-high level in the 90’s. The strong 1996 year class is contributing substantially to yield and spawning stock, but the benefits are reduced because of the retarded growth and heavy discarding of that year class. Fishing mortality is lower recently than in the mid-90’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 of 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 of 819 000 t. In 1997 the combined Danish and Norwegian landings of more than 1 million t was the highest ever recorded. Landings in 2001 for Norway and Denmark were 810 000 t (Table 2.1.2), which is just below the average for the period 1986-2000. The sandeel fishery in 2001 had rather low catches in the first half-year, where mainly 1-group and older fish are targeted. However, in the second half of the year there were very high catches of the 0-group sandeels. The catches for 2002 are not included in this assessment, however, provisional Danish landings statistics for the period until the end of May show very high landings. Danish landings were at 446 000 tonnes, compared to a mean value of 320 000 t in the same period for the years 1998-2001.

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 200 000 t, based on fishery on the strong 1999 year class. Landings in 2001 decreased to around 65 000 t, which are the lowest landings since 1966. The effort was also historically low in 2001.

Trends in effort of the Norwegian and Danish small-meshed fishing for Norway pout and sandeel are shown in Figure 2.1.1. The effort of the sandeel fleet gradually decreased from 1989 to 1994, increased from 1994 to 1998, and decreased from 1998 to 2000. In 2001 there has been a small increase in effort compared to 2000. 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 declined. The effort in the Norway pout fleet has decreased gradually from 1993 to 2001, except for a small increase in effort from 1988 to 2000. In 2001 the effort in the Norway pout fishery reached a historic low level (Figure 2.1.1).

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 a 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.

As in previous years, the predominant part (1 676 000 t or 94%) of the total landings in 2001 was taken in the directed fishery and 104 000 t taken as by-catch in other fisheries such as the Norway pout fishery. 4 000 t of the by-catch of blue whiting is taken in the North Sea (Table 2.1.5).

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 is taken as by-catch uses trawl with mesh sizes between 16 and 36 mm. The directed fishery caught 44 600 t mainly in Divisions IIa, Iva, and Vb, with small catches from Divisions VIa and VIIc. By-catches of blue whiting (8 700 t) are caught mainly in the Norway pout fishery in the North Sea and in the Skagerrak. Some blue whiting by-catches are also taken during the human consumption 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 2001. In addition, through international agreements, 190 640 t in the EEZ of EU and 47 000 t in the Faroese zone were made available to the Norwegian fishery. The total quota for Norwegian vessels in 2001 was 487 640 t.

In addition young blue whiting are fished by Norway as by-catch in other fisheries in the North Sea (areas south of 64^{o}N). An estimated catch of approximately 70 000 t was taken in this fishery in 2001.

2.1.4.5 Stock impressions

Trends in F and SSB for sandeel and Norway pout are given in Figures 2.1.4 and 2.1.5.

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 2000 and 2001 has increased to 200 000 t and 340 000 t to reach a similar level as in 1996 because of the strong 1999 year class. Fishing mortality has generally been decreasing since 1974. In 1995-1998 the fishing mortality fell to about 0.4 compared to the level of about 0.6 in 1988-1994. In 1999 and 2000 the fishing mortality increased again to a level around 0.5-0.6. In 2001 the fishing mortality reached a historically minimum just below 0.2.

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 2000. There is a general pattern of a large SSB being followed by a low SSB. This is caused by a 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 spawning stock biomass at the start at 2001 is estimated to 620 000 t, about the same level as in 2000 and below the long-term average. The number of recruits for the 2001 year class was estimated at 5 340*10^9, which is more than twice the estimate for 1996, the year with the highest recruitment for the time period 1989-2000. The high recruitment of 0-group sandeels in 2001, as estimated in the XSA from commercial CPUE, is confirmed by the large fishery for 0-group sandeels in the second half of 2001.

2.1.4.6 By-catches in industrial fisheries

By-catches of haddock, whiting, and saithe in the industrial fisheries are presented in Table 2.1.2 for the years 1974-2001. For the last five years quarterly data are presented. In 2001 the combined by-catch of haddock, whiting, and saithe was about 16 000 t, which is well below the average of 62 000 t in the period 1974–2001.

Fishing mortality on haddock due to the industrial fisheries was generally very low throughout the 1990s, but has increased in the last two years. This pattern is not as apparent for whiting, where industrial fishing mortality fell in 2001 after having risen in 2000.

It should be noted that the Norwegian landings of Norway pout given in Table 2.1.2 include by-catches of Norway pout in the small-meshed fishery for blue whiting, whereas the figures given in Section 12.1.1 are landings in the Norway pout fishery. Note also that the Norwegian landings of sandeel in Table 2.1.2 as compared to in Section 13.1.1 are without by-catches. Detailed catches of "other" species mentioned in Table 2.1.2 are for the period 1984-2001 given in Table 1.7.1.

Area distribution of industrial landings and associated by-catches of selected species from the North Sea in small-meshed fisheries by Denmark and Norway, divided by fishery (target species), is shown in Table 2.1.3. These data are for four small-meshed fisheries in 2001 divided in relation to two areas in the North Sea, north and south of 57 degrees N. This table is based on Danish and Norwegian estimates. In the northern area, the Norwegian fishery for Norway pout is associated with by-catch of blue whiting. The Danish fishery for blue whiting is included in the "other" fishery. There is a by-catch of totally 11 000 t of haddock, whiting, and saithe in the combined small-meshed fisheries in the northern area. In the southern area the by-catch of these species is totally about 6 000 tons. The by-catch of cod is generally low. The sprat fishery has had increasing landings since 1996 and has a by-catch of mainly herring and in the southern area also sandeels.

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

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

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

The industrial fishery is a small-mesh trawl fishery mainly carried out by vessels of a size above 20 m. This fleet component has also decreased over the past decade. The most important fisheries are those targeting sandeel and Norway pout. There is also a trawl fishery landing a mixture of species for reduction purposes. A description of the industrial fishery is given in Table 2.2.1.

There are important technical interactions between the fleets. 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 1.4.6. 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 show close affinities to the North Sea stocks: cod, haddock, whiting, plaice, and Norway pout.

The landings of cod in Division IIIa were 11.6 thousand tonnes in 2001 in the human consumption fishery, which is the lowest on record. 60% 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 Sea Working Group.

Landings of haddock in Division IIIa, in the human consumption fishery, amounted to 2.1 thousand tonnes. Most of the catches are taken in Skagerrak. Haddock in IIIa is assessed together with the North Sea (Division IV) stock.

Landings of whiting for human consumption were about 120 tonnes in 2001, which is half the amount reported last year. Official landings have steadily decreased since 1992, except for the landings in 2000. Most of the landings are taken in Skagerrak. No analytical assessment of whiting in IIIa was possible.

Landings of saithe in Divisions IV and IIIa were about 90 thousand tonnes in 2001, which is slightly above the landings last year, the lowest on record since 1989. The saithe assessment comprises Divisions IV, IIIa, and VI.

The plaice landings in Division IIIa amounted to 11.5 thousand tonnes in 2001, which is 30% higher than last year and almost reached the TAC level of 11.7 thousand tonnes. Historically, TAC has not been restrictive for this stock. About 80% of the landings were taken in Skagerrak. Plaice in IIIa is assessed as a separate stock.

The sole landings in Division IIIa are mostly taken in Kattegat and this stock is assessed by the Baltic Fishery Assessment Working Group. Landings data are available in the report of 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, Norway pout, herring, and sprat (Table 2.2.1). Data was provided by Denmark and Sweden for the years 1999-2001. All other years refer to data provided by Denmark only. The landing figures point out that landings in 2001 are below mean landings (1989-2001) for all species except for sprat. The Norway pout assessment comprises Divisions IIIa and IV. Sandeel in Division IIIa was not possible to assess.

2.3 Stocks in the Eastern Channel (Subarea VIId)

2.3.1 Description of the fisheries

Flatfish: The main feature of the flatfish fisheries in VIId are their importance to small (<10 m) 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 the 1980s and the 1990s (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.

2.3.2 Data

a) French effort and CPUE data were provided for 1999 and revised for 2000. There are no data routinely collected for the level of discarding on any of the main species from VIId, but levels are probably similar to the North Sea where average discards across all fleets by number appear to be very high for plaice and relatively low for sole.

b) Catch-at-age: French fleets are responsible for the major landings of cod, whiting, sole, and plaice, taking around 80-95% of the roundfish species and between 45 and 60% of the flatfish. Sampling for flatfish species was poor before 1986, but has improved since then. Quarterly sampling for age and sex is taken, and is thought to be representative of more than 80% of the landings of flatfish.

c) Surveys: There is a 4th quarter research vessel survey (GFS) which is used in tuning for whiting and plaice. A research vessel survey using beam trawl which covers most of VIId in August (BTS) is used in tuning sole and plaice. The two inshore surveys for 0- and 1-gp sole and plaice along the English coast and in the Baie de Somme on the French coast have been combined in a single international survey (YFS).

2.3.3 State of the stocks

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

Sole: The stock is considered to be within safe biological limits. The SSB is well above $\mathbf{B}_{pa}$ (8 000 t) following improved recruitment in recent years, particularly of the 1996, 1998, and 1999 year classes. However, the 1999 year class is not well established yet. There is considerable uncertainty about the substantial decrease in F in 2001. This decrease is not supported by a downward trend in effort. There exists also a tendency to underestimate F.

Plaice: The stock follows the pattern of a general decline in plaice stocks observed in other areas up to 1997. Since then SSB shows a quite stable figure but is below its precautionary reference level for the last two years, and F decreased in 2001. Recruitment remains close to mean levels since the strong 1996 year class, but there is some evidence that the 2000 year class may be above average. The state of the plaice stock in VIId depends both on the strength of this 2000 year class and on the persistence of the lower fishing mortality.

2.4 Overview of Industrial Fisheries in Division VIa

There are two distinct industrial fisheries operating in Division VIa; a Norway pout fishery and a sandeel fishery. The Norway pout fishery is predominately Danish, whereas the sandeel fishery is almost exclusively Scottish and operates in more inshore areas. No information is available on by-catches in the Norway pout fishery. The sandeel fishery has a small by-catch of other species; information from the 1995 and 1996 catches indicates that in excess of 97% of the catch consisted of *Ammodytes marinus*, with the by-catch consisting mostly of other species of sandeel. Landings from both fisheries are small compared to the fisheries in the North Sea. Landings of sandeel from VIa were very low in 2001, reflecting reduced effort in the fishery.

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

Year	cod	haddock hc	haddock ib	whiting hc	whiting ib	saithe hc	saithe ib	sole	plaice	Norway pout	sandeel	h cons total	industrial total	total
1970	226	525	180	83	115	163	59	20	130	238	191	1147	783	1930
1971	328	235	32	61	72	218	35	24	114	305	382	980	826	1806
1972	354	193	30	64	61	248	28	21	123	445	359	1003	923	1926
1973	239	179	11	71	90	229	31	19	130	346	297	867	775	1642
1974	214	150	48	81	130	267	42	18	113	736	524	843	1480	2323
1975	205	147	41	84	86	271	38	21	108	560	428	836	1153	1989
1976	234	166	48	83	150	295	67	17	114	437	488	909	1190	2099
1977	209	137	35	78	106	217	6	18	119	390	786	778	1323	2101
1978	297	86	11	97	55	163	3	20	114	270	787	777	1126	1903
1979	270	83	16	107	59	134	2	23	145	329	578	762	984	1746
1980	294	99	22	101	46	142		16	140	483	729	792	1280	2072
1981	335	130	17	90	67	145	1	15	140	239	569	855	893	1748
1982	303	166	19	81	33	185	5	22	155	395	611	912	1063	1975
1983	259	159	13	88	24	197	1	25	144	451	537	872	1026	1898
1984	228	128	10	86	19	214	6	27	156	393	669	839	1097	1936
1985	215	159	6	62	15	222	8	24	160	205	622	842	856	1698
1986	204	166	3	64	18	202	1	18	165	178	848	819	1048	1867
1987	216	108	4	68	16	177	4	17	154	149	825	740	998	1738
1988	184	105	4	56	49	140	1	22	154	110	893	661	1057	1718
1989	140	76	2	45	36	117	1	22	170	168	1039	570	1246	1816
1990	125	51	3	47	50	100	8	35	156	152	591	514	804	1318
1991	102	45	5	53	38	115	1	34	148	193	843	497	1080	1577
1992	114	70	11	52	27	104		29	125	300	855	494	1193	1687
1993	122	80	11	53	20	118	1	31	117	184	579	521	795	1316
1994	111	80	5	49	10	115		33	110	182	786	498	983	1481
1995	136	75	8	46	27	124	1	30	98	241	918	509	1195	1704
1996	126	76	5	41	5	120	0	23	82	166	777	468	953	1421
1997	124	79	7	36	7	110	3	15	83	170	1137	447	1324	1771
1998	146	77	5	28	3	107	3	21	71	80	1004	450	1095	1545
1999	96	66	4	30	5	114	3	25	81	92	735	412	839	1251
2000	71	47	9	28	8	88	6	23	81	184	699	338	906	1244
2001	50	41	8	25	7	95	3	20	82	66	862	313	946	1259

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
Mean 1974-2001	730	202	64	252	59	13	40	9	35	1398
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

Table 2.1.3 Distribution of landings and associated by-catches of selected species ('000 t) form the North Sea small-meshed fisheries in 2001 by Denmark and Norway north and south of 57ºN

Area	Fishery (target species)	Species composition: Norway pout	Sandeel	Sprat	Herring	Haddock	Whiting	Saithe	Blue whiting	Others	Total
Northern North Sea	Norway pout	56	0	0	3	3	3	3	52	5	125
	Sandeel	0	205	1	1	2	0	0	1	2	212
	Sprat	0	0	0	1	0	0	0	0	0	1
	Blue whiting [1)]	1	0	0	0	0	0	0	22	2	25
	Others	1	1	0	0	0	0	0	1	0	3
	Total	58	206	1	5	5	3	3	76	9	366
Southern North Sea	Norway pout	0	0	0	0	0	0	0	0	0	0
	Sandeel	0	584	15	3	1	3	0	0	3	609
	Sprat	0	17	136	13	0	2	0	0	1	169
	Blue whiting	0	0	0	0	0	0	0	0	0	0
	Others	0	4	3	1	0	0	0	0	1	9
	Total	0	605	154	17	1	5	0	0	5	787

Footnote:
[1]) The landings figures from the blue whiting fishery only include Danish landings as no Norwegian landings data were available to the Working Group. The Danish blue whiting fishery is carried out by trawlers using 40 mm mesh size.

Table 2.1.4 Country and fleet codes relevant to Figure 2.1.3.

	Country	Gear	Horsepower (HP)	Other feature
B_OTB	Belgium	Bottom Otter Trawl		
B_TBB	Belgium	Bottom Beam Trawl		
DK_GN	Denmark	Gillnet		
DK_OTB1	Denmark	Bottom Otter Trawl	< 300	
DK_OTB2	Denmark	Bottom Otter Trawl	> 300	
DK_PTB1	Denmark	Bottom Pair Trawl	< 300	
DK_PTB2	Denmark	Bottom Pair Trawl	> 300	
DK_SDN1	Denmark	Seine	< 300	
DK_SDN2	Denmark	Seine	> 300	
DK_TBB1	Denmark	Bottom Beam Trawl	< 300	
DK_TBB2	Denmark	Bottom Beam Trawl	> 300	
EW_GN	England & Wales	Gillnet		
EW_OTB1	England & Wales	Bottom Otter Trawl	< 300	
EW_OTB2	England & Wales	Bottom Otter Trawl	> 300	
EW_SDN1	England & Wales	Seine	< 300	
EW_SDN2	England & Wales	Seine	> 300	
EW_TBB1	England & Wales	Bottom Beam Trawl	< 300	
EW_TBB2	England & Wales	Bottom Beam Trawl	> 300	
FR_GN	France	Gillnet		
FR_OTB1	France	Bottom Otter Trawl		Coastal trawlers
FR_OTB2	France	Bottom Otter Trawl		Offshore trawlers
FR_TBB	France	Bottom Beam Trawl		
GER_GN	Germany	Gillnet		
GER_OTB1	Germany	Bottom Otter Trawl	< 300	
GER_OTB2	Germany	Bottom Otter Trawl	> 300	
GER_PTB1	Germany	Bottom Pair Trawl	< 300	
GER_PTB2	Germany	Bottom Pair Trawl	> 300	
GER_SDN1	Germany	Seine	< 300	
GER_SDN2	Germany	Seine	> 300	
GER_TBB1	Germany	Bottom Beam Trawl	< 300	
GER_TBB2	Germany	Bottom Beam Trawl	> 300	
N _OTB1	Norway	Bottom Otter Trawl	< 2000	
N _OTB2	Norway	Bottom Otter Trawl	> 2000	
N _TBB2	Norway	Bottom Beam Trawl	> 2000	
NL_OTB1	Netherlands	Bottom Otter Trawl	< 300	
NL_OTB2	Netherlands	Bottom Otter Trawl	> 300	
NL_PTB1	Netherlands	Bottom Pair Trawl	< 300	
NL_PTB2	Netherlands	Bottom Pair Trawl	> 300	
NL_TBB1	Netherlands	Bottom Beam Trawl	< 300	
NL_TBB2	Netherlands	Bottom Beam Trawl	> 300	
SC_OTB1	Scotland	Bottom Otter Trawl		Nephrops fishing
SC_OTB2	Scotland	Bottom Otter Trawl		Light trawlers
SC_OTB3	Scotland	Bottom Otter Trawl		Heavy trawlers
SC_SDN	Scotland	Seine		

Table 2.1.5 Landings (tonnes) of BLUE WHITING from directed fisheries and by-catches caught in other fisheries in Divisions IIIa, IVa 1987–2001, as estimated by the WGNPBW 2002.

Country	1987	1988	1989	1990	1991	1992	1993 3)	1994	1995	1996	1997	1998 2)	1999	2000	2001
Denmark 4)	28,541	18,144	3,632	10,972	5,961	4,438	25,003	5,108	4,848	29,137	9,552	40,143	36,492	30,360	21,995
Denmark 5)			22,973	16,080	9,577	26,751	16,050	14,578	7,591	22,695	16,718	16,329	8,521	7,749	7,505
Faroes 4) 6)	7,051	492	3,325	5,281	355	705	1,522	1,794	-	6,068	6,066	-	-	-	60
Faroes 5) 6)												296	265	42	6,741
Germany 1)	115	280	3	-	-	25	9	-	-	-	-			-	81
Netherlands	-	-	-	20	-	2	46	-	-	-	793			-	-
Norway 4)	24,969	24,898	42,956	29,336	22,644	31,977	12,333	3,408	78,565	57,458	27,394	28,814	48,338	73,006	21,804
Norway 5)															58,182
Russia															69
Sweden	2,013	1,229	3,062	1,503	1,000	2,058	2,867	3,675	13,000	4,000	4,568	9,299	12,993	3,319	2,086
UK	-	100	7	-	335	18	252	-	-	1	-			-	-
Total	62,689	45,143	75,958	63,192	39,872	65,974	58,082	28,563	104,004	119,359	65,091	94,881	106,609	114,476	118,523

1) Including directed fishery also in Division IVa.

2) Including mixed industrial fishery in the Norwegian Sea

3) Imprecise estimates for Sweden: reported catch of 34265 t in 1993 is replaced by the mean of 1992 and 1994, i.e. 2,867 t, and used in the assessment.

4) Directed fishery

5) By-catches of blue whiting in other fisheries.

6) For the periode 1987-2000 landings figures also include landings from mixed fisheries in Division Vb.

Table 2.1.6 Landings (tonnes) of BLUE WHITING from the Southern areas (Subareas VIII and IX and Divisions VIIg-k and VIId,e) 1987–2001, as estimated by the WGNPBW 2002.

Country	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Netherlands	-	-	-	450	10	-	-	-	-	-	-	10 1)	-	-	-
Norway	4	-	-	-	-	-	-	-	-	-	-			-	-
Portugal	9,148	5,979	3,557	2,864	2,813	4,928	1,236	1,350	2,285	3,561	2,439	1,900	2,625	2,032	1,746
Spain	23,644	24,847	30,108	29,490	29,180	23,794	31,020	28,118	25,379	21,538	27,683	27,490	23,777	22,622	23,218
UK	23	12	29	13	-	-	-	5	-	-	-	-	-	-	-
France	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
Total	32,819	30,838	33,695	32,817	32,003	28,722	32,256	29,473	27,664	25,099	30,122	29,390	26,402	24,654	24,964

1) Directed fisheries in VIIIa

Table 2.2.1 Catches of the most important species in the industrial fisheries in Division IIIa (' 000 t), 1989-2001

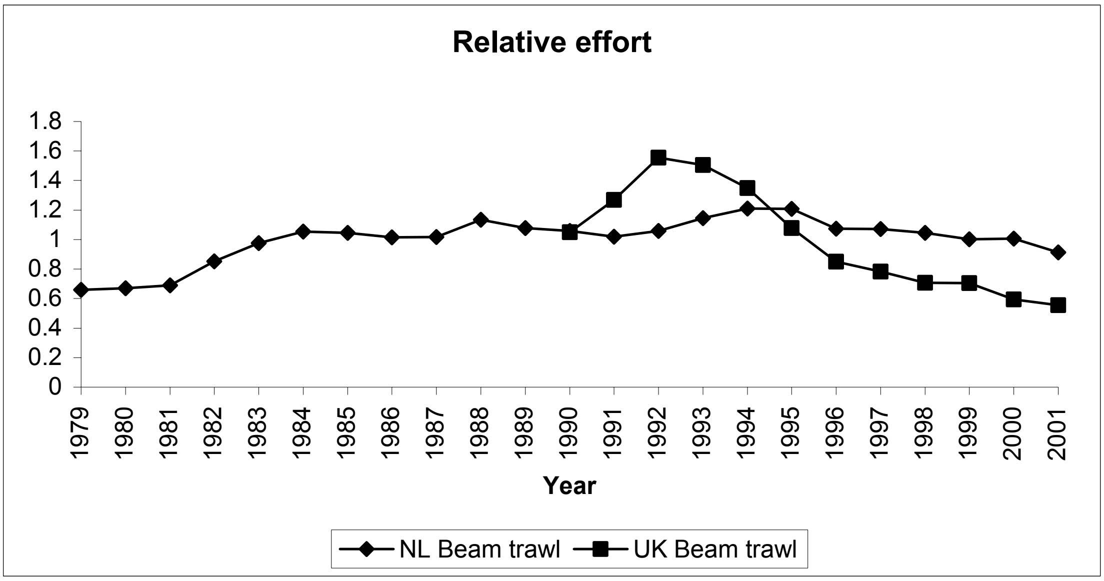
Year	Sandeel	Sprat[1]	Herring	Norway pout	Blue whiting	Total
1989	18	4	52	5	9	88
1990	16	2	51	27	10	106
1991	24	14	44	39	10	131
1992	39	4	66	45	19	173
1993	45	2	71	8	32	158
1994	55	58	30	7	12	162
1995	12	42	34	50	10	148
1996	53	10	26	36	15	140
1997	82	12	6	32	4	136
1998	11	11	5	15	7	49
1999*	13	26	11	7	16	73
2000*	17	19	18	10	7	71
2001*	25	28	16	9	5	83
Mean 1989-2001	32	18	33	22	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

Figure 2.1.1 Fishing effort of North Sea demersal fleets.

Beam trawl plaice fishery



Beam trawl sole fishery

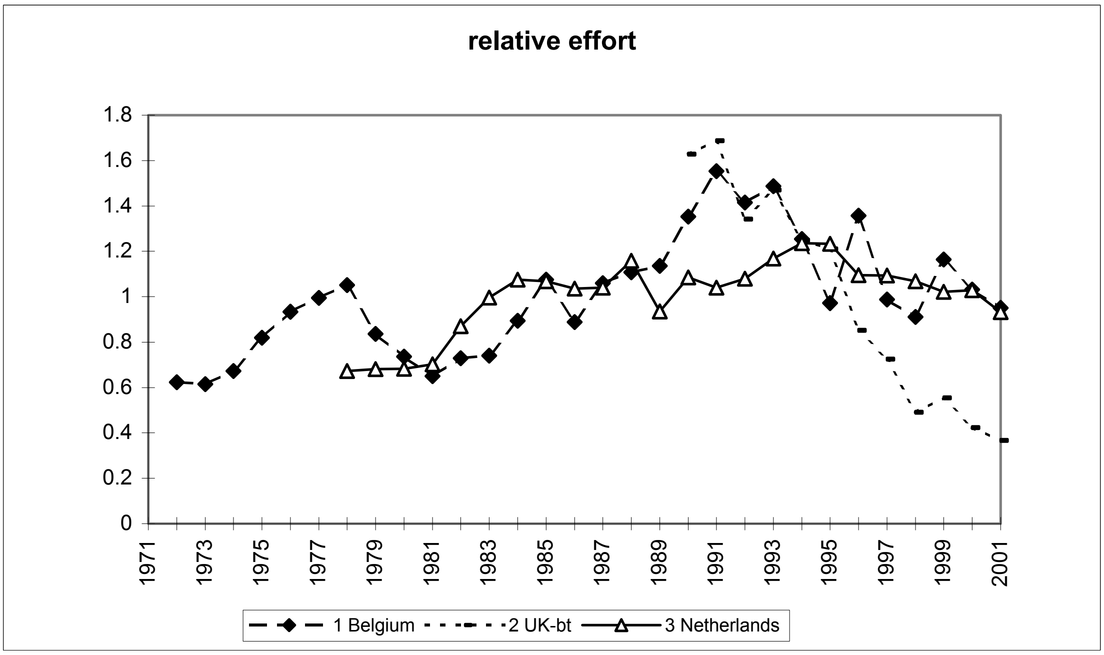
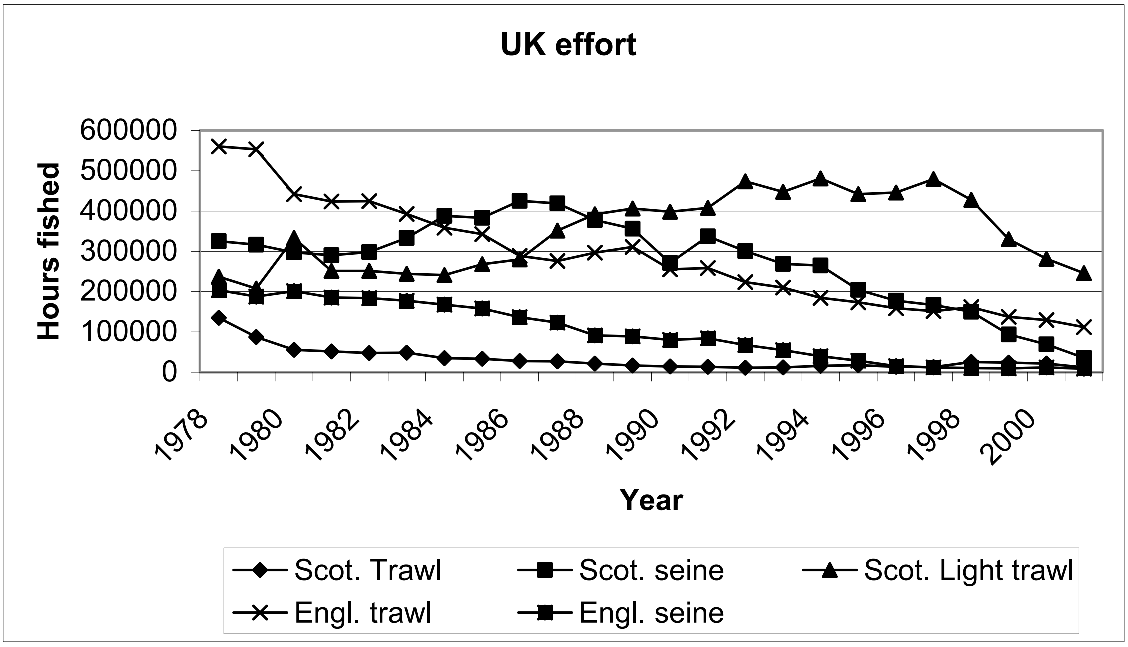


Figure 2.1.1 Fishing effort of North Sea demersal fleets (continued).

UK otter trawl and seine



Saithe fishery

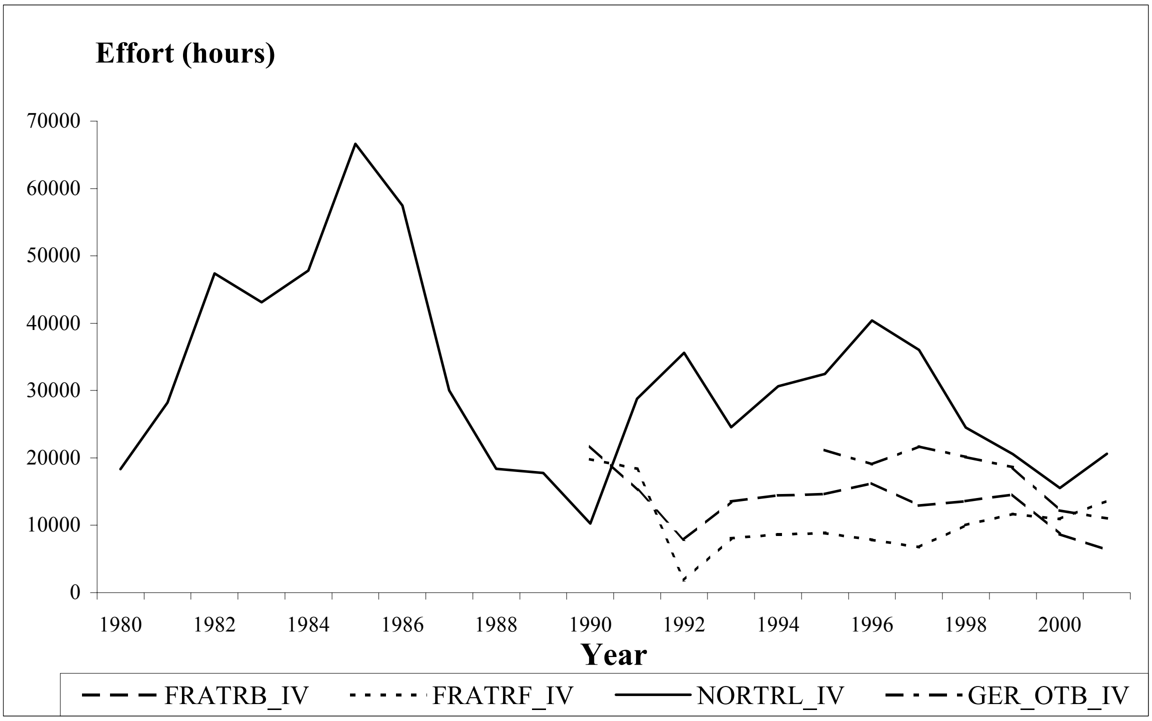
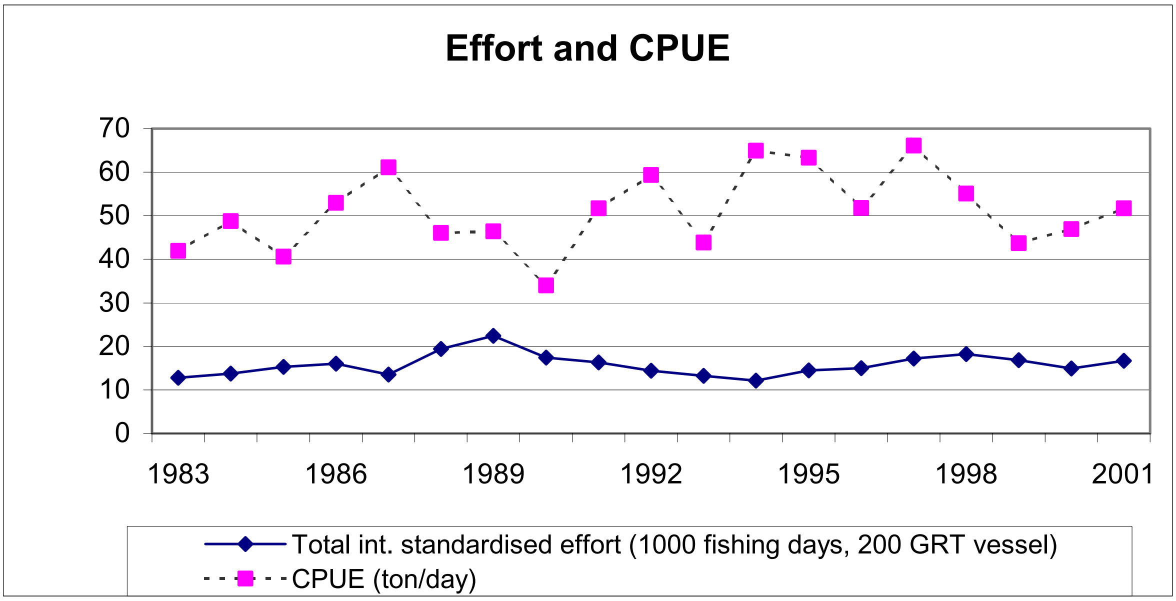


Figure 2.1.1 Fishing effort of North Sea demersal fleets (continued).

Sandeel fishery



Norway pout fishery

Figure 2.1.2 Demersal landings from the North Sea

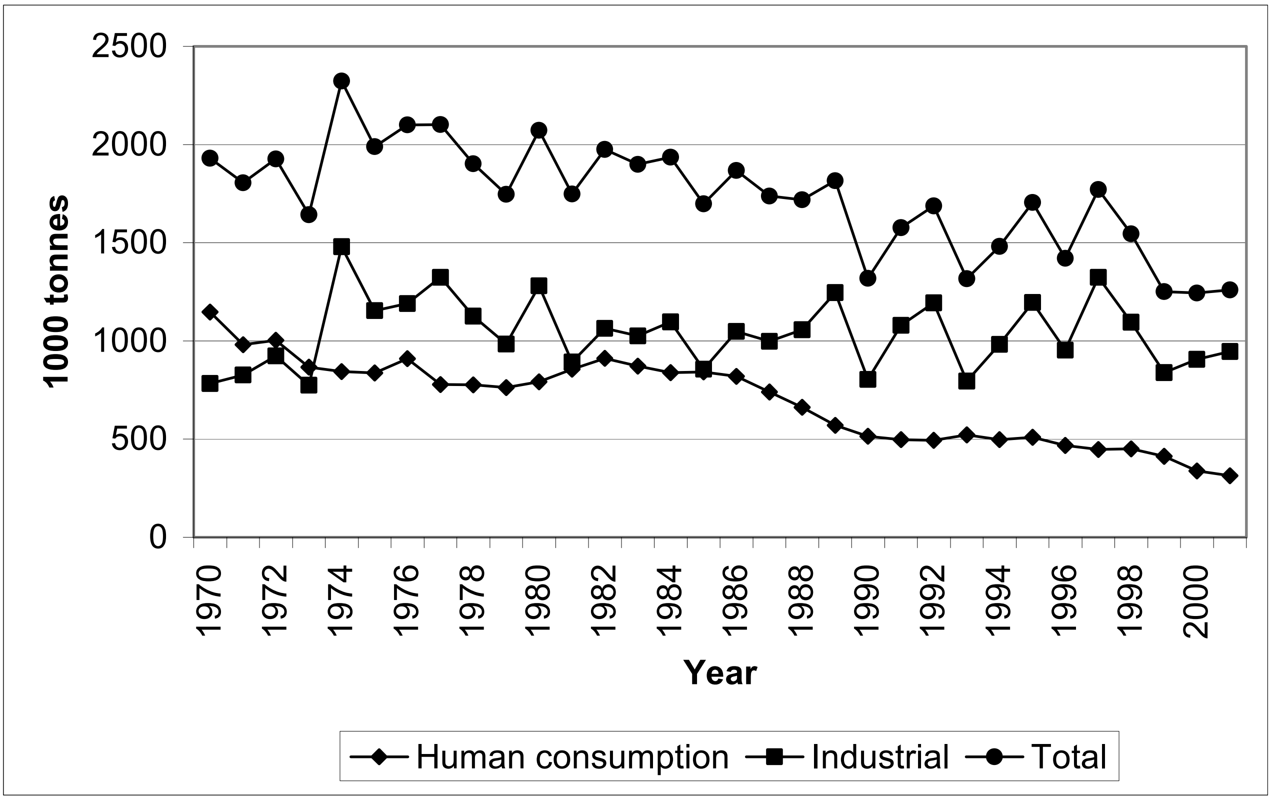


Figure 2.1.3a Landings by fleet segment for the human consumption fisheries of the North Sea : **roundfish species.**

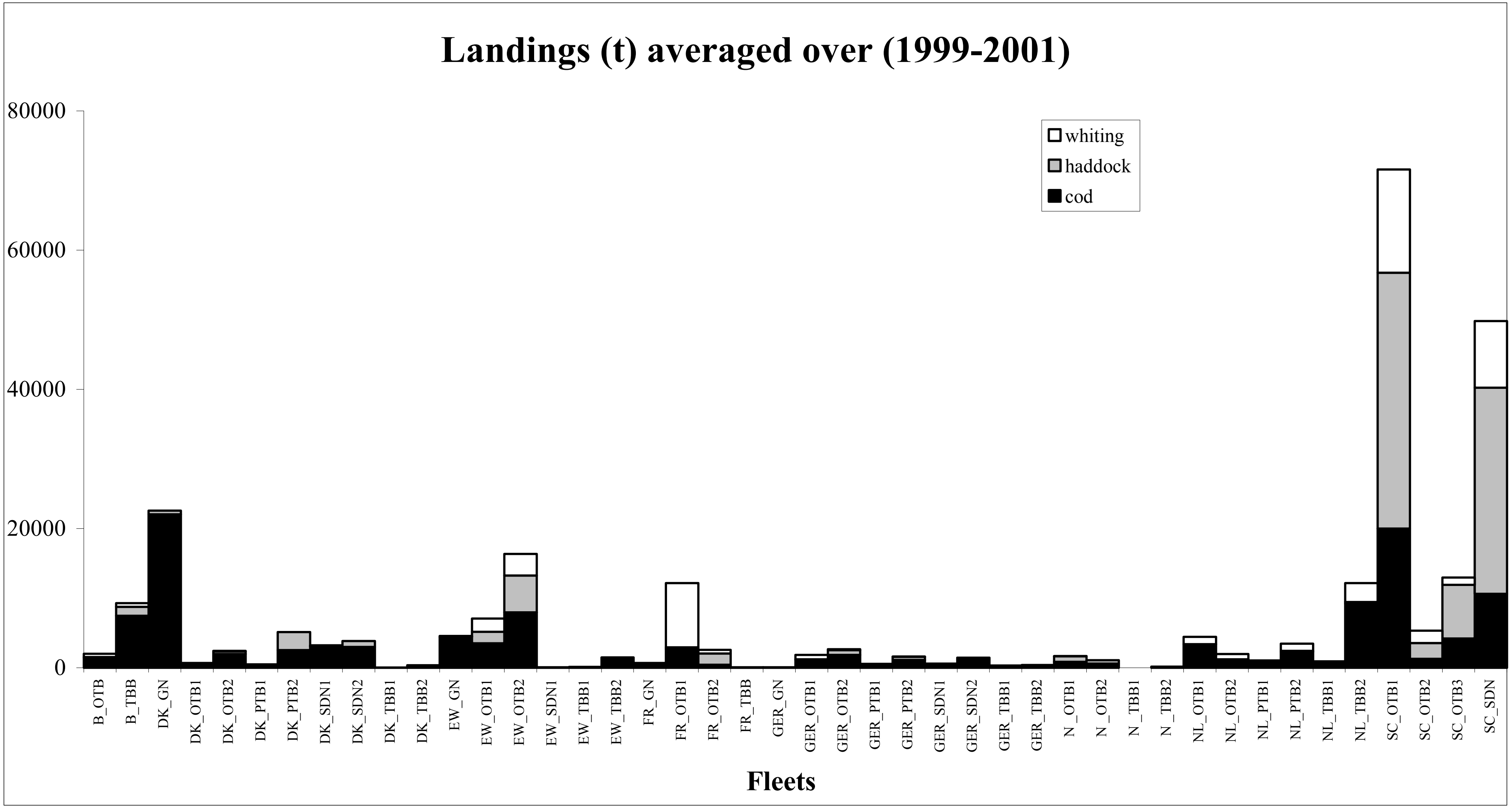


Figure 2.1.3b Landings by fleet segment for the human consumption fisheries of the North Sea : **flatfish species and saithe.**

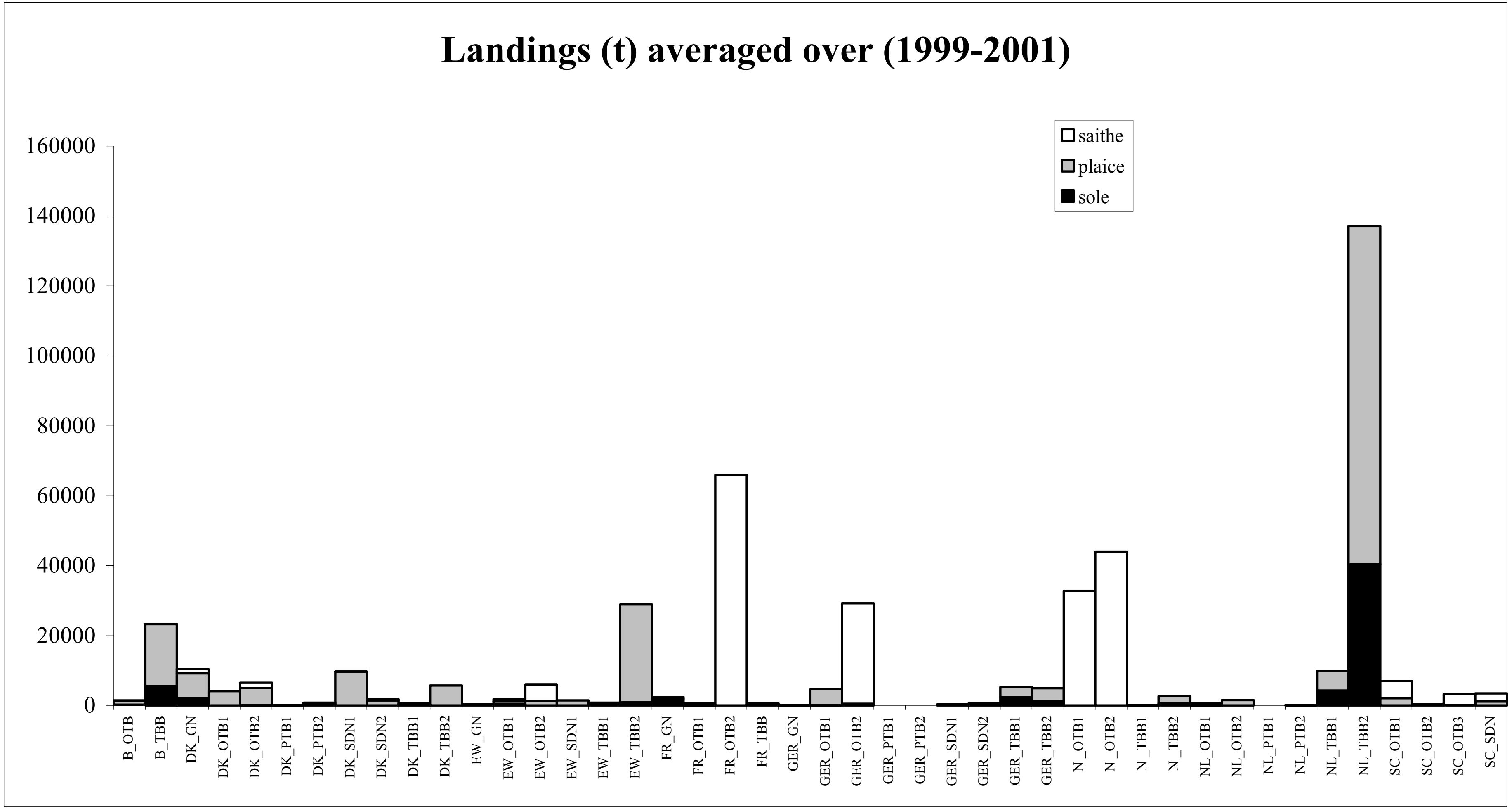


Figure 2.1.4 Recent trends in SSB for the demersal stocks assessed by WGNSSK02.

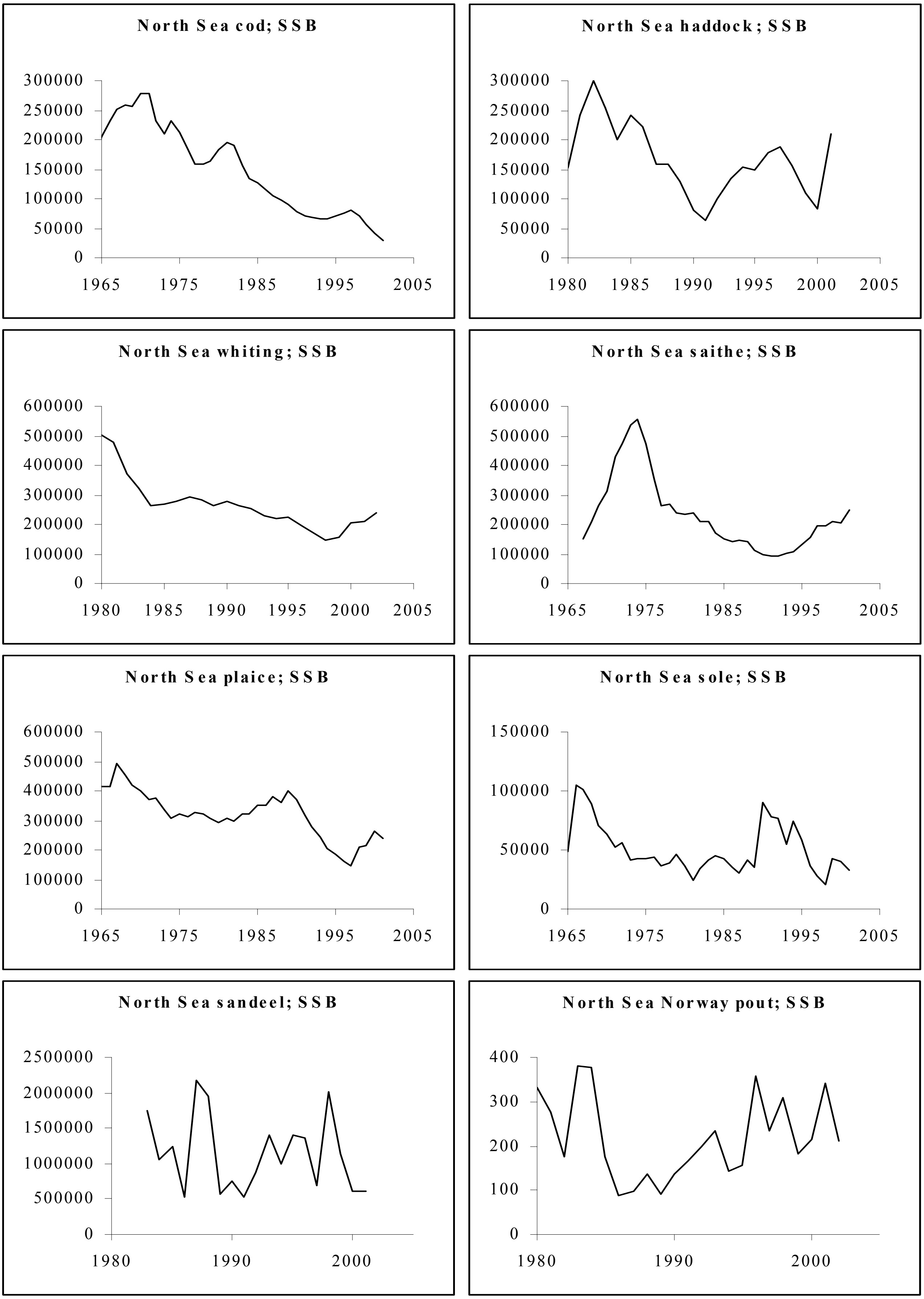


Figure 2.1.5 Recent trends in F for the demersal stocks assessed by WGNSSK02.

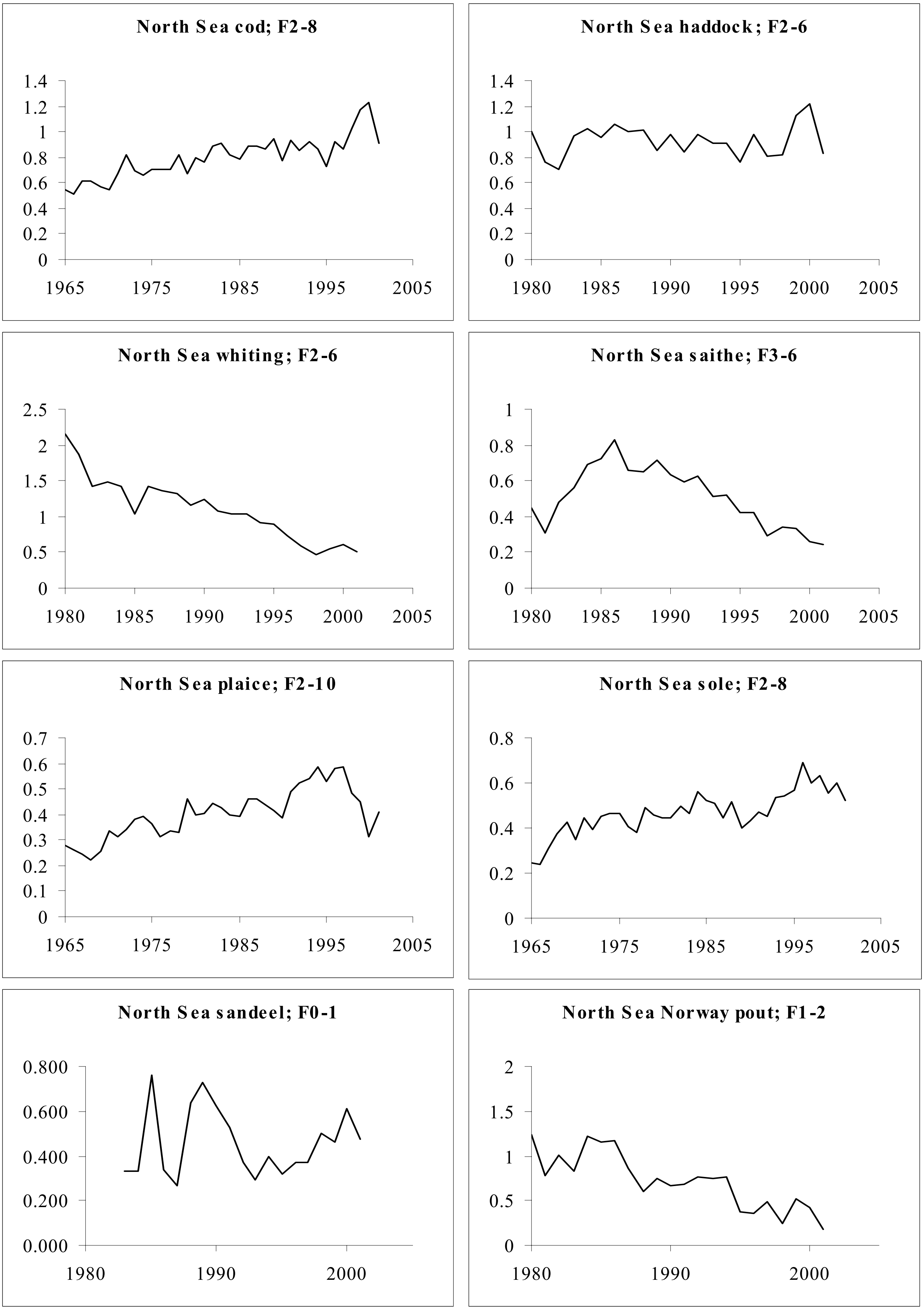
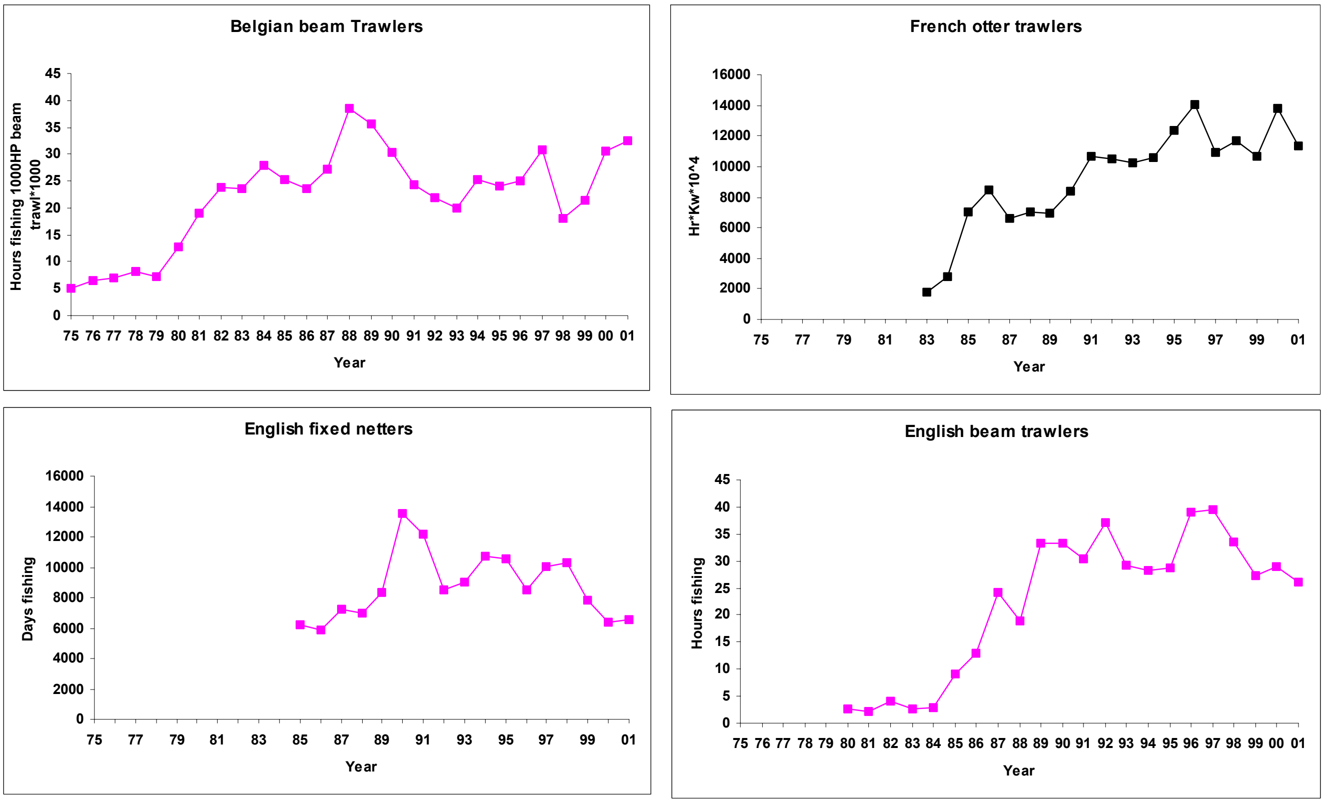


Figure 2.3.1 Fishing effort of demersal fleets in Division VIId (revised indices for French otter trawlers from 1991)



3 COD IN SUBAREA 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.

3.1 The Fishery

Cod are caught by virtually all the demersal gears in Subarea IV and Divisions IIIa (Skagerrak) and VIId, including trawls, seines, gillnets, 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 2001 and 2002

The advice from ICES for 2001 was as follows: **ICES recommends that fishing mortality on cod should be reduced to the lowest possible level in 2001. A rebuilding plan should be developed and implemented in order to rebuild SSB above B_{pa}. The necessary reduction in fishing mortality on cod cannot be achieved by a reduction in TAC alone. The rebuilding plan should include provisions to deter directed fishing, reduce by-catches of cod in fisheries for other species to the lowest practical levels, and to deter discarding and mis-reporting of cod in all fisheries.**

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

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

3.1.2 Management applicable in 2001 and 2002

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

	2001 Agreed TAC (000 t)	2002 Agreed TAC (000 t)
IIIa (Skagerrak)	7.0	7.1
IIa + IV	48.6	49.3

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 both 2001 and 2002 implied a reduction in *status quo* fishing mortality of about 50% in both years.

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 ($\mathbf{B}_{lim}$).*
2. *For 2000 and subsequent years the Parties agreed to restrict their fishing on the basis of a TAC consistent with a fishing mortality rate of 0.65 for appropriate age groups as defined by ICES.*
3. *Should the SSB fall below a reference point of 150 000 t ($\mathbf{B}_{pa}$), the fishing mortality referred to under paragraph 2 shall be adapted in the light of scientific estimates of the conditions then prevailing. Such adaptation shall ensure a safe and rapid recovery of SSB to a level in excess of 150 000 t.*
4. *In order to reduce discarding and to enhance the spawning biomass of cod, the Parties agreed that the exploitation pattern shall, while recalling that other demersal species are harvested in these fisheries, be improved in the light of new scientific advice from, inter alia, ICES.*

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

New technical regulations for EU waters came into force on 1 January 2000 (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 is 120 mm, although a transitional arrangement until 31 December 2002 allow vessels 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.

However, cod continue to form a by-catch in other towed-gear fisheries, and fisheries using other gears. In addition, during 2001, the UK unilaterally introduced legislation requiring the mandatory use of square mesh panels in the codend of trawls.

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. The details of the emergency regulation are given in Commission Regulation (EC) 259/2001 of 7 February 2001.

The minimum landing size (mls) for cod in Subarea IV and Divisions IIIa and VIId is 35 cm, although for Danish vessels the mls is 40 cm.

3.1.3 The fishery in 2001

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 2001 is 49 694 t, split as follows for the separate areas:

	2001 Landings '000 t
IIIa(Skagerrak)	7.1
IV	41.0
VIId	1.6
Total	49.7

The French landings data for 1999 and 2000, which because of database problems, were estimated based on the 1998 landings at the 2001 and 2000 WGs, have now been revised and corrected. Minor revisions for 2000 and 1999 were also reported for UK landings.

WG estimates of landings indicate that the TAC uptake for Subarea IV and Division IIIa was not taken in 2001. This is in keeping with previous years.

The WG suspects that under-reporting of landings by some countries may have been significant in 1998 because of the influence of the relatively strong 1996 year class as 2-year-olds. At the 1999 WG, the landed weight and input numbers-at-age data for 1998 were adjusted according to WG estimates, and these remain unchanged in the present assessment.

For 1999 and 2000, the WG has no evidence to suggest that there was significant under-reporting of landings. However, the reduction in fishing effort in 2001 compared to 2000 (>50%) implied by the 2001 agreed TAC (49 300 t) may have resulted in an increase of unreported catch in 2001. Anecdotal information from the fisheries in some countries also indicates that this may have been the case, but the WG has insufficient information to quantify the extent of potential under-reporting.

Furthermore, the emergency closure undoubtedly affected the fishing pattern for many fleets during February to April 2001, although the influence of the closure on the catches of cod or on the stock cannot be quantified at this stage.

Recent information on the seasonal spatial distribution of reported international landings is limited to logbook reports for about 90% of landings in 1999. These are shown in Figure 3.1.1, which indicates that the seasonal pattern of landings is similar with the highest densities of landings occurring in the northern North Sea, eastern North Sea, and southern North Sea. There is also a persistent area of high density of landings off the eastern coast of England. The distribution of landings is markedly different to the observed density of cod from the 1st Quarter International Bottom Survey (IBTS_Q1), shown for 1996-2001 in Figure 3.1.2. Age group 2 and older cod typically form the majority of the international landings, but the survey data indicate only low densities of cod aged 2 and older in the south and east of the North Sea.

Estimates of total international discards for the period 1997-2001 have been derived using information from the report of the SGDBI 2002 (See Section 1.11.4).

The industrial by-catch of cod sent for reduction to fishmeal and oil in 2001 is small (192 tonnes) compared to the overall landings from this stock (see Table 1.7.1).

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

Values for natural mortality and maturity are given in Table 3.2.1, and are unchanged from those used in recent assessments and are applied to all years. The sources of these data are multispecies VPA as performed by the Multispecies Working Group in 1986, and the International Bottom Trawl Survey 1981-1985 (maturity). 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 multispecies VPA indicate that this can probably not be the case. A comparison of XSA runs from single-species and multispecies assessments is given in Section 1.11.3. Results from IBTS Q1 surveys also indicate that the proportion mature at age has gradually increased over time, especially for age groups 3 and 4 (WD 6, ICES 2002/ACFM:1).

Landings in numbers-at-age for 1963-2001 are given in Table 3.2.2. SOP corrections have been applied. The data from 1990-2002 for age groups 1-6 + are given in Figure 3.2.1. 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 Subarea 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 2001, the landings were dominated by the 1999 year class as 2-year-olds, which accounted for 41% of the total numbers landed from VIId, 68% from Subarea IV, and 52% from Division IIIa Skagerrak. 85% of the international landings–at-age were composed of age groups 2 and 3. The relatively strong 1996 year class, which dominated the landings in 1998 and 1999, accounted for only 3% of the international landings number in 2001 at age 5. The 1997 year class at age 4, the weakest on record, accounted for only 4 % of the total international landings number in 2001, and it is important to note that only about 4% of the total international landings from the stock in 2001 comprised age groups 5 and older.

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 relative to the mean weight for each age group in 1963. 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 all age groups now seems to have stabilised. The data also indicate a slight downward trend in mean weight for age groups 3-6 over the whole time period. 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. The Report of the 2001 meeting of this WG (ICES CM 2002/ACFM:01), and the ICES advice for 2002 (ICES Coop. Res. Rep. No. 246, 2001) 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 200-m depth using a fixed station design of 75 standard tows with the GOV trawl. 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.

3.4 Catch-at-Age Analysis

Catch-at-age analysis was carried out using XSA. In addition two further methods were explored to examine the sensitivity of the outcome of the assessment to the alternative methods. The additional methods were as follows:

- A separable analysis using survey data only,
- A time-series analysis of the landings data calibrated with survey data.

The results of the additional assessments are presented and discussed in relation to the XSA in Section 3.10.

3.4.1 Exploration of the data

Single-fleet XSA tuning runs were performed using no time taper and light shrinkage (2.0) to look for trends in catchability over time. The log-catchability residuals are presented in Figure 3.4.1. Strong positive trends in catchability are observed for the IBTS_Q1 and SCOGFS_Q3 surveys for age groups 1, 2, and 3. No trends are seen for the EGFS_Q3 survey for age groups 1-5. The trends observed indicate that the use of a time taper for the final run is warranted.

The results in terms of terminal F and SSB are given in Figure 3.4.2. The results indicate that whichever of these tuning configurations is used, the resulting SSB in 2001 is very low, between about 30 000 and 40 000 t. However, the estimate of reference F(2-8) is sensitive to the tuning configuration and ranges between about 0.73 and 0.91. The IBTS gives the lowest estimate of F(2-8) (0.65), whereas the EGFS_Q3 and SCOGFS_Q3 surveys give estimates close to 0.9.

Figure 3.4.3. shows the terminal exploitation pattern generated by the different single-fleet runs. It is clear that the exploitation patterns generated by the Scottish and English surveys are consistent with each other, but that the IBTS-tuned XSA gives markedly different terminal F's at age which are not only lower than the other surveys, but the pattern is also different. All three surveys generate an exploitation pattern with F highest on age 4, the 1997 year class, which appears to be the worst year class on record.

3.4.2 Final assessment

The previous two reports of this WG contain arguments supporting the tuning configuration used in the 2001 assessment. The WG has no reason to change its argumentation and hence, the final assessment was carried out using survey data only and using a tricubic taper over 20 years. Catchability was set dependent on year-class strength (stock size) for age groups 1-3, and with age-independent catchability on age groups older than 4.

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

year of assessment	2001	2002
Assessment model	XSA	XSA
Scottish Light Trawl	not used	not used
Scottish Seiners	not used	not used
Scottish Trawl	not used	not used
English Seiners	not used	not used
English Trawl	not used	not used
SGFS	1982-2000 1-6	1982-2001 1-6
EGFS	1977-2000 1-5	1977-2001 1-5
IBTS Q1	1976-2000 1-5	1976-2002 1-5
Time series weights	Tricubic over 20 yrs	Tricubic over 20 yrs
Power model used for catchability	1-3	1-3
Catchability plateau age	5	5
Surv. est. shrunk towards mean F	5 years / 5 ages	5 years / 5 ages
s.e. of the means	0.5	0.5
Min. stand. error for pop. estimates	0.3	0.3
Prior weighting	none	none

The diagnostics from the final XSA run are given in Table 3.4.1 and plots of the log-catchability residuals for each fleet from this run are given in Figure 3.4.4. Note that tuning data are available only for age groups 1-5 in 2 surveys and 1-6 in the third.

Plots of log VPA population numbers against log tuning index are given in Figure 3.4.5, which indicates relatively good fits to the catch data for the surveys at younger ages, but poorer fits for older ages. The relative importance for the result in terms of regression weights by type of fleet or shrinkage in the present assessment compared to the 2001 assessment, are shown in Figures 3.4.6a & b.

The estimates of fishing mortality rates and population numbers resulting from the tuning procedure and XSA are given in Tables 3.4.2 and 3.4.3 and are summarised in Table 3.4.4. The mean F(2-8) for 2001 is estimated to be 0.91 and the estimate for 2000 has been revised upwards from F = 0.83 to F = 1.23. SSB in 2001 is now estimated to be 30 000 t (Table 3.4.4), compared to 55 000 t predicted from the 2001 assessment.

The results from a retrospective XSA analysis carried out by successively removing the terminal year using the options specified above are shown in Figure 3.4.7. Despite the fact that the same configuration of XSA has been used for the current assessment as the 2001 assessment, the result is an upward revision in F and a downward revision of SSB for 2000 and 1999. This is discussed further in the section on the quality of the assessment (Section 3.10.1). Table 3.4.4 also documents two levels of mean F; the standard age range of 2-8, and a shortened age range of 2-4, the ages that are predominant in the landings.

3.5 Recruitment Estimates

Average (geometric mean) recruitment-at age-1 over the period 1963-1999 was 311 million. The GM recruitment in the recent period (1990-1999) is 179 million 1-year-old fish.

The times series of survey data used to derive estimates of recruitment will be updated after the English and Scottish Q3 groundfish surveys which will take place in August/September 2002. These data are important indicators of recruitment and as a result the WG has not attempted to derive recruitment estimates for the 2001 or 2002 year classes. Input data files for RCT3 analysis were prepared, and the age 1 input file is shown in Table 3.5.1 showing the survey indices available at the time of the Working Group meeting.

The RCT3 input file can be found in W:\Groups\ACFM\wgnssk\2002\stock\cod_347d\final runs\recruitment \codrct31.inp

Year class 2000: The estimate of the 2000 year class at age 1 derived from XSA is 74 million, the second lowest in the times-series after the 1997 year-class.

Year class 2001: Estimates of the 2001 year class will be derived after the results of the SCOGFS and EGFS surveys become available in the Autumn of 2002. The preliminary indication from the 2002 IBTS_Q1 survey is that the index of the 2001 year class is about 50% of the long-term (1970-2000) survey mean and about 80% of the short-term (1987-2000) survey mean.

Year class 2002: No estimates are currently available for the 2002 year class. The only estimate available will be from the 2002 EGFS_Q3 survey 0-group index, which historically is not a precise estimator of year-class strength at age 1.

3.6 Historical Stock Trends

Historical trends in mean fishing mortality, landings, spawning stock biomass, and recruitment are shown in Table 3.4.4 and Figure 3.6.1. Mean fishing mortality (F2-8) has shown a more or less continuous increase over the whole period up to the early 80's and remained at about that level (F=0.9) throughout the 1990s, but the present assessment indicates a sharp increase in F over 1997 to 2000 from about F=0.9 to F=1.2. Spawning biomass decreased from a peak of 277,000 t in 1971 to a new historical low of about 30,000 t in 2001. 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 two 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. The 1997 year class is now estimated to be 58 million at age 1 and is the poorest on record. The XSA estimate for the 2000 year-class is 74 million, the second lowest on record.

Historically, landings increased in the 1960s and early 1970s to reach a peak of 350 000 t in 1972. After a further peak of about 335 000 t in 1981, landings have declined to an historical low in 2000 and 2001.

3.7 Short-Term Forecast

No short-term forecast is presented in the report. The forecast will be run after the results of the English and Scottish Groundfish surveys are made available towards the beginning of October. The *.SEN and *.SUM files are located in W:\Groups\ACFM\wgnssk\2002\stock\cod_347d\final runs\assessment\codrct31.inp.

3.8 Medium-Term Projections

No *status quo* F medium-term predictions have been undertaken for cod at the present meeting. However, evaluation of the EU cod recovery proposals are presented in section 1.9 of this report. Medium-term projections will be carried out after the results of the English and Scottish Groundfish surveys are made available towards the beginning of October 2002.

3.9 Biological Reference Points

The results of long-term equilibrium yield and SSB-per-recruit analyses are given Figure 3.9.1. The stock recruit relationship showing $\mathbf{F}_{high}$, $\mathbf{F}_{med}$, and $\mathbf{F}_{2000}$ is given in Figure 3.9.2. These analyses were undertaken using a three-year average for exploitation pattern and mean weight-at-age to indicate the long-term yield and SSB using the *status quo* exploitation pattern, which differs from the historic pattern and recent mean weights-at-age that are towards the lowest in the times-series for almost all age groups.

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

Biol. reference point	Estimate
$\mathbf{F}_{max}$	0.25
$\mathbf{F}_{0.1}$	0.15
$\mathbf{F}_{med}$	0.82
$\mathbf{F}_{high}$	1.19
Management reference point	Estimate
$\mathbf{B}_{lim}$	70,000 t
$\mathbf{B}_{pa}$	150,000 t
$\mathbf{F}_{lim}$	0.86
$\mathbf{F}_{pa}$	0.65

3.10 Comments on the Assessment

3.10.1 Assessment quality

Figure 3.10.1 shows an analysis of the assessment results carried out since 1982 as adopted by ACFM relative to the current assessment. Over this period there has been strong tendency to over-estimate SSB and under-estimate F.

The quality of the assessment was further explored using survey-only methods and Times-Series Analysis (TSA). Results are further discussed below.

3.10.1.1 Separable analysis using survey data

Following concerns regarding the quality of recent catch data, an attempt to analyse stock trends using fishery-independent data was made using onlysurvey data following the separable analysis methodology of Cook (1997). Three surveys were used, IBTS 1st quarter survey, the Scottish Groundfish Survey (ScoGFS), and the English Groundfish Survey (EGFS).

Parameters estimated by the fitting procedure are year effect, age effect, and the number of recruits. The user must make assumptions regarding catchability-at-age within the survey, which in this case involved lower estimates of q for age 1 in the IBTS and ScoGFS than for older ages. Whilst the choice of value is somewhat subjective, exploratory changes to q revealed some compensation in the age-effect parameter, hence the method is relatively robust to the choice of q.

The method was investigated using constant M and the latest estimates of M2 from the Workshop on Multispecies VPA in the North Sea (ICES 2002 / D:4). As the available software does not allow for variable M, a spreadsheet model was constructed during the Working Group meeting with Solver used for the minimisation. As a result, standard errors for the estimated parameters are not available.

The results are summarised in Figure 3.10.2 and detailed results for each model are shown in Figures 3.10.3a-c.

The SSB trends all point to a decline over the past 20 years, albeit with a brief period of recovery in the early 1990s, to the lowest estimate of SSB on record. Estimates of fishing mortality are more variable with the IBTS and ScoGFS in agreement for all but the last 2 years. Estimates of F from the EGFS are generally higher and with a different trend from 1980-1990, but they displayed trends similar to the IBTS from 1991 onwards. The F from the final XSA run, which is tuned using these three data sets, tends to run through the middle of these survey-only estimates.

The use of multispecies estimates of natural mortality makes a relatively little difference to the estimate of F_{bar}, the difference being mostly a scaling effect due to higher overall M2. The differences between estimates of relative SSB are greater and more variable, but the same overall trend emerges from single- and multispecies runs.

3.10.1.2 Time-series analysis (TSA)

Three separate TSA analyses of the landings data calibrated with the cpue from the three tuning surveys were performed, based on a model formulation presented at the 2000 meeting of the WG (WD 13).

- TSA incorporating all the landings data from 1963 to 2001 and survey data from 1976–2001
- TSA omitting the landings data for 2001, but including 1963 to 2000
- TSA omitting the landings data for 2000 and 2001, but including 1963 to 1999

The results in terms of F, SSB, and recruitment are summarised in Table 3.10.2, and the estimates are presented in Figure 3.10.4. All runs indicate a similar stock trajectory as has been observed for cod in previous assessments.

Omitting the landings data for 2000 and 2001 permits a comparison between the predicted landings for these years and the reported landings. Omitting the 2001 data only, results in a predicted catch in 2001 which is twice that reported. Similarly omitting catch data for both 2001 and 2000 also results in further increases in catch for these years than was reported. These results suggest that landings may be underestimated in these years at least. The inclusion of the 2001 data in the TSA gives the lowest estimates of recruitment, SSB, and F in 2001, although the difference between the other analyses is small.

3.10.1.3 Synthesis

The present retrospective analysis of the current assessment indicates a large underestimation of F for 2000 in the 2001 assessment. This may be indicative of under-reporting of catch, especially in 2001. Under-representation of catch data in the catch-at-age data due to restrictive quotas, may account in part for the retrospective increases in F in successive assessments.

The configuration of the XSA using survey data has little effect on the terminal estimate of SSB, and all configurations estimate the SSB to be in the region of 30,000 to 40,000 t. The apparent underestimation of F and overestimation of SSB for 2001 is a cause for concern and this may have been induced by an under-reporting of catch in 2001. However, despite the uncertainty in the assessment, there is no doubt that the cod stock is at an historic low level and the population is dominated by juvenile age groups. The demise of the relatively good 1996 year-class illustrates the high mortality rates. The assessment indicates that only about 3% of the 1996 year-class at age 1 survived to age 4, corresponding to a cumulative Z of 3.71. The estimate of mean F(2-8) for 2001 (0.91), is estimated to be at about the level observed for over a decade.

The results from the separable analysis of surveys-only, TSA, and XSA show a similar stock trajectory, and although the point estimates of F and SSB from TSA and XSA vary, all indicators indicate that SSB is dangerously low and that F has remained at the historic high level seen since the late 1980s and may be even higher.

The historical perception of the stock is primarily driven by the catch-at-age data. The analysis of the single-fleet tunings and the results of the final run all indicate increasing trends in catchability on age groups 1 and 2. There are also some signs of a downward trend in catchability on older ages, and the catch rates of 4- and 5-group cod have declined. The WG's interpretation of these observations is that the survey data are indicating fishing mortality estimates that are higher than the catch data would indicate. In other words, the fishery is not landing as much fish as the surveys are predicting it should. This may be indicative of increased discarding or under-reporting of landings or both, and highlights the need for reliable catch-at-age data, including discard estimates. These observations are supported by the TSA run.

3.10.2 State of the stock

Revised estimates of F, Recruits, and SSB over the period 1999-2001 are as follows:

Year	Recruits (Thousands}		Spawning Stock Biomass (t)		Fishing mortality (2-8)	
	2001 assessment	2002 assessment	2001 assessment	2002 assessment	2001 assessment	2002 assessment
1999	139369	113291	61471	56902	.89	1.1773
2000	215023	177149	52744	41110	.739	1.2317
2001	86000*	73747	55100	30278	0.83+	0.9123

* RCT3 estimate (see ACFM Technical Minutes of October 2001)
+ F Status Quo from 2001 assessment

The results from the current configuration of XSA indicate that mean F remains at the high level observed since the early 1980s. SSB is now estimated at an historic low level of about 30 000 t in 2001. The SSB has been in the region of $\mathbf{B}_{lim}$ (70 000 t) or below since 1990. Furthermore, current F (0.91) has been at or above $\mathbf{F}_{lim}$ (0.86) since the late 1980s. The results of this assessment are generally in agreement with the assessment presented at the 2001 meeting of the WG, although the F for 2000 has been revised upwards, and SSB has been revised downwards. The current fishing mortality rate is not sustainable. Over the past decade, approximately 99 % of the stock in number consists of fish aged 1-4 and approximately 90% of the spawning stock in number has comprised 1- to 3-year-old cod.

Management considerations

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

Cod is a specific target for some fleets, but the majority of cod are caught in the demersal mixed fisheries for other gadoids (mainly haddock and whiting) in the central and northern North Sea and as a by-catch in the beam trawl fisheries. This means it is important to take into account the impact of management of cod on other stocks, especially haddock and whiting, although fishing opportunities for other commercially important stocks may also be affected. The reverse is also true. Recent measures to protect North Sea cod, such as the closed area, and proposals to increase mesh size, will most likely have a greater beneficial effect to stocks other than cod. Any benefits for cod by such measures are likely to be through reduced discarding of fish below the minimum landing size. Discards are not accounted for in this assessment.

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

A discussion of the potential effects of cod recovery plans is given in Section 1.9. The main findings are reproduced below for information:

- The medium-term projections were found to be sensitive to the terminal assessment year since the starting population in 2002 was found significantly reduced compared with 2001. The reduction in the starting population of North Sea cod resulted in a reduced probability of recovery after 10 years from 90 to 82 percent.
- The main effect on the estimated recovery time and recovery probability was due to assessment bias. Assuming a consistent 20 % stock size overestimation caused a substantial prolongation of the recovery time by almost 4 years.
- Yield, SSB, fishing mortality, and recruitment projections were also found to differ with different software programs used. Properties of the used CS4 and STPR3 programs did generate dissimilar recruitment variation.
- As the fitted Shepherd, Beverton & Holt, and Ricker functions were found almost identical over the SSB range up to $\mathbf{B}_{pa}$, no effect on the medium-term stock parameters could be detected.

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

Sub-area IV

Country	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001****
Belgium	3,356	3,374	2,648	4,827	3,458	4,642	5,799	3,882	3,304	2,470
Denmark	18,479	19,547	19,243	24,067	23,573	21,870	23,002	19,697	14,000	8,358
Faroe Islands	109	46	80	219	44	40	102	96		
France	2,146	1,868	1,868	3,040	1,934	3,451	2,934	1,750	2,348	1,350
Germany	8,446	6,800	5,974	9,457	8,344	5,179	8,045	3,386	1,740	1,810
Netherlands	11,133	10,220	6,512	11,199	9,271	11,807	14,676	9,068	5,995	3,574
Norway	10,476	8,742	7,707	7,111	5,869	5,814	5,823	7,432	6,353	4,369
Poland	-	-	-	-	18	31	25	19	18	18
Sweden	823	646	630	709	617	832	540	625	640	626
UK (E/W/NI)	14,462	14,940	13,941	14,991	15,930	13,413	17,745	10,344	6,543	
UK (Scotland)	28,677	28,197	28,854	35,848	35,349	32,344	35,633	23,017	21,009	
United Kindom										19,683
Total Nominal Catch	98,107	94,380	87,457	111,468	104,407	99,423	114,324	79,316	61,950	42,258
Unallocated landings	-758	10,200	7,066	8,555	2,161	2,746	7,779	-924	-2,865	-1,224
WG estimate of total landings	**97,349**	**104,580**	**94,523**	**120,023**	**106,568**	**102,169**	**122,103**	**78,392**	**59,085**	**41,034**
Agreed TAC	*100,000*	*101,000*	*102,000*	*120,000*	*130,000*	*115,000*	*140,000*	*132,400*	*81,000*	*49,300*

Division VIId

Country	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000****	**2001****
Belgium	187	157	228	377	321	310	239	172	110	93
Denmark	1	1	9	-	-	-	-	-		
France	2,079	1,771	2,338	3,261	2,808	6,387	7,788			
Netherlands	2	-	-	-	+	-	19	3	4	17
UK (E/W/NI)	443	530	312	336	414	478	618	454	385	
UK (Scotland)	22	2	+	+	4	3	1	-		
United Kingdom										248
Total Nominal Catch	2,734	2,461	2,887	3,974	3,547	7,178	8,665	629	499	358
Unallocated landings	-65	-29	-37	-10	-44	-135	-85	6,229	1,826	1,215
WG estimate of total landings	**2,669**	**2,432**	**2,850**	**3,964**	**3,503**	**7,043**	**8,580**	**6,858**	**2,325**	**1,573**

Division IIIa (Skagerrak)

Country	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000****	**2001****
Denmark	11,194	11,997	11,953	8,948	13,573	12,164	12,340	8,734	7,683	
Sweden	2,436	2,574	1,821	2,658	2,208	2,303	1608	1,909	1,350	
Norway	270	75	60	169	265	348	303	345	301	
Germany	-	-	301	200	203	81	16	54	9	
Others	102	91	25	134	-	-	-	-	-	
Total Nominal Catch	14002	14737	14160	12109	16249	14896	14267	11042	9343	
Unallocated landings	0	0	-899	0	0	50	1,064	-68	-66	7,086
WG estimate of total landings	**14,002**	**14,737**	**13,261**	**12,109**	**16,249**	**14,946**	**15,331**	**10,974**	**9,277**	**7,086**
Agreed TAC	*15,000*	*15,000*	*15,500*	*20,000*	*23,000*	*16,100*	*20,000*	*19,000*	*11,600*	*7,000*

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

	1992	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000****	**2001****
Total Nominal Catch	114,843	111,578	104,504	127,551	124,203	121,497	137,256	90,987	71,792	42,616
Unallocated landings	-823	10,171	6,130	8,545	2,117	2,661	8,758	5,238	-1,105	7,077
WG estimate of total landings	**114,020**	**121,749**	**110,634**	**136,096**	**126,320**	**124,158**	**146,014**	**96,225**	**70,687**	**49,693**

n/a not available

** provisional

Division IIIa (Skagerrak) landings not included in the assessment

Country	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000****	**2001****
Norwegian coast *	923	909	760	846	748	911	976	788	624	846
Danish industrial by-catch	1,360	511	666	749	676	205	97	62	99	687
Total	**2,283**	**1,420**	**1,426**	**1,595**	**1,424**	**1,116**	**1,073**	**850**	**723**	**1,533**

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
8	0.2	1.0
9	0.2	1.0
10	0.2	1.0
11+	0.2	1.0

Table 3.2.2 Cod in Subarea IV and Divisions VIId and IIIa (Skagerrak): landings in numbers-at-age.

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

YEAR,	1963,	1964,	1965,	1966,	1967,	1968,	1969,	1970,	1971,
AGE									
1,	3214,	5030,	15813,	18224,	10803,	5829,	2947,	54493,	44824,
2,	42591,	22493,	51888,	62516,	70895,	83836,	22674,	33917,	155345,
3,	7030,	20113,	17645,	29845,	32693,	42586,	31578,	18488,	17219,
4,	3536,	4308,	9182,	6184,	11261,	12392,	13710,	13339,	6754,
5,	2788,	1918,	2387,	3379,	3271,	6076,	4565,	6297,	7101,
6,	1213,	1818,	950,	1278,	1974,	1414,	2895,	1763,	2700,
7,	81,	599,	658,	477,	888,	870,	588,	961,	893,
8,	492,	118,	298,	370,	355,	309,	422,	209,	458,
9,	14,	94,	51,	126,	138,	151,	147,	186,	228,
10,	6,	12,	75,	56,	40,	111,	46,	98,	77,
+gp,	0,	4,	8,	83,	17,	24,	78,	40,	94,
0 TOTALNUM,	60965,	56505,	98957,	122538,	132335,	153600,	79651,	129791,	235691,
TONSLAND,	116457,	126041,	181036,	221336,	252977,	288368,	200760,	226124,	328098,
SOPCOF %,	100,	100,	100,	100,	100,	100,	100,	100,	100,

YEAR,	1972,	1973,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,
AGE										
1,	3832,	25966,	15562,	33378,	5724,	75413,	29731,	34837,	62605,	20279,
2,	187686,	31755,	58920,	47143,	100283,	51118,	175727,	91697,	104708,	189007,
3,	48126,	54931,	11404,	18944,	18574,	25621,	17258,	44653,	35056,	34821,
4,	5682,	14072,	15824,	4663,	6741,	4615,	9440,	4035,	12316,	9019,
5,	2726,	2206,	4624,	7563,	1741,	2294,	3003,	3395,	1965,	4118,
6,	3201,	1109,	961,	2067,	3071,	836,	1108,	712,	1273,	785,
7,	1680,	1060,	438,	449,	924,	1144,	410,	398,	495,	604,
8,	612,	489,	395,	196,	131,	371,	405,	140,	197,	134,
9,	390,	80,	332,	229,	67,	263,	153,	158,	74,	65,
10,	113,	58,	81,	95,	63,	26,	36,	42,	55,	37,
+gp,	18,	162,	189,	63,	43,	96,	44,	17,	25,	21,
0 TOTALNUM,	254064,	131888,	108729,	114791,	137361,	161797,	237314,	180085,	218770,	258889,
TONSLAND,	353976,	239051,	214279,	205245,	234169,	209154,	297022,	269973,	293644,	335497,
SOPCOF %,	100,	100,	100,	100,	100,	100,	100,	101,	100,	100,

1

YEAR,	1982,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,
AGE										
1,	66777,	25733,	64751,	8845,	100239,	24915,	21480,	22239,	11738,	13466,
2,	65299,	129632,	66428,	118047,	32437,	128282,	55330,	36358,	54290,	23456,
3,	60411,	21662,	31276,	18995,	34109,	9800,	43955,	18193,	11906,	16776,
4,	9567,	11900,	4264,	7823,	5814,	8723,	3134,	9866,	4339,	3310,
5,	3476,	2830,	3436,	1377,	2993,	1534,	2557,	1002,	2468,	1390,
6,	2065,	1258,	1019,	1265,	604,	1075,	655,	1036,	310,	1053,
7,	428,	595,	437,	373,	556,	235,	295,	251,	310,	225,
8,	236,	181,	244,	173,	171,	215,	66,	140,	54,	139,
9,	78,	90,	60,	79,	69,	55,	63,	27,	60,	28,
10,	27,	28,	45,	16,	44,	48,	23,	31,	12,	4,
+gp,	16,	23,	20,	31,	23,	12,	18,	10,	9,	10,
0 TOTALNUM,	208380,	193932,	171978,	157022,	177058,	174895,	127577,	89153,	85496,	59857,
TONSLAND,	303251,	259287,	228286,	214629,	204053,	216212,	184240,	139936,	125314,	102478,
SOPCOF %,	99,	100,	100,	100,	101,	100,	100,	100,	99,	100,

YEAR,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,
AGE										
1,	27668,	4783,	15557,	15717,	4938,	23769,	1255,	5941,	8294,	2204,
2,	32059,	55272,	25279,	63586,	36805,	29194,	81737,	9731,	23033,	20800,
3,	8682,	11360,	21144,	12943,	23364,	18646,	16958,	32224,	6472,	6225,
4,	5007,	3190,	3083,	5301,	3169,	6499,	5967,	4034,	6697,	1164,
5,	1060,	1577,	870,	802,	1860,	1238,	2402,	1446,	1021,	1076,
6,	491,	435,	519,	286,	399,	700,	509,	626,	385,	149,
7,	329,	204,	142,	151,	162,	153,	236,	223,	139,	84,
8,	52,	108,	58,	42,	88,	47,	41,	91,	40,	28,
9,	40,	18,	32,	15,	43,	14,	16,	14,	18,	14,
10,	17,	10,	7,	13,	4,	15,	4,	10,	5,	6,
+gp,	9,	13,	16,	5,	8,	10,	12,	2,	1,	1,
0 TOTALNUM,	75415,	76970,	66706,	98861,	70837,	80285,	109137,	54342,	46105,	31750,
TONSLAND,	114020,	121749,	110634,	136096,	126320,	124158,	146014,	96225,	71371,	49694,
SOPCOF %,	99,	99,	99,	98,	100,	100,	100,	100,	100,	100,

Table 3.2.3 Cod in Subarea IV and Divisions VIId and IIIa (Skagerrak): landings in numbers-at-age.

Table 2 Catch weights-at-age (kg)

YEAR,	1963,	1964,	1965,	1966,	1967,	1968,	1969,	1970,	1971,
AGE									
1,	.5380,	.4960,	.5810,	.5790,	.5900,	.6400,	.5440,	.6260,	.5790,
2,	1.0040,	.8630,	.9650,	.9940,	1.0350,	.9730,	.9210,	.9610,	.9410,
3,	2.6570,	2.3770,	2.3040,	2.4420,	2.4040,	2.2230,	2.1330,	2.0410,	2.1930,
4,	4.4910,	4.5280,	4.5120,	4.1690,	3.1530,	4.0940,	3.8520,	4.0010,	4.2580,
5,	6.7940,	6.4470,	7.2740,	7.0270,	6.8030,	5.3410,	5.7150,	6.1310,	6.5280,
6,	9.4090,	8.5200,	9.4980,	9.5990,	9.6100,	8.0200,	6.7220,	7.9450,	8.6460,
7,	11.5620,	10.6060,	11.8980,	11.7660,	12.0330,	8.5810,	9.2620,	9.9530,	10.3560,
8,	11.9420,	10.7580,	12.0410,	11.9680,	12.4810,	10.1620,	9.7490,	10.1310,	11.2190,
9,	13.3830,	12.3400,	13.0530,	14.0590,	13.5890,	10.7200,	10.3840,	11.9190,	12.8810,
10,	13.7560,	12.5400,	14.4410,	14.7460,	14.2710,	12.4970,	12.7430,	12.5540,	13.1470,
+gp,	.0000,	14.9980,	15.6670,	15.6719,	19.0163,	11.5951,	11.5675,	14.3667,	15.5441,
0 SOPCOFAC,	.9998,	.9999,	1.0000,	1.0001,	1.0001,	.9999,	.9999,	1.0000,	.9999,

YEAR,	1972,	1973,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,
AGE										
1,	.6160,	.5590,	.5940,	.6190,	.5680,	.5420,	.5720,	.5500,	.5500,	.7230,
2,	.8360,	.8690,	1.0390,	.8990,	1.0290,	.9480,	.9370,	.9360,	1.0030,	.8370,
3,	2.0860,	1.9190,	2.2170,	2.3480,	2.4700,	2.1600,	2.0010,	2.4110,	1.9480,	2.1890,
4,	3.9680,	3.7760,	4.1560,	4.2260,	4.5770,	4.6070,	4.1460,	4.4230,	4.4010,	4.6150,
5,	6.0110,	5.4880,	6.1740,	6.4040,	6.4940,	6.7130,	6.5310,	6.5800,	6.1090,	7.0450,
6,	8.2460,	7.4530,	8.3330,	8.6910,	8.6200,	8.8280,	8.6670,	8.4750,	9.1200,	8.8840,
7,	9.7660,	9.0190,	9.8890,	10.1070,	10.1320,	10.0710,	9.6860,	10.6370,	9.5500,	9.9340,
8,	10.2280,	9.8100,	10.7900,	10.9100,	11.3410,	11.0520,	11.0990,	11.5500,	11.8670,	11.5190,
9,	11.8750,	11.0770,	12.1750,	12.3390,	12.8880,	11.8240,	12.4270,	13.0570,	12.7820,	13.3380,
10,	12.5300,	12.3590,	12.4250,	12.9760,	14.1400,	13.1340,	12.7780,	14.1480,	14.0810,	14.8970,
+gp,	14.3504,	12.8860,	13.7308,	14.4309,	14.5568,	14.3616,	13.9808,	15.4780,	15.3918,	16.6290,
0 SOPCOFAC,	1.0001,	.9999,	.9999,	.9998,	1.0000,	.9999,	1.0035,	1.0087,	.9963,	.9985,

1

YEAR,	1982,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,
AGE										
1,	.5890,	.6320,	.5940,	.5900,	.5830,	.6350,	.5860,	.6730,	.7370,	.6700,
2,	.9620,	.9190,	1.0070,	.9330,	.8560,	.9760,	.8810,	1.0520,	.9760,	1.0780,
3,	1.8580,	1.8350,	2.1560,	2.1400,	1.8340,	1.9550,	1.9820,	1.8460,	2.1760,	2.0370,
4,	4.1300,	3.8800,	3.9720,	4.1640,	3.5040,	3.6500,	3.1870,	3.5850,	3.7910,	3.9710,
5,	6.7840,	6.4910,	6.1900,	6.3240,	6.2300,	6.0520,	5.9920,	5.2730,	5.9320,	6.0830,
6,	8.9030,	8.4230,	8.3620,	8.4300,	8.1400,	8.3070,	7.9140,	7.9210,	7.8890,	8.0340,
7,	10.3990,	9.8480,	10.3170,	10.3620,	9.8960,	10.2420,	9.7640,	9.7250,	10.2350,	9.5450,
8,	12.5000,	11.8370,	11.3520,	12.0730,	11.9390,	11.4610,	12.1270,	11.2110,	10.9240,	10.9490,
9,	13.4690,	12.7970,	13.5050,	13.0720,	12.9510,	12.4470,	14.2420,	12.5860,	12.8020,	13.4810,
10,	12.8900,	12.5620,	13.4080,	14.4430,	13.8590,	18.6910,	17.7870,	15.5570,	15.5250,	13.1700,
+gp,	14.6081,	14.4262,	13.4716,	16.5875,	14.7074,	16.6044,	16.4766,	14.6938,	23.2333,	14.9888,
0 SOPCOFAC,	.9946,	.9968,	.9993,	.9952,	1.0098,	.9968,	1.0000,	.9950,	.9945,	.9970,

YEAR,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,
AGE										
1,	.6990,	.6990,	.6780,	.7210,	.6990,	.6560,	.5420,	.6400,	.6110,	.7210,
2,	1.1460,	1.0650,	1.0750,	1.0200,	1.1170,	.9600,	.9220,	.9350,	1.0210,	1.0010,
3,	2.5460,	2.4790,	2.2010,	2.2100,	2.1470,	2.1200,	1.7240,	1.6630,	1.7470,	2.2960,
4,	4.2230,	4.5500,	4.4710,	4.2920,	4.0340,	3.8210,	3.4950,	3.3050,	3.2160,	3.6770,
5,	6.2480,	6.5400,	7.1670,	7.2200,	6.6370,	6.2280,	5.3870,	5.7260,	4.9030,	5.8630,
6,	8.4830,	8.0940,	8.4360,	8.9800,	8.4940,	8.3940,	7.5630,	7.4030,	7.4880,	7.3500,
7,	10.1020,	9.6410,	9.5360,	10.2830,	9.7290,	9.9790,	9.6280,	8.5820,	9.6360,	9.2640,
8,	10.4810,	10.7350,	10.3230,	11.7430,	11.0800,	11.4240,	10.6430,	10.3650,	10.6710,	10.0730,
9,	11.8500,	12.3290,	12.2240,	13.1070,	12.2640,	12.3000,	11.4990,	11.6000,	10.8940,	12.0620,
10,	13.9050,	13.4430,	14.2470,	12.0520,	12.7560,	12.7610,	13.0850,	12.3300,	11.4140,	12.0090,
+gp,	15.7944,	13.9614,	12.5231,	13.9541,	11.3036,	13.4162,	14.9210,	11.9257,	15.0776,	10.1956,
0 SOPCOFAC,	.9928,	.9948,	.9941,	.9836,	.9990,	1.0002,	.9998,	1.0034,	1.0003,	1.0002,

Table 3.3.1 Cod in Subarea IV and Divisions VIId and IIIa (Skagerrak): tuning data

```
103
SCOGFS_IV
1982 2001
1    1    0.5  0.75
1    6
100  61.4 35.1 57.2 18.3 9.2  5.9
100  32.5 78   18.1 19.7 7.5  2.3
100  81.9 39.1 25.3 5    5.7  1.6
100  6.6  114.319.7 11.2 3    2.4
100  80.1 10.4 39.6 5.7  3.9  1.9
100  21.9 69.5 3.4  9.2  2.9  0.7
100  16.2 28.8 16.5 2.5  3.3  1.2
100  56.1 13.5 16.8 9.5  2    0.8
100  11.4 49   5.9  7.4  2.6  0.9
100  30.3 15.4 13.3 1.3  0.6  0.4
100  64.2 19.3 7.2  6.7  2.9  1.8
100  34.7 74.9 10.1 2.5  1.2  0.3
100  115.833.4 28.8 3.1  1.2  0.7
100  47.5 144.313   8.5  1.1  0.7
100  31.8 35.6 54.2 7.4  3.4  0.4
100  99.9 27.8 22.4 10.2 2.2  1
100  10.4 213.411.6 5.7  3.7  0.8
100  44   10.3 61.6 2.7  1    0.6
100  70   23.7 2.8  4.4  0    0.8
100  6.9  40.9 6.8  0.3  1.8  0
ENGGFS_IV
1977 2001
1    1    0.5  0.75
1    5
100  6.2690.4480.3230.0580.011
100  2.2841.25 0.0980.0990.013
100  2.4230.58 0.2  0.0270.036
100  5.0840.67 0.1530.0730.011
100  1.1361.3870.1270.0390.04
100  3.2380.29 0.3290.0530.038
100  1.5391.0960.12 0.1110.028
100  6.1220.4740.1780.04 0.021
100  0.43 1.1890.1070.0560.021
100  3.4380.1150.2020.0290.011
100  1.4221.0650.0270.0610.014
100  0.8360.4070.1990.0010.043
100  2.2850.2480.1190.0610.006
100  0.6080.5030.06 0.0140.012
100  0.7520.1550.0720.0130.003
100  2.4410.1580.0460.0350.008
100  0.7420.6510.0820.0150.017
100  2.6370.2950.1540.0190.005
100  1.0281.2770.1190.0560.002
100  0.6190.6680.1620.0190.02
100  4.0440.2840.0540.0250.001
100  0.1181.3960.0820.0080.007
100  0.3670.0550.2360.0130.006
100  0.9530.1970.0150.0320
100  0.1740.5280.0320.0020.005
IBTS_Q1_IV
1976 2001
1     1    0    0.25
1     5
1     7.9 19.9 -1   -1   -1
1    36.7  3.2 -1   -1   -1
1    12.9 29.3 -1   -1   -1
1     9.9  9.3 -1   -1   -1
1    16.9 14.8 -1   -1   -1
1     2.9 25.5 -1   -1   -1
1     9.2  6.7 -1   -1   -1
1     3.9 16.6  2.7  1.8  0.8
1    15.2  8    3.9  0.9  1
1     0.9 17.6  3.5  1.7  0.5
1    17    3.6  6.8  2.3  1.3
1     8.8 28.8  1.4  1.7  0.6
1     3.6  6.1  5.8  0.6  0.9
1    13.1  6.3  5    2.3  0.4
1     3.4 15.2  2    1    1
1     2.4  4.1  3.4  0.8  0.4
1    13    4.5  1.2  1    0.3
1    12.7 19.9  2    0.7  0.6
1    14.8  4.4  3    0.8  0.5
1     9.7 22.1  2.8  1.1  0.3
1     3.5  8    6    0.7  0.6
1    40    6.9  2.3  1.1  0.4
1     2.7 26.4  2    0.9  0.5
1     2.1  1.6  8.1  0.8  0.5
1     6.6  3.8  0.7  2    0.4
1     2.7  8.8  1.7  0.2  0.4
```

Table 3.4.1 Cod in Sub-area IV and Divisions VIId and IIIa (Skagerrak): XSA tuning output

Lowestoft VPA Version 3.1

18/06/2002 5:54

Extended Survivors Analysis

Cod North Sea/Skaggerak/Eastern Channel 6/6/2002

CPUE data from file CODIVEF.TUN

Catch data for 39 years. 1963 to 2001. Ages 1 to 11.

Fleet	Firs year	Last year	First age	Last age	Alpha	Beta
SCOGFS_	1982	2001	1	6	0.5	0.75
ENGGFS_	1977	2001	1	5	0.5	0.75
IBTS_Q1_	1976	2001	1	5	0	0.25

Time series weights :

Tapered time weighting applied
Power = 3 over 20 years

Catchability analysis :

Catchability dependent on stock size for ages < 4

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

Catchability independent of age for ages >= 5

Terminal population estimation :

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

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

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

Prior weighting not applied

Tuning converged after 16 iterations

1

Table 3.4.1 (Cont'd)

Regression weights

0.751	0.82	0.877	0.921	0.954	0.976	0.99	0.997	1	1

Fishing mortalities

Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	0.145	0.05	0.074	0.11	0.044	0.091	0.033	0.081	0.072	0.046
2	0.85	0.81	0.65	0.824	0.657	0.642	0.872	0.616	0.879	0.407
3	0.851	1.023	1.033	1.002	1.008	1.009	1.224	1.348	1.447	0.721
4	0.936	0.96	0.931	0.84	0.751	0.933	1.2	1.258	1.355	1.316
5	0.733	0.906	0.769	0.67	0.83	0.764	1.191	1.159	1.507	0.831
6	0.834	0.78	0.898	0.626	0.864	0.903	0.859	1.304	1.242	0.979
7	0.894	1.081	0.636	0.724	0.917	1.035	0.924	1.299	1.302	1.074
8	0.843	0.868	1.121	0.386	1.417	0.771	0.904	1.256	0.89	1.058
9	1.086	0.808	0.694	1.027	0.882	0.97	0.647	0.989	0.959	0.9
10	0.885	0.899	0.833	0.698	0.994	0.91	0.915	1.211	1.197	0.978

1

XSA population numbers (Thousands)

	AGE									
YEAR	1	2	3	4	5	6	7	8	9	10
1992	3.05E+05	6.67E+04	1.72E+04	9.11E+03	2.26E+03	9.59E+02	6.16E+02	1.01E+02	6.61E+01	3.27E+01
1993	1.47E+05	1.19E+05	2.01E+04	5.71E+03	2.93E+03	8.88E+02	3.41E+02	2.06E+02	3.54E+01	1.83E+01
1994	3.23E+05	6.30E+04	3.72E+04	5.63E+03	1.79E+03	9.68E+02	3.33E+02	9.47E+01	7.10E+01	1.29E+01
1995	2.26E+05	1.35E+05	2.32E+04	1.03E+04	1.82E+03	6.80E+02	3.23E+02	1.44E+02	2.53E+01	2.90E+01
1996	1.71E+05	9.10E+04	4.17E+04	6.63E+03	3.64E+03	7.61E+02	2.97E+02	1.28E+02	8.04E+01	7.41E+00
1997	4.08E+05	7.34E+04	3.32E+04	1.18E+04	2.56E+03	1.30E+03	2.63E+02	9.74E+01	2.54E+01	2.72E+01
1998	5.80E+04	1.67E+05	2.72E+04	9.44E+03	3.81E+03	9.76E+02	4.32E+02	7.64E+01	3.69E+01	7.89E+00
1999	1.13E+05	2.52E+04	4.93E+04	6.23E+03	2.33E+03	9.49E+02	3.38E+02	1.40E+02	2.53E+01	1.58E+01
2000	1.77E+05	4.69E+04	9.59E+03	9.97E+03	1.45E+03	5.98E+02	2.11E+02	7.56E+01	3.27E+01	7.71E+00
2001	7.37E+04	7.40E+04	1.37E+04	1.76E+03	2.11E+03	2.63E+02	1.41E+02	4.70E+01	2.54E+01	1.03E+01

Estimated population abundance at 1st Jan 2002

0.00E+00	3.17E+04	3.47E+04	5.20E+03	3.86E+02	7.51E+02	8.09E+01	3.96E+01	1.34E+01	8.46E+00

Taper weighted geometric mean of the VPA populations:

1.76E+05	7.93E+04	2.61E+04	7.38E+03	2.60E+03	8.96E+02	3.45E+02	1.22E+02	4.60E+01	1.69E+01

Standard error of the weighted Log(VPA populations) :

0.6147	0.5541	0.5246	0.5524	0.3791	0.5245	0.4553	0.5426	0.5952	0.7491

1

Table 3.4.1 (Cont'd)

Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
1	-0.44	-0.24	-0.04	-0.26	-0.53	-0.13	-0.07	0.16	0.12	0.01
2	-0.55	-0.29	-0.25	-0.25	-0.45	-0.46	-0.2	-0.12	-0.06	-0.1
3	-0.2	0.07	-0.18	-0.1	-0.14	-0.5	-0.28	0.15	-0.04	-0.26
4	0.25	0.76	0.65	0.35	0.19	0.49	-2.69	0.47	-0.33	-0.2
5	0.81	0.71	0.18	1.03	-0.17	0.55	1.24	0.16	-0.03	-0.74
6	No data for this fleet at this age									

Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	0.1	0.11	0.06	-0.11	-0.14	0.08	-0.02	-0.02	0.08	-0.03
2	-0.3	-0.04	0.06	0.25	0.19	-0.12	0.1	-0.05	0.2	0.16
3	-0.04	0.29	0.12	0.4	0.03	-0.52	0.07	0.28	0	-0.14
4	0.5	0.13	0.37	0.78	0.09	-0.1	-0.85	0.09	0.58	-0.48
5	0.35	0.95	0.14	-0.86	0.85	-1.83	-0.02	0.3	99.99	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	-16.866	-16.9276
S.E(Log q	0.69	0.8213

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	0.57	7.019	14.52	0.96	20	0.12	-16.33
2	0.6	3.692	14.25	0.9	20	0.2	-16.2
3	0.71	1.828	14.69	0.8	20	0.27	-16.52

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	1.091	14.57	0.59	20	0.49	-16.87
5	0.58	0.963	13.16	0.37	19	0.48	-16.93
1							

Fleet : IBTS_Q1_IV□□□□□

Age	1976	1977	1978	1979	1980	1981
1	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
3	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
5	99.99	99.99	99.99	99.99	99.99	99.99
6	No data for this fleet at this age					

Table 3.4.1 (Cont'd)

Terminal year survivor and F summaries :

Age 1 Catchability dependent on age and year class strength

Year class = 2000

Fleet		Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
SCOGFS_	19525	0.522	0	0	1	0.141	0.073
ENGGFS_	30666	0.3	0	0	1	0.428	0.047
IBTS_Q1_	37479	0.528	0	0	1	0.138	0.039
P shrinka	79341	0.55				0.131	0.018
F shrinka	21555	0.5				0.161	0.066

Weighted prediction :

Survivors at end of y	Int s.e	Ext s.e	N	Var Ratio	F
31659	0.2	0.21	5	1.07	0.046

1

Age 2 Catchability dependent on age and year class strength

Year class = 1999

Fleet		Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
SCOGFS_	41482	0.282	0.273	0.97	2	0.205	0.351
ENGGFS_	39109	0.212	0.042	0.2	2	0.358	0.369
IBTS_Q1_	38616	0.259	0.045	0.18	2	0.245	0.373
P shrinka	26126	0.52				0.091	0.512
F shrinka	15725	0.5				0.1	0.747

Weighted prediction :

Survivors at end of y	Int s.e	Ext s.e	N	Var Ratio	F
34713	0.13	0.13	8	0.969	0.407

Age 3 Catchability dependent on age and year class strength

Year class = 1998

Fleet		Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
SCOGFS_	6163	0.232	0.135	0.58	3	0.223	0.637
ENGGFS_	5035	0.193	0.096	0.5	3	0.294	0.738
IBTS_Q1_	6034	0.216	0.14	0.65	3	0.257	0.647
P shrinka	7384	0.55				0.102	0.556
F shrinka	2280	0.5				0.124	1.226

Weighted prediction :

Survivors at end of y	Int s.e	Ext s.e	N	Var Ratio	F
5200	0.13	0.12	11	0.937	0.721

1

Table 3.4.1 (Cont'd)

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

Year class = 1997

Fleet		Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
SCOGFS_	249	0.29	0.317	1.09	4	0.164	1.653
ENGGFS_	334	0.24	0.121	0.51	4	0.157	1.425
IBTS_Q1_	384	0.223	0.044	0.2	4	0.346	1.319
F shrinka	516	0.5				0.333	1.112

Weighted prediction :

Survivors at end of y	Int s.e	Ext s.e	N	Var Ratio	F
386	0.19	0.11	13	0.563	1.316

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

Year class = 1996

Fleet		Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
SCOGFS_	923	0.344	0.055	0.16	5	0.19	0.72
ENGGFS_	896	0.399	0.101	0.25	5	0.092	0.735
IBTS_Q1_	866	0.229	0.107	0.47	5	0.446	0.753
F shrinka	483	0.5				0.272	1.103

Weighted prediction :

Survivors at end of y	Int s.e	Ext s.e	N	Var Ratio	F
751	0.19	0.09	16	0.494	0.831

1

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

Year class = 1995

Fleet		Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
SCOGFS_	74	0.256	0.022	0.09	4	0.036	1.035
ENGGFS_	81	0.218	0.059	0.27	4	0.035	0.981
IBTS_Q1_	113	0.22	0.116	0.53	5	0.23	0.784
F shrinka	73	0.5				0.699	1.046

Weighted prediction :

Survivors at end of y	Int s.e	Ext s.e	N	Var Ratio	F
81	0.35	0.09	14	0.256	0.979

Table 3.4.1 (Cont'd)

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

Year class = 1994

Fleet		Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
SCOGFS_	60	0.356	0.242	0.68	6	0.095	0.82
ENGGFS_	34	0.309	0.216	0.7	5	0.026	1.177
IBTS_Q1_	42	0.214	0.098	0.46	5	0.099	1.039
F shrinka	38	0.5				0.781	1.108

Weighted prediction :

Survivors at end of y	Int s.e	Ext s.e	N	Var Ratio	F
40	0.39	0.08	17	0.192	1.074

1

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

Year class = 1993

Fleet		Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
SCOGFS_	19	0.353	0.07	0.2	6	0.03	0.846
ENGGFS_	14	0.288	0.05	0.17	5	0.009	1.039
IBTS_Q1_	11	0.204	0.086	0.42	5	0.032	1.212
F shrinka	13	0.5				0.93	1.06

Weighted prediction :

Survivors at end of y	Int s.e	Ext s.e	N	Var Ratio	F
13	0.47	0.02	17	0.051	1.058

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

Year class = 1992

Fleet		Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
SCOGFS_	10	0.291	0.064	0.22	6	0.03	0.779
ENGGFS_	6	0.263	0.44	1.67	5	0.012	1.067
IBTS_Q1_	7	0.197	0.073	0.37	5	0.039	0.978
F shrinka	8	0.5				0.92	0.899

Weighted prediction :

Survivors at end of y	Int s.e	Ext s.e	N	Var Ratio	F
8	0.46	0.03	17	0.064	0.9

1

Run title North Sea/Skaggerak/Eastern Channel 6/6/2002

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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
AGE									
1	0.0249	0.0203	0.0585	0.0551	0.0335	0.0457	0.0213	0.1098	0.0763
2	0.5316	0.3759	0.4704	0.5499	0.4973	0.6353	0.3906	0.5787	0.8861
3	0.3677	0.593	0.6602	0.6281	0.7287	0.739	0.6002	0.7466	0.7701
4	0.4524	0.4171	0.6212	0.5284	0.5327	0.7115	0.5817	0.5711	0.7088
5	0.4543	0.4763	0.4313	0.4895	0.5975	0.6229	0.6285	0.5845	0.6947
6	0.5623	0.6124	0.4609	0.4349	0.5987	0.5652	0.6994	0.532	0.5377
7	0.1599	0.6077	0.4675	0.4445	0.6205	0.5826	0.487	0.5284	0.5701
8	0.7843	0.3674	0.7092	0.5262	0.7115	0.4541	0.6319	0.3184	0.5191
9	0.3119	0.3243	0.2683	0.7611	0.3777	0.7745	0.4081	0.6432	0.6926
10	0.4579	0.4813	0.471	0.5356	0.5862	0.6051	0.5758	0.5255	0.6081
+gp	0.4579	0.4813	0.471	0.5356	0.5862	0.6051	0.5758	0.5255	0.6081
0 FBAR 2	0.4732	0.4928	0.5458	0.5145	0.6124	0.6158	0.5742	0.5514	0.6695
FBAR 2-	0.4506	0.462	0.5839	0.5688	0.5862	0.6953	0.5242	0.6321	0.7883

Table 8 Fishing mortality (F) at age

YEAR	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
AGE										
1	0.0335	0.1292	0.0922	0.108	0.0353	0.1439	0.0953	0.1042	0.1096	0.101
2	0.8906	0.6967	0.8121	0.7336	0.939	0.8433	1.0247	0.7936	0.8827	0.9718
3	0.9069	0.8383	0.6699	0.7845	0.8574	0.7703	0.9248	0.9486	0.9811	1.0113
4	0.6526	0.7781	0.6415	0.6705	0.7568	0.5485	0.7667	0.5896	0.7906	0.7705
5	0.7105	0.5736	0.6396	0.7445	0.5718	0.6355	0.8693	0.7059	0.6495	0.6772
6	0.8034	0.7219	0.5314	0.6716	0.7946	0.6027	0.742	0.5132	0.6343	0.5908
7	0.7788	0.6907	0.7151	0.5118	0.74	0.8038	0.6837	0.6594	0.8428	0.7195
8	1.0295	0.544	0.6029	0.8425	0.2718	0.7712	0.762	0.525	0.833	0.5766
9	1.2337	0.3377	0.9113	0.8802	0.8027	1.4552	0.8795	0.7848	0.5888	0.7392
10	0.9211	0.5785	0.6864	0.7373	0.6419	0.8627	0.7953	0.6434	0.7165	0.6668
+gp	0.9211	0.5785	0.6864	0.7373	0.6419	0.8627	0.7953	0.6434	0.7165	0.6668
0 FBAR 2	0.8246	0.6919	0.6589	0.7084	0.7045	0.7107	0.8247	0.6765	0.802	0.7597
FBAR 2-	0.8167	0.7711	0.7078	0.7295	0.8511	0.7207	0.9054	0.7772	0.8848	0.9179

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Run title North Sea/Skaggerak/Eastern Channel 6/6/2002

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Terminal Fs derived using XSA (With F shrinkage)

Table 8 Fishing mortality (F) at age

YEAR	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
AGE										
1	0.1756	0.1258	0.1767	0.0869	0.2342	0.1414	0.1775	0.129	0.1401	0.1269
2	0.9377	1.0857	0.9549	0.9843	0.895	0.9166	0.9153	0.8774	0.91	0.7639
3	1.2335	1.1905	1.0185	0.9596	1.0604	0.8922	1.1846	1.0925	0.9701	0.9653
4	0.921	0.917	0.8305	0.8077	0.9607	0.9278	0.8601	1.0157	0.8962	0.8449
5	0.7905	0.7903	0.7542	0.7143	0.869	0.7341	0.7929	0.7601	0.7724	0.8382
6	0.8993	0.7599	0.7539	0.7055	0.8182	0.9356	0.8335	0.9126	0.5627	0.9345
7	0.7699	0.7191	0.6588	0.6988	0.7986	0.9183	0.7301	0.9369	0.7854	1.1065
8	0.7	0.9126	0.7504	0.6002	0.8346	0.8645	0.7276	0.9788	0.5271	1.0671
9	0.8015	0.635	0.9165	0.5783	0.5122	0.7168	0.6817	0.754	2.0875	0.5704
10	0.8003	0.771	0.7744	0.6655	0.7742	0.8425	0.7606	0.8778	0.9564	0.9133
+gp	0.8003	0.771	0.7744	0.6655	0.7742	0.8425	0.7606	0.8778	0.9564	0.9133
0 FBAR 2	0.8931	0.9107	0.8173	0.7815	0.8909	0.8842	0.8634	0.9391	0.7748	0.9315
FBAR 2-	1.0307	1.0644	0.9346	0.9172	0.972	0.9122	0.9866	0.9952	0.9254	0.858

Table 8 Fishing mortality (F) at age

YEAR	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	FBAR 99-**	FBAR 89-98
AGE												
1	0.1453	0.0496	0.0745	0.1095	0.0441	0.0909	0.0328	0.0815	0.0724	0.0456	0.0665	0.0943
2	0.8498	0.8098	0.65	0.8245	0.6571	0.6421	0.8718	0.6161	0.8789	0.4075	0.6341	0.7856
3	0.8506	1.0231	1.0332	1.0017	1.0085	1.0092	1.2245	1.3485	1.4466	0.7209	1.172	1.0179
4	0.9356	0.9598	0.9305	0.84	0.7512	0.9329	1.1997	1.2579	1.3553	1.3158	1.3096	0.9306
5	0.7327	0.9059	0.7693	0.6696	0.8301	0.7645	1.1908	1.159	1.507	0.8314	1.1658	0.8234
6	0.8342	0.7796	0.8983	0.6263	0.8641	0.9032	0.8592	1.3038	1.2422	0.9794	1.1751	0.8175
7	0.8935	1.0805	0.6359	0.7243	0.9167	1.0355	0.9243	1.2993	1.3016	1.0737	1.2249	0.904
8	0.8428	0.8682	1.1208	0.3858	1.4172	0.7709	0.904	1.2563	0.89	1.0576	1.068	0.8883
9	1.086	0.8078	0.6944	1.0267	0.8823	0.97	0.6467	0.9889	0.9594	0.9002	0.9495	0.9526
10	0.8848	0.8987	0.8327	0.6981	0.9936	0.9101	0.9145	1.2108	1.1968	0.9781	1.1286	0.888
+gp	0.8848	0.8987	0.8327	0.6981	0.9936	0.9101	0.9145	1.2108	1.1968	0.9781		
0 FBAR 2	0.8484	0.9181	0.8626	0.7246	0.9207	0.8655	1.0249	1.1773	1.2317	0.9123		
FBAR 2-	0.8787	0.9309	0.8712	0.8887	0.8056	0.8614	1.0987	1.0741	1.2269	0.8147		

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Table 3.4.3 Cod in Sub-area IV and Divisions VIId and IIIa (Skagerrak): Stock Number at age

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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	1963	1964	1965	1966	1967	1968	1969	1970	1971
AGE									
1	195099	374080	415425	506863	488789	194587	209061	782003	910808
2	123040	85509	164714	176063	215532	212386	83526	91962	314849
3	25890	50951	41375	72514	71590	92370	79289	39826	36332
4	10741	13959	21931	16651	30136	26902	34355	33883	14701
5	8440	5594	7530	9648	8037	14484	10813	15722	15671
6	3117	4387	2845	4006	4842	3620	6360	4722	7175
7	606	1454	1947	1469	2123	2178	1684	2587	2271
8	1000	423	648	999	771	935	996	847	1249
9	56	374	240	261	483	310	486	433	505
10	17	33	221	150	100	271	117	265	187
+gp	0	11	23	219	42	57	194	108	225
0 TOT/	368005	536776	656900	788841	822444	548100	426882	972359	1303972

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

YEAR	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
AGE										
1	173496	319648	263657	486359	246421	839198	488156	525424	899522	314766
2	379206	75388	126222	108037	196161	106887	326525	199413	212736	362216
3	91465	109668	26468	39487	36558	54050	32411	82584	63548	62014
4	13100	28762	36933	10549	14034	12080	19483	10011	24910	18555
5	5925	5584	10815	15920	4417	5391	5715	7410	4545	9251
6	6406	2384	2576	4671	6191	2042	2338	1962	2995	1944
7	3431	2348	948	1240	1954	2290	915	911	961	1300
8	1051	1289	964	380	608	763	839	378	386	339
9	608	307	613	432	134	380	289	321	183	137
10	207	145	180	202	147	49	73	98	120	83
+gp	32	403	415	133	99	181	87	39	54	47
0 TOT/	674928	545928	469790	667408	506723	1023310	876830	828551	1209961	770652

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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	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
AGE										
1	618498	324685	596292	158611	716254	281821	197054	274077	133933	168552
2	127840	233147	128641	224528	65340	254641	109929	74144	108243	52312
3	96586	35272	55475	34888	59126	18815	71756	31018	21727	30704
4	17567	21909	8353	15603	10408	15947	6004	17094	8102	6414
5	7030	5726	7170	2981	5696	3260	5163	2080	5068	2707
6	3848	2611	2127	2761	1195	1956	1281	1913	796	1917
7	882	1282	1000	819	1117	432	628	456	629	371
8	518	334	511	424	334	411	141	248	146	235
9	156	211	110	198	190	119	142	56	76	71
10	54	57	91	36	91	93	47	59	21	8
+gp	32	47	40	69	47	23	38	19	16	17
0 TOT/	873011	625281	799810	440918	859797	577519	392184	401163	278759	263307

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

YEAR	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	GMST 63-99	AMST 63-99
AGE													
1	305284	147360	323413	226023	170710	407921	57961	113291	177149	73747	0	310633	374462
2	66709	118626	63007	134891	91023	73395	167358	25202	46922	74038	31659	130190	153496
3	17174	20096	37196	23180	41678	33247	27214	49320	9591	13731	34713	43427	48996
4	9107	5713	5626	10309	6630	11840	9438	6229	9973	1758	5200	13669	15783
5	2256	2926	1791	1816	3644	2561	3814	2328	1450	2105	386	5378	6458
6	959	888	968	680	761	1301	976	949	598	263	751	2244	2769
7	616	341	333	323	297	263	432	338	211	141	81	916	1167
8	101	206	95	144	128	97	76	140	76	47	40	385	518
9	66	35	71	25	80	25	37	25	33	25	13	153	223
10	33	18	13	29	7	27	8	16	8	10	8	59	91
+gp	17	24	30	11	14	19	22	3	1	2	4		
0 TOT/	402321	296234	432543	397431	314973	530697	267336	197842	246011	165869	72855		

1

Table 3.4.4 Cod in Subarea IV and Divisions VIId and IIIa (Skagerrak): summary table

Year	Recruitment Age 1 thousands	SSB tonnes	Landings tonnes	Mean F Ages 2-8	Mean F Ages 2-4
1963	195099	151521	116457	0.4732	0.4506
1964	374080	166150	126041	0.4928	0.462
1965	415425	205425	181036	0.5458	0.5839
1966	506863	230759	221336	0.5145	0.5688
1967	488789	250046	252977	0.6124	0.5862
1968	194587	258219	288368	0.6158	0.6953
1969	209061	255921	200760	0.5742	0.5242
1970	782003	276848	226124	0.5514	0.6321
1971	910808	277216	328098	0.6695	0.7883
1972	173496	231011	353976	0.8246	0.8167
1973	319648	209145	239051	0.6919	0.7711
1974	263657	230838	214279	0.6589	0.7078
1975	486359	211636	205245	0.7084	0.7295
1976	246421	182050	234169	0.7045	0.8511
1977	839198	159349	209154	0.7107	0.7207
1978	488156	159354	297022	0.8247	0.9054
1979	525424	164266	269973	0.6765	0.7772
1980	899522	181875	293644	0.8020	0.8848
1981	314766	195731	335497	0.7597	0.9179
1982	618498	190226	303251	0.8931	1.0307
1983	324685	154987	259287	0.9107	1.0644
1984	596292	133414	228286	0.8173	0.9346
1985	158611	126206	214629	0.7815	0.9172
1986	716254	114213	204053	0.8909	0.972
1987	281821	104722	216212	0.8842	0.9122
1988	197054	98642	184240	0.8634	0.9866
1989	274077	90604	139936	0.9391	0.9952
1990	133933	78044	125314	0.7748	0.9254
1991	168552	71117	102478	0.9315	0.858
1992	305284	68898	114020	0.8484	0.8787
1993	147360	65087	121749	0.9181	0.9309
1994	323413	64800	110634	0.8626	0.8712
1995	226023	70953	136096	0.7246	0.8887
1996	170710	76252	126320	0.9207	0.8056
1997	407921	79738	124158	0.8655	0.8614
1998	57961	70151	146014	1.0249	1.0987
1999	113291	56902	96225	1.1773	1.0741
2000	177149	41110	71371	1.2317	1.2269
2001	73747	30278	49694	0.9123	0.8147
2002	179000	39000		0.9123	
Average	357125	145568	196594	0.7874	

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

COD IV RCT3 INPUT VALUES; AGE 1*100; 23-Jun-01 Filename = RCT3in1.csv

20 31 2

'YEARCLASS' 'VPA' 'IYFS1' 'IYFS2' 'EGFS0' 'EGFS1' 'EGFS2' 'SGFS1' 'SGFS2' 'DGFS0' 'DGFS1' 'DGFS2' 'FRGSF' 'GGFS1' 'GGFS2' 'IBQ21' 'SCQ21' 'SCQ22' 'IBQ40' 'IBQ41' 'GQ40' 'GQ11'

1970	209061	9830	3450	-1	-1	-1	-1	-1	-1	-1	-1	9040	-1	-1	-1	-1	-1
1971	782003	410	1060	-1	-1	-1	-1	-1	-1	-1	-1	130	-1	-1	-1	-1	-1
1972	910808	3800	950	-1	-1	-1	-1	-1	-1	-1	-1	160	-1	-1	-1	-1	-1
1973	173496	1470	620	-1	-1	-1	-1	-1	-1	-1	-1	360	-1	-1	-1	-1	-1
1974	319648	4030	1990	-1	-1	-1	-1	-1	-1	-1	-1	800	-1	-1	-1	-1	-1
1975	263657	790	320	-1	-1	447	-1	-1	-1	-1	-1	780	-1	-1	-1	-1	-1
1976	486359	3670	2930	-1	6270	1250	-1	-1	-1	-1	-1	2820	-1	-1	-1	-1	-1
1977	246421	1290	930	1389	2284	580	-1	-1	-1	-1	-1	2720	-1	-1	-1	-1	-1
1978	839198	990	1480	1256	2423	670	-1	-1	-1	-1	450	3110	-1	-1	-1	-1	-1
1979	488156	1690	2550	1855	5084	1386	-1	-1	-1	16380	1120	3550	-1	-1	-1	-1	-1
1980	525424	290	670	1023	1136	290	-1	351	4320	4690	160	1410	-1	-1	-1	-1	-1
1981	899522	920	1660	7424	3237	1096	614	78	17680	8300	230	2320	-1	350	-1	-1	-1
1982	314766	390	800	255	1540	475	325	391	2690	2180	160	900	590	240	-1	-1	-1
1983	618498	1520	1760	9510	6122	1189	819	1143	12150	12130	310	4300	260	2240	-1	-1	-1
1984	324685	90	360	38	430	115	66	104	130	360	20	90	230	260	-1	-1	-1
1985	596292	1700	2880	828	3438	1065	801	695	14360	11120	800	950	1540	1140	-1	-1	-1
1986	158611	880	610	121	1422	407	219	288	3700	4150	170	230	700	950	-1	-1	-1
1987	716254	360	630	38	836	248	162	135	3620	1780	220	210	200	720	-1	-1	-1
1988	281821	1310	1520	1678	2285	504	561	490	1660	1660	190	420	9020	1470	-1	-1	-1
1989	197054	340	410	598	608	155	114	154	1370	920	70	60	1190	620	-1	-1	3140
1990	274077	240	450	383	752	159	303	193	2350	720	110	-1	1550	360	850	1490	5330
1991	133933	1300	1990	4840	2440	650	642	749	3980	4540	70	-1	1340	-1	3630	19080	14460
1992	168552	1270	440	1684	742	295	347	334	1160	170	90	-1	-1	450	1100	4820	3410
1993	305284	1480	2210	377	2637	1277	1158	1443	2410	4690	-1	-1	3080	1430	3200	2030	20470
1994	147360	970	800	2134	1028	668	475	356	6350	-1	-1	-1	430	-1	1960	4270	5660
1995	323413	350	690	26	619	284	318	278	-1	-1	-1	-1	-1	-1	370	770	1920
1996	226023	4000	2640	4122	4044	1396	999	-1	-1	-1	-1	-1	-1	-1	7580	2830	-1
1997	170710	270	160	4.9	118	55	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
1998	407921	210	380	389	367	197	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
1999	-1	660	880	95	953	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
2000	-1	270	319	40	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
2001	-1	755	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1

Table 3.10.2. Cod in Sub-area IV, Divisions IIIa (Skagerrak) and VIId: Results of TSA

No landings data for 2001 Number x 10^{-4}

year		landings		mean f		ssb		stock biomass		recruitment	
	actual	predicted	se	estimate	se	estimate	se	estimate	se	estimate	se
1990	12.6021	12.8477	0.5162	0.925	0.0343	7.8777	0.3111	32.7085	0.9106	13.3743	0.7491
1991	10.2788	10.472	0.4179	0.8869	0.0344	6.9609	0.2713	29.0546	0.8147	16.1234	0.8196
1992	11.4839	11.2015	0.4272	0.8763	0.034	6.7952	0.2347	39.8725	1.0593	30.8404	1.2591
1993	12.2382	12.6184	0.5452	0.9074	0.034	6.324	0.2095	34.4041	0.9129	15.7371	0.7775
1994	11.129	11.4914	0.4767	0.8696	0.0312	6.4502	0.2071	41.2572	1.2036	30.8179	1.4925
1995	13.8373	13.5187	0.5981	0.8667	0.0309	7.084	0.2298	41.339	1.1421	22.5102	1.0909
1996	12.6463	13.4035	0.5736	0.8463	0.0298	7.5189	0.2315	37.4002	1.0294	17.0759	0.9354
1997	12.414	12.4287	0.5093	0.8878	0.0328	7.7146	0.2585	49.346	1.5926	43.1509	2.1886
1998	14.6058	14.3401	0.7284	1.0222	0.0388	6.674	0.2404	29.7777	0.9861	4.8811	0.3524
1999	9.5897	9.9419	0.4819	1.0176	0.0428	5.9278	0.2657	23.4885	0.9011	11.8118	0.8589
2000	7.1351	7.1061	0.3621	1.0186	0.0571	4.8621	0.3665	26.1039	1.7669	22.9403	2.5701
2001	4.9686	9.0257	0.8219	1.0111	0.0774	4.3327	0.4408	22.8899	1.8719	8.3403	1.5638
2002	NA	7.7146	0.7634	1.0047	0.1031	3.7753	0.3917	24.7584	4.4088	18.977	6.2997
2003	NA	7.6023	1.3474	1.0059	0.1211	3.5748	0.5571	23.4435	5.5463	14.8627	6.94
2004	NA	7.9456	1.8372	1.0059	0.1362	3.5473	0.7759	23.0493	6.1388	14.244	6.78

Including landings for 2001

year		landings		mean f		ssb		stock biomass		recruitment	
	actual	predicted	se	estimate	se	estimate	se	estimate	se	estimate	se
1990	12.6021	12.8036	0.5398	0.9246	0.036	7.8441	0.3164	32.5964	0.9513	13.3433	0.7826
1991	10.2788	10.4464	0.4377	0.887	0.036	6.9314	0.2758	28.9327	0.8499	16.0324	0.8519
1992	11.4839	11.1145	0.4469	0.876	0.0356	6.7552	0.2384	39.6857	1.1034	30.7442	1.3107
1993	12.2382	12.5669	0.5693	0.9061	0.0355	6.2888	0.2135	34.291	0.9526	15.7084	0.8094
1994		11.4454	0.4968	0.87	0.0327	6.4271	0.2121	41.1639	1.13	30.749	1.339
1995	13.8373	13.57	0.5734	0.8709	0.0313	7.0709	0.2351	41.2293	1.0511	22.4072	0.9915
1996	12.6463	13.269	0.5293	0.8452	0.0286	7.4745	0.2277	37.1415	0.9343	16.9598	0.846
1997	12.414	12.392	0.4741	0.8862	0.0301	7.6613	0.2408	48.1596	1.3825	41.4799	1.8746
1998	14.6058	14.3401	0.6558	1.0586	0.0356	6.6074	0.2149	29.0027	0.8661	4.8022	0.3516
1999	9.5897	9.5629	0.4203	1.0799	0.0384	5.5824	0.2191	21.5062	0.7061	10.2894	0.6727
2000	7.1351	6.5131	0.3254	1.0729	0.0524	4.1162	0.2747	20.1418	1.0572	15.9107	1.4661
2001	4.9686	5.9567	0.3089	0.9471	0.0687	3.17	0.3124	17.1863	1.4345	7.0427	1.3762
2002	0	5.8568	0.5811	0.9526	0.1012	3.0743	0.3326	19.6436	3.5882	14.7075	5.0553
2003	NA	6.138	1.0461	0.9537	0.1206	3.158	0.5096	19.4184	4.6571	12.2222	5.7859
2004	NA	6.3834	1.4634	0.9537	0.1369	3.1406	0.7143	19.8438	5.4225	12.493	6.0366

No landings for 2000 or 2001

year		landings		mean f		ssb		stock biomass		recruitment	
	actual	predicted	se	estimate	se	estimate	se	estimate	se	estimate	se
1990	12.6021	12.8546	0.5086	0.9251	0.0338	7.8864	0.3097	32.7252	0.894	13.3704	0.7348
1991	10.2788	10.4636	0.4096	0.886	0.0339	6.9685	0.2704	29.0774	0.7988	16.1433	0.8039
1992	11.4839	11.22	0.4212	0.8753	0.0335	6.8139	0.234	39.9147	1.0407	30.8447	1.2371
1993	12.2382	12.6263	0.5376	0.9075	0.0335	6.3454	0.2087	34.4689	0.9226	15.7881	0.8182
1994	11.129	11.5159	0.4777	0.8684	0.0312	6.4686	0.2072	41.2776	1.2907	30.7875	1.63
1995	13.8373	13.4378	0.6308	0.8594	0.0318	7.1162	0.2338	41.3279	1.2325	22.4723	1.174
1996	12.6463	13.4222	0.6117	0.8444	0.0318	7.5839	0.2473	37.3925	1.0859	16.89	0.9539
1997	12.414	12.4619	0.5329	0.8835	0.0351	7.8309	0.2946	50.7086	1.7492	45.1542	2.4262
1998	14.6058	14.4226	0.7608	1.0089	0.0435	6.8122	0.2862	30.5348	1.0904	4.712	0.3363
1999	9.5897	10.1115	0.4996	1.0033	0.0493	6.2458	0.336	24.2432	1.1906	11.55	1.2391
2000	7.1351	8.5752	0.7767	1.0549	0.0699	5.7182	0.5196	30.6117	2.4503	28.4827	3.4848
2001	4.9686	10.1643	1.0891	1.0537	0.0843	4.54	0.4691	25.2119	2.1407	8.7103	1.6173
2002	0	8.5764	0.8855	1.0473	0.11	4.0897	0.4203	26.5474	4.6642	19.8947	6.6562
2003	NA	8.4129	1.4763	1.0476	0.1283	3.9333	0.6167	24.9734	5.9678	15.966	7.5676
2004	NA	8.335	1.9478	1.0476	0.1439	3.6472	0.8152	24.3188	6.6221	15.5031	7.4816

Figure 3.1.1 Cod in Subarea IV and Divisions VIId and IIIa (Skagerrak): Reported landings (tonnes) of cod by statistical rectangle for 1999 from logbook data. Approximately 90% of the reprted landings are displayed.

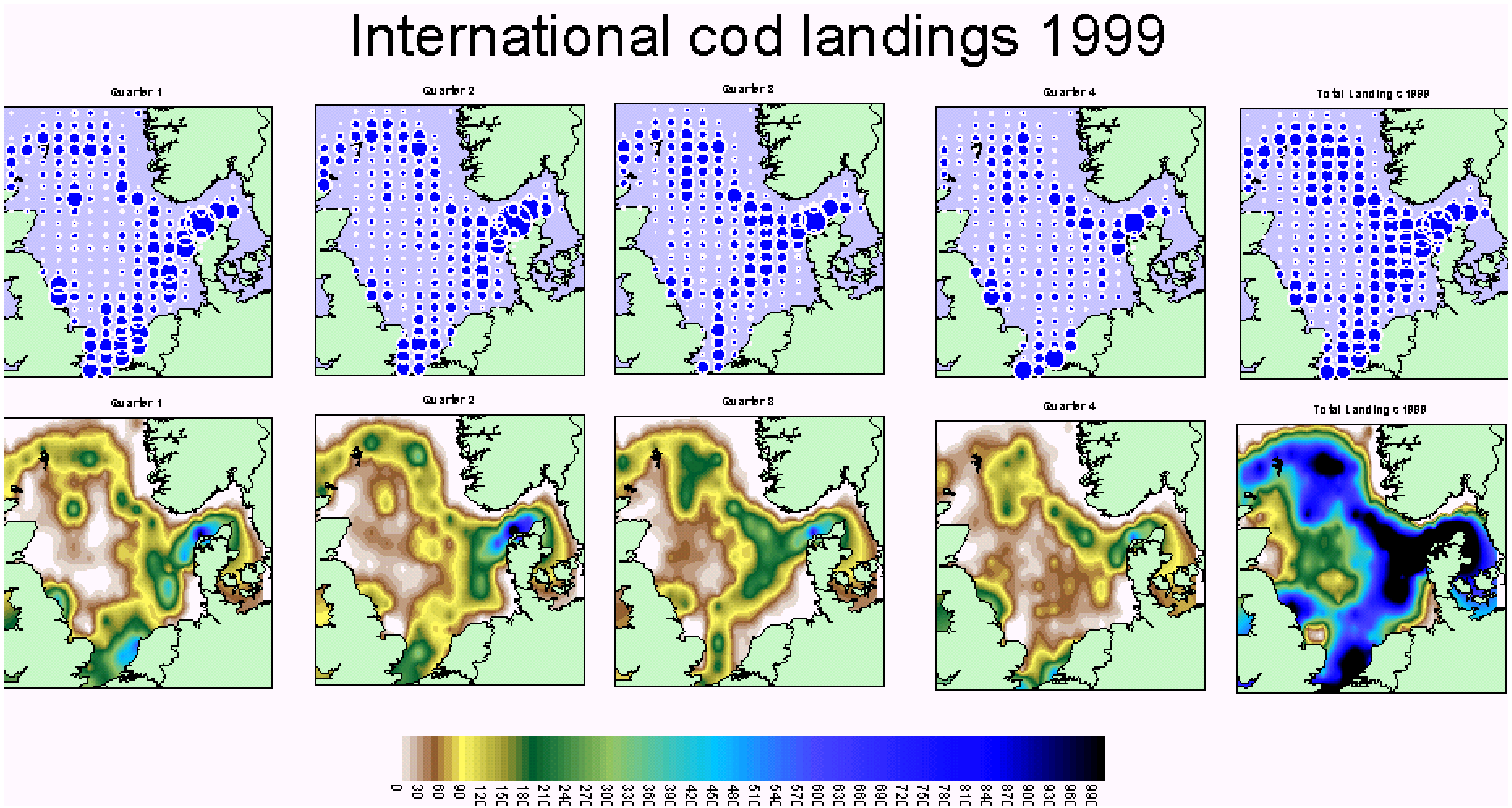


Figure 3.1.2. Cod in Subarea IV and Divisions VIId and IIIa (Skagerrak): Relative density plots (catch rate) of cod from Q1 IBTS 1996-2001.

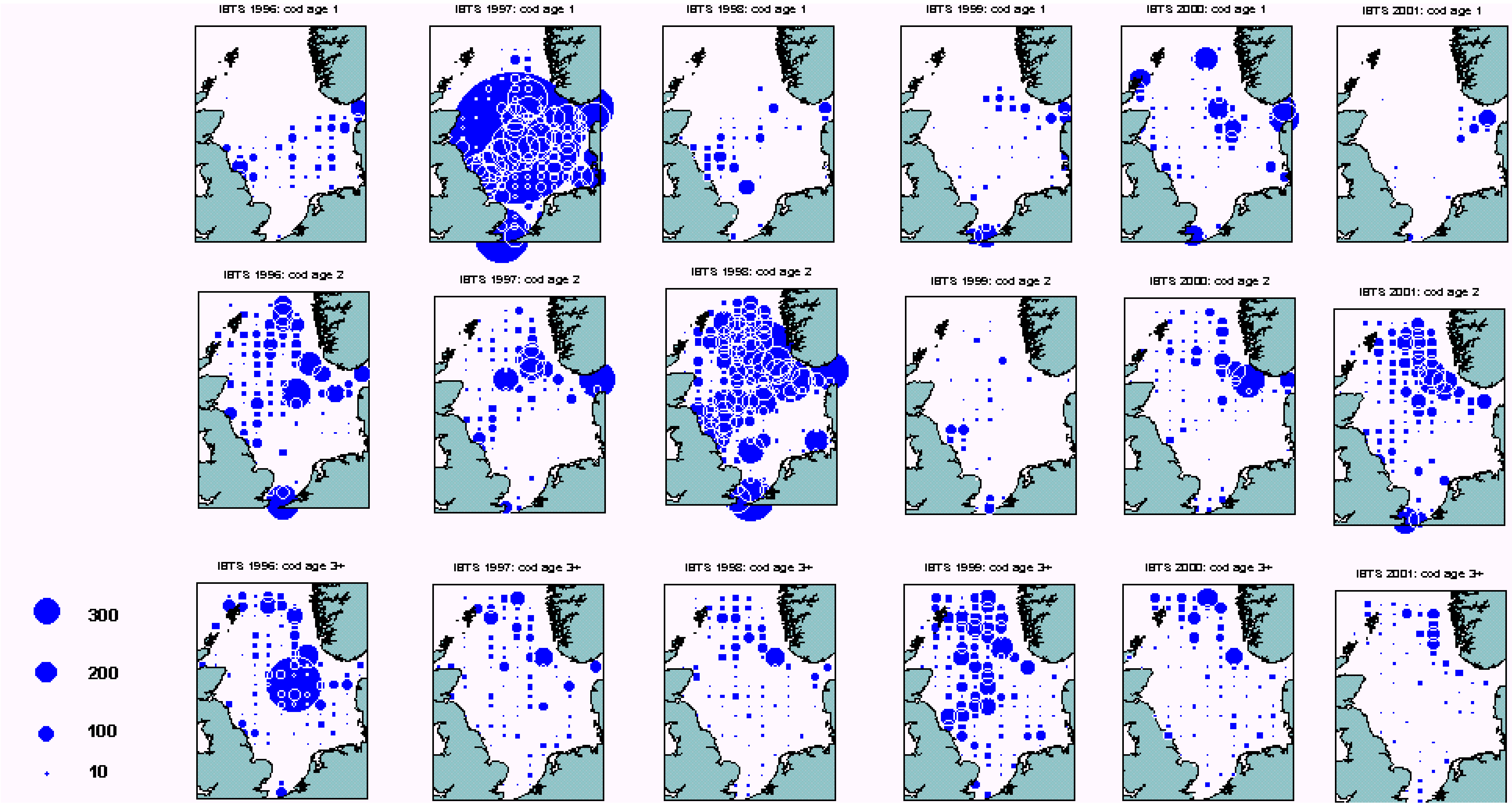


Figure 3.2.1. Cod in Sub-area IV and Divisions IIIa and VIId: Landings in numbers at age

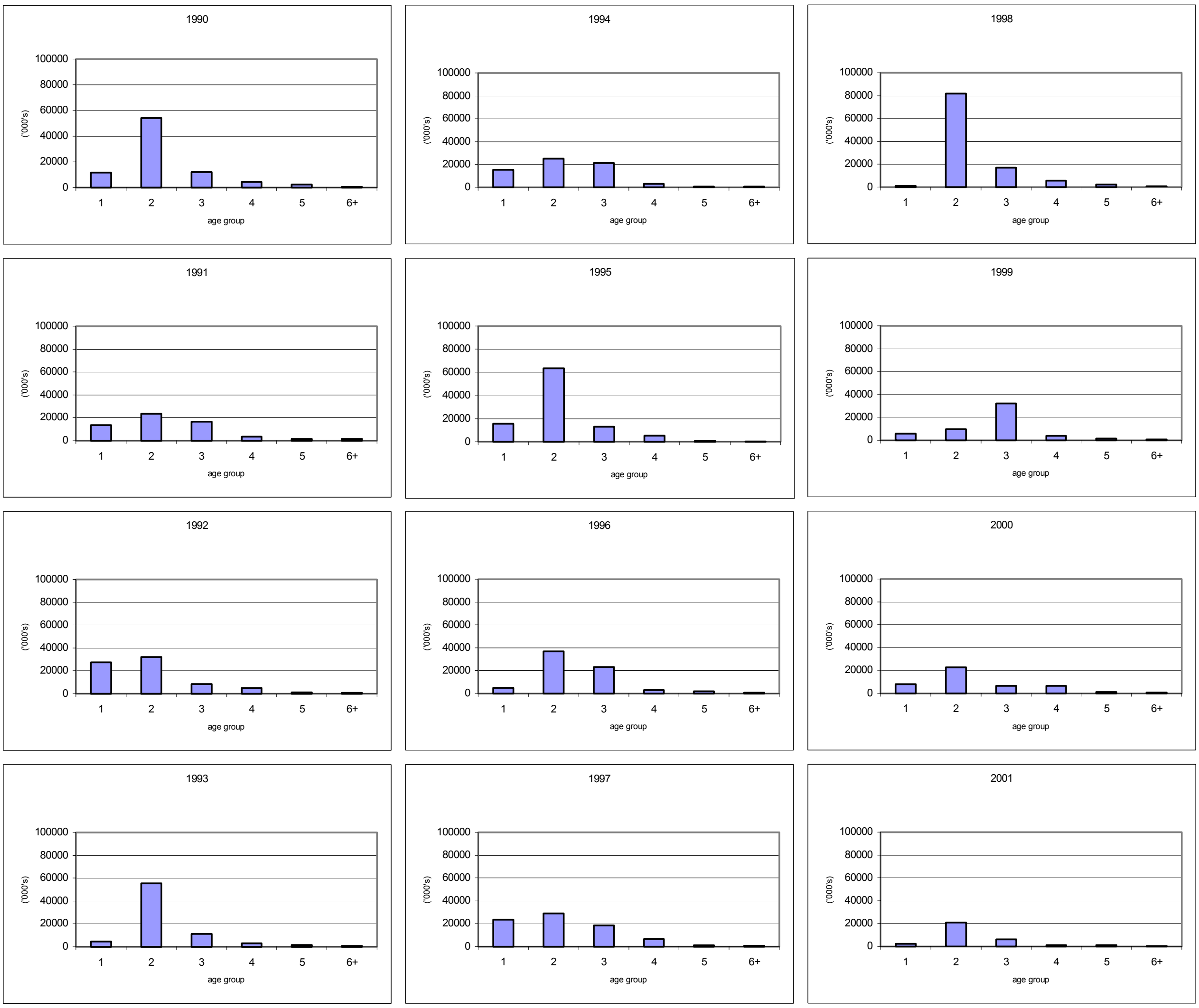
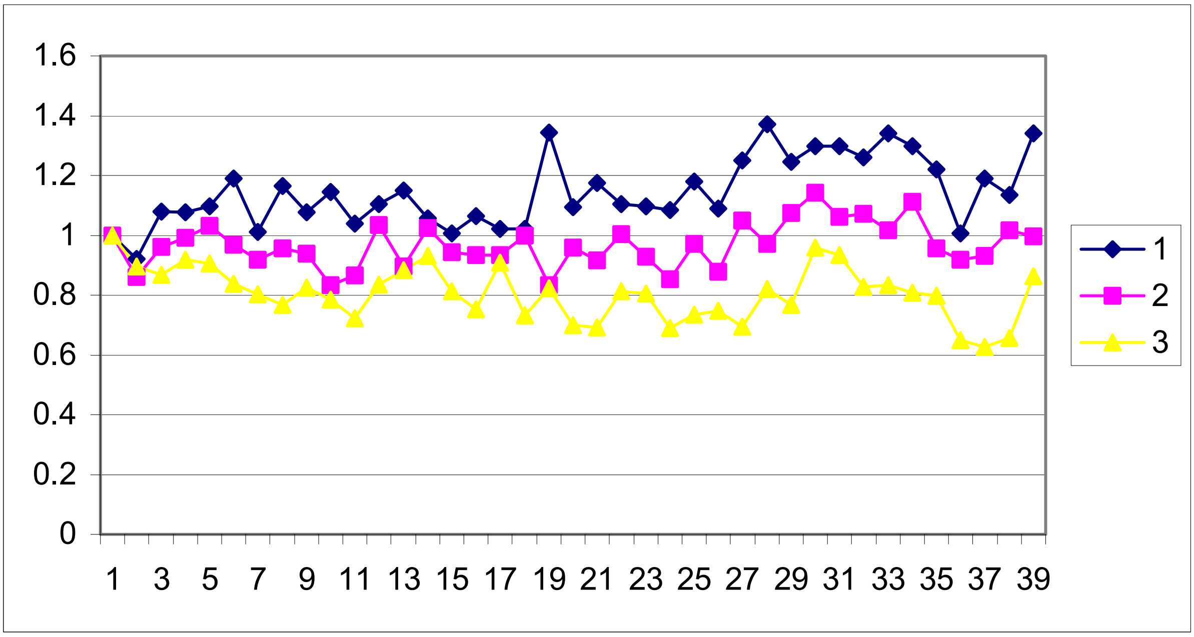


Figure 3.2.2. Cod in Sub-area IV and Divisions IIIa and VIId:
Trends in mean weight in the landings relative to means in 1963



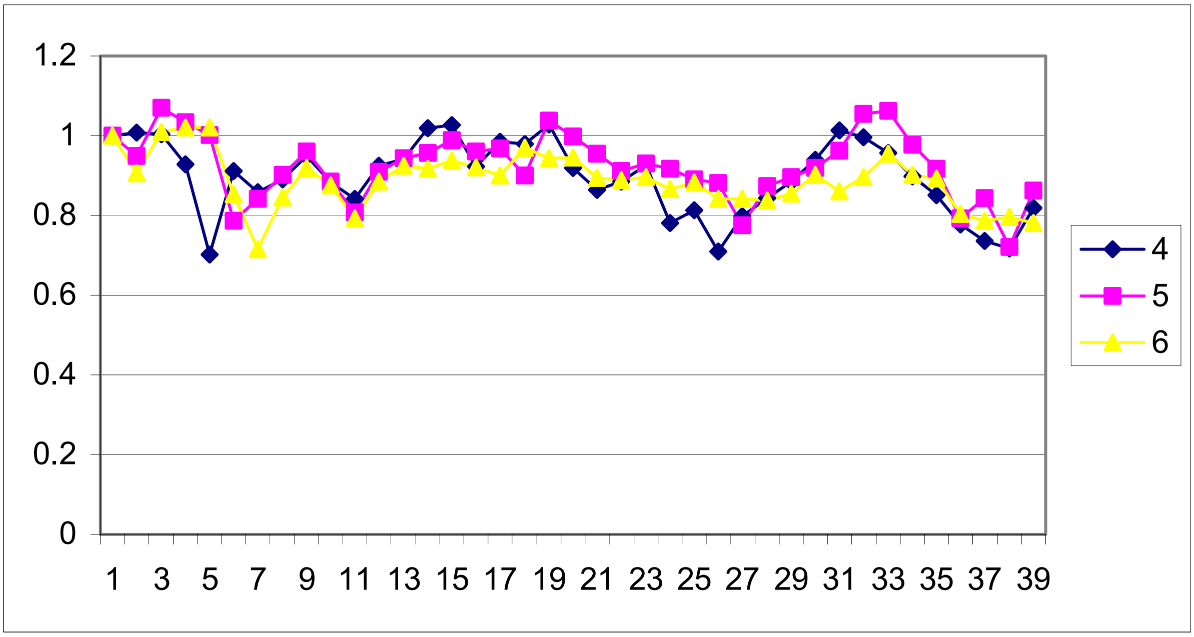


Figure 3.3.1a. Cod in Sub-area IV and Divisions IIIa and VIId: IBTS Q1_4: Survey cpue indices by age group

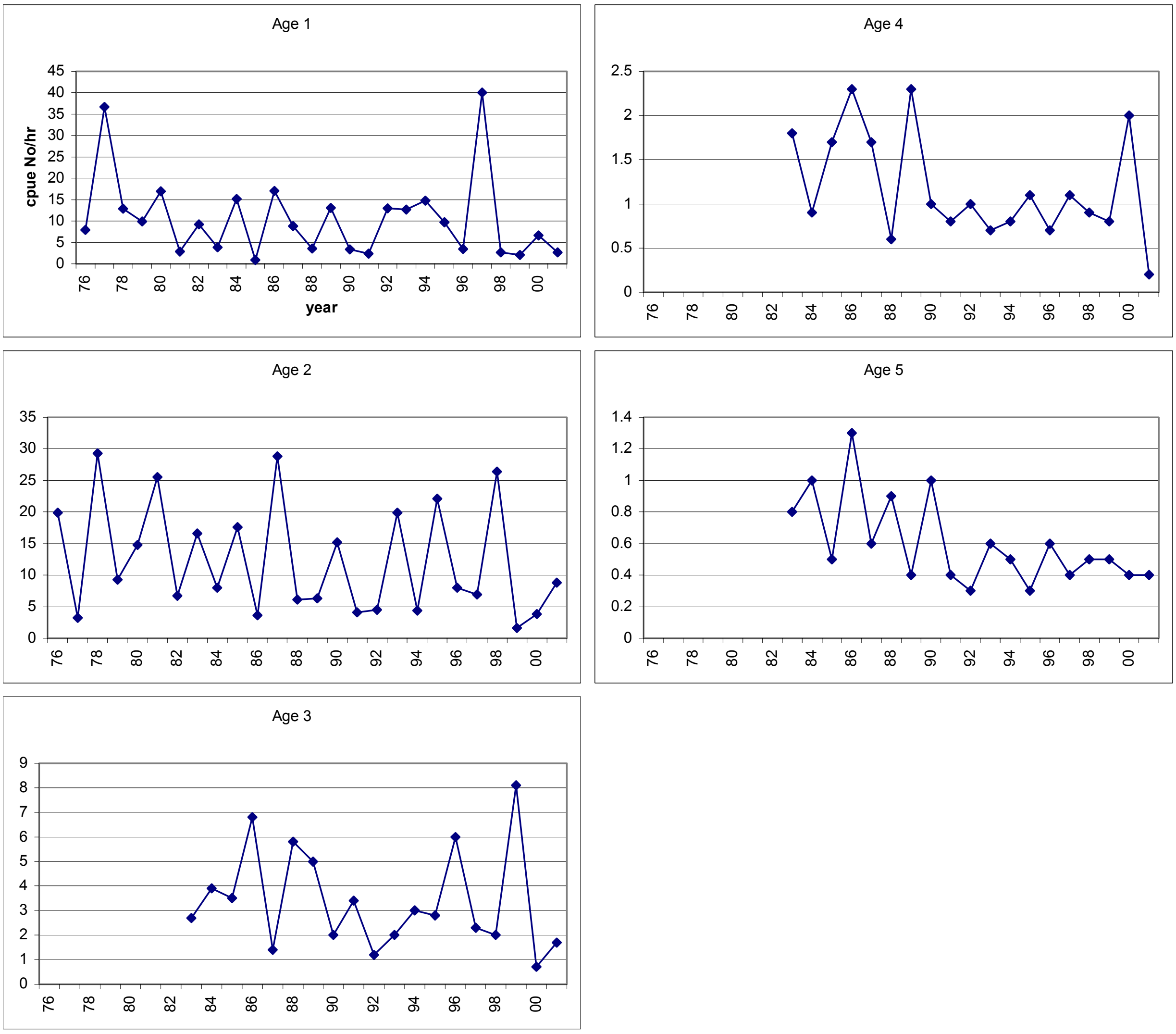


Figure 3.3.1b. Cod in Sub-area IV and Divisions IIIa and VIId: EGFS: Survey cpue indices by age group

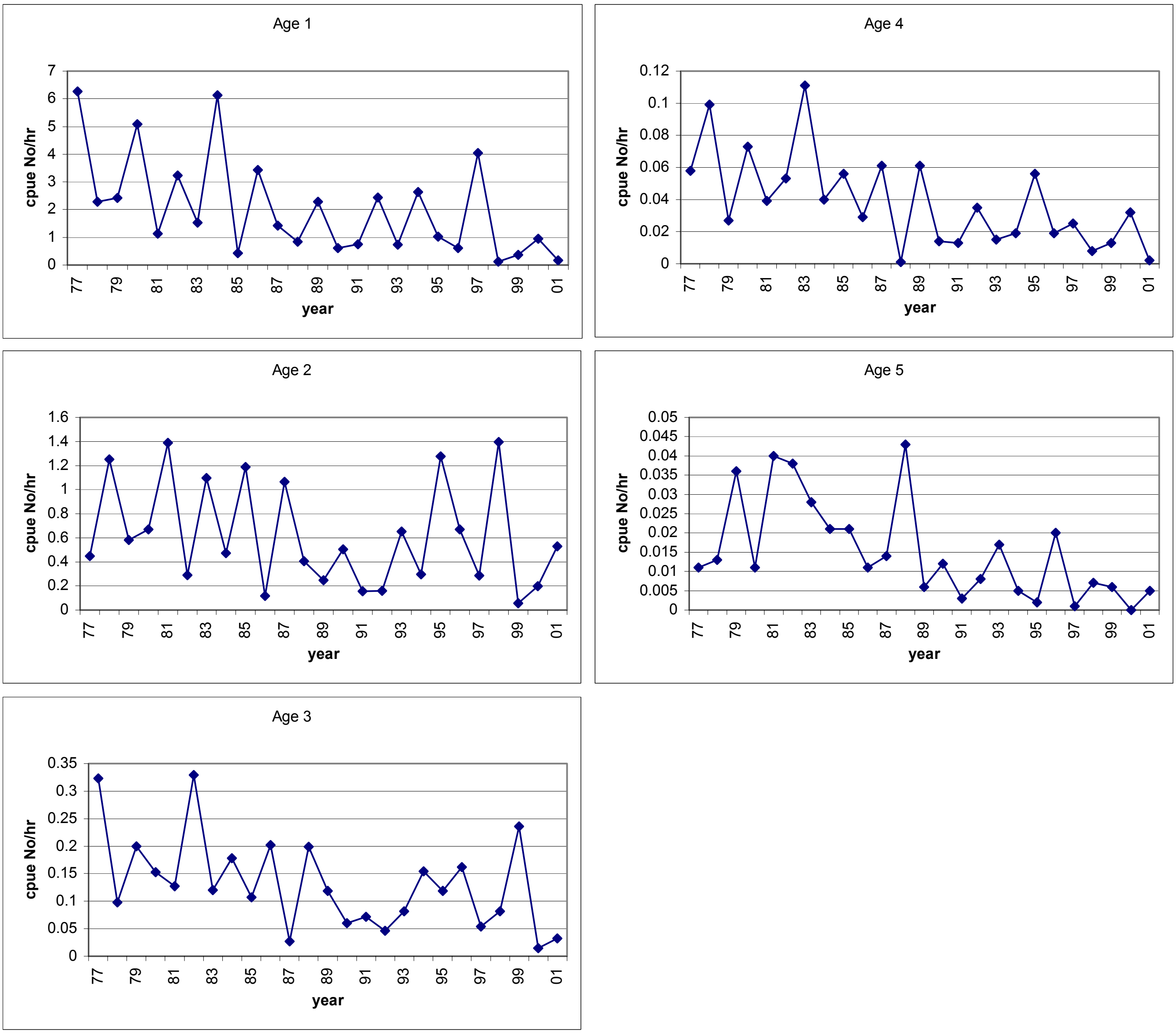


Figure 3.3.1c. Cod in Sub-area IV and Divisions IIIa and VIId: SCOGFS: Survey cpue indices by age group

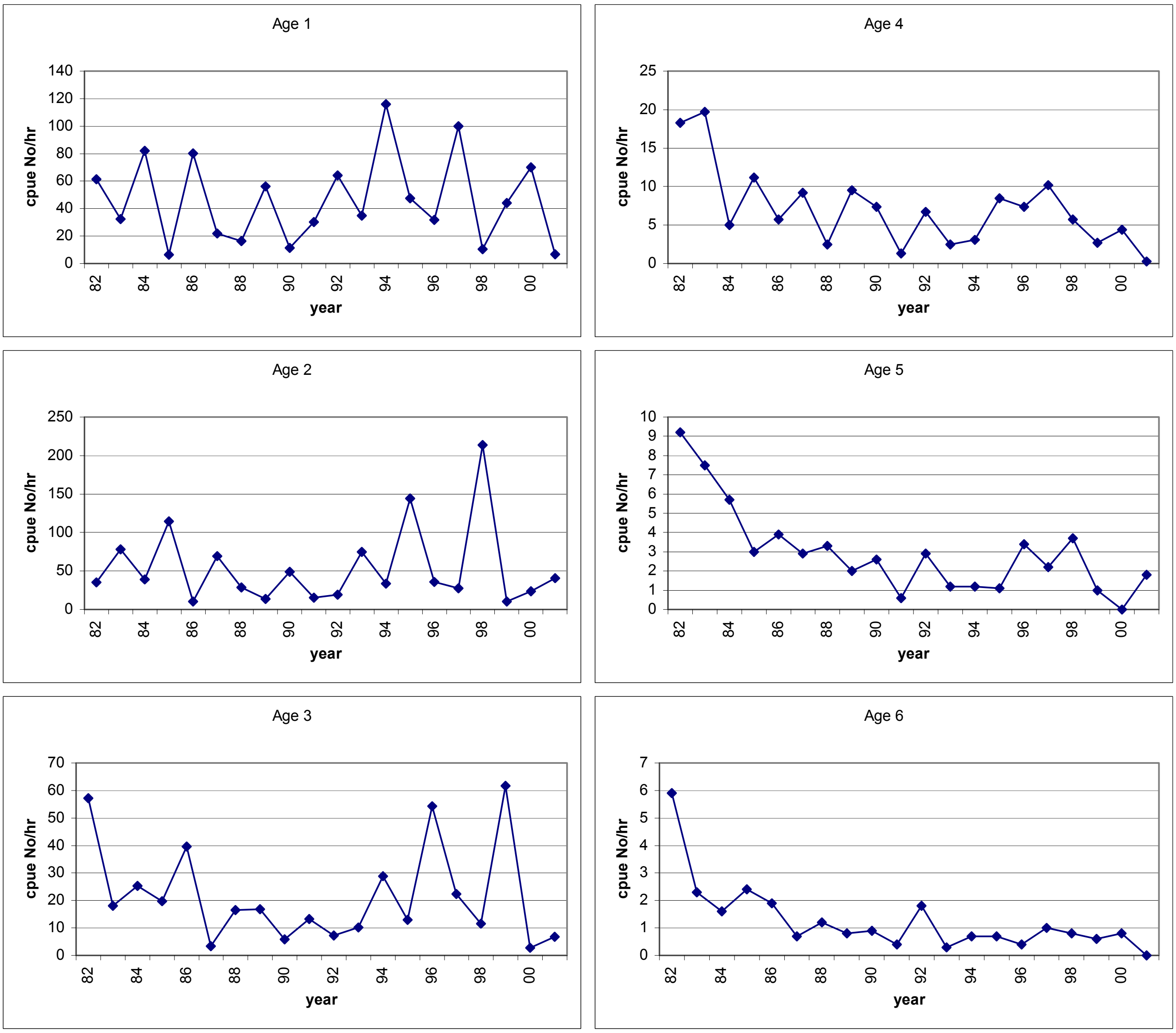


Figure 3.4.1 **Cod in IV, VIId, and IIIa (Skagerrak).** Log-catchability residuals for single-fleet XSA runs with low shrinkage (2.0) and constant q on all ages

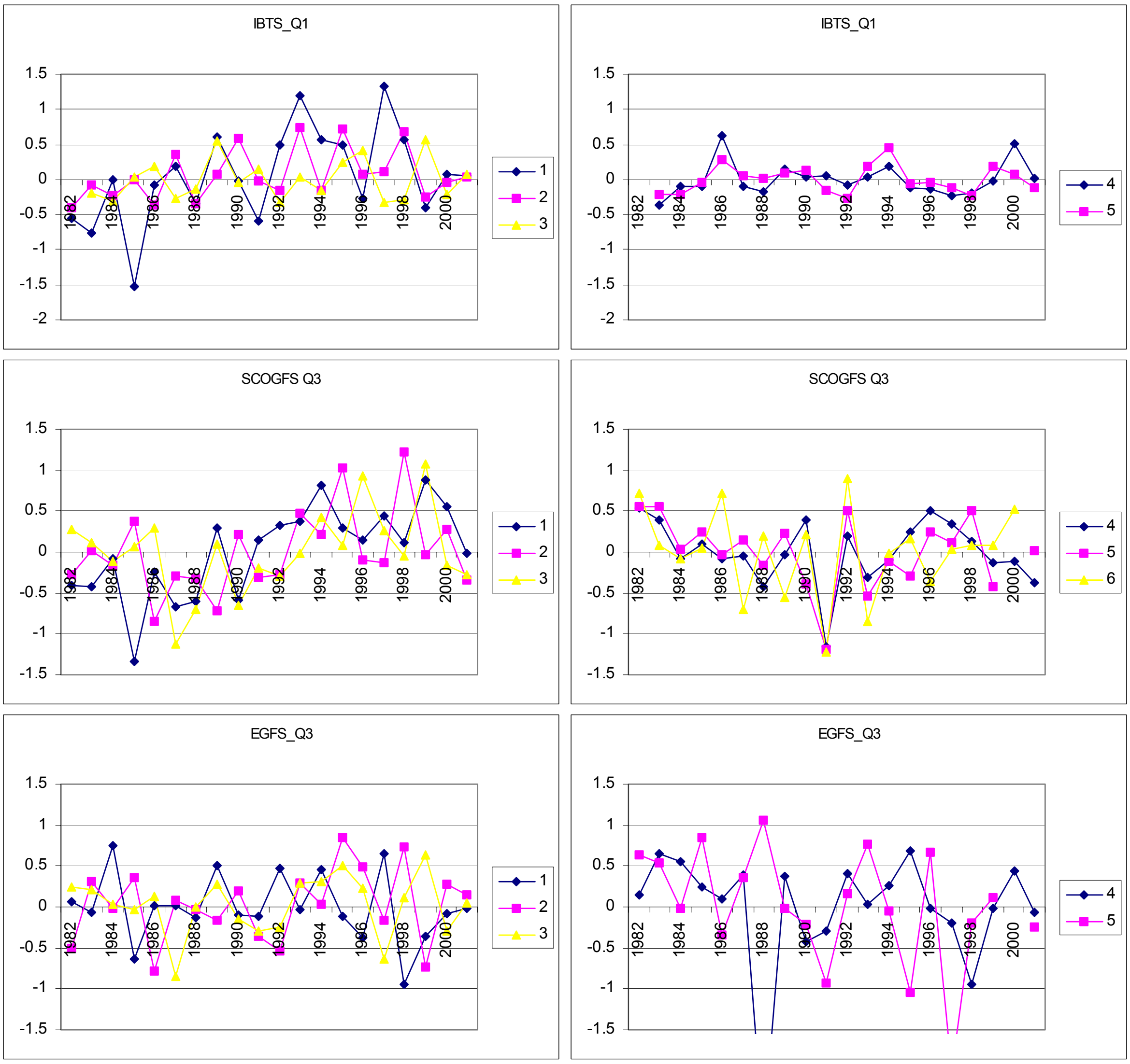


Figure 3.4.2. Cod in Sub-area IV and Divisions IIIa (Skagerrak) and VIId: Results of single-fleet tunings compared to final XSA

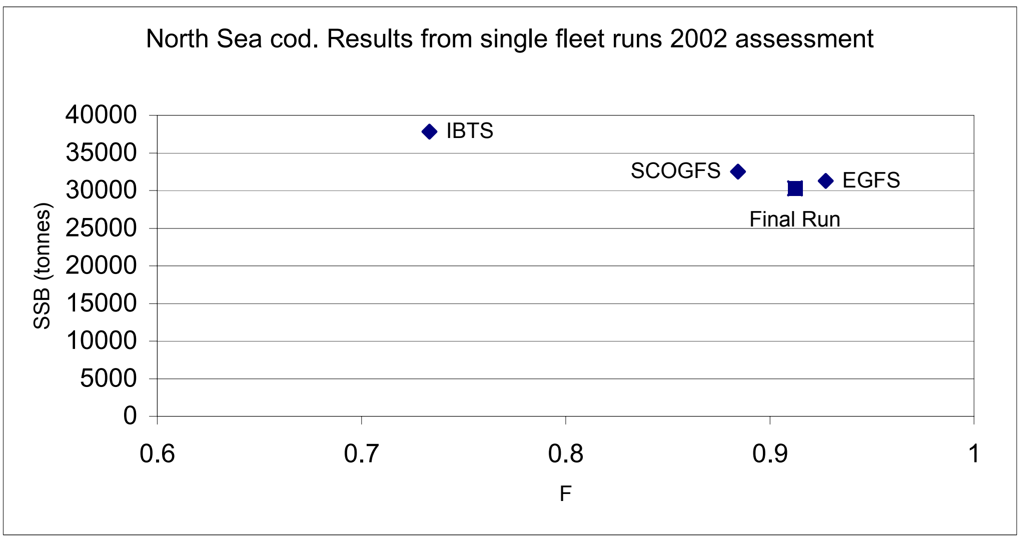


Figure 3.4.3. Cod in sub-area IV and Divisions VIId and IIIa: Exploitation patterns generated by single-fleet tuning runs of XSA

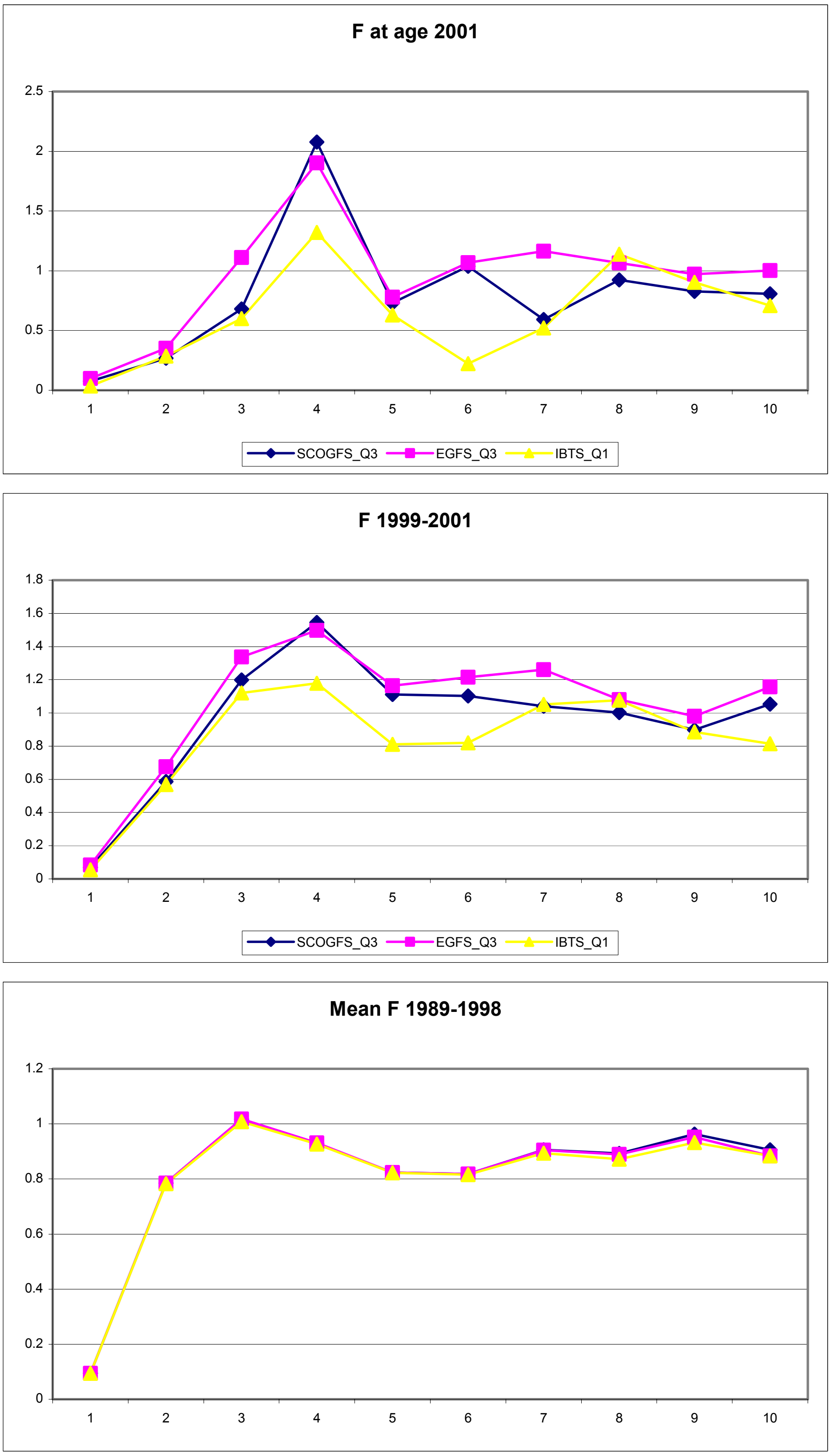


Figure 3.4.4. Cod in Sub-area IV and Divisions Iia and VIId: Log catchability residuals Final Run

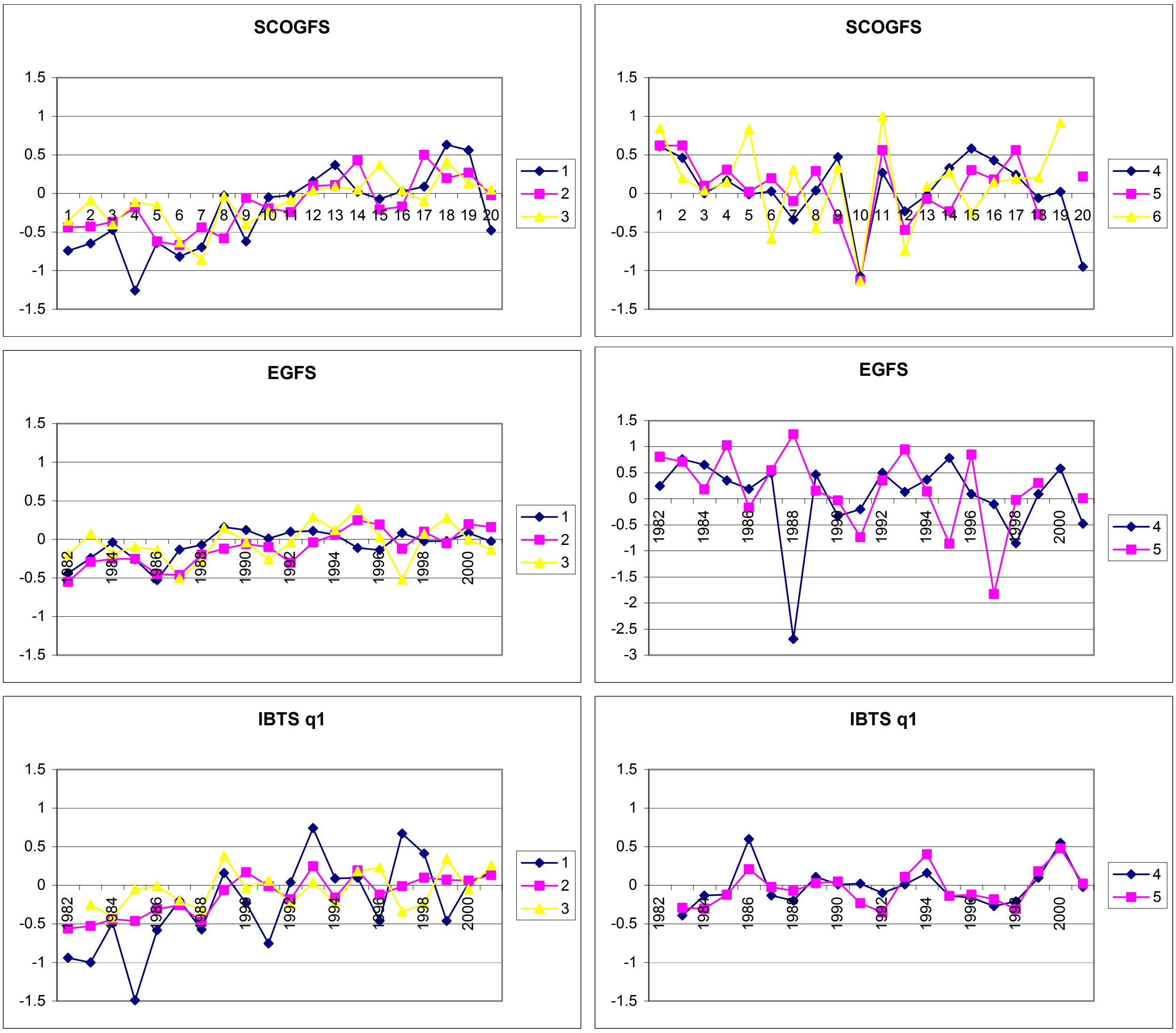
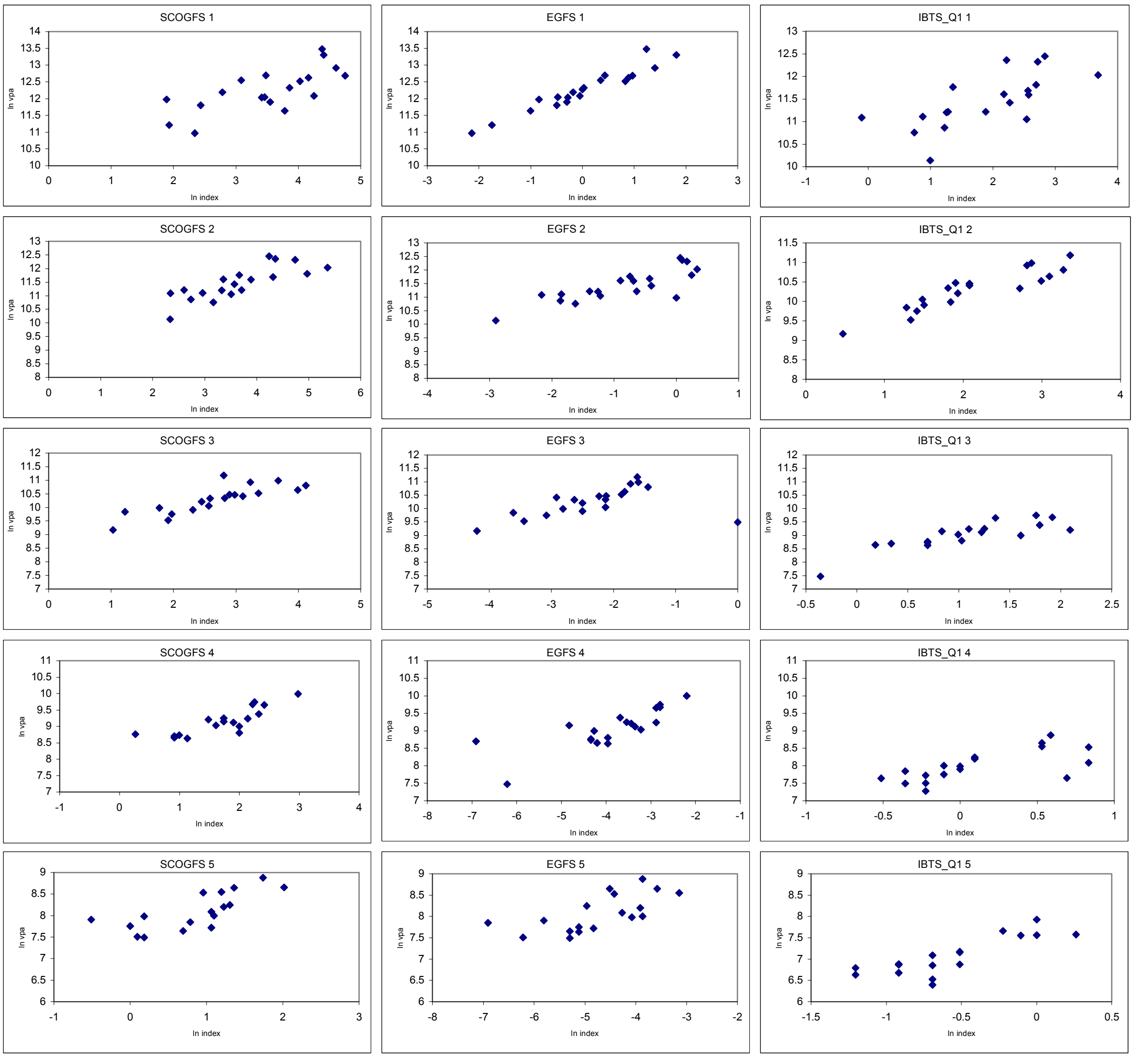
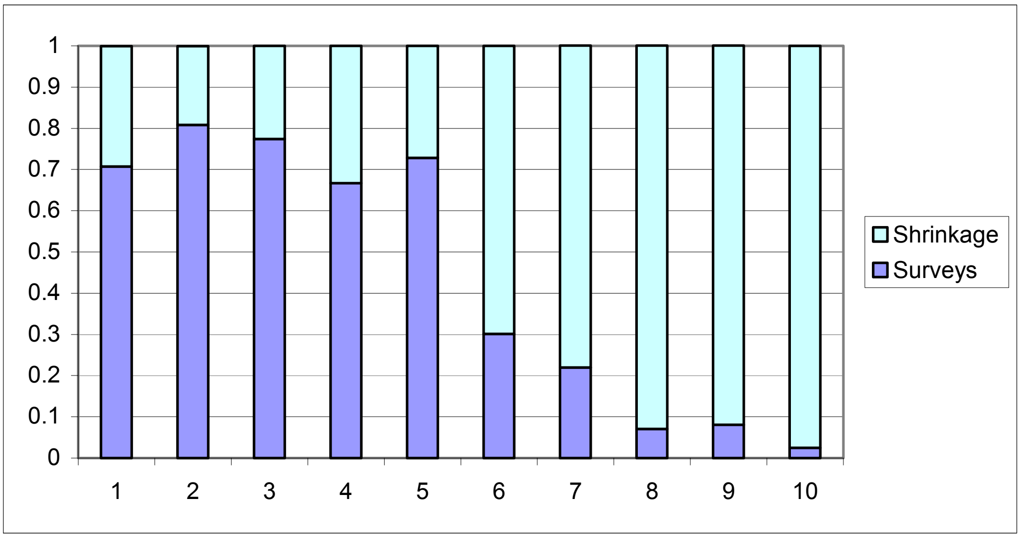
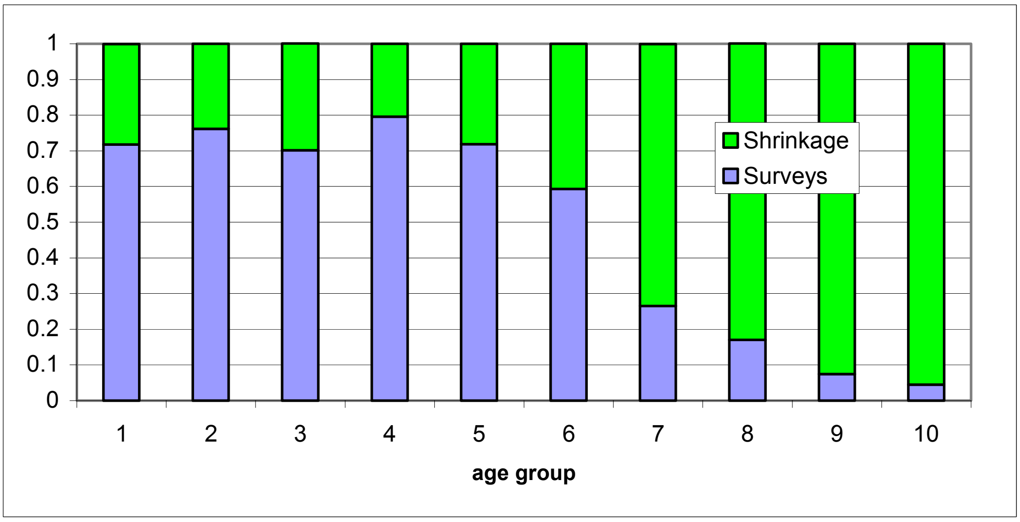


Figure 3.4.5. Cod in Sub-area IV and Divisions IIIa (Skagerrak) and VIId. Log (n) survey cpue adjusted to the start of the year against log(n) vpa population numbers.





1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1
2
3
4
5
6
7
8
9
10
Shrinkage
Surveys



1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1
2
3
4
5
6
7
8
9
10
age group
Shrinkage
Surveys

Figure 3.4.7. Cod in Sub-area IV and Divisions IIIa (Skagerrak) and VIId: Retrospective trends in F, SSB, and recruitment

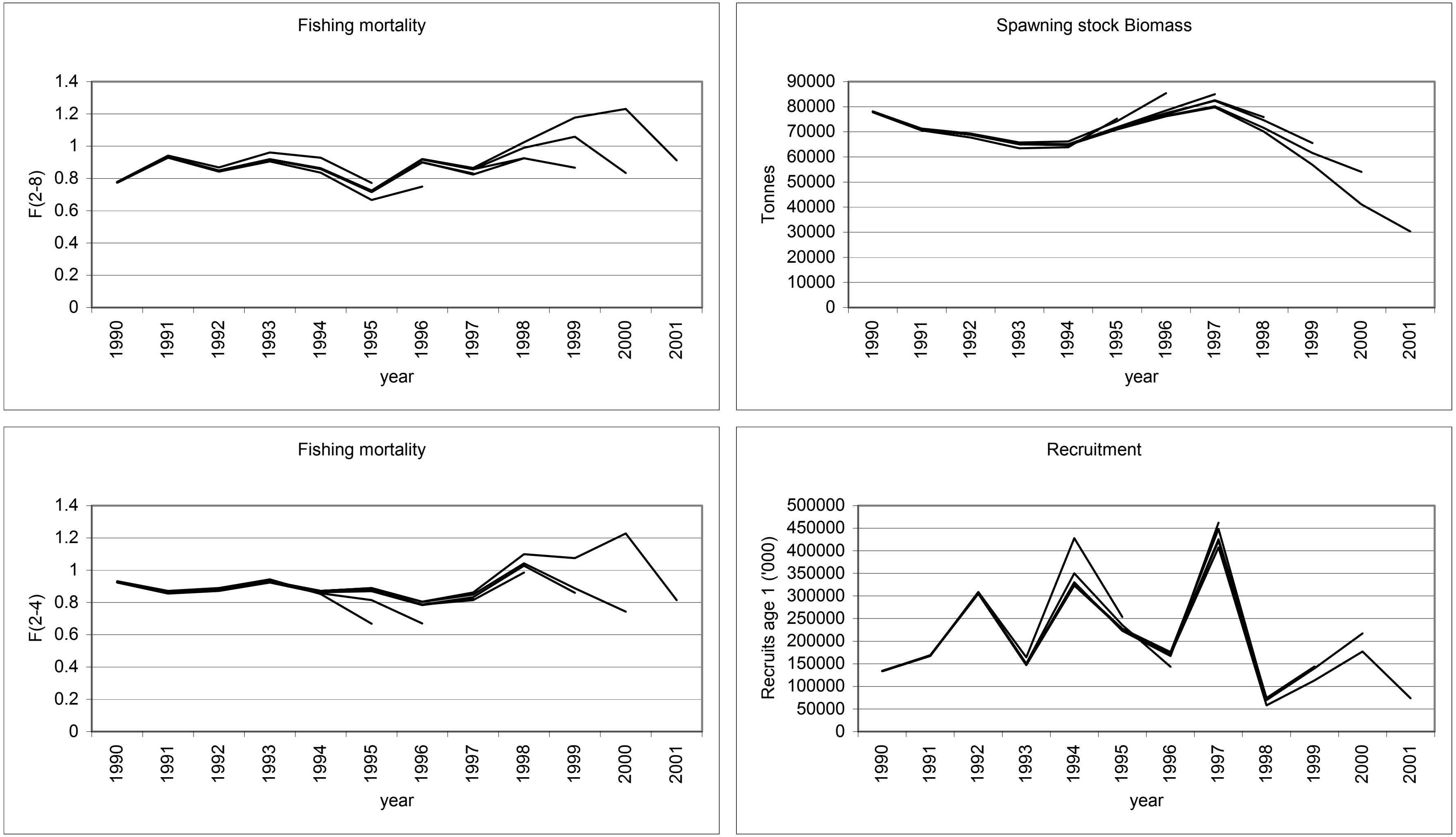
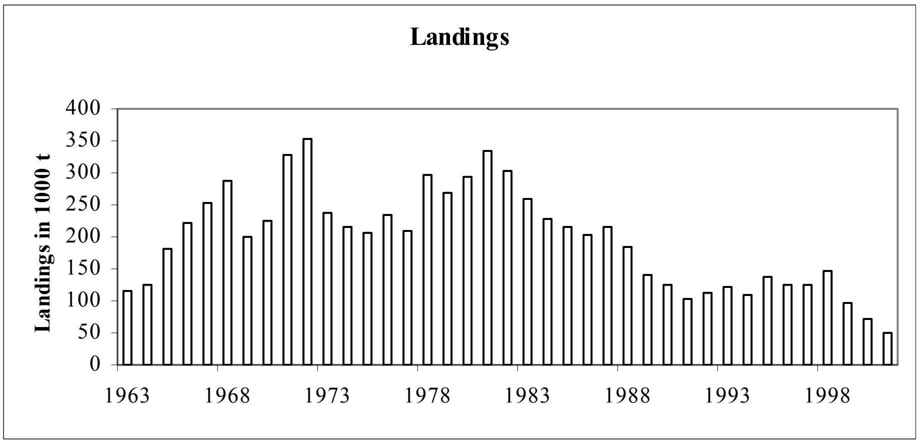
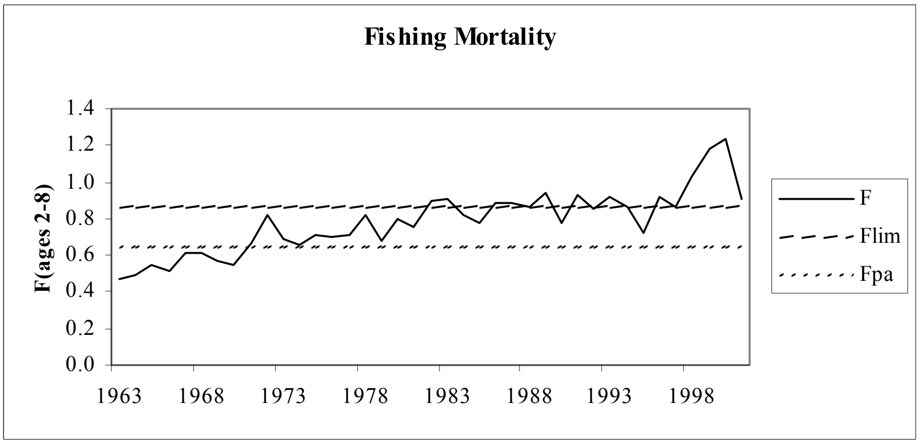
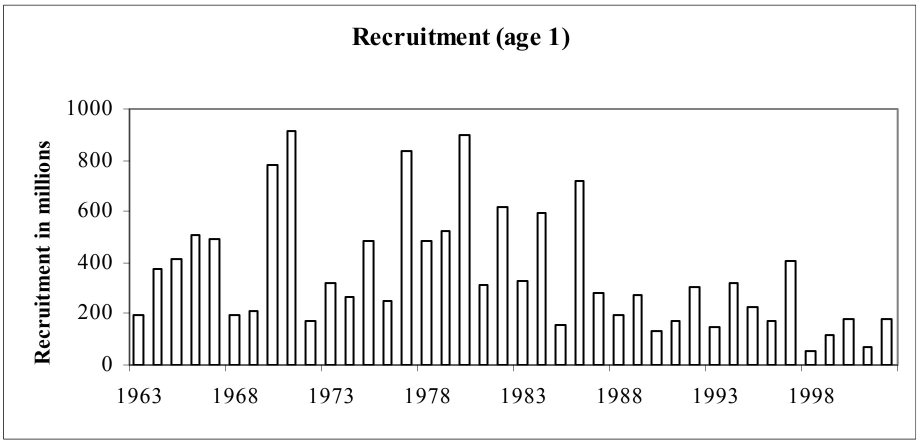


Figure 3.6.1 Cod in Sub-area IV, Divison VIId & Division IIIa (Skagerrak)







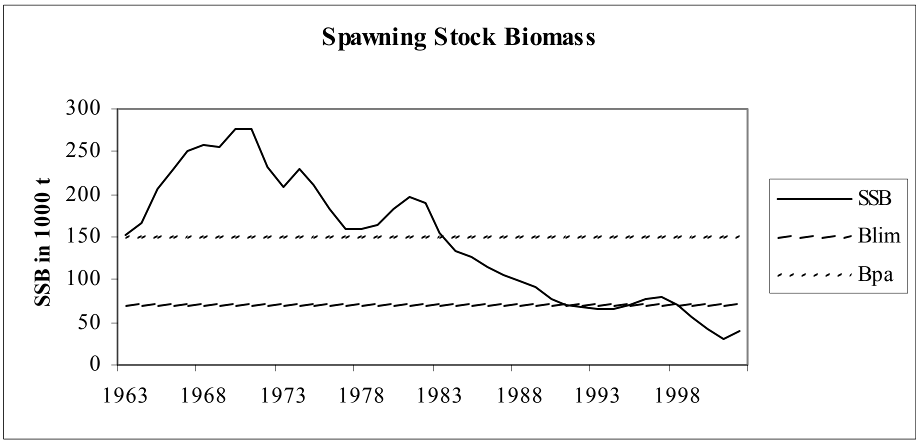
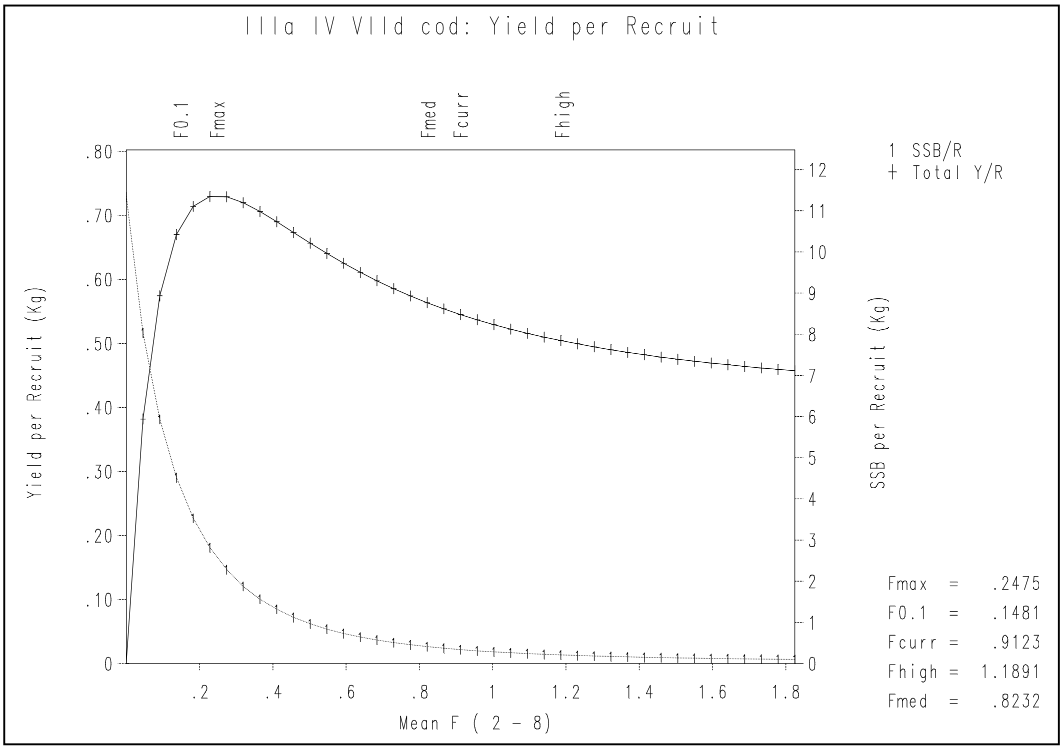


Figure 3.9.1 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId
Long-term equilibrium yield and SSB per recruit



4

Figure 3.9.2 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId
Stock and Recruitment.

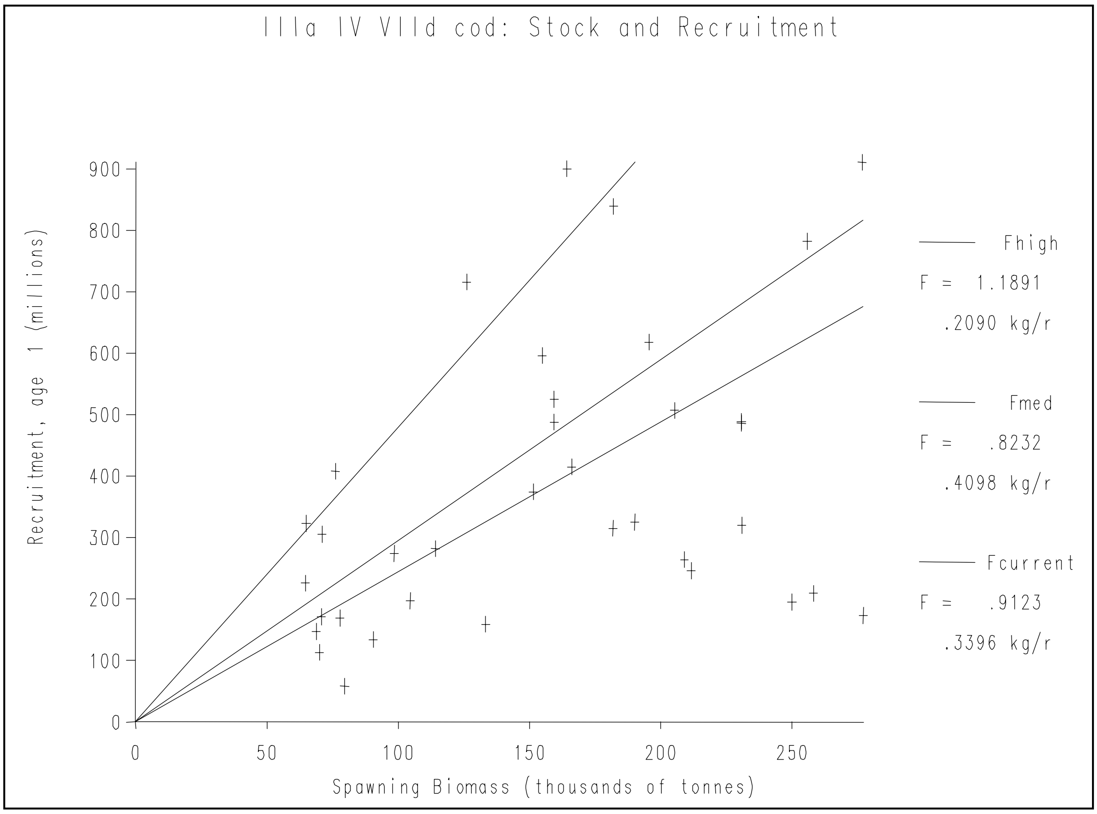


Figure 3.10.1 Cod in IV, VIId, and Skagerrak. Quality control of assessments generated by successive working groups.

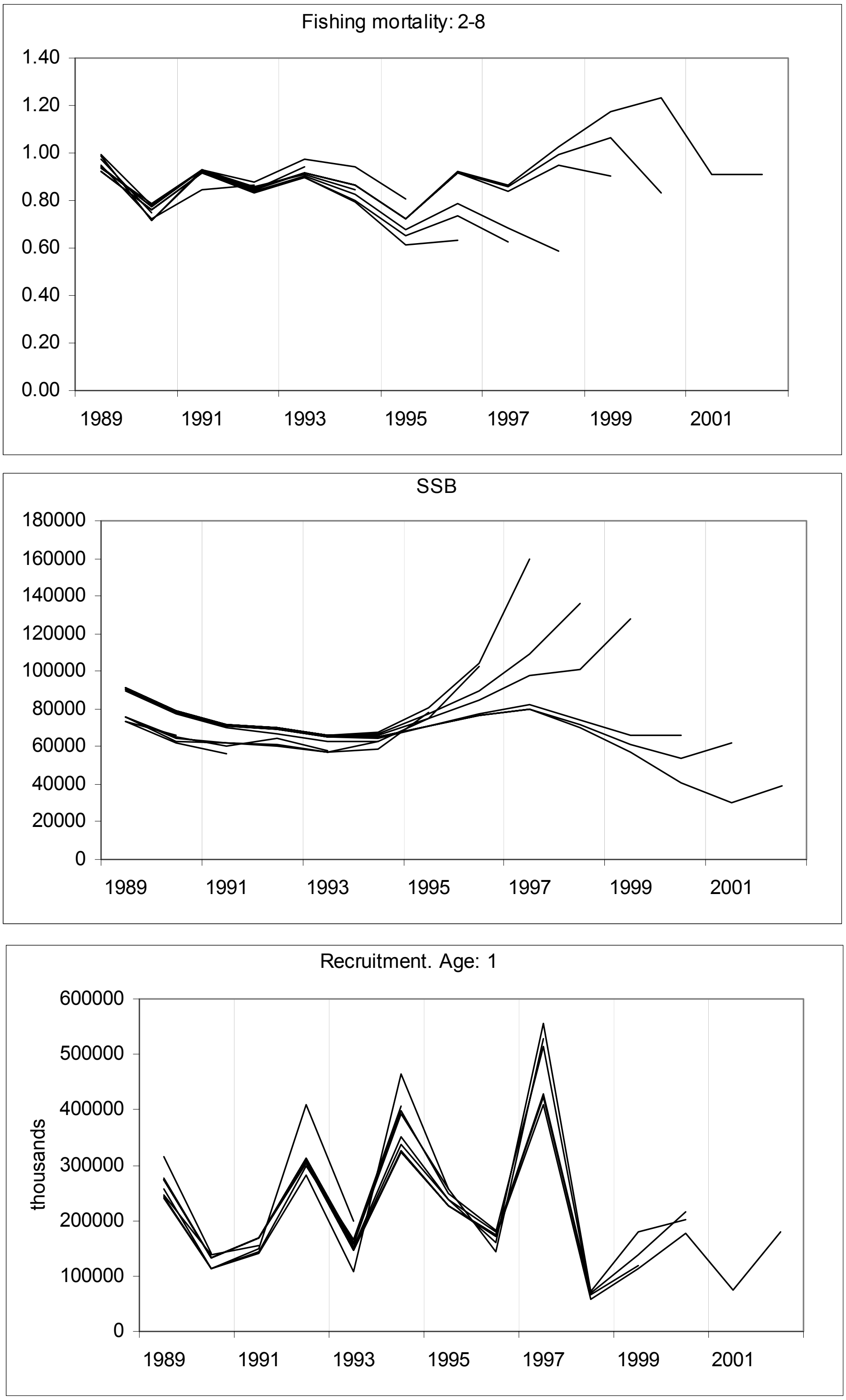


Figure 3.10.2 Cod in IV, VIId, and IIIa (Skagerrak). Comparison of relative SSB and relative F(204) for different survey-only models.

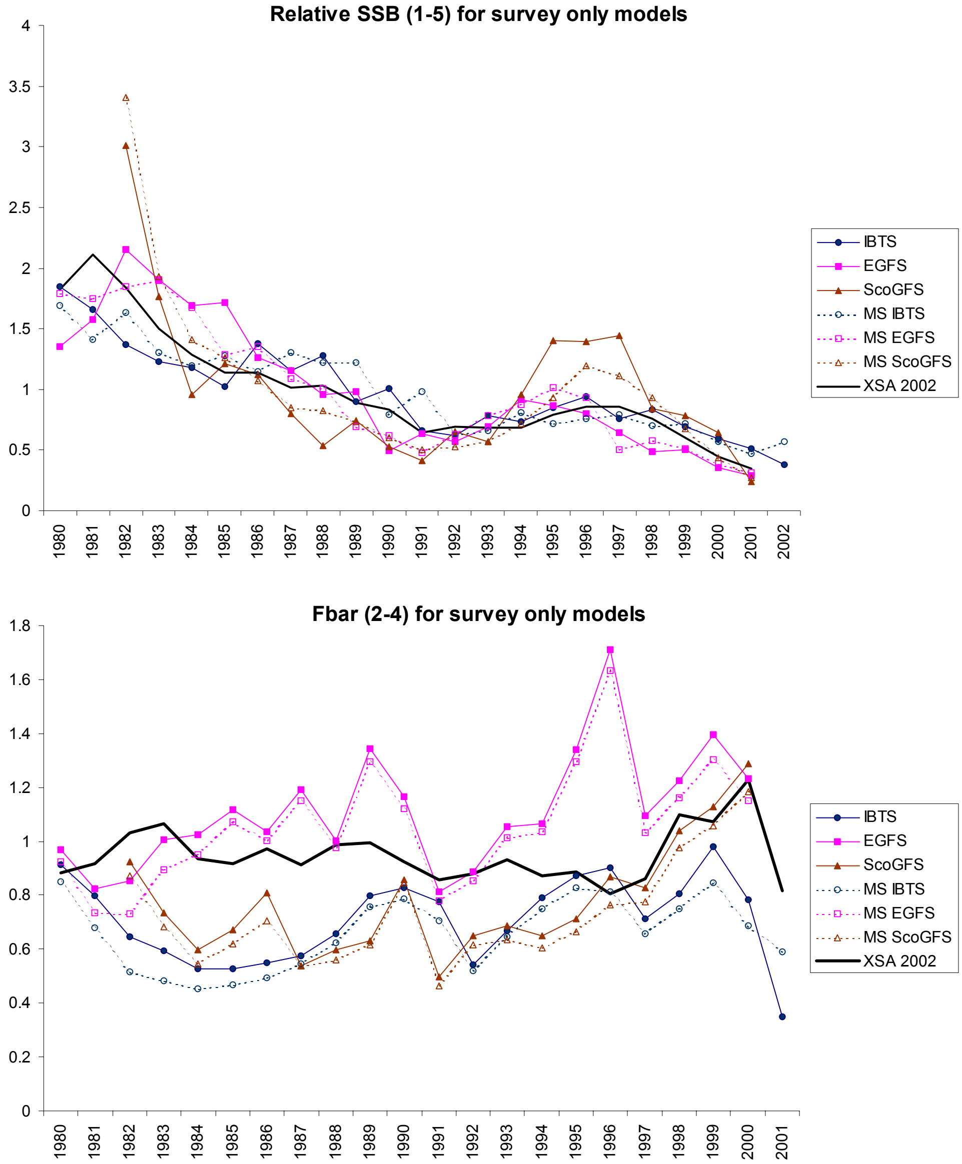


Figure 3.10.3a Cod in IV, VIId, and IIIa (Skagerrak). Results of separable model on surveys only: IBTS Q1.

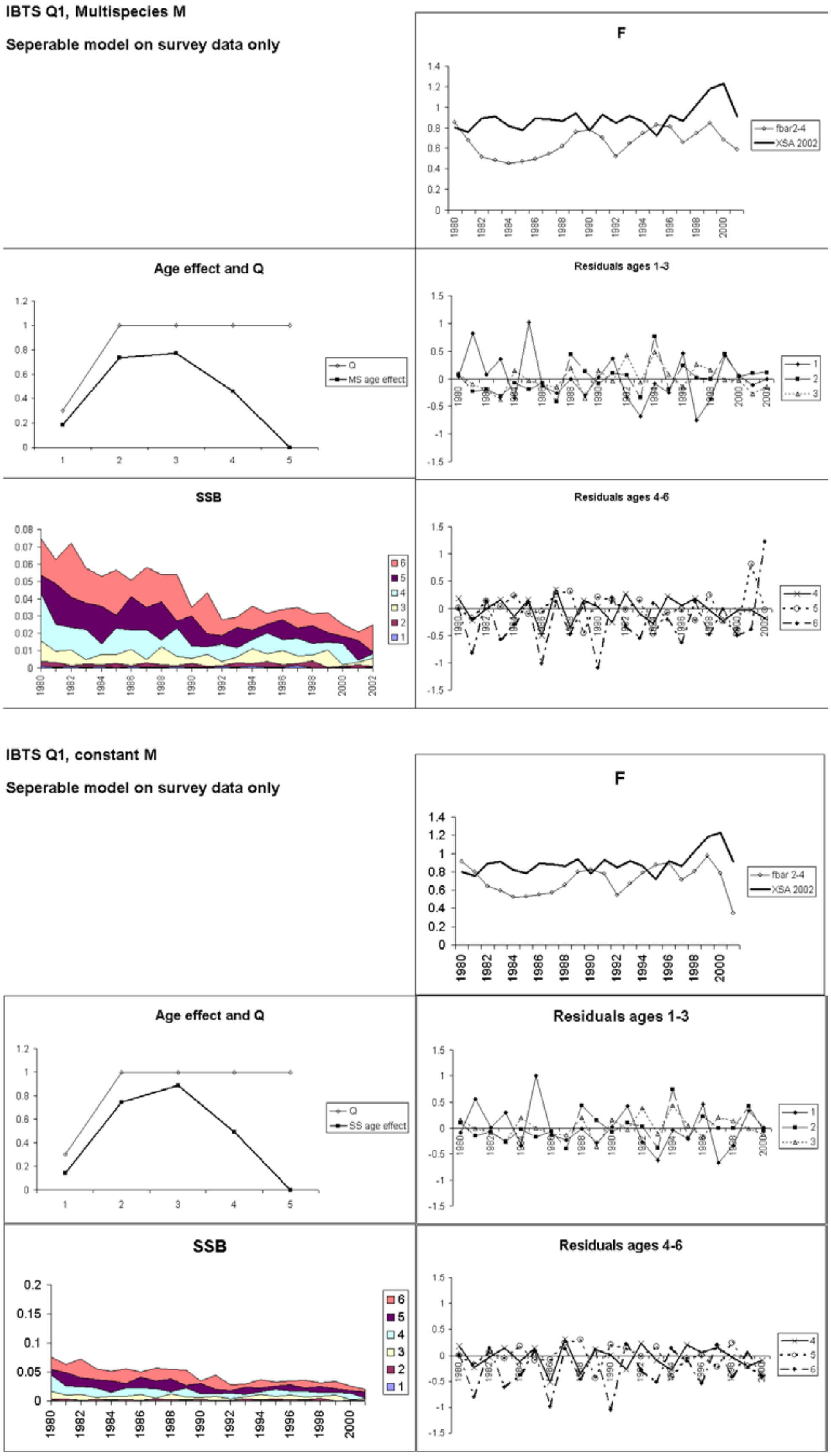


Figure 3.10.3b Cod in IV, VIId, and IIIa (Skagerrak). Results of separable model on surveys only: EGFS.

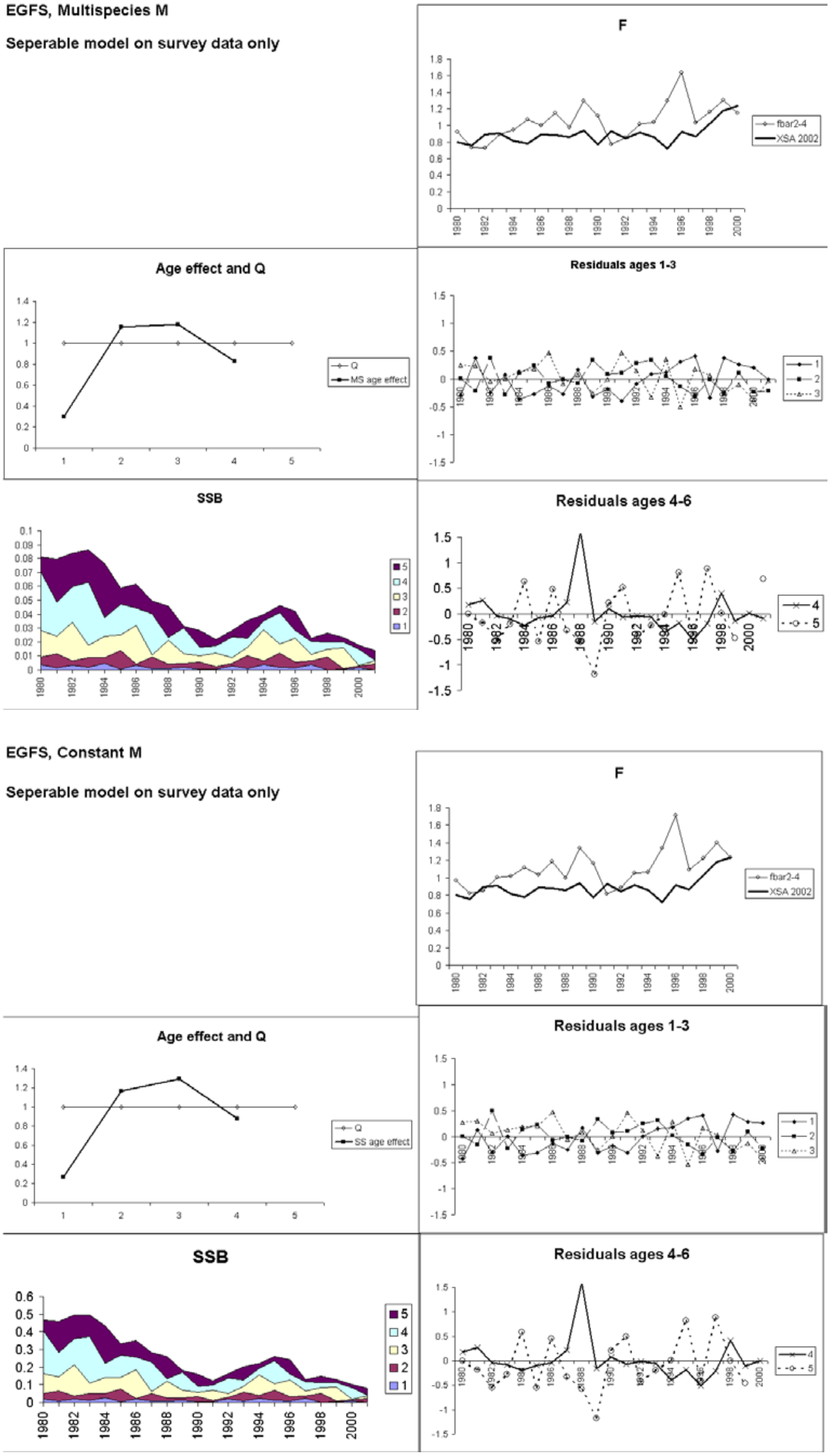


Figure 3.10.3c. Cod in IV, VIId, and IIIa (Skagerrak). Results of separable model on surveys only: SGFS.

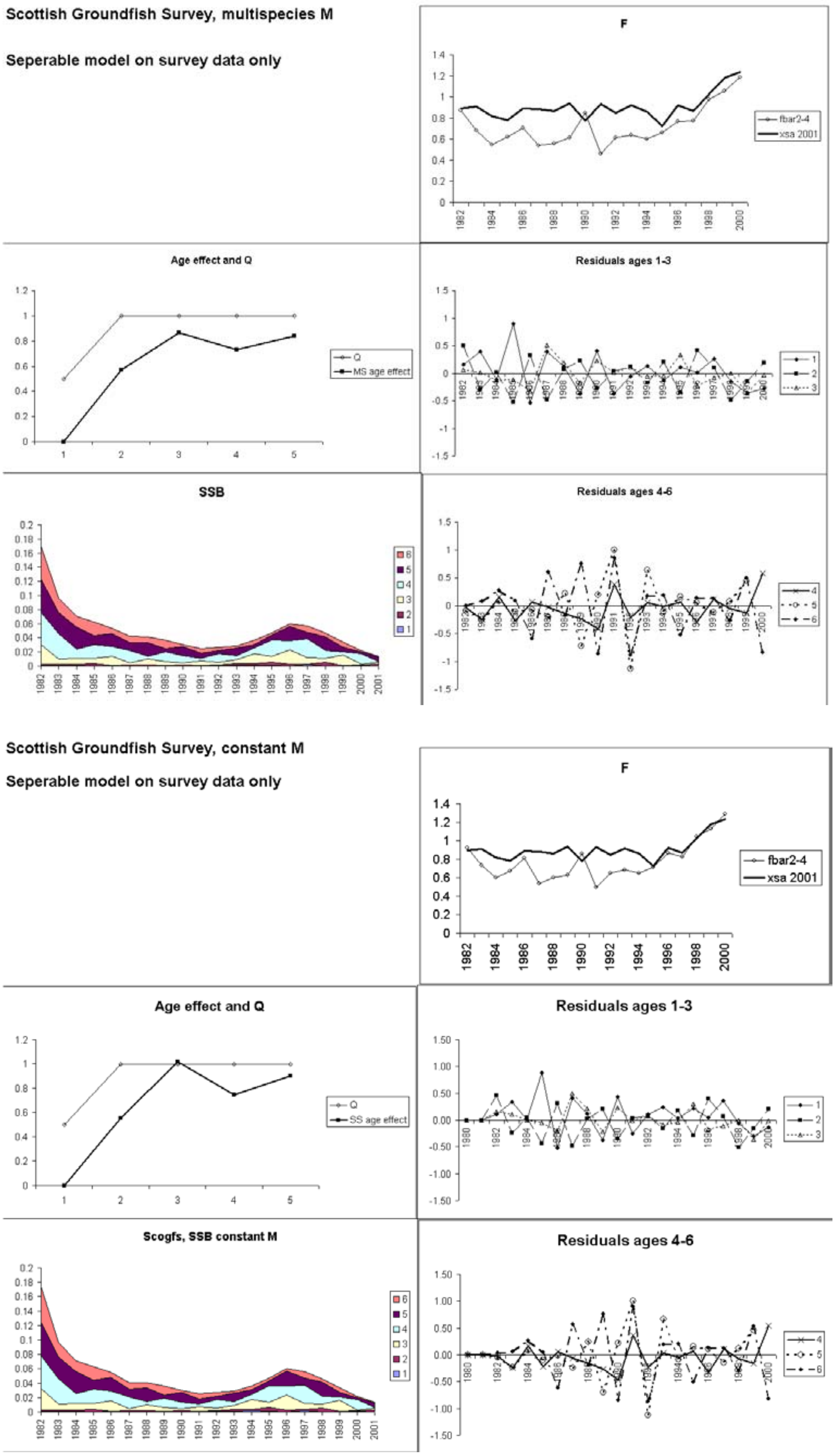
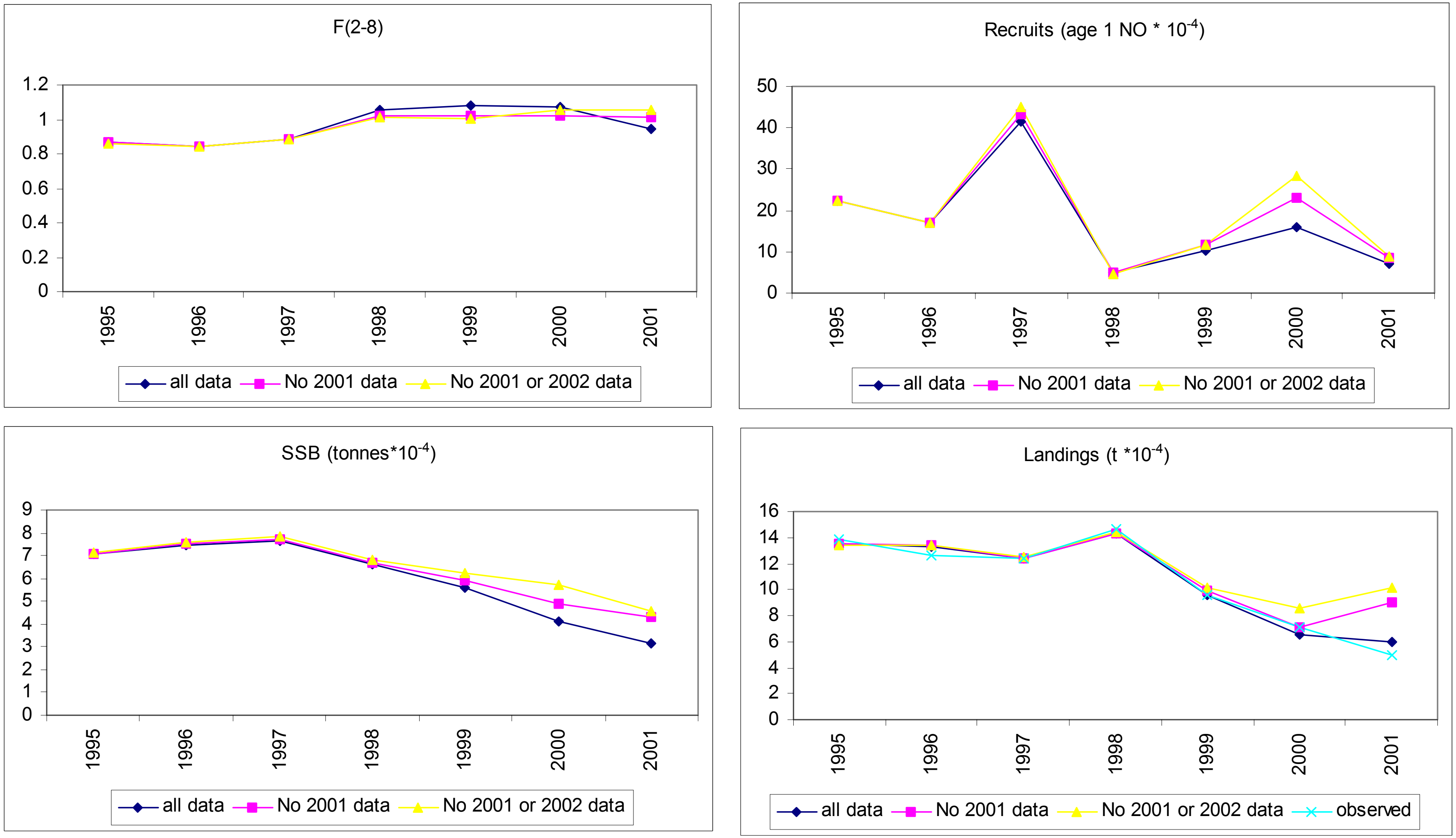


Figure 3.10.4 Cod in IV, VIId, and IIIa (Skagerrak). Summary of results of separate TSA runs.



4 HADDOCK IN SUBAREA IV AND DIVISION IIIA

4.1 The Fishery

In the North Sea, haddock is taken as part of a mixed demersal fishery, with the large majority of the catch being taken by Scottish light trawlers, seiners, and pair trawlers. Until 2002, 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 100 mm mesh and hence may have 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 the North Sea.

4.1.1 ACFM advice applicable to 2001 and 2002

In 2000 ACFM considered the stock to be outside safe biological limits and recommended that fishing mortality in 2001 should be below the proposed $\mathbf{F}_{pa}$ (0.7). Due to recruitment of the strong 1999 year class of haddock, SSB would increase above the proposed $\mathbf{B}_{pa}$ (140 000 t) in 2001. The assessment in 2001 indicated that the fishing mortality remained above $\mathbf{F}_{pa}$ and that SSB was above $\mathbf{B}_{pa}$. ACFM advice was to reduce F below $\mathbf{F}_{pa}$ in 2002. ACFM also recommended measures to reduce discarding in view of the large 1999 year class that was entering the fishery. Due to the very poor state of the North Sea cod stock, ACFM also commented that fishing mortality for North Sea haddock may have to be reduced further to retain consistency with the cod recovery plan.

4.1.2 Management applicable in 2001 and 2002

Until 2001 in the main North Sea fishery the minimum legal mesh size was 100 mm, although vessels using smaller mesh sizes to fish for *Nephrops* or industrial species could land haddock subject to by-catch limits. Unilateral legislation making 90 mm square mesh panels mandatory for UK vessels fishing for roundfish was introduced during summer 2000. That legislation also included constraints on the positioning and construction of the panel, with the intention of making gears more selective for haddock and thus reducing discarding of the large 1999 year class. In 2002, a new gear regulation was introduced by the EU as part of the North Sea cod recovery plan. Details of this regulation are given in Section 2.1. Essentially, it increases the minimum mesh size to 120 mm when fishing for cod, with a one-year derogation to 110 mm for vessels targeting other roundfish species, including haddock, in the mixed North Sea demersal fishery.

The closure of the Norway Pout box to industrial fishing is another measure by which by-catches of haddock are limited. The minimum landing size for haddock is 30 cm in the North Sea and 27 cm in Division IIIa. In 2001 the spring cod spawning closure displaced vessels from areas where haddock were commonly fished, and for a brief period a number of vessels remained in port.

On an annual basis, management of the fishery is through TACs. In Division IIIa the 2001 TAC was 4 000 t, and in the North Sea the 2001 TAC was 61 000 t. In 2002 the corresponding TACs are 6 300 t and 104 000 t.

4.1.3 The fishery in 2001

Nominal landings of haddock from Division IIIa for recent years are given in Table 4.1.1, along with Working Group estimates of landings and industrial by-catch. Table 4.1.1 also gives the corresponding figures for haddock in the North Sea. Table 4.1.2 gives the full time-series of Working Group estimates separately for both areas, and Table 4.1.3 gives the corresponding combined-area series.

In Division IIIa total landings during 2001 amounted to about 2 thousand tonnes, with industrial by-catch accounting for about 200 t of this total. The human consumption landings in 2001 represented an increase of about 400 t over the 2000 value, whereas the industrial by-catch represented an equivalent decrease in tonnage.

In the North Sea, human consumption landings in 2001 were around 40 000 t, which continues the decline in landings of recent years. The 2001 landing is below the TAC. The levels of discarding increased substantially in 2001, comprising mostly fish of the 1999 year class. The estimated landings and discards in 2001 were less than the predicted values made last year. Section 1.10 illustrates some difficulties inherent in the haddock stock forecasts for the industrial by-catch. These are likely also to affect forecasts for the other catch components for this stock.

4.2 Natural Mortality, Maturity, Age Composition, Mean Weight-at-Age

Natural mortality estimates are given in Table 4.2.1, along with the maturity ogive. The estimates of natural mortality originate from MSVPA (ICES CM 1989/Assess:20) - see Section 1.3.1.3 of the 1999 WG report for a fuller discussion of the sources of these estimates (ICES CM 2000/ACFM:7). None of the results from the recent meeting of the Multispecies Assessment WG were used in this assessment as there was insufficient time to explore fully the consequences of revising estimates of natural mortality.

The maturities are based on IBTS data. Both natural mortality and maturity are assumed constant with time. Biomass totals are calculated as at the beginning of the year.

For Division IIIa in 2001, age composition data for the human consumption and industrial catches were supplied by Denmark, which accounts for most of the human consumption landings and all of the industrial by-catch in this area. Age composition data for the North Sea human consumption landings were supplied by Denmark, England, France, and Scotland. These nations accounted for 90% of the total human consumption landings. Industrial by-catch age compositions for the North Sea were supplied by Denmark and Norway. Discard totals and age compositions for the North Sea were estimated from Scottish data. No estimates of discards are available for Division IIIa. Catch-at-age data are given in Table 4.2.2. The catch-at-age data for the North Sea are SOP corrected; there are slight SOP discrepancies in the combined data arising from minor discrepancies in the Division IIIa data. The 1999 year class is numerically the largest in the catches though most of these fish were discarded.

The mean weight-at-age data for the Division IIIa catches do not cover all years and for earlier years are not split by catch category, so only North Sea values have been used. Weight-at-age data from the total catch (i.e., human consumption, discards, and industrial by-catch) in the North Sea, which are also used as stock weights-at-age, are given in Table 4.2.3. The weight-at-age of the 1999 year class as two-year-olds is particularly low. Mean weight-at-age for the total catch and the separate catch components is given for all years in Tables 4.2.3 – 4.2.6, and are shown in Figure 4.2.1 for the period 1991 – 2001. 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, although it may have increased in 2001. For fish older than one in the industrial by-catch, mean weights appear to have been lower in the latter half of the last decade compared to the first half.

4.3 Catch, Effort, and Research Vessel Data

The fleet data available for tuning are listed in Table 4.3.1 along with the age and year ranges for which data are available. The fleets consist of two Scottish commercial fleets and three research vessel surveys. Definitions of the commercial fleets are the same as those given for the equivalent vessels working in Division VIa which are given in the Report of the 1998 Working Group on the Assessment of Northern Shelf Demersal Stocks (ICES CM 1999/ACFM:1, Appendix 2).

The English Groundfish Survey (EGFS) covers the whole of the North Sea in August-September each year to about 200-m depth using a fixed station design of 75 standard tows with the GOV trawl. The Scottish Groundfish survey (SGFS) is undertaken during August each year using a fixed station design using 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. The indices currently presented for this survey correspond to trawl stations within the area of the old survey coverage to maintain consistency of the time-series. 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.

In order to include the most recent information from the IBTS quarter 1 survey, this survey is treated as if it takes place at the end of the preceding year, by appropriate adjustments of the age and year ranges, and of the alpha and beta parameters. The IBTS Q1 survey in 2002 is the only new fishery-independent data since the last assessment. English and Scottish groundfish surveys for 2002 will be available in autumn 2002. These August surveys had not been carried out at the time of the Working Group meeting.

4.4 Catch-at-Age Analyses

The five tuning fleets available for this stock include two Scottish commercial series. From 1999 onwards the Scottish commercial effort data are incomplete, making these fleets unsuitable for tuning. In the Scottish August groundfish survey, the vessel and gear used were changed for the 1998 and subsequent surveys, leading to the possibility of catchability change in this series. These survey data were excluded from the 1999-2001 assessments because of evidence of an increase in catchability for the smaller fish. Last year it was shown that the results from exploratory XSA runs indicated that the choice of assessment model was not critical to the results and that the choice of tuning data was more important. It concluded that there were good reasons to exclude the commercial cpue from tuning, and given the doubts about the consistency of recent SGFS indices it, too, was excluded from the final assessment. This practice has been continued for the current assessment.

4.4.1 Exploration of data

Two exploratory runs were undertaken using the individual surveys that comprised the tuning fleets in last year's final XSA. In each case the program default settings were used except that only weak shrinkage was applied and no time taper was used. The relationship between XSA abundance and survey cpue (adjusted to 1 January) from these runs are shown in Figure 4.4.1 and demonstrate high correlation in both cases. These runs are summarised in Figure 4.4.2 which shows the terminal SSB and F(2-6) estimated for 2000 and 2001. The single-fleet estimates are more discrepant than observed in the previous assessment of this stock.

4.4.2 Final assessment

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

stock		haddock	
area		IV and IIIa	
year of assessment	2000	2001	2002
Assessment model	XSA	XSA	XSA
Scottish light trawl	not used	not used	not used
Scottish trawl	not used	not used	not used
EGFS	1990-1999 0-5	1977-2000 0-5	1977-2001 0-5
IBTS Q1 *	1991-2000 1-6	1974-2001 1-6	1974-2002 1-6
Time-series weights	none	Tricubic over 20 yrs	Tricubic over 20 yrs
Power model used for catchability	0	0-1	0-1
Catchability plateau age	7	3	3
Surv. est. shrunk towards mean F	5 years / 5 ages	5 years / 5 ages	5 years / 5 ages
s.e. of the means	0.5	0.5	0.5
Min. stand. error for pop. estimates	0.3	0.3	0.3
Prior weighting	none	none	none
Number of iterations		17	17
Convergence	yes	yes	yes

* These are the true year and age ranges. In XSA they were downshifted by one year.

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 most recently been underestimated. This is fully in accordance with an extended retrospective analysis undertaken last year, which showed that although there was no consistent bias there is auto-correlation in the assessment error and that in the case of fishing mortality the assessment has passed through a period of over-estimation, but appears now to be in a phase of under-estimation.

Log-catchability residuals are given in Table 4.4.1 and shown in Figure 4.4.4 for the two tuning series. Both the IBTS and EGFS residuals indicate a trend in the residual plots, although there is little consistency in the trends between ages or surveys. The tricubic time-taper applied to the tuning period will lessen the effect of time trends in the earlier years.

The contribution of the data to the final population estimates is given in Figure 4.4.5. The surveys contribute most to the estimates of survivors from ages 0-4 and have approximately 50% of the weight-at-age 5. These are the ages at which tuning data are available. The influence of the surveys on the survivors estimates of older ages is much reduced, and the effects of shrinkage dominate for these.

Estimates of fishing mortalities at age from the final XSA run are given in Table 4.4.2, and stock numbers-at-age are given in Table 4.4.3. The present assessment indicates a mean total F(2-6) in 2001 of 0.83. The current XSA run has revised the estimate of F(2-6) in 2000 from 0.92 to 1.22.

4.5 Recruitment Estimates

The only new data, since the last assessment, on the strength of the recruiting year classes comes from the catch data for 2001 and the IBTS Q1 index for 2002. Both of these data sources are included in the final XSA run. Additional survey data from the EGFS and SGFS surveys in August 2002 will become available prior to the October 2002 ACFM meeting. Because of this, no RCT3 estimates were made at the Working Group itself. This will be produced prior to the ACFM meeting. Input data files for RCT3 analysis were prepared, and the age 0 input file is shown in Table 4.5.1 showing the survey indices available at the time of the Working Group meeting. *NB:* the IBTS Q1 index of the 2001 year class at age 1 is the lowest on record by one order of magnitude. This year class was also recorded as the lowest-on-record value as 0-group fish in the 2001 EGFS.

4.5.1 The 1999 year class

The recruitment time-series for haddock in the North Sea and Skagerrak has tended to be characterised by occasional very strong year classes. However, from 1995 to 1998, the year classes that have been recruited to the stock have all been of below-average strength and although the 1994 year class was somewhat stronger, this has now been largely fished-out. Following this series of poor year classes, the 1999 cohort is very strong and thus forms a major part of the catch and the stock in the short to medium term. For this reason, the estimation of the strength of this year class is crucial for the short-term forecasts. The XSA gives an estimate for this year class at age 0 of 111 billion. This is higher than the value used last year of 93 billion, which was also estimated from XSA.

4.5.2 The 2000 year class

All the currently available survey data are included in the final XSA run with the surveys contributing 88% of its estimate of survivors at age 2. The XSA estimate obtained for this year class at age 0 is 21 billion, which is close to the value estimated last year.

4.5.3 The 2001 and subsequent year classes

The XSA estimate of this year class at age 0 is 1.4 billion, the lowest value in the time-series of recruits, 1963-2001. The XSA estimate includes the very low indices for this year class from the EGFS in 2000 and the IBTS in 2002. These surveys received 77% of the weighting in the final population estimate.

The text table below summarises the recruitment values used in the subsequent medium-term analysis (million). No short-term catch forecast was undertaken due to the non-availability of the 2002 EGFS and SGFS August survey indices.

Year class	Age	XSA	GM(63-99)
1999	3	**1207.8**	
2000	2	**485.8**	
2001	1	**185.2**	
2002	0		**25895.6**

4.6 Historical Stock Trends

Trends in spawning stock biomass, recruitment, and mean F since 1963 are given in Table 4.6.1 and Figure 4.6.1. Total mean F (2-6) has fluctuated around a mean of 0.94. Recruitment shows considerable variation, with the current estimate of the 1999 year class indicating that it is the strongest since 1974, while the four preceding year classes and the two subsequent ones are all of below-average strength. Spawning biomass has fluctuated, with occasional peaks corresponding to the maturation of strong year classes. SSB has declined in recent years as a result of a high fishing mortality rate and low recruitment. The estimate for 2001 is the third lowest recorded. However, the 1999 year class has resulted in a rapid increase in SSB for the short term.

4.7 Short-Term Prognosis

No short-term forecast was undertaken at the WG meeting due to the non-availability of the August EGFS and SGFS survey indices for 2002. These indices will be available prior to the October ACFM meeting, and short-term forecasts will be carried out at an *ad hoc* meeting of WGNSSK members immediately before the ACFM meeting.

As an *aide memoire* to participants at the *ad hoc* meeting, the following points should be specifically addressed in the short-term catch forecast for this stock:

- Check the mean weights-at-age taken forward in forecasts by stock and catch component, particularly for the 1999 year class. A three-year mean may not represent appropriate values for this year class;
- Discard proportions for the human consumption fisheries can be estimated as a recent three-year mean, which is the usual practice, or by relating discard proportions to the mean weight-at-age of fish in the stock (refer to documentation from the EU MATES contract interim report). Explore both approaches;
- The estimates of total fishing mortality on the dominant 1999 year class at age 1 in 2000 and age 2 in 2001 are relatively low (this is true also for the 1998 year class at age 1 in 2001). If this is solely a year-class effect, the incorporation of these values in the three-year means used for forecasting may inappropriately distort the exploitation pattern taken forward into prediction;
- Explore the potential effects of the EU technical conservation measures on mesh size, etc., enacted during 2002, including the 110 mm derogation in 2002;
- Refer to Section 1.10 of this report regarding the performance of forecasts for this stock.

4.8 Medium-Term Prognosis

Medium-term projections have been undertaken this year using a Beverton-Holt stock-recruitment curve (Table 4.8.1) and using default input values to the "Insens" program used to generate input files for forecasting (Table 4.8.2), ie mean weights- and F-at-age were calculated using a three-year mean, 1999-2001. F-at-age was scaled to the 2001 value of mean F.

The choice of stock-recruit curve is consistent with previous analyses.

The results of the projections for *status quo* F and $\mathbf{F}_{pa}$ are shown in Figure 4.8.1. In addition Figure 4.8.2 gives a summary diagram showing the probability that SSB is below $\mathbf{B}_{pa}$ for any of the stated values of fishing mortality over the next decade. At *status quo* F, there is a moderately high probability (greater than 40%) that SSB will be below $\mathbf{B}_{pa}$ in the medium term. This reflects a change from last year's medium-term prognosis, where the probability level was *ca*. 30%. This change is due to the high variability in starting conditions for the simulations from year to year due to the extreme fluctuations in recruitment seen recently, and the high fishing mortality rate.

4.9 Biological Reference Points

A yield-per-recruit curve based on the inputs to the medium-term forecast (Table 4.8.2) is given in Figure 4.9.1, and the stock-recruitment plot is given in Figure 4.9.2. The reference points given on Figure 4.9.1 are based on the total yield-per-recruit curve assuming constant industrial fishing mortality. The maximum on the human consumption (landings only) yield-per-recruit curve occurs at a fishing mortality of ca. 0.25 in the human consumption fishery. The text table below gives the values of various biological reference points for this stock, as well as the 'lim' and PA reference points currently used by ACFM.

F_{max}	$F_{0.1}$	F_{med}	F_{pa}	F_{lim}	B_{pa}	B_{lim}
0.25*	0.18	0.49	0.7	1.0	140 000 t	100 000 t

* corresponding to HC landings only

Figure 4.9.3 shows how the stock has performed in relation to the agreed PA values. In the majority of years, F has been above $\mathbf{F}_{pa}$ but SSB above $\mathbf{B}_{pa}$. In 2000, SSB is below $\mathbf{B}_{lim}$ and F is above $\mathbf{F}_{pa}$. In 2001 and 2002, SSB is above $\mathbf{B}_{pa}$ due to maturation of the strong 1999 year class, and F remains above $\mathbf{F}_{pa}$.

4.10 Quality of the Assessment

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

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

Discussion of the forecasting performance in the assessment of this stock is given in Section 1.10.

4.11 Management Considerations

4.11.1 State of the stock

At present the biomass and catches from the stock are driven almost entirely by the 1999 year class, as most of the other cohorts are average or below. It is particularly noticeable that at the present rate of fishing mortality the spawning stock will be quickly eroded and that by 2004 there is a moderately high probability that it will be below $\mathbf{B}_{pa}$. This illustrates the fact that the only factor maintaining the stock above $\mathbf{B}_{pa}$ is the random occurrence of very large year classes. A sequence of average or poor recruitment might easily result in stock collapse. Periods of poor recruitment have been more frequent from the 1980s and onwards.

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

4.11.2 Management issues

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

There is frequently debate about the extent to which the cod-haddock-whiting fisheries are linked. This linkage is not one-to-one, but it is also true that they are far from separate. It is possible for fishing vessels to increase their targeting of individual species, but this is never perfect and there will always be a significant by-catch of other roundfish. Hence, for example, measures to protect cod will require at least some reduction in the fishing mortality for haddock, and vice versa. This means that TACs for the three main roundfish species do need to be set in a way which acknowledges the fishery linkage, but it remains difficult to determine how close this linkage should be. This Working Group has explored one approach to address this problem (Section 1.4.6), although this still assumes a constant linkage within fleets.

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	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001*
Belgium	14	9	4	18	-	-	-	-	-	
Denmark	3,812	1,600	1,458	1,576	2,523	2,501	3,168	1,012	1,033	1,590
Germany	-	-	1	1	5	5	11	3	1	128
Norway	184	153	142	135	115	188	188	168	126*	148
Sweden	744	436	408	498	536	835	529	26	377	285
Total reported	4,754	2,198	2,013	2,228	3,179	3,529	3,896	1,389	1,527	2,158
Unallocated	-358	-239	-180	-37	-37	-128	-137	-29	-42	-255
WG estimate of H.cons. landings	4,396	1,959	1,833	2,191	3,142	3,401	3,759	1,360	1,485	1,903
WG estimate of industrial by-catch	4,604	2,415	2,180	2,162	2,925	610	275	334	617	218
WG estimate of total catch	9,000	4,374	4,013	4,353	6,067	4,011	4,034	1,694	2,102	2,121

* Preliminary

Subarea IV

Country	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Belgium	415	292	306	407	215	436	724	462	399	606
Denmark	1,476	3,582	3,208	2,902	2,520	2,722	2,608	2,104	1,670	2,407
Faroe Islands	13	25	43	49	13	9	43	55	-	-
France	508	960	587	441	369	548	427*	742[1*]	1,152[1*]	576[1]
Germany	764	348	1,829	1,284	1,769	1,462	1,314	565	342	681
Netherlands	148	192	96	147	110	480	275	110	119	274[2]
Norway	3,273	2,655	2,355	2,461	2,295	2,354	3,262	3,830	3,118*	1,877
Poland	-	-	-	-	18	8	7	17	13	12
Sweden	1,289	908	551	722	689	655	472	686	596	812
UK (Engl. & Wales)	2,926	4,259	4,043	3,616	3,379	3,330	3,280	2,398	1,876	
UK (Isle of Man)	11	-	-	-	-	-	-	-	-	-
UK (N. Ireland)	73	18	9	-	-	-	-	-	-	-
UK (Scotland)	39,896	66,799	73,793	63,411	63,542	61,098	60,3234	53,628	37,772	
UK(all)										32,544
Total reported	50,792	80,038	86,820	75,440	74,919	73,102	72,736	64,597	47,057	39,789
Unallocated landings	19,426	-458	-5923	-127	1,115	5,993	4,665	-388	-973	-831
WG estimate of H.cons. landings	70,218	79,580	80,897	75,313	76,034	79,095	77,311	64,209	46,084	38,958
WG estimate of discards	47,967	79,601	65,392	57,360	72,522	52,105	45,175	42,562	48,841	118,320
WG estimate of industrial by-catch	10,816	10,741	3,561	7,747	5,048	6,689	5,101	3,834	8,133	7,879
WG estimate of total catch	129,001	169,922	149,850	140,420	153,604	137,889	127,587	110,605	103,058	165,157

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

Division IIIa and Subarea IV

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
WG estimate of Total Catch	138,001	174,296	153,863	144,773	159,671	141,900	131,621	112,299	105,160	167,278

Table 4.1.2 Catches ('000 t) of Haddock from the North Sea and Division IIIa, 1963–2001. Figures are Working Group estimates.

	North Sea				Division IIIa			Total
Year	H.cons	Disc	Ind. BC	Total	H. cons.	Ind. BC	Total	
1963	68.4	189.0	13.7	271.1	0.4	0.1	0.5	271.6
1964	130.5	160.3	88.6	379.4	0.4	0.3	0.7	380.1
1965	161.6	62.2	74.6	298.4	0.7	0.3	1.0	299.4
1966	225.8	73.6	46.7	346.1	0.6	0.1	0.7	346.8
1967	147.4	78.1	20.7	246.2	0.4	0.1	0.5	246.7
1968	105.4	161.9	34.2	301.5	0.4	0.1	0.5	302.0
1969	330.9	260.2	338.4	929.5	0.5	0.5	1.0	930.5
1970	524.6	101.4	179.7	805.7	0.7	0.2	0.9	806.6
1971	235.4	177.5	31.5	444.4	2.0	0.3	2.3	446.7
1972	192.9	128.1	29.6	350.6	2.6	0.4	3.0	353.6
1973	178.6	114.7	11.3	304.6	2.9	0.2	3.1	307.7
1974	149.6	166.8	47.8	364.2	3.5	1.1	4.6	368.8
1975	146.6	260.4	41.4	448.4	4.8	1.3	6.1	454.5
1976	165.6	154.3	48.2	368.1	7.0	2.0	9.0	377.1
1977	137.3	44.3	35.0	216.6	7.8	2.0	9.8	226.4
1978	85.8	76.9	10.8	173.5	5.9	0.7	6.6	180.1
1979	83.1	41.7	16.4	141.2	4.0	0.8	4.8	146.0
1980	98.6	94.7	22.3	215.6	6.4	1.5	7.9	223.5
1981	129.6	60.1	17.1	206.8	9.1	1.2	10.3	217.1
1982	165.8	40.5	19.4	225.7	10.8	1.3	12.1	237.8
1983	159.3	65.9	13.1	238.3	8.0	7.2	15.2	253.5
1984	128.1	75.3	10.1	213.5	6.4	2.7	9.1	222.6
1985	158.5	85.4	6.0	249.9	7.2	1.0	8.2	258.1
1986	165.5	52.2	2.6	220.3	3.6	1.7	5.3	225.6
1987	108.0	59.2	4.4	171.6	3.8	1.4	5.2	176.8
1988	105.1	62.1	4.0	171.2	2.9	1.5	4.4	175.6
1989	76.2	25.7	2.4	104.3	4.1	0.4	4.5	108.8
1990	51.5	32.6	2.6	86.7	4.1	2.0	6.1	92.8
1991	44.6	40.3	5.4	90.3	4.1	2.6	6.7	97.0
1992	70.2	48.0	10.8	129.0	4.4	4.6	9.0	138.0
1993	79.6	79.6	10.7	169.9	2.0	2.4	4.4	174.3
1994	80.9	65.4	3.6	149.9	1.8	2.2	4.0	153.9
1995	75.3	57.4	7.7	140.4	2.2	2.2	4.4	144.8
1996	76.0	72.5	5.0	153.6	3.1	2.9	6.1	159.7
1997	79.1	52.1	6.7	137.9	3.4	0.6	4.0	141.9
1998	77.3	45.2	5.1	127.6	3.8	0.3	4.0	131.6
1999	64.2	42.6	3.8	110.6	1.4	0.3	1.7	112.3
2000	46.1	48.8	8.1	103.1	1.5	0.6	2.1	105.2
2001	39.0	118.3	7.9	165.2	1.9	0.2	2.1	167.3
Min	39.0	25.7	2.4	86.7	0.4	0.1	0.5	92.8
Mean	132.0	91.7	32.0	255.7	3.6	1.3	4.9	260.6
Max	524.6	260.4	338.4	929.5	10.8	7.2	15.2	930.5

Table 4.1.3 Catches of Haddock from the North Sea and Division IIIa combined 1963–2001. Figures are Working Group estimates.

Annual weight and numbers caught, 1963 to 2001.

Year	Wt.('000t) Total	Wt.('000t) H.cons	Wt.('000t) Disc	Wt.('000t) IBC	Nos.(millions) Total	Nos.(millions) H.cons	Nos.(millions) Disc	Nos.(millions) IBC
1963	272	69	189	14	1685	182	1246	257
1964	380	131	160	89	1597	353	644	601
1965	299	162	62	75	1723	372	254	1097
1966	347	226	74	47	3135	408	490	2238
1967	247	148	78	21	1423	273	448	701
1968	302	106	162	34	1620	222	838	560
1969	931	331	260	339	4007	911	1203	1893
1970	807	525	101	180	3385	1247	515	1624
1971	447	237	177	32	2680	477	1282	921
1972	354	195	128	30	1735	434	760	541
1973	308	182	115	11	1290	456	660	174
1974	369	153	167	49	2414	365	1091	958
1975	455	151	260	43	2994	374	1862	758
1976	377	173	154	50	1667	412	788	466
1977	226	145	44	37	934	338	226	370
1978	180	92	77	12	1072	205	418	449
1979	146	87	42	17	1517	199	286	1032
1980	224	105	95	24	1506	233	541	732
1981	217	139	60	18	1368	288	298	782
1982	238	177	41	21	987	325	181	481
1983	254	167	66	20	1269	305	389	576
1984	223	135	75	13	878	258	412	208
1985	258	166	85	7	983	371	457	155
1986	226	169	52	4	760	376	308	76
1987	177	112	59	6	702	233	334	136
1988	176	108	62	5	662	258	362	42
1989	109	80	26	3	303	173	111	19
1990	93	56	33	5	331	114	192	25
1991	97	49	40	8	473	107	218	148
1992	138	75	48	15	780	163	267	350
1993	174	82	80	13	883	178	441	264
1994	154	83	65	6	615	171	347	98
1995	145	78	57	10	863	166	316	382
1996	160	79	73	8	882	171	340	372
1997	142	82	52	7	508	180	231	97
1998	132	81	45	5	442	178	212	52
1999	112	66	43	4	467	145	209	113
2000	105	48	49	9	577	102	328	147
2001	167	41	118	8	772	98	600	73
Min.	93	41	26	3	303	98	111	19
Mean	261	136	92	33	1331	303	515	512
Max.	931	525	260	339	4007	1247	1862	2238

Table 4.2.1 Haddock in IV and IIIa. Natural mortality and proportion mature-at-age.

TABLE ______; Haddock, North Sea and IIIa
Natural Mortality and proportion mature

Age	Nat Mor	Mat.
0	2.050	0.000
1	1.650	0.010
2	0.400	0.320
3	0.250	0.710
4	0.250	0.870
5	0.200	0.950
6	0.200	1.000
7	0.200	1.000
8	0.200	1.000
9	0.200	1.000
10+	0.200	1.000

Table 4.2.2 Haddock in IV and IIIa. Total international catch-at-age in numbers ('000s), 1963-2001

International catch-at-age ('000), Total , 1963 to 2001.

Age	1963	1964	1965	1966	1967	1968	1969	1970	1971
0	1367	140235	652537	1671205	306037	11146	72670	925768	333396
1	1307178	7436	368593	1007322	838189	1098748	20493	266379	1815054
2	335092	1296771	15184	25674	89083	439511	3578611	218480	71035
3	20963	135227	649840	6425	4863	19600	303489	1908736	47546
4	13026	9069	29496	412551	3585	1947	7596	57435	400469
5	5781	5350	4662	9980	177857	2529	2411	1178	10374
6	502	2405	1972	1045	2443	45973	2515	1197	462
7	653	287	452	601	215	325	19129	256	195
8	566	236	107	165	216	40	200	5954	147
9	59	231	90	90	57	13	24	67	1592
10+	18	25	41	25	34	5	7	30	168

Age	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
0	244075	60545	614903	46388	174161	120798	305115	881823	399372	646419
1	679205	366830	1220855	2116937	170529	258923	463554	351451	678499	134470
2	587590	570630	176342	641755	1062943	107675	146957	204046	333261	423059
3	40604	240604	332967	58991	211544	394175	30377	41297	73043	143151
4	21213	6192	54314	109062	9952	40185	113703	7406	10476	15228
5	158000	4470	1875	15813	31311	4318	8708	28024	1901	2034
6	3563	39459	1351	983	4996	6275	1264	2237	8067	458
7	190	1257	10922	620	206	1300	2076	262	598	2498
8	34	108	242	2714	76	135	402	483	121	125
9	27	29	23	266	759	29	116	152	162	64
10+	419	163	41	82	63	204	94	78	119	61

Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
0	278705	639814	95502	139579	56503	13384	16535	12042	57702	123910
1	275686	157259	432193	178878	160398	314017	30044	47648	86819	228553
2	86126	252258	168273	534269	178824	250496	490706	35358	103021	78258
3	299895	73920	122984	78726	323650	47432	89940	182748	18947	23197
4	41435	127250	22079	37445	27685	67864	13431	18106	57830	3888
5	3407	16480	32658	5306	9691	4761	18579	2636	3905	12526
6	713	1708	3789	7355	1237	2877	1602	4058	896	976
7	279	297	596	965	1810	545	639	510	1380	401
8	784	61	84	212	237	778	166	200	210	614
9	30	191	41	52	117	135	141	83	78	148
10+	26	67	135	113	135	155	105	54	70	69

Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
0	270758	141209	85966	273689	347568	40082	23902	108254	52181	3510
1	209879	359995	99260	301733	53415	134642	83557	81423	350998	86744
2	253286	262765	296776	85925	357942	86231	167359	121249	88624	632880
3	32494	108421	100476	167801	56894	213293	49648	87242	43351	32343
4	6552	7107	29609	25875	55147	15272	108066	24739	26356	8886
5	1250	1698	1920	7645	7503	15406	5743	39860	6026	4122
6	4861	450	573	511	3052	1892	3562	2338	8707	1561
7	454	1138	191	127	756	679	472	1595	560	1305
8	301	146	509	45	52	62	140	342	234	195
9	293	103	115	62	31	15	14	41	32	64
10+	154	208	89	36	42	26	17	10	16	21

Table 4.2.3 Haddock in IV and IIIa. Mean weight-at-age in the stock, 1963-2001.

International mean weight-at-age (kg), Total catch, 1963 to 2001.

Age	1963	1964	1965	1966	1967	1968	1969	1970	1971
0	0.012	0.011	0.010	0.010	0.011	0.010	0.011	0.013	0.011
1	0.123	0.118	0.069	0.088	0.115	0.126	0.063	0.073	0.107
2	0.253	0.239	0.225	0.247	0.281	0.253	0.216	0.222	0.247
3	0.473	0.403	0.366	0.367	0.461	0.509	0.406	0.352	0.362
4	0.695	0.664	0.648	0.533	0.594	0.731	0.799	0.735	0.506
5	0.807	0.814	0.844	0.949	0.639	0.857	0.891	0.873	0.887
6	1.004	0.908	1.193	1.266	1.057	0.837	1.031	1.191	1.267
7	1.131	1.382	1.173	1.525	1.501	1.606	1.094	1.362	1.534
8	1.173	1.148	1.482	1.938	1.922	2.260	2.040	1.437	1.337
9	1.576	1.470	1.707	1.727	2.069	2.702	3.034	2.571	1.275
10+	1.825	1.781	2.239	2.889	2.348	2.073	3.264	3.899	2.058

Age	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
0	0.024	0.044	0.024	0.020	0.013	0.019	0.011	0.009	0.012	0.009
1	0.116	0.112	0.128	0.101	0.125	0.108	0.144	0.095	0.104	0.074
2	0.242	0.240	0.226	0.241	0.224	0.241	0.253	0.290	0.283	0.262
3	0.388	0.372	0.343	0.356	0.401	0.345	0.418	0.443	0.486	0.476
4	0.506	0.586	0.548	0.449	0.512	0.601	0.441	0.637	0.732	0.745
5	0.606	0.649	0.891	0.680	0.588	0.613	0.719	0.664	1.046	1.147
6	1.000	0.725	0.895	1.245	0.922	0.802	0.742	0.933	0.936	1.479
7	1.366	1.044	0.952	1.124	1.933	1.181	0.955	1.187	1.394	1.180
8	2.241	1.302	1.513	1.093	1.784	1.943	1.398	1.187	1.599	1.634
9	2.006	2.796	2.315	1.720	1.306	2.322	2.124	1.468	1.593	1.764
10+	1.684	1.828	2.639	2.420	2.430	1.812	2.158	2.374	2.143	1.709

Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
0	0.011	0.022	0.010	0.013	0.025	0.008	0.024	0.027	0.044	0.029
1	0.100	0.135	0.141	0.149	0.124	0.126	0.165	0.197	0.194	0.177
2	0.292	0.297	0.300	0.279	0.242	0.265	0.217	0.300	0.292	0.320
3	0.460	0.448	0.489	0.480	0.397	0.406	0.417	0.372	0.430	0.472
4	0.784	0.651	0.670	0.668	0.613	0.615	0.589	0.605	0.473	0.639
5	1.166	0.915	0.805	0.857	0.863	1.029	0.748	0.811	0.771	0.650
6	1.441	1.214	1.097	1.049	1.257	1.276	1.284	0.982	0.967	1.042
7	1.672	1.162	1.100	1.459	1.195	1.433	1.424	1.364	1.167	1.232
8	1.456	1.920	1.868	1.833	1.715	1.529	1.551	1.655	1.529	1.481
9	2.634	1.376	2.425	2.124	1.525	1.877	1.627	1.684	2.037	1.776
10+	2.156	1.725	2.050	2.043	2.607	2.217	2.363	2.229	2.618	2.092

Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
0	0.018	0.010	0.017	0.013	0.019	0.021	0.023	0.023	0.048	0.021
1	0.107	0.115	0.116	0.102	0.127	0.133	0.153	0.168	0.119	0.109
2	0.306	0.280	0.250	0.297	0.246	0.277	0.252	0.243	0.253	0.216
3	0.486	0.447	0.419	0.363	0.388	0.359	0.392	0.361	0.367	0.309
4	0.748	0.680	0.597	0.592	0.483	0.579	0.440	0.473	0.498	0.466
5	1.016	0.894	0.943	0.763	0.780	0.615	0.651	0.498	0.615	0.697
6	0.896	1.173	1.208	1.099	0.870	0.909	0.760	0.680	0.650	0.754
7	1.395	1.102	1.570	1.423	0.846	0.966	1.103	0.782	1.100	0.971
8	1.537	1.592	1.469	1.685	1.833	1.647	1.153	0.749	1.091	1.892
9	1.912	1.737	1.620	1.873	2.025	2.247	1.825	1.247	1.760	1.198
10+	2.021	1.874	2.444	1.986	1.970	2.388	2.352	1.780	2.054	2.252

Table 4.2.4 Haddock in IV and IIIa. Mean weight-at-age in the human consumption landings, 1963-2001.

International mean weight-at-age (kg), H.cons catch, 1963 to 2001.

Age	1963	1964	1965	1966	1967	1968	1969	1970	1971
0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1	0.233	0.221	0.310	0.301	0.260	0.256	0.178	0.242	0.256
2	0.326	0.313	0.357	0.384	0.404	0.361	0.302	0.310	0.335
3	0.512	0.459	0.410	0.416	0.510	0.591	0.506	0.403	0.399
4	0.715	0.695	0.679	0.553	0.614	0.761	0.870	0.786	0.524
5	0.817	0.870	0.907	0.995	0.645	0.863	0.984	0.949	0.905
6	1.009	0.934	1.242	1.288	1.063	0.846	1.065	1.235	1.281
7	1.131	1.386	1.182	1.529	1.501	1.610	1.102	1.370	1.534
8	1.173	1.148	1.482	1.938	1.922	2.260	2.040	1.437	1.337
9	1.576	1.470	1.707	1.727	2.069	2.702	3.034	2.571	1.275
10+	1.825	1.781	2.239	2.889	2.348	2.073	3.264	3.899	2.058

Age	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1	0.244	0.225	0.275	0.258	0.250	0.286	0.275	0.274	0.299	0.339
2	0.329	0.315	0.320	0.345	0.344	0.362	0.356	0.361	0.367	0.385
3	0.421	0.406	0.389	0.408	0.467	0.396	0.457	0.468	0.526	0.525
4	0.523	0.606	0.585	0.487	0.516	0.614	0.470	0.642	0.750	0.754
5	0.609	0.663	0.908	0.686	0.614	0.630	0.725	0.668	1.056	1.149
6	1.003	0.726	0.954	1.248	0.923	0.817	0.789	0.935	0.934	1.481
7	1.366	1.044	0.963	1.124	1.933	1.181	0.956	1.187	1.392	1.180
8	2.241	1.302	1.513	1.094	1.784	1.943	1.398	1.187	1.599	1.634
9	2.006	2.796	2.315	1.720	1.306	2.322	2.124	1.468	1.592	1.764
10+	1.684	1.828	2.639	2.420	2.430	1.812	2.158	2.374	2.143	1.709

Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1	0.300	0.312	0.281	0.277	0.276	0.274	0.258	0.310	0.308	0.319
2	0.364	0.387	0.376	0.359	0.351	0.345	0.324	0.388	0.379	0.377
3	0.507	0.482	0.515	0.502	0.433	0.451	0.445	0.415	0.484	0.480
4	0.818	0.663	0.677	0.671	0.613	0.622	0.619	0.617	0.516	0.643
5	1.237	0.925	0.810	0.871	0.863	1.029	0.752	0.810	0.802	0.653
6	1.441	1.243	1.097	1.051	1.257	1.276	1.284	0.982	1.039	1.042
7	1.672	1.162	1.100	1.459	1.195	1.433	1.424	1.361	1.191	1.232
8	1.456	1.920	1.868	1.833	1.715	1.529	1.551	1.653	1.543	1.481
9	2.634	1.376	2.425	2.124	1.525	1.877	1.627	1.684	2.037	1.776
10+	2.156	1.725	2.050	2.043	2.607	2.217	2.363	2.221	2.618	2.092

Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1	0.336	0.326	0.288	0.312	0.342	0.333	0.263	0.286	0.298	0.378
2	0.379	0.393	0.390	0.396	0.359	0.396	0.361	0.347	0.366	0.348
3	0.510	0.483	0.482	0.421	0.462	0.412	0.429	0.416	0.419	0.439
4	0.751	0.684	0.617	0.603	0.515	0.601	0.460	0.482	0.520	0.498
5	1.017	0.896	0.962	0.767	0.780	0.618	0.657	0.510	0.622	0.714
6	0.904	1.173	1.296	1.099	0.870	0.909	0.762	0.717	0.653	0.754
7	1.395	1.111	1.570	1.423	0.846	0.966	1.103	0.782	1.100	0.976
8	1.538	1.592	1.469	1.685	1.833	1.647	1.153	0.749	1.091	1.922
9	1.912	1.737	1.620	1.873	2.025	2.247	1.825	1.247	1.760	1.198
10+	2.021	1.874	2.444	1.986	1.970	2.388	2.352	1.780	2.054	2.252

Table 4.2.5 Haddock in IV and IIIa. Mean weight-at-age of discards, 1963-2001.

1

International mean weight-at-age (kg), Disc catch, 1963 to 2001.

Age	1963	1964	1965	1966	1967	1968	1969	1970	1971
0	0.064	0.065	0.064	0.063	0.064	0.063	0.064	0.063	0.063
1	0.139	0.177	0.131	0.141	0.171	0.186	0.129	0.129	0.134
2	0.218	0.249	0.200	0.208	0.209	0.212	0.216	0.210	0.201
3	0.327	0.306	0.341	0.244	0.274	0.256	0.237	0.238	0.242
4	0.397	0.337	0.613	0.310	0.306	0.318	0.301	0.263	0.263
5	0.321	0.321	0.321	0.321	0.321	0.321	0.321	0.321	0.321
6	0.321	0.321	0.321	0.321	0.321	0.321	0.321	0.321	0.321
7	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
8	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
9	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
10+	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Age	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
0	0.063	0.063	0.062	0.050	0.079	0.071	0.037	0.053	0.051	0.073
1	0.139	0.131	0.145	0.123	0.176	0.196	0.180	0.118	0.149	0.160
2	0.206	0.201	0.200	0.200	0.197	0.197	0.199	0.219	0.231	0.198
3	0.237	0.235	0.233	0.257	0.237	0.216	0.222	0.242	0.274	0.290
4	0.261	0.263	0.259	0.275	0.292	0.309	0.224	0.259	0.324	0.650
5	0.321	0.321	0.321	0.348	0.337	0.347	0.265	0.340	0.000	0.727
6	0.321	0.321	0.321	0.000	0.000	0.000	0.284	0.000	0.000	0.000
7	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
8	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
9	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
10+	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
0	0.072	0.067	0.046	0.040	0.045	0.023	0.063	0.085	0.046	0.065
1	0.197	0.187	0.162	0.155	0.138	0.159	0.172	0.187	0.196	0.179
2	0.248	0.237	0.245	0.214	0.184	0.200	0.170	0.229	0.229	0.243
3	0.271	0.347	0.317	0.264	0.245	0.225	0.238	0.268	0.249	0.344
4	0.264	0.476	0.300	0.336	0.408	0.287	0.254	0.335	0.266	0.464
5	0.000	0.711	0.314	0.423	0.329	0.000	0.360	0.708	0.290	0.493
6	0.000	0.792	0.000	0.421	0.000	0.000	0.000	0.844	0.333	0.000
7	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
8	0.000	0.000	0.000	0.000	0.000	0.000	0.000	2.572	0.000	0.000
9	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
10+	0.000	0.000	0.000	0.000	0.000	0.000	0.000	3.048	0.000	0.000

Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
0	0.043	0.027	0.044	0.064	0.046	0.063	0.041	0.049	0.030	0.045
1	0.137	0.142	0.126	0.131	0.138	0.161	0.162	0.183	0.129	0.116
2	0.246	0.237	0.211	0.251	0.219	0.254	0.231	0.217	0.246	0.205
3	0.286	0.287	0.269	0.275	0.279	0.286	0.293	0.273	0.281	0.307
4	0.347	0.344	0.306	0.363	0.297	0.321	0.315	0.307	0.319	0.308
5	0.000	0.369	0.304	0.384	0.358	0.385	0.391	0.304	0.355	0.364
6	0.415	0.000	0.270	0.000	0.000	0.000	0.428	0.250	0.287	0.000
7	0.000	0.369	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.411
8	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.416
9	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
10+	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Table 4.2.6 Haddock in IV and IIIa. Mean weight-at-age in the industrial by-catch, 1963-2001.

International mean weight-at-age (kg), IBC catch, 1963 to 2001.

Age	1963	1964	1965	1966	1967	1968	1969	1970	1971
0	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010
1	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040
2	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180
3	0.302	0.302	0.302	0.302	0.302	0.302	0.302	0.302	0.302
4	0.400	0.400	0.400	0.400	0.400	0.400	0.400	0.400	0.400
5	0.420	0.420	0.420	0.420	0.420	0.420	0.420	0.420	0.420
6	0.440	0.440	0.440	0.440	0.440	0.440	0.440	0.440	0.440
7	0.000	0.500	0.500	0.500	0.000	0.500	0.500	0.500	0.000
8	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
9	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
10+	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Age	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
0	0.023	0.035	0.022	0.020	0.012	0.013	0.011	0.009	0.012	0.009
1	0.067	0.068	0.058	0.039	0.046	0.042	0.040	0.039	0.039	0.040
2	0.136	0.141	0.150	0.173	0.181	0.184	0.174	0.177	0.176	0.176
3	0.255	0.246	0.260	0.275	0.304	0.307	0.286	0.285	0.268	0.371
4	0.288	0.327	0.359	0.267	0.473	0.490	0.372	0.384	0.623	0.467
5	0.231	0.396	0.579	0.413	0.360	0.352	0.473	0.461	0.722	0.858
6	0.000	0.000	0.277	0.585	0.725	0.442	0.411	0.735	1.102	1.200
7	0.000	0.000	0.447	0.000	0.000	1.234	0.456	1.234	1.591	1.234
8	0.000	0.000	0.000	0.585	0.000	1.315	1.315	1.315	0.000	1.315
9	0.000	0.000	0.000	0.000	0.000	1.319	0.000	0.000	1.796	1.319
10+	0.000	0.000	0.000	0.000	0.000	0.000	1.400	1.400	0.000	1.400

Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
0	0.010	0.008	0.009	0.009	0.010	0.006	0.018	0.015	0.005	0.027
1	0.040	0.047	0.045	0.043	0.040	0.038	0.077	0.165	0.104	0.058
2	0.206	0.173	0.211	0.186	0.186	0.258	0.196	0.251	0.229	0.206
3	0.379	0.428	0.414	0.371	0.375	0.442	0.274	0.347	0.506	0.357
4	0.636	0.584	0.626	0.550	0.626	0.908	0.455	0.670	0.609	0.472
5	0.751	1.006	0.751	0.563	1.259	1.171	0.549	0.923	0.842	0.477
6	1.225	1.225	1.225	0.565	1.225	1.225	1.225	1.065	0.829	1.225
7	1.233	1.234	1.234	1.234	1.234	1.234	1.234	1.492	0.796	1.234
8	1.315	1.315	1.315	1.315	1.315	1.315	1.315	1.315	0.956	1.315
9	1.319	1.319	1.319	1.319	1.319	1.319	1.319	0.000	1.319	1.319
10+	0.000	0.000	1.400	1.400	1.400	0.000	1.400	1.400	0.000	0.000

Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
0	0.015	0.008	0.011	0.012	0.018	0.007	0.020	0.018	0.058	0.014
1	0.059	0.053	0.055	0.045	0.077	0.076	0.075	0.064	0.070	0.086
2	0.217	0.206	0.155	0.193	0.136	0.149	0.166	0.177	0.113	0.133
3	0.422	0.399	0.435	0.285	0.162	0.309	0.291	0.304	0.176	0.110
4	0.552	0.521	0.595	0.387	0.264	0.419	0.351	0.416	0.370	0.353
5	0.615	0.578	0.698	0.000	0.000	0.601	0.453	0.309	0.203	0.431
6	0.548	1.225	0.490	0.000	0.000	0.000	0.000	0.000	0.000	0.000
7	1.234	0.582	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
8	0.621	1.315	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
9	0.820	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
10+	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Table 4.3.1 Haddock in IV and IIIa. Available tuning data.

Haddock in the North Sea/Skagerrak; Tuning data.

105

SCOSEI

1978	2001										
1	1	0	1								
0	10										
325246	1665.021	160842.859	69033.234	14339.891	44151.660	2365.977	481.996	672.993	85.999	29.000	3.000
316419	542.986	83630.891	78815.422	17214.719	3039.951	8072.871	647.990	69.999	112.998	24.000	4.000
297227	210.001	131314.297	128306.000	26204.932	3392.990	500.999	2414.993	123.000	20.000	56.000	23.000
289672	344.996	10366.878	134259.797	55726.172	5180.690	701.958	101.994	578.965	14.999	21.999	1.000
297730	1444.967	31143.318	30968.578	118897.859	14296.881	681.995	144.999	39.000	229.998	1.000	9.000
333168	18101.430	29021.006	77288.734	30413.863	50114.895	6394.235	582.521	118.749	14.600	69.108	26.281
388085	422.095	120868.211	63391.047	49285.750	9426.073	14976.844	1593.925	253.625	18.044	8.020	38.094
382910	2052.204	29238.559	164839.219	33202.645	15993.386	2292.755	2846.266	308.427	46.979	19.404	9.192
425017	8265.012	33999.168	72603.500	155836.391	12894.806	4169.091	489.713	620.234	58.473	11.486	19.839
418734	137.900	43645.945	97730.797	19730.920	28882.715	1989.147	1174.107	198.915	284.601	30.602	16.321
377132	498.662	11575.792	201533.422	37421.008	4735.789	7414.681	718.065	290.026	80.007	70.006	27.002
355735	122.757	19003.758	19274.379	91069.766	8388.754	1091.295	1611.435	223.083	88.504	39.511	13.370
300076	712.190	35843.578	46489.320	9055.270	26705.223	1434.486	302.388	407.550	67.207	28.721	5.366
336675	2225.837	66143.555	30754.680	9530.928	1484.518	5028.135	307.511	122.391	183.010	42.406	10.676
300217	1231.550	30384.277	64732.898	8588.196	1511.942	290.016	1179.738	79.037	56.679	53.277	17.957
268413	2912.944	74523.461	88375.047	34996.895	2349.233	445.716	100.011	314.410	28.586	14.710	14.290
264738	3230.533	26626.006	125357.344	34126.902	10522.028	415.035	138.226	41.743	94.732	9.389	6.690
204545	236.434	67772.078	32300.982	70290.070	8734.379	2180.770	116.890	39.103	13.449	9.427	3.759
177092	1333.347	9191.870	123828.508	18532.246	17077.139	2161.283	707.006	83.724	11.556	8.436	11.111
166817	3108.574	30046.252	19165.139	59308.570	3917.753	4082.625	495.431	194.737	9.571	6.679	1.772
150361	38.313	12692.390	36812.770	12002.680	26564.220	1658.977	855.953	68.527	22.136	4.219	1.612
93796	3466.166	23253.381	35101.580	21990.903	6627.722	11164.055	690.476	456.286	56.023	12.211	0.497
69505	109.784	46421.874	13649.786	8497.452	5609.592	1760.584	2356.751	109.619	41.356	3.543	1.124
36135	60.238	3973.356	91164.700	4468.835	1720.130	798.976	272.547	262.936	27.294	17.750	1.445

Table 4.3.1 (Cont'd)

SCOLTR

1978	2001										
1	1	0	1								
0	10										
236929	1691.974	45733.129	11470.503	2913.805	12279.115	773.938	109.992	166.987	23.998	4.000	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
333197	179.995	92519.258	46282.270	8061.933	754.994	196.998	1014.992	61.000	18.000	8.000	5.000
251504	436.018	7979.309	58146.379	13652.977	1517.987	160.999	20.000	319.997	12.000	6.000	7.000
250870	351.994	24574.580	10169.870	33462.625	3936.959	132.999	66.999	7.000	57.999	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
240725	514.080	56768.969	22191.479	13374.796	2074.455	3392.161	402.251	98.036	15.160	7.075	14.150
268136	3547.814	38850.406	57422.219	4912.630	2787.082	414.117	871.881	127.894	27.406	2.030	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
351128	96.701	26220.209	33647.762	6464.323	7197.125	496.072	377.057	71.620	119.015	27.384	2.106
391988	209.356	2930.596	57588.922	14074.734	2366.963	2923.692	167.036	84.018	28.006	21.005	6.001
405883	1076.998	10415.017	2919.387	24894.512	2753.952	541.324	626.922	108.898	30.131	21.314	6.988
441084	201.380	11886.348	19204.623	2664.623	10237.385	669.340	168.189	264.216	44.836	13.601	5.347
408056	1040.658	44141.125	12393.733	3355.596	564.193	2213.164	226.034	79.589	145.803	38.047	15.861
473955	1838.052	20443.346	31073.281	3889.020	756.982	144.252	765.573	97.505	52.225	57.939	17.465
447064	231.101	39863.391	39175.809	20213.473	1526.971	362.312	83.586	273.529	29.288	26.740	25.521
480400	1482.199	8266.777	49046.742	23557.340	6304.283	474.420	128.143	42.488	63.750	12.916	6.819
442010	143.844	22873.541	13761.645	32063.371	5821.263	1658.212	96.772	14.662	12.648	16.895	2.898
445995	352.525	14280.547	72692.008	9859.966	13958.747	2041.165	955.313	303.994	9.761	13.794	7.004
479449	459.847	15907.054	13450.542	49548.469	3536.682	4510.573	553.205	162.645	12.541	2.170	1.726
427868	156.690	27497.900	33166.450	9596.803	29613.580	1666.356	1228.130	173.209	46.331	4.427	0.827
329750	2100.591	24474.823	36848.743	24426.481	5531.454	11751.876	840.830	578.867	94.400	8.786	2.002
280938	4.881	64710.407	15037.658	11706.879	7060.598	1300.239	2593.344	173.991	82.995	7.893	1.966
245489	87.474	15567.304	173376.240	6323.384	2896.944	1252.629	365.207	443.732	61.520	16.846	8.614

Table 4.3.1 (Cont'd)

ENGGFS

1977	2001							
1	1	0.5	0.75					
0	5							
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

Table 4.3.1 (Cont'd)

SCOGFS

1982	2001						
1	1	0.5	0.75				
0	5						
100	12.35	24.88	9.96	13.36	1.15	0.07	0.02
100	22.03	18.13	16.11	3.72	4.55	0.53	0.12
100	8.73	43.67	7.88	3.36	0.55	0.65	0.09
100	8.18	19.76	29.81	2.32	1.03	0.14	0.22
100	17.47	23.29	5.74	5.98	0.36	0.27	0.04
100	2.77	23.93	7.04	1.06	1.28	0.08	0.05
100	4.06	4.67	19.82	1.70	0.27	0.23	0.02
100	4.32	8.86	2.14	5.74	0.31	0.04	0.07
100	31.63	10.02	2.40	0.32	1.03	0.07	0.01
100	34.71	17.05	1.78	0.21	0.05	0.16	0.02
100	82.70	38.32	9.63	0.48	0.08	0.03	0.08
100	8.59	58.36	13.80	2.69	0.06	0.04	0.01
100	137.62	12.65	20.80	2.10	0.53	0.02	0.00
100	15.66	81.53	7.34	9.26	0.74	0.28	0.02
100	19.80	22.31	47.05	2.31	2.06	0.22	0.06
100	9.72	27.79	8.49	13.97	0.66	0.56	0.06
100	32.80	63.49	19.24	4.90	5.11	0.24	0.18
100	660.67	19.07	11.41	6.88	1.97	1.64	0.06
100	119.02	306.11	4.60	2.21	1.30	0.73	0.27
100	0.79	37.90	113.52	1.79	0.65	0.40	0.18

Table 4.3.1 (Cont'd)

IBTS_Q1

1973	2001					
1	1	0.99	1			
0	5					
1	1136.1	136.1	-1	-1	-1	-1
1	1146.3	355.8	-1	-1	-1	-1
1	105	556.4	-1	-1	-1	-1
1	139.4	66.5	-1	-1	-1	-1
1	352.8	105.9	-1	-1	-1	-1
1	468.2	212.4	-1	-1	-1	-1
1	863.7	388.6	-1	-1	-1	-1
1	267.7	637.6	-1	-1	-1	-1
1	537.6	253	-1	-1	-1	-1
1	308.2	402.6	89.8	115.3	12.7	1.9
1	1067.7	221.3	130.9	20.9	21.2	4.6
1	228.5	828.4	105.1	33.8	4.3	7.2
1	584.5	251.1	285.9	17.2	6	2.1
1	917.3	328.8	47.2	61.1	4.7	2.6
1	100.7	671	97	12.7	13.6	2
1	217.6	97.4	273.7	16.8	2.1	4.7
1	217.4	139.1	33	50.4	3.2	1.8
1	678	133	24.8	4.2	8.4	2.4
1	1163	344.6	18.1	3	0.6	2
1	1254.3	540.8	154.5	8.9	1.1	1
1	228.7	503.9	98.3	23.3	1.6	0.8
1	1355.5	201.1	176.2	24.3	5.3	0.8
1	267.4	813.3	65.9	46.7	7.7	3.1
1	860.2	366.4	470.6	24.8	15.1	3.4
1	373.6	432.3	105.5	113.7	8.7	5.4
1	211.8	232.9	129.7	48.1	36.6	4.3
1	3702.1	107.8	49.9	25.4	15.6	10.3
1	887.6	2279	47.8	10.9	7.2	5.7
1	57	471.1	1308.4	8.7	6.7	3.8

Table 4.4.1 Haddock in IV and IIIa. XSA tuning report file.

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 Lowestoft VPA Version 3.1

   14/06/2002  15:45

 Extended Survivors Analysis

 Haddock in IV and IIIa

 cpue data from file HADIVEF.TUN

 Catch data for  39 years. 1963 to 2001. Ages  0 to  10.

      Fleet,            First, Last, First, Last, Alpha,  Beta
                    ,    year, year,  age ,  age
 ENGGFS              ,   1977, 2001,   0,     5,   .500,   .750
 IBTS_Q1             ,   1973, 2001,   0,     5,   .990,  1.000


 Time-series weights :

      Tapered time weighting applied
      Power =    3 over  20 years


 Catchability analysis :

      Catchability dependent on stock size for ages <    2

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


      Catchability independent of age for ages >=    3


 Terminal population estimation :

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

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

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

      Prior weighting not applied


 Tuning converged after   17 iterations

1


 Regression weights
       ,  .751,  .820,  .877,  .921,  .954,  .976,  .990,  .997, 1.000, 1.000



 Fishing mortalities
    Age,  1992,  1993,  1994,  1995,  1996,  1997,  1998,  1999,  2000,  2001

      0,  .019,  .031,  .005,  .063,  .048,  .009,  .007,  .003,  .007,  .007
      1,  .148,  .174,  .154,  .106,  .084,  .129,  .134,  .168,  .058,  .075
      2,  .740,  .811,  .576,  .514,  .464,  .501,  .649,  .866,  .808,  .357
      3, 1.139, 1.048, 1.085,  .941,  .955,  .669,  .731, 1.078, 1.144,  .989
      4, 1.070,  .908, 1.048, 1.043, 1.076,  .802,  .965, 1.167, 1.394,  .828
      5,  .805,  .971,  .694,  .914, 1.101, 1.128,  .865, 1.387, 1.125,  .901
      6, 1.119,  .786, 1.129,  .394, 1.305,  .963,  .892, 1.150, 1.615, 1.072
      7,  .712,  .890,  .965,  .835, 2.061, 1.311,  .680, 1.552,  .998, 1.337
      8,  .855,  .524, 1.530,  .630, 1.059, 1.159, 1.148, 1.984, 1.098, 1.305
      9,  .923,  .831, 1.086,  .772, 1.342, 1.088,  .924, 1.468, 1.262, 1.101


1
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Table 4.4.1 (Cont'd)

XSA population numbers (Thousands)

YEAR	AGE 0	1	2	3	4	5	6	7	8	9
1992	4.06E+07	3.49E+06	5.92E+05	5.42E+04	1.13E+04	2.50E+03	7.98E+03	9.85E+02	5.79E+02	5.37E+02
1993	1.27E+07	5.13E+06	5.78E+05	1.89E+05	1.35E+04	3.02E+03	9.14E+02	2.13E+03	3.96E+02	2.02E+02
1994	5.32E+07	1.59E+06	8.28E+05	1.72E+05	5.17E+04	4.24E+03	9.36E+02	3.41E+02	7.18E+02	1.92E+02
1995	1.25E+07	6.82E+06	2.61E+05	3.12E+05	4.53E+04	1.41E+04	1.73E+03	2.48E+02	1.06E+02	1.27E+02
1996	2.07E+07	1.51E+06	1.18E+06	1.05E+05	9.48E+04	1.24E+04	4.63E+03	9.57E+02	8.80E+01	4.64E+01
1997	1.19E+07	2.54E+06	2.67E+05	4.96E+05	3.14E+04	2.52E+04	3.38E+03	1.03E+03	9.99E+01	2.50E+01
1998	9.41E+06	1.52E+06	4.28E+05	1.09E+05	1.98E+05	1.10E+04	6.67E+03	1.06E+03	2.27E+02	2.57E+01
1999	1.11E+08	1.20E+06	2.56E+05	1.50E+05	4.07E+04	5.87E+04	3.78E+03	2.24E+03	4.38E+02	5.89E+01
2000	2.13E+07	1.42E+07	1.95E+05	7.21E+04	3.97E+04	9.86E+03	1.20E+04	9.80E+02	3.88E+02	4.93E+01
2001	1.45E+06	2.73E+06	2.57E+06	5.83E+04	1.79E+04	7.67E+03	2.62E+03	1.96E+03	2.96E+02	1.06E+02

Estimated population abundance at 1st Jan 2002

0.00E+00	1.85E+05	4.86E+05	1.21E+06	1.69E+04	6.09E+03	2.55E+03	7.35E+02	4.21E+02	6.56E+01

Taper weighted geometric mean of the VPA populations:

1.69E+07	2.64E+06	4.39E+05	1.24E+05	3.78E+04	1.08E+04	3.42E+03	1.10E+03	3.22E+02	1.01E+02

Standard error of the weighted Log(VPA populations) :

1.1050	.8328	.8849	.8076	.9017	.8906	.7878	.7010	.8185	.9437

1

Log catchability residuals.

Fleet : **ENGGFS**

Age	1973	1974	1975	1976	1977	1978	1979	1980	1981
0	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
1	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
2	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
3	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
4	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
5	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99

Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
0	.15	-.28	.18	-.10	-.78	-.02	-.03	.24	-.17	-.19
1	.49	.53	.37	.56	-.05	-.14	-.01	.35	.16	-.47
2	.65	.35	.20	.30	.30	-.22	.42	.29	.16	-.72
3	.57	.53	.35	.37	-.25	-.40	.31	.20	.05	-.53
4	.20	.16	.25	.19	-.24	-.45	-.26	-.04	.03	-.48
5	.87	.17	.07	.79	.12	-.75	-.04	-.86	-.40	-.15

Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
0	.21	.13	.03	.35	-.08	.15	-.23	-.15	.17	-.20
1	.11	-.03	-.02	.10	.02	.13	.11	-.11	.15	-.42
2	.36	-.08	-.15	.25	-.10	.20	.09	.04	-.34	-.14
3	.18	-.08	-.64	.07	.15	.11	.07	-.12	-.16	.58
4	-.75	-.84	-.56	-.43	-.06	-.42	-.33	.17	-.21	.36
5	-1.04	-.44	-.95	-.51	-.52	-.08	-.37	-.14	.21	.36

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	-15.2701	-15.3649	-15.3649	-15.3649
S.E(Log q)	.2843	.3205	.4451	.5454

Table 4.4.1 (Cont'd)

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,	.69,	4.939,	16.98,	.96,	20,	.23,	-17.13,
1,	1.03,	-.364,	15.70,	.93,	20,	.23,	-15.67,

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,	1.00,	-.027,	15.28,	.91,	20,	.30,	-15.27,
3,	1.01,	-.069,	15.40,	.86,	20,	.34,	-15.36,
4,	.92,	.776,	15.20,	.89,	20,	.33,	-15.63,
5,	.81,	1.708,	14.48,	.89,	20,	.33,	-15.68,

1

Fleet : **IBTS_Q1**

Age	1973	1974	1975	1976	1977	1978	1979	1980	1981
0	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
1	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
2	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
3	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
4	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
5	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99

Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
0	-.65	-.59	-.79	-.18	-.47	-.20	-.13	-.17	-.20	.37
1	-.25	-.46	-.29	-.12	-.25	-.25	.21	-.14	-.13	-.34
2	-.08	-.22	-.02	-.29	-.26	-.07	.11	.35	-.20	-.80
3	-.05	-.02	-.09	-.38	-.10	-.04	-.02	-.10	-.05	-.78
4	-.17	-.34	-.21	-.46	-.15	-.27	-.48	-.25	-.49	-.88
5	-.04	.23	.01	.30	-.04	.02	-.03	.26	.60	-.84

Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
0	.06	-.47	-.14	-.26	.39	.07	-.27	.13	.35	.29
1	.16	-.27	-.09	-.12	.52	.23	.09	-.45	.18	.19
2	.10	-.26	-.27	-.16	.25	.27	.16	-.07	.10	.38
3	.13	-.25	-.08	-.16	.31	-.01	.71	.10	.05	-.12
4	-.47	-.43	-.43	.07	.03	.31	.07	1.00	.48	.64
5	.64	.39	-.23	.14	.55	.33	.67	.39	1.32	.94

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	-7.2134	-7.4586	-7.4586	-7.4586
S.E(Log q)	.3015	.3223	.5257	.6615

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,	1.00,	-.011,	8.38,	.93,	20,	.31,	-8.39,
1,	1.06,	-.537,	6.69,	.90,	20,	.29,	-7.12,

Table 4.4.1 (Cont'd)

```
 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,     .90,    1.068,      7.78,     .92,     20,     .27,   -7.21,
  3,     .98,     .157,      7.54,     .87,     20,     .33,   -7.46,
  4,     .89,     .655,      7.77,     .79,     20,     .48,   -7.45,
  5,    1.13,    -.638,      6.77,     .71,     20,     .59,   -7.06,

1

 Terminal year survivor and F summaries :

 Age  0   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
 ENGGFS              ,    152034.,   .300,       .000,    .00,   1,  .460,     .000
 IBTS_Q1             ,    247388.,   .363,       .000,    .00,   1,  .313,     .000

   P shrinkage mean  ,   2638172.,    .83,,,,                        .060,     .000

   F shrinkage mean  ,     71049.,    .50,,,,                        .167,     .018

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
    185188.,       .20,      .45,    4,   2.235,   .007


 Age  1   Catchability dependent on age and year class strength

 Year class = 2000

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                  Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 ENGGFS              ,    427867.,   .212,       .299,   1.41,   2,  .458,     .085
 IBTS_Q1             ,    631545.,   .220,       .080,    .36,   2,  .425,     .058

   P shrinkage mean  ,    438715.,    .88,,,,                        .028,     .083

   F shrinkage mean  ,    276095.,    .50,,,,                        .089,     .129

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
    485845.,       .14,      .15,    6,   1.040,   .075


1
 Age  2   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
 ENGGFS              ,   1148384.,   .173,       .097,    .56,   3,  .510,     .372
 IBTS_Q1             ,   1546913.,   .196,       .080,    .41,   3,  .399,     .289

   F shrinkage mean  ,    541363.,    .50,,,,                        .091,     .671

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
   1207832.,       .13,      .13,    7,   1.048,   .357
```

Table 4.4.1 (Cont'd)

```
 Age  3   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
 ENGGFS              ,     18562.,   .170,       .235,   1.38,   4,  .416,     .931
 IBTS_Q1             ,     14485.,   .180,       .104,    .58,   4,  .383,    1.089

   F shrinkage mean  ,     18659.,    .50,,,,                        .201,     .928

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
     16899.,       .14,      .11,    9,    .779,   .989


1
 Age  4   Catchability constant w.r.t. time and age (fixed at the value for age)  3

 Year class = 1997

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                  Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 ENGGFS              ,      7015.,   .213,       .104,    .49,   5,  .378,     .750
 IBTS_Q1             ,      7738.,   .219,       .145,    .66,   5,  .323,     .700

   F shrinkage mean  ,      3930.,    .50,,,,                        .299,    1.097

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
      6089.,       .18,      .13,   11,    .692,   .828


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

 Year class = 1996

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                  Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 ENGGFS              ,      2922.,   .297,       .108,    .36,   6,  .300,     .823
 IBTS_Q1             ,      4486.,   .319,       .157,    .49,   6,  .232,     .605

   F shrinkage mean  ,      1768.,    .50,,,,                        .468,    1.135

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
      2551.,       .26,      .16,   13,    .598,   .901


1
 Age  6   Catchability constant w.r.t. time and age (fixed at the value for age)  3

 Year class = 1995

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                  Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 ENGGFS              ,       873.,   .233,       .039,    .17,   6,  .166,     .963
 IBTS_Q1             ,      1573.,   .243,       .223,    .92,   6,  .135,     .641

   F shrinkage mean  ,       609.,    .50,,,,                        .699,    1.200

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
       735.,       .35,      .17,   13,    .471,  1.072
```

Table 4.4.1 (Cont'd)

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

 Year class = 1994

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                  Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 ENGGFS              ,       388.,   .211,       .068,    .32,   6,  .031,    1.397
 IBTS_Q1             ,       472.,   .221,       .089,    .40,   6,  .025,    1.254

   F shrinkage mean  ,       420.,    .50,,,,                        .944,    1.337

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
       421.,       .47,      .01,   13,    .029,  1.337



1
 Age  8   Catchability constant w.r.t. time and age (fixed at the value for age)  3

 Year class = 1993

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                  Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 ENGGFS              ,        56.,   .228,       .121,    .53,   6,  .029,    1.419
 IBTS_Q1             ,        83.,   .240,       .163,    .68,   6,  .024,    1.137

   F shrinkage mean  ,        66.,    .50,,,,                        .947,    1.306

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
        66.,       .47,      .03,   13,    .054,  1.305



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

 Year class = 1992

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                  Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 ENGGFS              ,        28.,   .262,       .041,    .16,   6,  .006,    1.126
 IBTS_Q1             ,        30.,   .278,       .107,    .39,   6,  .005,    1.074

   F shrinkage mean  ,        29.,    .50,,,,                        .990,    1.101

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
        29.,       .49,      .01,   13,    .011,  1.101



1
1
```

Table 4.4.2 Haddock in IV and IIIa. XSA estimates of fishing mortality, 1963-2001

International F at age, Total , 1963 to 2001.

Age	1963	1964	1965	1966	1967	1968	1969	1970	1971
0	0.002	0.043	0.072	0.070	0.002	0.002	0.017	0.030	0.012
1	0.124	0.058	1.363	1.303	0.263	0.052	0.022	0.500	0.474
2	0.805	0.454	0.416	0.831	1.081	0.578	0.655	1.038	0.659
3	0.670	1.175	0.509	0.360	0.415	0.898	1.376	1.150	0.798
4	0.761	0.756	0.985	0.779	0.372	0.307	1.287	1.269	0.871
5	0.880	0.884	1.299	1.240	1.014	0.508	0.814	0.711	0.864
6	0.508	1.263	1.021	1.310	1.326	0.808	1.626	1.437	0.686
7	0.827	0.622	0.872	1.082	1.139	0.597	1.000	0.709	1.017
8	0.777	0.839	0.498	0.970	1.945	0.659	0.951	1.059	1.285
9	0.758	0.882	0.946	1.089	1.173	0.581	1.149	1.049	0.955
10+	0.758	0.882	0.946	1.089	1.173	0.581	1.149	1.049	0.955

Age	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
0	0.032	0.002	0.013	0.011	0.030	0.013	0.022	0.035	0.074	0.057
1	0.169	0.374	0.353	0.335	0.308	0.338	0.390	0.176	0.189	0.179
2	0.793	0.565	0.933	0.969	0.814	1.005	1.012	0.882	0.707	0.450
3	1.339	1.158	0.950	1.253	1.371	1.038	1.127	1.141	1.208	0.946
4	1.201	0.802	1.003	1.099	0.781	1.262	1.124	1.060	1.184	0.989
5	1.158	0.950	0.628	0.992	1.271	1.031	1.162	1.024	0.933	0.802
6	0.859	1.098	0.880	0.820	1.064	0.989	1.036	1.167	0.986	0.604
7	0.684	0.882	1.125	1.567	0.393	0.924	1.146	0.616	1.283	1.010
8	0.471	1.146	0.405	0.998	0.839	0.487	0.853	0.940	0.655	1.096
9	0.884	0.987	0.817	1.108	0.879	0.949	1.076	0.972	1.020	0.910
10+	0.884	0.987	0.817	1.108	0.879	0.949	1.076	0.972	1.020	0.910

Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
0	0.038	0.027	0.015	0.016	0.003	0.009	0.005	0.004	0.006	0.013
1	0.174	0.151	0.125	0.206	0.128	0.119	0.137	0.106	0.195	0.156
2	0.431	0.660	0.668	0.614	1.017	0.902	0.796	0.656	1.121	0.781
3	0.816	1.021	0.997	0.955	1.240	1.045	1.302	0.987	1.162	1.034
4	0.880	1.162	1.142	1.103	1.281	1.082	1.109	1.179	1.152	0.864
5	0.641	1.214	1.223	1.026	1.057	0.822	1.104	0.691	0.936	0.884
6	0.748	0.799	1.093	1.076	0.713	1.143	0.741	0.772	0.533	0.640
7	0.960	0.836	0.736	0.959	0.870	0.821	0.867	0.557	0.660	0.486
8	1.108	0.563	0.600	0.640	0.659	1.304	0.641	0.749	0.470	0.710
9	0.877	0.925	0.969	0.972	0.926	1.046	0.902	0.797	0.758	0.727
10+	0.877	0.925	0.969	0.972	0.926	1.046	0.902	0.797	0.758	0.727

Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
0	0.019	0.031	0.004	0.063	0.048	0.009	0.007	0.003	0.007	0.007
1	0.148	0.174	0.154	0.106	0.084	0.129	0.134	0.168	0.058	0.075
2	0.740	0.811	0.576	0.514	0.465	0.501	0.649	0.866	0.808	0.357
3	1.139	1.048	1.085	0.941	0.955	0.669	0.731	1.078	1.144	0.989
4	1.070	0.908	1.048	1.043	1.076	0.802	0.965	1.167	1.394	0.828
5	0.805	0.971	0.694	0.914	1.101	1.128	0.865	1.387	1.125	0.901
6	1.118	0.786	1.129	0.394	1.305	0.963	0.892	1.150	1.615	1.072
7	0.712	0.890	0.965	0.835	2.061	1.311	0.680	1.552	0.998	1.337
8	0.855	0.524	1.530	0.630	1.059	1.159	1.148	1.984	1.098	1.305
9	0.923	0.831	1.086	0.772	1.342	1.088	0.924	1.468	1.262	1.102
10+	0.923	0.831	1.086	0.772	1.342	1.088	0.924	1.468	1.262	1.102

Table 4.4.3 Haddock in IV and IIIa. XSA estimates of population size, 1963-2001

Tuned Stock Numbers-at-age (10**-5), 1963 to 2002, (numbers in 2002 are VPA survivors)

Age	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
0	23383	91721	263363	689923	3881121	171025	121955	877639	782849	215393
1	255640	3005	11304	31563	82821	498538	21977	15439	109661	99584
2	7401	43367	545	556	1647	12233	90929	4131	1798	13106
3	486	2217	18453	241	162	375	4601	31652	980	623
4	277	194	534	8636	131	83	119	905	7806	344
5	109	101	71	155	3085	70	48	26	198	2545
6	14	37	34	16	37	917	35	17	10	68
7	13	7	9	10	3	8	334	6	3	4
8	12	5	3	3	3	1	4	101	2	1
9	1	4	2	1	1	0	0	1	29	1
10+	0	0	1	0	1	0	0	1	3	8

Age	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
0	728990	1334922	115433	164838	257565	395470	721508	156532	324795	206252
1	26853	93629	169645	14694	20595	32724	49816	89719	18718	39493
2	16149	3550	12631	23303	2075	2821	4253	8027	14257	3006
3	3975	6153	936	3213	6918	509	688	1180	2652	6093
4	127	972	1853	208	635	1909	128	171	275	802
5	81	44	278	481	74	140	483	35	41	80
6	654	26	19	84	110	22	36	142	11	15
7	24	179	9	7	24	34	6	9	43	5
8	2	8	48	1	4	8	9	3	2	13
9	1	0	4	14	1	2	3	3	1	1
10+	3	1	1	1	4	2	1	2	1	0

Age	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
0	669817	172744	240531	498849	42019	84419	87061	281406	274243	406162
1	25552	83933	21896	30464	64017	5361	10808	11165	36020	34860
2	6377	4218	14225	3421	5148	10918	898	1867	1764	5916
3	1310	2209	1450	5161	829	1400	3301	312	408	542
4	2099	368	635	434	1163	227	296	958	76	113
5	259	512	91	164	94	307	58	71	236	25
6	34	63	123	27	47	34	83	24	23	80
7	6	13	17	34	11	12	13	32	12	10
8	2	2	5	5	12	4	4	6	13	6
9	3	1	1	2	2	3	2	2	3	5
10+	1	2	2	2	3	2	1	1	1	3

Age	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
0	127196	531846	125175	206655	119328	94089	1106706	213342	14483	0
1	51316	15868	68159	15132	25357	15218	12027	142083	27277	1852
2	5775	8278	2612	11768	2672	4280	2556	1953	25749	4858
3	1892	1720	3119	1048	4957	1085	1499	721	583	12078
4	135	517	453	948	314	1979	407	397	179	169
5	30	42	141	124	252	110	587	99	77	61
6	9	9	17	46	34	67	38	120	26	26
7	21	3	2	10	10	11	22	10	20	7
8	4	7	1	1	1	2	4	4	3	4
9	2	2	1	0	0	0	1	0	1	1
10+	4	1	1	1	0	0	0	0	0	0

1

Table 4.5.1 Haddock in IV and IIIa. RCT3 input data for haddock age 0.

HADDOCK IN IV, RCT3 INPUT VALUES Age 0 14-Jun-02
5 31 2

YEARCLASS	VPA	IBTS1	IBTS2	EGFS0	EGFS1	EGFS2	SGFS0	SGFS1	SGFS2
1971	78285	395.1	876.3	-1	-1	-1	-1	-1	-1
1972	21539	327.8	136.1	-1	-1	-1	-1	-1	-1
1973	72899	1136.1	355.8	-1	-1	-1	-1	-1	-1
1974	133492	1146.3	556.4	-1	-1	-1	-1	-1	-1
1975	11543	105	66.5	-1	-1	32.1	-1	-1	-1
1976	16484	139.4	105.9	-1	66.8	26.2	-1	-1	-1
1977	25757	352.8	212.4	534.8	136.9	54.6	-1	-1	-1
1978	39547	468.2	388.6	358.3	295.5	167.3	-1	-1	-1
1979	72151	863.7	637.6	875.5	623.3	439.1	-1	-1	-1
1980	15653	267.7	253	374	173.2	79.8	-1	-1	996
1981	32480	537.6	402.6	1537.5	315.5	109.5	-1	2488	1611
1982	20625	308.2	221.3	281.3	218.2	61.6	1235	1813	788
1983	66982	1067.7	828.4	831.9	599.3	238.2	2203	4367	2981
1984	17274	228.5	251.1	228.5	186.6	44.7	873	1976	574
1985	24053	584.5	328.8	245.9	149.7	4 3.1	818	2329	704
1986	49885	917.3	671	266	281.9	183.5	1747	2393	1982
1987	4202	100.7	97.4	22.4	28.6	14.5	277	467	214
1988	8442	217.6	139.1	60.7	81.7	19.8	406	886	240
1989	8706	217.4	133	94.3	66.4	9.6	432	1002	178
1990	28141	678	344.6	281.9	115	97.7	3163	1705	963
1991	27424	1163	540.8	263.3	196.9	58.6	3471	3832	1380
1992	40616	1254.3	503.9	827.7	246.1	90.2	8270	5836	2080
1993	12720	228.7	201.1	135.8	80.7	44.5	859	1265	734
1994	53185	1355.5	813.3	943	383.1	145.7	13762	8153	4705
1995	12518	267.4	366.4	180	83.1	43.3	1566	2231	849
1996	20667	860.2	432.3	199	149	56.8	1980	2779	-1
1997	11955	373.6	232.9	130	89	28.3	972	-1	-1
1998	9430	211.8	107.8	53	56	15.2	-1	-1	-1
1999	110919	3702.1	2279	2110	841	325	-1	-1	-1
2000	-1	887.6	471.1	310	96	-1	-1	-1	-1
2001	-1	57	-1	3.7	-1	-1	-1	-1	-1

File Locations:

W:\ACFM\WGNSSK\2002\Stock\Had-34\Final runs\Recruitment\HADIV00.RCT
W:\ACFM\WGNSSK\2002\Stock\Had-34\Final runs\Recruitment\HADIV01.RCT
W:\ACFM\WGNSSK\2002\Stock\Had-34\Final runs\Recruitment\HADIV02.RCT

For RCT3 calibrations at ages 0 – 3 respectively

Table 4.6.1 Haddock in IV and IIIa. Stock summary table

Mean fishing mortality, biomass and recruitment, 1963 - 2001.

	Mean F			Stock Biomass ('000 tonnes)		Recruits Age 0	
Year	H.cons Ages 2 to 6	Disc Ages 2 to 6	IBC Ages 2 to 6	Total	Spawning	Yclass	Million
1963	0.579	0.125	0.021	3387	137	1963	2338
1964	0.699	0.073	0.135	1188	420	1964	9172
1965	0.647	0.067	0.132	812	526	1965	26336
1966	0.715	0.104	0.085	780	432	1966	68992
1967	0.678	0.142	0.021	1216	229	1967	388112
1968	0.485	0.089	0.045	6700	265	1968	17103
1969	0.843	0.093	0.216	2344	816	1969	12196
1970	0.804	0.123	0.193	1405	900	1970	87764
1971	0.629	0.108	0.040	1672	418	1971	78285
1972	0.900	0.145	0.025	1677	301	1972	21539
1973	0.777	0.126	0.011	900	294	1973	72899
1974	0.639	0.140	0.100	1568	258	1974	133492
1975	0.763	0.203	0.061	2163	238	1975	11543
1976	0.812	0.153	0.095	885	308	1976	16484
1977	0.807	0.127	0.131	567	239	1977	25757
1978	0.878	0.185	0.029	665	132	1978	39547
1979	0.938	0.085	0.032	673	109	1979	72151
1980	0.846	0.080	0.078	1250	153	1980	15653
1981	0.652	0.086	0.020	671	240	1981	32480
1982	0.587	0.067	0.050	840	300	1982	20625
1983	0.800	0.145	0.027	759	253	1983	66982
1984	0.908	0.091	0.025	1493	199	1984	17274
1985	0.856	0.078	0.021	860	241	1985	24053
1986	0.880	0.178	0.004	715	221	1986	49885
1987	0.852	0.142	0.005	1068	157	1987	4202
1988	0.835	0.147	0.028	428	159	1988	8442
1989	0.701	0.132	0.024	396	129	1989	8706
1990	0.698	0.232	0.050	343	81	1990	28141
1991	0.760	0.065	0.015	740	63	1991	27424
1992	0.863	0.100	0.011	602	101	1992	40616
1993	0.744	0.143	0.018	853	133	1993	12720
1994	0.715	0.183	0.008	501	153	1994	53185
1995	0.608	0.149	0.004	926	148	1995	12518
1996	0.808	0.159	0.014	583	178	1996	20666
1997	0.668	0.127	0.018	627	188	1997	11933
1998	0.650	0.145	0.026	484	156	1998	9409
1999	0.862	0.249	0.018	371	110	1999	110671
2000	0.994	0.170	0.053	1802	84	2000	21334
2001	0.630	0.132	0.067	890	211	2001	1448
Min.	0.485	0.065	0.004	343	63	Min.	2338
Mean	0.757	0.130	0.050	1175	248	Gmean	25895
Max.	0.994	0.249	0.216	6700	900	Max.	388112

Min, max and geo. mean recruitment calculated over years 1963 to 1999
(Arithmetic mean recruitment 1963 - 1999 = 44846)
Biomass totals calculated at start of year.

Table 4.8.1 Haddock in IV and IIIa. Results of fitting the Beverton-Holt stock recruit model.

```
 Data read from file hadiv.rec

 Beverton-Holt curve
 Moving average term NOT fitted

 Number of observations=,  39

 Number of parameters  =,   2

 Residual mean square  =,    1.2270

 Coefficient of determination =,     .0078

Parameter,s.d.

  610.9181,  990.4547,
   49.8184,  101.4527,
```

Y/Class,	SSB,	Recruits,	Fit. rct,	residuals
1963,	137.20,	2338.00,	22327.63,	-2.2565
1964,	420.00,	9172.00,	27207.71,	-1.0873
1965,	526.10,	26336.00,	27802.26,	-.0542
1966,	432.20,	68992.00,	27289.40,	.9275
1967,	229.10,	388112.00,	24998.89,	2.7425
1968,	264.60,	17103.00,	25612.66,	-.4038
1969,	815.80,	12196.00,	28683.36,	-.8552
1970,	899.50,	87764.00,	28837.79,	1.1130
1971,	417.80,	78285.00,	27192.53,	1.0574
1972,	301.00,	21539.00,	26113.01,	-.1926
1973,	294.50,	72899.00,	26031.42,	1.0298
1974,	258.40,	133492.00,	25515.65,	1.6547
1975,	238.10,	11543.00,	25168.81,	-.7795
1976,	307.80,	16484.00,	26195.19,	-.4632
1977,	238.60,	25757.00,	25177.94,	.0227
1978,	132.30,	39547.00,	22109.49,	.5815
1979,	109.20,	72151.00,	20900.08,	1.2390
1980,	153.00,	15653.00,	22959.21,	-.3831
1981,	240.20,	32480.00,	25206.95,	.2535
1982,	299.80,	20625.00,	26098.17,	-.2354
1983,	252.90,	66982.00,	25426.28,	.9686
1984,	199.00,	17274.00,	24341.28,	-.3430
1985,	240.90,	24053.00,	25219.53,	-.0474
1986,	221.50,	49885.00,	24846.62,	.6970
1987,	157.50,	4202.00,	23121.47,	-1.7052
1988,	159.30,	8442.00,	23184.42,	-1.0103
1989,	129.10,	8706.00,	21960.59,	-.9252
1990,	81.40,	28141.00,	18880.02,	.3991
1991,	63.50,	27424.00,	17054.78,	.4750
1992,	101.20,	40616.00,	20394.99,	.6889
1993,	133.30,	12720.00,	22154.96,	-.5549
1994,	153.00,	53185.00,	22959.21,	.8401
1995,	148.40,	12518.00,	22785.72,	-.5990
1996,	177.70,	20666.00,	23770.79,	-.1400
1997,	188.20,	11933.00,	24064.78,	-.7014
1998,	156.10,	9409.00,	23071.75,	-.8969
1999,	109.60,	110671.00,	20924.01,	1.6657
2000,	83.80,	21334.00,	19087.56,	.1113
2001,	210.70,	1448.00,	24614.95,	-2.8332

Table 4.8.2 Haddock in IV and IIIa. Input to medium-term forecasts

Label	Value	CV
Number-at-age		
N0	25895467	1.02
N1	185199	0.45
N2	485800	0.15
N3	1207800	0.13
N4	16899	0.14
N5	6099	0.18
N6	2600	0.26
N7	699	0.35
N8	400	0.47
N9	100	0.47
N10	0	0.49

H.cons selectivity			Weight in the H.cons catch		
sH0	0	0	WH0	0	0
sH1	0.001	0.62	WH1	0.321	0.16
sH2	0.156	0.63	WH2	0.354	0.03
sH3	0.64	0.05	WH3	0.425	0.03
sH4	1.003	0.08	WH4	0.5	0.04
sH5	1.089	0.12	WH5	0.615	0.17
sH6	1.243	0.2	WH6	0.708	0.07
sH7	1.292	0.33	WH7	0.953	0.17
sH8	1.453	0.31	WH8	1.254	0.48
sH9	1.277	0.14	WH9	1.402	0.22
sH10	1.277	0.14	WH10	2.029	0.12

Discard selectivity			Weight in the discards		
sD0	0.001	0.94	WD0	0.041	0.24
sD1	0.08	0.57	WD1	0.143	0.25
sD2	0.438	0.36	WD2	0.223	0.09
sD3	0.296	0.17	WD3	0.287	0.06
sD4	0.117	0.56	WD4	0.311	0.02
sD5	0.046	0.45	WD5	0.341	0.09
sD6	0.036	1.45	WD6	0.179	0.87
sD7	0.003	1.73	WD7	0.137	1.73
sD8	0.01	1.73	WD8	0.139	1.73
sD9	0	0	WD9	0	0
sD10	0	0	WD10	0	0

IBC selectivity			Weight in the IBC		
sI0	0.005	0.2	WI0	0.03	0.81
sI1	0.019	0.95	WI1	0.073	0.16
sI2	0.084	0.89	WI2	0.141	0.23
sI3	0.134	0.73	WI3	0.197	0.5
sI4	0.01	1.2	WI4	0.38	0.09
sI5	0.003	1.41	WI5	0.314	0.36
sI6	0	1.73	WI6	0	0
sI7	0	0	WI7	0	0
sI8	0	0	WI8	0	0
sI9	0	0	WI9	0	0
sI10	0	0	WI10	0	0

Table 4.8.2(Cont'd) Haddock in IV and IIIa. Input to medium-term forecasts

Label	Value	CV
Weight in the stock		
WS0	0.031	0.49
WS1	0.132	0.24
WS2	0.237	0.08
WS3	0.346	0.09
WS4	0.479	0.04
WS5	0.603	0.17
WS6	0.695	0.08
WS7	0.951	0.17
WS8	1.244	0.47
WS9	1.402	0.22
WS10	2.029	0.12

Natural mortality			Proportion mature		
M0	2.05	0.03	MT0	0	0.1
M1	1.65	0.05	MT1	0.01	0.1
M2	0.4	0.07	MT2	0.32	0.1
M3	0.25	0.19	MT3	0.71	0.1
M4	0.25	0.12	MT4	0.87	0.1
M5	0.2	0.17	MT5	0.95	0.1
M6	0.2	0.1	MT6	1	0.1
M7	0.2	0.1	MT7	1	0
M8	0.2	0.1	MT8	1	0
M9	0.2	0.1	MT9	1	0
M10	0.2	0.1	MT10	1	0

Relative effort in H.Cons fishery		
HF02	1	0.22
HF03	1	0.22
HF04	1	0.22

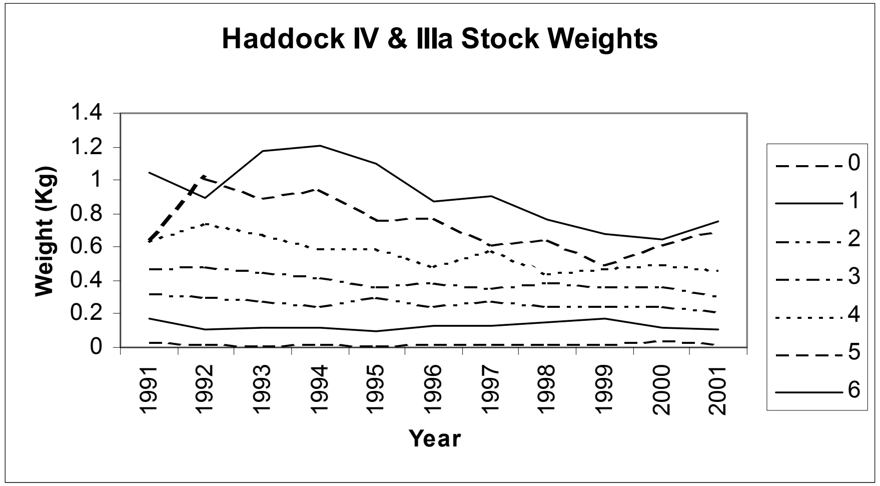
Relative effort in industrial fishery		
IF02	1	0.54
IF03	1	0.54
IF04	1	0.54

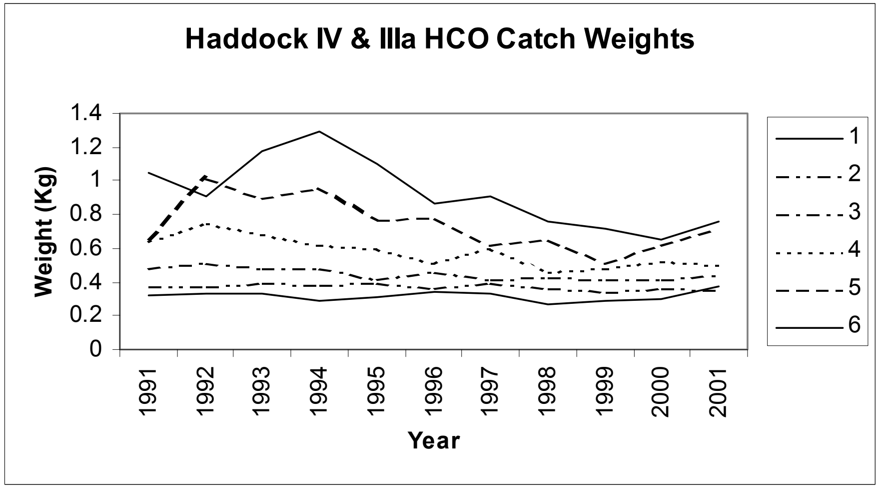
Recruitment in 2003 and 2004		
R03	25895500	1.02
R04	25895500	1.02

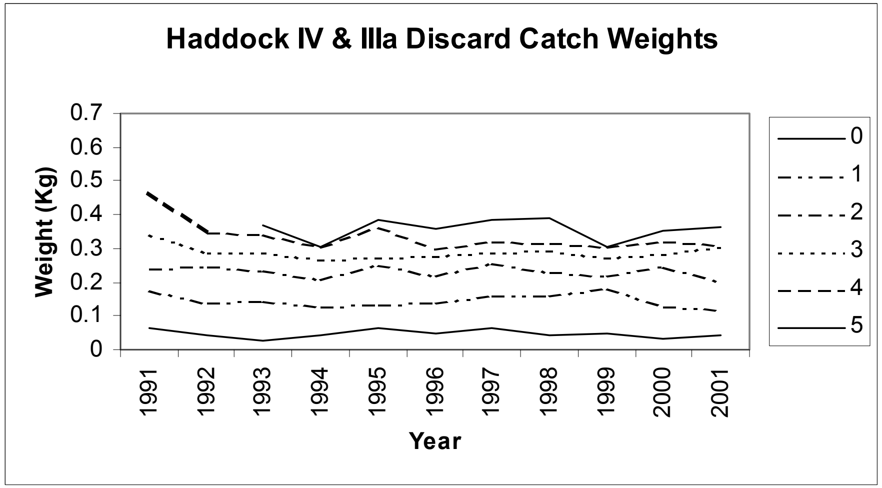
File location:

W:\ACFM\WGNSSK\2002\Stock\Had-34\Final runs\Medium-term\HADIV.SEN

Figure 4.2.1 Haddock in IV and IIIa. Mean weight-at-age in the total catch (used as stock mean weights) and by catch component for the period 1991-2001: Human consumption landings (HCO), discards and industrial by-catch (IBC).







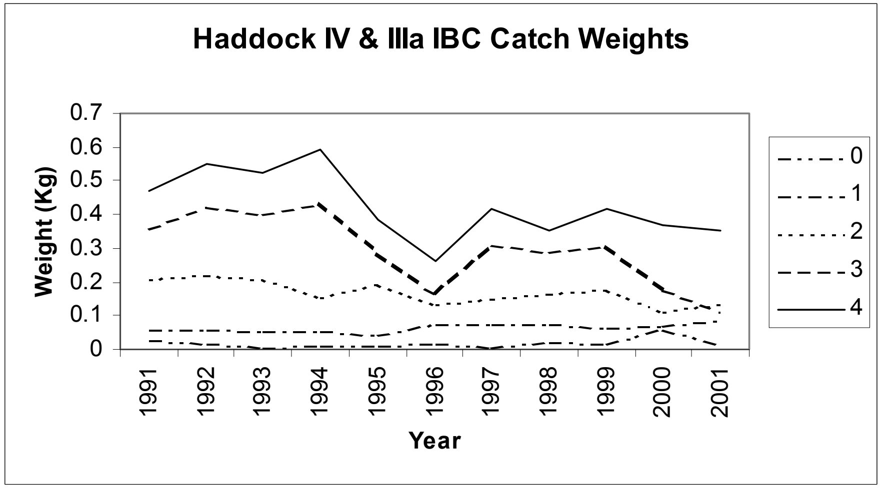


Figure 4.4.1 Haddock in IV and IIIa. IBTS Q1 abundance indices plotted against stock abundance estimated from a single-fleet XSA.

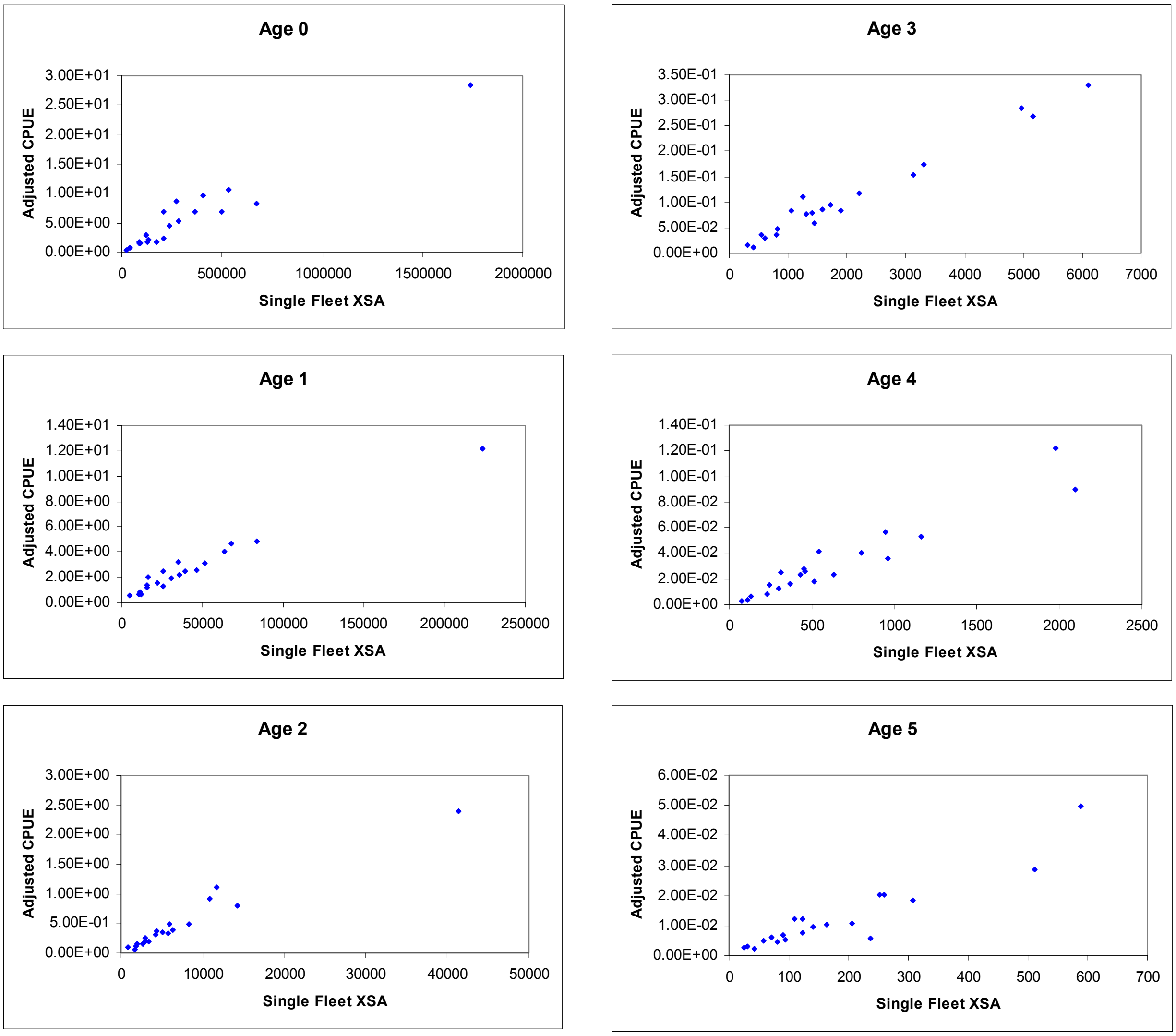


Figure 4.4.1 (cont'd) Haddock in IV and IIIa. EGFS abundance indices plotted against stock abundance estimated from a single-fleet XSA.

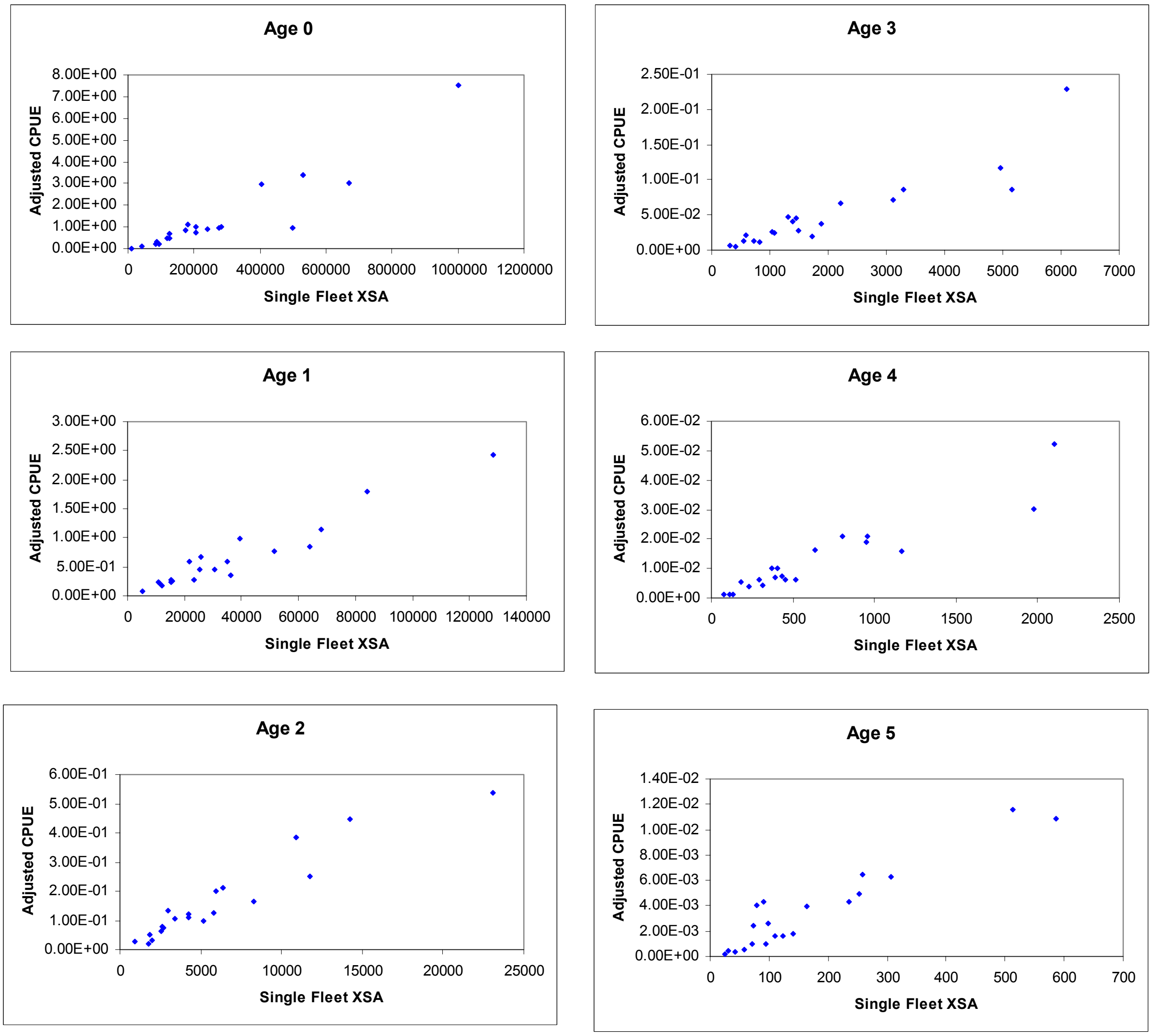
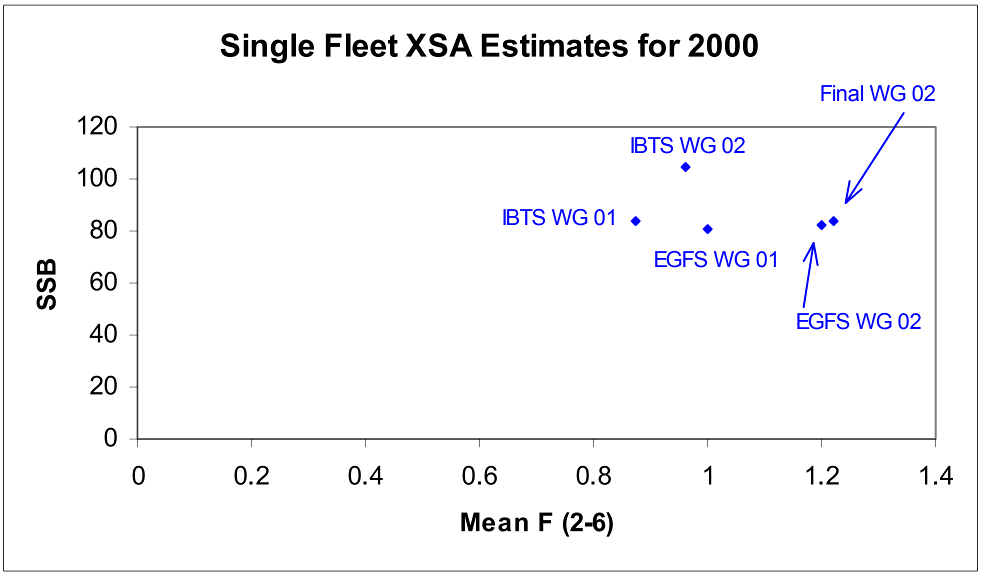


Figure 4.4.2 Haddock in IV and IIIa. Single-fleet XSA results.

a) single-fleet estimates of mean F and SSB in 2000 from exploratory runs at the previous Working Group (WG 01) and the current Working Group (WG 02). The earlier IBTS and EGFS stock estimates for 2000 showed closer agreement than the corresponding estimates made with the addition of a further year's data.



b) single-fleet estimates of mean F and SSB in 2001 from exploratory XSA runs undertaken at the current WG meeting.

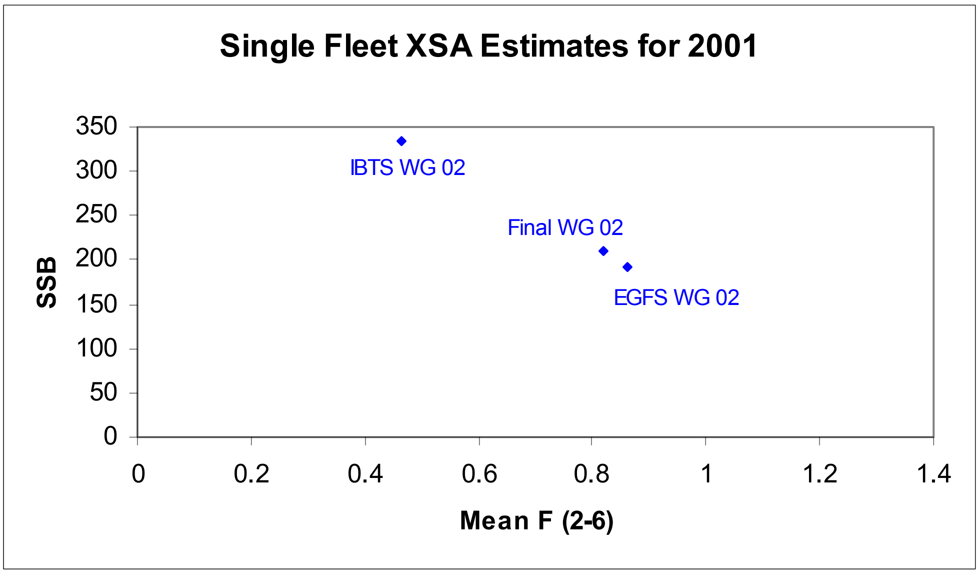
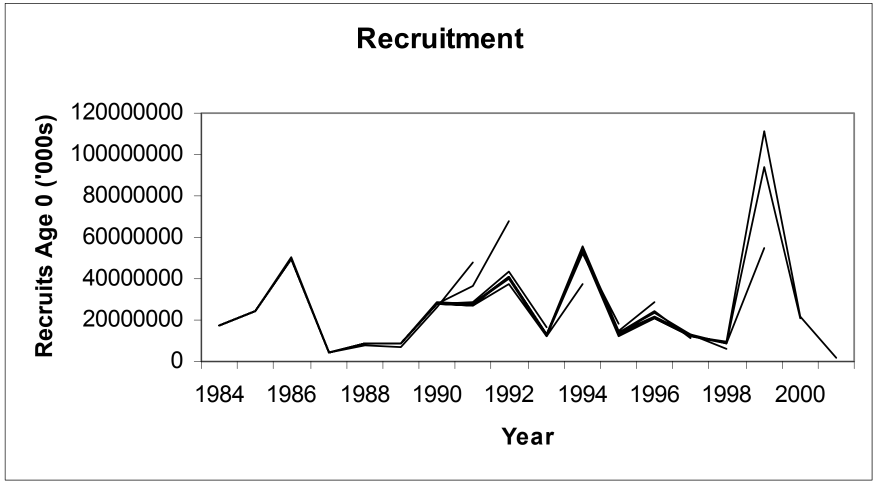
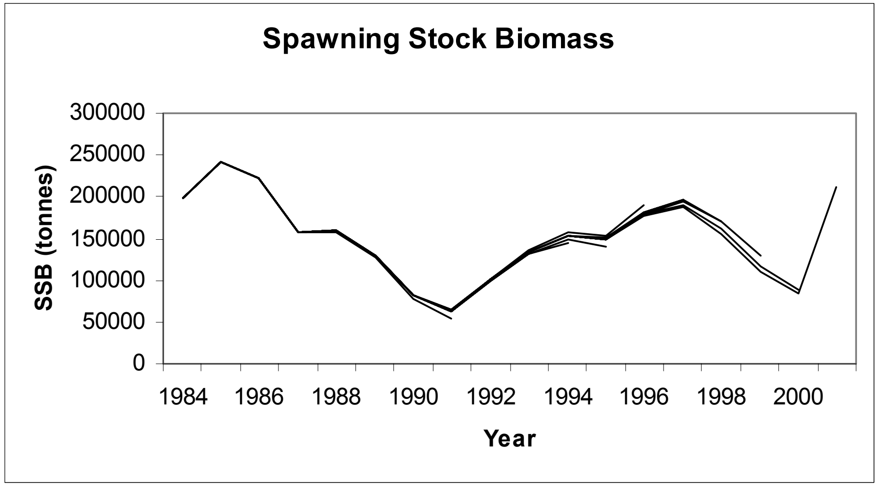


Figure 4.4.3 Haddock in IV and IIIa. Retrospective XSA results.





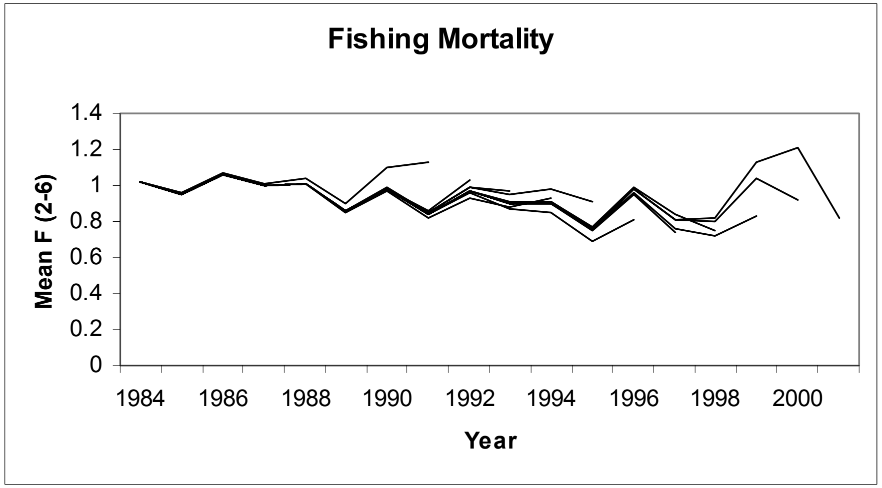


Figure 4.4.4 Haddock in IV and IIIa. Final XSA log catchability residuals.

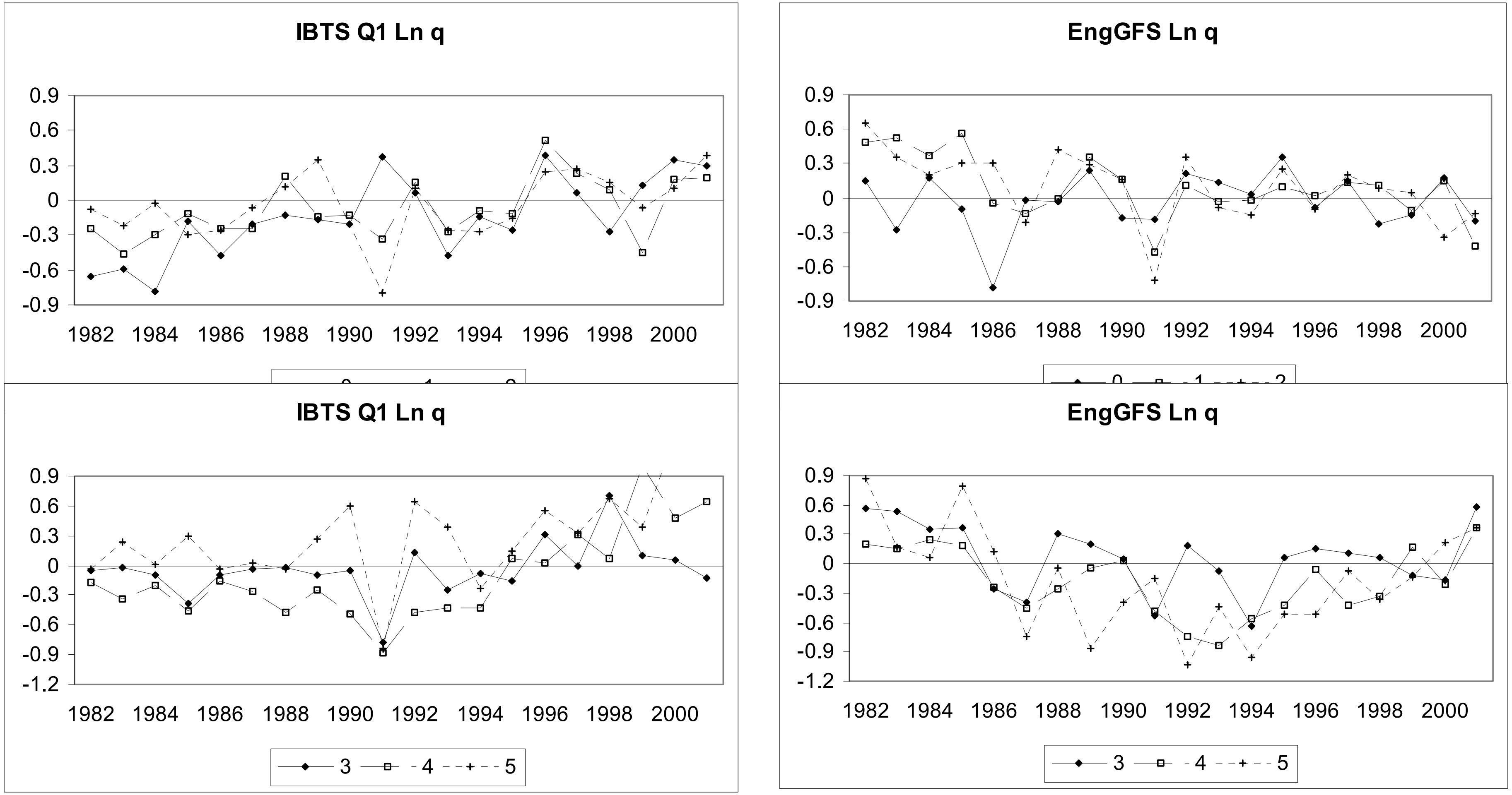
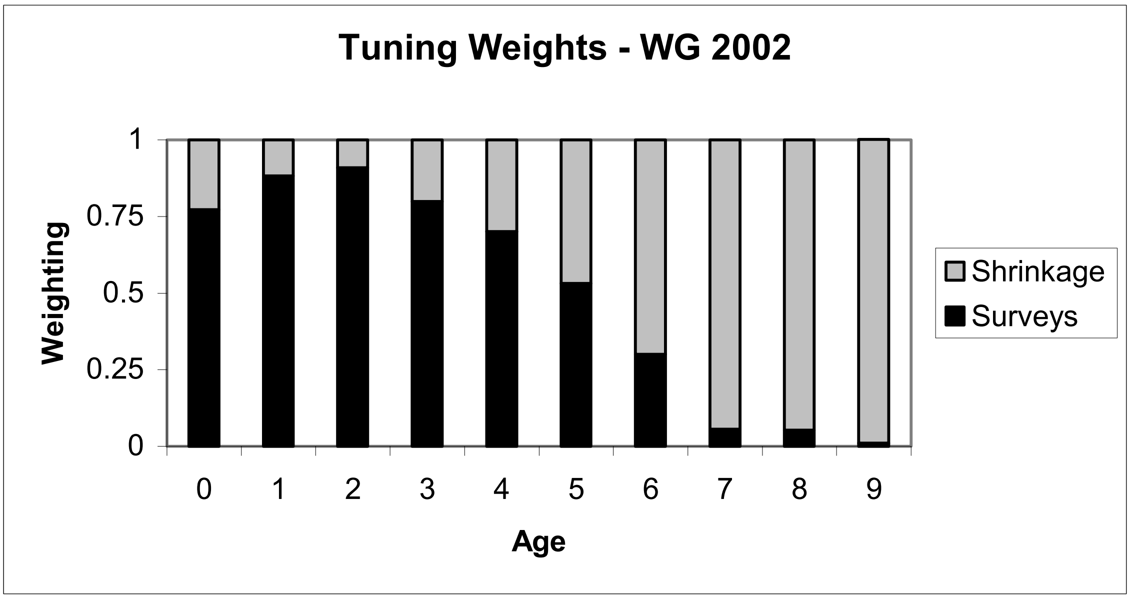


Figure 4.4.5 Haddock in IV and IIIa. Contribution of surveys and shrinkage to XSA survivors estimates from the present (WG 2002) and previous (WG 2001) assessments.



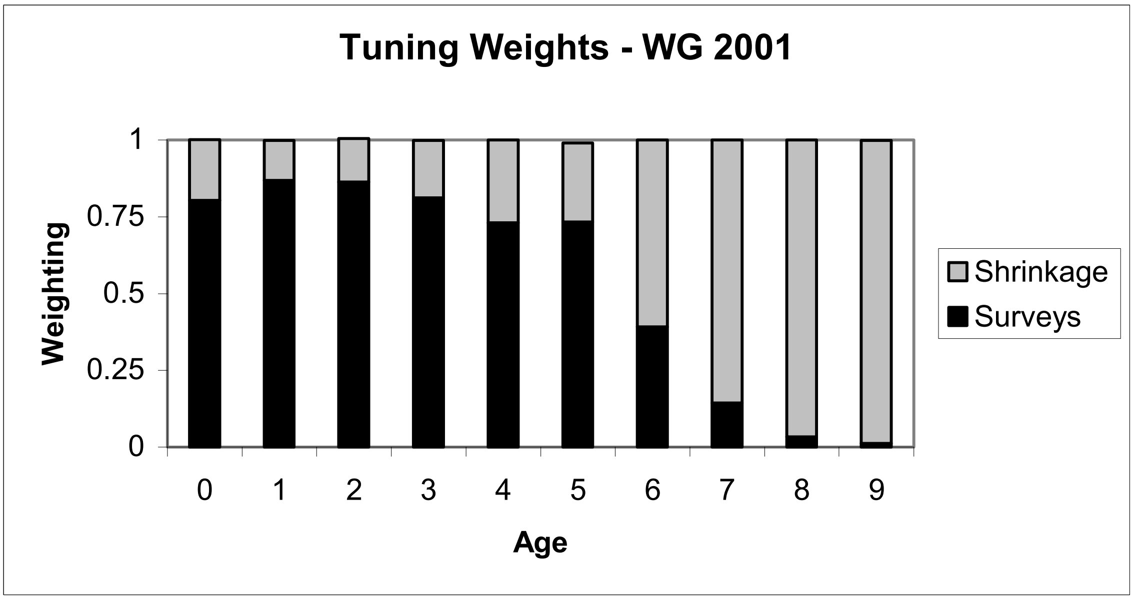


Figure 4.6.1 Haddock in IV and IIIa. Stock trends 1963-2001

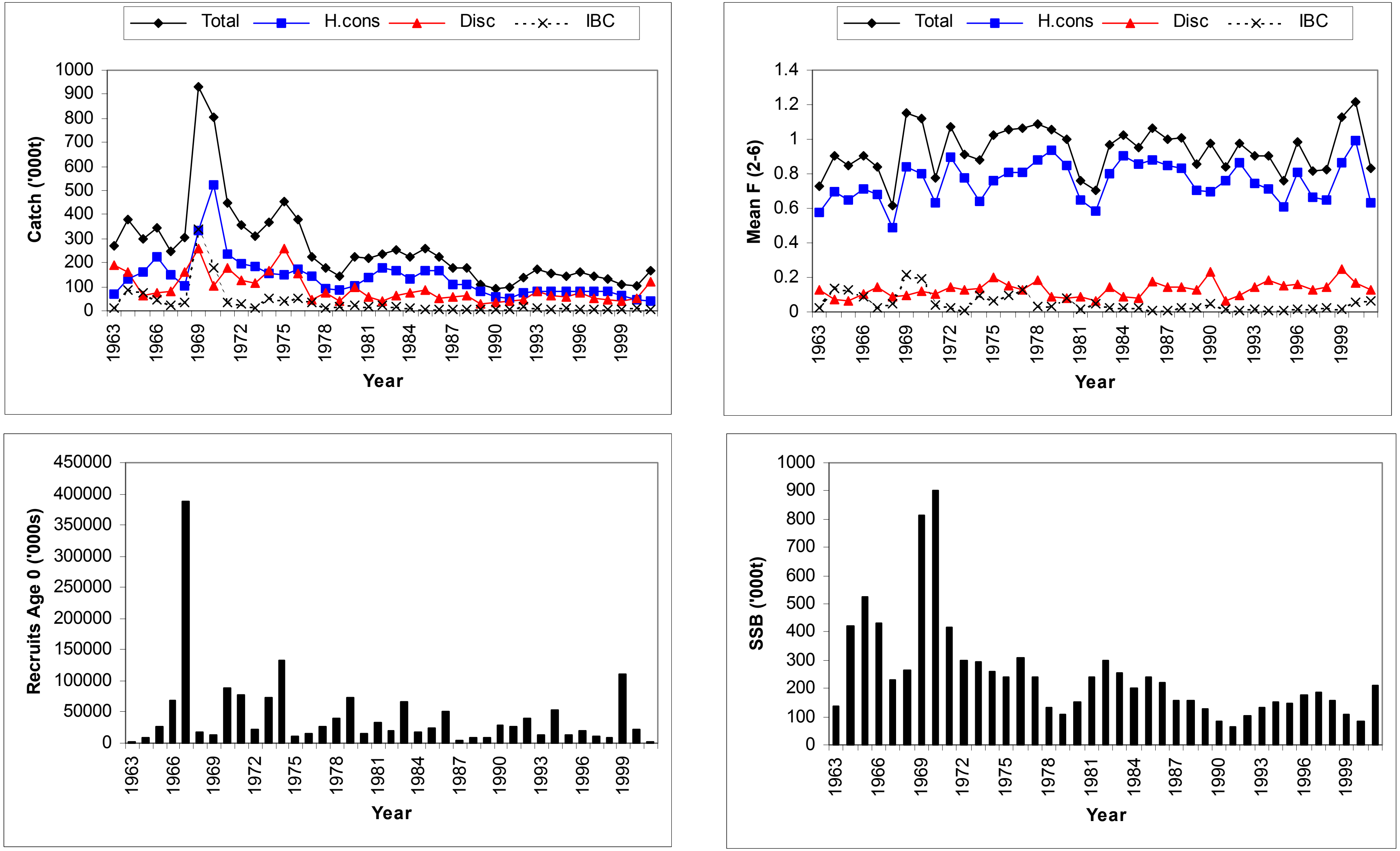


Figure 4.8.1 (a) Haddock in IV and IIIa. Results of medium-term analysis. - *Status quo* F.

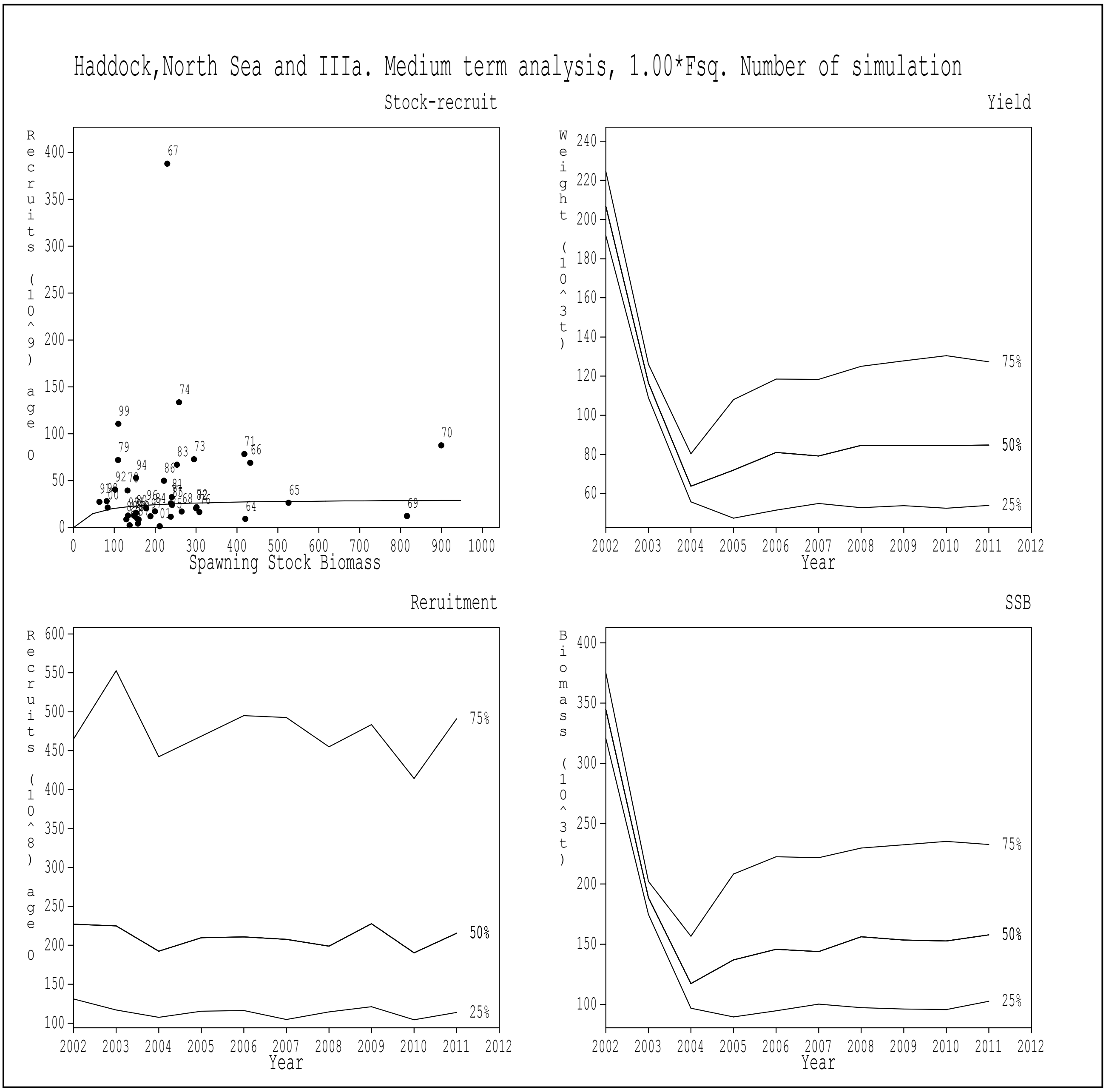


Figure 4.8.1 (b) Haddock in IV and IIIa. Results of medium-term analysis - $\mathbf{F}_{pa.}$

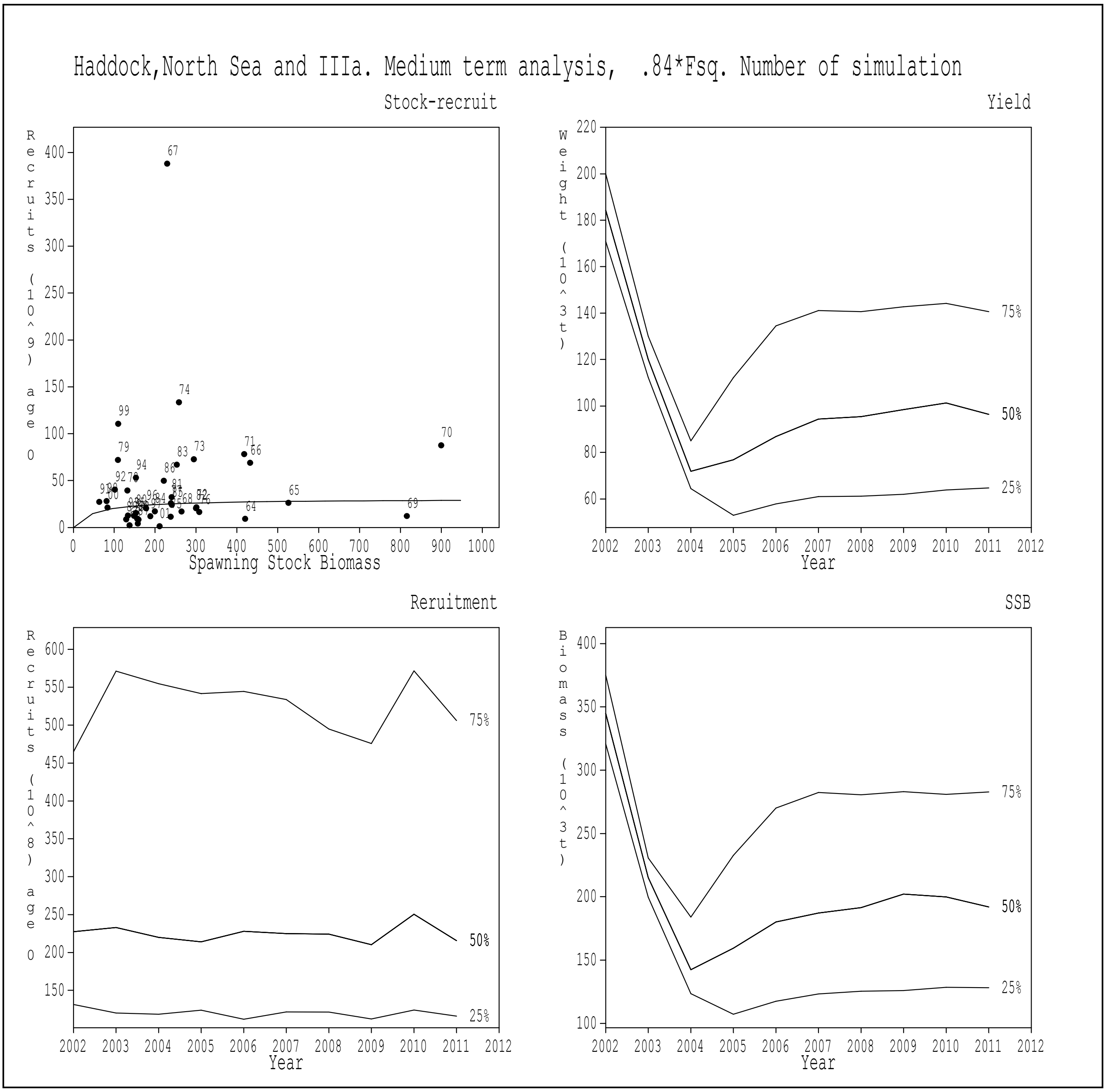


Figure 4.8.2 Haddock in IV and IIIa. Summary of medium-term analysis. Contours show the probability that SSB will be below $\mathbf{B}_{PA}$ for any combination of year and fishing mortality.

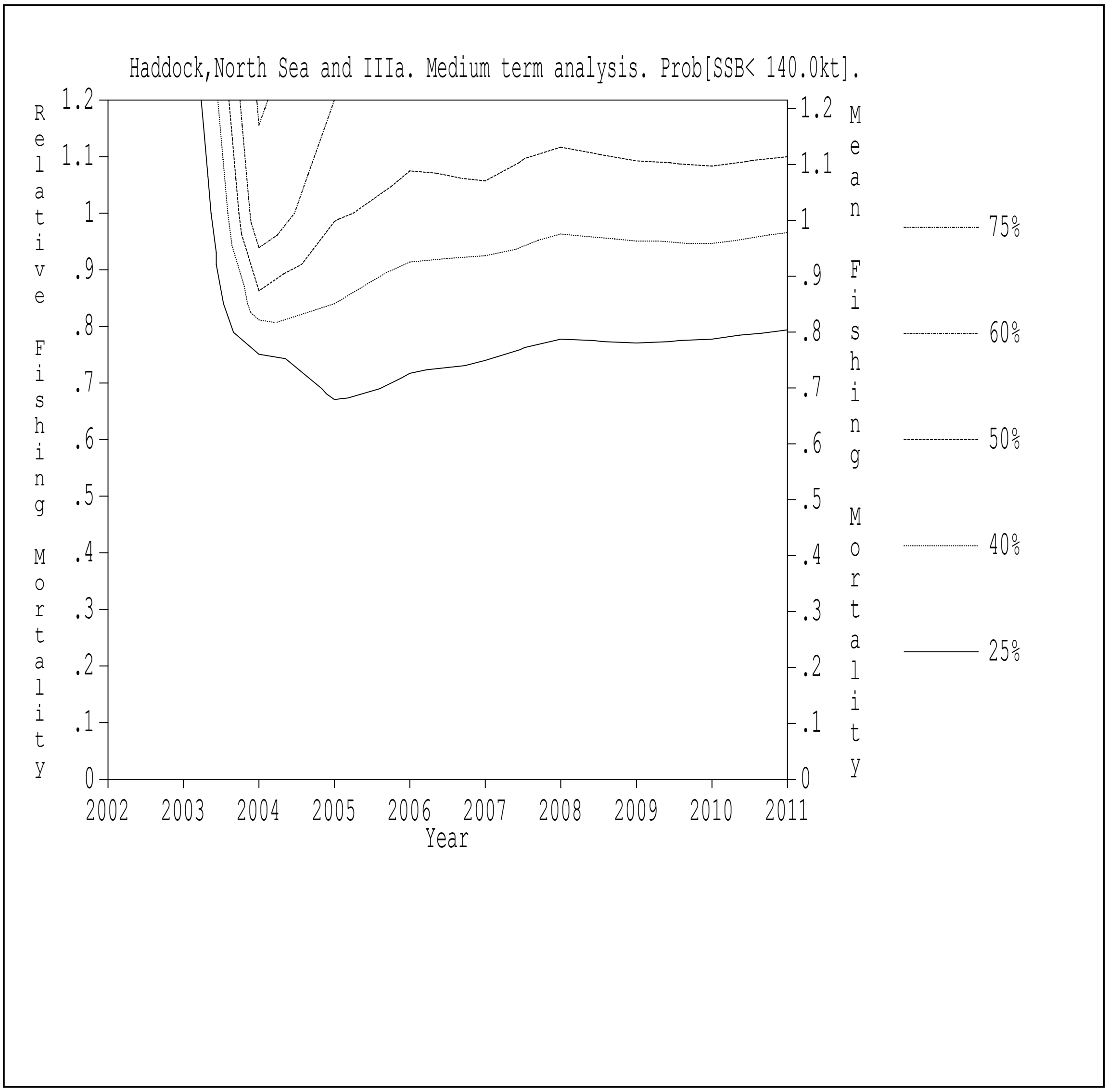


Figure 4.9.1 Haddock in IV and IIIa. Yield-per-recruit. Mean F on the x-axis refers to mean F in the human consumption fishery (landings plus discards). See comment in text regarding $\mathbf{F}_{max}$

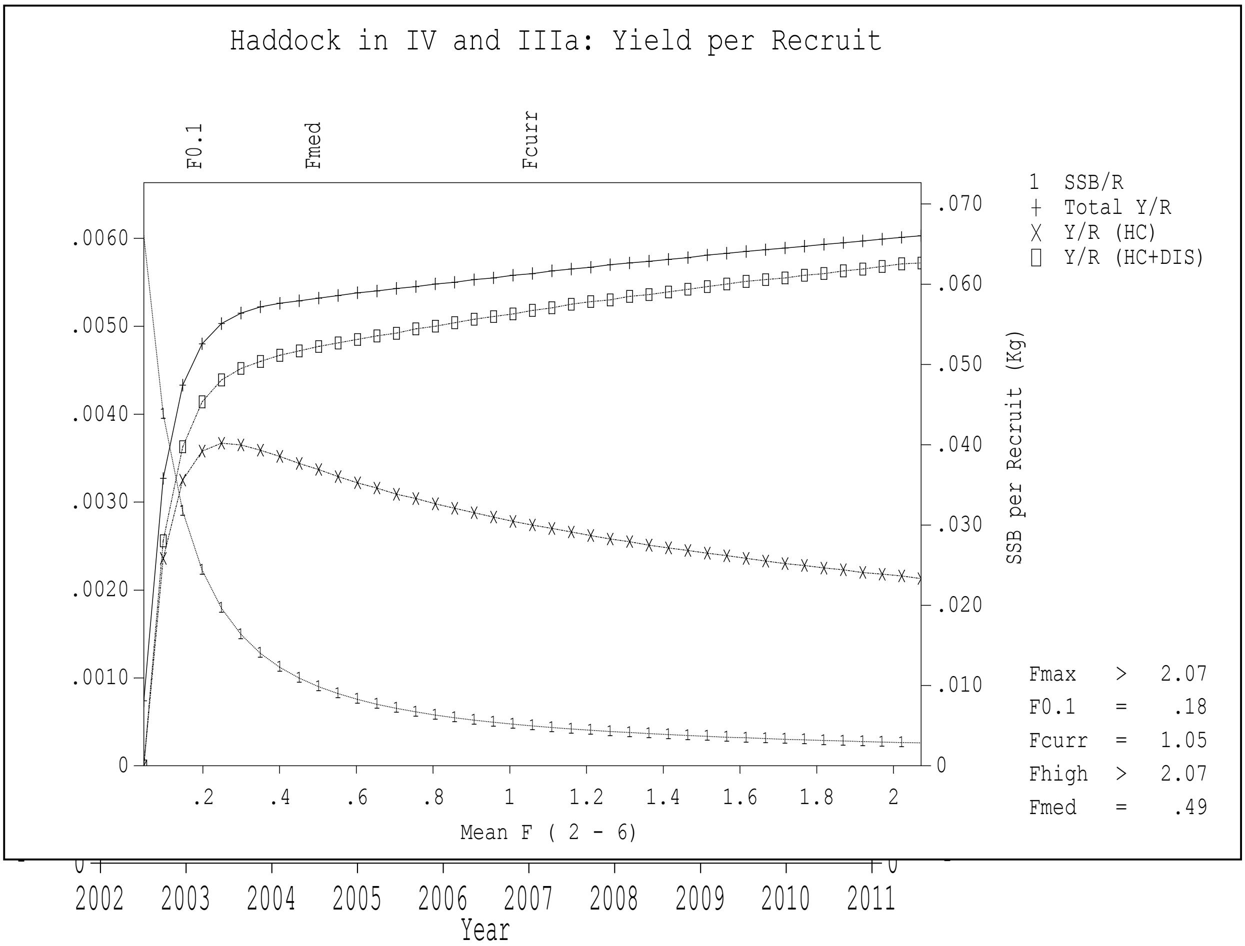


Figure 4.9.2 Haddock in IV and IIIa. Stock and recruitment

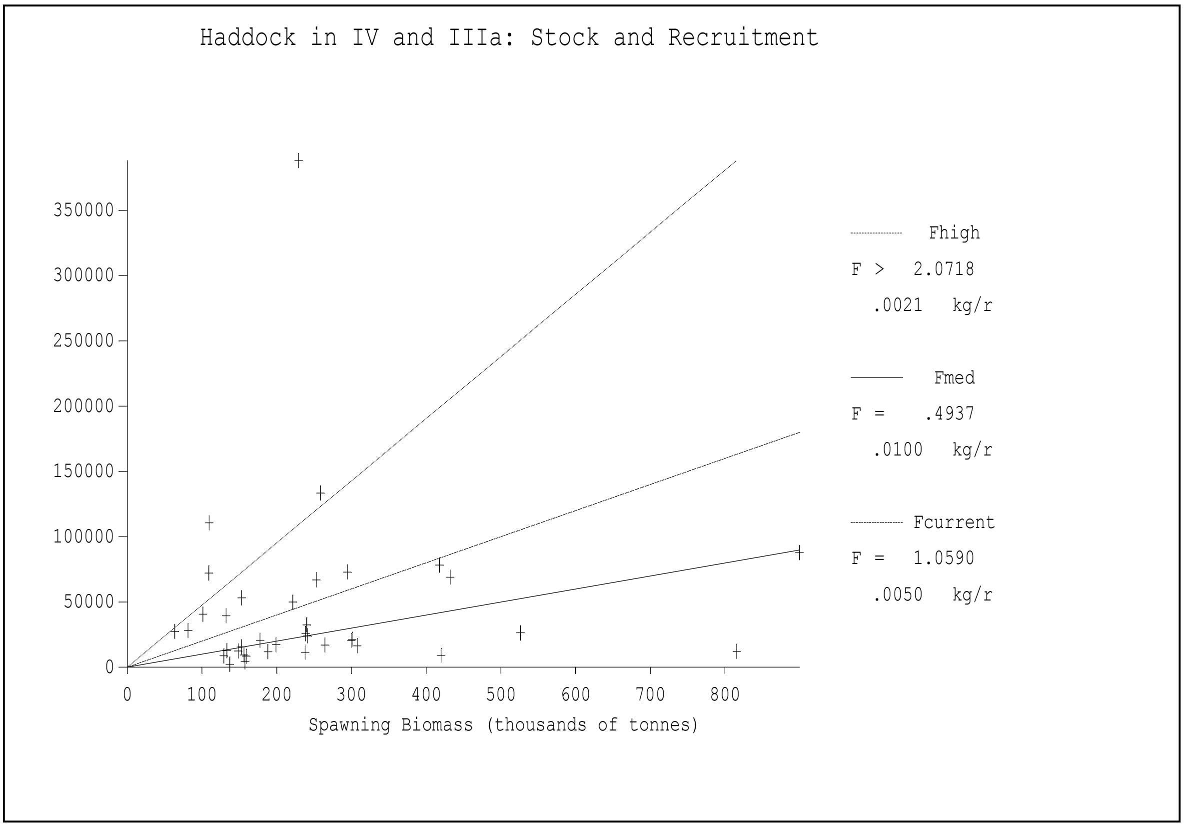


Figure 4.9.3 Haddock in IV and IIIa. Historical stock performance in relation to current PA values. Data before 1974 have been excluded to make the y-axis more readable.

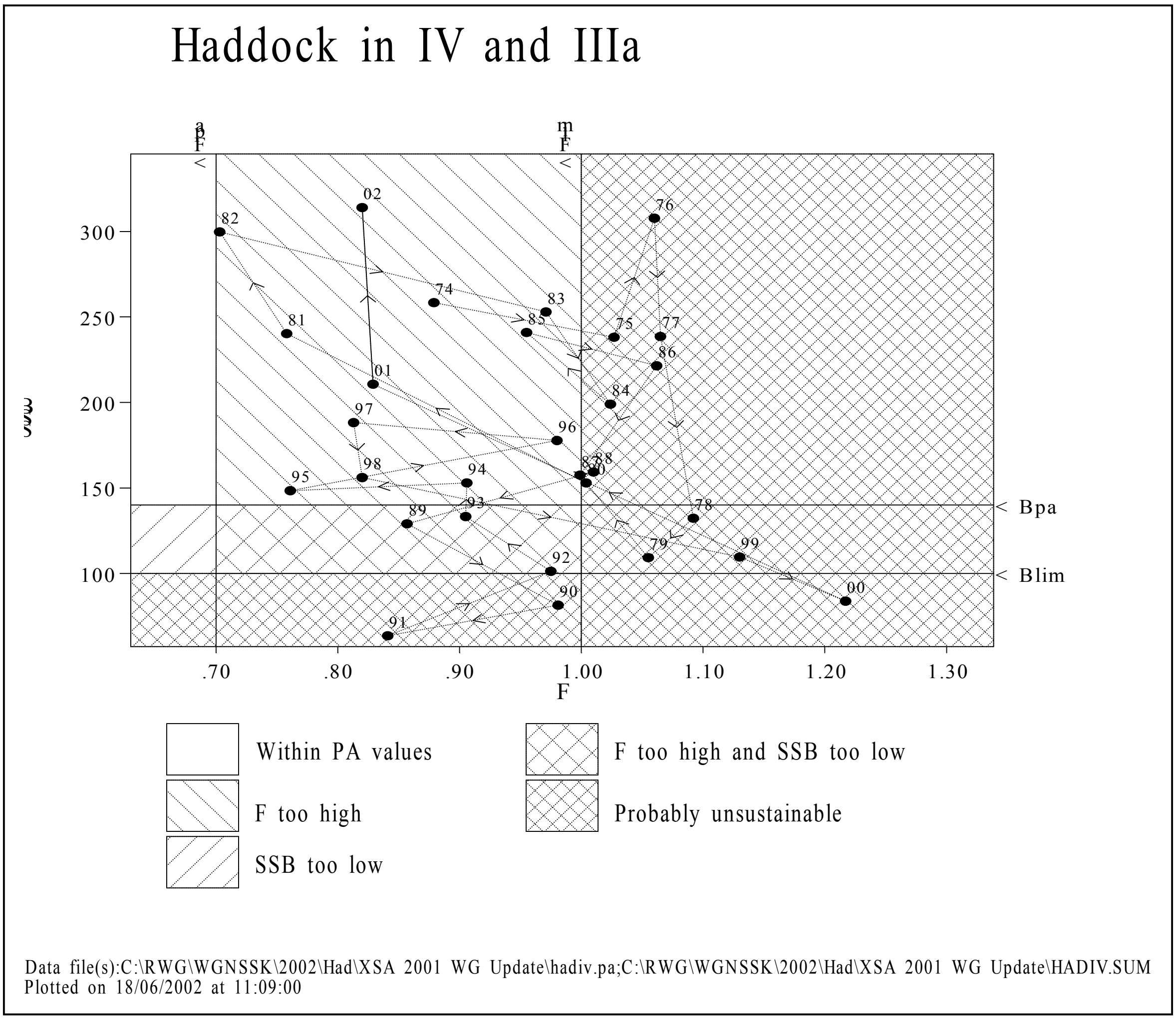
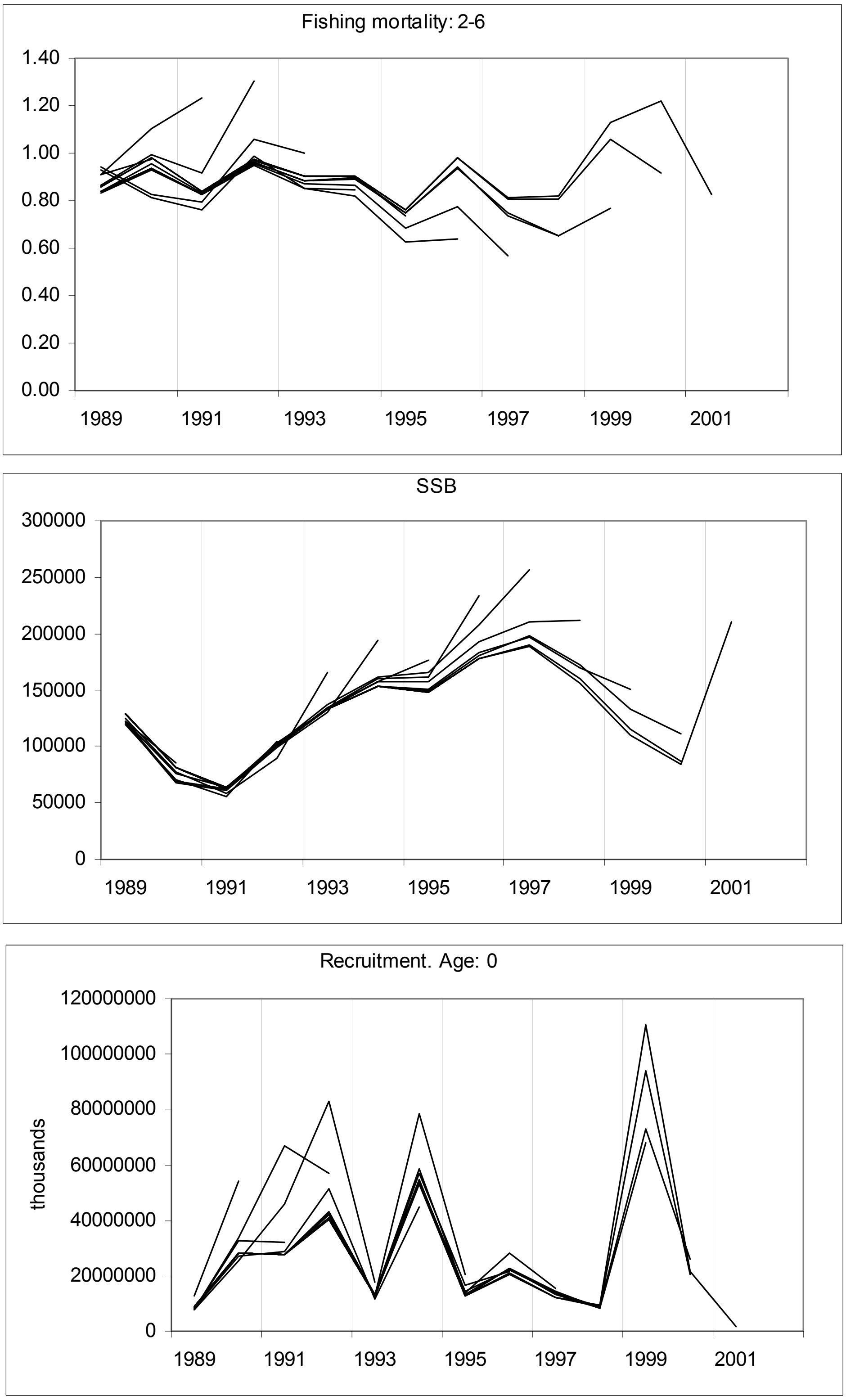


Figure 4.10.1 Haddock in IV and IIIa. Quality control of assessments generated by successive working groups.



5 WHITING

5.1 Whiting in Subarea IV and Division VIId

5.1.1 The fishery

Total nominal landings are given in Table 5.1.1.1 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 5.1.1.2. Eastern Channel catches as used by the Working Group are also shown separately in Table 5.1.1.3. The year-range of these data has been changed from 1960–2000 (as in the previous assessment) to 1980–2001: the reasons for this are discussed in Section 5.1.4.

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

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

5.1.1.1 ICES advice applicable to 2001 and 2002

The ICES advice in 2000 for the fishery in 2001 was to reduce fishing mortality to bring SSB above the proposed $\mathbf{B}_{pa}$ of 315 000 t. The stock was considered to be outside safe biological limits.

The ICES advice in 2001 for the fishery in 2002 was based on the perception that stock remained outside safe biological limits. Its advice was to recommend a reduction in fishing mortality to below 0.37, corresponding to human consumption landings of less than 37 000 t. ICES noted that further reductions might be necessary to achieve consistency with the recovery plan for cod.

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

5.1.1.2 Management applicable to 2001 and 2002

The 2001 and 2002 TACs for Areas IIa (EC zone) and IV are 29 700 t and 32 358 t. The minimum mesh size for vessels fishing for cod in the mixed demersal fishery in this area was changed to 120 mm from the start of 2002 under EU regulations regarding the cod recovery plan, with a one-year derogation of 110 mm for vessels targeting other species such as whiting (see Section 2.1). 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 the late summer of 2000, requiring the mandatory fitting of a square mesh panel in certain towed gears (Ferro and Graham, 2000). These measures are likely to affect the selectivity of whiting.

There is no separate TAC for Division VIId, landings from this Division are counted against the TAC for Divisions VIIb-k combined (21 000 t in 2001 and 31 700 t in 2002). Minimum mesh size for whiting in Division VIId is 80 mm, with a 27 cm minimum landing size.

5.1.1.3 The fishery in 2001

For the North Sea, the total international catches were 43 300 t in 2001, of which 19 400 t were human consumption landings, 16 500 t discards, and 7 400 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 each component in the North Sea decreased from 2000 to 2001. For the Eastern Channel, the total catch in 2001 (5 800 t) was the highest since 1994. The total North Sea and Eastern Channel human consumption landings of 25 200 t in 2001 were 62% of the *status quo* forecast from the 2001 assessment.

5.1.2 Natural mortality, maturity, age compositions, mean weight-at-age

The natural mortality and maturity-at-age values as used are shown in Table 5.1.2.1. These are applied to the full year range of the assessment. The natural mortality values are rounded averages of estimates produced by a previous key run of the North Sea MSVPA (see Section 1.3.1.3 of the 1999 WG report: ICES CM 2000/ACFM:7). Updated natural mortality estimates are available from a recent run of MSVPA (WD 3), but these have not been used in this assessment as there has been insufficient time to evaluate their reliability. The maturity ogive is based on North Sea IBTS quarter 1 data, averaged over the period 1981–1985. This is undoubtedly an oversimplification and could lead to considerable error in the estimation of SSB and associated biological reference points. Section 1.13.1 discusses this generic problem and suggests potential approaches to alleviate it.

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), 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 provided 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.

Numbers in the total international catch-at-age (North Sea and Eastern Channel combined) are presented in Tables 5.1.2.2, while Tables 5.1.2.3 – 5.1.2.5 give numbers-at-age for each of the human consumption landings, discards, and industrial by-catch components thereof. The corresponding mean weights-at-age are presented in Tables 5.1.2.6 – 5.1.2.9. The total catch mean weight-at-age was also used as the stock mean weight-at-age. The relative proportions by age in the total catch of the human consumption, discards, and industrial by-catch component are summarised in Figure 5.1.2.1. From this, it can be seen that the proportion of the total catch of age-1 whiting which has been landed has increased somewhat in recent years. Recent trends in mean weights-at-age in the different catch components are shown in Figure 5.1.2.2.

5.1.3 Catch, effort, and research vessel data

Catch and effort data from five commercial and six survey-vessel series were available to calibrate catch-at-age analyses. The number of years and ages available for each series are listed in Table 5.1.3.1.

Effort data are available for two Scottish commercial fleets, namely seiners (SCOSEI) and light trawlers (SCOLTR). Continuing concerns over the validity of effort data for these fleets meant that they could not reasonably be used for catch-at-age tuning.

The Scottish groundfish survey (SCOGFS) is carried out in August each year, and has historically covered 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. In addition, data for 1998 onwards have been removed from the SCOGFS series in recent assessments, as these data were obtained using new gear on a new vessel. However, there is now no reason to believe that the new data are inconsistent with the old data, at any rate for those ages (1 and older) which are used in this assessment. For this reason, the full SCOGFS series has been available for this year's assessment.

The English groundfish survey (ENGGFS) is also 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) has been revised this year. Last year, 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. This year, 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.

An additional inconsistency was identified in the way whiting abundance indices were obtained in FRAGFS. Previously, only the hauls in which whiting were caught were used to derive abundance indices. This procedure is thought to bias these estimates. Therefore, the indices supplied this year were calculated on the basis of all the fishing hauls, irrespective of the occurrence of whiting catches. Figure 5.1.3.12 suggests that there is a substantial difference between the old and the revisited time-series, for all age groups. In particular, the high peaks observed for the old series are substantially reduced in the new series.

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.

All the available tuning fleet data are listed in Table 5.1.3.2.

Comparative analyses of research-vessel surveys for whiting

There is currently considerable concern over the utility of research-vessel surveys as indicators for North Sea whiting abundance. With this in mind, Needle (WD 2) presented a series of analyses investigating the consistency among different survey series, and how they compare with an assessment method based on catch-at-age data only: the findings of that paper are discussed here.

Normalised (that is, mean-standardised) survey indices by age are plotted in Figure 5.1.3.1, although there is little discernible pattern to these raw data. Pairwise bivariate scatterplots of the survey indices by age are simple comparative tests of the consistency of different current survey series for whiting in IV and VIId. Figures 5.1.3.2 to 5.1.3.8 give these plots, with linear regression lines fitted through the points in each case: the reported statistics on the graphs are the R^2 goodness-of-fit measure, the slope of the fitted line, and the power of a *t*-test used to determine whether said slope is significantly different from zero ($P(t) < 0.05$). It can be seen that there is little correlation between the indices from different surveys, with the exception of the ENGGFS and SCOGFS surveys which are reasonably well-correlated at most ages and for which the regression slopes are significantly different from zero for all ages. There is also some correlation between the IBTS Q1 and SCOGFS surveys at ages 1 and 4–6, but none between the IBTS Q1 and ENGGFS surveys except for age 6. Finally, the FRAGFS survey has little in common with the other series, which may be explained by the fact that it covers only the Eastern Channel component of the stock.

In order to elucidate further the underlying population signal given by these surveys, a series of analyses were performed using the RCRV1A program (see Section 1.4). Relative trends arising from these analyses are given in Figures 5.1.3.9 (mean F_{2-6}), 5.1.3.10 (SSB), and 5.1.3.11 (recruitment). These plots also show the equivalent trends from the catch-only TSA (that is, no surveys) discussed in Section 5.1.4 below. The conclusions to be reached from these plots are rather tenuous, given the drawbacks of the method mentioned in Section 1.4, but they do tend to confirm much of what was suggested by the bivariate scatterplots mentioned above. In terms of smoothed trends, there would appear to be two different signals in mean F_{2-6}: a decline until the mid-1990s followed by a rise (suggested by SCOGFS, ENGGFS, and FRAGFS), or continued decline (suggested by TSA and, to a lesser extent as it jumps upwards in the most recent year, IBTS Q1). The groupings are broadly similar for trends in relative SSB, while recruitment trends are extremely variable, particularly in recent years. It would seem to be characteristic of the RCRV1A method that only two out of these three summary statistics are ever in accord, which may explain the uncertainty over recruitment.

In conclusion: while there are certainly different population-trend signals in the whiting survey series, the English and Scottish groundfish surveys (and, to a lesser extent, the French groundfish survey) appear to be in accord, while the IBTS Q1 survey is more consistent with the catch-at-age data. Without a more detailed analysis of the methodology and characteristics of these surveys, it is difficult to know which is the most representative of whiting population dynamics: there are no empirical diagnostics on which to base such a decision. Section 1.13.2 gives a recommendation as to how these questions might be addressed.

5.1.4 Catch-at-age analysis

It should be noted that the starting year for assessment data has been changed from 1960 to 1980. This was for two reasons: firstly, discard data (which form part of the catch data) for the years prior to 1978 were estimates only, and secondly, there is evidence of a change in recruitment "regime" around 1980, from high and variable to low and less variable. This does not change greatly the perceptions of recent stock dynamics, but does affect the shape of the stock-recruitment relationship and the calculation of biological reference points.

(i) Separable VPA analysis

A separable VPA was run on the catch-at-age dataset with all but the most recent 10 years heavily downweighted (ages 0–12, years 1980–2001), using a selection of 1.5 on the oldest true age (from exploratory runs) and terminal *F* (0.6 on age 3) from previous assessments. The results given in Figure 5.1.4.1 (top plot) suggest that residuals are large on the 0:1 log catch ratios on the one hand, and on the 6:7 and older log catch ratios on the other. The former consist of partially recruited age groups subject to discarding in the human consumption fishery and taken as by-catch in the industrial fisheries, while the latter are poorly represented in the historical record and are likely to be subject to noise as a result. These considerations support the restriction of the age range for assessment to 1–8+, as in the three most recent assessments. Figure 5.1.4.1 (lower plot) gives residuals for a separable VPA run on this reduced dataset (ages 1–8+, other settings as above), which are appropriately small. All catch and tuning data were therefore limited to the 1–8+ age range for all the assessment methods discussed below.

(ii) Time-Series Analysis

The time-series approach to catch-at-age analysis was first applied to this stock in last year's assessment, because it was thought to best capture the uncertainty of the assessment. 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), and Fryer (2001).

The Kalman filter TSA algorithm is a recursive procedure that represents the variables of interest (stock numbers- and fishing mortalities-at-age) as unobserved state variables that evolve forward over time. Each year, observed catches-at-age are used to update the estimates of the state variables. Year-class strength is assumed (in this implementation) to be distributed according to a Ricker stock-recruitment model. Model fitting proceeds by examination of standardised catch prediction errors (equivalent to model-fit residuals) and inflation of permitted variance on year-age pairs for which such errors are high. Each estimate of historical mean $F_{2–6}$ and stock numbers is produced with an associated standard error, allowing a statistical evaluation of the uncertainty in the assessment. A number of research-vessel tuning series can be incorporated. The model is also able to roll forward and produce estimates for all parameters for as many years as required following the last historical year.

The model used in last year's assessment was based only on catch-at-age data, and did not incorporate tuning indices from research-vessel surveys. There are a number of hypotheses which might suggest that catch-at-age data for whiting are questionable. One of these is that the Scottish pattern of discarding, which is used to generate discard estimates for other European fleets, might not be appropriate since these other fleets have much lower TACs for whiting than the Scottish fleet and are *a priori* more likely to discard whiting. Such concerns over the validity of recent whiting catch-at-age data led the Working Group to explore the implications of TSA using catch-at-age data tuned by the principal available survey series: ENGGFS (1981–2001, since survey data cannot begin in the same year as catch data in TSA); SCOGFS (1982–2001); and IBTS Q1 (1981–2002). The FRAGFS survey was not used in this exercise because of pressure of time, but it is anticipated that it would show similar results. Parameter estimates from these runs are given in Table 5.1.4.1, while Figures 5.1.4.2 (stock summary time-series) and 5.1.4.3 (scatterplot of mean *F* and SSB in 2001) show comparisons between these survey-tuned analyses and a no-survey TSA. From these outputs, there is clear evidence of persistent trends in catchability for all three surveys. It can also be seen that the survey-tuned TSA summaries (mean $F_{2–6}$, SSB, and recruitment) all lie within the approximate pointwise 95% confidence intervals of the no-survey TSA. The implication is that TSA does not assign much weight to survey tuning indices: RCRV1A analyses (Section 5.1.3) suggest that the different surveys measure quite different relative trends in whiting population dynamics, but these does not alter the TSA estimates as much as might be expected. Although not strictly accurate, a first approximation to the weighting assigned to the catch and survey data can be obtained from the estimates of variance (σ_{catch} and σ_{survey}) in Table 5.1.4.1. The former is invariably smaller than the latter, suggesting that catch data are weighted more heavily in these TSA runs. Since they make no statistically significant difference to the assessment, there does not seem to be any reason to include survey tuning indices, and the no-survey TSA was accepted as the final assessment. Suspected problems with whiting catch-at-age data cast some doubt on the validity of this approach, but there is no real alternative in the absence of an appropriate survey-driven methodology.

Final assessment

Input data for the final TSA assessment using catch data only are given in Tables 5.1.2.2 and 5.1.2.6. Model performance is evaluated by examination of standardised catch and survey prediction errors. The appropriate adjustments and their justifications for whiting in IV and VIId are given in Table 5.1.4.2. Two-year forecasts were generated.

Table 5.1.4.3 gives parameter estimates, comparing this year's assessment to last year's. The estimates are similar in general. There is some evidence of persistent changes ($\sigma_Y = 0.1083$) in the year effect on fishing mortality, and transitory (or temporary) changes ($\sigma_F = 0.1279$) in the overall level of fishing mortality over time. There is also weak evidence of transitory changes in the fitted separable pattern over time ($\sigma_V = 0.0259$), but no evidence of permanent changes in the separable pattern ($\sigma_U = 0.0000$). Catch and recruitment data are fairly noisy ($\sigma_{\text{catch}} = 0.0998, \sigma_{\text{rec}} = 0.3751$), although less so than in the previous assessment. The principal change is in the stock-recruitment model parameters, with the slope-at-the-origin of the fitted Ricker curve being much lower in this year's assessment: this implies lower recruitment for a given SSB. The algorithm needs initial estimates of *F* in 1960 at ages 1, 2, and 5 (the latter being the assumed age of full maturity), which is why the final values of these quantities are listed in the output.

Standardised catch prediction errors (equivalent to model residuals) are given in Table 5.1.4.4 and Figure 5.1.4.4, and do not show any significant trends or very large outliers after four points were down-weighted (see Table 5.1.4.2). It is noticeable, however, that prediction errors are generally negative in the late 1990s, and in the most recent year. Several TSA configurations analysed in last year's assessment concluded that the late 1990s negative prediction errors are a consequence of the catch-at-age data, rather than the TSA method itself. Stock trends and the fitted stock-recruitment curve are shown in Figure 5.1.4.5. TSA tabular outputs are presented in Tables 5.1.4.5 (numbers-at-age), 5.1.4.6 (standard error on numbers-at-age), 5.1.4.7 (variance-covariance matrix for forecast numbers-at-age in 2003), 5.1.4.8 (fishing mortality-at-age), 5.1.4.9 (standard error on log fishing mortality-at-age), and 5.1.4.10 (stock summary). It should be noted that the "actual catches" column in Table 5.1.4.10 refers to ages 1–12+ only, and is thus not directly comparable with the total reported catch (ages 0–12+) in Table 5.1.1.2.

Retrospective analyses are plotted in Figure 5.1.4.6. For significant evidence of retrospective bias, the current TSA estimate has to lie outwith the confidence intervals of the retrospective estimate. For mean $F_{2\text{–}6}$ and SSB this occurs only for the retrospective runs finishing in 1997 and 1998, and not at all for recruitment. The point estimates do not exhibit consistent bias either. Therefore, there seems little evidence of a significant retrospective bias in this assessment.

5.1.5 Recruitment estimates

The TSA implementation used here as the key assessment run generates predictions for all model parameters in 2002 and 2003. Recruitment predictions are based on a fitted Ricker stock-recruitment curve, and are *R*(2002) = 1949 million, *R*(2003) = 2024 million. The long-term (1980–2001) GM recruitment is 1931 million. These estimates are likely to be updated when the results of this year's ENGGFS and SCOGFS surveys become available in the autumn. RCT3 input data are presented in Table 5.1.5.1.

5.1.6 Historical stock trends

Long-term trends in fishing mortality, recruitment, and spawning biomass are given in Table 5.1.6.1 and plotted in Figure 5.1.6.1.

Fishing mortalities overall would appear to have been in a declining trend since the late 1980s. The current assessment indicates a decline in SSB from 1990 to 1998, falling to an historical low value in 1998 (~144 700 t). However, that trend would now appear to have reversed and SSB is estimated to have increased over the most recent 2 years to a value in 2001 of ~209 000 t.

Estimates of all year classes between 1989 and 2001 fluctuate around the long-term (1980–2001) geometric mean of 1931 million fish.

5.1.7 Short-term forecasts

Short-term forecasts for 2002 and 2003 will be contingent on the Scottish and English survey results available in the autumn of 2002. These forecasts will therefore be produced by a Working Group subgroup meeting to be convened later in the year (see Section 1.2). A sample input file to catch forecast and sensitivity analysis is given in Table 5.1.7.1: this is an example only and will be updated at the subgroup. Sensitivity (whiiv.sen) and summary (whiiv.sum) files can be found on the ICES system at W:\acfm\wgnssk\2002\Stock\whg-47d\final runs\shortterm.

5.1.8 Medium-term projections

Medium-term projections will be addressed later in the year by a subgroup of this Working Group (see Section 5.1.7).

5.1.9 Biological reference points

Empirical biological reference points will be addressed later in the year by a subgroup of this Working Group (see Section 5.1.7).

ICES proposed the following PA reference points: $\mathbf{B}_{pa}$ = 315 000 t, $\mathbf{B}_{lim}$ = 225 000 t, $\mathbf{F}_{pa}$ = 0.65, and $\mathbf{F}_{lim}$ = 0.9.

5.1.10 Quality of the assessment

(i) Previous meetings of this Working Group have concluded that the survey data and commercial catch data contain varying signals concerning the stock, and that there remain inconsistencies in the annual international catch-at-age distributions. Intersessional work to quantify the extent of these problems is required.

(ii) The starting year for assessment data has been changed from 1960 to 1980. This was for two reasons: firstly, discard estimates (which form part of the catch data) for the years prior to 1978 were not based on sampling, and secondly, there is evidence of a change in recruitment "regime" around 1980.

(iii) Data inconsistencies mean that any assessment produced will be extremely uncertain. An implementation (TSA) of the Kalman filter algorithm has been used as the assessment, as it is thought to best capture the uncertainty of the terminal-year estimates. Survey indices were not used to calibrate this assessment, as they did not make a significant difference to the outcome. It is hoped that a modified implementation, incorporating separate modelling of human consumption landings, discards, and industrial by-catch, will be presented to ACFM in its autumn meeting.

(iv) The historical pattern of stock size, fishing mortality, and recruitment resulting from this assessment is consistent with the pattern observed from the 2001 assessment. In terms of point estimates the perception of the more recent trajectory of mean $F_{2–6}$ has been revised upwards, but given the estimated uncertainty in this value it cannot be concluded that F has significantly increased.

(v) It has not been possible to evaluate the success of implementation of UK or EU technical conservation measures in 2001 (see Section 2.1), nor whether such measures have been fully implemented in 2002. The effect on the whiting fishery of the spring cod closure in 2001 is also not quantified.

(vi) 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: these data account for nearly 70% of human consumption landings. Data are also collected by other countries, but have not been made available to data collators.

(vii) No short-term or medium-term forecasts have been presented, due to the timing of the Working Group meeting. These will be produced by a subgroup meeting in the autumn.

5.1.11 Management considerations

Whiting are taken in a mixed roundfish fishery. This means it is important to take into account the impact of management of whiting on other stocks, notably cod and haddock, and *vice versa*. The fisheries for cod, haddock, and whiting are undoubtedly related, but there is uncertainty both over how closely, and over the degree to which fishing vessels can target particular species. Recent measures to protect North Sea cod, such as the closed area, and proposals to increase mesh size, have in all likelihood affected the whiting fishery, and will continue to do so. In the long-term improvements in selectivity related to measures to protect cod should benefit the whiting fishery by reducing discards and increasing landings, although in the medium term landings are likely to fall. This aspect is discussed in last year's Working Group report (ICES CM 2002/ACFM:01). Further discussions regarding fleet technical interactions can be found in Section 1.4.6.

5.2 Whiting in Division IIIa

Total landings are shown in Table 5.2.1.1.

No analytical assessment of this stock was possible.

Table 5.1.1.1 Nominal catch (in tonnes) of Whiting in Subarea IV and Division VIId, as officially reported to ICES.

Subarea IV

Country	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001*
Belgium	1,030	944	1,042	880	843	391	268	529	536	454
Denmark	1,377	1,418	549	368	189	103	46	58	105	105
Faroe Islands	16	7	2	21	-	6	1	1	-	-
France	5,071	5,502	4,735	5,963	4,704	3,526	1,908*	4,292*[1]	2,529*[1]	3,460*[1]
Germany, Fed.Rep.	511	441	239	124	187	196	103	176	424	402
Netherlands	5,390	4,799	3,864	3,640	3,388	2,539	1,941	1,795	1,884	2,478[2]
Norway	232	130	79	115	66	75	64	68	33	44
Poland	-	-	-	-	-	-	1	-	-	-
Sweden	22	18	10	1	1	1	1	9	4	1
UK (E.&W)[3]	2,528	2,774	2,722	2,477	2,329	2,638	2,909	2,268	1,782	…
UK (Scotland)	30,821	31,268	28,974	27,811	23,409	22,098	16,696	17,206	17,158	…
United Kingdom										11,876
Total	46,998	47,301	42,216	41,400	35,116	31,573	23,938	26,402	24,455	18,820
Unallocated landings	-554	680	401	-348	1,006	-276	-72	-421	-412	592
WG estimate of H.Cons. landings	46,444	47,981	42,617	41,052	36,122	31,297	23,866	25,981	24,044	19,412
WG estimate of discards	30,615	42,871	33,010	30,264	28,181	17,217	12,708	23,584	22,360	16,488
WG estimate of Ind. By-catch	26,901	20,099	10,354	26,561	4,702	5,965	3,141	5,183	8,886	7,357
WG estimate of total catch	103,960	110,951	85,981	97,877	69,005	54,479	39,715	54,748	55,290	43,258

*Preliminary: year 2001, France 1998–2001.
[1]Includes Division IIa (EC).
[2]Not included here are 68 t reported into an unknown area.
[3]1989-1994 revised. N. Ireland included with England and Wales.

Division VIId

Country	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001*
Belgium	66	74	61	68	84	98	53	48	65	75
France	5,414	5,032	6,734	5,202	4,771	4,532	4,495*	-	-	-
Netherlands	-	-	-	-	1	1	32	6	14	67
UK (E.&W)	419	321	293	280	199	147	185	135	118	…
UK (Scotland)	24	2	-	1	1	1	+	-	-	…
United Kingdom									110	133
Total	5,923	5,429	7,088	5,551	5,056	4,779	4,765	189	197	142
Unallocated	-178	-214	-463	-161	-104	-156	-167	4242	4101	5662
W.G. estimate	5,745	5,215	6,625	5,390	4,952	4,623	4,598	4,431	4,298	5,804

*Preliminary.

Subarea IV and Division VIId

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
W.G. estimate	109,705	116,166	92,606	103,267	73,957	59,102	44,313	59,179	60,907	49,062

Table 5.1.1.2 Whiting in IV and VIId. Annual weight and numbers caught, years 1980–2001, 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
Min	44	25	13	3	290	102	83	55
GM	107	52	33	18	830	183	236	353
AM	117	56	37	24	958	194	267	496
Max	224	101	80	67	2020	340	583	1659

Table 5.1.1.3. Whiting in VIId. Annual weight and numbers caught, year 1980–2001, ages 0–12+.

Year	Weight (thousand 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
Min	3483	13648
GM	5598	22316
AM	5788	23096
Max	9167	35509

Table 5.1.2.1. 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 5.1.2.2 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
1	72645	53408	71430	178079	66789	84121
2	113956	74200	44697	91355	124365	86178
3	98476	82944	42771	45627	63526	58908
4	48575	42154	36459	34175	23888	20559
5	14235	18492	17756	18528	16232	9177
6	4695	3358	6392	7547	8791	4814
7	1294	1020	1426	2049	4322	2232
8+	1113	460	407	676	1265	1268

Table 5.1.2.3 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
1	12516	6522	17081	16689	15406	12257
2	26768	23543	19894	26966	31989	28499
3	47593	48237	25016	25863	28500	27332
4	36288	31904	24713	23792	14327	17518
5	12023	15824	14717	14708	11841	8640
6	4453	2957	5446	6660	6657	4506
7	1116	1017	1213	1882	3774	2092
8+	1113	443	301	591	1159	1249

Table 5.1.2.4. 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
1	30480	19347	29979	84613	33848	27570
2	82020	28837	18755	51740	75869	44645
3	48240	30616	16361	14422	23590	21930
4	11319	9175	10992	8844	2898	2528
5	2192	2392	2976	3077	2257	385
6	240	399	935	857	1548	268
7	179	2	213	166	474	140
8+	0	17	106	85	107	19

Table 5.1.2.5. Whiting in IV and VIId. Industrial by-catch 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
1	29648	27539	24370	76777	17535	44294
2	5168	21820	6047	12649	16508	13034
3	2643	4091	1395	5342	11436	9646
4	968	1075	754	1539	6663	513
5	21	276	63	743	2134	152
6	2	2	12	30	586	40
7	0	0	0	0	74	0
8+	0	0	0	0	0	0

Table 5.1.2.6 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
1	0.093	0.091	0.091	0.076	0.113	0.072
2	0.167	0.178	0.18	0.174	0.182	0.191
3	0.236	0.243	0.236	0.233	0.238	0.227
4	0.302	0.295	0.281	0.256	0.288	0.283
5	0.387	0.333	0.314	0.289	0.287	0.270
6	0.406	0.381	0.339	0.303	0.277	0.300
7	0.428	0.381	0.33	0.309	0.277	0.287
8+	0.43	0.418	0.367	0.287	0.273	0.293

Table 5.1.2.7 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
1	0.1700	0.1715	0.1642	0.1840	0.1659	0.1600
2	0.2220	0.2067	0.2090	0.2365	0.2264	0.2168
3	0.2743	0.2607	0.2592	0.2702	0.2714	0.2682
4	0.3280	0.3140	0.3041	0.2801	0.3001	0.2857
5	0.4067	0.3476	0.3299	0.3024	0.2924	0.2692
6	0.4133	0.3977	0.3596	0.3139	0.3153	0.3033
7	0.4484	0.3807	0.3444	0.3175	0.2781	0.2909
8+	0.4302	0.4205	0.4237	0.2951	0.2737	0.2944

Table 5.1.2.8. 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
1	0.0940	0.1250	0.0860	0.1000	0.1272	0.0844
2	0.1510	0.1810	0.1730	0.1660	0.1669	0.1828
3	0.1980	0.2130	0.2040	0.1970	0.1946	0.2169
4	0.2250	0.2250	0.2280	0.2010	0.2262	0.2591
5	0.2810	0.2330	0.2340	0.2250	0.2086	0.2482
6	0.2650	0.2560	0.2240	0.2310	0.2191	0.2398
7	0.3040	0.6170	0.2470	0.2120	0.2223	0.2249
8+	0.0000	0.3523	0.2063	0.2266	0.2640	0.2425

Table 5.1.2.9. Whiting in IV and VIId. Industrial by-catch 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
1	0.0590	0.0480	0.0450	0.0270	0.0410	0.0402
2	0.1430	0.1440	0.1050	0.0770	0.1640	0.1643
3	0.2350	0.2500	0.2000	0.1460	0.2420	0.1323
4	0.2330	0.3210	0.3040	0.1960	0.2890	0.3200
5	0.3470	0.3480	0.2860	0.2860	0.3390	0.3510
6	0.2500	0.5880	0.0000	0.0000	0.0000	0.3860
7	0.0000	0.0000	0.0000	0.0000	0.5880	0.0000
8+	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Table 5.1.3.1. Whiting in IV and VIId. Summary of available tuning series.

Country	Fleet	Code	Year range	Age Range
Scotland	Groundfish survey	SCOGFS	1982–2001	0-6
	Seiners	SCOSEI	1978–2001	0–10
	Light trawlers	SCOLTR	1978–2001	0–10
England	Groundfish survey	ENGGFS	1977–2001	0-6
France	Trawlers	FRATRB	1978–2001	1–9
		FRATRO_IV	1986–2001	0-8
		FRATRO-7d	1986-2001	1-7
		FRAGFS-7d	1988–2001	0-3
International	Groundfish survey[1]	IBTS_QI	1967–2002	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. IBTS data have been revised this year by ICES.
[2] Scottish sub-set of IBTS data – discontinued in 1997.
[3] English sub-set of IBTS data – discontinued in 1996.

Table 5.1.3.2. Whiting in IV and VIId. Complete available tuning series.

SCOSEI_IV

1978	2001										
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

SCOLTR_IV

1978	2001										
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

Table 5.1.3.2 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 5.1.3.2 contd. Whiting in IV and VIId. Complete available tuning series.

SCOGFS_IV							
1982	2001						
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

ENGGFS_IV							
1977	2001						
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

Table 5.1.3.2 contd. Whiting in IV and VIId. Complete available tuning series.

IBTS_Q1_IV						
1967	2002					
1	1	0	0.25			
1	6					
1	440.40	97.80	21.20	7.20	0.80	1.20
1	1267.70	81.80	25.40	4.70	0.60	0.30
1	504.70	382.30	19.70	8.00	1.10	0.10
1	57.60	132.90	27.40	5.30	0.60	0.20
1	219.70	19.70	10.00	10.20	0.50	0.30
1	263.70	104.30	33.50	10.70	4.20	0.20
1	1460.00	381.80	53.70	33.60	8.40	5.70
1	312.50	486.00	105.70	7.10	0.60	1.30
1	881.20	174.50	91.10	19.70	3.80	0.60
1	676.20	349.40	130.00	31.30	5.00	0.50
1	411.40	232.60	69.10	12.30	11.00	13.00
1	542.90	256.80	88.70	21.10	5.00	7.50
1	440.90	228.80	112.60	33.10	4.90	1.20
1	674.00	403.30	125.80	25.60	9.10	2.00
1	229.30	464.30	228.30	45.90	9.30	2.80
1	151.40	216.10	257.40	68.50	10.10	4.60
1	127.10	126.90	112.60	79.20	33.40	6.40
1	439.00	178.90	89.20	30.30	25.40	10.50
1	339.00	361.80	65.70	18.50	7.00	7.20
1	469.40	268.40	194.60	32.40	6.60	3.90
1	683.40	556.50	90.40	46.20	5.00	2.00
1	450.70	863.70	312.80	34.20	12.30	1.30
1	1446.10	538.60	414.80	109.90	12.00	5.10
1	518.90	862.40	198.20	91.60	17.00	3.60
1	1009.20	686.20	479.40	70.90	37.60	7.60
1	904.60	677.70	250.40	162.90	15.00	14.30
1	1088.20	523.70	244.50	65.50	59.00	11.40
1	721.00	637.00	179.80	66.60	11.60	8.90
1	678.60	448.50	239.40	58.10	11.90	5.60
1	502.40	486.00	244.70	69.70	23.10	9.80
1	287.90	342.10	162.50	60.40	18.00	9.20
1	556.10	161.30	125.50	54.10	15.50	9.30
1	676.30	305.40	94.70	57.50	25.80	11.10
1	756.60	537.40	182.10	53.00	20.00	14.70
1	647.10	594.80	296.10	97.70	25.70	26.00
1	547.70	339.70	261.50	62.60	20.50	9.80

Table 5.1.3.2 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 5.1.3.2 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 5.1.4.1. Whiting in IV and VIId. TSA parameter estimates for runs using survey-series calibration.

Parameter		ENGGFS	SCOGFS	IBTS Q1
Initial fishing mortality	*F* (1, 1980)	0.1008	0.1085	0.1070
	F (2, 1980)	0.3352	0.4024	0.3980
	F (5, 1980)	0.9324	1.2376	1.2204
Survey selectivities	Φ(1)	3.3567	1.0717	0.0138
	Φ(2)	4.1522	2.0722	0.0328
	Φ(5)	3.3456	1.9672	0.0257
Standard deviations:				
Fishing mortalities	σ_F	0.1107	0.1299	0.1272
	σ_U	0.0000	0.0000	0.0000
	σ_V	0.0611	0.0461	0.0000
	σ_Y	0.0789	0.0873	0.1502
survey catchabilities	σ_Ω	0.0000	0.0000	0.0000
	σ_β	0.2374	0.5309	0.4161
Measurement	σ_{catch}	0.1343	0.0997	0.1072
	σ_{survey}	0.2882	0.2397	0.1593
Recruitment	∀	15.5701	18.2578	19.7469
	∃	0.2812	0.3203	0.3622
	cv_{rec}	0.3405	0.3639	0.3384

Notation:

F(*a*,*y*)	Fishing mortality-at-age *a* in year *y*
Φ(*a*)	Survey selectivity at age *a*
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_Ω	Transitory changes in survey catchability
σ_β	Persistent changes in survey catchability
σ_{catch}	Standard error of catch-at-age data
σ_{survey}	Standard error of survey data
∀	Ricker parameter (slope at the origin)
∃	Ricker parameter (curve dome occurs at 1/∃)
cv_{rec}	Standard error of recruitment data

Table 5.1.4.2. Whiting in IV and VIId. TSA parameters settings for final assessment run.

Parameter	*Setting*	*Justification*
Age of full selection.	$a_m = 5$	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 5.1.4.3 Whiting in IV and VIId. TSA parameter estimates for last year's (left) and this year's (right) assessments. The latter are given with lower and upper estimation bounds: these are not empirical standard errors, but user-defined run-time limits that are required to obtain a converged assessment.

parameter		Last year's assessment (1960–2000)	This year's assessment (1980–2001)		
		Estimate	Estimate	Lower bound	Upper bound
Initial fishing mortality	*F* (1, 1980)	0.0995	0.1048	0.05	0.4
	F (2, 1980)	0.3478	0.3637	0.1	0.8
	F (5, 1980)	0.8973	1.1723	0.3	1.5
Standard deviations:					
fishing mortalities	σ_F	0.1492	0.1279	0.0	0.2
	σ_U	0.0000	0.0000	0.0	0.1
	σ_V	0.0000	0.0259	0.0	0.08
	σ_Y	0.1259	0.1083	0.0	0.4
Measurement	σ_{catch}	0.1229	0.0998	0.05	0.2
Recruitment	∀	23.3877	17.9337	15.0	30.0
	∃	0.3915	0.3131	0.1	0.5
	cv_{rec}	0.3760	0.3751	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

∀ Ricker parameter (slope at the origin)
∃ Ricker parameter (curve dome occurs at 1/∃)
cv_{rec} Standard error of recruitment data

Table 5.1.4.4. Whiting in IV and VIId. TSA output: standardised catch prediction errors.

	1	2	3	4	5	6	7	8+
1981	0.9683	-0.0877	0.0406	-1.2886	-0.8195	-0.1138	0.8758	-0.9479
1982	0.7895	-1.4246	0.2339	-1.1925	-1.4163	-0.1799	-0.8887	-1.2951
1983	0.3428	-0.2785	1.0515	1.1008	-0.1953	0.4425	0.2506	0.5974
1984	1.6590	-0.4325	-0.3151	-0.0281	1.2308	1.3969	1.0070	-0.3283
1985	0.1333	-1.7428	-1.4981	-1.5464	-1.2192	1.0822	0.2490	0.2369
1986	2.7896	-0.1447	1.1441	-0.1052	-1.4744	-1.0663	-0.3890	-1.8762
1987	0.3034	1.3463	0.3300	1.5671	-0.8339	0.9893	0.3883	0.0144
1988	1.6040	1.6206	-0.8250	-0.8314	-0.9979	-0.6237	-1.0352	-1.9060
1989	0.3046	-1.5582	1.0623	0.8125	1.2898	1.9763	1.0621	2.5114
1990	0.1143	2.0401	-0.4540	0.8620	0.8851	-1.1488	-0.6601	-0.7114
1991	-1.0222	-0.0474	0.5022	-1.1220	0.3638	0.0815	0.3434	0.6235
1992	0.0390	0.5756	-1.1842	1.2108	-0.6858	0.8515	2.2728	-0.5954
1993	-0.0362	-0.4263	0.9039	-0.0548	2.2197	0.7055	0.1208	1.8883
1994	-0.3860	-0.5673	-1.1687	-0.5225	-0.6031	2.7306	-0.1250	-0.8122
1995	-0.4959	-0.2080	-0.0755	-1.4739	-1.4837	-0.3700	0.6926	-0.2698
1996	-1.2203	-0.4176	-0.1550	-0.4294	-1.0624	-0.5465	-0.6132	-0.5881
1997	-1.4218	-0.5012	-0.1484	-0.4793	-0.6495	-0.9598	-0.9410	-1.4640
1998	-1.1208	-0.8273	-0.6775	-0.1652	-0.0811	0.5811	0.9054	-0.4643
1999	0.9505	0.1216	0.7868	1.5529	0.2776	1.1798	0.2869	0.8672
2000	-1.0654	-0.4396	-0.3809	0.1169	0.5566	1.5758	1.7543	1.2778
2001	-0.7180	0.0669	-2.1124	-1.9527	-1.7025	-1.0791	-1.2368	-1.0204

Table 5.1.4.5. Whiting in IV and VIId. TSA output: estimated numbers-at-age (units are 10^{-5}).

	1	2	3	4	5	6	7	8+
1980	44.2238	14.1721	5.8828	1.6083	0.8103	0.1769	0.0152	0.0116
1981	17.3284	15.2003	5.8038	1.8216	0.4501	0.1825	0.0438	0.0059
1982	19.1427	5.6061	6.7699	1.9855	0.5243	0.1098	0.0394	0.0107
1983	16.6568	6.1949	2.5677	2.7488	0.6925	0.1512	0.028	0.0145
1984	27.1113	5.1914	2.5395	0.8693	0.9608	0.2004	0.0411	0.0108
1985	18.2096	8.256	1.9874	0.7779	0.2284	0.2497	0.041	0.0123
1986	36.5293	5.8253	3.8874	0.6992	0.2359	0.0493	0.0505	0.0099
1987	31.1217	11.3726	2.4398	1.3572	0.1702	0.063	0.011	0.0132
1988	23.7056	10.3692	4.3569	0.7245	0.3062	0.0334	0.0113	0.0039
1989	36.7334	6.2584	4.1893	1.4905	0.1953	0.067	0.0067	0.0033
1990	19.5302	12.2944	2.5008	1.4962	0.4728	0.034	0.0136	0.0022
1991	18.3815	6.078	5.0918	0.7521	0.4169	0.1045	0.0077	0.0037
1992	17.6411	6.1602	2.4647	2.027	0.2309	0.1051	0.0297	0.0029
1993	19.5141	5.4399	2.6877	0.947	0.7584	0.065	0.0259	0.0092
1994	17.588	6.2749	2.1891	0.909	0.3019	0.2456	0.017	0.0091
1995	15.3541	5.8075	2.7788	0.7683	0.2681	0.08	0.0607	0.0073
1996	10.6443	5.1089	2.5788	1.057	0.2555	0.0733	0.0192	0.0171
1997	8.144	3.618	2.3335	1.0249	0.3759	0.0744	0.0185	0.0099
1998	12.5279	2.7718	1.7109	0.9883	0.4014	0.127	0.0257	0.0097
1999	18.5193	4.3349	1.3638	0.8092	0.4225	0.1542	0.0463	0.0137
2000	14.6481	6.1147	2.0751	0.6043	0.3307	0.166	0.0575	0.0239
2001	16.4482	5.1777	2.9181	0.9284	0.2452	0.1188	0.0558	0.0302
2002	19.4863	5.8271	2.636	1.4906	0.4469	0.1065	0.05	0.0382
2003	20.2373	6.855	2.9812	1.2937	0.6911	0.1859	0.0443	0.0386

Table 5.1.4.6. Whiting in IV and VIId. TSA output: standard error on numbers-at-age (units are 10^{-5}).

	1	2	3	4	5	6	7	8+
1980	2.1096	0.6562	0.2934	0.0918	0.0463	0.013	0.0028	0.0014
1981	0.6805	0.7617	0.3145	0.1094	0.0305	0.0148	0.0053	0.001
1982	0.7095	0.2353	0.363	0.1181	0.0396	0.0101	0.006	0.0019
1983	0.5192	0.2433	0.1175	0.1475	0.0432	0.013	0.0039	0.002
1984	1.0164	0.1844	0.1155	0.0431	0.0512	0.0139	0.0051	0.0015
1985	0.6127	0.3488	0.0873	0.0431	0.0145	0.0156	0.0057	0.0019
1986	2.3977	0.2237	0.1846	0.0402	0.0173	0.0058	0.0071	0.0025
1987	1.3832	0.6046	0.1047	0.0685	0.013	0.0054	0.0021	0.0022
1988	0.8457	0.4963	0.272	0.0415	0.0226	0.0043	0.0021	0.0008
1989	2.4938	0.2763	0.2012	0.0968	0.0127	0.0056	0.0011	0.0005
1990	0.8449	0.9174	0.1428	0.0867	0.0361	0.0042	0.0023	0.0004
1991	0.7798	0.2972	0.3336	0.0528	0.0282	0.0104	0.0014	0.0007
1992	0.7266	0.2795	0.1364	0.1297	0.0186	0.0087	0.0036	0.0005
1993	0.9893	0.2578	0.1276	0.0554	0.0455	0.0058	0.0033	0.0012
1994	1.043	0.3551	0.1207	0.048	0.0196	0.0152	0.0024	0.0013
1995	0.7975	0.375	0.172	0.0491	0.017	0.0071	0.0066	0.0011
1996	0.5146	0.2869	0.1772	0.0683	0.0185	0.0062	0.0033	0.0027
1997	0.4732	0.1865	0.1378	0.0718	0.0248	0.0066	0.0028	0.0015
1998	1.1257	0.1714	0.0914	0.055	0.0268	0.0083	0.0027	0.0011
1999	2.2301	0.4174	0.0929	0.0447	0.023	0.0111	0.0039	0.0012
2000	2.5215	0.8824	0.255	0.0581	0.0257	0.0124	0.0069	0.0023
2001	4.9695	0.9587	0.5631	0.184	0.045	0.0214	0.0109	0.0056
2002	7.3903	1.8869	0.6026	0.3701	0.1201	0.0318	0.0154	0.0114
2003	7.6718	2.6239	1.0325	0.3696	0.2254	0.0699	0.0181	0.0154

Table 5.1.4.7. Whiting in IV and VIId. TSA output: estimated variance-covariance matrix for numbers-at-age in 2003.

	1	2	3	4	5	6	7	8+
1	58.856195	0.872859	1.038226	0.313761	0.187696	0.055408	0.01422	0.012657
2	0.872859	6.885024	0.320327	0.170148	0.101477	0.030124	0.007634	0.006788
3	1.038226	0.320327	1.066034	0.190958	0.120393	0.037131	0.009679	0.008642
4	0.313761	0.170148	0.190958	0.136619	0.06282	0.019617	0.005101	0.004549
5	0.187696	0.101477	0.120393	0.06282	0.050791	0.012513	0.003253	0.002897
6	0.055408	0.030124	0.037131	0.019617	0.012513	0.004891	0.001025	0.000915
7	0.01422	0.007634	0.009679	0.005101	0.003253	0.001025	0.000326	0.000241
8+	0.012657	0.006788	0.008642	0.004549	0.002897	0.000915	0.000241	0.000236

Table 5.1.4.8. Whiting in IV and VIId. TSA output: fishing mortality-at-age.

	1	2	3	4	5	6	7	8+
1980	0.1199	0.4342	0.7534	0.9478	1.2375	1.1458	1.3217	1.2639
1981	0.1745	0.3566	0.7103	0.9122	1.1595	1.272	1.3463	1.1406
1982	0.1753	0.3281	0.5357	0.7517	0.9793	1.1155	1.0319	0.9984
1983	0.2023	0.4326	0.7301	0.7353	0.974	1.0424	1.1792	1.1546
1984	0.2359	0.479	0.7932	1.003	1.0915	1.3288	1.2458	1.1983
1985	0.1848	0.3031	0.6604	0.8446	1.2005	1.3036	1.3584	1.2521
1986	0.2148	0.4199	0.6956	1.0811	1.0551	1.2483	1.3388	1.1851
1987	0.1395	0.5081	0.8538	1.1789	1.3618	1.4565	1.5379	1.5452
1988	0.3708	0.4335	0.6841	0.9656	1.1402	1.2672	1.1635	1.1456
1989	0.1309	0.4574	0.6772	0.8427	1.4746	1.3442	1.3067	1.3064
1990	0.2171	0.4147	0.8421	0.9694	1.236	1.2299	1.2206	1.2214
1991	0.1385	0.4513	0.5281	0.8814	1.11	0.9398	1.1657	1.1373
1992	0.222	0.3774	0.6059	0.6164	0.9965	1.1454	1.0197	1.0086
1993	0.1834	0.4425	0.727	0.8399	0.8362	1.0936	1.1449	1.1596
1994	0.1571	0.3628	0.6582	0.8807	1.063	1.1475	1.068	1.0412
1995	0.1491	0.3607	0.6122	0.774	1.02	1.1325	1.156	1.0834
1996	0.128	0.3336	0.5719	0.7323	0.9763	1.0927	1.069	1.0596
1997	0.1268	0.2955	0.5045	0.6275	0.8141	0.7814	0.8923	0.8265
1998	0.1108	0.2511	0.3769	0.5361	0.6735	0.7408	0.7384	0.6911
1999	0.1577	0.2869	0.4632	0.589	0.6611	0.7185	0.691	0.7341
2000	0.0898	0.2834	0.4478	0.594	0.769	0.8343	0.7823	0.7931
2001	0.0877	0.2251	0.3218	0.4311	0.5834	0.6165	0.6066	0.6227

Table 5.1.4.9. Whiting in IV and VIId. TSA output: standard error on log fishing mortality-at-age.

	1	2	3	4	5	6	7	8+
1980	0.1515	0.0713	0.06	0.0598	0.0573	0.0821	0.1124	0.1243
1981	0.1178	0.0883	0.0671	0.0556	0.0627	0.0813	0.1037	0.132
1982	0.1043	0.0632	0.083	0.0693	0.0727	0.093	0.1151	0.1319
1983	0.0662	0.0599	0.0618	0.073	0.0705	0.0979	0.1158	0.1294
1984	0.0986	0.0475	0.0537	0.0536	0.0597	0.0813	0.1121	0.1303
1985	0.0668	0.0664	0.0513	0.0591	0.0593	0.073	0.1072	0.1303
1986	0.2286	0.0566	0.0635	0.0505	0.0665	0.0867	0.0959	0.127
1987	0.1163	0.0827	0.0514	0.0546	0.0664	0.0941	0.1207	0.1132
1988	0.0684	0.0818	0.0767	0.0604	0.0758	0.1135	0.128	0.1334
1989	0.1623	0.0579	0.0747	0.0861	0.0712	0.1054	0.1293	0.1362
1990	0.0818	0.1321	0.0614	0.067	0.0809	0.1063	0.1245	0.1376
1991	0.0765	0.0728	0.1006	0.074	0.0747	0.1151	0.1283	0.136
1992	0.0772	0.082	0.0742	0.0943	0.0843	0.0969	0.124	0.1376
1993	0.1046	0.0697	0.0659	0.0716	0.0795	0.1014	0.1146	0.1332
1994	0.1171	0.0897	0.0686	0.0607	0.0674	0.0807	0.119	0.1266
1995	0.0999	0.0992	0.0839	0.069	0.0597	0.0823	0.0976	0.1292
1996	0.0666	0.091	0.0919	0.0784	0.069	0.0754	0.1119	0.1154
1997	0.0505	0.0844	0.0865	0.0891	0.0751	0.0924	0.1095	0.1214
1998	0.089	0.0847	0.0933	0.0866	0.0915	0.0907	0.1183	0.1324
1999	0.1737	0.1218	0.11	0.096	0.0901	0.1213	0.1194	0.1433
2000	0.1647	0.1553	0.1561	0.1425	0.1353	0.1429	0.1604	0.1702
2001	0.2554	0.2078	0.1869	0.2045	0.2033	0.2111	0.2125	0.215

Table 5.1.4.10. Whiting in IV and VIId. TSA output: stock summary table. Estimates for 2002 and 2003 are TSA forecasts. Note that TSA estimates refer to ages 1-8+: actual catch is thus not comparable with that reported in Tables 5.1.1.1 and 5.1.1.2.

Year	Catch			Mean F (2-6)		SSB		TSB		Recruitment	
	Actual	Predicted	SE	Estimate	SE	Estimate	SE	Estimate	SE	Estimate	SE
1980	2.1871	2.1602	0.0946	0.9037	0.0295	5.0373	0.136	8.1888	0.2128	44.2238	2.1096
1981	1.8643	1.8708	0.0887	0.8821	0.0308	4.766	0.1462	6.2504	0.1647	17.3284	0.6805
1982	1.3731	1.416	0.0691	0.742	0.0308	3.691	0.1094	4.8127	0.119	19.1427	0.7095
1983	1.5166	1.4763	0.0548	0.7829	0.0305	3.2298	0.0755	4.9106	0.0955	16.6568	0.5192
1984	1.4238	1.4167	0.0502	0.9391	0.0298	2.615	0.0529	4.8406	0.1053	27.1113	1.0164
1985	0.9761	1.0388	0.0338	0.8625	0.0273	2.6954	0.0692	4.3457	0.0937	18.2096	0.6127
1986	1.5809	1.4314	0.1301	0.9	0.0311	2.7587	0.0685	6.2577	0.2602	36.5293	2.3977
1987	1.378	1.3709	0.0621	1.0718	0.0393	2.9192	0.09	5.1866	0.1436	31.1217	1.3832
1988	1.2759	1.3127	0.0588	0.8981	0.041	2.8518	0.0922	4.1122	0.1068	23.7056	0.8457
1989	1.2152	1.1641	0.0531	0.9592	0.0427	2.6199	0.0699	4.987	0.1887	36.7334	2.4938
1990	1.4906	1.2367	0.0821	0.9384	0.0425	2.7784	0.1235	4.3558	0.1508	19.5302	0.8449
1991	1.0726	1.0681	0.0554	0.7821	0.036	2.649	0.0898	4.4162	0.1226	18.3815	0.7798
1992	1.0644	1.0279	0.0472	0.7483	0.0348	2.5263	0.0714	3.9049	0.0956	17.6411	0.7266
1993	1.0884	1.0375	0.0434	0.7878	0.0328	2.2981	0.0594	3.6421	0.0955	19.5141	0.9893
1994	0.8987	0.9094	0.0421	0.8224	0.029	2.1987	0.0678	3.5363	0.1107	17.588	1.043
1995	0.8828	0.886	0.0481	0.7799	0.0291	2.2599	0.0807	3.5329	0.1107	15.3541	0.7975
1996	0.7214	0.731	0.0392	0.7414	0.0288	1.9659	0.0665	2.9152	0.0854	10.6443	0.5146
1997	0.5868	0.5902	0.0297	0.6046	0.0266	1.7081	0.0539	2.4192	0.0751	8.144	0.4732
1998	0.4325	0.4583	0.0191	0.5157	0.0267	1.447	0.052	2.5016	0.1307	12.5279	1.1257
1999	0.5728	0.5517	0.0239	0.5437	0.0415	1.5607	0.1001	2.8737	0.2383	18.5193	2.2301
2000	0.6082	0.6171	0.023	0.5857	0.0715	2.0372	0.2308	3.5994	0.4613	14.6481	2.5215
2001	0.4664	0.5134	0.0232	0.4356	0.0779	2.092	0.3411	3.2251	0.5903	16.4482	4.9695
2002	NA	0.6397	0.1022	0.4609	0.0983	2.3708	0.5072	3.9647	0.8754	19.4863	7.3903
2003	NA	0.7145	0.1417	0.4609	0.1102	2.6671	0.6346	4.3341	0.985	20.2373	7.6718
Units:		10^{-5} tonnes				10^{-5} tonnes		10^{-5} tonnes		10^{-5} fish	

Table 5.1.5.1. 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
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 5.1.5.1 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			5426
1997		4141	2090
1998	12302	5410	3329
1999	15276	6646	2741
2000	17076	4146	-1
2001	10315	-1	-1

Table 5.1.6.1. Whiting in IV and VIId. Stock trends, 1980–2001.

				CATCH				MEAN F			
Year	Recruits	SSB	TSB	Total	H. cons	Disc	IBC	Total	H. cons	Disc	IBC
1980	4422.38	503.73	818.88	223.52	100.81	76.95	45.76	0.9037	0.6412	0.1956	0.0669
1981	1732.84	476.6	625.04	192.05	89.52	35.92	66.61	0.8821	0.6563	0.0773	0.1485
1982	1914.27	369.1	481.27	140.2	80.55	26.6	33.04	0.7421	0.5217	0.1022	0.1182
1983	1665.68	322.98	491.06	161.21	87.97	49.56	23.68	0.7829	0.592	0.1369	0.054
1984	2711.13	261.5	484.06	145.74	86.28	40.56	18.9	0.9391	0.7605	0.1205	0.0581
1985	1820.96	269.54	434.57	106.36	62.13	28.91	15.32	0.8624	0.7186	0.0832	0.0606
1986	3652.93	275.87	625.77	161.74	64.11	79.66	17.97	0.9	0.7072	0.1382	0.0545
1987	3112.17	291.92	518.66	138.77	68.3	54	16.48	1.0718	0.8686	0.1483	0.0549
1988	2370.56	285.18	411.22	133.47	56.1	28.15	49.22	0.8981	0.6935	0.1049	0.0997
1989	3673.34	261.99	498.7	123.75	45.19	35.85	42.71	0.9592	0.5613	0.1811	0.2168
1990	1953.02	277.84	435.58	153.45	46.9	55.84	50.72	0.9384	0.4906	0.2594	0.1884
1991	1838.15	264.9	441.62	124.98	53.02	33.64	38.31	0.7821	0.5404	0.1202	0.1215
1992	1764.11	252.63	390.49	109.7	52.19	30.61	26.9	0.7483	0.5398	0.1241	0.0844
1993	1951.41	229.81	364.21	116.17	53.2	42.87	20.1	0.7878	0.503	0.2108	0.074
1994	1758.8	219.87	353.63	92.61	49.24	33.01	10.35	0.8224	0.5879	0.2029	0.0315
1995	1535.41	225.99	353.29	103.27	46.44	30.26	26.56	0.7799	0.603	0.1503	0.0266
1996	1064.43	196.59	291.52	73.96	41.07	28.18	4.7	0.7414	0.5526	0.1794	0.0094
1997	814.4	170.81	241.92	59.1	35.92	17.22	5.97	0.6046	0.4494	0.1272	0.0281
1998	1252.79	144.7	250.16	44.31	28.46	12.71	3.14	0.5157	0.377	0.1265	0.0122
1999	1851.93	156.07	287.37	59.18	30.41	23.58	5.18	0.5437	0.3832	0.1305	0.03
2000	1464.81	203.72	359.94	60.91	28.81	23.21	8.89	0.5857	0.3646	0.133	0.0881
2001	1644.82	209.2	322.51	49.06	25.22	16.49	7.36	0.4356	0.3435	0.0696	0.0225
	age 1	000t	000t	000t	000t	000t	000t	2-6	2-6	2-6	2-6

Table 5.1.7.1. Whiting in IV and VIId. Input to catch forecast and linear sensitivity analyses.

Label	Value	CV	Label	Value	CV
Number-at-age			Weight in the stock		
N1	1948630	0.38	WS1	0.09	0.26
N2	582710	0.32	WS2	0.18	0.05
N3	263600	0.23	WS3	0.23	0.02
N4	149060	0.25	WS4	0.28	0.06
N5	44690	0.27	WS5	0.28	0.04
N6	10650	0.30	WS6	0.29	0.05
N7	5000	0.31	WS7	0.29	0.06
N8	3820	0.30	WS8	0.28	0.04
H.cons selectivity			Weight in the HC catch		
sH1	0.02	0.26	WH1	0.17	0.07
sH2	0.08	0.08	WH2	0.23	0.04
sH3	0.20	0.28	WH3	0.27	0.01
sH4	0.38	0.08	WH4	0.29	0.04
sH5	0.55	0.03	WH5	0.29	0.06
sH6	0.61	0.05	WH6	0.31	0.02
sH7	0.63	0.09	WH7	0.29	0.07
sH8	0.66	0.09	WH8	0.29	0.04
Discard selectivity			Weight in the discards		
sD1	0.05	0.02	WD1	0.10	0.21
sD2	0.15	0.03	WD2	0.17	0.06
sD3	0.14	0.02	WD3	0.20	0.06
sD4	0.09	0.05	WD4	0.23	0.13
sD5	0.08	0.05	WD5	0.23	0.09
sD6	0.09	0.06	WD6	0.23	0.05
sD7	0.06	0.02	WD7	0.22	0.03
sD8	0.06	0.04	WD8	0.24	0.08
Industrial selectivity			Weight in Ind. by-catch		
sI1	0.05	0.02	WI1	0.04	0.22
sI2	0.04	0.00	WI2	0.14	0.37
sI3	0.06	0.02	WI3	0.17	0.35
sI4	0.07	0.09	WI4	0.27	0.24
sI5	0.05	0.05	WI5	0.33	0.11
sI6	0.02	0.03	WI6	0.13	1.73
sI7	0.00	0.01	WI7	0.20	1.73
sI8	0.00	0.00	WI8	0.00	0.00
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
M7	0.20	0.10	MT7	1.00	0.00
M8	0.20	0.10	MT8	1.00	0.00
Relative effort in HC fishery			Year effect for natural mortality		
HF02	1.00	0.15	K01	1.00	0.10
HF02	1.00	0.15	K02	1.00	0.10
HF03	1.00	0.15	K03	1.00	0.10

Table 5.1.7.1. cont. Whiting in IV and VIId. Input to catch forecast and linear sensitivity analyses.

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

 Recruitment in 2003 and 2004
 R03     1510291   0.24
 R04     1510291   0.24


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

Stock numbers in 2002 are TSA predictions. CVs on stock numbers in 2002 are calculated as s.e.(N(a)) / N(a). Catch component F-at-age is calculated as unscaled 3-year (1999-2001) arithmetic mean of partial F estimated on the basis of reported numbers in each component. CVs are based on the standard error of the same 3 years. Catch component weight-at-age is calculated as the unscaled 3-year (1999-2001) arithmetic mean of the estimated weights; CVs are based on the same data. Stock weight-at-age is assumed equal to catch weight-at-age: same calculations as above. Recruitment estimates are 10-year GM of TSA estimates. Multipliers on mortality are taken from the North Sea haddock SEN file - this will be updated.

Table 5.2.1.1. 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	29	+	n/a

*Preliminary.

Figure 5.1.2.1. Whiting in IV and VIId. Proportions by age in estimated total catch of the human consumption landings, discards, and industrial by-catch components.

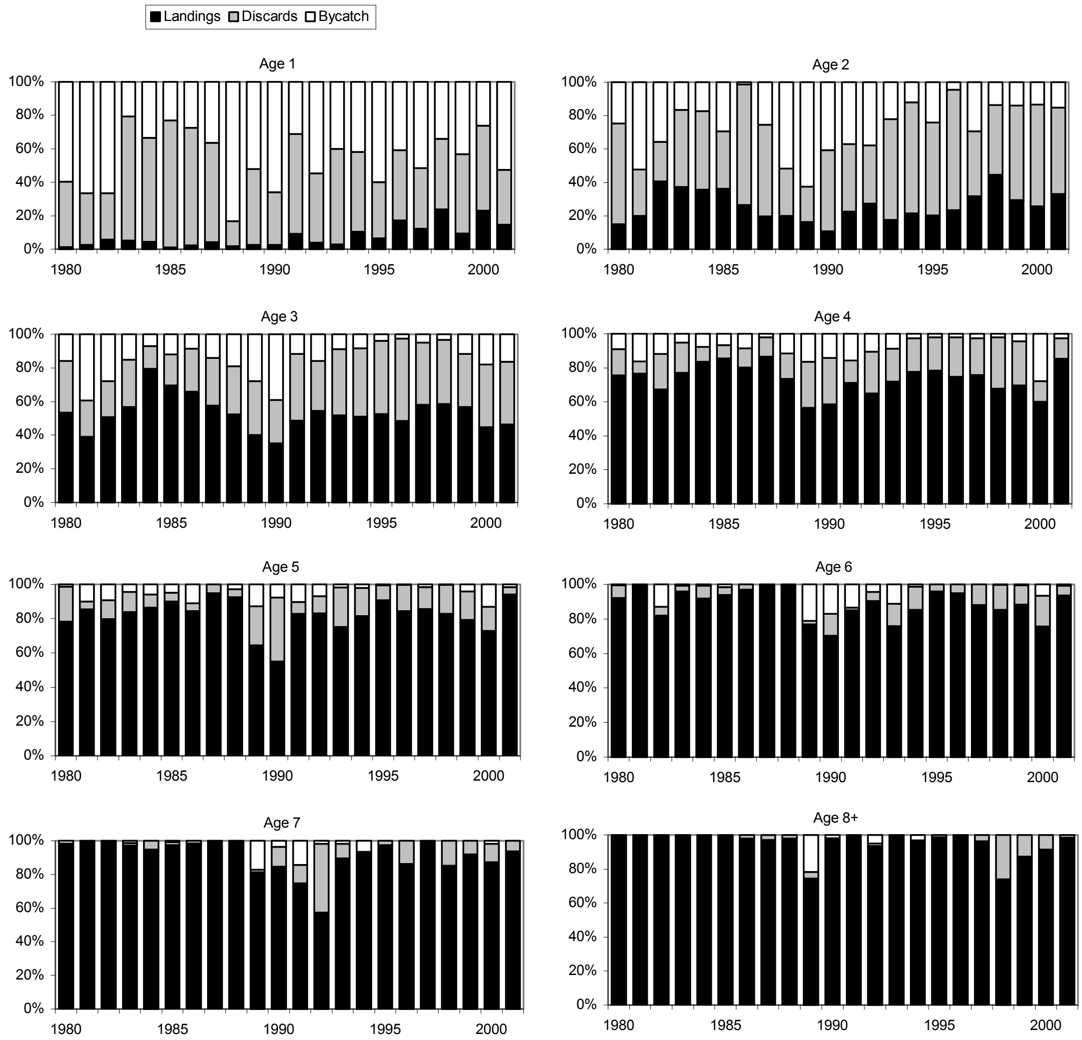


Figure 5.1.2.2. Whiting in IV and VIId. Trends in mean weight-at-age in three components of the fishery: human consumption landings, discards, and industrial by-catch.

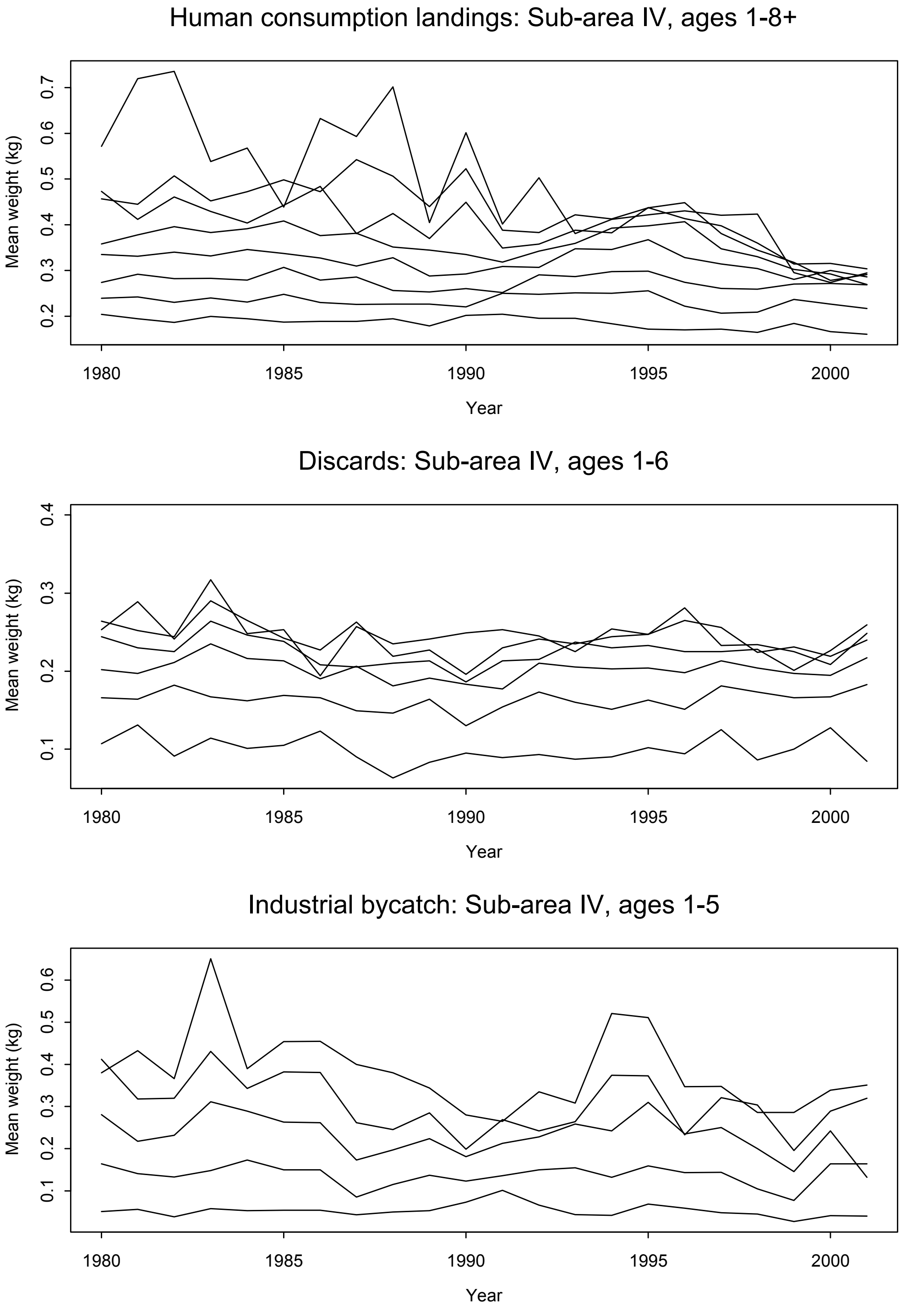


Figure 5.1.3.1. Whiting in IV and VIId. Normalised (mean-standardised) trends in survey tuning indices by age.

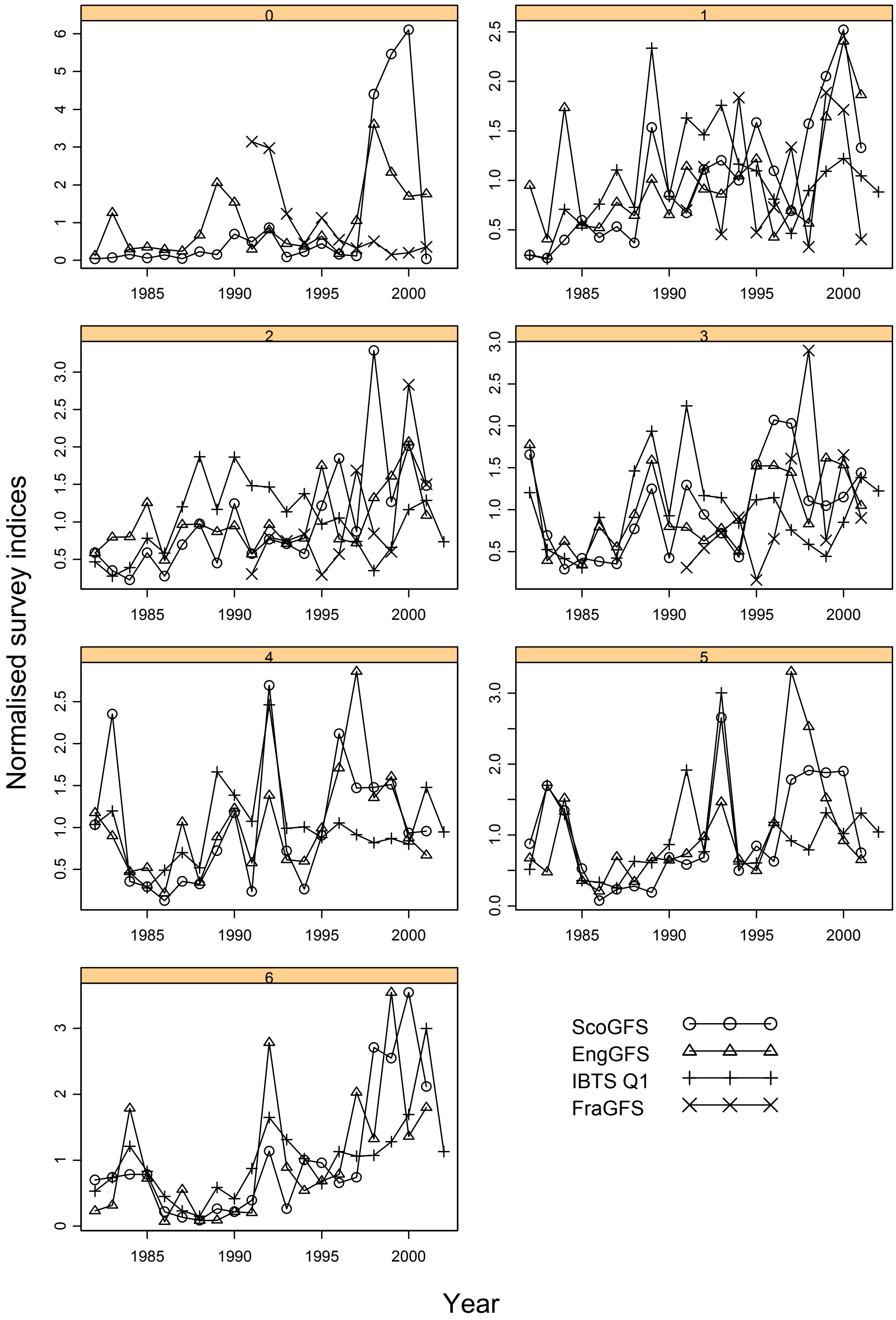


Figure 5.1.3.2. Whiting in IV and VIId. Pairwise bivariate scatterplots of survey indices at age 0, with fitted linear regression lines.

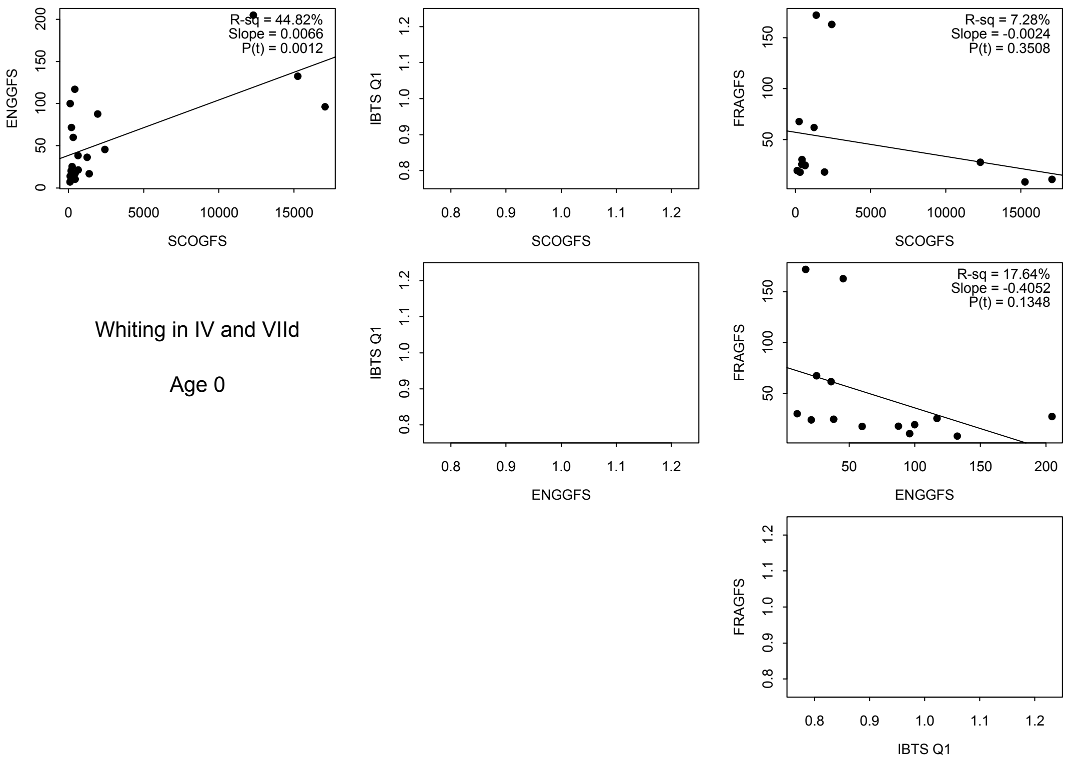


Figure 5.1.3.3. Whiting in IV and VIId. Pairwise bivariate scatterplots of survey indices at age 1, with fitted linear regression lines.

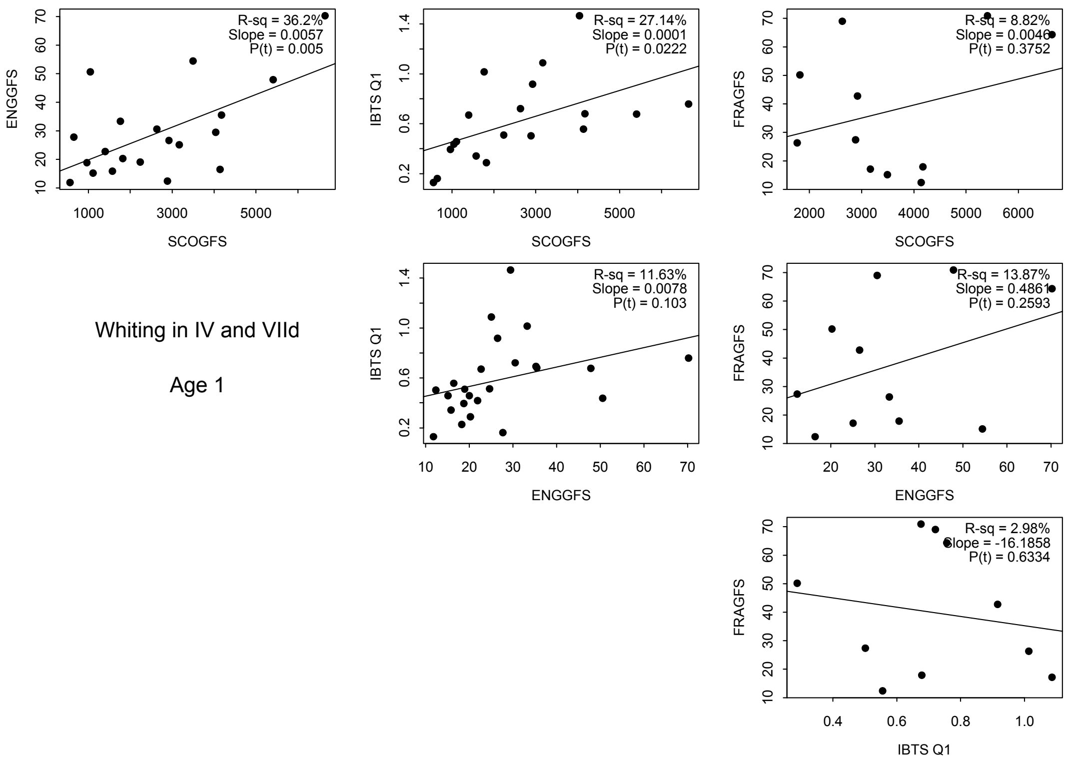


Figure 5.1.3.4. Whiting in IV and VIId. Pairwise bivariate scatterplots of survey indices at age 2, with fitted linear regression lines.

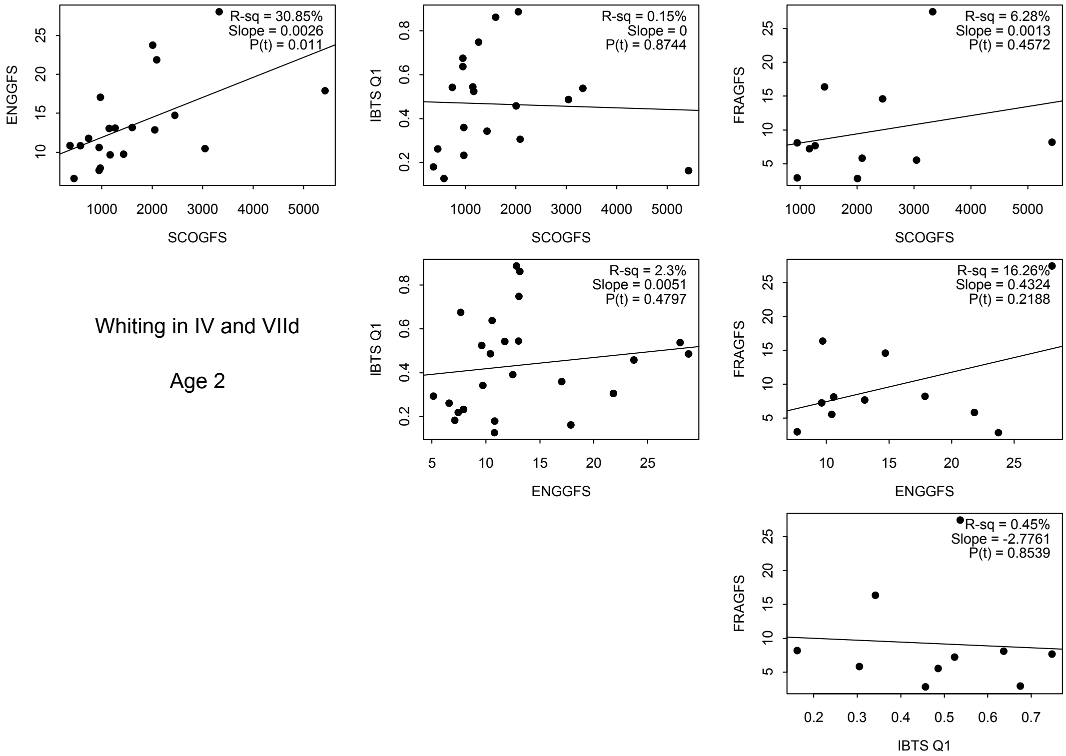


Figure 5.1.3.5 Whiting in IV and VIId. Pairwise bivariate scatterplots of survey indices at age 2, with fitted linear regression lines.

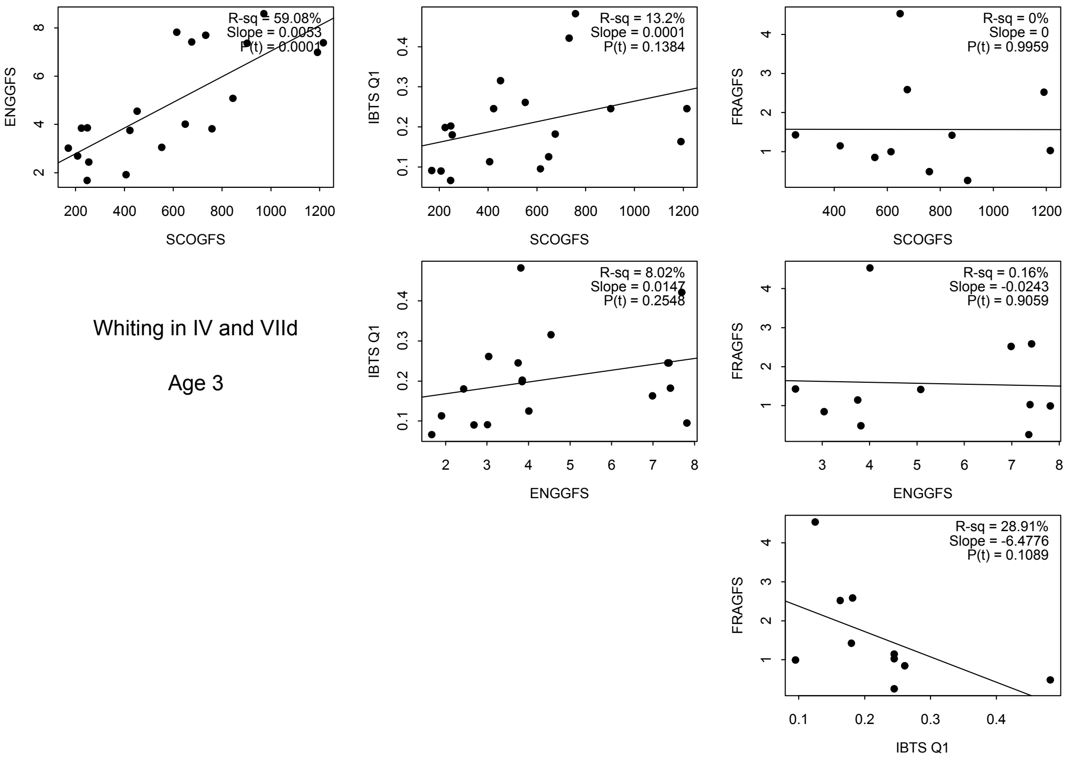


Figure 5.1.3.6. Whiting in IV and VIId. Pairwise bivariate scatterplots of survey indices at age 4, with fitted linear regression lines.

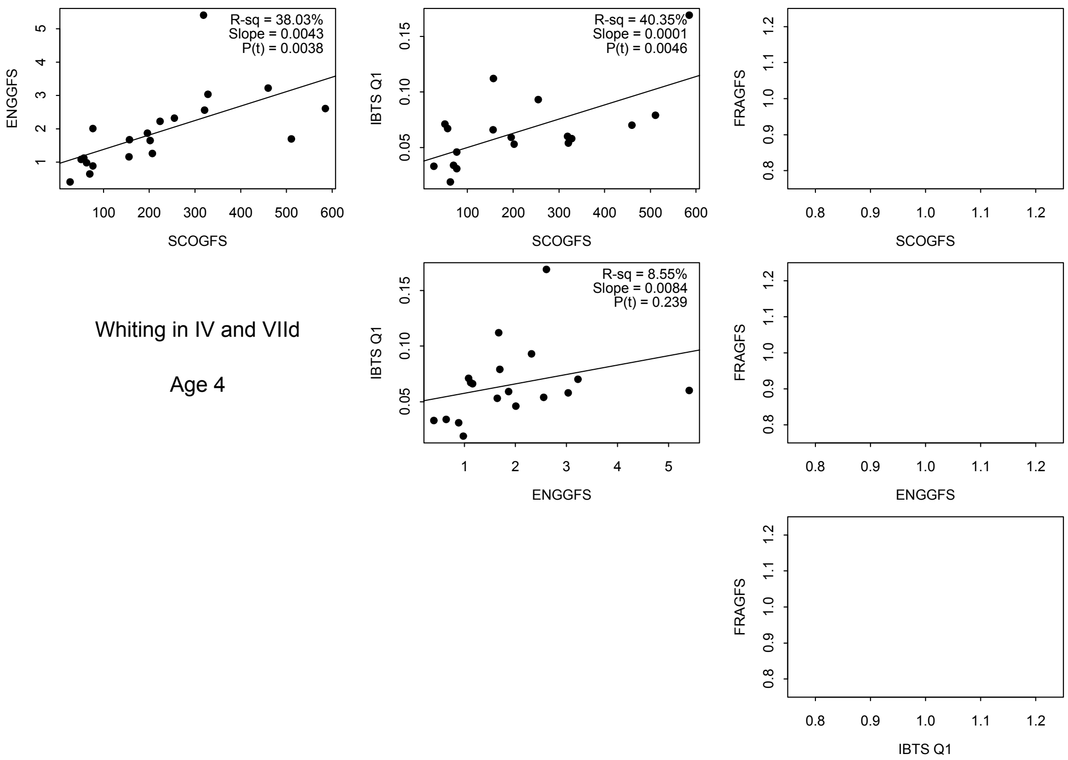


Figure 5.1.3.7 Whiting in IV and VIId. Pairwise bivariate scatterplots of survey indices at age 5, with fitted linear regression lines.

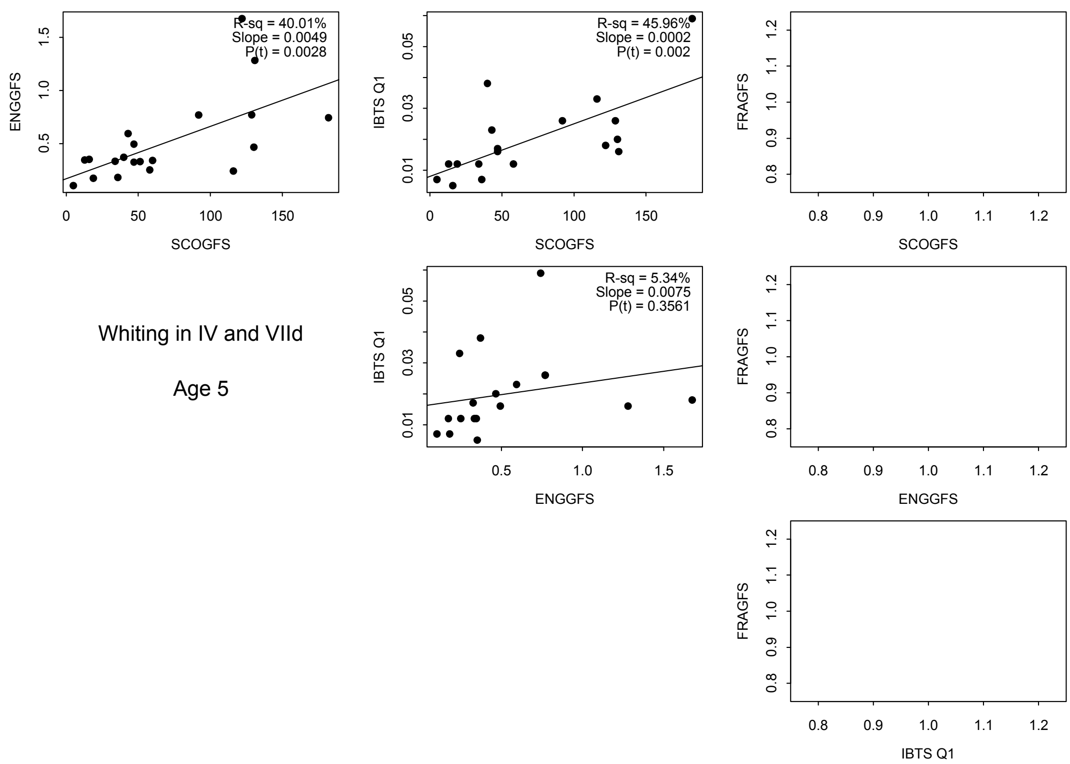


Figure 5.1.3.8. Whiting in IV and VIId. Pairwise bivariate scatterplots of survey indices at age 6, with fitted linear regression lines.

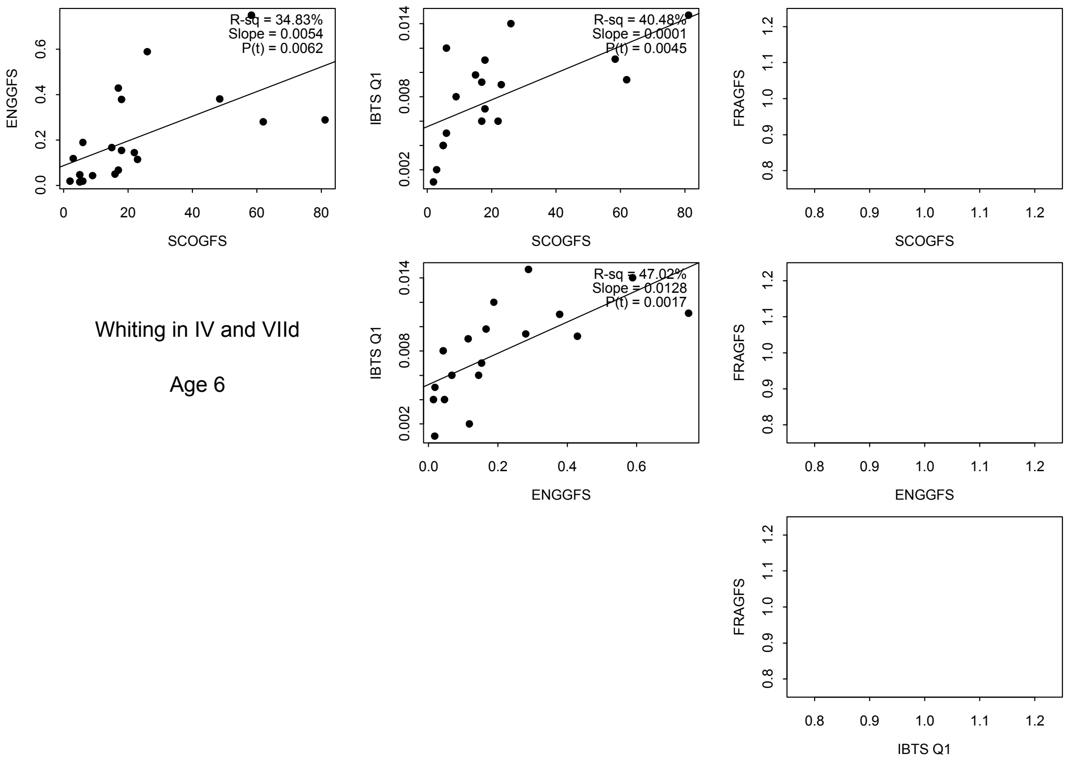


Figure 5.1.3.9. Whiting in IV and VIId. Relative trends in mean F(2-6) from RCRV1A analyses of ScoGFS, EngGFS, IBTS Q1, and FraGFS, and a TSA run with no survey data. The latter are mean-standardised to facilitate comparison. Dotted lines show loess smoothers through each time-series, and these are repeated in the final plot.

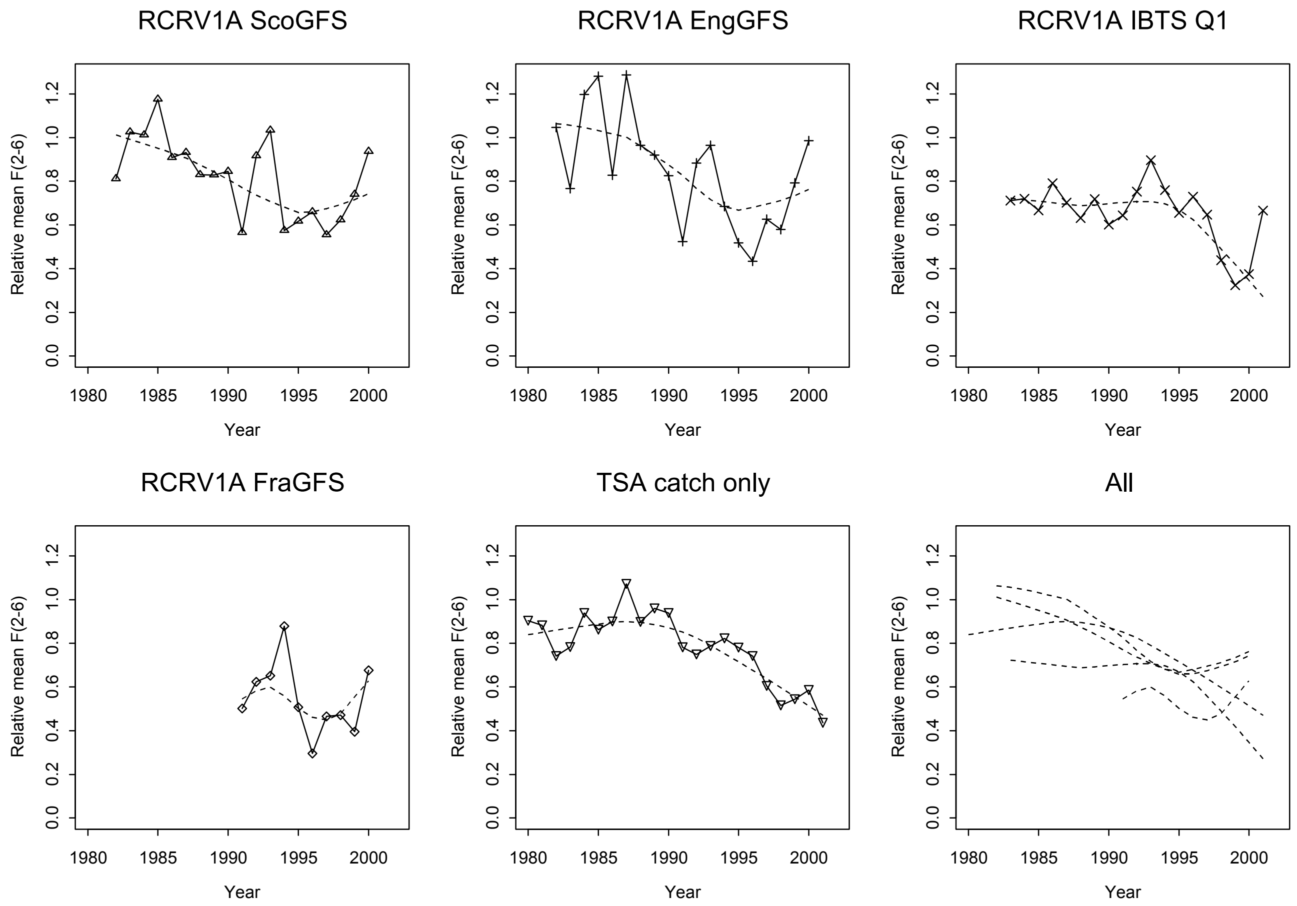


Figure 5.1.3.10. Whiting in IV and VIId. Relative trends in SSB from RCRV1A analyses of ScoGFS, EngGFS, IBTS Q1, and FraGFS, and a TSA run with no survey data. The latter are mean-standardised to facilitate comparison. Dotted lines show loess smoothers through each time-series, and these are repeated in the final plot.

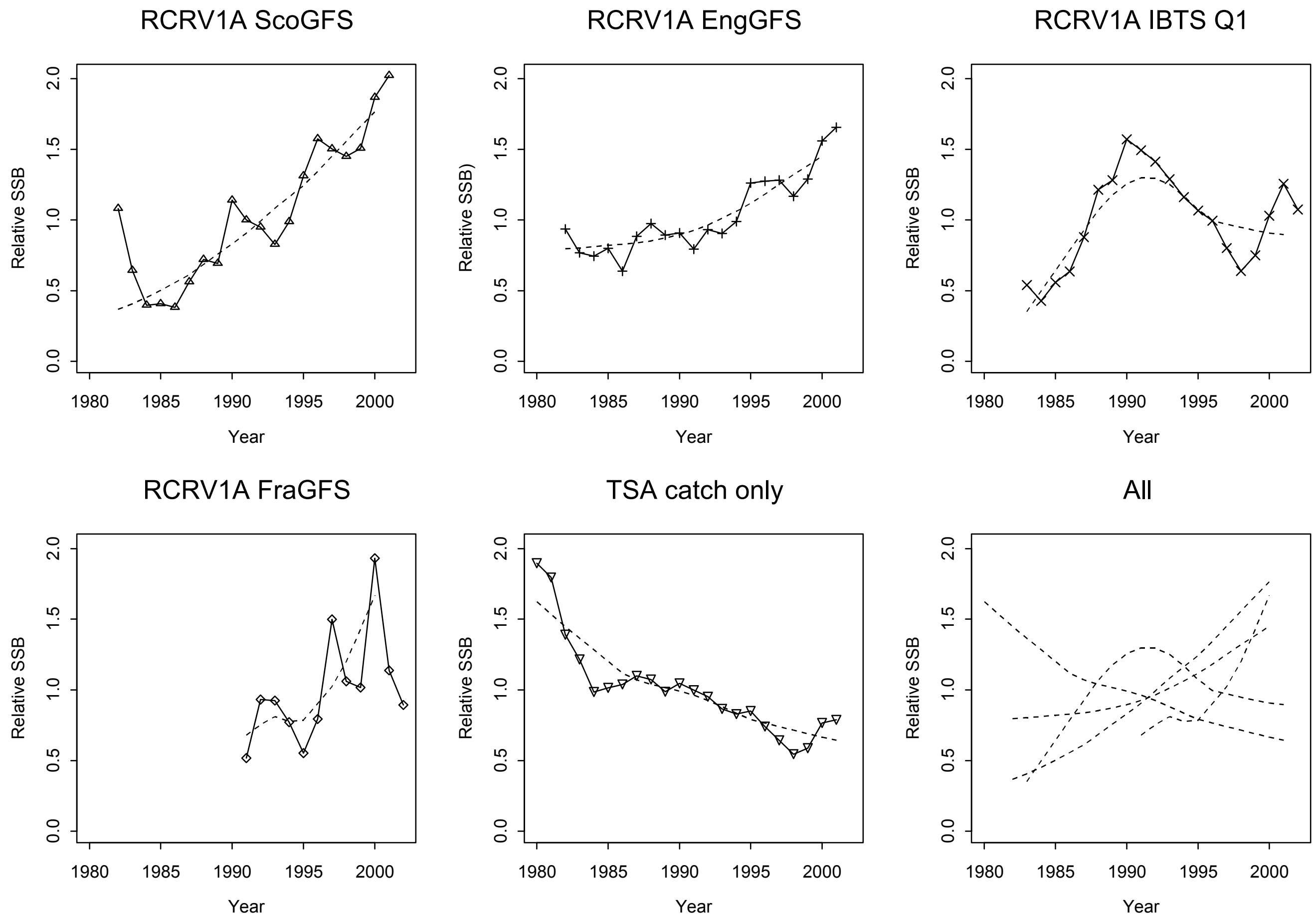


Figure 5.1.3.11 Whiting in IV and VIId. Relative trends in recruitment from RCRV1A analyses of ScoGFS, EngGFS, IBTS Q1, and FraGFS, and a TSA run with no survey data. The latter are mean-standardised to facilitate comparison. Dotted lines show loess smoothers through each time-series, and these are repeated in the final plot.

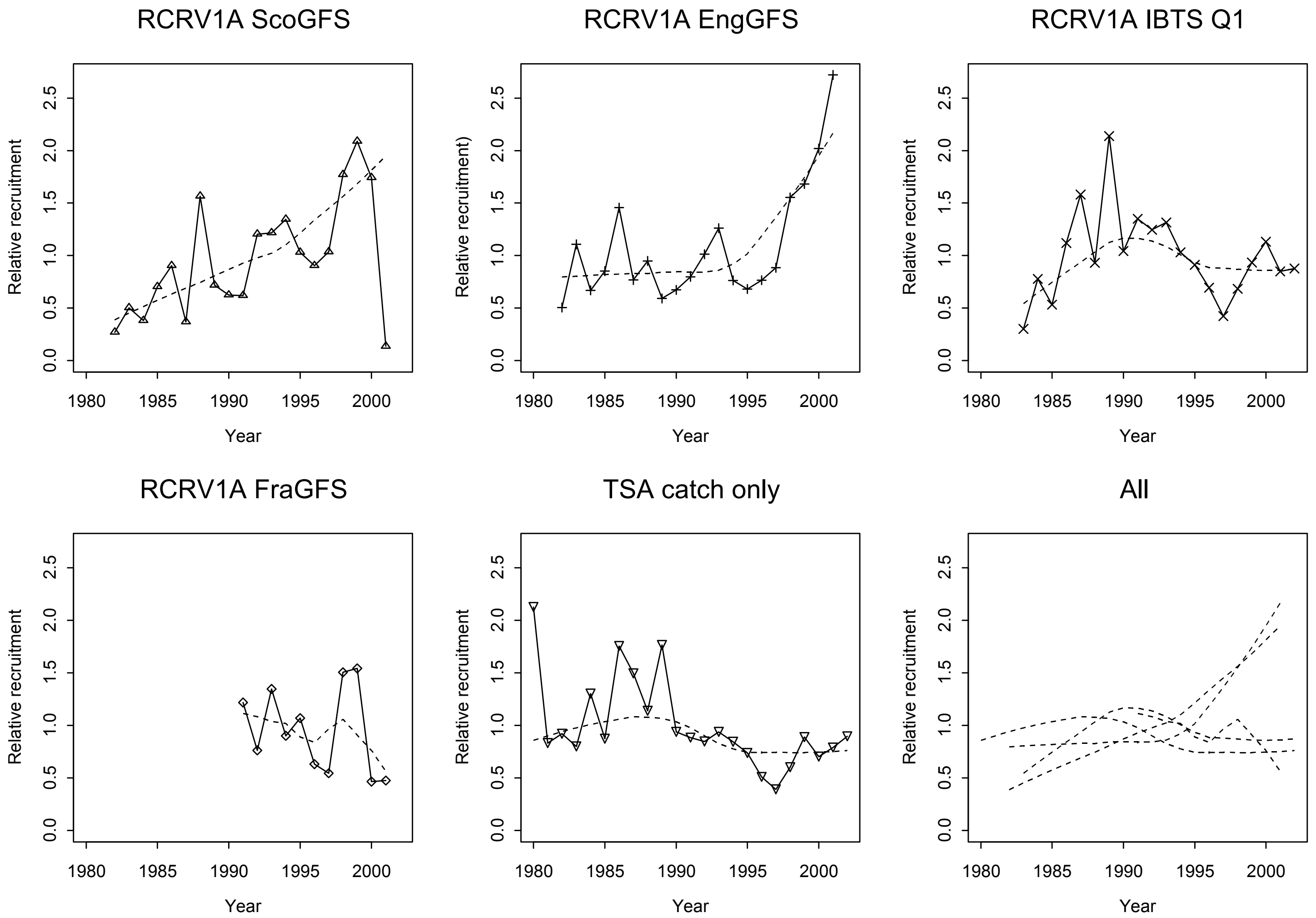


Figure 5.1.3.12. Whiting in IV and VIId. Comparison of old and new FRAGFS abundance indices.

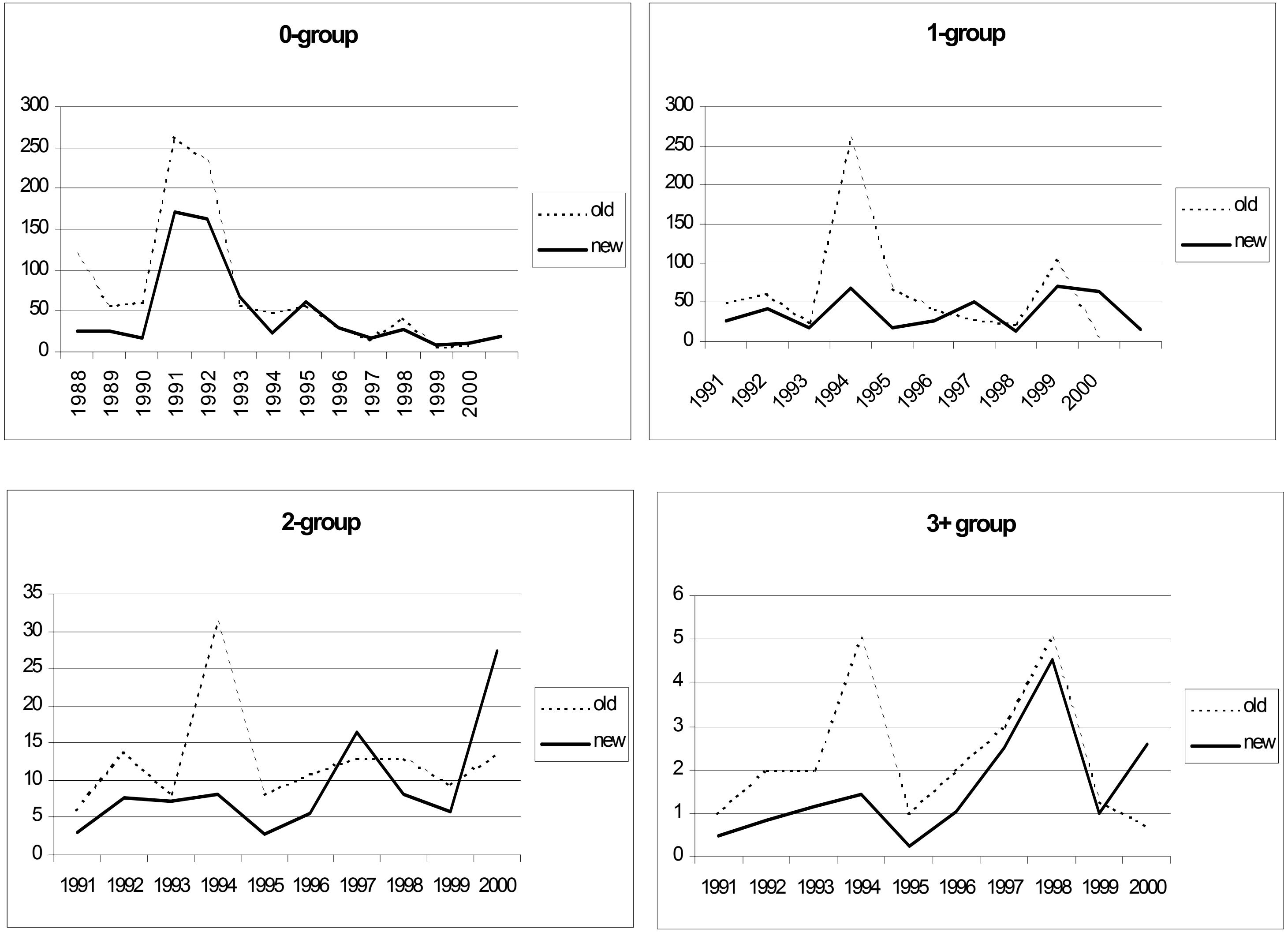
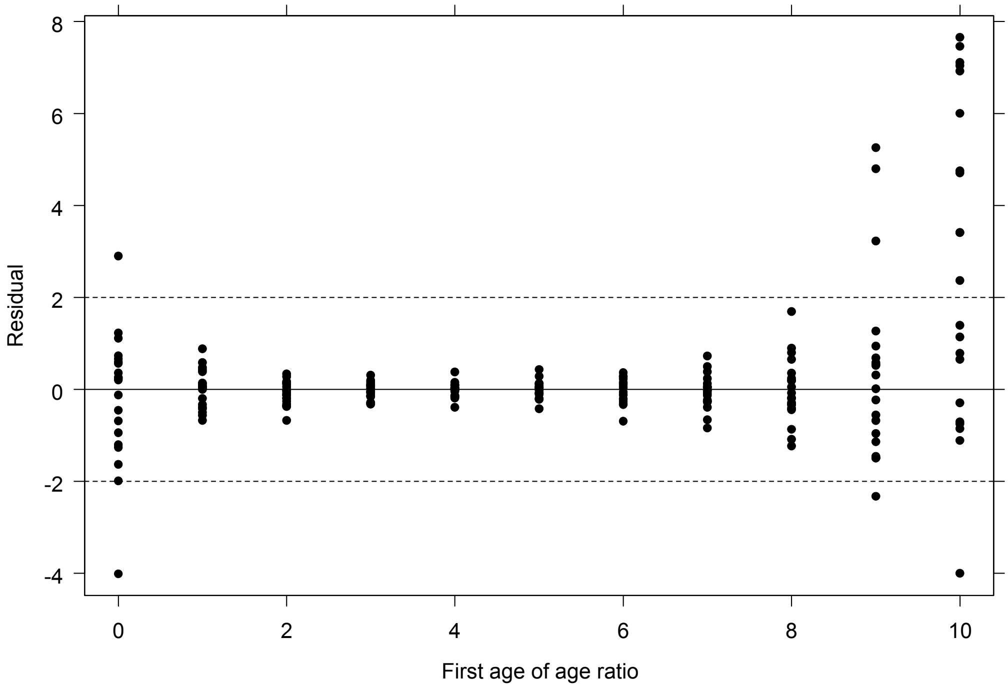


Figure 5.1.4.1. Whiting in IV and VIId. Residuals for two separable VPA runs: using ages 0–12+ (top plot), and ages 1–8+ (bottom plot).



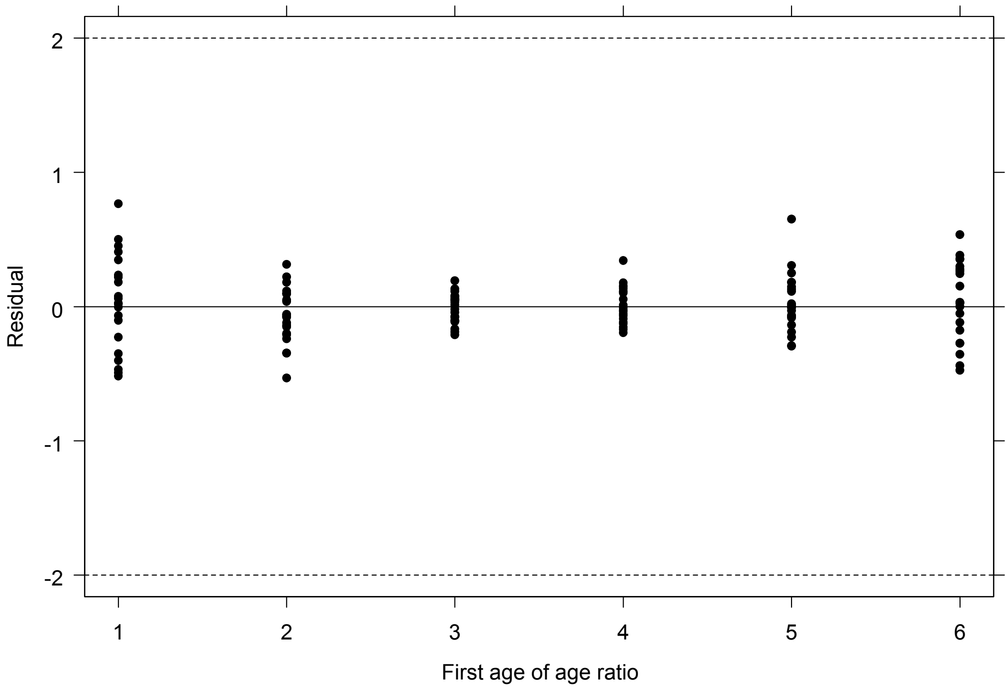


Figure 5.1.4.2. Whiting in IV and VIId. Comparison of stock summaries from four TSA runs: with no survey data, and with data from the EngGFS, ScoGFS, and IBTS Q1 surveys. The results from the TSA run with no survey data are plotted with ± 2 standard errors (equivalent to pointwise 95% confidence intervals). The vertical dashed line on each plot marks the present: all estimates thereafter are TSA forecasts. The filled circles on the Yield plot are observed catches.

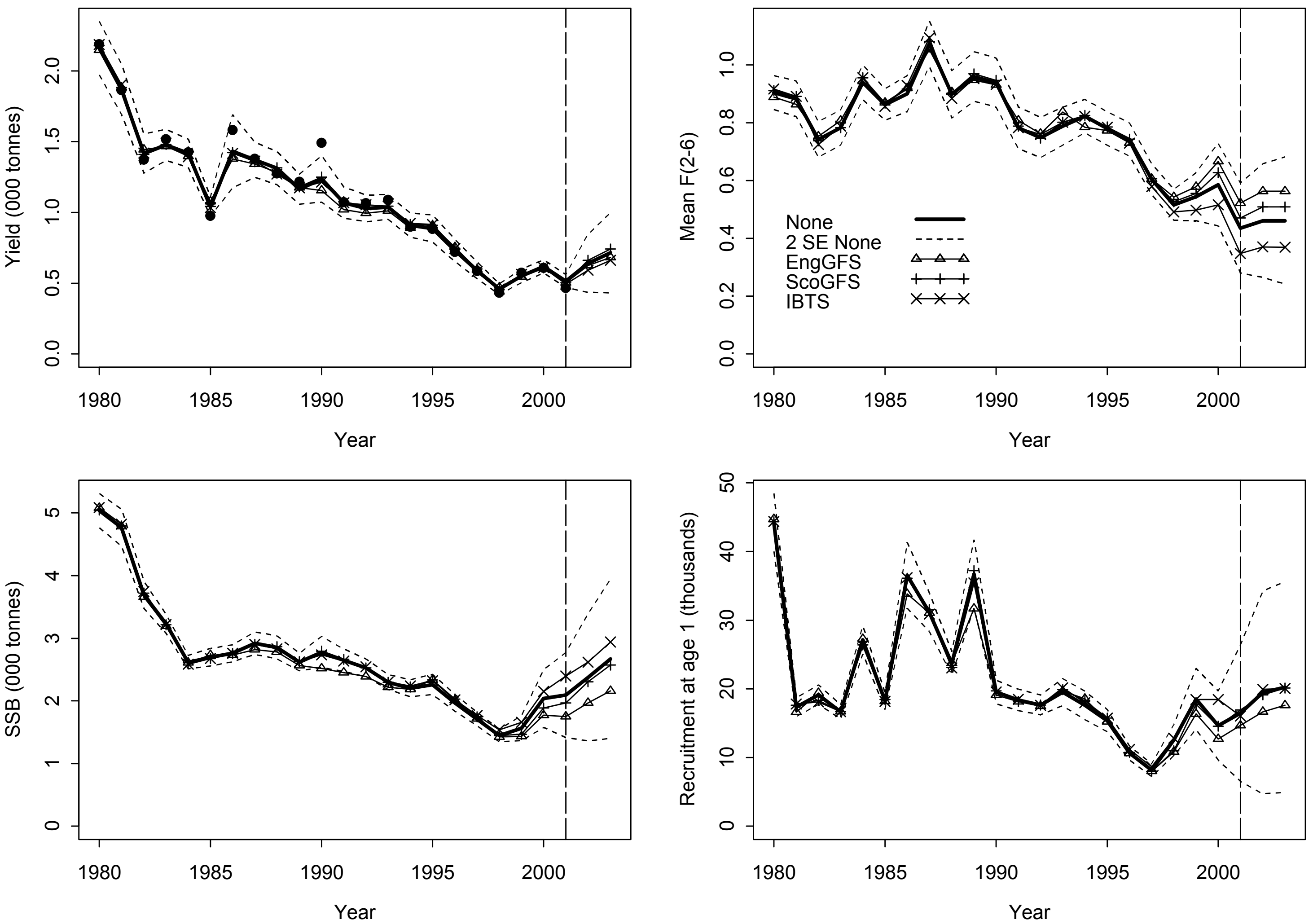


Figure 5.1.4.3. Whiting in IV and VIId. SSB (2001) against mean $F_{2\text{–}6}$ (2001) from four TSA runs: no survey (filled circle) and three single-survey runs (open circles), along with the *status quo* WG prediction (asterisk) from last year's assessment (as amended by ACFM). Dotted lines give approximate pointwise 95% confidence intervals about the TSA (no survey) estimate.

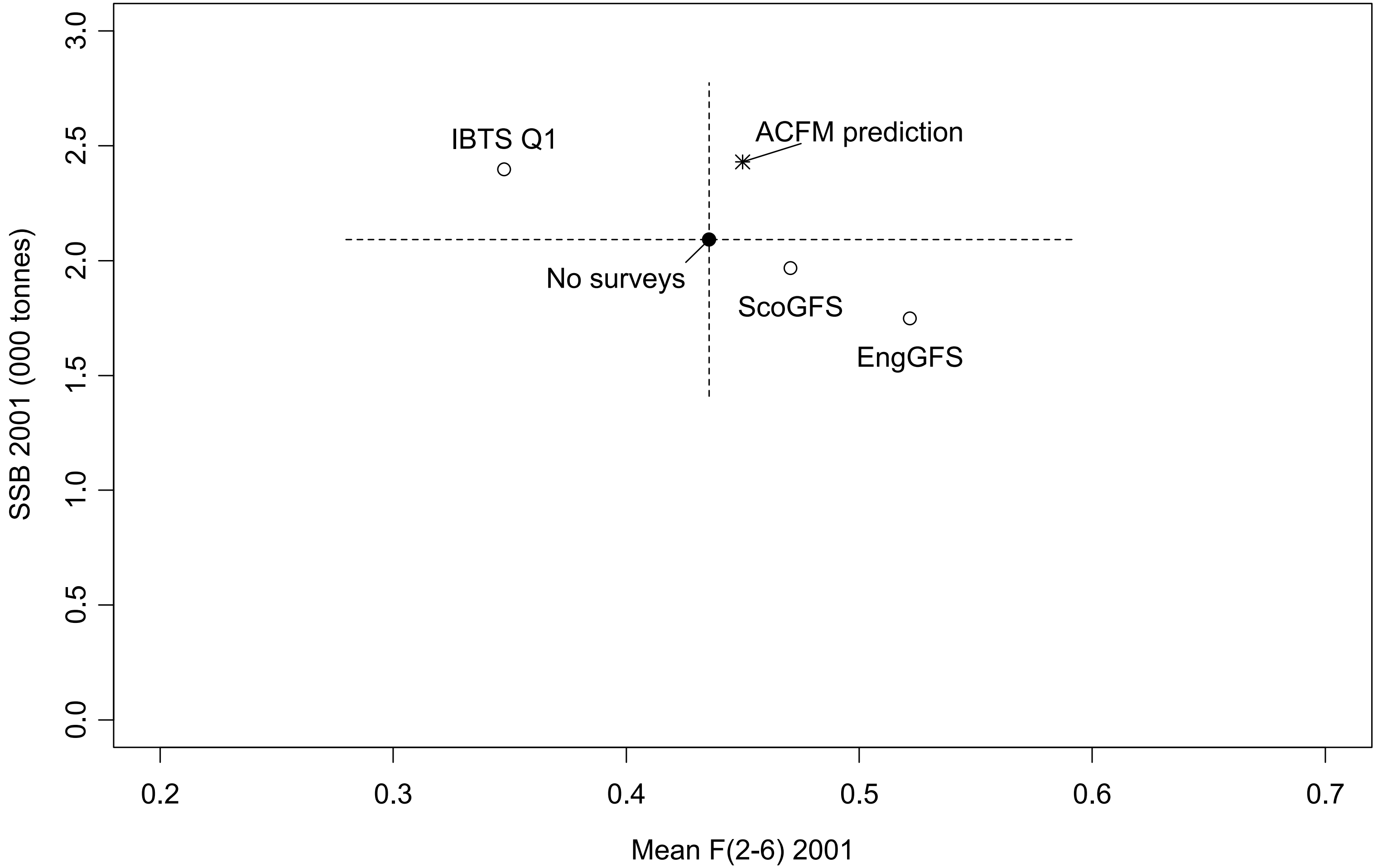
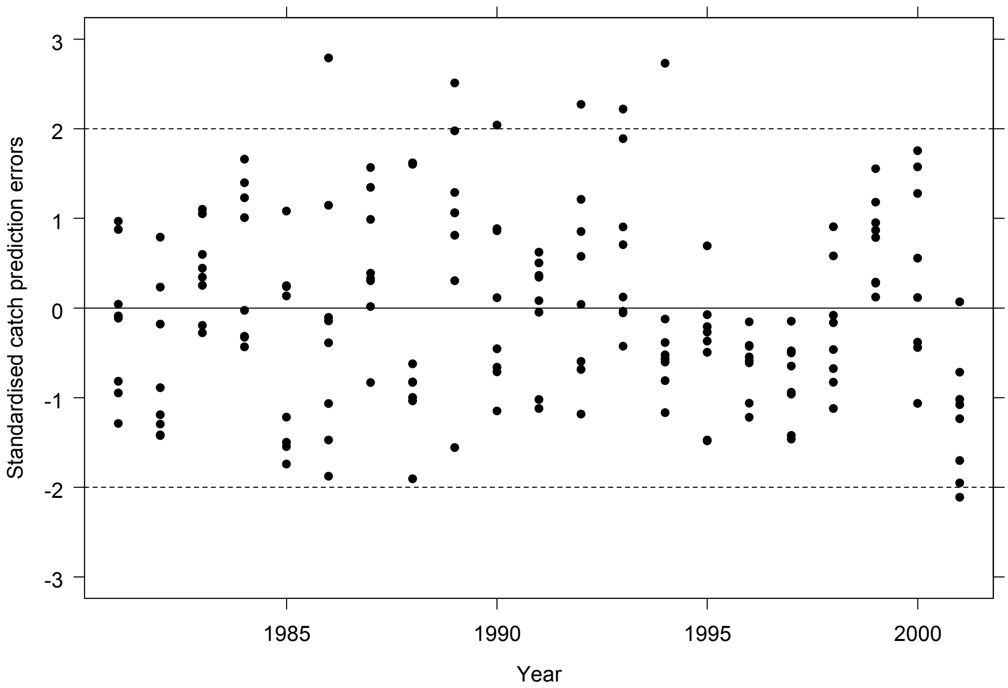


Figure 5.1.4.4. Whiting in IV and VIId. Standardised catch prediction errors from a TSA run with no survey data, plotted by year (upper plot) and by year and age (lower plot). Dotted lines give the approximate 95% confidence interval for a normal distribution.



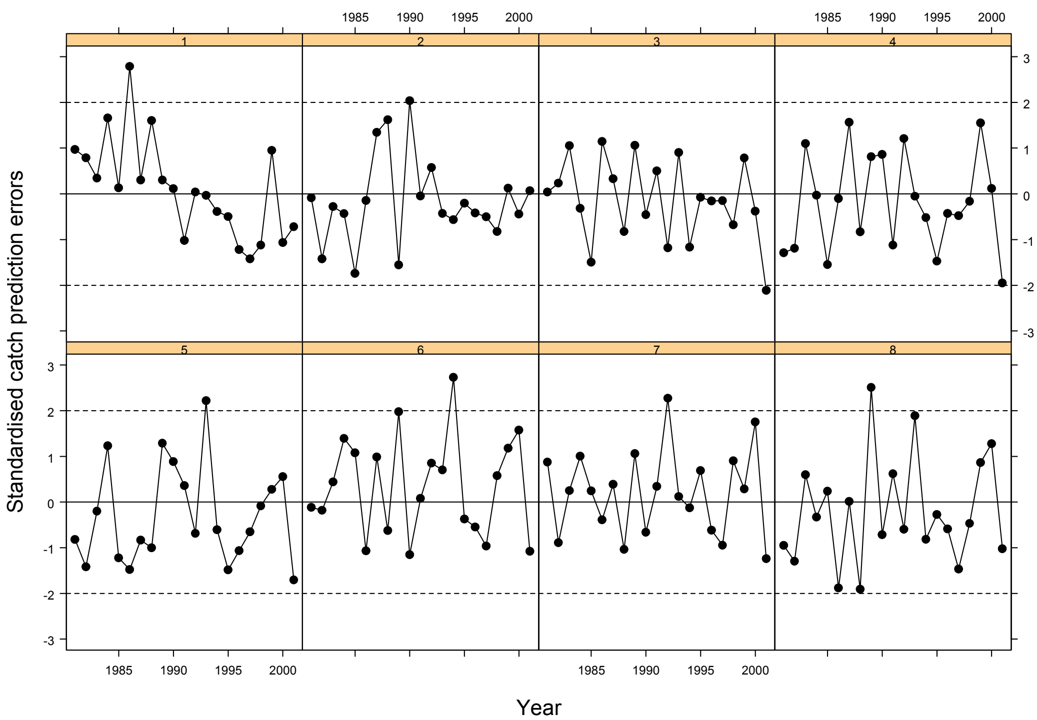


Figure 5.1.4.5. Whiting in IV and VIId. Upper plot: Summary diagrams from a TSA run with no survey data, with approximate pointwise 95% confidence intervals. The vertical dashed lines indicate the last year of catch data: all subsequent estimates are TSA forecasts. Filled circles on the yield plot show total reported catches (human consumption, discards, and industrial by-catch). Lower plot: Scatterplot of recruitment at age 1 against parental SSB, with TSA-estimated Ricker curve. Points are labelled with year classes (1980–2000).

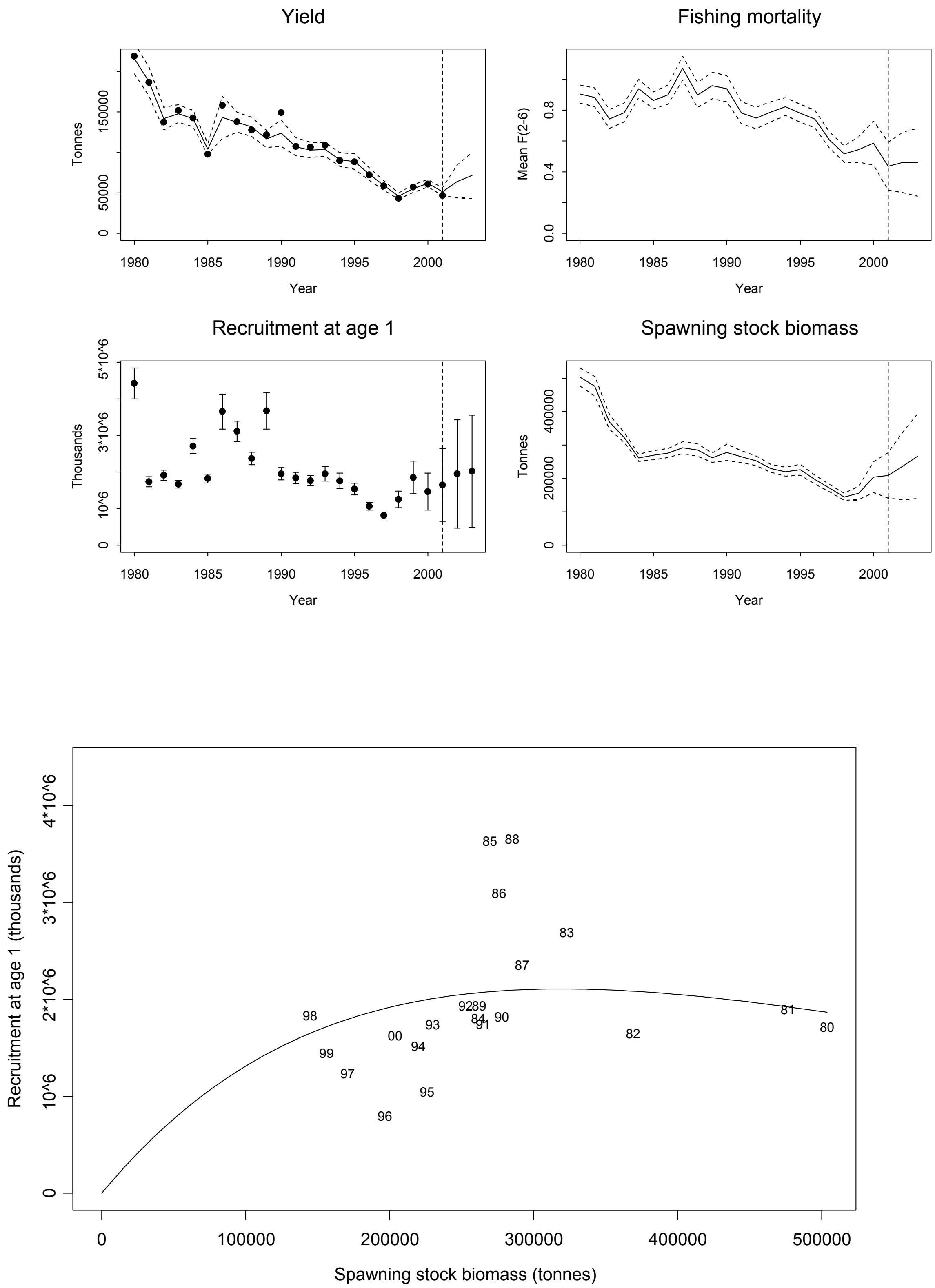
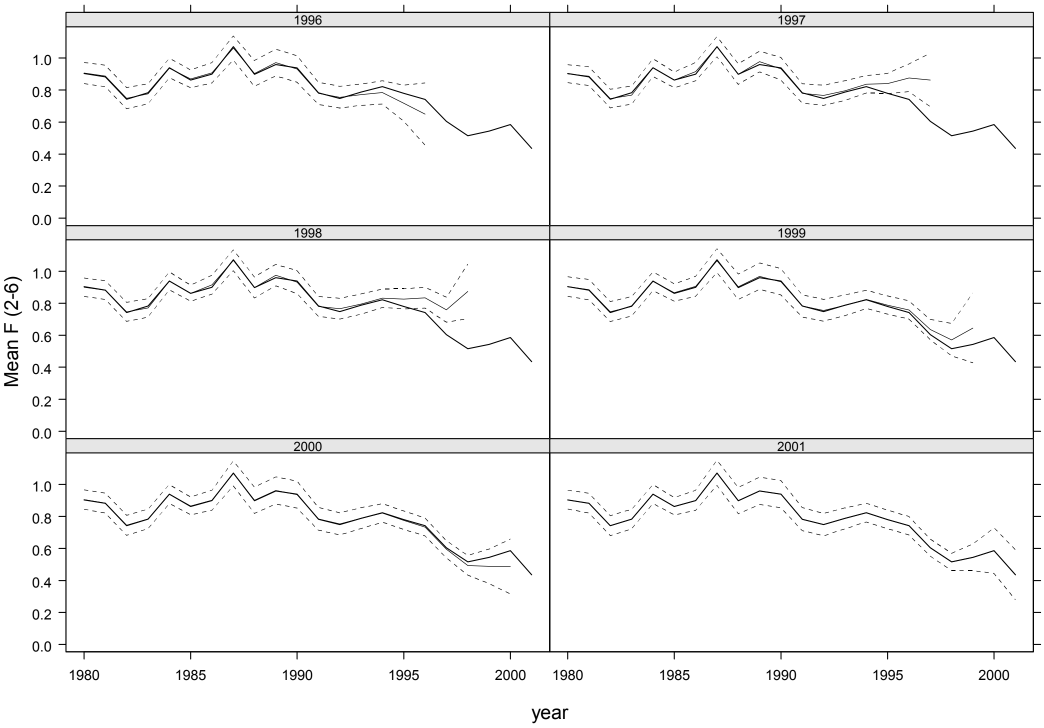


Figure 5.1.4.6. Whiting in IV and VIId. Mean F(2-6) and SSB plots from retrospective TSA analyses. The thick line is the 2001 estimate: the thinner lines give the retrospective estimates with approximate pointwise 95% confidence intervals.



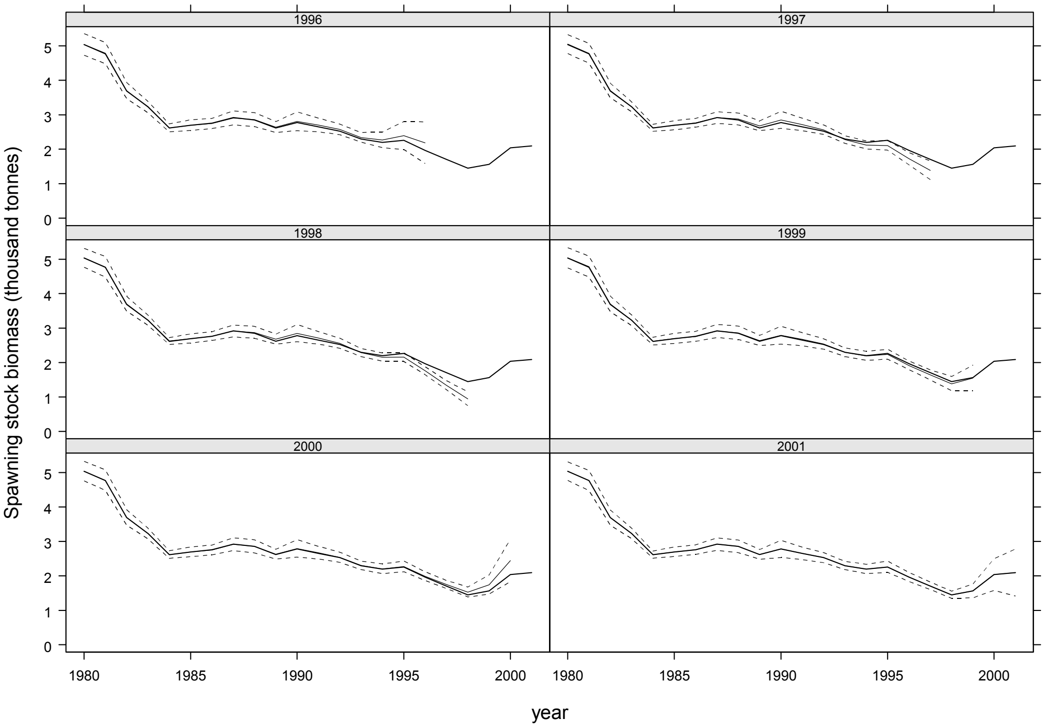


Figure 5.1.4.6. cont. Whiting in IV and VIId. Recruitment plots from retrospective TSA analyses. The thick line is the 2001 estimate: the thinner lines give the retrospective estimates with approximate pointwise 95% confidence intervals.

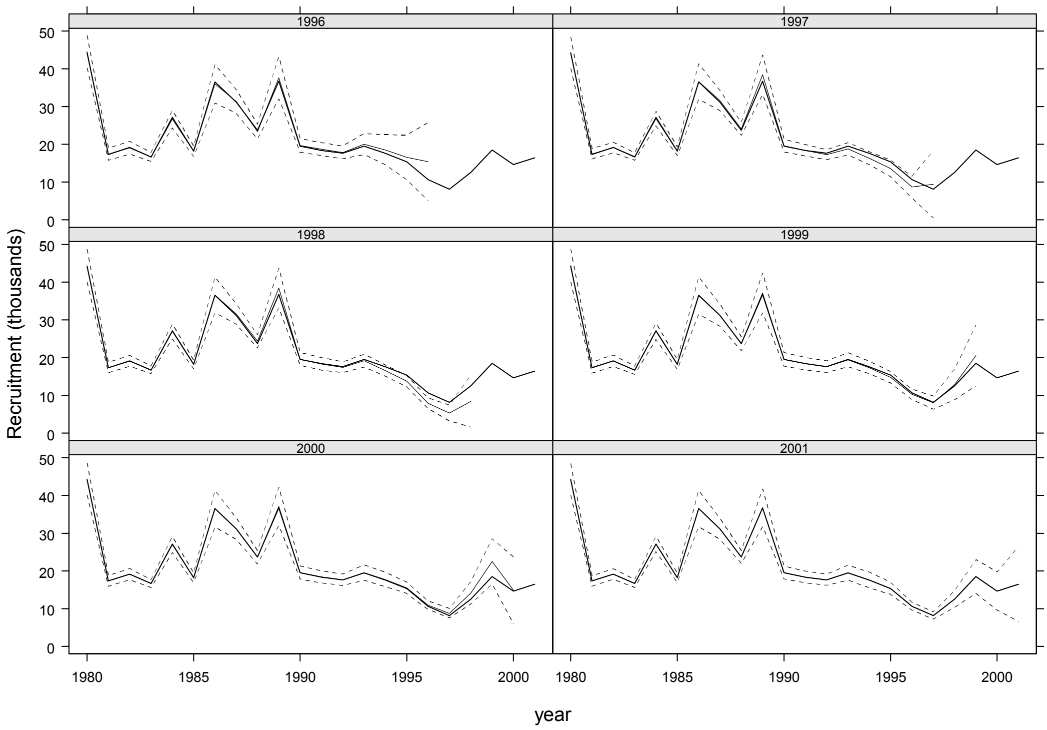


Figure 5.1.6.1. Whiting in IV and VIId. Stock trends, 1980–2001

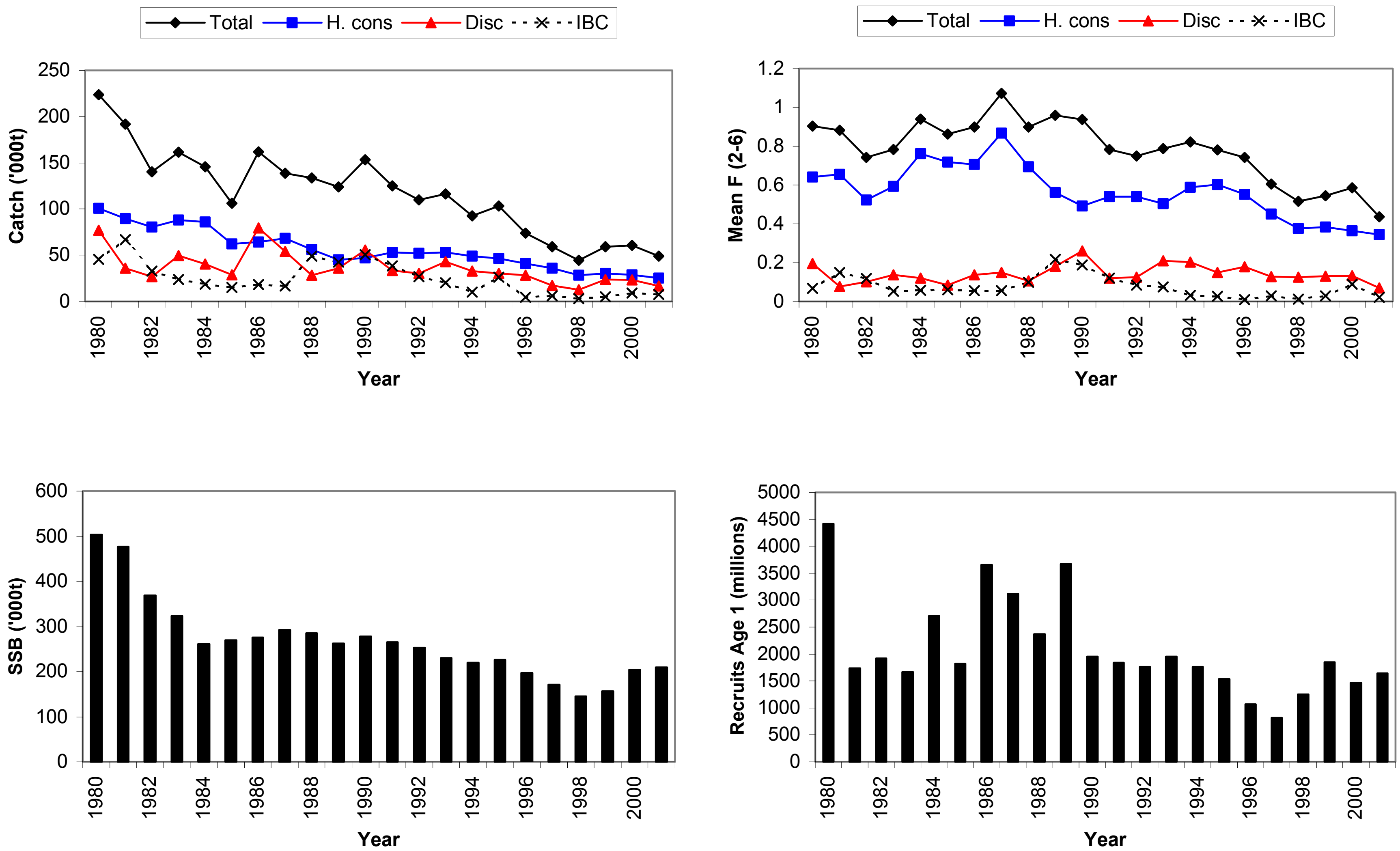
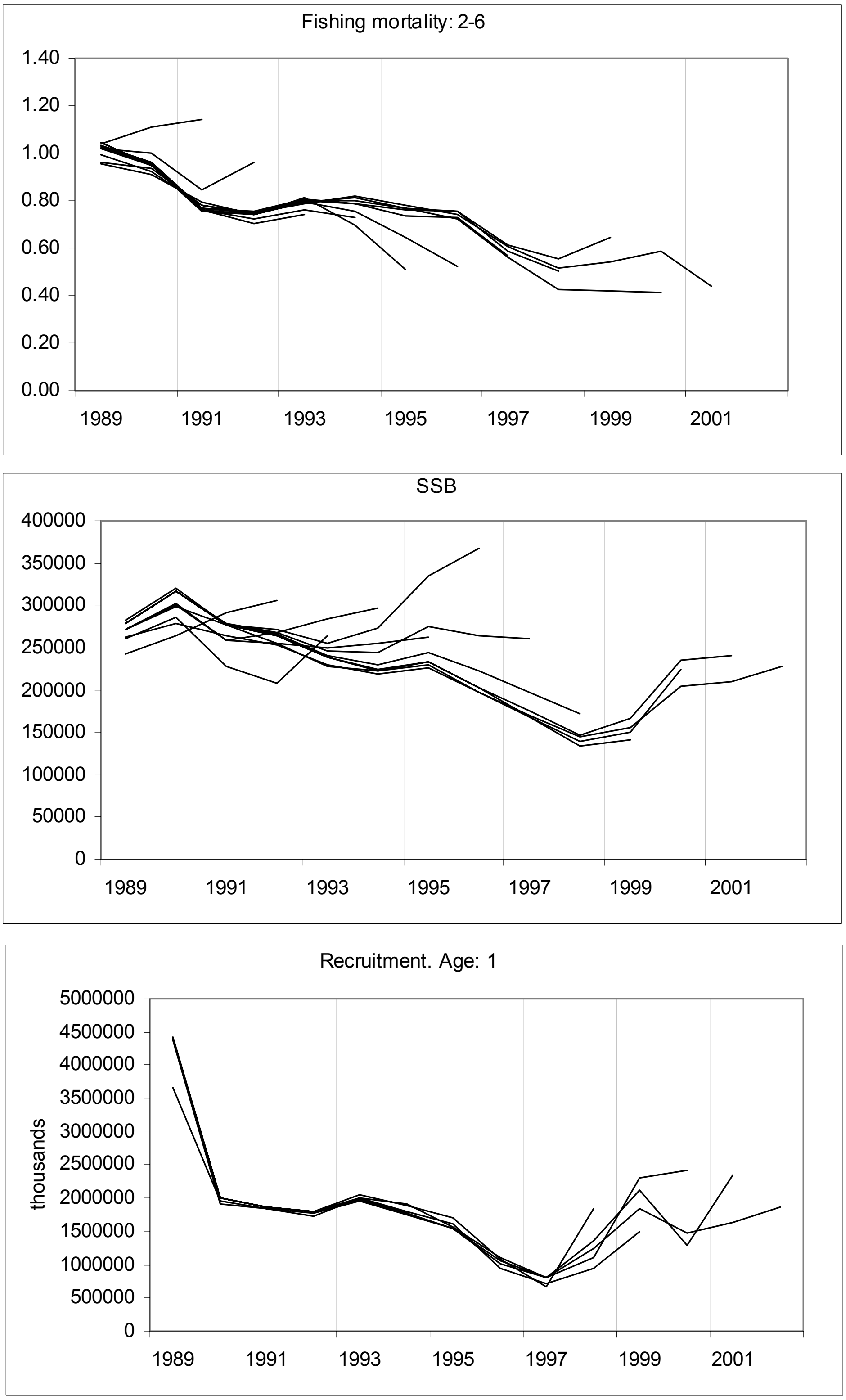


Figure 5.1.10 Whiting in IV and VIId. Quality control of assessments generated by successive working groups.



6 SAITHE IN SUBAREA IV, VI, AND DIVISION IIIA

6.1 The Fishery

Saithe in the North Sea are mainly taken in a direct trawl fishery in deep water near the Northern Shelf edge and the Norwegian deeps (eg. W.D. 1). 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 deepsea fish, and it is necessary to take account of that when tuning series are established. The fishery in Area VI consists largely of a directed French, German, and Norwegian deep-water fishery operating on the shelf edge, and a Scottish fishery operating inshore. In both areas most of the saithe do not enter the main fishery before age 3, because the younger ages are staying in inshore waters.

6.1.1 ACFM advice applicable to 2001 and 2002

For 2001 ACFM considered the stock to be outside safe biological limits and recommended that F on the combined stock should be reduced by 20% from *status quo*, corresponding to landings of 97 000 t in 2001 (87 000 t in IV+IIIa and 9 000 in VI).

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).

6.1.2 Management applicable to 2001 and 2002

Management of saithe is by TAC and technical measures. The agreed TAC for saithe in IV and IIIa for 2001 is 87 000 t and in Divisions Vb, VI, XII, and XIV the TAC for 2001 is 9 000 t. For 2002 the TACs were 135 000 t and 14 000 t, respectively.

Technical measures are described in Section 2.1.1.

6.1.3 The fishery in 2001

Recent nominal landings are given in Tables 6.1.1 and 6.1.2. The main part of the Working Group estimates of landings are shown in Figure 6.6.1. In 2001 the landings are estimated to be 89 673 t in Areas IV and IIIa, which are about 2 673 t above the TAC, and the landings in VI are estimated to be 8372 t, which are close to the TAC. Saithe are also taken as by-catch in the industrial fishery, but most of it is sorted out and delivered for human consumption. In 2001 a by-catch of about 3 000 t was estimated to go to reduction purposes.

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. This seems to have been a major problem the last two years. 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 (see Section. 1.11.4). 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. In 2000 the larger trawlers were fishing for four months in the North Sea while they were fishing six months in 2001.

6.2 Natural Mortality, Maturity, Age Compositions, Mean Weight-at-Age

A natural mortality rate of 0.2 was used for all ages in all years, and a maturity ogive based on biological sampling is used for all years (Table 6.2.1).

Total international age compositions are given in Table 6.2.2. Catch-at-age data for 2000 were updated with minor changes. Catch-at-age and weight-at-age data for 2001 were supplied by Denmark, Germany, France, Norway, UK (England), and UK (Scotland) for Area IV, amounting to about 97% of the reported total landings, and only UK(Scotland) for Area VI.

The mean weights-at-age in the landings are given in Table 6.2.3 and plotted in Figure 6.2.1. These are also used as stock mean weights. SOP corrections have been applied.

6.3 Catch, Effort, and Research Vessel Data

The age composition of the fleets and surveys used by the Working Group are listed in Table 6.3.1. 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. The German trawl fleet (GEROTB_IV) is described in W.D. 1. French large trawlers (FRATRB_IV) and French freezer trawlers (FRATRF_IV) mainly operate along the Northern Shelf in Subarea IV and Division VIa. For the French fleet (FRATRB_IV), the catch and effort time-series extends back to 1990. The Norwegian large trawlers (NORTRL_IV) operate in the North Sea for only part of the year, usually in the first and third quarters.

Effort by large French trawlers (FRATRB_IV), Norwegian trawlers (NORTRL_IV), and German trawlers (GEROTB_IV) in the North Sea has decreased in recent years, but in 2001 Norwegian trawlers increased their effort (Figure 6.3.1). French Freezer trawlers (FRATRF_IV) have also shown a slight increase in 2001 compared to 2000. The cpue for the Norwegian trawlers increased from 1997 to 1999 and decreased in 2000 and 2001, while the cpue for the other fleets increased from 1999 to 2001 (Figure 6.3.1). Normalised trends in tuning fleets by age are shown in Figure 6.3.2.

The fishery for saithe is a directed fishery. The fish are usually located using echosounding equipment, and their distribution is usually predictable in space and time and different age groups predominate in different areas. However, when the boats have set the trawl, they trawl for several hours and they are not guided by the echosounders in the same way. The use of commercial cpue data for tuning is of concern to the WG, since the different distribution of fishing effort in relation to the density and age composition of the stock could give conflicting signals of age-group abundance. However, the only fishery-independent surveys available for tuning are the English and Scottish Groundfish surveys and the Norwegian acoustic survey. Saithe are not well represented in the former two surveys and the time-series for the latter is only 7 years.

The Norwegian acoustic survey (NORACU_IV) 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.

6.4 Catch-at-Age Analysis

6.4.1 Exploration of data

Preliminary XSA runs with the same settings as shown in the text table in Section 6.4.2 were done with all single fleets and different combinations of fleets. Some of the results are shown in Figure 6.4.1, and the log catchability residuals from single-fleet runs are shown in Figure 6.4.2, which show that there may be some problem with slight trends for the older ages in some fleets. The catch numbers of age 2 are very small in the series because they are distributed inshore, and the diagnostics show that age 2 have very small r^2 and slopes different from 1. It was decided to take age 2 out of the tuning series.

Figure 6.4.3 shows that the French fleets predict much lower numbers of age 3 than the other fleets. This may be due to the fact that the French fleets in later years have had very little effort south of 61° N along the Norwegian deeps, and surveys show that we find the highest abundance of three-year-old fish in that area.

Last year's Working Group explored periods of tuning and found that tuning with a 20-year time span and tricubic taper gave the lowest standard errors of the weighted Log(VPA) populations. This setting was therefore chosen. The effect of shrinking was also explored last year, and we used a SE of 1.0 in the final assessment.

6.4.2 Final assessment

The settings of the final run are presented in the text table below:

	2001		2002	
year of assessment	**2001**		**2002**	
Assessment model	XSA		XSA	
French trawlers (TRB) IV	1990-2000	2-9	1990-2001	**3-9**
French freezer trawlers (TRF) IV	1990-2000	2-9	1990-2001	**3-9**
Norwegian trawlers IV	1980-2000	3-9	1980-2001	3-9
German trawlers IV	1995-2000	3-9	1995-2001	3-9
SGFS	not used		not used	
EGFS	not used		not used	
Norwegian acoustic survey IV	not used		**1995-2001**	**3-7**
Time-series weights	tricubic over 20 yrs		tricubic over 20 yrs	
Power model used for catchability	1-2		1-2	
Catchability plateau age	7		7	
Surv. est. shrunk towards mean F	5 years / 3 ages		5 years / 3 ages	
s.e. of the means	1.0		1.0	
Min. stand. error for pop. estimates	0.3		0.3	
Prior weighting	none		none	

The tuning converged after 35 iterations. Tuning diagnostics are given in Table 6.4.1, and the residuals are plotted in Figure 6.4.4. For age 1 and 2 the P shrinker has the greatest weight, while the estimation of survivors of the older ages are dominated by the commercial fleets. The surveys give some weight to age 3 and 4 (Figure 6.4.5).

Tables 6.4.2 and 6.4.3 list the fishing mortality and stock number by year and age, respectively. The VPA results are summarized in Table 6.6.1 and illustrated in Figure 6.6.1.

The results of the retrospective analysis are plotted in Figure 6.4.6. The tendency to overestimate $F_{3\text{-}6}$ and underestimate SSB in recent years seems to have been reduced. The retrospective estimation of the recruits at age 1 is scattered and needs almost 10 years to converge.

6.5 Recruitment Estimates

The arithmetic mean of numbers-at-age 1 for the period 1967 – 1998 is 266 million and the geometric mean is 248 million.

No survey or other independent age 1 or 2 indices were available to the Working Group. The group therefore decided to use geometric means 1985-99 (202 684 thousand) to estimate recruitment for the year classes 1999, 2000, and 2001 for the short-term prediction because they have not been well estimated by catch data. This short-term GM was used as there is evidence of reduced recruitment in recent years (Figure 6.6.1). Numbers-at-age 2 and 3 were estimated using natural mortality and fishing mortality in 2000 and 2001. Year-class strength used for predictions are printed in bold and can be summarized as follows (numbers in thousands):

Year class	Age in 2002	XSA	GM(85-99)
1998	4	**174 725**	
1999	3	113 615	**133 586**
2000	2	118 183	**165 794**
2001	1		**202 684**
2002	1		**202 684**

6.6 Historical Trends

The historical trends are given in Table 6.6.1 and shown in Figure 6.6.1. For the combined area the landings peaked during the mid-1970s, dropped rapidly to 140 000 t in 1980, increased again and exceeded 220 000 t in 1985. During the last 10 years, the landings remained at a lower level with small variations between 93 000 and 125 000 t.

The mean $F_{3\text{-}6}$ decreased continuously from 0.83 in 1986 to 0.25 in 2001. Recently, the SSB was estimated to have increased to about 247 000 tonnes in 2001 from the lowest observed 92 000 tonnes in the early 1990s. This increase is partly due to the good year classes 1994 and 1996 and to the decrease in fishing mortality. Since 1997 the fishing mortality has been below the $\mathbf{F}_{pa}$, and since 1999 the SSB has been above $\mathbf{B}_{pa}$.

6.7 Short-Term Forecast

Input data for the 2002-2004 prediction are given in Table 6.7.1. In 2002, numbers of ages 1 are GM(85-99) estimates, and ages 2 and 3 are GM estimates using respective Fs. The year classes 2001 and 2002 at age 1 were estimated by the short-term GM value of 202 millions. The exploitation pattern, the mean weights in the stock, and the catch is based on 1999-01 arithmetic means. The fishing pattern was scaled to $F_{3\text{-}6}$ in 2001. A *status quo* prediction resulted in a catch of 131 000 t in 2002. The Working Group considered that the TAC probably would be taken in 2002, so a TAC-constrained prediction was run. Results of the prediction are given in Table 6.7.2 and in Figure 6.7.1. The assumption of TAC fishing mortality in 2002 and *status quo* fishing mortality in 2003 corresponds to landings of 149 000 t in 2002 and 132 000 t in 2003. As a consequence, spawning stock size is predicted to increase from 298 000 t in 2002 to 338 000 t in 2004.

Table 6.7.3 lists the contribution of the different recruiting year classes in the catch in 2003 and the spawning stock in 2004. 22% of the expected landings in 2003, and 24% of the predicted SSB in 2004 is made up of year classes for which GM(85-99) recruitment is assumed.

Figure 6.7.3 shows that the forecast for catch in 2002 is highly sensitive to the effort multiplier in 2003 (HF03), and that most of the variance comes from HF03 and the numbers of the year class 1999 and HF02. The forecast for the spawning stock in 2004 seems to be sensitive to the effort multiplier, while the 1998 and 1999 year-class strength and the effort multipliers give a high contribution to the variance. Figure 6.7.2 shows that there may be a very low probability of being below $\mathbf{B}_{pa}$ (200 000 t) in 2004 when fishing at *status quo* in 2003. It is also seen that there will be about 50% probability that F will be above $\mathbf{F}_{sq}$ in 2003 with a catch of 132 000 t.

6.8 Medium-Term Projections

Medium-term projections have been undertaken this year using a Ricker recruitment curve (Table 6.8.1) and using default input values to the "Insens" program, used to generate input files for forecasting (Table 6.7.1). Because mean weights have decreased in recent years, both mean weights- and F-at-age were calculated using a three-year mean, 1999-2001. F-at-age was scaled to the 2001 value of mean F. The *status quo* fishing mortality is well below $\mathbf{F}_{pa}$, and the TAC in 2002 gives a fishing mortality of 1.17**status quo.* It was decided to run the medium-term prediction with a multiplier of 1.2, which is still well below $\mathbf{F}_{pa}$. The results indicate that under this fishing scenario the median landings will increase to 180 000 t after 10 years (Figure 6.8.1). The median SSB is projected to remain at around 300 000 t for five years after which it is predicted to increase to about 380 000 t. The contour plot suggests there is little probability of SSB falling below $\mathbf{B}_{pa}$ after ten years of fishing at $\mathbf{F}_{pa}$ (Figure 6.8.2).

6.9 Biological Reference Points

The stock-recruitment plot including values of $\mathbf{F}_{med}$ and $\mathbf{F}_{current}$ is given in Figure 6.9.1. The input parameters for the yield and biomass per recruit are listed in Table 6.9.1 and the results are shown in Figure 6.9.2. The mean weights in the stock and in the catch are assumed to be the same and represent the mean over the last 10 years. The exploitation pattern is calculated as the 1999-01 mean and scaled to $F_{3\text{-}6}$ in 2000. The oldest age group is defined as a plus group. The different reference points and agreed management points are listed in the text table below:

$\mathbf{F}_{0.1}$	0.09	$\mathbf{F}_{lim}$	0.60
$\mathbf{F}_{max}$	0.17	$\mathbf{F}_{pa}$	0.40
$\mathbf{F}_{med}$	0.49	$\mathbf{B}_{lim}$	106 000 t
$\mathbf{F}_{high}$	>0.49	$\mathbf{B}_{pa}$	200 000 t

Figure 6.9.3 shows the history of F_{3-6} versus SSB. In the period 1984 – 1998 the SSB was below $\mathbf{B}_{pa}$, but the last four years SSB has been above $\mathbf{B}_{pa}$. The fishing mortality has shown a declining trend, and since 1997 it has been below $\mathbf{F}_{pa}$.

6.10 Comment on the Assessment

This assessment gives a reduction in fishing mortalities for the years 2000 and 1999 of 10% and 3%, respectively, and a difference in the SSB for 2000 and 2001 of about –6% and +6%, respectively. The general tendency of this assessment to overestimate F and underestimate SSB seems to be reduced (Figure 6.10.1).

The cpue data from the commercial fleets may be biased because the saithe are partly schooling, and it is possible to find the schools with echosounders; however, when they have set the trawl, they trawl for several hours and they are not guided by the echo sounders in the same way. According to Figure 6.3.2, the survey and the commercial fleets give similar estimates of relative year-class strength.

The log catchability residuals show trends for some age groups in some fleets, which have to be analysed further.

The assessment and the present stock and catch prediction suffer from the lack of a representative data series from surveys or commercial fleets for recruitment at ages 1-3. The assessment is therefore liable to be revised every year. When the reference points are revised in the near future, the Working Group should consider to run the assessment with age 3 as recruits.

Data from SGDBI and Scotland indicate that the discard of saithe in 2000 and 2001 have been considerable in the fleets not targeting saithe. This is possibly a source of bias in the assessment.

6.11 Management Consideration

The present assessment indicates that SSB has been above $\mathbf{B}_{pa}$ and F has been below $\mathbf{F}_{pa}$ since 1999. The fact that the forecast does not track recruitment fluctuations can lead to management problems.

In recent years low saithe quotas seem to have caused large discarding when fishing for other species. However, the larger overall TAC in 2002 may have reduced the problem.

Table 6.1.1. Nominal catch (in tonnes) of SAITHE in Subarea IV and Division IIIa, 1989-2001, as officially reported to ICES.

Country	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001[1]
Belgium	13	23	29	70	113	130	228	157	254	249	200	122	24
Denmark	6,550	5,800	6,314	4,669	4,232	4,305[1]	4,388	4,705	4,513	3,967		3,529	3,575
Faroe Islands	739	1,650	671	2,480	2,875	1,780[1]	3,808	617	158	1,298 4,494			
France	30,761[1,2]	29,892[1,2]	14,795[1,2]	9,061[1]	15,258[1]	13,612[1,2]	11,224[1]	12,336	10,932	11,786[1]		20,399[12]	21,247[2]
Germany	14,339	15,006	19,574	13,177	14,814	10,013	12,093	11,567	12,581	10,117 1,101		9,273	9,479
Netherlands	257	206	199	180	79	18	9	17	40	7	24,305[12]	11	20
Norway	24,737	19,122	36,240	48,205	47,669	47,042	53,793[1]	55,531	46,424	50,254	10,481	42,735[1]	43,504
Poland	809	1,244	1,336	1,238	937[1]	151	592	365	822	813	7	747	727
Sweden	797	838	1,514	3,302	4,955	5,366	1,891	1,771	1,647	1,857	56,150	1,421	1,510
UK (E&W)	4,012	3,397	4,070	2,893	2,429	2,354	2,522	2,864	2,556	2,293	862	1,227	
UK (Scot.)	9,190	7,703	8,602	6,881	5,929	5,566	6,341	5,848	6,329	5,353	1,929[1]	5,484	
United											2,874		6,282
Kingdom	-	-	116[3]	-	-	-	-	-	-	-	5,420	67	
USSR													
	92,204	84,881	93,460	92,156	99,290	90,337	96,889	95,778	86,256	87,994	107,823	85,080	86,368
Unreported landings	-172	3,199	5,121	187	5,840	12,098	16,525	14,458	17,006	12,983	-175	1,945	3,305
Landings as used by WG	92,032	88,080	98,581	92,343	105,130	102,435	113,414	110,236	103,322	100,263	107,314	87,449	89,673
TAC	170,000	120,000	125,000	110,000	93,000	97,000	107,000	111,000	115,000	97,000	110,000	85,000	87,000

[1]Preliminary.
[2]Includes IIa(EC), IIIa-d(EC) AND IV.
[3]Includes Estonia.

Table 6.1.2 Nominal catch (tonnes) of SAITHE in Subarea VI, 1989–2001, as officially reported to ICES.

Country	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999[1]	2000	2001[1]
Belgium	15	-	6	2	2	+	-	-[4]	+	-	-	+	-
Denmark	2	-	+	1	2	+	+	1	+	-	-	-	-
Faroe Islands	-	-	24	1	-	-	-	3	1	-	2		
France	17,106	12,961[2]	12,423	6,534	10,216	8,423	6,145	4,781	4,662	3,635[1]	3,467[13]	3,314[13]	5,176[1]
Germany, Fed.Rep.	[2]	275	[2]	685	222	524	321	1,012	492	506	250	305	466
Ireland	1,116	520	590	278	317	438	530	419	411	216	320	449	422
Norway	593	64	260	67	59	74[1]	35	34	26[1]	41	126	58[1]	92
Spain	72	70	31	-	-		n/a		13	54	23	3	
Portugal	65		49						1	+	-	-	-
UK (Engl. & Wales &N.		855	593	540	799	744	317	708	294	526	503	276	
Iril)[3]	462	3,258		2,708	2,903	2,828							
UK (Scotland)	2,971		3,885				3,279	2,435	2,659	2,402	2,084	2,463	
UK (total)													2,522
Russia											3	25	-
Total reported to ICES	22,402	18,003	17,861	10,816	14,520	13,031	10,627	9,393	8,559	7,380	6,778	6,423	8,678
Unallocated	3,175	1,862	-866	988	-577	-210	1,143	40	859	1,054	564	-533	-306
Total figures used by WG	25,577	19,865	16,995	11,804	13,943	12,821	11,770	9,433	9,418	8,434	7,342	5,890	8,372
TAC	30,000	29,000	22,000	17,000	14,000	14,000	16,000	13,000	12,000	10,900	7,500	7,000	9,000

[1]Preliminary.
[2]Includes Division Vb (EC).
[3]Reported by TAC area, Vb(EC), VI, XII and XIV.
n/a = not available.

Table 6.2.1 Saithe in IV, VI and IIIa. Natural mortality and proportion mature.

Age	Nat Mor	Mat.
1	0.200	0.000
2	0.200	0.000
3	0.200	0.000
4	0.200	0.150
5	0.200	0.700
6	0.200	0.900
7	0.200	1.000
8	0.200	1.000
9	0.200	1.000
10+	0.200	1.000

Table 6.2.2.: Saithe in IV, VI and IIIa. Catch numbers at age Numbers*10**-3

YEAR	1967	1968	1969	1970	1971
AGE					
1	0	174	36	234	594
2	8879	3832	2099	2261	11156
3	17330	23223	30235	37249	69809
4	16220	21231	17681	76661	57792
5	15531	13184	11057	15000	32737
6	2303	6023	7609	12128	4736
7	1594	429	5738	3894	4248
8	292	242	791	1792	2843
9	198	123	626	318	1874
+gp	183	145	150	267	774
TOTALNUM	62530	68606	76022	149803	186562
TONSLAND	94514	116789	131882	236636	272481
SOPCOF %	100	100	100	100	100

YEAR	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
AGE										
1	430	4708	4753	335	270	2172	1253	916	1321	5457
2	23833	37832	19206	74231	34111	14125	20551	17756	24100	20644
3	48075	54332	66938	56987	207823	27461	35059	16332	17494	26178
4	66095	37698	33740	25864	53060	54967	27269	14216	12341	8339
5	25317	26849	14123	10319	11696	14755	18062	11182	9015	6739
6	21207	16061	20688	7566	6253	5490	3312	8699	6718	3675
7	3672	8428	14666	13657	3976	3777	1138	2805	5658	3335
8	2944	2000	5199	9357	5362	3447	1033	733	1150	3396
9	1641	1357	1477	3501	3586	3812	768	540	509	657
+gp	1607	2381	1955	2687	3490	4701	3484	2089	2302	2536
TOTALNUM	194822	191646	182744	204505	329627	134708	111927	75268	80608	80956
TONSLAND	275098	259602	309439	308926	361680	223395	166199	135967	142395	146092
SOPCOF %	100	100	100	100	100	100	100	100	100	100

YEAR	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
AGE										
1	1970	312	206	231	322	787	32	3664	355	492
2	29570	36824	37387	9415	7227	31017	8762	9871	5764	13091
3	31895	28242	80933	134024	55435	31220	32578	22128	40808	46117
4	40587	20604	32172	55605	91223	97470	26408	30752	19583	29871
5	9174	26013	12957	13281	15186	13990	35323	13187	11322	7467
6	5978	5678	13011	4765	5381	3158	3828	10951	4714	3583
7	2145	4893	1657	3005	2603	1811	1908	1557	2776	1716
8	1454	1494	1252	682	1456	1240	1104	739	745	953
9	982	1036	335	399	445	910	776	419	281	367
+gp	1254	1327	646	742	900	700	680	488	364	458
TOTALNUM	125010	126423	180556	222147	180178	182304	111398	93755	86710	104117
TONSLAND	189861	197774	219642	226129	202758	180776	140778	117609	107945	115576
SOPCOF %	100	100	100	100	100	100	100	100	100	100

YEAR	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
AGE										
1	319	160	106	157	354	27	218	64	145	4
2	6679	10118	8033	4338	8963	12396	3706	6634	2692	2024
3	18404	37823	19958	26664	11066	15036	10363	9429	7064	17263
4	33614	20828	40194	26034	38861	19299	31017	13872	17295	18316
5	12753	11845	13034	14797	11786	30177	16367	26684	8940	23208
6	3193	3125	4297	3774	7731	3676	16077	8389	12339	3639
7	1524	1568	947	3494	3163	2640	2231	10070	3159	3586
8	696	1511	346	674	808	1012	1206	2346	3226	1461
9	518	814	427	552	210	291	567	891	641	1201
+gp	422	1026	794	800	491	288	277	657	441	308
TOTALNUM	78121	88817	88135	81284	83432	84843	82028	79037	55943	71011
TONSLAND	104147	119073	115255	125183	119669	112740	108699	114655	93566	98045
SOPCOF %	100	100	100	100	100	100	100	100	106	103

Table 6.2.3.: Saithe in IV, VI and IIIa. Catch weights at age and Stock weights at age (kg)

YEAR	1967	1968	1969	1970	1971
AGE					
1	0	0.5006	0.451	0.434	0.495
2	0.697	0.77	0.6086	0.6955	0.6101
3	0.9305	1.2784	0.9663	0.9414	0.8399
4	1.362	1.6521	1.5568	1.4408	1.348
5	2.1035	1.9886	2.2614	2.0587	2.1775
6	3.1858	3.0093	2.7133	2.718	2.936
7	3.7541	4.0404	3.5588	3.5995	3.7657
8	5.3162	4.4278	4.4063	4.4632	4.6339
9	5.8905	6.1355	5.2203	5.6871	5.1725
+gp	7.719	7.4055	6.7675	6.8452	6.163
SOPCOFAC	0.9999	1.0001	1.0001	0.9998	1.0001

YEAR	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
AGE										
1	0.3281	0.1637	0.275	0.216	0.4588	0.4257	0.3548	0.4348	0.2586	0.2774
2	0.5488	0.4317	0.5093	0.5021	0.5156	0.4301	0.5165	0.406	0.421	0.5958
3	0.8082	0.8212	0.8608	0.8928	0.7024	0.7598	0.8215	1.1072	0.9546	0.9608
4	1.1958	1.4061	1.5606	1.4977	1.3092	1.256	1.3267	1.6228	1.8212	1.8211
5	1.961	1.641	2.3834	2.4904	2.2604	1.9348	2.1545	2.2381	2.3911	2.7175
6	2.3687	2.5709	2.7527	3.3002	3.0706	3.1107	3.3401	3.095	3.03	3.5868
7	3.7941	3.3571	3.4286	3.7647	4.0347	4.1618	4.5221	4.0504	4.0895	4.536
8	4.2276	4.6844	4.4977	4.2957	4.3833	4.6045	4.9005	5.2742	5.1262	5.4776
9	4.6304	4.8138	5.7128	5.5396	5.1117	4.8589	5.4494	6.3077	5.9393	6.9804
+gp	6.3263	6.4449	7.857	7.562	7.147	6.5419	7.4	7.9551	8.1476	8.7237
SOPCOFAC	0.9999	1	1	0.9999	1.0002	1	1.0001	1.0001	1.0001	1

YEAR	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
AGE										
1	0.2525	0.4126	0.3886	0.1487	0.6295	0.3711	0.5165	0.4264	0.2717	0.4794
2	0.5077	0.478	0.5009	0.555	0.5479	0.4181	0.6379	0.7263	0.7025	0.5571
3	1.0857	1.0276	0.7948	0.6632	0.6943	0.6739	0.7787	0.8954	0.8441	0.7913
4	1.5746	1.7178	1.6139	1.2654	1.0353	0.8763	0.981	1.0362	1.1958	1.1579
5	2.5293	2.1493	2.2966	1.9505	1.7944	1.8236	1.3859	1.4196	1.5828	1.7523
6	3.2202	3.1377	2.6899	2.7715	2.4316	3.0747	2.7907	1.9984	2.2472	2.3646
7	4.2069	3.6906	3.8959	3.4067	3.5717	4.2098	4.0238	3.9139	3.2419	3.1653
8	5.1251	4.6317	4.6647	4.9499	4.2094	5.33	5.2544	5.0175	4.8583	4.2221
9	5.9049	5.5053	6.183	5.8649	5.6506	6.1284	6.3221	6.4298	6.3149	6.0661
+gp	8.8232	8.4529	8.4735	8.8543	8.2184	8.6026	8.6489	8.4308	8.4162	8.1914
SOPCOFAC	1.0001	1	1	1	0.9999	1.0001	1	0.9999	0.9997	0.9998

YEAR	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
AGE										
1	0.6189	0.3585	0.2866	0.5024	0.2797	0.4324	0.6027	0.5195	0.5634	0.5212
2	0.6299	0.7437	0.6975	0.7593	0.5103	0.4357	0.6594	0.5887	0.8033	0.7503
3	0.9641	0.8994	0.9439	1.0022	0.9668	0.9047	0.8917	0.8808	1.0274	0.8071
4	1.1893	1.2603	1.1188	1.2937	1.1873	1.1448	0.966	1.0605	1.1266	1.0791
5	1.6066	1.7544	1.601	1.8159	1.8068	1.4522	1.3925	1.2112	1.5389	1.3139
6	2.2417	2.6363	2.4337	2.5619	2.3678	2.5867	1.744	1.7537	1.6843	2.0754
7	3.6677	3.1851	3.6175	3.5549	2.9518	3.5556	2.9486	2.3374	2.5936	2.5983
8	4.3296	3.9798	4.7869	4.767	4.7053	4.5251	3.8829	3.4934	3.0842	3.5513
9	5.4125	5.0802	6.5479	5.2674	6.0922	6.1575	4.9955	4.8438	4.7733	4.2291
+gp	7.0455	6.8909	8.3256	7.8907	8.3821	8.8663	7.2273	6.7452	7.4615	6.6073
SOPCOFAC	1	0.9999	1	1.0001	1.0002	0.9998	1	1.0016	1.063	1.0333

Table 6.3.1.: Saithe in IV, VI, and IIIa - Combined tuning data

105							
FRATRB_IV							
1990	2001						
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
FRATRF_IV							
1990	2001						
1	1	0	1				
3	9						
19797	3676	2595	1377	262	251	28	11
18369	1133	2487	686	325	105	55	9
1868	188	374	110	16	5	2	1
8059	1920	1142	413	23	2	2	2
8650	863	1664	560	165	15	3	1
8844	1305	788	494	128	43	16	8
7824	379	1790	345	182	37	9	5
6767	635	1148	1644	68	29	7	4
10031	627	2113	1362	988	35	14	6
11667	642	890	1783	375	229	14	8
10924	935.498	2211.278	981.59	1093.593	162.955	134.764	22.682
13631	1131.183	2057.669	3504.428	385.984	210.888	36.455	41.742
NORTRL_IV							
1980	2001						
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

Table 6.3.1.: Saithe in IV, VI, and IIIa - Continued.

GER_OTB_IV							
1995	2001						
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
NORACU							
1995	2001						
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		

Table 6.4.1 Saithe in IV, VI, and IIIa. Tuning diagnostics.

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Lowestoft VPA Version 3.1

  14/06/2002  16:28

Extended Survivors Analysis

SAITHE IN IV, VI and IIIa : 1967 - 2001

cpue data from file c:\work\data\final.tun

Catch data for  35 years. 1967 to 2001. Ages  1 to  10.

     Fleet,            First, Last, First, Last, Alpha,  Beta
                    ,    year, year,  age ,  age
FRATRB_IV       ,   1990, 2001,   3,     9,   .000,  1.000
FRATRF_IV       ,   1990, 2001,   3,     9,   .000,  1.000
NORTRL_IV       ,   1980, 2001,   3,     9,   .000,  1.000
GER_OTB_I          ,   1995, 2001,   3,     9,   .000,  1.000
NORACU          ,   1995, 2001,   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   35 iterations

1


Regression weights
      ,  .751,  .820,  .877,  .921,  .954,  .976,  .990,  .997, 1.000, 1.000
```

Fishing mortalities

Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	.002	.001	.001	.001	.003	.000	.001	.000	.001	.000
2	.039	.085	.032	.035	.045	.134	.022	.049	.010	.016
3	.248	.323	.241	.142	.117	.099	.158	.072	.068	.086
4	.732	.493	.684	.570	.317	.309	.305	.329	.183	.251
5	.936	.624	.667	.582	.554	.436	.469	.469	.367	.399
6	.603	.623	.484	.409	.701	.331	.440	.469	.413	.249
7	.443	.685	.386	.963	.727	.552	.344	.549	.322	.200
8	.432	1.126	.308	.526	.611	.541	.529	.748	.338	.242
9	.701	1.478	1.271	1.214	.305	.464	.675	.992	.465	.202

Table 6.4.1 Saithe in IV, VI, and IIIa. Continued.

1

XSA population numbers (Thousands)

YEAR	AGE 1	2	3	4	5	6	7	8	9
1992	1.68E+05	1.92E+05	9.26E+04	7.16E+04	2.32E+04	7.80E+03	4.70E+03	2.19E+03	1.14E+03
1993	3.43E+05	1.37E+05	1.51E+05	5.92E+04	2.82E+04	7.45E+03	3.49E+03	2.47E+03	1.17E+03
1994	1.71E+05	2.81E+05	1.03E+05	8.97E+04	2.96E+04	1.24E+04	3.27E+03	1.44E+03	6.56E+02
1995	2.75E+05	1.40E+05	2.23E+05	6.62E+04	3.71E+04	1.24E+04	6.25E+03	1.82E+03	8.67E+02
1996	1.34E+05	2.25E+05	1.10E+05	1.58E+05	3.06E+04	1.69E+04	6.77E+03	1.95E+03	8.82E+02
1997	2.29E+05	1.09E+05	1.76E+05	8.03E+04	9.43E+04	1.44E+04	6.88E+03	2.68E+03	8.67E+02
1998	1.87E+05	1.87E+05	7.82E+04	1.30E+05	4.83E+04	4.99E+04	8.48E+03	3.24E+03	1.28E+03
1999	3.51E+05	1.53E+05	1.50E+05	5.47E+04	7.88E+04	2.47E+04	2.63E+04	4.92E+03	1.56E+03
2000	1.72E+05	2.87E+05	1.19E+05	1.14E+05	3.22E+04	4.03E+04	1.27E+04	1.24E+04	1.91E+03
2001	1.44E+05	1.41E+05	2.32E+05	9.11E+04	7.79E+04	1.83E+04	2.19E+04	7.52E+03	7.27E+03

Estimated population abundance at 1st Jan 2002

	0.00E+00	1.18E+05	1.14E+05	1.75E+05	5.80E+04	4.28E+04	1.17E+04	1.47E+04	4.83E+03

Taper weighted geometric mean of the VPA populations:

	2.03E+05	1.71E+05	1.34E+05	8.30E+04	3.93E+04	1.60E+04	7.36E+03	3.03E+03	1.26E+03

Standard error of the weighted Log(VPA populations) :

	.3244	.3258	.3701	.3856	.5202	.5921	.6646	.6379	.6419

1

Log catchability residuals.

Fleet : FRATRB_IV

Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
3	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	.67	-.02
4	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	.35	.42
5	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	.02	.00
6	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	-.23	.38
7	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	1.00	.77
8	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	-.07	.75
9	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	.12	.07

Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
3	.29	.99	.48	.23	-.45	-.50	-.01	-.72	.07	-.48
4	.36	.33	.42	-.11	-.27	-.17	-.42	-.34	-.15	.03
5	.14	.12	.20	-.48	-.28	-.12	-.01	-.22	.20	.47
6	-.33	-.47	.33	-.38	.20	-.61	.20	-.03	.63	.17
7	-.32	-1.54	-.12	.06	.20	.09	-.74	.18	.71	.03
8	-.80	-.97	-1.33	.03	-.08	-.60	-.51	-.86	.56	-.62
9	-.24	-.42	-.81	.47	.09	.31	-.31	-.18	.76	-.47

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	-13.9101	-12.7885	-12.4365	-12.9317	-13.6076	-13.6076	-13.6076
S.E(Log q)	.5184	.3169	.2656	.3953	.6580	.7399	.4581

Table 6.4.1 Saithe in IV, VI, and IIIa. 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
3,	1.59,	-.751,	15.15,	.16,	12,	.85,	-13.91,
4,	1.68,	-1.612,	13.79,	.39,	12,	.49,	-12.79,
5,	1.01,	-.052,	12.45,	.80,	12,	.28,	-12.44,
6,	.73,	2.013,	12.07,	.87,	12,	.25,	-12.93,
7,	.78,	.920,	12.57,	.66,	12,	.51,	-13.61,
8,	.79,	.902,	12.73,	.68,	12,	.49,	-14.00,
9,	1.10,	-.412,	14.33,	.65,	12,	.53,	-13.66,

1

Fleet : FRATRF_IV

Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
3	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	.97,	-.28
4	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	.59,	.31
5	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	.31,	-.04
6	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	.04,	.38
7	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	1.29,	.70
8	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	.21,	.69
9	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	.26,	-.05

Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
3	.52,	.92,	.40,	-.03,	-.45,	-.27,	.17,	-.65,	.02,	-.67
4	.53,	.27,	.25,	-.27,	-.31,	.06,	-.21,	-.34,	-.17,	-.20
5	.28,	-.18,	.02,	-.39,	-.44,	.09,	.19,	-.18,	.13,	.32
6	-.09,	-1.14,	.19,	-.12,	.17,	-.67,	.42,	.02,	.64,	.09
7	-.13,	-2.10,	-.22,	.41,	.20,	.01,	-.50,	.19,	.54,	-.02
8	-.29,	-1.58,	-1.05,	.47,	-.02,	-.47,	-.37,	-.84,	.38,	-.69
9	-.20,	-.69,	-.96,	.80,	.05,	.06,	-.22,	-.16,	.53,	-.54

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,	-14.0317,	-12.8894,	-12.6535,	-13.2532,	-13.9474,	-13.9474,	-13.9474,
S.E(Log q),	.5423,	.3215,	.2640,	.4877,	.7762,	.7448,	.5126,

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,	2.88,	-1.341,	18.19,	.06,	12,	1.50,	-14.03,
4,	1.72,	-1.638,	14.01,	.38,	12,	.51,	-12.89,
5,	.94,	.356,	12.54,	.83,	12,	.26,	-12.65,
6,	.67,	2.317,	12.08,	.85,	12,	.27,	-13.25,
7,	.75,	.895,	12.71,	.60,	12,	.59,	-13.95,
8,	.93,	.213,	13.85,	.54,	12,	.65,	-14.27,
9,	1.14,	-.491,	15.01,	.59,	12,	.60,	-14.04,

1

Table 6.4.1 Saithe in IV, VI, and IIIa. Continued

Fleet : NORTRL_IV

Age	1980	1981
3	99.99	99.99
4	99.99	99.99
5	99.99	99.99
6	99.99	99.99
7	99.99	99.99
8	99.99	99.99
9	99.99	99.99

Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
3	.66	.23	1.24	.80	-.79	.17	.81	-.34	.02	1.73
4	-.14	-.28	-.06	.54	.81	.45	-.29	-.17	-.27	.24
5	-.43	-.08	-.87	-.22	-.30	-.14	-.47	-.69	.08	-.42
6	-.21	.36	.06	-.61	-.87	-1.02	-1.27	-.26	.46	-.52
7	-1.02	.71	-.53	-1.20	-1.31	-.80	-.52	.16	-.05	-.88
8	-1.07	.39	.01	-2.16	-2.00	-.59	-.62	.38	-.11	-1.62
9	-3.19	.36	-.09	-1.75	-2.03	-.10	.35	.29	-.79	-.47

Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
3	.39	1.10	.57	-.21	.13	-.51	-.02	-1.11	-1.61	.22
4	.51	.10	.94	.59	-.18	-.40	-.05	-.18	-1.14	-.05
5	.45	.15	.30	.22	-.03	-.29	.19	.09	.03	.00
6	.26	.62	-.26	-.47	.33	-.22	.35	.36	.73	-.37
7	-.33	.56	-.46	.96	.20	-.03	.15	.58	.28	-.47
8	-.61	.72	-.93	.21	-.41	-.18	.50	1.22	.43	-.26
9	-.25	1.24	1.30	.94	-2.22	-.51	.80	1.24	.66	-.51

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

Age	3	4	5	6	7	8	9
Mean Log q	-13.9487	-12.5735	-12.1626	-12.3353	-12.1554	-12.1554	-12.1554
S.E(Log q)	.8582	.5346	.2900	.5328	.5556	.7998	1.0918

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	1.09	-.114	14.14	.14	20	.98	-13.95
4	1.20	-.376	12.82	.27	20	.67	-12.57
5	1.06	-.303	12.25	.74	20	.32	-12.16
6	.73	1.413	11.62	.73	20	.37	-12.34
7	.86	.644	11.69	.67	20	.49	-12.16
8	.70	1.157	10.99	.60	20	.55	-12.25
9	1.01	-.021	12.11	.25	20	1.15	-12.05

1

Fleet : GER_OTB_IV

Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
3	99.99	99.99	99.99	-.01	-.03	-.17	.42	-.92	.38	.32
4	99.99	99.99	99.99	.39	-.20	.10	-.21	-.20	.14	.00
5	99.99	99.99	99.99	-.02	.04	-.05	-.25	-.17	.08	.35
6	99.99	99.99	99.99	.22	.02	-.69	.00	.16	.32	-.04
7	99.99	99.99	99.99	-.13	.32	-.36	-.21	.28	-.10	.19
8	99.99	99.99	99.99	-.71	.96	-.26	-.03	-.53	.22	.52
9	99.99	99.99	99.99	-.31	.34	-.24	.02	-.05	.01	.06

Table 6.4.1 Saithe in IV, VI, and IIIa. Continued

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

Age ,	3,	4,	5,	6,	7,	8,	9
Mean Log q,	-15.0475,	-13.3203,	-12.8912,	-12.9452,	-13.0181,	-13.0181,	-13.0181,
S.E(Log q),	.4703,	.2212,	.1976,	.3306,	.2639,	.5869,	.2107,

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,	1.36,	-.498,	16.17,	.29,	7,	.68,	-15.05,
4,	1.26,	-.842,	13.82,	.68,	7,	.29,	-13.32,
5,	1.00,	.015,	12.89,	.85,	7,	.22,	-12.89,
6,	.81,	.898,	12.38,	.82,	7,	.27,	-12.95,
7,	.80,	1.436,	12.29,	.92,	7,	.20,	-13.02,
8,	.87,	.391,	12.40,	.67,	7,	.55,	-12.99,
9,	.94,	.495,	12.72,	.94,	7,	.21,	-13.04,

1

Fleet : NORACU

Age ,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001
3 ,	99.99,	99.99,	99.99,	.26,	-.01,	-.44,	.01,	-.59,	.35,	.43
4 ,	99.99,	99.99,	99.99,	-1.16,	-.36,	-.29,	.31,	.37,	.90,	.12
5 ,	99.99,	99.99,	99.99,	-1.79,	.00,	.20,	.28,	.49,	.67,	.01
6 ,	99.99,	99.99,	99.99,	-2.45,	.70,	.20,	.34,	.13,	.75,	.17
7 ,	99.99,	99.99,	99.99,	-1.33,	.87,	1.05,	-.04,	.08,	.49,	-1.15
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,	-1.4235,	-.9911,	-1.1386,	-1.4409,	-1.6010,
S.E(Log q),	.3948,	.6560,	.8037,	1.0759,	.9242,

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,	.87,	.322,	2.74,	.57,	7,	.37,	-1.42,
4,	.73,	.492,	3.86,	.40,	7,	.51,	-.99,
5,	.70,	.558,	4.02,	.42,	7,	.60,	-1.14,
6,	.48,	1.373,	5.90,	.59,	7,	.48,	-1.44,
7,	1.68,	-.589,	-3.60,	.14,	7,	1.64,	-1.60,

1

Table 6.4.1 Saithe in IV, VI, and IIIa. Continued

```
Terminal year survivor and F summaries :

 Age  1   Catchability dependent on age and year class strength

 Year class = 2000

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
      ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 FRATRB_IV       ,         1.,   .000,       .000,    .00,   0,  .000,     .000
 FRATRF_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 ,    170844.,    .33,,,,                        .904,     .000

   F shrinkage mean ,      3675.,   1.00,,,,                        .096,     .001

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
    118183.,       .31,    11.73,    2,  37.876,   .000


1
 Age  2   Catchability dependent on age and year class strength

 Year class = 1999

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
      ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 FRATRB_IV       ,         1.,   .000,       .000,    .00,   0,  .000,     .000
 FRATRF_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 ,    133967.,    .37,,,,                        .880,     .014

   F shrinkage mean ,     34118.,   1.00,,,,                        .120,     .052

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
    113615.,       .35,    11.65,    2,  33.562,   .016


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

 Year class = 1998

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
      ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 FRATRB_IV       ,    108021.,   .542,       .000,    .00,   1,  .185,     .135
 FRATRF_IV       ,     88998.,   .567,       .000,    .00,   1,  .169,     .162
 NORTRL_IV       ,    218277.,   .893,       .000,    .00,   1,  .068,     .069
 GER_OTB_IV      ,    239988.,   .504,       .000,    .00,   1,  .214,     .063
 NORACU          ,    268908.,   .423,       .000,    .00,   1,  .304,     .056

   F shrinkage mean ,    143548.,   1.00,,,,                        .059,     .103

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
    174725.,       .23,      .20,    6,    .863,   .086
```

Table 6.4.1 Saithe in IV, VI, and IIIa. Continued

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

Year class = 1997

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
FRATRB_IV ,	60329.,	.283,	.020,	.07,	2,	.237,	.243
FRATRF_IV ,	49971.,	.290,	.095,	.33,	2,	.227,	.286
NORTRL_IV ,	36495.,	.472,	.690,	1.46,	2,	.085,	.374
GER_OTB_IV ,	63858.,	.258,	.161,	.62,	2,	.286,	.231
NORACU ,	77380.,	.362,	.105,	.29,	2,	.140,	.194
F shrinkage mean ,	49243.,	1.00,,,,				.025,	.290

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
57999.,	.14,	.09,	11,	.688,	.251

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

Year class = 1996

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
FRATRB_IV ,	47567.,	.207,	.296,	1.43,	3,	.239,	.366
FRATRF_IV ,	44264.,	.209,	.236,	1.13,	3,	.234,	.388
NORTRL_IV ,	32355.,	.255,	.348,	1.36,	3,	.164,	.500
GER_OTB_IV ,	47425.,	.197,	.289,	1.47,	3,	.263,	.367
NORACU ,	37349.,	.336,	.431,	1.28,	3,	.083,	.446
F shrinkage mean ,	35725.,	1.00,,,,				.017,	.462

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
42793.,	.10,	.12,	16,	1.144,	.399

1

Age 6 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
FRATRB_IV ,	12298.,	.192,	.128,	.66,	4,	.247,	.237
FRATRF_IV ,	11741.,	.200,	.117,	.59,	4,	.218,	.247
NORTRL_IV ,	10583.,	.238,	.098,	.41,	4,	.165,	.271
GER_OTB_IV ,	11642.,	.179,	.092,	.51,	4,	.290,	.249
NORACU ,	14642.,	.337,	.146,	.43,	4,	.064,	.203
F shrinkage mean ,	5423.,	1.00,,,,				.016,	.474

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
11665.,	.10,	.05,	21,	.537,	.249

Table 6.4.1 Saithe in IV, VI, and IIIa. Continued

Age 7 Catchability constant w.r.t. time and dependent on age

Year class = 1994

Fleet,		Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
FRATRB_IV	,	14519.,	.195,	.209,	1.08,	5,	.209,	.202
FRATRF_IV	,	14626.,	.204,	.167,	.82,	5,	.178,	.200
NORTRL_IV	,	15136.,	.235,	.208,	.89,	5,	.161,	.194
GER_OTB_IV	,	15937.,	.166,	.103,	.62,	5,	.372,	.185
NORACU	,	11543.,	.352,	.334,	.95,	5,	.062,	.248

F shrinkage mean , 4967., 1.00,,,, .018, .503

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
14656.,	.10,	.08,	26,	.830,	.200

1

Age 8 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
FRATRB_IV	,	4564.,	.203,	.165,	.81,	6,	.208,	.254
FRATRF_IV	,	4804.,	.215,	.164,	.76,	6,	.181,	.243
NORTRL_IV	,	5460.,	.241,	.110,	.46,	6,	.165,	.217
GER_OTB_IV	,	4954.,	.167,	.102,	.61,	6,	.370,	.237
NORACU	,	5519.,	.361,	.132,	.37,	5,	.052,	.215

F shrinkage mean , 1769., 1.00,,,, .023, .558

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
4832.,	.10,	.06,	30,	.639,	.242

Age 9 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
FRATRB_IV	,	4314.,	.226,	.144,	.64,	7,	.212,	.225
FRATRF_IV	,	4352.,	.243,	.155,	.64,	7,	.179,	.223
NORTRL_IV	,	5210.,	.260,	.168,	.65,	7,	.118,	.189
GER_OTB_IV	,	5298.,	.169,	.052,	.31,	7,	.437,	.187
NORACU	,	5512.,	.362,	.110,	.30,	5,	.031,	.180

F shrinkage mean , 4176., 1.00,,,, .023, .231

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
4866.,	.11,	.05,	34,	.494,	.202

Table 6.4.2 Saithe in IV, VI, and IIIa. Fishing mortality (F)-at-age

YEAR		1967	1968	1969	1970	1971
AGE						
	1	0	0.0004	0.0001	0.001	0.0025
	2	0.068	0.0115	0.0065	0.0062	0.0572
	3	0.1628	0.2548	0.1178	0.1521	0.2682
	4	0.2632	0.3074	0.3145	0.4897	0.3729
	5	0.3782	0.3551	0.2599	0.4828	0.3998
	6	0.4836	0.2455	0.3574	0.507	0.2735
	7	0.4161	0.1524	0.3913	0.3127	0.332
	8	0.2603	0.1004	0.4639	0.2016	0.3966
	9	0.3893	0.1668	0.407	0.3426	0.3361
+gp		0.3893	0.1668	0.407	0.3426	0.3361
FBAR 3- 6		0.322	0.2907	0.2624	0.4079	0.3286

YEAR		1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
AGE											
	1	0.0017	0.0174	0.0078	0.0017	0.0019	0.0167	0.0112	0.0035	0.0076	0.0276
	2	0.132	0.2072	0.0916	0.1612	0.2326	0.1297	0.2159	0.2165	0.1197	0.1578
	3	0.3712	0.499	0.688	0.4271	0.9117	0.2977	0.5441	0.2664	0.3437	0.1848
	4	0.4397	0.5629	0.6749	0.6294	0.931	0.6556	0.5457	0.4434	0.3309	0.2729
	5	0.2768	0.3202	0.4243	0.4464	0.6619	0.7383	0.4648	0.4519	0.5659	0.3033
	6	0.4925	0.2838	0.4389	0.4244	0.5386	0.7724	0.3559	0.4279	0.5433	0.4763
	7	0.3538	0.3695	0.4557	0.5875	0.4146	0.7476	0.3493	0.5838	0.5521	0.5755
	8	0.4054	0.3317	0.4107	0.5976	0.4834	0.785	0.4643	0.3991	0.5056	0.7767
	9	0.4202	0.3303	0.4382	0.5409	0.4825	0.776	0.3925	0.4738	0.538	0.6149
+gp		0.4202	0.3303	0.4382	0.5409	0.4825	0.776	0.3925	0.4738	0.538	0.6149
FBAR 3- 6		0.395	0.4165	0.5565	0.4818	0.7608	0.616	0.4776	0.3974	0.4459	0.3093

YEAR		1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
AGE											
	1	0.0061	0.0007	0.0005	0.0015	0.0017	0.0068	0.0002	0.0187	0.0025	0.0023
	2	0.2045	0.1505	0.1033	0.0293	0.057	0.2203	0.0975	0.0718	0.037	0.1204
	3	0.3894	0.3075	0.5727	0.6468	0.2405	0.37	0.3801	0.3797	0.4712	0.4592
	4	0.4852	0.471	0.6951	1.046	1.411	0.8769	0.621	0.7617	0.6916	0.7726
	5	0.5474	0.6711	0.6201	0.7055	0.9568	0.8692	0.9707	0.7443	0.7206	0.6242
	6	0.4842	0.8005	0.8776	0.4876	0.7076	0.5229	0.6214	0.97	0.6586	0.5244
	7	0.5707	0.9749	0.5748	0.5047	0.5437	0.55	0.7073	0.5585	0.7074	0.5355
	8	0.5351	1.0635	0.7252	0.4947	0.492	0.5452	0.7893	0.6666	0.5748	0.5649
	9	0.536	0.9561	0.7334	0.5349	0.7154	0.6641	0.8081	0.8143	0.5802	0.6291
+gp		0.536	0.9561	0.7334	0.5349	0.7154	0.6641	0.8081	0.8143	0.5802	0.6291
FBAR 3- 6		0.4766	0.5625	0.6914	0.7215	0.829	0.6597	0.6483	0.7139	0.6355	0.5951

YEAR		1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
AGE											
	1	0.0021	0.0005	0.0007	0.0006	0.0029	0.0001	0.0013	0.0002	0.0009	0
	2	0.0392	0.0852	0.0321	0.0349	0.0451	0.134	0.0221	0.0492	0.0104	0.016
	3	0.248	0.3233	0.2412	0.142	0.1175	0.0992	0.1583	0.072	0.0678	0.0856
	4	0.7315	0.4928	0.6839	0.5704	0.3168	0.3085	0.3048	0.3292	0.183	0.2514
	5	0.9356	0.6238	0.667	0.5822	0.5537	0.4362	0.469	0.4691	0.3666	0.3993
	6	0.6027	0.6228	0.484	0.4086	0.7015	0.331	0.4399	0.4694	0.4126	0.2486
	7	0.4434	0.6852	0.3855	0.9631	0.7269	0.5518	0.3437	0.5493	0.3223	0.2
	8	0.4318	1.1263	0.3081	0.526	0.6112	0.5409	0.529	0.7483	0.3376	0.2419
	9	0.701	1.4782	1.2712	1.2141	0.3051	0.4639	0.6749	0.9922	0.4646	0.2016
+gp		0.701	1.4782	1.2712	1.2141	0.3051	0.4639	0.6749	0.9922	0.4646	0.2016
FBAR 3- 6		0.6295	0.5156	0.519	0.4258	0.4224	0.2937	0.343	0.3349	0.2575	0.2462

YEAR		F3-6 99-**	F3-6 97-**
AGE			
	1	0.0004	0.0005
	2	0.0252	0.0463
	3	0.0752	0.0966
	4	0.2545	0.2754
	5	0.4116	0.428
	6	0.3769	0.3803
	7	0.3572	0.3934
	8	0.4426	0.4795
	9	0.5528	0.5594

Table 6.4.3 Saithe in IV,V!, And IIIa. Stock number-at-age (start of year) Numbers*10**-3

YEAR	AGE	1967	1968	1969	1970	1971
	1	453734	438367	492275	270952	260836
	2	149189	371486	358747	403008	221625
	3	127453	114111	300679	291818	327909
	4	77469	88669	72413	218817	205217
	5	54511	48749	53386	43289	109786
	6	6638	30577	27983	33704	21870
	7	5177	3351	19585	16025	16620
	8	1407	2795	2356	10843	9597
	9	680	888	2070	1213	7256
+gp		621	1041	490	1008	2974
TOTAL		876878	1100035	1329984	1290677	1183690

YEAR	AGE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
	1	273408	301448	678283	222257	157105	145287	124514	289321	192366	221833
	2	213017	223459	242545	551031	181665	128382	116985	100810	236047	156300
	3	171357	152838	148721	181201	383979	117871	92329	77184	66470	171452
	4	205304	96795	75972	61194	96791	126329	71656	43870	48415	38592
	5	115724	108284	45139	31671	26699	31235	53693	33993	23055	28473
	6	60263	71839	64361	24178	16594	11276	12222	27617	17713	10719
	7	13620	30151	44284	33975	12949	7928	4264	7010	14740	8423
	8	9764	7828	17059	22987	15459	7004	3073	2462	3201	6948
	9	5285	5330	4600	9263	10354	7805	2615	1582	1352	1581
+gp		5132	9286	6036	7034	9979	9487	11764	6058	6050	6031
TOTAL		1072875	1007258	1327000	1144790	911572	592603	493116	589907	609409	650351

YEAR	AGE	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
	1	357945	514738	440479	176446	212090	128172	192415	218332	156209	235324
	2	176684	291278	421150	360447	144253	173353	104226	157507	175440	127572
	3	109288	117900	205158	310979	286590	111565	113864	77405	120025	138423
	4	116687	60618	70974	94738	133338	184481	63093	63746	43352	61343
	5	24051	58810	30987	28998	27251	26626	62845	27762	24366	17774
	6	17213	11390	24612	13646	11725	8571	9140	19491	10798	9704
	7	5450	8684	4188	8378	6861	4731	4160	4020	6049	4575
	8	3879	2522	2682	1930	4141	3261	2235	1679	1883	2441
	9	2616	1860	713	1063	963	2073	1548	831	706	868
+gp		3306	2342	1355	1958	1920	1573	1335	954	903	1071
TOTAL		817119	1070142	1202298	998583	829132	644406	554861	571727	539729	599095

YEAR	AGE	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
	1	167520	343177	170611	274809	133791	228808	186804	350528	172384	144353
	2	192221	136865	280825	139589	224852	109219	187307	152745	286930	141005
	3	92601	151334	102900	222652	110360	175983	78205	150001	119054	232483
	4	71602	59163	89678	66189	158165	80342	130478	54652	114279	91081
	5	23195	28208	29593	37054	30634	94332	48316	78761	32193	77915
	6	7796	7451	12377	12435	16948	14417	49928	24748	40340	18268
	7	4703	3494	3272	6246	6766	6880	8477	26330	12672	21863
	8	2193	2471	1442	1822	1952	2678	3244	4922	12446	7516
	9	1136	1166	656	867	882	867	1277	1565	1907	7270
+gp		913	1432	1193	1231	2049	851	616	1134	1301	1856
TOTAL		563880	734760	692548	762893	686400	714377	694651	845387	793505	743611

YEAR	AGE	2002	GM 67-99	GM 85-99
	1	**0***	247556	202684
	2	**118183***	197800	168013
	3	**113615***	146629	136508
	4	174725	84734	82595
	5	57999	39871	34665
	6	42793	17539	13263
	7	11665	8264	5973
	8	14656	3730	2409
	9	4832	1723	1045
+gp		6108		
TOTAL		544576		

***overwritten by GM (85-99) in the prediction.**

Table 6.6.1.: Saithe in IV,VI, and IIIa. Summary (without SOP correction)

Terminal Fs derived using XSA (with F shrinkage)

	RECRUITS Age 1	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	FBAR 3- 6
1967	453734	703788	150835	94514	0.6266	0.322
1968	438367	1025921	211718	116789	0.5516	0.2907
1969	492275	1134482	263951	131882	0.4996	0.2624
1970	270952	1288446	311994	236636	0.7585	0.4079
1971	260836	1282557	429542	272481	0.6344	0.3286
1972	273408	1110185	474049	275098	0.5803	0.395
1973	301448	993206	534414	259602	0.4858	0.4165
1974	678283	1143610	554800	309439	0.5577	0.5565
1975	222257	1067899	471925	308926	0.6546	0.4818
1976	157105	917714	351358	361680	1.0294	0.7608
1977	145287	626026	262900	223395	0.8497	0.616
1978	124514	567657	267625	166199	0.621	0.4776
1979	289321	584472	240414	135967	0.5656	0.3974
1980	192366	543542	234130	142395	0.6082	0.4459
1981	221833	645400	239221	146092	0.6107	0.3093
1982	357945	686173	207456	189861	0.9152	0.4766
1983	514738	812799	210029	197774	0.9417	0.5625
1984	440479	841801	171294	219642	1.2822	0.6914
1985	176446	708438	153277	226129	1.4753	0.7215
1986	212090	690155	143753	202758	1.4105	0.829
1987	128172	495338	145489	180776	1.2425	0.6597
1988	192415	478854	143025	140778	0.9843	0.6483
1989	218332	458778	110095	117609	1.0682	0.7139
1990	156209	422485	97429	107945	1.1079	0.6355
1991	235324	457363	91930	115576	1.2572	0.5951
1992	167520	493259	93912	104147	1.109	0.6295
1993	343177	541357	100257	119073	1.1877	0.5156
1994	170611	552697	108291	115255	1.0643	0.519
1995	274809	697125	133786	125183	0.9357	0.4258
1996	133791	593832	154737	119669	0.7734	0.4224
1997	228808	621461	192718	112740	0.585	0.2937
1998	186804	634655	192791	108699	0.5638	0.343
1999	350528	694870	208498	114655	0.5499	0.3349
2000	**202684***	786220	205198	93566	0.456	0.2575
2001	**202684***	733763	247035	98045	0.3969	0.2462
2002	**202684***	839000	298000			
Arith. Mean	266483	743895	231711	171171	0.8269	0.4854
Units	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)		

***GM 85 - 99**

Table 6.7.1 Saithe,IV, VI, and IIIa

input data for catch forecast, linear sensitivity analysis and medium-term analysis

Label	Value	CV	Label	Value	CV
Number-at-age			Weight in the stock		
N1	202683	0.30	WS1	0.54	0.05
N2	165794	0.30	WS2	0.71	0.16
N3	133586	0.30	WS3	0.91	0.12
N4	174724	0.20	WS4	1.09	0.03
N5	57999	0.20	WS5	1.36	0.12
N6	42793	0.20	WS6	1.84	0.11
N7	11665	0.20	WS7	2.51	0.06
N8	14656	0.20	WS8	3.38	0.08
N9	4832	0.20	WS9	4.62	0.07
N10	6107	0.20	WS10	6.94	0.07
H.cons selectivity			Weight in the HC catch		
sH1	0.00	1.37	WH1	0.54	0.05
sH2	0.02	0.66	WH2	0.71	0.16
sH3	0.07	0.24	WH3	0.91	0.12
sH4	0.22	0.19	WH4	1.09	0.03
sH5	0.36	0.08	WH5	1.36	0.12
sH6	0.33	0.23	WH6	1.84	0.11
sH7	0.32	0.34	WH7	2.51	0.06
sH8	0.39	0.43	WH8	3.38	0.08
sH9	0.49	0.58	WH9	4.62	0.07
sH10	0.49	0.58	WH10	6.94	0.07
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		
HF02	1.17	0.17	K02	1.00	0.10
HF03	1.00	0.17	K03	1.00	0.10
HF04	1.00	0.17	K04	1.00	0.10
Recruitment in 2003 and 2004					
R03	202684	0.30			
R04	202684	0.30			

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

Stock numbers in 2002 are VPA survivors.
These are overwritten at Age 2 Age 3

Table 6.7.2 Saithe, IV, VI, and IIIa

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

TAC constraint of 149000 tonnes applied.

		Year 2002	2003						
Mean F	Ages								
H.cons	3 to 6	0.29	0.15	0.20	0.25	0.30	0.34	0.40	0.44
Effort relative to	2001								
H.cons		1.17	0.60	0.80	1.00	1.20	1.40	1.61	1.80
Biomass									
Total 1 January		839	816	816	816	816	816	816	816
SSB at spawning time		298	325	325	325	325	325	325	325
Catch weight (,000t)									
H.cons		149	84	109	132	153	173	193	211
Biomass in year....	2004								
Total 1 January			873	845	818	792	769	746	726
SSB at spawning time			386	361	338	317	297	277	261

Detailed forecast table

F multiplier 2002=1.17 F multiplier 2003=1.00

	Stock numbers		Catch numbers	
Age	2002	2003	2002	2003
1	202683	202684	0	0
2	165794	165943	3820	3824
3	133586	132787	9009	8955
4	174724	102386	36669	21488
5	57999	114344	18319	36115
6	42793	33030	12565	9699
7	11665	25138	3279	7066
8	14656	6970	4904	2332
9	4832	8124	1920	3229
10+	6107	5503	2427	2187

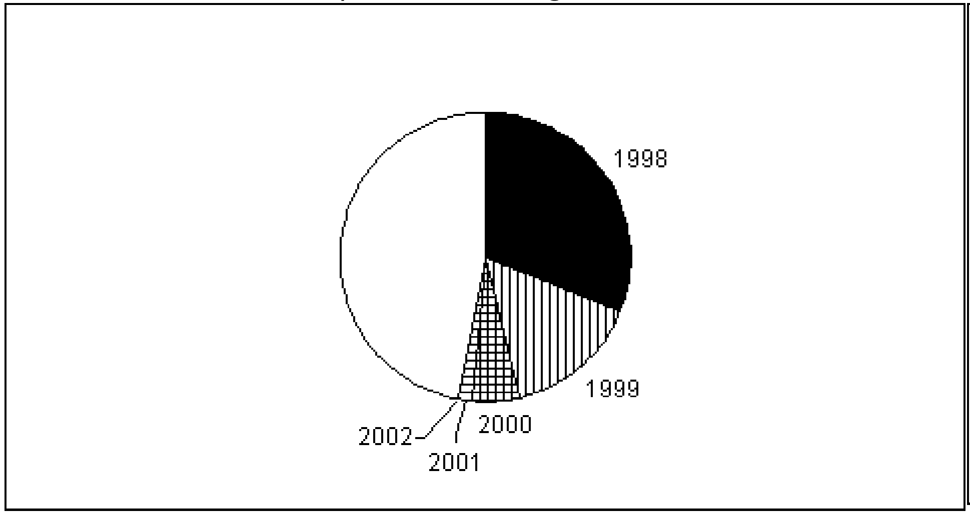
Table 6.7.3 Saithe IIIa, IV, and VIa
Stock numbers of recruits and their source for recent year classes used in predictions, and the relative (%) contributions to landings and SSB (by weight) of these year classes

Year-class			1998	1999	2000	2001		2002
Stock No. (thousands) of	1 year-olds		174725	202684	202684	202684		202684
Source			VPA	GM	GM	GM		GM
Status Quo F:								
% in	2002	landings	26.8	5.5	1.8	0.0	-	
% in	2003		31.2	14.9	5.2	1.7		0.0
% in	2002	SSB	9.6	0.0	0.0	0.0	-	
% in	2003	SSB	31.7	4.9	0.0	0.0		0.0
% in	2004	SSB	32.3	19.1	5.0	0.0		0.0

GM : geometric mean recruitment

Saithe IIIa, IV and Via : Year-class % contribution to

a) 2003 landings



b) 2004 SSB

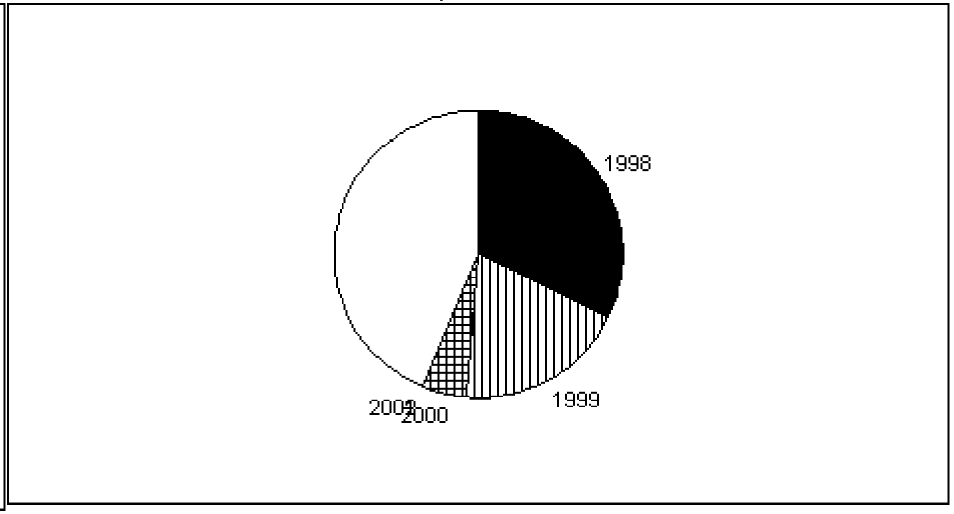


Table 6.8.1 Saithe in IV, VI, and IIIa. Results of fitting a Ricker stock-recruitment model

```
Data read from file c:\work\pred\recruit.in
Ricker curve
Moving average term NOT fitted
IFAIL on exit from E04FDF =,   5
Residual sum of squares=,    6.3729
Number of observations=,  34
Number of parameters  =,   2
Residual mean square  =,     .1992
Coefficient of determination =,    -.0336
Adj. coeff. of determination =,    -.0659
IFAIL from E04YCF=,  0
Parameter  Correlation matrix
,  1.0000,
,   .8780,  1.0000,

 Parameter,s.d.

   2.4059,     .3847,
    .0031,     .0006,
```

Y/Class,SSB,Recruits,Fit. rct,residuals,residuals,wt

1967,	150.80,	438.00,	226.30,	.6604,	.6604,	1.0000
1968,	211.70,	492.00,	262.55,	.6281,	.6281,	1.0000
1969,	264.00,	271.00,	277.96,	-.0254,	-.0254,	1.0000
1970,	312.00,	261.00,	282.67,	-.0798,	-.0798,	1.0000
1971,	429.50,	273.00,	269.37,	.0134,	.0134,	1.0000
1972,	474.00,	301.00,	258.63,	.1517,	.1517,	1.0000
1973,	534.40,	678.00,	241.35,	1.0329,	1.0329,	1.0000
1974,	554.80,	222.00,	235.06,	-.0572,	-.0572,	1.0000
1975,	471.90,	157.00,	259.18,	-.5013,	-.5013,	1.0000
1976,	351.40,	145.00,	281.43,	-.6631,	-.6631,	1.0000
1977,	262.90,	125.00,	277.76,	-.7984,	-.7984,	1.0000
1978,	267.60,	289.00,	278.60,	.0367,	.0367,	1.0000
1979,	240.40,	192.00,	272.52,	-.3502,	-.3502,	1.0000
1980,	234.10,	222.00,	270.67,	-.1982,	-.1982,	1.0000
1981,	239.20,	358.00,	272.18,	.2741,	.2741,	1.0000
1982,	207.50,	515.00,	260.74,	.6806,	.6806,	1.0000
1983,	210.00,	440.00,	261.83,	.5191,	.5191,	1.0000
1984,	171.30,	176.00,	241.08,	-.3147,	-.3147,	1.0000
1985,	153.30,	212.00,	228.25,	-.0739,	-.0739,	1.0000
1986,	143.80,	128.00,	220.57,	-.5442,	-.5442,	1.0000
1987,	145.50,	192.00,	222.00,	-.1452,	-.1452,	1.0000
1988,	143.00,	218.00,	219.90,	-.0087,	-.0087,	1.0000
1989,	110.10,	156.00,	187.67,	-.1848,	-.1848,	1.0000
1990,	97.40,	235.00,	172.75,	.3077,	.3077,	1.0000
1991,	91.90,	168.00,	165.83,	.0130,	.0130,	1.0000
1992,	93.90,	343.00,	168.38,	.7115,	.7115,	1.0000
1993,	100.30,	171.00,	176.29,	-.0305,	-.0305,	1.0000
1994,	108.30,	275.00,	185.64,	.3929,	.3929,	1.0000
1995,	133.80,	134.00,	211.76,	-.4576,	-.4576,	1.0000
1996,	154.70,	229.00,	229.33,	-.0014,	-.0014,	1.0000
1997,	192.70,	187.00,	253.63,	-.3048,	-.3048,	1.0000
1998,	192.80,	351.00,	253.68,	.3247,	.3247,	1.0000
1999,	208.50,	172.00,	261.18,	-.4177,	-.4177,	1.0000
2000,	205.20,	144.00,	259.72,	-.5898,	-.5898,	1.0000

Table 6.9.1 Saithe,IV, VI, and IIIa

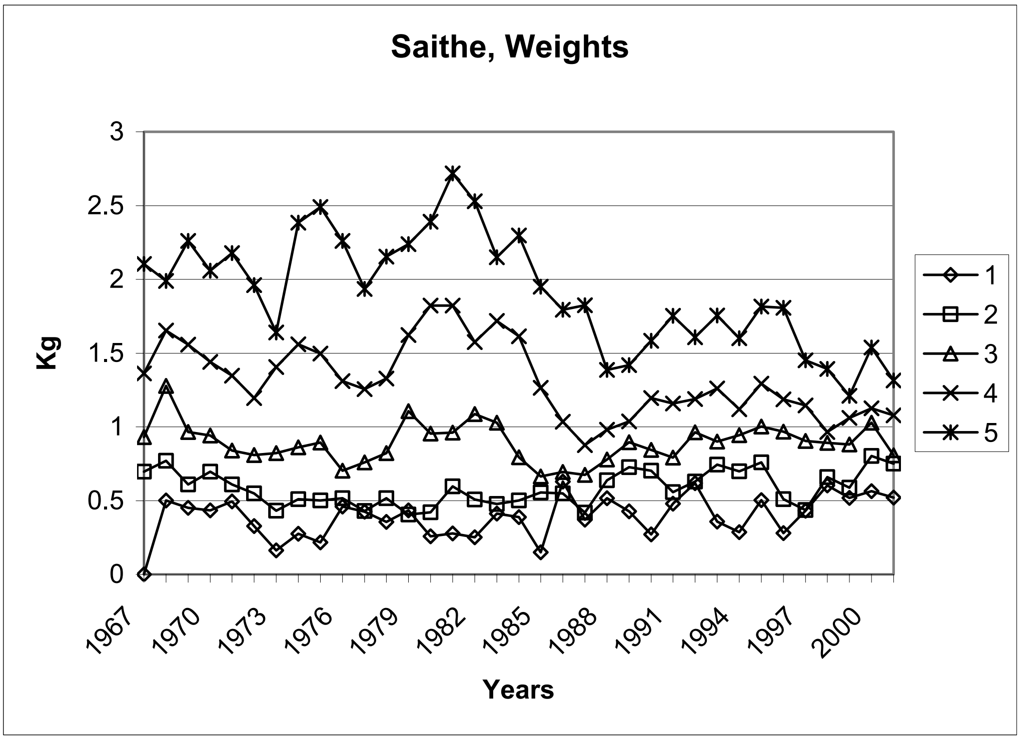
input data for yield per recruit analysis

Label	Value	CV	Label	Value	CV
Number-at-age			Weight in the stock		
N1	202683	0.30	WS1	0.47	0.05
N2	165794	0.30	WS2	0.66	0.16
N3	133586	0.30	WS3	0.93	0.12
N4	174724	0.20	WS4	1.14	0.03
N5	57999	0.20	WS5	1.55	0.12
N6	42793	0.20	WS6	2.21	0.11
N7	11665	0.20	WS7	3.10	0.06
N8	14656	0.20	WS8	4.11	0.08
N9	4832	0.20	WS9	5.34	0.07
N10	6107	0.20	WS10	7.54	0.07
H.cons selectivity			Weight in the HC catch		
sH1	0.00	1.37	WH1	0.47	0.05
sH2	0.02	0.66	WH2	0.66	0.16
sH3	0.07	0.24	WH3	0.93	0.12
sH4	0.22	0.19	WH4	1.14	0.03
sH5	0.36	0.08	WH5	1.55	0.12
sH6	0.33	0.23	WH6	2.21	0.11
sH7	0.32	0.34	WH7	3.10	0.06
sH8	0.39	0.43	WH8	4.11	0.08
sH9	0.49	0.58	WH9	5.34	0.07
sH10	0.49	0.58	WH10	7.54	0.07
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		
HF02	1.17	0.17	K02	1.00	0.10
HF03	1.00	0.17	K03	1.00	0.10
HF04	1.00	0.17	K04	1.00	0.10
Recruitment in 2003 and 2004					
R03	202684	0.30			
R04	202684	0.30			

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

Stock numbers in 2002 are VPA survivors.
These are overwritten at Age 2 Age 3

Figure 6.2.1 Saithe in IIIa, IV and Via. Mean weights at age.



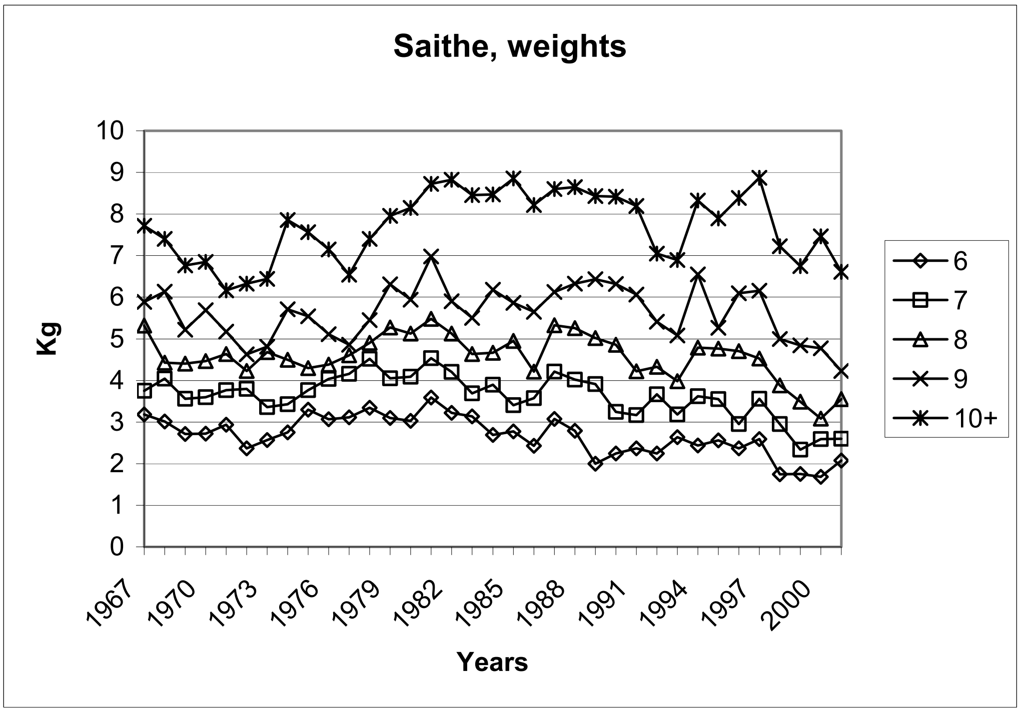
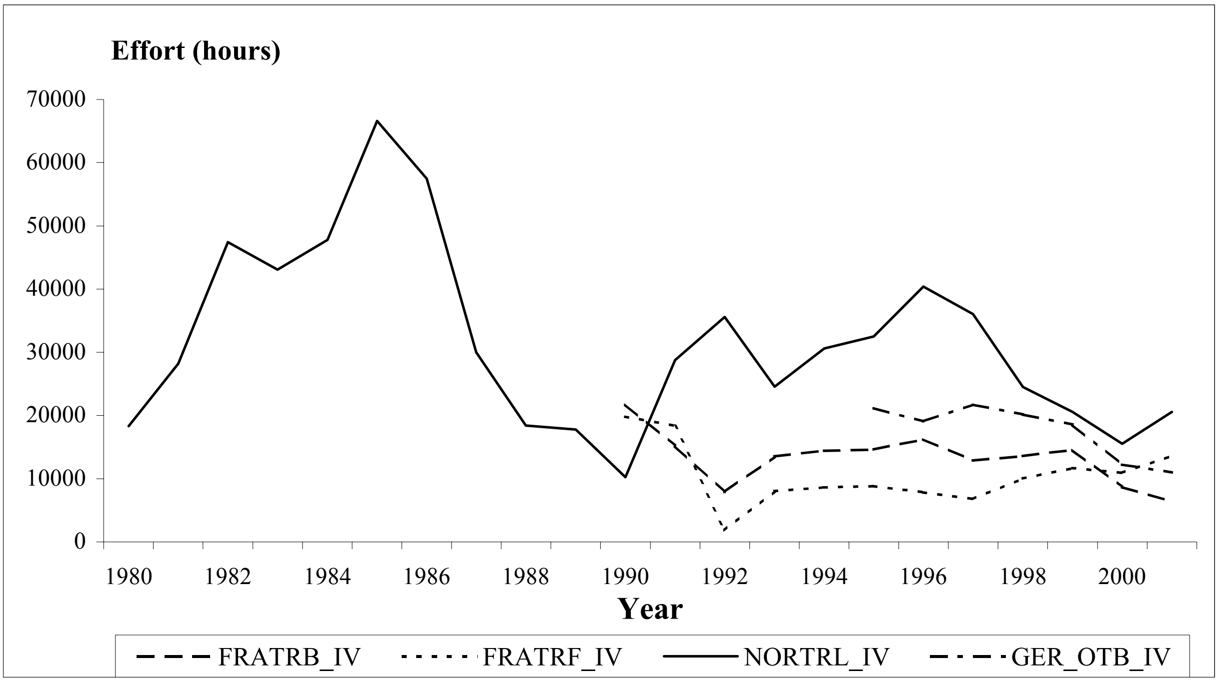


Figure 6.3.1.: Saithe in IV, VIa and III. Trends in Effort and CPUE in commercial fleets.



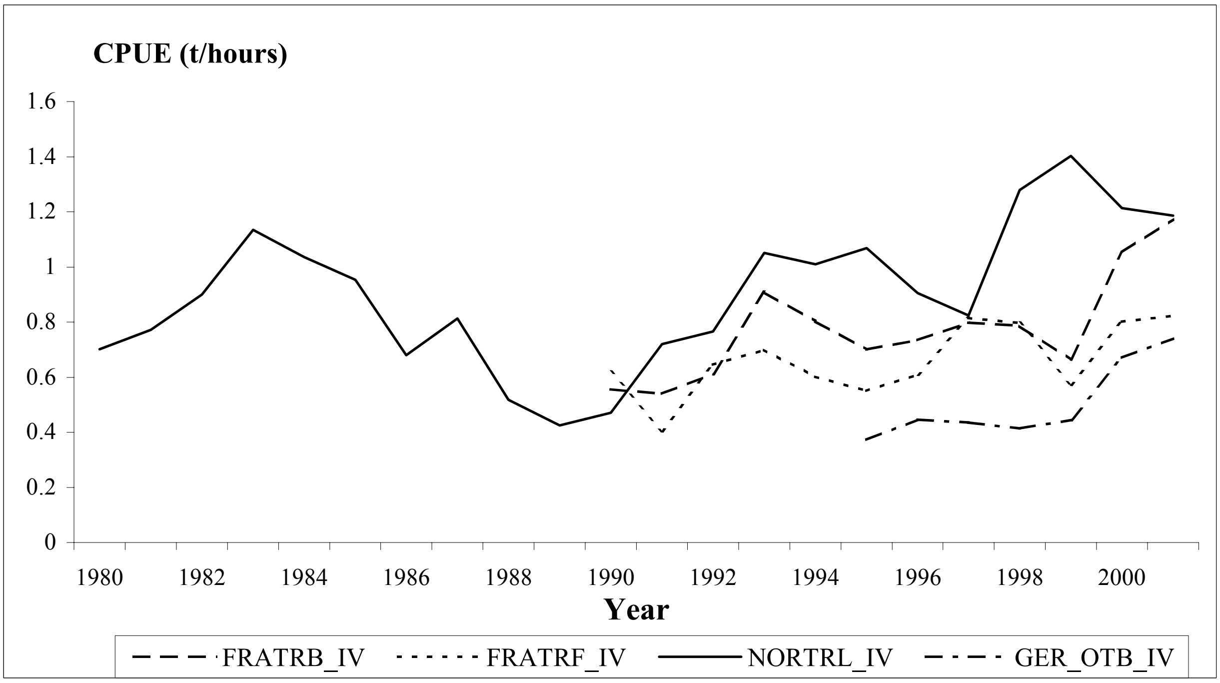


Figure 6.3.2.: Saithe in IV, VI and IIIa. Normalised trends in tuning fleets by age.

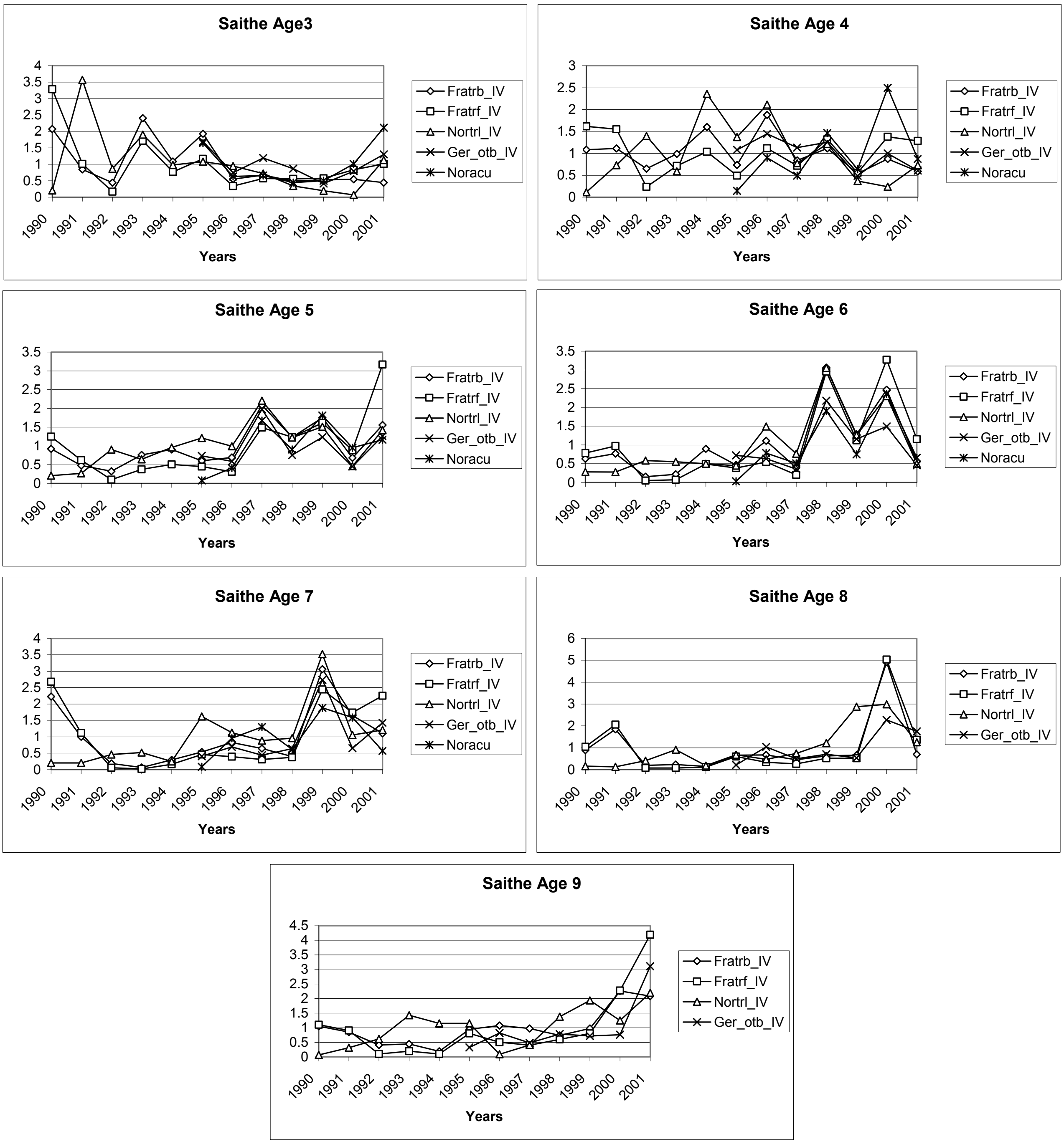


Figure 6.4.1 Saithe in IV, VI and IIIa Results from single fleet tunings and combined fleet tunings

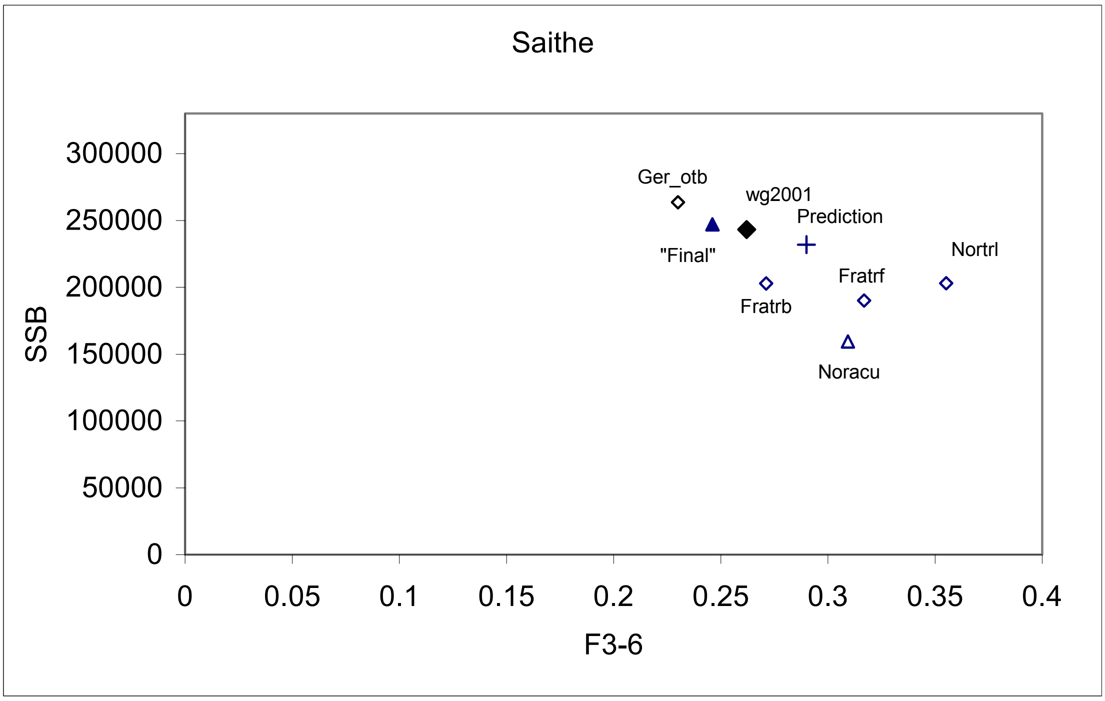


Figure 6.4.2 Saithe in IV, VI and IIIa. Residuals from single fleet tunings.

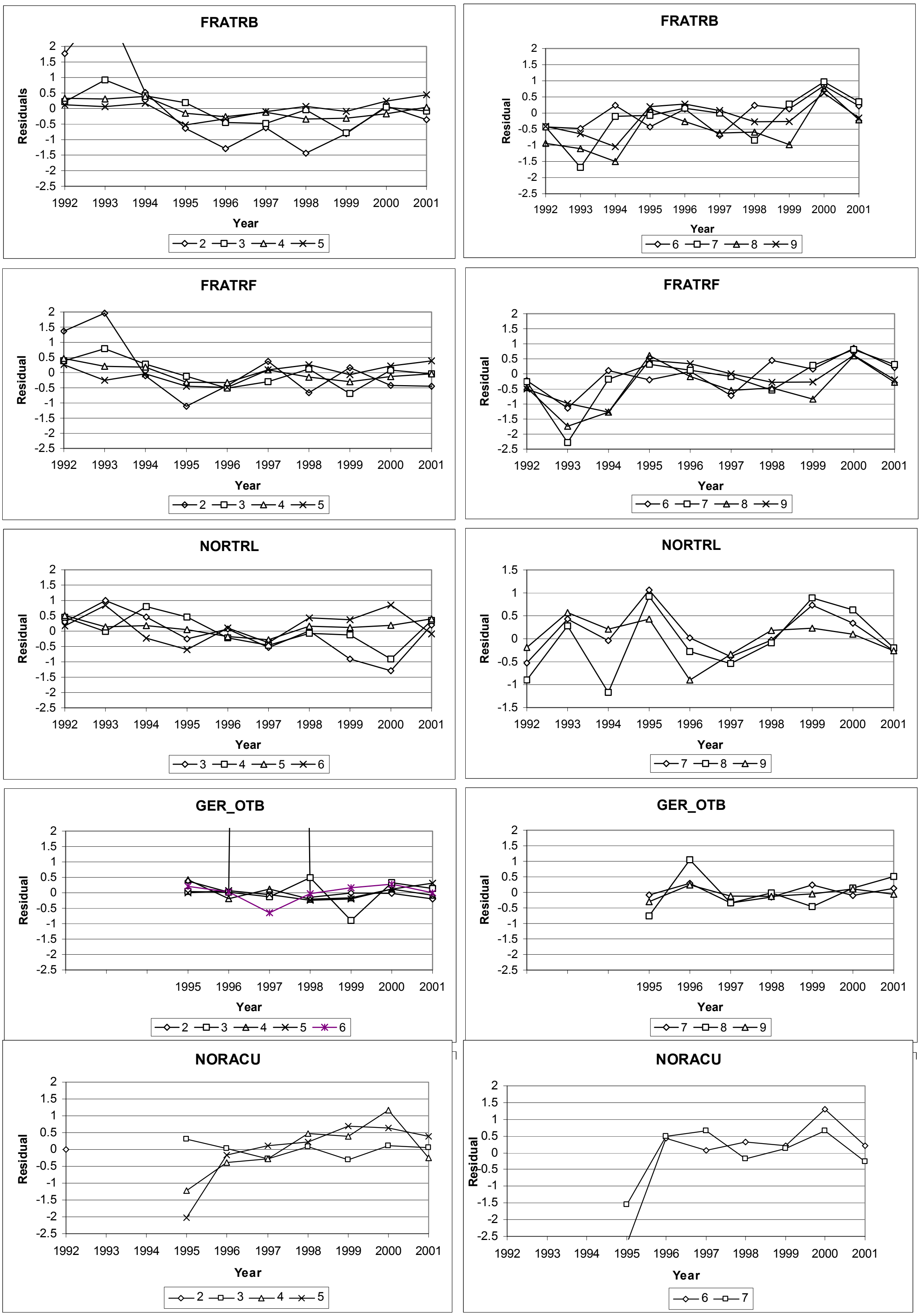
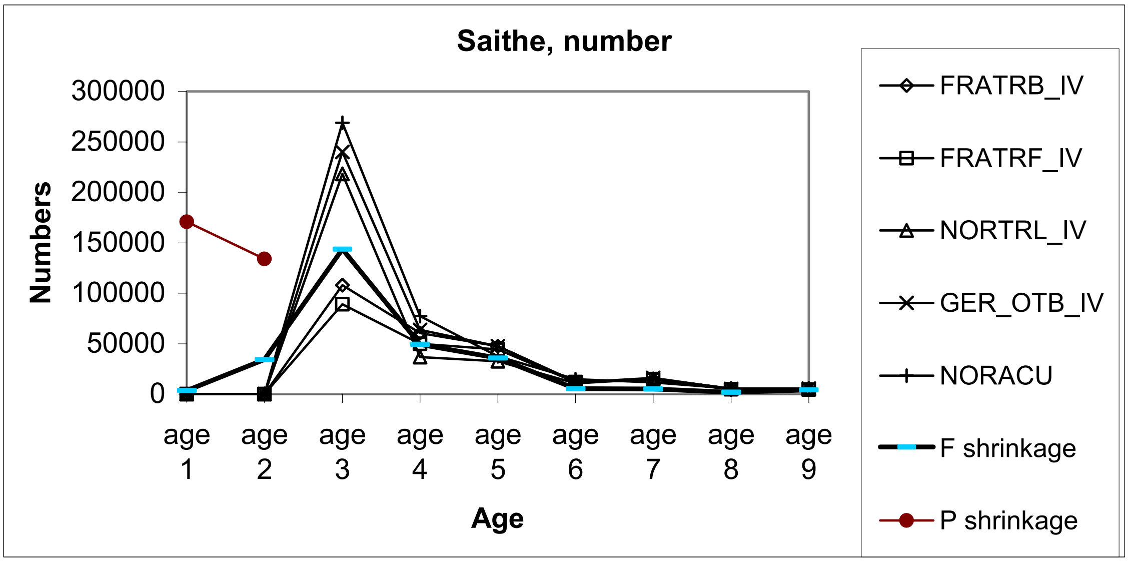


Figure 6.4.3. Saithe in IIIa, IV and Via. Numbers and F per age. Final tuning.



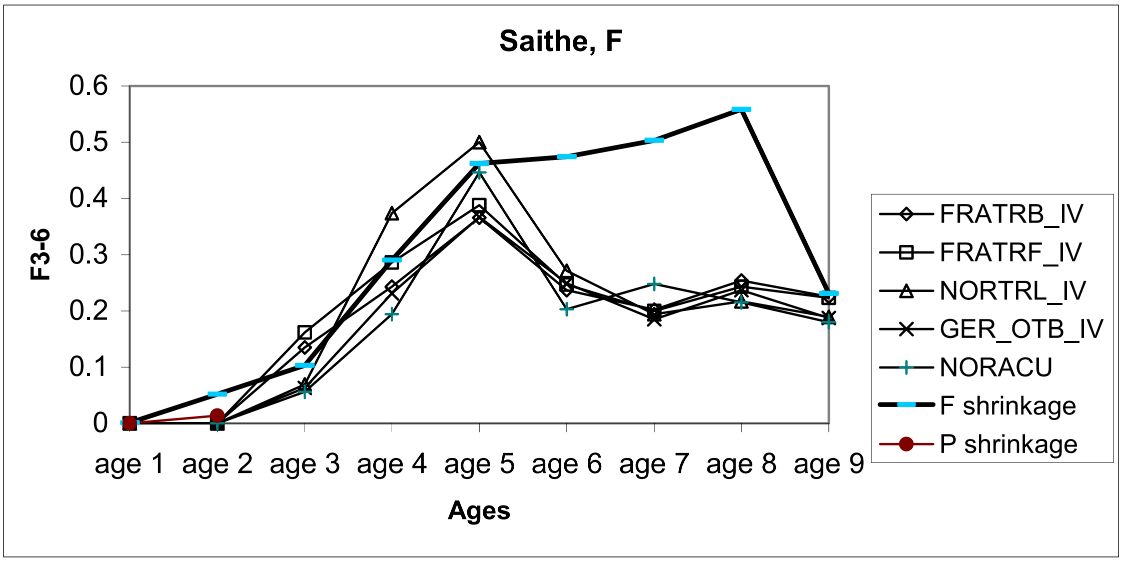


Figure 6.4.4 Saithe in IV, VI and IIIa. Residuals from final tuning.

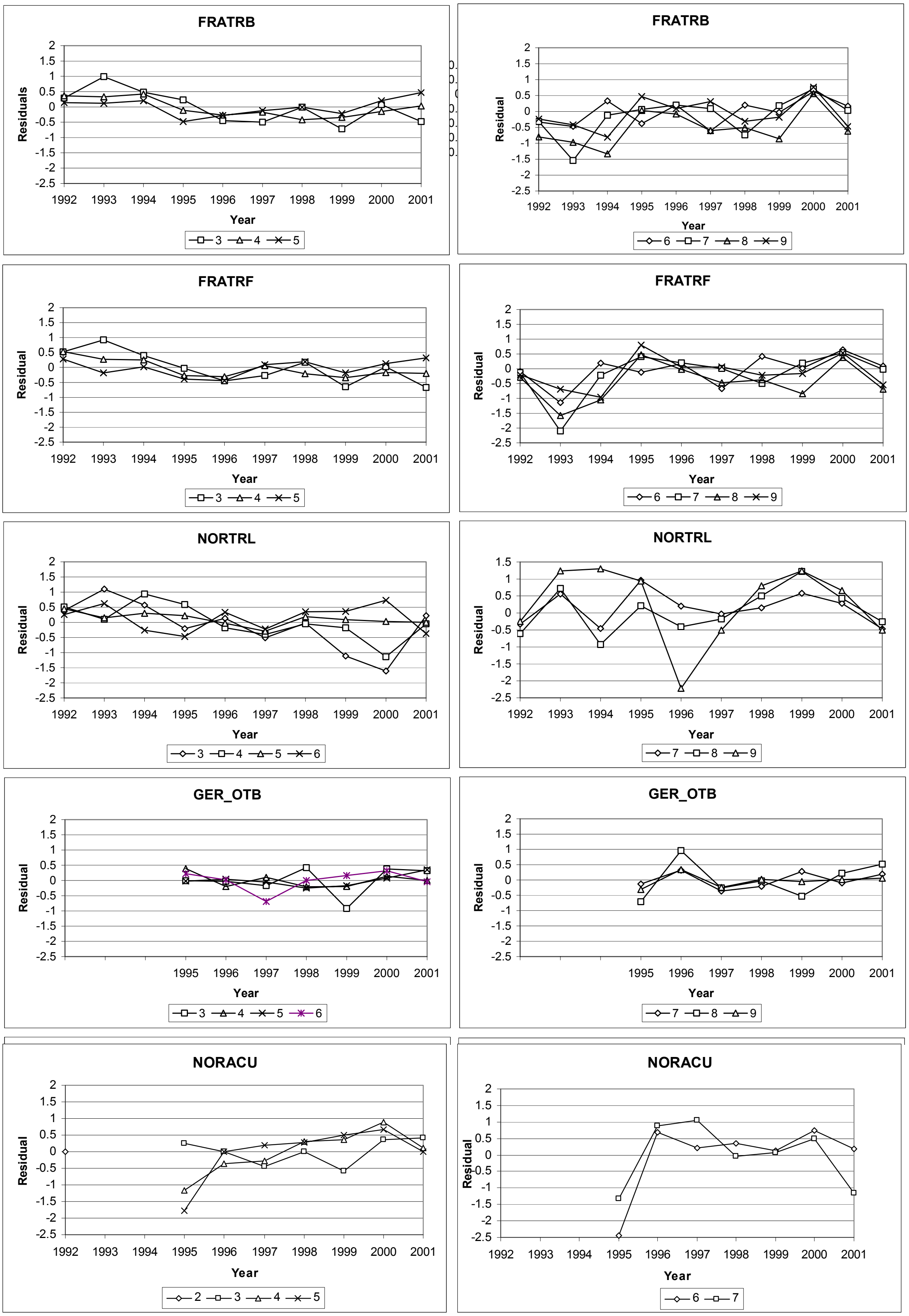
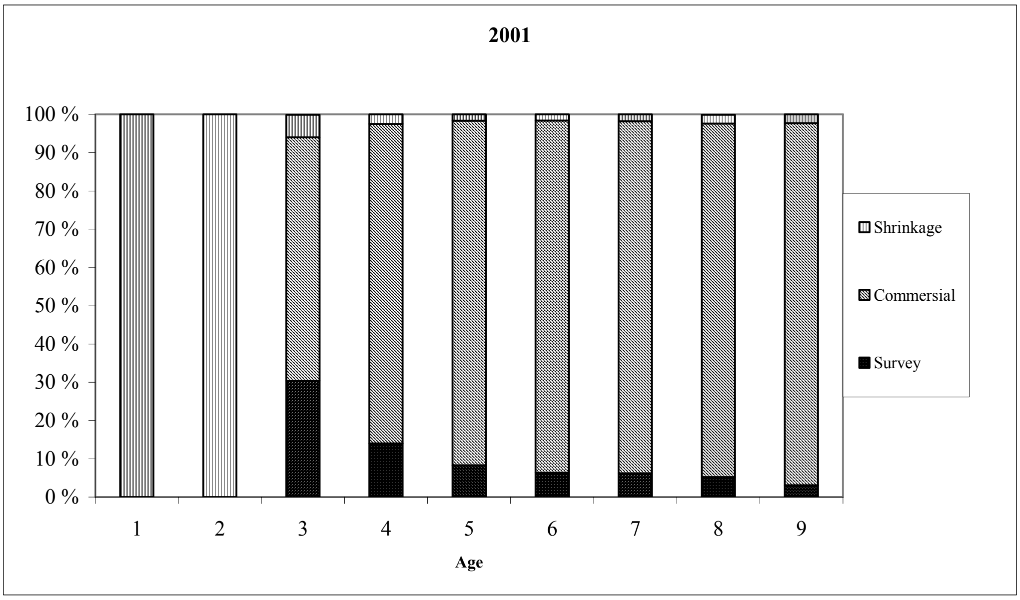


Figure 6.4.5. Saithe IV, VIa and IIIa - Contribution of Commercial fleets, survey and shrinkage to tuned XSA



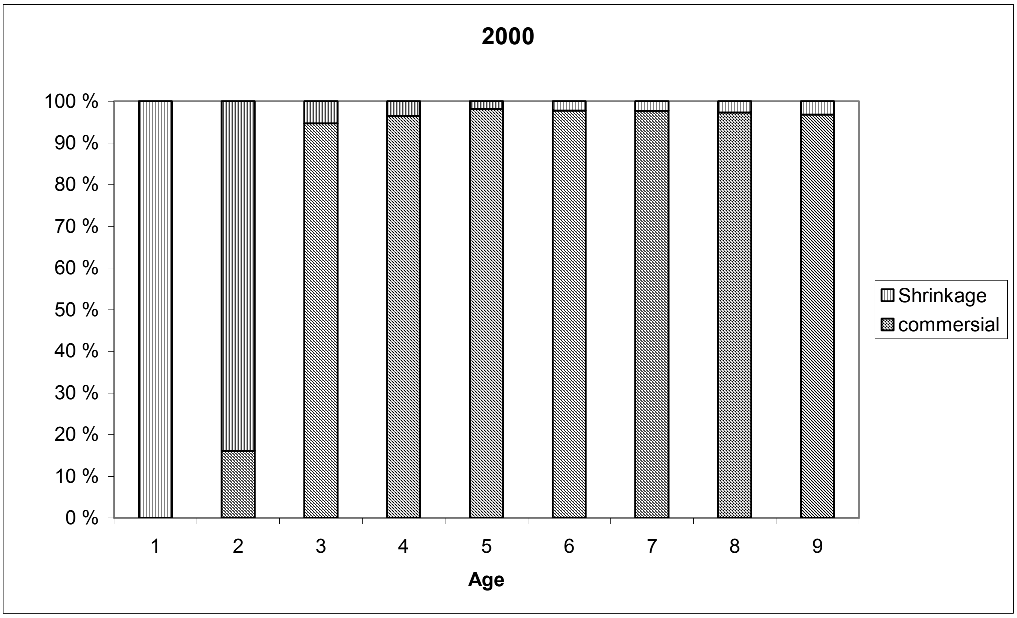
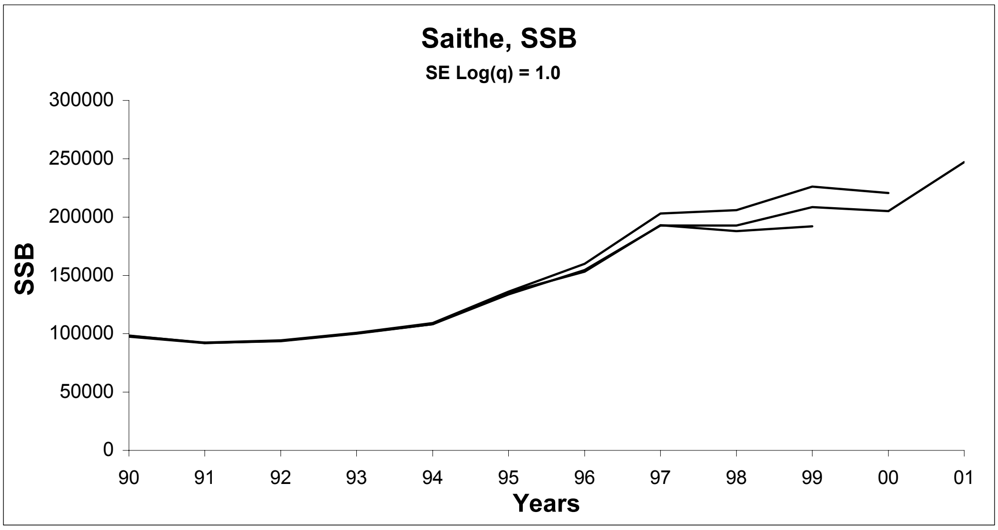


Figure 6.4.6 Saithe in IIIa, IV and Via. Retrospective analysis.



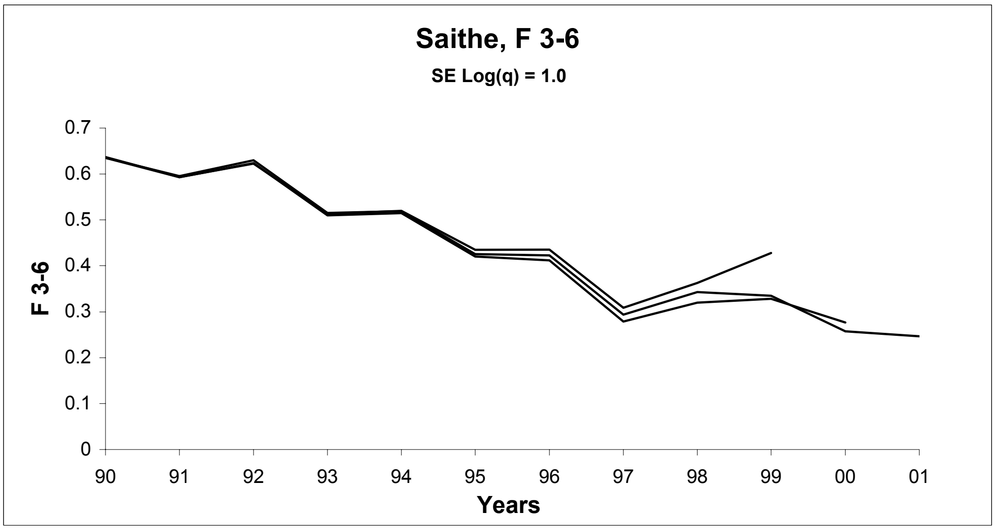


Figure 6.6.1 Saithe in Subarea IV, Division IIIa (Skagerrak) & Subarea VI

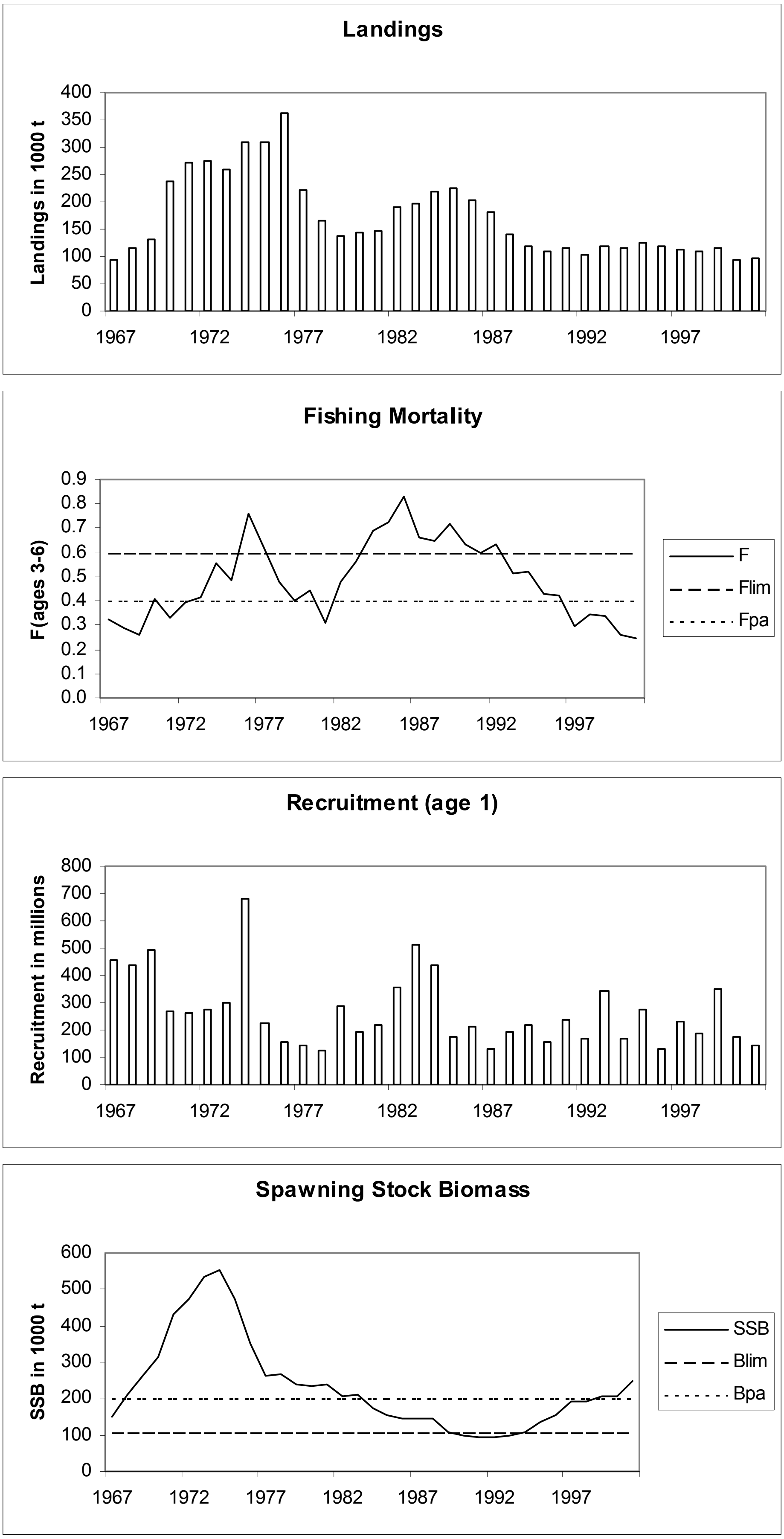
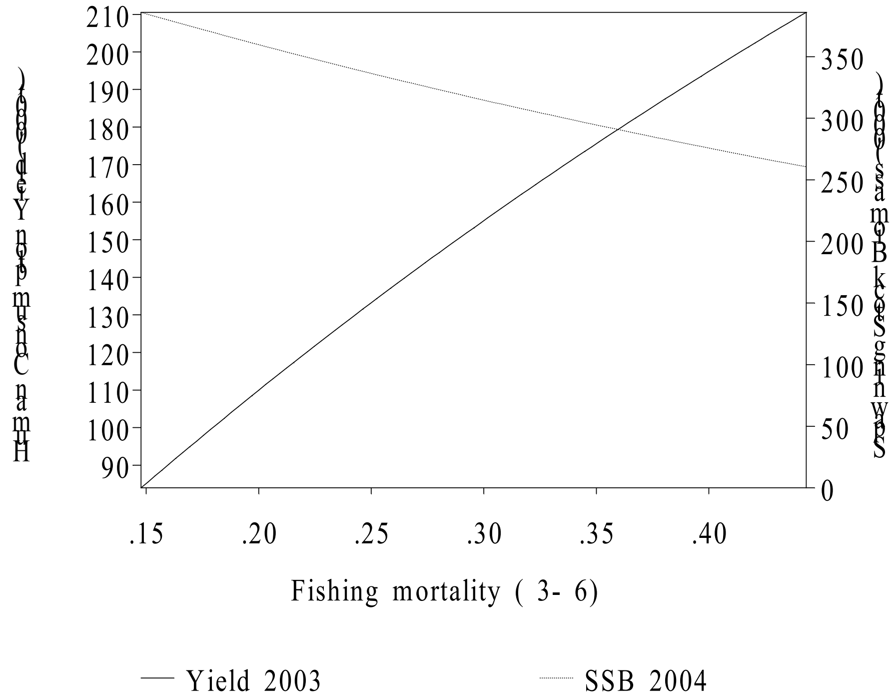
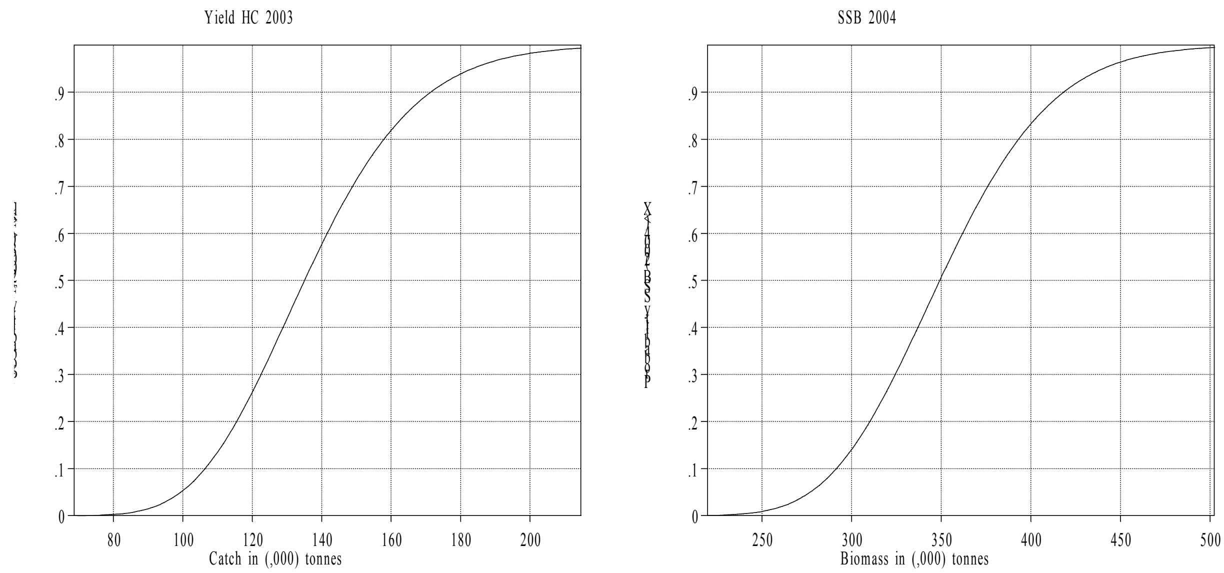


Figure 6.7.1.: Saithe, IV, VI and IIIa. Short term forecast



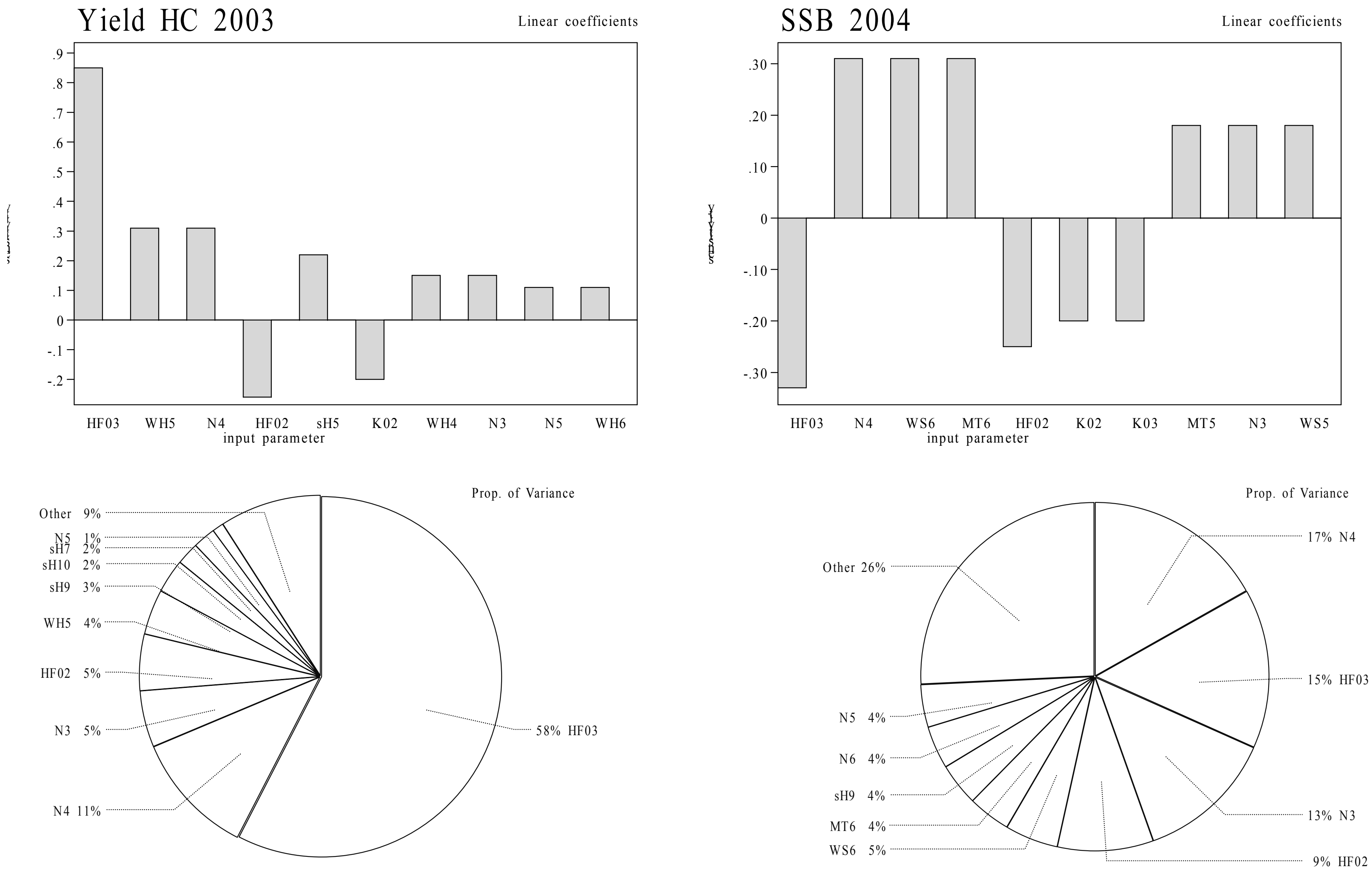
Data from file:C:\work\pred\SAI46.SEN on 16/06/2002 at 10:46:12

Figure 6.7.2.: Saithe, IV, VI and IIIa. Probability profiles for short term forecast.



Data from file:C:\work\pred\SAI46.SEN on 16/06/2002 at 10:47:42

Figure 6.7.3.: Saithe, IV, VI and IIIa. Sensitivity analysis of short term forecast.



Data from file:C:\work\pred\SAI46.SEN on 16/06/2002 at 12:52:03

Figure 6.8.1 Saithe in IV, VI, and IIIa. Medium-term predictions using a Ricker Stock-Recruitment model.

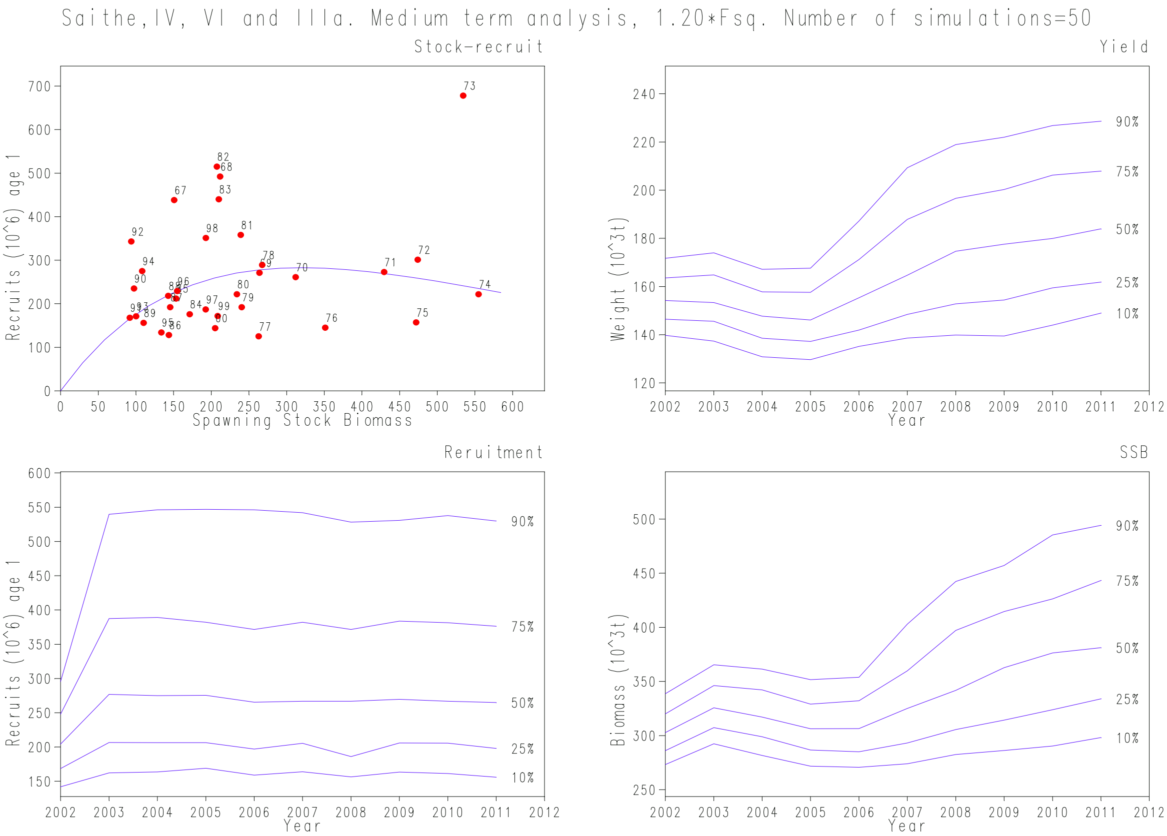


Figure 6.8.2 Saithe in IV, VI, and IIIa. Summary of medium-term analysis. Contours show the probability of SSB being below $\mathbf{B}_{pa}$ for any combination of year and fishing mortality.

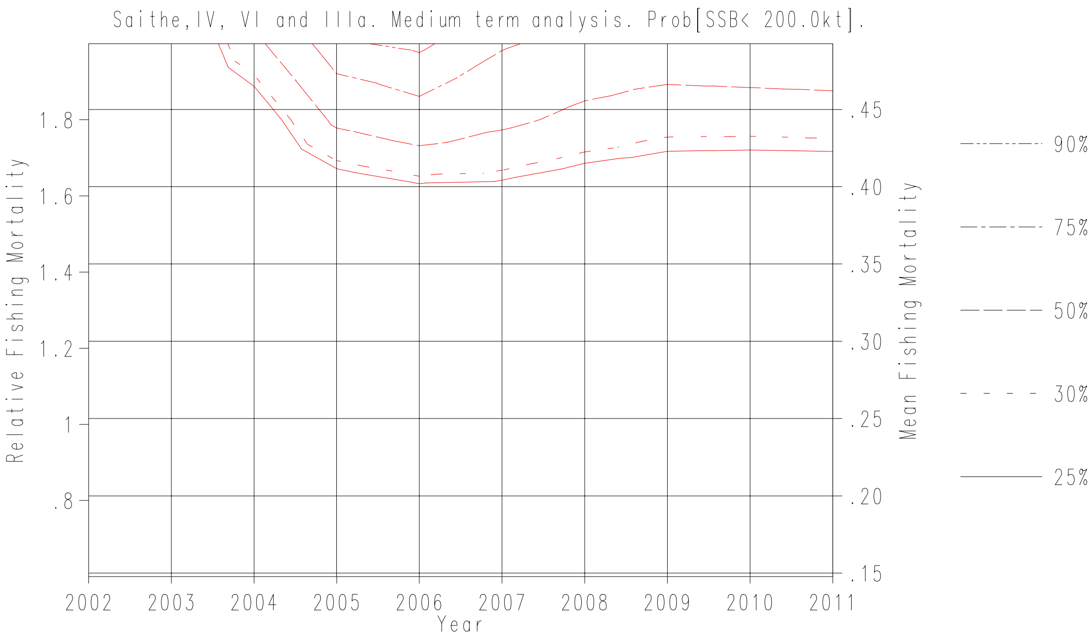


Figure 6.9.1 Saithe in IV, VI, and IIIa. Stock-recruitment plot.

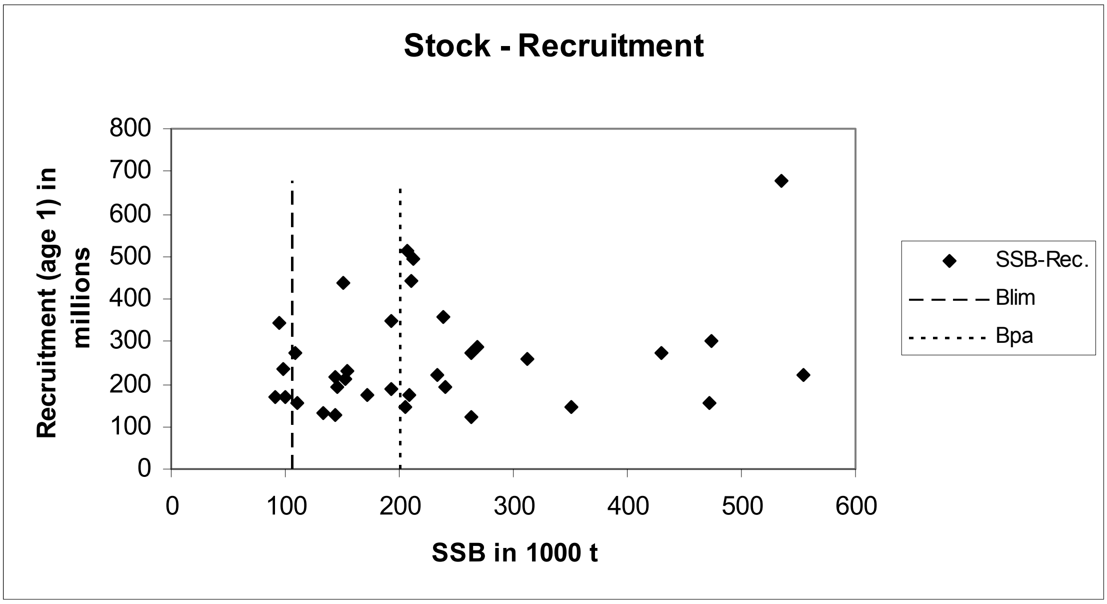


Figure 6.9.2 Saithe in IV, VI, and IIIa. Yield per recruit.

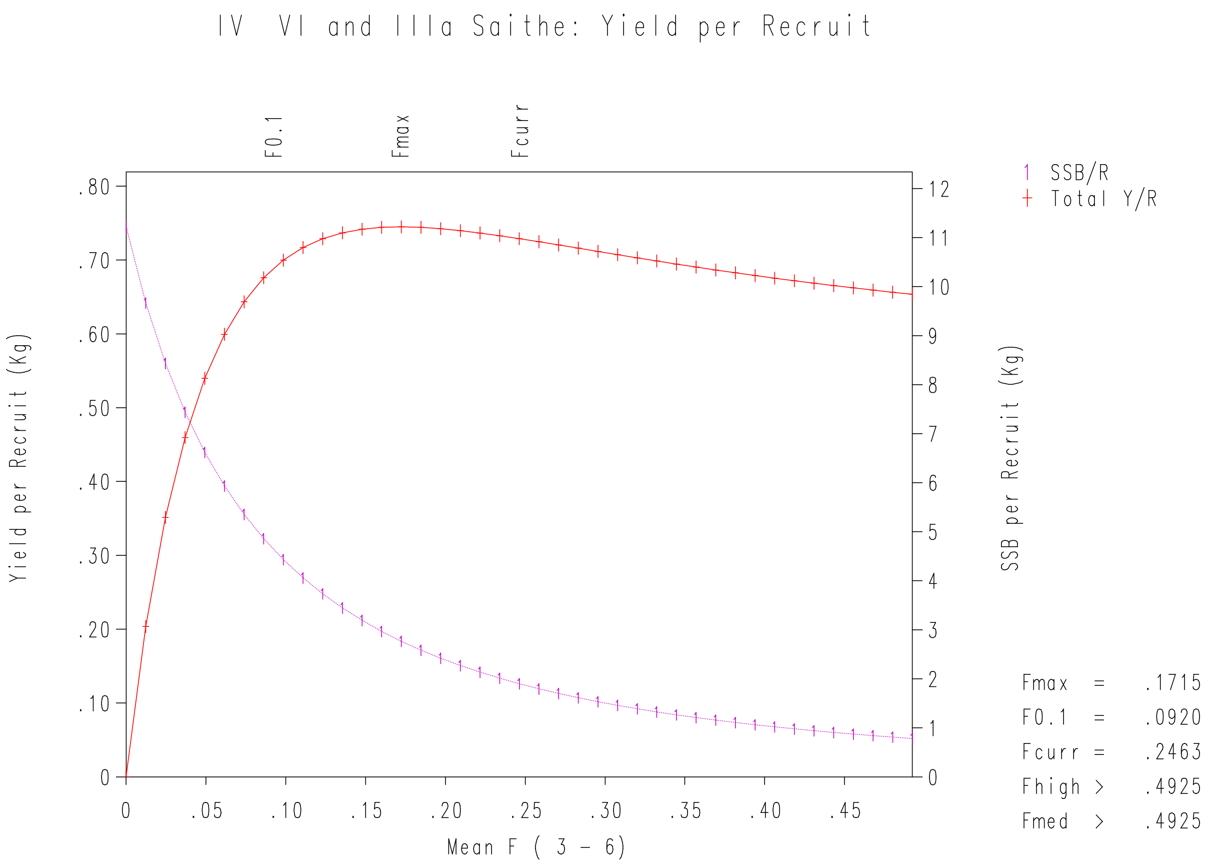


Figure 6.9.3 Saithe in IV, VI, and IIIa

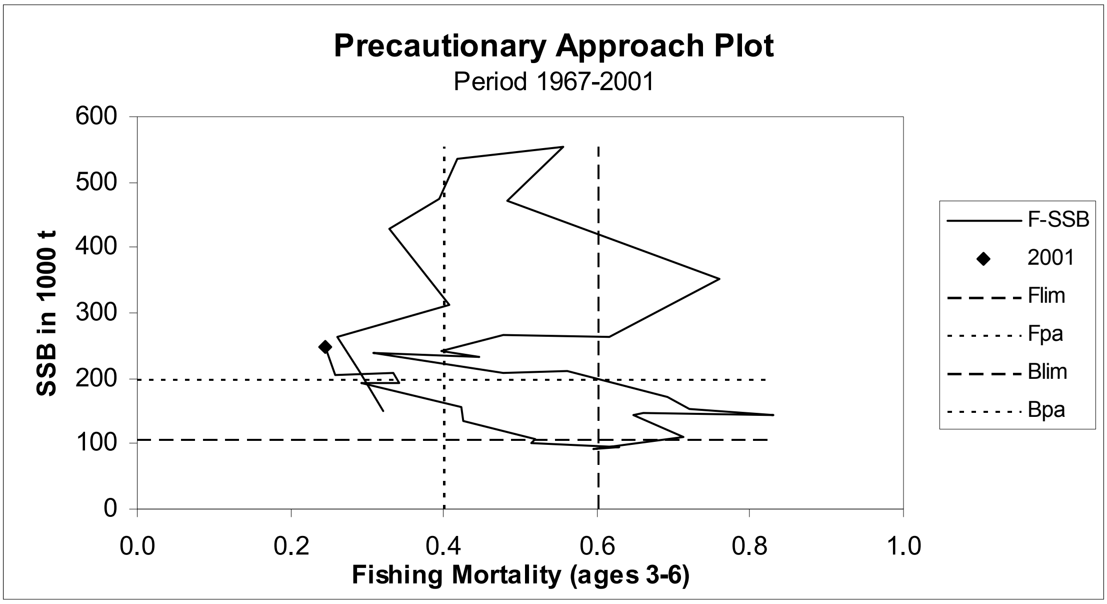


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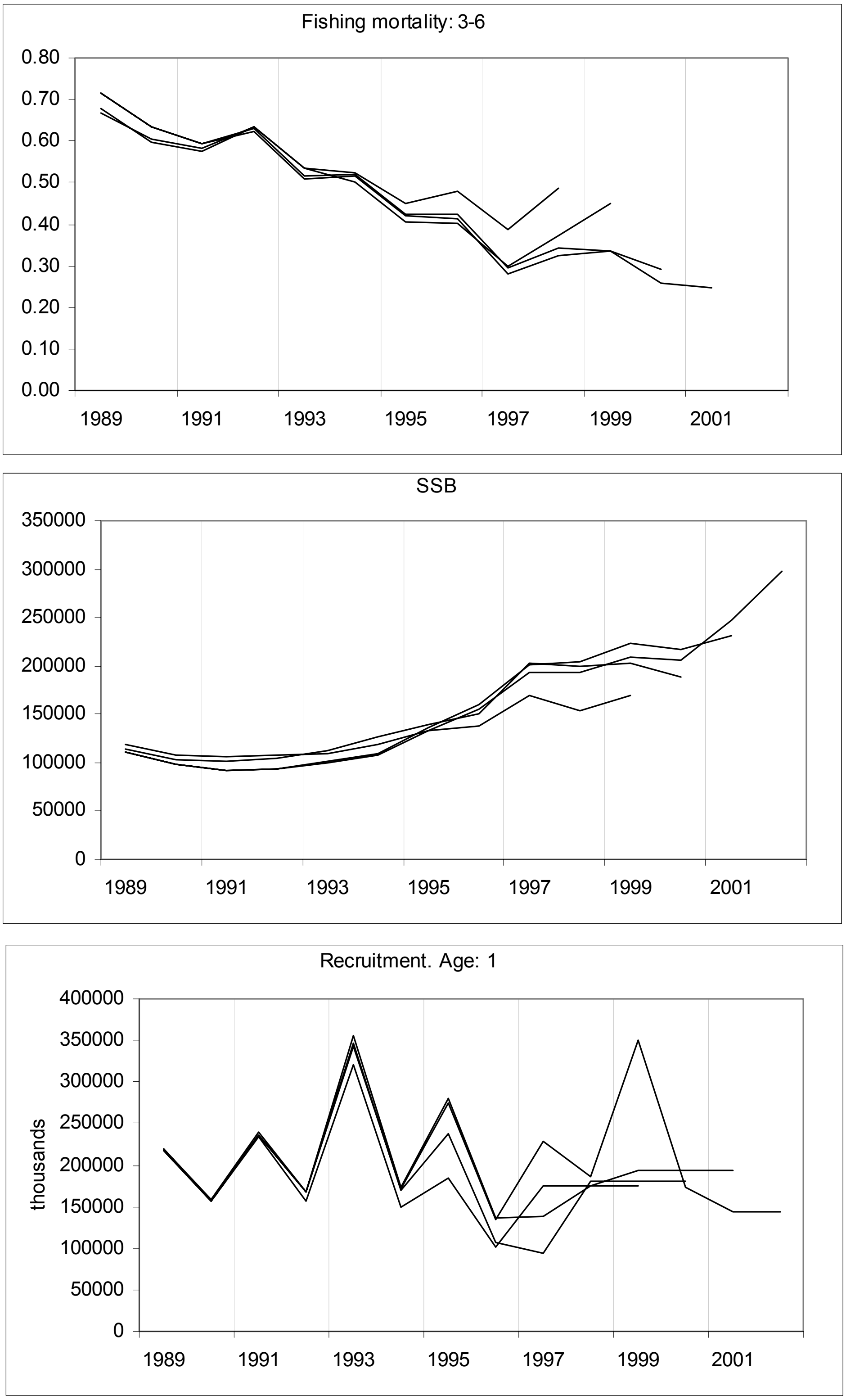
Figure 6.10.1 Saithe in IV, IIIa, and VI. Quality control of assessments generated by successive Working Groups.



7 SOLE IN SUBAREA IV

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 4 main ports: Oostende, Zeebrugge, Nieuwport, and Blankenberge. Out of a total fleet of 126 vessels, 115 use beam trawl exclusively and fish for sole and plaice. The fishing grounds change throughout the year depending on catch rates, although the central and southern North Sea (IVb,c) are the preferred fishing area of the Belgian fleet.

Denmark: The main Danish fishery 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. The introduction of the Plaice Box in 1989 resulted in a change in the distribution pattern of beam trawl vessels >300 HP with an increase in activity outside and to the north of the Box.

UK: The English fleet consists of a large number of small otter trawlers fishing in the southern North Sea for sole mainly in the 2nd and 3rd quarters of the year. Sole is also taken as by-catch in the English beam trawl fishery (9 vessels) which fishes mainly for plaice with 120 mm mesh. About 70% of the total UK catch are landed abroad by Dutch vessels fishing on the UK register.

7.1.1 ACFM advice applicable to 2001 and 2002

For both 2001 and 2002 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. In 2001, the advice was for a catch of less than 17 700 t, although the TAC was set at 19 000 t. For 2002, the advice was for a reduction in F to 0.37 (20% reduction), corresponding to a catch of 14 800 t, but the TAC was subsequently set at 16 000 t.

ACFM noted that the stock is decreasing as the strong 1996 year class is fished out, and the following year classes are only of average strength. It is expected to fall below $\mathbf{B}_{pa}$ in 2003 even if F is reduced.

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.

7.1.2 Management applicable to 2002

The TAC for 2002 was 16 000 t, which is about 11% above the maximum value recommended by ACFM.

In the technical measures applicable to the sole fishery before 2000 an exemption was made 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 are comprised of at least 70% of a mix of species as defined in the new technical measures of the EU.

Some additional protection is given to sole from the closure of the plaice box along the Dutch and Danish coast. In the years 1989 to 1993 the box was closed in the second and third quarters of the year to all vessels using towed gears and with engine power larger than 300 HP. Since the second quarter of 1994 the box has been closed during all quarters.

The closed area in spring 2001 under the North Sea cod emergency regulations resulted in a redistribution of fishing activity for flatfish. In particular beam trawlers were forced to fish further west towards the Dogger Bank.

7.1.3 Landings in 2001

The Working Group estimate of landings in 2001 (19 849 t) was 4% higher than the agreed TAC. Unallocated landings, which represent the difference between the figures reported to ICES and those supplied by WG members, have decreased considerably since 1993 (apart from 2001) and are now 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 (excluding Netherlands where data was not yet available) and 32% from otter trawlers.

For recent years, the officially reported landing by various countries as well as Working Group estimates of the total landings are given in Table 7.1.1. A longer time-series of landings is given in Table 7.6.1 and plotted in Figure 7.6.1.

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 or annual basis and by sex separately from Belgium, France, Germany, the Netherlands, and UK (England and Wales). The samples are thought to be representative of around 90% of the total landings in 2001. However, no samples are collected from national vessels which land abroad and this constitutes an increasing proportion of the total landings by some countries. The age compositions were combined separately by sex on a quarterly basis and then raised to the annual international total.

Revisions since the 2001 WG meeting:

- The data for 2000 were revised after the 2001 WG meeting to take account of age-reading errors, and the revised age composition was used by ACFM in October 2001.

- The English age compositions from 1986 onwards have been fully revised to exclude landings by flag vessels fishing on the UK register. These landings constitute up to 70% of the total English landings but are not sampled because they are landed abroad. The age composition of the foreign landings is expected to be different to the English landings because the fishery is mainly by beam trawlers taking juvenile sole and fishing in the eastern North Sea, whereas the English fishery is mainly by otter trawlers using 100-mm nets in the Thames estuary, IVc. The revised age compositions are given in Table 7.2.1 and distributions-at-age plotted since 1996 in Figure 7.2.1. The changes have had a minor impact on numbers and weights, mainly on older age groups.

Weights-at-age in the catch are measured weights from the various national market sampling programmes of the landings. Weights-at-age in the stock are those of the 2nd quarter in the landings. Revised weights-at-age in the catch and stock are given in Tables 7.2.2 and 7.2.3 and the trend in catch weights-at-age shown in Figure 7.2.2. No clear trends are evident over the last 6 years, although ages 2, 3, 5, and 6 all show a slight decline in 2000.

As in all previous assessments, a knife-edged maturity-ogive was used in all years, assuming full maturation at age 3 (Table 7.2.4). The maturity-ogive is based on market samples of females from observations in the sixties and seventies. Natural mortality in the period 1957-1999 has been assumed constant over all ages at 0.1 (Table 7.2.4), 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. Effort in the Netherlands commercial beam trawl is total HP effort days and this has nearly doubled between 1978 and 1994 and has been relatively stable over the period 1996-2000. The English effort was previously based on the UK commercial beam trawl fleet fishing south of 56^0 North to exclude vessels targeting plaice. This was largely based on effort by foreign beamers fishing on the UK register (flag vessels). A new tuning fleet was derived for otter trawlers which land most of the English catch of sole from IVc. Effort is in HP*hrs and excludes trips directed at cod or shrimps. Belgian effort data (Table 7.3.2) is from the beam trawl fleet and is in HP corrected hours. The effort of this fleet tends to be variable as it switches effort between Area VII and the North Sea. No age composition was available for this fleet and so it was not possible to include it in tuning.

The other 2 tuning fleets are Dutch research vessel surveys. The SNS (Sole Net Survey) is a coastal survey with a 6-m beam trawl carried out in October. The BTS (Beam Trawl Survey) is carried out in the southern and southeastern North Sea in August and September using an 8-m beam trawl.

- The BTS survey indices was revised in 1998 (ICES, 2002).

Available trends in commercial effort and cpue are listed in Table 7.3.2 and shown in Figure 7.3.1. The Dutch beam trawl cpue show a continuous decline since 1990 reaching a minimum in 1997. The good 1996 year class has resulted in an increase in cpue since 1998. The UK otter trawl cpue series also shows a historical low value for 1997 and 1998, but has increased as the 1996 year class has recruited to the UK fishery, one year later than for the Netherlands fleet. The Belgian data indicates a small increase in 2001.

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 less well sampled in the surveys.

7.4 Catch-at-Age Analysis

General approaches and methods are described in Section 1.4.

7.4.1 Data exploration

The effect of the minor changes to the database by removing catches from English flag vessels was investigated by comparing this year's with last year's assessment, using the same settings as previously. The results are shown in Figure 7.4.1. There are very minor differences resulting from the data revisions but a substantial difference caused by the addition of the 2001 data.

A preliminary inspection of the quality of international catch-at-age data was carried out using separable VPA, with a reference age of 4, terminal F = 0.5, and terminal S = 0.8. Except for ages 1/2, log-catch ratios did not show any large residuals or trends (Table 7.4.1). As in previous assessments, the age range for the analyses was kept as 1-15+.

Exploratory runs have previously been carried out to look at fleet catchability trends, the influence of different fleets, ages, and year ranges. In general, no improvements were found in alternative tuning configurations compared to the one used in 2000. This year trial runs were made to look at the sensitivity of the analysis to different fleets used in tuning.

Single-fleet catchability: The fleet data were examined for trends in catchability by carrying out XSA for single fleets over the year range available for each fleet, (settings as last year's final run except for a weak shrinkage of 1.5). Trends in catchability (Figure 7.4.2a) were apparent in the Netherlands BT fleet before 1989, particularly at ages 2-7. This may be due to the change in fishing pattern following the introduction of the plaice box after 1989. The years before 1990 were therefore excluded from subsequent tuning runs. The English otter trawl fleet showed a negative trend from 1990 to 1993 and a positive trend from 1993 for the younger ages. The survey fleets showed no clear trends. In order to reduce the trends in the commercial beam trawl fleet, the tuning was run from 1990 without a taper on all fleets. Analyses in previous years have shown that the alternative downweighting of early years using a tricubic time taper gave very similar results to the use of a shortened year range with no taper.

Combined fleet catchability: When combined with other fleets, the pattern of log-catchability residuals for the Netherlands and surveys were not markedly different from single-fleet runs (Figure 7.4.2b). However, in the English otter trawl fleet log-catchability residuals increased considerably resulting in high SEs (>0.5) at ages above 5. The cpue trend from this fleet matches the Netherlands BT series and it is likely that the poor performance reflects the fact that it is sampling a different area and age range compared to the Netherlands fleet. Despite the relatively poor performance of the UK fleet, it was decided to retain it as it provides additional information on the stock. Plots of log cpue against log VPA population numbers were made for the most important age groups for separate fleets from the combined XSA run (Figure 7.4.3). The plots show reasonable relationships, but there is a wider scatter of the points in the English otter trawl cpue.

The sensitivity of the assessment to the tuning fleets was examined by carrying out trial runs with different combinations of vessels. The results are shown in Figures 7.4.4 and 7.4.5. 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. A run with the addition of an increased age range in the BTS survey, slightly reduced F, and increased SSB was compared to the run with a shortened age range. The tuning diagnostics were similar for the two runs and it was decided to use the increased age range in the future.

Repeating last year's final assessment, without the additional year in the database but including the changes to the English age composition and tuning fleet, gave almost identical results compared to those of last year's Working Group.

The final XSA run was accepted as the same as last year. The only revisions were the change in the English commercial fleet from beam to inshore otter trawl and the extension of the age range in the Netherlands BTS. The inputs are shown below in comparison with last year.

stock	**sole**	
area	**IV**	
year of assessment	**2001**	**2002**
Assessment model	XSA	XSA
NL beamtrawl	1990-2000 2-14	1990-2001 2-14
UK beamtrawl	1990-2000 2-14	
UK Ottertrawl	1990-2000 2-14	1990-2001 2-14
BTS	1990-2000 1-4	1990-2001 **1-9**
SNS	1990-2000 1-4	1990-2001 1-4
Time series weights	none	none
Power model used for catchability	1-2	1-2
Catchability plateau age	7	7
Surv. est. shrunk towards mean F	5 years / 5 ages	5 years / 5 ages
s.e. of the means	0.5	0.5
Min. stand. error for pop. estimates	0.3	0.3
Prior weighting	none	none
Number of iterations	27	22
Convergence	yes	yes

Full tuning diagnostics for the final XSA are given in Table 7.4.2. The weighting given to fleets and to shrinkage is shown in Figure 7.4.6 and compared with previous year's assessments. There is considerable consistency across years. For age 1 (1999 year class), the two surveys are given 80% of the weight (F-shrinkage and P-shrinkage taking only 15% and 5%). For age 2, the surveys also contribute 74% to the weight, 11% coming from shrinkage and the remaining 15% from the two commercial fleets. From age group 3 onwards the commercial fleets start to contribute more, with the most weight given to the Netherlands commercial fleet. Although estimates of survivors from most of the tuning fleets appear to be quite consistent for all ages, the English otter trawl fleet tends to give slightly different estimates for most ages.

Retrospective analyses were run with a 10 year window to investigate the consistency in estimating F(2-8), SSB, and recruitment at age 1. The time-series of the tuning limit the retrospective analysis to only three runs (Figure 7.4.7). The results suggest that F has been underestimated in previous years, particularly in 2000, and SSB slightly overestimated.

The fishing mortality and stock numbers estimated by the final XSA are given in Tables 7.4.3 and 7.4.4. and plotted in Figure 7.6.1. The main impact of the new assessment is to revise upwards the exploitation pattern for the year 2000 from a mean F2-8 of 0.46 to 0.60. In particular, the F on age 4, the strong 1996 year class, has been estimated significantly higher in 2000 compared with last year (0.71 compared with 0.46). The revised fishing mortality resulting from the addition of the 2001 data is unexpected for this stock which usually shows considerable stabilility from year to year. The reason for the change is unclear.

7.5 Recruitment Estimates

Average recruitment in the period 1957-1999 was 134 million (arithmetic mean) or 99 million (geometric mean) 1-year-old fish.

Recruitment indices were available from pre-recruit surveys carried out in 2001 and previous years, but not from the 2002 surveys which will not be completed until later in the year. **As a result, no recruit estimates were made at the WG**. A WG sub-group will meet in September to review the available indices and calculate recruitment estimates. The input files (s4rct01.txt, s4rct02.txt, and s4rct03.txt for VPA recruits at age 1, 2, and 3) are available in the directory: acfm\ wgnssk\2002\stock\sol-nsea\final run\recruitment.

The surveys and indices available are listed in the RCT3 input (Table 7.5.1). The DFS index is an area-weighted survey index combining the inshore surveys of Netherlands, Belgium, Germany, and UK. Revisions to the UK survey resulting from changes in the survey area have resulted in a revised DFS series from 1981 to 2000 (from 1981 0gp and 1980 1gp). Since the UK survey has not been revised prior to 1981, the earlier DFS index should be omitted or down-weighted from any analysis. The 0gp and 1gp indices for 1998 and 1999 were not available because bad weather had prevented the completion of the surveys in these years.

Year-class strength estimates available to the WG are shown below:

Year class	Age in 2001	XSA Thousands	RCT3 Thousands	GM (57-99) Thousands
1999	3	72791	to be estimated	65590
2000	2	71826	to be estimated	87336
2001	1		to be estimated	98661
2002	recruits		to be estimated	98661

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(2-8) has more than trebled in the period 1957-1984, mainly because of the developing beam trawl fishery. It has exceeded the $\mathbf{F_{pa}}$ of 0.4 in most years since 1970. 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, inter-annual 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 22 000 t and 50 000 t, it increased sharply in 1990 and remained at a high level until 1994. Since 1994 it has declined from 74 000 t 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 35 000 t as this year class has been fished down.

7.7 Short-Term Prognosis

The short-term forecast will be carried out later in the year by the WG sub-group once full survey indices for 2001 become available. The input files for the assessment are available at ICES (acfm\wgnssk\2002\stock\sol-nsea\final runs\short term\ [solivsum;solivsen;solivvcf].

7.8 Medium-Term Prognosis

Medium-term forecasts will be made following the estimation of new recruitment indices by the WG**.**

7.9 Biological Reference Points

Input data to the yield-per-recruit analysis are given in Table 7.9.1. Catch and stock weights were the long-term averages (1962-2001). The yield-per-recruit and stock and recruitment curves are given in Figures 7.9.1 and 7.9.2. $\mathbf{F_{sq}}$ (0.52) is estimated to be 35% above $\mathbf{F_{med}}$, which is close to last year's estimate. The calculated biological reference points together with the management reference points for this stock are shown below:

$\mathbf{F_{0.1}}$	$\mathbf{F_{med}}$	$\mathbf{F_{max}}$	$\mathbf{F_{high}}$		$\mathbf{F_{lim}}$	$\mathbf{F_{pa}}$	$\mathbf{B_{lim}}$	$\mathbf{B_{pa}}$
0.1	0.34	0.25	0.81		not defined	0.40	25,000t	35,000t

Figure 7.9.3 shows the relationship between SSBs and F values, plotted into zones according to the proposed precautionary reference points. The figure shows that F has been above $\mathbf{F_{pa}}$ during much of the period, but the SSB in 2001 is estimated to be below $\mathbf{B_{pa}}$.

7.10 Quality of the assessment

Comparisons with previous WGs are shown in Figure 7.10.1. The main change in the assessment compared with last year is the apparent increase in F by about 23% in 2000 and 12% in the terminal year. The corresponding reduction in SSB for 2001 is -17%. The changes are particularly noticeable in view of the usual stability of the sole assessment from year to year. The changes are not driven by the minor revisions in the database or replacement of the English beam trawl tuning fleet with a more appropriate otter fleet. These changes were investigated and had a minor influence compared with the addition of the 2001 data. One possibility is an underestimate of natural mortality on ages exposed to the cold winter of 1996. Although it has not been possible to quantify the additional mortality, it was evident from surveys that there was a larger-than-expected decrease in numbers of young age classes on the continental coast.

The input data for sole indicates that:

- Quarterly catch-at-age data are available for around 90% of the landings
- Discarding is thought to be low (below 30%)
- commercial tuning fleets are well-sampled
- survey fleets cover main parts of the fishery
- historical data series are good

Other changes noted this year are:

- No recruitment estimates have been made pending the completion of Q3 surveys
- No short-term forecasts have been made

There is a shortage of representative data on effort and cpue of fisheries that exploit sole. The two commercial fleets, for which measured data have been used, are mixed fisheries for sole and plaice. The variable catch opportunities of the two species between years and the improved enforcement of management measures in recent years, affect the cpue's in this fishery and may bias the assessment.

7.11 Management Considerations

Sole is mainly caught in a mixed beam trawl fishery with plaice, using 80-mm mesh in the southern North Sea. Simulations on the technical interactions between fleets (Section 1.4.6) indicate that at the low stock levels of both plaice and sole, management of sole at $\mathbf{F_{pa}}$ (0.4) could result in plaice stocks remaining below $\mathbf{B_{pa}}$ in the short term, irrespective of the reduction in effort in other flatfish fleets such as the Danish gillnetters. It would be necessary to reduce fishing mortality on sole to below 0.3 to allow plaice stocks to rebuild above the $\mathbf{B_{pa}}$ of 300 000 t. Although very preliminary, the simulations provide some indication of the interdependence of the two stocks.

A knife-edged maturity ogive is used for sole, implying maturity-at-age 3. There is evidence from previous working documents that this may substantially overestimate the proportion of mature sole in some years. Consideration should be given to the use of maturity ogives based on annually available biological data such as length or weight.

The cod closure in the North Sea in 2001 affected the distribution and pattern of fishing activity of beam trawlers in the first quarter of the year. Effort was displaced westwards from around the plaice box towards the Dogger Bank and central North Sea. The impact of this change in fishing pattern has not been evaluated.

The sole stock is heavily dependent on recruiting year classes, and management measures which produced a reduction in the mortality on juvenile sole would benefit the stock in the long term. The continued use of 80-mm mesh together with the MLS of 24 cm results in a high proportion of sole being landed which are immature. The maintenance of the plaice box is a measure which probably benefits sole by protecting juveniles in the main continental nursery areas.

Table 7.1.1 North Sea sole, official landings as reported to ICES, 1982-2001

Year	Belgium	Denmark	France	Germany Fed. Rep.	Netherlands	UK (Engl. Wales)	Other countries	Total reported	Unallocated landings	WG Total	TAC
1982	1,927	522	686	290	17,749	403		21,577	2	21,579	20,000
1983	1,740	730	332	619	16,101	435		19,957	4,970	24,927	20,000
1984	1,771	818	400	1,034	14,330	586	1	18,940	7,899	26,839	20,000
1985	2,390	692	875	303	14,897	774	3	19,934	4,314	24,248	22,000
1986	1,833	443	296	155	9,558	647	2	12,934	5,266	18,200	20,000
1987	1,644	342	318	210	10,635	676	4	13,829	3,539	17,368	14,000
1988	1,199	616	487	452	9,841	740	28	13,363	8,227	21,590	14,000
1989	1,596	1,020	312	864	9,620	1,033	50	14,495	7,311	21,806	14,000
1990	2,389	1,428	352	2,296	18,202	1,614	263	26,544	8,576	35,120	25,000
1991	2,977	1,307	465	2,107	18,758	1,723	271	27,608	5,905	33,513	27,000
1992	2,058	1,359	548	1,880	18,601	1,281	277	26,004	3,337	29,341	25,000
1993	2,783	1,661	490	1,379	22,015	1,149	298	29,775	1,716	31,491	32,000
1994	2,935	1,804	499	1,744	22,874	1,137	298	31,291	1,711	33,002	32,000
1995	2,624	1,673	640	1,564	20,927	1,040	312	28,780	1,687	30,467	28,000
1996	2,555	1,018	535	670	15,344	848	229	20,351	2,300	22,651	23,000
1997	1,519	689	99	510	10,241	479	204	13,741	1,160	14,901	18,000
1998	1,844	520	510	782	15,198	549	338	19,739	1,129	20,868	19,100
1999	1,919	828	357	1,458	16,283	645	501	21,991	1,484	23,475	22,000
2000	1,806	1,069	362	1,280	15,273	600	346	20,736	1,796	22,532	22,000
2001	1,874	773	370	958	11,547	596	310	16,428	3,421	19,849	19,000

Table 7.2.1 North Sea sole, catch numbers-at-age

At 10/06/2002 09:27

YEAR	1957	1958	1959	1960	1961
AGE					
1	0	0	0	0	0
2	1415	1854	3659	12042	959
3	10148	8440	12025	14133	49786
4	12642	14169	10401	16798	19140
5	3762	9500	8975	9308	12404
6	2924	3484	5768	8367	4695
7	6518	3008	1206	4846	3944
8	1733	4439	2025	1593	4279
9	509	2253	2574	1056	836
10	5379	727	1366	2800	990
11	166	5215	736	992	1711
12	266	111	2875	515	1154
13	34	207	101	3135	444
14	79	35	128	133	2539
+gp	364	262	409	326	416
0 TOTALNUM	45939	53704	52248	76044	103297
TONSLAND	12067	14287	13832	18620	23566
SOPCOF %	104	100	101	99	101

YEAR	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
AGE										
1	0	0	55	0	0	0	1037	396	1299	420
2	1594	676	155	47100	12278	3686	17148	23922	6140	33369
3	6210	8339	2113	1089	133617	25683	13896	21451	25993	14425
4	59191	8555	5712	1599	990	85127	24973	5326	8235	12757
5	15346	46201	3809	5002	1181	1954	48571	12388	1784	4485
6	10541	8490	17337	2482	3689	536	462	25139	3231	1442
7	4826	6658	3126	12500	744	1919	245	331	11960	2327
8	4112	2423	1810	1557	6324	760	1644	244	246	7214
9	2087	3393	818	1525	702	5047	324	1190	140	192
10	900	1566	872	389	767	538	4407	289	686	232
11	1539	1002	495	627	287	610	254	2961	169	826
12	977	764	217	475	473	455	820	291	2416	291
13	1161	1778	474	322	120	348	82	538	238	1413
14	389	413	336	200	87	277	396	151	582	466
+gp	2528	2861	621	1195	716	685	564	1042	1143	1366
TOTALNUM	111401	93119	37950	76062	161975	127625	114823	95659	64262	81225
TONSLAND	26877	26164	11342	17043	33340	33439	33179	27559	19685	23652
SOPCOF %	99	99	97	96	99	102	100	102	100	101

Table 7.2.1 (Cont'd)

YEAR	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
AGE										
1	358	703	101	264	1041	1747	27	9	637	423
2	7594	12228	15380	22954	3542	22328	25031	8179	1209	29217
3	36759	12783	21540	28535	27966	12073	29292	41170	12511	3259
4	7075	16187	5487	11717	14013	15306	6129	16060	17781	6866
5	4965	4025	7061	2088	4819	7440	6639	2996	7297	8223
6	1565	2324	1922	3830	966	1779	4250	3222	1450	3661
7	523	994	1585	790	1909	319	1738	1747	2197	948
8	1232	765	658	907	550	1112	611	816	1409	886
9	4706	1218	401	508	425	256	646	241	367	766
10	120	3337	609	234	204	211	191	393	54	197
11	100	221	2363	252	195	93	235	154	415	107
12	492	297	104	1905	132	122	123	117	52	160
13	119	499	32	25	1320	108	106	103	52	92
14	922	110	305	84	39	852	68	73	32	21
+gp	1048	1326	1401	945	773	729	879	687	598	331
TOTALNUM	67578	57017	58949	75038	57894	64475	75965	75967	46061	55157
TONSLAND	21086	19309	17989	20773	17326	18003	20280	22598	15807	15403
SOPCOF %	99	102	99	101	102	102	100	101	102	103

YEAR	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
AGE										
1	2660	389	191	165	374	94	10	117	863	120
2	26435	34408	30734	16618	9363	29053	13219	46387	11939	13163
3	45746	41386	43931	43213	18497	22046	47182	18263	104454	25420
4	1843	21189	22554	20286	17702	8899	15232	22654	9767	77913
5	3535	624	8791	9403	7747	6512	4381	4624	9194	6724
6	4789	1378	741	3556	5515	3119	3882	1653	3349	3675
7	1678	1950	854	209	2270	1567	1551	1437	1043	1736
8	615	978	1043	379	110	903	891	647	1198	719
9	605	386	524	637	283	81	524	458	554	730
10	527	301	242	200	620	103	38	227	225	304
11	149	423	209	192	355	165	34	45	291	281
12	74	31	146	189	172	144	85	35	58	340
13	201	14	30	94	126	62	42	44	26	14
14	12	177	24	33	105	55	10	35	44	15
+gp	315	230	243	267	304	165	108	82	201	136
TOTALNUM	89184	103864	110257	95441	63543	72968	87189	96708	143206	131290
TONSLAND	21579	24927	26839	24248	18201	17368	21590	21805	35120	33513
SOPCOF %	101	100	100	99	99	99	100	98	99	98

YEAR	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
AGE										
1	980	54	718	4801	172	1590	244	287	2340	880
2	6832	50451	7804	12767	18824	6047	56648	15762	15000	25722
3	44378	16768	87403	16822	16190	23651	15141	72470	32580	21491
4	16204	31409	13550	68571	16964	7325	14934	8187	42597	19781
5	38319	13869	18739	6308	27257	5108	3496	6111	3272	16650
6	2477	24035	5711	7307	3858	12793	1941	1212	2465	1420
7	3041	1489	11310	1995	4780	1201	4768	664	800	830
8	741	1184	464	6015	943	2326	794	1984	433	273
9	399	461	916	295	3305	333	1031	331	926	168
10	454	172	265	331	239	1437	238	492	301	505
11	162	293	73	58	287	31	410	43	218	61
12	224	101	211	67	149	114	43	175	49	60
13	116	75	76	48	50	20	59	8	101	11
14	6	108	41	20	100	23	12	35	8	51
+gp	218	93	242	144	163	63	84	59	33	32
TOTALNUM	114551	140562	147523	125549	93281	62062	99843	107820	101123	87935
TONSLAND	29341	31491	33002	30467	22651	14901	20868	23475	22532	19849
SOPCOF %	99	99	99	99	99	99	99	99	99	97

Table 7.2.2 North Sea sole. Catch weights-at-age
At 10/06/2002 09:27

YEAR	1957	1958	1959	1960	1961
AGE					
1	0	0	0	0	0
2	0.154	0.145	0.162	0.153	0.146
3	0.177	0.178	0.188	0.185	0.174
4	0.204	0.22	0.228	0.235	0.211
5	0.248	0.254	0.261	0.254	0.255
6	0.279	0.273	0.301	0.277	0.288
7	0.29	0.314	0.328	0.301	0.319
8	0.335	0.323	0.321	0.309	0.304
9	0.436	0.388	0.373	0.381	0.346
10	0.394	0.401	0.391	0.363	0.372
11	0.432	0.409	0.438	0.436	0.369
12	0.471	0.502	0.417	0.428	0.397
13	0.631	0.287	0.437	0.442	0.478
14	0.437	0.578	0.412	0.427	0.45
+gp	0.533	0.577	0.589	0.578	0.551
SOPCOFAC	1.0402	1.005	1.0095	0.9936	1.0137

YEAR	1962	1963	1964	1965	1966	1967
AGE						
1	0	0	0.153	0	0	0
2	0.155	0.163	0.175	0.169	0.177	0.192
3	0.165	0.171	0.213	0.209	0.19	0.201
4	0.208	0.219	0.252	0.246	0.18	0.252
5	0.241	0.258	0.274	0.286	0.301	0.277
6	0.295	0.309	0.309	0.282	0.332	0.389
7	0.32	0.323	0.327	0.345	0.429	0.419
8	0.321	0.387	0.346	0.378	0.399	0.339
9	0.334	0.376	0.388	0.404	0.449	0.424
10	0.349	0.44	0.444	0.425	0.472	0.498
11	0.347	0.397	0.439	0.459	0.541	0.456
12	0.394	0.433	0.475	0.48	0.526	0.389
13	0.435	0.444	0.403	0.458	0.521	0.519
14	0.373	0.49	0.447	0.397	0.491	0.442
+gp	0.476	0.578	0.644	0.528	0.499	0.591
SOPCOFAC	0.994	0.9918	0.9661	0.9592	0.9892	1.0225

YEAR	1972	1973	1974	1975	1976	1977
AGE						
1	0.169	0.146	0.164	0.129	0.143	0.147
2	0.204	0.208	0.192	0.182	0.19	0.188
3	0.252	0.238	0.233	0.225	0.222	0.236
4	0.334	0.346	0.338	0.32	0.306	0.307
5	0.434	0.404	0.418	0.406	0.389	0.369
6	0.425	0.448	0.448	0.456	0.441	0.424
7	0.532	0.552	0.52	0.529	0.512	0.43
8	0.485	0.567	0.559	0.595	0.562	0.52
9	0.558	0.509	0.609	0.629	0.667	0.562
10	0.481	0.569	0.602	0.56	0.658	0.622
11	0.472	0.644	0.661	0.648	0.538	0.731
12	0.577	0.399	0.678	0.683	0.736	0.607
13	0.597	0.547	0.532	0.62	0.668	0.605
14	0.677	0.642	0.582	0.645	0.598	0.643
+gp	0.647	0.67	0.679	0.678	0.684	0.581
SOPCOFAC	0.989	1.0189	0.9864	1.0104	1.0216	1.0188

Table 7.2.2 (Cont'd)

YEAR	1982	1983	1984	1985	1986	1987
AGE						
1	0.141	0.134	0.153	0.122	0.135	0.139
2	0.188	0.182	0.171	0.187	0.179	0.185
3	0.216	0.217	0.221	0.216	0.213	0.205
4	0.307	0.301	0.286	0.288	0.299	0.277
5	0.371	0.389	0.361	0.357	0.357	0.356
6	0.409	0.416	0.386	0.427	0.407	0.378
7	0.437	0.467	0.465	0.447	0.485	0.428
8	0.491	0.489	0.555	0.544	0.543	0.481
9	0.58	0.505	0.575	0.612	0.568	0.393
10	0.556	0.609	0.512	0.634	0.536	0.608
11	0.628	0.622	0.655	0.509	0.575	0.646
12	0.591	0.6	0.631	0.656	0.634	0.615
13	0.771	0.334	0.722	0.767	0.632	0.697
14	0.898	0.631	0.845	0.801	0.789	0.728
+gp	0.768	0.756	0.707	0.68	0.715	0.696
SOPCOFAC	1.0138	1.004	1.0034	0.9898	0.9937	0.9946

YEAR	1992	1993	1994	1995	1996	1997
AGE						
1	0.146	0.097	0.143	0.151	0.163	0.151
2	0.178	0.167	0.18	0.186	0.177	0.18
3	0.213	0.196	0.202	0.196	0.202	0.206
4	0.258	0.239	0.228	0.247	0.234	0.236
5	0.298	0.264	0.257	0.265	0.274	0.267
6	0.38	0.3	0.3	0.319	0.285	0.296
7	0.409	0.338	0.317	0.344	0.318	0.323
8	0.46	0.441	0.432	0.356	0.37	0.306
9	0.487	0.496	0.409	0.444	0.39	0.384
10	0.531	0.636	0.415	0.511	0.516	0.406
11	0.59	0.564	0.544	0.792	0.546	0.579
12	0.468	0.583	0.478	0.564	0.555	0.605
13	0.63	0.651	0.702	0.764	0.601	0.668
14	0.779	0.61	0.614	0.94	0.7	0.45
+gp	0.626	0.641	0.554	0.602	0.763	0.762
SOPCOFAC	0.985	0.9885	0.9879	0.9927	0.9886	0.9901

Table 7.2.3 North Sea sole, stock weights-at-age derived from 2nd quarter catch weights

At 10/06/2002 09:27

YEAR	1957	1958	1959	1960	1961
AGE					
1	0.025	0.025	0.025	0.025	0.025
2	0.07	0.07	0.07	0.07	0.07
3	0.147	0.164	0.159	0.163	0.148
4	0.187	0.205	0.198	0.207	0.206
5	0.208	0.226	0.239	0.234	0.235
6	0.253	0.228	0.271	0.24	0.232
7	0.262	0.297	0.292	0.268	0.259
8	0.355	0.318	0.276	0.242	0.274
9	0.39	0.393	0.303	0.36	0.281
10	0.359	0.38	0.41	0.357	0.302
11	0.602	0.417	0.408	0.508	0.379
12	0.37	0.61	0.406	0.39	0.335
13	0.587	0.433	0.413	0.464	0.482
14	0.689	0.566	0.598	0.466	0.433
+gp	0.254	0.518	0.599	0.573	0.548

YEAR	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
AGE										
1	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.034
2	0.07	0.07	0.07	0.14	0.07	0.177	0.122	0.137	0.137	0.148
3	0.148	0.148	0.159	0.198	0.16	0.164	0.171	0.174	0.201	0.213
4	0.192	0.193	0.214	0.223	0.149	0.235	0.248	0.252	0.275	0.313
5	0.24	0.243	0.24	0.251	0.389	0.242	0.312	0.324	0.341	0.361
6	0.301	0.275	0.291	0.297	0.31	0.399	0.28	0.364	0.367	0.41
7	0.293	0.311	0.305	0.337	0.406	0.362	0.629	0.579	0.423	0.432
8	0.282	0.363	0.306	0.358	0.377	0.283	0.416	0.415	0.458	0.474
9	0.273	0.329	0.365	0.526	0.385	0.381	0.41	0.469	0.39	0.483
10	0.41	0.433	0.443	0.424	0.427	0.464	0.45	0.524	0.486	0.451
11	0.358	0.365	0.396	0.464	0.598	0.378	0.753	0.504	0.49	0.481
12	0.315	0.352	0.458	0.456	0.555	0.372	0.445	0.564	0.535	0.425
13	0.463	0.491	0.47	0.418	0.468	0.544	0.66	0.534	0.622	0.574
14	0.462	0.414	0.394	0.339	0.38	0.45	0.456	0.515	0.574	0.502
+gp	0.539	0.54	0.631	0.504	0.538	0.546	0.698	0.551	0.622	0.568

YEAR	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
AGE										
1	0.038	0.039	0.035	0.035	0.035	0.035	0.035	0.045	0.039	0.05
2	0.155	0.149	0.146	0.148	0.142	0.147	0.139	0.148	0.157	0.137
3	0.218	0.226	0.218	0.206	0.201	0.202	0.211	0.211	0.2	0.2
4	0.313	0.322	0.329	0.311	0.301	0.291	0.29	0.3	0.304	0.305
5	0.419	0.371	0.408	0.403	0.379	0.365	0.365	0.352	0.345	0.364
6	0.443	0.433	0.429	0.446	0.458	0.409	0.429	0.429	0.394	0.402
7	0.443	0.452	0.499	0.508	0.508	0.478	0.427	0.521	0.489	0.454
8	0.443	0.472	0.565	0.582	0.517	0.487	0.385	0.562	0.537	0.522
9	0.508	0.446	0.542	0.58	0.644	0.531	0.542	0.567	0.579	0.561
10	0.44	0.489	0.594	0.617	0.697	0.617	0.428	0.656	0.549	0.52
11	0.471	0.621	0.632	0.615	0.614	0.661	0.57	0.712	0.664	0.409
12	0.503	0.466	0.594	0.647	0.786	0.656	0.675	0.716	0.676	0.713
13	0.631	0.548	0.65	0.65	0.648	0.628	0.589	0.787	0.638	0.533
14	0.621	0.624	0.54	0.705	0.628	0.632	0.86	0.815	0.657	0.822
+gp	0.659	0.642	0.623	0.669	0.679	0.665	0.697	0.791	0.638	0.72

Table 7.2.3 (Cont'd)

YEAR	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
AGE										
1	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
2	0.13	0.14	0.133	0.127	0.133	0.154	0.133	0.133	0.148	0.139
3	0.193	0.2	0.203	0.185	0.191	0.191	0.193	0.195	0.203	0.184
4	0.27	0.285	0.268	0.267	0.278	0.262	0.26	0.29	0.294	0.254
5	0.359	0.329	0.348	0.324	0.345	0.357	0.335	0.35	0.357	0.301
6	0.411	0.435	0.386	0.381	0.423	0.381	0.409	0.34	0.447	0.413
7	0.429	0.464	0.488	0.38	0.495	0.406	0.417	0.411	0.399	0.447
8	0.476	0.483	0.591	0.626	0.487	0.454	0.474	0.475	0.494	0.522
9	0.583	0.51	0.567	0.554	0.587	0.332	0.486	0.419	0.481	0.548
10	0.593	0.583	0.559	0.589	0.547	0.512	0.454	0.463	0.511	0.557
11	0.57	0.601	0.632	0.517	0.681	0.639	0.829	0.705	0.716	0.532
12	0.531	0.721	0.731	0.734	0.646	0.582	0.658	0.788	0.557	0.566
13	0.791	0.741	0.873	0.74	0.743	0.634	0.533	0.723	0.797	0.469
14	0.611	0.68	0.952	0.642	0.941	0.691	0.85	0.62	0.489	1.109
+gp	0.691	0.719	0.7	0.673	0.888	0.671	0.696	0.736	0.765	0.665

YEAR	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
AGE										
1	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
2	0.156	0.128	0.143	0.151	0.147	0.15	0.14	0.131	0.139	0.144
3	0.194	0.184	0.174	0.179	0.178	0.19	0.173	0.187	0.185	0.185
4	0.257	0.229	0.209	0.24	0.208	0.225	0.234	0.216	0.226	0.223
5	0.307	0.265	0.257	0.253	0.274	0.252	0.267	0.259	0.264	0.263
6	0.398	0.293	0.326	0.321	0.268	0.303	0.281	0.296	0.275	0.319
7	0.406	0.344	0.349	0.365	0.321	0.319	0.328	0.34	0.287	0.327
8	0.472	0.482	0.402	0.357	0.375	0.325	0.273	0.322	0.337	0.421
9	0.5	0.437	0.494	0.545	0.402	0.36	0.336	0.369	0.391	0.41
10	0.551	0.576	0.341	0.46	0.401	0.385	0.334	0.418	0.269	0.502
11	0.498	0.564	0.436	0.411	0.47	0.581	0.488	0.424	0.332	0.396
12	0.443	0.504	0.519	0.715	0.548	0.635	0.306	0.499	0.3	0.6
13	0.602	0.681	0.473	0.694	0.628	0.715	0.549	0.566	0.688	0.604
14	0.672	0.579	0.695	0.584	0.641	0.717	0.483	0.684	1.071	0.568
+gp	0.612	0.67	0.498	0.661	0.81	0.654	0.641	0.627	0.634	1.016

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 Sea																
	104															
FLT01:	NL Comm BT															
	1979	2001														
	1	1	0	1												
	2	15														
		44.9	721.2	35400.6	12904.4	2096.5	2657.4	1490	641.6	177.2	323.3	104.9	85.5	77	53.7	476.1
		45	938.3	11061	14294.5	4914.8	938.1	1731.7	1133.1	214.3	17	347.8	16.5	32.5	23.7	432.2
		46.3	26036	2756	5720.5	6094.5	2265.5	586.6	531.3	439.4	98.9	15.3	102.4	56.9	4.4	173.2
		57.3	24290.1	38683	1085.1	2638.3	3214.2	961.1	234.8	352.9	287.6	80.2	41.7	157.3	7.9	141.1
		65.6	31274.7	36706.2	16386.3	375.1	768.9	1117.8	531.2	237.5	168.1	338.6	15	2	157.6	143.2
		70.8	26976.3	37398.3	18212.1	6529	301.2	492	633.5	321.8	123.7	130.9	90.3	6.4	14.5	155.4
		70.3	12923.7	34685.4	16979.4	7239.6	2536.8	146.5	285.1	426.8	84.9	68.7	113.3	61.9	9.1	134.5
		68.2	8027	13755	13809.8	6353.7	4342.4	1712.2	71.8	223.4	405.6	211.1	124.6	73.4	88.5	247.6
		68.5	23736.2	18618.8	6796	5209.3	2597.3	1136.9	580.1	44.4	67.4	70.1	83.3	29.7	31.2	122.1
		76.3	12191.9	40595.2	12448.9	2982.9	2955.6	1274.8	652.4	384.5	30.4	25.4	42.7	26.1	3.2	60.9
		61.6	40284.3	13165.6	17489.4	2688.9	1099.4	1134.4	409.4	333.9	161.6	8.9	22.7	16.2	10	40
		71.4	9071.1	84629.7	7242	6586.7	1669.1	634.6	819.2	375.9	137.6	134.1	42.5	10.1	12.6	138.2
		68.5	7336.6	17182.4	59754	4638.3	2137.6	682.7	312.1	392.3	156.6	98.4	180.5	6.3	6	48.1
		71.1	5046.7	33880.5	11131	29835.9	1457.9	2081.2	446.1	218.6	274.8	75.7	164.1	66.4	3.9	109
		76.9	39284.5	10948	24132	9625.4	18624	887.1	811.5	236.1	66.4	186.3	50.2	41.6	59.1	21.8
		81.4	5389.9	69878.8	7411.7	13010.4	3104.8	8932.9	190	524.2	175.9	25.9	158.5	25.2	20.1	149.5
		81.2	9778	11329.4	53488.8	2839.2	5128.8	896.5	4682.4	147.4	204.8	24.4	22.4	34.7	6.4	108.6
		72.1	15843.4	9093.9	11170.8	21211.9	1570	3173.4	471.9	2773.8	160	190.5	85.7	23.3	62.4	99.5
		72	4505.9	18426.8	4503.6	3329	9771.1	497.2	1800.4	94.6	1155.3	5.7	76.9	11.1	14.3	43.5
		70.2	50570.7	9023.1	11123.1	1826.2	1145.6	3395	210.7	337	21.4	286.6	5.2	37.2	4.9	42.9
		67.3	11820.5	55177.2	4152.6	4458.8	730.2	335.7	1526.8	133.4	362.5	6	126.7	2	21.5	30.1
		67.7	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
FLT02:	UK Comm OT			effort hphr's (000's)												
	1990	2001														
	1	1	0	1												
	2	15														
		6409.118	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
		6643.43	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
		5279.325	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
		5787.174	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
		4913.329	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
		4766.303	39.9	128.8	144.1	134.3	38.6	26.8	17	1	6	3	3.2	0.5	0.2	1.7
		3352.814	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
		2852.804	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
		1933.372	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
		2184.136	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
		1667.602	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
		1446.031	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
FLT03:	NL BTS															
	1985	2001														
	1	1	0.67	0.75												
	1	4														
		1	2.64	7.28	3.75	1.97										
		1	7.76	4.58	1.7	0.81										
		1	6.96	12.5	1.85	0.55										
		1	81.23	12.81	2.78	0.99										
		1	8.67	67.76	4.19	4.09										
		1	22.44	22.33	20.06	0.59										
		1	3.43	23.2	5.84	6.01										
		1	72.71	22.66	9.61	2.26										
		1	4.63	26.61	1.58	5.23										
		1	5.94	4.95	15.46	0.13										
		1	26.31	8.68	8.27	6.47										
		1	3.48	5.94	1.8	1.45										
		1	173.51	5.36	3.23	0.8										
		1	14.16	29.15	2	1.33										
		1	11.2	19.51	16.62	0.63										
		1	13.6	6.1	4.5	1.1										
		1	8.11	10.14	2.42	2.07										

Table 7.3.1 (Cont'd)

FLT04:		NL: SNS				
	1970	2001				
	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

Table 7.3.2 North Sea sole, indices of effort and cpue

	Effort			CPUE		
	1 Belgium	2 UK-ot	3 Netherlands	4 Belgium	5 UK-ot	6 Netherlands
1971						
1972	29.8			33.5		
1973	29.4			33.1		
1974	32.2			23.7		
1975	39.2			26.2		
1976	44.7			24.5		
1977	47.6			27.2		
1978	50.3		44.3	25.9		375.8
1979	40.0		44.9	38.7		423.2
1980	35.2		45.0	30.9		282.1
1981	31.1		46.3	35.2		267.8
1982	34.9		57.3	44.7		309.8
1983	35.4		65.6	42.8		319.9
1984	42.8		70.8	35.2		307.3
1985	51.4		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	70.3	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

1 fishing hours in 1000 HP beam trawl units * 10E3
2 thous HP hours
3 million HP days beam trawl
4 Kg/FH 1000 HP beam trawl
5 kg/ HP hours
6 kg/1000 HP day

Table 7.4.1 North Sea sole, Separable VPA output

Title : Sole in IV

At 13/06/2002 22:07

Separable analysis
from 1957 to 2001 on ages 1 to 14
with Terminal F of .500 on age 4 and Terminal S of .800

Initial sum of squared residuals was 1811.213 and
final sum of squared residuals is 412.141 after 150 iterations

Matrix of Residuals

Years	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87	1987/88	1988/89	1989/90	1990/91
1/ 2	-0.386	0.924	-0.576	-0.888	-0.176	-0.883	-1.4	-4.916	-0.787	1.007
2/ 3	0.274	0.025	0.537	0.225	0.72	-0.414	0.068	0.236	0.052	-0.017
3/ 4	0.253	0.196	0.366	0.299	0.683	0.108	-0.101	0.296	0.507	0.023
4/ 5	0.007	0.16	0.305	0.056	0.416	0.021	-0.104	0.421	0.459	-0.229
5/ 6	-0.087	0.048	-0.719	0.115	0.016	-0.039	-0.268	0.227	-0.096	0.34
6/ 7	0.109	-0.042	-0.114	0.429	-0.109	0.266	-0.136	0.193	-0.01	0.032
7/ 8	-0.004	-0.159	0.265	0.215	0.314	0.174	-0.031	0.31	-0.059	-0.02
8/ 9	-0.232	-0.415	0.089	-0.284	-0.209	-0.626	-0.231	-0.075	-0.257	-0.071
9/10	0.118	0.195	0.293	0.558	-0.126	0.451	0.362	0.487	0.674	0.405
10/11	-0.892	-1.237	-0.719	-1.114	-1.627	-0.196	-0.228	-1.459	-1.19	-1.334
11/12	0.109	1.055	0.88	-0.315	-0.044	0.338	0.25	-0.409	-0.317	-0.369
12/13	-1.219	0.393	-0.879	-0.724	-0.468	-0.304	0.068	-0.473	-0.494	0.473
13/14	1.791	-0.379	-0.715	-0.503	-0.247	0.28	1.412	-0.208	-0.071	0.337
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	1991/92	1992/93	1993/94	1994/95	1995/96	1996/97	1997/98	1998/99	1999/**	2000/**	TOT	WTS
1/ 2	-0.36	-0.17	-1.225	0.658	2.621	-0.161	0.171	-0.748	-0.162	0.946	-0.008	0.111
2/ 3	-0.534	-0.143	0.158	-0.264	0.67	0.096	-0.237	0.135	0.032	-0.022	0	0.539
3/ 4	0.113	0.073	-0.132	-0.318	-0.164	-0.01	0.065	-0.088	0.245	-0.219	0	0.805
4/ 5	0.036	-0.453	-0.172	-0.15	0.427	0.02	-0.006	-0.172	0.29	-0.134	0	0.978
5/ 6	0.351	-0.114	0.229	0.058	0.029	-0.387	0.255	0.027	0.311	-0.209	0	0.912
6/ 7	-0.506	-0.117	0.055	0.126	-0.071	-0.012	0.238	-0.002	-0.223	-0.003	0	1
7/ 8	0.391	0.551	0.702	-0.053	0.481	-0.207	-0.099	0.049	0.022	0.23	0	0.776
8/ 9	-0.047	-0.093	-0.385	-0.414	0.157	-0.078	0.122	-0.139	0.181	-0.084	0	0.967
9/10	0.21	0.634	0.264	0.518	0.092	0.075	-0.013	0.097	-0.135	-0.038	0	0.902
10/11	-0.56	-0.682	-0.35	0.069	-0.854	0.297	-0.014	0.096	-0.326	-0.022	0	0.51
11/12	-0.054	0.257	0.04	-0.416	-1.045	0.181	-0.665	0.209	-0.361	0.632	0	0.498
12/13	0.056	0.149	-0.734	0.225	-0.509	0.493	-0.409	0.273	-0.406	0.065	0	0.443
13/14	0.57	-0.134	0.336	0.85	-0.8	0.071	0.203	-0.099	-0.212	0.032	0	0.4
TOT	0	0	0	0	0	0	0	0	0	0	-63.935	

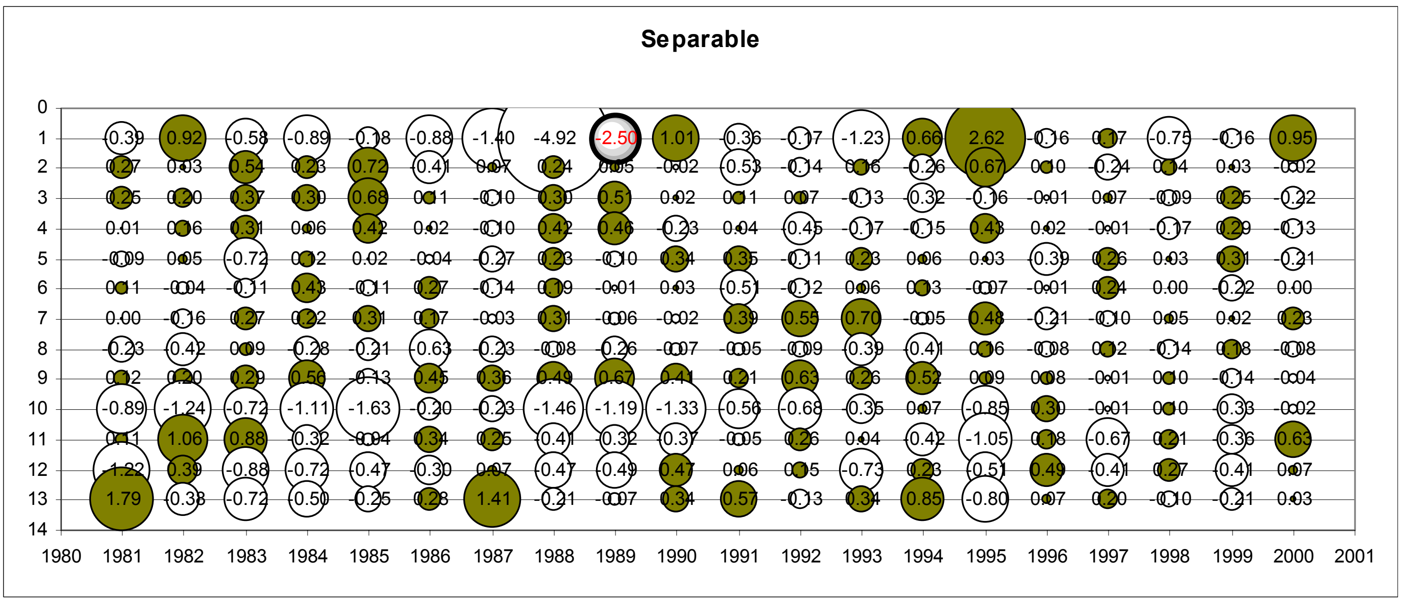


Table 7.4.2 North Sea sole: XSA tuning output

Lowestoft VPA Version 3.1 14/06/2002 12:22
Extended Survivors Analysis
Sole in IV

cpue data from file fleet02
Catch data for 45 years. 1957 to 2001. Ages 1 to 15.

Fleet	First year	Last year	First age	Last age	Alpha	Beta
FLT01: NL Comm BT	1990	2001	2	14	.000	1.000
FLT02: UK Comm OT	1990	2001	2	14	.000	1.000
FLT03: NL BTS	1990	2001	1	9	.670	.750
FLT04: NL: SNS	1990	2001	1	4	.670	.750

Time-series weights :
Tapered time weighting not applied
Catchability analysis :
Catchability dependent on stock size for ages < 3

Regression type = C
Minimum of 5 points used for regression
Survivor estimates shrunk to the population mean for ages < 3

Catchability independent of age for ages >= 7

Terminal population estimation :

Survivor estimates shrunk towards the mean F
of the final 5 years or the 5 oldest ages.
S.E. of the mean to which the estimates are shrunk = .500
Minimum standard error for population
estimates derived from each fleet = .300
Prior weighting not applied
Tuning converged after 22 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	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	.003	.001	.013	.054	.004	.006	.002	.004	.020	.012
2	.118	.183	.140	.304	.273	.156	.271	.167	.243	.290
3	.432	.416	.484	.444	.689	.573	.627	.579	.536	.572
4	.461	.550	.617	.775	.973	.685	.777	.735	.712	.646
5	.511	.808	.660	.578	.722	.793	.731	.759	.654	.595
6	.581	.620	.834	.516	.752	.797	.710	.532	.706	.584
7	.591	.742	.592	.699	.669	.487	.698	.496	.718	.481
8	.478	.426	.476	.644	.752	.717	.613	.624	.622	.504
9	.560	.547	.605	.559	.797	.575	.721	.494	.593	.462
10	.406	.442	.621	.403	1.109	.881	.951	.814	1.027	.669
11	.486	.441	.302	.233	.645	.344	.590	.382	.956	.513
12	.792	.564	.583	.443	1.371	.508	.993	.476	.880	.668
13	.369	.592	.995	.222	.615	.572	.475	.430	.493	.431
14	.506	.616	.669	.685	.847	.566	.718	.509	.901	.440

XSA population numbers (Thousands)

YEAR	AGE 1	2	3	4	5	6	7	8	9	10
1992	3.52E+05	6.45E+04	1.33E+05	4.61E+04	1.01E+05	5.91E+03	7.16E+03	2.05E+03	9.79E+02	1.43E+03
1993	6.94E+04	3.18E+05	5.18E+04	7.81E+04	2.63E+04	5.47E+04	2.99E+03	3.59E+03	1.15E+03	5.06E+02
1994	5.73E+04	6.28E+04	2.40E+05	3.09E+04	4.08E+04	1.06E+04	2.66E+04	1.29E+03	2.12E+03	6.02E+02
1995	9.65E+04	5.12E+04	4.94E+04	1.34E+05	1.51E+04	1.91E+04	4.17E+03	1.33E+04	7.25E+02	1.05E+03
1996	4.90E+04	8.28E+04	3.42E+04	2.87E+04	5.57E+04	7.68E+03	1.03E+04	1.88E+03	6.33E+03	3.75E+02
1997	2.79E+05	4.41E+04	5.70E+04	1.55E+04	9.80E+03	2.45E+04	3.28E+03	4.78E+03	8.01E+02	2.58E+03
1998	1.19E+05	2.51E+05	3.42E+04	2.91E+04	7.09E+03	4.01E+03	9.98E+03	1.82E+03	2.11E+03	4.08E+02
1999	8.11E+04	1.08E+05	1.73E+05	1.65E+04	1.21E+04	3.09E+03	1.78E+03	4.49E+03	8.93E+02	9.29E+02
2000	1.21E+05	7.31E+04	8.25E+04	8.79E+04	7.17E+03	5.12E+03	1.64E+03	9.83E+02	2.18E+03	4.93E+02
2001	8.03E+04	1.07E+05	5.19E+04	4.37E+04	3.91E+04	3.37E+03	2.29E+03	7.25E+02	4.77E+02	1.09E+03

Estimated population abundance at 1st Jan 2002
0.00E+00 7.18E+04 7.28E+04 2.65E+04 2.07E+04 1.95E+04 1.70E+03 1.28E+03 3.96E+02 2.72E+02
Taper weighted geometric mean of the VPA populations:
9.87E+04 8.74E+04 6.56E+04 3.68E+04 1.92E+04 1.04E+04 6.35E+03 4.03E+03 2.62E+03 1.82E+03

Table 7.4.2 continued

Standard error of the weighted Log(VPA populations) :

.7712	.8131	.8457	.8911	.9438	.9627	1.0316	1.0798	1.1388	1.2867

	AGE			
YEAR	11	12	13	14
1992	4.42E+02	4.31E+02	3.95E+02	1.59E+01
1993	8.63E+02	2.46E+02	1.77E+02	2.47E+02
1994	2.94E+02	5.02E+02	1.27E+02	8.84E+01
1995	2.93E+02	1.97E+02	2.54E+02	4.24E+01
1996	6.34E+02	2.10E+02	1.14E+02	1.84E+02
1997	1.12E+02	3.01E+02	4.82E+01	5.60E+01
1998	9.67E+02	7.18E+01	1.64E+02	2.46E+01
1999	1.42E+02	4.85E+02	2.41E+01	9.22E+01
2000	3.72E+02	8.80E+01	2.73E+02	1.42E+01
2001	1.60E+02	1.30E+02	3.30E+01	1.51E+02

Estimated population abundance at 1st Jan 2002
5.05E+02 8.66E+01 6.01E+01 1.94E+01
Taper weighted geometric mean of the VPA populations:
1.15E+03 7.74E+02 4.66E+02 3.09E+02
Standard error of the weighted Log(VPA populations) :

1.4156 1.4833 1.6449 1.7218

Log catchability residuals.

Fleet : FLT01: NL Comm BT

Age	1990	1991
1	No data for this fleet at this age	
2	-.28	-.95
3	-.07	-.19
4	-.12	.02
5	-.11	.17
6	-.24	-.42
7	-.25	-.33
8	-.22	-.34
9	.01	-.42
10	-.81	-.22
11	-.89	-.64
12	.77	-.02
13	-.40	-.16
14	-.45	-.16

Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	No data for this fleet at this age									
2	-.42	-.08	-.45	.40	.49	-.15	.52	-.04	.42	.55
3	-.08	-.36	-.06	-.32	.06	.21	.05	.26	.35	.16
4	-.31	-.10	-.38	.20	.38	-.04	.30	-.09	-.13	.27
5	-.11	.15	-.10	-.67	.22	.14	-.14	.28	-.03	.20
6	-.06	.20	.08	-.14	-.19	.50	.15	-.07	.26	-.06
7	.19	.20	.20	-.20	.27	-.52	.41	-.23	.25	.01
8	-.15	-.21	-.68	.27	.10	.49	-.71	.42	.37	-.14
9	-.09	-.26	-.10	-.31	.68	-.73	-.34	-.46	.25	-.12
10	-.31	-.75	.07	-.43	.78	.73	-1.35	.64	.81	.52
11	-.39	-.25	-1.27	-1.36	.23	-1.68	.22	-1.78	.46	-1.46
12	.55	-.26	.13	-.95	.84	.01	-1.02	.09	.27	.27
13	-.46	-.10	-.15	-.87	-.17	-.06	-.10	-1.08	-.20	-.08
14	-.02	-.07	-.16	-.56	.44	.04	-.12	-.01	.02	.19

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

Age	3	4	5	6	7	8	9	10	11	12
Mean Log q	-5.2926	-5.1084	-5.0829	-5.2780	-5.3638	-5.3638	-5.3638	-5.3638	-5.3638	-5.3638
S.E(Log q)	.2227	.2413	.2587	.2503	.2928	.4098	.3994	.7293	1.0996	.5844

Age	13	14
Mean Log q	-5.3638	-5.3638
S.E(Log q)	.4706	.2722

Table 7.4.2 continued

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
2	.97	.140	6.43	.62	12	.51	-6.25

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

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
3	.99	.150	5.38	.92	12	.23	-5.29
4	.98	.196	5.21	.92	12	.25	-5.11
5	.97	.267	5.21	.92	12	.26	-5.08
6	.93	.828	5.54	.94	12	.24	-5.28
7	.86	1.548	5.78	.93	12	.24	-5.36
8	.83	1.390	5.83	.87	12	.32	-5.43
9	.75	2.610	5.95	.92	12	.22	-5.52
10	.81	.587	5.64	.49	12	.61	-5.39
11	.59	3.080	6.06	.85	12	.35	-6.10
12	.91	.425	5.32	.69	12	.55	-5.31
13	.98	.199	5.66	.89	12	.34	-5.68
14	.93	.854	5.34	.94	12	.25	-5.44

Fleet : FLT02: UK Comm OT

Age	1990	1991
1	No data for this fleet at this age	
2	.65	.30
3	-.63	-.12
4	-.17	-.60
5	-.05	-1.00
6	.34	-.18
7	.38	.14
8	-.16	.32
9	.29	-.82
10	.24	.24
11	.09	.60
12	.35	.57
13	.14	.96
14	2.19	-.78

Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	No data for this fleet at this age									
2	.23	-.45	-1.86	.13	.11	.56	.31	-.75	.26	.51
3	-.45	.19	1.26	.10	.26	.03	.37	-.68	-.57	.24
4	-.39	-.22	.32	-.73	.57	.93	.11	.65	.14	-.62
5	-1.38	-.12	-.29	1.00	-.47	.73	.76	-.22	1.25	-.22
6	-.97	-1.02	-.31	-.73	.76	-.55	1.08	.54	.21	.84
7	-.63	-.72	-1.48	.27	-.43	1.10	-.31	.80	1.05	-.16
8	.08	-.56	-1.06	-1.37	.55	-.05	1.89	.12	1.26	1.14
9	.39	.30	-.39	-1.33	-.43	1.22	.82	1.72	.04	.76
10	-.13	.54	.62	.02	-.60	-.45	1.54	.64	2.50	.38
11	.39	-.32	.97	.52	.29	.44	.25	1.63	1.43	2.31
12	.14	.34	.01	1.08	1.06	.57	1.56	.50	2.06	1.27
13	.39	.82	1.44	-1.13	.98	1.54	.51	1.59	-.95	1.28
14	99.99	.53	1.32	-.05	.92	1.74	2.10	.97	1.50	.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	10	11	12
Mean Log q	-14.2593	-14.1660	-13.8724	-13.6464	-13.4101	-13.4101	-13.4101	-13.4101	-13.4101	-13.4101
S.E(Log q)	.5460	.5440	.7981	.7291	.7732	.9666	.8952	.9785	1.0530	1.0330

Age	13	14
Mean Log q	-13.4101	-13.4101
S.E(Log q)	1.1189	1.3771

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
2	1.55	-1.500	18.10	.42	12	.75	-15.75

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

Table 7.4.2 continued

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
3	1.20	-.755	14.86	.58	12	.67	-14.26
4	2.08	-3.740	17.90	.55	12	.77	-14.17
5	3.34	-3.479	23.09	.18	12	1.88	-13.87
6	2.73	-3.589	21.51	.30	12	1.38	-13.65
7	3.70	-3.889	26.88	.17	12	1.89	-13.41
8	3.95	-2.566	29.26	.07	12	3.05	-13.23
9	1.86	-1.269	18.32	.18	12	1.57	-13.20
10	3.68	-1.757	29.71	.04	12	2.87	-12.95
11	2.65	-2.830	23.76	.23	12	1.54	-12.69
12	2.27	-3.088	21.71	.37	12	1.05	-12.62
13	2.74	-2.768	26.99	.20	12	1.95	-12.78
14	1.17	-.424	13.87	.40	11	1.14	-12.44

Fleet : FLT03: NL BTS

Age	1990	1991
1	-.24	-.37
2	.63	.15
3	-.10	.09
4	-.43	-.12
5	-.30	-1.11
6	.89	-1.00
7	-.41	-.85
8	-1.11	-1.19
9	-1.68	99.99
10	No data for this fleet at this age	
11	No data for this fleet at this age	
12	No data for this fleet at this age	
13	No data for this fleet at this age	
14	No data for this fleet at this age	

Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	-.26	-.18	.16	.48	.01	.46	-.09	.16	-.12	-.01
2	1.06	-.29	-.70	.31	-.65	-.24	.13	.41	-.53	-.26
3	.06	-.81	-.01	.91	-.07	-.08	-.01	.45	-.14	-.28
4	.27	.65	-2.07	.48	.67	.48	.43	.21	-.93	.37
5	-.38	1.12	-.07	-.33	.19	.84	-1.15	1.58	.00	-.40
6	-.96	1.23	-.76	.67	.58	-.33	-1.57	1.36	.12	-.24
7	-.56	.49	.08	.91	.18	-.09	.28	1.26	-.54	-.75
8	-.08	-.32	-1.57	.72	-.14	-1.32	99.99	1.48	-1.19	.13
9	-1.23	1.49	99.99	.68	.40	.59	99.99	99.99	-.22	99.99
10	No data for this fleet at this age									
11	No data for this fleet at this age									
12	No data for this fleet at this age									
13	No data for this fleet at this age									
14	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	8	9
Mean Log q	-9.2192	-9.7967	-9.6534	-10.0589	-9.7904	-9.7904	-9.7904
S.E(Log q)	.4072	.8057	.8273	.9575	.6631	1.0546	1.1241

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	.56	3.154	10.08	.84	12	.29	-8.89
2	1.19	-.671	8.24	.56	12	.57	-8.76

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

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
3	.95	.325	9.33	.79	12	.40	-9.22
4	1.02	-.050	9.78	.49	12	.86	-9.80
5	1.02	-.060	9.65	.50	12	.88	-9.65
6	.79	.781	9.86	.58	12	.77	-10.06
7	.98	.072	9.77	.61	12	.68	-9.79
8	.69	1.244	9.48	.65	11	.65	-10.21
9	1.06	-.091	9.95	.28	7	1.31	-9.79

Table 7.4.2 continued

Fleet : FLT04:NL: SNS

Age	1990	1991
1	-.23	.11
2	.34	.32
3	.06	.95
4	.74	.53
5	No data for this fleet at this age	
6	No data for this fleet at this age	
7	No data for this fleet at this age	
8	No data for this fleet at this age	
9	No data for this fleet at this age	
10	No data for this fleet at this age	
11	No data for this fleet at this age	
12	No data for this fleet at this age	
13	No data for this fleet at this age	
14	No data for this fleet at this age	

Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	.00	.19	-.22	-.05	.08	.17	.16	.17	-.19	-.19
2	-.56	-.13	.31	.17	.08	-.04	-.18	.17	-.48	.01
3	-.08	-1.09	.45	-.01	-1.01	.54	.52	-.07	-.06	-.21
4	.76	.14	-1.69	.55	.20	.67	.13	-.78	-.41	-.86
5	No data for this fleet at this age									
6	No data for this fleet at this age									
7	No data for this fleet at this age									
8	No data for this fleet at this age									
9	No data for this fleet at this age									
10	No data for this fleet at this age									
11	No data for this fleet at this age									
12	No data for this fleet at this age									
13	No data for this fleet at this age									
14	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
Mean Log q	-5.5726	-5.8343
S.E(Log q)	.5988	.7762

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	.68	3.628	6.37	.93	12	.18	-3.94
2	.59	2.683	7.64	.81	12	.31	-4.92

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	.83	.834	6.55	.71	12	.50	-5.57
4	.84	.634	6.61	.61	12	.67	-5.83

Terminal year survivor and F summaries :

Age 1 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
FLT01: NL Comm BT	1.	.000	.000	.00	0	.000	.000
FLT02: UK Comm OT	1.	.000	.000	.00	0	.000	.000
FLT03: NL BTS	71439.	.300	.000	.00	1	.400	.012
FLT04: NL: SNS	59116.	.300	.000	.00	1	.400	.014
P shrinkage mean	87394.	.81				.055	.010
F shrinkage mean	115536.	.50				.146	.007

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
71826.	.19	.14	4	.746	.012

Table 7.4.2 continued

Age 2 Catchability dependent on age and year class strength
Year class = 1999

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT01: NL Comm BT	126264.	.541	.000	.00	1	.074	.177
FLT02: UK Comm OT	121705.	.789	.000	.00	1	.035	.183
FLT03: NL BTS	62485.	.268	.057	.21	2	.296	.330
FLT04: NL: SNS	65906.	.220	.098	.44	2	.440	.316
P shrinkage mean	65584.	.85				.040	.317
F shrinkage mean	98281.	.50				.115	.222

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
72791.	.15	.09	8	.618	.290

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

Year class = 1998

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT01: NL Comm BT	32708.	.262	.104	.40	2	.233	.486
FLT02: UK Comm OT	33928.	.461	.009	.02	2	.074	.472
FLT03: NL BTS	24593.	.229	.186	.81	3	.273	.605
FLT04: NL: SNS	23343.	.213	.211	.99	3	.301	.629
F shrinkage mean	24692.	.50				.119	.603

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
26510.	.13	.08	11	.654	.572

Age 4 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 Comm BT	27108.	.205	.075	.36	3	.338	.527
FLT02: UK Comm OT	11128.	.374	.039	.11	3	.100	.990
FLT03: NL BTS	20908.	.225	.124	.55	4	.201	.642
FLT04: NL: SNS	21133.	.207	.188	.91	4	.229	.637
F shrinkage mean	15923.	.50				.133	.780

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
20724.	.12	.09	15	.732	.646

Age 5 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 Comm BT	22203.	.190	.095	.50	4	.470	.538
FLT02: UK Comm OT	16927.	.382	.187	.49	4	.096	.660
FLT03: NL BTS	20711.	.276	.252	.91	5	.135	.568
FLT04: NL: SNS	18515.	.214	.121	.57	4	.130	.618
F shrinkage mean	14587.	.50				.169	.735

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
19498.	.14	.07	18	.537	.595

Age 6 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 Comm BT	1618.	.180	.018	.10	5	.541	.607
FLT02: UK Comm OT	3864.	.400	.130	.32	5	.097	.300
FLT03: NL BTS	1615.	.309	.061	.20	6	.107	.608
FLT04: NL: SNS	1673.	.213	.194	.91	4	.074	.592
F shrinkage mean	1326.	.50				.180	.703

Table 7.4.2 continued

```
 Weighted prediction :
Survivors        Int      Ext    N    Var     F
 at end of year   s.e      s.e         Ratio
      1703.       .14      .07   21    .491   .584

 Age  7   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
 FLT01:  NL Comm BT         1469.   .181       .058    .32   6  .581     .430
 FLT02:  UK Comm OT         1246.   .435       .077    .18   6  .093     .491
 FLT03:  NL BTS       1039.   .395       .288    .73   7  .111     .565
 FLT04:  NL: SNS            1411.   .211       .105    .50   4  .034     .444

   F shrinkage mean         927.    .50                       .180     .616

 Weighted prediction :

 Survivors        Int      Ext    N    Var     F
 at end of year   s.e      s.e         Ratio
      1279.       .15      .07   24    .457   .481

 Age  8   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
 FLT01:  NL Comm BT          399.   .182       .070    .38   7  .561     .502
 FLT02:  UK Comm OT          992.   .443       .112    .25   7  .094     .233
 FLT03:  NL BTS        374.   .407       .232    .57   8  .099     .527
 FLT04:  NL: SNS             373.   .216       .271   1.26   4  .024     .528
   F shrinkage mean          273.    .50                      .222     .669

 Weighted prediction :
 Survivors        Int      Ext    N    Var     F
 at end of year   s.e      s.e         Ratio
       396.       .16      .09   27    .526   .504

 Age  9   Catchability constant w.r.t. time and age (fixed at the value for age)  7

 Year class = 1992

 Fleet                 Estimated    Int       Ext    Var    N Scaled  Estimated
                       Survivors    s.e       s.e   Ratio     Weights    F
 FLT01:  NL Comm BT          272.   .194       .087    .45   8  .579     .462
 FLT02:  UK Comm OT          645.   .472       .121    .26   8  .103     .221
 FLT03:  NL BTS        309.   .410       .434   1.06   8  .065     .416
 FLT04:  NL: SNS             335.   .205       .056    .27   4  .015     .390

   F shrinkage mean         179.    .50                       .239     .639
 Weighted prediction :

 Survivors        Int      Ext    N    Var     F
 at end of year   s.e      s.e         Ratio
       272.       .17      .10   29    .562   .462

 Age 10   Catchability constant w.r.t. time and age (fixed at the value for age)  7

 Year class = 1991

 Fleet                 Estimated    Int       Ext    Var    N Scaled  Estimated
                       Survivors    s.e       s.e   Ratio     Weights    F
 FLT01:  NL Comm BT          729.   .217       .043    .20   9  .452     .506
 FLT02:  UK Comm OT          564.   .508       .115    .23   9  .112     .616
 FLT03:  NL BTS        666.   .479       .228    .48   9  .057     .543
 FLT04:  NL: SNS             547.   .213       .141    .66   4  .009     .630

   F shrinkage mean         297.    .50                       .370     .961
 Weighted prediction :

 Survivors        Int      Ext    N    Var     F
 at end of year   s.e      s.e         Ratio
       505.       .22      .10   32    .457   .669
```

Table 7.4.2 continued

Age 11 Catchability constant w.r.t. time and age (fixed at the value for age) 7

Year class = 1990

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT01: NL Comm BT	53.	.243	.204	.84	10	.352	.736
FLT02: UK Comm OT	650.	.562	.190	.34	10	.130	.086
FLT03: NL BTS	71.	.339	.238	.70	7	.025	.600
FLT04: NL: SNS	56.	.210	.346	1.65	4	.011	.713
F shrinkage mean	73.	.50				.481	.586

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
87.	.27	.16	32	.620	.513

Age 12 Catchability constant w.r.t. time and age (fixed at the value for age) 7

Year class = 1989

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT01: NL Comm BT	75.	.380	.079	.21	11	.320	.565
FLT02: UK Comm OT	178.	.645	.151	.23	11	.112	.278
FLT03: NL BTS	49.	.346	.248	.72	8	.010	.769
FLT04: NL: SNS	61.	.208	.145	.69	4	.004	.662
F shrinkage mean	43.	.50				.554	.850

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
60.	.31	.11	35	.368	.668

Age 13 Catchability constant w.r.t. time and age (fixed at the value for age) 7

Year class = 1988

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT01: NL Comm BT	17.	.335	.130	.39	12	.452	.485
FLT02: UK Comm OT	85.	.621	.130	.21	12	.110	.117
FLT03: NL BTS	30.	.521	.182	.35	8	.008	.298
FLT04: NL: SNS	33.	.279	.184	.66	3	.001	.274
F shrinkage mean	15.	.50				.428	.519

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
19.	.27	.11	36	.399	.431

Age 14 Catchability constant w.r.t. time and age (fixed at the value for age) 7

Year class = 1987

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT01: NL Comm BT	100.	.232	.050	.22	12	.663	.396
FLT02: UK Comm OT	74.	.591	.182	.31	12	.069	.502
FLT03: NL BTS	122.	.466	.159	.34	7	.004	.335
FLT04: NL: SNS	117.	.504	.236	.47	2	.000	.347
F shrinkage mean	66.	.50				.264	.551

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
88.	.21	.05	34	.252	.440

Table 7.4.3 North Sea sole. Fishing mortality

Run title : Sole in IV At 14/06/2002 12:23

Terminal Fs derived using XSA (With F shrinkage)

Table 8 Fishing mortality (F) at age

YEAR	1957	1958	1959	1960	1961
AGE					
1	0	0	0	0	0
2	0.019	0.013	0.030	0.025	0.017
3	0.106	0.136	0.099	0.138	0.125
4	0.210	0.189	0.221	0.176	0.251
5	0.172	0.216	0.158	0.281	0.171
6	0.128	0.213	0.176	0.194	0.199
7	0.201	0.169	0.095	0.197	0.118
8	0.123	0.183	0.147	0.157	0.240
9	0.075	0.208	0.138	0.096	0.104
10	0.129	0.131	0.168	0.196	0.110
11	0.104	0.159	0.170	0.159	0.158
12	0.168	0.084	0.111	0.155	0.250
13	0.116	0.171	0.092	0.152	0.174
14	0.118	0.151	0.136	0.152	0.159
+gp	0.118	0.151	0.136	0.152	0.159
FBAR 2- 8	**0.137**	**0.160**	**0.132**	**0.167**	**0.160**

YEAR	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
AGE										
1	0.000	0.000	0.000	0.000	0.000	0.000	0.011	0.008	0.010	0.011
2	0.016	0.042	0.018	0.104	0.125	0.110	0.307	0.330	0.153	0.324
3	0.129	0.151	0.251	0.148	0.421	0.368	0.661	0.687	0.632	0.563
4	0.192	0.376	0.204	0.273	0.175	0.459	0.649	0.505	0.544	0.651
5	0.291	0.318	0.408	0.247	0.296	0.539	0.458	0.695	0.279	0.571
6	0.192	0.368	0.263	0.451	0.259	0.190	0.207	0.404	0.341	0.339
7	0.289	0.249	0.315	0.274	0.209	0.186	0.112	0.201	0.304	0.391
8	0.156	0.324	0.135	0.228	0.194	0.305	0.215	0.139	0.201	0.270
9	0.158	0.261	0.240	0.145	0.136	0.210	0.184	0.213	0.099	0.214
10	0.140	0.237	0.135	0.154	0.091	0.132	0.255	0.222	0.164	0.213
11	0.223	0.322	0.150	0.122	0.146	0.087	0.076	0.243	0.175	0.271
12	0.114	0.229	0.146	0.189	0.115	0.321	0.146	0.106	0.285	0.453
13	0.379	0.451	0.305	0.298	0.060	0.104	0.078	0.121	0.107	0.239
14	0.203	0.315	0.196	0.182	0.110	0.171	0.148	0.181	0.166	0.279
+gp	0.203	0.315	0.196	0.182	0.110	0.171	0.148	0.181	0.166	0.279
FBAR 2- 8	**0.181**	**0.261**	**0.228**	**0.246**	**0.240**	**0.308**	**0.373**	**0.423**	**0.351**	**0.444**

YEAR	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
AGE										
1	0.005	0.007	0.001	0.007	0.010	0.013	0.001	0.001	0.004	0.003
2	0.239	0.205	0.185	0.276	0.104	0.260	0.235	0.226	0.127	0.249
3	0.627	0.698	0.586	0.540	0.557	0.533	0.564	0.659	0.559	0.515
4	0.527	0.552	0.652	0.652	0.492	0.600	0.503	0.614	0.589	0.605
5	0.502	0.573	0.439	0.489	0.541	0.467	0.501	0.435	0.554	0.528
6	0.352	0.411	0.524	0.401	0.389	0.347	0.471	0.429	0.345	0.528
7	0.176	0.351	0.483	0.376	0.317	0.191	0.593	0.319	0.518	0.353
8	0.328	0.373	0.368	0.499	0.432	0.274	0.587	0.544	0.408	0.360
9	0.253	0.553	0.304	0.477	0.408	0.326	0.227	0.428	0.446	0.361
10	0.180	0.256	0.524	0.260	0.316	0.324	0.382	0.188	0.142	0.405
11	0.120	0.512	0.259	0.378	0.320	0.207	0.637	0.535	0.275	0.407
12	0.230	0.540	0.428	0.305	0.310	0.302	0.410	0.673	0.307	0.145
13	0.300	0.342	0.089	0.153	0.319	0.398	0.413	0.634	0.637	1.210
14	0.217	0.442	0.322	0.315	0.335	0.312	0.415	0.493	0.362	0.507
+gp	0.217	0.442	0.322	0.315	0.335	0.312	0.415	0.493	0.362	0.507
FBAR 2- 8	**0.393**	**0.452**	**0.462**	**0.462**	**0.405**	**0.382**	**0.493**	**0.461**	**0.443**	**0.448**

Table 7.4.3 continued

Table 8 Fishing mortality (F) at age

YEAR	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
AGE										
1	0.0184	0.0028	0.0028	0.0021	0.0024	0.0014	0	0.0011	0.0051	0.0018
2	0.2312	0.3091	0.2855	0.3167	0.1436	0.2364	0.2364	0.1279	0.1364	0.09
3	0.672	0.5978	0.7155	0.7204	0.6132	0.514	0.6513	0.5228	0.4149	0.4216
4	0.5458	0.6742	0.6788	0.7623	0.6496	0.5978	0.7197	0.6678	0.5207	0.5516
5	0.6411	0.3169	0.5822	0.5936	0.6587	0.4651	0.5891	0.4363	0.5552	0.7336
6	0.5931	0.4896	0.6722	0.4356	0.7451	0.5359	0.4945	0.4073	0.5759	0.3974
7	0.4349	0.453	0.5667	0.3549	0.4864	0.4269	0.4937	0.3034	0.4317	0.5908
8	0.3617	0.4322	0.4137	0.4684	0.2848	0.3222	0.4075	0.3485	0.3955	0.5299
9	0.396	0.3599	0.3859	0.4244	0.6793	0.3122	0.2794	0.3365	0.5018	0.3955
10	0.4005	0.3108	0.3569	0.2215	0.8408	0.4962	0.2107	0.1676	0.2449	0.5029
11	0.5408	0.5743	0.3281	0.4717	0.6662	0.4905	0.2671	0.3667	0.2992	0.4829
12	0.4834	0.1803	0.3509	0.4913	0.9083	0.5524	0.447	0.4281	0.9967	0.5983
13	0.2443	0.1392	0.2374	0.3554	0.63	0.8907	0.2714	0.3893	0.5775	0.6088
14	0.4143	0.3137	0.3327	0.394	0.7483	0.5505	0.2959	0.3386	0.7465	0.6898
+gp	0.4143	0.3137	0.3327	0.394	0.7483	0.5505	0.2959	0.3386	0.7465	0.6898
FBAR 2- 8	**0.4971**	**0.4676**	**0.5592**	**0.5217**	**0.5116**	**0.4426**	**0.5132**	**0.402**	**0.4329**	**0.4735**

Table 8 Fishing mortality (F) at age

YEAR	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	FBAR 99-01
AGE											
1	0.0029	0.0008	0.0132	0.0537	0.0037	0.006	0.0022	0.0037	0.0205	0.0116	0.0119
2	0.1181	0.1826	0.1401	0.304	0.2733	0.1555	0.2706	0.1669	0.2429	0.2898	0.2332
3	0.4322	0.4157	0.4837	0.4435	0.6888	0.5735	0.6266	0.5788	0.536	0.5716	0.5621
4	0.4611	0.5497	0.6167	0.7752	0.973	0.6846	0.7774	0.7354	0.7118	0.646	0.6977
5	0.5109	0.8078	0.66	0.5776	0.7224	0.7935	0.7307	0.7588	0.6535	0.5946	0.669
6	0.5812	0.6202	0.834	0.5155	0.7516	0.7974	0.7105	0.5318	0.7058	0.584	0.6072
7	0.5909	0.7416	0.5922	0.6989	0.6687	0.4869	0.6981	0.4964	0.7178	0.4806	0.5649
8	0.4779	0.4257	0.4757	0.6442	0.7516	0.7171	0.613	0.6244	0.6223	0.5041	0.5836
9	0.5596	0.5469	0.6046	0.5587	0.7969	0.5749	0.7208	0.4939	0.5929	0.4623	0.5163
10	0.4056	0.442	0.6207	0.403	1.1089	0.8808	0.9512	0.8141	1.0267	0.6688	0.8365
11	0.486	0.4413	0.3021	0.2333	0.6454	0.3441	0.5897	0.3817	0.956	0.513	0.6169
12	0.7916	0.5642	0.5825	0.4428	1.3706	0.5076	0.9933	0.4764	0.8801	0.6676	0.6747
13	0.3694	0.5917	0.9953	0.2216	0.6151	0.5724	0.4753	0.4301	0.4931	0.4309	0.4514
14	0.5059	0.6158	0.6686	0.6853	0.8466	0.5658	0.7179	0.509	0.9013	0.4396	0.6166
+gp	0.5059	0.6158	0.6686	0.6853	0.8466	0.5658	0.7179	0.509	0.9013	0.4396	
FBAR 2- 8	**0.4532**	**0.5348**	**0.5432**	**0.5655**	**0.6899**	**0.6012**	**0.6324**	**0.5561**	**0.5986**	**0.5244**	

Table 7.4.4 North Sea sole, Stock numbers-at-age

Run title : Sole in IV

At 14/06/2002 12:23

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
AGE					
1	165503	144953	559006	66859	115734
2	78587	149753	131159	505810	60496
3	106074	69762	133739	115197	446221
4	70122	86327	55095	109573	90790
5	25073	51424	64634	39958	83167
6	25568	19109	37494	49946	27302
7	37658	20353	13976	28439	37234
8	15794	27874	15555	11499	21123
9	7421	12642	20999	12148	8889
10	46886	6230	9296	16552	9988
11	1774	37308	4946	7112	12314
12	1813	1447	28797	3775	5492
13	327	1387	1204	23322	2926
14	745	263	1058	993	18120
+gp	3427	1966	3376	2431	2964
0 TOTAL	586770	630799	1080333	993614	942760

YEAR	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
AGE										
1	28345	23008	554353	121486	41181	75332	100099	50588	141484	41937
2	104720	25648	9354	501547	109925	37262	68163	89587	45397	126784
3	53827	93239	9997	8317	409015	87785	30210	45365	58307	35237
4	356400	42798	32591	7035	6489	242992	55001	14117	20643	28033
5	63944	266179	11945	24056	4845	4930	138893	26011	7707	10845
6	63454	43261	78761	7185	17009	3260	2602	79473	11752	5277
7	20238	47388	12175	54775	4141	11881	2440	1915	47997	7561
8	29939	13721	15021	8043	37672	3039	8925	1975	1418	32053
9	15043	23178	4034	11870	5797	28071	2027	6512	1555	1049
10	7248	11626	7260	2872	9290	4577	20599	1526	4760	1274
11	8096	5702	3728	5740	2228	7676	3630	14447	1106	3655
12	9514	5861	1680	2903	4597	1743	6366	3043	10255	840
13	3871	7680	1896	1313	2175	3710	1145	4980	2477	6981
14	2225	2399	1989	1265	882	1853	3026	958	3994	2014
+gp	14430	15701	3668	7541	7249	4575	4302	6596	7830	5889
0 TOTAL	781294	627389	748451	765947	662494	518687	447427	347092	366682	309428

YEAR	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
AGE										
1	76954	106419	110814	41910	114341	140464	47052	11817	154662	149248
2	37547	69290	95623	100172	37670	102470	125435	42549	10684	139338
3	82978	26750	51064	71893	68805	30716	71479	89688	30720	8517
4	18162	40115	12045	25716	37908	35655	16309	36814	41991	15896
5	13230	9704	20900	5679	12123	20971	17703	8927	18034	21081
6	5547	7248	4951	12194	3153	6385	11898	9703	5228	9376
7	3403	3530	4348	2652	7391	1934	4085	6723	5715	3351
8	4628	2581	2249	2426	1648	4872	1446	2043	4422	3081
9	22141	3015	1608	1409	1333	968	3350	727	1073	2661
10	767	15557	1570	1074	792	802	633	2417	429	622
11	932	579	10903	841	749	522	525	391	1813	337
12	2521	748	314	7617	521	492	384	251	207	1246
13	483	1813	394	185	5080	346	329	231	116	138
14	4973	324	1166	326	144	3341	210	197	111	55
+gp	5640	3887	5340	3661	2842	2850	2710	1846	2061	871
0 TOTAL	279903	291561	323288	277757	294500	352789	303550	214325	277264	355817

Table 7.4.4 continued

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

	YEAR	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
	AGE										
	1	153150	144182	71321	81485	160722	73053	448821	108878	178585	71371
	2	134643	136045	130092	64352	73574	145072	66012	406101	98405	160769
	3	98286	96684	90369	88477	42421	57666	103630	47155	323331	77684
	4	4607	45418	48116	39981	38951	20789	31208	48888	25296	193202
	5	7852	2415	20941	22083	16880	18406	10346	13749	22686	13598
	6	11253	3742	1592	10586	11037	7904	10460	5194	8042	11782
	7	5002	5627	2075	735	6196	4741	4185	5772	3127	4091
	8	2130	2930	3237	1065	467	3447	2799	2311	3856	1838
	9	1945	1342	1720	1936	603	318	2260	1685	1476	2349
	10	1679	1184	848	1058	1146	277	210	1546	1089	809
	11	375	1018	785	537	767	447	153	154	1183	771
	12	203	198	519	512	303	357	248	106	97	794
	13	975	113	149	330	283	111	186	143	62	32
	14	37	691	89	107	210	137	41	128	88	32
	+gp	973	895	900	859	603	408	442	299	399	285
0	TOTAL	423109	442485	372752	314103	354163	333131	681000	642110	667722	539407

	YEAR	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	GMST 57-99	AMST 57-99
	AGE													
	1	352279	69422	57347	96501	48961	279247	119390	81109	121251	80305	0	98661	134404
	2	64465	317823	62765	51206	82751	44138	251160	107797	73118	107487	71826	87336	120980
	3	132949	51832	239588	49368	34189	56970	34186	173374	82545	51891	72791	65590	93792
	4	46111	78084	30949	133648	28669	15535	29051	16530	87940	43699	26510	35942	55201
	5	100703	26310	40776	15115	55703	9804	7089	12081	7169	39052	20724	19340	32291
	6	5908	54670	10613	19070	7676	24474	4012	3089	5118	3375	19498	10876	17634
	7	7165	2989	26605	4171	10305	3276	9976	1784	1642	2286	1703	6709	11608
	8	2050	3590	1289	13314	1876	4777	1821	4491	983	725	1279	4330	7682
	9	979	1150	2122	725	6326	801	2110	893	2177	477	396	2735	5355
	10	1431	506	602	1049	375	2580	408	929	493	1089	272	1897	4706
	11	442	863	294	293	634	112	967	142	372	160	505	1237	3418
	12	431	246	502	197	210	301	72	485	88	130	87	849	2516
	13	395	177	127	254	114	48	164	24	273	33	60	502	1819
	14	16	247	88	42	184	56	25	92	14	151	19	337	1278
	+gp	575	211	519	303	298	153	171	155	58	94	143		
0	TOTAL	715899	608121	474185	385257	278271	442272	460603	402976	383241	330952	215812		
	1													

Table 7.5.1 North Sea sole. Indices of recruitment (input to RCT3)

Year class	VPA-1	VPA-2	VPA-3	DFS INT-0	SNS-1	DFS INT-1	SNS-2	SNS-3	Ger-3	BTS-1	BTS-2
1968	50588	45397	35237	-11		-11	745	99	-11	-11	-11
1969	141484	126784	82978	-11	4938	-11	1961	161	-11	-11	-11
1970	41937	37547	26750	-11	613	-11	341	73	-11	-11	-11
1971	76954	69290	51064	-11	1410	-11	905	69	-11	-11	-11
1972	106419	95623	71893	-11	4686	-11	397	174	-11	-11	-11
1973	110814	100172	68805	-11	1924	-11	887	187	31.5	-11	-11
1974	41910	37670	30716	-11	597	*2.86*	79	77	16.3	-11	-11
1975	114341	102470	71479	*168.84*	1413	*6.95*	762	267	34.4	-11	-11
1976	140464	125435	89688	*82.28*	3724	*9.69*	1379	325	-11	-11	-11
1977	47052	42549	30720	*33.80*	1552	*2.13*	388	99	41.5	-11	-11
1978	11817	10684	8517	*96.87*	104	*2.27*	80	51	1.9	-11	-11
1979	154662	139338	98286	*392.08*	4483	*48.21*	1411	231	76.1	-11	-11
1980	149248	134643	96684	*404.00*	3739	13.90	1124	107	77.1	-11	-11
1981	153150	136045	90369	289.72	5098	14.06	1137	307	147.1	-11	-11
1982	144182	130092	88477	330.38	2640	25.87	1081	159	77.8	-11	-11
1983	71321	64352	42421	115.96	2359	12.45	709	67	10.8	-11	7.28
1984	81485	73574	57666	187.17	2151	3.32	465	59	29.8	2.64	4.58
1985	160722	145072	103630	292.92	3791	13.66	955	284	24.6	7.76	12.5
1986	73053	66012	47155	72.97	1890	6.19	594	248	20.3	6.96	12.81
1987	448821	406101	323331	527.45	11227	38.02	5369	907	66.9	81.23	67.76
1988	108878	98405	77684	56.08	3052	12.62	1078	527	86.4	8.67	22.33
1989	178585	160769	132949	62.77	2900	12.30	2515	319	54.1	22.44	23.2
1990	71371	64465	51832	22.54	1265	8.52	114	46	11.3	3.43	22.66
1991	352279	317823	239588	360.44	11081	17.66	3489	943	180.7	72.71	26.61
1992	69422	62765	49368	25.38	1351	10.60	475	126	-11	4.63	4.95
1993	57347	51206	34189	25.01	559	6.12	234	27	-11	5.94	8.68
1994	96501	82751	56970	74.25	1501	9.46	473	231	12.9	26.31	5.94
1995	48961	44138	34186	18.82	691	3.64	143	131	0.9	3.48	5.36
1996	279247	251160	173374	58.51	10132	19.92	1993	381	45.7	173.51	29.15
1997	119390	107797	82545	53.35	2875	-11	919	189	13.6	14.16	19.51
1998	81109	73118	51891	-11	1649	-11	150	99	-11	11.20	6.08
1999	121251	107487	-11	-11	1735	4.56	645	-11	-11	13.64	10.14
2000	-11	-11	-11	16.15	958	3.07	-11	-11	-11	8.11	-11
2001	-11	-11	-11	86.41	-11	-11	-11	-11	-11	-11	-11
mean(68-98)	**123366**	**110981**	**81705**	**167**	**3180**	**11**	**1044**	**229**	**48**	**30**	**17**

DFS International Demersal Fish Survey - revised 0 & 1gp indices WG2002
BTS International Beam Trawl Survey
SNS Sole Net Survey
GER German Solea survey

DFS: years in italics should not yet revised to include changes in English survey

Table 7.6.1 North Sea sole, Assessment Summary Table

Run title : Sole in IV At 14/06/2002 12:23

	RECRUITS Age 1	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	FBAR 2- 8
1957	165503	88541	78903	12067	0.1529	0.1369
1958	144953	99676	85570	14287	0.167	0.1599
1959	559006	116348	93191	13832	0.1484	0.1324
1960	66859	138323	101245	18620	0.1839	0.1669
1961	115734	156082	148954	23566	0.1582	0.1599
1962	28345	156825	148786	26877	0.1806	0.1806
1963	23008	150773	148403	26164	0.1763	0.2612
1964	554353	68097	53583	11342	0.2117	0.2277
1965	121486	122206	48953	17043	0.3482	0.2464
1966	41181	113510	104785	33340	0.3182	0.2398
1967	75332	109353	100874	33439	0.3315	0.3081
1968	100099	99740	88922	33179	0.3731	0.3726
1969	50588	83911	70373	27559	0.3916	0.4229
1970	141484	72698	62942	19685	0.3128	0.3506
1971	41937	72567	52377	23652	0.4516	0.4439
1972	76954	64477	55733	21086	0.3783	0.393
1973	106419	56341	41867	19309	0.4612	0.4519
1974	110814	60119	42280	17989	0.4255	0.4624
1975	41910	59312	43020	20773	0.4829	0.4617
1976	114341	52828	43477	17326	0.3985	0.4046
1977	140464	56024	36044	18003	0.4995	0.3817
1978	47052	57670	38588	20280	0.5256	0.4934
1979	11817	53012	46183	22598	0.4893	0.4609
1980	154662	43731	36021	15807	0.4388	0.4427
1981	149248	51264	24712	15403	0.6233	0.4483
1982	153150	59895	34734	21579	0.6213	0.4971
1983	144182	68312	42056	24927	0.5927	0.4676
1984	71321	66105	45237	26839	0.5933	0.5592
1985	81485	54664	42417	24248	0.5717	0.5217
1986	160722	53181	35359	18201	0.5147	0.5116
1987	73053	56705	30712	17368	0.5655	0.4426
1988	448821	72076	40855	21590	0.5284	0.5132
1989	108878	94893	35438	21805	0.6153	0.402
1990	178585	113978	90485	35120	0.3881	0.4329
1991	71371	103867	77951	33513	0.4299	0.4735
1992	352279	104746	77076	29341	0.3807	0.4532
1993	69422	99130	54977	31491	0.5728	0.5348
1994	57347	85764	73922	33002	0.4464	0.5432
1995	96501	71231	58674	30467	0.5193	0.5655
1996	48961	51530	36917	22651	0.6136	0.6899
1997	279247	49099	28516	14901	0.5226	0.6012
1998	119390	62185	21053	20868	0.9912	0.6324
1999	81109 *	61458	43281	23475	0.5424	0.5561
2000	121251*	56847	40621	22532	0.5547	0.5986
2001	80305*	52322	32829	19849	0.6046	0.5244
Arith. Mean	132910	80920	60864	22600	0.44	0.4163
0 Units	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)		

Note * indices to be reviewed when Q3 surveys completed

Table 7.9.1 North Sea sole, Input data to yield-per-recruit

Label	value	cv	Label	value	cv
Number at age in 2002			Weight in the catch		
N1	98661	0.78	WH1	0.125	0.4
N2	71550	0.19	WH2	0.184	0.07
N3	72367	0.15	WH3	0.213	0.09
N4	26491	0.13	WH4	0.276	0.14
N5	20716	0.12	WH5	0.33	0.16
N6	19491	0.14	WH6	0.375	0.15
N7	1701	0.14	WH7	0.423	0.18
N8	1278	0.15	WH8	0.455	0.18
N9	396	0.16	WH9	0.488	0.18
N10	272	0.17	WH10	0.512	0.17
N11	504	0.22	WH11	0.571	0.19
N12	87	0.27	WH12	0.568	0.18
N13	59	0.31	WH13	0.618	0.2
N14	19	0.27	WH14	0.647	0.24
N15	142	0.21	WH15	0.664	0.13
Fishing mortality			Weight in the stock		
sH1	0.011	0.66	WS1	0.041	0.25
sH2	0.219	0.3	WS2	0.135	0.18
sH3	0.527	0.1	WS3	0.19	0.1
sH4	0.654	0.05	WS4	0.259	0.16
sH5	0.627	0.12	WS5	0.32	0.17
sH6	0.569	0.11	WS6	0.367	0.17
sH7	0.53	0.17	WS7	0.414	0.19
sH8	0.547	0.08	WS8	0.441	0.21
sH9	0.484	0.07	WS9	0.471	0.19
sH10	0.784	0.15	WS10	0.493	0.19
sH11	0.578	0.43	WS11	0.544	0.22
sH12	0.632	0.26	WS12	0.562	0.24
sH13	0.423	0.04	WS13	0.62	0.17
sH14	0.578	0.34	WS14	0.642	0.28
sH15	0.578	0.34	WS15	0.664	0.15
Natural mortality			Proportion mature		
M1	0.1	0.1	MT1	0	0
M2	0.1	0.1	MT2	0	0.1
M3	0.1	0.1	MT3	1	0.1
M4	0.1	0.1	MT4	1	0
M5	0.1	0.1	MT5	1	0
M6	0.1	0.1	MT6	1	0
M7	0.1	0.1	MT7	1	0
M8	0.1	0.1	MT8	1	0
M9	0.1	0.1	MT9	1	0
M10	0.1	0.1	MT10	1	0
M11	0.1	0.1	MT11	1	0
M12	0.1	0.1	MT12	1	0
M13	0.1	0.1	MT13	1	0
M14	0.1	0.1	MT14	1	0
M15	0.1	0.1	MT15	1	0
Relative effort in HC fishery			Year efect for natural mortality		
HF02	1	0.07	K02	1	0.1
HF03	1	0.07	K03	1	0.1
HF04	1	0.07	K04	1	0.1
Recruitment in 2003 and 2004					
R03	98661	0.78			
R04	98661	0.78			

Proportion of F before spawning = 0.00
Proportion of M before spawning = 0.00

Stock numbers in 2002 are VPA survivors except age 1 = GM

Figure 7.2.1 North Sea sole, Catch numbers-at-age since 1966

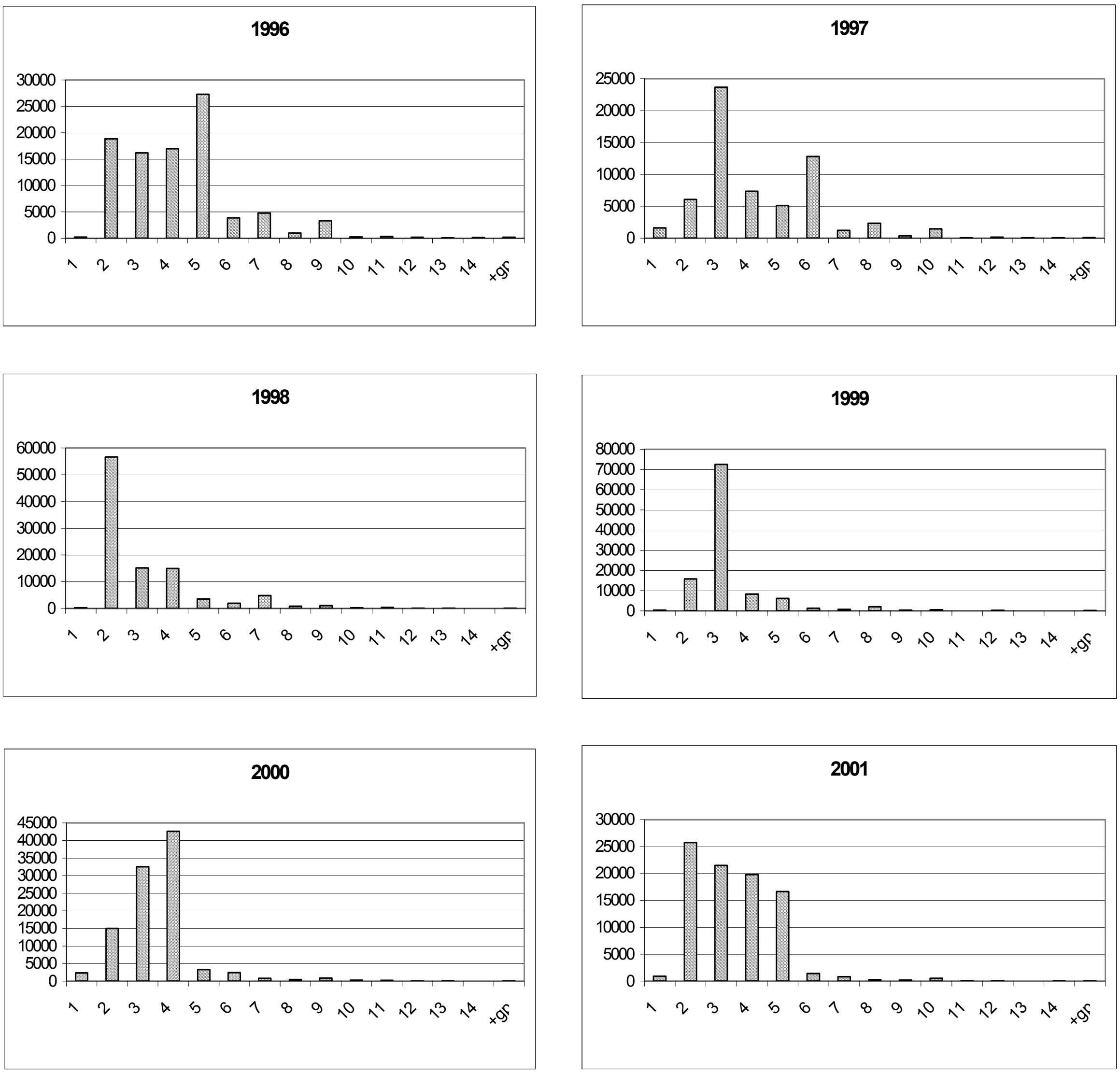
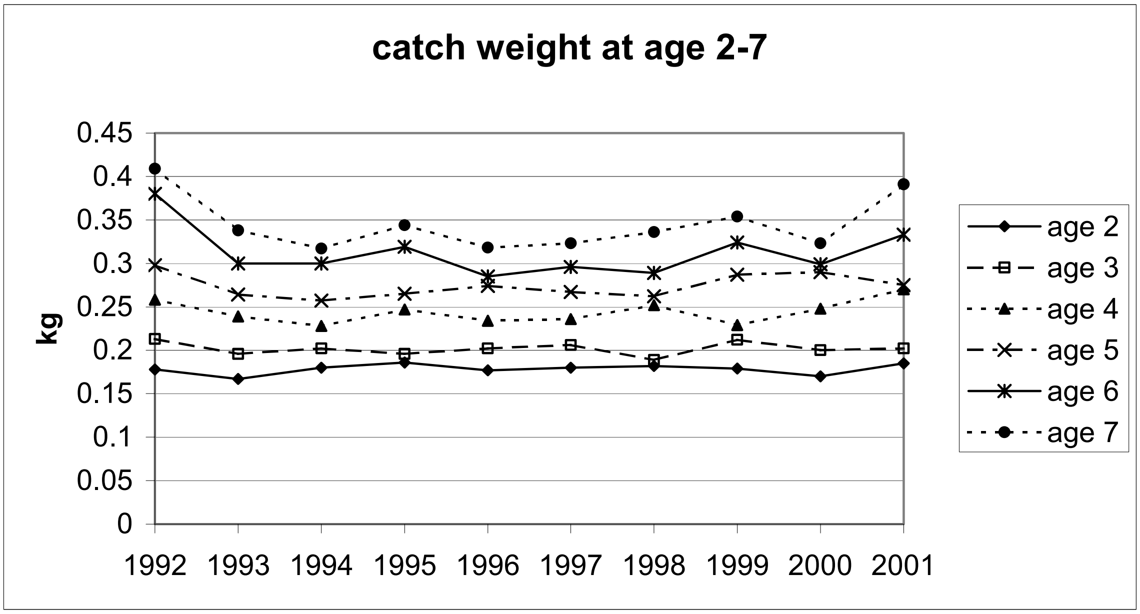


Figure 7.2.2 North Sea sole, trends in catch weights-at-age.



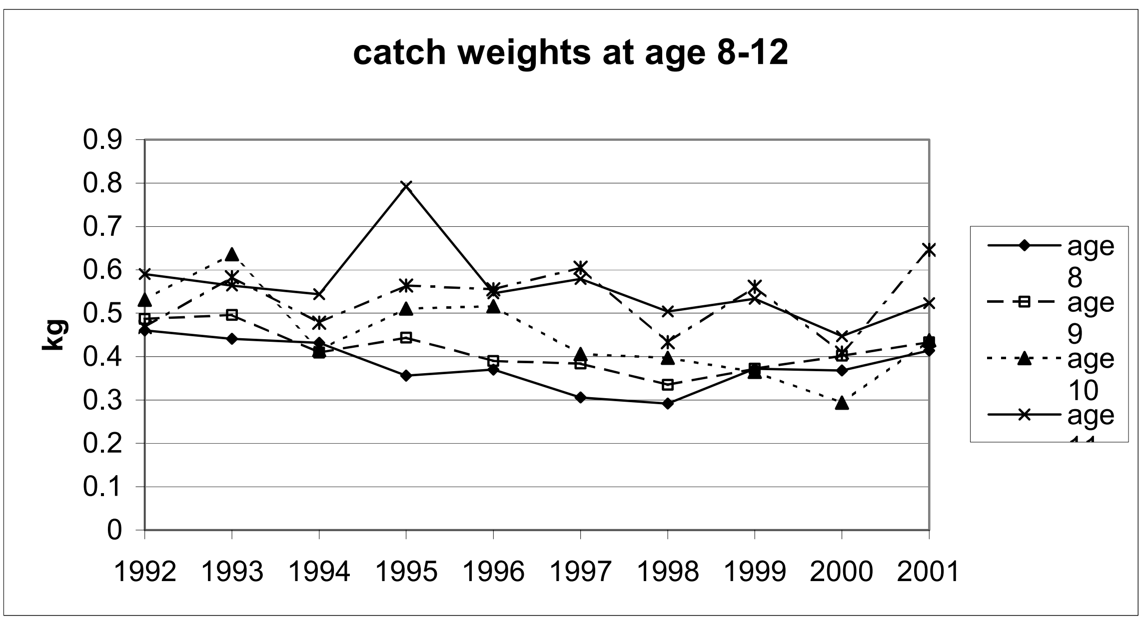
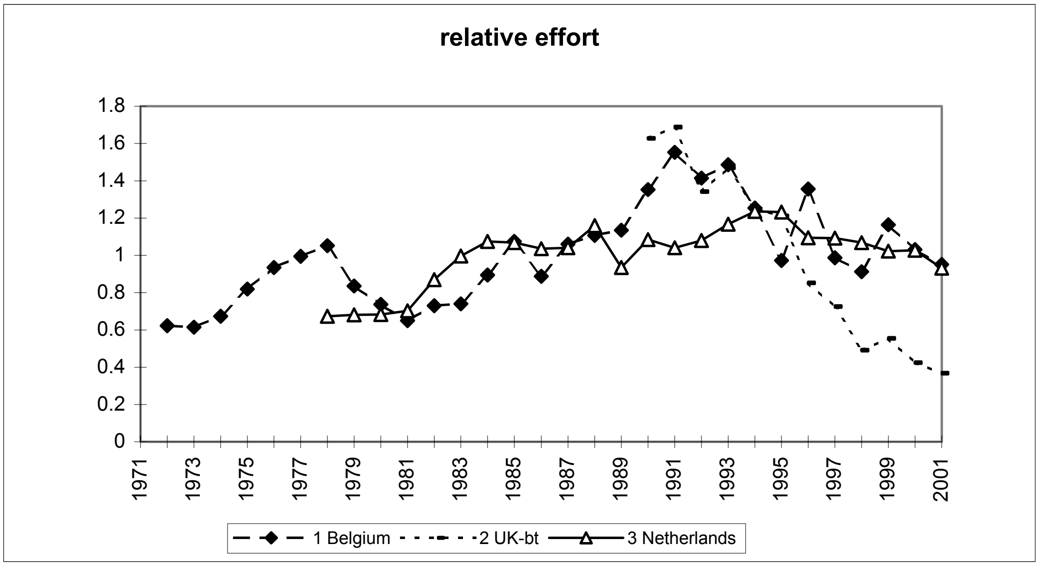


Figure 7.3.1 North Sea sole, Trends in effort and cpue



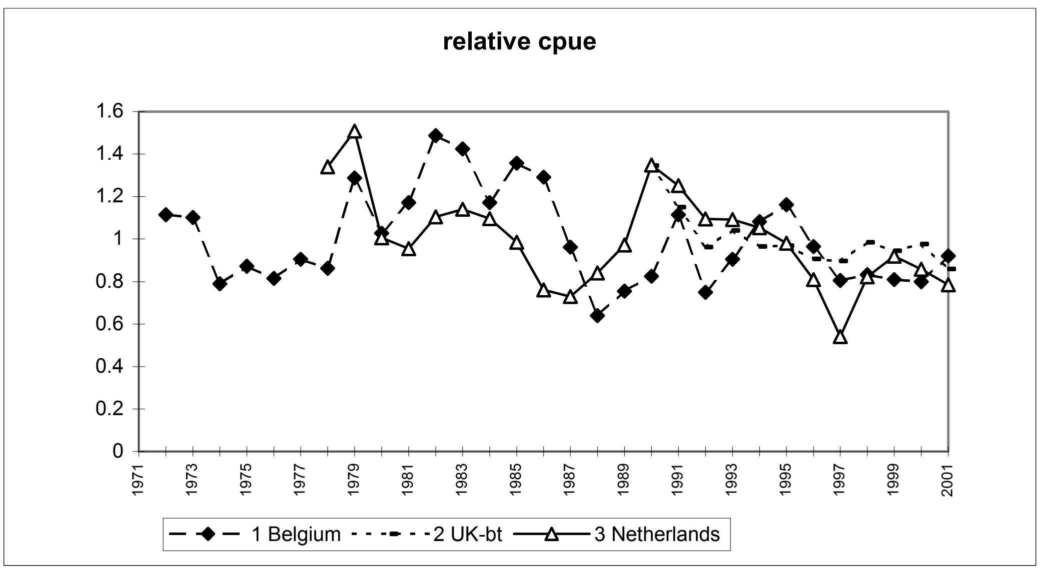


Figure 7.3.2 North Sea sole, Trends in survey indices at age.

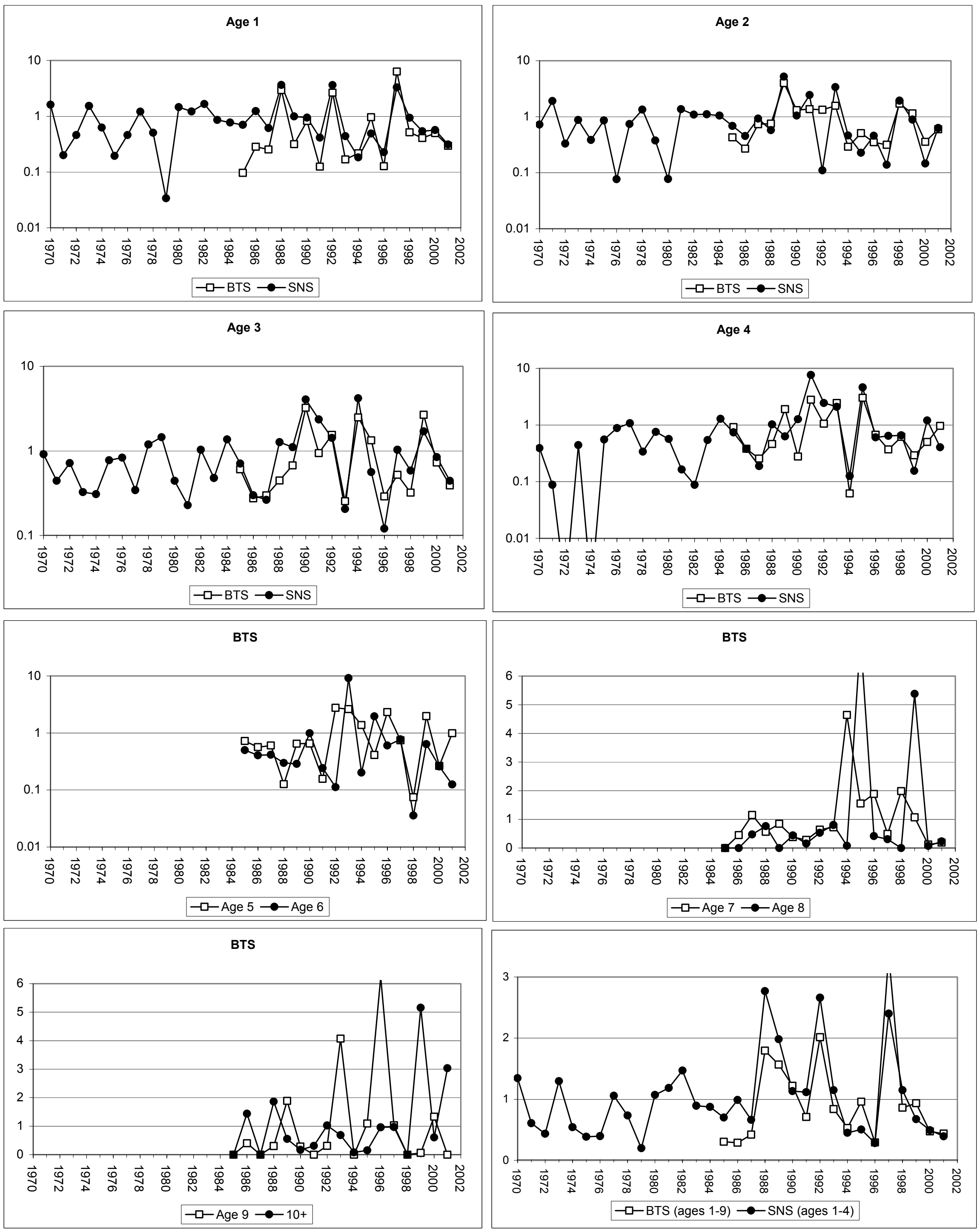
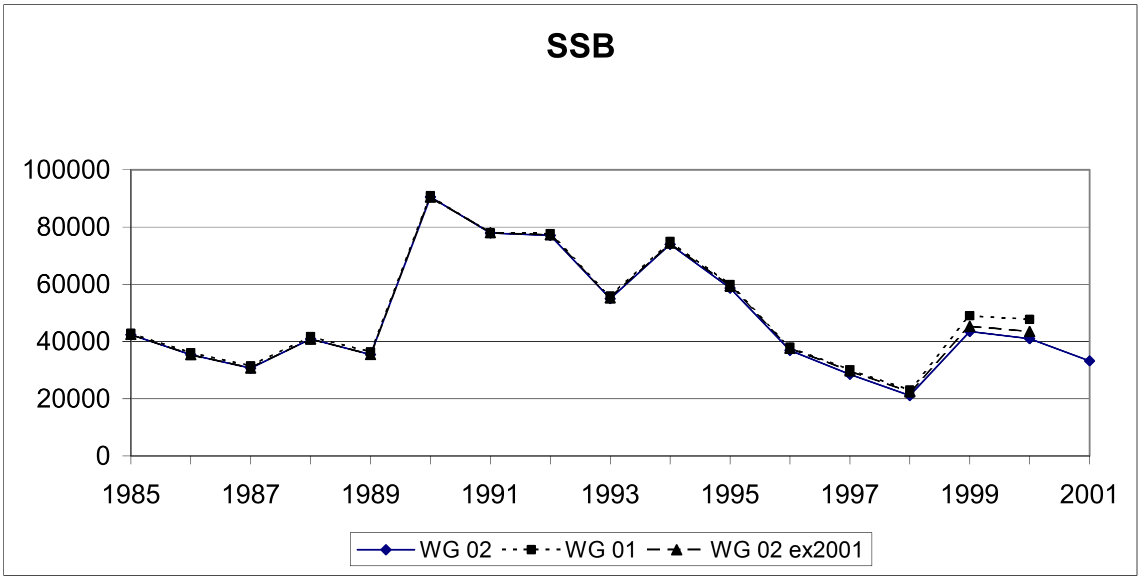


Figure 7.4.1 North Sea sole: effect of changes to the catch-at-age database since WG 2001.



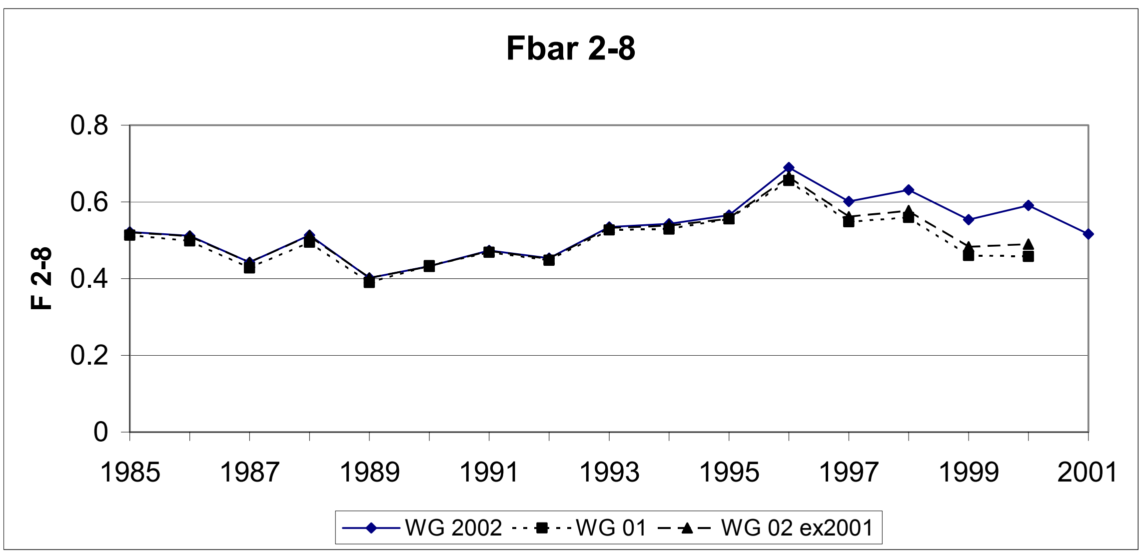


Figure 7.4.2a Comparison between single-fleet XSA-runs and combined runs by fleet; F shrinkage 1.5.

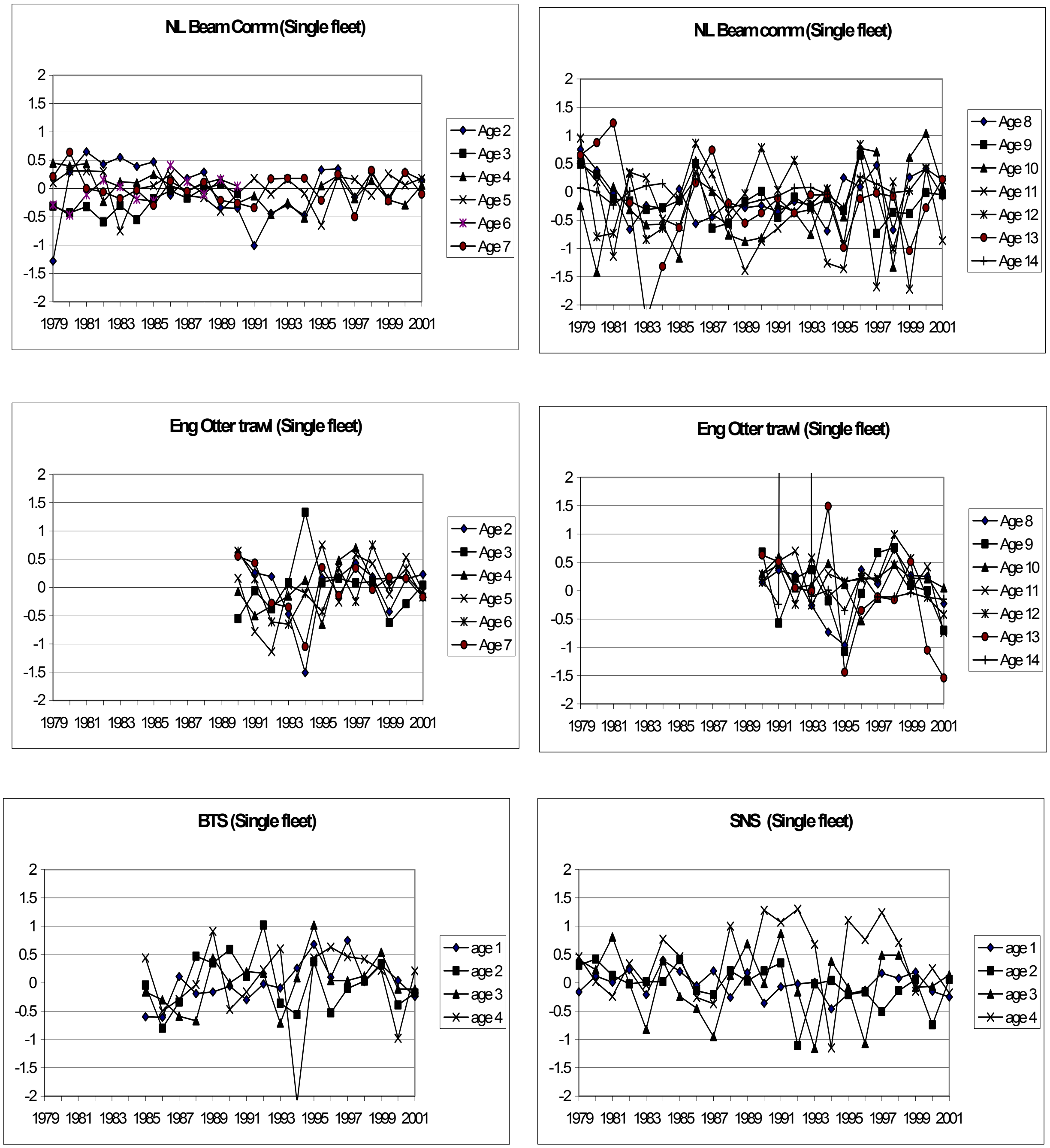


Figure 7.4.2b North Sea sole: log-catchability residuals by fleet for combined fleet XSA; F shrinkage 0.5.

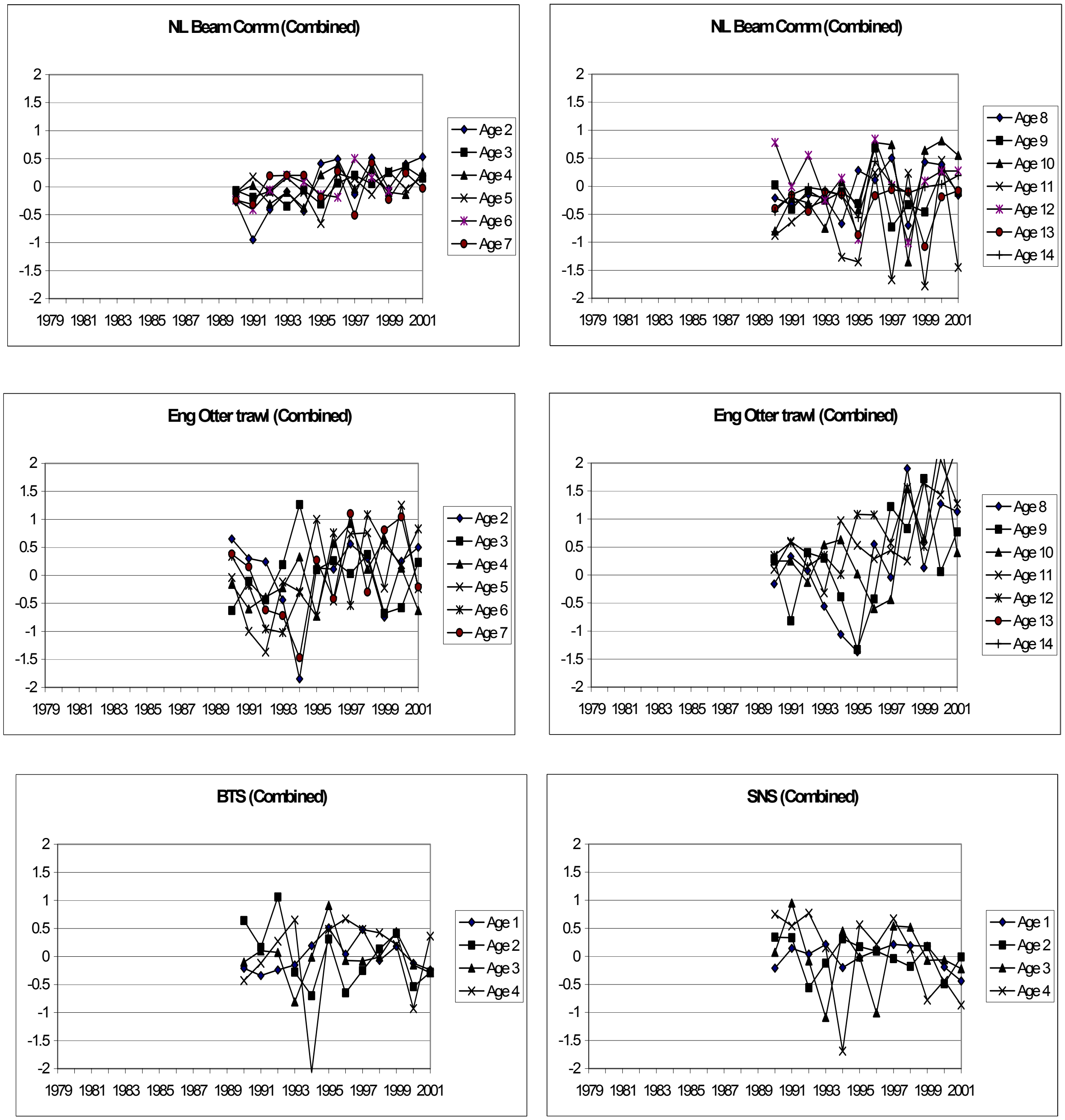


Figure 7.4.3 North Sea sole. Log survey cpue adjusted to start of the year (x-axis) against log VPA population numbers.

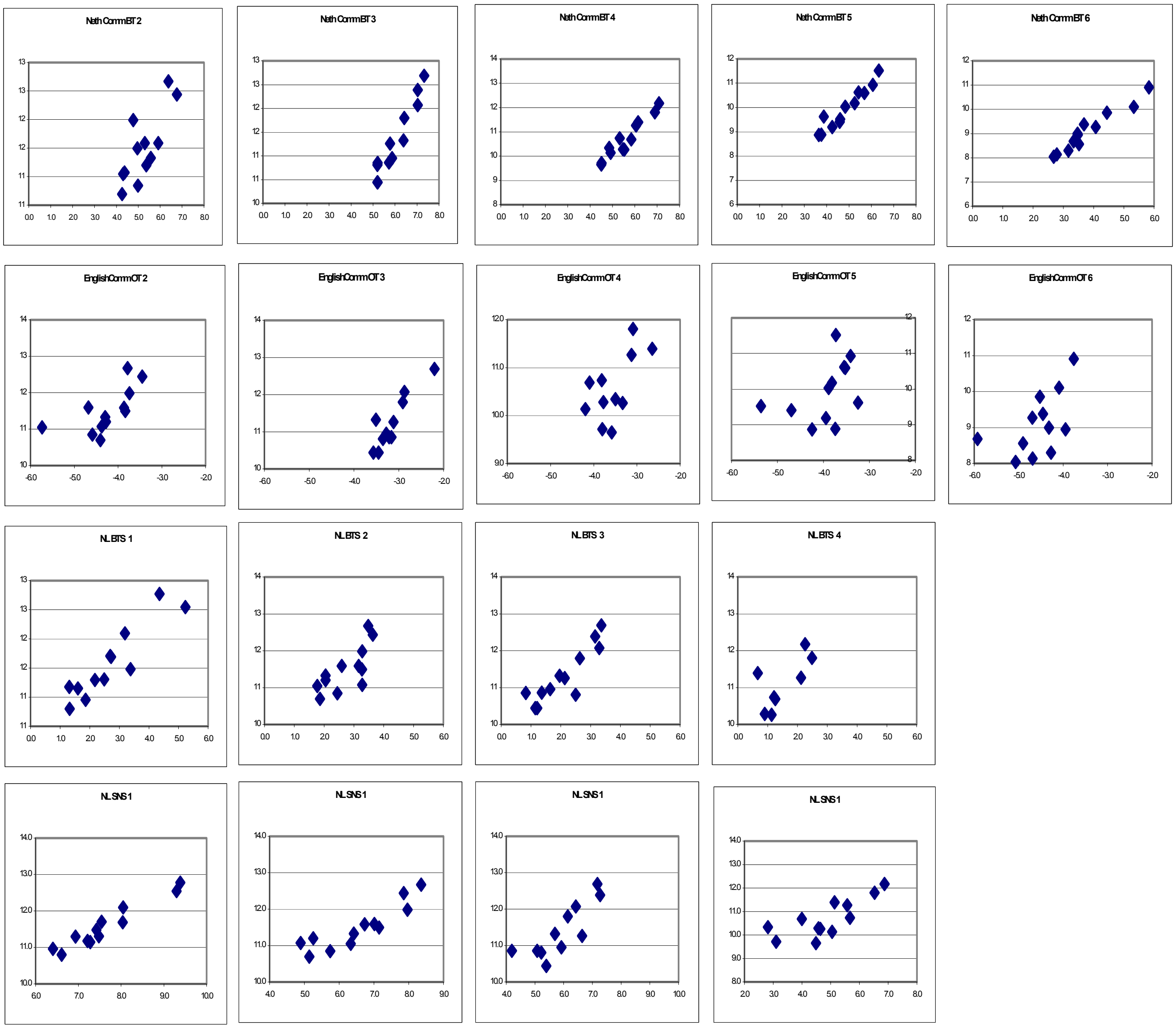
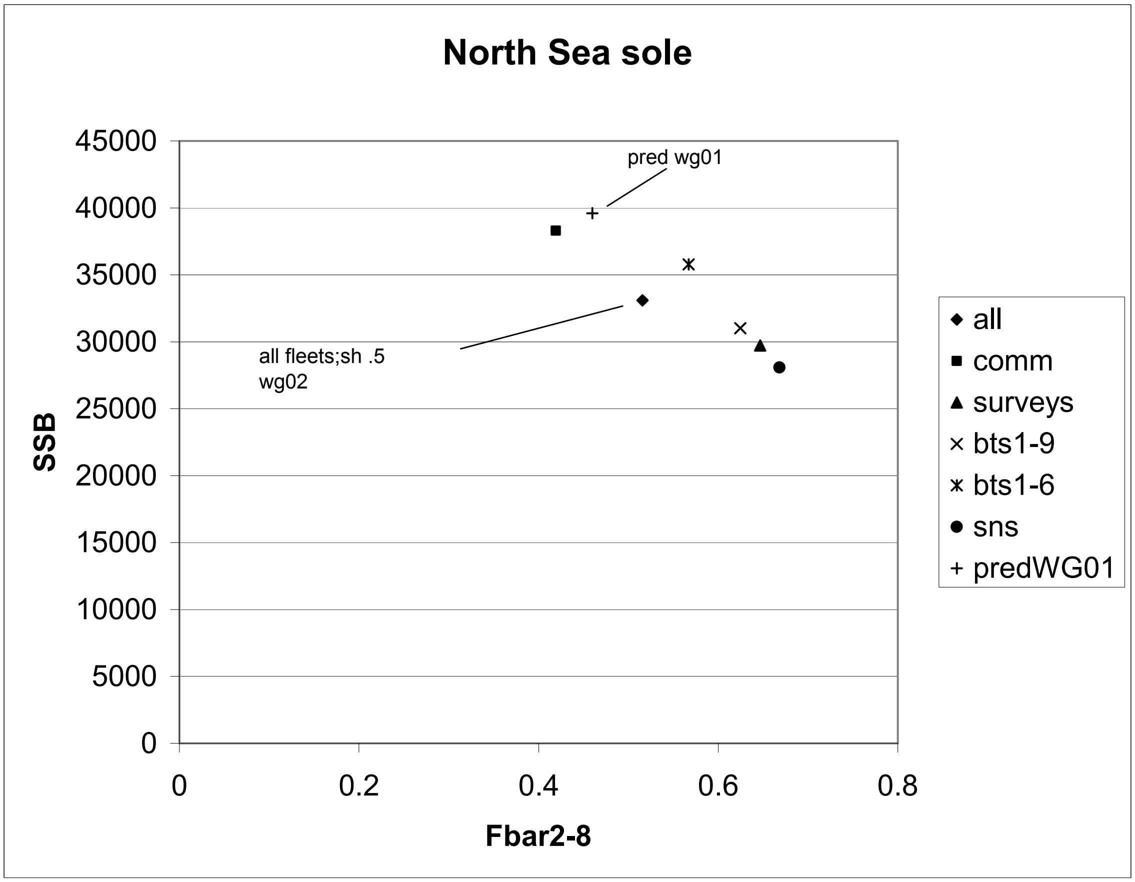
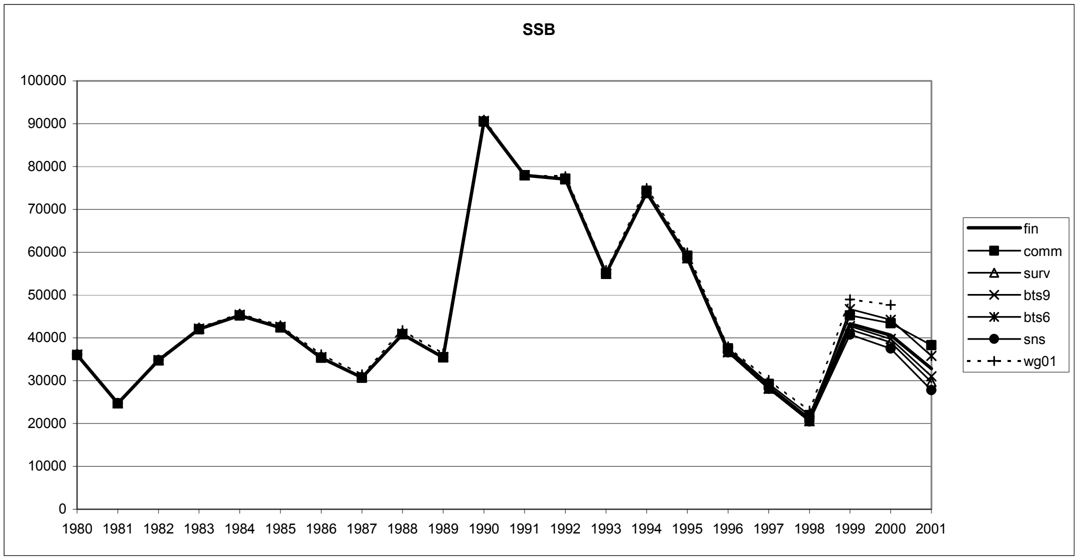


Figure 7.4.4 North Sea sole. Estimates of SSB and F2-8 in 2001 under different XSA fleet options.



all: 2 commercial, 2 surveys, final run shrinkage 0.5
comm: 2 commercial fleets only
surveys - 2 surveys only
bts 1-9: Neth BT survey ages 1-9 only
bts 1-6: Neth BT survey ages 1-6 only
sns: Neth SNS survey
predWG01: WG 2001 pred SSB at SQF

Figure 7.4.5 North Sea sole. Sensitivity of analyses to different XSA tuning options.



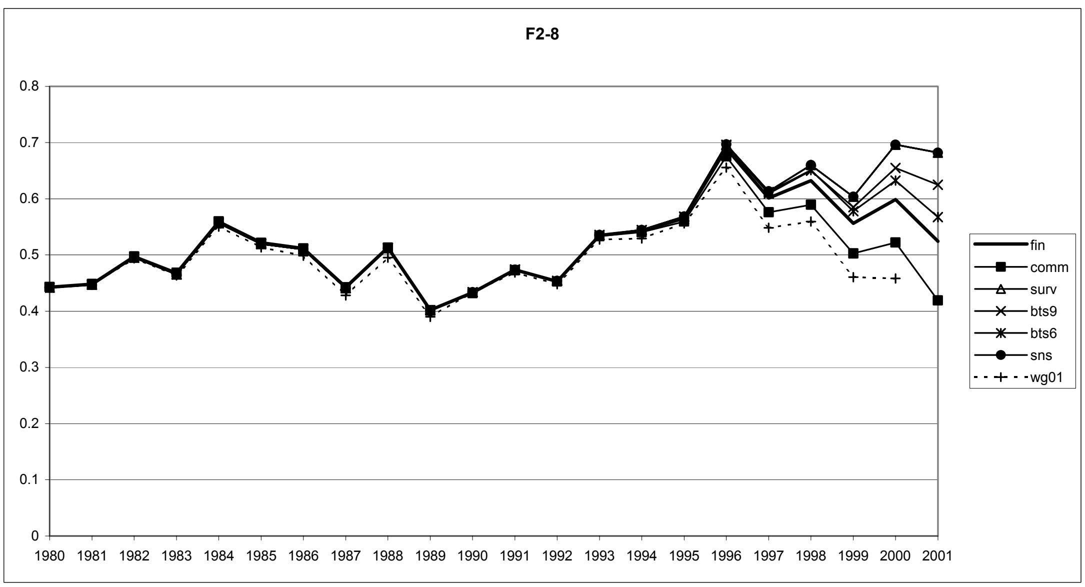
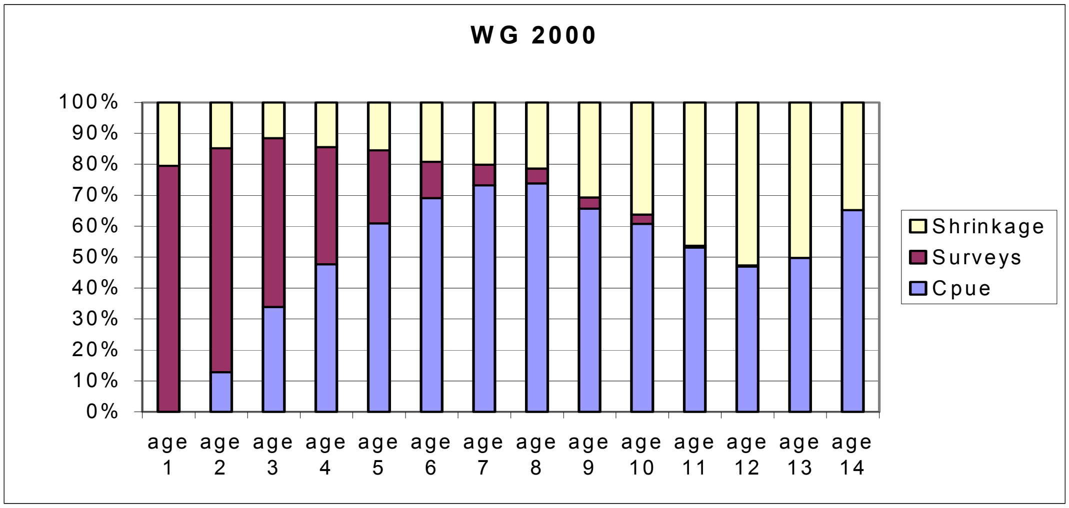
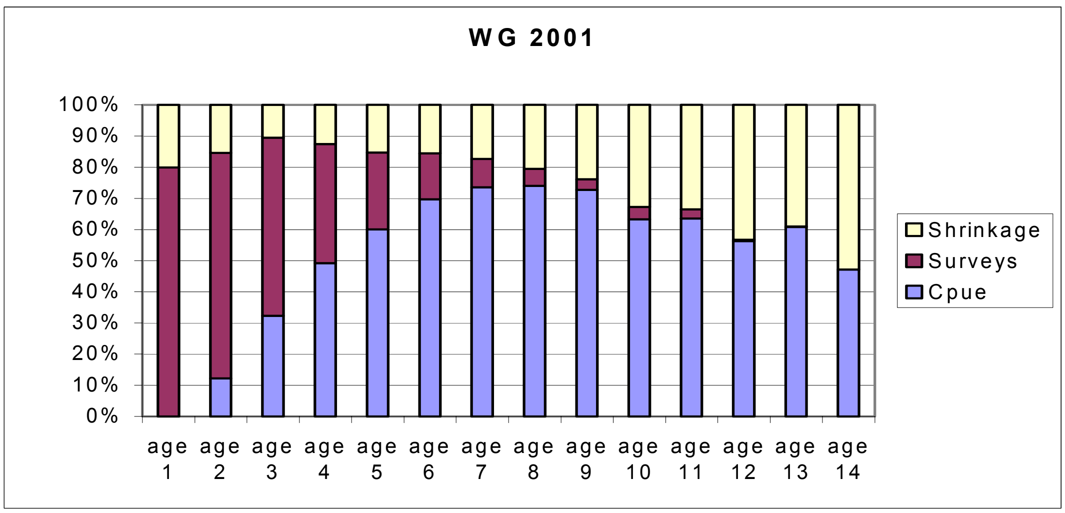


Figure 7.4.6 North Sea sole. Weighting of tuning fleets in 1999 (top), 2000 (middle), and 2001 (bottom).





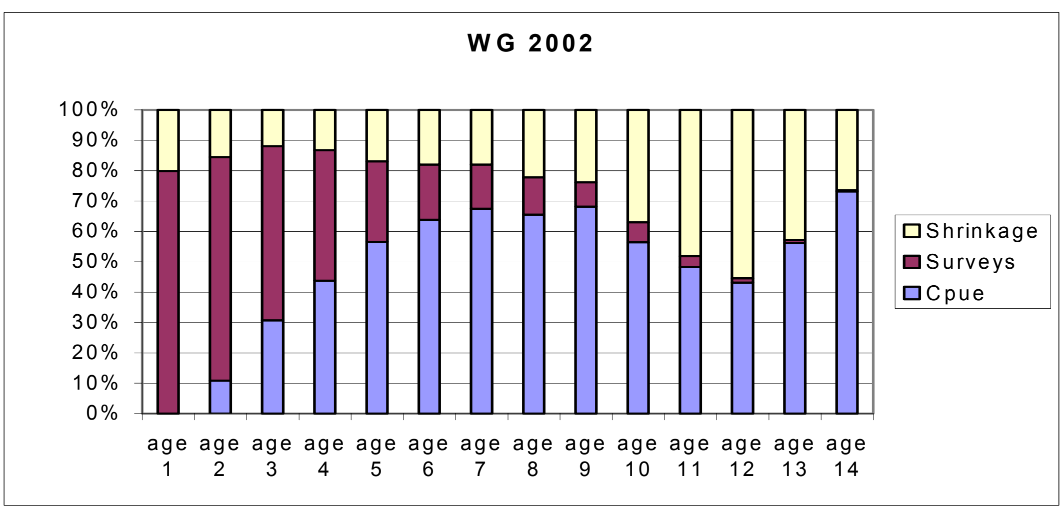


Figure 7.4.7 North Sea sole. Retrospective analysis

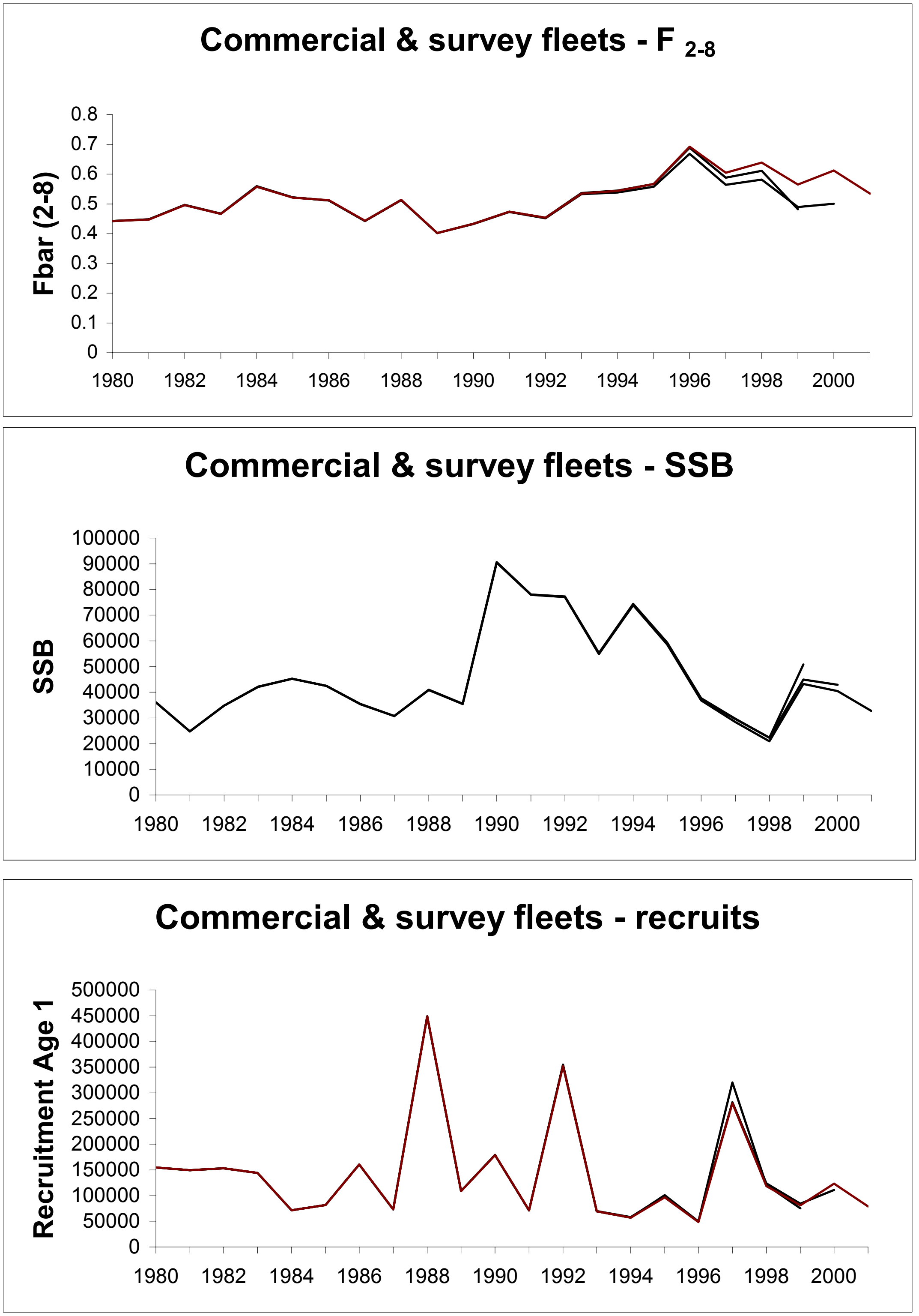


Figure 7.6.1 Sole in Subarea IV (North Sea). Summary plots.

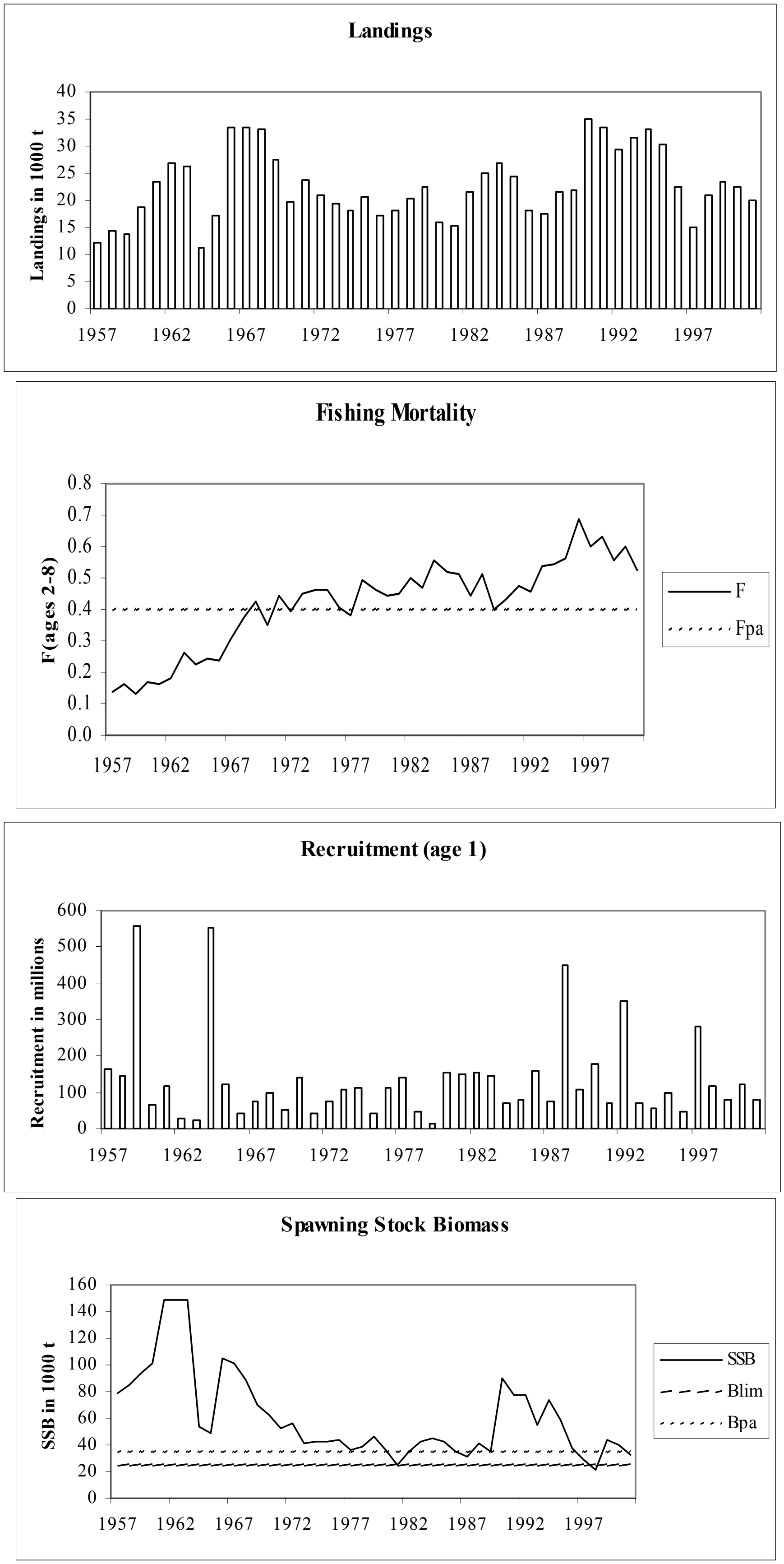


Figure 7.9.1 North Sea sole, Yield-per-recruit

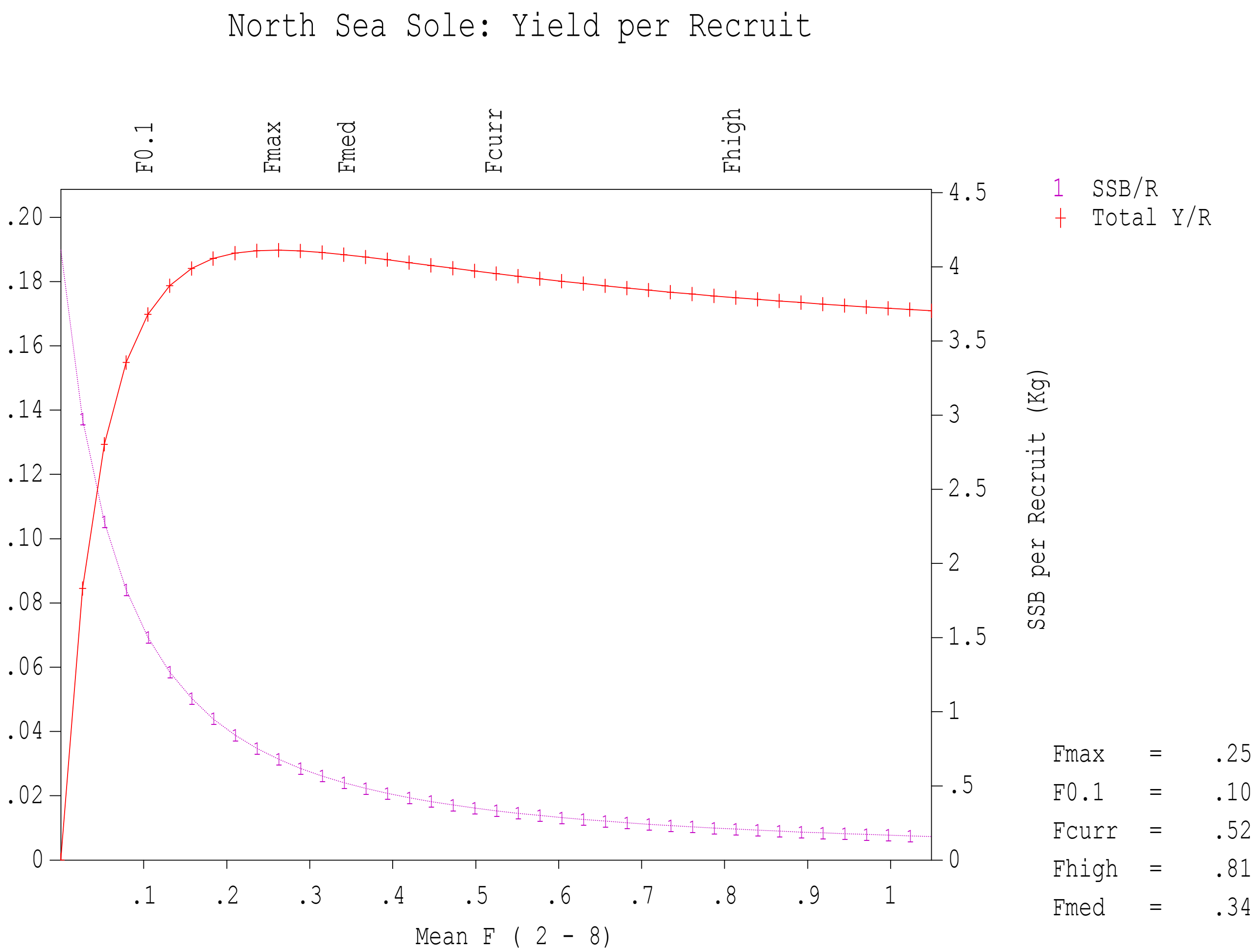


Figure 7.9.2 North Sea sole. Spawning stock per recruit

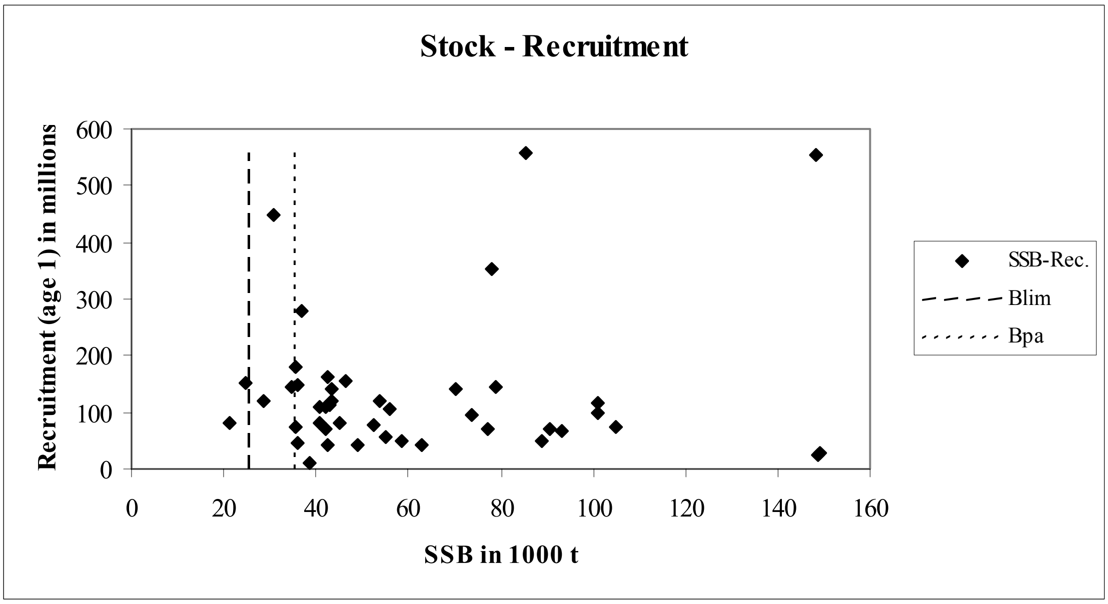


Figure 7.9.3 North Sea sole. Precautionary Approach plot

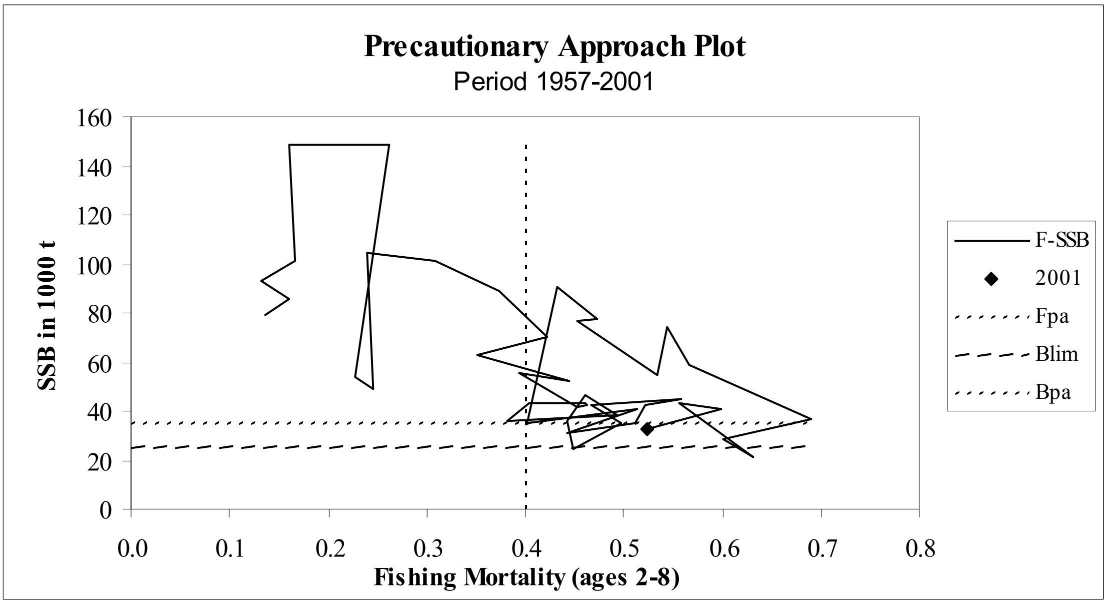
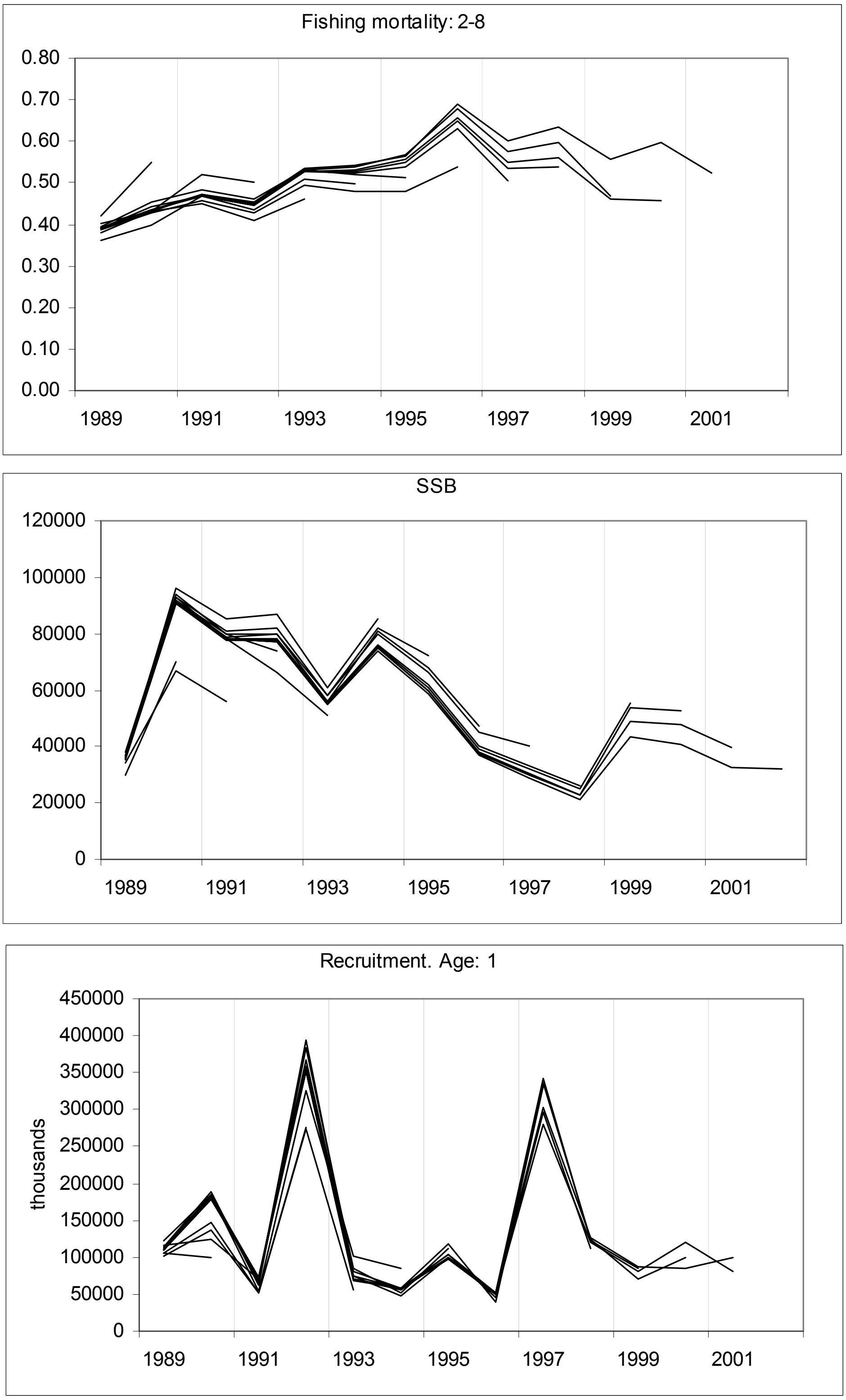


Figure 7.10.1 North Sea sole. Quality control of assessments generated by successive working groups.



8 SOLE IN DIVISION VIID

8.1 The Fishery

There is a directed fishery for sole by small inshore vessels using trammel nets and trawls, who fish mainly along the English and French coasts and possibly exploit different coastal populations. There is also a directed fishery by English and Belgian beam trawlers who are able to direct effort to different ICES divisions. These vessels are able to fish for sole in the winter before the fish move inshore and become accessible to the local fleets. In cold winters, sole are particularly vulnerable to the offshore beamers when they aggregate in localised areas of deeper water. Effort from the beam trawl 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.

8.1.1 ACFM advice applicable to 2001 and 2002

In 2000 ACFM recommended to reduce F below $\mathbf{F}_{pa}$, corresponding to landings in 2001 of less than 4 700 t. In 2001 ACFM considered the stock to be within safe biological limits, and recommended that fishing mortality should be maintained below the proposed $\mathbf{F}_{pa,}$ corresponding to landings in 2002 of less than 5 200 t, which was also set as TAC.

8.1.2 Management applicable to 2002

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 Divisions VIId and IVc permit the use of static gears with a minimum mesh size of 90 mm.

8.1.3 Landings in 2001

Landing data reported to ICES are shown in Table 8.1.1 together with the total landings estimated by the Working Group. The unallocated landings are mainly due to the misreporting by beam trawlers fishing from adjacent areas. There is also thought to be 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.

The 2001 landings used by the Working Group were 4 350 t, which is 5% below the agreed TAC of 4 600 t and around the catch predicted at *status quo* fishing mortality in 2001 (4 430 t).

Year	TAC	WG Landings
2000	4100	3649
2001	4600	4350
2002	5200	-

8.2 Natural Mortality, Maturity, Age Compositions, and Weight-at-Age

Natural mortality was assumed constant over ages and years at 0.1, and the maturity ogive used was knife-edged with sole regarded as fully mature at age 3 and older.

Age sampling for the period before 1980 was poor, but between 1981 and 1984 quarterly samples were provided by both Belgium and England. Since 1985, quarterly catch and weight-at-age compositions were available from Belgium, France, and England.

In previous years, stock weights were calculated from a smoothed curve of the catch weights interpolated to the 1st January. This year, second quarter catch weights were used as stock weights in order to be consistent with North Sea sole. Last year's assessment was re-run with the new stock weights for comparison. This resulted in slightly higher estimates of the spawning stock.

The age composition data and the mean weight-at-age in the catch and stock are shown in Tables 8.2.1 to 8.2.3 and Figure 8.2.1. There are some downward trends in weight for the older ages.

Discarding is expected to be similar as for North Sea sole.

8.3 Catch, Effort, and Research Vessel Data

Catch per unit effort and effort data are shown for 4 main commercial fleets in Table 8.3.1 and Figure 8.3.1. Effort increased from 1975 onwards and peaked in the late eighties. Since then, it has fluctuated around a higher level compared to the beginning of the time-series. cpue has fluctuated around a constant level over the time-series. The strong cpue increase in the French otter trawl fleet since 1999 can be explained by the increase in the recorded landings.

Abundance indices from the English beam trawl survey are shown in Table 8.3.2 and Figure 8.3.3. In 1999 a large increase in abundance for the 3+ fish was noticed as the strong 1996 year class recruited to the spawning stock. The abundance for the 3+ fish decreases again in 2000 but remains above the abundance of the previous years.

The English and French Young Fish Survey were combined into an International Young Fish Survey. 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%. Figure 8.3.2 gives the recruitment indices for the English, French, and International Young Fish Survey. Estimates between and within the two surveys are not always consistent.

8.4 Catch-at-Age Analysis

8.4.1 Data screening

Year range and age range: A separable analysis was run to examine the consistency of the age composition. The results are shown in Table 8.4.1. As last year, the residuals on ages 1/2 were high. There were high residuals at ages older than 11, and these ages were subsequently combined into an 11+ group.

8.4.2 Exploratory XSA runs

Three commercial fleets, i.e. the Belgian Beam Trawl fleet (BEL BT), the UK Beam Trawl fleet (UK BT), the French Otter Trawl fleet (FR OT), and two surveys, i.e. the UK Beam Trawl Survey (UK BTS) and the International Young Fish Survey (YFS) were available for the tuning (Table 8.4.2).

Each fleet was initially run separately, over the full year range and with low shrinkage (s.e. 1.5). The log-catchability residuals are plotted in Figure 8.4.1. Trends in log-catchability residuals for the final XSA are plotted in Figure 8.4.2.

French age composition data became available from 1986 onwards and French landings take half of the catch. Therefore the analysis started from 1986 onwards. Furthermore, there are some large catchability residuals in the years prior to 1986.

The French otter trawl fleet was excluded from the tuning series because of the observed increase in cpue, caused by the increase of reported landings.

Survivor estimates were shrunk towards the mean F over the last 5 years and 5 ages, as there was no further reason to restrict shrinkage to 4 years and 4 ages. Comparison of the two settings did not reveal any differences.

A run with surveys only in the tuning, resulted in lower estimates of the spawning stock and higher estimates of fishing mortality, especially in the last 5 years. However, this setting gave strong retrospective patterns (overestimation of SSB and underestimation of F).

SSB vs. F estimates in 2001 for the single fleets and two XSA runs are shown in Figure 8.4.3. The UK and French commercial fleets predict low values of F and high values of SSB compared to the Belgian fleet. The surveys give contradicting information. However, the young fish survey uses only age 1 in the tuning.

8.4.3 Final XSA run

The input parameters for the final runs used in the 2001 and 2002 assessment are compared below:

year of assessment	**2001**		**2002**	
Assessment model	XSA		XSA	
BEL beamtrawl	1986-2000	2-9	1986-2001	**2-10**
UK beamtrawl	1986-2000	2-10	1986-2001	2-10
FR ottertrawl	1991-2000	3-10	**not used**	
UK BTS	1986-2000	1-6	1986-2001	1-6
UK YFS	1986-2000	1	**not used**	
FR YFS	1987-2000	1	**not used**	
International YFS			**1987-2001**	**1**
Time-series weights	none		none	
Power model used for catchability	none		none	
Catchability plateau age	7		7	
Surv. est. shrunk towards mean F	4 years / 4 ages		**5 years / 5 ages**	
s.e. of the means	0.5		0.5	
Min. stand. error for pop. estimates	0.3		0.3	
Prior weighting	none		none	
Number of iterations	57			
Convergence	yes			

The input fleets used in the final XSA run are given in Table 8.4.2 and tuning results using the selected parameters, in Table 8.4.3. Fishing mortality and stock number-at-age are presented in Table 8.4.4 and 8.4.5. Scaled weights for the commercial fleets, the surveys, and F shrinkage for the final run are presented in Figure 8.4.4. This figure gives also the scaled weights from last year's final run. In either cases, the surveys get more than 50% of the weight-at-age 1 and less weight at older ages. In general, F shrinkage gets low weights for all ages greater than 2.

Last year, fishing mortality in 2000 was estimated to be 0.34, while this year the fishing mortality in 2000 was estimated to be 0.45.

A retrospective analysis using F shrinkage (s.e. 0.5) was taken over the full year range. Results are shown in Figure 8.4.5. The retrospective pattern is similar to the pattern in 2001. SSB tends to be slightly overestimated (1%), while F tends to be underestimated (8%) (averages over the last three years).

8.5 Recruitment Estimates

Recruit indices were available for 1- and 2-gp sole from the English beam trawl survey, which covers most of VIId in August, and for 0- and 1-gp from English and French coastal young fish surveys. The latter two are combined in the International Young Fish Survey. The input file to RCT3 is given in Table 8.5.1 and the output in Tables 8.5.2-3.

2001 year class: One survey estimate was available (International Young Fish Survey) for the estimation of the 2001 year class at age 1. Estimates from the English beam trawl survey covering the whole of VIId were not available (as the survey is carried out in August). The YFS estimate gets a low weight (10%) in RCT3 (high standard errors and low r^2). Therefore, the GM 82-99 (23.0 million) was used as an estimate for this year class.

2000 year class: The 2000 year class at age 2 was estimated at 43.9 million by XSA and 23.5 million by RCT3. The survey estimates in RCT3 received 56% weighting. Since there is variable information coming from the XSA estimate for this year class together with high F shrinkage (which increased the XSA estimate), the RCT3 estimate for the 2000 year class was accepted.

The table below gives an overview of the estimates for year classes 2000-2001 obtained by the different methods.

Year class	At age in 2002	XSA	GM 82-99	RCT3	Accepted Estimate
2000	2	43850	20026	23454	RCT3
2001	1	-	23054	23717	GM 1982-99
2002 & 2003	recruits	-	23054	-	GM 1982-99

8.6 Historical Stock Trends

Trends in yield, fishing mortality, SSB, and recruitment are shown in Table 8.6.1 and Figure 8.6.1. Landings have been rather constant over the time-series. Fishing mortality has been variable over the period and peaked in the periods 1987-89 and 1996-99. There appears to be a general increase in recruitment in recent years.

8.7 Short-Term Forecast and Sensitivity Analysis

The input data for the catch forecasts are given in Table 8.7.1. Stock numbers in 2002 were taken from the XSA output for age 3 and older, from RCT3 for age 2, and from the GM for age 1 and the recruits in 2003 and 2004. An exploitation pattern for the period 1999-2001 scaled to F_{bar} (3-8) in 2001 was used ($F_{3\text{-}8} = 0.34$). Catch and stock weights-at-age were the mean for the period 1999-2001, and the proportions of M and F before spawning were set to zero.

The results of the *status quo* catch prediction are given in Table 8.7.2 and a detailed output by age in Table 8.7.3. The predicted *status quo* landings in 2002 are estimated to be 4 860 t, compared to a TAC of 5 200 t. The predicted *status quo* landings in 2003 are estimated to be 4 720 t. At $\mathbf{F}_{sq}$ spawning stock biomass is forecast to stay at the same level (from 14 800 t in 2002 to 15 100 t in 2004). A plot of the short-term yield and SSB is shown in Figure 8.7.3.

Figure 8.7.1 shows the sensitivity of the predicted yields in 2003 and the predicted biomasses in 2004 to the input parameters. They also show the partial variances (proportions), and how the variability in the input parameters contributes to the variance of the predicted yield and biomasses. The variability of the F multiplier in 2003 has a major influence on the variance and sensitivity of the yield in 2003. Spawning stock biomass in 2004 is most sensitive to the estimate of the 2001 year class, and the maturity and stock weights-at-age 5.

Probability profiles of SSB in 2004 assuming *status quo* F, and the probability that F in 2003 will exceed *status quo* F at different 2003 catch levels are given in Figure 8.7.2. The probability that SSB in 2004 will fall below the $\mathbf{B}_{pa}$ (8 kt) is very low at $\mathbf{F}_{sq}$.

Table 8.7.4 shows the contribution of different year classes to the landings and SSB under *status quo* assumptions. The bulk of the landings in 2003 and SSB in 2004 will consist of the year classes 1998 to 2000.

8.8 Medium-term Projections

Last year, medium-term analysis was carried out based on a Ricker stock-recruitment model. ACFM considered this stock-recruitment curve inappropriate for this stock and suggested to use the Ockham model. Comparison of both models is given in Figure 8.8.1. The main difference lies in the trajectory to the origin.

As the Aberdeen software does not allow for the Ockham model, and the Ricker curve was considered to be inappropriate, no medium-term analysis is presented.

8.9 Biological Reference Points

The input data for the yield-per-recruit analysis are given in Table 8.9.1. Mean weights were taken from 1986-2001. Figure 8.9.1 shows the yield and SSB per recruit assuming *status quo* F in 2002. Figure 8.9.2 shows the relationship between stock and recruitment and gives the calculated reference points. The current level of $F_{3\text{-}8}$ is below $\mathbf{F}_{med}$ and above $\mathbf{F}_{max}$.

The precautionary reference points were not reviewed in this assessment. The management reference points proposed by ACFM are shown below together with the estimated reference points calculated from the recent assessment:

Management			Estimated			
$\mathbf{B}_{pa}$	$\mathbf{F}_{pa}$	$\mathbf{F}_{lim}$	$\mathbf{F}_{sq}$	$\mathbf{F}_{0.1}$	$\mathbf{F}_{max}$	$\mathbf{F}_{med}$
8 000 t	0.4	0.55	0.34	0.13	0.28	0.40

Historical SSBs and F values are plotted in Figure 8.9.3 into zones according to the proposed precautionary reference points. Sole in VIId is considered to be within safe biological limits.

8.10 Comments on the Assessment

Uncertainties in the current assessment are (1) under-reporting by important segments of the inshore fleet, since this fleet takes a major part of the landings of sole in VIId, (2) misreporting of beam trawl fleets fishing in adjacent areas, and (3) the poor quality of data at the youngest ages (because of a low sampling level), although data are improving over the last 5 years.

In order to cope with the problem of underreporting by some segments of the inshore fleet, a study should be carried out to investigate the magnitude of this problem.

There appears to be a decline in fishing mortality over the last three years, but this is not supported by a downward trend in effort.

There appears to be a general increase in recruitment in recent years, with strong year classes in 1996, 1998, and 1999. However, the latter strong year class is not well established yet.

8.11 Management Considerations

The stock is considered within safe biological limits, although there is a tendency to underestimate F.

The cumulative probability distribution from the sensitivity analysis indicates that the probability of the spawning biomass being below $\mathbf{B}_{pa}$ in 2004 is small.

Sole is mainly taken in fisheries with plaice as a by-catch.

Table 8.1.1 Sole in VIId. Nominal landings (tonnes) as officially reported to ICES and used by the 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	2171		621	.	3813	-164	3649	4100
2001	1313	2436		816		4565	-215	4350	4600

* Unallocated mainly due misreporting
** Preliminary

Table 8.2.1 Sole in VIId. Catch numbers at age (Numbers*103)**

YEAR	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
AGE										
1	155	0	24	49	49	9	95	163	1271	383
2	2625	852	1977	3693	1264	3284	2227	3704	3092	7381
3	5256	3452	3157	5211	5377	3827	7393	3424	6326	3796
4	1727	3930	2610	1646	3273	3417	1648	4842	1257	4316
5	570	897	1900	1027	925	2166	1219	1530	1654	585
6	653	735	742	1860	790	1064	910	943	329	1003
7	549	627	457	144	1087	1110	400	651	432	256
8	240	333	317	158	156	828	268	218	293	257
9	122	108	136	156	192	114	280	181	138	272
10	83	89	99	69	216	163	84	270	139	95
+gp	202	193	238	128	381	469	284	329	556	395
TOTALNUM	12182	11216	11657	14141	13710	16451	14808	16255	15487	18739
TONSLAND	3190	3458	3575	3837	4024	4974	3982	4187	4060	4382
SOPCOF %	97	99	99	100	100	100	100	100	99	100

YEAR	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
AGE										
1	106	85	34	683	11	30	41	182	145	184
2	4082	5225	783	2974	2055	1740	1814	3512	3787	6488
3	8967	6716	6660	4558	7934	6444	5929	9126	5368	6615
4	1886	5735	6152	5003	3081	5228	2890	3543	4914	1760
5	2065	1057	3514	3090	3381	2157	1760	1406	1227	2671
6	295	645	613	2052	1896	1840	651	945	577	798
7	382	171	613	394	1332	992	654	379	376	319
8	140	206	112	310	288	841	494	731	163	159
9	184	123	154	95	351	255	394	379	380	65
10	98	67	94	111	112	199	251	209	170	102
+gp	237	145	278	247	375	298	354	389	292	304
TOTALNUM	18442	20175	19007	19517	20816	20024	15232	20801	17399	19465
TONSLAND	4142	4511	4643	4583	5025	4983	3694	4238	3649	4350
SOPCOF %	100	100	100	100	100	98	100	93	94	100

Table 8.2.2 Sole in VIId. Catch weights at age (kg)

YEAR	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
AGE										
1	0.102	0	0.1	0.09	0.135	0.095	0.102	0.106	0.121	0.114
2	0.171	0.173	0.178	0.182	0.179	0.176	0.152	0.156	0.18	0.161
3	0.225	0.23	0.234	0.23	0.212	0.236	0.226	0.193	0.24	0.211
4	0.312	0.302	0.314	0.281	0.306	0.295	0.278	0.274	0.291	0.267
5	0.386	0.404	0.38	0.368	0.362	0.353	0.358	0.295	0.351	0.349
6	0.428	0.436	0.436	0.394	0.385	0.407	0.407	0.357	0.343	0.39
7	0.439	0.435	0.417	0.516	0.435	0.412	0.458	0.391	0.469	0.415
8	0.509	0.524	0.538	0.543	0.519	0.479	0.509	0.469	0.463	0.426
9	0.502	0.537	0.529	0.594	0.501	0.463	0.551	0.516	0.489	0.433
10	0.463	0.583	0.565	0.595	0.524	0.538	0.559	0.538	0.519	0.477
+gp	0.6729	0.6283	0.7135	0.8005	0.6029	0.6192	0.6662	0.7047	0.5667	0.559
SOPCOFAC	0.9713	0.991	0.9884	0.998	1.0044	1.0003	0.997	0.9974	0.9949	1.0004

YEAR	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
AGE										
1	0.103	0.085	0.099	0.127	0.142	0.139	0.133	0.133	0.146	0.111
2	0.153	0.148	0.151	0.174	0.167	0.155	0.16	0.153	0.143	0.154
3	0.202	0.197	0.188	0.18	0.179	0.189	0.174	0.193	0.175	0.211
4	0.267	0.245	0.236	0.233	0.23	0.233	0.236	0.219	0.223	0.28
5	0.291	0.331	0.29	0.257	0.272	0.291	0.285	0.264	0.335	0.286
6	0.399	0.374	0.354	0.332	0.323	0.341	0.341	0.285	0.379	0.329
7	0.386	0.528	0.38	0.356	0.36	0.385	0.379	0.295	0.426	0.361
8	0.455	0.54	0.505	0.38	0.403	0.401	0.412	0.347	0.431	0.361
9	0.445	0.505	0.492	0.48	0.436	0.495	0.48	0.363	0.387	0.48
10	0.461	0.742	0.496	0.49	0.461	0.469	0.432	0.379	0.461	0.488
+gp	0.5576	0.6467	0.6155	0.6419	0.5852	0.6428	0.6043	0.5452	0.6841	0.5346
SOPCOFAC	1.0006	1.0009	0.9997	1.0001	0.9999	0.978	0.9995	0.9348	0.9397	0.9999

Table 8.2.3 Sole in VIId. Stock weights at age (kg)

YEAR	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
AGE										
1	0.059	0.07	0.067	0.065	0.07	0.072	0.05	0.05	0.05	0.05
2	0.114	0.135	0.131	0.129	0.136	0.139	0.145	0.115	0.139	0.138
3	0.167	0.197	0.192	0.192	0.198	0.203	0.223	0.184	0.231	0.224
4	0.217	0.255	0.249	0.254	0.256	0.262	0.268	0.272	0.302	0.278
5	0.263	0.309	0.304	0.315	0.309	0.318	0.365	0.324	0.39	0.377
6	0.306	0.359	0.355	0.376	0.358	0.37	0.424	0.336	0.363	0.382
7	0.347	0.406	0.403	0.436	0.403	0.417	0.476	0.469	0.464	0.408
8	0.384	0.448	0.448	0.495	0.443	0.461	0.494	0.494	0.515	0.441
9	0.418	0.487	0.49	0.554	0.48	0.5	0.566	0.559	0.561	0.468
10	0.45	0.522	0.529	0.611	0.512	0.536	0.636	0.519	0.497	0.444
+gp	0.53	0.6008	0.6265	0.7798	0.5761	0.6156	0.7536	0.7119	0.5588	0.6097

YEAR	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
AGE										
1	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
2	0.144	0.131	0.111	0.126	0.155	0.141	0.141	0.131	0.123	0.125
3	0.199	0.188	0.159	0.128	0.175	0.167	0.16	0.159	0.148	0.179
4	0.275	0.243	0.217	0.22	0.259	0.221	0.233	0.191	0.209	0.235
5	0.301	0.356	0.278	0.234	0.286	0.265	0.296	0.275	0.402	0.263
6	0.448	0.363	0.325	0.338	0.308	0.318	0.368	0.305	0.438	0.277
7	0.398	0.531	0.371	0.365	0.367	0.372	0.353	0.366	0.395	0.324
8	0.449	0.543	0.536	0.335	0.395	0.402	0.351	0.34	0.552	0.327
9	0.416	0.546	0.483	0.633	0.435	0.559	0.44	0.448	0.444	0.423
10	0.524	0.782	0.476	0.381	0.467	0.492	0.365	0.348	0.417	0.408
+gp	0.5213	0.548	0.6305	0.6347	0.6355	0.6469	0.5589	0.4937	0.6854	0.5394

Table 8.3.1 Sole in VIId. Catch per unit effort and effort data

Catch per unit effort				
	Belgium	UK		France
Year	Beam trawl (kg/10hr) HP corr	Trammel (kg/day)	Beam trawl (kg/hr) GRT corr *	Trawl (kg/h*kw*10-4)
1975	24.1		11.5	
1976	27.3		10.5	
1977	30.0		11.0	
1978	26.3		9.1	
1979	37.4		8.3	
1980	23.3		15.2	
1981	24.5		13.7	
1982	23.6		11.2	
1983	22.4		21.4	
1984	21.6		13.3	
1985	22.9	33.8	12.8	
1986	33.5	38.9	10.9	
1987	36.6	31.6	11.0	
1988	15.9	33.8	11.3	
1989	16.8	28.2	10.6	
1990	25.9	20.2	11.9	
1991	22.6	31.8	8.1	18.5
1992	29.1	30.1	8.0	18.1
1993	34.8	18.7	8.4	21.6
1994	27.9	21.1	9.2	17.8
1995	24.7	21.8	9.0	18.5
1996	29.8	31.2	10.3	19.8
1997	32.6	32.8	9.9	14.4
1998	23.5	21.1	11.1	17.3
1999	26.4	35.2	12.0	30.4
2000	24.5	28.1	10.0	29.1
2001	24.6	25.8	11.3	46.1

Effort				
	Belgium	UK		France
Year	Beam trawl ('000 hr) HP corr	Trammel (days at sea)	Beam trawl ('000 hr) *	Trawl (h*kw*10-4)
1975	5.0			
1976	6.6			
1977	6.9			
1978	8.2			
1979	7.3			
1980	12.8		2.7	
1981	19.0		2.3	
1982	23.9		4.2	
1983	23.6		2.7	
1984	28.0		2.9	
1985	25.3	6243	9.1	
1986	23.5	5863	12.9	
1987	27.1	7192	24.3	
1988	38.5	6943	19.0	
1989	35.7	8380	33.3	
1990	30.3	13541	33.4	
1991	24.3	12188	30.4	10689
1992	22.0	8547	37.1	10519
1993	20.0	9062	29.3	10217
1994	25.2	10756	28.1	10609
1995	24.2	10571	28.6	12384
1996	25.0	8531	39.1	14088
1997	30.9	10066	39.6	10921
1998	18.1	10307	33.5	11707
1999	21.4	7862	27.2	10625
2000	30.5	6398	29.2	13779
2001	32.4	6514	26.0	11376

Table 8.3.2 Sole in VIId. English beam trawl survey numbers per hr raised to 8m beam trawl equivalent

(mean no/rectangle, averaged across rectangles).

Age	1	2	3	4	5	6	7	8	9	10+	1+	3+
1988	8.2	14.2	9.9	0.8	1.3	0.6	0.1	0.1	0.2		35.4	13.0
1989	2.6	15.4	3.4	1.7	0.6	0.2	0.2	0.0	0.0	0.6	24.7	6.7
1990	12.1	3.7	3.4	0.7	0.8	0.2	0.1	0.2	0.0	0.2	21.4	5.6
1991	8.9	22.8	2.2	2.3	0.3	0.5	0.1	0.2	0.1	0.4	37.8	6.1
1992	1.4	12.0	10.0	0.7	1.1	0.3	0.5	0.1	0.2	0.8	27.2	13.8
1993	0.5	17.5	8.4	7.0	0.8	1.0	0.3	0.2	0.0	0.3	36.1	18.1
1994	4.8	3.2	8.3	3.3	3.3	0.2	0.6	0.1	0.3	0.3	24.3	16.4
1995	3.5	10.6	1.5	2.3	1.2	1.5	0.2	0.3	0.2	0.2	21.5	7.4
1996	3.5	7.3	3.8	0.7	1.3	0.9	1.1	0.1	0.5	0.4	19.6	8.8
1997	19.0	7.3	3.2	1.3	0.2	0.5	0.4	0.9	0.0	0.6	33.4	7.1
1998	2.0	21.2	2.5	1.0	0.9	0.1	0.3	0.0	0.1	0.3	28.4	5.2
1999	28.1	9.4	13.2	2.5	1.7	1.3	0.2	0.9	1.1	0.5	58.9	21.3
2000	10.5	22.0	4.1	4.2	1.0	0.6	0.3	0.0	0.2	1.2	44.3	11.8
2001	9.1	21.0	8.4	1.2	1.9	0.5	0.6	0.3	0.0	1.0	44.1	14.0
mean	8.1	13.4	5.9	2.1	1.2	0.6	0.3	0.3	0.2	0.5	32.6	11.1

Table 8.4.1 Sole in VIId. Separable analysis

Title : Sole in VIId

At 14/06/2002 10:09

Separable analysis
from 1982 to 2001 on ages 1 to 14
with Terminal F of .450 on age 3 and Terminal S of .500

Initial sum of squared residuals was 495.986 and
final sum of squared residuals is 93.070 after 98 iterations

Matrix of Residuals

	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	TOT	WTS
1	-3.812	-1.234	1.211	0.27	-1.663	0.588	1.157	2.321	1.545	-0.005	2.05	-0.287	3.273	-0.801	-0.054	-0.128	0.862	0.111	-0.001	0.127
2	-0.055	-0.163	1.062	0.261	-0.041	0.738	0.477	0.795	0.676	0.398	1.026	-0.591	0.338	0.023	-0.271	-0.427	0.368	0.301	-0.001	0.433
3	-0.066	-0.17	0.329	0.195	-0.1	-0.054	0.338	-0.289	-0.092	-0.273	-0.221	-0.14	0.106	-0.072	0.066	0.029	-0.323	0.301	-0.001	1
4	0.306	0.032	0.366	0.084	0.012	-0.476	0.336	0.019	-0.131	-0.22	0.105	0.186	0.032	-0.205	0.279	0.164	0.043	-0.282	0	0.937
5	-0.225	-0.876	0.055	-0.454	-0.134	-0.28	0.815	-0.23	-0.174	0.367	0.16	0.038	0.137	0.063	0.406	0.087	-0.105	-0.449	0	0.511
6	0.046	0.724	0.312	-0.655	-0.021	-0.205	0.059	-0.481	0.099	-0.27	-0.354	-0.075	0.071	0.102	0.244	0.013	-0.066	-0.292	0	0.637
7	0.436	0.334	-0.127	0.145	0.623	0.257	0.272	-0.018	-0.07	-0.012	0.197	0.347	0.135	0.106	0.105	-0.445	0.061	0.171	0.001	0.907
8	0.657	-0.011	-0.234	0.193	0.293	0.05	-0.062	-0.456	-0.332	-0.493	0.072	-0.163	-0.295	-0.226	0.173	-0.062	-0.122	0.237	0	0.702
9	-0.279	-0.174	-0.491	-0.076	-0.612	-0.429	-0.379	-0.281	0.226	0.256	-0.079	-0.128	-0.46	0.099	-0.693	0.19	-0.098	0.506	0	0.658
10	0.297	0.651	-0.588	0.719	0.418	0.531	-0.31	0.009	-0.544	0.228	0.011	0.437	-0.021	0.084	-0.074	0.418	-0.044	-0.386	0	0.547
11	-0.072	-0.054	-0.522	0.33	-0.451	0.178	-1.245	-0.048	0.363	0.785	-0.053	-0.288	-0.59	-0.029	-0.31	-0.034	0.511	-0.137	-0.001	0.463
12	-0.25	-0.017	0.125	-1.119	-0.966	-0.171	-1.259	1.031	0.291	-0.141	-0.984	-0.681	-0.472	0.354	-0.243	0.657	-0.425	-0.339	-0.001	0.334
13	-1.121	-0.493	-1.254	-0.52	1.079	0.246	-0.802	0.804	-0.221	0.125	-0.864	0.941	0.054	0.341	-0.198	-0.469	0.435	-0.106	-0.001	0.31
TOT	0	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	0	0	0	0	3.379	
WTS	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	1	1	1	1	1		

Fishing Mortalities (F)

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
F-values	0.3989	0.3863	0.4529	0.3218	0.4486	0.6481	0.4918	0.5626	0.553	0.5316

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
F-values	0.4267	0.3323	0.3796	0.3989	0.5137	0.5969	0.5575	0.6956	0.559	0.45

Selection-at-age (S)

	1	2	3	4
S-values	0.0032	0.2332	1	1.0158

	5	6	7	8	9	10	11	12	13	14
S-values	0.9466	0.8584	0.7344	0.7353	0.7429	0.6496	0.685	0.7366	0.5124	0.5

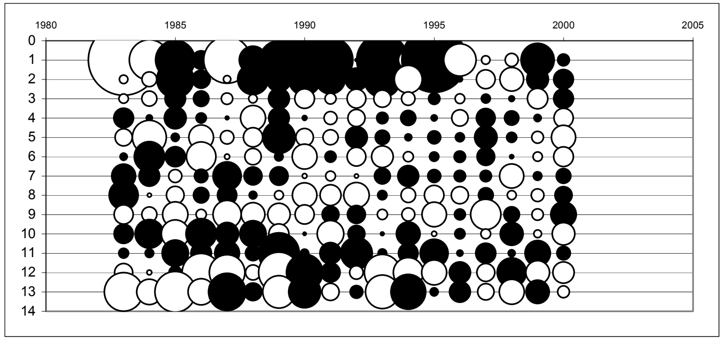


Table 8.4.2 **Sole in VIId. Tuning Fleets.**

SOLE 7d,TUNING														
106	1													
BELGIAN BT														
1980	2001													
1	1	0	1											
2	15													
12.8	69.3	46.1	298.7	189.6	57.4	24.7	10.3	5.1	8.6	3.1	5.5	2.4	2.6	37.9
19.0	640.7	161.4	82.1	312.8	229.6	44.7	32.9	33.1	6.9	9.0	18.4	9.3	0.8	51.9
23.9	148.7	980.9	128.0	93.4	155.9	112.6	38.8	60.1	15.2	14.0	7.4	12.5	5.9	54.3
23.6	190.4	373.0	818.9	65.5	54.0	81.7	73.2	23.5	20.2	27.0	5.0	1.0	7.1	33.0
28.0	603.8	347.2	311.2	436.0	53.7	38.5	104.9	59.9	25.4	23.2	25.3	9.0	8.2	42.4
25.3	382.9	612.1	213.0	209.1	260.2	58.2	34.1	48.0	31.0	16.9	19.6	9.2	7.7	21.3
23.4	215.0	1522.3	675.0	233.7	170.6	194.0	30.1	53.1	64.2	32.6	12.7	2.6	43.0	29.3
27.1	843.6	451.0	739.3	724.4	344.5	232.4	152.7	25.3	86.5	56.0	56.1	54.5	9.3	109.0
38.5	131.6	990.4	243.3	362.9	216.7	111.8	41.8	73.8	47.0	9.8	22.3	35.8	8.6	25.3
35.7	47.5	512.6	543.6	748.0	276.6	225.0	53.1	36.4	12.7	4.7	0.0	0.0	4.7	27.0
30.3	1011.4	1375.2	218.1	366.2	85.3	198.2	65.5	39.0	22.4	22.2	25.4	2.8	24.0	18.2
24.3	320.2	1358.6	710.1	125.6	283.9	60.6	56.2	21.0	19.8	22.2	18.0	5.6	0.3	21.4
22.0	499.3	1613.7	523.3	477.7	36.9	67.9	28.2	31.7	11.2	11.4	6.0	5.7	3.2	16.7
20.0	1654.5	1520.4	889.5	215.5	78.5	38.9	40.8	37.8	11.3	8.7	13.3	1.5	3.0	22.4
22.2	196.9	1183.2	1598.5	912.9	201.0	160.0	39.5	33.8	46.2	16.0	10.2	14.9	8.8	18.6
24.2	206.2	542.7	671.3	590.9	409.4	100.6	40.3	25.4	14.2	9.3	5.0	11.9	3.4	8.0
25.0	284.1	975.5	628.7	560.1	354.3	316.8	68.3	77.6	34.2	26.2	15.8	10.8	1.1	4.2
30.9	196.0	1282.3	966.1	500.2	422.3	301.1	144.7	56.6	29.3	25.8	12.1	12.6	3.4	1.4
18.1	254.1	450.3	375.4	175.1	54.8	116.1	95.9	59.1	12.4	16.0	7.7	2.9	4.4	19.2
21.4	367.7	1043.6	640.2	308.3	94.6	48.7	90.6	68.3	28.2	44.7	22.9	4.7	8.5	11.3
30.5	569.1	1170.7	1225.1	239.1	139.4	68.4	66.6	74.4	46.0	26.9	7.6	6.6	0.3	1.9
32.4	1055.5	1385.4	375.0	617.9	351.1	105.4	31.6	15.2	18.7	35.5	11.6	6.9	12.3	4.6
UK BT														
1981	2001													
1	1	0	1											
2	15													
2.3	41.5	31.2	6.7	25.7	8.5	1.9	2.3	1.6	0.3	0.4	0.8	0.1	0.0	2.8
4.2	17.2	137.2	10.1	3.3	14.1	1.8	1.8	1.9	4.5	1.1	0.0	0.1	0.1	2.3
2.7	18.5	38.4	118.6	2.0	2.8	6.9	4.4	0.3	0.0	0.0	0.0	0.0	1.7	1.3
2.9	42.6	34.8	26.1	30.1	2.6	1.1	0.7	0.6	0.4	0.1	0.1	0.1	0.3	1.5
9.1	12.8	295.0	43.8	21.9	79.8	0.3	0.1	4.9	0.0	0.1	0.5	1.8	0.5	0.5
12.9	38.4	185.4	128.7	35.9	36.9	50.5	1.5	3.1	6.7	3.3	3.6	2.0	2.2	6.8
24.3	362.0	152.3	206.4	142.6	26.8	21.0	54.1	2.1	0.6	4.8	1.5	2.2	4.7	3.5
19.0	145.2	402.6	81.8	94.4	61.4	13.4	17.6	25.6	2.6	0.4	6.7	7.1	0.0	0.3
33.3	310.0	186.9	369.7	44.0	81.7	60.5	12.7	10.8	42.6	2.5	1.1	5.0	6.8	34.5
33.4	199.8	662.3	97.2	146.7	29.1	34.2	34.7	8.7	15.0	48.6	4.1	1.1	6.8	17.7
30.4	488.9	200.3	287.8	12.3	45.9	7.5	11.0	16.3	4.1	2.7	12.7	0.4	0.0	7.4
37.1	332.3	684.6	105.6	215.2	15.0	26.1	8.2	19.0	6.6	3.0	1.9	4.2	0.1	3.3
29.3	272.1	358.5	357.3	56.9	86.8	8.6	17.7	7.4	5.0	5.5	1.9	2.1	3.5	4.6
28.1	49.6	394.0	217.4	170.0	41.6	68.3	6.7	15.8	4.9	5.9	5.5	3.6	2.4	13.9
28.6	229.9	136.3	291.6	140.5	124.3	24.4	51.3	7.2	13.1	2.6	5.9	6.1	1.2	10.8
39.1	446.0	376.0	118.1	251.3	127.7	101.8	26.3	50.5	6.3	13.5	6.3	8.0	5.4	18.2
39.6	427.3	504.4	239.9	64.2	180.2	75.3	71.0	16.6	33.1	4.0	10.4	1.7	5.4	12.1
33.5	527.5	337.9	185.8	125.1	41.7	94.1	54.3	43.0	10.8	22.9	4.0	10.2	2.8	17.5
27.2	350.3	613.7	214.2	87.8	64.8	25.3	54.0	26.7	14.8	7.1	7.7	1.4	5.1	8.5
29.0	298.9	342.0	320.9	102.1	47.5	33.1	12.7	39.8	17.9	10.6	4.4	7.6	1.1	14.3
26.0	722.3	631.1	219.6	236.2	92.8	39.5	42.0	12.5	29.7	25.8	10.8	3.0	6.6	10.0
FR OT *														
1991	2001													
1	1	0	1											
3	15													
10689	121.1	138.9	26.8	32.3	9.8	7.9	9.2	3.4	3.8	3.5	0.5	0.9	4.1	
10519	528.1	57.4	43.0	10.5	13.5	5.3	4.5	3.2	3.9	1.7	1.3	0.5	2.1	
10217	397.8	243.6	36.8	12.0	5.4	4.8	3.3	1.7	0.6	0.3	0.2	0.0	0.2	
10609	328.0	288.0	142.7	22.4	14.9	4.5	5.0	2.5	1.6	0.9	0.8	1.2	3.2	
12384	292.0	223.2	138.0	87.6	18.1	6.4	3.6	3.9	3.2	3.2	0.8	0.4	6.6	
14088	558.6	189.7	141.3	108.8	62.5	16.4	8.7	7.8	4.0	5.6	3.1	2.9	8.2	
10921	164.6	164.1	79.6	42.6	30.8	31.5	12.6	2.9	4.3	2.7	0.7	1.4	3.2	
11707	497.5	136.2	81.3	41.5	21.3	21.6	20.7	16.8	3.7	3.5	0.7	1.1	2.3	
10625	642.2	212.1	75.3	60.0	21.1	48.4	23.3	13.6	5.7	6.7	1.4	4.5	6.4	
13779	180.5	562.6	25.9	11.9	13.2	4.7	5.8	8.3	8.0	3.0	3.8	3.1	2.2	
11376	935.1	201.1	262.4	38.4	19.0	10.8	4.5	5.4	12.6	8.9	2.2	1.0	5.5	

Table 8.4.2 Sole in VIId. Continued

UK BTS

1988	2001					
1	1	0.5	0.75			
1	6					
1	8.2	14.2	9.9	0.8	1.3	0.6
1	2.6	15.4	3.4	1.7	0.6	0.2
1	12.1	3.7	3.4	0.7	0.8	0.2
1	8.9	22.8	2.2	2.3	0.3	0.5
1	1.4	12.0	10.0	0.7	1.1	0.3
1	0.5	17.5	8.4	7.0	0.8	1.0
1	4.8	3.2	8.3	3.3	3.3	0.2
1	3.5	10.6	1.5	2.3	1.2	1.5
1	3.5	7.3	3.8	0.7	1.3	0.9
1	19.0	7.3	3.2	1.3	0.2	0.5
1	2.0	21.2	2.5	1.0	0.9	0.1
1	28.1	9.4	13.2	2.5	1.7	1.3
1	10.49	22.03	4.15	4.24	1.03	0.58
1	9.09	21.01	8.36	1.20	1.91	0.54

YFS**

1987	2001		
1	1	0.5	0.75
1	1		
1	0.07		
1	0.17		
1	0.14		
1	0.54		
1	0.38		
1	0.22		
1	0.03		
1	0.70		
1	0.28		
1	0.15		
1	0.03		
1	0.10		
1	0.35		
1	0.31		
1	1.21		

* Not used in the assessment

** UK and French Young Fish Survey combined

Table 8.4.3 Sole in VIId. Tuning diagnostics

Lowestoft VPA Version 3.1

14/06/2002 17:03

Extended Survivors Analysis

Sole in VIId

CPUE data from file d:\wgnssk\2002\vpa\tun2.txt

Catch data for 20 years. 1982 to 2001. Ages 1 to 11.

Fleet	Firs year	Last year	First age	Last age	Alpha	Beta
BEL BT	1986	2001	2	10	0	1
UK BT	1986	2001	2	10	0	1
UK BTS	1988	2001	1	6	0.5	0.75
YFS	1987	2001	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 37 iterations

Regression weights

1	1	1	1	1	1	1	1	1	1

Fishing mortalities

Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	0.003	0.005	0.001	0.035	0.001	0.001	0.002	0.006	0.003	0.004
2	0.143	0.191	0.054	0.135	0.125	0.099	0.064	0.23	0.142	0.143
3	0.392	0.329	0.351	0.446	0.556	0.616	0.496	0.462	0.573	0.35
4	0.378	0.415	0.501	0.429	0.544	0.781	0.548	0.551	0.431	0.329
5	0.486	0.334	0.428	0.448	0.51	0.819	0.58	0.499	0.331	0.391
6	0.318	0.243	0.294	0.422	0.484	0.511	0.55	0.629	0.347	0.331
7	0.364	0.274	0.342	0.278	0.473	0.446	0.304	0.637	0.486	0.292
8	0.265	0.304	0.259	0.258	0.299	0.548	0.371	0.578	0.551	0.346
9	0.45	0.349	0.347	0.325	0.46	0.417	0.475	0.479	0.597	0.392
10	0.471	0.26	0.436	0.402	0.693	0.456	0.828	0.44	0.363	0.277

Table 8.4.3 Sole in VIId. Continued

XSA population numbers (Thousands)

YEAR	AGE 1	2	3	4	5	6	7	8	9	10
1992	3.51E+04	3.21E+04	2.91E+04	6.30E+03	5.64E+03	1.14E+03	1.31E+03	6.32E+02	5.34E+02	2.74E+02
1993	1.73E+04	3.17E+04	2.52E+04	1.78E+04	3.91E+03	3.14E+03	7.50E+02	8.26E+02	4.38E+02	3.08E+02
1994	2.74E+04	1.56E+04	2.37E+04	1.64E+04	1.06E+04	2.53E+03	2.23E+03	5.16E+02	5.52E+02	2.80E+02
1995	2.11E+04	2.47E+04	1.33E+04	1.51E+04	8.99E+03	6.26E+03	1.71E+03	1.43E+03	3.60E+02	3.53E+02
1996	2.15E+04	1.84E+04	1.95E+04	7.72E+03	8.90E+03	5.19E+03	3.72E+03	1.17E+03	1.00E+03	2.36E+02
1997	3.38E+04	1.95E+04	1.47E+04	1.01E+04	4.06E+03	4.83E+03	2.90E+03	2.10E+03	7.86E+02	5.72E+02
1998	1.99E+04	3.05E+04	1.59E+04	7.20E+03	4.20E+03	1.62E+03	2.62E+03	1.68E+03	1.10E+03	4.69E+02
1999	3.33E+04	1.80E+04	2.59E+04	8.79E+03	3.76E+03	2.13E+03	8.45E+02	1.75E+03	1.05E+03	6.17E+02
2000	5.67E+04	3.00E+04	1.29E+04	1.48E+04	4.58E+03	2.07E+03	1.03E+03	4.04E+02	8.89E+02	5.87E+02
2001	4.87E+04	5.12E+04	2.35E+04	6.61E+03	8.68E+03	2.98E+03	1.32E+03	5.72E+02	2.11E+02	4.43E+02

Estimated population abundance at 1st Jan 2002

0.00E+00	4.39E+04	4.01E+04	1.50E+04	4.30E+03	5.32E+03	1.94E+03	8.93E+02	3.66E+02	1.29E+02

Taper weighted geometric mean of the VPA populations:

2.50E+04	2.14E+04	1.61E+04	8.67E+03	4.75E+03	2.70E+03	1.58E+03	9.41E+02	5.87E+02	3.69E+02

Standard error of the weighted Log(VPA populations) :

0.4428	0.4181	0.3727	0.4393	0.4518	0.4565	0.4779	0.473	0.4445	0.3702

Log catchability residuals.

Fleet : BEL BT

Age	1986	1987	1988	1989	1990	1991
1	No data for this fleet at this age					
2	0.25	0.79	-0.52	-2.35	1.36	-0.53
3	0.66	-0.29	-0.51	-0.08	0.04	0.78
4	0.14	0.3	-0.81	-0.45	-0.2	0.07
5	-0.19	0.5	-0.33	0.88	-0.12	-0.14
6	-0.17	0.82	-0.27	0.22	-0.31	0.67
7	-0.13	0.49	-0.15	0.27	0.47	-0.15
8	-0.24	0.09	-0.88	-0.29	-0.26	-0.08
9	0.25	-0.07	-0.4	-0.44	0.08	-0.56
10	0.18	1.19	0.77	-1.5	-0.17	0.19

Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	No data for this fleet at this age									
2	0.19	1.53	-0.06	-0.53	0.05	-0.6	-0.27	0.54	0.07	0.09
3	0.05	0.2	-0.08	-0.33	-0.11	0.26	-0.38	-0.21	0.29	-0.3
4	0.32	-0.07	0.53	-0.37	0.25	0.3	0.13	0.3	0.02	-0.47
5	0.24	-0.17	0.22	-0.13	-0.18	0.42	-0.23	0.24	-0.64	-0.37
6	-0.59	-0.79	0.29	0.07	0.1	0.15	-0.24	-0.1	-0.17	0.32
7	-0.23	-0.17	0.09	-0.23	0.2	0.17	-0.21	0.03	-0.24	-0.21
8	-0.42	-0.2	0.11	-0.98	-0.26	-0.19	0.07	-0.1	0.69	-0.55
9	-0.05	0.38	-0.07	-0.03	0.1	-0.21	0.06	0.09	0.04	-0.27
10	-0.41	-0.52	0.96	-0.55	0.83	-0.53	-0.49	-0.29	-0.14	-0.85

Table 8.4.3 Sole in VIId. Continued

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

Age	2	3	4	5	6	7	8	9	10
Mean Log q	-7.3309	-5.7961	-5.6732	-5.5187	-5.7302	-5.6056	-5.6056	-5.6056	-5.6056
S.E(Log q)	0.8952	0.3651	0.3662	0.3837	0.4197	0.2513	0.4534	0.2622	0.7341

Regression statistics :

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

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
2	1.07	-0.11	7.15	0.17	16	0.99	-7.33
3	1.22	-0.728	4.93	0.44	16	0.45	-5.8
4	0.82	1.033	6.29	0.7	16	0.3	-5.67
5	1.1	-0.415	5.21	0.54	16	0.44	-5.52
6	0.79	1.102	6.17	0.67	16	0.33	-5.73
7	0.86	1.297	5.86	0.85	16	0.21	-5.61
8	1.15	-0.634	5.67	0.57	16	0.46	-5.82
9	0.96	0.279	5.7	0.79	16	0.25	-5.68
10	9.28	-2.12	3.47	0	16	6.09	-5.69
1							

Fleet : UK BT

Age	1986	1987	1988	1989	1990	1991
1	No data for this fleet at this age					
2	-0.52	0.42	0.64	-0.04	0.01	0.03
3	0.32	-0.1	0.47	0.15	0.38	-0.19
4	0.31	0.36	0.04	0.46	0.12	0.17
5	0.03	0.48	0.52	-0.4	0.35	-1.19
6	0.11	-0.42	0.39	0.28	-0.27	-0.17
7	0.52	-0.42	-0.17	0.42	0.01	-1.07
8	-1.25	0.55	0.35	-0.26	0.4	-0.55
9	-0.6	-1.06	0.64	-0.2	-0.12	0.35
10	-0.09	-2.28	-0.02	1.17	0.72	-0.21

Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	No data for this fleet at this age									
2	-0.37	-0.3	-1.31	-0.22	0.42	0.29	0.21	0.61	-0.16	0.3
3	-0.16	-0.46	-0.25	-0.71	-0.34	0.25	-0.12	0.19	0.28	0.3
4	-0.57	-0.14	-0.47	-0.15	-0.64	-0.11	0.04	0.19	-0.04	0.44
5	0.41	-0.39	-0.21	-0.24	0.07	-0.39	0.3	0.23	0.05	0.38
6	-0.8	0.14	-0.31	-0.08	-0.15	0.26	0.08	0.49	0.02	0.42
7	-0.31	-0.67	0.39	-0.42	0.01	-0.07	0.35	0.53	0.47	0.42
8	-0.78	-0.03	-0.51	0.49	-0.27	0.24	0.28	0.54	0.48	1.34
9	0.31	-0.24	0.33	-0.06	0.61	-0.29	0.52	0.3	0.85	1.15
10	-0.07	-0.33	-0.13	0.59	0.08	0.74	0.15	0.22	0.36	1.22

Table 8.4.3 Sole in VIId. Continued

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

Age	2	3	4	5	6	7	8	9	10
Mean Log q	-7.6943	-6.9635	-6.9	-7.0093	-6.9421	-6.9985	-6.9985	-6.9985	-6.9985
S.E(Log q)	0.4934	0.3404	0.3406	0.453	0.3459	0.481	0.6409	0.5901	0.8109

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	0.97	0.111	7.77	0.45	16	0.49	-7.69
3	1.05	-0.202	6.83	0.54	16	0.37	-6.96
4	1.16	-0.694	6.54	0.56	16	0.4	-6.9
5	0.71	1.731	7.45	0.71	16	0.3	-7.01
6	0.78	1.453	7.15	0.76	16	0.26	-6.94
7	0.78	1.156	7.09	0.66	16	0.37	-7
8	0.72	1.26	6.91	0.59	16	0.45	-6.93
9	0.79	0.817	6.75	0.53	16	0.46	-6.84
10	0.64	1.085	6.54	0.4	16	0.51	-6.87
1							

Fleet : UK BTS

Age	1986	1987	1988	1989	1990	1991
1	99.99	99.99	0.54	-0.15	0.43	0.34
2	99.99	99.99	1.1	0.28	-0.64	0.21
3	99.99	99.99	0.67	0.64	-0.43	-0.34
4	99.99	99.99	-0.23	0.06	0.13	0.2
5	99.99	99.99	0.43	0.12	-0.08	-0.24
6	99.99	99.99	0.16	-0.75	-0.3	0.21
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	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	-1.49	-1.81	-0.01	-0.04	-0.08	1.16	-0.57	1.56	0.05	0.06
2	-0.26	0.16	-0.91	-0.13	-0.21	-0.28	0.31	0.13	0.41	-0.17
3	0.17	0.09	0.16	-0.92	-0.3	-0.16	-0.56	0.6	0.21	0.17
4	-0.56	0.73	0.11	-0.21	-0.66	-0.17	-0.23	0.49	0.42	-0.1
5	0.01	-0.03	0.44	-0.39	-0.26	-1.16	0.16	0.86	0.06	0.07
6	0.35	0.49	-0.87	0.32	0.03	-0.47	-0.96	1.38	0.43	-0.02
7	No data for this fleet at this age									
8	No data for this fleet at this age									
9	No data for this fleet at this age									
10	No data for this fleet at this age									

Table 8.4.3 Sole in VIId. Continued

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

Age	1	2	3	4	5	6
Mean Log q	-8.5777	-7.48	-7.8329	-8.2481	-8.1896	-8.3281
S.E(Log q)	0.8865	0.49	0.4739	0.3881	0.4636	0.6312

Regression statistics :

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

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
1	0.54	1.404	9.37	0.43	14	0.46	-8.58
2	1.01	-0.042	7.44	0.43	14	0.52	-7.48
3	0.86	0.469	8.11	0.48	14	0.42	-7.83
4	0.74	1.689	8.48	0.77	14	0.27	-8.25
5	0.98	0.085	8.2	0.53	14	0.47	-8.19
6	0.96	0.109	8.31	0.39	14	0.63	-8.33
1							

Fleet : YFS

Age	1986	1987	1988	1989	1990	1991
1	99.99	0.65	0.15	-0.34	-0.14	0.56
2	No data for this fleet at this age					
3	No data for this fleet at this age					
4	No data for this fleet at this age					
5	No data for this fleet at this age					
6	No data for this fleet at this age					
7	No data for this fleet at this age					
8	No data for this fleet at this age					
9	No data for this fleet at this age					
10	No data for this fleet at this age					

Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	-0.27	0.19	0.67	0.86	-0.63	-0.66	-0.06	-0.15	-0.28	-0.54
2	No data for this fleet at this age									
3	No data for this fleet at this age									
4	No data for this fleet at this age									
5	No data for this fleet at this age									
6	No data for this fleet at this age									
7	No data for this fleet at this age									
8	No data for this fleet at this age									
9	No data for this fleet at this age									
10	No data for this fleet at this age									

Table 8.4.3 Sole in VIId. Continued

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	-10.3576
S.E(Log q)	0.4957

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	1.79	-1.548	10.46	0.23	15	0.85	-10.36
1							

Terminal year survivor and F summaries :

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

Year class = 2000

Fleet	I :	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	46437	0.918	0	0	1	0.132	0.004
YFS	25443	0.512	0	0	1	0.423	0.007
F shrinkage	72309	0.5				0.445	0.002

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
43850	0.33	0.45	3	1.339	0.004

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

Year class = 1999

Fleet	I :	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
BEL BT	43936	0.923	0	0	1	0.063	0.131
UK BT	53887	0.509	0	0	1	0.209	0.108
UK BTS	35716	0.444	0.09	0.2	2	0.274	0.159
YFS	30417	0.512	0	0	1	0.205	0.185
F shrinkage	43685	0.5				0.249	0.132

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
40114	0.24	0.09	6	0.392	0.143

Table 8.4.3 Sole in VIId. Continued

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

Year class = 1998

Fleet	I :	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
BEL BT	11664	0.349	0.121	0.35	2	0.218	0.431
UK BT	17734	0.289	0.212	0.73	2	0.309	0.304
UK BTS	23162	0.33	0.306	0.93	3	0.231	0.24
YFS	12873	0.512	0	0	1	0.089	0.398
F shrinkage	8732	0.5				0.153	0.543

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
15012	0.17	0.15	9	0.911	0.35

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

Year class = 1997

Fleet	I :	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
BEL BT	3672	0.267	0.274	1.03	3	0.262	0.376
UK BT	6501	0.235	0.074	0.31	3	0.328	0.229
UK BTS	4225	0.27	0.105	0.39	4	0.246	0.334
YFS	4059	0.512	0	0	1	0.039	0.345
F shrinkage	2163	0.5				0.126	0.573

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
4304	0.14	0.13	12	0.922	0.329

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

Year class = 1996

Fleet	I :	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
BEL BT	4314	0.229	0.097	0.42	4	0.296	0.463
UK BT	6283	0.215	0.101	0.47	4	0.303	0.34
UK BTS	7440	0.241	0.126	0.52	5	0.249	0.294
YFS	2745	0.512	0	0	1	0.03	0.655
F shrinkage	3467	0.5				0.122	0.55

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
5317	0.13	0.09	15	0.728	0.391

Table 8.4.3 Sole in VIId. Continued

Age 6 Catchability constant w.r.t. time and dependent on age

Year class = 1995

Fleet	I :	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
BEL BT	1784	0.216	0.224	1.03	5	0.304	0.355
UK BT	2454	0.201	0.097	0.48	5	0.356	0.27
UK BTS	2040	0.243	0.139	0.57	6	0.209	0.316
YFS	1027	0.512	0	0	1	0.018	0.554
F shrinkage	1153	0.5				0.114	0.506

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
1937	0.12	0.1	18	0.782	0.331

Age 7 Catchability constant w.r.t. time and dependent on age

Year class = 1994

Fleet	I :	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
BEL BT	815	0.193	0.082	0.43	6	0.43	0.316
UK BT	1074	0.204	0.078	0.38	6	0.318	0.249
UK BTS	1188	0.254	0.204	0.8	6	0.13	0.227
YFS	2118	0.512	0	0	1	0.009	0.134
F shrinkage	505	0.5				0.113	0.471

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
893	0.12	0.08	20	0.655	0.292

Age 8 Catchability constant w.r.t. time and age (fixed at the value for age) 7

Year class = 1993

Fleet	I :	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
BEL BT	272	0.203	0.082	0.4	7	0.463	0.442
UK BT	658	0.235	0.198	0.84	7	0.286	0.207
UK BTS	552	0.271	0.297	1.09	6	0.076	0.242
YFS	714	0.512	0	0	1	0.005	0.192
F shrinkage	251	0.5				0.171	0.471

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
366	0.14	0.12	22	0.828	0.346

Table 8.4.3 Sole in VIId. Continued

Age 9 Catchability constant w.r.t. time and age (fixed at the value for age) 7

Year class = 1992

Fleet	I :	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
BEL BT	122	0.195	0.128	0.66	8	0.56	0.41
UK BT	212	0.264	0.23	0.87	8	0.226	0.256
UK BTS	49	0.268	0.098	0.37	6	0.038	0.812
YFS	156	0.512	0	0	1	0.003	0.335
F shrinkage	99	0.5				0.173	0.487

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
129	0.15	0.11	24	0.696	0.392

Age 10 Catchability constant w.r.t. time and age (fixed at the value for age) 7

Year class = 1991

Fleet	I :	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
BEL BT	262	0.183	0.108	0.59	9	0.503	0.315
UK BT	533	0.248	0.164	0.66	9	0.251	0.167
UK BTS	238	0.241	0.134	0.56	6	0.048	0.342
YFS	233	0.512	0	0	1	0.004	0.349
F shrinkage	231	0.5				0.193	0.351

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
304	0.15	0.09	26	0.633	0.277

Table 8.4.4 Sole in VIId. Fishing mortality at age

YEAR	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
AGE										
1	0.0126	0	0.0011	0.0038	0.0019	0.0008	0.0037	0.01	0.0299	0.0113
2	0.1846	0.0803	0.1114	0.2153	0.1156	0.1529	0.2533	0.1739	0.2378	0.2164
3	0.3218	0.349	0.4192	0.4206	0.4887	0.5277	0.5295	0.673	0.4439	0.4528
4	0.4705	0.3765	0.4293	0.3568	0.4509	0.5845	0.4016	0.7037	0.4936	0.5469
5	0.209	0.423	0.2801	0.2655	0.3096	0.539	0.3756	0.7074	0.487	0.3979
6	0.242	0.4023	0.6565	0.4303	0.299	0.6186	0.4029	0.4938	0.2803	0.5456
7	0.4613	0.3432	0.416	0.2219	0.4267	0.7793	0.4397	0.4981	0.3905	0.3261
8	0.3976	0.4992	0.2598	0.2196	0.3531	0.5941	0.3781	0.4045	0.3873	0.377
9	0.3371	0.2781	0.3456	0.1759	0.4001	0.4186	0.3614	0.4201	0.4289	0.6641
10	0.3303	0.3903	0.3928	0.2633	0.3487	0.6192	0.5505	0.6234	0.5854	0.5233
+gp	0.3303	0.3903	0.3928	0.2633	0.3487	0.6192	0.5505	0.6234	0.5854	0.5233
FBAR 3- 8	0.3504	0.3989	0.4101	0.3191	0.388	0.6072	0.4212	0.5801	0.4138	0.4411

YEAR	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	FBAR 99-01
AGE											
1	0.0032	0.0052	0.0013	0.0346	0.0005	0.0009	0.0022	0.0058	0.0027	0.004	0.0041
2	0.1434	0.1905	0.0544	0.1352	0.1246	0.0988	0.0645	0.2296	0.1424	0.1431	0.1717
3	0.3922	0.3289	0.3505	0.4456	0.5563	0.616	0.4957	0.4625	0.5726	0.3501	0.4617
4	0.3776	0.4146	0.5014	0.4285	0.5438	0.7808	0.5483	0.5513	0.4306	0.3286	0.4368
5	0.486	0.3343	0.4276	0.4484	0.5101	0.8188	0.5802	0.4987	0.3306	0.3906	0.4066
6	0.3179	0.2434	0.2936	0.4222	0.4841	0.5112	0.5496	0.6286	0.3471	0.3307	0.4355
7	0.3645	0.2741	0.3417	0.2776	0.4729	0.4464	0.304	0.6375	0.4857	0.2924	0.4719
8	0.2653	0.304	0.2591	0.2583	0.299	0.5481	0.3705	0.5778	0.5513	0.3457	0.4916
9	0.45	0.3495	0.3474	0.3247	0.4601	0.4172	0.4747	0.4785	0.5966	0.3918	0.489
10	0.4706	0.2597	0.4359	0.4018	0.6928	0.4558	0.8281	0.4403	0.3627	0.2771	0.36
+gp	0.4706	0.2597	0.4359	0.4018	0.6928	0.4558	0.8281	0.4403	0.3627	0.2771	
FBAR 3- 8	0.3672	0.3165	0.3623	0.3801	0.4777	0.6202	0.4747	0.5594	0.453	0.3397	

Table 8.4.5 Sole in VIId. Stock number at age

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

YEAR	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
AGE										
1	12991	21786	22175	13505	26959	11572	27065	17148	45403	35909
2	16372	11607	19712	20042	12173	24347	10462	24399	15361	39873
3	20079	12317	9692	15956	14622	9812	18906	7348	18554	10958
4	4837	13169	7861	5767	9481	8116	5238	10075	3392	10770
5	3177	2734	8177	4631	3652	5465	4093	3172	4510	1874
6	3194	2333	1621	5592	3213	2425	2885	2544	1415	2507
7	1562	2269	1412	761	3290	2156	1182	1745	1405	967
8	769	891	1457	843	551	1943	895	689	959	860
9	448	468	489	1017	612	350	971	555	416	589
10	310	290	320	313	771	371	209	612	330	245
+gp	753	626	767	580	1356	1062	702	741	1312	1014
TOTAL	64492	68488	73684	69004	76681	67619	72606	69027	93056	105568

YEAR	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	GMST 82-99	AMST 82-99
AGE													
1	35104	17275	27367	21096	21510	33786	19934	33349	56686	48656**	0*	23054	24663
2	32127	31662	15550	24731	18439	19453	30542	17998	30002	51154	43850**	20026	21381
3	29058	25187	23679	13326	19548	14730	15946	25910	12945	23545	40114	15908	16979
4	6304	17763	16402	15091	7722	10141	7198	8789	14764	6607	15012	8544	9340
5	5640	3911	10617	8989	8896	4056	4203	3764	4582	8685	4304	4604	5087
6	1139	3139	2533	6264	5194	4833	1619	2129	2068	2979	5317	2722	3032
7	1315	750	2227	1709	3716	2896	2623	845	1027	1323	1937	1632	1824
8	632	826	516	1432	1171	2095	1677	1751	404	572	893	1014	1109
9	534	438	552	360	1001	786	1096	1048	889	211	366	607	652
10	274	308	280	353	236	572	469	617	587	443	129	356	382
+gp	661	665	824	782	784	852	656	1144	1006	1317	1207		
TOTAL	112788	101924	100547	94132	88217	94200	85963	97344	124961	145490	113130		

* Replaced by GM (82-99)
** Replaced by RCT3 estimate

Table 8.5.1 Sole in VIId. Input data for RCT3

7D Sole (1year olds)

4	21	2			
1981	12991	1.881	0.2005	-11	-11
1982	21786	2.6555	0.695	-11	-11
1983	22175	11.887	-11	-11	-11
1984	13505	-11	-11	-11	-11
1985	26959	-11	-11	-11	-11
1986	11572	-11	0.6595	-11	14.2
1987	27065	7.995	0.935	8.2	15.4
1988	17148	1.1875	0.356	2.6	3.7
1989	45403	12.588	1.152	12.1	22.8
1990	35909	3.3285	1.8695	8.9	12
1991	35104	1.3865	0.796	1.4	17.5
1992	17275	1.281	0.615	0.5	3.2
1993	27367	6.534	1.591	4.8	10.6
1994	21096	8.1035	1.4635	3.5	7.4
1995	21510	5.3135	0.339	3.5	7.3
1996	33786	0.9865	0.5205	19	21.23
1997	19934	1.942	0.559	2	9.44
1998	33349	9.3725	0.854	28.14	22.03
1999	-11	2.7455	1.282	10.49	21.01
2000	-11	1.8475	0.8365	9.09	-11
2001	-11	4.5135	-11	-11	-11

yfs0
yfs1
ebts1
ebts2

7D Sole (2 year olds)

4	21	2			
1981	11607	1.881	0.2005	-11	-11
1982	19712	2.6555	0.695	-11	-11
1983	20042	11.887	-11	-11	-11
1984	12173	-11	-11	-11	-11
1985	24347	-11	-11	-11	-11
1986	10462	-11	0.6595	-11	14.2
1987	24399	7.995	0.935	8.2	15.4
1988	15361	1.1875	0.356	2.6	3.7
1989	39873	12.588	1.152	12.1	22.8
1990	32127	3.3285	1.8695	8.9	12
1991	31662	1.3865	0.796	1.4	17.5
1992	15550	1.281	0.615	0.5	3.2
1993	24731	6.534	1.591	4.8	10.6
1994	18439	8.1035	1.4635	3.5	7.4
1995	19453	5.3135	0.339	3.5	7.3
1996	30542	0.9865	0.5205	19	21.23
1997	17998	1.942	0.559	2	9.44
1998	30002	9.3725	0.854	28.14	22.03
1999	-11	2.7455	1.282	10.49	21.01
2000	-11	1.8475	0.8365	9.09	-11
2001	-11	4.5135	-11	-11	-11

yfs0
yfs1
ebts1
ebts2

Table 8.5.2 Sole in VIId. RCT3 estimates at age 1

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

 s7DREC1.CSV

 7D Sole (1year olds),,,,,

 Data for    4 surveys over   21 years :  1981 - 2001

 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

 yfs0,,    1.38   7.92    .93   .127     15   1.05    9.37    1.053     .058
 yfs1,,    2.81   8.44    .61   .308     15    .61   10.15     .679     .139
 ebts1,     .53   9.22    .36   .460     12   2.31   10.45     .419     .366
 ebts2,

                                       VPA Mean =   10.05     .383     .437


 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,,    1.38   7.92    .93   .127     15   1.71   10.28    1.033     .121
 yfs1,,
 ebts1,
 ebts2,

                                       VPA Mean =   10.05     .383     .879


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

 2000       26084     10.17     .25     .16      .38
 2001       23717     10.07     .36     .08      .05
```

Table 8.5.3 Sole in VIId. RCT3 estimates at age 2

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

S7DREC2.CSV

7D Sole (2 year olds),,,,,

Data for    4 surveys over   21 years :  1981 - 2001

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

yfs0,,    1.42   7.76    .96   .120     15   1.05    9.24    1.083     .055
yfs1,,    2.84   8.32    .62   .300     15    .61   10.05     .690     .135
ebts1,     .53   9.12    .36   .460     12   2.31   10.34     .417     .369
ebts2,

                                       VPA Mean =    9.94     .381     .441


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,,    1.42   7.76    .96   .120     15   1.71   10.18    1.063     .114
yfs1,,
ebts1,
ebts2,

                                       VPA Mean =    9.94     .381     .886


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

2000       23454     10.06     .25     .15     .37
2001       21280      9.97     .36     .08     .04
```

Table 8.6.1 Sole in VIId. Stock summary

Year	Recruitment Age 1 thousands	SSB tonnes	Landings tonnes	Mean F Ages 3-8
1982	12991	7779	3190	0.3504
1983	21786	9542	3458	0.3989
1984	22175	8991	3575	0.4101
1985	13505	10045	3837	0.3191
1986	26959	10641	4024	0.3880
1987	11572	9576	4974	0.6072
1988	27065	10552	3982	0.4212
1989	17148	8289	4187	0.5801
1990	45403	9859	4060	0.4138
1991	35909	8890	4382	0.4411
1992	35104	11241	4142	0.3672
1993	17275	13274	4511	0.3165
1994	27367	13121	4643	0.3623
1995	21096	11208	4583	0.3801
1996	21510	12435	5025	0.4777
1997	33786	10505	4983	0.6202
1998	19934	8603	3694	0.4747
1999	33349	9636	4238	0.5594
2000	56686	9707	3649	0.4530
2001	26084*	10472	4350	0.3397
2002	23054**	14800		
Average	26179	10436	4174	0.4340

* RCT3 estimate
** GM 82-99

Table 8.7.1 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	23054	0.38	WS1	0.05	0.00
N2	23454	0.25	WS2	0.13	0.03
N3	40114	0.24	WS3	0.16	0.10
N4	15012	0.17	WS4	0.21	0.10
N5	4304	0.14	WS5	0.31	0.25
N6	5317	0.13	WS6	0.34	0.25
N7	1936	0.12	WS7	0.36	0.10
N8	893	0.12	WS8	0.41	0.31
N9	366	0.14	WS9	0.44	0.03
N10	129	0.15	WS10	0.39	0.10
N11	1206	0.15	WS11	0.57	0.17
H.cons selectivity			Weight in the HC catch		
sH1	0.00	0.32	WH1	0.13	0.14
sH2	0.13	0.15	WH2	0.15	0.04
sH3	0.35	0.21	WH3	0.19	0.09
sH4	0.33	0.02	WH4	0.24	0.14
sH5	0.31	0.23	WH5	0.29	0.12
sH6	0.33	0.19	WH6	0.33	0.14
sH7	0.36	0.14	WH7	0.36	0.18
sH8	0.37	0.10	WH8	0.38	0.12
sH9	0.37	0.21	WH9	0.41	0.15
sH10	0.27	0.02	WH10	0.44	0.13
sH11	0.27	0.02	WH11	0.59	0.14
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		
HF02	1.00	0.24	K02	1.00	0.10
HF03	1.00	0.24	K03	1.00	0.10
HF04	1.00	0.24	K04	1.00	0.10
Recruitment in 2003 and 2004					
R03	23054	0.38			
R04	23054	0.38			

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

Table 8.7.2 Sole in VIId

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

		Year							
		2002	2003						
Mean F	Ages								
H.cons	3 to 8	0.34	0.20	0.24	0.27	0.31	0.34	0.40	0.41
Effort relative to	2001								
H.cons		1.00	0.60	0.70	0.80	0.90	1.00	1.18	1.20
Biomass									
Total 1 January		18.9	18.9	18.9	18.9	18.9	18.9	18.9	18.9
SSB at spawning time		14.8	15.1	15.1	15.1	15.1	15.1	15.1	15.1
Catch weight (,000t)									
H.cons		4.86	3.00	3.45	3.89	4.31	4.72	5.42	5.50
Biomass in year....	2004								
Total 1 January			20.8	20.3	19.8	19.4	18.9	18.1	18.0
SSB at spawning time			17.0	16.5	16.1	15.6	15.1	14.4	14.3

Table 8.7.3 Sole in VIId

Detailed forecast tables.

Forecast for year 2002
F multiplier H.cons=1.00

	Populations	Catch number	
Age	Stock No.	H.Cons	Total
1	23054	66	66
2	23454	2704	2704
3	40114	11252	11252
4	15012	4016	4016
5	4304	1082	1082
6	5317	1419	1419
7	1936	553	553
8	893	264	264
9	366	108	108
10	129	29	29
11	1206	273	273
Wt	19	5	5

Forecast for year 2003
F multiplier H.cons=1.00

	Populations	Catch number	
Age	Stock No.	H.Cons	Total
1	23054	66	66
2	20798	2398	2398
3	18654	5232	5232
4	25629	6856	6856
5	9775	2458	2458
6	2868	765	765
7	3466	991	991
8	1227	363	363
9	558	164	164
10	229	52	52
11	921	209	209
Wt	19	5	5

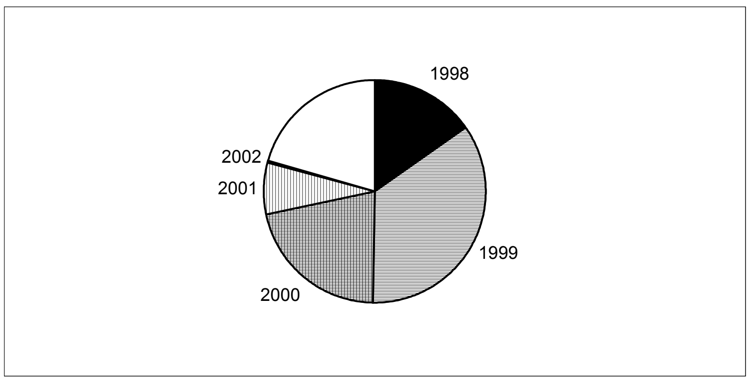
Table 8.7.4 Sole in VIId
Stock numbers of recruits and their source for recent year classes used in predictions, and the relative (%) contributions to landings and SSB (by weight) of these year classes

			1998	1999	2000	2001	2002
Year-class			1998	1999	2000	2001	2002
Stock No. (thousands) of 1 year-olds			33349	56686	26084	23054	23054
Source			VPA	VPA	RCT3	GM	GM
Status Quo F:							
% in	2002	landings	20.0	44.4	8.4	0.2	-
% in	2003		15.2	35.1	21.2	7.7	0.2
% in	2002	SSB	21.5	43.7	0.0	0.0	-
% in	2003	SSB	20.2	35.9	19.9	0.0	0.0
% in	2004	SSB	15.1	35.3	17.1	18.0	0.0

GM : geometric mean recruitment

Sole in VIId : Year-class % contribution to

a) 2003 landings



b) 2004 SSB

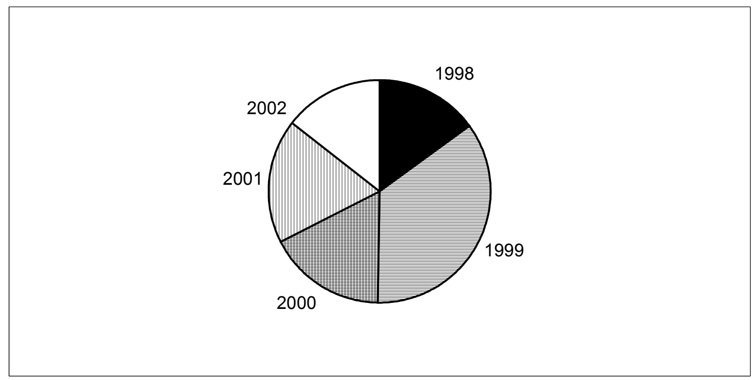


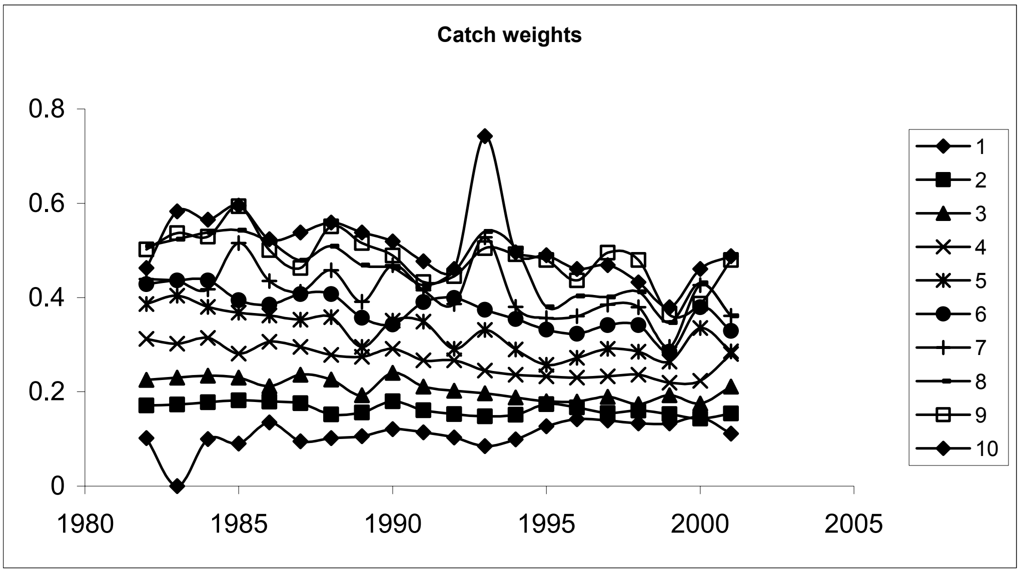
Table 8.9.1 Sole in VIId

input data for Yield-per-recruit

Label	Value	CV	Label	Value	CV
Number-at-age			Weight in the stock		
N1	23054	0.38	WS1	0.05	0.14
N2	23454	0.25	WS2	0.13	0.09
N3	40114	0.24	WS3	0.18	0.16
N4	15012	0.17	WS4	0.25	0.12
N5	4304	0.14	WS5	0.32	0.16
N6	5317	0.13	WS6	0.36	0.14
N7	1936	0.12	WS7	0.41	0.14
N8	893	0.12	WS8	0.44	0.17
N9	366	0.14	WS9	0.50	0.13
N10	129	0.15	WS10	0.49	0.22
N11	1206	0.15	WS11	0.60	0.12
H.cons selectivity			Weight in the HC catch		
sH1	0.00	0.32	WH1	0.12	0.16
sH2	0.13	0.15	WH2	0.16	0.07
sH3	0.35	0.21	WH3	0.20	0.10
sH4	0.33	0.02	WH4	0.26	0.11
sH5	0.31	0.23	WH5	0.31	0.12
sH6	0.33	0.19	WH6	0.36	0.10
sH7	0.36	0.14	WH7	0.40	0.13
sH8	0.37	0.10	WH8	0.44	0.13
sH9	0.37	0.21	WH9	0.47	0.10
sH10	0.27	0.02	WH10	0.50	0.16
sH11	0.27	0.02	WH11	0.61	0.08
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		
HF02	1.00	0.24	K02	1.00	0.10
HF03	1.00	0.24	K03	1.00	0.10
HF04	1.00	0.24	K04	1.00	0.10
Recruitment in 2003 and 2004					
R03	23054	0.38			
R04	23054	0.38			

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

Figure 8.2.1 Sole in VIId. Catch and stock weights at age



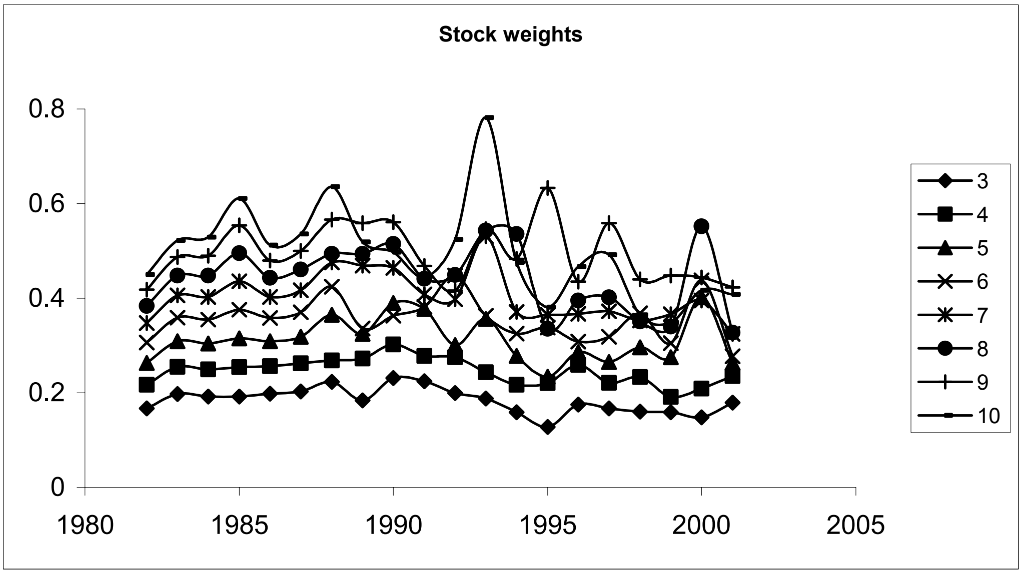
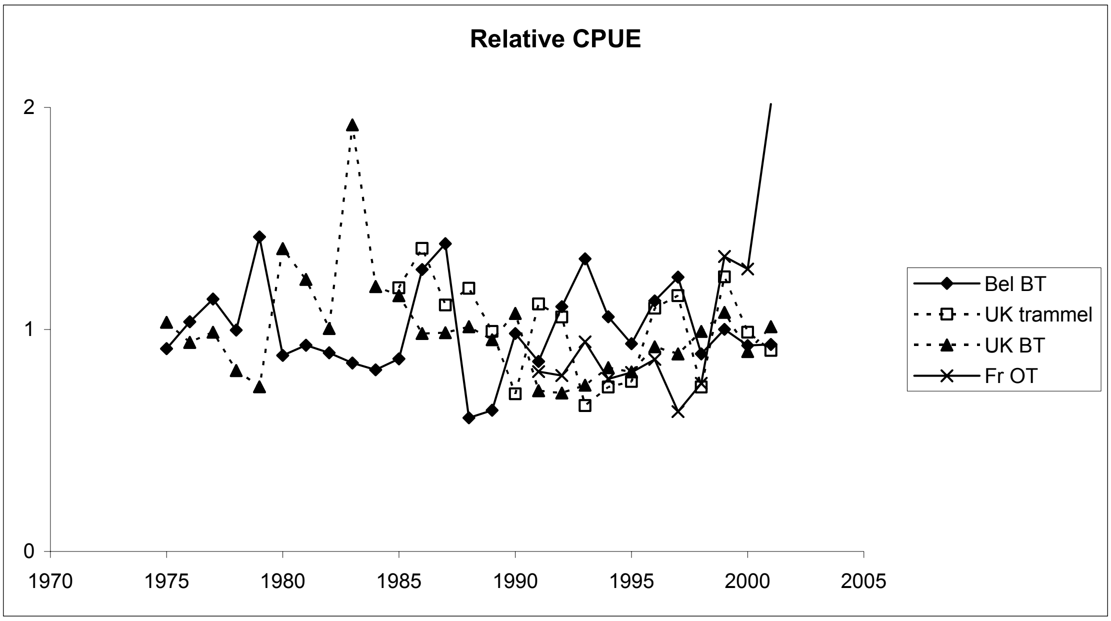


Figure 8.3.1 Sole in VIId. Trends in CPUE and effort for the main commercial fleets



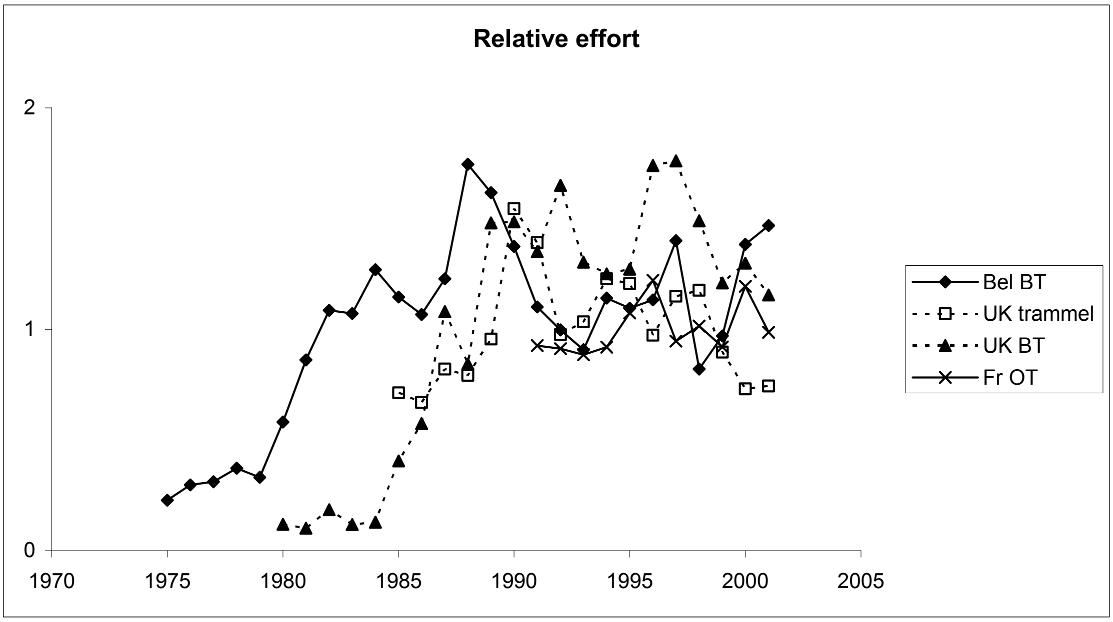
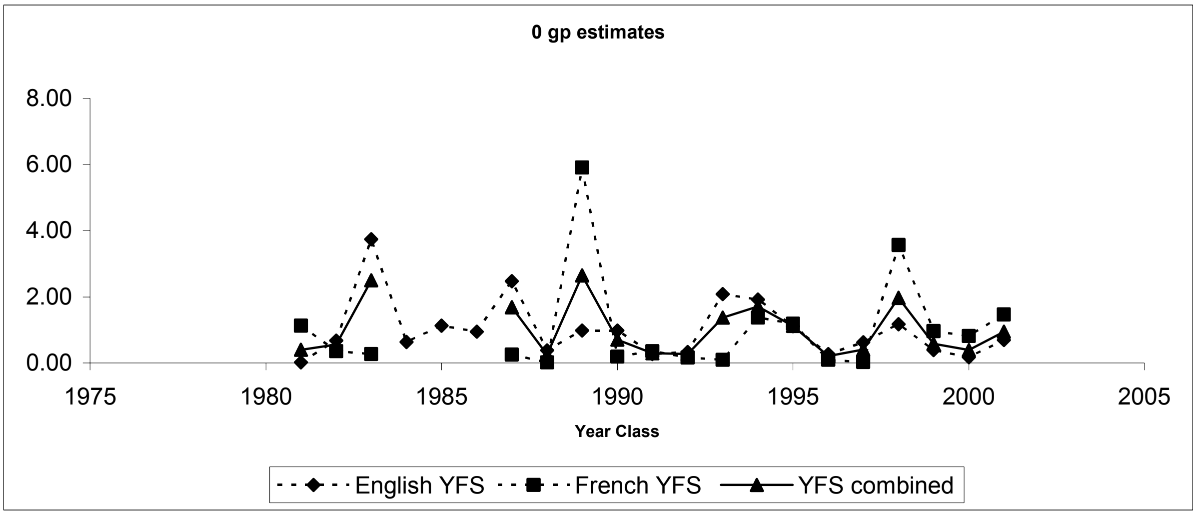


Figure 8.3.2 Sole in VIId. Survey indices of recruitment (relative) for the English, French and combined Young Fish Survey



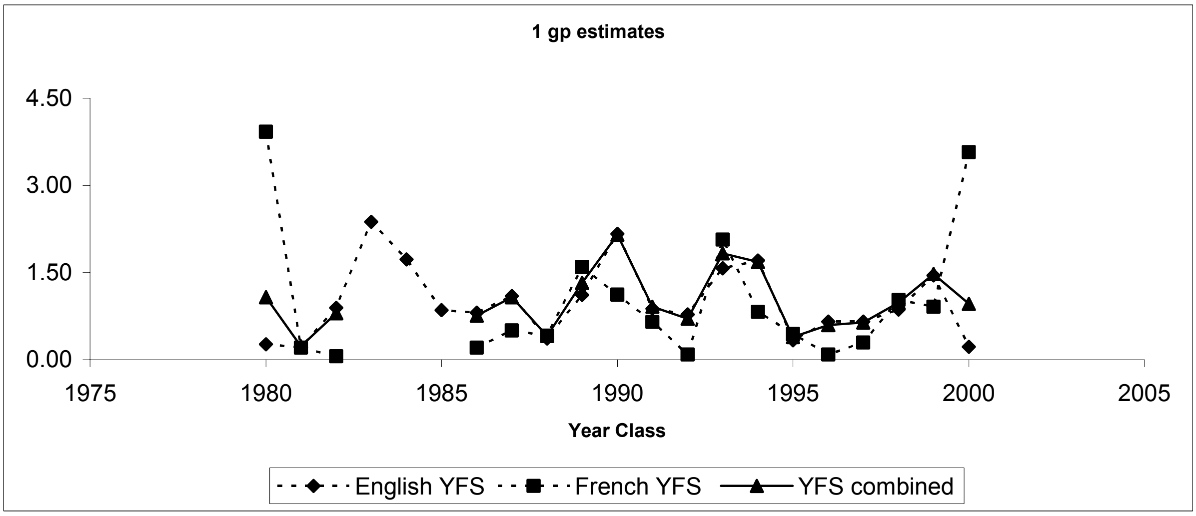


Figure 8.3.3 Sole in VIId. Relative abundance indices for the UK beam trawl survey

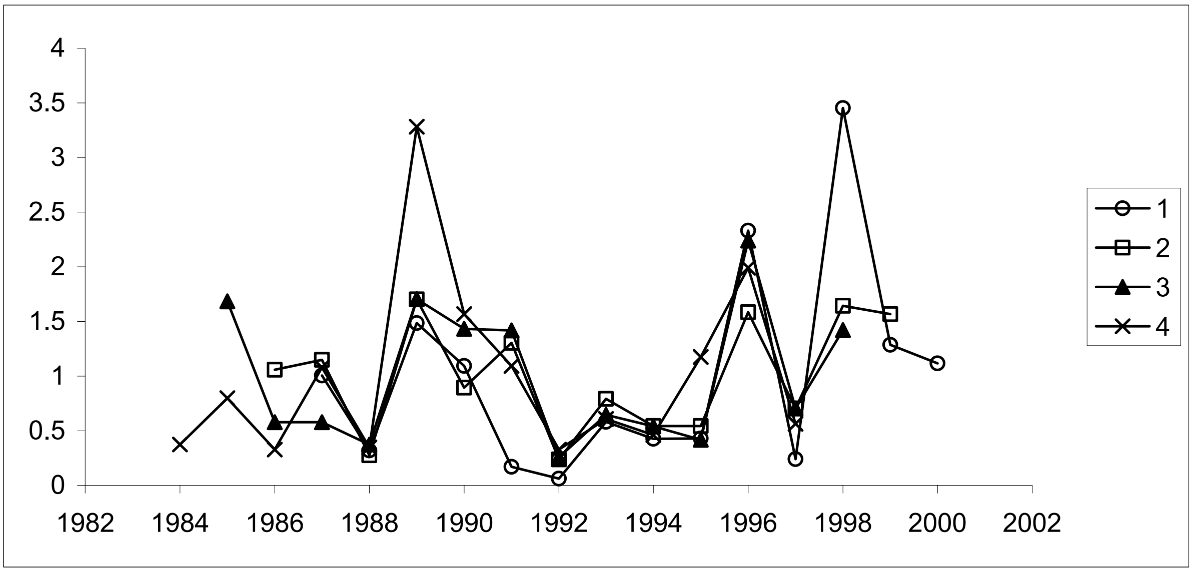


Figure 8.4.1 Sole in VIId. Trends in log catchability residuals (single fleets)

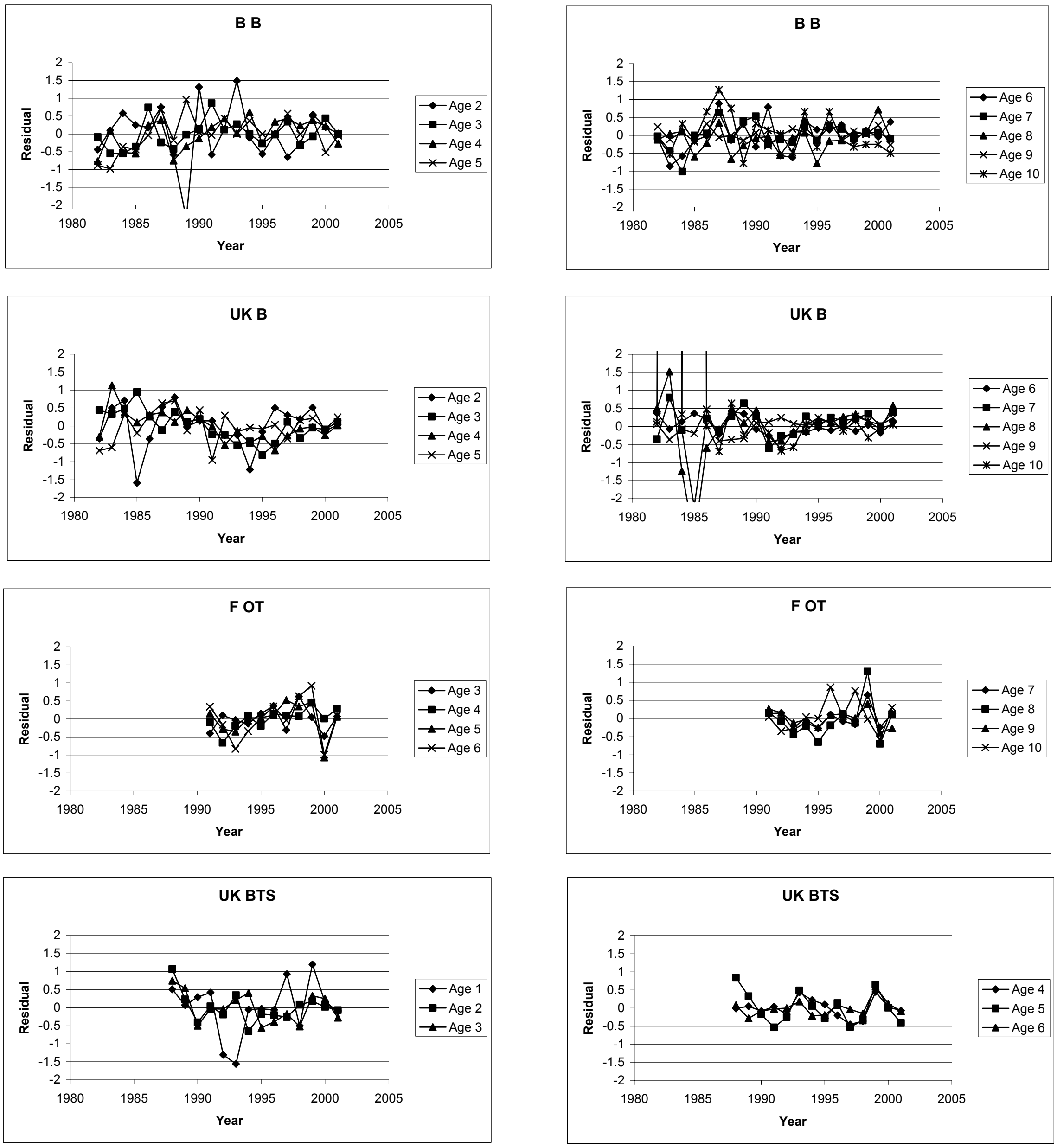


Figure 8.4.2 Sole in VIId. Trends in log catchability residuals (combined fleets)

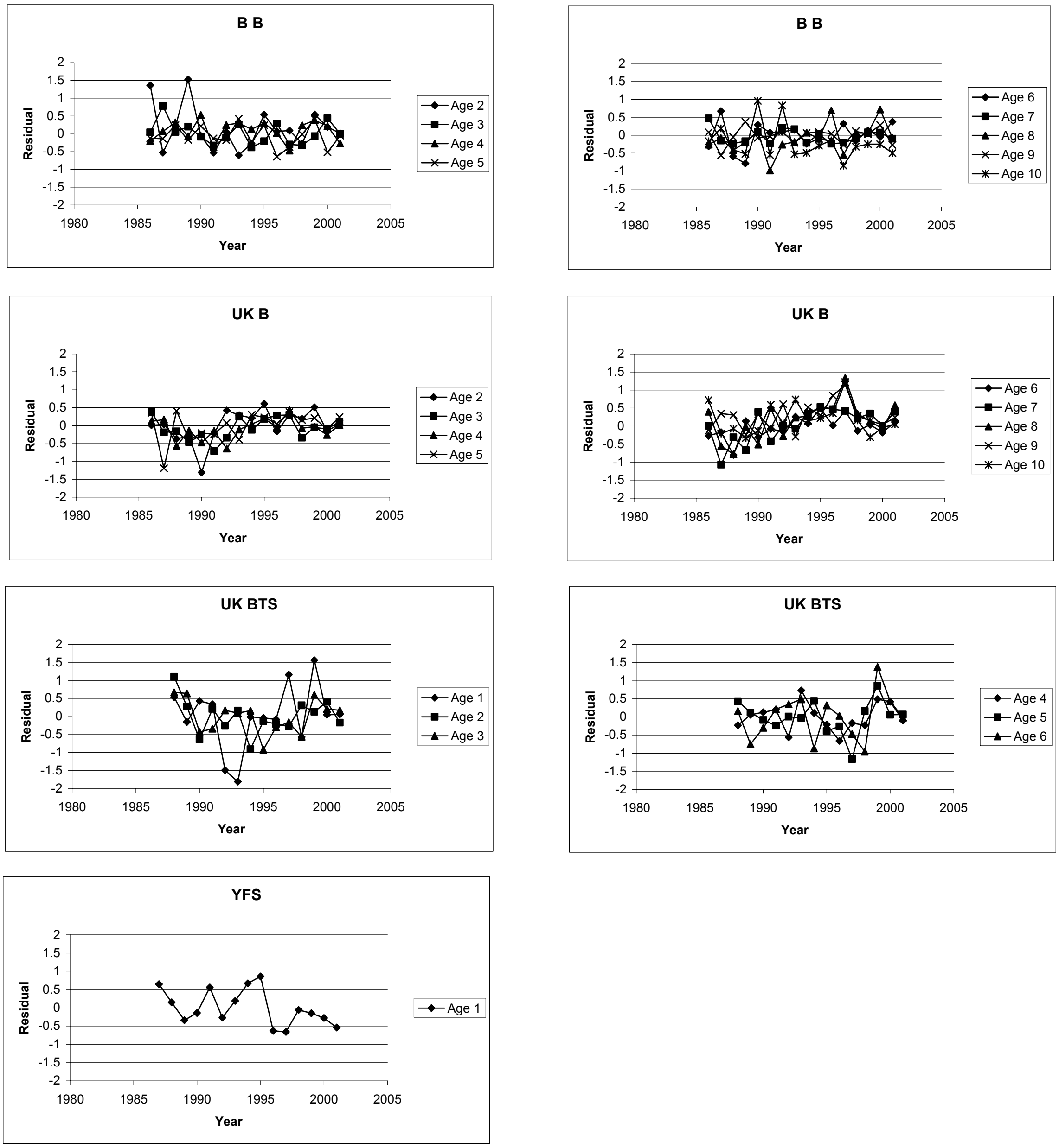


Figure 8.4.3 Sole in VIId. Year estimates for single fleet runs and final XSA run.

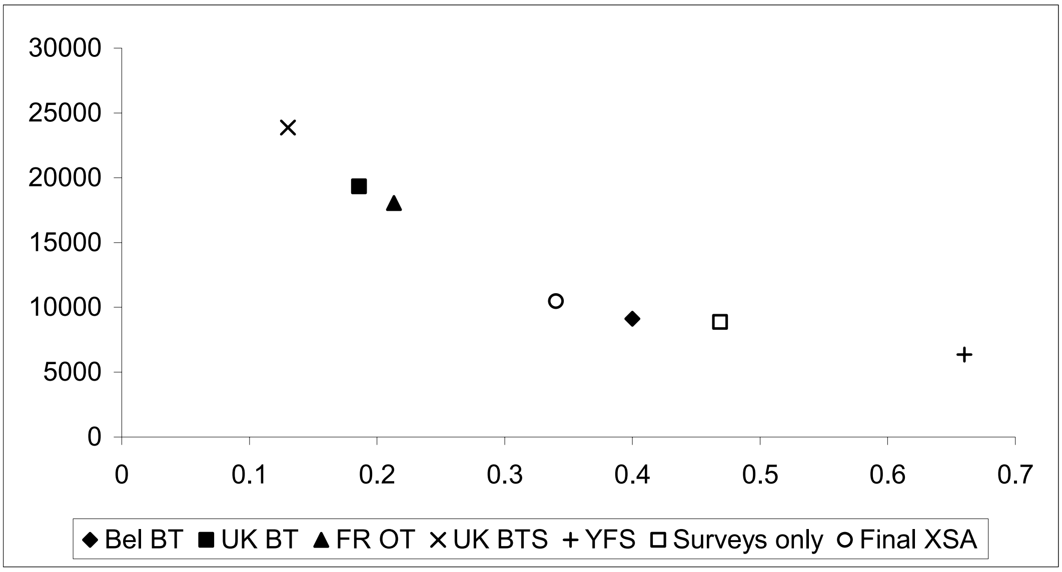
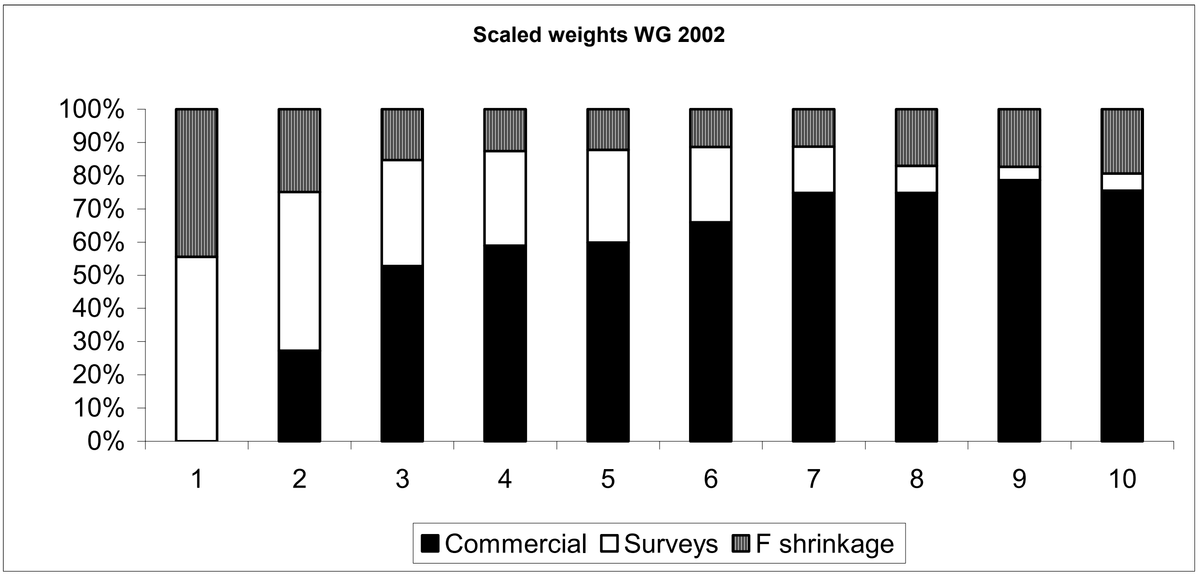


Figure 8.4.4. Sole in VIId. Scaled weights for the commercial fleets, surveys and F shrinkage.



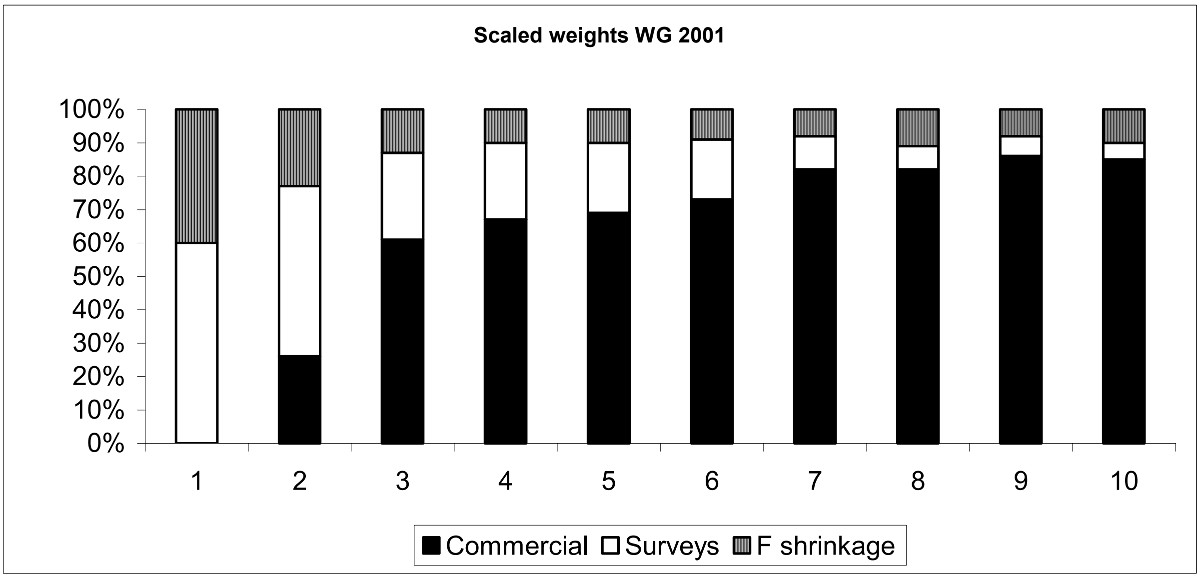
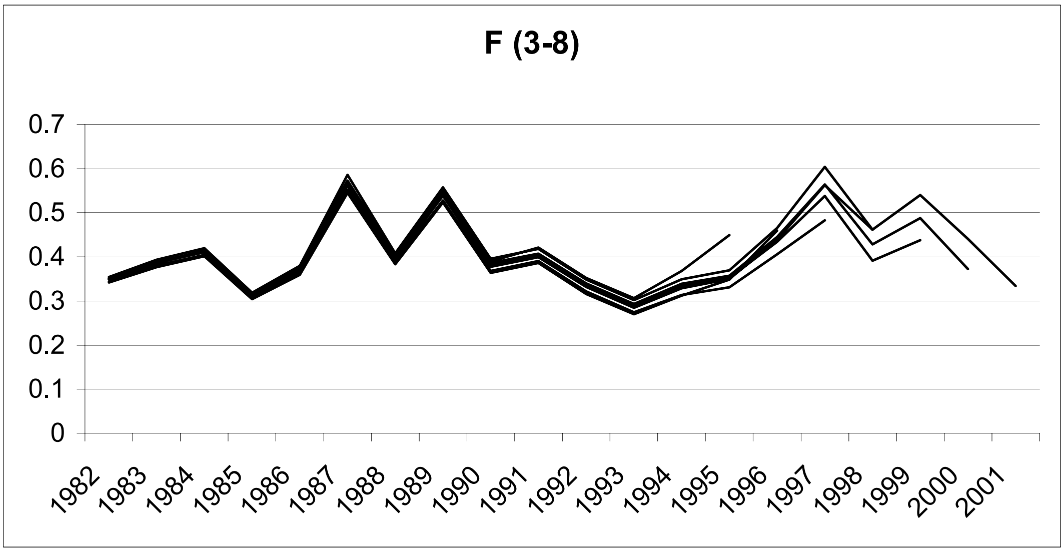
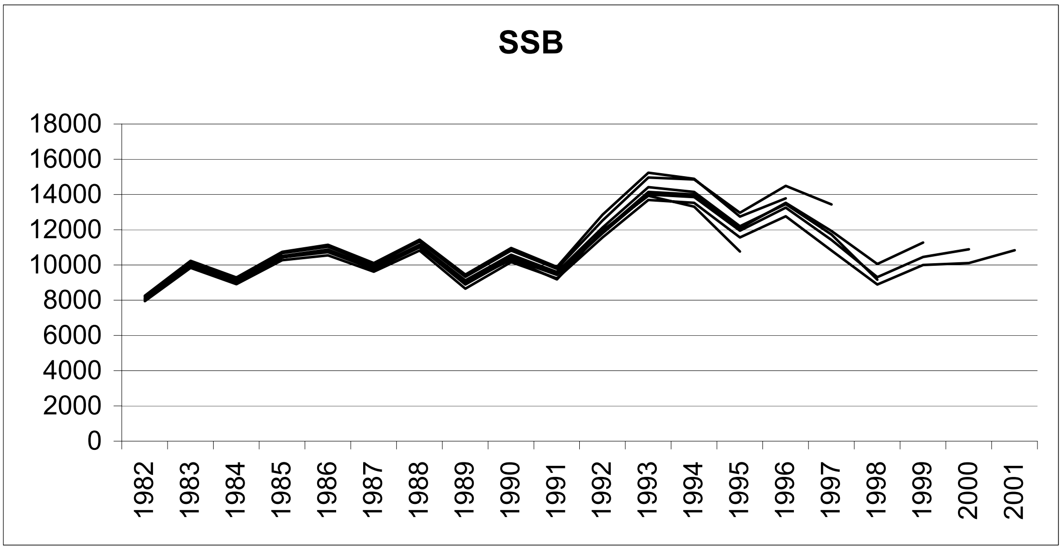


Figure 8.4.5 Sole in VIId. Retrospective pattern for the final run





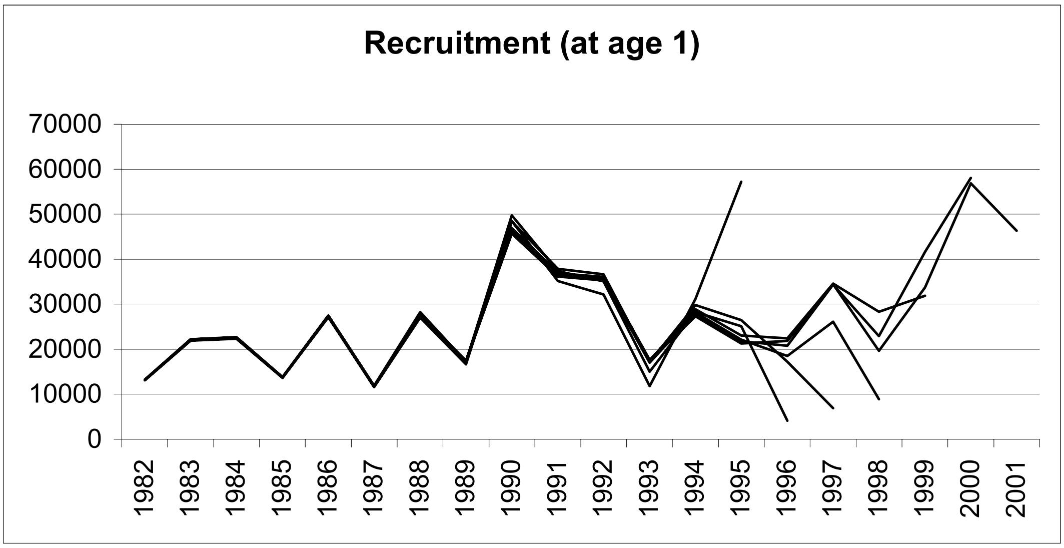


Figure 8.6.1 Sole in VIId. Stock summary.

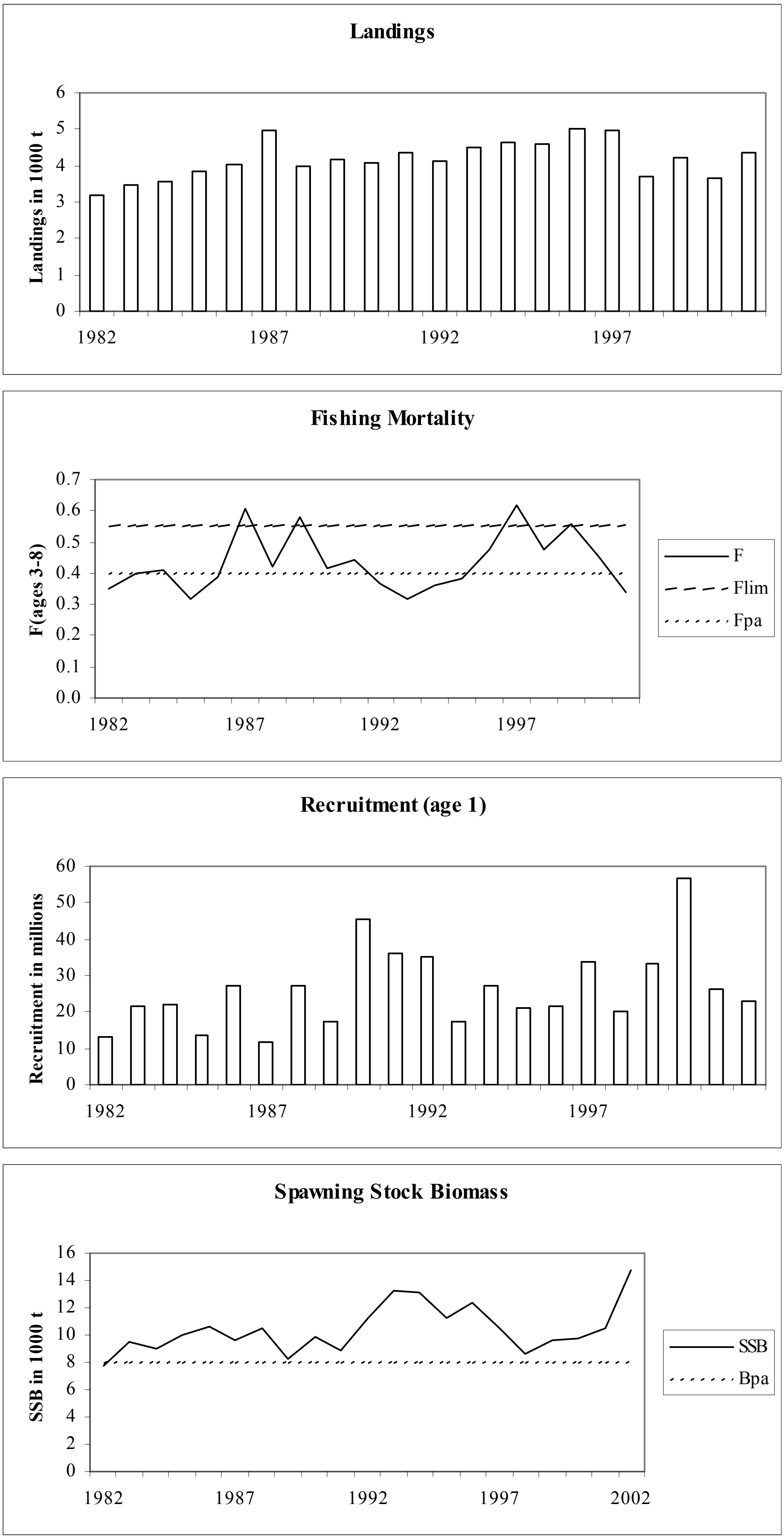
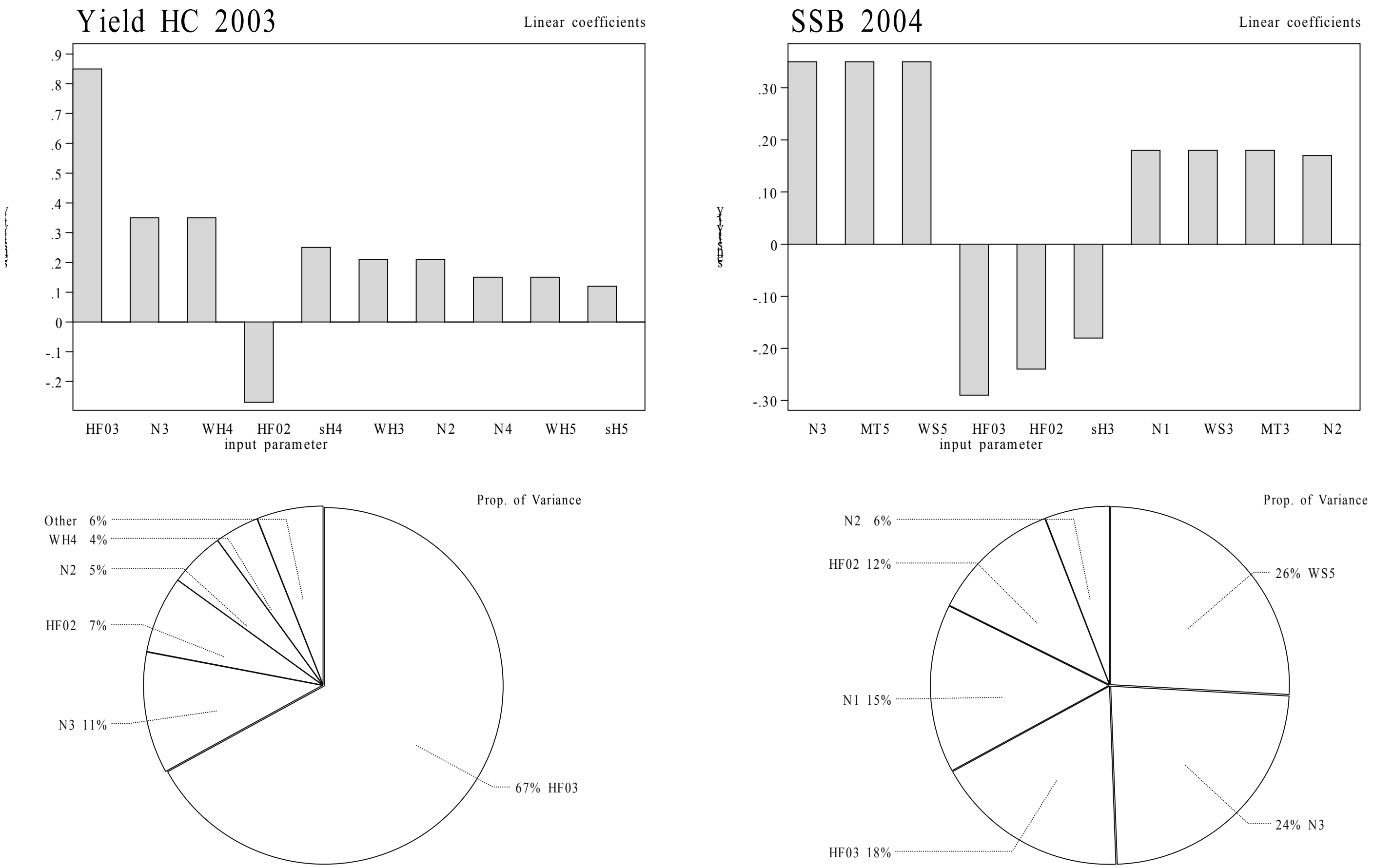


Figure 8.7.1 Sole in VIId. Sensitivity analysis

Figure Sole,Eastern English Chan. Sensitivity analysis of short term forecast.



Data from file:D:\wgnssk\2002\VPA\Solviid.sen on 16/06/2002 at 12:13:03

Figure 8.7.2 Sole in VIId. Probability plot

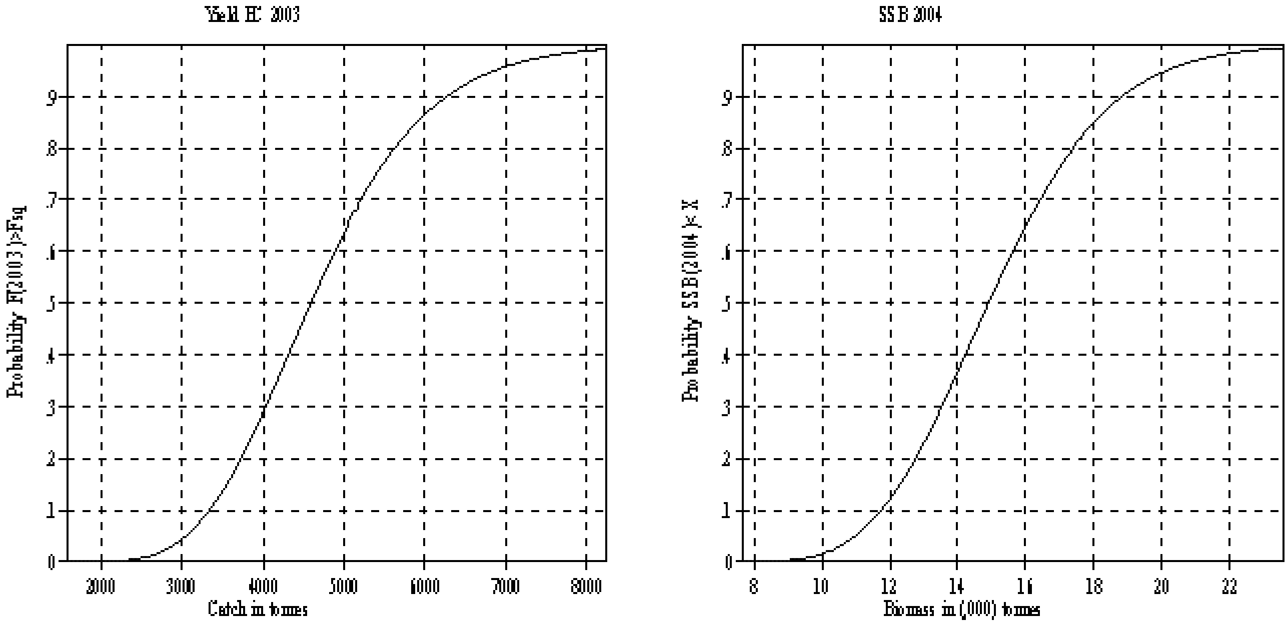


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Figure 8.7.3 Sole in VIId. Short-term forecast

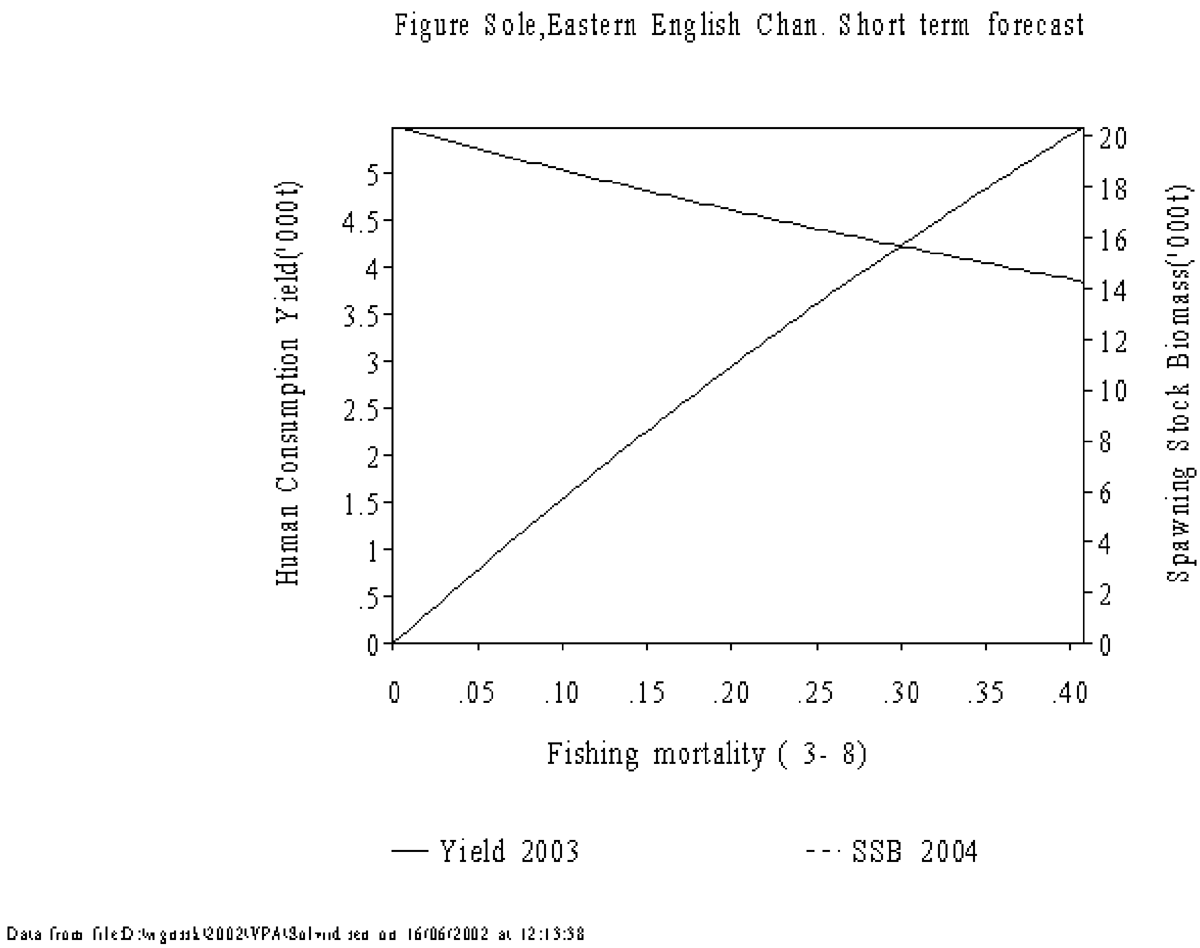
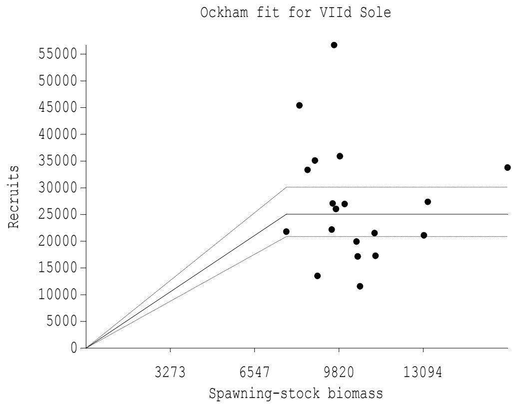
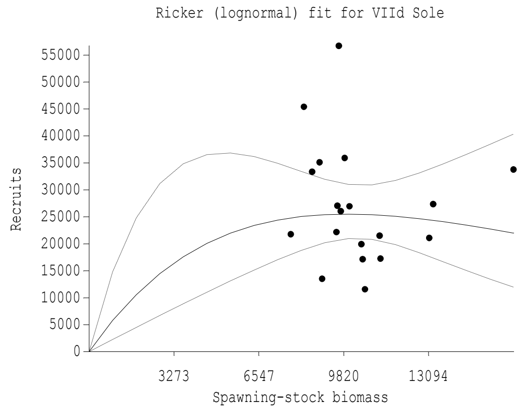


Figure 8.8.1 Sole in VIId. Comparison between Ockham and Ricker stock-recruitment curve





Solviid.sum: calculation of Ockham parameter

Mean = , 2.50734E+04

Variance of mean (log scale) = , 8.34901E-03

Residual sum-of-squares = , 2.85536E+00
Mean absolute residual = , 8.24219E+03
Residual variance = , 1.23862E+08
Akaike's Information Criterion = , 5.69689E+01

Solviid.sum: lognormal Ricker parameters

Initial estimate for alpha = ,6.9803E+00
Initial estimate for beta = ,1.0068E-04

Final estimate for alpha = ,6.9803E+00,+/-,3.5776E+00
Final estimate for beta = ,1.0068E-04,+/-,4.8359E-05

Variance-covariance matrix:
, 1, 2
1, 1.27992E+01, 1.69963E-04
2, 1.69963E-04, 2.33857E-09
Corr[alpha,beta] =, 0.98

RSS =, 2.9598E+00
Mean absolute residual =, 8.3803E+03
Residual variance =, 1.5578E-01
Akaike (AIC) =, 5.9005E+01
-2 log likelihood =, 1.8592E+01

IFAIL from nonlinear fit =, 0

Figure 8.9.1 Sole in VIId. Yield-per-recruit plot

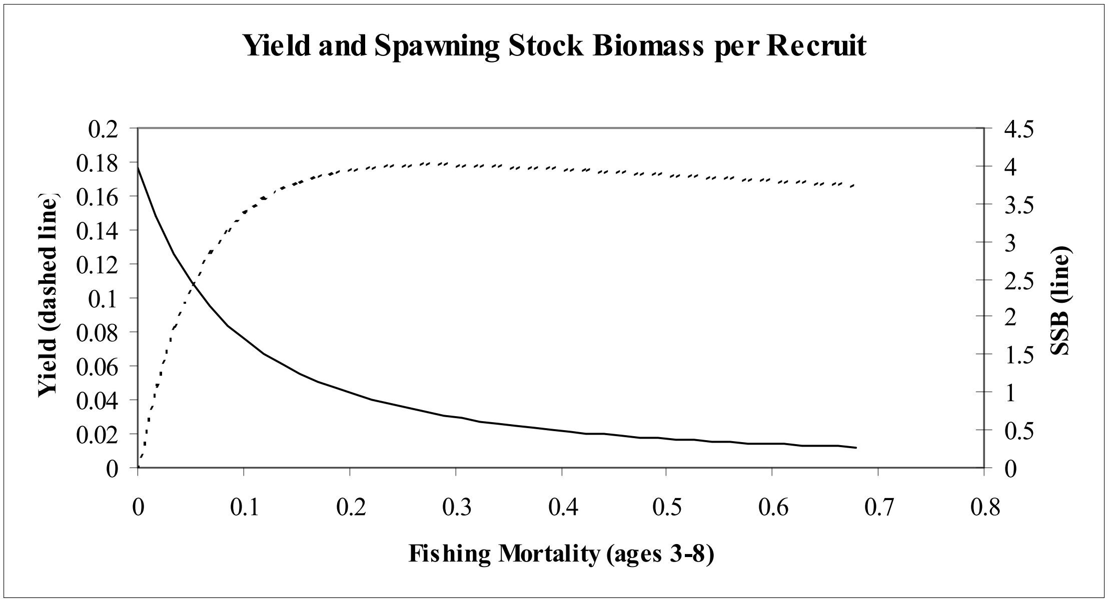


Figure 8.9.2 Sole in VIId. Stock and recruitment plot

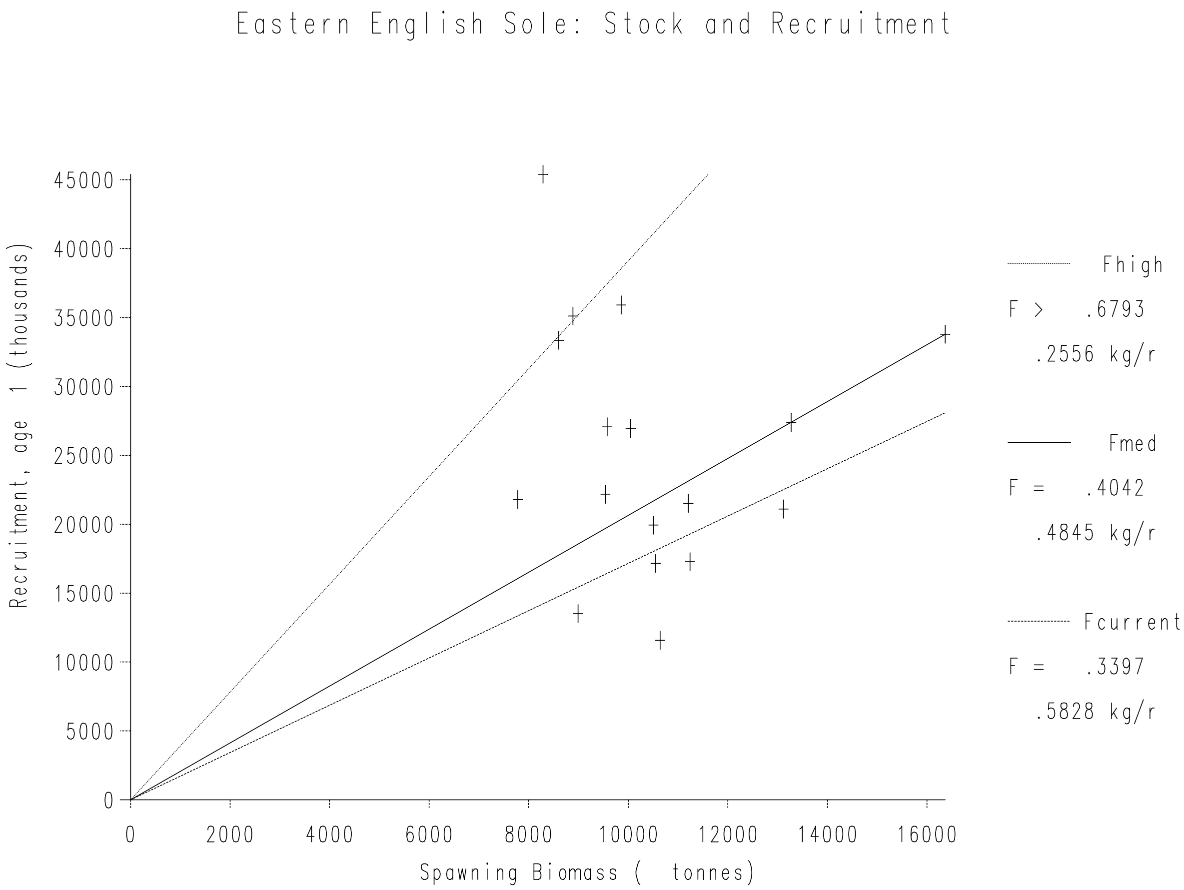


Figure 8.9.3 Sole in VIId. PA plot

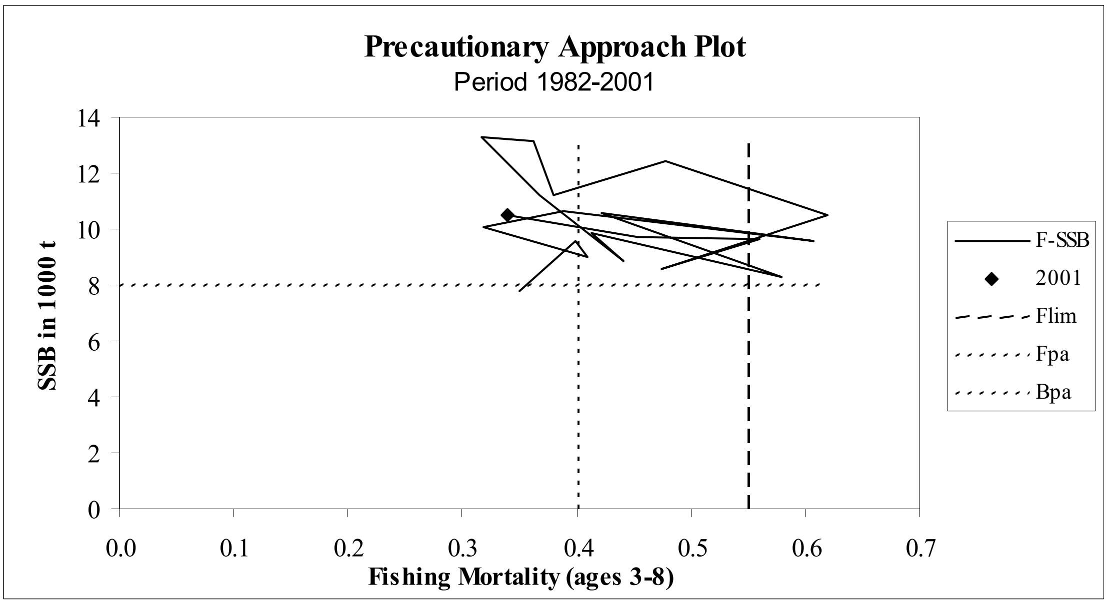
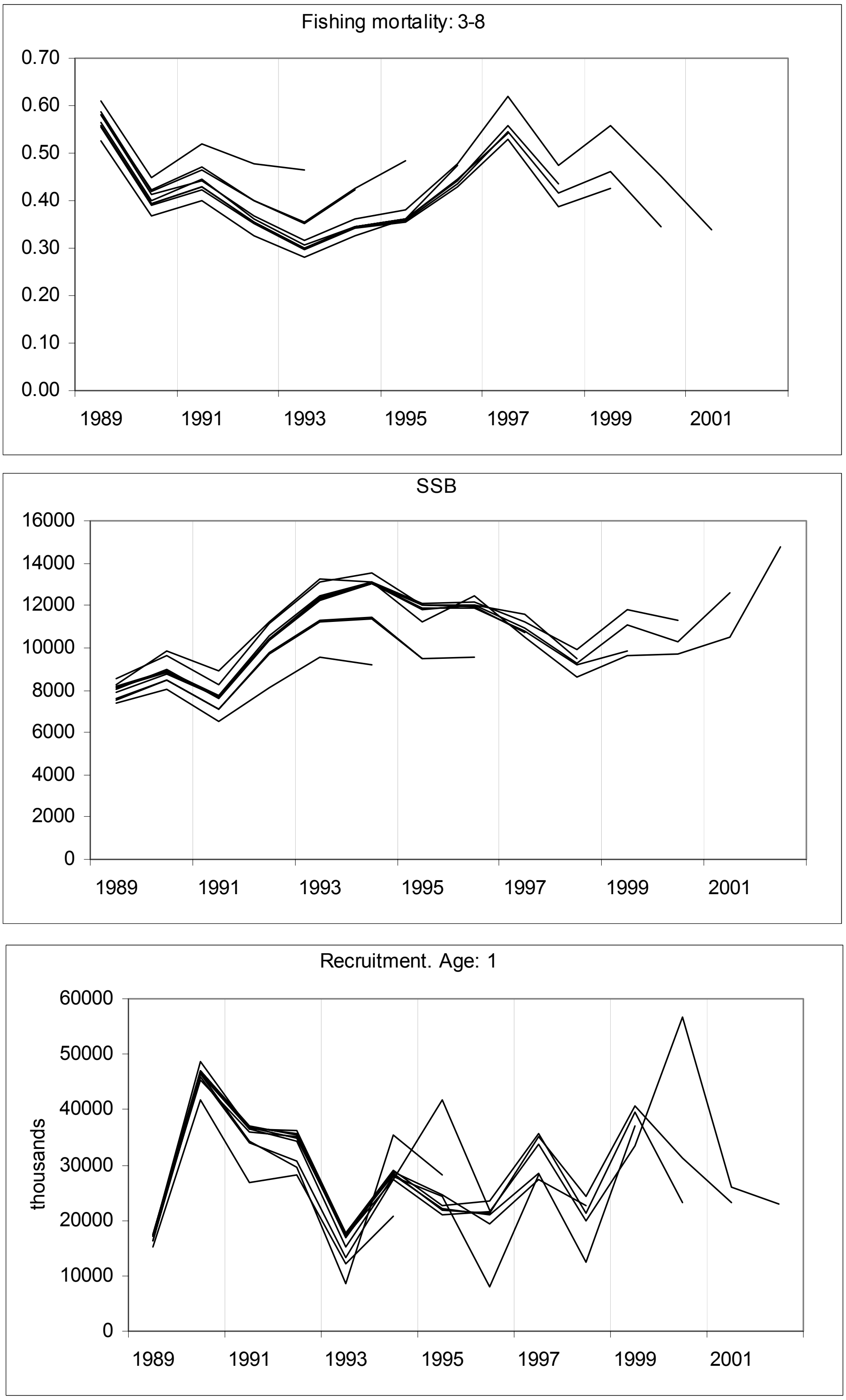


Figure 8.10.1 Sole in VIId. Quality control of assessments generated by successive working groups.



9 NORTH SEA PLAICE

9.1 The Fishery

North Sea plaice is taken mainly in a mixed flatfish fishery by beam trawlers in the southern and southeastern North Sea. Directed fisheries are also carried out with seine and gillnet, 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 9.1.3).

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 (see Section 9.1.3). The Dutch beam trawl fleet, one of the major operators in the mixed flatfish fishery in the North Sea, has seen a reduction in the number of vessels and also a shift towards two categories of vessels: 2000HP (the maximum engine power allowed) and 300HP (the maximum engine power for vessels that are allowed to fish within the 12-mile coastal zone and the plaice box). The overall effort level (expressed as HP days) has remained relatively constant.

Approximately 60% of plaice landings from the UK (England and Scotland) quota is landed into the Netherlands by Dutch vessels fishing on the UK register. Vessels landing into other countries than the country they are registered in 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 vessels registered in the same country.

9.1.1 ACFM advice applicable to 2001 and 2002

In October 2000 ACFM considered the North Sea plaice stock to be outside safe biological limits. SSB was below the proposed $\mathbf{B}_{pa}$ and fishing mortality was above the proposed $\mathbf{F}_{pa}$. The advice provided by ACFM was based on the Agreed Record of the EC/Norway consultation. ACFM considered that the agreed fishing mortality of F = 0.30 was consistent with the precautionary approach and advised a reduction in fishing mortality in 2001 to F = 0.3, corresponding to landings of 78 000 t in 2001. ACFM noted that the observed reduced growth rate of the strong 1996 year class resulted in this year class becoming available to the fishery (in marketable size) one year later than normally expected. This could result in additional discard mortality.

In the 2001 autumn session, ACFM again stated that the stock is outside safe biological limits, with respect to both biomass and fishing mortality. In regard to the EU/Norway agreement, as a rebuilding measure a reduction of at least 20% for F was recommended in order to achieve a value below 0.26, which would correspond to a catch of less than 77 000 t in 2002. ACFM stressed that the slow growth of the strong 1996 year class, resulting in additional discard mortality, and the delayed maturation of this year class, could adversely affect the rebuilding of the SSB. ACFM also stated that the first indications for the 2001 year class are that it is a strong year class. If this year class follows a similar pattern in growth and maturation as the 1996 year class, it may show delayed recruitment and high discard rates over an extended period.

9.1.2 Management applicable to 2001 and 2002

The North Sea plaice TAC for 2001 was agreed at 78 000 tonnes, which is the maximum quantity being in line with the ACFM recommendation. The TAC in 2002 was agreed at 77 000 tonnes which is also in line with the ACFM recommendation.

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

1. *Every effort shall be made to maintain a minimum level of SSB greater than 210 000 tonnes ($\mathbf{B}_{lim}$).*

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 required that vessels fishing north of 55°N (or 56°N east of 5°E, since January 2000) should have a minimum mesh opening of 100 mm, while to the south of this limit, where the majority of the plaice fishery takes place, an 80-mm mesh is allowed. In addition to this, a minor part of North Sea plaice fishery is affected by the additional cod recovery plan (EU regulation 2056/2001) that prohibits beam trawl fishery with a mesh size <120 mm in the area to the north of 56°N, from 2002 onwards.

The minimum landing size for North Sea plaice is 27 cm. A closed area has been in operation since 1989 (the plaice box). Since 1995 this area was closed for all quarters. The closed area is only applicable for towed gears, but vessels smaller than 300 HP using towed gears have been exempted from the regulation. An additional technical measure concerning the fishing gear is the restriction of the aggregate beam length of beam trawlers to 24 m.

9.1.3 The fishery in 2001

Landings

Total landings of North Sea plaice in 2001 (Table 9.1.3) were estimated by the WG to be just over 80 thousand tonnes, which is at the same level as in the years 1996, 1997, 1999, and 2000. Unlike the previous years, the total landings in 2001 exceeded the TAC (+5%). The text table below contrasts recent total landings (tonnes, estimated by the WG) with the agreed TAC.

Year	Total WG landings	TAC
1997	83 048	91 000
1998	71 534	87 000
1999	80 662	102 000
2000	80 662[1]	97 000
2001	81 847	78 000
2002		77 000

[1]Revised 2002

The national uptake rates reported by the WG members indicated that for 2002 almost 40% of the national quota was taken by the beginning of June 2002.

Discards

Recent estimates of discarding show very high rates of discarding for plaice: almost 40% in weight and almost 70% in numbers.

Due to reduced growth rates, the strong 1996 year class has been undersized and subject to discarding for an extended period. This is believed to have caused an increase in discarding in recent years.

Discarding will have an impact on the catch-at-age matrix, thereby giving rise to an underestimate of fishing mortality. However, no time-series of discards estimates are available to incorporate in the assessment (see Section 1.11). Therefore, catch-at-age will be equated to landings-at-age in subsequent analyses.

9.2 Age Composition, Natural Mortality, Maturity, and Mean Weight-at-Age

Natural mortality and maturity-at-age were the conventional numbers 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. A working document was presented at the 2001 Working Group meeting on a time-series analysis of maturity data which showed considerable discrepancies to the conventional values, which are overestimating the mature stock. In the absence of a validated model describing the time trends in the maturity ogive, it was decided to postpone the evaluation of the effects of using the new estimates in this assessment. The analyses of maturity ogives are discussed in more detail in Section 1.13.1.

Age distributions were available from countries, contributing together up to 68% of the official total landings in 2001. The age composition of the landings is presented in Table 9.2.2. Age compositions by sex and quarter were available from Belgium, England, and the Netherlands. Combined age compositions by quarter were available from Denmark and France. Age composition data from German landings were available for the first and second quarter, but these data have not been used in the assessment. No SOP-correction was applied.

The landings of the flag vessels registered in the UK and elsewhere were not sampled in 2001, so no age composition was available for this part of the catches. These landings, as for landings from other countries that do not provide age compositions, were raised to the international age composition. From 2002 onwards, following EU regulation (1639/2001), each country is obliged to sample landings from foreign vessels that land in their country. Therefore, more age compositions will become available to the Working Group next year.

As shown in Figure 9.2.1 the relative age compositions of the Dutch, English, and Danish landings have more or less the same distribution in 2000, with the highest catch numbers-at-age 4, the strong 1996 year class. This pattern has changed in 2001 showing significant difference between especially the Dutch and Danish age compositions. The Dutch landings comprise relatively more 2- and 3-year-old fish, whereas the Danish landings have a relatively high proportion of 6-year-old plaice. A difference in age composition between these fleets is understandable taking into account the different gears used. However, it is surprising that 20% of the Danish catches consists of the 95 year class, which appears to be a weak year class in all other commercial and survey fleets. To rule out errors due to age reading bias an otolith exchange between England, Denmark, and The Netherlands has been initiated. The results of this exchange will be available before the ACFM meeting in October 2002. During the Working Group meeting the effort distribution of the Danish fleet fishing for plaice was investigated to see if a change in fishing grounds could have caused the change in the relative age composition. No substantial differences were observed in the effort distribution, and it was concluded that this could not be the cause of the observed differences.

Mean weights-at-age in the catch were estimated from the 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 in the past four years (Figure 9.2.2). A decrease in weights is also observed in the older age groups in 2001. This same trend is observed in the stock weights-at-age. The changes in weight-at-age can partially be explained by a changes in the sex ratio of the catches (see Figure 9.2.4). However, sex ratio changes were only observed in the first quarter, whereas weight-at-age decreased in all quarters. Weight-at-age in the stock for the most important age groups (4-6) has decreased by 4 to 19% since 2000. The changes in stock weights-at-age between 2000 and 2001 is illustrated in Figure 9.2.3. This has a strong effect on the SSB estimates and the catch forecasts.

9.3 Catch, Effort, and Research Vessel Data

The following tuning data were available for North Sea plaice assessment:

- NL commercial beam trawl cpue
- UK commercial beam-trawl cpue, excluding all flag vessels
- Beam Trawl Survey (BTS)
- Sole Net Survey (SNS)
- Demersal Young Fish Survey (DFS)

The Dutch commercial beam-trawl cpue consists of the total catch-at-age by the Dutch (beam trawl) fleet and the effort in horsepower days (days absent from port times the horsepower of the vessel). The effort series are estimated by the Agricultural Economics Institute (LEI-DLO), 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. In previous assessments, only the years 1989 onwards have been used because of strong patterns in log catchability residuals in the earlier years.

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 fished multiplied by the horsepower (HP) of the vessel. The series is available for 1990 onwards and for the age 4 to 12.

At the ACFM meeting in October 2001 and at this WG meeting the validity of the information provided by commercial tuning fleets was discussed. An upward trend in the cpue appears to have occurred in some fleet segments in recent years (WD-7). However, the relationship between cpue and abundance is questionable in recent years. The commercial cpue data may well be biased by the constraints imposed by the TAC regulation applicable to the fleets. Vessels that go out to sea may choose to direct their effort to non-quota species (e.g. dab, turbot, brill), thereby influencing the cpue for a quota species like plaice (WD-8). Therefore the WG decided to exclude commercial tuning fleets from the assessment.

The Beam Trawl Survey (BTS) 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. The survey is carried out in international cooperation and covers both inshore and offshore areas throughout the North Sea, Channel, and western waters of the UK. The Dutch survey is carried out using the RV ISIS. The fishing gear used is a pair of 8-m beam trawls with 40 mm stretched mesh cod-ends. The Dutch participation in the survey is used as a tuning series for the plaice assessment and consists of average catches in numbers by fishing hour. At the previous WG, age groups 1 to 4 were used for tuning the North Sea plaice assessment. The age range has been extended to 1 to 9 in the revision done by ACFM in October 2001, and for this year's assessment.

The Sole Net Survey (SNS) was carried out with RV Tridens until 1995. Since 1996 the RV ISIS is used for this survey. The gear used is a pair of 6-m beam trawls with 40 mm stretched mesh cod-ends. The stations fished are on transects perpendicular to the coast. This tuning fleet has a year range of 1982 to the present and an age range of 0 to 3. Only the ages 1 to 3 are used for tuning the North Sea plaice assessment, the 0-group index is used in the RCT3.

The Demersal Young Fish Survey (DFS) is an international survey carried out by The Netherlands, England, Belgium, and Germany. In the Wadden Sea and Scheldt estuaries a single light 3-meter beam trawl is used with a 20-mm cod-end and one light tickler chain from the shoes. The coastal area is fished with a pair of 6-m beam trawls rigged with a similar net as the 3-meter beam trawl. The combined index is calculated as a mean of the international indices with a fixed weighting by country, which refers to the area covered. In 1998 and 1999 no 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. Revisions to the UK survey resulting from changes in the survey area have resulted in a revised DFS series from 1981 to 2000. Since the UK survey has not been revised prior to 1981, the earlier DFS index should be omitted or down-weighted from any analysis. The revision of UK surveys hardly affects the combined DFS index due to the low area coverage (weighting) of the UK survey (Figure 9.3.1). The combined DFS index is only used for the RCT3 analysis and not for tuning the VPA.

The relative cpue and effort time-series of the commercial fleets are presented in Figure 9.3.2. The underlying data for these figures are presented in Tables 9.3.1 and 9.3.2. The fishing effort has decreased in the NL beam trawl since 1995, and since 1992 in the UK beam trawl. The cpue of the NL beam trawl fleet is more or less constant in recent years, whereas the cpue of the UK beam trawl fleet appears to be slightly higher in 2000 and 2001 as compared to 1999 (Figure 9.3.2). The latter pattern is also observed in the cpue data of the flag vessels (WD-7). The commercial fleets have not been used in the final XSA, for reasons explained above. The tuning fleet file used for the final XSA run is shown in Table 9.3.1. The commercial vessels were excluded by applying prior weighting.

The relative cpue (by age and ages combined) of the BTS and SNS surveys are presented in Figure 9.3.3. It is difficult to examine the overall trends in the plots by age group due to the occurrence of strong year classes. Overall there seems to be a slight decline in the cpue of both the BTS and the SNS.

9.4 Catch-at-Age Analyses

9.4.1 Data exploration

International catches-at-age were preliminarily examined using separable VPA, with a reference age of 4, terminal F = 0.65, and terminal selectivity set to 0.65. The diagnostics are presented in Table 9.4.1.1. Residuals in log-catch ratios were low apart from age 1/2 in some years, and for age 5/6 in the last year, but no consistent trends could be detected for these ages. The other residuals showed little variability and trends. The high residual for age 5/6 in the last year is caused by the unexpected high catch numbers for age 6 in 2001. As in previous years, the age range for the analyses was set to 1-15+.

A number of exploratory XSA runs have then been carried out and are summarised in the table below:

Run	Fleet	Settings	Remarks
1 (a-f)	Single-fleet XSA runs: - NL beam trawl - UK beam trawl - BTS (age 1-9) - SNS (age 1-3) - SNS (age 1-5) DFS (age 1)	No taper, no power, F shrinkage 1.5	
2	BTS, SNS (age 1-5), DFS (age 1)	No taper, no power, F shrinkage 0.5	
3	BTS & SNS (age 1-3) **(final run)**	No taper, no power, F shrinkage 0.5	
4	BTS & SNS (age 1-3)	No taper, no power, F shrinkage 0.5	No Danish age composition

Single-fleet XSA runs were carried out for all available tuning fleets, with a low shrinkage of 1.5, no tuning window and no taper. Log-catchability residuals derived from these analyses are presented in Figure 9.4.1.1. Although the Dutch and UK beam trawl cpue data are not used for tuning the final XSA run for reasons explained in Section 9.3, the log-catchability plots are presented for comparison purposes.

For the Dutch beam trawl cpue, the log-catchability residuals for 2-year-olds are strongly negative in 1998 and 1999. This may indicate that catch numbers-at-age 2 are particularly underestimated in these years, possibly as a result of increased discarding. However, this pattern appeared to be more a year effect rather than a consistent trend. The UK beam trawl cpue shows low log-catchability residuals. The positive trend observed over 1991-1997 was followed by a downward trend in1998-2001 (Figure 9.4.1.1).

No obvious trends were observed in the catchability residuals for the BTS and SNS. These surveys have high log-q residuals compared to the commercial fleets, especially at ages 3, 4, and 5 in the SNS. The DFS residuals were not large and did not show a clear trend (Figure 9.4.1.1).

Multi-fleet XSAs (Runs 2-4) have been carried out for selected combinations of tuning fleets, using the whole range of observations for tuning without a time taper.

In Run 2 the additional DFS tuning fleet and the additional age groups in the SNS fleet were included. With these settings all three surveys showed strongly conflicting signals in the estimated survivors at younger ages. This is presumably caused by the fact that the SNS survey has a poor coverage for 4+ group plaice, and similarly the DFS for 1+ group plaice. It was decided not to add the DFS and the extra SNS age groups to the tuning fleets.

Therefore, in Run 3 only 2 tuning fleets were used: BTS (ages 1-9) and SNS ages (1-3). With these settings the difference between the surveys in estimated survivors at younger ages was largely reduced. It was decided that this would be the final run. This configuration is the same as used by ACFM in the revised North Sea plaice assessment of last year.

An additional run (Run 4) was carried out to assess the effect of the Danish age composition. In this run the Danish age composition data were left out and the Danish landings were raised to the age compositions provided by other countries.

Figure 9.4.1.2 shows the recruitment, SSB, and F trajectories and the plot of F-SSB in 2001, derived from single-fleet and multi-fleet XSA runs. There are discrepancies between the trajectories derived from the single-fleet runs (run 1). Both the SNS and BTS surveys have a relatively high SSB estimate and a low F(2-10) estimate in the final year of the assessment. As the DFS survey only includes 1-group plaice, this survey does not supply much information for the estimation of SSB and F(2-10). The recruitment estimated in the final year using a single-fleet DFS tuning is lower than when estimated by tuning with the other fleets. The commercial beam trawl fleets are not included in the tuning of the final run. The final run shows a lower SSB than the BTS and SNS surveys separately due to shrinkage.

The Fbar(2-10) trajectories estimated in Run2 and Run3 are almost identical. A difference in SBB and recruitment in the final year is observed between these 2 runs. Using the DFS survey as a tuning fleet appears to estimate a lower recruitment in the final year. This is also observed in the single-fleet runs.

The effect of the Danish age compositions can be evaluated by comparing Run3 and Run4. Exclusion of the Danish age composition data hardly affects Fbar(2-10) in the final year of the assessment, but it does affect the Fbar(2-10) trajectory and the SSB in the final year. For reasons mentioned in Section 9.2, it was decided to keep the Danish age composition data in.

9.4.2 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	2001 (ACFM)					2002				
		years	age	alpha	beta		years	age	alpha	beta
fleets	NL Beam trawl (age 2-9)	1989-2000	2-9	0.000	1.000	NL Beam trawl (age 2-9)	1989-2001	2-9	0.000	1.000
	UK Beam trawl (age 4-12)	1990-2000	4-12	0.000	1.000	UK Beam trawl (age 4-12)	1990-2001	4-12	0.000	1.000
	BTS (age 1-9)	1985-2000	1-9	0.660	0.750	BTS (age 1-9)	1985-2001	1-9	0.660	0.750
	SNS (age 1-3)	1982-2000	1-3	0.660	0.750	SNS (age 1-3)	1982-2001	1-3	0.660	0.750
first tuning year	1982					1982				
last data year	2000					2001				
time series weights	no taper					no taper				
Catchability dependent on stocksize for age<	1					1				
Catchability independent of age for ages >=	10					10				
Survivor estimates shrunk towards the mean F	5 years / 5 ages					5 years / 5 ages				
s.e. of the mean	0.5					0.5				
Minumum standard error for pop Estimates	0.3					0.3				
Prior weighting	NL Beam trawl = 0					NL Beam trawl = 0				
	UK Beam trawl = 0					UK Beam trawl = 0				
	BTS = 1					BTS = 1				
	SNS =1					SNS =1				
Number of iterations	23					25				
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 9.4.2.1. Figure 9.4.2.1 shows the log-catchability residuals for the tuning fleets in the final run. Fishing mortality and stock numbers are shown in Tables 9.4.2.2 and 9.4.2.3. Weighting of the different data sources in the assessment is shown in Figure 9.4.2.2. The surveys account for most of the weight on ages 1-8.

The retrospective analysis is shown in Figure 9.4.2.3 and was carried out by chopping off one year at the end and without a tuning window. The analysis does not show a retrospective pattern in fishing mortality or SSB. A marked difference is observed in Fbar(2-10) in 2000. In the last assessment year the increase in F is caused by the high F on ages 6 and 7. Increased discarding, not included in the assessment, may cause underestimation of fishing mortality at the youngest age groups.

9.5 Recruitment Estimates

The GM for recruitment at age 1 is 410 million (arithmic mean 450 million). The 2002 data are not yet available for the BTS, SNS, and DFS surveys, which take place in the third quarter of the year. A WG-subgroup will meet in October to review the available indices and calculate recruitment estimates. The files for the input of the RCT3 are available at \acfm\wgnssk\2002\Stock\ple-nsea\final runs\recruitment .

The following text table summarises the recruitment as estimated by XSA, expressed as year-class strength at the respective ages in 2002.

Year class	Age in 2002	XSA	RCT3	GM(57-99)
1998	4	106	No estimate	191
1999	3	173	No estimate	303
2000	2	246	No estimate	369
2001	1	No estimate	No estimate	410

9.6 Historical Stock Trends

Figure 9.6.1 shows the trends in landings, mean F(2-10), 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 appears to have decreased since 1997, with a marked increase in 2001. Current fishing mortality (0.41) is estimated to be substantially higher than in 2000 (0.31) and above $\mathbf{F}_{pa}$ (0.3).

The SSB increased to a peak in 1967 when the strong 1963 year class became mature. Since then, SSB declined to a level of 300 kt in the early 1980s. Due to the recruitment of the strong year classes 1981 and 1985, SSB again increased to a peak in 1989 and rapidly declined since then. SSB has increased in recent years and is currently above $\mathbf{B}_{lim}$, but still below $\mathbf{B}_{pa}$.

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 appears to be strong and is currently estimated at 970 million. This year class is driving the development of the stock.

9.7 Short-Term Prognoses

No short-term forecast was carried out. This will be done at the WG-subgroup in October. The input files are available at \acfm\wgnssk\2002\Stock\ple-nsea\final runs\short-term.

9.8 Medium-Term Prognoses

No medium-term forecast was carried out. This will be done at the WG-subgroup in October. The input files are available at \acfm\wgnssk\2002\Stock\ple-nsea\final runs\medium-term.

9.9 Biological Reference Points

Biological reference points have been calculated and are presented in Figure 9.9.1, Figure 9.9.2, and the text table below. The input for the yield-per-recruit analysis is shown in Table 9.9.1. The catch weights-at-age and stock weights-at-age were taken as a long-term mean. The yield-per-recruit analysis and SSB per recruit, based on the current exploitation pattern are shown in Figures 9.9.1 and 9.9.2. Figure 9.9.3 shows the precautionary approach plot.

$\mathbf{F}_{max}$ was revised downwards (0.29 last year). $\mathbf{F}_{med}$ was revised slightly upwards from 0.33 in last years assessment to 0.35 in this year's. Figure 9.4.2.3 indicates that SSB was below $\mathbf{B}_{lim}$ in the period 1994-1998 and exceeded this threshold only after 1999. The current estimation of $\mathbf{B}_{lim}$, which is defined as $\mathbf{B}_{loss}$, is 144 440 tonnes (SSB in 1997).

Management point	Value	Reference point	Value
$\mathbf{F}_{pa}$	0.3	$\mathbf{F}_{max}$	0.24
$\mathbf{F}_{lim}$	0.6	$\mathbf{F}_{high}$	0.68
$\mathbf{B}_{pa}$	300 000 tonnes	$\mathbf{F}_{med}$	0.35
$\mathbf{B}_{lim}$	210 000 tonnes	$\mathbf{F}_{0.1}$	0.1

9.10 Quality of the Assessment

In general, the quality of the assessment can be affected by potential problems in commercial cpue data and by discarding.

At the October 2001 ACFM meeting, a working document was presented (WD-8) on further explorations into the assessment of North Sea Plaice. In this paper it was stated that inclusion of commercial cpue data in the tuning of the assessment could bias the assessment, due to differences in the spatial distributions of fleets or by the constraints imposed by the TAC regulation applicable to the fleets. Vessels may choose to direct their effort to other species like dab and brill and thereby influence the cpue of plaice or sole, as it is a mixed fishery.

Another working document was made available to the Working Group during the meeting (WD-7), which deals with trends in effort and cpue of plaice for a selection of beam trawl vessels. It was concluded that cpue has increased since 1999. The selection of vessels mainly consisted of flag vessels, which have relatively large individual quota's and are therefore less constrained by TAC regulations. These results do not solve the problem as to whether the observed trends in cpue are related to TAC or abundance.

For reasons mentioned above commercial tuning fleet data was not used in the final assessment.

Due to reduced growth rates, the strong 1996 year class has been undersized and subject to discarding for an extended period. This is believed to have caused an increase in discarding in recent years. Discarding of plaice in general is high due to the minimum mesh size (80 mm) that applies to the majority of the beam trawl fishery for plaice. This discarding will have an impact on the catch-at-age matrix, thereby giving rise to an underestimation of fishing mortality on the younger ages. Adjusting catch numbers-at-age for discards may contribute to improve the quality of this assessment and the accuracy of advised TACs. Although the collection of discard information has started, time-series are so far too short to attempt any adjustment of the catch data.

The cod closure in the North Sea in 2001 affected the distribution and pattern of fishing activity of beam trawlers in the first quarter of the year. Effort was displaced westwards from around the plaice box towards the Dogger Bank and central North Sea. The impact of this change in fishing pattern has not been evaluated and is not included in the assessment.

Contrary to previous assessments the current retrospective analysis (Figure 9.4.2.3) shows no retrospective pattern for this assessment. In general this (analytical) assessment shows a high consistency with last year's assessment as done by ACFM. The differences appear to be caused by changes in the age compositions by country (Figure 9.4.1.2). The short- and medium-term predictions will be carried out in October by a WG sub group when the survey data for the third quarter 2002 becomes available for inclusion in the predictions.

Although this assessment shows high consistency over the last years, the uncertainty on the impact of high levels of discarding remains.

9.11 Management Considerations

Plaice is mainly caught by beam trawlers in a mixed fishery with sole, but also partly in a directed gillnet fishery. Section 1.4.6 shows some simulations on the technical interaction between different fleets. This preliminary analysis indicates that a rebuild of the plaice stock on the short term (above $\mathbf{B}_{pa}$ =300 000 t) can only be realised in some scenarios with a reduced fishing mortality on sole (<0.3) by the beam trawl fleet, without a special reduction in F for e.g. Danish gillnet fishery. This analysis is an indication for the interdependence of the two stocks.

The amounts of discards is a major problem for the plaice fishery, and an improvement to the exploitation pattern would be a major benefit for this stock. Plaice is mainly caught in a mixed beam trawl fishery with sole using 80-mm mesh in the southern North Sea. One of the reasons for high discarding of plaice is the fact that the mesh size of this fishery is desirable for sole, but not for plaice. This means it is important to stress that management measures intended for plaice will affect sole and vice versa. In relation to this, new technical measures introduced in January 2000 may affect the exploitation of the sole and plaice. The area where fishing with 80 mm is allowed has extended from 55ºN to 56ºN, east of 5ºE.

Table 9.1.3 North Sea plaice. Nominal landings (tonnes) in Subarea IV as officially reported to ICES.

Country	1994	1995	1996	1997	1998	1999	2000	2001
Belgium	7,951	7,093	5,765	5,223	5,592	6,160	7,620	6,369
Denmark	17,056	13,358	11,776	13,940	10,087	13,468	13,408	13,797
France	407	442	379	254	489	624	836	429
Germany	5,697	6,329	4,780	4,159	2,773	3,144	4,310	4,739
Netherlands	50,289	44,263	35,419	34,143	30,541	37,513	35,030	33,290*
Norway	524	527	917	1,775	1,004	913	835	1,926
Sweden	6	3	5	10	2	4	3	3
UK (E/W/NI)	17,806	15,801	13,541	13,789	11,473	9,743	…	
UK (Scotland)	9,943	8,594	7,451	8,345	8,442	7,318	…	
United Kingdom							20,711	19,111
Others					1			
Total	109,679	96,410	80,033	81,638	70,404	78,887	82,753	79,668
Unallocated	713	1,946	1,640	1,410	1,130	1,775	0	2,183
WG estimate	110,392	98,356	81,673	83,048	71,534	80,662	81,148[1]	81,847
TAC	165,000	115,000	81,000	91,000	87,000	102,000	97,000	78,000

[1]Revised 2002 *not including 544t reported in unknown area

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 9.2.3 North Sea plaice, catch numbers-at-age (thousands).

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

YEAR	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
AGE										
1	0	0	0	0	0	0	0	3	76	19
2	2147	4340	14708	9858	4144	5982	9474	15017	17294	29591
3	35876	21471	40486	42202	65009	30304	40698	45187	51174	48282
4	66779	76926	64735	53188	51488	112917	38140	36084	56153	33475
5	50060	54364	57408	43674	36667	41383	123619	35585	40686	26059
6	20628	31799	37091	30151	27370	22053	17139	102014	35074	22903
7	9060	12848	15819	18361	16500	16175	10341	10410	78886	16913
8	9035	6833	6595	8554	10784	8004	10102	6086	6311	29730
9	5257	7047	3980	4213	6467	6728	3925	8192	4185	6414
10	3428	3863	3804	4015	3336	3045	4891	3739	4778	4602
11	2659	3591	3066	2807	1843	2033	2273	4760	2202	3377
12	2266	2117	1905	2221	2552	968	1556	1796	2871	2213
13	2001	2089	1518	1745	1624	1303	607	1223	1150	1910
14	1061	1536	1300	1338	1032	783	1007	703	939	929
+gp	1386	3396	5293	5461	4541	3043	3031	3871	2900	3879
0 TOTALNUM	211643	232220	257708	227788	233357	254721	266803	274670	304679	230296
TONSLAND	87472	107118	110540	97143	101834	108819	111534	121651	130342	113944
SOPCOF %	97	102	101	101	102	102	103	106	97	103

YEAR	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
AGE										
1	2233	1268	2223	981	2820	3220	1143	1318	979	253
2	36528	31733	23120	28124	33643	56969	60578	58031	64904	100927
3	62199	59099	55548	61623	77649	43289	62343	118863	133741	122296
4	52906	73065	42125	31262	96398	66013	54341	48962	77523	57604
5	23043	42255	41075	25419	13779	83705	50102	47886	24974	35745
6	16998	13817	19666	21188	9904	9142	35510	39932	17982	12414
7	14380	8885	8005	11873	9120	5912	5940	24228	13761	9564
8	10903	9848	6321	5923	6391	5022	3352	4161	8458	8092
9	18585	6084	5568	4106	2947	4061	2419	2807	1864	4874
10	3467	13829	3931	3337	2020	1927	2176	2333	1326	1406
11	2841	1680	10118	1741	2111	1301	1145	1849	952	1097
12	2538	1995	1634	7935	911	1357	603	1113	1173	830
13	1553	1516	1686	1080	4478	489	689	707	433	796
14	1591	1355	1242	1424	388	2290	330	707	284	468
+gp	3661	3603	3369	4178	2644	1827	2525	2579	1209	1306
0 TOTALNUM	253426	270032	225631	210194	265203	286524	283196	355476	349563	357672
TONSLAND	122843	130429	112540	108536	113670	119188	113984	145347	139951	139747
SOPCOF %	103	105	104	106	103	100	96	100	101	102

YEAR	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
AGE										
1	3334	1214	108	121	1674	0	0	1261	1550	1461
2	47776	119695	63252	73552	67125	85123	15146	46757	32533	43266
3	209007	115034	274209	144316	163717	115951	250675	105929	97766	83603
4	69544	99076	53549	185203	93801	111239	74335	231414	110997	116155
5	28655	29359	37468	32520	84479	64758	47380	52909	159814	72961
6	16726	12906	13661	15544	24049	34728	25091	19247	26757	77557
7	7589	8216	6465	6871	9299	11452	16774	10567	8129	14910
8	5470	4193	5544	3650	4490	4341	5381	7561	4216	5233
9	4482	3013	2720	2698	2733	2154	3162	2120	3451	3141
10	3706	2947	2088	1543	2026	1743	1671	1692	1097	2325
11	1134	2144	1307	1030	1178	1033	932	927	716	956
12	712	1219	1143	1070	1084	663	932	630	456	592
13	575	581	455	727	806	529	505	446	293	356
14	519	344	310	371	628	296	516	328	208	289
+gp	2007	1052	1262	1057	1228	1214	1677	1557	1038	1073
0 TOTALNUM	401236	400993	463541	470273	458317	435224	444177	483345	449021	423878
TONSLAND	154547	144038	156147	159838	165347	153670	154475	169818	156240	148004
SOPCOF %	101	99	98	98	99	99	98	99	98	96

YEAR	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
AGE										
1	3410	3461	1394	7751	1104	892	196	549	2634	3589
2	43954	53949	45148	36575	42496	42855	30401	8689	15819	28139
3	85120	98375	101617	81398	64382	86948	68920	155971	39550	44848
4	72494	72286	80236	78370	46359	43669	56329	39857	164330	48096
5	72703	51405	38542	36499	32130	22541	16713	24112	14993	91572
6	33406	29001	20388	17953	14460	13518	6432	6829	9343	17519
7	29547	13472	15323	9772	10605	6362	4986	2783	2130	5996
8	6970	11272	6399	4366	4528	3632	2506	2246	1030	1766
9	3200	3645	5368	2336	2624	2179	1761	1521	940	797
10	2240	1888	2319	1682	1659	1252	912	1180	544	696
11	1516	1241	942	864	1170	690	500	515	392	356
12	925	932	646	427	511	889	403	381	393	448
13	524	743	580	229	260	396	431	230	203	196
14	490	215	300	209	238	224	176	267	134	151
+gp	1233	864	646	342	1054	730	697	520	431	460
0 TOTALNUM	357732	342749	319848	278773	223580	226777	191363	245650	252866	244629
TONSLAND	125190	117113	110392	98356	81673	83048	71534	80662	81148	81847
SOPCOF %	98	98	97	99	98	99	98	99	97	99

Table 9.2.3. North Sea plaice, catch weights at age (kg)

Table 2 Catch w eights at age (kg)

YEAR		1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
AGE											
	1	0	0	0	0	0	0	0	0.217	0.315	0.256
	2	0.211	0.253	0.25	0.242	0.232	0.232	0.267	0.294	0.286	0.318
	3	0.248	0.286	0.273	0.282	0.27	0.279	0.298	0.31	0.318	0.356
	4	0.3	0.319	0.312	0.321	0.348	0.322	0.331	0.333	0.356	0.403
	5	0.4	0.399	0.388	0.385	0.436	0.425	0.366	0.359	0.419	0.448
	6	0.541	0.533	0.487	0.471	0.484	0.547	0.517	0.412	0.443	0.514
	7	0.57	0.624	0.628	0.539	0.559	0.597	0.59	0.573	0.499	0.542
	8	0.692	0.667	0.7	0.663	0.624	0.662	0.596	0.655	0.672	0.607
	9	0.777	0.715	0.737	0.726	0.69	0.738	0.686	0.658	0.744	0.699
	10	0.959	0.86	0.841	0.615	0.813	0.837	0.75	0.694	0.762	0.724
	11	0.995	0.92	0.89	0.792	0.858	0.87	0.817	0.81	0.78	0.818
	12	1.1	1.033	0.954	0.857	0.843	0.902	0.939	0.838	0.892	0.848
	13	1.187	1.004	0.938	0.974	0.943	0.95	0.936	1.022	0.941	0.922
	14	1.41	1.182	1.098	0.878	1.018	1.032	0.973	0.863	1.021	1.004
+gp		1.54	1.276	1.204	1.121	1.08	1.214	1.201	1.179	1.128	1.133
SOPCOFAC		0.9665	1.0193	1.0075	1.0057	1.0182	1.0198	1.0291	1.0582	0.9744	1.0331

YEAR		1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
AGE											
	1	0.246	0.272	0.285	0.249	0.265	0.254	0.244	0.235	0.238	0.237
	2	0.296	0.316	0.311	0.3	0.295	0.323	0.315	0.311	0.286	0.274
	3	0.352	0.344	0.354	0.33	0.338	0.353	0.369	0.349	0.344	0.329
	4	0.428	0.405	0.405	0.42	0.375	0.38	0.397	0.388	0.401	0.416
	5	0.493	0.486	0.476	0.495	0.513	0.418	0.438	0.429	0.473	0.505
	6	0.541	0.539	0.554	0.587	0.594	0.556	0.491	0.474	0.545	0.558
	7	0.608	0.605	0.609	0.636	0.641	0.647	0.609	0.55	0.588	0.604
	8	0.646	0.627	0.693	0.703	0.705	0.721	0.687	0.675	0.662	0.642
	9	0.674	0.677	0.707	0.783	0.741	0.715	0.776	0.796	0.772	0.725
	10	0.785	0.729	0.779	0.853	0.813	0.791	0.781	0.871	0.931	0.869
	11	0.841	0.978	0.849	0.854	0.851	0.898	0.886	0.818	0.943	0.95
	12	0.901	0.907	0.971	0.983	0.928	0.97	0.983	0.894	0.848	0.931
	13	0.9	0.942	1.002	0.953	1.019	0.855	1.039	1.083	1.015	0.933
	14	0.964	0.983	1.04	1.138	1.009	1.063	0.933	1.044	1.308	1.179
+gp		1.192	1.079	1.224	1.264	1.159	1.165	1.094	1.115	1.248	1.236
SOPCOFAC		1.0283	1.0508	1.0369	1.0624	1.0254	1.0016	0.9643	0.9983	1.0136	1.0175

YEAR		1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
AGE											
	1	0.279	0.2	0.233	0.247	0.221	0.221	0.221	0.236	0.271	0.227
	2	0.262	0.25	0.263	0.264	0.269	0.249	0.254	0.28	0.285	0.286
	3	0.311	0.3	0.283	0.29	0.304	0.3	0.278	0.309	0.298	0.294
	4	0.424	0.383	0.375	0.337	0.347	0.351	0.352	0.332	0.317	0.306
	5	0.514	0.515	0.491	0.462	0.425	0.402	0.453	0.392	0.366	0.365
	6	0.608	0.604	0.613	0.577	0.488	0.504	0.512	0.533	0.447	0.455
	7	0.664	0.677	0.684	0.678	0.675	0.583	0.608	0.603	0.597	0.528
	8	0.712	0.771	0.725	0.729	0.751	0.728	0.699	0.67	0.692	0.671
	9	0.738	0.815	0.837	0.804	0.853	0.829	0.813	0.792	0.761	0.747
	10	0.84	0.893	0.916	0.9	0.921	0.826	0.936	0.819	0.826	0.843
	11	0.983	0.913	0.981	1.001	0.948	0.996	0.964	0.923	1.044	0.93
	12	1.045	0.984	1.026	0.95	1.063	1.015	1.041	0.952	1.098	0.944
	13	1.174	1.24	1.112	1.071	1.078	1.045	1.137	1.157	1.117	1
	14	0.97	1.209	1.25	1.139	1.074	1.127	1.115	1.084	0.991	0.976
+gp		1.177	1.167	1.214	1.215	1.11	1.15	1.038	0.994	1.094	1.026
SOPCOFAC		1.0062	0.9938	0.9844	0.9799	0.9877	0.9875	0.9848	0.9854	0.9846	0.9634

YEAR		1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
AGE											
	1	0.251	0.249	0.229	0.272	0.24	0.208	0.152	0.245	0.228	0.238
	2	0.263	0.273	0.263	0.277	0.28	0.271	0.26	0.253	0.267	0.267
	3	0.29	0.289	0.286	0.301	0.307	0.313	0.31	0.28	0.284	0.289
	4	0.318	0.326	0.339	0.338	0.355	0.364	0.394	0.355	0.314	0.301
	5	0.341	0.356	0.397	0.402	0.42	0.457	0.497	0.455	0.432	0.357
	6	0.425	0.423	0.449	0.454	0.486	0.524	0.607	0.547	0.5	0.403
	7	0.531	0.518	0.502	0.528	0.499	0.603	0.633	0.63	0.684	0.544
	8	0.605	0.631	0.611	0.611	0.589	0.616	0.695	0.682	0.71	0.667
	9	0.715	0.721	0.732	0.734	0.72	0.683	0.7	0.752	0.751	0.752
	10	0.755	0.775	0.787	0.881	0.854	0.803	0.8	0.608	0.831	0.785
	11	0.843	0.806	0.936	0.865	0.928	0.907	0.975	0.75	0.843	0.793
	12	0.945	0.903	0.948	0.923	0.933	0.957	1.078	0.933	0.749	0.777
	13	0.994	0.846	1.034	0.918	0.923	0.884	0.888	1.031	0.853	0.875
	14	0.928	0.919	0.92	0.943	0.829	1.1	0.907	0.936	1.013	0.86
+gp		1.098	1.046	1.131	1.104	0.739	1.076	0.943	1.093	1.102	0.892
SOPCOFAC		0.9818	0.9767	0.9738	0.9935	0.9846	0.992	0.9842	0.986	0.9711	0.9923

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	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
AGE										
1	0.141	0.141	0.141	0.141	0.141	0.141	0.141	0.175	0.175	0.175
2	0.187	0.2	0.2	0.2	0.2	0.203	0.2	0.203	0.25	0.248
3	0.258	0.232	0.228	0.246	0.243	0.246	0.265	0.258	0.261	0.305
4	0.306	0.29	0.276	0.274	0.301	0.281	0.301	0.297	0.311	0.363
5	0.424	0.378	0.373	0.333	0.403	0.442	0.344	0.344	0.369	0.413
6	0.573	0.54	0.477	0.43	0.455	0.528	0.532	0.39	0.41	0.489
7	0.684	0.663	0.645	0.516	0.503	0.585	0.592	0.565	0.468	0.512
8	0.806	0.788	0.673	0.601	0.565	0.65	0.362	0.621	0.636	0.583
9	0.873	0.882	0.845	0.722	0.581	0.703	0.667	0.679	0.732	0.696
10	1.335	0.961	0.973	0.578	0.848	0.833	0.746	0.635	0.747	0.707
11	1.074	1.097	0.999	0.79	0.949	0.907	0.791	0.772	0.771	0.817
12	1.24	1.261	1.255	0.843	0.704	1.007	0.919	0.741	0.898	0.847
13	1.141	1.246	1.201	1.072	1.052	0.898	0.81	0.995	0.839	0.941
14	1.8	1.403	1.62	0.721	1.056	0.976	0.938	0.907	1.155	0.936
+gp	1.619	1.678	1.46	1.234	1.216	1.221	1.17	1.179	1.175	1.102

YEAR	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
AGE										
1	0.175	0.175	0.17	0.17	0.17	0.16	0.15	0.15	0.15	0.15
2	0.274	0.264	0.234	0.275	0.217	0.25	0.242	0.243	0.229	0.25
3	0.321	0.322	0.304	0.294	0.281	0.309	0.336	0.303	0.307	0.282
4	0.401	0.38	0.375	0.417	0.332	0.364	0.367	0.363	0.372	0.378
5	0.473	0.468	0.437	0.483	0.484	0.405	0.411	0.414	0.444	0.473
6	0.534	0.521	0.524	0.544	0.55	0.551	0.467	0.459	0.524	0.536
7	0.579	0.566	0.57	0.61	0.593	0.627	0.547	0.543	0.582	0.57
8	0.606	0.583	0.629	0.668	0.658	0.69	0.63	0.667	0.651	0.624
9	0.655	0.617	0.652	0.704	0.694	0.667	0.704	0.764	0.778	0.707
10	0.759	0.69	0.69	0.762	0.743	0.759	0.773	0.826	1.025	0.849
11	0.815	0.926	0.774	0.83	0.784	0.818	0.848	0.894	0.947	0.91
12	0.869	0.899	0.932	0.886	0.875	0.909	0.939	0.88	0.838	0.866
13	0.849	0.961	1.017	0.874	0.972	0.838	0.959	1.127	1.209	1.114
14	0.971	0.977	0.962	1.07	1.158	1.055	1.024	1.041	1.194	1.218
+gp	1.237	0.998	1.113	1.217	1.107	1.116	1.119	1.255	1.31	1.324

YEAR	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
AGE										
1	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.131
2	0.242	0.211	0.203	0.208	0.195	0.194	0.212	0.215	0.245	0.208
3	0.265	0.248	0.242	0.243	0.253	0.265	0.238	0.248	0.272	0.263
4	0.381	0.329	0.338	0.31	0.336	0.33	0.315	0.282	0.281	0.275
5	0.49	0.494	0.464	0.452	0.44	0.401	0.426	0.362	0.342	0.34
6	0.589	0.559	0.571	0.536	0.533	0.503	0.467	0.484	0.421	0.4
7	0.631	0.624	0.649	0.635	0.692	0.573	0.547	0.553	0.555	0.463
8	0.679	0.712	0.692	0.656	0.779	0.711	0.644	0.616	0.648	0.64
9	0.726	0.754	0.787	0.764	0.888	0.747	0.706	0.759	0.713	0.658
10	0.828	0.791	0.898	0.869	0.971	0.817	0.897	0.837	0.769	0.762
11	0.981	0.824	0.932	0.955	0.953	1.009	0.937	0.791	1.051	0.855
12	1.066	1.011	1.042	0.906	1.107	1.018	1.009	0.968	1.154	0.99
13	1.182	1.13	1.235	1.068	1.153	1.019	1.065	1.215	1.022	0.982
14	0.897	1.257	1.127	1.108	1.126	1.214	1.135	0.899	1.09	0.86
+gp	1.197	1.124	1.235	1.308	1.354	1.114	0.972	0.857	1.084	0.928

YEAR	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
AGE										
1	0.131	0.131	0.131	0.124	0.124	0.124	0.124	0.124	0.124	0.124
2	0.262	0.257	0.222	0.245	0.245	0.217	0.205	0.211	0.224	0.213
3	0.266	0.264	0.249	0.265	0.282	0.254	0.269	0.251	0.236	0.247
4	0.3	0.301	0.302	0.311	0.329	0.342	0.362	0.346	0.29	0.273
5	0.316	0.328	0.366	0.401	0.39	0.442	0.471	0.436	0.409	0.331
6	0.402	0.391	0.41	0.451	0.464	0.491	0.578	0.524	0.468	0.406
7	0.501	0.491	0.467	0.52	0.49	0.563	0.588	0.591	0.687	0.519
8	0.575	0.595	0.548	0.607	0.572	0.586	0.657	0.68	0.742	0.615
9	0.696	0.646	0.679	0.705	0.689	0.684	0.676	0.696	0.707	0.772
10	0.751	0.737	0.752	0.836	0.845	0.771	0.709	0.639	0.864	0.801
11	0.844	0.805	0.912	0.739	0.906	0.913	1.004	0.764	0.872	0.792
12	0.886	0.942	0.961	0.885	0.973	0.865	1.092	0.898	0.744	0.767
13	0.998	0.866	1.027	0.827	0.9	0.898	0.788	1.185	0.818	0.826
14	0.859	0.912	0.846	0.913	0.781	1.287	1.175	0.839	1.082	0.957
+gp	1.078	1.101	1.02	1.128	0.87	1.052	0.829	1.102	1.081	0.986

Table 9.3.1 North Sea plaice: tuning fleets

NL Beam Trawl & English Beam Trawl NOT used in tuning of final XSA run

Plaice Sub-area IV									
104									
NL Beam Trawl (1)									
1989	2001								
1	1	0	1						
2	9								
72.5	40443	73696	131915	23064	9634	5240	2715	947	
71.1	21956	60038	49862	76521	12187	3682	1790	1161	
68.5	27501	42376	53152	30697	34092	6879	1954	1137	
71.1	24271	44306	31854	27165	12219	9485	2464	993	
76.9	27552	46536	31333	19705	10984	6040	3611	1025	
81.4	30194	48106	35901	15371	7938	6174	2866	1929	
81.2	22519	43505	33883	14453	6575	3418	1549	931	
72.1	26600	27628	20922	13980	5313	3644	1366	944	
72	23098	45655	18156	6884	4337	2016	975	460	
70.3	15288	32486	26751	6389	2290	1359	669	314	
67.3	4341	76295	18251	11058	2999	998	833	506	
67.7*	8973	16995	72228	5789	3880	735	336	214	
61.4	16227	22535	19715	40807	2745	1759	390	196	
English Beam Trawl (2) (excl flag vessels)									
1990	2001								
1	1	0	1						
4	12								
102.3	2764	9488	1786	1133	722	842	251	170	98
123.6	2711	3538	6599	1325	837	427	610	226	183
151.5	2909	4446	2787	3674	968	558	485	497	166
146.6	3436	3060	2530	923	1876	635	400	357	255
131.4	3038	2890	1772	1252	593	850	431	189	160
105	3574	1657	1475	1020	620	332	378	287	143
82.9	1105	1579	890	836	543	388	207	274	163
76.3	1253	844	1066	599	686	505	211	148	229
68.8	1623	892	617	598	347	415	317	134	110
68.6	1011	1045	457	327	367	258	224	193	98
57.8	3655	865	575	255	141	201	108	103	146
54.1	794	2436	481	336	134	93	112	49	91
BTS (3)									
1985	2001								
1	1	0.66	0.75						
1	9								
1	130	180	38.8	11.8	1.4	1	0.4	0.2	0.1
1	660.2	131.8	50.9	8.9	3.3	0.5	0.4	0.1	0.1
1	225.1	765	33.1	4.8	2	1	0.3	0.1	0.1
1	605.1	139.9	173.2	9.2	2.7	0.7	0.4	0.1	0.1
1	426.6	332.6	38.6	47.3	5.9	0.8	0.4	0.6	0.1
1	107	99.8	57.7	24.8	7.6	0.8	0.2	0.3	0.2
1	184.4	122.1	28.5	11.9	4.3	5.7	0.3	0.2	0.1
1	172.8	125.7	27.3	5.6	3.2	2.7	1.1	0.3	0.1
1	122.6	181	38.8	6.1	1	0.8	0.6	0.4	0.1
1	141.7	65.7	37.4	11.9	3.2	0.7	0.8	1	0.4
1	249.4	43.6	14.2	8.3	1.2	0.9	0.4	1.1	0.2
1	215.8	206.8	22.8	4.8	3.7	0.9	0	0.2	0.1
1	-11	-11	19.9	2.8	0.2	0.4	0.2	0.1	0
1	337	433.1	47.3	8.9	1.5	0.7	0.1	0.1	0.1
1	298.9	133.1	181.8	4	2	0.1	0.1	0	0
1	275.9	72.9	32.4	23	0.7	0.2	0.5	0	0
1	219	84.2	19.5	10.8	9.5	0.4	0.1	0	0
SNS (3)									
1982	2001								
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						

(*) Revised at ACFM oct 2001
(1) Effort is specified in Hpdays (*100,000), catch numbers in thousands. Source: RIVO
(2) Effort is specified in HP fishing hours (million), catch numbers in thousands. Source: CEFAS
(3) Source: RIVO

Table 9.3.2. North Sea plaice: effort and CPUE trends for the NL and UK commercial fleets

	Effort		CPUE	
	NL beam-trawlers	English beam-trawlers	NL beam-trawlers	UK beam-trawlers
Year	HP days * 100000	HP days *million		
1979	44.3		1693	
1980	45		1729	
1981	46.3		1853	
1982	57.3		1707	
1983	65.6		1441	
1984	70.8		1439	
1985	70.3		1511	
1986	68.2		1651	
1987	68.4		1440	
1988	76.2		1194	
1989	72.5		1379	
1990	71.1	102.3	1104	86
1991	68.5	123.6	1022	70
1992	71.1	151.5	745	59
1993	76.9	146.6	656	51
1994	81.4	131.4	626	47
1995	81.2	105.0	565	49
1996	72.1	82.9	510	46
1997	72	76.3	492	55
1998	70.3	68.8	451	55
1999	67.3	68.6	577	45
2000	67.7 (1)	57.8	536	68 (2)
2001	61.4 (3)	54.1	550	61

(1) Updated at ACFM meeting october 2001
(2) Revised 2002
(3) Provisional

Table 9.4.1.1 North Sea Plaice: Separable VPA output

Title : Plaice in IV

At 13/06/2002 14:54

Separable analysis
from 1957 to 2001 on ages 1 to 14
with Terminal F of .650 on age 4 and Terminal S of .450

Initial sum of squared residuals was 2722.354 and
final sum of squared residuals is 765.024 after 150 iterations

Matrix of Residuals

Years,	1981/82,	1982/83,	1983/84,	1984/85,	1985/86,	1986/87,	1987/88,	1988/89,	1989/90,	1990/91,
1/ 2,	-1.782,	-.154,	-.660,	-3.154,	-2.705,	-.645,	-7.323,	-8.565,	-.015,	.280,
2/ 3,	.469,	.280,	.209,	.299,	.542,	.472,	.153,	-.830,	.242,	.390,
3/ 4,	.504,	.637,	.540,	.273,	.518,	.127,	.410,	-.089,	-.336,	-.098,
4/ 5,	.069,	.178,	.169,	-.187,	.312,	-.475,	.248,	-.413,	-.503,	-.069,
5/ 6,	.181,	.165,	.014,	.244,	-.122,	.097,	.395,	.201,	-.139,	.285,
6/ 7,	-.182,	-.016,	-.158,	-.048,	-.002,	-.146,	.081,	.073,	-.056,	.055,
7/ 8,	-.072,	-.087,	-.411,	-.124,	-.047,	-.077,	.156,	.056,	.046,	-.045,
8/ 9,	.131,	.089,	-.199,	.192,	-.015,	.072,	-.111,	.367,	.087,	-.021,
9/10,	-.239,	-.140,	-.319,	-.017,	-.070,	-.265,	-.225,	.010,	-.093,	.028,
10/11,	-.417,	-.129,	.007,	-.002,	-.203,	-.158,	.031,	-.139,	-.012,	-.346,
11/12,	.323,	-.224,	.352,	.016,	-.007,	.274,	.030,	.191,	.369,	.225,
12/13,	-.066,	-.273,	.381,	-.056,	.007,	.088,	-.123,	.210,	.097,	-.038,
13/14,	.106,	.150,	.137,	-.193,	-.019,	.487,	-.258,	.019,	.208,	-.161,

Years,	1991/92,	1992/93,	1993/94,	1994/95,	1995/96,	1996/97,	1997/98,	1998/99,	1999/**,	2000/**,
1/ 2,	.180,	.685,	.876,	-.106,	1.783,	-.251,	-.337,	-.386,	-.203,	1.294,
2/ 3,	.593,	.304,	.460,	.256,	.602,	.365,	.421,	-.516,	-.612,	.342,
3/ 4,	.100,	-.083,	-.080,	-.263,	.403,	.120,	-.003,	.373,	-.424,	-.070,
4/ 5,	-.158,	-.515,	-.278,	-.373,	.134,	-.159,	-.095,	.087,	.015,	.151,
5/ 6,	.208,	.118,	.078,	-.336,	.224,	.043,	.256,	.187,	.039,	-.539,
6/ 7,	.308,	.026,	-.287,	-.451,	-.260,	-.085,	-.090,	.039,	.158,	-.031,
7/ 8,	.164,	.156,	-.100,	.145,	.048,	.237,	-.091,	.053,	.034,	-.242,
8/ 9,	.076,	.031,	.093,	.095,	-.027,	.087,	-.109,	-.067,	.088,	-.005,
9/10,	-.123,	-.130,	-.236,	.204,	-.238,	.053,	-.009,	-.215,	.191,	-.012,
10/11,	-.135,	-.159,	-.079,	-.064,	-.317,	.096,	-.066,	-.154,	.146,	-.004,
11/12,	-.007,	.270,	.414,	.287,	.374,	.027,	.095,	.075,	-.151,	-.045,
12/13,	-.241,	-.327,	-.095,	.195,	.018,	-.322,	-.053,	.037,	-.122,	.465,
13/14,	-.567,	.465,	.460,	.302,	-.399,	-.308,	.154,	.071,	-.097,	.176,

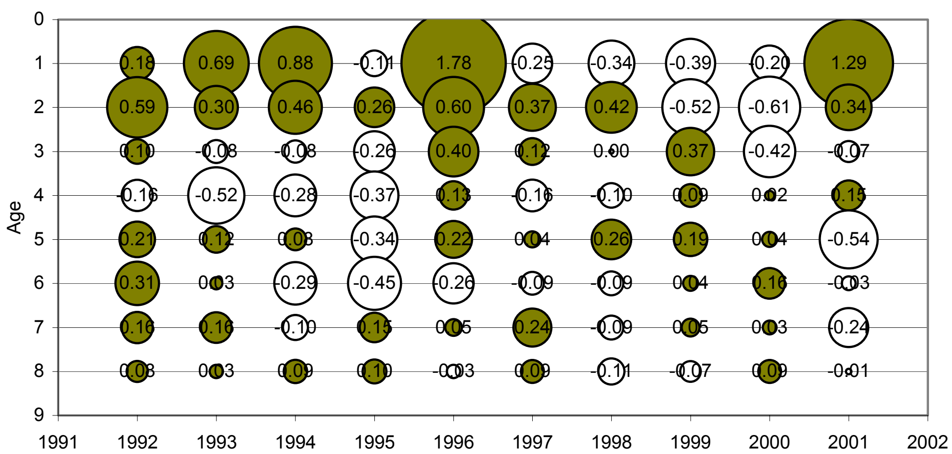


Table 9.4.2.1 North Sea Plaice Final XSA output

```
 Lowestoft VPA Version 3.1

   14/06/2002  15:45

 Extended Survivors Analysis

 Plaice in IV

 cpue data from file fleet

 Catch data for  45 years. 1957 to 2001. Ages  1 to  15.

      Fleet,            First, Last, First, Last, Alpha,  Beta
                    ,    year, year,  age ,  age
 NL Beam Trawl       ,   1989, 2001,   2,     9,   .000,  1.000
 FLT02: English Beam ,   1990, 2001,   4,    12,   .000,  1.000
 BTS                 ,   1985, 2001,   1,     9,   .660,   .750
 SNS                 ,   1982, 2001,   1,     3,   .660,   .750

 Time-series weights :

      Tapered time weighting not applied

 Catchability analysis :

      Catchability independent of stock size for all ages

      Catchability independent of age for ages >=   10

 Terminal population estimation :

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

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

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

      Prior weighting applied :
      Fleet  Weight
      NL Beam    .00
      FLT02: E   .00
      BTS       1.00
      SNS       1.00

 Tuning converged after   25 iterations

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

Fishing mortalities
    Age,  1992,  1993,  1994,  1995,  1996,  1997,  1998,  1999,  2000,  2001

      1,  .009,  .013,  .006,  .025,  .004,  .001,  .001,  .003,  .011,  .014
      2,  .137,  .171,  .206,  .194,  .168,  .194,  .037,  .033,  .087,  .144
      3,  .382,  .450,  .490,  .608,  .537,  .535,  .478,  .241,  .182,  .338
      4,  .505,  .575,  .718,  .773,  .749,  .761,  .705,  .498,  .383,  .313
      5,  .743,  .723,  .612,  .751,  .752,  .914,  .659,  .663,  .312,  .338
      6,  .718,  .666,  .626,  .569,  .673,  .738,  .637,  .547,  .515,  .641
      7,  .739,  .632,  .804,  .617,  .695,  .629,  .588,  .555,  .289,  .649
      8,  .512,  .619,  .621,  .492,  .575,  .478,  .481,  .509,  .362,  .367
      9,  .483,  .488,  .600,  .426,  .548,  .534,  .398,  .534,  .367,  .466
     10,  .501,  .520,  .584,  .335,  .540,  .486,  .395,  .449,  .327,  .450
     11,  .448,  .508,  .471,  .395,  .365,  .399,  .324,  .360,  .233,  .329
     12,  .442,  .485,  .479,  .359,  .381,  .462,  .380,  .388,  .454,  .403
     13,  .658,  .679,  .562,  .275,  .344,  .506,  .378,  .345,  .328,  .381
     14,  .540,  .548,  .568,  .357,  .453,  .495,  .391,  .377,  .308,  .384
```

Table 9.4.2.1 North Sea Plaice Final XSA output (continued)

XSA population numbers (Thousands)

YEAR	AGE 1	2	3	4	5	6	7	8	9	10
1992	4.03E+05	3.62E+05	2.82E+05	1.92E+05	1.46E+05	6.85E+04	5.94E+04	1.83E+04	8.78E+03	5.98E+03
1993	2.85E+05	3.62E+05	2.85E+05	1.74E+05	1.05E+05	6.27E+04	3.02E+04	2.57E+04	9.93E+03	4.90E+03
1994	2.43E+05	2.55E+05	2.76E+05	1.65E+05	8.86E+04	4.61E+04	2.92E+04	1.45E+04	1.25E+04	5.51E+03
1995	3.27E+05	2.18E+05	1.88E+05	1.53E+05	7.27E+04	4.35E+04	2.23E+04	1.18E+04	7.08E+03	6.21E+03
1996	2.84E+05	2.89E+05	1.63E+05	9.25E+04	6.39E+04	3.10E+04	2.23E+04	1.09E+04	6.53E+03	4.18E+03
1997	9.70E+05	2.56E+05	2.21E+05	8.61E+04	3.96E+04	2.72E+04	1.43E+04	1.01E+04	5.54E+03	3.42E+03
1998	3.15E+05	8.77E+05	1.91E+05	1.17E+05	3.64E+04	1.44E+04	1.18E+04	6.90E+03	5.64E+03	2.94E+03
1999	2.20E+05	2.85E+05	7.64E+05	1.07E+05	5.23E+04	1.70E+04	6.87E+03	5.92E+03	3.86E+03	3.43E+03
2000	2.47E+05	1.99E+05	2.50E+05	5.43E+05	5.88E+04	2.44E+04	8.92E+03	3.57E+03	3.22E+03	2.05E+03
2001	2.76E+05	2.21E+05	1.65E+05	1.88E+05	3.35E+05	3.89E+04	1.32E+04	6.05E+03	2.25E+03	2.02E+03

Estimated population abundance at 1st Jan 2002

, 0.00E+00, 2.46E+05, 1.73E+05, 1.06E+05, 1.25E+05, 2.16E+05, 1.85E+04, 6.24E+03, 3.79E+03, 1.28E+03,

Taper weighted geometric mean of the VPA populations:

, 4.02E+05, 3.60E+05, 2.98E+05, 1.96E+05, 1.11E+05, 5.89E+04, 3.41E+04, 2.10E+04, 1.38E+04, 9.46E+03,

Standard error of the weighted Log(VPA populations) :

, .4109, .4215, .4230, .4556, .5266, .5614, .6136, .6643, .7146, .7492,

YEAR	AGE 11	12	13	14
1992	4.41E+03	2.72E+03	1.14E+03	1.23E+03
1993	3.28E+03	2.55E+03	1.59E+03	5.36E+02
1994	2.63E+03	1.78E+03	1.42E+03	7.28E+02
1995	2.78E+03	1.49E+03	1.00E+03	7.32E+02
1996	4.02E+03	1.70E+03	9.40E+02	6.87E+02
1997	2.21E+03	2.53E+03	1.05E+03	6.03E+02
1998	1.90E+03	1.34E+03	1.44E+03	5.72E+02
1999	1.79E+03	1.24E+03	8.29E+02	8.93E+02
2000	1.98E+03	1.13E+03	7.63E+02	5.31E+02
2001	1.34E+03	1.42E+03	6.50E+02	4.98E+02

Estimated population abundance at 1st Jan 2002

, 1.16E+03, 8.70E+02, 8.60E+02, 4.02E+02,

Taper weighted geometric mean of the VPA populations:

, 6.45E+03, 4.51E+03, 3.04E+03, 2.09E+03,

Standard error of the weighted Log(VPA populations) :

, .7910, .7986, .8339, .8718,

1

Log catchability residuals.

Fleet : NL Beam Trawl

Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
1	No data for this fleet at this age									
2	99.99	99.99	99.99	99.99	99.99	99.99	99.99	.23	-.03	.28
3	99.99	99.99	99.99	99.99	99.99	99.99	99.99	.08	-.09	-.05
4	99.99	99.99	99.99	99.99	99.99	99.99	99.99	.12	-.07	.06
5	99.99	99.99	99.99	99.99	99.99	99.99	99.99	-.06	.30	.19
6	99.99	99.99	99.99	99.99	99.99	99.99	99.99	.15	.06	.47
7	99.99	99.99	99.99	99.99	99.99	99.99	99.99	.15	-.12	.27
8	99.99	99.99	99.99	99.99	99.99	99.99	99.99	.07	-.08	.10
9	99.99	99.99	99.99	99.99	99.99	99.99	99.99	.00	-.08	.12
10	No data for this fleet at this age									
11	No data for this fleet at this age									
12	No data for this fleet at this age									

Table 9.4.2.1 North Sea Plaice Final XSA output (continued)

Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	No data for this fleet at this age									
2	.10,	.16,	.57,	.42,	.42,	.41,	-1.29,	-1.38,	-.23,	.34
3	.04,	.03,	.06,	.40,	.17,	.37,	.18,	-.42,	-.80,	.03
4	-.13,	-.09,	.10,	.14,	.27,	.21,	.29,	-.05,	-.32,	-.53
5	.10,	.02,	-.17,	.03,	.25,	.09,	.01,	.24,	-.64,	-.36
6	.13,	.01,	-.08,	-.23,	.06,	.01,	.00,	.10,	.02,	-.68
7	.12,	.22,	.29,	-.11,	.11,	-.07,	-.26,	.00,	-.65,	.05
8	.14,	.15,	.43,	-.03,	.09,	-.22,	-.19,	.24,	-.20,	-.51
9	.11,	-.06,	.33,	.10,	.37,	-.19,	-.63,	.33,	-.39,	-.01
10	No data for this fleet at this age									
11	No data for this fleet at this age									
12	No data for this fleet at this age									

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

Age ,	2,	3,	4,	5,	6,	7,	8,	9
Mean Log q,	-6.9488,	-5.9239,	-5.6428,	-5.6493,	-5.7377,	-5.8281,	-6.1197,	-6.2727,
S.E(Log q),	.6279,	.3164,	.2360,	.2651,	.2584,	.2556,	.2426,	.2868,

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,	3.74,	-1.753,	-8.73,	.04,	13,	2.17,	-6.95,
3,	1.50,	-1.721,	2.63,	.52,	13,	.44,	-5.92,
4,	1.18,	-1.470,	4.45,	.85,	13,	.27,	-5.64,
5,	1.00,	.016,	5.66,	.88,	13,	.28,	-5.65,
6,	.88,	1.121,	6.30,	.89,	13,	.23,	-5.74,
7,	.79,	2.731,	6.69,	.94,	13,	.16,	-5.83,
8,	.82,	2.001,	6.69,	.92,	13,	.18,	-6.12,
9,	.87,	.923,	6.60,	.82,	13,	.25,	-6.27,

1

Fleet : FLT02: English Beam

Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
1	No data for this fleet at this age									
2	No data for this fleet at this age									
3	No data for this fleet at this age									
4	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	-.34,	-.52
5	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	.19,	-.22
6	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	-.33,	.13
7	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	-.08,	-.39
8	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	-.22,	-.20
9	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	.01,	-.68
10	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	-.59,	-.08
11	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	-.27,	-.53
12	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	-.69,	.07

Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	No data for this fleet at this age									
2	No data for this fleet at this age									
3	No data for this fleet at this age									
4	-.29,	.04,	.14,	.63,	.18,	.47,	.50,	.03,	-.20,	-.63
5	-.13,	-.15,	.02,	-.05,	.27,	.27,	.40,	.20,	-.09,	-.72
6	-.21,	-.21,	-.16,	-.09,	.02,	.45,	.60,	.09,	.12,	-.40
7	.00,	-.72,	-.20,	.01,	.08,	.24,	.52,	.45,	-.01,	.10
8	-.41,	-.01,	-.48,	-.06,	.16,	.51,	.31,	.54,	.19,	-.32
9	-.45,	-.41,	-.19,	-.42,	.11,	.61,	.44,	.41,	.44,	.14
10	-.27,	-.22,	-.13,	-.27,	-.14,	.14,	.76,	.28,	.18,	.36
11	.03,	.06,	-.26,	.29,	.10,	.18,	.30,	.74,	.12,	-.11
12	-.58,	-.03,	-.04,	.20,	.45,	.51,	.48,	.44,	1.14,	.48

Table 9.4.2.1 North Sea Plaice Final XSA output (continued)

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

Age	4	5	6	7	8	9	10	11	12
Mean Log q	-8.6310	-7.9884	-7.6316	-7.4104	-7.2561	-7.0436	-6.9762	-6.9762	-6.9762
S.E(Log q)	.4062	.3008	.3006	.3396	.3445	.4273	.3592	.3327	.5450

Regression statistics :

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

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
4	1.89	-2.475	5.57	.44	12	.63	-8.63
5	1.37	-2.839	6.70	.85	12	.32	-7.99
6	1.33	-2.005	6.67	.79	12	.35	-7.63
7	1.53	-2.603	6.10	.71	12	.42	-7.41
8	1.43	-1.772	6.40	.63	12	.45	-7.26
9	2.00	-2.541	5.32	.39	12	.70	-7.04
10	2.55	-3.339	4.88	.32	12	.66	-6.98
11	1.53	-1.341	6.42	.39	12	.48	-6.92
12	-4.57	-3.471	10.70	.04	12	1.62	-6.78

1

Fleet : BTS

Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
1	99.99	99.99	99.99	-.94	-.18	-.41	.53	.51	-.85	-.32
2	99.99	99.99	99.99	-.14	-.30	.55	-.35	.52	-.36	-.10
3	99.99	99.99	99.99	-.26	.05	-.31	.36	-.38	.04	-.30
4	99.99	99.99	99.99	-.33	-.26	-.69	-.19	.50	.62	-.08
5	99.99	99.99	99.99	-.56	-.14	-.30	.19	.66	.10	.29
6	99.99	99.99	99.99	.21	-.63	-.29	-.29	-.03	-.37	1.01
7	99.99	99.99	99.99	.06	.03	-.33	-.38	-.05	-.71	-.54
8	99.99	99.99	99.99	-.26	-.93	-.94	-.92	.54	.05	-.27
9	99.99	99.99	99.99	-.40	-.28	-.28	-.17	-.25	.16	-.35
10	No data for this fleet at this age									
11	No data for this fleet at this age									
12	No data for this fleet at this age									

Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	-.38	-.38	-.08	.20	.19	99.99	.53	.77	.58	.24
2	-.09	.30	-.34	-.60	.66	99.99	.19	.13	-.07	.01
3	-.25	.13	.16	-.34	.22	-.22	.75	.54	-.10	-.08
4	-.49	-.25	.57	.32	.26	-.20	.61	-.24	-.20	.05
5	.07	-.78	.48	-.21	1.05	-1.27	.64	.57	-.84	.04
6	.96	-.20	-.06	.21	.62	-.01	1.12	-1.06	-.75	-.44
7	.38	.37	.81	.26	99.99	.02	-.51	.01	1.17	-.58
8	.00	.02	1.51	1.72	.16	-.53	-.15	99.99	99.99	99.99
9	-.17	-.29	.94	.70	.17	99.99	.21	99.99	99.99	99.99
10	No data for this fleet at this age									
11	No data for this fleet at this age									
12	No data for this fleet at this age									

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

Age	1	2	3	4	5	6	7	8	9
Mean Log q	-7.2950	-7.7091	-8.6481	-9.5280	-10.2060	-10.5262	-10.6814	-10.5855	-10.8019
S.E(Log q)	.5212	.3659	.3292	.4055	.6153	.6276	.5171	.8127	.4201

Table 9.4.2.1 North Sea Plaice Final XSA output (continued)

Regression statistics :

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

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
1,	1.83,	-1.524,	2.68,	.19,	16,	.92,	-7.29,
2,	.78,	1.504,	8.84,	.77,	16,	.27,	-7.71,
3,	.89,	.711,	9.08,	.75,	17,	.30,	-8.65,
4,	1.04,	-.216,	9.42,	.64,	17,	.44,	-9.53,
5,	.93,	.283,	10.29,	.56,	17,	.59,	-10.21,
6,	.84,	.695,	10.55,	.56,	17,	.54,	-10.53,
7,	1.09,	-.349,	10.74,	.51,	16,	.58,	-10.68,
8,	.91,	.127,	10.50,	.16,	14,	.77,	-10.59,
9,	1.07,	-.110,	10.92,	.20,	13,	.47,	-10.80,

1

Fleet : SNS

Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
1	-.14	-.29	-.07	-.40	-.05	-.24	-.19	.15	-.23	.60
2	-.01	-.34	-.14	.12	-.33	.23	.20	.24	-.15	.33
3	-.45	-1.51	-.29	-.25	-.53	-.39	.99	.49	.37	-.03
4	No data for this fleet at this age									
5	No data for this fleet at this age									
6	No data for this fleet at this age									
7	No data for this fleet at this age									
8	No data for this fleet at this age									
9	No data for this fleet at this age									
10	No data for this fleet at this age									
11	No data for this fleet at this age									
12	No data for this fleet at this age									

Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	.42	-.01	-.05	-.02	.10	99.99	.29	.71	.17	-.75
2	.53	.18	-.11	-.53	.49	99.99	.33	.29	-.62	-.72
3	.46	-.33	-.38	-.67	.48	.33	1.85	1.21	-.47	-.88
4	No data for this fleet at this age									
5	No data for this fleet at this age									
6	No data for this fleet at this age									
7	No data for this fleet at this age									
8	No data for this fleet at this age									
9	No data for this fleet at this age									
10	No data for this fleet at this age									
11	No data for this fleet at this age									
12	No data for this fleet at this age									

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

Age ,	1,	2,	3
Mean Log q,	-2.4674,	-3.6286,	-4.9494,
S.E(Log q),	.3468,	.3708,	.7802,

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,	1.27,	-1.265,	-.39,	.56,	19,	.43,	-2.47,
2,	.79,	1.504,	5.54,	.76,	19,	.28,	-3.63,
3,	.76,	.860,	6.80,	.42,	20,	.60,	-4.95,

1

Table 9.4.2.1 North Sea Plaice Final XSA output (continued)

```
Terminal year survivor and F summaries :

Age  1   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
NL Beam Trawl       ,          1.,   .000,       .000,    .00,   0,  .000,     .000
FLT02: English Beam ,          1.,   .000,       .000,    .00,   0,  .000,     .000
BTS                 ,    311905.,   .537,       .000,    .00,   1,  .225,     .011
SNS                 ,    116226.,   .356,       .000,    .00,   1,  .512,     .029

  F shrinkage mean  ,    868248.,    .50,,,,                         .263,     .004

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
   246233.,       .26,      .68,    3,   2.660,   .014


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

Year class = 1999

Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
    ,                  Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
NL Beam Trawl       ,          1.,   .000,       .000,    .00,   0,  .000,     .000
FLT02: English Beam ,          1.,   .000,       .000,    .00,   0,  .000,     .000
BTS                 ,    210356.,   .309,       .267,    .86,   2,  .351,     .120
SNS                 ,    135700.,   .260,       .444,   1.71,   2,  .494,     .180

  F shrinkage mean  ,    244290.,    .50,,,,                         .155,     .104

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
   173366.,       .18,      .22,    5,   1.169,   .144

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

Year class = 1998

Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
    ,                  Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
NL Beam Trawl       ,          1.,   .000,       .000,    .00,   0,  .000,     .000
FLT02: English Beam ,          1.,   .000,       .000,    .00,   0,  .000,     .000
BTS                 ,    113773.,   .228,       .226,    .99,   3,  .469,     .318
SNS                 ,    104954.,   .247,       .489,   1.98,   3,  .387,     .341

  F shrinkage mean  ,     87819.,    .50,,,,                         .144,     .396

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
   106250.,       .16,      .20,    7,   1.249,   .338


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

Year class = 1997

Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
    ,                  Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
NL Beam Trawl       ,          1.,   .000,       .000,    .00,   0,  .000,     .000
FLT02: English Beam ,          1.,   .000,       .000,    .00,   0,  .000,     .000
BTS                 ,    135373.,   .201,       .113,    .56,   4,  .534,     .291
SNS                 ,    154897.,   .247,       .161,    .65,   3,  .330,     .259

  F shrinkage mean  ,     53066.,    .50,,,,                         .136,     .622
```

Table 9.4.2.1 North Sea Plaice Final XSA output (continued)

```
 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
    124586.,       .15,      .16,    8,   1.044,   .313

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

 Year class = 1996

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
      ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 NL Beam Trawl       ,         1.,   .000,       .000,    .00,   0,  .000,     .000
 FLT02: English Beam ,         1.,   .000,       .000,    .00,   0,  .000,     .000
 BTS                 ,    257428.,   .210,       .168,    .80,   4,  .595,     .291
 SNS                 ,    356331.,   .344,       .347,   1.01,   2,  .178,     .219

   F shrinkage mean  ,     92631.,    .50,,,,                        .227,     .663

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
    216315.,       .18,      .24,    7,   1.363,   .338
1
 Age  6   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
 NL Beam Trawl       ,         1.,   .000,       .000,    .00,   0,  .000,     .000
 FLT02: English Beam ,         1.,   .000,       .000,    .00,   0,  .000,     .000
 BTS                 ,     16362.,   .240,       .281,   1.17,   5,  .504,     .702
 SNS                 ,     28785.,   .326,       .695,   2.13,   2,  .112,     .457

   F shrinkage mean  ,     19213.,    .50,,,,                        .384,     .625

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
     18541.,       .23,      .19,    8,    .812,   .641

 Age  7   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
 NL Beam Trawl       ,         1.,   .000,       .000,    .00,   0,  .000,     .000
 FLT02: English Beam ,         1.,   .000,       .000,    .00,   0,  .000,     .000
 BTS                 ,      4930.,   .271,       .221,    .82,   7,  .478,     .769
 SNS                 ,      7886.,   .248,       .172,    .69,   3,  .073,     .544

   F shrinkage mean  ,      7716.,    .50,,,,                        .449,     .553

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
      6238.,       .26,      .15,   11,    .579,   .649

 Age  8   Catchability constant w.r.t. time and dependent on age

 Year class = 1993

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
      ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 NL Beam Trawl       ,         1.,   .000,       .000,    .00,   0,  .000,     .000
 FLT02: English Beam ,         1.,   .000,       .000,    .00,   0,  .000,     .000
 BTS                 ,      5415.,   .277,       .354,   1.28,   7,  .472,     .270
 SNS                 ,      3149.,   .248,       .232,    .94,   3,  .067,     .428
```

Table 9.4.2.1 North Sea Plaice Final XSA output (continued)

```
F shrinkage mean  ,      2709.,    .50,,,,                         .461,     .483

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
     3793.,       .27,      .24,   11,    .890,   .367

Age  9   Catchability constant w.r.t. time and dependent on age

Year class = 1992

Fleet,                 Estimated,    Int,       Ext,    Var,     N, Scaled,  Estimated
     ,                 Survivors,    s.e,       s.e,   Ratio,     , Weights,    F
NL Beam Trawl       ,         1.,   .000,      .000,     .00,    0,  .000,     .000
FLT02: English Beam ,         1.,   .000,      .000,     .00,    0,  .000,     .000
BTS                 ,      1391.,   .307,      .249,     .81,    7,  .291,     .435
SNS                 ,      1123.,   .248,      .142,     .57,    3,  .031,     .516

  F shrinkage mean  ,      1238.,    .50,,,,                         .678,     .478

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
     1277.,       .35,      .11,   11,    .308,   .466

Age 10   Catchability constant w.r.t. time and dependent on age

Year class = 1991

Fleet,                 Estimated,    Int,       Ext,    Var,     N, Scaled,  Estimated
     ,                 Survivors,    s.e,       s.e,   Ratio,     , Weights,    F
NL Beam Trawl       ,         1.,   .000,      .000,     .00,    0,  .000,     .000
FLT02: English Beam ,         1.,   .000,      .000,     .00,    0,  .000,     .000
BTS                 ,      1024.,   .299,      .193,     .65,    7,  .199,     .499
SNS                 ,      1467.,   .248,      .173,     .70,    3,  .026,     .373

  F shrinkage mean  ,      1195.,    .50,,,,                         .776,     .441

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
     1165.,       .39,      .08,   11,    .196,   .450

Age 11   Catchability constant w.r.t. time and age (fixed at the value for age) 10

Year class = 1990

Fleet,                 Estimated,    Int,       Ext,    Var,     N, Scaled,  Estimated
     ,                 Survivors,    s.e,       s.e,   Ratio,     , Weights,    F
NL Beam Trawl       ,         1.,   .000,      .000,     .00,    0,  .000,     .000
FLT02: English Beam ,         1.,   .000,      .000,     .00,    0,  .000,     .000
BTS                 ,       930.,   .307,      .105,     .34,    8,  .196,     .310
SNS                 ,      1387.,   .247,      .197,     .80,    3,  .021,     .218

  F shrinkage mean  ,       845.,    .50,,,,                         .783,     .337

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
      870.,       .40,      .06,   12,    .140,   .329

Age 12   Catchability constant w.r.t. time and age (fixed at the value for age) 10

Year class = 1989

Fleet,                 Estimated,    Int,       Ext,    Var,     N, Scaled,  Estimated
     ,                 Survivors,    s.e,       s.e,   Ratio,     , Weights,    F
NL Beam Trawl       ,         1.,   .000,      .000,     .00,    0,  .000,     .000
FLT02: English Beam ,         1.,   .000,      .000,     .00,    0,  .000,     .000
BTS                 ,       927.,   .314,      .108,     .34,    8,  .300,     .378
```

Table 9.4.2.1 North Sea Plaice Final XSA output (continued)

```
SNS                 ,       932.,   .247,       .207,    .84,   3,  .020,     .377

   F shrinkage mean  ,       830.,    .50,,,,                       .680,     .414

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
       860.,       .35,      .06,   12,    .159,   .403

 Age 13   Catchability constant w.r.t. time and age (fixed at the value for age) 10

 Year class = 1988

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
      ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 NL Beam Trawl       ,         1.,   .000,      .000,    .00,   0,  .000,     .000
 FLT02: English Beam ,         1.,   .000,      .000,    .00,   0,  .000,     .000
 BTS                 ,       400.,   .282,      .124,    .44,   8,  .089,     .383
 SNS                 ,       404.,   .247,      .101,    .41,   3,  .013,     .379

   F shrinkage mean  ,       402.,    .50,,,,                       .897,     .381

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
       402.,       .45,      .03,   12,    .067,   .381

 Age 14   Catchability constant w.r.t. time and age (fixed at the value for age) 10

 Year class = 1987

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
      ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 NL Beam Trawl       ,         1.,   .000,      .000,    .00,   0,  .000,     .000
 FLT02: English Beam ,         1.,   .000,      .000,    .00,   0,  .000,     .000
 BTS                 ,       453.,   .297,      .181,    .61,   9,  .150,     .275
 SNS                 ,       322.,   .247,      .165,    .67,   3,  .008,     .369

   F shrinkage mean  ,       286.,    .50,,,,                       .842,     .407

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
       307.,       .42,      .13,   13,    .309,   .384


1
```

Table 9.4.2.2 North Sea plaice: F derived from final XSA run

Run title : Plaice in IV

At 14/06/2002 15:46

Table 8 Fishing mortality (F) at age

YEAR	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
AGE										
1	0	0	0	0	0	0	0	0	0.0002	0.0001
2	0.007	0.0159	0.0557	0.0113	0.0157	0.023	0.0405	0.0737	0.0633	0.0974
3	0.1215	0.0804	0.1811	0.2006	0.0862	0.1366	0.1925	0.2458	0.3399	0.2253
4	0.2837	0.3654	0.3271	0.3402	0.3561	0.1898	0.2276	0.2332	0.4825	0.3462
5	0.4067	0.3498	0.4523	0.3403	0.3692	0.4779	0.2915	0.306	0.3965	0.3828
6	0.3365	0.4344	0.3794	0.4034	0.3296	0.3521	0.3291	0.3691	0.4942	0.3605
7	0.2697	0.3221	0.3554	0.2909	0.3574	0.2943	0.2468	0.3033	0.4806	0.4165
8	0.2474	0.2985	0.2428	0.2944	0.2474	0.2618	0.2695	0.201	0.271	0.2971
9	0.2306	0.277	0.2535	0.2157	0.3369	0.2151	0.177	0.3246	0.1854	0.4301
10	0.2077	0.2365	0.2113	0.388	0.2366	0.2338	0.2142	0.2279	0.2839	0.2844
11	0.2082	0.311	0.2666	0.213	0.2751	0.1982	0.245	0.297	0.1823	0.2963
12	0.2091	0.2278	0.2406	0.2806	0.2725	0.2031	0.2051	0.2776	0.2621	0.2511
13	0.2426	0.2704	0.2265	0.3222	0.3034	0.1945	0.1697	0.2203	0.2567	0.2488
14	0.2201	0.2652	0.2402	0.2846	0.2856	0.2093	0.2026	0.2701	0.2346	0.3029
+gp	0.2201	0.2652	0.2402	0.2846	0.2856	0.2093	0.2026	0.2701	0.2346	0.3029
FBAR 2-10	0.2345	0.2645	0.2732	0.2761	0.2595	0.2427	0.221	0.2539	0.333	0.3156
1										

YEAR	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
AGE										
1	0.0101	0.0025	0.0052	0.0031	0.0092	0.0072	0.0028	0.0031	0.0016	0.0006
2	0.1673	0.1729	0.051	0.0755	0.1242	0.2305	0.1631	0.1712	0.1867	0.1961
3	0.2714	0.3941	0.4544	0.1673	0.2734	0.2084	0.3762	0.4847	0.6454	0.5577
4	0.3653	0.519	0.4788	0.4428	0.3781	0.3501	0.3877	0.5048	0.597	0.565
5	0.3779	0.4929	0.5493	0.5269	0.3166	0.5816	0.4332	0.6185	0.4623	0.5381
6	0.4098	0.3629	0.397	0.5401	0.3548	0.3189	0.4618	0.6494	0.439	0.3899
7	0.3584	0.3461	0.3286	0.3933	0.4166	0.3299	0.3143	0.5844	0.4281	0.3916
8	0.4589	0.3949	0.3933	0.383	0.3379	0.3776	0.2809	0.3368	0.3657	0.4266
9	0.2731	0.445	0.3604	0.4245	0.2965	0.3316	0.28	0.3569	0.221	0.3301
10	0.3872	0.2987	0.5112	0.3388	0.339	0.2869	0.2651	0.4223	0.2535	0.2308
11	0.2541	0.292	0.3306	0.3954	0.3312	0.3386	0.2462	0.3356	0.2705	0.3062
12	0.3376	0.2543	0.4534	0.4148	0.3292	0.3271	0.2312	0.3565	0.3279	0.3556
13	0.2502	0.308	0.3153	0.5431	0.3866	0.263	0.2448	0.4111	0.2035	0.344
14	0.3012	0.3204	0.3954	0.4247	0.3374	0.3102	0.254	0.3776	0.2558	0.3142
+gp	0.3012	0.3204	0.3954	0.4247	0.3374	0.3102	0.254	0.3776	0.2558	0.3142
FBAR 2-10	0.341	0.3807	0.3916	0.3658	0.3152	0.3351	0.3292	0.4588	0.3999	0.4029

YEAR	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
AGE										
1	0.0034	0.0022	0.0002	0.0002	0.0014	0	0	0.0033	0.0041	0.0038
2	0.1403	0.1464	0.1335	0.1516	0.1601	0.0829	0.0332	0.1016	0.0981	0.1364
3	0.685	0.5124	0.5096	0.4463	0.5155	0.4027	0.3305	0.3026	0.284	0.3462
4	0.6335	0.7244	0.422	0.6855	0.5177	0.7061	0.4328	0.5102	0.5262	0.5642
5	0.5405	0.5319	0.5879	0.4345	0.686	0.7287	0.6597	0.5552	0.7093	0.6994
6	0.4598	0.4413	0.448	0.4571	0.5883	0.5939	0.6147	0.5437	0.5359	0.807
7	0.3889	0.3812	0.3669	0.3772	0.4832	0.5474	0.5673	0.5029	0.4113	0.5739
8	0.3609	0.3428	0.4247	0.3237	0.4018	0.3864	0.4755	0.4787	0.3399	0.4493
9	0.394	0.3073	0.347	0.3348	0.3802	0.304	0.4776	0.308	0.3706	0.4054
10	0.3985	0.4322	0.3223	0.3012	0.4006	0.3946	0.3633	0.4494	0.231	0.4065
11	0.2632	0.3755	0.3079	0.2324	0.3517	0.3252	0.3368	0.3128	0.3084	0.288
12	0.297	0.4428	0.3127	0.3948	0.3628	0.3041	0.4832	0.3554	0.2227	0.4006
13	0.396	0.3738	0.2611	0.2985	0.5159	0.269	0.3555	0.3984	0.2476	0.2424
14	0.3507	0.3875	0.311	0.3131	0.4035	0.3202	0.4045	0.3659	0.2907	0.3657
+gp	0.3507	0.3875	0.311	0.3131	0.4035	0.3202	0.4045	0.3659	0.2907	0.3657
FBAR 2-10	0.4446	0.4244	0.3958	0.3902	0.4593	0.4608	0.4394	0.4169	0.3896	0.4876

YEAR	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	FBAR 99-01
AGE											
1	0.0089	0.0128	0.0061	0.0252	0.0041	0.001	0.0007	0.0026	0.0113	0.0138	0.0092
2	0.1367	0.1706	0.206	0.1936	0.1681	0.1939	0.0371	0.0326	0.0875	0.1436	0.0879
3	0.3823	0.45	0.4897	0.6084	0.5371	0.5345	0.4785	0.2414	0.1822	0.3376	0.2537
4	0.505	0.5746	0.7181	0.7734	0.7489	0.7613	0.7051	0.4979	0.3826	0.3128	0.3978
5	0.7432	0.7233	0.6115	0.751	0.7525	0.9138	0.659	0.6625	0.3123	0.3384	0.4377
6	0.7182	0.6658	0.6258	0.5693	0.6733	0.7378	0.637	0.5469	0.5149	0.6412	0.5677
7	0.7394	0.6317	0.8038	0.6175	0.6947	0.6295	0.5885	0.555	0.2889	0.6494	0.4978
8	0.5116	0.619	0.6206	0.492	0.5753	0.4776	0.4806	0.509	0.3617	0.3666	0.4124
9	0.4835	0.4879	0.5999	0.4261	0.5484	0.5337	0.3975	0.5343	0.3666	0.4662	0.4557
10	0.5009	0.5198	0.5837	0.3349	0.5396	0.4865	0.3948	0.4486	0.3274	0.45	0.4087
11	0.4485	0.5077	0.4715	0.3951	0.3651	0.3987	0.3237	0.3597	0.233	0.3287	0.3071
12	0.4415	0.4853	0.479	0.3592	0.3808	0.462	0.3801	0.3885	0.4543	0.4026	0.4151
13	0.6577	0.6787	0.5615	0.2754	0.3437	0.5057	0.3778	0.3448	0.3279	0.3813	0.3513
14	0.5399	0.548	0.5682	0.3567	0.4528	0.4951	0.3905	0.3774	0.3081	0.3842	0.3565
+gp	0.5399	0.548	0.5682	0.3567	0.4528	0.4951	0.3905	0.3774	0.3081	0.3842	
FBAR 2-10	0.5245	0.5381	0.5843	0.5296	0.582	0.5854	0.4865	0.4476	0.3138	0.4117	

Table 9.4.2.3 North Sea plaice: stock numbers at age derived from the final XSA r

Run title : Plaice in IV

At 14/06/2002 15:46

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

	YEA	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
	AGE										
	1	318796	315179	1021863	309561	305362	277218	245491	327458	370424	275456
	2	325180	288458	285186	924619	280102	276303	250837	222130	296294	335102
	3	329695	292192	256879	244056	827253	249505	244319	217955	186707	251647
	4	284203	264194	243963	193923	180687	686691	196936	182356	154230	120261
	5	157481	193636	165878	159169	124874	114515	513934	141915	130678	86139
	6	75892	94876	123496	95485	102478	78112	64253	347436	94560	79541
	7	40290	49048	55599	76462	57718	66691	49702	41836	217335	52198
	8	43334	27837	32159	35261	51720	36530	44958	35135	27952	121614
	9	26835	30615	18689	22825	23768	36540	25440	31070	26002	19289
	10	19213	19281	20999	13124	16646	15355	26663	19285	20321	19547
	11	14870	14124	13771	15382	8056	11888	10997	19473	13893	13842
	12	12626	10926	9364	9544	11248	5536	8823	7789	13092	10477
	13	9766	9269	7873	6661	6523	7750	4089	6503	5339	9115
	14	5646	6933	6400	5679	4367	4358	5773	3122	4721	3737
	+gp	7359	15288	25994	23116	19162	16900	17340	17146	14547	15558
Total		1671185	1631857	2288112	2134867	2019966	1883893	1709555	1620610	1576097	1413523
	1										

	YEA	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
	AGE										
	1	234544	541811	451872	335629	324487	471109	429732	444124	659445	424196
	2	249225	210100	489044	406756	302756	290925	423214	387750	400606	595759
	3	275065	190761	159921	420513	341296	241943	209049	325316	295650	300745
	4	181772	189723	116391	91864	321879	234955	177741	129853	181292	140297
	5	76974	114149	102167	65244	53385	199551	149803	109136	70922	90298
	6	53154	47730	63092	53373	34856	35197	100939	87888	53200	40417
	7	50186	31926	30045	38381	28139	22118	23152	57555	41540	31032
	8	31143	31731	20437	19571	23435	16786	14390	15298	29031	24497
	9	81761	17808	19344	12479	12074	15125	10412	9832	9884	18223
	10	11352	56302	10326	12207	7386	8122	9823	7120	6226	7171
	11	13309	6974	37789	5604	7871	4761	5516	6818	4223	4372
	12	9313	9340	4712	24569	3415	5114	3071	3902	4411	2916
	13	7375	6012	6554	2709	14683	2223	3336	2205	2472	2875
	14	6431	5196	3998	4326	1424	9026	1546	2363	1323	1825
	+gp	14755	13773	10805	12644	9674	7179	11803	8591	5616	5077
Total		1296359	1473337	1526497	1505869	1486759	1564136	1573526	1597752	1765842	1689699

	YEA	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
	AGE										
	1	1024371	589445	607487	527246	1244290	538557	562115	405934	395899	401173
	2	383588	923717	532197	549574	476957	1124288	487306	508622	366105	356750
	3	443060	301638	721957	421384	427310	367717	936326	426525	415744	300319
	4	155794	202084	163510	392418	244007	230914	222428	608773	285173	283183
	5	72151	74816	88609	97013	178904	131560	103126	130552	330713	152452
	6	47703	38027	39769	44536	56847	81520	57441	48243	67799	147222
	7	24762	27253	22132	22990	25512	28561	40728	28107	25344	35895
	8	18982	15187	16844	13876	14266	14239	14949	20896	15381	15199
	9	14469	11972	9753	9968	9084	8637	8754	8408	11715	9907
	10	11853	8828	7967	6238	6453	5620	5767	4914	5591	7318
	11	5151	7200	5185	5222	4176	3912	3427	3628	2837	4016
	12	2913	3582	4475	3448	3746	2658	2557	2214	2401	1886
	13	1849	1958	2082	2962	2102	2358	1775	1427	1404	1739
	14	1844	1126	1219	1451	1988	1136	1630	1125	867	992
	+gp	7108	3430	4949	4121	3874	4643	5279	5324	4314	3670
Total		2215596	2210264	2228134	2102446	2699515	2546318	2453607	2204694	1931288	1721720

	YEA	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	GMST 57-99	AMST 57-99
	AGE													
	1	403247	285412	242906	327156	283668	969979	315197	219964	247211	275903	0	410210	450048
	2	361607	361629	254959	218464	288650	255623	876825	285015	198510	221180	246232	369238	405766
	3	281645	285385	275898	187751	162883	220758	190533	764466	249627	164571	173366	303463	334709
	4	192214	173874	164650	152982	92456	86141	117042	106842	543353	188251	106250	191194	212304
	5	145744	104964	88567	72658	63876	39559	36404	52322	58762	335331	124586	109908	125658
	6	68542	62718	46078	43477	31025	27234	14353	17042	24407	38908	216315	60680	71191
	7	59437	30242	29163	22299	22262	14318	11784	6869	8924	13197	18541	35972	42601
	8	18297	25675	14549	11812	10882	10056	6904	5919	3568	6049	6238	22582	26947
	9	8775	9925	12509	7078	6535	5539	5644	3863	3220	2249	3793	14887	18260
	10	5976	4896	5514	6213	4182	3417	2939	3432	2048	2019	1277	10161	12881
	11	4410	3277	2634	2783	4022	2206	1901	1792	1983	1336	1165	6875	9026
	12	2724	2548	1784	1488	1696	2526	1340	1244	1131	1421	870	4789	6333
	13	1143	1585	1419	1000	940	1049	1440	829	763	650	860	3252	4341
	14	1235	536	728	732	687	603	572	893	531	498	402	2235	3048
	+gp	3092	2142	1559	1194	3030	1956	2258	1733	1704	1511	1237		
Total		1558088	1354810	1142917	1057086	976793	1640964	1585135	1472226	1345743	1253073	901133		

Table 9.6.1 North Sea plaice: summary table derived from the final XSA run

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Run title : Plaice in IV
    At 14/06/2002  15:46
        Table 16    Summary     (without SOP correction)

Terminal Fs derived using XSA (With F shrinkage)
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	RECRUITS Age1	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	FBAR2-10
1957	296163	457371	354623	70563	0.199	0.1973
1958	429983	443677	340635	73354	0.2153	0.2118
1959	433434	457564	345186	79300	0.2297	0.2266
1960	405321	497691	368309	87541	0.2377	0.2469
1961	359379	461922	352876	85984	0.2437	0.2331
1962	318796	564453	446568	87472	0.1959	0.2345
1963	315179	547151	439971	107118	0.2435	0.2645
1964	1021863	624814	422929	110540	0.2614	0.2732
1965	309561	580476	414347	97143	0.2344	0.2761
1966	305362	587956	416378	101834	0.2446	0.2595
1967	277218	590817	492995	108819	0.2207	0.2427
1968	245491	548160	456089	111534	0.2445	0.221
1969	327458	526231	418263	121651	0.2908	0.2539
1970	370424	525781	399555	130342	0.3262	0.333
1971	275456	500463	372329	113944	0.306	0.3156
1972	234544	495110	375773	122843	0.3269	0.341
1973	541811	487952	334689	130429	0.3897	0.3807
1974	451872	467120	308775	112540	0.3645	0.3916
1975	335629	494777	319976	108536	0.3392	0.3658
1976	324487	450400	314437	113670	0.3615	0.3152
1977	471109	478249	329126	119188	0.3621	0.3351
1978	429732	473260	322472	113984	0.3535	0.3292
1979	444124	472177	309162	145347	0.4701	0.4588
1980	659445	484995	294826	139951	0.4747	0.3999
1981	424196	485383	304879	139747	0.4584	0.4029
1982	1024371	556041	297266	154547	0.5199	0.4446
1983	589445	543696	320424	144038	0.4495	0.4244
1984	607487	553363	320866	156147	0.4866	0.3958
1985	527246	540174	352734	159838	0.4531	0.3902
1986	1244290	639897	352695	165347	0.4688	0.4593
1987	538557	619441	380880	153670	0.4035	0.4608
1988	562115	609214	361820	154475	0.4269	0.4394
1989	405934	569537	401080	169818	0.4234	0.4169
1990	395899	533438	372664	156240	0.4193	0.3896
1991	401173	444048	314900	148004	0.47	0.4876
1992	403247	416321	278667	125190	0.4492	0.5245
1993	285412	366360	244831	117113	0.4783	0.5381
1994	242906	300164	205694	110392	0.5367	0.5843
1995	327156	275331	183125	98356	0.5371	0.5296
1996	283668	256034	162533	81673	0.5025	0.582
1997	969979	320489	144440	83048	0.575	0.5854
1998	315197	362313	207727	71534	0.3444	0.4865
1999	219964	367098	213813	80662	0.3773	0.4476
2000	247211	345498	263154	81148	0.3084	0.3138
2001	275903	318730	240637	81847	0.3401	0.4117
Arith. Mean	441671	480914	330558	116144	0.3681	0.3738
0 Units	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)		
1						

Table 9.9.1 North Sea plaice Input to sensitivity analysis

Number at age			Weight in the stock		
N1	412696	0.43	WS1	0.127	0.03
N2	246231	0.68	WS2	0.228	0.09
N3	173366	0.22	WS3	0.259	0.05
N4	106250	0.2	WS4	0.312	0.09
N5	124586	0.16	WS5	0.385	0.14
N6	216315	0.24	WS6	0.453	0.13
N7	18540	0.23	WS7	0.535	0.13
N8	6238	0.26	WS8	0.62	0.09
N9	3793	0.27	WS9	0.692	0.05
N10	1277	0.35	WS10	0.77	0.08
N11	1165	0.39	WS11	0.855	0.09
N12	870	0.4	WS12	0.909	0.11
N13	859	0.35	WS13	0.92	0.13
N14	401	0.45	WS14	0.956	0.17
N15	1237	0.42	WS15	1.016	0.1

H. cons selectivity			Weight in the HC catch		
sH1	0.01	0.67	WH1	0.231	0.13
sH2	0.093	0.61	WH2	0.269	0.04
sH3	0.267	0.23	WH3	0.295	0.04
sH4	0.419	0.23	WH4	0.337	0.08
sH5	0.461	0.31	WH5	0.407	0.12
sH6	0.598	0.15	WH6	0.479	0.13
sH7	0.524	0.26	WH7	0.564	0.11
sH8	0.434	0.14	WH8	0.644	0.06
sH9	0.48	0.03	WH9	0.728	0.03
sH10	0.43	0.04	WH10	0.793	0.09
sH11	0.323	0.04	WH11	0.871	0.08
sH12	0.437	0.28	WH12	0.917	0.1
sH13	0.37	0.15	WH13	0.931	0.08
sH14	0.375	0.08	WH14	0.939	0.08
sH15	0.375	0.08	WH15	1.023	0.12

Natural mortality			Proportion mature		
M1	0.1	0.1	MT1	0	0.1
M2	0.1	0.1	MT2	0.5	0.1
M3	0.1	0.1	MT3	0.5	0.1
M4	0.1	0.1	MT4	1	0.1
M5	0.1	0.1	MT5	1	0
M6	0.1	0.1	MT6	1	0
M7	0.1	0.1	MT7	1	0
M8	0.1	0.1	MT8	1	0
M9	0.1	0.1	MT9	1	0
M10	0.1	0.1	MT10	1	0
M11	0.1	0.1	MT11	1	0
M12	0.1	0.1	MT12	1	0
M13	0.1	0.1	MT13	1	0
M14	0.1	0.1	MT14	1	0
M15	0.1	0.1	MT15	1	0

Recruitment in 2003 & 2004		
R03	412697	0.43
R04	412697	0.43

Relative effort in HC fishery		
HF02	1	0.18
HF03	1	0.18
HF04	1	0.18

Year effect for natural mortality		
K02	1	0.1
K03	1	0.1
K04	1	0.1

Figure 9.2.1 North Sea plaice: Relative age composition of the catches and percentage of the total landings in weight (legend) by country in 2000 and 2001.

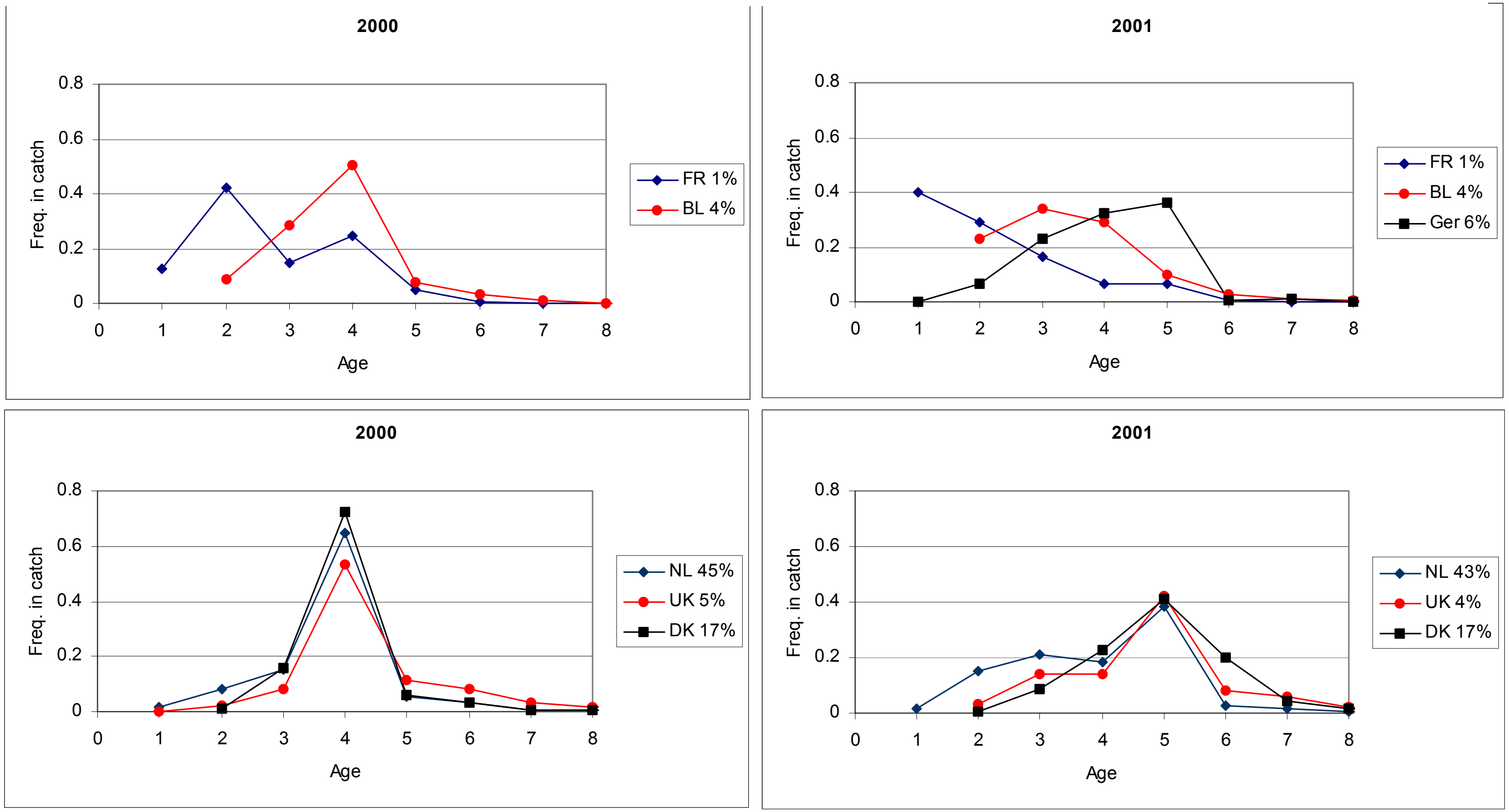
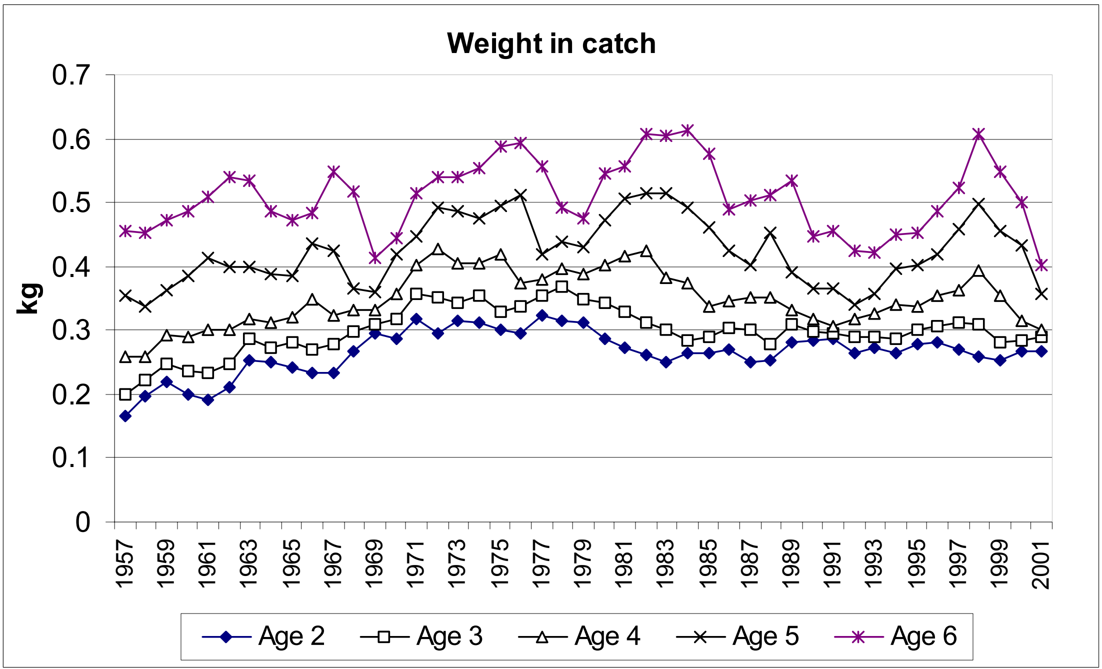


Figure 9.2.2 North Sea plaice: mean weights in the catch.



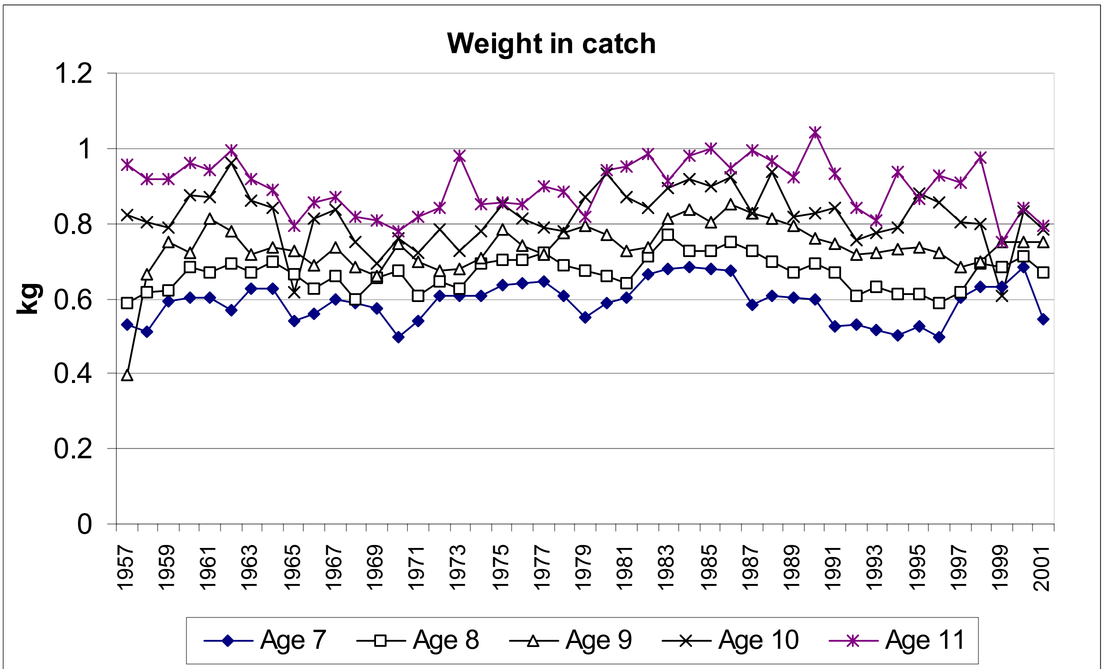


Figure 9.2.3 North Sea plaice: mean weights in the catch by age for 2000 and 2001

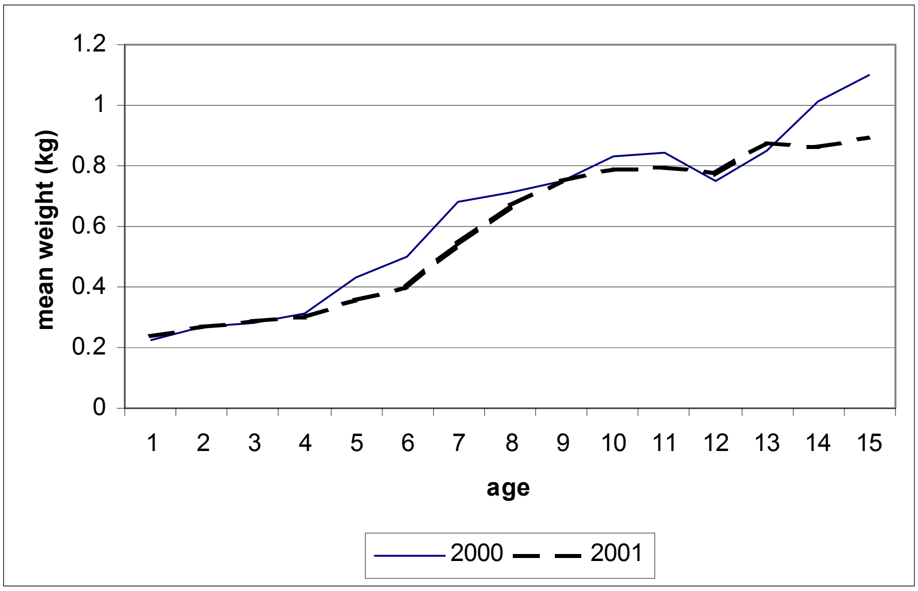


Figure 9.2.4. North Sea plaice: comparison of catch numbers by sex and by country between 2000-2001.

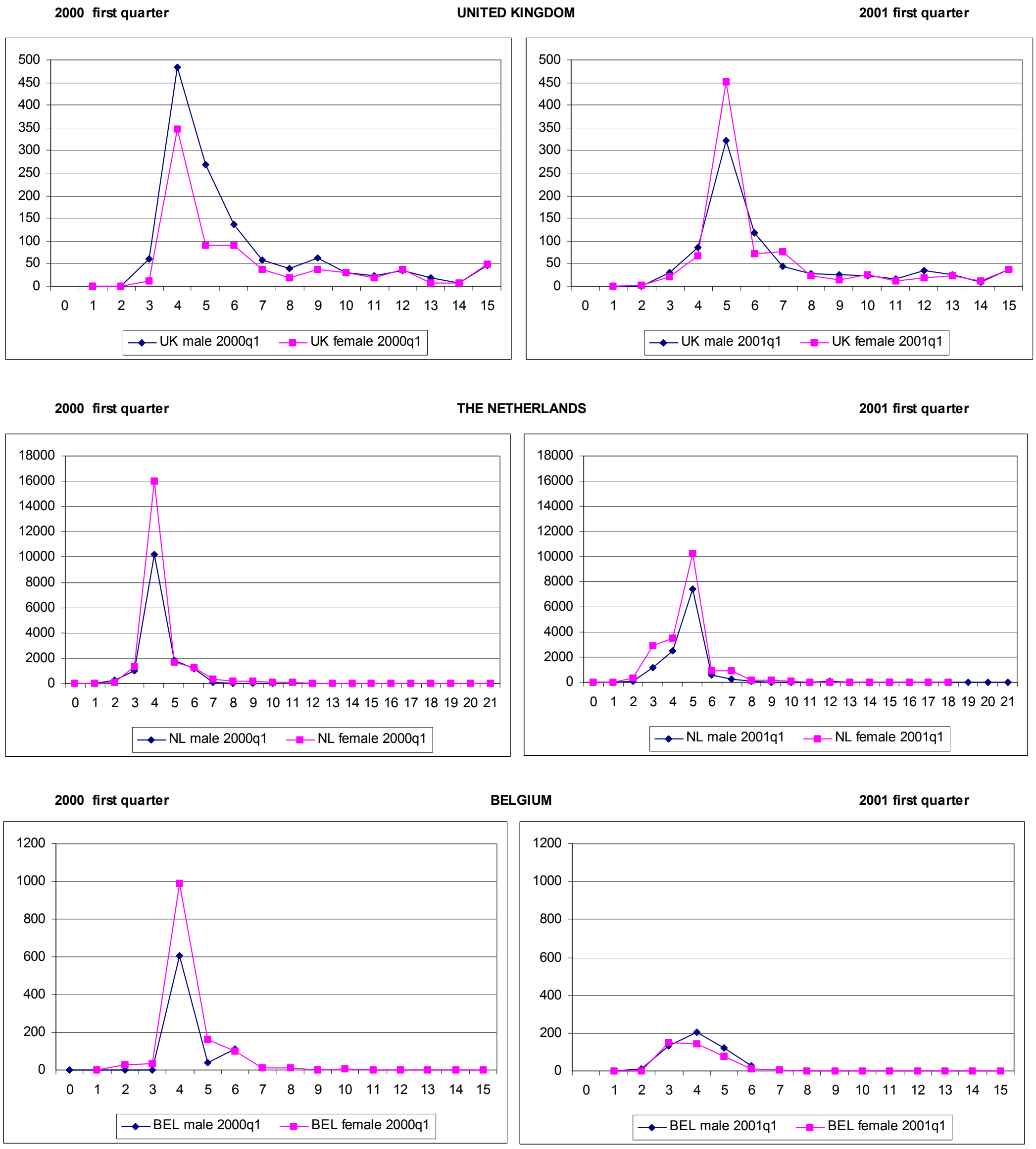
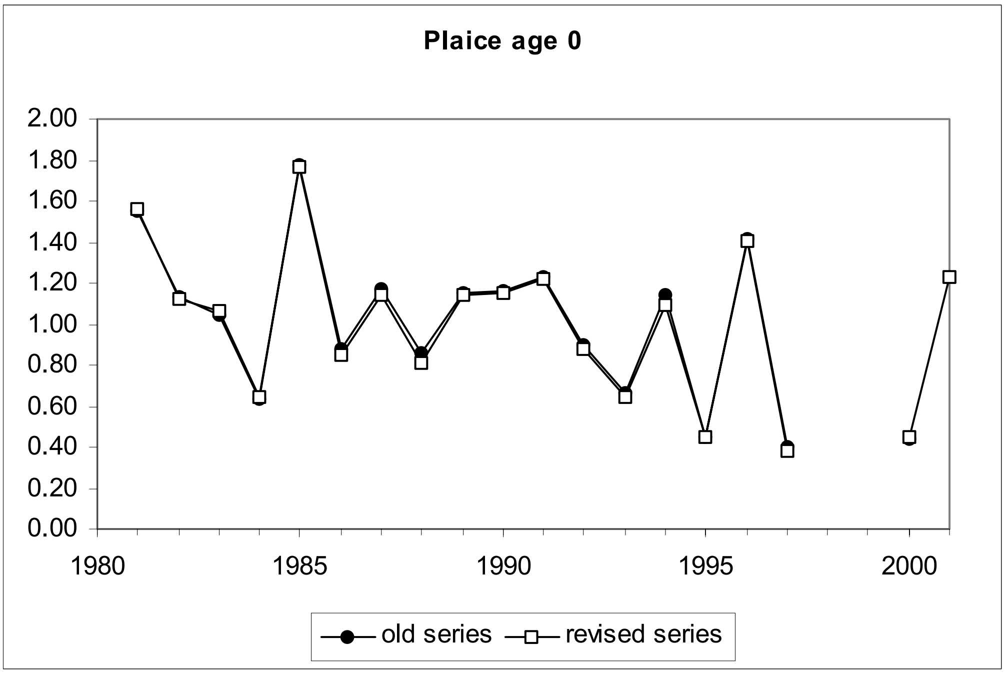


Figure 9.3.1 North Sea plaice: Comparison of the international DFS indices before and after revision of the UK series



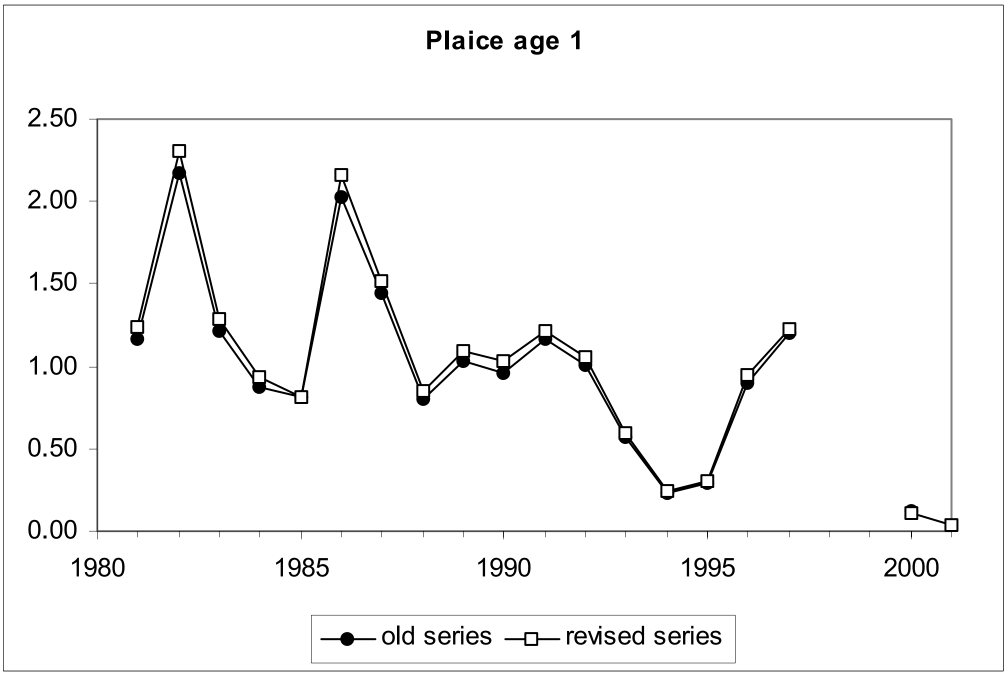
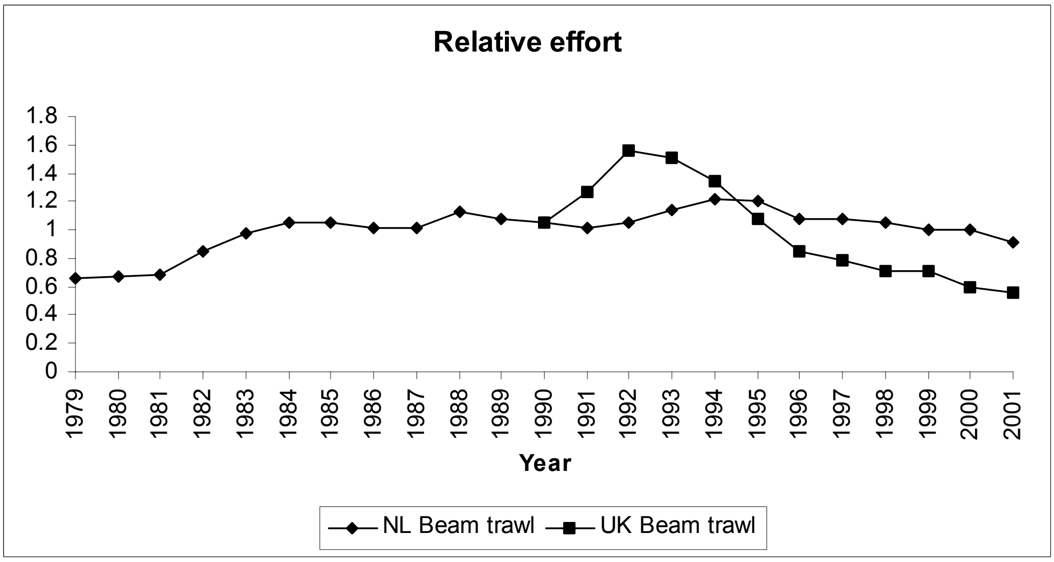


Figure 9.3.2 North Sea plaice: relative effort and cpue (scaled to the average for each fleet).

igure 9.3.2 No a plaice: relative effort and CPUE (scaled to the average for each fleet)



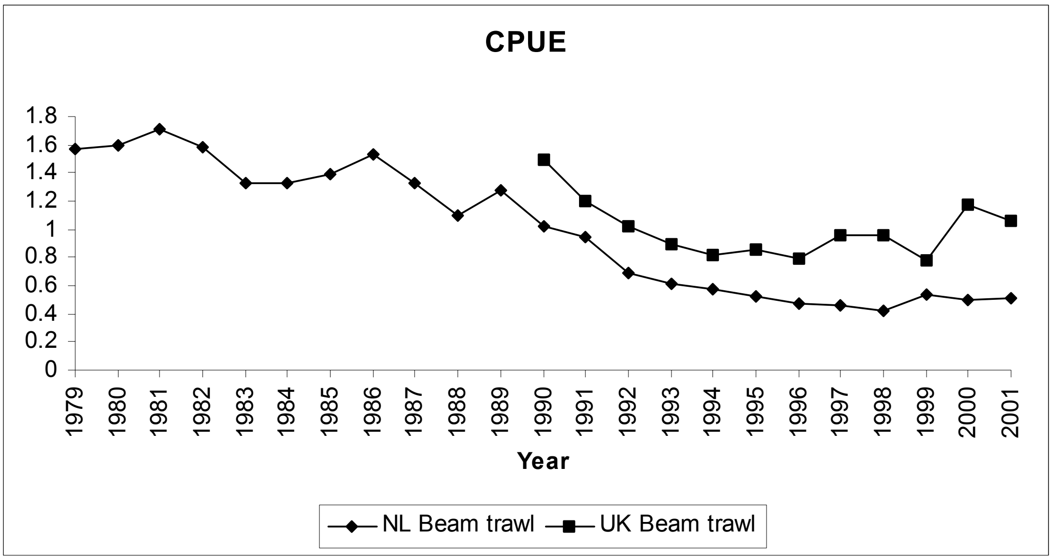
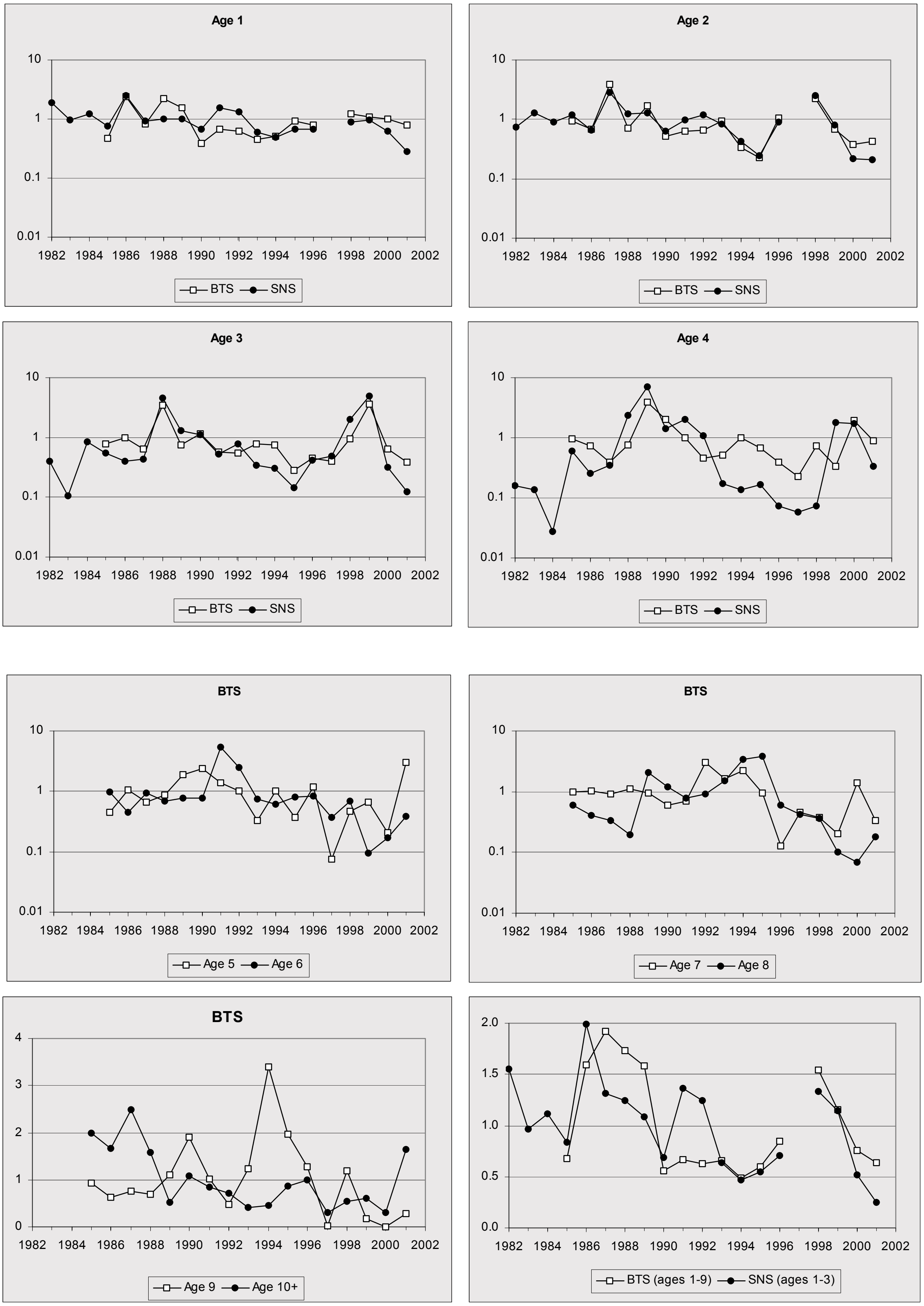


Figure 9.3.3 North Sea plaice: Survey indices by age and combined, scaled to average for each fleet



(NO LOG SCALE) (NO LOG SCALE)

Figure 9.4.1.1 North Sea plaice: Log-catchability residuals derived from single-fleet XSA (shrinkage 1.5).

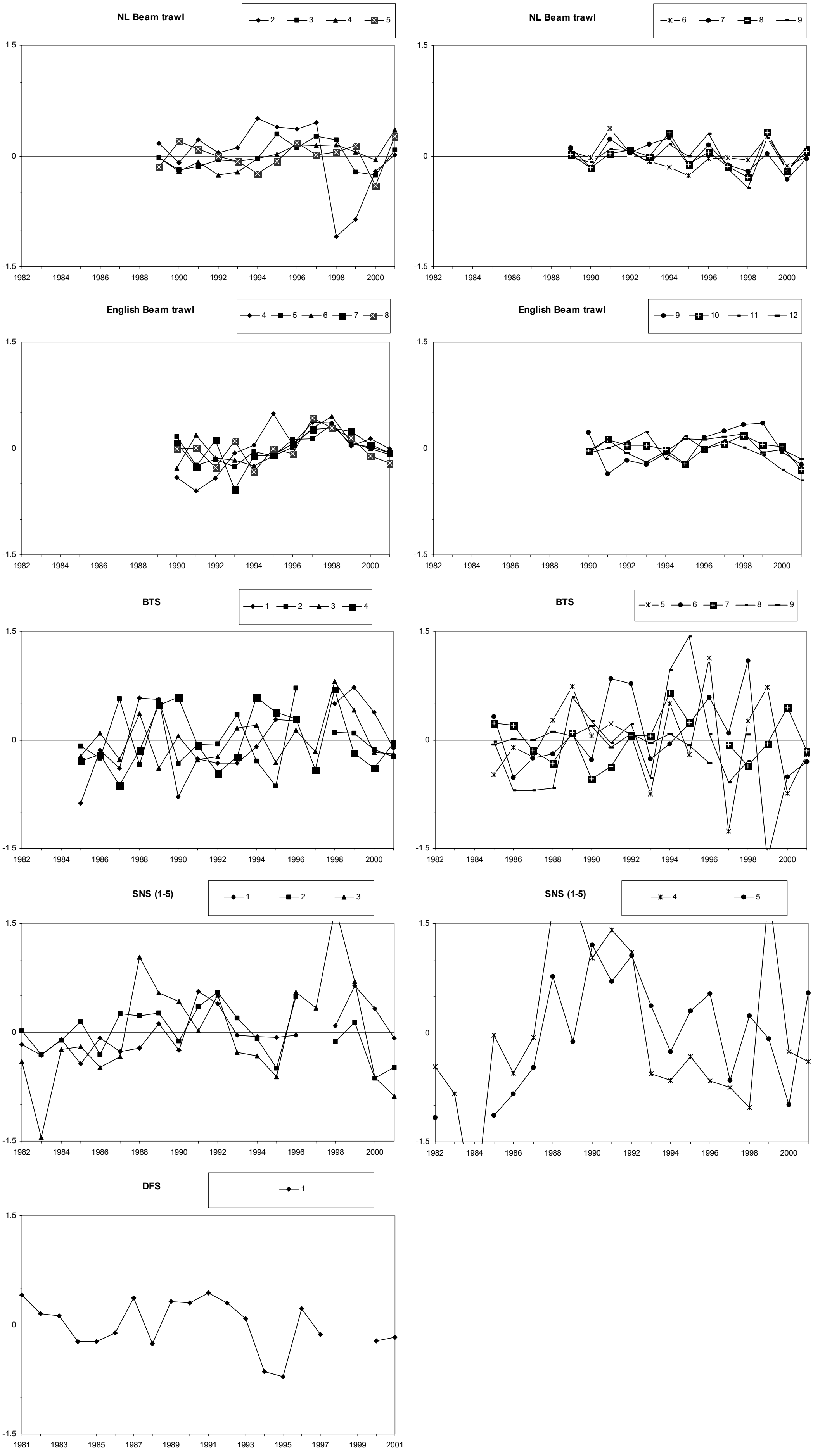


Figure 9.4.1.2 North Sea plaice: SSB, F_{2-10}, and recruitment estimated by single-fleet and combined fleet XSAs. Single-fleet runs 1a-f and final run. Combined fleet runs 2-4 and ACFM final run

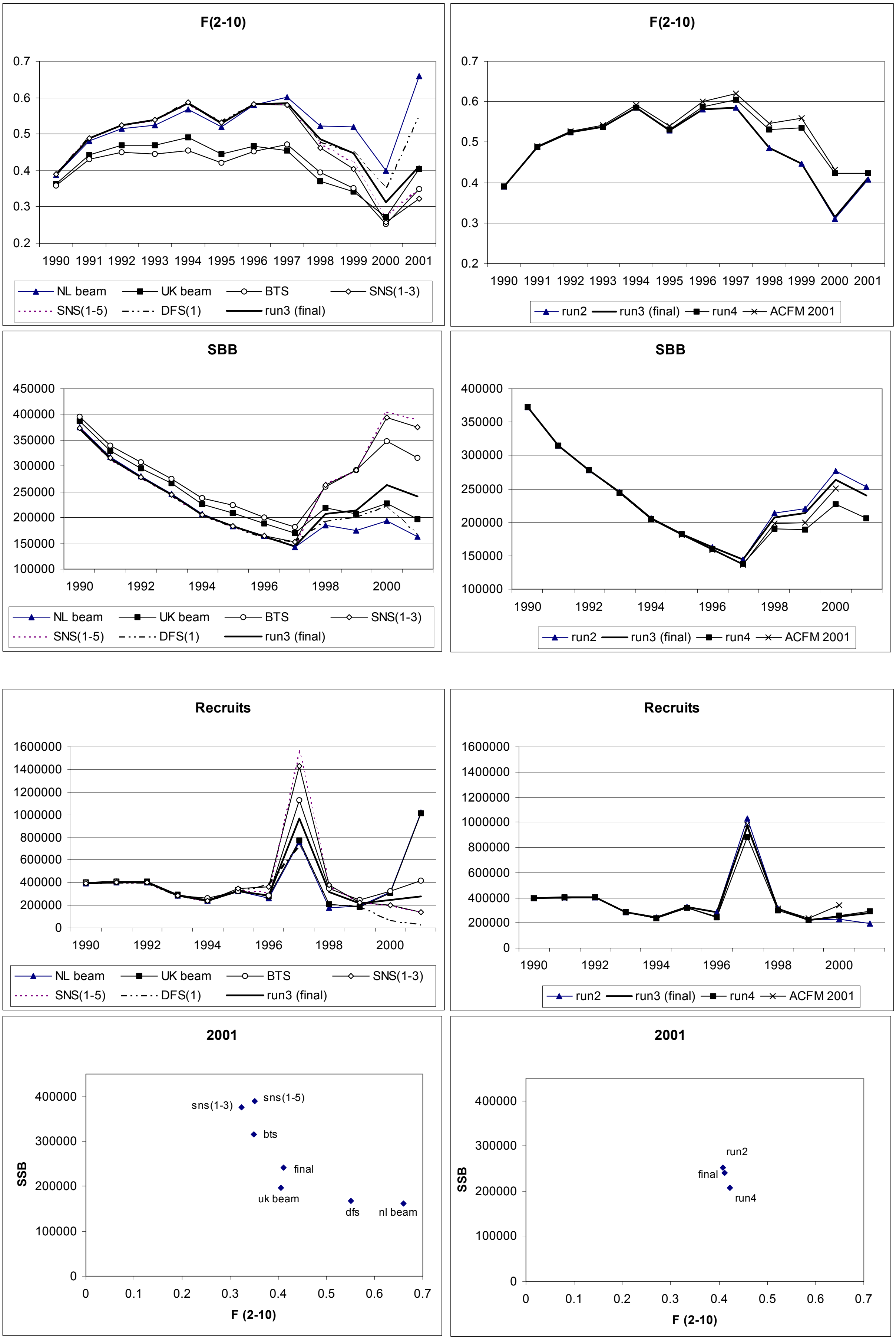


Figure 9.4.2.1 North Sea plaice: Log catchability residuals of final XSA run.

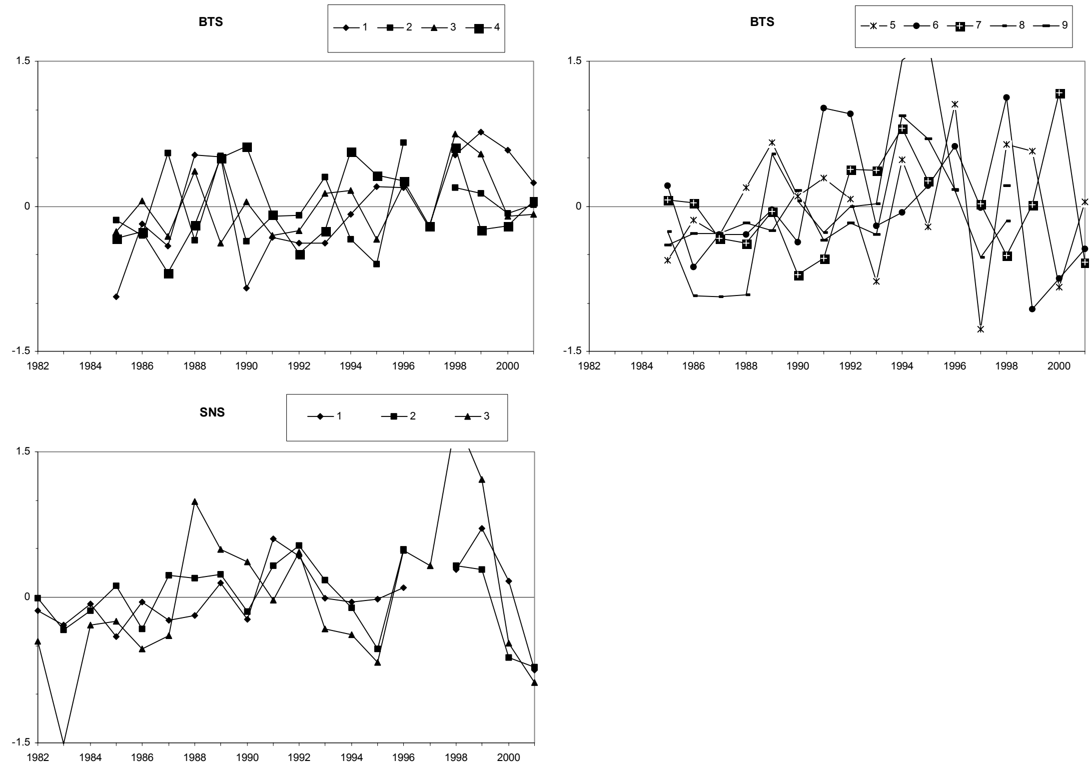
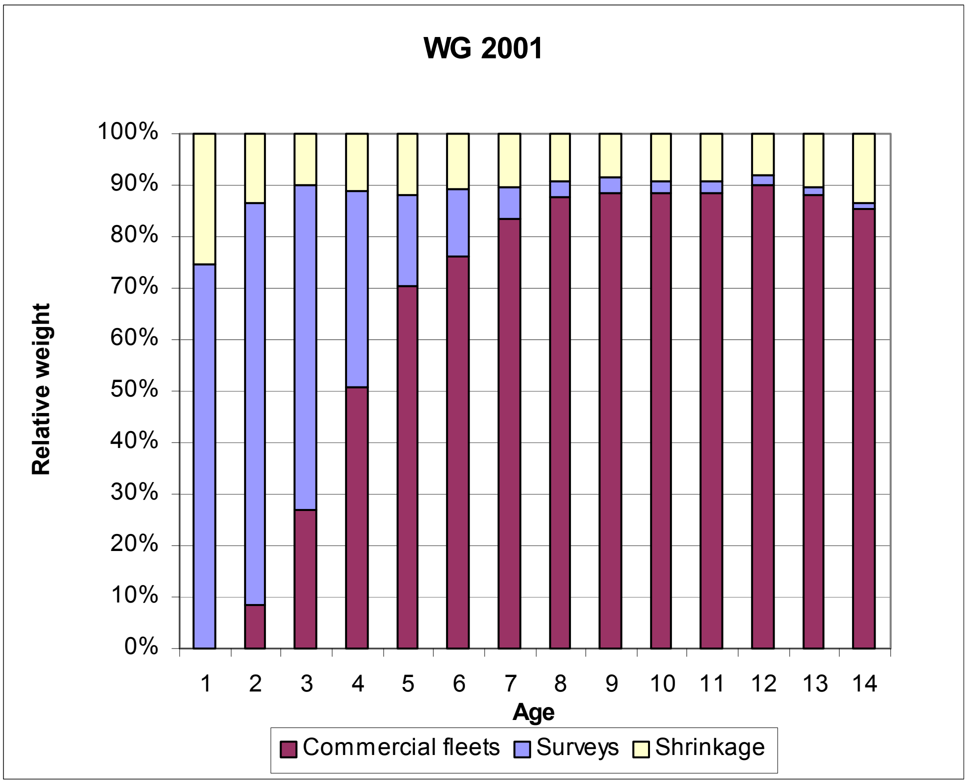


Figure 9.4.2.2 North Sea Plaice: weighting of tuning fleets



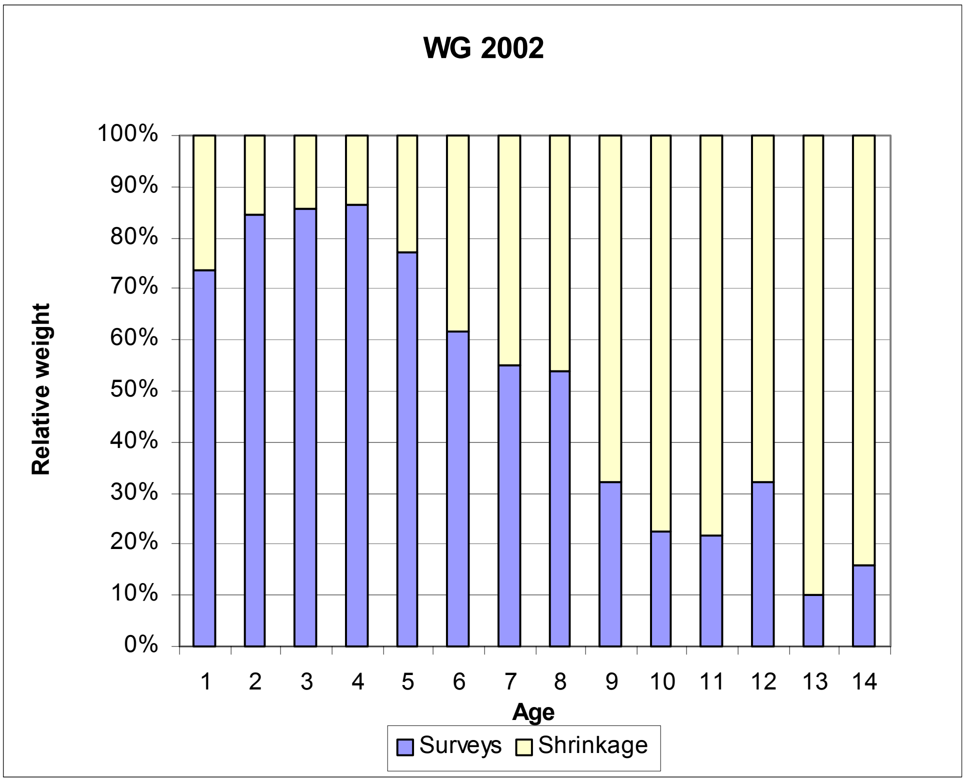


Figure 9.4.2.3 North Sea plaice: Retrospective analysis (F shrinkage=0.5).

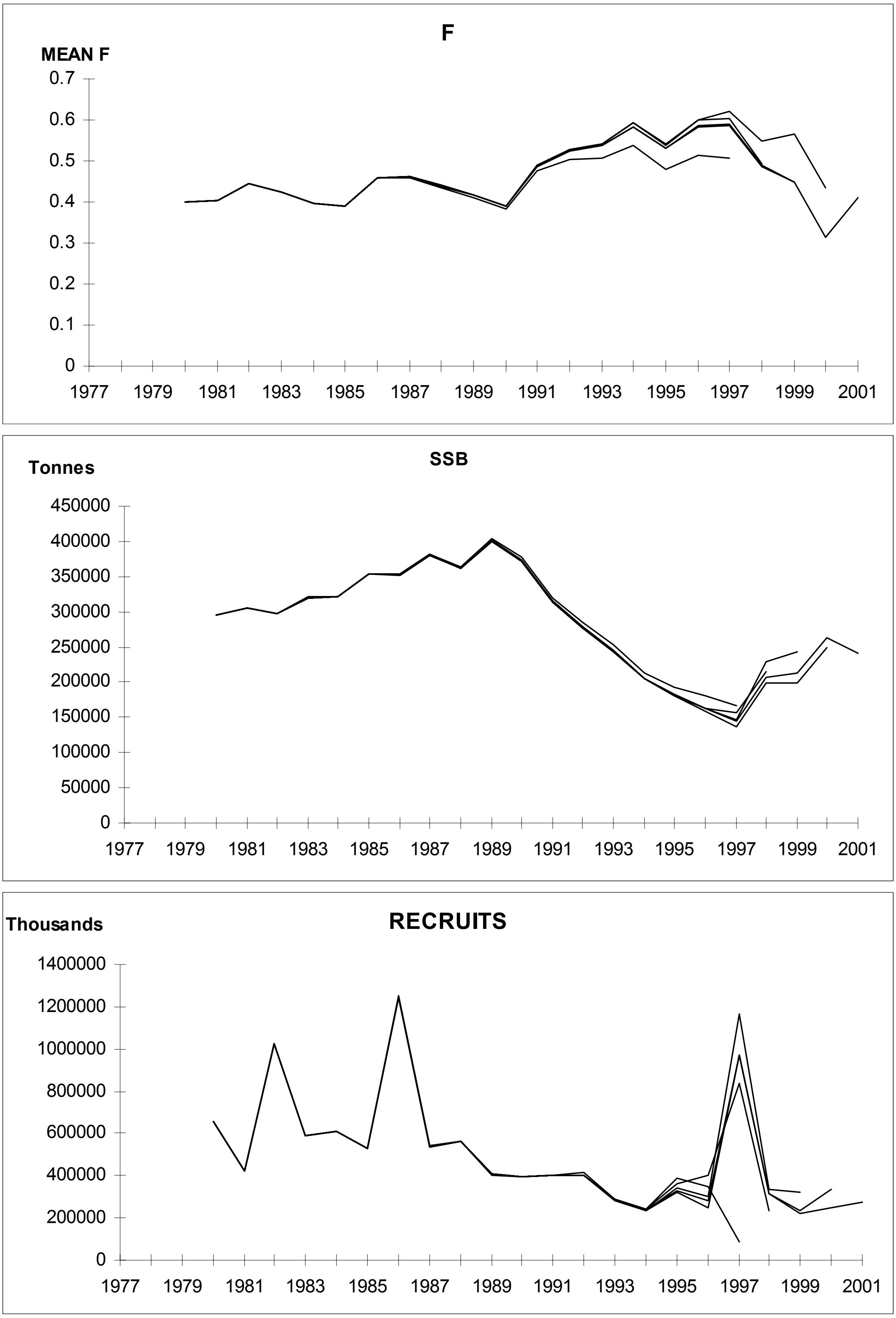


Figure 9.6.1 North Sea Plaice: Overview of the final assessment

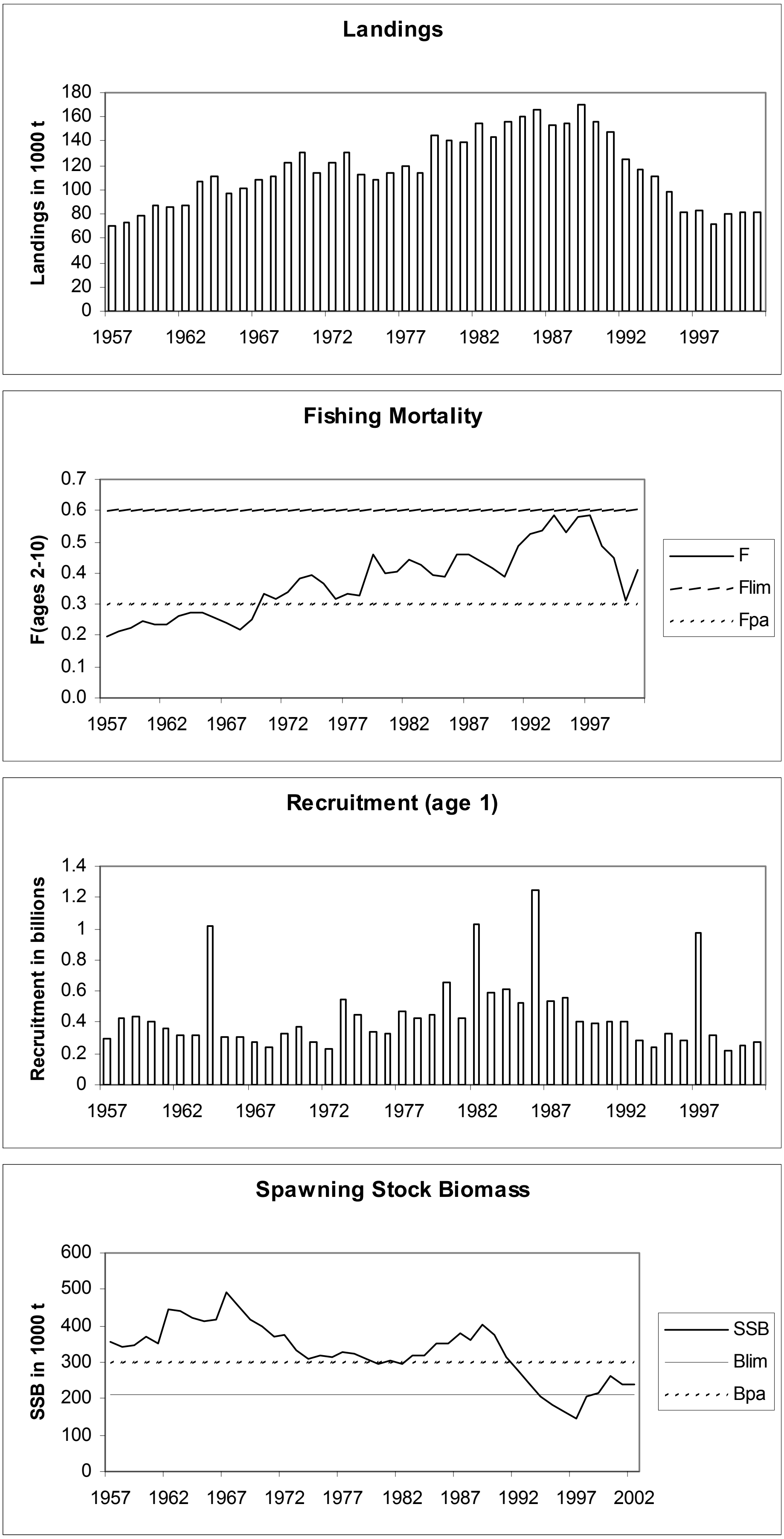
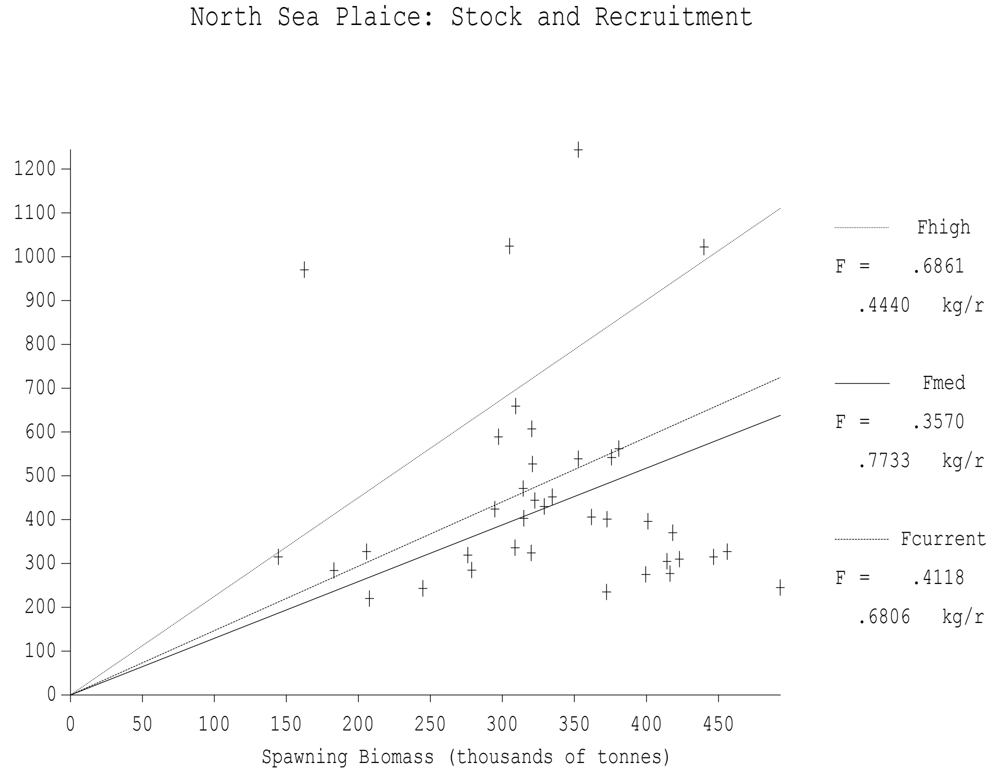


Figure 9.9.1 North Sea Plaice: Stock recruitment



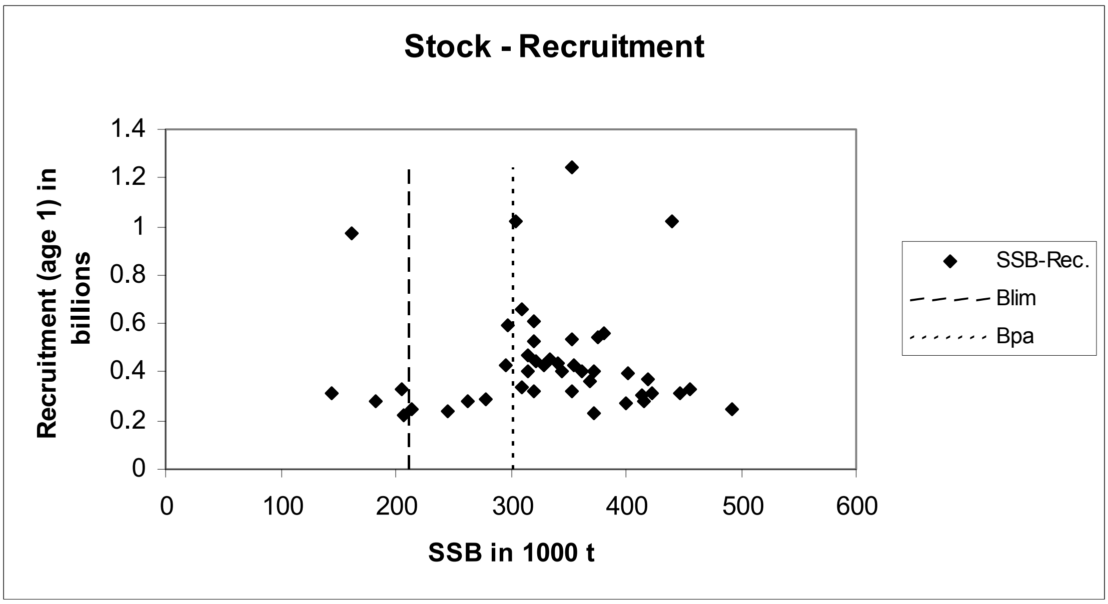


Figure 9.9.2 North Sea Plaice: Yield-per-recruit

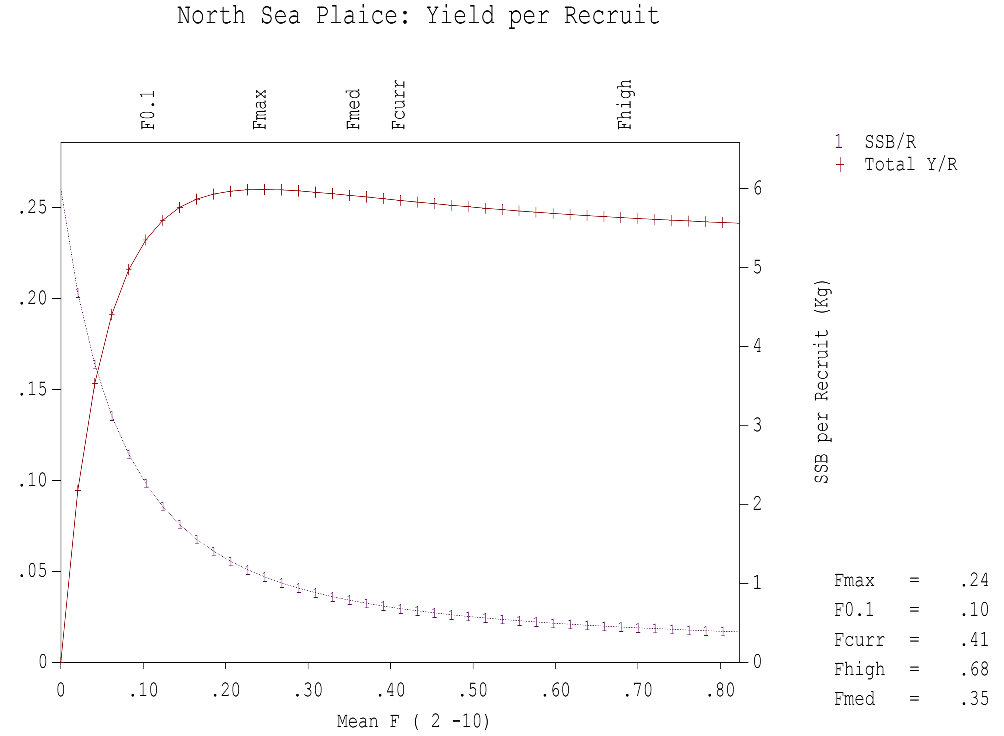


Figure 9.9.3 North Sea Plaice: Precautionary approach plot

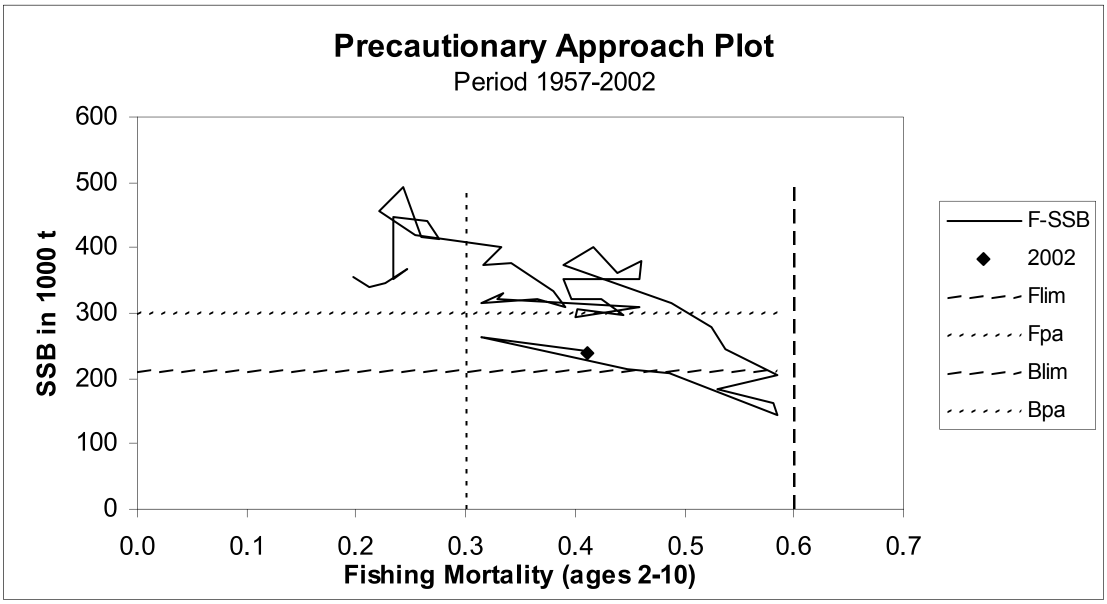
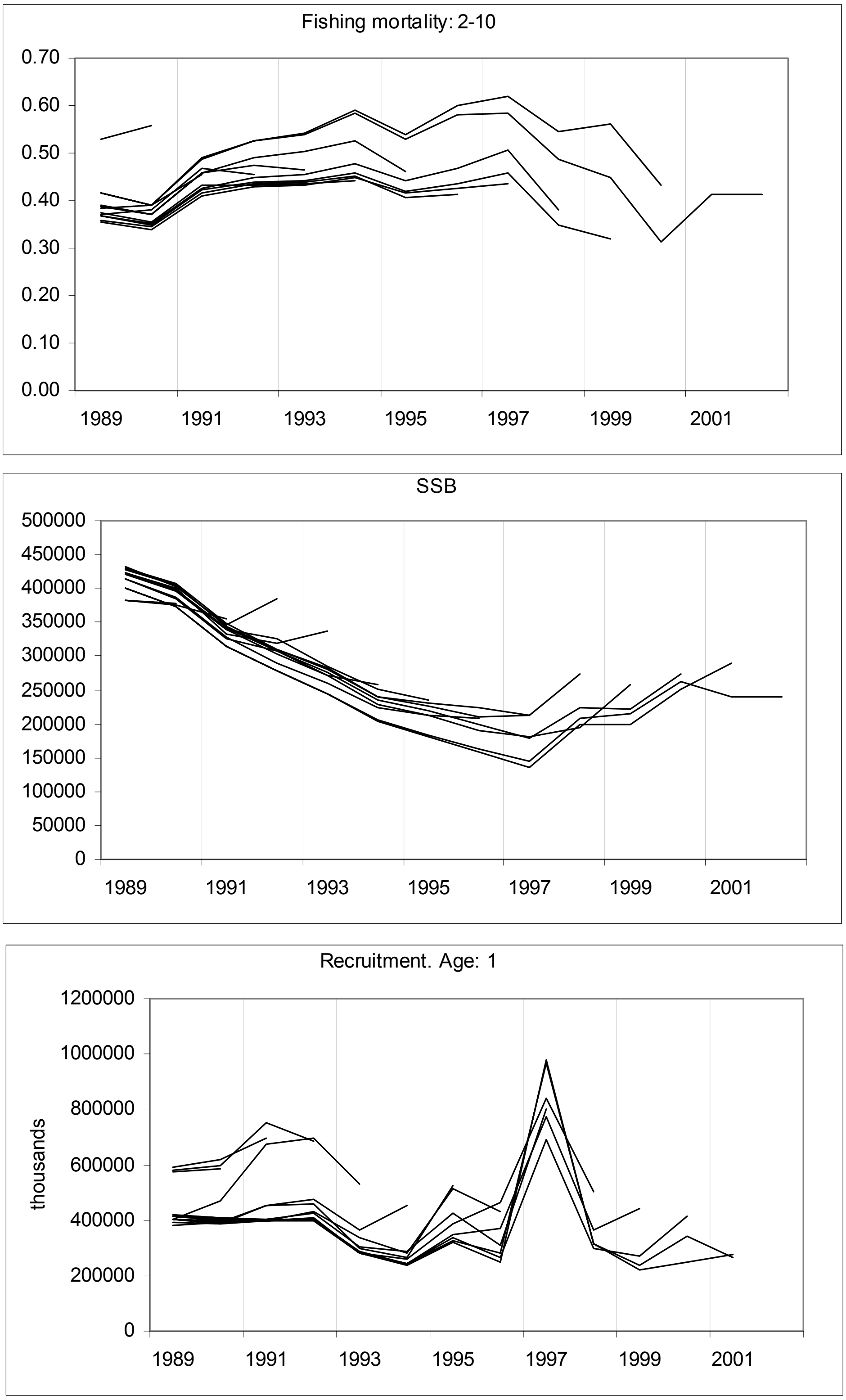


Figure 9.10.1 Plaice in IV. Quality control of assessments generated by successive working groups.



10 PLAICE IN DIVISION IIIA

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 for otter trawlers and gillnetters, often within a mixed cod-plaice fishery.

10.1.1 ACFM advice applicable to 2001 and 2002

ACFM recommended for 2001 to reduce or maintain fishing mortality below the proposed $\mathbf{F}_{pa}$ ($\mathbf{F}_{pa} = 0.73$), corresponding to landings in 2001 of less than 9 400 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 $\mathbf{B}_{lim}$ were defined.

In its October 2001 meeting, ACFM recommended landings in 2002 being less than 8 500 t.

This advice has been contested by the fishing industry that found that recruitment has been better in recent years than reflected by the assessment. Furthermore the industry noted that catches and cpue have increased since 2000, while the effort had remained at a constant level. As a result the European Commission (December 2001 Fisheries Council) accepted a commitment to seek additional advice from ICES regarding TACs for 2002 on this particular stock.

Additional analyses have been performed in February and March 2001, both by the Danish Institute of Fisheries Research (DIFRES), and by the ICES secretariat (OD1. and OD2., this report). ACFM concluded that the TAC 2002 could be increased by up to 32% without increased risks for the stock.

10.1.2 Management applicable to 2001 and 2002

The use of any 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.

The 2001 TAC was 11 750 tonnes (9 400t in Skagerrak and 2 350t in Kattegat), which was lower than the constant TAC of 14 000 tonnes applied since 1992. Because of cod by-catch considerations, the 2002 TAC was initially set at 8 000 tonnes (6 400t in Skagerrak and 1 600t in Kattegat). At the time of the Working Group meeting, the revised ACFM advice had been provided to the Commission, but no decision concerning the increase of the TAC had been taken yet.

10.1.3 Catches in 2001

Plaice landings in 2001 were the highest observed since 1993 (11 560 t). The landings have matched the TAC for the first time since TACs were set in 1987. The official landings reported to ICES are given in Table 10.1.1. The annual landings used by the Working Group, available since 1972, are given by country for Kattegat and Skagerrak separately in Table 10.1.2 and 10.1.3. At the beginning of this period, landings were mostly taken in Kattegat, but from the mid-1970s, the major proportion of the landings have been taken in Skagerrak. In 2001, around 80% of the landings were taken in Skagerrak.

The total landings have been estimated for 2001 according to ICES official tables (Belgian, Norwegian, and German landings) and national statistics (Danish and Swedish landings). Minor revisions for Norwegian catch data for 1997-99 were reported to ICES in 2002.

No quantitative information on mis-reporting is available, but it is not suspected to be major in this fishery.

Some discard estimates in the Skagerrak (Danish seiners 1999-2000, Danish otter trawlers 1999-2001, Danish *Nephrops* trawlers 2000-2001, Danish beam trawlers 2000, Swedish otter and *Nephrops* trawlers 2001) were available from the report of the Study Group on Discards and By-Catch Information (ICES CM 2002/ACFM:9). These 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. Discard estimates cannot be included in the assessment.

10.2 Natural Mortality, Maturity, Age Compositions, and Mean Weight-at-age

Catch-at-age and mean weight-at-age information were provided by Denmark only and are available for the period 1978-2001. The sampling scheme was 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. The catch numbers-at-age and the mean catch weight-at-age are presented in Figures 10.2.1 and 10.2.2, and in Tables 10.2.1 and 10.2.2.

The distribution of catches-at-age in 2001 differs from what has been observed during the last decade. The fishery exploits traditionally three age classes (ages 4 to 6). In 2001 the catches of these three age classes were comparable to those in 2000, but the fishery also caught larger amounts of fish aged 2 and 3 (Figure 10.2.1).

Mean catch weights-at-age of Kattegat plaice have remained stable over years for all age groups (Figure 10.2.2). By contrast, decreasing trends in weights-at-age have been observed in the Skagerrak for age groups 8-11+ since 1984, with a historical minimum reached in 1997. However, the low values perceived in year 1997 for plaice aged 8+ could be due to the low number of large fish being sampled in the most recent years. The variability of growth for plaice is observed to be higher in the Kattegat and Skagerrak than in the North Sea (U. Nielsen, pers. comm..).

Weights-at-age in the stock were assumed equal to those of the catch.

A natural mortality of 0.1 per year was assumed for all years and ages. A knife-edge maturity distribution was employed: age group 2 was assumed to be immature, whereas age 3 and older plaice were assumed mature. Analysis of maturity ogives is discussed in Working Document 6 and Section 1.13.1.

10.3 Catch, Effort, and Research Vessel Data

Three Danish fleets, i.e., trawlers, gillnetters, and Danish seiners, are available for tuning. The age-disaggregated indices were derived by merging logbook statistics supplying catch weight per market category with the age distribution within these categories available from the market sampling. Fishing effort has been defined as standardised days fishing. The standardisation of effort by vessel length is obtained by modelling log-cpue using a GLM approach, with (log-) vessel length (continuous variable), year (discrete variable), and quarter (discrete variable) taken as external factors. A 15-m vessel is used as the reference fishing unit. This procedure explicitly splits some important sources of variability that underlie cpue dynamics, and is therefore preferred to simple linear regression of log-cpue versus log-length.

The trends in fishing effort and cpue of the tuning fleets are presented in Figure 10.3.1. 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. But change in effort is more to be due to an extension of the database. All commercial fleets show increase in both the yield and the cpue in 2001. Highest values and increases are observed for the Danish seiners. The tuning fleet data are provided in Table 10.3.1.

Data from four surveys were available this year. IBTS survey data for Kattegat and Skagerrak for the first quarter were provided by Sweden for the period 1992–2002, as numbers-per-age and hour on a haul-by-haul basis.

Two Danish bottom trawl surveys are also available. They are conducted by the vessel ‘Havfisken’ in Kattegat, Belt sea, and Western Baltic in the first and fourth quarter of each year. They were made available to the WG for the first time last year, but were not used in assessment because of the short time-series. Since last year, inter-sessional work has been conducted on the earlier years of the ‘Havfisken’ survey data to address problems associated with exclusion of hauls in which no plaice were caught, and with the use of ALKs from areas outside of IIIa. Furthermore, through the use of commercial ALKs from IIIa applied to survey length compositions, it has also been possible to extend the series of indices by one and two years (first and fourth quarter survey, respectively). Since the last WG assessment was conducted, the two ‘Havfisken’ surveys have been both revised and extended. The new indices available thus cover the period 1996-2002 for the first quarter survey (except 1998), and 1994-2001 for the fourth quarter survey.

The IBTS survey in the third quarter has been made available by Sweden to the WG for the first time this year. It covers the years 1995 to 2001, but no survey was performed in 2000. The survey indices of the IBTS and ‘Havfisken’ surveys first quarter were 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. Despite the short time-series, all surveys converge in showing that the latest year classes (1997 to 1999) are the highest of their time-series (Figure 10.3.2).

10.4 Catch-at-Age Analysis

10.4.1 Data exploration

The catch information in the age groups used in the VPA were restricted to ages 2–11+, as age 1 plaice account for less than 1% of the total catch number. International catches-at-age were preliminarily examined using separable VPA, with a reference age of 6, terminal F = 1.1 (corresponding to the mean 97-99 F at age 6 estimated in last year's assessment), and terminal selectivity set to unity (Table 10.4.1). Large residuals in log-catch ratios were detected for some ages and some years, but without consistent trends. In particular, no evidence could be seen for decreasing the age of the plus-group, in spite of the low amount of catches of ages 8 and over.

As an initial exploration of the fleet data available for tuning, XSA runs with low shrinkage (1.5) were made using each fleet individually. Diagnostics from these runs, in particular the log-catchability residuals, were investigated to determine whether the fleets were appropriate for inclusion in the final XSA run (Figure 10.4.1).

High residuals were observed for age 2 caught by commercial fleets. Residuals are low for young ages in the surveys, but are more variable for ages older than 4. The three new surveys appear to contain reasonable information. No significant trends were observed for the seven fleets available. The whole age-range was thus kept for each of these fleets. The level of estimated F and SSB differs widely between fleets (Figure 10.4.2). The commercial fleets show close estimates of relatively low SSB and low F, whereas the surveys tend to higher levels of both F and SSB.

Various combined-fleet XSA runs have been performed. They all use the same XSA settings as last year (no power model applied on young ages, and tricubic taper weighting on twenty years applied on tuning fleets, shrinkage 0.5).

Run 1 used the whole age-range and cpue time-series of the three commercial and the four survey fleets.

Run 2 used the same configuration as last year (three commercial fleets with all ages, and IBTS first quarter ages 4 to 6 only). The level of fishing mortality it outputs is unchanged compared to Run 1, but the SSB is estimated much lower. The difference arises mostly from the age 3 estimates (1998 year class). This year class is estimated to be very high by all the survey indices, but this age class is usually incompletely recruited in the fishery, and might be underestimated by the commercial tuning fleets. Furthermore, the commercial fleets used for the tuning account for the major part of the landings, and are thus not completely independent of the catch-at-age matrix. To investigate the influence of these issues, two additional runs have been performed.

Run 3 uses commercial data only. Results are very close to Run 2. The level of SSB estimated is comparable to the commercial single-fleet estimates, but the level of F is higher, because of a high weight of the shrinkage on old ages.

Finally, Run 4 uses the four surveys only, and outputs high levels of both SSB and F. However, in spite of the advantage of using only independent information for the tuning, this run has not been kept as the final run, for two reasons. First, the surveys themselves show differences in results, even if they converge on the general trends. Second, the Danish surveys cover only the Kattegat. The final run used in the assessment is thus Run 1.

10.4.2 Final assessment

The configuration of the final XSA assessment was similar to last year concerning the XSA settings, but differed concerning the tuning fleets. Parameters are given below (changes compared to last year are highlighted).

year of assessment	**2001**	**2002**
Assessment model	XSA	XSA
DK gillnet	1987-2000 2-10	1987-2001 2-10
DK trawlers	1987-2000 2-10	1987-2001 2-10
DK seiners	1987-2000 2-10	1987-2001 2-10
* IBTS Q1	1992-2001 5-7	1992-2002 **1-7**
IBTS Q3	not used	**1995-2001 1-6**
* Havfisken Q1	not used	**1996-2002 1-6**
Havfisken Q4	not used	**1994-2001 1-6**
Time series weights	Tricubic over 20 yrs	Tricubic over 20 yrs
Power model used for catchability	not used	not used
Catchability plateau age	8	8
Surv. est. shrunk towards mean F	5 years / 5 ages	5 years / 5 ages
s.e. of the means	0.5	0.5
Min. stand. error for pop. estimates	0.3	0.3
Prior weighting	none	none
Number of iterations	24	25
Convergence	yes	yes

* surveys indices backshifted in the assessment

Plots of the log-catchability residuals are shown in Figure 10.4.3. The observed change in catchability for the Danish seiners at old ages after 1997 could not really be explained. This will be investigated before the next Working Group meeting. Figure 10.4.4 shows the weighting in tuning fleets and shrinkage, as derived from the assessment. Overall, the weight of shrinkage is low for the most exploited ages. The surveys account for 74% of the estimation for the recruiting age, and for around 50% of the ages 3 to 5 estimates. The relationship between logcpue and log-abundance for the various tuning fleets is shown in Figure 10.4.5.

Retrospective VPA runs are carried only to 1999, because of the short survey time-series (Figure 10.4.6). The pattern is still very variable, as in all previous assessments. The addition of the new surveys significantly improved the retrospective pattern for the recruitment. Differences in final SSB estimates between one assessment year and the next is less than 10%. But the retrospective pattern for the fishing mortality estimate remains worrying. Similar patterns are observed for all preliminary run configurations. Additional trials have been conducted, to investigate whether changing the plus group age range in the catch-at-age matrix, or the age range of the reference F would improve the retrospective pattern, but these only lead to minor changes. The reasons for such variability are difficult to assess. The hypothesis of old fish migrating into the North Sea is not supported by tagging experiments. It seems that the selection pattern up to age 7 is relatively constant from one year to another, but that the year effect is highly variable.

The VPA results are given in Tables 10.4.2-10.4.5. The fishing mortality (age 4–8) estimated for 2001 is 0.86, which is above $\mathbf{F}_{pa}$ (0.73). The fishing mortality increases up to age 8. Total and spawning stock biomass in 2001 are estimated to be significantly higher than in 2000 (95 000 t and 55 000 t, respectively). The current XSA run has revised the estimate of F in 2000 from 0.82 to 1.29. This change appears to be the result of the 2001 catch data, all exploratory runs resulted in inflated estimates of F in 2000. The general perception of the stock in 2002 is that the increase of catches at young ages is not related to a drastic change in the exploitation pattern, but to the arrival in the fishery of one year class above average (1997) and two very strong year classes (1998-1999). The year classes 1997 and 1998 already participated in the spawning stock biomass in 2001. The fishing mortality is still high, but it is mostly directed at the mature stock, rather than at young fish.

10.5 Recruitment Estimates

The abundance indices from the IBTS and Danish surveys in Kattegat and Skagerrak are given in Table 10.3.1. The four time-series indicate that the year classes 1998 and 1999 are the highest in the time-series. These surveys participate already significantly in the XSA estimates for these year classes, and the influence of shrinkage is low. Further trials of estimating young ages were conducted with RCT3 software, and using the additional information provided by survey indices at age 1. However, to estimate recent year-class strengths with RCT3, recent points are removed from the calibration. Consequently the time-series are relatively short. The RCT3 results have not been considered relevant, and they are not presented here. The recruitment in 2002 is thus set at the 1978-1999 geometric mean (46 millions).

10.6 Historical Trends

The historical trends in the fisheries are presented in Tables 10.1.1 and 10.4.5 and in Figure 10.6.1.

Since 1978, landings have declined from 27 000 to 9 000 tonnes in the late nineties. Landings in 2001 were the highest since 1992. The fishing mortality has consistently remained at a high level of 0.6-1.2 over the period of assessment, with extreme values observed in 1988, 1997, 1999, and 2000. SSB and recruitment have fluctuated around a mean since 1980, and have increased since 2000. SSB and recruitment estimated in 2001 are among the highest of the time period.

10.7 Short-Term Forecast

The inputs used for the predictions are given in Table 10.7.1. Stock sizes for age 3 and older are taken from the estimated number of survivors from the XSA. The age 2 recruitments in 2002, 2003, and 2004 (year classes 2000-2002) are taken as the geometric average over the 1978–1999 period (46 millions). The mean weights-at-age are taken as the average for the years 1999–2001. The exploitation pattern is calculated as the average F over 1999-2001, and then rescaled to the 2001 value of F(4-8) = 0.86.

The *status quo* predictions result in catches of 14 200 and 20 800 tonnes in 2002 and 2003, respectively (Table 10.7.2). These values are very different from those derived last year. The estimate of SSB over 2002-2004, at *status quo* F, remains over 60 000 tonnes. The short-term yield and SSB are shown in Figure 10.7.1.

The sensitivity coefficients and the probability distribution of the forecast and are shown in Figures 10.7.2 and 10.7.3. The prediction of yield is sensitive to the estimated abundance and mean weight-at-age of year classes 1998 and 1999, whereas the prediction of biomass relies mostly on the stock weight, abundance, and maturity. In comparison to previous assessments, the SSB estimate is less sensitive to the predicted strength of year classes to come (Figure 10.7.2). Overall, the probability of falling below $\mathbf{B}_{pa}$ (24 000 t) in 2004 when fishing at *status quo* is very small (Figure 10.7.3).

The contribution of the various year classes in a *status quo* short-term forecast are shown in Table 10.7.3. Year classes 1998 and 1999, which are estimated by XSA, are expected to provide the largest contribution to landings predicted in year 2003 (76%), and also to the spawning stock biomass in year 2004 (62%). The contribution of the year classes 2001 and 2002, which have been set to the geometric mean calculated over 1978-1999, contribute to 35% only of the SSB predicted in 2004.

10.8 Medium-Term Forecast

Medium-term analyses based on the Ricker stock-recruitment relationship were performed last year. The Ricker model is inappropriate for this stock: the position of the dome of the Ricker curve to the left of the historically-observed SSB range is not consistent with precautionary management advice (Figure 10.8.1). The Ockham model combines geometric mean recruitment over the SSB range and a linear decline to the origin at lower SSB, and thus incorporates simple averaging (suitable in the absence of a clear stock-recruitment relationship) with hypothesised reduced recruitment at low SSB.

The software WGMTERMC from the Aberdeen suite, traditionally used for the medium-term projections, does not allow for alternative stock-recruitment relationships, such as the Ockham curve. Therefore medium-term analyses are not presented here.

10.9 Biological Reference Points

A yield-per-recruit analysis was carried out (Figure 10.9.1). The stock and recruitment plot is given in Figure 10.9.2. The values of the biological and precautionary reference points are presented in the following table:

$\mathbf{F}_{0.1}$	0.11	$\mathbf{F}_{lim}$	N/A
$\mathbf{F}_{max}$	0.22	$\mathbf{F}_{pa}$	0.73
$\mathbf{F}_{med}$	1.14	$\mathbf{B}_{lim}$	N/A
$\mathbf{F}_{high}$	> 1.5	$\mathbf{B}_{pa}$	24 000 t

$\mathbf{F}_{max}$ and $\mathbf{F}_{0.1}$ remain at the same level as last year. $\mathbf{F}_{med}$ has increased by 30% compared to last year. It is noticeable that for this stock $\mathbf{F}_{med}$ is much higher than $\mathbf{F}_{max}$. Figure 10.9.3 shows historical and projected trends in F and SSB, in relation to $\mathbf{F}_{pa}$ and $\mathbf{B}_{pa}$. It may be observed that the current F is above $\mathbf{F}_{pa}$, while SSB is above $\mathbf{B}_{pa}$.

10.10 Comments on the Assessment

- Major changes have been made this year in comparison to last year, regarding the tuning fleets. Three new surveys have been included. The overall influence of the commercial fleets data has decreased. The tuning of the most abundant age group relies now for more than 50% on data fully independent of the catch-at-age matrix. This is considered as a major improvement for the assessment.

- These surveys give different scales of results, even if they converge towards the same trends.Two surveys cover only one part of the stock distribution area (Kattegat). This prevented assessing the stock with survey tuning only.

- The inclusion of the new surveys has significantly improved the retrospective pattern for the recruitment. The retrospective pattern and the quality control plot for fishing mortality remain worrying (Figure 10.10.1). The variability does not arise from the tuning and XSA settings choice, as it has been observed for all assessment runs. This might come from a major underestimation of discards and mis-reporting. This might also come from fishery-independent reasons. The variability of the natural mortality is unknown. However, it is possible that, as for observed growth, natural mortality is more variable in the Skagerrak-Kattegat than in the North Sea, because of more variability in the temperature and salinity. Should it be true, this would lead to mis-estimation of the fishing mortality. Further investigations should be carried out before the next Working Group meeting.

- It seems that major changes have occurred in 2001, after a relative stability of the stock during the nineties. A problem identified in this assessment is the uncertainty of the ages 3 and 4 estimates (year classes 1998 and 1997). All fleets show survivors estimates higher than in the previous years, but at different scales. It is thus likely that these year classes are stronger than during the last decade, but their exact strength is still unknown. The 1997 year class seems to be above average, while the 1998 and 1999 year classes appear to be the strongest of the time period. The SSB estimate in 2002 is uncertain, and could be overestimated, as shown in the retrospective pattern.

- Some problems have been identified with the commercial tuning data (changes in the database coverage at the beginning of the time period for gillnetters, high catchability residuals observed for old ages at the end of the time period for Danish seiners). These issues did not lead to changes in the XSA tuning settings in comparison to previous assessments. But further analyses will be conducted during the next Working Group meeting, to decide whether these settings are still relevant.

- The assessment results do not fully support the views contained in the revised advice provided by ACFM to the European Commission in March 2002. This revised advice stated that the increase in catch at young ages in 2001 was partly due to a drastic change in the exploitation pattern. Such a change has not been detected in the current assessment. The increase in catches seems now to arise only from the increase in recruitment. This discrepancy between the two advices supports the point of the difficulty to revise advice with incomplete new data.

10.11 Management Considerations

Compared to the neighbour stock of plaice in the North Sea, the stock of plaice in Kattegat and Skagerrak seems able to sustain higher levels of fishing mortality. This might come from a favourable exploitation pattern on the young ages (less than 4).

The estimation of fishing mortality might be biased by unaccounted discard and natural mortality. This suggests that the estimation of F is not very precise.

The short-term forecast in the *status quo* scenario estimates catches in 2002 at 14 200 tonnes. This is 77% higher than the actual TAC for 2002 (8 000 tonnes). If the fishing continues at *status quo* in 2002, this will lead to greater levels of discards or misreporting.

Table 10.1.1 Plaice in IIIa. Official landings in tonnes as reported to ICES and WG estimates, 1972-2001

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

Table 10.1.2 Plaice in Kattegat. Landings in tonnes Working Group estimates, 1972-2001

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

* years 1972-1990 landings refers to IIIA

Table 10.1.3 Plaice in Skagerrak. Landings in tonnes Working Group estimates, 1972-2001

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

Table 10.2.1 Plaice in IIIa. Catch numbers-at-age (Numbers*10**-3)

At 14/06/2002 10:37

YEAR	1978	1979	1980	1981
AGE				
2	489	1105	362	190
3	15692	9789	4772	4048
4	39531	29655	16353	13098
5	24919	20807	12575	10970
6	8011	7646	6033	4306
7	620	2514	2393	1427
8	63	170	949	546
9	63	75	203	213
10	48	50	54	119
+gp	60	55	50	97
TOTALNUM	89496	71866	43744	35014
TONSLAND	26953	21976	16445	12602
SOPCOF %	102	104	106	103

YEAR	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
AGE										
2	526	1481	2154	1400	375	623	101	1012	3147	2309
3	2067	9715	12620	8641	4366	4227	3052	3844	8748	8611
4	9204	8630	11140	21798	14749	12400	12037	7102	8623	9583
5	10602	8026	4463	6232	19193	17710	13783	6255	9718	4663
6	5554	2673	2183	1715	4477	10205	6860	2708	3222	2893
7	1851	925	985	698	633	2089	2745	1171	981	892
8	758	531	904	260	274	373	946	549	481	306
9	301	257	695	197	154	242	322	254	349	156
10	113	96	337	168	141	125	136	136	155	87
+gp	48	106	120	156	98	190	156	236	273	137
TOTALNUM	31024	32440	35601	41265	44460	48184	40138	23267	35697	29637
TONSLAND	11047	10780	11591	13482	14052	15658	12850	7741	12082	8700
SOPCOF %	102	101	100	100	100	100	100	100	100	100

YEAR	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
AGE										
2	904	1038	1411	446	4527	529	563	687	1223	2946
3	3858	3505	6919	2277	5353	4733	6710	2704	3937	9172
4	11759	10088	8016	6606	7971	6379	8219	8432	8302	9399
5	17427	13233	9859	11530	5283	9465	6856	8520	11212	11001
6	4297	6891	8002	6622	4751	5104	2971	7419	3599	4744
7	1033	1657	2780	4929	1812	3072	791	1301	888	410
8	296	376	448	853	1355	1369	385	380	139	102
9	115	104	111	137	151	849	234	77	17	19
10	27	47	38	65	23	114	170	106	7	14
+gp	115	69	55	51	45	36	64	43	29	33
TOTALNUM	39831	37008	37639	33516	31271	31650	26963	29669	29353	37840
TONSLAND	11931	11323	11325	10766	10545	10291	8430	8740	8820	11560
SOPCOF %	100	100	100	100	101	100	100	100	101	103

Table 10.2.2 Plaice in IIIa. Catch and stock weight-at-age (kg)

At 14/06/2002 10:37

YEAR	1978	1979	1980	1981
AGE				
2	0.236	0.222	0.261	0.23
3	0.248	0.255	0.274	0.263
4	0.268	0.267	0.306	0.296
5	0.322	0.297	0.345	0.357
6	0.417	0.378	0.414	0.432
7	0.598	0.451	0.579	0.537
8	0.752	0.655	0.64	0.671
9	0.818	0.922	0.753	0.813
10	0.914	1.02	0.811	0.912
+gp	0.843	1.044	0.91	0.999
SOPCOFAC	1.0159	1.039	1.0625	1.0268

YEAR	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
AGE										
2	0.27	0.285	0.282	0.278	0.25	0.322	0.252	0.274	0.292	0.263
3	0.301	0.274	0.299	0.282	0.277	0.28	0.267	0.263	0.288	0.27
4	0.286	0.293	0.304	0.308	0.284	0.281	0.268	0.282	0.294	0.259
5	0.318	0.356	0.372	0.354	0.31	0.292	0.29	0.32	0.337	0.274
6	0.386	0.423	0.403	0.437	0.384	0.363	0.35	0.376	0.397	0.365
7	0.544	0.483	0.406	0.544	0.531	0.527	0.475	0.466	0.498	0.492
8	0.704	0.531	0.383	0.68	0.707	0.711	0.567	0.635	0.684	0.584
9	0.813	0.647	0.36	0.737	0.85	0.904	0.755	0.741	0.775	0.67
10	0.912	0.986	0.443	0.755	0.903	1.036	0.833	0.825	0.951	0.882
+gp	0.986	1.184	1.061	0.914	1.099	1.084	1.193	1.002	1.15	1.08
SOPCOFAC	1.0184	1.006	1.0009	1.0012	0.9997	0.9996	1.0002	0.9999	1.0004	1.0006

YEAR	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
AGE										
2	0.309	0.267	0.275	0.263	0.266	0.3	0.26	0.271	0.257	0.257
3	0.31	0.272	0.263	0.301	0.268	0.294	0.25	0.271	0.262	0.272
4	0.272	0.271	0.272	0.303	0.294	0.283	0.28	0.29	0.276	0.29
5	0.28	0.295	0.289	0.289	0.384	0.299	0.327	0.29	0.302	0.322
6	0.336	0.338	0.33	0.328	0.399	0.341	0.398	0.294	0.355	0.31
7	0.5	0.441	0.381	0.368	0.436	0.41	0.464	0.336	0.388	0.425
8	0.646	0.566	0.516	0.499	0.43	0.465	0.515	0.37	0.517	0.589
9	0.817	0.712	0.658	0.736	0.561	0.445	0.587	0.656	0.857	0.836
10	0.804	0.802	0.766	0.752	0.87	0.531	0.641	0.567	0.97	0.679
+gp	0.976	1.168	0.979	1.022	0.957	0.76	0.863	0.831	0.967	0.818
SOPCOFAC	0.9999	0.9991	1.0001	1.0015	1.0113	1.0003	1.0016	1	1.0061	1.0251

Table 10.3.1 Plaice IIIa. Tuning data by fleet

107										
Danish Gillnetters										
1987	2001									
1	1	0	1							
2	11									
4189	20592	169059	650916	1071313	803165	286784	58777	33991	18818	24877
4005	27444	168504	529771	606818	410016	309311	134000	55393	19492	23977
3807	18882	63447	175206	186617	129661	111415	85514	44764	24564	43810
4215	64308	246880	272984	362432	157274	62094	42383	38230	20604	41001
3817	43034	181507	242271	148622	168826	68492	32399	14923	11663	17809
4897	67456	350855	854331	1065380	260669	108795	39021	18755	5675	21064
5666	4846	80411	339540	652443	591404	199282	42122	12860	3774	2597
11610	93332	788950	992744	1280086	1145581	443000	78443	26304	7859	14155
10023	93997	320239	744931	1661991	911912	979462	185418	30434	13976	10309
9765	431700	632571	858288	762350	711940	291167	215022	22193	3298	8388
8131	67268	468037	544401	912161	684171	509591	271094	101874	19323	7745
7188	52000	481000	803000	854000	380000	112000	63000	42000	31000	15000
7071	62000	183000	698000	841000	1001000	206000	70000	21000	13000	9000
7424	44000	250000	847000	1044000	439000	93000	19000	4000	1000	6000
7885	257408	421089	734508	1514962	901478	101935	32356	4397	3983	4543
Danish Trawlers										
1987	2001									
1	1	0	1							
2	11									
33420	255915	1177661	2468347	2379126	1046122	215078	50415	32514	24420	37438
30635	108178	839066	1906117	1819047	700988	226895	75481	23885	20953	22426
33956	430316	927355	1291748	1026225	456678	165557	71803	37576	18121	35819
38820	1181442	2311097	2020630	2065160	631904	200416	85590	45586	22634	42975
37834	660031	2459249	2424238	1085399	580774	151470	52786	31364	18475	27441
35071	324054	1244765	2463167	3594631	910595	232058	62318	14226	3014	12454
30019	172192	866648	2265364	2200206	1312213	455227	82231	15921	12071	15309
29400	506609	1815439	1886714	2177012	1785146	732729	113303	17909	12336	11983
26124	262364	791718	1217689	2119319	1052643	706432	144496	23084	11096	8823
28100	1044742	1432920	1503021	1053244	772862	329651	235696	24501	4352	9874
26046	166014	1234787	1637715	1843447	841073	352324	143468	96237	15809	6255
25254	210000	1613000	1953000	1285000	495000	120000	54000	36000	23000	9000
26773	223000	761000	1739000	1403000	1024000	212000	58000	10000	11000	8000
28994	514000	1392000	2182000	2529000	762000	168000	25000	6000	3000	6000
27548	1213134	2297369	2297400	2241237	982424	99667	19672	6921	4216	5405
Danish Seiners										
1987	2001									
1	1	0	1							
2	11									
7913	97426	1157332	4050596	5227390	2536790	426009	72398	40925	20944	22943
6975	466750	1343996	3116463	3368983	1446989	521283	158464	47106	16431	19006
9627	334835	1483241	3030013	2733969	1193297	477612	171227	76749	33563	39868
9420	1116082	3542256	3431384	3748325	1097119	299716	116328	81119	32922	60674
8963	515012	2426848	3289407	1838074	1057052	265606	88516	42174	17972	28587
8820	106267	791895	4199036	6819566	1725235	324760	77400	27070	4686	17868
7398	139121	509253	1721085	2800822	1649545	413535	89601	21958	5718	3978
7268	336892	1620907	1883228	2514844	1977352	552285	69993	19937	4536	4288
6818	195908	569871	1348638	2282155	1664669	1118605	153081	23915	11391	8384
6407	949342	1363113	1878662	980782	913661	327089	230807	22762	3019	6502
5785	165538	1193786	1794123	2572264	1359436	909634	392850	278160	26736	5420
5526	144000	2251000	2489000	2044000	884000	231000	109000	61000	49000	14000
6058	173000	721000	2487000	2755000	2425000	367000	103000	16000	36000	9000
5917	286000	1240000	2954000	4300000	1202000	334000	46000	3000	1000	3000
6173	1534686	3619758	3159809	3377381	1347729	137169	33892	5948	4204	4928

Table 10.3.1. (continued)

Havfisken_q4						
1994	2001					
1	1	1	1			
1	6					
1	0.87	10.51	5.88	0.37	0.99	0.03
1	1.67	10.33	3.77	0.19	1.10	0.06
1	2.48	37.87	11.07	0.36	0.42	0.10
1	11.14	11.27	4.32	1.25	0.64	0.36
1	17.85	14.80	5.19	3.50	0.00	0.11
1	89.27	33.15	7.70	0.27	0.60	0.65
1	99.71	121.08	15.63	0.00	0.47	0.47
1	52.84	99.58	29.67	1.70	0.49	0.82
Havfisken_q1_shifted						
1995	2001					
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	
IBTSQ1_Shifted						
1991	2001					
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
IBTSQ3						
1995	2001					
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

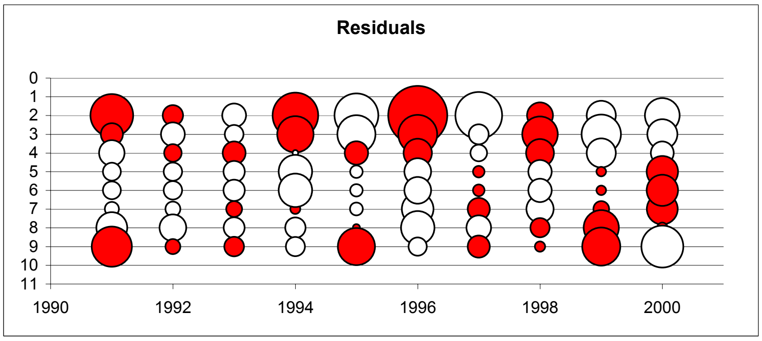
Table 10.4.1 Plaice in IIIa. Results of the separable VPA

Separable analysis
from 1978 to 2001 on ages 2 to 10
with Terminal F of 1.100 on age 6 and Terminal S of 1.000

Initial sum of squared residuals was 391.961 and
final sum of squared residuals is 65.935 after 87 iterations

Matrix of Residuals

Years	1978/79	1979/80	1980/81
Ages			
2/ 3	-1.352	0.126	-1.02
3/ 4	0.05	0.113	-0.565
4/ 5	0.971	1.12	0.506
5/ 6	0.88	0.854	0.562
6/ 7	0.045	-0.055	0.097
7/ 8	0.177	-0.246	0.133
8/ 9	-1.589	-1.698	-0.172
9/10	-0.509	-0.503	-0.425
TOT	0	0	0
WTS	0.001	0.001	0.001



Years	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87	1987/88	1988/89	1989/90	1990/91
2/ 3	-0.621	-1.521	-0.327	-0.142	0.398	-0.526	0.191	-2.31	-0.285	0.337
3/ 4	-0.009	-0.982	0.722	-0.243	0.077	-0.09	-0.239	-0.478	0.089	0.282
4/ 5	0.677	0.248	1.166	0.558	0.447	0.445	0.32	0.657	0.197	0.608
5/ 6	0.536	0.875	1.193	0.327	0.115	0.687	0.714	0.966	0.512	0.518
6/ 7	-0.08	0.459	0.111	-0.334	0.032	0.08	0.262	0.221	0.06	-0.316
7/ 8	-0.293	-0.085	-0.866	-0.141	-0.022	-0.151	-0.266	0.058	-0.073	-0.443
8/ 9	-0.622	-0.573	-1.445	-0.284	-0.758	-0.847	-1.191	-0.557	-0.781	-0.798
9/10	0.067	0.193	-0.801	0.336	-0.29	-0.139	-0.098	-0.272	-0.091	0.213
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

		1991/92	1992/93	1993/94	1994/95	1995/96	1996/97	1997/98	1998/99	1999/00	2000/01	TOT
2	2/ 3	1.031	0.243	-0.31	1.194	-1.087	1.984	-1.221	0.392	-0.474	-0.674	0.001
3	3/ 4	0.278	-0.318	-0.196	0.756	-0.809	0.867	-0.22	0.717	-0.861	-0.5	0.001
4	4/ 5	-0.359	0.177	0.304	-0.019	0.32	0.465	-0.151	0.45	-0.482	-0.291	0
5	5/ 6	-0.305	0.602	0.159	0.1	0.352	-0.006	0.339	-0.349	-0.156	0.163	0
6	6/ 7	-0.18	-0.185	-0.252	-0.631	-0.085	-0.399	0.083	-0.307	0.055	0.568	0
7	7/ 8	-0.109	-0.128	0.146	0.061	-0.091	-0.564	0.283	-0.417	0.148	0.552	0
8	8/ 9	-0.54	-0.396	-0.245	-0.228	0.03	-0.631	-0.341	0.216	0.706	0.062	0
9	9/10	0.924	0.131	0.223	-0.203	0.795	-0.188	0.28	0.062	0.831	-0.986	0
	TOT	0	0	0	0	0	0	0	0	0	0	-5.781
	WTS	0.001	0.001	0.001	0.001	0.001	1	1	1	1	1	

Fishing Mortalities (F)

	1978	1979	1980	1981						
F-values	1.0625	1.134	1.1456	0.9432						
	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
F-values	1.1345	0.9342	1.1843	0.8378	0.7864	1.0728	1.323	1.0263	1.3917	1.1005
	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
F-values	1.0585	1.0748	1.0798	1.1881	0.9843	1.574	1.2239	1.8589	1.3945	1.1

Selection-at-age (S)

Table 10.4.2 Plaice in IIIa. Diagnostic from the final run

```
Lowestoft VPA Version 3.1

   14/06/2002  10:36

 Extended Survivors Analysis

 Plaice IIIa VPA data,2002 WG,ANON,COMBSEX,PLUSGROUP

 cpue data from file ple3afl2.dat

 Catch data for  24 years. 1978 to 2001. Ages  2 to  11.

      Fleet,            First, Last, First, Last, Alpha,  Beta
                      ,    year, year,  age ,  age
 Danish Gillnetters  ,    1987, 2001,   2,    10,   .000,  1.000
 Danish Trawlers     ,    1987, 2001,   2,    10,   .000,  1.000
 Danish Seiners      ,    1987, 2001,   2,    10,   .000,  1.000
 Havfisken_Q4        ,    1994, 2001,   1,     6,   .830,   .920
 Havfisken_Q1_shifted,    1995, 2001,   1,     5,   .990,  1.000
 IBTSQ1_Shifted      ,    1991, 2001,   1,     6,   .990,  1.000
 IBTSQ3              ,    1995, 2001,   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   25 iterations

1


 Regression weights
       ,  .751,  .820,  .877,  .921,  .954,  .976,  .990,  .997, 1.000, 1.000



 Fishing mortalities
    Age,  1992,  1993,  1994,  1995,  1996,  1997,  1998,  1999,  2000,  2001

      2,  .021,  .031,  .043,  .012,  .128,  .012,  .014,  .012,  .010,  .020
      3,  .097,  .096,  .268,  .082,  .181,  .172,  .186,  .075,  .078,  .084
```

Table 10.4.2. (continued)

4,	.290,	.350,	.294,	.392,	.402,	.303,	.445,	.335,	.307,	.240
5,	.867,	.542,	.602,	.786,	.551,	1.048,	.544,	1.027,	.879,	.749
6,	.971,	.924,	.656,	.949,	.785,	1.538,	1.030,	2.002,	1.811,	1.075
7,	.929,	1.203,	1.131,	.998,	.652,	1.912,	.984,	2.050,	1.876,	1.034
8,	.953,	.958,	1.190,	1.245,	.734,	1.461,	1.601,	2.204,	1.606,	1.211
9,	.929,	.965,	.743,	1.484,	.662,	1.388,	.981,	2.077,	.508,	.920
10,	.991,	1.176,	1.068,	1.247,	1.002,	1.527,	1.094,	1.798,	1.208,	.923

1

XSA population numbers (Thousands)

AGE									
YEAR ,	2,	3,	4,	5,	6,	7,	8,	9,	10,
1992 ,	4.54E+04,	4.38E+04,	4.91E+04,	3.16E+04,	7.27E+03,	1.79E+03,	5.06E+02,	2.00E+02,	4.51E+01,
1993 ,	3.53E+04,	4.02E+04,	3.59E+04,	3.32E+04,	1.20E+04,	2.49E+03,	6.41E+02,	1.77E+02,	7.15E+01,
1994 ,	3.50E+04,	3.10E+04,	3.30E+04,	2.29E+04,	1.75E+04,	4.31E+03,	6.77E+02,	2.23E+02,	6.09E+01,
1995 ,	3.81E+04,	3.04E+04,	2.14E+04,	2.23E+04,	1.14E+04,	8.21E+03,	1.26E+03,	1.86E+02,	9.59E+01,
1996 ,	3.96E+04,	3.40E+04,	2.53E+04,	1.31E+04,	9.18E+03,	3.98E+03,	2.74E+03,	3.28E+02,	3.82E+01,
1997 ,	4.64E+04,	3.16E+04,	2.57E+04,	1.53E+04,	6.83E+03,	3.79E+03,	1.87E+03,	1.19E+03,	1.53E+02,
1998 ,	4.40E+04,	4.15E+04,	2.41E+04,	1.72E+04,	4.86E+03,	1.33E+03,	5.07E+02,	3.94E+02,	2.69E+02,
1999 ,	6.19E+04,	3.93E+04,	3.11E+04,	1.40E+04,	9.02E+03,	1.57E+03,	4.49E+02,	9.25E+01,	1.34E+02,
2000 ,	1.33E+05,	5.53E+04,	3.30E+04,	2.02E+04,	4.52E+03,	1.10E+03,	1.83E+02,	4.49E+01,	1.05E+01,
2001 ,	1.55E+05,	1.19E+05,	4.63E+04,	2.19E+04,	7.57E+03,	6.69E+02,	1.53E+02,	3.32E+01,	2.44E+01,

Estimated population abundance at 1st Jan 2002

,	0.00E+00,	1.37E+05,	9.92E+04,	3.30E+04,	9.38E+03,	2.34E+03,	2.15E+02,	4.12E+01,	1.20E+01,

Taper weighted geometric mean of the VPA populations:

,	5.46E+04,	4.34E+04,	3.13E+04,	1.90E+04,	7.71E+03,	2.20E+03,	6.70E+02,	2.15E+02,	8.43E+01,

Standard error of the weighted Log(VPA populations) :

,	.5033,	.4025,	.2829,	.3296,	.4296,	.6950,	.8529,	1.0388,	1.0239,

1

Log catchability residuals.

Fleet : Danish Gillnetters

Age ,	1987,	1988,	1989,	1990,	1991
2 ,	-.17,	.19,	-.81,	.22,	.29
3 ,	.21,	.31,	-.57,	.02,	-.27
4 ,	.50,	.72,	-.43,	.03,	-.75
5 ,	.45,	.45,	-.43,	-.02,	-.86
6 ,	.26,	.20,	-.38,	-.30,	-.21
7 ,	.14,	.36,	-.01,	-.43,	-.16
8 ,	-.47,	.23,	.01,	-.16,	-.11
9 ,	-.10,	.24,	.16,	.10,	.26
10 ,	.13,	.41,	.44,	.29,	.24

Age ,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001
2 ,	.59,	-1.94,	.32,	.37,	1.94,	.05,	-.03,	-.18,	-1.34,	.22
3 ,	.48,	-1.05,	.86,	.03,	.67,	.63,	.51,	-.44,	-.52,	-.82
4 ,	.19,	-.54,	-.12,	.21,	.22,	-.11,	.53,	.10,	.17,	-.40
5 ,	.14,	-.68,	-.33,	.19,	-.14,	.28,	.01,	.42,	.16,	.33
6 ,	-.37,	-.22,	-.77,	-.29,	-.37,	.37,	.05,	.78,	.53,	.39
7 ,	-.15,	.09,	-.40,	-.16,	-.77,	.51,	-.18,	.67,	.12,	.34
8 ,	-.08,	-.39,	-.44,	-.03,	-.85,	.24,	.26,	.71,	.05,	.56
9 ,	.10,	-.28,	-.61,	.16,	-1.03,	-.31,	-.13,	1.05,	-.55,	-.03
10 ,	.42,	-.52,	-.38,	-.04,	-.64,	.13,	-.01,	.10,	-.18,	.18

Table 10.4.2. (continued)

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

Age ,	2,	3,	4,	5,	6,	7,	8,	9,	10
Mean Log q,	-8.6264,	-6.8003,	-5.6413,	-4.6762,	-4.0564,	-3.7716,	-3.5874,	-3.5874,	-3.5874,
S.E(Log q),	.9401,	.6260,	.3861,	.3930,	.4559,	.4112,	.4362,	.5319,	.3374,

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,	1.86,	-.805,	6.66,	.08,	15,	1.78,	-8.63,
3,	6.90,	-2.067,	-16.05,	.01,	15,	3.78,	-6.80,
4,	3.51,	-1.808,	-6.16,	.05,	15,	1.23,	-5.64,
5,	.99,	.013,	4.70,	.40,	15,	.41,	-4.68,
6,	1.58,	-1.146,	1.20,	.29,	15,	.71,	-4.06,
7,	1.22,	-1.015,	2.90,	.69,	15,	.50,	-3.77,
8,	1.36,	-1.916,	2.54,	.75,	15,	.53,	-3.59,
9,	1.08,	-.442,	3.56,	.78,	15,	.58,	-3.68,
10,	.88,	1.301,	3.69,	.93,	15,	.29,	-3.60,

1

Fleet : Danish Trawlers

Age ,	1987,	1988,	1989,	1990,	1991
2 ,	-.08,	-.82,	-.23,	.56,	.37
3 ,	.02,	-.17,	-.13,	-.02,	-.01
4 ,	.08,	.28,	-.30,	.14,	-.42
5 ,	-.18,	.15,	-.27,	.15,	-.52
6 ,	-.59,	-.33,	-.35,	-.17,	-.30
7 ,	-1.01,	-.78,	-.60,	-.28,	-.45
8 ,	-1.26,	-.93,	-.91,	-.23,	-.48
9 ,	-.78,	-1.19,	-.76,	-.50,	.15
10 ,	-.24,	-.11,	-.61,	-.40,	-.16

Age ,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001
2 ,	-.16,	-.38,	.73,	.09,	1.42,	-.56,	-.24,	-.58,	-.59,	.17
3 ,	-.27,	-.39,	.71,	-.07,	.38,	.38,	.41,	-.40,	-.21,	-.43
4 ,	-.40,	.01,	-.09,	.07,	.04,	.14,	.48,	.00,	.07,	-.19
5 ,	.03,	-.49,	-.08,	.12,	-.23,	.46,	-.20,	.25,	.33,	.12
6 ,	-.12,	-.13,	-.29,	-.14,	-.38,	.38,	.02,	.43,	.68,	.19
7 ,	-.15,	.46,	.38,	-.24,	-.49,	.19,	-.16,	.58,	.56,	.27
8 ,	-.14,	.06,	.44,	.20,	-.37,	-.12,	.29,	.63,	.41,	.25
9 ,	-.70,	-.29,	-.48,	.37,	-.54,	-.09,	-.10,	.41,	-.06,	.61
10 ,	-.74,	.42,	.58,	.21,	.02,	.20,	-.12,	.05,	.99,	.42

Table 10.4.2. (continued)

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

Age ,	2,	3,	4,	5,	6,	7,	8,	9,	10
Mean Log q,	-8.2779,	-6.7484,	-5.9606,	-5.3202,	-5.0220,	-4.9788,	-5.0282,	-5.0282,	-5.0282,
S.E(Log q),	.6247,	.3724,	.2431,	.2969,	.3560,	.4601,	.4780,	.5095,	.4756,

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,	1.30,	-.602,	7.48,	.29,	15,	.84,	-8.28,
3,	1.83,	-1.760,	3.50,	.32,	15,	.62,	-6.75,
4,	2.79,	-3.184,	-1.86,	.25,	15,	.50,	-5.96,
5,	1.09,	-.282,	4.90,	.49,	15,	.34,	-5.32,
6,	1.49,	-1.340,	3.09,	.43,	15,	.51,	-5.02,
7,	1.28,	-1.121,	4.21,	.62,	15,	.58,	-4.98,
8,	1.42,	-1.962,	4.41,	.69,	15,	.60,	-5.03,
9,	1.37,	-2.205,	5.13,	.79,	15,	.57,	-5.18,
10,	1.41,	-2.518,	5.13,	.80,	15,	.53,	-4.92,

1

Fleet : Danish Seiners

Age ,	1987,	1988,	1989,	1990,	1991
2 ,	-.82,	.91,	-.43,	.71,	.35
3 ,	-.01,	.33,	.15,	.37,	-.03
4 ,	.30,	.54,	.10,	.37,	-.39
5 ,	.18,	.38,	.11,	.29,	-.42
6 ,	-.21,	-.07,	-.07,	-.14,	-.20
7 ,	-.78,	-.36,	-.17,	-.35,	-.34
8 ,	-1.30,	-.56,	-.62,	-.35,	-.36
9 ,	-.96,	-.88,	-.63,	-.35,	.05
10 ,	-.80,	-.72,	-.57,	-.45,	-.59

Age ,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001
2 ,	-1.11,	-.41,	.50,	-.07,	1.58,	-.27,	-.31,	-.56,	-.81,	.69
3 ,	-.80,	-.98,	.54,	-.51,	.36,	.40,	.81,	-.42,	-.19,	.07
4 ,	-.20,	-.57,	-.41,	-.20,	.03,	.03,	.53,	.13,	.26,	-.09
5 ,	.19,	-.72,	-.41,	-.33,	-.69,	.43,	-.08,	.54,	.58,	.16
6 ,	-.05,	-.44,	-.73,	-.28,	-.68,	.42,	.18,	.84,	.78,	.06
7 ,	-.33,	-.12,	-.40,	-.32,	-.91,	.75,	.13,	.72,	.95,	.20
8 ,	-.39,	-.30,	-.49,	-.24,	-.76,	.55,	.67,	.85,	.76,	.44
9 ,	-.52,	-.42,	-.82,	-.10,	-.98,	.63,	.10,	.53,	-1.01,	.11
10 ,	-.76,	-.77,	-.87,	-.27,	-.71,	.39,	.31,	.87,	-.36,	.07

Table 10.4.2. (continued)

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

Age	2	3	4	5	6	7	8	9	10
Mean Log q,	-7.0609,	-5.2966,	-4.2485,	-3.4544,	-3.0799,	-3.0901,	-3.1843,	-3.1843,	-3.1843,
S.E(Log q),	.7657,	.5331,	.3318,	.4568,	.5038,	.5748,	.6257,	.6411,	.6242,

Regression statistics :

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

Age,	Slope ,	t-value ,	Intercept,	RSquare,	No Pts,	Reg s.e,	Mean Q
2,	1.13,	-.239,	6.56,	.26,	15,	.91,	-7.06,
3,	1.08,	-.168,	4.89,	.33,	15,	.60,	-5.30,
4,	2.34,	-1.651,	-3.94,	.13,	15,	.72,	-4.25,
5,	1.29,	-.493,	1.60,	.23,	15,	.61,	-3.45,
6,	2.78,	-2.013,	-7.36,	.12,	15,	1.23,	-3.08,
7,	1.59,	-1.585,	.39,	.43,	15,	.85,	-3.09,
8,	1.66,	-2.046,	1.00,	.50,	15,	.91,	-3.18,
9,	.95,	.303,	3.56,	.79,	15,	.57,	-3.46,
10,	.88,	.790,	3.56,	.81,	15,	.50,	-3.45,

1

Fleet : Havfisken_Q4

Age ,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001
2 ,	99.99,	99.99,	-.43,	-.55,	.81,	-.66,	-.34,	.13,	.65,	.32
3 ,	99.99,	99.99,	.10,	-.49,	.56,	-.31,	-.39,	-.04,	.33,	.21
4 ,	99.99,	99.99,	-.78,	-.92,	-.44,	.70,	1.92,	-1.00,	99.99,	.36
5 ,	99.99,	99.99,	.04,	.33,	-.31,	.39,	99.99,	.40,	-.34,	-.49
6 ,	99.99,	99.99,	-3.19,	-1.81,	-1.23,	1.00,	-.29,	1.72,	1.92,	1.32
7 ,	No data for this fleet at this age									
8 ,	No data for this fleet at this age									
9 ,	No data for this fleet at this age									
10 ,	No data for this fleet at this age									

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

Age ,	2,	3,	4,	5,	6
Mean Log q,	-7.5605,	-8.3484,	-10.2787,	-9.4723,	-9.4206,
S.E(Log q),	.5656,	.3719,	1.0868,	.3884,	1.8448,

Table 10.4.2. (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,	.66,	1.550,	8.74,	.78,	8,	.34,	-7.56,
3,	.78,	.898,	8.86,	.75,	8,	.29,	-8.35,
4,	1.40,	-.150,	10.28,	.03,	7,	1.67,	-10.28,
5,	1.69,	-.566,	9.25,	.13,	7,	.70,	-9.47,
6,	-.49,	-2.502,	8.77,	.33,	8,	.67,	-9.42,

1

Fleet : Havfisken_Q1_shifted

Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
2	99.99	99.99	99.99	.17	-.03	99.99	-.16	.26	-.07	-.15
3	99.99	99.99	99.99	.33	-.07	99.99	-.75	.33	-.32	.49
4	99.99	99.99	99.99	.41	-.24	99.99	.05	.09	-.09	-.20
5	99.99	99.99	99.99	.00	.11	99.99	-1.66	1.42	.75	-.63
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,	-7.3152,	-8.5272,	-9.3716,	-9.3446,
S.E(Log q),	.1734,	.4774,	.2356,	1.0835,

Regression statistics :

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

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
2,	1.12,	-.828,	6.86,	.92,	6,	.20,	-7.32,
3,	.79,	.571,	9.00,	.66,	6,	.41,	-8.53,
4,	2.04,	-1.486,	8.42,	.34,	6,	.43,	-9.37,
5,	-2.57,	-.604,	10.90,	.01,	6,	2.98,	-9.34,

1

Table 10.4.2. (continued)

Fleet : IBTSQ1_Shifted

Age	1987	1988	1989	1990	1991
2	99.99	99.99	99.99	99.99	-.39
3	99.99	99.99	99.99	99.99	-.28
4	99.99	99.99	99.99	99.99	-.73
5	99.99	99.99	99.99	99.99	-.40
6	99.99	99.99	99.99	99.99	-.67
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	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
2	-.73	-.40	.09	.23	.27	-.48	-.29	.58	.68	.09
3	-.07	-1.11	.12	.11	-.31	.02	-.73	.59	.75	.62
4	.37	-.81	-.74	.10	-.36	-.21	.44	.36	.22	.98
5	.77	-.14	-.04	-.44	-1.49	-.17	-1.69	1.58	1.09	.85
6	.02	-.40	-.58	-.98	-2.11	.04	-.67	.57	2.41	1.83
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	-8.0727	-8.6613	-9.1476	-9.4619	-9.3562
S.E(Log q)	.4580	.5789	.5776	1.0623	1.3269

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	.72	1.412	8.86	.76	11	.31	-8.07
3	.67	1.079	9.33	.57	11	.38	-8.66
4	.80	.351	9.40	.27	11	.48	-9.15
5	.57	.668	9.64	.23	11	.62	-9.46
6	-3.63	-1.239	7.62	.01	11	4.67	-9.36

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Fleet : IBTSQ3

Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
2	99.99	99.99	99.99	-.59	.01	-.14	.04	.49	99.99	.15
3	99.99	99.99	99.99	.18	-.27	.14	-.71	.24	99.99	.42
4	99.99	99.99	99.99	.30	-.22	-.10	.48	-.79	99.99	.34
5	99.99	99.99	99.99	.09	-.38	.08	-1.10	.70	99.99	.59
6	99.99	99.99	99.99	-.08	-.91	.48	99.99	-.05	99.99	.53
7	No data for this fleet at this age									
8	No data for this fleet at this age									
9	No data for this fleet at this age									
10	No data for this fleet at this age									

Table 10.4.2. (continued)

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

Age ,	2,	3,	4,	5,	6
Mean Log q,	-7.5902,	-8.0360,	-8.7682,	-8.8439,	-8.4892,
S.E(Log q),	.3508,	.4190,	.4795,	.6719,	.5827,

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,	1.018,	8.37,	.83,	6,	.27,	-7.59,
3,	.77,	.789,	8.65,	.75,	6,	.34,	-8.04,
4,	1.09,	-.089,	8.64,	.22,	6,	.58,	-8.77,
5,	.69,	.300,	9.12,	.20,	6,	.51,	-8.84,
6,	-1.32,	-1.218,	9.82,	.09,	5,	.73,	-8.49,

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Terminal year survivor and F summaries :

Age 2 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 ,	171340.,	.979,	.000,	.00,	1,	.030,	.016
Danish Trawlers ,	163119.,	.651,	.000,	.00,	1,	.069,	.017
Danish Seiners ,	272702.,	.798,	.000,	.00,	1,	.046,	.010
Havfisken_Q4 ,	188417.,	.601,	.000,	.00,	1,	.081,	.015
Havfisken_Q1_shifted,	117623.,	.300,	.000,	.00,	1,	.325,	.024
IBTSQ1_Shifted ,	150223.,	.480,	.000,	.00,	1,	.127,	.018
IBTSQ3 ,	158893.,	.380,	.000,	.00,	1,	.203,	.017
F shrinkage mean ,	78653.,	.50,,,,				.119,	.035

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
137308.,	.17,	.11,	8,	.659,	.020

Table 10.4.2. (continued)

Age 3 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 ,	37290.,	.543,	.239,	.44,	2,	.059,	.210
Danish Trawlers ,	62035.,	.333,	.072,	.22,	2,	.157,	.132
Danish Seiners ,	80215.,	.456,	.411,	.90,	2,	.084,	.103
Havfisken_Q4 ,	139860.,	.330,	.203,	.61,	2,	.160,	.061
Havfisken_Q1_shifted,	106585.,	.259,	.243,	.94,	2,	.258,	.079
IBTSQ1_Shifted ,	190780.,	.377,	.029,	.08,	2,	.122,	.045
IBTSQ3 ,	150905.,	.453,	.000,	.00,	1,	.085,	.056
F shrinkage mean ,	58713.,	.50,,,,				.076,	.139

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
99184.,	.13,	.14,	14,	1.038,	.084

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Age 4 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 ,	21959.,	.324,	.064,	.20,	3,	.093,	.342
Danish Trawlers ,	25857.,	.223,	.084,	.38,	3,	.195,	.297
Danish Seiners ,	27870.,	.276,	.104,	.38,	3,	.128,	.278
Havfisken_Q4 ,	43540.,	.318,	.066,	.21,	3,	.092,	.187
Havfisken_Q1_shifted,	31991.,	.197,	.170,	.87,	3,	.248,	.246
IBTSQ1_Shifted ,	69505.,	.320,	.117,	.37,	3,	.092,	.121
IBTSQ3 ,	50853.,	.307,	.071,	.23,	2,	.101,	.162
F shrinkage mean ,	20672.,	.50,,,,				.051,	.359

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
32965.,	.10,	.08,	21,	.860,	.240

Age 5 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 ,	11010.,	.257,	.142,	.55,	4,	.119,	.668
Danish Trawlers ,	9261.,	.184,	.115,	.63,	4,	.229,	.756
Danish Seiners ,	10102.,	.242,	.149,	.62,	4,	.128,	.711
Havfisken_Q4 ,	6929.,	.264,	.148,	.56,	3,	.111,	.920
Havfisken_Q1_shifted,	8644.,	.195,	.110,	.57,	4,	.175,	.793
IBTSQ1_Shifted ,	11238.,	.311,	.242,	.78,	4,	.070,	.658
IBTSQ3 ,	11602.,	.274,	.146,	.53,	3,	.091,	.643
F shrinkage mean ,	8328.,	.50,,,,				.078,	.814

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
9383.,	.09,	.05,	27,	.589,	.749

Table 10.4.2. (continued)

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Age 6 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
Danish Gillnetters ,	3079.,	.261,	.072,	.28,	5,	.143,	.902
Danish Trawlers ,	2818.,	.190,	.094,	.49,	5,	.256,	.956
Danish Seiners ,	2966.,	.256,	.140,	.55,	5,	.136,	.925
Havfisken_Q4 ,	1668.,	.268,	.208,	.78,	5,	.076,	1.310
Havfisken_Q1_shifted,	2256.,	.256,	.279,	1.09,	3,	.067,	1.099
IBTSQ1_Shifted ,	2814.,	.342,	.450,	1.32,	5,	.050,	.957
IBTSQ3 ,	2113.,	.292,	.319,	1.09,	4,	.095,	1.143
F shrinkage mean ,	1397.,	.50,,,,				.175,	1.442

Weighted prediction :

Survivors,	Int,	Ext,	N,	Var,	F
at end of year,	s.e,	s.e,	,	Ratio,	
2340.,	.12,	.08,	33,	.680,	1.075

Age 7 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 ,	314.,	.345,	.055,	.16,	6,	.218,	.807
Danish Trawlers ,	311.,	.314,	.084,	.27,	6,	.217,	.813
Danish Seiners ,	305.,	.417,	.112,	.27,	6,	.130,	.823
Havfisken_Q4 ,	319.,	.280,	.318,	1.13,	5,	.022,	.798
Havfisken_Q1_shifted,	237.,	.216,	.230,	1.07,	3,	.024,	.973
IBTSQ1_Shifted ,	489.,	.375,	.446,	1.19,	5,	.014,	.586
IBTSQ3 ,	286.,	.252,	.154,	.61,	4,	.019,	.860
F shrinkage mean ,	111.,	.50,,,,				.358,	1.504

Weighted prediction :

Survivors,	Int,	Ext,	N,	Var,	F
at end of year,	s.e,	s.e,	,	Ratio,	
215.,	.21,	.11,	36,	.516,	1.034

1

Age 8 Catchability constant w.r.t. time and dependent on age

Year class = 1993

Fleet,	Estimated,	Int,	Ext,	Var,	N,	Scaled,	Estimated
,	Survivors,	s.e,	s.e,	Ratio,	,	Weights,	F
Danish Gillnetters ,	67.,	.377,	.070,	.19,	7,	.212,	.896
Danish Trawlers ,	55.,	.397,	.054,	.14,	7,	.184,	1.022
Danish Seiners ,	68.,	.516,	.088,	.17,	7,	.108,	.886
Havfisken_Q4 ,	60.,	.334,	.352,	1.05,	4,	.003,	.958
Havfisken_Q1_shifted,	40.,	.265,	.344,	1.30,	3,	.004,	1.233
IBTSQ1_Shifted ,	35.,	.326,	.299,	.92,	5,	.003,	1.323

Table 10.4.2. (continued)

IBTSQ3	29.,	.252,	.171,	.68,	5,	.007,	1.477
F shrinkage mean	27.,	.50,,,,				.480,	1.531

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
41.,	.27,	.10,	39,	.361,	1.211

Age 9 Catchability constant w.r.t. time and age (fixed at the value for age) 8

Year class = 1992

Fleet, ,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
Danish Gillnetters	12.,	.418,	.048,	.11,	8,	.202,	.913
Danish Trawlers	21.,	.418,	.043,	.10,	8,	.209,	.622
Danish Seiners	15.,	.535,	.097,	.18,	8,	.130,	.785
Havfisken_Q4	11.,	.280,	.211,	.75,	5,	.002,	.949
Havfisken_Q1_shifted,	11.,	.267,	.241,	.90,	2,	.001,	.985
IBTSQ1_Shifted	10.,	.373,	.150,	.40,	5,	.001,	1.028
IBTSQ3	12.,	.325,	.123,	.38,	3,	.001,	.909
F shrinkage mean	9.,	.50,,,,				.455,	1.129

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
12.,	.27,	.07,	40,	.276,	.920

1

Age 10 Catchability constant w.r.t. time and age (fixed at the value for age) 8

Year class = 1991

Fleet, ,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
Danish Gillnetters	9.,	.289,	.108,	.37,	9,	.336,	.890
Danish Trawlers	11.,	.347,	.086,	.25,	9,	.213,	.773
Danish Seiners	7.,	.447,	.197,	.44,	9,	.127,	1.090
Havfisken_Q4	8.,	.305,	.205,	.67,	4,	.001,	1.015
Havfisken_Q1_shifted,	13.,	.304,	.087,	.29,	2,	.001,	.709
IBTSQ1_Shifted	7.,	.351,	.256,	.73,	5,	.001,	1.073
IBTSQ3	11.,	.393,	.238,	.61,	3,	.001,	.786
F shrinkage mean	8.,	.50,,,,				.321,	1.003

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
9.,	.21,	.05,	42,	.256,	.923

Table 10.4.3 Plaice in IIIa. Fishing mortalities-at-age

At 14/06/2002 10:37

Terminal Fs derived using XSA (With F shrinkage)

Table 8 Fishing mortality (F) at age

YEAR	1978	1979	1980	1981
AGE				
2	0.0084	0.0257	0.0111	0.0078
3	0.2335	0.2058	0.1327	0.1487
4	0.7571	0.7969	0.5479	0.5627
5	1.0753	1.0747	0.8465	0.7786
6	1.0199	1.0636	0.9627	0.7009
7	0.5951	0.9543	1.0673	0.5502
8	0.2824	0.2829	1.0973	0.6559
9	0.4844	0.5608	0.5648	0.6834
10	0.6945	0.791	0.9124	0.6768
+gp	0.6945	0.791	0.9124	0.6768
FBAR 4- 8	0.746	0.8345	0.9044	0.6497

Table 8 Fishing mortality (F) at age

YEAR	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
AGE										
2	0.0115	0.0166	0.0326	0.0305	0.0107	0.0191	0.0032	0.0162	0.0462	0.049
3	0.0988	0.2684	0.1721	0.1591	0.113	0.1434	0.1103	0.1454	0.1697	0.1543
4	0.5155	0.6523	0.4945	0.4438	0.3935	0.4706	0.664	0.3566	0.4911	0.2535
5	1.126	1.05	0.746	0.5034	0.7842	1.0215	1.3402	0.7794	1.0437	0.4764
6	1.0771	0.8687	0.8174	0.6364	0.733	1.2029	1.4306	0.9476	1.1141	0.9295
7	0.6587	0.4406	0.8292	0.5922	0.4508	0.8155	1.1797	0.9167	1.0006	0.9842
8	0.5633	0.3503	0.9114	0.4728	0.4316	0.4635	0.9963	0.6893	1.1439	0.8987
9	0.8317	0.3333	0.9336	0.4437	0.5037	0.7482	0.8269	0.7071	1.1945	1.4555
10	0.8556	0.6111	0.8518	0.5317	0.583	0.8854	1.1757	0.9172	1.182	1.0056
+gp	0.8556	0.6111	0.8518	0.5317	0.583	0.8854	1.1757	0.9172	1.182	1.0056
FBAR 4- 8	0.7881	0.6724	0.7597	0.5297	0.5586	0.7948	1.1222	0.7379	0.9587	0.7084

Table 8 Fishing mortality (F) at age

YEAR	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	FBAR 99-01
AGE											
2	0.0212	0.0314	0.0433	0.0124	0.1279	0.0121	0.0135	0.0117	0.0097	0.0202	0.0139
3	0.0973	0.0961	0.2678	0.0821	0.1809	0.1715	0.1865	0.0751	0.0778	0.0843	0.0791
4	0.2901	0.3498	0.2945	0.3917	0.4021	0.3026	0.4448	0.335	0.3075	0.24	0.2942
5	0.8671	0.5423	0.602	0.7859	0.5513	1.0485	0.5442	1.0268	0.8789	0.7491	0.8849
6	0.9714	0.924	0.6561	0.9494	0.785	1.5382	1.0297	2.0017	1.8114	1.0745	1.6292
7	0.9291	1.2026	1.1314	0.9976	0.6521	1.9115	0.9842	2.0501	1.8764	1.0343	1.6536
8	0.9533	0.958	1.1903	1.2453	0.7341	1.4606	1.6008	2.2037	1.6055	1.2106	1.6733
9	0.9285	0.9651	0.7426	1.4842	0.6617	1.3877	0.9808	2.0767	0.5082	0.9196	1.1682
10	0.9907	1.1758	1.0678	1.2473	1.0023	1.5267	1.0939	1.7977	1.2075	0.9232	1.3095
+gp	0.9907	1.1758	1.0678	1.2473	1.0023	1.5267	1.0939	1.7977	1.2075	0.9232	
FBAR 4- 8	0.8022	0.7953	0.7749	0.874	0.6249	1.2523	0.9207	1.5235	1.296	0.8617	

Table 10.4.4 Plaice in IIIa. Estimated population numbers-at-age

At 14/06/2002 10:37

Terminal Fs derived using XSA (With F shrinkage)

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

YEAR	1978	1979	1980	1981
AGE				
2	61661	45790	34422	25729
3	79225	55328	40382	30802
4	78264	56759	40751	32000
5	39763	33213	23149	21318
6	13172	12276	10260	8984
7	1453	4298	3834	3545
8	269	725	1497	1193
9	173	184	495	452
10	101	96	95	254
+gp	125	105	87	206
TOTAL	274206	208774	154973	124484

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

YEAR	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
AGE										
2	48503	94318	70514	48961	37159	34607	33106	66183	73274	50795
3	23100	43387	83934	61755	42970	33266	30721	29859	58922	63308
4	24020	18935	30017	63942	47658	34728	26080	24894	23361	44993
5	16495	12979	8924	16564	37122	29093	19628	12148	15770	12936
6	8854	4841	4110	3830	9059	15333	9479	4649	5042	5025
7	4033	2729	1837	1642	1834	3939	4166	2051	1631	1497
8	1850	1889	1589	725	822	1057	1577	1159	742	543
9	560	953	1204	578	409	483	602	527	526	214
10	207	221	618	428	336	224	207	238	235	144
+gp	87	242	218	396	232	337	235	410	410	225
TOTAL	127710	180494	202965	198821	177602	153067	125799	142118	179913	179679

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

YEAR	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	GM 78-99	AM 78-99
AGE													
2	45377	35303	35043	38061	39649	46387	44003	61863	133086	154847	0	46318	48669
3	43764	40199	30956	30366	34015	31570	41470	39280	55322	119258	137308	41525	44026
4	49092	35930	33039	21429	25310	25686	24063	31141	32970	46313	99184	33465	36004
5	31596	33235	22915	22270	13106	15319	17174	13955	20156	21935	32965	19634	21303
6	7269	12012	17484	11356	9183	6833	4858	9018	4523	7573	9383	8003	8769
7	1795	2490	4314	8209	3976	3790	1328	1570	1102	669	2340	2654	2998
8	506	641	677	1259	2739	1874	507	449	183	153	215	945	1104
9	200	177	223	186	328	1189	394	93	45	33	41	373	461
10	45	71	61	96	38	153	269	134	10	24	12	154	194
+gp	191	104	87	74	74	48	100	53	43	57	29		
TOTAL	179835	160162	144799	133306	128418	132850	134165	157555	247441	350862	281478		

Table 10.4.5 Plaice in IIIa. Historical trends in SSB, recruitment, and F-bar from the final XSA run

Run title : Plaice IIIa VPA data 2002WG ANON COMBSEX PLUSGROUP

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Table 16 Summary (without SOP correction)

Terminal Fs derived using XSA (With F shrinkage)

	RECRUITS Age 2	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	FBAR 4- 8
1978	61661	74881	60329	26953	0.4468	0.746
1979	45790	56724	46558	21976	0.472	0.8345
1980	34422	48460	39476	16445	0.4166	0.9044
1981	25729	38492	32575	12602	0.3869	0.6497
1982	48503	39808	26713	11047	0.4136	0.7881
1983	94318	54427	27546	10780	0.3913	0.6724
1984	70514	61376	41491	11591	0.2794	0.7597
1985	48961	60755	47144	13482	0.286	0.5297
1986	37159	52175	42885	14052	0.3277	0.5586
1987	34607	48139	36996	15658	0.4232	0.7948
1988	33106	36324	27981	12850	0.4592	1.1222
1989	66183	41332	23198	7741	0.3337	0.7379
1990	73274	54972	33576	12082	0.3598	0.9587
1991	50795	49051	35692	8700	0.2438	0.7084
1992	45377	53841	39819	11931	0.2996	0.8022
1993	35303	45727	36301	11323	0.3119	0.7953
1994	35043	41429	31792	11325	0.3562	0.7749
1995	38061	39738	29728	10766	0.3621	0.874
1996	39649	39000	28453	10545	0.3706	0.6249
1997	46387	40450	26533	10291	0.3879	1.2523
1998	44003	37462	26021	8430	0.324	0.9207
1999	61863	44013	27248	8740	0.3208	1.5235
2000	133086	66103	31899	8820	0.2765	1.296
2001	154847	95540	55745	11560	0.2074	0.8617
2002	46318*		79256			
Arith. Mean	56610	50842	35654	12487	0.3524	0.8538
0 Units	(Thousand	(Tonnes)	(Tonnes)	(Tonnes)		

*GM (1978-99)
SSB 2002 estimated using average wt at age in the stock (1998-2000)

Table 10.7.1 Plaice in IIIa. Input data for catch forecast and linear sensitivity analysis.

Label	Value	CV	Label	Value	CV
Number-at-age			Weight in the stock		
N2	46317	0.32	WS2	0.26	0.03
N3	137308	0.17	WS3	0.27	0.02
N4	99184	0.14	WS4	0.28	0.03
N5	32964	0.10	WS5	0.31	0.05
N6	9382	0.09	WS6	0.32	0.10
N7	2340	0.12	WS7	0.38	0.12
N8	214	0.21	WS8	0.49	0.23
N9	40	0.27	WS9	0.78	0.14
N10	11	0.27	WS10	0.74	0.28
N11	28	0.21	WS11	0.87	0.09
H.cons selectivity			Weight in the HC catch		
sH2	0.01	0.71	WH2	0.26	0.03
sH3	0.06	0.37	WH3	0.27	0.02
sH4	0.21	0.12	WH4	0.28	0.03
sH5	0.62	0.15	WH5	0.31	0.05
sH6	1.14	0.06	WH6	0.32	0.10
sH7	1.16	0.09	WH7	0.38	0.12
sH8	1.18	0.08	WH8	0.49	0.23
sH9	0.82	0.53	WH9	0.78	0.14
sH10	0.92	0.12	WH10	0.74	0.28
sH11	0.92	0.12	WH11	0.87	0.09
Natural mortality			Proportion mature		
M2	0.10	0.10	MT2	0.00	0.10
M3	0.10	0.10	MT3	1.00	0.10
M4	0.10	0.10	MT4	1.00	0.00
M5	0.10	0.10	MT5	1.00	0.00
M6	0.10	0.10	MT6	1.00	0.00
M7	0.10	0.10	MT7	1.00	0.00
M8	0.10	0.10	MT8	1.00	0.00
M9	0.10	0.10	MT9	1.00	0.00
M10	0.10	0.10	MT10	1.00	0.00
M11	0.10	0.10	MT11	1.00	0.00
Relative effort in HC fishery			Year effect for natural mortality		
HF02	1.00	0.27	K02	1.00	0.10
HF03	1.00	0.27	K03	1.00	0.10
HF04	1.00	0.27	K04	1.00	0.10
Recruitment in 2003 and 2004					
R03	46318	0.32			
R04	46318	0.32			

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

Stock numbers in 2002 are VPA survivors.

Table 10.7.2 Plaice in IIIa. Short-term catch forecast output and estimates of coefficient of variation (CV) from the linear analysis.

	Year 2002	2003						
Mean F Ages								
H.cons 4 to 8	0.86	0.60	0.69	0.73	0.78	0.86	0.95	1.03
Effort relative to 2001								
H.cons	1.00	0.70	0.80	0.85	0.90	1.00	1.10	1.20
Biomass								
Total 1 January	91.3	85.6	85.6	85.6	85.6	85.6	85.6	85.6
SSB at spawning time	79.2	73.4	73.4	73.4	73.4	73.4	73.4	73.4
Catch weight (,000t)								
H.cons	14.2	15.7	17.5	18.4	19.2	20.8	22.3	23.8
Biomass in year.... 2004								
Total 1 January		78.6	76.8	75.9	75.0	73.4	71.9	70.4
SSB at spawning time		66.4	64.6	63.7	62.9	61.3	59.7	58.3

	Year 2002	2003						
Effort relative to 2001								
H.cons	1.00	0.70	0.80	0.85	0.90	1.00	1.10	1.20
Est. Coeff. of Variation								
Biomass								
Total 1 January	0.09	0.11	0.11	0.11	0.11	0.11	0.11	0.11
SSB at spawning time	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11
Catch weight								
H.cons	0.24	0.34	0.29	0.28	0.26	0.24	0.22	0.20
Biomass in year.... 2004								
Total 1 January		0.13	0.13	0.13	0.13	0.13	0.13	0.13
SSB at spawning time		0.14	0.14	0.14	0.14	0.14	0.14	0.14

Table 10.7.2. (Continued). Detailed forecast tables

Forecast for year 2002
F multiplier H.cons=1.00

Age	Populations Stock No.	Catch number H.Cons	Catch number Total
2	46317	439	439
3	137308	7119	7119
4	99184	17679	17679
5	32964	14586	14586
6	9382	6141	6141
7	2340	1544	1544
8	214	142	142
9	40	21	21
10	11	6	6
11	28	16	16
Wt	91	14	14

Forecast for year 2003
F multiplier H.cons=1.00

Age	Populations Stock No.	Catch number H.Cons	Catch number Total
2	46318	439	439
3	41492	2151	2151
4	117475	20939	20939
5	72965	32286	32286
6	16029	10492	10492
7	2704	1784	1784
8	663	440	440
9	60	32	32
10	16	9	9
11	14	8	8
Wt	86	21	21

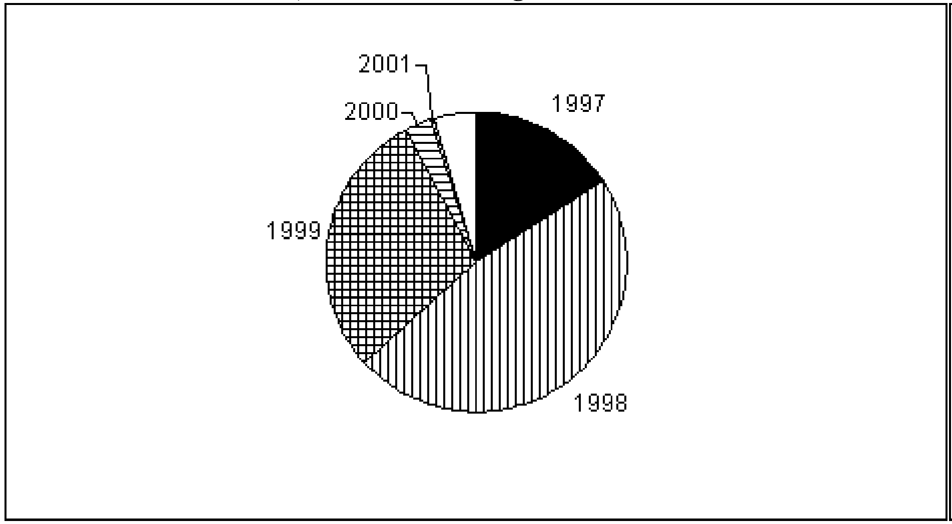
Table 10.7.3 Plaice in IIIa. Stock numbers of recruits and their source for recent year classes used in predictions, and the relative (%) contributions to landings and SSB (by weight) of these year classes.

Year-class	1997	1998	1999	2000	2001
Stock No. (thousands) of 2 year-olds	61863	133086	154847	46318	46318
Source	VPA	VPA	VPA	GM	GM
Status Quo F:					
% in 2002 landings	31.9	34.9	13.6	0.8	-
% in 2003	15.9	47.4	29.1	2.7	0.5
% in 2002 SSB	12.9	35.1	46.9	0.0	-
% in 2003 SSB	7.0	30.9	44.9	15.3	0.0
% in 2004 SSB	2.9	18.5	43.5	16.1	18.1

GM : geometric mean recruitment

Plaice (IIIa) : Year-class % contribution to

a) 2003 landings



b) 2004 SSB

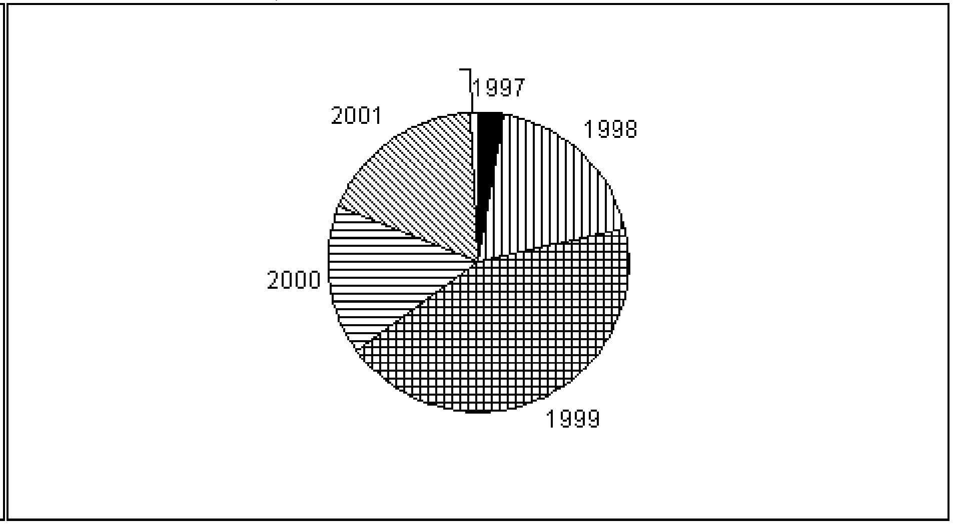


Figure 10.2.1 Plaice in IIIa. Distribution of catch in numbers ('000) by age (2 to 11) and by year

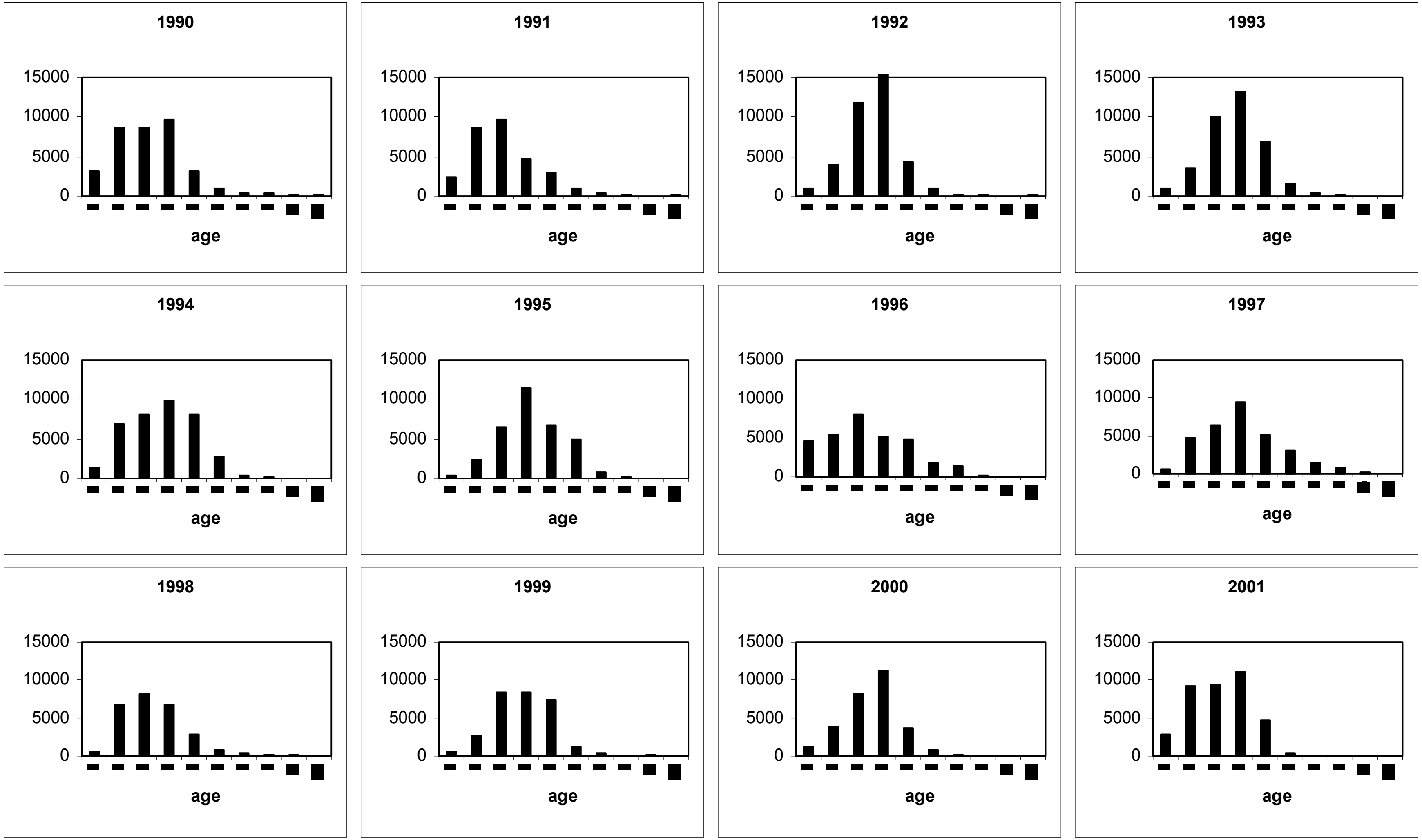


Figure 10.2.2 Time-series of catch weight-at-age for plaice in Kattegat and Skagerrak.

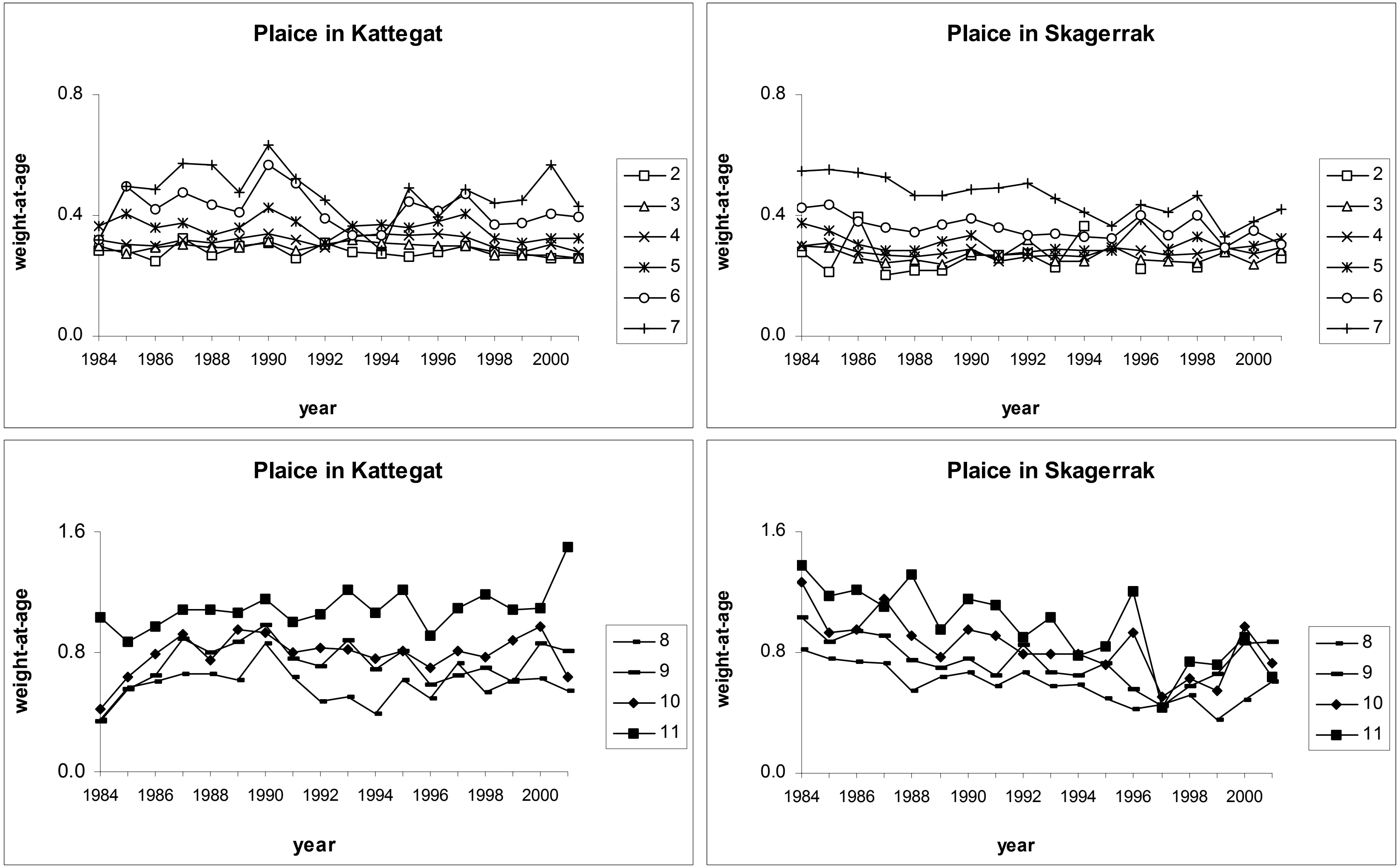


Figure 10.3.1 Plaice in IIIa. Time-series of standardised fishing effort, yield, and cpue from commercial fleets and from surveys.

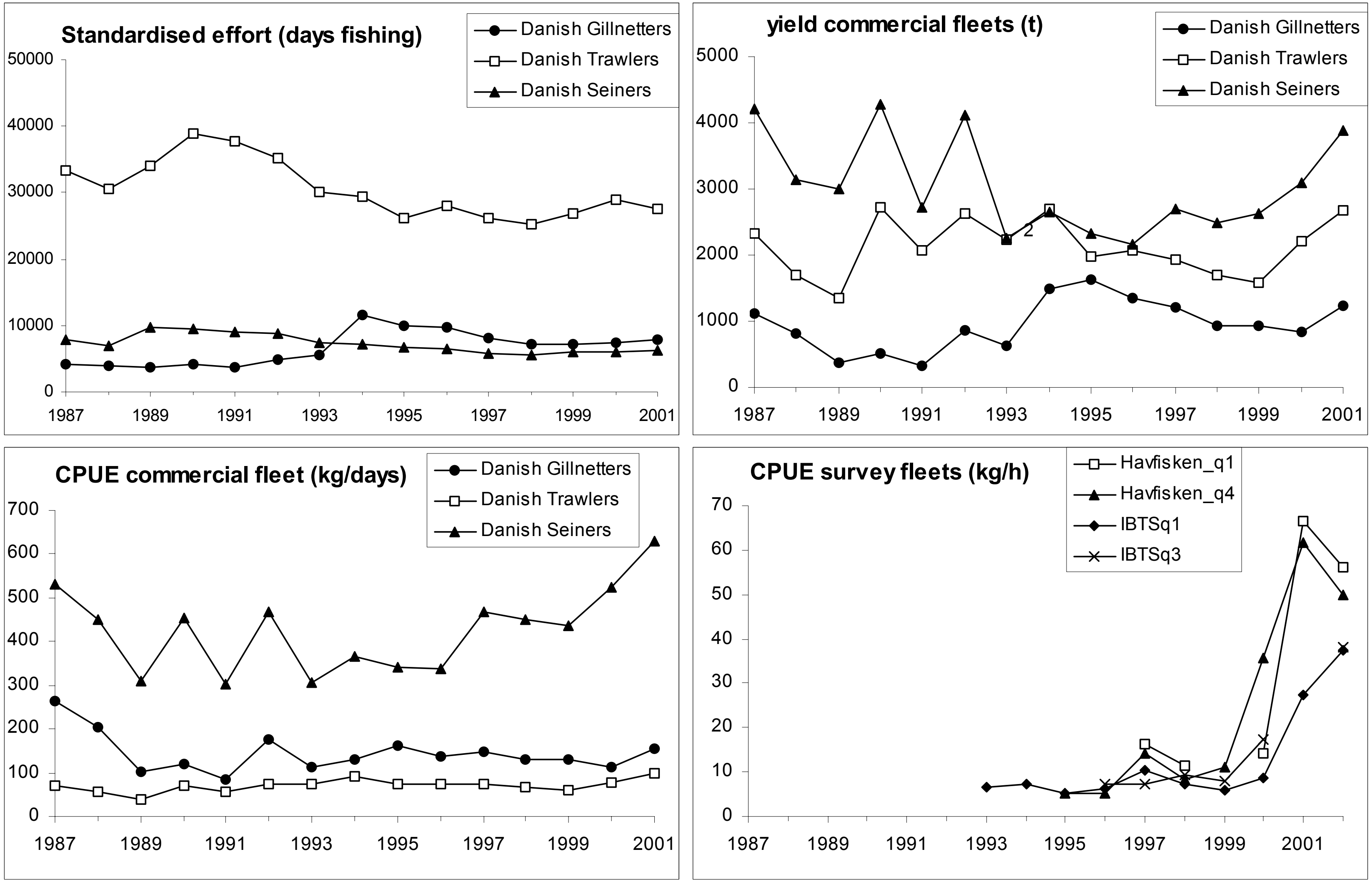


Figure 10.3.2 Plaice in IIIa. Relative survey indices by age.

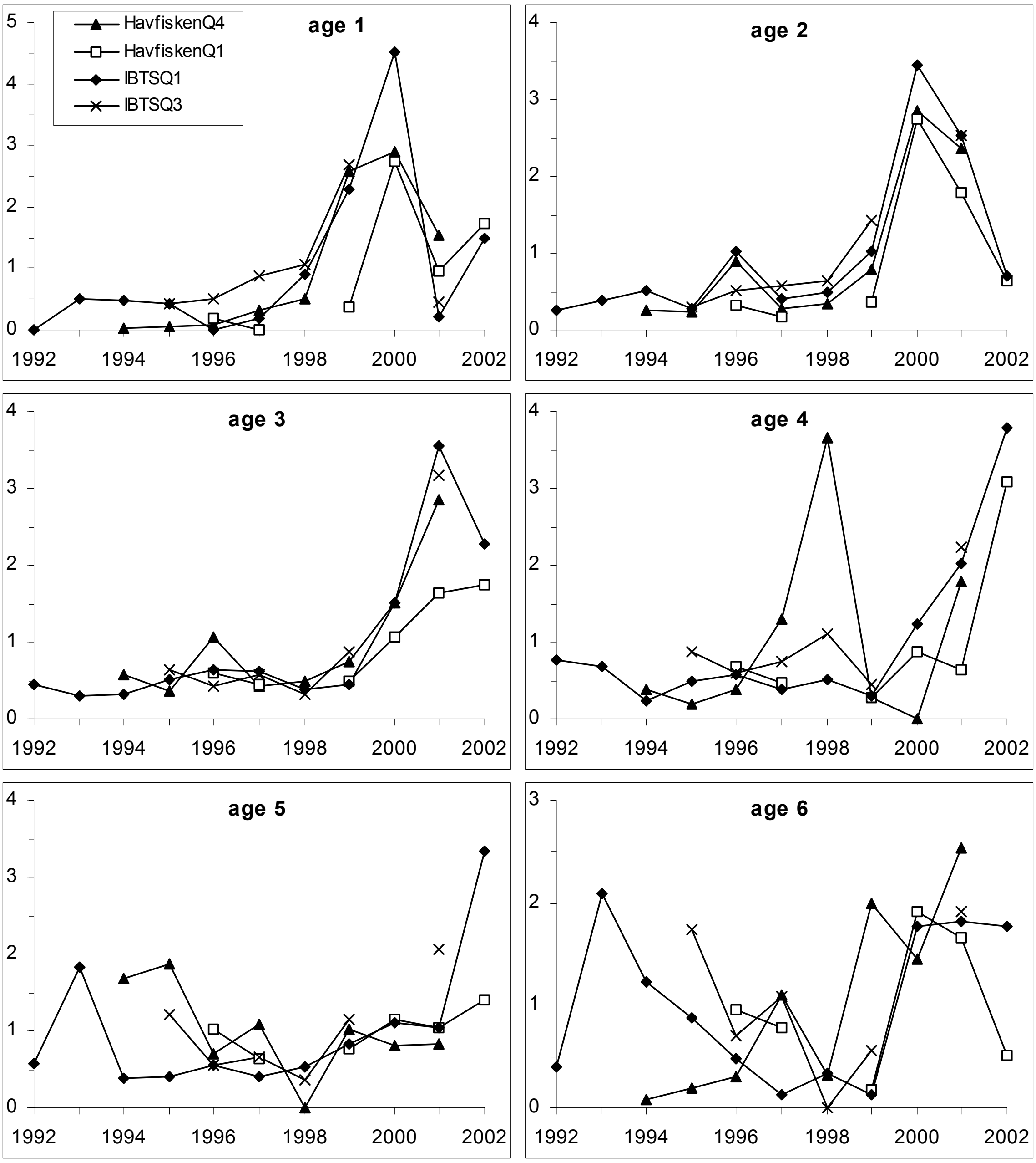


Figure 10.4.1 Plaice IIIa. log residuals by fleet and age (Single-fleet XSA runs. Shrinkage 1.5)

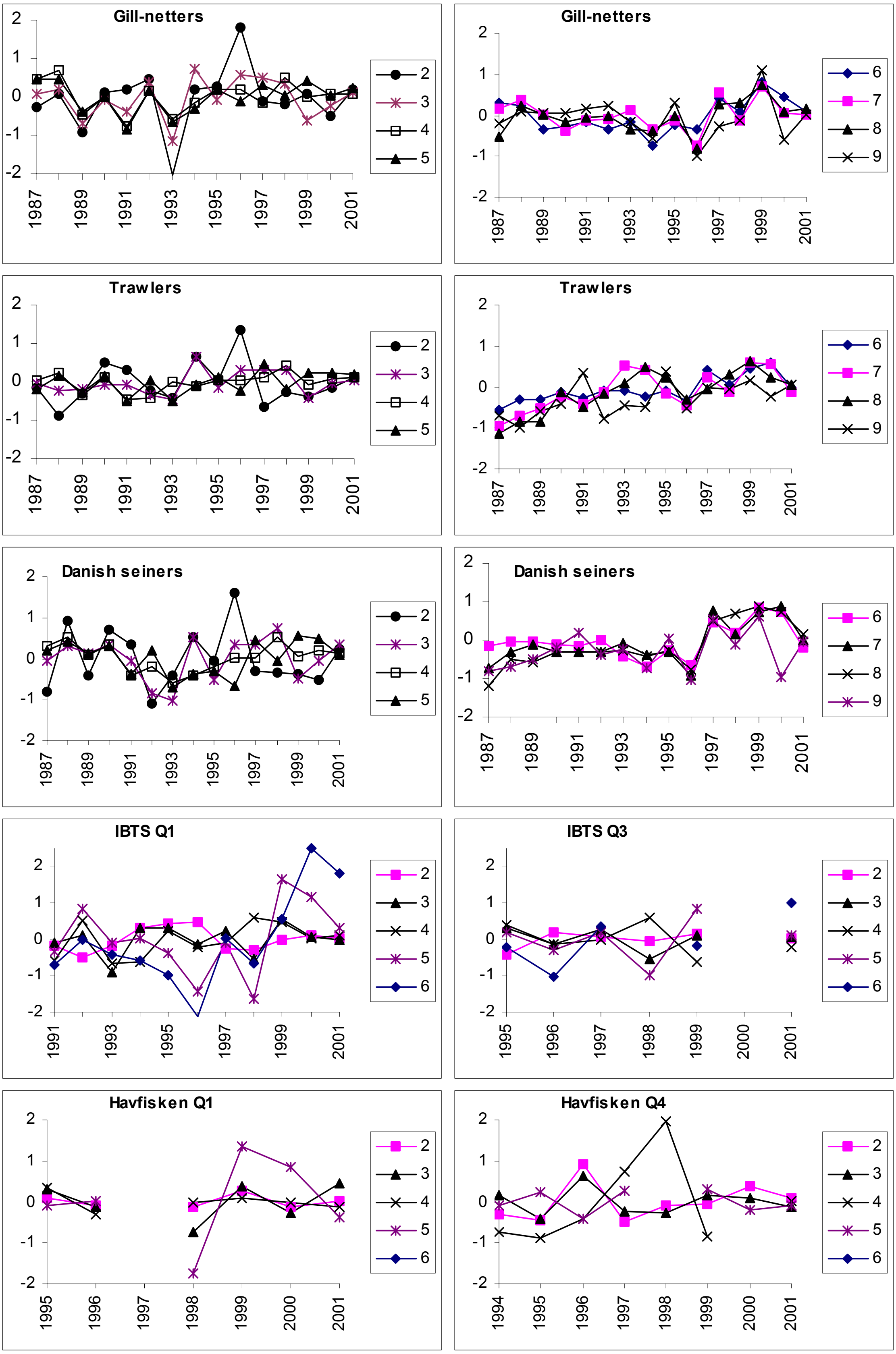


Figure 10.4.2 Plaice in IIIa. SSB versus F 4-8 in 2001. Single-fleet runs (shrinkage 1.5) and combined-fleet runs (shrinkage 0.5).

Run 1 : all fleets. Run 2 : same configuration as in WG 2001. Run 3 : commercial fleets only. Run 4 : surveys only. WG2001 : status quo forecast from the WG 2001.

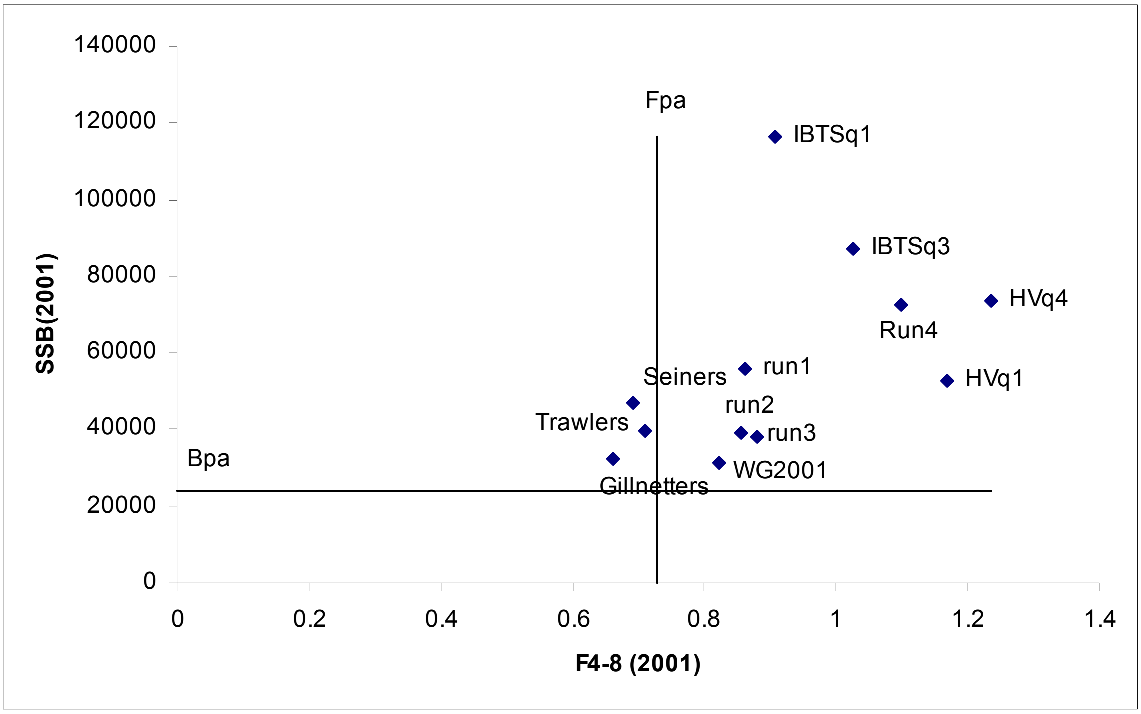


Figure 10.4.3 Plaice IIIa. log residuals by fleet and age in the final run

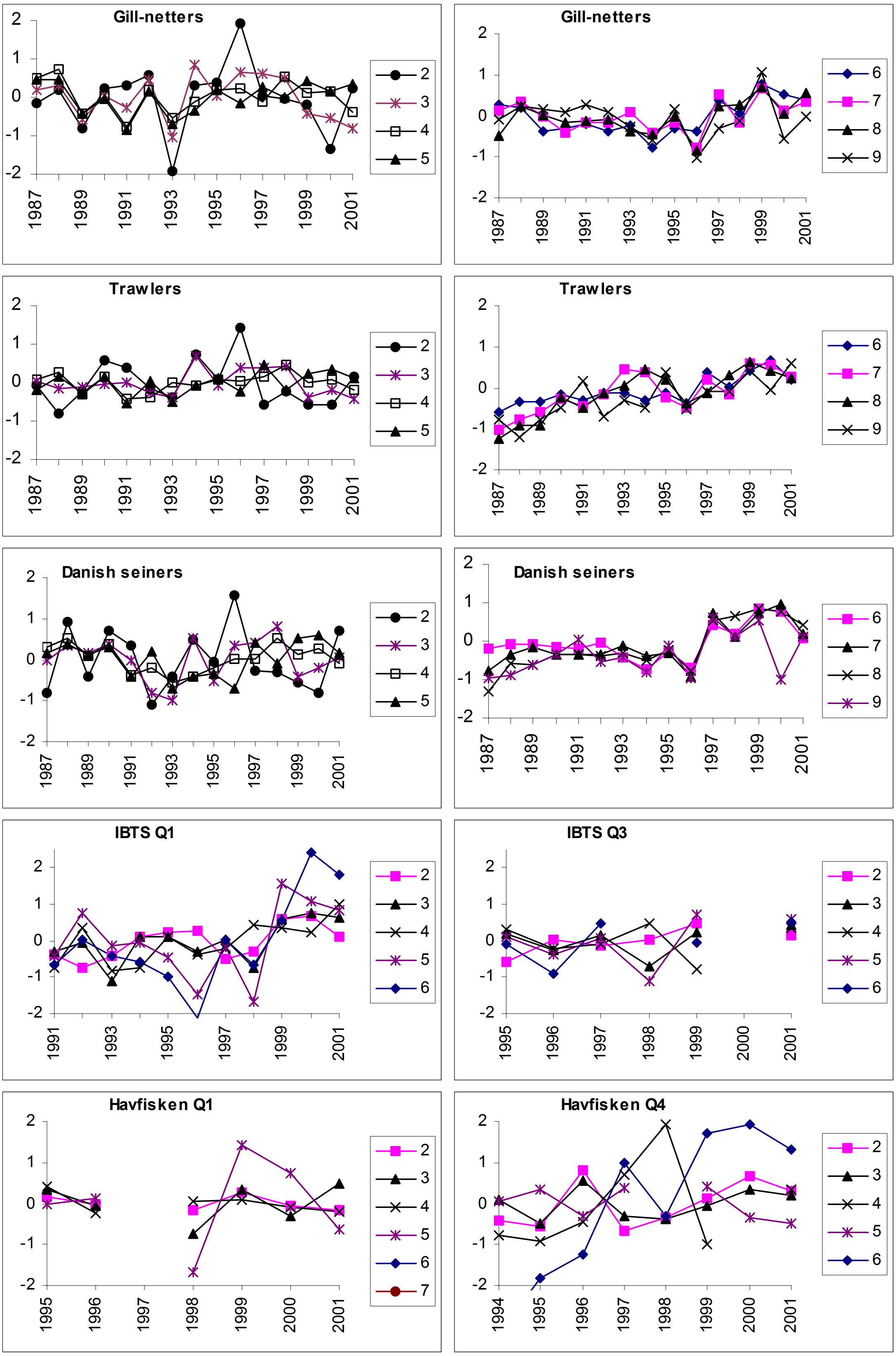
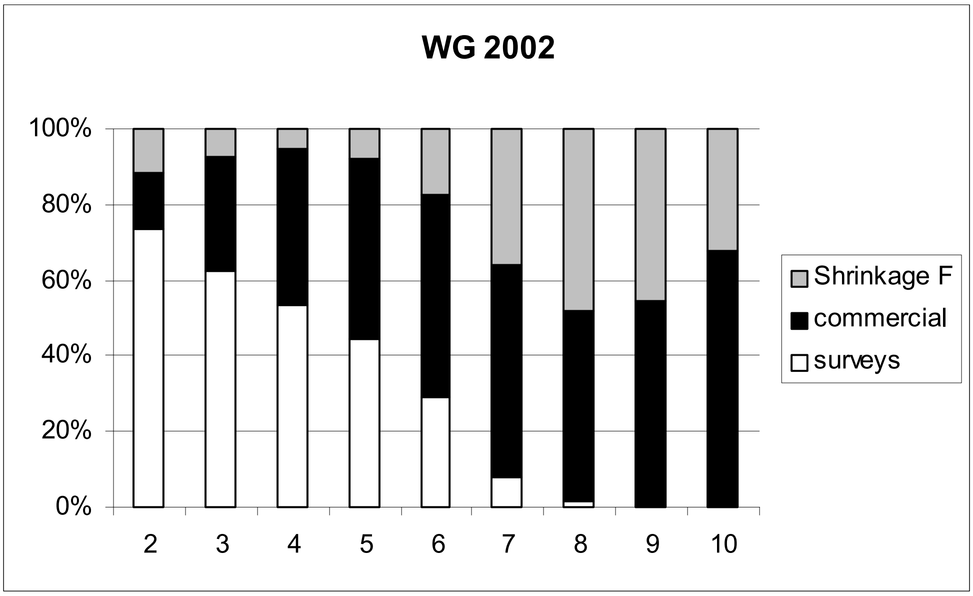


Figure 10.4.4 Plaice IIIa. weighting in tuning fleets.



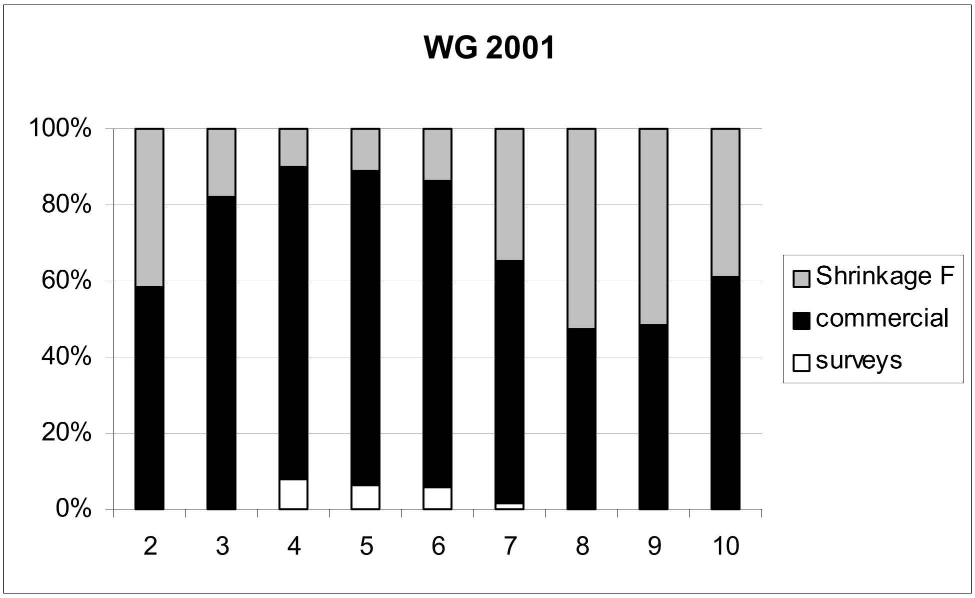


Figure 10.4.5 Plaice in IIIa. Log cpue vs log N xsa, final run

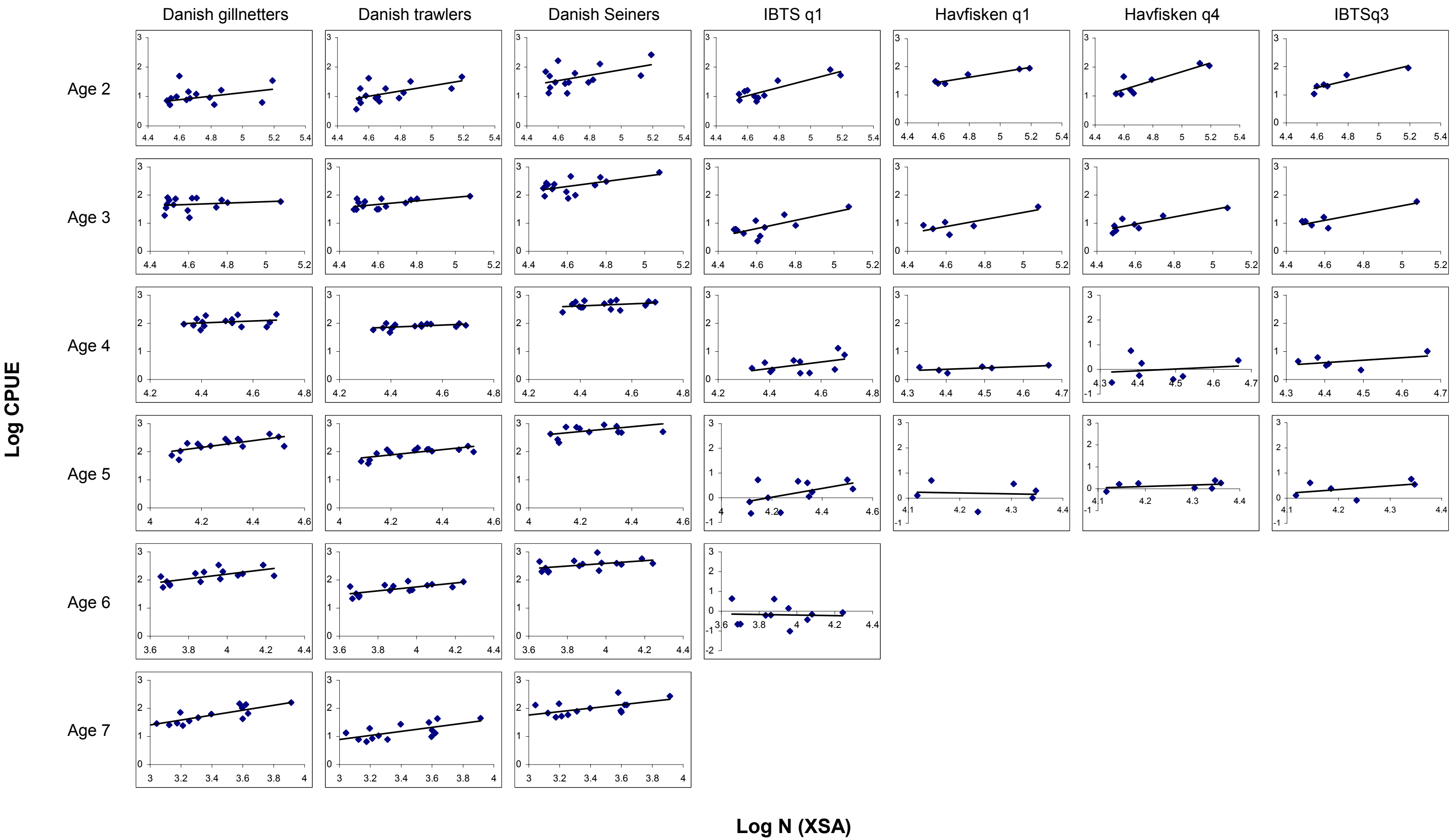


Figure 10.4.6 Plaice in IIIa. Retrospective pattern for the final XSA run.

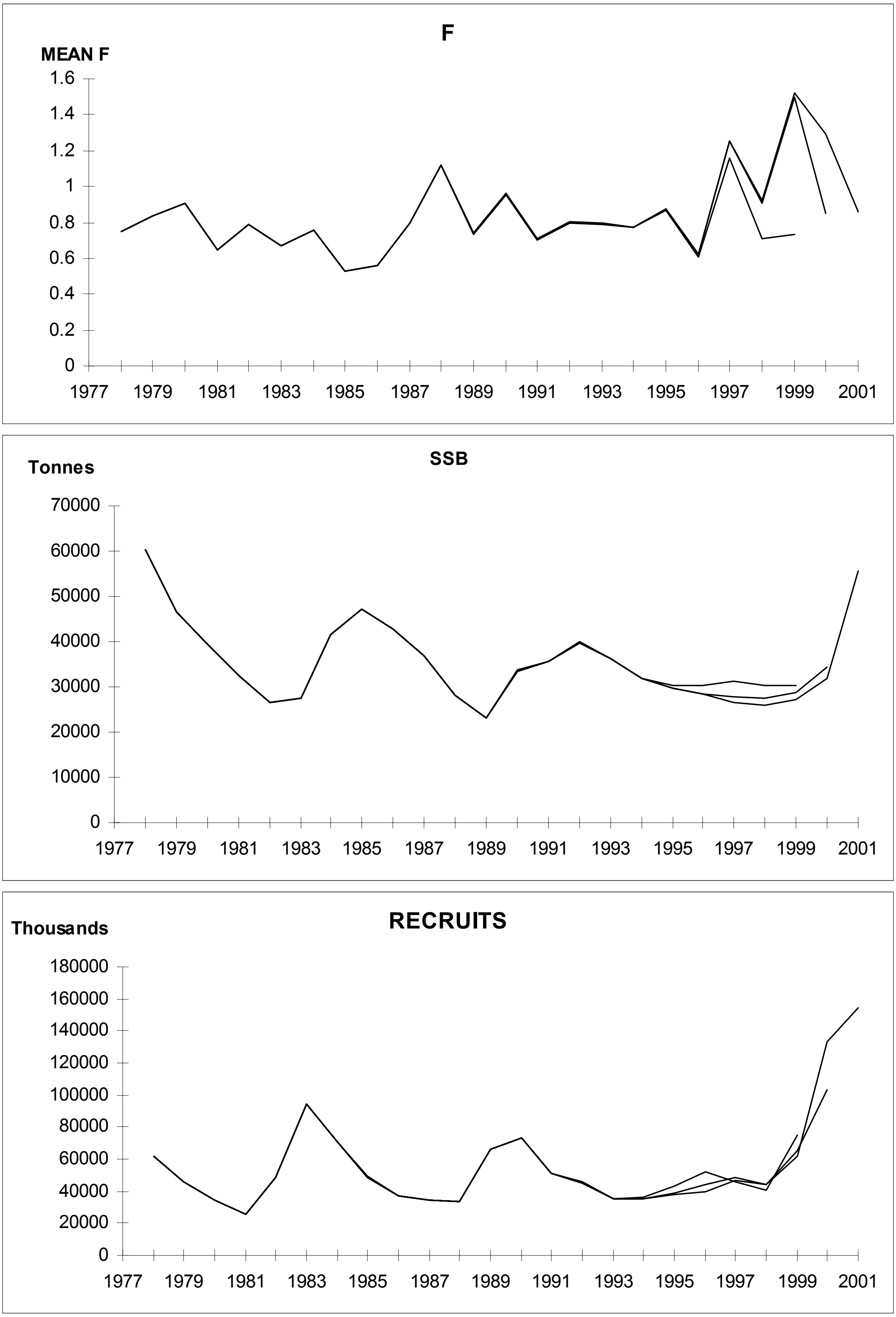


Figure 10.6.1 Plaice in Division IIIa. Stock trends plot.

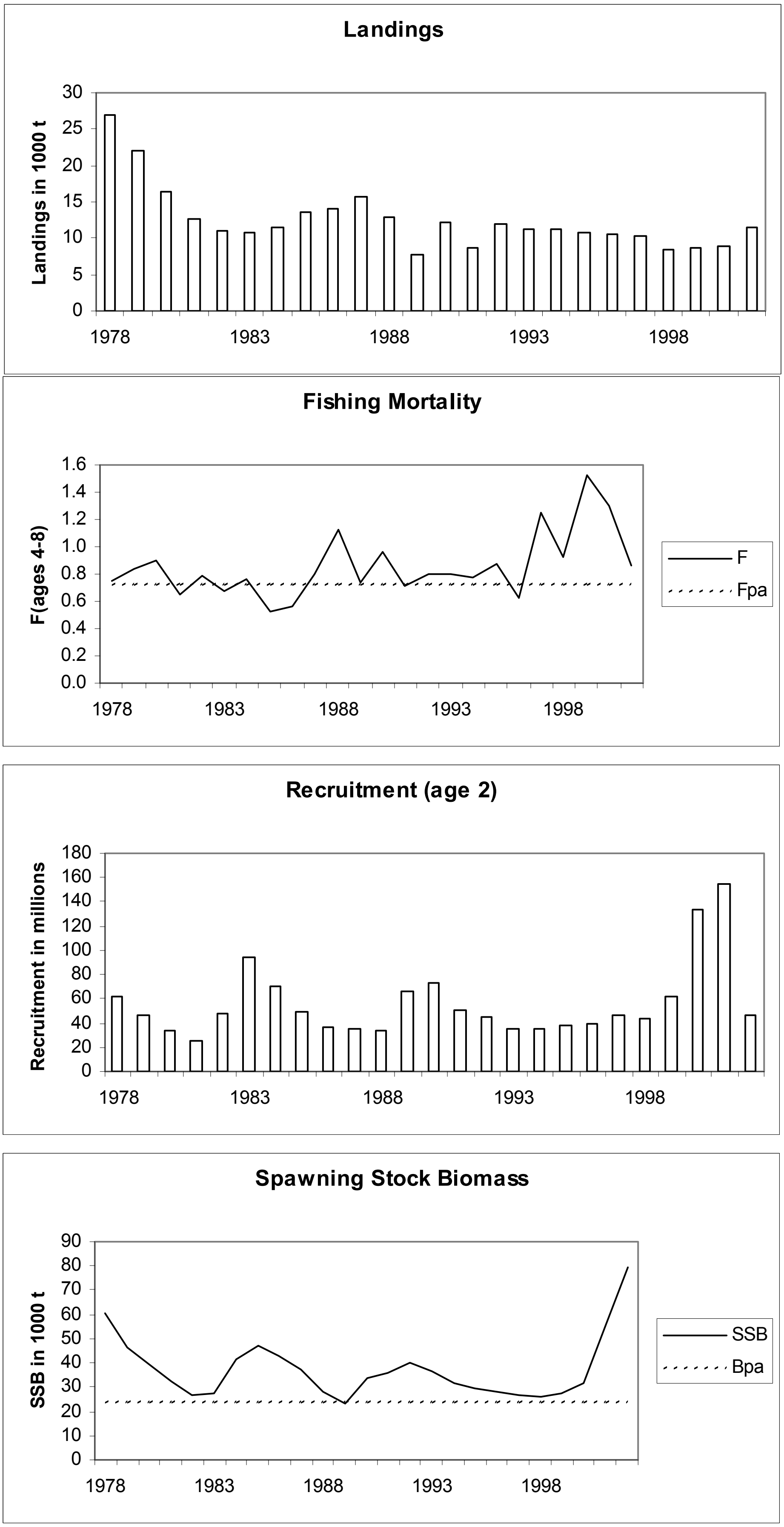


Figure 10.7.1 Plaice in IIIa. Short-term forecast.

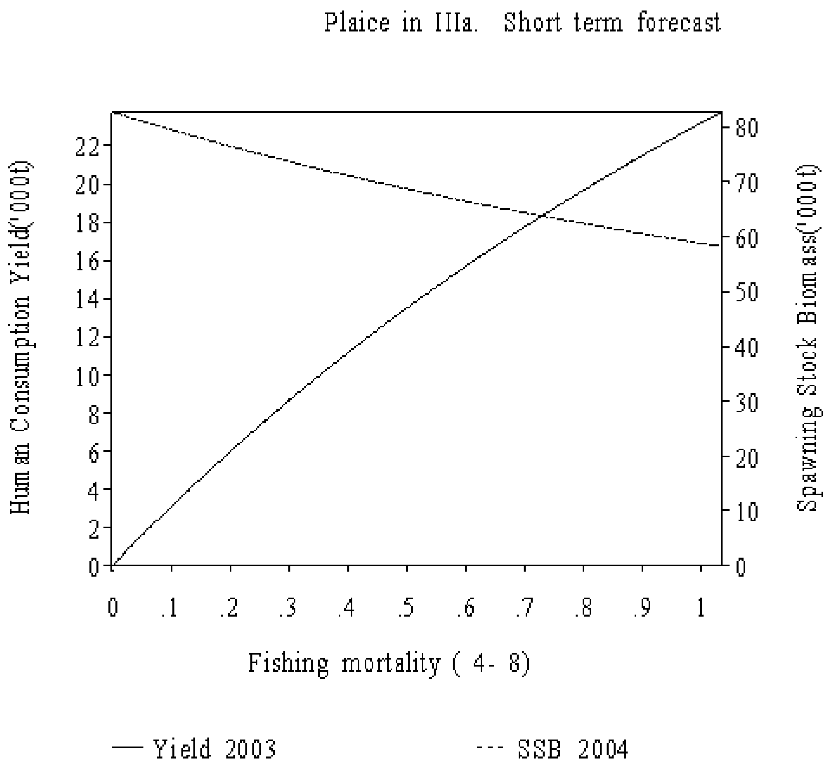


Figure 10.7.2 Plaice in IIIa. Probability profiles for the short-term forecast.

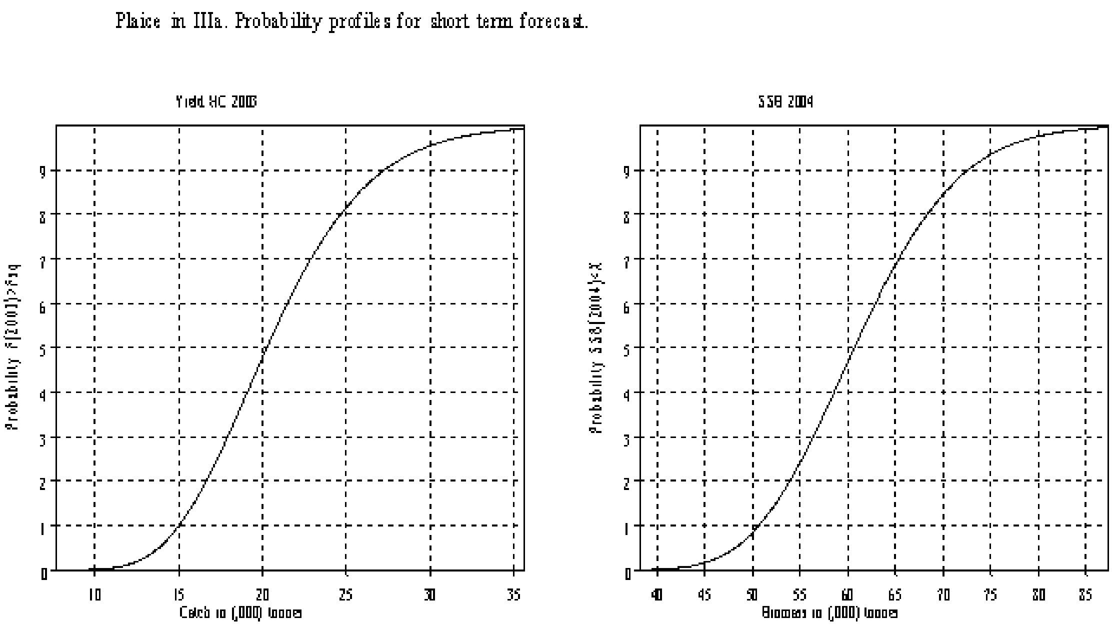
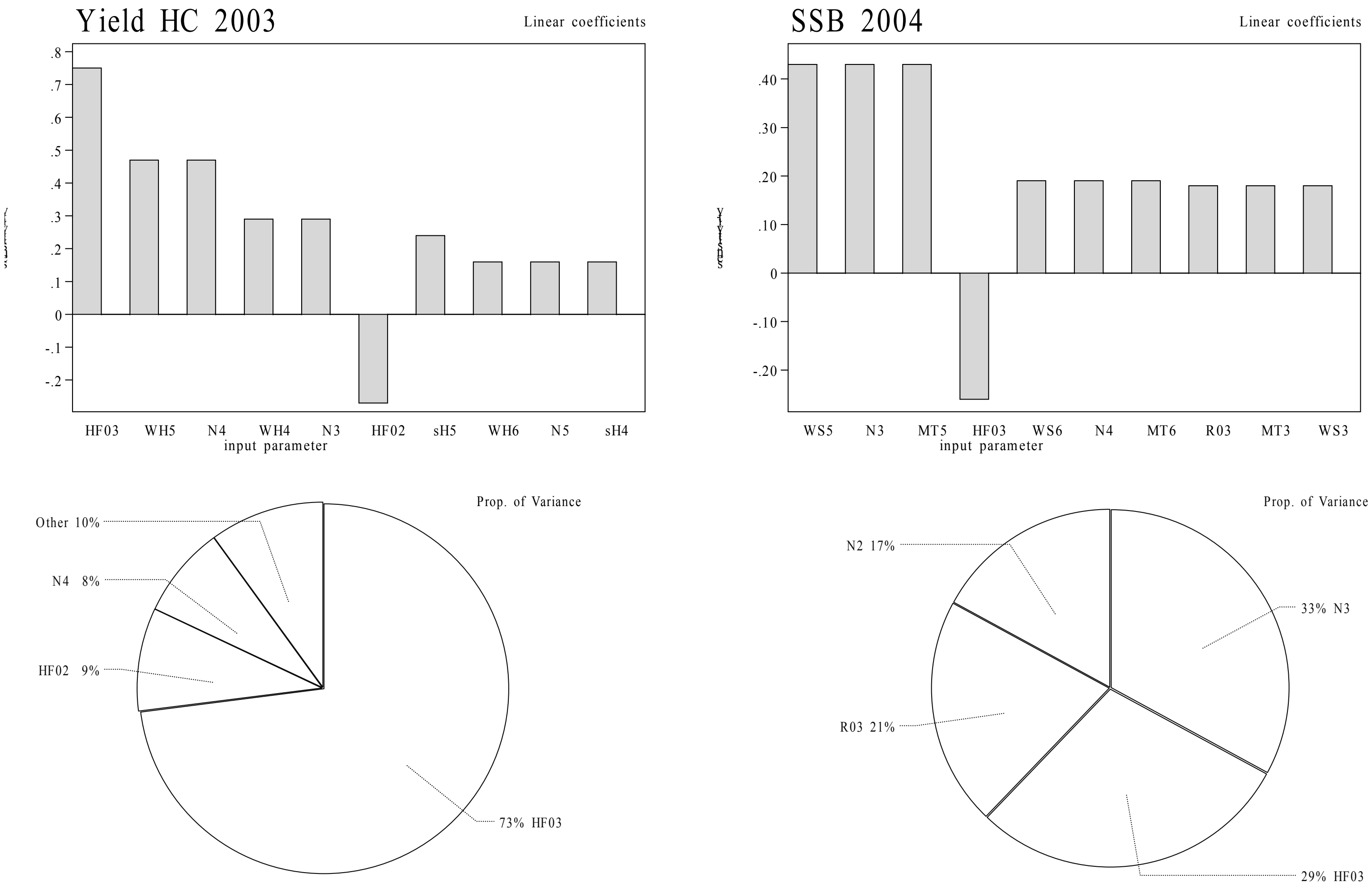


Figure 10.7.3 Plaice in IIIa. Sensitivity analysis for the short-term



Data from file:C:\CLARA\ICES_WG\WGNSSK\2002\PleIIIa\assessment\outputs\forecast\

Figure 10.8.1 Plaice in IIIa. Stock/recruitment relationship.

PLE3A.SUM: lognormal Ricker parameters

Initial estimate for alpha = ,1.1323E+01
Initial estimate for beta = ,5.8011E-02

Final estimate for alpha = ,1.1323E+01,+/- ,3.7628E+00
Final estimate for beta = ,5.8011E-02,+/- ,9.2329E-03

Variance-covariance matrix:
, 1, 2
 1, 1.41586E+01, 3.36951E-02
 2, 3.36951E-02, 8.52458E-05
Corr[alpha,beta] =, 0.97

RSS =, 2.8826E+00
Mean absolute residual =, 1.8228E+01
Residual variance =, 1.3103E-01
Akaike (AIC) =, 6.7492E+01
-2 log likelihood =, 1.7722E+01

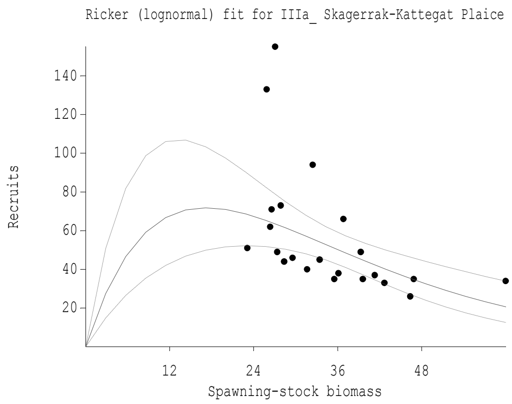
IFAIL from nonlinear fit =, 0

PLE3A.SUM: calculation of Ockham parameter

Mean = , 5.06907E+01

Variance of mean (log scale) = , 9.53056E-03

Residual sum-of-squares = , 4.40312E+00
Mean absolute residual = , 2.10520E+01
Residual variance = , 1.07015E+03
Akaike's Information Criterion = , 6.59156E+01



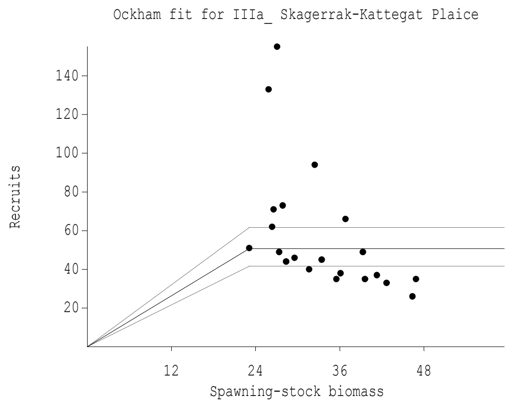


Figure 10.9.1 Plaice in IIIa. Yield-per-recruit.

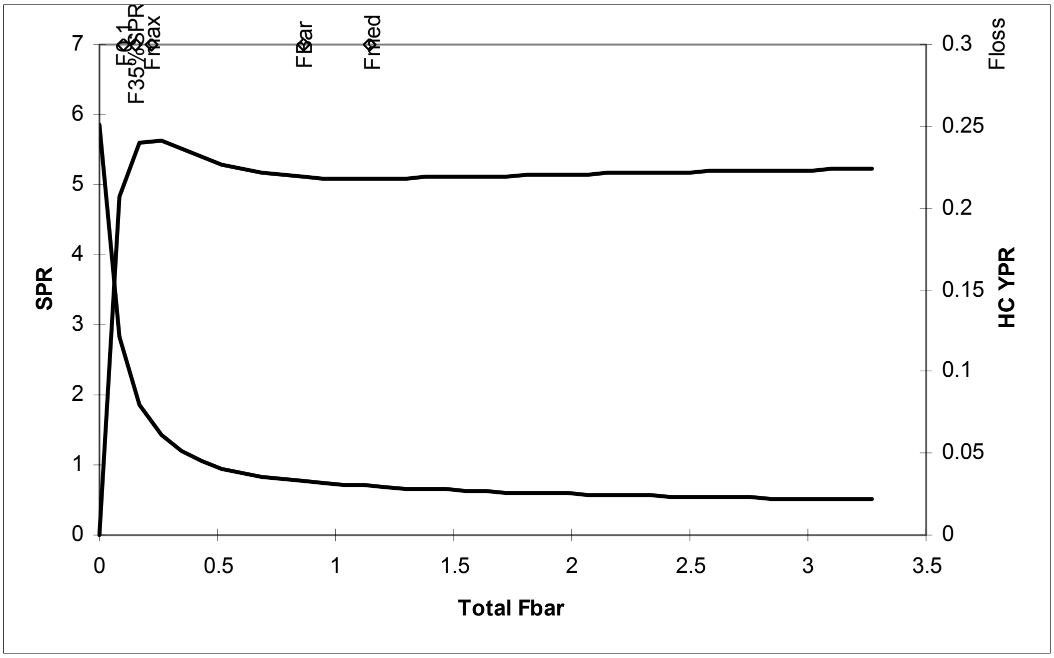


Figure 10.9.2 Plaice in Division IIIa. Stock-recruitment plot.

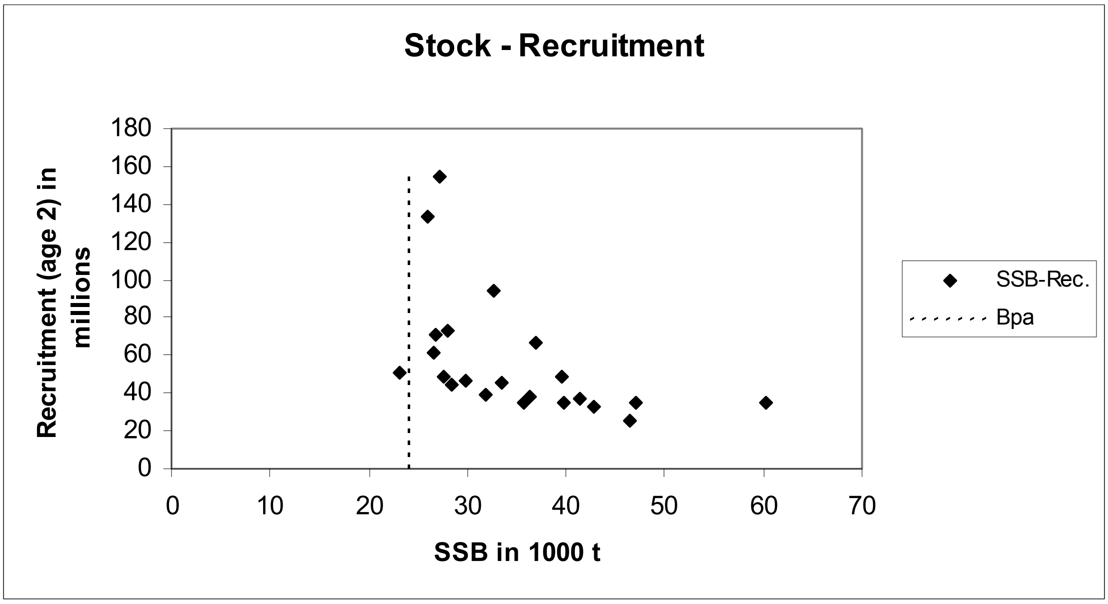


Figure 10.9.3 Plaice in Division IIIa. Precautionary approach plot.

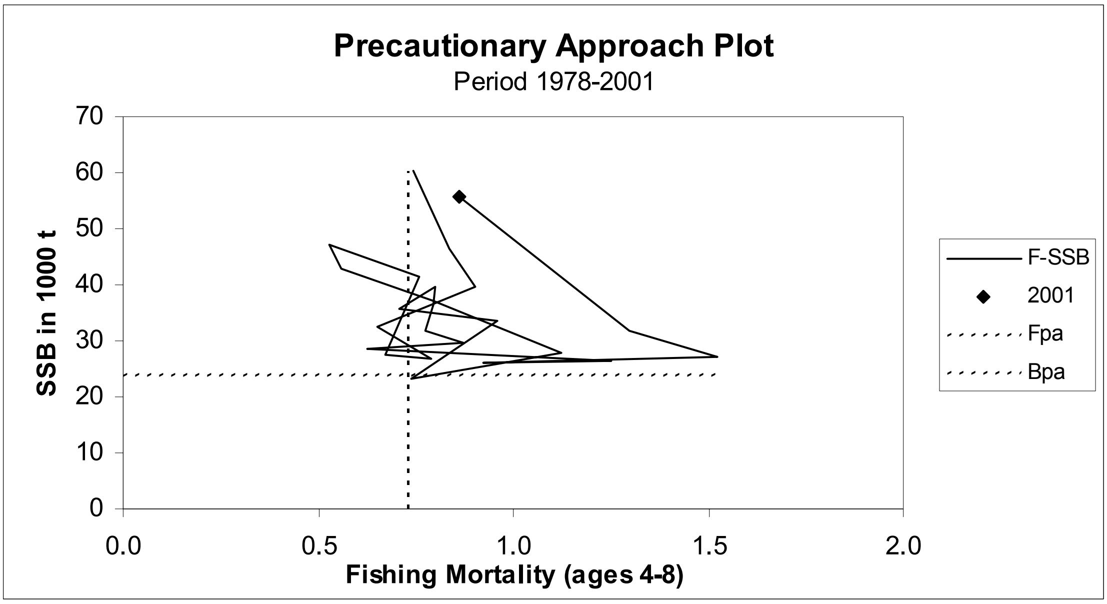
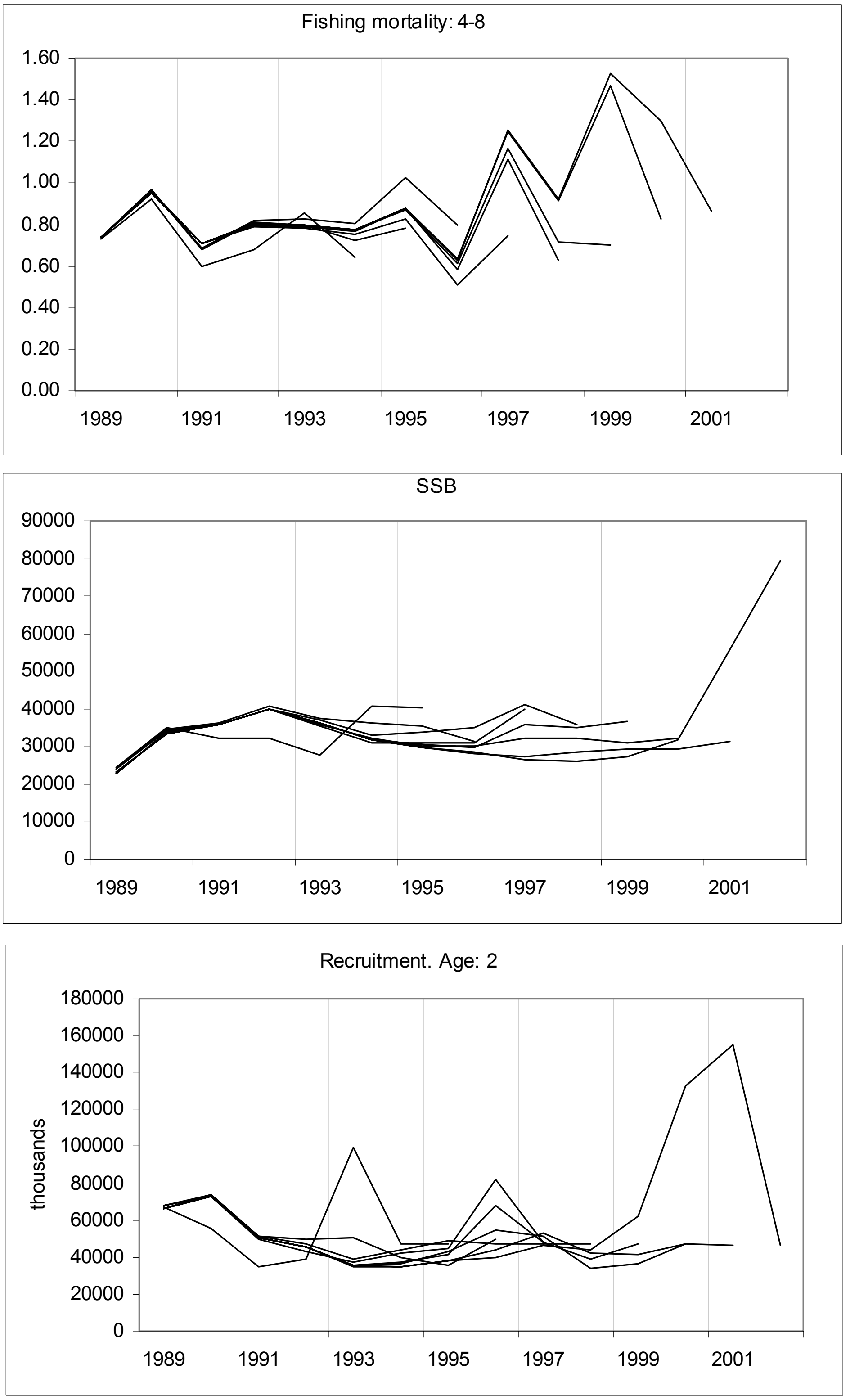


Figure 10.10.1 Plaice in IIIa. Quality control of assessments generated by successive working groups.



11 PLAICE IN VIID

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 2001 and 2002

ACFM advice for 2001 and 2002 was that the stock was harvested outside safe biological limits.

The fishing mortality in 2001 should be reduced to less than the proposed $\mathbf{F}_{pa}$ (0.45), corresponding to landings in 2001 of less than 4 400 t.

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 5 800 t.

The precautionary fishing mortality and biomass reference points proposed by ACFM are as follows:

$\mathbf{B}_{lim}$ = 5 600 t, $\mathbf{B}_{pa}$ = 8 000 t, $\mathbf{F}_{lim}$ = 0.54, $\mathbf{F}_{pa}$= 0.45.

11.1.2 Management applicable to 2001 and 2002

There is no separate TAC for VIId plaice which at present is managed together with Area VIIe. The TAC in 2001 and 2002 were set respectively to 6 000 t and 6 690 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 2001

Landings data as reported to ICES together with the total landings estimated by the Working Group are shown in Table 11.1.1. No correction was made for SOP discrepancies which have been very low since 1992.

Landings peaked at 10 400 t in 1988 and have declined to 5 266 t in 2001 (Figure 11.6.1). This was significantly below the 6 500 t predicted at *status quo* F from last year's assessment. France contributed 61% of the official landings in 2001, followed by Belgium (27%) and UK (12%).

The first quarter is the most important for the fisheries and the landings (in weights) in 2001 for this period was 41% of the annual total, compared to 44% in 2000.

11.2 Natural Mortality, Maturity, Age Composition and Mean Weight-at-age

The natural mortality was assumed to be constant over ages and years at 0.10 as for the North Sea stock (Table 11.2.1). The maturity ogive used is similar to that for VIIe plaice and is the same for all years (Table 11.2.1).

Quarterly catch numbers and weights were available for a range of years depending on country; 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.

Country	Numbers	Weights-at-age
Belgium	1981-2001	1986-2001
France	1989-2001	1989-2001
UK	1980-2001	1989-2001

The age composition of the landings is shown in Table 11.2.2 and in Figure 11.2.1. It appears that during 2001 there has been a shift in the age composition as the fishery has targeted mostly 3-year-old plaice in the 1st quarter, 2-year-old plaice in the 2nd quarter, and 1-year-old plaice during the 3rd and 4th quarters. The result is that a great number of 1-year-old plaice has been landed at the end of 2001.

The mean weight-at-age in the catch and in the stock are given in the Tables 11.2.3 and 11.2.4. The mean weight-at-age in the stock has been revised as the method used for smoothing in previous years was not adequate. The revision has been made from the year 1990 and consisted in replacing the weight in the stock by the 1st quarter weight in the catches. The largest difference is observed in 1999 (Figure 11.2.2). The difference in historical SSB is shown in Figure 11.2.3. This revision has changed the SSB estimate for 2001 from an increase over 2000 to a decrease. No trends appear in the weights from 1990 (Figure 11.2.4) except during the last year, where an increase in weight for all ages is observed.

The data do not include discards (they are not sampled for this stock) although they are probably quite substantial.

11.3 Catch, Effort, and Research Vessel Data

Commercial effort and cpue data are available from three commercial fleets covering inshore and offshore trawlers. French effort data for 1999 has been provided and effort data for 2000 has been revised as the new French database is now fully documented and operational. Trends in effort and cpue are shown in Table 11.3.1 and Figure 11.3.1 (see also overview Section 2.3). All fleets show a decline in cpue from 1988/89 to 1996. Since then all the cpue have increased from 1997 to 2000 and decreased in 2001. Effort increased in all fleets from 1983 to 1989. The UK effort has been declining since 1994, French effort has remained stable with a peak in 2000, and the Belgian effort has increased sharply over the last 4 years.

Survey data were obtained since 1988 from two trawls surveys covering most of VIId. These were the English beam trawl survey (BTS) in August and French otter trawl ground fish survey (GFS) in October. Recruit survey estimates for 0 and 1-group fish were also available from coastal research surveys in VIId, the English and the French YFS.

UK beam trawl survey samples the main flatfish distribution area in Division VIId and provides a stratified index for ages 1 to 6.

In the previous years the Eastern Channel was split into five zones and abundance indices were first calculated for each zone, and then averaged 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. Figure 11.3.2 suggests that there is only little difference between the old and the revisited abundance indices. The French GFS series for plaice has been revised in 2002 in the same way as for whiting.

In 2000, the Working Group rejected the English YFS for plaice in VIId, and in 2001 the Working Group rejected the French YFS. These two surveys operate with the same gear (beam trawl) during the same period (September) in two different nursery areas. Previous analyses (Riou *et al*, 2001) have shown that asynchronous spawning occurs for flatfish in Division VIId. In last year's report it was proposed to analyse the accuracy of a combined YFS. The combination consisted in weighting the individual index with the area nursery surface sampled by the survey. The map that has been used for the calculation is shown in Figure 11.3.3, and taking into account the low, medium, and high potential area of recruitment, the French YFS has a weight index of 55% and the English YFS a weight index of 45%.

The range of ages and years used in each fleet is shown in the input file for tuning (Table 11.3.1).

11.4 Catch-at-Age Analysis

11.4.1 Exploration of data

As previously the analysis was carried out with XSA. A number of trial runs were made to select the most appropriate model for the data and a multi-stage process was used to select the final tuning options:

a) Catch data : A separable VPA has been run to explore the characteristics of the catch data. Figures 11.4.1a and 11.4.1b show a long-term trend in catch structure pattern for one-year-old plaice. During the 80's very few 1-year-old plaice were caught, whereas from the early 90's these plaice were landed. From 1990, F ratios from this age group are around 1, leading to the conclusion that this age is more uniformly represented in the landings.

b) Trends in catchability were examined for residual trends by fleet and age. Trends were examined using XSA with single-fleet tuning runs with low (1.5) shrinkage (Figure 11.4.2). Although there are some trends in catchability all of the fleets and ages were included in the final analysis. The new International YFS appears to be very stable and shows very little noise in the historical series.

c) Choice of age to be treated as recruits: A run was made with the combined fleets where all ages were not treated as recruits (constant catchabitity). There is borderline evidence for negative slopes at age 1 from the UK beam trawl survey and age 2 from the French trawlers. The other two series with data for 1-year-old fish (French GFS and YFS) have very low R^2 values and non-significant slopes. There are no consistent trends over all fleets for a given age, therefore no power model was used.

The SSB and Fbar(2-6) estimates for 2002 for a selection of exploratory runs are given in Figure 11.4.4. The scatter of points from the tuning fleets reflects the conflicting information provided by the surveys and the commercial fleets. The surveys generally give an optimistic view of the fishery with the exception of the YFS, although it only samples age 1 and has little weight in the final run. The commercial tuning fleets produce estimates of F and SSB in 2001 which are close to the final run. The use of a low shrinkage (2.0) gives more influence to the surveys. It should be noted that the use of 3 commercial tuning fleets gives them a strong influence in the final run, compared to the use of a single commercial tuning fleet with all surveys that give a very high influence to the surveys. The three commercial fleets were chosen as they cover different parts of the Channel.

11.4.2 Final assessment

The following table summarises the final XSA configuration used this year, in comparison to that used last year.

stock	**plaice**			
area	**VIId**			
year of assessment	**2001**		**2002**	
Assessment model	XSA		XSA	
UK inshore trawl	1988-2000	2-9	1988-2001	2-9
BEL beamtrawl	1988-2000	2-9	1988-2001	2-9
FR trawlers	1989-2000	2-9	1989-2001	2-9
UK BTS	1988-2000	1-6	1988-2001	1-6
FR GFS	1988-2000	1-5	1988-2001	1-5
INT YFS	not used		**1988-2001**	**1**
Time series weights	none		none	
Power model used for catchability	1		**not used**	
Catchability plateau age	7		7	
Surv. est. shrunk towards mean F	5 years / 3 ages		5 years / 3 ages	
s.e. of the means	0.5		0.5	
Min. stand. error for pop. estimates	0.3		0.3	
Prior weighting	none		none	
Number of iterations	30		30	
Convergence	no		no	

The list of tuning fleets, input parameters, and output from the final run are shown in Table 11.4.1. Fishing mortality and stock numbers are in Tables 11.4.2 and 11.4.3, respectively. The weights of tuning categories are presented in Figure 11.4.5. Surveys dominate the tuning weighting for younger ages whilst commercial fleets dominate for older ages. The weight of F shrinkage is nearly the same for all ages.

There is a high degree of consistency between the current assessment and the preceding two years (Figure 11.10.1). Estimates of SSB and F, in particular the very high estimate of F in 1997, have been repeated.

Retrospective analysis was carried out using final XSA options with a strong shrinkage of 0.5 and truncating the time-series. Like the 2000 WG the full (1988-) year range was used, thus maintaining consistency with the final run. There was a period of overestimation of fishing mortality until 1996 and a period of underestimation of fishing mortality in the recent years (Figure 11.4.6).

11.5 Recruitment Estimates

Research vessel survey indices of 0- and 1–year-olds were available and are shown in Table 11.5.1.

Year class 2001 :RCT3 estimates of 1-year-olds (Table 11.5.2) is largely influenced by the VPA mean as R^2 of the 2 surveys is very poor and the recruitment estimates are different. The recruitment estimate for the 2001 year class (1-year-old in 2002) is therefore taken as the GM recruitment (23 427).

Year class 2000 : RCT3 estimates of 2-year-olds (Table 11.5.3) in 2002 is largely influenced by the UK BTS, getting 50% of the weight and having an R^2 value of 0.67. The French GFS and the YFS get very little weight. For estimates of 2-year-olds, there is a conflicting signal coming from XSA and RCT3 as surveys did not predict a good 2000 year class and the commercial fleets have landed a large amount of 1-year-olds in the second part of 2001. The XSA values have thus been used.

		RCT3	XSA	GM_{80-99}	AM_{80-99}
Year-Class	Age in 2002	Weighted average			
2000	2	22160	31628	20378	21956
2001	1	21455		23427	25108
2002	Recruit		-	23427	

- numbers are * 10^{-3}. Underlined values are those accepted by the Working Group.

11.6 Historical Stock Trends

Trends in fishing mortality, SSB, and recruitment are shown in Table 11.6.1 and Figure 11.6.1. Fishing mortality has fluctuated widely in the past 10 years. After a peak in 1997 there has been a sharp decrease to the current year (0.48). This decrease of fishing mortality is not accompanied by a decrease in effort in the commercial tuning fleets. SSB increased rapidly in 1987 following recruitment of the strong 1985 year class. Since 1990 SSB has declined steeply until 1992 and is now below $\mathbf{B}_{pa}$. Recruitment has been close to the GM level of 24 million of 1-year-olds since 1987.

11.7 Short-Term Prognoses

The input data for the catch forecasts are given in Table 11.7.1. Stock numbers in 2001 were taken from the VPA for age 2 and older and the GM of 23.4 million was used for age 1 in 2001, 2002, and 2003. The exploitation pattern used was the mean F-at-age over 1999-2001, rescaled to mean F(2-6) in 2001. Catch and stock weights-at-age were the mean for the period 1999-2001, and proportions of M and F before spawning were set to zero. The results of the *status quo* catch prediction are given in Table 11.7.2 and Figure 11.7.1.

The predicted catch in 2002 is estimated to be 5 180 t with a SSB of 7 490 t for the same year. This compares with a figure of 6 210 t forecast for the catch and 8 700 t for the SSB made last year. Continuing with the same level of F implies an increase in catch to 5 970 t in 2003 and a predicted SSB of 10 210 t in 2004.

Figure 11.7.2 shows the sensitivity analysis of the short-term prediction. The parameter which dominates the uncertainty surrounding the estimate of landings in 2003 is the F multiplier, taking the largest share (41%). Uncertainty in the estimate of SSB in 2004 is largely driven by uncertainty in the estimates of the 2-year-olds in the current assessment. Figure 11.7.3 shows the probability profiles for the *status quo* short-term prediction, the left panel shows the probability that $F_{2002}>F_{2001}$ for a given catch, while the right panel shows the probability that SSB in 2004 will be above a certain point. The probability that SSB 2004 will be below $\mathbf{B}_{pa}$ (8 000 t) is about 20%.

11.8 Medium-Term Prognoses

Medium-term analyses based on the Ricker stock-recruitment relationship were performed last year. The Ricker model is inappropriate for this stock: the position of the dome of the Ricker curve to the left of the historically-observed SSB range is not consistent with precautionary management advice (Figure 11.8.1). The Ockham model combines geometric mean recruitment over the SSB range and a linear decline to the origin at lower SSB, and thus incorporates simple averaging (suitable in the absence of a clear stock-recruitment relationship) with hypothesised reduced recruitment at low SSB.

The software WGMTERMC from the Aberdeen suite, traditionally used for the medium-term projections, does not allow for alternative stock-recruitment relationships, such as the Ockham curve. Therefore medium-term analyses are not presented here.

11.9 Biological Reference Point

The catch and stock weights used for the yield-per-recruit were the average for 1999-2001 as for the short-term prediction, but next year the use of long-term weights will be more accurate. The YPR curve is shown in Figure 11.9.1. The PA plot (SSB vs F) is given in Figure 11.9.2. The current estimate is that the stock is below $\mathbf{B}_{pa}$, and fishing mortality has recently come below $\mathbf{F}_{lim}$.

The available reference points are :

Estimated reference points				
$\mathbf{F}_{max}$	$\mathbf{F}_{0.1}$	$\mathbf{F}_{low}$	$\mathbf{F}_{high}$	$\mathbf{F}_{med}$
.19	.11	0.35	.87	0.57
Management reference points				
$\mathbf{F}_{lim}$	$\mathbf{F}_{pa}$	$\mathbf{B}_{lim}$	$\mathbf{B}_{pa}$	
0.54	0.45	5 600 t	8 000 t	

The current assessment has made minor changes to the estimated reference points.

11.10 Quality of the Assessment

The conflicting estimation of the 2000 year class between XSA (31.7 millions) and RCT3 (20.4 millions) gives a higher uncertainty to the recruitment estimates. This uncertainty can be partly resolved by the estimation of UK BTS in August as this survey has the most important weight in estimating Age 2.

The revision of stock weight as 1st quarter weight has modified the recent estimates of SSB (Figure 11.2.3) by increasing SSB in 1999 and decreasing SSB in 2000.

Different signals from the tuning fleets are reason for concern and should be investigated.

The apparent decrease in fishing mortality is not accompanied by a decrease in fishing effort.

This assessment doesn’t include discards.

11.11 Management Consideration

The current estimate of SSB and subsequent predictions are uncertain, due in particular to the problems with the conflicting signal on the recruitment.

The level of any discarding of plaice in VIId is an unknown but is considered likely to be significant.

The TAC is set for Division VIId and VIIe combined.

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]	1,439	376	-	1,963	-	1,963
1977	149	81 [2]	1,714	302	-	2,246	-	2,246
1978	161	156 [2]	1,810	349	-	2,476	-	2,476
1979	217	28 [2]	2,094	278	-	2,617	-	2,617
1980	435	112 [2]	2,905	304	-	3,756	-1,106	2,650
1981	815	-	3,431	489	-	4,735	34	4,769
1982	738	-	3,504	541	22	4,805	60	4,865
1983	1,013	-	3,119	548	-	4,680	363	5,043
1984	947	-	2,844	640	-	4,431	730	5,161
1985	1,148	-	3,943	866	-	5,957	65	6,022
1986	1,158	-	3,288	828	488 [2]	5,762	1,072	6,834
1987	1,807	-	4,768	1,292	-	7,867	499	8,366
1988	2,165	-	5,688 [2]	1,250	-	9,103	1,317	10,420
1989	2,019	+	3,265 [1]	1,383	-	6,667	2,091	8,758
1990	2,149	-	4,170 [1]	1,479	-	7,798	1,249	9,047
1991	2,265	-	3,606 [1]	1,566	-	7,437	376	7,813
1992	1,560	1	3,099	1,553	19	6,232	105	6,337
1993	0,877	+ [2]	2,792	1,075	27	4,771	560	5,331
1994	1,418	+	3,199	993	23	5,633	488	6,121
1995	1,157	-	2,598 [2]	796	18	4,569	561	5,130
1996	1,112	-	2,630 [2]	856	+	4,598	795	5,393
1997	1,161	-	3,077	1,078	+	5,316	991	6,307
1998	854	-	3,276 [23]	700	+	4,830	932	5,762
1999	1,306	-	3,388 [23]	743	+	5,437	889	6,326
2000	1,315	-	3,513 [2]	752	+	5,580	434	6,014
2001	1,346	-	3,265 [2]	655	+	5,266	-	5,266

[1]Estimated by the Working Group from combined Division VIId+e
[2]Includes Division VIIe
[3]Provisional

Table 11.2.1 Plaice in VIId. Natural mortality and proportion mature

Age	Natural Mortality	Maturity
1	0.100	0.000
2	0.100	0.150
3	0.100	0.530
4	0.100	0.960
5	0.100	1.000
6	0.100	1.000
7	0.100	1.000
8	0.100	1.000
9	0.100	1.000
10+	0.100	1.000

Table 11.2.2 Plaice in VIId. Catch numbers-at-age

	1	2	3	4	5	6	7	8	9	10+
1980	53	2644	1451	540	490	75	45	44	4	103
1981	16	2446	6795	2398	290	159	51	42	56	200
1982	265	1393	6909	3302	762	206	96	62	21	88
1983	92	3030	3199	5908	931	226	92	122	4	101
1984	350	1871	7310	2814	1874	533	236	101	34	100
1985	142	5714	6195	4883	413	612	164	99	139	50
1986	679	4884	7034	3663	1458	562	254	69	19	34
1987	25	8499	7508	3472	1257	430	442	154	105	77
1988	16	5011	18813	4900	1118	541	439	127	105	174
1989	826	3638	7227	9453	2672	588	288	179	81	197
1990	1632	2627	8746	5983	3603	801	243	203	178	231
1991	1542	5860	5445	4524	2437	1681	286	120	113	125
1992	1665	6193	4450	1725	1187	1044	698	200	116	118
1993	740	7606	3817	1259	542	468	334	287	102	152
1994	1242	3633	6968	3111	850	419	312	267	275	312
1995	2592	4340	2933	2928	922	228	277	225	122	258
1996	1119	4847	3606	1547	1436	488	179	176	165	347
1997	550	4246	7189	3434	1080	752	464	199	114	306
1998	464	4400	8629	3419	537	143	136	81	52	188
1999	741	1758	12104	6460	1043	171	86	81	38	111
2000	1383	6214	4284	7241	1652	307	82	27	42	98
2001	2682	4159	4380	2141	1985	310	87	22	13	73

Table 11.2.3 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

Table 11.2.4 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

Table 11.3.1 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 2001
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

FLT02: BELGIAN BEAM TRAWL(HP corr) all gears age comp [rev: 15/06/00-EB] (Catch: Unknown) (Effort: Unknown)
1981 2001
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	422.58	1759.9	1085.0	705.3	119.4	26.5	9.3	7.6	26.9

FLT03: FRENCH TRAWLERS (EFFORT H*KW*10-4) 1989-90 DERAISED 1991-98 TRUE (Catch: Unknown) (Effort: Unknown)
1989 2001
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

Table 11.3.1 (continued)– Plaice in VIId. Tuning fleets

```
FLT04: UK BEAM TRAWL SURVEY  true age 6 [rev: 23/5/01-RM] (Catch: Unknown) (Effort: Unknown)
1988 2001
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
FLT05: French GFS [option 2]  true age 5 [rev: 6/6/02-JV] (Catch: Unknown) (Effort: Unknown)
1988 2001
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
FLT06: Intl YFS [rev: 6/6/02-JV] (Catch: Unknown) (Effort: Unknown)
1987 2001
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
```

Table 11.4.1 Plaice in VIId. Tuning diagnostic

```
 Lowestoft VPA Version 3.1

   14/06/2002  10:43

 Extended Survivors Analysis

 Plaice in VIId (run: XSAAEDB01/X01)

 cpue data from file fleet.dat

 Catch data for  22 years. 1980 to 2001. Ages  1 to  10.

      Fleet,            First, Last, First, Last, Alpha,  Beta
                    ,     year, year,  age ,  age
 FLT01: UK INSHORE TR,   1988, 2001,   2,     9,   .000,  1.000
 FLT02: BELGIAN BEAM ,   1988, 2001,   2,     9,   .000,  1.000
 FLT03: FRENCH TRAWLE,   1989, 2001,   2,     9,   .000,  1.000
 FLT04: UK BEAM TRAWL,   1988, 2001,   1,     6,   .500,   .750
 FLT05: French GFS [o,   1988, 2001,   1,     5,   .750,  1.000
 FLT06: Intl YFS [rev,   1988, 2001,   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 =     .00019

 Final year F values
 Age         ,      1,      2,      3,      4,      5,      6,      7,      8,      9
 Iteration 29,  .0776,  .2635,  .5115,  .5936,  .6118,  .4313,  .4421,  .4281,  .4251
 Iteration 30,  .0776,  .2634,  .5115,  .5935,  .6118,  .4313,  .4421,  .4281,  .4250


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,  1992,  1993,  1994,  1995,  1996,  1997,  1998,  1999,  2000,  2001

      1,  .065,  .061,  .079,  .115,  .039,  .015,  .033,  .036,  .067,  .078
      2,  .443,  .412,  .415,  .379,  .290,  .184,  .146,  .154,  .415,  .263
      3,  .809,  .478,  .725,  .614,  .551,  .803,  .606,  .647,  .594,  .512
      4,  .607,  .493,  .803,  .682,  .681, 1.484, 1.044, 1.170,  .920,  .594
      5,  .523,  .342,  .645,  .517,  .754, 1.396,  .890,  .970,  .989,  .612
      6,  .642,  .356,  .429,  .313,  .504, 1.054,  .588,  .703,  .761,  .431
      7,  .481,  .383,  .378,  .496,  .384, 1.169,  .468,  .759,  .777,  .442
      8,  .468,  .330,  .532,  .456,  .600,  .855,  .559,  .499,  .501,  .428
      9,  .651,  .409,  .534,  .438,  .632,  .887,  .495,  .492,  .463,  .425
```

Table 11.4.1 (continued)- Plaice in VIId. Tuning diagnostic

1

XSA population numbers (Thousands)

YEAR	AGE 1	2	3	4	5	6	7	8	9
1992	2.79E+04	1.82E+04	8.44E+03	3.99E+03	3.06E+03	2.32E+03	1.92E+03	5.63E+02	2.55E+02
1993	1.32E+04	2.37E+04	1.06E+04	3.40E+03	1.97E+03	1.64E+03	1.10E+03	1.07E+03	3.19E+02
1994	1.73E+04	1.13E+04	1.42E+04	5.92E+03	1.88E+03	1.26E+03	1.04E+03	6.80E+02	6.99E+02
1995	2.51E+04	1.45E+04	6.72E+03	6.23E+03	2.40E+03	8.92E+02	7.45E+02	6.46E+02	3.62E+02
1996	3.05E+04	2.02E+04	8.95E+03	3.29E+03	2.85E+03	1.29E+03	5.90E+02	4.10E+02	3.70E+02
1997	3.83E+04	2.65E+04	1.37E+04	4.67E+03	1.51E+03	1.21E+03	7.07E+02	3.64E+02	2.04E+02
1998	1.48E+04	3.41E+04	2.00E+04	5.55E+03	9.58E+02	3.38E+02	3.82E+02	1.99E+02	1.40E+02
1999	2.20E+04	1.30E+04	2.67E+04	9.85E+03	1.77E+03	3.56E+02	1.70E+02	2.17E+02	1.03E+02
2000	2.23E+04	1.92E+04	1.01E+04	1.27E+04	2.76E+03	6.06E+02	1.60E+02	7.20E+01	1.19E+02
2001	3.78E+04	1.89E+04	1.15E+04	5.03E+03	4.56E+03	9.30E+02	2.56E+02	6.64E+01	3.95E+01

Estimated population abundance at 1st Jan 2002

0.00E+00	3.16E+04	1.31E+04	6.24E+03	2.51E+03	2.24E+03	5.47E+02	1.49E+02	3.92E+01

Taper weighted geometric mean of the VPA populations:

2.39E+04	2.03E+04	1.37E+04	6.43E+03	2.50E+03	1.04E+03	5.27E+02	2.89E+02	1.41E+02

Standard error of the weighted Log(VPA populations) :

.3676	.3654	.4520	.5201	.5259	.6676	.7403	.7907	1.0833

1

Log catchability residuals.

Fleet : FLT01: UK INSHORE TR

Age	1988	1989	1990	1991
1	No data for this fleet at this age			
2	.14	-1.64	-.73	.48
3	.27	-.35	-.32	.47
4	-.15	.64	-.41	.41
5	.20	.42	-.05	-.03
6	.07	.68	.24	.03
7	-.24	.43	.39	-.32
8	-.62	-.47	.43	-.42
9	-.01	-.62	.39	-.64

Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	No data for this fleet at this age									
2	.43	.20	.33	.26	.59	.22	-.25	-.01	.34	-.37
3	.55	-.02	.02	.04	-.46	.28	-.33	.39	.05	-.61
4	.77	.14	.07	-.09	-.70	-.74	.13	-.47	.56	-.16
5	.35	.07	.13	-.11	-.46	-.67	-.24	-.02	.28	.14
6	.33	-.06	-.17	-.24	-.44	-.32	-.12	-.53	.57	-.04
7	.34	.14	-.10	-.39	-.98	.14	.65	-.74	.62	.07
8	.45	.29	-.25	-.17	-.30	.19	.32	.15	.50	1.01
9	-.29	.46	.43	.06	-.40	.22	.49	-.14	.68	.43

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	-12.1190	-11.5913	-11.6166	-11.5615	-11.5492	-11.6662	-11.6662	-11.6662
S.E(Log q)	.5933	.3668	.4821	.3036	.3554	.4903	.4703	.4418

Table 11.4.1 (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,	1.48,	-.625,	13.21,	.12,	14,	.90,	-12.12,
3,	.99,	.069,	11.56,	.66,	14,	.38,	-11.59,
4,	.80,	.970,	11.07,	.67,	14,	.39,	-11.62,
5,	.82,	1.484,	10.92,	.86,	14,	.24,	-11.56,
6,	.87,	1.044,	10.95,	.84,	14,	.31,	-11.55,
7,	.99,	.058,	11.61,	.70,	14,	.50,	-11.67,
8,	1.43,	-2.158,	14.06,	.68,	14,	.58,	-11.59,
9,	1.10,	-.537,	12.24,	.69,	14,	.49,	-11.59,

1

Fleet : FLT02: BELGIAN BEAM

Age	1988	1989	1990	1991
1	No data for this fleet at this age			
2	.40,	-1.69,	.62,	1.28
3	-.06,	-.27,	.54,	.88
4	-.50,	-.12,	.05,	.12
5	-.96,	.11,	-.33,	.39
6	-.89,	.02,	-.27,	.49
7	-.39,	-.07,	-.67,	-.12
8	-.31,	-.34,	-.17,	-.19
9	-.39,	-.01,	-1.14,	.80

Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	No data for this fleet at this age									
2	1.55,	.76,	1.22,	-1.38,	.09,	99.99,	-.64,	-1.22,	-1.39,	.42
3	.62,	-.07,	.20,	.18,	-.01,	-1.40,	-.20,	.00,	-.86,	.45
4	-.27,	-.45,	.63,	.12,	.20,	.52,	.28,	.40,	-1.20,	.22
5	-.48,	-.37,	-.03,	.09,	.24,	1.06,	.29,	.67,	-.52,	-.17
6	.18,	-.36,	-.13,	-.28,	-.07,	.79,	.37,	.76,	-.48,	-.13
7	-.14,	-.30,	-.01,	.66,	-.30,	.79,	.35,	.68,	-.28,	-.20
8	.07,	-.47,	.11,	.25,	.24,	-.02,	.26,	-.31,	-.33,	.09
9	.99,	-1.00,	.26,	-.33,	.09,	.28,	.59,	.47,	-.28,	.41

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

Age ,	2,	3,	4,	5,	6,	7,	8,	9
Mean Log q,	-7.7374,	-5.7292,	-5.1214,	-5.0583,	-5.3644,	-5.4998,	-5.4998,	-5.4998,
S.E(Log q),	1.1337,	.5903,	.4794,	.5242,	.4764,	.4456,	.2650,	.6283,

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,	2.63,	-.591,	4.33,	.01,	13,	3.06,	-7.74,
3,	1.21,	-.519,	4.92,	.33,	14,	.74,	-5.73,
4,	1.37,	-1.080,	3.77,	.42,	14,	.65,	-5.12,
5,	1.46,	-1.240,	3.74,	.38,	14,	.75,	-5.06,
6,	1.13,	-.587,	5.14,	.61,	14,	.55,	-5.36,
7,	1.16,	-.810,	5.35,	.68,	14,	.52,	-5.50,
8,	1.02,	-.181,	5.57,	.91,	14,	.27,	-5.58,
9,	1.35,	-1.068,	5.47,	.43,	14,	.84,	-5.45,

Table 11.4.1 (continued)- Plaice in VIId. Tuning diagnostic

Fleet : FLT03: FRENCH TRAWLE

Age	1988	1989	1990	1991
1	No data for this fleet at this age			
2	99.99	-.08	-.24	.57
3	99.99	-.25	-.05	.10
4	99.99	-.04	-.01	.29
5	99.99	.46	.11	-.24
6	99.99	.06	.34	-.13
7	99.99	-.10	.15	-.43
8	99.99	.23	.25	-.47
9	99.99	1.03	.97	-.36

Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	No data for this fleet at this age									
2	.33	.24	.23	.08	-.64	-.47	-.77	.06	.41	.28
3	.24	-.32	.16	-.49	-.34	.64	.11	.41	-.14	-.07
4	-.45	-.63	-.52	-.58	-.59	.85	.72	.76	.39	-.18
5	-.18	-1.36	-.07	-1.14	-.17	.19	.76	.49	.91	.25
6	.32	-.58	-.38	-1.42	-.33	.80	.07	.35	.88	.02
7	.15	-.39	-.39	-1.06	-.23	.92	-.31	.93	.58	.17
8	-.54	-.80	.11	-.59	-.03	.90	.26	.52	.01	-1.22
9	-.23	-.37	-.33	-.25	.12	.67	-.37	-.41	.24	-.85

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	-11.6375	-10.8784	-10.8554	-11.2125	-11.5387	-11.7276	-11.7276	-11.7276
S.E(Log q)	.4162	.3210	.5519	.6626	.6036	.5686	.5960	.5816

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	3.32	-2.064	15.83	.07	13	1.23	-11.64
3	.74	1.608	10.51	.78	13	.22	-10.88
4	.72	1.347	10.28	.68	13	.39	-10.86
5	1.04	-.110	11.34	.42	13	.72	-11.21
6	1.14	-.465	12.16	.51	13	.71	-11.54
7	1.59	-1.869	14.91	.47	13	.83	-11.73
8	.96	.186	11.61	.69	13	.59	-11.83
9	.83	.900	10.64	.71	13	.49	-11.74

1

Fleet : FLT04: UK BEAM TRAWL

Age	1988	1989	1990	1991
1	.72	-1.21	-.51	.15
2	.50	-.30	-.64	.05
3	.72	.29	-.48	.38
4	.04	.55	-.09	.14
5	.62	-.11	.06	.22
6	.06	.22	.13	-.03
7	No data for this fleet at this age			
8	No data for this fleet at this age			
9	No data for this fleet at this age			

Table 11.4.1 (continued)- Plaice in VIId. Tuning diagnostic

Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	.23	-.67	.03	-.01	-.10	.58	.47	.07	.23	.02
2	.17	-.04	.12	-.75	-.08	-.29	.14	.45	.62	.06
3	.03	-.22	.25	-.20	-1.36	-.45	-.44	.11	.96	.41
4	.46	-.36	.47	-.07	-1.10	-1.10	.10	-.47	.69	.74
5	.67	-.08	.15	-.41	-.58	-1.01	-.87	-.23	.59	.99
6	.94	-.01	-.40	-.41	-.26	-.95	-.37	-.35	.66	.77
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	-7.5598	-7.1149	-7.0743	-6.8729	-6.5834	-6.6351
S.E(Log q)	.5101	.3984	.5853	.5926	.5935	.5223

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	.57	1.967	8.63	.63	14	.26	-7.56
2	.84	.532	7.55	.49	14	.35	-7.11
3	.77	.909	7.64	.57	14	.45	-7.07
4	.68	1.593	7.49	.68	14	.38	-6.87
5	.64	2.218	7.07	.76	14	.33	-6.58
6	.85	.779	6.70	.70	14	.45	-6.64

1

Fleet : FLT05: French GFS [o

Age	1988	1989	1990	1991
1	-.15	-.44	-.81	-1.43
2	.89	.17	-1.48	-.77
3	.54	-.28	-.33	-.73
4	.45	-.50	.12	-.56
5	.77	-1.35	.34	-.45
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	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	.94	1.47	-.09	-.49	-.83	.98	.91	.12	.33	-.52
2	-.41	.57	-.08	-.05	-.61	.20	.42	.29	1.14	-.27
3	.20	.86	-.88	.09	-1.55	.96	.04	.68	.83	-.44
4	-.77	.79	-1.00	.10	-1.21	.24	.19	.68	1.09	.37
5	-.49	.49	-.59	-.25	-.21	.29	99.99	.45	1.41	-.40
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	-7.8664	-8.0075	-8.1892	-8.5103	-8.6043
S.E(Log q)	.8370	.6884	.7457	.6992	.7121

Table 11.4.1 (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,    1.94,    -.669,      5.84,     .04,     14,    1.66,   -7.87,
  2,     .49,    1.908,      8.95,     .54,     14,     .31,   -8.01,
  3,     .74,     .824,      8.54,     .46,     14,     .56,   -8.19,
  4,     .75,     .897,      8.59,     .52,     14,     .53,   -8.51,
  5,    1.73,   -1.013,      9.05,     .15,     13,    1.23,   -8.60,
1



 Fleet : FLT06: Intl YFS [rev

  Age  ,  1988,  1989,  1990,  1991
     1 ,   .26,  -.05,   .04,  -.25
     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  ,  1992,  1993,  1994,  1995,  1996,  1997,  1998,  1999,  2000,  2001
     1 ,   .54,   .54,   .22,   .62,  -.55,  -.58,   .36,  -.09,  -.54,  -.51
     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,  -10.1007,
 S.E(Log q),     .4376,




 Regression statistics :


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

 Age, Slope , t-value , Intercept, RSquare, No Pts, Reg s.e,  Mean Q

  1,    3.41,   -2.160,     10.28,     .06,     14,    1.32,  -10.10,
1
```

Table 11.4.1 (continued)- Plaice in VIId. Tuning diagnostic

Terminal year survivor and F summaries :

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

Year class = 2000

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
FLT01: UK INSHORE TR,	1.,	.000,	.000,	.00,	0,	.000,	.000
FLT02: BELGIAN BEAM ,	1.,	.000,	.000,	.00,	0,	.000,	.000
FLT03: FRENCH TRAWLE,	1.,	.000,	.000,	.00,	0,	.000,	.000
FLT04: UK BEAM TRAWL,	32144.,	.528,	.000,	.00,	1,	.254,	.076
FLT05: French GFS [o,	18875.,	.866,	.000,	.00,	1,	.094,	.127
FLT06: Intl YFS [rev,	18914.,	.453,	.000,	.00,	1,	.345,	.127
F shrinkage mean ,	65337.,	.50,,,,				.306,	.038

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
31628.,	.27,	.36,	4,	1.321,	.078

1

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

Year class = 1999

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
FLT01: UK INSHORE TR,	9097.,	.614,	.000,	.00,	1,	.086,	.361
FLT02: BELGIAN BEAM ,	19984.,	1.177,	.000,	.00,	1,	.023,	.181
FLT03: FRENCH TRAWLE,	17451.,	.432,	.000,	.00,	1,	.173,	.204
FLT04: UK BEAM TRAWL,	14841.,	.325,	.082,	.25,	2,	.298,	.236
FLT05: French GFS [o,	12668.,	.551,	.292,	.53,	2,	.104,	.272
FLT06: Intl YFS [rev,	7634.,	.453,	.000,	.00,	1,	.147,	.418
F shrinkage mean ,	14704.,	.50,,,,				.168,	.238

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
13125.,	.18,	.11,	9,	.585,	.263

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

Year class = 1998

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
FLT01: UK INSHORE TR,	4118.,	.327,	.379,	1.16,	2,	.185,	.699
FLT02: BELGIAN BEAM ,	7398.,	.548,	.659,	1.20,	2,	.067,	.447
FLT03: FRENCH TRAWLE,	6675.,	.268,	.215,	.80,	2,	.268,	.485
FLT04: UK BEAM TRAWL,	9415.,	.292,	.156,	.53,	3,	.190,	.366
FLT05: French GFS [o,	7780.,	.458,	.492,	1.07,	3,	.082,	.429
FLT06: Intl YFS [rev,	5704.,	.453,	.000,	.00,	1,	.066,	.548
F shrinkage mean ,	4619.,	.50,,,,				.142,	.643

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
6239.,	.14,	.13,	14,	.872,	.512

1

Table 11.4.1 (continued)- Plaice in VIId. Tuning diagnostic

Age 4 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,	2395.,	.285,	.068,	.24,	3,	.190,	.615
FLT02: BELGIAN BEAM ,	2197.,	.382,	.379,	.99,	3,	.123,	.656
FLT03: FRENCH TRAWLE,	2260.,	.250,	.067,	.27,	3,	.220,	.642
FLT04: UK BEAM TRAWL,	4735.,	.275,	.112,	.41,	4,	.179,	.358
FLT05: French GFS [o,	4245.,	.405,	.145,	.36,	4,	.091,	.392
FLT06: Intl YFS [rev,	3592.,	.453,	.000,	.00,	1,	.047,	.449
F shrinkage mean ,	1070.,	.50,,,,				.151,	1.066

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
2513.,	.13,	.13,	19,	.949,	.594

Age 5 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,	2736.,	.245,	.098,	.40,	4,	.315,	.525
FLT02: BELGIAN BEAM ,	1422.,	.359,	.275,	.77,	4,	.132,	.845
FLT03: FRENCH TRAWLE,	2637.,	.288,	.236,	.82,	4,	.143,	.540
FLT04: UK BEAM TRAWL,	4321.,	.313,	.178,	.57,	5,	.138,	.363
FLT05: French GFS [o,	2734.,	.430,	.326,	.76,	5,	.082,	.525
FLT06: Intl YFS [rev,	1254.,	.453,	.000,	.00,	1,	.020,	.919
F shrinkage mean ,	1090.,	.50,,,,				.170,	1.005

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
2238.,	.14,	.12,	24,	.851,	.612

1

Age 6 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,	566.,	.244,	.095,	.39,	5,	.342,	.419
FLT02: BELGIAN BEAM ,	461.,	.359,	.132,	.37,	4,	.168,	.495
FLT03: FRENCH TRAWLE,	676.,	.378,	.200,	.53,	5,	.127,	.362
FLT04: UK BEAM TRAWL,	938.,	.366,	.188,	.51,	6,	.151,	.273
FLT05: French GFS [o,	1366.,	.461,	.331,	.72,	5,	.033,	.196
FLT06: Intl YFS [rev,	315.,	.453,	.000,	.00,	1,	.007,	.661
F shrinkage mean ,	277.,	.50,,,,				.173,	.725

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
547.,	.15,	.10,	27,	.660,	.431

Table 11.4.1 (continued)- Plaice in VIId. Tuning diagnostic

Age 7 Catchability constant w.r.t. time and dependent on age

Year class = 1994

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
FLT01: UK INSHORE TR,	190.,	.251,	.112,	.45,	6,	.305,	.362
FLT02: BELGIAN BEAM ,	122.,	.316,	.143,	.45,	6,	.240,	.518
FLT03: FRENCH TRAWLE,	220.,	.376,	.151,	.40,	6,	.158,	.319
FLT04: UK BEAM TRAWL,	215.,	.368,	.179,	.49,	6,	.079,	.326
FLT05: French GFS [o,	205.,	.467,	.188,	.40,	5,	.018,	.339
FLT06: Intl YFS [rev,	278.,	.453,	.000,	.00,	1,	.003,	.261
F shrinkage mean ,	79.,	.50,,,,				.197,	.715

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
149.,	.16,	.09,	31,	.562,	.442

1

Age 8 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,	63.,	.266,	.262,	.98,	7,	.246,	.288
FLT02: BELGIAN BEAM ,	43.,	.240,	.093,	.39,	7,	.408,	.399
FLT03: FRENCH TRAWLE,	26.,	.372,	.355,	.95,	7,	.138,	.592
FLT04: UK BEAM TRAWL,	23.,	.377,	.134,	.35,	6,	.033,	.646
FLT05: French GFS [o,	30.,	.415,	.413,	1.00,	4,	.002,	.532
FLT06: Intl YFS [rev,	49.,	.453,	.000,	.00,	1,	.001,	.357
F shrinkage mean ,	25.,	.50,,,,				.171,	.605

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
39.,	.15,	.11,	33,	.688,	.428

Age 9 Catchability constant w.r.t. time and age (fixed at the value for age) 7

Year class = 1992

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
FLT01: UK INSHORE TR,	29.,	.257,	.166,	.65,	8,	.296,	.359
FLT02: BELGIAN BEAM ,	24.,	.232,	.158,	.68,	8,	.329,	.423
FLT03: FRENCH TRAWLE,	18.,	.344,	.239,	.69,	8,	.169,	.529
FLT04: UK BEAM TRAWL,	14.,	.382,	.137,	.36,	6,	.023,	.618
FLT05: French GFS [o,	22.,	.416,	.365,	.88,	5,	.004,	.453
FLT06: Intl YFS [rev,	40.,	.453,	.000,	.00,	1,	.001,	.269
F shrinkage mean ,	23.,	.50,,,,				.178,	.435

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
23.,	.15,	.08,	37,	.512,	.425

Table 11.4.2 Plaice in VIId. Fishing mortality-at-age

Run title : Plaice in VIId (run: XSAAEDB01/X01)

At 14/06/2002 10:44

Terminal Fs derived using XSA (With F shrinkage)

YEAR	1980	1981
AGE		
1	0.0022	0.0013
2	0.1675	0.1183
3	0.279	0.7294
4	0.3375	0.886
5	0.6177	0.2722
6	0.4144	0.366
7	0.3991	0.4875
8	0.2538	0.7049
9	0.3567	0.5214
+gp	0.3567	0.5214
0 FBAR 2- 6	0.3632	0.4743

YEAR	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
AGE										
1	0.0111	0.0049	0.0148	0.005	0.0119	0.0008	0.0006	0.0548	0.0955	0.0776
2	0.1347	0.1523	0.1162	0.3137	0.2134	0.1814	0.2063	0.1741	0.2205	0.5073
3	0.4974	0.4555	0.5773	0.5992	0.6957	0.5178	0.6669	0.4544	0.704	0.8326
4	0.8596	0.939	0.8229	0.8597	0.7685	0.7947	0.6718	0.7476	0.7472	0.8774
5	0.6942	0.5524	0.7896	0.2321	0.5971	0.5774	0.5655	0.8608	0.6318	0.6935
6	0.2818	0.3982	0.6285	0.5692	0.4992	0.3095	0.4647	0.5833	0.6019	0.6057
7	0.3494	0.1751	0.8314	0.353	0.4335	0.827	0.5265	0.4277	0.449	0.3942
8	1.8586	0.8852	0.2643	0.9191	0.2192	0.4519	0.5251	0.3744	0.5375	0.37
9	0.834	0.4879	0.577	0.6163	0.3851	0.5315	0.5629	0.6672	0.6913	0.5759
+gp	0.834	0.4879	0.577	0.6163	0.3851	0.5315	0.5629	0.6672	0.6913	0.5759
0 FBAR 2- 6	0.4935	0.4995	0.5869	0.5148	0.5548	0.4762	0.515	0.5641	0.5811	0.7033
1										

YEAR	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	FBAR 99-**
AGE											
1	0.0647	0.0607	0.0786	0.115	0.0394	0.0152	0.0335	0.036	0.0674	0.0776	0.0603
2	0.4433	0.4116	0.4147	0.3793	0.2903	0.1843	0.1456	0.1538	0.4148	0.2634	0.2773
3	0.8086	0.4781	0.7247	0.6135	0.5508	0.8034	0.6063	0.6471	0.5936	0.5115	0.5841
4	0.6068	0.493	0.8033	0.6816	0.6806	1.4837	1.0444	1.1702	0.9205	0.5935	0.8947
5	0.5231	0.3422	0.6452	0.5172	0.7542	1.3957	0.8896	0.9701	0.9893	0.6118	0.8571
6	0.642	0.3559	0.4287	0.3129	0.5045	1.0544	0.5879	0.7027	0.7612	0.4313	0.6317
7	0.4813	0.3832	0.3782	0.4961	0.3839	1.1694	0.4681	0.759	0.7768	0.4421	0.6593
8	0.4676	0.3298	0.532	0.4563	0.5997	0.8555	0.5592	0.4991	0.5012	0.4281	0.4761
9	0.6507	0.4095	0.5339	0.438	0.6322	0.8872	0.4953	0.4918	0.4635	0.425	0.4601
+gp	0.6507	0.4095	0.5339	0.438	0.6322	0.8872	0.4953	0.4918	0.4635	0.425	
0 FBAR 2- 6	0.6048	0.4161	0.6033	0.5009	0.5561	0.9843	0.6548	0.7288	0.7359	0.4823	
1											

Table 11.4.3 Plaice in VIId. Stock numbers-at-age

Run title : Plaice in VIId (run: XSAAEDB01/X01)

At 14/06/2002 10:44

Terminal Fs derived using XSA (With F shrinkage)

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

	YEAR	1980	1981
	AGE		
	1	25536	12863
	2	18027	23055
	3	6266	13796
	4	1982	4290
	5	1118	1280
	6	232	545
	7	144	139
	8	206	87
	9	14	145
	+gp	360	515
0	TOTAL	53885	56715

	YEAR	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
	AGE										
	1	25201	19917	25025	29678	60223	31260	26464	16293	18828	21713
	2	11623	22550	17935	22311	26719	53846	28261	23931	13957	15484
	3	18535	9192	17522	14448	14752	19530	40638	20805	18193	10130
	4	6020	10199	5275	8901	7180	6657	10530	18875	11951	8142
	5	1600	2306	3608	2096	3409	3013	2721	4867	8087	5122
	6	882	723	1201	1482	1504	1698	1530	1399	1862	3890
	7	342	602	439	580	759	826	1127	870	706	923
	8	77	218	457	173	368	445	327	603	513	408
	9	39	11	82	318	62	268	256	175	375	271
	+gp	162	274	239	114	111	195	423	423	484	299
0	TOTAL	64482	65993	71782	80100	115089	117738	112277	88239	74955	66382
	1										

	YEAR	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	GMST 80-99	AMST 80
	AGE													
	1	27942	13212	17281	25073	30481	38310	14818	22044	22317	37774	0	23427	25108
	2	18180	23699	11250	14455	20222	26516	34141	12967	19241	18878	31628	20378	21956
	3	8437	10559	14209	6724	8951	13687	19954	26707	10061	11499	13125	14074	15652
	4	3986	3401	5923	6228	3294	4669	5546	9847	12652	5028	6239	6294	7145
	5	3064	1966	1880	2400	2850	1509	958	1766	2765	4560	2513	2412	2781
	6	2317	1643	1263	892	1295	1213	338	356	606	930	2238	1080	1313
	7	1921	1103	1042	745	590	707	382	170	160	256	547	580	706
	8	563	1074	680	646	410	364	199	217	72	66	149	333	402
	9	255	319	699	362	370	204	140	103	119	39	39	151	223
	+gp	258	474	789	762	774	543	504	299	277	236	163		
0	TOTAL	66921	57449	55016	58286	69238	87722	76981	74475	68269	79267	56641		
	1													

Table 11.5.1 Plaice in VIId. Input to RCT3

7D PLAICE - VPA / Indices all * per 100
5 16 2

YEARCLASS'	VPA age 1'	VPA age 2'	VPA age 3'	'yfs0'	'yfs1'	'bts1'	'gfs0'	'gfs1'
1986	31260	28261	20805	-11	134	-11	-11	-11
1987	26464	23931	18193	1168	118	2647	-11	1033
1988	16293	13957	10130	556	62	231	19	408
1989	18828	15484	8437	397	66	516	16	270
1990	21713	18180	10559	342	57	1175	10	173
1991	27942	23699	14209	436	159	1653	10	2379
1992	13212	11250	6724	404	78	322	66	1916
1993	17281	14455	8951	370	74	833	438	517
1994	25073	20222	13687	869	189	1132	362	491
1995	30481	26516	19954	687	68	1320	136	447
1996	38310	34141	26707	407	67	3310	2360	3549
1997	14818	12967	-11	223	66	1140	890	1253
1998	22044	-11	-11	530	60	1130	768	848
1999	-11	-11	-11	381	55	1319	103	1026
2000	-11	-11	-11	514	62	1791	1590	738
2001	-11	-11	-11	374	-11	-11	461	-11

Table 11.5.2 Plaice in VIId. RCT3 ouput for Age 1

```
Analysis by RCT3 ver3.1 of data from file :
recpl7d.txt
7D PLAICE - VPA AGE 1 / indices all * per 100
Data for    5 surveys over   16 years :  1986 - 2001
Regression type = C
Tapered time weighting applied
power =    3 over  20 years
Survey weighting not applied
Final estimates shrunk towards mean
Minimum S.E. for any survey taken as    .20
Minimum of   3 points used for regression
Forecast/Hindcast variance correction used.

 Yearclass =   1999

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

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

 yfs0      1.68   -.35    .68   .205     12   5.95    9.63     .803     .068
 yfs1      2.66  -1.80   1.09   .093     13   4.03    8.92    1.309     .026
 bts1       .55   6.18    .26   .642     12   7.19   10.13     .303     .479
 gfs0       .86   5.71   1.73   .041     11   4.64    9.68    2.028     .011
 gfs1      1.66  -1.07   1.57   .047     12   6.93   10.41    1.832     .013

                                       VPA Mean =   10.00     .330     .404


 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      1.69   -.38    .68   .209     12   6.24   10.15     .804     .072
 yfs1      2.87  -2.69   1.18   .081     13   4.14    9.19    1.411     .023
 bts1       .56   6.08    .26   .641     12   7.49   10.30     .317     .463
 gfs0       .87   5.57   1.76   .040     11   7.37   12.00    2.237     .009
 gfs1      1.70  -1.40   1.62   .045     12   6.61    9.84    1.899     .013

                                       VPA Mean =   10.00     .333     .420


 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      1.69   -.38    .68   .215     12   5.93    9.63     .823     .141
 yfs1
 bts1
 gfs0       .90   5.38   1.81   .039     11   6.14   10.88    2.196     .020
 gfs1

                                       VPA Mean =   10.01     .337     .840



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

 1999       22291     10.01     .21     .10      .23
 2000       25548     10.15     .22     .12      .32
 2001       21360      9.97     .31     .13      .18
```

Table 11.5.3 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   16 years :  1986 - 2001
 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 =   1999

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

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

 yfs0      1.68   -.57    .74   .194     11   5.95    9.44     .864     .059
 yfs1      2.38   -.78    .94   .131     12   4.03    8.78    1.132     .034
 bts1       .51   6.27    .25   .674     11   7.19    9.97     .293     .513
 gfs0       .75   6.34   1.50   .058     10   4.64    9.81    1.763     .014
 gfs1      1.29   1.26   1.25   .078     11   6.93   10.22    1.450     .021

                                       VPA Mean =    9.86     .351     .359


 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      1.68   -.57    .74   .194     11   6.24    9.94     .855     .061
 yfs1      2.38   -.78    .94   .131     12   4.14    9.06    1.108     .037
 bts1       .51   6.27    .25   .674     11   7.49   10.13     .298     .504
 gfs0       .75   6.34   1.50   .058     10   7.37   11.85    1.930     .012
 gfs1      1.29   1.26   1.25   .078     11   6.61    9.79    1.443     .022

                                       VPA Mean =    9.86     .351     .365


 Yearclass =   2001

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

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

 yfs0      1.68   -.57    .74   .194     11   5.93    9.41     .865     .137
 yfs1
 bts1
 gfs0       .75   6.34   1.50   .058     10   6.14   10.92    1.815     .031
 gfs1

                                       VPA Mean =    9.86     .351     .832



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

 1999       19174       9.86     .21     .11      .27
 2000       21871       9.99     .21     .13      .40
 2001       18601       9.83     .32     .18      .31
```

Table 11.5.4 Plaice in VIId. RCT3 ouput for Age 3

```
Analysis by RCT3 ver3.1 of data from file : recpl7d3.in
7D PLAICE - VPA AGE 3 / indices all * per 100
Data for    5 surveys over   16 years :  1986 - 2001
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 =   1999

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

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

yfs0      2.39  -5.50    .93   .194     10   5.95    8.71    1.125     .050
yfs1      3.68  -7.07   1.55   .081     11   4.03    7.72    1.894     .018
bts1       .60   5.28    .30   .694     10   7.19    9.62     .359     .489
gfs0       .44   7.47    .77   .271      9   4.64    9.52     .918     .075
gfs1      1.13   2.01   1.10   .149     10   6.93    9.85    1.293     .038

                                       VPA Mean =    9.49     .437     .331


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      2.39  -5.50    .93   .194     10   6.24    9.42    1.095     .054
yfs1      3.68  -7.07   1.55   .081     11   4.14    8.16    1.849     .019
bts1       .60   5.28    .30   .694     10   7.49    9.81     .366     .486
gfs0       .44   7.47    .77   .271      9   7.37   10.72    1.036     .061
gfs1      1.13   2.01   1.10   .149     10   6.61    9.47    1.284     .039

                                       VPA Mean =    9.49     .437     .341


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      2.39  -5.50    .93   .194     10   5.93    8.66    1.129     .110
yfs1
bts1
gfs0       .44   7.47    .77   .271      9   6.14   10.17     .960     .153
gfs1

                                       VPA Mean =    9.49     .437     .737
```

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
1999	**13355**	9.50	.25	.14	.31		
2000	16132	9.69	.26	.16	.41		
2001	13386	9.50	.38	.27	.52		

Table 11.6.1 Plaice in VIId. Stock summary

Run title : Plaice in VIId (run: XSAAEDB01/X01) ,

At 14/06/2002 10:44

Table 16 Summary (without SOP correction)

Terminal Fs derived using XSA (With F shrinkage)

,	RECRUITS, Age 1	TOTALBIO,	TOTSPBIO,	LANDINGS,	YIELD/SSB,	FBAR 2- 6,
1980,	25536,	16506,	5584,	2650,	.4746,	.3632,
1981,	12863,	14333,	6558,	4769,	.7272,	.4743,
1982,	25201,	15056,	7574,	4865,	.6424,	.4935,
1983,	19917,	15124,	8122,	5043,	.6209,	.4995,
1984,	25025,	14118,	7453,	5161,	.6925,	.5869,
1985,	29678,	15748,	8130,	6022,	.7407,	.5148,
1986,	60223,	23062,	10047,	6834,	.6802,	.5548,
1987,	31260,	31725,	13394,	8366,	.6246,	.4762,
1988,	26464,	24331,	13077,	10420,	.7968,	.5150,
1989,	16293,	21400,	14115,	8758,	.6205,	.5641,
1990,	18828,	21797,	14549,	9047,	.6218,	.5811,
1991,	21713,	17507,	10101,	7813,	.7735,	.7033,
1992,	27942,	16146,	8564,	6337,	.7400,	.6048,
1993,	13212,	15945,	7800,	5331,	.6835,	.4161,
1994,	17281,	14999,	8333,	6121,	.7345,	.6033,
1995,	25073,	14797,	7538,	5130,	.6805,	.5009,
1996,	30481,	17091,	6577,	5393,	.8199,	.5561,
1997,	38310,	15293,	6783,	6307,	.9298,	.9843,
1998,	14818,	17238,	7640,	5762,	.7542,	.6548,
1999,	22044,	14657,	8363,	6326,	.7565,	.7288,
2000,	22317,	12195,	6512,	6015,	.9237,	.7359,
2001,	37774,	15334,	6966,	5266,	.7559,	.4823,
Arith. Mean ,	25557,	17473,	8808,	6261,	.7179,	.5724,
0 Units,	(Thousands),	(Tonnes),	(Tonnes),	(Tonnes),		

1

Table 11.7.1 Plaice in VIId. Input for short-term prediction

Label	Value	CV	Label	Value	CV
Number-at-age			Weight in the stock		
N1	23426	0.37	WS1	0.08	0.16
N2	31628	0.36	WS2	0.19	0.09
N3	13125	0.18	WS3	0.23	0.17
N4	6239	0.14	WS4	0.31	0.18
N5	2512	0.13	WS5	0.40	0.10
N6	2238	0.14	WS6	0.61	0.08
N7	547	0.15	WS7	0.77	0.10
N8	148	0.16	WS8	0.86	0.13
N9	38	0.15	WS9	0.88	0.32
N10	162	0.15	WS10	1.23	0.12
H.cons selectivity			Weight in the HC catch		
sH1	0.05	0.56	WH1	0.20	0.08
sH2	0.21	0.45	WH2	0.25	0.02
sH3	0.43	0.14	WH3	0.28	0.15
sH4	0.67	0.15	WH4	0.35	0.11
sH5	0.64	0.03	WH5	0.45	0.02
sH6	0.47	0.07	WH6	0.67	0.11
sH7	0.49	0.08	WH7	0.80	0.08
sH8	0.35	0.16	WH8	0.95	0.08
sH9	0.34	0.18	WH9	1.00	0.13
sH10	0.34	0.18	WH10	1.31	0.13
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		
HF02	1.00	0.22	K02	1.00	0.10
HF03	1.00	0.22	K03	1.00	0.10
HF04	1.00	0.22	K04	1.00	0.10
Recruitment in 2003 and 2004					
R03	23427	0.37			
R04	23427	0.37			

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

Stock numbers in 2002 are VPA survivors.

Data from file:C:\mediumterm\new\PLAVIID.SEN on 17/06/2002 at 19:19:19

Table 11.7.2 Plaice in VIId. Short-term prediction (management option table)

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

	Year 2002	2003						
Mean F Ages 2 to 6								
H.cons	0.48	0.29	0.34	0.39	0.43	0.45	0.48	0.53
Effort relative to 2001								
H.cons	1.00	0.60	0.70	0.80	0.90	0.93	1.00	1.10
Biomass								
Total 1 January	15.86	16.75	16.75	16.75	16.75	16.75	16.75	16.75
SSB at spawning time	7.49	9.06	9.06	9.06	9.06	9.06	9.06	9.06
Catch weight (,000t)								
H.cons	5.18	3.90	4.45	4.98	5.49	5.65	5.97	6.44
Biomass in year.... 2004								
Total 1 January		19.21	18.63	18.09	17.56	17.40	17.07	16.59
SSB at spawning time		12.12	11.61	11.12	10.65	10.51	10.21	9.79

	Year 2002	2003						
Effort relative to 2001								
H.cons	1.00	0.60	0.70	0.80	0.90	0.93	1.00	1.10
Est. Coeff. of Variation								
Biomass								
Total 1 January	0.16	0.18	0.18	0.18	0.18	0.18	0.18	0.18
SSB at spawning time	0.10	0.18	0.18	0.18	0.18	0.18	0.18	0.18
Catch weight								
H.cons	0.25	0.37	0.32	0.29	0.27	0.26	0.25	0.24
Biomass in year.... 2004								
Total 1 January		0.18	0.18	0.18	0.18	0.18	0.19	0.19
SSB at spawning time		0.23	0.23	0.23	0.23	0.23	0.23	0.23

Table 11.7.3 Plaice in VIId. Short-term prediction (detailed output)

Detailed forecast tables.

Forecast for year 2002
F multiplier H.cons=1.00

	Populations	Catch number	
Age	Stock No.	H.Cons	Total
1	23426	981	981
2	31628	5613	5613
3	13125	4413	4413
4	6239	2900	2900
5	2512	1132	1132
6	2238	800	800
7	547	202	202
8	148	42	42
9	38	11	11
10	162	45	45
Wt	16	5	5

Forecast for year 2003
F multiplier H.cons=1.00

	Populations	Catch number	
Age	Stock No.	H.Cons	Total
1	23427	981	981
2	20264	3596	3596
3	23290	7832	7832
4	7695	3576	3576
5	2903	1308	1308
6	1202	430	430
7	1267	469	469
8	303	86	86
9	94	26	26
10	129	36	36
Wt	17	6	6

Figure 11.2.1 Plaice in VIId. Numbers-at-age in the landings

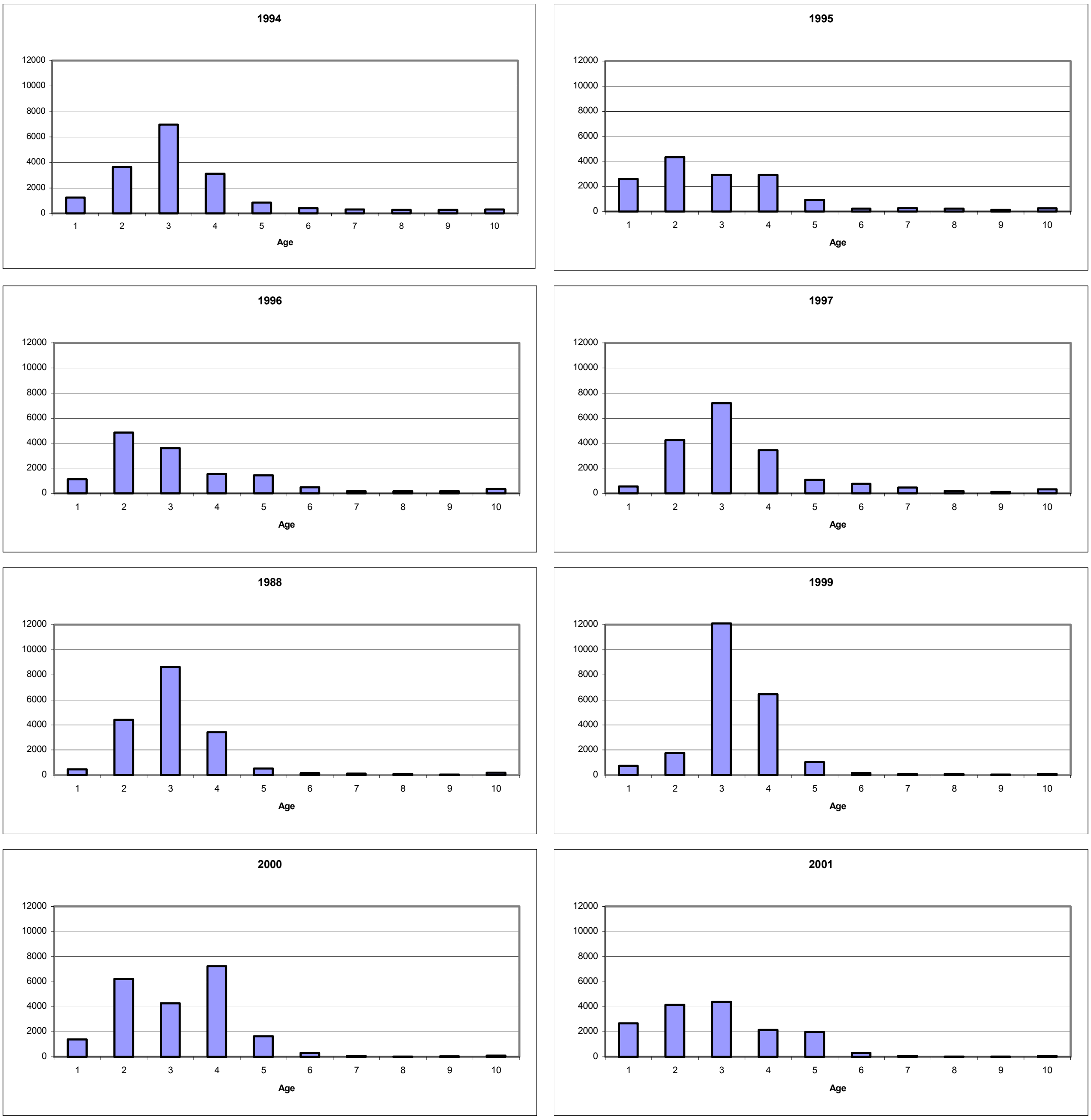


Figure 11.2.2 Plaice in VIId. Comparison between previous and revised mean stock weight

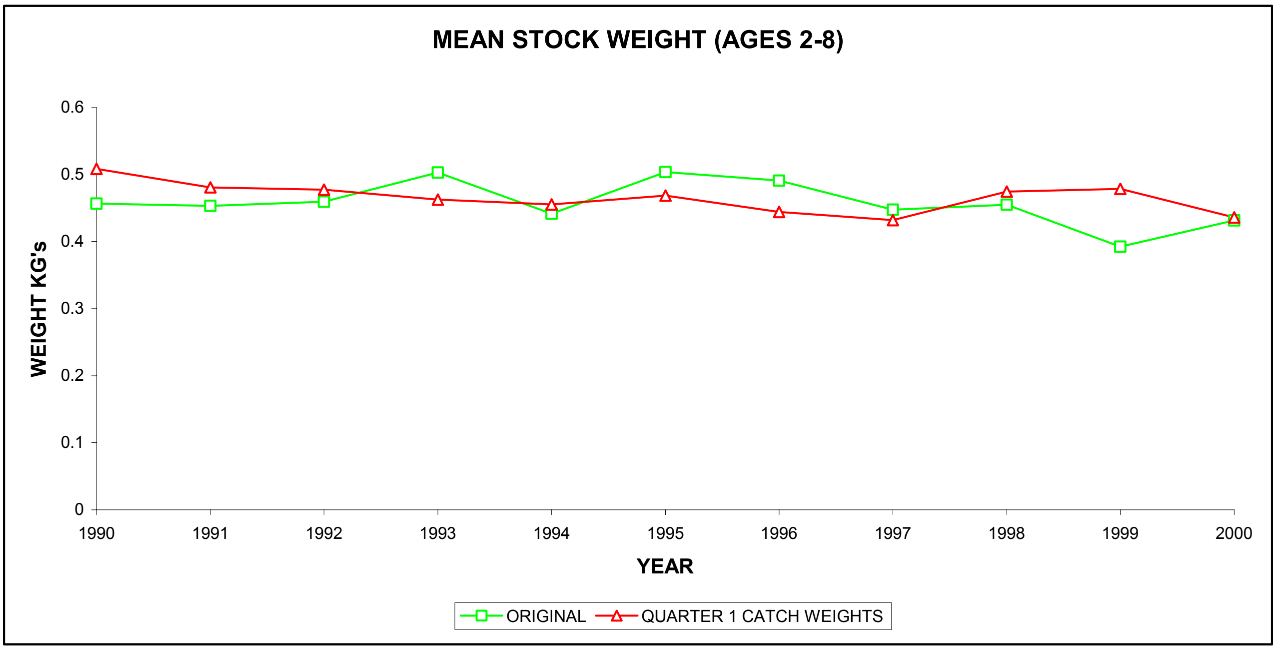


Figure 11.2.3 Plaice in VIId. Influence of stock weight revision on historical estimates of SSB

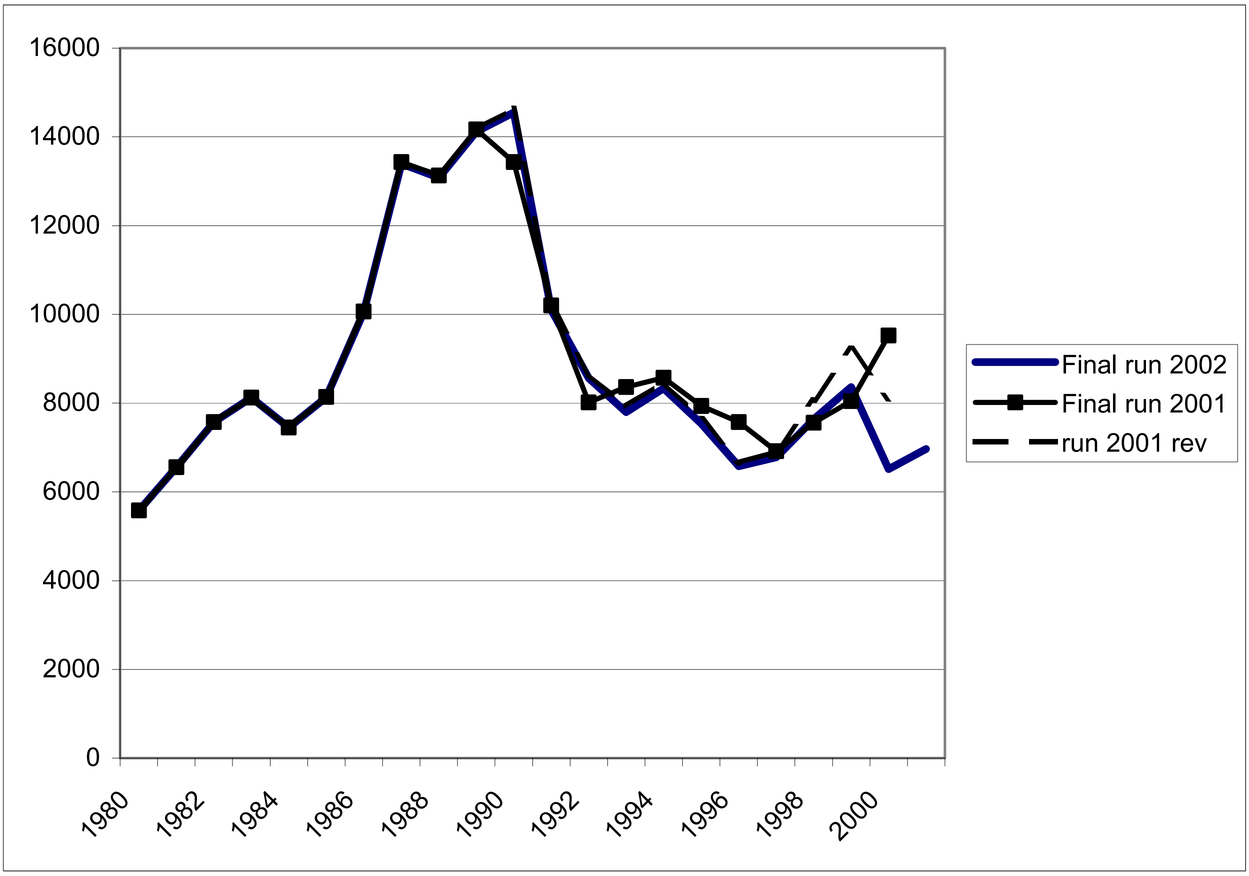
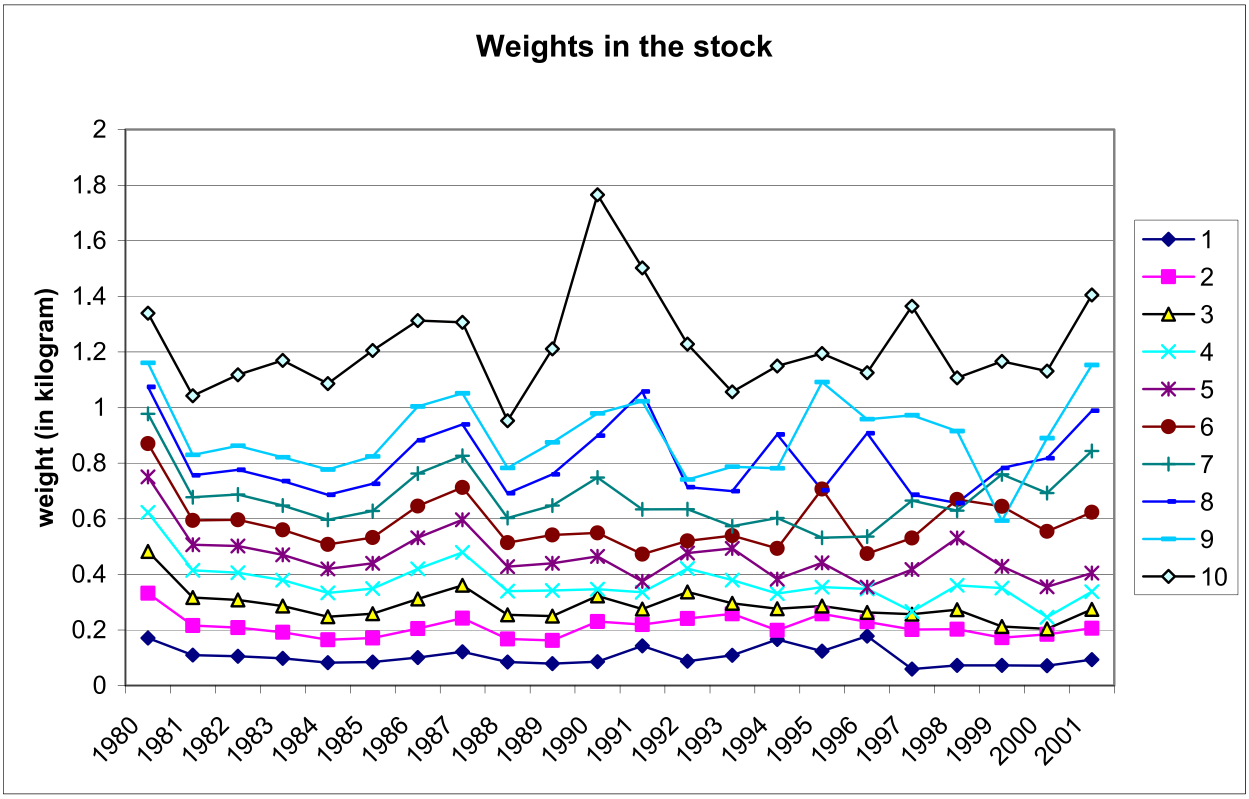


Figure 11.2.4 Plaice in VIId. Trends in weights-at-age in the stock/catch



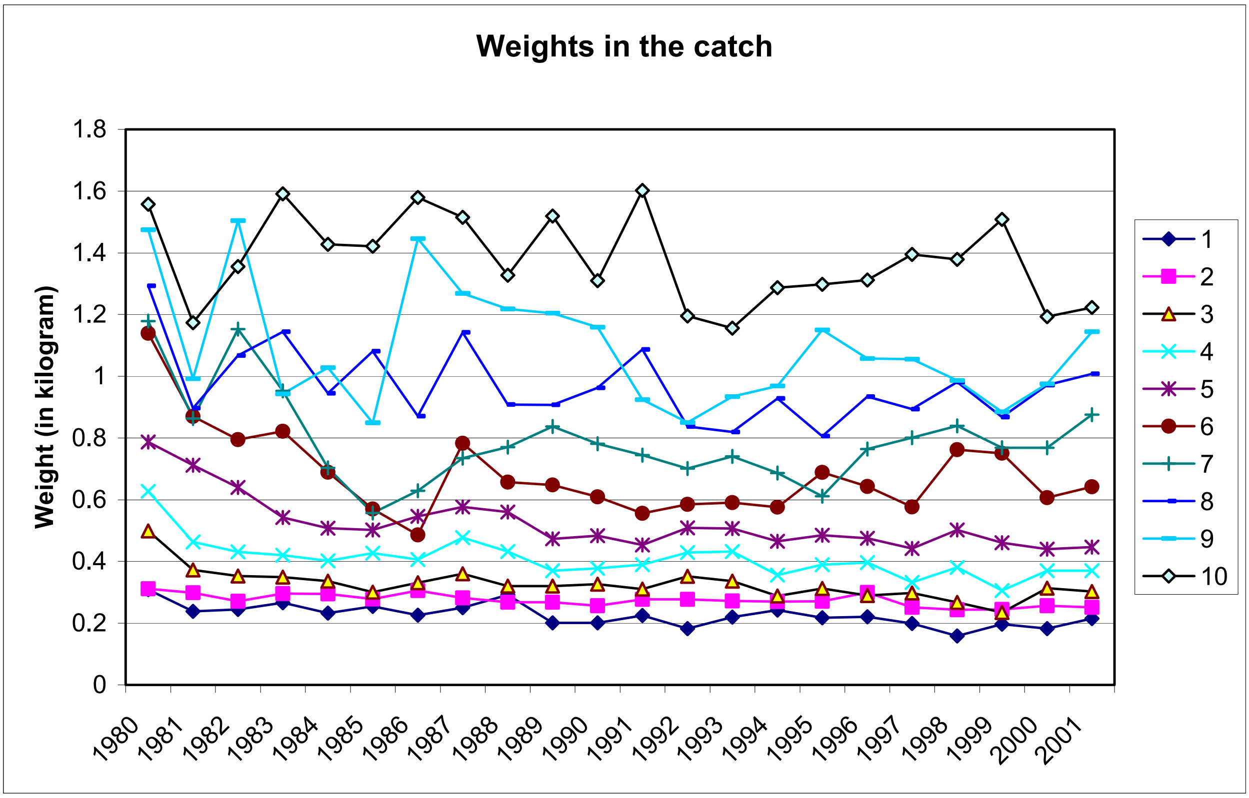
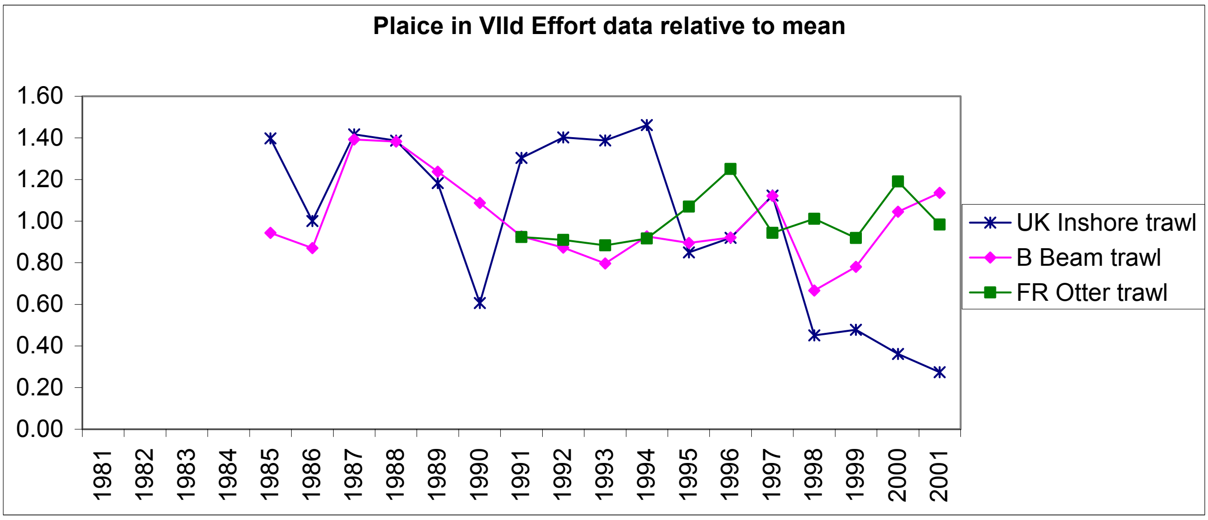


Figure 11.3.1 Plaice in VIId. Effort and cpue



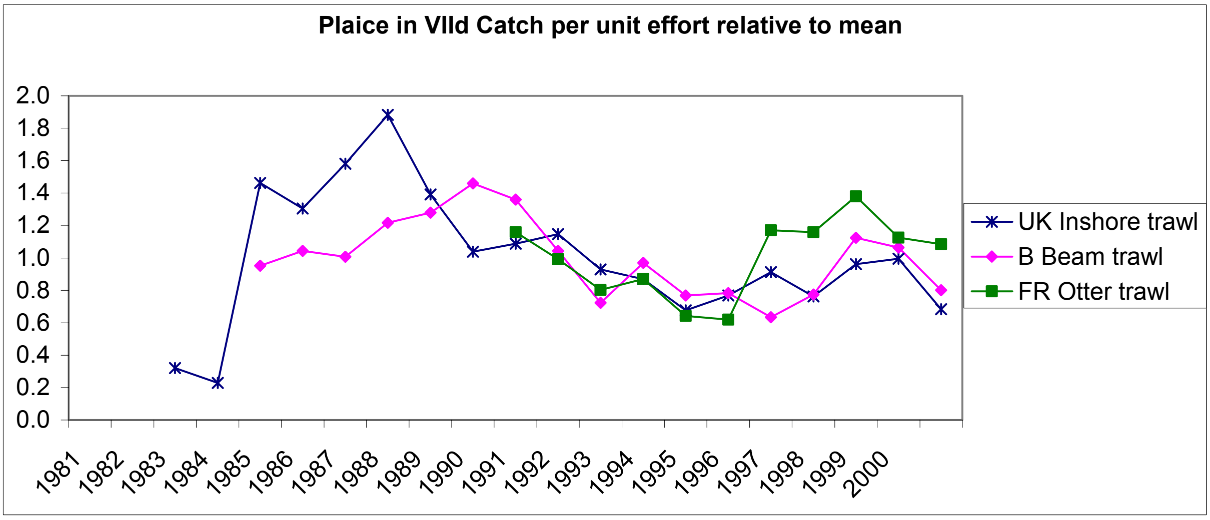


Figure 11.3.2 Plaice in VIId. Influence of the French GFS index revision per age group

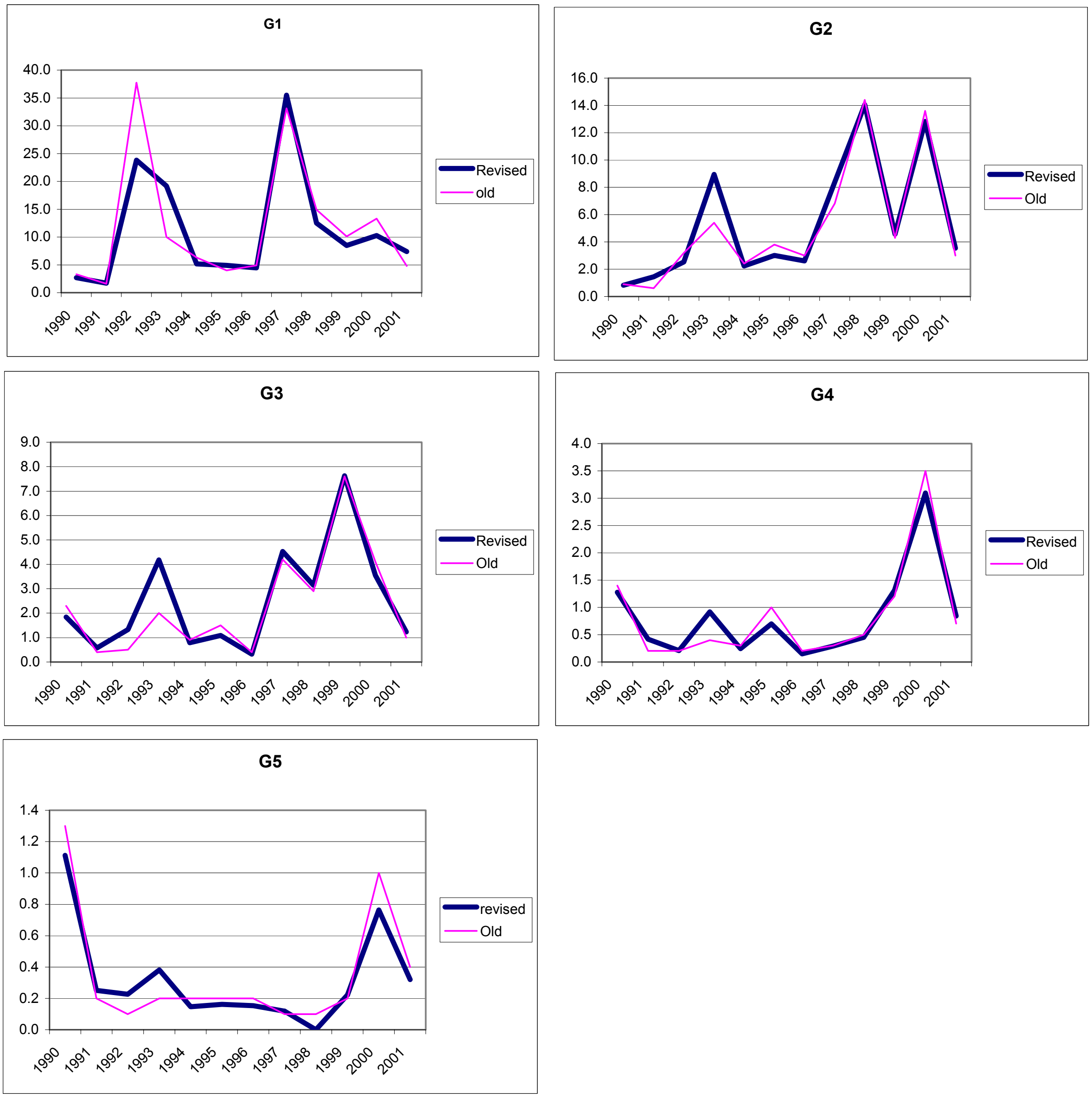


Figure 11.3.3 Plaice in VIId. Nursery reception potentiality for flatfish juveniles sampled by English and French YFS

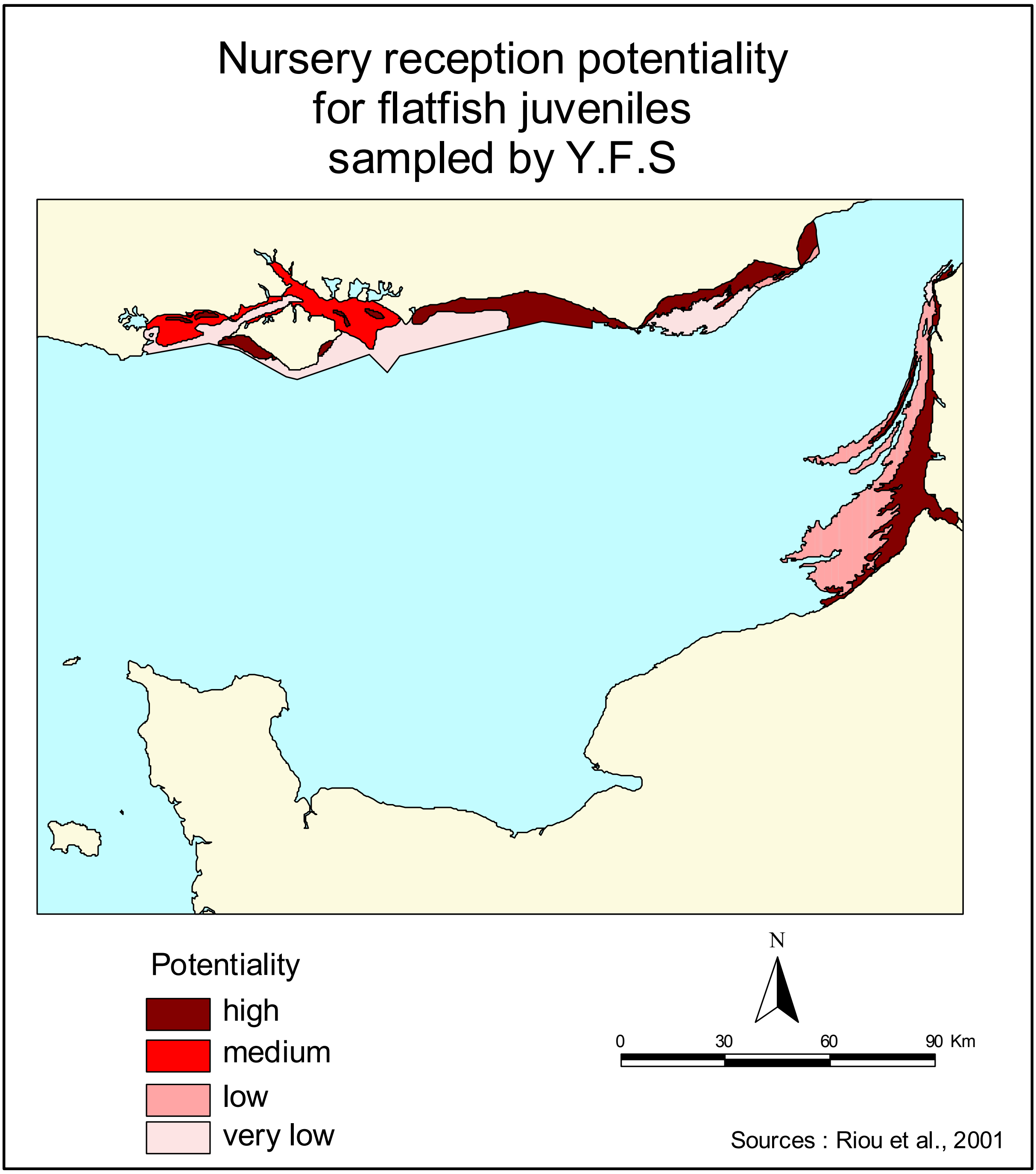
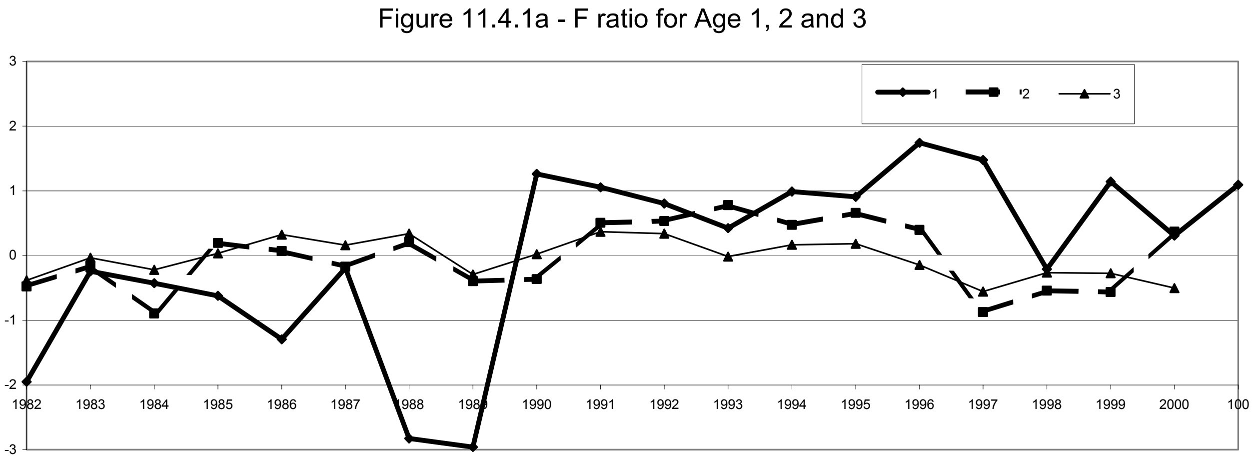


Figure 11.4.1 Plaice in VIId. Diagnostics from separable model analysis



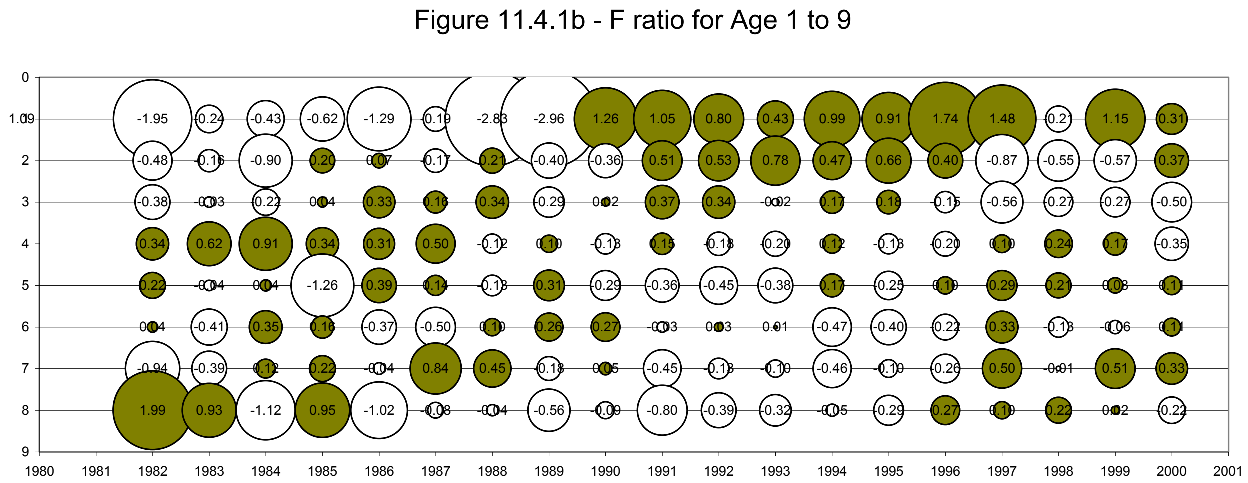


Figure 11.4.2 Plaice in VIId. Log q residuals per fleet and age (single-fleet XSA, F shrinkage = 1.5, no taper, no power model)

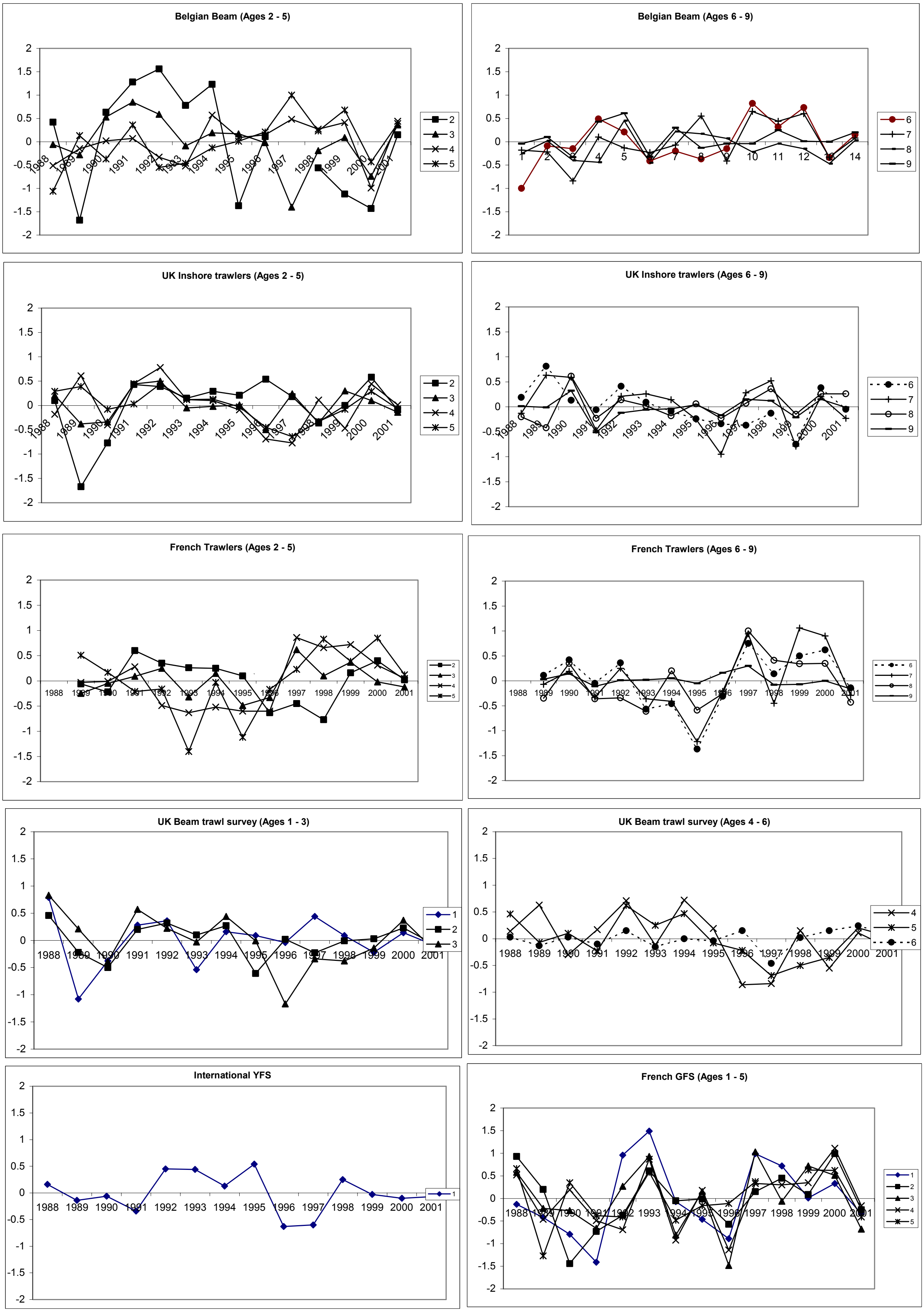


Figure 11.4.3 Plaice in VIId. Log q residuals from final run.

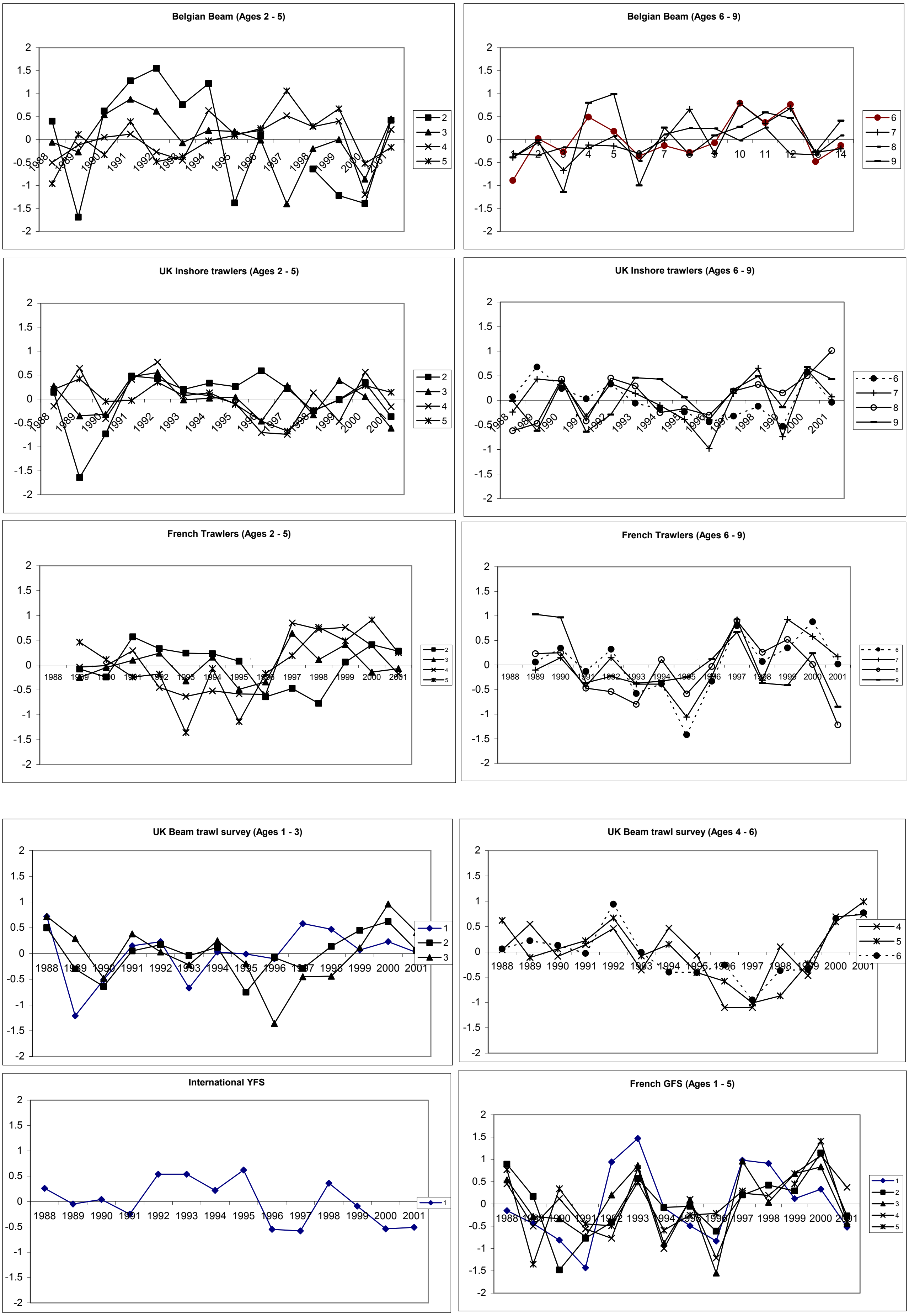


Figure 11.4.4 Plaice in VIId. Estimates of terminal Fbar (2-6) against estimates of terminal SSB for a range of XSA tuning configurations.

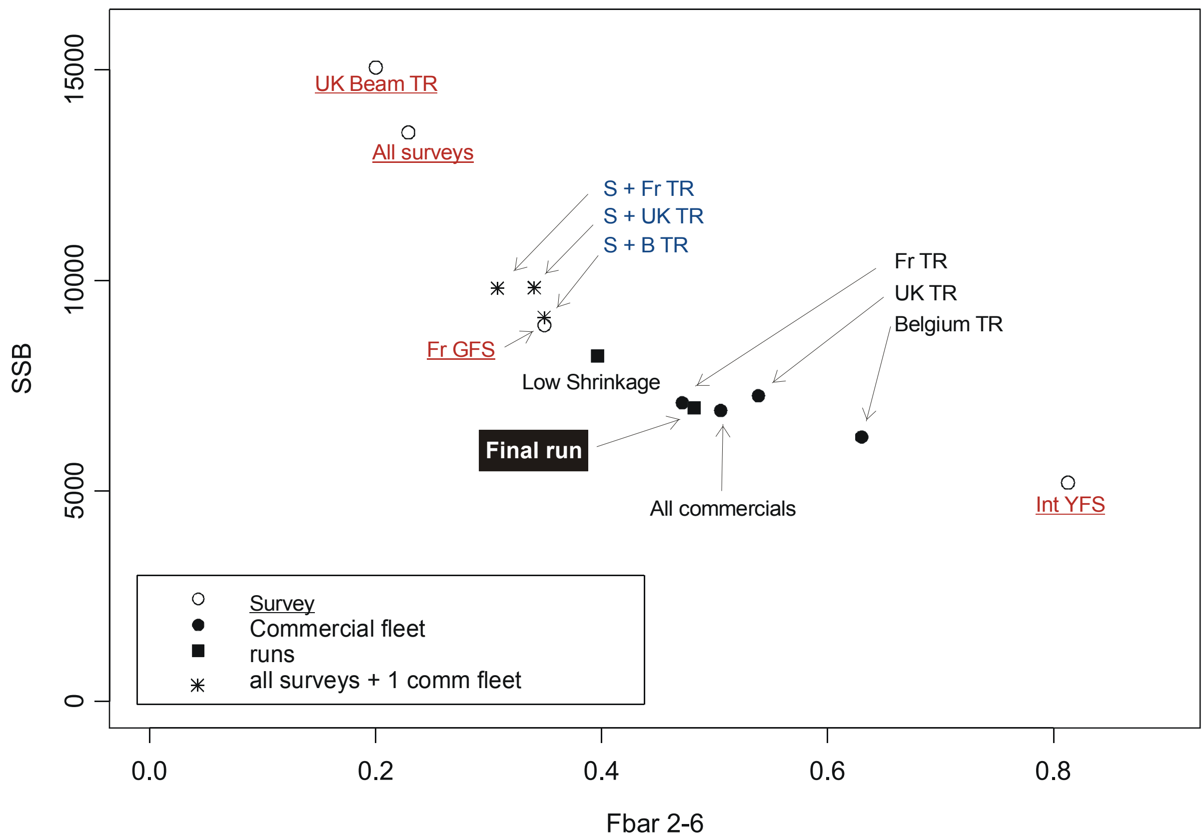


Figure 11.4.5 Plaice in VIId. Weights of different components in the final model fit

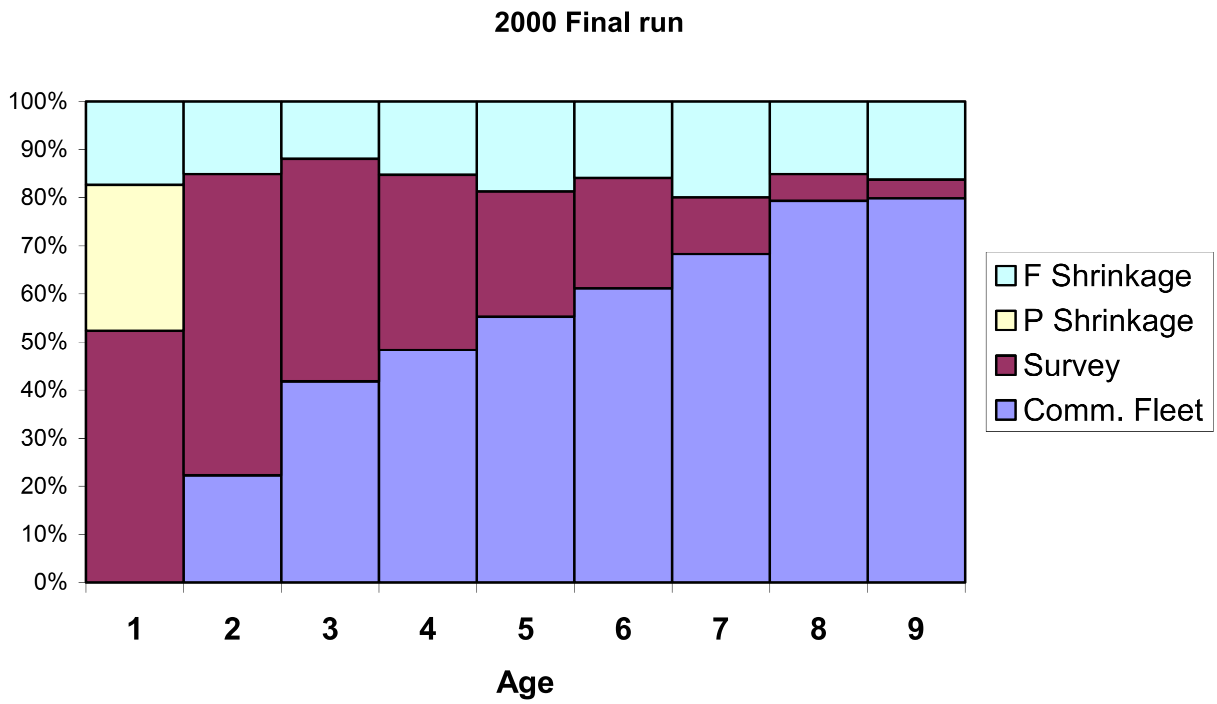


Figure 11.4.6 Plaice in VIId. Retrospective analysis with final run with tuning range 1988 - 2001, truncation of year range, no taper, no power model, and F shrinkage of 0.5

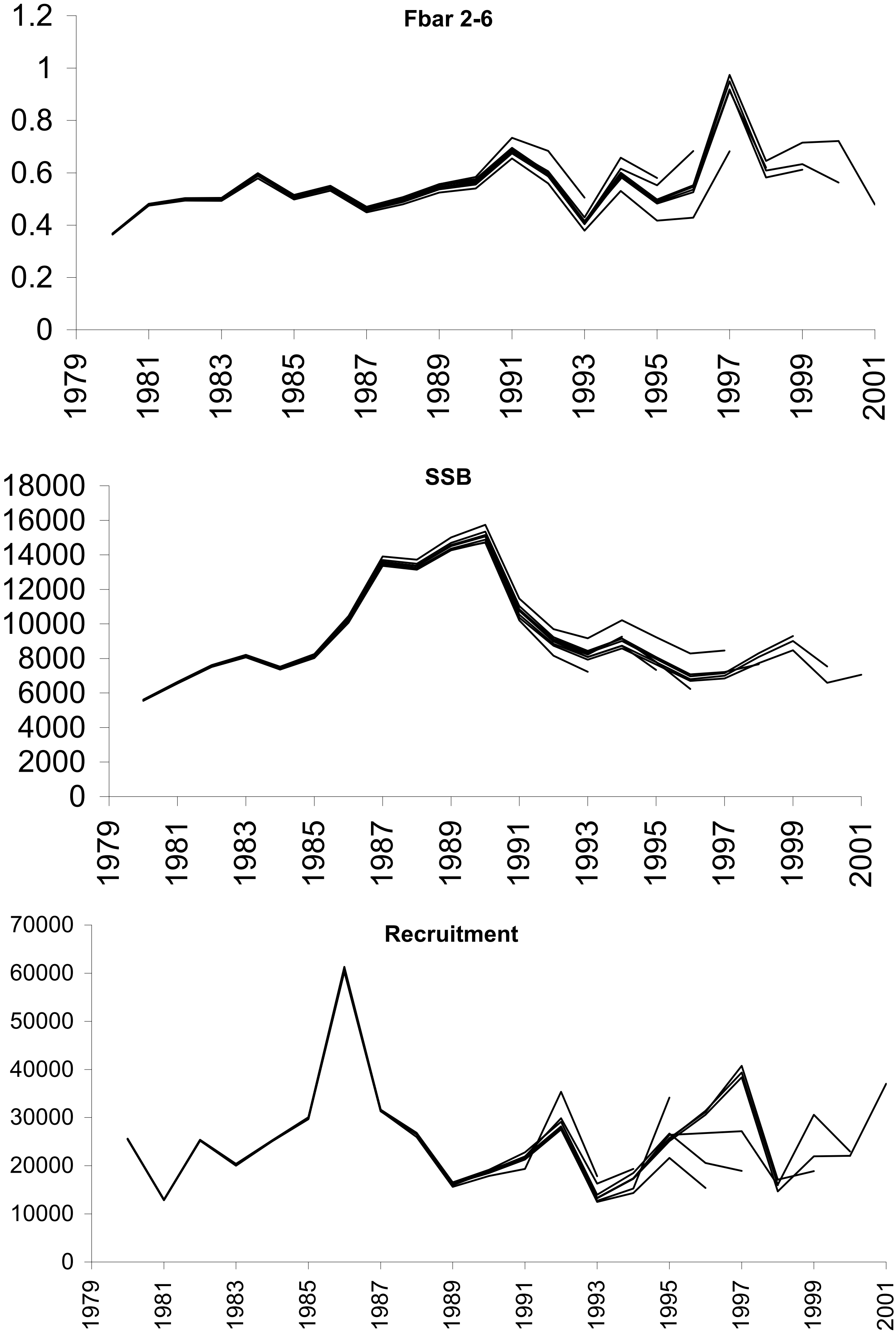


Figure 11.6.1 Plaice in Division VIId. Historical trends in landings, fishing mortality, recruitment, and spawning stock biomass.

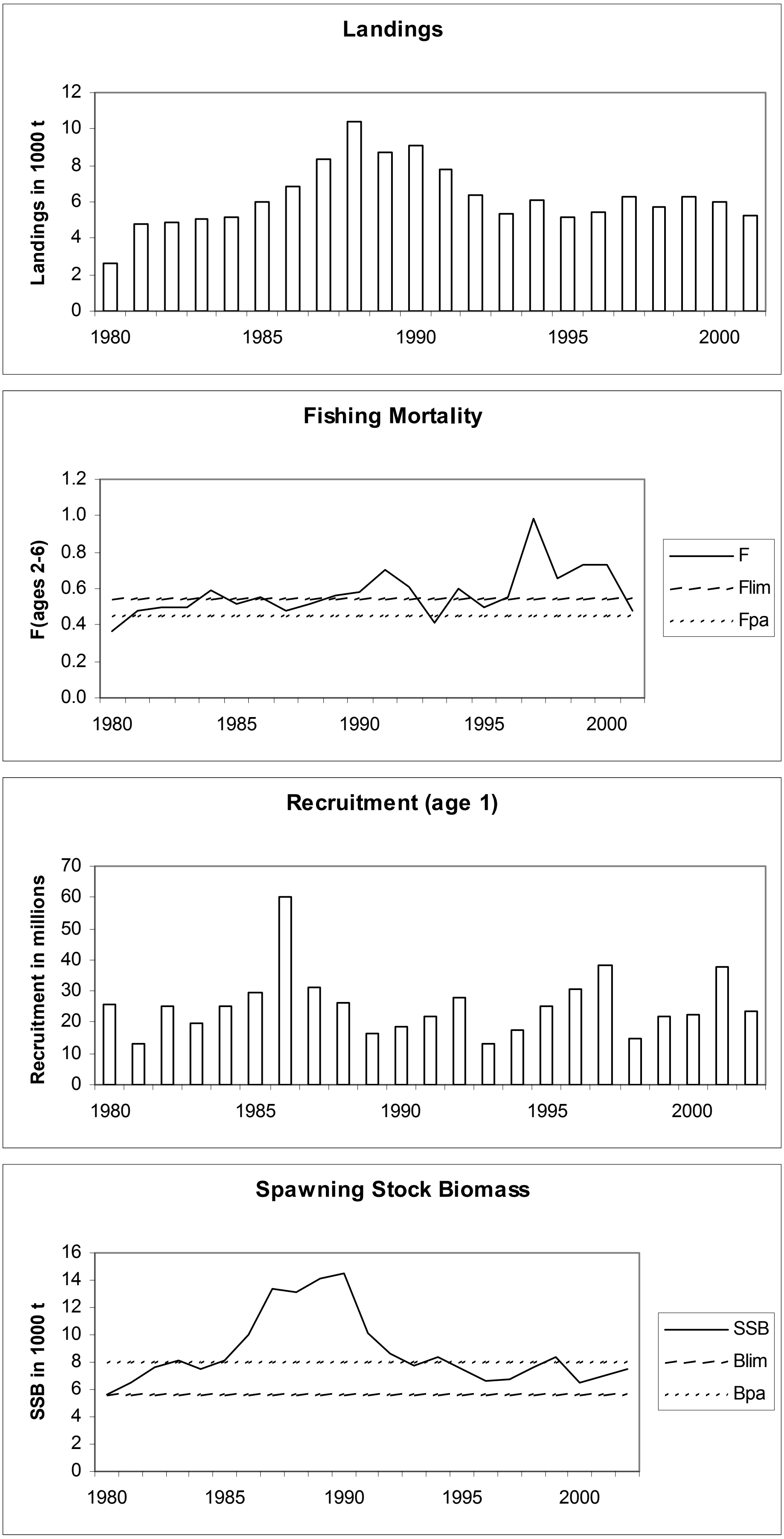
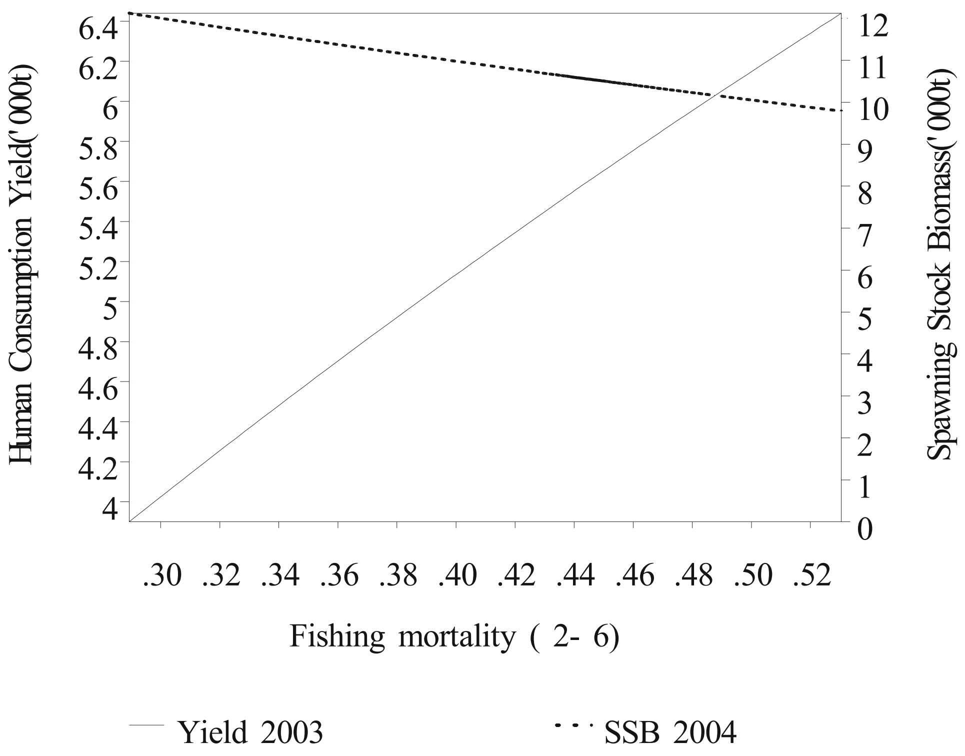
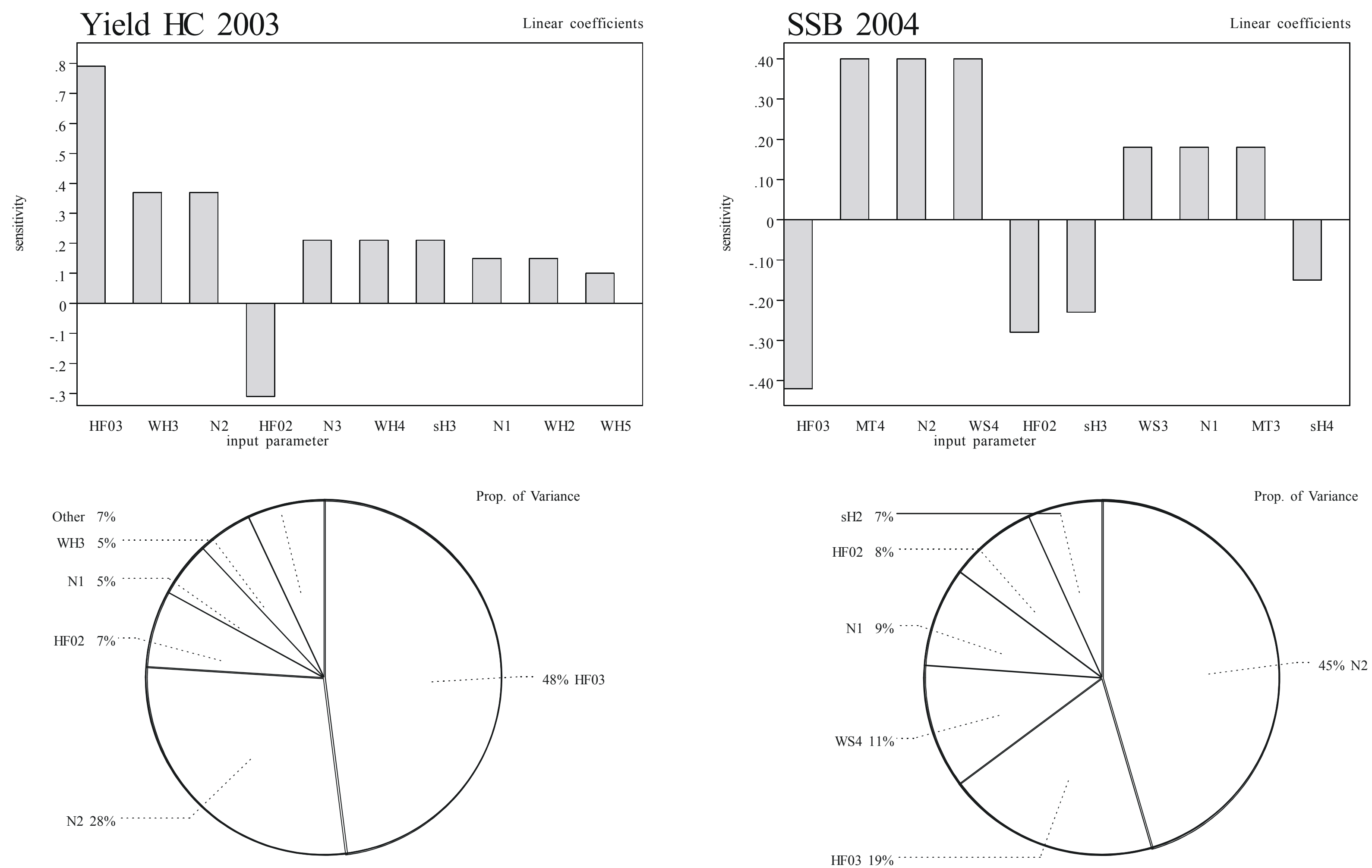


Figure 11.7.1 Plaice in VIId. Short-term forecast



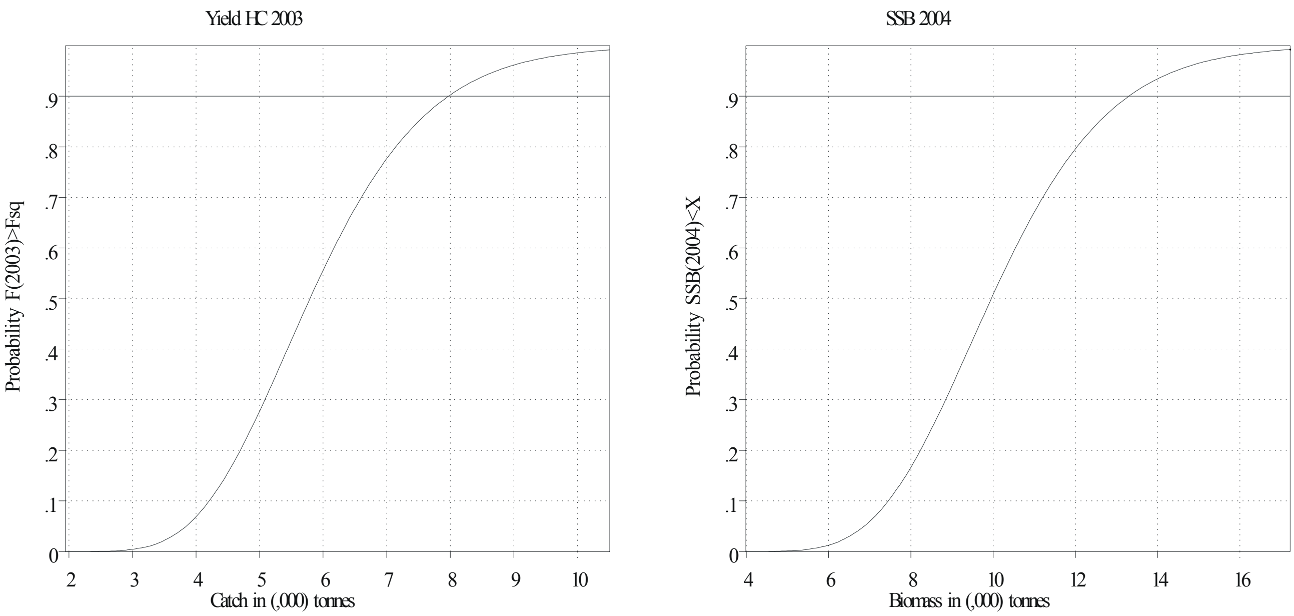
Data from file:C:\mediumterm\new\PLAVIID.SEN on 17/06/2002 at 19:41:51

Figure 11.7.2 Plaice in VIId. Sensitivity analysis of short-term prediction



Data from file:C:\mediumterm\new\PLAVIID.SEN on 19/06/2002 at 10:06:42

Figure 11.7.3 Plaice in VIId. Probability profiles for short-term forecast.



Data from file:C:\mediumterm\new\PLAVIID.SEN on 17/06/2002 at 19:41:10

Figure 11.8.1 Plaice in VIId. Comparison between Ockham and Ricker stock-recruitment curves

PLAVIID.SUM: calculation of Ockham parameter

Mean = , 2.38127E+04

Variance of mean (log scale) = , 6.74361E-03

Residual sum-of-squares = , 2.83232E+00
Mean absolute residual = , 7.34916E+03
Residual variance = , 1.14621E+08
Akaike's Information Criterion = ,
6.26365E+01PLAVIID.SUM: calculation of LOESS Smoother parameter

PLAVIID.SUM: lognormal Ricker parameters

Initial estimate for alpha = ,7.8740E+00
Initial estimate for beta = ,1.1704E-04

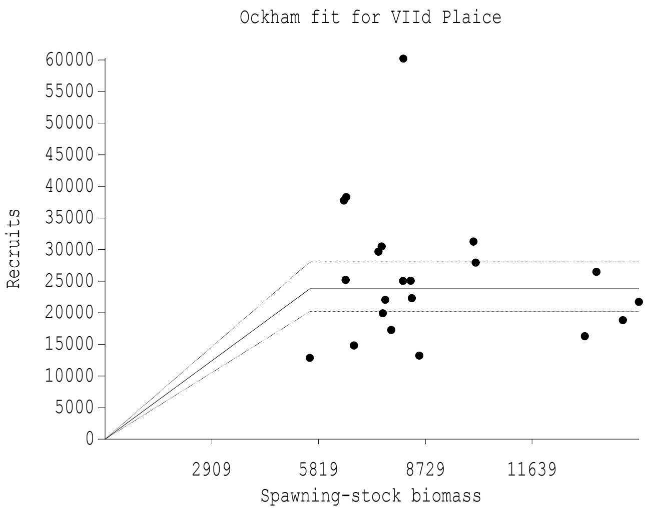
Final estimate for alpha = ,7.8740E+00,+/-
,2.3052E+00
Final estimate for beta = ,1.1704E-04,+/-,3.1587E-05
Variance-covariance matrix:

	1	2
1	5.31400E+00	6.98911E-05
2	6.98911E-05	9.97768E-10

Corr[alpha,beta] =, 0.96

RSS =, 2.6919E+00
Mean absolute residual =, 7.0804E+03
Residual variance =, 1.2819E-01
Akaike (AIC) =, 6.4586E+01
-2 log likelihood =, 1.6456E+01

IFAIL from nonlinear fit =, 0



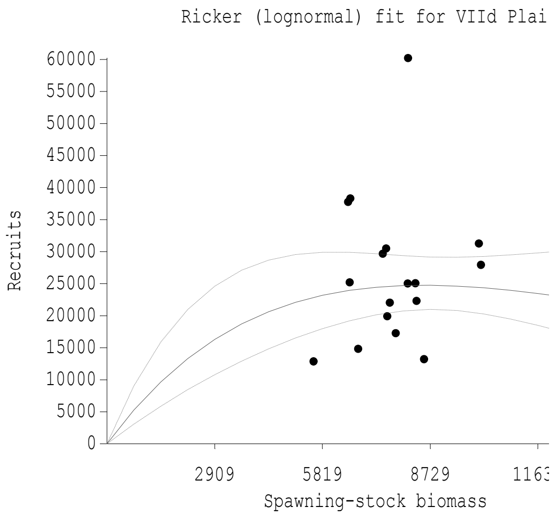


Figure 11.9.1 Plaice in Division VIId. Yield-per-recruit

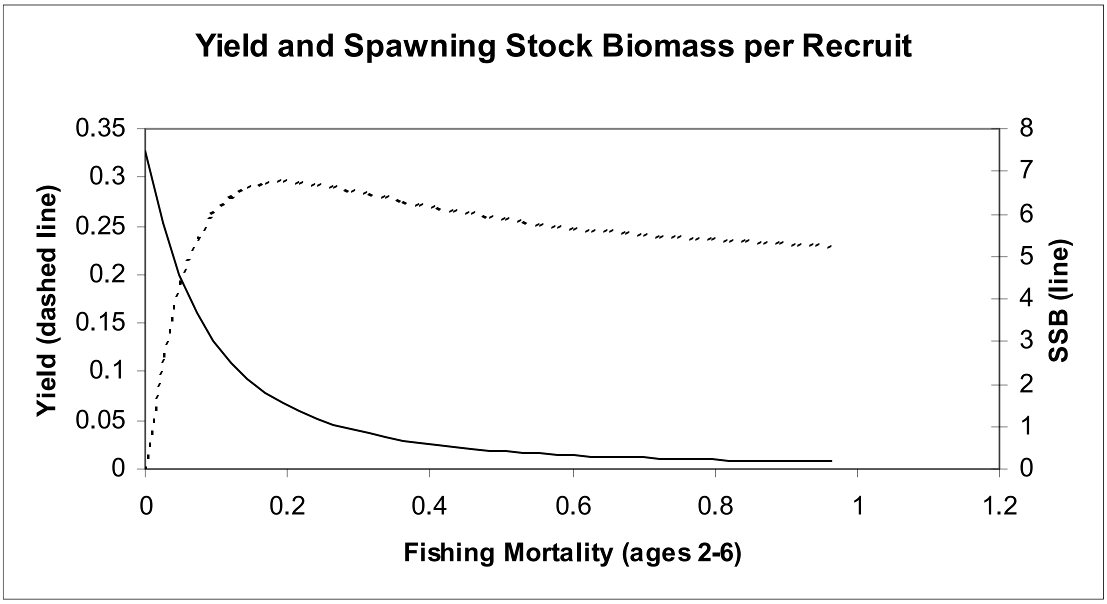


Figure 11.9.2 Plaice in Division VIId. Stock-recruitment plot

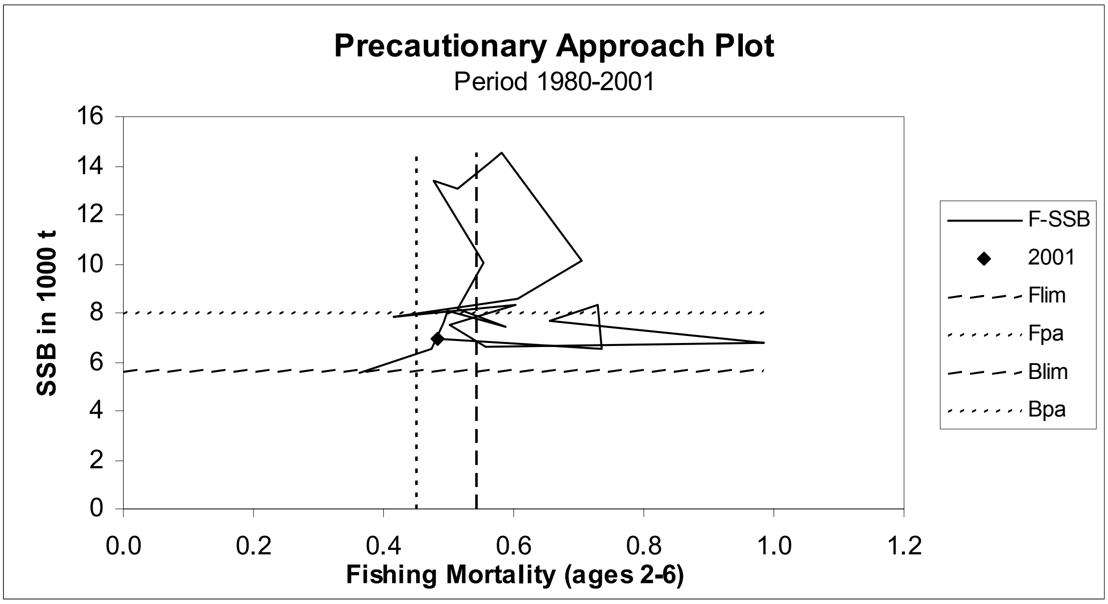
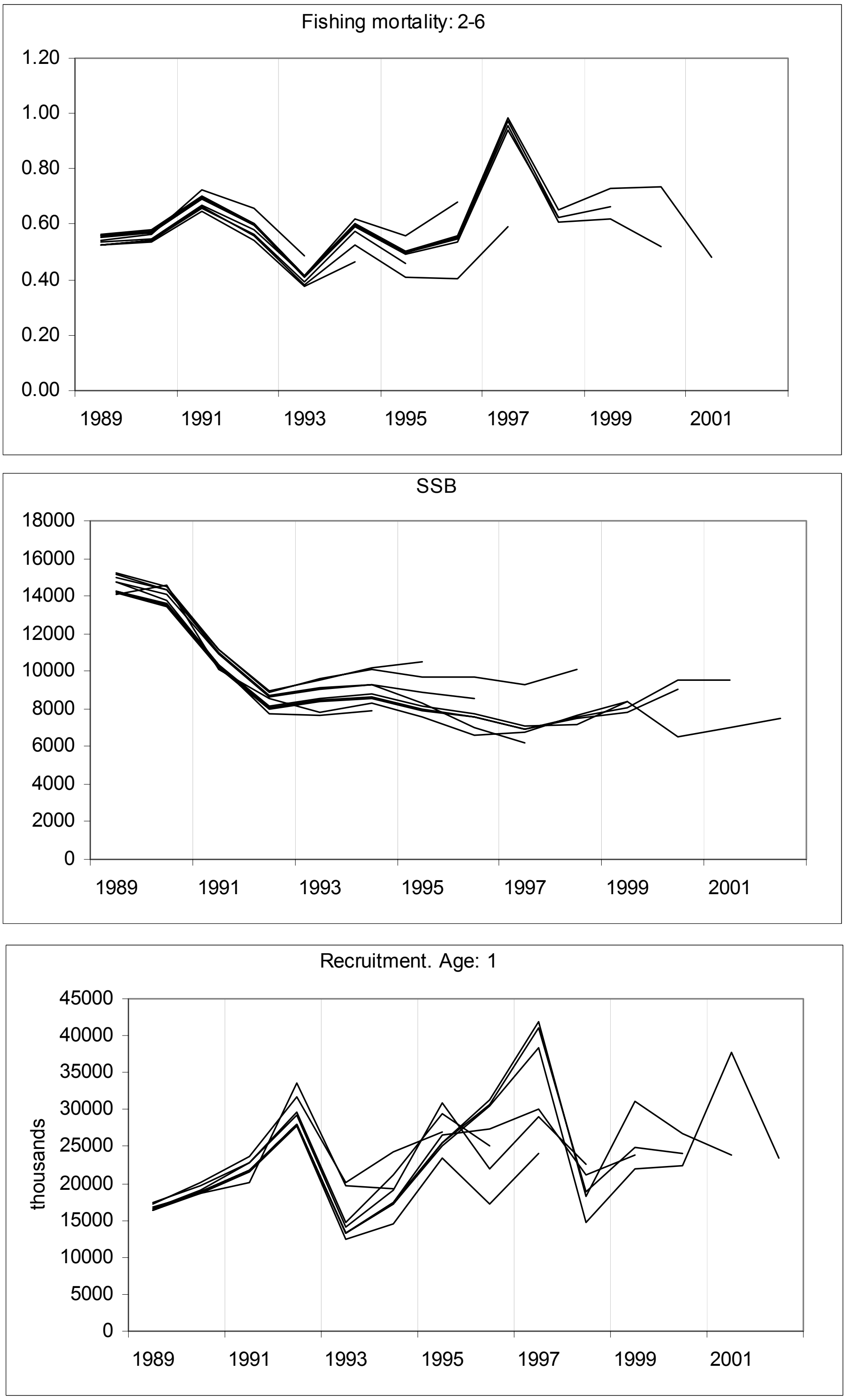


Figure 11.10.1 Plaice in VIId. Quality control of assessments generated by successive Working Groups.



12 NORWAY POUT IN ICES SUBAREA IV AND DIVISION IIIA

12.1 The 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. The fishery targets both Norway pout and blue whiting. Distribution of Danish Norway pout landings by ICES quarter square and quarter of the year for year 2000 and 2001 are shown in Figures 12.1.1-4.

12.1.1 ACFM advice applicable to 2001 and 2002

There is no management objective set for this stock. With present fishing mortality levels the status of the stock is more determined by natural processes and less by the fishery. The ACFM advice for 2001 and 2002 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. The present (1996-2002) TAC of 220 000 t should be maintained.

12.1.2 Management applicable to 2001 and 2002

In 1996-2002 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 2001 and 2002

Nominal landings of Norway pout as officially reported to ICES are given in Table 12.1.1. Annual landings as provided by Working Group members are shown in Table 12.1.2, and trends in yield are shown in Figures 12.6.1-2.

The total yearly landings in 1998-99 were between 80-100 000 t, increasing in year 2000 to nearly 200 000 t, mainly based on fishery on the strong 1999 year class (age 1) (Table 12.2.1).

Landings in 2001 decreased to around 65 000 t, which are the lowest yearly landings since 1966. While 1st quarter 2001 landings were well above average, the landings for 3rd and 4th quarter 2001 were much below average. This is mainly because the industrial fishing fleets in the second half year of 2001 primarily targeted sandeels in the North Sea, and partly due to the weak 2000 year class of Norway pout (Figure 12.6.1). The strong 1999 year class contributed less to the landings in 2001 relative to the landings in year 2000 due to mortality, Table 12.2.1. The 0-group landings of the 2001 Norway pout year class, having average year-class strength, were relatively small in 3rd and 4th quarter 2001. The effort in the Norway pout fishery has been historically low in 2001, especially in 3rd and 4th quarter of the year.

Landings in the 1st quarter of 2002 were below average within the last 5 year period (Table 12.2.1), and here effort for Norway pout was also historically low compared to previous years.

Highest catches are in general taken in the 1st, 3rd, and 4th quarters of the year (Table 12.1.3).

12.1.4 Fleet developments

The fishing effort and number of vessels as well as the catch rates per vessel size category of the Danish trawlers participating in the Norway pout fishery for the years 1982-2001 are shown in Figure 12.3.2. The number of small vessels in the fleet is reduced and the relative number of large vessels has increased in the latest years.

12.2 Natural Mortality, Maturity, Age Composition, and Mean Weight-at-Age

Age compositions were available from Norway and Denmark. Catch-at-age is shown in Table 12.2.1. Mean weight-at-age in the catch was estimated as a weighted average of Danish and Norwegian data (Table 12.2.2). The mean weights-at-age in the catches are very variable between years and seasons, and also between countries, for the same age groups in the same year. The same mean weight-at-age in the stock, proportion mature, and natural mortality are used for all years (Table 12.2.3). Mean weight in catch is not used as an estimator of weight in the stock, partly because the smallest 0-group fish are not fully recruited to the fishery in the 3rd quarter of the year. The natural mortality is set to 0.4 for all age groups in all seasons, which results in an annual natural mortality of 1.6 for all age groups.

Exploratory runs were made with revised input data for natural mortality based on the results from two papers presented to the Working Group in 2001, Sparholt *et al.* (2002a,b; in press). This is further described in Sections 12.4 and 12.10-11.

12.3 Catch, Effort, and Research Vessel Data

The assessment uses the combined catch and effort data from the commercial Danish and Norwegian small-meshed trawler fleets fishing mainly in the northern North Sea.

12.3.1 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). In previous years 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 present (and in the 2001) assessment the output of the regression analyses, using time-series from 1987-2002, 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 (Table 12.3.1; Figure 12.3.2). Furthermore, no trends in cpue were found between vessel categories over time (Figure 12.3.2). For these reasons the cpue indices used in the regression has been obtained from pooled catch and effort data over the years 1994-2002 by vessel category in order to obtain and include estimates for all vessel categories, also for the latest years where no observations exists for the smallest vessels groups. The combined cpue-values by vessel category for 1994-2002, which have been used in the regression, are shown in Figure 12.3.3. 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 12.3.2. The upper table of Table 12.3.2 gives regression results with the combined cpue-values for the period 1994-2002 which have been used in the assessment. For comparison purposes results and parameters from the regression of disaggregated data by year (1994-2002), i.e. not combined data, are shown in the lower table.

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 are shown in Figure 12.4.4. It appears that the differences are small.

12.3.2 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 Table 12.3.3.

12.3.3 Danish effort data

Table 12.3.1 shows cpue data by vessel size category and year for the Danish commercial fishery in Area IVa for fishing trips the where total catch included at least 70% Norway pout and blue whiting per trip. The comparative trends in effort, vessel number, and cpue for different vessel size categories for the Danish commercial fishery given in Figure 12.3.2 shows a relative reduction in the number 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.

12.3.4 Standardized effort data

The resulting combined and standardized Danish and Norwegian effort for the commercial fishery used in the assessment is presented in Table 12.3.4, and combined cpue indices by age and quarter for the commercial fishery tuning fleet are shown in Table 12.3.5 and Figure 12.3.1. Seasonal trends in effort and landings of the combined tuning fleet are shown in Figures 12.3.4-5. The seasonal variation in effort data is one reason for performing a seasonal VPA. This is further described in Section 12.10.

12.3.5 Research vessel data

Survey indices series of abundance of Norway pout by age and quarter were available from the IBTS and the EGFS and SGFS, Table 12.3.6 and Figure 12.3.1. The SGFS data from 1998-2001 was used with caution as a new survey design (new vessel from 1998 and new gear and extended survey area from 1999) was introduced. The 0-group indices from this survey were not used 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 was included in the SXSA.

Research vessel indices from the 3rd quarter IBTS are also presented in Table 12.3.6, but for comparison purposes only. These survey data are not used in the assessment. This is further described in Section 12.4 and 12.10.

12.4 Catch-at-Age Analyses

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 parameter settings and options of the SXSA were the same this year as in last year's assessment (Table 12.4.1). No time taper or shrinkage was used in the catch-at-age analysis.

In the SXSA the catchability, r, per age and quarter and fleet was assumed to be constant within the period 1983-2002 where the estimated catchability, rhat, is a geometric mean over years by age, quarter, and tuning fleet. Tuning was performed over the period 1983 to 2002 producing log residual (log(Nhat/N)) stock numbers and survivor estimates by year, quarter, age, and tuning fleet. The contributions from the various age groups to the survivor estimates by year and quarter and fleet were in the SXSA combined to an overall survivors estimate, shat, estimated as the geometric mean over years of log(shat) weighted by the exponential of the inverse cumulated fishing mortality as described in Skagen (1993).

The three surveys and the seasonally (by quarter) divided commercial fleets were all used in the tuning (Table 12.4.1). The data time-series for the tuning fleets used in the SXSA are given in Tables 12.3.4-12.3.6. 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.

Table 12.4.1 contains the SXSA parameter settings, options, and input data used in the SXSA. Tables 12.4.2-12.4.4 present the estimated stock numbers, the fishing mortalities, and the diagnostics, respectively, from the SXSA output. A summary of the results is shown in Table 12.6.1 and in Figures 12.6.1-12.6.2. Total stock biomass is given for 3rd quarter of the year because this is the biomass including 0-groups available for the commercial fishery.

The log residual stock numbers by year for each tuning fleet are least variable for 1- and 2-year-old fish, as the precision in the estimated catch is higher for these age groups (Fig. 12.4.1). There are no apparent trends in the residuals with time for the commercial tuning fleets. Estimated SSQ residuals by tuning fleet and season (Figure 12.4.2) indicate large inter-annual variations with a large sum of squared residuals for commercial fishery in some years for 3rd and 4th quarter. The surveys, especially the EGFS, show large variations in SSQ, while the values for SGFS and 1Q IBTS are lower and more stable. There might be a slight trend in the residuals for the 1Q IBTS and the existence of two slightly different levels for the 3Q SGFS over time.

In order to investigate this an exploratory run of the SXSA was made in the 2001 assessment, using the cosine time taper option in the SXSA, down-weighting the period 1983 to 1991 (both years included; 12 cohorts). The trends in the log residual stock numbers for the 1Q IBTS and the 3Q SGFS disappeared and no trends were introduced in the other tuning fleets (not shown) in the output from this run. The resulting SSB and F for this run compared to those for the run with standard settings were not very different. In 2001 the Working Group decided to use the assessment with standard settings (without time taper) as in previous years, which was also decided by the Working Group for this year's assessment.

The estimated weighting factors for computing survivors by tuning fleet used in the tuning process in the final run were evenly distributed over the different cpue series, with a general tendency towards most weight being given to the cpue data from the commercial fishery (Figure 12.4.2; Table 12.4.4.). The commercial fishery was used in tuning in each quarter of the year, while survey weighting was only used for the 1st and 3rd quarter of the year. For several age groups and seasons approximately the same weight was given to the IBTS and SGFS surveys as the weight given to the commercial fishery. Relatively high weight is given to SGFS age 3.

Retrospective analyses have been made for SSB, recruitment, and fishing mortality estimated by the SXSA, Figure 12.4.3. The method used was running the SXSA by sequential exclusion of the more recent assessment year. The analyses revealed no tendencies in over- or under-estimating the SSB, recruitment, and fishing mortality in the last year. In nearly all cases the estimates converged rapidly. The SXSA seems to estimate recruitment well.

As in 2001 an exploratory run of the SXSA was made in 2002 with revised input data for natural mortality based on the results from two papers presented to the Working Group in 2001, Sparholt et al. (2002a,b; in press in ICES J. Mar. Sci.). The results of this are shown in Figure 12.4.5. This will be further commented on in Section 12.10-11.

12.5 Recruitment Estimates

The long-term average recruitment (age 0, 3rd quarter) is 133 billions (arithmetic mean) and 113 billions (geometric mean) for the period 1974-2001 (Table 12.6.1). Recruitment is highly variable and influences SSB and TSB rapidly, due to the short life span of the species.

The SXSA shows that recruitment in 1997-98 was well below the long-term averages, while the 1996 and 1999 year classes were well above average. Recruitment in 2000 was historically low within the last 12 years period, and much below the long-term average. Recruitment in 2001 was close to the long-term average.

12.6 Historical Stock Trends

Historical trends in stock biomass (SSB, TSB), landings, recruitment, and fishing mortality of Norway pout for the period 1974–2002 are presented in Table 12.6.1-2 and Figures 12.6.1-12.6.2. The historical data from 1974 to 1982 are obtained from previous Working Group reports. The present assessment covers the period 1983-2002.

Spawning stock biomass decreased in the mid-1980s to around 100 000 t after having reached peaks at above 350 000 t in 1983-84, but has since slowly increased again fluctuating between 150 000 t and 350 000 t.

Trends in annual landings are also shown in Table 12.1.2 for the period 1961-2001, where data before 1983 are obtained from previous Working Group reports. The long-term averages in landings were in the period 1959-66 below 100 000 t rising to a level around 375 000 t in the period 1967-84 and falling again to between 75-200 000 t in the period 1985-2000. Yield was historically low in 2001. The seasonal distribution of the landings by country, Table 12.1.3, show that catches in all years were highest in the 1st, 3rd, and 4th quarters of the year.

The fishing mortality has during the period 1974–2000 decreased from a level fluctuating between 1-2 from 1974-1986 to a level between 0.75-0.3 in the period 1987-2000. The fishing mortality in 2001 was historically low (F = 0.2), especially in the 3rd and 4th quarters of the year (Tab. 12.3.4).

12.7 Short-Term Predictions (Forecasts)

No forecast is given for this stock. Catch predictions for 0- and 1-groups are important as the fishery targets the 0-group already in the 3rd and (especially in) the 4th quarter of the year, as well as the 1-group in the 1st quarter of the following year. Deterministic catch forecasts are uncertain, due to the catch possibilities being largely dependent on the size of a few year classes, the large dependence on the strength of the recruiting 0-group year class that is unknown for 2002, and the added uncertainty in the assessment and forecast arising from variations in natural mortality (Sparholt et al. 2002a,b; in press ICES J. Mar. Sci.). Traditional catch prediction for traditional TAC-based management for 2002 will therefore be uncertain and will not cover the important year classes in the future fishery.

12.8 Medium-term Predictions

No medium-term predictions are given for this stock (see also Section 12.9 and 12.10).

12.9 Biological Reference Points

Figures 12.9.1 and 12.9.2 show recruitment-SSB-plots, yield-per-recruit plots, and pa-plots for Norway pout in the North Sea and Skagerrak.

$\mathbf{B}_{lim}$ is 90 000 t
$\mathbf{B}_{pa}$= 150 000 t
$\mathbf{F}_{low}$ =0.23
$\mathbf{F}_{med}$ =0.67
$\mathbf{F}_{high}$ =1.21

In 1997-2001 a precautionary limit reference point for SSB was proposed, based on the lowest observed level of SSB where the stock has produced strong year classes, i.e. the level of below-average recruitment. $\mathbf{F}_{med}$=0.67, which represents the exploitation level where the stock has a 50% chance of replacing itself (Fig. 12.9.1), is a little above the F-level in 1999-2000 around 0.5-0.6 and much above the present F-level in 2001 and 1st quarter 2002.

12.10 Quality of the Assessment and Comments to the Assessment

12.10.1 Seasonal VPA

The reasons for performing seasonal VPA are that there are seasonal differences in the fishery and in the fishing pattern (and most likely also in the natural mortality). If the ratio between F and M varies between seasons, then seasonal and annual VPAs will produce different results. The seasonal patterns and variations over years in effort and catch in the Danish and Norwegian Norway pout fishery appear from Figures 12.3.4 and 12.3.5. Comparisons between annual and seasonal assessments were performed for Norway pout in 1997 (ICES CM 1998/Assess:7). The annual VPA had a tendency to estimate the lower stock numbers.

12.10.2 Recruitment

It should be noted that there seems to be two levels of the stock-recruitment-relationship for the stock (Fig. 12.9.1), a level well above and one well below recruitment around 125 billions. There are no periodical or 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.

For the SXSA recruitment estimates are available from the EGFS and SGFS surveys carried out in August (Tab. 12.3.6), as well as the 3rd quarter IBTS (Tab. 12.3.6) and the commercial fishery in the 3rd and 4th quarters of the year (Table 12.3.5). The SGFS recruitment indices from 1998-2001 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 1991-2001. This new time-series seems to estimate 0-groups better than the EGFS alone and it gives a longer time-series than the new SGFS alone; however, it contains shorter time-series than the EGFS and the full time-series of the SGFS used as separate tuning time-series and, furthermore, it is not independent of EGFS and SGFS. The 0-group are recruited to the 4th quarter commercial fishery that tends to predict strong year classes well as 0-group. However, no information on the strength of the 2002 year class is available at the time of the assessment, i.e. the recruitment in 2002 is unknown.

12.10.3 Survey tuning fleets in the assessment

As the IBTS 3rd quarter survey 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 it has so far not been used as tuning fleet in the assessment. However, future exploratory assessment runs should be made using the 3Q IBTS fleet as tuning fleet instead of 3Q EGFS and 3Q EGFS, as the 3Q IBTS is now starting to contribute with a relatively long data time-series from 1991 and onwards. Furthermore, the 3rd quarter IBTS survey is together with the other surveys (IBTS 1Q, EGFS, SGFS) evaluated as survey tuning fleets with respect to variance in abundance indices and with respect to their performance of describing trends in the Norway pout stock carried out in an EU Tender Project, EVARES (Evaluation). This project will be finalized within 2002.

12.10.4 Research results on population dynamics parameters (e.g. natural mortality)

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. An exploratory run of the SXSA model was made with revised input data for natural mortality by age, based on the results from two papers presented to the Working Group in 2001, Sparholt et al. (2002a,b; in press in ICES J. Mar. Sci. 2002). The resulting SSB, TSB (3rd quarter of year), TSB (1st quarter of year), and F for this run compared to those for the run with standard settings are shown in Figure 12.4.5. It appears that the implications of these revised input data are very significant. This year is the second assessment year where exploratory runs with revised natural mortality values have been performed. The scientific background for the revised natural mortality estimates have been positively evaluated in a peer-reviewed journal. The Working Group therefore suggests that assessments with partly the traditional settings (constant M) and partly new assessments with the revised values for M are made in at least a 3-year period in order to compare the output and the performance of the assessments before the Working Group decides on adoption of the revised values for M to be used in the assessment.

It appears from the quality control diagrams made from the results of the performed assessment on the Norway pout stock in the North Sea and Skagerrak (Figure 12.10.1) that the estimates of the SSB, recruitment, and the average fishing mortality of the 1- and 2-group are consistent with the estimates of previous years' assessments; besides, the new standardization procedure has resulted in slightly higher estimates of SSB and slightly lower estimates of F in the latest years of the assessment period.

12.11 Management Considerations

There is no management objective set for this stock. With the present fishing mortality levels the status of the stock is more determined by natural processes and less by the fishery. However, there is a need to ensure that the stock remains high enough to provide food for a variety of predator species. The stock can on average sustain the current F, which is low. The average recruitment in 2001 has – despite the very low recruitment in 2000 – resulted in only a moderate decrease in SSB from 2001 to 1st quarter 2002, reaching a level around 200 000 t as in year 2000. Consequently, the relatively high spawning stock biomass level in recent years (except for 1999) will probably be maintained in the first part of 2002, based on the average 2001 year class and also older fish from the strong 1999 year. However, recruitment in 2002 is unknown at the time of assessment. This should be taken into account when setting a TAC. In managing this fishery, by-catches of other species should be taken into account. Existing measures to protect other species should be maintained.

It may be more appropriate to formulate reference points based on total stock biomass (TSB) or based on estimates of total mortality from surveys for use within management of this stock.

12.12 Norway Pout in Division VIa

12.12.1 Catch trends and assessment

Landings of Norway pout from Division VIa as reported to ICES are given in Table 12.12.1 and Figure 12.12.1. Reported landings in 2001 were 3 200 t, which is well below the series average of 11 000 t (1974-2001). No data are available on by-catches in this fishery. Since no age compositions are available, data are insufficient for an assessment of this stock.

12.12.2 Stock identity

ACFM (October 2001) asked the Working Group to verify the justification of treating Division VIa as a management area for Norway pout and sandeel separately from 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 et al. in ICES C.M.2001/ACFM:07), gave no evidence for a stock separation in the whole northern area.

The WG considers that the extent of the data that is available on VIa Norway pout should be assessed before the discussion on the merging of the VIa stock with the North Sea stock is finalized.

Table 12.1.1 **Nominal landings (tonnes) of Norway pout from the North Sea and Skagerrak / Kattegat, ICES areas IV and IIIa in the period 1995-2001, as officially reported to ICES.**

Norway pout
Division IIIa

Country	1995	1996	1997	1998	1999	2000	2001**
Denmark	67.841	57.529	34.746	11.080	7.194	14.545	13.619
Sweden	68	237	2			133	744
Total IIIa	67.909	57.766	34.748	11.080	7.194	14.678	14.363

Norway pout
Division IVa

Country	1995	1996	1997	1998	1999	2000	2001**
Denmark	141687	95708	106.958	42.154	39.319	133.149	44.818
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*	16.835
Sweden			+				
UK (Scotland)		74					
Total IVa	259.521	191.541	153.032	69.074	86.694	181.210	61.653

Norway pout Division IVb

Country	1995	1996	1997	1998	1999	2000	2001**
Denmark	28.584	3.531	1.794	3.258	5.299	158	632
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

Norway pout Division IVc

Country	1995	1996	1997	1998	1999	2000	2001**
Denmark					514	182	304
Netherlands					+		
UK (E/W/NI)							
UK (Scotland)		+					
United Kingdom							+
Total IVc	0	0	0	0	514	182	304

Sub-area IV and IIIa (Skagerrak) combined

Country	1995	1996	1997	1998	1999	2000	2001
Denmark	238112	156768	143498	56492	52326	148034	59373
Faroe Islands	8849	7574	7033	4707	2534	0	0
Norway	110031	90181	39006	22270	44841	48095	16835
Sweden	68	237	2			133	744
Netherlands	131	5	85	2	0	3	0
Germany	34					2	
UK		74					
Total nominal landings	357225	254839	189624	83471	99701	196267	76952
By-catch of other species and other	-120425	-91039	-19924	-3671	-7701	-11867	-11352
WG estimate of total landings (IV+IIIaN)	236800	163800	169700	79800	92000	184400	65600
Agreed TAC	180000	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 1961–2001 (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

Table 12.1.3 Norway Pout, North Sea and Skagerak. National landings (t) by quarter of year 1989-2002.
(Data provided by Working Group members. Norwegian landing data include landings of by-catch of other species).

Year	Quarter	Denmark									Norway		Total
	Area	IIIaN	IIIaS	Div. IIIa	IVaE	IVaW	IVb	IVc	Div. IV	Div. IV + IIIaN	IVaW	Div. IV	Div. IV + IIIaN
1989	1	194	67	261	6.213	6.058	8	-	12.279	12.473			
	2	301	21	322	793	47	725	-	1.566	1.867			
	3	1.917	303	2.220	13.876	16.361	3.479	-	33.717	35.634			
	4	1.772	910	2.681	7.802	31.892	8.403	-	48.097	49.869			
	Total	4.184	1.300	5.484	28.684	54.359	12.615	-	95.659	99.842			
1990	1	323	33	356	16.171	4.613	594		21.377	21.700			
	2	6.770	366	7.136	2.682	283	3.768	-	6.732	13.502			
	3	12.616	2.696	15.312	6.253	2.041	138	-	8.432	21.048			
	4	4.059	466	4.525	7.341	17.506	81	-	24.928	28.987			
	Total	23.768	3.561	27.329	32.446	24.443	4.580	-	61.469	85.237			
1991	1	139	53	191	17.007	10.331	37	-	27.375	27.514			
	2	1.918	694	2.613	183	231	92	-	506	2.424			
	3	23.467	4.101	27.568	3.119	11.042	299	-	14.460	37.927			
	4	6.571	1.719	8.290	14.584	27.693	332	-	42.609	49.180			
	Total	32.094	6.567	38.662	34.894	49.297	760	-	84.950	117.044			
1992	1	2.330	619	2.950	29.701	8.862	1.096	-	39.659	41.989			
	2	9.235	1.684	10.919	1.610	264	1.529	-	3.403	12.638			
	3	22.586	817	23.402	9.908	34.053	6.465	-	50.426	73.012			
	4	7.561	263	7.824	4.102	47.704	1.630	2	53.439	61.000			
	Total	41.713	3.383	45.095	45.321	90.883	10.720	2	146.926	188.639			
1993	1	319	30	350	16.471	6.581	151	-	23.203	23.522			
	2	1.052	77	1.129	594	102	802	-	1.498	2.550			
	3	3.629	531	4.161	7.461	25.072	409	-	32.941	36.570			
	4	1.728	406	2.133	10.685	28.994	9	-	39.688	41.416			
	Total	6.729	1.044	7.773	35.210	60.748	1.371	-	97.330	104.058			
1994	1	568	75	643	18.660	3.588	533	-	22.781	23.350			
	2	4	0	4	511	170	-	-	681	685			
	3	2.137	74	2.211	5.674	12.604	493	-	18.772	20.908			
	4	3.623	116	3.739	5.597	49.935	91	-	55.622	59.246			
	Total	6.332	265	6.598	30.442	66.298	1.117	-	97.857	104.189			
1995	1	576	9	585	19.421	1.336	7	-	20.764	21.339	15521	15521	36.860
	2	10.495	290	10.793	2.841	30	3.670	-	6.540	17.035	10639	10639	27.674
	3	20.563	976	21.540	13.316	17.681	11.445	-	42.442	63.004	5790	5790	68.794
	4	14.748	2.681	17.430	10.812	56.159	1.426	-	68.396	83.145	11131	11131	94.276
	Total	46.382	3.956	50.347	46.390	75.205	16.547	-	138.142	184.524	43.081	43081	227.605
1996	1	1.231	164	1.395	6.133	3.149	658	2	9.943	11.174	10604	10604	21.778
	2	7.323	970	8.293	1.018	452	1.476	-	2.946	10.269	4281	4281	14.550
	3	20.176	836	21.012	7.119	17.553	1.517	-	26.188	46.364	27466	27466	73.830
	4	5.028	500	5.528	9.640	25.498	42	-	35.180	40.208	5466	5466	45.674
	Total	33.758	2.470	36.228	23.910	46.652	3.692	2	74.257	108.015	47.817	47817	155.832
1997	1	2.707	460	3.167	6.203	2.219	7	-	8.429	11.137	4183	4183	15.320
	2	5.656	200	5.857	141	-	45		185	5.842	8466	8466	14.308
	3	16.432	649	17.081	19.054	21.024	740	-	40.818	57.250	21546	21546	78.796
	4	4.464	1.042	5.505	6.555	38.202	7		44.765	49.228	4884	4884	54.112
	Total	29.259	2.351	31.610	31.953	61.445	799	-	94.197	123.456	39.079	39079	162.535
1998	1	1.117	317	1.434	7.111	2.292	-	-	9.403	10.520	8913	8913	19.433
	2	3.881	103	3.984	131	5	124	-	259	4.140	7885	7885	12.025
	3	6.011	406	6.417	7.161	1.763	2.372	-	11.297	17.308	3559	3559	20.867
	4	2.161	677	2.838	1.051	17.752	77	-	18.880	21.041	1778	1778	22.819
	Total	13.171	1.503	14.673	15.454	21.811	2.573	-	39.838	53.009	22.135	22135	75.144
1999	1	4	12	15	2.769	1.246	1	-	4.016	4.020	3021	3021	7.041
	2	1.568	36	1.605	953	361	418	-	1.731	3.300	10321	10321	13.621
	3	3.094	109	3.203	7.500	3.710	2.584	-	13.794	16.887	24449	24449	41.336
	4	2.156	517	2.673	3.577	16.921	928	1	21.426	23.583	6385	6385	29.968
	Total	6.822	674	7.496	14.799	22.237	3.931	1	40.968	47.790	44.176	44176	91.966
2000	1	0	11	12	3.726	1.038	-	-	4.764	4.765	5440	5440	10.205
	2	929	15	944	684	22	227	-	933	1.862	9779	9779	11.641
	3	7.380	139	7.519	1.708	5.613	515	-	7.836	15.216	28428	28428	43.644
	4	947	209	1.157	1.656	111.732	76	-	113.464	114.411	4334	4334	118.745
	Total	9.257	375	9.631	7.774	118.406	818	-	126.998	136.255	47.981	47981	184.236
2001	1	198	104	302	7.341	9.734	103	72	17.250	17.448	3838	3838	21.286
	2	2.010	163	2.174	31	30	269	-	330	2.340	9268	9268	11.608
	3	1.714	293	2.006	15	154	191	-	360	2.074	2263	2263	4.337
	4	2.995	64	3.059	2.553	19.826	329	-	22.708	25.703	1426	1426	27.129
	Total	6.917	624	7.541	9.940	29.744	892	72	40.648	47.565	16.795	16795	64.360
2002	1	-	1	1	4.869	1.660	114	-	6.643	6.644	1896	1896	8.540

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	2	3	4	1985	2	3	4	1986	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	2	3	4	1988	2	3	4	1989	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	2	3	4	1991	2	3	4	1992	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	2	3	4	1994	2	3	4	1995	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	2	3	4	1997	2	3	4	1998	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	2	3	4	2000	2	3	4	2001	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											
0		0											
1		310											
2		192											
3		17											
4+		0											
SOP		8549											

Table 12.2.2 **NORWAY POUT in the North Sea and Skagerrak. Mean weights (grams) at age in catch, by quarter 1983-2002, from Danish and Norwegian catches combined. Data for 1974 to 1982 are assumed to be the same as in 1983.**

Year	1983				1984				1985			
Quarter of year	1	2	3	4	1	2	3	4	1	2	3	4
Age 0			4,00	6,00			6,54	6,54			8,37	6,23
1	7,00	15,00	25,00	23,00	6,55	8,97	17,83	20,22	7,86	12,56	23,10	26,97
2	22,00	34,00	43,00	42,00	24,04	22,66	34,28	35,07	22,7	28,81	36,52	40,90
3	40,00	50,00	60,00	58,00	39,54	37,00	34,10	46,23	45,26	43,38	58,99	
4									41,80			
Year	1986				1987				1988			
Quarter of year	1	2	3	4	1	2	3	4	1	2	3	4
Age 0				7,20			5,80	7,40			9,42	7,91
1	6,69	14,49	28,81	26,90	8,13	12,59	20,16	23,36	9,23	11,61	26,54	30,60
2	29,74	42,92	43,39	44,00	28,26	31,51	34,53	37,32	27,31	33,26	39,82	43,31
3	44,08	55,39	47,60		52,93			46,60	38,38			
4	82,51				63,09				69,48			
Year	1989				1990				1991			
Quarter of year	1	2	3	4	1	2	3	4	1	2	3	4
Age 0			7,48	6,69			6,40	6,67			6,06	6,64
1	7,98	13,49	26,58	26,76	6,51	13,75	20,29	28,70	7,85	12,95	30,95	30,65
2	26,74	28,70	35,44	34,70	25,47	25,30	32,92	38,90	20,54	28,75	44,28	43,10
3	39,95	44,39		46,50	37,72	40,35	39,40	52,94	35,43	49,87	67,25	59,37
4					68,00				44,30			
Year	1992				1993				1994			
Quarter of year	1	2	3	4	1	2	3	4	1	2	3	4
Age 0		8,00	6,70	8,14			4,40	8,14			5,40	8,81
1	8,78	11,71	26,52	27,49	9,32	14,76	25,03	26,24	8,56	15,22	29,26	31,23
2	25,73	31,25	42,42	44,14	24,94	30,58	35,19	36,44	25,91	29,27	38,91	49,59
3	41,80	49,49	50,00	50,30	46,50	48,73	55,40	70,80	42,09	46,88	53,95	
4	43,90											
Year	1995				1996				1997			
Quarter of year	1	2	3	4	1	2	3	4	1	2	3	4
Age 0			5,01	7,19			3,88	5,95			3,61	10,18
1	7,70	10,99	25,37	24,6	8,95	12,06	27,81	28,09	7,01	11,69	20,14	22,11
2	24,69	22,95	33,40	39,57	21,47	25,72	40,90	38,81	23,11	26,40	31,13	32,69
3	50,78	37,69	45,56	57,00	37,58	37,94	50,44	56,00	39,11	34,47	44,03	38,62
4												
Year	1998				1999				2000			
Quarter of year	1	2	3	4	1	2	3	4	1	2	3	4
Age 0			4,82	8,32			2,84	7,56			7,21	13,86
1	8,76	12,55	23,82	24,33	8,98	12,40	22,16	25,60	10,05	15,65	23,76	22,98
2	22,16	25,27	31,73	30,93	25,84	24,15	32,66	37,74	19,21	25,14	38,90	34,48
3	34,84	32,18	44,92	33,24	36,66	35,24	43,98	51,63	32,10	41,30	39,61	50,04
4	42,40	40,00			46,57	46,57						
Year	2001				2002							
Quarter of year	1	2	3	4	1							
Age 0			6,34	7,90								
1	8,34	16,79	27,00	30,01	8,58							
2	21,50	23,57	39,54	35,51	27,83							
3	39,84	37,63	54,20	55,70	32,30							
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 12.3.1 Danish cpue data (tonnes/day fishing) and fishing activities by vessel category for 1986-2001. Non-standardized cpue-data for the Danish part of the commercial tuning fleet. (Logbook information).

Vessel GRT	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
51-100	10.83	11.73	20.27	14.58	10.03	12.56	31.75	31.00	24.80	29.53	-	20.00	-	-	-	-
101-150	19.49	20.70	18.83	19.59	17.38	24.14	26.42	23.72	26.76	38.96	20.48	22.68	-	-	-	-
151-200	22.97	22.26	22.71	23.17	25.60	28.22	34.20	27.36	31.52	34.73	22.05	27.45	16.85	12.43	29.13	-
201-250	25.20	25.63	30.44	26.10	24.87	29.74	36.00	27.76	40.59	39.34	24.96	30.59	19.68	26.69	48.55	25.35
251-300	25.12	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
301-	26.63	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

Table 12.3.2 **Results of regression of Danish CPUE-data used for effort standardization of the Danish and Norwegian fishery (commercial) 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 1994-2002 combined. Lower table (shown for comparison purposes): Data for 1994-2002 not combined. Not used.**

Regression models: $CPUE=b*GRT^a$ => ln(CPUE)=ln(b)+a*ln((GRT-50))

Year	Slope	Intercept	R-Square	CPUE(175 tonnes)
1987	0,39	3,51	0,98	22,75
1988	0,22	8,81	0,71	25,27
1989	0,28	5,91	1,00	22,91
1990	0,37	3,32	0,91	20,24
1991	0,40	3,79	0,96	25,98
1992	0,10	20,74	0,56	33,69
1993	0,05	23,23	0,31	29,33
1994	0,18	13,92	0,80	32,99
1995	0,18	13,92	0,80	32,99
1996	0,18	13,92	0,80	32,99
1997	0,18	13,92	0,80	32,99
1998	0,18	13,92	0,80	32,99
1999	0,18	13,92	0,80	32,99
2000	0,18	13,92	0,80	32,99
2001	0,18	13,92	0,80	32,99
2002	0,18	13,92	0,80	32,99

Year	Slope	Intercept	R-Square	CPUE(175 tonnes)
1987	0,39	3,51	0,98	22,75
1988	0,22	8,81	0,71	25,27
1989	0,28	5,91	1,00	22,91
1990	0,37	3,32	0,91	20,24
1991	0,40	3,79	0,96	25,98
1992	0,10	20,74	0,56	33,69
1993	0,05	23,23	0,31	29,33
1994	0,24	10,48	0,92	34,05
1995	0,19	15,44	0,77	39,55
1996	0,48	2,36	0,92	23,89
1997	0,29	7,33	0,92	29,03
1998	0,65	0,68	0,74	15,74
1999	1,05	0,09	0,88	14,22
2000	0,90	0,41	0,93	30,79
2001	1,52	0,01	0,68	12,55
2002	1,66	0,00	0,94	8,08

Table 12.3.3 Effort in days fishing and average GRT of Norwegian vessels fishing for Norway pout by quarter, 1983-2002.

	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	65	219,4
2002	98	208,6						

Table 12.3.4 Norway pout. Combined Danish and Norwegian fishing effort (standardised) to be used in the assessment.

	Quarter 1			Quarter 2			Quarter 3			Quarter 4			Year total		
Year	Norway	Denmark	Total	Norway	Denmark	Total	Norway	Denmark	Total	Norway	Denmark	Total	Norway	Denmark	Total
1987	441	1127	1568	547	31	578	197	1194	1391	355	1637	1992	1540	3989	5530
1988	315	883	1198	144	13	156	75	417	492	617	1894	2511	1150	3207	4357
1989	146	777	923	485	195	680	1093	1749	2841	1701	2284	3985	3424	5005	8429
1990	406	992	1397	2002	87	2089	1162	463	1625	1185	1653	2838	4754	3195	7949
1991	824	1319	2143	833	33	866	1027	485	1512	869	1724	2593	3553	3561	7114
1992	866	2092	2959	354	17	371	1051	1530	2581	1154	1242	2396	3424	4882	8306
1993	483	1234	1718	1056	37	1094	1145	1560	2705	508	1671	2179	3193	4503	7696
1994	464	1265	1729	477	74	551	1364	617	1981	718	1227	1945	3023	3183	6206
1995	578	809	1387	254	99	353	164	853	1017	313	1487	1800	1309	3249	4558
1996	478	579	1057	144	185	329	571	760	1331	138	1240	1378	1331	2764	4095
1997	137	394	531	204	17	221	617	1244	1861	220	1121	1341	1178	2776	3954
1998	509	446	955	285	34	319	264	562	826	208	457	665	1266	1499	2765
1999	266	305	571	740	56	796	1185	387	1572	226	733	959	2417	1481	3898
2000	303	303	606	351	75	426	966	221	1187	207	1903	2110	1827	2502	4329
2001	261	441	702	304	15	319	128	48	176	69	541	610	762	1045	1807
2002	102	386	488										102	386	488

Table 12.3.5 CPUE indices (´000s per fishing day) by age and quarter from Danish and Norwegian commercial fishery (CF) in the North Sea (Area IV, commercial tuning fleet).

Year	CF, 1st quarter				CF, 2nd quarter				CF, 3rd quarter				CF, 4th quarter			
	0-group	1-group	2-group	3-group	0-group	1-group	2-group	3-group	0-group	1-group	2-group	3-group	0-group	1-group	2-group	3-group
1982	.	2144,5	169,0	87,9	.	1705,7	144,3	12,1	30,3	1320,2	86,5	12,4	368,4	1050,5	16,0	0,0
1983	.	1524,2	470,0	5,4	.	1044,9	706,5	5,5	74,3	969,6	262,0	2,8	604,9	972,9	85,9	1,7
1984	.	1137,9	566,8	59,1	.	1518,0	784,9	181,1	0,2	990,2	314,9	1,5	462,0	723,1	152,1	0,0
1985	.	877,1	528,2	74,3	.	1310,5	221,5	20,3	2,6	599,0	339,0	8,3	183,6	809,5	47,2	0,0
1986	.	108,5	292,9	19,8	.	267,9	89,3	3,0	0,0	531,1	109,7	2,7	892,9	277,1	5,9	0,0
1987	.	1699,6	253,8	7,7	.	1856,4	103,8	0,0	5,8	1139,5	118,6	0,0	110,9	1073,3	115,5	2,5
1988	.	205,2	583,1	16,4	.	525,6	457,7	0,0	48,2	372,4	508,9	0,0	1173,6	251,6	161,3	0,0
1989	.	1860,8	52,1	7,6	.	1019,8	214,9	9,6	2,4	386,0	69,6	0,0	1184,7	488,1	22,6	3,2
1990	.	1063,6	450,8	25,7	.	865,0	258,2	14,7	9,5	571,0	126,6	7,2	444,1	394,5	39,7	2,3
1991	.	692,9	623,0	43,3	.	484,3	458,2	22,0	50,2	668,2	44,0	1,0	1005,4	397,3	71,5	6,6
1992	.	1128,6	360,6	39,6	.	2686,5	619,9	53,4	13,0	1010,4	144,0	0,4	190,3	1103,2	105,9	1,0
1993	.	1120,3	403,0	7,9	.	689,2	431,6	52,7	3,9	384,4	328,5	6,9	426,5	474,2	203,0	0,8
1994	.	1100,2	340,7	32,6	.	675,7	517,0	52,4	93,9	519,3	203,1	35,6	1950,6	590,1	68,9	0,0
1995	.	2846,0	171,0	4,0	.	3179,5	726,3	90,1	117,6	1860,5	38,5	2,9	198,3	1701,8	32,9	1,7
1996	.	365,0	730,6	13,2	.	121,1	408,5	115,7	121,8	346,2	714,4	27,4	1063,4	472,0	241,7	0,2
1997	.	988,8	479,3	146,6	.	435,0	593,0	540,5	1,9	1254,0	154,0	56,4	75,0	1344,0	152,5	25,8
1998	.	149,9	722,7	49,3	.	182,8	756,7	54,8	31,0	318,7	349,3	1,1	232,4	773,4	322,0	20,0
1999	.	351,0	224,6	128,0	.	280,3	230,0	116,8	0,0	725,5	213,5	21,9	1084,5	515,2	166,6	24,1
2000	.	1077,6	304,8	4,5	.	575,3	426,9	113,6	20,0	894,8	206,9	17,2	121,9	2174,1	114,5	2,8
2001	.	299,9	1195,2	49,9	.	216,0	662,1	312,0	30,5	369,2	142,7	6,3	557,3	321,6	718,4	1,5
2002	.	633,1	393,3	34,2												

Table 12.3.6 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	1791	809	880	-	-	-	-	-	-	-	-	-	-	-	-

[1]International Bottom Trawl Survey, arithmetic mean catch in no./h in standard area.
[2]English groundfish survey, arithmetic mean catch in no./h, 22 selected rectangles within Roundfish areas 1, 2, and 3.
[3]1982-91 EGFS numbers adjusted from Granton trawl to GOV trawl by multiplying by 3.5.
[4]Scottish groundfish surveys, arithmetic mean catch no./h. Survey design changed in 1998 and 2000. 0-group indices not used from this survey.

Table 12.4.1 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 in 2002
Run: npns3a02 (NP3B02) (Summary from NP3A02)


The following parameters were used:
Year range:                                                          1983 - 2002
Seasons per year:                                                         4
The last season in the last year is season :                              1
Youngest age:  0;       Oldest age:  3;         (Plus age:  4)
Recruitment in season:                                                    3
Spawning in season:                                                       1

The following fleets were included:
Fleet  1:                                                         commercial
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)


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 12.4.2 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	*	*	153165.	102304.	*	*	78866.	52864.	*	*	57107.	38275.
1	108827.	69504.	45095.	25459.	66390.	42243.	26472.	13414.	33609.	20675.	13157.	7673.
2	13608.	8059.	4392.	1655.	13548.	7956.	4380.	1558.	6133.	2994.	1889.	617.
3	114.	64.	35.	10.	799.	418.	60.	34.	443.	140.	83.	40.
4+	6.	3.	0.	0.	0.	0.	0.	0.	23.	15.	10.	7.
SSN	24611.				20986.				9960.			
SSB	380466.				376509.				177452.			
TSN	122555.	77631.	202686.	129428.	80737.	50618.	109778.	67870.	40208.	23824.	72246.	46612.
TSB	1066077.	1319938.	1930984.	1269459.	794763.	925075.	1169218.	693102.	389192.	419764.	643561.	434360.

Year	1986				1987				1988			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	*	110121.	73816.	*	*	32236.	21602.	*	*	88447.	58681.
1	25101.	16501.	10848.	6301.	44919.	27910.	17828.	10619.	14295.	9378.	6209.	4012.
2	2695.	931.	553.	170.	2757.	1520.	970.	510.	5357.	3018.	1963.	1111.
3	271.	122.	80.	49.	82.	45.	30.	20.	151.	85.	57.	38.
4+	31.	18.	12.	8.	38.	25.	17.	11.	17.	11.	8.	5.
SSN	5507.				7370.				6955.			
SSB	89435.				97524.				134852.			
TSN	28098.	17573.	121614.	80344.	47797.	29500.	51080.	32762.	19820.	12492.	96682.	63847.
TSB	247573.	286321.	740244.	597769.	380514.	473963.	618152.	396434.	224907.	248162.	596808.	493229.

Year	1989				1990				1991			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	*	99506.	66571.	*	*	94330.	63215.	*	*	165660.	110444.
1	36759.	23219.	15009.	8692.	40650.	25742.	15798.	9795.	41561.	26630.	17330.	10373.
2	2172.	1417.	841.	345.	4401.	2472.	1189.	645.	5599.	2660.	1452.	797.
3	413.	272.	177.	115.	155.	88.	43.	24.	338.	150.	85.	39.
4+	29.	19.	13.	9.	72.	40.	27.	18.	25.	12.	8.	5.
SSN	6290.				8694.				10118.			
SSB	91656.				135552.				167172.			
TSN	39373.	24927.	115546.	75732.	45279.	28342.	111387.	73697.	47523.	29452.	184536.	121659.
TSB	323241.	411133.	820034.	620521.	391646.	476830.	825986.	633074.	429007.	498052.	1163452.	936966.

Table 12.4.2 (Cont'd)

Year	1992				1993				1994			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	*	77065.	50938.	*	*	60943.	40772.	*	*	231158.	154421.
1	71179.	44801.	28785.	16465.	33364.	20774.	13260.	7949.	26369.	16059.	10459.	6169.
2	6095.	3196.	1903.	957.	8757.	5298.	3164.	1374.	4469.	2512.	1450.	628.
3	381.	159.	90.	60.	423.	271.	134.	75.	557.	328.	196.	73.
4+	15.	8.	5.	3.	41.	27.	18.	12.	57.	38.	25.	17.
SSN	13609.				12557.				7719.			
SSB	200006.				235210.				142215.			
TSN	77671.	48164.	107848.	68423.	42585.	26371.	77519.	50183.	31451.	18935.	243289.	161307.
TSB	648435.	789079.	1115117.	727974.	445403.	506851.	719400.	489506.	308337.	344769.	1260223.	1099005.

Year	1995				1996				1997			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	*	72968.	48339.	*	*	175308.	116919.	*	*	51013.	34106.
1	100041.	63792.	41201.	25534.	31017.	20354.	13185.	7984.	76313.	50604.	33839.	20154.
2	3195.	1945.	1094.	695.	14375.	9003.	5871.	3115.	4819.	2964.	1880.	956.
3	311.	204.	111.	72.	418.	269.	149.	70.	1815.	1152.	675.	367.
4+	60.	41.	27.	18.	58.	39.	26.	17.	58.	39.	26.	18.
SSN	13571.				17952.				14324.			
SSB	156145.				357896.				235323.			
TSN	103608.	65981.	115401.	74658.	45867.	29664.	194539.	128106.	83006.	54759.	87433.	55600.
TSB	786404.	1035476.	1375581.	910681.	553305.	627018.	1292225.	1020039.	716092.	919630.	1171369.	729571.

Year	1998				1999				2000			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	*	76539.	51229.	*	*	203023.	136057.	*	*	50462.	33766.
1	22581.	14923.	9831.	6253.	34062.	22667.	14934.	8947.	90279.	59981.	39977.	25678.
2	11936.	7436.	4731.	2899.	3757.	2413.	1438.	687.	5526.	3553.	2212.	1265.
3	471.	277.	171.	113.	1767.	1125.	678.	426.	330.	219.	107.	55.
4+	229.	147.	79.	53.	100.	67.	45.	30.	287.	192.	129.	86.
SSN	14894.				9031.				15170.			
SSB	310060.				182800.				214010.			
TSN	35217.	22783.	91350.	60547.	39687.	26272.	220117.	146147.	96421.	63945.	92887.	60850.
TSB	452323.	498747.	765597.	579517.	397394.	482040.	1287932.	1075702.	782769.	1042207.	1302806.	849504.

Year	2001				2002
Season	1	2	3	4	1
AGE					
0	*	*	106750.	71531.	*
1	22387.	14827.	9830.	6490.	47647.
2	13433.	8312.	5371.	3578.	4132.
3	648.	405.	190.	126.	2039.
4+	90.	60.	40.	27.	102.
SSN	16409.				11037.
SSB	342128.				211512.
TSN	36557.	23605.	122181.	81752.	53919.
TSB	483167.	528660.	915085.	736038.	511688.

Table 12.4.3 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	0.169	0.226	0.052	0.067	0.272	0.369	0.085	0.051	0.137	0.602
2	0.122	0.203	0.542	0.318	0.130	0.193	0.591	0.772	0.307	0.060	0.662	0.406
3	0.170	0.196	0.795	1.600	0.242	1.206	0.176	0.000	0.689	0.121	0.325	0.000
4+	0.000	1.807	*	*	0.000	0.000	0.000	0.000	0.039	0.000	0.000	0.000
F (1- 2)	0.085	0.118	0.355	0.272	0.091	0.130	0.432	0.570	0.196	0.056	0.400	0.504

Year	1986				1987				1988			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	*	0.000	0.096	*	*	0.000	0.013	*	*	0.010	0.067
1	0.019	0.019	0.141	0.409	0.075	0.048	0.117	0.277	0.021	0.012	0.036	0.209
2	0.616	0.119	0.711	0.317	0.192	0.049	0.236	0.740	0.171	0.030	0.166	0.553
3	0.379	0.029	0.095	0.000	0.194	0.000	0.013	0.351	0.174	0.000	0.000	0.000
4+	0.124	0.000	0.000	0.000	0.033	0.000	0.000	0.000	0.000	0.000	0.000	0.000
F (1- 2)	0.318	0.069	0.426	0.363	0.134	0.048	0.176	0.508	0.096	0.021	0.101	0.381

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	0.144	0.273	0.056	0.087	0.077	0.157	0.045	0.029	0.112	0.130
2	0.027	0.120	0.466	0.383	0.174	0.322	0.206	0.242	0.333	0.201	0.196	0.326
3	0.018	0.027	0.032	0.146	0.168	0.298	0.182	0.222	0.394	0.165	0.373	0.752
4+	0.000	0.000	0.000	0.000	0.181	0.000	0.000	0.000	0.335	0.000	0.000	0.000
F (1- 2)	0.043	0.078	0.305	0.328	0.115	0.204	0.142	0.199	0.189	0.115	0.154	0.228

Year	1992				1993				1994			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	*	0.014	0.023	*	*	0.002	0.036	*	*	0.003	0.034
1	0.062	0.042	0.156	0.226	0.073	0.049	0.110	0.173	0.095	0.029	0.126	0.252
2	0.240	0.117	0.280	0.400	0.101	0.114	0.416	0.478	0.173	0.147	0.419	0.293
3	0.451	0.164	0.014	0.041	0.043	0.294	0.186	0.033	0.129	0.113	0.549	0.000
4+	0.275	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	0.313	0.087	0.081	0.263	0.325	0.134	0.088	0.272	0.273

Table 12.4.3 (Cont'd)

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	0.037	0.078	0.171	0.021	0.034	0.100	0.103	0.011	0.002	0.117	0.122
2	0.095	0.172	0.053	0.108	0.067	0.027	0.228	0.138	0.085	0.055	0.269	0.299
3	0.022	0.207	0.033	0.052	0.041	0.186	0.344	0.005	0.054	0.133	0.206	0.121
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	0.140	0.044	0.031	0.164	0.121	0.048	0.029	0.193	0.211

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	0.010	*	*	0.002	0.011
1	0.014	0.017	0.052	0.108	0.007	0.017	0.111	0.081	0.009	0.006	0.042	0.242
2	0.072	0.052	0.089	0.094	0.042	0.116	0.328	0.323	0.041	0.073	0.156	0.263
3	0.128	0.083	0.011	0.152	0.051	0.105	0.064	0.068	0.010	0.306	0.257	0.139
4+	0.043	0.221	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	0.070	0.101	0.025	0.067	0.219	0.202	0.025	0.039	0.099	0.252

Year	2001				2002
Season	1	2	3	4	1
AGE					
0	*	*	0.000	0.006	*
1	0.012	0.011	0.015	0.051	0.008
2	0.079	0.036	0.006	0.160	0.058
3	0.068	0.346	0.007	0.009	0.010
4+	0.000	0.000	0.000	0.000	0.000
F (1- 2)	0.046	0.024	0.011	0.105	0.033

Table 12.4.4 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 1983-2002 (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	*	*	15.448	11.649
1	10.765	10.408	9.955	9.384
2	9.348	8.815	8.991	8.883
3	9.348	8.815	8.991	8.883

Log inverse catchabilities, fleet no: 2
ibts-1q

Year 1983-2002 (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	2.719	*	*	*
2	1.536	*	*	*
3	1.536	*	*	*

Log inverse catchabilities, fleet no: 3
egfs

Year 1983-2002 (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	*	*	3.845	*
1	*	*	2.234	*
2	*	*	1.656	*
3	*	*	*	*

Log inverse catchabilities, fleet no: 4
sgfs

Year 1983-2002 (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	*	*	3.023	*
2	*	*	2.373	*
3	*	*	2.373	*

Table 12.4.4 (Cont´d.).

Weighting factors for computing survivors:
Fleet no: 1
commercial

Year 1983-2002 (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	*	*	0.618	1.678
1	1.553	1.264	3.147	2.693
2	2.122	1.933	1.490	1.738
3	1.071	0.842	0.665	0.593

Weighting factors for computing survivors:
Fleet no: 2
ibts-1q

Year 1983-2002 (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	1.614	*	*	*
2	1.817	*	*	*
3	1.127	*	*	*

Weighting factors for computing survivors:
Fleet no: 3
egfs

Year 1983-2002 (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	*	*	0.823	*
1	*	*	1.327	*
2	*	*	1.032	*
3	*	*	*	*

Weighting factors for computing survivors:
Fleet no: 4
sgfs

Year 1983-2002 (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	*	*	1.177	*
2	*	*	1.289	*
3	*	*	1.440	*

Table 12.6.1 Norway pout in Subarea 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 are the same as given in previous years' reports.

Year	Recruitment Age 0 thousands	SSB tonnes	Landings tonnes	Mean F Ages 1-2
1974	176000000	171000	735800	1.840
1975	212000000	208000	559700	1.206
1976	198000000	200000	437400	1.204
1977	102000000	242000	389900	0.835
1978	201000000	241000	270100	0.907
1979	233000000	198000	329200	1.006
1980	61000000	332000	482700	1.233
1981	306000000	278000	238500	0.777
1982	238000000	174000	395300	1.016
1983	153165000	380466	451400	0.830
1984	78866000	376509	393000	1.223
1985	57107000	177452	205100	1.156
1986	110121000	89435	178400	1.176
1987	32236000	97524	149300	0.866
1988	88447000	134852	109500	0.599
1989	99506000	91656	166400	0.754
1990	94330000	135552	163300	0.660
1991	165660000	167172	186600	0.686
1992	77065000	200006	296800	0.762
1993	60943000	235210	183100	0.756
1994	231158000	142215	182000	0.767
1995	72968000	156145	236800	0.382
1996	175308000	357896	163800	0.360
1997	51013000	235323	169700	0.481
1998	76539000	310060	79800	0.248
1999	203023000	182800	92000	0.513
2000	50462000	214010	184400	0.415
2001	106750000	342128	65600	0.186
2002		211512		
Average	132559536	216618	267700	0.816

Table 12.6.2 Norway pout in Subarea IV and Division IIIa. Yield and spawning biomass per Recruit F-reference points:

	Fish Mort Ages 1-2	Yield/R	SSB/R
Average Current	0.816	1.827	9.984
$\mathbf{F}_{max}$	N/A		
$\mathbf{F}_{0.1}$	N/A		
$\mathbf{F}_{med}$	N/A		

Table 12.12.1 Norway pout in Division VIa
Officially reported landings (tonnes)

Country	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Denmark	5849	28180	3316	4348	5147	7338	14147	24431	6175	9549
Faroes	376	11	-	-	-	-	-	-	-	-
Germany	-	-	-	-	-	-	-	1	-	-
Netherlands	-	-	-	-	10	-	-	7	7	-
Norway	-	-	-	-	-	-	-	-	-	-
Poland	-	-	-	-	-	-	-	-	-	-
UK (E+W)	-	-	-	-	1	-	1	-	-	-
UK (Scotland)	517	5	-	-	-	-	+	-	140	13
Total	6742	28196	3316	4348	5158	7338	14148	24439	6322	9562

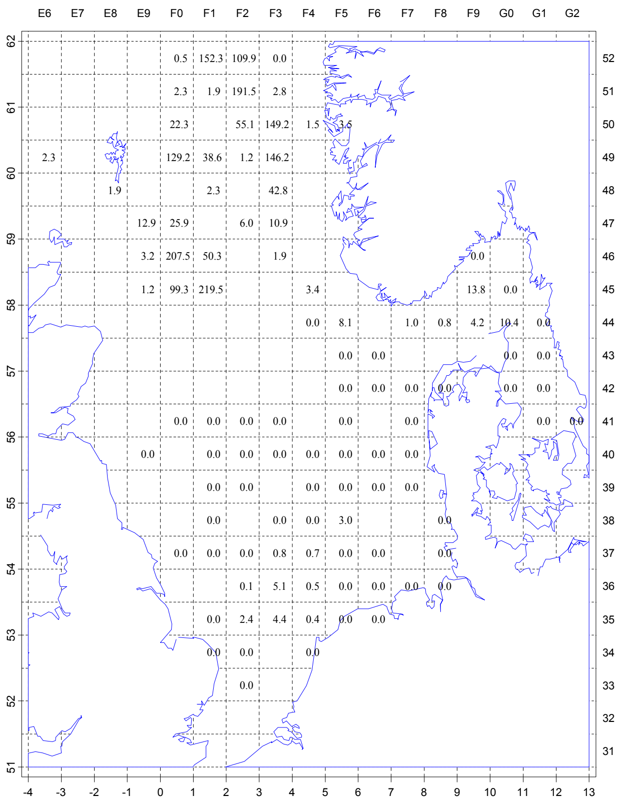
Country	1998	1999	2000	2001
Denmark	7186	4624	2005	3214
Faroes	-	-	-	
Germany	-	-	-	
Netherlands	-	1	-	
Norway	-	-	-	
Poland	-	-	-	
UK (E+W)	-	-	-	
UK (Scotland)	-	-	-	
Total	7186	4625	2005	3214

Figure 12.1.1 Plot of landings from the Danish Norway pout fishery by ICES Statistical rectangle and quarter of year. Year: 2001. Quarter: 1-2. The numbers indicate landings (catch) in 10 tons per ICES square.

Danish Norway pout landings in 2001 quarter 1

Total landings: 17552 ton

Max landings per rectangle: 2195 ton



Danish Norway pout landings in 2001 quarter 2

Total landings: 2503 ton

Max landings per rectangle: 709 ton

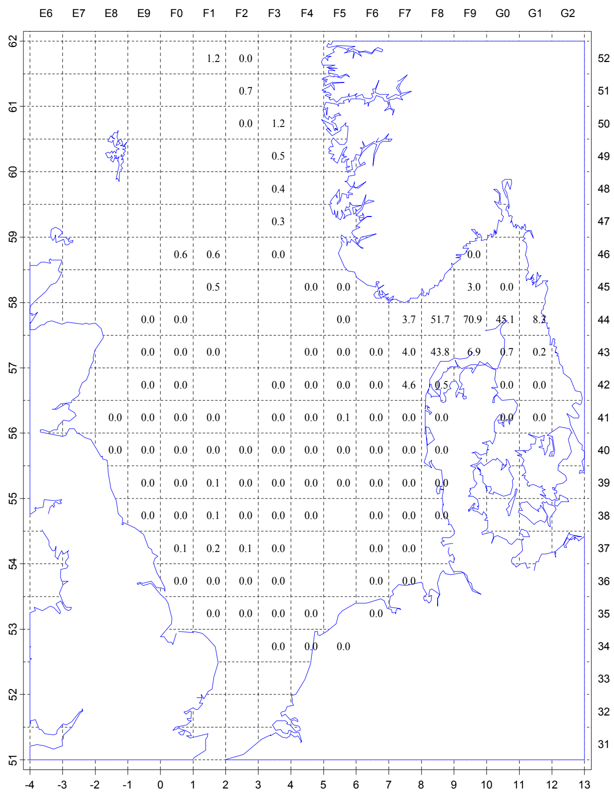
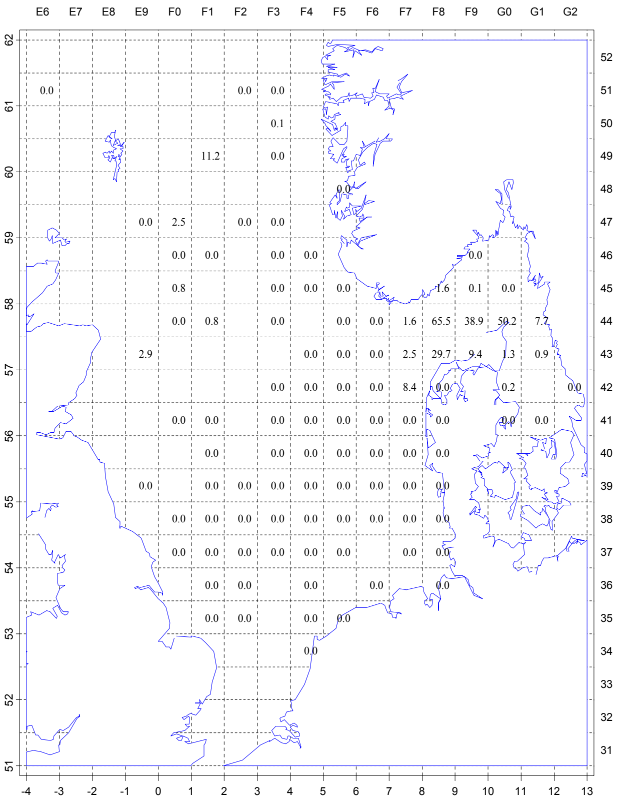


Figure 12.1.2 Plot of landings from the Danish Norway pout fishery by ICES Statistical rectangle and quarter of year. Year: 2001. Quarter: 3-4. The numbers indicate landings (catch) in 10 tons per ICES square.

Danish Norway pout landings in 2001 quarter 3

Total landings: 2365 ton

Max landings per rectangle: 655 ton



Danish Norway pout landings in 2001 quarter 4

Total landings: 25767 ton

Max landings per rectangle: 9091 ton

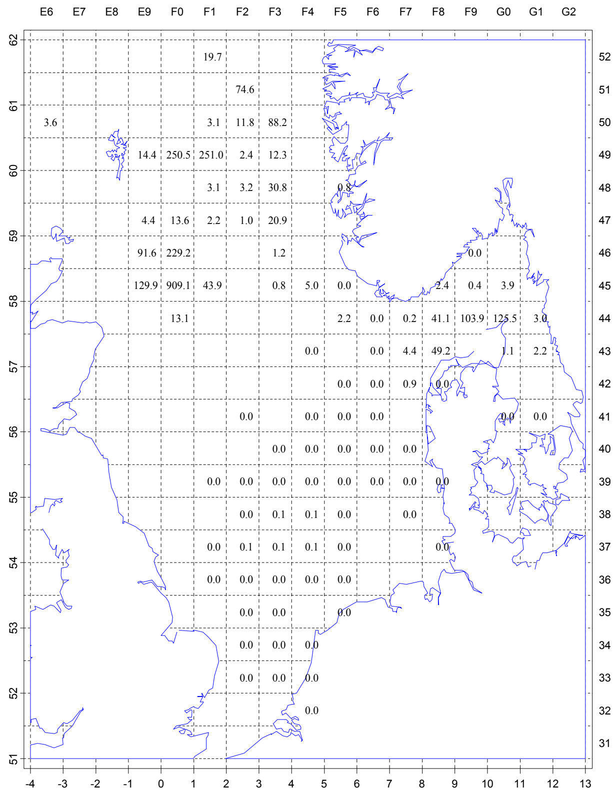
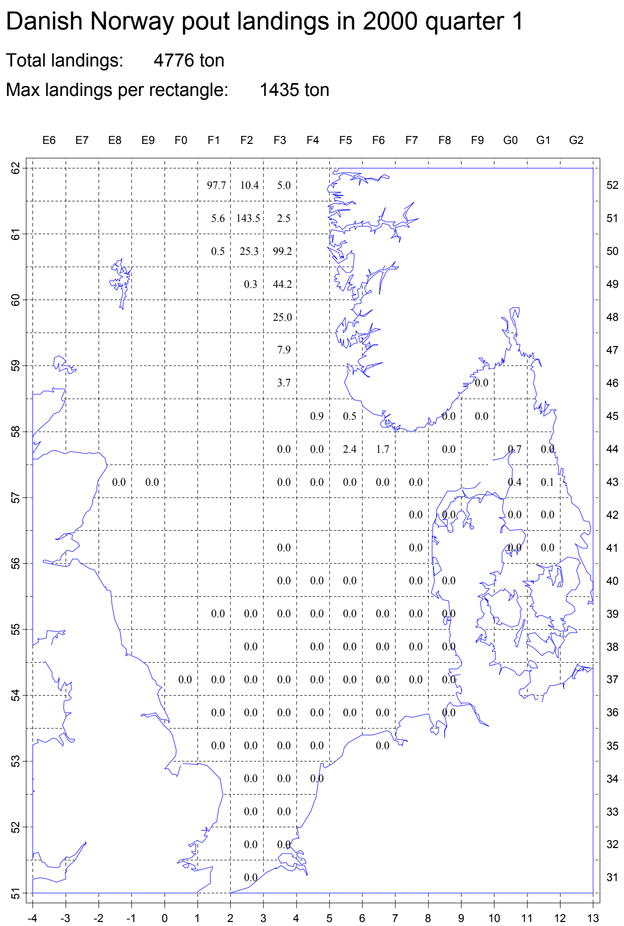


Figure 12.1.3 Plot of landings from the Danish Norway pout fishery by ICES Statistical rectangle and quarter of year. Year: 2000. Quarter: 1-2. The numbers indicate landings (catch) in 10 tons per ICES square**.**



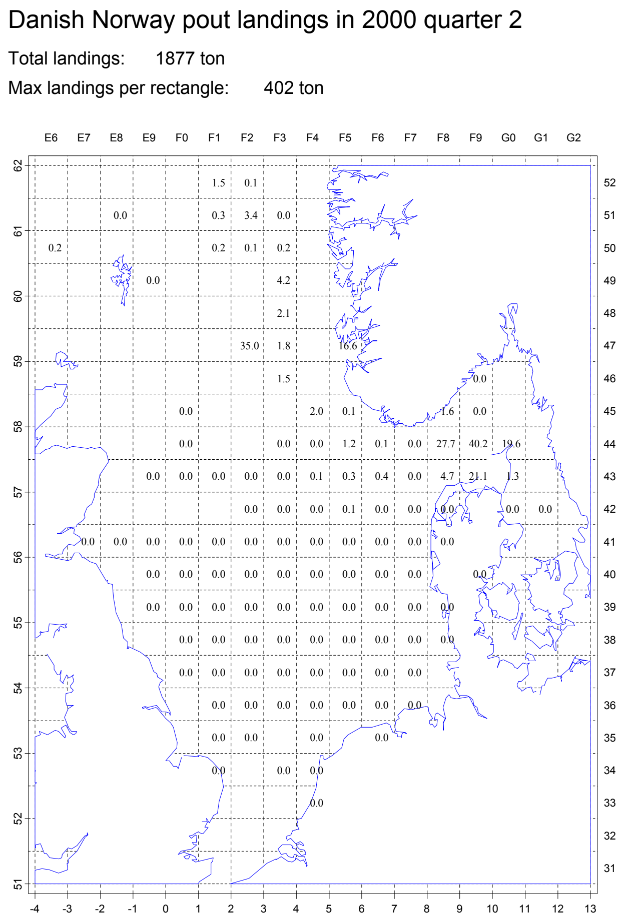
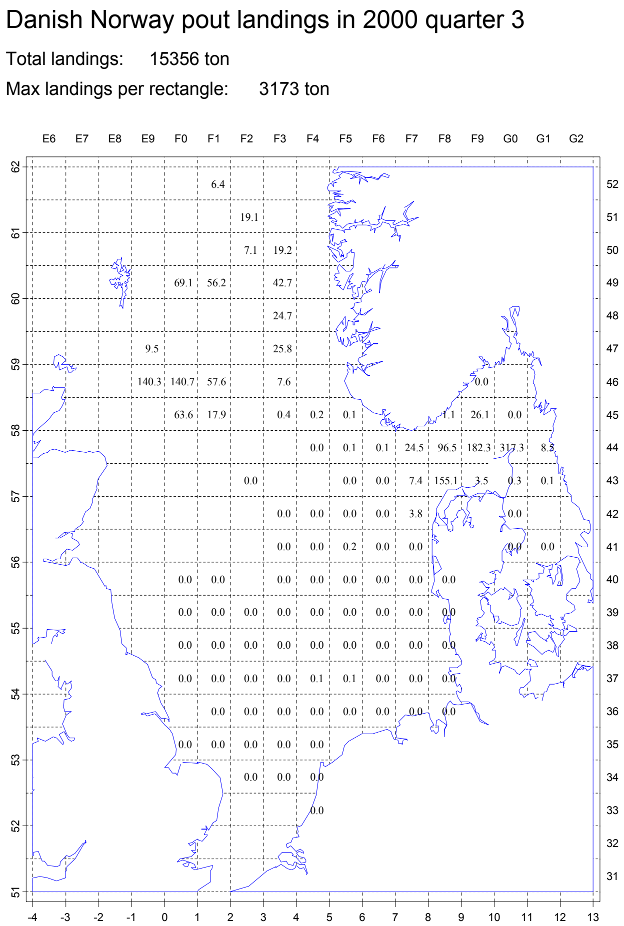


Figure 12.1.4 Plot of landings from the Danish Norway pout fishery by ICES Statistical rectangle and quarter of year. Year: 2000. Quarter: 3-4. The numbers indicate landings (catch) in 10 tons per ICES square.



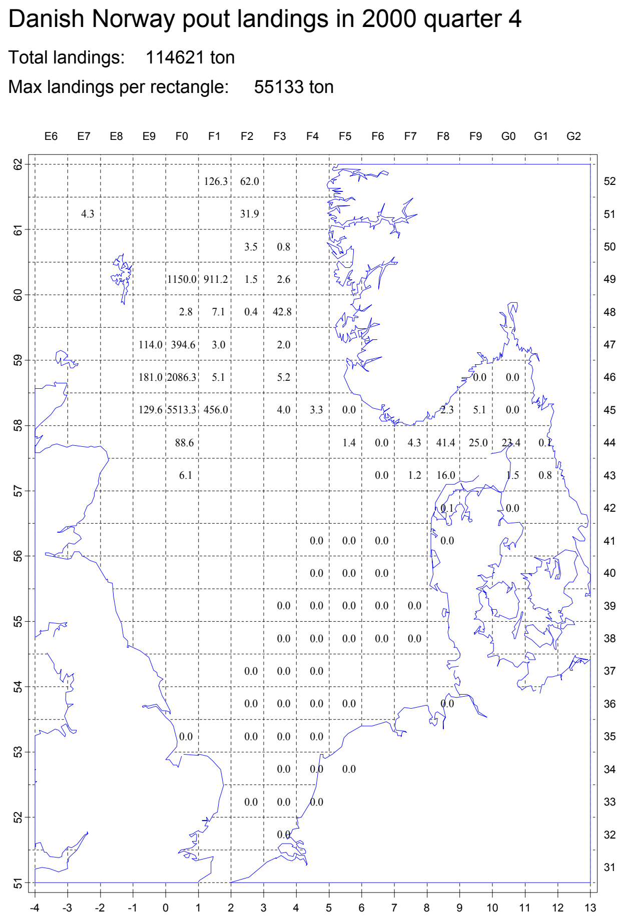


Figure 12.3.1 Trends in CPUE (normalized) by quarterly commercial tuning fleet and survey tuning fleet used in the Norway pout SXSA Assessment for each age group and all age groups together.

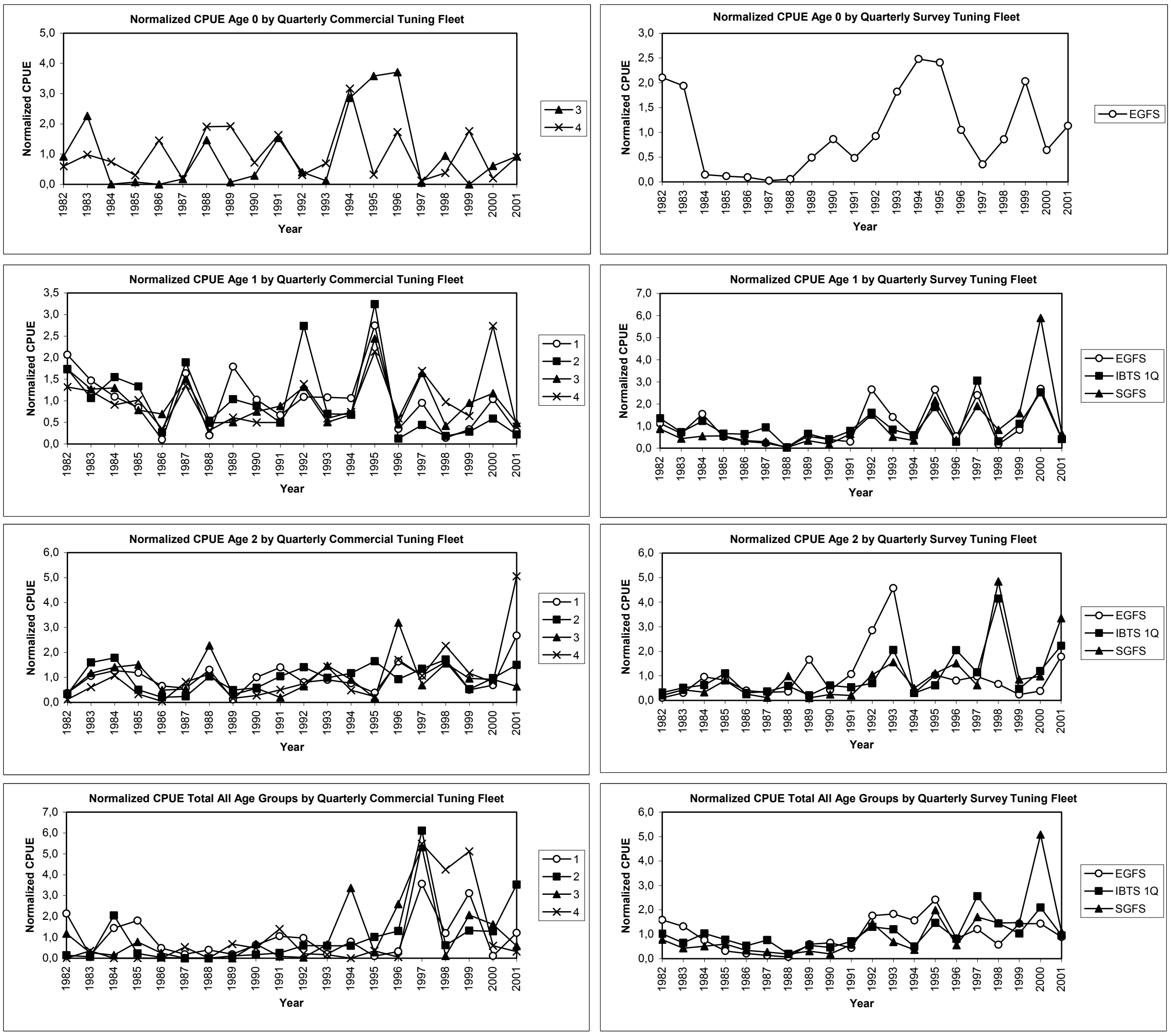
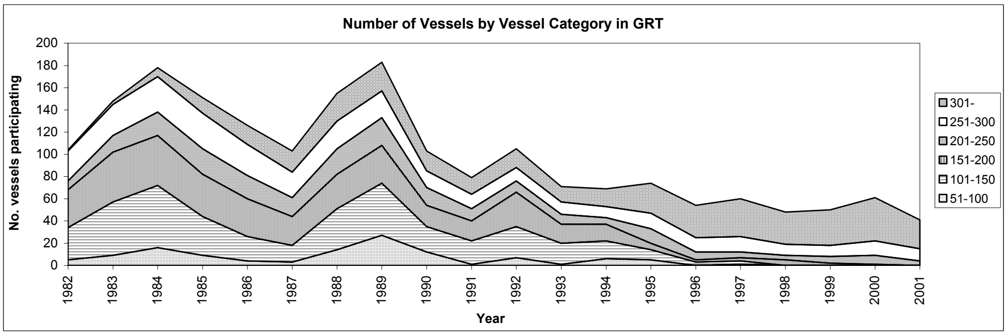
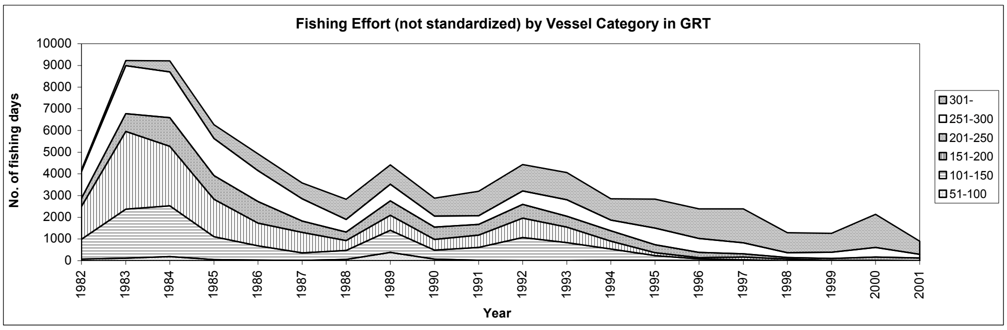
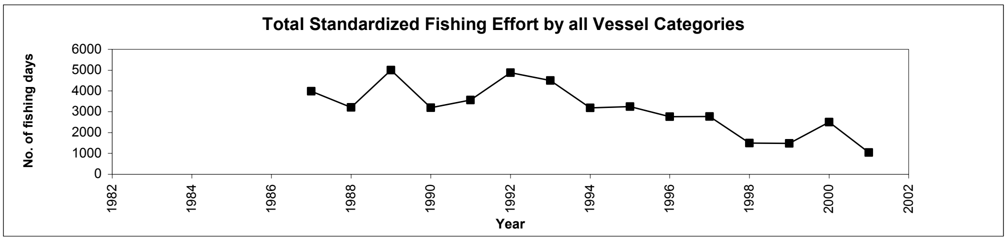


Figure 12.3.2 **Development in the fleet structure and effort and catch rates by vessel category in GRT participating in the Danish Norway pout fishery during the last 20 years (1982-2002).** (Logbook Data provided by the Working Group).







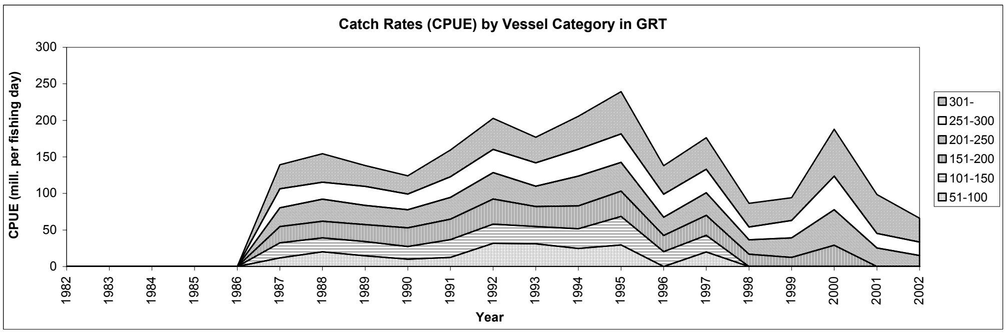


Figure 12.3.3 **CPUE-values from the Danish Norway pout fishing fleet used in the regression for standardisation of effort for the Danish and Norwegian commercial tuning fleet. CPUE-values for the period 1994-2002 are calculated as overall averages over years based on summed effort and catch data by vessel category over years.**

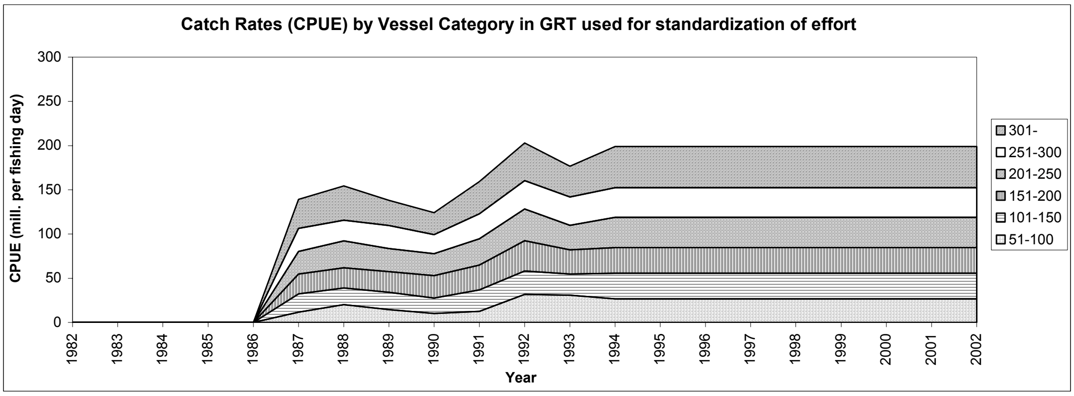


Figure 12.3.4 **Development in seasonal and yearly fishing effort for the combined Danish and Norwegian commercial tuning fleet included in the Norway Pout assessment. Standardized fishing effort.**

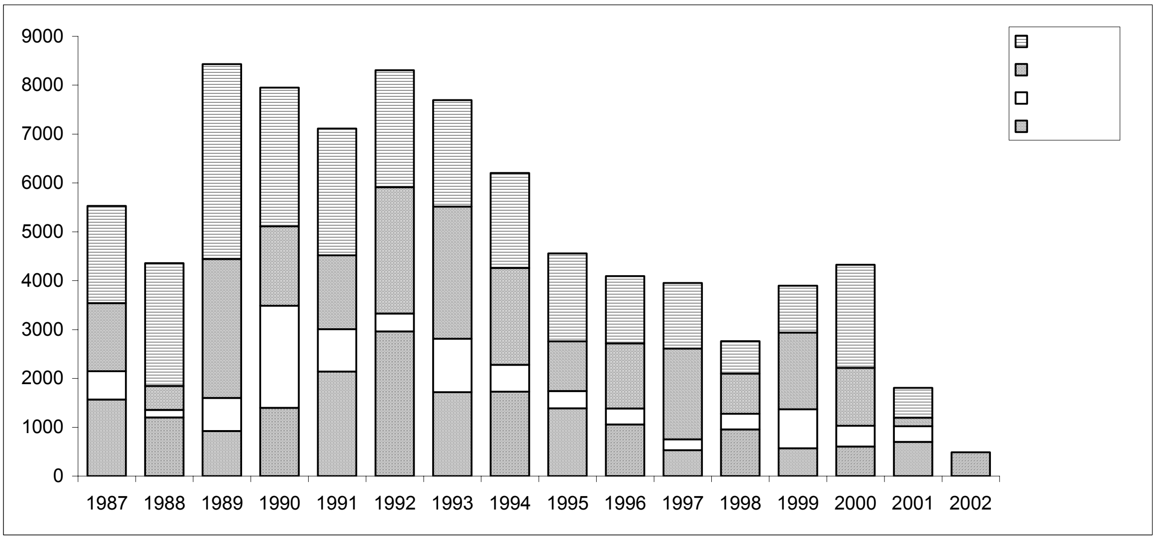


Figure 12.3.5 **Development in seasonal and yearly landings of the Danish commercial fleet participating in the Danish Norway Pout fishery in the North Sea and Skagerrak.**

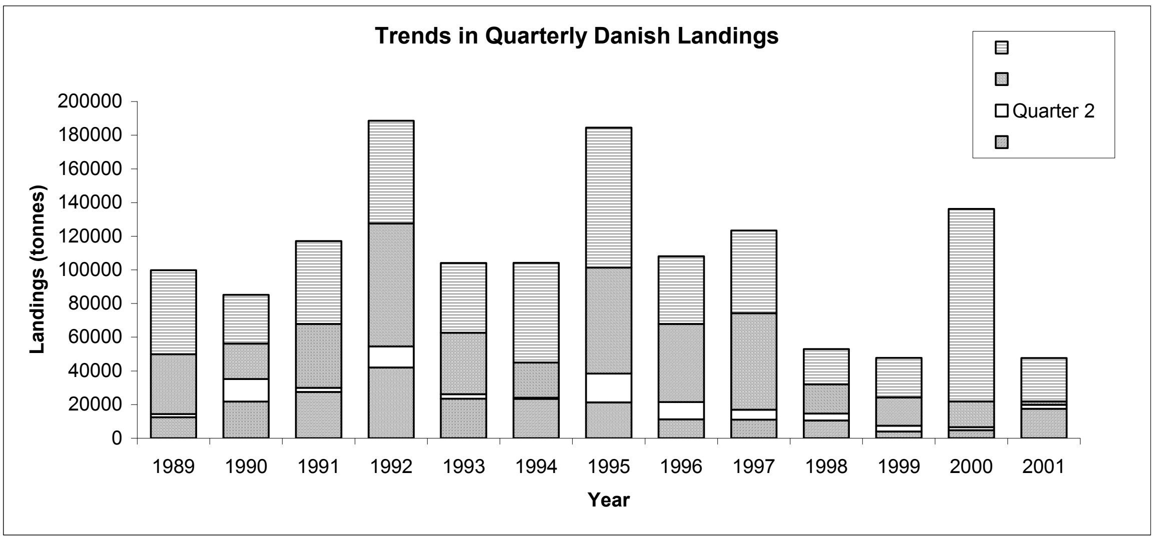
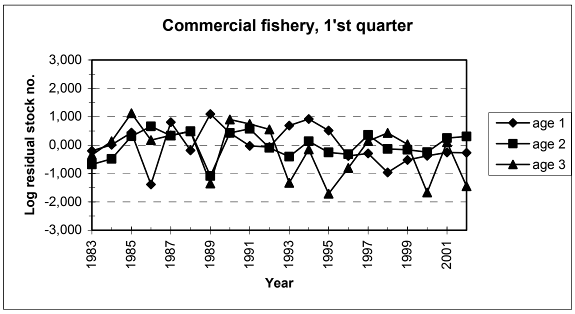
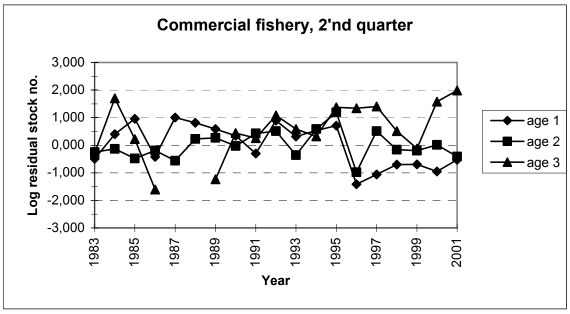
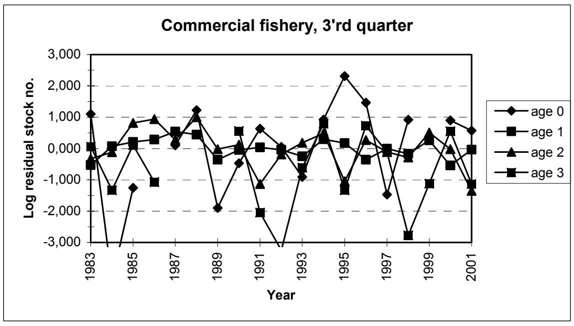
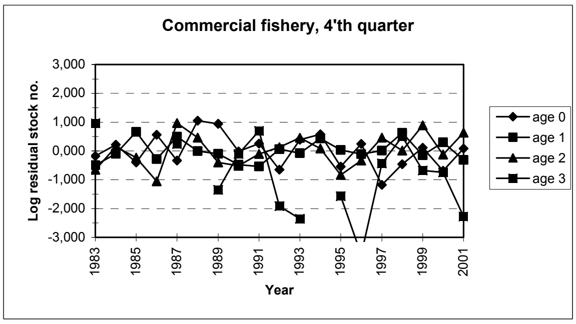


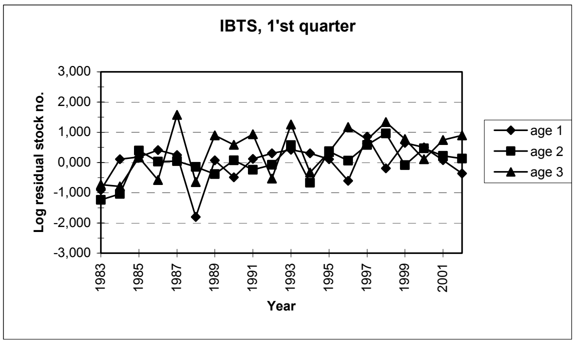
Figure 12.4.1 Log residual stock numbers (log (Nhat/N)) per age group divided by fleet and season. SXSA-Norway pout in the North Sea and Skagerak.

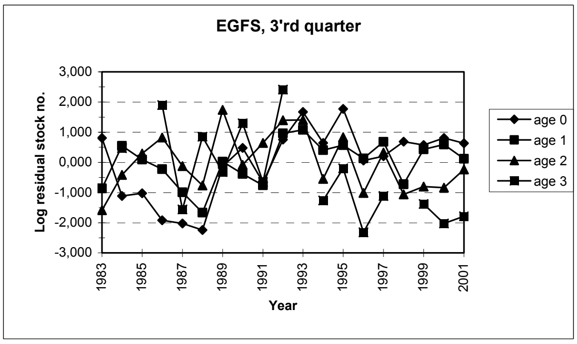












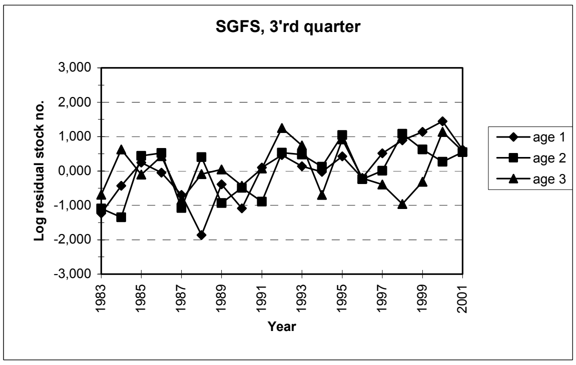
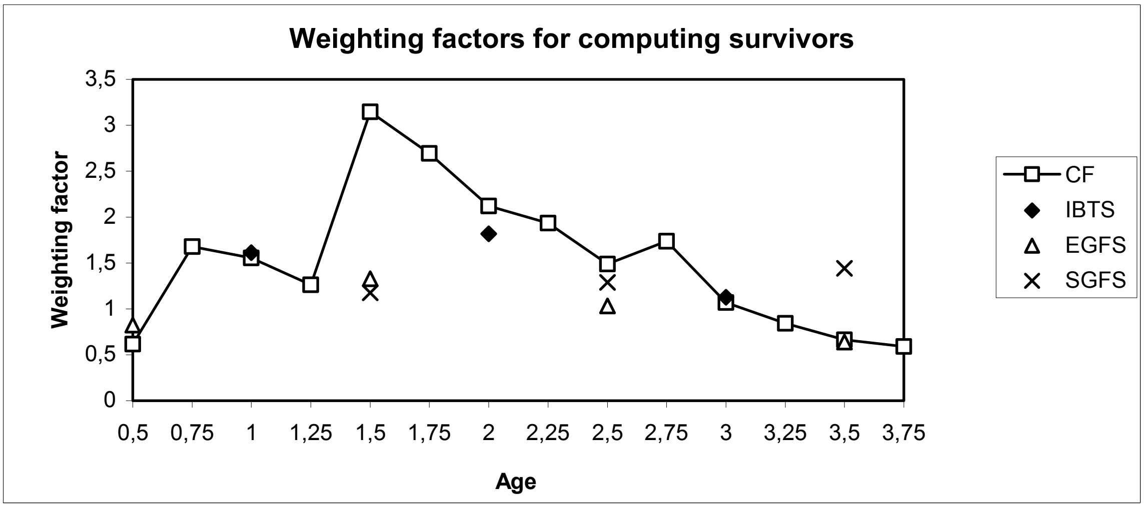
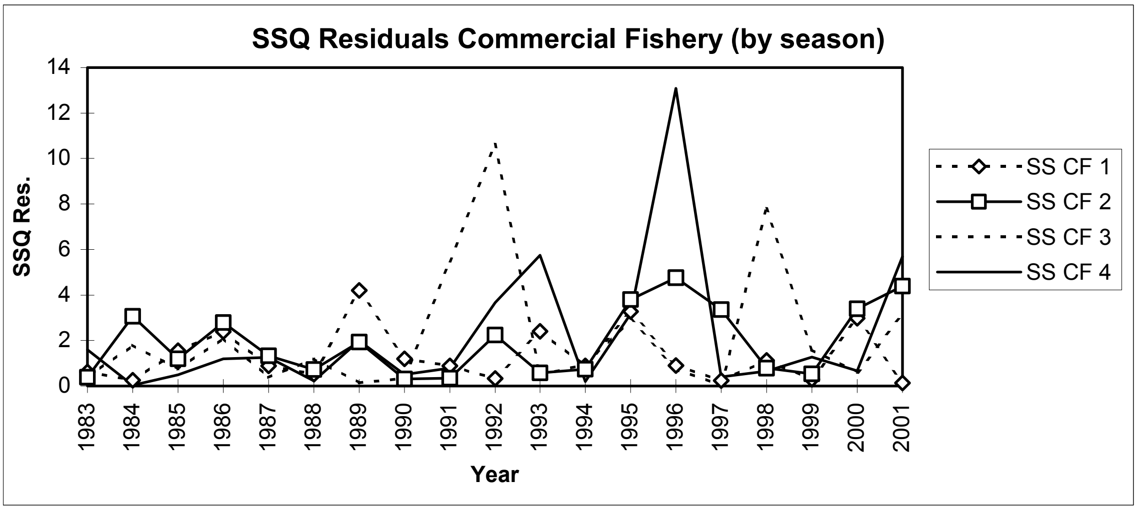


Figure 12.4.2 **Weighting factors for computing survivors and summed of squared (SSQ) residual stock number for commercial fishery (by season) and for the survey series summed for all age groups. Output from seasonal extended survivors analysis (SXSA). Commercial fishery fleet (CF), IBTS, EGFS, SGFS.** (For comparison it should be noticed that only some of the fleets include SSQ for the 0-group).





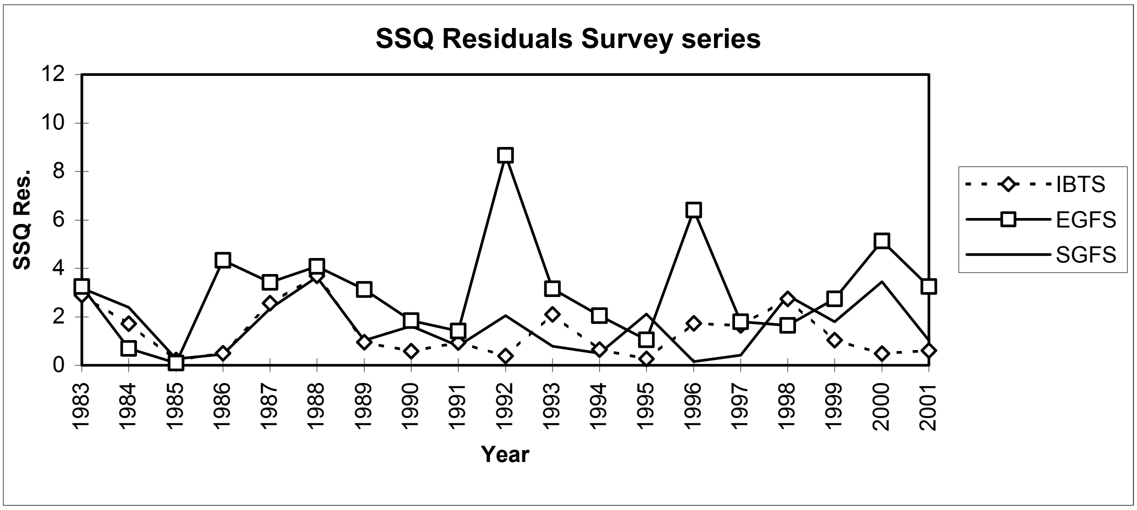
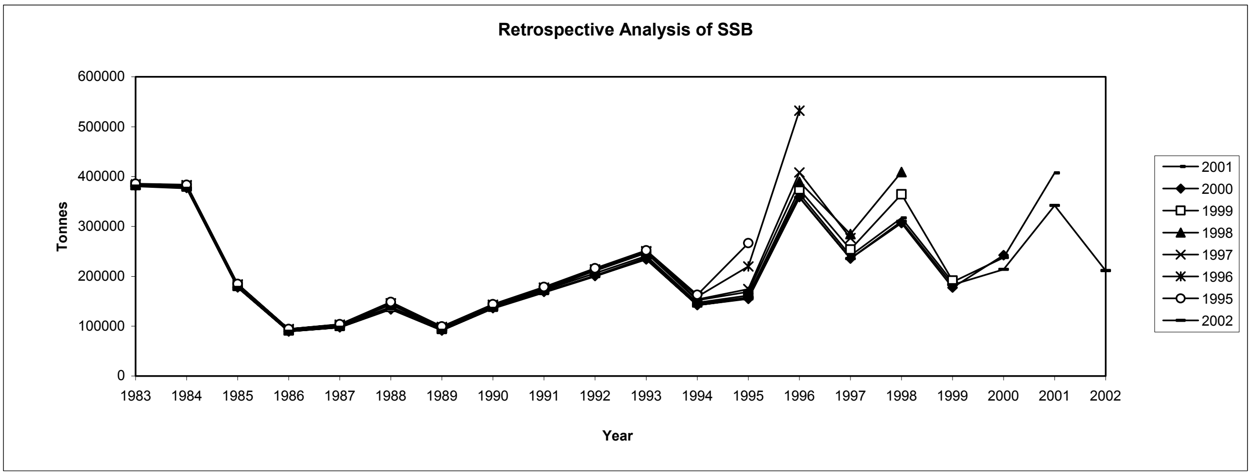
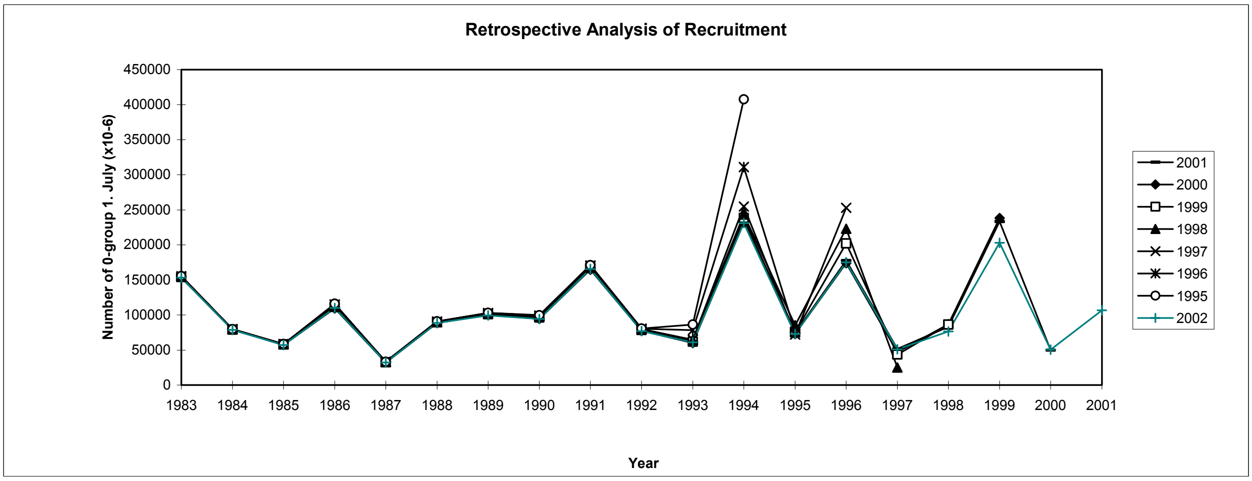


Figure 12.4.3 Retrospective analyses of SSB and Recruitment and $F_{ann(1-2)}$. No shrinkage used.

SXSA - Norway pout in the North Sea and Skagerrak





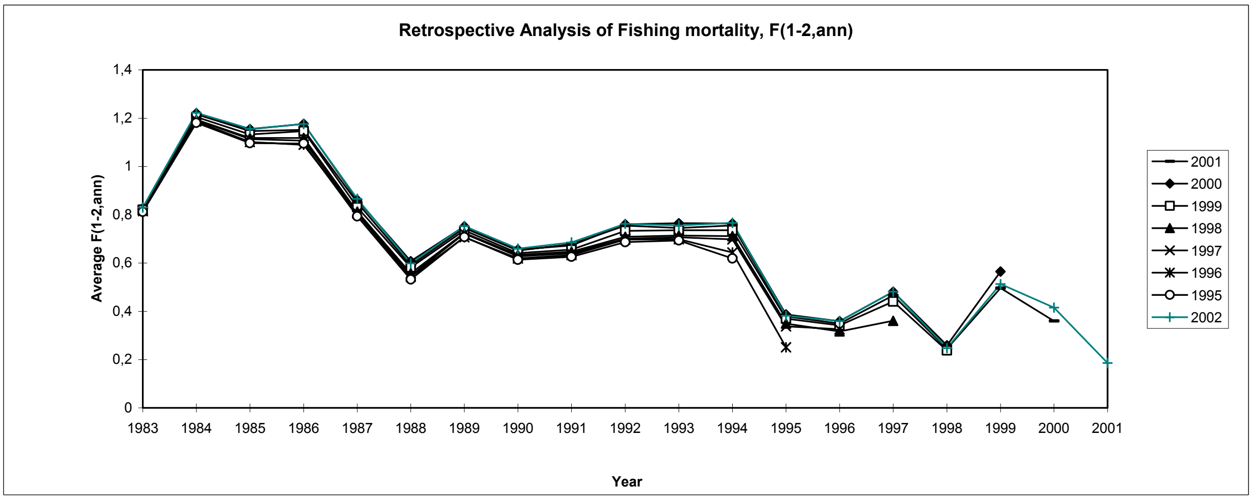
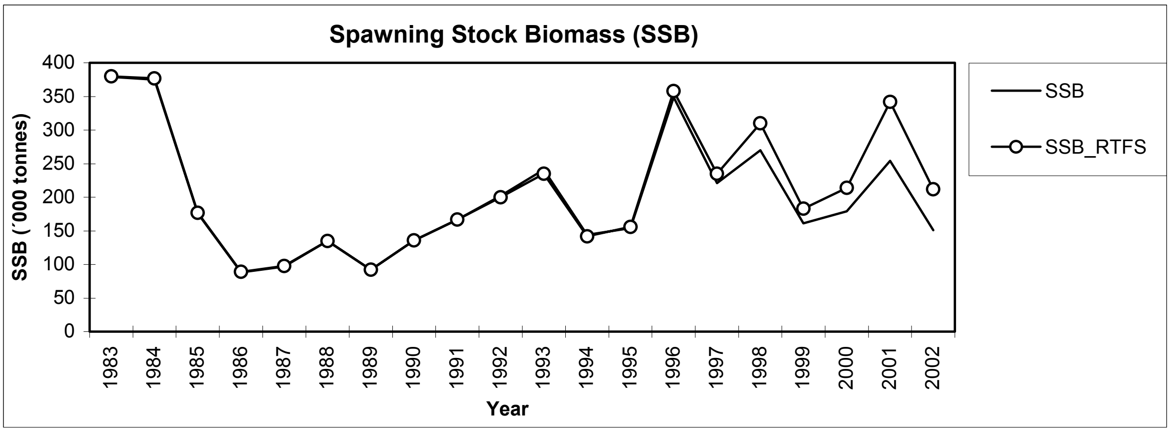
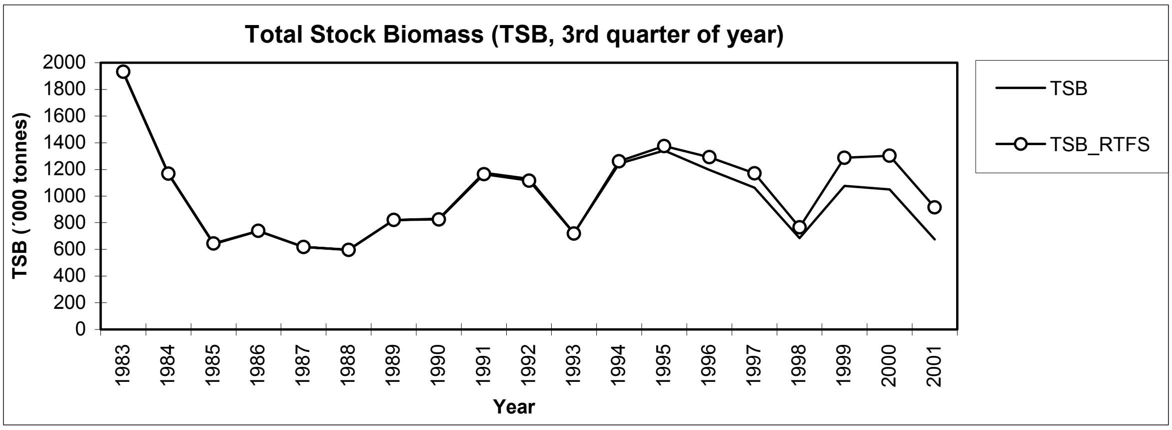


Figure 12.4.4 Difference in trends in annual fishing mortality as average for age 1 and 2, and stock biomass, in assessment partly with tuning fleet standardization as in previous years (accepted assessment in 2001) and with revised tuning fleet standardization (RTF=Revised Tuning Fleet Standardization) used in the accepted assessment in 2002.





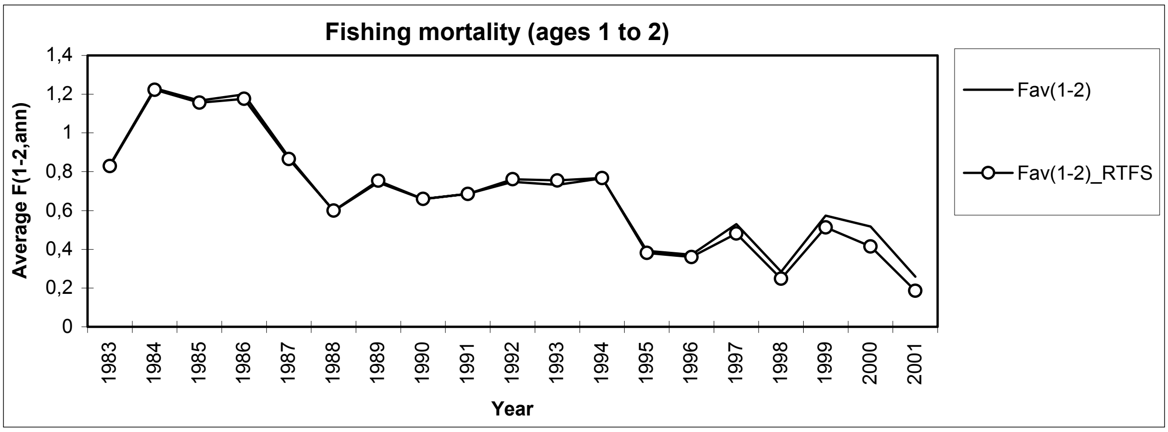


Figure 12.4.5 Difference in trends in annual fishing mortality as average for age 1 and 2, and stock biomass, in assessment partly with natural mortalities as in previous years (accepted assessment in 2002) and with revised natural mortalities applied (NM=New Mortalities).

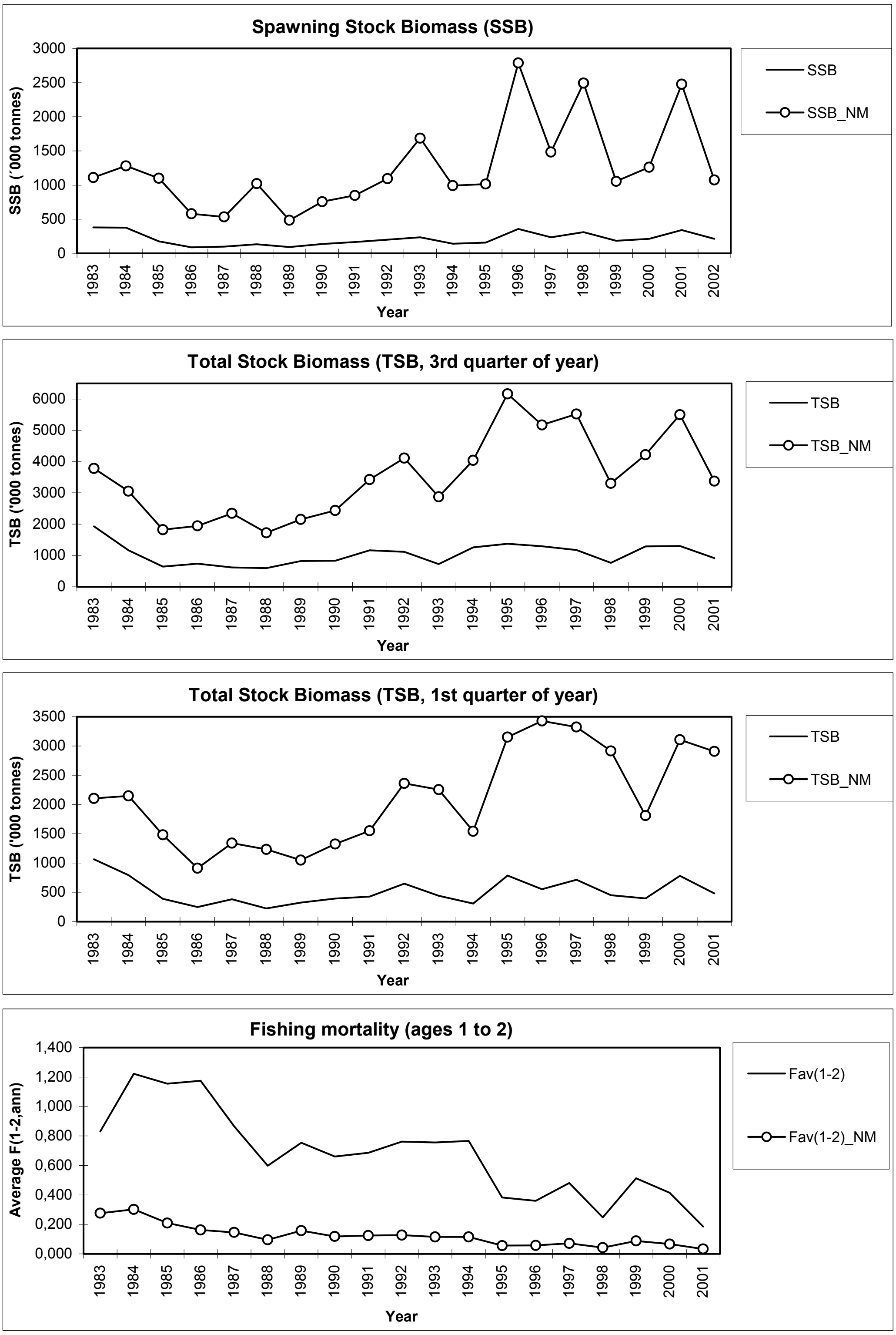


Figure 12.6.1 Norway pout in Subarea IV and Division IIIa. Historical trends in landings yield, annual fishing mortality, recruitment, and spawning stock biomass.

Figure 12.6.2 **Trends in yield, SSB and TSB for Norway pout in the North Sea and Skagerrak during the period 1983-2001.**

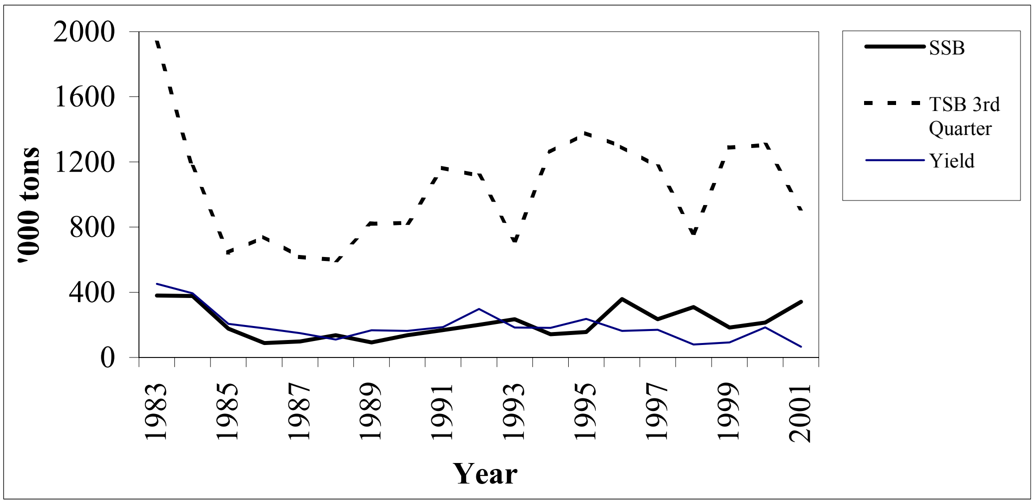
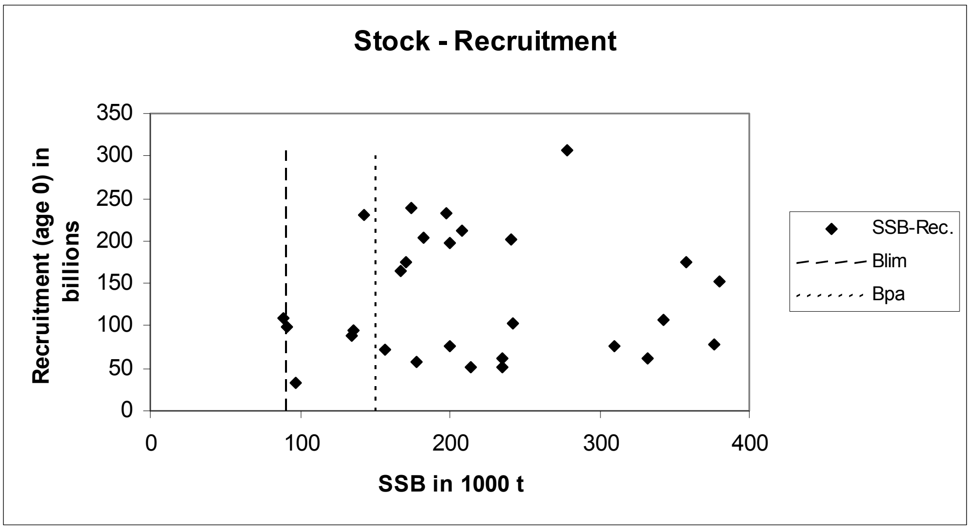
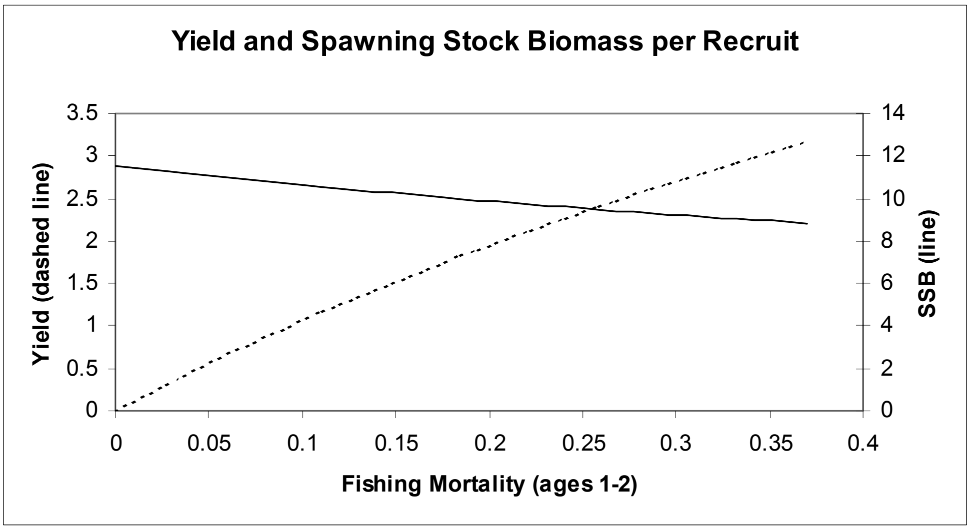


Figure 12.9.1 Recruitment / SSB plot used to calculate F(pa). SXSA - Norway pout in the North Sea and Skagerak. Period: 1974-2001





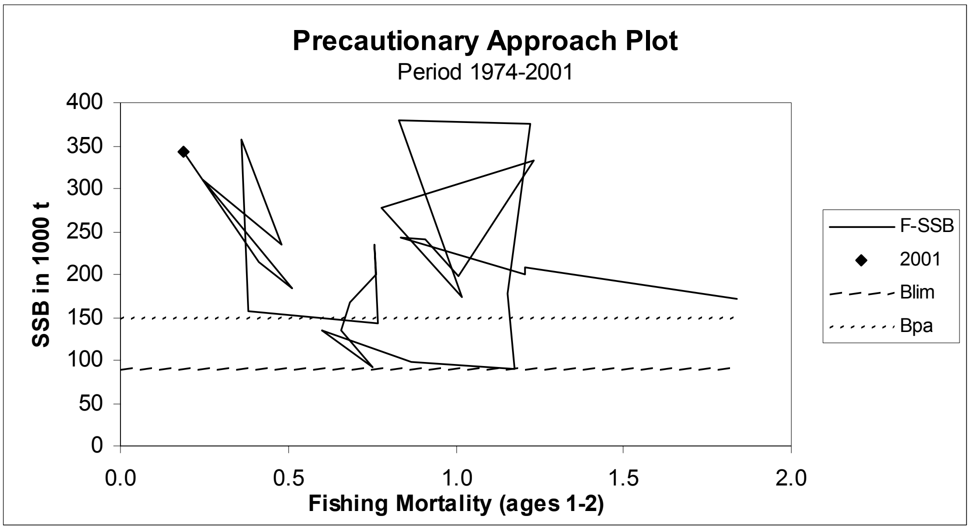


Figure 12.9.2 Norway pout in Subarea IV and Division IIIa. Biological reference points.

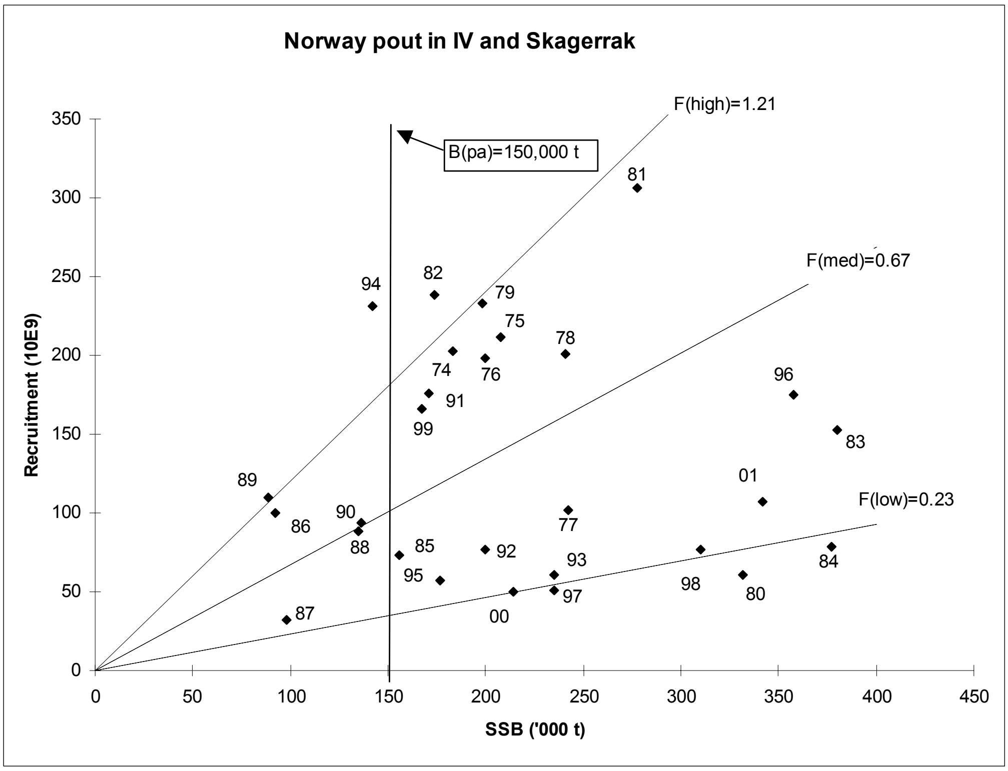


Figure 12.10.1 Norway pout in IV. Quality control of assessments generated by successive working groups.

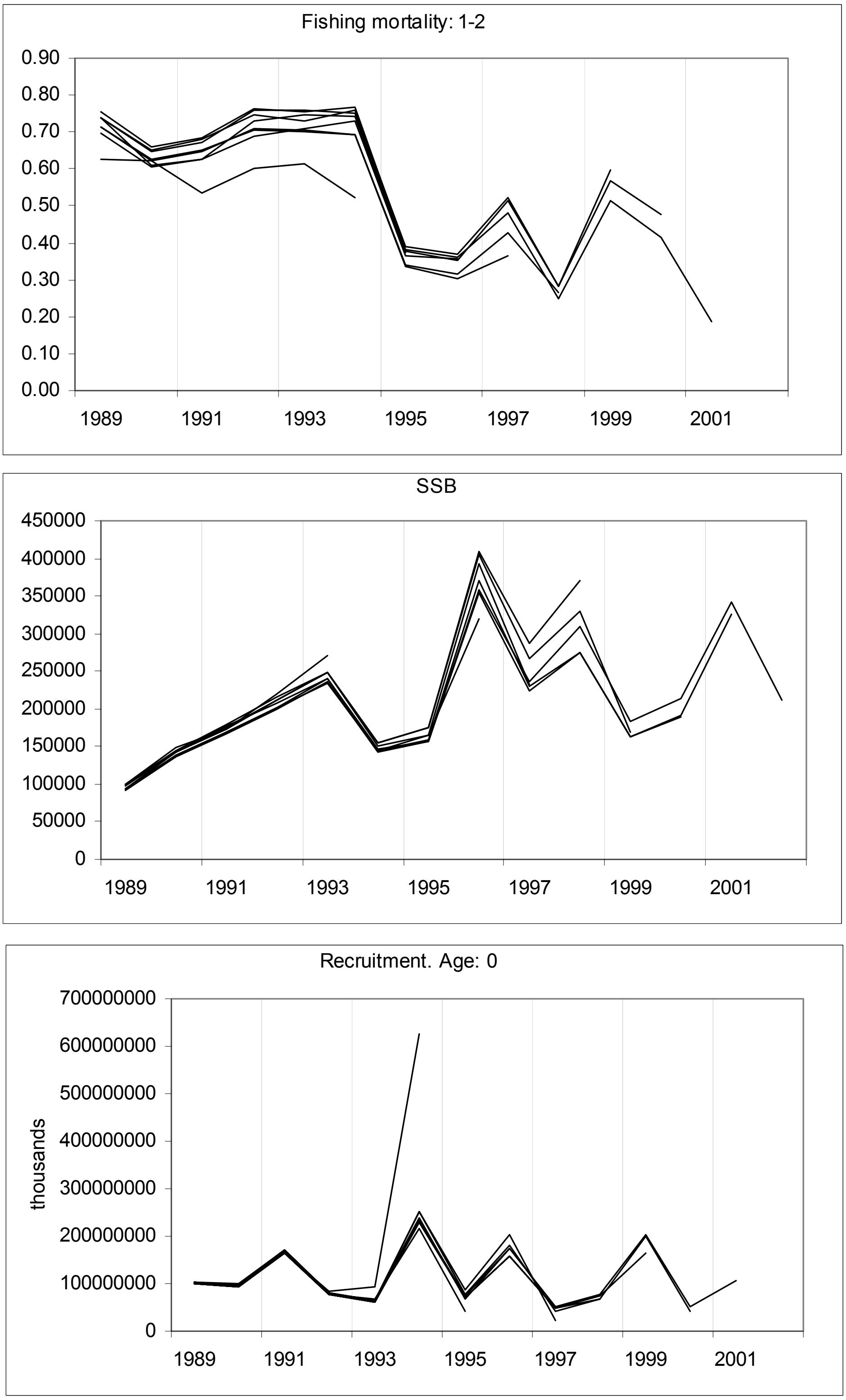


Figure 12.12.1 Norway pout in Division VIa. Catch trends

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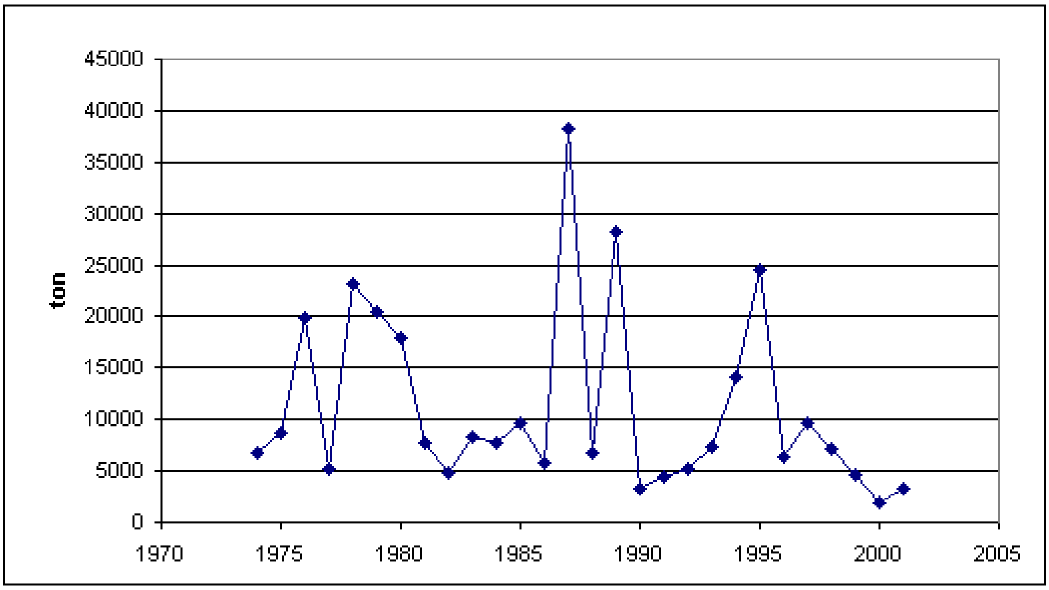


13 SANDEEL

13.1 Sandeel in Subarea IV

13.1.1 Fishery and stock definition

Sandeel is taken by trawlers using small mesh gear. The fishery is seasonal, taking place mostly in the spring and summer. Most of the sandeel catch consists of *Ammodytes marinus*, although small quantities of other Ammodytoidei spp. are caught as well. There is little by-catch of protected species.

Sandeels are largely stationary after settlement and the North Sea sandeel fishery must be considered as exploiting a complex of local populations. Recruitment to local areas may not only be related to the local stock, as interchange between areas seems to take place during the early phases of life before settlement. For assessment purposes, the European continental shelf was divided into four regions for sandeel assessment purposes up to 1995: Division IIIa (Skagerrak), northern North Sea, southern North Sea, and Shetland Islands 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 with two fleets, one fleet in the northern North Sea and one in the southern North Sea. The Shetland sandeel stock is assessed separately. ICES assessments have used these stock definitions since 1995.

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 was high correlation between the results from the study and the one-area assessment made by the WG.

13.1.1.1 ACFM advice applicable to 2001

There is no management objective set for this stock. There is a need to ensure that the stock remains high enough to provide food for a variety of predator species. The ACFM advice for 2001 was that the stock 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. Management of fisheries should try to prevent local depletion of sandeel aggregations, particularly in areas where predators congregate.

In the light of studies linking low sandeel availability to poor breeding success of kittiwake, ICES advised a closure for 2000 of the sandeel fisheries east of Scotland (Figure 13.1.1.1). All commercial fishing was excluded, except for a maximum of 10 boat days in each of May and June for stock monitoring purposes. The closed area will be maintained for three years with an evaluation every year.

$\mathbf{B}_{lim}$ is determined as 430 000 t and $\mathbf{B}_{pa}$ 600 000 t. No F reference points are given.

13.1.1.2 Management applicable to 2001 and 2002

The TAC was set to 1 020 000 tonnes for 2001 and 2002.

Technical measures for the sandeel fishery include a minimum percentage of the target species at 95% for meshes < 16 mm, or a minimum of 90% target species and maximum 5% of the mixture of cod, haddock, and saithe for 16 to 31 mm meshes.

13.1.1.3 The fishery in 2001

The sandeel fishery in 2001 had a rather low catch in the first half-year where the 1-group and older fish are targeted; however, due to very high catches of the 0-group in the second half of the year the total landings in 2001 were slightly higher than the arithmetic mean of the catches in the last 20 years.

Official landings statistics of sandeel by country and area of the North Sea are presented in Table 13.1.1.1. These are slightly higher than the landings provided by the Working Group members (Table 13.1.1.2). Industrial species are not sorted by species before processing and it is assumed that the landings consist of one species only in the calculation of the official landings. For Norway and Sweden, the official landings and the WG estimated landings are the same. For

Denmark, 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 the 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).

The landings of sandeel in the North Sea in 2001, as estimated by the Working Group members were 862 000 t, of which 73% were landed by the Danish fishery (Table 13.1.1.2). Norway, and in the later years Sweden has had significant landings as well. The catch history is shown in Figure 13.1.1.2. The sandeel fishery was developed in the beginning of the fifties and rose to a peak in 1997 (1.1 million t).

Total international standardized effort (see Section 13.1.3) peaked in 1989, decreased until 1994, and was followed by an increase until 1998 (Figure 13.1.1.2). The effort in 2001 is 74% of the highest observed effort. cpue has fluctuated without a clear trend throughout the period.

Figure 13.1.1.1 shows the areas for which catches are tabulated in Tables 13.1.1.3 and 13.1.1.4. Compared to the average of the 5 previous years, a much larger fraction of the catch in 2001 was taken from Area 2a (Table 13.1.1.3). The fishery had relatively small landings in the first half of 2001 followed by relatively high landings in the second half year, mainly from Areas 2a and 2b. The 0-group constituted 99% of the catch numbers in the second half-year, against an average of 47% for the period 1981-2000.

Figure 13.1.1.3 shows the distribution of catches for 2001 by quarter and ICES statistical rectangle based on logbook data from Danish, Norwegian, and Scottish vessels. A catch of "0.0" in a rectangle indicates a very small catch or, for Danish data, that no sandeel was found in a sample from an industrial catch in the rectangle.

The catches for 2002 are not included in this assessment, but provisional Danish landings statistics for the period until the end of May show very high landings. Danish landings were at 446 000 tonnes, compared to a mean value of 320 000 t in the same period for the years 1998-2001. For the first two weeks of June, the Danish landings were approximately 65 000 tonnes/week, mainly determined by processing capacity.

13.1.2 Natural mortality, maturity, age composition, mean weight-at-age

Estimates of natural mortality and maturity-at-age used in the assessment are given in Table 13.1.2.1. 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.

The proportion mature is assumed constant over the whole period with 100% mature from age 2. 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. Analysis of proportion mature is discussed further in Section 13.1.1.1.

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 were constructed by combining Danish and Norwegian data by half-year. Prior to 1996, the Norwegian age composition data were based on Danish ALK's. Catch numbers and weight-at-age for the southern North Sea are based on Danish age compositions.

The mean weights-at-age in the catch for the southern and northern North Sea are given in Tables 13.1.2.2-13.1.2.3. The mean weight-at-age in the catch used in the assessment (Table 13.1.2.4) is the mean of these values weighted by catch numbers.

The mean weight-at-age in the stock (Table 13.1.2.5) was 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.

The fishing fleets catch sandeels in different parts of the North Sea during the year, and the fishing pattern changes from year to year (see Table 13.1.1.3 13.1.1.4, 13.1.1.5). Because sandeels, *Ammodytes marinus*, in the North Sea possibly consist of a number of sub-populations the industrial fishery targets different parts 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. Furthermore, 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 (Table 13.1.2.2 and 13.1.2.3).

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 2001 with the same sampling level. Basic analysis of the data from 1999-2000 is not completed and data have not yet been used for estimation of assessment catch-at-age numbers. Data for 2001 sampling were used together with data from the routine sampling for estimation of catch-at-age numbers in 2001. Due to the new sampling program, the number of fish measured and aged has increased by a factor of around 10 compared to previous years.

13.1.3 Catch, effort, and research vessel data

Effort data from the southern and northern North Sea were treated as two independent fleets. The effort data for the southern North Sea prior to 1999 are only available for Danish vessels, although 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. Total international standardised effort was estimated as described in the WG report from 1996 (ICES 1996/Assess:6). Input data for these calculations are given in Tables 13.1.3.1, 13.1.3.2, and 13.1.3.3. The results of the regressions used to standardise effort to a 200 GRT vessel are given in Table 13.1.3.4. Total international effort is given in Tables 13.1.3.5 and 13.1.3.6 by area and combined in Figure 13.1.1.2. Table 13.1.3.7 gives cpue data by fleet raised to total international effort level.

The cpue given as total catch weight per effort shows a high correlation between the fleets over the years (Figure 13.1.3.1). cpue as number per effort by age group (Figure 13.1.3.2) shows a weak correlation between the fleets for the 0-group and a strong correlation for ages 1 and 2. cpue of the 0-group in 2001 is the highest in the shown time-series.

There are no survey time-series available for this stock.

13.1.4 Catch-at-age analysis

The Seasonal XSA (SXSA) developed by Skagen (1993) has previously been used for stock assessment of sandeel. Annual XSA was tried at last years' WG where it was concluded that the two approaches gave similar results. For a standardization of methodology, it was decided to shift to XSA this year, if ACFM had no strong views against it. Therefore, XSA is used for the final assessment this year and SXSA is only included as an explorative run.

13.1.4.1 Exploration of data

A number of exploratory runs were made to evaluate the sensitivity of the assessment to both the data and the assessment model. XSA runs were first performed to investigate temporal trend in catchability using single fleet tuning (run 1-4) with data from the period 1983-2001, no taper, light shrinkage of 1.5, and minimum standard error of fleet estimate set to 0.1 for a maximum influence on the terminal population and F. The log-catchability residuals (Figure 13.1.4.1) from these runs indicate no trend in catchability over the years. The residuals for the oldest ages in all four single fleet runs are very small, which might be a result of the few age-groups and a relatively weak signal in the time-series for other ages. First half-year fleets, in which most of the catch is taken, have in general smaller residuals.

Overview Table of explorative runs.

Run	Fleets	F-Shrinkage S.E. (default over 5 years and 3 ages)	Catchability independent of age	Power model
1	North, 1 half-year	1.5	>=3	No
2	South, 1 half-year	1.5	>=3	No
3	North, 2 half-year	1.5	>=3	No
4	South, 2 half-year	1.5	>=3	No
5	All	0.5	>=3	No
6	All	1.5	>=3	Yes, age 0 & 1 (pop. shrinkage)
7	All	1.5	>=3	No
8	All	1.5	>=3	Yes, age 0 & 1 (no pop. shrinkage)
9	All	5.0	>=3	No
FINAL	All	1.5 (5 years and 2 ages)	>=2	no
11	SXSA			

XSA's default settings were applied in run 5 for which the retrospective analysis results are shown in Figure 13.1.4.2. The estimates of SSB and recruits are highly variable from one year to the next. A tuning (run 7) with shrinkage S.E. at 1.5 (light shrinkage) gave a much more consistent retrospective pattern. No F-shrinkage (run 9) gave slightly more variable recruit estimates in the retrospective analysis, and light F shrinkage was chosen for the final run. All the retrospective analyses were done over the full year range of tuning data.

Stock-size-dependent catchability was analysed in run 6, where age 0 and 1 were treated as recruits. The slopes for age 0 and 1 were significantly different from 1 according to the tuning statistic output for only parts of the fleets (Southern fleet age 1 in the first half-year and age 0 in the second half-year). Population shrinkage might be inappropriate for a stock like sandeel with highly variable recruitment, and the effect of no population shrinkage for age 0 and 1 was tried in run 8. The retrospective recruitment estimates for both runs were slightly more variable than for the tuning without stock size dependent catchability (run 7). Stock-size-dependent catchability was not chosen for the final run.

For all the explorative runs catchability was assumed age-dependent for all true ages. The effect of setting catchability to be equal for ages 2 and 3 was not significant (hardly detectable), and age 2 was chosen as lower age for age-independent catchability in the final run. Tuning converged after 26 iterations when age 2 was used as lower catchability age. None of the explorative runs with age 3 as lower age converged.

For all the explorative runs with F-shrinkage, the shrinkage was done over 3 ages. This was an error, as the much lower F for age 0 is then included in the calculation of average F. Estimated SSB in the years with tuning data becomes slightly lower when just 2 ages are used for shrinkage, as the average F from shrinkage becomes higher. For years without tuning data, where the "backward extension" method is used for estimation of terminal F, the difference in SSB was up to a factor two for tuning using 2 or 3 ages.

Figure 13.1.4.3 shows SSB and F in the 2001 as estimated from the exploratory runs. Three of the single fleet tuning runs give estimates of SSB and F far from the other methods. The Southern fleet, first half-year gives results similar to the runs where all the fleets are included. F-shrinkage (S.E. 0.5) used in run 5 and population shrinkage used in run 6 both give a relatively high SSB. The remaining methods with light or no shrinkage, including SXSA, give similar results with respect to SSB and F-bar.

13.1.4.2 Final assessment

The assessment used the XSA method (Table 13.1.4.1) with the following settings for tuning:

Tuning settings for Sandeel in the North Sea

stock		**Sandeel**			
area		**IV**			
year of assessment		**2001**		**2002**	
Assessment model		SXSA		**XSA**	
Combined Northern 1st half-year	0-4+	1983-2000	0-4+	1983-2001	0-4+
Combined Northern 2nd half-year	0-4+	1983-2000	0-4+	1983-2001	0-4+
Combined Southern 1st half-year	0-4+	1983-2000	0-4+	1983-2001	0-4+
Combined Southern 2nd half-year	0-4+	1983-2000	0-4+	1983-2001	0-4+
Time-series weights		none		**none**	
Power model used for catchability		na		**not used**	
Catchability plateau age		3		**2**	
Surv. est. shrunk towards mean F		na		**5 years / 2 ages**	
s.e. of the means		na		**1.5**	
Min. stand. error for pop. estimates		na		**0.3**	
Prior weighting		Low on 2nd half-year fleet		**none**	
Number of iterations		55		26	
Convergence		yes		yes	

The log-catchability residuals show no clear trends (Figure 13.1.4.4), however, the southern fleet first half-year has three positive residuals for age 1 in the most recent years.

The plot of tuning weights (Figure 13.1.4.5) shows that F-shrinkage has a high weight for the 0-group, even though a low F-shrinkage (S.E.=1.5) was used. This indicates that 0-group cpue is a rather poor predictor of recruitment. The first half-year fleets get the highest weight for the ages 1-3, which is in line with the relatively higher catches taken in this period. The Northern fleet gets the highest weight for the 1-group, while age 3 survivors are mainly estimated from the southern fleet cpue.

Figure 13.1.4.6 shows the relationship between log stock numbers and log cpue for age 0 (second half-year fleets) and ages 1-4+ (first half-year tuning fleets). Ages 1-4+ give correlation coefficients in the range 0.19-0.94, with the highest values from the southern fleet, which takes the greatest part of the landings. The low correlation coefficients (0.16-0.31) for the 0-group emphasise that commercial cpue data are not a good predictor for recruitment.

The retrospective analysis, Figure 13.1.4.7, shows that the SSB estimates converge rapidly and show no signs of bias in the most recent estimates. The retrospective average F is more variable, but without a trend. Recruitment to the fishery takes place in the third quarter and the stock number estimated is based on commercial cpue data only, which makes the estimate of recruits highly variable and uncertain in the terminal year.

In contrast to SXSA, XSA is able to estimate terminal F for years without tuning data by the so-called "backward extension" method. However, due to the low numbers of age groups the method was not seen reliable for this stock and output are just presented for years with tuning data. Last year's WG report had included outputs from old assessments covering the period 1976-1982. These data have not been included in the stock summary graphs this year.

Fishing mortality-at-age is given in Table 13.1.4.2, stock numbers-at-age in Table 13.1.4.3, and stock summary in Table 13.1.4.4 and Figure 13.1.4.8.

The recruitment estimate for 2001 is the highest ever seen (Figure 13.1.4.8). A fishery well above average (of mainly the same cohort) in the first 5 months of 2002 supports the estimated very high recruitment. Both the northern and the southern tuning fleet estimate a very high recruitment (Table 13.1.4.1), however, the Southern tuning fleet estimates recruitment seven times higher than the Northern fleet. Historically, the 0-group fishery has mainly taken place in the Northern area and this fleet also gets the highest weight in the overall estimation of recruitment. This weighting and a relatively high weight on the F-shrinkage "fleet" produce a common XSA estimate close to the estimate from the Northern fleet.

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 high landings in the period up to mid-June, 2002 of mainly the same cohort confirm, however, a high 2001 recruitment such that it is likely that the recruitment in 2001 was well above average.

13.1.6 Historical stock trends

Landings have fluctuated without a clear trend in the assessment period (Figure 13.1.4.8). Fishing mortality in 2001 is lower than F in 2000, but higher than the average F in the assessment period.

Recruitment fluctuates without a clear pattern. The recruitments in 1997-2000 were below average for the period 1983-2000, but the preliminary recruitment estimate for 2001 is the highest observed. The 2001 recruitment is estimated from commercial cpue, which historically has been a poor predictor. Very high landings in 2002 confirm, however, a high 2001 recruitment.

Spawning stock biomass has fluctuated around a level of 1 million t in the assessment period. After the peak in 1998 (due to the large 1996 year class) the SSB reached a local minimum 2000 and has increased slightly in 2001 (620 000 t). SSB has been estimated above $\mathbf{B}_{pa}$ (600 000 t) since 1992, however, the SSB's for the last two years are close to $\mathbf{B}_{pa}$.

13.1.7 Catch forecasts

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. Recruits (age 0) have not appeared in the fishery at the time of the WG. Traditional deterministic forecasts are therefore not considered appropriate.

13.1.8 Biological reference points

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 means 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 in this WG. 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.

Figure 13.1.8.1 shows the relationship between Fbar(1-2) and SSB in relation to $\mathbf{B}_{pa}$ for the period 1983-2001. SSB in 2001 is estimated to be 3% above the $\mathbf{B}_{pa}$. SSB has not been below $\mathbf{B}_{pa}$ since 1991 and never below $\mathbf{B}_{lim}$.

The stock-recruitment scatter plot (Figure 13.1.8.2) shows no clear relationship between stock and recruitment over the observed stock sizes. The largest estimated recruitment (in 2001) comes from a SSB close to $\mathbf{B}_{pa}$.

The yield-per-recruit plot (Figure 13.1.8.3) indicates that maximum yield-per-recruit is obtained by a higher fishing mortality than historically observed. A higher F does however reduce the SSB-per-recruit considerably.

13.1.9 Quality of the assessment

This year (annual) XSA tuning was chosen for the assessment, where seasonal XSA has been used previously. The results from last year's WG showed similar results for the two approaches, and this year's assessment confirmed similar results for the two methods (Figure 13.1.9.1). In general, XSA gives a lower F and a higher SSB. Recruitment in 2001 is estimated a factor 2 higher by the SXSA method.

The relatively poor correlation between the tuning indices and the stock size is perhaps a reflection of the fact that we are assessing several sub-stocks as a single unit.

The assessment appears to be internally consistent, however, with large log-catchability residuals. No bias was seen in the retrospective analysis for F and SSB.

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 uncertain.

The very high recruitment estimate for 2001 is based exclusively on commercial catch-at-age data. The tuning diagnostics indicate that the 0-group cpue is a rather poor predictor of recruitment and the estimate must be seen as very preliminary. High catch rates in 2002 do however confirm a high recruitment.

The natural mortality of the 0-group is well below the MSVPA estimates such that the absolute recruitment numbers might be seriously underestimated. The estimated average 0-group fishing mortality on just 0.03 is therefore an overestimate.

13.1.10 Management considerations

There is a need to ensure that the sandeel stock remains high enough to provide food for a variety of predator species. 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.

The sandeel fishery in the first half of the year consists mainly of age 1 and older fish. The 0-group recruits to the fishery in the third quarter. Historically the 0-group has mainly been taken in the northern Subareas. However, in 2001 the main catches were taken in the southern part. The estimated fishing mortality for the 0-group, which represents the entire stock is very low, but locally fishing mortality might be much higher. Management of fisheries should try to prevent local depletion of sandeel aggregations, particularly in areas where predators congregate.

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 2001 were 25 500 t, which is a small increase compared to the values in 1998-2000, but below the average of 32 000 t for the period 1989-2001 (Table 2.2.1).

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 2001 were 1 264 tonnes (Table 13.1.1.3), which is 40% of the average of the previous three years and far less than the the 7 000 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

The main problem in trying to assess the stock using traditional catch-at-age analyses is that the fishing mortality is very low compared to natural mortality, and as a result VPA-like methods tend to fail. A separable model for survey data only (Cook 1997), was applied at the 2001 meeting of the WG for the years 1985-2000 (ICES C.M. 2002/ACFM:01). The results showed that total mortality is more stable than the highly fluctuating recruitment and biomass. The assessment carried out last year suggested that the SSB was at a relatively low level and that recent recruitment has been poor. SSB was likely to decrease in the short term.

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, and trends in landings are shown in Figure 13.4.1. In 2001 landings were 295 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) 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.

13.4.3 Stock identity

ACFM (October 2001) asked the Working Group to verify the the justification of treating Division VIa as a management area for Norway pout and sandeel separately from IV and IIIa. The latest investigation of population structure in *Ammodytes marinus* in the North Sea and neighbouring waters is given by Wright et al. (1998). The investigation suggests there exist 5 sub-populations of sandeels in the North Sea (Area IV), one population around Shetland (Areas Vb1 and Vb2), and one population in Area VIa. The analysis was based on information about distribution of the spawning population and pre-settled fish, information from the commercial fishery on sandeels, and information about the length of the larval stage and the dispersal pattern of larvae between spawning areas. The dispersal pattern of larvae was simulated by use of a hydrographic model. The separation of spawning populations between Areas VIa and IV was substantiated by the information available, i.e. there is only little interchange of larvae between these two areas. The separation between Areas IV and III was not investigated in the same detail, primarily because data on distribution of sandeels in Area III is even more sparse than in the other areas mentioned. The study indicated that there did not appear to be a clear separation between the spawning populations in Area IV and Area IIIa, i.e. there seemed to be a substantial transport of larvae between Area IV and Area IIIa. The extent of transport of larvae between the two areas was not described in detail.

The information about the distribution pattern of the different life stages of sandeels has been significantly improved in recent years (see Section 13.2). Further, hydrographic models have been developed (see e.g. Schrum et al. 2000) that can perform more spatially and temporally resolved analyses of dispersal of larvae than the model that was used by Wright et al. (1998, see also Proctor et al. 1998). It would therefore be valuable to explore larval drift between smaller as well as larger aggregations of post-settled fish, in order to verify the present perception of the population structure of sandeels in the North Sea and adjacent waters, and in order to be able to define the spatial scale relevant for evaluating the effect of the sandeel fishery on the sandeel populations.

In conclusion, the available information suggests that Area VIa should be considered as a separate stock unit for sandeel assessment. On the other hand, Areas IV and IIIa might be combined to one stock unit. Up to now, there has not been made any assessment of sandeels in Area III. Further, historical biological data for this area are sparse and would have to be evaluated before a decision is made about treating sandeels in Areas IV and IIIa as one stock.

Table 13.1.1.1 SANDEEL in the North Sea. Official landings reported to ICES

SANDEELS IVa

Country	1995	1996	1997	1998	1999	2000	2001*
Denmark	48,495	12,367	26,498	23,138	3,388	4,742	1,058
Faroe Islands	2,888	15	11,221	11,000	6,582		
Norway	195,220	61,593	98,386	172,887	44,620	11,522*	4,130
Sweden	+	-	-	55	495	55	-
UK (E/W/NI)	560	550	-	-	-	-	-
UK (Scotland)	1,451	1,311	3,463	5,742	4,195	4,781	-
United Kingdom							970
Total	248,614	75,836	139,568	212,822	59,280	21,100	6,158

*Preliminary.

SANDEELS IVb

Country	1995	1996	1997	1998	1999	2000	2001*
Denmark	766,430	607,290	731,184	603,491	503,572	533,905	638,657
Faroe Islands	4,597	5,008	-	-	-		
Ireland	-	-	-	-	389	-	-
Norway	68,270	99,109	252,177	170,737	142,969	107,493*	183,370
Sweden	-	-	-	8,465	21,920	27,867	46,537
UK (E/W/NI)	2,020	1,130	2,575	-	-	-	-
UK (Scotland)	6,386	6,688	20,554	18,008	7,280	5,978	-
United Kingdom							-
Total	847,703	719,225	1,006,490	800,701	676,130	675243	868564

*Preliminary.

SANDEELS IVc

Country	1995	1996	1997	1998	1999	2000	2001*
Denmark	4,752	1,481	3,163	9,674	10,356	11,993	7,177
Netherlands	-	-	-	+	+	-	-
UK (E/W/NI)	-	-	-	-	-	+	-
Total	4,752	1,481	3,163	9,674	10,356	11,993	7,177

*Preliminary.

Summary table official landings

	1995	1996	1997	1998	1999	2000	2001
Total IV tonnes	1,101,069	796,542	1,149,221	1,023,197	745,766	708,336	881,899

By-catch and other landings

	1995	1996	1997	1998	1999	2000	2001
Area IV tonnes: official-WG	183,169	19,598	11,439	18,797	10,628	9,187	20,288

Summary table - landing data provided by Working Group members

	1995	1996	1997	1998	1999	2000	2001
Total IV - tonnes	917,900	776,944	1,137,782	1,004,400	735,138	699,149	861,611

Table 13.1.1.2. SANDEEL in the North Sea. Landings ('000 t), 1952-2001.
(Data provided by Working Group members.)

Year	Denmark	Germany	Faroes	Ireland	Netherlands	Norway	Sweden	UK	Total
1952	1.6	-	-	-	-	-	-	-	1.6
1953	4.5	+	-	-	-	-	-	-	4.5
1954	10.8	+	-	-	-	-	-	-	10.8
1955	37.6	+	-	-	-	-	-	-	37.6
1956	81.9	5.3	-	-	+	1.5	-	-	88.7
1957	73.3	25.5	-	-	3.7	3.2	-	-	105.7
1958	74.4	20.2	-	-	1.5	4.8	-	-	100.9
1959	77.1	17.4	-	-	5.1	8.0	-	-	107.6
1960	100.8	7.7	-	-	+	12.1	-	-	120.6
1961	73.6	4.5	-	-	+	5.1	-	-	83.2
1962	97.4	1.4	-	-	-	10.5	-	-	109.3
1963	134.4	16.4	-	-	-	11.5	-	-	162.3
1964	104.7	12.9	-	-	-	10.4	-	-	128.0
1965	123.6	2.1	-	-	-	4.9	-	-	130.6
1966	138.5	4.4	-	-	-	0.2	-	-	143.1
1967	187.4	0.3	-	-	-	1.0	-	-	188.7
1968	193.6	+	-	-	-	0.1	-	-	193.7
1969	112.8	+	-	-	-	-	-	0.5	113.3
1970	187.8	+	-	-	-	+	-	3.6	191.4
1971	371.6	0.1	-	-	-	2.1	-	8.3	382.1
1972	329.0	+	-	-	-	18.6	8.8	2.1	358.5
1973	273.0	-	1.4	-	-	17.2	1.1	4.2	296.9
1974	424.1	-	6.4	-	-	78.6	0.2	15.5	524.8
1975	355.6	-	4.9	-	-	54.0	0.1	13.6	428.2
1976	424.7	-	-	-	-	44.2	-	18.7	487.6
1977	664.3	-	11.4	-	-	78.7	5.7	25.5	785.6
1978	647.5	-	12.1	-	-	93.5	1.2	32.5	786.8
1979	449.8	-	13.2	-	-	101.4	-	13.4	577.8
1980	542.2	-	7.2	-	-	144.8	-	34.3	728.5
1981	464.4	-	4.9	-	-	52.6	-	46.7	568.6
1982	506.9	-	4.9	-	-	46.5	0.4	52.2	610.9
1983	485.1	-	2.0	-	-	12.2	0.2	37.0	536.5
1984	596.3	-	11.3	-	-	28.3	-	32.6	668.5
1985	587.6	-	3.9	-	-	13.1	-	17.2	621.8
1986	752.5	-	1.2	-	-	82.1	-	12.0	847.8
1987	605.4	-	18.6	-	-	193.4	-	7.2	824.6
1988	686.4	-	15.5	-	-	185.1	-	5.8	892.8
1989	824.4	-	16.6	-	-	186.8	-	11.5	1039.1
1990	496.0	-	2.2	-	0.3	88.9	-	3.9	591.3
1991	701.4	-	11.2	-	-	128.8	-	1.2	842.6
1992	751.1	-	9.1	-	-	89.3	0.5	4.9	854.9
1993	482.2	-	-	-	-	95.5	-	1.5	579.2
1994	603.5	-	10.3	-	-	165.8	-	5.9	785.5
1995	647.8	-	-	-	-	263.4	-	6.7	917.9
1996	601.6	-	5.0	-	-	160.7	-	9.7	776.9
1997	751.9	-	11.2	-	-	350.1	-	24.6	1137.8
1998	617.8	-	11.0	-	+	343.3	8.5	23.8	1004.4
1999	500.1	-	13.2	0.4	+	187.6	22.4	11.5	735.1
2000	541.0	-	-	-	+	119.0	28.4	10.8	699.1
2001	630.8	-	-	-	-	183.0	46.5	1.3	861.6

+ = less than half unit.
- = no information or no catch.

Table 13.1.1.3 SANDEEL in the North Sea. Monthly landings (ton) by Denmark, Norway and Scotland from each area defined in Fig 13.1.1.1

	1A	1B	1C	2A	2B	2C	3	4	5	6	Shetland	Total
1996												
Mar	0	28	10	0	2379	0	0	0	0	0		2417
Apr	8792	35	1551	3944	21184	0	5438	247	0	534		41725
May	78847	13217	4595	13739	54993	611	18817	2509	455	3064		190847
Jun	112059	81	20441	12692	32264	489	25078	7097	1711	35186		247098
Jul	108624	1976	59	1282	9565	1	22477	2885	802	6034		153705
Aug	1313	461	3679	7153	8849	125	34315	0	0	5441		61336
Sep	875	43	767	1256	12586	3307	19781	0	0	2262		40877
Oct	0	2671	0	726	10252	0	8156	0	0	0		21805
Nov	0	48	0	0	879	0	0	0	0	0		927
Total	310510	18560	31102	40792	152951	4533	134062	12738	2968	52521	1000	761737
1997												0
Mar	17	7562	2326	1402	25821		1220				0	38348
Apr	23736	35036	5800	11404	42308	535	21745	588		180	892	142224
Mai	117700	6326	584	24309	76216	487	36499	3074	1768	13636	503	281102
Jun	132631	2751		37848	142941		36966	1121	51	29935	442	384686
Jul	58429	1235	197	14212	42478		11632	11057	1278	31738	534	172790
Aug	1660	293		1552	24113	15	3497	83	1602	12211	503	45529
Sep				1024	23859	156	1230			666	0	26935
Okt		140		859	12513		134			61	0	13707
Total	334173	53343	8907	92610	390249	1193	112923	15923	4699	88427	2874	1105321
1998												0
Mar	5631	6378	322	1176	8431	150	697	1275	0	0	0	24060
Apr	55616	12943	589	34884	73929	351	11619	482	225	843	1073	192554
May	80124	30002	1103	41509	85448	481	13613	8688	1173	10151	1224	273516
Jun	129065	6115	0	7693	86544	0	9248	14485	1488	27392	0	282030
Jul	6172	396	0	1675	43587	0	2490	6750	1188	23786	50	86094
Aug	149	1477	0	964	55421	0	1852	642	0	473	2362	63340
Sept	0	676	0	733	37012	0	1094	0	0	212	503	40230
Oct	0	26	4	0	4472	0	0	0	0	16	0	4518
Total	276757	58013	2018	88634	394844	982	40613	32322	4074	62873	5212	966342
1999												0
Mar	1448	2587	136	1047	9371	0	466	73	218	0	479	15826
Apr	52710	3030	0	64860	17779	0	644	80	55	1360	1080	141598
May	151806	15520	0	42635	45709	0	7299	1567	82	1271	461	266351
Jun	52943	9427	0	6199	8224	0	3304	12744	1097	18254	6	112198
Jul	7816	1883	0	15142	13918	0	14841	2434	1270	5274	0	62578
Aug	1	0	0	1770	29621	0	15376	0	0	99	2043	48909
Sept	1	155	0	930	26486	0	4129	0	0	883	88	32672
Oct	0	0	0	42	16440	0	1754	0	0	68	0	18305
Dec	0	0	0	181	358	0	198	0	0	0	0	737
Total	266725	32603	136	132807	167905	0	48011	16898	2722	27208	4157	699174
2000												0
Mar	800	42	0	3257	5618	0	739	0	0	393	687	11536
Apr	30931	19012	0	15259	71384	281	33583	479	0	595	1436	172959
May	110128	6843	0	24941	42647	0	53911	6685	3089	662	1651	250558
Jun	73632	3262	26	18564	16440	0	17287	11240	2503	29205	0	172160
Jul	10610	33	4	25193	3286	11	5996	2024	2692	12201	0	62049
Aug	0	0	0	3	113	0	117	0	1	127	560	921
Sept	0	0	0	21	393	0	18	0	0	145	0	577
Oct	0	0	0	0	0	0	2	0	0	1	0	3
Total	226102	29192	30	87238	139882	292	111652	20428	8285	43329	4334	670763
2001												0
Mar	3205	0	0	5235	2078	0	915	218	334	180	144	12309
Apr	60040	10891	0	19956	16609	0	1968	916	0	265	295	110940
May	96489	2014	0	71446	20668	0	15266	4829	510	3767	589	215578
Jun	72384	0	1556	15160	8103	120	8265	4790	4291	22748	0	137417
Jul	6703	90	0	67814	24065	0	8769	1664	2204	13747	0	125056
Aug	473	0	0	51965	61169	0	8679	0	0	2927	236	125449
Sep	578	0	0	24926	31178	0	4802	0	0	4840	0	66324
Oct	0	0	0	6464	14027	0	972	0	0	500	0	21963
Total	239872	13026	1556	262966	177898	120	49635	12417	7339	48974	1264	815067
%	29%	2%	0%	32%	22%	0%	6%	2%	1%	6%	0%	
Average 1996-2000												
	34%	5%	1%	11%	30%	0%	11%	2%	1%	7%	0%	

Table 13.1.1.4 SANDEEL in the North Sea. Annual landings ('000 t) by area of the North Sea .
Data provided by Working Group members (Denmark, Norway and Scotland).

	Area										Sampling area		
Year	1A	1B	1C	2A	2B	2C	3	4	5	6	Shetland	Northern	Southern
1972	98.8	28.1	3.9	24.5	85.1	0.0	13.5	58.3	6.7	28.0	0	130.6	216.3
1973	59.3	37.1	1.2	16.4	60.6	0.0	8.7	37.4	9.6	59.7	0	107.6	182.4
1974	50.4	178.0	1.7	2.2	177.9	0.0	29.0	27.4	11.7	25.4	7.4	386.6	117.1
1975	70.0	38.2	17.8	12.2	154.7	4.8	38.2	42.8	12.3	19.2	12.9	253.7	156.5
1976	154.0	3.5	39.7	71.8	38.5	3.1	50.2	59.2	8.9	36.7	20.2	135.0	330.6
1977	171.9	34.0	62.0	154.1	179.7	1.3	71.4	28.0	13.0	25.3	21.5	348.4	392.3
1978	159.7	--50.2--		346.5	--70.3--		42.5	37.4	6.4	27.2	28.1	163.0	577.2
1979	194.5	0.9	61.0	32.3	27.0	72.3	34.1	79.4	5.4	44.3	13.4	195.3	355.9
1980	215.1	3.3	119.3	89.5	52.4	27.0	90.0	30.8	8.7	57.1	25.4	292	401.2
1981	105.2	0.1	42.8	151.9	11.7	23.9	59.6	63.4	13.3	45.1	46.7	138.1	378.9
1982	189.8	5.4	4.4	132.1	24.9	2.3	37.4	75.7	6.9	74.7	52.0	74.4	479.2
1983	197.4	-	2.8	59.4	17.7	-	57.7	87.6	8.0	66.0	37.0	78.2	419.0
1984	337.8	4.1	5.9	74.9	30.4	0.1	51.3	56.0	3.9	60.2	32.6	91.8	532.8
1985	281.4	46.9	2.8	82.3	7.1	0.1	29.9	46.6	18.7	84.5	17.2	79.7	513.5
1986	295.2	35.7	8.5	55.3	244.1	2.0	84.8	22.5	4.0	80.3	14.0	375.1	457.4
1987	275.1	63.6	1.1	53.5	325.2	0.4	5.6	21.4	7.7	45.1	7.2	395.9	402.8
1988	291.1	58.4	2.0	47.0	256.5	0.3	37.6	35.3	12.0	102.2	4.7	384.8	487.6
1989	228.3	31.0	0.5	167.9	334.1	1.5	125.3	30.5	4.5	95.1	3.5	492.4	526.3
1990	141.4	1.4	0.1	80.4	156.4	0.6	61.0	45.5	13.8	85.5	2.3	219.5	366.7
1991	228.2	7.1	0.7	114.0	252.8	1.8	110.5	22.6	1.0	93.1	+	372.9	458.9
1992	422.4	3.9	4.2	168.9	67.1	0.3	101.2	20.1	2.8	54.4	0	176.7	668.6
1993	196.5	21.9	0.1	26.2	164.9	0.3	88.0	26.6	3.9	48.7	0	276.0	301.9
1994	157.0	108.6	-	61.7	203.4	2.7	175.0	16.0	2.8	42.0	0	489.7	279.5
1995	322.4	43.9	147.4	86.7	169.5	1.0	59.4	26.6	5.3	55.8	1.3	421.2	496.8
1996	310.5	18.6	31.2	40.8	153.0	4.5	134.1	12.7	3.0	52.5	1	341.2	419.5
1997	352.0	53.3	8.9	92.8	390.5	1.2	112.9	18.1	4.7	88.6	2.4	566.8	535.8
1998	282.2	58.3	2.0	90.3	395.3	1.0	40.6	34.5	4.2	63.4	5.2	497.2	480.7
1999	266.7	32.6	0.1	132.8	167.9	0.0	48.0	16.9	2.7	27.2	4.2	248.7	446.4
2000	226.1	29.2	0.0	87.2	139.9	0.3	111.7	20.4	8.3	43.3	4.3	281.0	385.4
2001	239.9	13.0	1.6	263.0	177.9	0.1	49.6	12.4	7.3	49.0	1.3	242.2	571.6

Sampling areas: Northern - Areas 1B, 1C, 2B, 2C, 3.
Southern - Areas 1A, 2A, 4, 5, 6.

Table 13.1.1.5 SANDEEL in the North Sea. Monthly landings (t) by Denmark, Norway and Scotland. (Data provided by Working Group members).

Year	Month	Denmark	Norway	Scotland	Total
1997	Mar	15,343	23,005		38,348
	Apr	88,690	52,642		141,332
	May	208,647	71,951	8,029	288,627
	Jun	276,974	107,270	11,581	395,825
	Jul	136,708	35,369	2,396	174,473
	Aug	22,394	22,811		45,205
	Sept	2,490	24,448		26,938
	Oct	640	13,067		13,707
	Nov	0			0
	Total	751,886	350,563	22,007	1,124,456
1998	Mar	14,729	9,332		24,061
	Apr	130,629	60,852	2,359	193,840
	May	191,407	80,885	8,246	280,538
	Jun	204,102	77,929	7,933	289,964
	Jul	56,586	29,457		86,043
	Aug	17,894	43,084		60,978
	Sept	2,395	37,331		39,726
	Oct	17	4,503		4,520
	Nov				0
	Total	617,759	343,373	18,538	979,670
1999	Mar	6,851	8,496	479	15,826
	Apr	115,596	24,149	1,854	141,599
	May	202,813	56,961	6,578	266,352
	Jun	97,284	14,478	434	112,197
	Jul	49,333	13,245	0	62,578
	Aug	19,044	27,823	2,043	48,910
	Sept	6,217	26,366	88	32,672
	Oct	2,567	15,738	0	18,305
	Nov	405	332		737
	Total	500,110	187,589	11,476	699,175
2000	Mar	7,524	3,325	687	11,536
	Apr	126,644	44,879	1,436	172,959
	May	195,866	48,292	6,400	250,558
	Jun	150,394	20,089	1,677	172,160
	Jul	60,126	1,923		62,049
	Aug	247	113	560	921
	Sept	184	393		577
	Oct	3			3
	Total	540,988	119,015	10,759	670,763
2001	Mar	10,684	1,481	144	12,310
	Apr	95,723	14,922	295	110,940
	May	183,757	31,231	589	215,577
	Jun	127,292	10,124	0	137,416
	Jul	106,654	18,403	0	125,057
	Aug	65,021	60,192	236	125,449
	Sep	33,741	32,583	0	66,324
	Oct	7,910	14,054	0	21,963
	Nov	30	0	0	30
	Total	630,811	182,991	1,264	815,066

Table 13.1.2.1 SANDEEL in the North Sea. Natural mortality and proportion mature.

Age	Proportion mature	Natural mortality
0	0.0	0.8
1	0.0	1.2
2	1.0	0.6
3	1.0	0.6
4+	1.0	0.6

Table 13.1.2.2 SANDEEL, Northern North Sea. Mean weight (g) in the catch by country and combined. Age group 4++ is the 4-plus group used in assessment

		Denmark		Norway		Combined	
		Half-year		Half-year		Half-year	
Year	Age	1	2	1	2	1	2
1997	0	-	4.63	-	1.58	-	1.71
	1	4.20	9.12	5.97	7.69	4.94	8.11
	2	6.23	23.93	8.77	9.86	7.95	10.15
	3	10.67	10.65	12.25	28.06	11.76	23.96
	4	14.73	14.02	16.97	-	15.53	14.02
	5	17.94	17.94	-	-	17.94	17.94
	5+	-	-	30.90	-	30.90	-
	6	19.26	18.56	-	-	19.26	18.56
	7	21.57	18.55	-	-	21.57	18.55
	4++	18.07	17.19	29.36	-	24.64	17.19
1998	0	-	2.84	-	2.23	-	2.48
	1	4.03	10.31	4.89	3.82	4.24	3.91
	2	8.11	18.33	9.24	10.56	8.73	11.13
	3	12.72	20.33	14.42	20.14	14.21	20.15
	4	15.41	26.40	31.00	12.75	28.60	13.39
	5	19.90	-	-	-	19.90	-
	5+	-	-	49.94	-	49.94	-
	6	16.62	-	-	-	16.62	-
	7	18.37	-	-	-	18.37	-
	4++	16.59	26.40	36.61	12.75	33.61	13.39
1999	0	-	4.08	-	2.67	-	3.07
	1	6.72	18.52	3.87	2.90	6.53	7.78
	2	10.89	-	7.12	10.43	8.08	10.43
	3	17.47	24.15	11.65	-	13.20	24.15
	4	20.07	-	20.72	-	20.57	-
	5	22.23	-	-	-	22.23	-
	5+	-	-	37.82	-	37.82	-
	6	26.11	-	-	-	26.11	-
	7	27.00	-	-	-	27.00	-
	8+	30.33	-	-	-	30.33	-
	4++	21.30	-	27.14	-	25.68	-
2000	0	-	-	-	-	-	-
	1	6.41	14.92	8.46	-	6.78	14.92
	2	7.44	17.95	8.05	-	7.90	17.95
	3	12.68	19.18	11.17	-	11.86	19.18
	4	18.49	22.62	-	-	18.49	22.62
	4+	-	-	21.92	-	21.92	-
	5	19.37	25.37	-	-	19.37	25.37
	6	18.41	18.41	-	-	18.41	18.41
	4++	18.60	22.67	21.92	-	19.66	22.67
2001	0	1.89	2.48	1.62	3.28	1.68	3.10
	1	5.48	9.73	7.21	9.07	6.29	9.61
	2	10.10	17.00	15.63	17.61	11.78	17.50
	3	11.55	-	19.81	9.07	15.82	9.07
	4	13.09	-	25.45	-	-	-
	5	16.93	-	-	-	-	-
	5+			8.03			
	6	21.04	-	-	-	-	-
	4++	15.20	-	9.18	-	11.58	-

Table 13.1.2.3 SANDEEL, Southern North Sea. Mean weight (g) in the catch (Denmark)
Age group 4++ is the 4-plus group used in assessment

		Half-year	
Year	Age	1	2
1997	0	-	4.72
	1	6.52	7.99
	2	10.92	13.54
	3	11.81	14.73
	4	16.19	16.74
	5	-	23.33
	6	17.05	20.01
	4++	16.27	18.88
1998	0	-	2.79
	1	5.54	3.01
	2	8.38	12.65
	3	10.64	11.57
	4	12.05	17.23
	5	15.59	14.87
	6	17.82	-
	7	18.28	-
	4++	13.21	17.14
1999	0	-	5.42
	1	5.52	10.02
	2	9.27	11.05
	3	13.50	16.85
	4	16.84	15.59
	5	22.23	9.16
	6	20.95	21.38
	7	-	21.38
	4++	18.33	15.68
2000	0	1.72	1.66
	1	6.16	6.61
	2	9.56	13.68
	3	14.42	15.74
	4	15.41	18.06
	5	16.66	19.60
	6	19.82	19.75
	7	18.69	19.75
	8+	19.88	-
	4++	15.93	18.34
2001	0	1.75	2.40
	1	4.22	9.51
	2	7.93	17.00
	3	12.57	-
	4	16.19	-
	5	16.71	-
	6	17.73	-
	7	21.56	-
	8+	-	-
	4++	16.76	-

Table 13.1.2.4 SANDEEL in the North Sea. Mean weight in the catch

Catch weights at age (kg)

YEAR AGE	1983	1984	1985	1986	1987	1988	1989	1990	1991
0	0.0027	0.0000	0.0024	0.0030	0.0023	0.0030	0.0050	0.0029	0.0030
1	0.0059	0.0059	0.0059	0.0064	0.0070	0.0061	0.0055	0.0053	0.0077
2	0.0103	0.0117	0.0103	0.0115	0.0116	0.0130	0.0131	0.0129	0.0159
3	0.0149	0.0140	0.0166	0.0151	0.0187	0.0165	0.0161	0.0180	0.0188
+gp	0.0177	0.0172	0.0297	0.0172	0.0291	0.0191	0.0181	0.0243	0.0229

YEAR AGE	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
0	0.0054	0.0027	0.0066	0.0051	0.0029	0.0019	0.0025	0.0032	0.0017	0.0027
1	0.0073	0.0064	0.0067	0.0074	0.0073	0.0061	0.0045	0.0057	0.0065	0.0045
2	0.0131	0.0131	0.0149	0.0150	0.0113	0.0098	0.0087	0.0089	0.0088	0.0086
3	0.0180	0.0172	0.0166	0.0198	0.0150	0.0120	0.0121	0.0137	0.0136	0.0132
+gp	0.0249	0.0211	0.0194	0.0210	0.0261	0.0214	0.0164	0.0216	0.0172	0.0152

Table 13.1.2.5 SANDEEL in the North Sea. Mean weight in the stock

Stock weights at age (kg)

YEAR AGE	1983	1984	1985	1986	1987	1988	1989	1990	1991
0	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010
1	0.0050	0.0041	0.0042	0.0042	0.0047	0.0044	0.0044	0.0043	0.0043
2	0.0129	0.0138	0.0128	0.0131	0.0128	0.0148	0.0135	0.0133	0.0132
3	0.0169	0.0163	0.0188	0.0163	0.0160	0.0158	0.0196	0.0176	0.0170
+gp	0.0248	0.0210	0.0221	0.0278	0.0212	0.0192	0.0183	0.0193	0.0206

YEAR AGE	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
0	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010
1	0.0041	0.0045	0.0063	0.0071	0.0068	0.0056	0.0050	0.0056	0.0064	0.0044
2	0.0131	0.0127	0.0130	0.0154	0.0100	0.0094	0.0085	0.0088	0.0086	0.0085
3	0.0172	0.0164	0.0146	0.0200	0.0145	0.0118	0.0120	0.0134	0.0133	0.0135
+gp	0.0212	0.0213	0.0187	0.0209	0.0211	0.0216	0.0163	0.0222	0.0170	0.0152

Table 13.1.3.1 SANDEEL. Northern North Sea. Danish CPUE data (t/day fishing) by half year

First half year

	Vessel size (GRT)						
Year	0-50	50-100	100-150	150-200	200-250	250-300	>300
1982	11.2	17.2	31.8	26.7	47.6	40.8	25.8
1983	11.1	17.1	23.6	23.9	31.6	36.4	41.3
1984	14.6	24.8	33.4	32.1	44.4	55.5	19.7
1985	12.1	17.2	35.7	51.2	57.9	67.2	55.8
1986	21.0	32.0	45.5	50.2	63.9	57.4	71.8
1987	23.7	37.8	67.0	66.5	78.6	79.9	113.0
1988	19.0	25.6	34.4	42.5	48.0	47.8	75.3
1989	16.3	25.2	36.7	41.0	49.6	51.4	76.2
1990	14.5	21.6	27.3	27.8	29.5	27.4	39.7
1991	16.7	25.5	38.4	42.5	47.6	47.5	72.2
1992	16.6	24.6	36.3	34.7	60.6	46.9	76.9
1993	14.9	19.3	33.6	36.5	47.2	51.1	51.8
1994	26.9	32.0	53.9	61.8	75.0	87.9	102.5
1995	19.6	29.5	49.5	57.8	61.0	66.9	73.6
1996	16.5	21.1	35.9	39.1	36.7	40.0	56.2
1997	24.9	34.9	51.4	56.1	76.8	58.9	90.4
1998	16.9	24.4	28.7	44.6	52.8	54.3	64.8
1999	24.2	27.3	22.7	34.9	35.2	47.3	67.4
2000	17.5	33.2	32.8	40.0	50.7	54.5	71.2
2001	19.4	29.7	28.6	40.1	36.9	36.5	55.0

Second half year

	Vessel size (GRT)						
Year	0-50	50-100	100-150	150-200	200-250	250-300	>300
1982	-	17.7	33.6	46.7	19.9	-	-
1983	17.9	25.7	31.0	32.9	44.5	34.3	57.1
1984	113.2	22.0	21.5	35.2	-	28.3	24.0
1985	21.6	23.5	25.8	39.6	60.7	33.3	-
1986	17.1	27.5	50.2	50.0	77.9	74.0	80.7
1987	21.3	31.8	23.9	24.3	42.6	25.4	46.3
1988	16.8	21.3	30.0	32.4	38.0	33.1	43.9
1989	16.6	22.3	23.6	27.3	28.3	35.6	25.0
1990	17.6	32.5	29.4	34.1	40.4	32.6	53.3
1991	15.1	26.3	40.8	44.8	54.4	51.3	72.5
1992	20.4	25.4	35.2	38.2	53.6	50.9	52.1
1993	18.5	21.4	26.5	27.5	38.8	47.9	59.0
1994	24.3	31.5	42.7	53.5	59.8	65.8	74.6
1995	21.9	34.6	46.1	53.8	58.6	62.7	68.6
1996	15.3	30.6	41.9	37.8	47.4	44.9	47.3
1997	14.1	26.2	32.5	34.1	40.2	33.6	43.3
1998	12.4	18.9	14.9	27.8	33.1	31.1	38.5
1999	17.4	29.5	17.3	31.9	39.8	37.3	42.3
2000	22.4	20.4	22.4	30.1	50.2	42.3	54.5
2001	24.4	35.7	29.4	47.3	49.5	51.0	66.0

Table 13.1.3.2 SANDEEL in the North Sea. Norwegian effort data

Northern area

Year	Fishing days		Mean gross register tonnage (Av. GRT pr. trip)	
	Jan-Jun	Jul-Dec	Jan-Jun	Jul-Dec
1976	595		199	
1977	2212	457	172	185
1978	1747	806	203	204
1979	1407	1720	214	189
1980	2642	1099	216	210
1981	1740	404	217	191
1982	1206		209	
1983	304	66	255	191
1984	145		183	
1985	366		220	
1986	1562	567	201	187
1987	2123	1584	219	201
1988	3571	925	203	198
1989	4292	588	192	202
1990	2275	731	208	189
1991	1749	958	200	194
1992	1202	23	205	213
1993	1462	971	231	201
1994	2559	742	222	227
1995	3305	980	216	218
1996	1935	724	224	219
1997	3354	1484	218	221
1998	2479	2176	222	219
1999	2030	1540	240	241
2000	2045	n/a (very low)	254	n/a
2001	579	1371	281	256

Southern area

Year	Fishing days		Mean gross register tonnage (Av. GRT pr. trip)	
	Jan-Jun	Jul-Dec	Jan-Jun	Jul-Dec
1999	521	10	262	316
2000	111	n/a	259	n/a
2001	137.8	n/a	295	n/a

Table 13.1.3.3 SANDEEL. Southern North Sea. Danish CPUE data (t/day fishing) by half year

First half year

	Vessel size (GRT)						
Year	0-50	50-100	100-150	150-200	200-250	250-300	>300
1982	16.1	26.9	43.1	47.2	59.2	53.2	59.6
1983	17.0	20.6	36.3	44.4	49.1	51.2	50.9
1984	19.9	26.3	42.6	50.4	60.9	56.4	60.1
1985	13.8	21.2	35.5	43.4	49.8	49.1	56.3
1986	23.2	31.4	41.1	49.8	58.9	58.4	69.4
1987	23.9	33.9	53.9	67.4	76.1	76.4	115.5
1988	19.2	26.8	42.9	52.3	60.0	56.6	82.8
1989	19.4	24.5	43.3	52.3	58.9	55.2	74.3
1990	20.0	20.8	30.4	33.7	39.8	35.7	49.1
1991	27.0	30.0	49.5	50.3	62.8	60.7	92.8
1992	18.4	23.4	53.1	63.2	83.8	82.4	115.9
1993	17.2	18.1	38.1	40.2	58.6	60.9	89.5
1994	24.6	29.0	59.1	59.5	75.2	78.9	96.6
1995	23.6	33.2	63.7	63.5	68.0	80.0	100.8
1996	23.4	25.3	40.9	48.4	58.8	56.4	84.1
1997	32.2	36.7	60.1	55.9	86.5	90.3	124.9
1998	20.0	27.1	40.7	44.7	58.0	60.9	87.7
1999	19.7	28.2	38.2	43.5	55.0	52.3	66.0
2000	21.6	26.9	33.9	36.1	56.7	59.1	74.9
2001	16.4	25.0	35.8	35.2	47.7	52.0	65.8

Second half year

	Vessel size (GRT)						
Year	0-50	50-100	100-150	150-200	200-250	250-300	>300
1982	-	20.3	37.5	40.5	-	27.9	-
1983	15.1	21.3	25.1	32.4	45.4	34.0	34.7
1984	12.7	16.4	26.9	34.2	36.5	40.2	40.9
1985	13.2	19.5	26.0	35.8	36.2	38.2	39.4
1986	18.4	25.2	32.5	44.5	45.8	51.8	55.5
1987	16.2	22.6	41.4	45.8	49.3	45.6	75.4
1988	18.8	29.3	29.9	31.1	38.6	31.1	44.0
1989	26.7	26.2	27.0	38.3	38.0	29.3	40.4
1990	27.9	32.8	36.4	41.3	48.3	45.2	42.7
1991	21.4	26.8	41.8	49.4	65.1	53.7	98.3
1992	21.3	28.7	36.7	42.6	44.8	39.1	58.3
1993	20.2	22.7	30.8	35.6	45.3	39.3	51.8
1994	28.6	38.9	50.4	54.3	60.7	56.9	65.2
1995	28.6	42.2	50.2	53.3	72.4	60.8	73.9
1996	22.9	23.3	56.3	69.4	81.0	87.5	123.6
1997	22.9	25.9	35.5	41.7	54.8	51.0	74.9
1998	12.8	17.9	19.1	36.5	36.5	32.7	40.0
1999	-	-	-	26.2	34.3	33.9	37.2
2000	18.7	19.6	30.6	29.4	38.1	36.9	53.0
2001	19.7	32.7	46.0	56.3	59.5	56.4	77.4

CPUE data for the 0-150 GRT groups in 1999, second half year have not been used as effort has been less than totally 7 fishing days

Table 13.1.3.4 SANDEEL North Sea, Danish cpue data. Parameter estimates from regressions of ln(Av. cpue) versus ln(Av. GRT) by year together with estimates of standardized cpue (200 GRT)

$$cpue = b * GRT^a$$

Northern North Sea

	Jan-Jun				Jul-Dec			
Year	**SLOPE**	**INTERCEPT**	**R-square**	**cpue**	**SLOPE**	**INTERCEPT**	**R-square**	**cpue**
1987	0.57	3.60	0.98	75.2	0.20	11.22	0.58	31.9
1988	0.48	3.58	0.95	46.4	0.36	5.06	0.96	33.9
1989	0.55	2.54	0.98	47.5	0.23	8.11	0.87	27.3
1990	0.33	5.13	0.95	29.4	0.33	6.37	0.89	37.3
1991	0.52	2.99	0.97	46.5	0.58	2.31	0.99	49.4
1992	0.55	2.55	0.94	47.0	0.41	5.05	0.96	43.7
1993	0.54	2.40	0.97	40.9	0.43	3.86	0.90	37.4
1994	0.54	4.02	0.96	70.3	0.45	5.20	0.98	56.1
1995	0.54	3.36	0.99	57.8	0.45	5.15	1.00	55.5
1996	0.44	3.72	0.95	38.9	0.43	4.30	0.96	42.3
1997	0.47	5.11	0.95	62.6	0.40	4.24	0.96	35.6
1998	0.54	2.66	0.97	45.9	0.44	2.73	0.89	27.7
1999	0.33	6.78	0.76	39.3	0.33	5.75	0.79	33.2
2000	0.49	3.49	0.97	47.9	0.37	5.26	0.80	37.2
2001	0.33	6.60	0.92	38.3	0.35	7.33	0.90	47.3

Southern North Sea

	Jan -Jun				Jul-Dec			
Year	**SLOPE**	**INTERCEPT**	**R-square**	**cpue**	**SLOPE**	**INTERCEPT**	**R-square**	**cpue**
1987	0.58	3.28	0.97	71.7	0.55	2.54	0.95	47.4
1988	0.55	3.00	0.97	54.7	0.27	8.17	0.91	34.4
1989	0.53	3.18	0.96	52.6	0.15	15.33	0.69	33.7
1990	0.34	5.93	0.92	35.8	0.20	14.18	0.94	41.8
1991	0.45	5.54	0.93	58.8	0.54	3.23	0.93	56.3
1992	0.74	1.41	0.96	70.6	0.34	6.85	0.95	42.5
1993	0.64	1.67	0.93	51.0	0.37	5.56	0.94	38.5
1994	0.55	3.60	0.96	67.8	0.32	10.23	0.99	55.6
1995	0.55	3.71	0.97	69.6	0.36	8.88	0.97	60.1
1996	0.48	4.14	0.93	53.3	0.68	1.97	0.93	73.8
1997	0.51	5.17	0.92	76.7	0.44	4.67	0.93	48.3
1998	0.54	3.06	0.96	54.1	0.47	2.61	0.93	30.9
1999	0.46	4.19	0.98	48.5	0.52	1.86	0.91	29.4
2000	0.47	3.99	0.93	48.7	0.38	4.81	0.91	35.4
2001	0.51	2.92	0.98	44.5	0.50	3.87	0.98	56.0

Tabel 13.1.3.5 SANDEEL in the Northern North Sea. Fishing effort (days fishing times scaling factors for each vessel category to represent days fishing for a vessel of 200 GRT)

	Norweigian			Danish			Total	Derived
Year	Standardized Fishing days	Catch sampled for fishing effort ('000t)	CPUE (t/day)	Catch sampled for fishing effort ('000 t)	CPUE (t/day)	Mean CPUE (t/day)	internat. catch ('000t)	internat. effort ('000 days)
				First half-year				
1976	593	11.1	18.7	-	-	18.7	110.3	5.90
1977	2061	50.4	24.4	-	-	24.5	276.0	11.27
1978	1761	44.9	25.5	-	-	25.5	109.7	4.30
1979	1451	29.6	20.4	-	-	20.4	47.7	2.34
1980	2733	112.8	41.3	-	-	41.3	220.9	5.35
1981	1804	42.8	23.7	-	-	23.7	93.3	3.94
1982	1231	26.9	21.9	13.5	34.9	26.2	62.3	2.38
1983	338	8.7	25.7	17.4	28.9	27.8	54.5	1.96
1984	139	3.5	25.2	54.1	41.2	40.2	74.1	1.84
1985	382	8.7	22.8	47.4	46.7	43.0	69.9	1.63
1986	1565	60.4	38.6	154.1	54.7	50.2	221.3	4.41
1987	2235	122.9	55.0	213.2	75.2	67.8	360.9	5.32
1988	3599	143.8	40.0	158.1	46.4	43.3	332.0	7.66
1989	4200	146.9	35.0	267.3	47.5	43.1	435.2	10.11
1990	2304	58.6	25.4	94.9	29.4	27.9	148.7	5.34
1991	1748	67.7	38.7	210.6	46.5	44.6	282.2	6.33
1992	1217	53.7	44.1	124.0	47.0	46.1	151.2	3.28
1993	1579	70.7	44.8	133.8	40.9	42.2	189.0	4.48
1994	2709	130.1	48.0	299.6	70.3	63.6	413.4	6.50
1995	3442	208.6	60.6	143.2	57.8	59.5	348.5	5.86
1996	2034	100.9	49.6	107.1	38.9	44.1	203.1	4.61
1997	3493	254.9	73.0	207.4	62.6	68.3	456.5	6.68
1998	2623	220.8	84.2	144.2	45.9	69.1	364.8	5.28
1999	2158	77.4	35.9	49.1	39.3	37.2	137.2	3.68
2000	2299	104.5	45.5	163.1	47.9	47.0	271.1	5.77
2001	648	44.6	68.8	67.5	38.3	50.4	88.5	1.75
				Second half-year				
1976	108	2.0	18.5	-	-	18.5	44.9	2.43
1977	445	11.8	26.5	-	-	26.5	110.0	4.15
1978	811	22.5	27.6	-	-	27.8	53.3	1.92
1979	1688	52.2	30.9	-	-	30.9	147.7	4.78
1980	1117	33.1	29.6	-	-	29.5	71.1	2.41
1981	398	7.9	19.6	-	-	19.9	44.9	2.26
1982	-	-	-	1.8	32.3	33.0	12.0	0.36
1983	65	2.4	36.9	12.3	36.6	37.3	23.7	0.64
1984	-	-	-	10.7	29.6	30.2	17.7	0.59
1985	-	-	-	16.4	38.0	38.8	16.8	0.43
1986	555	21.8	39.3	96.1	60.2	57.4	153.8	2.68
1987	1585	68.1	43.0	5.5	31.9	42.1	76.9	1.83
1988	922	26.9	29.2	41.5	33.9	32.0	71.4	2.23
1989	589	11.5	19.5	44.9	27.3	25.7	57.2	2.23
1990	718	22.8	31.8	65.8	37.3	35.9	70.8	1.97
1991	942	30.3	32.2	96.0	49.4	45.3	90.7	2.00
1992	24	1.5	63.6	48.0	43.7	44.3	25.5	0.58
1993	972	30.7	31.6	59.4	37.4	35.4	87.0	2.46
1994	785	35.7	45.5	90.8	56.1	53.1	76.4	1.44
1995	1018	53.3	52.3	77.6	55.5	54.2	72.6	1.34
1996	752	42.9	57.0	93.3	42.3	47.0	140.7	3.00
1997	1545	95.7	61.9	25.7	35.6	56.4	121.5	2.16
1998	2265	114.4	50.5	34.6	27.7	45.2	148.5	3.28
1999	1638	77.8	47.5	43.7	33.2	42.3	125.2	2.96
2000	-	-	-	20.7	37.2	37.2	10.0	0.27
2001	1497	122.0	81.6	49.9	47.3	71.7	153.8	2.15

Table 13.3.6 Sandeels Southern North Sea. Derived standardized international effort calculated from total catches and standardized CPUE based on Danish and Norweigian data (from 1999-)

	First half year			Second half year		
Year	CPUE (t/day)	Total Int'l catch ('000 t)	Total int'l effort ('000 days)	CPUE (t/day)	Total Int'l catch ('000 t)	Total int'l effort ('000 days)
1982	48.2	427	8.85	35.7	52.6	1.47
1983	42.8	360	8.41	33.9	59.3	1.75
1984	50.5	461	9.13	32.9	71.1	2.16
1985	41.9	417	9.95	33.6	110.6	3.29
1986	53.7	386	7.20	44.1	75.5	1.71
1987	71.7	298	4.15	47.4	105.1	2.22
1988	54.7	462	8.45	34.4	33.4	0.97
1989	52.6	506	9.62	33.7	18.5	0.55
1990	35.8	342	9.54	41.8	24.0	0.57
1991	58.8	327	5.55	56.3	132.3	2.35
1992	70.6	621	8.80	42.5	73.0	1.72
1993	51.0	268	5.25	38.5	34.2	0.89
1994	67.8	226	3.34	55.6	47.6	0.86
1995	69.6	429	6.17	60.1	67.6	1.12
1996	53.3	293	5.49	73.8	138.7	1.88
1997	76.7	421	5.49	48.3	138.2	2.86
1998	54.1	448	8.28	30.9	42.8	1.39
1999	48.5	432	8.91	29.4	35.9	1.22
2000	48.9	360	7.36	35.4	53.0	1.50
2001	45.8	433	9.45	56.0	184.8	3.30

Table 13.1.3.7. SANDEEL in the North Sea. Tuning datal.
Total international standadized effort and catch at age numbers (millions).

Year	Effort	Age 0	Age 1	Age 2	Age 3	Age 4+	Effort	Age 0	Age 1	Age 2	Age 3	Age 4+
Northen North Sea, 1st half-year							**Southern North Sea, 1st half-year**					
1976	5.90	237	5697	1130	445	155						
1977	11.27	3686	24307	2351	516	144						
1978	4.30	0	6127	2338	573	144						
1979	2.34	0	2335	1328	242	12						
1980	5.35	17	13394	8865	1050	827						
1981	3.94	17	5505	4109	904	174						
1982	2.38	2	3518	2132	556	85	8.85	242	56545	6224	3277	1939
1983	1.96	0	5684	1215	89	12	8.41	955	2232	35029	934	387
1984	1.84	0	11692	1647	153	5	9.13	20	62517	2257	13272	442
1985	1.63	1	2688	3292	1002	480	9.95	6573	7790	39301	2490	265
1986	4.41	7	23934	2600	200	0	7.20	0	43629	7333	1604	30
1987	5.32	0	26236	10855	350	155	4.15	0	4351	22771	1158	165
1988	7.66	2453	9855	25922	1319	26	8.45	1420	2349	10074	17914	2769
1989	10.11	6124	56661	2219	3385	0	9.62	29	44444	4525	957	3368
1990	5.34	0	13101	3907	578	175	9.54	0	20179	16670	2467	745
1991	6.33	0	41855	2342	908	318	5.55	0	20058	9224	1320	454
1992	3.28	137	9871	4056	486	305	8.80	2	60337	10021	1002	621
1993	4.48	1112	15768	2635	1023	646	5.25	0	3581	14659	3707	1012
1994	6.50	398	28490	7225	5954	2156	3.34	0	24697	2594	2654	715
1995	5.86	0	36140	3360	1091	145	6.17	0	39060	6503	1531	1226
1996	4.61	0	11524	5385	761	301	5.49	0.0	10194	16015	6403	1169
1997	6.68	2434	67038	3640	5254	1206	5.49	0.0	52359	3648	2405	683
1998	5.28	2278	6667	33216	2039	410	8.28	56.6	9546	39553	3188	2260
1999	3.68	265	2118	3491	5086	1023	8.91	0.0	31951	6499	13150	947
2000	5.77	0	22887	8810	1420	1470	7.36	1126	35613	5973	1825	3528
2001	1.75	87	6434	2408	472	1035	9.46	579	64084	13531	1158	2389
Northern North Sea, 2nd half-year							**Southern North Sea, 2nd half-year**					
1976	2.43	6126	648	84	368	36.6						
1977	4.15	3067	2856	913	142	141.1						
1978	1.92	7820	1001	307	39	1.9						
1979	4.78	44203	1310	433	66	9.5						
1980	2.41	8349	1173	214	19	7.5						
1981	2.26	9128	346	94	14	6						
1982	0.36	6530	65	0	0	0	1.47	5039	4718	490	344	40
1983	0.64	7911	303	316	19	0	1.75	9298	240	2806	513	2
1984	0.59	0	1207	121	43	0	2.16	0	9423	92	577	43.8
1985	0.43	349	109	239	89	11	3.29	11940	1896	3229	2234	298
1986	2.68	7105	7077	473	0	0	1.71	112	5350	293	241	18
1987	1.83	455	5768	198	0	0	2.22	298	3095	6664	196	51
1988	2.23	13196	1283	340	119	17	0.97	0	0	234	2084	68
1989	2.23	3380	4038	274	0	0	0.55	1	1619	165	35	123
1990	1.97	12107	1670	342	51	15	0.57	597	1438	477	71	21
1991	2.00	13616	866	28	8	3	2.35	12115	11411	344	111	0
1992	0.58	6797	48	3	0	0	1.72	134	3903	382	157	34
1993	2.46	26960	1004	112	34	22	0.89	838	1037	953	266	87
1994	1.44	457	829	1211	396	24.7	0.86	0	4093	322	198	137
1995	1.34	4046	3374	338	26	2	1.12	0	3166	2789	307	157
1996	3.00	31817	1706	1772	136	55.3	1.88	2088	2031	4080	536	1023
1997	2.16	2431	11346	633	25	1.9	2.86	198	15238	536	406	136
1998	3.28	35220	10005	1837	79	0.6	1.39	1142	738	2673	209	65
1999	2.96	33653	694	551	58	0.0	1.22	1322	203	58	1392	166
2000	0.27	0	467	84	24	46.1	1.50	6659	3601	496	339	330
2001	2.15	46385	771	73	134	0	3.30	73443	819	15	0	0

Table 13.1.4.1 SANDEEL in the North Sea. Tuning diagnostics

```
PLEASE NOTE: Due to the very high stock numbers  there were format errors in
"Estimated survivors". For the production of this output,catch data have been
given as millions (normally thousands)


Lowestoft VPA Version 3.1

   17/06/2002   9:02

 Extended Survivors Analysis

 Sandeel in IV

 cpue data from file fleet.dat

 Catch data for  19 years. 1983 to 2001. Ages  0 to   4.

      Fleet             First  Last  First  Last  Alpha   Beta
                         year  year   age    age
 North IV 1.half year    1983  2001    1      3    .250    .500
 South IV 1.half year    1983  2001    1      3    .250    .500
 North IV 2.half year    1983  2001    0      3    .500    .750
 South IV 2.half year    1983  2001    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


 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   1992   1993   1994   1995   1996   1997   1998   1999   2000   2001

      0   .030   .053   .001   .016   .024   .011   .139   .082   .016   .034
      1   .441   .296   .370   .478   .321   .332   .383   .495   .540   .633
      2   .429   .412   .598   .286   .690   .369   .719   .600  1.175   .600
      3   .576   .415   .627   .497   .447   .772   .757   .670   .713   .632
```

Table 13.1.4.1 cont'd

XSA population numbers (Thousands)

YEAR	AGE 0	1	2	3
1992	3.49E+05	3.79E+05	5.59E+04	5.07E+03
1993	8.03E+05	1.52E+05	7.34E+04	2.00E+04
1994	8.80E+05	3.42E+05	3.40E+04	2.67E+04
1995	3.82E+05	3.95E+05	7.11E+04	1.03E+04
1996	2.15E+06	1.69E+05	7.38E+04	2.93E+04
1997	3.48E+05	9.41E+05	3.70E+04	2.03E+04
1998	4.18E+05	1.54E+05	2.03E+05	1.40E+04
1999	6.60E+05	1.63E+05	3.17E+04	5.44E+04
2000	6.33E+05	2.73E+05	3.00E+04	9.55E+03
2001	5.34E+06	2.80E+05	4.79E+04	5.08E+03

Estimated population abundance at 1st Jan 2002

0.00E+00 2.32E+06 4.48E+04 1.44E+04

Taper weighted geometric mean of the VPA populations:

6.78E+05 2.51E+05 5.26E+04 1.33E+04

Standard error of the weighted Log(VPA populations) :

.7623 .6143 .6323 .7911

Log catchability residuals.

Fleet : North IV 1.half year

Age	1983	1984	1985	1986	1987	1988	1989	1990	1991
0	No data for this fleet at this age								
1	.64	.21	-.02	-.54	.24	-.12	.39	.28	.50
2	-1.45	.42	.69	.05	-.48	1.33	-.80	.03	-.15
3	-.73	-2.24	1.22	-1.32	-.99	-1.83	1.14	-.29	-.13

Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
0	No data for this fleet at this age									
1	-.50	.51	-.05	.18	.08	-.24	-.49	-1.29	.14	.07
2	.04	-.98	.50	-1.02	-.19	-.38	.49	.41	1.15	.37
3	.37	-.62	.56	-.14	-1.32	.73	.39	.27	.30	1.00

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

Age	1	2	3
Mean Log q	-3.7293	-3.4733	-3.4733
S.E(Log q)	.4629	.7348	1.0261

Table 13.1.4.1 cont'd

Regression statistics :

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

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
1	1.11	-.562	2.74	.59	19	.53	-3.73
2	1.36	-.957	.84	.30	19	1.00	-3.47
3	1.92	-1.672	-1.69	.16	19	1.84	-3.66

Fleet : South IV 1.half year

Age	1983	1984	1985	1986	1987	1988	1989	1990	1991
0	No data for this fleet at this age								
1	-1.46	.53	-.52	-.17	-1.05	-1.39	.46	.40	.15
2	.13	-1.23	.99	.24	.15	-.06	-.39	.55	.99
3	-.16	.26	-.05	-.08	.09	.34	-.41	.24	.02

Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
0	No data for this fleet at this age									
1	.59	-.86	.76	.48	.05	-.02	-.31	.80	.61	.95
2	-.38	.23	-.20	-.76	.37	-.53	-.14	-.21	.17	.06
3	-.23	.15	.08	-.19	.29	-.20	.04	-.01	-.04	-.14

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

Age	1	2	3
Mean Log q	-3.9974	-3.1272	-3.1272
S.E(Log q)	.7476	.5450	.1999

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	.64	2.201	7.07	.68	19	.43	-4.00
2	.89	.575	3.95	.63	19	.50	-3.13
3	.87	3.121	3.97	.97	19	.14	-3.13

Fleet : North IV 2.half year

Age	1983	1984	1985	1986	1987	1988	1989	1990	1991
0	.95	99.99	-2.25	-.28	-1.63	.35	-.19	.42	.36
1	.20	.39	-.54	.03	1.12	.40	.73	.58	-.85
2	.22	.64	1.54	.67	-1.63	.30	.43	.51	-1.51
3	.75	-.59	2.15	99.99	99.99	-1.12	99.99	.13	-1.91

Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
0	1.79	.92	-2.70	.39	-.10	-.53	1.62	1.18	99.99	-.29
1	-2.77	-.34	-.71	.69	-.08	.43	1.73	-.83	.69	-.85
2	-3.69	-1.78	2.07	-.06	.97	.76	-.08	.60	1.53	-1.51
3	99.99	-1.66	1.21	-.56	-.83	-1.62	-.53	-2.15	1.12	1.36

Table 13.1.4.1 cont'd

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	-4.6971	-4.6699	-4.9963	-4.9963
S.E(Log q)	1.2514	.9819	1.4193	1.3708

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	1.37	-.652	1.46	.17	17	1.74	-4.70
1	1.15	-.329	3.54	.23	19	1.15	-4.67
2	2.20	-1.033	-2.05	.04	19	3.12	-5.00
3	5.73	-2.064	-15.45	.01	15	6.91	-5.28

Fleet : South IV 2.half year

Age	1983	1984	1985	1986	1987	1988	1989	1990	1991
0	1.86	99.99	1.02	-2.12	-.40	99.99	-4.99	.46	1.91
1	-1.59	.69	-.25	-.24	-.16	99.99	.84	1.18	1.09
2	.48	-1.76	1.21	-.17	.86	-.11	.58	1.22	-.01
3	2.12	-.11	2.43	.77	.24	1.70	.81	.84	-.29

Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
0	-1.33	.32	99.99	99.99	-.52	-1.48	.90	.68	2.09	1.59
1	.13	.26	.87	.33	.09	-.02	-.48	-1.63	.56	-1.68
2	-.71	.56	.36	1.39	1.44	-.52	.33	-1.58	.76	-4.34
3	.90	.59	.13	1.25	.18	.05	.48	1.10	1.24	99.99

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

Age	0	1	2	3
Mean Log q	-6.5471	-4.2142	-4.1710	-4.1710
S.E(Log q)	1.8982	.8873	1.3874	1.1155

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	.48	1.896	10.18	.50	15	.83	-6.55
1	.69	1.249	6.76	.51	18	.60	-4.21
2	.60	1.293	6.83	.38	19	.82	-4.17
3	1.22	-.750	2.03	.43	18	.93	-3.37

Table 13.1.4.1 cont'd

Terminal year survivor and F summaries :

Age 0 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	1.	.000	.000	.00	0	.000	.000
South IV 1.half year	1.	.000	.000	.00	0	.000	.000
North IV 2.half year	1726742.	1.288	.000	.00	1	.456	.000
South IV 2.half year	11328460.	1.960	.000	.00	1	.197	.000
F shrinkage mean	1391653.	1.50				.348	.056

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
2319076.	.87	.59	3	.676	.034

Age 1 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	48275.	.475	.000	.00	1	.471	.599
South IV 1.half year	116300.	.767	.000	.00	1	.181	.293
North IV 2.half year	19077.	1.007	.000	.00	1	.105	1.123
South IV 2.half year	16231.	.827	1.435	1.74	2	.155	1.235
F shrinkage mean	69871.	1.50				.089	.449

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
44809.	.34	.39	6	1.138	.633

Age 2 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
North IV 1.half year	18238.	.416	.111	.27	2	.361	.501
South IV 1.half year	17472.	.464	.232	.50	2	.348	.519
North IV 2.half year	15138.	.723	.811	1.12	3	.114	.579
South IV 2.half year	4179.	.741	1.680	2.27	3	.111	1.346
F shrinkage mean	10908.	1.50				.067	.736

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
14435.	.27	.32	11	1.181	.600

Table 13.1.4.1 cont'd

Age 3 Catchability constant w.r.t. time and age (fixed at the value for age) 2

Year class = 1998

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
North IV 1.half year	1803.	.486	.800	1.65	3	.135	.545
South IV 1.half year	1353.	.273	.119	.44	3	.735	.676
North IV 2.half year	3947.	.830	.523	.63	4	.055	.286
South IV 2.half year	893.	.738	.854	1.16	3	.025	.901
F shrinkage mean	1465.	1.50				.050	.638

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
1482.	.23	.16	14	.712	.632

Table 13.1.4.2 SANDEEL in the North Sea. Fishing mortality at age

Fishing mortality (F) at age

YEAR	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
AGE										
0	0.0278	0.0000	0.0123	0.0170	0.0048	0.0258	0.0149	0.0262	0.0445	0.0301
1	0.1619	0.4739	0.2102	0.2468	0.2949	0.2690	0.8548	0.5808	0.5471	0.4412
2	0.5411	0.2361	1.6583	0.6794	0.4285	1.5237	0.5182	1.0963	1.0092	0.4295
3	0.5971	0.6287	1.1571	0.4214	0.3317	0.7258	1.5267	0.7885	0.5081	0.5758
+gp	0.5971	0.6287	1.1571	0.4214	0.3317	0.7258	1.5267	0.7885	0.5081	0.5758
FBAR 1-2	0.3515	0.3550	0.9343	0.4631	0.3617	0.8964	0.6865	0.8386	0.7782	0.4354

YEAR	1993	1994	1995	1996	1997	1998	1999	2000	2001
AGE									
0	0.0531	0.0008	0.0159	0.0239	0.0113	0.1391	0.0823	0.0158	0.0340
1	0.2962	0.3705	0.4780	0.3206	0.3321	0.3829	0.4945	0.5402	0.6330
2	0.4120	0.5980	0.2857	0.6905	0.3694	0.7191	0.6000	1.1754	0.6002
3	0.4155	0.6266	0.4965	0.4473	0.7723	0.7572	0.6705	0.7131	0.6323
+gp	0.4155	0.6266	0.4965	0.4473	0.7723	0.7572	0.6705	0.7131	0.6323
FBAR 1-2	0.3541	0.4843	0.3819	0.5056	0.3508	0.5510	0.5473	0.8578	0.6166

Table 13.1.4.3 SANDEEL in the North Sea. Stock numbers at age

Stock number at age (start of year) Numbers*10**-6

YEAR	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
AGE										
0	937219	267035	1501430	637127	232976	773114	339972	732943	881410	348656
1	103122	409584	119987	666399	281442	104178	338537	150493	320817	378795
2	127150	26418	76804	29288	156816	63118	23976	43373	25357	55912
3	4668	40619	11449	8028	8148	56068	7548	7837	7953	5073
+gp	1152	1355	1934	182	1719	7163	5521	2243	2523	2835
TOTAL	1173313	745010	1711604	1341024	681101	1003641	715554	936888	1238060	791270

YEAR	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
AGE										
0	802584	879747	382363	2145685	347538	417682	660096	633442	5339951	-
1	152015	341991	394990	169095	941391	154397	163303	273156	280160	2319042
2	73391	34047	71115	73767	36961	203426	31710	29997	47935	44808
3	19971	26677	10275	29328	20295	14020	54393	9551	5082	14434
+gp	6772	8399	5074	9191	4824	6604	5627	13535	9419	4229
TOTAL	1054734	1290862	863816	2427065	1351009	796129	915128	959681	5682547	2382512

Table 13.1.4.4 SANDEEL in the North Sea. Stock summary.

Year	Recruitment Age 0 thousands	SSB tonnes	Landings tonnes	Mean F Ages 1-2
1983	937219328	1746479	530640	0.3515
1984	267035072	1054563	750040	0.3550
1985	1501430144	1239700	707105	0.9343
1986	637127296	519749	685950	0.4631
1987	232975712	2177245	791050	0.3617
1988	773113728	1960427	1007304	0.8964
1989	339971808	572160	826835	0.6865
1990	732942592	758347	584912	0.8386
1991	881409536	522139	898959	0.7782
1992	348655904	877877	820140	0.4354
1993	802584256	1403708	576932	0.3541
1994	879747072	988379	770747	0.4843
1995	382363008	1407776	915043	0.3819
1996	2145684608	1356703	776126	0.5056
1997	347538240	692029	1114044	0.3508
1998	417682368	2013825	1000375	0.5510
1999	660095936	1135217	718668	0.5473
2000	633442240	614597	692498	0.8578
2001	5339951000	619656	858619	0.6166
2002		640558*		
Average	961103676	1140030	790841	0.5658

* calculated using the 2001 weight in the stock

Table 13.4.1 Sandeel, Division VIa
Landings (tonnes), 1981-2001, as officially reported to ICES.

Country	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Denmark	-	-	-	-	-	-	-	-	-	-
UK, Scotland	5972	10786	13051	14166	18586	24469	14479	24465	18785	16515
Total	5972	10786	13051	14166	18586	24469	14479	24465	18785	16515

Country	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Denmark	-	-	80	-	-	-	-	-	-	-
UK, Scotland	8532	4935	6156	10627	7111	13257	12679	5320	2627	-
United Kingdom										5771
Total	8532	4935	6236	10627	7111	13257	12679	5320	2627	5771

Country	2001
Denmark	
UK, Scotland	
United Kingdom	295
Total	295

Preliminary data for 2001

Figure 13.1.1.1 Sandeel sampling and aggregation areas used by the Working Group

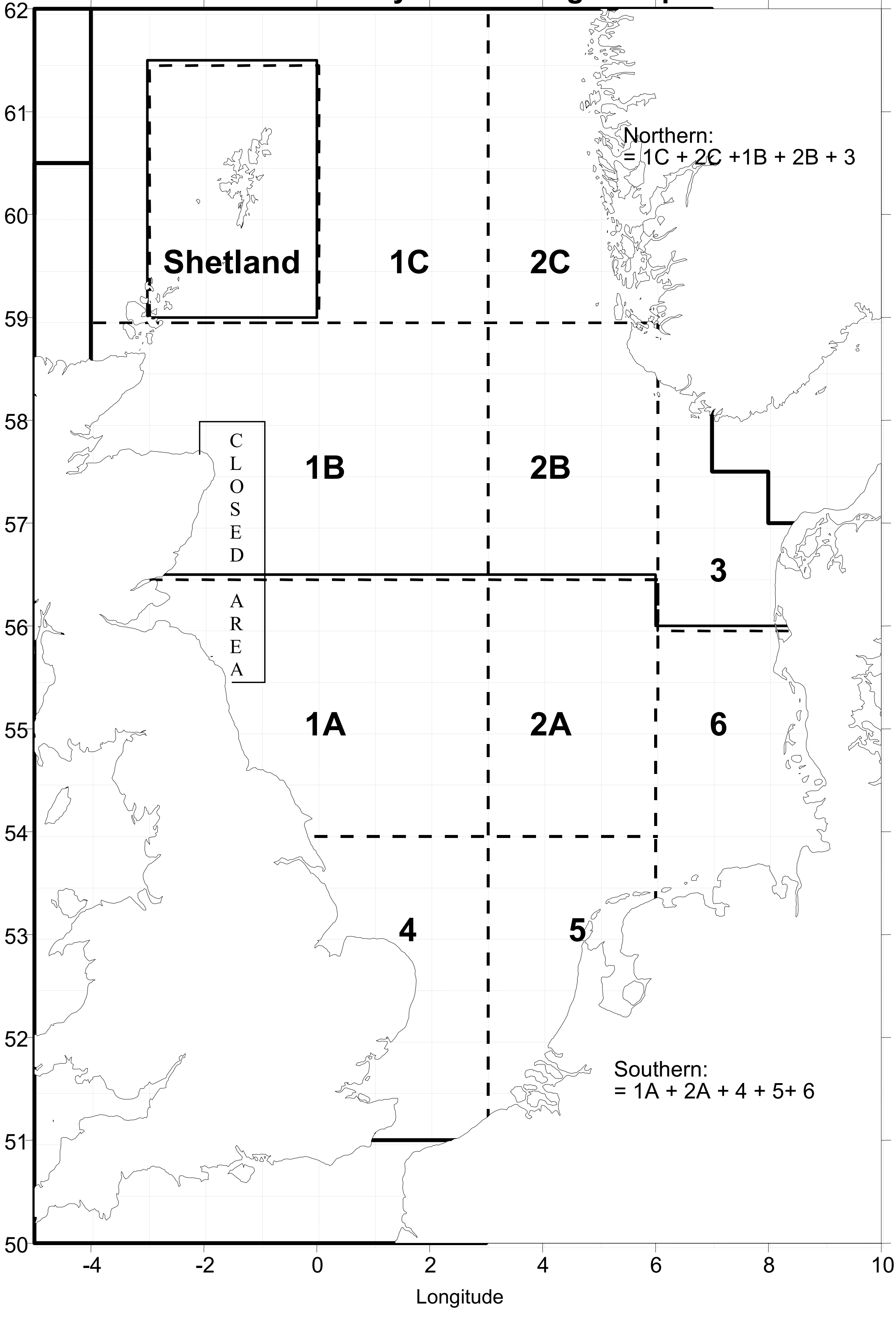
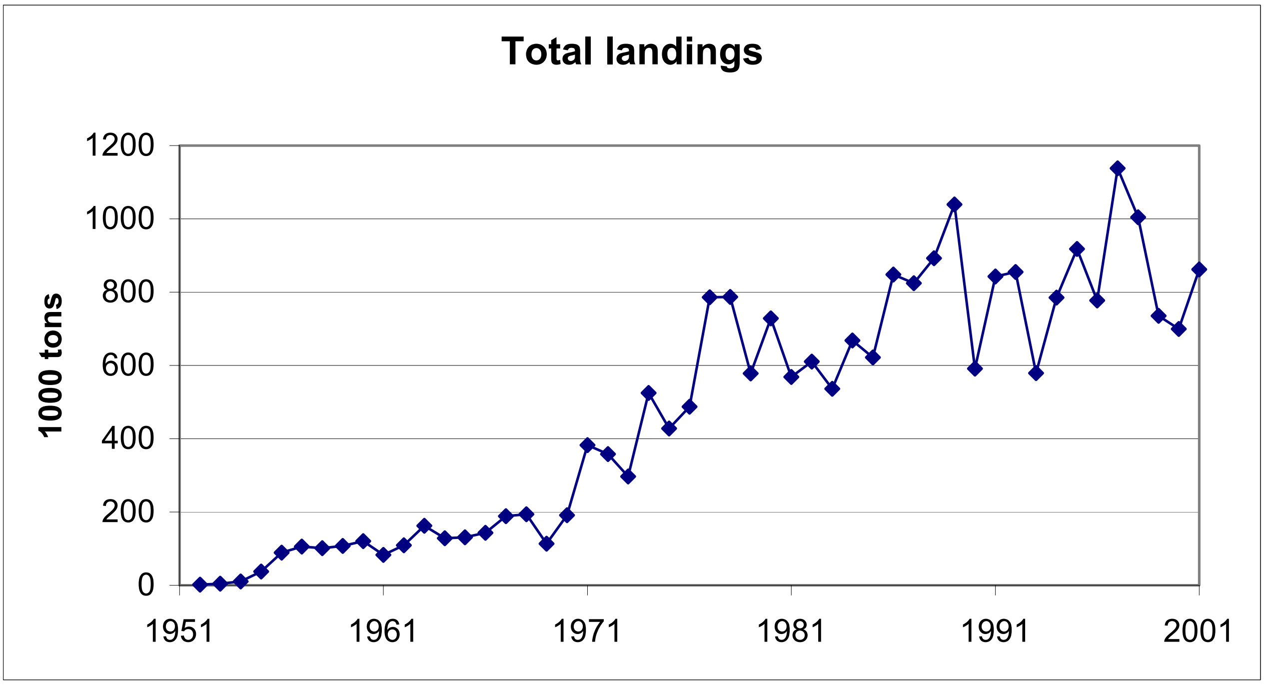


Figure 13.1.1.2 SANDEEL in the North Sea, Total international landings, effort and cpue.



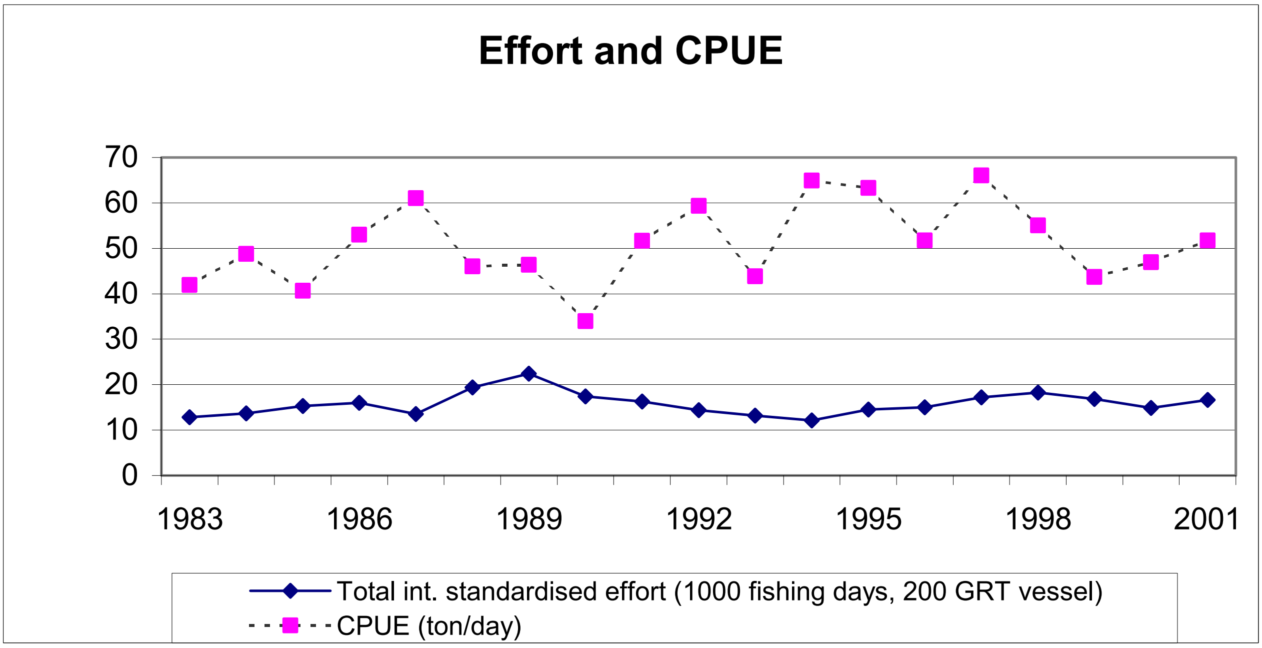
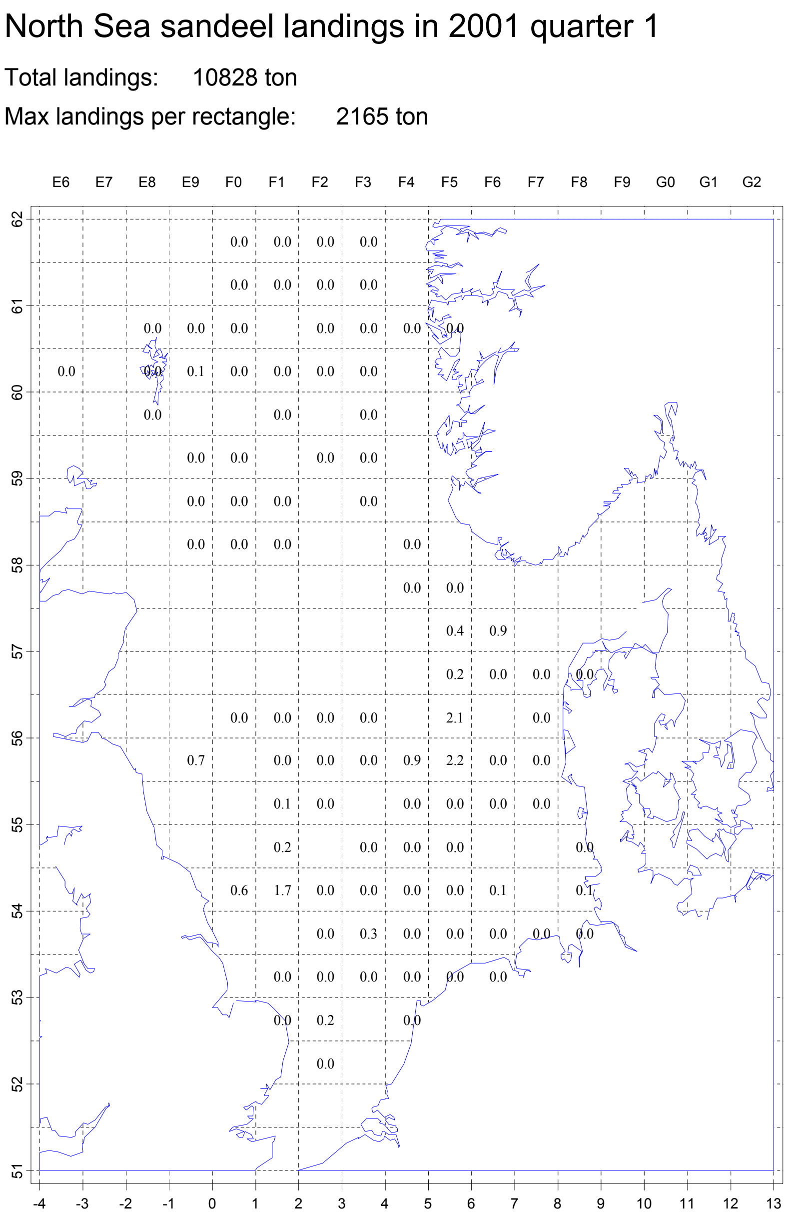


Figure 13.1.1.3 Quarterly catches (Denmark, Norway, and Scotland) of Sandeel by ICES rectangle (‘000 tonnes).



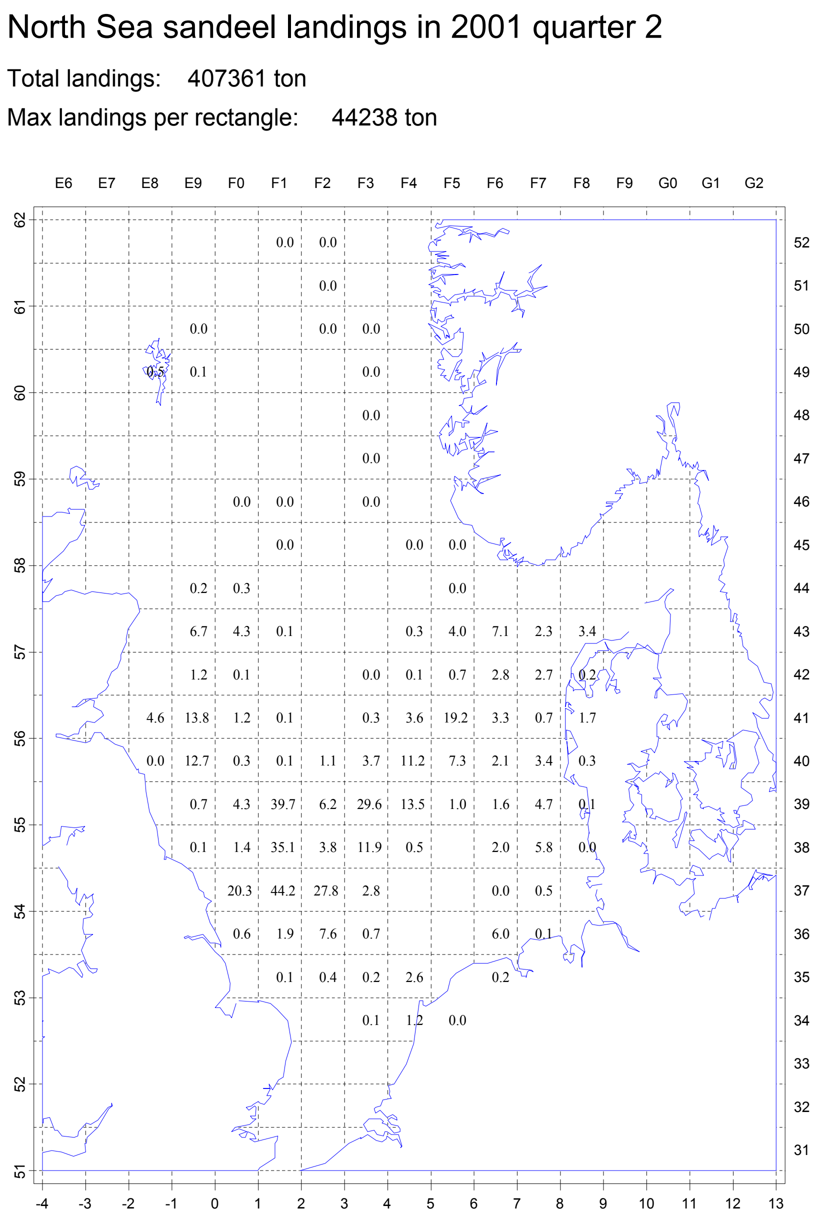
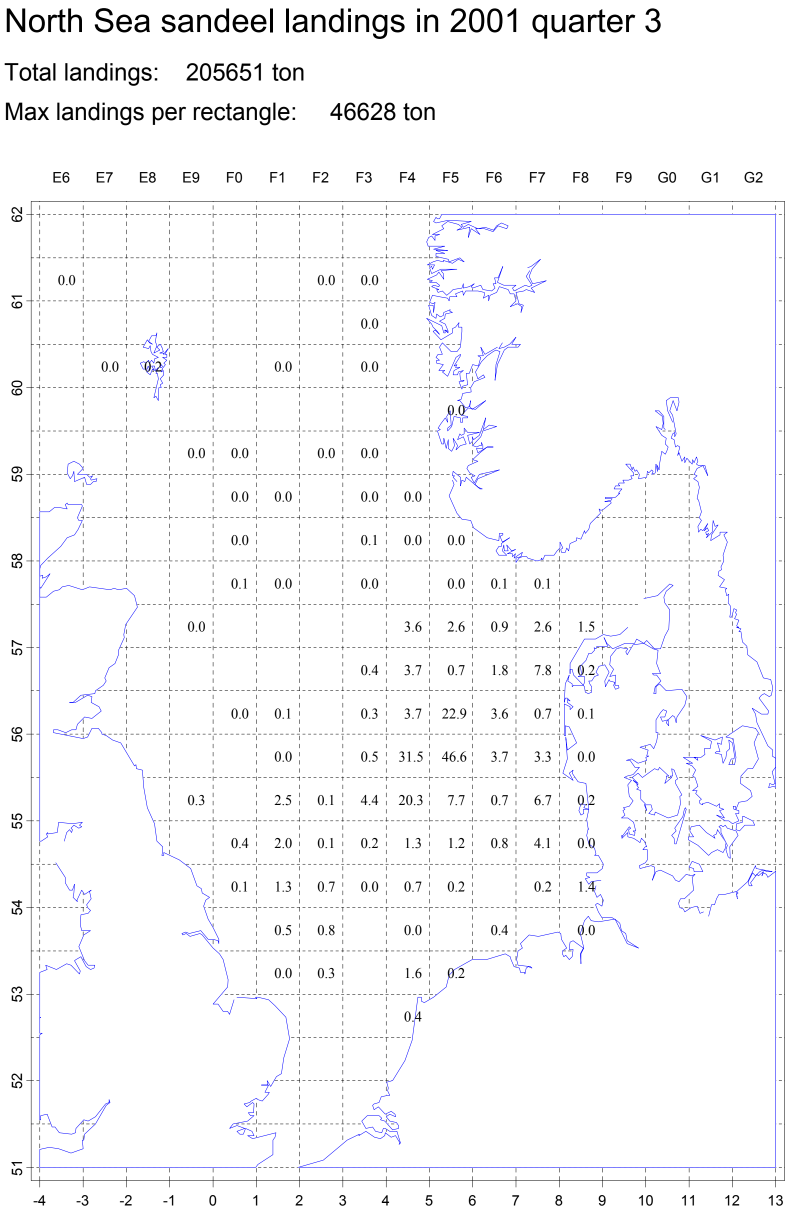


Figure 13.1.1.3 (continued) Quarterly catches of Sandeel by ICES rectangle (‘000 tonnes).



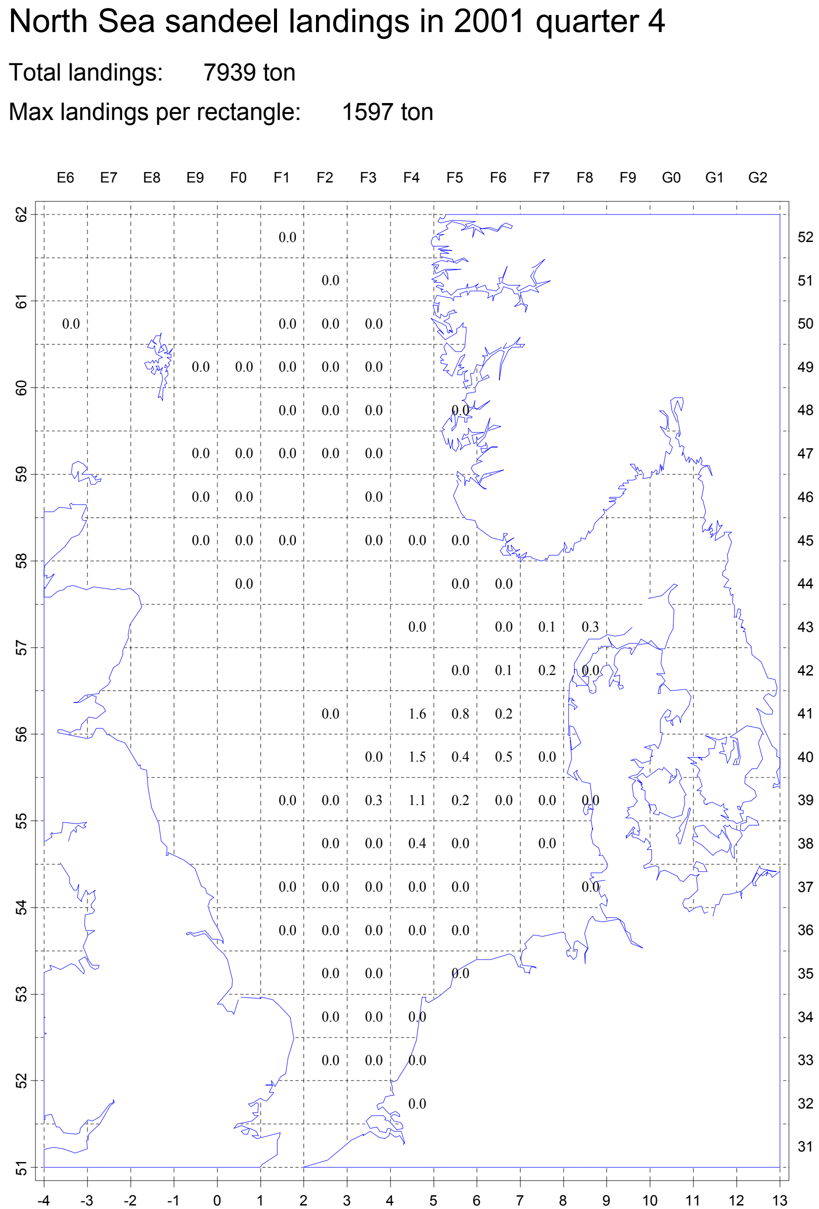


Figure 13.1.3.1 SANDEEL in the North Sea, CPUE (ton/day) by fleet

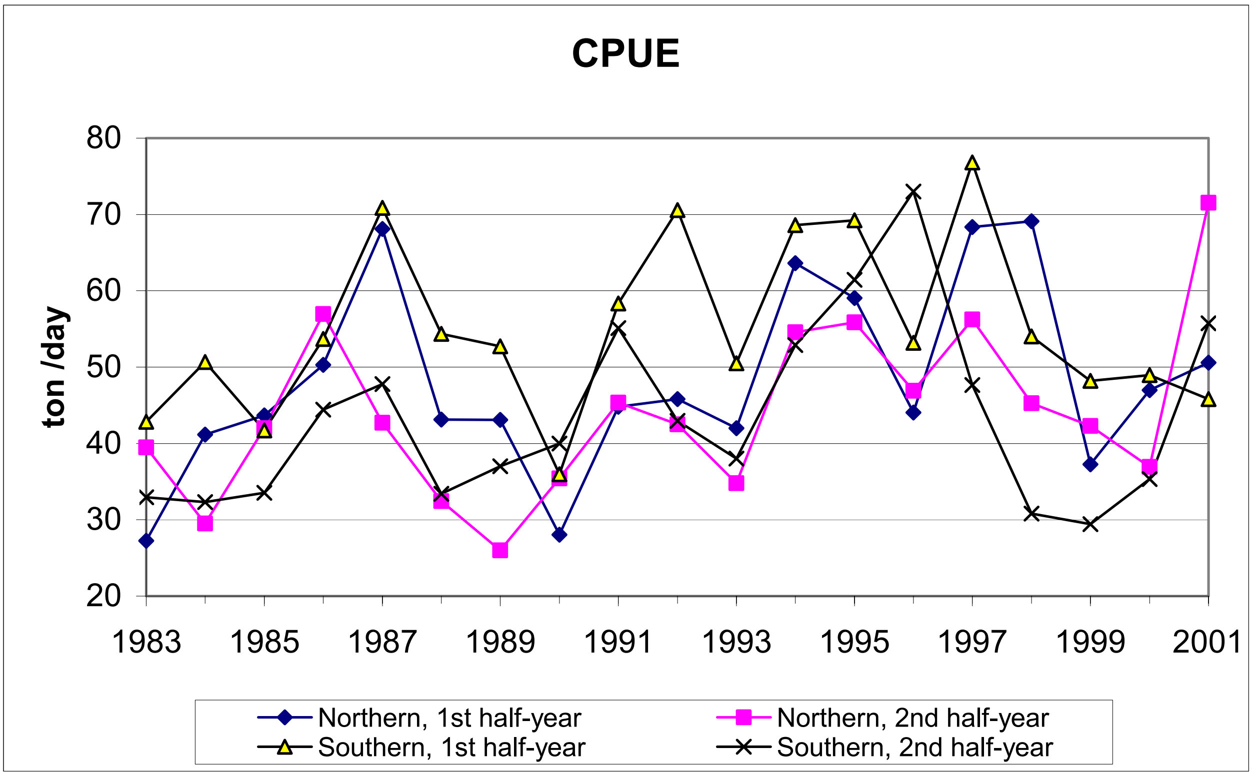


Figure 13.1.3.2 SANDEEL in the North Sea, Normalized CPUE by age group and year

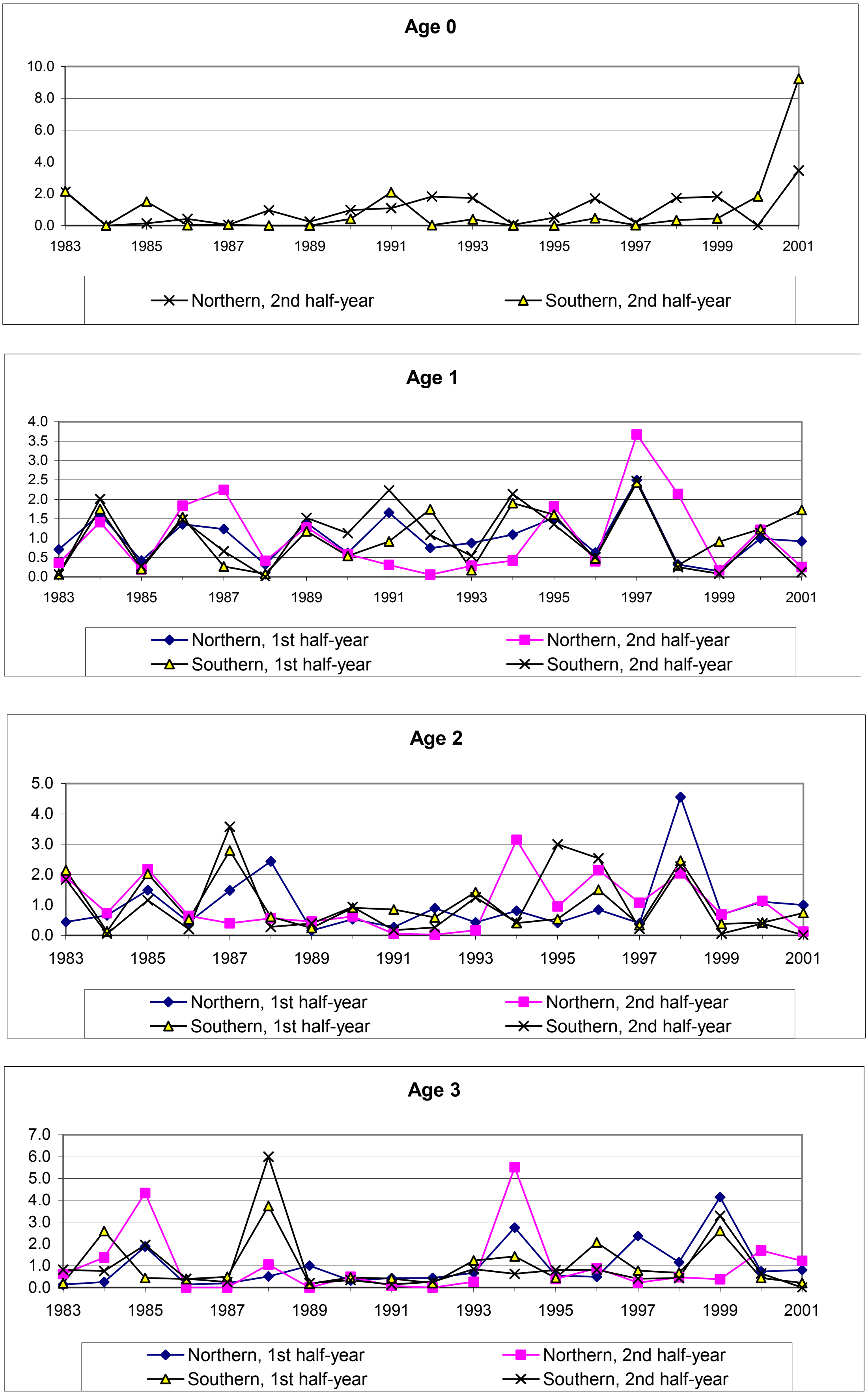


Figure 13.1.4.1 Sandeel in the North Sea. Log catchability residuals by single fleet exploraty runs.

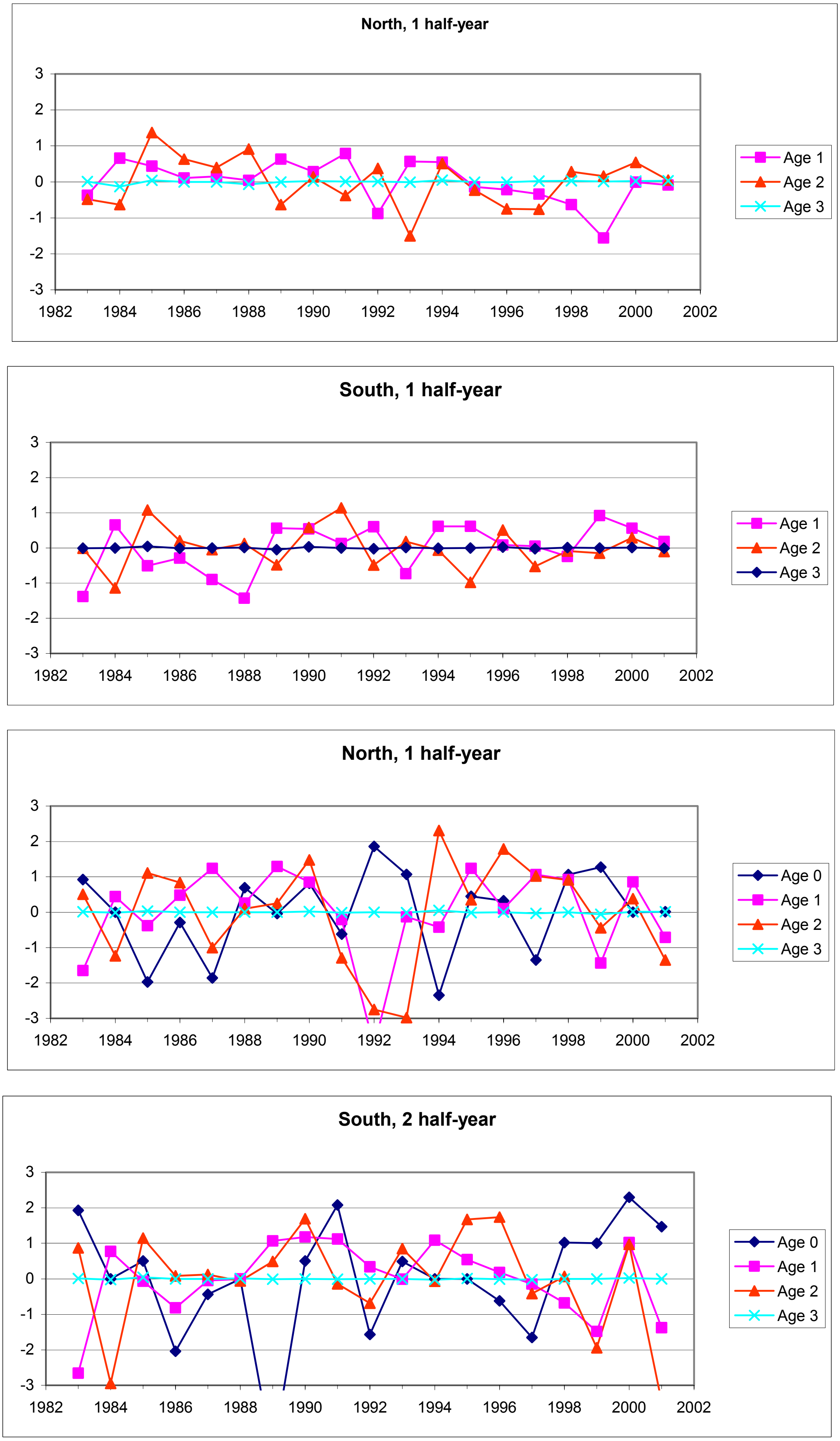
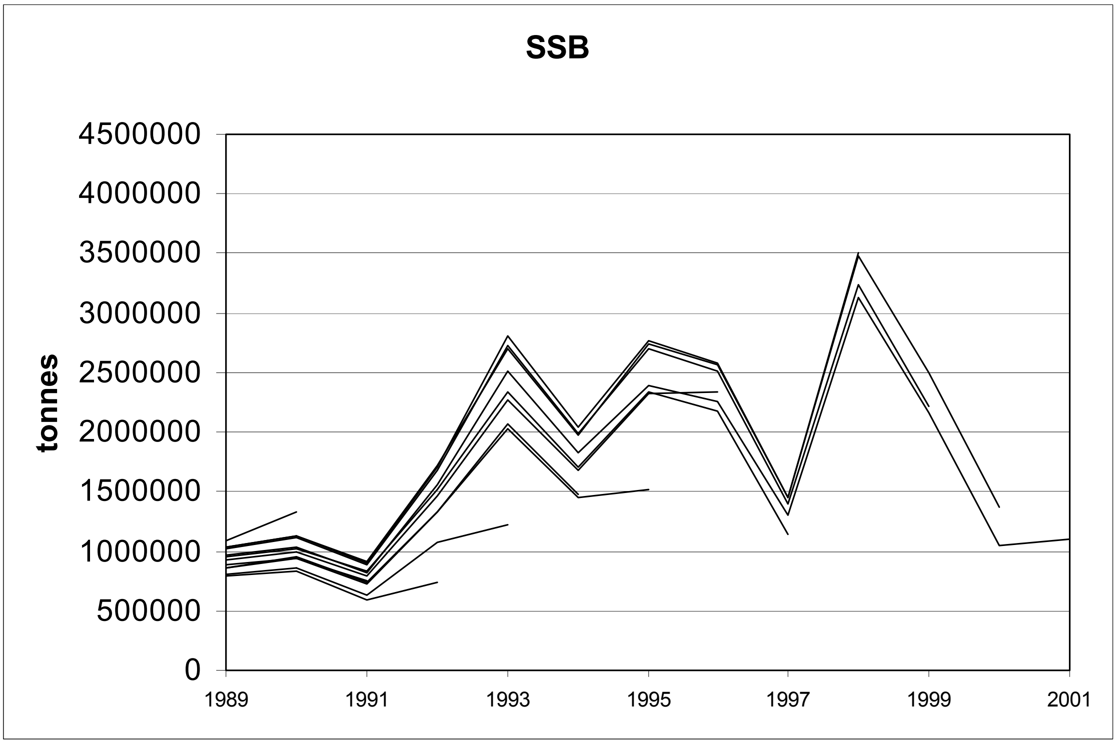


Figure 13.1.4.2 SANDEEL in the North Sea. Retrospective analysis of SSB and recruitment, 1983-2001 (Run 5 F-shrinkage=0.5))



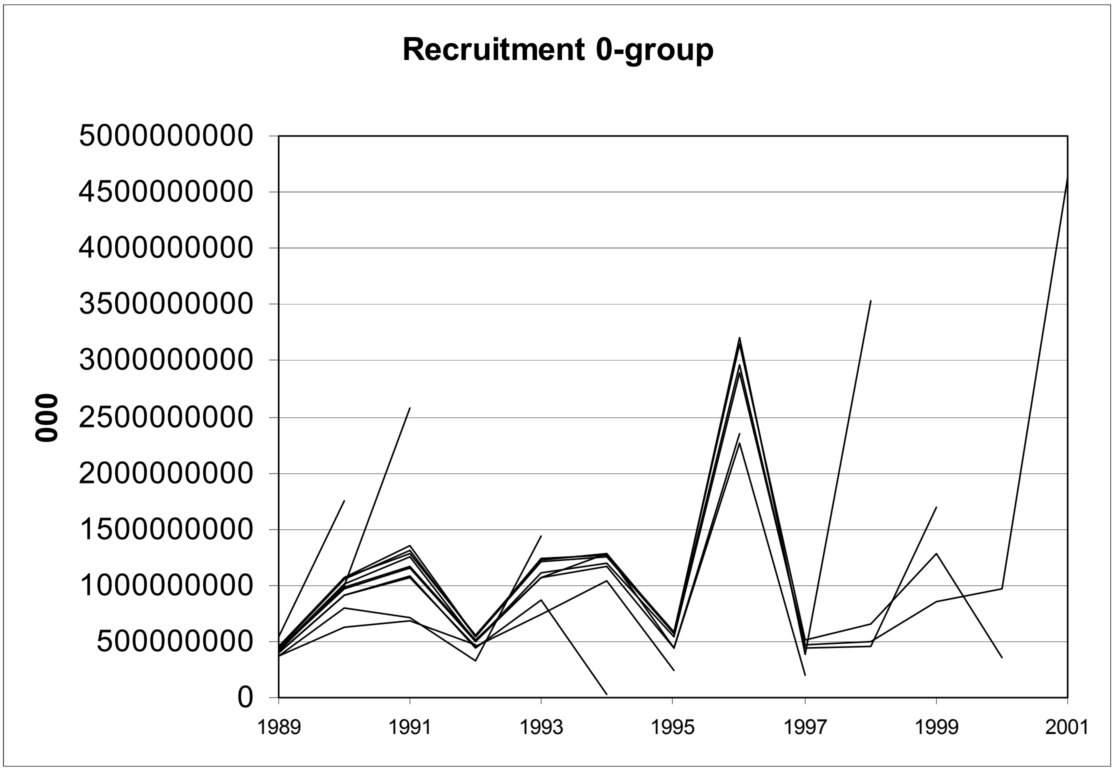


Figure13.1.4.3 Sandeel in the North Sea. Overview of exploratory runs

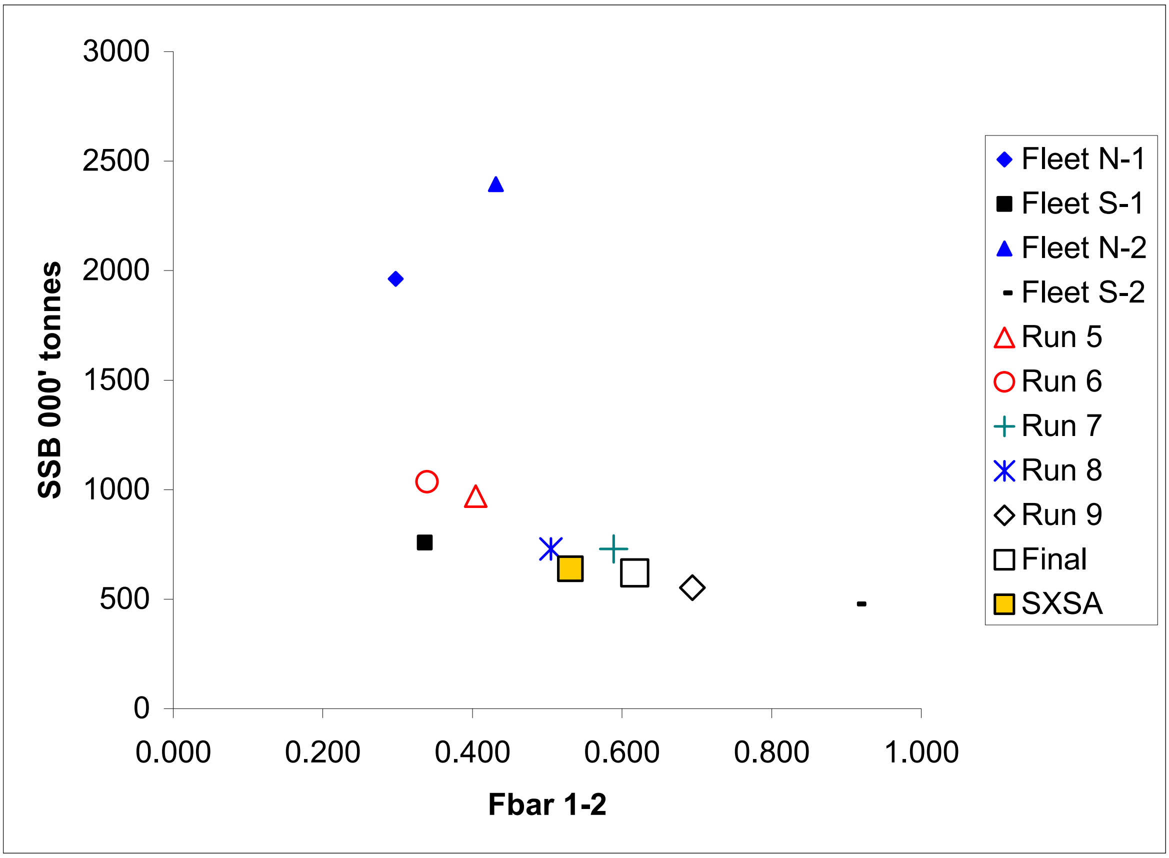
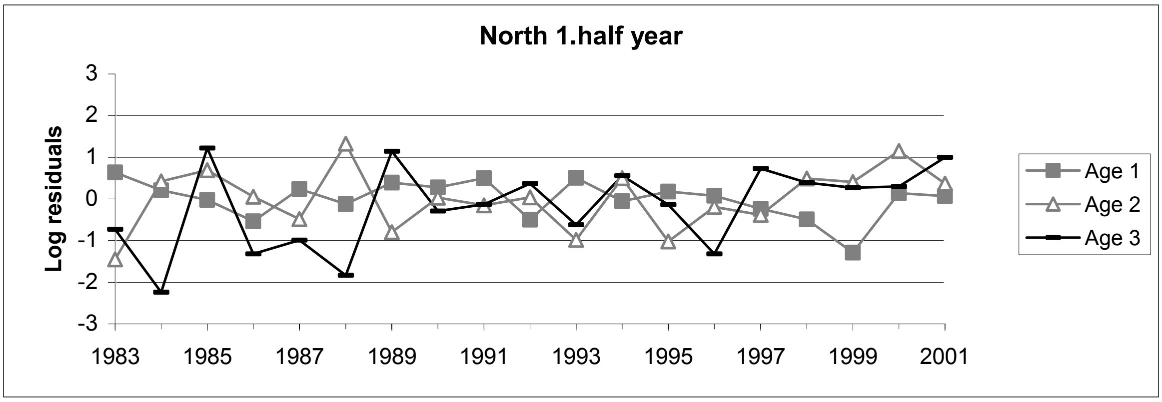
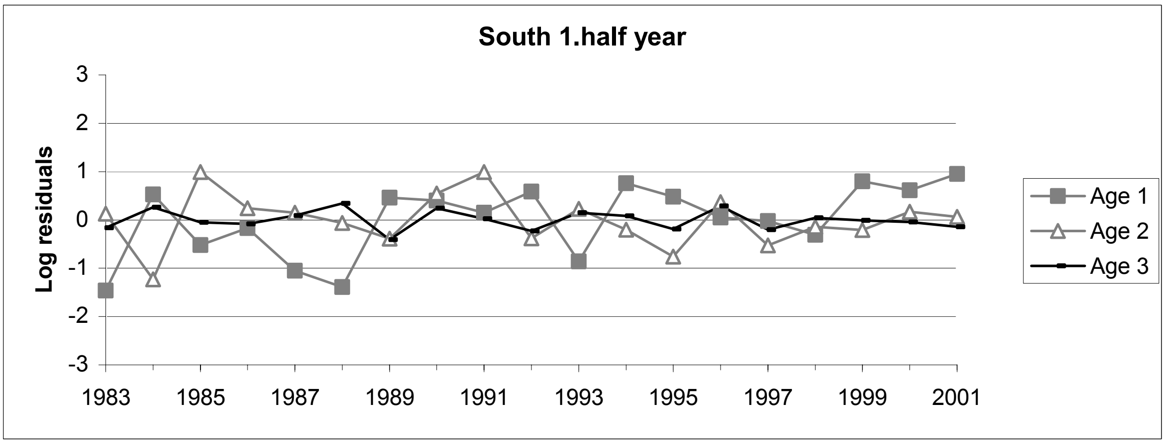
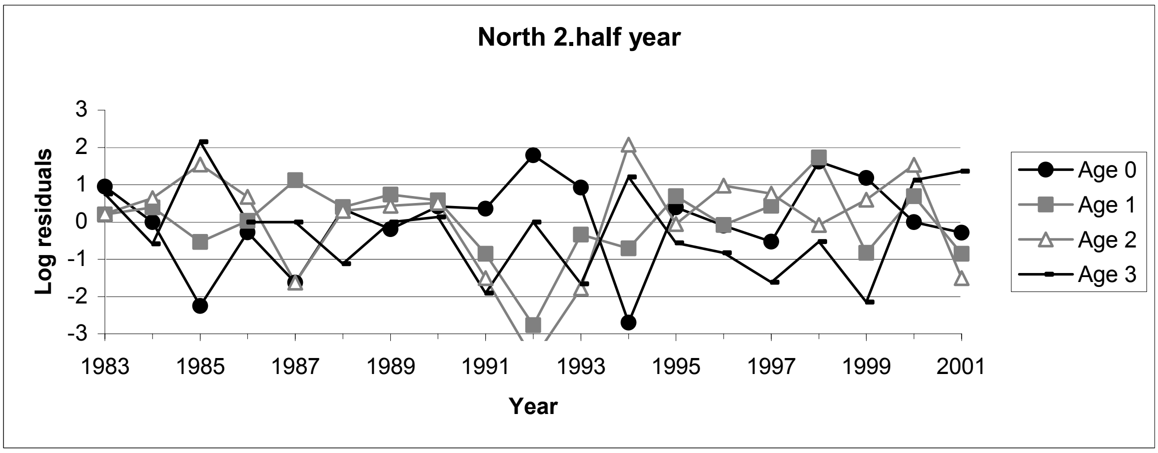


Figure 13.1.4.4 SANDEEL in the North Sea. Log catchability residuals by fleet - final run







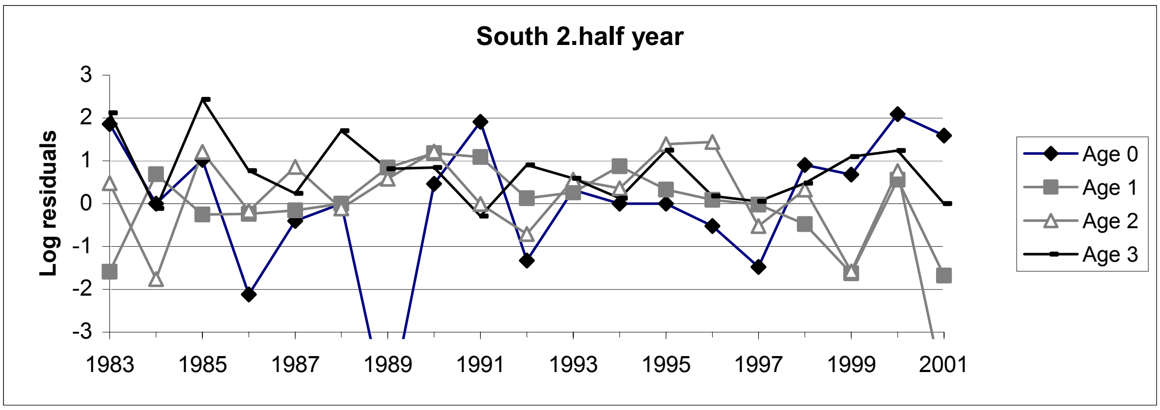


Figure 13.1.4.5 SANDEEL in the North Sea. Tuning weights

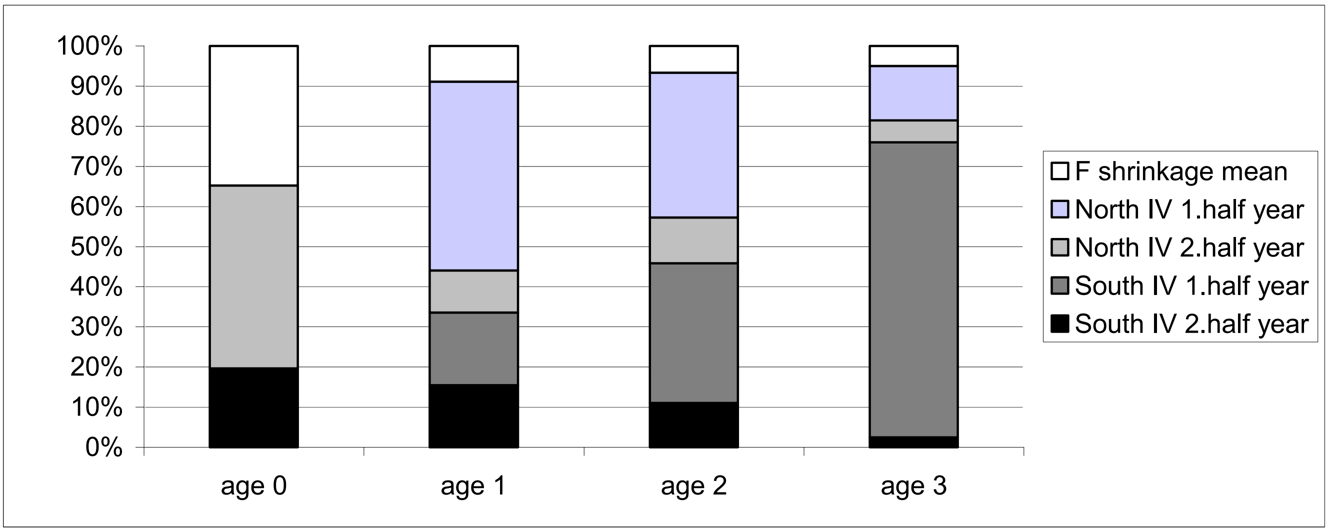


Figure 13.1.4.6
Sandeel in the North Sea. Relation between numbers estimated by XSA and CPUE of tuning fleets.

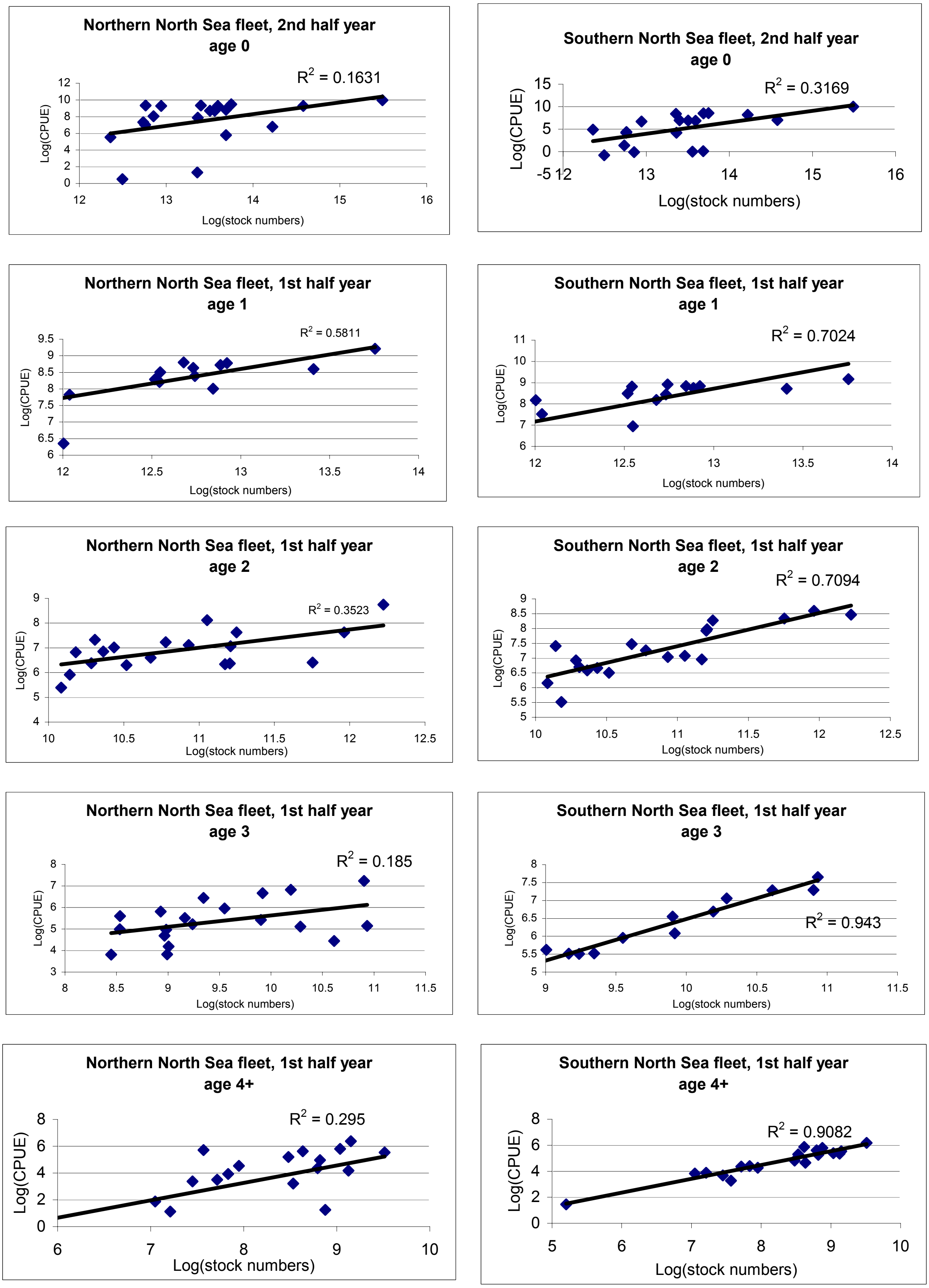
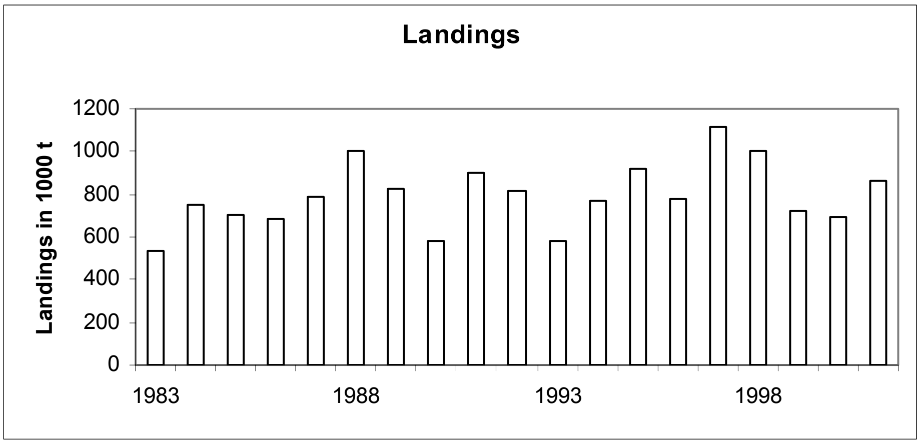
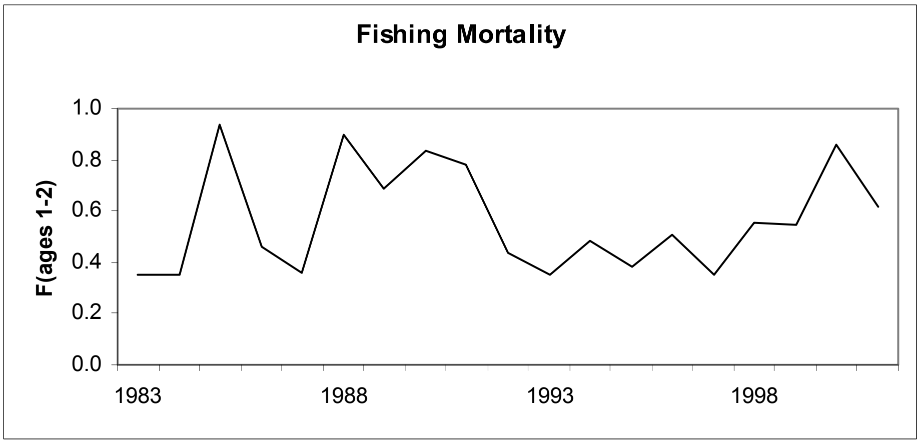


Figure 13.1.4.7 SANDEEL in the North Sea. Retrospective analysis of SSB, recruitment, and Fbar 1983-2001. Final assessment

Figure 13.1.4.8 SANDEEL in the North Sea. Stock summary





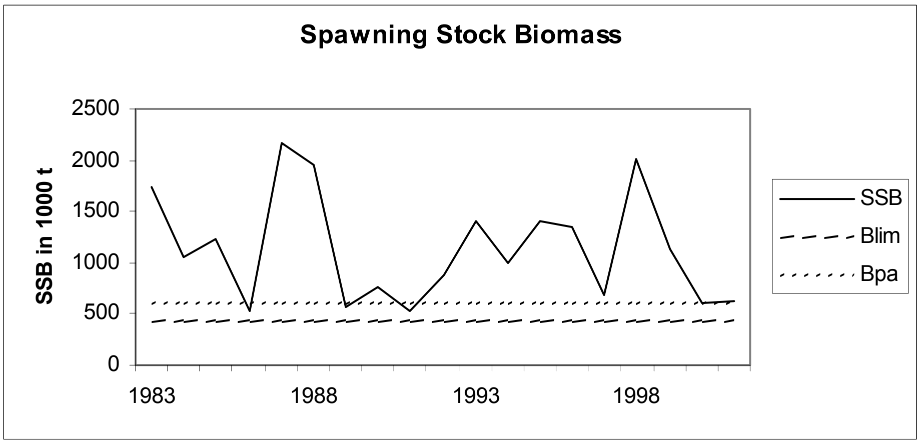


Figure 13.1.8.1 SANDEEL in the North Sea. Precautionary approach plot

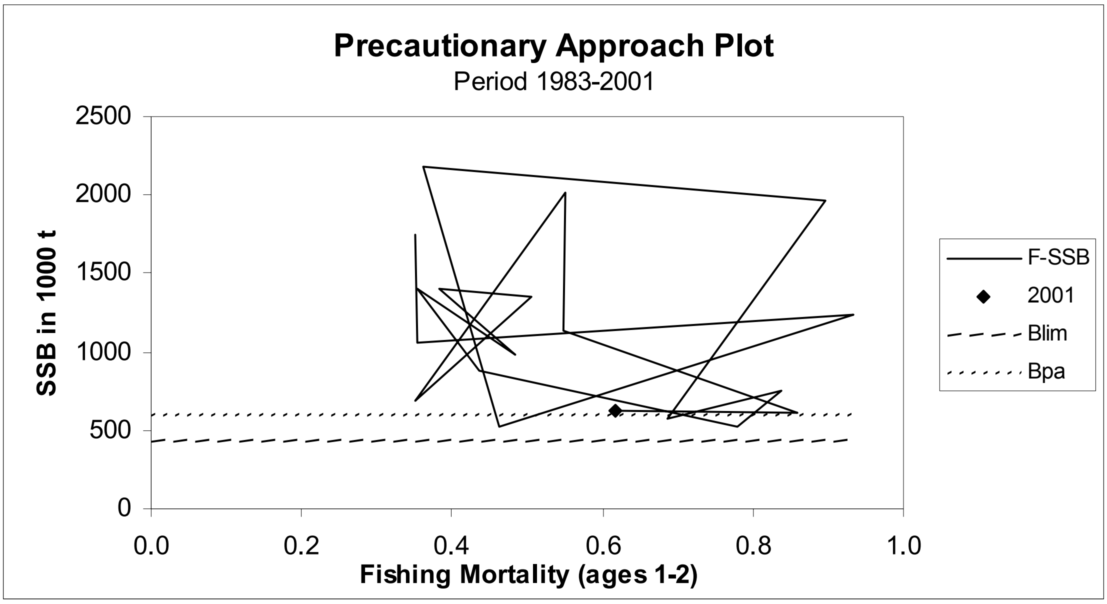


Figure 13.1.8.2 SANDEEL in the North Sea. Stock recruitment plot.

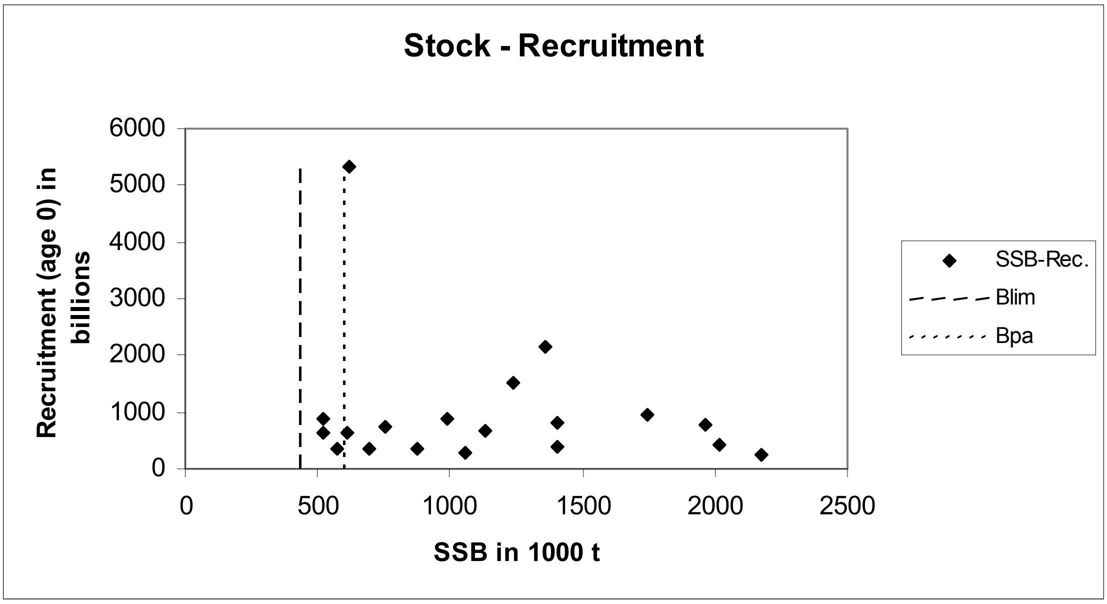


Figure 13.1.8.3 SANDEEL in the North Sea. Yield-per-recruit

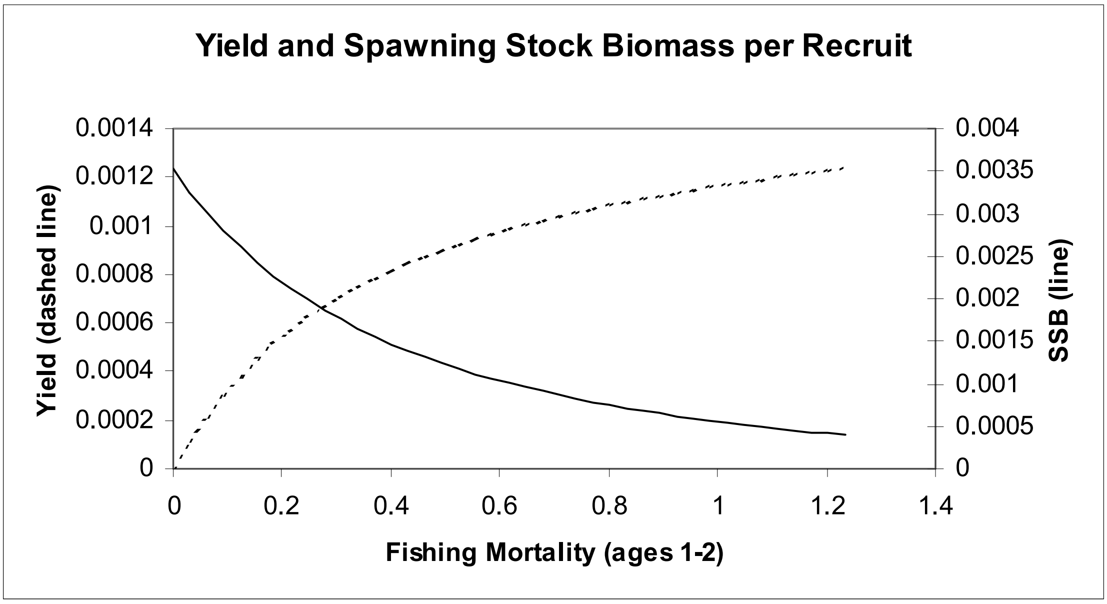


Figure 13.1.9.1 SANDEEL in the North Sea. Comparison of XSA and SXSA output from the 2001 assessment

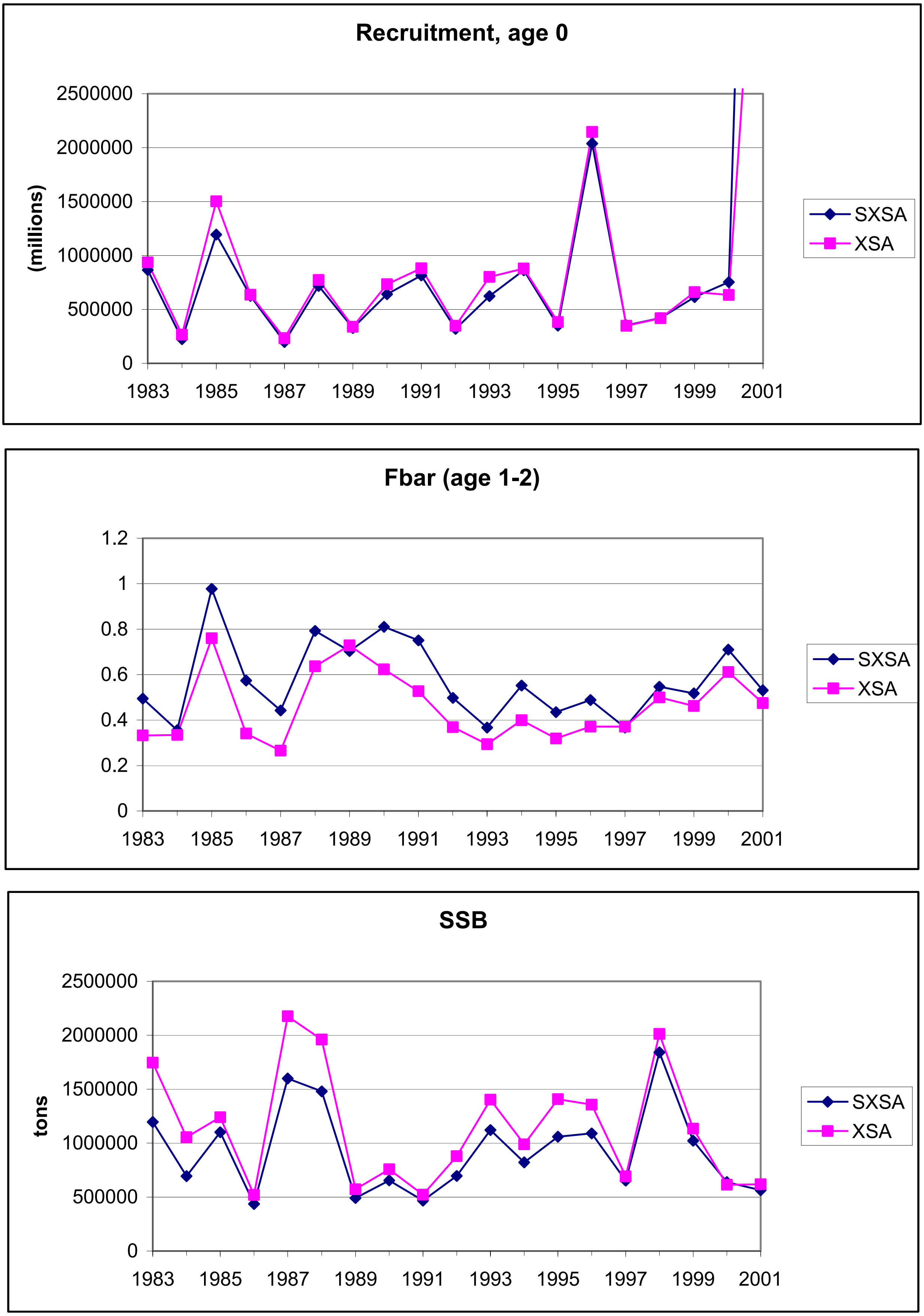


Figure 13.1.10.1 Sandeel in IV. Quality control of assessments generated by successive working groups.

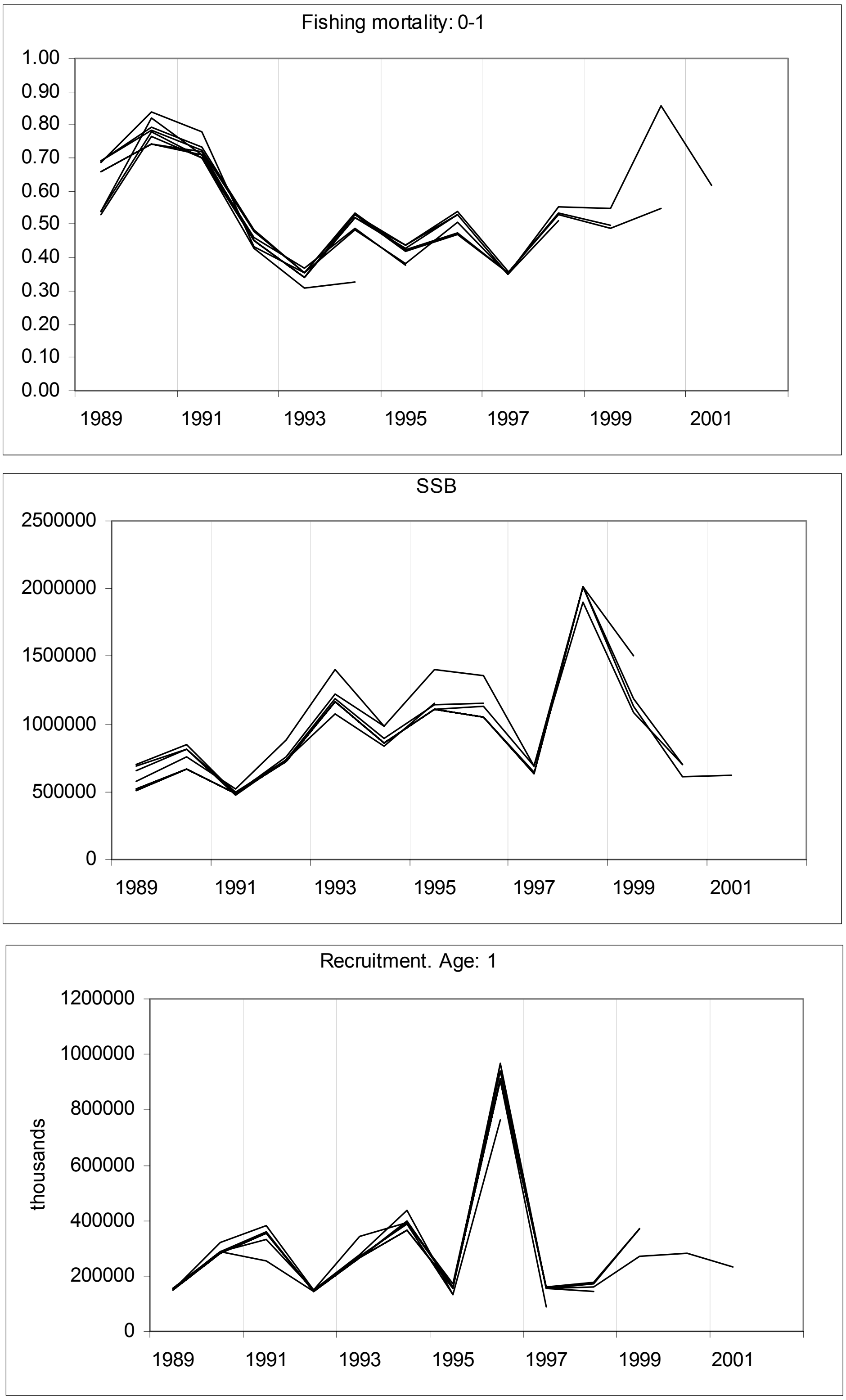
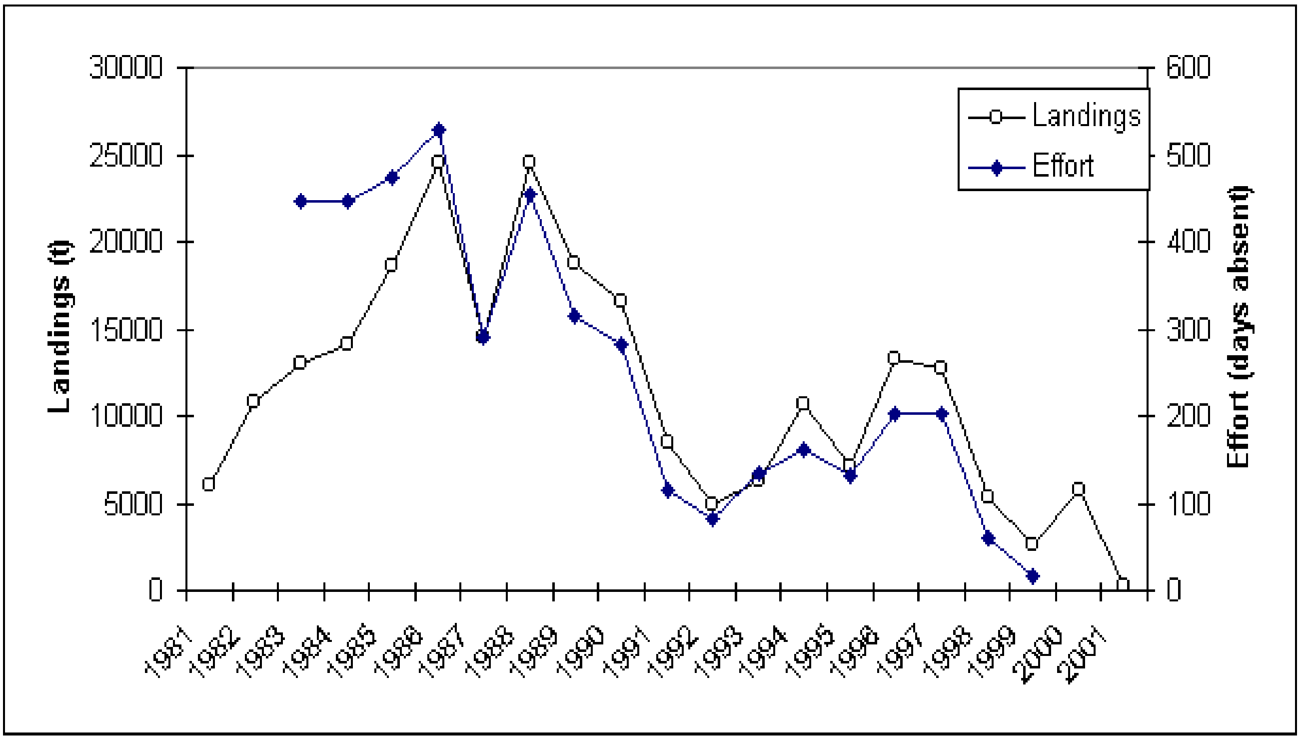


Figure 13.4.1 Sandeel, Division VIa. Trends in landings and effort



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Advisory Committee on Fishery Management **ICES CM 2003/ACFM:02**
Appendix

REPORT OF THE

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

Subgroup of WGNSSK
RIVO, IJmuiden, The Netherlands
7-8 October 2002

International Council for the Exploration of the Sea

Conseil International pour l'Exploration de la Mer

Palægade 2–4 DK–1261 Copenhagen K Denmark

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1 GENERAL

1.1 Participants

A subgroup of the Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak (WGNSSK) met at the Netherlands Institute of Fisheries Research in IJmuiden on 7 and 8 October 2002 with the following participants:

Martin Pastoors (chair)	Netherlands
J. Rasmus Nielsen	Denmark
John Casey	England
Hans-Joachim Rätz	Germany
Sieto Verver	Netherlands
Knut Korsbrekke	Norway
Coby Needle	Scotland

1.2 Terms of Reference

The subgroup of the **Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak** was to:

a) provide catch options for 2003 for the following stocks:

1) **cod** in Sub-area IV and Division IIIaN (Skagerrak), and Division VIId,
2) **haddock** in Sub-area IV and Division IIIa,
3) **whiting** and **plaice** in Sub-area IV, Division IIIa, and Division VIId,
4) **sole** in Sub-area IV and Division VIId,

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

The additional subgroup was considered necessary because the important autumn surveys for the listed stocks only become available in august and september and therefore cannot be addressed by the WG meeting in June.

1.3 Material and methods

1.3.1 Research vessel data

The following research vessel data was made available to the WG:

Survey	Acronym	Species
English Groundfish Survey	EGFS	Cod, Haddock, Whiting, (saithe)
Scottish Groundfish Survey	SGFS	Cod, Haddock, Whiting, (saithe)
Beam trawl survey	BTS	Plaice, Sole
Sole Net Survey	SNS	Plaice, Sole
German Solea survey	DFS	Plaice, Sole, Cod, Whiting

The German contribution to the Demersal Fish Survey has for the first time been made available for cod and whiting.

1.3.2 Methods

The methods applied by the subgroup were the same as routinely applied by the WG:

- RCT3 for recruitment estimation
- WGFRANSW for short term predictions
- WGMTERMC for medium term predictions

In addition, new software was made available to carry out assessments on survey data only (Needle 2002). This software is based on earlier version developed by Robin Cook (Cook 1997) and was applied to whiting, cod and plaice in the subgroup, basically as a quality check of the XSA or TSA assessments. SURBA 2.00 (Survey-Based Assessment, version 2.00) is a recent development of RCRV1A, migrating the code to Compaq Visual Fortran and extending its functionality and flexibility. RCRV1A was an implementation by Robin Cook (FRS Marine Laboratory) of the separable survey model described in Cook (1997). In brief, it assumed that fishing mortality $\mathbf{F} = \lfloor F_{a,y} \rfloor$ is separable into an age effect $\mathbf{s} = \lfloor s_y \rfloor$ and a year effect $\mathbf{f} = \lfloor f_y \rfloor$, so that $\mathbf{F} = \mathbf{s} \times \mathbf{f}$. It estimated these **s** and **f** parameters, along with a year-class effect **r**, by minimising the sum-of-squares differences between observed and fitted survey-derived abundance, using an assumed fixed vector of catchabilities-at-age $\mathbf{q} = [q_a]$. Since these abundances are relative indices only, the model can only be used to estimate relative rather than absolute population numbers. However, these can be used to indicate the population trends suggested by each particular survey.

RCRV1A had apparently been written in some haste, and aspects of its development had been left uncompleted. In particular, weights, proportion mature and natural mortality at age were all assumed to be time-invariant, and *ad hoc* assumptions had to be made about survey catchabilites **q** and age weightings **w**. SURBA has addressed these and other issues as follows.

1. Weights, proportion mature and natural mortality are read into the program as arrays, thus allowing variation through time as well as by age.

2. Catchabilities **q** may be entered manually, which is appropriate if there is information on what the empirical catchability-at-age of the survey in question is likely to be. However, this information will be lacking for many surveys. To introduce some element of rigour into a process which would otherwise be entirely *ad hoc*, SURBA currently allows the option of searching over a range of values of q_1, q_2 and q_3 (that is, the catchabilities on the three youngest ages) for appropriate combinations: these are taken to be those values of catchability which generate positive selectivities that are within 2 standard deviations of a user-supplied selectivity ogive (generally obtained from catch-at-age analyses). The suitable combination with the lowest RSS is then used. This catchability "search" should be thought of more as an informal guide than as a formal statistical algorithm, and requires further work to be made rigorous.

3. Estimation age weightings **w** may also be entered manually. Alternatively, they can be calculated as the inverse of the variance of the survey index at that age, so that $w_a = (n-1) \big/ \sum_y \left(I_{a,y} - \bar{I}\right)^2$ where $I_{a,y}$ is the index value at age *a* in year *y*, and *n* is the number of years in the survey time-series.

4. Problems arise if the model-fitting algorithm encounters zero index values, in that unfeasibly-high values of *F* are generated. To circumvent this, SURBA fills in such zero values with the lowest non-zero value at that age in the survey time-series.

5. In RCRV1A, summary statistics (SSB, TSB, yield) were mean-standardised before output. This mean standardisation did not include the last year, although the last-year value was printed. In SURBA, mean standardisation is done over the full time-series. Furthermore, mean *F* is now calculated from the $F_{a,y}$ array, rather than from scaled selectivity vectors.

SURBA is currently under development, and beta-test versions are available from the author (Coby Needle: c.needle@marlab.ac.uk).

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

2.1 Survey data

Time series of data for recruitment estimates are available for 20 fleets. However, up-dated survey indices are only available for IYFS 1 and 2-year olds, EGFS 0, 1 and 2 –year-olds, and for SGFS 1 and 2-year olds. Only these indices are used for estimates of recent year-classes. Updated indices are also available for 0 and 1-group cod from the the Q4 German and Q1 German surveys, although as has been the recent practice, these data have not been used for predicting recruitment since the survey coverage is restricted to a limited area of the German Bight.

2.2 Recruitment estimates

Average (geometric mean) recruitment at age 1 over the period 1963-1999 was 311 million. The GM recruitment in the recent period (1987-1998) is 171 million 1- year old fish.

Input data for RCT3 analysis are shown in Table 2.2.1.

Since the estimates of the 1999 and earlier year-classes were derived using the year-class-dependent (power) model in XSA, the WG accepted the estimates of stock numbers at age and F in 2001 for age groups 2 and older.

Using RCT3, research vessel survey data for 1-year old fish were regressed against VPA population numbers for year classes back to and including 1970 to compare the estimate of 1-groups in 2001 (2000 year-class) with the XSA estimate and to estimate recruitment at age 1 in 2002 (2001 year-class). The results are presented in Table 2.2.2.

Year-class 2000: The estimate of the 2000 year-class at age 1 derived from XSA is 74 million, the second lowest in the time series after the 1997 year-class.

Year-class 2001: The estimate of the 2001 year-class using the whole time series of survey data regressed against VPA population numbers at age 1 is 167 million 1-year-old cod. This is approximately equal to the short-term (1987-1998) GM of 171 million

Year-class 2002. The only estimate for the 2002 year-class is derived from the EGFS_Q3 survey 0-group index, which historically is not a precise estimator of year-class strength at age 1. One third of the weighted RCT3 estimate is ascribed to the 0-group survey. The sub-group therefore argued that ignoring the information provided by the survey in favour of a GM estimate would be inappropriate and hence the RCT3 estimate of 127 million was accepted as input to predictions.

Year-class 2003. The WG chose the short term GM of 171 million as input to the short term predictions although the choice of value will have little influence on the estimate of SSB in 2004 since only 1% of 1-group cod are considered mature.

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

Year class	XSA Estimate (Millions age 1)	RCT3 estimate (millions at age 1)	Short-term GM
2000	**74**	87	171
2001	-	**167**	171
2002	-	**127**	171
2003	-	-	**171**

Values used for input to prediction are underlined in bold.

2.3 Short term forecast

The input data for the status quo prediction are given in Table 2.3.1. Mean weight at age is the average for the period 1999-2001. Fishing mortalities at age are the un-scaled mean values for the same period. An un-scaled mean was used since the assessment estimated F(2-8) in 2001 at a low level compared to the recent period. While there may have been a reduction in F in 2001 because of the measures implemented under the cod recovery plan in that year, this assessment has a retrospective bias in underestimating F and overestimating N in the terminal year. The Sub-group therefore felt that the use of an un-scaled mean exploitation pattern would be more appropriate than one scaled to a low terminal mean F.

Population numbers at the start of 2002 are XSA survivor estimates, except for age 1, which was derived from RCT3. Note that the un-scaled mean F (1.11), is rather large compared to the terminal F from XSA (0.81). This will give relatively higher landings for 2002 and fewer survivors to 2003, compared to a scaled value, since no changes have been made to survivor estimates from XSA.

The results of predictions for 2003 are given in Tables 2.3.2 (management options) and 2.3.3 (detailed tables). The predicted status quo landings are 76,600 t for 2002, and 71,000 t for 2003. Under these conditions spawning biomass is estimated to be 38,000 t at the start of 2002, 35,000 t in 2003 and 33,000 at the start of 2004. The detailed output tables (Table 2.3.3) and Table 2.3.4 confirm that the landings in 2003 and SSB in 2004 will not be dominated by any particular year-class.

The results of sensitivity analyses of the short-term prediction are presented in Figure 2.3.1 and probability profiles in Figure 2.3.2. The sensitivity plots indicate that yield in 2003 and SSB in 2004 are primarily sensitive to the assumed fishing mortality rate in 2003. Figure 2.3.2 indicates there is almost 100% probability that SSB will remain below about 60,000 t ($\mathbf{B}_{lim}$ = 70,000t) in 2004 at status quo F.

2.4 Medium term projections

The Sub-group undertook medium-term projections of landings and SSB for a range of fishing mortalities over a 10 year period. The input values are given in Table 2.4.1, and are the same as for the short-term forecast, except that mean weight at age is the average over the period 1992-2001. The projections were carried forward for 10 years using the software WGMTERMC and assuming a Shepherd stock-recruit model fit. This was the model previously assumed for North Sea cod and the one used to calculate precautionary reference points for cod. Figure 2.4.1 displays trajectories of catch, recruits and SSB at status quo F expressed as percentiles (10, 25, 50, 75, and 90).

The trajectories under status quo fishing mortality indicate that the recruitment, yield and SSB are predicted to decline over the ten-year period. Figure 2.4.2. (contour plot) illustrates probability trajectories of the SSB being below $\mathbf{B}_{pa}$ as a function of time and fishing mortality. A reduction in the fishing mortality to $\mathbf{F}_{pa}$ (0.65) results in a 30 % probability that the SSB will not exceed the $\mathbf{B}_{pa}$ level of 150 000 t by 2011. Even if F is reduced by 50%, there is still a 5% chance that SSB will remain below $\mathbf{B}_{pa}$ in 2011.

2.5 Comments

The current prognosis for North Sea cod looks grim. Since 1996, recruitment appears to have been at or below the recent (post 1986) average. Fishing mortality remains high and above $\mathbf{F}_{lim}$. The Sub-group is concerned that the reduced TACs in recent years which have been agreed in order to bring about a reduction in fishing mortality have not succeeded inn doing so. Indeed they may have simply resulted in an increase in unreported catch for whatever reason. The net effect will undoubtedly give a perception of a reduction in stock size simply because beyond the most recent 2-3 years, the VPA is almost wholly determined by the input catch at age data, which if under-estimated will result in an underestimation of stock size.

The short-term predictions are based on an un-scaled exploitation pattern based on the mean F at age over 1999-2001. These values are then applied to survivor estimates from XSA in 2002 that are based on terminal estimates of F from XSA which are lower. The result is likely to be over-prediction of landings for 2002, and reduced survivors to 2003 leading to underestimates of stock size and hence SSB in 2003 and 2004. The TAC for 2002 is 56,400 t and the predicted landings are 76,600 t.

The medium-term projections indicate that significant reductions in fishing mortality are required to give the stock a high probability of recovering to $\mathbf{B}_{pa}$ within 10 years. The significant reductions are required in order to allow SSB to rebuild and generate higher recruitment, since currently, F is too high, the exploitation pattern is poor and the stock is at its lowest level and on the descending limb of the stock-recruit relationship.

Table 2.2.1. Cod in IIIa, IV and VIId. Input data for RCT3 .

COD IV RCT3 INPUT VALUES; AGE 1*100; 08-Oct-02

20 33 2

'YEARCLASS' 'VPA' 'IYFS1' 'IYFS2' 'EGFS0' 'EGFS1' 'EGFS2' 'SGFS1' 'SGFS2' 'DGFS0' 'DGFS1' 'DGFS2' 'FRGSF' 'GGFS1' 'GGFS2' 'IBQ21' 'SCQ21' 'SCQ22' 'IBQ40' 'IBQ41' 'GQ40' 'GQ11'

Yclass	VPA	IYFS1	IYFS2	egfs0	egfs1	egfs2	sgfs1	sgfs2	dgfs0	dgfs1	dgfs2	frgsf	ggfs1	ggfs2	IBQ21	SCQ21	SCQ22
1970	782003	9830	3450	-1	-1	-1	-1	-1	-1	-1	-1	9040	-1	-1	-1	-1	-1
1971	910808	410	1060	-1	-1	-1	-1	-1	-1	-1	-1	130	-1	-1	-1	-1	-1
1972	173496	3800	950	-1	-1	-1	-1	-1	-1	-1	-1	160	-1	-1	-1	-1	-1
1973	319648	1470	620	-1	-1	-1	-1	-1	-1	-1	-1	360	-1	-1	-1	-1	-1
1974	263657	4030	1990	-1	-1	-1	-1	-1	-1	-1	-1	800	-1	-1	-1	-1	-1
1975	486359	790	320	-1	-1	447	-1	-1	-1	-1	-1	780	-1	-1	-1	-1	-1
1976	246421	3670	2930	-1	6270	1250	-1	-1	-1	-1	-1	2820	-1	-1	-1	-1	-1
1977	839198	1290	930	1389	2284	580	-1	-1	-1	-1	-1	2720	-1	-1	-1	-1	-1
1978	488156	990	1480	1256	2423	670	-1	-1	-1	-1	450	3110	-1	-1	-1	-1	-1
1979	525424	1690	2550	1855	5084	1386	-1	-1	-1	16380	1120	3550	-1	-1	-1	-1	-1
1980	899522	290	670	1023	1136	290	-1	351	4320	4690	160	1410	-1	-1	-1	-1	-1
1981	314766	920	1660	7424	3237	1096	614	78	17680	8300	230	2320	-1	350	-1	-1	-1
1982	618498	390	800	255	1540	475	325	391	2690	2180	160	900	590	240	-1	-1	-1
1983	324685	1520	1760	9510	6122	1189	819	1143	12150	12130	310	4300	260	2240	-1	-1	-1
1984	596292	90	360	38	430	115	66	104	130	360	20	90	230	260	-1	-1	-1
1985	158611	1700	2880	828	3438	1065	801	695	14360	11120	800	950	1540	1140	-1	-1	-1
1986	716254	880	610	121	1422	407	219	288	3700	4150	170	230	700	950	-1	-1	-1
1987	281821	360	630	38	836	248	162	135	3620	1780	220	210	200	720	-1	-1	-1
1988	197054	1310	1520	1678	2285	504	561	490	1660	1660	190	420	9020	1470	-1	-1	-1
1989	274077	340	410	598	608	155	114	154	1370	920	70	60	1190	620	-1	-1	3140
1990	133933	240	450	383	752	159	303	193	2350	720	110	-1	1550	360	850	1490	5330
1991	168552	1300	1990	4840	2440	650	642	749	3980	4540	70	-1	1340	-1	3630	19080	14460
1992	305284	1270	440	1684	742	295	347	334	1160	170	90	-1	-1	450	1100	4820	3410
1993	147360	1480	2210	377	2637	1277	1158	1443	2410	4690	-1	-1	3080	1430	3200	2030	20470
1994	323413	970	800	2134	1028	668	475	356	6350	-1	-1	-1	430	-1	1960	4270	5660
1995	226023	350	690	26	619	284	318	278	-1	-1	-1	-1	-1	-1	370	770	1920
1996	170710	4000	2640	4122	4044	1396	999	2134	-1	-1	-1	-1	-1	-1	7580	2830	-1
1997	407921	270	160	4.9	118	55	104	102.7	-1	-1	-1	-1	-1	-1	-1	-1	-1
1998	57961	210	380	389	367	197	440	237	-1	-1	-1	-1	-1	-1	-1	-1	-1
1999	-1	660	880	95	953	528	700	409	-1	-1	-1	-1	-1	-1	-1	-1	-1
2000	-1	270	319	40	174	146	69	120	-1	-1	-1	-1	-1	-1	-1	-1	-1
2001	-1	755	-1	26	789	-1	274	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
2002	-1	-1	-1	19	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1

* = not used

Table 2.2.2. Results of RCT3

```
Analysis by RCT3 ver3.1 of data from file :
 rct3in1.csv
 COD IV,RCT3 INPUT VALUES; AGE 1*100; ,,,,,01-Oct-02,,,,,,,,,,,,,,
 Data for   20 surveys over   33 years :  1970 - 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   5 points used for regression
 Forecast/Hindcast variance correction used.

 Yearclass =   1999
          I-----------Regression----------I  I-----------Prediction---------I
 Survey/  Slope  Inter-   Std  Rsquare  No.  Index Predicted  Std     WAP
 Series           cept   Error          Pts  Value   Value    Error   Weights
 IYFS1      .84   6.75    .58   .549     29   6.49   12.19     .659     .039
 IYFS2      .74   7.26    .24   .873     29   6.78   12.31     .278     .218
 EGFS0      .44   9.58    .74   .427     22   4.56   11.58     .859     .023
 EGFS1      .61   7.98    .17   .936     23   6.86   12.19     .191     .421
 EGFS2      .69   8.17    .28   .840     24   6.27   12.48     .319     .165
 SGFS1     1.02   6.21    .57   .560     18   6.55   12.86     .661     .039
 SGFS2      .83   7.31    .51   .611     19   6.02   12.31     .581     .050
                                        VPA Mean =   12.22     .609     .045

 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
 IYFS1      .81   6.91    .55   .577     29   5.60   11.44     .657     .039
 IYFS2      .72   7.39    .22   .890     29   5.77   11.56     .270     .228
 EGFS0      .42   9.65    .72   .443     22   3.71   11.23     .868     .022
 EGFS1      .60   8.07    .15   .945     23   5.16   11.16     .199     .415
 EGFS2      .67   8.26    .26   .855     24   4.99   11.59     .315     .167
 SGFS1      .99   6.31    .53   .589     18   4.25   10.52     .730     .031
 SGFS2      .79   7.52    .46   .661     19   4.80   11.30     .561     .053
                                        VPA Mean =   12.19     .607     .045

 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
 IYFS1      .78   7.04    .52   .604     29   6.63   12.24     .612     .077
 EGFS0      .41   9.74    .69   .467     22   3.30   11.08     .866     .039
 EGFS1      .59   8.14    .14   .954     23   6.67   12.06     .166     .723
 SGFS1      .97   6.41    .50   .625     18   5.62   11.85     .590     .083
                                        VPA Mean =   12.16     .608     .078

 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      .39   9.82    .66   .496     22   3.00   10.99     .862     .337
                                        VPA Mean =   12.14     .614     .663


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

 1999      215890      12.28     .13      .07      .30
 2000       86795      11.37     .13      .11      .76
 2001      167309      12.03     .17      .10      .38
 2002      126736      11.75     .50      .54     1.18
```

Table_2.3.1 Cod, North sea

Input data for Short-Trem catch forecast and linear sensitivity analysis

Label	Value	CV	Label	Value	CV
Number at age			Weight in the stock		
N1	167309	0.17	WS1	0.66	0.09
N2	31659	0.21	WS2	0.99	0.05
N3	34712	0.13	WS3	1.90	0.18
N4	5200	0.13	WS4	3.40	0.07
N5	385	0.19	WS5	5.50	0.09
N6	751	0.19	WS6	7.41	0.01
N7	80	0.35	WS7	9.16	0.06
N8	40	0.39	WS8	10.37	0.03
N9	12	0.47	WS9	11.52	0.05
N10	8	0.46	WS10	11.92	0.04
N11	4	0.49	WS11	12.40	0.20
H.cons selectivity			Weight in the HC catch		
sH1	0.07	0.16	WH1	0.66	0.09
sH2	0.63	0.24	WH2	0.99	0.05
sH3	1.17	0.21	WH3	1.90	0.18
sH4	1.31	0.17	WH4	3.40	0.07
sH5	1.17	0.16	WH5	5.50	0.09
sH6	1.18	0.05	WH6	7.41	0.01
sH7	1.23	0.05	WH7	9.16	0.06
sH8	1.07	0.23	WH8	10.37	0.03
sH9	0.95	0.12	WH9	11.52	0.05
sH10	1.13	0.05	WH10	11.92	0.04
sH11	1.13	0.05	WH11	12.40	0.20
Natural mortality			Proportion mature		
M1	0.80	0.13	MT1	0.01	0.10
M2	0.35	0.10	MT2	0.05	0.10
M3	0.25	0.18	MT3	0.23	0.10
M4	0.20	0.18	MT4	0.62	0.10
M5	0.20	0.18	MT5	0.86	0.10
M6	0.20	0.18	MT6	1.00	0.10
M7	0.20	0.18	MT7	1.00	0.00
M8	0.20	0.18	MT8	1.00	0.00
M9	0.20	0.18	MT9	1.00	0.00
M10	0.20	0.18	MT10	1.00	0.00
M11	0.20	0.18	MT11	1.00	0.00
Relative effort in HC fishery			Year effect for natural mortality		
HF02	1.00	0.15	K02	1.00	0.10
HF03	1.00	0.15	K03	1.00	0.10
HF04	1.00	0.15	K04	1.00	0.10
Recruitment in 2003 and 2004					
R03	126736	0.54			
R04	171009	0.64			

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

Stock numbers in 2002 are VPA survivors.
These are overwritten at Age 1 with estimate from RCT3

Data from file:C:\WGNSSK 2002\Cod\m_l_a\codiv.sen on 08/10/2002 at 09:05:09

Table_2.3.2.Cod North sea

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

	Year 2002	2003						
Mean F Ages 2 to 8								
H.cons	1.11	0.00	0.22	0.44	0.66	0.89	1.11	1.33
Effort relative to 2001								
H.cons	1.00	0.00	0.20	0.40	0.60	0.80	1.00	1.20
Biomass								
Total 1 January	233.9	212.8	212.8	212.8	212.8	212.8	212.8	212.8
SSB at spawning time	37.6	35.4	35.4	35.4	35.4	35.4	35.4	35.4
Catch weight (,000t)								
H.cons	76.6	0.0	19.7	36.0	49.7	61.2	70.9	79.2
Biomass in year.... 2004								
Total 1 January		341.4	312.2	288.1	268.2	251.6	237.7	226.1
SSB at spawning time		87.1	71.0	58.1	47.8	39.6	33.0	27.7

	Year 2002	2003						
Effort relative to 2001								
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	0.11	0.24	0.24	0.24	0.24	0.24	0.24	0.24
SSB at spawning time	0.12	0.23	0.23	0.23	0.23	0.23	0.23	0.23
Catch weight								
H.cons	0.17	0.00	0.70	0.35	0.25	0.21	0.19	0.18
Biomass in year.... 2004								
Total 1 January		0.25	0.28	0.30	0.31	0.33	0.34	0.36
SSB at spawning time		0.20	0.25	0.26	0.26	0.26	0.27	0.27

Table_2.3.3 Cod North Sea
Detailed forecast tables.

Forecast for year 2002
F multiplier H.cons=1.00

Populations		Catch number	
Age	Stock No.	H.Cons	Total
1	167309	7496	7496
2	31659	12773	12773
3	34712	21708	21708
4	5200	3515	3515
5	385	245	245
6	751	480	480
7	80	52	52
8	40	24	24
9	12	7	7
10	8	5	5
11	4	2	2
Wt	234	77	77

Forecast for year 2003
F multiplier H.cons=1.00

Populations		Catch number	
Age	Stock No.	H.Cons	Total
1	126736	5678	5678
2	70305	28365	28365
3	11835	7401	7401
4	8374	5660	5660
5	1149	730	730
6	98	63	63
7	190	124	124
8	19	12	12
9	11	6	6
10	4	2	2
11	3	2	2
Wt	213	71	71

Table 2.3.4 Cod in IIIa, IV and VIId

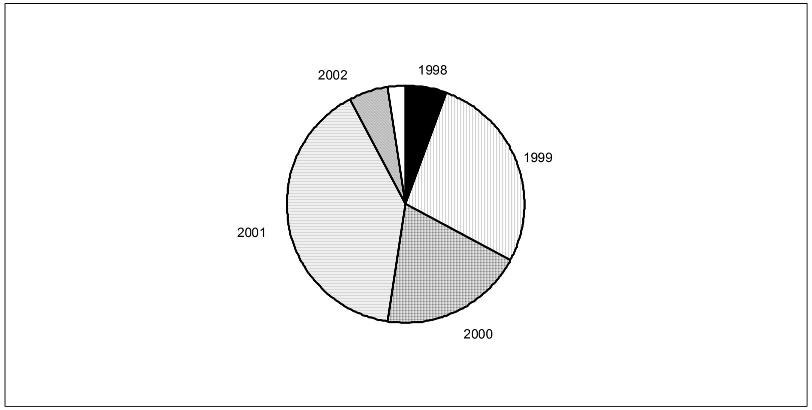
Stock numbers of recruits and their source for recent year classes used in predictions, and the relative (%) contributions to landings and SSB (by weight) of these year classes

Year-class				1998	1999	2000	2001	2002
Stock No. (thousands)				8710	5479	6161	167309	126736
of	1	year-olds						
Source				VPA	VPA	VPA	RCT3	RCT3
	Status Quo F:							
	% in	2002	landings	15.6	53.9	16.5	6.5	-
	% in	2003		5.7	27.1	19.8	39.6	5.3
	% in	2002	SSB	29.1	40.3	4.2	2.9	-
	% in	2003	SSB	15.3	49.8	14.6	9.8	2.4
	% in	2004	SSB	6.5	26.5	18.2	34.9	8.0

GM : geometric mean recruitment

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

a) 2003 landings



b) 2004 SSB

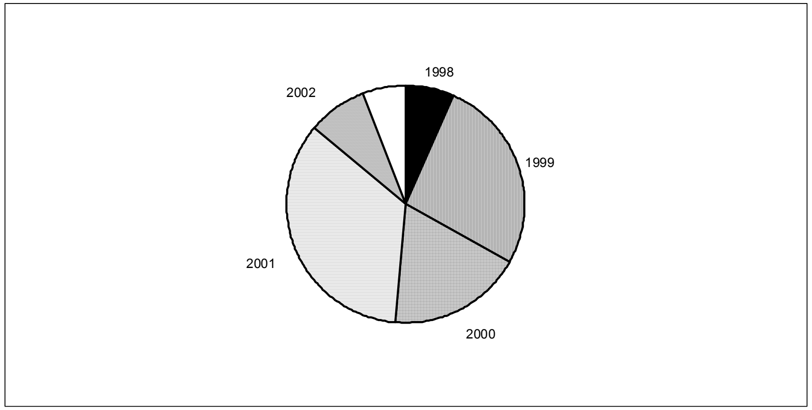


Table_2.4.2 Cod, North Sea
Input data for medium-term predictions

Label	Value	CV	Label	Value	CV
Number at age			Weight in the stock		
N1	167309	0.17	WS1	0.67	0.08
N2	31659	0.21	WS2	1.03	0.07
N3	34712	0.13	WS3	2.11	0.15
N4	5200	0.13	WS4	3.91	0.12
N5	385	0.19	WS5	6.19	0.12
N6	751	0.19	WS6	8.07	0.07
N7	80	0.35	WS7	9.64	0.05
N8	40	0.39	WS8	10.75	0.05
N9	12	0.47	WS9	12.01	0.05
N10	8	0.46	WS10	12.80	0.07
N11	4	0.49	WS11	13.31	0.13
H.cons selectivity			Weight in the HC catch		
sH1	0.07	0.16	WH1	0.67	0.08
sH2	0.63	0.24	WH2	1.03	0.07
sH3	1.17	0.21	WH3	2.11	0.15
sH4	1.31	0.17	WH4	3.91	0.12
sH5	1.17	0.16	WH5	6.19	0.12
sH6	1.18	0.05	WH6	8.07	0.07
sH7	1.23	0.05	WH7	9.64	0.05
sH8	1.07	0.23	WH8	10.75	0.05
sH9	0.95	0.12	WH9	12.01	0.05
sH10	1.13	0.05	WH10	12.80	0.07
sH11	1.13	0.05	WH11	13.31	0.13
Natural mortality			Proportion mature		
M1	0.80	0.13	MT1	0.01	0.10
M2	0.35	0.10	MT2	0.05	0.10
M3	0.25	0.18	MT3	0.23	0.10
M4	0.20	0.18	MT4	0.62	0.10
M5	0.20	0.18	MT5	0.86	0.10
M6	0.20	0.18	MT6	1.00	0.10
M7	0.20	0.18	MT7	1.00	0.00
M8	0.20	0.18	MT8	1.00	0.00
M9	0.20	0.18	MT9	1.00	0.00
M10	0.20	0.18	MT10	1.00	0.00
M11	0.20	0.18	MT11	1.00	0.00
Relative effort in HC fishery			Year effect for natural mortality		
HF02	1.00	0.15	K02	1.00	0.10
HF03	1.00	0.15	K03	1.00	0.10
HF04	1.00	0.15	K04	1.00	0.10
Recruitment in 2003 and 2004					
R03	126736	0.54			
R04	171009	0.64			

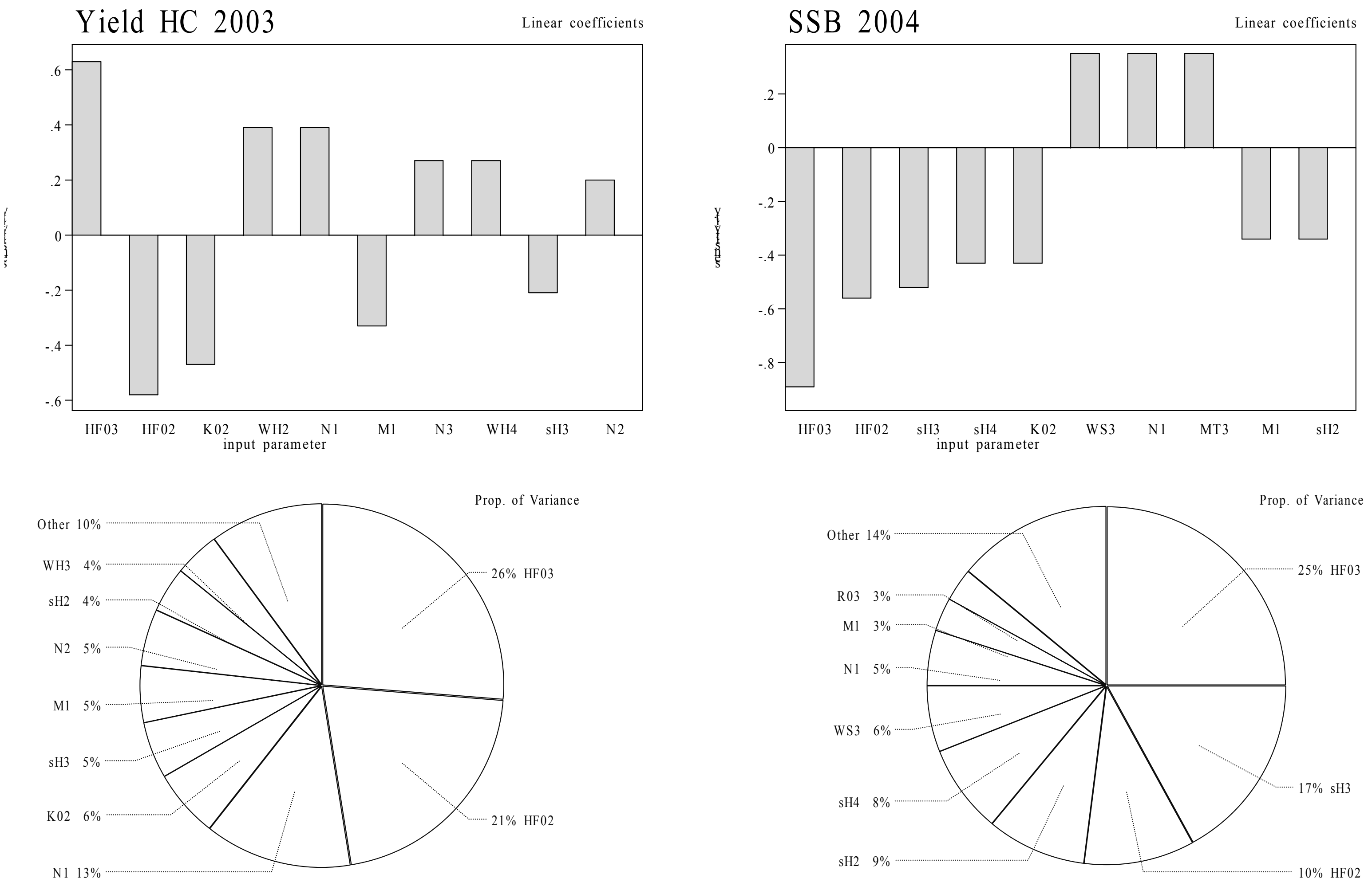
Proportion of F before spawning = .00
Proportion of M before spawning = .00

Stock numbers in 2002 are VPA survivors.
These are overwritten at Age 1

Data from file:C:\WGNSSK 2002\Cod\m_l_a\codivmt.sen on 08/10/2002 at 08:36:13

Figure 2.3.1.

Figure NS,North sea. Sensitivity analysis of short term forecast.



Data from file:C:\WGNSSK 2002\Cod\m_l_a\codiv.sen on 08/10/2002 at 09:05:14

Figure 2.3.2

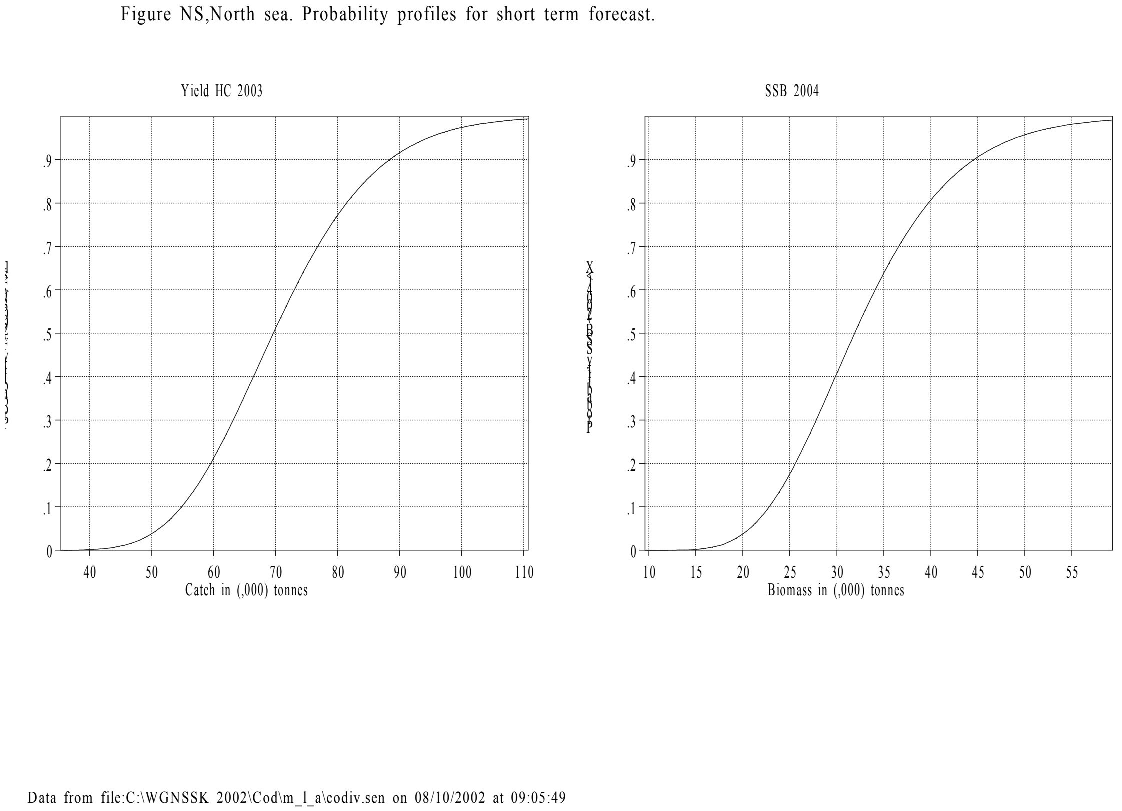


Figure 2.3.3

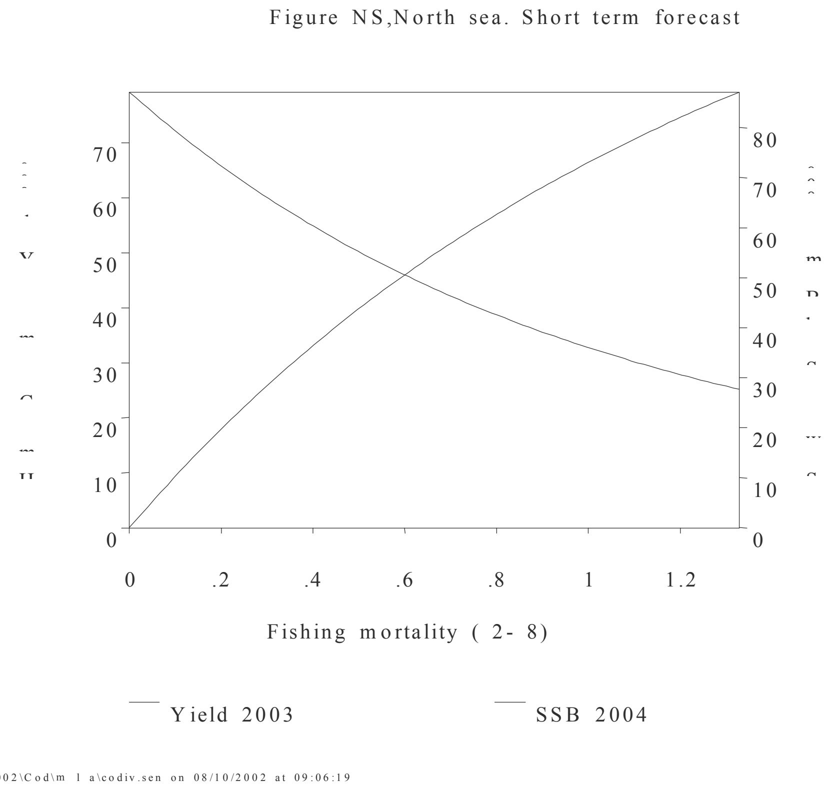
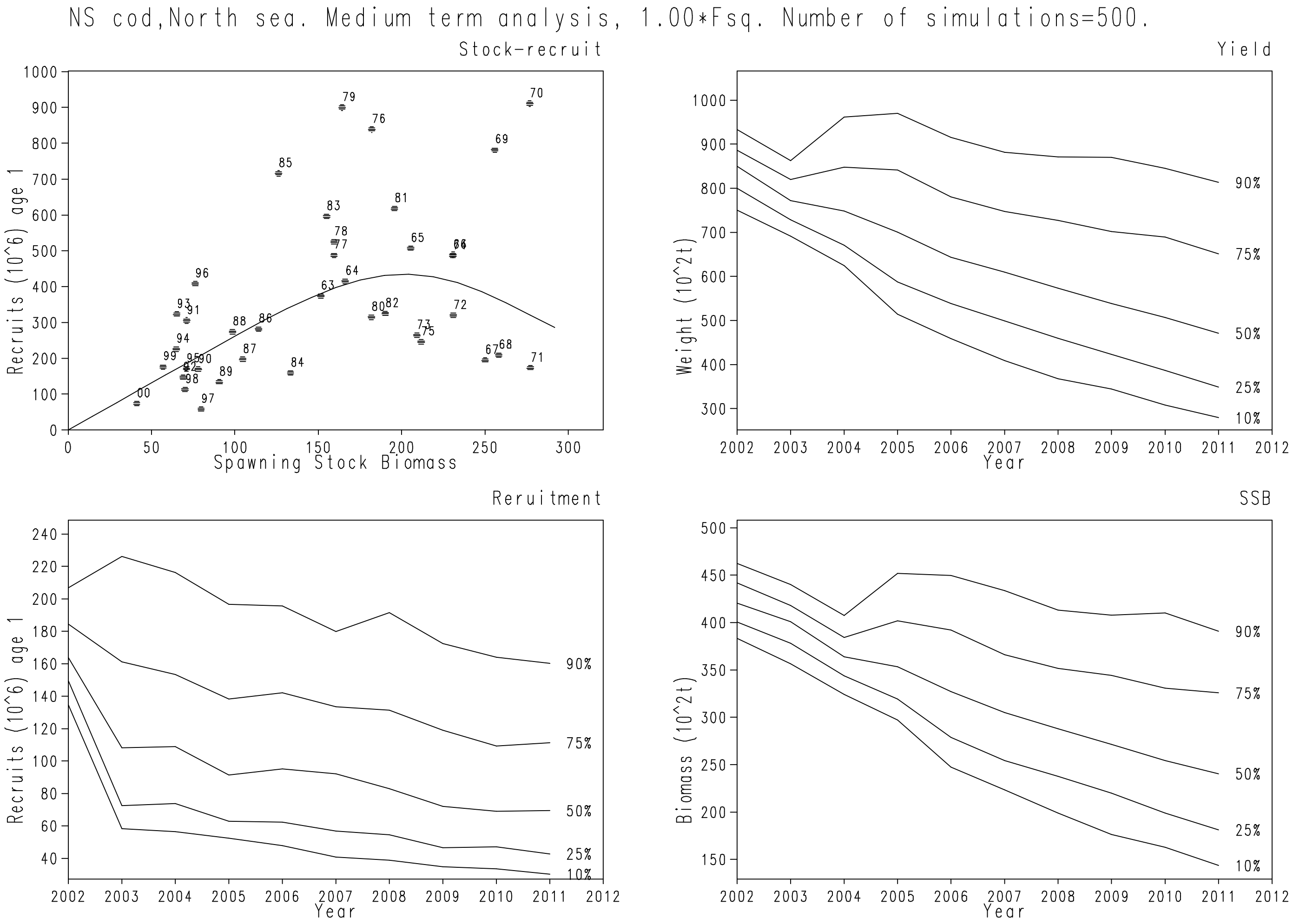
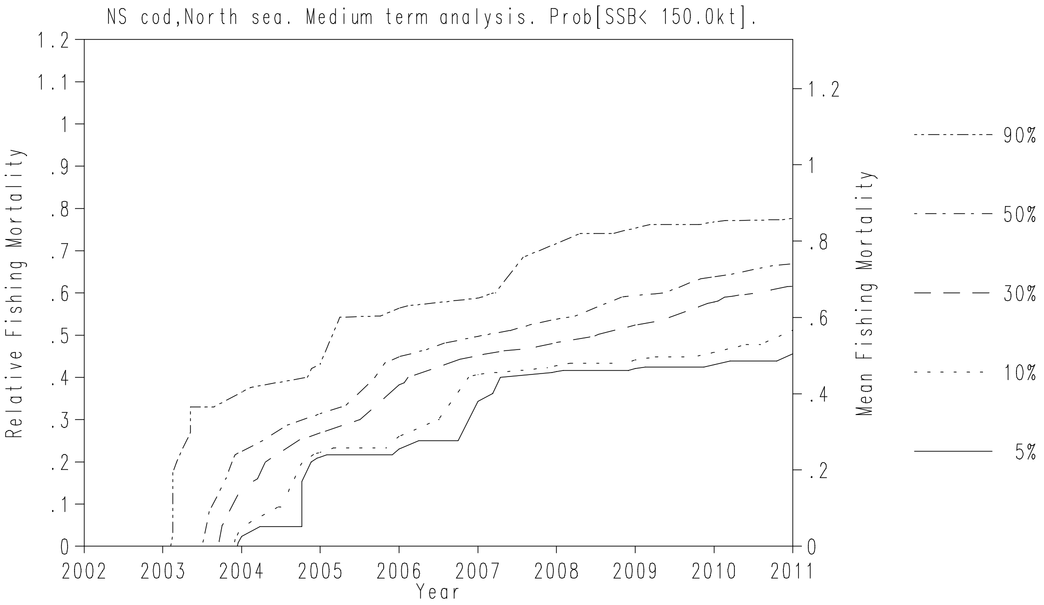


Figure 2.4.1



 O:\ACFM\WGREPS\WGNSSK\REPORTS\2003\WGRECNSSK.Doc

Figure 2.4.2


NS cod,North sea. Medium term analysis. Prob[SSB< 150.0kt].
Relative Fishing Mortality
Mean Fishing Mortality
Year
0
.1
.2
.3
.4
.5
.6
.7
.8
.9
1
1.1
1.2
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
90%
50%
30%
10%
5%

3 HADDOCK IN SUBAREA IV AND DIVISION IIIA

3.1 Survey data

The English Groundfish Survey (EGFS) 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 with the GOV trawl The Scottish Groundfish survey (SGFS) is undertaken during August each year using a fixed station design using 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. The indices currently presented for this survey correspond to trawl stations within the area of the old survey coverage to maintain consistency of the time series. 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.

The IBTS quarter 1 survey is treated as if it takes place at the end of the preceding year, by appropriate adjustments of the age and year ranges. The English and Scottish groundfish surveys for 2002 are the new information to the subgroup relative to the working group.

The 1999 year class is the dominating year class in both surveys and the age 3 index is the highest on record (since 1977 for the EGFS and since 1982 for the SCOGFS).

The 2000 year class indices at age 2 is closer to average, but the yearclass appears relatively stronger in the SCOGFS than in the EGFS.

The 2001 year class EGFS index at age 0 was the lowest on record. The age 1index from that survey in 2002 is also the lowest observed. The age 1 index from the SCOGFS was also very low in the 2002 survey.

The 0-group index from the 2002 EGFS is the second lowest while the 0-group index from the SCOGFS is a more optimistic, but is difficult to evaluate due to the changes introduced to the survey in 1998.

3.2 Recruitment estimates

The EGFS and SCOGFS survey indices where updated with the august 2002 numbers. Due to the previous changes to the SCOGFS, only EGFS and IBTS Q1 indices were used. Attempts should be made at the next working group meeting to include SCGFS indices from 1998 and forwards as input to the recruitment estimates.

The input tables to the RCT3 predictions are given in tables 3.2.1 and 3.2.2. The RCT3 output is shown in tables 3.2.3 and 3.2.4.

The XSA and RCT3 estimates of year class 2000 at age 2 is very close to each other and they are slightly below the the geometric mean for the period 1966-1999.

The XSA estimate of the 2001 year class at age 1 is around 30% lower than the corresponding RCT3 estimate. But both estimates are more than an order of magnitude lower than the geometric mean.

The RCT3 estimate of the 2002 year class at age 0 is an order of magnitude lower than the geometric mean. The SCOGFS is not used as input to the RCT3, but the results point to a somewhat stronger year class.

Estimates of year class strength is summarised in the following table. Values used as input to predictions are underlined:

Year class	Age in 2002	XSA	RCT3	GM
2000	2	**<u>4858</u>**	4846	5088
2001	1	**<u>1852</u>**	2682	33092
2002	0		**<u>28215</u>**	258956

3.3 Short term prediction

The mean weights and F at age were calculated using a three year mean, 1999-2001. F at age was scaled to the 2001 value of mean F by keeping the 3 year average industrial bycatch F and scaling the human consumption and discard F.

The input is shown in table 3.3.1.

The output from the short term forecast is shown in table 3.3.2 and 3.3.3. Assuming a *status quo* F results in an expected total catch in 2002 of 271 thousand tonnes. The predicted human consumption landings of 174 thousand tonnes is far above the TAC for 2002 (104 thousand tonnes). Continuing at the *status quo* F in 2003 corresponds to a total catch of 145 thousand tonnes and leaving a spawning stock of 115 thousand tonnes in 2004.

The sensitivity analysis is visualized in figure 3.3.1 and probability profiles are shown in figure 3.3.2 and 3.3.3. The prediction is most sensitive to variation in the relative effort in the human consumption fishery, but is also sensitive to human consumptions selectivity at age 4 (the 1999 year class in 2003) and industrial bycatch selectivity at age 3 (see section 3.5).

3.4 Medium term prediction

A medium term prediction was made using the input files used by the working group, but with the stock numbers at age in 2002 replaced with the current recruitment updates. The results are visualized in figures 3.4.1 and 3.4.2. The pattern is similar to the one produced by the working group, but with a more serious decline in SSB due to the introduction of one more weak year class (2002 year class).

3.5 Comments

The 1999 year class is the dominating year class in all the surveys and it should be noted that the last survey Z ($Log(I_{2002})-Log(I_{2001})$) for this year class is the lowest observed in the SCOGFS and the second lowest in the EGFS survey (at age 2 to 3). The latest survey Z's for the 2000 year class is the second lowest for (age 1 to 2) both surveys. See Table 3.5.1. This could be indications of some improvement in the overall mortality pattern and could be related to the technical measures introduced in 2000. There was not enough time during the 2 day subgroup meeting to look into this in further detail.

The XSA estimate of F at age 3 in 2001 in the industrial bycatch is as high as 0.31 which is considered unrealistic. This could be caused by age reading problems in industrial bycatches of haddock ("spillover" from the 1999 year class to the 1998 year class). This has the effect that the 3 year mean selectivity pattern used in the short term prediction has a relatively high F at age 3 in the industrial bycatches (F=0.13). And since the 1999 year class is 3 years old in 2002 the prediction of industrial bycatch is likely to be an overestimate. The overall selectivity patterns used for the youngest age groups is influenced by the overall low fishing mortality estimated for the 1999 year class. Because of the very low recruitment estimates for the 2001 and 2002 year classes the effect on the short term prediction of overall stock size is reduced.

Table 3.1.1 Haddock in IV and IIIa. Survey indices.

ENGGFS

1977	2002							
1	1	0.5	0.75					
0	5							
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 3.1.1 (Cont'd)

SCOGFS

1982	2002						
1	1	0.5	0.75				
0	5						
100	12.35	24.88	9.96	13.36	1.15	0.07	0.02
100	22.03	18.13	16.11	3.72	4.55	0.53	0.12
100	8.73	43.67	7.88	3.36	0.55	0.65	0.09
100	8.18	19.76	29.81	2.32	1.03	0.14	0.22
100	17.47	23.29	5.74	5.98	0.36	0.27	0.04
100	2.77	23.93	7.04	1.06	1.28	0.08	0.05
100	4.06	4.67	19.82	1.70	0.27	0.23	0.02
100	4.32	8.86	2.14	5.74	0.31	0.04	0.07
100	31.63	10.02	2.40	0.32	1.03	0.07	0.01
100	34.71	17.05	1.78	0.21	0.05	0.16	0.02
100	82.70	38.32	9.63	0.48	0.08	0.03	0.08
100	8.59	58.36	13.80	2.69	0.06	0.04	0.01
100	137.62	12.65	20.80	2.10	0.53	0.02	0.00
100	15.66	81.53	7.34	9.26	0.74	0.28	0.02
100	19.80	22.31	47.05	2.31	2.06	0.22	0.06
100	9.72	27.79	8.49	13.97	0.66	0.56	0.06
100	32.80	63.49	19.24	4.90	5.11	0.24	0.18
100	660.67	19.07	11.41	6.88	1.97	1.64	0.06
100	119.02	306.11	4.60	2.21	1.30	0.73	0.27
100	0.79	37.90	113.52	1.79	0.65	0.40	0.18
100	21.49	6.75	26.32	69.31	0.70	0.37	0.18

Table 3.1.1 (Cont'd)

IBTS_Q1

1973	2001					
1	1	0.99	1			
0	5					
1	1136.1	136.1	-1	-1	-1	-1
1	1146.3	355.8	-1	-1	-1	-1
1	105	556.4	-1	-1	-1	-1
1	139.4	66.5	-1	-1	-1	-1
1	352.8	105.9	-1	-1	-1	-1
1	468.2	212.4	-1	-1	-1	-1
1	863.7	388.6	-1	-1	-1	-1
1	267.7	637.6	-1	-1	-1	-1
1	537.6	253	-1	-1	-1	-1
1	308.2	402.6	89.8	115.3	12.7	1.9
1	1067.7	221.3	130.9	20.9	21.2	4.6
1	228.5	828.4	105.1	33.8	4.3	7.2
1	584.5	251.1	285.9	17.2	6	2.1
1	917.3	328.8	47.2	61.1	4.7	2.6
1	100.7	671	97	12.7	13.6	2
1	217.6	97.4	273.7	16.8	2.1	4.7
1	217.4	139.1	33	50.4	3.2	1.8
1	678	133	24.8	4.2	8.4	2.4
1	1163	344.6	18.1	3	0.6	2
1	1254.3	540.8	154.5	8.9	1.1	1
1	228.7	503.9	98.3	23.3	1.6	0.8
1	1355.5	201.1	176.2	24.3	5.3	0.8
1	267.4	813.3	65.9	46.7	7.7	3.1
1	860.2	366.4	470.6	24.8	15.1	3.4
1	373.6	432.3	105.5	113.7	8.7	5.4
1	211.8	232.9	129.7	48.1	36.6	4.3
1	3702.1	107.8	49.9	25.4	15.6	10.3
1	887.6	2279	47.8	10.9	7.2	5.7
1	57	471.1	1308.4	8.7	6.7	3.8

Table 3.2.1

```
HADDOCK IN IV, RCT3 INPUT VALUES    Age 0   07.okt.02

5   32   2
'YEARCLASS'     'VPA'   'IYFS1' 'IYFS2' 'EGFS0' 'EGFS1' 'EGFS2' 'SGFS0' 'SGFS1' 'SGFS2' 'GGFS1' 'GGFS2' 'IBQ21' 'SCQ21' 'SCQ22' 'IBQ40' 'IBQ41' 'ENQ40'
'ENQ41' 'ENQ42'

1971     782849   395.1    876.3    -1   -1   -1   -1   -1   -1   -1   -1   -1   -1   -1   -1   -1   -1   -1   -1
1972     215393   327.8    136.1    -1   -1   -1   -1   -1   -1   -1   -1   -1   -1   -1   -1   -1   -1   -1   -1
1973     728990   1136.1   355.8    -1   -1   -1   -1   -1   -1   -1   -1   -1   -1   -1   -1   -1   -1   -1   -1
1974     1334922  1146.3   556.4    -1   -1   -1   -1   -1   -1   -1   -1   -1   -1   -1   -1   -1   -1   -1   -1
1975     115433   105      66.5     -1   -1   32.1 -1   -1   -1   -1   -1   -1   -1   -1   -1   -1   -1   -1   -1
1976     164838   139.4    105.9    -1        66.8      26.2 -1   -1   -1   -1   -1   -1   -1   -1   -1   -1   -1   -1   -1
1977     257565   352.8    212.4    534.8     136.9     54.6 -1   -1   -1   -1   -1   -1   -1   -1   -1   -1   -1   -1   -1
1978     395470   468.2    388.6    358.3     295.5     167.3     -1   -1   -1   -1   -1   -1   -1   -1   -1   -1   -1   -1   -1
1979     721508   863.7    637.6    875.5     623.3     439.1     -1   -1   -1   -1   -1   -1   -1   -1   -1   -1   -1   -1   -1
1980     156532   267.7    253      374       173.2     79.8      -1   -1   99.6 -1   -1   -1   -1   -1   -1   -1   -1   -1   -1
1981     324795   537.6    402.6    1537.5    315.5     109.5     -1   248.8     161.1     -1   72.8 -1   -1   -1   -1   -1   -1   -1   -1
1982     206252   308.2    221.3    281.3     218.2     61.6           123.5     181.3     78.8 93.9 47.2 -1   -1   -1   -1   -1   -1   -1   -1
1983     669817   1067.7   828.4    831.9     599.3     238.2     220.3     436.7     298.1     272.9     259.6     -1   -1   -1   -1   -1   -1   -1   -1
1984     172744   228.5    251.1    228.5     186.6     44.7      87.3      197.6     57.4 129.7     38   -1   -1   -1   -1   -1   -1   -1   -1
1985     240531   584.5    328.8    245.9     149.7     43.1      81.8      232.9     70.4 142.3     154.4     -1   -1   -1   -1   -1   -1   -1   -1
1986     498849   917.3    671      266       281.9     183.5     174.7     239.3     198.2     307.4     179.9     -1   -1   -1   -1   -1   -1   -1   -1
1987     42019    100.7    97.4     22.4      28.6      14.5      27.7      46.7      21.4 68.6 45.3 -1   -1   -1   -1   -1   -1   -1   -1
1988     84419    217.6    139.1    60.7      81.7      19.8      40.6      88.6      24   135  54.7 -1   -1   -1   -1   -1   -1   -1   -1
1989     87061    217.4    133      94.3      66.4      9.6       43.2      100.2     17.8 180  54.9 -1   -1   493  -1   -1   -1   -1 5.094
1990     281406   678      344.6    281.9     115       97.7      316.3     170.5     96.3 601  129.2     502  4087 2854 -1   481  -1   57.81822.977
1991     274243   1163     540.8    263.3     196.9     58.6      347.1     383.2     138  480.1     -1   772  8196 2680 1128 845.63    90.712    74.86517.137
1992     406162   1254.3   503.9    827.7     246.1     90.2 827  583.6     208  -1   163.5     1276 11963     3838 2461.76   1005.92   198.232   7522.192
1993     127196   228.7    201.1    135.8     80.7 44.5 85.9 126.5     73.4 186.8     69.4 495  1295 1186 636.18    673.3     42.168    185.2617.995
1994     531846   1355.5   813.3    943  383.1     145.7     1376.2    815.3     470.5     526.6     -1   1549 12539     6889 3519.24   2190.92   137.483160.92855.913
1995     125175   267.4    366.4    180  83.1 43.3 156.6     223.1     84.9 -1   -1   790  1922 1472 598.78    -1   51.541    24.735    -1
1996     206655   860.2    432.3    199  149  56.8 198  277.9     192.4     -1   -1   1463 3144 -1   -1   -1   65.677    -1   -1
1997     119328   373.6    232.9    130  89   28.3      97.2      634.9     114.1     -1   -1   -1   -1   -1   -1   -1   -1   -1   -1
1998     94089    211.8    107.8    53   56   15.2      328  190.7     46   -1   -1   -1   -1   -1   -1   -1   -1   -1   -1
1999     1106706  3702.1   2279     2110      841  325  6606.7    3061.1    1135.2    -1   -1   -1   -1   -1   -1   -1   -1   -1   -1
2000 -1  887.6    471.1    310  96   75.962    1190.2    379  263.2     -1   -1   -1   -1   -1   -1   -1   -1   -1   -1
2001 -1  57   -1   3.7  13.289    -1   7.9  67.5 -1   -1   -1   -1   -1   -1   -1   -1   -1   -1   -1
2002 -1  -1   -1   9.189     -1   -1   214.9     -1   -1   -1   -1   -1   -1   -1   -1   -1   -1   -1

Yclass   VPA  IBQ11    IBQ12    egfs0    egfs1    egfs2    sgfs0    sgfs1    sgfs2    ggfs1    ggfs2    IBQ21    SCQ21    SCQ22    IBQ40    IBQ41    ENQ40
    ENQ41 ENQ42
```

Table 3.2.2

```
HADDOCK IN IV, RCT3 INPUT VALUES   Age 1    07.okt.02

5   32  2
'YEARCLASS'     'VPA'    'IYFS1' 'IYFS2' 'EGFS0' 'EGFS1' 'EGFS2' 'SGFS0' 'SGFS1' 'SGFS2' 'GGFS1' 'GGFS2' 'IBQ21' 'SCQ21' 'SCQ22' 'IBQ40' 'IBQ41' 'ENQ40'
'ENQ41' 'ENQ42'

1971 99584    395.1    876.3    -1   -1   -1   -1   -1   -1   -1   -1   -1   -1   -1   -1   -1   -1   -1   -1
1972 26853    327.8    136.1    -1   -1   -1   -1   -1   -1   -1   -1   -1   -1   -1   -1   -1   -1   -1   -1
1973 93629    1136.1   355.8    -1   -1   -1   -1   -1   -1   -1   -1   -1   -1   -1   -1   -1   -1   -1   -1
1974 169645   1146.3   556.4    -1   -1   -1   -1   -1   -1   -1   -1   -1   -1   -1   -1   -1   -1   -1   -1
1975 14694    105  66.5 -1   -1   32.1 -1   -1   -1   -1   -1   -1   -1   -1   -1   -1   -1   -1   -1
1976 20595    139.4    105.9    -1   66.8 26.2 -1   -1   -1   -1   -1   -1   -1   -1   -1   -1   -1   -1   -1
1977 32724    352.8    212.4    534.8    136.9    54.6 -1   -1   -1   -1   -1   -1   -1   -1   -1   -1   -1   -1   -1
1978 49816    468.2    388.6    358.3    295.5    167.3    -1   -1   -1   -1   -1   -1   -1   -1   -1   -1   -1   -1   -1
1979 89719    863.7    637.6    875.5    623.3    439.1    -1   -1   -1   -1   -1   -1   -1   -1   -1   -1   -1   -1   -1
1980 18718    267.7    253  374  173.2    79.8 -1   -1   99.6 -1   -1   -1   -1   -1   -1   -1   -1   -1   -1
1981 39493    537.6    402.6    1537.5   315.5    109.5    -1   248.8    161.1    -1   72.8 -1   -1   -1   -1   -1   -1   -1   -1
1982 25552    308.2    221.3    281.3    218.2    61.6 123.5    181.3    78.8 93.9 47.2 -1   -1   -1   -1   -1   -1   -1   -1
1983 83933    1067.7   828.4    831.9    599.3    238.2    220.3    436.7    298.1    272.9    259.6    -1   -1   -1   -1   -1   -1   -1   -1
1984 21896    228.5    251.1    228.5    186.6    44.7 87.3 197.6    57.4 129.7    38   -1   -1   -1   -1   -1   -1   -1   -1
1985 30464    584.5    328.8    245.9    149.7    43.1 81.8 232.9    70.4 142.3    154.4    -1   -1   -1   -1   -1   -1   -1   -1
1986 64017    917.3    671  266  281.9    183.5    174.7    239.3    198.2    307.4    179.9    -1   -1   -1   -1   -1   -1   -1   -1
1987 5361 100.7    97.4 22.4 28.6 14.5 27.7 46.7 21.4 68.6 45.3 -1   -1   -1   -1   -1   -1   -1   -1
1988 10808    217.6    139.1    60.7 81.7 19.8 40.6 88.6 24   135  54.7 -1   -1   -1   -1   -1   -1   -1   -1
1989 11165    217.4    133  94.3 66.4 9.6  43.2 100.2    17.8 180  54.9 -1   -1   493  -1   -1   -1   -15.094
1990 36020    678  344.6    281.9    115  97.7 316.3    170.5    96.3 601  129.2    502  4087 2854 -1   481  -1   57.81822.977
1991 34860    1163 540.8    263.3    196.9    58.6 347.1    383.2    138  480.1    -1   772  8196 2680 1128 845.63    90.712   74.86517.137
1992 51316    1254.3   503.9    827.7    246.1    90.2 827  583.6    208  -1   163.5    1276 11963    3838 2461.76   1005.92  198.232  7522.192
1993 15868    228.7    201.1    135.8    80.7 44.5 85.9 126.5    73.4 186.8    69.4 495  1295 1186 636.18   673.3    42.168   185.2617.995
1994 68159    1355.5   813.3    943  383.1    145.7    1376.2   815.3    470.5    526.6    -1   1549 12539    6889 3519.24  2190.92  137.483160.92855.913
1995 15132    267.4    366.4    180  83.1 43.3 156.6    223.1    84.9 -1   -1   790  1922 1472 598.78   -1   51.541   24.735   -1
1996 25357    860.2    432.3    199  149  56.8 198  277.9    192.4    -1   -1   1463 3144 -1   -1   -1   65.677   -1   -1
1997 15218    373.6    232.9    130  89   28.3 97.2 634.9    114.1    -1   -1   -1   -1   -1   -1   -1   -1   -1   -1
1998 12027    211.8    107.8    53   56   15.2 328  190.7    46   -1   -1   -1   -1   -1   -1   -1   -1   -1   -1
1999 142083   3702.1   2279 2110 841  325  6606.7   3061.1   1135.2   -1   -1   -1   -1   -1   -1   -1   -1   -1   -1
2000 -1   887.6    471.1    310  96   75.962   1190.2   379  263.2    -1   -1   -1   -1   -1   -1   -1   -1   -1   -1
2001 -1   57   -1   3.7  13.289   -1   7.9  67.5 -1   -1   -1   -1   -1   -1   -1   -1   -1   -1
2002 -1   -1   -1   9.189    -1   -1   214.9    -1   -1   -1   -1   -1   -1   -1   -1   -1   -1   -1

Yclass   VPA  IBQ11    IBQ12    egfs0    egfs1    egfs2    sgfs0    sgfs1    sgfs2    ggfs1    ggfs2    IBQ21    SCQ21    SCQ22    IBQ40    IBQ41    ENQ40
    ENQ41    ENQ42
```

Table 3.2.3

```
Analysis by RCT3 ver3.1 of data from file :
rct3_0.txt
HADDOCK IN IV, RCT3 INPUT VALUES    Age 0 07.okt.02
Data for    5 surveys over   32 years :  1971 - 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.

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
IYFS1      .91   6.47    .26   .922     29   6.79   12.68     .302     .187
IYFS2     1.04   6.15    .30   .900     29   6.16   12.55     .345     .143
EGFS0      .76   8.10    .26   .924     23   5.74   12.47     .296     .195
EGFS1     1.02   7.17    .21   .950     24   4.57   11.85     .238     .300
EGFS2      .93   8.53    .29   .905     25   4.34   12.57     .335     .152
                                       VPA Mean =   12.24     .863     .023

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
IYFS1      .90   6.52    .25   .929     29   4.06   10.19     .354     .294
EGFS0      .76   8.12    .25   .931     23   1.55    9.29     .405     .225
EGFS1     1.02   7.20    .20   .955     24   2.66    9.91     .292     .432
                                       VPA Mean =   12.25     .868     .049

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      .75   8.15    .24   .936     23   2.32    9.89     .368     .850
                                       VPA Mean =   12.26     .875     .150

Year     Weighted      Log      Int      Ext      Var      VPA       Log
Class     Average      WAP      Std      Std     Ratio               VPA
         Prediction             Error    Error
2000      229594     12.34      .13      .15      1.31
2001       21320      9.97      .19      .35      3.36
2002       28215     10.25      .34      .85      6.22
```

Table 3.2.4

Analysis by RCT3 ver3.1 of data from file :
rct3_1.txt
HADDOCK IN IV, RCT3 INPUT VALUES Age 1 07.okt.02
Data for 5 surveys over 32 years : 1971 - 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.

Yearclass = 2000

Survey/ Series	Regression: Slope	Inter- cept	Std Error	Rsquare	No. Pts	Prediction: Index Value	Predicted Value	Std Error	WAP Weights
IYFS1	.92	4.38	.26	.922	29	6.79	10.61	.305	.193
IYFS2	1.05	4.03	.32	.893	29	6.16	10.48	.361	.137
EGFS0	.77	6.00	.27	.920	23	5.74	10.41	.307	.190
EGFS1	1.03	5.07	.21	.950	24	4.57	9.78	.240	.310
EGFS2	.94	6.43	.30	.899	25	4.34	10.50	.349	.147
					VPA Mean =		10.17	.867	.024

Yearclass = 2001

Survey/ Series	Regression: Slope	Inter- cept	Std Error	Rsquare	No. Pts	Prediction: Index Value	Predicted Value	Std Error	WAP Weights
IYFS1	.91	4.41	.26	.928	29	4.06	8.11	.358	.297
EGFS0	.76	6.02	.26	.926	23	1.55	7.20	.422	.214
EGFS1	1.02	5.11	.20	.955	24	2.66	7.83	.295	.439
					VPA Mean =		10.18	.873	.050

Yearclass = 2002

Survey/ Series	Regression: Slope	Inter- cept	Std Error	Rsquare	No. Pts	Prediction: Index Value	Predicted Value	Std Error	WAP Weights
EGFS0	.76	6.04	.25	.932	23	2.32	7.80	.385	.840
					VPA Mean =		10.19	.880	.160

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
2000	28894	10.27	.13	.15	1.28		
2001	**2682**	7.89	.20	.36	3.32		
2002	3588	8.19	.35	.88	6.18		

Table 3.3.1

Haddock,North Sea and IIIa
input data for catch forecast and linear sensitivity analysis

Label	Value	CV	Label	Value	CV
Number at age			Weight in the stock		
N0	2821500	0.85	WS0	0.03	0.49
N1	185188	0.45	WS1	0.13	0.24
N2	485845	0.15	WS2	0.24	0.08
N3	1207832	0.13	WS3	0.35	0.09
N4	16899	0.14	WS4	0.48	0.04
N5	6089	0.18	WS5	0.60	0.17
N6	2551	0.26	WS6	0.70	0.08
N7	735	0.35	WS7	0.95	0.17
N8	421	0.47	WS8	1.24	0.47
N9	66	0.47	WS9	1.40	0.22
N10	29	0.49	WS10	2.03	0.12
H.cons selectivity			Weight in the HC catch		
sH0	0.00	0.00	WH0	0.00	0.00
sH1	0.00	0.73	WH1	0.32	0.16
sH2	0.13	0.72	WH2	0.35	0.03
sH3	0.49	0.21	WH3	0.43	0.03
sH4	0.78	0.28	WH4	0.50	0.04
sH5	0.84	0.21	WH5	0.62	0.17
sH6	0.96	0.25	WH6	0.71	0.07
sH7	1.00	0.22	WH7	0.95	0.17
sH8	1.13	0.32	WH8	1.25	0.48
sH9	0.99	0.14	WH9	1.40	0.22
sH10	0.99	0.14	WH10	2.03	0.12
Discard selectivity			Weight in the discards		
sD0	0.00	0.71	WD0	0.04	0.24
sD1	0.06	0.67	WD1	0.14	0.25
sD2	0.33	0.45	WD2	0.22	0.09
sD3	0.23	0.34	WD3	0.29	0.06
sD4	0.09	0.47	WD4	0.31	0.02
sD5	0.04	0.49	WD5	0.34	0.09
sD6	0.03	1.44	WD6	0.18	0.87
sD7	0.00	1.73	WD7	0.14	1.73
sD8	0.01	1.73	WD8	0.14	1.73
sD9	0.00	0.00	WD9	0.00	0.00
sD10	0.00	0.00	WD10	0.00	0.00
Industrial selectivity			Weight in Ind. bycatch		
sI0	0.01	0.46	WI0	0.03	0.81
sI1	0.02	0.31	WI1	0.07	0.16
sI2	0.08	1.19	WI2	0.14	0.23
sI3	0.13	1.14	WI3	0.20	0.50
sI4	0.01	0.67	WI4	0.38	0.09
sI5	0.00	0.92	WI5	0.31	0.36
sI6	0.00	1.73	WI6	0.00	0.00
sI7	0.00	0.00	WI7	0.00	0.00
sI8	0.00	0.00	WI8	0.00	0.00
sI9	0.00	0.00	WI9	0.00	0.00
sI10	0.00	0.00	WI10	0.00	0.00
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
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		
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

Table 3.3.1 (Cont'd)

```
Relative effort in industrial fishery
IF02       1.00   0.54
IF03       1.00   0.54
IF04       1.00   0.54

Recruitment in 2003 and 2004
R03    25895600   1.02
R04    25895600   1.02



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

 Stock numbers in 2002 are VPA survivors.


 Human consumption + discard Fs are obtained from mean exploitation pattern over 1999 to 2001.
 This is scaled to give a value for mean F (ages 2 to  6) equal to that in 2001, i.e.  0.783
 Fs are distributed between consumption and discards by mean proportion retained over 1999 to 2001.
 N.B. Above value for H.cons+Disc   ref F is value for both catch categories combined.


 Bycatch Fs are obtained from mean exploitation pattern over 1999 to 2001.,
 This is scaled to give a value for mean F (ages 2 to  6) equal to that in 2001, i.e.  0.046

Data from file:C:\2002had_b\shortterm\hadiv.sen on 08/10/2002 at 14:32:03
```

Table 3.3.2

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

	Year 2002	2003						
Mean F Ages								
H.cons+disc 2 to 6	0.78	0.39	0.47	0.55	0.58	0.63	0.71	0.78
Ind BC 2 to 6	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Effort relative to 2001								
H.cons+disc	1.00	0.50	0.60	0.70	0.74	0.80	0.90	1.00
Ind BC	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Biomass								
Total 1 January	572	318	318	318	318	318	318	318
SSB at spawning time	347	221	221	221	221	221	221	221
Catch weight (,000t)								
H.cons	174	73	84	95	99	104	113	122
Discards	73	10	12	13	14	15	16	17
Ind BC	23	7	7	6	6	6	6	6
Total Landings	198	79	91	101	105	111	119	128
Total Catch	271	89	102	114	119	125	135	145
Biomass in year.... 2004								
Total 1 January		626	612	600	595	588	577	568
SSB at spawning time		169	156	144	140	134	124	115

	Year 2002	2003						
Effort relative to 2001								
H.cons+disc	1.00	0.50	0.60	0.70	0.74	0.80	0.90	1.00
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	0.12	0.28	0.28	0.28	0.28	0.28	0.28	0.28
SSB at spawning time	0.16	0.27	0.27	0.27	0.27	0.27	0.27	0.27
Catch weight								
H.cons	0.26	0.48	0.42	0.39	0.38	0.36	0.35	0.33
Discards	0.32	0.50	0.45	0.41	0.40	0.39	0.37	0.36
Ind BC	1.13	0.89	0.89	0.89	0.89	0.89	0.89	0.89
Biomass in year.... 2004								
Total 1 January		0.81	0.83	0.84	0.85	0.86	0.87	0.89
SSB at spawning time		0.36	0.37	0.37	0.37	0.37	0.38	0.38

Table 3.3.3

Haddock,North Sea and IIIa
Detailed forecast tables.

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

Populations		Catch number			
Age	Stock No.	H.Cons	Discards	By-catch	Total
0	2821500	0	0	5986	5986
1	185188	88	5456	1672	7216
2	485845	40578	103804	26423	170805
3	1207832	358493	170120	97837	626451
4	16899	7916	872	101	8890
5	6089	3134	134	11	3279
6	2551	1437	39	0	1476
7	735	427	1	0	429
8	421	262	2	0	263
9	66	38	0	0	38
10	29	17	0	0	17
Wt	572	174	73	23	271

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

Populations		Catch number			
Age	Stock No.	H.Cons	Discards	By-catch	Total
0	25895600	0	0	54936	54936
1	361414	172	10648	3263	14083
2	32765	2737	7001	1782	11519
3	189216	56161	26651	15327	98138
4	398849	186844	20574	2392	209811
5	5475	2818	120	10	2948
6	2066	1164	31	0	1195
7	777	452	1	0	453
8	221	137	1	0	138
9	111	64	0	0	64
10	29	17	0	0	17
Wt	318	122	17	6	145

Table 3.5.1

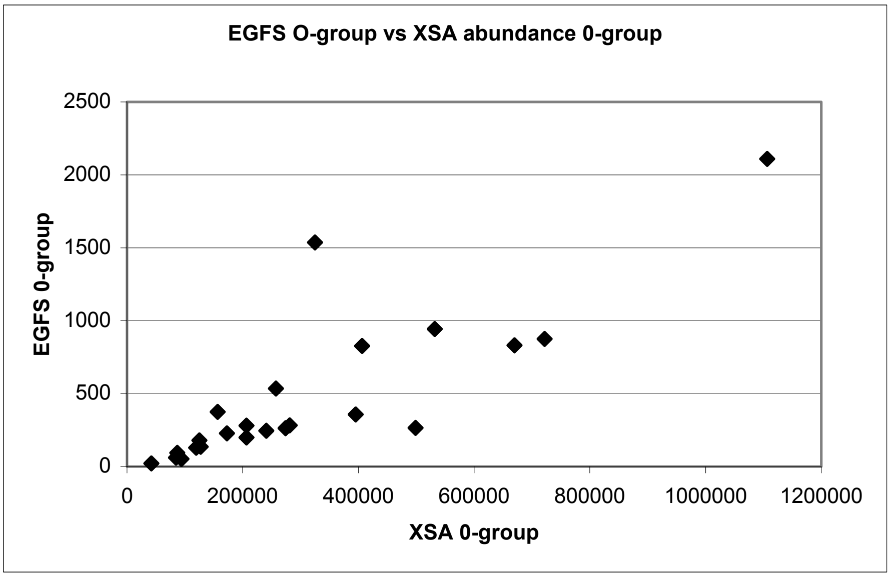
Survey Z by yearclass. Fleet: ENGGFS

	Age						
	0-1	1-2	2-3	3-4	4-5	5-6	6-7
Yearclass							
1971							0.25
1972						1.95	
1973					1.48	1.66	0.69
1974				1.02	1.62	1.15	0.85
1975			2.59	0.78	1.01		
1976		0.94	1.10	1.17	1.50	-0.51	2.30
1977	1.36	0.92	0.75	1.25	1.13	1.79	1.39
1978	0.19	0.57	0.79	1.99	1.34	0.99	0.92
1979	0.34	0.35	1.31	1.69	1.51	1.31	1.18
1980	0.77	0.77	1.32	1.63	0.74	1.61	
1981	1.58	1.06	1.27	1.48	1.36	1.79	1.10
1982	0.25	1.26	1.07	2.02	1.72	0.22	1.39
1983	0.33	0.92	1.95	1.59	0.90	1.54	1.79
1984	0.20	1.43	2.13	1.20	1.67	0.00	1.10
1985	0.50	1.25	1.02	1.82	1.61		
1986	-0.06	0.43	1.53	1.51	1.39	1.01	2.08
1987	-0.24	0.68	1.61	1.76	1.61		
1988	-0.30	1.42	2.15	1.53	0.92		
1989	0.35	1.94	0.50	2.27	1.10	0.69	
1990	0.90	0.16	1.77	1.78	1.13	0.59	2.12
1991	0.29	1.21	1.94	1.10	1.39	0.95	2.20
1992	1.21	1.00	0.98	1.41	1.35	1.55	1.34
1993	0.52	0.60	1.29	1.68	1.01	1.78	
1994	0.90	0.97	0.79	1.54	1.25	1.23	1.83
1995	0.77	0.65	1.17	1.16	1.32	0.92	0.34
1996	0.29	0.96	1.53	1.61	0.74	0.84	
1997	0.38	1.14	1.64	0.68	2.13		
1998	-0.05	1.30	0.40	1.72			
1999	0.92	0.95	0.47				
2000	1.17	0.24					
2001	-1.27						

Survey Z by yearclass. Fleet: SCOGFS

	Age							
	0-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8
Yearclass								
1975								0.00
1976							0.69	0.00
1977						-0.54	0.88	0.92
1978					0.77	1.77	0.81	
1979				1.08	1.95	1.08	1.99	0.41
1980			0.98	1.91	1.37	1.25	1.39	
1981		0.43	1.57	1.18	1.34	1.69	1.61	
1982	-0.38	0.83	1.22	1.86	1.50	1.39	0.69	0.00
1983	-0.68	0.38	1.61	1.54	1.72	1.19	0.85	1.10
1984	-0.82	1.24	1.69	1.37	1.91	1.39		
1985	-1.05	1.20	1.42	1.70	1.49	1.25		
1986	-0.31	0.19	1.24	1.72	1.86	0.69	0.98	
1987	-0.52	0.78	1.90	1.86	0.51	1.10		
1988	-0.78	1.31	2.44	0.97	0.69			
1989	-0.84	1.73	1.31	2.08	1.10	0.00		
1990	0.62	0.57	1.28	1.62	0.64	1.54		
1991	-0.10	1.02	1.88	1.04	1.21	1.30	1.10	0.69
1992	0.35	1.03	0.81	1.50	1.30	1.13	0.94	0.85
1993	-0.39	0.54	1.16	1.25	1.01	1.39	0.41	1.39
1994	0.52	0.55	1.21	1.01	1.14	1.80	0.66	1.54
1995	-0.35	0.97	0.55	0.91	0.99	1.40	1.79	
1996	-0.34	0.37	1.03	1.67	1.18	0.80		
1997	-1.88	1.72	1.64	1.22	0.56			
1998	0.54	1.42	0.94	0.94				
1999	0.77	0.99	0.49					
2000	1.14	0.36						
2001	-2.15							

Figure 3.2.1 Haddock. Regression of EGFS 0-group index agains XSA 0-group estimate in numbers (top) and log numbers (bottom)



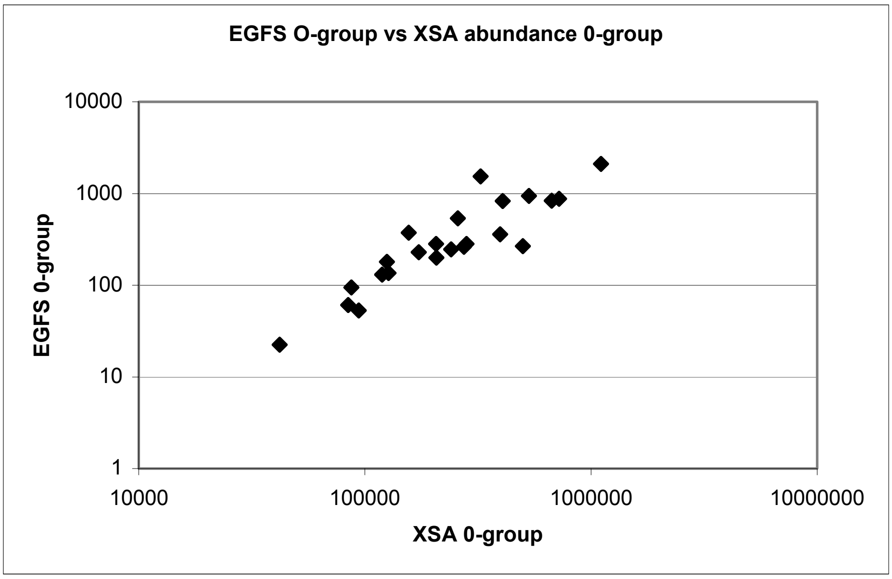
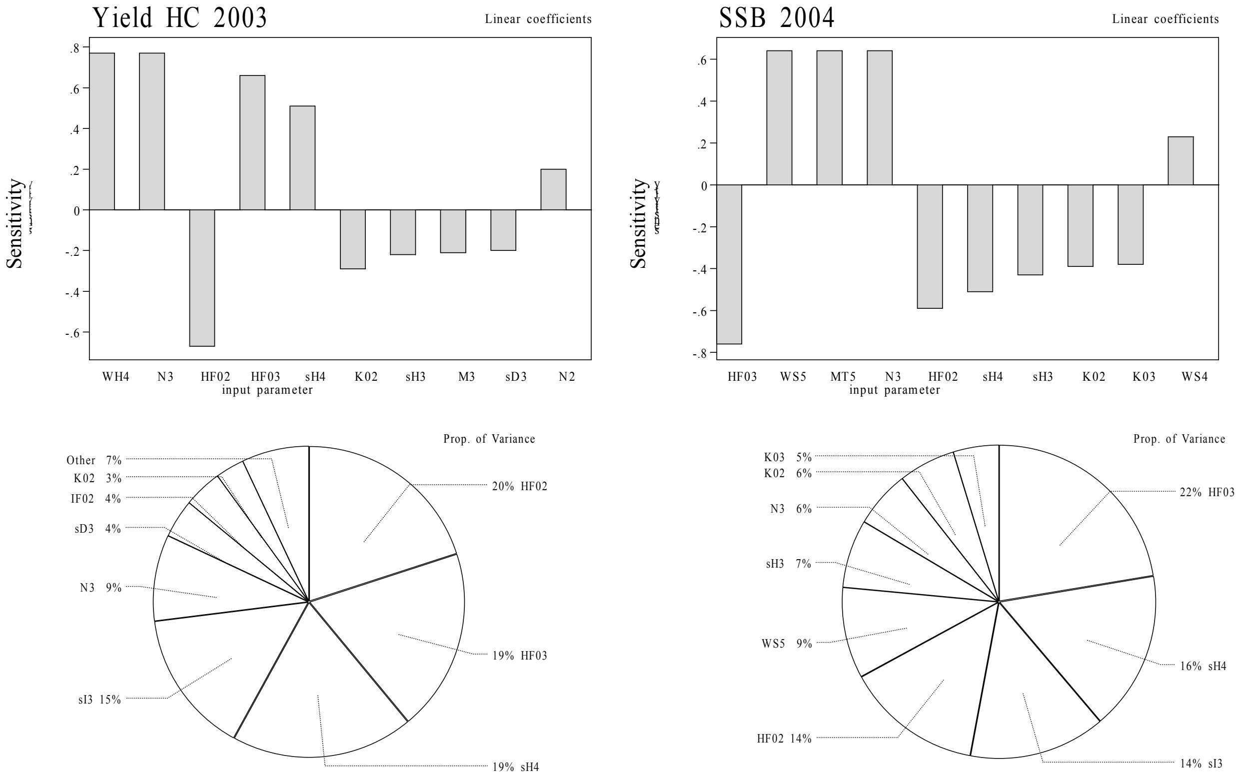


Figure 3.3.1

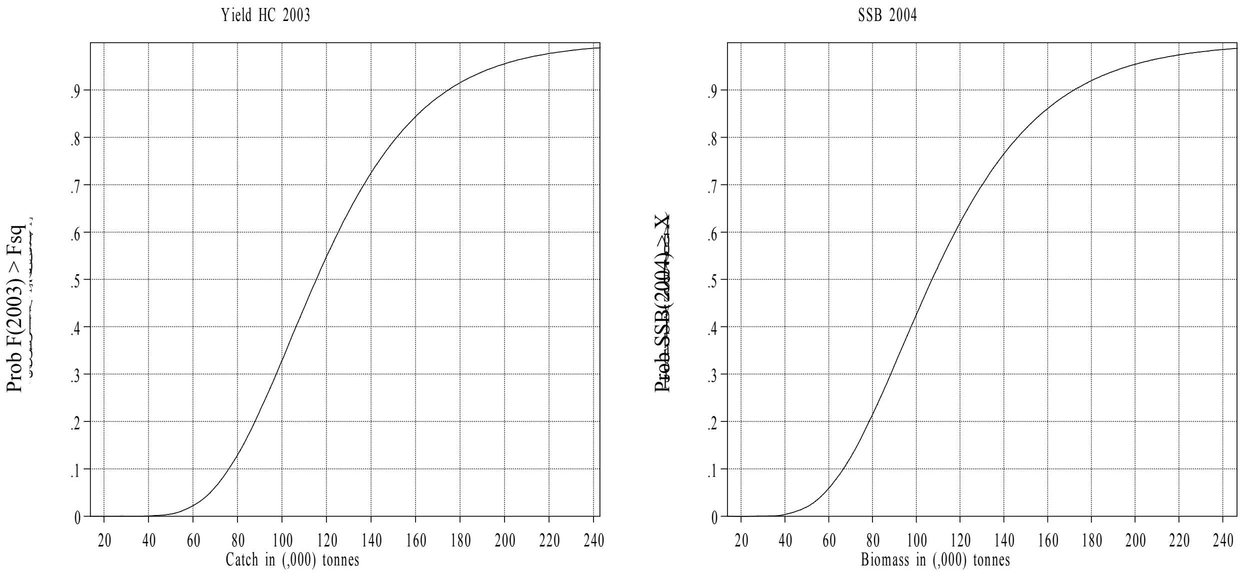
Figure Haddock,North Sea and IIIa. Sensitivity analysis of short term forecast.



Data from file:C:\2002had_b\shortterm\hadiv.sen on 08/10/2002 at 11:49:59

Figure 3.3.2

Figure Haddock,North Sea and IIIa. Probability profiles for short term forecast.



Data from file:C:\2002had_b\shortterm\hadiv.sen on 08/10/2002 at 11:50:20

Figure 3.3.3

Figure Haddock,North Sea and IIIa. Short term forecast

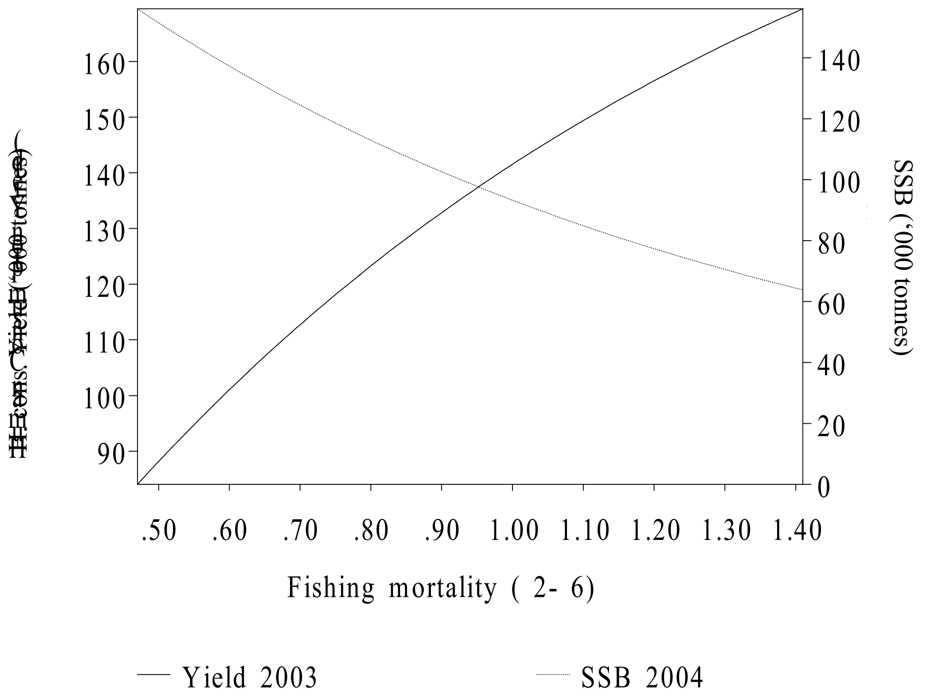


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Figure 3.4.1

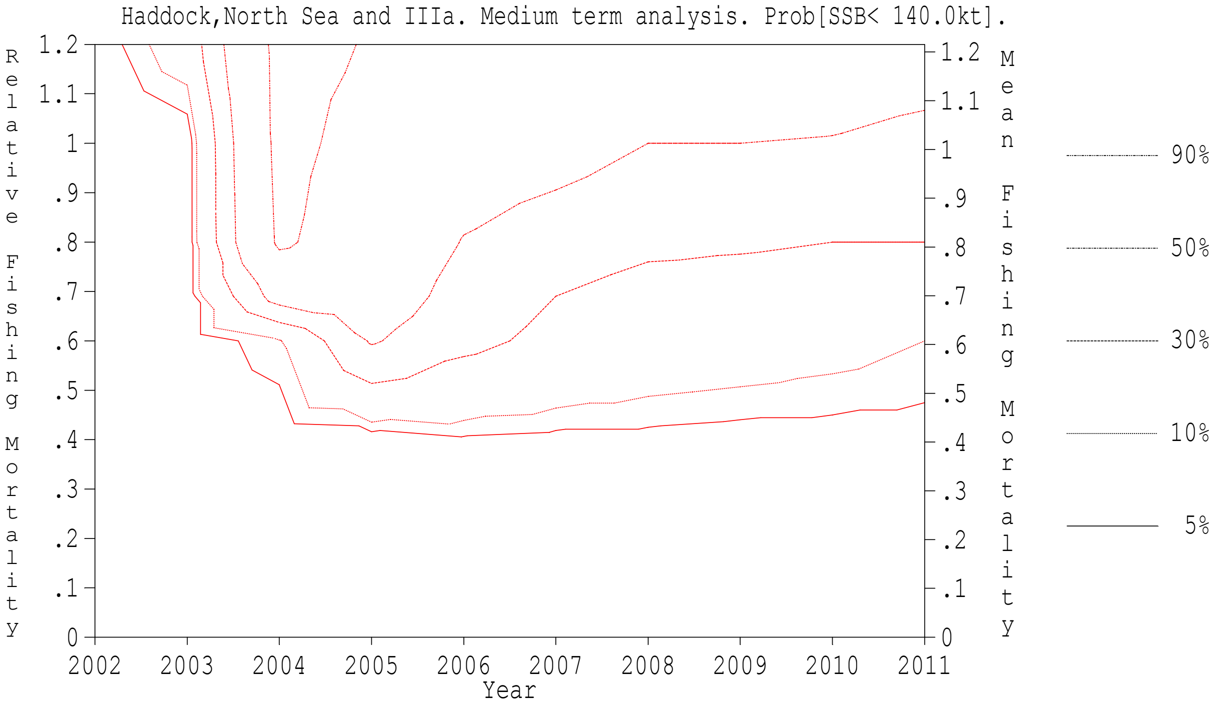
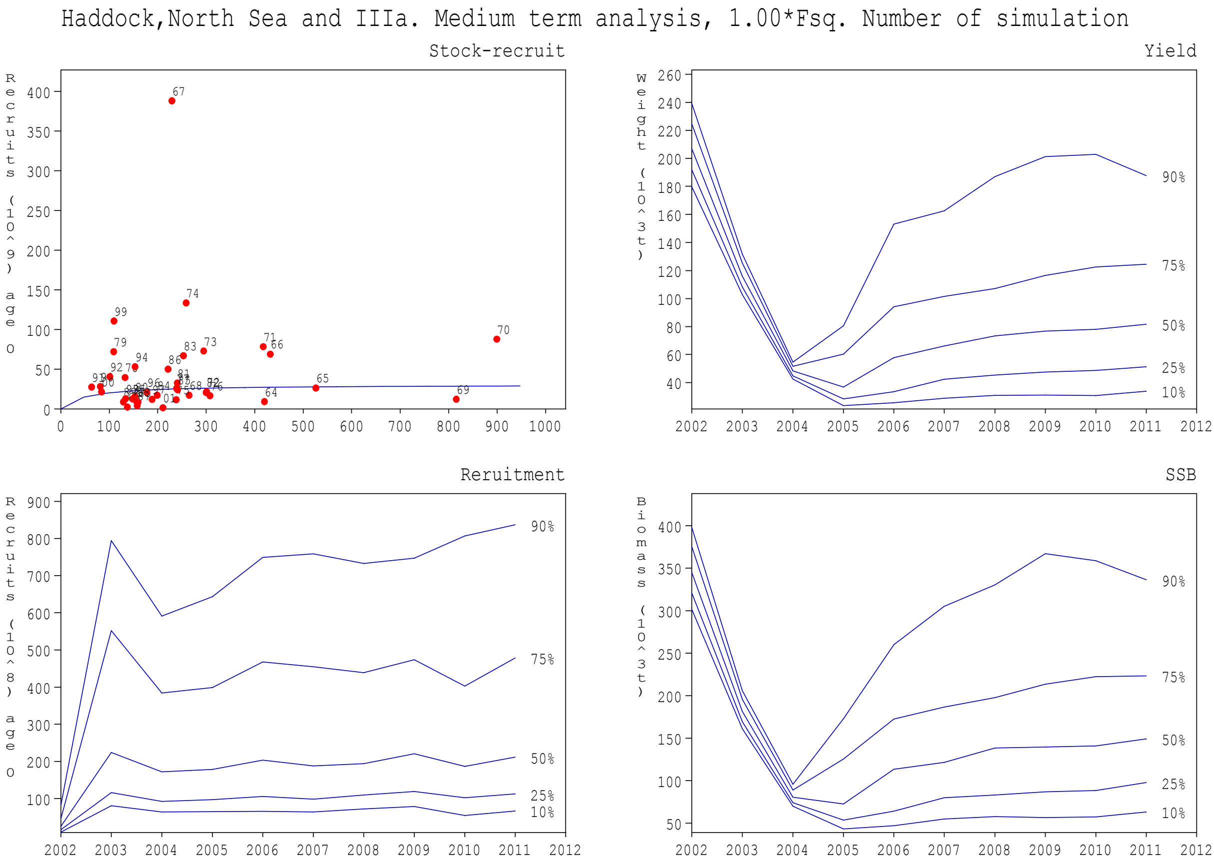


Figure 3.4.2



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4 WHITING IN SUB-AREA IV AND DIVISION VIID

4.1 Survey data

Since the Working Group meeting in June 2002, additional survey data has been collated and made available for the Scottish (ScoGFS) and English (EngGFS) late summer groundfish surveys. The availability of these data provided an impetus for the Subgroup to analyse the extant survey indices in rather more detail than had been done previously. This was done using SURBA (Version 2.00), a new assessment method based on a separable model of fishing mortality as indicated by research-vessel survey indices, and which has been described in detail elsewhere (see Section 1.3 and Needle 2002). SURBA runs were performed for the ScoGFS, EngGFS and IBTS survey series, using manual catchability in all cases and either manual (EngGFS) or inverse-variance (ScoGFS and IBTS) age weighting.

Summary output plots for these three SURBA runs are given in Figures 4.1.1 to 4.1.3, while the summaries are compared with the mean-standardised equivalents from the final no-survey TSA run (see below) in Figure 4.1.4. The trends for relative SSB can be grouped into three distinct periods. From the early to mid 1980s, all estimates rise to a peak around 1981, before falling. From the mid-1980s to the mid-1990s the estimates are divergent, with the TSA SURBA estimates falling, ScoGFS rising, EngGFS steady with a slight rise, and IBTS domed. The estimates are consistent again from the mid-1990s onwards, with all showing a decline then a rise. The important point to note is that there is evidence from a number of different sources for a moderate recent recovery of SSB in this whiting stock. The picture for mean $F_{2–6}$ is more confused: EngGFS and IBTS show decline then rise, while TSA and ScoGFS show quite steady decline. Changes in recent fishing mortality are therefore more difficult to characterise with any confidence.

4.2 Historical TSA assessments revisited

Four different TSA assessments were presented in the 2002 Working Group report, one using catch-at-age data alone and three using catch-at-age data tuned by each of the major survey series in turn (ScoGFS, EngGFS, and IBTS). In preparation for the subgroup meeting, the runs using the ScoGFS and EngGFS were redone in order to accommodate the newly-available 2002 survey data, while a TSA run tuned by the FraGFS series is presented here for the first time. Summary statistics from these five TSA runs are compared in Figures 4.2.1 and 4.2.2. As was the case in the original WG report, these show that incorporating survey series in the TSA runs makes no significance difference to the outcome. There is therefore nothing in the model diagnostics to imply the use of anything other than the no-survey TSA assessment. However, catch-at-age data for North Sea whiting are prone to considerable inaccuracies from various misreporting biases, and an assessment based entirely on such data must be viewed with caution.

4.3 Recruitment estimates

Forecasts of abundance at age-1 in 2002 and 2003 are available from each of the five TSA runs presented above. They are listed below, along with the geometric mean (GM) of the 1980–2001 recruitment time-series. It would be possible to produce RCT3 estimates for these surveys, but there seems little reason to do so since the most recent survey data are already included in the tuned TSA assessments.

Source	*R* (2002) (millions)	*R* (2003) (millions)
TSA (no surveys)	1949 (se 739)	2024 (se 767)
TSA (ScoGFS)	2073 (se 759)	2085 (se 762)
TSA (EngGFS)	1838 (se 618)	1909 (se 644)
TSA (IBTS Q1)	1887 (se 407)	1998 (se 664)
TSA (FraGFS)	2056 (se 741)	2092 (se 751)
GM (1980 – 2001)	1931	1931

Estimated recruitment thus ranges from 1838 million to 2073 million in 2002, and from 1909 million to 2092 million in 2003. In each case the GM is near the midpoint of the range (midpoint for 2002 = 1956 million, midpoint for 2003 =

2001 million). The Subgroup decided to use the TSA (no survey) estimates for both year-classes: these are constrained by the same Ricker stock-recruitment model which was used to constrain the historical assessment, so the assessment and forecast methodologies are consistent.

4.4 Short-term forecasts

Population numbers at 1 January 2002 for the catch forecast were taken directly from the TSA results for all ages. CVs for these estimates were approximated by their TSA-estimated log standard errors. The TSA estimates were also used for recruiting year-class abundance in 2003 and 2004.

Estimates of fishing mortality-at-age are plotted in Figure 4.4.1. *Status quo* fishing mortalities were the unscaled values of *F*-at-age in 2001. TSA is a statistical time-series method which has already smoothed the estimates of *F* to a certain extent, so to smooth further by taking a three-year mean (scaled or unscaled) would be inappropriate and inconsistent. *F*-at-age for landings, discards and industrial bycatch in each year was apportioned from the total *F*s-at-age, using the ratio of component catch-at-age to the total catch-at-age in each year for each age. The CVs of these *F*-values were estimated using standard errors from the period 1999–2001. As there seemed to be little trend in these data (Figure 4.4.2), mean weights-at-age in landings, discards and total catch were taken to be the average values over the period 1999–2001 (3 years) for short-term forecasts and sensitivity analyses, and 1992–2001 (10 years) for medium-term forecasts and equilibrium analyses. The coefficient of variation used for year-classes recruiting in 2002 and 2003 was the standard deviation of the TSA forecasts for log recruitment in those years. The CV on the human-consumption and industrial bycatch fishing-mortality multipliers was calculated as the CV of the relevant catch component's mean $F_{2–6}$ for 1999–2001.

Input data are shown in Table 4.4.1. The results of the forecast assuming *status quo* F during 2001 are shown in Table 4.4.2 (detailed) and Table 4.4.3 (management options). The predicted landings and SSB at *status quo F* are given below (along with coefficients of variation from WGFRANSW in parentheses), together with figures for 2001:

Year	Catches				Biomass	
	Landings (kt)	Discards (kt)	Bycatch (kt)	Source	SSB (kt)	Source
2001	25.2	16.5	7.4	WG estimates	209.2	TSA
2002	35.8 (0.15)	18.4 (0.24)	6.1 (0.82)	SQ forecast	237.0 (0.17)	TSA
2003	41.1 (0.16)	20.7 (0.27)	6.8 (0.82)	SQ forecast	270.0 (0.21)	SQ forecast
2004	-	-	-	-	294.5 (0.23)	SQ forecast

The approximate 90% confidence interval for 2003 *status quo* human consumption landings is [31,000 t, 53,000 t] (from WGFRANSW outputs).

The proportionate contributions of the 1998–2002 year classes to the *status quo* landings and discards predictions for 2002 and 2003, and to the corresponding spawning biomass predictions for 2002–2004, are given in Table 4.4.4. The prediction of landings in 2003 is largely shared between the 1998 (19%), 1999 (25%), 2000 (22%) and 2001 (21%) year-classes at age-1, all estimated by TSA. The spawning biomass forecast for 2004 is dominated by the TSA estimates of the 2001 (28%) and 2002 (41%) age-1 abundances.

Inputs to a sensitivity analysis of the *status quo* catch prediction are shown in Table 4.4.1 and the results presented in Figure 4.4.3. These indicate that the prediction of landings for human consumption in 2003 is most sensitive to the year effects on natural mortality in 2002 and fishing mortality in 2003, while the majority (61%) of the variance of this prediction is provided by the population estimates in 2001 for ages 1–4. SSB in 2004 is sensitive to a combination of assumed natural mortality at age-1, the multiplier on natural mortality and the forecast recruitment in 2003, and the assumed maturity and stock weight values at age-2: much of the variance of this prediction is explained by the forecast recruitment in 2003 (46%) and the estimated year-class size in 2001 (21%).

Cumulative probability distributions are presented in Figure 4.4.4. For the probability of *F* in 2003 being below *status quo F* to be 0.5 or less, landings in 2002 should be *ca*. 41,000 t or less. The probability of SSB remaining below $\boldsymbol{B_{pa}}$ (315,000 t) in 2003 is *ca*. 60%. Short-term forecasts for landings and spawning stock biomass are presented in Figure 4.4.5.

Yield and biomass per recruit values are given in Figure 4.4.6. The stock and recruitment scatterplot is shown in Figure 4.4.7.

4.5 Medium-term projections

WGMTERMC was used to run medium term stock projections over a period of 10 years, for 1000 simulations and for a range of *F*-multipliers. Projections were based on the Ricker stock-recruitment model estimated by TSA: this formulation was used as it conformed to perceptions about density-dependent mortality in the species.

Stochastic trends are given in Figure 4.5.1a for the *status quo* projection. The projections rise steadily for yield, recruits and SSB, driven largely by a relatively low *status quo F* and a compensatory stock-recruitment model. Figure 4.5.1b shows the contour distribution of the probability of SSB remaining below $\boldsymbol{B}_{pa}$ for a range of *F*-multipliers – this probability is estimated to be between 30% and 50% by 2011 at *status quo F*.

4.6 Comments

In the forecasts presented above, no account has been taken of the possible effects of the various technical management measures implemented in recent years as part of the cod recovery plan. The principal hindrance to the analyses that would be necessary to attempt such an evaluation has been the lack of empirically-derived selectivity-model parameters. Work to address this lack is currently being pursued in various participating institutes, but could not be completed in time for the Subgroup meeting. This must be viewed as an intersessional priority.

Current fishing-mortality for whiting is estimated to be relatively low, which leads in turn to moderately optimistic short- and medium-term forecasts. However, these do not take into account biological interactions with competing species such as cod, haddock and herring. For this reason, the forecasts must be viewed as conjectural. In addition, the mixed nature of the demersal whitefish fishery in the North Sea means that management considerations for whiting must be driven to a large extent by measures deemed necessary for other species, principally cod.

Table 4.4.1. Whiting in Sub-Area IV and Division VIId. Input data for catch forecast and linear sensitivity analysis, using a short-term (3-year) mean for weights-at-age.

Label	Value	CV	Label	Value	CV
Number at age			Weight in the stock		
N1	1948630	0.38	WS1	0.09	0.26
N2	582710	0.32	WS2	0.18	0.05
N3	263600	0.23	WS3	0.23	0.02
N4	149060	0.25	WS4	0.28	0.06
N5	44690	0.27	WS5	0.28	0.04
N6	10650	0.30	WS6	0.29	0.05
N7	5000	0.31	WS7	0.29	0.06
N8	3820	0.30	WS8	0.28	0.04
H.cons selectivity			Weight in the HC catch		
sH1	0.01	0.26	WH1	0.17	0.07
sH2	0.07	0.08	WH2	0.23	0.04
sH3	0.15	0.28	WH3	0.27	0.01
sH4	0.37	0.08	WH4	0.29	0.04
sH5	0.55	0.03	WH5	0.29	0.06
sH6	0.58	0.05	WH6	0.31	0.02
sH7	0.57	0.09	WH7	0.29	0.07
sH8	0.61	0.09	WH8	0.29	0.04
Discard selectivity			Weight in the discards		
sD1	0.03	0.47	WD1	0.10	0.21
sD2	0.12	0.20	WD2	0.17	0.06
sD3	0.12	0.16	WD3	0.20	0.06
sD4	0.05	0.57	WD4	0.23	0.13
sD5	0.02	0.60	WD5	0.23	0.09
sD6	0.03	0.65	WD6	0.23	0.05
sD7	0.04	0.40	WD7	0.22	0.03
sD8	0.01	0.76	WD8	0.24	0.08
Industrial selectivity			Weight in Ind. bycatch		
sI1	0.05	0.48	WI1	0.04	0.22
sI2	0.03	0.08	WI2	0.14	0.37
sI3	0.05	0.25	WI3	0.17	0.35
sI4	0.01	1.26	WI4	0.27	0.24
sI5	0.01	1.06	WI5	0.33	0.11
sI6	0.01	1.41	WI6	0.13	1.73
sI7	0.00	1.73	WI7	0.20	1.73
sI8	0.00	0.00	WI8	0.00	0.00
Natural mortality			Proportion mature		
M1	0.95	0.10	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
M7	0.20	0.10	MT7	1.00	0.00
M8	0.20	0.10	MT8	1.00	0.00
Relative effort in HC fishery			Year effect for natural mortality		
HF02	1.00	0.05	K02	1.00	0.10
HF03	1.00	0.05	K03	1.00	0.10
HF04	1.00	0.05	K04	1.00	0.10
Relative effort in industrial fishery					
IF02	1.00	0.77			
IF03	1.00	0.77			
IF04	1.00	0.77			
Recruitment in 2003 and 2004					
R03	2023730	0.38			
R04	2074920	0.38			

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

Table 4.4.2. Whiting in Sub-Area IV and Division VIId. Input data for medium-term projections and equilibrium calculations, using a longer-term (10-year) mean for weights-at-age.

Label	Value	CV	Label	Value	CV
Number at age			Weight in the stock		
N1	1948630	0.38	WS1	0.09	0.14
N2	582710	0.32	WS2	0.18	0.04
N3	263600	0.23	WS3	0.24	0.05
N4	149060	0.25	WS4	0.30	0.09
N5	44690	0.27	WS5	0.33	0.13
N6	10650	0.30	WS6	0.35	0.14
N7	5000	0.31	WS7	0.36	0.17
N8	3820	0.30	WS8	0.38	0.20
H.cons selectivity			Weight in the HC catch		
sH1	0.01	0.26	WH1	0.18	0.07
sH2	0.07	0.08	WH2	0.23	0.08
sH3	0.15	0.28	WH3	0.28	0.05
sH4	0.37	0.08	WH4	0.32	0.09
sH5	0.55	0.03	WH5	0.34	0.14
sH6	0.58	0.05	WH6	0.37	0.12
sH7	0.57	0.09	WH7	0.37	0.16
sH8	0.61	0.09	WH8	0.39	0.19
Discard selectivity			Weight in the discards		
sD1	0.03	0.47	WD1	0.10	0.16
sD2	0.12	0.20	WD2	0.17	0.07
sD3	0.12	0.16	WD3	0.20	0.03
sD4	0.05	0.57	WD4	0.23	0.07
sD5	0.02	0.60	WD5	0.24	0.08
sD6	0.03	0.65	WD6	0.24	0.06
sD7	0.04	0.40	WD7	0.29	0.42
sD8	0.01	0.76	WD8	0.28	1.24
Industrial selectivity			Weight in Ind. bycatch		
sI1	0.05	0.48	WI1	0.05	0.27
sI2	0.03	0.08	WI2	0.14	0.20
sI3	0.05	0.25	WI3	0.22	0.24
sI4	0.01	1.26	WI4	0.29	0.20
sI5	0.01	1.06	WI5	0.36	0.23
sI6	0.01	1.41	WI6	0.22	1.02
sI7	0.00	1.73	WI7	0.17	1.38
sI8	0.00	0.00	WI8	0.08	2.24
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
M7	0.20	0.10	MT7	1.00	0.00
M8	0.20	0.10	MT8	1.00	0.00
Relative effort in HC fishery			Year effect for natural mortality		
HF02	1.00	0.05	K02	1.00	0.10
HF03	1.00	0.05	K03	1.00	0.10
HF04	1.00	0.05	K04	1.00	0.10
Relative effort in industrial fishery					
IF02	1.00	0.77			
IF03	1.00	0.77			
IF04	1.00	0.77			
Recruitment in 2003 and 2004					
R03	2023730	0.38			
R04	2074920	0.38			

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

Table 4.4.3. Whiting in Sub-Area IV and Division VIId. Catch forecast output and estimates of coefficient of variation (CV) from linear analysis.

a. Effort multipliers 0.1 – 0.7 on human consumption and discard mortality.

	Year 2002	2003						
Mean F Ages								
H.cons+disc 2 to 6	0.41	0.04	0.08	0.12	0.17	0.21	0.25	0.29
Ind BC 2 to 6	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Effort relative to 2001								
H.cons+disc	1.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70
Ind BC	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Biomass								
Total 1 January	396	436	436	436	436	436	436	436
SSB at spawning time	237	270	270	270	270	270	270	270
Catch weight (,000t)								
H.cons	35.8	4.8	9.4	13.8	18.1	22.3	26.3	30.1
Discards	18.4	2.3	4.5	6.6	8.8	10.8	12.9	14.9
Ind BC	6.1	7.4	7.3	7.2	7.2	7.1	7.1	7.0
Total Landings	42.0	12.1	16.7	21.0	25.3	29.4	33.3	37.1
Total Catch	60.4	14.4	21.1	27.7	34.0	40.2	46.2	52.0
Biomass in year.... 2004								
Total 1 January		514	508	502	497	491	486	480
SSB at spawning time		343	337	331	325	320	314	309

	Year 2002	2003						
Effort relative to 2001								
H.cons+disc	1.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70
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	0.22	0.23	0.23	0.23	0.23	0.23	0.23	0.23
SSB at spawning time	0.17	0.21	0.21	0.21	0.21	0.21	0.21	0.21
Catch weight								
H.cons	0.15	0.51	0.29	0.22	0.19	0.18	0.17	0.17
Discards	0.24	0.56	0.36	0.31	0.30	0.29	0.28	0.28
Ind BC	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82
Biomass in year.... 2004								
Total 1 January		0.22	0.22	0.22	0.22	0.22	0.23	0.23
SSB at spawning time		0.22	0.22	0.22	0.22	0.22	0.22	0.23

Table 4.4.3. cont. Whiting in Sub-Area IV and Division VIId. Catch forecast output and estimates of coefficient of variation (CV) from linear analysis.

b. Effort multipliers 0.8 – 1.3 and 1.52 (=> F_{pa}) on human consumption and discard mortality. Forecasts corresponding to F_{sq} and F_{pa} are highlighted in bold face.

	Year 2002	2003						
Mean F Ages								
H.cons+disc 2 to 6	0.41	0.33	0.37	**0.41**	0.45	0.50	0.54	**0.63**
Ind BC 2 to 6	0.02	0.02	0.02	**0.02**	0.02	0.02	0.02	**0.02**
Effort relative to 2001								
H.cons+disc	1.00	0.80	0.90	**1.00**	1.10	1.20	1.30	**1.52**
Ind BC	1.00	1.00	1.00	**1.00**	1.00	1.00	1.00	**1.00**
Biomass								
Total 1 January	396	436	436	**436**	436	436	436	**436**
SSB at spawning time	237	270	270	**270**	270	270	270	**270**
Catch weight (,000t)								
H.cons	35.8	33.9	37.5	**41.1**	44.5	47.8	51.0	**57.6**
Discards	18.4	16.9	18.8	**20.7**	22.6	24.4	26.2	**30.1**
Ind BC	6.1	6.9	6.9	**6.8**	6.8	6.7	6.7	**6.5**
Total Landings	42.0	40.8	44.4	**47.9**	51.2	54.5	57.6	**64.2**
Total Catch	60.4	57.7	63.2	**68.6**	73.8	78.9	83.8	**94.3**
Biomass in year.... 2004								
Total 1 January		475	470	**466**	461	456	452	**443**
SSB at spawning time		304	299	**294**	290	285	281	**272**

	Year 2002	2003						
Effort relative to 2001								
H.cons+disc	1.00	0.80	0.90	**1.00**	1.10	1.20	1.30	**1.52**
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	0.22	0.23	0.23	**0.23**	0.23	0.23	0.23	**0.23**
SSB at spawning time	0.17	0.21	0.21	**0.21**	0.21	0.21	0.21	**0.21**
Catch weight								
H.cons	0.15	0.16	0.16	**0.16**	0.16	0.16	0.16	**0.16**
Discards	0.24	0.28	0.27	**0.27**	0.27	0.27	0.27	**0.27**
Ind BC	0.82	0.82	0.82	**0.82**	0.82	0.82	0.82	**0.82**
Biomass in year.... 2004								
Total 1 January		0.23	0.23	**0.23**	0.23	0.23	0.24	**0.24**
SSB at spawning time		0.23	0.23	**0.23**	0.23	0.23	0.23	**0.24**

Table 4.4.3. Whiting in Sub-Area IV and Division VIId. Detailed forecast tables.

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

	Populations	Catch number			
Age	Stock No.	H.Cons	Discards	By-catch	Total
1	1948630	15762	35160	55772	106694
2	582710	31356	49577	14407	95340
3	263600	28599	23033	10173	61804
4	149060	38808	5604	1163	45575
5	44690	16649	728	303	17680
6	10650	4111	242	36	4389
7	5000	1952	130	0	2083
8	3820	1597	23	0	1620
Wt	396	36	18	6	60

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	2023730	16369	36515	57921	110805
2	690131	37137	58716	17063	112916
3	296691	32189	25924	11450	69563
4	134617	35048	5061	1050	41159
5	71762	26734	1169	487	28390
6	19429	7500	442	65	8007
7	4480	1749	117	0	1866
8	3910	1634	24	0	1658
Wt	436	41	21	7	69

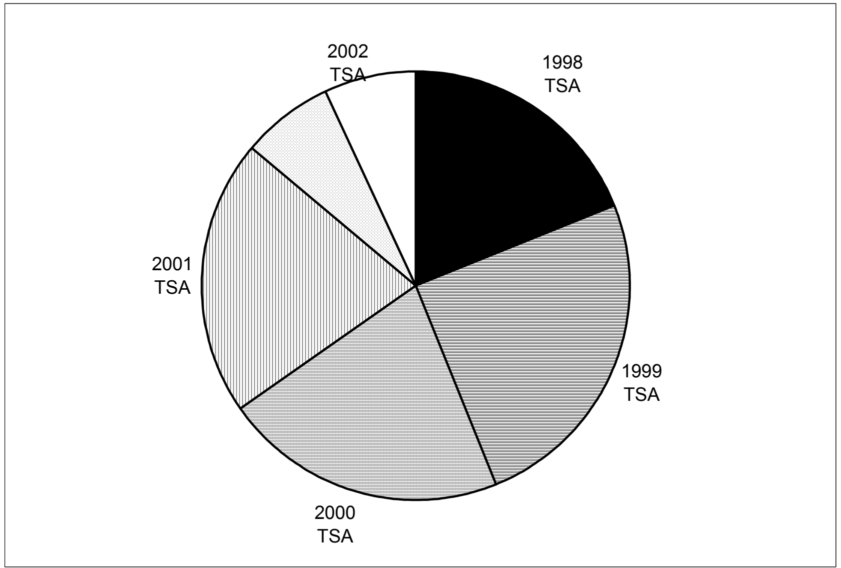
Table 4.4.5. Whiting in Sub-Area IV and Division VIId.

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

Year-class	1998	1999	2000	2001	2002
Stock No. (millions) of 1 year-olds	1852	1465	1649	1949	2024
Source	TSA	TSA	TSA	TSA	TSA
Status Quo F:					
% in 2002 landings	31.3	21.6	19.9	7.3	-
% in 2003 landings	19.0	25.0	21.5	20.9	6.7
% in 2002 SSB	17.3	25.9	41.2	7.9	-
% in 2003 SSB	7.5	13.8	25.6	42.9	7.2
% in 2004 SSB	3.1	6.2	14.2	27.8	40.8

Whiting in Sub-Area IV and Division VIId. : Year-class % contribution to

a) 2003 landings



b) 2004 SSB

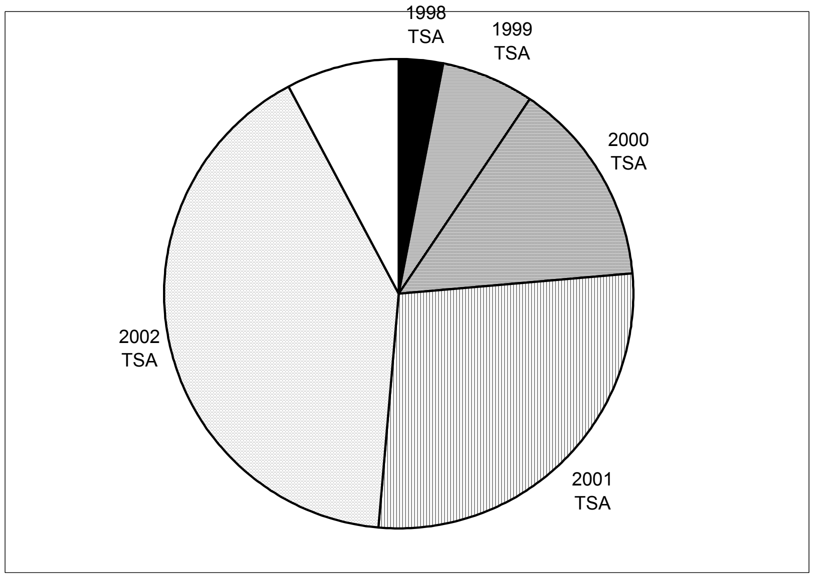


Figure 4.1.1. Whiting in Sub-Area IV and Division VIId. Summary output plots for SURBA analysis of the ScoGFS series (manual catchability, inverse-variance age weighting). See Needle (2002) for description of methodology.

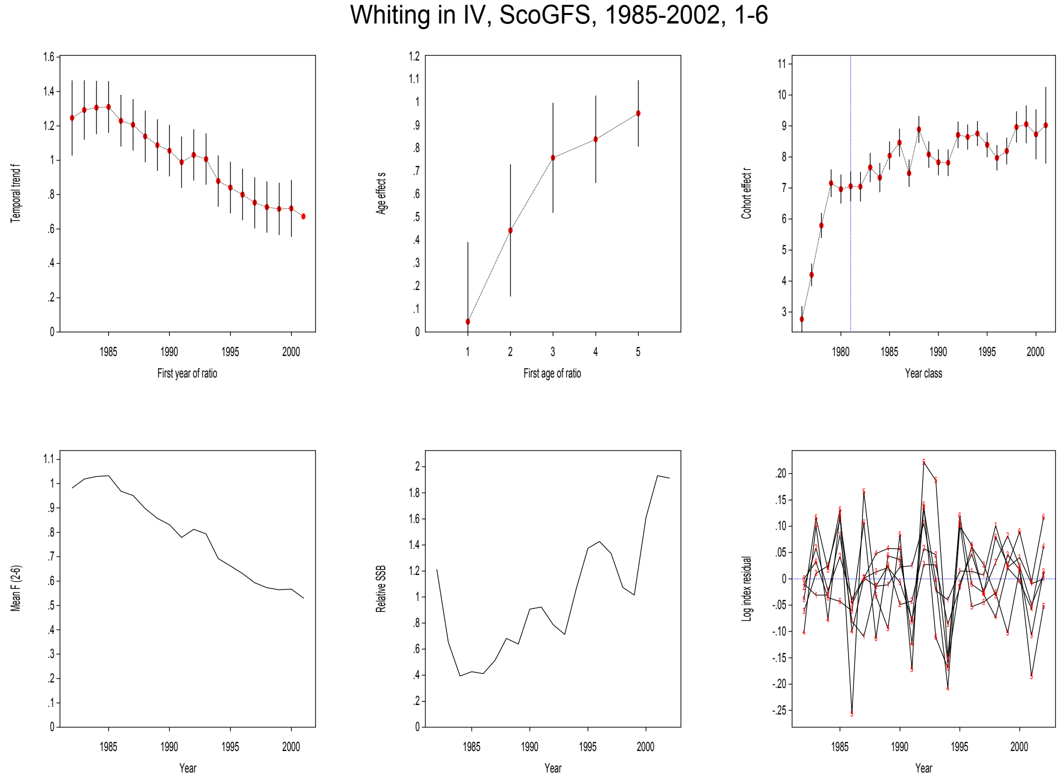


Figure 4.1.2. Whiting in Sub-Area IV and Division VIId. Summary output plots for SURBA analysis of the EngGFS series (manual catchability, manual age weighting). See Needle (2002) for description of methodology.

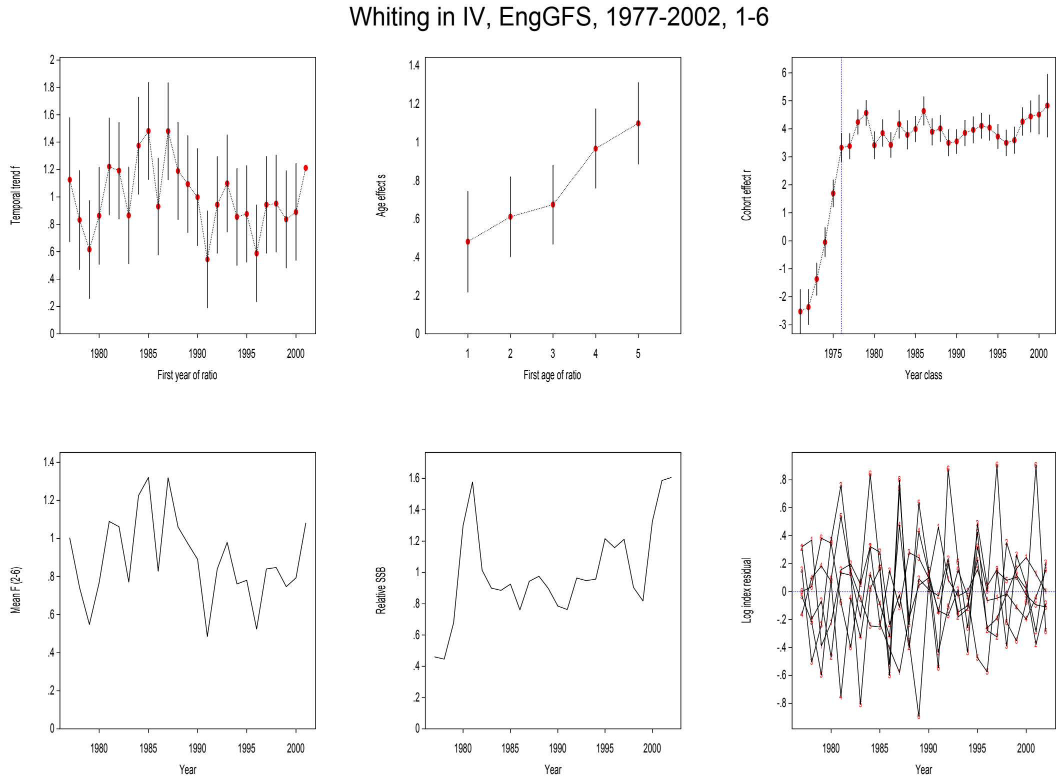


Figure 4.1.3. Whiting in Sub-Area IV and Division VIId. Summary output plots for SURBA analysis of the IBTS series (manual catchability, inverse-variance age weighting). See Needle (2002) for description of methodology.

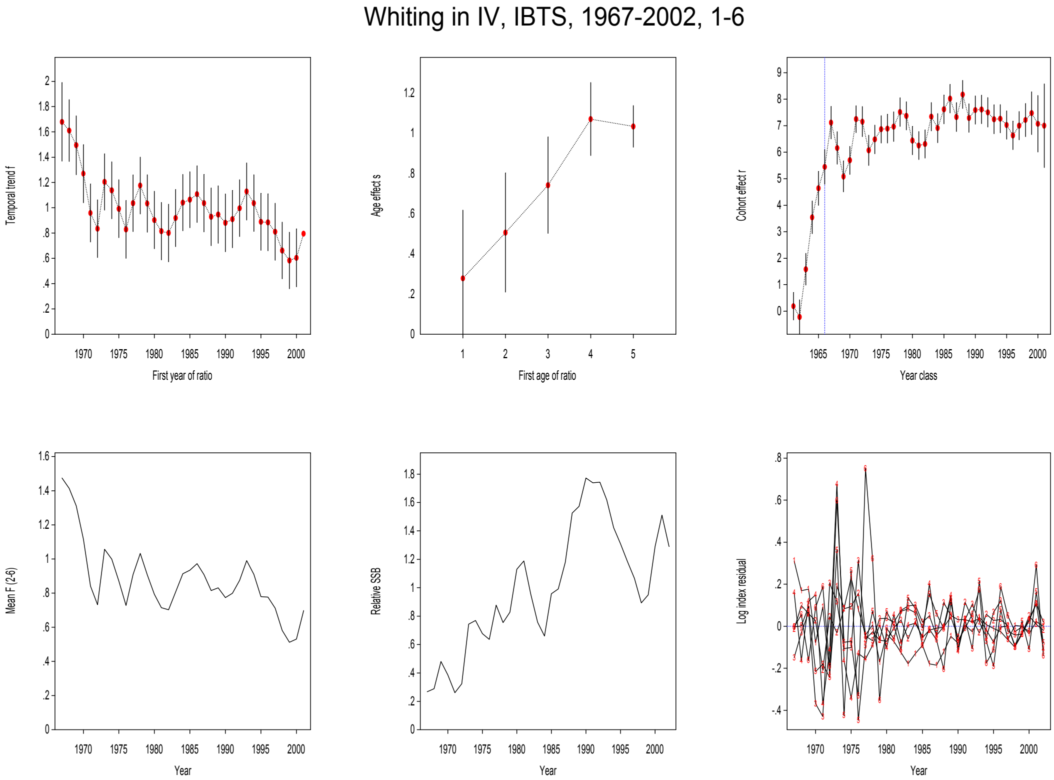


Figure 4.1.4. Whiting in Sub-Area IV and Division VIId. Comparison of relative SSB (upper plot) and mean $F_{2\text{–}6}$ (lower plot) for three SURBA runs (ScoGFS, EngGFS and IBTS) and the final no-survey TSA run.

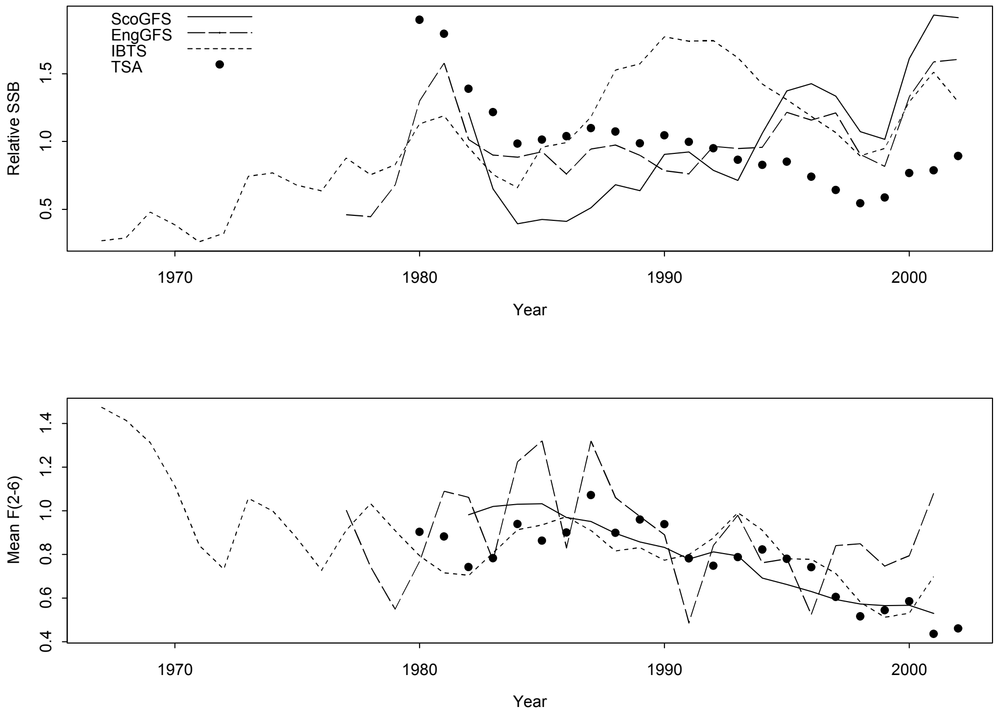


Figure 4.2.1. Whiting in Sub-Area IV and Division VIId. Comparison of stock summaries from five TSA runs: with no survey data, and with data from the EngGFS, ScoGFS, FraGFS and IBTS Q1 surveys. The results from the TSA run with no survey data are plotted with ± 2 standard errors (equivalent to pointwise 95% confidence intervals). The vertical dashed line on each plot marks the present: all estimates thereafter are TSA forecasts. The filled circles on the Yield plot are observed catches.

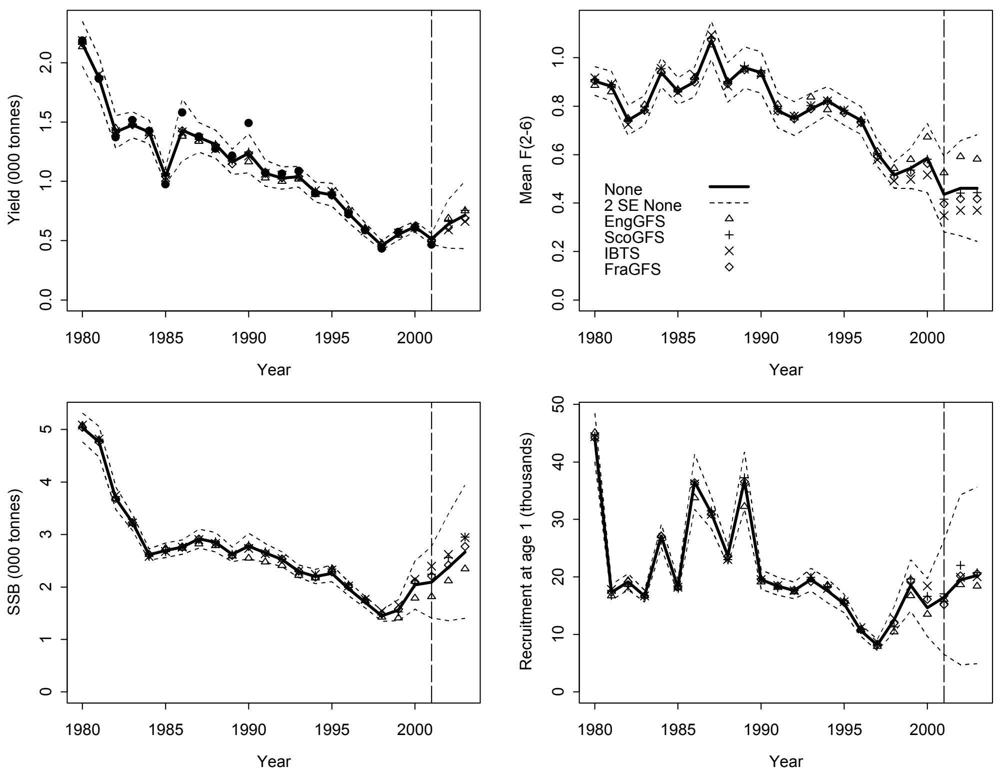


Figure 4.2.2. Whiting in Sub-Area IV and Division VIId. SSB (2001) against mean $F_{2\text{–}6}$ (2001) from five TSA runs: no survey (filled circle) and four single-survey runs (open circles), along with the *status quo* WG prediction (asterisk) from last year's assessment (as amended by ACFM). Dotted lines give approximate pointwise 95% confidence intervals about the TSA (no survey) estimate.

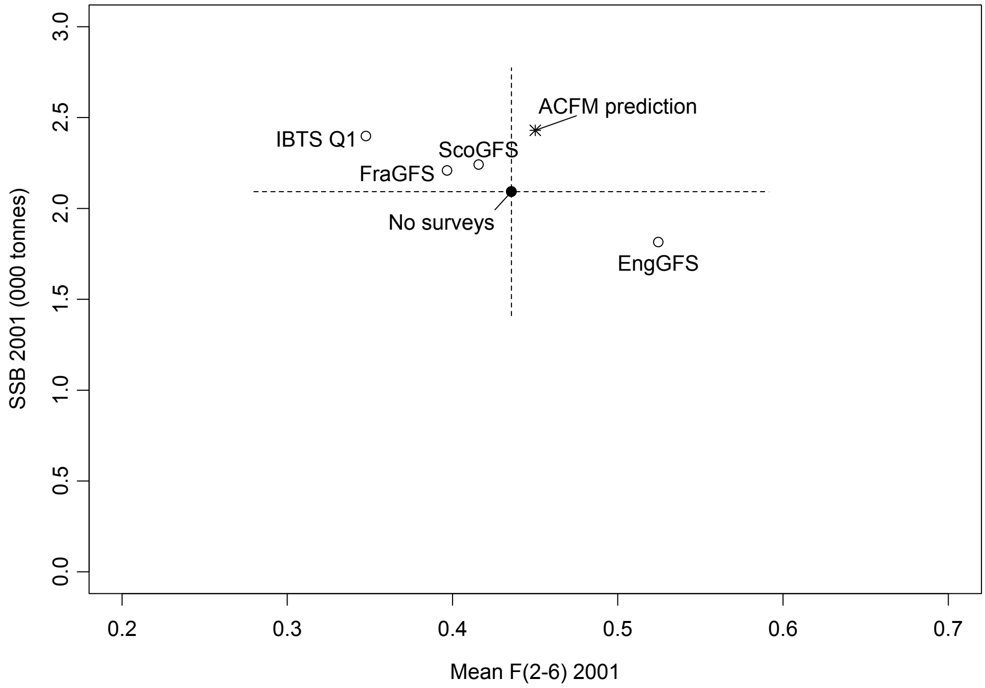


Figure 4.4.1. Whiting in Sub-Area IV and Division VIId. Estimated fishing mortality-at-age from the no-survey TSA assessment, ages 1–8+.

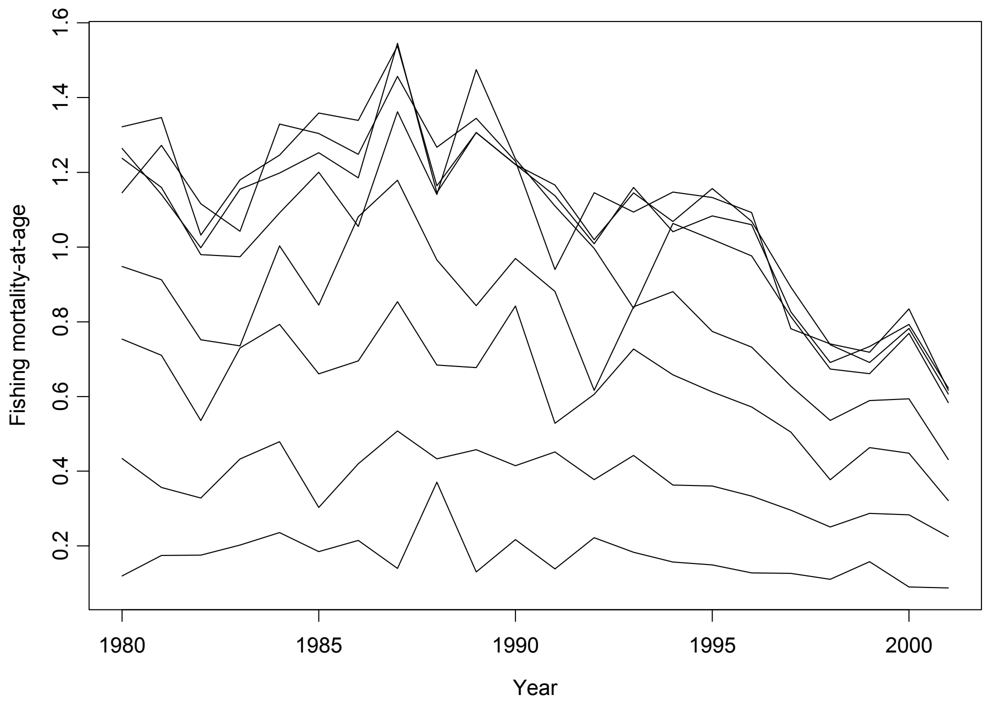


Figure 4.4.2. Whiting in Sub-Area IV and Division VIId. Mean catch weights-at-age, ages 1–8+.

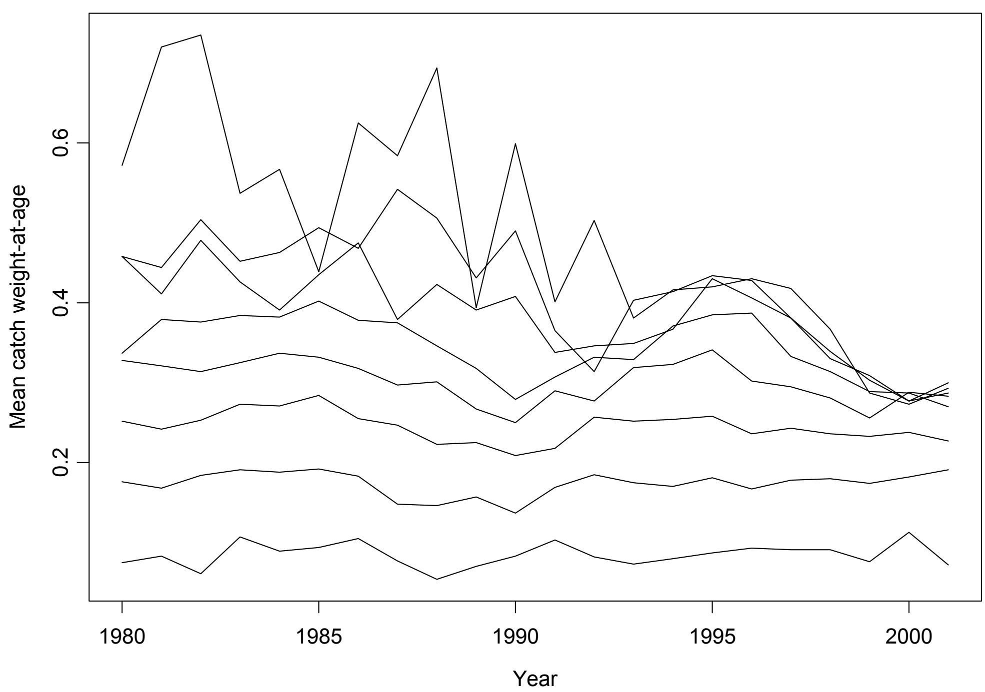
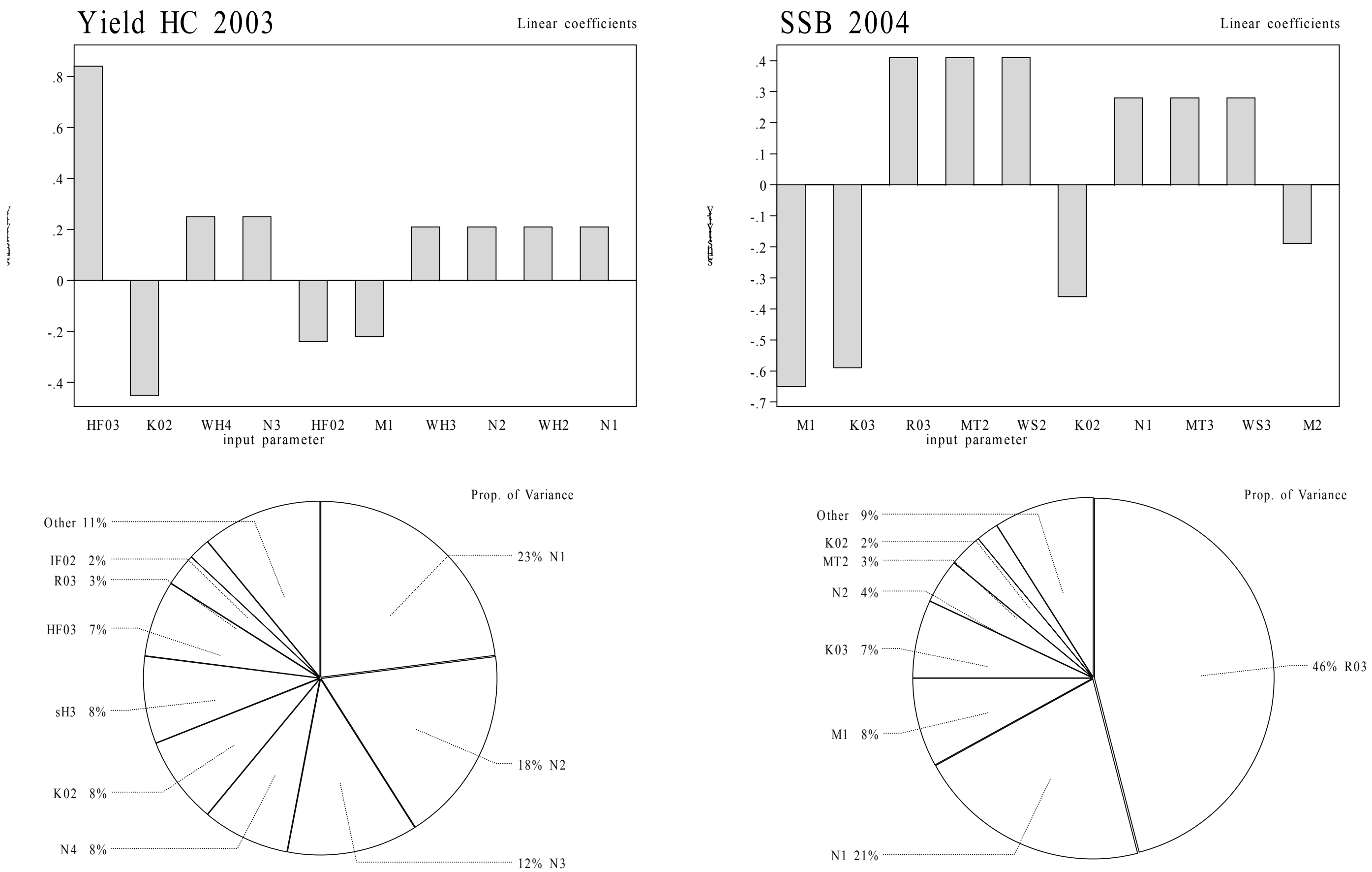
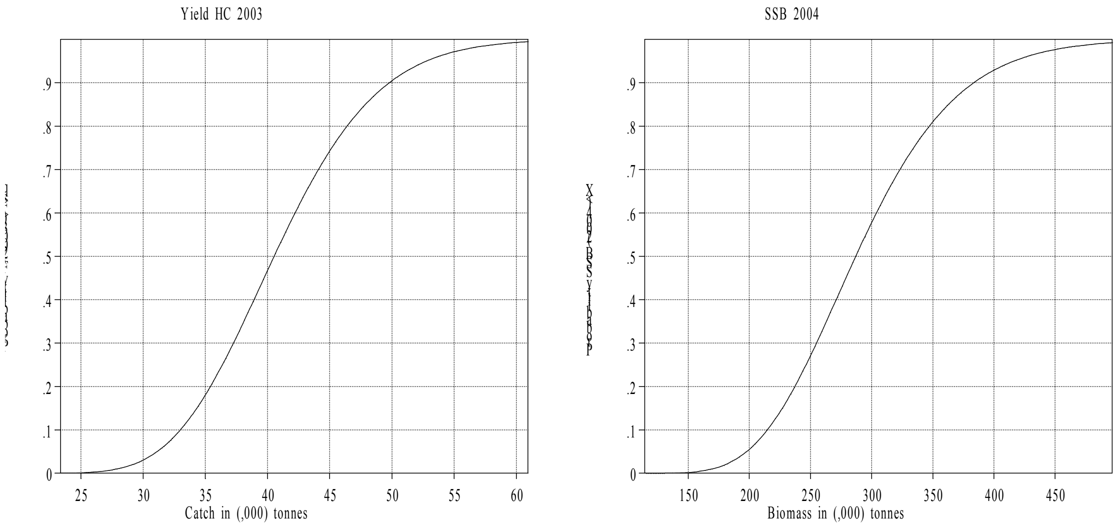


Figure 4.4.3. Whiting in Sub-Area IV and Division VIId. Sensitivity analysis of the short-term forecast. Notation is defined in Section 1.3.



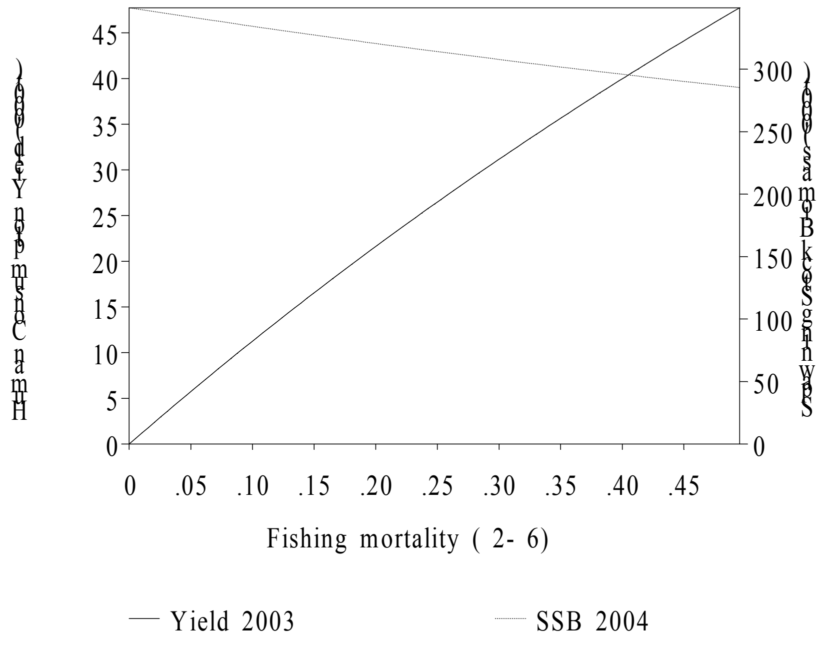
Data from file:C:\Working Files\NS 2002\Whiting\forecasts\whiiv.sen on 07/10/200

Figure 4.4.4. Whiting in Sub-Area IV and Division VIId. Probability profiles for *status quo* forecast.



Data from file:C:\Working Files\NS 2002\Whiting\forecasts\whiiv.sen on 07/10/200

Figure 4.4.5. Whiting in Sub-Area IV and Division VIId. Short-term forecast.



Data from file:C:\Working Files\NS 2002\Whiting\forecasts\whiiv.sen on 07/10/200

Figure 4.4.7. Whiting in Sub-Area IV and Division VIId. Yield-per-recruit.

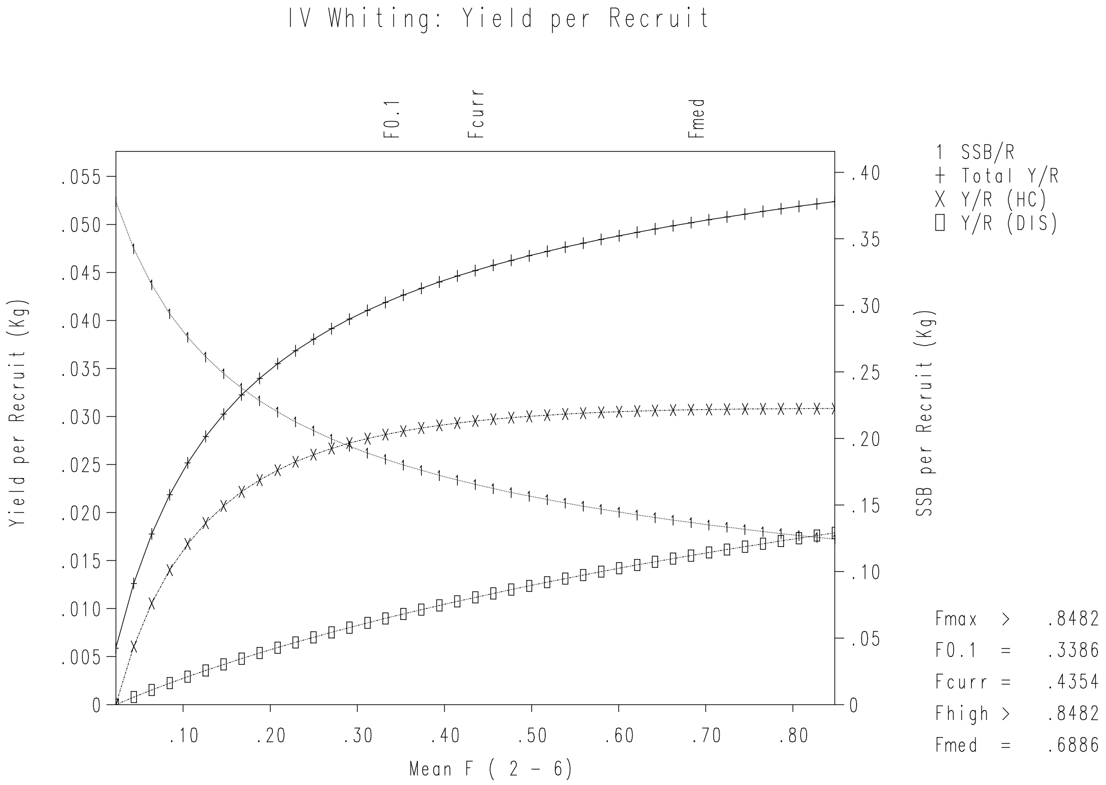


Figure 4.4.8. Whiting in Sub-Area IV and Division VIId. Stock-recruitment scatterplot.

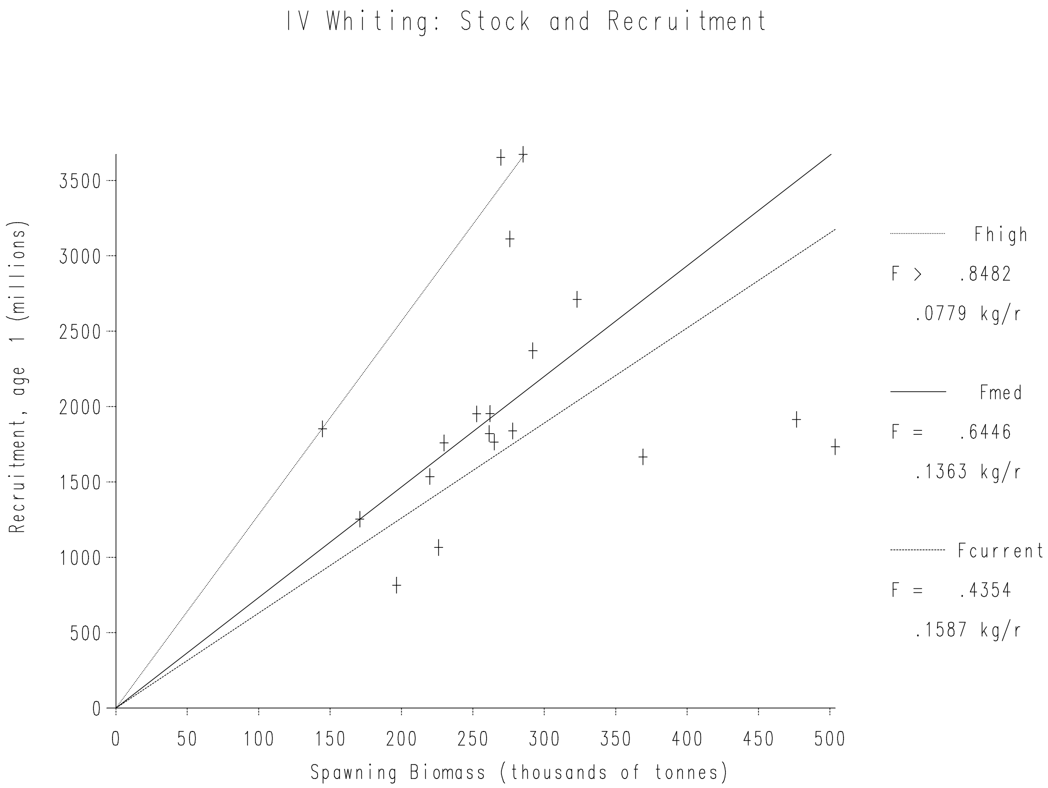
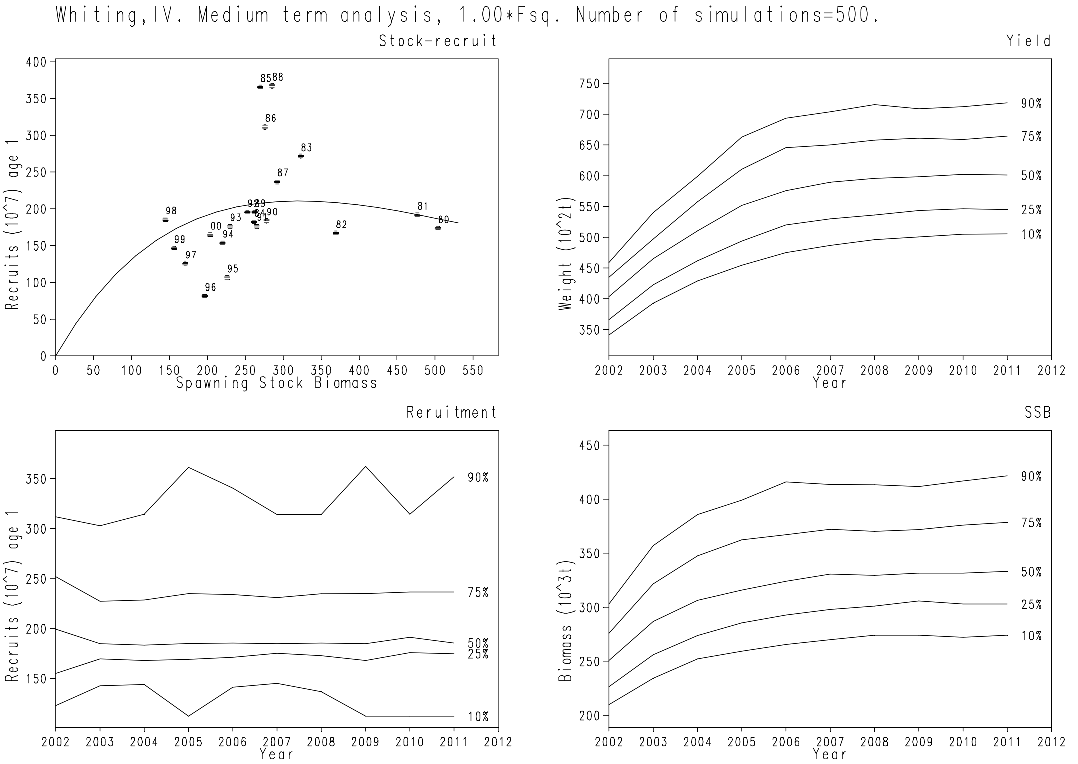
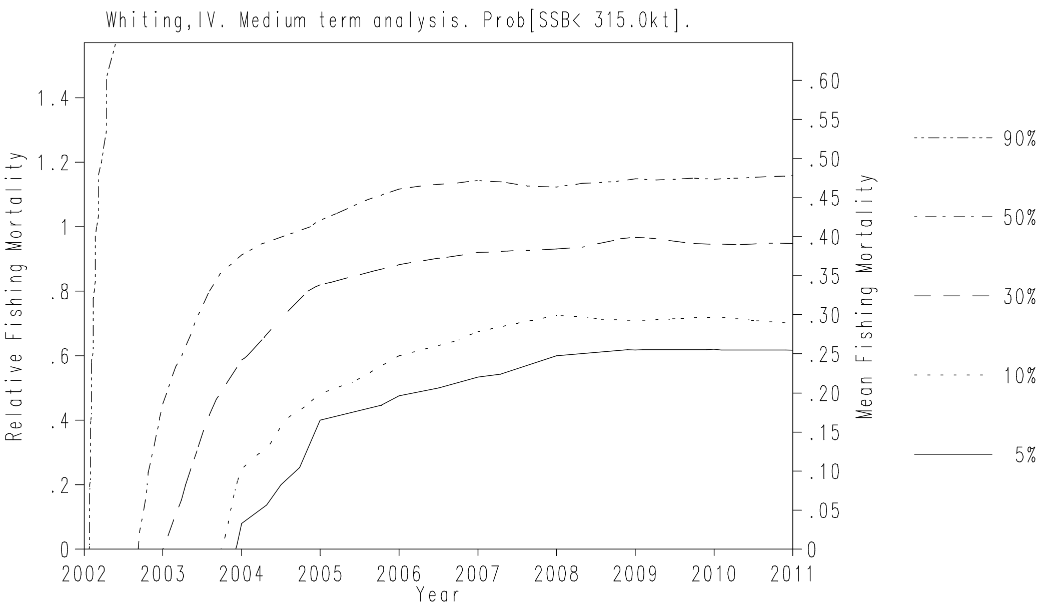


Figure 4.5.1. Whiting in Sub-Area IV and Division VIId. Medium-term projections based on a Ricker stock-recruitment model (WGMTERMC with 1000 iterations).

a. Projected values at *status quo F*. The solid line on the stock-recruitment plot is the TSA-estimated Ricker fit. On the other figures, the lines shown are the 10th, 25th, 50th, 75th and 90th percentiles of stochastic projections.



b. Contour plot of the probability of SSB falling below 315,000 t.



5 SOLE IN SUBAREA IV

5.1 Survey data

Data from 2002 for the two Dutch research vessel surveys were available for the subgroup. The SNS (Sole Net Survey) is a coastal survey with a 6- m beam trawl carried out in October. The BTS (Beam Trawl Survey) is carried out in the southern and south-eastern North Sea covering both inshore and offshore areas in August and September using an 8-m beam trawl. The BTS survey indices were revised in 1998 (ICES, 2002).

The DFS index is an area weighted survey index combining the inshore surveys of Netherlands, Belgian, Germany and UK. Revisions to the UK survey resulting from changes in the survey area have resulted in a revised DFS series from 1981 to 2000 (from 1981 0gp and 1980 1gp). Since the UK survey has not been revised prior to 1981, the earlier DFS index should be omitted or down-weighted from any analysis. The 0gp and 1gp indices for 1998 and 1999 were not available because bad weather had prevented the completion of the surveys in these years. The DFS survey indices for 2002 were not available for this subgroup in October 2002. Indices from 2001 have been used in RCT3.

The German survey is a beam trawl survey carried out in May during the sole spawning season in the inshore area of the German Bight. The survey uses 7m beam trawls with 80mm mesh cod-ends and age groups younger than 3 are not sampled. Survey indices from 2001 and 2002 for the German survey have been used in RCT3.

5.2 Recruitment estimates

Average recruitment in the period 1957-1999 was 134 million (arithmetic mean) or 99 million (geometric mean) 1-year-old-fish.

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 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, 2 and 3 and are shown in Tables 5.2a,b,c

The 1999 year class (as age 3 in 2002, in millions) was estimated as 73 by XSA and 58 by RCT3. Long term GM (1957-1999) at age 3 is 66. As the surveys receive 74 % of the weight in the XSA for the 1999 year class the XSA result was accepted. Consequently, this suggests the 1999 year class to be above long term average.

The 2000 year class (as age 2 in 2002, in millions) was estimated as 72 in XSA and 50 in RCT3. Both estimates are below long term (1957-1999) GM at age 2 at 87. The RCT3 estimate of the 2000 year class is based on more independent observations (estimates) of the year class strength than the XSA estimate and, furthermore, the 2000 year class is not yet fully recruited to the fishery. Consequently, the RCT3 result was accepted. This suggests the 2000 year class being well below the long term average recruitment.

The 2001 year class (as age 1 in 2002, in millions) was estimated as 197 in RCT3. This is well above the long term GM (99). No XSA estimate for this year class is available, and all survey indices available for the year class are included in the RCT3. On this basis the RCT3 estimate was accepted. This estimate indicate a strong 2001 year class.

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

Year Class	Age in 2002	XSA Thousands	RCT3 Thousands	GM (1957-1999) Thousands
1999	3	**72791**	57628	65590
2000	2	71826	**49680**	87336
2001	1		**197033**	98661
2002	0			**98661**

5.3 Short term forecast and sensitivity analysis

For the current prediction, population survivors at the start of 2002 for age 1 were from RCT3, and also 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 1999-2001, scaled to the reference $F_{(2-8)}$ in 2001 of 0.52. Weight at age in the catch and in the stock are averages for the years 1999-2001. Maturity-ogive and natural mortality was the same as in the XSA and the long-term GM recruitment (99 millions) was assumed for age 1 in 2003. The input data are shown in Table 5.3.

The management options table is given in Table 5.4 and the detailed predictions for $\mathbf{F}_{sq}$ are presented in Table 5.5. The options are also illustrated in Figure 5.3.

Yield and SSB at *status quo* F: Assuming a *status quo* F results in an expected catch in 2002 of 16,800 t (compared with a TAC of 16,000 t and ACFM advice for a TAC of 14,800 t). The yield in 2003 is expected to be 18,100 t at *status quo*. The sensitivity of the short term forecast to the various input parameters are shown in Figures 5.1 and 5.2. This forecast is particularly sensitive to the estimates of F on the 2001 year class being relatively strong (Figure 5.1) generating nearly 85 % of the total variance.

The SSB in 2002 is predicted to be 32,300 t compared with 36,100 t in last year's assessment. At *status quo* it is expected to fall to 25,700 t in 2003 ($\mathbf{B}_{lim}$=25,000 t) and there is a 50% probability that the SSB will fall below $\mathbf{B}_{pa}$ in 2004 (Figure 5.2). 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 2003 and SSB in 2004 are given in Table 5.6. More than half the yield in 2003 is dependent on year classes 1999 and 2001 which are based on RCT3 and XSA estimates. Similarly, 75% of the SSB in 2004 is dependent on these two year classes where the 2001 year class is dominating with more than 60 %.

5.4 Medium term projections

Medium term predictions were made for a period of 10 years, to estimate percentiles of the distribution of the predicted yields, SSB and recruitment at a *status quo* level of fishing mortality.

The input values for the medium term predictions are presented in Table 5.3. 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. WGMTERMC was run using *status quo* fishing mortality, $\mathbf{F}_{sq}$. Figure 5.4 shows the trajectory of yields and SBB with associated 10, 25 50,75 and 90 percentiles for the *status quo* projection. The plots indicate that the 50 percentile of yield remains close to 20,000 t over the medium term. SSB is expected to remain close to $\mathbf{B}_{pa}$ of 35,000 t (50 % percenttile). The contour plot (Figure 5.4b) suggests that at $\mathbf{F}_{pa}$ (0.4), there is a 25% probability of the SSB falling below $\mathbf{B}_{pa}$ over the medium term.

Table 5.1 North Sea sole, Indices of recruitment (input data for RCT3).

Sole North Sea

'yc'	'VPA-1'	'VPA-2'	'VPA-3'	'DFS-0'	'SNS-1'	'DFS-1'	'SNS-2'	'SNS-3'	'Solea-3'	'BTS-1'	'BTS-2'
1968	50588	45397	35237	-11	-11	-11	745	99	-11	-11	-11
1969	141484	126784	82978	-11	4938	-11	1961	161	-11	-11	-11
1970	41937	37547	26750	-11	613	-11	341	73	-11	-11	-11
1971	76954	69290	51064	-11	1410	-11	905	69	-11	-11	-11
1972	106419	95623	71893	-11	4686	-11	397	174	-11	-11	-11
1973	110814	100172	68805	-11	1924	-11	887	187	31.5	-11	-11
1974	41910	37670	30716	-11	597	2.86	79	77	16.3	-11	-11
1975	114341	102470	71479	168.84	1413	6.95	762	267	34.4	-11	-11
1976	140464	125435	89688	82.28	3724	9.69	1379	325	-11	-11	-11
1977	47052	42549	30720	33.8	1552	2.13	388	99	41.5	-11	-11
1978	11817	10684	8517	96.87	104	2.27	80	51	1.9	-11	-11
1979	154662	139338	98286	392.08	4483	48.21	1411	231	76.1	-11	-11
1980	149248	134643	96684	404	3739	13.9	1124	107	77.1	-11	-11
1981	153150	136045	90369	289.72	5098	14.06	1137	307	147.1	-11	-11
1982	144182	130092	88477	330.38	2640	25.87	1081	159	77.8	-11	-11
1983	71321	64352	42421	115.96	2359	12.45	709	67	10.8	-11	7.28
1984	81485	73574	57666	187.17	2151	3.32	465	59	29.8	2.64	4.58
1985	160722	145072	103630	292.92	3791	13.66	955	284	24.6	7.76	12.5
1986	73053	66012	47155	72.97	1890	6.19	594	248	20.3	6.96	12.81
1987	448821	406101	323331	527.45	11227	38.02	5369	907	66.9	81.23	67.76
1988	108878	98405	77684	56.08	3052	12.62	1078	527	86.4	8.67	22.33
1989	178585	160769	132949	62.77	2900	12.3	2515	319	54.1	22.44	23.2
1990	71371	64465	51832	22.54	1265	8.52	114	46	11.3	3.43	22.66
1991	352279	317823	239588	360.44	11081	17.66	3489	943	180.7	72.71	26.61
1992	69422	62765	49368	25.38	1351	10.6	475	126	-11	4.63	4.95
1993	57347	51206	34189	25.01	559	6.12	234	27	-11	5.94	8.68
1994	96501	82751	56970	74.25	1501	9.46	473	231	12.9	26.31	5.94
1995	48961	44138	34186	18.82	691	3.64	143	131	0.9	3.48	5.36
1996	279247	251160	173374	58.51	10132	19.92	1993	381	45.7	173.51	29.15
1997	119390	107797	82545	53.35	2875	-11	919	189	13.6	14.16	19.51
1998	81109	73118	51891	-11	1649	-11	150	99	3.2	11.2	6.08
1999	121251	107487	72791	-11	1735	4.56	645	175	16.3	13.64	10.14
2000	-11	-11	-11	16.15	958	3.07	361	-11	-11	8.11	3.6
2001	-11	-11	-11	86.41	7093	-11	-11	-11	-11	22.8	-11
2002	-11	-11	-11	-11	-11	-11	-11	-11	-11	-11	-11
mean	122024	109710	80414	154	3187	12	1011	223	43	27	16

Table 5.2a North Sea sole, Recruitment estimates at age 1

Analysis by RCT3 ver3.1 of data from file :
s4rct101.txt

Sole North Sea - Age1.,,,,,,,,,

Data for 8 surveys over 34 years : 1968 - 2001

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

Final estimates shrunk towards mean
Minimum S.E. for any survey taken as .20
Minimum of 3 points used for regression

Forecast/Hindcast variance correction used.

Yearclass = 1999

	I-----------Regression----------I					I-----------Prediction---------I			
Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
DFS-0									
SNS-1	.76	5.68	.25	.888	30	7.46	11.34	.268	.388
DFS-1	1.31	8.41	.58	.654	23	1.72	10.66	.634	.070
SNS-2	.79	6.36	.44	.730	31	6.47	11.47	.459	.133
SNS-3	1.08	5.99	.58	.603	31	5.17	11.59	.612	.075
Solea-	.90	8.57	.76	.519	23	2.85	11.13	.812	.042
BTS-1	.66	9.92	.39	.763	15	2.68	11.68	.433	.149
BTS-2	1.12	8.66	.51	.642	16	2.41	11.38	.567	.087
					VPA Mean =		11.48	.706	.056

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
DFS-0	1.35	5.30	1.20	.294	23	2.84	9.15	1.368	.017
SNS-1	.76	5.66	.26	.881	31	6.87	10.90	.276	.419
DFS-1	1.33	8.41	.62	.616	24	1.40	10.27	.682	.069
SNS-2	.79	6.35	.43	.727	32	5.89	11.02	.456	.154
SNS-3									
Solea-									
BTS-1	.66	9.92	.38	.763	16	2.21	11.37	.417	.184
BTS-2	1.13	8.67	.50	.634	17	1.53	10.40	.590	.092
					VPA Mean =		11.49	.695	.066

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
DFS-0	1.35	5.30	1.20	.294	23	4.47	11.36	1.287	.029
SNS-1	.76	5.66	.26	.881	31	8.87	12.43	.280	.602
DFS-1									
SNS-2									
SNS-3									
Solea-									
BTS-1	.66	9.92	.38	.763	16	3.17	12.00	.417	.271
BTS-2									
					VPA Mean =		11.49	.695	.098

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
1999	87864	11.38	.17	.09	.30	121252	11.71
2000	55612	10.93	.18	.17	.88		
2001	197033	12.19	.22	.19	.79		

Table 5.2b North Sea sole, Recruitment estimates at age 2

```
Analysis by RCT3 ver3.1 of data from file :
 s4rct201.txt
 Sole North Sea - Age2.,,,,,,,,,

 Data for    8 surveys over   34 years :  1968 - 2001

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

 Final estimates shrunk towards mean
 Minimum S.E. for any survey taken as    .20
 Minimum of   3 points used for regression

 Forecast/Hindcast variance correction used.

 Yearclass =   1999

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

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

 DFS-0
 SNS-1      .76   5.58    .25   .890     30   7.46   11.24     .266     .394
 DFS-1     1.31   8.30    .58   .654     23   1.72   10.55     .633     .070
 SNS-2      .79   6.26    .44   .731     31   6.47   11.37     .457     .134
 SNS-3     1.08   5.88    .58   .602     31   5.17   11.48     .613     .074
 Solea-     .89   8.47    .75   .520     23   2.85   11.02     .810     .043
 BTS-1      .66   9.80    .40   .753     15   2.68   11.57     .446     .141
 BTS-2     1.12   8.56    .51   .648     16   2.41   11.27     .561     .089

                                       VPA Mean =   11.38     .706     .056

 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

 DFS-0     1.35   5.20   1.20   .295     23   2.84    9.05    1.364     .017
 SNS-1      .76   5.56    .26   .883     31   6.87   10.80     .273     .426
 DFS-1     1.32   8.31    .62   .618     24   1.40   10.17     .679     .069
 SNS-2      .79   6.25    .43   .729     32   5.89   10.91     .455     .154
 SNS-3
 Solea-
 BTS-1      .66   9.80    .39   .753     16   2.21   11.26     .429     .173
 BTS-2     1.12   8.58    .50   .641     17   1.53   10.29     .582     .094

                                       VPA Mean =   11.38     .695     .066

 Yearclass =   2001

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

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

 DFS-0     1.35   5.20   1.20   .295     23   4.47   11.25    1.283     .029
 SNS-1      .76   5.56    .26   .883     31   8.87   12.32     .277     .616
 DFS-1
 SNS-2
 SNS-3
 Solea-
 BTS-1      .66   9.80    .39   .753     16   3.17   11.90     .429     .257
 BTS-2

                                       VPA Mean =   11.38     .695     .098

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

 1999       78772     11.27     .17     .09      .29 107488    11.59
 2000       49680     10.81     .18     .17      .87
 2001      178009     12.09     .22     .19      .79
```

Table 5.2c North Sea sole, Recruitment estimates at age 3

Analysis by RCT3 ver3.1 of data from file :
s4rct301.txt
Sole North Sea - Age3.,,,,,,,,,

Data for 8 surveys over 34 years : 1968 - 2001

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

Final estimates shrunk towards mean
Minimum S.E. for any survey taken as .20
Minimum of 3 points used for regression

Forecast/Hindcast variance correction used.

Yearclass = 1999

Survey/ Series	Regression: Slope	Regression: Intercept	Regression: Std Error	Regression: Rsquare	Regression: No. Pts	Prediction: Index Value	Prediction: Predicted Value	Prediction: Std Error	Prediction: WAP Weights
DFS-0									
SNS-1	.76	5.27	.27	.872	30	7.46	10.92	.288	.373
DFS-1	1.32	7.97	.61	.630	23	1.72	10.24	.660	.071
SNS-2	.79	5.96	.45	.714	31	6.47	11.06	.471	.139
SNS-3	1.05	5.72	.55	.621	31	5.17	11.17	.581	.091
Solea-	.89	8.17	.76	.508	23	2.85	10.72	.817	.046
BTS-1	.70	9.41	.47	.698	15	2.68	11.29	.521	.114
BTS-2	1.13	8.24	.50	.671	16	2.41	10.97	.547	.103
					VPA Mean =		11.07	.697	.064

Yearclass = 2000

Survey/ Series	Regression: Slope	Regression: Intercept	Regression: Std Error	Regression: Rsquare	Regression: No. Pts	Prediction: Index Value	Prediction: Predicted Value	Prediction: Std Error	Prediction: WAP Weights
DFS-0	1.39	4.70	1.25	.275	23	2.84	8.66	1.427	.017
SNS-1	.76	5.26	.27	.868	31	6.87	10.48	.290	.419
DFS-1	1.33	8.00	.63	.602	24	1.40	9.86	.694	.073
SNS-2	.79	5.95	.44	.713	32	5.89	10.60	.466	.163
SNS-3									
Solea-									
BTS-1	.70	9.40	.45	.697	16	2.21	10.95	.502	.140
BTS-2	1.13	8.26	.48	.668	17	1.53	9.98	.563	.112
					VPA Mean =		11.07	.686	.075

Yearclass = 2001

Survey/ Series	Regression: Slope	Regression: Intercept	Regression: Std Error	Regression: Rsquare	Regression: No. Pts	Prediction: Index Value	Prediction: Predicted Value	Prediction: Std Error	Prediction: WAP Weights
DFS-0	1.39	4.70	1.25	.275	23	4.47	10.93	1.342	.031
SNS-1	.76	5.26	.27	.868	31	8.87	12.00	.294	.635
DFS-1									
SNS-2									
SNS-3									
Solea-									
BTS-1	.70	9.40	.45	.697	16	3.17	11.62	.503	.217
BTS-2									
					VPA Mean =		11.07	.686	.117

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
1999	57628	10.96	.18	.09	.27	72791	11.20
2000	35535	10.48	.19	.17	.81		
2001	130418	11.78	.23	.20	.72		

Table 5.3 North Sea Sole, Input data for the short term catch forecast and linear sensitivity **analysis**

Label	Value	CV	Label	Value	CV
Number at age			Weight in the stock		
N1	197033	0.79	WS1	0.05	0.00
N2	49680	0.19	WS2	0.14	0.05
N3	72791	0.15	WS3	0.19	0.01
N4	26510	0.13	WS4	0.22	0.02
N5	20723	0.12	WS5	0.26	0.01
N6	19498	0.14	WS6	0.30	0.07
N7	1702	0.14	WS7	0.32	0.09
N8	1278	0.15	WS8	0.36	0.15
N9	396	0.16	WS9	0.39	0.05
N10	272	0.17	WS10	0.40	0.30
N11	504	0.22	WS11	0.38	0.12
N12	87	0.27	WS12	0.47	0.33
N13	59	0.31	WS13	0.62	0.10
N14	19	0.27	WS14	0.77	0.34
N15	142	0.21	WS15	0.76	0.29
H.cons selectivity			Weight in the HC catch		
sH1	0.01	0.66	WH1	0.15	0.07
sH2	0.22	0.30	WH2	0.18	0.04
sH3	0.53	0.10	WH3	0.21	0.03
sH4	0.65	0.05	WH4	0.25	0.08
sH5	0.63	0.12	WH5	0.28	0.03
sH6	0.57	0.11	WH6	0.32	0.06
sH7	0.53	0.17	WH7	0.36	0.10
sH8	0.55	0.08	WH8	0.39	0.07
sH9	0.48	0.07	WH9	0.40	0.08
sH10	0.78	0.15	WH10	0.37	0.20
sH11	0.58	0.43	WH11	0.50	0.09
sH12	0.63	0.26	WH12	0.54	0.22
sH13	0.42	0.04	WH13	0.65	0.08
sH14	0.58	0.34	WH14	0.73	0.35
sH15	0.58	0.34	WH15	0.76	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
M11	0.10	0.10	MT11	1.00	0.00
M12	0.10	0.10	MT12	1.00	0.00
M13	0.10	0.10	MT13	1.00	0.00
M14	0.10	0.10	MT14	1.00	0.00
M15	0.10	0.10	MT15	1.00	0.00
Relative effort in HC fishery			Year effect for natural mortality		
HF02	1.00	0.07	K02	1.00	0.10
HF03	1.00	0.07	K03	1.00	0.10
HF04	1.00	0.07	K04	1.00	0.10
Recruitment in 2003 and 2004					
R03	98661	0.79			
R04	98661	0.79			

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

Stock numbers in 2002 are VPA survivors.
These are overwritten at age 1 and 2

Data from file:C:\rn\VPA-FOR\SOLIV.SEN on 07/10/2002 at 14:23:47

Table 5.4 North Sea sole, Management options

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

	Year							
	2002	2003						
Mean F Ages								
H.cons 2 to 8	0.52	0.31	0.37	0.40	0.42	0.47	0.52	0.63
Effort relative to 2001								
H.cons	1.00	0.60	0.70	0.77	0.80	0.90	1.00	1.20
Biomass								
Total 1 January	49.0	55.0	55.0	55.0	55.0	55.0	55.0	55.0
SSB at spawning time	32.3	25.7	25.7	25.7	25.7	25.7	25.7	25.7
Catch weight (,000t)								
H.cons	16.8	11.8	13.5	14.6	15.1	16.6	18.1	20.8
Biomass in year.... 2004								
Total 1 January		62.1	60.5	59.4	58.9	57.4	55.9	53.2
SSB at spawning time		44.9	43.3	42.2	41.7	40.2	38.8	36.1

	Year							
	2002	2003						
Effort relative to 2001								
H.cons	1.00	0.60	0.70	0.77	0.80	0.90	1.00	1.20
Est. Coeff. of Variation								
Biomass								
Total 1 January	0.17	0.36	0.36	0.36	0.36	0.36	0.36	0.36
SSB at spawning time	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
Catch weight								
H.cons	0.10	0.28	0.28	0.28	0.28	0.28	0.28	0.28
Biomass in year.... 2004								
Total 1 January		0.37	0.38	0.38	0.38	0.38	0.39	0.39
SSB at spawning time		0.47	0.47	0.48	0.48	0.49	0.49	0.51

Table 5.5 North Sea sole, Detailed forecast tables

Forecast for year 2002
F multiplier H.cons=1.00

Age	Populations: Stock No.	Catch number: H.Cons	Catch number: Total
1	197033	2051	2051
2	49680	9277	9277
3	72791	28499	28499
4	26510	12176	12176
5	20723	9234	9234
6	19498	8089	8089
7	1702	668	668
8	1278	515	515
9	396	145	145
10	272	142	142
11	504	212	212
12	87	39	39
13	59	19	19
14	19	8	8
15	142	60	60
Wt	49	17	17

Forecast for year 2003
F multiplier H.cons=1.00

Age	Populations: Stock No.	Catch number: H.Cons	Catch number: Total
1	98661	1027	1027
2	176332	32928	32928
3	36147	14152	14152
4	38884	17859	17859
5	12472	5557	5557
6	10017	4156	4156
7	9987	3922	3922
8	907	365	365
9	669	245	245
10	221	115	115
11	112	47	47
12	256	115	115
13	42	14	14
14	35	15	15
15	82	34	34
Wt	55	18	18

Table 5.6 North Sea sole

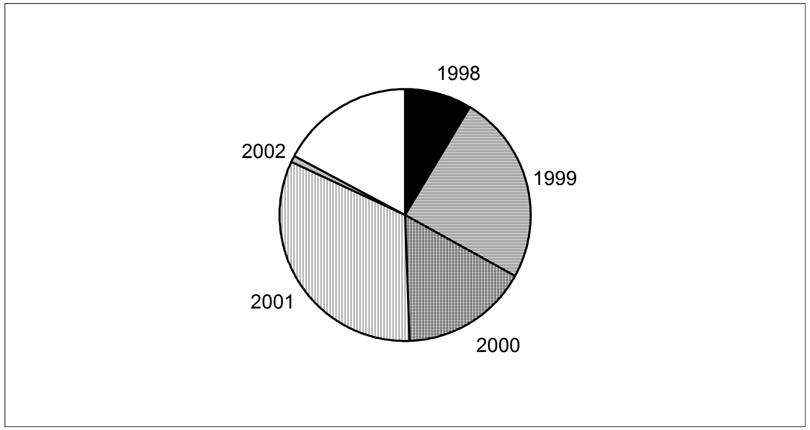
Stock numbers of recruits and their source for recent year classes used in predictions, and the relative (%) contributions to landings and SSB (by weight) of these year classes

Year-class			1998	1999	2000	2001	2002
Stock No. (thousands) of 1 year-olds			81109	121251	80305	197033	98661
Source			VPA	VPA	VPA	RCT3	GM
Status Quo F:							
% in	2002	landings	18.0	35.4	9.9	1.8	-
% in	2003		8.5	24.5	16.3	32.5	0.8
% in	2002	SSB	17.9	42.5	0.0	0.0	-
% in	2003	SSB	12.6	33.1	26.6	0.0	0.0
% in	2004	SSB	4.6	12.2	10.8	62.1	0.0

GM : geometric mean recruitment

North Sea sole : Year-class % contribution to

a) 2003 landings



b) 2004 SSB

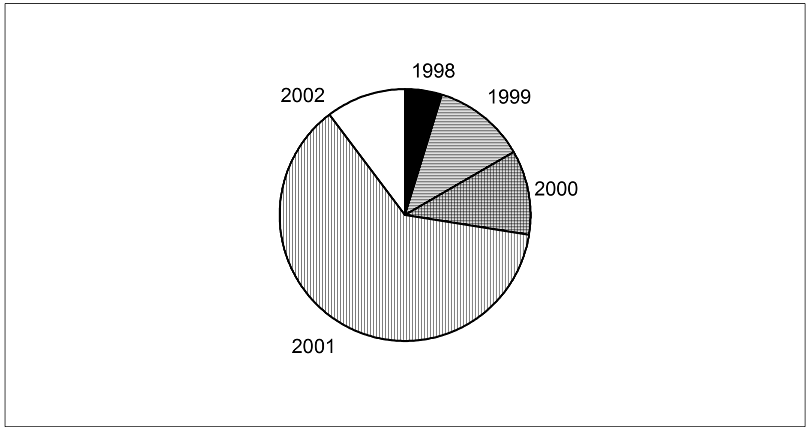


Figure 5.1 North Sea sole, Sensitivity analysis short-term forecast

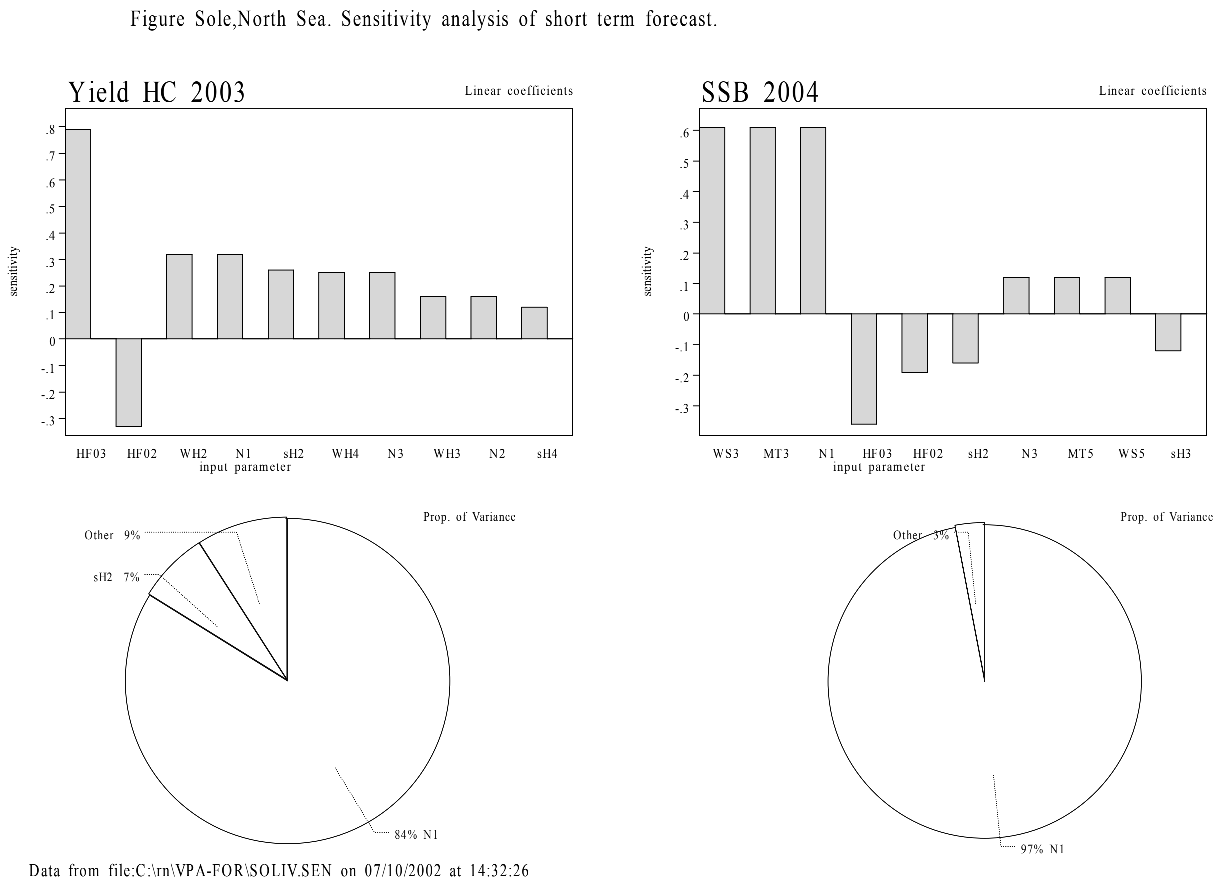


Figure 5.2 North Sea sole, Probability profiles for short term forecast.

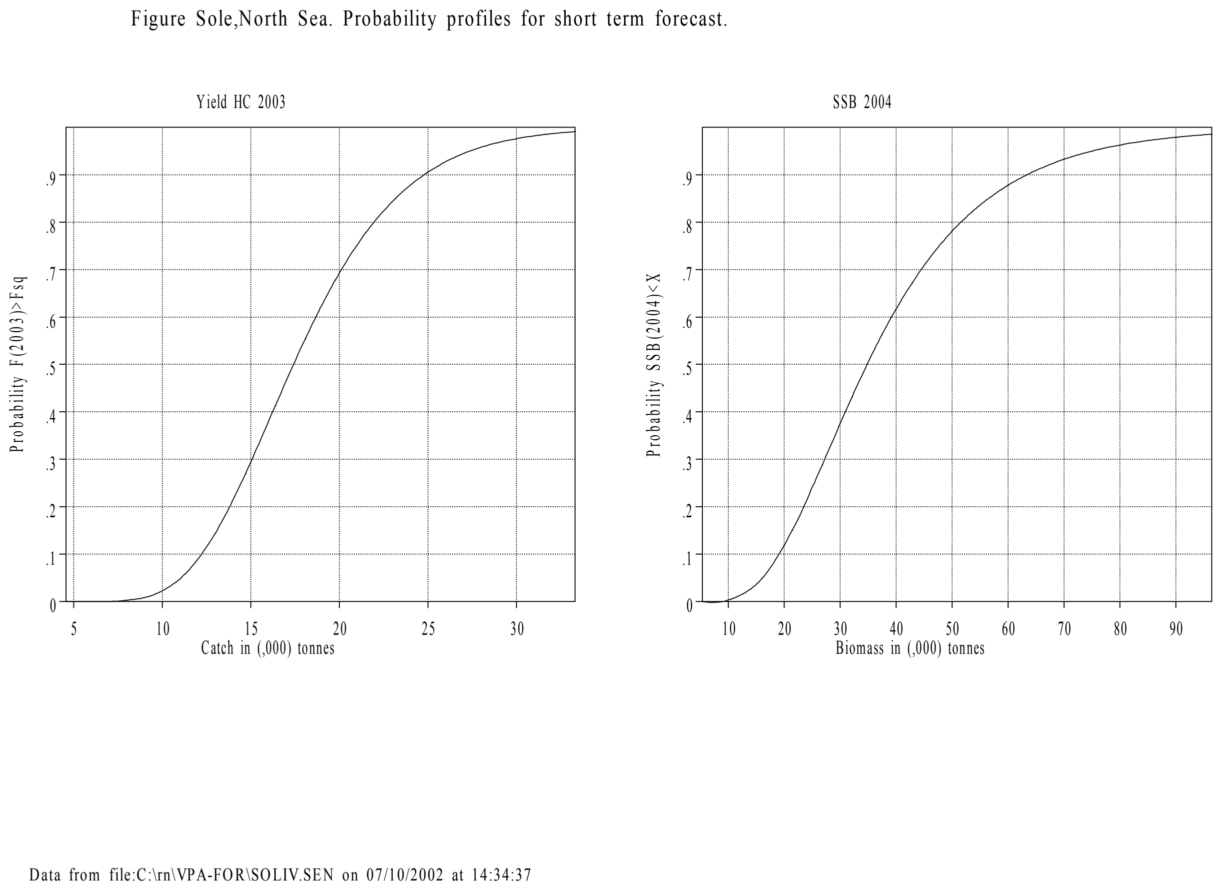


Figure 5.3 North Sea sole Short term forecast

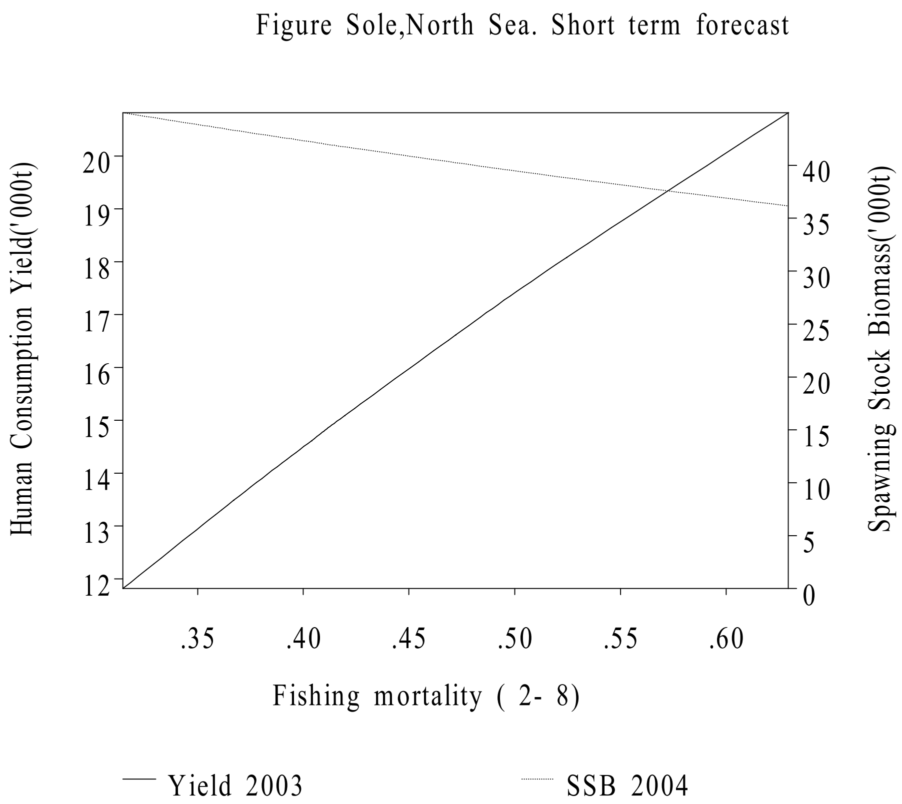


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Figure 5.4a North Sea sole, Medium term analysis

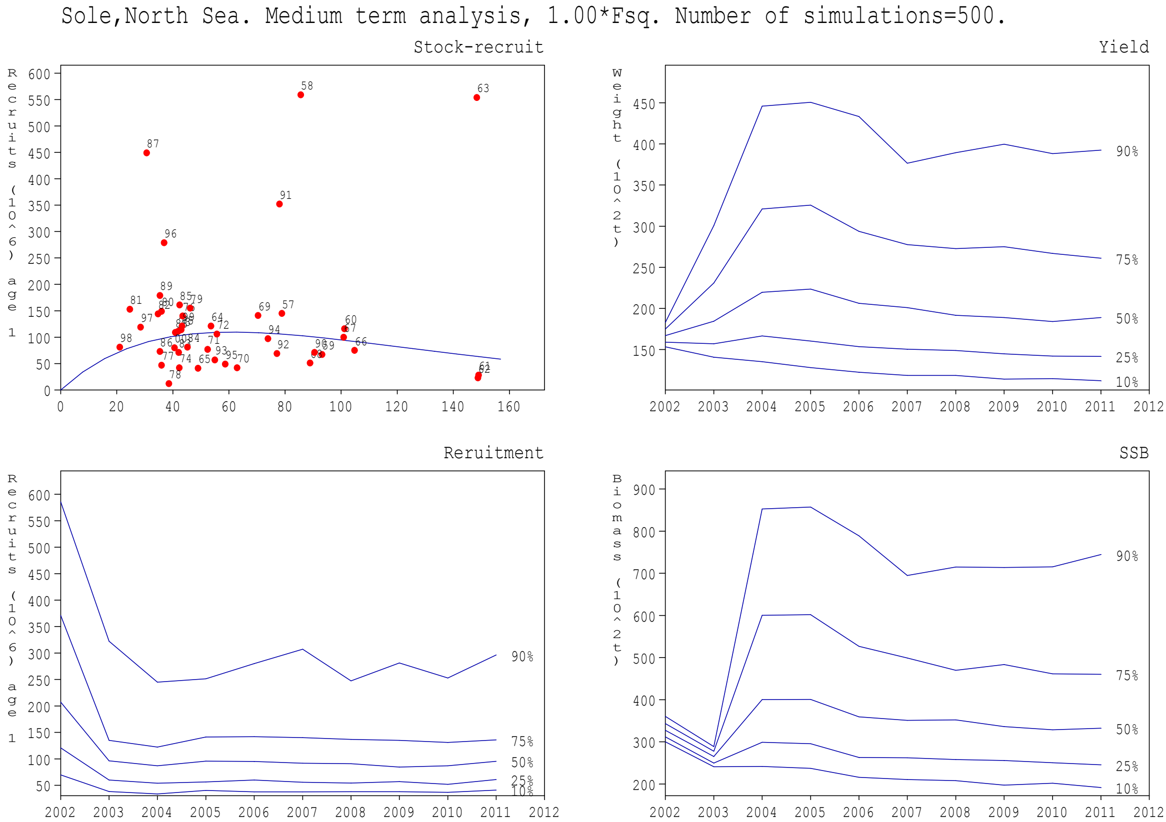
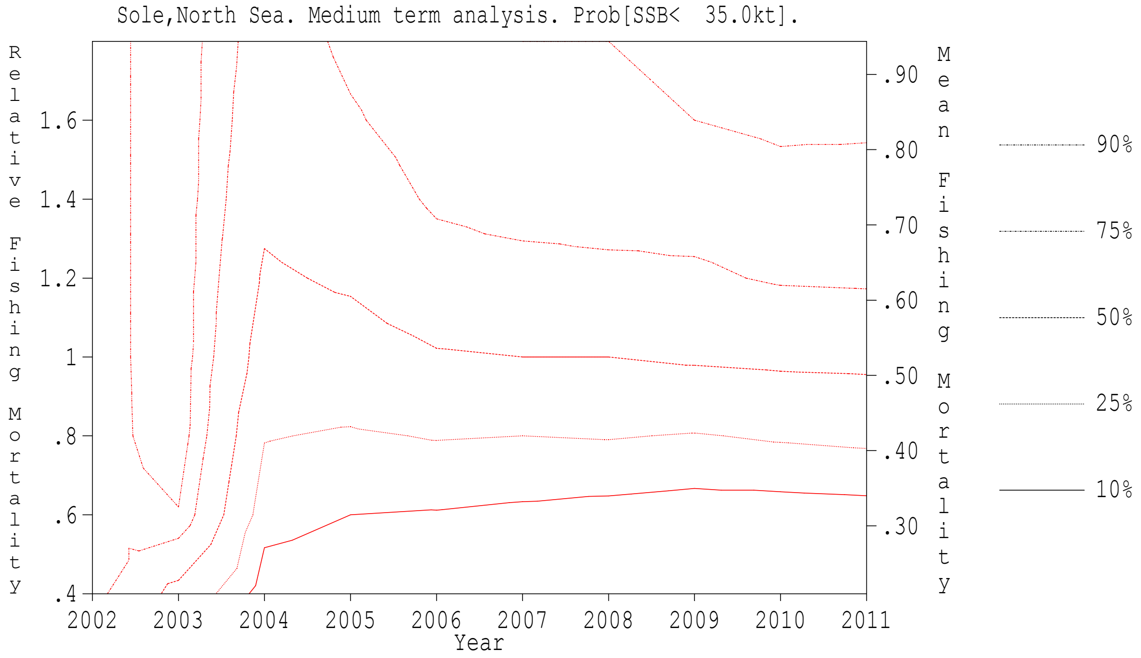


Figure 5.4b **North Sea sole, Medium term analysis**



6 NORTH SEA PLAICE

6.1 Survey data

The additional survey data available for North Sea plaice at the subgroup was:

- Beam trawl survey (BTS) 2002, ages 1 – 9

- Beam trawl survey TRIDENS (extended area), 1996-2001, ages 1 – 9

- Sole net survey (SNS) 2002, ages 0 - 3

- German contribution to the Demersal Fish Survey 2002, age 0

The BTS is traditionally calculated for the standard survey area, which is covered by the research vessel ISIS. This series is available for the years 1985-2002. It covers ages 1 to 9, however the older ages (age 6 onwards) are considered to be less well sampled because the standard index area does not cover the distributional areas of these age groups.

Since 1996 the research vessel Tridens is also engaged in the BTS survey and it covers the more offshore areas in the southern and central North Sea. This survey has now been made available to the WG for the first time. The method of calculation of the index is similar to the standard BTS index; i.e. average number per haul per ICES square and then the mean from the squares.

6.2 Final assessment

The assessment of North Sea plaice has been revised compared to the assessment accepted by the WG in june 2002. There are two reasons for this change:

- problems discovered in the Danish age reading of market data in 2001
- the number of significant digits of the survey data in the tuning fleet file was too low, which resulted in unreliable behaviour at the older ages (almost binary data).

The problems in the age-reading of the Danish samples in 2001 were already mentioned in the WG report (ICES 2003) and are further analysed in WD S1 (Bolle 2002). The final assessment presented here is the same as the final run in the WG report (ICES 2003), except that the Danish catch at age data were removed (run: WG2002-DK). At the WG, the German catch at age data were already removed due to SoP errors.

Input to the assessment is presented in tables 6.2.1 to 6.2.3. For input data that is not presented in tables, the same data has been used as in the WGNSSK report. The general effect of removing the Danish age composition in 2001 is that the total international age composition is more heavily influenced by the Dutch age composition which consists predominantly of smaller fish.

Table 6.2.4 documents the tuning data where the number of significant digits of the BTS index has been increased to three. The commercial fleets are no longer listed as tuning fleets as they were not used in the assessment.

The F-SSB 2001 phase plot is presented in figure 6.2.1. The time trends of F and SSB for three different configurations of the XSA assessment are presented in figure 6.2.2 in comparison with the ACFM 2001 assessment (ICES 2002).

Tuning diagnostics are presented in table 6.2.5. Log catchability residuals are shown in figure 6.2.3 for both fleets combined. Relative differences in fleet-wise survivor estimates from the weighted survivor estimates are shown in figure 6.2.4. These indicate that the shrinkage is pulling the survivor estimates down for ages 4 to 6 and up for ages 1 and 2.

Fishing mortality at age and stock numbers at age are presented in tables 6.2.6 and 6.2.7, and the stock summary in figure 6.2.5 and table 6.2.8. The assessment is more consistent with the assessment that was accepted by ACFM in October 2001 compared to the WG assessment that included the Danish age compositions for 2001.

A comparison of historical assessments of this stock is presented in figure 6.2.6.

6.3 Sensitivity analysis

Apart from a new final assessment run, which is presented in section 6.2, the subgroup considered a number of exploratory analysis in order to validate the results of the final run with additional information and with alternative assessment models. This can be considered as a kind of sensitivity analysis. The following explorations were carried out:

- Retrospective analysis of the final with different levels of shrinkage
- Application of the ICA model (Patterson 1998) to the data as used in the final run.
- Application of the Surba model version 2.00 (Needle 2002) on the standard BTS survey and on the extended BTS TRIDENS survey.
- Analysis of fishing effort of the Dutch and English beam trawl fleets.

6.3.1 Retrospective analysis

A retrospective analysis using a shrinking window approach was carried out using the data as presented in the final assessment. Shrinkage was varied between 0.5 (high shrinkage) and 2.0 (low shrinkage) in steps of 0.5.

Figure 6.3.1 shows that the retrospective patterns in F are heavily influenced by shrinkage. Applying a low shrinkage results in a very much reduced retrospective pattern on F. The effects of shrinkage on SSB is relatively small in recent years but was very large in the late 1980s when using low shrinkage. A lower shrinkage weight, therefore, does not improve the historic retrospective pattern for SSB, but rather makes it marginally worse. Trends in recruitment appear to be less affected by shrinkage.

Figure 6.3.2 compares runs made with shrinkage CVs of 0.5 and 2.0 (based on the WG assessment!). In each case the left hand figure plots the proportional contribution of the assessment information, the right hand figure the estimated F in the final year. In the right hand figures the open circle is the F shrinkage the square the SNS and the diamond the BTS surveys. It can be seen that if the shrinkage is used at the oldest ages we have a flat topped exploitation pattern. In the low shrinkage situation we have a dome shaped low F scenario at the oldest ages.

A lower shrinkage weight does improve the historic retrospective pattern for fishing mortality but also introduces a very low (artificial?) F at age at the oldest assessment ages in order to make the populations consistent with the CPUE data from the surveys. F at age is also more variable because individual cohorts are released from the averaging constraints. The older ages are included in the Fbar (2 – 10) and therefore have a strong effect on that average.

At the younger ages there is much less of an effect (see the bottom plot in Figure 6.3.2) of shrinkage. This results from the information contributed by the surveys dominating estimates at those ages.

The effect of shrinkage on the estimated population number and SSB at age is illustrated in Figure 6.3.3. The figures show that the dominant effect of the shrinkage is on the abundance and biomass of age 5 in 2001, the 1996 year class. In terms of the difference in biomass estimated by the models, the size of this year class dominates the uncertainty (bottom figure of Figure 6.3.3).

In the catch at age data the 1996 year class is 3x the magnitude of the previous 5 year classes at age 4 and 4x at age 5. In the "heavily shrunk" assessment the year class is estimated to be 5x and 7x respectively and in the "light shrinkage" assessment 7x and 10x. Any prediction based on the light shrinkage assessment could be over estimating the contribution of this year class to the population and recent catch at age data.

In conclusion: the lower shrinkage gives a better retrospective pattern, predominantly on fishing mortality. However, by reducing shrinkage, the assessments is less well behaved in terms of estimating the size of the 1996 year class and fishing mortality at older ages. Therefore, the default shrinkage option is retained for purposes of consistency with preivous assessments.

6.3.2 ICA

Results of an ICA assessment on the new catch at age data, assuming a six year separable pattern and reference age 4 and with manual weighting of the survey indices, is shown in figure 6.3.4. Apperently, ICA indicates that F has remained high and that SSB is lower than indicated by XSA. This indicates that the outcome of this assessment is sensitive to the model used.

6.3.3 Surba

Surba models (Needle 2002) were applied to the standard BTS index (figure 6.3.5) and to the extended BTS TRIDENS series (figure 6.3.6). The results are considered preliminary but do give support to the hypothesis that most age groups plaice tend to be more offshore in recent years. The SSB estimated using the standard index gives increases due to the strong 1985 year class and persisted for a number of years. The 1996 year class appears to give only a single peak which indicates that either they have been fished or they have migrated out of the survey area. With the new TRIDENS BTS survey, we now have the complementary picture which indicates an increase in SSB over the years 1996-2001, although also with a peak value in 1998 like on the standard BTS index. The index values for extended BTS survey 2002 are not yet available but will hopefully be available during ACFM.

6.3.4 Effort trends

Trends in fishing effort of the Dutch (top) and English (bottom) beam trawl fleets is shown in figure 6.3.7. Fishing effort decreased from 1994 to 2001, which could corroborate a decrease in fishing mortality.

6.4 Recruitment estimates

Input to the RCT3 analysis is presented in table 6.4.1. Results for ages 1 to 3 are presented in tables 6.4.2 – 6.4.4. The Geometric mean recruitment is 410 million and the arithmetric mean is 450 million.

The **1999 year class** in 2002 (at age 3) is estimated to be at 173 million in XSA and 190 million in RCT3. It is therefore substantially lower than the average recruitment at age 3 (303 million). The XSA estimate is used for prediction purposes because the survey receive a relatively high weight (84%) in the tuning of the assessment.

The **2000 year class** in 2002 (at age 2) is estimated at 246 million in XSA and 201 in RCT3. Again the yearclass is thought to be lower than the average yearclass strength at age 2 (369 million). The XSA estimate is used for prediction purposes because the survey receive a relatively high weight (73%) in the tuning of the assessment.

The **2001 year class** in 2002 (at age 1) is estimated to be strong in the RCT3 analysis: 650 million. The RCT3 estimate is used for prediction purposes because the surveys are consistent in estimating a strong yearclass and they receive a weight of around 73% in the RCT3 analysis.

The first indications of the **2002 year class** at age 1 come from one survey only (SNS 0-group). Although this survey indicates a somewhat strong yearclass, the information is considered to be too unreliable to base the recruitment estimation on. Therefore the GM recruitment (410 million) is used in the predictions.

The recruitment information can be summarized as follows:

yearclass	age in 2002	XSA	RCT3	GM*
1999	3	**173**	190	303
2000	2	**246**	201	369
2001	1		**650**	410
2002	recruits			**410**

** GM 1957-1999*

6.5 Short term forecast

The input for the short term forecast is given in table 6.5.1. 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 2001 (0.38). Population numbers at ages 2 and older are XSA survivor estimates. Numbers at age 1 are estimated from RCT3. The recruitment of the 2002 yearclass was taken as the long term geometric mean (1957-1999).

A management option table for status quo fishing mortality in 2001 in presented in table 6.5.2 Detailed tables for for F status quo are given in table 6.5.3 A detailed deterministic plot of the catch forecast is given in figure 6.5.1 At status quo fishing mortality in 2002 and 2003 the SSB is expected to be at around 269,000 tonnes in 2003 and 2004.

The yield at status quo F is expected to be around 96,000 tonnes in 2002, about 7% lower than the predicted value for 2002 from last years status quo forecast. The status quo catch prediction for 2002 is substantially higher than the TAC for 2002 (77,000 tonnes). The yield in 2003 is predicted to be 93,000 tonnes at status quo F.

A sensitivity analysis has been made to indentify the different sources of uncertainty underlying the predictions (figure 6.5.2) About 70% of the variability of the SSB in 2004 is explained by the numbers at age 1 and 2 in 2002.

The probability profiles relative to the short term forecast are given in figure 6.5.3.At the current yield of around 96,000 tonnes, the probability that F is higher that $\mathbf{F}_{sq}$ is around 55%. The probability that SSB will fall below $\mathbf{B}_{lim}$ (210,000 tonnes) is predicted to be slightly higher than 10%. The risk of falling below $\mathbf{B}_{pa}$ (300,000 tonnes) is around 75%.

6.6 Medium term projections

A 10 year average was used for the catch weigth at age and stock weight at age. A traditional Shepherd stock recruit curve was used to fit the model. The estimated parameters and the residuals from the fit were exported to the inputfile for the WGTERMC program. Figure 6.6.1 shows the stock-recruitment fit and the medium term forecasts at $\mathbf{F}_{sq}$. Both landings and SSB are predicted to remain stable for the next years with fishing at the current F (0.38). The apparent discrepancy between the medium and short term forecast is a result of the strong 2001 yearclass which will take the stock to around the maximum of the SRR curve at status quo F.

Figure 6.6.2 shows the probability of SSB to fall below $\mathbf{B}_{pa}$ over the next 10 years. At $\mathbf{F}_{pa}$ the probability of remaining below $\mathbf{B}_{pa}$ is around 50% in 2011.

6.7 Comments

This plaice assessment is considered to be problematic. Different assessment methods give different results and the calibration data that are currently used (surveys only) do not cover the whole stock area.

The shrinkage option does have a strong effect on the XSA assessment. This results from the fact that as fishing mortality is reduced convergence in the VPA decreases and we require better information for the CPUE data. The WG has rejected the use of commercial CPUE data which has less uncertainty but unknown bias and used the survey series with greater noise and, hopefully, no bias.

Although the WG has reduced the range of ages used for tuning the age range of the assessment has not been reduced. Therefore the estimates of F and N at the oldest ages, where the survey has more noise, are increasingly estimated from the average fishing mortality. The majority of those ages do not significantly affect the estimated SSB although they do have a big influence to the mean F, the age range of which has also remained unchanged.

The two main effects of the shrinkage are to:

1) impose a flat topped selection pattern at the oldest ages

2) reduce the abundance of the 1996 year class.

The question is open as whether there is evidence to support the strong reduction in F on older ages from the low shrinkage run. Effort has been shown to decrease since 1994 but it still cannot be explained that this would affect the oldest ages only.

The newly developed survey index series (BTS TRIDENS) appears to deliver very useful information and should be expanded in the future. Also there may be scope to developed a combined BTS index for the whole distribution area, if the relative efficiencies of the vessels can be estimated.

Work has been ongoing to estimate the age compositions and CPUE at age for the so-called flag-vessels, i.e. vessels registered in the UK but fishing with a predominantly Dutch crew and from Dutch companies. Just before the subgroup, the relevant information for the years 1991-2001 was obtained from the fishermen's organization, but unfortunately there was not sufficient time to work up the basic data for this subgroup. This information is thought to improve the quality of the total international age compositions of plaice.

The North Sea Commission has reviewed the assessment of North Sea plaice. The following items have been put forward by the commission:

- The commission had a long discussion of changes in fishing mortality. Very high values were shown in some figures in the report and questions were asked as to how F could be as high as was shown when there had been a decrease in effort, the imposition of the plaice box, and restrictive TACs?

- There was discussion of the changes in fishing mortality for any given year as observed in the retrospective analyses. It was pointed out that it was not uncommon to find such discrepancies, as it is inherent in the process of retrospective analysis.

- It was considered to be especially important to have estimates of discards for plaice. In addition, there would be value in carrying out more widely–based surveys which would include adult fish as well as juveniles Additional, more detailed CPUE data were also required, though there were difficulties in using CPUE data to evaluate stock size because of the effects of ITQs and other regulatory measures.

- The biomass limit reference point for plaice was discussed. It has been set at the lowest known biomass for plaice at the time. It is not known whether this is a danger point for plaice, or that it represents a biological limit beyond which the stock will be threatened. New limit reference points are due to be considered by ICES in 2003. There was a strong feeling within the meeting that this issue was important, and that the fishing industry should be involved in the discussions.

- Previous advice on plaice gives the impression that uncertainties are small. For example, one year, ICES advised changing the TAC from 78 000t to 77 000t, giving the impression that it was statistically possible to differentiate the two numbers. Scientists would like to provide advice incorporating the uncertainties, but managers and politicians prefer to have advice without the uncertainties.

The subgroup considered that the comments by the North Sea Commission were valid and that the discussion often mimick the discussion that are carried out in the WGNSSK.

Table 6.2.1. North Sea plaice. Catch numbers at age.

At 17/09/2002 11:41

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

YEAR,	1957,	1958,	1959,	1960,	1961,
1,	0,	0,	0,	0,	0,
2,	4315,	7129,	16556,	5959,	2264,
3,	59818,	22205,	30427,	61876,	33392,
4,	44718,	62047,	25489,	51022,	67906,
5,	31771,	34112,	41099,	21321,	32699,
6,	8885,	19594,	22936,	27329,	12759,
7,	11029,	8178,	13873,	14186,	14680,
8,	9028,	8000,	6408,	9013,	9748,
9,	4973,	6110,	6596,	5087,	5996,
10,	4300,	4093,	5360,	4711,	3446,
11,	2580,	4530,	3386,	3418,	3621,
12,	1312,	1740,	3564,	2391,	2887,
13,	787,	1110,	1507,	1966,	1743,
14,	875,	528,	869,	1014,	1345,
+gp,	1005,	1147,	1494,	1653,	1618,
0 TOTALNUM,	185396,	180523,	179564,	210946,	194104,
TONSLAND,	70563,	73354,	79300,	87541,	85984,
SOPCOF %,	111,	106,	102,	101,	102,

YEAR,	1962,	1963,	1964,	1965,	1966,	1967,	1968,	1969,	1970,	1971,
1,	0,	0,	0,	0,	0,	0,	0,	3,	76,	19,
2,	2147,	4340,	14708,	9858,	4144,	5982,	9474,	15017,	17294,	29591,
3,	35876,	21471,	40486,	42202,	65009,	30304,	40698,	45187,	51174,	48282,
4,	66779,	76926,	64735,	53188,	51488,	112917,	38140,	36084,	56153,	33475,
5,	50060,	54364,	57408,	43674,	36667,	41383,	123619,	35585,	40686,	26059,
6,	20628,	31799,	37091,	30151,	27370,	22053,	17139,	102014,	35074,	22903,
7,	9060,	12848,	15819,	18361,	16500,	16175,	10341,	10410,	78886,	16913,
8,	9035,	6833,	6595,	8554,	10784,	8004,	10102,	6086,	6311,	29730,
9,	5257,	7047,	3980,	4213,	6467,	6728,	3925,	8192,	4185,	6414,
10,	3428,	3863,	3804,	4015,	3336,	3045,	4891,	3739,	4778,	4602,
11,	2659,	3591,	3066,	2807,	1843,	2033,	2273,	4760,	2202,	3377,
12,	2266,	2117,	1905,	2221,	2552,	968,	1556,	1796,	2871,	2213,
13,	2001,	2089,	1518,	1745,	1624,	1303,	607,	1223,	1150,	1910,
14,	1061,	1536,	1300,	1338,	1032,	783,	1007,	703,	939,	929,
+gp,	1386,	3396,	5293,	5461,	4541,	3043,	3031,	3871,	2900,	3879,
0 TOTALNUM,	211643,	232220,	257708,	227788,	233357,	254721,	266803,	274670,	304679,	230296,
TONSLAND,	87472,	107118,	110540,	97143,	101834,	108819,	111534,	121651,	130342,	113944,
SOPCOF %,	97,	102,	101,	101,	102,	102,	103,	106,	97,	103,

YEAR,	1972,	1973,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,
1,	2233,	1268,	2223,	981,	2820,	3220,	1143,	1318,	979,	253,
2,	36528,	31733,	23120,	28124,	33643,	56969,	60578,	58031,	64904,	100927,
3,	62199,	59099,	55548,	61623,	77649,	43289,	62343,	118863,	133741,	122296,
4,	52906,	73065,	42125,	31262,	96398,	66013,	54341,	48962,	77523,	57604,
5,	23043,	42255,	41075,	25419,	13779,	83705,	50102,	47886,	24974,	35745,
6,	16998,	13817,	19666,	21188,	9904,	9142,	35510,	39932,	17982,	12414,
7,	14380,	8885,	8005,	11873,	9120,	5912,	5940,	24228,	13761,	9564,
8,	10903,	9848,	6321,	5923,	6391,	5022,	3352,	4161,	8458,	8092,
9,	18585,	6084,	5568,	4106,	2947,	4061,	2419,	2807,	1864,	4874,
10,	3467,	13829,	3931,	3337,	2020,	1927,	2176,	2333,	1326,	1406,
11,	2841,	1680,	10118,	1741,	2111,	1301,	1145,	1849,	952,	1097,
12,	2538,	1995,	1634,	7935,	911,	1357,	603,	1113,	1173,	830,
13,	1553,	1516,	1686,	1080,	4478,	489,	689,	707,	433,	796,
14,	1591,	1355,	1242,	1424,	388,	2290,	330,	707,	284,	468,
+gp,	3661,	3603,	3369,	4178,	2644,	1827,	2525,	2579,	1209,	1306,
0 TOTALNUM,	253426,	270032,	225631,	210194,	265203,	286524,	283196,	355476,	349563,	357672,
TONSLAND,	122843,	130429,	112540,	108536,	113670,	119188,	113984,	145347,	139951,	139747,
SOPCOF %,	103,	105,	104,	106,	103,	100,	96,	100,	101,	102,

YEAR,	1982,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,
1,	3334,	1214,	108,	121,	1674,	0,	0,	1261,	1550,	1461,
2,	47776,	119695,	63252,	73552,	67125,	85123,	15146,	46757,	32533,	43266,
3,	209007,	115034,	274209,	144316,	163717,	115951,	250675,	105929,	97766,	83603,
4,	69544,	99076,	53549,	185203,	93801,	111239,	74335,	231414,	110997,	116155,
5,	28655,	29359,	37468,	32520,	84479,	64758,	47380,	52909,	159814,	72961,
6,	16726,	12906,	13661,	15544,	24049,	34728,	25091,	19247,	26757,	77557,
7,	7589,	8216,	6465,	6871,	9299,	11452,	16774,	10567,	8129,	14910,
8,	5470,	4193,	5544,	3650,	4490,	4341,	5381,	7561,	4216,	5233,
9,	4482,	3013,	2720,	2698,	2733,	2154,	3162,	2120,	3451,	3141,
10,	3706,	2947,	2088,	1543,	2026,	1743,	1671,	1692,	1097,	2325,
11,	1134,	2144,	1307,	1030,	1178,	1033,	932,	927,	716,	956,
12,	712,	1219,	1143,	1070,	1084,	663,	932,	630,	456,	592,
13,	575,	581,	455,	727,	806,	529,	505,	446,	293,	356,
14,	519,	344,	310,	371,	628,	296,	516,	328,	208,	289,
+gp,	2007,	1052,	1262,	1057,	1228,	1214,	1677,	1557,	1038,	1073,
0 TOTALNUM,	401236,	400993,	463541,	470273,	458317,	435224,	444177,	483345,	449021,	423878,
TONSLAND,	154547,	144038,	156147,	159838,	165347,	153670,	154475,	169818,	156240,	148004,
SOPCOF %,	101,	99,	98,	98,	99,	99,	98,	99,	98,	96,

Table 6.2.1 (Continued)

YEAR	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	3410	3461	1394	7751	1104	892	196	549	2634	4773
2	43954	53949	45148	36575	42496	42855	30401	8689	15819	37092
3	85120	98375	101617	81398	64382	86948	68920	155971	39550	52428
4	72494	72286	80236	78370	46359	43669	56329	39857	164330	45725
5	72703	51405	38542	36499	32130	22541	16713	24112	14993	88273
6	33406	29001	20388	17953	14460	13518	6432	6829	9343	7156
7	29547	13472	15323	9772	10605	6362	4986	2783	2130	4487
8	6970	11272	6399	4366	4528	3632	2506	2246	1030	1167
9	3200	3645	5368	2336	2624	2179	1761	1521	940	637
10	2240	1888	2319	1682	1659	1252	912	1180	544	599
11	1516	1241	942	864	1170	690	500	515	392	313
12	925	932	646	427	511	889	403	381	393	493
13	524	743	580	229	260	396	431	230	203	245
14	490	215	300	209	238	224	176	267	134	183
+gp	1233	864	646	342	1054	730	697	520	431	611
0 TOTALNUM	357732	342749	319848	278773	223580	226777	191363	245650	252866	244182
TONSLAND	125190	117113	110392	98356	81673	83048	71534	80662	81148	81847
SOPCOF %	98	98	97	99	98	99	98	99	97	99

Table 6.2.2. North Sea plaice. Catch weight at age (kg).

	YEAR	1957	1958	1959	1960	1961
	1	.0000	.0000	.0000	.0000	.0000
	2	.1650	.1980	.2180	.2000	.1910
	3	.2010	.2210	.2460	.2360	.2330
	4	.2580	.2590	.2930	.2890	.3020
	5	.3530	.3370	.3620	.3860	.4120
	6	.4560	.4530	.4730	.4850	.5090
	7	.5330	.5130	.5920	.6010	.6040
	8	.5890	.6150	.6230	.6830	.6710
	9	.3960	.6650	.7500	.7240	.8120
	10	.8210	.8020	.7910	.8740	.8700
	11	.9570	.9200	.9180	.9590	.9420
	12	1.0480	1.0450	1.0090	1.1620	1.0330
	13	1.2330	1.1340	1.1900	1.2320	1.2240
	14	1.1410	1.3700	1.2670	1.3600	1.2390
	+gp	1.4870	1.5630	1.5630	1.5720	1.5530
0	SOPCOFAC	1.1105	1.0634	1.0217	1.0067	1.0156

	YEAR	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
	1	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.2170	.3150	.2560
	2	.2110	.2530	.2500	.2420	.2320	.2320	.2670	.2940	.2860	.3180
	3	.2480	.2860	.2730	.2820	.2700	.2790	.2980	.3100	.3180	.3560
	4	.3000	.3190	.3120	.3210	.3480	.3220	.3310	.3330	.3560	.4030
	5	.4000	.3990	.3880	.3850	.4360	.4250	.3660	.3590	.4190	.4480
	6	.5410	.5330	.4870	.4710	.4840	.5470	.5170	.4120	.4430	.5140
	7	.5700	.6240	.6280	.5390	.5590	.5970	.5900	.5730	.4990	.5420
	8	.6920	.6670	.7000	.6630	.6240	.6620	.5960	.6550	.6720	.6070
	9	.7770	.7150	.7370	.7260	.6900	.7380	.6860	.6580	.7440	.6990
	10	.9590	.8600	.8410	.6150	.8130	.8370	.7500	.6940	.7620	.7240
	11	.9950	.9200	.8900	.7920	.8580	.8700	.8170	.8100	.7800	.8180
	12	1.1000	1.0330	.9540	.8570	.8430	.9020	.9390	.8380	.8920	.8480
	13	1.1870	1.0040	.9380	.9740	.9430	.9500	.9360	1.0220	.9410	.9220
	14	1.4100	1.1820	1.0980	.8780	1.0180	1.0320	.9730	.8630	1.0210	1.0040
	+gp	1.5400	1.2760	1.2040	1.1210	1.0800	1.2140	1.2010	1.1790	1.1280	1.1330
0	SOPCOFAC	.9665	1.0193	1.0075	1.0057	1.0182	1.0198	1.0291	1.0582	.9744	1.0331

	YEAR	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
	1	.2460	.2720	.2850	.2490	.2650	.2540	.2440	.2350	.2380	.2370
	2	.2960	.3160	.3110	.3000	.2950	.3230	.3150	.3110	.2860	.2740
	3	.3520	.3440	.3540	.3300	.3380	.3530	.3690	.3490	.3440	.3290
	4	.4280	.4050	.4050	.4200	.3750	.3800	.3970	.3880	.4010	.4160
	5	.4930	.4860	.4760	.4950	.5130	.4180	.4380	.4290	.4730	.5050
	6	.5410	.5390	.5540	.5870	.5940	.5560	.4910	.4740	.5450	.5580
	7	.6080	.6050	.6090	.6360	.6410	.6470	.6090	.5500	.5880	.6040
	8	.6460	.6270	.6930	.7030	.7050	.7210	.6870	.6750	.6620	.6420
	9	.6740	.6770	.7070	.7830	.7410	.7150	.7760	.7960	.7720	.7250
	10	.7850	.7290	.7790	.8530	.8130	.7910	.7810	.8710	.9310	.8690
	11	.8410	.9780	.8490	.8540	.8510	.8980	.8860	.8180	.9430	.9500
	12	.9010	.9070	.9710	.9830	.9280	.9700	.9830	.8940	.8480	.9310
	13	.9000	.9420	1.0020	.9530	1.0190	.8550	1.0390	1.0830	1.0150	.9330
	14	.9640	.9830	1.0400	1.1380	1.0090	1.0630	.9330	1.0440	1.3080	1.1790
	+gp	1.1920	1.0790	1.2240	1.2640	1.1590	1.1650	1.0940	1.1150	1.2480	1.2360
0	SOPCOFAC	1.0283	1.0508	1.0369	1.0624	1.0254	1.0016	.9643	.9983	1.0136	1.0175

	YEAR	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
	1	.2790	.2000	.2330	.2470	.2210	.2210	.2210	.2360	.2710	.2270
	2	.2620	.2500	.2630	.2640	.2690	.2490	.2540	.2800	.2850	.2860
	3	.3110	.3000	.2830	.2900	.3040	.3000	.2780	.3090	.2980	.2940
	4	.4240	.3830	.3750	.3370	.3470	.3510	.3520	.3320	.3170	.3060
	5	.5140	.5150	.4910	.4620	.4250	.4020	.4530	.3920	.3660	.3650
	6	.6080	.6040	.6130	.5770	.4880	.5040	.5120	.5330	.4470	.4550
	7	.6640	.6770	.6840	.6780	.6750	.5830	.6080	.6030	.5970	.5280
	8	.7120	.7710	.7250	.7290	.7510	.7280	.6990	.6700	.6920	.6710
	9	.7380	.8150	.8370	.8040	.8530	.8290	.8130	.7920	.7610	.7470
	10	.8400	.8930	.9160	.9000	.9210	.8260	.9360	.8190	.8260	.8430
	11	.9830	.9130	.9810	1.0010	.9480	.9960	.9640	.9230	1.0440	.9300
	12	1.0450	.9840	1.0260	.9500	1.0630	1.0150	1.0410	.9520	1.0980	.9440
	13	1.1740	1.2400	1.1120	1.0710	1.0780	1.0450	1.1370	1.1570	1.1170	1.0000
	14	.9700	1.2090	1.2500	1.1390	1.0740	1.1270	1.1150	1.0840	.9910	.9760
	+gp	1.1770	1.1670	1.2140	1.2150	1.1100	1.1500	1.0380	.9940	1.0940	1.0260
0	SOPCOFAC	1.0062	.9938	.9844	.9799	.9877	.9875	.9848	.9854	.9846	.9634

	YEAR	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
	1	.2510	.2490	.2290	.2720	.2400	.2080	.1520	.2450	.2280	.2380
	2	.2630	.2730	.2630	.2770	.2800	.2710	.2600	.2530	.2670	.2670
	3	.2900	.2890	.2860	.3010	.3070	.3130	.3100	.2800	.2840	.2950
	4	.3180	.3260	.3390	.3380	.3550	.3640	.3940	.3550	.3140	.3130
	5	.3410	.3560	.3970	.4020	.4200	.4570	.4970	.4550	.4320	.3680
	6	.4250	.4230	.4490	.4540	.4860	.5240	.6070	.5470	.5000	.4810
	7	.5310	.5180	.5020	.5280	.4990	.6030	.6330	.6300	.6840	.5900
	8	.6050	.6310	.6110	.6110	.5890	.6160	.6950	.6820	.7100	.7100
	9	.7150	.7210	.7320	.7340	.7200	.6830	.7000	.7520	.7510	.8040
	10	.7550	.7750	.7870	.8810	.8540	.8030	.8000	.6080	.8310	.7760
	11	.8430	.8060	.9360	.8650	.9280	.9070	.9750	.7500	.8430	.7650
	12	.9450	.9030	.9480	.9230	.9330	.9570	1.0780	.9330	.7490	.7250
	13	.9940	.8460	1.0340	.9180	.9230	.8840	.8880	1.0310	.8530	.8310
	14	.9280	.9190	.9200	.9430	.8290	1.1000	.9070	.9360	1.0130	.7990
	+gp	1.0980	1.0460	1.1310	1.1040	.7390	1.0760	.9430	1.0930	1.1020	.8920
0	SOPCOFAC	.9818	.9767	.9738	.9935	.9846	.9920	.9842	.9860	.9711	.9898

Table 6.2.3. North Sea plaice. Stock weight at age (kg).

YEAR,	1957,	1958,	1959,	1960,	1961,
1,	.1410,	.1410,	.1410,	.1410,	.1410,
2,	.2000,	.2000,	.1460,	.1900,	.1260,
3,	.2680,	.1970,	.1940,	.2080,	.2020,
4,	.2380,	.2260,	.2400,	.2400,	.2540,
5,	.3250,	.3030,	.3290,	.3640,	.3370,
6,	.4850,	.4420,	.4700,	.4690,	.4830,
7,	.7190,	.5770,	.6500,	.6330,	.5790,
8,	.6820,	.7780,	.6860,	.7260,	.6910,
9,	.8440,	.7930,	.9080,	.8450,	.7790,
10,	.9180,	.9450,	.8970,	.9180,	.9110,
11,	1.1370,	1.0810,	.9010,	.9750,	.9470,
12,	1.1820,	.7850,	1.1380,	1.1260,	1.0790,
13,	1.3850,	1.0420,	1.4100,	1.1480,	1.1840,
14,	1.4800,	1.6150,	.9450,	1.3730,	1.1860,
+gp,	1.5850,	2.1590,	1.3400,	1.5220,	1.4240,

YEAR,	1962,	1963,	1964,	1965,	1966,	1967,	1968,	1969,	1970,	1971,
1,	.1410,	.1410,	.1410,	.1410,	.1410,	.1410,	.1410,	.1750,	.1750,	.1750,
2,	.1870,	.2000,	.2000,	.2000,	.2000,	.2030,	.2000,	.2030,	.2500,	.2480,
3,	.2580,	.2320,	.2280,	.2460,	.2430,	.2460,	.2650,	.2580,	.2610,	.3050,
4,	.3060,	.2900,	.2760,	.2740,	.3010,	.2810,	.3010,	.2970,	.3110,	.3630,
5,	.4240,	.3780,	.3730,	.3330,	.4030,	.4420,	.3440,	.3440,	.3690,	.4130,
6,	.5730,	.5400,	.4770,	.4300,	.4550,	.5280,	.5320,	.3900,	.4100,	.4890,
7,	.6840,	.6630,	.6450,	.5160,	.5030,	.5850,	.5920,	.5650,	.4680,	.5120,
8,	.8060,	.7880,	.6730,	.6010,	.5650,	.6500,	.3620,	.6210,	.6360,	.5830,
9,	.8730,	.8820,	.8450,	.7220,	.5810,	.7030,	.6670,	.6790,	.7320,	.6960,
10,	1.3350,	.9610,	.9730,	.5780,	.8480,	.8330,	.7460,	.6350,	.7470,	.7070,
11,	1.0740,	1.0970,	.9990,	.7900,	.9490,	.9070,	.7910,	.7720,	.7710,	.8170,
12,	1.2400,	1.2610,	1.2550,	.8430,	.7040,	1.0070,	.9190,	.7410,	.8980,	.8470,
13,	1.1410,	1.2460,	1.2010,	1.0720,	1.0520,	.8980,	.8100,	.9950,	.8390,	.9410,
14,	1.8000,	1.4030,	1.6200,	.7210,	1.0560,	.9760,	.9380,	.9070,	1.1550,	.9360,
+gp,	1.6190,	1.6780,	1.4600,	1.2340,	1.2160,	1.2210,	1.1700,	1.1790,	1.1750,	1.1020,

YEAR,	1972,	1973,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,
1,	.1750,	.1750,	.1700,	.1700,	.1700,	.1600,	.1500,	.1500,	.1500,	.1500,
2,	.2740,	.2640,	.2340,	.2750,	.2170,	.2500,	.2420,	.2430,	.2290,	.2500,
3,	.3210,	.3220,	.3040,	.2940,	.2810,	.3090,	.3360,	.3030,	.3070,	.2820,
4,	.4010,	.3800,	.3750,	.4170,	.3320,	.3640,	.3670,	.3630,	.3720,	.3780,
5,	.4730,	.4680,	.4370,	.4830,	.4840,	.4050,	.4110,	.4140,	.4440,	.4730,
6,	.5340,	.5210,	.5240,	.5440,	.5500,	.5510,	.4670,	.4590,	.5240,	.5360,
7,	.5790,	.5660,	.5700,	.6100,	.5930,	.6270,	.5470,	.5430,	.5820,	.5700,
8,	.6060,	.5830,	.6290,	.6680,	.6580,	.6900,	.6300,	.6670,	.6510,	.6240,
9,	.6550,	.6170,	.6520,	.7040,	.6940,	.6670,	.7040,	.7640,	.7780,	.7070,
10,	.7590,	.6900,	.6900,	.7620,	.7430,	.7590,	.7730,	.8260,	1.0250,	.8490,
11,	.8150,	.9260,	.7740,	.8300,	.7840,	.8180,	.8480,	.8940,	.9470,	.9100,
12,	.8690,	.8990,	.9320,	.8860,	.8750,	.9090,	.9390,	.8800,	.8380,	.8660,
13,	.8490,	.9610,	1.0170,	.8740,	.9720,	.8380,	.9590,	1.1270,	1.2090,	1.1140,
14,	.9710,	.9770,	.9620,	1.0700,	1.1580,	1.0550,	1.0240,	1.0410,	1.1940,	1.2180,
+gp,	1.2370,	.9980,	1.1130,	1.2170,	1.1070,	1.1160,	1.1190,	1.2550,	1.3100,	1.3240,

YEAR,	1982,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,
1,	.1500,	.1500,	.1500,	.1500,	.1500,	.1500,	.1500,	.1500,	.1500,	.1310,
2,	.2420,	.2110,	.2030,	.2080,	.1950,	.1940,	.2120,	.2150,	.2450,	.2080,
3,	.2650,	.2480,	.2420,	.2430,	.2530,	.2650,	.2380,	.2480,	.2720,	.2630,
4,	.3810,	.3290,	.3380,	.3100,	.3360,	.3300,	.3150,	.2820,	.2810,	.2750,
5,	.4900,	.4940,	.4640,	.4520,	.4400,	.4010,	.4260,	.3620,	.3420,	.3400,
6,	.5890,	.5590,	.5710,	.5360,	.5330,	.5030,	.4670,	.4840,	.4210,	.4000,
7,	.6310,	.6240,	.6490,	.6350,	.6920,	.5730,	.5470,	.5530,	.5550,	.4630,
8,	.6790,	.7120,	.6920,	.6560,	.7790,	.7110,	.6440,	.6160,	.6480,	.6400,
9,	.7260,	.7540,	.7870,	.7640,	.8880,	.7470,	.7060,	.7590,	.7130,	.6580,
10,	.8280,	.7910,	.8980,	.8690,	.9710,	.8170,	.8970,	.8370,	.7690,	.7620,
11,	.9810,	.8240,	.9320,	.9550,	.9530,	1.0090,	.9370,	.7910,	1.0510,	.8550,
12,	1.0660,	1.0110,	1.0420,	.9060,	1.1070,	1.0180,	1.0090,	.9680,	1.1540,	.9900,
13,	1.1820,	1.1300,	1.2350,	1.0680,	1.1530,	1.0190,	1.0650,	1.2150,	1.0220,	.9820,
14,	.8970,	1.2570,	1.1270,	1.1080,	1.1260,	1.2140,	1.1350,	.8990,	1.0900,	.8600,
+gp,	1.1970,	1.1240,	1.2350,	1.3080,	1.3540,	1.1140,	.9720,	.8570,	1.0840,	.9280,

YEAR,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,
1,	.1310,	.1310,	.1310,	.1240,	.1240,	.1240,	.1240,	.1240,	.1240,	.1240,
2,	.2620,	.2570,	.2220,	.2450,	.2450,	.2170,	.2050,	.2110,	.2240,	.2130,
3,	.2660,	.2640,	.2490,	.2650,	.2820,	.2540,	.2690,	.2510,	.2360,	.2470,
4,	.3000,	.3010,	.3020,	.3110,	.3290,	.3420,	.3620,	.3460,	.2900,	.2750,
5,	.3160,	.3280,	.3660,	.4010,	.3900,	.4420,	.4710,	.4360,	.4090,	.3320,
6,	.4020,	.3910,	.4100,	.4510,	.4640,	.4910,	.5780,	.5240,	.4680,	.4510,
7,	.5010,	.4910,	.4670,	.5200,	.4900,	.5630,	.5880,	.5910,	.6870,	.5580,
8,	.5750,	.5950,	.5480,	.6070,	.5720,	.5860,	.6570,	.6800,	.7420,	.6410,
9,	.6960,	.6460,	.6790,	.7050,	.6890,	.6840,	.6760,	.6960,	.7070,	.8060,
10,	.7510,	.7370,	.7520,	.8360,	.8450,	.7710,	.7090,	.6390,	.8640,	.8160,
11,	.8440,	.8050,	.9120,	.7390,	.9060,	.9130,	1.0040,	.7640,	.8720,	.8050,
12,	.8860,	.9420,	.9610,	.8850,	.9730,	.8650,	1.0920,	.8980,	.7440,	.6980,
13,	.9980,	.8660,	1.0270,	.8270,	.9000,	.8980,	.7880,	1.1850,	.8180,	.7840,
14,	.8590,	.9120,	.8460,	.9130,	.7810,	1.2870,	1.1750,	.8390,	1.0820,	.8110,
+gp,	1.0780,	1.1010,	1.0200,	1.1280,	.8700,	1.0520,	.8290,	1.1020,	1.0810,	.9860,

Table 6.2.4. North Sea plaice. Tuning fleets.

```
Plaice in the North Sea (Area IV)
102
BTS
   1985      2001
    1         1        0.66      0.75
    1         9
1         129.989   179.993   38.808    11.819    1.406     1.036     0.375     0.166     0.103     0.249
1         660.199   131.772   50.870    8.929     3.267     0.476     0.384     0.113     0.070     0.210
1         225.136   764.984   33.071    4.786     2.034     0.993     0.345     0.094     0.084     0.312
1         605.146   139.901   173.211   9.217     2.676     0.726     0.408     0.054     0.077     0.197
1         426.607   332.611   38.599    47.259    5.871     0.822     0.356     0.590     0.122     0.064
1         106.988   99.835    57.675    24.814    7.567     0.822     0.224     0.339     0.212     0.135
1         184.375   122.078   28.548    11.854    4.289     5.667     0.267     0.219     0.112     0.106
1         172.833   125.658   27.269    5.609     3.177     2.656     1.136     0.259     0.053     0.091
1         122.602   180.976   38.785    6.128     1.020     0.810     0.616     0.425     0.136     0.051
1         141.702   65.665    37.422    11.934    3.186     0.653     0.824     0.970     0.377     0.058
1         249.426   43.591    14.181    8.274     1.159     0.867     0.356     1.076     0.218     0.109
1         215.771   206.779   22.799    4.803     3.671     0.899     0.047     0.172     0.142     0.124
1             -11       -11   19.913    2.778     0.233     0.396     0.174     0.118     0.002     0.038
1         336.998   433.129   47.252    8.854     1.451     0.733     0.140     0.103     0.131     0.066
1         298.886   133.073   181.779   4.047     2.032     0.104     0.076     0.029     0.019     0.077
1         275.860   72.927    32.376    23.029    0.653     0.184     0.518     0.019     0.000     0.038
1         219.044   84.159    19.480    10.811    9.495     0.411     0.128     0.052     0.032     0.205
SNS
   1982      2001
    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
```

Table 6.2.5. North Sea plaice. XSA diagnostics

Lowestoft VPA Version 3.1
30/09/2002 15:35
Extended Survivors Analysis

Plaice in IV

CPUE data from file fleet

Catch data for 45 years. 1957 to 2001. Ages 1 to 15.

Fleet,	First, year,	Last, year,	First, age ,	Last, age	Alpha,	Beta
BTS ,	1985,	2001,	1,	9,	.660,	.750
SNS ,	1982,	2001,	1,	3,	.660,	.750

Time series weights :

Tapered time weighting not applied

Catchability analysis :

Catchability independent of stock size for all ages

Catchability independent of age for ages >= 10

Terminal population estimation :

Survivor estimates shrunk towards the mean F
of the final 3 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 28 iterations

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

Fishing mortalities

Age,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001
1,	.009,	.013,	.006,	.025,	.005,	.001,	.001,	.002,	.009,	.017
2,	.137,	.171,	.207,	.198,	.170,	.223,	.039,	.033,	.080,	.153
3,	.381,	.450,	.490,	.611,	.553,	.544,	.587,	.255,	.184,	.362
4,	.503,	.572,	.717,	.773,	.755,	.808,	.728,	.714,	.413,	.299
5,	.740,	.718,	.606,	.749,	.752,	.932,	.746,	.707,	.567,	.361
6,	.717,	.660,	.617,	.560,	.669,	.737,	.665,	.694,	.581,	.516
7,	.738,	.629,	.789,	.602,	.674,	.622,	.588,	.601,	.424,	.541
8,	.508,	.617,	.616,	.475,	.550,	.453,	.471,	.508,	.411,	.385
9,	.479,	.482,	.596,	.421,	.517,	.494,	.367,	.517,	.366,	.427
10,	.495,	.512,	.572,	.332,	.528,	.442,	.350,	.397,	.311,	.372
11,	.446,	.497,	.460,	.383,	.360,	.386,	.281,	.304,	.197,	.264
12,	.436,	.481,	.463,	.346,	.364,	.452,	.362,	.319,	.356,	.361
13,	.648,	.664,	.552,	.262,	.326,	.471,	.366,	.322,	.250,	.348
14,	.511,	.533,	.546,	.348,	.422,	.458,	.350,	.360,	.280,	.333

XSA population numbers (Thousands)

	AGE									
YEAR ,	1,	2,	3,	4,	5,	6,	7,	8,	9,	10,
1992 ,	4.03E+05,	3.62E+05,	2.82E+05,	1.93E+05,	1.46E+05,	6.86E+04,	5.95E+04,	1.84E+04,	8.84E+03,	6.03E+03,
1993 ,	2.85E+05,	3.62E+05,	2.86E+05,	1.75E+05,	1.05E+05,	6.31E+04,	3.03E+04,	2.57E+04,	1.00E+04,	4.95E+03,
1994 ,	2.38E+05,	2.54E+05,	2.76E+05,	1.65E+05,	8.91E+04,	4.65E+04,	2.95E+04,	1.46E+04,	1.26E+04,	5.59E+03,
1995 ,	3.24E+05,	2.14E+05,	1.87E+05,	1.53E+05,	7.28E+04,	4.40E+04,	2.27E+04,	1.21E+04,	7.15E+03,	6.27E+03,
1996 ,	2.50E+05,	2.85E+05,	1.59E+05,	9.19E+04,	6.39E+04,	3.12E+04,	2.27E+04,	1.13E+04,	6.83E+03,	4.25E+03,
1997 ,	9.26E+05,	2.25E+05,	2.18E+05,	8.28E+04,	3.91E+04,	2.72E+04,	1.44E+04,	1.05E+04,	5.88E+03,	3.69E+03,
1998 ,	3.12E+05,	8.37E+05,	1.63E+05,	1.14E+05,	3.34E+04,	1.39E+04,	1.18E+04,	7.01E+03,	6.03E+03,	3.24E+03,
1999 ,	2.40E+05,	2.82E+05,	7.29E+05,	8.21E+04,	5.00E+04,	1.43E+04,	6.47E+03,	5.93E+03,	3.96E+03,	3.78E+03,
2000 ,	3.06E+05,	2.17E+05,	2.47E+05,	5.11E+05,	3.64E+04,	2.23E+04,	6.48E+03,	3.21E+03,	3.23E+03,	2.14E+03,
2001 ,	3.02E+05,	2.75E+05,	1.81E+05,	1.86E+05,	3.06E+05,	1.87E+04,	1.13E+04,	3.84E+03,	1.93E+03,	2.03E+03,

Estimated population abundance at 1st Jan 2002

, 0.00E+00, 2.68E+05, 2.13E+05, 1.14E+05, 1.25E+05, 1.93E+05, 1.01E+04, 5.94E+03, 2.37E+03, 1.14E+03,

Taper weighted geometric mean of the VPA populations:

, 4.04E+05, 3.61E+05, 2.97E+05, 1.94E+05, 1.09E+05, 5.76E+04, 3.38E+04, 2.09E+04, 1.38E+04, 9.55E+03,

Standard error of the weighted Log(VPA populations) :

, .4034, .4158, .4233, .4645, .5462, .5971, .6391, .6899, .7173, .7366,

Table 6.2.5 (Cont'd)

AGE

YEAR	11	12	13	14
1992	4.43E+03	2.75E+03	1.16E+03	1.29E+03
1993	3.33E+03	2.57E+03	1.61E+03	5.47E+02
1994	2.69E+03	1.83E+03	1.44E+03	7.50E+02
1995	2.86E+03	1.53E+03	1.04E+03	7.48E+02
1996	4.07E+03	1.76E+03	9.81E+02	7.26E+02
1997	2.27E+03	2.57E+03	1.11E+03	6.41E+02
1998	2.15E+03	1.40E+03	1.48E+03	6.26E+02
1999	2.07E+03	1.47E+03	8.79E+02	9.29E+02
2000	2.30E+03	1.38E+03	9.64E+02	5.77E+02
2001	1.42E+03	1.71E+03	8.76E+02	6.79E+02

Estimated population abundance at 1st Jan 2002

, 1.26E+03, 9.85E+02, 1.08E+03, 5.59E+02,

Taper weighted geometric mean of the VPA populations:

, 6.54E+03, 4.60E+03, 3.10E+03, 2.14E+03,

Standard error of the weighted Log(VPA populations) :

, .7706, .7733, .8040, .8455,

1

Log catchability residuals.

Fleet : BTS

Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
1	99.99	99.99	99.99	-.93	-.16	-.40	.54	.52	-.84	-.30
2	99.99	99.99	99.99	-.12	-.29	.56	-.34	.53	-.35	-.09
3	99.99	99.99	99.99	-.28	.03	-.33	.34	-.39	.02	-.32
4	99.99	99.99	99.99	-.36	-.29	-.72	-.22	.46	.58	-.12
5	99.99	99.99	99.99	-.62	-.21	-.35	.12	.60	.03	.23
6	99.99	99.99	99.99	.19	-.74	-.36	-.31	-.06	-.41	.94
7	99.99	99.99	99.99	.06	.06	-.11	-.29	-.10	-.52	-.58
8	99.99	99.99	99.99	-.25	-.61	-.80	-1.34	.72	.37	.02
9	99.99	99.99	99.99	-.08	-.34	-.16	-.13	.25	.51	.06

Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	-.37	-.36	-.04	.23	.33	99.99	.55	.69	.37	.16
2	-.08	.31	-.32	-.57	.68	99.99	.25	.16	-.15	-.19
3	-.27	.12	.14	-.35	.24	-.21	.97	.59	-.11	-.18
4	-.53	-.29	.53	.28	.24	-.17	.61	.15	-.15	.02
5	.00	-.82	.41	-.30	.98	-1.16	.70	.61	-.31	.09
6	.88	-.26	-.20	.10	.56	-.08	1.15	-.81	-.76	.18
7	.48	.46	.90	.19	-1.79	-.06	-.10	-.10	1.69	-.18
8	.05	.28	1.67	1.86	.16	-.22	.06	-1.01	-.89	-.08
9	-.51	.31	1.18	1.07	.76	-3.37	.70	-.71	99.99	.47

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	-7.3094	-7.7228	-8.6327	-9.4921	-10.1471	-10.4666	-10.7557	-10.7889	-11.1043
S.E(Log q)	.5021	.3725	.3728	.4022	.5684	.5952	.7124	.8576	1.0499

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	1.66	-1.317	3.67	.22	16	.81	-7.31
2	.74	1.818	9.06	.78	16	.26	-7.72
3	.95	.297	8.85	.67	17	.36	-8.63
4	1.11	-.546	9.20	.64	17	.45	-9.49
5	1.00	-.011	10.14	.59	17	.59	-10.15
6	.92	.340	10.48	.58	17	.57	-10.47
7	1.33	-.840	11.01	.30	17	.96	-10.76
8	.68	1.288	10.33	.52	17	.57	-10.79
9	.74	.580	10.54	.27	16	.80	-11.10

Table 6.2.5 (Cont'd)

Fleet : SNS

Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
1	-.13	-.28	-.06	-.39	-.04	-.23	-.18	.16	-.22	.61
2	.00	-.33	-.13	.13	-.32	.24	.21	.25	-.14	.34
3	-.47	-1.52	-.31	-.26	-.54	-.41	.97	.47	.35	-.05
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	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	.43	.01	-.02	.00	.24	99.99	.32	.63	-.03	-.83
2	.54	.19	-.10	-.49	.52	99.99	.39	.31	-.70	-.91
3	.45	-.34	-.39	-.67	.50	.34	2.07	1.26	-.47	-.97
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	-2.4796	-3.6402	-4.9360
S.E(Log q)	.3496	.4062	.8204

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	1.26	-1.156	-.21	.54	19	.44	-2.48
2	.79	1.334	5.59	.70	19	.31	-3.64
3	.84	.503	6.20	.35	20	.70	-4.94

1

Terminal year survivor and F summaries :

Age 1 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	316243.	.518	.000	.00	1	.240	.014
SNS	117553.	.359	.000	.00	1	.499	.038
F shrinkage mean	1118825.	.50				.261	.004

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
268409.	.25	.75	3	2.965	.017

Age 2 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	215265.	.308	.269	.87	2	.366	.152
SNS	141624.	.272	.437	1.61	2	.471	.222
F shrinkage mean	680593.	.50				.163	.051

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
213238.	.19	.34	5	1.804	.153

Table 6.2.5 (Cont'd)

Age 3 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 ,	115756.,	.241,	.246,	1.02,	3,	.457,	.358
SNS ,	109459.,	.259,	.494,	1.91,	3,	.384,	.375
F shrinkage mean ,	121934.,	.50,,,,				.159,	.343

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
114234.,	.17,	.20,	7,	1.200,	.362

Age 4 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 ,	138108.,	.209,	.123,	.59,	4,	.533,	.274
SNS ,	158358.,	.259,	.165,	.64,	3,	.323,	.243
F shrinkage mean ,	50553.,	.50,,,,				.144,	.621

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
124871.,	.16,	.17,	8,	1.096,	.299

Age 5 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 ,	233024.,	.219,	.160,	.73,	4,	.594,	.308
SNS ,	340164.,	.373,	.350,	.94,	2,	.156,	.221
F shrinkage mean ,	86835.,	.50,,,,				.250,	.677

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
193039.,	.19,	.25,	7,	1.303,	.361

Age 6 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
BTS ,	12113.,	.277,	.189,	.68,	5,	.486,	.446
SNS ,	17981.,	.331,	.714,	2.16,	2,	.077,	.321
F shrinkage mean ,	7443.,	.50,,,,				.437,	.649

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
10092.,	.26,	.19,	8,	.728,	.516

Age 7 Catchability constant w.r.t. time and dependent on age

Year class = 1994

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
BTS ,	5697.,	.287,	.217,	.76,	7,	.439,	.559
SNS ,	7533.,	.259,	.171,	.66,	3,	.070,	.449
F shrinkage mean ,	5966.,	.50,,,,				.491,	.540

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
5943.,	.28,	.12,	11,	.416,	.541

Table 6.2.5 (Cont'd)

Age 8 Catchability constant w.r.t. time and dependent on age

Year class = 1993

```
Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
    ,                  Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
BTS                  ,      3180.,   .326,       .341,   1.05,   8,  .432,      .299
SNS                  ,      2059.,   .259,       .225,    .87,   3,  .044,      .431

  F shrinkage mean  ,      1875.,    .50,,,,                         .524,      .465

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
     2365.,       .30,      .21,   12,    .709,   .385
```

Age 9   Catchability constant w.r.t. time and dependent on age

```
Year class = 1992

Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
    ,                  Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
BTS                  ,      1090.,   .373,       .255,    .68,   9,  .360,      .442
SNS                  ,      1016.,   .259,       .147,    .57,   3,  .023,      .468

  F shrinkage mean  ,      1169.,    .50,,,,                         .617,      .418

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
     1136.,       .34,      .13,   13,    .375,   .427
```

Age 10   Catchability constant w.r.t. time and dependent on age

```
Year class = 1991

Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
    ,                  Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
BTS                  ,      1013.,   .341,       .226,    .66,   8,  .230,      .446
SNS                  ,      1621.,   .259,       .179,    .69,   3,  .024,      .301

  F shrinkage mean  ,      1342.,    .50,,,,                         .746,      .354

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
     1263.,       .38,      .11,   12,    .286,   .372
```

Age 11   Catchability constant w.r.t. time and age (fixed at the value for age) 10

```
Year class = 1990

Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
    ,                  Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
BTS                  ,       906.,   .359,       .150,    .42,   9,  .228,      .284
SNS                  ,      1589.,   .259,       .203,    .78,   3,  .021,      .172

  F shrinkage mean  ,       997.,    .50,,,,                         .751,      .261

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
      985.,       .38,      .06,   13,    .169,   .264
```

Age 12   Catchability constant w.r.t. time and age (fixed at the value for age) 10

```
Year class = 1989

Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
    ,                  Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
BTS                  ,       885.,   .328,       .274,    .84,   9,  .205,      .425
SNS                  ,      1151.,   .259,       .205,    .79,   3,  .026,      .342

  F shrinkage mean  ,      1133.,    .50,,,,                         .768,      .346

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
     1077.,       .39,      .12,   13,    .299,   .361
```

Table 6.2.5 (Cont'd)

Age 13 Catchability constant w.r.t. time and age (fixed at the value for age) 10

Year class = 1988

Fleet,	Estimated,	Int,	Ext,	Var,	N,	Scaled,	Estimated
,	Survivors,	s.e,	s.e,	Ratio,	,	Weights,	F
BTS ,	239.,	.337,	.496,	1.47,	9,	.126,	.680
SNS ,	574.,	.259,	.101,	.39,	3,	.016,	.341
F shrinkage mean ,	633.,	.50,,,,				.857,	.313

Weighted prediction :

Survivors,	Int,	Ext,	N,	Var,	F
at end of year,	s.e,	s.e,	,	Ratio,	
559.,	.43,	.28,	13,	.640,	.348

Age 14 Catchability constant w.r.t. time and age (fixed at the value for age) 10

Year class = 1987

Fleet,	Estimated,	Int,	Ext,	Var,	N,	Scaled,	Estimated
,	Survivors,	s.e,	s.e,	Ratio,	,	Weights,	F
BTS ,	936.,	.362,	.255,	.70,	9,	.092,	.171
SNS ,	459.,	.259,	.162,	.63,	3,	.011,	.322
F shrinkage mean ,	407.,	.50,,,,				.897,	.356

Weighted prediction :

Survivors,	Int,	Ext,	N,	Var,	F
at end of year,	s.e,	s.e,	,	Ratio,	
440.,	.45,	.22,	13,	.483,	.333

Table 6.2.6. North Sea plaice. Fishing mortality at age.

```
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,	1957,	1958,	1959,	1960,	1961,
AGE					
1,	.0000,	.0000,	.0000,	.0000,	.0000,
2,	.0256,	.0284,	.0458,	.0161,	.0065,
3,	.2180,	.1593,	.1459,	.2150,	.1059,
4,	.2746,	.3275,	.2472,	.3439,	.3437,
5,	.3028,	.3099,	.3336,	.3001,	.3435,
6,	.1572,	.2758,	.3146,	.3440,	.2633,
7,	.2051,	.1901,	.2857,	.2913,	.2793,
8,	.2155,	.2014,	.2001,	.2710,	.2968,
9,	.1931,	.1983,	.2273,	.2161,	.2599,
10,	.1834,	.2154,	.2391,	.2250,	.1992,
11,	.2214,	.2671,	.2482,	.2112,	.2412,
12,	.1991,	.2042,	.3095,	.2482,	.2478,
13,	.2392,	.2307,	.2444,	.2499,	.2575,
14,	.2077,	.2236,	.2543,	.2306,	.2416,
+gp,	.2077,	.2236,	.2543,	.2306,	.2416,
0 FBAR 2-10,	.1973,	.2118,	.2266,	.2469,	.2331,

YEAR,	1962,	1963,	1964,	1965,	1966,	1967,	1968,	1969,	1970,	1971,
AGE										
1,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0002,	.0001,
2,	.0070,	.0159,	.0557,	.0113,	.0157,	.0230,	.0405,	.0737,	.0633,	.0974,
3,	.1215,	.0804,	.1811,	.2006,	.0862,	.1366,	.1925,	.2458,	.3399,	.2253,
4,	.2837,	.3654,	.3270,	.3401,	.3561,	.1898,	.2276,	.2332,	.4825,	.3462,
5,	.4067,	.3498,	.4523,	.3403,	.3692,	.4779,	.2915,	.3060,	.3965,	.3828,
6,	.3365,	.4344,	.3794,	.4034,	.3296,	.3521,	.3291,	.3691,	.4942,	.3605,
7,	.2697,	.3221,	.3554,	.2909,	.3574,	.2943,	.2468,	.3032,	.4806,	.4164,
8,	.2474,	.2985,	.2428,	.2944,	.2474,	.2618,	.2695,	.2010,	.2710,	.2970,
9,	.2306,	.2770,	.2535,	.2157,	.3369,	.2151,	.1770,	.3246,	.1854,	.4301,
10,	.2077,	.2365,	.2113,	.3880,	.2366,	.2338,	.2142,	.2279,	.2839,	.2843,
11,	.2082,	.3110,	.2666,	.2130,	.2751,	.1982,	.2450,	.2970,	.1823,	.2963,
12,	.2091,	.2278,	.2406,	.2805,	.2725,	.2031,	.2050,	.2776,	.2620,	.2511,
13,	.2426,	.2704,	.2265,	.3221,	.3034,	.1945,	.1697,	.2203,	.2567,	.2488,
14,	.2201,	.2652,	.2402,	.2846,	.2856,	.2093,	.2026,	.2701,	.2346,	.3029,
+gp,	.2201,	.2652,	.2402,	.2846,	.2856,	.2093,	.2026,	.2701,	.2346,	.3029,
0 FBAR 2-10,	.2345,	.2645,	.2732,	.2761,	.2594,	.2427,	.2210,	.2538,	.3330,	.3156,

YEAR,	1972,	1973,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,
AGE										
1,	.0101,	.0025,	.0052,	.0031,	.0092,	.0072,	.0028,	.0031,	.0016,	.0006,
2,	.1673,	.1729,	.0510,	.0755,	.1242,	.2304,	.1630,	.1711,	.1866,	.1961,
3,	.2714,	.3940,	.4543,	.1673,	.2733,	.2083,	.3760,	.4844,	.6451,	.5573,
4,	.3652,	.5189,	.4788,	.4427,	.3780,	.3500,	.3876,	.5046,	.5964,	.5645,
5,	.3779,	.4929,	.5493,	.5268,	.3164,	.5814,	.4331,	.6181,	.4620,	.5372,
6,	.4097,	.3628,	.3970,	.5401,	.3547,	.3187,	.4616,	.6491,	.4386,	.3894,
7,	.3584,	.3461,	.3286,	.3933,	.4165,	.3297,	.3141,	.5840,	.4278,	.3909,
8,	.4589,	.3949,	.3932,	.3829,	.3377,	.3775,	.2807,	.3364,	.3653,	.4261,
9,	.2731,	.4449,	.3603,	.4244,	.2964,	.3315,	.2799,	.3565,	.2206,	.3296,
10,	.3872,	.2987,	.5111,	.3387,	.3389,	.2868,	.2650,	.4220,	.2532,	.2304,
11,	.2541,	.2920,	.3305,	.3953,	.3311,	.3385,	.2460,	.3353,	.2702,	.3057,
12,	.3375,	.2543,	.4533,	.4147,	.3290,	.3269,	.2311,	.3561,	.3276,	.3551,
13,	.2502,	.3080,	.3153,	.5430,	.3865,	.2628,	.2446,	.4107,	.2033,	.3435,
14,	.3012,	.3204,	.3953,	.4246,	.3373,	.3101,	.2539,	.3773,	.2555,	.3137,
+gp,	.3012,	.3204,	.3953,	.4246,	.3373,	.3101,	.2539,	.3773,	.2555,	.3137,
0 FBAR 2-10,	.3410,	.3807,	.3915,	.3657,	.3151,	.3349,	.3290,	.4585,	.3995,	.4024,

YEAR,	1982,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,
AGE										
1,	.0034,	.0022,	.0002,	.0002,	.0014,	.0000,	.0000,	.0033,	.0041,	.0038,
2,	.1403,	.1464,	.1334,	.1516,	.1600,	.0829,	.0332,	.1015,	.0979,	.1361,
3,	.6849,	.5122,	.5096,	.4462,	.5153,	.4025,	.3305,	.3025,	.2835,	.3454,
4,	.6327,	.7243,	.4218,	.6854,	.5174,	.7056,	.4325,	.5101,	.5259,	.5629,
5,	.5396,	.5307,	.5877,	.4342,	.6858,	.7279,	.6589,	.5545,	.7090,	.6987,
6,	.4585,	.4401,	.4464,	.4568,	.5876,	.5936,	.6134,	.5425,	.5347,	.8063,
7,	.3882,	.3795,	.3654,	.3751,	.4826,	.5462,	.5667,	.5011,	.4098,	.5716,
8,	.3600,	.3419,	.4220,	.3219,	.3985,	.3857,	.4738,	.4778,	.3380,	.4468,
9,	.3933,	.3063,	.3457,	.3318,	.3773,	.3006,	.4763,	.3064,	.3696,	.4022,
10,	.3976,	.4311,	.3208,	.2996,	.3953,	.3901,	.3575,	.4475,	.2294,	.4048,
11,	.2626,	.3743,	.3067,	.2310,	.3492,	.3191,	.3313,	.3059,	.3065,	.2855,
12,	.2964,	.4413,	.3112,	.3927,	.3598,	.3011,	.4697,	.3473,	.2163,	.3971,
13,	.3952,	.3727,	.2598,	.2966,	.5116,	.2660,	.3506,	.3813,	.2401,	.2336,
14,	.3500,	.3863,	.3097,	.3111,	.3999,	.3162,	.3983,	.3587,	.2735,	.3506,
+gp,	.3500,	.3863,	.3097,	.3111,	.3999,	.3162,	.3983,	.3587,	.2735,	.3506,
0 FBAR 2-10,	.4439,	.4236,	.3948,	.3892,	.4578,	.4595,	.4381,	.4160,	.3887,	.4861,

Table 6.2.6 (Cont'd)

YEAR,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	FBAR 99-01
AGE											
1,	.0089,	.0129,	.0062,	.0255,	.0046,	.0010,	.0007,	.0024,	.0091,	.0168,	.0094,
2,	.1366,	.1706,	.2066,	.1976,	.1702,	.2229,	.0389,	.0329,	.0797,	.1531,	.0886,
3,	.3811,	.4497,	.4897,	.6110,	.5534,	.5438,	.5868,	.2549,	.1841,	.3623,	.2671,
4,	.5031,	.5717,	.7170,	.7733,	.7554,	.8077,	.7285,	.7137,	.4125,	.2989,	.4750,
5,	.7398,	.7183,	.6061,	.7487,	.7523,	.9324,	.7459,	.7075,	.5674,	.3612,	.5453,
6,	.7167,	.6597,	.6173,	.5603,	.6691,	.7373,	.6653,	.6941,	.5809,	.5155,	.5968,
7,	.7381,	.6290,	.7886,	.6021,	.6740,	.6221,	.5878,	.6013,	.4237,	.5413,	.5221,
8,	.5080,	.6168,	.6157,	.4748,	.5499,	.4528,	.4710,	.5080,	.4113,	.3848,	.4347,
9,	.4791,	.4823,	.5960,	.4206,	.5169,	.4941,	.3666,	.5167,	.3656,	.4274,	.4366,
10,	.4947,	.5121,	.5723,	.3315,	.5283,	.4415,	.3504,	.3974,	.3111,	.3723,	.3603,
11,	.4457,	.4973,	.4601,	.3828,	.3598,	.3855,	.2810,	.3036,	.1974,	.2641,	.2550,
12,	.4360,	.4806,	.4631,	.3463,	.3636,	.4520,	.3619,	.3192,	.3555,	.3615,	.3454,
13,	.6479,	.6639,	.5523,	.2624,	.3264,	.4709,	.3655,	.3216,	.2502,	.3483,	.3067,
14,	.5114,	.5333,	.5456,	.3476,	.4225,	.4581,	.3501,	.3597,	.2800,	.3331,	.3243,
+gp,	.5114,	.5333,	.5456,	.3476,	.4225,	.4581,	.3501,	.3597,	.2800,	.3331,	
0 FBAR 2-10,	.5219,	.5345,	.5788,	.5244,	.5744,	.5839,	.5046,	.4918,	.3707,	.3796,	

1

Table 6.2.7. North Sea plaice. Stock numbers at age (thousands).

Run title : Plaice in IV
At 30/09/2002 15:35
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,
AGE					
1,	296163,	429984,	433436,	405322,	359381,
2,	179756,	267980,	389065,	392189,	366751,
3,	320995,	158545,	235697,	336292,	349199,
4,	195756,	233548,	122336,	184324,	245431,
5,	127849,	134591,	152302,	86448,	118250,
6,	64211,	85461,	89334,	98714,	57940,
7,	62540,	49649,	58690,	59016,	63324,
8,	48951,	46097,	37145,	39909,	39905,
9,	29767,	35705,	34100,	27514,	27537,
10,	26976,	22203,	26495,	24581,	20057,
11,	13657,	20319,	16197,	18875,	17761,
12,	7639,	9903,	14076,	11435,	13828,
13,	3889,	5664,	7306,	9346,	8072,
14,	4906,	2770,	4069,	5177,	6587,
+gp,	5622,	6004,	6978,	8419,	7904,
0 TOTAL,	1388676,	1508422,	1627225,	1707562,	1701927,

YEAR,	1962,	1963,	1964,	1965,	1966,	1967,	1968,	1969,	1970,	1971,
AGE										
1,	318799,	315180,	1021876,	309564,	305368,	277223,	245500,	327470,	370435,	275472,
2,	325181,	288461,	285187,	924631,	280105,	276309,	250842,	222138,	296305,	335111,
3,	329696,	292194,	256882,	244057,	827264,	249508,	244324,	217959,	186714,	251657,
4,	284205,	264195,	243964,	193925,	180688,	686701,	196938,	182361,	154234,	120268,
5,	157481,	193637,	165879,	159170,	124876,	114517,	513943,	141917,	130683,	86142,
6,	75893,	94877,	123497,	95486,	102479,	78114,	64254,	347444,	94562,	79545,
7,	40290,	49048,	55600,	76463,	57718,	66692,	49703,	41836,	217342,	52200,
8,	43334,	27838,	32159,	35261,	51721,	36531,	44959,	35137,	27953,	121620,
9,	26835,	30616,	18689,	22826,	23769,	36541,	25441,	31071,	26004,	19290,
10,	19213,	19281,	20999,	13124,	16646,	15355,	26664,	19286,	20322,	19548,
11,	14871,	14124,	13772,	15382,	8056,	11889,	10998,	19474,	13894,	13843,
12,	12626,	10926,	9364,	9545,	11248,	5536,	8823,	7789,	13093,	10477,
13,	9766,	9269,	7873,	6661,	6524,	7750,	4089,	6504,	5339,	9116,
14,	5646,	6933,	6400,	5679,	4367,	4358,	5773,	3122,	4721,	3737,
+gp,	7359,	15288,	25995,	23116,	19163,	16900,	17341,	17147,	14547,	15559,
0 TOTAL,	1671194,	1631866,	2288135,	2134890,	2019993,	1883922,	1709591,	1620655,	1576148,	1413585,

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

YEAR,	1972,	1973,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,
AGE										
1,	234574,	541864,	451917,	335705,	324555,	471281,	429861,	444315,	659486,	424278,
2,	249239,	210127,	489093,	406797,	302825,	290987,	423370,	387867,	400779,	595796,
3,	275073,	190775,	159945,	420557,	341332,	242005,	209105,	325457,	295756,	300901,
4,	181781,	189731,	116403,	91886,	321918,	234988,	177797,	129904,	181420,	140393,
5,	76980,	114157,	102174,	65255,	53404,	199587,	149833,	109187,	70968,	90413,
6,	53157,	47735,	63099,	53379,	34866,	35215,	100971,	87916,	53246,	40458,
7,	50189,	31929,	30050,	38388,	28145,	22127,	23168,	57584,	41565,	31074,
8,	31144,	31734,	20439,	19575,	23441,	16791,	14398,	15313,	29058,	24520,
9,	81767,	17809,	19347,	12481,	12078,	15131,	10416,	9839,	9898,	18247,
10,	11353,	56307,	10327,	12209,	7388,	8126,	9828,	7124,	6233,	7183,
11,	13310,	6974,	37794,	5605,	7873,	4763,	5519,	6823,	4227,	4378,
12,	9313,	9341,	4713,	24573,	3416,	5116,	3072,	3905,	4415,	2919,
13,	7375,	6013,	6555,	2710,	14687,	2224,	3338,	2206,	2475,	2879,
14,	6432,	5196,	3999,	4327,	1425,	9029,	1547,	2365,	1324,	1827,
+gp,	14756,	13774,	10807,	12646,	9677,	7182,	11809,	8597,	5622,	5084,
0 TOTAL,	1296444,	1473468,	1526661,	1506093,	1487030,	1564553,	1574034,	1598402,	1766470,	1690350,

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

YEAR,	1982,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,
AGE										
1,	1024429,	589588,	607625,	527444,	1244422,	538723,	562781,	406684,	396763,	401395,
2,	383662,	923771,	532326,	549699,	477136,	1124407,	487457,	509225,	366783,	357531,
3,	443094,	301706,	722005,	421501,	427424,	367879,	936434,	426662,	416289,	300933,
4,	155935,	202114,	163571,	392461,	244113,	231016,	222575,	608871,	285297,	283676,
5,	72238,	74943,	88636,	97068,	178943,	131656,	103218,	130685,	330802,	152564,
6,	47808,	38106,	39884,	44561,	56897,	81555,	57528,	48327,	67920,	147302,
7,	24800,	27348,	22203,	23094,	25534,	28606,	40760,	28186,	25419,	36004,
8,	19019,	15221,	16930,	13941,	14361,	14259,	14990,	20925,	15452,	15268,
9,	14489,	12006,	9784,	10045,	9142,	8723,	8773,	8445,	11742,	9971,
10,	11875,	8847,	7998,	6265,	6523,	5672,	5844,	4930,	5625,	7342,
11,	5162,	7219,	5202,	5250,	4201,	3975,	3475,	3698,	2852,	4046,
12,	2918,	3592,	4493,	3463,	3771,	2681,	2614,	2257,	2465,	1899,
13,	1852,	1963,	2090,	2978,	2116,	2381,	1795,	1479,	1443,	1796,
14,	1848,	1129,	1224,	1459,	2003,	1148,	1651,	1144,	914,	1027,
+gp,	7121,	3439,	4967,	4143,	3902,	4694,	5346,	5412,	4548,	3801,
0 TOTAL,	2216248,	2210992,	2228938,	2103374,	2700488,	2547377,	2455242,	2206930,	1934313,	1724556,

Table 6.2.7 (Cont'd)

YEAR,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	GMST 57-99	AMST 57-99
AGE													
1,	403264,	284693,	238459,	323671,	250311,	926430,	312257,	240475,	306314,	301655,	0,	409130,	448568,
2,	361808,	361644,	254309,	214440,	285496,	225441,	837420,	282356,	217068,	274659,	268409,	367493,	403995,
3,	282352,	285567,	275912,	187162,	159243,	217904,	163222,	728810,	247221,	181364,	213238,	301841,	333163,
4,	192769,	174514,	164814,	152994,	91923,	82847,	114461,	82131,	511091,	186073,	114234,	189803,	211655,
5,	146191,	105467,	89146,	72807,	63887,	39077,	33423,	49986,	36402,	306138,	124871,	109613,	125590,
6,	68643,	63122,	46532,	44000,	31160,	27244,	13917,	14345,	22293,	18676,	193039,	60469,	71179,
7,	59510,	30334,	29528,	22710,	22736,	14440,	11793,	6474,	6484,	11285,	10092,	36002,	42647,
8,	18395,	25741,	14632,	12142,	11254,	10484,	7014,	5928,	3211,	3841,	5943,	22673,	26997,
9,	8837,	10015,	12569,	7153,	6834,	5876,	6032,	3963,	3227,	1925,	2365,	14984,	18305,
10,	6034,	4952,	5594,	6267,	4250,	3688,	3244,	3783,	2139,	2026,	1136,	10255,	12920,
11,	4431,	3329,	2685,	2856,	4070,	2267,	2146,	2068,	2300,	1418,	1263,	6948,	9054,
12,	2752,	2568,	1832,	1534,	1762,	2570,	1395,	1466,	1381,	1709,	985,	4839,	6352,
13,	1155,	1610,	1437,	1043,	981,	1109,	1480,	879,	964,	876,	1077,	3283,	4354,
14,	1287,	547,	750,	748,	726,	641,	626,	929,	577,	679,	559,	2262,	3059,
+gp,	3223,	2187,	1607,	1221,	3203,	2079,	2472,	1803,	1850,	2260,	1906,		
0 TOTAL,	1560651,	1356288,	1139806,	1050749,	937837,	1562097,	1510902,	1425395,	1362522,	1294583,	939119,		

Table 6.2.8. North Sea plaice. Assessment summary

Run title : Plaice in IV

,

At 30/09/2002 15:35

Table 16 Summary (without SOP correction)

Terminal Fs derived using XSA (With F shrinkage)

,	RECRUITS, Age 1	TOTALBIO,	TOTSPBIO,	LANDINGS,	YIELD/SSB,	FBAR 2-10,
1957,	296163,	457372,	354624,	70563,	.1990,	.1973,
1958,	429984,	443678,	340635,	73354,	.2153,	.2118,
1959,	433436,	457565,	345186,	79300,	.2297,	.2266,
1960,	405322,	497693,	368310,	87541,	.2377,	.2469,
1961,	359381,	461924,	352877,	85984,	.2437,	.2331,
1962,	318799,	564456,	446570,	87472,	.1959,	.2345,
1963,	315180,	547155,	439974,	107118,	.2435,	.2645,
1964,	1021876,	624820,	422932,	110540,	.2614,	.2732,
1965,	309564,	580482,	414351,	97143,	.2344,	.2761,
1966,	305368,	587964,	416384,	101834,	.2446,	.2594,
1967,	277223,	590826,	493003,	108819,	.2207,	.2427,
1968,	245500,	548171,	456098,	111534,	.2445,	.2210,
1969,	327470,	526244,	418273,	121651,	.2908,	.2538,
1970,	370435,	525798,	399568,	130342,	.3262,	.3330,
1971,	275472,	500485,	372346,	113944,	.3060,	.3156,
1972,	234574,	495140,	375795,	122843,	.3269,	.3410,
1973,	541864,	487993,	334716,	130429,	.3897,	.3807,
1974,	451917,	467172,	308810,	112540,	.3644,	.3915,
1975,	335705,	494851,	320025,	108536,	.3391,	.3657,
1976,	324555,	450487,	314499,	113670,	.3614,	.3151,
1977,	471281,	478374,	329206,	119188,	.3620,	.3349,
1978,	429861,	473420,	322583,	113984,	.3533,	.3290,
1979,	444315,	472381,	309301,	145347,	.4699,	.4585,
1980,	659486,	485234,	295023,	139951,	.4744,	.3995,
1981,	424278,	485652,	305108,	139747,	.4580,	.4024,
1982,	1024429,	556355,	297558,	154547,	.5194,	.4439,
1983,	589588,	544031,	320724,	144038,	.4491,	.4236,
1984,	607625,	553751,	321214,	156147,	.4861,	.3948,
1985,	527444,	540599,	353101,	159838,	.4527,	.3892,
1986,	1244422,	640392,	353138,	165347,	.4682,	.4578,
1987,	538723,	619952,	381332,	153670,	.4030,	.4595,
1988,	562781,	609838,	362315,	154475,	.4264,	.4381,
1989,	406684,	570285,	401635,	169818,	.4228,	.4160,
1990,	396763,	534565,	373504,	156240,	.4183,	.3887,
1991,	401395,	445009,	315671,	148004,	.4689,	.4861,
1992,	403264,	417333,	279556,	125190,	.4478,	.5219,
1993,	284693,	367158,	245697,	117113,	.4767,	.5345,
1994,	238459,	300384,	206567,	110392,	.5344,	.5788,
1995,	323671,	274744,	183541,	98356,	.5359,	.5244,
1996,	250311,	251025,	162560,	81673,	.5024,	.5744,
1997,	926430,	307565,	140553,	83048,	.5909,	.5839,
1998,	312257,	345068,	198560,	71534,	.3603,	.5046,
1999,	240475,	349792,	198719,	80662,	.4059,	.4918,
2000,	306314,	335900,	244434,	81148,	.3320,	.3707,
2001,	301655,	319699,	230644,	81847,	.3549,	.3796,
2002,	650000 *		250000 **			
Arith. Mean ,	442142,	479751,	329494,	116144,	.3700,	.3749,
0 Units,	(Thousands),	(Tonnes),	(Tonnes),	(Tonnes),		

* RCT3

** Assuming mean weight 1999-2001

Table 6.4.1 North Sea plaice. Input to the RCT3 analysis.

Plaice North Sea - 1-Y-Rcr.

9	36	36	36	2								
'yc'	'VPA-1'	'VPA-2'	'VPA-3'	'SNS-0'	'SNS-1'	'SNS-2'	'SNS-3'	'BTS-1'	'BTS-2'	'BTS-3'	'comb DFS/YFS-0'	'comb DFS/YFS-1'
1967	245500	222138	186714	-11	-11	-11	2813	-11	-11	-11	-11	-11
1968	327470	296305	251657	-11	-11	9450	1008	-11	-11	-11	-11	-11
1969	370435	335111	275073	-11	8032	23848	4484	-11	-11	-11	-11	-11
1970	275472	249239	190775	3678	18101	9584	1631	-11	-11	-11	-11	-11
1971	234574	210127	159945	6705	6437	4191	1261	-11	-11	-11	-11	-11
1972	541864	489093	420557	9242	57238	17985	10744	-11	-11	-11	-11	-11
1973	451917	406797	341332	5451	15648	9171	791	-11	-11	-11	-11	-11
1974	335705	302825	242005	2193	9781	2274	1720	-11	-11	-11	-11	-11
1975	324555	290987	209105	1151	9037	2900	435	-11	-11	-11	-11	-11
1976	471281	423370	325457	11544	19119	12714	1577	-11	-11	-11	-11	-11
1977	429861	387867	295756	4378	13924	9540	456	-11	-11	-11	-11	-11
1978	444315	400779	300901	3252	21681	12084	785	-11	-11	-11	-11	-11
1979	659486	595796	443094	27835	58049	16106	1146	-11	-11	-11	-11	-11
1980	424278	383662	301706	4039	19611	8503	308	-11	-11	-11	-11	154
1981	1024429	923771	722005	31542	70108	14708	2480	-11	-11	-11	633.51	286.65
1982	589588	532326	421501	23987	34884	10413	1584	-11	-11	39	456.51	160.16
1983	607625	549699	427424	36722	44667	13789	1155	-11	180	51	432.42	116.62
1984	527444	477136	367879	7958	27832	7558	1232	130	132	33	263.33	100.94
1985	1244422	1124407	936434	47385	93573	33021	13140	660	765	173	717.73	268.55
1986	538723	487457	426662	8818	33426	14429	3709	225	140	39	345.13	188.55
1987	562781	509225	416289	21270	36672	14952	3248	605	333	58	465.11	105.29
1988	406684	366783	300933	15598	37238	7287	1507	427	100	29	330.73	135.02
1989	396763	357531	282352	24198	24903	11149	2257	107	122	27	462.70	128.61
1990	401395	361808	285567	9559	57349	13742	988	184	126	39	468.23	150.72
1991	403264	361644	275912	17120	48223	9484	884	173	181	37	495.57	131.09
1992	284693	254309	187162	5398	22184	4866	415	123	66	14	356.84	74.09
1993	238459	214440	159243	9226	18225	2786	1189	142	44	23	263.03	30.50
1994	323671	285496	217904	27901	24900	10377	1393	249	207	20	444.90	37.74
1995	250311	225441	163222	13029	24663	-11	5739	216	-11	47	184.47	116.73
1996	926430	837420	728810	91713	-11	29431	14347	-11	433	182	572.38	152.64
1997	312257	282356	247221	15363	33391	9235	905	337	133	32	156.64	-11
1998	240475	217068	181364	22720	35188	2489	356	299	73	19	-11	-11
1999	-11	-11	-11	39201	23028	2416	263	276	84	16	-11	13.92
2000	-11	-11	-11	24185	10193	1047	-11	219	42	-11	184.61	5.21
2001	-11	-11	-11	101291	30265	-11	-11	572	-11	-11	499.55	-11
2002	-11	-11	-11	29905	-11	-11	-11	-11	-11	-11	-11	-11

Table 6.4.2 North Sea plaice. Results from the RCT3 analysis at age 1.

Analysis by RCT3 ver3.1 of data from file :

p4rct1.csv
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 = 1998

Survey/ Series	Regression: Slope	Inter- cept	Std Error	Rsquare	No. Pts	Prediction: Index Value	Predicted Value	Std Error	WAP Weights
SNS-0	.71	6.40	.58	.357	28	10.03	13.51	.614	.066
SNS-1	.85	4.29	.42	.478	28	10.47	13.23	.448	.125
SNS-2	.87	4.97	.39	.523	29	7.82	11.80	.448	.125
SNS-3	1.00	5.55	.88	.188	31	5.88	11.44	.965	.027
BTS-1	1.30	5.84	.66	.319	13	5.70	13.25	.755	.044
BTS-2	.71	9.43	.26	.765	14	4.30	12.48	.304	.272
BTS-3	.82	9.97	.31	.695	16	3.00	12.42	.355	.198
					VPA Mean =		12.97	.418	.143

Yearclass = 1999

Survey/ Series	Regression: Slope	Inter- cept	Std Error	Rsquare	No. Pts	Prediction: Index Value	Predicted Value	Std Error	WAP Weights
SNS-0	.81	5.39	.69	.286	29	10.58	13.99	.747	.043
SNS-1	.95	3.26	.49	.411	29	10.04	12.83	.520	.089
SNS-2	.81	5.52	.37	.558	30	7.79	11.87	.420	.136
SNS-3	.91	6.22	.81	.222	32	5.58	11.32	.888	.030
BTS-1	1.56	4.34	.81	.243	14	5.62	13.13	.910	.029
BTS-2	.72	9.35	.26	.781	15	4.44	12.57	.291	.283
BTS-3	.82	9.95	.30	.716	17	2.83	12.28	.346	.200
comb D	1.10	7.83	.44	.566	16	2.71	10.81	.648	.057
					VPA Mean =		12.95	.423	.134

Yearclass = 2000

Survey/ Series	Regression: Slope	Inter- cept	Std Error	Rsquare	No. Pts	Prediction: Index Value	Predicted Value	Std Error	WAP Weights
SNS-0	.81	5.39	.69	.286	29	10.09	13.60	.735	.058
SNS-1	.95	3.26	.49	.411	29	9.23	12.05	.538	.108
SNS-2	.81	5.52	.37	.558	30	6.95	11.19	.458	.149
BTS-1	1.56	4.34	.81	.243	14	5.39	12.77	.908	.038
BTS-2	.72	9.35	.26	.781	15	3.76	12.07	.312	.321
comb D	1.62	3.44	.47	.528	17	5.23	11.88	.562	.099
comb D	1.10	7.83	.44	.566	16	1.79	9.80	.787	.051
					VPA Mean =		12.95	.423	.175

Yearclass = 2001

Survey/ Series	Regression: Slope	Inter- cept	Std Error	Rsquare	No. Pts	Prediction: Index Value	Predicted Value	Std Error	WAP Weights
SNS-0	.81	5.39	.69	.286	29	11.53	14.76	.787	.103
SNS-1	.95	3.26	.49	.411	29	10.32	13.09	.520	.237
BTS-1	1.56	4.34	.81	.243	14	6.35	14.26	.982	.066
comb D	1.62	3.44	.47	.528	17	6.22	13.49	.521	.236
					VPA Mean =		12.95	.423	.357

Yearclass = 2002

Survey/ Series	Regression: Slope	Inter- cept	Std Error	Rsquare	No. Pts	Prediction: Index Value	Predicted Value	Std Error	WAP Weights
SNS-0	.81	5.39	.69	.286	29	10.31	13.77	.740	.247
					VPA Mean =		12.95	.423	.753

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
1998	303139	12.62	.16	.20	1.54	240475	12.39
1999	249968	12.43	.15	.23	2.13		
2000	175210	12.07	.18	.31	3.05		
2001	649677	13.38	.25	.29	1.32		
2002	515174	13.15	.37	.35	.92		

Table 6.4.3 North Sea plaice. Results from the RCT3 analysis at age 2.

Analysis by RCT3 ver3.1 of data from file :
p4rct2.csv
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 = 1998

Survey/ Series	Regression: Slope	Inter- cept	Std Error	Rsquare	No. Pts	Prediction: Index Value	Predicted Value	Std Error	WAP Weights
SNS-0	.72	6.24	.58	.354	28	10.03	13.41	.622	.066
SNS-1	.86	4.13	.43	.477	28	10.47	13.13	.451	.125
SNS-2	.88	4.83	.40	.524	29	7.82	11.69	.449	.126
SNS-3	1.00	5.44	.88	.189	31	5.88	11.34	.964	.027
BTS-1	1.31	5.69	.67	.319	13	5.70	13.15	.759	.044
BTS-2	.72	9.28	.27	.758	14	4.30	12.37	.311	.263
BTS-3	.82	9.85	.31	.698	16	3.04	12.35	.354	.204
					VPA Mean =		12.86	.419	.145

Yearclass = 1999

Survey/ Series	Regression: Slope	Inter- cept	Std Error	Rsquare	No. Pts	Prediction: Index Value	Predicted Value	Std Error	WAP Weights
SNS-0	.82	5.22	.70	.284	29	10.58	13.89	.754	.056
SNS-1	.96	3.11	.50	.411	29	10.04	12.72	.523	.116
SNS-2	.82	5.39	.38	.558	30	7.79	11.76	.422	.179
BTS-1	1.57	4.22	.81	.244	14	5.62	13.02	.911	.038
BTS-2	.73	9.21	.26	.775	15	4.44	12.46	.297	.359
comb D	1.10	7.71	.44	.571	16	2.71	10.70	.646	.076
					VPA Mean =		12.85	.425	.176

Yearclass = 2000

Survey/ Series	Regression: Slope	Inter- cept	Std Error	Rsquare	No. Pts	Prediction: Index Value	Predicted Value	Std Error	WAP Weights
SNS-0	.82	5.22	.70	.284	29	10.09	13.50	.742	.109
SNS-1	.96	3.11	.50	.411	29	9.23	11.94	.540	.206
BTS-1	1.57	4.22	.81	.244	14	5.39	12.66	.910	.073
comb D	1.64	3.21	.48	.520	17	5.23	11.76	.573	.183
comb D	1.10	7.71	.44	.571	16	1.79	9.69	.784	.098
					VPA Mean =		12.85	.425	.332

Yearclass = 2001

Survey/ Series	Regression: Slope	Inter- cept	Std Error	Rsquare	No. Pts	Prediction: Index Value	Predicted Value	Std Error	WAP Weights
SNS-0	.82	5.22	.70	.284	29	11.53	14.67	.794	.149
comb D	1.64	3.21	.48	.520	17	6.22	13.39	.532	.331
					VPA Mean =		12.85	.425	.520

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
1998	274326	12.52	.16	.20	1.52	217068	12.29
1999	242933	12.40	.18	.28	2.53		
2000	201336	12.21	.25	.45	3.34		
2001	595265	13.30	.31	.44	2.07		
2002	No valid surveys						

Table 6.4.4 North Sea plaice. Results from the RCT3 analysis at age 3.

Analysis by RCT3 ver3.1 of data from file :
p4rct3.csv
Plaice North Sea - 3-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 = 1998

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression			----------I	I-----------	Prediction		---------I	
SNS-0	.75	5.63	.61	.363	28	10.03	13.20	.651	.066
SNS-1	.91	3.39	.45	.476	28	10.47	12.90	.478	.122
SNS-2	.89	4.47	.38	.563	29	7.82	11.43	.437	.146
SNS-3	.96	5.51	.83	.228	31	5.88	11.17	.903	.034
BTS-1	1.34	5.26	.67	.355	13	5.70	12.93	.760	.048
BTS-2	.77	8.79	.29	.760	14	4.30	12.11	.333	.251
BTS-3	.89	9.37	.34	.697	16	3.04	12.08	.383	.190
					VPA Mean =		12.63	.441	.143

Yearclass = 1999

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression			----------I	I-----------	Prediction		---------I	
SNS-0	.84	4.81	.70	.304	29	10.58	13.68	.760	.058
SNS-1	.99	2.58	.51	.423	29	10.04	12.48	.533	.118
SNS-2	.83	5.00	.37	.585	30	7.79	11.51	.417	.193
BTS-1	1.53	4.16	.77	.289	14	5.62	12.79	.865	.045
BTS-2	.77	8.79	.28	.778	15	4.44	12.21	.312	.345
comb D	1.19	7.07	.47	.573	16	2.71	10.28	.694	.070
					VPA Mean =		12.61	.444	.171

Yearclass = 2000

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression			----------I	I-----------	Prediction		---------I	
SNS-0	.84	4.81	.70	.304	29	10.09	13.27	.748	.118
SNS-1	.99	2.58	.51	.423	29	9.23	11.68	.551	.217
BTS-1	1.53	4.16	.77	.289	14	5.39	12.44	.864	.088
comb D	1.82	1.89	.56	.478	17	5.23	11.40	.665	.149
comb D	1.19	7.07	.47	.573	16	1.79	9.19	.843	.093
					VPA Mean =		12.61	.444	.335

Yearclass = 2001

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression			----------I	I-----------	Prediction		---------I	
SNS-0	.84	4.81	.70	.304	29	11.53	14.47	.801	.168
comb D	1.82	1.89	.56	.478	17	6.22	13.20	.617	.283
					VPA Mean =		12.61	.444	.549

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
1998	209992	12.25	.17	.21	1.55	181364	12.11
1999	189842	12.15	.18	.30	2.62		
2000	158723	11.97	.26	.48	3.46		
2001	486055	13.09	.33	.47	2.08		
2002	No valid surveys						

6.5.1 North Sea Plaice

Input data for for catch forecast and linear sensitivity analysis

Label	Value	CV	Label	Value	CV
Number at age			Weight in the stock		
N1	650000*	0.41	WS1	0.12	0.00
N2	268409	0.75	WS2	0.22	0.03
N3	213237	0.34	WS3	0.25	0.03
N4	114234	0.20	WS4	0.30	0.12
N5	124870	0.17	WS5	0.39	0.14
N6	193039	0.25	WS6	0.48	0.08
N7	10091	0.26	WS7	0.61	0.11
N8	5943	0.28	WS8	0.69	0.07
N9	2364	0.30	WS9	0.74	0.08
N10	1135	0.34	WS10	0.77	0.15
N11	1262	0.38	WS11	0.81	0.07
N12	985	0.38	WS12	0.78	0.13
N13	1076	0.39	WS13	0.93	0.24
N14	558	0.43	WS14	0.91	0.16
N15	1906	0.45	WS15	1.06	0.06
H.cons selectivity			Weight in the HC catch		
sH1	0.01	0.80	WH1	0.24	0.04
sH2	0.08	0.74	WH2	0.26	0.03
sH3	0.25	0.39	WH3	0.29	0.03
sH4	0.44	0.30	WH4	0.33	0.07
sH5	0.50	0.24	WH5	0.42	0.11
sH6	0.55	0.08	WH6	0.51	0.07
sH7	0.48	0.12	WH7	0.64	0.07
sH8	0.40	0.05	WH8	0.70	0.02
sH9	0.40	0.07	WH9	0.77	0.04
sH10	0.33	0.11	WH10	0.74	0.16
sH11	0.23	0.13	WH11	0.79	0.06
sH12	0.32	0.21	WH12	0.80	0.14
sH13	0.28	0.20	WH13	0.91	0.12
sH14	0.30	0.10	WH14	0.92	0.12
sH15	0.30	0.10	WH15	1.03	0.12
Natural mortality			Proportion mature		
M1	0.10	0.10	MT1	0.00	0.10
M2	0.10	0.10	MT2	0.50	0.10
M3	0.10	0.10	MT3	0.50	0.10
M4	0.10	0.10	MT4	1.00	0.10
M5	0.10	0.10	MT5	1.00	0.00
M6	0.10	0.10	MT6	1.00	0.00
M7	0.10	0.10	MT7	1.00	0.00
M8	0.10	0.10	MT8	1.00	0.00
M9	0.10	0.10	MT9	1.00	0.00
M10	0.10	0.10	MT10	1.00	0.00
M11	0.10	0.10	MT11	1.00	0.00
M12	0.10	0.10	MT12	1.00	0.00
M13	0.10	0.10	MT13	1.00	0.00
M14	0.10	0.10	MT14	1.00	0.00
M15	0.10	0.10	MT15	1.00	0.00
Relative effort in HC fishery			Year effect for natural mortality		
HF02	1.00	0.16	K02	1.00	0.10
HF03	1.00	0.16	K03	1.00	0.10
HF04	1.00	0.16	K04	1.00	0.10
Recruitment in 2003 and 2004					
R03	409129	0.41			
R04	409129	0.41			

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

Stock numbers in 2002 are VPA survivors. *N1 replaced by RCT3 value

6.5.2 North Sea Plaice

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

	Year							
	2002	2003						
Mean F Ages								
H.cons 2 to10	0.38	0.00	0.08	0.15	0.23	0.30	0.38	0.46
Effort relative to 2001								
H.cons	1.00	0.00	0.20	0.40	0.60	0.80	1.00	1.20
Biomass								
Total 1 January	386	410	410	410	410	410	410	410
SSB at spawning time	250	269	269	269	269	269	269	269
Catch weight (,000t)								
H.cons	96.6	0.0	21.7	41.7	60.3	77.5	93.4	108.2
Biomass in year.... 2004								
Total 1 January		516	494	473	453	435	419	403
SSB at spawning time		361	339	319	301	284	269	254

	Year							
	2002	2003						
Effort relative to 2001								
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	0.15	0.17	0.17	0.17	0.17	0.17	0.17	0.17
Catch weight								
H.cons	0.20	0.00	0.79	0.41	0.30	0.25	0.23	0.21
Biomass in year.... 2004								
Total 1 January		0.17	0.18	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

6.5.3 North Sea Plaice

Detailed forecast tables.

Forecast for year 2002
F multiplier H.cons=1.00

	Populations	Catch number	
Age	Stock No.	H.Cons	Total
1	650000	5542	5542
2	268409	19887	19887
3	213237	44184	44184
4	114234	38555	38555
5	124870	46950	46950
6	193039	77748	77748
7	10091	3669	3669
8	5943	1867	1867
9	2364	744	744
10	1135	304	304
11	1262	251	251
12	985	255	255
13	1076	251	251
14	558	137	137
15	1906	467	467
Wt	386	97	97

Forecast for year 2003
F multiplier H.cons=1.00

	Populations	Catch number	
Age	Stock No.	H.Cons	Total
1	409129	3489	3489
2	582875	43187	43187
3	223970	46408	46408
4	151019	50970	50970
5	66836	25130	25130
6	68530	27601	27601
7	101078	36755	36755
8	5656	1777	1777
9	3608	1136	1136
10	1434	385	385
11	738	147	147
12	904	234	234
13	649	152	152
14	735	180	180
15	1657	406	406
Wt	410	93	93

Figure 6.2.1. North Sea plaice. Phase plot of SSB and F(2-10) in 2001. Comparison of single fleet XSA runs with low shrinkage (BTS, SNS, UK beam, NL beam) with the survey fleets combined runs, as carried out by WGNSSK 2002 and by the subgroup (NEW).

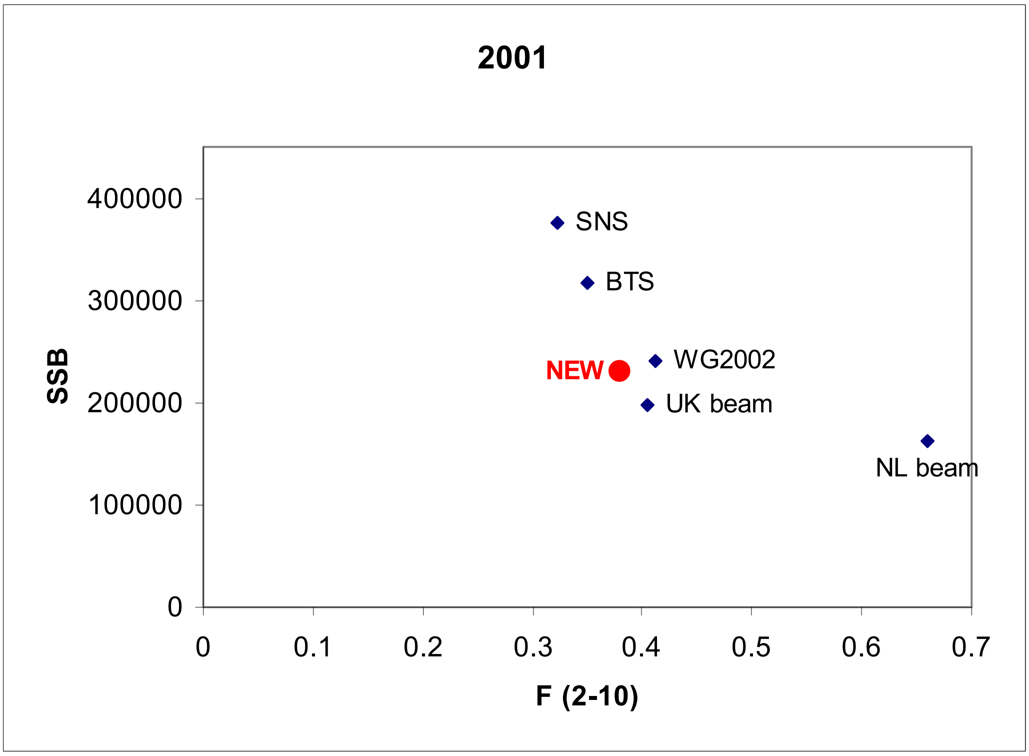
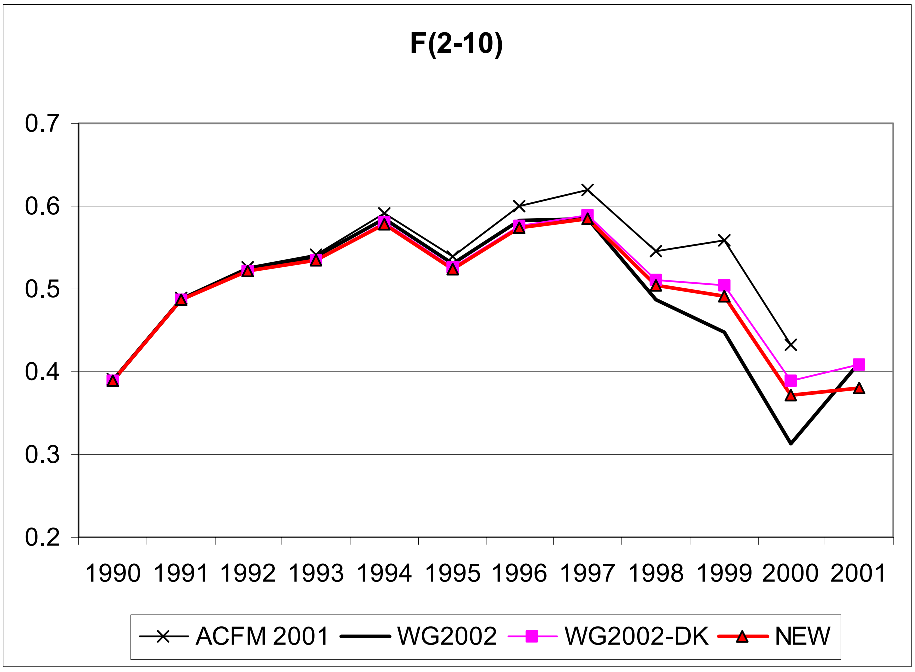


Figure 6.2.2. North Sea plaice. Comparison of time trends in different assessment configurations. *ACFM 2001* is the XSA assessment accepted by ACFM in 2001. *WG2002* is the XSA accepted by the WG in 2001. *WG2002-DK* is the same but with the Danish age compositions removed from the catches. *NEW* is the proposed new final run with Danish age compositions removed and BTS survey indices reported to three decimal digits.



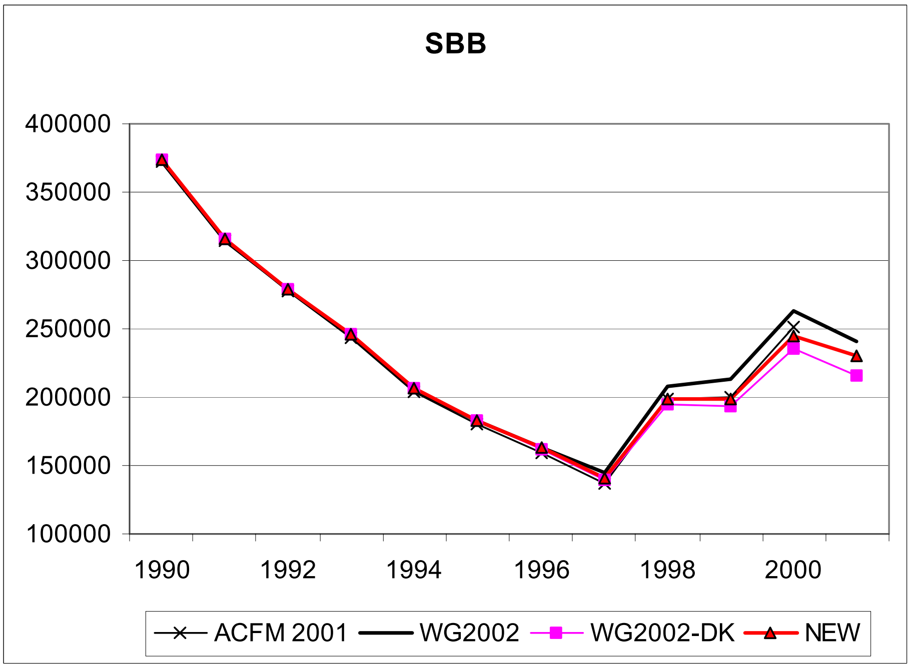


Figure 6.2.3. North Sea plaice. Log catchability residuals of the proposed new final XSA run.

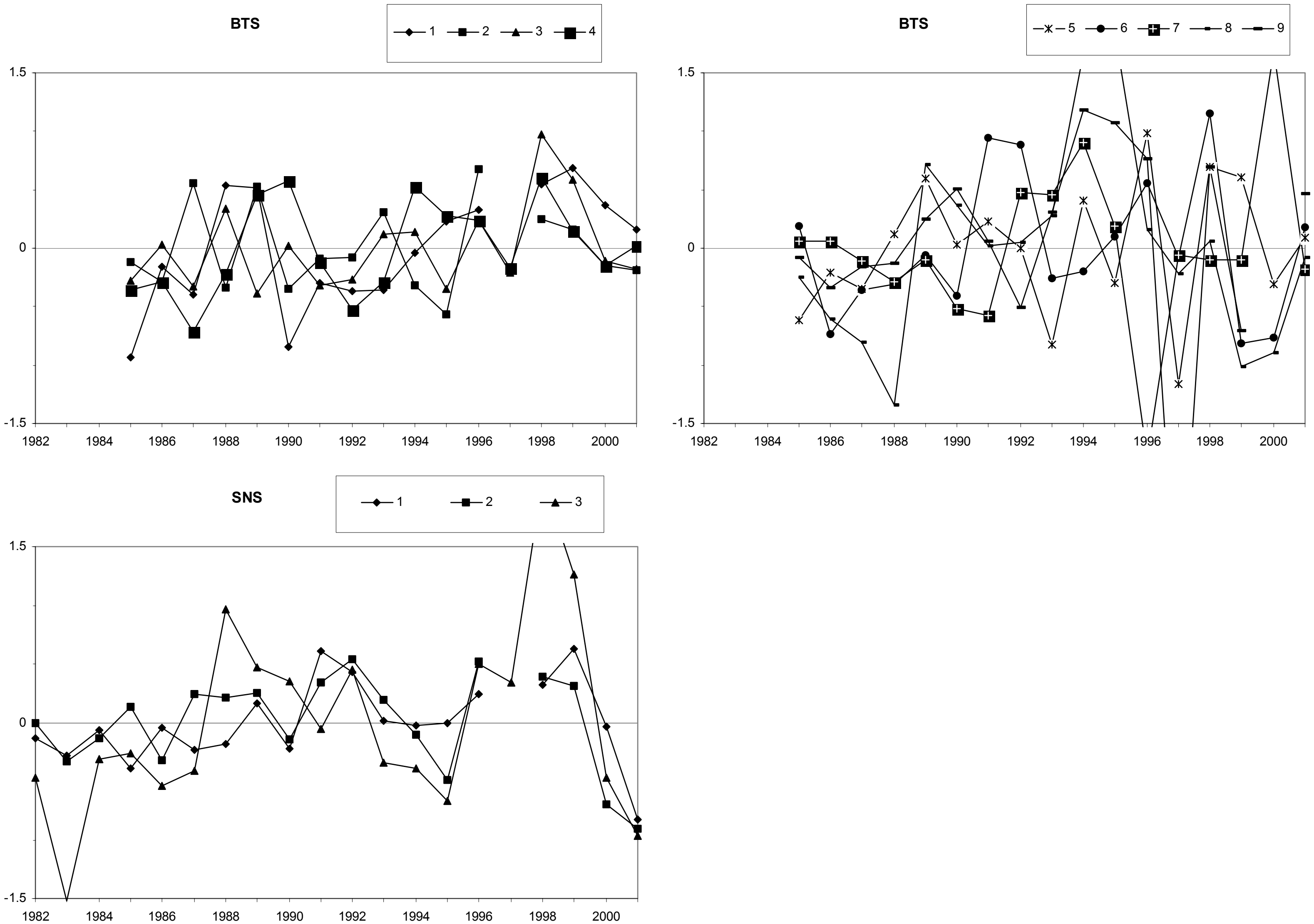


Figure 6.2.4. North Sea plaice. Relative difference of fleet-wise survivor estimates from the weighted survivor estimates. Shrinkage has a negative difference for ages 4-6 which results in lower stock numbers than estimated by the surveys.

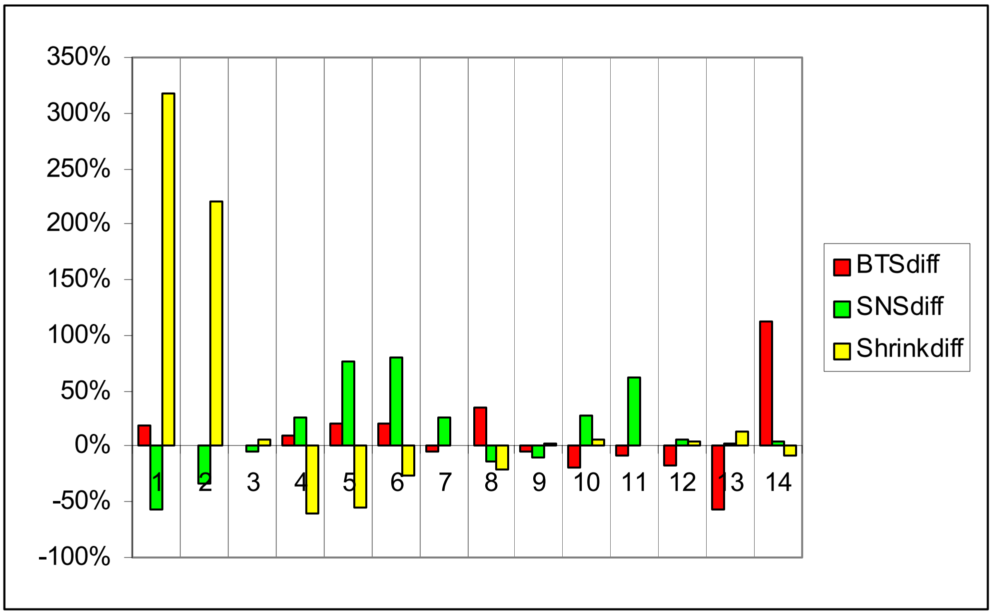


Figure 6.2.5. North Sea plaice. Stock summary.

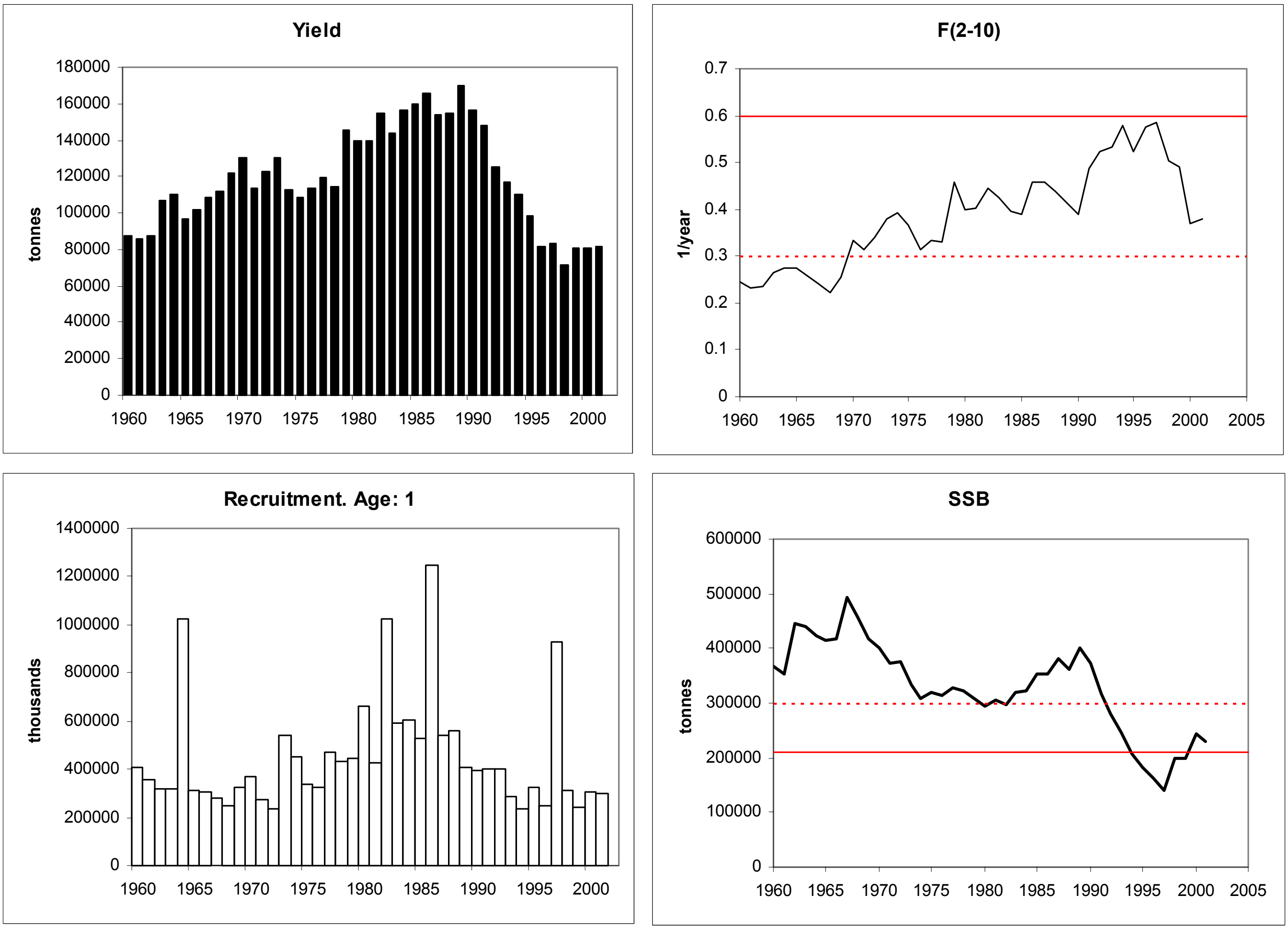


Figure 6.2.6. North Sea plaice. Comparison of historical performance of the assessments as accepted by ACFM including the newly proposed final assessment.

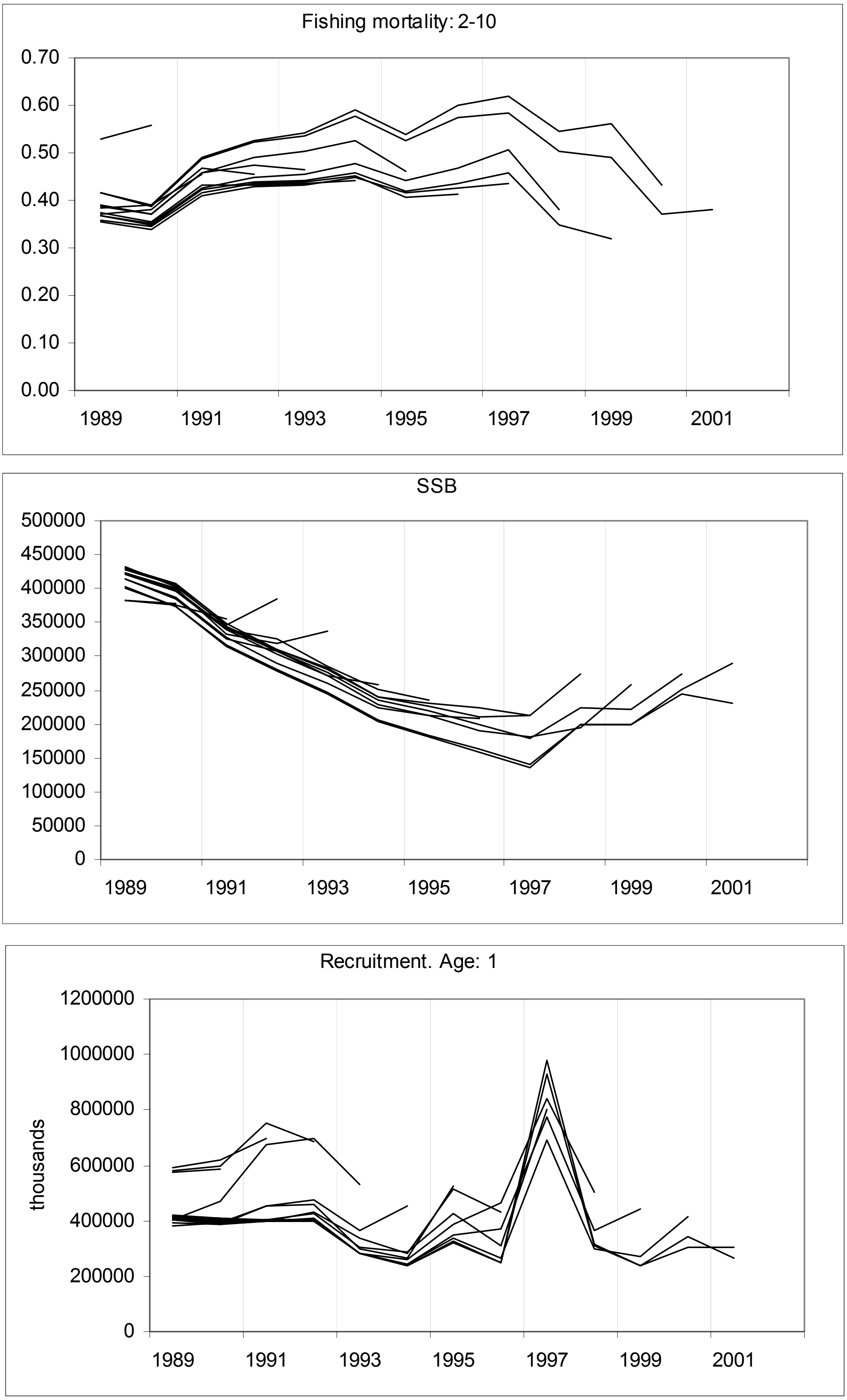


Figure 6.3.1 North Sea plaice. Retrospective analysis using shrinking window at different levels of shrinkage.

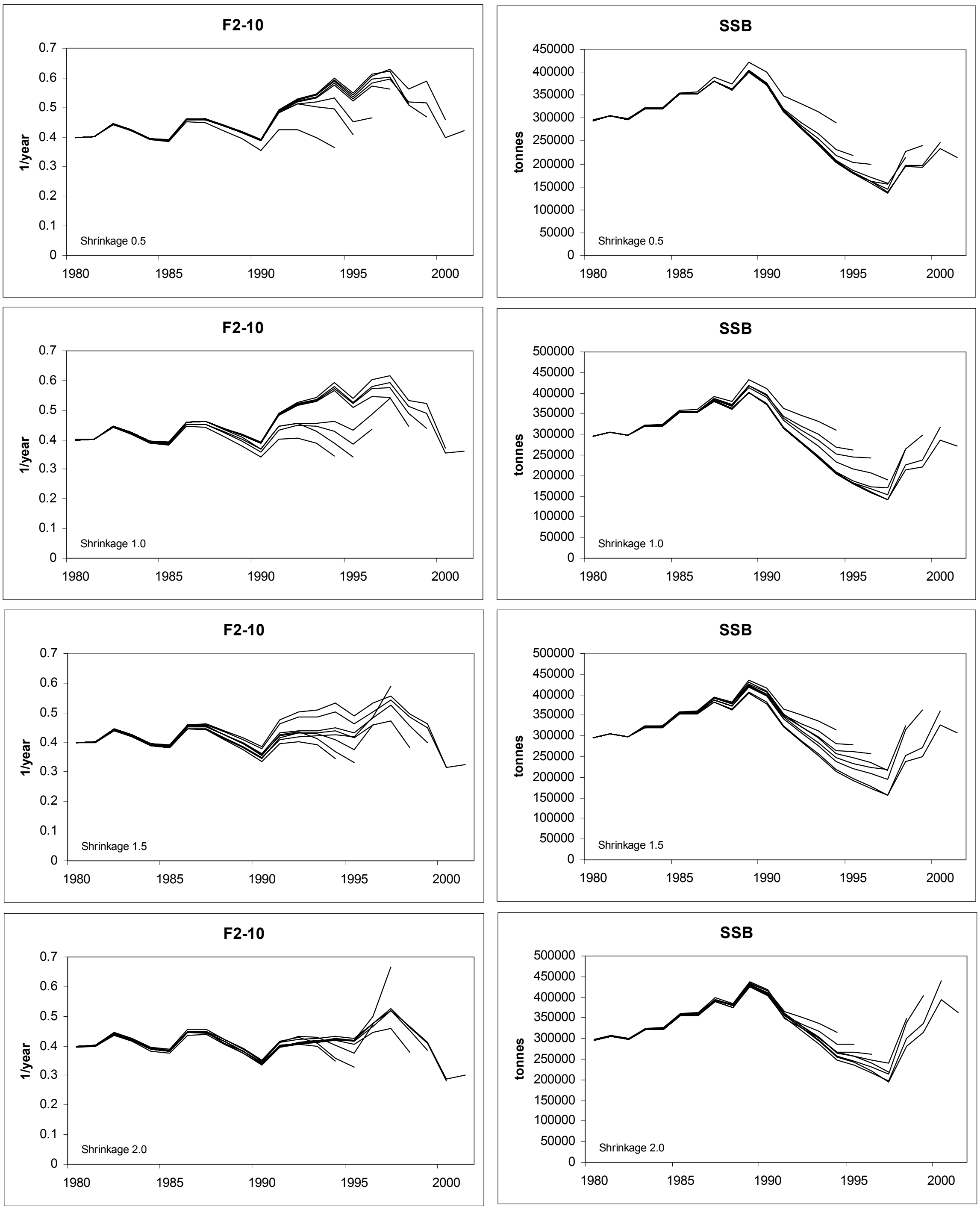


Figure 6.3.2 North Sea plaice. Retrospective analysis using shrinking window at different levels of shrinkage. Comparison of F at age resulting from the WGNSSK 2002 assessment of North Sea plaice with high and low shrinkage. Left – Contribution from the survey or shrinkage estimates in the final weighted average. Right – The estimates of F at age from the three sources and the overall average. The bottom figure compares the overall means from the two models. (top shr 0.5; bottom shr 2.0)

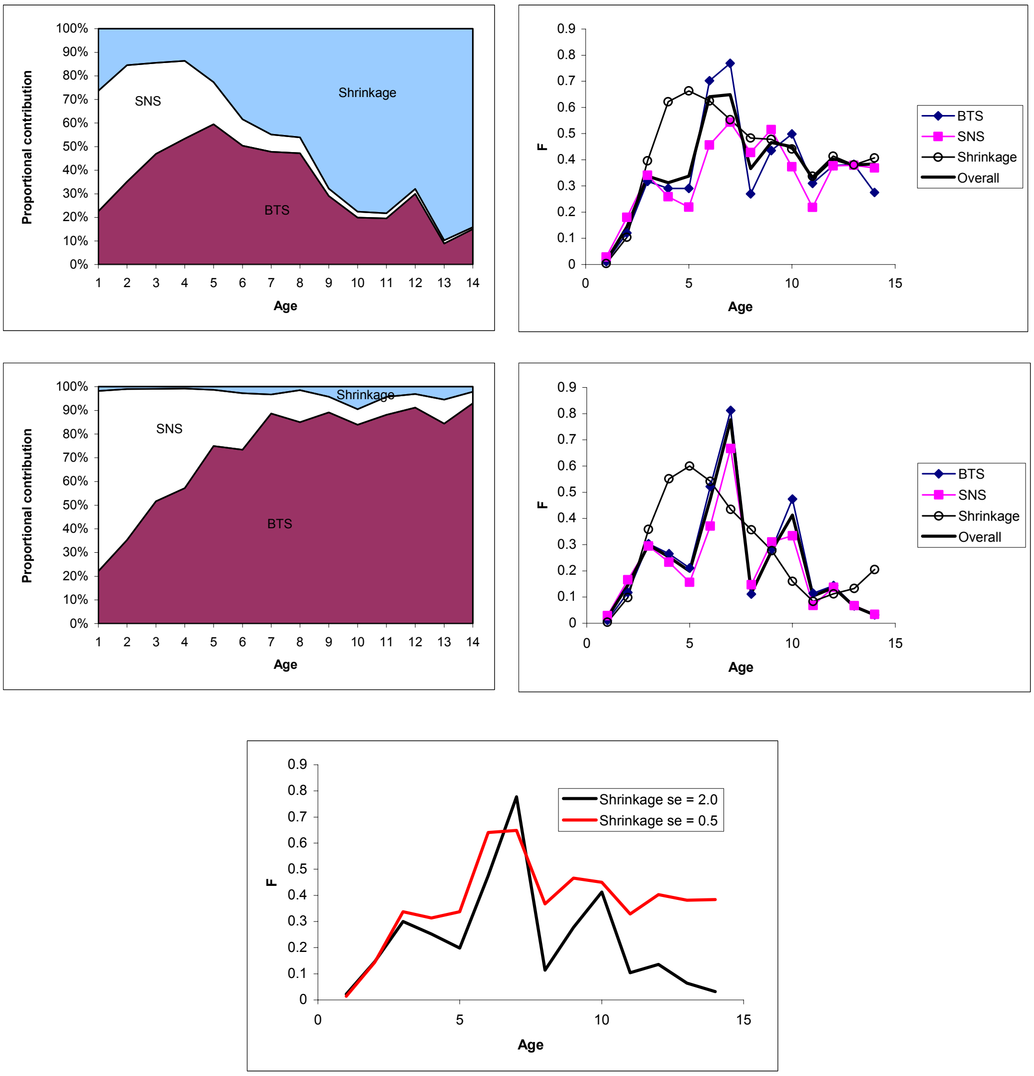


Figure 6.3.3. North Sea plaice. Comparison of F at age resulting from the WGNSSK 2002 assessment with high and low shrinkage. Top – Population numbers at age. Centre – SSB at age. Bottom – Cumulative SSB at age. In the bottom figure the open circles indicate the cumulative SSB at age with age 5 replaced by the estimate from cv = 0.5.

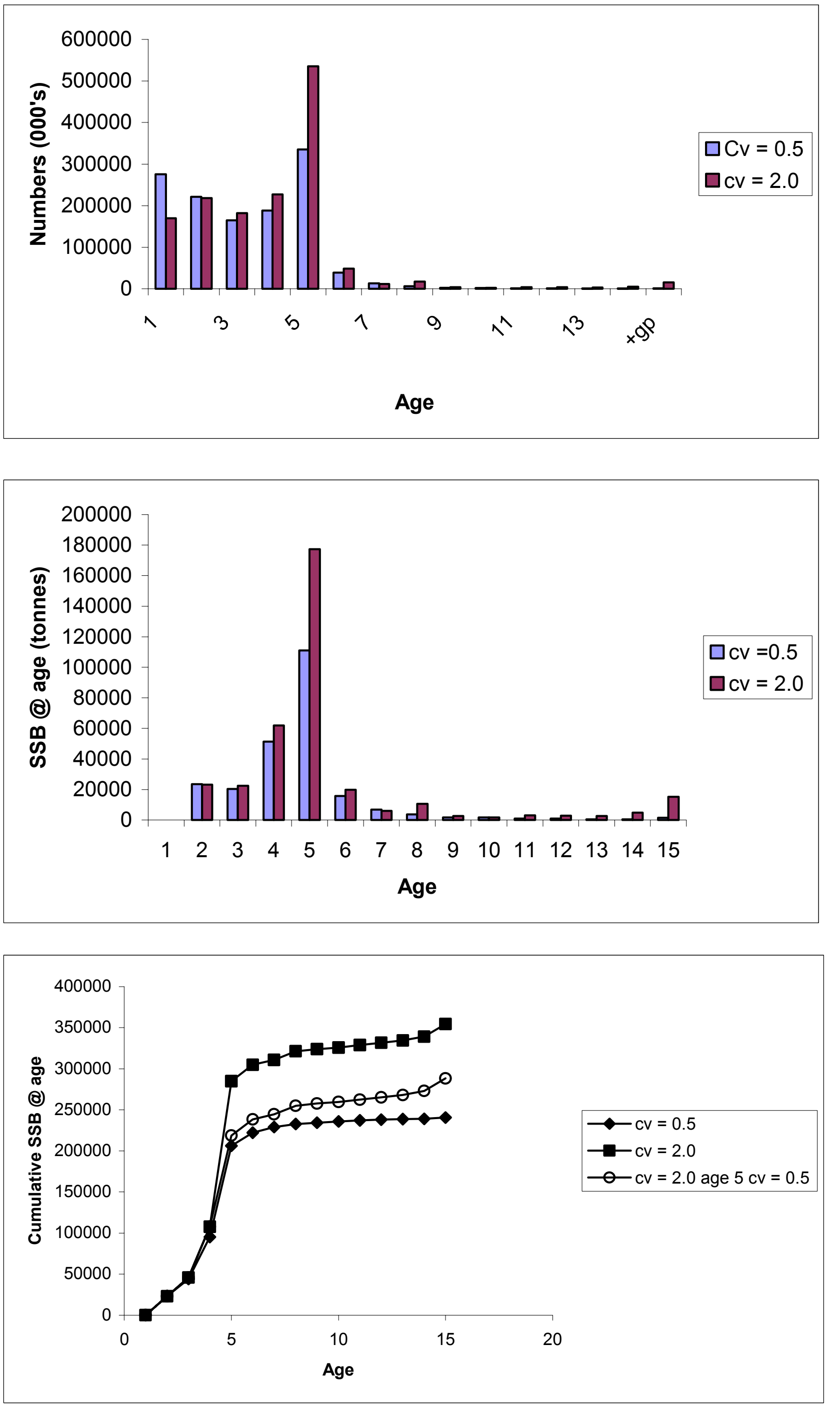
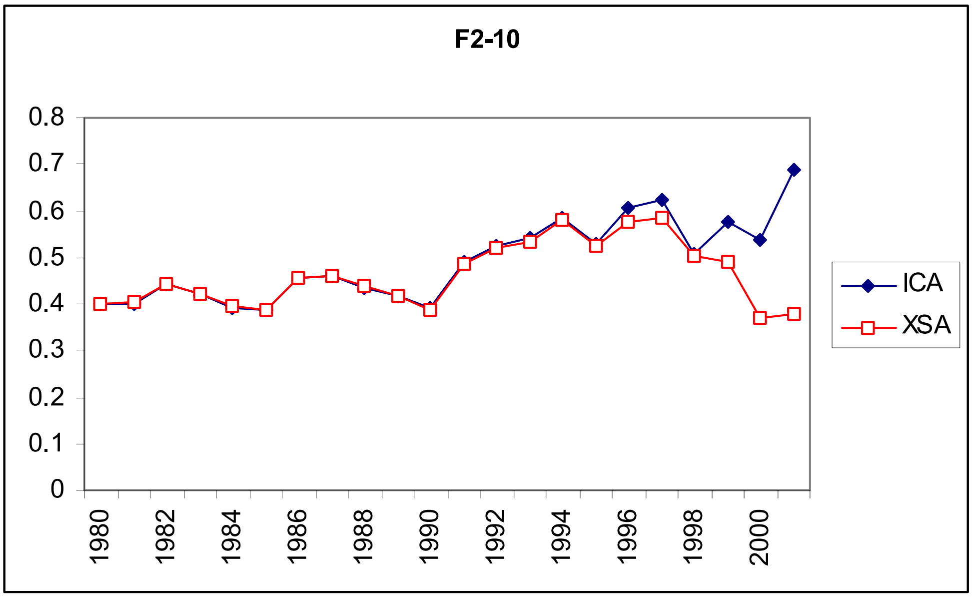


Figure 6.3.4. North Sea plaice. Comparison of an ICA run to the final XSA run.



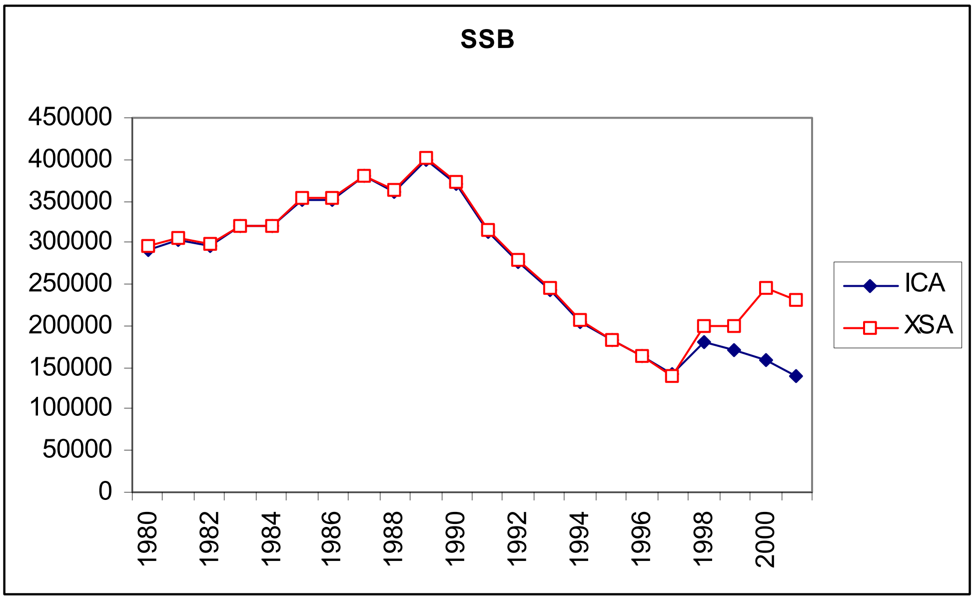


Figure 6.3.5 North Sea plaice. Survey only analysis (Surba 2.00) of the standard BTS survey index.

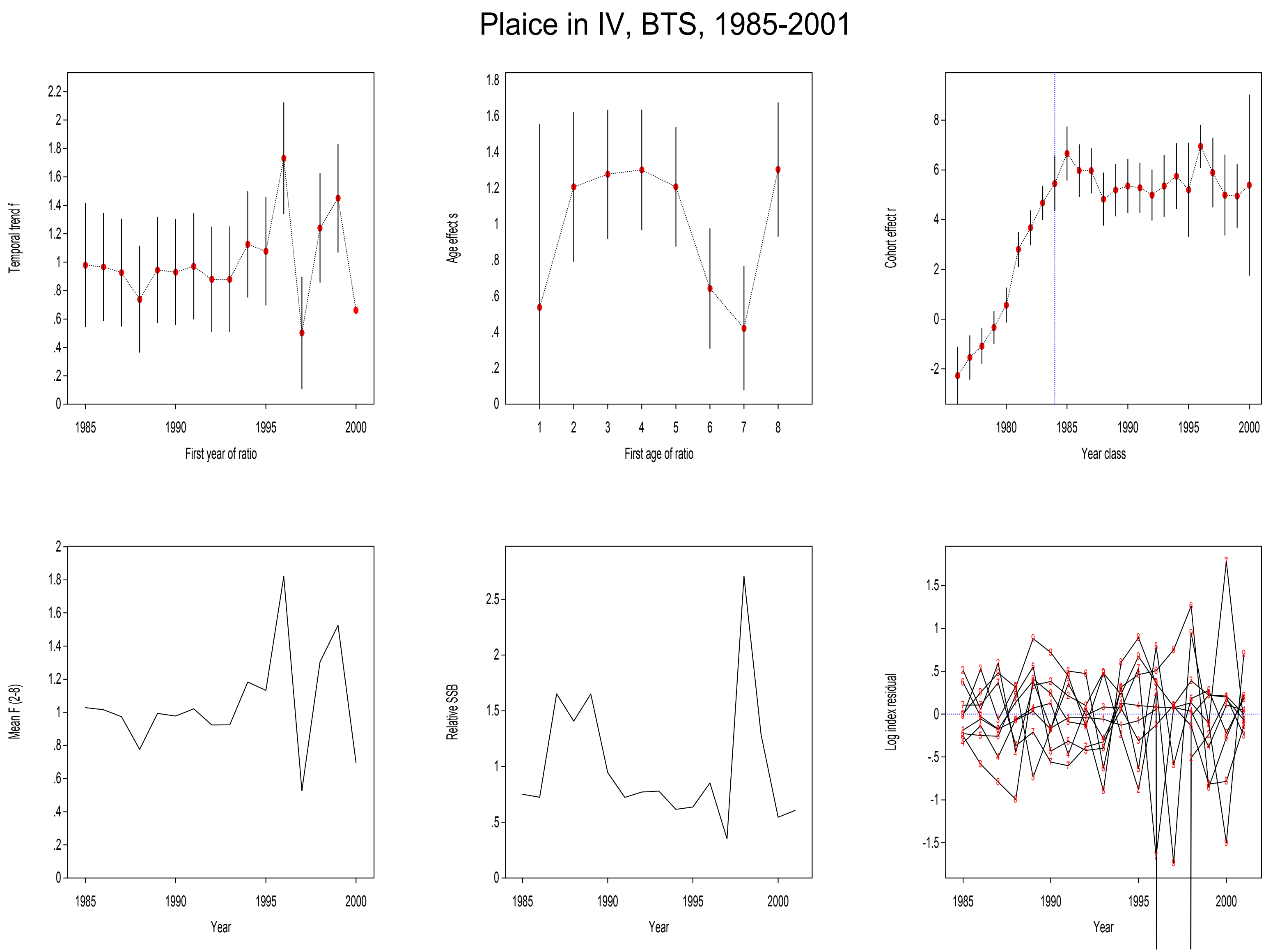


Figure 6.3.6 North Sea plaice. Survey only analysis (Surba 2.00) of the new BTS TRIDENS survey index.

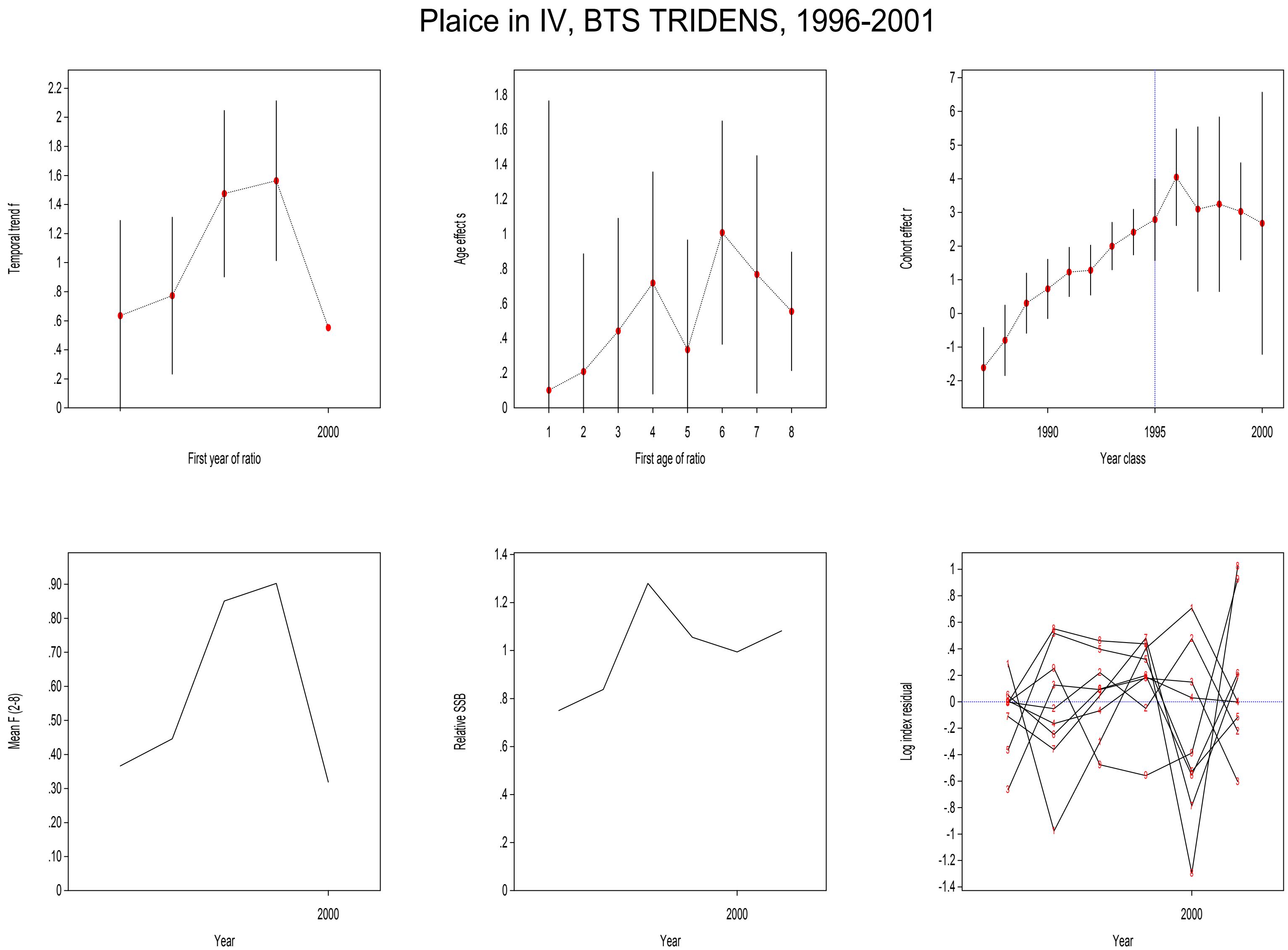
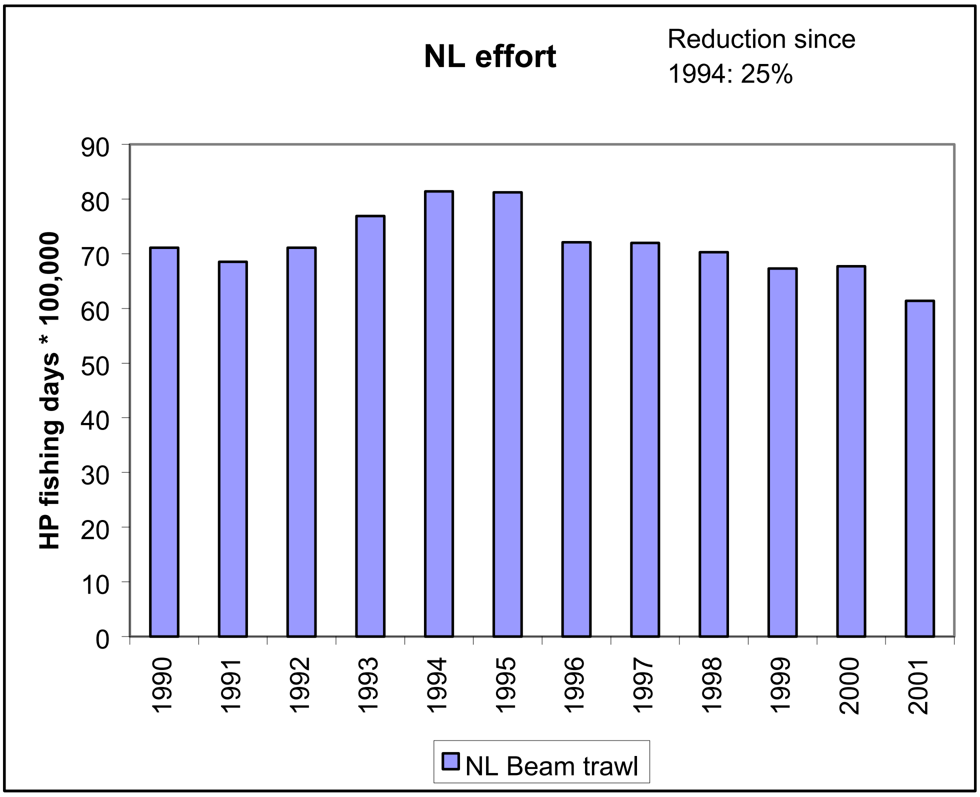


Figure 6.3.7. North Sea plaice. Trends in fishing effort of the Dutch (top) and English (bottom) beam trawl fleets.



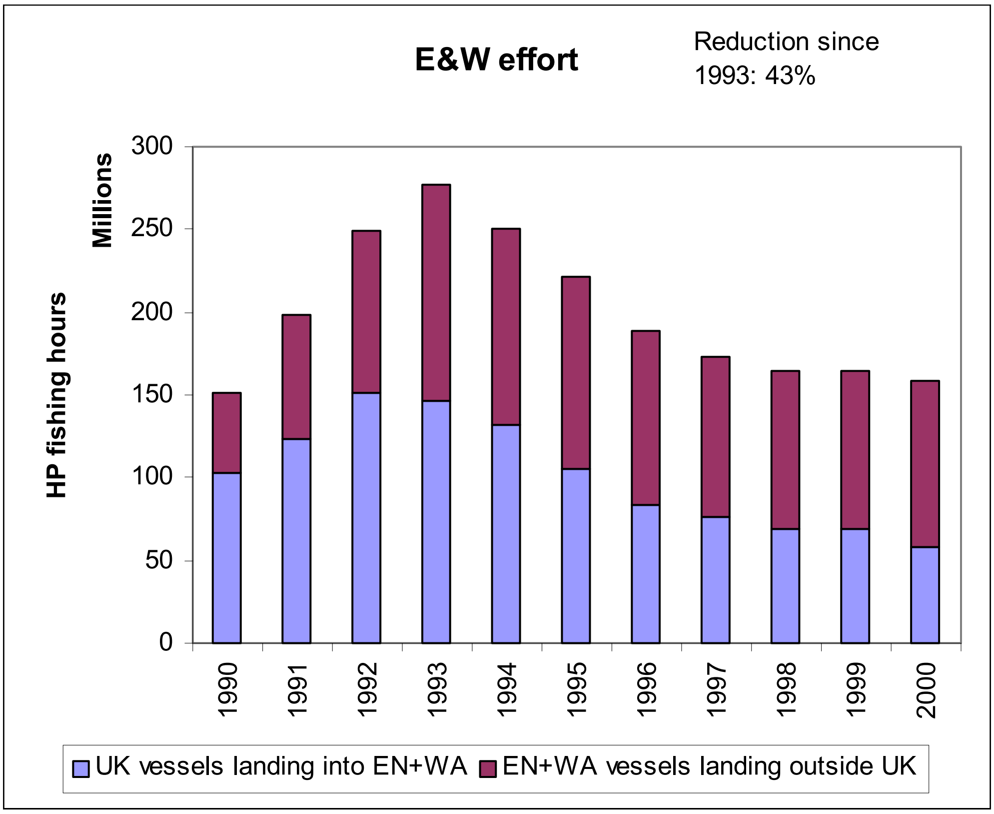
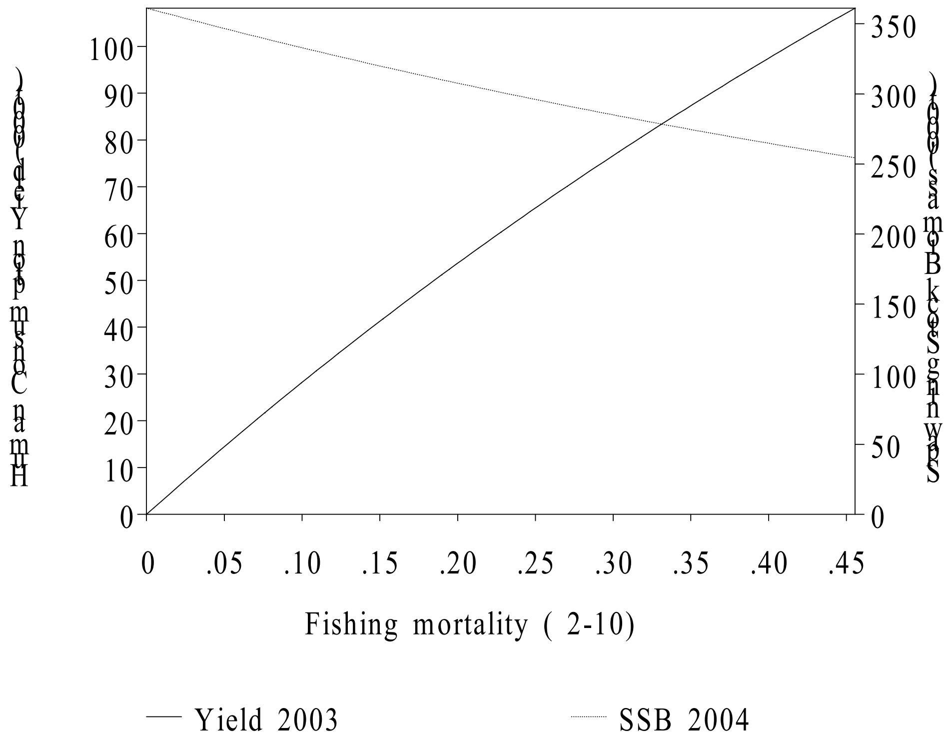


Figure 6.5.1 North Sea plaice, short term forecast



Data from file:N:\Rivop\subgroup\stock\ple\shortterm\PLEIV.SEN on 08/10/2002 at

Figure 6.5.2 North Sea plaice, sensitivity analysis of short term forecast

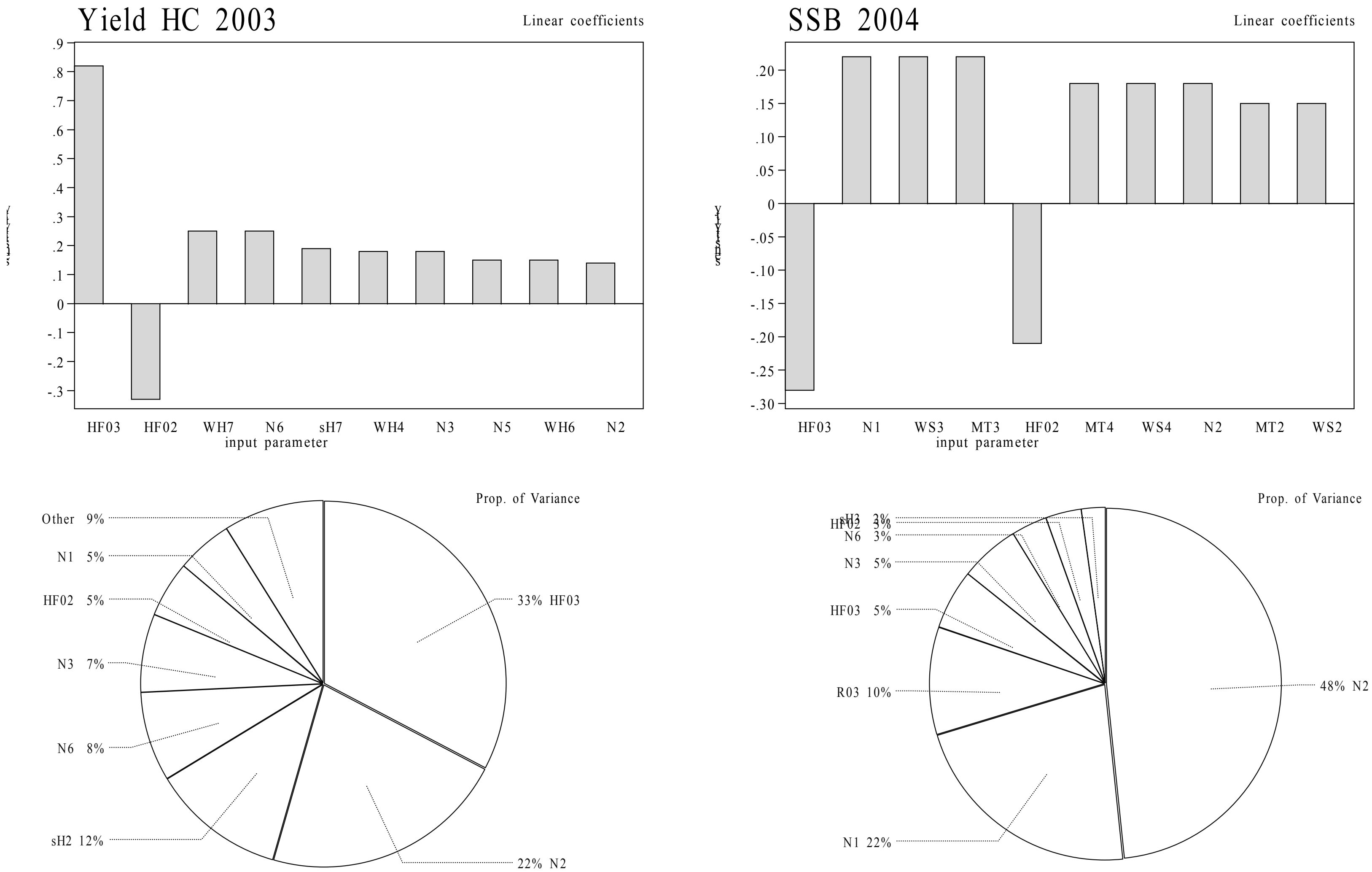


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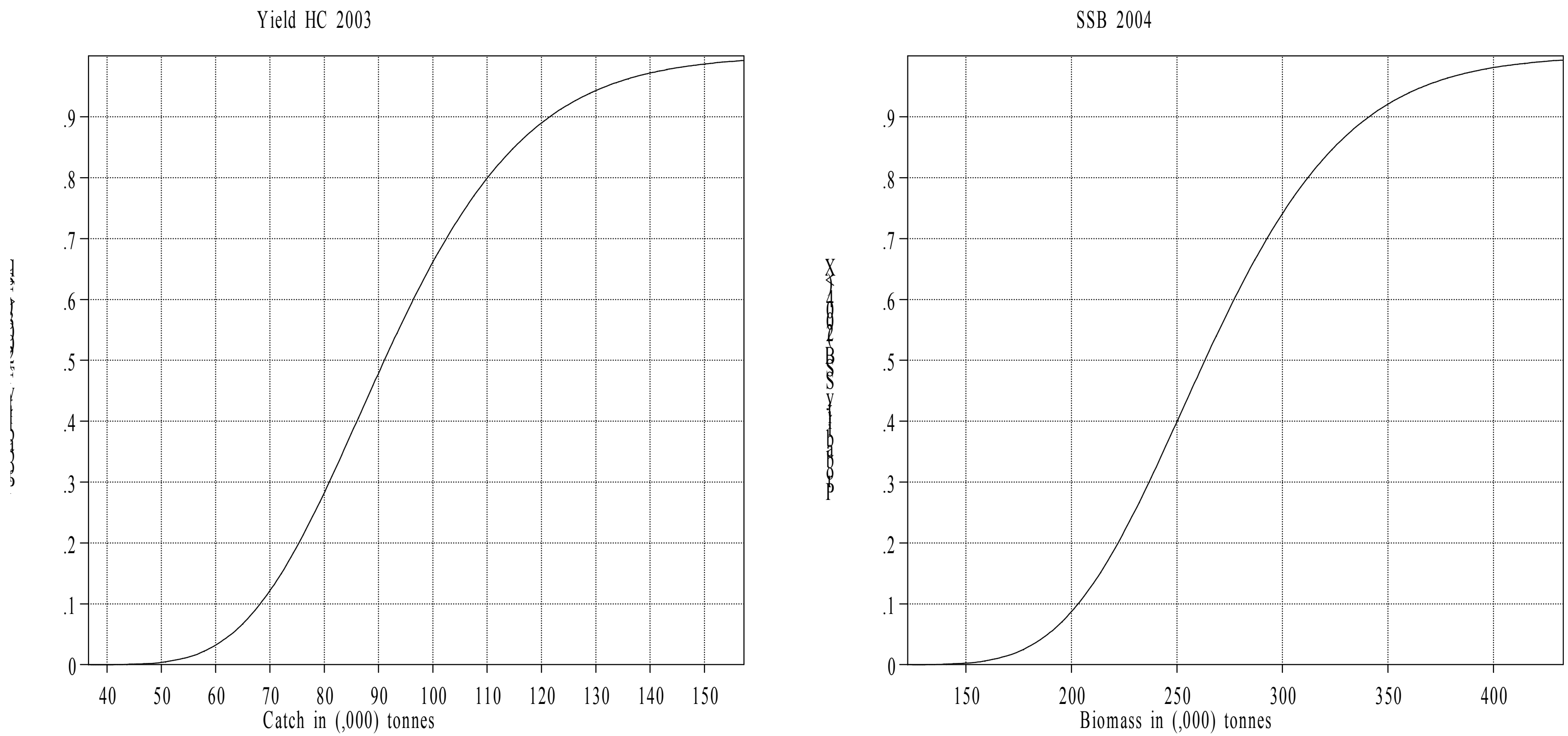
Figure 6.5.3 North Sea Plaice: Probability profiles for short-term forecast



Data from file:N:\Rivop\subgroup\stock\ple\shortterm\PLEIV.SEN on 08/10/2002 at

Figure 6.6.1 North Sea Placie: Medium term analysis

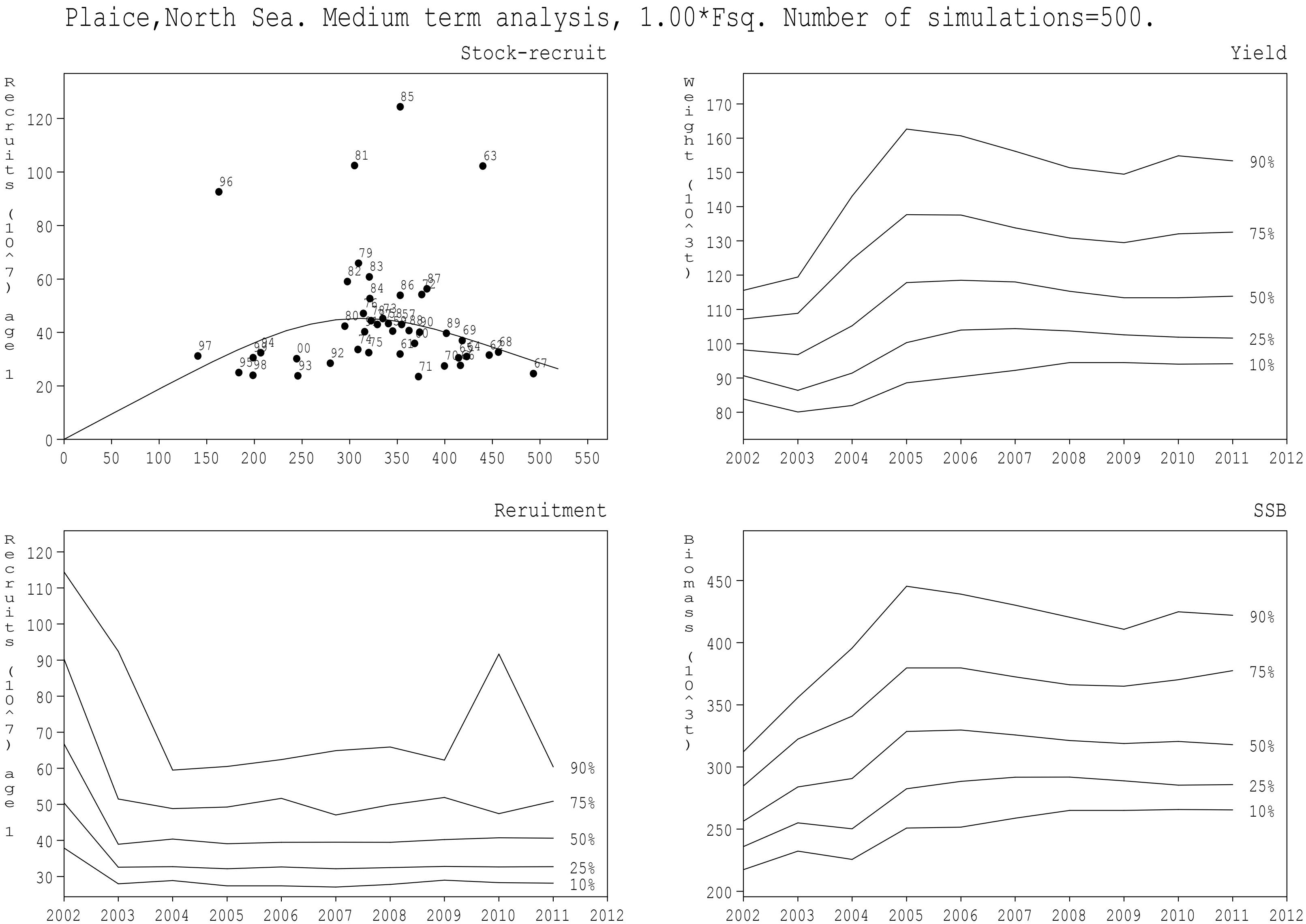
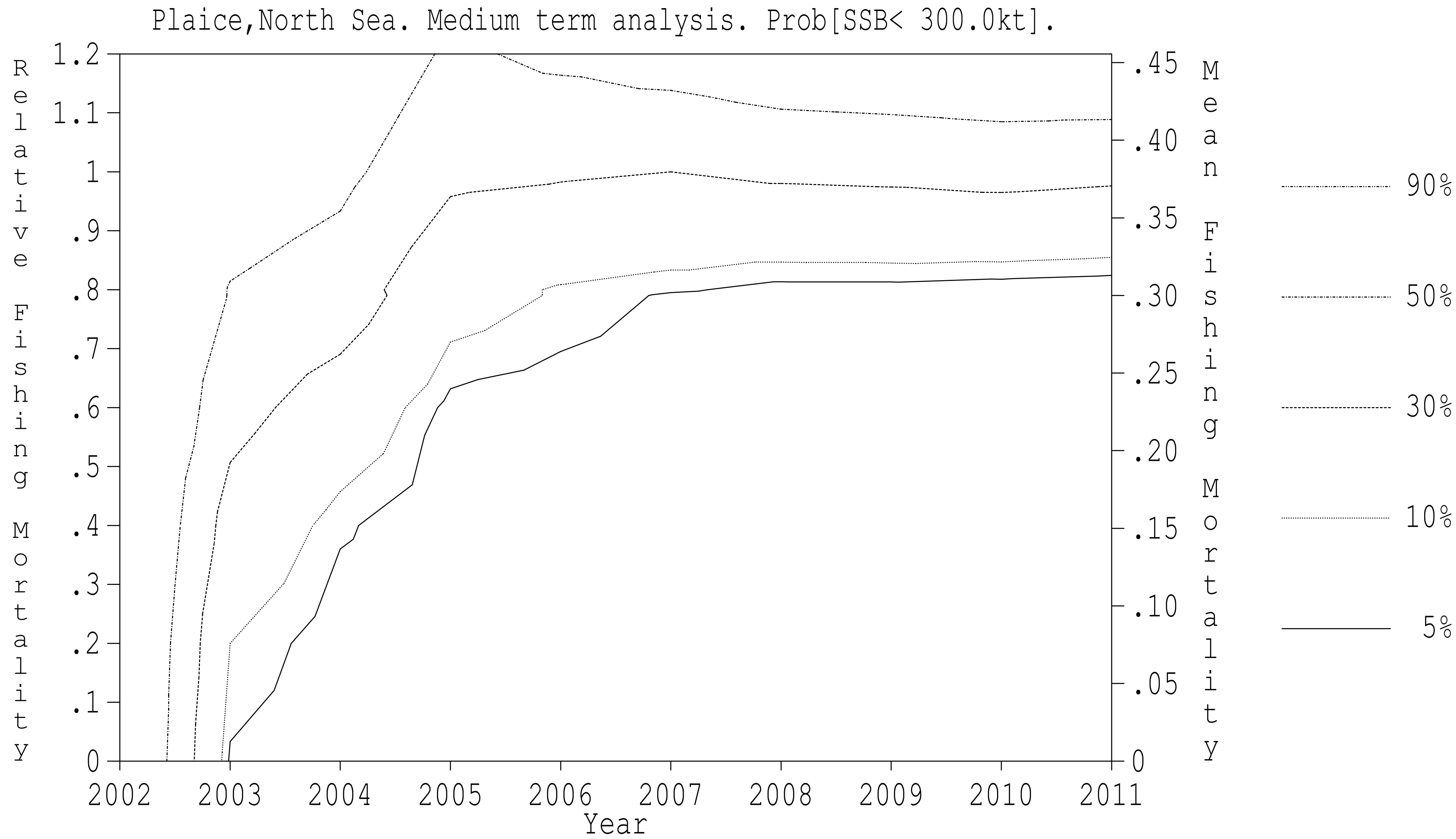


Figure 6.6.2 North Sea plaice. Probability profiles for the Medium term analysis



7 NORWAY POUT IN IV AND IIIA

7.1 Supplementary comment to recruitment and short term predictions

Norway pout recruitment estimates have in previous years assessments been based on fishery data from the combined Danish and Norwegian commercial trawl fleet targeting Norway pout in 3rd and 4th quarter of the year as well as on 0-group indices from the English Groundfish Survey (EGFS) in the 3rd quarter of the year. Additional recruitment data are available from the Scottish Groundfish Survey (SGFS) and from the combined IBTS 3rd quarter survey which so far has not been used in assessment.

At the time of this October 2002 subgroup group meeting the catch at age data for 3rd quarter of the year for the Danish and Norwegian commercial fishery targeting Norway pout are not yet available.

In table 12.6.1 (updated data) 0-group survey indices for the 2002 year class from the EGFS and the Scottish Groundfish Survey (SGFS) are presented.

The EGFS 2002 0-group index is very much the same as in 2001, where the 2001 year class in this years assessment has been assessed as an average year class. The 2002 SGFS 0-group index also indicates that the 2002 year class is in between the very large 1999 year class and the historical low 2000 year class.

The combined IBTS 3rd quarter indices are not yet available to the working group. These data gives basis for a qualified guess of an about average Norway pout 2002 year class, i.e. about average recruitment in 2002.

Table 7.1 (updated October 2002) 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	1791	809	880	3,677	780	40	11	2,559	1192	151	123	-	-	-	-

[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.

8 RECOMMENDATIONS

The Subgroup of the 2002 Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak makes the following recommendations:

1. The poor quality of discard estimation is a major uncertainty in the assessment of several stocks under the remit of this Working Group. Discard data are either not available, or are inappropriately collated and raised. The lack of such data for stocks in which discarding of young fish is a significant factor must seriously degrade the quality of advice stemming from these assessments. It is therefore strenuously recommended that efforts be made to collate discard time-series for stocks for which none have hitherto been available, or revise the discard collation and raising methodology if one already exists.

2. Survey-based assessment methods, of which SURBA is but one example, would appear to be useful techniques for investigating the dynamics of fisheries independently of the commercial catch and CPUE data. However, the precise behaviour of such methods and their response to violations in model assumptions (such as survey catchability trends or catch misreporting) is currently unknown, and cannot be evaluated using real data sampled from populations for which the true distributions are themselves unknown. The WG therefore endorses the recommendation of the 2002 WG on the Assessment of Northern Shelf Demersal Stocks, that a study group (SGSURBA) be initiated to investigate the theoretical properties and practical behaviour of survey-based assessment methods. It would be beneficial for the proposed SG also to evaluate and revise (if necessary) the current index-generation methodologies, and complementary techniques such as absolute abundance estimates via swept-area considerations.

3. The current timing of the WG meeting in June has made necessary the formation of this Subgroup, in order to be able to utilise the 2002 survey data from Scottish, English and Dutch late summer survey series. This is illogical and self-defeating for two main reasons: the extra meeting incurs an unnecessary expense and additional workload for the participants, and the long gap between the historical assessment and forecast meetings can lead to some inconsistency of approach between the two. In addition, there is no valid reason to have the WG meeting in June at all. The Subgroup therefore recommends that the WG meeting be moved to a date in September, possibly at the same time as with the WG on the Assessment of Mackerel, Horse Mackerel, Sardine and Anchovy. This might necessitate a change of location for the WGNSSK so as to avoid overloading the facilities at ICES headquarters, but the experience of the 2001 meeting in Hamburg proved that this can be done with little difficulty and that it can in fact be beneficial to all concerned.

9 WORKING DOCUMENTS AND REFERENCES

Working documents

WD S1 Bolle, L. (2002) Ageing problems in plaice: the results of the otolith exchange initiated at the WGNSSK meeting in June, 2002.

WS S2 Pastoors, M.A. & C.M. Darby (2002) Retrospective analysis of the North Sea plaice assessment.

WD S3 Pastoors, M.A., L. Bolle & C. Needle (2002) North Sea plaice assessment: a new final assessment.

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