Advisory Committee on Fishery Management ICES CM 2003/ACFM:22

REPORT OF THE

Arctic Fisheries Working Group

San Sebastian, Spain
23 April–2 May 2003

PARTS 1 AND 2

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International Council for the Exploration of the Sea

Conseil International pour l'Exploration de la Mer

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TECHNICAL MINUTES

Arctic Fisheries Working Group (AFWG)

ACFM May 2003

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WG Chair and Presenter to ACFM Sub-group: Sigbjörn Mehl, Norway
ACFM Rapporteur and Reviewer: Gary Shepherd, USA
ACFM Reviewer: Phil Kunzlik, UK

General Comments:

The AFWG was commended for addressing the comments provided in the Technical Minutes of the 2002 reviews by ACFM. However, if conclusions were made by the WG about a particular issue, there should be more documented information in the stock assessment report, including figures and tables if appropriate to justify a conclusion rather than the WG simply referring to WDs. References to the quality handbook would be helpful.

A recommendation of the ACFM review panel that pertains to all stocks is that it would be timely to review the age groups used in calculating the average F by stock. Inclusion of age groups experiencing only partial fishing mortality whilst excluding older, mature fish, may increase the risk of a reduction in SSB.

Norwegian Coastal cod:

Following the recommendations of the 2002 ACFM review, age 9 tuning indices were removed and the status quo forecast was provided.

In general, the values in tables of input data should be checked for errors. The maturity-at-age summary table needs to be reviewed to evaluate the 0 % maturity at older age groups. Also, sums in the table of survey spawning biomass weights should be checked.

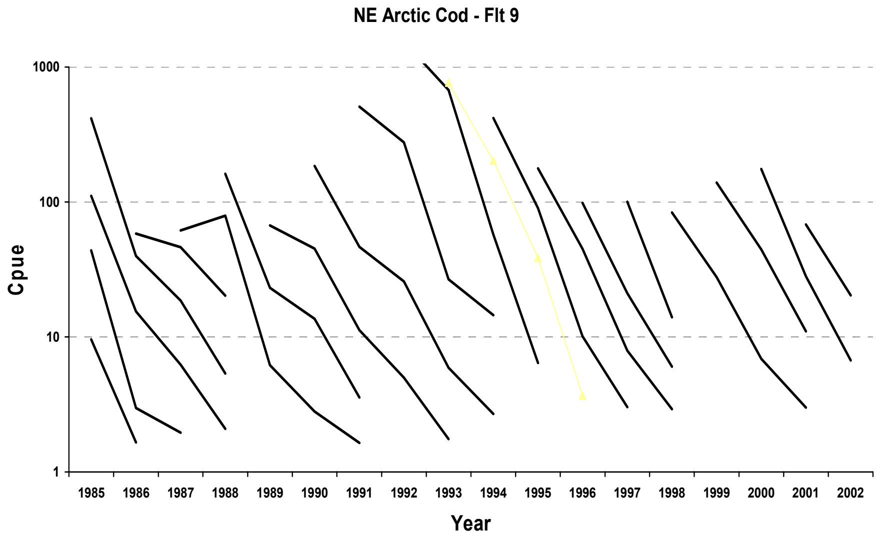
Overall, more detailed explanations should be provided regarding diagnostics (e.g. for XSA), the model inputs (e.g. RCT3 and XSA) and associated justifications for input values (e.g. use of 2002 recruit values in predicting 2003). The XSA model shows a strong year effect in 2003 F estimates which should be further examined. A retrospective analysis should be included as part of future analyses. It is also recommended that the WG provide more details on the sources of uncertainty in the assessment. A case in point is a justification for the heavy reliance on the survey data for tuning the XSA model.

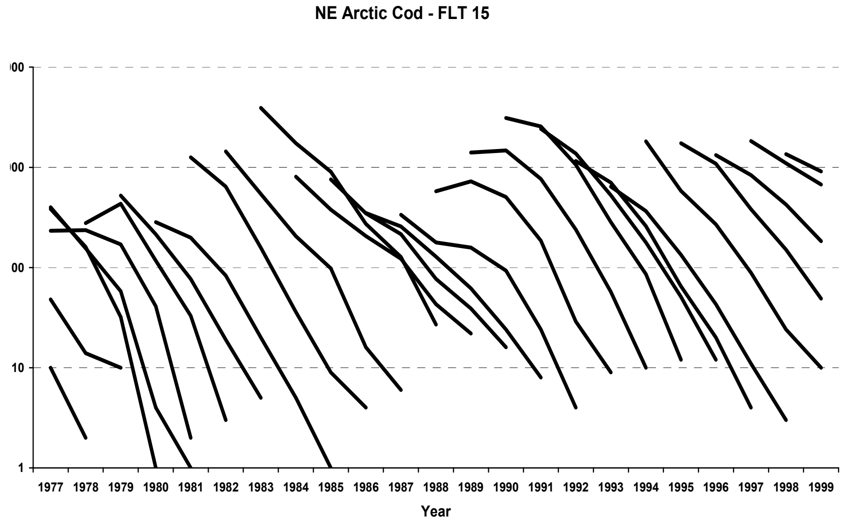
The reviewers concluded that there was no technical basis for the rejection of this assessment.

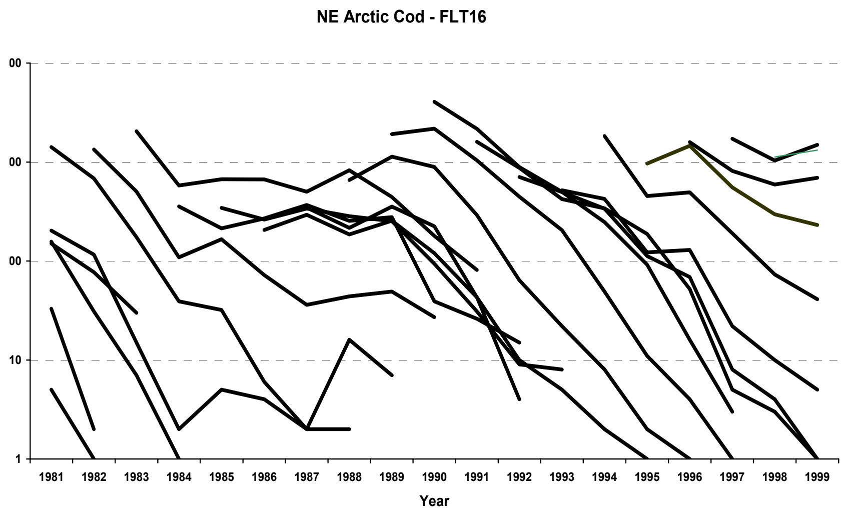
Northeast Arctic Cod:

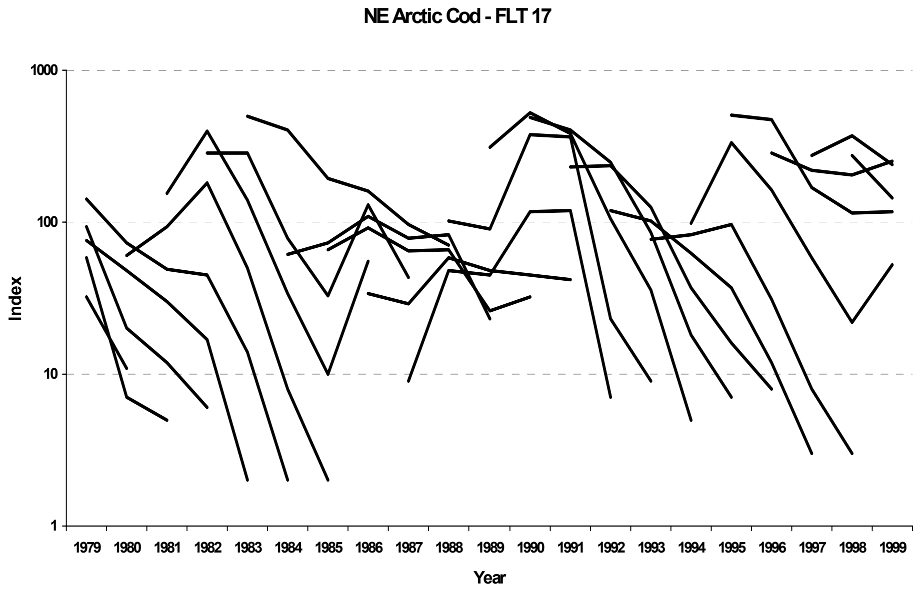
Values used in catch tables should be in agreement with input values in VPA (e.g. 1965 catch weight). It was recommended that the AFWG provide more information/justification for new methods of calculating weights used in predictions as compared to last years methods. Also recommended that the age groups included in tables are consistent with the ages in the analysis. Questions arose concerning the consistency within each survey data series and whether the results represent population trends. After evaluation of survey trends by cohort and correlation within cohorts, inconsistencies were identified in results of the Russian trawl survey (fleet 17). A re-run of the XSA model without fleet 17 did not result in any significant changes in residual patterns, estimates of F or stock size. It is recommended that the WG evaluate the surveys included in the analysis and the influence on the results. In addition, the WG report would benefit from additional figures of the survey indices by cohort.

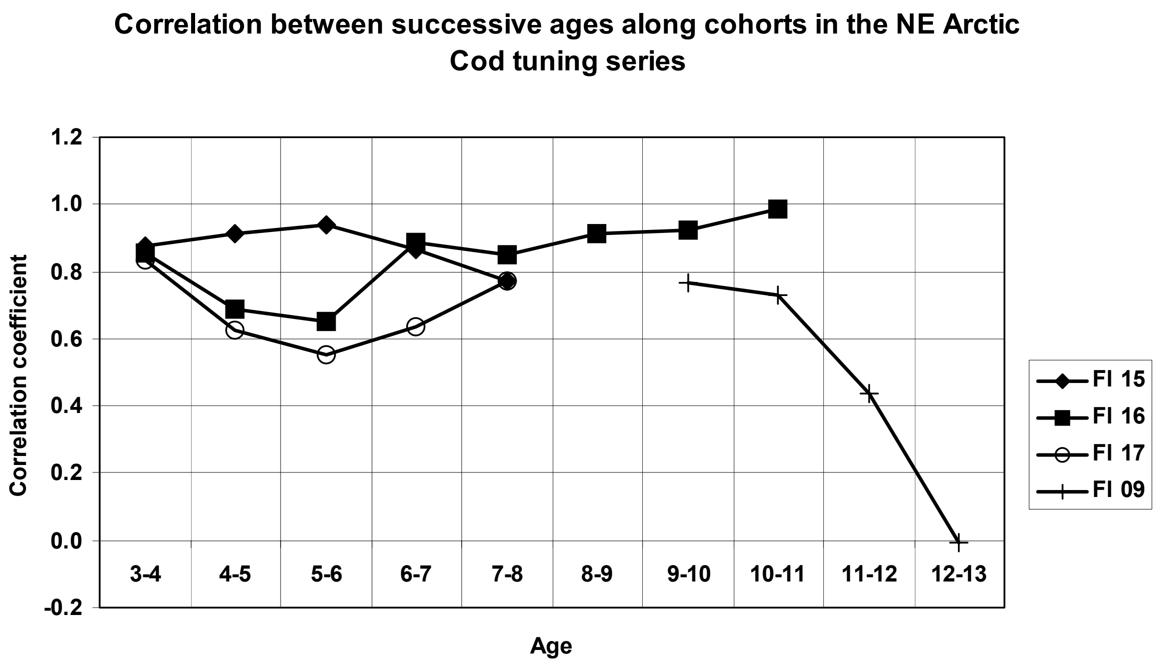
The following figures are NE Arctic cod tuning indices by cohort and fleet (presented on a log scale):


NE Arctic Cod - Flt 9
1000
100
10
1
Cpue
1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002
Year


NE Arctic Cod - FLT 15
10
1
1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999
Year


NE Arctic Cod - FLT16
10
1
1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999
Year





It was noted that the use of SOP corrected biomass estimates would be inappropriate for this stock since such values account for cannibalism effects rather than weight differences.

Biological Reference Points for NE Arctic Cod:

The ACFM reviewers recommended adoption of the proposed revised BRPs for annual management advice, although with reservation about the advantages of the alternative approach. However, this approach may be inappropriate for management plans that apply to multiple years. Given the uncertainty, multi-year management would require re-estimating the BRPs to determine appropriate precautionary reference values within any proposed (new) harvesting strategy.

Northeast Arctic Saithe:

The WG addressed the issues identified in last year's review.

The review committee recommended that the commercial CPUE series be examined using generalized linear models to remove possible seasonal and vessel effects.

Use of RCT3 for recruitment predictions may be no better then a geometric mean since RCT3 uses VPA estimates that have not converged. The reviewers suggested that the working group should justify use of the RCT3 model for projections. Also recommended that the number of years used in GM estimate should be consistent.

Greenland Halibut:

See general comments regarding justification of conclusions in the General Comments section above.

The assessment was rejected for the same reasons as last year (aging error, incomplete survey coverage, and unreported landings). Therefore, the assessment results are only appropriate as an indication of trends rather than absolute estimates of fishing mortality and population abundance.

Sebastes mentella (deep-sea redfish):

The WG has provided XSA results but this approach was hampered by methodological difficulties in dealing with the plus group. It is recommended that use of this model for redfish should be discontinued and other analytical methods involving survey and/or length data explored. The WG recommended a re-evaluation of the algorithm used in the XSA model for handling plus groups and the ACFM reviewers agreed with this proposal.

Sebastes marinus (golden redfish):

The ACFM review group recommends that the WG consider analytical models other than XSA. Alternative methods may be found in assessments of *Sebastes* stocks in the eastern North Pacific (e.g Methot). Additional effort should be made to consider survey and length-based models, and explore alternative methods for estimating uncertainty around CPUE and survey time-series (e.g. jack-knife or bootstrap methods).

Shrimp (*Pandalus borealis*):

No comments.

Arctic Haddock:

The ACFM review group appreciated that the WG addressed the issues raised in the technical minutes from last year.

Catch weights and stock weights-at-age should be re-examined to account for the abrupt change in ages 9 and 10 during the 1980s. The WG should consider modelling natural mortality related to cannibalism to determine a method of predicting an alternative to M=0.2 for years prior to 1984. The report should clearly identify which recruitment estimates are results of XSA versus those from the RCT3 model.

Medium-term projections for 2006-2010 were made using the same input parameters (F, M, maturity, and weights-at-age) as 2005 (see Table 4.19 in ICES CM 2003/ACFM:22). A constant recruitment input of 185629 (thousands) was the average of VPA age 3 values from 1950-2002.

Table 1. Northeast Arctic haddock. Inputs to short-term catch forecast, assuming *status quo* fishing mortality in 2003, and fishing at F_{pa} during 2004-2006.

MFDP version 1a
Run: afwg03
Time and date: 15:11 31.05.2003
Fbar age range: 4-7

2003						Stock		Catch
Age	N	M	Maturity	% Female	% Male	Weight	Selectivity	Weight
3	250000	0.4413	0.003	0	0	0.241	2.65E-02	0.573
4	208676	0.2098	0.047	0	0	0.475	0.202867	0.979
5	161085	0.2062	0.37	0	0	1.074	0.4497	1.379
6	21279	0.2013	0.629	0	0	1.44	0.651033	1.62
7	11837	0.2	0.881	0	0	1.953	0.622567	2.114
8	2249	0.2	1	0	0	2.484	0.7667	2.208
9	746	0.2	0.923	0	0	2.784	0.601467	2.643
10	274	0.2	1	0	0	2.962	0.6831	2.436
11	688	0.2	1	0	0	4.655	0.6831	2.695

2004						Stock		Catch
Age	N	M	Maturity	% Female	% Male	Weight	Selectivity	Weight
3	277000	0.432	0.002	0	0	0.228	2.65E-02	0.595
4	.	0.233	0.034	0	0	0.455	0.202867	0.905
5	.	0.217	0.277	0	0	0.941	0.4497	1.255
6	.	0.204	0.54	0	0	1.371	0.651033	1.558
7	.	0.2	0.863	0	0	1.877	0.622567	1.99
8	.	0.2	0.96	0	0	2.529	0.7667	2.207
9	.	0.2	0.962	0	0	2.81	0.601467	2.539
10	.	0.2	1	0	0	3.02	0.6831	2.584
11	.	0.2	1	0	0	4.134	0.6831	2.786

2005						Stock		Catch
Age	N	M	Maturity	% female	% male	Weight	Selectivity	Weight
3	422000	0.423	0	0	0	0.216	2.65E-02	0.618
4	.	0.255	0.021	0	0	0.435	0.202867	0.83
5	.	0.227	0.184	0	0	0.808	0.4497	1.13
6	.	0.207	0.45	0	0	1.302	0.651033	1.495
7	.	0.2	0.844	0	0	1.801	0.622567	1.865
8	.	0.2	0.92	0	0	2.574	0.7667	2.205
9	.	0.2	1	0	0	2.835	0.601467	2.435
10	.	0.2	1	0	0	3.078	0.6831	2.733
11	.	0.2	1	0	0	3.613	0.6831	2.878

2006						Stock		Catch
Age	N	M	Maturity	% Female	% male	Weight	Selectivity	Weight
3	185000	0.423	0	0	0	0.216	2.65E-02	0.618
4	.	0.255	0.021	0	0	0.435	0.202867	0.83
5	.	0.227	0.184	0	0	0.808	0.4497	1.13
6	.	0.207	0.45	0	0	1.302	0.651033	1.495
7	.	0.2	0.844	0	0	1.801	0.622567	1.865
8	.	0.2	0.92	0	0	2.574	0.7667	2.205
9	.	0.2	1	0	0	2.835	0.601467	2.435
10	.	0.2	1	0	0	3.078	0.6831	2.733
11	.	0.2	1	0	0	3.613	0.6831	2.878

Table 2. Northeast Arctic haddock. Forecast results, assuming *status quo* fishing mortality in 2003, and fishing at F_{pa} during 2004-2006.

MFDP version 1a
Run: afwg03
Time and date: 15:11 31.05.2003
Fbar age range: 4-7

Year:	2003	F multiplier:	1	Fbar:	0.4815				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
3	0.0265	5298	3036	250000	60250	750	181	750	181
4	0.2029	34686	33957	208676	99121	9808	4659	9808	4659
5	0.4497	53126	73261	161085	173005	59601	64012	59601	64012
6	0.651	9323	15103	21279	30642	13384	19274	13384	19274
7	0.6226	5023	10619	11837	23118	10428	20367	10428	20367
8	0.7667	1105	2440	2249	5587	2249	5587	2249	5587
9	0.6015	309	816	746	2077	689	1917	689	1917
10	0.6831	124	303	274	812	274	812	274	812
11	0.6831	312	841	688	3203	688	3203	688	3203
Total		109306	140376	656834	397813	97872	120009	97872	120009

Year:	2004	F multiplier:	0.7269	Fbar:	0.35				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
3	0.0193	4300	2558	277000	63156	554	126	554	126
4	0.1475	19206	17382	156589	71248	5324	2422	5324	2422
5	0.3269	34825	43705	138119	129970	38259	36002	38259	36002
6	0.4732	28740	44777	83599	114614	45143	61892	45143	61892
7	0.4525	3016	6002	9074	17031	7831	14698	7831	14698
8	0.5573	2032	4485	5200	13151	4992	12625	4992	12625
9	0.4372	277	702	855	2404	823	2312	823	2312
10	0.4965	120	309	335	1011	335	1011	335	1011
11	0.4965	142	396	398	1644	398	1644	398	1644
Total		92658	120317	671169	414230	103659	132733	103659	132733

Year:	2005	F multiplier:	0.7269	Fbar:	0.35				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
3	0.0193	6578	4065	422000	91152	0	0	0	0
4	0.1475	21414	17774	176396	76732	3704	1611	3704	1611
5	0.3269	26865	30358	107036	86485	19695	15913	19695	15913
6	0.4732	27527	41152	80176	104390	36079	46975	36079	46975
7	0.4525	14116	26327	42470	76488	35845	64556	35845	64556
8	0.5573	1847	4072	4725	12162	4347	11189	4347	11189
9	0.4372	788	1920	2438	6913	2438	6913	2438	6913
10	0.4965	162	442	452	1392	452	1392	452	1392
11	0.4965	131	376	365	1319	365	1319	365	1319
Total		99428	126485	836059	457033	102926	149869	102926	149869

Year:	2006	F multiplier:	0.7269	Fbar:	0.35				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
3	0.0193	2884	1782	185000	39960	0	0	0	0
4	0.1475	32919	27323	271162	117956	5694	2477	5694	2477
5	0.3269	29605	33453	117951	95304	21703	17536	21703	17536
6	0.4732	21120	31574	61515	80092	27682	36041	27682	36041
7	0.4525	13498	25173	40609	73137	34274	61728	34274	61728
8	0.5573	8643	19058	22115	56924	20346	52370	20346	52370
9	0.4372	716	1744	2216	6281	2216	6281	2216	6281
10	0.4965	461	1260	1289	3969	1289	3969	1289	3969
11	0.4965	146	419	407	1471	407	1471	407	1471
Total		109991	141787	702264	475094	113611	181873	113611	181873

Table 3. Northeast Arctic haddock catch options for 2004 based on two interpretations of the Joint Norwegian-Russian Fisheries Commission harvest law.

Catch forecast for 2004:

Basis: F(2003)=$\mathbf{F}_{sq}$ = F(00-02) =0.48 ; landings =140 000 t ; SSB(2004) =133 000 t.

F (2004)	Basis	Catch (2004)	Landings (2004)	SSB (2005)
0.37	Catch rule2 (=0.77*Fsq): 1.25*2003 TAC		126	146
0.38	Catch rule1 (=0.795*Fsq)		130	144

Weights in ‘000 t.
Shaded scenarios considered inconsistent with the precautionary approach.
Catch rule 1 corresponds to ICES’s interpretation of the new harvesting strategy in the first year of its operation.
Catch rule 2 corresponds to an application of the ±25 % constraint in the first year of the new harvesting strategy.

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INTRODUCTION

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Terms of Reference

At its October 2002 meeting ACFM decided the following:

The **Arctic Fisheries Working Group** [AFWG] (Chair: S. Mehl, Norway) will meet in Pasaia, Spain from 23 April–2 May 2003 to:

a) assess the status of and provide catch options for the year 2004 for the stocks of cod, haddock, saithe, Greenland halibut, and redfish in Subareas I and II, taking into account interactions with other species and attempting alternative assessment methods where applicable;

b) evaluate the agreed management strategy for cod, with special attention to the reference points for spawning stock biomass and fishing mortality;

c) assess the status of the shrimp stock in the Barents Sea, taking predation by cod into account;

d) 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;

e) 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;

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

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

AFWG will report by 5 May 2003 for the attention of ACFM.

General Comments

The host (AZTI, Pasaia, Spain) provided excellent facilities, assistance and transportation, which allowed the meeting to proceed effectively and efficiently. An excursion to Rioja with an unforgettable visit and lunch at a bodega, stimulated people to work hard for long hours, 1 of May included.

Management strategy for NEA cod and haddock

At the 31st session of The Joint Norwegian-Russian Fishery Commission the Parties agreed on a new harvesting strategy for Northeast Arctic cod and haddock. At the present meeting there was neither software nor time available to do an evaluation of the new harvesting strategy, but some comments and projections for NEA cod based on the rule are given in Section 3.8.

Comments on the PA reference points proposed by SGPRP

The Study Group on Biological Reference Points for Northeast Arctic Cod (SGBRP) met at Svanhovd, Norway, 13-17 January 2003 to determine the most appropriate time period for estimating biomass and fishing mortality reference points, specify the technical basis for the reference point calculations and establish reference points based on this. The study group agreed on the use of the full time-series and the numbers-at-age 5 as the recruitment index until more accurate estimates of the number-at-age 3 may become available. The framework implemented for establishing new reference points was mainly the one proposed by SGPA at its December 2002 meeting (ICES CM 2003/ACFM:??). Further details and the calculation of new reference points are given in the SGBRP report (ICES CM 2003/ACFM:11). SGBRP considered the estimated reference points to be provisional since the group expected AFWG to revise them on the basis of the latest assessment with possible incorporation of discarding mortalities.

The Study Group on Precautionary Reference Points for Advice on Fishery Management (SGPRP) met at ICES Headquarters 24–26 February 2003 to review a proposal prepared by the ICES Secretariat on reference points for the stocks dealt with by HAWG, WGBFAS, AFWG, NWWG, WGNPBW WGNSSK, WGHMM, WGNSDS, WGSSDS, WGMHSA. The proposal was built on the framework developed and agreed by SGPA in December 2002 and the outcome of SGBRP. SGPRP should further propose revisions of the reference points used by ACFM in formulating advice on fishery management for consideration by the assessment working groups and with a view for adoption and use by ACFM in its May and October 2003 meetings. SGPRP (ICES CM 2003/ACFM:15) recommended that the revised LIMIT reference points proposed by SGBRP be adopted for NEA cod, while the appropriate PA-reference points be adopted upon clarification of the acceptable method for calculation.

However, AFWG did not have the data available to revise the proposed reference points. The proposed new values were recommended to be adopted by ACFM, with the PA-reference points based on *status quo* F in the intermediate year.

For most other species, included those dealt with by AFWG, SGPRP did not propose any revisions of the existing reference points, but just gave some comments and recommendations to be followed up by the different Working Groups, e.g. to look more carefully at the need for any revision and the best methods to be applied for the different stocks. A new SGPRP meeting will than look at the result of this work with a view for adoption and use by ACFM in its May and October 2004 meetings. Some of the comments and recommendations given by SGPRP are contained in the respective stock sections of the present report.

Inadequacies in the data and possible deficiencies in the assessments

The working group also this year met quite early, with Easter just prior to the meeting. This continues to cause some problems and concerns. The work on compiling national and international catch data were not ready before the meeting and the Norwegian survey covering spawning Northeast Arctic cod ended just before Easter. This affects the quality checking of important input data, the possibility to make exploratory runs ready prior to the meeting and the time available during the meeting to discuss e.g. inadequacies in the data and available software, resulting deficiencies in the assessments and how to improve these shortcomings.

While the area coverage of the winter surveys was incomplete in 1997 and 1998, the coverage was normal for these surveys in 1999-2002. In the autumn 2002 and winter 2003, however, surveys have again been incomplete due to lack of access to both the Norwegian and Russian Economic Zones. This affects the reliability of some of the most important survey time-series for cod and haddock and consequently also the quality of the assessments. There is no acceptable way around this problem except asking the Norwegian and Russian authorities to give each other's research vessels full access to the respective economical zones when assessing the joint resources.

At recent AFWG meetings it has been recognized that there is growing evidence of both substantial discarding and mis-/un-reporting of catches throughout the Barents Sea for most groundfish stocks in recent years (ICES CM 2002/ACFM:18, ICES CM 2001/ACFM:02, ICES CM 2001/ACFM:19, Dingsør WD 13 2002 WG, Hareide and Garnes WD 14 2002 WG, Nakken WD 10 2001 WG, Nakken WD8 2000 WG, Schöne WD4 1999 WG). During the present meeting a working document (Sokolov, WD 9) comparing results obtained using two methods to estimate cod discard in the Barents Sea in 1993-2002 was presented. The discard was found to be highly variable over time and affected mainly age groups 3 and 4. There were some differences in the results obtained by the two methods. Ajiad and Nedreaas (WD 10) presents preliminary results on the total cod by-catch in the Norwegian shrimp fishery during a trial year (2000) based on data from the Norwegian commercial shrimp landing statistics, data from the Norwegian fishery surveillance agency and the scientific shrimp surveys. The results show clear evidence that the shrimp fishery encounter a different composition of by-catch of cod depending on season. During the fourth quarter, the shrimp fishery caught mainly 0-group cod while in the rest of the year the cod by-catch was one year olds.

The total effect of the discarding is still very unclear and requires a lot more work before it can be included in the assessments. This and other inaccuracies in the catch statistics continue to represent one of the most serious errors in stock assessments and generally results in underestimating fishing mortality and overestimating stock size. Therefore, additional precaution is advised when considering total allowable catches (TACs).

In 1992 PINRO, Murmansk and IMR, Bergen began a routine exchange program of cod otoliths in order to validate age readings and ensure consistency in age interpretations (Nedreaas and Yaragina, WD 11). Later, a similar exchange program was established for haddock otoliths. Once a year the age readers come together and evaluate discrepancies which are seldom more than 1 year, and the results show an improvement over the time period from 30% to 15% discrepancies for cod. The discrepancies are discussed and a final agreement is at present achieved for all otoliths except ca. 2%. A similar positive development is also seen for haddock age readings.

Use of age- and length structured models in assessment (Fleksibest)

The development of a new assessment model for Northeast Arctic cod – Fleksibest – started at IMR, Bergen, in 1997. A description of the model is given in Frøysa et al. (2002). The model is age- and length-structured, and the biological processes growth, maturation, mortality, fishing and cannibalism are modelled as length-structured processes. Fleksibest is a forward simulation model based on the Gadget (formerly BORMICON, Stefánsson and Pálsson 1997, 1998, Anon., 2001, 2002a) framework within which different formulations of biological processes can be tested and compared. Fleksibest is an extension of the type of age-structured assessment models where catches are modelled, sometimes termed CAGEAN or 'statistical catch-at-age analysis' (Fournier and Archibald, 1982, Deriso et al., 1985).

For NEA cod, Fleksibest has been used as a supplementary model to XSA for some years. Fleksibest is now a complete assessment model which provides the same kind of output (assessment, retrospective analysis, prognosis, diagnostics) as e.g. XSA. Earlier problems with finding the optimum solution now seem to be solved, as seen from the sensitivity analysis given in Section 3. Although questions concerning choice of likelihood functions and appropriate aggregation level for model/data comparisons need further study, it may be time to give the results from Fleksibest more weight.

Fleksibest has not been approved by ACFM, but there are other ICES assessment WGs, e.g. WGNPBW, which use models (e.g. SeaStar, ISVPA) which have not been approved by ACFM. Use of several assessment models for the same stock is also common in several assessment working groups.

Adding length structure makes it easier to include biological realism by modelling growth, maturity, fecundity, recruitment, fishing mortality and natural mortality (e.g. cannibalism) as processes depending on fish length/weight, temperature, prey abundance and other factors. For Northeast Arctic cod, there is ongoing work on modelling these processes in a way that could be utilised in Fleksibest as well as in the StockAn/RecAn/MedAn suite (Needle and Marshall, WD2; Marshall and Needle, WD3). The advantage of Fleksibest vs. the StockAn/RecAn/MedAn suite is that Fleksibest models the stock abundance by length and age directly without involving transformations from numbers-at-age to numbers-at-length and vice versa using age-length keys.

For NEA cod, it is planned to extend Fleksibest to include six sub-stocks (0-group, ages 1-2, immature females, immature males, mature females, mature males) in order to model the stock abundance from age 0 upwards as well as taking sex differences in maturity into account. This will also make it easier to include fecundity/length/weight relationships.

It has been found that a precise mathematical formulation of population dynamics models with age-length-area-multispecies-multifleet-structure (e.g. BORMICON; Stefánsson and Pálsson 1997, 1998) is needed. Such a description is provided by Frøysa *et al*. (2002) for Fleksibest, which is a single-species, single-area, age-length structured multifleet model where the catches are modelled. A description in detailed mathematical terms of models with age-length-area-multispecies-multifleet-structure will be available as a WD to SGASAM in June 2003. This WD will also describe the difference between the mortality formulation used in Fleksibest and in Gadget.

There are also other applications of Fleksibest/BORMICON/Gadget. At present this includes the assessment of *Sebastes marinus* in Icelandic waters (Björnsson and Sigurdsson, 2003) and West of Scotland anglerfish (cooperation with Helen Dobby, FRS, Aberdeen). In the future such models may be applied to all species assessed by AFWG, but it would be of greatest interest to apply it to stocks where the age data are less reliable or non-existent, such as *Sebastes mentella* and shrimp. A model for shrimp should include predation by cod.

It is planned to use set up a multispecies (cod, capelin, herring, minke whale, harp seal) and multi-area model for the Barents Sea using the Gadget modelling framework. This model will be similar to the MULTSPEC model (Bogstad et al., 1997). This work is dependent on the funding of a new EU project.

Kvamme and Frøysa (2003) used Fleksibest to study the effect of using different selectivity curves in the fishery for NEA cod. Age-length structured models are particularly well suited for such studies.

Age-length structured models such as Fleksibest will be studied at the ICES Study Group on Age-Length Structured Assessment Models (SGASAM) in Bergen in June 2003. The ToRs of that meeting are as follows:

a) investigate process model formulations, goodness of fit and model sensitivity in age-length based models;
b) evaluate the usefulness of such tools in specific case studies on stocks with differing life-histories, data availability and quality, such as sprat, anglerfish, blue whiting, Nephrops, Greenland halibut and deepwater species

ICES Quality Handbook

Following the guidelines as adopted by ACFM in October 2002, a stock specific template was filled out for most AFWG stocks, describing how the annual assessment calculations and projections are performed, as well as the biological stock dynamic, ecosystem aspect, and the fisheries relevant for fisheries management. These templates are presented as appendices to the working group report, and the report has been re-structured accordingly.

Since shrimp most probably will be dealt with by a joint NAFO-ICES pandalus working group in the future, no appendix was filled out for this stock. For NEA haddock a lot of time was spent on improving the input data and the stock assessment, and the time available did not permit the preparation of a quality handbook appendix.

Scientific Presentations

WD 1 (presented by J.E. Stiansen) describes the present oceanographic conditions, the role of zooplankton and some relations between climate and fish population parameters. A forecast for sea temperature in the Barents Sea is given.

WD 2 and 3 (presented by C.T. Marshall) presents software being developed for ICES use. The software is divided into three different modules: StockAN, RecAN, and MedAN. StockAN uses the output of the assessment to estimate alternative indices of stock reproductive potential. RecAN fits a wide variety of stock/recruitment relationships to either the conventional stock/recruit relationship which uses SSB as the index of reproductive potential or alternative parameterisations (e.g., using total egg production). MedAN is an updated version of the medium-term stock projection software. When completed, these modules will produce medium-term stock projections that incorporate a higher degree of biological realism than is presently the case. As part of this initiative, growth models are being developed for Northeast Arctic cod. For each cohort a robust parameterization of the von Bertalanffy model was used to describe length-at-age and the model coefficients were determined using non-linear regression. In general the growth of Northeast Arctic cod is quite linear up to age 8 or 9 when a reduction in growth in length occurs.

WD4 (presented by A. Filin) describes results of monitoring of abundance and distribution of krill (euphausiids) in the Barents Sea, conducted by PINRO since 1952. By the data from monitoring, the abundance of euphausiids, as well as the peculiarities of their distribution and specific composition are characterized by significant year-to-year dynamics, that influence the conditions of fish feeding. Therefore, the data on euphausiids stock and distribution of concentrations may serve as a predictor of fishing forecasting. According to the data from the survey conducted in October-December 2002, mean indices of krill abundance in the Barents Sea exceeded the mean long-term index in two times. The decrease in the percentage of warm-water species *M.norvegica* in euphausiid concentrations as compared to the previous years and the increase in abundance of euphausiid arctic boreal species *Th.inermis* and *Th.raschii* were recorded.

WD7 (presented by T. Bulgakova) proposed a simulation model of NEA cod stock dynamics since 1980 up to 2005 with the same input parameters as used in the recent AFWG-2002 run with cannibalism. This model incorporates the algorithm of PA management scheme proposed at SGBPA-2003 and simultaneously two additional indices for the stock-recruitment relationship: index equal to population fecundity divided by SSB and index of steady Atlantic water inflow which is equal to number of months in the year of a year class birth with positive temperature anomalies. The model simulates and then compares various scenarios of management scheme and as result arrives at different population dynamics. The performed simulations using various F_{pa} values sent a challenge in a practicability of the choice so low value for F_{pa} as 0.4.

WD 8 (presented by J.E. Stiansen) presents an alternative recruitment model for three-year-old NEA cod, with the possibility of a three-year prediction. The multiple regression model is a result of the wish to include climatic effects into the assessment. The variables used are the Kola temperature, the one-year-old bottom survey index and the capelin biomass. The model explains 83 % of the variation in the recruitment data (number of 3 year olds) from the 2002 assessment. Retrospective analysis of the errors in both this model and the error given by earlier assessments show that the errors of the regression model are within the same range as those from earlier assessments.

WD 9 (presented by K.V. Drevetnyak) presents a method aimed at estimation of the Northeast cod discards during bottom trawl fishery. The method based on a logistic curve is proposed to describe the discarding process. An attempt is made to estimate discards during Russian bottom trawl fishery for cod in 1993-2002. General results of the calculations suggest that the cod discards depend on abundance of fish at age 3 and 4 and proportion of total catch taken in different areas of the Barents Sea. This method can be a useful tool for retrospective estimation of discards. Some differences between the existing methods to calculate discards are also discussed.

WD 10 (presented by K. Nedreaas) provides preliminary results of the total cod by-catch in the Norwegian shrimp fishery during the example year 2000 based on data from the Norwegian commercial shrimp landing statistics, data from the Norwegian fishery surveillance agency and the scientific shrimp surveys. During the fourth quarter of the year, the shrimp fishery had impact on 0-group cod while in the rest of the year the main impact was on one year old cod. Before the sorting grid was introduced in the shrimp trawl, the by-catch of cod was much larger, also incl. bigger fish. The plan is to use this method, incl. by-catch data from other countries, to make a database of by-catch of different species in the shrimp fishery for every year back to the mid-1980s. The data should be presented on length- and age-groups.

WD 11 (presented by K. Nedreaas) gives a status report of the PINRO-IMR otolith exchange program for NEA cod that started in 1992. Later, a similar exchange program was established for haddock otoliths. Once a year the age readers themselves come together and discuss the discrepancies within the previous two most recent exchanged samples. The discrepancies are seldom more than 1 year. Most often PINRO reads one year more than IMR, and this seems to be area/season related. The results show an improvement over the time period, i.e., the number of age readings showing different result has decreased from about 30% in 1992 to about 15% today. During an annual exchange of age readers the discrepancies are discussed and a final agreement is at present achieved for all otoliths except ca. 2%. A similar positive development is also seen for haddock age readings where about 10% of the fish are aged different. Differences in age reading may also cause different mean-weight-at-age. Based on the comparative age readings in 2002, consequences for mean-weight-at-age are shown.

WD12 (presented by A. Filin) describes a results of cod growth rate in the Barents Sea, performed by the STOCOBAR model. Model parameters were estimated by historical data for 1984-2000. The prognosis of cod growth rate is done for a five-year period, from 2001 to 2005. In the prognosis the forecasts of mean annual temperature in the Kola Section for 2002-2004 was used as input data, together with the prognosis of capelin biomass. According to the prognosis mean weight of 3-4 year old cod in the beginning of 2004-2005 is expected to be below the long-term mean. For the 6-7 year old cod the mean weight s expected to exceed the long-term mean, while age 5 and age 8 years and older are expected to be close to the long-term mean.

WD 14 (presented by S. Mehl) presents results of retrospective XSA-analysis for NEA saithe with all and one and one tuning fleet. All runs show similar retrospective trends, i.e. a tendency to overestimate fishing mortality and underestimate stock size in the assessment year. Analysis was also done without age group 2 in the acoustic survey fleet due to the high value of the S.E. (log q). The estimates of survivors from age 2 and 3 in the terminal year were reduced, but the numbers-at-age 2 and 3 in the last assessment year are normally estimated by the RCT3 routine. The numbers-at-age 2 and older in the more converged part of the XSA are not influenced to any extent by the 2-group in the acoustic survey fleet. A new survey where younger age groups of saithe may be better covered is planed. Until we have at least five measurements from this survey it is probably best to exclude age group two from the tuning.

WD 19 (presented by A. Aglen) reports the joint Norwegian Russian demersal fish survey in the Barents Sea, February 2003. Compared to the previous couple of years the area distribution of cod and haddock appeared more patchy in the 2003-survey, both in the acoustic observations and in the bottom trawl catches. It is observed that the CVs in the swept area estimates are higher in this year's survey. For several cohorts the survey results of cod are high compared to the results in the 2002 survey. This is in particular the case for the year classes 1997-2001 in the acoustic estimates. Some dense acoustic recordings close to the cost of Finnmark might have lead to over-estimation due to lack of acoustic transects perpendicular to the coast.

Oral presentation (by Carolina Alonso):

The eggs and larvae of NEA cod and *Calanus finmarchicus* are sensitive to solar ultraviolet (280-400 nm) doses in the Lofoten Islands (Norway). When they were incubated at a fixed depth of 15 cm during their embryonic period, mortality and failure to hatch increased in eggs and larvae exposed to full sunlight compared to those that were protected from UVB and/or UVA. Similarly, buoyancy of developing eggs and viability of hatched larvae decreased. However, this impact was dramatically reduced when incubations were performed at 50 cm, suggesting that the vertical circulation due to turbulent forces that are typical in the upper layer might diminish the impact of UVR upon these organisms. In addition, the strongest effects were observed late in the season (late May), when solar irradiance is higher, at a time when most spawning events have already taken place for both cod and *Calanus finmarchicus.*

Oral presentation:

Some environmental variables influencing cod recruitment and *Calanus* spp. abundance in the Lofoten area (Norway)
Ángel Borja
AZTI Foundation, Pasaia (Spain)The impact of climate phenomena (North Atlantic Oscillation (NAO)/Arctic Oscillation (AO)) on oceanographic factors (Gulf Stream Index (GSI), Ekman transport, turbulence, etc.) is investigated; these, in turn, might govern recruitment success of Northeast Arctic cod, one of the world´s commercially most important fish stocks, and the abundance of *Calanus finmarchicus* and *C. hyperboreus*. The study is based on a 32-year record (1967-1998) of data, from 10 locations off the Norwegian coasts. NAO and AO show a significant correlation with 0-group index for cod 2 years later (explaining 33.5% of the variability), while GSI has a significant correlation with the recruitment in the same year (explaining 30.8% of the variability). There is a significant relationship between recruitment and Ekman transport eastwards, explaining 25% of the variability. The correlation between recruitment and the summation of the turbulence, on each of the locations studied, is highly significant; explaining 40.1% of the variability in the recruitment. Applying a multiple linear regression model with two independent variables, GSI (or NAO) and turbulence, on cod recruitment explains about 53% of the variability. In years with a large positive NAO index a strong GSI transport northwards with a two year-lag is induced, increasing the heat transport by the North Atlantic current, up to the Barents Sea. In the case of *Calanus* we have demonstrated that several local and global factors affect the abundance in the Lofoten area. These factors are favourable for the zooplankton production and the survival of cod larvae, being advected from the spawning areas (in the Lofoten area) to the recruitment areas (in the Barents Sea); while the turbulence generated by moderate to strong winds increases the encounter rate between cod larvae and its prey, increasing the survival of cod.

Nomination for New Chair

The Working Group was pleased to unanimously endorse the nomination of Yuri Kovalev, Russia as the new chairman of the Arctic Fisheries Working Group.

Time of Next Meeting

The Working Group proposes the dates of April 20 – 29, 2004 for it's next meeting.

1 ECOSYSTEM INFLUENCES ON BARENTS SEA FISH STOCKS

The population dynamics of all commercial fish stocks are determined by fisheries effects and by environmental effects on growth, recruitment and natural mortality. The goal of this chapter is to describe the implications of interannual variation in the climate and trophic interactions for fish stocks in the Barents Sea ecosystem. Forecasts for the upcoming year are made for several variables. The consequences for growth, recruitment and natural mortality are also discussed.

1.1 Climate considerations in the Barents Sea

1.1.1 Hydrography and ice conditions

The Barents Sea is characterised by large year-to-year fluctuations in heat content and ice coverage caused by variations in the influx of Atlantic water from the Norwegian Sea. Temperatures in the Barents Sea have been relatively high during most of the 1990s, and with a continuous warm period from 1989-1995. During 1996-1997, the temperature was just below the long-term average before it turned warm again at the end of the decade. Even though the whole decade was warm; it was only the third warmest decade in the 20^{th} century (Ingvaldsen *et al.* 2002).

In January 2002 the temperature was just above the long-term average in the whole Barents Sea (Figure 1.1), but from April the temperature increased rapidly. In the Fugløya-Bjørnøya section the temperature in June was 1^{o}C above average, which is the highest observed value since the start of the measurements in 1977. In the Kola section the maximum temperature was in August/September with 0.8^{o}C above average, which was 0.1-0.2^{o}C below the maximum for the period 1921–1999. The temperature decreased slightly until October, followed by a rapid decrease towards the average in December. In January 2003, the temperature was exactly at the long-term average (Asplin and Dahl, 2003, Stiansen *et al.,* WD1). The situation was similar in the whole Barents Sea.

The variability in the ice coverage is closely linked to the temperature of the inflowing Atlantic water. The ice has a relatively short response time on temperature changes in the ocean, but usually the sea ice distribution in the eastern Barents Sea responds a bit later than in the western part. 2001 had the highest ice index recorded since 1970, which means very little ice. 2002 had the second highest ice index. During the winter of 2002 there was about the same ice conditions as the year before, but the ice melt during summer was quite high. The winter of 2003 will have more ice than 2002, but the ice index is still expected to be higher than average for the whole year.

1.1.2 Inflow of Atlantic water

Transport of Atlantic water to the Barents Sea has been measured since August 1997. The flow of Atlantic water is very variable. Most of the time there is a net inflow of Atlantic water to the Barents Sea, but in some periods large outflows are observed. Large outflows occurred in April both in 1998 and 1999, and in 2000 there were two periods with strong outflow, one in January and a second one in June. In January and March 2002 there were two peaks of high inflow into the Barents Sea. The intensity of the flow was reduced during spring and summer. In October 2002 there was a peak of weak outflow. Results from a wind driven model shows similar results. The inflow from the model during the first two months were stronger than average. The rest of the year the model showed average inflow, except for the last two months when the flow was reduced.

1.1.3 Predicting Barents Sea temperature

Prediction of Barents Sea temperature is complicated since the variation is governed by processes of both external and local origin that operate on different time scales (Stiansen *et al*, WD1). The volume flux and temperature of inflowing Atlantic water masses, as well as heat exchange with the atmosphere, is important in determining the temperature of the Barents Sea. Thus, both slowly moving advective propagation and rapid barotropic responses due to large-scale changes in air pressure must be considered. The major changes in Barents Sea climate take place during the winter months. The variability in the amount of heat flowing in with Atlantic water masses from the south is particularly high during this season. Furthermore, variability in low-pressure passages and cloud cover has a strong influence on the winter atmosphere-ocean heat exchange.

This seasonal difference is reflected in the merit of simple six-month forecasts of Kola-section temperature based on linear regression models. The tendency is that persistence across the spring and summer months is higher than for other seasons, allowing for reasonably reliable forecasts from spring until autumn. Data available until February 2003 allow for a six-month forecast for August 2003. The value for February 2003 of 3.3 ºC is inserted into the equation $T_{August} = 2.37 + 0.67^{*} T_{February}$, statistically derived from data for the years 1921-1997 (Stiansen *et al*, WD1). This gives an objective temperature forecast for August 2003 of 4.58 ºC. This will be slightly below the 1921-1999 mean of 4.67 ºC. We conclude that summer sea temperatures in the southern Barents Sea are expected to lie around the long-term mean.

Assuming that temperatures in the Barents Sea fluctuate periodically, it is possible to forecast by means of statistical methods. The results of Asplin and Dahl (2003, Stiansen *et al.,* WD1) indicate a decrease in Barents Sea temperatures towards a minimum in 2003, followed by a local maximum above average in 2005 (Figure 1.2). However, for the last four years this model has persistently been below the observed values. A Russian prognosis (Figure 1.3, Filin, WD12) to 2006 shows much the same development, but with a minimum in 2004, a year later than that of Asplin and Dahl (2003). However, the statistical precision of such forecasts is low. Ottersen *et al*. (2000) showed that historically only about 25% of the variability in the time-series was explained by forecasts as those given by Asplin and Dahl (2003). With this in mind these predictions should be treated with caution.

Conclusions section 1.1:

- 2002 was warmer than average. The temperature in the beginning of the year was just above average, followed by an extremely hot summer, while the temperature decreased against the average at the end of the year.

- The inflow of Atlantic water was normal for most of 2002, except for a higher inflow in the beginning of the year.

- The temperature in 2003 is expected to be lower than in 2002, and will be close to the long-term mean in most of the Barents Sea.

- A Norwegian long-term prediction indicates that the temperature will decrease to a local minimum in 2003 before reaching a local maximum in 2005. A similar Russian model shows that the same minimum will appear one year later.

1.2 Zooplankton

The standing stock of zooplankton has been monitored by IMR in the Barents Sea from the early 1980s in connection with the joint Norwegian/Russian 0-group and capelin surveys during August-October. At this time of the year most of the production has taken place and the zooplankton biomass can be expressed as the overwintering population of zooplankton. Plankton samples were obtained by using WP2 and the MOCNESS (Multiple Opening Closing Net and Environmental Sensing System) plankton net. In 2002 PINRO also joined to the collection of sample of zooplankton during August/October. Plankton samples in Russian surveys are collected using the Juday net.

The mean biomass (gm^{-2}) values from 1988 to present are estimated for the 7 different areas in the Barents Sea. There was a marked increase in zooplankton biomass during the period 1991-1994. The highest biomass values were observed in 1994 when the capelin stock was at an extremely low level. Though the biomass has decreased from 1994 to present, the average biomass values during 1995 to 2002 are still higher than in the 1988-1992 period. In 2002 the zooplankton biomass was at an average level, with a slight increase from 2001 to 2002.

Figure 1.4 shows the total biomass of zooplankton together with capelin stock size (million tonnes). A commonly observed inverse relationship between capelin stock size and zooplankton biomass can be seen from Figure 1.4 indicating capelin to exercise strong feedback control on the system through its predation pressure on zooplankton.

Since 1952, PINRO have conducted annual monitoring of distribution and abundance of krill (euphausiids) in the Barents Sea (Drobysheva *et al.,* WD4). Collection of macrozooplankton samples were carried out during a Russian trawl-acoustic survey for demersal fishes in autumn-winter. Net attached on top of the trawl collected macrozooplankton in a layer 6-10 m from the ground. The number of individuals caught by the net during an hour of research hauls serves as the index of euphausiids abundance. Annually, 200-300 samples of macrozooplankton are collected during these surveys.

The abundance of krill, as well as the distribution and specific composition, is characterized by significant year-to-year dynamics (Figure1.5), which influences the conditions of feeding fish. Therefore, it may serve as a predictor of fish stock condition and recruitment. It was shown that winter feeding of cod juveniles on euphausiids influenced their survival rate.

In 2002 the abundance index of euphausiid was twice as high as the long-term average (Drobysheva *et al*, WD4), with a smaller percentage of warm water species *Meganyctiphanes norvegica* compared to previous years. In 2003 the abundance of euphausiid is expected to be moderately high in the Barents Sea.

Conclusion section 1.2:

- An overwintering zooplankton biomass in 2002 moderately above the average will create the basis for average zooplankton production in 2003 and feeding conditions for capelin, as well as for other pelagic fish and juvenile demersal species in the Barents Sea.

1.3 Trophic interactions

1.3.1 Predicting capelin biomass

Capelin is the most important prey species for Northeast Arctic cod, and the development of the capelin stock may have a strong effect on growth and maturation of cod, as well as cod cannibalism.

The biomass of capelin (1+) decreased from 3.6 million tonnes in 2001 to 2.2 million tonnes in 2002 (Anon., 2002b). This is lower than the prediction for 2002 made by AFWG last year (3.4 million tonnes). The prediction method used in Anon. (2002b), which is essentially the same as previously used, predicts the biomass of 2+ capelin in October 2003 to be 1.40 million tonnes and the biomass of 1 year old capelin at the same time to be 0.59 million tonnes, giving a total of 1.99 million tonnes. Of this 1.17 million tonnes are predicted to be mature capelin. The stock history for capelin from 1984 onwards is given in Table 1.1 together with the estimated biomass of capelin removed from the stock by natural mortality.

A 1-year prognosis has been presented to AFWG since 1999. A review of the prognoses made during this period is given in Table 1.2. The prognoses seem to be overestimates in most cases. The prediction methodology is still under development. AFWG requests WGNPBW to provide a review of how the present prognosis method would have performed when run on historical data. Also, the prediction should be given with uncertainty.

1.3.2 Predation by cod

The consumption by cod of various prey species for the period 1984-2002 is given in Table 1.3, using the same method as described by Bogstad and Mehl (1997).

As usual, capelin was the most important prey for cod. However, the consumption of capelin by cod decreased markedly from 2001 to 2002. This may be related to the decrease in the capelin stock. The consumption by cod of other fish species (herring, polar cod, cod, haddock and blue whiting) increased from 2001 to 2002. The consumption of blue whiting increased to 277 000 tonnes, the highest value in the 19-year time-series. The consumption of shrimp, krill and amphipods decreased from 2001 to 2002. The calculation of consumption of cod and haddock by cod using this method are used in the assessment of cod and haddock (Sections 3 and 4).

Dolgov (WD 6, Table 1.4) also calculated the consumption by cod based on the same data, using a somewhat different methodology. The consumption by prey species from the two calculation methods for 2002 is similar. The main difference is that the calculations in Table 1.3 give a decrease in the consumption of capelin from 2001 to 2002, while the calculations in Table 1.4 show an increase. Also, there are notable differences in the number-at-age of cod and haddock consumed by cod. It should be noted that the calculations in Table 1.3 are based on the number-at-age of cod from the VPA given in this year's report, while the calculations in Table 1.4 are based on the VPA from the 2002 AFWG meeting.

The annual consumption for each age group of cod (kg/year), based on the consumption calculations shown in Tables 1.3 and 1.4 are given in Tables 1.5 and 1.6, respectively. Table 1.5 shows that the consumption per cod decreased from 2001 to 2002 for age 3 and older fish. The consumption per cod in 2002 was close to the 1998 level, but lower than in the period 1999-2001. Such a trend in the consumption per cod is not found in Table 1.6. The calculations by Dolgov generally give a lower consumption per cod for age 1-4 and a higher consumption per cod for age 6+ compared to the calculations using the method described by Bogstad and Mehl. The discrepancies in consumption per cod by age group are much larger than the discrepancies in total consumption by the cod stock.

The consumption estimates in Tables 1.3 and 1.4 do not include the consumption by mature cod in the period when it is outside the Barents Sea (assumed to be 3 months during the first half of the year). During this period it may consume significant amounts of adult herring (Bogstad and Mehl 1997).

Johansen *et al*. (2002) describe a new method for calculating the consumption by cod, and applies this to calculate the consumption of herring by cod in the period 1992-1997. Their consumption estimates are comparable to the estimates given in Table 1.3, except for 1994, when they obtained a much higher estimate (494 vs. 147 thousand tonnes).

As in previous years, the consumption of cod and haddock by cod (Section 3 and 4), which is taken into account in the assessment of these species, was calculated using the method described by Bogstad and Mehl (1997). It is important to agree on a joint methodology for consumption calculations.

1.3.3 Predation by other fish species

Dolgov *et al*. (WD 11, AFWG 2002) investigated the diet of blue whiting in the Barents Sea in the period 1998-2001. They concluded that predation by blue whiting will not have a significant impact on the recruitment of cod, haddock and redfish. However, food competition between blue whiting and juveniles of other commercial fish stocks due to blue whiting grazing zooplankton in the areas of larval drift may occur. The diet of saithe in the period 1998-2001 was investigated by Dolgov (WD12, AFWG 2002). The diet of saithe > 40 cm is dominated by capelin, with herring and euphausiids being next in order of importance. In some areas there are significant amounts of blue whiting and haddock juveniles. For saithe < 40cm, the diet is dominated by euphausiids.

1.3.4 Predation by mammals

The consumption by minke whale (Folkow *et al.* 2000) and by harp seal (Nilssen *et al.* 2000) is given in Table 1.7. These consumption estimates are based on stock size estimates of 85 000 minke whales in the Barents Sea and Norwegian coastal waters (Schweder *et al*., 1997) and of 2 223 000 harp seals in the Barents Sea (ICES 1999/ACFM:7). The consumption by harp seal is calculated both for situations with high and low capelin stock, while the consumption by minke whale is calculated for a situation with a high herring stock and a low capelin stock. It is worth noting that the abundance estimate of harp seals was revised considerably upwards in 1998 (ICES 1999/ACFM:7), which also increased estimates of the consumption by harp seals correspondingly. Food consumption by harp seals and minke whales combined is at about the same level as the food consumption by cod, and the predation by these two species needs to be considered when calculating the mortality of capelin and young herring in the Barents Sea.

In the period 1992-1999, the mean annual consumption of immature herring by minke whales in the southern Barents Sea varied considerably (640 t –118 000 t) (Lindstrøm *et al.* 2002). The major part of the consumed herring belonged to the strong 1991 and 1992 year classes and there was a substantial reduction in the dietary importance of herring to whales after 1995, when a major part of both the 1991 and 1992 year classes migrated out of the Barents Sea. In 1992-1997, minke whales may have consumed 230 000 t and 74 000 t, corresponding to 14.6 billion and 2.8 billion individuals of the herring year classes of 1991 and 1992, respectively. The dietary importance of herring to whales appeared to increase in a non-linear relation with herring abundance.

Conclusions section 1.3:

- The capelin biomass in 2003 is expected to be approximately at the same level as in 2002, which suggests that the decline observed in recent years has been halted.
- The consumption of capelin by cod decreased from 2001 and 2002, according to Norwegian consumption calculations, but increased according to the Russian calculations.
- The consumption of other fish species by cod increased from 2001 to 2002, while the consumption of shrimp, amphipods and krill decreased from 2001 to 2002
- The consumption per cod decreased from 2001 to 2002 according to Norwegian calculations, while Russian calculations showed a stable consumption by cod

1.4 Applications to population models

1.4.1 Recruitment

1.4.1.1 Recruitment models

Predictions of the recruitment in fish stocks are essential for future harvesting of the fish stocks. Traditionally prediction methods have not included effects of climate variability. Multiple linear regression models can be used to incorporate both climate and fish parameters. Especially interesting are the cases where there exists a time lag between the predictor and response variables since this gives the opportunity to make a prediction.

Models (Stiansen *et al*., WD1 and WD8), based on climate and fish parameters, for prediction of recruitment have been given for the 0-group index (with 2-year prognoses) and the number of three-year-old fish for North East Arctic Cod (with 3-year prognoses), for the number of one-year-old fish for Barents Sea capelin (with 1-year prognoses) and for the number of three-year old fish for Norwegian spring spawning herring (with 3-year prognoses) (Table 1.8).

The models are novice, and are still under evaluation in search for better fit and input variables. However, the fit of the models are encouraging, and the models might at present prove useful as background information for stock assessment, and may in the future be incorporated as recruitment models in the assessments.

Borisov and Bulgakova (WD7) give another approach. A new stock-recruitment model are developed, which includes an index of Atlantic inflow. This model together with a new management scheme, are incorporated in a simulation model for NEA cod. This simulation model allows for a three-year prediction of recruits of age 3 (Table 1.8).

The recruitment estimates from XSA/RCT3 and from Fleksibest are also given in Table 1.8. There is good agreement between the different methods concerning the cod recruitment at age 3 in 2003 and 2005, while for 2004; RCT3 gives a much lower value than two other methods. It was decided to use the 'traditional' RCT3 estimates in the predictions of cod recruitment.

1.4.1.2 UV-radiation and other climatic effects on cod and Calanus

During the springtime of 2000 and 2001, a series of in situ experiments were performed in order to study whether solar ultraviolet (UV) radiation (280-400 nm) can affect early life stages of NEA cod and *Calanus finmarchicus,* and therefore their recruitment (see http://phaeocystis.nfh.uit.no/uvac/ for annual reports and additional information). The experiments took place in the Vestfjord area (Lofoten Islands, Norway), one of the main spawning sites of northeast arctic cod.

It was found that, when incubated at fixed depths of 15 and 50 cm, up to 40% of eggs died or did not hatch after 7-10 days as a result of the negative influence of UV for both cod and *Calanus finmarchicus*. Buoyancy of cod eggs and fitness of yolk-sac larvae was also affected. However, this deleterious impact was mainly observed when incubations were run late in the springtime or in experimental conditions of extremely transparent waters. Since the peak of spawning lies around late March for *Calanus finmarchicus* and mid April for cod, it seems reasonable to think that most of the egg population is not therefore exposed to lethal UV doses. Additionally, seawater in the fjords is typically loaded with organic matter from snow melting, a process most remarkable late in the springtime, which partially blocks the penetration of UV light into surface waters. Finally, planktonic organisms with low mobility such as eggs and larvae are subject to the turbulent forces operating in the mixed layer and consequently they do not stay at fixed depths for prolonged periods. This can provide them with extra protection regarding UV exposure.

However, given the predictions of further ozone depletion and presumably higher UVB values, we can not rule out the possibility that episodes of low stratospheric ozone thickness, clear skies and low wind speed might provoke high mortalities in the egg and larval population.

The statistical analysis of long-term data series of UVB doses and *Calanus finmarchicus* recruitment indicates a negative correlation between these two variables, whereas the correlation is positive for cod recruitment. This implies a contradiction between short and long-term effects so that the impact of solar UV light on cod is not a straightforward one, but rather acting indirectly. The mechanisms involved in this process are yet a matter of speculation.

Regarding the influences of other physical parameters on *Calanus* abundance, Principal Component Analysis (PCA) of the historical data shows that *C. hyperboreus* seems to be related more closely to variables acting "locally" such as temperature and turbulence while *C. finmarchicus* is more influenced by "global" processes such as NAO and AO index. This trend was consistent both for two different periods (abundance in February and October) and for two fjords (Mistfjord and Saltfjord).

In the case of cod, oceanographic-meteorological factors appear to influence recruitment (considered as 0-group abundance) strongly, with 50-73% of the variability being explained by Gulf Stream Index (GSI), turbulence and the NAO index (two years earlier).

As a conclusion, this indicates a connection between environmental forcing and zooplankton response acting at different levels of the biological production process and which can determine the success of cod recruitment.

Conclusions sections 1.4.1:

- The 0-group index of NEA cod is expected to decrease in 2003, before increasing in 2004 to approximately the same medium level as in 2002.
- All recruitment models show that the number of recruits (age 3) of NEA cod in 2003 and 2005 is expected to be above average. The models that include climatic variables indicate the recruitment at age 3 in 2004 to be slightly above average, while the RCT3 method, which is based only on survey indices indicate a recruitment of about 50% of the average level in this year. The assessment used the ‘traditional’ RCT3 method to predict recruitment also in this year’s assessment.
- The number of recruits (age 1) of Barents Sea capelin is expected to be at a medium level in 2003.
- The number of recruits (age 3) of Norwegian spring spawning herring is expected to be at a medium level in 2003 and 2004, and increase moderately in 2005.
- Exposure to solar UV radiation significantly affects the survival of *Calanus finmarchicus* and NEA cod eggs (up to 40% mortality) when incubated at fixed depths. However, only periods of 7-10 days of low wind speed, clear skies and low ozone thickness would provoke such high mortalities.
- Investigations on historical climatic and oceanic data series indicate that their fluctuations account for 53-73% of the observed variability of 0-group abundance of NEA cod.

1.4.2 Growth

1.4.2.1 Prediction of NEA cod growth rate

The prognosis of cod growth in the Barents Sea was performed by the STOCOBAR model. The model is used to calculate mean weight of fish at age 2-10 years in the beginning of the year on the basis of feeding conditions in the previous year (Filin, AFWG 2002, WD6). Model parameters were estimated by historical data for 1984-2000 using stomach data from the Russian-Norwegian database, mean annual temperature data in the Kola Section, estimated biomass of capelin and data on abundance and mean weight-at-age from the AFWG 2002 assessment.

The prognosis of cod growth rate is done for a five-year period, from 2001 to 2005 (Filin, WD12). In the prognosis the forecasts of mean annual temperature in the Kola Section for 2002-2004 was used as input data (Figure1.3), together with the prognosis of capelin biomass (Table 1.2) and mean weight-at-age of cod of age one in 2003 and 2004. The simulated growth rates for cod at age 3-8 years are presented in Figure 1.6.

According to the prognosis, cod growth rate in 2002 will not differ notably from that observed in 2001. Consequently, mean weight of cod at the beginning of 2003 is expected to be close to the corresponding data for 2002. This is in agreement with the observations of weight-at-age in late 2002/early 2003 (Table A7 and A13). Simulations showed that in the beginning of 2004-2005, mean weight of cod at age 3-5 is expected to decrease, which can be explained by the forecasted colder water and capelin stock decline in the Barents Sea. In older fish, no significant reduction in growth rates is expected in 2003-2004 as compared to 2002. This appears to be the result of a rather high growth rate in the preceding years. The predictions used in the assessment, which assume growth increments for each cohort to be equal to the mean for the recent 8 years (Section 3.3.8), give stable values for weight-at-age for all age groups.

1.4.2.2 Predicting condition of NEA cod

For many ICES stocks weight-at-age (W_a) is the only metric of body size that is routinely reported. However, W_a combines two distinct components of body size, namely length-at-age (L_a) and condition (i.e., W_l), into a single value. Thus, it is not possible to assess the degree of interannual variation in condition from a time-series of W_a. Provided that the W_a values are based on observed values (and not derived using a fixed weight/length relationship) then it is possible to disaggregate the W_a time-series into its two constituent parts as described below for Northeast Arctic cod.

Estimates of L_a were obtained from both Norwegian and Russian age/length keys compiled for each year (see Marshall and Needle, WD3). These were then paired with the corresponding Norwegian and Russian estimates of W_a (ICES 2001/ACFM:19) to construct the bivariate weight/length relationship for each year (Figure 1.7). The fitted weight/length relationships were used to generate a time-series of $\hat{W}_l$ for standard lengths of 30 to 120 cm (Figure 1.8). These show that there are differences in the long-term trends exhibited by small cod (< 60 cm) compared to larger cod (> 70 cm). For the smaller length-classes, current values of $\hat{W}_l$ are not significantly different from the post-war values, suggesting that there has been no long-term change in condition (Figure 1.8). However, for cod 70 cm and larger the current values of $\hat{W}_l$ are significantly higher than the post-war values (Figure 1.8). The magnitude of the differences in $\hat{W}_l$ is considerable (i.e, current values of $\hat{W}_l$ are approximately 25% higher than post-war values). In addition to the obvious implications for higher yields, fish that are heavier for their length will mature earlier and be more fecund.

The time-series for $\hat{W}_l$ for a 70 cm cod (Figure 1.8) and the annual mean liver condition index for cod in the 61-70 cm length class ($\overline{LCI}_{61\text{-}70}$; see Yaragina and Marshall 2000) were multiplied to derive estimates of the liver weight at 70cm. A bivariate plot of the $\hat{W}_{70}$ versus capelin stock biomass shows that there is no significant correlation ($n = 50$, $p = 0.66$, $r^2 < 0.01$) between these two variables (Figure 1.9a). However, there is a significant, positive correlation between $\overline{LCI}_{61\text{-}70}$ and capelin stock biomass ($n = 54$, $p < 0.001$, $r^2 = 0.44$; Figure 1.9b). Because of this correlation, there is also a significant, positive correlation between liver weight of a 70 cm cod and capelin stock biomass ($n = 50$, $p < 0.001$, $r^2 = 0.24$; Figure 1.9c). This implies that $\hat{W}_l$ may be an insensitive index of condition compared to liver weight observations.

In principle, the empirical relationships shown in Figures 1.9b and 1.9c could be used to forecast liver condition (on either absolute or relative scales) in the upcoming year using projected values of capelin stock biomass that are currently being provided to the AFWG (see Section 1.3.1). The lack of a significant correlation between $\hat{W}_l$ and capelin stock biomass suggests that it may not be possible to forecast $\hat{W}_l$ from capelin stock biomass alone.

Conclusions section 1.4.2:

- Mean weight of 3-4-year-old cod in the beginning of 2004-2005 is expected to be below the long-term mean. For the 6-7-year-old cod the mean weight is expected to exceed the long-term mean, while age 8 years and older are expected to be close to the long-term mean. The predictions used in the assessment assume stable weights-at-age for this period.

- Large cod (> 70 cm) show a long-term increase in weight-at-length, whereas, smaller cod have shown no overall long-term trend.

- Weight-at-length is uncorrelated with capelin stock biomass, whereas, liver weights show a positive correlation. Thus, assessing the degree of interannual variation in condition requires routine monitoring of liver weights, such as has been done by Russia since 1927.

1.4.3 Cannibalism mortality

The estimates of consumption by cod provided in Section 1.3.2, together with the prediction of capelin biomass given in Section 1.3.1, provide the necessary background for predicting the mortality of young cod and haddock resulting from predation by cod. The mortality due to cod cannibalism seems to be inversely related to capelin abundance (Figure 3.2a), and attempts have been made to model this relationship (ICES 2001/ACFM:19). Such modeling work should be continued. Since the capelin stock in 2003 is predicted to be at approximately the same level as in 2002, the mortality due to cod cannibalism is assumed to be the same in 2003 and later years as in 2002 (Section 3.3.8).

Table 1.1 Capelin stock history from 1984, and prognosis for capelin biomass in 2003. M output biomass is the estimated biomass of the capelin removed from the stock by natural mortality.

Year	Total stock number, billions (Oct. 1)	Total stock biomass in 1000 tonnes (Oct. 1)	M output biomass (MOB) during year (1000 tonnes)
1984	393	2964	3151
1985	109	860	1975
1986	14	120	681
1987	39	101	200
1988	50	428	80
1989	209	864	537
1990	894	5831	415
1991	1016	7287	3307
1992	678	5150	7745
1993	75	796	4631
1994	28	199	982
1995	17	194	163
1996	96	503	261
1997	140	909	828
1998	263	2056	915
1999	285	2775	2070
2000	595	4373	2464
2001	364	3630	3906
2002	201	2210	2666
2003*	240	1990	

* Estimate, includes the 2002 year class, which size is estimated from a regression on an 0-group index

Table 1.2 Capelin one-year prognoses compared with survey estimates (in million tonnes).

Year	Prognosis (1+ capelin biomass) Available at AFWG in this year	Survey estimate (1+ capelin biomass)
1999	4.0	2.8
2000	3.8	4.3
2001	4.1	3.6
2002	3.4	2.2

Table 1.3 The Northeast arctic COD stock's consumption of various prey species in 1984-2002 (1000 tonnes), based on Norwegian consumption calculations.

Year	Other	Amphipods	Krill	Shrimp	Capelin	Herring	Polar cod	Cod	Haddock	Redfish	G. halibut	Blue whiting	Total
1984	506	27	112	436	722	78	15	22	50	364	0	0	2332
1985	1157	169	57	155	1619	183	3	32	47	225	0	1	3649
1986	665	1223	108	142	835	133	141	83	110	313	0	0	3754
1987	680	1084	67	191	229	32	205	25	4	324	1	0	2843
1988	407	1236	317	129	339	8	92	9	3	223	0	4	2767
1989	725	800	241	132	580	3	32	8	10	232	0	0	2765
1990	1447	136	83	194	1593	7	6	19	15	243	0	85	3829
1991	1076	65	75	188	2902	8	12	26	20	312	7	10	4702
1992	1014	102	157	373	2455	331	97	54	106	189	20	2	4900
1993	782	252	713	315	3041	164	278	285	71	100	2	2	6004
1994	668	561	702	516	1084	147	581	225	49	79	0	1	4613
1995	854	980	514	362	627	115	253	392	116	194	1	0	4408
1996	640	633	1160	341	536	47	104	534	68	96	0	10	4171
1997	438	391	529	311	906	5	112	340	41	36	0	55	3164
1998	428	365	466	325	714	88	151	153	32	9	0	13	2743
1999	387	148	275	256	1747	133	226	62	26	16	1	31	3308
2000	409	170	463	459	1767	54	198	76	52	7	0	38	3693
2001	733	178	377	283	1744	71	256	63	50	6	1	154	3916
2002	452	101	367	186	1184	141	323	106	183	0	0	277	3322

Table 1.4 The Northeast arctic COD stock's consumption of various prey species in 1984-2002 (1000 tonnes), based on Russian consumption calculations.

Year	Other	Amphipods	Krill	Shrimp	Capelin	Herring	Polar cod	Cod	Haddock	Redfish	G. halibut	Blue whiting	Total
1984	536	14	44	277	546	22	8	13	45	130	0	4	1639
1985	701	238	18	172	922	22	0	103	25	69	0	17	2287
1986	602	489	40	114	760	39	88	32	109	115	1	5	2393
1987	539	295	44	179	160	7	67	33	2	95	0	12	1433
1988	585	99	137	100	251	14	0	16	100	96	0	0	1397
1989	518	188	118	84	663	3	21	21	2	117	0	0	1735
1990	412	17	53	194	1150	52	5	20	15	162	0	36	2117
1991	370	52	33	210	3475	30	33	53	23	112	4	7	4401
1992	940	19	146	206	1698	428	89	66	42	100	1	0	3734
1993	807	100	83	162	2496	190	104	139	165	32	6	4	4288
1994	604	145	291	309	1265	96	247	305	74	47	0	2	3384
1995	875	271	301	371	611	212	111	436	132	98	3	0	3421
1996	656	235	734	163	499	99	53	447	71	66	0	7	3030
1997	515	85	386	207	527	56	83	409	33	37	3	3	2343
1998	493	115	379	206	657	67	80	148	23	18	0	25	2211
1999	275	43	263	192	1264	64	82	56	13	13	1	26	2291
2000	334	69	248	269	1437	46	85	60	24	4	0	22	2600
2001	486	47	246	246	1393	85	89	60	46	3	3	120	2822
2002	356	12	233	157	1687	39	167	114	146	4	0	122	3037

Table 1.5 Consumption per cod by cod age group (kg/year), based on Norwegian consumption calculations.

Year/Age	1	2	3	4	5	6	7	8	9	10	11+
1984	0.247	0.814	1.686	2.527	3.953	5.213	8.037	8.554	9.213	9.947	10.019
1985	0.304	0.761	1.833	3.111	4.678	7.364	11.305	12.033	12.562	13.822	13.936
1986	0.161	0.489	1.349	3.168	5.628	6.834	11.062	11.978	12.787	13.553	13.785
1987	0.219	0.601	1.275	2.055	3.538	5.466	7.044	8.112	8.923	9.344	9.296
1988	0.164	0.703	1.149	2.149	3.745	5.880	10.103	11.226	12.579	13.131	13.355
1989	0.223	0.716	1.611	2.720	3.987	5.621	7.706	8.527	9.630	10.231	10.678
1990	0.397	1.058	2.072	3.697	4.954	5.837	8.572	9.516	10.538	10.802	11.399
1991	0.293	0.974	2.185	3.565	5.346	7.113	9.531	10.303	11.364	12.417	12.059
1992	0.216	0.662	2.103	3.137	4.142	5.094	7.898	9.071	9.440	9.943	10.212
1993	0.112	0.526	1.544	3.045	4.810	6.289	9.424	11.287	11.814	12.303	11.957
1994	0.130	0.407	0.922	2.520	3.512	4.540	6.412	8.923	9.731	10.038	10.236
1995	0.103	0.297	0.922	1.802	3.362	5.272	7.734	10.459	12.411	12.816	13.260
1996	0.108	0.355	0.931	1.849	3.055	4.437	7.426	11.255	15.010	15.207	15.590
1997	0.138	0.311	0.935	1.768	2.694	3.539	5.242	8.222	12.757	13.667	13.282
1998	0.117	0.398	0.985	1.940	2.924	4.189	5.749	8.078	11.573	12.099	12.157
1999	0.163	0.505	1.093	2.717	3.721	5.162	6.987	9.125	11.234	12.079	12.135
2000	0.157	0.501	1.238	2.467	4.262	5.651	7.711	9.391	12.695	13.683	13.839
2001	0.171	0.460	1.230	2.426	3.722	5.227	7.298	10.910	13.480	14.531	14.700
2002	0.176	0.549	1.032	2.027	3.012	4.219	5.528	7.916	9.923	10.660	10.747

Table 1.6 Consumption per cod by cod age group (kg/year), based on Russian consumption calculations.

Year/Age	1	2	3	4	5	6	7	8	9	10	11	12	13+
1984	0.143	0.631	1.111	2.666	3.863	6.056	8.070	10.449	14.301	17.847	21.440	25.148	30.208
1985	0.127	0.573	1.192	2.336	4.036	7.181	9.895	13.839	18.254	24.072	33.991	25.809	31.905
1986	0.084	0.393	0.938	2.710	4.445	6.490	7.982	11.816	13.445	13.956	22.323	22.019	27.573
1987	0.065	0.246	0.469	1.182	2.890	4.467	8.730	12.496	15.760	22.749	31.785	26.061	33.419
1988	0.108	0.454	0.676	1.222	2.125	4.946	9.113	12.933	17.699	31.666	29.716	28.873	22.496
1989	0.100	0.621	0.971	1.672	2.767	4.734	7.570	12.092	18.200	29.092	27.509	31.944	24.690
1990	0.158	0.639	1.223	2.077	2.931	3.915	6.320	8.751	11.536	19.307	22.170	26.846	33.213
1991	0.117	0.641	2.084	4.363	6.510	9.194	12.131	15.742	21.272	33.258	29.318	33.661	43.774
1992	0.096	0.615	1.591	2.829	4.147	6.326	8.979	11.379	13.063	20.539	26.593	23.213	29.229
1993	0.061	0.292	1.077	2.921	4.249	6.169	9.823	12.664	15.049	19.050	20.561	24.118	28.646
1994	0.083	0.315	0.675	1.903	3.403	6.115	9.786	13.058	15.973	18.383	19.539	26.140	30.728
1995	0.089	0.306	0.588	1.475	3.598	6.895	11.199	15.596	20.948	26.682	29.550	31.744	37.235
1996	0.087	0.326	0.663	1.517	2.965	5.326	9.318	15.851	20.723	26.787	28.132	28.606	33.310
1997	0.066	0.266	0.737	1.728	2.873	4.383	7.567	13.674	26.353	40.331	36.182	36.016	44.404
1998	0.107	0.404	0.735	1.805	3.213	5.219	7.837	11.560	17.608	26.501	30.002	27.728	35.512
1999	0.111	0.335	0.702	2.080	4.183	7.058	9.923	13.588	17.179	29.047	30.772	30.687	38.739
2000	0.083	0.406	0.806	2.016	4.678	7.809	11.889	16.042	18.698	26.431	31.089	34.377	44.041
2001	0.080	0.360	0.917	1.872	3.897	7.820	10.508	18.214	20.210	29.856	36.909	35.597	47.083
2002	0.112	0.397	0.911	1.791	3.650	6.981	11.114	17.672	19.670	29.058	35.923	34.646	45.825

Table 1.7. Consumption by minke whale and harp seal (thousand tonnes). The figures for minke whales are based on data from 1992-1995, while the figures for harp seals are based on data for 1990-1996.

Prey	Minke whale consumption	Harp seal consumption (low capelin stock)	Harp seal consumption (high capelin stock)
Capelin	142	23	812
Herring	633	394	213
Cod	256	298	101
Haddock	128	47	[1]
Krill	602	550	605
Amphipods	0	304	313[2]
Shrimp	0	[1]	[1]
Polar cod	[1]	880	608
Other fish	55	622	406
Other crustaceans	0	356	312
Total	1817	3491	3371

[1] the prey species is included in the relevant 'other' group for this predator.
[2] only Parathemisto

Table 1.8 Overview of recruitment models prognoses together with the 2003 assessment estimates. Models A-C is from WD1, model D from WD8 and model E from WD7. The model F is similar to model D, with the exception that for the survey index two year olds are used instead of one year olds. The two last rows are the NEA cod recruitment estimates from the 2003 assessments by XSA and Fleksibest (Section 3.5.2 and 3.10.4). The given month in the fifth column indicate when the prognoses can be extended for another year.

	Species	**Variable**	**Prognoses year**	**Prognoses available**	**2003 Prognoses**	**2004 Prognoses**	**2005 Prognoses**
A	NEA cod	0-group, log (age 0)	2	November	0.57	1.32	X
B	Barents Sea capelin	Recruits (age 1)	1	November	$1.7*10^{11}$	X	X
C	Norwegian spring spawning herring	Recruits (age 3)	3	November	$3.5*10^{9}$	$3.3*10^{9}$	$9.2*10^{9}$
D	NEA cod	Recruits (age 3)	2 (3 [1])	November (March [1])	$789*10^{6}$	$678*10^{6}$	$827*10^{6}$ [1]
E	NEA cod	Recruits (age 3)	3	Before assessment	$774*10^{6}$	$784*10^{6}$	$811*10^{6}$
F	NEA cod	Recruits (age 3)			$816*10^{6}$	$595*10^{6}$	X
XSA/RCT3 Assessment 2003	NEA cod	Recruits (age 3)	3	At assessment	$681*10^{6}$	$308*10^{6}$	$664*10^{6}$
Fleksibest Assessment 2003	NEA cod	Recruits (age 3)	1	At assessment	$908*10^{6}$	X	X

[1] For the prognosis of NEA cod recruitment (model D) in 2005 a prognosis of mature capelin biomass (1.17 mill tonnes) is used (Section 1.3.1), thereby allowing for a three-year prognosis.

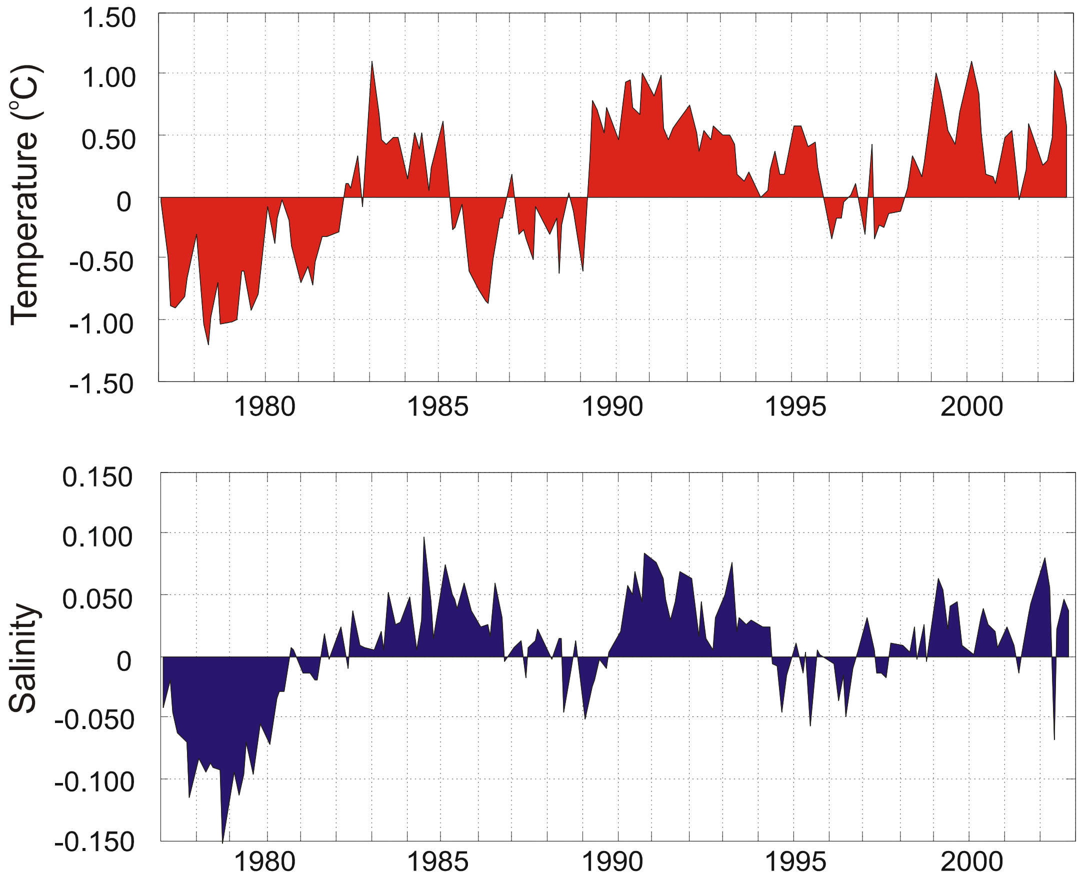

Figure 1.1 Temperature anomalies (upper panel) and salinity anomalies (lower panel) in the section Fugløya – Bear Island (Asplin and Dahl, 2003).

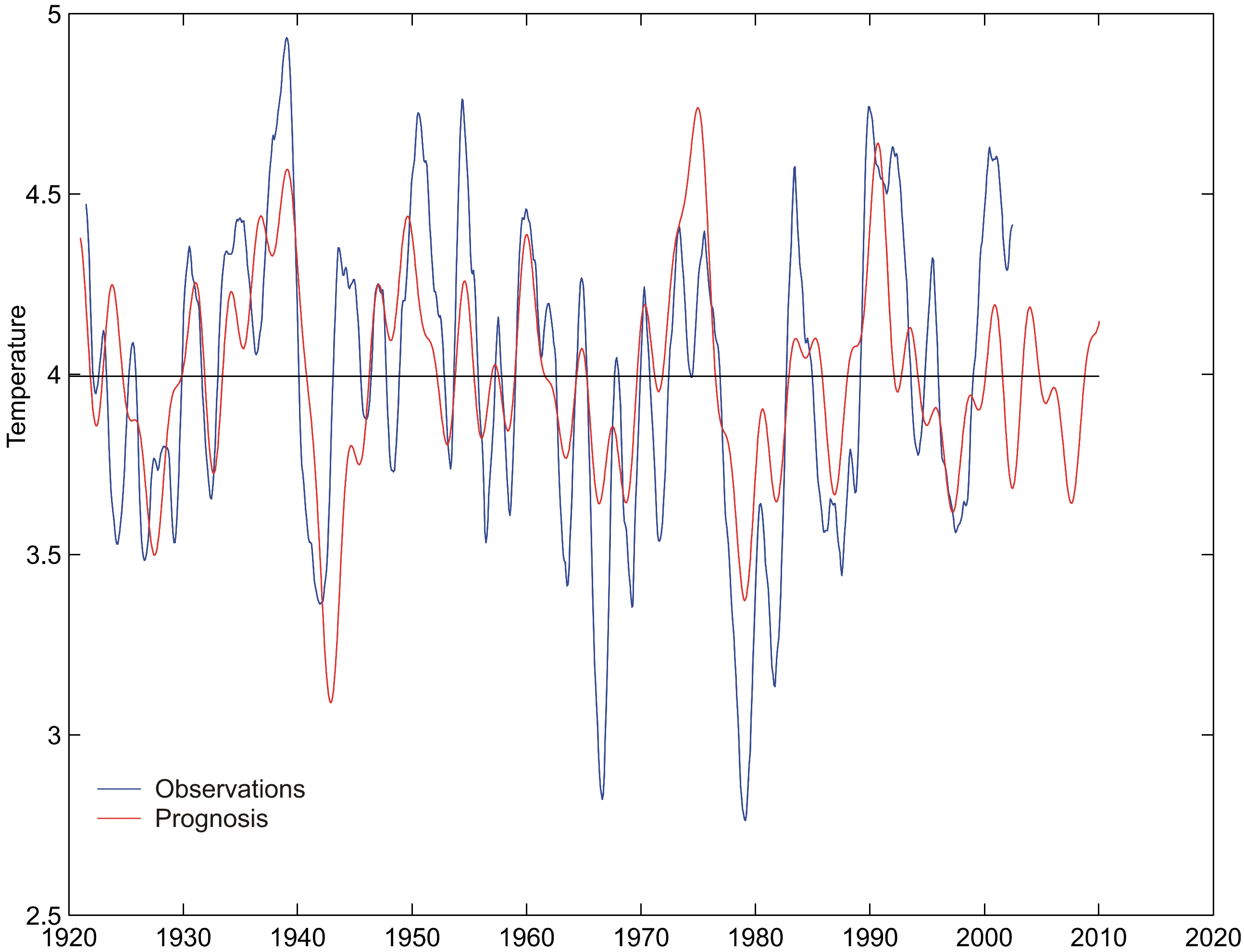

Figure 1.2. Observed (thin blue line) and modeled (thick red line) development of the temperature in the Kola-section and temperature prognosis to 2010 (Asplin and Dahl, 2003)

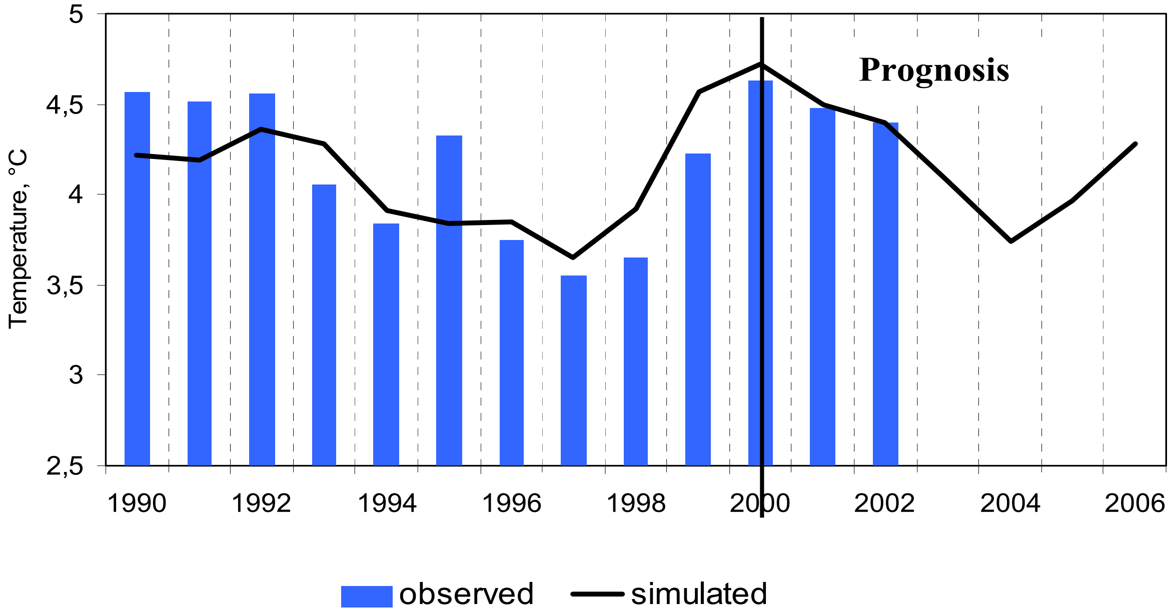

Figure 1.3 Forecast of water temperature in the 0-200 m layer of the Kola Section for 2001-2006 made by A.Korsakov (PINRO) on the basis of analyses of frequency structure of the time-series.

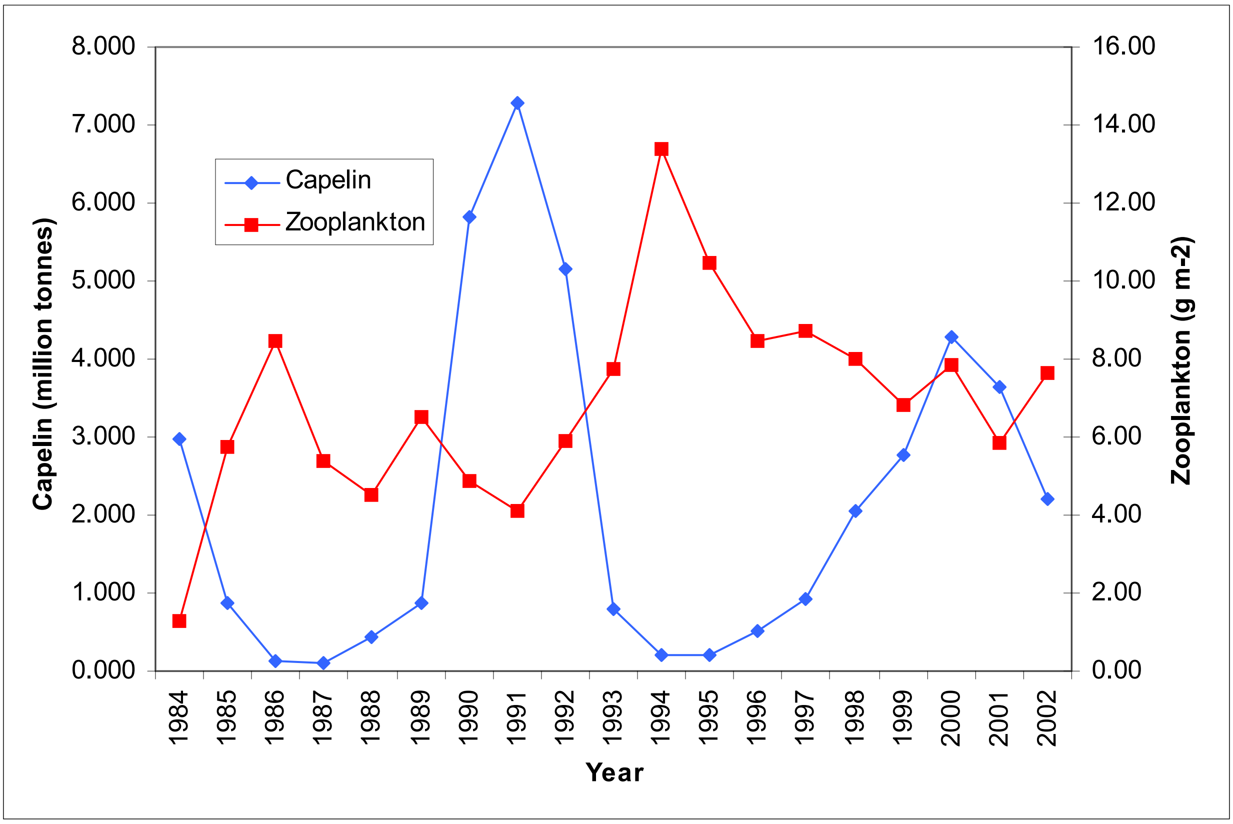

Figure 1.4. Average zooplankton biomass (g m^{-2}) together with biomass of one year old and older capelin (million tonnes) during 1984 – 2002, in the Barents Sea (from Dalpadado *et al.* 2002, updated with data for 2001-2002).

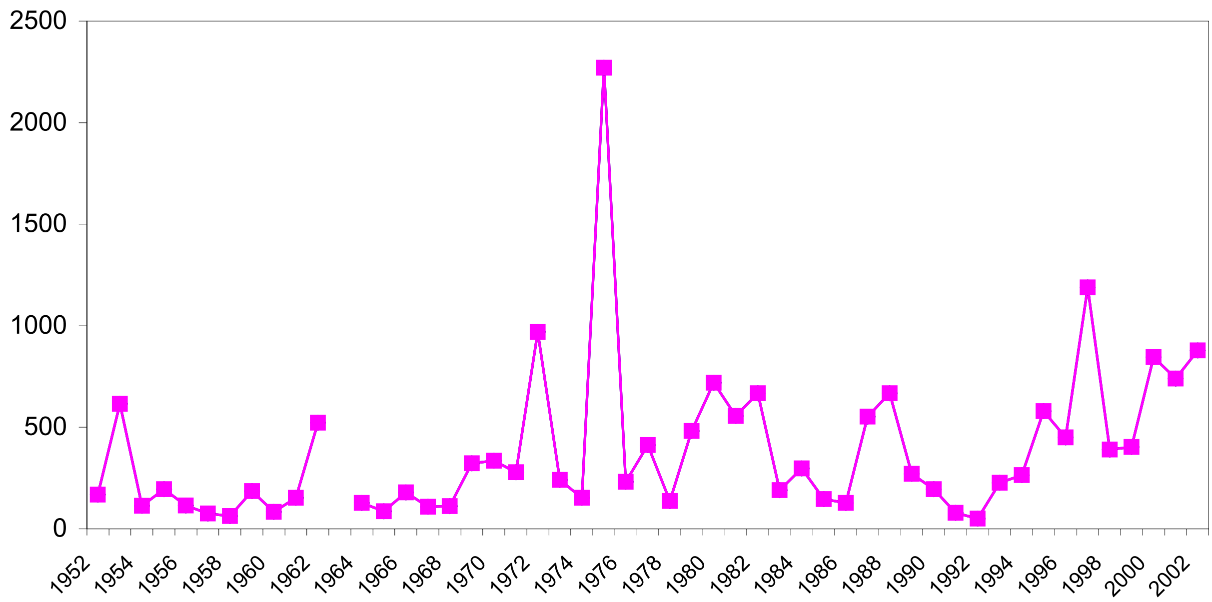

Figure 1.5 Dynamics of index of euphausiids abundance (ind./1000 m^3) in 1952-2002

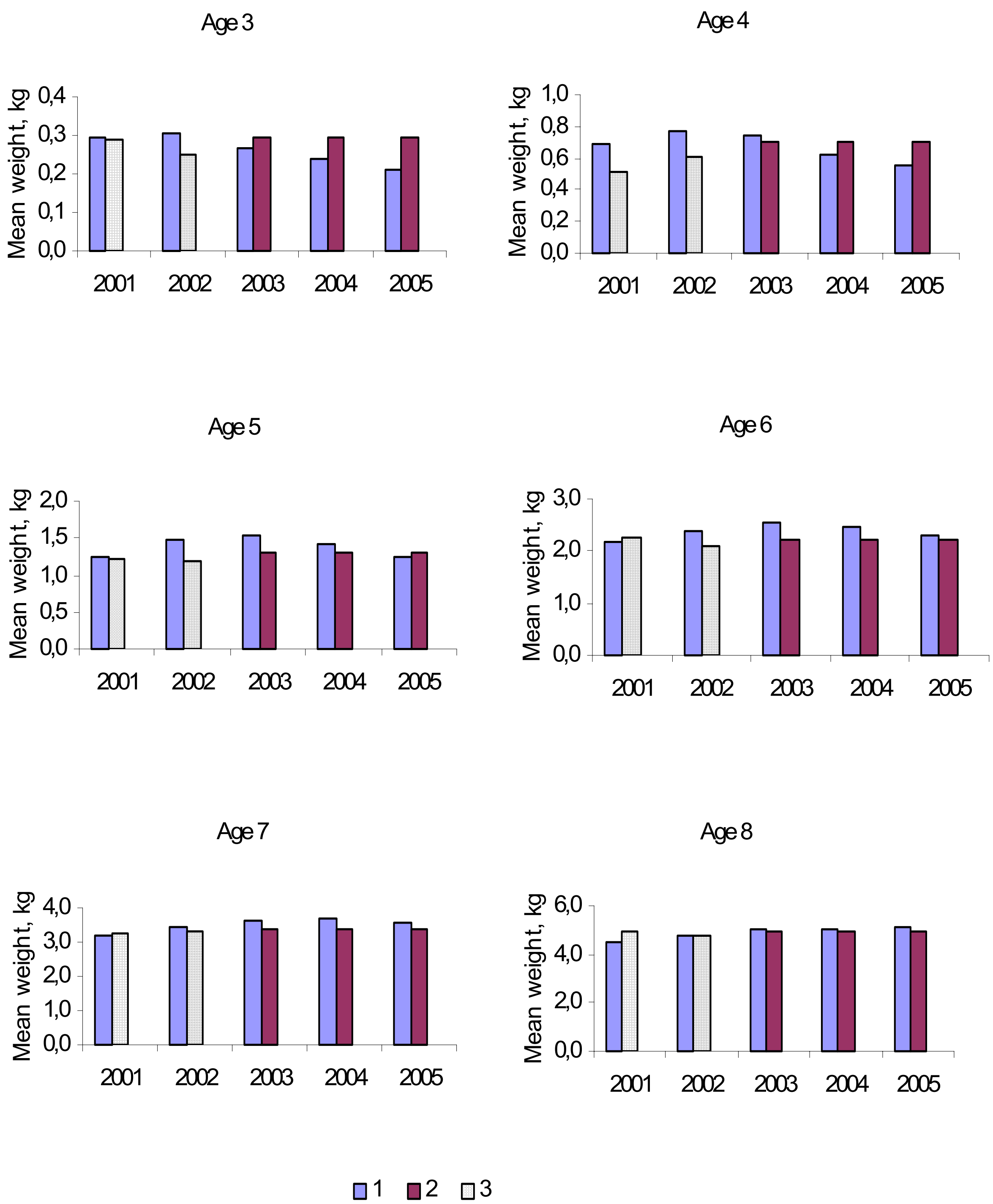

Figure 1.6. Prognoses of mean weight of cod as for the beginning of the year (starting year 2000). Blue bars (1) are modeled, red bars (2) are long-term means (1984-2001) and white dotted bars (3) are observed.

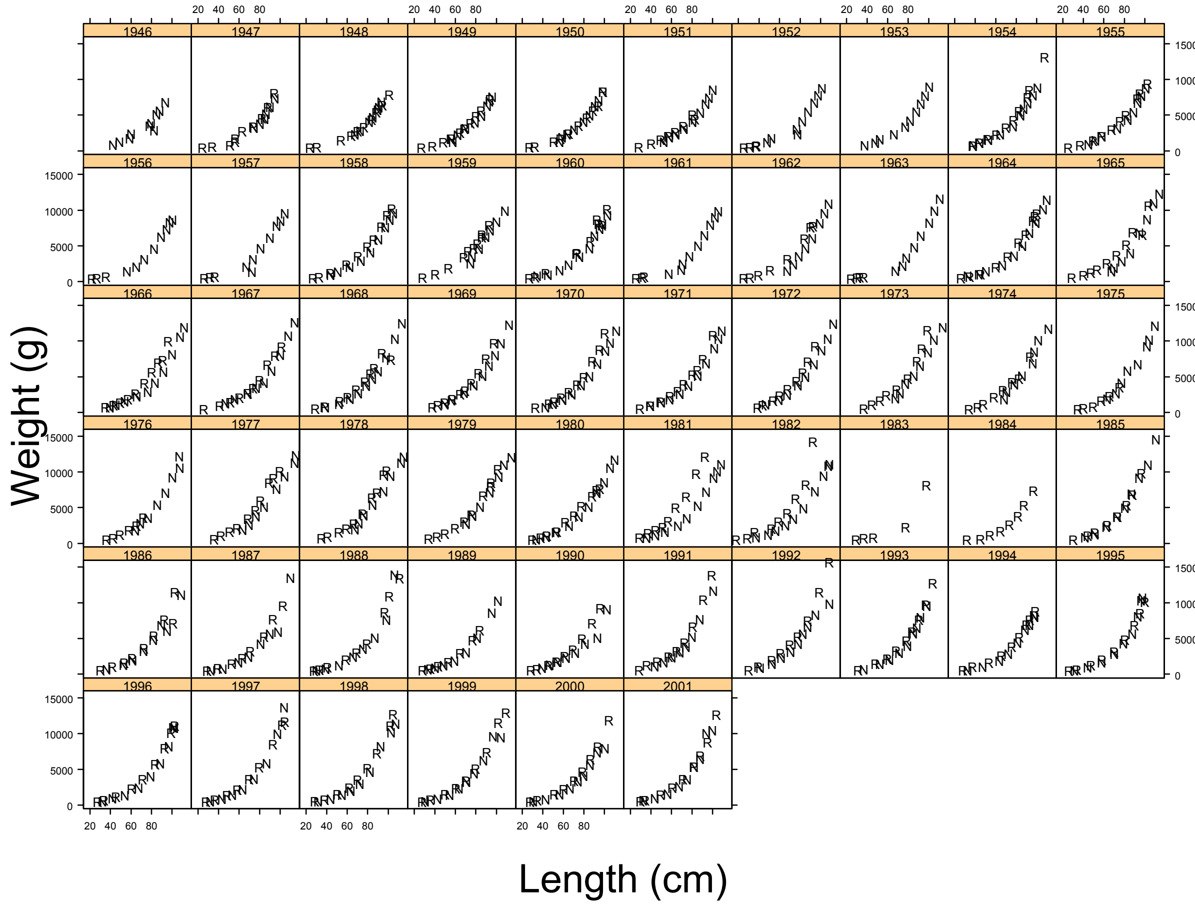

Figure 1.7. A scatterplot matrix showing the relationship between length and weight of cod (all ages combined) for Norwegian (N) and Russian (R) data for the years 1946 to 2001.

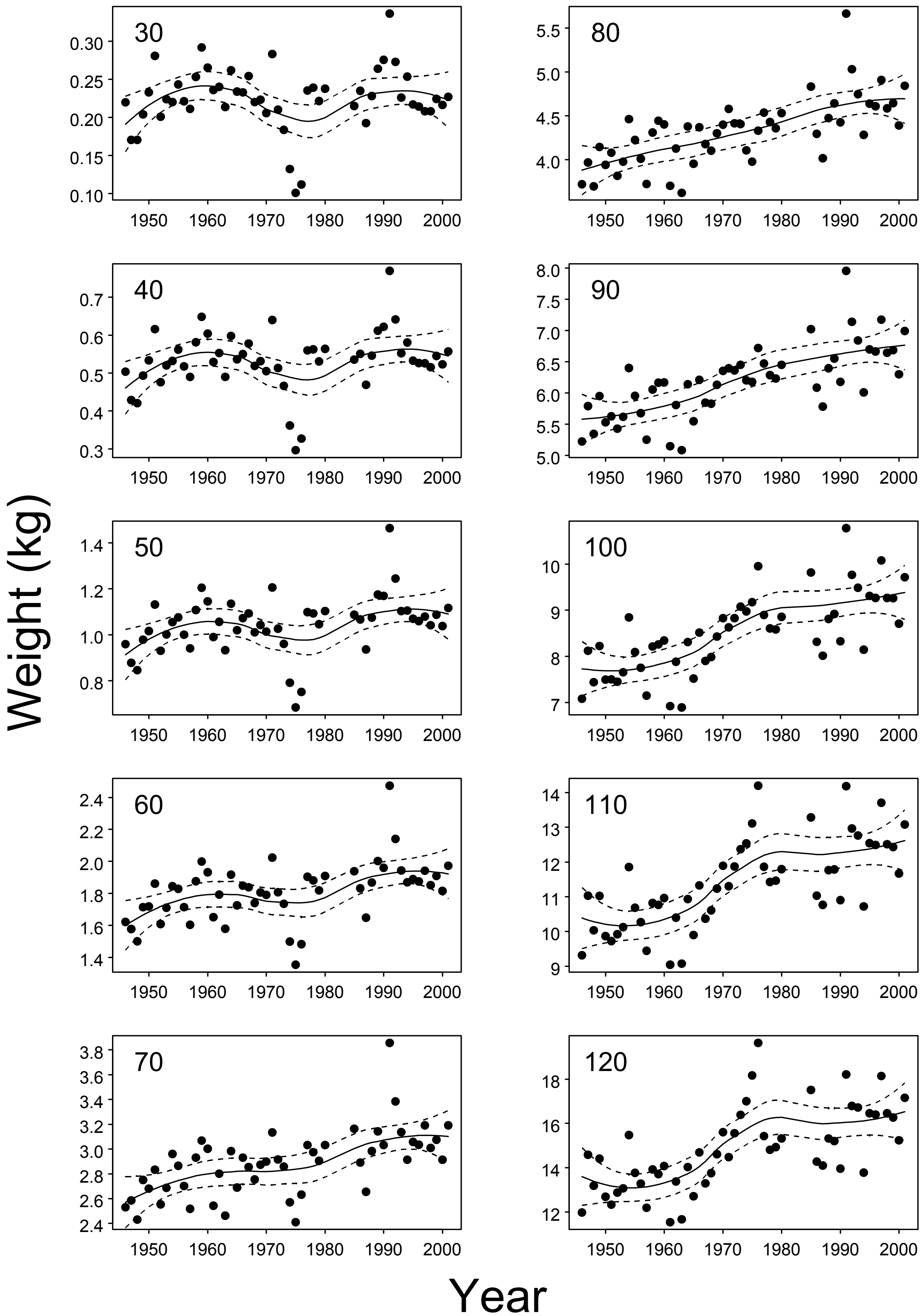

Figure 1.8. Predicted weight-at-length values for a cod of standard lengths ranging (10 cm intervals) from 30 to 120 cm (length given in upper left corner of the plot). The LOESS smoother (solid line) and approximate 95% confidence intervals (dotted lines) are also indicated.

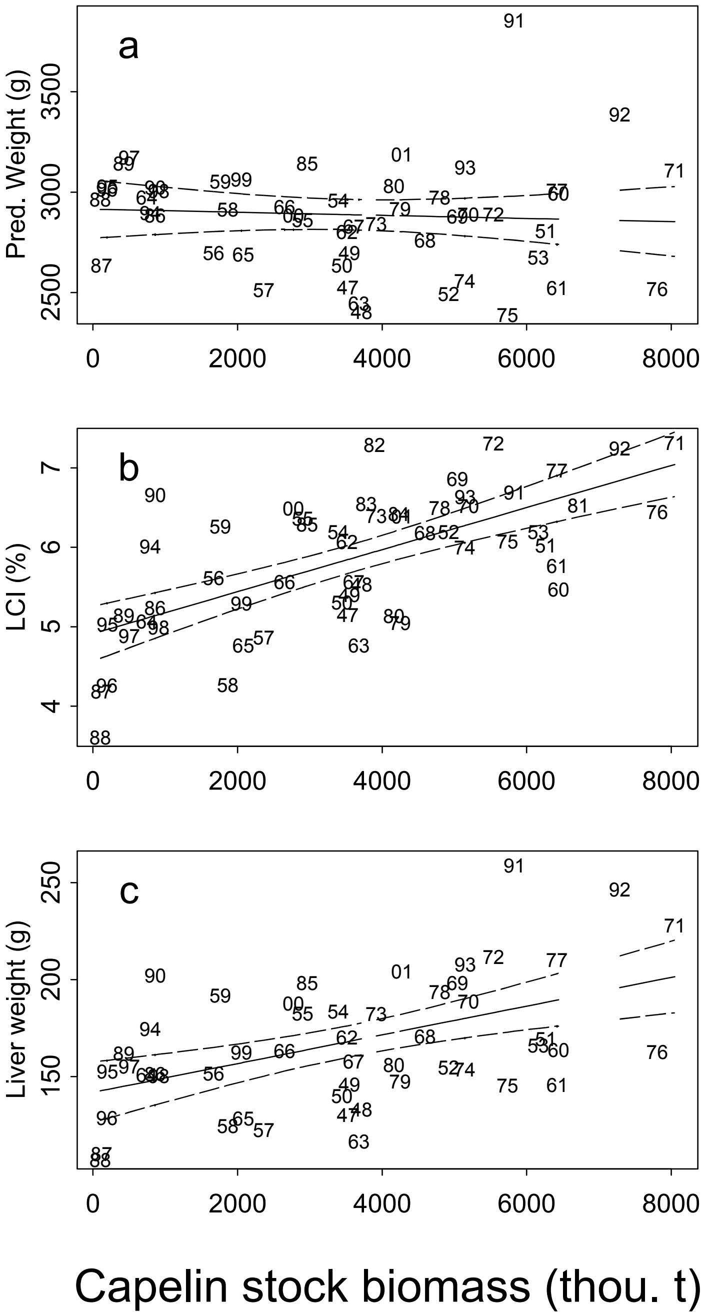

Figure 1.9. Bivariate relationships between capelin stock biomass (thousand t) and a) predicted weight of cod at 70 cm (g); b) liver condition index of the 61-70 cm length class of cod (%); and c) estimated liver weight of cod at 70 cm (g). Observations are denoted by year. Solid line indicates the least squares model fit and dashed lines indicate approximate 95% confidence intervals for the estimate.

2 NORWEGIAN COASTAL COD IN SUBAREAS I AND II

2.1 Status of the Fisheries

2.1.1 Landings prior to 2003 (Table 2.9, Figure 2.2)

The catches of Norwegian Coastal cod (NCC) have been calculated back to 1984. During this period the catches have been between 25,000 and 75,000 t. The estimated landings of NCC in 2001 reported to the Working Group is 29,699 t and the provisional figure for 2002 is 40,994 t (Table 2.9, Figure 2.2).

The landings in 2002 increased compared with 2001 despite a reduction in the stock. Vessels smaller than 15 meters over fished their total cod quotas by approximately 18,000 tonnes. This fleet therefore had a substantial increase in the fishing effort in 2002. Since these vessels take a major part of their cod quotas in fjords and near the coast, the increased landings in 2002 were therefore located to the fjords. In this area the proportion of NCC is high and might explain the increased landings of coastal cod. The cod catches inside the 12 n.mile zone was separated to type of cod by the structure of the otoliths. A total of 12,204 otoliths were collected from the commercial catches (Table 2.1.A) and separated into quarter of catch and fishing gear. Approximately 21 % of the otoliths were classified as coastal cod.

2.1.2 Expected landings in 2003

During winter/spring the amount of Northeast Arctic cod at spawning migration at the Norwegian coast was large (Mehl et al., WD 21) and hence the accessibility for the fishermen, and most of the vessels quotas were therefore taken. However, new regulations in 2003 in Norway instructs the vessels to fish at least 25% of their quotas in the autumn. Most of the cod caught in the autumn is supposed to be Norwegian coastal cod. This makes it difficult to estimate the landings in 2003. The working group therefore assume a status quo fishing mortality in 2003, which will result in landings of 27,269 tonnes using the same exploitation pattern as in the period 2000-2002, scaled to the 2002 level.

2.2 Status of Research

2.2.1 Survey results (Tables 2.1.B, 2.2, 2.3, 2.4, 2.7)

A Norwegian trawl-acoustic survey was conducted along the coast from Varanger to Stad in October-November 2002 using RV Jan Mayen. In 2002 the survey covered the same areas as the coastal surveys in 1995-2001.

The trawl-acoustic coastal survey in 2002 estimated a total survey biomass of NCC of about 41,000 t (26 million fish) for the coastal area from Varanger to Stad at 62^{o} N (Tables 2.1.B, 2.2, 2.7). The spawning biomass accounted for 26,000 t (9 million fish) of the total (Tables 2.3, 2.4). More than seventy percent of the total coastal biomass was distributed from the Russian border to 67^{o} N and 25% south of 67^{o} N (Norwegian statistical areas 06 and 07). The bulk of the biomass was comprised of ages 3-7 (Table 2.2).

The data indicated a higher proportion of NCC in the fjords and to the south compared with the northern and outer areas. In the Norwegian statistical areas 06 and 07 (south of 67^{o} N) nearly all otoliths collected were of the NCC type, which is similar to the results of the 1995-2001 surveys.

The numbers of NCC per age groups from all the coastal surveys is given in Table 2.7. The total numbers decreased in 2002 compared with the 2001 survey. For age groups below 6 year the biomass and numbers decreased considerably from 2001 to 2002.

The Norwegian 2003 coastal survey (October-November) will be conducted in a similar way as the previous ones to further extend the time-series for NCC over its distribution area.

2.2.2 Age reading and stock separation

Age readings of the cod both from the surveys and from the catches, are done the same way as for the NEAC. A total of 2086 cod otoliths were sampled during the 2002 survey. These were separated into NCC type (1175) and NEAC (911). As in previous years, NCC was found throughout the survey area. The 2002 survey data shows the same pattern as the 1995-2001 surveys. The proportion of the NCC increases going from north to south along the Norwegian coast. The NCC type otoliths dominate south of 67^{o} N (Norwegian statistical areas 06 and 07). Although the proportion is lower, there is significant biomass of NCC north of 67^{o} N. It must be emphasised that the Norwegian coastal surveys have been conducted in August-November, and therefore there may be more NEAC in the southern area at other times of the year, especially during the spawning season in the winter time.

2.2.3 Weight-at-age (Table 2.11)

The weight-at-age (weighted average) from the trawl-acoustic survey in 2002 was at the same level as in 2001 for ages younger than 5 years. The difference in weight-at-age between 2001 and 2002 are mixed for cod older than 5 years. However, these weights are uncertain due to limited number of age samples. Weight-at-age for NCC is well above the present level for NEAC. There is a general tendency for cod to be heavier when caught further south along the coast (Table 2.11). The same tendency was found for the surveys in 1995-2001.

2.2.4 Maturity-at-age (Table 2.12)

The maturity-at-age is estimated from the data collected at the Norwegian coastal survey. The age at 50% maturity (M_{50}) for the NCC was estimated to be between 5 and 6 year on average for the surveyed area in 2002 (Table 2.12). There are some variations between the different areas. The 2002 data show that the average M_{50} is at the same level as that found in the 2001 survey. In addition, the average M_{50} for the NEAC in 2001 is close to 7 years.

2.3 Data Used in the Assessment

2.3.1 Catch-at-age (Table 2.9)

The catch-at-age (0-10+) for the period 1984-2002 is given in Table 2.9. The exploitation pattern in 2002 shifted towards older cod.

2.3.2 Weight-at-age (Table 2.10, 2.11)

The weight-at-age in the stock, used in the assessment, is obtained from the Norwegian coastal survey (Table 2.11). The weight-at-age in 2002 was slightly higher for cod at age 5 and younger and slightly lower for age 6 and older compared with 2001. The weight-at-age in the catch is given in Table 2.10.

2.3.3 Natural mortality

A fixed natural mortality of 0.2 was used.

2.3.4 Maturity-at-age (Table 2.12)

The maturity ogive data in 2002 is obtained from the Norwegian coastal survey and the values are at the same level as in 2001. The proportion mature-at-age is given in Table 2.12.

2.3.5 Tuning data (Table 2.7)

In previous assessments the acoustic indices (age 2-10+) from the Norwegian coastal survey conducted late autumn (1995-2001) have been used in the tuning (Table 2.7). ACFM proposed to exclude age group 9 from the tuning fleet due to high S.E. (log q) for this age group. The S.E. (log q) was slightly lower for several ages when excluding age 9, and the WG therefore decided to exclude it in the tuning in this years assessment.

2.3.6 Prediction data (Tables 2.20, 2.21, 2.22)

The input data to the short-term prediction with management option table (2003-2005) are given in Table 2.21. For 2003-2005 the weight in stock, weight in catch and maturity-at-age were set to an average of 2000-2002. The recruitment in 2003 was estimated using RCT3 and set to the same level in 2004 and 2005 (6.1 million, Table 2.20). This might be an overestimation since the SSB has steadily decreased in this period and is presently at a lower level. The exploitation pattern is calculated using the average fishing mortality (age 4-7) from 2000 to 2002 scaled to the fishing mortality (age 4-7) in 2002. The scaling was used since there has been a trend towards fishing at older ages in recent years.

2.4 Methods Used in the Assessment

2.4.1 VPA and tuning (Table 2.8)

Tuning of the VPA was carried out using Extended Survival Analysis (XSA), using the default settings for the XSA with the following exceptions: (1) catchability was set to be stock size independent for all ages, and age independent for ages 8 and older. (2) The survivors estimate was shrunk towards the mean F of the final 2 years or the 4 oldest ages. (3) The standard error of the mean to which the survivor estimates are shrunk was set to 1.0 (Table 2.8). The standard error of the mean to which the survivor estimates are shrunk was set above the default level because the coastal survey has shown a steadily decline in the latest years. The WG assumes the survey is reflecting the development of the stock and more weight is therefore assigned to the survey. The value is set to the same level as for NEAC (1.0).

2.5 Results of the Assessment

2.5.1 Fishing mortality and VPA (Tables 2.13-2.19, Figure 2.2)

As a result of excluding age 9 in the tuning the historical F_{4-7} values decreased and the historical SSB increased. The F_{4-7} in 2002 decreased and the SSB in 2002 increased using this new setting (see below).

Ages in the tuning	F_{4-7} in 2002	SSB in 2002	Stock biomass in 2002	Historical F_{4-7}	Recruits (age 2) in 2002
2-9	0.65	63,470	107,083	0.40	5,883
2-8	0.60	76,443	121,818	0.38	6,055

The average ages 4-7 fishing mortality in 2002 were estimated to be 0.60 (Table 2.13). This is the highest observed level and well above the level in 2001 (0.37). In 1990 and 1991 the lowest F-values was estimated (0.18 and 0.16). The fishing mortality was stable in the period 1996-2001 at a level of about 0.35. The total biomass of the stock in the period from 1984-2002 has been between 122,000 t and 328,000 t (Tables 2.17, 2.19). In 2002 the biomass was estimated to be the lowest observed and about half the biomass estimated five years ago in 1997. The spawning stock biomass has been between 76,000 t and 207,000 t (Tables 2.18, 2.19, Figure 2.2). As for the total stock biomass, the lowest observed SSB was estimated in 2002. The SSB has declined steadily from 1994 to present. The SSB in 2002 was only about half of the average in the period 1984-2002.

A summary of landings, fishing mortality, stock biomass, spawning stock biomass and recruitment since 1984 is given in Table 2.19 and Figure 2.2.

2.5.2 Recruitment (Tables 2.7, 2.15, 2.19, 2.20)

Both the survey estimates of abundance in 2002 (age 1-4, Table 2.7), the XSA-estimate (age 2 and 3, Tables 2.15, 2.19) and result from the RCT3 (Table 2.20) indicate lower than average year classes from 1996-2000. The 2000 year class is the lowest observed in the time-series. Since 2000 the SSB has decreased further and the probability of weak year classes after 2000 is assumed to be high.

2.6 Reference Points and Safe Biological Limits

Candidates for reference points for Norwegian coastal cod were calculated by the WG last year. However, they were not adopted by ACFM.

The SSB is present the lowest observed in the time-series extending back to 1984. The year classes 1997-2000 are well below average. The XSA estimates of the recruiting year classes (age 2) are stable from one assessment to the next, and the recruitment from SSB below 100.000 t is clearly impaired. The SSB is at present well below this level and will at the beginning of 2004 be 50,000 t assuming F status quo in 2003. In that sense, SSB will in 2004 be below any $\mathbf{B}_{\text{lim}}$ candidate, and the probability of further recruitment failure is assumed to be high. A rebuilding plan for this stock is therefore required.

2.7 Catch Options for 2004 and Management Scenarios (Tables 2.22-2.23, Figure 2.2)

The total stock biomass and the SSB were further reduced during 2002 (respectively 25% and close to 15%). The management option table (2.22) shows that the expected catch of 27,269 t in 2003 (assuming F *status quo*) will give an unchanged fishing mortality (F_{2003}=0.60). The total stock biomass and the SSB will however be further reduced (more than 20 %). The status quo catch in 2004 is 18,832 t, and leads to a further decrease of the total stock biomass. In 2005 the total stock biomass and the SSB will be 53,000 t and the 37,000 t., which is less than half of the level in 2002. The SSB will not be rebuilt to the 2003 level even if the fishing mortality in 2004 is set to zero (Table 2.22). A catch of 6,500 t (F=0.18) brings the SSB up to the level in 2004 (Table 2.22, Figure 2.2).

2.8 Comments to the Assessment

2.8.1 General comments

There is no explicit management of this stock. In accordance with the precautionary approach and the state of the stock, management objectives should be defined.

2.8.2 A comparison of the assessment results and the survey results (Figure 2.1)

Both the assessment and the surveys from 1995-2002 show a steeply declining stock. For ages 2-8 the survey indices and the XSA estimates are well correlated (Figure 2.1). It therefore seems like the survey and the XSA assessment reflect the changes in the stock number quite well. There is a general trend towards decreasing catchability with increasing age, except for cod older than 8 years.

2.8.3 Comparison of this years assessment with last years assessment.

The calculated fishing mortality F_{4-7} and SSB in 2001 is lower (23%) and SSB higher (40%) in this years assessment compared with last years assessment (see below). The recruitment in 2001 (1999 year class) is exactly the same in this year's assessment. Excluding age 9 in the tuning causes most of the observed reduction in F and increase in SSB and total stock biomass.

Assessment year	F_{4-7} year 2001	SSB year 2001	Total stock biomass 2001	Recruits age 2 year 2000
2001	0.48	56,584	102,214	9,536
2002	0.37	78,957	130,557	9,769

Table 2.1.a Number of otoliths sampled from commercial catches inside the 12 n.mile zone in the period 1985-2002. CC=coastal cod, NEAC=Northeast Arctic cod.

Year	Quarter 1		Quarter 2		Quarter 3		Quarter 4		Total		
	CC	NEAC	CC	NEAC	CC	NEAC	CC	NEAC	CC	NEAC	% CC
1985	1 451	3 852	777	1 540	1 277	1 767	1 966	730	5 471	7 889	41
1986	940	1 594	1 656	2 579	0	0	669	966	3 265	5 139	39
1987	1 195	2 322	937	3 051	638	1 108	1 122	1 137	3 892	7 618	34
1988	257	546	160	619	87	135	55	44	559	1 344	29
1989	556	1 387	72	374	65	501	97	663	790	2 925	21
1990	731	2 974	61	689	252	97	265	674	1 309	4 434	23
1991	285	1 168	92	561	77	96	279	718	733	2 543	22
1992	152	619	281	788	79	82	272	672	784	2 161	27
1993	314	1 098	172	1 046	0	0	310	541	796	2 685	23
1994	317	1 605	179	923	21	31	126	674	643	3 233	17
1995	188	1 591	232	1 682	2 095	1 057	752	1 330	3 267	5 660	37
1996	861	5 486	591	1 958	1 784	1 076	958	2 256	4 194	10 776	28
1997	1 106	5 429	367	2 494	1 940	894	1 690	1 755	5 103	10 572	33
1998	608	4 930	552	1 342	489	1 094	2 999	2 217	4 648	9 583	33
1999	1 277	4 702	493	2 379	202	717	961	1 987	2 933	9 785	23
2000	1 283	4 918	365	2 112	386	1 295	472	1 668	2 506	9 993	20
2001	1 102	5 091	352	2 295	126	786	432	983	2 012	9 155	18
2002	823	5 818	321	1 656	503	831	897	1 355	2 544	9 660	21

Table 2.1.b Estimated survey number (x1000) of Norwegian Coastal cod at age from the Norwegian coastal survey during the autumn 2002.

	Age											
Area	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10+**	**Total**
03 East Finnmark	1206	125	212	490	462	303	177	69	28	0	6	3078
04 West Finnmark/Tromsø	3131	565	1046	1480	1568	1618	522	438	151	6	61	10586
05 Lofoten/Vesterålen	261	358	1309	1155	1702	949	1456	650	149	0	3	7992
00 Vestfjord	0	108	188	118	232	270	93	93	0	23	19	1144
06 Nordland	0	155	194	703	729	310	48	148	39	0	39	2365
07 Møre	0	18	41	157	247	167	297	72	41	0	0	1040
Total	4598	1329	2990	4103	4940	3617	2593	1470	408	29	128	26205

Table 2.2 Estimated survey biomass (tonnes) of Norwegian Coastal cod at age from the Norwegian coastal survey during the autumn 2002.

	Age											
Area	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10+**	**Total**
03 East Finnmark	9	9	60	359	775	736	551	142	97	0	81	2819
04 West Finnmark/Troms	31	53	449	1226	2449	4260	1576	1888	564	39	930	13465
05 Lofoten/Vesterålen	2	32	609	1050	2625	1768	3736	2411	782	0	22	13037
00 Vestfjord	0	21	83	105	455	781	699	690	0	186	306	3326
06 Nordland	0	14	39	715	1617	595	96	646	137	0	324	4183
07 Møre	0	8	39	217	679	661	1466	505	214	0	0	3789
Total	42	137	1279	3672	8600	8801	8124	6282	1794	225	1663	40619

Table 2.3 Estimated survey spawning stock number (x1000) of Norwegian Coastal cod at age from the Norwegian coastal survey during the autumn 2002.

	Age											
Area	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10+**	**Total**
03 East Finnmark	0	0	0	10	154	231	177	69	28	0	6	674
04 West Finnmark/Troms	0	0	9	87	344	1405	522	438	140	6	61	3012
05 Lofoten/Vesterålen	0	0	37	0	495	844	1290	650	149	0	3	3468
00 Vestfjord	0	0	0	0	23	240	93	93	0	23	19	491
06 Nordland	0	0	0	0	182	310	48	0	39	0	39	618
07 Møre	0	0	0	0	88	137	281	72	41	0	0	618
Total	0	0	46	97	1287	3165	2410	1322	397	29	128	8881

Table 2.4 Estimated survey spawning stock biomass (tonnes) of Norwegian Coastal cod at age from the Norwegian coastal survey during the autumn 2002.

Area	Age											
	0	1	2	3	4	5	6	7	8	9	10+	Total
03 East Finnmark	0	0	0	7	258	560	551	142	97	0	81	1696
04 West Finnmark/Troms	0	0	4	72	537	3698	1576	1888	524	39	930	9268
05 Lofoten/Vesterålen	0	0	17	0	764	1572	3309	2411	782	0	22	8877
00 Vestfjord	0	0	0	0	46	694	699	690	0	186	306	2621
06 Nordland	0	0	0	0	404	595	96	0	137	0	324	1556
07 Møre	0	0	0	0	243	541	1385	505	214	0	0	2887
Total	0	0	20	87	2240	7702	7551	5650	1747	225	1663	26883

Table 2.5 Weight (gram)-at-age (year) for Norwegian Coastal cod from the Norwegian coastal survey during the autumn 2002.

Area	Age										
	0	1	2	3	4	5	6	7	8	9	10+
03 East Finnmark	7	72	283	733	1677	2429	3113	2058	3464		13500
04 West Finnmark/Troms	10	94	429	828	1562	2633	3019	4311	3735	6500	15246
05 Lofoten/Vesterålen	8	89	465	909	1542	1863	2566	3709	5248		7333
00 Vestfjord		194	441	890	1961	2893	7516	7419		8087	16105
06 Nordland		90	201	1017	2218	1919	2000	4365	3513		8308
07 Møre		444	951	1382	2749	3958	4936	7014	5220		
Weighted average	9	103	428	895	1741	2433	3133	4273	4397	7759	12992

Table 2.6 Percent mature at age for Norwegian Coastal cod at age from the Norwegian coastal survey during the autumn 2002.

Area	Age										
	0	1	2	3	4	5	6	7	8	9	10+
03 East Finnmark	0	0	0	2	33	76	100	100	100	100	100
04 West Finnmark/Troms	0	0	1	6	22	87	100	100	93	100	100
05 Lofoten/Vesterålen	0	0	3	0	29	89	89	100	100	100	100
00 Vestfjord	0	0	0	0	10	89	100	100	100	100	100
06 Nordland	0	0	0	0	25	100	100	0	100	100	100
07 Møre	0	0	0	0	36	82	94	100	100	100	100
Weighted average	0	0	2	2	26	88	93	90	97	100	100

Table 2.7 Estimated survey numbers-at-age (x1000) of Norwegian Coastal cod from the coastal surveys from 1995-2002.

YEAR	Age											
	0	1	2	3	4	5	6	7	8	9	10+	TOTAL
1995	2157	28707	20191	13633	15636	16219	9550	3174	1158	781	579	111785
1996	-	1756	17378	22815	12382	12514	6817	3180	754	242	5	77843
1997	5632	30694	18827	28913	17334	12379	10612	3928	1515	26	663	130523
1998	35098	14455	13659	15003	13239	7415	3137	1578	315	169	128	104197
1999	34	6850	11309	12171	10123	7197	3052	850	242	112	54	51994
2000	17620	9587	11528	11612	8974	7984	5451	1365	488	85	97	74791
2001	9292	8366	6729	7994	7578	4751	2567	1493	487	189	116	49562
2002	4598	1329	2990	4103	4940	3617	2593	1470	408	29	128	26205

Table 2.8

Lowestoft VPA Version 3.1

24/04/2003 14:17

Extended Survivors Analysis

Norwegian Coastal Cod,COMBSEX,PLUSGROUP

CPUE data from file c:\VPA\DATA\2003age9\NOR-COAS.TUN

Catch data for 19 years. 1984 to 2002. Ages 2 to 10.

Fleet,	First, year,	Last, year,	First, age ,	Last, age,	Alpha,	Beta
Norw. Coast. survey ,	1995,	2002,	0,	8,	.750,	.850

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 2 years or the 4 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 114 iterations

Regression weights

, .877,	.921,	.954,	.976,	.990,	.997,	1.000,	1.000

Fishing mortalities

Age,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002
2,	.026,	.032,	.048,	.024,	.015,	.011,	.005,	.036
3,	.046,	.098,	.123,	.137,	.074,	.075,	.045,	.132
4,	.131,	.173,	.182,	.253,	.161,	.299,	.198,	.300
5,	.252,	.447,	.236,	.373,	.375,	.425,	.424,	.528
6,	.305,	.377,	.427,	.397,	.479,	.429,	.415,	.905
7,	.436,	.396,	.642,	.518,	.544,	.355,	.423,	.660
8,	.306,	.554,	.638,	.715,	.515,	.198,	.295,	.540
9,	.327,	.314,	.538,	.387,	.777,	.156,	.167,	.289

Table 2.8 (continued)

XSA population numbers (Thousands)

YEAR	AGE 2	3	4	5	6	7	8	9
1995	3.53E+04	2.20E+04	2.11E+04	2.57E+04	2.33E+04	1.02E+04	6.11E+03	2.21E+03
1996	4.13E+04	2.82E+04	1.72E+04	1.51E+04	1.63E+04	1.41E+04	5.41E+03	3.68E+03
1997	3.13E+04	3.27E+04	2.09E+04	1.19E+04	7.92E+03	9.18E+03	7.76E+03	2.55E+03
1998	2.58E+04	2.44E+04	2.37E+04	1.43E+04	7.66E+03	4.23E+03	3.95E+03	3.35E+03
1999	1.85E+04	2.06E+04	1.74E+04	1.51E+04	8.06E+03	4.22E+03	2.06E+03	1.58E+03
2000	1.57E+04	1.49E+04	1.57E+04	1.22E+04	8.47E+03	4.09E+03	2.00E+03	1.01E+03
2001	9.77E+03	1.27E+04	1.13E+04	9.50E+03	6.50E+03	4.52E+03	2.35E+03	1.35E+03
2002	6.06E+03	7.96E+03	9.93E+03	7.60E+03	5.09E+03	3.52E+03	2.42E+03	1.43E+03

Estimated population abundance at 1st Jan 2003

0.00E+00	4.78E+03	5.71E+03	6.02E+03	3.67E+03	1.69E+03	1.49E+03	1.16E+03

Taper weighted geometric mean of the VPA populations:

2.51E+04	2.38E+04	2.09E+04	1.60E+04	1.07E+04	6.65E+03	3.52E+03	1.79E+03

Standard error of the weighted Log(VPA populations) :

.6747	.5297	.4378	.4398	.4606	.4743	.5110	.6130

Log catchability residuals.

Fleet : Norw. Coast. survey

Age	1995	1996	1997	1998	1999	2000	2001	2002
2	-.01	-.31	.06	-.08	.05	.23	.16	-.14
3	-.11	.20	.31	-.05	-.13	.14	-.09	-.25
4	.09	.09	.24	-.10	-.13	-.04	.04	-.16
5	-.07	.36	.42	-.17	-.25	.11	-.16	-.22
6	-.30	-.22	.98	-.23	-.24	.25	-.25	-.02
7	-.01	-.36	.48	.24	-.35	.00	.04	-.05
8	.08	-.03	.38	-.46	-.23	.24	.16	-.13

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
Mean Log q	-.3722	-.1718	-.1202	-.0315	-.1897	-.6532	-1.3387
S.E(Log q)	.1731	.1920	.1349	.2641	.4366	.2786	.2737

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	1.08	-.679	-.35	.93	8	.19	-.37
3	.78	2.229	2.27	.95	8	.12	-.17
4	.86	.920	1.42	.89	8	.12	-.12
5	.91	.317	.87	.69	8	.26	-.03
6	1.28	-.612	-2.34	.45	8	.59	-.19
7	1.02	-.088	.49	.77	8	.31	-.65
8	.90	.563	2.05	.84	8	.26	-1.34

Table 2.8 (continued)

```
Terminal year survivor and F summaries :
Age  2   Catchability constant w.r.t. time and dependent on age
Year class = 2000

Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
Norw. Coast. survey ,      4158.,   .300,       .000,    .00,   1,  .915,     .041

  F shrinkage mean  ,     21523.,   1.00,,,,                         .085,     .008

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
     4784.,       .29,      .48,    2,   1.671,   .036


Age  3   Catchability constant w.r.t. time and dependent on age
Year class = 1999

Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
Norw. Coast. survey ,      5469.,   .212,       .205,    .97,   2,  .951,     .138

  F shrinkage mean  ,     13059.,   1.00,,,,                         .049,     .060

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
     5708.,       .21,      .20,    3,    .947,   .132


Age  4   Catchability constant w.r.t. time and dependent on age
Year class = 1998

Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
Norw. Coast. survey ,      5972.,   .173,       .120,    .69,   3,  .960,     .302

  F shrinkage mean  ,      7433.,   1.00,,,,                         .040,     .250

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
     6025.,       .17,      .10,    4,    .582,   .300


Age  5   Catchability constant w.r.t. time and dependent on age
Year class = 1997

Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
Norw. Coast. survey ,      3625.,   .151,       .082,    .54,   4,  .956,     .533

  F shrinkage mean  ,      4783.,   1.00,,,,                         .044,     .428

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
     3669.,       .15,      .08,    5,    .497,   .528
```

Table 2.8 (continued)

```
Age  6   Catchability constant w.r.t. time and dependent on age
Year class = 1996

Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
Norw. Coast. survey ,      1536.,   .150,       .028,    .19,   5,  .916,     .961

  F shrinkage mean  ,      4689.,   1.00,,,,                        .084,     .425

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
     1686.,       .16,      .15,    6,    .912,   .905


Age  7   Catchability constant w.r.t. time and dependent on age
Year class = 1995

Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
Norw. Coast. survey ,      1424.,   .146,       .046,    .32,   6,  .939,     .682

  F shrinkage mean  ,      2905.,   1.00,,,,                        .061,     .391

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
     1488.,       .15,      .08,    7,    .551,   .660


Age  8   Catchability constant w.r.t. time and dependent on age
Year class = 1994

Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
Norw. Coast. survey ,      1096.,   .145,       .068,    .47,   7,  .946,     .563

  F shrinkage mean  ,      2946.,   1.00,,,,                        .054,     .248

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
     1156.,       .15,      .11,    8,    .723,   .540


Age  9   Catchability constant w.r.t. time and age (fixed at the value for age)  8
Year class = 1993

Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
Norw. Coast. survey ,       931.,   .143,       .058,    .40,   7,  .946,     .274

  F shrinkage mean  ,       312.,   1.00,,,,                        .054,     .664

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
      877.,       .15,      .11,    8,    .750,   .289
```

Table 2.9

Run title : Norwegian Coastal Cod,COMBSEX,PLUSGROUP
At 24/04/2003 14:17

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

YEAR,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,
AGE									
2,	829,	396,	4095,	170,	110,	41,	7,	125,	40,
3,	3478,	7848,	4095,	940,	1921,	1159,	349,	607,	665,
4,	6954,	7367,	12662,	8236,	3343,	1434,	1233,	1452,	3160,
5,	7278,	8699,	8906,	12430,	6451,	2299,	1330,	3114,	4422,
6,	6004,	7085,	5750,	4427,	6626,	5197,	1129,	1873,	2992,
7,	4964,	3066,	3868,	2649,	4687,	2720,	3456,	1297,	1945,
8,	2161,	705,	1270,	1127,	1461,	949,	773,	873,	898,
9,	819,	433,	342,	313,	497,	236,	141,	132,	837,
+gp,	624,	264,	407,	149,	333,	86,	73,	94,	279,
TOTALNUM,	33111,	35863,	41395,	30441,	25429,	14121,	8491,	9567,	15238,
TONSLAND,	74824,	75451,	68905,	60972,	59294,	40285,	28127,	24822,	41690,
SOPCOF %,	100,	100,	100,	100,	100,	100,	100,	100,	100,

Table 2.9 (continued)

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

YEAR,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,
AGE										
2,	4,	332,	810,	1193,	1326,	554,	252,	156,	44,	192,
3,	369,	573,	896,	2376,	3438,	2819,	1322,	971,	505,	893,
4,	1706,	1693,	2345,	2480,	3150,	4786,	2346,	3664,	1837,	2331,
5,	2343,	4302,	5188,	4930,	2258,	4023,	4263,	3807,	2974,	2822,
6,	2684,	2467,	5546,	4647,	2490,	2272,	2773,	2671,	1998,	2742,
7,	3072,	3337,	3270,	4160,	3935,	1546,	1602,	1104,	1409,	1538,
8,	1871,	1514,	1455,	2082,	3312,	1826,	751,	326,	542,	915,
9,	627,	777,	557,	898,	959,	975,	774,	132,	187,	325,
+gp,	690,	798,	433,	543,	684,	343,	320,	152,	119,	377,
TOTALNUM,	13366,	15793,	20500,	23309,	21552,	19144,	14403,	12983,	9615,	12135,
TONSLAND,	52557,	54562,	57207,	61776,	63319,	51572,	40732,	36715,	29699,	40994,
SOPCOF %,	100,	100,	100,	100,	100,	99,	100,	100,	100,	102,

Table 2.10

Table 2 Catch weights-at-age (kg)

YEAR,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,
AGE									
2,	.2480,	.2140,	.2270,	.3310,	.2460,	.3000,	.3450,	.1640,	.1680,
3,	.6190,	.7120,	.5250,	.6730,	.6340,	.6610,	1.1740,	.9220,	.5560,
4,	1.1490,	1.4150,	1.0800,	1.1200,	1.1700,	1.8360,	1.5150,	1.6080,	1.3590,
5,	1.7340,	2.0360,	1.7060,	1.6930,	1.7270,	2.1700,	1.6780,	2.1080,	2.2670,
6,	2.3250,	2.7370,	2.2560,	2.3590,	2.3280,	2.4480,	2.7080,	2.5070,	2.9570,
7,	3.4860,	4.0120,	3.3530,	3.7430,	3.2560,	4.3910,	3.8980,	3.4690,	3.9030,
8,	4.8450,	6.1160,	4.8380,	5.3260,	4.7000,	4.8990,	6.5150,	4.9760,	5.3170,
9,	5.6080,	6.4600,	5.8380,	6.1290,	5.4500,	6.6610,	7.2990,	5.7340,	4.5580,
+gp,	8.8400,	10.7550,	7.0530,	11.6230,	8.2020,	11.6080,	13.9240,	11.0590,	7.0320,
SOPCOFAC,	1.0002,	1.0000,	1.0001,	1.0001,	1.0001,	1.0000,	1.0002,	1.0003,	1.0001,

Table 2.10 (continued)

Table 2 Catch weights-at-age (kg)

YEAR,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,
AGE										
2,	.2410,	.2540,	.3020,	.2740,	.2770,	.3760,	.4670,	.5150,	.1640,	.4910,
3,	.6450,	.8050,	.7100,	.9210,	.9700,	.9780,	1.1550,	1.3050,	.9520,	1.1790,
4,	1.7100,	1.4760,	1.3350,	1.4640,	1.5540,	1.5180,	1.6330,	2.2720,	1.6370,	1.8000,
5,	2.5910,	2.0970,	1.8420,	1.9790,	1.9700,	2.2810,	2.1710,	2.5550,	2.8810,	2.4850,
6,	3.5880,	3.2870,	2.4670,	2.5160,	2.8970,	3.1250,	3.2490,	3.2830,	3.4240,	3.8600,
7,	4.3660,	4.0950,	4.1910,	3.4610,	3.7160,	3.9000,	4.0950,	4.5040,	4.0380,	4.7600,
8,	5.8990,	5.5920,	5.7780,	4.8660,	4.8290,	5.5200,	5.0130,	5.4000,	5.3970,	5.1950,
9,	6.4940,	7.2170,	6.3760,	5.3910,	6.3490,	6.3330,	6.0180,	6.3790,	7.2080,	5.5070,
+gp,	7.5090,	8.3310,	9.9030,	8.8540,	9.2670,	9.3370,	6.2550,	6.4200,	6.8810,	9.1830,
SOPCOFAC,	1.0000,	1.0000,	1.0001,	1.0001,	1.0003,	.9919,	1.0002,	.9999,	1.0004,	1.0181,

Table 2.11

Table 3 Stock weights-at-age (kg)

YEAR,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,
AGE									
2,	.3210,	.3210,	.3210,	.3210,	.3210,	.3210,	.3210,	.3210,	.3210,
3,	.7580,	.7580,	.7580,	.7580,	.7580,	.7580,	.7580,	.7580,	.7580,
4,	1.4790,	1.4790,	1.4790,	1.4790,	1.4790,	1.4790,	1.4790,	1.4790,	1.4790,
5,	2.1370,	2.1370,	2.1370,	2.1370,	2.1370,	2.1370,	2.1370,	2.1370,	2.1370,
6,	2.8140,	2.8140,	2.8140,	2.8140,	2.8140,	2.8140,	2.8140,	2.8140,	2.8140,
7,	4.7220,	4.7220,	4.7220,	4.7220,	4.7220,	4.7220,	4.7220,	4.7220,	4.7220,
8,	6.6850,	6.6850,	6.6850,	6.6850,	6.6850,	6.6850,	6.6850,	6.6850,	6.6850,
9,	6.9800,	6.9800,	6.9800,	6.9800,	6.9800,	6.9800,	6.9800,	6.9800,	6.9800,
+gp,	9.7230,	9.7230,	9.7230,	9.7230,	9.7230,	9.7230,	9.7230,	9.7230,	9.7230,

Table 2.11 (continued)

Table 3 Stock weights-at-age (kg)

YEAR,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,
AGE										
2,	.3210,	.3210,	.3900,	.2520,	.2400,	.3720,	.3230,	.3650,	.3960,	.4280,
3,	.7580,	.7580,	.7910,	.7240,	.6830,	.8830,	.8410,	.8090,	.9660,	.8950,
4,	1.4790,	1.4790,	1.5250,	1.4330,	1.3640,	1.4560,	1.6750,	1.5540,	1.5240,	1.7410,
5,	2.1370,	2.1370,	2.2220,	2.0530,	1.8930,	2.1070,	2.1920,	2.5390,	2.3140,	2.4330,
6,	2.8140,	2.8140,	2.8810,	2.7480,	2.8160,	2.9500,	2.8570,	3.0490,	3.3200,	3.1330,
7,	4.7220,	4.7220,	4.6650,	4.7220,	4.4260,	4.3190,	4.5400,	4.3520,	3.6950,	4.2730,
8,	6.6850,	6.6850,	6.9790,	6.6850,	6.4060,	5.6250,	6.5790,	6.2030,	6.1440,	4.3970,
9,	6.9800,	6.9800,	6.7590,	6.9320,	7.8050,	8.3230,	9.4540,	8.5270,	8.7680,	7.7590,
+gp,	9.7230,	9.7230,	9.8970,	9.7230,	10.8270,	12.4680,	12.9020,	12.0660,	12.4680,	12.9920,

Table 2.12

Table 5 Proportion mature at age

YEAR,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,
AGE									
2,	.0100,	.0100,	.0100,	.0100,	.0100,	.0100,	.0100,	.0100,	.0100,
3,	.0600,	.0600,	.0600,	.0600,	.0600,	.0600,	.0600,	.0600,	.0600,
4,	.2400,	.2400,	.2400,	.2400,	.2400,	.2400,	.2400,	.2400,	.2400,
5,	.4900,	.4900,	.4900,	.4900,	.4900,	.4900,	.4900,	.4900,	.4900,
6,	.7200,	.7200,	.7200,	.7200,	.7200,	.7200,	.7200,	.7200,	.7200,
7,	.8800,	.8800,	.8800,	.8800,	.8800,	.8800,	.8800,	.8800,	.8800,
8,	.9500,	.9500,	.9500,	.9500,	.9500,	.9500,	.9500,	.9500,	.9500,
9,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
+gp,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,

Table 2.12 (continued)

Table 5 Proportion mature at age

YEAR,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,
AGE										
2,	.0100,	.0100,	.0000,	.0000,	.0000,	.0000,	.0100,	.0100,	.0000,	.0000,
3,	.0600,	.0600,	.0100,	.0300,	.0600,	.0600,	.0300,	.0600,	.0000,	.0200,
4,	.2400,	.2400,	.2000,	.2400,	.2900,	.2500,	.2100,	.2400,	.0700,	.0200,
5,	.4900,	.4900,	.4700,	.5600,	.4500,	.5300,	.4400,	.4900,	.3700,	.2600,
6,	.7200,	.7200,	.6700,	.8000,	.7600,	.7400,	.6500,	.7200,	.7900,	.8800,
7,	.8800,	.8800,	.8500,	.9200,	.9700,	.8700,	.7700,	.8800,	.9700,	.9300,
8,	.9500,	.9500,	.8600,	.9900,	1.0000,	.8900,	1.0000,	.9500,	.9800,	.9000,
9,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	.9800,	.9700,
+gp,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,

Table 2.13

Table 8 Fishing mortality (F) at age

YEAR	1984	1985	1986	1987	1988	1989	1990	1991	1992
AGE									
2	.0105	.0058	.1329	.0049	.0030	.0009	.0002	.0021	.0009
3	.0743	.1296	.0765	.0407	.0707	.0389	.0097	.0185	.0141
4	.2167	.2226	.3184	.2172	.1988	.0691	.0530	.0509	.1267
5	.3335	.4617	.4592	.5969	.2640	.2042	.0846	.1837	.2162
6	.6281	.6361	.6420	.4368	.7585	.3528	.1460	.1646	.2700
7	1.3091	.7878	.8988	.7063	1.2318	.8420	.4210	.2493	.2575
8	1.0720	.6327	.9324	.7305	1.1761	.9169	.6134	.1762	.2737
9	.8444	.6352	.7402	.6231	.8667	.5839	.3182	.1943	.2557
+gp	.8444	.6352	.7402	.6231	.8667	.5839	.3182	.1943	.2557
FBAR 4- 7	.6219	.5271	.5796	.4893	.6133	.3670	.1762	.1621	.2176

Table 2.13 (continued)

Table 8 Fishing mortality (F) at age

YEAR	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	FBAR 84-02
AGE											
2	.0001	.0135	.0257	.0325	.0480	.0241	.0152	.0111	.0050	.0357	.0172
3	.0100	.0243	.0460	.0978	.1234	.1366	.0736	.0748	.0450	.1324	.0841
4	.0454	.0579	.1313	.1733	.1819	.2528	.1610	.2992	.1978	.3002	.2657
5	.1304	.1544	.2525	.4470	.2363	.3729	.3754	.4251	.4244	.5282	.4592
6	.1971	.1975	.3050	.3772	.4272	.3969	.4787	.4286	.4148	.9048	.5827
7	.4923	.4018	.4361	.3956	.6423	.5178	.5441	.3547	.4228	.6604	.4793
8	.4232	.4826	.3057	.5536	.6384	.7146	.5149	.1981	.2947	.5403	.3444
9	.3126	.3109	.3268	.3141	.5379	.3875	.7769	.1562	.1666	.2891	.2039
+gp	.3126	.3109	.3268	.3141	.5379	.3875	.7769	.1562	.1666	.2891	
FBAR4-7	.2163	.2029	.2812	.3483	.3719	.3851	.3898	.3769	.3650	.5984	

Table 2.14

Table 9 Relative F at age

YEAR	1984	1985	1986	1987	1988	1989	1990	1991	1992
AGE									
2	.0168	.0110	.2293	.0101	.0048	.0025	.0010	.0132	.0041
3	.1195	.2459	.1319	.0831	.1153	.1061	.0552	.1143	.0646
4	.3486	.4224	.5493	.4438	.3241	.1884	.3007	.3142	.5821
5	.5363	.8760	.7923	1.2200	.4305	.5564	.4801	1.1329	.9936
6	1.0100	1.2069	1.1076	.8926	1.2369	.9613	.8291	1.0154	1.2410
7	2.1051	1.4946	1.5507	1.4436	2.0085	2.2940	2.3901	1.5375	1.1833
8	1.7239	1.2004	1.6087	1.4930	1.9178	2.4983	3.4821	1.0866	1.2577
9	1.3579	1.2052	1.2772	1.2735	1.4132	1.5910	1.8060	1.1984	1.1750
+gp	1.3579	1.2052	1.2772	1.2735	1.4132	1.5910	1.8060	1.1984	1.1750
REFMEAN	.6219	.5271	.5796	.4893	.6133	.3670	.1762	.1621	.2176

Table 2.14 (continued)

Table 9 Relative F at age

YEAR	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	MEAN
AGE											
2	.0006	.0668	.0913	.0932	.1290	.0625	.0390	.0293	.0137	.0596	.0342
3	.0462	.1199	.1636	2808	.3319	.3546	.1889	.1984	.1232	.2213	.1810
4	.2099	.2854	.4671	.4977	.4891	.6565	.4131	.7940	.5420	.5016	.6125
5	.6030	.7609	.8978	1.2834	.6354	.9682	.9630	1.1278	1.1629	.8828	1.0578
6	.9113	.9732	1.0845	1.0831	1.1485	1.0307	1.2282	1.1372	1.1366	1.5120	1.2619
7	2.2757	1.9805	1.5507	1.1358	1.7270	1.3445	1.3958	.9410	1.1585	1.1036	1.0677
8	1.9563	2.3788	1.0869	1.5895	1.7163	1.8556	1.3209	.5256	.8076	.9029	.7453
9	1.4451	1.5323	1.1620	.9018	1.4461	1.0062	1.9930	.4143	.4566	.4831	.4513
+gp	1.4451	1.5323	1.1620	.9018	1.4461	1.0062	1.9930	.4143	.4566	.4831	
REFMEAN	.2163	.2029	.2812	.3483	.3719	.3851	.3898	.3769	.3650	.5984	

Table 2.15

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

YEAR	1984	1985	1986	1987	1988	1989	1990	1991	1992
AGE									
2	88072	75530	36372	38171	41088	48712	44618	64406	50154
3	53664	71357	61481	26073	31098	33541	39845	36523	52618
4	39439	40790	51321	46631	20497	23722	26412	32307	29354
5	28363	25998	26730	30561	30726	13756	18125	20509	25137
6	14227	16636	13414	13826	13774	19319	9182	13636	13973
7	7516	6216	7210	5779	7314	5282	11115	6496	9469
8	3631	1662	2315	2403	2335	1747	1863	5973	4145
9	1587	1018	723	746	948	590	572	826	4100
+gp	1191	613	848	351	625	212	294	585	1359
TOTAL	237690	239819	200412	164541	148404	146882	152026	181261	190309

Table 2.15 (continued)

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

YEAR	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	GMST
AGE												
2	32188	27269	35325	41281	31278	25755	18466	15675	9769	6055	0	38228
3	41027	26350	22026	28189	32718	24409	20585	14891	12692	7958	4784	33411
4	42478	33256	21055	17223	20929	23677	17433	15657	11313	9935	5708	27661
5	21173	33235	25696	15117	11857	14285	15054	12151	9504	7600	6025	20512
6	16579	15215	23318	16344	7916	7664	8056	8468	6503	5090	3669	12953
7	8733	11145	10225	14073	9176	4228	4219	4086	4516	3517	1686	7306
8	5993	4370	6105	5413	7758	3952	2062	2005	2347	2423	1488	3312
9	2581	3214	2208	3682	2548	3354	1584	1009	1346	1431	1156	1489
+gp	2821	3278	1705	2211	1798	1171	645	1157	853	1649	1889	
TOTN	173574	157332	147663	143531	125978	108495	88105	75099	58843	45657	26403	

Table 2.16

Table 11 Spawning stock number-at-age (spawning time) Numbers*10**-3

YEAR	1984	1985	1986	1987	1988	1989	1990	1991	1992
AGE									
2	881	755	364	382	411	487	446	644	502
3	3220	4281	3689	1564	1866	2012	2391	2191	3157
4	9465	9789	12317	11191	4919	5693	6339	7754	7045
5	13898	12739	13098	14975	15056	6741	8881	10049	12317
6	10244	11978	9658	9955	9917	13910	6611	9818	10061
7	6614	5470	6345	5086	6436	4648	9781	5717	8333
8	3450	1579	2199	2283	2218	1660	1770	5674	3938
9	1587	1018	723	746	948	590	572	826	4100
+gp	1191	613	848	351	625	212	294	585	1359

Table 2.16 (continued)

Table 11 Spawning stock number-at-age (spawning time) Numbers*10**-3

YEAR	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
AGE										
2	322	273	0	0	0	0	185	157	0	0
3	2462	1581	220	846	1963	1465	618	893	0	159
4	10195	7981	4211	4133	6070	5919	3661	3758	792	199
5	10375	16285	12077	8465	5336	7571	6624	5954	3516	1976
6	11937	10955	15623	13075	6016	5672	5236	6097	5138	4479
7	7685	9808	8691	12947	8901	3678	3249	3596	4381	3270
8	5693	4152	5251	5359	7758	3518	2062	1905	2300	2180
9	2581	3214	2208	3682	2548	3354	1584	1009	1320	1388
+gp	2821	3278	1705	2211	1798	1171	645	1157	853	1649

Table 2.17

Table 14 Stock biomass at age with SOP (start of year) Tonnes

YEAR	1984	1985	1986	1987	1988	1989	1990	1991	1992
AGE									
2	28276	24246	11676	12254	13190	15637	14325	20680	16101
3	40684	54090	46605	19765	23574	25424	30208	27693	39888
4	58340	60330	75908	68971	30316	35085	39070	47796	43418
5	60621	55558	57125	65313	65666	29397	38739	43840	53722
6	40042	46815	37749	38909	38763	54364	25844	38383	39325
7	35496	29351	34046	27292	34539	24941	52492	30685	44718
8	24280	11110	15474	16064	15610	11680	12458	39940	27714
9	11082	7104	5045	5207	6615	4116	3992	5768	28622
+gp	11581	5961	8248	3412	6076	2066	2859	5693	13212
TOTALBIO	310401	294565	291876	257187	234349	202709	219986	260478	306721

Table 2.17 (continued)

Table 14 Stock biomass at age with SOP (start of year) Tonnes

YEAR	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
AGE										
2	10332	8754	13778	10403	7509	9503	5966	5721	3870	2638
3	31097	19973	17424	20410	22352	21378	17315	12046	12266	7251
4	62822	49185	32113	24682	28555	34194	29206	24329	17249	17609
5	45246	71022	57102	31036	22451	29855	33005	30847	22001	18826
6	46651	42816	67185	44915	22296	22427	23019	25817	21601	16235
7	41236	52627	47705	66455	40624	18111	19159	17782	16695	15298
8	40061	29217	42614	36186	49708	22051	13571	12435	14424	10845
9	18017	22431	14928	25526	19890	27693	14974	8603	11811	11303
+gp	27430	31872	16872	21501	19472	14477	8328	13959	10640	21812
TOTALBIO	322891	327898	309722	281116	232857	199690	164543	151538	130557	121818

Table 2.18

Table 15 Spawning stock biomass with SOP (spawning time) Tonnes

YEAR	1984	1985	1986	1987	1988	1989	1990	1991	1992
AGE									
2	283	242	117	123	132	156	143	207	161
3	2441	3245	2796	1186	1414	1525	1812	1662	2393
4	14002	14479	18218	16553	7276	8420	9377	11471	10420
5	29704	27224	27991	32003	32176	14405	18982	21482	26324
6	28830	33707	27179	28014	27909	39142	18607	27635	28314
7	31236	25829	29961	24017	30394	21948	46193	27003	39352
8	23066	10554	14701	15261	14829	11096	11835	37943	26328
9	11082	7104	5045	5207	6615	4116	3992	5768	28622
+gp	11581	5961	8248	3412	6076	2066	2859	5693	13212
TOTSPBIO	152225	128346	134255	125776	126823	102875	113801	138864	175127

Table 2.18 (continued)

Table 15 Spawning stock biomass with SOP (spawning time) Tonnes

YEAR	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
AGE										
2	103	88	0	0	0	0	60	57	0	0
3	1866	1198	174	612	1341	1283	519	723	0	145
4	15077	11805	6423	5924	8281	8549	6133	5839	1207	352
5	22170	34801	26838	17380	10103	15823	14522	15115	8141	4895
6	33589	30828	45014	35932	16945	16596	14962	18588	17065	14287
7	36288	46312	40549	61139	39406	15757	14752	15648	16194	14227
8	38058	27756	36648	35825	49708	19626	13571	11813	14136	9761
9	18017	22431	14928	25526	19890	27693	14974	8603	11575	10963
+gp	27430	31872	16872	21501	19472	14477	8328	13959	10640	21812
TOTSPB	192597	207090	187446	203840	165145	119803	87823	90345	78957	76443

Table 2.19

Run title : Norwegian Coastal Cod,COMBSEX,PLUSGROUP
At 24/04/2003 14:17

Table 17 Summary (with SOP correction)

Terminal Fs derived using XSA (With F shrinkage)

	RECRUITS, AGE 2	TOTALBIO,	TOTSPBIO,	LANDINGS,	YIELD/SSB,	SOPCOFAC,	FBAR 4-7,
1984,	88072,	310401,	152225,	74824,	.4915,	1.0002,	.6219,
1985,	75530,	294565,	128346,	75451,	.5879,	1.0000,	.5271,
1986,	36372,	291876,	134255,	68905,	.5132,	1.0001,	.5796,
1987,	38171,	257187,	125776,	60972,	.4848,	1.0001,	.4893,
1988,	41088,	234349,	126823,	59294,	.4675,	1.0001,	.6133,
1989,	48712,	202709,	102875,	40285,	.3916,	1.0000,	.3670,
1990,	44618,	219986,	113801,	28127,	.2472,	1.0002,	.1762,
1991,	64406,	260478,	138864,	24822,	.1788,	1.0003,	.1621,
1992,	50154,	306721,	175127,	41690,	.2381,	1.0001,	.2176,
1993,	32188,	322891,	192597,	52557,	.2729,	1.0000,	.2163,
1994,	27269,	327898,	207090,	54562,	.2635,	1.0000,	.2029,
1995,	35325,	309722,	187446,	57207,	.3052,	1.0001,	.2812,
1996,	41281,	281116,	203840,	61776,	.3031,	1.0001,	.3483,
1997,	31278,	232857,	165145,	63319,	.3834,	1.0003,	.3719,
1998,	25755,	199690,	119803,	51572,	.4305,	.9919,	.3851,
1999,	18466,	164543,	87823,	40732,	.4638,	1.0002,	.3898,
2000,	15675,	151538,	90345,	36715,	.4064,	.9999,	.3769,
2001,	9769,	130557,	78957,	29699,	.3761,	1.0004,	.3650,
2002,	6055,	121818,	76443,	40994,	.5363,	1.0181,	.5984,
Arith. Mean,	38431,	243205,	137241,	50711,	.3864,		.3837,
Units	(Thousands),	(Tonnes),	(Tonnes),	(Tonnes),			

Table 2.20
Analysis by RCT3 ver3.1 of data from file : ncc-inn1.txt

NORWEGIAN COASTAL COD: recruits as 2 year-olds

Data for 1 surveys over 8 years : 1993 – 2000

Regression type = C
Tapered time weighting applied
power = 3 over 20 years
Survey weighting not applied
Final estimates shrunk towards mean
Minimum S.E. for any survey taken as .20
Minimum of 3 points used for regression

Forecast/Hindcast variance correction used.

Year class = 1999

Survey/ Series	Regression: Slope	Inter-cept	Std Error	Rsquare	No. Pts	Prediction: Index Value	Predicted Value	Std Error	WAP Weights
Norweg	1.66	-5.75	.20	.818	6	8.81	8.85	.442	.423
					VPA Mean =		10.18	.379	.577

Year class = 2000

Survey/ Series	Regression: Slope	Inter-cept	Std Error	Rsquare	No. Pts	Prediction: Index Value	Predicted Value	Std Error	WAP Weights
Norweg	1.39	-3.22	.17	.915	7	8.00	7.94	.394	.628
					VPA Mean =		10.03	.512	.372

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
1999	14985	9.61	.29	.66	5.23	9770	9.19
2000	6124	8.72	.31	1.01	10.43	6056	8.71

Table 2.21 Prediction with management option table: Input data

Year: 2003								
Age	Stock size	Natural mortality	Maturity ogive	Prop.of F and M bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
2	6124	0.2	0.00	0	0	0.396	0.0231	0.390
3	4784	0.2	0.03	0	0	0.890	0.1126	1.145
4	5708	0.2	0.11	0	0	1.606	0.3559	1.903
5	6025	0.2	0.37	0	0	2.429	0.6151	2.640
6	3669	0.2	0.80	0	0	3.167	0.7805	3.522
7	1686	0.2	0.93	0	0	4.107	0.6420	4.434
8	1488	0.2	0.94	0	0	5.581	0.4613	5.331
9	1156	0.2	0.98	0	0	8.351	0.2732	6.365
10+	1889	0.2	1.00	0	0	12.509	0.2732	7.495
Unit	Thousands	-	-	-	-	Grams	-	Grams

Year: 2004								
Age	Stock size	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
2	6124	0.2	0.00	0	0	0.396	0.0231	0.390
3	.	0.2	0.03	0	0	0.890	0.1126	1.145
4	.	0.2	0.11	0	0	1.606	0.3559	1.903
5	.	0.2	0.37	0	0	2.429	0.6151	2.640
6	.	0.2	0.80	0	0	3.167	0.7805	3.522
7	.	0.2	0.93	0	0	4.107	0.6420	4.434
8	.	0.2	0.94	0	0	5.581	0.4613	5.331
9	.	0.2	0.98	0	0	8.351	0.2732	6.365
10+	.	0.2	1.00	0	0	12.509	0.2732	7.495
Unit	Thousands	-	-	-	-	Grams	-	Grams

Year: 2005								
Age	Stock size	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
2	6124	0.2	0.00	0	0	0.396	0.0231	0.390
3	.	0.2	0.03	0	0	0.890	0.1126	1.145
4	.	0.2	0.11	0	0	1.606	0.3559	1.903
5	.	0.2	0.37	0	0	2.429	0.6151	2.640
6	.	0.2	0.80	0	0	3.167	0.7805	3.522
7	.	0.2	0.93	0	0	4.107	0.6420	4.434
8	.	0.2	0.94	0	0	5.581	0.4613	5.331
9	.	0.2	0.98	0	0	8.351	0.2732	6.365
10+	.	0.2	1.00	0	0	12.509	0.2732	7.495
Unit	Thousands	-	-	-	-	Grams	-	Grams

Basis; Weight in catch 2003-2005 - average 2000-2002
Weight in stock 2003-2005 - average 2000-2002
Maturity ogive 2003-2005 - average 2000-2002
Exploit. Pattern 2003-2005 average 2000-2002 scaled to 2002

Table 2.22
Prediction with management option table

Year: 2003					Year: 2004					Year: 2005	
F Factor	Reference F	Stock biomass	Sp.stock biomass	Catch in weight	F Factor	Reference F	Stock biomass	Sp.stock biomass	Catch in weight	Stock biomass	Sp.stock Biomass
1	0.5984	90619	63224	27269	0	0	68656	49539	0	76297	56616
					0.1	0.0598	68656	49539	2351	73441	54165
					0.2	0.1197	68656	49539	4580	70729	51841
					0.3	0.1795	68656	49539	6696	68154	49636
					0.4	0.2394	68656	49539	8705	65706	47544
					0.5	0.2992	68656	49539	10613	63379	45557
					0.6	0.359	68656	49539	12425	61166	43671
					0.7	0.4189	68656	49539	14149	59060	41878
					0.8	0.4787	68656	49539	15788	57055	40173
					0.9	0.5386	68656	49539	17348	55146	38553
					1	0.5984	68656	49539	18832	53327	37011
					1.1	0.6582	68656	49539	20246	51593	35543
					1.2	0.7181	68656	49539	21594	49939	34146
					1.3	0.7779	68656	49539	22878	48362	32815
					1.4	0.8378	68656	49539	24103	46856	31546
					1.5	0.8976	68656	49539	25272	45419	30337
					1.6	0.9574	68656	49539	26387	44045	29183
					1.7	1.0173	68656	49539	27453	42733	28083
					1.8	1.0771	68656	49539	28471	41478	27033
					1.9	1.137	68656	49539	29444	40278	26029
					2	1.1968	68656	49539	30374	39130	25071
-	-	Tonnes	Tonnes	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes

Basis for 2003 : Status quo fishing mortality

Table 2.23 Catch options for 2004 with corresponding total stock biomasses and spawning stock biomasses in 2005.

Basis: F(2003) =$\mathbf{F}_{sq}$ = 0.60; Landings(2003) = 27, 000 t, SSB(2004) = 49,500 t.

F(2004)	Basis	Catch 2004 (t)	Total stock biomass 2005 (t)	SSB 2005 (t)
0	0*$\mathbf{F}_{sq}$	0	76,297	56,616
0.06	0.1*$\mathbf{F}_{sq}$	2,351	73,441	54,165
0.12	0.2*$\mathbf{F}_{sq}$	4,580	70,729	51,841
0.24	0.4*$\mathbf{F}_{sq}$	8,705	65,706	47,544
0.36	0.6*$\mathbf{F}_{sq}$	12,425	61,166	43,671
0.48	0.8*$\mathbf{F}_{sq}$	15,788	57,055	40,173
0.60	1.0*$\mathbf{F}_{sq}$	18,832	53,327	37,011

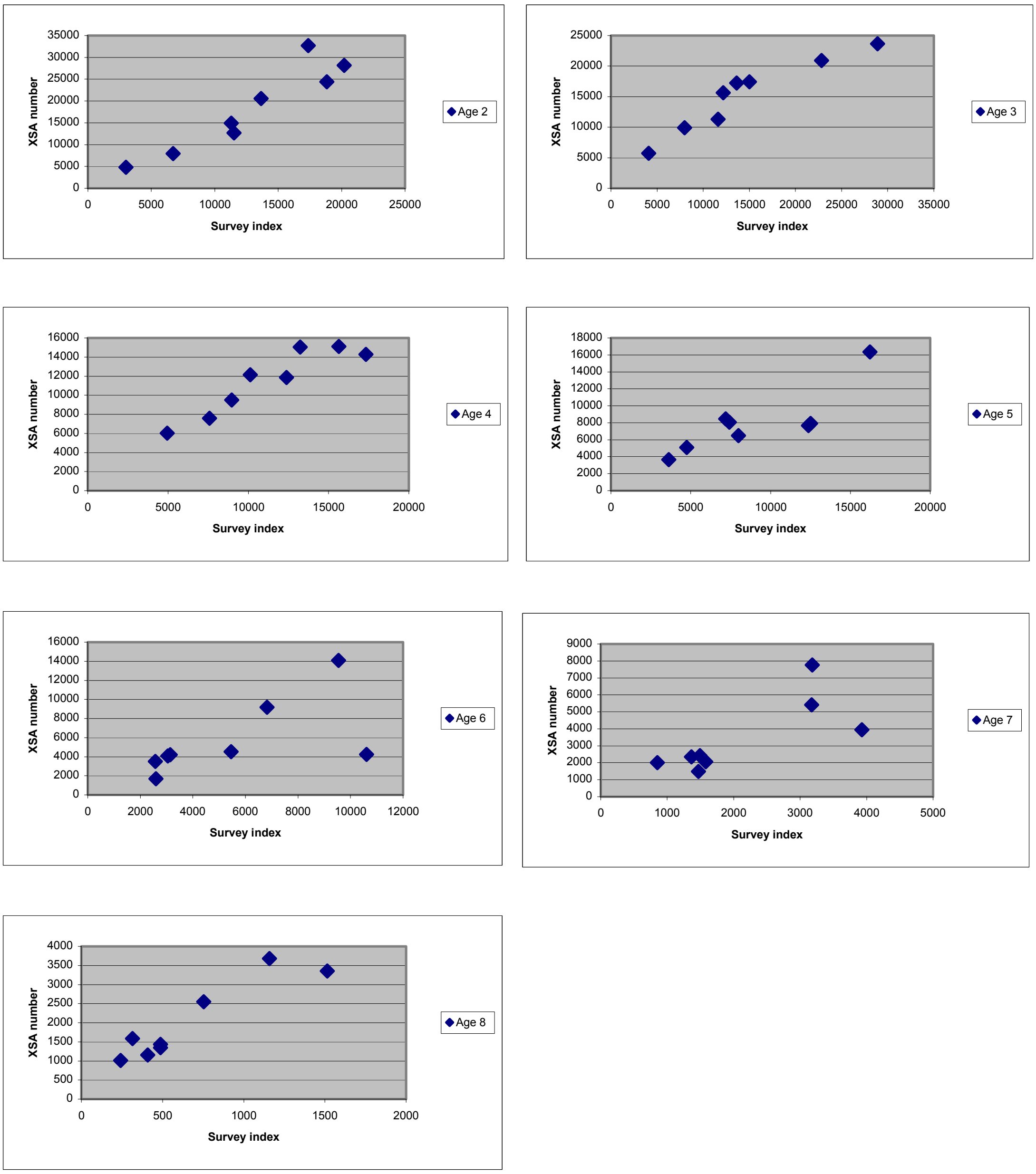

Figure 2.1 Norwegian Coastal cod – Coastal acoustic survey vs XSA. Age (n) in survey = age (n+1) from XSA the year after because the surveys are conducted late autumn (1995-2002).

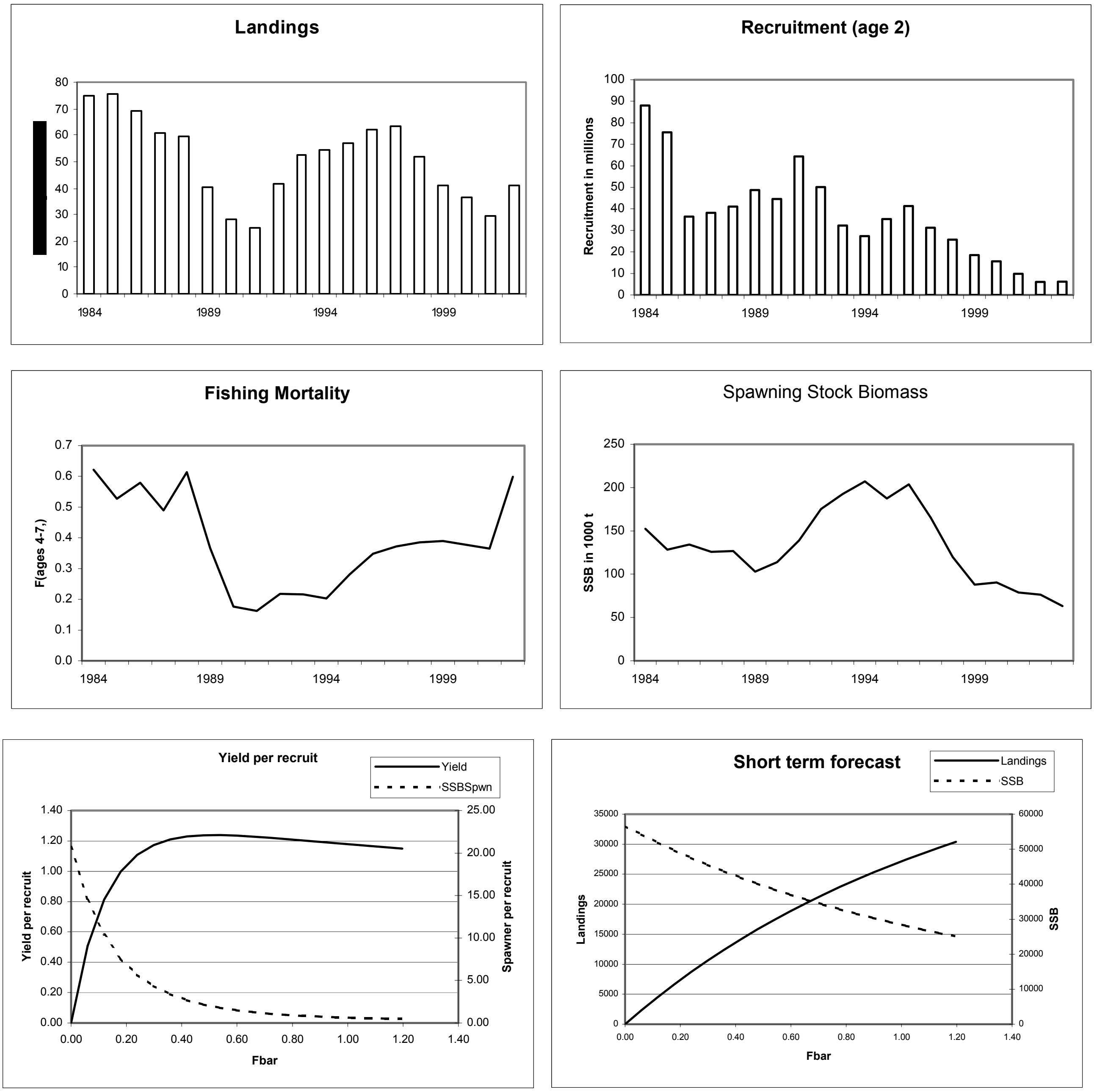

Figure 2.2 Norwegian Coastal cod: Historical landings, recruitment, fishing mortality and spawning stock biomass. Long-term yield pr recruit and spawning stock biomass per recruit. Short-term yield and spawning stock biomass.

3 NORTHEAST ARCTIC COD (SUBAREAS I AND II)

3.1 Status of the fisheries

3.1.1 Historical development of the fisheries (Table 3.1)

From a level of about 900,000 t in the mid-1970s, landings declined steadily to around 300,000 t in 1983-1985 (Table 3.1). Landings increased to above 500,000 t in 1987 before dropping to 212,000 t in 1990, the lowest level recorded in the post-war period. The catches increased rapidly from 1991 onwards, stabilised around 750,000 t in 1994-1997 but decreased to about 414,000 t in 2000. The catch in 2002 was 445,000 tonnes. The fishery is conducted both with an international trawler fleet and with coastal vessels using traditional fishing gears. Quotas were introduced in 1978 for the trawler fleets and in 1989 for the coastal fleets. In addition to quotas, the fishery is regulated by a minimum catch size, a minimum mesh size in trawls and Danish seines, a maximum by-catch of undersized fish, closure of areas having high densities of juveniles and by seasonal and area restrictions.

3.1.2 Landings prior to 2003 (Tables 3.1-3.3, Figure 3.1)

Total landings of cod in Subarea I and Divisions IIa and IIb:

Final reported landings for 2001 amount to 440,745 t. Provisional landings for 2002 are 464,271 t, which is nearly 30,000 t above the agreed quota.

Landing figures used for the assessment of Northeast Arctic cod:

The historical practise (considering catches between 62 and 67 deg. North for the whole year and catches between 67 and 69 deg. North for the second half of the year to be Norwegian coastal cod) lead to landings of Northeast Arctic cod at 426,471 t in 2001 and 445,060 t in 2002 (Table 3.1). The landings by area, split into trawl and other gears, is given in Table 3.2 and the nominal landings by country is given in Table 3.3. Compared to 2001, the landings in 2002 decreased in Division IIb and increased in Subarea I (Table 3.1).

3.1.3 Expected landings in 2003

The mixed Norwegian-Russian fisheries commission agreed on a TAC of 435,000 t for 2003, including 40,000 t Norwegian coastal cod. Since this quota is equal to the 2002 quota, it is reasonable to assume a similar catch (445,000 t) in 2003 as in 2002.

The Working Group has no information on the size of expected unreported landings in 2003 but believes this could continue to be a problem.

3.2 Status of research

3.2.1 Fishing effort and CPUE (Table A1)

CPUE series of the Norwegian, Russian and Spanish trawl fisheries are given in Table A1. The data reflect the total trawl effort, both for Norway and Russia. The Norwegian series is given as a total for all areas (Table A1).

3.2.2 Survey results (Tables A2-A5, A10-A11, A14-A15)

a) With respect to year class strength, the overall picture seen in the surveys is summarized as follows: the 1999, 2000, and 2002 year classes are close to average and the 2001 year class is weak. Most age groups in the fishable stock, have increased in the last surveys compared to the year before.

Joint Barents Sea winter survey (bottom trawl and acoustics(WD 19)

The preliminary swept area estimates and acoustic estimates from the Joint winter survey on demersal fish in the Barents Sea in winter 2003 are given in Tables A2 and A3.

Before 2000 this survey was made without participation from Russian vessels, while in the three latest surveys Russian vessels have covered important parts of the Russian zone. The indices for 1997 and 1998, when the Russian EEZ was not covered, have been adjusted as reported previously (Mehl, 1999). The number of fish (age group by age group) in the Russian EEZ in 1997 and 1998 was interpolated assuming a linear development in the proportion found in the Russian EEZ from 1996 to 1999. These estimates were then added to the numbers of fish found in the Norwegian EEZ and the Svalbard area in 1997 and 1998.

It should be noted that the survey conducted in 1993 and later years covered a larger area compared to previous years (Jakobsen *et al*. 1997). In 1991 and 1992, the number of young cod (particularly 1- and 2-year old fish) was probably underestimated, as cod of these ages were distributed at the edge of the old survey area. Other changes in the survey methodology through time are described by Jakobsen *et al*. (1997). Note that the change from 35 to 22 mm mesh size in the codend in 1994 is not corrected for in the time-series. This mainly affects the age 1 indices.

Lofoten acoustic survey on spawners (WD 21)

The estimated abundance indices from the Norwegian acoustic survey off Lofoten and Vesterålen (the main spawning area for this stock) in March/April are given in Table A4. A description of the survey, sampling effort and details of the estimation procedure can be found in Korsbrekke (1997). There was a high proportion of first time spawners in the survey.

Norwegian summer/autumn survey (WD 23)

Table A5 gives the results of the Norwegian bottom trawl survey in the Svalbard and Barents Sea area in August/September (Høines, WD 23). The results for the Svalbard area (Division IIb) have been used earlier in the XSA tuning but have been left out in the three latest assessments. The series given for the Barents Sea covers ICES Division IIa and IIb and the north-western part of subarea I, and thus includes the Svalbard area estimates.

Russian autumn survey (WD 24)

Abundance estimates from the Russian autumn survey (November-December) are given in Table A10 (acoustic estimates) and Table A11 (bottom trawl estimates). The Russian autumn survey did not cover the Norwegian economical zone in 2002. Indices obtained were adjusted assuming area distribution as 1998-2001 average.

International 0-group survey

Abundance indices of 0-group cod from the International 0-group survey are provided in Tables A14 and A15. It should be noted that in 1985 some gear changes were made, and the earlier part of the time-series is now adjusted to take account of these changes (Nakken and Raknes 1996). The abundance of 0-group cod was low in the years 1999-2001, and average in 2002. The same pattern is observed for age 1 of the same year classes in the groundfish surveys. The 0-group abundance in the years 1992-1997 is rather outstanding in the time-series. Among those year classes only 1994 and 1995 appear to be above average at age 3 in other surveys.

3.2.3 Age reading

The joint Norwegian-Russian work on cod otolith reading has continued, with regular exchanges of otoliths and age readers (Introduction chapter). Within laboratory (IMR) and between laboratories (IMR-PINRO) differences in age reading are presented in WD 11.

3.2.4 Length and Weight-at-age (Tables A6-A9, A12-A13)

Length-at-age is shown in Table A6 for the Norwegian survey in the Barents Sea in winter, in Table A8 for the Lofoten survey and in Table A12 for the Russian survey in October-December. Weight-at-age is shown in Table A7 for the Norwegian survey in the Barents Sea in winter, in Table A9 for the Lofoten survey and in Table A13 for the Russian survey in October-December.

Both the joint winter survey in 2003 and the Russian autumn survey in 2002 show little change in weights for most ages (Table A7 and A13).

3.2.5 Maturity-at-age (Table 3.5, Figure 3.2-3.7)

Historical (pre 1982) Norwegian and Russian time-series on maturity ogives were reconstructed by the 2001 AFWG meeting (ICES 2001/ACFM:02). The Norwegian maturity ogives were constructed using the Gulland method for individual cohorts, based on information on age at first spawning from otoliths. For the time period 1946-1958 only the Norwegian data were available. The Russian proportions mature at age, based on visual examinations of gonads, were available from 1959.

Since 1982 Russian and Norwegian survey data have been used (Table 3.5). For the years 1985-2003, Norwegian maturity-at-age ogives have been obtained by combining the Barents Sea and Lofoten surveys according to the method described in Marshall *et al*. (1998). Russian maturity ogives from the autumn survey are available from 1984 until present. The Norwegian maturity ogives tend to give a higher percent mature at age compared to the Russian ogives, which is consistent with the generally higher growth rates observed in cod sampled by the Norwegian surveys. The approach used is consistent with the approach used to estimate the weight-at-age in the stock (described in Section 3.3.2). The percent mature at age for the Russian and Norwegian surveys have been arithmetically averaged for all years, except 1982-1983 when only Norwegian observations were used and 1984 when only Russian observations were used.

At this years WG meeting several investigations into cod maturity were undertaken to address the following issues:

- the ACFM technical minutes regarding timing of the Russian survey with respect to evaluating maturity stage (Section 3.2.5.1);
- the combination of the Barents Sea Winter survey and Lofoten survey in estimating the Norwegian maturity ogive (Section 3.2.5.2);
- differences between maturity ogives for males and females combined versus females-only (Section 3.2.5.3);
- causes of interannual variation in proportions mature at age and the implications for stock projection (Section 3.2.5.4).

3.2.5.1 Timing of Russian surveys in relation to gonadal development

The technical minutes from ACFM (ICES Copenhagen, 21-30 May 2002, p.2) stated: "*It was noted that estimation of maturity stages during autumn might be difficult. The AFWG should further investigate maturity-at-age, especially how reliable autumn values reflect the true maturity and how methods to combine maturity estimates from autumn and spring surveys can be refined*".

Cod have group synchronous development of oocytes and are batch spawners. Usually, the development of gametes begins 4-6 months before the spawning and occurs more or less synchronously. Spawning occurs from late February to early May, peaking in late March or early April (Ellertsen 1981; Pedersen 1984).

The Russian maturity ogives for NEA cod are based on both autumn survey data and from data collected by observers onboard commercial vessels (November-February). Cod maturity stage is determined by visual examination of the gonads. Cod having gonads that are not at maturity stage 3 (developing oocytes, visible with naked eye) are classified as immature.

The Russian surveys have the advantage of sampling stock in the period when immature and mature parts of cod stock are distributed at the same area and therefore of equal availability to the survey. Moreover, the gonads of maturing fish can be clearly distinguished from immature specimens during this time period. Thus, the Russian maturity data are considered to be representative of the portion of the stock sampled by Russia.

To evaluate the potential for errors and biases in maturity ogives it is useful to compare the Norwegian and Russian maturity ogives (Figure 3.2). The Norwegian maturity ogives tend to give a higher percent mature at age compared to the Russian ogives. This is consistent with the generally higher growth rates observed in the cod sampled by the Norwegian surveys. Despite the differences in survey timing (approximately 3 months lag between surveys) and methodology (e.g., maturity scales), the Norwegian and Russian maturity ogives show the same temporal trends in maturity for all age classes (Figure 3.2).

Possible intersessional work on refining the maturity ogives includes:

- review the comparability between the Norwegian and Russian maturity stages with particular reference to the procedures used to exclude fish with uncertain maturity stages or identify individuals that may have skipped spawning;

- fill in gaps in the data (by regions and months) by smoothing data using appropriate weighting factors (Lepesevich, WD 8, 2002).

3.2.5.2 Combination of Norwegian winter and Lofoten surveys

In winter the mature and immature parts of the NEA cod stock are in a large degree spatially separated from each other. The Norwegian maturity ogives are estimated by combining data from two surveys (Barents Sea Winter survey and Lofoten survey). For each survey the total number of mature and immature cod is determined using the acoustic abundance estimates of total abundance and these values are then combined for the two surveys. It is not known the degree to which the two surveys double count cod or miss counting certain components of the stock due to the migration of the stock at this time of year. This source of error might possibly explain the discrepancy between Norwegian and Russian proportions mature for age 6 cod (Figure 3.2). The difference between Norwegian and Russian values is greatest when the proportions are high. One possible explanation of this tendency is that mature age 6 cod are being over-sampled by the Winter and Lofoten surveys over-represented in the combined survey results.

It may be possible to make improvements to the methods used for combining the Winter and Lofoten surveys. This issue should be reviewed in the coming year. However, the high degree of consistency between the Norwegian and Russian values of maturity-at-age (Figure 3.2) suggests that the magnitude of the error is small.

Possible intersessional work on estimating the Norwegian maturity ogives includes:

- review the procedures used to combine the Barents Sea Winter survey and Lofoten survey.

3.2.5.3 Gender-dependent maturity ogives

Currently, maturity-at-age ogives are estimated for males and females combined. However, female cod grow more slowly and therefore mature later than male cod. As a consequence of this dimorphic growth, both length- and age-based maturity-ogives for females differ from those for males (Ajiad et al. 1999). Changes in the age and size composition of the stock will impact the proportional contribution of females to the spawning stock and contribute to a lack of proportionality between SSB and reproductive potential (Tomkiewicz et al. 1997). For Baltic cod, estimates of female-only SSB give an improved stock/recruit relationship compared to the conventional (males and females combined) estimate of SSB used by management (Köster et al. 2001).

To investigate the degree of bias introduced to estimates of SSB from using combined maturity ogives for NEA cod Norwegian and Russian databases were used to estimate female-only SSB. The proportional contribution of females to the SSB was compared to a reference value of 0.5 that assumes a 1:1 sex ratio in the spawning stock.

3.2.5.3.1 Norwegian female-only maturity

Differences in maturity ogives between combined (males and females) and female-only cod were investigated using data from 1985 to 2001. Observations for individual cod were selected for the 1st quarter with observations for coastal cod being excluded. Cod in maturity stages greater than 1 were classified as being mature. In constructing the ogives it was noted that the database reverses the coding for sex for 1988.

The differences between the combined ogive and the female-only ogive are highest for ages 5 and 6 and decrease to negligible values for older age-classes (Fig. 3.3a). The magnitude of differences for ages 5 and 6 generally falls between 0.05 and 0.15. The female-only maturity ogives for the stock (1985-2001) were then estimated by subtracting these differences from the ogives used in the assessment (Table 3.13). For the youngest age-classes this frequently resulted in negative values. In such cases the proportion mature was set to 0.

3.2.5.3.2 Russian female-only maturity

The Russian data are expressed as the proportion of mature individuals that are female. These values extend back to the beginning of standardized sampling for maturity in 1959. To be comparable to both the Norwegian data and the assessment, the proportions have been shifted forward by one year and age-class. The proportion of mature individuals that are female increases with increasing age (Fig. 3.4). The proportions are negligible for age 3 and quite variable for ages 4-6 and for the older age classes.

3.2.5.3.3 Female-only SSB

As noted above, the Norwegian data is expressed as the proportion of females that are mature, whereas, the Russian data is expressed as the proportion of mature fish that are female. Because of the difference in how the maturity data were formulated the procedures used for estimating female-only SSB differed between the two countries, as is described below.

For the Norwegian data female-only SSB was estimated as:

$$\text{Female-only SSB} = \Sigma\, n_a \times s_a \times m_a \times w_a$$

where n_a and w_a are number- and weight-at-age, respectively. Both terms are identical to values used in estimating SSB. The sex ratio at age (s_a) expresses the proportion of females and was determined from the same Norwegian databases that were used to estimate the maturity ogives. The m_a represents the proportion of females that are mature for a given age.

Sex ratios of 1:1 were assumed for cod younger than age 8. For cod age 8 and older modelled values were used (Fig. 3.3b). These show the proportions of females to increase with increasing age. The proportion of females is often lower than 0.5 for age classes younger than 8 (Ajiad and Aglen, unpublished Working Document to SGPA December 2002). However, this tendency is likely an artefact resulting from the differential catchability and availability of males.

The Russian female-only SSB differed in its formulation of female-only SSB because maturity data was expressed as the proportion of mature individuals who were female (p_a) rather than the proportion of females who were mature. Consequently, female-only SSB for the Russian data was estimated as:

$$\text{Female-only SSB} = \Sigma\, n_a \times m_a \times p_a \times w_a$$

where n_a, m_a, and w_a are number-, maturity- and weight-at-age, respectively. These terms are identical to values used in estimating SSB.

3.2.5.3.4 Temporal trends in female-only SSB

If both sexes contribute equally to the SSB then contribution of females to the SSB should fluctuate randomly about a value of 0.5. However, both the Norwegian and Russian estimates show a strong tendency for the proportion of female-only SSB to be less than 0.5 (Fig. 3.5). The time trends in the Norwegian and Russian estimates are reasonably synchronous despite differences in their formulation. Females made an especially low (approx. 25%) contribution to SSB in the years1987-1989. Thus, SSB overestimates the reproductive potential of the stock in those years by a considerable margin. Low ratios were also observed in 1994, 1995, 2000 and 2001.

The temporal trends in female-only SSB are driven by the trends in the age composition of the spawning stock (Figure 3.5). Lower mean age of the spawning stock reduces the contribution of females to the spawning stock. This is not accounted for using SSB as an index of reproductive potential. Thus, SSB contains a *systematic* source of error that is related to the variable size and age composition of the stock. The WG should consider alternative formulations of reproductive potential that include information on sex ratios and gender-specific proportions mature. These alternative formulations should be compared to SSB as well as to recruitment to see if improvements to the stock/recruit relationship are possible, such as has been observed for Baltic cod.

Future work on estimating reproductive potential includes:

- to develop a full time-series of female-only maturity ogives that can be used to estimate female-only SSB.

3.2.5.3.5 Status of research on reproductive potential of NA cod

Research is ongoing into developing alternative indices of reproductive potential for NEA cod (Marshall et al. 1998). This research is benefiting from the improved accessibility of both Norwegian and Russian databases.

Preliminary estimates of total egg production were presented to the WG (Needle and Marshall WD#2). These estimates require further refinements before being considered as final. These refinements include: a) developing female-only maturity ogives for the full time period (1946-2001); b) refinements to the method of hindcasting fecundity and c) developing a model to incorporate maternal effects on egg viability. Female-only SSB will also be estimated for the full time period. Time-series for female-only SSB and total egg production should be available by next years WG meeting. Additionally, software tools are being developed to estimate alternative indices of reproductive potential from standard assessment output and link this information to both recruitment and medium-term stock projections (Needle and Marshall WD#2).

3.2.5.4 Potential causes of interannual variation in maturity ogives

The maturity ogives used for the medium-term stock projections have a considerable impact on the forecasted SSB values. Average values are used, however, it would be advantageous to identify factors contributing to variation in maturity ogives. Ongoing research into the growth dynamics of Northeast Arctic cod has shown that there is a positive relationship between weight-at-length and maturity-at-length (ICES CM 2003/D:01). Similarly, there is a positive relationship between weight-at-age and maturity-at-age for age-classes 4 to 7 (Fig. 3.6). Liver weight estimates (g) for a 70 cm cod (derived from the Russian liver condition index and age/length keys described in Marshall and Needle WD#3) show a significant, positive relationship with the proportion of mature age 7 cod for the time period 1984 to 2001 (Figure 3.7). During this time period liver weight varies from a historical low in 1988 (108 g) to a historical high in 1991 (260 g). Both Figures 3.6 and 3.7 results are consistent with bioenergetic studies showing that maturation rates of cod reflect their growth history.

The 2003 maturity-at-age values for age classes 6 and 7 are slightly lower than those for 2002. The decreasing trend may continue in the short-term particularly given the high levels of biomass. Short-term projections of maturity-at-age should therefore be consistent with forecasts for weight-at-age, liver condition and potentially capelin stock biomass.

Possible future work on projecting maturity ogives includes:

- model the link between liver weights and maturity using available data resources and establish a method for predicting liver weights in the upcoming year. This research can take advantage of the links between capelin stock biomass and liver condition.

3.3 Data used in the assessment

3.3.1 Catch-at-age (Tables 3.8, 3.9 and 3.10)

For 2001 final total landings for all countries only differed by 31 tons to those used in last year’s assessment. Some Norwegian trawl catches were moved from area IIa to IIb and some Icelandic catches were moved from area I to IIa. This lead to very minor adjustments of the number-at-age in the 2001 landings. For 2002, age compositions for all areas were available from Norway (by gears) Russia and Spain. German catches were sampled for some areas and quarters. For the unsampled areas and quarters German catches were distributed on ages by use of Russian or Norwegian trawl samples. Age compositions of the total landings were calculated separately in Subarea I and Division IIa and IIb by using the age compositions that were available and raising the landings from other countries by Russian trawl (Subarea I and Division IIa), and by Norwegian trawl (Division IIb).

Table 3.8 show available catch-at-age data for all ages 1-15+. The catch numbers shown in Table 3.10 together with cannibalism figures (Tables 3.9) were used in the XSA tuning.

3.3.2 Weight-at-age (Tables 3.4 and 3.11-3.12)

The weights-at-age in stock and catches for the age group 13+ was calculated by the IFAP system when ages 13,14 and 15+ were merged.

Catch weights

For 2001, the mean weight-at-age in the catch (Table 3.11) was calculated as a weighted average of the weight-at-age in the catch for Norway, Russia, Germany and Spain. The weight-at-age in the catch for these countries is given in Table 3.4.

Stock weights

The technical minutes from ACFM May 2001 raise the question about weight-at-age for ages 12 and 13+. Since these ages are scarce in the survey samples, fixed values for ages 12 to 15+ has been used (set equal to typical weights for these ages observed in catches). The IFAP data base has been updated for all ages 1-15+ with these fixed values for ages 12-15+. When the assessment applies 13 as plus group, the 13+ weights is calculated year by year as a weighted mean of the fixed values by older ages.

For ages 1-11 stock weights-at-age a (W_a) at the start of year y for 1983-2002 (Table 3.12) were calculated as follows:

$$W_a = 0.5(W_{rus,a-1} + (\frac{N_{nbar,a}W_{nbar,a} + N_{lof,a}W_{lof,a}}{N_{nbar,a} + N_{lof,a}}))$$

where

$W_{rus,a-1}$: Weight-at-age a-1 in the Russian survey in year y-1 (Table A13)

$N_{nbar,a}$: Abundance at age a in the Norwegian Barents Sea acoustic survey in year y (Table A2)

$W_{nbar,a}$: Weight-at-age a in the Norwegian Barents Sea acoustic survey in year y (Table A7)

$N_{lof,a}$: Abundance at age a in the Lofoten survey in year y (Table A4)

$W_{lof,a}$: Weight-at-age a in the Lofoten survey in year y (Table A9)

3.3.3 Natural mortality

A natural mortality of 0.2 was used. In addition, cannibalism was taken into account as described in Section 3.4.2. The proportion of F and M before spawning was set to zero.

3.3.4 Maturity-at-age (Tables 3.5 and 3.13)

As noted in Section 3.2.5, arithmetic averages of the Russian and Norwegian maturity-at-age values were used for 1985-2002.

3.3.5 Tuning data (Tables 3.14 and 3.15)

The following surveys and commercial CPUE data series was used for initial tuning runs by single fleets:

	Name	Place	Season	Age	Years
Fleet 17	Russian bottom trawl surv.	Total area	Autumn	3-8	1982-2002
Fleet 09	Russian trawl CPUE	Total area	All year	9-12	1985-2002
Fleet 15	Joint bottom trawl survey	Barents Sea	Winter	3-8	1981-2003
Fleet 16	Joint acoustic survey	Barents Sea + Lofoten	Winter	3-11	1985-2003 (Table A16)

Table 3.15 and Figure 3.8 shows a comparison between the fleets. The table show some differences between fleets, and concerns were raised regarding increased uncertainty in fleet 16 and 17. Table 3.15 show the effect of removing the latest observations in these fleets. It also show the effect of increasing the weight on shrinkage (reducing the minimum SE for shrinkage), and the effect of changing ages for stock size dependent catchabilities. The conclusion was to keep the tuning settings used in previous assessments. Plots of log-catcability residuals are shown in Figures 3.12-3.14.

The output tables from the tuning include ages 1 and 2, just to show the year class abundance at age 1 and 2 created by the cannibalism numbers used in the tuning.

As in earlier assessments the surveys that were conducted during winter were allocated to the end of the previous year. This was done so that data from the surveys in 2003 could be included in the assessment. Some of the survey indices have been multiplied by a factor 10. This was done to keep the dynamics of the surveys even for very low indices, because XSA adds 1.0 to the indices before the logarithm is taken.

Tuning of the VPA was carried out with XSA using default settings with the following exceptions:

1. Tapered time weighting power 3 over 10 years

2. Catchability dependent of stock size for ages less than 6

3. F of the 2 oldest age groups used in F shrinkage

4. Standard error of the mean to which estimates are shrunk set to 1.0

These settings are identical to those used by last years Working Group.

3.3.6 Recruitment indices (Tables 3.6 and 3.7)

The survey data on ages 0,1 and 2 in the autumn survey and ages 1,2 and 3 in the joint winter survey are not used in the XSA, and are instead used to estimate the year class strength at age 3 by making regressions with VPA estimates of recruitment at age 3 (the RCT3-program in the ICES software). The input is shown in Table 3.6, and the output is shown in Table 3.7.

3.3.7 Cannibalism

The method used for calculation of the consumption is described by Bogstad and Mehl (1997). It should be noted that the temperature is used in these calculations. The estimates were obtained as follows:

The cod stomach content data were taken from the joint PINRO-IMR stomach content database (methods described in Mehl and Yaragina 1992). On average 7,500 cod stomachs from the Barents Sea have been analysed annually. The stomachs are sampled throughout the year, although sampling is less frequent in the second quarter of the year. The consumption calculations have been updated by data for 2002 as well as additional data for 2001. The Barents Sea was divided into three areas (west, east and north) and the consumption by cod was calculated from the average stomach content of each prey group by area, half-year and cod age group.

The number of cod predators at age is taken from the VPA, and thus an iterative procedure has to be applied (Section 3.4.2). It was assumed that the mature part of the cod stock is found outside the Barents Sea for three months during the first half of the year. There were very few samples of the stomach contents of cod in the spawning areas. Thus, consumption by cod in the spawning period was omitted from the calculations. It is believed that the cod generally eats very little during spawning, although some predation by cod on herring has been observed close to the spawning areas. The geographical distribution of the cod stock by season is based on Norwegian survey data. The total number of cod ages 0–6 (million) consumed is given in Table 3.9. Alternative calculations of the number of cod consumed by cod, giving somewhat different results, were presented in WD 6.

3.3.8 Prediction data (Tables 3.23 and 3.28, Figure 3.9)

The input data to the short-term prediction with management option table (2003-2005) are given in Table 3.28. For 2003 stock weights and maturity were taken from surveys as described in Sections 3.3.2 and 3.3.4.

Catch weights in 2003 onwards and Stock weights in 2004 onwards are predicted by the method described by Brander (2002), where the latest observation of weights by cohort are used together with average annual increments to predict the weight of the cohort the following year.

For Catch Weights average annual increments by age were calculated for the period 1994-2001 (based on weights for the period 1994-2002), and for Stock Weights average annual increments by age were calculated for the period 1995-2002 (based on weights for the period 1995-2003).

A preliminary prediction indicated further increase of stock size to levels which in earlier years have been associated with reduced maturation, and the observed maturity in 2003 is slightly lower than in 2002 (see section 3.2.5.4). It was therefore decided to assume a reduced maturation for 2004 and later years. It was decided to use last 20-year average

(1984-2003). The exploitation pattern in 2003 and later years was set equal to the 2000-2002 average. The reference F were set equal to the 2002 value (no 3 year averaging) since the two latest assessments have indicated a recent declining trend in reference F.

The stock number-at-age in 2003 was taken from the final VPA (Table 3.23) for ages 4 and older. The recruitment at age 3 in year 2003 and later was estimated from surveys (section 3.3.6). Fig. 3.9A shows the development in natural mortality due to cannibalism for cod (prey) age groups 1-3 together with the abundance of capelin in the period 1984-2002. It is seen that the level of cannibalism is inversely related to the capelin abundance. Because the capelin abundance is expected to change rather little from 2002 to 2003, the natural mortality due to cannibalism (M2) in 2003 and later years was set equal to the 2002 values.

3.4 Methods used in the assessment

3.4.1 VPA and tuning

For several years each new assessment of this stock has shown a considerable downward revision in population size. This has been clearly shown both in the Quality Control Diagrams and in the retrospective analysis presented by earlier Working Groups. In the assessments in August 2000, several changes in model settings and data choices were made, and since then the retrospective analysis has considerably improved, and the Quality Control Diagrams now indicate rather consistent assessments since 1999.

There were no changes in the present assessment method compared to last year.

3.4.2 Including cannibalism in the VPA (Tables 3.16-3.20, 3.22)

As a starting point the number of cod consumed by cod were estimated from the stock estimates in the last assessment. Then the number consumed was added to the catches used for tuning. The resulting stock then lead to new estimates of consumption. This procedure was repeated until the revision of consumed numbers for the latest year (2002) differed less than 1% from the previous iteration.

The tuning diagnostics from VPA with cannibalism are given in Table 3.16 and the total fishing mortalities (true fishing mortality plus mortality from cannibalism) and population numbers in Tables 3.17 and 3.18.

In order to build a matrix of natural mortality which includes predation, the fishing mortality estimated in the final XSA analyses was split into the mortality caused by the fishing fleet (true F) and the mortality caused by cod cannibalism (M2 in MSVPA terminology) by using the number caught by fishing and by cannibalism. The new natural mortality data matrix was prepared by adding 0.2 (M1) to the M2. This new M matrix (Table 3.19) was used together with the new true Fs to run the final VPA on ages 3-13+. M2 and F values for ages 1-6 in 1984-2002 are given in Tables 3.20 and 3.22. The values for the 2000 and 2001 year classes (age 1 in 2001 and ages 1 and 2 in 2002) are removed because they depend on the RCT3 estimates of these year classes.

Cannibalism on cod age 3 and older may of course also have occurred before 1984. Thus, there is an inconsistency in the recruitment time-series. For comparison with the historic time-series an additional VPA with the same terminal Fs and fixed natural mortality (0.2) is presented (Table 3.27).

Figure 3.9B shows the survey mortality for age 1-2 and 2-3 from the Norwegian bottom trawl survey (Table A3), compared to the mortality calculated for age 1 and 2 by the XSA with cannibalism (Table 3.20 and 3.22). It is seen that the variation over time and also the absolute level of survey mortality and the mortality calculated from the XSA are in good correspondence with each other, particularly for age 2. As the survey estimates for ages 1-3 are not used in the tuning, these values of calculating mortality should be independent.

3.5 Results of the assessment

3.5.1 Fishing mortalities and VPA (Tables 3.21-3.26, Figures 3.1)

The estimated $F_{5\text{-}10}$ in 2002 is higher than predicted with TAC constraint last year (0.70 vs. 0.65), while the spawning stock biomass in 2002 is estimated to be 505,000 t, which is well above last year's assessment (430,000 t). The SSB in 2003 is 653,000 t, compared to 430,000 t in the prediction made last year.

Figure 3.10 shows the results of a retrospective analysis when cannibalism is taken into account. The number of cod consumed by cod was not recalculated year by year in the retrospective analysis, however. The fishing mortalities and stock numbers are given in Tables 3.21 -3.23, while the stock biomass at age and the spawning stock biomass at age are given in Tables 3.24-3.25. A summary of landings, fishing mortality, stock biomass, spawning stock biomass and recruitment since 1946 is given in Table 3.26 and Figures 3.1A and 3.1B.

3.5.2 Recruitment (Table 3.6- 3.7)

From the RCT3 calculations the estimated number (millions) of recruits at age 3 is 681 millions for the 2000 year class, 308 millions for the 2001 year class and 664 millions for the 2002 year class. A comparison of these results with the results of other recruitment models is given in Section 1.4.1.1.

3.6 Reference points

During the 2001 WG considerable revisions of maturity-at-age and weights-at-age were introduced. As a consequence. the PA reference points for Northeast Arctic cod have to be revised. They have been debated for several years and the AFWG 2002 agreed that a special meeting devoted to a full discussion of the PRP for Northeast Arctic cod needed to resolve the matters. In accordance with framework proposed by ICES and developed further at the December 2002 meeting of SGPA the revision of PA reference points for NEA cod was done during the special meeting SGBRP (see Introduction). AFWG proposes these values to be adopted by ACFM

3.6.1 Biomass reference points (Figure 3.1)

The values in current use are $\mathbf{B}_{lim}$ =112,000 t (lowest observed in the 1997 assessment) and $\mathbf{B}_{pa}$ = 500,000 t (former MBAL).

The new values are $\mathbf{B}_{lim}$ = 220,000t, $\mathbf{B}_{pa}$ = 460,000t. (ICES 2003/ACFM:11).

3.6.2 Fishing mortality reference points

The SGPAFM (ICES 1998/ACFM:10) suggested the limit reference point $\mathbf{F}_{lim}$=$\mathbf{F}_{med}$ for Northeast Arctic cod, haddock, and saithe. A precautionary fishing mortality ($\mathbf{F}_{pa}$) is then defined as $\mathbf{F}_{pa}$= $F_{lim}e^{-1.645\sigma}$ (σ = 0.2-0.3). The 1998 WG, however, found that setting $\mathbf{F}_{lim}$=$\mathbf{F}_{med}$ did not correspond very well with the exploitation history for cod. The median value for $\mathbf{F}_{loss}$ was estimated at 0.70, and the 5th percentile of this value was adopted as a precautionary reference fishing mortality ($\mathbf{F}_{pa}$=0.42) by the WG in 1998. Since 1998 ACFM has used $\mathbf{F}_{lim}$=$\mathbf{F}_{loss}$=0.70 and $\mathbf{F}_{pa}$ =0.42. This value of $\mathbf{F}_{pa}$ corresponded both to the upper 5 percentile of $\mathbf{F}_{loss}$ and to σ = 0.3 in the equation above.

With the revisions of the time-series made at the 2001 WG meeting, the F reference points relating to the stock-recruitment–plot needed to be reconsidered. The new values estimated by SGBRP are $\mathbf{F}_{lim}$ = 0.74 and $\mathbf{F}_{pa}$ = 0.40 (ICES 2003/ACFM:11).

3.7 Catch options (Tables 3.29-3.30)

Catch options are presented in Table 3.29. The detailed outputs corresponding to $\mathbf{F}_{sq}$ in 2003 and $\mathbf{F}_{pa}$ in 2004 and 2005 is given in Table 3.30.

In Figure 3.1 the catch level in 2004 and spawning stock biomass level in 2005 are plotted against the fishing mortality in 2004.

3.8 Medium-term forecasts and management scenarios

3.8.1 Input data (Table 3.28)

The simulation period was 2003-2007. The input data were the same as used for the short-term predictions, using the same data for the years after 2005 as for 2005 (Table 3.28). The abundance of the 2003 and 2004 year classes at age 3 was set equal to the long-term average of 600 million individuals.

3.8.2 Methods

It was decided to limit the risk analysis for Northeast Arctic cod to a single-species analysis, where only uncertainty in the initial stock estimate and the recruitment is taken into account. The uncertainty of the stock estimate in 2003 and later years was modeled using a lognormal distribution with a standard error on log scale of 0.3 for all ages. This value is somewhat above the external standard error from the XSA, in recognition of the risk of bias in the assessment, which has been observed in previous years. The errors in numbers-at-age are assumed to be uncorrelated. A modified version of the general-purpose @RISK simulation spreadsheet previously used for studying harvest control rules for Norwegian Spring-spawning herring by the WGNPBW (see e.g. ICES C. M. 1997/Assess:14) was used in the simulations. 2000 simulations were performed for each harvest control rule.

3.8.3 New harvesting strategy adopted

At the 31st session of The Joint Norwegian-Russian Fishery Commission in autumn 2002, the Parties agreed that the new harvesting strategy for Northeast Arctic cod and haddock should incorporate the following considerations:

- to prepare the basis for a long-term high yield of the stocks
- the desirability to obtain a high degree of stability in the TAC from year to year
- full utilization, at all times, of the most recent information available on the stock development

On this basis, the Parties determined the following decision rule for setting the annual fishing quota for Northeast Arctic cod from 2004 onwards:

- estimate the average TAC level for the coming 3 years based on $\mathbf{F}_{pa}$. TAC for next year will be set to this level as a starting value for the 3 years period
- the year after, the TAC calculation for the next 3 years is repeated based on updated information about the stock development, though such that the TAC should not be changed by more than +/- 10% compared with the previous year's TAC.
- if the spawning stock falls below $\mathbf{B}_{pa}$, the Parties should consider a lower TAC than according to the decision rule above.

3.8.4 Comments to the new harvesting strategy

First, a clarification concerning the constraint on the change in quota from one year to the next is needed. It is not entirely clear whether the constraint of a maximum change of 10% from year to year also applies to the setting of the TAC for 2004. In the following, applying this constraint to the 2004 TAC (less than 10% different from the 2003 TAC) is denoted as catch rule 1, while not applying this constraint to the 2004 TAC is denoted as catch rule 2.

The appropriateness of the maximum percentage change will be evaluated by a dedicated working group appointed by the Joint Norwegian-Russian Fisheries Commission before a final decision is made. However, the AFWG notice that the stock fluctuations from year to year may exceed +/- 10%. An attempt to retain catch variations within the 10% may entail both underfishing and overfishing of the stock. It is necessary to test the decision rule with simulation models in order to consider various scenarios of SSB dynamics (both for an increasing and decreasing stock situation). This work needs to be done before the rule is adopted.

A "multi-annual" rule as described above for setting the TAC for Northeast Arctic cod has not previously been considered by ICES Working and Study Groups. Some general points relating to such rules were noted:

According to the ACFM form of Advice any target F should be below $\mathbf{F}_{pa}$ to be in accordance with the Precautionary Approach .The medium-term prognosis shows that the new strategy will not always keep F at below $\mathbf{F}_{pa}$. The reason is that when F=$\mathbf{F}_{pa}$ is applied for a three-year period, the stock will in many cases increase, so that the catch corresponding to F=$\mathbf{F}_{pa}$ will also increase during the period. When applying the 3-year averaging method to find the TAC in the first year, this will thus be higher than the TAC corresponding to F= $\mathbf{F}_{pa}$ in the first year.

Involving the medium-term prognosis (three years into future) in the setting of quotas for next year also introduces additional uncertainty due to uncertainty in the prognosis of growth, maturation, recruitment and mortality. Thus, the fishing mortality associated with a multi-annual TAC rule may have to be set lower than $\mathbf{F}_{pa}$ in order to ensure the same probability of avoiding limit values. The ICES should provide guidelines on how to evaluate the effect on multi-annual TAC rules on reference points.

The Working Group did not have available software which could perform a risk analysis applying the agreed harvest control rule.

3.8.5 Results (Figure 3.11)

In all runs F *status quo* was used in 2003, with various options for 2004 and later years. The text table below shows the average catch in the period 2004-2006 and the probability of SSB to be below B_{pa} = 460 000 tonnes in 2007 for the various catch options. Risk profiles for the total stock biomass, spawning stock biomass and catch are shown in Figs 3.11a-c.

Basis 2003: F status quo=0.70

F	Basis, 2004-2006	Average catch 2004-2006 (annual catches in brackets)	P (SSB< $\mathbf{B}_{pa}$) in 2007
0.00	0	0	<5%
0.25	0.36*$\mathbf{F}_{sq}$	361 (265-366-452)	<5%
0.40	$\mathbf{F}_{pa}$ (=0.57*$\mathbf{F}_{sq}$)	486(400-498-560)	<5%
	Catch rule1: 10%>03TAC	480 (435-479-527)	N/A
	Catch rule 2	528(486-529-569)	N/A
0.70	1.0*$\mathbf{F}_{sq}$	634(629-646-627)	14%

Short-term catch forecast based on status quo fishing mortality in 2003:

Basis 2003: F=$\mathbf{F}_{sq}$=0.70, Catch=578000 t, leads to SSB2004=652000 t

F	Basis	Landings 2004	SSB 2005	P (SSB< $\mathbf{B}_{pa}$) in 2007
0.00	0	0	1189	<5%
0.25	0.36*$\mathbf{F}_{sq}$	265	967	<5%
0.40	$\mathbf{F}_{pa}$ (=0.57*$\mathbf{F}_{sq}$)	400	856	<5%
0.44	Catch rule1 (=0.63*$\mathbf{F}_{sq}$): 10%>03TAC	435	829	N/A
0.50	Catch rule2 (=0.73*$\mathbf{F}_{sq}$)	486	788	N/A
0.70	1.0*$\mathbf{F}_{sq}$	629	677	14%

It should be noted that for catch rule2, the constraint of maximum 10% change from year to year does not affect the catch in 2005 and 2006, while for catch rule 1, the constraint of maximum 10% change from year to year limit the catch both in 2004, 2005 and 2006.

3.8.6 Management considerations

The spawning stock in 2003 is above $\mathbf{B}_{pa}$, and is predicted to grow further in 2004. The fishing mortality has decreased somewhat, but is still close to $\mathbf{F}_{lim}$.

The forecasts indicate that fishing at $\mathbf{F}_{pa}$ in 2004 (400,000 t) allows for further stock increase in 2005, and the medium-term projections indicate that there is high probability that the stock will remain above $\mathbf{B}_{pa}$ the following two years.

The catch rule in its present form (Section 3.8.3) is not sufficiently specified to be in agreement with the precautionary approach. It does not clearly specify the actions to be taken to ensure that the stock rebuilds in case it falls below $\mathbf{B}_{pa}$, and the rule could allow the F to be above $\mathbf{F}_{pa}$ for long periods. The rule might be considered to be in agreement with the precautionary approach if sufficient action for a quick rebuilding above $\mathbf{B}_{pa}$ is specified.

The main criteria to be fulfilled for satisfying the precautionary approach is that the probability for SSB>$\mathbf{B}_{lim}$ is kept high (90-95%). Comprehensive simulations would give information on the additional specifications needed for the rule to meet this criterion.

It is therefore advised that the F in 2004 should be below $\mathbf{F}_{pa}$, corresponding to landings less than 400,000 tonnes. If the catch rule is adjusted and proved to be in agreement with the precautionary approach, the landings could be set by the rule.

It should be noted that the current assessment might be over-optimistic (see below). Compared to the prediction above, an assessment based on the Joint bottom trawl survey index alone (Fleet 15 in Table 3.15) gives a prediction with 30% lower spawning stock and 21% lower $\mathbf{F}_{pa}$-catch in 2004. These values for 2004 are within the 10%-90% percentile range shown in the probabilistic projections shown in Figure 3.11.

3.9 Comments to the assessment (Figures 3.10-3.16, Table 3.31).

There are indications of reduced precision of the latest surveys compared to those in the previous 2-3 years. The Russian autumn survey was not allowed to cover the Norwegian Zone, and at the Joint winter survey, the fish appeared to be more patchy distributed than in recent years. Concerns were raised that at least some of the surveys might have over-estimated the stock.

Previous Working Groups have been concerned about possible discarding and under-reporting (Introduction, and ACFM CM 2001/ACFM:02). The Working Group expresses serious concerns that mis-reporting and discarding of similar magnitude still continues (Sokolov, WD9). This creates uncertainties in the catch statistics and undermines the basis for the assessment and catch predictions. This is a strong reason for additional precaution when setting quotas. It also calls for an evaluation of the current management and catch control systems.

A time-series of discard estimates for cod was presented at the 2002 WG (Dingsør, 2001). Some results are shown in Table 3.31. The later part of this time-series overlaps with the period reported in WD 9. The results in the overlapping years differ considerably. The discrepancies should be analysed before these time-series are used in the assessment.

3.9.1 Comparison of this year's assessment with last year's assessment.

Retrospective plots of F, SSB and recruitment are shown in Figure 3.10.

The text table compares this years estimates with last years estimate for the year 2002 for number-at-age, total biomass, spawning biomass and reference F-values, as well as reference F for the year 2001.

		2002										F(2002)
	F(2001)	age3	age4	age5	age6	age7	age8	age9	age10	TSB	SSB	C.cons/$\mathbf{F}_{sq}$
2002ass	0.84	278	361	315	157	73	16	2.1	1.00	1343	430	0.65/0.84
2003 ass	0.83	498	385	360	193	83	20	2.8	0.74	1593	505	0.7
ratio	0.99	1.79	1.07	1.14	1.23	1.14	1.25	1.33	0.74	1.19	1.17	1.08/0.83

The reference F in 2001 is nearly unchanged, and the F in 2002 is near the F corresponding to the catch constraint and somewhat below the assumed $\mathbf{F}_{sq}$. The upward revision of stock numbers and biomass in 2002 seems contradictory to the agreements among Fs. A further shift in exploitation pattern towards older fish seem to be the main reason why the increased stock numbers have not lead to decreased reference F. Compared to the catch constrained prediction from the 2002 assessment the new Fs at age for 2002 are lower for ages 5-6 and higher for ages 9-10.

For comparison the retrospective pattern for F(4-8) is also shown (Fig. 3.10B). This show considerably less between year revision than the F(5-10), particularly some years back in time. This is most likely caused by some sampling noise associated with the age groups 9 and 10, which in some years are rather scarce in some fishing fleets and survey fleets. It could be considered to change the age range for the reference F for this stock.

3.10 Alternative assessment methods (Fleksibest)

3.10.1 Introduction

A complete description of the mathematical formulations used in Fleksibest is given in Frøysa *et al*. (2002). Fleksibest is a length-structured extension of the type of age structured assessment models sometimes termed 'statistical catch-at-age analysis' (Fournier and Archibald, 1982; Deriso *et al*., 1985). As last year, a complete assessment including a medium-term prediction is presented for comparison with the XSA assessment. An outline of the plans for future work on Fleksibest is given in the Introduction section.

3.10.2 Stock assessment using Fleksibest

3.10.2.1 Model structure

A quarterly time step is used. The model is run for the period 1.quarter 1985- 1.quarter 2003. The cod stock is divided into an immature (ages 3-10, lengths 15-105 cm) and a mature part (ages 4-12+, lengths 55-135 cm). Maturation takes part in the fourth quarter each year. 1 cm wide length groups are used in the model, and 5 cm wide length groups in the survey and catch data files.

3.10.2.2 Data used

Survey data

The Norwegian summer bottom trawl survey was not included in the Fleksibest assessment this year, in order to be consistent with the XSA assessment. Otherwise, the same surveys as in last year's assessment were used. Some age and length groups with few or very noisy observations are deleted from some surveys. The table below shows the year, age and length range for the surveys used.

Survey	Quarter	Year range	Age range	Length range	Stock covered
Norwegian winter bottom trawl	1	1985-1993	3-9	20-90 cm	Immature
Norwegian winter bottom trawl	1	1994-2003	3-9	20-90 cm	Immature
Norwegian winter acoustic	1	1985-1993	3-9	20-90 cm	Immature
Norwegian winter acoustic	1	1994-2003	3-9	20-90 cm	Immature
Lofoten acoustic	1	1985-1989	5-12+	55-110 cm	Mature
Lofoten acoustic	1	1990-2003	5-12+	55-110 cm	Mature
Russian bottom trawl	4	1985-1993 and 1995-2002	3-8	21-106 cm	Immature and mature

The Norwegian winter survey in the Barents Sea (bottom trawl and acoustic indices) was split into two time periods because of the change of gear and increase in area coverage in 1994 (Jakobsen *et al*., 1997). The Lofoten acoustic survey was split into two periods because of the change of echosounder in 1990 (Korsbrekke, 1997). The 1994 data from the Russian bottom trawl survey gave extremely high residuals and were removed. The XSA also indicates a bad fit for this survey in 1994.

Catch data

As last year, it was decided to treat the gillnet fishery separately from the other fleets, as this fleet is fishing on much larger fish than the other fleets. It was also attempted to treat the Russian trawl fleet separately, but in the final run, this fleet was combined with the non-gillnet Norwegian fleets, just like last year. This is further discussed in Section 3.10.3. Thus, we use catch in numbers-at-age and length by quarter from the following two fleets:

- Combined fleet: All Norwegian fleets except gillnet (Danish seine, handline, longline, Norwegian trawl)+ Russian trawl
- Gillnet

Data for 1985-2002 are used, for length groups 15-135 cm and ages 3-12+.

In addition, two fleets contribute to the fishing mortality in the model, with assumed mortality parameters.

Third countries. The ratio between partial F for this fleet and of the combined fleet is the same as the ratio between the catch in tonnes for these fleets, for each year.

Overfishing. In 1990-1994, the Working Group included estimates of unreported landings (assumed to have the same age distribution as the total reported landings) in the assessment. To account for this we have introduced an 'overfishing' fleet which fishes (with the same selection as the combined fleet) in these years. The partial F for this fleet is estimated for each of the years 1990-1994 is estimated.

Consumption data

Data on the consumption (kg/time step) of cod by cod for the period 1985-2002 calculated in the same way as in Bogstad and Mehl (1997). The data are given by predator age group and prey length group.

Differences between data used in XSA and in Fleksibest

It should be noted that there is some difference between the tuning series used is XSA and in Fleksibest. The older part of all the survey time-series are downweighted in XSA. In Fleksibest, all years are given the same weight, but the Norwegian winter bottom trawl survey, the Norwegian winter acoustic survey and the Lofoten survey are split into two time periods. Also, the Norwegian winter acoustic survey and the Lofoten survey are combined in XSA, but not in Fleksibest.

3.10.2.3 Model assumptions

The Pearson function, which is scale dependent, was used as an objective function.

The length selectivity was assumed to be a linear function of length for all surveys except for the Lofoten survey. The slope of this function is close to zero for all the surveys. For the Lofoten survey and for the commercial fleets a logistic length selection curve was assumed.

Linear mean growth in length, variable by year, was assumed. The ratio between the growth rate of mature and immature fish was assumed to be the same for all years.

The maturation parameters were set to values giving slightly lower values for maturity-at-age than in the input to the XSA. However, as the mean weight of mature fish is higher than that of immature fish, the proportion of the biomass, which is mature, is quite similar. A large discrepancy is observed for 1987, when the condition factor was very low. This could possibly be accounted for by also including the condition factor in the maturation function.

The values of the contribution to the objective function from catches were upweighted with a factor of 20 compared to the surveys in order to get approximately the same contribution to the total value of the objective function for both groups of data sources. Also, consumption data were downweighted in the estimations, for the same reasons as given in the 2001 AFWG report. The effect of changing the weighting of the different data sources was investigated during the 2001 AFWG meeting and was not studied this year.

3.10.2.4 Optimization algorithm

A combination of the Simulated Annealing and Hooke & Jeeves algorithms was used. Repeated searches with the combination of these algorithms were performed, starting at the optimum found during the previous search. Sensitivity tests indicate that a minimum was found for the key run.

Changes from last year:

- 1 cm length classes
- Beta-binomial distribution used to model distribution of length growth
- Different handling of Russian length distributions
- Norwegian summer survey excluded

- Catch in tonnes likelihood included

1cm length classes

The model has been altered to use 1cm length classes rather than the previous 2.5cm ones. This allows for a more accurate modelling of the length distribution of modelled fish, in particular it allows for more accurate modelling of the actual distribution of growth in each time step. The previous 2.5cm length classes were too large to capture this distribution accurately (with almost all fish growing by 0, 1 or 2 2.5cm classes each time step). It should be noted that this is a change to the internal model dynamics, and does not directly affect the comparison with the data.

Beta-binomial distribution describing distribution of length growth

The look-up table for determining how many length groups the fish will grow when the mean growth is given, has now been replaced with a fully modelled distribution, controlled by an optimizable parameter. The distribution is controlled using the beta-binomial distribution, with a single optimized parameter, in the same way as described by Björnsson and Sigurdsson (2003). Separate parameters are used for the mature and immature population groups in order to capture the different dynamics of the two stocks.

Handling of Russian length distributions

The Russian catch and survey data have always been given on length classes which are shifted 1cm compared with the Norwegian data (21-25 cm instead of 20-24 cm etc.). Previously, this has been ignored, and the Russian data have been assumed to be given on the same length groups as the Norwegian data. With 1cm wide model length classes, the correct length distribution can be used for the Russian data. This was done for the Russian survey data, but not for the Russian catch data (see below).

Catch in tonnes likelihood

In order to compare the observed and modeled catch in tonnes, a new likelihood function has been included in Fleksibest. This is simply the sum of squares of the difference between the observed ($C_{y,q,f}$) and modeled ($\hat{C}_{y,q,f}$) catch in tonnes, for each year *y*, quarter *q* and fleet *f*:

$$(C_{y,q,f} - \hat{C}_{y,q,f})^2$$

The observations available for a given fleet are, in addition to the catch in tonnes, length distributions and age distributions for given length. Such proportions at length and age should be used when comparing model results and observations, as done by Björnsson and Sigurdsson (2003). They should be supplemented by the catch in tonnes likelihood described above. This year the catch in tonnes likelihood was only used to determine the fishing mortality for the 'overfishing' fleet in the years 1990-1994 by comparing the modeled to the 'observed' overfishing in tonnes for these years.

3.10.2.5 Estimates of parameters outside the model

The mean length-at-age and the standard deviation of the mean length-at-age for all age groups of immature and mature fish in the first year and for age 3 in all years were taken from survey data. The SD of mean length of mature in the first year was not available, and was set to values obtained during previous estimations. The number of fish in the first year in age groups with low abundance was fixed. The residual natural mortality was set to 0.2. The maturation function was given values consistent with the work by Ajiad et al., (1999). The weight-length relationship used is the same as for Norwegian commercial catch data. This relationship is variable by quarter and year. The parameters governing size selectivity in cod cannibalism were set to the values given by Bogstad (WD 15, AFWG 2001).

3.10.3 Results from the assessment (Tables 3.32–3.33, Figures 3.17–3.18)

Choice of key run

In order to take into account the 1cm shift between length classes in Norwegian and Russian catch data, the Russian trawl fleet would need to be split from the 'combined' fleet. Thus, selectivity parameters need to be estimated also for the Russian trawl fleet. The ratio between the fishing mortality of Russian trawl and the combined fleet is then assumed to be the same as the ratio between the catch in weight of those two fleets for each quarter. This may cause some error if the selectivity of the two fleets is different.

This approach was attempted, but led to each of the fleets (Norwegian except gillnet and Russian) giving about the same likelihood score as the combined fleet. The reasons for this are unknown. Thus, it was decided to combine the Norwegian non-gillnet fleets and the Russian trawl fleet into one fleet, as in last years' assessment.

No other changes from last year's key run than those listed in Section 3.10.2.5 were attempted.

Effect of excluding Russian survey data for 2002.

As for XSA, the effect of excluding the Russian survey for 2002, where the area coverage by this survey was incomplete, was tested. This caused no change in F for 2002, but a slightly lower F in years with high F. SSB in 2002 decreased from 436 to 434 thousand tonnes, while the SSB decreased in years with a high SSB. The effect on the 2002 values is less than seen when the same exercise was done by XSA (Table 3.15).

Parameter sensitivity

Likelihood components, input data and parameter estimates for the key run are given in Table 3.32a-c. The parameter values obtained during the two previous year's assessments are given for comparison. Also, the effect on the total likelihood score of changing each parameter with +/- 5% is given. Sensitivity tests show that the estimation procedure has found a well-defined optimum, and that the likelihood function is quadratic around the optimum with respect to each parameter.

It is seen that the total likelihood score is most sensitive to L_{50} (length at 50 % selection) in the commercial fleets. It is also quite sensitive to the growth parameters and the length of a cohort at age 3. Due to the formulation of the catch in tonnes likelihood component and the parameter correlations in the model, the sensitivities for parameters relevant to the stock abundance in the period 1990-1994 were high. Another run was performed where the partial F values for overfishing for these years were fixed, and this run showed sensitivities similar to those presented in last year's report. This run gave small changes in parameter values and stock development.

Model results

The model values of natural mortality, maturity, stock weight, catch weights and catch in numbers by age group derived from these parameters are given in Table 3.33. This table also presents the fishing mortalities, stock numbers, stock biomass and spawning stock biomass. Results (total stock biomass, SSB, F, catches, recruitment, total stock number) of the key run are shown in Fig. 3.17a-f. The total annual catch in weight as estimated by the model is somewhat higher than the reported catches in almost all years, but in general there is good agreement with the reported catches in tonnes. The maximum discrepancy is about 168 000 tonnes in 1995. In general, the trends given by XSA and Fleksibest are very similar for the recruitment, the stock numbers and stock biomass. Fleksibest shows the same overall trends for F_{5-10} as XSA, but the curve given by Fleksibest is smoother. One reason for this may be that Fleksibest is less vulnerable to noise in the catch data of the oldest ages due to the fixed selectivity pattern by length. Fleksibest gives high spawning biomass in the years 1992-1995, with significantly higher SSB than in the XSA assessment for the years 1993-1995. Else the SSB trends are very similar.

Compared to the stock weights used in the XSA, the mean weight-at-age in Fleksibest is higher for age 3 and lower for age 7 and older. The discrepancy is higher for weight-at-age in the stock than for weight-at-age in the catch. The maturity-at-age is lower in Fleksibest than in XSA for ages 6 and older, except in the period 1986-1988, when Fleksibest give higher maturity ogives than XSA for all ages.

Figure 3.18a-f shows the fit between modeled and observed survey indices and between modeled and observed catch in number. The plots show the sum over age and length groups year by year.

Compared to last year's Fleksibest results, the results obtained this year give a more optimistic view of the stock. The fishing mortality (F_{5-10}) in 2001 decreased from 0.68 in last year's assessment to 0.58 in this year' assessment, while the SSB in 2002 increased from 376 thousand tonnes to 436 thousand tonnes. This change is partly due to the exclusion of the Norwegian summer survey in this year's assessment. As mentioned in last year's report, excluding this survey led to increasing SSB and decreasing F.

3.10.4 Retrospective analysis (Figure 3.19)

Results (total stock biomass, SSB, F, catches, recruitment, total stock number) of a retrospective analysis with the same settings as in the key run are shown in Figure 3.19a-f. The runs stops in first quarter, and are labeled after the year that contains the last time step. The shortest run stops in first quarter in 1998, and is thus labeled 1998. The retrospective pattern seems to be fairly consistent back to 1999.

3.10.5 Use of Fleksibest for predictions (Tables 3.34–3.35, Figure 3.20a-f)

Fleksibest is well suited for prognosis, because the length-dependence of population dynamics processes makes it easy to get consistency between the values of weight, maturity and mortality-at-age. In the prognosis runs with Fleksibest for the period 2003-2007, the same values as in the key run were used for most parameters. For the parameters that are variable by year, the values for 2002 were used for all years in the prognosis, except for recruitment and fishing mortality.

The recruitment at age 3 in 2004 and 2005 is set to the values obtained from the RCT3 analysis. The recruitment at age 3 in 2006 and later is assumed to be equal to the average recruitment (600 million individuals). This is consistent with the assumptions made in the medium-term prognosis based on the XSA run (see Section 3.3.8). Runs were made with F=0.25, $\mathbf{F}_{pa}$ =0.40, $F_{status\ quo}$ =0.47 and F=0.70 for the period 2003-2007. In all runs $F_{status\ quo}$ was assumed for 2003. In addition a run with a constant catch of 500 000 tonnes for the period 2003-2007 was made. The values of recruitment, catch weight, stock weight, maturity, natural mortality and fishing mortality-at-age for the $\mathbf{F}_{pa}$ run are given in Table 3.34. This is comparable to the usual prediction input table (Table 3.28). The management option table for the Fleksibest prediction is given in Table 3.35, and results of medium-term projections with these different fishing mortalities are shown in Figure 3.20a-f.

3.10.5.1 Comments to the prognosis

From Figures 3.20a-f it is seen that the four alternatives give large differences in the development of the spawning stock biomass and significant differences in the development of the stock biomass. It should be noted that fishing mortalities of 0.40 and 0.47.throughout the period gives a higher catch in 2007 than fishing at 0.70.

3.10.6 Reference points related to Fleksibest

In order to use Fleksibest for providing management advice for NEA cod, reference points would need to be calculated. It needs to be outlined how reference points could be calculated using Fleksibest. It should be noted that it is somewhat difficult to extend Fleksibest to the time period when survey data are not available (before 1981). Such an extension will require assumptions about the selection pattern of the various fishing fleets backwards in time.

3.11 Comparison of results from XSA and Fleksibest

3.11.1 Comparison of the assessments

The abundance at age in 2002 in the Fleksibest assessment is lower for ages 3-6 and higher for ages 7 and older compared to the XSA assessment (Table 3.15). The reference F in 2002 estimated by Fleksibest is lower (0.47 vs. 0.70), the reason for this is higher fishing mortalities in XSA compared to Fleksibest for age 7 and older fish. The reason for this discrepancy in fishing pattern should be investigated. The spawning stock biomass in 2002 is somewhat lower in Fleksibest than in XSA, 436 vs. 507 thousand tonnes. The declining trend in fishing mortality from 1999 to 2002 is stronger in Fleksibest than in XSA.

3.11.2 Comparison of the predictions (Figure 3.21)

The standard and Fleksibest predictions differ in a fundamental way because all input values to the standard prediction (Table 3.28) are independent and can be determined separately. This may lead to internal inconsistencies in the prediction input to the standard prediction. Also, effects of different exploitation levels on weight, maturity and selection at age cannot be accounted for using standard predictions. This may be important for medium-term predictions.

The population parameters at age in the Fleksibest prediction (Table 3.34) are determined by the values of growth, recruitment and fishing mortality chosen, as mentioned in Section 3.10.5. With this method, the values of weight, maturity and fishing mortality-at-age will be consistent with each other.

Although F *status quo* is quite different between the XSA run and the Fleksibest run, the catch resulting from applying F *status quo* in 2003 is not very different (506 thousand tonnes with Fleksibest and 583 thousand tonnes with XSA). The development of fishing mortality, total stock biomass and spawning stock biomass in Fleksibest and XSA for a constant catch of 500 000 tonnes in the period 2003-2007 is compared in Fig. 3.21. The Fleksibest predictions show a less optimistic development of the stock than the XSA predictions.

Table 3.1 North-East Arctic COD. Total catch (t) by fishing areas and unreported catch. (Data provided by Working Group members.)

Year	Sub-area I	Division IIa	Division IIb	Unreported catches	Total catch
1961	409,694	153,019	220,508		783,221
1962	548,621	139,848	220,797		909,266
1963	547,469	117,100	111,768		776,337
1964	206,883	104,698	126,114		437,695
1965	241,489	100,011	103,430		444,983
1966	292,253	134,805	56,653		483,711
1967	322,798	128,747	121,060		572,605
1968	642,452	162,472	269,254		1,074,084
1969	679,373	255,599	262,254		1,197,226
1970	603,855	243,835	85,556		933,246
1971	312,505	319,623	56,920		689,048
1972	197,015	335,257	32,982		565,254
1973	492,716	211,762	88,207		792,685
1974	723,489	124,214	254,730		1,102,433
1975	561,701	120,276	147,400		829,377
1976	526,685	237,245	103,533		867,463
1977	538,231	257,073	109,997		905,301
1978	418,265	263,157	17,293		698,715
1979	195,166	235,449	9,923		440,538
1980	168,671	199,313	12,450		380,434
1981	137,033	245,167	16,837		399,037
1982	96,576	236,125	31,029		363,730
1983	64,803	200,279	24,910		289,992
1984	54,317	197,573	25,761		277,651
1985	112,605	173,559	21,756		307,920
1986	157,631	202,688	69,794		430,113
1987	146,106	245,387	131,578		523,071
1988	166,649	209,930	58,360		434,939
1989	164,512	149,360	18,609		332,481
1990	62,272	99,465	25,263	25,000	212,000
1991	70,970	156,966	41,222	50,000	319,158
1992	124,219	172,532	86,483	130,000	513,234
1993	195,771	269,383	66,457	50,000	581,611
1994	353,425	306,417	86,244	25,000	771,086
1995	251,448	317,585	170,966		739,999
1996	278,364	297,237	156,627		732,228
1997	273,376	326,689	162,338		762,403
1998	250,815	257,398	84,411		592,624
1999	159,021	216,898	108,991		484,910
2000	137,197	204,167	73,506		414,870
2001	142,628	185,890	97,953		426,471
2002 [1]	184,795	188,935	71,239		445,060

[1] Provisional figures.

Table 3.2 North-East Arctic COD. Total nominal catch ('000 t) by trawl and other gear for each area, data provided by Working Group members.

	Sub-area I		Division IIa		Division IIb	
Year	Trawl	Others	Trawl	Others	Trawl	Others
1967	238.0	84.8	38.7	90.0	121.1	-
1968	588.1	54.4	44.2	118.3	269.2	-
1969	633.5	45.9	119.7	135.9	262.3	-
1970	524.5	79.4	90.5	153.3	85.6	-
1971	253.1	59.4	74.5	245.1	56.9	-
1972	158.1	38.9	49.9	285.4	33.0	-
1973	459.0	33.7	39.4	172.4	88.2	-
1974	677.0	46.5	41.0	83.2	254.7	-
1975	526.3	35.4	33.7	86.6	147.4	-
1976	466.5	60.2	112.3	124.9	103.5	-
1977	471.5	66.7	100.9	156.2	110.0	-
1978	360.4	57.9	117.0	146.2	17.3	-
1979	161.5	33.7	114.9	120.5	8.1	-
1980	133.3	35.4	83.7	115.6	12.5	-
1981	91.5	45.1	77.2	167.9	17.2	-
1982	44.8	51.8	65.1	171.0	21.0	-
1983	36.6	28.2	56.6	143.7	24.9	-
1984	24.5	29.8	46.9	150.7	25.6	-
1985	72.4	40.2	60.7	112.8	21.5	-
1986	109.5	48.1	116.3	86.4	69.8	-
1987	126.3	19.8	167.9	77.5	129.9	1.7
1988	149.1	17.6	122.0	88.0	58.2	0.2
1989	144.4	19.5	68.9	81.2	19.1	0.1
1990	51.4	10.9	47.4	52.1	24.5	0.8
1991	58.9	12.1	73.0	84.0	40.0	1.2
1992	103.7	20.5	79.7	92.8	85.6	0.9
1993	165.1	30.7	155.5	113.9	66.3	0.2
1994	312.1	41.3	165.8	140.6	84.3	1.9
1995	218.1	33.3	174.3	143.3	160.3	10.7
1996	248.9	32.7	137.1	159.0	147.7	6.8
1997	235.6	37.7	150.5	176.2	154.7	7.6
1998	219.8	31.0	127.0	130.4	82.7	1.7
1999	133.3	25.7	101.9	115.0	107.2	1.8
2000	111.7	25.5	105.4	98.8	72.2	1.3
2001	119.1	23.5	83.1	102.8	95.4	2.5
2002 [1]	147.4	37.4	83.4	105.6	70.1	1.3

[1] Provisional figures.

Table 3.3 North-East Arctic COD. Nominal catch (t) by countries
(Sub-area I and Divisions IIa and IIb combined, data provided by Working Group members.)

Year	Faroe Islands	France	German Dem.Rep.	Fed.Rep. Germany	Norway	Poland	United Kingdom	Russia[2]		Others	Total all countries
1961	3,934	13,755	3,921	8,129	268,377	-	158,113	325,780		1,212	783,221
1962	3,109	20,482	1,532	6,503	225,615	-	175,020	476,760		245	909,266
1963	-	18,318	129	4,223	205,056	108	129,779	417,964		-	775,577
1964	-	8,634	297	3,202	149,878	-	94,549	180,550		585	437,695
1965	-	526	91	3,670	197,085	-	89,962	152,780		816	444,930
1966	-	2,967	228	4,284	203,792	-	103,012	169,300		121	483,704
1967	-	664	45	3,632	218,910	-	87,008	262,340		6	572,605
1968	-	-	225	1,073	255,611	-	140,387	676,758		-	1,074,084
1969	29,374	-	5,907	5,543	305,241	7,856	231,066	612,215		133	1,197,226
1970	26,265	44,245	12,413	9,451	377,606	5,153	181,481	276,632		-	933,246
1971	5,877	34,772	4,998	9,726	407,044	1,512	80,102	144,802		215	689,048
1972	1,393	8,915	1,300	3,405	394,181	892	58,382	96,653		166	565,287
1973	1,916	17,028	4,684	16,751	285,184	843	78,808	387,196		276	792,686
1974	5,717	46,028	4,860	78,507	287,276	9,898	90,894	540,801		38,453	1,102,434
1975	11,309	28,734	9,981	30,037	277,099	7,435	101,843	343,580		19,368	829,377
1976	11,511	20,941	8,946	24,369	344,502	6,986	89,061	343,057		18,090	867,463
1977	9,167	15,414	3,463	12,763	388,982	1,084	86,781	369,876		17,771	905,301
1978	9,092	9,394	3,029	5,434	363,088	566	35,449	267,138		5,525	698,715
1979	6,320	3,046	547	2,513	294,821	15	17,991	105,846		9,439	440,538
1980	9,981	1,705	233	1,921	232,242	3	10,366	115,194		8,789	380,434
						Spain					
1981	12,825	3,106	298	2,228	277,818	14,500	5,262	83,000		-	399,037
1982	11,998	761	302	1,717	287,525	14,515	6,601	40,311		-	363,730
1983	11,106	126	473	1,243	234,000	14,229	5,840	22,975		-	289,992
1984	10,674	11	686	1,010	230,743	8,608	3,663	22,256		-	277,651
1985	13,418	23	1,019	4,395	211,065	7,846	3,335	62,489		4,330	307,920
1986	18,667	591	1,543	10,092	232,096	5,497	7,581	150,541		3,505	430,113
1987	15,036	1	986	7,035	268,004	16,223	10,957	202,314		2,515	523,071
1988	15,329	2,551	605	2,803	223,412	10,905	8,107	169,365		1,862	434,939
1989	15,625	3,231	326	3,291	158,684	7,802	7,056	134,593		1,273	332,481
1990	9,584	592	169	1,437	88,737	7,950	3,412	74,609		510	187,000
1991	8,981	975	**Greenland**	2,613	126,226	3,677	3,981	119,427 [3]		3,278	269,158
1992	11,663	2	3,337	3,911	168,460	6,217	6,120	182,315	**Iceland**	1,209	383,234
1993	17,435	3,572	5,389	5,887	221,051	8,800	11,336	244,860	9,374	3,907	531,611
1994	22,826	1,962	6,882	8,283	318,395	14,929	15,579	291,925	36,737	28,568	746,086
1995	22,262	4,912	7,462	7,428	319,987	15,505	16,329	296,158	34,214	15,742	739,999
1996	17,758	5,352	6,529	8,326	319,158	15,871	16,061	305,317	23,005	14,851	732,228
1997	20,076	5,353	6,426	6,680	357,825	17,130	18,066	313,344	4,200	13,303	762,403
1998	14,290	1,197	6,388	3,841	284,647	14,212	14,294	244,115	1,423	8,217	592,624
1999	13,700	2,137	4,093	3,019	223,390	8,994	11,315	210,379	1,985	5,898	484,910
2000	13,350	2,621	5,787	3,513	192,860	8,695	9,165	166,202	7,562	5,115	414,870
2001	12,500	2,681	5,727	4,524	188,431	9,196	8,698	183,572	5,917	5,225	426,471
2002 [1]	15,693	2,936	6,419	4,517	202,559	8,414	8,977	184,058	6,003	5,484	445,060

[1] Provisional figures.
[2] USSR prior to 1991.
[3] Includes Baltic countries.

Table 3.4 North-east Arctic COD. Weights at age (kg) in landings from various countries

Norway

Year	Age 2	3	4	5	6	7	8	9	10	11	12	13	14	15+
1983	0.41	0.82	1.32	2.05	2.82	3.94	5.53	7.70	9.17	11.46	16.59	16.42	16.96	24.46
1984	1.16	1.47	1.97	2.53	3.13	3.82	4.81	5.95	7.19	7.86	8.46	7.99	9.78	10.64
1985	0.34	0.99	1.43	2.14	3.27	4.68	6.05	7.73	9.86	11.87	14.16	14.17	13.52	15.33
1986	0.30	0.67	1.34	2.04	3.14	4.60	5.78	6.70	7.52	9.74	10.68	12.86	9.59	16.31
1987	0.24	0.48	0.88	1.66	2.72	4.35	6.21	8.78	9.78	12.50	13.75	15.12	10.43	19.95
1988	0.36	0.56	0.83	1.31	2.34	3.84	6.50	8.76	9.97	11.06	14.43	19.02	12.89	10.16
1989	0.53	0.75	0.90	1.17	1.95	3.20	4.88	7.82	9.40	11.52	11.47		19.47	14.68
1990	0.40	0.81	1.22	1.59	2.14	3.29	4.99	7.83	10.54	14.21	17.63	7.97	14.64	
1991	0.63	1.37	1.77	2.31	3.01	3.68	4.63	6.06	8.98	12.89	17.00		14.17	16.63
1992	0.41	1.10	1.79	2.45	3.22	4.33	5.27	6.21	8.10	10.51	11.59		15.81	6.52
1993	0.30	0.83	1.70	2.41	3.35	4.27	5.45	6.28	7.10	7.82	10.10	16.03	19.51	17.68
1994	0.30	0.82	1.37	2.23	3.35	4.27	5.56	6.86	7.45	7.98	9.53	12.16	11.45	19.79
1995	0.44	0.78	1.26	1.87	2.80	4.12	5.15	5.96	7.90	8.67	9.20	11.53	17.77	21.11
1996	0.29	0.90	1.15	1.67	2.58	4.08	6.04	6.62	7.96	9.36	10.55	11.41	9.51	24.24
1997	0.35	0.78	1.14	1.56	2.25	3.48	5.35	7.38	7.55	8.30	11.15	8.64	12.80	
1998	0.38	0.68	1.03	1.64	2.23	3.24	4.85	6.88	9.18	9.84	15.78	14.37	13.77	15.58
1999	0.46	0.88	1.16	1.65	2.40	3.12	4.26	6.00	6.52	10.64	14.05	12.67	9.20	17.22
2000	0.31	0.65	1.23	1.80	2.54	3.58	4.49	5.71	7.54	7.86	12.71	14.71	15.40	20.26
2001	0.30	0.77	1.18	1.83	2.75	3.64	4.88	5.93	7.43	8.90	10.22	11.11	13.03	18.85
2001	0.53	0.93	1.36	1.90	2.70	3.80	5.00	6.30	7.50	8.93	8.11	10.12	12.25	11.42

Russia (trawl only)

Year	Age 2	3	4	5	6	7	8	9	10	11	12	13	14	15+
1983	0.65	1.05	1.58	2.31	3.39	4.87	6.86	8.72	10.40	12.07	14.43			
1984	0.53	0.88	1.45	2.22	3.21	4.73	6.05	8.43	10.34	12.61	14.95			
1985	0.33	0.77	1.31	1.84	2.96	4.17	5.94	6.38	8.58	10.28				
1986	0.29	0.61	1.14	1.75	2.45	4.17	6.18	8.04	9.48	11.33	12.35	14.13		
1987	0.24	0.52	0.88	1.42	2.07	2.96	5.07	7.56	8.93	10.80	13.05	18.16		
1988	0.27	0.49	0.88	1.32	2.06	3.02	4.40	6.91	9.15	11.65	12.53	14.68		
1989	0.50	0.73	1.00	1.39	1.88	2.67	4.06	6.09	7.76	9.88				
1990	0.45	0.83	1.21	1.70	2.27	3.16	4.35	6.25	8.73	10.85	13.52			
1991	0.36	0.64	1.05	2.03	2.85	3.77	4.92	6.13	8.36	10.44	15.84	19.33		
1992	0.55	1.20	1.44	2.07	3.04	4.24	5.14	5.97	7.25	9.28	11.36			
1993	0.48	0.78	1.39	2.06	2.62	4.07	5.72	6.79	7.59	11.26	14.79	17.71		
1994	0.41	0.81	1.24	1.80	2.55	2.88	4.96	6.91	8.12	10.28	12.42	16.93		
1995	0.37	0.77	1.21	1.74	2.37	3.40	4.71	6.73	8.47	9.58	12.03	16.99		
1996	0.30	0.64	1.09	1.60	2.37	3.42	5.30	7.86	8.86	10.87	11.80			
1997	0.30	0.57	1.00	1.52	2.18	3.30	4.94	7.15	10.08	11.87	13.54			
1998	0.33	0.68	1.06	1.60	2.34	3.39	5.03	6.89	10.76	12.39	13.61	14.72		
1999	0.24	0.58	0.98	1.41	2.17	3.26	4.42	5.70	7.27	10.24	14.12			
2000	0.18	0.48	0.85	1.44	2.16	3.12	4.44	5.79	7.49	9.66	10.36			
2001	0.12	0.31	0.62	1.00	1.53	2.30	3.31	4.57	6.55	8.11	9.52	11.99		
2002	0.05	0.20	0.60	1.05	1.46	2.14	3.27	4.47	6.23	8.37	10.06	12.37		

Germany (Division IIa and IIb)

Year	Age 2	3	4	5	6	7	8	9	10	11	12	13	14	15+
1994		0.68	1.04	2.24	3.49	4.51	5.79	6.93	8.16	8.46	8.74	9.48	15.25	
1995		0.44	0.84	1.50	2.72	3.81	4.46	4.81	7.37	7.69	8.25	9.47		
1996		0.84	1.15	1.64	2.53	3.58	4.13	3.90	4.68	6.98	6.43	11.32		
1997		0.43	0.92	1.42	2.01	3.15	4.04	5.16	4.82	3.96	7.04	8.80		
1998	0.23	0.73	1.17	1.89	2.72	3.25	4.13	5.63	6.50	8.57	8.42	11.45	8.79	
1999 [1]		0.85	1.45	2.00	2.65	3.47	4.16	5.45	6.82	5.90		8.01		
2000 [2]	0.26	0.73	1.36	2.04	2.87	3.67	4.88	5.78	7.05	8.45	8.67	9.33	6.88	
2001	0.38	0.80	1.21	1.90	2.74	3.90	4.99	5.69	7.15	7.32	11.72	9.11	6.60	
2002	0.06	0.35	1.00	1.31	1.80	2.53	3.64	4.38	5.07	6.82	9.21	7.59	13.18	

[1] Division IIa only
[2] IIa and IIb combined

Spain (Division IIb)

Year	Age 2	3	4	5	6	7	8	9	10	11	12	13	14	15+
1994	0.43	1.08	1.38	2.32	2.47	2.68	3.46	5.20	7.04	6.79	7.20	8.04	10.46	15.35
1995	0.42	0.51	0.98	1.99	3.41	4.95	5.52	8.62	9.21	11.42	9.78	8.08		
1996		0.66	1.12	1.57	2.43	3.17	3.59	4.44	5.48	6.79	8.10			
1997 [1]	0.51	0.65	1.22	1.68	2.60	3.39	4.27	6.67	7.88	11.34	13.33	10.03	8.69	
1998	0.47	0.74	1.15	1.82	2.44	3.32	3.71	5.00	7.26					
1999 [1]	0.21	0.69	1.06	1.69	2.50	3.32	4.72	5.76	6.77	7.24	7.63			
2000 [1]	0.23	0.61	1.24	1.75	2.47	3.12	4.65	6.06	7.66	10.94	11.40	7.20		
2001	0.23	0.64	1.25	1.95	2.86	3.55	4.95	6.46	8.50	11.07	13.09			
2002	0.16	0.55	1.00	1.48	2.17	3.29	4.47	5.35	8.29	12.23	9.01	12.16	15.2	

[1] IIa and IIb combined

Iceland (Sub-area I)

Year	2	3	4	5	6	7	8	9	10	11	12	13	14	15+
1994	0.42	0.85	1.44	2.77	3.54	4.08	5.84	6.37	7.02	7.48	7.37			
1995		1.17	0.91	1.60	2.28	3.61	4.73	6.27			6.26			
1996		0.36	0.99	1.55	2.83	3.79	4.81	5.34	7.25	7.68	9.08	8.98	10.52	
1997	0.42	0.43	0.76	1.60	2.40	3.45	4.40	5.74	6.15		8.28	10.52	9.89	

UK (England & Wales)

Year	2	3	4	5	6	7	8	9	10	11	12	13	14	15+
1995 [1]			1.47	2.11	3.47	5.57	6.43	7.17	8.12	8.05	10.2	10.1		
1996 [2]			1.55	1.81	2.42	3.61	6.3	6.47	7.83	7.91	8.93	9.38	10.9	
1997 [2]			1.93	2.17	3.07	4.17	4.89	6.46		12.3	8.44			

[1] Division IIa and IIb
[2] Division IIa

Table 3.5 North-East Arctic COD. Basis for maturity ogives (percent) used in the assessment. Norwegian and Russian data.

Norway

	Percentage mature							
	Age							
Year	3	4	5	6	7	8	9	10
1982	-	5	10	34	65	82	92	100
1983	5	8	10	30	73	88	97	100

Russia

	Percentage mature							
	Age							
Year	3	4	5	6	7	8	9	10
1984	-	5	18	31	56	90	99	100
1985	-	1	10	33	59	85	92	100
1986	-	2	9	19	56	76	89	100
1987	-	1	9	23	27	61	81	80
1988	-	1	3	25	53	79	100	100
1989	-	-	2	15	39	59	83	100
1990	-	2	6	20	47	62	81	95
1991	-	3	1	23	66	82	96	100
1992	-	1	8	31	73	92	95	100
1993	-	3	7	21	56	89	95	99
1994	-	1	8	30	55	84	95	98
1995	-	-	4	23	61	75	94	97
1996	-	-	1	22	56	82	95	100
1997	-	-	1	10	48	73	90	100
1998	-	-	2	15	47	87	97	96
1999	-	-	1	10	38	75	94	100
2000	-	-	6	19	51	84	96	100
2001	-	-	4	28	62	89	96	100
2002		2	11	34	68	83	98	100
2003	0	0	11	29	66	90	95	100

Norway

	Percentage mature							
	Age							
Year	3	4	5	6	7	8	9	10
1985	-	1	9	38	51	85	100	79
1986	3	7	8	19	50	67	36	80
1987	-	0	4	12	16	31	19	-
1988	-	2	6	41	54	45	100	100
1989	-	1	8	21	43	79	87	100
1990	-	1	4	22	68	93	91	100
1991	-	5	12	34	65	84	99	100
1992	-	1	16	55	77	94	100	100
1993	-	3	12	40	66	94	98	99
1994	-	1	14	36	64	79	98	100
1995	-	1	9	43	63	73	96	98
1996	-	-	2	30	70	84	100	100
1997	-	-	2	17	64	92	100	89
1998	-	1	6	23	40	77	90	100
1999	-	-	-	11	52	83	83	100
2000	-	-	6	26	76	83	99	100
2001	-	1	7	39	53	64	100	100
2002	-	1	5	46	71	89	97	100
2003	0	0	9	44	60	86	90	100

Table 3.6 Recruitment indicies for NEA cod. Input for the RCT- analysis.

```
NORTHEAST ARCTIC COD : recruits as 3 year-olds (inc. data for ages 0,1),,,,
9,18,2             (No. of surveys, No. of years, VPA Column No.),,
1985,   205,   6,    2,   4,    -11,     -11,     -11,  -11,   -11,  -11
1986,   173,   1,    1,   3,    -11,     -11,     -11,  -11,   -11,  -11
1987,   243,   1,    1,   1,    -11,     -11,     -11,  -11,   -11,  -11
1988,   412,   1,    1,   4,    -11,     -11,     -11,  -11,   -11,  -11
1989,   721,   1,    3,   8,    -11,     -11,     -11,  -11,   -11,  -11
1990,   894,   4,    4,  44,    -11,     -11,     -11,  -11,   -11,  -11
1991,   807,   4,    8,  15,    -11,     -11,     -11    -11, 296.5, 349.8
1992,   656,  32,    3,  13,    -11,     -11,   535.8, 577.2, 274.6, 166.2
1993,   435,   3,    4,   6, 1035.9,   858.3,   541.5, 292.9, 170.0,  92.9
1994,   714,  12,    8,  10, 5253.1,  2619.2,   707.6, 339.8, 238.0, 188.3
1995,   840,  30,   13,  26, 5768.5,  2396.0,  1045.1, 430.5, 396.0, 427.7
1996,   584,  10,    7,  27, 4815.5,  1623.5,   643.7, 632.9, 211.8, 150.0
1997,   640,  16,    6,  18, 2418.5,  3401.3,   340.1, 304.3, 235.2, 245.1
1998,   498,   2,    4,  12,  484.6,   358.3,   248.3, 221.4, 191.1, 138.2
1999,   498,   1,    1,  13,  128.8,   154.1,    76.6,  63.9,  88.3,  69.3
2000,   -11,   6,    7,  20,  657.9,   629.9,   443.9, 215.1, 377.0, 303.4
2001,   -11,   2,    1, -11,   35.3,    18.2,    79.1,  61.5,   -11,   -11
2002,   -11,  14,  -11, -11, 2991.7,  1693.9,     -11,   -11,   -11,   -11
R-0      Russian Bottom trawl survey, area I+IIb,   age 0
R-1      Russian Bottom trawl survey, area I+IIb,   age 1
R-2      Russian Bottom trawl survey, area I+IIb,   age 2
N-BST1     Norwegian Barents Sea, Bottom trawl survey, age 1
N-BSA1     Norwegian Barents Sea Acoustic survey age 1
N-BST2     Norwegian Barents Sea, Bottom trawl survey, age 2
N-BSA2     Norwegian Barents Sea Acoustic survey age 2
N-BST3     Norwegian Barents Sea, Bottom trawl survey, age 3
N-BSA3     Norwegian Barents Sea Acoustic survey age 3
```

Table 3.7. Recruitment predictions based on survey indicies shrunk towards the vpa mean.

Analysis by RCT3 ver3.1 of data from file :

rec2003.rct

NORTHEAST ARCTIC COD : recruits as 3 year-olds (inc. data for ages 0,1),,,,

Data for 9 surveys over 18 years : 1985 - 2002

Regression type = C
Tapered time weighting applied
power = 3 over 20 years
Survey weighting not applied

Final estimates shrunk towards mean
Minimum S.E. for any survey taken as .20
Minimum of 3 points used for regression

Forecast/Hindcast variance correction used.

Year class = 1995

Survey/Series	Slope	Intercept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
R-0	1.55	3.74	1.45	.157	10	3.43	9.07	2.055	.006
R-1	1.36	4.28	.54	.574	10	2.64	7.86	.792	.042
R-2	.81	4.42	.41	.697	10	3.30	7.10	.536	.091
N-BST1									
N-BSA1									
N-BST2	2.77	-11.32	.49	.368	3	6.95	7.96	2.399	.005
N-BSA2	1.37	-1.81	.58	.293	3	6.07	6.53	1.185	.019
N-BST3	1.17	.04	.13	.870	4	5.98	7.04	.293	.305
N-BSA3	.53	3.73	.12	.889	4	6.06	6.92	.239	.457
					VPA Mean =		6.17	.589	.075

Year class = 1996

Survey/Series	Slope	Intercept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
R-0	1.10	4.29	1.10	.234	11	2.40	6.93	1.319	.006
R-1	1.13	4.51	.52	.580	11	2.08	6.86	.632	.025
R-2	.76	4.50	.38	.725	11	3.33	7.04	.472	.045
N-BST1	.36	3.55	.09	.964	3	8.48	6.61	.194	.252
N-BSA1	.58	2.13	.16	.906	3	7.39	6.42	.313	.103
N-BST2	1.16	-1.08	.28	.596	4	6.47	6.40	.450	.050
N-BSA2	1.79	-4.26	.55	.280	4	6.45	7.31	1.128	.008
N-BST3	.94	1.29	.14	.824	5	5.36	6.30	.210	.229
N-BSA3	.46	4.05	.11	.885	5	5.02	6.35	.161	.252
					VPA Mean =		6.24	.576	.030

Year class = 1997

Survey/Series	Slope	Intercept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
R-0	1.05	4.33	1.01	.240	12	2.83	7.30	1.224	.007
R-1	1.10	4.52	.50	.561	12	1.95	6.65	.591	.029
R-2	.73	4.51	.40	.670	12	2.94	6.67	.471	.046
N-BST1	.39	3.27	.17	.800	4	7.79	6.29	.282	.127
N-BSA1	.59	2.06	.12	.900	4	8.13	6.84	.222	.205
N-BST2	1.17	-1.15	.23	.600	5	5.83	5.65	.503	.040
N-BSA2	2.58	-9.20	.94	.084	5	5.72	5.53	1.491	.005
N-BST3	.91	1.44	.12	.832	6	5.46	6.42	.163	.253
N-BSA3	.46	4.07	.09	.891	6	5.51	6.58	.127	.253
					VPA Mean =		6.27	.537	.035

Table 3.7 (Cont'd)

Year class = 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
R-0	.96	4.41	.92	.248	13	1.10	5.47	1.090	.011
R-1	1.07	4.54	.47	.559	13	1.61	6.26	.540	.045
R-2	.71	4.54	.37	.667	13	2.56	6.37	.430	.071
N-BST1	.39	3.26	.17	.737	5	6.19	5.69	.376	.093
N-BSA1	.57	2.10	.21	.642	5	5.88	5.47	.532	.046
N-BST2	1.21	-1.28	.44	.240	6	5.52	5.39	.821	.019
N-BSA2	2.73	-9.96	.98	.060	6	5.40	4.78	1.642	.005
N-BST3	.90	1.48	.11	.828	7	5.26	6.24	.151	.328
N-BSA3	.46	4.03	.10	.858	7	4.94	6.30	.131	.328
					VPA Mean =		6.30	.499	.053

Year class = 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
R-0	.90	4.58	.84	.249	14	.69	5.21	1.023	.013
R-1	1.05	4.56	.44	.549	14	.69	5.28	.560	.043
R-2	.71	4.54	.35	.653	14	2.64	6.40	.405	.082
N-BST1	.29	4.15	.19	.654	6	4.87	5.56	.401	.083
N-BSA1	.38	3.65	.24	.553	6	5.04	5.55	.477	.059
N-BST2	.75	1.69	.32	.371	7	4.35	4.97	.739	.024
N-BSA2	1.35	-1.58	.51	.184	7	4.17	4.05	1.327	.008
N-BST3	.92	1.41	.10	.851	8	4.49	5.53	.214	.291
N-BSA3	.49	3.86	.10	.853	8	4.25	5.95	.157	.334
					VPA Mean =		6.32	.459	.064

Year class = 2000

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression	----------	----------	----------I	I-----------	Prediction	---------	---------	---------I
R-0	.80	4.84	.76	.248	15	1.95	6.40	.872	.015
R-1	.97	4.75	.47	.469	15	2.08	6.78	.546	.037
R-2	.70	4.52	.34	.630	15	3.04	6.67	.391	.073
N-BST1	.21	4.81	.23	.546	7	6.49	6.20	.299	.124
N-BSA1	.28	4.45	.25	.506	7	6.45	6.23	.321	.108
N-BST2	.44	3.74	.31	.358	8	6.10	6.43	.388	.074
N-BSA2	.61	2.94	.41	.244	8	5.38	6.20	.517	.042
N-BST3	.67	2.83	.18	.633	9	5.93	6.79	.244	.186
N-BSA3	.43	4.21	.12	.816	9	5.72	6.66	.146	.278
					VPA Mean =		6.33	.417	.064

Year class = 2001

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression	----------	----------	----------I	I-----------	Prediction	---------	---------	---------I
R-0	.73	4.96	.70	.258	15	1.10	5.77	.829	.053
R-1	.93	4.82	.45	.457	15	.69	5.47	.573	.112
R-2									
N-BST1	.21	4.83	.23	.548	7	3.59	5.59	.413	.214
N-BSA1	.27	4.47	.25	.509	7	2.95	5.28	.527	.132
N-BST2	.43	3.79	.31	.363	8	4.38	5.69	.476	.161
N-BSA2	.60	2.99	.41	.246	8	4.14	5.46	.649	.087
N-BST3									
N-BSA3									
					VPA Mean =		6.35	.390	.240

Table 3.7 (Cont'd)

Year class = 2002

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression----------I					I-----------Prediction---------I			
R-0	.66	5.11	.62	.272	15	2.71	6.89	.753	.058
R-1									
R-2									
N-BST1	.21	4.85	.23	.550	7	8.00	6.52	.298	.369
N-BSA1	.27	4.51	.24	.512	7	7.44	6.51	.320	.320
N-BST2									
N-BSA2									
N-BST3									
N-BSA3									
					VPA Mean =		6.37	.360	.253

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
1995	1058	6.97	.16	.13	.66	840	6.73
1996	644	6.47	.10	.07	.47	585	6.37
1997	673	6.51	.10	.09	.81	640	6.46
1998	470	6.15	.11	.10	.69	498	6.21
1999	315	5.75	.12	.12	1.14	498	6.21
2000	681	6.52	.11	.08	.53		
2001	308	5.73	.19	.15	.62		
2002	664	6.50	.18	.07	.13		

Table 3.8
NE Arctic cod. International catch (thousands) at age for ages 1-15+

	AGE														
Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+
1946	1	16	4008	10387	18906	16596	13843	15370	59845	22618	10093	9573	5460	1927	750
1947	1	1	710	13192	43890	52017	45501	13075	19718	47678	31392	9348	9330	4622	4103
1948	1	16	140	3872	31054	55983	77375	21482	15237	9815	30041	7945	4491	3899	4205
1949	1	7	991	6808	35214	100497	83283	29727	13207	5606	8617	13154	3657	1895	2167
1950	1	79	1281	10954	29045	45233	62579	30037	19481	9172	6019	4133	6750	1662	1450
1951	1615	1625	24687	77924	64013	46867	37535	33673	23510	10589	4221	1288	1002	3322	611
1952	1	1202	24099	120704	113203	73827	49389	20562	24367	15651	8327	3565	647	467	1044
1953	1	81	47413	107659	112040	55500	22742	16863	10559	10553	5637	1752	468	173	156
1954	1	9	11473	155171	146395	100751	40635	10713	11791	8557	6751	2370	896	268	123
1955	1	322	3902	37652	201834	161336	84031	30451	13713	9481	4140	2406	867	355	128
1956	81	1498	10614	24172	129803	250472	86784	51091	14987	7465	3952	1655	1292	448	166
1957	987	3487	17321	33931	27182	70702	87033	39213	17747	6219	3232	1220	347	299	173
1958	1	2600	31219	133576	71051	40737	38380	35786	13338	10475	3289	1070	252	40	141
1959	590	2601	32308	77942	148285	53480	18498	17735	23118	9483	3748	997	254	161	98
1960	465	7147	37882	97865	64222	67425	23117	8429	7240	11675	4504	1843	354	102	226
1961	1	1699	45478	132655	123458	51167	38740	17376	5791	6778	5560	1682	910	280	108
1962	1	1713	42416	170566	167241	89460	28297	21996	7956	2728	2603	1647	392	280	103
1963	1	4	13196	106984	205549	95498	35518	16221	11894	3884	1021	1025	498	129	157
1964	103	675	5298	45912	97950	58575	19642	9162	6196	3553	783	172	387	264	131
1965	1	2522	15725	25999	78299	68511	25444	8438	3569	1467	1161	131	67	91	179
1966	1	869	55937	55644	34676	42539	37169	18500	5077	1495	380	403	77	9	70
1967	1	151	34467	160048	69235	22061	26295	25139	11323	2329	687	316	225	40	14
1968	1	1	3709	174585	267961	107051	26701	16399	11597	3657	657	122	124	70	46
1969	1	275	2307	24545	238511	181239	79363	26989	13463	5092	1913	414	121	23	46
1970	1	591	7164	10792	25813	137829	96420	31920	8933	3249	1232	260	106	39	35
1971	38	2210	7754	13739	11831	9527	59290	52003	12093	2434	762	418	149	42	25
1972	1	4701	35536	45431	26832	12089	7918	34885	22315	4572	1215	353	315	121	40
1973	1	8277	294262	131493	61000	20569	7248	8328	19130	4499	677	195	81	59	55
1974	115	21347	91855	437377	203772	47006	12630	4370	2523	5607	2127	322	151	83	62
1975	1	1184	45282	59798	226646	118567	29522	9353	2617	1555	1928	575	231	15	37
1976	706	1908	85337	114341	79993	118236	47872	13962	4051	936	558	442	139	26	53
1977	1	11288	39594	168609	136335	52925	61821	23338	5659	1521	610	271	122	92	54
1978	3	802	78822	45400	88495	56823	25407	31821	9408	1227	913	446	748	48	51
1979	0	224	8600	77484	43677	31943	16815	8274	10974	1785	427	103	59	38	45
1980	31	403	3911	17086	81986	40061	17664	7442	3508	3196	678	79	24	26	8
1981	1	212	3407	9466	20803	63433	21788	9933	4267	1311	882	109	37	3	1
1982	2	94	8948	20933	19345	28084	42496	8395	2878	708	271	260	27	5	5
1983	13	86	3108	19594	20473	17656	17004	18329	2545	646	229	74	58	20	5
1984	11	999	6942	14240	18807	20086	15145	8287	5988	783	232	153	49	12	8
1985	92	1805	24634	45769	27806	19418	11369	3747	1557	768	137	36	31	32	8
1986	41	855	28968	70993	78672	25215	11711	4063	976	726	557	136	28	34	14
1987	14	390	13648	137106	98210	61407	13707	3866	910	455	187	227	21	59	20
1988	4	178	9828	22774	135347	54379	21015	3304	1236	519	106	69	43	14	5
1989	3	237	5085	17313	32165	81756	27854	5501	827	290	41	13	1	11	16
1990	6	170	1911	7551	12999	17827	30007	6810	828	179	59	15	6	5	2
1991	24	663	4963	10933	16467	20342	19479	25193	3888	428	48	12	1	1	2
1992	844	1184	21835	36015	27494	23392	18351	13541	18321	2529	264	82	3	9	1
1993	42	634	10094	46182	63578	33623	14866	9449	6571	12593	1749	377	63	22	1
1994	32	312	6531	59444	102548	59766	32504	10019	6163	3671	7528	995	121	19	4
1995	9	212	4879	42587	115329	98485	32036	7334	3014	1725	1174	1920	222	41	1
1996	184	895	7655	28782	80711	100509	54590	10545	2023	930	462	230	809	84	1
1997	79	1228	12827	36491	69633	83017	65768	28392	4651	1151	373	213	144	238	1
1998	97	1596	31887	88874	48972	40493	34513	26354	6583	965	197	69	42	22	53
1999	13	313	7501	77714	92816	31139	15778	15851	8828	1837	195	40	34	8	30
2000	32	215	4701	33094	93044	47210	12671	6677	4787	1647	321	71	11	1	14
2001	23	237	5044	35019	62139	62456	22794	5266	1773	1163	343	84	6	7	22
2002	36	104	1907	24824	60622	54709	35572	10053	1593	482	201	113	20	9	5

Table 3.9 Total number (million) of cod consumed by cod, by year and prey age group.

	Age						
Year	0	1	2	3	4	5	6
1984	0	417	21	0	0	0	0
1985	1497	376	67	0	0	0	0
1986	53	413	392	99	0	0	0
1987	681	182	281	14	0	0	0
1988	29	411	22	2	0	0	0
1989	916	144	0	0	0	0	0
1990	0	62	28	0	0	0	0
1991	123	153	215	2	0	0	0
1992	4304	1028	155	4	0	0	0
1993	3802	20264	512	52	1	0	0
1994	8311	6926	645	133	54	8	0
1995	8343	15411	756	251	86	3	0
1996	10010	21902	1499	142	56	20	1
1997	2942	16834	1923	176	17	1	0
1998	79	4925	585	207	25	2	1
1999	579	1848	296	53	4	0	0
2000	1711	2323	171	35	13	4	0
2001	95	2257	111	21	9	1	1
2002	6258	2404	456	34	6	0	0

Table 3.10

Run title : Arctic Cod (run: SVPASA15/V15)

At 30/04/2003 23:56

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

YEAR,	1946,	1947,	1948,	1949,	1950,	1951,	1952,
AGE							
3,	4008,	710,	140,	991,	1281,	24687,	24099,
4,	10387,	13192,	3872,	6808,	10954,	77924,	120704,
5,	18906,	43890,	31054,	35214,	29045,	64013,	113203,
6,	16596,	52017,	55983,	100497,	45233,	46867,	73827,
7,	13843,	45501,	77375,	83283,	62579,	37535,	49389,
8,	15370,	13075,	21482,	29727,	30037,	33673,	20562,
9,	59845,	19718,	15237,	13207,	19481,	23510,	24367,
10,	22618,	47678,	9815,	5606,	9172,	10589,	15651,
11,	10093,	31392,	30041,	8617,	6019,	4221,	8327,
12,	9573,	9348,	7945,	13154,	4133,	1288,	3565,
+gp,	8137,	18055,	12595,	7719,	9862,	4935,	2158,
TOTALNUM,	189376,	294576,	265539,	304823,	227796,	329242,	455852,
TONSLAND,	706000,	882017,	774295,	800122,	731982,	827180,	876795,
SOPCOF %,	103,	91,	89,	99,	109,	115,	93,

Run title : Arctic Cod (run: SVPASA15/V15)

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

YEAR,	1953,	1954,	1955,	1956,	1957,	1958,	1959,	1960,	1961,	1962,
AGE										
3,	47413,	11473,	3902,	10614,	17321,	31219,	32308,	37882,	45478,	42416,
4,	107659,	155171,	37652,	24172,	33931,	133576,	77942,	97865,	132655,	170566,
5,	112040,	146395,	201834,	129803,	27182,	71051,	148285,	64222,	123458,	167241,
6,	55500,	100751,	161336,	250472,	70702,	40737,	53480,	67425,	51167,	89460,
7,	22742,	40635,	84031,	86784,	87033,	38380,	18498,	23117,	38740,	28297,
8,	16863,	10713,	30451,	51091,	39213,	35786,	17735,	8429,	17376,	21996,
9,	10559,	11791,	13713,	14987,	17747,	13338,	23118,	7240,	5791,	7956,
10,	10553,	8557,	9481,	7465,	6219,	10475,	9483,	11675,	6778,	2728,
11,	5637,	6751,	4140,	3952,	3232,	3289,	3748,	4504,	5560,	2603,
12,	1752,	2370,	2406,	1655,	1220,	1070,	997,	1843,	1682,	1647,
+gp,	797,	1287,	1350,	1906,	819,	433,	513,	682,	1298,	775,
TOTALNUM,	391515,	495894,	550296,	582901,	304619,	379354,	386107,	324884,	429983,	535685,
TONSLAND,	695546,	826021,	1147841,	1343068,	792557,	769313,	744607,	622042,	783221,	909266,
SOPCOF %,	105,	93,	106,	105,	100,	112,	93,	104,	110,	124,

Run title : Arctic Cod (run: SVPASA15/V15)

At 30/04/2003 23:56

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

YEAR,	1963,	1964,	1965,	1966,	1967,	1968,	1969,	1970,	1971,	1972,
AGE										
3,	13196,	5298,	15725,	55937,	34467,	3709,	2307,	7164,	7754,	35536,
4,	106984,	45912,	25999,	55644,	160048,	174585,	24545,	10792,	13739,	45431,
5,	205549,	97950,	78299,	34676,	69235,	267961,	238511,	25813,	11831,	26832,
6,	95498,	58575,	68511,	42539,	22061,	107051,	181239,	137829,	9527,	12089,
7,	35518,	19642,	25444,	37169,	26295,	26701,	79363,	96420,	59290,	7918,
8,	16221,	9162,	8438,	18500,	25139,	16399,	26989,	31920,	52003,	34885,
9,	11894,	6196,	3569,	5077,	11323,	11597,	13463,	8933,	12093,	22315,
10,	3884,	3553,	1467,	1495,	2329,	3657,	5092,	3249,	2434,	4572,
11,	1021,	783,	1161,	380,	687,	657,	1913,	1232,	762,	1215,
12,	1025,	172,	131,	403,	316,	122,	414,	260,	418,	353,
+gp,	784,	782,	337,	156,	279,	240,	190,	180,	216,	476,
TOTALNUM,	491574,	248025,	229081,	251976,	352179,	612679,	574026,	323792,	170067,	191622,
TONSLAND,	776337,	437695,	444930,	483711,	572605,	1074084,	1197226,	933246,	689048,	565254,
SOPCOF %,	102,	103,	129,	123,	109,	108,	105,	112,	124,	118,

Table 3.10 (continued)

Run title : Arctic Cod (run: SVPASA15/V15)

At 30/04/2003 23:56

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

YEAR,	1973,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,	1982,
AGE										
3,	294262,	91855,	45282,	85337,	39594,	78822,	8600,	3911,	3407,	8948,
4,	131493,	437377,	59798,	114341,	168609,	45400,	77484,	17086,	9466,	20933,
5,	61000,	203772,	226646,	79993,	136335,	88495,	43677,	81986,	20803,	19345,
6,	20569,	47006,	118567,	118236,	52925,	56823,	31943,	40061,	63433,	28084,
7,	7248,	12630,	29522,	47872,	61821,	25407,	16815,	17664,	21788,	42496,
8,	8328,	4370,	9353,	13962,	23338,	31821,	8274,	7442,	9933,	8395,
9,	19130,	2523,	2617,	4051,	5659,	9408,	10974,	3508,	4267,	2878,
10,	4499,	5607,	1555,	936,	1521,	1227,	1785,	3196,	1311,	708,
11,	677,	2127,	1928,	558,	610,	913,	427,	678,	882,	271,
12,	195,	322,	575,	442,	271,	446,	103,	79,	109,	260,
+gp,	195,	296,	283,	218,	268,	847,	142,	58,	41,	37,
TOTALNUM,	547596,	807885,	496126,	465946,	490951,	339609,	200224,	175669,	135440,	132355,
TONSLAND,	792685,	1102433,	829377,	867463,	905301,	698715,	440538,	380434,	399038,	363730,
SOPCOF %,	130,	137,	115,	127,	107,	109,	121,	127,	118,	125,

Run title : Arctic Cod (run: SVPASA15/V15)

At 30/04/2003 23:56

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

YEAR,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,
AGE										
3,	3108,	6942,	24634,	28968,	13648,	9828,	5085,	1911,	4963,	21835,
4,	19594,	14240,	45769,	70993,	137106,	22774,	17313,	7551,	10933,	36015,
5,	20473,	18807,	27806,	78672,	98210,	135347,	32165,	12999,	16467,	27494,
6,	17656,	20086,	19418,	25215,	61407,	54379,	81756,	17827,	20342,	23392,
7,	17004,	15145,	11369,	11711,	13707,	21015,	27854,	30007,	19479,	18351,
8,	18329,	8287,	3747,	4063,	3866,	3304,	5501,	6810,	25193,	13541,
9,	2545,	5988,	1557,	976,	910,	1236,	827,	828,	3888,	18321,
10,	646,	783,	768,	726,	455,	519,	290,	179,	428,	2529,
11,	229,	232,	137,	557,	187,	106,	41,	59,	48,	264,
12,	74,	153,	36,	136,	227,	69,	13,	15,	12,	82,
+gp,	83,	69,	71,	76,	100,	62,	28,	13,	4,	13,
TOTALNUM,	99741,	90732,	135312,	222093,	329823,	248639,	170873,	78199,	101757,	161837,
TONSLAND,	289992,	277651,	307920,	430113,	523071,	434939,	332481,	212000,	319158,	513234,
SOPCOF %,	90,	95,	102,	102,	102,	100,	99,	101,	95,	103,

Run title : Arctic Cod (run: SVPASA15/V15)

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

YEAR,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,
AGE										
3,	10094,	6531,	4879,	7655,	12827,	31887,	7501,	4701,	5044,	1907,
4,	46182,	59444,	42587,	28782,	36491,	88874,	77714,	33094,	35019,	24824,
5,	63578,	102548,	115329,	80711,	69633,	48972,	92816,	93044,	62139,	60622,
6,	33623,	59766,	98485,	100509,	83017,	40493,	31139,	47210,	62456,	54709,
7,	14866,	32504,	32036,	54590,	65768,	34513,	15778,	12671,	22794,	35572,
8,	9449,	10019,	7334,	10545,	28392,	26354,	15851,	6677,	5266,	10053,
9,	6571,	6163,	3014,	2023,	4651,	6583,	8828,	4787,	1773,	1593,
10,	12593,	3671,	1725,	930,	1151,	965,	1837,	1647,	1163,	482,
11,	1749,	7528,	1174,	462,	373,	197,	195,	321,	343,	201,
12,	377,	995,	1920,	230,	213,	69,	40,	71,	85,	113,
+gp,	86,	144,	264,	894,	383,	117,	72,	26,	35,	34,
TOTALNUM,	199168,	289313,	308747,	287331,	302899,	279024,	251771,	204249,	196117,	190110,
TONSLAND,	581611,	771086,	739999,	732228,	762403,	592624,	484910,	414868,	426471,	445060,
SOPCOF %,	101,	101,	100,	101,	100,	101,	100,	100,	100,	100,

Table 3.11

Run title : Arctic Cod (run: SVPASA15/V15)

At 30/04/2003 23:56

Table 2 Catch weights-at-age (kg)

YEAR,	1946,	1947,	1948,	1949,	1950,	1951,	1952,
AGE							
3,	.3500,	.3200,	.3400,	.3700,	.3900,	.4000,	.4400,
4,	.5900,	.5600,	.5300,	.6700,	.6400,	.8300,	.8000,
5,	1.1100,	.9500,	1.2600,	1.1100,	1.2900,	1.3900,	1.3300,
6,	1.6900,	1.5000,	1.9300,	1.6600,	1.7000,	1.8800,	1.9200,
7,	2.3700,	2.1400,	2.4600,	2.5000,	2.3600,	2.5400,	2.6400,
8,	3.1700,	2.9200,	3.3600,	3.2300,	3.4800,	3.4600,	3.7100,
9,	3.9800,	3.6500,	4.2200,	4.0700,	4.5200,	4.8800,	5.0600,
10,	5.0500,	4.5600,	5.3100,	5.2700,	5.6200,	5.2000,	6.0500,
11,	5.9200,	5.8400,	5.9200,	5.9900,	6.4000,	7.1400,	7.4200,
12,	7.2000,	7.4200,	7.0900,	7.0800,	7.9600,	8.2200,	8.4300,
+gp,	8.1460,	8.8480,	8.4300,	8.2180,	8.8910,	9.3890,	10.1850,
SOPCOFAC,	1.0300,	.9143,	.8915,	.9920,	1.0880,	1.1483,	.9348,

Table 2 Catch weights-at-age (kg)

YEAR,	1953,	1954,	1955,	1956,	1957,	1958,	1959,	1960,	1961,	1962,
AGE										
3,	.4000,	.4400,	.3200,	.3300,	.3300,	.3400,	.3500,	.3400,	.3100,	.3200,
4,	.7600,	.7700,	.5700,	.5800,	.5900,	.5200,	.7200,	.5100,	.5500,	.5500,
5,	1.2800,	1.2600,	1.1300,	1.0700,	1.0200,	.9500,	1.4700,	1.0900,	1.0500,	.9300,
6,	1.9300,	1.9700,	1.7300,	1.8300,	1.8200,	1.9200,	2.6800,	2.1300,	2.2000,	1.7000,
7,	2.8100,	3.0300,	2.7500,	2.8900,	2.8900,	2.9400,	3.5900,	3.3800,	3.2300,	3.0300,
8,	3.7200,	4.3300,	3.9400,	4.2500,	4.2800,	4.2100,	4.3200,	4.8700,	5.1100,	5.0300,
9,	5.0600,	5.4000,	4.9000,	5.5500,	5.4900,	5.6100,	5.4500,	6.1200,	6.1500,	6.5500,
10,	6.3400,	6.7500,	7.0400,	7.2800,	7.5100,	7.3500,	6.4400,	8.4900,	8.1500,	7.7000,
11,	7.4000,	7.7900,	7.2000,	8.0000,	8.2400,	8.6700,	7.1700,	7.7900,	8.6800,	9.2700,
12,	8.6700,	10.6700,	8.7800,	8.3500,	9.2500,	9.5800,	8.6300,	8.3000,	9.6000,	10.5600,
+gp,	10.2380,	9.6800,	10.0770,	9.9440,	10.6050,	11.6310,	11.6210,	11.4220,	11.9520,	12.7170,
SOPCOFAC,	1.0485,	.9294,	1.0634,	1.0455,	1.0004,	1.1232,	.9305,	1.0416,	1.0970,	1.2356,

Run title : Arctic Cod (run: SVPASA15/V15)

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Table 2 Catch weights-at-age (kg)

YEAR,	1963,	1964,	1965,	1966,	1967,	1968,	1969,	1970,	1971,	1972,
AGE										
3,	.3200,	.3300,	.3800,	.4400,	.2900,	.3300,	.4400,	.3700,	.4500,	.3800,
4,	.6100,	.5500,	.6800,	.7400,	.8100,	.7000,	.7900,	.9100,	.8800,	.7700,
5,	.9600,	.9500,	1.0300,	1.1800,	1.3500,	1.4800,	1.2300,	1.3400,	1.3800,	1.4300,
6,	1.7300,	1.8600,	1.4900,	1.7800,	2.0400,	2.1200,	2.0300,	2.0000,	2.1600,	2.1200,
7,	3.0400,	3.2500,	2.4100,	2.4600,	2.8100,	3.1400,	2.9000,	3.0000,	3.0700,	3.2300,
8,	4.9600,	4.9700,	3.5200,	3.8200,	3.4800,	4.2100,	3.8100,	4.1500,	4.2200,	4.3800,
9,	6.4400,	6.4100,	5.7300,	5.3600,	4.8900,	5.2700,	5.0200,	5.5900,	5.8100,	5.8300,
10,	7.9100,	8.0700,	7.5400,	7.2700,	7.1100,	6.6500,	6.4300,	7.6000,	7.1300,	7.6200,
11,	9.6200,	9.3400,	8.4700,	8.6300,	9.0300,	9.0100,	8.3300,	8.9700,	8.6200,	9.5200,
12,	11.3100,	10.1600,	11.1700,	10.6600,	10.5900,	9.6600,	10.7100,	10.9900,	10.8300,	12.0900,
+gp,	12.7370,	12.8860,	13.7220,	14.1480,	13.8290,	14.8480,	14.2110,	14.0740,	12.9450,	13.6730,
SOPCOFAC,	1.0226,	1.0277,	1.2903,	1.2327,	1.0911,	1.0785,	1.0520,	1.1170,	1.2405,	1.1822,

Table 3.11 (Continued)

Table 2 Catch weights-at-age (kg)

YEAR	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
AGE										
3	.3800	.3200	.4100	.3500	.4900	.4900	.3500	.2700	.4900	.3700
4	.9100	.6600	.6400	.7300	.9000	.8100	.7000	.5600	.9800	.6600
5	1.5400	1.1700	1.1100	1.1900	1.4300	1.4500	1.2400	1.0200	1.4400	1.3500
6	2.2600	2.2200	1.9000	2.0100	2.0500	2.1500	2.1400	1.7200	2.0900	1.9900
7	3.2900	3.2100	2.9500	2.7600	3.3000	3.0400	3.1500	3.0200	2.9800	2.9300
8	4.6100	4.3900	4.3700	4.2200	4.5600	4.4600	4.2900	4.2000	4.8500	4.2400
9	6.5700	5.5200	5.7400	5.8800	6.4600	6.5400	6.5800	5.8400	6.5700	6.4600
10	8.3700	7.8600	8.7700	9.3000	8.6300	7.9800	8.6100	7.2600	9.1600	8.5100
11	10.5400	9.8200	9.9200	10.2800	9.9300	10.1500	9.2200	8.8400	10.8200	12.2400
12	11.6200	11.4100	11.8100	11.8600	10.9000	10.8500	10.8900	9.2800	10.7700	10.7800
+gp	13.9040	13.2420	13.1070	13.5440	13.6680	13.1770	14.3440	14.4480	13.9320	14.0410
SOPCOFAC	1.3003	1.3660	1.1520	1.2688	1.0683	1.0890	1.2139	1.2723	1.1809	1.2521

Table 2 Catch weights-at-age (kg)

YEAR	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
AGE										
3	.8400	1.4200	.9400	.6400	.4900	.5400	.7400	.8100	1.0500	1.1600
4	1.3700	1.9300	1.3700	1.2700	.8800	.8500	.9600	1.2200	1.4500	1.5700
5	2.0900	2.4900	2.0200	1.8800	1.5500	1.3200	1.3100	1.6400	2.1500	2.2100
6	2.8600	3.1400	3.2200	2.7900	2.3300	2.2400	1.9200	2.2200	2.8900	3.1000
7	3.9900	3.9100	4.6300	4.4900	3.4400	3.5200	2.9300	3.2400	3.7500	4.2700
8	5.5800	4.9100	6.0400	5.8400	5.9200	5.3500	4.6400	4.6800	4.7100	5.1900
9	7.7700	6.0200	7.6600	6.8300	8.6000	8.0600	7.5200	7.3000	6.0800	6.1400
10	9.2900	7.4000	9.8100	7.6900	9.6000	9.5100	9.1200	9.8400	8.8200	7.7700
11	11.5500	8.1300	11.8000	9.8100	12.1700	11.3600	11.0800	13.2500	11.8000	10.1200
12	16.2000	8.5700	14.1600	10.7100	13.7200	14.0900	11.4700	16.8800	16.5800	11.5400
+gp	17.0340	8.6090	14.0080	12.0510	13.3800	16.7060	16.4840	11.6170	16.6900	14.3320
SOPCOFAC	.8953	.9483	1.0182	1.0160	1.0224	1.0001	.9879	1.0108	.9521	1.0270

Table 2 Catch weights-at-age (kg)

YEAR	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
AGE										
3	.8100	.8200	.7700	.7900	.6700	.6800	.6300	.5720	.6600	.7400
4	1.5200	1.3000	1.2000	1.1100	1.0400	1.0500	1.0100	1.0360	1.0500	1.1400
5	2.1600	2.0600	1.7800	1.6100	1.5300	1.6200	1.5400	1.6090	1.6200	1.5800
6	2.7900	2.8900	2.5900	2.4600	2.2200	2.3000	2.3400	2.3440	2.5100	2.3300
7	4.0700	3.2100	3.8100	3.8200	3.4200	3.3000	3.2100	3.3410	3.5100	3.5600
8	5.5300	5.2000	4.9900	5.7200	5.2000	4.8600	4.2900	4.4760	4.7800	4.8400
9	6.4700	6.8000	6.2300	6.7400	7.1900	6.8700	6.0000	5.7240	6.0400	6.2400
10	7.1900	7.5700	8.0500	8.0400	7.7300	9.3000	6.7300	7.5230	7.5400	7.6600
11	7.9800	8.0100	8.7400	9.2800	8.6100	10.3000	10.0800	8.0210	9.0000	9.1000
12	10.1100	9.4800	9.2200	10.4000	11.0700	15.0500	13.8800	12.4780	10.4800	8.1800
+gp	14.1830	11.9780	12.3190	10.9660	11.1170	14.5240	14.0360	17.2410	16.1800	10.9510
SOPCOFAC	1.0127	1.0090	1.0030	1.0147	1.0004	1.0072	.9967	1.0039	.9994	1.0001

Table 3.12

Run title : Arctic Cod (run: SVPASA15/V15)

At 30/04/2003 23:56

Table 3 Stock weights-at-age (kg)

YEAR, AGE	1946,	1947,	1948,	1949,	1950,	1951,	1952,
3,	.3500,	.3200,	.3400,	.3700,	.3900,	.4000,	.4400,
4,	.5900,	.5600,	.5300,	.6700,	.6400,	.8300,	.8000,
5,	1.1100,	.9500,	1.2600,	1.1100,	1.2900,	1.3900,	1.3300,
6,	1.6900,	1.5000,	1.9300,	1.6600,	1.7000,	1.8800,	1.9200,
7,	2.3700,	2.1400,	2.4600,	2.5000,	2.3600,	2.5400,	2.6400,
8,	3.1700,	2.9200,	3.3600,	3.2300,	3.4800,	3.4600,	3.7100,
9,	3.9800,	3.6500,	4.2200,	4.0700,	4.5200,	4.8800,	5.0600,
10,	5.0500,	4.5600,	5.3100,	5.2700,	5.6200,	5.2000,	6.0500,
11,	5.9200,	5.8400,	5.9200,	5.9900,	6.4000,	7.1400,	7.4200,
12,	7.2000,	7.4200,	7.0900,	7.0800,	7.9600,	8.2200,	8.4300,
+gp,	8.1460,	8.8480,	8.4300,	8.2180,	8.8910,	9.3890,	10.1850,

Table 3 Stock weights-at-age (kg)

YEAR, AGE	1953,	1954,	1955,	1956,	1957,	1958,	1959,	1960,	1961,	1962,
3,	.4000,	.4400,	.3200,	.3300,	.3300,	.3400,	.3500,	.3400,	.3100,	.3200,
4,	.7600,	.7700,	.5700,	.5800,	.5900,	.5200,	.7200,	.5100,	.5500,	.5500,
5,	1.2800,	1.2600,	1.1300,	1.0700,	1.0200,	.9500,	1.4700,	1.0900,	1.0500,	.9300,
6,	1.9300,	1.9700,	1.7300,	1.8300,	1.8200,	1.9200,	2.6800,	2.1300,	2.2000,	1.7000,
7,	2.8100,	3.0300,	2.7500,	2.8900,	2.8900,	2.9400,	3.5900,	3.3800,	3.2300,	3.0300,
8,	3.7200,	4.3300,	3.9400,	4.2500,	4.2800,	4.2100,	4.3200,	4.8700,	5.1100,	5.0300,
9,	5.0600,	5.4000,	4.9000,	5.5500,	5.4900,	5.6100,	5.4500,	6.1200,	6.1500,	6.5500,
10,	6.3400,	6.7500,	7.0400,	7.2800,	7.5100,	7.3500,	6.4400,	8.4900,	8.1500,	7.7000,
11,	7.4000,	7.7900,	7.2000,	8.0000,	8.2400,	8.6700,	7.1700,	7.7900,	8.6800,	9.2700,
12,	8.6700,	10.6700,	8.7800,	8.3500,	9.2500,	9.5800,	8.6300,	8.3000,	9.6000,	10.5600,
+gp,	10.2380,	9.6800,	10.0770,	9.9440,	10.6050,	11.6310,	11.6210,	11.4220,	11.9520,	12.7170,

Run title : Arctic Cod (run: SVPASA15/V15)

At 30/04/2003 23:56

Table 3 Stock weights-at-age (kg)

YEAR, AGE	1963,	1964,	1965,	1966,	1967,	1968,	1969,	1970,	1971,	1972,
3,	.3200,	.3300,	.3800,	.4400,	.2900,	.3300,	.4400,	.3700,	.4500,	.3800,
4,	.6100,	.5500,	.6800,	.7400,	.8100,	.7000,	.7900,	.9100,	.8800,	.7700,
5,	.9600,	.9500,	1.0300,	1.1800,	1.3500,	1.4800,	1.2300,	1.3400,	1.3800,	1.4300,
6,	1.7300,	1.8600,	1.4900,	1.7800,	2.0400,	2.1200,	2.0300,	2.0000,	2.1600,	2.1200,
7,	3.0400,	3.2500,	2.4100,	2.4600,	2.8100,	3.1400,	2.9000,	3.0000,	3.0700,	3.2300,
8,	4.9600,	4.9700,	3.5200,	3.8200,	3.4800,	4.2100,	3.8100,	4.1500,	4.2200,	4.3800,
9,	6.4400,	6.4100,	5.7300,	5.3600,	4.8900,	5.2700,	5.0200,	5.5900,	5.8100,	5.8300,
10,	7.9100,	8.0700,	7.5400,	7.2700,	7.1100,	6.6500,	6.4300,	7.6000,	7.1300,	7.6200,
11,	9.6200,	9.3400,	8.4700,	8.6300,	9.0300,	9.0100,	8.3300,	8.9700,	8.6200,	9.5200,
12,	11.3100,	10.1600,	11.1700,	10.6600,	10.5900,	9.6600,	10.7100,	10.9900,	10.8300,	12.0900,
+gp,	12.7370,	12.8860,	13.7220,	14.1480,	13.8290,	14.8480,	14.2110,	14.0740,	12.9450,	13.6730,

Table 3.12 (continued)

Table 3 Stock weights-at-age (kg)

YEAR, AGE	1973,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,	1982,
3,	.3800,	.3200,	.4100,	.3500,	.4900,	.4900,	.3500,	.2700,	.4900,	.3700,
4,	.9100,	.6600,	.6400,	.7300,	.9000,	.8100,	.7000,	.5600,	.9800,	.6600,
5,	1.5400,	1.1700,	1.1100,	1.1900,	1.4300,	1.4500,	1.2400,	1.0200,	1.4400,	1.3500,
6,	2.2600,	2.2200,	1.9000,	2.0100,	2.0500,	2.1500,	2.1400,	1.7200,	2.0900,	1.9900,
7,	3.2900,	3.2100,	2.9500,	2.7600,	3.3000,	3.0400,	3.1500,	3.0200,	2.9800,	2.9300,
8,	4.6100,	4.3900,	4.3700,	4.2200,	4.5600,	4.4600,	4.2900,	4.2000,	4.8500,	4.2400,
9,	6.5700,	5.5200,	5.7400,	5.8800,	6.4600,	6.5400,	6.5800,	5.8400,	6.5700,	6.4600,
10,	8.3700,	7.8600,	8.7700,	9.3000,	8.6300,	7.9800,	8.6100,	7.2600,	9.1600,	8.5100,
11,	10.5400,	9.8200,	9.9200,	10.2800,	9.9300,	10.1500,	9.2200,	8.8400,	10.8200,	12.2400,
12,	11.6200,	11.4100,	11.8100,	11.8600,	10.9000,	10.8500,	10.8900,	9.2800,	10.7700,	10.7800,
+gp,	13.9040,	13.2420,	13.1070,	13.5440,	13.6680,	13.1770,	14.3440,	14.4480,	13.9320,	14.0410,

Table 3 Stock weights-at-age (kg)

YEAR, AGE	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,
3,	.3700,	.4200,	.4100,	.3100,	.1900,	.2100,	.3000,	.4000,	.5180,	.4400,
4,	.9200,	1.1600,	.8800,	.8800,	.5100,	.4000,	.5200,	.7100,	1.1360,	.9310,
5,	1.6000,	1.8100,	1.6000,	1.4700,	1.2800,	.7900,	.8700,	1.1800,	1.7430,	1.8120,
6,	2.4400,	2.7900,	2.8100,	2.4700,	1.9400,	1.9000,	1.4800,	1.7200,	2.4280,	2.7160,
7,	3.8200,	3.7800,	4.0600,	3.9200,	3.2800,	2.9800,	2.6900,	2.4600,	3.2140,	3.8950,
8,	4.7600,	4.5700,	5.8300,	5.8100,	5.1700,	4.3900,	4.6300,	3.5700,	4.5380,	5.1760,
9,	6.1700,	6.1700,	7.6900,	6.5800,	6.5200,	7.8100,	7.0500,	4.7100,	6.8800,	6.7740,
10,	7.7000,	7.7000,	10.1200,	6.8300,	9.3000,	12.1100,	9.9800,	7.8000,	10.7190,	9.5980,
11,	9.2500,	9.2500,	14.2900,	11.0000,	13.1500,	13.1100,	9.2500,	8.9600,	9.4450,	12.4270,
12,	10.8500,	10.8500,	10.8500,	10.8500,	10.8500,	10.8500,	10.8500,	10.8500,	10.8500,	10.8500,
+gp,	12.9880,	13.0330,	13.4130,	13.5870,	13.8260,	13.0180,	14.4790,	13.4230,	14.1000,	13.6620,

Table 3 Stock weights-at-age (kg)

YEAR, AGE	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,
3,	.3440,	.2350,	.2010,	.1950,	.2020,	.2170,	.2030,	.1940,	.2850,	.2510,
4,	1.1720,	.7530,	.4850,	.4870,	.5210,	.5330,	.5200,	.4650,	.5220,	.6050,
5,	1.8200,	1.4200,	1.1400,	1.0310,	1.0790,	1.1610,	1.1740,	1.2080,	1.1940,	1.1860,
6,	2.8230,	2.4130,	2.1180,	2.0540,	1.8780,	1.9390,	2.0310,	1.9720,	2.2310,	2.1100,
7,	4.0310,	3.8250,	3.4700,	3.5250,	3.3690,	2.9450,	3.0340,	3.0480,	3.3060,	3.3120,
8,	5.4970,	5.4160,	4.9380,	5.5030,	5.2630,	4.5740,	4.4640,	4.0960,	5.0500,	4.7210,
9,	6.7650,	6.6310,	7.1600,	7.7670,	8.9270,	7.4230,	6.4820,	5.7240,	6.3760,	6.8660,
10,	8.5710,	7.6300,	9.1190,	10.1590,	12.1540,	10.3670,	10.2690,	7.4570,	9.1150,	9.0830,
11,	10.8470,	8.1120,	10.1010,	10.6690,	10.8230,	11.7380,	10.8820,	9.5820,	11.2720,	10.2060,
12,	10.8500,	10.8500,	10.8500,	10.8500,	10.8500,	10.8500,	10.8500,	10.8500,	10.8500,	10.8500,
+gp,	12.8870,	12.7540,	12.7270,	12.6340,	13.3770,	13.8960,	13.6970,	13.9000,	14.3510,	12.9950,

Table 3.13

Run title : Arctic Cod (run: SVPASA15/V15)

At 30/04/2003 23:56

Table 5 Proportion mature at age

YEAR,	1946,	1947,	1948,	1949,	1950,	1951,	1952,
AGE							
3,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
4,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
5,	.0100,	.0100,	.0100,	.0100,	.0100,	.0100,	.0100,
6,	.0300,	.0300,	.0300,	.0300,	.0300,	.0300,	.0300,
7,	.0600,	.0600,	.0700,	.0900,	.0900,	.1000,	.0800,
8,	.1100,	.1300,	.1300,	.1700,	.2300,	.2400,	.2200,
9,	.1800,	.1600,	.2500,	.2900,	.3500,	.4000,	.4100,
10,	.4400,	.4200,	.4700,	.5400,	.5200,	.5800,	.6300,
11,	.6500,	.7500,	.7300,	.7900,	.7900,	.7200,	.8200,
12,	.8600,	.9100,	.9100,	.8800,	.9500,	.8500,	.9200,
+gp,	.9600,	.9500,	.9700,	.9700,	.9700,	.9600,	.9700,

Table 5 Proportion mature at age

YEAR,	1953,	1954,	1955,	1956,	1957,	1958,	1959,	1960,	1961,	1962,
AGE										
3,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
4,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0100,	.0000,	.0000,
5,	.0100,	.0100,	.0100,	.0100,	.0100,	.0100,	.0100,	.0300,	.0100,	.0100,
6,	.0300,	.0300,	.0300,	.0300,	.0300,	.0300,	.0400,	.0600,	.0600,	.0500,
7,	.0700,	.0800,	.0700,	.0600,	.0600,	.0600,	.1200,	.1000,	.1200,	.1500,
8,	.1900,	.1600,	.1300,	.1200,	.0900,	.1000,	.3400,	.1900,	.3100,	.3400,
9,	.4000,	.3700,	.2600,	.1400,	.1200,	.1000,	.4900,	.4500,	.6500,	.6100,
10,	.6400,	.6800,	.5300,	.4100,	.2200,	.3000,	.6700,	.6900,	.9100,	.8100,
11,	.8400,	.8700,	.8300,	.6700,	.6000,	.5000,	.8400,	.7700,	.9800,	.9200,
12,	.9400,	.9300,	.9200,	.9100,	.8200,	.8200,	.8700,	.8500,	.9800,	.9700,
+gp,	.9700,	.9600,	.9700,	.9600,	.9700,	.9700,	1.0000,	.9900,	1.0000,	1.0000,

Run title : Arctic Cod (run: SVPASA15/V15)

At 30/04/2003 23:56

Table 5 Proportion mature at age

YEAR,	1963,	1964,	1965,	1966,	1967,	1968,	1969,	1970,	1971,	1972,
AGE										
3,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0100,
4,	.0100,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0100,	.0000,	.0200,
5,	.0100,	.0000,	.0000,	.0100,	.0000,	.0300,	.0000,	.0000,	.0100,	.0200,
6,	.0300,	.0300,	.0100,	.0200,	.0300,	.0500,	.0200,	.0100,	.0500,	.0100,
7,	.0700,	.1300,	.0600,	.0600,	.0700,	.0900,	.0400,	.0700,	.1100,	.1000,
8,	.2800,	.3700,	.2000,	.2200,	.1400,	.1900,	.1200,	.2300,	.3000,	.3400,
9,	.4200,	.6600,	.5500,	.3500,	.3800,	.3900,	.3400,	.5800,	.5900,	.6400,
10,	.8100,	.8900,	.7300,	.7400,	.6400,	.5800,	.5500,	.8100,	.7900,	.8100,
11,	.9800,	.9500,	.9900,	.9400,	.8900,	.8200,	.7400,	.8900,	.8600,	.9400,
12,	.9800,	.9900,	.9800,	.9400,	.9000,	1.0000,	.9500,	.9100,	.8800,	1.0000,
+gp,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,

Table 3.13 (continued)

Table 5 Proportion mature at age

YEAR, AGE	1973,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,	1982,
3,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
4,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0500,
5,	.0000,	.0000,	.0100,	.0000,	.0200,	.0000,	.0000,	.0000,	.0200,	.1000,
6,	.0200,	.0100,	.0200,	.0500,	.0800,	.0200,	.0300,	.0200,	.0700,	.3400,
7,	.1600,	.0300,	.0900,	.1200,	.2600,	.1300,	.1300,	.1300,	.2000,	.6500,
8,	.5300,	.2100,	.2100,	.2900,	.5400,	.4400,	.3900,	.3500,	.5400,	.8200,
9,	.8100,	.5000,	.5600,	.4500,	.7600,	.7100,	.7700,	.6500,	.8000,	.9200,
10,	.9200,	.9600,	.7800,	.8400,	.8700,	.7700,	.8900,	.8200,	.9700,	1.0000,
11,	.9500,	1.0000,	.7900,	.8300,	.9300,	.8100,	.8300,	1.0000,	1.0000,	1.0000,
12,	.9800,	.9600,	.9500,	1.0000,	.9400,	.8900,	.7800,	.9000,	1.0000,	1.0000,
+gp,	1.0000,	1.0000,	1.0000,	.9000,	.9000,	.8000,	.9000,	.9000,	1.0000,	1.0000,

Table 5 Proportion mature at age

YEAR, AGE	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,
3,	.0100,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0100,
4,	.0800,	.0500,	.0100,	.0500,	.0100,	.0200,	.0000,	.0100,	.0400,	.0100,
5,	.1000,	.1800,	.0900,	.0800,	.0700,	.0500,	.0500,	.0500,	.0600,	.1200,
6,	.3000,	.3100,	.3600,	.1900,	.1800,	.3300,	.1800,	.2100,	.2800,	.4300,
7,	.7300,	.5600,	.5500,	.5300,	.2200,	.5300,	.4100,	.5800,	.6500,	.7500,
8,	.8800,	.9000,	.8500,	.7100,	.4600,	.6200,	.6900,	.7700,	.8300,	.9300,
9,	.9700,	.9900,	.9600,	.6200,	.5000,	1.0000,	.8500,	.8600,	.9700,	.9700,
10,	1.0000,	1.0000,	.9000,	.9000,	.7500,	1.0000,	1.0000,	.9800,	1.0000,	1.0000,
11,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
12,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
+gp,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,

Table 5 Proportion mature at age

YEAR, AGE	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,
3,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
4,	.0300,	.0100,	.0000,	.0000,	.0000,	.0100,	.0000,	.0000,	.0100,	.0100,
5,	.0900,	.1100,	.0700,	.0200,	.0200,	.0400,	.0100,	.0600,	.0500,	.0800,
6,	.3000,	.3300,	.3300,	.2600,	.1400,	.1900,	.1000,	.2200,	.3400,	.4000,
7,	.6100,	.6000,	.6200,	.6300,	.5600,	.4400,	.4500,	.6400,	.5800,	.7000,
8,	.9100,	.8100,	.7400,	.8300,	.8200,	.8200,	.7900,	.8300,	.7700,	.8600,
9,	.9700,	.9700,	.9500,	.9800,	.9500,	.9300,	.8800,	.9700,	.9800,	.9800,
10,	.9900,	.9900,	.9800,	1.0000,	.9500,	.9800,	1.0000,	1.0000,	1.0000,	1.0000,
11,	1.0000,	.9900,	1.0000,	1.0000,	.9500,	1.0000,	1.0000,	1.0000,	.9700,	1.0000,
12,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
+gp,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,

Table 3.14

```
Northeast Arctic cod (Subareas I and II) (run name: XSAASA26)
104
FLT09: Russian trawl  catch and effort  ages 9 - 14 (Catch: Thousa (Catch: Unknown) (Effort:
Unknown)
1985 2002
1 1 0.00 1.00
9 13
   0.70     291      77      30       6       0
   1.52      87      59      22       3       1
   2.10     127      95      37      11       2
   2.75     442     215      53      12       3
   2.12     140      47      11       0       0
   1.11     204      49      14       2       0
   1.56     791      71      16       4       1
   2.50    3852     689      62      10       0
   2.64    2019    1778      68      13       2
   2.96    1237     595     167      40       5
   3.88     684     345     146      21       1
   3.73     364     164      34      10       0
   4.92     488      99      34      10       0
   6.77     559      88      34      13       1
   6.39     882     171       0       0       0
   4.25     742     185      25       1       0
   3.50     235      95      35       7       0
   3.15     336      61      18       1       0


FLT15: NorBarTrSur rev99 (Catch: Unknown) (Effort: Unknown)
1980 2002
1 1 0.99 1.00
3 8
   1     233     400     384      48      10       3
   1     277     236     155     160      14       2
   1     523     433     170      58      32      10
   1     283     214     117      41       4       1
   1    1260     199      77      33       2       1
   1    1439     641      83      19       3       0
   1    3911     543     157      20       5       0
   1     805    1733     205      36       5       0
   1     759     378     902      98       9       1
   1     349     346     206     272      16       4
   1     337     257     215     122     127       6
   1     577     178     128      77      43      27
   1    1401     725     158      62      39      22
   1    3102    1474     506      93      24      16
   1    2414    2559     767     185      24       8
   1    1154    1372    1061     240      29       4
   1     640     704     527     283      57       9
   1    1813     365     259     178      86      10
   1    1732     581     134      65      51      12
   1    1321    1083     269      43      20      12
   1    1828     834     382      89      11       4
   1    1350    1096     425     151      24       3
   1    1297     911     673     183      49      10
```

Table 3.14 (continued)

```
FLT16: NorBarLofAcSur rev99 (Catch: Unknown) (Effort: Unknown)
1984 2002
1 1 0.99 1.00
3 11
   1    1416     203     150     157      33      12      11       5       0
   1    1343     684     116      77      31       2       0       4       1
   1    2049     502     174      15      30       7       0       0       0
   1     355     578     109      39       2       0       1       0       0
   1     344     214     670     166      32       5       1       0       1
   1     206     262     269     668      72       6       4       0       0
   1     346     293     339     367     500      36       2       2       0
   1     658     216     185     284     254     824      44      16       2
   1    1911    1131     354     255     252     277     443      49       7
   1    4045    2174     894     224     120      94      39     179      27
   1    1598    2166    1041     291      43      43      31      26      81
   1     705     872     891     446      64      10       4       9      15
   1     517     497     422     499     205      22       5       0       8
   1    1826     424     338     340     247      49       8       2       0
   1     964     454     122     112     187      92      11       2       1
   1    1589    1457     493     129      69      52      16       4       1
   1    1716     812     554     190      22       8       5       3       1
   1    1122    1035     591     297      73      10       4       3       0
   1    1144    1320    1492     692     231      41       5       1       1
```

```
FLT17: RusSurCatch/hr rev00 (ages 1-8) (Catch: Unknown) ( (Catch: Unknown) (Effort: Unknown)
1982 2002
1 1 0.90 1.00
3 8
   1    141     76     94     58     32     11
   1     60     73     48     20      7     11
   1    156     93     49     30     12      5
   1    283    397    181     45     17      6
   1    495    286    140     50     14      2
   1     61    402     78     34      8      2
   1     66     73    193     33     10      2
   1     34     91    109    161    131     55
   1      9     29     65     78     96     43
   1    102     48     58     66     83     71
   1    309     90     45     48     26     23
   1    491    526    377    117     45     32
   1    230    404    383    366    120     42
   1    119    235    247    105     23      7
   1     77    101    126     86     36      9
   1     99     83     62     37     18      5
   1    508    334     97     37     16      7
   1    284    475    162     31     12      8
   1    276    219    169     58      8      3
   1    277    372    206    115     22      3
   1    180    144    241    252    117     52
```

Table 3.15. NEAcod. Compared diagnostics and results for xsa tuned by single fleets and combination of fleets.
Cannibalism included in catch

		FLT 09 Rus trawl CPUE	FLT 15 Joint BT survey	FLT 16 Joint+Lof Ac survey	FLT 17 Rus BT survey	Final run ALL Fleets	Fleksi-best Final	ALL Fleets	ALL Fleets	ALL Fleets	Red.surv. weights ALL Fleets	02 deleted in FL 17 ALL fleets	02,03 deleted in FL16and17 ALL fleets
Min. SE for shrinkage		1.0	1.0	1.0	1.0	1.0		1.0	1.0	1.0	0.5	1.0	1.0
SS-ind.Q for age>		6	6	6	6	6	2	4	5	7	6	6	6
ages with fleet data		9 to 12	3 to 8	3 to 11	3 to 8	3 to 12	3 to 12	3 to 12	3 to 12	3 to 12	3 to 12	3 to 12	3 to 12
# of iterations to converg		23	18	21	>30	23	0	25	25	26	21	25	>30
age3	PshrinkW	**0.93**	**0.58**	**0.58**	**0.74**	0.35	0	0.30	0.33	0.38	**0.40**	**0.43**	**0.58**
	FshrinkW	0.07	0.04	0.04	0.07	0.03	0	0.02	0.03	0.03	0.11	0.03	0.04
age4	PshrinkW	**0.90**	0.29	0.31	0.32	0.12	0	*	0.12	0.13	0.15	0.15	0.29
	FshrinkW	0.10	0.04	0.04	0.05	0.02	0	0.02	0.02	0.02	0.08	0.02	0.04
age5	PshrinkW	**0.83**	0.16	0.17	0.20	0.06	0	*	*	0.06	0.07	0.07	0.14
	FshrinkW	0.17	0.04	0.04	0.05	0.02	0	0.02	0.02	0.02	0.07	0.02	0.03
age6	FshrinkW	**1.00**	0.05	0.04	0.08	0.02	0	0.02	0.02	0.05 / 0.02	0.08	0.02	0.04
age7	FshrinkW	**1.00**	0.08	0.10	0.11	0.03	0	0.03	0.03	0.03	0.13	0.04	0.06
age8	FshrinkW	**1.00**	0.10	0.17	0.21	0.05	0	0.05	0.05	0.05	0.20	0.06	0.08
age9	FshrinkW	0.37	0.38	0.22	**0.71**	0.10	0	0.10	0.10	0.10	0.39	0.10	0.19
age10	FshrinkW	0.24	**0.68**	0.22	**0.92**	0.13	0	0.13	0.13	0.13	**0.41**	0.13	0.18
age11	FshrinkW	0.23	**0.90**	0.37	**0.98**	0.17	0	0.17	0.17	0.17	**0.50**	0.17	0.22
age12	FshrinkW	**0.45**	**0.97**	**0.73**	**0.99**	**0.44**	0	**0.44**	**0.44**	**0.44**	**0.76**	**0.44**	**0.40**
N2002	age3	42870	47193	50338	48587	50165	33980	52047	50760	49193	43687	50690	47695
N*10^-4	age4	28995	34727	39260	33378	38589	30270	41935	38966	37838	33969	40861	35139
	age5	20833	29771	35213	32601	36201	32884	39336	38440	35303	32630	35273	30670
	age6	11926	15522	20705	21241	19438	17504	20088	19772	17831	17721	18534	15848
	age7	7059	7361	7924	12275	8401	10963	8612	8490	8249	7884	8052	7658
	age8	1677	1861	1892	2696	2046	3042	2049	2056	2039	1887	1974	1908
	age9	324	234	272	243	284	461	284	284	284	258	286	269
	age10	88	71	71	71	75	153	75	75	75	73	75	88
F2002	age 4	0.12	0.10	0.09	0.11	0.09	0.10	0.08	0.09	0.09	0.10	0.09	0.10
	age5	0.39	0.26	0.21	0.23	0.21	0.21	0.19	0.19	0.21	0.23	0.21	0.25
	age6	0.71	0.49	0.35	0.34	0.37	0.35	0.36	0.37	0.41	0.42	0.39	0.48
	age7	0.81	0.76	0.69	0.39	0.63	0.46	0.61	0.62	0.65	0.69	0.67	0.72
	age8	1.09	0.91	0.88	0.53	0.78	0.54	0.78	0.78	0.79	0.89	0.83	0.87
	age9	0.78	1.39	1.04	1.28	0.97	0.60	0.97	0.97	0.96	1.14	0.96	1.07
	age10	0.93	1.37	1.38	1.41	1.23	0.66	1.23	1.23	1.23	1.32	1.23	0.93
2002	F(5-10)	0.79	0.86	0.76	0.70	0.70	0.47	0.69	0.69	0.71	0.78	0.71	0.72
	F(4-8)	0.62	0.50	0.44	0.32	0.42	0.33	0.40	0.41	0.43	0.47	0.44	0.48
TSB2002	incl Age1-2	1245	1489	1726	1844	1730	1595	1815	1771	1672	1574	1700	1527
SSB2002	('000 T)	391	438	504	637	513	436	527	520	494	474	494	454

Table 3.16

```
Lowestoft VPA Version 3.1

  28/04/2003  15:01

Extended Survivors Analysis

Arctic Cod (run: XSAASA27/X27)

CPUE data from file fleet

Catch data for  19 years. 1984 to 2002. Ages  1 to  13.

     Fleet,           First, Last, First, Last, Alpha,  Beta
                 ,     year, year,  age ,  age
FLT09: Russian trawl,   1985, 2002,   9,    12,   .000,  1.000
FLT15: NorBarTrSur r,   1984, 2002,   3,     8,   .990,  1.000
FLT16: NorBarLofAcSu,   1984, 2002,   3,    11,   .990,  1.000
FLT17: RusSurCatch/h,   1984, 2002,   3,     8,   .900,  1.000


Time-series weights :

     Tapered time weighting applied
     Power =    3 over  10 years


Catchability analysis :

     Catchability dependent on stock size for ages <    6

        Regression type = C
        Minimum of   5 points used for regression
        Survivor estimates shrunk to the population mean for ages <  6


     Catchability independent of age for ages >=   10


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 =   1.000

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

     Prior weighting not applied


Tuning converged after   25 iterations


Regression weights
      ,  .020,  .116,  .284,  .482,  .670,  .820,  .921,  .976,  .997, 1.000

Fishing mortalities
   Age,  1993,  1994,  1995,  1996,  1997,  1998,  1999,  2000,  2001,  2002

     1, 2.567, 1.716, 1.870, 1.983, 2.497, 1.609, 1.129, 1.350,  .973, 1.103
     2,  .450,  .631,  .939, 1.058, 1.116,  .643,  .349,  .270,  .182,  .522
     3,  .079,  .208,  .554,  .472,  .341,  .373,  .120,  .070,  .059,  .083
     4,  .096,  .202,  .302,  .354,  .304,  .355,  .210,  .128,  .105,  .091
     5,  .347,  .339,  .336,  .413,  .574,  .531,  .554,  .411,  .259,  .206
     6,  .460,  .646,  .576,  .543,  .726,  .791,  .747,  .616,  .518,  .373
     7,  .566, 1.168,  .892,  .750,  .845,  .778,  .837,  .804,  .697,  .631
     8,  .598,  .986,  .943,  .864, 1.237, 1.049, 1.080, 1.131,  .984,  .783
     9,  .665, 1.056,  .962,  .752, 1.344, 1.178, 1.423, 1.264, 1.141,  .966
    10,  .668, 1.033, 1.023,  .941, 1.510, 1.267, 1.452, 1.265, 1.399, 1.229
    11,  .683, 1.185, 1.227,  .875, 1.448, 1.335,  .994, 1.197, 1.042, 1.034
    12,  .684, 1.143, 1.229,  .861, 1.551, 1.328, 1.187, 1.413, 1.375, 1.341
```

Table 3.16 (continued)

XSA population numbers (Thousands)

YEAR	AGE 1	2	3	4	5	6	7	8	9	10
1993	2.43E+07	1.56E+06	9.05E+05	5.73E+05	2.42E+05	1.01E+05	3.80E+04	2.32E+04	1.50E+04	2.86E+04
1994	9.33E+06	1.53E+06	8.17E+05	6.84E+05	4.26E+05	1.40E+05	5.21E+04	1.77E+04	1.04E+04	6.30E+03
1995	2.01E+07	1.37E+06	6.65E+05	5.43E+05	4.58E+05	2.49E+05	6.00E+04	1.33E+04	5.39E+03	2.98E+03
1996	2.81E+07	2.54E+06	4.40E+05	3.13E+05	3.29E+05	2.68E+05	1.14E+05	2.01E+04	4.23E+03	1.69E+03
1997	2.03E+07	3.16E+06	7.22E+05	2.25E+05	1.80E+05	1.78E+05	1.27E+05	4.42E+04	6.95E+03	1.63E+03
1998	6.80E+06	1.37E+06	8.48E+05	4.20E+05	1.36E+05	8.29E+04	7.05E+04	4.48E+04	1.05E+04	1.48E+03
1999	3.02E+06	1.11E+06	5.88E+05	4.78E+05	2.41E+05	6.54E+04	3.07E+04	2.65E+04	1.29E+04	2.65E+03
2000	3.46E+06	8.00E+05	6.44E+05	4.27E+05	3.17E+05	1.14E+05	2.54E+04	1.09E+04	7.37E+03	2.54E+03
2001	4.01E+06	7.35E+05	5.00E+05	4.91E+05	3.08E+05	1.72E+05	5.02E+04	9.29E+03	2.88E+03	1.71E+03
2002	3.98E+06	1.24E+06	5.02E+05	3.86E+05	3.62E+05	1.94E+05	8.40E+04	2.05E+04	2.84E+03	7.53E+02

Estimated population abundance at 1st Jan 2003

	0.00E+00	1.08E+06	6.02E+05	3.78E+05	2.88E+05	2.41E+05	1.10E+05	3.66E+04	7.66E+03	8.86E+02

Taper weighted geometric mean of the VPA populations:

	6.10E+06	1.25E+06	6.02E+05	4.06E+05	2.67E+05	1.36E+05	5.65E+04	2.00E+04	5.87E+03	1.76E+03

Standard error of the weighted Log(VPA populations) :

	.8353	.5001	.2199	.2726	.3795	.4933	.5944	.6190	.6236	.5249

YEAR	AGE 11	12
1993	3.90E+03	8.41E+02
1994	1.20E+04	1.61E+03
1995	1.84E+03	3.00E+03
1996	8.75E+02	4.40E+02
1997	5.39E+02	2.99E+02
1998	2.95E+02	1.04E+02
1999	3.42E+02	6.36E+01
2000	5.08E+02	1.04E+02
2001	5.86E+02	1.26E+02
2002	3.45E+02	1.69E+02

Estimated population abundance at 1st Jan 2003

	1.80E+02	1.00E+02

Taper weighted geometric mean of the VPA populations:

	5.10E+02	1.66E+02

Standard error of the weighted Log(VPA populations) :

	.6755	.9766

Log catchability residuals.

Fleet : FLT09: Russian trawl

Age	1984	1985	1986	1987	1988	1989	1990	1991	1992
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	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
10	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
11	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
12	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99

Table 3.16 (continued)

Age	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
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	.79	.70	.46	.03	-.22	-.88	-.47	.26	.20	.60
10	.15	.60	.53	.36	-.17	-.60	-.39	.07	.04	.46
11	-1.12	-1.25	.23	-.58	-.15	.09	99.99	-.35	-.02	-.06
12	-1.24	-.70	-2.20	-1.13	-.75	.17	99.99	-1.90	.04	-2.11

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

Age	9	10	11	12
Mean Log q	-3.3593	-3.4899	-3.4899	-3.4899
S.E(Log q)	.5265	.4035	.3497	1.5479

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
9	2.57	-2.173	-5.01	.31	10	1.04	-3.36
10	1.21	-.481	2.65	.55	10	.53	-3.49
11	1.32	-1.271	2.80	.83	9	.38	-3.65
12	1.41	-.518	4.22	.32	9	1.60	-4.53

Fleet : FLT15: NorBarTrSur r

Age	1984	1985	1986	1987	1988	1989	1990	1991	1992
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
6	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
7	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
8	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
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	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
3	.08	.09	.01	-.08	.10	-.07	-.09	.02	.04	.03
4	.04	.41	.20	.25	.00	-.20	.06	-.11	-.04	.04
5	.32	.09	.29	.10	.25	-.06	-.03	-.13	-.14	.04
6	-.07	.47	.09	.14	.27	.09	-.13	-.08	-.07	-.14
7	-.08	.20	-.03	-.14	.26	.26	.22	-.22	-.23	-.10
8	.24	.21	-.24	.07	-.24	-.25	.30	.14	-.13	.08
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									

Table 3.16 (continued)

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

Age	6	7	8
Mean Log q	-6.2573	-6.5231	-6.7288
S.E(Log q)	.1627	.2261	.2146

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
3	.74	1.668	7.61	.91	10	.08	-5.65
4	.82	.676	7.04	.78	10	.16	-5.79
5	.84	.871	7.05	.87	10	.16	-5.99

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
6	.92	.548	6.69	.92	10	.16	-6.26
7	.91	.551	6.92	.90	10	.22	-6.52
8	1.09	-.523	6.43	.88	10	.25	-6.73

1

Fleet : FLT16: NorBarLofAcSu

Age	1984	1985	1986	1987	1988	1989	1990	1991	1992
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
6	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
7	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
8	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
9	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
10	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
11	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
12	No data for this fleet at this age								

Age	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
3	.77	.00	-.31	-.33	.41	-.41	.22	.16	-.06	-.01
4	.43	.35	-.18	-.10	.04	-.48	.34	-.16	-.10	.36
5	.44	-.04	-.21	-.32	.24	-.18	.18	-.11	-.14	.28
6	-.02	.10	-.11	-.11	.10	-.18	.15	-.14	-.21	.37
7	.38	-.36	-.38	.00	.17	.42	.31	-.67	-.26	.31
8	.69	.57	-.64	-.35	.03	.46	.45	-.48	-.25	.17
9	.31	.83	-.65	-.39	.17	-.09	.32	-.44	.15	.22
10	.79	.74	.42	99.99	.00	-.15	.15	-.28	.25	-.20
11	.90	1.38	1.61	1.37	99.99	.84	.35	.16	99.99	.39
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	6	7	8	9	10	11
Mean Log q	-5.4371	-5.3793	-5.4092	-5.3985	-5.0001	-5.0001
S.E(Log q)	.2245	.4165	.4140	.3534	.2670	.8720

Table 3.16 (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
3,	1.09,	-.143,	5.14,	.38,	10,	.31,	-5.80,
4,	.93,	.132,	6.27,	.45,	10,	.34,	-5.77,
5,	.66,	1.175,	7.98,	.74,	10,	.25,	-5.66,

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
6,	.97,	.149,	5.64,	.84,	10,	.24,	-5.44,
7,	.74,	1.231,	6.85,	.84,	10,	.29,	-5.38,
8,	.67,	2.204,	6.88,	.91,	10,	.21,	-5.41,
9,	1.01,	-.027,	5.37,	.75,	10,	.40,	-5.40,
10,	.80,	1.137,	5.49,	.90,	9,	.21,	-5.00,
11,	.72,	1.253,	4.90,	.88,	8,	.35,	-4.38,

Fleet : FLT17: RusSurCatch/h

Age	1984	1985	1986	1987	1988	1989	1990	1991	1992
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
6	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99
7	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99
8	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99
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	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
3	.08,	-.27,	-.29,	-.24,	-.65,	.36,	.15,	.01,	.26,	-.04
4	.05,	-.21,	-.23,	-.11,	.09,	.25,	.24,	-.11,	.02,	-.26
5	1.20,	.65,	-.01,	-.47,	-.60,	.22,	.35,	-.05,	.05,	.03
6	.62,	1.61,	-.28,	-.58,	-.84,	-.02,	.00,	-.05,	.13,	.65
7	.89,	2.12,	.07,	-.26,	-.97,	-.56,	.04,	-.21,	.02,	1.11
8	.88,	1.80,	.25,	.01,	-1.01,	-.87,	-.18,	-.22,	-.20,	1.67
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	6	7	8
Mean Log q,	-6.7569,	-6.8987,	-6.7119,
S.E(Log q),	.5174,	.7213,	.9348,

Table 3.16 (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
3,	.71,	.419,	9.24,	.32,	10,	.35,	-7.54,
4,	.54,	1.282,	9.75,	.65,	10,	.22,	-7.10,
5,	1.32,	-.762,	5.07,	.57,	10,	.37,	-6.88,

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
6,	1.10,	-.172,	6.27,	.43,	10,	.63,	-6.76,
7,	1.10,	-.152,	6.51,	.36,	10,	.88,	-6.90,
8,	1.78,	-.627,	4.23,	.13,	10,	1.77,	-6.71,

Terminal year survivor and F summaries :

Age 1 Catchability dependent on age and year class strength

Year class = 2001

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
FLT09: Russian trawl,	1.,	.000,	.000,	.00,	0,	.000,	.000
FLT15: NorBarTrSur r,	1.,	.000,	.000,	.00,	0,	.000,	.000
FLT16: NorBarLofAcSu,	1.,	.000,	.000,	.00,	0,	.000,	.000
FLT17: RusSurCatch/h,	1.,	.000,	.000,	.00,	0,	.000,	.000
P shrinkage mean ,	1252507.,	.50,,,,				.800,	1.007
F shrinkage mean ,	599976.,	1.00,,,,				.200,	1.532

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
1081034.,	.45,	13.90,	2,	31.071,	1.103

Age 2 Catchability dependent on age and year class strength

Year class = 2000

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
FLT09: Russian trawl,	1.,	.000,	.000,	.00,	0,	.000,	.000
FLT15: NorBarTrSur r,	1.,	.000,	.000,	.00,	0,	.000,	.000
FLT16: NorBarLofAcSu,	1.,	.000,	.000,	.00,	0,	.000,	.000
FLT17: RusSurCatch/h,	1.,	.000,	.000,	.00,	0,	.000,	.000
P shrinkage mean ,	601980.,	.22,,,,				.954,	.523
F shrinkage mean ,	611614.,	1.00,,,,				.046,	.516

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
602420.,	.21,	13.31,	2,	61.968,	.522

Table 3.16 (continued)

Age 3 Catchability dependent on age and year class strength

Year class = 1999

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
FLT09: Russian trawl,	1.,	.000,	.000,	.00,	0,	.000,	.000
FLT15: NorBarTrSur r,	388539.,	.300,	.000,	.00,	1,	.266,	.081
FLT16: NorBarLofAcSu,	372630.,	.345,	.000,	.00,	1,	.202,	.084
FLT17: RusSurCatch/h,	364621.,	.392,	.000,	.00,	1,	.156,	.086
P shrinkage mean ,	405726.,	.27,,,,				.350,	.077
F shrinkage mean ,	153097.,	1.00,,,,				.026,	.193

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
378034.,	.16,	.08,	5,	.487,	.083

Age 4 Catchability dependent on age and year class strength

Year class = 1998

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
FLT09: Russian trawl,	1.,	.000,	.000,	.00,	0,	.000,	.000
FLT15: NorBarTrSur r,	299874.,	.212,	.004,	.02,	2,	.345,	.088
FLT16: NorBarLofAcSu,	330959.,	.257,	.207,	.80,	2,	.235,	.080
FLT17: RusSurCatch/h,	268696.,	.236,	.248,	1.05,	2,	.281,	.098
P shrinkage mean ,	267272.,	.38,,,,				.122,	.098
F shrinkage mean ,	111161.,	1.00,,,,				.018,	.222

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
288372.,	.13,	.09,	8,	.679,	.091

Age 5 Catchability dependent on age and year class strength

Year class = 1997

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
FLT09: Russian trawl,	1.,	.000,	.000,	.00,	0,	.000,	.000
FLT15: NorBarTrSur r,	243018.,	.174,	.025,	.14,	3,	.368,	.204
FLT16: NorBarLofAcSu,	277853.,	.196,	.111,	.56,	3,	.294,	.181
FLT17: RusSurCatch/h,	246435.,	.206,	.006,	.03,	3,	.262,	.202
P shrinkage mean ,	136257.,	.49,,,,				.062,	.340
F shrinkage mean ,	92047.,	1.00,,,,				.015,	.469

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
241302.,	.11,	.07,	11,	.663,	.206

Table 3.16 (continued)

```
Age  6   Catchability constant w.r.t. time and dependent on age

Year class = 1996

Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
FLT09: Russian trawl,         1.,   .000,       .000,    .00,   0,  .000,     .000
FLT15: NorBarTrSur r,     96840.,   .155,       .012,    .08,   4,  .400,     .413
FLT16: NorBarLofAcSu,    122188.,   .167,       .139,    .83,   4,  .353,     .340
FLT17: RusSurCatch/h,    122305.,   .197,       .153,    .78,   4,  .230,     .340

  F shrinkage mean  ,     50180.,   1.00,,,,                        .017,     .686

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
   109644.,       .10,      .07,   13,    .723,   .373


Age  7   Catchability constant w.r.t. time and dependent on age

Year class = 1995

Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
FLT09: Russian trawl,         1.,   .000,       .000,    .00,   0,  .000,     .000
FLT15: NorBarTrSur r,     33966.,   .157,       .027,    .17,   5,  .467,     .667
FLT16: NorBarLofAcSu,     35898.,   .177,       .130,    .74,   5,  .329,     .640
FLT17: RusSurCatch/h,     49462.,   .222,       .190,    .86,   5,  .172,     .501

  F shrinkage mean  ,     26250.,   1.00,,,,                        .032,     .800

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
    36599.,       .11,      .07,   16,    .648,   .631


Age  8   Catchability constant w.r.t. time and dependent on age

Year class = 1994

Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
FLT09: Russian trawl,         1.,   .000,       .000,    .00,   0,  .000,     .000
FLT15: NorBarTrSur r,      7399.,   .171,       .060,    .35,   6,  .533,     .802
FLT16: NorBarLofAcSu,      7634.,   .211,       .098,    .46,   6,  .303,     .785
FLT17: RusSurCatch/h,     11586.,   .286,       .304,   1.06,   6,  .113,     .579

  F shrinkage mean  ,      4477.,   1.00,,,,                        .051,    1.109

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
     7656.,       .13,      .08,   19,    .622,   .783
```

Table 3.16 (continued)

Age 9 Catchability constant w.r.t. time and dependent on age
Year class = 1993

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
FLT09: Russian trawl,	1620.,	.567,	.000,	.00,	1,	.121,	.636
FLT15: NorBarTrSur r,	768.,	.184,	.023,	.13,	6,	.295,	1.057
FLT16: NorBarLofAcSu,	930.,	.256,	.111,	.43,	7,	.426,	.936
FLT17: RusSurCatch/h,	841.,	.337,	.074,	.22,	6,	.055,	.999
F shrinkage mean ,	551.,	1.00,,,,				.103,	1.286

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
886.,	.17,	.07,	21,	.428,	.966

Age 10 Catchability constant w.r.t. time and dependent on age
Year class = 1992

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
FLT09: Russian trawl,	274.,	.377,	.096,	.25,	2,	.240,	.952
FLT15: NorBarTrSur r,	212.,	.197,	.020,	.10,	6,	.072,	1.117
FLT16: NorBarLofAcSu,	156.,	.241,	.059,	.24,	8,	.546,	1.335
FLT17: RusSurCatch/h,	155.,	.407,	.082,	.20,	6,	.012,	1.337
F shrinkage mean ,	143.,	1.00,,,,				.130,	1.397

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
180.,	.21,	.06,	23,	.292,	1.229

Age 11 Catchability constant w.r.t. time and age (fixed at the value for age) 10
Year class = 1991

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
FLT09: Russian trawl,	97.,	.320,	.042,	.13,	3,	.519,	1.055
FLT15: NorBarTrSur r,	132.,	.206,	.021,	.10,	6,	.025,	.864
FLT16: NorBarLofAcSu,	124.,	.297,	.084,	.28,	9,	.278,	.903
FLT17: RusSurCatch/h,	66.,	.416,	.108,	.26,	6,	.004,	1.329
F shrinkage mean ,	76.,	1.00,,,,				.174,	1.218

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
100.,	.25,	.05,	25,	.179,	1.034

Age 12 Catchability constant w.r.t. time and age (fixed at the value for age) 10
Year class = 1990

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
FLT09: Russian trawl,	29.,	.334,	.373,	1.12,	4,	.390,	1.521
FLT15: NorBarTrSur r,	34.,	.229,	.108,	.47,	6,	.014,	1.395
FLT16: NorBarLofAcSu,	30.,	.258,	.085,	.33,	8,	.150,	1.480
FLT17: RusSurCatch/h,	19.,	.507,	.151,	.30,	6,	.002,	1.872
F shrinkage mean ,	48.,	1.00,,,,				.444,	1.145

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
36.,	.46,	.11,	25,	.233,	1.341

Table 3.17

Run title : Arctic Cod (run: XSAASA27/X27)

At 28/04/2003 15:03

Terminal Fs derived using XSA (With F shrinkage)

Table 8   Fishing mortality (F) at age

YEAR, AGE	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,
1,	.2459,	.3590,	.5092,	.5267,	.8044,	.2166,	.0483,	.1029,	.4669,
2,	.0373,	.0578,	.8026,	.8029,	.1102,	.0020,	.0594,	.2371,	.1447,
3,	.0199,	.0533,	.1452,	.1136,	.0629,	.0327,	.0086,	.0183,	.0405,
4,	.1235,	.1702,	.2122,	.2287,	.1269,	.1284,	.0622,	.0624,	.1265,
5,	.3075,	.3763,	.4934,	.5099,	.3708,	.2658,	.1342,	.1875,	.2205,
6,	.6274,	.6052,	.7053,	.9367,	.5976,	.4022,	.2309,	.3211,	.4428,
7,	1.1361,	.9249,	.9481,	1.1402,	1.0456,	.7167,	.2510,	.4255,	.5398,
8,	1.2111,	1.0189,	1.0910,	1.0145,	.9844,	.8914,	.3752,	.3461,	.5984,
9,	1.2623,	.7786,	.8282,	.7786,	1.1598,	.7183,	.3072,	.3819,	.4578,
10,	.9579,	.5057,	1.1121,	1.3243,	1.7194,	.9874,	.3255,	.2575,	.4612,
11,	1.0876,	.4205,	.8746,	1.0272,	1.5382,	.5835,	.5421,	.1347,	.2501,
12,	1.0346,	.4666,	1.0046,	1.1901,	1.6509,	.7934,	.4370,	.1970,	.3579,
+gp,	1.0346,	.4666,	1.0046,	1.1901,	1.6509,	.7934,	.4370,	.1970,	.3579,
FBAR 5-10,	.9171,	.7016,	.8630,	.9507,	.9796,	.6636,	.2707,	.3199,	.4534,

Table 8   Fishing mortality (F) at age

YEAR, AGE	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	FBAR **-**
1,	2.5667,	1.7162,	1.8704,	1.9831,	2.4968,	1.6093,	1.1286,	1.3502,	.9732,	1.1028,	1.1421,
2,	.4497,	.6305,	.9387,	1.0581,	1.1160,	.6432,	.3485,	.2700,	.1824,	.5222,	.3249,
3,	.0791,	.2084,	.5545,	.4716,	.3411,	.3728,	.1200,	.0705,	.0587,	.0829,	.0707,
4,	.0964,	.2019,	.3021,	.3541,	.3040,	.3548,	.2102,	.1280,	.1054,	.0913,	.1082,
5,	.3467,	.3395,	.3359,	.4126,	.5735,	.5305,	.5538,	.4107,	.2592,	.2056,	.2919,
6,	.4597,	.6459,	.5763,	.5433,	.7265,	.7915,	.7473,	.6162,	.5185,	.3726,	.5024,
7,	.5664,	1.1681,	.8915,	.7500,	.8448,	.7781,	.8374,	.8037,	.6971,	.6310,	.7106,
8,	.5980,	.9865,	.9434,	.8638,	1.2365,	1.0492,	1.0801,	1.1309,	.9844,	.7830,	.9661,
9,	.6647,	1.0557,	.9622,	.7519,	1.3442,	1.1777,	1.4232,	1.2637,	1.1411,	.9657,	1.1235,
10,	.6683,	1.0331,	1.0235,	.9406,	1.5097,	1.2675,	1.4516,	1.2654,	1.3994,	1.2288,	1.2979,
11,	.6833,	1.1850,	1.2272,	.8752,	1.4477,	1.3355,	.9938,	1.1970,	1.0420,	1.0340,	1.0910,
12,	.6842,	1.1431,	1.2289,	.8605,	1.5513,	1.3282,	1.1869,	1.4132,	1.3751,	1.3409,	1.3764,
+gp,	.6842,	1.1431,	1.2289,	.8605,	1.5513,	1.3282,	1.1869,	1.4132,	1.3751,	1.3409,	
FBAR 5-10,	.5506,	.8715,	.7888,	.7104,	1.0392,	.9324,	1.0156,	.9151,	.8333,	.6978,	

Table 3.18

Run title : Arctic Cod (run: XSAASA27/X27)

At 28/04/2003 15:03

Terminal Fs derived using XSA (With F shrinkage)

Table 10 Stock number-at-age (start of year) Numbers*10**-4

YEAR, AGE	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,
1,	211582,	137727,	114445,	49253,	82174,	81893,	144715,	172897,	304842,
2,	67018,	135470,	78748,	56313,	23814,	30098,	53992,	112891,	127716,
3,	40278,	52860,	104687,	28896,	20657,	17463,	24593,	41656,	72915,
4,	13542,	32328,	41032,	74125,	21116,	15881,	13837,	19962,	33487,
5,	7852,	9799,	22326,	27170,	48283,	15228,	11436,	10646,	15355,
6,	4763,	4727,	5507,	11161,	13359,	27284,	9557,	8186,	7226,
7,	2465,	2082,	2113,	2227,	3581,	6017,	14941,	6212,	4862,
8,	1304,	648,	676,	670,	583,	1031,	2406,	9517,	3323,
9,	923,	318,	192,	186,	199,	178,	346,	1354,	5512,
10,	140,	214,	120,	69,	70,	51,	71,	208,	756,
11,	39,	44,	106,	32,	15,	10,	16,	42,	132,
12,	26,	11,	24,	36,	9,	3,	5,	7,	30,
+gp,	12,	21,	13,	16,	8,	6,	4,	2,	5,
TOTAL,	349945,	376248,	369987,	250154,	213869,	195141,	275918,	383580,	576160,

Table 10 Stock number-at-age (start of year) Numbers*10**-4

YEAR, AGE	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003,	GMST84-00
1,	2425850,	933228,	2013369,	2806845,	2027385,	680474,	301966,	346496,	400921,	397775,	0,	347314,
2,	156482,	152508,	137333,	253968,	316296,	136684,	111439,	79977,	73530,	124039,	108103,	98090,
3,	90475,	81714,	66466,	43980,	72175,	84832,	58822,	64389,	49984,	50165,	60242,	50387,
4,	57327,	68443,	54316,	31256,	22468,	42013,	47839,	42714,	49130,	38589,	37803,	32601,
5,	24158,	42624,	45793,	32876,	17960,	13574,	24123,	31742,	30768,	36201,	28837,	20414,
6,	10083,	13983,	24852,	26797,	17816,	8287,	6538,	11351,	17234,	19438,	24130,	10654,
7,	3800,	5213,	6001,	11434,	12743,	7054,	3075,	2535,	5018,	8401,	10964,	4652,
8,	2320,	1766,	1327,	2015,	4422,	4482,	2653,	1090,	929,	2046,	3660,	1729,
9,	1496,	1045,	539,	423,	695,	1051,	1285,	737,	288,	284,	766,	612,
10,	2855,	630,	298,	169,	163,	148,	265,	254,	171,	75,	89,	201,
11,	390,	1198,	184,	88,	54,	30,	34,	51,	59,	34,	18,	60,
12,	84,	161,	300,	44,	30,	10,	6,	10,	13,	17,	10,	21,
+gp,	19,	23,	40,	169,	52,	17,	11,	4,	5,	5,	5,	
TOTAL,	2775339,	1302537,	2350818,	3210062,	2492261,	978656,	558056,	581350,	628050,	677070,	274627,	

Table 3.19

Run title : Arctic Cod (run: SVPASA15/V15)

At 30/04/2003 23:56

Table 4 Natural Mortality (M) at age

YEAR, AGE	1946,	1947,	1948,	1949,	1950,	1951,	1952,
3,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
4,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
5,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
6,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
7,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
8,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
9,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
10,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
11,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
12,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
+gp,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,

Table 4 Natural Mortality (M) at age

YEAR, AGE	1953,	1954,	1955,	1956,	1957,	1958,	1959,	1960,	1961,	1962,
3,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
4,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
5,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
6,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
7,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
8,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
9,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
10,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
11,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
12,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
+gp,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,

Run title : Arctic Cod (run: SVPASA15/V15)

At 30/04/2003 23:56

Table 4 Natural Mortality (M) at age

YEAR, AGE	1963,	1964,	1965,	1966,	1967,	1968,	1969,	1970,	1971,	1972,
3,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
4,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
5,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
6,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
7,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
8,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
9,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
10,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
11,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
12,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
+gp,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,

Table 3.19 (continued)

Table 4 Natural Mortality (M) at age

YEAR, AGE	1973,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,	1982,
3,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
4,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
5,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
6,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
7,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
8,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
9,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
10,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
11,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
12,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
+gp,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,

Table 4 Natural Mortality (M) at age

YEAR, AGE	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,
3,	.2000,	.2006,	.2004,	.3108,	.2580,	.2087,	.2000,	.2000,	.2050,	.2067,
4,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
5,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
6,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
7,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
8,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
9,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
10,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
11,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
12,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
+gp,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,

Table 4 Natural Mortality (M) at age

YEAR, AGE	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,
3,	.2662,	.3986,	.7439,	.6475,	.5179,	.5229,	.3050,	.2621,	.2473,	.2786,
4,	.2030,	.2959,	.4017,	.4332,	.2958,	.2770,	.2111,	.2368,	.2224,	.2169,
5,	.2026,	.2259,	.2082,	.2815,	.2105,	.2167,	.2000,	.2157,	.2059,	.2009,
6,	.2000,	.2047,	.2001,	.2060,	.2020,	.2098,	.2000,	.2005,	.2052,	.2000,
7,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
8,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
9,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
10,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
11,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
12,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
+gp,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,

Table 3.20 Natural mortality of cod (M2) due to cannibalism.

Year	M2 age 1	M2 age 2	M2 age 3	M2 age 4	M2 age 5	M2 age 6
1984	0.2435	0.0351	0.0006	0.0000	0.0000	0.0000
1985	0.3583	0.0555	0.0004	0.0000	0.0000	0.0000
1986	0.5068	0.7908	0.1108	0.0000	0.0000	0.0000
1987	0.5205	0.7947	0.0580	0.0000	0.0000	0.0000
1988	0.7998	0.1087	0.0087	0.0000	0.0000	0.0000
1989	0.2148	0.0011	0.0000	0.0000	0.0000	0.0000
1990	0.0480	0.0587	0.0000	0.0000	0.0000	0.0000
1991	0.1023	0.2356	0.0050	0.0000	0.0000	0.0000
1992	0.4666	0.1432	0.0067	0.0000	0.0000	0.0000
1993	2.5667	0.4492	0.0662	0.0030	0.0026	0.0000
1994	1.7162	0.6302	0.1986	0.0959	0.0259	0.0047
1995	1.8704	0.9384	0.5439	0.2017	0.0082	0.0001
1996	1.9831	1.0575	0.4475	0.2332	0.0815	0.0060
1997	2.4968	1.1153	0.3179	0.0958	0.0105	0.0020
1998	1.6093	0.6414	0.3229	0.0770	0.0167	0.0098
1999	1.1286	0.3482	0.1050	0.0111	0.0000	0.0000
2000	1.3502	0.2697	0.0621	0.0368	0.0157	0.0005
2001		0.1820	0.0473	0.0224	0.0059	0.0052
2002			0.0786	0.0169	0.0009	0.0000

Table 3.21

Run title : Arctic Cod (run: SVPASA15/V15)

At 30/04/2003 23:56

Traditional vpa using file input for terminal F

Table 8 Fishing mortality (F) at age

YEAR,	1946,	1947,	1948,	1949,	1950,	1951,	1952,
AGE							
3,	.0061,	.0018,	.0003,	.0023,	.0020,	.0254,	.0225,
4,	.0200,	.0249,	.0124,	.0209,	.0321,	.1612,	.1667,
5,	.0532,	.1101,	.0751,	.1484,	.1167,	.2637,	.3700,
6,	.0973,	.2024,	.1997,	.3662,	.2882,	.2787,	.5501,
7,	.1781,	.4160,	.5201,	.5101,	.4096,	.4122,	.5311,
8,	.1932,	.2545,	.3536,	.3869,	.3480,	.4046,	.4175,
9,	.3125,	.4047,	.5286,	.3832,	.4741,	.5057,	.5790,
10,	.2798,	.4405,	.3617,	.3766,	.5031,	.5149,	.7613,
11,	.3432,	.7827,	.5536,	.6259,	.9031,	.4585,	1.0260,
12,	.3120,	.6182,	.4604,	.5039,	.7111,	.4879,	.9056,
+gp,	.3120,	.6182,	.4604,	.5039,	.7111,	.4879,	.9056,
FBAR 5-10,	.1857,	.3047,	.3398,	.3619,	.3566,	.3966,	.5348,
FBAR 4- 8,	.1084,	.2016,	.2322,	.2865,	.2389,	.3041,	.4071,

Table 8 Fishing mortality (F) at age

YEAR,	1953,	1954,	1955,	1956,	1957,	1958,	1959,	1960,	1961,	1962,
AGE										
3,	.0334,	.0199,	.0159,	.0270,	.0240,	.0718,	.0535,	.0543,	.0562,	.0663,
4,	.1325,	.1457,	.0840,	.1291,	.1128,	.2589,	.2564,	.2266,	.2717,	.3063,
5,	.2299,	.2676,	.2859,	.4568,	.2094,	.3626,	.5093,	.3477,	.4944,	.6498,
6,	.3125,	.3333,	.5297,	.6900,	.4862,	.5517,	.5121,	.4607,	.5168,	.8279,
7,	.3243,	.3969,	.5139,	.6129,	.5494,	.5357,	.5251,	.4363,	.5279,	.6094,
8,	.3469,	.2494,	.5880,	.6880,	.6287,	.4593,	.5111,	.4855,	.6931,	.6564,
9,	.3932,	.4364,	.5805,	.6551,	.5463,	.4535,	.6141,	.4053,	.7389,	.8167,
10,	.5364,	.6441,	.7645,	.7380,	.6333,	.7388,	.6860,	.7381,	.8379,	.9855,
11,	.6980,	.8035,	.7621,	.8756,	.8584,	.8415,	.6511,	.8449,	1.0011,	.9522,
12,	.6217,	.7304,	.7704,	.8152,	.7529,	.7990,	.6734,	.7981,	.9284,	.9756,
+gp,	.6217,	.7304,	.7704,	.8152,	.7529,	.7990,	.6734,	.7981,	.9284,	.9756,
FBAR 5-10,	.3572,	.3879,	.5437,	.6401,	.5089,	.5169,	.5596,	.4789,	.6348,	.7576,
FBAR 4- 8,	.2692,	.2786,	.4003,	.5154,	.3973,	.4337,	.4628,	.3914,	.5008,	.6100,

Run title : Arctic Cod (run: SVPASA15/V15)

At 30/04/2003 23:56

Traditional vpa using file input for terminal F

Table 8 Fishing mortality (F) at age

YEAR,	1963,	1964,	1965,	1966,	1967,	1968,	1969,	1970,	1971,	1972,
AGE										
3,	.0313,	.0174,	.0226,	.0398,	.0298,	.0251,	.0230,	.0409,	.0214,	.0394,
4,	.2366,	.1449,	.1110,	.1037,	.1525,	.2064,	.2292,	.1422,	.1028,	.1673,
5,	.7420,	.3537,	.3909,	.2119,	.1814,	.4087,	.4792,	.4004,	.2285,	.2976,
6,	1.0069,	.4854,	.4494,	.3818,	.2026,	.4683,	.5382,	.5680,	.2517,	.3849,
7,	.9764,	.5787,	.4033,	.4713,	.4320,	.4019,	.7725,	.6211,	.5144,	.3427,
8,	.8798,	.7409,	.5303,	.5797,	.6844,	.5291,	.9302,	.8479,	.8330,	.6583,
9,	.9416,	1.0674,	.7389,	.7183,	.8781,	.8041,	1.1783,	.9682,	.9584,	1.1338,
10,	1.3731,	.8476,	.8074,	.8182,	.8850,	.8105,	1.0769,	1.0900,	.7876,	1.3393,
11,	1.4366,	1.2968,	.7617,	.5024,	1.2253,	.6772,	1.5554,	.8533,	.8388,	1.2904,
12,	1.4264,	1.0883,	.7927,	.6634,	1.0696,	.7458,	1.3377,	.9829,	.8179,	1.3377,
+gp,	1.4264,	1.0883,	.7927,	.6634,	1.0696,	.7458,	1.3377,	.9829,	.8179,	1.3377,
FBAR 5-10,	.9866,	.6789,	.5533,	.5302,	.5439,	.5704,	.8292,	.7493,	.5956,	.6928,
FBAR 4- 8,	.7683,	.4607,	.3770,	.3497,	.3306,	.4029,	.5899,	.5159,	.3861,	.3702,

Table 3.21 (Continued)

Table 8 Fishing mortality (F) at age

YEAR, AGE	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
3	.1959	.2141	.0837	.1660	.1338	.1460	.0489	.0318	.0252	.0672
4	.1996	.4959	.2106	.3121	.5671	.2234	.2090	.1296	.1003	.2121
5	.3536	.5375	.5211	.4800	.7544	.6703	.3475	.3562	.2300	.3045
6	.3917	.5078	.7021	.5715	.6857	.8497	.5478	.6225	.5163	.5518
7	.4210	.4451	.7050	.6973	.6763	.8581	.6643	.6766	.8475	.7996
8	.7375	.4863	.7032	.8908	.9121	.9296	.7789	.7123	1.0789	.9846
9	.9698	.5192	.6109	.7746	1.2298	1.3057	1.0352	.9390	1.2765	1.1589
10	.7386	.8842	.7149	.4600	.7689	1.0301	.9848	1.0380	1.2299	.7508
11	.7222	.9905	.9079	.6132	.6231	1.8042	1.4314	1.4798	.9557	.9516
12	.7358	.9492	.8218	.5389	.6958	1.4375	1.2219	1.2775	1.1082	.8607
+gp	.7358	.9492	.8218	.5389	.6958	1.4375	1.2219	1.2775	1.1082	.8607
FBAR 5-10	.6020	.5633	.6595	.6457	.8379	.9406	.7264	.7241	.8632	.7583
FBAR 4- 8	.4207	.4945	.5684	.5904	.7191	.7062	.5095	.4994	.5546	.5705

Table 8 Fishing mortality (F) at age

YEAR, AGE	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
3	.0208	.0194	.0533	.0330	.0555	.0546	.0330	.0087	.0134	.0341
4	.2050	.1247	.1717	.2134	.2295	.1276	.1292	.0627	.0631	.1276
5	.3308	.3096	.3788	.4961	.5107	.3714	.2669	.1352	.1889	.2226
6	.5033	.6301	.6078	.7079	.9366	.5979	.4030	.2322	.3228	.4449
7	.7821	1.1350	.9264	.9488	1.1367	1.0422	.7153	.2524	.4273	.5419
8	1.0295	1.2083	1.0192	1.0911	1.0146	.9798	.8873	.3765	.3481	.6004
9	.9701	1.2573	.7818	.8326	.7843	1.1553	.7151	.3080	.3838	.4606
10	.9204	.9564	.5088	1.1134	1.3248	1.7042	.9809	.3255	.2587	.4640
11	.5854	1.0812	.4237	.8774	1.0331	1.5293	.5824	.5398	.1352	.2516
12	.7590	1.0346	.4666	1.0046	1.1901	1.6509	.7934	.4370	.1970	.3579
+gp	.7590	1.0346	.4666	1.0046	1.1901	1.6509	.7934	.4370	.1970	.3579
FBAR 5-10	.7560	.9161	.7038	.8650	.9513	.9751	.6614	.2717	.3216	.4557
FBAR 4- 8	.5701	.6816	.6208	.6914	.7656	.6238	.4804	.2118	.2700	.3875

Table 8 Fishing mortality (F) at age

YEAR, AGE	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	FBAR 00-02
3	.0129	.0099	.0106	.0242	.0233	.0499	.0150	.0084	.0115	.0044	.0081
4	.0942	.1068	.1010	.1216	.2094	.2788	.2000	.0915	.0831	.0744	.0830
5	.3464	.3156	.3298	.3331	.5651	.5156	.5547	.3960	.2538	.2048	.2849
6	.4635	.6436	.5791	.5402	.7263	.7832	.7484	.6166	.5140	.3726	.5011
7	.5694	1.1663	.8930	.7541	.8477	.7812	.8401	.8052	.6978	.6310	.7113
8	.6013	.9869	.9447	.8679	1.2366	1.0524	1.0820	1.1313	.9842	.7830	.9661
9	.6678	1.0559	.9638	.7577	1.3429	1.1800	1.4210	1.2641	1.1420	.9657	1.1240
10	.6723	1.0339	1.0248	.9450	1.5072	1.2662	1.4493	1.2642	1.3952	1.2288	1.2961
11	.6870	1.1855	1.2232	.8812	1.4463	1.3338	.9978	1.1989	1.0450	1.0340	1.0926
12	.6842	1.1439	1.2289	.8605	1.5513	1.3282	1.1869	1.4132	1.3751	1.3409	1.3764
+gp	.6842	1.1439	1.2289	.8605	1.5513	1.3282	1.1869	1.4132	1.3751	1.3409	
FBAR 5-10	.5534	.8670	.7892	.6996	1.0376	.9298	1.0159	.9129	.8312	.6977	
FBAR 4- 8	.4150	.6438	.5695	.5233	.7170	.6822	.6851	.6081	.5066	.4132	

Table 3.22 Fishing mortality of age 1-6 cod.

Year	F age 1	F age 2	F age 3	F age 4	F age 5	F age 6
1984	0.0000	0.0017	0.0192	0.1235	0.3075	0.6275
1985	0.0001	0.0015	0.0529	0.1702	0.3763	0.6052
1986	0.0001	0.0017	0.0324	0.2123	0.4934	0.7056
1987	0.0000	0.0011	0.0548	0.2287	0.5100	0.9365
1988	0.0000	0.0009	0.0542	0.1270	0.3709	0.5977
1989	0.0000	0.0009	0.0327	0.1284	0.2661	0.4025
1990	0.0000	0.0004	0.0086	0.0622	0.1343	0.2311
1991	0.0000	0.0007	0.0133	0.0623	0.1872	0.3210
1992	0.0004	0.0011	0.0337	0.1265	0.2205	0.4427
1993	0.0000	0.0006	0.0128	0.0934	0.3442	0.4597
1994	0.0000	0.0003	0.0098	0.1060	0.3136	0.6412
1995	0.0000	0.0003	0.0106	0.1004	0.3277	0.5762
1996	0.0000	0.0006	0.0241	0.1208	0.3311	0.5373
1997	0.0000	0.0007	0.0232	0.2081	0.5630	0.7245
1998	0.0000	0.0018	0.0499	0.2778	0.5138	0.7816
1999	0.0000	0.0004	0.0150	0.1991	0.5538	0.7474
2000	0.0000	0.0003	0.0084	0.0912	0.3950	0.6157
2001		0.0004	0.0114	0.0830	0.2534	0.5133
2002			0.0044	0.0744	0.2048	0.3726

Table 3.23

Run title : Arctic Cod (run: SVPASA15/V15)

At 30/04/2003 23:56

Traditional vpa using file input for terminal F

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

YEAR, AGE	1946,	1947,	1948,	1949,	1950,	1951,	1952,
3,	728139,	425311,	442592,	468348,	704908,	1083753,	1193111,
4,	577860,	592530,	347574,	362238,	382556,	575973,	865011,
5,	402060,	463732,	473210,	281072,	290427,	303320,	401364,
6,	197212,	312115,	340097,	359415,	198391,	211595,	190765,
7,	93323,	146496,	208708,	228044,	204032,	121764,	131099,
8,	96213,	63939,	79121,	101579,	112107,	110900,	66016,
9,	244722,	64933,	40588,	45487,	56484,	64808,	60583,
10,	101777,	146581,	35470,	19586,	25387,	28785,	32000,
11,	38117,	62991,	77255,	20227,	11003,	12568,	14083,
12,	39205,	22142,	23578,	36361,	8856,	3651,	6506,
+gp,	33324,	42765,	37377,	21337,	21133,	13989,	3938,
TOTAL,	2551952,	2343535,	2105569,	1943694,	2015284,	2531108,	2964476,

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

YEAR, AGE	1953,	1954,	1955,	1956,	1957,	1958,	1959,	1960,	1961,	1962,
3,	1590377,	641584,	272778,	439602,	804781,	496824,	683690,	789653,	916842,	728338,
4,	955076,	1259285,	514924,	219807,	350332,	643259,	378598,	530599,	612324,	709603,
5,	599477,	684912,	891184,	387619,	158175,	256234,	406511,	239862,	346346,	382037,
6,	226975,	389987,	429102,	548181,	200984,	105033,	145989,	199996,	138702,	172949,
7,	90099,	135956,	228785,	206850,	225110,	101196,	49529,	71623,	103298,	67732,
8,	63110,	53333,	74845,	112048,	91748,	106395,	48488,	23986,	37908,	49883,
9,	35603,	36525,	34028,	34036,	46105,	40060,	55027,	23813,	12084,	15518,
10,	27799,	19673,	19329,	15591,	14474,	21860,	20840,	24380,	13000,	4726,
11,	12237,	13311,	8459,	7368,	6103,	6291,	8550,	8592,	9541,	4605,
12,	4133,	4985,	4880,	3232,	2513,	2118,	2220,	3650,	3022,	2871,
+gp,	1880,	2707,	2738,	3722,	1687,	857,	1142,	1351,	2332,	1351,
TOTAL,	3606766,	3242259,	2481052,	1978057,	1902013,	1780129,	1800584,	1917505,	2195401,	2139612,

Run title : Arctic Cod (run: SVPASA15/V15)

At 30/04/2003 23:56

Traditional vpa using file input for terminal F

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

YEAR, AGE	1963,	1964,	1965,	1966,	1967,	1968,	1969,	1970,	1971,	1972,
3,	472064,	338678,	776941,	1582560,	1295416,	164955,	112039,	197105,	404774,	1015319,
4,	558039,	374580,	272501,	621906,	1245195,	1029477,	131705,	89647,	154909,	324399,
5,	427678,	360621,	265306,	199663,	458995,	875269,	685697,	85743,	63671,	114439,
6,	163321,	166726,	207288,	146941,	132256,	313440,	476187,	347649,	47037,	41482,
7,	61876,	48854,	84015,	108284,	82121,	88421,	160667,	227600,	161288,	29940,
8,	30149,	19083,	22424,	45954,	55340,	43651,	48433,	60756,	100131,	78947,
9,	21185,	10240,	7448,	10803,	21072,	22854,	21054,	15642,	21306,	35642,
10,	5614,	6764,	2883,	2913,	4313,	7170,	8373,	5306,	4863,	6690,
11,	1444,	1164,	2373,	1053,	1052,	1457,	2610,	2335,	1461,	1811,
12,	1455,	281,	261,	907,	522,	253,	606,	451,	815,	517,
+gp,	1113,	1278,	670,	351,	461,	498,	278,	312,	421,	697,
TOTAL,	1743938,	1328269,	1642109,	2721334,	3296742,	2547445,	1647648,	1032545,	960676,	1649883,

Table 3.23 (continued)

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

YEAR,	1973,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,	1982,
AGE										
3,	1818949,	523916,	621616,	613942,	348054,	638490,	198490,	137735,	150867,	151828,
4,	799193,	1224278,	346265,	468089,	425778,	249276,	451722,	154747,	109237,	120443,
5,	224670,	535936,	610486,	229669,	280485,	197708,	163230,	300088,	111295,	80899,
6,	69576,	129164,	256342,	296843,	116349,	108003,	82807,	94414,	172067,	72401,
7,	23112,	38504,	63643,	104000,	137232,	47987,	37806,	39202,	41481,	84063,
8,	17401,	12421,	20199,	25746,	42398,	57130,	16658,	15929,	16316,	14551,
9,	33463,	6815,	6253,	8186,	8650,	13943,	18463,	6259,	6397,	4542,
10,	9391,	10388,	3320,	2779,	3089,	2070,	3093,	5368,	2004,	1461,
11,	1435,	3673,	3513,	1330,	1436,	1172,	605,	946,	1557,	480,
12,	408,	571,	1117,	1160,	590,	631,	158,	118,	176,	490,
+gp,	408,	525,	550,	572,	583,	1198,	218,	87,	66,	70,
TOTAL,	2998007,	2486189,	1933303,	1752317,	1364643,	1317607,	973250,	754892,	611463,	531227,

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

YEAR,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,
AGE										
3,	166820,	397785,	523524,	1036538,	286341,	204612,	172775,	242749,	411783,	720690,
4,	116232,	133774,	319216,	406226,	734960,	209277,	157242,	136866,	197020,	330987,
5,	79768,	77523,	96688,	220126,	268686,	478354,	150813,	113133,	105242,	151440,
6,	48847,	46916,	46569,	54201,	109738,	132012,	270130,	94548,	80909,	71337,
7,	34138,	24176,	20455,	20761,	21862,	35217,	59442,	147803,	61368,	47966,
8,	30937,	12785,	6362,	6631,	6582,	5744,	10169,	23800,	94018,	32772,
9,	4451,	9047,	3127,	1880,	1823,	1954,	1765,	3428,	13373,	54349,
10,	1167,	1381,	2107,	1171,	669,	681,	504,	707,	2063,	7459,
11,	565,	381,	435,	1037,	315,	146,	101,	155,	418,	1304,
12,	152,	257,	106,	233,	353,	92,	26,	46,	74,	299,
+gp,	170,	116,	208,	130,	156,	82,	56,	40,	25,	47,
TOTAL,	483247,	704143,	1018797,	1748935,	1431486,	1068171,	823024,	763275,	966292,	1418649,

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

YEAR,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003,	GMST 46-00,	AMST 46-00,
AGE													
3,	894155,	806823,	655968,	434591,	713845,	840213,	584058,	640598,	498208,	497625,	0,	498730,	612877,
4,	566467,	676371,	536273,	308468,	222009,	415507,	473856,	424110,	488787,	384609,	374970,	376569,	461705,
5,	238525,	420808,	452178,	324376,	177124,	133962,	238337,	314123,	305409,	360100,	287415,	258196,	314187,
6,	99244,	137759,	244858,	264038,	175448,	81553,	64408,	112055,	170394,	192858,	240010,	147532,	180770,
7,	37430,	51114,	58982,	112339,	125200,	69342,	30212,	24948,	49494,	83005,	108783,	72911,	92118,
8,	22842,	17342,	13036,	19772,	43270,	43914,	25993,	10678,	9130,	20167,	36158,	33046,	44762,
9,	14720,	10250,	5292,	4150,	6796,	10287,	12552,	7212,	2821,	2794,	7546,	14296,	25038,
10,	28073,	6181,	2919,	1653,	1593,	1453,	2588,	2481,	1668,	737,	871,	5633,	13345,
11,	3840,	11734,	1800,	858,	526,	289,	335,	497,	574,	338,	177,	2129,	6890,
12,	830,	1581,	2936,	434,	291,	101,	62,	101,	123,	165,	99,	782,	3516,
+gp,	189,	229,	404,	1685,	523,	172,	112,	37,	51,	50,	46,		
TOTAL,	1906314,	2140190,	1974647,	1472364,	1466626,	1596792,	1432514,	1536842,	1526658,	1542448,	1056075,		

Table 3.24

Run title : Arctic Cod (run: SVPASA15/V15)

At 30/04/2003 23:56

Traditional vpa using file input for terminal F

Table 12 Stock biomass at age (start of year) Tonnes

YEAR,	1946,	1947,	1948,	1949,	1950,	1951,	1952,
AGE							
3,	254849,	136099,	150481,	173289,	274914,	433501,	524969,
4,	340937,	331817,	184214,	242699,	244836,	478058,	692009,
5,	446286,	440545,	596245,	311990,	374651,	421615,	533814,
6,	333289,	468173,	656387,	596629,	337265,	397799,	366270,
7,	221176,	313502,	513421,	570111,	481515,	309280,	346101,
8,	304996,	186702,	265846,	328099,	390132,	383714,	244919,
9,	973994,	237005,	171279,	185131,	255308,	316264,	306548,
10,	513974,	668411,	188345,	103218,	142673,	149682,	193600,
11,	225651,	367868,	457348,	121160,	70420,	89737,	104495,
12,	282275,	164292,	167165,	257435,	70497,	30013,	54844,
+gp,	271456,	378386,	315087,	175349,	187892,	131347,	40110,
TOTALBIO,	4168882,	3692801,	3665819,	3065111,	2830103,	3141009,	3407679,

Table 12 Stock biomass at age (start of year) Tonnes

YEAR,	1953,	1954,	1955,	1956,	1957,	1958,	1959,	1960,	1961,	1962,
AGE										
3,	636151,	282297,	87289,	145069,	265578,	168920,	239291,	268482,	284221,	233068,
4,	725857,	969649,	293507,	127488,	206696,	334495,	272591,	270606,	336778,	390282,
5,	767331,	862989,	1007038,	414753,	161338,	243423,	597571,	261449,	363663,	355294,
6,	438062,	768275,	742347,	1003170,	365792,	201664,	391251,	425991,	305145,	294013,
7,	253178,	411947,	629160,	597796,	650567,	297518,	177809,	242086,	333654,	205229,
8,	234769,	230934,	294890,	476204,	392683,	447924,	209470,	116810,	193710,	250910,
9,	180151,	197233,	166739,	188902,	253117,	224738,	299899,	145737,	74320,	101645,
10,	176245,	132792,	136079,	113501,	108698,	160673,	134210,	206985,	105953,	36390,
11,	90555,	103693,	60902,	58944,	50286,	54540,	61300,	66934,	82819,	42684,
12,	35831,	53190,	42844,	26988,	23247,	20287,	19159,	30297,	29013,	30314,
+gp,	19247,	26204,	27591,	37015,	17892,	9967,	13275,	15429,	27875,	17178,
TOTALBIO,	3557376,	4039204,	3488383,	3189831,	2495895,	2164149,	2415826,	2050805,	2137149,	1957006,

Run title : Arctic Cod (run: SVPASA15/V15)

At 30/04/2003 23:56

Traditional vpa using file input for terminal F

Table 12 Stock biomass at age (start of year) Tonnes

YEAR,	1963,	1964,	1965,	1966,	1967,	1968,	1969,	1970,	1971,	1972,
AGE										
3,	151061,	111764,	295238,	696327,	375671,	54435,	49297,	72929,	182148,	385821,
4,	340404,	206019,	185301,	460210,	1008608,	720634,	104047,	81578,	136320,	249787,
5,	410571,	342590,	273265,	235602,	619644,	1295399,	843407,	114895,	87866,	163647,
6,	282545,	310111,	308859,	261555,	269803,	664492,	966659,	695298,	101599,	87943,
7,	188104,	158775,	202475,	266378,	230760,	277642,	465934,	682799,	495154,	96707,
8,	149537,	94841,	78931,	175545,	192584,	183771,	184531,	252138,	422555,	345787,
9,	136428,	65640,	42675,	57905,	103040,	120443,	105690,	87437,	123791,	207793,
10,	44408,	54588,	21740,	21174,	30662,	47678,	53839,	40323,	34676,	50977,
11,	13894,	10875,	20098,	9087,	9500,	13129,	21742,	20948,	12590,	17245,
12,	16454,	2856,	2911,	9669,	5524,	2444,	6492,	4958,	8822,	6248,
+gp,	14173,	16470,	9201,	4967,	6369,	7389,	3953,	4396,	5449,	9529,
TOTALBIO,	1747579,	1374529,	1440693,	2198418,	2852164,	3387455,	2805591,	2057698,	1610969,	1621485,

Table 3.24 (continued)

Table 12 Stock biomass at age (start of year) Tonnes

YEAR, AGE	1973,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,	1982,
3,	691201,	167653,	254863,	214880,	170547,	312860,	69471,	37188,	73925,	56176,
4,	727266,	808024,	221610,	341705,	383200,	201913,	316205,	86658,	107052,	79493,
5,	345992,	627045,	677639,	273307,	401093,	286676,	202406,	306090,	160265,	109213,
6,	157241,	286743,	487049,	596655,	238515,	232207,	177207,	162392,	359620,	144077,
7,	76038,	123596,	187748,	287041,	452865,	145879,	119088,	118389,	123613,	246303,
8,	80219,	54527,	88269,	108649,	193334,	254800,	71461,	66900,	79133,	61698,
9,	219854,	37616,	35894,	48132,	55876,	91184,	121484,	36552,	42028,	29339,
10,	78601,	81651,	29113,	25849,	26656,	16521,	26635,	38975,	18354,	12436,
11,	15127,	36074,	34848,	13669,	14264,	11898,	5579,	8362,	16843,	5870,
12,	4742,	6512,	13192,	13760,	6427,	6843,	1720,	1099,	1899,	5283,
+gp,	5674,	6947,	7206,	7750,	7970,	15783,	3124,	1256,	924,	979,
TOTBIO,	2401955,	2236387,	2037430,	1931396,	1950748,	1576565,	1114380,	863861,	983656,	750868,

Table 12 Stock biomass at age (start of year) Tonnes

YEAR, AGE	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,
3,	61724,	167070,	214645,	321327,	54405,	42969,	51833,	97099,	213304,	317104,
4,	106934,	155178,	280911,	357479,	374830,	83711,	81766,	97175,	223814,	308149,
5,	127629,	140317,	154701,	323585,	343919,	377899,	131207,	133497,	183437,	274410,
6,	119188,	130895,	130858,	133876,	212891,	250822,	399793,	162622,	196448,	193750,
7,	130406,	91385,	83046,	81385,	71709,	104948,	159899,	363596,	197236,	186826,
8,	147261,	58429,	37091,	38527,	34028,	25215,	47084,	84967,	426654,	169626,
9,	27463,	55823,	24044,	12369,	11889,	15259,	12445,	16148,	92003,	368160,
10,	8986,	10636,	21322,	8001,	6225,	8252,	5028,	5514,	22111,	71588,
11,	5224,	3521,	6210,	11408,	4142,	1910,	939,	1386,	3948,	16203,
12,	1645,	2794,	1147,	2527,	3831,	996,	280,	504,	801,	3243,
+gp,	2209,	1513,	2796,	1768,	2151,	1074,	806,	540,	347,	647,
TOTBIO,	738666,	817561,	956772,	1292252,	1120019,	913053,	891080,	963046,	1560102,	1909707,

Table 12 Stock biomass at age (start of year) Tonnes

YEAR, AGE	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,
3,	307589,	189603,	131850,	84745,	144197,	182326,	118564,	124276,	141989,	124904,
4,	663899,	509307,	260093,	150224,	115667,	221465,	246405,	197211,	255147,	232688,
5,	434115,	597547,	515483,	334432,	191117,	155530,	279807,	379461,	364658,	427078,
6,	280167,	332412,	518609,	542335,	329492,	158130,	130813,	220972,	380149,	406930,
7,	150880,	195511,	204669,	395996,	421798,	204212,	91664,	76042,	163628,	274912,
8,	125560,	93923,	64373,	108803,	227732,	200865,	116034,	43737,	46106,	95209,
9,	99579,	67967,	37892,	32230,	60671,	76357,	81362,	41284,	17984,	19182,
10,	240613,	47159,	26623,	16791,	19356,	15060,	26574,	18504,	15205,	6695,
11,	41648,	95185,	18177,	9152,	5692,	3390,	3649,	4765,	6469,	3454,
12,	9006,	17159,	31854,	4705,	3157,	1100,	676,	1098,	1332,	1793,
+gp,	2440,	2919,	5138,	21294,	6998,	2389,	1536,	515,	726,	646,
TOTBIO,	2355498,	2148691,	1814760,	1700706,	1525878,	1220825,	1097084,	1107866,	1393393,	1593491,

Table 3.25

Run title : Arctic Cod (run: SVPASA15/V15)

At 30/04/2003 23:56

Traditional vpa using file input for terminal F

Table 13 Spawning stock biomass at age (spawning time) Tonnes

YEAR,	1946,	1947,	1948,	1949,	1950,	1951,	1952,
AGE							
3,	0,	0,	0,	0,	0,	0,	0,
4,	0,	0,	0,	0,	0,	0,	0,
5,	4463,	4405,	5962,	3120,	3747,	4216,	5338,
6,	9999,	14045,	19692,	17899,	10118,	11934,	10988,
7,	13271,	18810,	35939,	51310,	43336,	30928,	27688,
8,	33550,	24271,	34560,	55777,	89730,	92091,	53882,
9,	175319,	37921,	42820,	53688,	89358,	126506,	125685,
10,	226148,	280733,	88522,	55738,	74190,	86815,	121968,
11,	146673,	275901,	333864,	95716,	55632,	64611,	85686,
12,	242756,	149506,	152120,	226543,	66972,	25511,	50457,
+gp,	260598,	359467,	305634,	170088,	182256,	126093,	38907,
TOTSPBIO,	1112776,	1165059,	1019114,	729879,	615339,	568705,	520599,

Table 13 Spawning stock biomass at age (spawning time) Tonnes

YEAR,	1953,	1954,	1955,	1956,	1957,	1958,	1959,	1960,	1961,	1962,
AGE										
3,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
4,	0,	0,	0,	0,	0,	0,	0,	2706,	0,	0,
5,	7673,	8630,	10070,	4148,	1613,	2434,	5976,	7843,	3637,	3553,
6,	13142,	23048,	22270,	30095,	10974,	6050,	15650,	25559,	18309,	14701,
7,	17722,	32956,	44041,	35868,	39034,	17851,	21337,	24209,	40038,	30784,
8,	44606,	36949,	38336,	57144,	35341,	44792,	71220,	22194,	60050,	85309,
9,	72060,	72976,	43352,	26446,	30374,	22474,	146950,	65582,	48308,	62004,
10,	112796,	90299,	72122,	46535,	23914,	48202,	89921,	142819,	96417,	29476,
11,	76066,	90213,	50549,	39492,	30172,	27270,	51492,	51539,	81163,	39269,
12,	33681,	49467,	39416,	24559,	19063,	16635,	16668,	25753,	28433,	29404,
+gp,	18670,	25156,	26763,	35534,	17356,	9668,	13275,	15274,	27875,	17178,
TOTSPBIO,	396417,	429694,	346919,	299823,	207840,	195377,	432489,	383479,	404228,	311678,

Run title : Arctic Cod (run: SVPASA15/V15)

At 30/04/2003 23:56

Traditional vpa using file input for terminal F

Table 13 Spawning stock biomass at age (spawning time) Tonnes

YEAR,	1963,	1964,	1965,	1966,	1967,	1968,	1969,	1970,	1971,	1972,
AGE										
3,	0,	0,	0,	0,	0,	0,	0,	0,	0,	3858,
4,	3404,	0,	0,	0,	0,	0,	0,	816,	0,	4996,
5,	4106,	0,	0,	2356,	0,	38862,	0,	0,	879,	3273,
6,	8476,	9303,	3089,	5231,	8094,	33225,	19333,	6953,	5080,	879,
7,	13167,	20641,	12149,	15983,	16153,	24988,	18637,	47796,	54467,	9671,
8,	41870,	35091,	15786,	38620,	26962,	34917,	22144,	57992,	126766,	117567,
9,	57300,	43323,	23471,	20267,	39155,	46973,	35935,	50714,	73036,	132988,
10,	35970,	48583,	15870,	15669,	19624,	27653,	29611,	32662,	27394,	41292,
11,	13616,	10332,	19897,	8542,	8455,	10766,	16089,	18644,	10827,	16210,
12,	16125,	2828,	2853,	9089,	4972,	2444,	6167,	4512,	7763,	6248,
+gp,	14173,	16470,	9201,	4967,	6369,	7389,	3953,	4396,	5449,	9529,
TOTSPBIO,	208207,	186570,	102315,	120722,	129784,	227215,	151870,	224482,	311662,	346511,

Table 3.25 (continued)

Table 13 Spawning stock biomass at age (spawning time) Tonnes

YEAR,	1973,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,	1982,
AGE										
3,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
4,	0,	0,	0,	0,	0,	0,	0,	0,	0,	3975,
5,	0,	0,	6776,	0,	8022,	0,	0,	0,	3205,	10921,
6,	3145,	2867,	9741,	29833,	19081,	4644,	5316,	3248,	25173,	48986,
7,	12166,	3708,	16897,	34445,	117745,	18964,	15481,	15391,	24723,	160097,
8,	42516,	11451,	18536,	31508,	104400,	112112,	27870,	23415,	42732,	50592,
9,	178082,	18808,	20100,	21659,	42466,	64741,	93543,	23759,	33622,	26992,
10,	72313,	78385,	22708,	21713,	23191,	12721,	23705,	31960,	17804,	12436,
11,	14370,	36074,	27530,	11345,	13266,	9637,	4630,	8362,	16843,	5870,
12,	4647,	6251,	12532,	13760,	6041,	6090,	1342,	989,	1899,	5283,
+gp,	5674,	6947,	7206,	6975,	7173,	12626,	2812,	1130,	924,	979,
TOTSPBI	332913,	164491,	142028,	171238,	341385,	241536,	174699,	108253,	166925,	326132,

Table 13 Spawning stock biomass at age (spawning time) Tonnes

YEAR,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,
AGE										
3,	617,	0,	0,	0,	0,	0,	0,	0,	0,	3171,
4,	8555,	7759,	2809,	17874,	3748,	1674,	0,	972,	8953,	3081,
5,	12763,	25257,	13923,	25887,	24074,	18895,	6560,	6675,	11006,	32929,
6,	35756,	40577,	47109,	25437,	38320,	82771,	71963,	34151,	55005,	83312,
7,	95196,	51176,	45675,	43134,	15776,	55622,	65559,	210885,	128203,	140119,
8,	129590,	52586,	31528,	27354,	15653,	15633,	32488,	65424,	354123,	157752,
9,	26639,	55265,	23083,	7669,	5944,	15259,	10578,	13887,	89243,	357115,
10,	8986,	10636,	19190,	7200,	4669,	8252,	5028,	5404,	22111,	71588,
11,	5224,	3521,	6210,	11408,	4142,	1910,	939,	1386,	3948,	16203,
12,	1645,	2794,	1147,	2527,	3831,	996,	280,	504,	801,	3243,
+gp,	2209,	1513,	2796,	1768,	2151,	1074,	806,	540,	347,	647,
TOTSPBIO,	327179,	251084,	193470,	170258,	118309,	202086,	194201,	339827,	673740,	869164,

Table 13 Spawning stock biomass at age (spawning time) Tonnes

YEAR,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,
AGE										
3,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
4,	19917,	5093,	0,	0,	0,	2215,	0,	0,	2551,	2327,
5,	39070,	65730,	36084,	6689,	3822,	6221,	2798,	22768,	18233,	34166,
6,	84050,	109696,	171141,	141007,	46129,	30045,	13081,	48614,	129251,	162772,
7,	92037,	117307,	126895,	249478,	236207,	89853,	41249,	48667,	94904,	192439,
8,	114260,	76077,	47636,	90306,	186740,	164709,	91667,	36302,	35502,	81880,
9,	96592,	65928,	35998,	31585,	57638,	71012,	71598,	40046,	17624,	18798,
10,	238207,	46687,	26090,	16791,	18388,	14759,	26574,	18504,	15205,	6695,
11,	41648,	94233,	18177,	9152,	5408,	3390,	3649,	4765,	6275,	3454,
12,	9006,	17159,	31854,	4705,	3157,	1100,	676,	1098,	1332,	1793,
+gp,	2440,	2919,	5138,	21294,	6998,	2389,	1536,	515,	726,	646,
TOTSPBIO,	737227,	600829,	499012,	571006,	564488,	385694,	252829,	221278,	321602,	504969,

Table 3.26

Run title : Arctic Cod (run: SVPASA15/V15) ,

At 30/04/2003 23:56

Table 16 Summary (without SOP correction)

Traditional vpa using file input for terminal F

	RECRUITS, Age 3	TOTALBIO,	TOTSPBIO,	LANDINGS,	YIELD/SSB,	FBAR 5-10,	FBAR 4- 8,
1946,	728139,	4168882,	1112776,	706000,	.6344,	.1857,	.1084,
1947,	425311,	3692801,	1165059,	882017,	.7571,	.3047,	.2016,
1948,	442592,	3665819,	1019114,	774295,	.7598,	.3398,	.2322,
1949,	468348,	3065111,	729879,	800122,	1.0962,	.3619,	.2865,
1950,	704908,	2830103,	615339,	731982,	1.1896,	.3566,	.2389,
1951,	1083753,	3141009,	568705,	827180,	1.4545,	.3966,	.3041,
1952,	1193111,	3407679,	520599,	876795,	1.6842,	.5348,	.4071,
1953,	1590377,	3557376,	396417,	695546,	1.7546,	.3572,	.2692,
1954,	641584,	4039204,	429694,	826021,	1.9223,	.3879,	.2786,
1955,	272778,	3488383,	346919,	1147841,	3.3087,	.5437,	.4003,
1956,	439602,	3189831,	299823,	1343068,	4.4795,	.6401,	.5154,
1957,	804781,	2495895,	207840,	792557,	3.8133,	.5089,	.3973,
1958,	496824,	2164149,	195377,	769313,	3.9376,	.5169,	.4337,
1959,	683690,	2415826,	432489,	744607,	1.7217,	.5596,	.4628,
1960,	789653,	2050805,	383479,	622042,	1.6221,	.4789,	.3914,
1961,	916842,	2137149,	404228,	783221,	1.9376,	.6348,	.5008,
1962,	728338,	1957006,	311678,	909266,	2.9173,	.7576,	.6100,
1963,	472064,	1747579,	208207,	776337,	3.7287,	.9866,	.7683,
1964,	338678,	1374529,	186570,	437695,	2.3460,	.6789,	.4607,
1965,	776941,	1440693,	102315,	444930,	4.3486,	.5533,	.3770,
1966,	1582560,	2198418,	120722,	483711,	4.0068,	.5302,	.3497,
1967,	1295416,	2852164,	129784,	572605,	4.4120,	.5439,	.3306,
1968,	164955,	3387455,	227215,	1074084,	4.7272,	.5704,	.4029,
1969,	112039,	2805591,	151870,	1197226,	7.8832,	.8292,	.5899,
1970,	197105,	2057698,	224482,	933246,	4.1573,	.7493,	.5159,
1971,	404774,	1610969,	311662,	689048,	2.2109,	.5956,	.3861,
1972,	1015319,	1621485,	346511,	565254,	1.6313,	.6928,	.3702,
1973,	1818949,	2401955,	332913,	792685,	2.3811,	.6020,	.4207,
1974,	523916,	2236387,	164491,	1102433,	6.7021,	.5633,	.4945,
1975,	621616,	2037430,	142028,	829377,	5.8395,	.6595,	.5684,
1976,	613942,	1931396,	171238,	867463,	5.0658,	.6457,	.5904,
1977,	348054,	1950748,	341385,	905301,	2.6518,	.8379,	.7191,
1978,	638490,	1576565,	241536,	698715,	2.8928,	.9406,	.7062,
1979,	198490,	1114380,	174699,	440538,	2.5217,	.7264,	.5095,
1980,	137735,	863861,	108253,	380434,	3.5143,	.7241,	.4994,
1981,	150867,	983656,	166925,	399038,	2.3905,	.8632,	.5546,
1982,	151828,	750868,	326132,	363730,	1.1153,	.7583,	.5705,
1983,	166820,	738666,	327179,	289992,	.8863,	.7560,	.5701,
1984,	397785,	817561,	251084,	277651,	1.1058,	.9161,	.6816,
1985,	523524,	956772,	193470,	307920,	1.5916,	.7038,	.6208,
1986,	1036538,	1292252,	170258,	430113,	2.5262,	.8650,	.6914,
1987,	286341,	1120019,	118309,	523071,	4.4212,	.9513,	.7656,
1988,	204612,	913053,	202086,	434939,	2.1522,	.9751,	.6238,
1989,	172775,	891080,	194201,	332481,	1.7120,	.6614,	.4804,
1990,	242749,	963046,	339827,	212000,	.6238,	.2717,	.2118,
1991,	411783,	1560102,	673740,	319158,	.4737,	.3216,	.2700,
1992,	720690,	1909707,	869164,	513234,	.5905,	.4557,	.3875,
1993,	894155,	2355498,	737227,	581611,	.7889,	.5534,	.4150,
1994,	806823,	2148691,	600829,	771086,	1.2834,	.8670,	.6438,
1995,	655968,	1814760,	499012,	739999,	1.4829,	.7892,	.5695,
1996,	434591,	1700706,	571006,	732228,	1.2823,	.6996,	.5233,
1997,	713845,	1525878,	564488,	762403,	1.3506,	1.0376,	.7170,
1998,	840213,	1220825,	385694,	592624,	1.5365,	.9298,	.6822,
1999,	584058,	1097084,	252829,	484910,	1.9179,	1.0159,	.6851,
2000,	640598,	1107866,	221278,	414868,	1.8749,	.9129,	.6081,
2001,	498208,	1393393,	321602,	426471,	1.3261,	.8312,	.5066,
2002,	497625,	1593491,	504969,	445060,	.8814,	.6977,	.4132,
Arith. Mean,	608843,	2026865,	373975,	662764,	2.4443,	.6514,	.4788,
Units,	(Thousands),	(Tonnes),	(Tonnes),	(Tonnes),			

Table 3.27 Summary, no cannibalism included.

Table 16 Summary (without SOP correction)

Traditional vpa using file input for terminal F

	RECRUITS Age 3	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	FBAR 5-10	FBAR 4- 8
1946	728139	4168882	1112776	706000	0.6344	0.1857	0.1084
1947	425311	3692801	1165059	882017	0.7571	0.3047	0.2016
1948	442592	3665819	1019114	774295	0.7598	0.3398	0.2322
1949	468348	3065111	729879	800122	1.0962	0.3619	0.2865
1950	704908	2830103	615339	731982	1.1896	0.3566	0.2389
1951	1083753	3141009	568705	827180	1.4545	0.3966	0.3041
1952	1193111	3407679	520599	876795	1.6842	0.5348	0.4071
1953	1590377	3557376	396417	695546	1.7546	0.3572	0.2692
1954	641584	4039204	429694	826021	1.9223	0.3879	0.2786
1955	272778	3488383	346919	1147841	3.3087	0.5437	0.4003
1956	439602	3189831	299823	1343068	4.4795	0.6401	0.5154
1957	804781	2495895	207840	792557	3.8133	0.5089	0.3973
1958	496824	2164149	195377	769313	3.9376	0.5169	0.4337
1959	683690	2415826	432489	744607	1.7217	0.5596	0.4628
1960	789653	2050805	383479	622042	1.6221	0.4789	0.3914
1961	916842	2137149	404228	783221	1.9376	0.6348	0.5008
1962	728338	1957006	311678	909266	2.9173	0.7576	0.61
1963	472064	1747579	208207	776337	3.7287	0.9866	0.7683
1964	338678	1374529	186570	437695	2.346	0.6789	0.4607
1965	776941	1440693	102315	444930	4.3486	0.5533	0.377
1966	1582560	2198418	120722	483711	4.0068	0.5302	0.3497
1967	1295416	2852164	129784	572605	4.412	0.5439	0.3306
1968	164955	3387455	227215	1074084	4.7272	0.5704	0.4029
1969	112039	2805591	151870	1197226	7.8832	0.8292	0.5899
1970	197105	2057698	224482	933246	4.1573	0.7493	0.5159
1971	404774	1610969	311662	689048	2.2109	0.5956	0.3861
1972	1015319	1621485	346511	565254	1.6313	0.6928	0.3702
1973	1818949	2401955	332913	792685	2.3811	0.602	0.4207
1974	523916	2236387	164491	1102433	6.7021	0.5633	0.4945
1975	621616	2037430	142028	829377	5.8395	0.6595	0.5684
1976	613942	1931396	171238	867463	5.0658	0.6457	0.5904
1977	348054	1950748	341385	905301	2.6518	0.8379	0.7191
1978	638490	1576565	241536	698715	2.8928	0.9406	0.7062
1979	198490	1114380	174699	440538	2.5217	0.7264	0.5095
1980	137735	863861	108253	380434	3.5143	0.7241	0.4994
1981	150867	983656	166925	399038	2.3905	0.8632	0.5546
1982	151828	750868	326132	363730	1.1153	0.7583	0.5705
1983	166820	738666	327179	289992	0.8863	0.756	0.5701
1984	397549	817461	251084	277651	1.1058	0.9161	0.6816
1985	523321	956688	193470	307920	1.5916	0.7038	0.6208
1986	929624	1259109	170258	430113	2.5262	0.865	0.6914
1987	270655	1117038	118309	523071	4.4212	0.9513	0.7656
1988	202889	912691	202086	434939	2.1522	0.9751	0.6238
1989	172775	891080	194201	332481	1.712	0.6614	0.4804
1990	242749	963046	339827	212000	0.6238	0.2717	0.2118
1991	408102	1558196	673740	319158	0.4737	0.3216	0.27
1992	700238	1899457	869061	513234	0.5906	0.4557	0.3876
1993	758776	2291839	736594	581611	0.7896	0.5537	0.4157
1994	515805	2017694	598529	771086	1.2883	0.8679	0.6461
1995	305220	1680824	498631	739999	1.4841	0.7896	0.5737
1996	254712	1609946	569908	732228	1.2848	0.7021	0.5296
1997	488820	1467101	564378	762403	1.3509	1.0386	0.7207
1998	600884	1151504	385269	592624	1.5382	0.9309	0.6857
1999	506060	1075642	252828	484910	1.9179	1.016	0.6859
2000	589292	1084258	220908	414868	1.878	0.9136	0.6094
2001	471559	1376865	320932	426471	1.3289	0.8315	0.5072
2002	479211	1586824	504936	445060	0.8814	0.6977	0.4132
Arith. Mean	578236	2015207	373868	662764	2.4446	0.6515	0.4792
0 Units	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)			

Table 3.28 Short-term prediction input

MFDP version 1a
Run: 84_
Time and date: 13:47 01.05.2003
Fbar age range: 5-10

2003

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
3	681000	0.279	0	0	0	0.23	0.007	0.694
4	374970	0.217	0	0	0	0.537	0.071	1.121
5	287415	0.201	0.101	0	0	1.312	0.244	1.652
6	240010	0.2	0.365	0	0	2.015	0.43	2.296
7	108783	0.2	0.628	0	0	3.255	0.61	3.37
8	36158	0.2	0.879	0	0	4.974	0.828	5.002
9	7546	0.2	0.927	0	0	6.731	0.964	6.28
10	871	0.2	1	0	0	8.696	1.111	7.68
11	177	0.2	0.953	0	0	10.403	0.937	9.1
12	99	0.2	1	0	0	11.785	1.18	10.54
13	46	0.2	1	0	0	14.43	1.18	9.62

2004

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
3	308000	0.279	0	0	0	0.232	0.007	0.694
4	.	0.217	0.014	0	0	0.535	0.071	1.121
5	.	0.201	0.07	0	0	1.188	0.244	1.652
6	.	0.2	0.272	0	0	2.194	0.43	2.296
7	.	0.2	0.562	0	0	3.197	0.61	3.37
8	.	0.2	0.791	0	0	4.835	0.828	5.002
9	.	0.2	0.91	0	0	6.553	0.964	6.28
10	.	0.2	0.971	0	0	8.31	1.111	7.68
11	.	0.2	0.993	0	0	10.275	0.937	9.1
12	.	0.2	1	0	0	11.982	1.18	10.54
13	.	0.2	1	0	0	13.364	1.18	9.62

2005

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
3	664000	0.279	0	0	0	0.232	0.007	0.694
4	.	0.217	0.014	0	0	0.535	0.071	1.121
5	.	0.201	0.07	0	0	1.188	0.244	1.652
6	.	0.2	0.272	0	0	2.194	0.43	2.296
7	.	0.2	0.562	0	0	3.197	0.61	3.37
8	.	0.2	0.791	0	0	4.835	0.828	5.002
9	.	0.2	0.91	0	0	6.553	0.964	6.28
10	.	0.2	0.971	0	0	8.31	1.111	7.68
11	.	0.2	0.993	0	0	10.275	0.937	9.1
12	.	0.2	1	0	0	11.982	1.18	10.54
13	.	0.2	1	0	0	13.364	1.18	9.62

Input units are thousands and kg - output in tonnes

Table 3.29. Management option table

MFDP version 1a
Run: 84_
1MFDP Index file 30.04.2003
Time and date: 13:47 01.05.2003
Fbar age range: 5-10

2003				
Biomass	**SSB**	**FMult**	**FBar**	**Landings**
1814674	653307	1.0000	0.6978	577934

2004					2005	
Biomass	**SSB**	**FMult**	**FBar**	**Landings**	**Biomass**	**SSB**
1833819	651579	0.0000	0.0000	0	2631332	1189133
.	651579	0.0600	0.0419	48200	2572401	1147989
.	651579	0.1200	0.0837	94777	2515533	1108485
.	651579	0.1800	0.1256	139798	2460645	1070551
.	651579	0.2400	0.1675	183324	2407655	1034118
.	651579	0.3000	0.2094	225416	2356488	999121
.	651579	0.3600	0.2512	266130	2307069	965497
.	651579	0.4200	0.2931	305522	2259328	933189
.	651579	0.4800	0.3350	343643	2213199	902138
.	651579	0.5400	0.3768	380544	2168617	872292
.	651579	0.6000	0.4187	416271	2125520	843600
.	651579	0.6600	0.4606	450871	2083851	816011
.	651579	0.7200	0.5024	484388	2043552	789480
.	651579	0.7800	0.5443	516862	2004571	763961
.	651579	0.8400	0.5862	548335	1966856	739412
.	651579	0.9000	0.6281	578844	1930357	715792
.	651579	0.9600	0.6699	608426	1895029	693063
.	651579	1.0200	0.7118	637117	1860825	671187
.	651579	1.0800	0.7537	664949	1827703	650129
.	651579	1.1400	0.7955	691954	1795621	629855
.	651579	1.2000	0.8374	718165	1764541	610332

Input units are thousands and kg - output in tonnes

Table 3.30

Single option prediction: Detailed tables

MFDP version 1a
Run: 222
Time and date: 12:16 02.05.2003
Fbar age range: 5-10 version 1a
Input units are thousands and kg - output in tonnes

Year: 2003 F multiplier: 1 Fbar: 0.6978

Age	F	CatchNos	Yield	StockNos	Biomass	SSNos (JAN)	SSB (JAN)	SSNos (ST)	SSB (ST)
3	0.0070	4146	2877	681000	156630	0	0	0	0
4	0.0710	23132	25931	374970	201359	0	0	0	0
5	0.2440	56604	93510	287415	377088	29029	38086	29029	38086
6	0.4300	76569	175803	240010	483620	87604	176521	87604	176521
7	0.6100	45479	153264	108783	354089	68316	222368	68316	222368
8	0.8280	18705	93564	36158	179850	31783	158088	31783	158088
9	0.9640	4298	26992	7546	50792	6995	47084	6995	47084
10	1.1110	539	4141	871	7574	871	7574	871	7574
11	0.9370	99	902	177	1841	169	1755	169	1755
12	1.1800	63	668	99	1167	99	1167	99	1167
13	1.1800	29	283	46	664	46	664	46	664
Total		229664	577934	1737075	1814674	224911	653307	224911	653307

Year: 2004 F multiplier: 0.5732 Fbar: 0.4

Age	F	CatchNos	Yield	StockNos	Biomass	SSNos (JAN)	SSB (JAN)	SSNos (ST)	SSB (ST)
3	0.0040	1076	747	308000	71456	0	0	0	0
4	0.0407	18355	20576	511610	273711	7163	3832	7163	3832
5	0.1399	33320	55044	281138	333992	19680	23379	19680	23379
6	0.2465	36616	84071	184183	404096	50098	109914	50098	109914
7	0.3497	34384	115874	127827	408664	71839	229669	71839	229669
8	0.4746	16705	83556	48393	233980	38279	185078	38279	185078
9	0.5526	5022	31541	12935	84760	11770	77131	11770	77131
10	0.6368	1016	7807	2356	19579	2288	19012	2288	19012
11	0.5371	89	812	235	2412	233	2395	233	2395
12	0.6764	26	270	57	680	57	680	57	680
13	0.6764	16	158	36	488	36	488	36	488
Total		146626	400455	1476769	1833819	201442	651579	201442	651579

Year: 2005 F multiplier: 0.5732 Fbar: 0.4

Age	F	CatchNos	Yield	StockNos	Biomass	SSNos (JAN)	SSB (JAN)	SSNos (ST)	SSB (ST)
3	0.0040	2320	1610	664000	154048	0	0	0	0
4	0.0407	8326	9334	232081	124163	3249	1738	3249	1738
5	0.1399	46860	77413	395387	469720	27677	32880	27677	32880
6	0.2465	39748	91260	199934	438654	54382	119314	54382	119314
7	0.3497	31702	106834	117855	376781	66234	211751	66234	211751
8	0.4746	25466	127382	73776	356705	58357	282154	58357	282154
9	0.5526	9571	60108	24649	161526	22431	146989	22431	146989
10	0.6368	2629	20192	6094	50643	5917	49174	5917	49174
11	0.5371	388	3528	1020	10485	1013	10411	1013	10411
12	0.6764	51	533	112	1346	112	1346	112	1346
13	0.6764	17	168	39	519	39	519	39	519
Total		167078	498363	714947	2144590	239412	856276	239412	856276

Table 3.31 North East arctic cod. Stock numbers-at-age (in thousands) estimated by VPA including discard estimates, and % increase in stock numbers relative to a VPA without discards. From Dingsør (2001).

	Estimated stock numbers (thousands)			Percent increase		
Year	Age 3	Age 4	Age 5	Age 3	Age 4	Age 5
1946	875 346	602 579	407 163	20 %	4 %	1 %
1947	531 993	676 806	465 099	27 %	14 %	0 %
1948	570 356	392 309	497 476	29 %	14 %	5 %
1949	589 367	416 668	285 459	26 %	16 %	3 %
1950	799 732	414 016	291 200	13 %	9 %	1 %
1951	1 235 322	586 054	302 346	14 %	2 %	0 %
1952	1 388 731	889 509	401 768	17 %	3 %	0 %
1953	1 801 114	975 004	600 908	13 %	2 %	0 %
1954	830 653	1 321 053	684 303	29 %	5 %	0 %
1955	381 489	615 696	907 875	40 %	19 %	2 %
1956	567 555	274 235	399 344	29 %	25 %	3 %
1957	914 850	387 496	161 710	14 %	10 %	2 %
1958	552 600	672 221	262 135	11 %	4 %	2 %
1959	757 567	391 906	406 694	11 %	3 %	0 %
1960	855 470	534 350	240 047	8 %	1 %	0 %
1961	1 041 570	620 707	347 043	13 %	1 %	0 %
1962	894 728	739 196	382 556	23 %	4 %	0 %
1963	551 938	614 025	429 068	17 %	10 %	0 %
1964	389 151	396 165	361 790	15 %	5 %	0 %
1965	845 469	293 844	266 134	9 %	8 %	0 %
1966	1 618 188	647 435	203 168	2 %	4 %	2 %
1967	1 404 569	1 249 506	465 035	9 %	0 %	1 %
1968	210 875	1 088 071	876 095	24 %	6 %	0 %
1969	143 791	155 947	699 033	28 %	15 %	2 %
1970	222 635	104 415	92 541	13 %	17 %	4 %
1971	462 474	164 397	65 112	14 %	6 %	2 %
1972	1 221 559	358 357	115 892	20 %	10 %	1 %
1973	1 858 123	947 409	249 400	2 %	19 %	11 %
1974	598 555	1 246 499	583 612	14 %	2 %	9 %
1975	654 442	382 692	627 793	5 %	10 %	3 %
1976	622 230	477 390	233 608	1 %	2 %	1 %
1977	397 826	426 386	280 645	14 %	0 %	0 %
1978	653 256	277 410	198 204	2 %	11 %	0 %
1979	225 935	460 104	164 243	14 %	2 %	1 %
1980	152 937	171 954	300 312	11 %	11 %	0 %
1981	161 752	116 964	116 337	7 %	7 %	4 %
1982	151 642	125 307	81 780	0 %	4 %	1 %
1983	166 310	115 423	82 423	0 %	-1 %	3 %
1984	408 525	133 333	77 728	3 %	0 %	0 %
1985	543 828	324 072	96 327	4 %	2 %	0 %
1986	1 114 252	412 683	219 993	7 %	2 %	0 %
1987	307 425	767 656	268 642	7 %	4 %	0 %
1988	222 819	215 720	490 161	9 %	3 %	2 %
1989	180 066	166 955	151 576	4 %	6 %	0 %
1990	249 968	139 922	114 006	3 %	2 %	1 %
1991	418 955	200 700	105 559	2 %	2 %	0 %
1992	748 962	333 517	151 973	4 %	1 %	0 %
1993	1 002 933	576 112	238 980	10 %	2 %	0 %
1994	896 184	744 062	420 039	9 %	8 %	0 %
1995	733 664	584 808	476 048	10 %	6 %	3 %
1996	467 093	341 918	344 124	3 %	7 %	3 %
1997	765 234	238 202	193 102	3 %	0 %	4 %
1998	836 301	429 147	144 629	2 %	1 %	-1 %

Table 3.32a Likelihood components at end of keyrun.

Likelihood Component	Unweighted Likelihood		Weight	Weighted Likelihood	
	Keyrun	2002 wg		Keyrun	2002 wg
overfish.tons	16		1	**16**	
norxgil.catch	374200	373863	20	**7484000**	7477260
gillnet.catch	102700	96616	20	**2054000**	1932320
Wintersur-85-93	1540000	1610232	1	**1540000**	1610232
Wintersur-94-03	925800	794985	1	**925800**	794985
lofotensur-85-89	100900	87933	1	**100900**	87933
lofotensur-90-03	562900	555611	1	**562900**	555611
acousticsur-85-93	1296000	1282978	1	**1296000**	1282978
acousticsur-94-03	1441000	1189236	1	**1441000**	1189236
rustrawlsur-85-02	1428000	1243521	1	**1428000**	1243521
stomach-85-03	2612	1746	100	**261200**	174600
Bounds	0		1	**0**	
Total	7774128	7236721		**17093816**	16348676

Table 3.32b Parameter values and sensitivity (effect of parameter change on likelihood score) in keyrun, and 2001/2002 values

Parameter	Value	2002 wg	2001 wg	-5%	+5%
ba1ac.b	0.104241	0.0783	0.2469	0.01	0.01
ba1ac.slope	0.00470287	0.0053	0.0014	0.02	0.02
ba1tr.b	0.505311	0.4065	0.4062	0.11	0.10
ba1tr.slope	-0.00235214	0	-0.0002	0.01	0.00
ba2ac.b	0.18179	0.2332	0.3993	0.02	0.02
ba2ac.slope	0.0064221	0.0058	0.0016	0.03	0.03
ba2tr.b	0.390517	0.3758	0.4276	0.07	0.06
ba2tr.slope	0.00172339	0.003	0.0014	0.00	0.00
betabinimm	44.0124			0.01	0.01
betabinmat	3.39452			0.00	0.00
cann_alpha	0.000102867			0.50	0.48
cann_delta	0.406176			14.62	9.70
gil.f1985	0.788735	0.6769	0.5679	0.03	0.04
gil.f1986	0.456546	0.3928	0.3032	0.02	0.02
gil.f1987	0.497441	0.4278	0.2589	0.01	0.01
gil.f1988	0.647429	0.5144	0.3785	0.00	0.00
gil.f1989	1.15757	0.9582	0.6628	0.06	0.05
gil.f1990	0.265434	0.2082	0.1485	0.05	0.05
gil.f1991	0.213375	0.1842	0.1282	0.20	0.20
gil.f1992	0.156414	0.1359	0.0967	0.26	0.26
gil.f1993	0.190386	0.1679	0.1287	0.07	0.05
gil.f1994	0.246661	0.2222	0.1774	0.02	0.02
gil.f1995	0.494976	0.4294	0.3106	0.01	0.01
gil.f1996	0.487043	0.4368	0.3323	0.01	0.01
gil.f1997	0.591147	0.5145	0.3709	0.01	0.01
gil.f1998	0.653523	0.5586	0.4538	0.01	0.01
gil.f1999	0.706263	0.6272	0.4633	0.00	0.00
gil.f2000	0.725594	0.626	0.4804	0.00	0.00
gil.f2001	0.541593	0.5014		0.00	0.00
gil.f2002	0.374576			0.00	0.00
gil.l50	85.3849	83.3239	80	117.49	70.00
gil.slope	0.0359626	0.0367	0.0387	2.88	2.23

Table 3.32b (continued)

growth.1985	8.1602	8.3317	8.7728	1.23	1.22
growth.1986	6.54222	6.2809	7.3012	4.14	4.07
growth.1987	6.97071	8.3566	6.9926	3.68	3.66
growth.1988	7.66196	7.15	7.3956	1.00	1.03
growth.1989	12.2885	13.0489	13.1577	12.83	12.68
growth.1990	11.5764	10.5856	11.8511	36.06	36.49
growth.1991	11.4681	10.5828	9.8304	83.50	86.40
growth.1992	8.13503	8.8248	8.0952	18.18	18.67
growth.1993	7.72257	6.7464	6.6638	3.72	3.88
growth.1994	9.56092	9.561	10.258	0.97	0.96
growth.1995	8.53934	8.4603	7.5524	0.22	0.22
growth.1996	10.4876	11.1062	10.7937	0.24	0.24
growth.1997	10.3318	10.6062	9.6489	0.27	0.27
growth.1998	9.40794	8.5245	9.726	0.22	0.22
growth.1999	10.8541	11.8582	10.5666	0.25	0.24
growth.2000	12.0504	12.0683	11.7	0.27	0.26
growth.2001	10.071	10.8442		0.14	0.13
growth.2002	9.85303			0.06	0.06
growth.ratio	0.740864	0.7792	0.7957	3.49	3.57
imm.n_age3	54.1396	55.2526	55.6596	0.34	0.33
imm.n_age4	37.7218	37.608	37.1615	0.09	0.08
imm.n_age5	7.72005	10.5822	10.7376	0.02	0.02
imm.n_age6	3.76807	3.5504	3.4023	0.02	0.02
imm.n_age7	1.26253	1.2868	1.0011	0.01	0.01
imm.n_age8	0.244392	0.2046	0.1865	0.00	0.00
imm.n_age9	0.182001	0.1365	0.1335	0.00	0.00
l_minage.1986	34.292	34.3425	34.1084	27.60	42.49
l_minage.1987	31.9464	31.6591	32.1017	2.35	2.52
l_minage.1988	31.9066	32.1587	32.1236	5.19	3.73
l_minage.1989	32.5765	32.303	32.6073	8.20	7.08
l_minage.1990	33.4169	33.5965	34.021	34.51	35.51
l_minage.1991	37.8729	37.8337	39.7212	99.58	120.12
l_minage.1992	39.4278	38.8367	39.7733	70.37	108.70
l_minage.1993	35.8976	36.396	36.5644	9.75	12.88
l_minage.1994	30.6703	30.6195	30.8819	2.31	1.88
l_minage.1995	29.1334	29.6721	30.062	0.90	0.72
l_minage.1996	29.7007	29.3409	29.7766	0.92	0.81
l_minage.1997	30.8486	30.3504	30.9709	2.01	1.78
l_minage.1998	31.15	31.3425	31.0328	2.66	2.53
l_minage.1999	28.7398	28.4458	28.9558	1.01	0.91
l_minage.2000	29.0021	28.8552	28.7652	1.08	0.96
l_minage.2001	32.9234	32.8703	33.2432	0.89	0.83
l_minage.2002	30.0252	31.5538		0.64	0.57
l_minage.2003	29.838			0.64	0.49

Table 3.32b (Continued)

lof1ac.cbt	0.851288	0.7317	0.6775	0.00	0.00
lof1ac.l50	66.5567	51.2518	43.1426	0.01	0.01
lof1ac.slope	0.0138748	0.0103	0.0081	0.00	0.00
lof2ac.cbt	2.06362	2.01	1.01	0.02	0.02
lof2ac.l50	90	87.8967	64.5238	0.12	0.13
lof2ac.slope	0.0119362	0.0117	0.0219	0.01	0.01
mat.n_age10	0.220849			0.00	0.00
mat.n_age5	3.71008			0.00	0.00
mat.n_age6	1.64682			0.00	0.00
mat.n_age7	1.25175			0.01	0.00
mat.n_age8	0.510124			0.00	0.00
mat.n_age9	0.166826			0.00	0.00
n_minage.1986	117.512	123.5562	125.8591	16.68	16.84
n_minage.1987	36.2056	36.8587	38.5834	5.53	5.67
n_minage.1988	29.059	28.0084	28.7296	7.30	7.56
n_minage.1989	20.4847	19.4994	19.8993	4.84	4.99
n_minage.1990	30.4749	30.325	30.0839	5.96	6.13
n_minage.1991	49.0125	49.2732	50.121	8.19	8.35
n_minage.1992	76.257	79.876	81.562	2.84	2.93
n_minage.1993	97.2025	104.5486	106.2583	0.35	0.36
n_minage.1994	89.904	88.6541	90.1468	0.10	0.09
n_minage.1995	57.8611	56.803	57.1602	0.06	0.06
n_minage.1996	35.8281	36.2454	36.1087	0.05	0.05
n_minage.1997	59.9047	59.7255	61.0898	0.10	0.08
n_minage.1998	73.4807	69.9894	72.7707	0.11	0.10
n_minage.1999	51.6259	43.4426	42.7957	0.06	0.06
n_minage.2000	58.5576	51.1067	54.4713	0.05	0.04
n_minage.2001	38.6685	31.8426	37.4844	0.02	0.02
n_minage.2002	33.9831	17.8735		0.01	0.01
n_minage.2003	90.6698			0.01	0.01
ovr.f1990	0.0288109			8.98	8.99
ovr.f1991	0.0405644			35.58	35.46
ovr.f1992	0.0852345			231.23	229.48
ovr.f1993	0.0333141			35.57	35.68
ovr.f1994	0.0180057			9.03	9.00
rustr.b	0.0734692	0.0705	0.0836	0.01	0.01
rustr.slope	0.000842825	0.0009	0.0008	0.00	0.00

Table 3.32b (Continued)

tot.f1985	0.391033	0.3171	0.3202	0.05	0.07
tot.f1986	0.592219	0.5069	0.4952	0.05	0.05
tot.f1987	1.06524	0.9153	0.8641	0.94	0.91
tot.f1988	0.938983	0.7756	0.7614	4.22	4.13
tot.f1989	0.629011	0.5318	0.5163	8.58	8.32
tot.f1990	0.209154	0.1805	0.1731	3.25	3.16
tot.f1991	0.199448	0.1824	0.1721	5.17	5.04
tot.f1992	0.230824	0.2055	0.194	3.45	3.36
tot.f1993	0.336908	0.2829	0.2743	1.27	1.23
tot.f1994	0.526697	0.427	0.4139	0.50	0.51
tot.f1995	0.60691	0.4866	0.467	0.07	0.07
tot.f1996	0.693183	0.587	0.5655	0.07	0.06
tot.f1997	0.968366	0.8436	0.8191	0.08	0.07
tot.f1998	1.0644	0.9528	0.9394	0.07	0.07
tot.f1999	0.969765	0.8989	0.8454	0.05	0.06
tot.f2000	0.656558	0.595	0.5622	0.04	0.04
tot.f2001	0.498924	0.5042		0.04	0.04
tot.f2002	0.424178			0.04	0.03
tot.l50	53.8298	52.9363	52.8097	214.34	234.69
tot.slope	0.0474371	0.0501	0.05	7.72	6.35

Table 3.32c Fixed parameter values used in keyrun

Constant parameters (not optimized)

Name	Value	Name	Value
growth.exponent	0	mat.n_age4	0
cann_p1	1.12	mat.n_age11	0.04
cann_p2	0.015	mat.n_age12	0.03
cann_p3	0.228	mat.l_age4	51
imm.mort1	0.05	mat.l_age5	59.6
imm.mort2	0.05	mat.l_age6	71.1
imm.mort3	0.05	mat.l_age7	79
imm.n_age10	0	mat.l_age8	88.2
imm.l_age3	40.6	mat.l_age9	97.3
imm.l_age4	48.7	mat.l_age10	105.2
imm.l_age5	61.3	mat.l_age11	114
imm.l_age6	71.1	mat.l_age12	114
imm.l_age7	81.2	mat.d_age4	14.9
imm.l_age8	85.7	mat.d_age5	1.1
imm.l_age9	90	mat.d_age6	6.7450297
imm.l_age10	90	mat.d_age7	3.184107
imm.d_age3	5.1	mat.d_age8	5.1070776
imm.d_age4	4.1	mat.d_age9	3.0645865
imm.d_age5	4.9	mat.d_age10	5.4373194
imm.d_age6	5.3	mat.d_age11	10.621258
imm.d_age7	5.4	mat.d_age12	3.2658864
imm.d_age8	8.7	ovr.f1985	0
imm.d_age9	8.7	ovr.f1986	0
imm.d_age10	8.7	ovr.f1987	0
maturation.slope	0.03	ovr.f1988	0
maturation.l50	76	ovr.f1989	0
d_minage.1986	4.4	ovr.f1995	0
d_minage.1987	3.5	ovr.f1996	0
d_minage.1988	3.1	ovr.f1997	0
d_minage.1989	2.9	ovr.f1998	0
d_minage.1990	4.3	ovr.f1999	0
d_minage.1991	5.8	ovr.f2000	0
d_minage.1992	4.8	ovr.f2001	0
d_minage.1993	4.4	ovr.f2002	0
d_minage.1994	5	ba1tr.cbt	1
d_minage.1995	5.9	ba1tr.b0	1
d_minage.1996	5	ba2tr.cbt	1
d_minage.1997	3.9	ba2tr.b0	1
d_minage.1998	4.4	lof1ac.b0	1
d_minage.1999	4.2	lof2ac.b0	1
d_minage.2000	4.1	ba1ac.cbt	1
d_minage.2001	4.1	ba1ac.b0	1
d_minage.2002	4.1	ba2ac.cbt	1
d_minage.2003	4.5	ba2ac.b0	1
mat.mort1	0.05	rustr.cbt	1
mat.mort2	0.05	rustr.b0	1

Table 3.33 Results from the keyrun

```
; Gadget version 2.0.02 running on FLEXIDELL Wed Apr 30 15:25:23 2003
stocks cod.imm cod.mat
areas 0
```

Total fishing mortality-at-age

Year / Age	1985	1986	1987	1988
3	0.0669	0.0345	0.0385	0.0334
4	0.1647	0.2301	0.1757	0.1169
5	0.3524	0.4140	0.6202	0.3260
6	0.4941	0.5997	0.9066	0.7139
7	0.6632	0.7264	1.1159	0.9219
8	0.8368	0.8444	1.2670	1.0979
9	0.9566	0.9208	1.3892	1.2686
10	1.1295	0.9748	1.4543	1.4074
11	1.1492	1.0383	1.5014	1.4731
12+	1.1688	1.0469	1.5515	1.5352
F 5-10	0.7388	0.7467	1.1255	0.9560

Total fishing mortality-at-age

Year / Age	1989	1990	1991	1992	1993	1994	1995
3	0.0322	0.0174	0.0363	0.0457	0.0297	0.0257	0.0251
4	0.1021	0.0776	0.0797	0.1403	0.1366	0.1510	0.1274
5	0.2275	0.1360	0.1736	0.2167	0.2583	0.3574	0.3589
6	0.4094	0.1885	0.2174	0.3032	0.3296	0.4888	0.5505
7	0.6646	0.2367	0.2510	0.3347	0.4025	0.5584	0.6667
8	0.8563	0.3021	0.2870	0.3611	0.4355	0.6370	0.7508
9	1.0914	0.3518	0.3397	0.3881	0.4643	0.6747	0.8737
10	1.3524	0.3934	0.3735	0.4196	0.4917	0.7053	0.9318
11	1.5746	0.4403	0.3962	0.4366	0.5212	0.7336	0.9785
12+	1.6882	0.4813	0.4268	0.4494	0.5372	0.7642	1.0217
F 5-10	0.7669	0.2681	0.2737	0.3372	0.3970	0.5703	0.6887

Total fishing mortality-at-age

Year / Age	1996	1997	1998	1999	2000	2001	2002	2000-2002
3	0.0287	0.0407	0.0464	0.0296	0.0211	0.0258	0.0139	0.0203
4	0.1290	0.2025	0.2156	0.1887	0.1145	0.0945	0.1016	0.1035
5	0.3414	0.4738	0.5339	0.4778	0.3379	0.2563	0.2143	0.2695
6	0.5886	0.7788	0.8246	0.7566	0.5385	0.4331	0.3531	0.4416
7	0.7369	1.0059	1.0623	0.9553	0.6819	0.5486	0.4611	0.5639
8	0.8384	1.1560	1.2523	1.1361	0.8118	0.6458	0.5394	0.6657
9	0.9147	1.2617	1.3924	1.3117	0.9635	0.7383	0.6032	0.7683
10	1.0170	1.3375	1.4815	1.4325	1.1066	0.8330	0.6561	0.8652
11	1.0626	1.4309	1.5458	1.5063	1.1963	0.9113	0.7056	0.9377
12+	1.1149	1.4930	1.6493	1.5898	1.2658	0.9645	0.7486	0.9930
F 5-10	0.7395	1.0023	1.0912	1.0117	0.7400	0.5758	0.4712	

Table 3.33 (Continued)

; Gadget version 2.0.02 running on FLEXIDELL Wed Apr 30 15:25:23 2003
stocks cod.imm cod.mat
areas 0

Residual natural mortality (M1)

Year	1985	1986	1987	1988
Age				
3	0.2000	0.2000	0.2000	0.2000
4	0.2000	0.2000	0.2000	0.2000
5	0.2000	0.2000	0.1999	0.2000
6	0.2000	0.2000	0.2000	0.1999
7	0.2000	0.2000	0.2000	0.2000
8	0.1999	0.2000	0.2000	0.1999
9	0.2000	0.2000	0.2000	0.1999
10	0.2000	0.2000	0.2000	0.2000
11	0.2000	0.2000	0.2000	0.2000
12+	0.2000	0.2000	0.2000	0.2000

Residual natural mortality (M1)

Year	1989	1990	1991	1992	1993	1994	1995
Age							
3	0.2000	0.2000	0.2000	0.2000	0.2000	0.1998	0.1997
4	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
5	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
6	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
7	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
8	0.1999	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
9	0.1998	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
10	0.1998	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
11	0.1999	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
12+	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000

Residual natural mortality (M1)

Year	1996	1997	1998	1999	2000	2001	2002	2000-2002
Age								
3	0.1999	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
4	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
5	0.2000	0.1999	0.1999	0.1999	0.2000	0.2000	0.2000	0.2000
6	0.2000	0.2000	0.1999	0.1999	0.2000	0.2000	0.2000	0.2000
7	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
8	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
9	0.2000	0.2000	0.1999	0.1999	0.1999	0.2000	0.2000	0.2000
10	0.2000	0.2000	0.1999	0.1999	0.1999	0.2000	0.2000	0.2000
11	0.2000	0.2000	0.2000	0.1999	0.1999	0.2000	0.2000	0.2000
12+	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000

Predation mortality (M2)

Year	1985	1986	1987	1988
Age				
3	0.0108	0.0648	0.0731	0.0215
4	0.0006	0.0025	0.0109	0.0037

Predation mortality (M2)

Year	1989	1990	1991	1992	1993	1994	1995
Age							
3	0.0087	0.0155	0.0173	0.0249	0.1256	0.4217	0.4884
4	0.0013	0.0003	0.0015	0.0031	0.0099	0.0357	0.0573

Predation mortality (M2)

Year	1996	1997	1998	1999	2000	2001	2002	2000-2002
Age								
3	0.2400	0.1088	0.0538	0.0388	0.0298	0.0191	0.0842	0.0444
4	0.0361	0.0154	0.0055	0.0031	0.0023	0.0025	0.0028	0.0025

Table 3.33 (Continued)

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Stock numbers (thousands) at age by Jan. 1

Year	1985	1986	1987	1988	1989
Age					
3	541396	1175114	362055	290590	204847
4	377218	410124	871130	265109	225220
5	114301	256487	259607	574613	186971
6	54148	65771	138001	112761	330820
7	25142	27049	29561	45579	45013
8	7545	10603	10710	7929	14839
9	3488	2674	3731	2470	2165
10	2208	1095	875	762	568
11	400	584	334	166	152
12+	300	180	221	99	48
Total	1126148	1949685	1676230	1300082	1010648

Stock numbers (thousands) at age by Jan. 1

Year	1990	1991	1992	1993	1994	1995	1996
Age							
3	304746	490107	762569	972024	898347	574051	357749
4	160996	241430	380323	581726	681355	470287	281346
5	161292	119439	178637	264963	401921	450480	310805
6	119923	114530	82050	117071	166285	228303	254193
7	179108	81215	75424	49597	68859	83395	107668
8	18946	115715	51728	44186	27151	32248	35040
9	5158	11466	71096	29513	23402	11756	12459
10	595	2970	6688	39498	15315	9793	4028
11	120	328	1669	3584	19650	6159	3146
12+	33	80	223	1000	2221	8572	4422
Total	950921	1177284	1610412	2103166	2304509	1875049	1370860

Stock numbers (thousands) at age by Jan. 1

Year	1997	1998	1999	2000	2001	2002	2003
Age							
3	599036	734733	516026	585422	386683	339797	906317
4	223895	422342	544203	394554	455499	302703	252196
5	189812	143251	268869	357263	279434	328842	217185
6	177868	95176	67688	134754	206740	175038	214599
7	115401	66698	34048	25937	64317	109632	100499
8	42179	34545	18868	10718	10733	30417	56590
9	12400	10866	8083	4958	3894	4605	14518
10	4088	2878	2213	1783	1550	1527	2066
11	1190	874	533	431	481	548	644
12+	2077	615	249	138	138	201	299
Total	1367950	1511983	1460783	1515962	1409472	1293313	1764918

Table 3.33 (Continued)

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areas 0
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Spawning stock biomass (tons) at Jan. 1

Year	1985	1986	1987
Age			
4	0	0	0
5	65519	39543	30989
6	51564	93286	75028
7	52608	77080	72394
8	30153	50976	46678
9	13208	16688	23612
10	22315	8090	6864
11	5164	6380	3210
12+	3854	2419	3199
SSB total	244384	294461	261973

Spawning stock biomass (tons) at Jan. 1

Year	1988	1989	1990	1991	1992	1993	1994	1995
Age								
4	0	0	0	0	0	0	0	0
5	10321	2123	10465	22469	37823	69961	62788	46786
6	46011	46957	32136	68481	92131	98278	146325	161901
7	58975	49733	151474	108357	167079	131171	129511	170467
8	28766	39671	51798	301474	182650	180720	110505	110258
9	13919	11176	24143	56731	362982	162142	125407	67932
10	5817	4176	3978	19838	48954	276962	99081	69504
11	1563	1492	1094	2733	14950	33300	154533	52358
12+	1320	656	439	928	2508	11334	22682	89581
SSB total	166691	155983	275528	581013	909077	963867	850831	768787

Spawning stock biomass (tons) at Jan. 1

Year	1996	1997	1998	1999	2000	2001	2002	2003
Age								
4	0	0	0	0	0	0	0	0
5	16112	11184	9075	12060	21137	19127	21119	20093
6	124310	68878	35015	22640	49592	103224	82124	93376
7	192065	182189	88494	36501	31681	95116	188088	152102
8	122554	149980	117951	49271	28291	31422	104153	197854
9	61337	66270	60841	38201	23145	17564	23391	78268
10	28442	27699	21045	14257	12136	9766	10069	14393
11	26388	10937	7757	4205	3718	3976	4619	5536
12+	47859	25897	8502	2692	1545	1472	2227	3409
SSB total	619066	543034	348680	179827	171245	281667	435791	565030

Table 3.33 (Continued)

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stocks cod.imm cod.mat
areas 0
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Total stock biomass (tons) at Jan. 1

Year	1985	1986	1987
Age			
3	311554	462467	114956
4	367623	395140	477690
5	216934	384548	335175
6	167718	170443	269789
7	110799	106586	95021
8	43496	56299	51152
9	24490	17488	23952
10	22315	8524	6939
11	5164	6380	3210
12+	3854	2419	3199
Total	1273946	1610294	1381083

Total stock biomass (tons) at Jan. 1

Year	1988	1989	1990	1991	1992	1993	1994	1995
Age								
3	86385	71776	118176	296330	473526	437021	257638	149339
4	138716	134914	142609	227306	439694	594004	560127	339082
5	529173	178010	211904	204703	304671	472644	629690	632147
6	201931	493632	217921	263958	235050	290404	407424	519389
7	119631	118680	452874	241881	279088	193678	222545	274653
8	31948	55838	74783	450058	237280	216074	127706	136261
9	14233	11549	26952	62882	403705	174617	132406	70540
10	5830	4194	4002	20241	49918	283559	101568	70478
11	1563	1492	1094	2733	14950	33300	154533	52358
12+	1320	656	439	928	2508	11334	22682	89581
Total	1130730	1070742	1250754	1771019	2440389	2706634	2616319	2333827

Total stock biomass (tons) at Jan. 1

Year	1996	1997	1998	1999	2000	2001	2002	2003
Age								
3	94709	167706	216560	117358	136267	134308	90331	239280
4	178928	153932	280398	334907	229028	292863	225301	160720
5	363076	224908	171029	301491	420058	334439	399434	295931
6	506023	336063	174575	119470	252014	417835	352979	427208
7	333720	345656	188248	86266	71340	189775	350395	302302
8	149941	184120	149792	68791	40869	42652	134058	249548
9	65993	70636	64526	41251	25886	19727	25669	83999
10	28743	28200	21395	14469	12358	10029	10370	14715
11	26388	10937	7757	4205	3718	3976	4619	5536
12+	47859	25897	8502	2692	1545	1472	2227	3409
Total	1795379	1548055	1282781	1090899	1193082	1447075	1595383	1782648

Table 3.33 (Continued)

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stocks cod.imm cod.mat
areas 0
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Weight (kg) in catch (Observed)

Year / Age	1985	1986	1987	1988	1989	1990	1991	1992	1993
1	-	-	-	-	-	-	-	-	-
2	-	-	-	-	-	-	-	-	-
3	0.91	0.62	0.49	0.53	0.74	0.83	1.03	1.15	0.76
4	1.30	1.25	0.87	0.83	0.92	1.22	1.43	1.56	1.44
5	1.96	1.87	1.53	1.29	1.26	1.61	2.11	2.22	2.07
6	3.19	2.80	2.34	2.22	1.86	2.13	2.80	3.14	2.71
7	4.63	4.46	3.55	3.52	2.86	3.15	3.58	4.31	4.05
8	6.04	5.78	5.97	5.28	4.58	4.57	4.61	5.24	5.44
9	7.67	6.76	8.60	7.92	7.51	7.26	5.99	6.16	6.40
10	9.81	7.60	9.61	9.01	9.09	9.85	8.78	7.89	7.13
11	11.83	9.76	12.26	11.21	11.40	13.54	11.82	10.32	7.99
12+	14.32	10.63	13.77	13.99	12.00	17.13	16.58	11.81	10.31

Weight (kg) in catch (Observed)

Year / Age	1994	1995	1996	1997	1998	1999	2000	2001	2002	2000-2002
1	-	-	-	-	-	-	-	-	-	-
2	-	-	-	-	-	-	-	-	-	-
3	0.83	0.80	0.80	0.67	0.61	0.62	0.55	0.66	0.70	0.64
4	1.27	1.22	1.09	0.99	0.98	1.00	1.00	1.03	1.10	1.04
5	1.97	1.73	1.59	1.45	1.54	1.48	1.56	1.58	1.54	1.56
6	2.89	2.55	2.41	2.13	2.22	2.26	2.29	2.48	2.32	2.36
7	3.41	3.81	3.82	3.34	3.22	3.17	3.29	3.48	3.57	3.45
8	5.33	5.02	5.83	5.26	4.83	4.32	4.45	4.76	4.83	4.68
9	6.91	6.18	6.91	7.28	6.88	6.05	5.71	6.01	6.31	6.01
10	7.67	8.03	8.16	7.83	9.39	6.90	7.52	7.46	7.67	7.55
11	8.07	8.84	9.65	8.57	10.75	11.08	7.71	8.73	9.02	8.49
12+	9.71	9.24	10.75	11.32	15.73	14.33	12.34	10.95	7.93	10.41

Table 3.33 (Continued)

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stocks cod.imm cod.mat
areas 0
```

Weight (kg) in catch (Model)

Year / Age	1985	1986	1987	1988	1989	1990	1991	1992	1993
1	-	-	-	-	-	-	-	-	-
2	-	-	-	-	-	-	-	-	-
3	0.94	0.59	0.46	0.52	0.62	0.83	1.10	0.97	0.73
4	1.31	1.33	0.88	0.88	0.99	1.39	1.46	1.67	1.40
5	2.23	1.80	1.60	1.33	1.36	1.82	2.22	2.17	2.17
6	3.58	2.87	2.18	2.17	1.87	2.31	2.85	3.31	2.79
7	4.93	4.25	3.49	2.96	2.99	3.05	3.59	4.21	4.19
8	6.43	5.59	5.19	4.42	4.07	4.55	4.59	5.17	5.19
9	7.79	6.79	6.98	6.23	5.63	5.81	6.29	6.32	6.22
10	10.96	7.96	8.69	8.18	7.49	7.32	7.64	8.16	7.47
11	14.04	10.96	10.58	10.02	9.59	9.49	9.18	9.65	9.52
12+	13.91	13.28	16.12	14.18	12.83	13.04	12.26	11.87	11.46

Weight (kg) in catch (Model)

Year / Age	1994	1995	1996	1997	1998	1999	2000	2001	2002	2000-2002
1	-	-	-	-	-	-	-	-	-	-
2	-	-	-	-	-	-	-	-	-	-
3	0.63	0.61	0.60	0.56	0.58	0.51	0.53	0.61	0.52	0.55
4	1.20	1.08	1.07	1.08	1.03	1.05	1.02	1.04	1.13	1.06
5	1.89	1.73	1.60	1.59	1.59	1.56	1.63	1.63	1.61	1.62
6	2.77	2.67	2.45	2.29	2.21	2.22	2.32	2.46	2.37	2.38
7	3.56	3.87	3.69	3.45	3.18	3.07	3.25	3.47	3.57	3.43
8	5.19	4.89	5.06	4.91	4.70	4.40	4.39	4.65	4.87	4.64
9	6.29	6.76	6.23	6.32	6.32	6.18	5.91	5.89	6.15	5.98
10	7.42	7.99	8.38	7.57	7.82	7.99	7.77	7.48	7.49	7.58
11	8.86	9.29	9.85	9.92	9.23	9.72	9.65	9.49	9.26	9.47
12+	11.63	11.19	12.70	13.17	13.91	13.39	12.41	12.12	12.08	12.20

Table 3.33 (Continued)

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areas 0
```

Weight (kg) in stock at Jan. 1

Year	1985
Age	
3	0.58
4	0.97
5	1.90
6	3.10
7	4.41
8	5.76
9	7.02
10	10.10
11	12.91
12+	12.85

Weight (kg) in stock at Jan. 1

Year	1986	1987	1988	1989	1990	1991	1992	1993	1994
Age									
3	0.39	0.32	0.30	0.35	0.39	0.60	0.62	0.45	0.29
4	0.96	0.55	0.52	0.60	0.89	0.94	1.16	1.02	0.82
5	1.50	1.29	0.92	0.95	1.31	1.71	1.71	1.78	1.57
6	2.59	1.95	1.79	1.49	1.82	2.30	2.86	2.48	2.45
7	3.94	3.21	2.62	2.64	2.53	2.98	3.70	3.91	3.23
8	5.31	4.78	4.03	3.76	3.95	3.89	4.59	4.89	4.70
9	6.54	6.42	5.76	5.33	5.23	5.48	5.68	5.92	5.66
10	7.78	7.92	7.65	7.38	6.72	6.81	7.46	7.18	6.63
11	10.92	9.59	9.36	9.77	9.10	8.32	8.96	9.29	7.86
12+	13.43	14.47	13.28	13.45	13.23	11.58	11.20	11.33	10.21

Weight (kg) in stock at Jan. 1

Year	1995	1996	1997	1998	1999	2000	2001	2002	2003	2001-2003
Age										
3	0.26	0.26	0.28	0.29	0.23	0.23	0.35	0.27	0.26	0.29
4	0.72	0.64	0.69	0.66	0.62	0.58	0.64	0.74	0.64	0.67
5	1.40	1.17	1.18	1.19	1.12	1.18	1.20	1.21	1.36	1.26
6	2.27	1.99	1.89	1.83	1.76	1.87	2.02	2.02	1.99	2.01
7	3.29	3.10	3.00	2.82	2.53	2.75	2.95	3.20	3.01	3.05
8	4.23	4.28	4.37	4.34	3.65	3.81	3.97	4.41	4.41	4.26
9	6.00	5.30	5.70	5.94	5.10	5.22	5.06	5.57	5.79	5.47
10	7.20	7.13	6.90	7.43	6.54	6.93	6.47	6.79	7.12	6.79
11	8.50	8.39	9.19	8.87	7.89	8.63	8.26	8.42	8.60	8.43
12+	10.45	10.82	12.46	13.82	10.79	11.16	10.62	11.05	11.37	11.01

Table 3.33 (Continued)

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stocks cod.imm cod.mat
areas 0
1985
```

Proportion mature at age

Year	1985
Age	
3	0.000
4	0.000
5	0.327
6	0.303
7	0.508
8	0.664
9	0.445
10	1.000
11	1.000
12+	1.000

Proportion mature at age

Year	1986	1987	1988	1989	1990	1991	1992	1993	1994
Age									
3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5	0.080	0.058	0.009	0.006	0.033	0.084	0.089	0.103	0.069
6	0.545	0.230	0.162	0.061	0.113	0.214	0.337	0.274	0.283
7	0.700	0.747	0.430	0.332	0.275	0.389	0.541	0.621	0.512
8	0.900	0.897	0.887	0.651	0.628	0.610	0.724	0.796	0.831
9	0.938	0.983	0.972	0.961	0.873	0.872	0.872	0.906	0.929
10	0.926	0.982	0.997	0.994	0.993	0.974	0.973	0.967	0.966
11	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
12+	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

Proportion mature at age

Year	1995	1996	1997	1998	1999	2000	2001	2002	2003	2001-2003
Age										
3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0000
4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0000
5	0.050	0.026	0.028	0.031	0.023	0.029	0.035	0.031	0.044	0.0367
6	0.252	0.191	0.153	0.142	0.135	0.146	0.189	0.174	0.164	0.1757
7	0.535	0.499	0.455	0.388	0.340	0.359	0.428	0.460	0.426	0.4380
8	0.753	0.753	0.760	0.729	0.644	0.611	0.669	0.722	0.735	0.7087
9	0.948	0.901	0.908	0.919	0.899	0.854	0.851	0.880	0.906	0.8790
10	0.979	0.985	0.973	0.974	0.978	0.974	0.963	0.959	0.968	0.9633
11	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.0000
12+	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.0000

Table 3.33 (Continued)

```
; Gadget version 2.0.02 running on FLEXIDELL Wed Apr 30 15:25:23 2003
stocks cod.imm cod.mat
areas 0
fleets  rusnorfleet gillnetfleet
```

Model catch in numbers (thousands) at age

Year	1985	1986
Age		
1	0	0
2	0	0
3	26480	29926
4	43963	66614
5	26756	69478
6	17364	24157
7	10483	11679
8	3793	5175
9	1934	1396
10	1366	596
11	250	333
12+	190	103
Total	132578	209455

Model catch in numbers (thousands) at age

Year	1987	1988	1989	1990	1991	1992	1993	1994
Age								
1	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0
3	10277	7394	4811	3382	11179	19389	18562	12133
4	110603	23145	16639	7992	12125	29259	52459	65179
5	97165	128946	29737	13926	12902	20767	43603	86120
6	67423	47657	89244	14296	15525	13220	24081	46862
7	16579	23102	18242	26971	12847	13600	12367	21822
8	6545	4551	7343	3726	21316	10250	11958	9753
9	2420	1562	1276	1197	2554	15430	8536	8891
10	584	514	382	155	733	1599	12115	6072
11	228	116	111	35	86	419	1166	8085
12+	153	70	37	11	23	58	335	949
Total	311975	237057	167821	71691	89290	123989	185181	265865

Model catch in numbers (thousands) at age

Year	1995	1996	1997	1998	1999	2000	2001	2002
Age								
1	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0
3	7469	6372	17106	25061	11381	8806	7310	3341
4	39902	25049	31824	64439	73771	32042	31473	22336
5	101506	68832	56882	47460	82208	79693	49800	49551
6	74116	88790	77666	43355	29391	44716	58732	41573
7	31990	45162	60206	35965	17398	10465	22470	33145
8	13716	16373	24277	20788	10856	4987	4327	10624
9	5684	6246	7578	7005	5113	2634	1757	1779
10	4986	2192	2595	1928	1478	1046	769	634
11	3256	1769	788	600	366	266	255	242
12+	4682	2573	1410	438	177	89	77	93
Total	287307	263357	280330	247039	232139	184742	176970	163318

Table 3.33 (Continued)

```
; Gadget version 2.0.02 running on FLEXIDELL Wed Apr 30 15:25:23 2003
stocks cod.imm cod.mat
areas 0
fleets  rusnorfleet gillnetfleet

Observed catch in numbers (thousands) at age
Year        1985    1986
Age
  1            0       0
  2            0       0
  3        19823   24596
  4        41151   59086
  5        24948   71516
  6        16753   23479
  7        10561   10438
  8         3508    3797
  9         1432     888
 10          713     688
 11          134     519
 12+          38     134

Total     119061  195140


Observed catch in numbers (thousands) at age
Year        1987    1988    1989    1990    1991    1992    1993    1994
Age
  1            0       0       0       0       0       0       0       0
  2            0       0       0       0       0       0       0       0
  3        10450    9317    4902    1315    3493   14276    7680    5558
  4       117698   19548   15828    5807    8514   22802   37098   49632
  5        84253  117460   28904    9870   12308   18685   54328   79314
  6        57239   48949   66506   13786   15174   17113   28245   50230
  7        13074   19899   24993   23668   14189   12899   11520   28770
  8         3568    3151    5186    5151   18096    9543    7441    7676
  9          867    1163     789     605    2701   12820    5183    4523
 10          449     381     275     125     264    1761    9806    2498
 11          183     107      42      47      37     192    1296    5457
 12+         204      68      14      12      12      46     249     750

Total     287984  220041  147438   60385   74787  110135  162845  234409


Observed catch in numbers (thousands) at age
Year        1995    1996    1997    1998    1999    2000    2001    2002
Age
  1            0       0       0       0       0       0       0       0
  2            0       0       0       0       0       0       0       0
  3         4741    7034   10454   28160    8084    4266    4348    1588
  4        35100   25574   32828   78268   72593   27993   30719   20863
  5        95618   70969   63737   42650   81439   76991   53307   50536
  6        79441   87253   75825   35602   27616   40926   53506   45840
  7        28290   46081   60395   29462   13875   11508   20104   31170
  8         6786    8729   22648   23799   14370    6318    4707    9061
  9         2495    1791    3191    6133    7967    4563    1622    1371
 10         1433     808     814     883    1812    1517    1063     409
 11          808     357     352     174     210     261     275     149
 12+        1664     174     146      58      41      41      49      95

Total     256374  248771  270388  245188  228007  174384  169700  161082
```

Table 3.33 (Continued)

```
; Gadget version 2.0.02 running on FLEXIDELL Wed Apr 30 15:25:23 2003
stocks cod.imm cod.mat
areas 0
fleets  rusnorfleet gillnetfleet
```

Model catch in biomass (tons) at age

Year	1985	1986
Age		
1	0	0
2	0	0
3	24890	17716
4	57433	88382
5	59750	124718
6	62156	69413
7	51639	49682
8	24380	28907
9	15070	9478
10	14960	4748
11	3509	3645
12+	2636	1369
Total	316423	398057
Total+	356218	449765

(+ Also includes: thirdcountries overfishing)

Model catch in biomass (tons) at age

Year	1987	1988	1989	1990	1991	1992	1993	1994
Age								
1	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0
3	4744	3815	2974	2803	12255	18738	13608	7594
4	97100	20333	16424	11086	17667	48859	73427	77999
5	155422	171539	40580	25306	28692	45023	94502	163166
6	147286	103192	166960	32985	44239	43757	67286	129820
7	57806	68267	54462	82220	46065	57249	51811	77701
8	33960	20104	29917	16968	97894	52942	62059	50600
9	16892	9733	7177	6956	16079	97510	53095	55915
10	5075	4203	2865	1137	5604	13045	90509	45062
11	2406	1157	1066	334	793	4042	11100	71663
12+	2469	998	472	138	280	689	3840	11038
Total	523160	403340	322896	179932	269567	381854	521236	690558
Total+	588529	451418	370953	232191	347244	550387	640895	860876

(+ Also includes: thirdcountries overfishing)

Model catch in biomass (tons) at age

Year	1995	1996	1997	1998	1999	2000	2001	2002
Age								
1	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0
3	4569	3844	9607	14452	5804	4660	4483	1741
4	43219	26755	34457	66612	77190	32695	32780	25145
5	175870	109868	90598	75412	127910	130274	80983	79607
6	198167	217647	177606	95719	65274	103607	144444	98515
7	123762	166574	207620	114405	53476	34012	77990	118428
8	67105	82828	119124	97698	47721	21892	20114	51717
9	38438	38900	47897	44245	31621	15564	10348	10944
10	39821	18372	19637	15069	11809	8131	5750	4748
11	30246	17430	7813	5541	3561	2569	2425	2242
12+	52410	32687	18577	6090	2366	1100	928	1128
Total	773606	714904	732937	535243	426732	354502	380245	394214
Total+	910867	825742	823603	597785	478257	412978	436599	453243

(+ Also includes: thirdcountries overfishing)

Table 3.33 (Continued)

; Gadget version 2.0.02 running on FLEXIDELL Wed Apr 30 15:25:23 2003
stocks cod.imm cod.mat
areas 0
fleets rusnorfleet gillnetfleet

Observed catch in biomass (tons) at age

Year	1985	1986
Age		
1	0	0
2	0	0
3	17946	15200
4	53607	73787
5	48920	133381
6	53388	65666
7	48902	46521
8	21186	21949
9	10978	5997
10	6995	5232
11	1581	5068
12+	547	1422
Total	264050	374222
Total+	301279	424322

(+ Also includes: thirdcountries overfishing)

Observed catch in biomass (tons) at age

Year	1987	1988	1989	1990	1991	1992	1993	1994
Age								
1	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0
3	5086	4968	3624	1090	3597	16403	5869	4605
4	101978	16313	14598	7070	12153	35478	53248	62856
5	128842	151174	36498	15879	25920	41467	112199	156455
6	133719	108829	123969	29412	42533	53720	76633	144955
7	46379	69956	71372	74450	50742	55633	46655	98004
8	21314	16648	23732	23544	83489	49966	40484	40920
9	7454	9215	5923	4394	16170	78925	33172	31231
10	4318	3431	2496	1229	2314	13899	69911	19171
11	2247	1195	477	632	437	1976	10359	44036
12+	2810	947	168	199	192	548	2563	7283
Total	454146	382675	282856	157898	237546	348015	451093	609515
Total+	511736	428270	323683	207083	312608	514345	566914	770657

(+ Also includes: thirdcountries overfishing)

Observed catch in biomass (tons) at age

Year	1995	1996	1997	1998	1999	2000	2001	2002
Age								
1	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0
3	3802	5644	7034	17085	5037	2354	2870	1105
4	42832	27948	32452	76328	72745	27998	31511	22854
5	165865	112514	92423	65520	120436	120413	84376	77875
6	202254	210237	161292	79064	62387	93671	132569	106462
7	107761	175919	201478	94788	44052	37826	70026	111213
8	34062	50900	119086	114831	62122	28120	22413	43796
9	15421	12384	23228	42175	48170	26052	9745	8650
10	11505	6598	6372	8289	12502	11409	7930	3139
11	7145	3449	3012	1869	2330	2012	2400	1344
12+	15370	1874	1650	914	592	506	537	754
Total	606017	607465	648026	500863	430373	350362	364376	377190
Total+	730289	710383	732930	561249	481619	405588	418744	431731

(+ Also includes: thirdcountries overfishing)

Table 3.34 Fleksibest equivalent to standard prediction input table (3.28)

Year: 2003								
Age	Stock size	Natural Mortality	Maturity ogive	Prop.Of F bef.spaw.	Prop.Of M bef.spaw.	Weight in stock	Exploit pattern	Weight in catch
3	906317	0.3275	0.0000	0.0000	0.0000	0.2600	0.0144	0.5400
4	252196	0.2106	0.0000	0.0000	0.0000	0.6400	0.0722	0.9900
5	217185	0.2000	0.0440	0.0000	0.0000	1.3600	0.2415	1.7000
6	214599	0.2000	0.1640	0.0000	0.0000	1.9900	0.3475	2.3200
7	100499	0.2000	0.4260	0.0000	0.0000	3.0100	0.4486	3.4000
8	56590	0.2000	0.7340	0.0000	0.0000	4.4100	0.5414	4.9300
9	14518	0.2000	0.9060	0.0000	0.0000	5.7900	0.6143	6.3700
10	2066	0.2000	0.9680	0.0000	0.0000	7.1200	0.6660	7.7400
11	644	0.2000	1.0000	0.0000	0.0000	8.6000	0.7062	9.2200
12+	299	0.2000	1.0000	0.0000	0.0000	11.3700	0.7479	11.9300
Unit	Thousands	-	-	-	-	Kilograms	-	Kilograms

Year: 2004								
Age	Stock size	Natural Mortality	Maturity ogive	Prop.Of F bef.spaw.	Prop.Of M bef.spaw.	Weight in stock	Exploit pattern	Weight in catch
3	307870	0.3485	0.0000	0.0000	0.0000	0.2600	0.0144	0.5400
4	643869	0.2165	0.0000	0.0000	0.0000	0.6400	0.0736	1.0100
5	184496	0.2000	0.0240	0.0000	0.0000	1.1800	0.1997	1.5400
6	138403	0.2000	0.2010	0.0000	0.0000	2.1500	0.3694	2.4700
7	123884	0.2000	0.4110	0.0000	0.0000	2.9500	0.4444	3.3400
8	52522	0.2000	0.7010	0.0000	0.0000	4.2100	0.5292	4.7100
9	26957	0.2000	0.9080	0.0000	0.0000	5.8200	0.6146	6.4100
10	6435	0.2000	0.9780	0.0000	0.0000	7.3600	0.6744	7.9800
11	864	0.2000	1.0000	0.0000	0.0000	8.8800	0.7129	9.5000
12+	376	0.2000	1.0000	0.0000	0.0000	11.4500	0.7490	12.0000
Unit	Thousands	-	-	-	-	Kilograms	-	Kilograms

Year: 2005								
Age	Stock size	Natural Mortality	Maturity ogive	Prop.Of F bef.spaw.	Prop.Of M bef.spaw.	Weight in stock	Exploit pattern	Weight in catch
3	663720	0.3567	0.0000	0.0000	0.0000	0.2600	0.0144	0.5400
4	214179	0.2206	0.0000	0.0000	0.0000	0.6400	0.0741	1.0100
5	467842	0.2000	0.0250	0.0000	0.0000	1.1800	0.2005	1.5500
6	121850	0.2000	0.1450	0.0000	0.0000	1.9100	0.3370	2.2300
7	78235	0.2000	0.4660	0.0000	0.0000	3.1600	0.4609	3.5500
8	65021	0.2000	0.6890	0.0000	0.0000	4.1400	0.5252	4.6400
9	25327	0.2000	0.8890	0.0000	0.0000	5.5900	0.6034	6.1800
10	11945	0.2000	0.9770	0.0000	0.0000	7.3900	0.6740	8.0100
11	2675	0.2000	1.0000	0.0000	0.0000	9.1600	0.7189	9.7700
12+	492	0.2000	1.0000	0.0000	0.0000	11.6700	0.7523	12.2100
Unit	Thousands	-	-	-	-	Kilograms	-	Kilograms

Table 3.35 Management options table from Fleksibest.

Year: 2003					Year: 2004					Year: 2005	
F Factor	Reference F	Stock biomass	Sp.stock biomass	Catch in weight	F Factor	Reference F	Stock biomass	Sp.stock biomass	Catch in weight	Stock biomass	Sp.stock biomass
0.7997	0.4765	1782648	565030	505535	0.0000	0.0000	1811384	637748	0	2481543	1081547
.	.	.	.	.	0.0500	0.0297	.	637748	40897	2434675	1047328
.	.	.	.	.	0.1000	0.0595	.	637748	80545	2389196	1014271
.	.	.	.	.	0.1500	0.0892	.	637748	118988	2345059	982334
.	.	.	.	.	0.2000	0.1188	.	637748	156266	2302220	951476
.	.	.	.	.	0.2500	0.1484	.	637748	192419	2260633	921660
.	.	.	.	.	0.3000	0.1781	.	637748	227484	2220259	892848
.	.	.	.	.	0.3500	0.2076	.	637748	261499	2181056	865004
.	.	.	.	.	0.4000	0.2371	.	637748	294499	2142986	838093
.	.	.	.	.	0.4500	0.2666	.	637748	326519	2106012	812084
.	.	.	.	.	0.5000	0.2961	.	637748	357591	2070095	786943
.	.	.	.	.	0.5500	0.3255	.	637748	387747	2035204	762640
.	.	.	.	.	0.6000	0.3548	.	637748	417019	2001304	739146
.	.	.	.	.	0.6500	0.3842	.	637748	445433	1968362	716432
.	.	.	.	.	0.7000	0.4135	.	637748	473019	1936347	694471
.	.	.	.	.	0.7500	0.4428	.	637748	499806	1905230	673236
.	.	.	.	.	0.8000	0.4721	.	637748	525820	1874980	652701
.	.	.	.	.	0.8500	0.5013	.	637748	551085	1845571	632843
.	.	.	.	.	0.9000	0.5305	.	637748	575628	1816974	613637
.	.	.	.	.	0.9500	0.5596	.	637748	599470	1789164	595061
.	.	.	.	.	1.0000	0.5887	.	637748	622636	1762115	577094
.	.	.	.	.	1.0500	0.6178	.	637748	645146	1735804	559713
.	.	.	.	.	1.1000	0.6469	.	637748	667024	1710206	542898
.	.	.	.	.	1.1500	0.6759	.	637748	688289	1685300	526631
.	.	.	.	.	1.2000	0.7049	.	637748	708960	1661063	510891
.	.	.	.	.	1.2500	0.7339	.	637748	729058	1637473	495661
.	.	.	.	.	1.3000	0.7627	.	637748	748600	1614512	480924
.	.	.	.	.	1.3500	0.7917	.	637748	767605	1592158	466662
.	.	.	.	.	1.4000	0.8205	.	637748	786090	1570393	452859
.	.	.	.	.	1.4500	0.8493	.	637748	804070	1549199	439499
.	.	.	.	.	1.5000	0.8781	.	637748	821563	1528557	426568

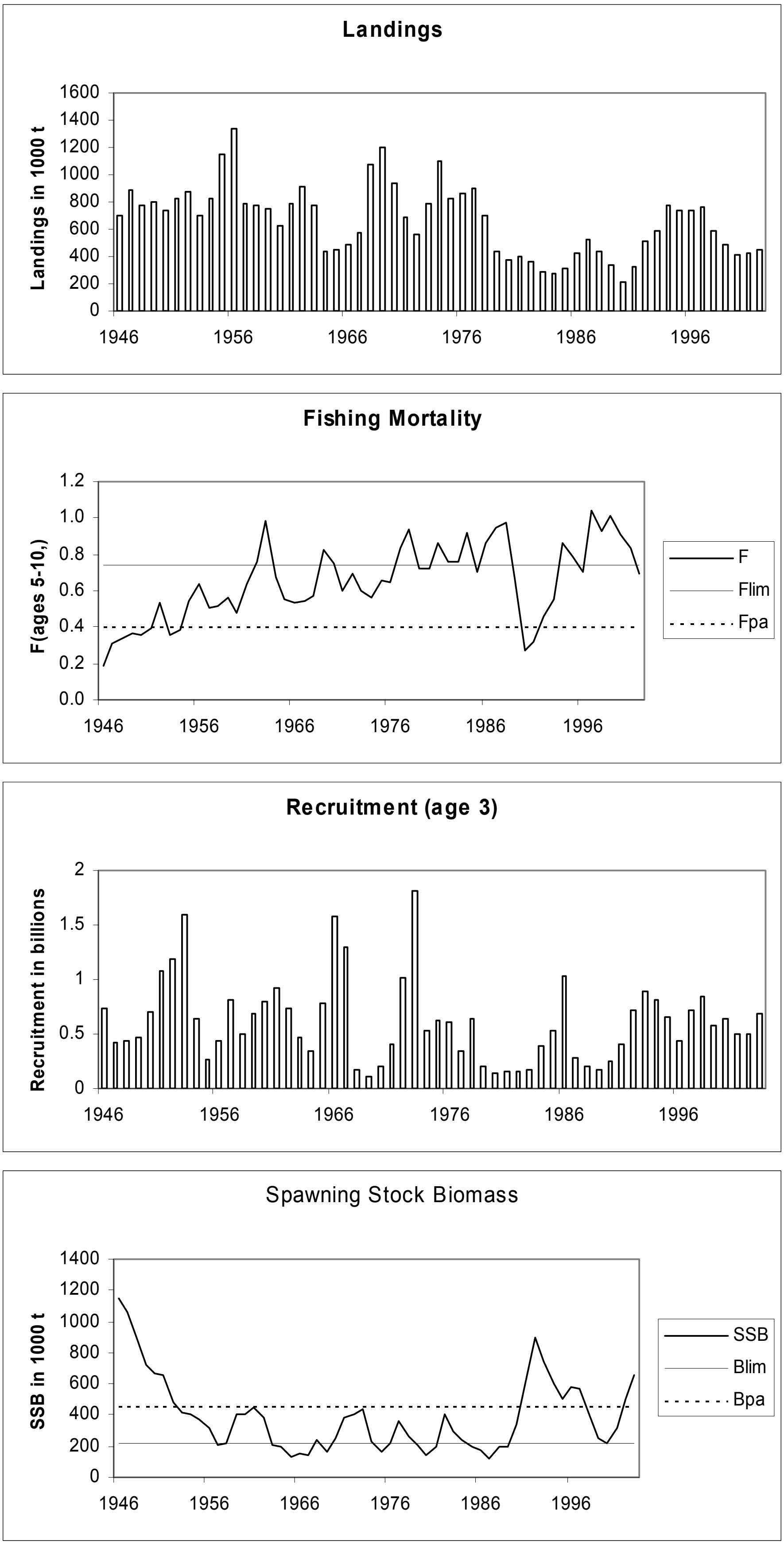
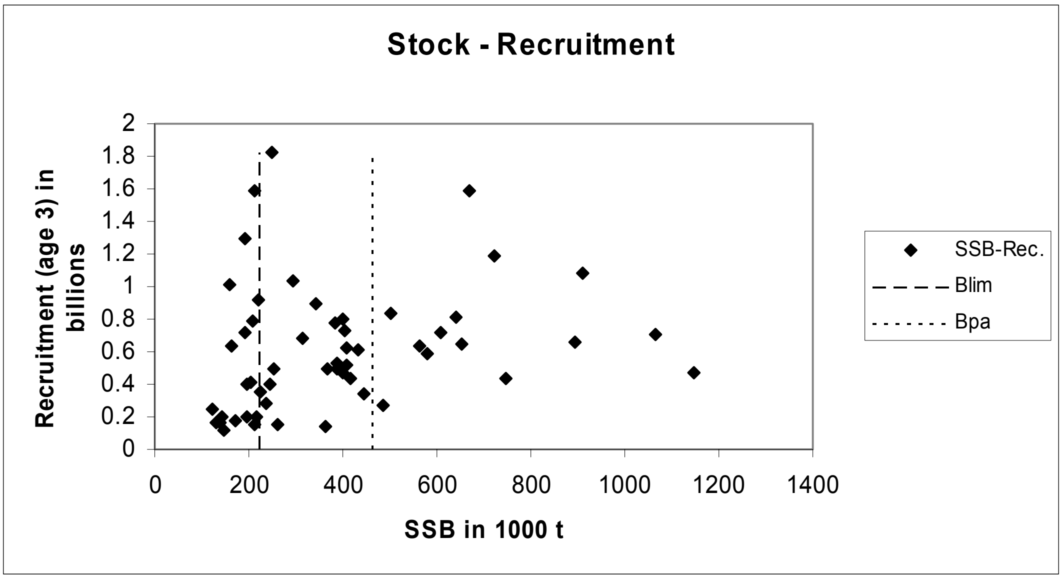
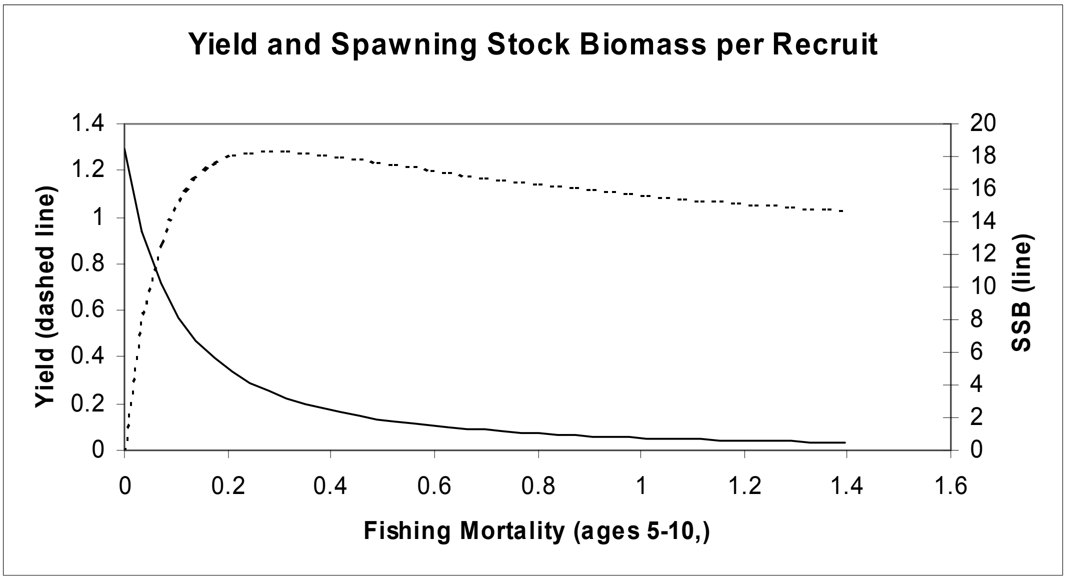


Figure 3.1 ICES Standard plots for Northeast Arctic cod (Subareas I and II).





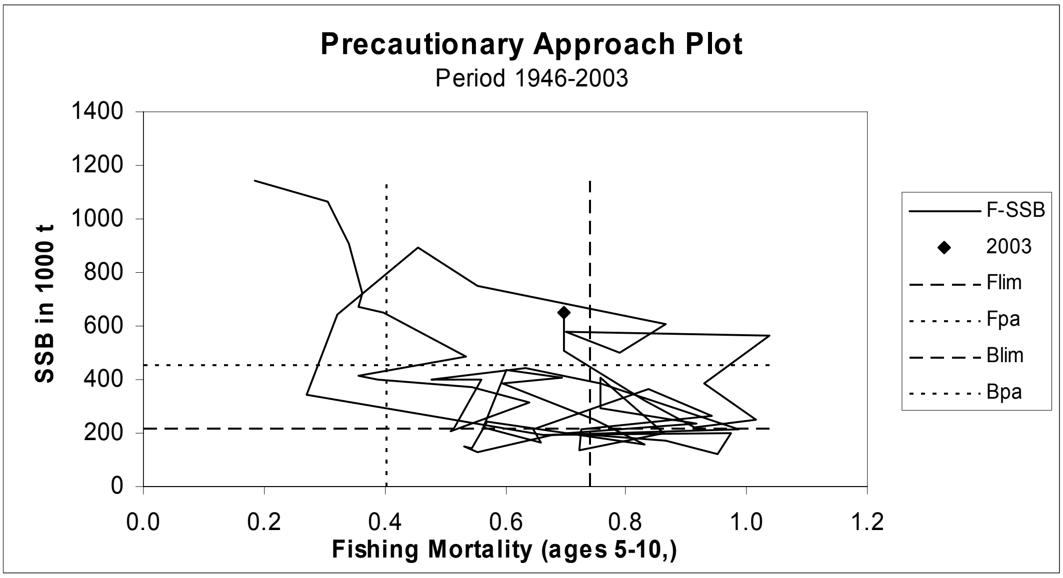


Figure 3.1 Continued ICES Standard plots for Northeast Arctic cod (Subareas I and II).

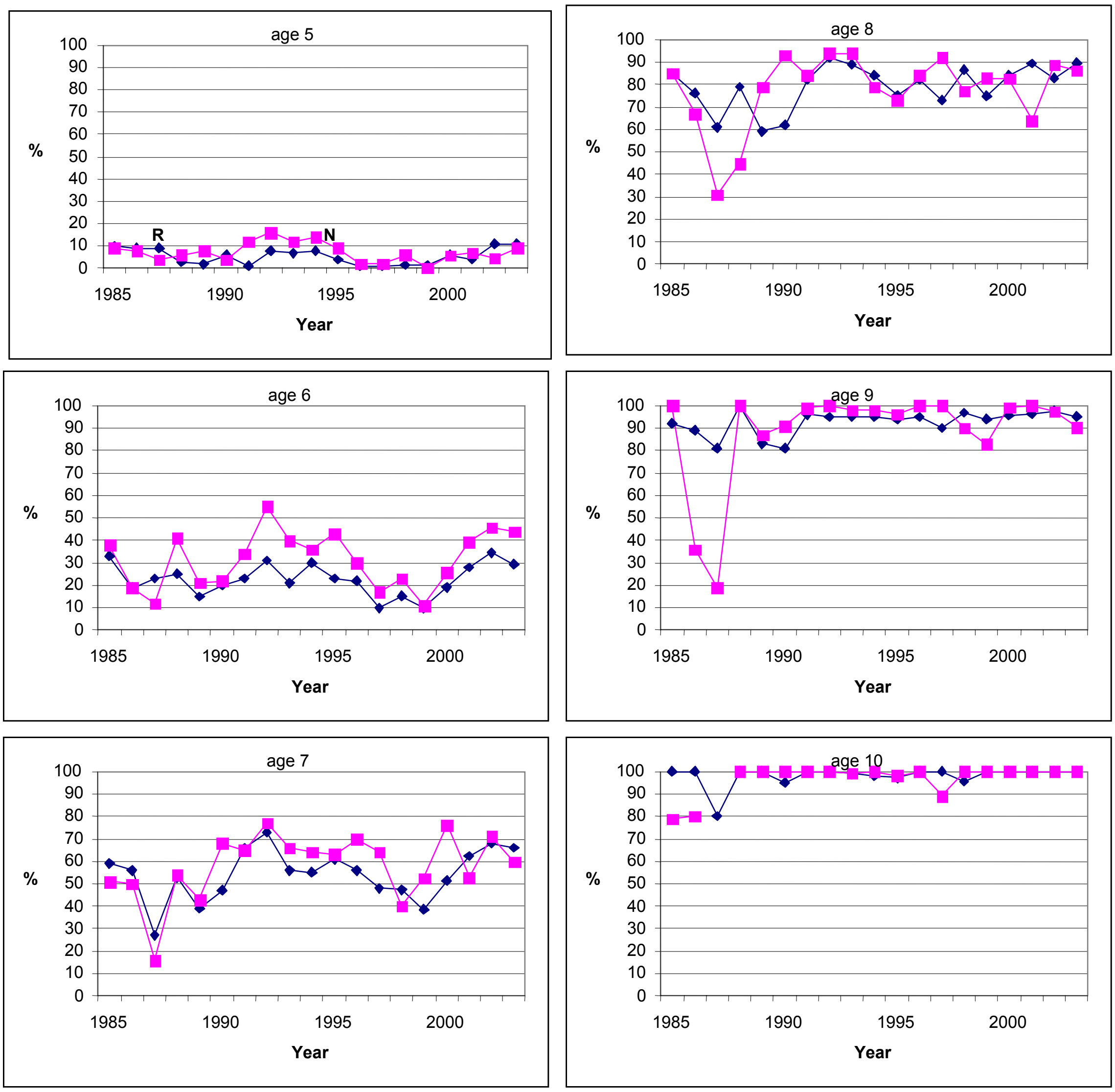


Figure 3.2 Maturity ogives of cod from Norwegian (squares) and Russian (diamonds) sources for cod age 5 to 10.

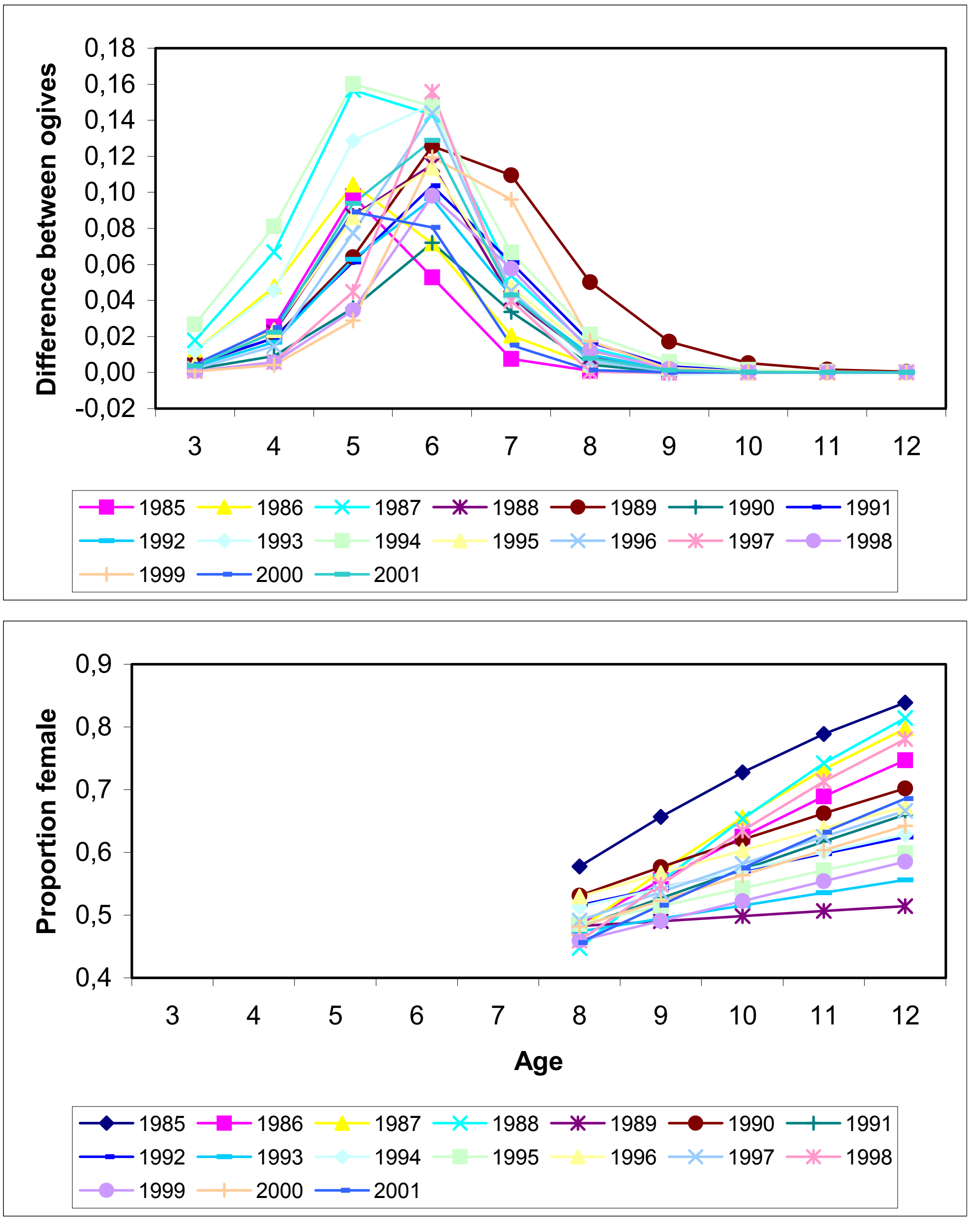


Figure 3.3 The difference between the proportion mature at age estimated for males and females combined and the proportion mature at age estimated for female only plotted by age for the years 1985 to 2001; and b) the proportion of females by age for years 1985 to 2001.

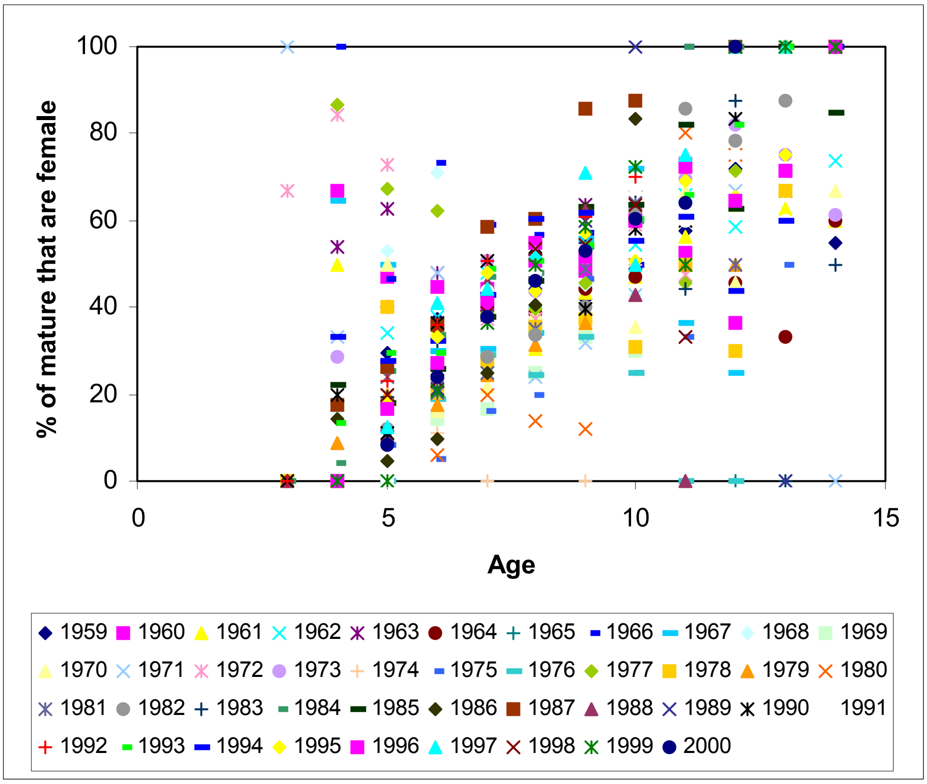


Figure 3.4 The percentage of mature cod that are female plotted by age for 1959 to 2000.

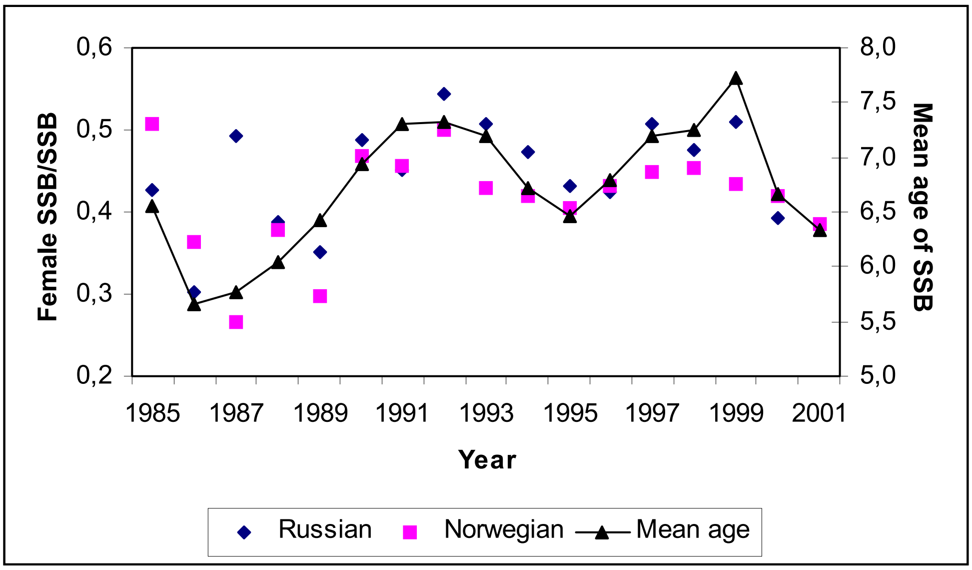


Figure 3.5 Temporal trends in the proportion of female-only SSB in the SSB as estimated for Russian (diamonds) and Norwegian (squares) data. The mean age of the mature stock is also shown (line and triangles).

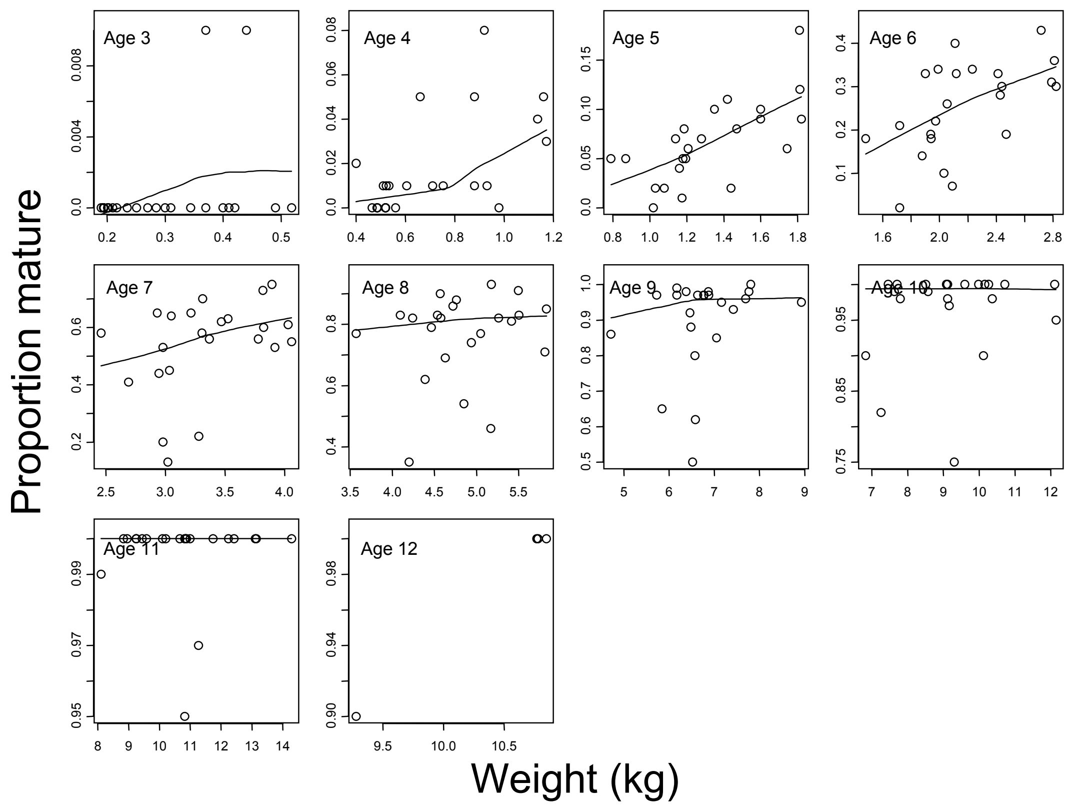


Figure 3.6 Scatterplot matrix showing the relationship between weight-at-age and proportion mature-at-age for years 1980 to 2002 and age-classes 3-12. LOESS smoothers (span=1) are indicated by the solid line.

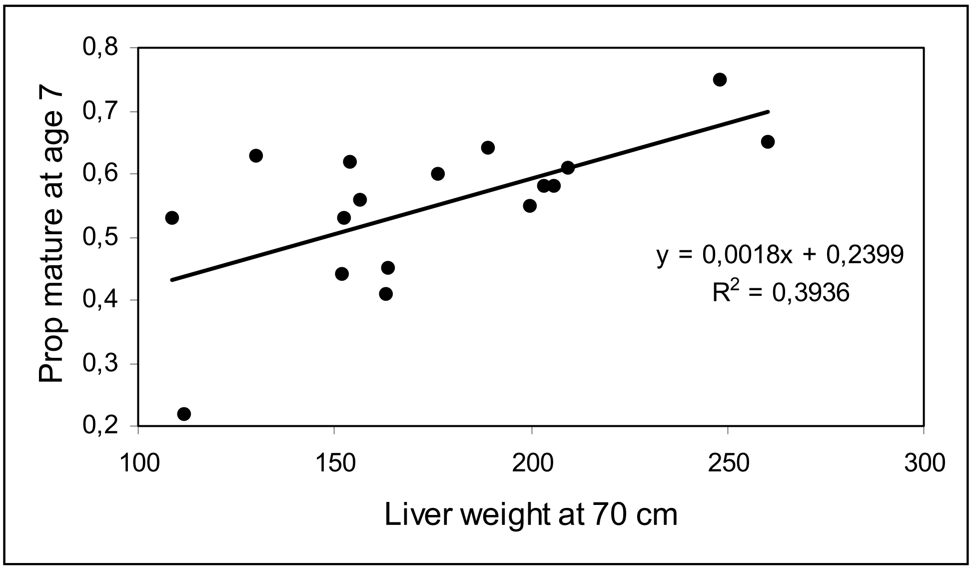


Figure 3.7 The bivariate relationship between liver weight(g) of a 70 cm cod and the proportion mature at age 7 for the years 1984 to 2001. Mean length of age 7 cod during this time period varied between a minimum of 66.3 cm in 1990 and a maximum of 78.6 cm in 1993 thus including the 70 cm value used to estimate liver weights (from the Russian liver condition database).

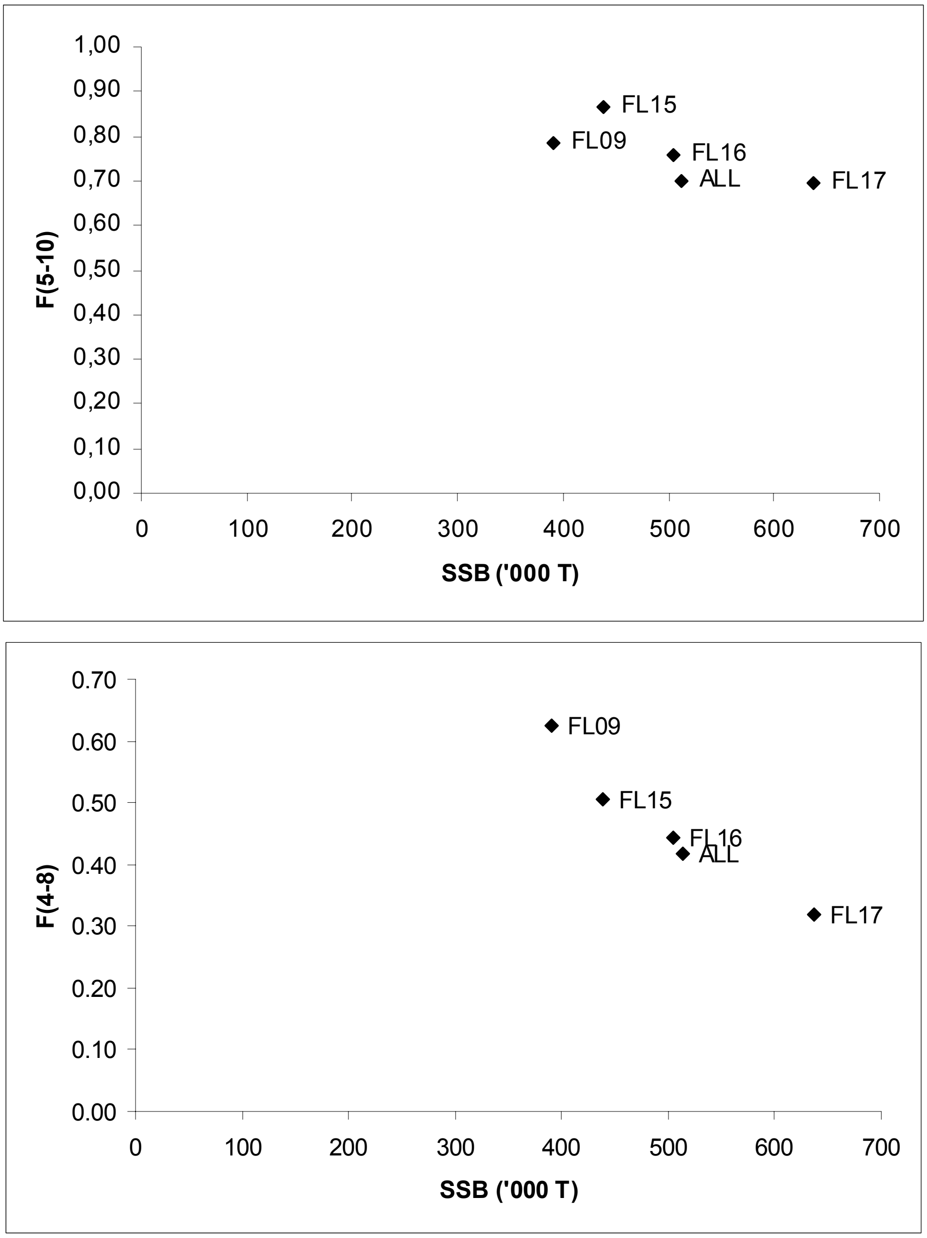
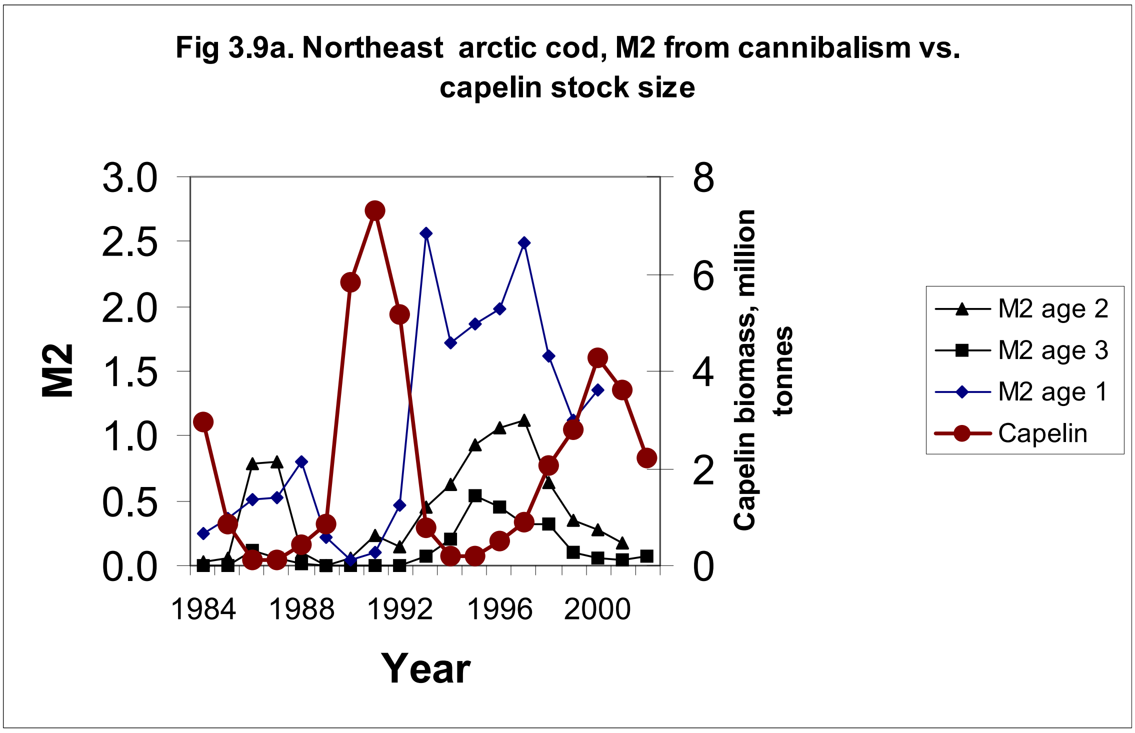


Figure 3.8 Single fleet tuning results.



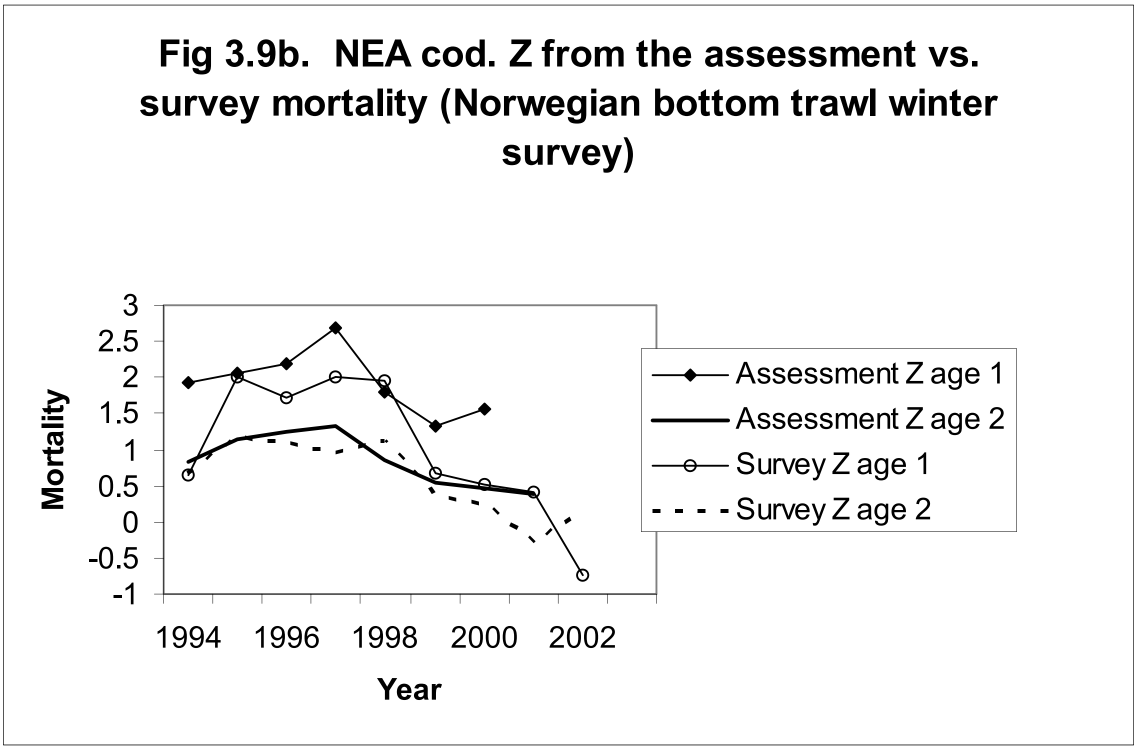


Figure 3.9 Temporal trends in mortality.

Figure 3.10a. NEA Cod, retrospective F_{5-10}

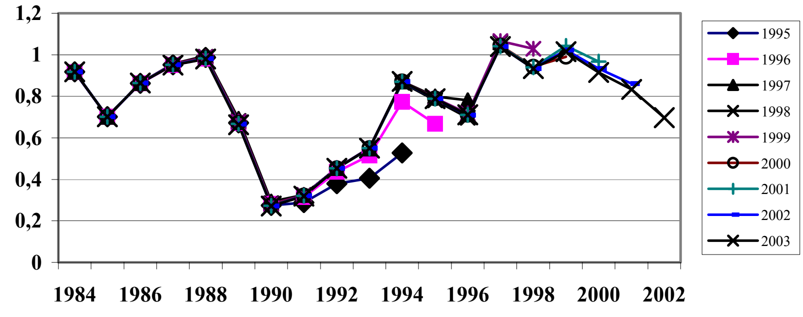


Figure 3.10b. NEA Cod, retrospective recruitement age 3

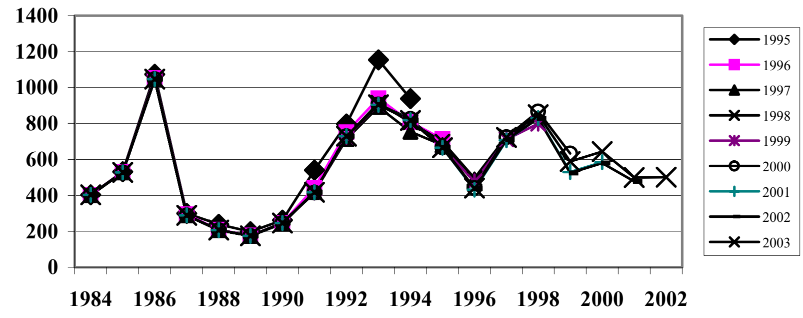


Figure 3.10c NEA Cod, retrospective SSB

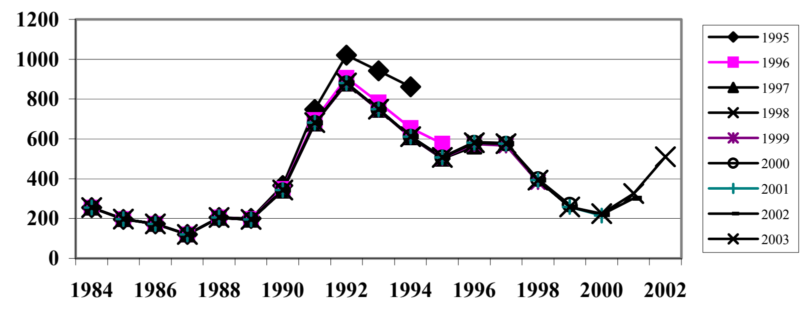


Figure 3.10d NEA Cod, retrospective F_{4-8}

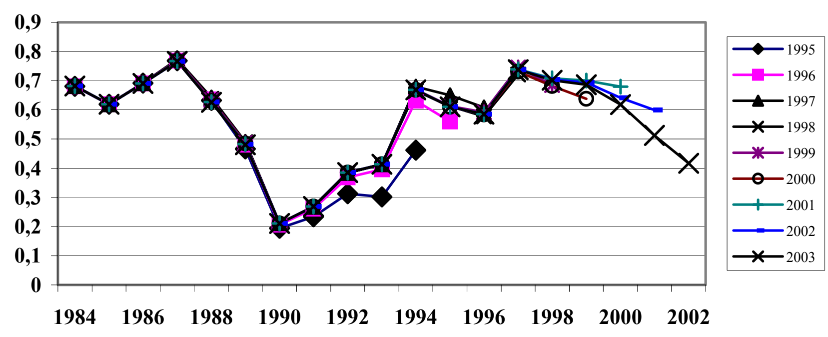


Figure 3.10 Retrospective plots.

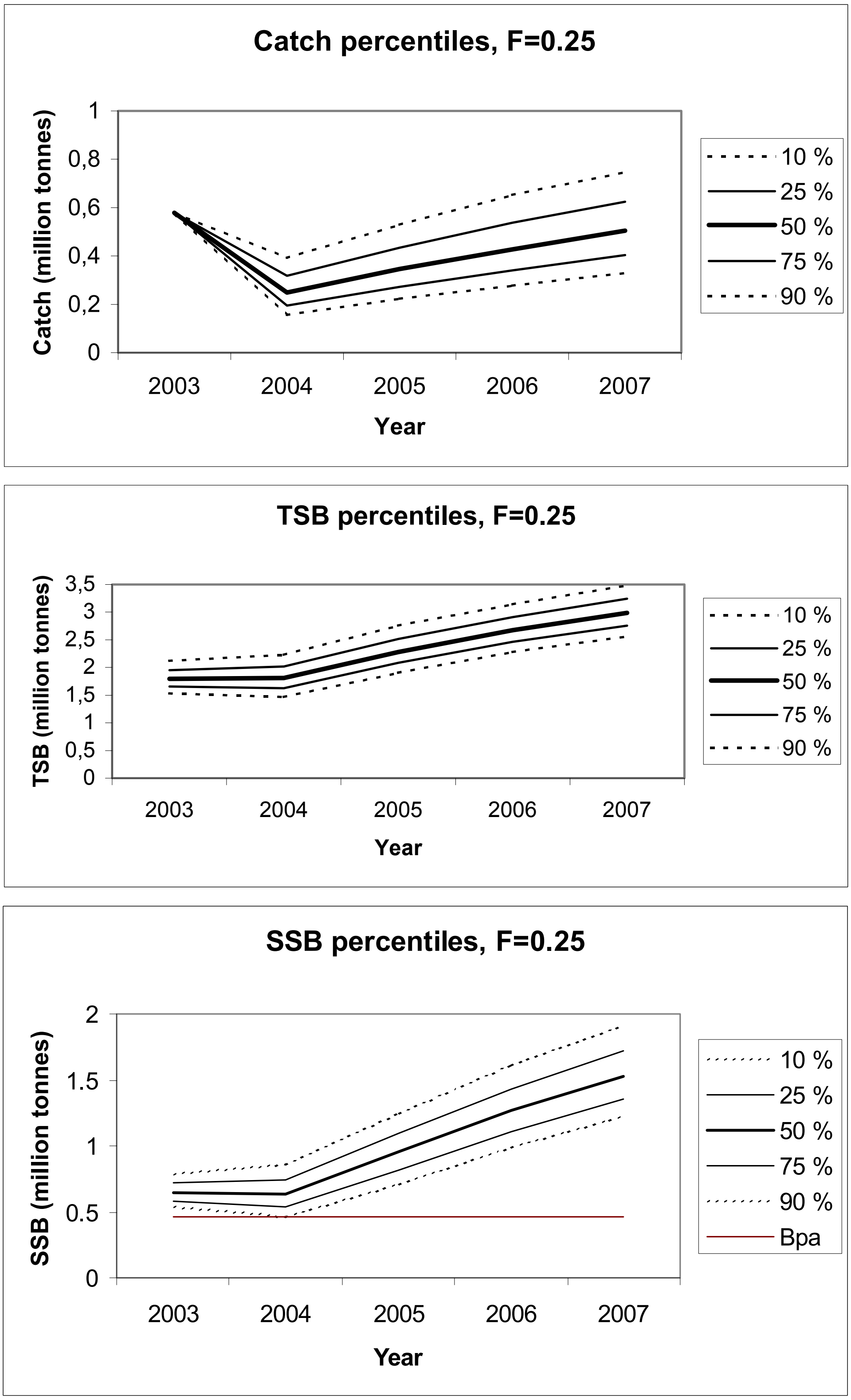


Figure 3.11a Medium-term projections, assuming F=0.25.

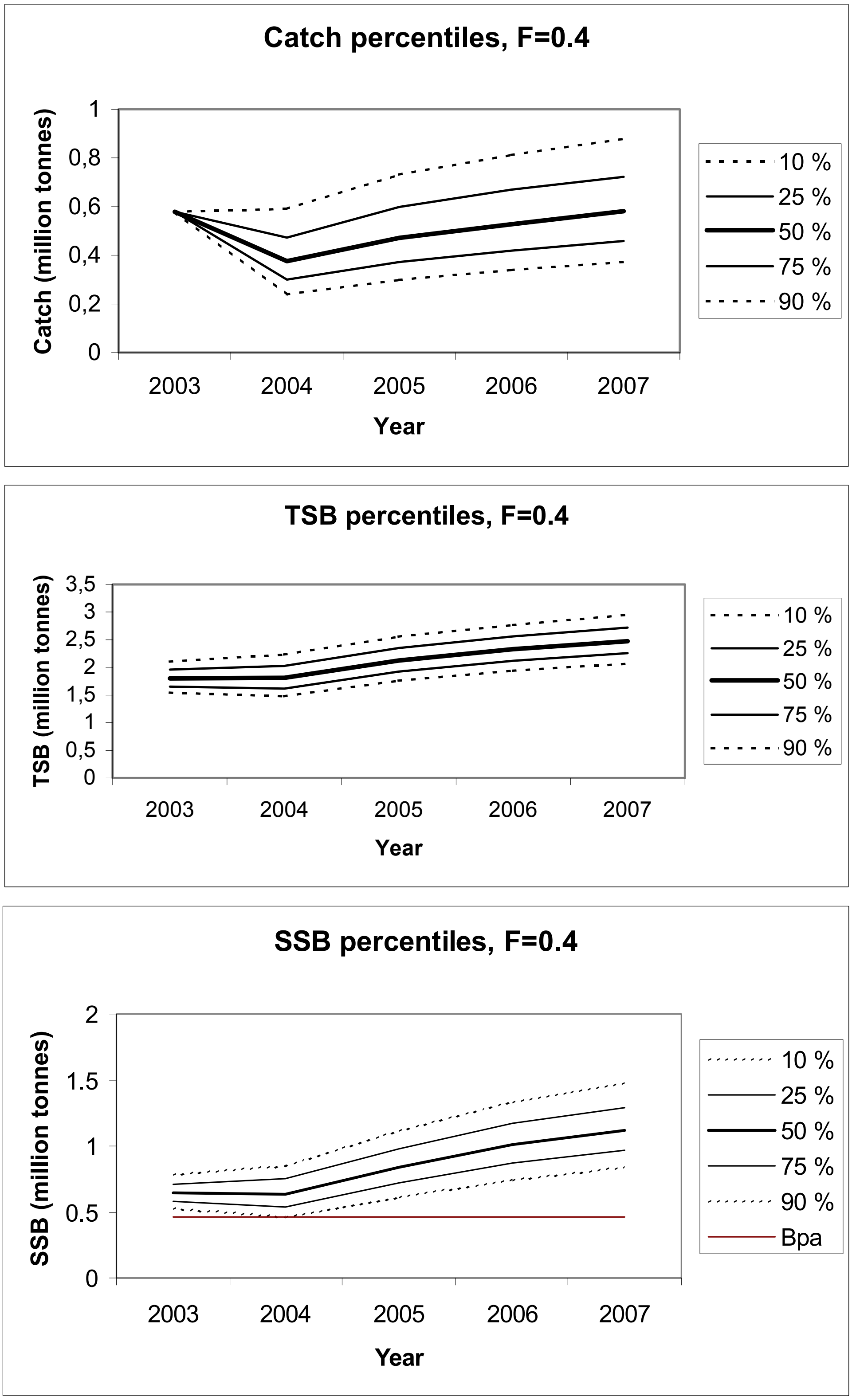


Figure 3.11b Medium-term projections, assuming F=0.40.

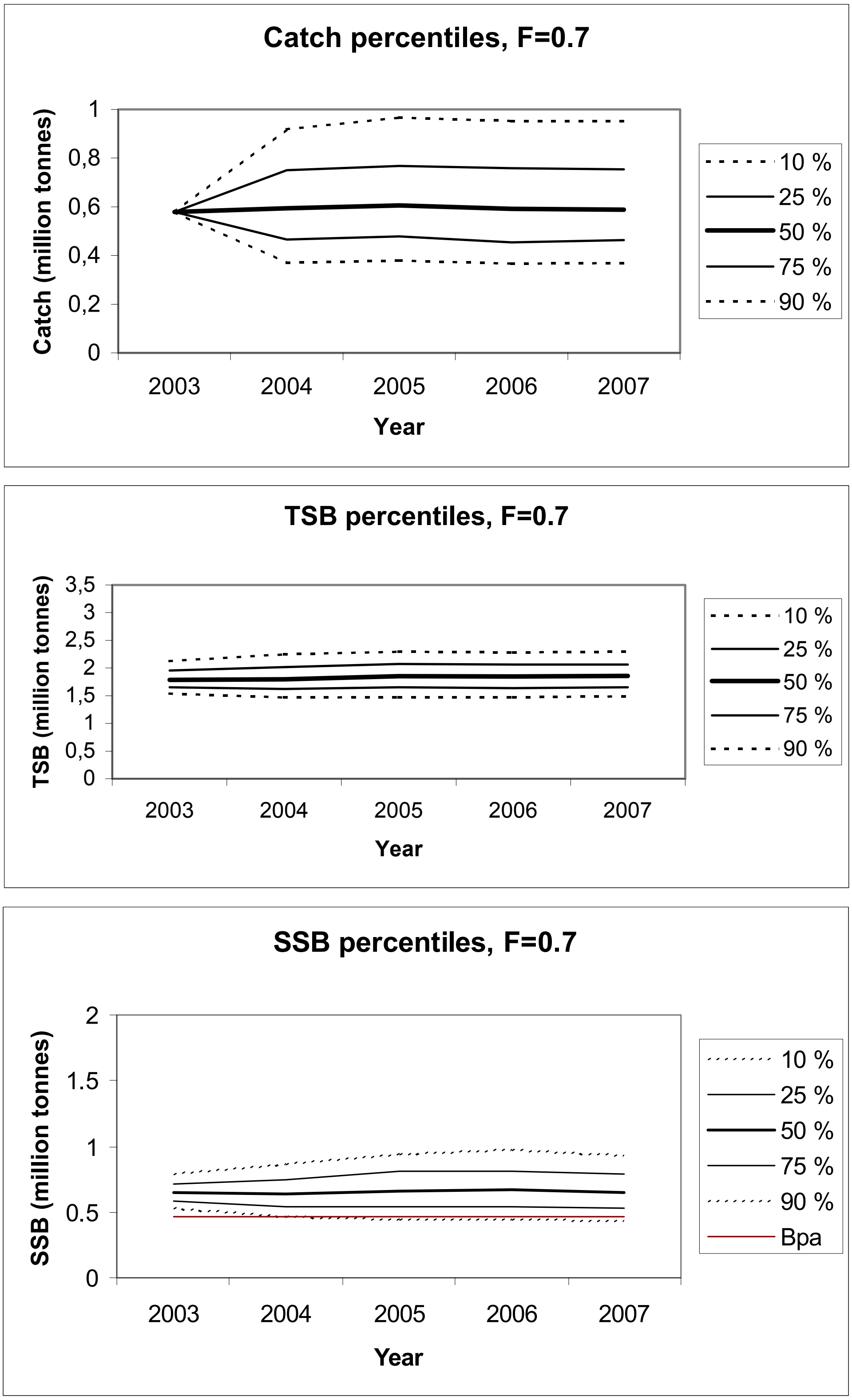


Figure 3.11c Medium-term projections, assuming F=0.70.

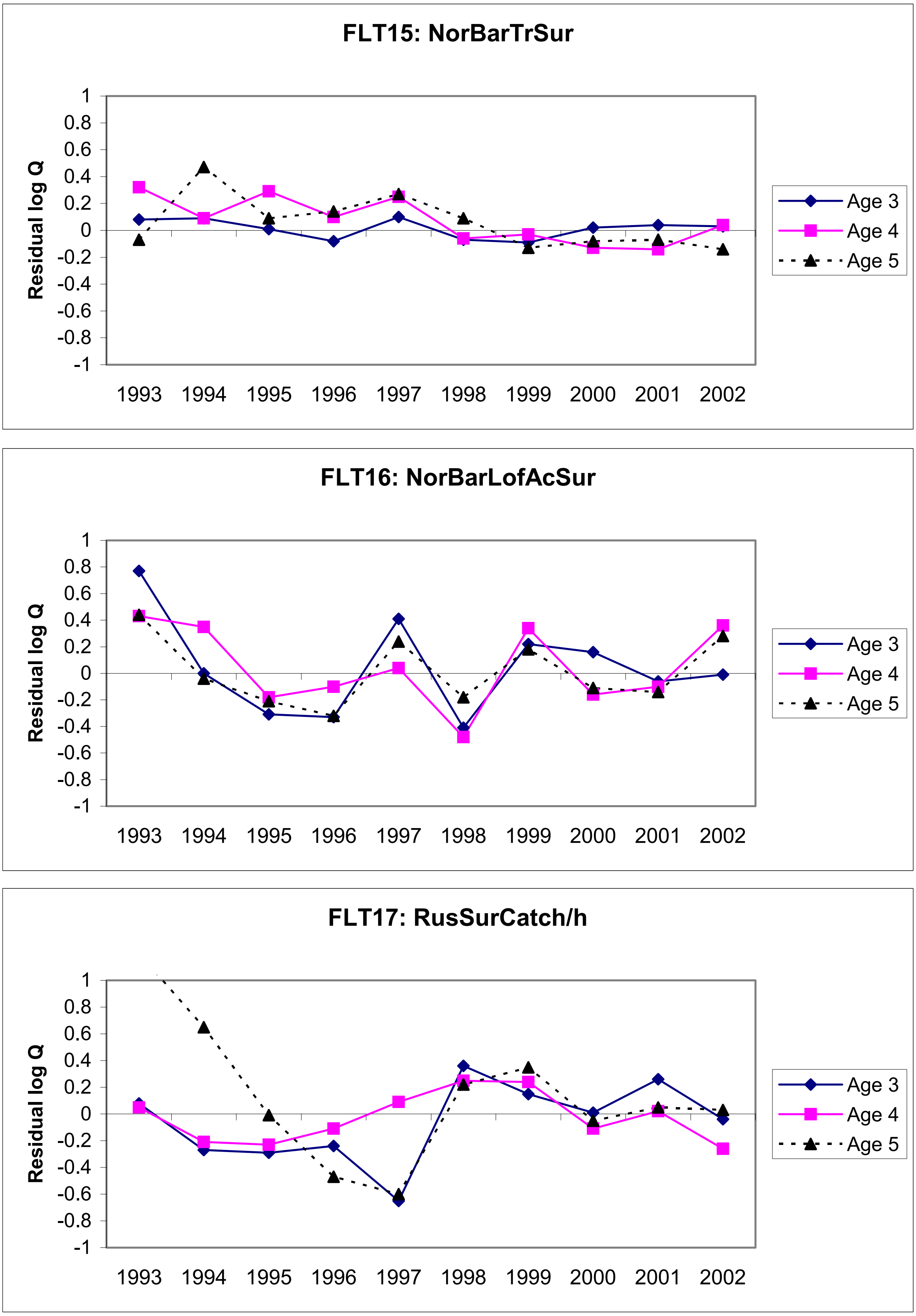


Figure 3.12 North-East Arctic cod. Residual log catchability by fleet and age from the XSA output in the 2003 assessment.

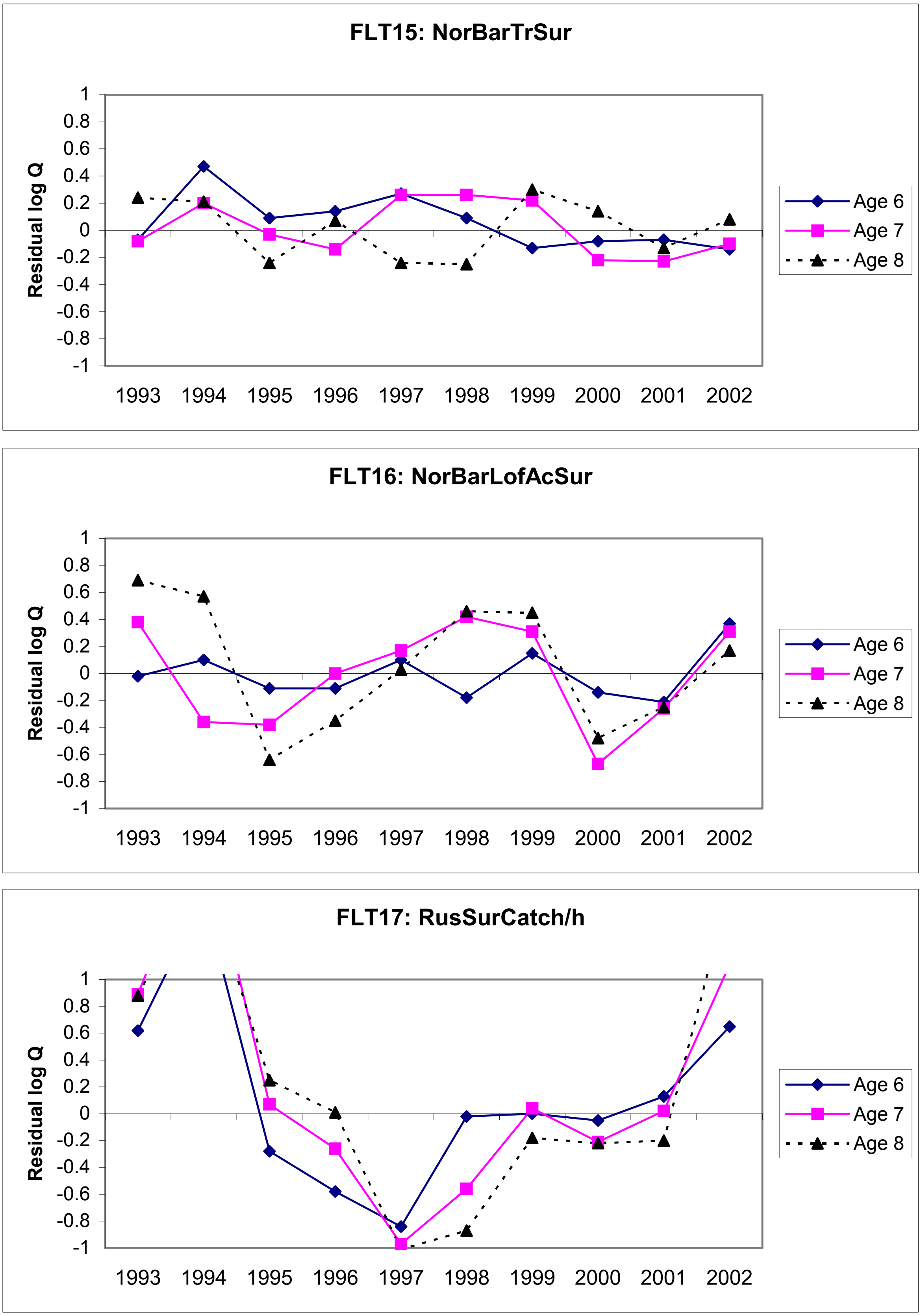


Figure 3.13 North-East Arctic cod. Residual log catchability by fleet and age from the XSA output in the 2003 assessment.

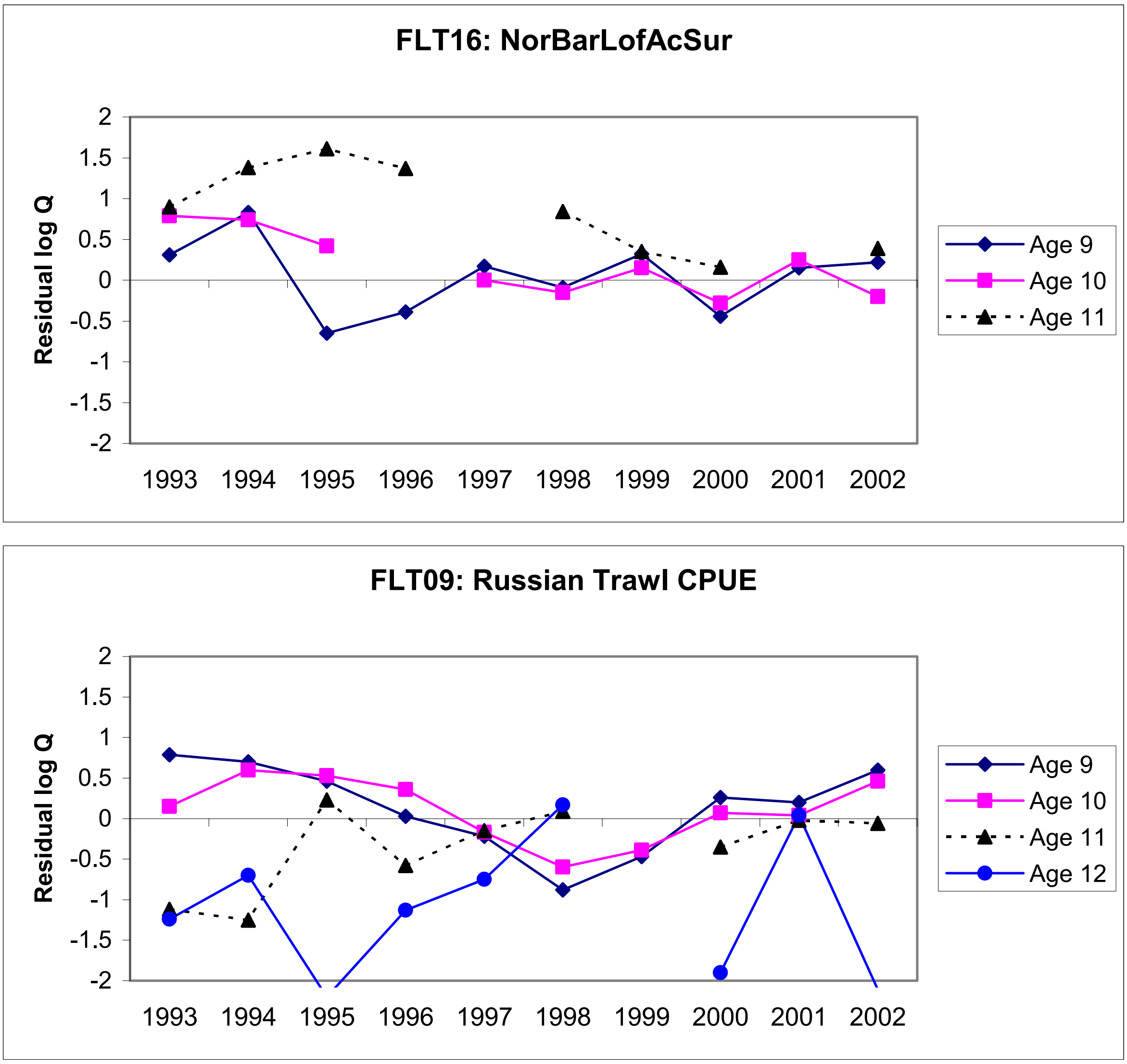


Figure 3.14 North-East Arctic cod. Residual log catchability by fleet and age from the XSA output in the 2003 assessment.

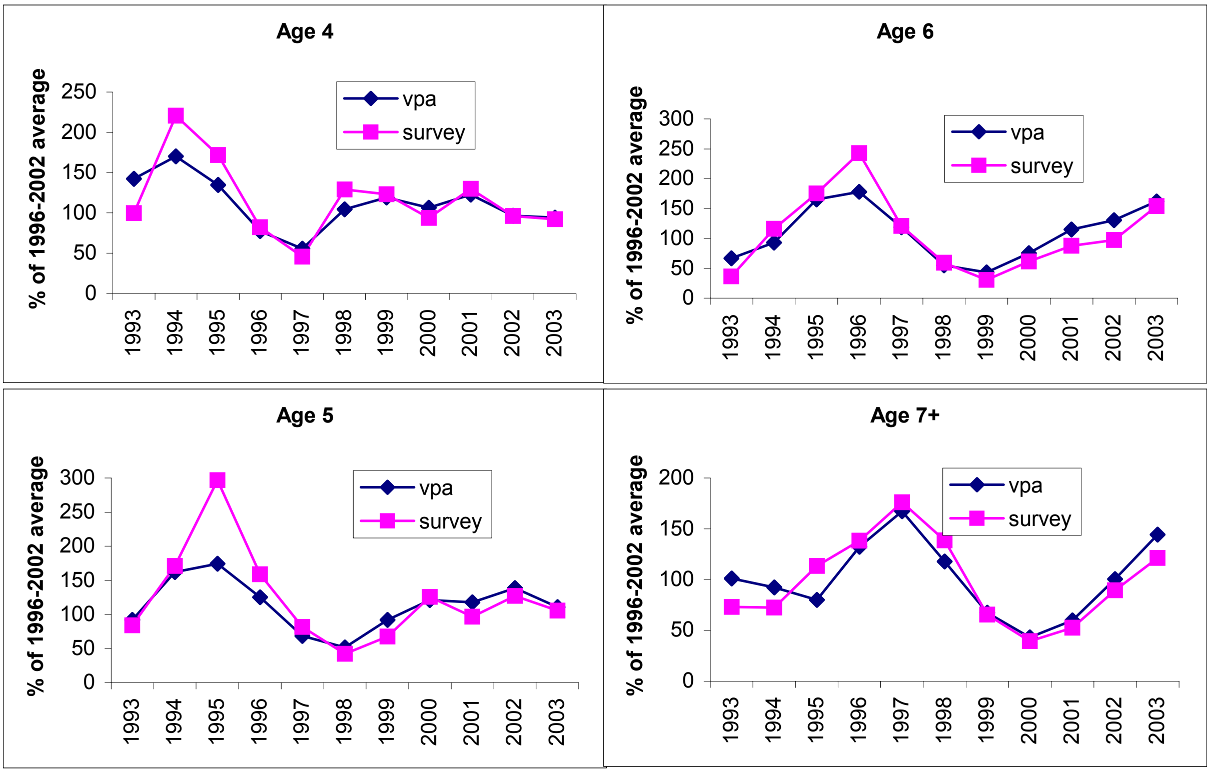


Figure 3.15 NEA cod. Stock numbers by age relative to the average for the period 1996-2002 for the vpa and the Joint winter bottom trawl survey.

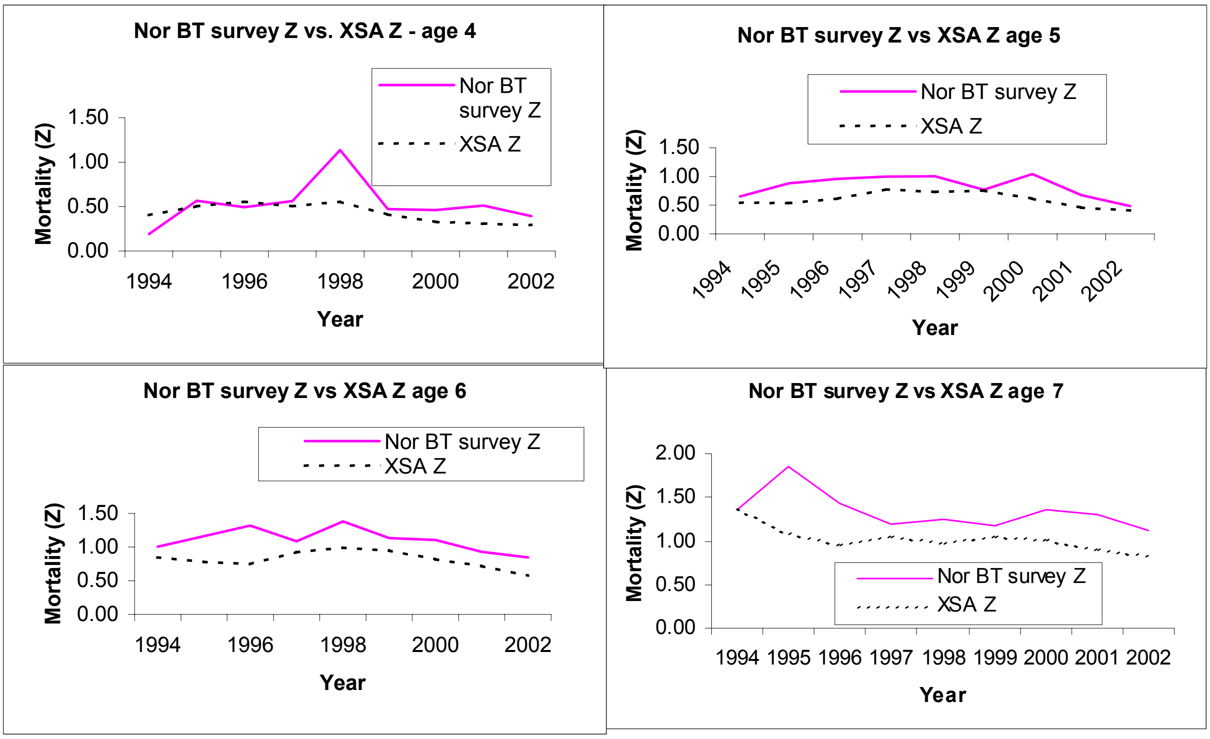


Figure 3.16 NEA cod. Survey mortalities in the Joint winter bottom trawl survey, compared to vpa total mortalities.

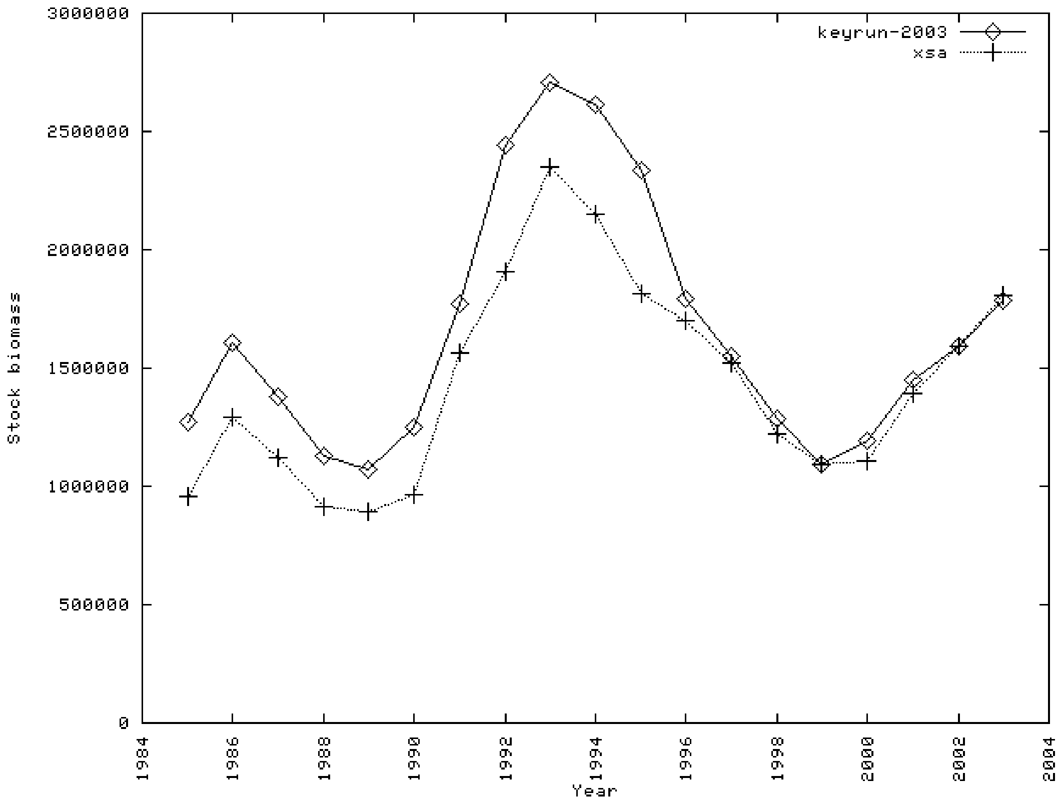


Figure 3.17a stock biomass in keyrun, and XSA

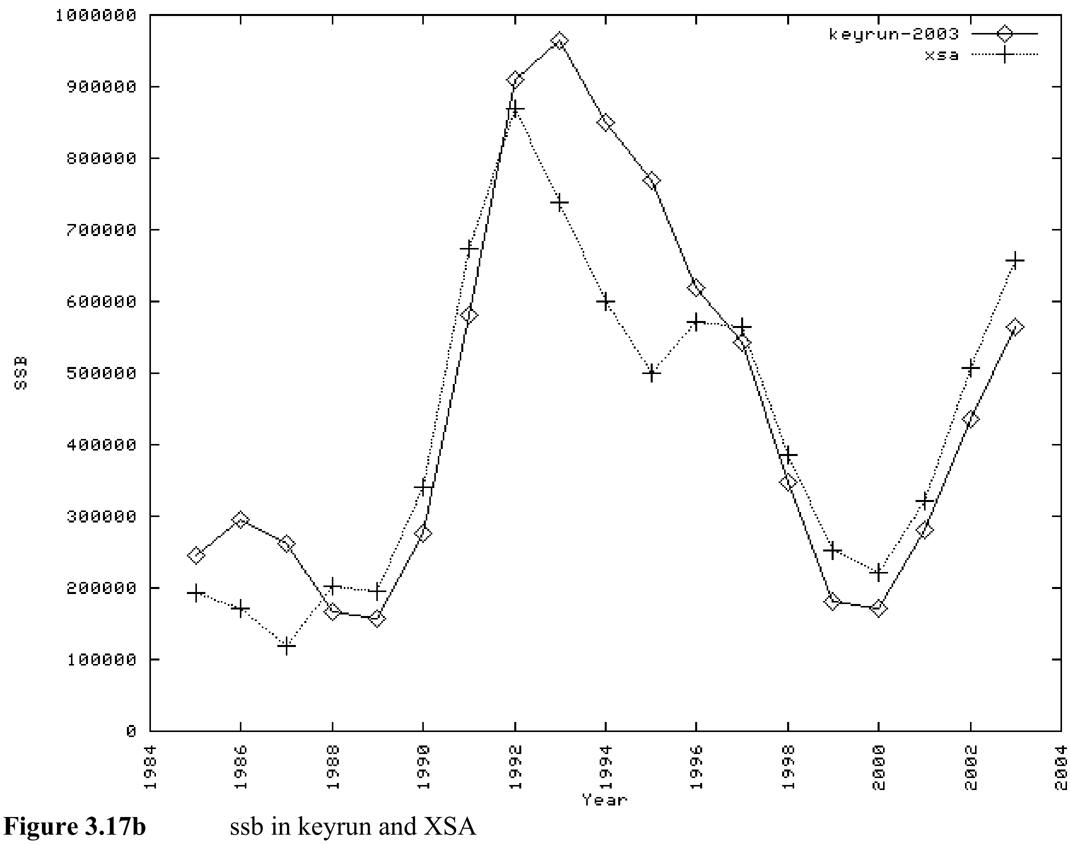


Figure 3.17b ssb in keyrun and XSA

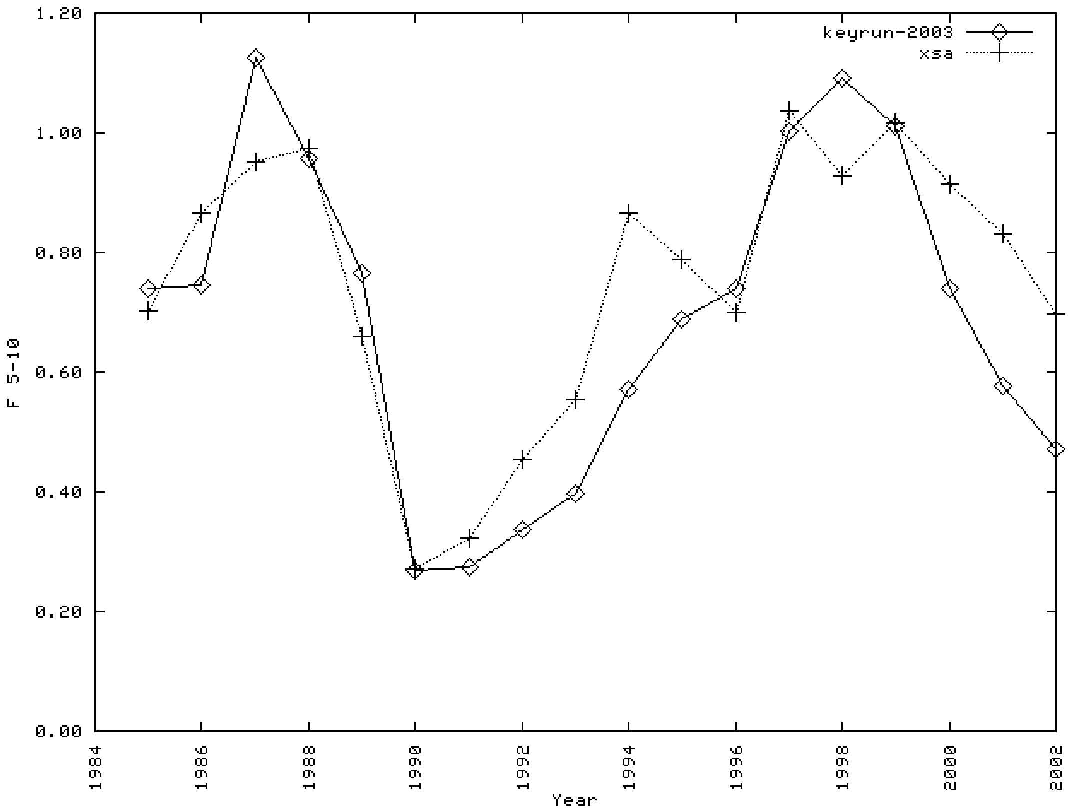


Figure 3.17c F5-10 in keyrun and XSA

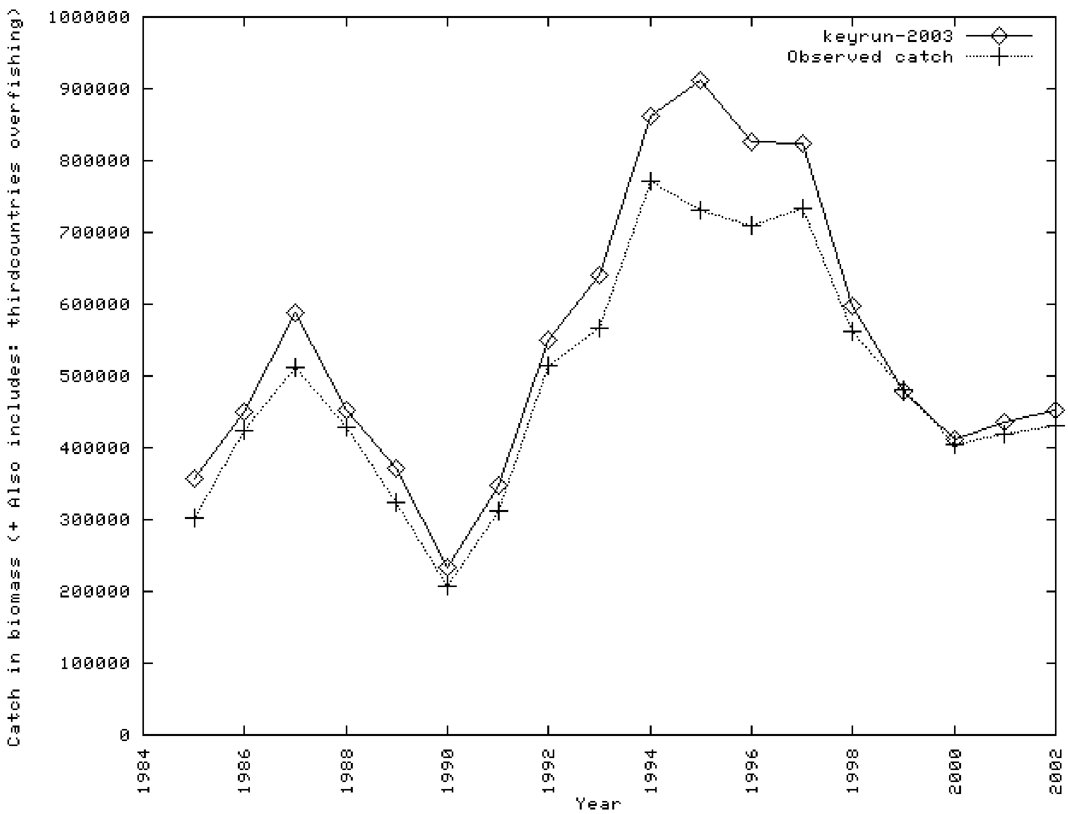


Figure 3.17d Catch in biomass in keyrun, and observed catches

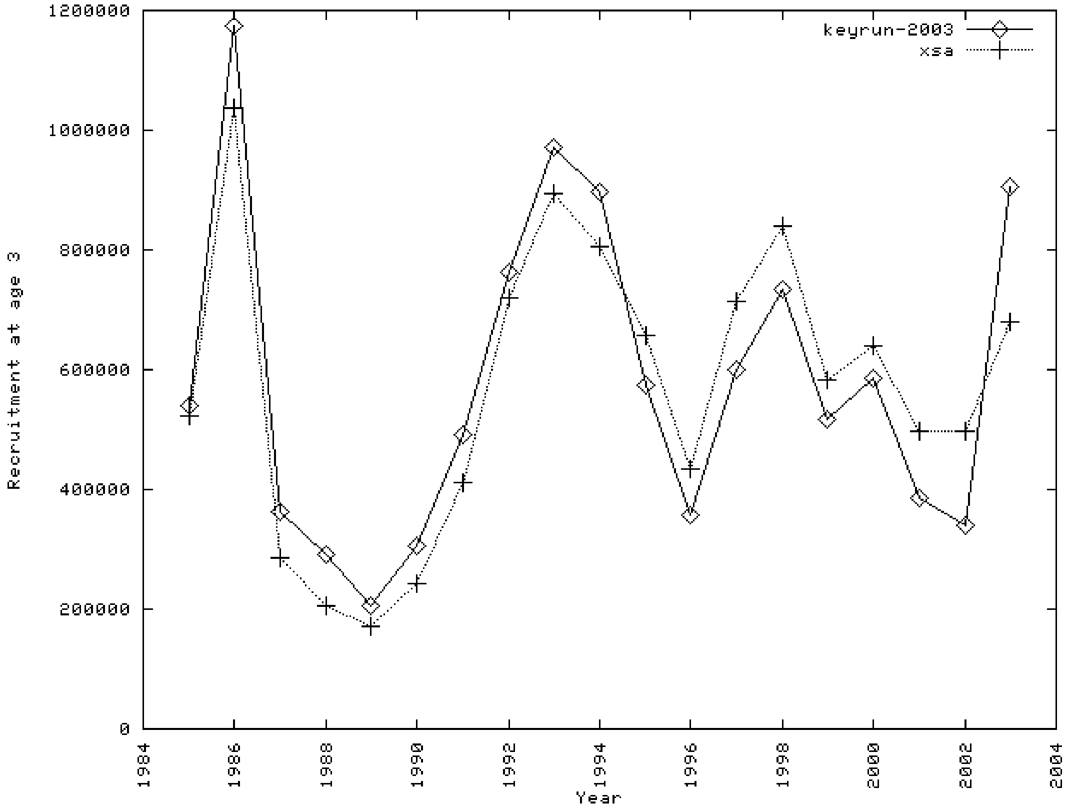


Figure 3.17e Recruitment (number of 3 year old) in keyrun and XSA

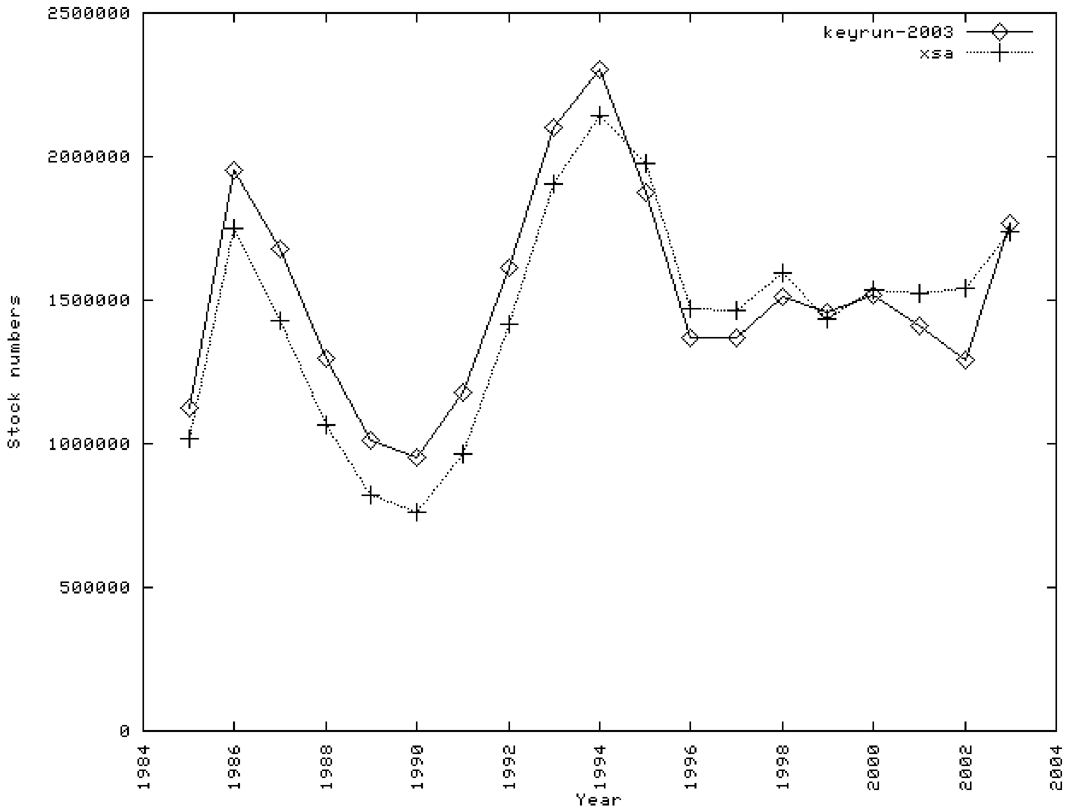


Figure 3.17f Stock numbers in keyrun and XSA

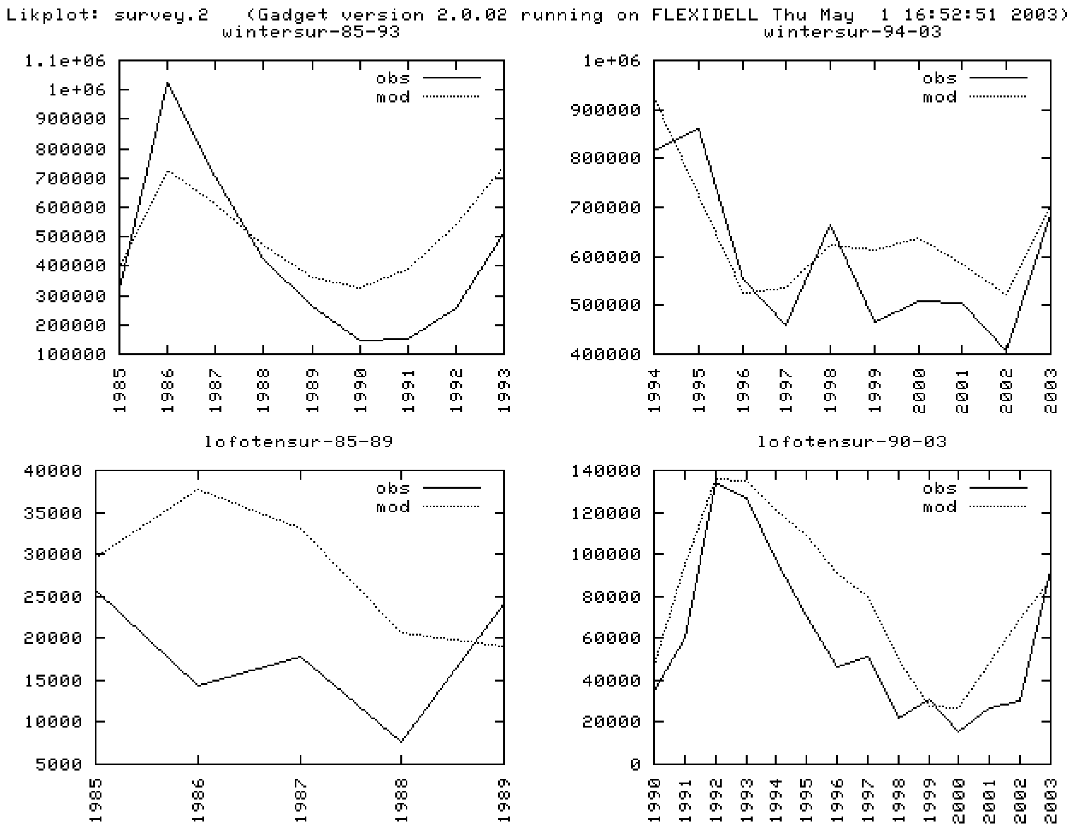


Figure3.18a Observed and modelled survey indices

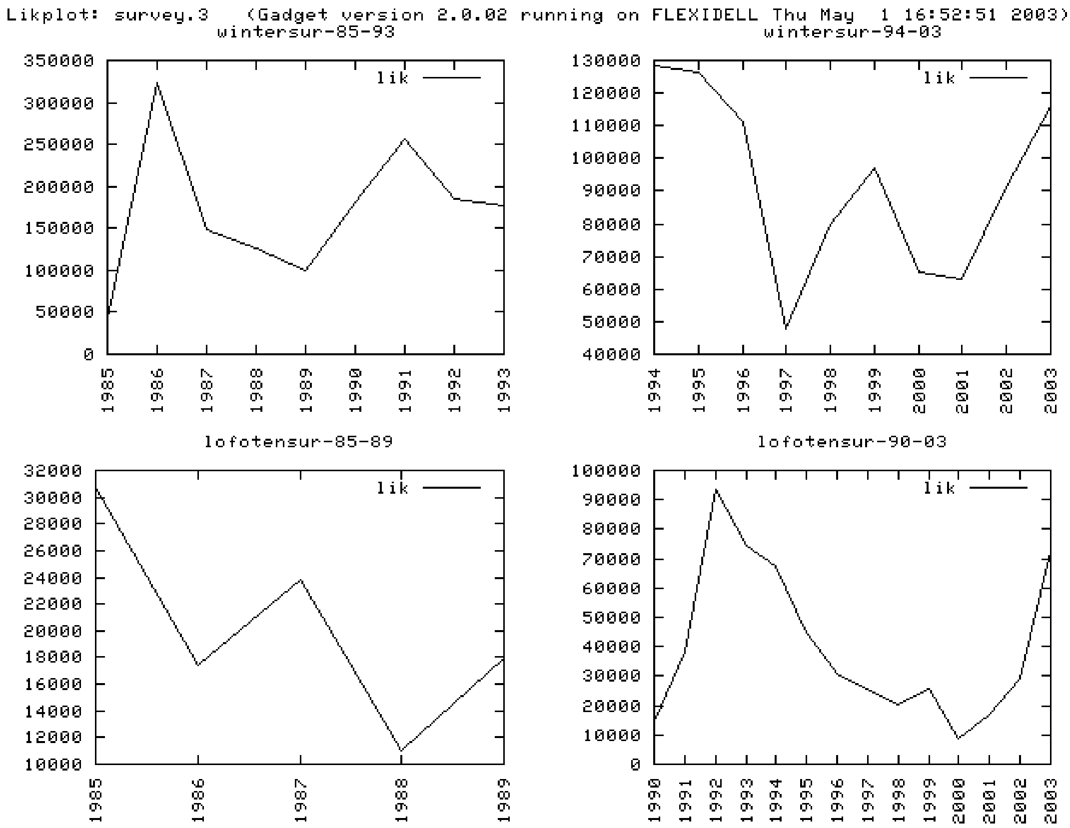


Figure3.18b Unweighted likelihood contribution from surveys

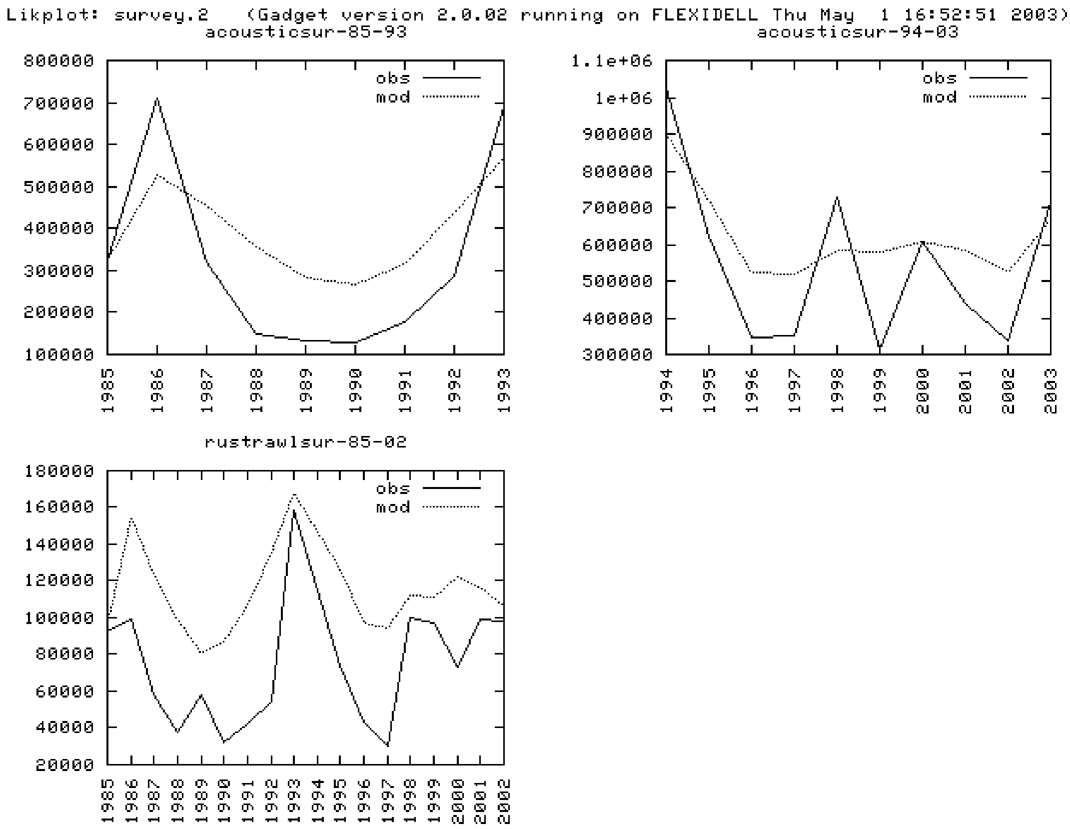


Figure3.18c Observed and modelled survey indices

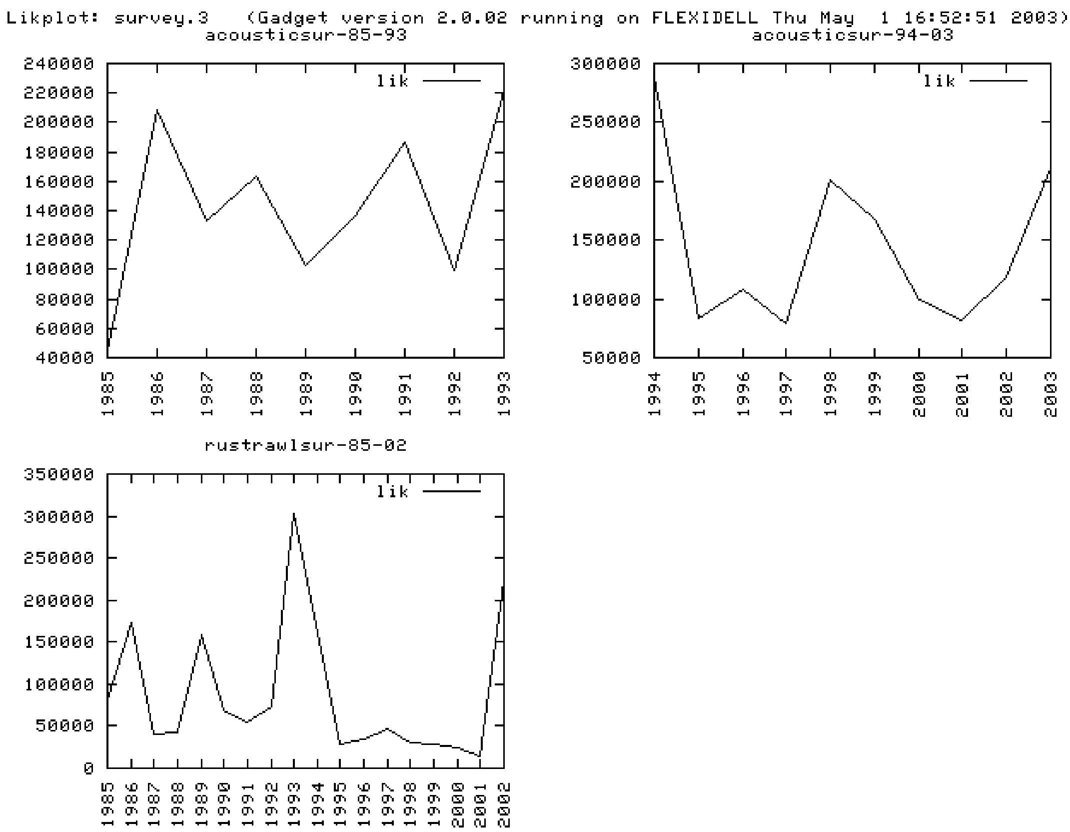


Figure3.18d Unweighted likelihood contribution from surveys

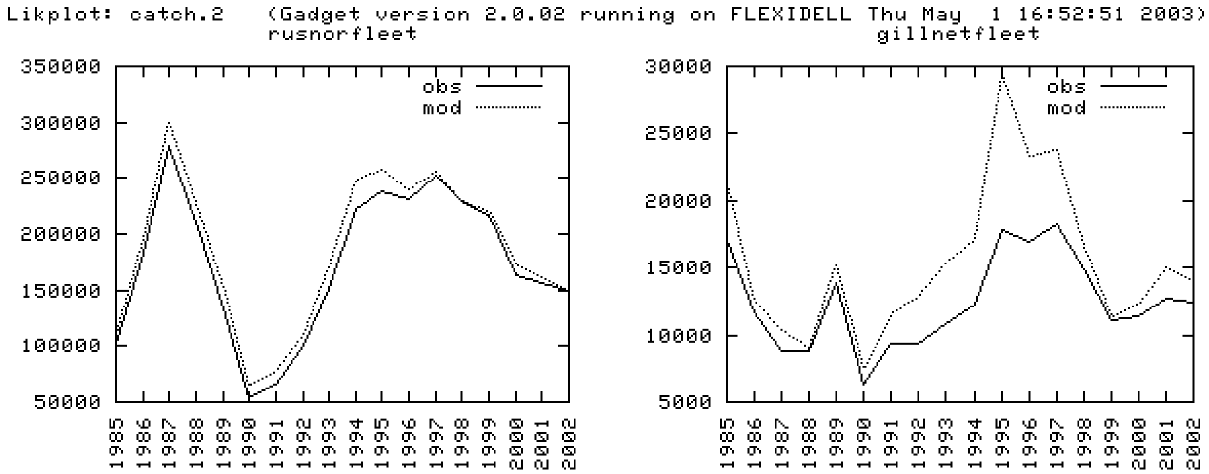


Figure3.18e Observed and modelled catches

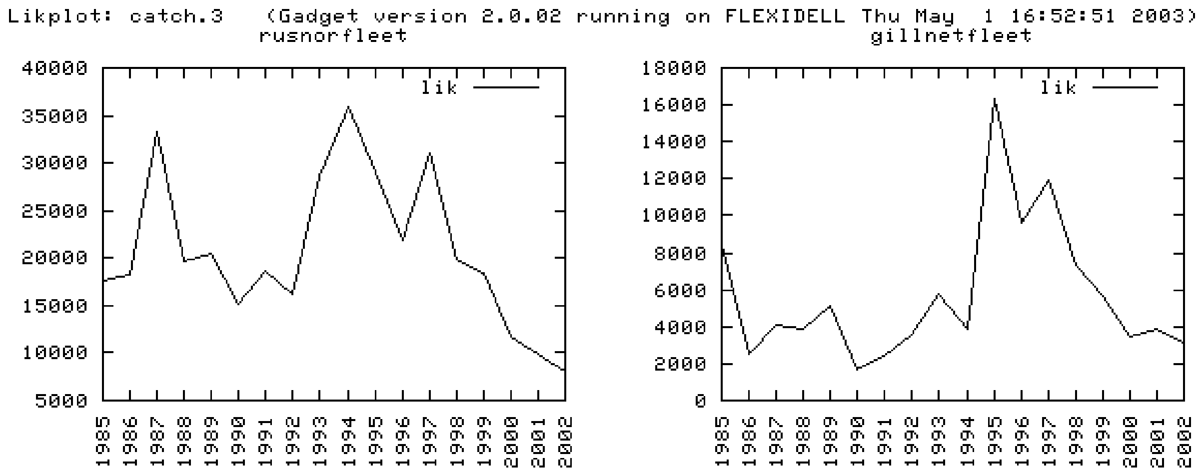


Figure3.18f Unweighted likelihood contribution from catches

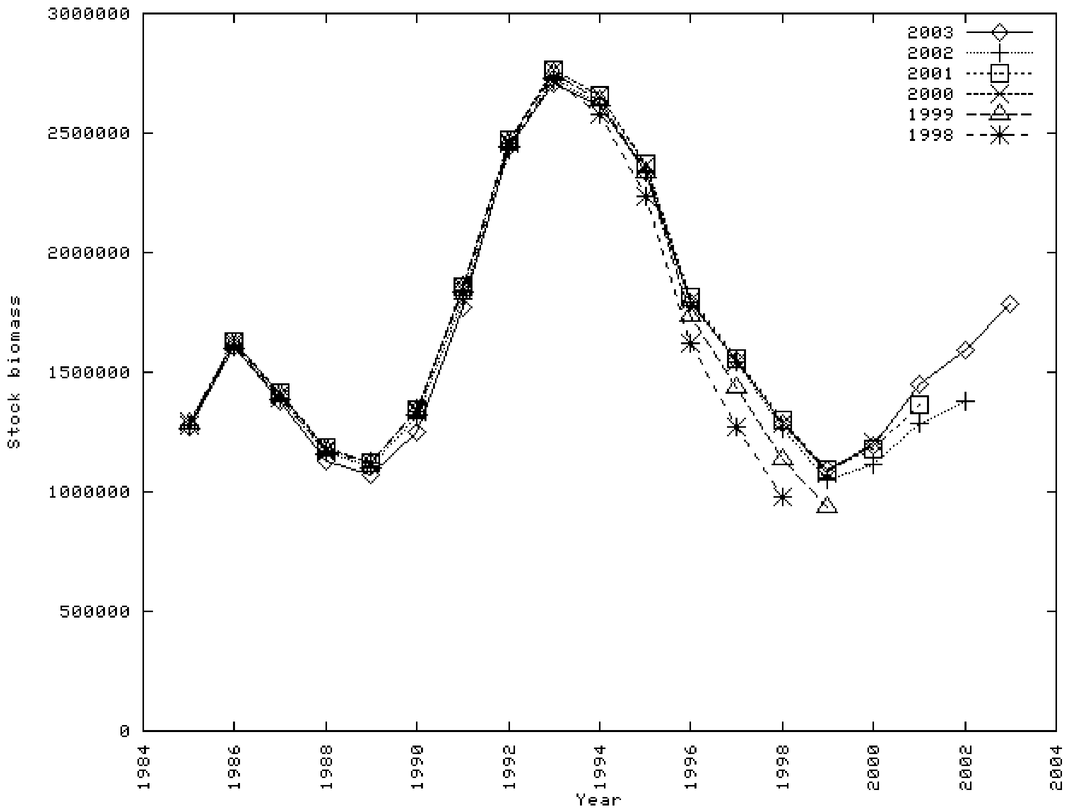


Figure 3.19a Retrospective pattern for stock biomass in keyrun

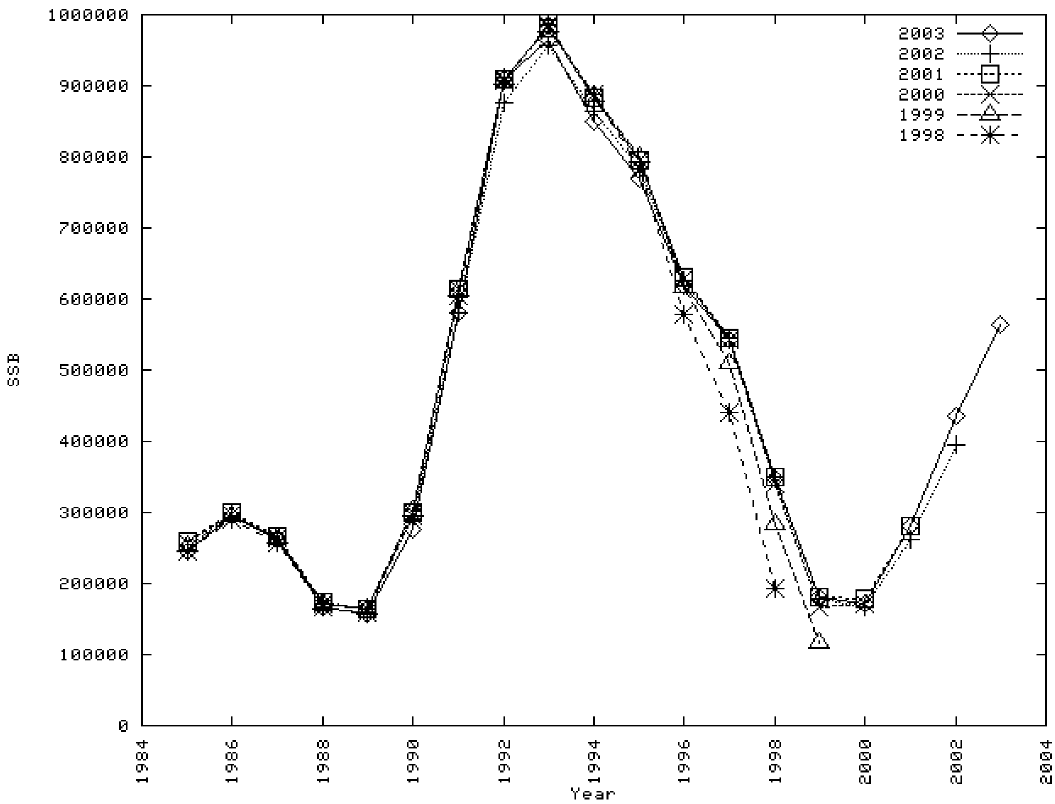


Figure 3.19b Retrospective pattern for SSB in keyrun

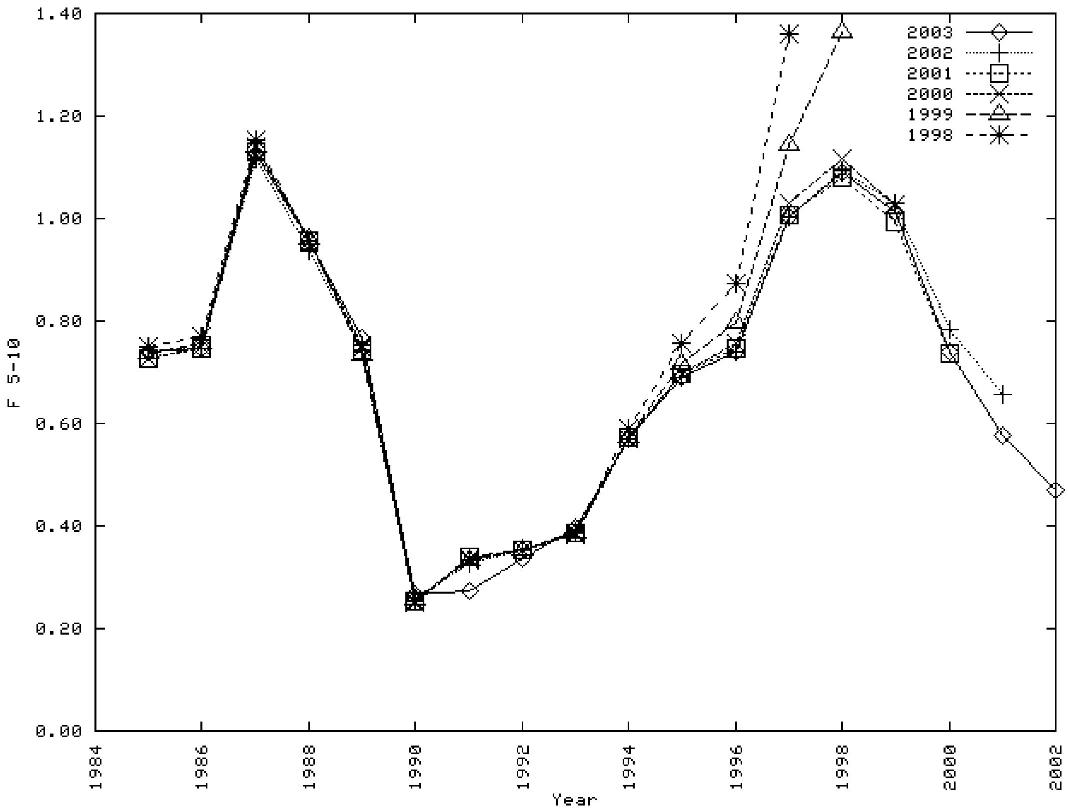


Figure 3.19c Retrospective pattern for F5-10 in keyrun

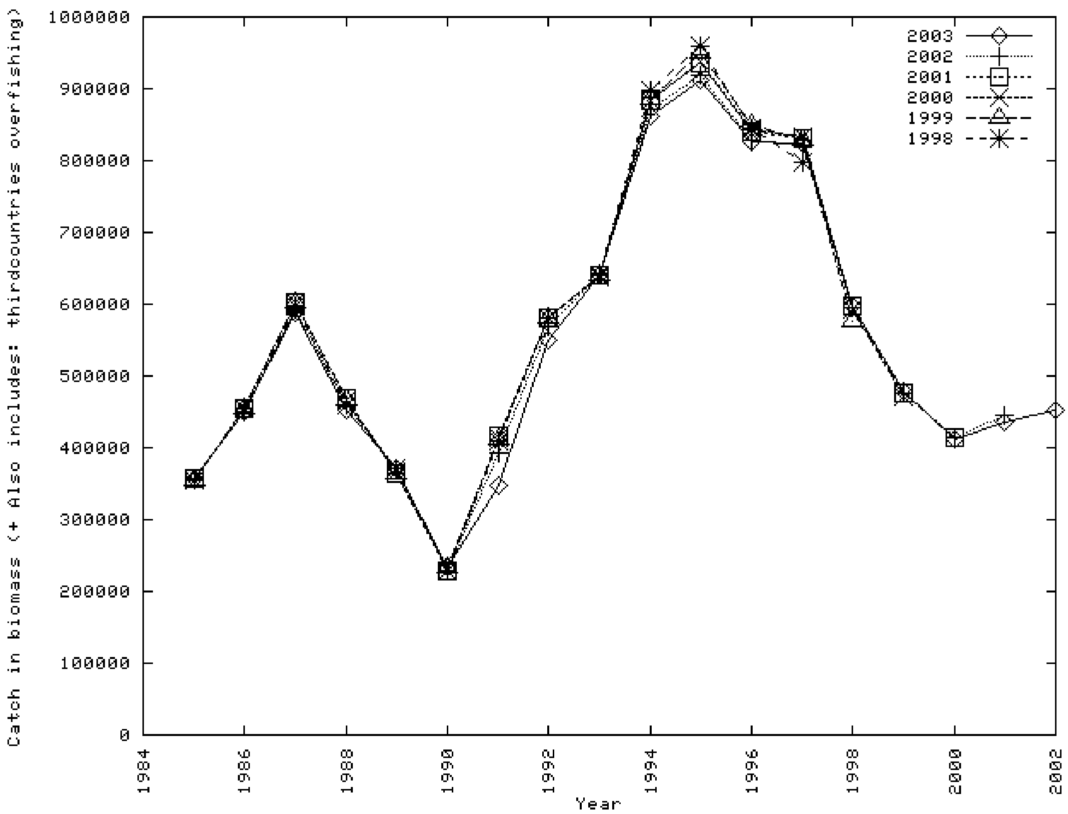


Figure 3.19d Retrospective pattern for Catch in biomass in key run

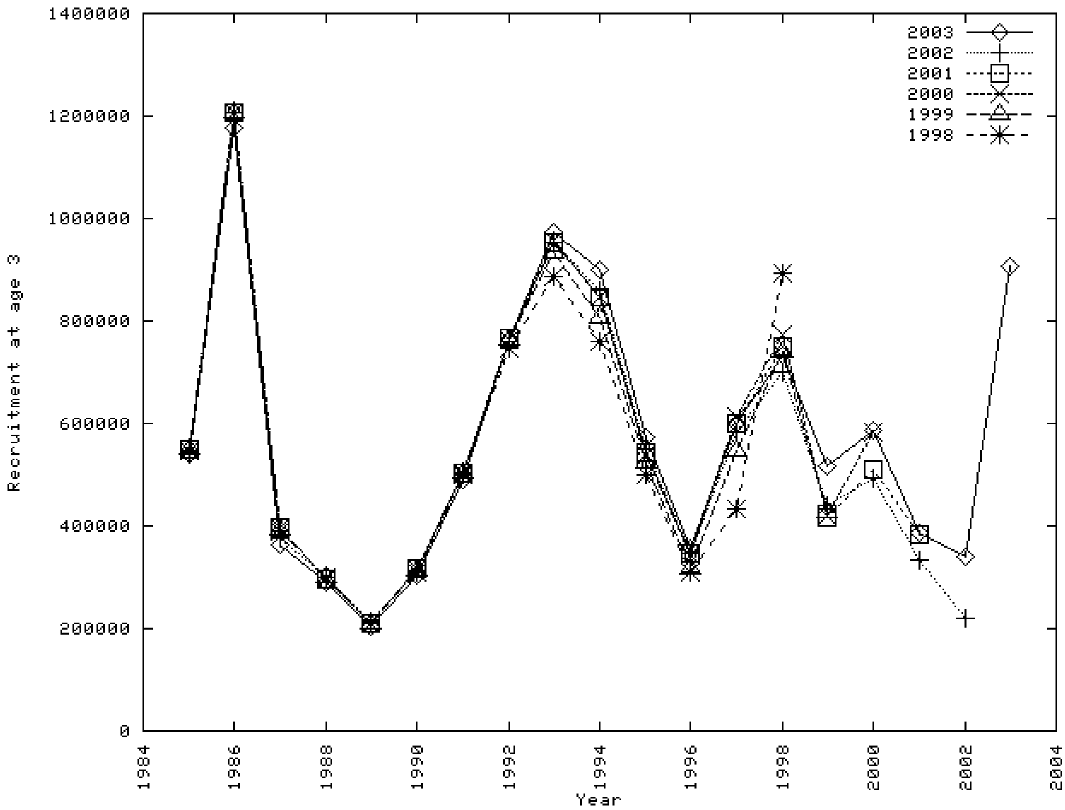


Figure 3.19e Retrospective pattern for recruitment in keyrun

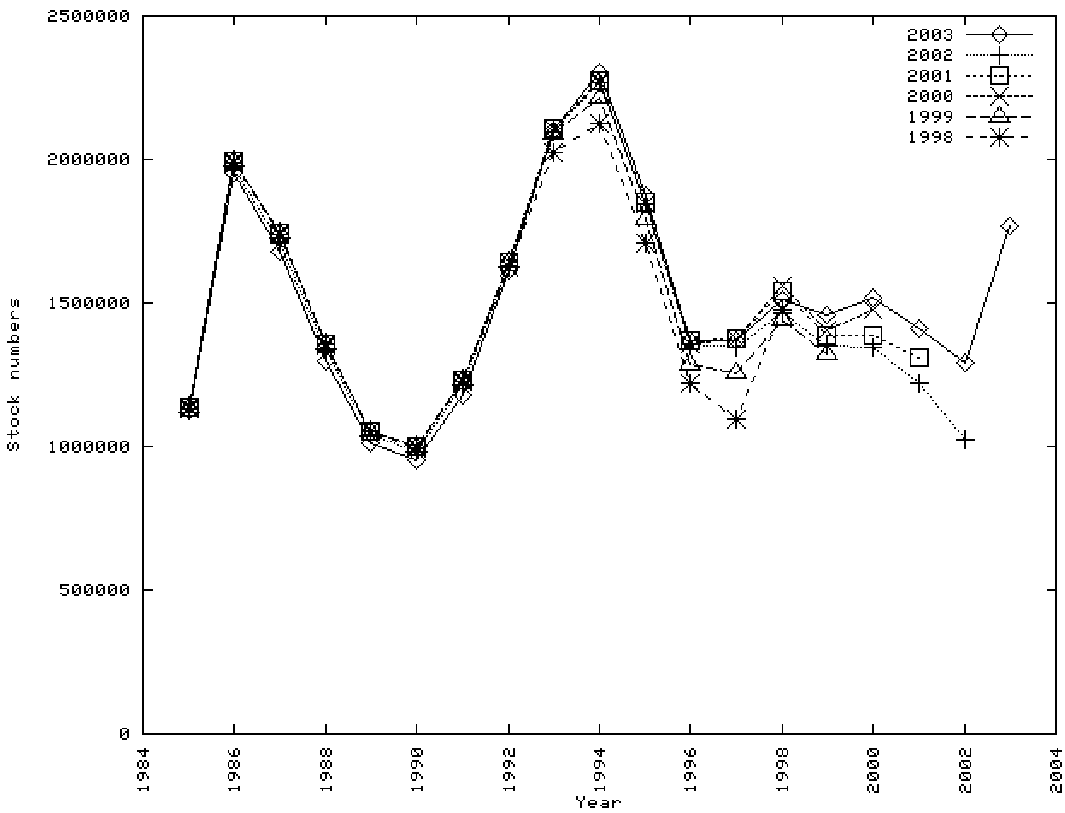


Figure 3.19f Retrospective pattern for stock numbers in keyrun

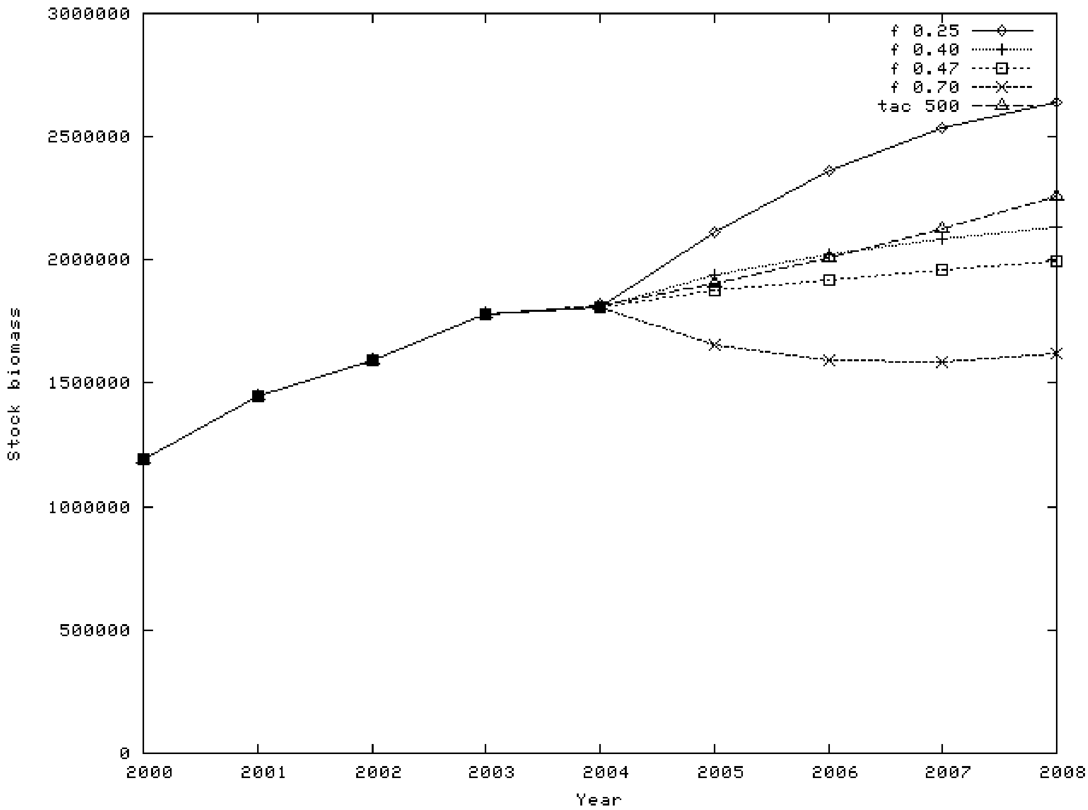


Figure 3.20a Prediction of stock biomass

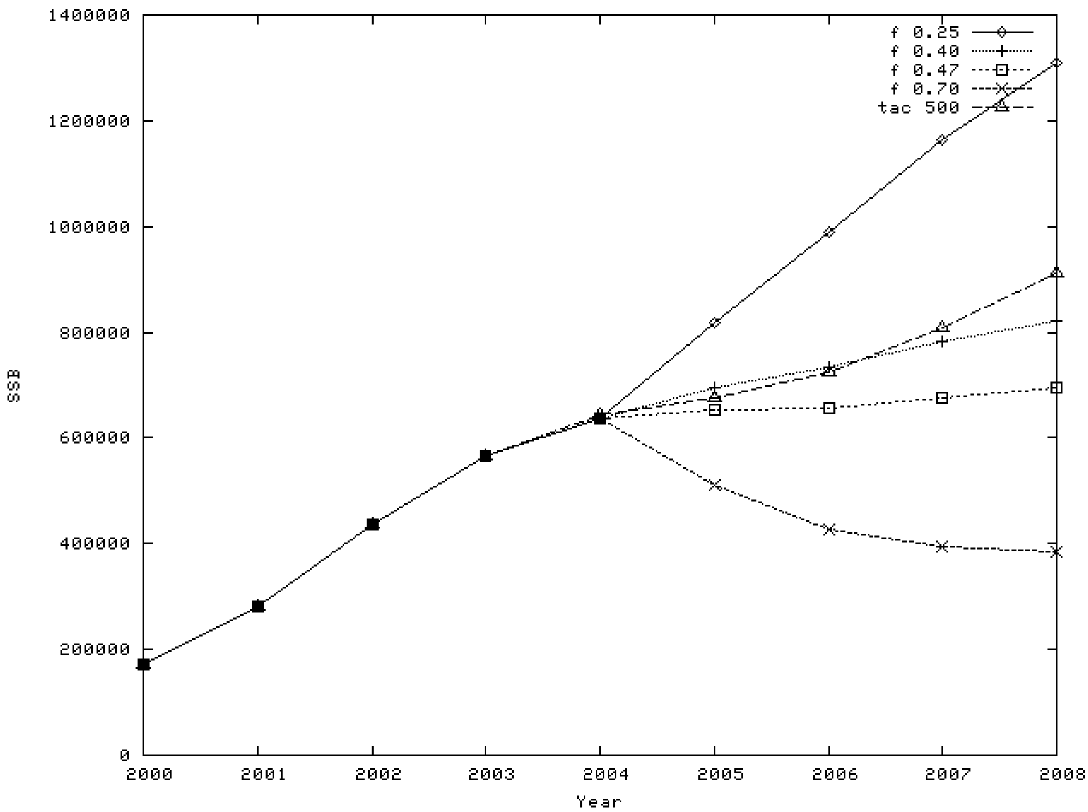


Figure 3.20b Prediction of SSB

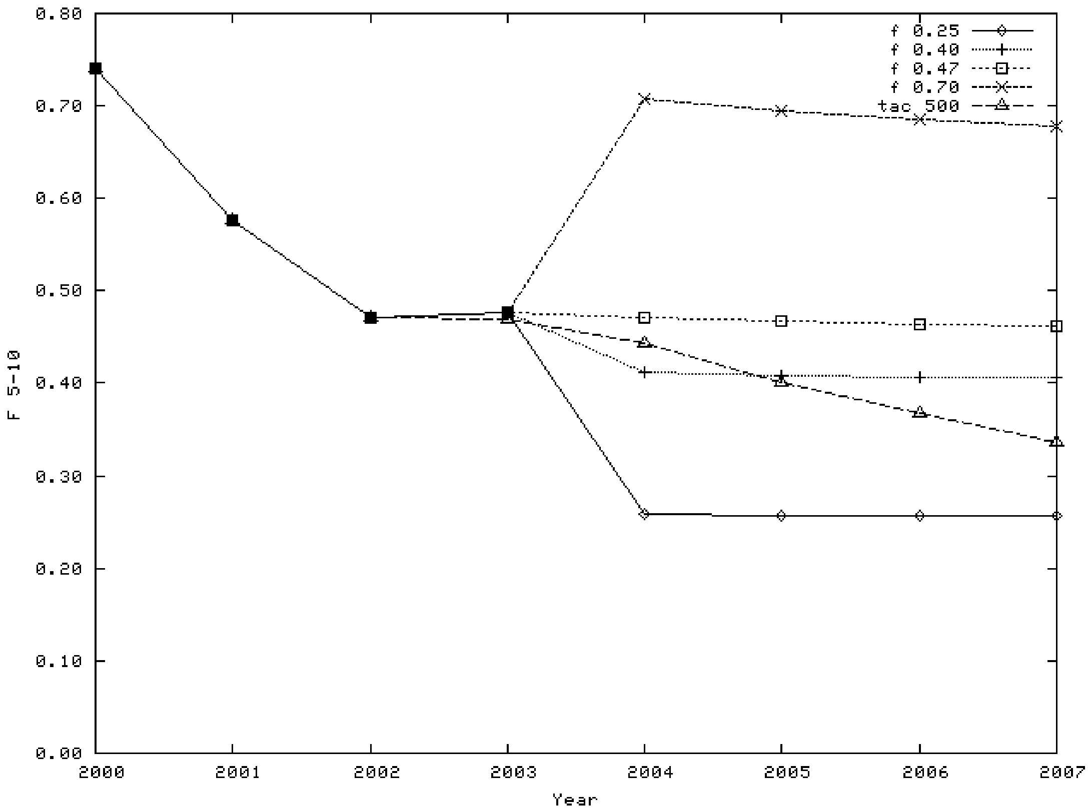


Figure 3.20c F 5-10 in predictions

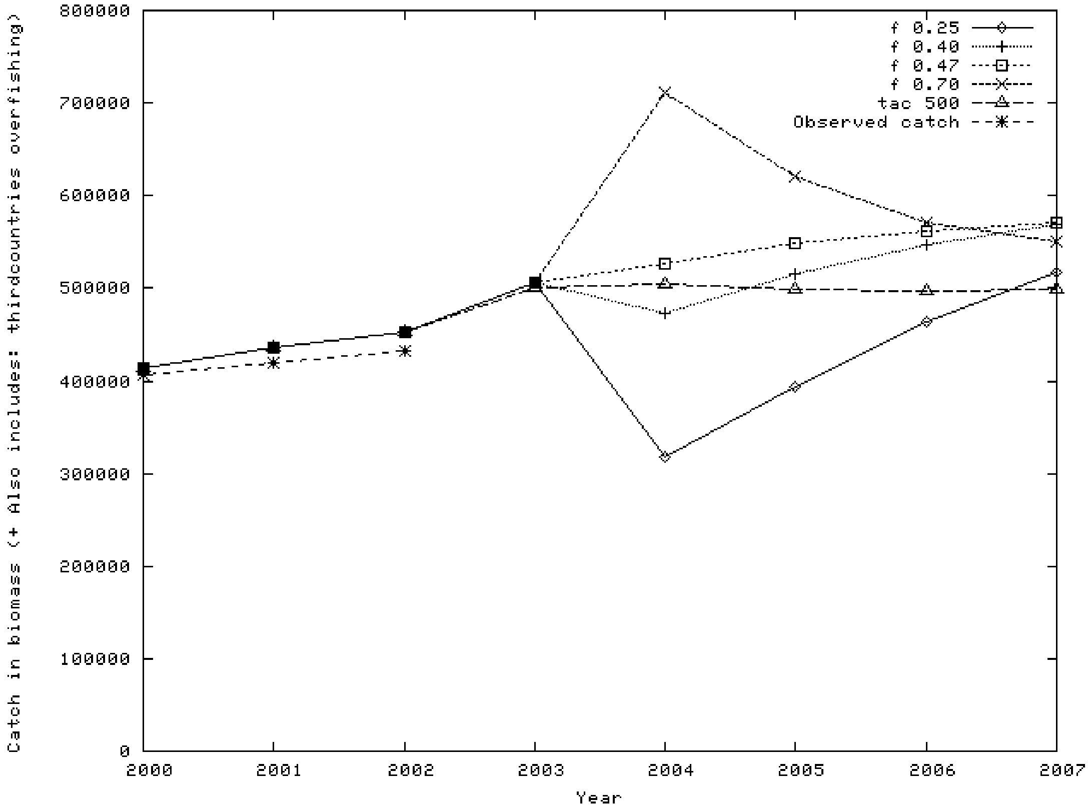


Figure 3.20d Prediction of catch in biomass

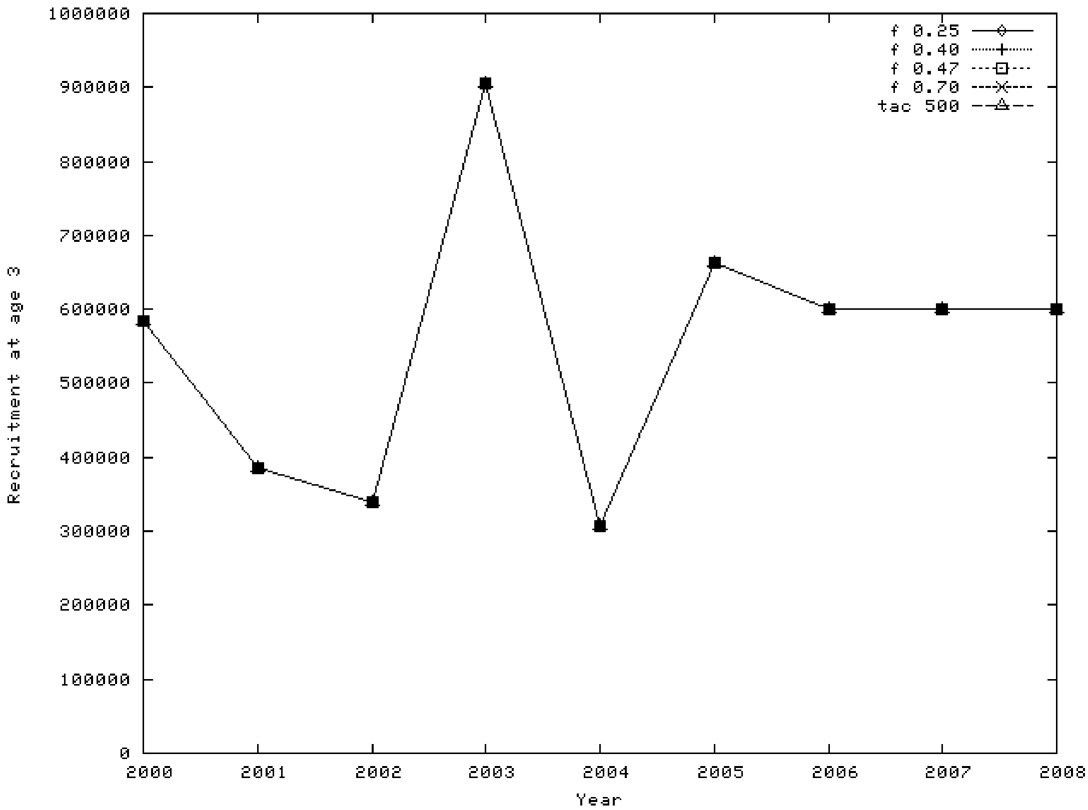


Figure 3.20e Recruitment in prediction

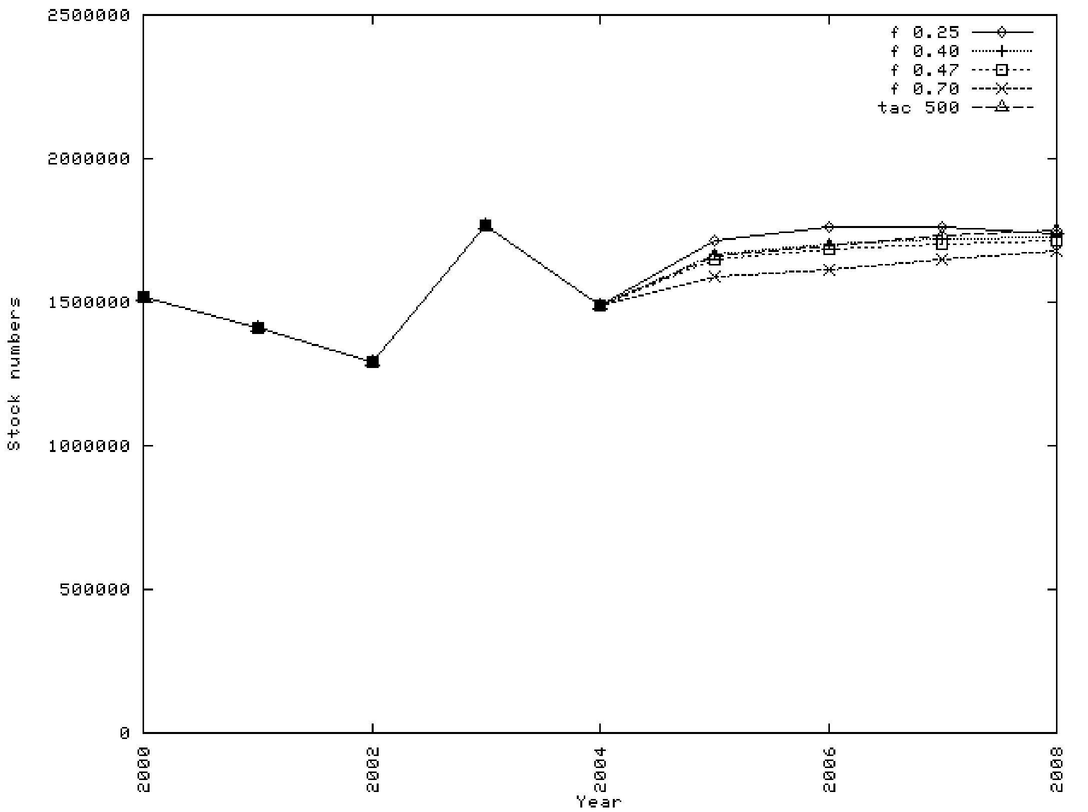
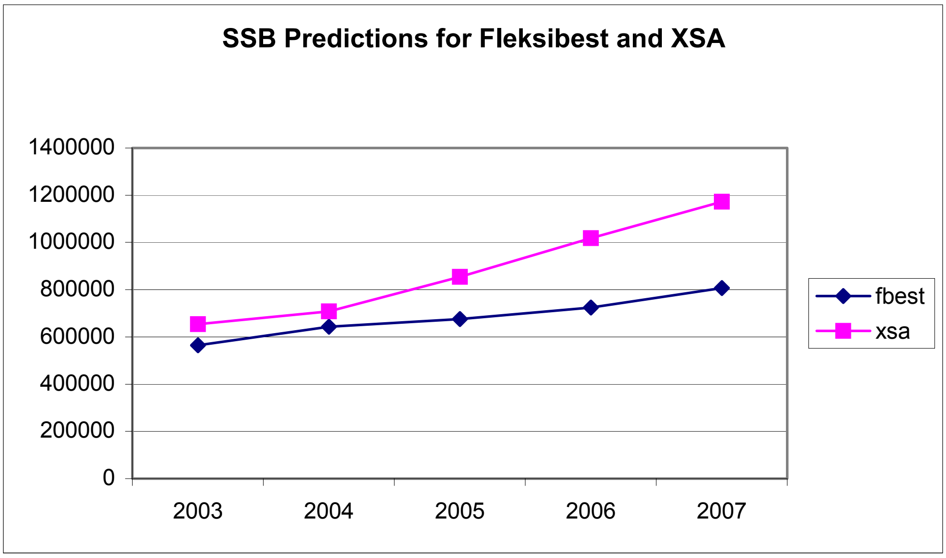
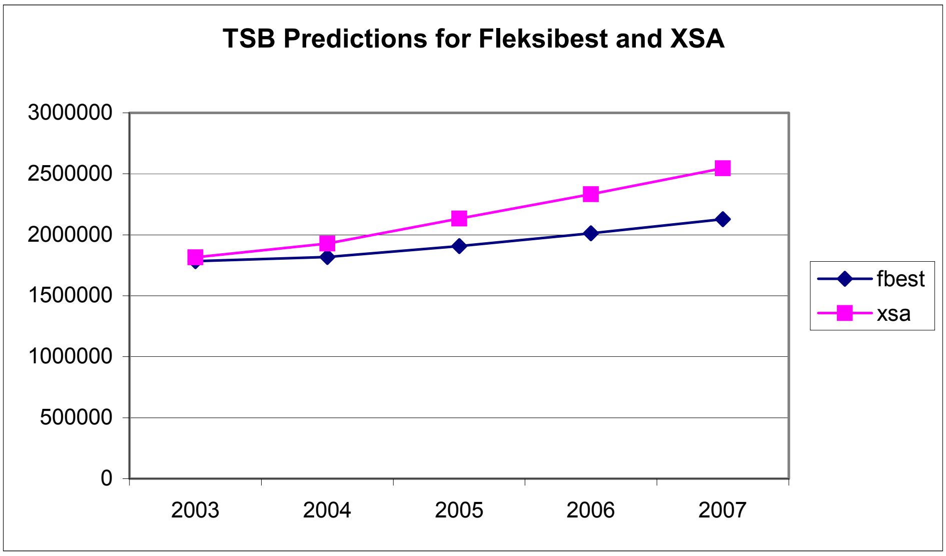


Figure 3.20f Prediction of stock numbers





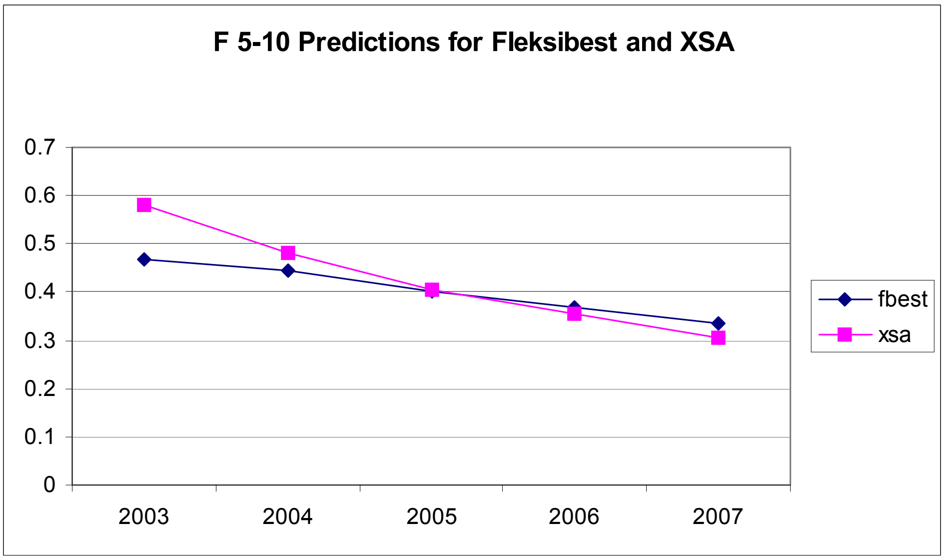


Figure 3.21 Comparison of F, SSB and TSB for Fleksibest and XSA prediction, both assuming a fixed annual catch=500,000 t for the period 2003-2007.

Table A1 North-East Arctic COD. Catch per unit effort.

	Sub-area I			Division IIb			Division IIa		Total
Year	Norway[2]	UK[3]	Russia[4]	Norway[2]	UK[3]	Russia[4]	Norway[2]	UK[3]	Norway
1960	-	0.075	0.42	-	0.105	0.31	-	0.067	
1961	-	0.079	0.38	-	0.129	0.44	-	0.058	
1962	-	0.092	0.59	-	0.133	0.74	-	0.066	
1963	-	0.085	0.60	-	0.098	0.55	-	0.066	
1964	-	0.056	0.37	-	0.092	0.39	-	0.070	
1965	-	0.066	0.39	-	0.109	0.49	-	0.066	
1966	-	0.074	0.42	-	0.078	0.19	-	0.067	
1967	-	0.081	0.53	-	0.106	0.87	-	0.052	
1968	-	0.110	1.09	-	0.173	1.21	-	0.056	
1969	-	0.113	1.00	-	0.135	1.17	-	0.094	
1970	-	0.100	0.80	-	0.100	0.80	-	0.066	
1971	-	0.056	0.43	-	0.071	0.16	-	0.062	
1972	0.90	0.047	0.34	0.59	0.051	0.18	1.08	0.055	
1973	1.05	0.057	0.56	0.43	0.054	0.57	0.71	0.043	
1974	1.75	0.079	0.86	1.94	0.106	0.77	0.19	0.028	
1975	1.82	0.077	0.94	1.67	0.100	0.43	1.36	0.033	
1976	1.69	0.060	0.84	1.20	0.081	0.30	1.69	0.035	
1977	1.54	0.052	0.63	0.91	0.056	0.25	1.16	0.044	1.17
1978	1.37	0.062	0.52	0.56	0.044	0.08	1.12	0.037	0.94
1979	0.85	0.046	0.43	0.62	-	0.06	1.06	0.042	0.85
1980	1.47	-	0.49	0.41	-	0.16	1.27	-	1.23
					Spain[5]			**Russia[4]**	
1981	1.42	-	0.41	(0.96)	-	0.07	1.02	0.35	1.21
1982	1.30	-	0.35	-	0.86	0.26	1.01	0.34	1.09
1983	1.58	-	0.31	(1.31)	0.92	0.36	1.05	0.38	1.11
1984	1.40	-	0.45	1.20	0.78	0.35	0.73	0.27	0.96
1985	1.86	-	1.04	1.51	1.37	0.50	0.90	0.39	1.29
1986	1.97	-	1.00	2.39	1.73	0.84	1.36	1.14	1.70
1987	1.77	-	0.97	2.00	1.82	1.05	1.73	0.67	1.77
1988	1.58	-	0.66	1.61	(1.36)	0.54	0.97	0.55	1.03
1989	1.49	-	0.71	0.41	2.70	0.45	0.78	0.43	0.76
1990	1.35	-	0.70	0.39	2.69	0.80	0.38	0.60	0.49
1991	1.38	-	0.67	0.29	4.96	0.76	0.50	0.90	0.44
1992	2.19	-	0.79	3.06	2.47	0.23	0.98	0.65	1.29
1993	2.33	-	0.85	2.98	3.38	1.00	1.74	1.03	1.87
1994	2.50	-	1.01	2.82	1.44	1.14	1.27	0.86	1.59
1995	1.57	-	0.59	2.73	1.65	1.10	1.00	1.01	1.92
1996			0.74		1.11	0.85		0.99	1.81
1997			0.61			0.57		0.74	1.36
1998			0.37			0.29		0.40	0.83
1999			0.29			0.34		0.39	0.74
2000			0.34			0.37		0.53	0.92
2001			0,46			0,46		0,69	1.21
2002[1]			0,58			0,66		0,57	1.34

[1]Preliminary figures.
[2]Norwegian data - t per 1,000 tonnage*hrs fishing.
[3]United Kingdom data - t per 100 tonnage*hrs fishing.
[4]Russian data - t per hr fishing.
5panish data - t per hr fishing.

Period	Sub-area I	Divisions IIa and IIb
1960–1973	RT	RT
1974–1980	PST	RT
1981–	PST	PST

Vessel type:
RT = side trawlers, 800–1000 HP.
PST = stern trawlers, up to 2000 HP.

Table A2. North-east Arctic COD. Abundance indices (millions) from the Norwegian acoustic survey in the Barents Sea in January-March. New TS and rock-hopper gear (1981-1988 back-calculated from bobbins gear). Corrected for length-dependent effective spread of trawl.

Year	Age 1	2	3	4	5	6	7	8	9	10+	Total
1981	8.0	82.0	40.0	63.0	106.0	103.0	16.0	3.0	1.0	1.0	423.0
1982	4.0	5.0	49.0	43.0	40.0	26.0	28.0	2.0	+	0.0	197.0
1983	60.5	2.8	5.3	14.3	17.4	11.1	5.6	3.0	0.5	0.1	120.5
1984	745.4	146.1	39.1	13.6	11.3	7.4	2.8	0.2	0.0	0.0	966.0
1985	69.1	446.3	153.0	141.6	19.7	7.6	3.3	0.2	0.1	0.0	840.9
1986	353.6	243.9	499.6	134.3	65.9	8.3	2.2	0.4	0.1	0.0	1308.2
1987	1.6	34.1	62.8	204.9	41.4	10.4	1.2	0.2	0.7	0.0	357.3
1988	2.0	26.3	50.4	35.5	56.2	6.5	1.4	0.2	0.0	0.0	178.4
1989	7.5	8.0	17.0	34.4	21.4	53.8	6.9	1.0	0.1	0.1	150.1
1990	81.1	24.9	14.8	20.6	26.1	24.3	39.8	2.4	0.1	0.0	234.1
1991	181.0	219.5	50.2	34.6	29.3	28.9	16.9	17.3	0.9	0.0	578.7
1992	241.4	562.1	176.5	65.8	18.8	13.2	7.6	4.5	2.8	0.2	1092.9
1993 [1]	1074.0	494.7	357.2	191.1	108.2	20.8	8.1	5.0	2.3	2.5	2264.0
1994 [1]	858.3	577.2	349.8	404.5	193.7	63.6	12.1	3.7	1.7	0.9	2465.4
1995 [1]	2619.2	292.9	166.2	159.8	210.1	68.8	16.7	2.1	0.7	1.0	3537.4
1996 [1]	2396.0	339.8	92.9	70.5	85.8	74.7	20.6	2.8	0.3	0.4	3083.8
1997 [1,2]	1623.5	430.5	188.3	51.7	49.3	37.2	22.3	4.0	0.7	0.1	2407.5
1998 [1,2]	3401.3	632.9	427.7	182.6	42.3	33.5	26.9	13.6	1.7	0.3	4762.8
1999	358.3	304.3	150.0	96.4	45.1	10.3	6.4	4.1	0.8	0.3	976.1
2000	154.1	221.4	245.2	158.9	142.1	45.4	9.6	4.7	3.0	1.1	985.5
2001	629.9	63.9	138.2	171.6	77.3	39.7	11.8	1.4	0.5	0.2	1134.5
2002	18.2	215.5	69.3	112.2	102.0	47.0	18.0	3.0	0.4	0.3	585.9
2003	1693.9	61.5	303.4	114.4	129.0	114.9	34.3	7.7	1.9	0.5	2461.5

[1] Survey covered a larger area
[2] Adjusted indices

Table A3. North-East Arctic COD. Abundance indices (millions) from the Norwegian bottom trawl survey in the Barents Sea in January-March. Rock-hopper gear (1981-1988 back-calculated from bobbins gear). Corrected for length-dependent effective spread of trawl.

Year	Age 1	2	3	4	5	6	7	8	9	10+	Total
1981	4.6	34.3	16.4	23.3	40	38.4	4.8	1	0.3	0	163.1
1982	0.8	2.9	28.3	27.7	23.6	15.5	16	1.4	0.2	0	116.4
1983	152.9	13.4	25.0	52.3	43.3	17.0	5.8	3.2	1.0	0.1	313.9
1984	2755.0	379.1	97.5	28.3	21.4	11.7	4.1	0.4	0.1	0.1	3297.7
1985	49.5	660.0	166.8	126.0	19.9	7.7	3.3	0.2	0.1	0.1	1033.6
1986	665.8	399.6	805.0	143.9	64.1	8.3	1.9	0.3	0.0	0.0	2089.1
1987	30.7	445.0	240.4	391.1	54.3	15.7	2.0	0.5	0.0	0.0	1179.8
1988	3.2	72.8	148.0	80.5	173.3	20.5	3.6	0.5	0.0	0.0	502.5
1989	8.2	15.6	46.4	75.9	37.8	90.2	9.8	0.9	0.1	0.1	285.0
1990	207.2	56.7	28.4	34.9	34.6	20.6	27.2	1.6	0.4	0.0	411.5
1991	460.5	220.1	45.9	33.7	25.7	21.5	12.2	12.7	0.6	0.0	832.7
1992	126.6	570.9	158.3	57.7	17.8	12.8	7.7	4.3	2.7	0.2	959.0
1993 [1]	534.5	420.4	273.9	140.1	72.5	15.8	6.2	3.9	2.2	2.4	1471.9
1994 [1]	1035.9	535.8	296.5	310.2	147.4	50.6	9.3	2.4	1.6	1.3	2391.0
1995 [1]	5253.1	541.5	274.6	241.4	255.9	76.7	18.5	2.4	0.8	1.1	6666.2
1996 [1]	5768.5	707.6	170.0	115.4	137.2	106.1	24.0	2.9	0.4	0.5	7032.5
1997 [1,2]	4815.5	1045.1	238.0	64.0	70.4	52.7	28.3	5.7	0.9	0.5	6321.1
1998 [1,2]	2418.5	643.7	396.0	181.3	36.5	25.9	17.8	8.6	1.0	0.5	3729.8
1999 [1]	484.6	340.1	211.8	173.2	58.1	13.4	6.5	5.1	1.2	0.4	1294.4
2000	128.8	248.3	235.2	132.1	108.3	26.9	4.3	2.0	1.2	0.4	887.5
2001	657.9	76.6	191.1	182.8	83.4	38.2	8.9	1.1	0.4	0.2	1240.6
2002	35.3	443.9	88.3	135.0	109.6	42.5	15.1	2.4	0.3	0.2	872.6
2003	2991.7	79.1	377.0	129.7	91.1	67.3	18.3	4.9	1.0	0.2	3760.3

[1] Survey covered a larger area
[2] Adjusted indices

Table A4. North East Arctic COD. Abundance at age (millions) from the Norwegian acoustic survey on the spawning grounds off Lofoten in March-April.

Year	5	6	7	8	9	10	11	12+	Sum
1985	0.68	7.45	12.36	3.11	1.15	1.01	0.45		26.21
1986	2.49	3.30	5.54	2.71	0.16		0.40	0.08	14.68
1987	8.77	7.04	0.23	2.83	0.04		0.03	0.03	18.97
1988	1.57	4.43	2.56	0.05	0.01	0.05			8.67
1989	0.04	13.20	9.73	2.20	0.38	0.12		0.06	25.73
1990	0.13	2.60	27.02	4.85	0.49	0.32			35.41
1991	0.00	5.00	19.83	32.67	2.75	0.19	0.17		60.61
1992	2.74	5.23	20.80	20.87	79.60	4.17	1.61	0.22	135.24
1993	4.87	14.58	17.35	20.22	25.44	41.95	4.74	0.71	129.86
1994	23.78	25.85	10.36	8.21	7.68	3.49	17.53	2.61	99.51
1995	6.49	35.24	12.34	2.27	3.60	2.56	2.15	7.96	72.61
1996	1.41	14.43	24.00	3.65	0.79	0.25	0.80	1.30	46.63
1997	0.40	4.95	27.56	16.50	1.50	0.42		0.75	52.08
1998	0.05	0.30	7.06	11.05	3.24	0.51	0.18	0.02	22.41
1999	0.25	1.92	4.84	14.58	8.42	0.75	0.19	0.10	31.05
2000	3.61	3.85	3.25	2.15	2.23	0.45	0.39	0.05	15.98
2001	3.91	15.73	7.17	0.84	0.30	0.31	0.23	0.06	28.55
2002	1.53	12.06	11.71	4.27	0.64	0.18	0.23	0.01	30.61
2003	3.01	34.31	34.90	15.36	2.16	0.14	0.04	0.02	89.95

Table A5. North-east Arctic COD.
Abundance indices (millions) from the Norwegian Bottom Trawl
survey in the Svalbard area in September-October (1983-1994) and July-August (1995-2002).
Swept area estimates of number of fish at each age. Rock-hopper gear.
(1983-1988 back-calculated from bobbins gear). Corrected for length-dependent effective spread of trawl.

			Age							
Year	1	2	3	4	5	6	7	8	9+	Total
1983	191.2	17.0	4.3	4.4	1.3	1.1	0.5	0.8	0.2	220.8
1984	598.4	106.8	6.3	3.3	3.4	1.3	0.3	0.3	0.3	720.3
1985	280.6	447.7	81.1	21.5	9.8	3.9	0.7	0.3	0.2	845.8
1986	49.8	182.3	260.6	32.5	11.0	1.9	0.7	0.2	0.1	539.1
1987	48.8	117.7	147.1	137.2	20.2	5.0	0.5	0.3	0.1	476.7
1988	2.6	26.8	30.8	24.4	37.2	7.1	1.5	0.1	0.1	130.6
1989	4.0	1.4	12.1	11.3	9.3	14.7	3.0	0.4	0.1	56.3
1990	95.0	10.3	7.0	10.9	17.0	11.4	17.4	1.6	0.3	170.8
1991	144.5	88.0	22.4	6.1	9.5	10.2	8.5	13.2	1.5	303.7
1992	168.0	125.6	81.8	37.9	8.4	3.9	4.4	2.1	4.5	436.6
1993	157.9	153.1	116.0	44.8	16.8	3.4	2.4	1.5	4.1	499.9
1994	105.6	149.3	103.1	48.5	39.7	18.6	4.3	1.6	3.0	473.7
1995	465.2	67.1	101.4	80.8	82.5	43.1	14.6	3.2	1.4	859.2
1996	553.2	195.6	60.0	38.1	35.1	32.0	17.7	2.3	0.9	934.9
1997	243.2	209.1	55.0	18.2	10.3	10.2	6.9	2.0	0.4	555.4
1998	189.9	272.2	168.5	62.8	17.1	8.2	5.6	2.7	0.5	727.4
1999	105.0	179.2	132.2	106.2	20.8	4.0	3.9	2.1	0.4	553.8
2000	30.3	121.3	130.9	52.5	43.5	9.6	0.9	1.4	0.3	390.7
2001	75.8	20.7	39.6	28.4	15.4	18.3	3.8	0.6	0.2	202.8
2002	6.6	80.5	28.6	18.5	17.2	6.8	3.4	0.5	0.1	162.2

Abundance indices (millions) from the Norwegian Bottom Trawl
survey in the Svalbard and Barents Sea area in July-August (1995-2002).
Swept area estimates of number of fish at each age. Rock-hopper gear.
This survey covers ICES Division IIa and IIb, as well as the north-eastern part of Sub-area I.
The figures given above for the Svalbard area are included in these estimates

			Age							
Year	1	2	3	4	5	6	7	8	9+	Total
1995	746.1	116.5	176.7	178.3	106.0	47.4	18.1	3.8	2.1	1395.0
1996	1314.8	440.9	104.9	87.8	73.4	45.6	25.0	4.2	1.5	2098.1
1997	745.3	551.7	163.8	38.3	27.0	29.5	20.1	7.4	2.0	1585.1
1998	841.0	466.2	299.3	104.9	27.2	14.6	10.6	5.3	1.6	1770.7
1999	200.2	274.6	191.2	145.6	35.3	6.7	5.2	3.3	0.9	863.0
2000	64.5	181.5	220.4	98.5	74.0	21.7	2.7	2.1	1.1	666.5
2001	319.0	42.3	62.6	49.6	29.1	24.2	6.7	0.7	0.4	534.6
2002	20.0	147.7	49.2	41.4	38.9	19.4	14.5	2.4	0.7	334.2

Table A6. North-east Arctic COD. Mean length at age(cm) from Norwegian surveys in January-March 1983-1999 values re-calculated from raw data.

Year	1	2	3	4	5	6	7	8
1978	14.2	23.1	32.1	45.9	54.2	64.6	67.6	76.9
1979	12.8	22.9	33.1	40.0	52.3	64.4	74.7	83.0
1980	17.6	24.8	34.2	40.5	52.5	63.5	73.6	83.6
1981	17.0	26.1	35.5	44.7	52.0	61.3	69.6	77.9
1982	14.8	25.8	37.6	46.3	54.7	63.1	70.8	82.9
1983	12.8	27.6	34.8	45.9	54.5	62.7	73.1	78.6
1984	14.2	28.4	35.8	48.6	56.6	66.2	74.1	79.7
1985	16.5	23.7	40.3	48.7	61.3	71.1	81.2	85.7
1986	11.9	21.6	34.4	49.9	59.8	69.4	80.3	93.8
1987	13.9	21.0	31.8	41.3	56.3	66.3	77.6	87.9
1988	15.3	23.3	29.7	38.7	47.6	56.8	71.7	79.4
1989	12.5	25.4	34.7	39.9	46.8	56.2	67.0	83.3
1990	14.4	27.9	39.4	47.1	53.8	60.6	68.2	79.2
1991	13.6	27.2	41.6	51.7	59.5	67.1	72.3	77.6
1992	13.2	23.9	41.3	49.9	60.2	68.4	76.1	82.8
1993	11.3	20.3	35.9	50.8	59.0	68.2	76.8	85.8
1994	12.0	18.3	30.5	44.7	55.4	64.3	73.5	82.4
1995	12.7	18.7	29.9	42.0	54.1	64.1	74.8	80.6
1996	12.6	19.6	28.1	41.0	49.3	61.4	72.2	85.3
1997 [1]	11.4	18.8	28.0	40.4	49.9	59.3	69.1	80.6
1998 [1]	10.9	17.4	28.7	40.0	50.5	58.9	67.5	76.3
1999	12.1	18.8	29.0	40.6	50.6	59.9	70.3	78.0
2000	13.0	21.0	28.7	39.7	51.5	61.6	70.5	75.7
2001	12.0	22.5	33.1	41.6	52.2	63.1	71.2	79.2
2002	12.2	19.9	30.1	43.6	52.2	61.7	71.6	79.1
2003	12.0	21.2	29.1	39.2	53.3	61.6	70.3	80.7

[1] Adjusted lengths

Table A7. North-east Arctic COD. Weight (g) at age from Norwegian surveys in January-March

Year	Age 1	2	3	4	5	6	7	8
1983		190	372	923	1597	2442	3821	4758
1984	23	219	421	1155	1806	2793	3777	4566
1985		171	576	1003	2019	3353	5015	6154
1986		119	377	997	1623	2926	3838	7385
1987 [2]	21	65	230	490	1380	2300	3970	
1988	24	114	241	492	892	1635	3040	4373
1989	16	158	374	604	947	1535	2582	4906
1990	26	217	580	1009	1435	1977	2829	4435
1991	18	196	805	1364	2067	2806	3557	4502
1992	20	136	619	1118	1912	2792	3933	5127
1993	9	71	415	1179	1743	2742	3977	5758
1994	13	55	259	788	1468	2233	3355	4908
1995	16	54	248	654	1335	2221	3483	4713
1996	15	62	210	636	1063	1999	3344	5514
1997 [1]	12	54	213	606	1112	1790	2851	4761
1998 [1]	10	47	231	579	1145	1732	2589	3930
1999	13	55	219	604	1161	1865	2981	3991
2000	17	77	210	559	1189	1978	2989	3797
2001	14	103	338	664	1257	2188	3145	4463
2002	15	68	256	747	1234	2024	3190	4511
2003	14	82	228	569	1302	1980	2975	4666

[1] Adjusted weights
[2] Estimated weights

Table A8. Northeast Arctic COD. Length at age in cm in the Lofoten survey

Year/age	5	6	7	8	9	10	11	12+
1985	59.6	71.1	79.0	88.2	97.3	105.2	114.0	
1986	62.7	70.0	80.0	89.4	86.6		105.8	115.0
1987	58.2	64.5	76.7	86.2	88.0		118.5	116.0
1988	53.1	67.1	71.6	94.0	97.0	119.6		
1989	54.0	59.0	69.8	80.8	96.6	103.0		125.0
1990	56.9	65.1	69.2	79.5	83.7	100.1		
1991	59.0	67.3	74.4	81.0	91.3	99.8	85.0	
1992	66.3	68.7	78.3	83.9	89.2	92.2	101.9	127.0
1993	58.3	66.1	72.8	83.6	87.4	92.7	95.4	111.2
1994	64.3	70.6	82.0	87.3	90.0	95.3	92.4	101.4
1995	61.5	69.7	77.8	84.4	92.6	96.7	100.3	99.5
1996	62.2	67.1	75.9	81.0	93.6	100.9	97.4	104.1
1997	63.7	68.6	74.2	83.8	99.9	108.4		109.0
1998	55.0	62.6	70.2	80.0	92.0	98.0	96.7	115.0
1999	52.7	67.0	69.4	78.6	85.8	100.3	102.0	125.0
2000	58.4	66.5	72.6	77.0	83.9	90.6	93.7	112.4
2001	59.2	66.8	73.1	86.4	88.9	101.8	98.1	128.2
2002	57.8	65.8	73.0	80.8	88.2	102.0	91.2	101.4
2003'	62.3	65.0	73.2	80.9	89.0	86.2	120.0	122.0

' - preliminary

Table A9. Northeast Arctic COD. Mean weight at age (kg) in the Lofoten survey

Year	5	6	7	8	9	10	11	12+
1985	2.00	3.42	4.61	6.67	8.89	10.73	14.29	
1986	2.22	3.22	4.74	6.40	5.80		10.84	13.48
1987	1.44	1.94	3.61	5.40	5.64		13.15	12.55
1988	1.46	2.82	3.39	6.63	7.27	13.64		
1989	1.30	1.77	2.89	4.74	8.28	9.98		26.00
1990	1.54	2.32	2.55	3.78	4.77	8.80		
1991	2.21	2.52	3.51	5.18	7.40	11.36	5.35	
1992	2.56	2.85	3.99	5.43	6.35	8.03	9.50	17.80
1993	1.79	2.58	3.55	5.31	6.21	7.69	9.28	14.71
1994	2.31	3.27	5.06	6.39	6.64	7.92	7.73	10.10
1995	2.20	3.24	4.83	5.98	7.80	10.03	10.39	10.68
1996	2.22	2.75	4.11	5.63	7.92	10.53	10.58	12.08
1997	2.42	2.92	3.86	5.71	9.65	13.41		12.67
1998	1.88	2.09	2.98	4.85	7.92	9.91	11.05	18.34
1999	1.51	2.80	2.96	4.22	5.92	9.33	9.17	16.00
2000	1.71	2.50	3.16	3.85	5.32	7.07	7.62	12.84
2001	1.89	2.71	3.48	6.02	6.88	10.69	10.19	28.58
2002	1.76	2.51	3.49	4.62	6.12	10.59	8.74	10.48
2003'	2.32	2.35	3.50	4.60	5.90	8.03	24.50	27.70

' - preliminary

Table A10 North-east Arctic COD. Results from the Russian trawl-acoustic survey in the Barents Sea and adjacent wates in the autumn. Stock number in millions.

Year	Age										
	1	2	3	4	5	6	7	8	9	10+	Total
1985 [1]	77	569	400	568	244	51	20	8	1	3	1941
1986 [1]	25	129	899	612	238	69	20	3	2	1	1998
1987 [2]	2	58	103	855	198	82	19	4	1	1	1323
1988 [2]	3	23	96	100	305	54	16	3	1	1	602
1989 [1]	1	3	17	45	57	91	75	25	13	5	332
1990 [1]	36	27	8	27	62	74	91	39	10	3	377
1991 [1]	63	65	96	45	50	54	66	49	5	1	494
1992 [1]	133	399	380	121	56	58	33	29	11	2	1222
1993 [1]	20	44	220	234	164	51	19	13	8	10	783
1994 [1]	105	38	147	275	303	314	100	35	10	8	1335
1995 [1]	242	42	111	219	229	97	21	6	2	2	971
1996 [1,3,5]	424	275	189	316	449	314	126	27	3	4	2127
1997 [4,5]	72	160	263	198	112	57	27	9	1	1	900
1998 [1]	26	86	279	186	57	23	10	4	1	0	672
1999 [1]	19	79	166	260	98	20	8	5	2	1	658
2000 [1, rev]	24	82	191	159	127	48	6	3	1	1	642
2001 [1]	38	59	148	204	120	70	14	2	1		656

[1] October-December
[2] September-October
[3] Area IIb not covered
[4] Areas IIa, IIb covered in October-December, part of Area I covered in February-March 1998
[5] Adjusted for incomplete area coverage

Table A11. North-East Arctic COD. Results from the Russian bottom trawl survey in the Barents Sea and adjacent waters in November-December (numbers per hour trawling)

Year	Age									
	1	2	3	4	5	6	7	8	9	10+	Total
			Total (Sub-area I and Division IIa and IIb)								
1982	2.1	2.5	14.1	7.6	9.4	5.8	3.2	1.1	0.4	0.3	46.3
1983	11.7	5.1	6.0	7.3	4.8	2.0	0.7	1.1	0.2	0.2	39.2
1984	11.1	11.3	15.6	9.3	4.9	3.0	1.2	0.5	0.3	0.2	57.2
1985	6.2	39.6	28.3	39.7	18.1	4.5	1.7	0.6	0.1	0.2	139.0
1986	1.5	8.0	49.5	28.6	14.0	5.0	1.4	0.2	0.1	0.1	108.4
1987	0.1	2.5	6.1	40.2	7.8	3.4	0.8	0.2	0.1	0.1	61.2
1988	0.2	1.5	6.6	7.3	19.3	3.3	1.0	0.2	0.1	0.1	39.5
1989	0.3	0.6	3.4	9.1	10.9	16.1	13.1	5.5	2.9	0.8	62.7
1990	3.8	2.9	0.9	2.9	6.5	7.8	9.6	4.3	1.1	0.3	40.1
1991	6.9	7.1	10.2	4.8	5.8	6.6	8.3	7.1	0.7	0.1	57.6
1992	10.8	30.6	30.9	9.0	4.5	4.8	2.6	2.3	0.9	0.1	96.4
1993	4.5	10.3	49.1	52.6	37.7	11.7	4.5	3.2	1.9	2.5	178.0
1994	11.4	5.8	23.0	40.4	38.3	36.6	12.0	4.2	1.3	1.4	174.3
1995	26.0	4.5	11.9	23.5	24.7	10.5	2.3	0.7	0.2	0.2	104.5
1996 [1]	17.8	11.6	7.7	10.1	12.6	8.6	3.6	0.9	0.1	0.1	73.1
1997 [1]	7.3	17.3	9.9	8.3	6.2	3.7	1.8	0.5	0.1	0.0	55.1
1998	4.9	15.9	50.8	33.4	9.7	3.7	1.6	0.7	0.1	0.1	120.9
1999	3.6	14.3	28.4	47.5	16.2	3.1	1.2	0.8	0.2	0.1	115.4
2000	3.1	11.7	27.6	21.9	16.9	5.8	0.8	0.3	0.1	0.1	88.3
2001	6.7	11.0	27.7	37.2	20.6	11.5	2.2	0.3	0.1	0.1	117.4
2002 [2]	12.6	0.3	18.0	14.4	24.1	25.2	11.7	5.2	1.2	0.3	113.1

[1] Adjusted assuming area distribution as 1982-1995 average.
[2] Adjusted assuming area distribution as 1998-2001 average.

Table A12 North-East Arctic COD. Length at age (cm) from Russian surveys in November–December

Year	Age									
	0	1	2	3	4	5	6	7	8	9
1984	15.7	22.3	30.7	44.3	51.7	63.6	73.4	82.5	88.4	97.0
1985	15.0	21.1	30.6	43.2	53.7	61.2	72.8	83.0	92.8	101.3
1986	15.2	19.7	28.3	39.0	51.8	62.2	70.9	83.0	91.3	104.0
1987	-	19.2	27.9	33.4	41.4	59.1	69.2	80.1	95.7	102.6
1988	11.3	21.3	28.7	36.2	43.9	53.3	65.3	79.5	85.0	-
1989	-	20.8	28.8	34.8	46.0	53.9	61.8	69.8	78.7	88.6
1990	16.0	24.0	30.4	46.5	54.9	62.5	69.7	77.6	87.8	102.0
1991	11.5	22.4	30.6	43.0	55.9	64.6	72.8	78.5	87.9	101.8
1992	11.3	21.3	31.9	50.1	59.8	69.1	78.6	84.0	90.8	97.5
1993	12.1	17.4	29.1	43.4	52.7	64.3	73.9	81.2	89.1	91.8
1994	12.2	20.3	26.3	33.7	47.4	58.7	70.6	80.8	90.1	96.1
1995	11.6	19.8	27.6	33.8	45.2	60.5	71.1	83.5	92.9	99.1
1996	10.2	20.0	28.1	36.7	48.7	58.9	70.5	80.0	93.6	102.7
1997	9.6	18.5	28.8	38.2	50.8	62.0	70.5	80.1	88.9	103.5
1998	11.4	19.0	28.0	36.4	50.5	61.0	70.7	80.3	91.1	102.5
1999	11.7	19.7	27.9	35.3	51.6	60.6	70.6	78.9	86.8	94.3
2000	10.7	20.8	30.1	34.7	49.8	61.1	71.6	82.0	88.3	85.7
2001	10.6	19.4	29.8	37.3	50.4	61.9	71.9	81.4	91.0	98.7
2002	10.7	19.2	29.9	38.2	52.5	60.4	70.6	82.2	91.3	97.2

Table A13 North-East Arctic COD. Weight (g) at age from Russian surveys in November–December.

Year	Age										
	0	1	2	3	4	5	6	7	8	9	10
1984	26	90	250	746	1,187	2,234	3,422	5,027	6,479	9,503	-
1985	26	80	245	762	1,296	1,924	3,346	5,094	7,360	6,833	11,167
1986	25	63	191	506	1,117	1,940	2,949	4,942	7,406	9,300	-
1987	-	54	182	316	672	1,691	2,688	3,959	8,353	10,583	13,107
1988	15	78	223	435	789	1,373	2,609	4,465	5,816	-	-
1989	-	73	216	401	928	1,427	2,200	3,133	4,649	6,801	8,956
1990	28	106	230	908	1,418	2,092	2,897	4,131	6,359	10,078	13,540
1991	26	93	260	743	1,629	2,623	3,816	4,975	7,198	11,165	15,353
1992	10	76	273	1,165	1,895	2,971	4,377	5,596	7,319	9,452	12,414
1993	11	46	211	717	1,280	2,293	3,509	4,902	6,621	7,339	8,494
1994	12	69	153	316	919	1,670	2,884	4,505	6,520	8,207	9,812
1995	11	61	180	337	861	1,987	3,298	5,427	7,614	9,787	10,757
1996	7	64	191	436	1,035	1,834	3,329	5,001	8,203	10,898	11,358
1997	6	48	203	487	1,176	2,142	3,220	4,805	6,925	10,823	12,426
1998	11	55	187	435	1,186	2,050	3,096	4,759	7,044	11,207	12,593
1999	10	58	177	371	1,214	1,925	3,064	4,378	6,128	7,843	11,543
2000	8	74	232	379	1,101	2,128	3,341	5,054	6,560	8,497	12,353
2001	9	58	221	459	1,125	2,078	3,329	4,950	7,270	9,541	11,672
2002	8	65	232	505	1,299	1,964	3,271	5,325	7,249	9,195	11,389

Table A14 Abundance indices of 0-group fish in the Barents Sea and adjacent waters in 1965-2002
Indices for 1965-1985 adjusted according to Nakken and Raknes (1996).

Year	Cod	Haddock	Polar cod		Redfish	Greenland halibut	Long rough Dab
			West	East			
1965	11	13		0	159		66
1966	2	2		129	236		97
1967	62	76		165	44		73
1968	45	14		60	21		17
1969	211	186		208	295		26
1970	1097	208		197	247	1	12
1971	356	166		181	172	1	81
1972	225	74		140	177	8	65
1973	1101	87		(26)	385	3	67
1974	82	237		227	468	13	83
1975	453	224		75	315	21	113
1976	57	148		131	447	16	96
1977	279	187	157	70	472	9	72
1978	192	110	107	144	460	35	76
1979	129	95	23	302	980	22	69
1980	61	68	79	247	651	12	108
1981	65	30	149	73	861	38	95
1982	136	107	14	50	694	17	150
1983	459	219	48	39	851	16	80
1984	559	293	115	16	732	40	70
1985	742	156	60	334	795	36	86
1986	434	160	111	366	702	55	755
1987	102	72	17	155	631	41	174
1988	133	86	144	120	849	8	72
1989	202	112	206	41	698	5	92
1990	465	227	144	48	670	2	35
1991	766	472	90	239	200	1	28
1992	1,159	313	195	118	150	3	32
1993	910	240	171	156	162	11	55
1994	899	282	50	448	414	20	272
1995	1,069	148	6	-	220	15	66
1996	1,142	196	59	484	19	5	10
1997	1,077	150	129	453	50	13	42
1998	576	593	144	457	78	11	28
1999	194	184	116	696	27	13	66
2000	870	417	76	387	195	28	81
2001	212	394	148	146	11	32	86
2002	1055	412	179	588	28	34	173

Table A15 Estimated logarithmic indices with 90% confidence limits of year class abundance for 0-group herring, cod and haddock in the Barents Sea and adjacent waters 1965–2002

Year	Herring[1]			Cod			Haddock		
	Index	Confidence limits		Index	Confidence limits		Index	Confidence limits	
1965				+					
1966	0.14	0.04	0.31	0.02	0.01	0.04	0.01	0.00	0.03
1967	0.00	-	-	0.04	0.02	0.08	0.08	0.03	0.13
1968	0.00	-	-	0.02	0.01	0.04	0.00	0.00	0.02
1969	0.01	0.00	0.04	0.25	0.17	0.34	0.29	0.20	0.41
1970	0.00	-	-	2.51	2.02	3.05	0.64	0.42	0.91
1971	0.00	-	-	0.77	0.57	1.01	0.26	0.18	0.36
1972	0.00	-	-	0.52	0.35	0.72	0.16	0.09	0.27
1973	0.05	0.03	0.08	1.48	1.18	1.82	0.26	0.15	0.40
1974	0.01	0.01	0.01	0.29	0.18	0.42	0.51	0.39	0.68
1975	0.00	-	-	0.90	0.66	1.17	0.60	0.40	0.85
1976	0.00	-	-	0.13	0.06	0.22	0.38	0.24	0.51
1977	0.01	0.00	0.03	0.49	0.36	0.65	0.33	0.21	0.48
1978	0.02	0.01	0.05	0.22	0.14	0.32	0.12	0.07	0.19
1979	0.09	0.01	0.20	0.40	0.25	0.59	0.20	0.12	0.28
1980	-	-	-	0.13	0.08	0.18	0.15	0.10	0.20
1981	0.00	-	-	0.10	0.06	0.18	0.03	0.00	0.05
1982	0.00	-	-	0.59	0.43	0.77	0.38	0.30	0.52
1983	1.77	1.29	2.33	1.69	1.34	2.08	0.62	0.48	0.77
1984	0.34	0.20	0.52	1.55	1.18	1.98	0.78	0.60	0.99
1985	0.23	0.18	0.28	2.46	2.22	2.71	0.27	0.23	0.31
1986	0.00	-	-	1.37	1.06	1.70	0.39	0.28	0.52
1987	0.00	0.00	0.03	0.17	0.01	0.40	0.10	0.00	0.25
1988	0.32	0.16	0.53	0.33	0.22	0.47	0.13	0.05	0.34
1989	0.59	0.49	0.76	0.38	0.30	0.48	0.14	0.10	0.20
1990	0.31	0.16	0.50	1.23	1.04	1.34	0.61	0.48	0.75
1991	1.19	0.90	1.52	2.30	1.97	2.65	1.17	0.98	1.37
1992	1.06	0.69	1.50	2.94	2.53	3.39	0.87	0.71	1.06
1993	0.75	0.45	1.14	2.09	1.70	2.51	0.64	0.48	0.82
1994	0.28	0.17	0.42	2.27	1.83	2.76	0.64	0.49	0.81
1995	0.16	0.07	0.29	2.40	1.97	2.88	0.25	0.13	0.40
1996	0.65	0.47	0.85	2.87	2.53	3.24	0.39	0.25	0.56
1997	0.39	0.25	0.54	1.60	1.35	1.86	0.21	0.12	0.31
1998	0.59	0.40	0.82	0.68	0.48	0.91	0.59	0.44	0.76
1999	0.41	0.25	0.59	0.21	0.11	0.34	0.25	0.11	0.44
2000	0.30	0.17	0.46	1.49	1.21	1.78	0.64	0.46	0.84
2001	0.13	0.04	0.25	0.23	0.12	0.36	0.67	0.52	0.84
2002	0.53	0.36	0.73	1.22	0.97	1.50	0.99	0.75	1.25

[1]Assessment for 1965–1984 made by Toresen (1985).

Table A16. Sum of acoustic abundance estimates (millions) in the Joint winter Barents Sea aurvey (Table A2) and the Norwegian Lofoten acoustic survey (Table A4)

	Age											
Year	1	2	3	4	5	6	7	8	9	10	11	12+
1985	69.1	446.3	153.0	141.6	20.4	15.1	15.7	3.3	1.3	1.0	0.5	0.0
1986	353.6	243.9	499.6	134.3	68.4	11.6	7.7	3.1	0.3	0.0	0.4	0.1
1987	1.6	34.1	62.8	204.9	50.2	17.4	1.4	3.0	0.7	0.0	0.0	0.0
1988	2.0	26.3	50.4	35.5	57.8	10.9	4.0	0.3	0.0	0.1	0.0	0.0
1989	7.5	8.0	17.0	34.4	21.4	67.0	16.6	3.2	0.5	0.2	0.0	0.1
1990	81.1	24.9	14.8	20.6	26.2	26.9	66.8	7.3	0.6	0.3	0.0	0.0
1991	181.0	219.5	50.2	34.6	29.3	33.9	36.7	50.0	3.7	0.2	0.2	0.0
1992	241.4	562.1	176.5	65.8	21.5	18.4	28.4	25.4	82.4	4.4	1.6	0.2
1993	1074.0	494.7	357.2	191.1	113.1	35.4	25.5	25.2	27.7	44.5	4.7	0.7
1994	858.3	577.2	349.8	404.5	217.5	89.5	22.5	11.9	9.4	4.4	17.5	2.6
1995	2619.2	292.9	166.2	159.8	216.6	104.0	29.0	4.4	4.3	3.6	2.2	8.0
1996	2396.0	339.8	92.9	70.5	87.2	89.1	44.6	6.5	1.1	0.7	0.8	1.3
1997	1623.5	430.5	188.3	51.7	49.7	42.2	49.9	20.5	2.2	0.5	0.0	0.8
1998	3401.3	632.9	427.7	182.6	42.4	33.8	34.0	24.7	4.9	0.8	0.2	0.0
1999	358.3	304.3	150.0	96.4	45.4	12.2	11.2	18.7	9.2	1.1	0.2	0.1
2000	154.1	221.4	245.2	158.9	145.7	49.3	12.9	6.9	5.2	1.6	0.4	0.1
2001	629.9	63.9	138.2	171.6	81.2	55.4	19.0	2.2	0.8	0.5	0.3	0.1
2002	18.2	215.5	69.3	112.2	103.5	59.1	29.7	7.3	1.0	0.4	0.3	0.0
2003	1693.9	61.5	303.4	114.4	132.0	149.2	69.2	23.1	4.1	0.5	0.1	0.1

4 NORTHEAST ARCTIC HADDOCK (SUBAREAS I AND II)

4.1 Status of the Fisheries

4.1.1 Historical development of the fisheries

Haddock is mainly fished by trawl as a by-catch in the fishery for cod. Occasionally there is also a directed trawl fishery for haddock. On average approximately 25% of the catch is with conventional gears, mostly longline, which are used almost exclusively by Norway. Part of the longline catches are from a directed fishery. The fishery is restricted by national quotas. In the Norwegian fishery the quotas are set separately for trawl and other gears. The fishery is also regulated by a minimum landing size, a minimum mesh size in trawls and Danish seine, a maximum by-catch of undersized fish, closure of areas with high density/catches of juveniles and other seasonal and areal restrictions.

Historical landings of the fishery show a cyclical pattern (Figure 4.1A, Table 4.1). The historical high catch level of 320,000 t in 1973 divides the time-series into two periods. In the first period, highs were close to 200,000 t around 1956, 1961 and 1968, and lows were between 75,000 and 100,000 t in 1959, 1964 and 1971. The second period showed a steady decline from the peak in 1973 down to the historically low level of 17,300 t in 1984. Afterwards, landings increased to 151,000 t before declining to 26,000 t in 1990. A new increase peaked in 1996 at 174,000 t.

The trawl fishery has been more variable than other gears (Table 4.2). In recent years Norway and Russia have accounted for more than 90% of the landings (Table 4.3). Before the introduction of national economic zones in 1977, UK (mainly England) landings made up 10–30% of the total.

The exploitation rate of haddock has been variable. The highest fishing mortalities for haddock have occurred at intermediate stock levels and show little relationship with the exploitation rate of cod, in spite of haddock being primarily a by-catch in the cod fishery. The exception is the 1990s when more restrictive quota regulations resulted in a similar pattern in the exploitation rate for both species. It might be expected that good year classes of haddock would attract more directed trawl fishing, but this is not reflected in the fishing mortalities.

4.1.2 Landings prior to 2003 (Tables 4.1–4.3, Figure 4.1A)

Final reported landings in 2001 are 81 842 t (Table 4.1), which is close to the figure used in last year’s assessment. The provisional landings for 2002 are 83 848 t, which is slightly less than the 85 000 t landings expected by the Working Group last year. The agreed TAC was 85 000 t. Catches increased in subareas I and IIb. The catch by area, broken down by trawl and other gears, is given in Table 4.2. The nominal catch by country is given in Table 4.3. Landings from 2001 and 2002 were revised according to official statistics from ICES.

4.1.3 Expected landings in 2003

The 85 000 t TAC agreed for 2002 was not exceeded. ACFM recommended to set a TAC lower than 101 000 t for 2003. The agreed TAC for 2003 is 101 000 t. The total landing in 2003 is expected to be equal to the agreed TAC.

4.2 Status of Research

4.2.1 Fishing effort and CPUE

After a period of reduced trawl fishery for haddock, it has increased in recent years (Table 4.2). The CPUE series of Norwegian trawl fisheries has previously been updated for tuning of the older ages in the VPA. The basis was the trawl effort in Norwegian statistical areas 03, 04, and 05, covering the Norwegian coastal banks north of Lofoten. These areas account for approximately 70% of the Norwegian trawl landings. However, because of the large proportion taken as by-catch it is difficult to estimate the actual trawl effort on haddock. The CPUE series was not used for tuning the XSA in last year’s assessment and the series has not been updated with values for 2002.

4.2.2 Survey results (Tables B1-B6)

The overall picture seen in the surveys is summarized as follows: the year class 1997 seems to be poor, and the 1998, 1999, 2000, and 2001 year classes appear above average. The 2002 year class looks even more promising and can be the first sign of a year class comparable with the 1990 or 1983 year classes. Regarding the fishable stock, numbers of 6+ age groups are much reduced after the fading of the strong 89-91 year classes from the surveys.

Norwegian bottom trawl and acoustic survey

Norway provided indices from the 2003 Barents Sea bottom trawl and acoustic survey in January-March (Table B1 and B3). There was a reduced coverage of the Barents Sea in 1997-1998, but full coverage since then. Trawl survey indices from 1983 onwards have been recalculated in the same way as for cod (Section 3.2.2). High indices, caused by the good period of recruitment around 1990, can be tracked from year to year in both series and the 1990 year class appears as the strongest for age groups 3–8. The year classes 1998 to 2001 have been observed as stronger than the 1992-1997 year classes. The 2002 year class has been observed only once, but the results suggest a year class even stronger and possibly as strong as the 1990 year class.

Russian bottom trawl and acoustic survey

Russia provided indices from the 2002 Barents Sea trawl and acoustic survey (Tables B2, B4a, and B4b), which was carried out in October-December. The Russian survey shows the same main trends as the Norwegian survey. From 1995 onwards there has been a substantial change in the method for calculating acoustic indices. The acoustic survey is therefore presented in 2 tables (Table B4a and B4b) for old and new method of calculating indices.

International 0-group survey

Estimates of the abundance of 0-group haddock from the International 0-group survey are presented in Tables A14 and A15. The indices indicate good recruitment for haddock from 1990 to 1994, average from 1995 to 1997, good in 1998, average in 1999 and good again in 2000 and 2001 and very good in 2002.

4.2.3 Weight-at-age (Table B6)

Length and weight-at-age from the surveys are given in Tables B5 and B6, respectively. All weights-at-age are comparable with the previous years except the weight-at-age for the 1997 year class, which is somewhat reduced.

4.3 Data Used in the Assessment

4.3.1 Catch-at-age (Table 4.7)

Age compositions of the landings for 2002 were available from Norway and Russia in Subarea I, from Norway, Russia, and Germany in Division IIa, and from Norway and Russia in Division IIb. The catches of the other countries were distributed among ages using the combined Norwegian/Russian age composition in Subarea I and in Division IIb, and the Russian trawl age composition in Division IIa. The SOP check gave no deviation from the nominal catch of 2002.

4.3.2 Weight-at-age (Tables 4.8–4.9)

The mean weights-at-age in the catch (Table 4.8) were calculated as weighted averages of the weights in the catch of Norway and Russia. The weights-at-age in the catch in 2002 are showing a declining tendency for ages 1 to 6.

Stock weights (Table 4.9) used from 1985 to 2003 are averages of values derived from Russian surveys in autumn (mostly October-December) and Norwegian surveys in January-March the following year (Table B6). These averages are assumed to give representative values for the beginning of the year. For the oldest age groups, fixed weights were used when survey data were missing or inadequate. The fixed weights have been reduced in the most recent years to be more consistent with observed weights on the younger year classes.

4.3.3 Natural mortality (Table 4.10)

Natural mortality was set to 0.2+mortality from predation by cod (see Section 4.4.1). The proportion of F and M before spawning was set to zero.

4.3.4 Maturity-at-age (Table 4.4 and 4.11)

A maturity ogive was available from Russia for the period 1981-2003 (Table 4.4). The ogive shows a relatively early maturation compared to the period 1994 to 1998. The maturity-at-age series for the whole period 1950-2002 is shown in Table 4.11.

4.3.5 Data for tuning (Table 4.12)

The following surveys series are included in the data for tuning:

Name	Place	Season	Age	Year	prior weight
Russian bottom trawl	Total area	Autumn	1–7	1983–2002	1
Norwegian bottom trawl	Barents Sea	Winter	1–8	1982–2002	1
Norwegian acoustic	Barents Sea	Winter	1–7	1980–2002	1

The indices for the 1996 year class was not used for tuning the XSA. See Section 4.4.1 in last years report.

4.3.6 Recruitment indices (Table 4.5)

The table with recruitment indices cover the year classes 1980 and later. The 0-group index was not used for input to the RCT3. Since the indices of the 1996 year classes were removed from the tuning of the XSA, they were also removed from recruitment estimation. See section 4.4.1 in last years report.

4.3.7 Prediction data (Table 4.19)

Weights-at-age and proportions mature at age shows strong cyclic patterns related to periods of good recruitment. The working group believes that the estimated recruitment in the latest years is so high that it will effect growth and maturation processes. The working group therefore decided to use similar trends in weight-at-age, maturity and natural mortality as has been observed in previous periods following good recruitment. The input data for making the prediction was then:

- The estimated recruitment given in Table 4.6.
- The average fishing pattern observed in the 3 last years.
- Observed maturity for 2003, average maturity for the periods 1987-1989 and 1994-1997 (7 years) for 2005 and maturity-at-age in 2004 as the average between 2003 and 2005
- Weight-at-age in the stock was calculated in the same way as maturity-at-age with the exception that the period 1987-1989 was not used. This due to poor weight data for that period.
- Weight-at-age in the catches for 2003 was set equal to the observed data in 2002,. The 2004 and 2005 numbers was calculated in the same way as the weight-at-age in the stock (using the average weight-at-age in the catches in 1994-1997 as the weight-at-age in 2005).
- Natural mortality was calculated similar to the maturity with the exception that natural mortality for 2003 was set equal to 2002.
- And stock numbers and fishing mortalities from the standard VPA.

4.4 Methods Used in the Assessment

4.4.1 VPA and tuning

The Extended Survivors Analysis (XSA) was used to tune the VPA to the available index series (Table 4.12). The settings used by the AFWG in 2002 were used. We quote from the 2001 WG report: “The catchability dependent on stock size for ages <7 was used instead of 6 because the diagnostics show the age 6 as the last age group in which the slope differs from 1. In addition, the assessment was made to truncate the older ages (e.g., 1-11+). An age span of ages 1 to 11+ was used because the catchability analysis for the old ages are under-determined. Survivor estimates shrunk towards the mean F of the final 5 years of the 3 oldest ages, and S.E.D. of the mean to which the estimates are shrunk was set to 1, due to high variability in the fishing mortality of recent years. “

The estimated consumption of NEA haddock by NEA cod is incorporated into the XSA analysis by first constructing a catch number-at-age matrix, adding the numbers of haddock eaten by cod to the catches for the years where such data are available (1984–2001) (Table A16). The consumption of NEA haddock by NEA cod is given below:

	Consumption of Haddock by NEA Cod (millions)					
	1	2	3	4	5	6
1984	980.0	14.7	0.1	0.0	0.0	0.0
1985	1203.5	5.2	0.0	0.0	0.0	0.0
1986	563.9	244.9	168.0	0.0	0.0	0.0
1987	766.7	0.0	0.0	0.0	0.0	0.0
1988	17.1	0.5	9.1	0.0	0.2	0.0
1989	236.4	0.0	0.0	0.0	0.0	0.0
1990	142.3	36.4	3.5	0.0	0.0	0.0
1991	460.5	14.4	0.0	0.0	0.0	0.0
1992	2114.9	151.1	1.1	0.0	0.0	0.0
1993	1375.7	167.7	37.4	3.4	2.9	0.0
1994	1407.7	80.8	25.1	7.7	0.9	0.0
1995	2895.2	163.7	12.0	30.1	30.1	0.3
1996	1586.9	160.9	40.0	5.4	2.6	3.4
1997	900.9	35.4	25.7	1.7	0.8	0.5
1998	1513.5	27.7	2.0	2.9	0.5	0.0
1999	908.5	23.3	0.3	0.0	0.0	0.0
2000	1251.5	64.8	1.9	1.0	0.2	0.1
2001	574.0	51.8	4.3	0.1	0.0	0.0
2002	4169.4	410.5	65.5	1.8	0.2	0.0

The fishing mortality estimated by this XSA was split into the mortality caused by the fishing fleet (F) and the mortality caused by the cod's predation (M2) according to the ratio of fleet catch and predation "catch". The new natural mortality data set was then prepared by adding 0.2 (M1) to the predation mortality. This new M matrix (Table 4.10) was used in the final XSA. Based on this last run, a conventional VPA was made, which includes age group 3 and older in order to get a summary table needed for the report. Terminal F's were set equal to the last year and highest true age (10 years) F's from the XSA.

The retrospective performance of the XSA is illustrated in Figures 4.5 to 4.7

4.4.2 Recruitment (Tables 4.6)

The recruiting year classes 2000-2002 were estimated using RCT3 (input given in Tables 4.5 and output given in 4.6). The 0-group index was not used and the indices for the 1996 year class was also removed. This year class was removed because there is strong evidence that this year class is distributed mainly outside the areas covered by the surveys used. See also section 4.4.1 of last years report. The 2002 year class estimate was heavily influenced by the "shrinkage" (high weight given to mean recruitment). The different indices all indicates a year class strength more than twice the 422 millions estimated in Table 4.6.

4.5 Results of the Assessment

4.5.1 Fishing mortality and VPA (Tables 4.13–4.18 and Figures 4.1A-B, 4.1D, 4.5-4.7)

The tuning diagnostics of the final XSA (predation included) are given in Table 4.13.

Natural mortalities, fishing mortalities, and stock numbers of the final VPA are given in Tables 4.10, 4.14, and 4.15, respectively, while the stock biomass at age and the spawning biomass at age are given in Tables 4.16 and 4.17. A summary of landings, fishing mortality, spawning stock biomass, and recruitment since 1950 is given in Table 4.18 and Figures 4.1A, 4.1B, 4.1C, and 4.1D.

This years assessment revised the 2001fishing mortality slightly upwards. F_{4-7} indicates a slightly reduced fishing mortality relative to the period 1997-1999, but since the assessment is rather uncertain (especially for the 1996 year class) this cannot be a strong conclusion. We can however, conclude that the fishing mortality in 2002 was well above $\mathbf{F}_{pa}$ (0.35).

The fishery has in 2000 and 2001 mainly been targeting the 1996 year class, but the 1998 yerclass is the most numerous in the 2002 catches.

The spawning stock biomass was revised through the changes made to the assessment, but the trends are quite similar to last year's assessment. The maturity ogives used are rather "noisy" and show clear signs of inconsistencies. The spawning stock biomass seemed to reach the bottom in 2000 and the small decrease in 2002 from the 2001 estimate was not expected, but could in part be caused by the afore mentioned "noisy" ogives.

4.5.2 Recruitment (Tables 4.6A, 4.6B, 4.15 and Figure 4.1C)

This year's assessment made the following revisions to the estimated year class strength of the recruiting year classes (numbers in millions at age 3):

Year Class	2002	2003
1997	58	61
1998	265	309
1999	241	330
2000	199	250
2001	284	277
2002		422

The overall picture is towards higher estimates than the previous assessment. This could be expected as the shrinkage towards mean recruitment gets less weight.

4.5.3 Yield-per-recruit (Table 4.20, Figure 4.3)

A simple yield-per-recruit plot with updated data is presented in Figure 4.3.

4.5.4 Catch options for 2004 (Table 4.21)

The catch in 2002 correspond to Fbar=0.44 and the estimated spawning stock biomass will be 120 000 t in the beginning of 2003. Assuming a status quo F in 2003 the deterministic projection suggests an increase in SSB to 133000 t in the beginning of 2004 (which is well above $\mathbf{B}_{pa}$). Fishing at $\mathbf{F}_{pa}$ in 2004 corresponds to total landings of 120000 t, with a further strengthening of the SSB into the beginning of 2005. A prediction with single option table is shown in Table 4.22. The input to the prediction is given in Table 4.19.

4.6 Biological reference points.

4.6.1 Biomass reference points (Figures 4.2 and 4.4)

The biomass reference points adopted by ACFM for this stock are $\mathbf{B}_{lim}$=50,000 t and $\mathbf{B}_{pa}$ =80,000 t. No revisions to these values were put forward for consideration at this meeting. However, in light of the strong retrospective year class dependent bias in haddock assessments it appears that the separation between $\mathbf{B}_{lim}$ and $\mathbf{B}_{pa}$ is rather small. Therefore, a more conservative level for $\mathbf{B}_{pa}$ should be investigated.

4.6.2 Fishing mortality reference points (Figure 4.4)

The fishing mortality reference points adopted by ACFM for this stock are $\mathbf{F}_{lim}$=0.49 and $\mathbf{F}_{pa}$ =0.35. No revisions to these values were put forward for consideration at this meeting. However, given the concerns noted above a more conservative level for $\mathbf{F}_{pa}$ also should be investigated.

4.7 Comments to the assessment and forecasts

As commented on in section 4.9 the tuning is not very stable.

The working groups had problems to estimate reasonable fishing mortalities for the 1996 year class in last year's assessment. Our solution was to delete it all together from the tuning and let the fishing mortality be decided by "shrinkage" to the mean F. The WG groups made runs both with and without this year class in the tuning this year as well, but came to the same conclusion (the inclusion of tuning indices gave an estimate of F=1.15 for this year class). The same reasoning was used when we decided to not use the indices from this year class as input to the RCT3.

The problem with the survey coverage of the 1996 year class is not new and similar problems with earlier year classes can have been a contributing factor to previous assessment problems for this stock.

The forecasts are very much depending on the estimates of the year class strength of the incoming year classes. The forecasts are also quite depending on the maturity-at-age, natural mortality and weight-at-age numbers used as input. These parameters are known to vary quite a lot for this stock and we have tried to create a trend towards observations of such parameters made after period of good recruitment (1987-1989 and 1994-1997). This makes the forecast much more conservative than the traditional average over some range of most recent years. But the working group believes this to be amore realistic approach.

4.7.1 Changes from last year

The following changes was made to the assessment compared to last year:

1) Total landings in 2001 were revised slightly.
2) As in the 2002 assessment the tuning data for the 1996 year class was removed.
3) The XSA estimate of the recruiting year class (1999) was accepted. (Last years XSA estimate of the 1998 year class was replaced with a RCT3 estimate.
4) Age group 4 was not used in the RCT3 run (see 3) and neither was the 0-group index.

4.8 Technical minutes from ACFM

Age 1 and 2

We quote: "It was proposed in the last Technical minutes that the AFWG runs the XSA without the age groups 1 and 2 due to low catches and uncertain predation mortality at these ages. This suggests that population estimates at these ages will be very noisy. As these estimates contribute to estimation of survivors from the oldest age of the cohort they are likely to add noise to the survivor estimates. Also it was noted that there are no weight-at-age estimates for theses young age groups available.

AFWG did not follow this and ran the XSA with age groups 1 and 2. The AFWG is asked to either exclude these age groups or to explain why they wish to include them in present assessment."

The working group agree with ACFM in their concern that these agegroups may contribute to increased noise in the estimate of survivors over the whole age range. We believe however, that this level of noise is negligible relative to other problems with assessing this stock.

The working group started the preparation of assessing the deletion of ages 1 and 2 from the assessment by comparing single fleet runs with a combined run of 3 fleets. The combined tuning gave most weight to the fleet that indicated the lowest SSB in 2002, but the combined run SSB estimate was higher than any of the single fleet runs. See Figure 4.8 top panel. The estimates are all shrunk towards the mean and we increased the shrinkage from the modest se=1.00 to the default se=0.5. The effect can be seen in the middle panel of Figure 4.8. And the difference in the regression parameters in the single fleet runs and the combined run was larger than with the more modest shrinkage. The third attempt was the removal of all shrinkage and the results can be seen in the bottom panel. The regression parameters did not change much between the single fleet runs and the combined, but the single fleet runs "spread" out too much.

The working group tried also to assess the effect of removing younger agegroups from the assessment by comparing retrospective runs. See Figures 4.9 and 4.10. The removal of the youngest agegroups seemed to increase the overall bias. The observed retrospective bias is clearly year class dependent and it was mainly the year classes 1989-1991 that was overestimated. Other (and weaker) year classes were typically underestimated. Since we know are entering a period with potentially quite high abundance we choose to let the youngest agegroups be included in the assessment for now. The additional tuning problems without these agegroups contributed to that decision.

0-group data as input to RCT3

We quote: “Also in the technical minutes from last year it was noted that 0 group survey data were of little significance in estimating recruitment and the AFWG was asked to remove these from the RCT3 data set.

The AFWG did not follow this either. The AFWG is asked to explain why they included the 0-group in the present assessment.”

The working group removed the logarithmic 0-group index series and replaced it with an area based 0-group index.

More than one RCT3 run

We quote: ” ACFM could not understand why two RCT3 runs were made using different surveys to estimate population numbers for the same age group. The reason for this was not explained in the report, so ACFM chose to re-run RCT3 using only one combined set of survey indices, with the 1996 year class included in the RCT3 input file.”

As ACFM raised the question of indices representing younger agegroups being more “noisy” than older agegroups we tried to remove this potential noise by not using them as input when we had indices representing the year class at age 2, 3 or 4. This year we used the input suggested by ACFM, but we did not include the indices for the 1996 year class (this year class is distributed mainly outside the survey areas).

Data series

We quote: “By rerunning the RCT3 it was noted that similar values in the input RCT3-Table 4.5A (column RT1) could not be found in Table B2.”

The RT1 series used in last year’s assessment was representing only a part of the total survey area. It has been replaced with the corresponding index representing the total survey area. The labelling was also misleading because this series represented the 0-group fish late in the year. The labelling of the 2 other indices from this survey was also misleading. The indices are no labelled RT0, RT1, and RT2 with values taken from Table 4.5.

Missing plots

We quote: “Comments were made that the standard plots summary figures (A-D) are missing.”

By a mistake the plots was not copied from final runs\standard graphs into the report folder.

Table 4.1 North-East Arctic HADDOCK. Total nominal catch (t) by fishing areas. (Data provided by Working Group members).

Year	Sub-area I	Division IIa	Division IIb	Total
1960	125,026	27,781	1,844	154,651
1961	165,156	25,641	2,427	193,224
1962	160,561	25,125	1,723	187,408
1963	124,332	20,956	936	146,224
1964	79,262	18,784	1,112	99,158
1965	98,921	18,719	943	118,578
1966	125,009	35,143	1,626	161,778
1967	107,996	27,962	440	136,397
1968	140,970	40,031	725	181,726
1969	89,948	40,306	566	130,820
1970	60,631	27,120	507	88,257
1971	56,989	21,453	463	78,905
1972	221,880	42,111	2,162	266,153
1973	285,644	23,506	13,077	322,226
1974	159,051	47,037	15,069	221,157
1975	121,692	44,337	9,729	175,758
1976	94,054	37,562	5,648	137,264
1977	72,159	28,452	9,547	110,158
1978	63,965	30,478	979	95,422
1979	63,841	39,167	615	103,623
1980	54,205	33,616	68	87,889
1981	36,834	39,864	455	77,153
1982	17,948	29,005	2	46,955
1983	7,550	13,872	185	21,607
1984	4,000	13,247	71	17,318
1985	30,385	10,774	111	41,270
1986	69,865	26,006	714	96,585
1987	109,425	38,181	3,048	150,654
1988	43,990	47,087	668	91,745
1989	31,116	23,390	353	54,859
1990	15,093	10,344	303	25,741
1991	18,772	14,417	416	33,605
1992	30,746	22,177	964	53,887
1993	47,574	27,010	3,037	77,621
1994	75,059	46,329	7,315	128,703
1995	70,390	54,169	14,118	138,677
1996	112,781	57,189	3,294	173,264
1997	78,335	67,917	2,504	148,756
1998	45,471	47,774	701	93,946
1999	36,096	42,036	4,214	82,346
2000 .	25,312	31,857	4,126	61,295
2001	35,071	39,449	7,323	81,842
2002 [1]	40,390	30,891	12,567	83,848

[1] Provisional figures, Norwegian catches on Russian quotas are included

Table 4.2 North-East Arctic HADDOCK.
Total nominal catch ('000 t) by trawl and other gear for each area.

	Sub-area I		Division IIa		Division IIb
Year	Trawl	Others	Trawl	Others	Trawl
1967	73.7	34.3	20.5	7.5	0.4
1968	98.1	42.9	31.4	8.6	0.7
1969	41.4	47.8	33.2	7.1	1.3
1970	37.4	23.2	20.6	6.5	0.5
1971	27.5	29.2	15.1	6.7	0.4
1972	193.9	27.9	34.5	7.6	2.2
1973	242.9	42.8	14.0	9.5	13.1
1974	133.1	25.9	39.9	7.1	15.1
1975	103.5	18.2	34.6	9.7	9.7
1976	77.7	16.4	28.1	9.5	5.6
1977	57.6	14.6	19.9	8.6	9.5
1978	53.9	10.1	15.7	14.8	1.0
1979	47.8	16.0	20.3	18.9	0.6
1980	30.5	23.7	14.8	18.9	0.1
1981	18.8	17.7	21.6	18.5	0.5
1982	11.6	11.5	23.9	13.5	-
1983	3.7	3.8	7.6	6.3	0.2
1984	1.6	2.4	6.4	6.9	0.1
1985	24.4	6.0	4.5	6.3	0.1
1986	51.7	18.1	12.8	13.2	0.7
1987	77.8	31.6	22.1	16.1	3.0
1988	27.5	16.5	33.6	13.5	0.7
1989	21.4	9.7	11.6	11.7	0.4
1990	5.9	9.2	4.8	5.6	0.3
1991	9.8	9.0	7.8	6.6	0.4
1992	21.2	9.5	9.3	12.9	1.0
1993	37.9	9.7	18.0	9.0	3.0
1994	61.3	13.8	31.3	15.1	7.3
1995	57.0	12.1	32.6	20.5	13.9
1996	96.3	14.2	34.0	22.0	3.2
1997	56.9	20.6	42.1	25.1	2.5
1998	26.4	20.0	25.3	23.5	0.7
1999	28.5	8.5	16.8	23.7	4.9
2000	19.5	5.8	17.1	14.8	4.0
2001	28.4	6.7	21.5	17.9	7.0
2002 [1]	30.2	10.2	15.8	15.1	12.5

[1] Provisional

Table 4.3 North-East Arctic HADDOCK. Nominal catch (t) by countries
Sub-area I and Divisions IIa and IIb combined. (Data provided by Working Group members).

Year	Faroe Islands	France	German Dem.Re.	Fed. Re. Germ.	Norway	Poland	United Kingdom	Russia[2]	Others	Total
1960	172	-	-	5,597	46,263	-	45,469	57,025	125	154,651
1961	285	220	-	6,304	60,862	-	39,650	85,345	558	193,224
1962	83	409	-	2,895	54,567	-	37,486	91,910	58	187,408
1963	17	363	-	2,554	59,955	-	19,809	63,526	-	146,224
1964	-	208	-	1,482	38,695	-	14,653	43,870	250	99,158
1965	-	226	-	1,568	60,447	-	14,345	41,750	242	118,578
1966	-	1,072	11	2,098	82,090	-	27,723	48,710	74	161,778
1967	-	1,208	3	1,705	51,954	-	24,158	57,346	23	136,397
1968	-	-	-	1,867	64,076	-	40,129	75,654	-	181,726
1969	2	-	309	1,490	67,549	-	37,234	24,211	25	130,820
1970	541	-	656	2,119	37,716	-	20,423	26,802	-	88,257
1971	81	-	16	896	45,715	43	16,373	15,778	3	78,905
1972	137	-	829	1,433	46,700	1,433	17,166	196,224	2,231	266,153
1973	1,212	3,214	22	9,534	86,767	34	32,408	186,534	2,501	322,226
1974	925	3,601	454	23,409	66,164	3,045	37,663	78,548	7,348	221,157
1975	299	5,191	437	15,930	55,966	1,080	28,677	65,015	3,163	175,758
1976	536	4,459	348	16,660	49,492	986	16,940	42,485	5,358	137,264
1977	213	1,510	144	4,798	40,118	-	10,878	52,210	287	110,158
1978	466	1,411	369	1,521	39,955	1	5,766	45,895	38	95,422
1979	343	1,198	10	1,948	66,849	2	6,454	26,365	454	103,623
1980	497	226	15	1,365	61,886	-	2,948	20,706	246	87,889
1981	381	414	22	2,398	58,856	**Spain**	1,682	13,400	-	77,153
1982	496	53	-	1,258	41,421	-	827	2,900	-	46,955
1983	428	-	1	729	19,371	139	259	680	-	21,607
1984	297	15	4	400	15,186	37	276	1,103	-	17,318
1985	424	21	20	395	17,490	77	153	22,690	-	41,270
1986	893	33	75	1,079	48,314	22	431	45,738	-	96,585
1987	464	26	83	3,106	69,333	99	563	76,980	-	150,654
1988	1,113	116	78	1,324	57,273	72	435	31,293	41	91,745
1989	1,218	125	26	171	31,825	1	590	20,903	-	54,859
1990	875	-	5	128	17,634	-	494	6,605	-	25,741
1991	1,117	60	**Greenld**	219	19,285	-	514	12,388	22	33,605
1992	1,093	151	1,719	387	30,203	38	596	19,699	1	53,887
1993	546	1,215	880	1,165	36,590	76	1,802	34,700	646	77,620
1994	2,761	678	770	2,412	64,688	22	4,673	51,822	877	128,703
1995	2,833	598	1,351	2,675	72,864	14	3,108	54,516	718	138,677
1996	3,743	537	1,524	942	89,500	669	2,275	73,857	217	173,264
1997	3,327	495	1,877	972	97,789	424	2,340	41,228	304	148,756
1998	1,566	241	854	385	68,747	257	1,241	20,559	96	93,946
1999	1,003	64	252	437	48,632	652	694	30,520	92	82,346
2000	631	169	432	931	34,172	582	814	22,738	823	61,292
2001	1,210	324	553	554	41,269	1,497	1,068	34,307	2,471	81,842
2002 [1]	1,564	297	858	627	40,029	1,505	1,129	37,157	2,152	83,848

[1] Provisional figures, Norwegian catches on Russian quotas are included.
[2] USSR prior to 1991.

Table 4.3 North-East Arctic HADDOCK. Nominal catch (t) by countries
Sub-area I and Divisions IIa and IIb combined. (Data provided by Working Group members).

Year	Faroe Islands	France	German Dem.Re.	Fed. Re. Germ.	Norway	Poland	United Kingdom	Russia[2]	Others	Total
1960	172	-	-	5,597	46,263	-	45,469	57,025	125	154,651
1961	285	220	-	6,304	60,862	-	39,650	85,345	558	193,224
1962	83	409	-	2,895	54,567	-	37,486	91,910	58	187,408
1963	17	363	-	2,554	59,955	-	19,809	63,526	-	146,224
1964	-	208	-	1,482	38,695	-	14,653	43,870	250	99,158
1965	-	226	-	1,568	60,447	-	14,345	41,750	242	118,578
1966	-	1,072	11	2,098	82,090	-	27,723	48,710	74	161,778
1967	-	1,208	3	1,705	51,954	-	24,158	57,346	23	136,397
1968	-	-	-	1,867	64,076	-	40,129	75,654	-	181,726
1969	2	-	309	1,490	67,549	-	37,234	24,211	25	130,820
1970	541	-	656	2,119	37,716	-	20,423	26,802	-	88,257
1971	81	-	16	896	45,715	43	16,373	15,778	3	78,905
1972	137	-	829	1,433	46,700	1,433	17,166	196,224	2,231	266,153
1973	1,212	3,214	22	9,534	86,767	34	32,408	186,534	2,501	322,226
1974	925	3,601	454	23,409	66,164	3,045	37,663	78,548	7,348	221,157
1975	299	5,191	437	15,930	55,966	1,080	28,677	65,015	3,163	175,758
1976	536	4,459	348	16,660	49,492	986	16,940	42,485	5,358	137,264
1977	213	1,510	144	4,798	40,118	-	10,878	52,210	287	110,158
1978	466	1,411	369	1,521	39,955	1	5,766	45,895	38	95,422
1979	343	1,198	10	1,948	66,849	2	6,454	26,365	454	103,623
1980	497	226	15	1,365	61,886	-	2,948	20,706	246	87,889
1981	381	414	22	2,398	58,856	**Spain**	1,682	13,400	-	77,153
1982	496	53	-	1,258	41,421	-	827	2,900	-	46,955
1983	428	-	1	729	19,371	139	259	680	-	21,607
1984	297	15	4	400	15,186	37	276	1,103	-	17,318
1985	424	21	20	395	17,490	77	153	22,690	-	41,270
1986	893	33	75	1,079	48,314	22	431	45,738	-	96,585
1987	464	26	83	3,106	69,333	99	563	76,980	-	150,654
1988	1,113	116	78	1,324	57,273	72	435	31,293	41	91,745
1989	1,218	125	26	171	31,825	1	590	20,903	-	54,859
1990	875	-	5	128	17,634	-	494	6,605	-	25,741
1991	1,117	60	**Greenld**	219	19,285	-	514	12,388	22	33,605
1992	1,093	151	1,719	387	30,203	38	596	19,699	1	53,887
1993	546	1,215	880	1,165	36,590	76	1,802	34,700	646	77,620
1994	2,761	678	770	2,412	64,688	22	4,673	51,822	877	128,703
1995	2,833	598	1,351	2,675	72,864	14	3,108	54,516	718	138,677
1996	3,743	537	1,524	942	89,500	669	2,275	73,857	217	173,264
1997	3,327	495	1,877	972	97,789	424	2,340	41,228	304	148,756
1998	1,566	241	854	385	68,747	257	1,241	20,559	96	93,946
1999	1,003	64	252	437	48,632	652	694	30,520	92	82,346
2000	631	169	432	931	34,172	582	814	22,738	823	61,292
2001	1,210	324	553	554	41,269	1,497	1,068	34,307	2,471	81,842
2002 [1]	1,564	297	858	627	40,029	1,505	1,129	37,157	2,152	83,848

[1] Provisional figures, Norwegian catches on Russian quotas are included.
[2] USSR prior to 1991.

Table 4.4 North-East Arctic HADDOCK. Maturity at age in percent from Russian data

	Age									
Year	3	4	5	6	7	8	9	10	11	12
1981	1	12	64	73	96	100	100	-	-	-
1982	9	55	73	93	96	100	93	-	-	-
1983	17	70	100	99	99	100	-	-	-	-
1984	7	14	35	47	74	82	89	-	-	-
1985	2	8	80	93	96	91	96	-	-	-
1986	+	22	53	86	86	100	83	100	-	-
1987	-	1	21	53	100	100	-	100	-	-
1988	-	3	33	51	-	-	-	-	-	-
1989	-	4	30	63	82	100	-	-	-	-
1990	-	2	30	54	77	87	80	100	-	-
1991	-	7	30	50	80	92	100	100	-	-
1992	2	13	50	62	77	80	94	100	-	-
1993	2	22	49	76	79	88	88	87	100	100
1994	-	2	13	41	90	88	100	100	97	100
1995	-	2	12	42	81	88	100	87	100	94
1996	-	-	10	36	78	86	90	93	90	100
1997	-	3	10	29	60	82	100	83	100	100
1998	-	5	28	50	66	81	91	100	-	100
1999	1	17	50	71	81	91	92	100	100	-
2000		10	32	59	72	94	94	96	100	100
2001	0	6	54	72	87	94	90	100	91	100
2002	1	13	33	73	83	90	100	94	100	100
2003*	0	5	37	63	88	100	92	100	100	100

* Preliminary data, revised in april/may meeting.
(Data provided by Working Group members).

Table 4.5 North-East Arctic HADDOCK. Input data for recruitment prediction (RCT3).

Yearclass in first column, VPA numbers at age 3 in second.

	VPA	R-T-0	R-T-1	R-T-2	N-BST1	N_BST2	N_BST3	N_BST4	N-BSA1	0GP_A
1980	5	-11	-11	-11	3	2	3	2	7	68
1981	8	-11	-11	9.5	4	5	19	15	9	30
1982	260	-11	59.2	58.4	2919	515	476	111	0	107
1983	537	29.8	58.6	134.3	3833	1594	385	290	1685	219
1984	84	6.4	14.4	10.7	1901	370	154	69	1530	293
1985	43	3	1.4	1.7	665	80	25	22	556	156
1986	17	0.2	0.9	0.7	164	15	14	3	85	160
1987	25	0.3	0.3	2.4	35	10	5	5	18	72
1988	82	1.3	1.8	10.6	81	55	33	24	52	86
1989	198	2.2	14.3	17.6	644	300	151	106	270	112
1990	642	44.8	42.9	128.6	2006	1376	508	437	1890	227
1991	281	16.7	28.2	35.7	1659	599	340	171	1135	472
1992	81	16.4	4.8	5.8	728	228	54	48	947	313
1993	91	3.5	4.9	4.2	603	179	53	28	562	240
1994	101	9.1	7.2	5.7	1464	264	86	33	1379	282
1995	43	6.4	2.3	1.9	310	68	23	12	249	148
1996	182	6	4.6	11.5	1268	138	60	35	693	196
1997	62	1.8	2.9	6.1	213	58	27	29	220	150
1998	311	10.7	28.9	26.2	1245	452	296	185	856	593
1999	333	11.7	20.7	26.1	847	460	315	182	1024	184
2000	-11	15.1	14.9	18.9	1221	535	317	-11	976	417
2001	-11	20.8	19.3	-11	1680	513	-11	-11	2062	394
2002	-11	33.2	-11	-11	3332	-11	-11	-11	2394	412

R-T-1	Russian Bottom Trawl Survey		age 0
0GP_A	International 0 Group Survey	area based index	age 0
N-BST1	Norwegian Barents Sea Bottom Trawl Survey		age 1
N-BSA1	Norwegian Barents Sea Acoustic Survey		age 1
N-BST2	Norwegian Barents Sea Bottom Trawl Survey		age 2
N-BST3	Norwegian Barents Sea Bottom Trawl Survey		age 3

Table 4.6

```
Analysis by RCT3 ver3.1 of data from file :
 t1_96.txt

 NORTHEAST ARCTIC HADDOCK: recruits as 3 year-olds
 Data for    8 surveys over   23 years :  1980 - 2002
 Regression type = C
 Tapered time weighting applied
 power =    3 over  20 years
 Survey weighting not applied

 Final estimates shrunk towards mean
 Minimum S.E. for any survey taken as    .20
 Minimum of   3 points used for regression

 Forecast/Hindcast variance correction used.

 Year class =   2000

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

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

 RT1        .93   2.77    .30   .923     17   2.77    5.34     .349     .277
 RT2        .89   2.63    .35   .898     18   2.99    5.28     .409     .202
 NT2        .83    .45    .42   .862     19   6.28    5.66     .495     .137
 NT3        .79   1.28    .29   .928     19   5.76    5.85     .351     .274
 NT4
 RT0       1.32   2.16    .91   .562     16   2.78    5.83    1.085     .029
 NT1       1.17  -2.64    .92   .559     19   7.11    5.65    1.087     .029
 NA1       1.18  -2.43   1.26   .407     19   6.88    5.68    1.470     .016

                                        VPA Mean =    4.83     .951     .037

 Year class =   2001

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

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

 RT1        .93   2.78    .28   .932     17   3.01    5.58     .333     .557
 RT2
 NT2        .84    .38    .42   .858     19   6.24    5.64     .502     .246
 NT3
 NT4
 RT0       1.36   2.07    .95   .539     16   3.08    6.26    1.174     .045
 NT1       1.21  -2.91    .92   .554     19   7.43    6.07    1.124     .049
 NA1       1.19  -2.54   1.14   .445     19   7.63    6.53    1.429     .030

                                        VPA Mean =    4.85     .926     .072
```

Table 4.6 (Cont'd)

Year class = 2002

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression----------I					I-----------Prediction---------I			
RT1									
RT2									
NT2									
NT3									
NT4									
RT0	1.41	1.94	.98	.514	16	3.53	6.93	1.327	.192
NT1	1.24	-3.11	.91	.555	19	8.11	6.95	1.236	.222
NA1	1.21	-2.73	1.07	.471	19	7.78	6.71	1.402	.172
					VPA Mean =		4.88	.904	.414

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
2000	250	5.52	.18	.10	.32		
2001	277	5.63	.25	.14	.31		
2002	422	6.05	.58	.57	.96		

Table 4.7

Run title : NEA Haddock (AFWG03: Final run)

At 30/04/2003 13:48

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

YEAR	1950	1951	1952
AGE			
1	0	4069	0
2	4446	222	13674
3	3189	65643	6012
4	37949	9178	151996
5	35344	18014	13634
6	18849	13551	9850
7	28868	6808	4693
8	9199	6850	3237
9	1979	3322	2434
10	1093	1182	606
+gp	2977	1348	880
TOTALNUM	143893	130187	207016
TONSLAND	132125	120077	127660
SOPCOF %	45	65	51

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

YEAR	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962
AGE										
1	392	1726	0	97	828	153	169	2319	362	0
2	8031	493	989	3012	243	2312	2425	3613	5531	4524
3	64528	6563	1154	16437	2074	1727	20318	39910	15429	39503
4	13013	154696	10689	5922	24704	5914	7826	70912	56855	30868
5	70781	5885	176678	14713	7942	31438	7243	13647	63351	48903
6	5431	27590	4993	127879	12535	5820	14040	7101	8706	33836
7	2867	3233	28273	3182	46619	12748	3154	6236	3578	3201
8	1080	1302	1445	8003	1087	17565	2237	1579	4407	1341
9	424	712	271	450	1971	822	5918	2340	788	1773
10	315	319	100	200	356	1072	285	2005	527	242
+gp	1005	543	100	185	176	601	500	606	1434	756
TOTALNUM	167867	203062	224692	180080	98535	80172	64115	150268	160968	164947
TONSLAND	123920	156788	202286	213924	123583	112672	88211	154651	193224	187408
SOPCOF %	57	60	47	55	57	61	80	84	80	75

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

YEAR	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
AGE										
1	3	149	0	0	0	0	0	480	15	133
2	2143	834	3498	2577	53	33	1061	281	3535	9399
3	28466	22363	5936	26345	15907	657	1524	23444	1978	230942
4	72736	49290	46356	22631	41346	67632	1968	2454	24358	22315
5	18969	30672	40201	63176	13496	41267	44634	1906	1257	42981
6	13579	5815	12631	29048	25719	7748	19002	22417	918	3206
7	9257	3527	1679	5752	8872	15599	3620	8100	9279	1611
8	1239	2716	974	582	1616	5292	4937	2012	3056	6758
9	559	833	897	438	218	655	1628	2016	826	2638
10	409	104	123	189	175	182	316	740	1043	900
+gp	375	633	802	242	271	286	109	293	534	1652
TOTALNUM	147735	116936	113097	150980	107673	139351	78799	64143	46799	322535
TONSLAND	146224	99158	118578	161778	136397	181726	130820	88257	78905	266153
SOPCOF %	74	62	70	66	79	79	80	75	101	86

Table 4.7 (continued)

Table 1	Catch numbers at age		Numbers*10**-3							
YEAR	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
AGE										
1	0	281	1321	3475	184	46	0	0	1	2
2	5956	3713	4355	7499	18456	2033	48	0	68	29
3	70679	9685	10037	13994	55967	47311	17540	627	486	883
4	260520	41706	14088	13454	22043	18812	35290	22878	2561	900
5	24180	88120	33871	6810	7368	4076	10645	21794	22124	3372
6	6919	5829	49711	20796	2586	1389	1429	2971	10685	12203
7	422	4138	2135	40057	7781	1626	812	250	1034	2625
8	426	382	1236	1247	11043	2596	546	504	162	344
9	1692	618	92	1350	311	6215	1466	230	162	75
10	529	2043	131	193	388	162	2310	842	72	80
+gp	584	1870	934	1604	379	400	323	1460	963	649
TOTALNUM	371907	158385	117911	110479	126506	84666	70409	51556	38318	21162
TONSLAND	322226	221157	175758	137264	110158	95422	103623	87889	77153	46955
SOPCOF %	83	87	81	63	77	95	113	104	99	95

Table 1	Catch numbers at age		Numbers*10**-3							
YEAR	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
AGE										
1	0	0	1	96	8	0	0	6	21	1258
2	162	247	2288	690	154	46	179	293	329	2668
3	704	447	29548	25596	3928	794	1045	516	3968	12342
4	1930	825	1153	61470	88294	9031	3932	1171	1967	12652
5	884	820	546	1013	52609	50869	12246	1866	1886	2411
6	1374	301	715	376	586	19465	22922	4126	2876	1740
7	3282	750	316	346	207	382	3407	6734	4442	2070
8	906	2206	634	144	123	65	246	849	4422	2619
9	52	489	1312	295	74	35	11	388	398	2737
10	37	69	416	484	119	44	36	50	21	241
+gp	172	284	113	157	285	310	66	30	17	18
TOTALNUM	9503	6438	37042	90667	146387	81041	44090	16029	20347	40756
TONSLAND	21607	17318	41270	96585	150654	91745	54859	25741	33605	53887
SOPCOF %	92	94	97	90	98	99	96	96	96	100

Table 1	Catch numbers at age		Numbers*10**-3							
YEAR	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
AGE										
1	117	11	33	69	75	11	136	88	37	39
2	455	369	196	393	253	2036	451	585	831	392
3	13398	3048	1282	1622	2193	2411	20329	939	12010	4821
4	25902	43740	12915	5512	6043	13615	7722	30029	5268	35977
5	13154	32614	71007	34791	11506	8214	16295	5458	35236	7384
6	2784	8330	20209	70893	32302	7303	5765	4489	4045	16254
7	973	1627	3361	10315	47298	12003	3574	1686	2468	1672
8	1297	660	367	1885	4579	17811	7095	1206	885	1039
9	2131	1142	295	417	530	1117	2764	1390	493	270
10	2011	1756	447	281	183	227	255	1830	855	242
+gp	384	1889	963	1230	536	227	139	327	1014	776
TOTALNUM	62606	95186	111075	127408	105498	64975	64525	48027	63142	68866
TONSLAND	77621	128703	138677	173264	148756	93946	82346	61292	81842	83848
SOPCOF %	100	111	105	105	105	105	105	100	100	100

Table 4.8

Run title : NEA Haddock (AFWG03: Final run)

At 30/04/2003 13:48

Table 2 Catch weights at age (kg)

YEAR	1950	1951	1952
AGE			
1	0	0	0
2	0	0	0
3	0.66	0.66	0.66
4	1.03	1.03	1.03
5	1.79	1.79	1.79
6	2.38	2.38	2.38
7	2.86	2.86	2.86
8	3.33	3.33	3.33
9	3.7	3.7	3.7
10	4.41	4.41	4.41
+gp	5.4	5.4	5.4
SOPCOFAC	0.4545	0.6514	0.5127

Table 2 Catch weights at age (kg)

YEAR	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962
AGE										
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66
4	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03
5	1.79	1.79	1.79	1.79	1.79	1.79	1.79	1.79	1.79	1.79
6	2.38	2.38	2.38	2.38	2.38	2.38	2.38	2.38	2.38	2.38
7	2.86	2.86	2.86	2.86	2.86	2.86	2.86	2.86	2.86	2.86
8	3.33	3.33	3.33	3.33	3.33	3.33	3.33	3.33	3.33	3.33
9	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7
10	4.41	4.41	4.41	4.41	4.41	4.41	4.41	4.41	4.41	4.41
+gp	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4
SOPCOFAC	0.5742	0.6021	0.4731	0.5529	0.5679	0.6146	0.8007	0.8379	0.8026	0.7459

Table 2 Catch weights at age (kg)

YEAR	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
AGE										
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66
4	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03
5	1.79	1.79	1.79	1.79	1.79	1.79	1.79	1.79	1.79	1.79
6	2.38	2.38	2.38	2.38	2.38	2.38	2.38	2.38	2.38	2.38
7	2.86	2.86	2.86	2.86	2.86	2.86	2.86	2.86	2.86	2.86
8	3.33	3.33	3.33	3.33	3.33	3.33	3.33	3.33	3.33	3.33
9	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7
10	4.41	4.41	4.41	4.41	4.41	4.41	4.41	4.41	4.41	4.41
+gp	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4
SOPCOFAC	0.7442	0.6183	0.6978	0.6601	0.7919	0.7921	0.8028	0.7547	1.0105	0.8593

Table 4.8 (continued)

Table 2	Catch weights at age (kg)									
YEAR	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
AGE										
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66
4	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03
5	1.79	1.79	1.79	1.79	1.79	1.79	1.79	1.79	1.79	1.79
6	2.38	2.38	2.38	2.38	2.38	2.38	2.38	2.38	2.38	2.38
7	2.86	2.86	2.86	2.86	2.86	2.86	2.86	2.86	2.86	2.86
8	3.33	3.33	3.33	3.33	3.33	3.33	3.33	3.33	3.33	3.33
9	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7
10	4.41	4.41	4.41	4.41	4.41	4.41	4.41	4.41	4.41	4.41
+gp	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4
SOPCOFAC	0.8281	0.8657	0.8127	0.6296	0.7708	0.9507	1.1278	1.0352	0.9942	0.951

Table 2	Catch weights at age (kg)									
YEAR	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
AGE										
1	0	0	0	0	0	0	0	0.25	0	0.04
2	0	0	0	0	0	0	0	0.64	0	0.28
3	1.52	1.57	0.92	0.86	0.64	0.58	0.8	0.89	0.77	0.84
4	1.86	1.99	1.66	1.25	0.86	0.84	0.89	1.22	1.31	1.36
5	2.1	2.42	2.39	1.88	1.33	1.05	1.17	1.4	1.61	1.7
6	2.38	2.68	2.71	2.41	2.45	1.43	1.37	1.6	1.86	1.96
7	2.86	2.93	2.89	2.66	2.98	1.97	1.71	1.77	2.11	2.29
8	3.33	3.37	3.22	3.04	2.98	2.52	2.01	2.16	2.34	2.39
9	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	2.93	2.32
10	4.41	4.41	4.41	4.41	4.41	4.41	4.41	4.41	2.34	2.88
+gp	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	3.14
SOPCOFAC	0.9205	0.9405	0.9689	0.9019	0.9836	0.995	0.9634	0.9583	0.9589	0.9983

Table 2	Catch weights at age (kg)									
YEAR	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
AGE										
1	0.09	0.25	0.19	0.1	0.1	0.12	0.1	0.1	0.11	0.104
2	0.3	0.44	0.31	0.24	0.39	0.53	0.23	0.28	0.33	0.303
3	0.59	0.54	0.63	0.64	0.66	0.71	0.73	0.6	0.63	0.573
4	1.06	0.88	0.66	0.79	0.99	0.9	1.06	1.09	0.97	0.979
5	1.52	1.33	1.06	1.04	1.09	1.27	1.27	1.39	1.4	1.379
6	1.84	1.74	1.68	1.34	1.22	1.38	1.55	1.59	1.76	1.62
7	2.18	2.06	2.11	1.81	1.48	1.54	1.66	1.82	1.95	2.114
8	2.3	2.2	2.34	2.29	1.99	1.79	1.79	1.91	2.13	2.208
9	2.52	2.5	2.67	2.31	2.26	2.37	2.06	2.07	2.32	2.643
10	2.64	2.58	2.91	3.18	2.26	2.51	2.6	2.22	2.41	2.436
+gp	3.11	2.89	3.02	2.62	2.98	2.68	2.85	2.58	2.56	2.695
SOPCOFAC	1.0002	1.1112	1.0541	1.0517	1.049	1.0468	1.0536	0.9991	0.9993	1

Table 4.9

Run title : NEA Haddock (AFWG03: Final run)

At 30/04/2003 13:48

Table 3 Stock weights at age (kg)

YEAR	1950	1951	1952
AGE			
1	0	0	0
2	0	0	0
3	0.66	0.66	0.66
4	1.03	1.03	1.03
5	1.79	1.79	1.79
6	2.38	2.38	2.38
7	2.86	2.86	2.86
8	3.33	3.33	3.33
9	3.7	3.7	3.7
10	4.41	4.41	4.41
+gp	6.875	6.875	6.875

Table 3 Stock weights at age (kg)

YEAR	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962
AGE										
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66
4	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03
5	1.79	1.79	1.79	1.79	1.79	1.79	1.79	1.79	1.79	1.79
6	2.38	2.38	2.38	2.38	2.38	2.38	2.38	2.38	2.38	2.38
7	2.86	2.86	2.86	2.86	2.86	2.86	2.86	2.86	2.86	2.86
8	3.33	3.33	3.33	3.33	3.33	3.33	3.33	3.33	3.33	3.33
9	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7
10	4.41	4.41	4.41	4.41	4.41	4.41	4.41	4.41	4.41	4.41
+gp	6.875	6.875	6.875	6.875	6.875	6.875	6.875	6.875	6.875	6.875

Table 3 Stock weights at age (kg)

YEAR	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
AGE										
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66
4	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03
5	1.79	1.79	1.79	1.79	1.79	1.79	1.79	1.79	1.79	1.79
6	2.38	2.38	2.38	2.38	2.38	2.38	2.38	2.38	2.38	2.38
7	2.86	2.86	2.86	2.86	2.86	2.86	2.86	2.86	2.86	2.86
8	3.33	3.33	3.33	3.33	3.33	3.33	3.33	3.33	3.33	3.33
9	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7
10	4.41	4.41	4.41	4.41	4.41	4.41	4.41	4.41	4.41	4.41
+gp	6.875	6.875	6.875	6.875	6.875	6.875	6.875	6.875	6.875	6.875

Table 3 Stock weights at age (kg)

YEAR	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
AGE										
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66
4	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03
5	1.79	1.79	1.79	1.79	1.79	1.79	1.79	1.79	1.79	1.79
6	2.38	2.38	2.38	2.38	2.38	2.38	2.38	2.38	2.38	2.38
7	2.86	2.86	2.86	2.86	2.86	2.86	2.86	2.86	2.86	2.86
8	3.33	3.33	3.33	3.33	3.33	3.33	3.33	3.33	3.33	3.33
9	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7
10	4.41	4.41	4.41	4.41	4.41	4.41	4.41	4.41	4.41	4.41
+gp	6.875	6.875	6.875	6.875	6.875	6.875	6.875	6.875	6.875	6.875

Table 4.9 (continued)

Table 3 Stock weights at age (kg)

YEAR	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
AGE										
1	0.052	0.036	0.036	0.042	0.031	0.035	0.039	0.043	0.052	0.045
2	0.133	0.196	0.133	0.103	0.09	0.117	0.116	0.127	0.141	0.135
3	0.48	0.289	0.435	0.296	0.241	0.214	0.279	0.264	0.373	0.342
4	1.043	0.964	0.773	0.776	0.481	0.386	0.441	0.73	0.774	0.82
5	1.641	1.81	1.874	1.049	0.927	0.62	0.679	0.945	1.438	1.519
6	2.081	2.506	2.456	1.47	1.47	1.124	1.005	1.291	1.63	1.962
7	2.592	2.24	1.835	1.835	1.835	1.835	1.835	1.415	1.557	1.793	2.24
8	3.33	3.33	2.345	2.345	3.1	2.345	2.345	2.004	2.233	2.32
9	3.7	3.7	2.741	2.741	2.741	2.741	2.741	2.716	2.731	2.568
10	4.41	4.41	2.949	2.949	2.949	2.949	2.949	2.949	3.092	3.525
+gp	6.875	6.875	3.777	3.777	3.777	3.777	3.777	3.777	3.777	3.777

Table 3 Stock weights at age (kg)

YEAR	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
AGE										
1	0.033	0.028	0.029	0.029	0.033	0.024	0.027	0.028	0.029	0.028
2	0.101	0.091	0.089	0.094	0.096	0.114	0.09	0.106	0.108	0.093
3	0.298	0.234	0.215	0.208	0.205	0.234	0.282	0.23	0.308	0.194
4	0.808	0.54	0.362	0.448	0.388	0.459	0.592	0.684	0.492	0.578
5	1.43	1.059	0.803	0.685	0.684	0.829	1.017	1.059	1.174	0.973
6	2.002	1.531	1.444	1.125	1.108	1.193	1.488	1.296	1.555	1.518
7	2.265	1.939	1.95	1.845	1.468	1.462	1.653	1.487	2.026	2.049
8	3.045	2.509	2.913	2.43	2.442	1.966	1.914	1.608	2.488	2.469
9	3.391	2.374	2.934	2.815	3.218	3.155	2.539	1.814	2.625	2.704
10	3.4	2.621	3.033	3.323	3.333	2.815	2.513	2.21	2.648	2.867
+gp	4.2	3.16	3.163	3.479	4.648	3.813	3.813	2.978	3.817	3.817

Table 4.10

Run title : NEA Haddock (AFWG03: Final run)

At 30/04/2003 13:48

Table 4 Natural Mortality (M) at age

YEAR	1950	1951	1952
AGE			
1	0.2	0.2	0.2
2	0.2	0.2	0.2
3	0.2	0.2	0.2
4	0.2	0.2	0.2
5	0.2	0.2	0.2
6	0.2	0.2	0.2
7	0.2	0.2	0.2
8	0.2	0.2	0.2
9	0.2	0.2	0.2
10	0.2	0.2	0.2
+gp	0.2	0.2	0.2

Table 4 Natural Mortality (M) at age

YEAR	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962
AGE										
1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
4	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
5	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
6	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
7	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
8	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
9	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
10	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
+gp	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2

Table 4.10 (continued)

Table 4 Natural Mortality (M) at age

YEAR	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
AGE										
1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
4	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
5	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
6	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
7	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
8	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
9	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
10	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
+gp	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2

Table 4 Natural Mortality (M) at age

YEAR	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
AGE										
1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
4	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
5	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
6	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
7	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
8	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
9	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
10	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
+gp	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2

Table 4 Natural Mortality (M) at age

YEAR	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
AGE										
1	0.2	1.0446	1.5641	2.5793	3.7031	0.6136	1.1214	0.601	0.5621	1.7289
2	0.2	0.2498	0.2086	1.49	0.2	0.2264	0.2	0.5356	0.263	0.3925
3	0.2	0.2103	0.2	0.6375	0.2	0.4749	0.2	0.3741	0.2	0.2062
4	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
5	0.2	0.2	0.2	0.2	0.2	0.2023	0.2	0.2	0.2	0.2
6	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
7	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
8	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
9	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
10	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
+gp	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2

Table 4 Natural Mortality (M) at age

YEAR	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
AGE										
1	2.2293	1.8749	2.4694	2.9958	1.6293	2.8288	1.2645	1.4198	0.7375	2.3652
2	0.6311	0.8445	1.1588	1.0901	0.7438	0.3276	0.4772	0.3811	0.3286	1.1727
3	0.2672	0.3043	0.3816	0.8662	0.5339	0.2519	0.2021	0.2332	0.2167	0.4413
4	0.2281	0.219	0.3845	0.3259	0.2577	0.2664	0.2	0.2099	0.2014	0.2098
5	0.3031	0.2132	0.3159	0.2272	0.2321	0.2299	0.2	0.2113	0.2	0.2062
6	0.2	0.2009	0.2102	0.2258	0.2114	0.2	0.2	0.2086	0.2	0.2013
7	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
8	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
9	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
10	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
+gp	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2

Table 4.11

Run title : NEA Haddock (AFWG03: Final run)

At 30/04/2003 13:48

Table 5 Proportion mature at age

YEAR	1950	1951	1952
AGE			
1	0	0	0
2	0	0	0
3	0	0	0
4	0.05	0.05	0.05
5	0.23	0.23	0.23
6	0.53	0.53	0.53
7	0.88	0.88	0.88
8	0.98	0.98	0.98
9	1	1	1
10	1	1	1
+gp	1	1	1

Table 5 Proportion mature at age

YEAR	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962
AGE										
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0
4	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
5	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23
6	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53
7	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
8	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
9	1	1	1	1	1	1	1	1	1	1
10	1	1	1	1	1	1	1	1	1	1
+gp	1	1	1	1	1	1	1	1	1	1

Table 5 Proportion mature at age

YEAR	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
AGE										
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0
4	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
5	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23
6	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53
7	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
8	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
9	1	1	1	1	1	1	1	1	1	1
10	1	1	1	1	1	1	1	1	1	1
+gp	1	1	1	1	1	1	1	1	1	1

Table 5 Proportion mature at age

YEAR	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
AGE										
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0.01	0.09
4	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.12	0.55
5	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.64	0.73
6	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.73	0.93
7	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.96	0.96
8	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	1	1
9	1	1	1	1	1	1	1	1	1	1
10	1	1	1	1	1	1	1	1	1	1
+gp	1	1	1	1	1	1	1	1	1	1

Table 4.11 (continued)

Table 5 Proportion mature at age

YEAR	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
AGE										
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0.17	0.07	0.02	0	0	0	0	0	0	0.02
4	0.7	0.14	0.08	0.22	0.01	0.03	0.04	0.02	0.07	0.13
5	1	0.35	0.8	0.53	0.21	0.33	0.3	0.3	0.3	0.5
6	1	0.47	0.93	0.86	0.53	0.51	0.63	0.54	0.5	0.62
7	1	0.74	0.96	0.86	1	1	0.82	0.77	0.8	0.77
8	1	1	1	1	1	1	1	0.87	0.92	0.8
9	1	1	1	1	1	1	1	0.8	1	0.94
10	1	1	1	1	1	1	1	1	1	1
+gp	1	1	1	1	1	1	1	1	1	1

Table 5 Proportion mature at age

YEAR	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
AGE										
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0.015	0	0	0	0	0	0.01	0	0.004	0.008
4	0.219	0.017	0.02	0	0.03	0.05	0.17	0.1	0.06	0.13
5	0.49	0.13	0.12	0.1	0.1	0.28	0.5	0.32	0.54	0.33
6	0.76	0.41	0.42	0.36	0.29	0.5	0.71	0.59	0.72	0.73
7	0.79	0.9	0.81	0.78	0.6	0.66	0.81	0.72	0.87	0.83
8	0.88	0.88	0.88	0.86	0.82	0.81	0.91	0.94	0.94	0.9
9	0.88	1	1	0.9	1	0.91	0.92	0.94	0.9	1
10	0.87	1	0.87	0.93	0.83	1	1	0.96	1	0.94
+gp	1	0.97	1	0.9	1	1	1	1	0.91	1

Table 4.12

```
Northeast Arctic haddock
105
FLT01: Russian bottom trawl survey, total area, Nov-Dec, age 1-7
1983 2002
1 1 0.90 1.00
1 7
   1    592.0     95.0      5.0      4.0      0.1      0.0      0.0
   1    586.0    584.0     15.0      2.0      1.0      0.1      0.0
   1    144.0   1343.0    900.0      4.0      1.0      1.0      0.0
   1     14.0    107.0    363.0    164.0      1.0      0.1      0.1
   1      9.0     17.0     83.0    225.0     57.0      0.1      0.1
   1      3.0      7.0     17.0     40.0     76.0      8.0      0.1
   1     18.0     24.0      4.0     14.0     41.0     81.0     11.0
   1    143.0    106.0     73.0     42.0     73.0     74.0     57.0
   1    429.0    176.0     62.0      9.0      3.0      6.0     18.0
   1    282.0   1286.0    346.0     50.0      4.0      6.0      9.0
   1     48.0    357.0   1985.0    356.0     48.0      8.0      4.0
   1     49.0     58.0    442.0   1014.0    116.0     15.0      1.0
   1     72.0     42.0     31.0    123.0    370.0     40.0      5.0
   1     23.0     57.0     28.0     49.0    362.0    334.0     29.0
   1     46.0     19.0     32.0     32.0     10.0     27.0     10.0
   1     29.0    115.0     38.0     46.0      8.0      5.0     15.0
   1    289.0     61.0    196.0     39.0     37.0      8.0      3.0
   1    207.0    262.0     60.0    109.0     26.0     11.0      2.0
   1    149.0    261.0    334.0     40.0     65.0     11.0      4.0
   1    193.0    189.0    399.0    450.0     47.0     24.0      4.0
```

```
FLT02: Norwegian acoustic survey, Barents sea, Jan-Mar, age 1-7, shifted
1980 2002
1 1 0.99 1.00
1 7
   1     140      50     210     600     180      10       0
   1      20      30      40      40     100      60       0
   1      50      20      30      10      10      40      20
   1    1730      60      20      10       0       0       0
   1    7760    2150      50       0       0       0       0
   1    2660    4520    1890       0       0       0       0
   1     170     490    1710     500       0       0       0
   1      40      80     230     460      70       0       0
   1      50      60     110     200     210      20       0
   1     350      30      30      40      70     110      20
   1    2520     450      80      30      30      30      60
   1    8680    1340     230      20       0       0      10
   1    6260    5630    1300     130       0       0       0
   1    1930    2550    6310    1110     120       0       0
   1    2850     360    1110    3870     420      20       0
   1    2290     440     310     760    1510      80       0
   1     240     510     170     120     430     430      20
   1    1220     200     280     120      50     130     160
   1     460     570     130     140      40      10      20
   1    5090     320     650     190     110      20      10
   1    3160    2100     230     220      10      10       0
   1    2820    2160    1490     140     120      10       0
   1    2790    1450    1980    1690     170      50       0
```

Table 4.12 (continued)

```
FLT04: Norwegian bottom trawl survey, Jan-Mar, age 1-7, shifted
1982 2002
1 1 0.99 1.00
1 8
   1      48      31      24       9      19      25       7       0
   1    5146     189      15       8       2       1       4       1
   1   15938    4759     147       5       5       1       1       4
   1    3703    3846    1108       6       2       1       1       1
   1     799    1544    2902     529       0       0       0       0
   1     153     253     689    1164     138       1       0       0
   1      95     141     216     340     327      34       1       0
   1     546      45      34      50      92     118      18       0
   1    3003     334      51      42      27      17      42       0
   1   13755    1505     244      21       6       7      16      23
   1    5990    5077    1056     105       6       4       3       4
   1    2280    3395    4366     497      34       2       1       2
   1    1793     536    1711    3395     345      28       0       1
   1    2636     525     481    1486    2528     116       9       0
   1     679     861     280     194     467     622      35       1
   1    1379     227     332     132      34      80      81       7
   1     576     598     122     102      28      10      17      11
   1    4522     272     354      84      40       8       3       7
   1    4603    2960     293     251      17       9       1       1
   1    5347    3147    1853     176      82       8       3       0
   1    5131    3174    1820     736      55      23       2       1
```

Table 4.13

Lowestoft VPA Version 3.1

30/04/2003 13:47

Extended Survivors Analysis

NEA Haddock (AFWG03: Final run)

CPUE data from file fleet

Catch data for 53 years. 1950 to 2002. Ages 1 to 11.

Fleet	First year	Last year	First age	Last age	Alpha	Beta
FLT01: Russia	1983	2002	1	7	0.9	1
FLT02: Norwe	1980	2002	1	7	0.99	1
FLT04: Norwe	1982	2002	1	8	0.99	1

Time series weights :

Tapered time weighting applied
Power = 3 over 20 years

Catchability analysis :

Catchability dependent on stock size for ages < 7

Regression type = C
Minimum of 5 points used for regression
Survivor estimates shrunk to the population mean for ages < 7

Catchability independent of age for ages >= 9

Terminal population estimation :

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

S.E. of the mean to which the estimates are shrunk = 1.000

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

Prior weighting not applied

Tuning had not converged after 30 iterations

Total absolute residual between iterations
29 and 30 = .00343

Final year F values

Age	1	2	3	4	5	6	7	8	9	10
Iteration 29	0	0.0011	0.0182	0.1825	0.2708	0.7992	0.5105	0.8078	0.6324	0.8419
Iteration 30	0	0.0011	0.0182	0.1824	0.2708	0.799	0.5103	0.807	0.631	0.8412

Regression weights

0.751	0.82	0.877	0.921	0.954	0.976	0.99	0.997	1	1

Table 4.13 (continued)

Fishing mortalities

Age	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
1	0	0	0	0	0	0	0	0	0	0
2	0.001	0.003	0.001	0.002	0.004	0.009	0.006	0.002	0.002	0.001
3	0.024	0.013	0.019	0.028	0.029	0.066	0.132	0.017	0.044	0.018
4	0.215	0.107	0.08	0.128	0.205	0.316	0.319	0.295	0.129	0.182
5	0.469	0.472	0.275	0.362	0.473	0.501	0.827	0.396	0.681	0.271
6	0.537	0.668	0.62	0.534	0.701	0.648	0.833	0.57	0.583	0.799
7	0.374	0.707	0.632	0.773	0.872	0.622	0.787	0.625	0.731	0.51
8	0.382	0.471	0.333	0.927	1.001	1.022	0.976	0.681	0.813	0.807
9	0.487	0.695	0.398	0.796	0.743	0.719	0.412	0.504	0.667	0.631
10	0.305	0.999	0.654	0.841	1.055	0.86	0.348	0.531	0.677	0.841

XSA population numbers (Thousands)

	AGE									
YEAR	1	2	3	4	5	6	7	8	9	10
1993	1.75E+06	5.28E+05	6.42E+05	1.50E+05	4.09E+04	7.41E+03	3.45E+03	4.51E+03	6.11E+03	8.45E+03
1994	1.89E+06	1.88E+05	2.81E+05	4.80E+05	9.64E+04	1.89E+04	3.55E+03	1.94E+03	2.52E+03	3.07E+03
1995	3.55E+06	2.90E+05	8.06E+04	2.04E+05	3.46E+05	4.86E+04	7.93E+03	1.43E+03	9.93E+02	1.03E+03
1996	1.81E+06	3.00E+05	9.08E+04	5.40E+04	1.28E+05	1.92E+05	2.12E+04	3.45E+03	8.40E+02	5.46E+02
1997	1.30E+06	9.06E+04	1.01E+05	3.71E+04	3.43E+04	7.13E+04	8.98E+04	8.00E+03	1.12E+03	3.10E+02
1998	1.69E+06	2.55E+05	4.29E+04	5.73E+04	2.34E+04	1.69E+04	2.86E+04	3.07E+04	2.41E+03	4.35E+02
1999	1.61E+06	1.00E+05	1.82E+05	3.12E+04	3.20E+04	1.13E+04	7.25E+03	1.26E+04	9.05E+03	9.60E+02
2000	1.92E+06	4.56E+05	6.17E+04	1.31E+05	1.86E+04	1.15E+04	4.01E+03	2.70E+03	3.88E+03	4.91E+03
2001	1.29E+06	4.64E+05	3.11E+05	4.80E+04	7.88E+04	1.01E+04	5.26E+03	1.76E+03	1.12E+03	1.92E+03
2002	4.04E+06	6.16E+05	3.33E+05	2.40E+05	3.45E+04	3.27E+04	4.62E+03	2.07E+03	6.38E+02	4.70E+02

Estimated population abundance at 1st Jan 2003

0.00E+00	3.79E+05	1.91E+05	2.11E+05	1.62E+05	2.14E+04	1.20E+04	2.27E+03	7.59E+02	2.79E+02

Taper weighted geometric mean of the VPA populations:

1.60E+06	2.46E+05	1.23E+05	7.47E+04	4.21E+04	2.09E+04	8.79E+03	3.95E+03	1.73E+03	8.38E+02

Standard error of the weighted Log(VPA populations) :

0.77	0.9146	0.9621	1.0217	1.0299	1.0838	1.1383	1.1748	1.154	1.2884

Log catchability residuals.

Fleet : FLT01: Russian botto

Age	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	1.71	0.82	0.13	-0.02	0.25	-0.28	-0.48	0.72	0.31	0.3
2	2.74	0.8	0.77	0.26	-0.29	-0.11	0.54	0.48	0.08	0.52
3	0.99	1.14	0.79	-0.35	0.1	-0.22	-0.54	1.33	-0.1	0.31
4	0.13	0.06	-0.13	-0.12	-0.19	-0.51	-0.47	1.09	-0.43	-0.23
5	-1.82	-0.22	0.32	-0.54	-0.18	-0.59	-0.08	1.14	-0.57	-0.55
6	99.99	-1.73	0.22	-1.14	-2.17	-0.52	0.1	0.74	-0.49	0.31
7	99.99	99.99	99.99	-1.59	-1.15	-2.47	0.84	0.75	0.31	0.45
8	No data for this fleet at this age									

Table 4.13 (continued)

Age	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
1	-0.22	-0.56	-0.42	-0.27	99.99	-0.14	0.57	0.25	-0.15	0.17
2	0.24	-0.06	-0.51	-0.35	-0.33	99.99	0.33	-0.07	-0.13	-0.02
3	0.44	0.17	-0.49	-0.34	-0.57	0.24	99.99	0.16	-0.18	0.02
4	0.59	0.23	-0.61	-0.08	-0.06	-0.09	0.33	99.99	-0.23	0.28
5	0.3	0.05	-0.43	0.55	-0.75	-0.52	0.53	0.51	99.99	0.24
6	0.47	0.14	-0.04	0.23	-0.68	-0.65	0.28	0.32	0.45	99.99
7	0.48	-0.62	0.12	1.03	-1.39	-0.08	-0.16	-0.12	0.4	0.32
8	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	7
Mean Log q	-6.6953
S.E(Log q)	0.7767

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	0.81	1.195	9.29	0.82	19	0.4	-8.13
2	0.82	1.53	8.08	0.89	19	0.35	-7.15
3	0.74	1.749	7.99	0.83	19	0.47	-6.69
4	0.86	1.083	7.12	0.86	19	0.44	-6.44
5	0.75	1.42	7.45	0.79	19	0.58	-6.42
6	0.8	1.192	7.15	0.8	18	0.59	-6.47

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
7	0.98	0.102	6.75	0.69	17	0.8	-6.7

Fleet : FLT02: Norwegian aco

Age	1980	1981	1982
1	99.99	99.99	99.99
2	99.99	99.99	99.99
3	99.99	99.99	99.99
4	99.99	99.99	99.99
5	99.99	99.99	99.99
6	99.99	99.99	99.99
7	99.99	99.99	99.99
8	No data for this fleet at this age		

Age	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	0.21	0.42	0.06	-0.27	-0.75	-0.12	-0.35	0.64	0.26	0.3
2	1.02	0.22	0.05	-0.08	-0.38	0.32	-0.56	0.14	0.14	-0.02
3	0.87	0.9	0.25	-0.27	-0.26	0.05	-0.19	0.28	-0.24	0.2
4	0.29	99.99	99.99	-0.27	-0.69	-0.11	-0.35	0.07	-0.44	-0.34
5	99.99	99.99	99.99	99.99	-0.7	-0.54	-0.34	-0.16	99.99	99.99
6	99.99	99.99	99.99	99.99	99.99	-0.16	-0.07	-0.39	99.99	99.99
7	99.99	99.99	99.99	99.99	99.99	99.99	0.69	0.04	-1.04	99.99
8	No data for this fleet at this age									

Table 4.13 (continued)

Age	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
1	0.33	0.28	-0.07	-0.68	99.99	-0.25	0.42	0.01	-0.18	-0.13
2	0.16	-0.09	-0.14	-0.12	0.14	99.99	0.19	-0.02	-0.05	-0.01
3	0.22	-0.24	0.11	-0.09	-0.06	0.03	99.99	0.04	-0.16	0.13
4	0.37	0.04	-0.2	-0.23	0.15	-0.08	0.7	99.99	-0.09	0.17
5	0.3	0.28	-0.15	-0.06	-0.2	0.04	0.67	-0.8	99.99	0.51
6	99.99	-0.02	0.1	0.01	0.17	-0.47	0.63	-0.14	-0.01	99.99
7	99.99	99.99	99.99	-0.09	0.65	-0.54	0.31	99.99	99.99	99.99
8	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	7
Mean Log q	-5.9101
S.E(Log q)	0.6085

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	0.74	1.73	7.47	0.83	19	0.38	-5.07
2	0.74	4.334	7.11	0.97	19	0.19	-5.2
3	0.75	4.25	6.79	0.97	19	0.18	-5.19
4	0.73	2.519	6.83	0.91	17	0.35	-5.24
5	0.72	1.602	6.94	0.81	13	0.48	-5.41
6	0.79	1.746	6.77	0.91	11	0.33	-5.86

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
7	0.93	0.212	6.2	0.73	7	0.64	-5.91

Fleet : FLT04: Norwegian bot

Age	1980	1981	1982
1	99.99	99.99	99.99
2	99.99	99.99	99.99
3	99.99	99.99	99.99
4	99.99	99.99	99.99
5	99.99	99.99	99.99
6	99.99	99.99	99.99
7	99.99	99.99	99.99
8	99.99	99.99	99.99

Age	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	0.73	0.77	0.07	0.61	-0.05	-0.14	-0.39	0.47	0.39	0.07
2	1.67	0.57	-0.3	0.54	0.27	0.75	-0.44	-0.29	0.01	-0.32
3	0.44	1.56	-0.23	0.08	0.46	0.42	-0.29	-0.24	-0.33	-0.04
4	0.07	0.24	-0.39	-0.14	0.12	0.35	-0.18	0.31	-0.43	-0.47
5	0.58	1	0.98	99.99	-0.12	-0.18	0.07	0.15	-0.06	-0.26
6	-0.63	0.44	0.5	99.99	-0.01	0.31	-0.05	-0.56	-0.36	0.07
7	-0.78	-0.83	0.27	99.99	99.99	-0.26	1.25	0.35	0.1	-0.74
8	-0.83	0.05	0.05	99.99	99.99	99.99	99.99	99.99	0.35	-0.62

Table 4.13 (continued)

Age	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
1	0.23	-0.32	-0.17	-0.16	99.99	-0.36	0.09	0.06	0.03	0.15
2	0.15	-0.01	-0.23	0.05	0.03	99.99	-0.13	0.01	0	0.33
3	-0.1	0.02	0.34	0.18	-0.05	-0.17	99.99	0.1	-0.07	0
4	-0.13	0.09	0.42	0.18	0.26	-0.28	0.13	99.99	0.12	-0.34
5	-0.29	0.18	0.02	0.01	-0.15	0.13	0.2	-0.01	99.99	-0.01
6	-0.47	0.39	0.34	0.01	-0.23	-0.18	0.2	0.1	0.15	99.99
7	-1	99.99	0.62	1.14	0.63	-0.03	-0.23	-0.9	0.03	-0.46
8	-0.43	-0.19	99.99	-0.31	0.87	-0.01	0.39	-0.31	99.99	0.08

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

Age	7	8
Mean Log q	-6.5769	-6.7136
S.E(Log q)	0.6959	0.4485

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
1	0.8	1.933	6.67	0.91	19	0.27	-4.73
2	0.73	3.233	6.96	0.94	19	0.26	-4.91
3	0.78	3.088	6.48	0.96	19	0.22	-5.04
4	0.77	2.535	6.68	0.93	19	0.31	-5.32
5	0.59	7.074	7.78	0.97	18	0.19	-5.84
6	0.65	3.997	7.52	0.93	18	0.3	-6.2

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
7	0.72	2.198	7.32	0.87	17	0.43	-6.58
8	0.87	0.904	6.97	0.88	13	0.4	-6.71
1							

Terminal year survivor and F summaries :

Age 1 Catchability dependent on age and year class strength

Year class = 2001

Fleet	Estir Surv	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT01: Russia	450930	0.447	0	0	1	0.207	0
FLT02: Norwe	332942	0.414	0	0	1	0.241	0
FLT04: Norwe	441042	0.3	0	0	1	0.46	0
P shrinkage r	246393	0.91				0.05	0
F shrinkage n	106227	1				0.041	0

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
379200	0.2	0.16	5	0.791	0

Table 4.13 (continued)

Age 2 Catchability dependent on age and year class strength

Year class = 2000

Fleet	Estir Surv	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT01: Russia	176538	0.282	0.065	0.23	2	0.232	0.001
FLT02: Norwe	177664	0.241	0.081	0.34	2	0.319	0.001
FLT04: Norwe	229027	0.212	0.15	0.71	2	0.411	0.001
P shrinkage r	123071	0.96				0.02	0.002
F shrinkage n	44871	1				0.019	0.005

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
190558	0.14	0.1	8	0.751	0.001

Age 3 Catchability dependent on age and year class strength

Year class = 1999

Fleet	Estir Surv	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT01: Russia	217243	0.245	0.115	0.47	3	0.207	0.018
FLT02: Norwe	218015	0.188	0.058	0.31	3	0.354	0.018
FLT04: Norwe	215043	0.173	0.018	0.1	3	0.415	0.018
P shrinkage r	74689	1.02				0.012	0.05
F shrinkage n	64633	1				0.013	0.058

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
210539	0.11	0.06	11	0.571	0.018

Age 4 Catchability dependent on age and year class strength

Year class = 1998

Fleet	Estir Surv	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT01: Russia	187916	0.22	0.169	0.77	4	0.205	0.159
FLT02: Norwe	170400	0.169	0.118	0.7	4	0.347	0.174
FLT04: Norwe	151470	0.154	0.091	0.59	4	0.423	0.194
P shrinkage r	42055	1.03				0.012	0.571
F shrinkage n	111852	1				0.012	0.254

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
161876	0.1	0.08	14	0.75	0.182

Table 4.13 (continued)

Age 5 Catchability dependent on age and year class strength

Year class = 1997

Fleet	Estir Surv	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT01: Russia	23154	0.205	0.114	0.56	5	0.199	0.253
FLT02: Norwe	22893	0.159	0.108	0.68	5	0.327	0.255
FLT04: Norwe	20244	0.137	0.086	0.63	5	0.452	0.284
P shrinkage r	20899	1.08				0.011	0.277
F shrinkage n	8462	1				0.012	0.581

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
21418	0.09	0.06	17	0.63	0.271

Age 6 Catchability dependent on age and year class strength

Year class = 1996

Fleet	Estir Surv	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT01: Russia	1	0	0	0	0	0	0
FLT02: Norwe	1	0	0	0	0	0	0
FLT04: Norwe	1	0	0	0	0	0	0
P shrinkage r	8790	1.14				0.436	0.983
F shrinkage n	15298	1				0.564	0.673

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
12017	0.75	9.4	2	12.51	0.799

Age 7 Catchability constant w.r.t. time and dependent on age

Year class = 1995

Fleet	Estir Surv	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT01: Russia	2659	0.221	0.131	0.59	7	0.194	0.45
FLT02: Norwe	2274	0.159	0.186	1.17	6	0.3	0.51
FLT04: Norwe	2211	0.137	0.073	0.53	7	0.471	0.521
F shrinkage n	1395	1				0.035	0.735

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
2274	0.1	0.07	21	0.727	0.51

Table 4.13 (continued)

Age 8 Catchability constant w.r.t. time and dependent on age

Year class = 1994

Fleet	Estir Surv	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT01: Russia	780	0.247	0.159	0.64	7	0.146	0.791
FLT02: Norweg	728	0.173	0.098	0.57	6	0.221	0.829
FLT04: Norweg	790	0.193	0.044	0.23	8	0.538	0.784
F shrinkage n	635	1				0.095	0.908

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
759	0.15	0.05	22	0.308	0.807

Age 9 Catchability constant w.r.t. time and dependent on age

Year class = 1993

Fleet	Estir Surv	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT01: Russia	219	0.238	0.118	0.49	7	0.168	0.75
FLT02: Norweg	340	0.16	0.139	0.87	6	0.256	0.542
FLT04: Norweg	267	0.146	0.147	1.01	7	0.393	0.649
F shrinkage n	288	1				0.183	0.614

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
279	0.2	0.07	21	0.373	0.631

Age 10 Catchability constant w.r.t. time and age (fixed at the value for age) 9

Year class = 1992

Fleet	Estir Surv	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT01: Russia	123	0.227	0.103	0.45	7	0.117	1.023
FLT02: Norweg	153	0.168	0.117	0.7	7	0.211	0.886
FLT04: Norweg	150	0.18	0.084	0.47	8	0.408	0.899
F shrinkage n	237	1				0.264	0.655

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
166	0.28	0.07	23	0.255	0.841

Table 4.14

Run title : Arctic Haddock (run: Standard VPA AFWG03)

At 1/05/2003 13:16

Traditional vpa using file input for terminal F

Table 8 Fishing mortality (F) at age

YEAR	1950	1951	1952
AGE			
3	0.0547	0.14	0.1163
4	0.5936	0.2196	0.5485
5	0.8245	0.6341	0.5849
6	0.8125	0.9135	0.8887
7	1.157	0.8053	0.9961
8	1.0055	1.0036	1.2502
9	0.6504	1.4256	1.3695
10	0.946	1.0901	1.2251
+gp	0.946	1.0901	1.2251
FBAR 4- 7	0.8469	0.6431	0.7546

Table 8 Fishing mortality (F) at age

YEAR	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962
AGE										
3	0.072	0.0619	0.0254	0.1141	0.0454	0.0287	0.0719	0.2012	0.1697	0.1995
4	0.3926	0.246	0.1356	0.1753	0.2502	0.176	0.175	0.3802	0.4876	0.5958
5	0.5373	0.3091	0.4901	0.2792	0.3751	0.5789	0.3383	0.5192	0.6974	1.0616
6	0.4899	0.4146	0.4691	0.8125	0.4072	0.5215	0.5583	0.6531	0.7516	1.0617
7	0.7145	0.6139	1.0131	0.6249	0.8167	0.9643	0.6025	0.5207	0.8335	0.7002
8	0.6589	0.8609	0.6211	0.9345	0.4513	0.8693	0.4321	0.7026	0.8825	0.904
9	0.5162	1.3582	0.43	0.3985	0.6298	0.743	0.8446	1.1478	0.9636	1.1812
10	0.6331	0.9584	0.6948	0.6588	0.6371	0.8688	0.6304	0.7976	0.9015	0.9374
+gp	0.6331	0.9584	0.6948	0.6588	0.6371	0.8688	0.6304	0.7976	0.9015	0.9374
FBAR 4- 7	0.5336	0.3959	0.527	0.473	0.4623	0.5602	0.4185	0.5183	0.6925	0.8548

Table 8 Fishing mortality (F) at age

YEAR	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
AGE										
3	0.1219	0.0811	0.0671	0.1303	0.0615	0.0421	0.1016	0.1708	0.0234	0.2858
4	0.6784	0.3193	0.2401	0.3875	0.3091	0.3971	0.1707	0.2355	0.2691	0.392
5	0.9366	0.6929	0.4682	0.5962	0.4224	0.5791	0.498	0.2483	0.1818	1.0699
6	1.0265	0.871	0.6985	0.7436	0.5206	0.4594	0.5818	0.504	0.1815	0.9505
7	1.0012	0.8437	0.6762	0.8235	0.5329	0.7022	0.4051	0.5298	0.4033	0.5516
8	0.6536	0.9605	0.5955	0.5278	0.5806	0.716	0.5023	0.4139	0.3896	0.581
9	1.3586	1.3821	1.0492	0.5925	0.384	0.4946	0.5017	0.3945	0.2979	0.6928
10	1.0158	1.0779	0.7832	0.6549	0.5027	0.6449	0.4735	0.4494	0.365	0.6151
+gp	1.0158	1.0779	0.7832	0.6549	0.5027	0.6449	0.4735	0.4494	0.365	0.6151
FBAR 4- 7	0.9107	0.6817	0.5208	0.6377	0.4462	0.5344	0.4139	0.3794	0.2589	0.741

Table 8 Fishing mortality (F) at age

YEAR	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
AGE										
3	0.3385	0.2252	0.2573	0.3213	0.7669	0.3616	0.1542	0.0378	0.0928	0.1263
4	0.6042	0.3429	0.5905	0.6487	1.2663	0.6431	0.5041	0.3077	0.2125	0.2478
5	0.9919	0.4214	0.5184	0.644	0.9363	0.8651	0.9687	0.6793	0.5514	0.4766
6	0.4782	0.6968	0.4478	0.7091	0.5447	0.446	0.8883	0.8177	0.8689	0.6823
7	0.2982	0.5926	0.6002	0.8046	0.6391	0.8069	0.5124	0.3687	0.7727	0.5406
8	0.2728	0.4829	0.3512	0.8775	0.5411	0.4552	0.7128	0.7048	0.4347	0.6437
9	0.2772	0.8009	0.2027	0.8145	0.5624	0.678	0.5064	0.7646	0.5159	0.3684
10	0.2829	0.6318	0.3856	0.8431	0.5857	0.653	0.5817	0.6192	0.5803	0.5228
+gp	0.2829	0.6318	0.3856	0.8431	0.5857	0.653	0.5817	0.6192	0.5803	0.5228
FBAR 4- 7	0.5931	0.5134	0.5392	0.7016	0.8466	0.6903	0.7184	0.5434	0.6014	0.4868

Table 8 Fishing mortality (F) at age

YEAR	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
AGE										
3	0.1807	0.061	0.1355	0.0671	0.0533	0.0239	0.0706	0.0257	0.0552	0.0721
4	0.4425	0.3323	0.2214	0.4569	0.4589	0.1666	0.185	0.1055	0.1424	0.2487
5	0.4101	0.3415	0.3832	0.3087	0.9187	0.5272	0.3557	0.1255	0.2463	0.2596
6	0.363	0.2376	0.5655	0.4976	0.2952	1.1343	0.4826	0.1939	0.2889	0.377
7	0.39	0.3452	0.4198	0.5964	0.5675	0.3192	0.6064	0.2529	0.3295	0.3485
8	0.3612	0.4957	0.5519	0.3435	0.4385	0.3482	0.3504	0.2945	0.2623	0.33
9	0.184	0.3381	0.6258	0.5424	0.2976	0.2132	0.0904	1.5752	0.2185	0.2572
10	0.3129	0.395	0.5389	0.4987	0.4392	0.2901	0.3536	0.7338	0.299	0.1993
+gp	0.3129	0.395	0.5389	0.4987	0.4392	0.2901	0.3536	0.7338	0.299	0.1993
FBAR 4- 7	0.4014	0.3141	0.3975	0.4649	0.5601	0.5368	0.4074	0.1694	0.2518	0.3084

Table 4.14 (continued)

Table 8   Fishing mortality (F) at age

YEAR	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	FBAR **-**
AGE											
3	0.0243	0.0128	0.0195	0.0274	0.0289	0.0662	0.1326	0.0173	0.0441	0.0182	0.0265
4	0.2161	0.1082	0.08	0.1287	0.2058	0.3177	0.3203	0.2966	0.1296	0.1824	0.2029
5	0.4681	0.4735	0.2752	0.3631	0.4741	0.5016	0.8258	0.3963	0.682	0.2708	0.4497
6	0.538	0.6688	0.6212	0.535	0.7005	0.6489	0.832	0.5715	0.5826	0.799	0.651
7	0.375	0.7076	0.6342	0.7736	0.8718	0.6239	0.7869	0.6258	0.7316	0.5103	0.6226
8	0.384	0.4723	0.3359	0.9258	0.9964	1.0171	0.9724	0.6812	0.8119	0.807	0.7667
9	0.4903	0.6949	0.4004	0.798	0.7441	0.7161	0.4123	0.5049	0.6685	0.631	0.6015
10	0.3051	0.9987	0.654	0.8411	1.0553	0.8599	0.3475	0.5307	0.6774	0.8412	0.6831
+gp	0.3051	0.9987	0.654	0.8411	1.0553	0.8599	0.3475	0.5307	0.6774	0.8412	
FBAR 4- 7	0.3993	0.4896	0.4026	0.4501	0.563	0.523	0.6912	0.4726	0.5315	0.4406	

Table 4.15

Run title : Arctic Haddock (run: Standard VPA AFWG03)

At 1/05/2003 13:16

Traditional vpa using file input for terminal F

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

YEAR	1950	1951	1952
AGE			
3	66026	553019	60283
4	92622	51179	393614
5	68513	41886	33641
6	36893	24596	18190
7	45596	13404	8078
8	15745	11738	4905
9	4518	4716	3523
10	1941	1930	928
+gp	5287	2201	1348
TOTAL	337141	704669	524510

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

YEAR	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962
AGE										
3	1023249	120542	50765	167878	51537	67410	322648	240840	108736	240221
4	43935	779545	92769	40521	122627	40323	53631	245830	161251	75127
5	186200	24292	499066	66319	27842	78175	27687	36860	137614	81075
6	15346	89074	14600	250291	41068	15665	35875	16162	17956	56095
7	6123	7697	48176	7478	90933	22377	7613	16806	6886	6934
8	2442	2454	3411	14321	3277	32898	6985	3412	8175	2450
9	1150	1035	849	1501	4605	1709	11292	3712	1384	2769
10	733	562	218	452	825	2009	665	3973	964	432
+gp	2339	957	218	418	408	1126	1168	1201	2624	1350
TOTAL	1281518	1026158	710071	549179	343123	261691	467564	568796	445591	466453

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

YEAR	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
AGE										
3	273037	316145	100872	237489	293825	17580	17380	164303	94306	1020049
4	161110	197881	238663	77231	170693	226209	13800	12855	113403	75425
5	33898	66931	117722	153693	42919	102594	124511	9526	8317	70941
6	22960	10878	27406	60348	69323	23033	47073	61952	6084	5677
7	15885	6735	3728	11159	23488	33723	11912	21540	30640	4155
8	2818	4779	2372	1552	4010	11286	13681	6504	10382	16760
9	812	1200	1497	1070	750	1837	4516	6778	3520	5757
10	696	171	247	429	485	418	917	2239	3740	2140
+gp	638	1040	1609	550	750	657	316	886	1915	3927
TOTAL	511853	605760	494115	543521	606242	417336	234107	286584	272308	1204831

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

YEAR	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
AGE										
3	270065	52805	48611	55887	113858	170999	135116	18656	6039	8193
4	627516	157622	34517	30772	33183	43296	97521	94820	14708	4506
5	41726	280766	91589	15658	13169	7658	18633	48229	57071	9737
6	19925	12670	150824	44651	6733	4228	2640	5790	20019	26921
7	1797	10112	5168	78910	17990	3197	2216	889	2093	6874
8	1959	1092	4578	2322	28896	7774	1168	1087	503	791
9	7676	1221	551	2638	790	13772	4037	469	440	267
10	2358	4763	449	369	956	369	5723	1992	179	215
+gp	2603	4359	3200	3064	934	911	800	3454	2390	1744
TOTAL	975624	525410	339488	234270	216510	252202	267854	175386	103441	59248

Table 4.15 (continued)

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

YEAR	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
AGE										
3	4686	8370	256679	531455	83414	42171	16887	24337	81501	196086
4	5912	3202	6381	183519	262700	64748	25608	12883	16316	63146
5	2879	3110	1881	4187	95144	135925	44876	17425	9492	11586
6	4950	1564	1809	1050	2517	31082	65536	25744	12585	6074
7	11141	2819	1010	842	522	1534	8185	33115	17362	7718
8	3278	6176	1634	543	380	242	913	3655	21055	10224
9	340	1870	3080	770	316	200	140	526	2229	13261
10	151	232	1092	1349	367	192	133	105	89	1467
+gp	703	954	297	438	878	1352	243	63	72	110
TOTAL	34040	28297	273863	724152	446237	277447	162522	117853	160701	309672

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

YEAR	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	GMST 50-**	AMST 50-**
AGE													
3	634499	277171	79624	89684	99341	42504	180336	61329	309488	330393	0	93510	180362
4	148450	474041	201845	53313	36698	56587	30922	129034	47739	238443	208676	65672	125373
5	40318	95207	341759	126851	33839	23087	31555	18379	77755	34286	161085	37635	71803
6	7317	18646	47909	189240	70293	16700	11109	11313	10010	32186	21279	18268	35027
7	3411	3498	7814	20862	88428	28242	7146	3958	5185	4577	11837	8419	16234
8	4460	1920	1411	3393	7880	30278	12391	2664	1733	2043	2249	3818	6844
9	6018	2487	980	826	1101	2382	8965	3836	1103	630	746	1731	2974
10	8395	3018	1016	538	304	428	953	4860	1896	463	274	737	1356
+gp	1603	3246	2190	2353	892	428	519	868	2248	1485	688		
TOTAL	854472	879233	684549	487058	338775	200637	283896	236241	457158	644505	406835		

Table 4.16

Run title : Arctic Haddock (run: Standard VPA AFWG03)

At 1/05/2003 13:16

Traditional vpa using file input for terminal F

Table 14 Stock biomass at age with SOP (start of year) Tonnes

YEAR	1950	1951	1952
AGE			
3	19804	237753	20398
4	43355	34338	207854
5	55734	48839	30873
6	39904	38131	22195
7	59263	24971	11844
8	23827	25461	8374
9	7596	11367	6682
10	3890	5545	2098
+gp	16519	9858	4751
TOTALBIO	269894	436263	315070

Table 14 Stock biomass at age with SOP (start of year) Tonnes

YEAR	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962
AGE										
3	387813	47898	15852	61258	19316	27344	170497	133185	57597	118254
4	25986	483407	45207	23075	71725	25527	44228	212155	133299	57716
5	191395	26179	422644	65632	28301	86005	39680	55284	197698	108244
6	20973	127633	16440	329341	55505	22915	68363	32229	34299	99578
7	10057	13254	65187	11824	147685	39334	17433	40273	15807	14791
8	4671	4920	5374	26366	6198	67331	18622	9521	21848	6085
9	2444	2305	1487	3070	9677	3886	33452	11508	4109	7642
10	1857	1492	454	1103	2066	5444	2350	14680	3414	1422
+gp	9236	3960	708	1591	1592	4758	6427	6917	14481	6924
TOTALBIO	654431	711048	573353	523259	342063	282543	401051	515752	482552	420654

Table 14 Stock biomass at age with SOP (start of year) Tonnes

YEAR	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
AGE										
3	134114	129020	46459	103472	153559	9191	9209	81845	62897	578504
4	123500	126029	171543	52513	139218	184567	11411	9994	118034	66757
5	45158	74082	147049	181611	60834	145472	178927	12869	15044	109117
6	40668	16009	45517	94815	130647	43424	89943	111285	14633	11611
7	33811	11910	7440	21067	53192	76402	27350	46495	88554	10210
8	6985	9840	5511	3412	10573	29771	36575	16347	34936	47958
9	2237	2746	3866	2615	2196	5384	13414	18929	13162	18304
10	2284	466	759	1250	1692	1460	3247	7452	16669	8108
+gp	3264	4422	7717	2495	4086	3577	1746	4600	13304	23202
TOTALBIO	392020	374524	435861	463249	555997	499249	371822	309815	377234	873771

Table 4.16 (continued)

Table 14	Stock biomass at age with SOP (start of year)			Tonnes						
YEAR	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
AGE										
3	147607	30172	26075	23225	57920	107298	100578	12746	3963	5142
4	535248	140551	28894	19956	26343	42397	113288	101100	15061	4413
5	61852	435089	133241	17647	18169	13032	37618	89368	101562	16574
6	39271	26106	291733	66913	12350	9566	7086	14266	47367	60931
7	4255	25038	12012	142101	39656	8693	7147	2632	5951	18696
8	5403	3147	12389	4868	74166	24610	4387	3746	1667	2505
9	23518	3912	1658	6146	2254	48444	16847	1796	1618	939
10	8610	18184	1609	1024	3251	1546	28467	9094	784	901
+gp	14818	25947	17881	13264	4951	5951	6205	24582	16338	11399
TOTALBIO	840583	708146	525492	295144	239061	261537	321622	259331	194309	121501

Table 14	Stock biomass at age with SOP (start of year)			Tonnes						
YEAR	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
AGE										
3	2070	2275	108183	141876	19772	8979	4539	6200	29150	67949
4	5676	2903	4779	128438	124280	24867	10880	9076	12110	52465
5	4349	5294	3415	3961	86748	83851	29356	15892	13088	17832
6	9481	3687	4306	1391	3640	34761	63454	32074	19670	12076
7	26581	5938	1796	1393	943	2801	11158	49759	29851	17517
8	10047	19343	3713	1149	1157	566	2062	7068	45084	24034
9	1159	6508	8180	1905	851	547	370	1380	5837	34505
10	614	961	3120	3587	1064	563	377	298	264	5238
+gp	4447	6168	1085	1490	3263	5080	884	229	262	419
TOTALBIO	64424	53078	138577	285191	241716	162015	123081	121977	155317	232036

Table 14	Stock biomass at age with SOP (start of year)			Tonnes						
YEAR	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
AGE										
3	189485	72174	18054	19632	21379	10538	53660	14133	95577	64193
4	120204	284858	77057	25135	14948	27520	19316	88428	23550	138029
5	57778	112198	289416	91445	24298	20279	33861	19500	91528	33411
6	14681	31767	72958	224049	81761	21109	17441	14690	15608	48933
7	7743	7548	16069	40507	136274	43748	12464	5897	10534	9392
8	13609	5359	4336	8676	20201	63071	25024	4291	4323	5051
9	20451	6570	3032	2447	3718	7962	24018	6973	2904	1706
10	28606	8802	3251	1880	1065	1277	2527	10762	5034	1329
+gp	6747	11416	7304	8616	4351	1730	2090	2591	8605	5675
TOTALBIO	459304	540693	491478	422388	307995	197235	190400	167265	257664	307720

Table 4.17

Run title : Arctic Haddock (run: Standard VPA AFWG03)

At 1/05/2003 13:16

Traditional vpa using file input for terminal F

Table 15 Spawning stock biomass with SOP (spawning time) Tonnes

YEAR	1950	1951	1952
AGE			
3	0	0	0
4	2168	1717	10393
5	12819	11233	7101
6	21149	20209	11764
7	52152	21975	10423
8	23351	24952	8207
9	7596	11367	6682
10	3890	5545	2098
+gp	16519	9858	4751
TOTSPBIO	139644	106855	61418

Table 15 Spawning stock biomass with SOP (spawning time) Tonnes

YEAR	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962
AGE										
3	0	0	0	0	0	0	0	0	0	0
4	1299	24170	2260	1154	3586	1276	2211	10608	6665	2886
5	44021	6021	97208	15095	6509	19781	9126	12715	45471	24896
6	11116	67646	8713	174551	29417	12145	36232	17082	18179	52776
7	8850	11664	57364	10405	129963	34613	15341	35440	13910	13016
8	4577	4821	5267	25839	6074	65985	18250	9330	21411	5963
9	2444	2305	1487	3070	9677	3886	33452	11508	4109	7642
10	1857	1492	454	1103	2066	5444	2350	14680	3414	1422
+gp	9236	3960	708	1591	1592	4758	6427	6917	14481	6924
TOTSPBIO	83400	122079	173462	232807	188884	147888	123389	118280	127639	115524

Table 4.17 (continued)

Run title : Arctic Haddock (run: Standard VPA AFWG03)

At 1/05/2003 13:16

Traditional vpa using file input for terminal F

Table 15 Spawning stock biomass with SOP (spawning time) Tonnes

YEAR	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
AGE										
3	0	0	0	0	0	0	0	0	0	0
4	6175	6301	8577	2626	6961	9228	571	500	5902	3338
5	10386	17039	33821	41771	13992	33459	41153	2960	3460	25097
6	21554	8485	24124	50252	69243	23015	47670	58981	7756	6154
7	29754	10481	6547	18539	46809	67233	24068	40915	77928	8985
8	6845	9643	5401	3344	10362	29176	35843	16020	34237	46999
9	2237	2746	3866	2615	2196	5384	13414	18929	13162	18304
10	2284	466	759	1250	1692	1460	3247	7452	16669	8108
+gp	3264	4422	7717	2495	4086	3577	1746	4600	13304	23202
TOTSPBIO	82499	59583	90813	122890	155341	172533	167712	150357	172417	140187

Table 15 Spawning stock biomass with SOP (spawning time) Tonnes

YEAR	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
AGE										
3	0	0	0	0	0	0	0	0	40	463
4	26762	7028	1445	998	1317	2120	5664	5055	1807	2427
5	14226	100070	30645	4059	4179	2997	8652	20555	65000	12099
6	20814	13836	154619	35464	6546	5070	3755	7561	34578	56665
7	3745	22034	10571	125049	34897	7650	6289	2316	5713	17948
8	5295	3084	12141	4770	72683	24118	4299	3671	1667	2505
9	23518	3912	1658	6146	2254	48444	16847	1796	1618	939
10	8610	18184	1609	1024	3251	1546	28467	9094	784	901
+gp	14818	25947	17881	13264	4951	5951	6205	24582	16338	11399
TOTSPBIO	117788	194095	230569	190774	130078	97896	80180	74630	127542	105348

Table 15 Spawning stock biomass with SOP (spawning time) Tonnes

YEAR	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
AGE										
3	352	159	2164	0	0	0	0	0	0	1359
4	3973	406	382	28256	1243	746	435	182	848	6820
5	4349	1853	2732	2099	18217	27671	8807	4767	3926	8916
6	9481	1733	4004	1197	1929	17728	39976	17320	9835	7487
7	26581	4394	1724	1198	943	2801	9150	38314	23881	13488
8	10047	19343	3713	1149	1157	566	2062	6149	41477	19228
9	1159	6508	8180	1905	851	547	370	1104	5837	32435
10	614	961	3120	3587	1064	563	377	298	264	5238
+gp	4447	6168	1085	1490	3263	5080	884	229	262	419
TOTSPBIO	61003	41526	27104	40882	28666	55702	62061	68364	86330	95391

Table 15 Spawning stock biomass with SOP (spawning time) Tonnes

YEAR	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
AGE										
3	2842	0	0	0	0	0	537	0	382	514
4	26325	4843	1541	0	448	1376	3284	8843	1413	17944
5	28311	14586	34730	9145	2430	5678	16930	6240	49425	11025
6	11157	13024	30642	80658	23711	10555	12383	8667	11238	35721
7	6117	6794	13016	31595	81764	28874	10096	4246	9164	7795
8	11976	4716	3816	7462	16565	51088	22772	4034	4064	4546
9	17997	6570	3032	2202	3718	7246	22096	6554	2614	1706
10	24887	8802	2828	1749	884	1277	2527	10331	5034	1250
+gp	6747	11073	7304	7755	4351	1730	2090	2591	7831	5675
TOTSPBIO	136360	70408	96910	140565	133871	107823	92714	51506	91165	86176

Table 4.18

Run title : Arctic Haddock (run: Standard VPA AFWG03)

At 1/05/2003 13:16

Table 17 Summary (with SOP correction)

Traditional vpa using file input for terminal F

	RECRUITS Age 3	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	SOPCOFAC	FBAR 4- 7
1950	66026	269894	139644	132125	0.9462	0.4545	0.8469
1951	553019	436263	106855	120077	1.1237	0.6514	0.6431
1952	60283	315070	61418	127660	2.0785	0.5127	0.7546
1953	1023249	654431	83400	123920	1.4859	0.5742	0.5336
1954	120542	711048	122079	156788	1.2843	0.6021	0.3959
1955	50765	573353	173462	202286	1.1662	0.4731	0.527
1956	167878	523259	232807	213924	0.9189	0.5529	0.473
1957	51537	342063	188884	123583	0.6543	0.5679	0.4623
1958	67410	282543	147888	112672	0.7619	0.6146	0.5602
1959	322648	401051	123389	88211	0.7149	0.8007	0.4185
1960	240840	515752	118280	154651	1.3075	0.8379	0.5183
1961	108736	482552	127639	193224	1.5138	0.8026	0.6925
1962	240221	420654	115524	187408	1.6222	0.7459	0.8548
1963	273037	392020	82499	146224	1.7724	0.7442	0.9107
1964	316145	374524	59583	99158	1.6642	0.6183	0.6817
1965	100872	435861	90813	118578	1.3057	0.6978	0.5208
1966	237489	463249	122890	161778	1.3164	0.6601	0.6377
1967	293825	555997	155341	136397	0.8781	0.7919	0.4462
1968	17580	499249	172533	181726	1.0533	0.7921	0.5344
1969	17380	371822	167712	130820	0.78	0.8028	0.4139
1970	164303	309815	150357	88257	0.587	0.7547	0.3794
1971	94306	377234	172417	78905	0.4576	1.0105	0.2589
1972	1020049	873771	140187	266153	1.8986	0.8593	0.741
1973	270065	840583	117788	322226	2.7356	0.8281	0.5931
1974	52805	708146	194095	221157	1.1394	0.8657	0.5134
1975	48611	525492	230569	175758	0.7623	0.8127	0.5392
1976	55887	295144	190774	137264	0.7195	0.6296	0.7016
1977	113858	239061	130078	110158	0.8469	0.7708	0.8466
1978	170999	261537	97896	95422	0.9747	0.9507	0.6903
1979	135116	321622	80180	103623	1.2924	1.1278	0.7184
1980	18656	259331	74630	87889	1.1777	1.0352	0.5434
1981	6039	194309	127542	77153	0.6049	0.9942	0.6014
1982	8193	121501	105348	46955	0.4457	0.951	0.4868
1983	4686	64424	61003	21607	0.3542	0.9205	0.4014
1984	8370	53078	41526	17318	0.417	0.9405	0.3141
1985	256679	138577	27104	41270	1.5226	0.9689	0.3975
1986	531455	285191	40882	96585	2.3626	0.9019	0.4649
1987	83414	241716	28666	150654	5.2555	0.9836	0.5601
1988	42171	162015	55702	91745	1.6471	0.995	0.5368
1989	16887	123081	62061	54859	0.8839	0.9634	0.4074
1990	24337	121977	68364	25741	0.3765	0.9651	0.1694
1991	81501	155317	86330	33605	0.3893	0.9589	0.2518
1992	196086	232036	95391	53887	0.5649	1.0132	0.3084
1993	634499	459304	136360	77621	0.5692	1.0021	0.3993
1994	277171	540693	70408	128703	1.828	1.1128	0.4896
1995	79624	491478	96910	138677	1.431	1.0546	0.4026
1996	89684	422388	140565	173264	1.2326	1.0524	0.4501
1997	99341	307995	133871	148756	1.1112	1.0498	0.563
1998	42504	197235	107823	93946	0.8713	1.0595	0.523
1999	180336	190400	92714	82346	0.8882	1.0552	0.6912
2000	61329	167265	51506	61292	1.19	1.0019	0.4726
2001	309488	257664	91165	81842	0.8977	1.0027	0.5315
2002	330393	307720	86176	83848	0.973	1.0015	0.4406
Arith. Mean	185629	363543	112812	120372	1.1841		.5324
Units	(Thousands	(Tonnes)	(Tonnes)	(Tonnes)			

Table 4.19

PREDICTION WITH MANAGEMENT OPTION TABLE: INPUT DATA

MFDP version 1a
Run: had03_final
Time and date: 20:50 01.05.2003
Fbar age range: 4-7

2003

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
3	250000	0.4413	0.003	0	0	0.241	2.65E-02	0.573
4	208676	0.2098	0.047	0	0	0.475	0.202867	0.979
5	161085	0.2062	0.37	0	0	1.074	0.4497	1.379
6	21279	0.2013	0.629	0	0	1.44	0.651033	1.62
7	11837	0.2	0.881	0	0	1.953	0.622567	2.114
8	2249	0.2	1	0	0	2.484	0.7667	2.208
9	746	0.2	0.923	0	0	2.784	0.601467	2.643
10	274	0.2	1	0	0	2.962	0.6831	2.436
11	688	0.2	1	0	0	4.655	0.6831	2.695

2004

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
3	277000	0.432	0.002	0	0	0.228	2.65E-02	0.595
4	.	0.233	0.034	0	0	0.455	0.202867	0.905
5	.	0.217	0.277	0	0	0.941	0.4497	1.255
6	.	0.204	0.54	0	0	1.371	0.651033	1.558
7	.	0.2	0.863	0	0	1.877	0.622567	1.99
8	.	0.2	0.96	0	0	2.529	0.7667	2.207
9	.	0.2	0.962	0	0	2.81	0.601467	2.539
10	.	0.2	1	0	0	3.02	0.6831	2.584
11	.	0.2	1	0	0	4.134	0.6831	2.786

2005

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
3	422000	0.423	0	0	0	0.216	2.65E-02	0.618
4	.	0.255	0.021	0	0	0.435	0.202867	0.83
5	.	0.227	0.184	0	0	0.808	0.4497	1.13
6	.	0.207	0.45	0	0	1.302	0.651033	1.495
7	.	0.2	0.844	0	0	1.801	0.622567	1.865
8	.	0.2	0.92	0	0	2.574	0.7667	2.205
9	.	0.2	1	0	0	2.835	0.601467	2.435
10	.	0.2	1	0	0	3.078	0.6831	2.733
11	.	0.2	1	0	0	3.613	0.6831	2.878

Input units are thousands and kg - output in tonnes

Table 4.20 Yield-per-recruit. Input data and results.

MFYPR version 2a
Run: NEA Haddock
NEA Haddock (AFWG03: Final run)
Time and date: 15:58 02.05.2003
Fbar age range: 4-7

Age	M	Mat	PF	PM	SWt	Sel	CWt
3	0.36984	0.00	0	0	0.2408	0.0265	0.6303
4	0.25027	0.08	0	0	0.5351	0.2029	0.9379
5	0.23389	0.29	0	0	0.9713	0.4497	1.2749
6	0.20582	0.55	0	0	1.4260	0.6510	1.5720
7	0.2	0.78	0	0	1.8144	0.6226	1.8724
8	0.2	0.88	0	0	2.3784	0.7667	2.0948
9	0.2	0.95	0	0	2.7569	0.6015	2.3723
10	0.2	0.94	0	0	2.8763	0.6831	2.5746
11	0.2	0.98	0	0	3.6888	0.6831	2.7985

Weights in kilograms

Yield per results

FMult	Fbar	CatchNos	Yield	StockNos (Jan)	Biomass (Spawn)	SpwnNos	SSBJan	SpwnNos	SSBSpwn
0	0	0	0	4.5661	7.3993	2.2067	5.8174	2.2067	5.8174
0.05	0.0241	0.0765	0.1515	4.1891	6.1879	1.8582	4.6658	1.8582	4.6658
0.1	0.0482	0.1341	0.2563	3.9059	5.3085	1.6005	3.8368	1.6005	3.8368
0.15	0.0722	0.1793	0.3314	3.685	4.6457	1.4026	3.2176	1.4026	3.2176
0.2	0.0963	0.2158	0.3868	3.5075	4.1314	1.2462	2.7417	1.2462	2.7417
0.25	0.1204	0.246	0.4285	3.3613	3.7229	1.1198	2.3676	1.1198	2.3676
0.3	0.1445	0.2715	0.4605	3.2388	3.392	1.0156	2.0679	1.0156	2.0679
0.35	0.1685	0.2933	0.4855	3.1343	3.1195	0.9284	1.8239	0.9284	1.8239
0.4	0.1926	0.3123	0.5052	3.0441	2.8919	0.8545	1.6226	0.8545	1.6226
0.45	0.2167	0.3289	0.5209	2.9652	2.6995	0.7911	1.4545	0.7911	1.4545
0.5	0.2408	0.3437	0.5337	2.8956	2.5351	0.7362	1.3127	0.7362	1.3127
0.55	0.2648	0.357	0.5441	2.8336	2.3932	0.6882	1.192	0.6882	1.192
0.6	0.2889	0.3689	0.5526	2.778	2.2696	0.646	1.0882	0.646	1.0882
0.65	0.313	0.3798	0.5597	2.7278	2.1612	0.6085	0.9985	0.6085	0.9985
0.7	0.3371	0.3897	0.5656	2.6821	2.0655	0.5751	0.9203	0.5751	0.9203
0.75	0.3612	0.3989	0.5706	2.6404	1.9803	0.5452	0.8518	0.5452	0.8518
0.8	0.3852	0.4073	0.5748	2.6021	1.9041	0.5182	0.7914	0.5182	0.7914
0.85	0.4093	0.4151	0.5783	2.5668	1.8355	0.4937	0.7378	0.4937	0.7378
0.9	0.4334	0.4224	0.5814	2.534	1.7735	0.4715	0.6901	0.4715	0.6901
0.95	0.4575	0.4293	0.5839	2.5036	1.7172	0.4512	0.6474	0.4512	0.6474
1	0.4815	0.4357	0.5862	2.4752	1.6658	0.4326	0.609	0.4326	0.609

Reference point	F multiplier	Absolute F
Fbar(4-7)	1	0.4815
$\mathbf{F}_{max}$	2.2591	1.0879
$\mathbf{F}_{0.1}$	0.3902	0.1879
F35%SPR	0.306	0.1473

Weights in kilograms

Table 4.21

PREDICTION WITH MANAGEMENT OPTION TABLE

MFDP version 1a
Run: had03_final
North East Arctic Haddock
Time and date: 20:50 01.05.2003
Fbar age range: 4-7

2003				
Biomass	SSB	FMult	FBar	Landings
397813	120009	1	0.4815	140376

2004					2005	
Biomass	SSB	FMult	FBar	Landings	Biomass	SSB
414230	132733	0.25	0.1204	46234	527838	194135
.	132733	0.3	0.1445	54822	519564	188889
.	132733	0.35	0.1685	63204	511503	183796
.	132733	0.4	0.1926	71386	503649	178851
.	132733	0.45	0.2167	79374	495998	174049
.	132733	0.5	0.2408	87172	488544	169387
.	132733	0.55	0.2648	94786	481280	164860
.	132733	0.6	0.2889	102220	474201	160464
.	132733	0.65	0.313	109480	467303	156195
.	132733	0.7	0.3371	116571	460579	152049
.	132733	0.75	0.3612	123496	454026	148023
.	132733	0.8	0.3852	130261	447638	144113
.	132733	0.85	0.4093	136869	441412	140316
.	132733	0.9	0.4334	143326	435341	136627
.	132733	0.95	0.4575	149634	429422	133045
.	132733	1	0.4815	155798	423651	129564
.	132733	1.05	0.5056	161821	418024	126184
.	132733	1.1	0.5297	167708	412536	122900
.	132733	1.15	0.5538	173462	407184	119710
.	132733	1.2	0.5779	179087	401964	116610
.	132733	1.25	0.6019	184585	396873	113599

Input units are thousands and kg - output in tonnes

Table 4.22
Prediction single option table

MFDP version 1a
Run: had03_final
Time and date: 20:50 01.05.2003
Fbar age range: 4-7

Year:		2003	F multiplier:	1	Fbar:	0.4815				
Age	F		CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
	3	0.0265	5298	3036	250000	60250	750	181	750	181
	4	0.2029	34686	33957	208676	99121	9808	4659	9808	4659
	5	0.4497	53126	73261	161085	173005	59601	64012	59601	64012
	6	0.651	9323	15103	21279	30642	13384	19274	13384	19274
	7	0.6226	5023	10619	11837	23118	10428	20367	10428	20367
	8	0.7667	1105	2440	2249	5587	2249	5587	2249	5587
	9	0.6015	309	816	746	2077	689	1917	689	1917
	10	0.6831	124	303	274	812	274	812	274	812
	11	0.6831	312	841	688	3203	688	3203	688	3203
Total			109306	140376	656834	397813	97872	120009	97872	120009

Year:		2004	F multiplier:	0.75	Fbar:	0.3612				
Age	F		CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
	3	0.0199	4435	2639	277000	63156	554	126	554	126
	4	0.1522	19773	17895	156589	71248	5324	2422	5324	2422
	5	0.3373	35762	44882	138119	129970	38259	36002	38259	36002
	6	0.4883	29456	45893	83599	114614	45143	61892	45143	61892
	7	0.4669	3092	6153	9074	17031	7831	14698	7831	14698
	8	0.575	2081	4592	5200	13151	4992	12625	4992	12625
	9	0.4511	284	720	855	2404	823	2312	823	2312
	10	0.5123	123	317	335	1011	335	1011	335	1011
	11	0.5123	146	406	398	1644	398	1644	398	1644
Total			95152	123496	671169	414230	103659	132733	103659	132733

Year:		2005	F multiplier:	0.75	Fbar:	0.3612				
Age	F		CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
	3	0.0199	6785	4193	422000	91152	0	0	0	0
	4	0.1522	22033	18288	176288	76685	3702	1610	3702	1610
	5	0.3373	27460	31029	106535	86081	19603	15839	19603	15839
	6	0.4883	27921	41742	79348	103311	35707	46490	35707	46490
	7	0.4669	14256	26587	41836	75347	35310	63593	35310	63593
	8	0.575	1864	4109	4657	11988	4285	11029	4285	11029
	9	0.4511	794	1934	2396	6792	2396	6792	2396	6792
	10	0.5123	163	447	446	1373	446	1373	446	1373
	11	0.5123	132	379	359	1298	359	1298	359	1298
Total			101408	128708	833865	454026	101806	148023	101806	148023

Input units are thousands and kg - output in tonnes

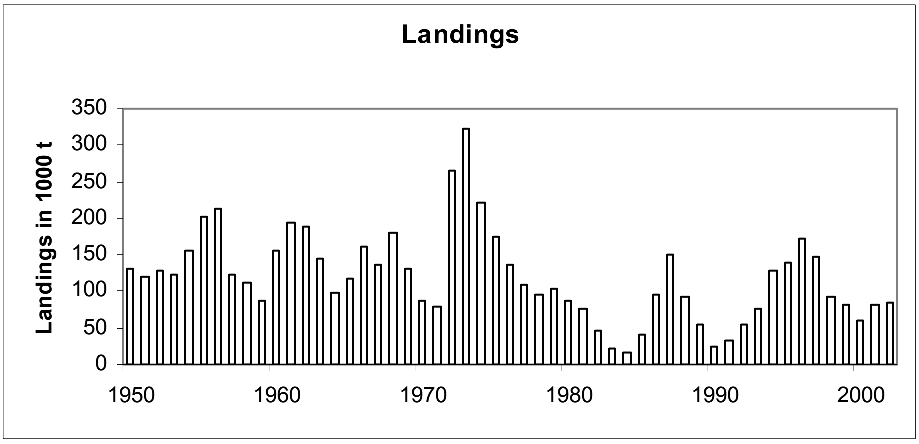


Figure 4.1 A Landings of Northeast Arctic Haddock

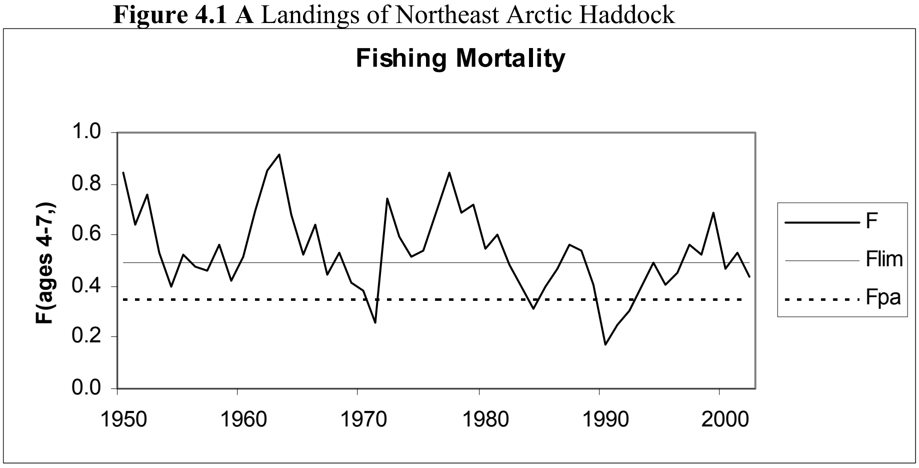


Figure 4.1 B Fishing mortality of Northeast Arctic Haddock

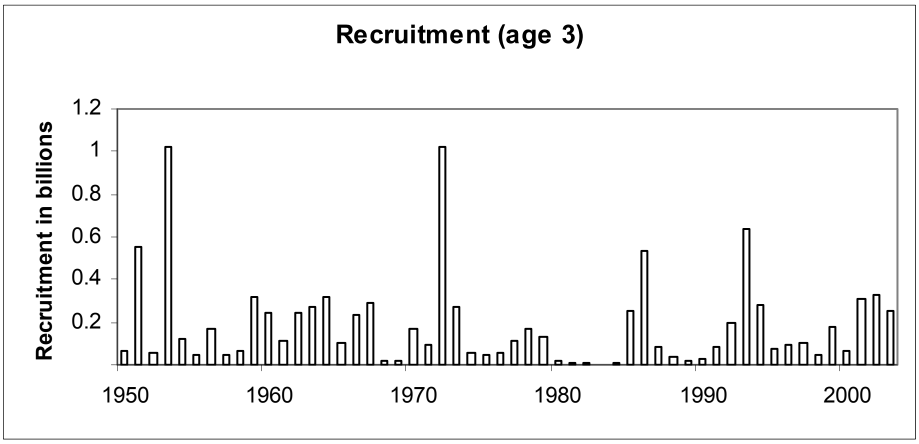


Figure 4.1C Recruitment of Northeast Arctic Haddock

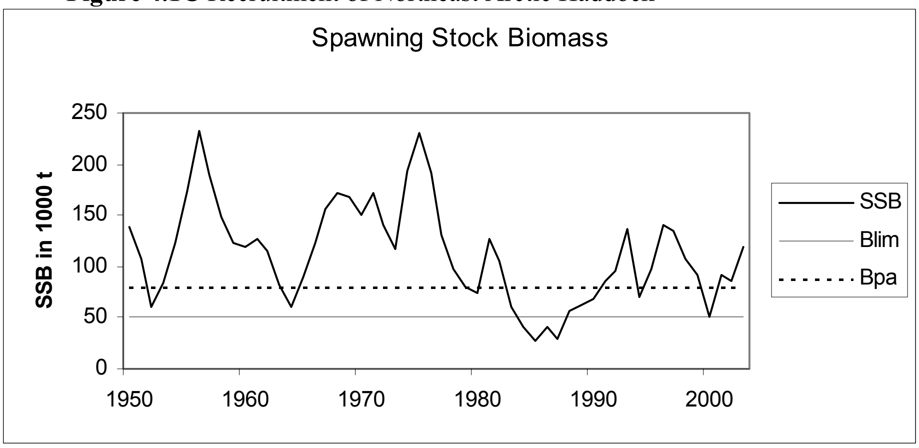


Figure 4.1D Spawning stock biomass of Northeast Arctic haddock

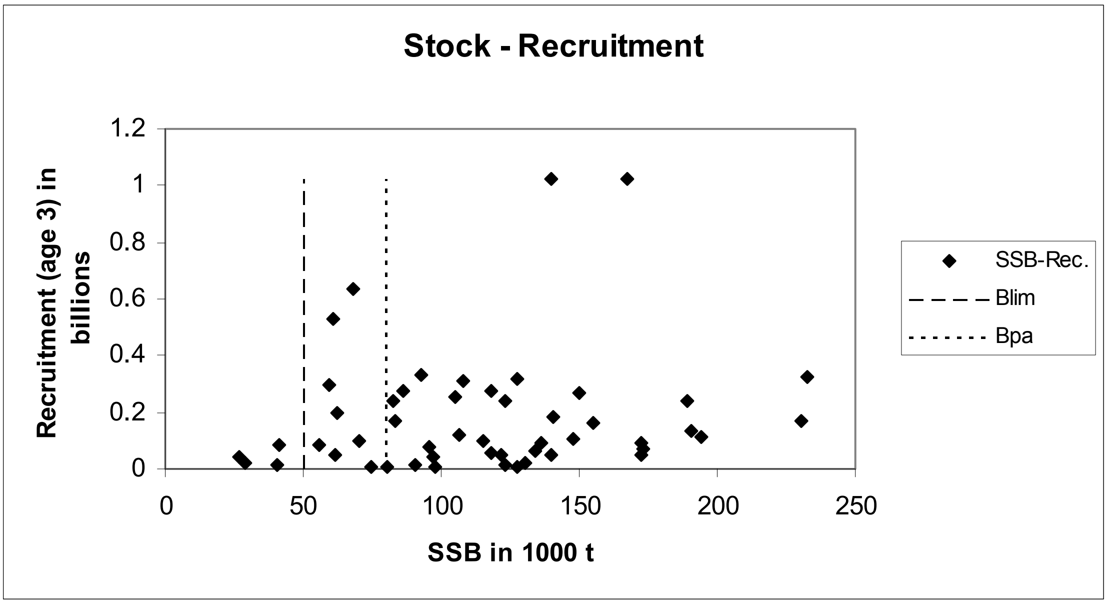


Figure 4.2 Northeast Arctic haddock

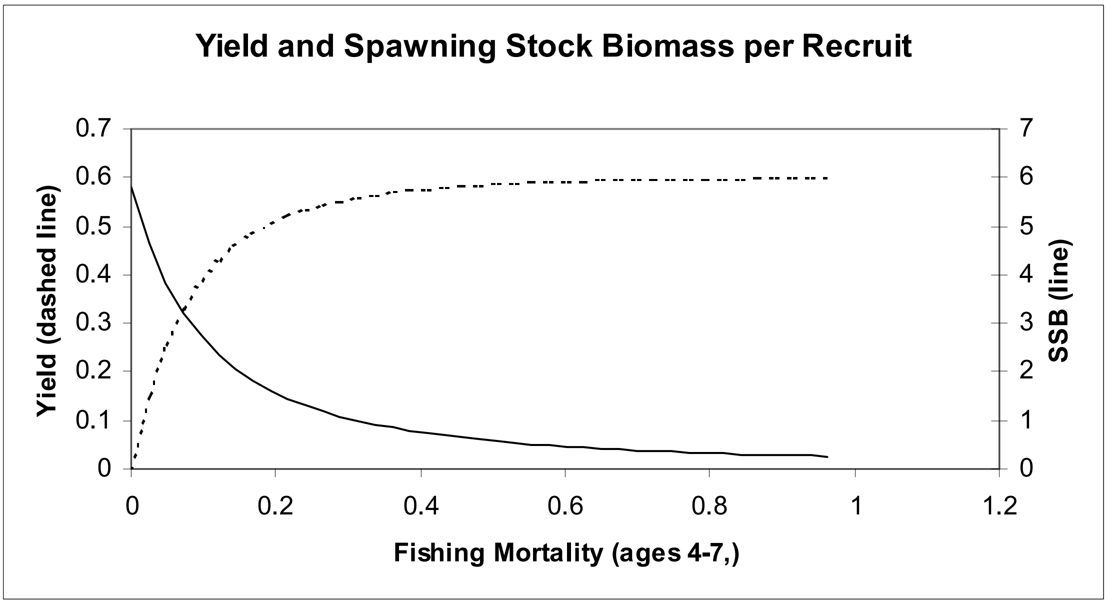


Figure 4.3 Northeast Arctic haddock

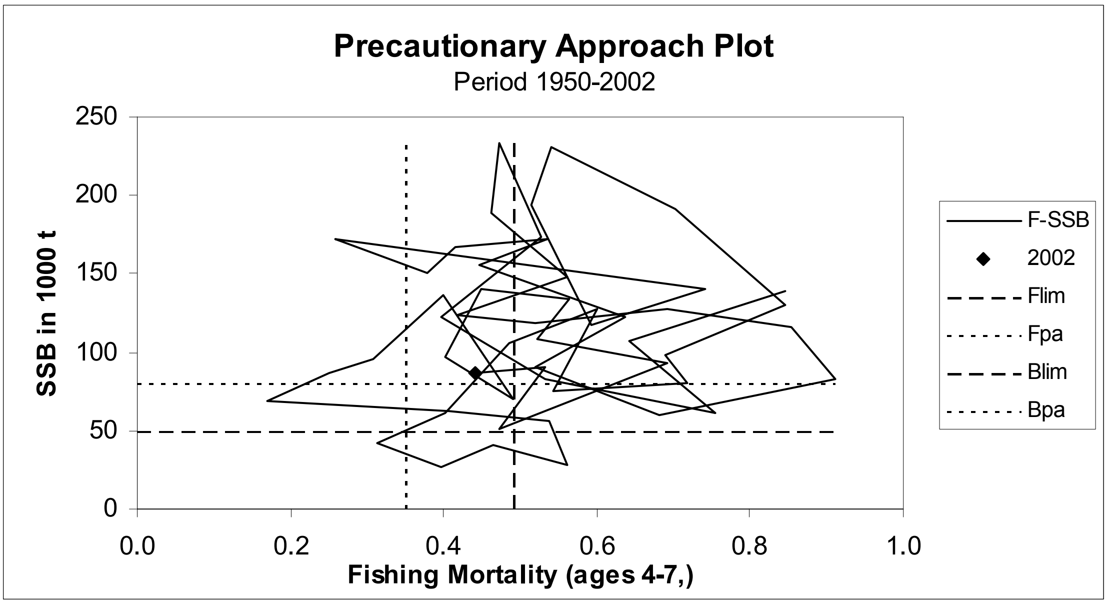


Figure 4.4 Northeast Arctic haddock

Retrospective plots

Figure 4.5. NEA Haddock, retrospective F4-7

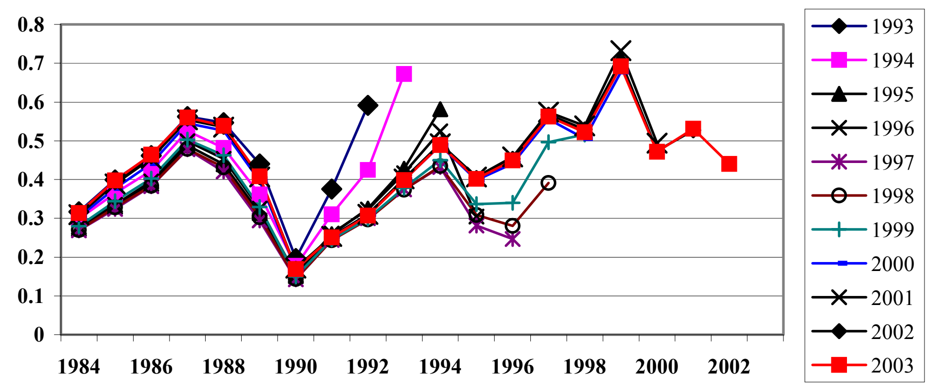


Figure 4.6. NEA Haddock, retrospective recruitement age 3

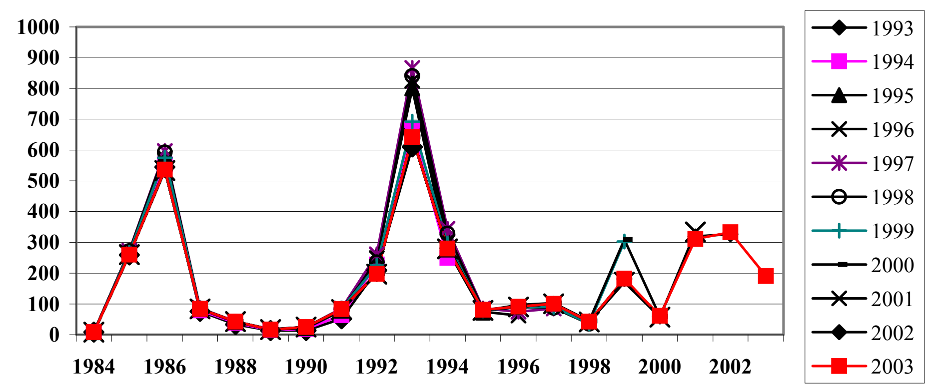
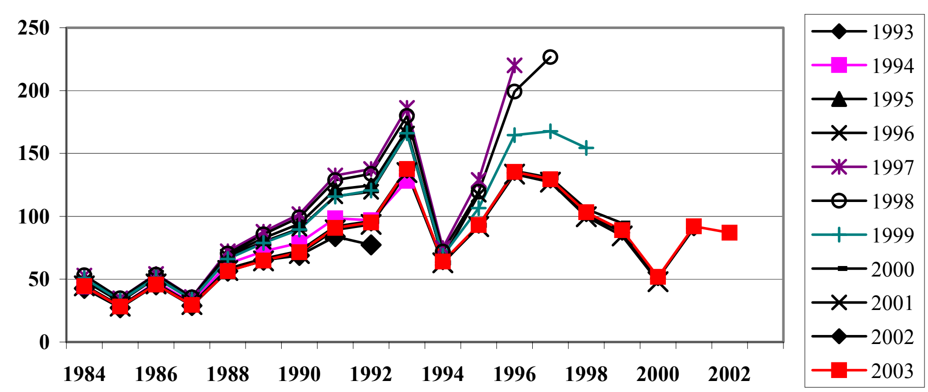


Figure 4.7. NEA Haddock, retrospective SSB



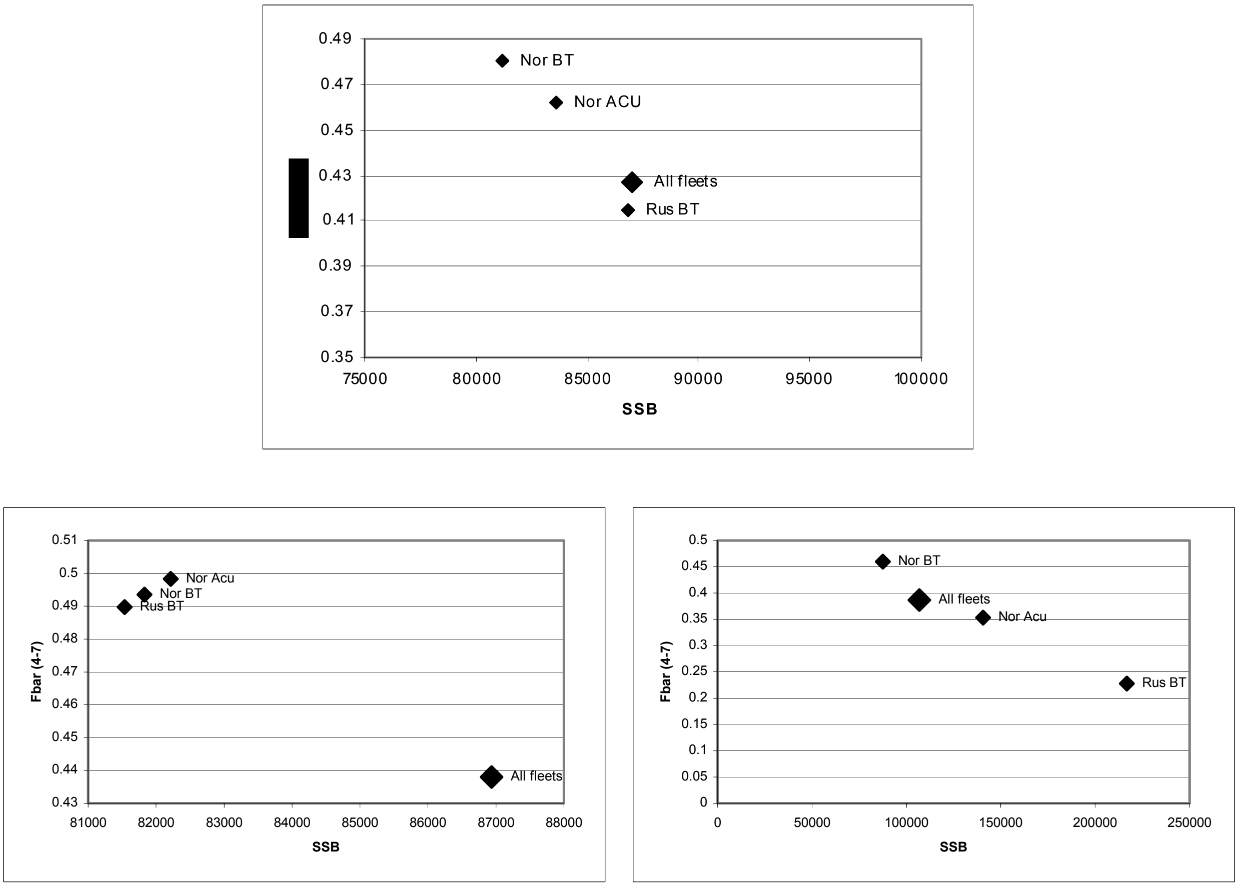
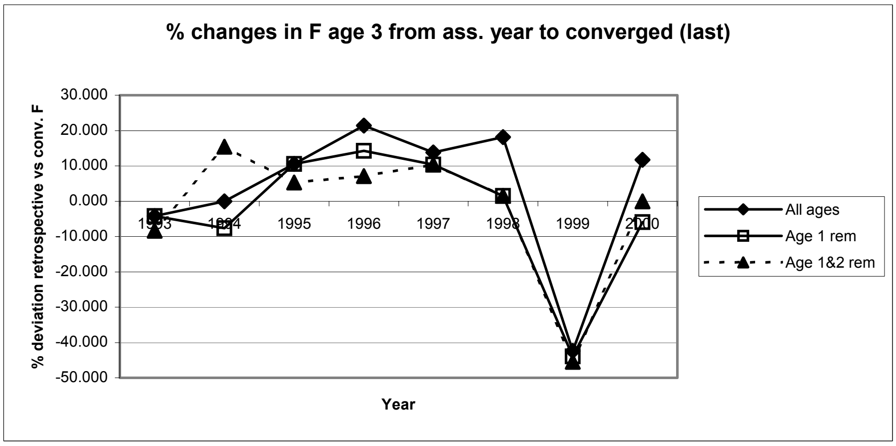
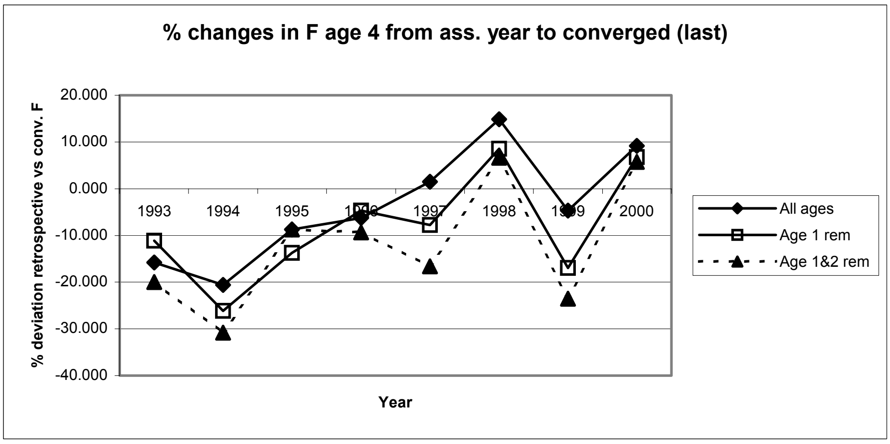


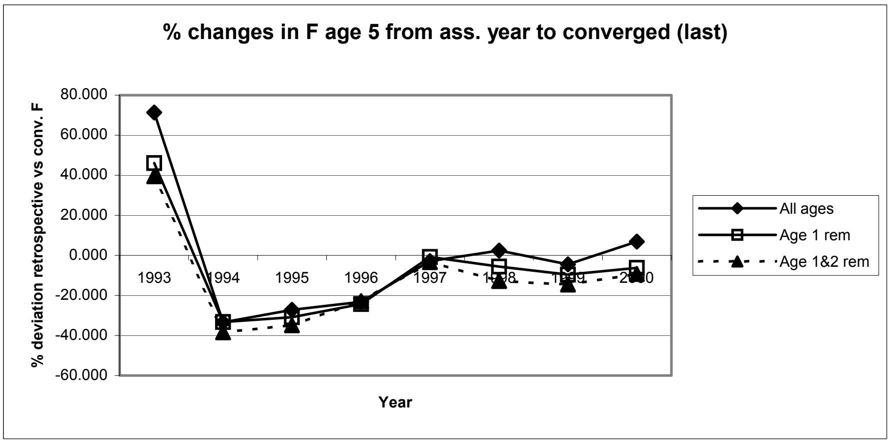
Figure 4.8 Illustration of the observed instability of the XSA tuning after the deletion of agegroups 1 and 2. The top panel shows the single fleet tuning results compared with a combined tuning with the same settings as with the final XSA run, but with agegroups 1 and 2 deleted. The second panel illustrates the effect of increasing the shrinkage from the se=1.00 in the top panel down to se=0.50. The lower panel is results after tuning with no shrinkage.



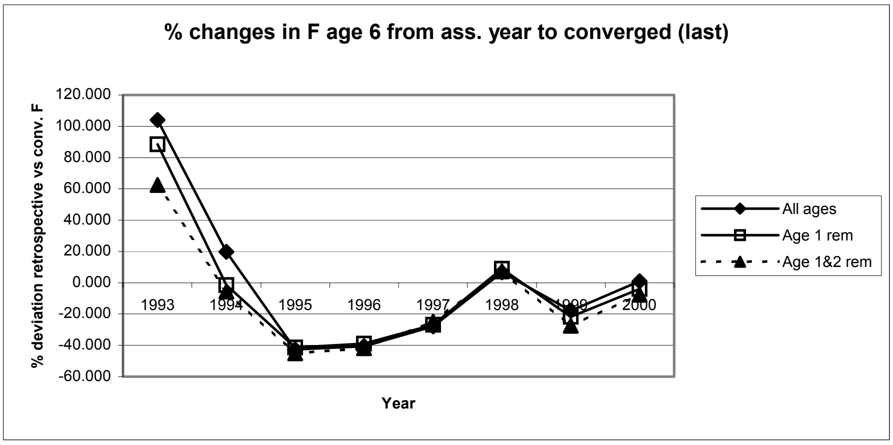
% changes in F age 3 from ass. year to converged (last)
% deviation retrospective vs conv. F
30.000
20.000
10.000
0.000
-10.000
-20.000
-30.000
-40.000
-50.000
1993
1994
1995
1996
1997
1998
1999
2000
Year
All ages
Age 1 rem
Age 1&2 rem



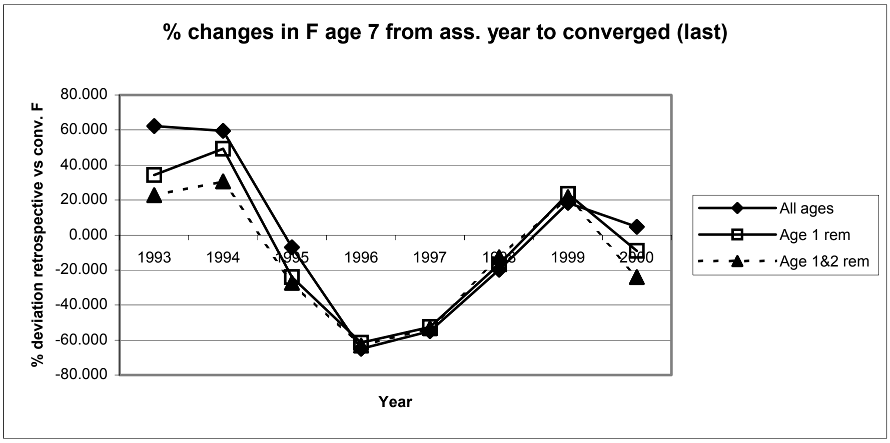
% changes in F age 4 from ass. year to converged (last)
% deviation retrospective vs conv. F
20.000
10.000
0.000
-10.000
-20.000
-30.000
-40.000
1993
1994
1995
1996
1997
1998
1999
2000
Year
All ages
Age 1 rem
Age 1&2 rem



% changes in F age 5 from ass. year to converged (last)
% deviation retrospective vs conv. F
80.000
60.000
40.000
20.000
0.000
-20.000
-40.000
-60.000
1993
1994
1995
1996
1997
1998
1999
2000
Year
All ages
Age 1 rem
Age 1&2 rem



% changes in F age 6 from ass. year to converged (last)
% deviation retrospective vs conv. F
120.000
100.000
80.000
60.000
40.000
20.000
0.000
-20.000
-40.000
-60.000
1993
1994
1995
1996
1997
1998
1999
2000
Year
All ages
Age 1 rem
Age 1&2 rem



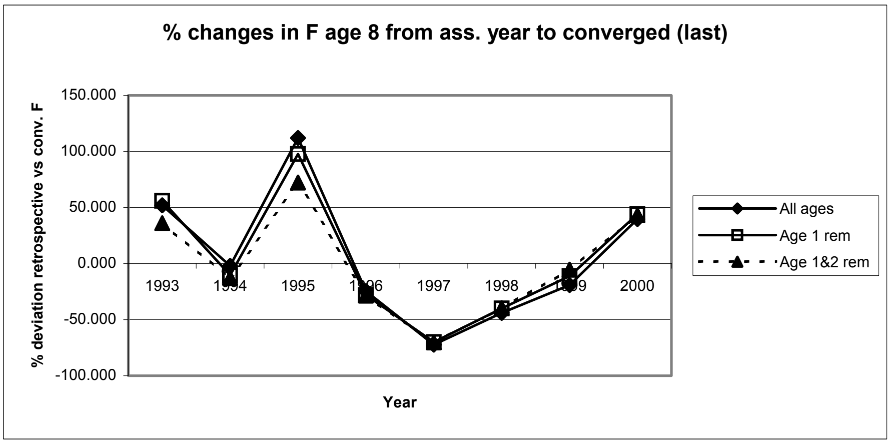


Figure 4.9 The "retrospective"effect of keeping all ages, deleting age 1 or deleting both age 1 and 2 from the assessment. Points on the graph represents mean percentage change of F at age from the assessment year relative to the converged (last assessment)

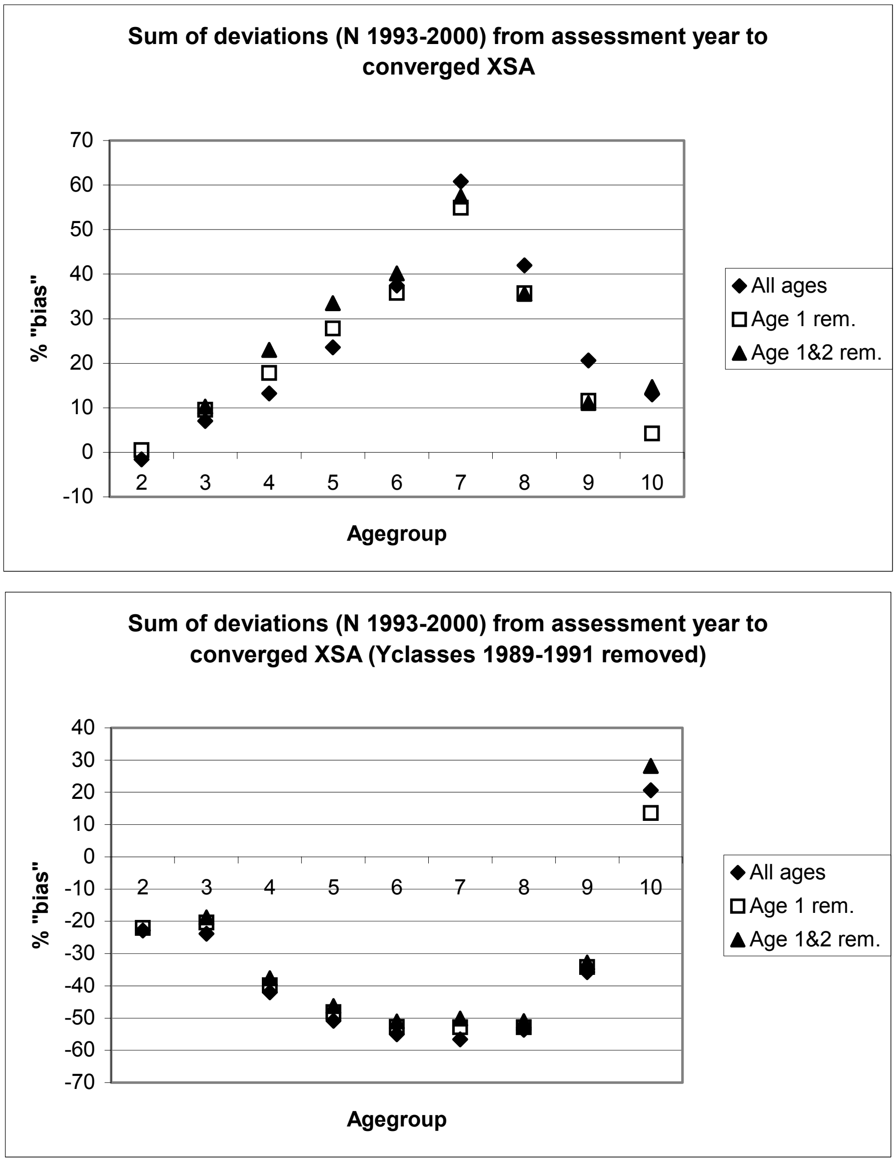


Figure 4.10 "Overall bias" in numbers-at-age. Residual numbers-at-age (ass. year minus converged) added together and presented as a percentage of the sum of numbers-at-age from the converged series. The top panel shows the overall effect while the bottom panel shows the effect of removing the year classes 1989, 1990 and 1991 from the calculations.

Table B1 North-East Arctic HADDOCK. Results from the Norwegian bottom trawl survey in the Barents Sea in January-March. Index of number of fish at age. Indices for 1983-1998 revised August 1999.

	Age										
Year	1	2	3	4	5	6	7	8	9	10+	Total
1981	3.1	7.3	2.3	7.8	1.8	5.3	0.5	0.2	-	-	28.3
1982	3.9	1.5	1.7	1.8	1.9	4.8	2.4	0.2	-	-	18.2
1983	2919.3	4.8	3.1	2.4	0.9	1.9	2.5	0.7	-	-	2935.6
1984	3832.6	514.6	18.9	1.5	0.8	0.2	0.1	0.4	0.1	-	4369.2
1985	1901.1	1593.8	475.9	14.7	0.5	0.5	0.1	0.1	0.4	0.3	3987.4
1986	665.0	370.3	384.6	110.8	0.6	0.2	0.1	0.1	0.1	0.1	1531.9
1987	163.8	79.9	154.4	290.2	52.9	0.0	-	-	-	0.3	741.5
1988	35.4	15.3	25.3	68.9	116.4	13.8	0.1	-	-	-	275.2
1989	81.2	9.5	14.1	21.6	34.0	32.7	3.4	0.1	-	-	196.6
1990	644.1	54.6	4.5	3.4	5.0	9.2	11.8	1.8	-	-	734.4
1991	2006.0	300.3	33.4	5.1	4.2	2.7	1.7	4.2	-	-	2357.6
1992	1659.4	1375.5	150.5	24.4	2.1	0.6	0.7	1.6	2.3	-	3217.1
1993	727.9	599.0	507.7	105.6	10.5	0.6	0.4	0.3	0.4	1.1	1953.5
1994	603.2	228.0	339.5	436.6	49.7	3.4	0.2	0.1	0.2	0.6	1661.5
1995	1463.6	179.3	53.6	171.1	339.5	34.5	2.8	-	0.1	-	2244.5
1996	309.5	263.6	52.5	48.1	148.6	252.8	11.6	0.9	-	0.1	1087.7
1997[1]	1268.0	67.9	86.1	28.0	19.4	46.7	62.2	3.5	0.1	-	1581.9
1998[1]	212.9	137.9	22.7	33.2	13.2	3.4	8.0	8.1	0.7	0.1	440.2
1999	1244.9	57.6	59.8	12.2	10.2	2.8	1.0	1.7	1.1	-	1391.3
2000	847.2	452.2	27.2	35.4	8.4	4.0	0.8	0.3	0.7	0.2	1376.4
2001	1220.5	460.3	296.0	29.3	25.1	1.7	0.9	0.1	0.1	0.3	2034.3
2002	1680.3	534.7	314.7	185.3	17.6	8.2	0.8	0.3	+	0.3	2742.2
2003	3332.1	513.1	317.4	182	73.6	5.5	2.3	0.2	0.1	0.2	4426.5

[1] Indices adjusted to account for limited area coverage.
Survey area extended from 1993 onwards.

Table B2 North-East Arctic HADDOCK. Results from the Russian trawl survey in the Barents Sea and adjacent waters in late autumn (numbers per hour trawling).

Year	Age											Total
	0	1	2	3	4	5	6	7	8	9	Older	
						Sub-area I						
1983	39.9	97.3	16.5	0.8	0.7	+					1.1	156.3
1984	9.7	100.2	110.6	2.8	0.4	0.2	+				0.7	224.6
1985	3.9	19.1	213.4	168.8	0.8	0.2	0.1	-			0.3	406.6
1986	0.2	2.3	16.6	58.1	27.6	0.1	+	+	+		-	105.0
1987	0.4	1.4	2.5	12.5	34.2	8.6	+	+	-	+		59.8
1988	1.9	0.4	1.1	2.8	6.2	11.6	1.1	+	+	+		25.2
1989	3.3	3.0	3.6	0.7	2.5	7.1	13.9	1.8	0.1	+		36.0
1990	71.7	22.2	18.6	13.2	7.5	13.2	13.3	10.3	0.6	0.1		170.7
1991	15.9	61.5	27.5	10.8	1.6	0.6	1.0	3.3	2.6	0.3		125.1
1992	19.6	44.2	180.6	52.1	8.4	0.7	1.0	1.6	1.3	0.2		309.7
1993	5.5	8.1	69.2	371.5	78.4	10.2	1.4	0.7	0.8	1.8		547.7
1994	13.5	6.7	8.0	65.9	146.0	15.9	1.7	0.1	0.2	0.7		258.8
1995	9.9	12.7	6.5	4.0	26.8	77.6	7.3	1.0	0.1	0.5		146.3
1996	5.0	3.1	5.6	3.4	7.7	62.3	56.5	4.8	0.4	0.6		149.3
1997[1]	2.7	6.9	3.2	5.3	5.5	1.5	4.5	1.7	1.5	-		32.7
1998	10.5	2.9	17.2	6.7	7.8	0.6	0.9	2.1	0.7	+		49.4
1999	6.9	34.9	8.8	34.0	5.3	5.6	1.2	0.3	0.9	0.3		98.2
2000	18.0	25.4	37.5	9.3	13.0	3.2	1.1	0.2	0.1	0.4		108.3
2001	30.5	18.6	42.3	58.9	5.8	6.8	0.8	0.5	0.1	0.1		164.5
2002	39.7	29.2	29.4	69.2	74.7	6.7	3.2	0.6	0.1	0.2		252.7
						Division IIa						
1983	5.4	5.5	0.1	0.2	0.3	0.1					1.0	12.6
1984	4.9	14.4	5.6	0.1	0.1	0.1	-				0.2	25.4
1985	3.8	7.0	11.7	4.1	0.1	-	+	-			0.1	26.8
1986	0.4	0.3	3.5	10.4	2.9	0.1	+	+	-		-	17.6
1987	-	-	-	-	0.3	0.3	-	-	-	-		0.6
1988	1.0	0.1	-	+	0.2	0.5	0.2	-	-	-		2.1
1989	0.1	0.7	2.7	+	0.1	0.1	0.1	-	-	-		3.8
1990	6.1	0.9	0.9	0.1	0.1	0.1	0.1	0.1	-	-		8.4
1991	5.7	3.8	0.6	0.1	+	-	-	-	-	-		10.2
1992	1.2	2.3	5.6	2.3	3.0	0.3	0.3	0.4	0.4	-		15.9
1993	1.8	1.1	1.5	4.5	2.5	0.8	0.2	0.1	0.2	0.2		12.8
1994	1.0	0.6	0.5	3.1	15.9	4.4	1.5	+	0.1	0.1		27.2
1995	5.0	8.5	6.3	5.3	6.2	23.9	4.1	0.6	+	0.2		60.1
1996	29.2	4.1	25.0	8.1	4.9	9.1	13.4	1.3	0.4	0.1		95.7
1997	1.2	2.8	0.8	1.3	0.7	0.6	0.9	0.5	0.1	-		8.9
1998	23.2	7.8	15.5	1.1	2.4	3.2	0.5	2.8	0.8	0.1		57.3
1999	34.8	34.1	4.3	16.9	3.9	6.3	1.7	0.9	1.2	0.5		104.6
2000	27.9	23.9	13.5	1.8	9.3	2.0	0.9	0.2	0.2	0.4		80.1
2001	39.0	13.5	7.6	8.4	2.2	7.9	1.4	0.3	0.1	0.4		80.8
2002[2]	61.9	16.6	5.3	10.2	29.9	6.0	3.3	0.3	0.1	0.2		133.7

Table B3. North-East Arctic HADDOCK. Results from the Norwegian acoustic survey in the Barents Sea in January-March. Stock numbers in millions. New TS and rock-hopper gear (1981-1988 back-calculated from bobbins gear). Corrected for length dependent effective spread of the trawl.

	Age										
Year	1	2	3	4	5	6	7	8	9	10+	Total
1981	7	14	5	21	60	18	1	+	+	+	126
1982	9	2	3	4	4	10	6	+	+	+	38
1983	0	5	2	3	1	1	4	2	+	+	18
1984	1,685	173	6	2	1	+	+	+	+	+	1,867
1985	1,530	776	215	5	+	+	+	+	+	+	2,526
1986	556	266	452	189	+	+	+	+	+	+	1,463
1987	85	17	49	171	50	+	+	+	-	+	372
1988	18	4	8	23	46	7	+	-	-	+	106
1989	52	5	6	11	20	21	2	-	-	-	117
1990	270	35	3	3	4	7	11	2	+	+	335
1991	1,890	252	45	8	3	3	3	6	+	-	2,210
1992	1,135	868	134	23	2	+	+	1	2	+	2,165
1993	947	626	563	130	13	+	+	+	+	3	2,282
1994	562	193	255	631	111	12	+	+	+	+	1,764
1995	1,379	285	36	111	387	42	2	+	+	+	2,242
1996	249	229	44	31	76	151	8	+	-	+	788
1997[1]	693	24	51	17	12	43	43	2	+	+	885
1998[1]	220	122	20	28	12	5	13	16	1	+	437
1999	856	46	57	13	14	4	1	2	2	+	994
2000	1,024	509	32	65	19	11	2	1	2	+	1,664
2001	976	316	210	23	22	1	1	+	+	1	1,549
2002	2,062	282	216	149	14	12	1	+	+	1	2,737
2003	2394	279	145	198	169	17	5	+	+	1	3208

[1] Indices adjusted to account for limited area coverage.
Survey area extended from 1993 onwards.

Table B4a. North-East Arctic HADDOCK. Results from the Russian trawl-acoustic survey in the Barents Sea and adjacent waters in late autumn 1985-2001 (old method). Index of number of fish at age.

Year	Age 0	1	2	3	4	5	6	7	8	9	10+	Total
1985[1]	194	434	1,468	636	3	1	+	-	-	-	1	2,737
1986[1]	34	37	208	917	910	2	+	+	+	-	+	2,109
1987[2]	6	16	29	62	197	61	+	-	-	+	12	383
1988[2]	2	1	3	18	83	301	46	-	-	-	+	454
1989[1]	41	32	94	2	14	35	67	9	1	+	-	295
1990[1]	594	176	75	28	17	23	43	44	4	1	-	1,004
1991[1]	240	368	143	65	11	4	7	21	17	2	+	878
1992[1]	199	245	758	218	35	3	4	7	6	+	+	1,475
1993[1]	20	26	199	1,076	228	31	5	2	3	2	3	1,595
1994[1]	118	51	39	252	591	76	9	+	1	1	3	1,141
1995[1]	38	40	18	18	77	225	23	3	1	1	+	443
1996[1,4]	281	44	148	93	69	280	242	19	3	1	1	1,181
1997[1,4]	70	138	41	207	82	48	41	25	20	-	-	671
1998[3]	107	27	82	22	25	7	3	9	3	+	+	284
1999[1]	222	330	43	129	25	29	7	3	7	2	+	798
2000[1]	246	292	238	49	86	23	9	2	1	2	2	949
2001[1]	256	122	200	229	24	45	7	3	1	2	+	888
2002[1,5]	462	166	127	263	267	31	20	3	1	1	1	1340

[1] October-December
[2] September-October
[3] November-January
[4] Adjusted data based on average 1985-1995 distribution
[5] Adjusted data based on 2001 distribution

Table B4b. North-East Arctic HADDOCK. Results from the Russian trawl-acoustic survey in the Barents Sea and adjacent waters in late autumn 1996-2001 (new method). Index of number of fish at age.

Year	Age 0	1	2	3	4	5	6	7	8	9	10+	Total
1996[1,3]	992	245	291	91	63	206	187	17	1	+	+	2,092
1997[1,3]	185	104	21	121	94	48	47	31	20	+	+	671
1998[2]	257	44	83	20	20	6	2	7	2	+	+	442
1999[1]	632	499	60	123	14	16	4	1	4	1	+	1,355
2000[1]	524	395	287	54	57	14	6	1	1	2	+	1,340
2001[1]	491	160	227	221	19	35	5	2	1	1	1	1,163
2002[1,4]	1062	204	140	268	237	26	15	2	1	+	1	1955

[1] October-December
[2] November-January
[3] Adjusted data based on average 1985-1995 distribution
[4] Adjusted data based on 2001 distribution

Table B5 North-East Arctic HADDOCK. Length data (cm) from Norwegian surveys in January-March and Russian surveys in November-December.

	Year	Age									
Norway		1	2	3	4	5	6	7			
	1983	16.8	25.2	34.9	44.7	52.5	58.0	62.4			
	1984	16.6	27.5	32.7	-	56.6	62.4	61.8			
	1985	15.7	23.9	35.6	41.9	58.5	61.9	63.9			
	1986	15.1	22.4	31.5	43.0	54.6	-	-			
	1987	15.4	22.4	29.2	37.3	46.5	-	-			
	1988	13.5	24.0	28.7	34.7	41.5	47.9	54.6			
	1989	16.0	23.2	31.1	36.5	41.7	46.4	52.9			
	1990	15.7	24.7	32.7	43.4	46.1	50.1	52.4			
	1991	16.8	24.0	35.7	44.4	52.4	54.8	55.6			
	1992	15.1	23.9	33.9	45.5	53.1	59.2	60.6			
	1993	14.5	21.4	31.8	42.4	50.6	56.1	59.4			
	1994	14.7	21.0	29.7	38.5	47.8	54.2	56.9			
	1995	15.4	20.1	28.7	34.2	42.8	51.2	55.8			
	1996	15.4	21.6	28.6	37.8	42.0	46.7	55.3			
	1997	16.1	27.7	27.7	35.4	39.7	47.5	50.1			
	1998	14.4	29.2	29.2	35.8	41.3	48.4	50.9			
	1999	14.7	20.8	32.3	39.4	45.5	52.3	54.6			
	2000	15.8	22.5	30.3	41.6	47.7	50.8	51.1			
	2001	22.2	22.2	32.2	37.8	47.2	51.2	58.7			
	2002	21.1	21.1	29.6	40.2	44.2	50.9	58.4			
	2003	16.5	24.1	28	37.2	46.5	49.6	54.7			
Russia		0	1	2	3	4	5	6	7	8	9
	1984	-	24.1	35.8	44.4	56.4	62.8	64.8	-	-	-
	1985	16.5	22.4	30.9	44.1	53.8	61.3	64.7	-	-	-
	1986	17.0	20.7	28.1	35.4	46.7	62.0	-	68.0	-	-
	1987	12.1	21.5	27.8	32.3	37.3	48.6	-	-	-	-
	1988	13.7	23.2	29.7	33.7	39.3	46.2	51.2	-	-	-
	1989	14.9	22.2	26.5	38.5	44.5	49.3	53.0	57.7	64.1	-
	1990	17.0	24.5	30.9	40.4	50.6	53.2	55.7	59.7	63.8	67.7
	1991	17.2	24.2	30.5	39.7	53.4	55.4	58.3	60.5	62.7	70.2
	1992	16.0	22.8	31.1	44.6	53.8	63.8	61.2	66.4	69.0	69.6
	1993	15.3	21.7	28.7	38.3	48.3	54.3	60.9	64.2	63.2	65.0
	1994	15.7	22.5	28.1	33.0	44.1	54.9	61.5	67.5	67.7	67.8
	1995	15.5	22.5	28.5	33.3	39.7	49.9	58.2	63.1	66.3	69.5
	1996[2]	15.8	22.8	28.4	33.7	42.0	48.7	54.8	63.4	69.3	72.0
	1997[2]	13.8	23.5	29.3	36.1	45.3	50.0	54.6	58.9	69.4	66.0
	1998	15.0	22.0	29.0	38.3	47.7	52.1	54.5	57.8	63.4	-
	1999	-	22.8	27.4	40.1	47.4	50.9	54.6	55.9	58.0	61.6
	2000	15.0	22.7	30.4	35.2	49.3	55.1	57.8	62.4	63.3	63.6
	2001	15.1	22.4	29.8	37.8	48	55.3	58.8	62.1	63.6	65.4
	2002	14.6	23.8	30.1	35.6	48.2	55.1	60.2	60.5	63.3	66.8

[1] Lengths adjusted to account for limited area coverage.
[2] Limited area coverage.

Table B6 North-East Arctic HADDOCK. Weight data (g) from Norwegian surveys in January-March and Russian surveys in November-December.

	Year	Age										
Norway		1	2	3	4	5	6	7				
	1983	52	133	480	1,043	1,641	2,081	2,592				
	1984	36	196	289	964	1,810	2,506	2,240				
	1985	35	138	432	731	1,970	2,517	-				
	1986	47	100	310	734	-	-	-				
	1987	24	91	273	542	934	-	-				
	1988	23	139	232	442	743	1,193	1,569				
	1989	43	125	309	484	731	1,012	1,399				
	1990	34	148	346	854	986	1,295	1,526				
	1991	41	138	457	880	1,539	1,726	1,808				
	1992	32	136	392	949	1,467	2,060	2,274				
	1993	26	93	317	766	1,318	1,805	2,166				
	1994	25	86	250	545	1,041	1,569	1,784				
	1995	30	71	224	386	765	1,286	1,644				
	1996	30	93	220	551	741	1,016	1,782				
	1997	35	88	200	429	625	1,063	1,286				
	1998	25	112	241	470	746	1,169	1,341				
	1999	27	85	333	614	947	1,494	1,616				
	2000	32	108	269	720	1,068	1,341	1,430				
	2001	28	106	337	556	1,100	1,429	2,085				
	2002	30	84	144	623	848	1,341	2,032				
	2003	38	127	202	493	981	1189	1613				
Russia		0	1	2	3	4	5	6	7	8	9	10
	1984	36	127	438	815	1,777	2,395	2,688	-	-	-	-
	1985	37	105	282	817	1,530	2,262	2,263	-	-	-	-
	1986	38	88	209	419	919	2,240	-	3,100	-	-	-
	1987	-	95	196	330	497	1,055	-	-	-	-	-
	1988	35	106	248	398	627	997	1,431	-	-	-	-
	1989	52	105	181	606	903	1,287	1,587	2,004	2,716	-	-
	1990	62	143	288	667	1,337	1,533	1,778	2,233	2,731	3,092	-
	1991	57	133	292	690	1,570	1,863	2,206	2,320	2,568	3,525	-
	1992	40	108	279	850	1,542	2,199	2,363	3,045	3,391	3,400	4,200
	1993	31	96	217	535	1,077	1,493	2,094	2,509	2,374	2,621	3,160
	1994	27	106	205	337	841	1,602	2,256	2,913	2,934	3,033	3,163
	1995	28	95	196	345	628	1,234	1,908	2,430	2,815	3,323	3,479
	1996[2]	30	103	209	347	743	1,152	1,650	2,442	3,218	3,333	4,648
	1997[2]	22	115	227	447	911	1,216	1,583	1,966	3,155	2,815	-
	1998	27	94	230	569	1,087	1,482	1,690	1,914	2,539	-	-
	1999	-	104	191	648	1,049	1,251	1,544	1,608	1,814	2,210	2,978
	2000	29	110	278	427	1,249	1,681	1,966	2,488	2,625	2,648	-
	2001	26	102	244	533	1,097	1,695	2,065	2,469	2,704	2,867	-
	2002	25	127	280	457	1166	1690	2293	2484	2784	2962	4655

[1] Lengths adjusted to account for limited area coverage.
[2] Limited area coverage.

5 NORTHEAST ARCTIC SAITHE (SUBAREAS I AND II)

5.1 Status of the Fishery

5.1.1 Landings prior to 2003 (Tables 5.1-5.2, Figure 5.6)

Landings of saithe were highest in 1970-1976 with an average of 238,000 t and a maximum of 265,000 t in 1970. This period was followed by a sharp decline to a level of about 160,000 t in the years 1978-1984. Another decline followed and from 1985 to 1991 the landings ranged from 70,000-122,000 t (Table 5.1). An increasing trend was seen after 1990 to 171,498 t in 1996. Since then the annual landings have been between 134,000 and 154,000 t.

The TAC for 2002 was initially set at 152,000 t. Based on last year's assessment results Norwegian authorities increased the TAC for 2002 by 10,000 tonnes. Provisional figures show that the landings in 2002 were approximately 154,000 t, which is also the level expected by the WG last year.

5.1.2 Expected landings in 2003

Last year ACFM advised that the fishing mortality should be below $\mathbf{F}_{pa}$, corresponding to catch in 2003 of less than 168,000 t. Due to the increased TAC for 2002 Norwegian authorities set the TAC for 2003 to 164,000 t. Official landings in 2003 are expected to be around the TAC of 164,000 t, not accounting for problems with by-catch and discards of saithe in the cod fishery.

5.2 Status of Research

5.2.1 Fishing Effort and Catch-per-unit-effort (Tables C1-C2)

Until 1992, all Norwegian trawl CPUE observations were first averaged for each month and then averaged over the year to calculate a yearly index. The CPUE indices were split on age groups by quarterly weight, length and age data from the trawl fishery. In the present analysis, all CPUE observations were first averaged for each quarter, and then averaged over the year to calculate a yearly index. The CPUE indices are finally split on age groups by yearly catch in numbers and weight-at-age data from the trawl fishery. The new approach is less influenced by short periods with poor data but still smooths out seasonal variations.

In 1992, the Directorate of Fishery changed the format of the logbook data. The trawl CPUE analyses show some discrepancies in the results when merging the time-series based on old and new data format. All data have been revised and updated to the latest format and the CPUE have been recalculated backwards to 1980, (Mehl and Fotland, WD 15). Updated 2002 XSA-analysis resulted in relatively small changes (F3-6 in 2001 of 0.24 compared to 0.22).

5.2.2 Survey results (Tables C3-C4)

The results from the survey in autumn 2002 showed a stock in sound condition with some year class differences, e.g., fewer 3-, 5- and 6+ year old fish than 2001 (Korsbrekke and Mehl, WD 20).

5.3 Data used in the Assessment

5.3.1 Catch numbers-at-age (Table 5.3)

The age composition of Norwegian landings in 2001 was revised, resulting in only minor changes in the catch numbers-at-age. Age composition data for 2002 was available from Norway, Russia (Subarea I and Division IIA) and Germany (Division IIA). These countries accounted for 98% of the landings. Russian length compositions were available for Division IIB, and were applied on the Russian landings together with an age-length-key from the Norwegian trawl landings. Other countries were assumed to have the same age composition as Norwegian trawlers.

5.3.2 Weight-at-age (Table 5.4)

Constant weight-at-age values were used for the period 1960-1979. For subsequent years, annual estimates of weight-at-age in the catches were used. Weight-at-age in the stock was assumed to be the same as weight-at-age in the catch. An increase in individual weights is observed for age groups 7-9, while a slight decrease is observed for the younger compared with recent previous years.

5.3.3 Natural mortality

A fixed natural mortality of 0.2 was used both in the assessment and the forecast.

5.3.4 Maturity-at-age (Table 5.14)

The same ogive was used for all years.

5.3.5 Tuning data (Table 5.5)

The tuning is based on three data series: indices from the Norwegian acoustic survey on saithe, data from the purse seine fishery and a CPUE series from the trawl fisheries (see chapter 5.2.1). The time span in the Norwegian acoustic survey series included data from 1992 – 2002 only because area coverage was extended from 1992 and onwards. Age 2 data were not included from this series in the current assessment. The CPUE series from the Norwegian trawl fishery, used in WG 2002, was revised and used in the current assessment.

5.3.6 Recruitment indices

Reliable recruitment indices are crucial for the predictions. Attempts at establishing year class strength at age 0 or 1 have so far failed. An observer program aimed at establishing a 0-group index series has started (2000) (Borge and Mehl, WD 21 2002). The accuracy of the recruitment indices varies from year to year according to the extent to which 2 year old saithe (and in some years even 3 year olds) have migrated out from the near coast areas and become available to the acoustic saithe survey on the banks.

5.3.7 Prediction data (Table 5.14)

The input data to the predictions based on results from the XSA-analysis are given in Table 5.14. The stock number-at-age in 2003 was taken from the XSA for age 5 and older. The recruitment at ages 2 and 3 in 2002 (1999 and 2000 year classes) was estimated using RCT3 (Section 5.5.2). The corresponding numbers-at-age 3 and 4 in 2003 was calculated applying a natural mortality of 0.2 and fishing mortalities according to the catches taken of these year classes. The long-term geometric mean recruitment (1960-1998) of 211 million was used for the 2001 and subsequent year classes. The natural mortality and the maturity ogive are the same as were used in the assessment. For the exploitation pattern the average of 2000-2002 has been used, scaled to the 2002 level. For ages 3 to 9 the changes in exploitation pattern in 2002 have increased compared to the most recent years. For weight-at-age in the catch and stock, the average weight-at-age for the last three years in the VPA has been used.

5.4 Methods used in the Assessment

5.4.1 XSA and tuning (Table 5.6, Figures 5.2A-C, 5.3)

Extended Survivors Analysis (XSA) was used for the assessment with the same settings as the last year in the analyses and the revised tuning fleets as described above. Figures 5.2A-C show plots of the tuning indices versus stock numbers from the XSA, and Figure 5.3 shows how the three tuning fleets separately assess the stock. The tuning fleet diagnostics are given in Table 5.6.

5.4.2 Recruitment (Tables 5.12-5.13, C.3 and 5.3, Figures 5.2A-C)

Estimates of the recruiting year classes up to the 1998 year class from the XSA were accepted. Catches of age group 2 have declined to very low levels in recent years except for an increase in 2000, probably due to a strong 1998 year class (Tables 5.3, Table C3). RCT3-runs were therefore conducted to estimate both the 1999- and 2000- year classes, with 2 and 3 year olds from the survey as input for the estimation.

5.5 Results of the Assessment

5.5.1 Fishing mortalities and VPA (Tables 5.7-5.11, Figures 5.1, 5.5,5.6)

The fishing mortality ($F_{3\text{-}6}$) in 2001 was 0.19 which is below the value of 0.21 from last year's assessment (Figure 5.1). Using the RCT3 estimation of the 1999 year class gives a fishing mortality ($F_{3\text{-}6}$) in 2002 of 0.22, i.e lower than current $\mathbf{F}_{pa}$. Fishing mortalities and stock size tend to be over- and underestimated, respectively, in the assessment year as is illustrated by the retrospective plots in Figure 5.5. The retrospective analysis carried out fleet by fleet all show the same trend (Mehl and Fotland,WD 15).

The XSA-estimates of the 1999-2000 year classes are not considered to be valid and these estimates are therefore put in brackets (Tables 5.8-5.9). In Table 5.11 the long-term average recruitment and recalculated total biomass are presented. The 1992 and 1996 year classes have been well represented in the catches over several years. These year classes appeared to be above average in the current assessment. The 1997 year class has shown up as being weaker than the 1996 year class both in the catches and in the assessment.

The total biomass (ages 2+) has been at a stable and high level above the long-term (1960-2001) mean since 1993. Likewise, the SSB has been above the long-term mean since 1996 (Tables 5.9-5.11).

5.5.2 Recruitment (Tables 5.12-5.13)

The RCT3 estimate (with 2 year olds as input, Table 5.12) of the 2000 year class is 192 million individuals, while the RCT3 estimate (with 3 year olds as input and back calculating the strength as 2 year olds, Table 5.13) of the 1999 year class gives 244 million individuals. Thus, the 1999-year class is estimated to be of similar strength as the 1997-year class at age 2, while the 2000-year class is estimated to be somewhat weaker and below the long-term mean. It was decided to use the RCT3 estimates for ages 2 and 3 in 2002, and the long-term geometric mean of 211 million individuals for the 2001 and subsequent year classes in the predictions.

5.6 Reference points

5.6.1 Biomass reference points

In 1995 MBAL for Northeast Arctic saithe was set at 170,000 t. (ICES 1996/Assess:4). This was also proposed as a suitable level for $\mathbf{B}_{pa}$ by The Study Group on the Precautionary Approach to Fisheries Management (SGPAFM, ICES 1998/ACFM:10). Based on a examination of the stock-recruitment plot ACFM reduced the $\mathbf{B}_{pa}$ to 150,000 t (ICES 1998).

5.6.2 Fishing mortality reference points (Tables 5.14, 5.15, Figures 5.1A, 5.4)

Yield and SSB per recruit were based on the parameters in Table 5.14 and are presented in Table 5.15. $\mathbf{F}_{0.1}$ and $\mathbf{F}_{max}$ were estimated to be 0.11 and 0.24, respectively, which is as obtained last year. The plot of SSB versus recruitment is shown in Figure 5.5. The values of $\mathbf{F}_{low}$, $\mathbf{F}_{med}$ and $\mathbf{F}_{high}$ obtained in 1999 were 0.18, 0.34 and 0.70, respectively, while the values that were recalculated by WG 2002 were 0.1113, 0.3438 and 0.6945, respectively. ACFM estimated $\mathbf{F}_{pa}$ using the formula $\mathbf{F}_{pa}=\mathbf{F}_{lim}\cdot e^{-1.645\sigma}$ with $\sigma = 0.3$ giving a $\mathbf{F}_{pa} = 0.26$ based on an estimated $\mathbf{F}_{lim} = 0.45$ (ICES 1998). Since then the fishing pattern has changed due to the introduction of new minimum catch sizes effective 1 March 1999. A revision of the present fishing mortality reference points will be conducted if and when the new regulation has manifested itself in a stable and improved fishing pattern.

5.7 Catch options for 2004 (short-term predictions) (Table 5.16)

The management option table (Table 5.16) shows that the expected catch of 164,000 t in 2003 will keep the fishing mortality below $\mathbf{F}_{pa}$. A catch in 2004 corresponding to F_{01} *(status quo)* level of 0.22 will give 159,000 t, while a catch corresponding to $\mathbf{F}_{pa}$, which is also close to $\mathbf{F}_{max}$, in 2003, will give 183,000 t. It should be kept in mind when deciding upon catch level for 2004 that the fishing mortality in the assessment year still tends to be overestimated for this stock. The SSB is expected to increase to 438,000 t in the beginning of 2004 which is above the prediction made by last year's working group. The 1996 year class is now fully represented in the spawning stock and this can explain much of the increase in SSB.

5.8 Medium-term forecasts and management scenarios (Table 5.17A,B, Figures 5.1B, 5.4A,B)

The input data were the same as used for the short-term predictions (Table 5.14). At $F_{status\ quo}$ the catch will decrease to 159,000 t in 2006-2007. Assuming the F*(status quo)* fishing mortality for this period the SSB will stay at a stable level of about 430.000-438,000 t. At $\mathbf{F}_{pa}$ the catch will increase to 183,000 t in 2004, and stay above 160,000 t during the forecast period. At the same fishing mortality the SSB will increase to about 438,000 t in 2004 and decrease to 385,000 in the years 2006-2007. Results from a projection using RISK is shown for $\mathbf{F}_{pa}$ for SSB and catch as for $\mathbf{F}_{sq}$ for SSB and catch up to 2007 (Figure 5.4).

5.9 Comparison of this year's assessment with last year's assessment.

The current assessment estimated the total stock and SSB for 2002 to be about 13% higher than in the previous assessment while the F in 2001 is estimated to be marginally lower.

	Total stock (2+) by 1 January 2002	SSB by 1 January 2002	F3-6 in 2002	F3-6 in 2001
WG 2002	798380	388289	0.22 (prediction)	0.21
WG 2003	908668	447221	0.22	0.20

5.10 Comments on the assessment and the forecast

The AFWG WG should further investigate the data from purse seine tuning series to clarify the use of this tuning fleet series in the assessment. Trial XSA-runs using only the fishery independent acoustic survey series gave positive log q residuals. Relying only on the acoustic series therefore tends to give the highest stock. In general, the working group tends to put greater reliance in the survey, especially for ages 4 and 5, compared with purse seine commercial CPUEs. The applicability of only using the survey or together with the trawl series should therefore be further investigated.

In order to enhance the reliability of the assessment, the area of saithe distribution should be covered by the acoustic surveys as completely as possible. This coverage would include the Russian EEZ where much of the saithe are distributed (Drevetnyak, WD 16). Standardization of trawling performance, acoustic methods, scrutinizing data and estimation methods needs to be undertaken before different surveys can be combined.

The new increased minimum landing size together with growing interest to fish bigger saithe will probably improve the exploitation patterns further. Current fishing mortality reference points should be updated accordingly when an improved exploitation pattern are realised, and the retrospective assessment trend can be dealt with in the new estimation framework.

Prediction of growth has been a small problem in some periods, especially for abundant year classes. In the last years, however, the prediction of the weight-at-age the next year has been close to the actual weights used in the following years' assessments. Difficulty in estimating initial stock size due to the widely divergent indices of abundance used in the tuning of the XSA is, in addition to recruitment, at present the major problem in the forecast. This may also be the cause for underestimating the stock size in the assessment year Prediction of catches beyond the TAC year will, to a large extent, be dependent on assumptions of average recruitment.

Table 5.1
Northeast Arctic saithe. Nominal catch (t) by countries as officially reported to ICES. (Sub-area I and Divisions IIa and IIb combined.)

Year	Faroe Islands	France	Germany Dem.Rep	Fed.Rep. Germany	Norway	Poland	Portugal	Russia[3]	Spain	UK (England & Wales)	UK (Scotland)	Others[5]	Total all countries
1960	23	1,700	-	25,948	96,050	-	-	-	-	9,780	-	14	133,515
1961	61	3,625	-	19,757	77,875	-	-	-	-	4,595	20	18	105,951
1962	2	544	-	12,651	101,895	-	-	912	-	4,699	-	4	120,707
1963	-	1,110	-	8,108	135,297	-	-	-	-	4,112	-	-	148,627
1964	-	1,525	-	4,420	184,700	-	-	84	-	6,511	-	186	197,426
1965	-	1,618	-	11,387	165,531	-	-	137	-	6,741	5	181	185,600
1966	-	2,987	813	11,269	175,037	-	-	563	-	13,078	-	41	203,788
1967	-	9,472	304	11,822	150,860	-	-	441	-	8,379	-	48	181,326
1968	-	-	70	4,753	96,641	-	-	-	-	8,781	2	-	110,247
1969	20	193	6,744	4,355	115,140	-	-	-	-	13,585	-	23	140,060
1970	1,097	-	29,362	23,466	151,759	-	-	43,550	-	15,469	221	-	264,924
1971	215	14,536	16,840	12,204	128,499	6,017	-	39,397	13,097	10,361	106	-	241,272
1972	109	14,519	7,474	24,595	143,775	1,111	-	1,278	13,125	8,223	125	-	214,334
1973	7	11,320	12,015	30,338	148,789	23	-	2,411	2,115	6,593	248	-	213,859
1974	46	7,119	29,466	33,155	152,699	2,521	-	38,931	7,075	3,001	103	5	274,121
1975	28	3,156	28,517	41,260	122,598	3,860	6,430	13,389	11,397	2,623	140	55	233,453
1976	20	5,609	10,266	49,056	131,675	3,164	7,233	9,013	21,661	4,651	73	47	242,468
1977	270	5,658	7,164	19,985	139,705	1	783	989	1,327	6,853	82	-	182,817
1978	809	4,345	6,484	18,190	121,069	35	203	381	121	2,790	37	-	154,464
1979	1,117	2,601	2,435	14,823	141,346	-	-	3	685	1,170	-	-	164,180
1980	532	1,016	-	12,511	128,878	-	-	43	780	794	-	-	144,554
1981	236	194	-	8,431	166,139	-	-	121	-	395	-	-	175,516
1982	339	82	-	7,224	159,643	-	-	14	-	731	1	-	168,034
1983	539	418	-	4,933	149,556	-	-	206	33	1,251	-	-	156,936
1984	503	431	6	4,532	152,818	-	-	161	-	335	-	-	158,786
1985	490	657	11	1,873	103,899	-	-	51	-	202	-	-	107,183
1986	426	308	-	3,470	66,152	-	-	27	-	54	21	-	70,458
1987	712	576	-	4,909	85,710	-	-	426	-	54	3	1	92,391
1988	441	411	-	4,574	108,244	-	-	130	-	436	6	-	114,242
1989	388	460 [2]	-	606	119,625	-	-	23	506	-	702	-	122,310
1990	1,207	340 [2]	-	1,143	92,397	-	-	52	-	681	28	-	95,848
1991	963	77 [2]	**Greenland**	2,003	103,283	-	-	504 [4]	-	449	42	5	107,326
1992	165	1,890 [2]	734	3,451	119,765	-	-	964	6	516	25	-	127,516
1993	31	566 [2]	78	3,687	139,288	-	1	9,509	4	408	7	5	153,584
1994	67	151 [2]	15	1,863	141,589	-	1	1,640	655	548	9	6	146,544
1995	172 [2]	222 [2]	53	872	165,001	-	4	1,144	-	589	99	18	168,174
1996	248 [2]	365 [2]	176 [2]	2,615	166,149	-	24	1,159	9 [2]	690 [2]	16	47 [2]	171,498
1997	193 [2]	560	363 [2]	2,915	137,054	-	12	1,774	45 [2]	676	123	45	143,760
1998	366 [2]	932	437 [2]	2,936	144,468	-	49 [2]	3,836	407 [2]	355		36 [2]	153,822
1999	181 [2]	638 [2]	655 [2]	2,473	141,828	-	18 [2]	3,929	35 [2]	339		178 [2]	150,274
2000	224 [2]	237 [2]	651 [2]	2,573 [6]	126,336	-	46	4,452	167 [2]	443		41 [2]	135,170
2001	519	1279	701	2,690	125,495	-	75	4,951	119	352	162	59	136,402
2002 [1]	520 [2]	972 [1]	823 [2]	2,642 [6]	143,941	-	122	5,081	38 [2]	420		72 [1]	154,631

[1] Provisional figures.
[2] As reported to Norwegian authorities.
[3] USSR prior to 1991.
[4] Includes Estonia.
[5] Includes Denmark,Netherlands, Iceland, Ireland and Sweden
[6] As reported by Working Group members

Table 5.2 Northeast Arctic saithe. Landings ('000 tonnes) by gear category for Sub-area I, Division IIa and Division IIb combined.

Year	Purse Seine	Trawl	Gill Net	Others	Total
1977	75.2	69.5	19.3	12.7	176.7 [2]
1978	62.9	57.7	21.1	13.9	155.6 [2]
1979	74.7	52.0	21.6	15.9	164.2
1980	61.3	46.8	21.1	15.4	144.6
1981	64.3	72.4	24.0	14.8	175.5
1982	76.4	59.4	16.7	15.5	168.0
1983	54.1	68.2	19.6	15.0	156.9
1984	36.4	85.6	23.7	13.1	158.8
1985	31.1	49.9	14.6	11.6	107.2
1986	7.9	36.2	12.3	8.2	64.6 [2]
1987	34.9	28.0	19.0	10.8	92.7 [2]
1988	43.5	45.4	15.3	10.0	114.2
1989	48.6	44.8	16.8	12.1	122.3
1990	24.6	44.0	19.3	7.9	95.8
1991	38.9	40.1	18.9	9.4	107.3
1992	27.1	66.9	21.2	12.3	127.5
1993	33.1	83.5	21.2	15.8	153.6
1994	30.2	81.7	21.1	13.5	146.5 [3]
1995	21.8	103.5	26.9	15.9	168.2 [4]
1996	46.9	72.7	31.6	20.3	171.5
1997	44.4	56.1	24.4	19.0	143.8
1998	44.4	58.2	27.6	23.6	153.8
1999	39.2	57.9	29.7	23.5	150.3
2000	28.2	52.2	29.6	25.1	135.2
2001	28.1	58.3	28.1	21.9	136.4
2002 [1]	27.4	75.4	30.3	21.5	154.6

[1] Provisional figures.
[2] Unresolved discrepancy between Norwegian catch by gear figures and the total reported to ICES for these years.
[3] Includes 4,300 tonnes not categorized by gear, proportionally adjusted.
[4] Reduced by 1,200 tonnes not categorized by gear, proportionally adjusted.

Table 5.3 Catch numbers at age

Run title : North-East Arctic saithe

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

YEAR	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
AGE													
2	7381	4936	1246	2815	20308	30430	7450	6952	5297	4090	25952	19842	11608
3	10509	17824	37266	42050	9001	37115	22392	29664	25196	77333	43540	77019	65178
4	13083	9131	11131	28925	59601	5001	54537	24836	18384	11949	62846	59280	52389
5	13545	12506	4421	5888	13154	26300	13124	35956	5101	16939	13987	26961	29146
6	5064	3799	8290	4650	2718	10142	12899	4125	8282	4747	16189	9556	10186
7	4883	1332	2427	3861	3472	2861	4652	5616	787	4798	5122	9592	5616
8	2401	968	1024	1099	2655	2110	1374	2916	1913	1126	7950	2901	3547
9	1315	520	938	1075	1251	2733	933	1413	900	1711	2504	4352	1865
10	743	405	451	697	1221	699	965	1397	577	675	3697	2195	2140
+gp	1525	1229	1728	1777	3559	3593	2900	3493	1166	511	2799	5490	3149
0 TOTAL	60449	52650	68922	92837	116940	120984	121226	116368	67603	123879	184586	217188	184824
TONSL	133515	105951	120707	148627	197426	185600	203788	181326	110247	140060	264924	241272	214334
SOPCC	126	138	123	121	116	108	111	95	117	97	97	78	84

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

YEAR	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
AGE										
2	13829	21159	81601	54151	31662	45758	28334	18226	10467	17225
3	76296	36782	60832	125030	99049	48969	61963	40796	83954	34733
4	25206	44027	11691	30576	34317	27685	23328	36644	21822	65052
5	26911	15671	16366	7947	10140	12476	14122	9211	21528	13060
6	16031	20419	4436	8712	2062	4534	4400	6379	3619	8212
7	7114	12148	7808	3435	4332	1468	2901	3200	2550	1054
8	3935	4802	6789	3212	1456	1848	963	1338	2008	1251
9	2871	3258	2914	2679	1606	938	1356	147	369	461
10	2610	2505	2350	1724	963	976	438	730	279	263
+gp	3924	3821	4140	2880	1134	2150	1192	1629	629	448
0 TOTAL	178727	164592	198927	240346	186721	146802	138997	118300	147225	141759
TONSL	213859	274121	233453	242486	182817	154464	164180	144554	175516	168034
SOPCC	81	101	102	100	101	103	114	94	100	98

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

YEAR	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
AGE										
2	11638	14624	2216	3311	3867	5017	11157	11543	6135	14333
3	17244	41466	48917	22115	17869	8126	12378	21002	73878	49750
4	23768	33233	11974	12895	49829	35847	19915	13463	11619	26640
5	32700	12064	7189	6062	4339	32827	32643	8996	5395	4865
6	3226	11204	5279	4525	3118	4560	18751	9152	5066	5594
7	3008	1135	3740	2805	3490	2328	1939	7735	2988	4850
8	1177	1772	775	1399	755	1219	377	1126	2009	3353
9	760	560	878	351	620	966	191	154	272	1480
10	247	557	134	454	257	320	179	121	81	291
+gp	760	897	701	285	797	102	149	253	132	267
0 TOTAL	94528	117512	81803	54202	84941	91312	97679	73545	107575	111423
TONSL	156936	158786	107183	70458	92391	114242	122310	95848	107326	127516
SOPCC	101	100	99	99	102	99	99	100	99	100

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

YEAR	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
AGE										
2	3379	1432	70	961	326	35	91	1192	246	92
3	26933	9369	16402	10225	14827	3100	9644	9397	4101	6669
4	63451	38499	48351	57448	13295	16261	12220	22921	8795	17827
5	26254	48587	37268	18667	43309	11981	22804	7865	27411	11640
6	3427	17617	32240	17805	13029	31918	10321	11282	8610	26258
7	1636	1772	4842	17861	11219	8405	18932	5806	6858	4639
8	1263	517	572	2765	5837	5556	3384	8177	3041	4104
9	950	305	139	485	755	2881	3335	2330	4625	2343
10	650	275	280	202	63	731	2293	2526	1834	3431
+gp	106	697	305	443	160	397	589	1210	2076	2477
0 TOTAL	128049	119070	140469	126862	102820	81265	83613	72706	67597	79480
TONSL	153584	146544	168174	171498	143760	153822	150274	135170	136402	154631
SOPCC	100	100	100	100	100	100	100	100	100	100

1

Table 5.4 Catch weight at age

Run title : North-East Arctic saithe

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Table 2 Catch weights at age (kg)

	YEAR	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
	AGE													
	2	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34
	3	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71
	4	1.11	1.11	1.11	1.11	1.11	1.11	1.11	1.11	1.11	1.11	1.11	1.11	1.11
	5	1.63	1.63	1.63	1.63	1.63	1.63	1.63	1.63	1.63	1.63	1.63	1.63	1.63
	6	2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.33
	7	3.16	3.16	3.16	3.16	3.16	3.16	3.16	3.16	3.16	3.16	3.16	3.16	3.16
	8	4.03	4.03	4.03	4.03	4.03	4.03	4.03	4.03	4.03	4.03	4.03	4.03	4.03
	9	4.87	4.87	4.87	4.87	4.87	4.87	4.87	4.87	4.87	4.87	4.87	4.87	4.87
	10	5.63	5.63	5.63	5.63	5.63	5.63	5.63	5.63	5.63	5.63	5.63	5.63	5.63
	+gp	8.03	8.039	7.924	7.851	7.781	7.959	8.106	7.994	7.716	7.479	7.404	7.052	7.477
0	SOPC(	1.2559	1.3848	1.2272	1.2075	1.1644	1.0782	1.1067	0.9475	1.1662	0.9734	0.9741	0.7841	0.8362

Table 2 Catch weights at age (kg)

	YEAR	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
	AGE										
	2	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.45	0.43	0.51
	3	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.79	0.73	0.77
	4	1.11	1.11	1.11	1.11	1.11	1.11	1.11	1.27	1.4	1.12
	5	1.63	1.63	1.63	1.63	1.63	1.63	1.63	2.03	2.05	2.02
	6	2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.55	2.76	2.61
	7	3.16	3.16	3.16	3.16	3.16	3.16	3.16	3.29	3.3	3.27
	8	4.03	4.03	4.03	4.03	4.03	4.03	4.03	4.34	4.38	3.91
	9	4.87	4.87	4.87	4.87	4.87	4.87	4.87	5.15	5.95	4.69
	10	5.63	5.63	5.63	5.63	5.63	5.63	5.63	5.75	6.39	5.63
	+gp	7.385	7.217	7.127	7.32	7.394	7.527	7.809	6.937	6.841	7.558
0	SOPC(	0.8099	1.0131	1.0155	1.002	1.0062	1.0278	1.1384	0.9355	0.9975	0.9794

Table 2 Catch weights at age (kg)

	YEAR	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
	AGE										
	2	0.6	0.53	0.38	0.32	0.34	0.33	0.45	0.54	0.4	0.45
	3	1.05	0.71	0.75	0.59	0.53	0.62	0.74	0.76	0.72	0.7
	4	1.33	1.26	1.33	1.22	0.84	0.87	0.97	1.08	1.19	1.1
	5	1.86	2.02	2.07	1.97	1.66	1.31	1.39	1.56	1.78	1.98
	6	2.8	2.7	2.63	2.3	2.32	2.43	1.81	2.12	2.24	2.34
	7	4	3.88	3.28	2.87	2.97	3.87	3.02	2.4	2.86	2.81
	8	4.18	4.47	3.96	3.72	4	5.38	3.76	3.65	3.32	3.25
	9	5.33	5.36	4.54	4.3	4.72	5.83	4.64	3.6	4.53	4.06
	10	5.68	6.06	5.55	4.69	5.44	5.36	4.75	6.37	5.7	6.19
	+gp	8.665	7.19	8.012	6.597	6.904	7.448	7.5	4.795	7.125	7.376
0	SOPC(	1.0089	0.9997	0.9933	0.9929	1.0233	0.9879	0.9949	1.0049	0.9912	0.9993

Table 2 Catch weights at age (kg)

	YEAR	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
	AGE										
	2	0.46	0.35	0.5	0.4	0.38	0.35	0.64	0.37	0.426	0.4
	3	0.63	0.52	0.56	0.59	0.62	0.68	0.67	0.61	0.752	0.69
	4	1.02	0.74	0.78	0.82	0.92	1	1.05	1.02	1.108	1.009
	5	1.7	1.22	1.21	1.32	1.19	1.48	1.45	1.61	1.531	1.48
	6	2.5	2.16	1.74	1.83	1.66	1.87	1.93	2.12	2.037	1.957
	7	2.88	3.19	2.8	2.47	2.31	2.58	2.28	2.66	2.62	2.627
	8	3.09	3.97	3.74	3.72	3.1	3.07	2.97	3.21	3.172	3.258
	9	3.7	4.62	4.4	4.49	4.34	4.12	3.6	3.74	3.657	3.865
	10	6.19	5.28	5.28	5.3	6.04	5.45	4.11	4.35	4.585	4.274
	+gp	8.175	6.072	7.451	7.016	7.62	8.052	5.513	5.975	5.37	5.758
0	SOPC(	1.0008	1.0038	0.9999	0.9999	1.0011	1.0015	1.0003	1.0031	0.9991	0.999

Table 5.5 Tuning data

```
Northeast Arctic saithe (Subareas I and II)
103
FLT08: Norway Purse Seine reviced 2000 (Catch: Unknown) (Effort: Unknown)
1989 2002
1 1 0.00 1.00
3 7
  119.2     5250     8521    18211     2880       24
   56.4     7207     3319     2582     1845      673
   98.5    43110     1907      453      162       95
   88.8    29527     5214       89       45       38
   71.9     8010    24251     1302       39       23
   79.3     6365    16182     8997     1151       90
   52.2     5524    13357     4368     1335      105
   81.9     4053    36274     6022     2610      589
   92.0     9665     6691    18403     1852     1329
  130.1     1994     9690     5302    10330     1226
  133.0     6420     5990    10422     2275     2749
  126.6     8000    13543     1316     1247      281
  104.5     2420     4321    11502      651      279
   77.7     4825     9963     3220     3091      307
FLT12: Nor new trawl revised 2000 (Catch: Unknown) (Effort: Unknown)
1994 2002
1 1 0.00 1.00
5 9
   1   395.6   260.4    37.4     8.2     4.2
   1   293.8   359.1    65.8    11.1     1.2
   1   139.5   205.6   293.0    32.9     8.5
   1   371.4   194.1   183.4   112.0    16.9
   1    55.3   244.0    93.1    56.6    16.1
   1   105.5    80.0   187.5    43.0    30.8
   1    78.7   170.1   100.2   156.2    44.5
   1   276.4   194.4   183.1    77.1   109.9
   1   122.7   396.0    84.9    78.9    39.5
FLT13: Norway Ac Survey extended 2000 (Catch: Unknown) (Effort: Unknown)
1992 2002
1 1 0.75 0.85
3 6
   1   273.6    57.5     6.2     8.8
   1   227.7   103.9    12.7     3.2
   1    87.8   112.4    39.5    10.0
   1   165.2    87.0    46.8    20.0
   1   118.9   214.7    32.1    19.3
   1    36.7   185.8    79.8    61.7
   1    96.5   200.6    70.0    96.7
   1   233.8    72.9    62.2    47.8
   1   142.5   176.3    11.6    26.5
   1   275.9    45.9    53.8    20.1
   1   206.1    88.1    18.2    14.9
```

Table 5.6 Tuning Diagnostics

Lowestoft VPA Version 3.1 25/04/2003 9:35

Extended Survivors Analysis

North-East Arctic saithe

CPUE data from file fleetall.dat

Catch data for 43 years. 1960 to 2002. Ages 2 to 11.

Fleet	Firs year	Last year	First age	Last age	Alpha	Beta
FLT08: Nc	1989	2002	3	7	0	1
FLT12: Nc	1994	2002	5	9	0	1
FLT13: Nc	1992	2002	3	6	0.75	0.85

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 42 iterations

1

Regression weights

0.751	0.82	0.877	0.921	0.954	0.976	0.99	0.997	1	1

Fishing mortalities

Age	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
2	0.015	0.003	0.001	0.005	0.003	0	0.001	0.007	0.001	0.002
3	0.117	0.054	0.05	0.094	0.105	0.039	0.044	0.106	0.029	0.05
4	0.293	0.245	0.429	0.245	0.17	0.16	0.215	0.141	0.137	0.168
5	0.481	0.383	0.397	0.291	0.295	0.228	0.352	0.209	0.251	0.272
6	0.553	0.706	0.474	0.335	0.34	0.37	0.314	0.294	0.373	0.406
7	0.658	0.629	0.423	0.529	0.366	0.384	0.392	0.292	0.293	0.353
8	0.584	0.445	0.423	0.457	0.326	0.311	0.262	0.292	0.244	0.286
9	0.738	0.267	0.203	0.79	0.215	0.264	0.311	0.289	0.267	0.302
10	0.592	0.488	0.42	0.511	0.212	0.333	0.348	0.412	0.39	0.324

Table 5.6 Tuning Diagnostics (Cont'd)

1

XSA population numbers (Thousands)

YEAR	AGE 2	3	4	5	6	7	8	9	10
1993	2.45E+05	2.69E+05	2.76E+05	7.60E+04	8.91E+03	3.75E+03	3.15E+03	2.01E+03	1.61E+03
1994	4.60E+05	1.97E+05	1.96E+05	1.69E+05	3.84E+04	4.20E+03	1.59E+03	1.44E+03	7.87E+02
1995	1.54E+05	3.75E+05	1.53E+05	1.26E+05	9.43E+04	1.55E+04	1.83E+03	8.35E+02	9.02E+02
1996	2.03E+05	1.26E+05	2.92E+05	8.17E+04	6.91E+04	4.81E+04	8.33E+03	9.82E+02	5.58E+02
1997	1.09E+05	1.65E+05	9.41E+04	1.87E+05	5.00E+04	4.05E+04	2.32E+04	4.32E+03	3.65E+02
1998	3.00E+05	8.86E+04	1.22E+05	6.50E+04	1.14E+05	2.91E+04	2.30E+04	1.37E+04	2.85E+03
1999	1.26E+05	2.45E+05	6.97E+04	8.50E+04	4.24E+04	6.45E+04	1.63E+04	1.38E+04	8.61E+03
2000	1.97E+05	1.03E+05	1.92E+05	4.60E+04	4.89E+04	2.54E+04	3.57E+04	1.02E+04	8.27E+03
2001	1.85E+05	1.60E+05	7.57E+04	1.37E+05	3.06E+04	2.98E+04	1.55E+04	2.18E+04	6.28E+03
2002	4.09E+04	1.51E+05	1.27E+05	5.40E+04	8.70E+04	1.72E+04	1.82E+04	9.95E+03	1.37E+04

Estimated population abundance at 1st Jan 2003

0.00E+00	3.34E+04	1.18E+05	8.83E+04	3.37E+04	4.75E+04	9.91E+03	1.12E+04	6.02E+03

Taper weighted geometric mean of the VPA populations:

1.79E+05	1.64E+05	1.17E+05	6.93E+04	3.87E+04	1.75E+04	8.03E+03	3.62E+03	1.66E+03

Standard error of the weighted Log(VPA populations) :

0.6773	0.5377	0.6271	0.7376	0.8138	0.9236	1.1211	1.2673	1.3754

1

Log catchability residuals.

Fleet : FLT08: Norway Purse

Age	1989	1990	1991	1992
3	0.63	1.74	1.66	0.73
4	0.44	0.7	-0.25	-0.56
5	1.64	1	-0.84	-2.19
6	0.83	1.64	-1.09	-1.63
7	-1.4	1.61	-0.63	-1.06
8	No data for this fleet at this age			
9	No data for this fleet at this age			

Age	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
3	-0.01	-0.06	-0.42	-0.07	0.42	-0.92	-0.79	0.38	-1.1	-0.05
4	0.38	0.2	0.75	0.57	-0.13	-0.37	-0.29	-0.48	-0.5	0.13
5	-0.8	0.19	0.19	0.44	0.61	0.05	0.49	-0.98	0.31	0.27
6	-1.5	0.39	-0.04	0.43	0.29	0.86	0.28	-0.42	-0.37	0.45
7	-0.55	0.6	-0.23	-0.04	0.76	0.67	0.66	-0.68	-0.66	0.31
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	-7.6287	-6.8517	-7.2178	-7.8541	-8.4253
S.E(Log q)	0.8012	0.4632	0.8538	0.8445	0.7568

Table 5.6 Tuning Diagnostics (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
3	1.19	-0.337	6.78	0.24	14	1	-7.63
4	0.83	0.868	7.66	0.74	14	0.39	-6.85
5	0.59	2.268	8.86	0.76	14	0.42	-7.22
6	0.57	3.02	9.06	0.84	14	0.36	-7.85
7	0.78	1.078	8.73	0.72	14	0.59	-8.43
1							

Fleet : FLT12: Nor new trawl

Age	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
3	No data for this fleet at this age									
4	No data for this fleet at this age									
5	99.99	0.34	0.35	-0.02	0.13	-0.74	-0.31	-0.05	0.13	0.26
6	99.99	0.76	0.08	-0.23	0.04	-0.54	-0.69	-0.09	0.55	0.23
7	99.99	0.75	-0.08	0.33	-0.04	-0.38	-0.48	-0.21	0.23	0.03
8	99.99	0.27	0.43	0.01	0.16	-0.52	-0.47	0.04	0.15	0.03
9	99.99	-0.37	-1.11	0.94	-0.1	-1.29	-0.62	0.03	0.17	-0.05

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

Age	5	6	7	8	9
Mean Log	-6.1194	-5.3345	-5.0837	-5.238	-5.238
S.E(Log q)	0.3529	0.4681	0.3704	0.3179	0.7338

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
5	0.77	1.239	7.36	0.81	9	0.26	-6.12
6	1.73	-1.14	1.23	0.27	9	0.79	-5.33
7	1.43	-2.088	2.89	0.78	9	0.44	-5.08
8	1.19	-1.708	4.44	0.92	9	0.34	-5.24
9	1.07	-0.305	5.29	0.75	9	0.77	-5.5
1							

Fleet : FLT13: Norway Ac Sur

Age	1989	1990	1991	1992
3	99.99	99.99	99.99	-0.1
4	99.99	99.99	99.99	-0.48
5	99.99	99.99	99.99	0.04
6	99.99	99.99	99.99	0.85

Table 5.6 Tuning Diagnostics (Cont'd)

7	No data for this fleet at this age
8	No data for this fleet at this age
9	No data for this fleet at this age

Age	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
3	0.07	-0.62	-0.64	0.16	-1.28	0.26	0.13	0.56	0.71	0.5
4	-0.69	-0.31	-0.17	-0.06	0.87	0.68	0.27	0.08	-0.34	-0.18
5	-0.72	-0.46	0.02	-0.01	0.07	0.94	0.66	-0.52	-0.04	-0.18
6	-0.21	-0.41	-0.8	-0.64	0.85	0.5	0.74	-0.01	0.25	-1.07
7	No data for this fleet at this age									
8	No data for this fleet at this age									
9	No data for this fleet at this age									

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

Age	3	4	5	6
Mean Log q	-6.8925	-6.7984	-7.4344	-7.1188
S.E(Log q)	0.6162	0.4747	0.4923	0.6917

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	2.03	-1.218	1.53	0.15	11	1.22	-6.89
4	1.63	-1.202	3.64	0.32	11	0.75	-6.8
5	1.01	-0.051	7.38	0.63	11	0.53	-7.43
6	1.41	-0.978	5.65	0.42	11	0.98	-7.12
1							

Terminal year survivor and F summaries :

Age 2 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
FLT08: Norway Purse	1	0	0	0	0	0	0
FLT12: Nor new trawl	1	0	0	0	0	0	0
FLT13: Norway Ac Sur	1	0	0	0	0	0	0
F shrinkage mean	33375	0.5				1	0.002

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
33375	0.5	0	1	0	0.002

Table 5.6 Tuning Diagnostics (cont'd)

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

Year class = 1999

Fleet	I	Int	Ext	Var	N	Scaled	Estimated
	:	s.e	s.e	Ratio		Weights	F
FLT08: Norway Purse	112395	0.836	0	0	1	0.178	0.052
FLT12: Nor new trawl	1	0	0	0	0	0	0
FLT13: Norway Ac Sur	193078	0.646	0	0	1	0.298	0.031
F shrinkage mean	90032	0.5				0.524	0.065

Weighted prediction :

Survivors	Int	Ext	N	Var	F
at end of year	s.e	s.e		Ratio	
117577	0.36	0.31	3	0.878	0.05

1

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

Year class = 1998

Fleet	I	Int	Ext	Var	N	Scaled	Estimated
	:	s.e	s.e	Ratio		Weights	F
FLT08: Norway Purse	74207	0.418	0.529	1.26	2	0.339	0.197
FLT12: Nor new trawl	1	0	0	0	0	0	0
FLT13: Norway Ac Sur	101797	0.395	0.431	1.09	2	0.379	0.147
F shrinkage mean	89689	0.5				0.282	0.165

Weighted prediction :

Survivors	Int	Ext	N	Var	F
at end of year	s.e	s.e		Ratio	
88254	0.25	0.21	5	0.857	0.168

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

Year class = 1997

Fleet	I	Int	Ext	Var	N	Scaled	Estimated
	:	s.e	s.e	Ratio		Weights	F
FLT08: Norway Purse	28226	0.38	0.284	0.75	3	0.221	0.317
FLT12: Nor new trawl	43651	0.373	0	0	1	0.26	0.216
FLT13: Norway Ac Sur	30725	0.315	0.238	0.75	3	0.33	0.295
F shrinkage mean	34204	0.5				0.19	0.268

Weighted prediction :

Survivors	Int	Ext	N	Var	F
at end of year	s.e	s.e		Ratio	
33712	0.19	0.12	8	0.629	0.272

1

Age 6 Catchability constant w.r.t. time and dependent on age

Year class = 1996

Fleet	I	Int	Ext	Var	N	Scaled	Estimated
	:	s.e	s.e	Ratio		Weights	F
FLT08: Norway Purse	38929	0.353	0.271	0.77	4	0.197	0.476
FLT12: Nor new trawl	56516	0.3	0.047	0.16	2	0.314	0.351
FLT13: Norway Ac Sur	39155	0.292	0.263	0.9	4	0.294	0.474
F shrinkage mean	58641	0.5				0.195	0.34

Table 5.6 Tuning Diagnostics (Cont'd)

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
47479	0.17	0.12	11	0.688	0.406

Age 7 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
FLT08: Norway Purse	7444	0.338	0.225	0.66	5	0.185	0.447
FLT12: Nor new trawl	11137	0.245	0.161	0.66	3	0.431	0.32
FLT13: Norway Ac Sur	9879	0.293	0.214	0.73	4	0.201	0.354
F shrinkage mean	10104	0.5				0.184	0.347

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
9914	0.16	0.09	13	0.578	0.353

1

Age 8 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
FLT08: Norway Purse	8432	0.342	0.202	0.59	5	0.128	0.365
FLT12: Nor new trawl	11388	0.205	0.097	0.47	4	0.572	0.282
FLT13: Norway Ac Sur	13880	0.298	0.398	1.34	4	0.137	0.237
F shrinkage mean	11103	0.5				0.162	0.289

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
11213	0.15	0.1	14	0.619	0.286

Age 9 Catchability constant w.r.t. time and age (fixed at the value for age) 8

Year class = 1993

Fleet	I :	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT08: Norway Purse	4987	0.34	0.167	0.49	5	0.118	0.354
FLT12: Nor new trawl	5069	0.2	0.173	0.87	5	0.568	0.349
FLT13: Norway Ac Sur	12828	0.298	0.153	0.51	4	0.128	0.153
F shrinkage mean	6818	0.5				0.186	0.271

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
6023	0.16	0.12	15	0.741	0.302

Table 5.6 Tuning Diagnostics (Cont'd)

Age 10 Catchability constant w.r.t. time and age (fixed at the value for age) 8

Year class = 1992

Fleet	I :	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT08: Norway Purse	14185	0.355	0.165	0.46	5	0.095	0.198
FLT12: Nor new trawl	7314	0.206	0.136	0.66	5	0.539	0.354
FLT13: Norway Ac Sur	8359	0.305	0.201	0.66	4	0.1	0.316
F shrinkage mean	8066	0.5				0.265	0.326

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
8103	0.18	0.08	15	0.467	0.324

Table 5.7
Run title : North-East Arctic saithe

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Terminal Fs derived using XSA (With F shrinkage)

Table 8 Fishing mortality (F) at age

YEAR	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
AGE													
2	0.0694	0.0259	0.0039	0.0259	0.0628	0.1742	0.0347	0.0409	0.016	0.0131	0.0785	0.1052	0.0472
3	0.1412	0.2383	0.2772	0.1747	0.108	0.1562	0.1876	0.1886	0.2041	0.3402	0.188	0.3511	0.5893
4	0.1843	0.1755	0.2297	0.3606	0.4012	0.0805	0.3616	0.3278	0.1709	0.1406	0.5146	0.4216	0.4299
5	0.5007	0.2695	0.1204	0.1825	0.276	0.3093	0.3131	0.4319	0.1024	0.2354	0.2432	0.4348	0.3782
6	0.2407	0.2519	0.2882	0.1797	0.1198	0.3557	0.2447	0.1522	0.1649	0.1307	0.3709	0.261	0.2894
7	0.3847	0.0915	0.253	0.2108	0.1978	0.1786	0.2736	0.1595	0.0391	0.1356	0.2034	0.3929	0.2409
8	0.4184	0.1206	0.0942	0.1734	0.2195	0.1772	0.1219	0.2757	0.0747	0.0721	0.348	0.1697	0.2451
9	0.3585	0.1479	0.1645	0.1355	0.3055	0.369	0.1106	0.1777	0.1274	0.0885	0.2271	0.3262	0.1569
10	0.3832	0.177	0.1849	0.1771	0.2248	0.2795	0.2138	0.2406	0.102	0.133	0.28	0.3188	0.2635
+gp	0.3832	0.177	0.1849	0.1771	0.2248	0.2795	0.2138	0.2406	0.102	0.133	0.28	0.3188	0.2635
0 FBAR 3	0.2667	0.2338	0.2289	0.2244	0.2262	0.2254	0.2767	0.2751	0.1606	0.2117	0.3292	0.3671	0.4217

Terminal Fs derived using XSA (With F shrinkage)

Table 8 Fishing mortality (F) at age

YEAR	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
AGE										
2	0.1396	0.1204	0.2763	0.2181	0.2178	0.1964	0.2067	0.0582	0.0788	0.1461
3	0.4905	0.6669	0.5962	0.9053	0.7860	0.6157	0.4446	0.5172	0.4112	0.4041
4	0.4766	0.5911	0.4590	0.6942	0.6807	0.5240	0.6834	0.5183	0.5842	0.6566
5	0.4110	0.6230	0.4556	0.6609	0.5207	0.5675	0.5606	0.6404	0.6680	0.8678
6	0.3693	0.6370	0.3552	0.4704	0.3522	0.4670	0.3990	0.5356	0.5631	0.5849
7	0.3373	0.5334	0.5379	0.5163	0.4538	0.4574	0.6257	0.5720	0.4245	0.3133
8	0.2654	0.4017	0.6559	0.4431	0.4306	0.3556	0.6248	0.6730	0.8954	0.3811
9	0.3210	0.3673	0.4563	0.5920	0.4163	0.5508	0.4824	0.1765	0.3907	0.5211
10	0.3429	0.5166	0.4960	0.5409	0.4378	0.4833	0.5429	0.5237	0.5934	0.5380
+gp	0.3429	0.5166	0.4960	0.5409	0.4378	0.4833	0.5429	0.5237	0.5934	0.5380
0 FBAR 3	0.4369	0.6295	0.4665	0.6827	0.5849	0.5435	0.5219	0.5529	0.5567	0.6284

Table 8 Fishing mortality (F) at age

YEAR	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
AGE										
2	0.1145	0.1249	0.0090	0.0181	0.0421	0.0725	0.1483	0.0442	0.0140	0.0471
3	0.2136	0.7502	0.7847	0.1174	0.1279	0.1169	0.2570	0.4581	0.4363	0.1509
4	0.5382	0.8220	0.5011	0.4840	0.4199	0.4069	0.4640	0.4931	0.4987	0.2756
5	0.8438	0.5834	0.4108	0.5146	0.2955	0.5446	0.8178	0.3941	0.3740	0.4014
6	0.5393	0.8088	0.5505	0.4953	0.5496	0.5822	0.7033	0.5680	0.4039	0.8541
7	0.4394	0.3670	0.7087	0.6471	0.9259	1.1028	0.5281	0.7217	0.3638	0.8719
8	0.6968	0.5058	0.4617	0.6372	0.3555	1.0505	0.5077	0.6802	0.4089	0.9198
9	0.4220	0.8805	0.5082	0.3924	0.6585	1.1001	0.4397	0.4005	0.3389	0.6061
10	0.5933	0.6347	0.5323	0.5417	0.5617	0.8854	0.6045	0.5575	0.3804	0.7491
+gp	0.5933	0.6347	0.5323	0.5417	0.5617	0.8854	0.6045	0.5575	0.3804	0.7491
0 FBAR 3	0.5337	0.7411	0.5618	0.4028	0.3482	0.4127	0.5605	0.4783	0.4282	0.4205

Table 8 Fishing mortality (F) at age

YEAR	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	FBAR **-**
AGE											
2	0.0154	0.0034	0.0005	0.0053	0.0033	0.0001	0.0008	0.0067	0.0015	0.0025	0.0036
3	0.1172	0.0539	0.0496	0.0938	0.1045	0.0394	0.0444	0.1064	0.0287	0.0500	0.0617
4	0.2926	0.2448	0.4289	0.2450	0.1698	0.1597	0.2153	0.1414	0.1374	0.1679	0.1489
5	0.4813	0.3826	0.3974	0.2911	0.2953	0.2278	0.3519	0.2093	0.2508	0.2719	0.2440
6	0.5534	0.7065	0.4743	0.3352	0.3397	0.3699	0.3136	0.2942	0.3729	0.4058	0.3576
7	0.6577	0.6289	0.4227	0.5288	0.3659	0.3839	0.3919	0.2917	0.2930	0.3530	0.3126
8	0.5844	0.4448	0.4234	0.4571	0.3260	0.3109	0.2615	0.2919	0.2443	0.2861	0.2741
9	0.7384	0.2668	0.2033	0.7896	0.2148	0.2644	0.3111	0.2895	0.2668	0.3016	0.2860
10	0.5924	0.4882	0.4199	0.5111	0.2117	0.3331	0.3484	0.4119	0.3898	0.3244	0.3754
+gp	0.5924	0.4882	0.4199	0.5111	0.2117	0.3331	0.3484	0.4119	0.3898	0.3244	
0 FBAR 3	0.3611	0.3469	0.3376	0.2413	0.2273	0.1992	0.2313	0.1878	0.1975	0.2239	

Table 5.8

Run title : North-East Arctic saithe

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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	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
	AGE													
	2	121650	213269	355505	121815	368899	210354	241202	191872	367843	347431	379816	219524	278465
	3	88173	92920	170143	289935	97187	283654	144689	190738	150801	296372	280751	287484	161778
	4	85921	62681	59948	105582	199330	71425	198653	98200	129322	100667	172675	190463	165683
	5	38001	58508	43057	39010	60271	109269	53953	113296	57927	89246	71608	84509	102299
	6	26165	18857	36586	31252	26611	37443	65664	32298	60225	42811	57741	45971	44795
	7	16897	16840	12001	22453	21379	19328	21479	42090	22711	41814	30755	32626	28992
	8	7761	9416	12582	7630	14890	14362	13236	13376	29379	17882	29893	20546	18033
	9	4823	4181	6833	9375	5252	9788	9850	9593	8313	22322	13622	17281	14197
	10	2580	2759	2953	4746	6703	3168	5541	7220	6576	5992	16728	8887	10210
	+gp	5253	8334	11260	12044	19432	16183	16565	17951	13243	4518	12585	22073	14934
0	TOT/	397223	487765	710869	643841	819953	774974	770831	716635	846340	969055	1066173	929364	839385

Terminal Fs derived using XSA (With F shrinkage)

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

	YEAR	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
	AGE										
	2	117299	206220	373549	305466	178777	283593	167696	356258	152604	140075
	3	217485	83523	149693	232001	201097	117721	190783	111660	275188	115470
	4	73477	109026	35101	67515	76814	75021	52073	100133	54506	149340
	5	88246	37350	49426	18160	27611	31839	36371	21526	48825	24880
	6	57383	47900	16400	25658	7677	13431	14779	17000	9289	20495
	7	27458	32476	20741	9413	13124	4420	6893	8119	8147	4331
	8	18655	16044	15597	9916	4599	6825	2290	3019	3751	4363
	9	11554	11713	8790	6627	5212	2448	3916	1004	1261	1255
	10	9936	6862	6642	4560	3002	2814	1155	1979	689	699
	+gp	14828	10361	11586	7538	3503	6140	3111	4371	1535	1177
0	TOT/	636321	561475	687525	686855	521416	544252	479068	625068	555795	462085

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

	YEAR	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
	AGE										
	2	118922	137604	271883	204561	103694	79271	89466	294803	486337	344503
	3	99098	86835	99428	220594	164485	81399	60362	63153	230920	392628
	4	63111	65532	33574	37143	160596	118500	59291	38220	32702	122214
	5	63408	30165	23582	16654	18742	86398	64584	30524	19110	16261
	6	8553	22326	13781	12803	8150	11419	41034	23340	16851	10765
	7	9350	4083	8141	6506	6388	3851	5223	16629	10828	9212
	8	2592	4933	2316	3281	2789	2072	1047	2522	6616	6162
	9	2440	1057	2436	1195	1420	1600	593	516	1046	3599
	10	610	1310	359	1200	661	602	436	313	283	610
	+gp	1855	2084	1858	745	2027	189	359	647	457	552
0	TOT/	369939	355929	457358	504681	468953	385301	322394	470667	805150	906505

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

	YEAR	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	GMST 60-**	AMST 60-**
	AGE													
	2	244946	459563	154241	202688	108559	299688	125751	197051	[184676]	[40865]	[0]	211082	234700
	3	269086	197488	374963	126219	165077	88586	245332	102874	160253	[150977]	[33375]	158200	177994
	4	276441	195939	153212	292153	94087	121738	69723	192135	75723	127494	[117577]	94610	111216
	5	75955	168918	125586	81689	187213	65002	84957	46027	136567	54039	88254	50245	61219
	6	8911	38431	94335	69100	49991	114090	42378	48923	30567	87009	33712	26685	33942
	7	3752	4195	15524	48063	40464	29140	64528	25358	29846	17236	47479	14155	18920
	8	3154	1591	1831	8329	23189	22977	16253	35701	15508	18231	9914	7368	10766
	9	2011	1439	835	982	4317	13704	13785	10245	21830	9945	11213	3844	6157
	10	1607	787	902	558	365	2852	8613	8269	6279	13688	6023	2095	3725
	+gp	259	1975	975	1211	922	1538	2196	3927	7050	9813	13912		
0	TOT/	886123	1070327	922405	830991	674185	759314	673516	670508	[668300]	[529296]	[361458]		

Table 5.9

Run title : North-East Arctic saithe At 25/04/2003 9:38

Terminal Fs derived using XSA (With F shrinkage)

Table 12 Stock biomass at age (start of year) Tonnes

YEAR	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
AGE													
2	41361	72511	120872	41417	125426	71520	82009	65237	125067	118126	129137	74638	94678
3	62603	65973	120802	205854	69002	201394	102729	135424	107069	210424	199334	204114	114862
4	95372	69576	66543	117196	221257	79282	220505	109002	143548	111741	191669	211414	183908
5	61942	95368	70183	63586	98241	178108	87943	184673	94421	145470	116720	137749	166748
6	60964	43936	85246	72817	62003	87243	152998	75254	140323	99750	134537	107113	104371
7	53395	53214	37924	70952	67559	61076	67874	133004	71766	132132	97187	103098	91613
8	31275	37946	50706	30748	60005	57880	53339	53906	118396	72064	120469	82800	72672
9	23490	20363	33278	45655	25578	47669	47968	46718	40485	108710	66337	84158	69137
10	14524	15534	16625	26719	37737	17837	31196	40649	37021	33734	94178	50032	57485
+gp	42179	66999	89227	94556	151201	128800	134275	143498	102186	33794	93178	155657	111663
0 TOTAL	487106	541421	691404	769500	918009	930808	980836	987365	980281	1065944	1242746	1210774	1067137

AGE										
2	39882	70115	127007	103859	60784	96422	57016	160316	65620	71438
3	154414	59301	106282	164721	142779	83582	135456	88211	200887	88912
4	81559	121019	38962	74942	85264	83273	57801	127169	76308	167261
5	143841	60881	80564	29601	45005	51898	59286	43697	100092	50258
6	133703	111606	38212	59783	17888	31293	34435	43351	25638	53493
7	86767	102624	65541	29747	41471	13967	21783	26710	26884	14161
8	75179	64656	62856	39963	18534	27505	9231	13102	16431	17058
9	56270	57041	42810	32273	25385	11921	19070	5170	7503	5884
10	55938	38634	37392	25675	16899	15845	6505	11379	4402	3933
+gp	109507	74775	82570	55177	25903	46217	24295	30321	10504	8899
0 TOTAL	937060	760652	682197	615738	479912	461923	424877	549427	534269	481297

Table 12 Stock biomass at age (start of year) Tonnes

YEAR	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
AGE										
2	71353	72930	103315	65460	35256	26160	40260	159194	194535	155026
3	104053	61653	74571	130150	87177	50467	44668	47997	166262	274840
4	83938	82570	45661	45315	134901	103095	57512	41278	38916	134435
5	117938	60933	49287	32808	31112	113181	89772	47617	34016	32197
6	23948	60279	36244	29446	18907	27748	74271	49481	37745	25189
7	37399	15844	26702	18673	18971	14904	15773	39909	30969	25886
8	10835	22051	9196	12206	11156	11146	3914	9204	21964	20026
9	13005	5666	11033	5139	6705	9329	2753	1857	4737	14610
10	3465	7938	1988	5626	3595	3227	2071	1993	1613	3776
+gp	16077	14985	15213	4915	13997	1406	2691	3103	3259	4071
0 TOTAL	482011	404850	373211	349738	361777	360663	333685	401633	534016	690057

Table 12 Stock biomass at age (start of year) Tonnes

YEAR	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
AGE										
2	112675	160847	77121	81075	41253	104891	80481	72909	[78672]	[16346]
3	169524	102694	209979	74469	102348	60238	164372	62753	120510	[104174]
4	281970	144995	119505	239565	86560	121738	73209	195977	83901	128641
5	129124	206080	151959	107830	222784	96203	123187	74104	209084	79977
6	22278	83011	164143	126453	82985	213347	81790	103716	62266	170276
7	10805	13382	43468	118715	93471	75181	147124	67452	78197	45278
8	9745	6317	6849	30984	71887	70540	48271	114599	49190	59395
9	7440	6650	3674	4408	18737	56461	49626	38315	79834	38437
10	9948	4154	4765	2957	2204	15541	35400	35968	28791	58504
+gp	2118	11992	7262	8498	7026	12380	12107	23466	37860	56502
0 TOTAL	755628	740123	788725	794954	729255	826522	815568	789259	[828305]	[757533]

Table 5.10

Run title : North-East Arctic saithe

At 25/04/2003 9:38

Terminal Fs derived using XSA (With F shrinkage)

Table 13 Spawning stock biomass at age (spawning time) Tonnes

	YEAR	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
	AGE													
	2	0	0	0	0	0	0	0	0	0	0	0	0	0
	3	0	0	0	0	0	0	0	0	0	0	0	0	0
	4	954	696	665	1172	2213	793	2205	1090	1435	1117	1917	2114	1839
	5	34068	52452	38601	34972	54033	97959	48369	101570	51932	80009	64196	75762	91711
	6	51820	37346	72459	61894	52703	74156	130048	63966	119275	84787	114356	91046	88716
	7	52327	52150	37165	69533	66208	59854	66516	130344	70331	129489	95244	101036	89781
	8	31275	37946	50706	30748	60005	57880	53339	53906	118396	72064	120469	82800	72672
	9	23490	20363	33278	45655	25578	47669	47968	46718	40485	108710	66337	84158	69137
	10	14524	15534	16625	26719	37737	17837	31196	40649	37021	33734	94178	50032	57485
	+gp	42179	66999	89227	94556	151201	128800	134275	143498	102186	33794	93178	155657	111663
0	TOTSF	250637	283486	338725	365250	449677	484948	513917	581741	541060	543704	649874	642605	583004

Table 13 Spawning stock biomass at age (spawning time) Tonnes

	YEAR	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
	AGE										
	2	0	0	0	0	0	0	0	0	0	0
	3	0	0	0	0	0	0	0	0	0	0
	4	816	1210	390	749	853	833	578	1272	763	1673
	5	79112	33485	44310	16280	24753	28544	32607	24033	55051	27642
	6	113647	94865	32481	50815	15205	26599	29269	36848	21792	45469
	7	85032	100572	64231	29152	40642	13688	21348	26176	26347	13878
	8	75179	64656	62856	39963	18534	27505	9231	13102	16431	17058
	9	56270	57041	42810	32273	25385	11921	19070	5170	7503	5884
	10	55938	38634	37392	25675	16899	15845	6505	11379	4402	3933
	+gp	109507	74775	82570	55177	25903	46217	24295	30321	10504	8899
0	TOTSF	575501	465237	367039	250083	168173	171152	142903	148302	142793	124436

Table 13 Spawning stock biomass at age (spawning time) Tonnes

	YEAR	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
	AGE										
	2	0	0	0	0	0	0	0	0	0	0
	3	0	0	0	0	0	0	0	0	0	0
	4	839	826	457	453	1349	1031	575	413	389	1344
	5	64866	33513	27108	18044	17112	62250	49374	26189	18709	17708
	6	20356	51237	30808	25029	16071	23586	63130	42059	32084	21411
	7	36651	15527	26168	18300	18592	14606	15458	39111	30350	25369
	8	10835	22051	9196	12206	11156	11146	3914	9204	21964	20026
	9	13005	5666	11033	5139	6705	9329	2753	1857	4737	14610
	10	3465	7938	1988	5626	3595	3227	2071	1993	1613	3776
	+gp	16077	14985	15213	4915	13997	1406	2691	3103	3259	4071
0	TOTSF	166093	151744	121970	89713	88576	126581	139966	123929	113104	108315

Table 13 Spawning stock biomass at age (spawning time) Tonnes

	YEAR	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
	AGE										
	2	0	0	0	0	0	0	0	0	0	0
	3	0	0	0	0	0	0	0	0	0	0
	4	2820	1450	1195	2396	866	1217	732	1960	839	1286
	5	71018	113344	83578	59307	122531	52912	67753	40757	114996	43988
	6	18937	70560	139521	107485	70537	181345	69522	88159	52926	144735
	7	10589	13115	42599	116341	91601	73678	144181	66103	76633	44373
	8	9745	6317	6849	30984	71887	70540	48271	114599	49190	59395
	9	7440	6650	3674	4408	18737	56461	49626	38315	79834	38437
	10	9948	4154	4765	2957	2204	15541	35400	35968	28791	58504
	+gp	2118	11992	7262	8498	7026	12380	12107	23466	37860	56502
0	TOTSF	132615	227582	289443	332375	385390	464076	427592	409326	441069	447221

Table 5.11
Run title : North-East Arctic saithe

At 25/04/2003 9:38

Table 16 Summary (without SOP correction)

Terminal Fs derived using XSA (With F shrinkage)

	RECRUITS Age 2	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	FBAR 3- 6
1960	121650	487106	250637	133515	0.5327	0.2667
1961	213269	541421	283486	105951	0.3737	0.2338
1962	355505	691404	338725	120707	0.3564	0.2289
1963	121815	769500	365250	148627	0.4069	0.2244
1964	368899	918009	449677	197426	0.439	0.2262
1965	210354	930808	484948	185600	0.3827	0.2254
1966	241202	980836	513917	203788	0.3965	0.2767
1967	191872	987365	581741	181326	0.3117	0.2751
1968	367843	980281	541060	110247	0.2038	0.1606
1969	347431	1065944	543704	140060	0.2576	0.2117
1970	379816	1242746	649874	264924	0.4077	0.3292
1971	219524	1210774	642605	241272	0.3755	0.3671
1972	278465	1067137	583004	214334	0.3676	0.4217
1973	117299	937060	575501	213859	0.3716	0.4369
1974	206220	760652	465237	274121	0.5892	0.6295
1975	373549	682197	367039	233453	0.636	0.4665
1976	305466	615738	250083	242486	0.9696	0.6827
1977	178777	479912	168173	182817	1.0871	0.5849
1978	283593	461923	171152	154464	0.9025	0.5435
1979	167696	424877	142903	164180	1.1489	0.5219
1980	356258	549427	148302	144554	0.9747	0.5529
1981	152604	534269	142793	175516	1.2292	0.5567
1982	140075	481297	124436	168034	1.3504	0.6284
1983	118922	482011	166093	156936	0.9449	0.5337
1984	137604	404850	151744	158786	1.0464	0.7411
1985	271883	373211	121970	107183	0.8788	0.5618
1986	204561	349738	89713	70458	0.7854	0.4028
1987	103694	361777	88576	92391	1.0431	0.3482
1988	79271	360663	126581	114242	0.9025	0.4127
1989	89466	333685	139966	122310	0.8739	0.5605
1990	294803	401633	123929	95848	0.7734	0.4783
1991	486337	534016	113104	107326	0.9489	0.4282
1992	344503	690057	108315	127516	1.1773	0.4205
1993	244946	755628	132615	153584	1.1581	0.3611
1994	459563	740123	227582	146544	0.6439	0.3469
1995	154241	788725	289443	168174	0.581	0.3376
1996	202688	794954	332375	171498	0.516	0.2413
1997	108559	729255	385390	143760	0.373	0.2273
1998	299688	826522	464076	153822	0.3315	0.1992
1999	125751	815568	427592	150274	0.3514	0.2313
2000	197051	789259	409326	135170	0.3302	0.1878
2001	244552	888181	441069	136402	0.3093	0.1975
2002	192000	908668	447221	154631	0.3458	0.2208
Arith. Mean	233936	700679	315603	159724	0.6601	0.3835
0 Units	(Thousar	(Tonnes	(Tonnes	(Tonnes)		

Table 5.12 Input to RCT3 analysis program

```
NORTHEAST ARCTIC SAITHE : recruits as 2 year-olds
1 11 2  (No. of surveys   No. of years   VPA Column No.)
'Yearcl' 'VPA' 'Ac-surv'
1990   345    163.5
1991   245    106.9
1992   460    34.4
1993   154    38.7
1994   203    37.0
1995      109    5.1
1996   300    43.6
1997   126    61.1
1998   197  164.8
1999        -11  104.7
2000        -11   21.9


NORTHEAST ARCTIC SAITHE : recruits as 3 year-olds
1 11 2  (No. of surveys, No. of years, VPA Column No.)
'Yearcl' 'VPA' 'Ac-surv'
1989      393    273.6
1990   269    227.7
1991      198    87.8
1992      375    165.2
1993      126    118.9
1994      165    36.7
1995       89     96.5
1996      246    233.8
1997   103   142.5
1998   160   275.9
1999   -11   206.1
```

Table 5.13 Analysis by RCT3 program

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

rct2-02.txt

NORTHEAST ARCTIC SAITHE : recruits as 2 year-olds

Data for    1 surveys over   11 years :  1990 - 2000

Regression type = C
Tapered time weighting applied
power =    3 over  20 years
Survey weighting not applied

Final estimates shrunk towards mean
Minimum S.E. for any survey taken as    .20
Minimum of   3 points used for regression

Forecast/Hindcast variance correction used.

Year class =   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

Ac-sur    1.09   1.09   1.08   .182      9   4.66    6.17    1.341     .111

                                       VPA Mean =    5.36     .473     .889


Year class =   2000

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

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

Ac-sur    1.09   1.08   1.09   .179      9   3.13    4.50    1.370     .106

                                       VPA Mean =    5.35     .473     .894


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

1999        232       5.45     .45     .25     .32
2000        192       5.26     .45     .26     .35
```

Table 5.13 Analysis by RCT3 program (Cont.d)

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

 rct3-02.txt

 NORTHEAST ARCTIC SAITHE : recruits as 3 year-olds

 Data for    1 surveys over   11 years :  1989 - 1999

 Regression type = C
 Tapered time weighting applied
 power =    3 over  20 years
 Survey weighting not applied

 Final estimates shrunk towards mean
 Minimum S.E. for any survey taken as    .20
 Minimum of   3 points used for regression

 Forecast/Hindcast variance correction used.

 Year class =   1992

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

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

 Ac-sur     .62   2.40    .22   .823      3   5.11    5.58     .450     .366

                                         VPA Mean =    5.62     .342     .634


 Year class =   1993

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

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

 Ac-sur     .84   1.34    .33   .580      4   4.79    5.38     .566     .241

                                         VPA Mean =    5.70     .319     .759


 Year class =   1994

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

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

 Ac-sur    1.45  -1.83    .54   .503      5   3.63    3.42    1.356     .108

                                         VPA Mean =    5.53     .473     .892


 Year class =   1995

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

 Survey/  Slope  Inter-   Std  Rsquare  No.  Index Predicted   Std     WAP
```

Table 5.13 Analysis by RCT3 program (Cont.d)

```
Series          cept   Error          Pts  Value   Value    Error   Weights

 Ac-sur     .93    .98    .55   .461      6   4.58    5.22     .741     .274

                                           VPA Mean =    5.45     .456     .726


 Year class =   1996

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

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

 Ac-sur    1.38  -1.31    .81   .358      7   5.46    6.23    1.109     .199

                                           VPA Mean =    5.31     .552     .801


 Year class =   1997

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

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

 Ac-sur    1.30  -1.01    .75   .358      8   4.97    5.45     .926     .237

                                           VPA Mean =    5.33     .516     .763


 Year class =   1998

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

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

 Ac-sur    1.69  -3.02    .97   .259      9   5.62    6.51    1.269     .151

                                           VPA Mean =    5.25     .535     .849


 Year class =   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

 Ac-sur    1.90  -4.19   1.16   .176     10   5.33    5.94    1.408     .114

                                           VPA Mean =    5.22     .505     .886
```

Table 5.13 Analysis by RCT3 program (Cont.d)

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
1992	272	5.61	.27	.02	.01	376	5.93
1993	276	5.62	.28	.14	.24	127	4.84
1994	200	5.30	.45	.65	2.15	165	5.11
1995	219	5.39	.39	.11	.07	90	4.50
1996	243	5.49	.49	.37	.55	247	5.51
1997	212	5.36	.45	.05	.01	104	4.64
1998	229	5.44	.49	.45	.84	160	5.08
1999	200	5.30	.47	.23	.23		

Table 5.14 Prediction with management option table: input data
MFDP version 1a
Run: 03
Time and date: 16:50 28.04.2003
Fbar age range: 2-11

2003

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
2	211340	0.2	0	0	0	0.3987	0.0030	0.3987
3	157113	0.2	0	0	0	0.6840	0.0629	0.6840
4	157726	0.2	0.01	0	0	1.0457	0.1627	1.0457
5	88254	0.2	0.55	0	0	1.5403	0.2666	1.5403
6	33712	0.2	0.85	0	0	2.0380	0.3908	2.0380
7	47479	0.2	0.98	0	0	2.6357	0.3416	2.6357
8	9914	0.2	1	0	0	3.2133	0.2995	3.2133
9	11213	0.2	1	0	0	3.7540	0.3125	3.7540
10	6023	0.2	1	0	0	4.4030	0.4102	4.4030
11	13912	0.2	1	0	0	5.7010	0.4102	5.7010

2004

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
2	211340	0.2	0	0	0	0.3987	0.0030	0.3987
3	.	0.2	0	0	0	0.6840	0.0629	0.6840
4	.	0.2	0.01	0	0	1.0457	0.1627	1.0457
5	.	0.2	0.55	0	0	1.5403	0.2666	1.5403
6	.	0.2	0.85	0	0	2.0380	0.3908	2.0380
7	.	0.2	0.98	0	0	2.6357	0.3416	2.6357
8	.	0.2	1	0	0	3.2133	0.2995	3.2133
9	.	0.2	1	0	0	3.7540	0.3125	3.7540
10	.	0.2	1	0	0	4.4030	0.4102	4.4030
11	.	0.2	1	0	0	5.7010	0.4102	5.7010

2005

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
2	211340	0.2	0	0	0	0.3987	0.0030	0.3987
3	.	0.2	0	0	0	0.6840	0.0629	0.6840
4	.	0.2	0.01	0	0	1.0457	0.1627	1.0457
5	.	0.2	0.55	0	0	1.5403	0.2666	1.5403
6	.	0.2	0.85	0	0	2.0380	0.3908	2.0380
7	.	0.2	0.98	0	0	2.6357	0.3416	2.6357
8	.	0.2	1	0	0	3.2133	0.2995	3.2133
9	.	0.2	1	0	0	3.7540	0.3125	3.7540
10	.	0.2	1	0	0	4.4030	0.4102	4.4030
11	.	0.2	1	0	0	5.7010	0.4102	5.7010

Input units are thousands and kg - output in tonnes

Table 5.15 Yield per recruit: summary table
MFYPR version 2a
Run: sop
Time and date: 12:14 29.04.2003
Yield per results

FMult	Fbar	CatchNos	Yield	StockNos	Biomass	SpwnNosJan	SSBJan	SpwnNosSpwn	SSBSpwn
0.0000	0.0000	0.0000	0.0000	5.5167	12.3715	2.7126	10.1818	2.7126	10.1818
0.1000	0.0221	0.0942	0.2906	5.0475	10.1438	2.2575	7.9756	2.2575	7.9756
0.2000	0.0442	0.1630	0.4661	4.7051	8.5989	1.9288	6.4516	1.9288	6.4516
0.3000	0.0662	0.2159	0.5760	4.4425	7.4725	1.6795	5.3455	1.6795	5.3455
0.4000	0.0883	0.2580	0.6462	4.2334	6.6200	1.4834	4.5127	1.4834	4.5127
0.5000	0.1104	0.2926	0.6916	4.0622	5.9558	1.3249	3.8675	1.3249	3.8675
0.6000	0.1325	0.3215	0.7209	3.9190	5.4259	1.1941	3.3561	1.1941	3.3561
0.7000	0.1545	0.3462	0.7396	3.7970	4.9951	1.0842	2.9432	1.0842	2.9432
0.8000	0.1766	0.3676	0.7511	3.6916	4.6389	0.9907	2.6045	0.9907	2.6045
0.9000	0.1987	0.3863	0.7578	3.5995	4.3403	0.9100	2.3228	0.9100	2.3228
1.0000	0.2208	0.4028	0.7611	3.5181	4.0870	0.8399	2.0860	0.8399	2.0860
1.1000	0.2428	0.4176	0.7621	3.4455	3.8698	0.7783	1.8847	0.7783	1.8847
1.2000	0.2649	0.4309	0.7615	3.3803	3.6817	0.7239	1.7122	0.7239	1.7122
1.3000	0.2870	0.4429	0.7598	3.3213	3.5174	0.6755	1.5631	0.6755	1.5631
1.4000	0.3091	0.4539	0.7574	3.2677	3.3729	0.6321	1.4333	0.6321	1.4333
1.5000	0.3311	0.4639	0.7545	3.2186	3.2448	0.5931	1.3196	0.5931	1.3196
1.6000	0.3532	0.4732	0.7512	3.1735	3.1305	0.5579	1.2193	0.5579	1.2193
1.7000	0.3753	0.4817	0.7476	3.1318	3.0280	0.5259	1.1304	0.5259	1.1304
1.8000	0.3974	0.4897	0.7440	3.0932	2.9356	0.4967	1.0512	0.4967	1.0512
1.9000	0.4194	0.4971	0.7403	3.0573	2.8517	0.4700	0.9804	0.4700	0.9804
2.0000	0.4415	0.5040	0.7366	3.0237	2.7754	0.4456	0.9167	0.4456	0.9167

Reference point	F multiplier	Absolute F
Fbar(3-6)	1.0000	0.2208
FMax	1.1077	0.2445
F0.1	0.4918	0.1086
F35%SPR	0.5567	0.1229

Weights in kilograms

Table 5.16 Prediction with management optin table
MFDP version 1a
Run: 03
North-East Arctic saithe
Time and date: 12:11 29.04.2003
Fbar age range: 3-6

2003 Biomass	SSB	FMult	FBar	Landings
866212	437232	1.0201	0.2252	164000

2004 Biomass	SSB	FMult	FBar	Landings	2005 Biomass	SSB
859129	438371	0.0000	0.0000	0	1039643	592614
.	438371	0.1000	0.0221	18233	1018817	574656
.	438371	0.2000	0.0442	35925	998617	557279
.	438371	0.3000	0.0662	53092	979023	540462
.	438371	0.4000	0.0883	69752	960014	524187
.	438371	0.5000	0.1104	85921	941573	508435
.	438371	0.6000	0.1325	101615	923679	493189
.	438371	0.7000	0.1545	116851	906316	478432
.	438371	0.8000	0.1766	131641	889465	464147
.	438371	0.9000	0.1987	146002	873111	450319
.	438371	1.0000	0.2208	159947	857237	436931
.	438371	1.1000	0.2428	173490	841827	423970
.	438371	1.2000	0.2649	186642	826867	411421
.	438371	1.3000	0.2870	199418	812342	399270
.	438371	1.4000	0.3091	211828	798237	387504
.	438371	1.5000	0.3311	223885	784540	376110
.	438371	1.6000	0.3532	235600	771237	365076
.	438371	1.7000	0.3753	246984	758316	354390
.	438371	1.8000	0.3974	258047	745764	344039
.	438371	1.9000	0.4194	268800	733570	334014
.	438371	2.0000	0.4415	279252	721722	324304

Input units are thousands and kg - output in tonnes

Table 5.17 A, medium term projection Fpa
MFDP version 1a
Run: fpa
North-East Arctic saithe
Time and date: 09:05 02.05.2003
Fbar age range: 3-6

2003

Biomass	SSB	FMult	FBar	Landings
866212	437232	1.0201	0.2252	164000

2004

Biomass	SSB	FMult	FBar	Landings
859129	438371	1.1777	0.26	183744

2005

Biomass	SSB	FMult	FBar	Landings
830163	414183	1.1777	0.26	176314

2006

Biomass	SSB	FMult	FBar	Landings
810744	394711	1.1777	0.26	169363

2007

Biomass	SSB	FMult	FBar	Landings
801395	384546	1.1777	0.26	165510

2008					2009	
Biomass	SSB	FMult	FBar	Landings	Biomass	SSB
794136	377179	0	0	0	980114	532514
.	377179	0.1	0.0221	16173	961371	516594
.	377179	0.2	0.0442	31873	943181	501184
.	377179	0.3	0.0662	47117	925527	486266
.	377179	0.4	0.0883	61919	908390	471825
.	377179	0.5	0.1104	76294	891756	457843
.	377179	0.6	0.1325	90254	875607	444307
.	377179	0.7	0.1545	103814	859927	431200
.	377179	0.8	0.1766	116986	844701	418509
.	377179	0.9	0.1987	129782	829916	406220
.	377179	1	0.2208	142215	815556	394319
.	377179	1.1	0.2428	154297	801608	382794
.	377179	1.2	0.2649	166037	788059	371631
.	377179	1.3	0.287	177448	774896	360819
.	377179	1.4	0.3091	188539	762107	350347
.	377179	1.5	0.3311	199321	749680	340203
.	377179	1.6	0.3532	209804	737603	330375
.	377179	1.7	0.3753	219996	725865	320855
.	377179	1.8	0.3974	229907	714456	311631
.	377179	1.9	0.4194	239546	703365	302694
.	377179	2	0.4415	248921	692583	294034

Input units are thousands and kg - output in tonnes

Table 5.17 B medium term projection, Fsq
MFDP version 1a
Run: fsq
North-East Arctic saithe
Time and date: 09:04 02.05.2003
Fbar age range: 3-6

2003				
Biomass	SSB	FMult	FBar	Landings
866212	437232	1.0201	0.2252	164000

2004				
Biomass	SSB	FMult	FBar	Landings
859129	438371	1	0.2207	159947

2005				
Biomass	SSB	FMult	FBar	Landings
857237	436931	1	0.2208	160530

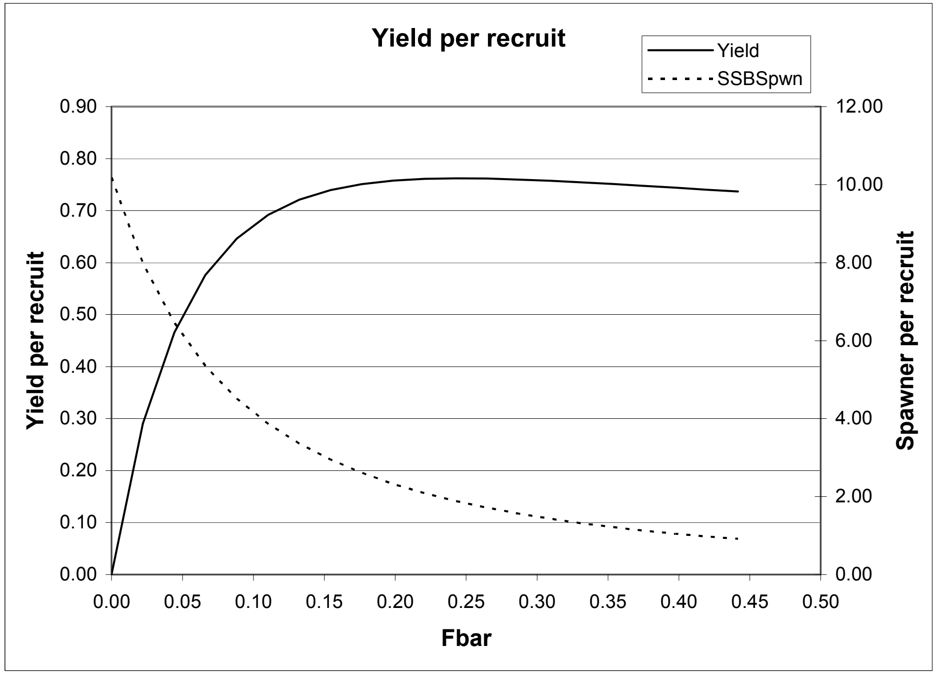
2006				
Biomass	SSB	FMult	FBar	Landings
856367	434756	1	0.2208	159364

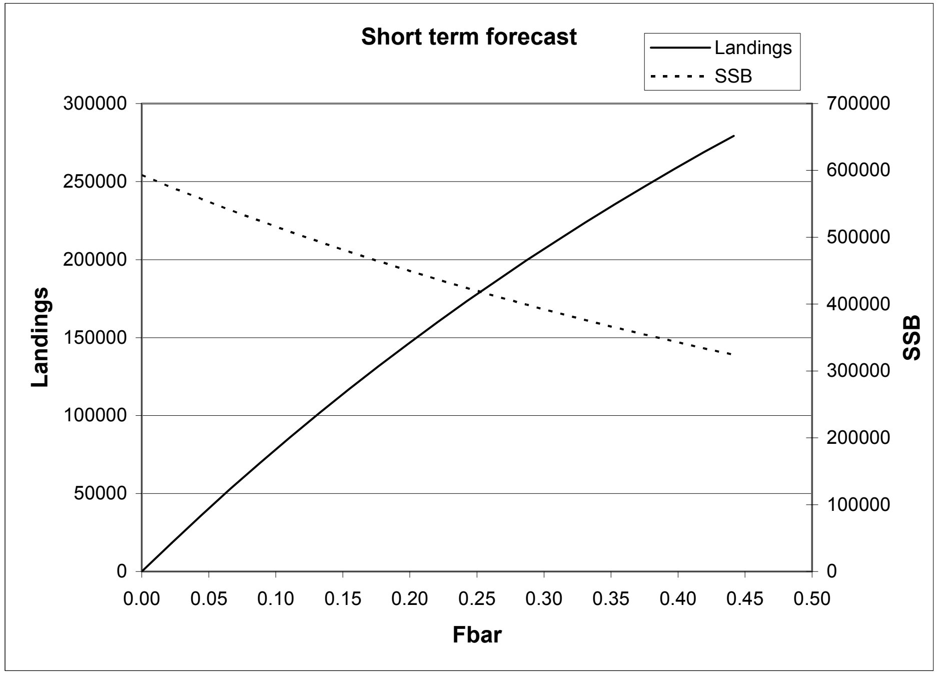
2007				
Biomass	SSB	FMult	FBar	Landings
859401	436654	1	0.2208	159184

2008					2009	
Biomass	SSB	FMult	FBar	Landings	Biomass	SSB
859610	436709	0	0	0	1044782	595098
.	436709	0.1	0.0221	18173	1023873	577059
.	436709	0.2	0.0442	35807	1003591	559603
.	436709	0.3	0.0662	52920	983918	542710
.	436709	0.4	0.0883	69529	964832	526362
.	436709	0.5	0.1104	85650	946314	510540
.	436709	0.6	0.1325	101299	928346	495227
.	436709	0.7	0.1545	116491	910911	480405
.	436709	0.8	0.1766	131241	893990	466057
.	436709	0.9	0.1987	145563	877566	452169
.	436709	1	0.2208	159472	861625	438723
.	436709	1.1	0.2428	172980	846149	425707
.	436709	1.2	0.2649	186100	831125	413104
.	436709	1.3	0.287	198845	816537	400902
.	436709	1.4	0.3091	211227	802372	389088
.	436709	1.5	0.3311	223257	788615	377647
.	436709	1.6	0.3532	234947	775254	366568
.	436709	1.7	0.3753	246307	762276	355838
.	436709	1.8	0.3974	257348	749668	345446
.	436709	1.9	0.4194	268079	737420	335382
.	436709	2	0.4415	278512	725519	325633

Input units are thousands and kg - output in tonnes

Figure 5.1 A and B, Yield and spawning stock biomass





MFYPR version 2a
Run: sop
Time and date: 12:14 29.04.2003

Reference point	F multiplier	Absolute F
Fbar(3-6)	1.0000	0.2208
FMax	1.1077	0.2445
F0.1	0.4918	0.1086
F35%SPR	0.5567	0.1229

Weights in kilograms

MFDP version 1a
Run: 03
North-East Arctic saithe
Time and date: 12:11 29.04.2003
Fbar age range: 3-6

Input units are thousands and kg - output in tonnes

Figure 5.2A. North-East Arctic Saithe - Acoustic survey vs VPA

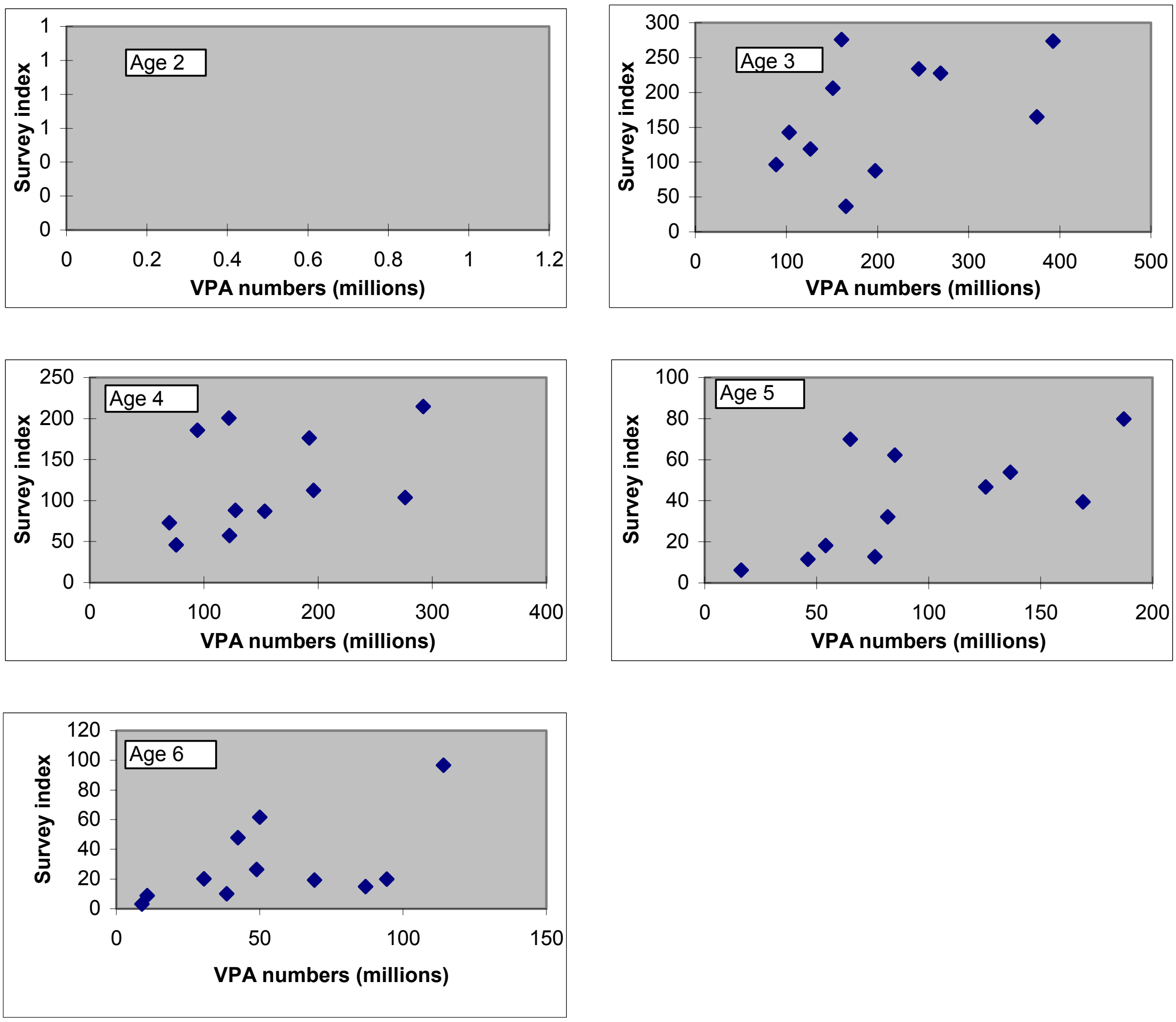


Figure 5.2B. North-East Arctic Saithe - Norwegian purse seine vs VPA

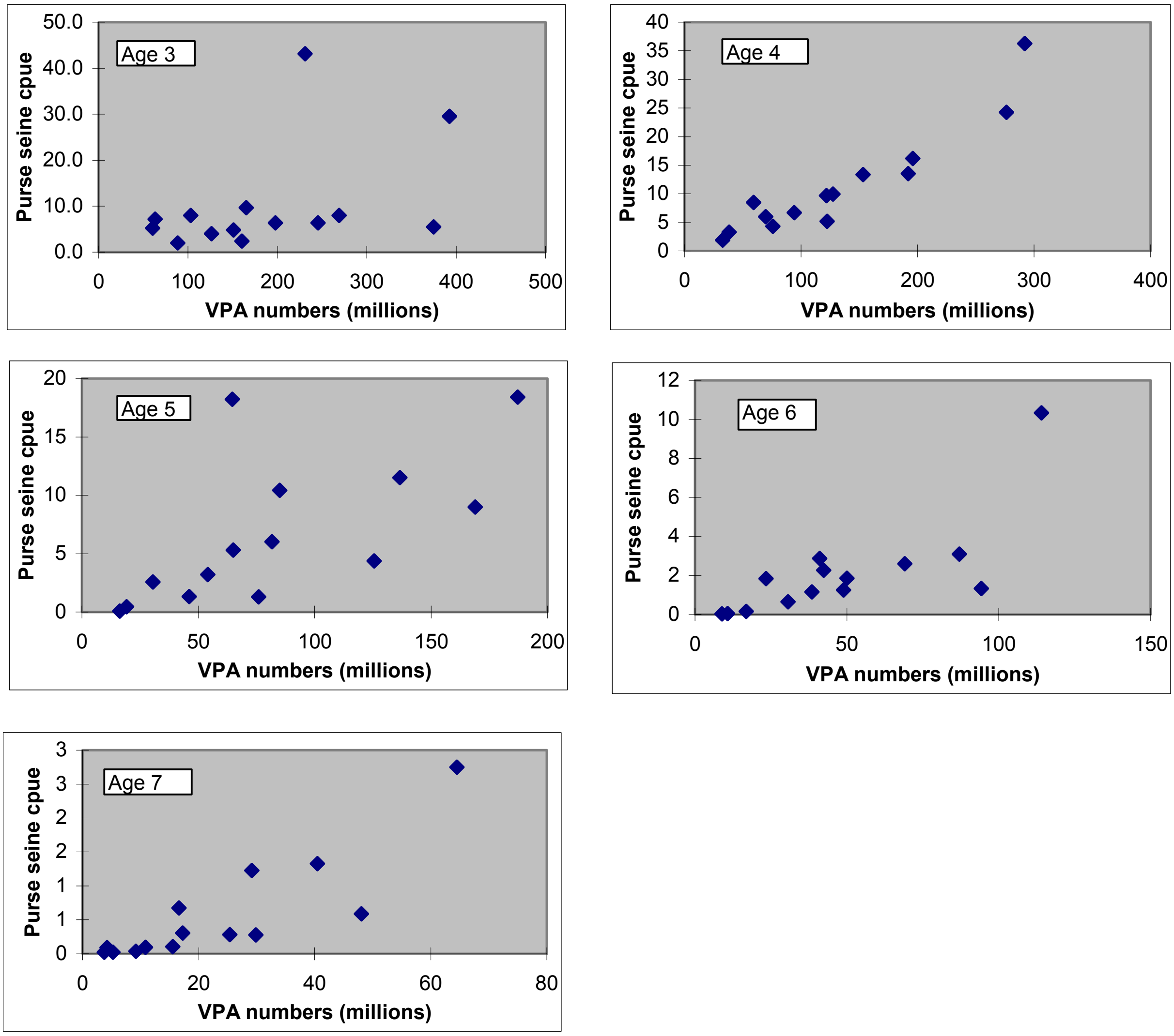


Figure 5.2C. North-East Arctic Saithe - Norwegian trawl vs VPA

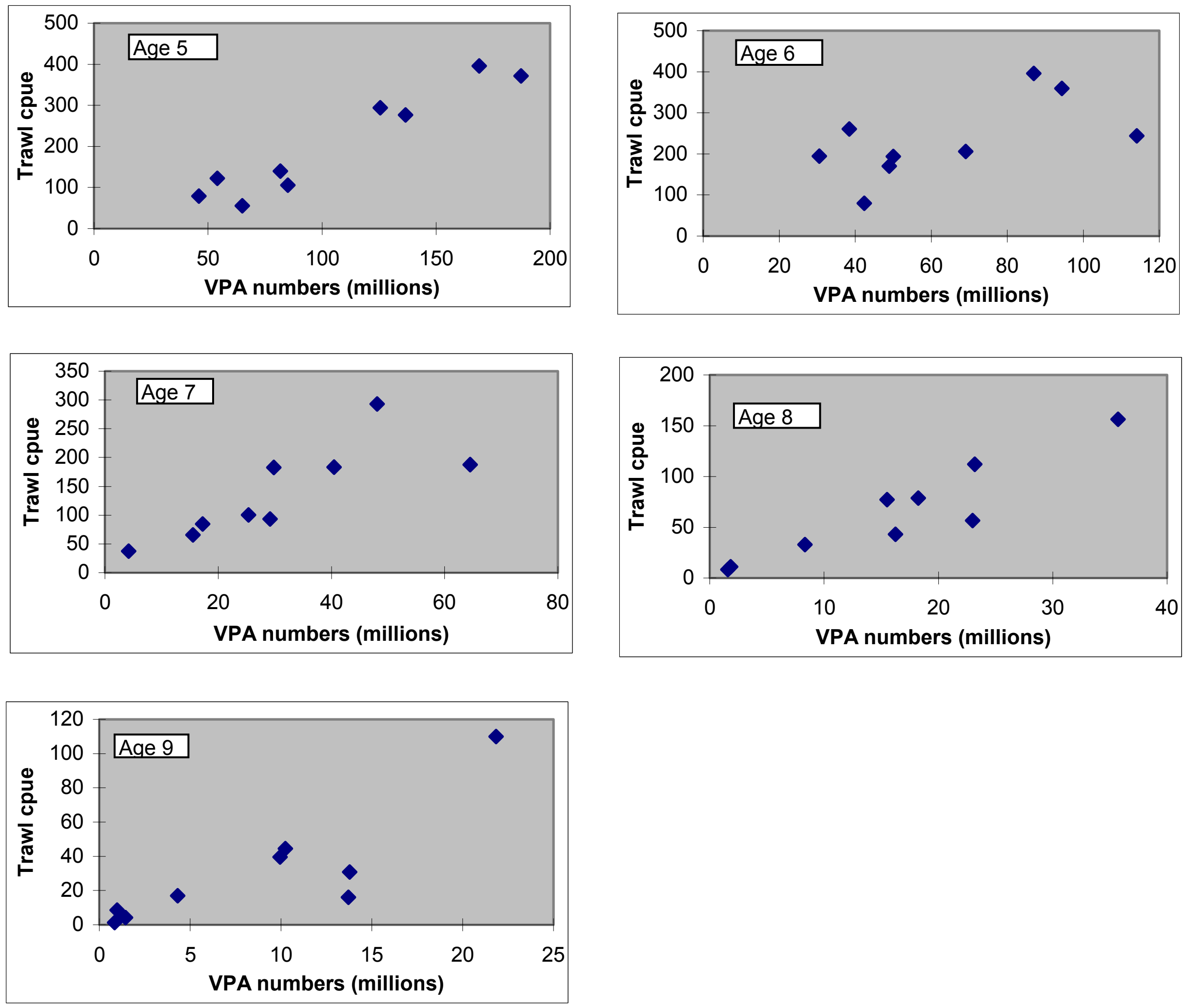
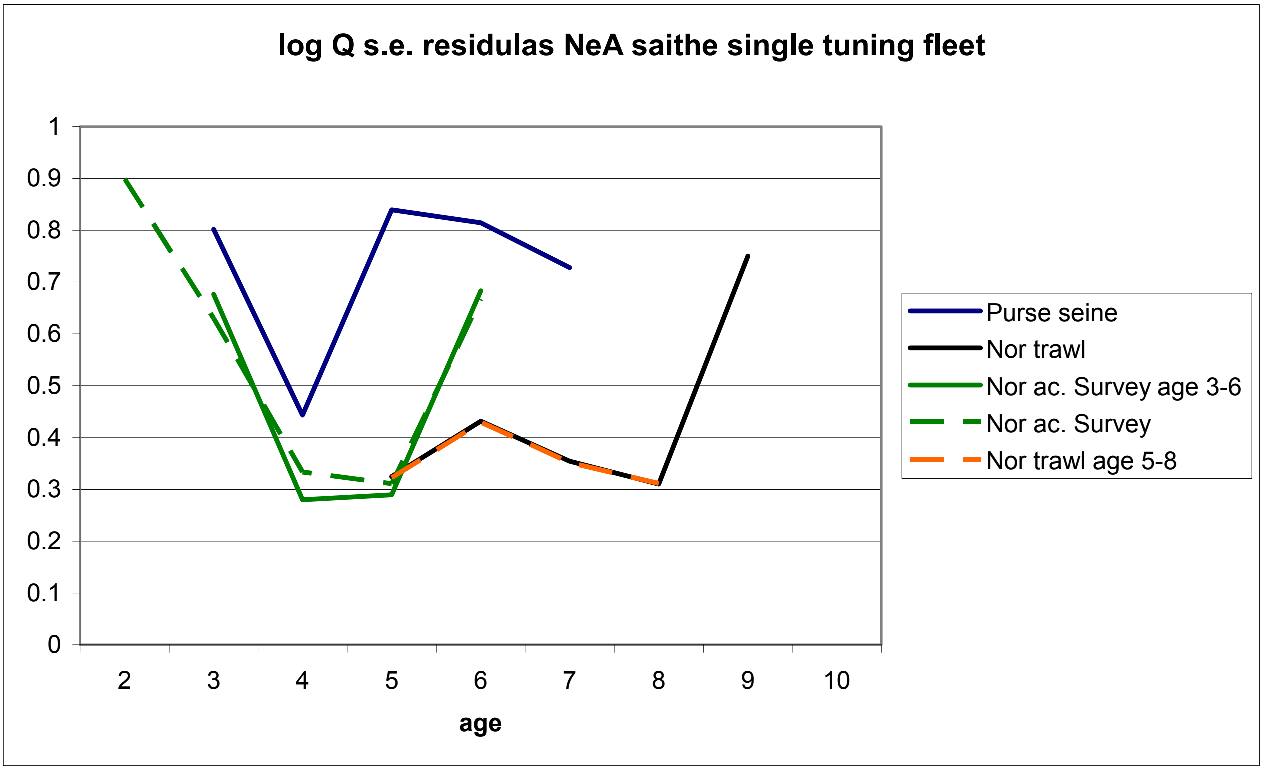
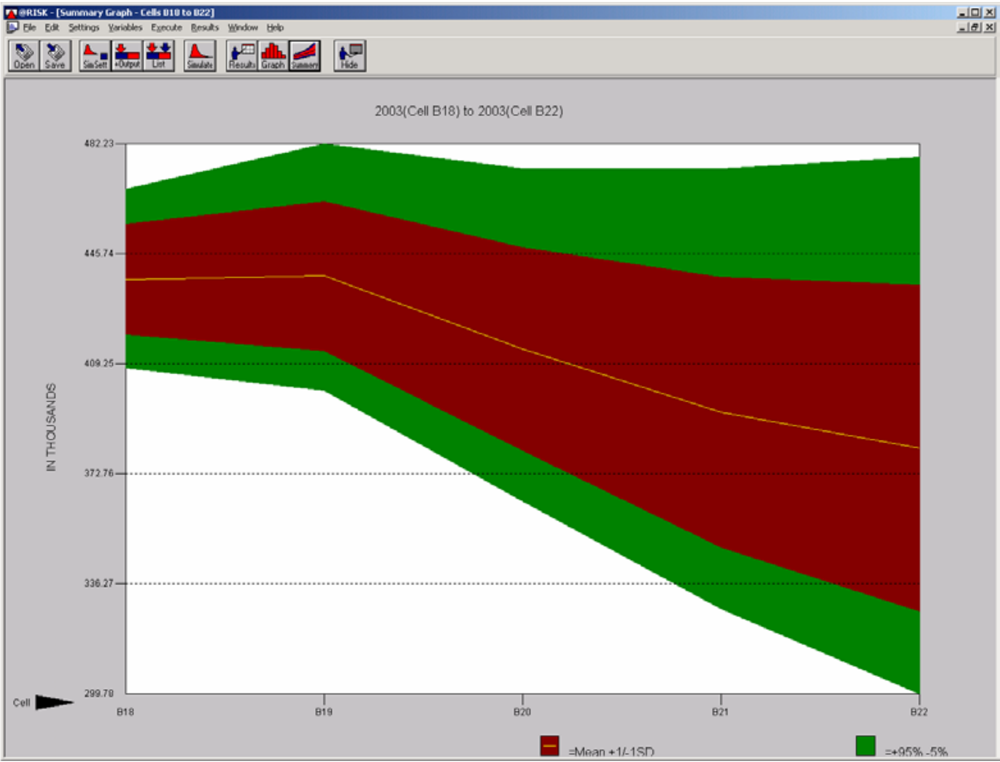


Figure 5.3 log Q se residuals NeA saithe, XSA

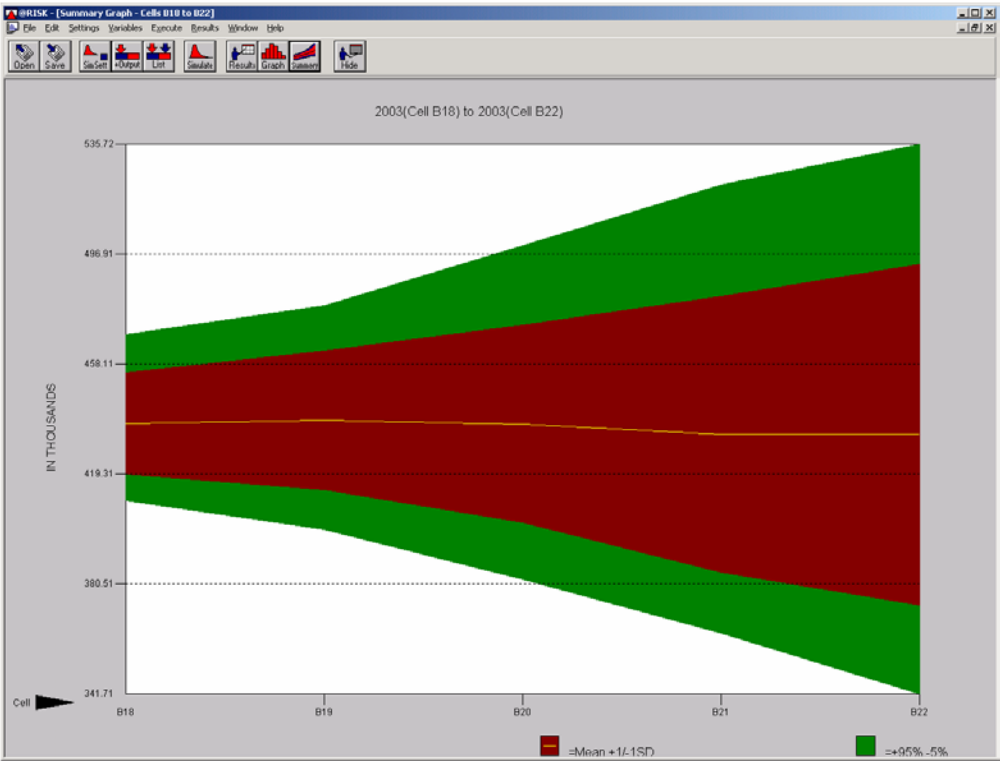
age	2	3	4	5	6	7	8	9	10
Purse seine		0.8019	0.4436	0.8395	0.8146	0.7282			
Nor trawl				0.3246	0.4316	0.3542	0.3103	0.7502	
Nor ac. Survey age 3-6		0.6762	0.2801	0.2891	0.6835				
Nor ac. Sur	0.8988	0.6297	0.3338	0.3111	0.6673				
Nor trawl age 5-8				0.3224	0.4296	0.3513	0.3115		



The three tuning fleets marked as "solid lines" were allocated as tuning fleets used in afwg 2003 assessment.



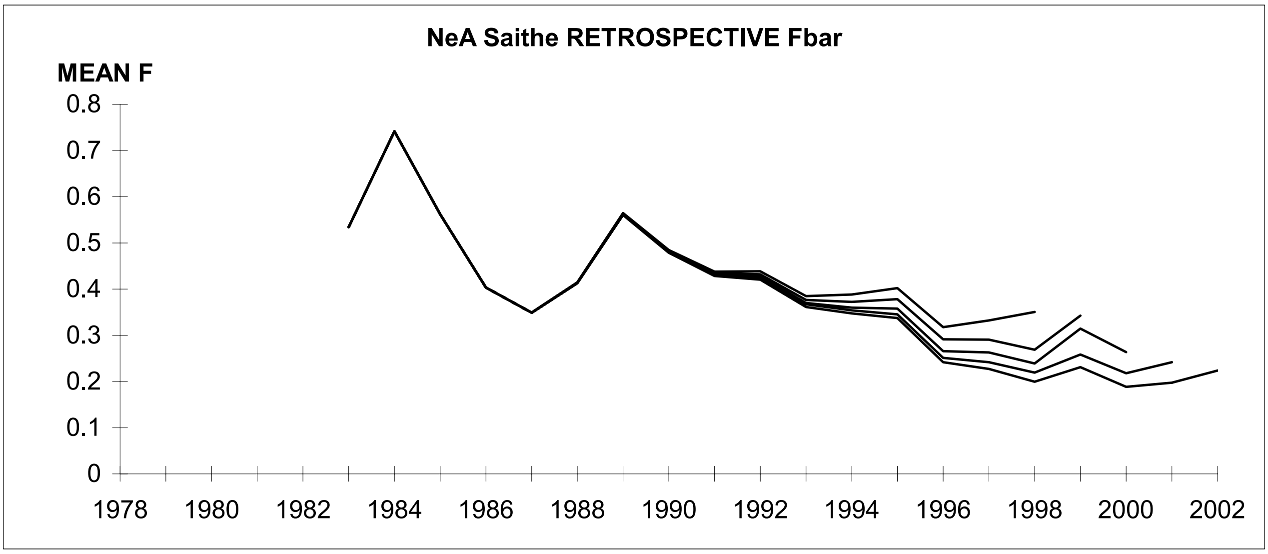
SSB according to Fbar=0.26 (Fpa)

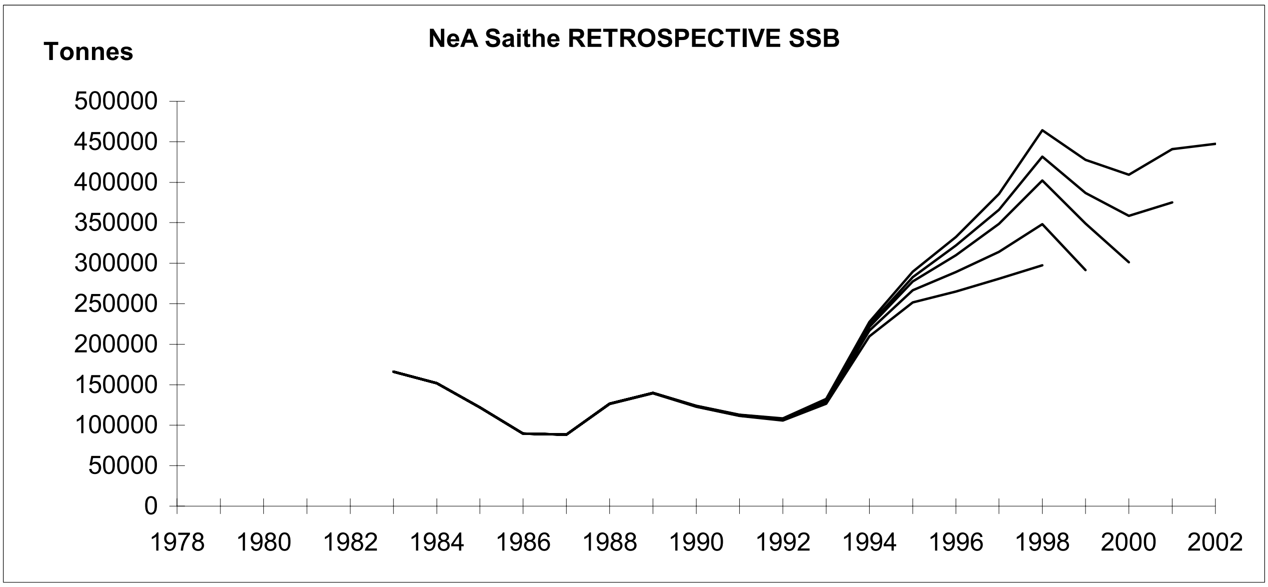


SSB according to Fbar=0.22 (F status quo)

Figure 5.4 Risk analysis on medium-term projections, time span 2003-2007 (Continued)

NeA Saithe RETROSPECTIVE XSA
(Shrinkage SE=0.5) P-shrinkage OFF





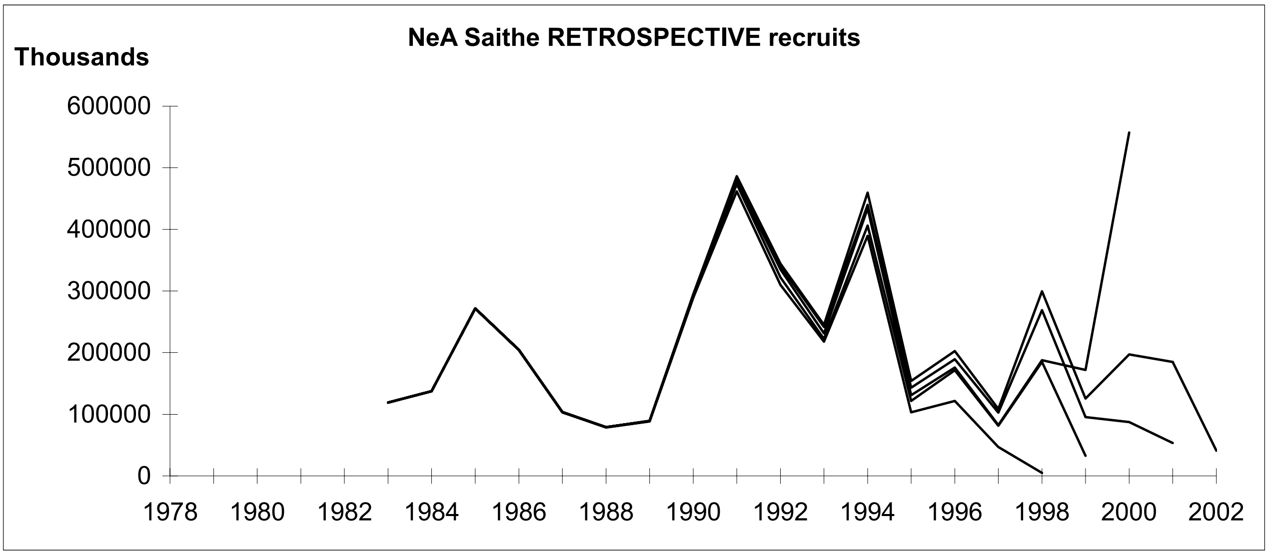


Figure 5.5

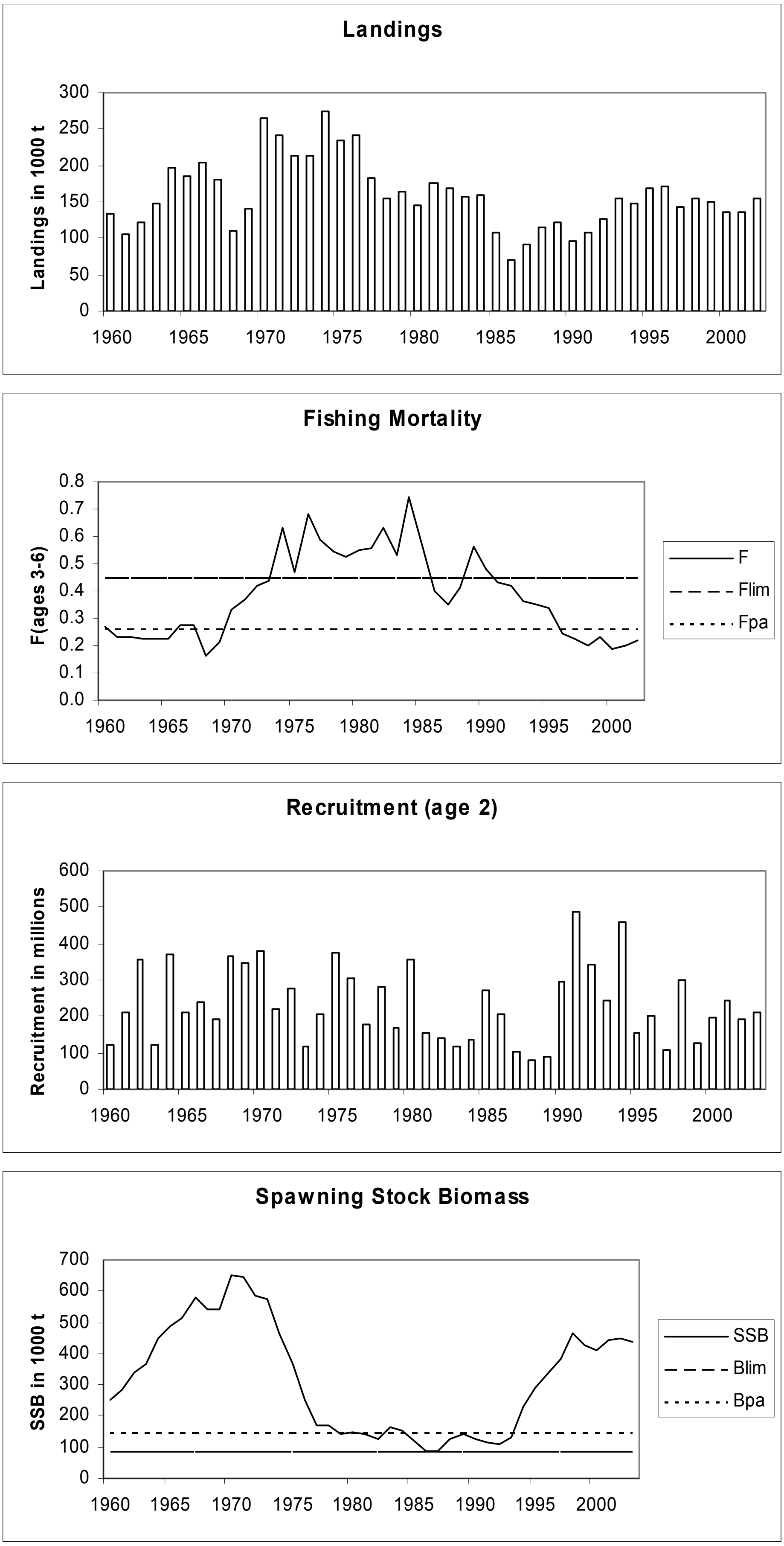


Figure 5.6 Northeast Arctic saithe (Subareas I and II)

Table C.1 Northeast Arctic saithe. Catches splitted on vessels with catch < 100 t and > 100 t, and number of vessels with catch > 100 t scaled by total purse seine catch

Year	No. of vessels with catch < 100 (t)	No. of vessels with catch > 100 (t)	No. of vessels with catch total	No. of vessels in % with catch < 100 (t)	No. of vessels in % with catch > 100 (t)	Catch from vessel with catch < 100 (t)	Catch from vessel with catch > 100 (t)	Catch from vessel with catch total	Catch in % by vessel < 100 (t)	Catch in % by vessel > 100 (t)	Catch per vessel by vessel < 100 (t)	Catch per vessel by vessel > 100 (t)	effort, by vessel>100(t) scaled to total
1989	160	109	269	59%	41%	4,164.8	44,308.7	48,473.5	9%	91%	26.0	406.5	119.2
1990	110	51	161	68%	32%	2,340.7	22,277.5	24,618.2	10%	90%	21.3	435.8	56.4
1991	105	92	197	53%	47%	2,568.5	36,329.4	38,897.9	7%	93%	24.5	394.9	98.5
1992	89	80	169	53%	47%	2,670.7	24,206.3	26,877.0	10%	90%	30.0	302.6	88.8
1993	41	69	110	37%	63%	1,319.4	31,831.5	33,150.9	4%	96%	32.2	461.3	71.9
1994	56	75	131	43%	57%	1,601.3	27,746.3	29,347.6	5%	95%	28.6	370.0	79.3
1995	72	48	120	60%	40%	1,762.7	20,137.6	21,900.3	8%	92%	24.5	419.5	52.2
1996	83	79	162	51%	49%	1,653.7	45,194.5	46,848.2	4%	96%	19.9	572.1	81.9
1997	69	88	157	44%	56%	1,942.7	42,357.8	44,300.5	4%	96%	28.2	481.3	92.0
1998	193	118	311	62%	38%	4,141.5	40,234.0	44,375.5	9%	91%	21.5	341.0	130.1
1999	213	115	328	65%	35%	5,314.0	33,885.0	39,199.0	14%	86%	24.8	293.8	133.0
2000	200	102	302	66%	34%	5,308.0	22,922.0	28,230.0	19%	81%	26.5	224.7	125.6
2001	215	87	302	71%	29%	4,715.0	23,396.0	28,111.0	17%	83%	21.9	268.9	104.5
2002 [1]	229	68	297	77%	23%	3,435.0	23,995.0	27,430.0	13%	87%	15.0	352.9	77.7
Mean	131.1	84.4	215.4	58%	42%	3,067.0	31,344.4	34,411.4	9%	91%	24.6	380.4	93.7

[1] Provisional figures.

Table C.2 Northeast Arctic saithe. Trawl CPUE by agegroup.
Catch in numbers per trawlhour.

Year	Agegroup								
	effort	3	4	5	6	7	8	9	10
1993	1	91.3	338.6	376.7	59.5	23.4	23.7	10.9	15.5
1994	1	8.1	136.9	395.6	260.4	37.4	8.2	4.2	5.6
1995	1	40.8	200.4	293.8	359.1	65.8	11.1	1.2	3.0
1996	1	27.3	140.3	139.5	205.6	293.0	32.9	8.5	0.2
1997	1	49.1	65.7	371.4	194.1	183.4	112.0	16.9	3.0
1998	1	3.3	33.0	55.3	244.0	93.1	56.6	16.1	7.8
1999	1	15.6	37.7	105.5	80.0	187.5	43.0	30.8	9.2
2000	1	9.4	71.5	78.7	170.1	100.2	156.2	44.5	56.0
2001	1	8.3	50.2	276.4	194.4	183.1	77.1	109.9	48.4
2002 [2]	1	11.2	80.0	122.7	396.0	84.9	78.9	39.5	68.2

[2] Provisional figures.

Table C.3 Northeast Arctic saithe. Acoustic abundance indices from Norwegian surveys in October-November. In 1985 - 1987 the area was incomplete. Numbers in millions.

Year	Age					
	2	3	4	5	6+	Total
1985	3.1	4.9	2.4	0.5	0.0	10.9
1986	19.5	40.8	3.6	1.8	1.8	67.5
1987	1.8	22.0	48.4	1.8	1.7	75.7
1988	15.7	22.5	19.0	7.1	0.6	64.9
1989	24.8	28.4	17.0	10.1	12.4	92.7
1990	99.6	31.9	14.7	5.1	7.4	158.7
1991	87.8	104.0	4.6	4.0	7.1	207.5
1992	163.5	273.6	57.5	6.2	8.8	509.6
1993	106.9	227.7	103.9	12.7	3.2	454.4
1994	34.4	87.8	112.4	39.5	10.0	284.1
1995	38.7	165.2	87.0	46.8	20.0	357.7
1996	37.0	118.9	214.7	32.1	19.3	422.0
1997	5.1	36.7	185.8	79.8	61.7	369.1
1998	43.6	96.5	200.6	70.0	96.7	507.4
1999	61.1	233.8	72.9	62.2	47.8	477.8
2000	164.8	142.5	176.3	11.6	26.5	521.7
2001	104.7	275.9	45.9	53.8	20.1	500.4
2002	21.9	206.1	88.1	18.2	14.9	349.2

Table C.4 Northeast Arctic saithe. Acoustic abundance indices from Norwegian coast and fjord surveys by Fiskeriforskning, using ALKs from IMR's survey the same year. Numbers in thousands. Only inner parts of areas A,C and D (which are not covered by IMR) are included.

	agegroup											
Year	1	2	3	4	5	6	7	8	9	10	6+	Total
1995	680	13686	33703	9365	5695	2404	1342	708	110	171	4735	67865
1996	453	8332	21694	39385	7477	9440	3868	1249	0	0	14556	91897
1997	713	3410	7249	25713	7163	3741	2001	727	66	114	6648	50896
1998	1561	4451	3277	4260	1562	1257	1027	1854	378	332	4848	19958
1999	305	1166	14044	1869	4916	1790	3098	4414	991	511	10804	33104
2000	0	6170	6617	9221	1463	4963	1565	1504	1163	8585	17780	41251
2001	0	13036	18232	7494	7523	2249	2799	1067	2404	7728	16247	62532
2002	303	1591	3225	1792	1052	3640	1430	1825	1370	1718	9984	17947

6 SEBASTES *MENTELLA* (DEEP-SEA REDFISH) IN SUBAREAS I AND II

6.1 Status of the Fisheries

6.1.1 Historical development of the fishery

A description of the historical development of the fishery is found in the Quality handbook for this stock (see Annex….).

Since 1 January 2003 the regulations for this stock have been enlarged since from this date all directed trawl fishery for redfish (both *S. marinus* and *S. mentella*) outside the permanently closed areas is forbidden in the Norwegian Economic Zone north of 62°N and in the Svalbard area. When fishing for other species it is legal to have up to 20% redfish (both species together) in round weight as by-catch per haul and on board at any time.

6.1.2 Landings prior to 2003 (Tables 6.1–6.4, D1-D2)

Nominal catches of *S. mentella* by country for Subareas I and II combined are presented in Table 6.1, and for both redfish species (i.e., *S. mentella* <u>and</u> *S. marinus*) in Table D1. The nominal catches by country for Subarea I and Divisions IIa and IIb are shown in Tables 6.2–6.4.

After a continuous decrease in the total landings from 48,727 t in 1991 to a historical low at about 8,000 t in 1996 and 1997. Apart from a temporary increase of 18,434 t in 2001, caused by Norwegian trawlers obtaining very good catch rates along the continental slope outside the closed areas in winter 2001, the catches decreased to 7,022 t in 2002.

The redfish population in Subarea IV (North Sea) is believed to belong to the Northeast Arctic stock. Since this area is outside the traditional areas handled by this Working Group, the catches are not included in the assessment. The total redfish landings from Subarea IV have been 1,000–3,000 t per year, and show a preliminary landing of about 1,000 t in 2002 (Table D2).

6.1.3 Expected landings in 2003

There will be no directed fishery for *S. mentella* in 2003, and in addition, the legal by-catch percentage has been reduced from 25% (previous regulations for northern areas only) to 20% (new regulations for all areas) from 2003 onwards. Based on these new strengthened regulations, and reports from the first months in 2003, the total landings of *S. mentella* for 2003 are expected to be **3,000 t**.

6.2 Data used in the Assessment

All input data sets were updated up to and including 2002.

6.2.1 Fishing effort and catch-per-unit-effort (Table D3, Figure 6.8)

CPUEs (catch per hour trawling) from Russian BMRT-trawlers fishing in ICES Division IIa in March-May 1975-2002, representative for the directed Russian fishery accounting for 60-80% of the total Russian catch, are plotted in Figure 6.8. The Working Group considers that the Russian trawl CPUE series do not represent the trend in stock size but is more a reflection of stock density. This is because the fishery on which these data are based since 1996 was carried out by one or two vessels on localised concentrations in the Kopytov area southwest of Bear Island. In 2002, no BMRT-trawlers were fishing, and CPUE from the PST-trawlers have therefore been converted to BMRT-units (based on historic comparisons of these trawler types) in order to maintain the time-series. Figure 6.8 shows a considerable drop in the CPUE from 2001 to 2002, which probably is influenced by an increased effort (15-20 vessels).

6.2.2 Catch-at-age (Table 6.5)

Catch-at-age for 2000-2001 was revised according to new catch data. Age data for 2002 for *S. mentella* were only available from Norway. Russian length distributions were available from all Subareas/Divisions, and these were converted to age using the total Norwegian age-length key from trawl. The landings from other countries were distributed on age according to the Norwegian age distribution.

The Norwegian fishery along the slope outside Lofoten in winter 2001 was composed of fish older than 18 years, making a big plus-group in the catch-at-age matrix. Although this area also was open for fishing in 2002, the trawlers did not find similar *S. mentella* concentrations.

6.2.3 Weight-at-age (Table 6.6)

Catch weight-at-age data for 2002 were available from Norway (Table 6.6). The weight-at-age in the stock was set equal to the weight-at-age in the catch. It should be investigated further whether it would be better to use a constant weight-at-age series (e.g., based on survey information) instead of catch weight-at-age which may vary due to changes and selections in the fisheries and not due to growth changes in the stock.

6.2.4 Maturity-at-age (Tables 6.7 and D9)

Age-based maturity ogives for *S. mentella* (sexes combined) were available for 2000 and 2001 from Russian research vessel observations in spring. For 2002, when the Russian research vessel did not get access to the survey area, a weighted (by sample size) average of the 2000 and 2001 data was used.

6.2.5 Survey results (Tables A14, D4-D8, Figures 6.1–6.7)

The results from the following research vessel survey series were evaluated by the Working Group:

1) The international 0-group survey in the Svalbard and Barents Sea areas in August-September (Table A14 and Figure 6.1).
2) Russian bottom trawl survey in the Svalbard and Barents Sea areas in October-December from 1978–2001 in fishing depths of 100–900 m (Table D4, Figure 6.2).
3) Norwegian Svalbard (Division IIb) bottom trawl survey (August-September) from 1986–2002 in fishing depths of 100–500 m. Data disaggregated by age only for the years 1992–2002 (Table D5a,b and Figure 6.3a,b).
4) Norwegian Barents Sea bottom trawl survey (February) from 1986–2003 (joint with Russia since 2000) in fishing depths of 100–500 m. Data disaggregated by age only for the years 1992–2003 (Tables D6a,b and Figures 6.4a,b).

Although the Norwegian Svalbard (August-September) and Barents Sea (February) groundfish surveys are conducted at different times of the year and may overlap in the south of Bear Island area, the two series can be combined to get an approximate total estimate for the whole area. This has been done in Figures 6.5a,b.

5) A new Norwegian survey designed for redfish and Greenland halibut covers the Norwegian Economic Zone (NEZ) and Svalbard incl. north and east of Spitsbergen in August 1996-2002 from less than 100 m to 500 m depth (Table D7, Figure 6.6). This survey includes survey no. 3 above.
6) Russian acoustic survey in April-May from 1992–2001 (except 1994 and 1996) on *S. mentella* spawning grounds in the western Barents Sea (Table D8, Figure 6.7).

A considerable reduction in the abundance of 0-group redfish has been observed since 1991: abundance decreased to only 20% of the 1979–1990 average. With the exception of an abundance index of twice the 1991-level in 1994, the indices have remained very low. Record low levels of less than 20% of the 1991–1995 average have been observed for the 1996-1999 year classes. The 2000 year class was stronger than the preceding four year classes, whereas the estimate of the 2001 and 2002 year classes are among the lowest on record.

The Norwegian Svalbard groundfish survey in August-September (Table D5a,b and Figures 6.3a,b), with age disaggregated data from 1992 onwards, shows some relatively good year classes (1988–1990) followed by weak ones after 1991.

Since 1981, a stratified bottom trawl survey, targeted for cod and haddock, has been carried out by Norway in February in the Barents Sea, and joint with Russia since 2000. The results for *S. mentella* are available by length from 1986–2003 and are age disaggregated from 1992 onwards (Tables D6a,b and Figures 6.4a,b). Also in this survey the 1988–1990 year classes (possibly also the 1987 year class) are stronger than the adjacent ones. In this survey the 1991–1992 year classes are poor, while the 1993–1995 year classes which seemed to be at an intermediate level as 1-3 year olds have decreased since then and must now be considered poor.

In the Russian bottom trawl survey the most recent estimates are among the lowest observed (Table D4, Figure 6.2). The overall picture of the relative strength of the year classes is, however, very similar in the Russian and Norwegian surveys.

The decrease in the abundance of young redfish in the surveys is consistent with the decline in the consumption of redfish by cod from 1995 onwards (Tables 1.3, 1.4 and Figure 6.5a).

Russian acoustic surveys estimating the commercial sized and mature part of the *S. mentella* stock have been conducted in April-May on the Malangen, Kopytov, and Bear Island Banks since 1986. Table D8 shows a 43% decrease in the estimated spawning stock biomass in 1997 to a low level that was observed up to 2000 inclusive. The strong 1982-year class migrating west-southwest and out of the surveyed area could explain this. The next year classes expected to contribute significantly to the spawning stock (i.e., the 1987–1990 year classes) are now more than 50% mature (males before females), and these year classes contributed in the 2001 survey to a three fold increase in the survey abundance of mature fish (Table D8, Figure 6.7). This is the only survey targeting commercial sized *S. mentella*, but only a limited area of its distribution. In 2002 it was unfortunately impossible to run this survey due to denied access to the NEZ.

6.3 Results of the Assessment (Tables 6.8-6.14 , Figures 6.9-6.11)

All available information since last year's assessment confirms the poor condition of this stock. The surveys indicate that recruitment continues to decline.

Length and age data from Norwegian and Russian surveys show that the 1982 and 1983 year classes are stronger than those just before and after. The 1988–1990 year classes (possibly also the 1987 year class) appear to be at a similar level to those of 1982–1983. The 0-group survey indicates at present record low levels of *S. mentella*. There is no doubt that the recruitment to the fishable biomass will be poor after a short period of expected increase in the fishable stock due to the 1987–1990 year classes.

Any improvement of the stock condition is not expected until a significant increase in spawning stock biomass has been detected in surveys with a following increase in the number of juveniles. As long as the recruitment of new year classes is very poor and no signs of improved recruitment have appeared, it is of crucial importance that the 1987–1990 year classes (approx. 30–36 cm) which currently have recruited more than 50% to the spawning stock are protected.

It is also of vital importance that the younger recruiting year classes be given the strongest possible protection from being taken as by-catch in any fishery, e.g., the shrimp fisheries in the Barents Sea and Svalbard area. This will ensure that they can contribute as much as possible to the stock rebuilding.

The Working Group has previously been asked by ACFM to provide results of exploratory XSA analyses. A XSA was run with settings similar to recent years. Only fishery independent tuning series were included, and the time-series was reduced due to changed age reading method in 1991 and improved surveys since then. Standard errors of log catchability at age for the different fleets used for tuning the XSA are shown in graphically in Figure 6.9. Log catchability residuals are shown in Figure 6.10 for single fleet runs.

Although the two Norwegian survey series covering the Barents Sea in winter and Svalbard in summer extend 4 more years back in time than the new Norwegian survey, last year's working group rejected these series as they produced an unlikely stock development. This is caused most probably by their limited area coverage, partly overlapping, and therefore not easy to combine directly.

Input tuning data for the final exploratory run are given in Table 6.8. Results from the exploratory XSA runs, excluding ages 12-16 from the new Norwegian survey (F14), are shown in Figure 6.11, and the diagnostics are presented in Table 6.9. The XSA output results are shown in Tables 6.10-6.14. The handling of the plus-group in the XSA leads to contradictory results, i.e., the low F on the oldest true age group (F-old) in 2000 generates a higher plus-group biomass than the very large plus-group in the catches of 2001, accounting for ca. 50% of the catch-in-numbers. To overcome this problem and to get a picture of the SSB, a traditional VPA was used to calculate the plus-group. The input of F-old was iterated to F10-16, assuming a flat fishing pattern, and the F-at-age for 2002 from the XSA was used as input for the Fs in the last year.

The results from the traditional/standard VPA are plotted in Figure 6.11. The results suggest a spawning stock level about 50% of the level in the early 1990s.

6.4 Comments to the assessment

An expected increase in the fishable stock due to the last strong year classes 1987-1990 observed in the research surveys is not showing up in the exploratory XSA/VPA run, neither in the Russian trawl fishery. It is difficult to interpret the increase (Figure 6.8) in the Russian catch rates of 11-15 year old fish in 2000-2001 in relation to the stock development, since the catch rates decreased again in 2002 when more effort was used (15-20 vessels). Preliminary survey data on *S. mentella* from the Greenland halibut survey along the western slope of the Barents Sea deeper than 400 m from 68N to 80N show lower abundance in 2002. It is therefore highly recommended to produce survey maps to visualize any specific migration pattern of the *S. mentella* to better explain why the shown increase of 12 years and older fish in some surveys do not show up in other data series.

The trawlers did not find similar concentrations of plus-group *S. mentella* in 2002 compared to the year before. The current most likely explanation for this temporary increase is therefore that these old fish may migrate in from the Norwegian Sea and settle on the fishing grounds along the continental slope some years. However, this is probably only a minor buffer to the stock as long as the recruitment to the stock, as observed by surveys expected to cover the entire nursery area, is critically low.

The Working Group would like to repeat its request to ACFM to have a closer look at the algorithm for how a plus-group is or may be handled by XSA, e.g., an age group specific shrinkage option would probably be one of several possibilities to reduce this technical problem. This matter is especially important for long-lived species and in cases where the relative contribution from plus-group fish may vary from year to year due to migration in and out of an 'assessment-area'.

The survey tuning series may still be improved further, and it is imperative for good results that valuable research survey time-series are continued, and that Norwegian and Russian research vessels get full access to each other's exclusive economic zones.

Possible alternative methods to conventional catch-at-age analyses, such as the FLEKSIBEST model, have previously been discussed also for this redfish stock. This model is closely related to the BORMICON model which currently is used by the ICES North-Western WG on *S. marinus* (Björnsson and Sigurdsson 2003). Preparatory work may be done in order to explore these possibilities.

6.5 Biological reference points

Until an analytical assessment can be accepted and used as basis for reference points calculations, candidate reference points for the biomass or numbers (U_{lim}) could be set at the maximum biomass (or number) level, or at a certain percentage of this level, estimated by the Russian and Norwegian trawl surveys since 1986. Such practice is currently used by ICES for the Icelandic redfish stocks (ICES CM 2002/ACFM:20) and is a procedure mentioned and recommended as an alternative by the ICES Study Groups on the Precautionary Approach.

6.6 Management advice

ICES recommended last year that there be no directed fishery on this stock until a significant increase in spawning stock biomass has been detected in surveys with a following increase in the number of juveniles. In addition, the by-catch of redfish in other fisheries should be reduced to the lowest possible level. The current assessment indicates no improvement in recruitment while a stabilizing or temporary increase of the SSB is expected if the catches are kept low.

As long as the recruitment of new year classes is very poor and no signs of improved recruitment have appeared, it is of crucial importance and urgent that the 1987–1990 year classes (approx. 30–36 cm) which currently have recruited more than 50% to the spawning stock are protected. The Working Group is therefore satisfied with the stronger regulations enforced in the trawl fisheries from 1 January 2003 onwards.

It is also of vital importance that the younger recruiting year classes be given the strongest possible protection to ensure that they can contribute as much as possible to the stock rebuilding.

Therefore the same advice should be maintained for 2004. Given the current depleted state of the stock it is imperative that data collection and surveys be maintained in order to monitor the progress of the resource.

Table 6.1 *Sebastes mentella*. Nominal catch (t) by countries in Subarea I, Divisions IIa and IIb combined.

Year	Canada	Denmark	Faroe Islands	France	Germany[3]	Greenland	Ireland
1986	-	-	-	-	1,252	-	-
1987	-	-	200	63	1,321	-	-
1988			No species-specific data available by country.				
1989	-	-	335	1,111	3,833	-	-
1990	-	-	108	142	6,354	36	-
1991	-	-	487	85	-	23	-
1992	-	-	23	12	-	-	-
1993	8	4	13	50	35	1	-
1994	-	28	4	74	18	1	3
1995	-	-	3	16	176	2	4
1996	-	-	4	75	119	3	2
1997	-	-	4	37	81	16	6
1998	-	-	20	73	100	14	9
1999	Iceland	-	73	26	202	50	3
2000	48	Estonia	50	63	62	11	7
2001[1]	3	-	52	16	198	17	4
2002[1]	41	15	53	56	99	18	4

Year	Norway	Poland	Portugal	Russia[4]	Spain	UK (Eng. & Wales)	UK (Scotland)	Total
1986	1,274	-	1,273	17,815	-	84	-	23,112[2]
1987	1,488	-	1,175	6,196	25	49	1	10,455
1988			No species-specific data available by country.					15,586
1989	4,633	-	340	13,080	5	174	1	23,512
1990	10,173	-	830	17,355	-	72	-	35,070
1991	33,592	-	166	14,302	1	68	3	48,727
1992	10,751	-	972	3,577	14	238	3	15,590
1993	5,182	-	963	6,260	5	293	-	12,814
1994	6,511	-	895	5,021	30	124	12	12,721
1995	2,646	-	927	6,346	67	93	4	10,284
1996	6,053	-	467	925	328	76	23	8,075
1997	4,657	1	474	2,972	272	71	7	8,598
1998	9,733	13	125	3,646	177	93	41	14,045
1999	7,884	6	65	2,731	29	112	28	11,209
2000	6,151[1]	2	115	3,519	87		130[5]	10,245
2001	13,975[1]	5	179	3,775	90		120[5]	18,434
2002[1]	2,204	8	242	3,904	190		188[5]	7,022

[1] Provisional figures.
[2] Including 1,414 tonnes in Division IIb not split on countries.
[3] Includes former GDR prior to 1991.
[4] USSR prior to 1991.
[5] UK(E&W)+UK(Scot.)

Table 6.2 *Sebastes mentella*. Nominal catch (t) by countries in Subarea I.

Year	Faroe Islands	Germany[4]	Greenland	Norway	Russia[5]	UK(Eng. &Wales)	Iceland	Total
1986[3]	-	-	-	1,274	911	-	-	2,185
1987[3]	-	2	-	1,166	234	3	-	1,405
1988			No species-specific data presently available					
1989	13	-	-	60	484	9[2]	-	566
1990	2	-	-	-	100	-	-	102
1991	-	-	-	8	420	-	-	428
1992	-		-	561	408	-	-	969
1993	2[2]	-	-	16	588	-	-	606
1994	2[2]	2	-	36	308	-	-	348
1995	2[2]	-	-	20	203	-	-	225
1996	-	-	-	5	101	-	-	106
1997	-	-	3[2]	12	174	1[2]	-	190
1998	20[2]	-	-	26	378	-	-	424
1999	69[2]	-	-	69	489	-	-	627
2000	-	-	-	43[1]	406	-	48[2]	497
2001	-	-	-	8[1]	296	-	3[2]	307
2002[1]	-	-	-	12	587	-	.	599

[1] Provisional figures.
[2] Split on species according to reports to Norwegian authorities.
[3] Based on preliminary estimates of species breakdown by area.
[4] Includes former GDR prior to 1991.
[5] USSR prior to 1991.

Table 6.3 *Sebastes mentella*. Nominal catch (t) by countries in Division IIa.

Year	Faroe Islands	France	Germany[4]	Greenland	Ireland	Norway
1986[3]	-	-	1,252	-	-	-
1987[3]	200	63	970	-	-	149
1988		No species-specific data presently available				
1989	312[2]	1,065[2]	3,200	-	-	4,573
1990	98[2]	137[2]	1,673	-	-	8,842
1991	487[2]	72[2]	-	-	-	32,810
1992	23[2]	7[2]	-	-	-	9,816
1993	11[2]	15[2]	35	1[2]	-	5,029
1994	2[2]	33[2]	16[2]	1[2]	2[2]	6,119
1995	1[2]	16[2]	176[2]	2[2]	2[2]	2,251
1996	-	75[2]	119[2]	3[2]	-	5,895
1997	-	37[2]	77	12[2]	2[2]	4,422
1998	-	73[2]	58[2]	14[2]	6[2]	9,186
1999	-	16[2]	160[2]	50[2]	3[2]	7,358
2000	50[2]	58[2]	35[2]	11[2]	-	5,975[1]
2001[1]	33[2]	12[2]	161[2]	17[2]	4[2]	13,673[1]
2002[1]	14[2]	52[2]	59[2]	18[2]	3[2]	1,990

Year	Portugal	Russia[5]	Spain	UK(Eng. & Wales)	UK (Scotland)	Total
1986[3]	1,273	16,904	-	84	-	19,513
1987[3]	1,156	4,469	-	34	1	7,042
1988		No species-specific data presently available				
1989	251	9,749	-	158[2]	1[2]	19,309
1990	824	6,492	-	9	-	18,075
1991	159[2]	7,596	-	23[2]	-	41,147
1992	824[2]	1,096	-	27[2]	-	11,793
1993	648[2]	5,328	-	2[2]	-	11,069
1994	687[2]	4,692	8[2]	4[2]	-	11,564
1995	715[2]	5,916	65[2]	41[2]	2[2]	9,187
1996	429[2]	677	5[2]	42[2]	19[2]	7,264
1997	410[2]	2,341	9[2]	48[2]	7[2]	7,365
1998	118[2]	2,626	55[2]	65[2]	41[2]	12,242
1999	56[2]	1,340	14[2]	94[2]	26[2]	9,117
2000	98[2]	2,167	18[2]	Iceland	103[2, 6]	8,515
2001	105[2]	2,716	18[2]	-	95[2, 6]	16,834
2002[1]	124[2]	2,615	8[2]	41[2]	157[2, 6]	5,081

[1] Provisional figures.
[2] Split on species according to reports to Norwegian authorities.
[3] Based on preliminary estimates of species breakdown by area.
[4] Includes former GDR prior to 1991.
[5] USSR prior to 1991.
[6]UK(E&W)+UK(Scot.)

Table 6.4 *Sebastes mentella*. Nominal catch (t) by countries in Division IIb.

Year	Canada	Denmark	Faroe Islands	France	Germany[5]	Greenland	Ireland
1986[4]	Data not available on countries						
1987[4]	-	-	-	-	349	-	-
1988	No species-specific data presently available						
1989	-	-	10	28	633	-	-
1990	-	-	8[2]	5[2]	4,681	36[2]	-
1991	-	-	-	13[2]	-	23	-
1992	-	-	-	5[2]	-	-	-
1993	8[2]	4[2]	-	35[2]	-	-	-
1994	-	28[2]	-	41[2]	-	-	1[2]
1995	-	-	-	-	-	-	2[2]
1996	-	-	4[2]	-	-	-	2[2]
1997	-	-	4[2]	-	3	1[2]	4[2]
1998	-	-	-	-	42[2]	-	3[2]
1999	-	-	4[2]	10[2]	42[2]	-	-
2000	-	-	-	5[2]	27[2]	-	7[2]
2001[1]	-	-	19[2]	4[2]	37[2]	-	-
2002[1]			39[2]	4[2]	40[2]		1[2]

Year	Norway	Poland	Portugal	Russia[6]	Spain	UK(Eng. & Wales)	UK (Scotland)	Total
1986[4]	Data not available on countries							1,414
1987[4]	173	-	19	1,493	25	12	-	2,071
1988	No species-specific data presently available							
1989	-	-	89	2,847	5	7[2]	-	3,619
1990	1,331	-	6	10,763	-	63[2]	-	16,893
1991	774	-	7	6,286	1	45[2]	3[2]	7,152
1992	374	-	148[2]	2,073	14	211[2]	3[2]	2,828
1993	137	-	315[2]	344	57[3]	291[2]	-	1,191
1994	356	-	208[2]	21	22[3]	120[2]	12[2]	809
1995	375	-	212[2]	227	2[3]	52[2]	2[2]	872
1996	153	-	38[2]	147	323[2]	34[2]	4[2]	705
1997	223	1[2]	64[2]	457	263[2]	22[2]	-	1,042
1998	521	13[2]	7[2]	642	122[2]	28[2]	1[2]	1,379
1999	457	6[2]	9[2]	902	15[2]	18[2]	2[2]	1,465
2000	133[1]	2[2]	17[2]	946	69[2]		27[2, 7]	1,233
2001	294[1]	5[2]	74[2]	763	72[2]	Estonia	25[2, 7]	1,293
2002[1]	202	8[2]	118[2]	702	182[2]	15[8]	31[2, 7]	1,342

[1] Provisional figures.
[2] Split on species according to reports to Norwegian authorities.
[3] Split on species according to the 1992 catches.
[4] Based on preliminary estimates of species breakdown by area.
[5] Includes former GDR prior to 1991.
[6] USSR prior to 1991.
[7]UK(E&W)+UK(Scot.)
[8]Split on species by Working Group.

Table 6.5. Catch numbers at age

Run title : Arctic S. mentella
At 30/04/2003 16:24
Catch numbers at age Numbers*10**-3

YEAR	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
AGE										
6	1653	1873	159	738	662	223	125	37	9	1
7	5453	2498	159	730	941	634	533	882	83	24
8	7994	1898	174	722	1279	1699	1287	2904	441	397
9	6781	1622	512	992	719	1554	1247	4236	1511	1259
10	8226	1780	2094	2561	740	1236	1297	3995	2250	2485
11	5344	1531	3139	2734	1230	1078	1244	2741	3262	2160
12	6227	2108	2631	3060	2013	1146	876	1877	1867	1838
13	9880	2288	2308	1535	4297	1413	1416	1373	1454	1214
14	10824	2258	2987	2253	3300	1865	1784	1277	1447	1016
15	4049	2506	1875	2182	2162	880	1217	1595	1557	1004
16	2105	2137	1514	3336	1454	621	537	1117	1418	948
17	9603	1512	1053	1284	757	498	1177	784	1317	511
18	6522	677	527	734	794	700	342	786	658	606
+gp	19299	9258	6022	3257	2404	2247	3568	6241	3919	5827
TOTALNUM	103960	33946	25154	26118	22752	15794	16650	29845	21193	19290
TONSLAND	48727	15590	12866	12721	10284	8075	8597	14045	11209	10245
SOPCOF %	100	103	101	104	100	95	101	101	102	101

Table 6.6. Catch weights at age

Run title : Arctic S. mentella
At 30/04/2003 16:24
Catch weights at age (kg)

YEAR	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
AGE										
6	0.13	0.19	0.17	0.16	0.14	0.2	0.18	0.14	0.15	0.1
7	0.18	0.22	0.23	0.22	0.16	0.2	0.21	0.19	0.22	0.15
8	0.21	0.26	0.25	0.24	0.19	0.25	0.25	0.23	0.22	0.22
9	0.27	0.28	0.28	0.3	0.21	0.31	0.29	0.29	0.28	0.26
10	0.34	0.31	0.33	0.34	0.28	0.42	0.33	0.33	0.33	0.31
11	0.35	0.33	0.38	0.37	0.32	0.44	0.38	0.38	0.37	0.36
12	0.42	0.38	0.44	0.4	0.37	0.47	0.46	0.43	0.44	0.42
13	0.46	0.46	0.47	0.44	0.41	0.59	0.48	0.48	0.49	0.44
14	0.51	0.43	0.5	0.45	0.47	0.67	0.51	0.54	0.53	0.51
15	0.58	0.43	0.57	0.49	0.53	0.69	0.55	0.59	0.56	0.56
16	0.59	0.45	0.58	0.55	0.58	0.71	0.6	0.61	0.62	0.62
17	0.58	0.52	0.62	0.58	0.66	0.74	0.66	0.64	0.66	0.63
18	0.59	0.57	0.65	0.67	0.71	0.74	0.65	0.66	0.67	0.67
+gp	0.7	0.67	0.662	0.79	0.806	0.847	0.787	0.753	0.805	0.774
SOPCOFAC	1.0032	1.0291	1.0052	1.0377	0.9998	0.9465	1.0103	1.0085	1.0184	1.0065

Table 6.7. Proportion mature at age

Run title : Arctic S. mentella
At 30/04/2003 16:24
Proportion mature at age

YEAR	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
AGE										
6	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0.018	0.021	0	0
8	0.015	0.015	0	0	0	0	0	0.014	0.016	0
9	0.055	0.062	0.023	0.023	0	0.014	0.027	0	0.059	0.048
10	0.132	0.133	0.113	0.113	0.055	0.093	0.13	0.074	0.11	0.087
11	0.202	0.224	0.267	0.267	0.111	0.212	0.312	0.171	0.333	0.202
12	0.481	0.411	0.438	0.438	0.368	0.325	0.281	0.276	0.579	0.375
13	0.545	0.539	0.574	0.574	0.587	0.577	0.566	0.622	0.689	0.489
14	0.741	0.774	0.843	0.843	0.696	0.716	0.736	0.714	0.788	0.742
15	0.85	0.888	0.951	0.951	0.729	0.78	0.831	0.871	0.813	0.833
16	0.962	0.946	0.92	0.92	0.789	0.874	0.958	0.919	0.903	0.904
17	1	0.992	0.989	0.989	1	0.975	0.95	1	0.923	1
18	1	1	1	1	1	1	1	1	1	1
+gp	1	1	1	1	1	1	1	1	1	1

Table 6.8. Tuning data

Sebastes mentella in Sub-areas I & II
103
FLT10: Rus young SURVEY. Effort and catch rates. S.mentella (Catch: Number) (Effort: Unknown)
1991 2002
1 1 0.85 0.95
6 8

1	17	22	40
1	21	17	24
1	20	12	6
1	86	106	56
1	40	112	96
1	115	66	28
1	39	65	66
1	20	33	55
1	30	23	46
1	52	42	49
1	35	43	26
1	10	34	31

FLT13: Rus acous spring survey (Catch: Number) (Effort: Unknown)
1995 2002
1 1 0.30 0.50
6 14

1	51	83	90	41	31	31	41	94	73
-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
1	24	102	150	53	48	24	20	26	36
1	8	47	77	63	71	46	27	19	23
1	9	14	57	75	63	73	31	25	17
1	14	15	62	100	143	122	54	34	24
1	11	22	24	84	123	134	144	115	78
-1	-1	-1	-1	-1	-1	-1	-1	-1	-1

FLT14: Norw New Combined
1996 2002
1 1 0.58 0.68
2 11

1	146,198	112742	22353	53507	165531	181980	108738	43328	65310	40546
1	62,682	130816	12492	23452	74342	55880	76607	82503	17640	14274
1	313	78767	85715	39849	25805	23413	84825	100332	54287	24329
1	5,359	23240	117170	47851	41608	76797	128677	73306	58018	64781
1	5,964	23169	14336	19960	52666	68081	83857	77513	100442	72294
1	5,026	6541	10957	1093	19766	25591	36594	51644	44407	61704
1	9,112	6646	7379	3821	8635	28215	47456	63903	103368	49964

Table 6.9. Tuning diagnostics

Lowestoft VPA Version 3.1
30/04/2003 16:23
Extended Survivors Analysis
Arctic S. mentella
CPUE data from file fleet-final
Catch data for 12 years. 1991 to 2002. Ages 6 to 19.

Fleet	Firs year	Last year	First age	Last age	Alpha	Beta
FLT10: Ru	1991	2002	6	8	0.85	0.95
FLT13: Ru	1995	2002	6	14	0.3	0.5
FLT14: No	1996	2002	2	11	0.58	0.68

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 >= 17
Terminal population estimation :
Survivor estimates shrunk towards the mean F
of the final 2 years or the 5 oldest ages.
S.E. of the mean to which the estimates are shrunk = 2.000
Minimum standard error for population
estimates derived from each fleet = .300
Prior weighting not applied
Tuning converged after 188 iterations
Regression weights

0.751	0.82	0.877	0.921	0.954	0.976	0.99	0.997	1	1

Fishing mortalities

Age	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
6	0.004	0.011	0.008	0.003	0.002	0.001	0	0	0.004	0
7	0.008	0.021	0.016	0.009	0.007	0.017	0.003	0.001	0.01	0.002
8	0.011	0.039	0.042	0.033	0.02	0.045	0.009	0.014	0.02	0.008
9	0.029	0.075	0.045	0.06	0.027	0.077	0.027	0.03	0.039	0.024
10	0.101	0.174	0.066	0.092	0.059	0.103	0.048	0.05	0.025	0.032
11	0.09	0.166	0.107	0.117	0.113	0.152	0.103	0.054	0.04	0.016
12	0.13	0.107	0.159	0.123	0.118	0.224	0.132	0.07	0.078	0.037
13	0.146	0.093	0.192	0.144	0.197	0.245	0.241	0.107	0.124	0.065
14	0.309	0.185	0.265	0.107	0.243	0.245	0.391	0.237	0.218	0.091
15	0.137	0.346	0.243	0.094	0.085	0.317	0.469	0.456	0.724	0.126
16	0.223	0.342	0.364	0.092	0.069	0.094	0.457	0.514	1.496	0.534
17	0.25	0.267	0.108	0.182	0.224	0.122	0.138	0.262	0.821	0.705
18	0.214	0.247	0.235	0.124	0.164	0.205	0.128	0.078	0.748	0.614

XSA population numbers (Thousands)

	AGE									
YEAR	6	7	8	9	10	11	12	13	14	15
1993	4.06E+04	2.19E+04	1.61E+04	1.91E+04	2.29E+04	3.85E+04	2.28E+04	1.79E+04	1.18E+04	1.54E+04
1994	6.97E+04	3.66E+04	1.96E+04	1.44E+04	1.68E+04	1.88E+04	3.18E+04	1.81E+04	1.40E+04	7.83E+03
1995	8.43E+04	6.24E+04	3.24E+04	1.71E+04	1.21E+04	1.28E+04	1.44E+04	2.59E+04	1.49E+04	1.05E+04
1996	8.63E+04	7.57E+04	5.55E+04	2.81E+04	1.48E+04	1.03E+04	1.04E+04	1.11E+04	1.93E+04	1.03E+04
1997	6.19E+04	7.79E+04	6.79E+04	4.86E+04	2.40E+04	1.22E+04	8.26E+03	8.32E+03	8.69E+03	1.57E+04
1998	3.72E+04	5.59E+04	6.99E+04	6.02E+04	4.28E+04	2.04E+04	9.85E+03	6.64E+03	6.18E+03	6.17E+03
1999	3.46E+04	3.36E+04	4.97E+04	6.05E+04	5.04E+04	3.49E+04	1.59E+04	7.13E+03	4.70E+03	4.38E+03
2000	4.23E+04	3.13E+04	3.03E+04	4.45E+04	5.33E+04	4.35E+04	2.85E+04	1.26E+04	5.06E+03	2.88E+03
2001	3.00E+04	3.83E+04	2.83E+04	2.71E+04	3.91E+04	4.59E+04	3.73E+04	2.40E+04	1.02E+04	3.62E+03
2002	9.41E+03	2.70E+04	3.43E+04	2.51E+04	2.36E+04	3.45E+04	3.99E+04	3.12E+04	1.92E+04	7.45E+03

Estimated population abundance at 1st Jan 2003

0.00E+00	8.52E+03	2.44E+04	3.08E+04	2.22E+04	2.06E+04	3.07E+04	3.48E+04	2.65E+04	1.59E+04

Table 6.9. (Continued)

Taper weighted geometric mean of the VPA populations:

3.92E+04	3.99E+04	3.62E+04	3.22E+04	2.87E+04	2.44E+04	1.93E+04	1.48E+04	1.10E+04	7.54E+03

Standard error of the weighted Log(VPA populations) :

0.6421	0.4512	0.47	0.5054	0.5144	0.5388	0.5579	0.5647	0.5609	0.5757

	AGE		
YEAR	16	17	18
1993	7.95E+03	5.00E+03	2.88E+03
1994	1.21E+04	5.76E+03	3.52E+03
1995	5.01E+03	7.79E+03	3.99E+03
1996	7.47E+03	3.15E+03	6.33E+03
1997	8.52E+03	6.16E+03	2.38E+03
1998	1.31E+04	7.20E+03	4.46E+03
1999	4.07E+03	1.08E+04	5.77E+03
2000	2.48E+03	2.33E+03	8.48E+03
2001	1.65E+03	1.34E+03	1.62E+03
2002	1.59E+03	3.35E+02	5.34E+02

Estimated population abundance at 1st Jan 2003

5.94E+03	8.42E+02	1.50E+02

Taper weighted geometric mean of the VPA populations:

5.13E+03	3.82E+03	3.45E+03

Standard error of the weighted Log(VPA populations) :

0.7539	1.0528	0.8511

Log catchability residuals.

Fleet : FLT10: Rus young SUR

Age	1991	1992
6	-0.13	0.02
7	-0.2	-0.09
8	0.19	0.04
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	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
6	-0.54	0.39	-0.57	0.46	-0.29	-0.45	0.02	0.37	0.33	0.23
7	-0.62	1.05	0.57	-0.16	-0.2	-0.54	-0.41	0.26	0.09	0.2
8	-1.06	1	1.05	-0.73	-0.09	-0.28	-0.15	0.41	-0.15	-0.17
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	6	7	8
Mean Log	-6.9845	-6.7872	-6.7394
S.E(Log q)	0.384	0.4745	0.6033

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
6	1.1	-0.432	6.64	0.7	12	0.44	-6.98
7	0.99	0.029	6.83	0.48	12	0.5	-6.79
8	1.37	-0.624	5.36	0.25	12	0.85	-6.74

Table 6.9. (Continued)

Fleet : FLT13: Rus acous spr

Age	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
6	99.99	99.99	0.58	99.99	0.14	-0.45	-0.26	-0.02	0.08	99.99
7	99.99	99.99	0.6	99.99	0.58	0.14	-0.56	-0.43	-0.24	99.99
8	99.99	99.99	0.61	99.99	0.37	-0.32	-0.29	0.29	-0.59	99.99
9	99.99	99.99	0.35	99.99	-0.44	-0.47	-0.32	0.28	0.61	99.99
10	99.99	99.99	0.19	99.99	-0.05	-0.22	-0.53	0.24	0.39	99.99
11	99.99	99.99	0.02	99.99	-0.19	-0.04	-0.13	0.14	0.18	99.99
12	99.99	99.99	0.13	99.99	-0.05	0.11	-0.26	-0.32	0.4	99.99
13	99.99	99.99	0.08	99.99	-0.07	-0.14	0.06	-0.25	0.33	99.99
14	99.99	99.99	0.06	99.99	-0.12	-0.23	-0.2	0.01	0.48	99.99

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

Age	6	7	8	9	10	11	12	13	14
Mean Log	-7.9511	-7.1775	-6.4385	-6.3259	-6.0972	-5.9596	-5.8849	-5.5791	-5.228
S.E(Log q)	0.3517	0.5037	0.4713	0.4687	0.3434	0.1475	0.2728	0.2058	0.2641

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
6	0.6	2.164	9.06	0.88	6	0.16	-7.95
7	0.43	7.042	9.2	0.98	6	0.07	-7.18
8	1.05	-0.077	6.24	0.41	6	0.55	-6.44
9	3.89	-2.447	-6	0.16	6	1.28	-6.33
10	1.21	-0.568	5.19	0.66	6	0.45	-6.1
11	0.86	1.599	6.52	0.97	6	0.11	-5.96
12	0.93	0.313	6.14	0.85	6	0.28	-5.88
13	0.84	1.354	6.2	0.95	6	0.16	-5.58
14	0.76	1.212	6.11	0.87	6	0.19	-5.23

Fleet : FLT14: Norw New Comb

Age	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
6	99.99	99.99	99.99	0.61	0.14	-0.41	0.14	0.17	-0.46	-0.13
7	99.99	99.99	99.99	0.75	-0.46	-0.99	0.7	0.64	-0.53	-0.09
8	99.99	99.99	99.99	0.17	-0.39	-0.3	0.44	0.51	-0.25	-0.19
9	99.99	99.99	99.99	-0.1	-0.02	-0.01	-0.36	0	0.1	0.38
10	99.99	99.99	99.99	0.97	-0.84	-0.27	-0.4	0.09	-0.43	0.92
11	99.99	99.99	99.99	0.9	-0.32	-0.28	0.14	0	-0.22	-0.17
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	6	7	8	9	10	11
Mean Log	0.1103	0.1955	0.5823	0.633	0.6384	0.6089
S.E(Log q)	0.3701	0.7001	0.3703	0.2242	0.696	0.417

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
6	0.77	1.456	2.29	0.9	7	0.26	0.11
7	1.57	-0.506	-6.44	0.14	7	1.18	0.2
8	1.39	-0.656	-4.93	0.37	7	0.54	0.58
9	1.65	-2.018	-7.93	0.67	7	0.3	0.63
10	4.88	-1.415	-43.49	0.03	7	3.14	0.64
11	1.4	-1.007	-4.92	0.57	7	0.58	0.61

Table 6.9. (Continued)

Terminal year survivor and F summaries :

Age 6 Catchability constant w.r.t. time and dependent on age

Year class = 1996

Fleet	I	Int	Ext	Var	N	Scaled	Estimated
	:	s.e	s.e	Ratio		Weights	F
FLT10: Rus young SUR	10690	0.402	0	0	1	0.483	0
FLT13: Rus acous spr	1	0	0	0	0	0	0
FLT14: Norw New Comb	7452	0.396	0	0	1	0.497	0
F shrinkage mean	918	2				0.02	0.002

Weighted prediction :

Survivors	Int	Ext	N	Var	F
at end of year	s.e	s.e		Ratio	
8517	0.28	0.26	3	0.922	0

Age 7 Catchability constant w.r.t. time and dependent on age

Year class = 1995

Fleet	I	Int	Ext	Var	N	Scaled	Estimated
	:	s.e	s.e	Ratio		Weights	F
FLT10: Rus young SUR	32160	0.312	0.061	0.2	2	0.402	0.001
FLT13: Rus acous spr	26501	0.381	0	0	1	0.27	0.001
FLT14: Norw New Comb	16700	0.35	0.154	0.44	2	0.319	0.002
F shrinkage mean	6853	2				0.01	0.006

Weighted prediction :

Survivors	Int	Ext	N	Var	F
at end of year	s.e	s.e		Ratio	
24393	0.2	0.14	6	0.727	0.002

Age 8 Catchability constant w.r.t. time and dependent on age

Year class = 1994

Fleet	I	Int	Ext	Var	N	Scaled	Estimated
	:	s.e	s.e	Ratio		Weights	F
FLT10: Rus young SUR	36724	0.28	0.15	0.54	3	0.338	0.006
FLT13: Rus acous spr	28022	0.313	0.102	0.33	2	0.271	0.008
FLT14: Norw New Comb	28608	0.263	0.17	0.65	3	0.385	0.008
F shrinkage mean	13840	2				0.007	0.017

Weighted prediction :

Survivors	Int	Ext	N	Var	F
at end of year	s.e	s.e		Ratio	
30800	0.16	0.09	9	0.529	0.008

Age 9 Catchability constant w.r.t. time and dependent on age

Year class = 1993

Fleet	I	Int	Ext	Var	N	Scaled	Estimated
	:	s.e	s.e	Ratio		Weights	F
FLT10: Rus young SUR	23706	0.281	0.105	0.37	3	0.24	0.023
FLT13: Rus acous spr	14998	0.267	0.097	0.36	3	0.266	0.035
FLT14: Norw New Comb	26629	0.198	0.162	0.82	4	0.489	0.02
F shrinkage mean	15441	2				0.005	0.034

Weighted prediction :

Survivors	Int	Ext	N	Var	F
at end of year	s.e	s.e		Ratio	
22172	0.14	0.1	11	0.751	0.024

Table 6.9. (Continued)

Age 10 Catchability constant w.r.t. time and dependent on age
Year class = 1992

Fleet	I :	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT10: Rus young SUR	15840	0.282	0.24	0.85	3	0.216	0.041
FLT13: Rus acous spr	19074	0.237	0.277	1.17	4	0.306	0.035
FLT14: Norw New Comb	24564	0.192	0.201	1.05	5	0.473	0.027
F shrinkage mean	17410	2				0.005	0.038

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
20644	0.13	0.13	13	0.989	0.032

Age 11 Catchability constant w.r.t. time and dependent on age
Year class = 1991

Fleet	I :	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT10: Rus young SUR	21811	0.285	0.104	0.37	3	0.175	0.023
FLT13: Rus acous spr	36426	0.201	0.11	0.55	5	0.357	0.014
FLT14: Norw New Comb	30934	0.177	0.147	0.83	6	0.464	0.016
F shrinkage mean	10468	2				0.004	0.047

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
30722	0.12	0.09	15	0.726	0.016

Age 12 Catchability constant w.r.t. time and dependent on age
Year class = 1990

Fleet	I :	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT10: Rus young SUR	38191	0.288	0.244	0.85	3	0.157	0.033
FLT13: Rus acous spr	38894	0.186	0.136	0.73	5	0.409	0.033
FLT14: Norw New Comb	30461	0.178	0.161	0.91	6	0.43	0.042
F shrinkage mean	16916	2				0.004	0.074

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
34798	0.12	0.09	15	0.793	0.037

Age 13 Catchability constant w.r.t. time and dependent on age
Year class = 1989

Fleet	I :	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT10: Rus young SUR	18899	0.294	0.156	0.53	3	0.133	0.09
FLT13: Rus acous spr	30094	0.153	0.174	1.13	6	0.555	0.058
FLT14: Norw New Comb	24497	0.199	0.137	0.69	5	0.308	0.07
F shrinkage mean	14580	2				0.004	0.115

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
26472	0.11	0.1	15	0.894	0.065

Age 14 Catchability constant w.r.t. time and dependent on age
Year class = 1988

Fleet	I :	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT10: Rus young SUR	19512	0.302	0.352	1.16	3	0.116	0.075
FLT13: Rus acous spr	15120	0.147	0.137	0.93	6	0.616	0.096
FLT14: Norw New Comb	16574	0.208	0.072	0.35	4	0.264	0.087
F shrinkage mean	5917	2				0.005	0.228

Table 6.9. (Continued)

Weighted prediction :

Survivors	Int	Ext	N	Var	F
at end of year	s.e	s.e		Ratio	
15885	0.11	0.09	14	0.792	0.091

Age 15 Catchability constant w.r.t. time and dependent on age
Year class = 1987

Fleet	I	Int	Ext	Var	N	Scaled	Estimated
	:	s.e	s.e	Ratio		Weights	F
FLT10: Rus young SUR	8262	0.313	0.559	1.78	3	0.096	0.093
FLT13: Rus acous spr	6109	0.138	0.144	1.04	6	0.723	0.123
FLT14: Norw New Comb	4712	0.244	0.158	0.65	3	0.176	0.157
F shrinkage mean	991	2				0.006	0.592

Weighted prediction :

Survivors	Int	Ext	N	Var	F
at end of year	s.e	s.e		Ratio	
5944	0.11	0.12	13	1.09	0.126

Age 16 Catchability constant w.r.t. time and dependent on age
Year class = 1986

Fleet	I	Int	Ext	Var	N	Scaled	Estimated
	:	s.e	s.e	Ratio		Weights	F
FLT10: Rus young SUR	866	0.329	0.428	1.3	3	0.097	0.522
FLT13: Rus acous spr	865	0.15	0.061	0.41	5	0.795	0.522
FLT14: Norw New Comb	835	0.394	0.549	1.39	2	0.082	0.537
F shrinkage mean	340	2				0.026	1.011

Weighted prediction :

Survivors	Int	Ext	N	Var	F
at end of year	s.e	s.e		Ratio	
842	0.14	0.1	11	0.706	0.534

Age 17 Catchability constant w.r.t. time and dependent on age
Year class = 1985

Fleet	I	Int	Ext	Var	N	Scaled	Estimated
	:	s.e	s.e	Ratio		Weights	F
FLT10: Rus young SUR	104	0.351	0.295	0.84	3	0.09	0.903
FLT13: Rus acous spr	135	0.163	0.071	0.43	4	0.719	0.757
FLT14: Norw New Comb	369	0.465	0	0	1	0.067	0.347
F shrinkage mean	212	2				0.124	0.544

Weighted prediction :

Survivors	Int	Ext	N	Var	F
at end of year	s.e	s.e		Ratio	
150	0.28	0.12	9	0.436	0.705

Age 18 Catchability constant w.r.t. time and age (fixed at the value for age) 17

Year class = 1984

Fleet	I	Int	Ext	Var	N	Scaled	Estimated
	:	s.e	s.e	Ratio		Weights	F
FLT10: Rus young SUR	239	0.501	0.12	0.24	2	0.056	0.656
FLT13: Rus acous spr	233	0.182	0.072	0.4	3	0.829	0.668
FLT14: Norw New Comb	1	0	0	0	0	0	0
F shrinkage mean	622	2				0.115	0.305

Weighted prediction :

Survivors	Int	Ext	N	Var	F
at end of year	s.e	s.e		Ratio	
261	0.28	0.15	6	0.56	0.614

Table 6.10. Fishing mortality (F)at age

Run title : Arctic S. mentella
At 30/04/2003 16:24
Terminal Fs derived using XSA (With F shrinkage)
Fishing mortality (F) at age

YEAR	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	FBAR
AGE													
6	0.074	0.0783	0.0041	0.0112	0.0083	0.0027	0.0021	0.001	0.0003	0	0.0041	0.0002	0.0015
7	0.2023	0.1373	0.0077	0.0212	0.016	0.0088	0.0072	0.0167	0.0026	0.0008	0.0103	0.0016	0.0042
8	0.2477	0.0902	0.0114	0.0394	0.0424	0.0327	0.0201	0.0446	0.0094	0.0139	0.0203	0.0077	0.014
9	0.1357	0.0651	0.0285	0.075	0.0453	0.0599	0.0273	0.0769	0.0266	0.0302	0.0387	0.0241	0.031
10	0.2566	0.0431	0.1009	0.1744	0.0663	0.0921	0.0586	0.1032	0.048	0.0502	0.0252	0.0319	0.0358
11	0.2079	0.062	0.0897	0.1663	0.1066	0.117	0.1135	0.1519	0.1033	0.0536	0.04	0.0162	0.0366
12	0.3246	0.1062	0.1296	0.1066	0.1592	0.1232	0.1182	0.2236	0.1318	0.0702	0.0777	0.0367	0.0615
13	0.3959	0.1693	0.1457	0.0935	0.1919	0.1437	0.1972	0.245	0.2414	0.1068	0.1236	0.0652	0.0985
14	0.6425	0.1309	0.3094	0.1854	0.265	0.107	0.243	0.245	0.3906	0.2368	0.2182	0.0911	0.1821
15	0.4026	0.2621	0.1374	0.3464	0.2433	0.0937	0.085	0.3171	0.4685	0.4564	0.7239	0.1264	0.4356
16	0.3503	0.3413	0.2233	0.3418	0.3637	0.0915	0.0685	0.0942	0.4567	0.5144	1.4964	0.5335	0.8481
17	1.3766	0.4051	0.2504	0.2672	0.1078	0.1816	0.224	0.1215	0.1379	0.2621	0.8208	0.7049	0.5959
18	0.6362	0.2623	0.2136	0.2474	0.2348	0.1237	0.1638	0.205	0.1277	0.0781	0.7483	0.6141	0.4802
+gp	0.6362	0.2623	0.2136	0.2474	0.2348	0.1237	0.1638	0.205	0.1277	0.0781	0.7483	0.6141	
FBAR 10-16	0.3686	0.1593	0.1623	0.2021	0.1994	0.1097	0.1263	0.1972	0.2629	0.2126	0.3864	0.1287	

Table 6.11. Stock number at age

Run title : Arctic S. mentella
At 30/04/2003 16:24
Terminal Fs derived using XSA (With F shrinkage)
Stock number at age (start of year) Numbers*10**-3

YEAR	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	GMST 91-**	AMST 91-**
AGE															
6	24355	26141	40600	69689	84330	86284	61856	37172	34617	42330	29963	9415	0	46185	50737
7	31299	20465	21872	36585	62355	75676	77861	55851	33599	31314	38301	27000	8517	40216	44688
8	38306	23133	16141	19639	32409	55526	67871	69944	49697	30323	28311	34302	24393	35961	40299
9	56165	27056	19126	14440	17083	28108	48626	60188	60526	44548	27060	25101	30800	33124	37587
10	38214	44370	22939	16819	12122	14774	23955	42813	50431	53329	39111	23555	22172	28245	31976
11	29928	26753	38454	18764	12782	10265	12192	20442	34938	43492	45890	34508	20644	22172	24801
12	23616	21997	22750	31809	14378	10396	8262	9849	15889	28511	37298	39894	30722	17046	18746
13	31769	15445	17898	18083	25871	11095	8317	6643	7126	12601	24049	31226	34798	13659	15485
14	24006	19347	11799	13999	14902	19322	8695	6178	4705	5065	10247	19230	26472	11095	12802
15	12844	11426	15358	7835	10524	10345	15709	6170	4376	2880	3616	7454	15885	8651	9747
16	7487	7770	7955	12113	5013	7466	8523	13056	4066	2478	1651	1587	5944	6873	7593
17	13504	4773	4998	5757	7787	3153	6165	7201	10751	2330	1341	335	842	5895	6642
18	14566	3085	2880	3521	3988	6326	2379	4459	5770	8475	1622	534	150	4759	5545
+gp	42857	42072	32839	15585	12046	20278	24781	35327	34316	81409	32118	9175	4754		
TOTAL	388915	293831	275609	284638	315592	359013	375192	375292	350807	389085	320579	263316	226093		

Table 6.12. Stock biomass at age

Run title : Arctic S. mentella

At 30/04/2003 16:24

Terminal Fs derived using XSA (With F shrinkage)

Stock biomass at age (start of year) Tonnes

YEAR	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
AGE												
6	3166	4967	6902	11150	14589	17257	11134	5204	5192	4233	3296	1224
7	5634	4502	5031	8049	13905	15135	16351	10612	7392	4697	5745	4590
8	8044	6015	4035	4713	8102	13882	16968	16087	10933	6671	5662	7547
9	15164	7576	5355	4332	4903	8714	14102	17455	16947	11582	6765	7279
10	12993	13755	7570	5718	3964	6205	7905	14128	16642	16532	11733	8009
11	10475	8828	14613	6943	4602	4516	4633	7768	12927	15657	15603	13458
12	9919	8359	10010	12724	5852	4886	3801	4235	6991	11974	14546	17553
13	14614	7105	8412	7956	11823	6546	3992	3189	3492	5545	10582	13739
14	12243	8319	5781	6300	6855	12945	4434	3336	2493	2583	4919	10192
15	7450	4913	8754	3839	5230	7138	8640	3641	2450	1613	1917	4249
16	4418	3497	4614	6662	2642	5301	5114	7964	2521	1536	974	920
17	7968	2482	3099	3339	4462	2333	4069	4609	7096	1468	831	207
18	8594	1758	1872	2359	2513	4681	1547	2943	3866	5679	1055	326
+gp	30000	28188	21739	12312	8517	17175	19502	26601	27624	63010	22322	6771
TOTALBIO	150680	110263	107787	96396	97959	126715	122191	127771	126568	152781	105949	96065

Table 6.13. Spawning stock biomass at age

Run title : Arctic S. mentella

At 30/04/2003 16:24

Terminal Fs derived using XSA (With F shrinkage)

Spawning stock biomass at age (spawning time) Tonnes

YEAR	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
AGE												
6	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	294	223	0	0	0	0
8	121	90	0	0	0	0	0	225	175	0	0	0
9	834	470	123	100	0	122	381	0	1000	556	555	364
10	1715	1829	855	646	218	577	1028	1045	1831	1438	2300	721
11	2116	1978	3902	1854	511	957	1446	1328	4305	3163	6319	3095
12	4771	3435	4384	5573	2153	1588	1068	1169	4048	4490	6429	6846
13	7964	3829	4829	4567	6940	3777	2259	1983	2406	2711	4677	6458
14	9072	6439	4874	5311	4771	9269	3264	2382	1965	1917	3187	7032
15	6332	4363	8325	3651	3813	5568	7180	3171	1992	1344	1485	3442
16	4250	3308	4245	6129	2085	4633	4899	7319	2276	1389	843	810
17	7968	2462	3065	3303	4462	2275	3865	4609	6550	1468	755	195
18	8594	1758	1872	2359	2513	4681	1547	2943	3866	5679	1055	326
+gp	30000	28188	21739	12312	8517	17175	19502	26601	27624	63010	22322	6771
TOTSPBIO	83736	58150	58213	45804	35982	50623	46733	52999	58037	87165	49927	36059

Table 6.14. Summary

Run title : Arctic S. mentella

At 30/04/2003 16:24

Summary (without SOP correction)

Terminal Fs derived using XSA (With F shrinkage)

	RECRUITS Age 6	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	FBAR 10-16
1991	24355	150680	83736	48727	0.5819	0.3686
1992	26141	110263	58150	15590	0.2681	0.1593
1993	40600	107787	58213	12866	0.221	0.1623
1994	69689	96396	45804	12721	0.2777	0.2021
1995	84330	97959	35982	10284	0.2858	0.1994
1996	86284	126715	50623	8075	0.1595	0.1097
1997	61856	122191	46733	8597	0.184	0.1263
1998	37172	127771	52999	14045	0.265	0.1972
1999	34617	126568	58037	11209	0.1931	0.2629
2000	42330	152781	87165	10245	0.1175	0.2126
2001	29963	105949	49927	18434	0.3692	0.3864
2002	9415	96065	36059	7022	0.1947	0.1287
Arith. Mean	45563	118427	55286	14818	0.2598	0.2096
Units	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)		

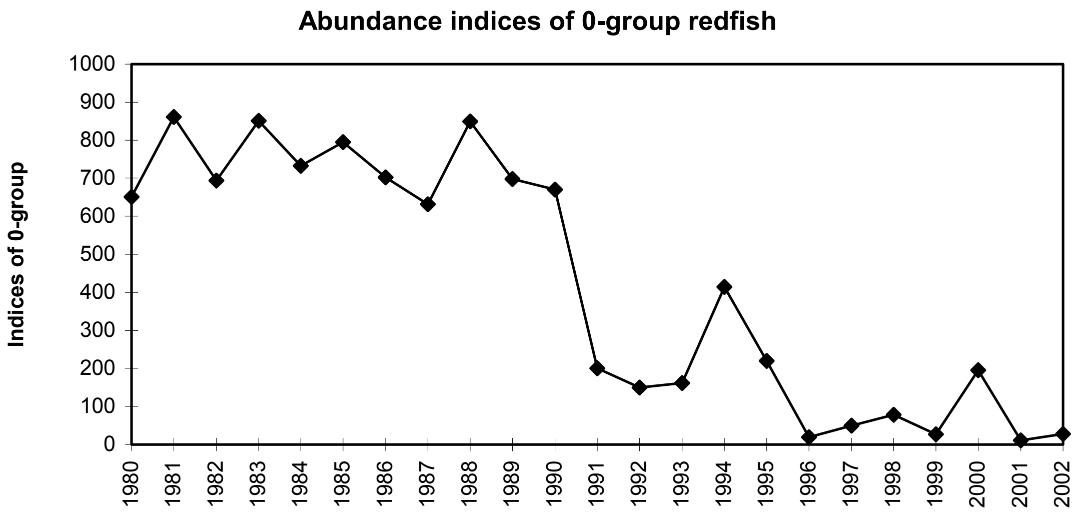


Figure 6.1. Abundance indices of 0-group redfish (believed to be mostly *S.mentella*) in the international 0-group survey in the Barents Sea and Svalbard areas in August-September 1980-2002.

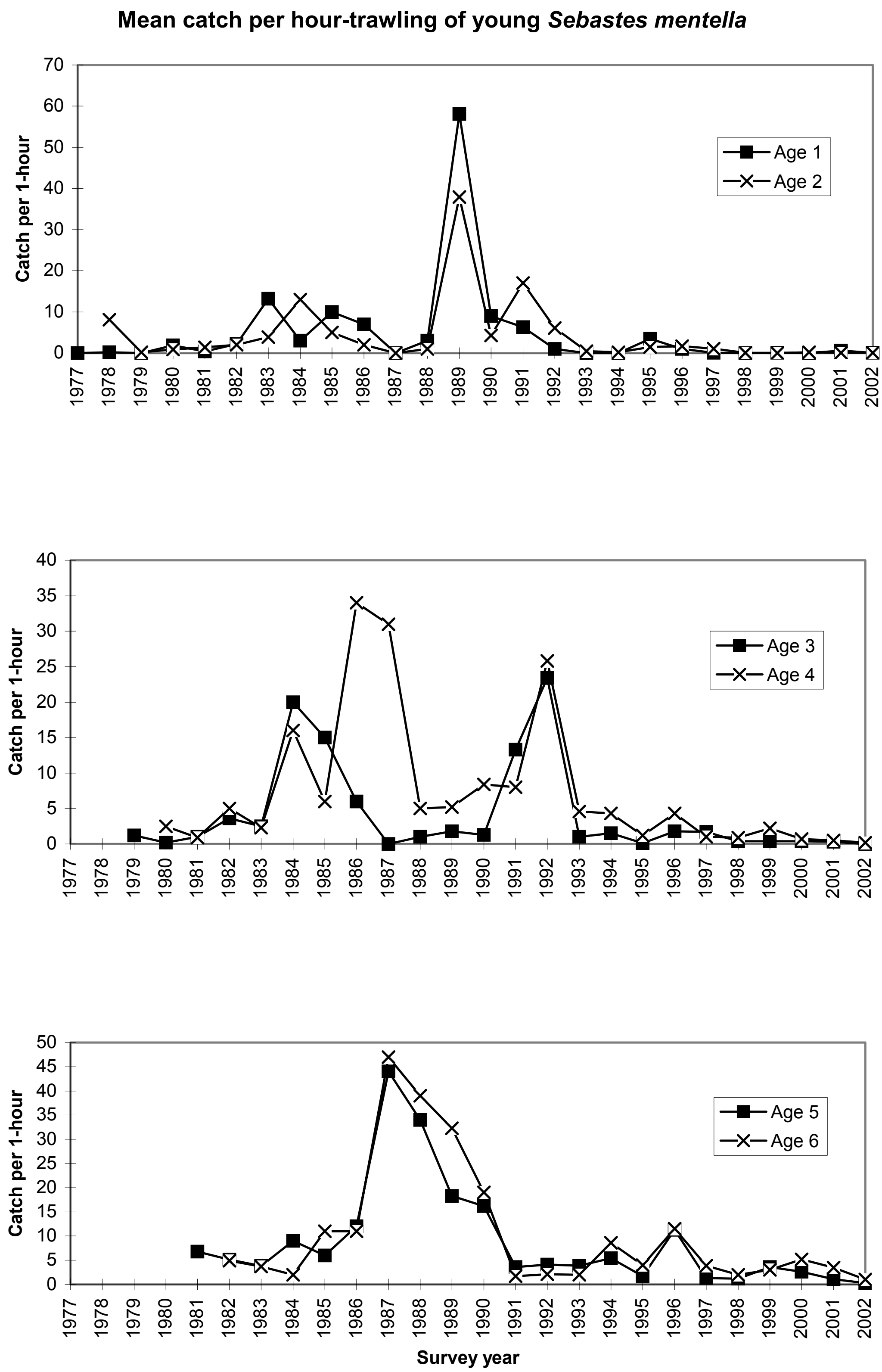
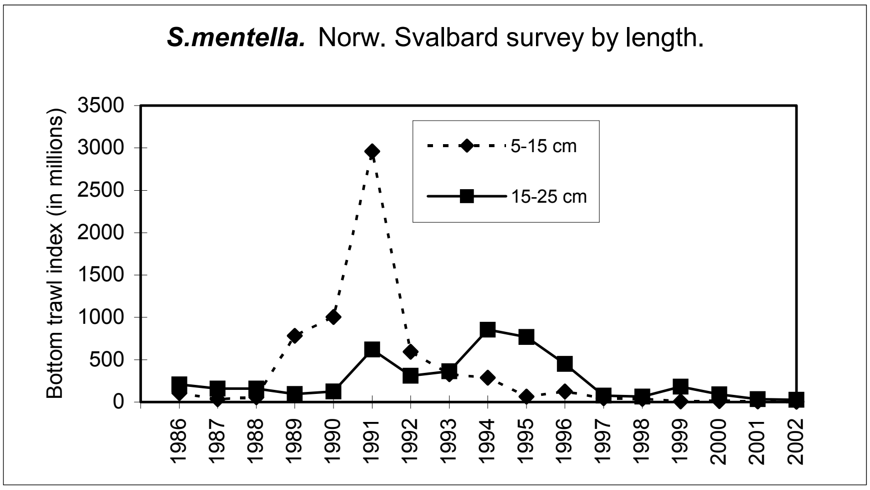


Figure 6.2. Catch (numbers of specimens) per hour trawling of different ages of *Sebastes mentella* in the Russian groundfish survey in the Barents Sea and Svalbard areas (ref. Table D4).



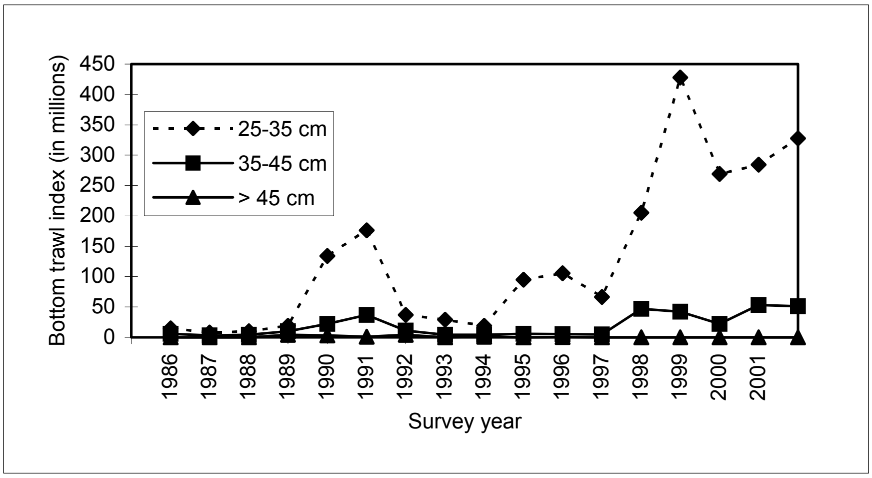
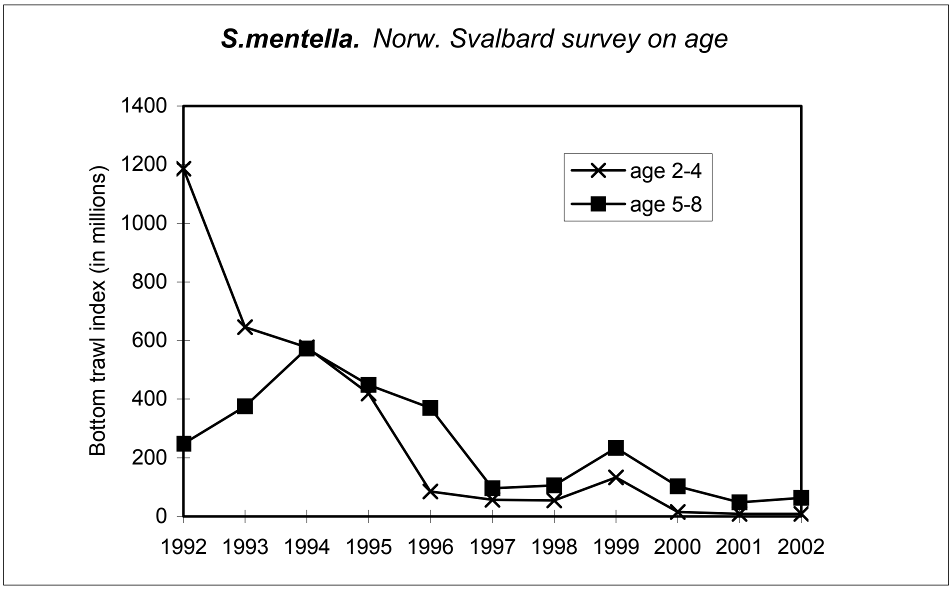


Figure 6.3a. *Sebastes mentella.* Abundance indices (on length) from the Norwegian bottom trawl survey in the Svalbard area (Division IIb) in summer/fall 1986-2002 (ref. Table D5a).



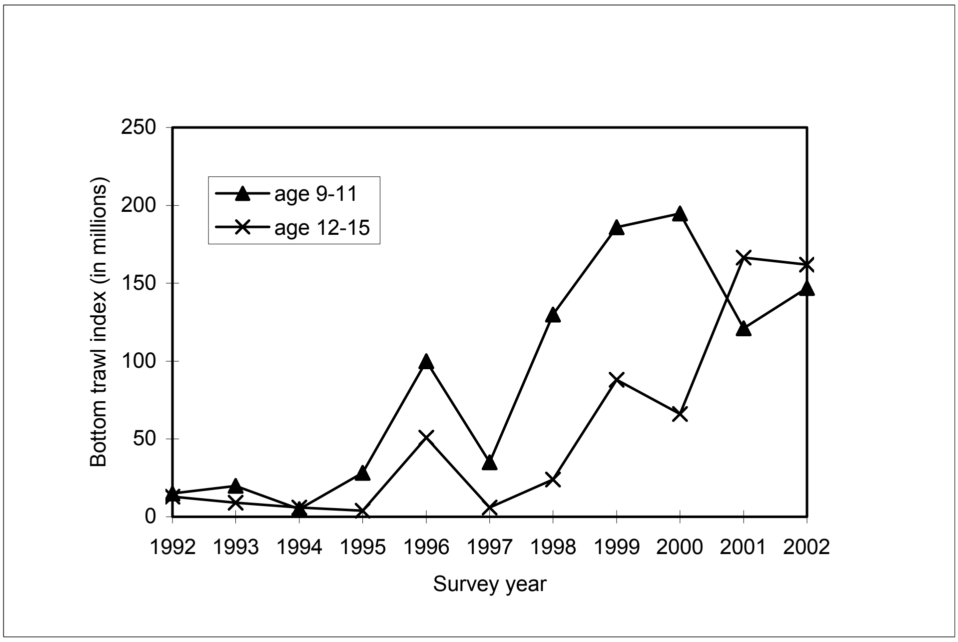
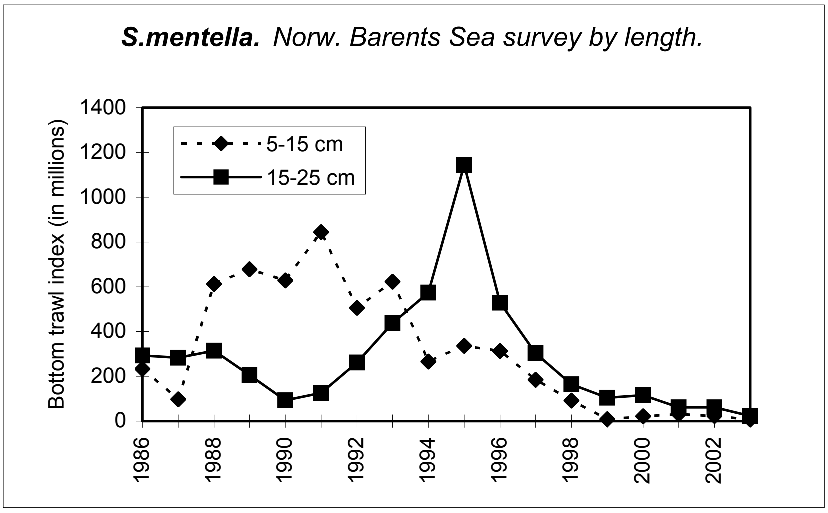


Figure 6.3b. *Sebastes mentella.* Abundance indices (on age) from the Norwegian bottom trawl survey in the Svalbard area (Division IIb) in summer/fall 1992-2002 (ref. Table D5b).



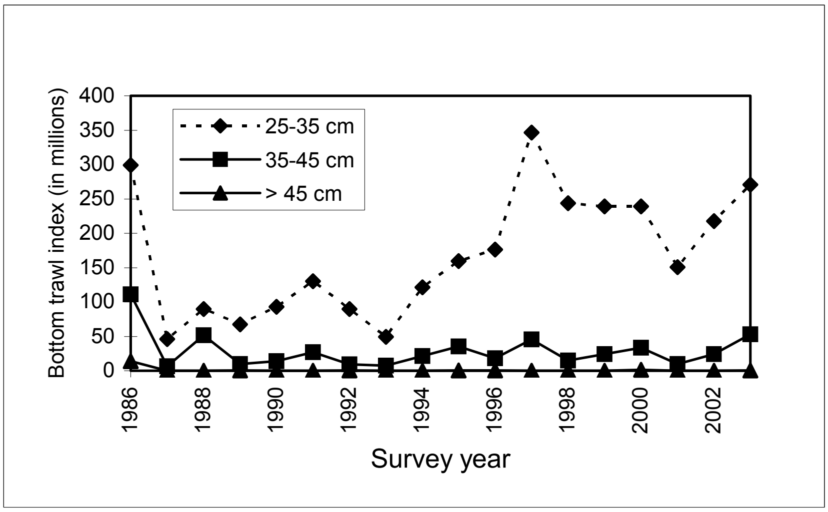
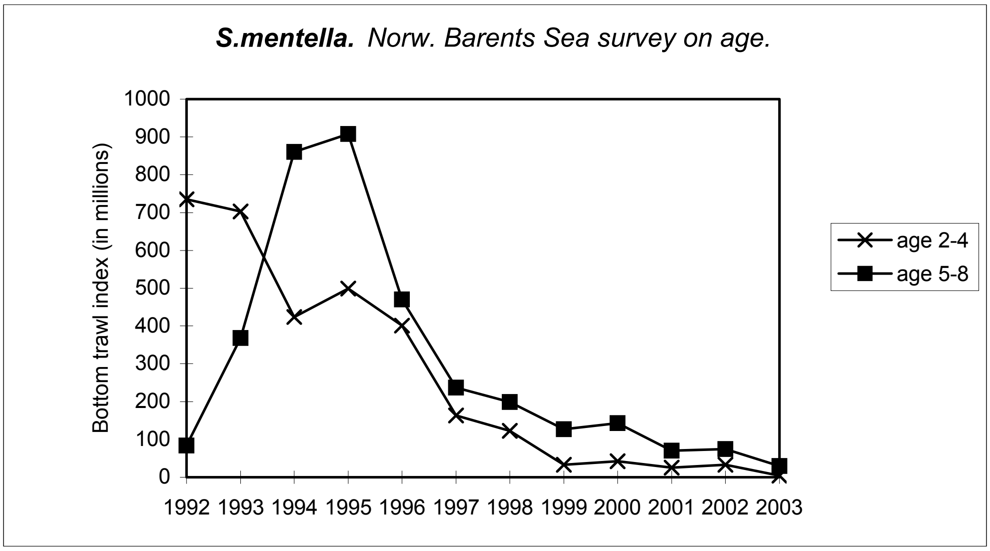


Figure 6.4a. *Sebastes mentella.* Abundance indices (**on length**) from the Norwegian bottom trawl survey in the Barents Sea in winter 1986-2003 (ref. Table D6a).



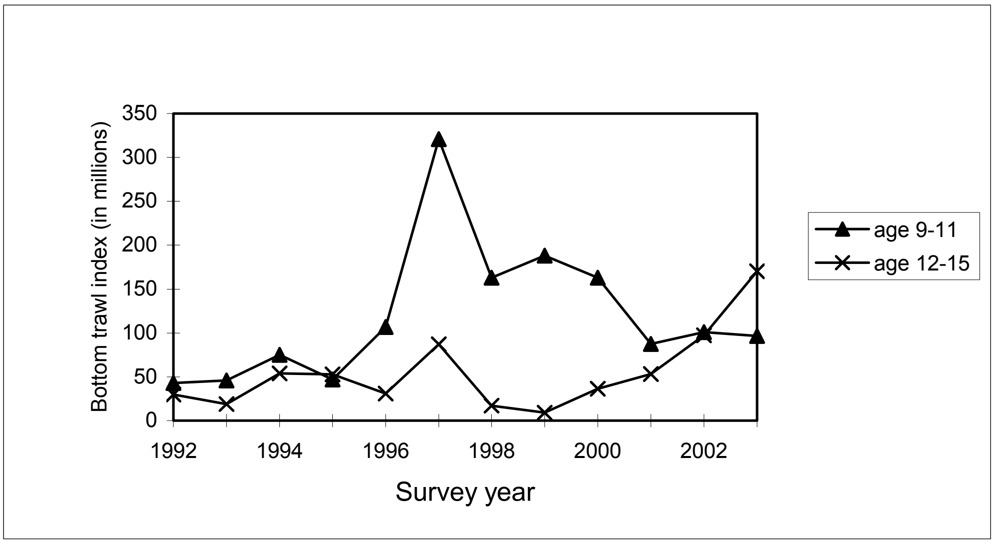


Figure 6.4b. *Sebastes mentella.* Abundance indices (**on age**) from the Norwegian bottom trawl survey in the Barents Sea in winter 1992-2003 (ref. Table D6b).

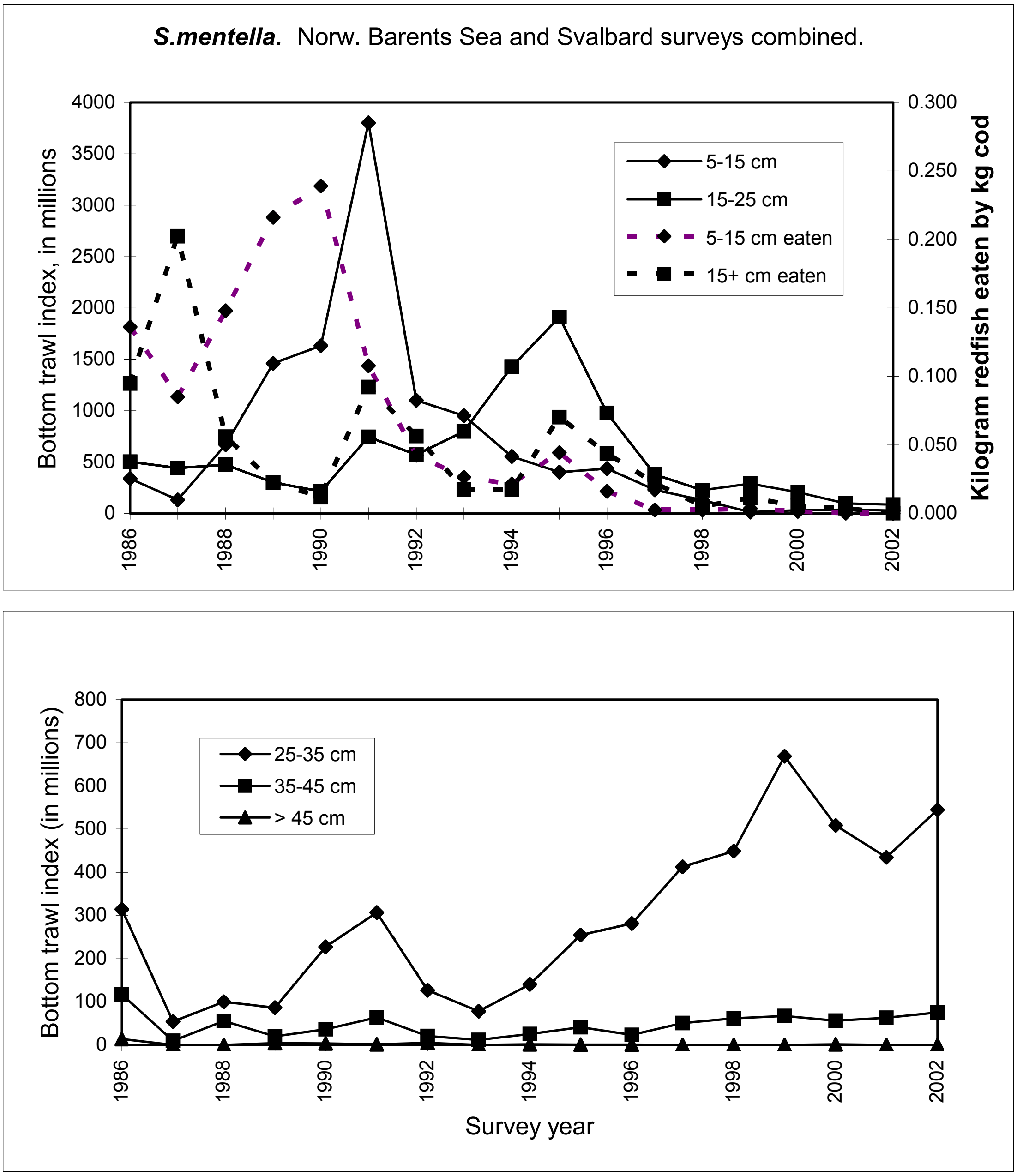
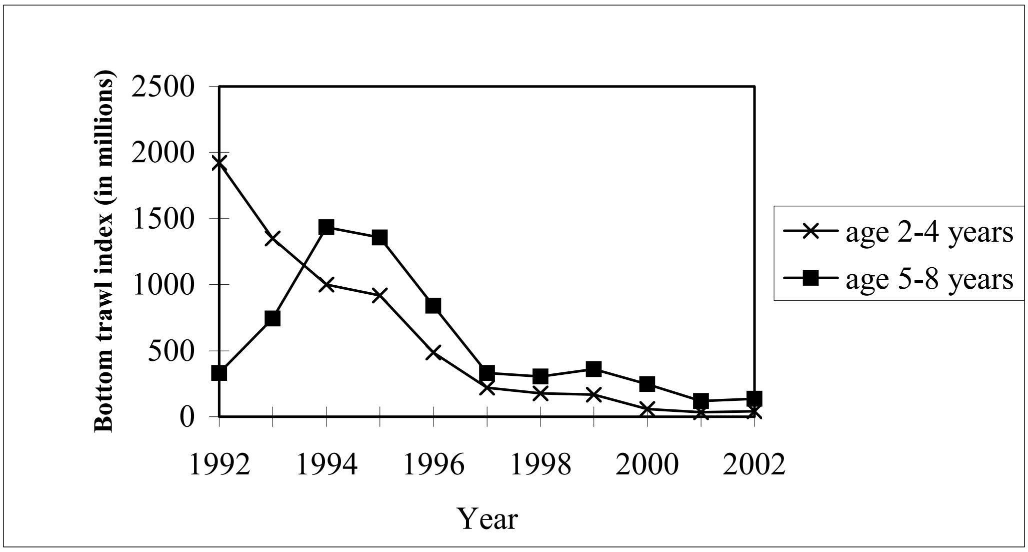


Figure 6.5a. *Sebastes mentella.* Left axis - abundance indices (**on length**) when combining the Norwegian bottom trawl surveys 1986-2002 at Svalbard (summer/fall) and in the Barents Sea (winter). Right axis (upper panel) - kilogram *Sebastes* spp. eaten per kilogram 3 year and older cod per year.



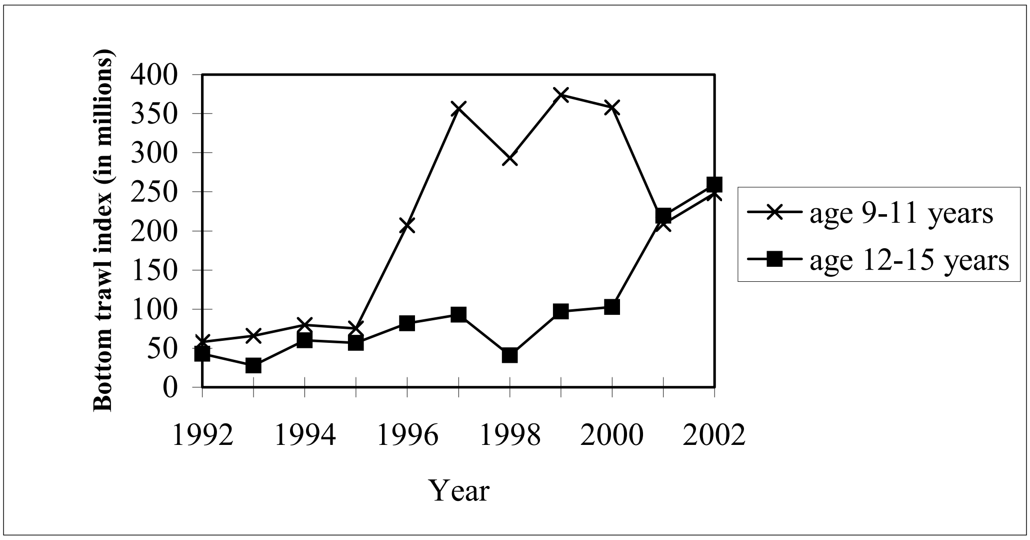


Figure 6.5b. *Sebastes mentella* . Abundance indices (**on age**) when combining the Norwegian bottom trawl surveys 1992-2002 at Svalbard (summer/fall) and in the Barents Sea (winter).

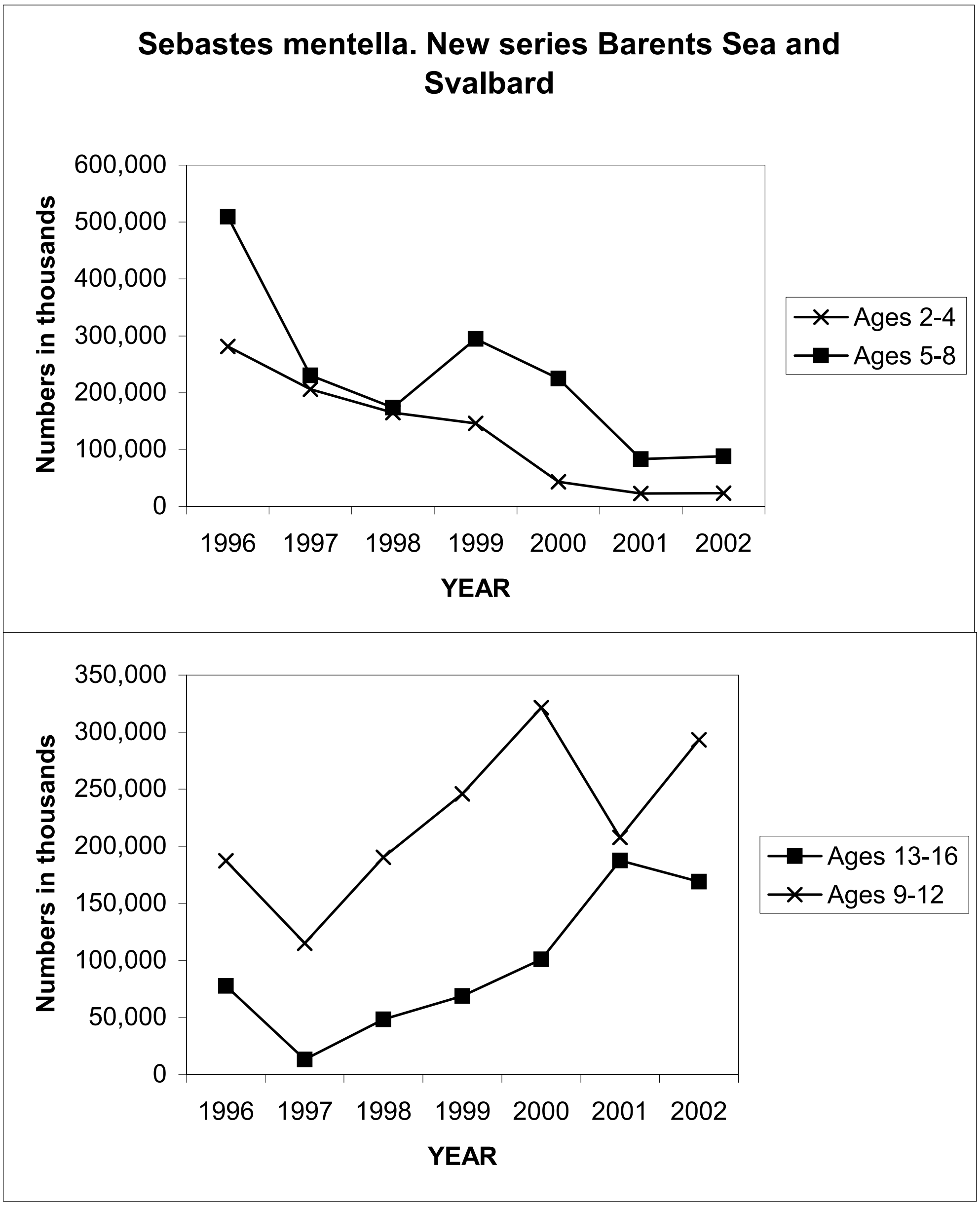


Figure 6.6. *Sebastes mentella* . Abundance indices (**on age**) from the new Norwegian demersal fish survey in August-September 1996-2002 covering the Norwegian Economic Zone (NEZ) and Svalbard incl. the area north and east of Spitsbergen.

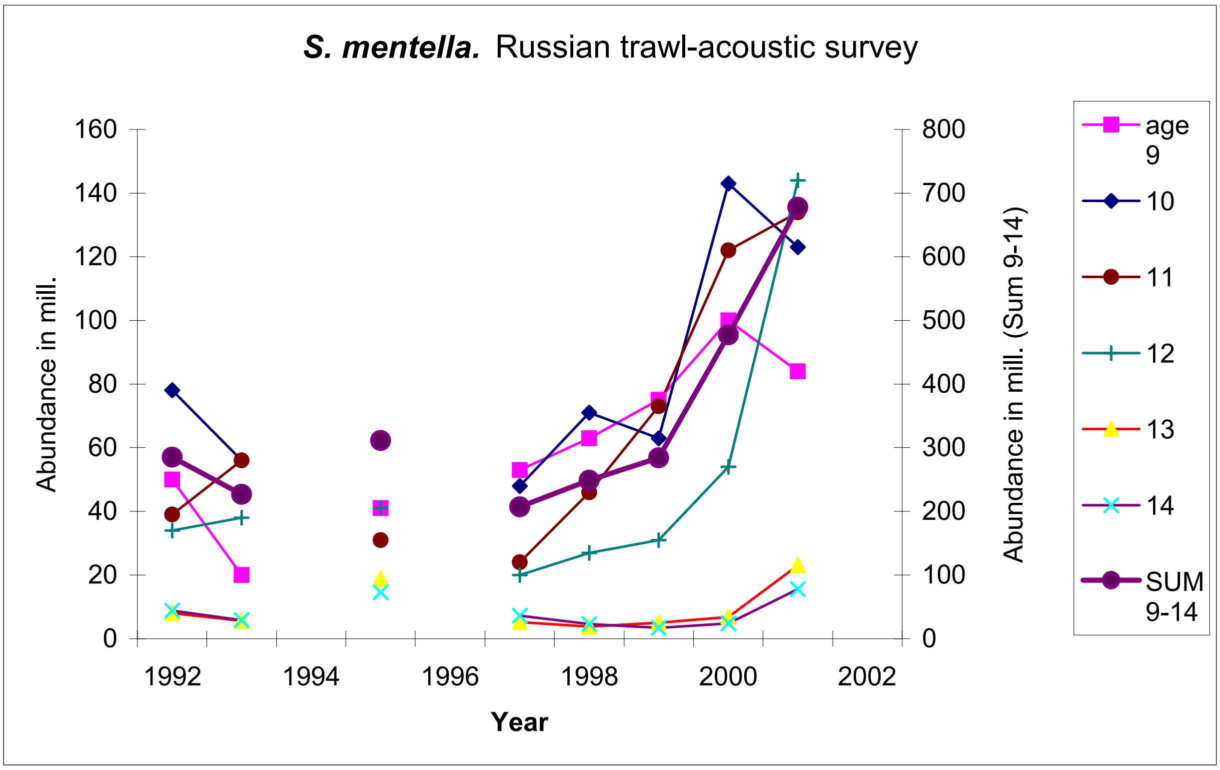


Figure 6.7. Results of the Russian trawl/acoustic redfish survey for ages 9-14 (ref. Table D7).

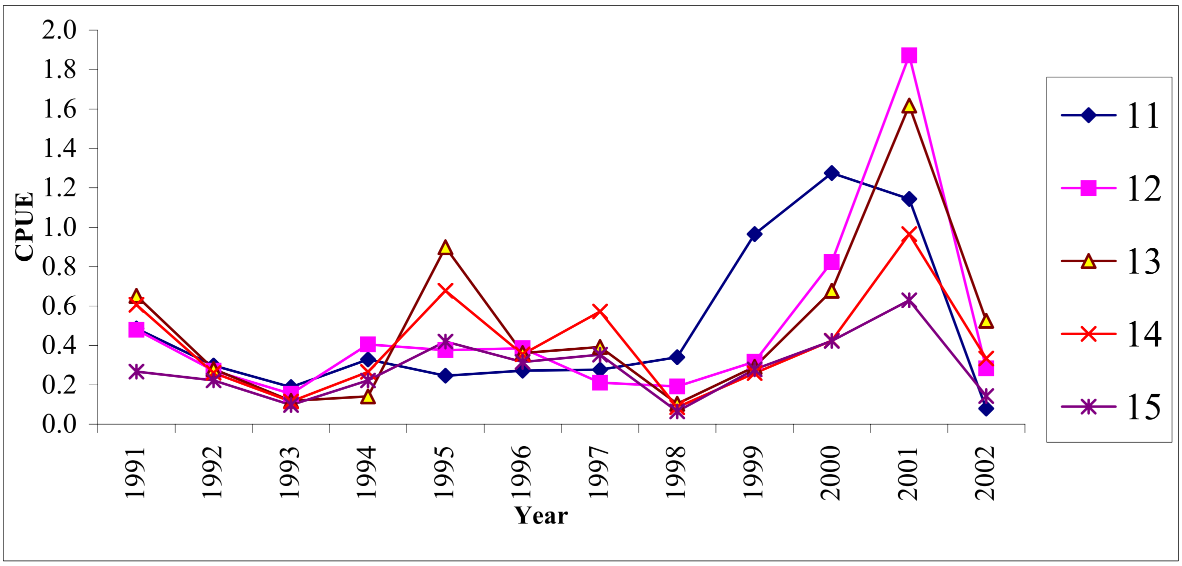


Figure 6.8. Russian trawl (BMRT) CPUE for ages 11-15.

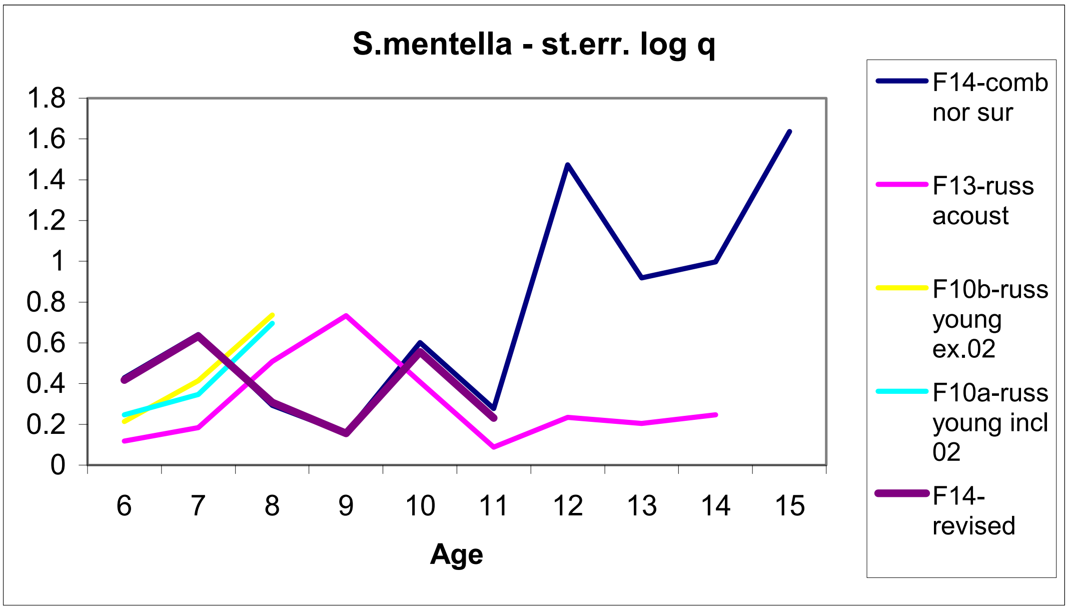


Figure 6.9. St. errors of log Q at age for different fleets included in the exploratory XSA runs.

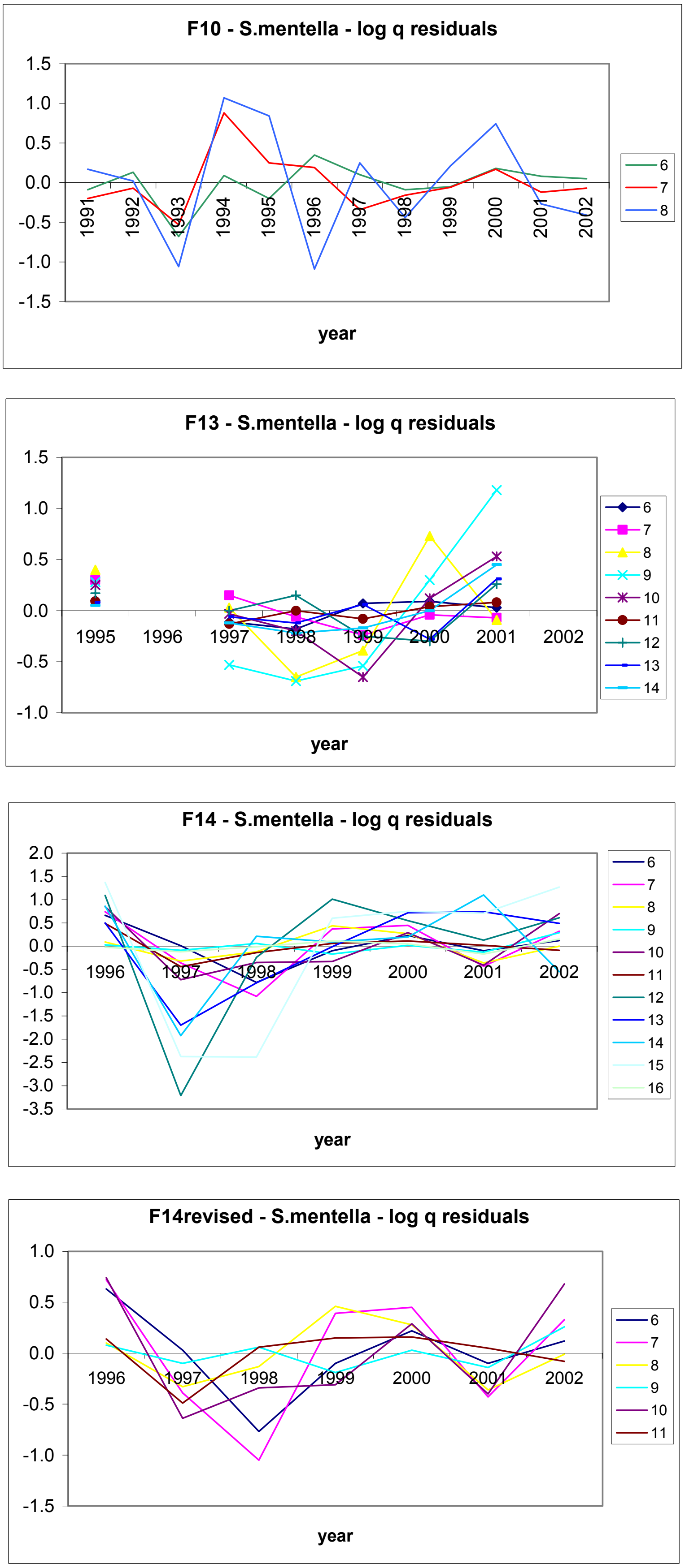
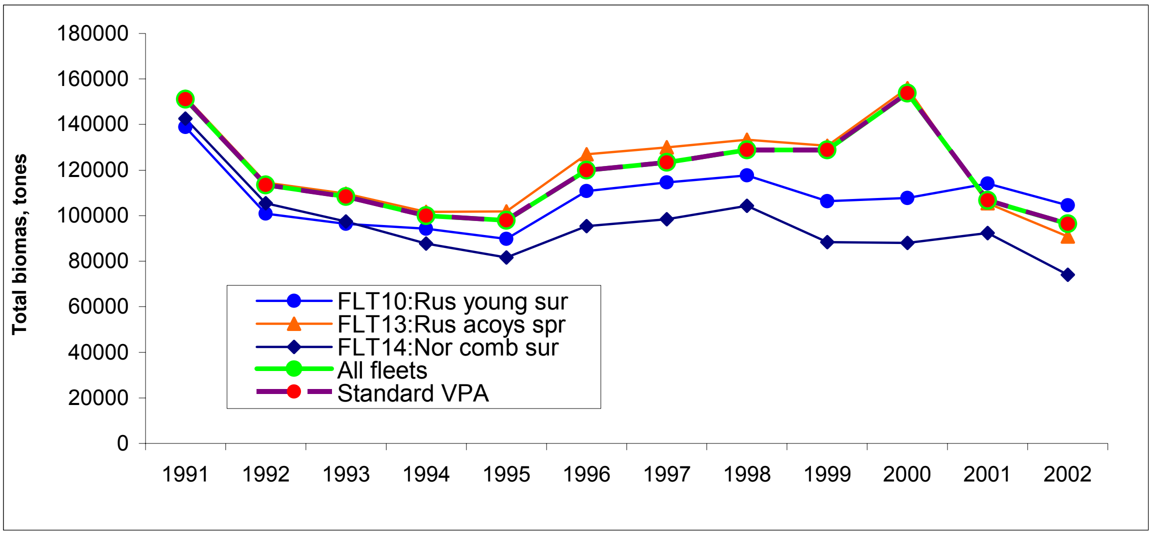
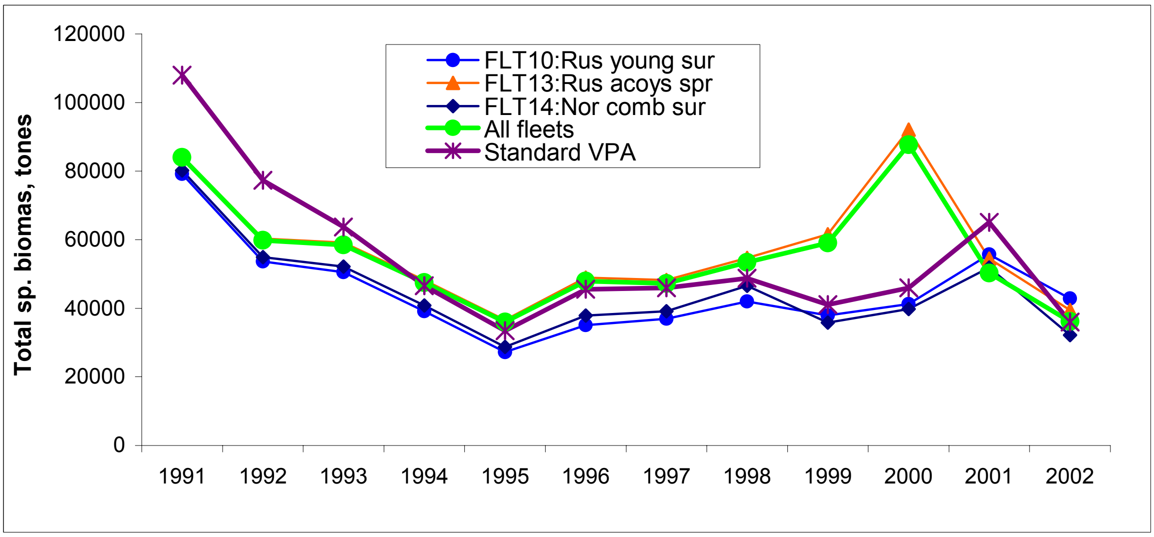


Figure 6.10. Log q residuals from different fleets included in the exploratory XSA runs.





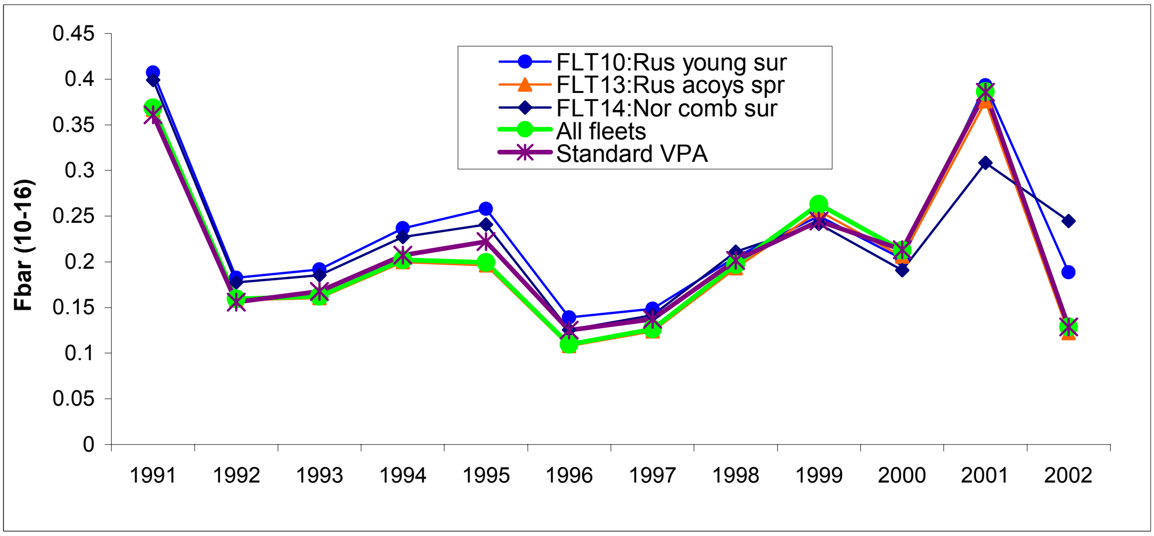


Fig. 6.11. Estimated total biomass, SSB and fishing mortality from exploratory XSA/VPA runs.

Table D1 REDFISH in Subareas I and II. Nominal catch (t) by countries in Subarea I, Divisions IIa and IIb combined as officially reported to ICES.

Year	Canada	Denmark	Faroe Islands	France	Germany[4]	Greenland	Iceland	Ireland	Netherlands	Norway	Poland	Portugal	Russia[5]	Spain	UK (E&W)	UK (Scot.)	Total
1984	-	-	-	2,970	7,457	-	-	-	-	18,650	-	1,806	69,689	25	716	-	101,313
1985	-	-	-	3,326	6,566	-	-	-	-	20,456	-	2,056	59,943	38	167	-	92,552
1986	-	-	29	2,719	4,884	-	-	-	-	23,255	-	1,591	20,694	-	129	14	53,315
1987	-	+	450[3]	1,611	5,829	-	-	-	-	18,051	-	1,175	7,215	25	230	9	34,595
1988	-	-	973	3,349	2,355	-	-	-	-	24,662	-	500	9,139	26	468	2	41,494
1989	-	-	338	1,849	4,245	-	-	-	-	25,295	-	340	14,344	5[2]	271	1	46,688
1990	-	37[3]	386	1,821	6,741	-	-	-	-	34,090	-	830	18,918	-	333	-	63,156
1991	-	23	639	791	981	-	-	-	-	49,463	-	166	15,354	1	336	13	67,768
1992	-	9	58	1,301	530	614	-	-	-	23,451	-	977	4,335	16	479	3	31,773
1993	8[3]	4	152	921	685	15	-	-	-	18,319	-	1,040	7,573	65	734	1	29,517
1994	-	28	26	771	1026	6	4	3	-	21,466	-	985	6,220	34	259	13	30,841
1995	-	-	30	748	692	7	1	5	1	16,162	-	936	6,985	67	252	13	25,899
1996	-	-	42[3]	746	618	37	-	2	-	21,675	-	523	1,641	408	305	121	26,118
1997	-	-	7	1,011	538	39[2]	-	11	-	18,839	1	535	4,556	308	235	29	26,109
1998	-	-	98	567	231	47[3]	-	28	-	26,273	13	131	5,278	228	211	94	33,199
1999	-	-	108	61[3]	430	97	14	10	-	24,634	6	68	4,422	36	247	62	30,195
2000	-	-	67[3]	132	222	19	65	7	-	19,187[1]	2	131	4,631	87		203[6]	24,753
2001	-	-	69[3]	397	436	39	38	5	-	23,133[1]	5	186	4,738	91	Estonia	239[6]	29,376
2002[1]	-	-	70[3]	85	141	49[3]	44	4[3]	-	10,619	8	276	4,736	193[2]	15	234[6]	16,474

[1] Provisional figures.
[2] Working Group figure.
[3] As reported to Norwegian authorities.
[4] Includes former GDR prior to 1991.
[5] USSR prior to 1991.
[6] UK(E&W)+UK(Scot.)

Table D2 REDFISH in Subarea IV (North Sea). Nominal catch (t) by countries as officially reported to ICES. Not included in the assessment.

Year	Belgium	Denmark	Faroe Islands	France	Germany	Ireland	Nether-lands	Norway	UK (England & Wales)	UK (Scotl)	Total
1986	-	24	-	578	183	-	-	1,048	35	1	1,869
1987	-	16	3	833	70	-	-	411	16	55	1,404
1988	-	32	90	915	188	-	-	696	125	9	2,055
1989	1	23	13	554	111	-	-	500[2]	134	6	1,342
1990	+	41	25	554	47	-	-	483[2]	369	6	1,525
1991	5	29	144	914	213	-	2	415[2]	43	38	1,803
1992	4	22	23	1,960	170	-	1	416	65	122	2,783
1993	28	14	4	1,211	33	-	1	373	138	71	1,873
1994	4	13	1	863	324	-	8	371	38	66	1,688
1995	16	12	65	1,120	80	-	16	297	46	241	1,893
1996	20	20	1	932	74	-	41	363	37	146	1,634
1997	16	23	-	1,049	45	-	53	595	21	528	2,330
1998	2	27	12	570[1]	370	4	21	1,113	68	681	2,868
1999	3	52	1	n.a.	58	39	16	862	67	465	1,563
2000	5	41	n.a.	224.	19	28	19	350[1]	132	486	1,080
2001	4	96	n.a.	254[1]	13	19	+	422[1]	80	458	1,346
2002[1]	4	39	n.a.	96	11	n.a.	-	235		524[3]	909

[1] Provisional figures.
[2] Working Group figure.
[3] UK(E/W/)+UK(Scotl)
n.a. = not available.

Table D3. *Sebastes mentella* in Divisions IIa and IIb. Catch per unit effort and calculated total international effort.

	USSR/Russia		Total effort	
	catch/hour trawling (t/hr)		(USSR/Russia units)	
Year	BMRT[1]	PST[2]	BMRT[1]	PST[2]
1975	2.0	0.9	119,535	265,634
1976	1.7	1.11	158,198	242,285
1977	1.5	1.02	97,576	143,495
1978	0.9	0.75	102,901	123,482
1979	0.9	0.84	96,828	103,744
1980	1.8	1.25	44,085	63,483
1981	1.9	1.31	42,669	61,886
1982	1.8	1.59	64,102	72,568
1983	3.0	1.86	35,091	56,599
1984	1.8	1.42	40,519	51,362
1985	1.1	1.01	57,335	62,444
1986	0.8	0.81	28,890	28,533
1987	0.8	0.78	13,148	13,485
1988	0.8	0.71	19,483	21,952
1989	0.8	0.79	29,367	29,739
1990	0.8	0.72	43,838	48,708
1991	1.0	0.77	48,727	63,282
1992	0.5	0.70	31,180	22,271
1993	0.4	0.90	32,165	14,296
1994	1.1	0.83	11,565	15,327
1995	1.5	0.80	8,856	12,855
1996	1.5[3]	0.80[3]	5,383	10,094
1997	1.3	0.80	6,088	10,654
1998	0.8	1.0	17,556	
1999	1.7		6,593	
2000	2.5		4,082	
2001	3.8	1.6	4,851	
2002	1.0[4]	0.8	7,022	

[1]Stern trawlers, 1900-2400 HP.
[2]Stern trawlers, 2200 HP.
[3] Average 1995 and 1997
[4] Using the relationship BMRT=1.59*PST-0.2621 for the period 1975–1997.

Table D4. *Sebastes mentella*. Average catch (numbers of specimens) per hour trawling of different ages of *Sebastes mentella* in the Russian groundfish survey in the Barents Sea and Svalbard areas (1976–1983 published in "Annales Biologiques").

Year class	0	1	2	3	4	5	6	7	8	9	10	11
1965	-	-	-	-	-	-	-	-	-	-	-	0.4
1966	-	-	-	-	-	-	-	-	-	-	3.0	-
1967	-	-	-	-	-	-	-	-	-	11.7	-	0.3
1968	-	-	-	-	-	-	-	-	16.2	-	1.5	0.3
1969	-	-	-	-	-	-	-	43.4	-	8.7	12.2	3.1
1970	-	-	-	-	-	-	85.8	-	19.8	34.9	11.9	-
1971	-	-	-	-	-	22.7	-	19.5	51.9	18.0	5.7	-
1972	-	-	-	-	9.4	-	6.7	57.6	12.3	6.7	-	-
1973	-	-	-	0.6	-	4.3	37.3	8.6	5.6	-	-	-
1974	-	-	4.8	-	4.9	22.8	4.8	4.8	-	-	-	3.0
1975	-	7.4	-	1.7	6.4	2.4	3.5	5.0	-	-	4.0	-
1976	7.0	-	8.1	1.2	2.5	6.8	4.9	5.0	1.0	13.0	-	-
1977	-	0.2	0.2	0.2	0.9	5.1	3.7	1.0	19.0	2.0	-	-
1978	0.8	0.02	0.9	1.0	5.0	3.8	2.0	20.0	6.0	-	-	-
1979	-	1.9	1.4	3.6	2.3	9.0	11.0	16.0	1.0	-	-	0.1
1980	0.3	0.4	2.0	2.5	16.0	6.0	11.0	25.0	2.0	-	1.5	2.0
1981	-	2.2	3.9	20.0	6.0	12.0	47.0	18.0	6.3	1.6	0.5	1.0
1982	19.8	13.2	13.0	15.0	34.0	44.0	39.0	32.6	4.3	3.1	4.9	+
1983	12.5	3.0	5.0	6.0	31.0	34.0	32.3	13.3	4.0	4.2	0.6	1.1
1984	-	10.0	2.0	-	5.0	18.3	19.0	2.2	2.4	0.2	1.7	2.4
1985	107.0	7.0	-	1.0	5.2	16.2	1.7	1.7	0.6	2.8	3.8	0.3
1986	2.0	-	1.0	1.8	8.4	3.6	2.1	1.2	5.6	8.2	0.9	0.7
1987	-	3.0	37.9	1.3	8.0	4.1	2.0	10.6	9.6	1.4	2.0	1.3
1988	4.0	58.1	4.3	13.3	25.8	3.9	8.6	11.2	2.8	4.2	3.0	4.7
1989	8.7	9.0	17.0	23.4	4.6	5.4	4.0	6.6	6.6	4.1	7.7	5.3
1990	2.5	6.3	6.1	1.0	4.3	1.7	11.5	6.5	5.5	6.7	7.4	3.6
1991	0.3	1.0	0.5	1.5	1.2	11.3	3.9	3.3	4.6	5.8	2.7	1.9
1992	0.6	+	0.2	0.1	4.3	1.3	2.0	2.3	4.9	2.3	1.0	-
1993[1]	-	+	1.5	1.8	1.0	1.2	3.0	4.2	2.6	2.0	-	-
1994	0.3	3.5	1.7	1.7	0.9	3.6	5.2	4.3	3.1	-	-	-
1995	2.8	1.0	1.1	0.4	2.2	2.6	3.5	3.4	-	-	-	-
1996[2]	+	0.1	0.1	0.4	0.7	1.1	1.0	-	-	-	-	-
1997	-	-	+	0.4	0.5	0.3	-	-	-	-	-	-
1998	-	0.1	0.2	0.3	0.2	-	-	-	-	-	-	-
1999	0.1	-	0.1	+	-	-	-	-	-	-	-	-
2000	-	0.6	0.1	-	-	-	-	-	-	-	-	-
2001	-	0.1	-	-	-	-	-	-	-	-	-	-
2002[3]	0.1											

[1] - Not complete area coverage of Division IIb.
[2] - Area surveyed restricted to Subarea I and Division IIa only.
[3] - Area surveyed restricted to Subarea I and Division IIb only.

Table D5a *Sebastes mentella*[1] in Division IIb. Abundance indices (**on length**) from the bottom trawl survey in the Svalbard area (Division IIb) in summer/fall 1986-2002 (numbers in millions).

	Length group (cm)									
Year	5.0-9.9	10.0-14.9	15.0-19.9	20.0-24.9	25.0-29.9	30.0-34.9	35.0-39.9	40.0-44.9	>45.0	Total
1986[2]	6	101	192	17	10	5	2	4	+	338
1987[2]	20	14	140	19	6	2	1	2	+	208
1988[2]	33	23	82	77	7	3	2	2	+	228
1989	566	225	24	72	17	2	2	8	4	921
1990	184	820	59	65	111	23	15	7	3	1,287
1991	1,533	1,426	563	55	138	38	30	7	1	3,791
1992	149	446	268	43	22	15	4	7	4	958
1993	9	320	272	89	16	13	3	1	+	722
1994	4	284	613	242	10	9	2	2	1	1,165
1995	33	33	417	349	77	18	5	1	+	933
1996	56	69	139	310	97	8	4	1	1	685
1997	3	44	13	65	57	9	5	+	+	195
1998	+	37	35	28	132	73	45	2	+	353
1999	4	3	121	62	259	169	42	1	0	661
2000	+	10	31	59	126	143	21	1	0	391
2001	1	5	3	32	57	228	50	3	0	378
2002	1	4	6	21	62	266	47	4	+	410

[1] - Includes some unidentified *Sebastes* specimens, mostly less than 15 cm.
[2] - Old trawl equipment (bobbins gear and 80 meter sweep length)

Table D5b *Sebastes mentella*[1] in Division IIb. Norwegian bottom trawl survey indices (**on age**) in the Svalbard area (Division IIb) in summer/fall 1992-2002 (numbers in millions).

	Age													
Year	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total
1992	283	419	484	131	58	45	14	8	5	2	7	2	1	3	1,462
1993	2	527	117	202	142	8	23	6	13	1	7	1	1	+	1,050
1994	7	280	290	202	235	42	94	1	1	3	4	1	1	+	1,161
1995	4	50	365	237	132	61	19	17	11	+	1	3	0	0	900
1996	23	47	15	37	105	144	84	17	51	32	34	9	6	2	605
1997	8	43	6	6	40	20	30	25	7	3	1	2	2	1	194
1998	+	26	28	14	10	13	69	66	49	15	1	6	15	5	317
1999	3	16	114	27	36	53	117	78	67	41	45	11	19	13	640
2000	4	6	6	14	35	22	31	54	81	60	24	24	10	8	379
2001	2	4	3	1	9	16	22	30	34	57	57	50	54	6	344
2002	3	2	4	2	5	22	34	23	88	36	62	64	15	21	379

[1] - Includes some unidentified *Sebastes* specimens, mostly less than 15 cm.

Table D6a *Sebastes mentella*[1]. Abundance indices (**on length**) from the bottom trawl surveys in the Barents Sea in the winter 1986-2003 (numbers in millions). The area coverage was extended from 1993.

	Length group (cm)									
Year	5.0-9.9	10.0-14.9	15.0-19.9	20.0-24.9	25.0-29.9	30.0-34.9	35.0-39.9	40.0-44.9	>45.0	Total
1986	81.3	151.9	205.4	87.7	169.2	129.8	87.5	23.6	13.8	950.2
1987	71.8	25.1	227.4	56.1	34.6	11.4	5.3	1.1	0.1	432.9
1988	587.0	25.2	132.6	182.1	39.6	50.1	47.9	3.6	0.1	1068.
1989	622.9	55.0	28.4	177.1	58.0	9.4	8.0	1.9	0.3	961.0
1990	323.6	304.5	36.4	55.9	80.2	12.9	12.5	1.5	0.2	827.7
1991	395.2	448.8	86.2	38.9	95.6	34.8	24.3	2.5	0.2	1126.
1992	139.0	366.5	227.1	34.6	55.2	34.4	7.5	1.8	0.5	866.6
1993	30.8	592.7	320.2	116.3	24.2	25.0	6.3	1.0	+	1116.
1994	6.9	258.6	289.4	284.3	51.4	69.8	19.9	1.4	0.1	981.8
1995	263.7	71.4	637.8	505.8	90.8	68.8	31.3	3.9	0.5	1674.
1996	213.1	100.2	191.2	337.6	134.3	41.9	16.6	1.4	0.3	1036.
1997[2]	62.8	121.1	24.7	277.9	274.4	72.3	40.7	5.1	0.2	879.0
1998[2]	1.3	90.6	62.8	100.8	203.1	40.7	13.0	1.7	0.2	514.0
1999	2.2	6.8	67.6	36.8	167.4	71.9	21.0	3.1	0.1	376.8
2000	9.0	12.9	39.3	76.8	141.9	97.2	26.6	6.9	1.5	412.1
2001	9.3	22.5	7.0	54.9	77.4	73.2	9.4	0.6	0.1	254.2
2002	16.1	7.2	19.1	41.7	103.9	113.7	22.9	1.4	+	326.0
2003	3.9	3.9	10.0	12.4	70.8	199.8	46.9	6.0	0.3	354.0

[1] - Includes some unidentified *Sebastes* specimens, mostly less than 15 cm.
[2] - Adjusted indices to account for not covering the Russian EEZ in Subarea I.

Table D6b *Sebastes mentella*[1] in Subareas I and II. Preliminary Norwegian bottom trawl indices (**on age**) from the annual Barents Sea survey in February 1992-2003 (numbers in millions). The area coverage was extended from 1993 onwards.

	Age													
Year	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total
1992	351	252	132	56	14	11	3	9	18	16	12	11	2	5	892
1993	38	473	192	242	62	45	19	22	13	11	10	4	2	3	1,136
1994	7	85	332	189	370	228	73	42	3	30	8	14	25	7	1,413
1995	308	45	146	264	364	211	69	23	7	17	23	9	11	10	1,507
1996	173	119	109	114	128	122	106	64	24	19	12	7	8	4	1,009
1997[2]	43	101	19	54	96	43	44	171	76	74	39	29	10	9	808
1998[2]	1	73	49	27	13	52	107	104	41	18	7	4	3	3	502
1999	1	+	32	43	30	24	30	81	79	28	2	1	6	+	357
2000	9	12	21	17	9	39	77	73	50	41	14	10	7	6	385
2001	1	17	8	1	7	22	39	30	34	23	24	17	9	3	236
2002	18	4	12	7	4	14	49	55	27	19	34	24	28	11	306
2003	0	2	2	4	6	6	14	39	24	34	39	65	46	20	301

[1] - Includes some unidentified *Sebastes* specimens, mostly less than 15 cm.
[2] - Adjusted indices to account for not covering the Russian EEZ in Subarea I.

Table D7 *Sebastes mentella* in Subareas I and II. Abundance indices (on age) from the new Norwegian demersal fish survey in August-September 1996-2002 covering the Norwegian Economic Zone (NEZ) and Svalbard incl. the area north and east of Spitsbergen (numbers in thousands).

Year	Age															
	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
1996	146198	112742	22353	53507	165531	181980	108738	43328	65310	40546	38254	19843	29446	10931	17414	1366761
1997	62682	130816	12492	23452	74342	55880	76607	82503	17640	14274	675	2238	1723	633	8765	587223
1998	313	78767	85715	39849	25805	23413	84825	100332	54287	24329	11334	7457	15250	576	25212	577670
1999	5359	23240	117170	47851	41608	76797	128677	73306	58018	64781	49890	13565	18458	12171	24672	755562
2000	5964	23169	14336	19960	52666	68081	83857	77513	100442	72294	71148	36599	17183	20590	26501	690837
2001	5026	6541	10957	1093	19766	25591	36594	51644	44407	61704	50083	86122	53952	15699	31877	507131
2002	9112	6646	7379	3821	8635	28215	47456	63903	103368	49964	76133	71970	25241	36765	34957	573565

Table D8 *Sebastes mentella* in Subareas I and II.
Results of the Russian trawl/acoustic redfish survey in the western Barents Sea in April-May 1992-2001. Abundance indices in millions.

Year	Period of survey	Age																		Total				Area of survey
		1-4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21+	Numbers 10^6	Biomass t 10^3	SSN 10^6	SSB t 10^3	in n.m.^{2}
1992	April	29	27	27	37	36	50	78	39	34	40	44	43	28	17	13	4	7	3	566	218	191	114	25300
1993	April	31	15	13	6	6	20	56	56	38	28	29	27	19	12	7	3	1	2	396	150	151	90	23500
1994												No Data												
1995	May	+	32	51	83	90	41	31	31	41	94	73	48	30	10	9	4	1	+	669	202	211	102	23300
1996												No Data												
1997	Apr-May	86	6	24	102	150	53	48	24	20	26	36	28	11	9	4	2	1	+	630	170	111	58	22400
1998	April	1	+	8	47	77	63	71	46	27	19	23	23	25	6	3	2	1	+	442	153	106	57	22931
1999	Apr-May	11	1	9	14	57	75	63	73	31	25	17	15	11	8	3	1	1	1	415	134	120	55	19333
2000	Apr-May	2	2	14	15	62	100	143	122	54	34	24	29	12	11	7	2	1	1	635	208	114	53	22000
2001	Apr-May	11	1	11	22	24	84	123	134	144	115	78	40	27	19	10	4	+	3	850	316	339	152	23000
2002												No Data												

Table D9 *Sebastes mentella.* Maturity ogives from Russian research vessels. Sexes combined. Data collected during April-June in the Kopytov area (western Barents Sea) and adjacent waters

	1988	1989	1990	1991	1992	1993	1995	1997	1998	1999	2000	2001
7	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.018	0.021	0.000	0.000	0.000
8	0.000	0.000	0.000	0.046	0.000	0.000	0.000	0.000	0.014	0.016	0.000	0.000
9	0.000	0.000	0.012	0.139	0.013	0.033	0.000	0.027	0.000	0.059	0.048	0.082
10	0.028	0.074	0.131	0.174	0.092	0.133	0.055	0.130	0.074	0.110	0.087	0.196
11	0.125	0.178	0.300	0.138	0.169	0.364	0.111	0.312	0.171	0.333	0.202	0.405
12	0.297	0.473	0.688	0.358	0.396	0.480	0.368	0.281	0.276	0.579	0.375	0.442
13	0.562	0.684	0.714	0.470	0.452	0.696	0.587	0.566	0.622	0.689	0.489	0.442
14	0.760	0.716	0.824	0.637	0.761	0.925	0.696	0.736	0.714	0.788	0.742	0.648
15	0.855	0.794	0.848	0.762	0.939	0.962	0.729	0.831	0.871	0.813	0.833	0.775
16	1.000	1.000	1.000	1.000	0.886	0.953	0.789	0.958	0.919	0.903	0.904	0.865
17	1.000	1.000	1.000	1.000	1.000	0.977	1.000	0.950	1.000	0.923	1.000	0.909
18	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

7 SEBASTES MARINUS (GOLDEN REDFISH) IN SUBAREAS I AND II

7.1 Status of the Fisheries

7.1.1 Historical development of the fishery

A description of the historical development of the fishery is found in the Quality handbook for this stock (see Annex….).

Until 1 January 2003 there were no regulations particularly for the *S. marinus* fishery, and the regulations aimed at *S. mentella* (see chapter 6.1.1) had only marginal effects on the *S. marinus* stock. After this date, all directed trawl fishery for redfish (both *S. marinus* and *S. mentella*) is forbidden in the Norwegian Economic Zone north of 62°N and in the Svalbard area. When fishing for other species it is legal to have up to 20% redfish (both species together) in round weight as by-catch per haul and on board at any time.

7.1.2 Landings prior to 2003 (Tables 7.1–7.5, D1 and D2)

Nominal catches of *S. marinus* by country for Subareas I and II combined are presented in Table 7.1 and the totals for both *S. marinus* and *S. mentella* in Tables D1 and D2. Landings of *S. marinus* showed a decrease in 1991 from a level of 23,000–30,000 t in 1984–1990 to a stable level of about 16,000-19,000 t in the years 1991–1999. Since then the landings have decreased further, and the provisional total landings figure for *S. marinus* in 2002 of 9,452 t is the lowest since the mid-1940ies (!).

Information describing the splitting of the redfish landings by species and area is given in Section 6.1.2. The time-series of *S. marinus* landings are given in Table 7.5 and shows a long-term (1908-2002) mean of 17,440 t.

7.1.3 Expected landings in 2003

On the basis of reports from the first months of the year and no directed trawl fishery, the Norwegian landings in 2003 are expected to further decrease to around 4,000 t. The Russian catch is expected to be 800 t. On this basis landings of **5,000 t** are expected in 2003.

7.2 Data Used in the Assessment

7.2.1 Fishing effort and catch-per-unit-effort (Tables D10, Figure 7.1)

Data for *S. marinus* were available for Norwegian freezer trawlers (ISSCFV-code 07, 250–499.9 GRT) since 1981 (Table D10). The total international effort was estimated from these data. Mean CPUEs together with standard errors are presented in Table D10 and Figure 7.1.

A lower but stable effort was observed in 1991-1997 compared to previous years. In 1998-1999 the effort increased to 80% of the 1981-1990 level. In recent years the effort has again decreased and stabilized at the 1991-1997 level. The year, area and month effects are all significant. The provisional figure for 2002 of 0.42 t/hour is the lowest in the time-series. Although the trawl fishery in 2002 was almost unregulated, it is worrying that fewer and fewer fishing days fulfilled the input data requirements when only including days with more than 50% *S marinus* in the catches (from 200-300 days in 1998-2000 to less than 40 days in 2002).

7.2.2 Catch-at-age (Table 7.8).

Catch-at-age data for 2000-2001 were revised. Age composition data for 2002 were provided only by Norway, accounting for 89% of the total landings. Russian catch-at-length from each Subarea and German catch-at-length from Division IIa were converted to catch-at-age by using the Norwegian age-length keys for trawlers in Divisions IIa and IIb. Other countries were assumed to have the same relative age distribution and mean weight as Norway.

7.2.3 Weight-at-age (Table 7.9).

Weight-at-age data for ages 7–24+ were available from the Norwegian landings in 2002.

7.2.4 Maturity-at-age

A maturity ogive was not available for *S. marinus,* and knife-edge maturity-at-age 15 was assumed.

7.2.5 Survey results (Tables 7.6, 7.7, D11a,b-D12a,b, Figures 7.2a,b–7.3a,b)

The results from the following research vessel survey series were evaluated by the Working Group:

1) Norwegian Barents Sea bottom trawl survey (February) from 1986–2003 (joint with Russia since 2000) in fishing depths of 100–500 m. Length compositions for the years 1986–2003 are shown in Table D11a and Fig 7.2a. Age compositions for the years 1992–2003 are shown in Table D11b and Figure 7.2b. This survey covers important nursery areas for the stock

2) Norwegian Svalbard (Division IIb) bottom trawl survey (August-September) from 1985–2002 in fishing depths of 100–500 m. Length compositions for the years 1985–2002 and age compositions for the years 1992–2002 are shown in Table D12a and D12b, respectively. This survey covers the northernmost part of the species' distribution.

Data on length and age from both these surveys have been combined and are shown in Figures 7.3a,b.

3) Catch rates (numbers/nautical mile) and acoustic indices of *Sebastes marinus* from the Norwegian Coastal and Fjord survey in 1995-2002 from Finnmark to Møre (Tables 7.6-7.7).

The bottom trawl surveys covering the Barents Sea and the Svalbard areas show that the abundance indices over the commercial size range (> 25 cm) were relatively stable up to 1998. Since then the abundance has decreased. In addition, fewer pre-recruit sized fish (< 25 cm) will lead to poorer recruitment to the fishable biomass.

Results from the Norwegian Coastal and Fjord survey confirm poor recruitment and also show an overall reduction in the abundance of this species irrespective of fish size (except for fish > 35 cm). Some variation in the results from year to year may be due to a variable number of trawl stations taken in some of the areas from year to year (Table 7.6).

7.3 Results of the Assessment

The current assessment is an update of last year's assessment, and all present available information confirms last years' evaluation of stock status.

The current assessment raises great concern about the stock. Data from both the scientific surveys and commercial CPUE show a very disturbing reduction in fishable biomass. The survey covering the near-coast and fjord resources show an overall reduction in abundance from 1995 to 2002 for all sizes less than 35 cm. Concerns are again expressed about the low number of pre-recruit size groups in all the recent surveys suggesting that future recruitment to the fishery may be poor. Further declines in the stock can therefore be expected in the near future.

S. marinus is considered to be an easier species to age than *S. mentella*, and since it is possible to follow year classes through the input survey data series, a trial XSA run was made which showed a likely stock development. Ongoing work to improve the tuning series as well as a need for more exploratory XSA-analyses, lead the working group to postpone any presentation of possible XSA-analyses. Possible alternative methods to conventional catch-at-age analyses, such as the FLEKSIBEST model, were mentioned also for this redfish stock. This model is closely related to the BORMICON model which currently is used by the ICES North-Western WG on *S. marinus* (Björnsson and Sigurdsson 2003). Preparatory work should be done in order to explore these possibilities.

7.4 Biological reference points

Candidate limit reference point for the biomass or numbers (U_{lim}) could be set at the maximum biomass (or number) level of *S. marinus* above 25 cm, or at a certain percentage of this level, estimated by the Russian and Norwegian trawl surveys for the time period 1986-1997. Such practice is currently used by ICES for the Icelandic redfish stocks (ICES CM 2002/ACFM:20) and is a procedure mentioned and recommended as an alternative by the ICES Study Groups on the Precautionary Approach.

7.5 Management advice

The stock is expected to continue to decline over the next several years as a series of poor year classes will recruit to the fishery. ICES has recommended that a management plan consistent with the precautionary approach to be immediately developed and implemented as a pre-requisite to continued fishing. Such a plan may consider an enlargement of the current by-catch regime, restricted fishing periods, closure of areas and TAC. The Working Group is confident with the new regulations enforced in 2003, but re-iterates the need for a management plan, also including the gillnet fishery directed on unisex shoals of females during the live-bearing period.

Table 7.1 *Sebastes marinus*. Nominal catch (t) by countries in Subarea I and Divisions IIa and IIb combined.

Year	Faroe Islands	France	Germany[2]	Greenland	Iceland	Ireland	Netherlands
1986	29	2,719	3,369	-	-	-	-
1987	250	1,553	4,508	-	-	-	-
1988	No species-specific data presently available on countries						
1989	3	796	412	-	-	-	-
1990	278	1,679	387	1	-	-	-
1991	152	706	981	-	-	-	-
1992	35	1,289	530	623	-	-	-
1993	139	871	650	14	-	-	-
1994	22	697	1,008	5	4	-	-
1995	27	732	517	5	1	1	1
1996	38	671	499	34	-	-	-
1997	3	974	457	23	-	5	-
1998	78	494	131	33	-	19	-
1999	35	35	228	47	14	7	-
2000	17	69	160	8	16	-	-
2001	17	30	238	17	-	1	-
2002[1]	17	29	42	31	3	-	-

Year	Norway	Portugal	Russia[3]	Spain	UK (Eng. & Wales)	UK (Scotland)	Total
1986	21,680	-	2,350	-	42	14	30,203
1987	16,728	-	850	-	181	7	24,077
1988	No species-specific data presently available on countries						25,908
1989	20,662	-	1,264	-	97	-	23,234
1990	23,917	-	1,549	-	261	-	28,072
1991	15,872	-	1.052	-	268	10	19.041
1992	12,700	5	758	2	241	2	16,185
1993	13,137	77	1,313	8	441	1	16,651
1994	14,955	90	1,199	4	135	1	18,120
1995	13,516	9	639	-	159	9	15,616
1996	15,622	55	716	81	229	98	18,043
1997	14,182	61	1,584	36	164	22	17,511
1998	16,540	6	1,632	51	118	53	19,155
1999	16,750	3	1,691	7	135	34	18,986
2000	13,036[1]	16	1,112	-		73[4]	14,507
2001	9,158[1]	7	963	1		119[4]	10,551
2002[1]	8,415	34	832	3		46[4]	9,452

[1] Provisional figures.
[2] Includes former GDR prior to 1991.
[3] USSR prior to 1991.
[4] UK(E&W)+UK(Scot.)

Table 7.2 *Sebastes marinus*. Nominal catch (t) by countries in Subarea I.

Year	Faroe Islands	Germany[4]	Greenland	Iceland	Norway	Russia[5]	UK(Eng &Wales)	UK (Scotland)	Total
1986[3]	-	50	-	-	2,972	155	32	3	3,212
1987[3]	-	8	-	-	2,013	50	11	-	2,082
1988				No species-specific data presently available					
1989	-	-	-	-	1,763	110	4[2]	-	1,877
1990	5	-	-	-	1,263	14	-	-	1,282
1991	-	-	-	-	1,993	92	-	-	2,085
1992	-	-	-	-	2,162	174	-	-	2,336
1993	24[2]	-	-	-	1,178	330	-	-	1,532
1994	12[2]	72	-	4	1,607	109		-	1,804
1995	19[2]	1[2]	-	1[2]	1,947	201	1[2]	-	2,170
1996	7[2]	-	-	-	2,245	131	3[2]	-	2,386
1997	3[2]	-	5[2]	-	2,431	160	2[2]	-	2,601
1998	78[2]	5[2]	-	-	2,109	308	30[2]	-	2,530
1999	35[2]	18[2]	9[2]	14[2]	2,114	360	11[2]	-	2,561
2000	-	1[2]	-	16[2]	1,843[1]	146		12[6]	2,018
2001	-	11[2]	-	-	1,056[1]	128	France	16[6]	1,211
2002[1]	-	5[2]	-	-	678	220	1	9[2,6]	913

[1] Provisional figures.
[2] Split on species according to reports to Norwegian authorities.
[3] Based on preliminary estimates of species breakdown by area.
[4] Includes former GDR prior to 1991.
[5] USSR prior to 1991.
[6] UK(E&W)+UK(Scot.)

Table 7.3 *Sebastes marinus*. Nominal catch (t) by countries in Division IIa.

Year	Faroe Islands	France	Germany[4]	Greenland	Ireland	Netherlands	Norway	Portugal	Russia[5]	Spain	UK (Eng. & Wales)	UK (Scotland)	Total
1986[3]	29	2,719	3,319	-	-	-	18,708	-	2,195	-	10	11	26,991
1987[3]	250	1,553	2,967	-	-	-	14,715	-	800	-	170	7	20,462
1988	No species-specific data presently available												
1989	3[2]	784[2]	412	-	-	-	18,833	-	912	-	93[2]	-	21,037
1990	273	1,684[2]	387	-	-	-	22,444	-	392	-	261	-	25,441
1991	152[2]	706[2]	678	-	-	-	13,835	-	534	-	268[2]	10[2]	16,183
1992	35[2]	1,294[2]	211	614	-	-	10,536	-	404	-	206[2]	2[2]	13,302
1993	115[2]	871[2]	473	14[2]	-	-	11,959	77[2]	940	-	431[2]	1[2]	14,881
1994	10[2]	697[2]	654[2]	5[2]	-	-	13,330	90[2]	1,030	-	129[2]	-	15,945
1995	8[2]	732[2]	328[2]	5[2]	1[2]	1	11,466	2[2]	405	-	158[2]	9[2]	13,115
1996	27[2]	671[2]	448[2]	34[2]	-	-	13,329	51[2]	449	5[2]	223[2]	98[2]	15,335
1997	-	974[2]	438	18[2]	5[2]	-	11,708	61[2]	1,199	36[2]	162[2]	22[2]	14,623
1998	-	494[2]	116[2]	33[2]	19[2]	-	14,326	6[2]	1,078	51[2]	85[2]	52[2]	16,260
1999	-	35[2]	210[2]	38[2]	7[2]	-	14,598	3[2]	976	7[2]	122[2]	34[2]	16,030
2000	17[2]	63[2]	159[2]	8[2]	-	-	11,176[1]	16[2]	658	-		61[6]	12,158
2001	17[2]	30[2]	227[2]	17[2]	1[2]	-	8,023[1]	6[2]	612	1[2]	Iceland	103[2, 6]	9,037
2002[1]	17[2]	28[2]	37[2]	31[2]	-	-	7,632	18[2]	192	2[2]	3[2]	32[2, 6]	7,992

[1] Provisional figures.
[2] Split on species according to reports to Norwegian authorities.
[3] Based on preliminary estimates of species breakdown by area.
[4] Includes former GDR prior to 1991.
[5] USSR prior to 1991.
[6] UK(E&W)+UK(Scot.)

Table 7.4 *Sebastes marinus*. Nominal catch (t) by countries in Division IIb.

Year	Faroe Islands	Germany[5]	Greenland	Norway	Portugal	Russia[6]	Spain	UK(Eng. & Wales)	UK (Scotland)	Total
1986	-									+
1987[4]	-	1533	-	-	-	-	-	-	-	1533
1988	No species-specific data presently available									
1989	-	-	-	66	-	242	-	-	-	308
1990	-	-	1[2]	210	-	1157	-	-	-	1368
1991	-	303	-	44	-	426	-	-	-	773
1992	-	319	9[2]	2	5[2]	180	2	35[2]	-	552
1993	-	177	-	-	-	43	8[3]	10[2]	-	238
1994	-	282	-	18	-	60	4[3]	6[2]	1[2]	371
1995	-	187	-	103	7	33	-	-	-	330
1996	4	51[2]	-	27	5	136	76[2]	3[2]	-	302
1997	-	20	-	43	-	225	-	-	-	288
1998	-	10[2]	-	105	-	246	-	3[2]	-	364
1999	-	-	-	38	-	355	-	2[2]	-	395
2000	-	-	-	17[1]	-	308	-	-	-	325
2001	-	-	-	79[1]	1[2]	223	-	-	-	303
2002[1]	-	-	-	106	16[2]	420	1[2]	-	5[2, 7]	548

[1] Provisional figures.
[2] Split on species according to reports to Norwegian authorities.
[3] Split on species according to the 1992 catches.
[4] Based on preliminary estimates of species breakdown by area.
[5] Includes former GDR prior to 1991.
[6] USSR prior to 1991.
[7] UK(E&W)+UK(Scot.)

Table 7.5 *Sebastes marinus* in Subareas I and II, Total international landings 1908-2002 (thousand tonnes),

Year	Landings '000 t	Year	Landings '000 t
1908	0.65	1957	51.61
1909	1.00	1958	33.12
1910	1.03	1959	28.07
1911	1.01	1960	31.77
1912	1.01	1961	26.73
1913	0.81	1962	22.82
1914	1.14	1963	28.10
915	1.31	1964	26.55
1916	1.46	1965	24.31
1917	1.16	1966	25.63
1918	1.11	1967	17.73
1919	1.51	1968	13.35
1920	1.17	1969	24.07
1921	1.83	1970	12.82
1922	1.47	1971	13.82
1923	1.94	1972	17.73
1924	2.21	1973	21.44
1925	2.72	1974	27.27
1926	3.19	1975	39.13
1927	4.47	1976	48.58
1928	1.95	1977	39.51
1929	5.28	1978	31.74
1930	5.29	1979	26.48
1931	5.88	1980	23.41
1932	6.10	1981	20.83
1933	9.59	1982	16.37
1934	15.86	1983	19.26
1935	17.69	1984	28.38
1936	21.03	1985	29.48
1937	34.59	1986	30.20
1938	39.17	1987	24.08
1939	21.87	1988	25.91
1940	2.29	1989	23.23
1941	1.68	1990	28.07
1942	1.43	1991	19.04
1943	1.02	1992	16.19
1944	0.92	1993	16.65
1945	0.56	1994	18.12
1946	3.57	1995	15.62
1947	14.88	1996	18.04
1948	20.00	1997	17.51
1949	22.36	1998	19.15
1950	25.56	1999	18.99
1951	45.30	2000	14.47
1952	56.17	2001	10.55
1953	34.83	2002	9.45
1954	35.78	Average	17.44
1955	35.47		
1956	43.38		

Table 7.6. *Sebastes marinus*. Mean catch rates (N/nm^2) of *Sebastes marinus* from Norwegian Coastal Surveys in 1995-2002 within 100-350 m depth. Catch rates for the total area are area-weighted means of catch rates from the individual subareas.

Area 3 - East Finnmark								
Length range (cm)	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
0-4	0	0	0	0	0	0	0	0
5-9	244	322	39	0	0	0	3	0
10-14	152	273	98	0	0	17	15	0
15-19	19	157	112	28	2	93	43	0
20-24	69	287	77	33	2	33	52	0
25-29	169	476	268	42	4	50	84	10
30-34	299	333	255	28	15	20	56	48
35-39	112	200	19	8	47	56	24	52
40-44	38	53	27	6	50	43	19	15
45-49	2	16	12	0	11	12	7	0
50-54	2	3	0	0	2	0	2	0
55-59	0	0	0	0	0	0	0	0
60-64	0	0	4	0	0	2	0	0
Total	1106	2120	911	144	134	326	305	125
Measured	398	602	230	52	62	139	111	18
# trawls	23	17	19	16	25	25	22	22
# trawl with species	18	12	16	7	10	8	13	2
Area nm^2	4205							

Area 4 - W.Finnmark/Troms								
Length range (cm)	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
0-4	0	0	0	0	0	0	0	0
5-9	107	19	0	0	0	0	0	0
10-14	318	331	0	2	4	2	5	0
15-19	135	574	10	6	2	26	23	0
20-24	62	698	7	2	8	16	38	10
25-29	24	64	20	50	10	18	28	6
30-34	7	696	40	43	39	49	28	16
35-39	21	796	30	43	55	83	69	16
40-44	7	238	23	22	25	81	57	8
45-49	3	48	3	2	23	56	34	8
50-54	0	0	3	0	8	2	0	0
55-59	0	0	7	0	4	2	2	0
60-64	0	0	0	0	0	0	0	0
Total	684	3463	142	170	178	335	284	63
Measured	198	243	43	54	87	108	92	32
# trawls	15	16	20	21	25	25	24	25
# trawl with species	10	15	9	10	9	10	11	9
Area nm^2	7303							

Area 5 - Lofoten/Vesterålen								
Length range (cm)	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
0-4	0	0	0	0	0	0	0	0
5-9	0	0	0	0	0	0	0	0
10-14	219	21	0	0	31	0	0	0
15-19	149	49	0	0	314	0	0	0
20-24	162	6	0	16	136	3	10	0
25-29	72	27	17	8	9	3	3	12
30-34	133	88	54	18	62	8	16	36
35-39	92	529	324	341	295	239	71	244
40-44	60	133	385	291	263	269	154	309
45-49	11	24	83	50	40	43	61	48
50-54	0	0	0	8	5	3	0	3
55-59	4	0	0	0	0	0	0	0
60-64	0	0	0	0	0	0	0	0
Total	903	878	864	731	1156	568	315	654
Measured	168	185	70	97	148	156	53	139
# trawls	13	14	17	15	22	19	16	16
# trawl with species	9	13	9	9	13	15	6	9
Area nm^2	9962							

Area 0 - Vestfjord								
Length range (cm)	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
0-4	0	0	0	0	0	0	0	0
5-9	0	0	0	0	0	0	0	0
10-14	0	0	0	0	55	0	0	0
15-19	0	0	0	6	711	0	0	0
20-24	0	0	430	26	273	0	0	0
25-29	0	8	587	6	88	8	0	0
30-34	18	41	286	0	88	132	0	85
35-39	454	206	380	58	328	136	366	564
40-44	442	33	361	64	230	182	683	401
45-49	53	8	88	13	0	8	25	24
50-54	9	0	6	6	0	8	12	16
55-59	0	0	0	0	0	0	0	0
60-64	0	0	0	0	0	0	0	0
Total	976	296	2138	180	1772	474	1086	1091
Measured	75	22	162	28	40	38	38	58
# trawls	10	6	11	7	5	6	4	6
# trawl with species	7	3	11	4	3	5	4	6
Area nm^2	5542							

Area 6 - Nordland								
Length range (cm)	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
0-4	0	0	0	0	0	0	0	0
5-9	0	0	0	0	0	0	0	0
10-14	0	0	0	0	0	0	0	0
15-19	0	7	0	0	0	0	8	0
20-24	0	25	5	7	0	0	0	0
25-29	5	15	21	4	0	0	16	4
30-34	28	167	75	15	0	0	8	4
35-39	564	526	225	78	44	20	31	356
40-44	373	599	229	81	61	133	117	246
45-49	52	217	59	19	4	31	31	34
50-54	3	0	5	0	4	0	0	4
55-59	3	0	0	0	4	0	0	0
60-64	0	0	0	0	0	0	0	0
Total	1028	1556	620	204	118	184	211	648
Measured	183	172	91	55	27	36	27	54
# trawls	22	16	12	15	13	12	7	12
# trawl with species	15	12	9	6	4	7	5	7
Area nm^2	9316							

Area 7 - Møre								
Length range (cm)	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
0-4	0	0	0	0	0	0	0	0
5-9	0	0	0	0	0	0	0	0
10-14	0	0	0	0	26	0	0	0
15-19	0	0	0	0	479	0	10	0
20-24	0	0	0	0	557	0	0	0
25-29	0	0	0	0	111	4	29	0
30-34	0	0	0	0	57	9	0	11
35-39	5	14	3	0	114	388	0	284
40-44	14	10	3	0	31	147	10	214
45-49	0	7	3	4	0	9	0	18
50-54	0	0	0	0	0	9	0	0
55-59	0	0	0	0	0	0	0	4
60-64	0	0	0	0	0	0	0	0
Total	19	31	10	4	1374	566	49	530
Measured	4	9	3	1	95	26	5	25
# trawls	11	15	16	13	12	12	7	15
# trawl with species	2	5	3	4	3	5	2	5
Area nm^2	7246							

Table 7.6 (Continued)

Length range (cm)	Total 1995	1996	1997	1998	1999	2000	2001	2002
0-4	0	0	0	0	0	0	0	0
5-9	41	34	4	0	0	0	0	0
10-14	118	87	9	0	19	2	2	0
15-19	59	124	12	4	242	13	11	0
20-24	54	151	64	12	160	7	14	2
25-29	38	67	112	16	34	10	22	6
30-34	69	210	96	17	43	30	15	29
35-39	214	415	178	110	151	160	83	259
40-44	157	209	190	96	117	155	160	213
45-49	21	64	45	18	15	30	30	26
50-54	2	0	2	3	4	4	2	4
55-59	1	0	1	0	2	0	0	1
60-64	0	0	0	0	0	0	0	0
Total	775	1361	715	277	786	411	340	538
Measured	1026	1233	599	287	459	419	326	326
# trawls	94	84	95	87	102	96	80	96
# trawl with species	61	60	57	40	42	49	41	38

Table 7.7 Acoustic index (numbers) of *Sebastes marinus* from the Norwegian Coastal Surveys in 1995-2002, within 5-cm length-groups and total for six subareas.

Length (cm)	Areas 00 and 03-07 1995	1996	1997	1998	1999	2000	2001	2002
5-9	40519	1908	232	0	0	31	4	0
10-14	13627	7656	706	24	519	221	45	0
15-19	8161	11057	1207	96	6926	1112	488	0
20-24	9396	7983	6171	1500	5679	2661	262	106
25-29	4229	10275	12113	81	1183	4310	825	293
30-34	3914	10504	7382	2090	2423	3797	1564	2457
35-39	15711	34437	22440	9914	9082	14036	5391	13317
40-44	13960	19171	28846	5477	7881	14680	12310	10399
45-49	3431	4539	5653	499	1587	2278	1612	4061
50-54	657	8	230	0	376	709	97	300
55-59	519	0	147	0	179	40	33	383
60-64	0	0	20	0	0	18	0	0

Table 7.8 *Sebastes marinus.* Catch numbers at age Numbers*10**-3

YEAR	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
AGE										
6	0	0	4	0	0	0	0	0	0	10
7	0	46	60	9	9	28	78	4	23	17
8	24	7	85	119	98	51	593	13	23	33
9	193	292	230	313	156	206	855	69	44	49
10	359	640	672	361	321	470	572	239	199	137
11	406	816	908	879	686	721	1006	902	346	348
12	1036	1930	1610	1234	1065	968	1230	947	481	620
13	1022	2096	2038	1638	1781	1512	1618	1775	1117	1059
14	1523	2030	2295	2134	2276	1736	1480	1415	1339	1715
15	2353	1601	1783	1675	2172	1582	1612	2132	1670	1274
16	1410	2725	1406	1614	1848	1045	1239	2213	1650	1223
17	1655	2668	785	1390	1421	1277	1407	1723	1241	1143
18	1678	1409	563	952	851	970	1558	754	567	409
19	745	617	670	679	804	1018	1019	484	118	292
20	716	733	593	439	608	846	394	463	183	99
21	534	514	419	560	511	443	197	133	154	97
22	528	256	368	334	205	764	459	231	112	120
23	576	177	250	490	334	486	174	227	135	103
+gp	3482	1508	3232	3135	2131	3389	2131	903	254	221
0 TOTALNUM	18240	20065	17971	17955	17277	17512	17622	14627	9656	8969
TONSLAND	16651	18120	15616	18043	17511	19155	18986	14507	10551	9452
SOPCOF %	104	100	100	105	100	99	103	101	99	100

Table 7.9 *Sebastes marinus.* Catch weights at age (kg)

YEAR	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
AGE										
6	0.00	0.00	0.24	0.00	0.00	0.00	0.00	0.00	0.00	0.13
7	0.00	0.25	0.33	0.22	0.23	0.37	0.14	0.19	0.15	0.22
8	0.33	0.37	0.43	0.49	0.51	0.21	0.26	0.24	0.26	0.28
9	0.36	0.38	0.64	0.56	0.53	0.47	0.44	0.32	0.45	0.34
10	0.43	0.49	0.61	0.65	0.74	0.62	0.57	0.44	0.56	0.45
11	0.51	0.51	0.59	0.71	0.72	0.67	0.69	0.54	0.58	0.59
12	0.51	0.64	0.65	0.81	0.78	0.77	0.78	0.64	0.67	0.70
13	0.64	0.74	0.74	0.84	0.80	0.77	0.86	0.73	0.80	0.76
14	0.64	0.76	0.79	0.88	0.86	0.85	1.04	0.84	0.89	0.88
15	0.76	0.86	0.84	0.96	0.91	1.05	1.07	0.96	1.01	1.02
16	0.86	0.95	0.92	1.00	0.99	0.96	1.12	1.11	1.14	1.14
17	0.89	1.03	1.12	1.02	1.16	1.25	1.18	1.25	1.33	1.25
18	0.98	1.07	1.01	1.01	1.18	1.28	1.71	1.32	1.43	1.34
19	1.00	1.11	1.01	1.00	1.21	1.30	1.09	1.53	1.62	1.49
20	1.03	1.16	1.21	1.03	1.34	1.23	1.18	1.06	1.60	1.87
21	1.21	1.15	1.14	1.04	1.28	1.87	1.04	1.29	1.47	1.79
22	1.03	1.13	1.09	1.14	1.54	1.46	1.34	1.32	2.00	1.99
23	1.20	1.02	1.30	1.09	1.19	1.73	1.18	1.12	2.70	2.22
+gp	1.14	1.36	1.01	1.16	1.29	1.29	1.34	1.20	2.31	1.99

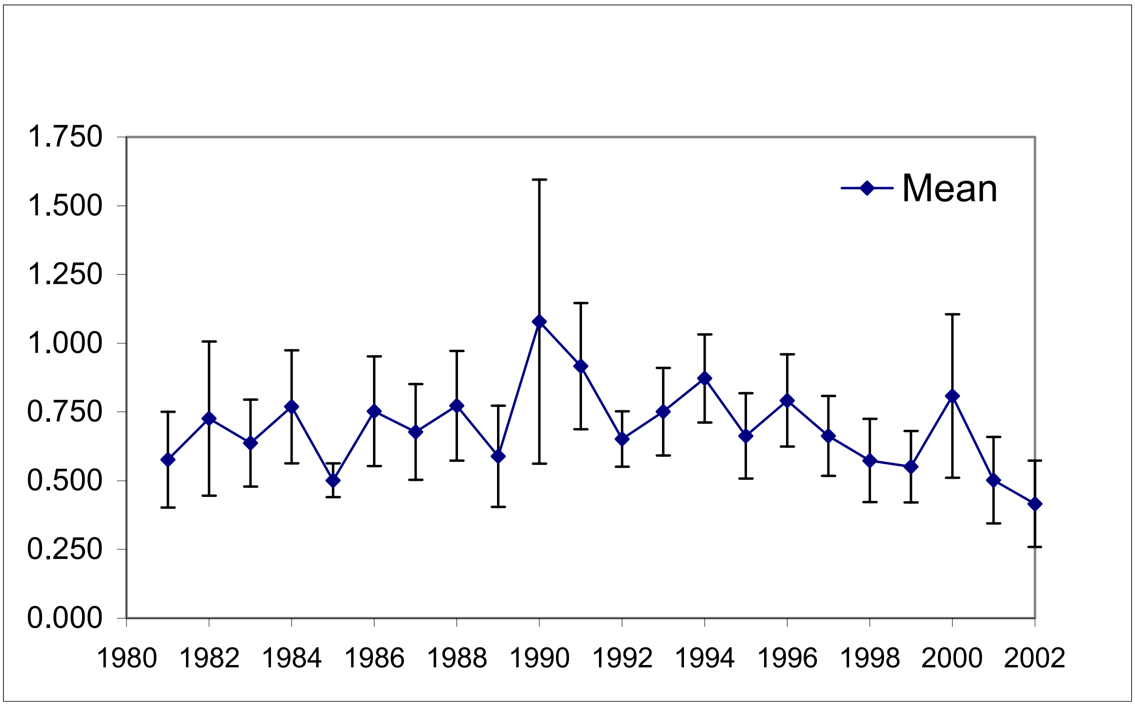
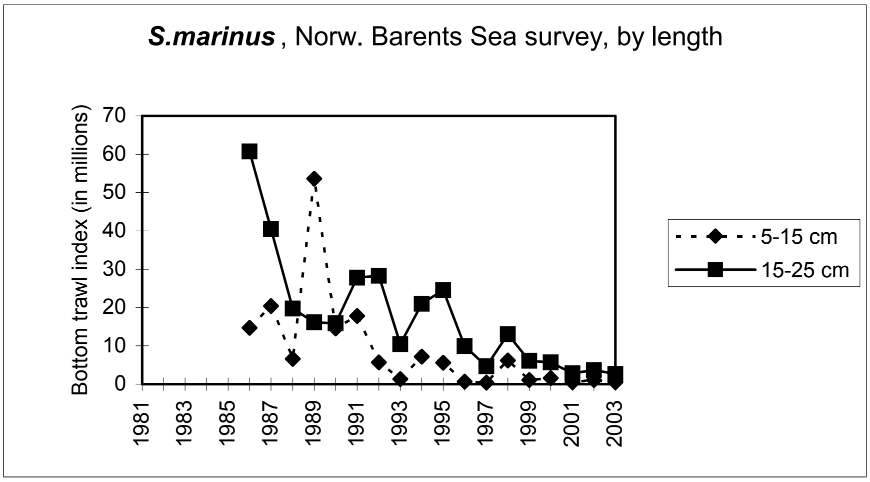


Figure 7.1. *Sebastes marinus.* Plot of simple mean CPUEs with 2 st.errors from the Norwegian trawl fishery. The figure is an illustration of the data given in Table D9.



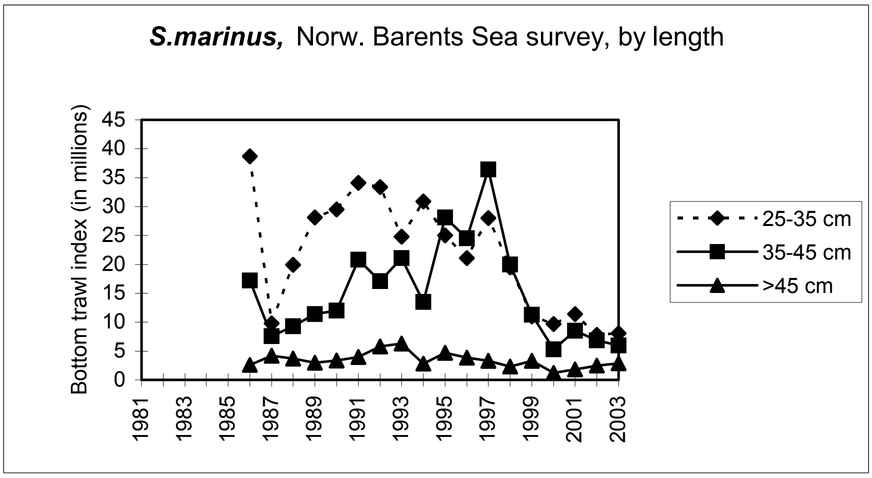
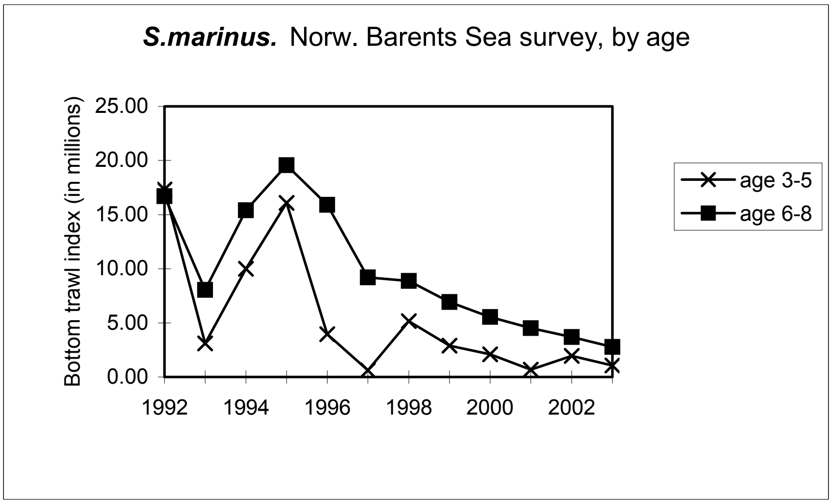


Figure 7.2a. *Sebastes marinus.* Abundance indices **(by length)** from the Norwegian bottom trawl survey in the Barents Sea in winter 1986-2003 (ref. Table D10a).



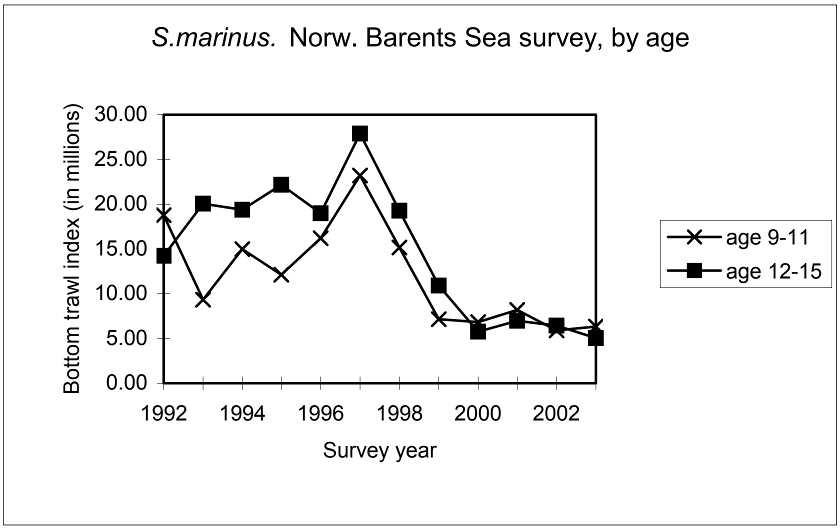
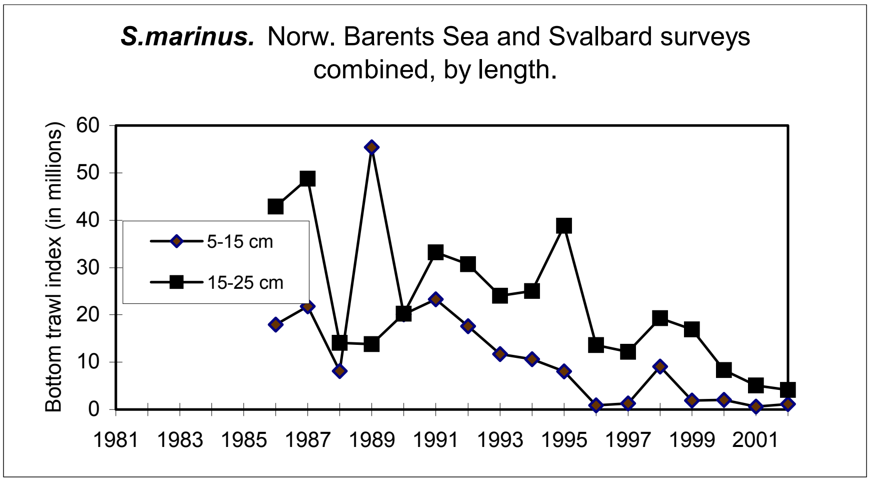


Figure 7.2b. *Sebastes marinus.* Abundance indices (by age) from the Norwegian bottom trawl surveys 1992-2003 in the Barents Sea (ref. Table D10b).



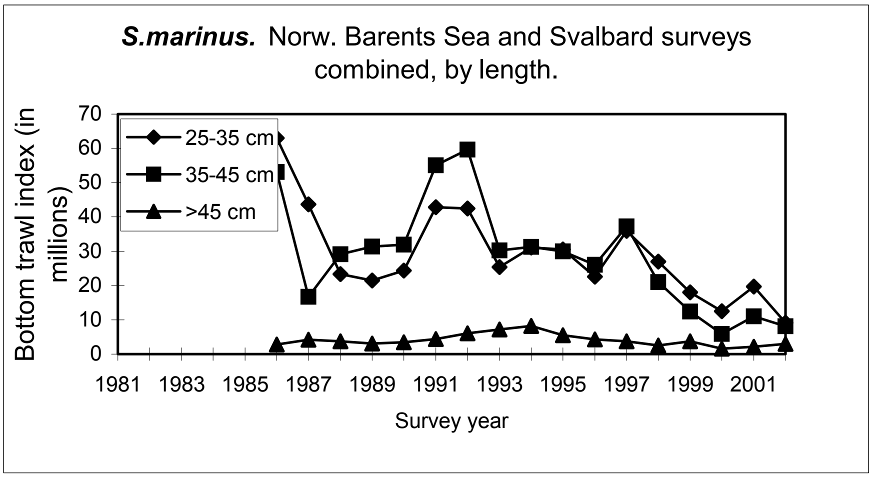
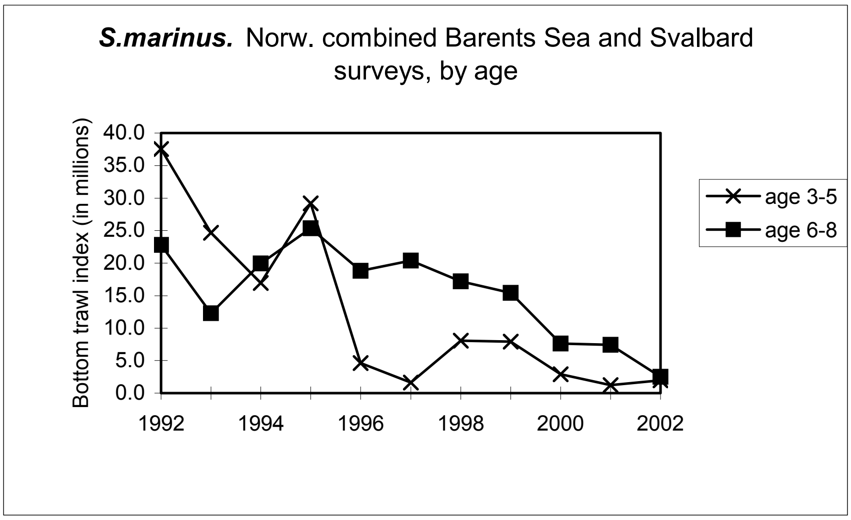


Figure 7.3a. *Sebastes marinus.* Abundance indices (**by length**) when combining the Norwegian bottom trawl surveys 1986-2002 in the Barents Sea (winter) and at Svalbard (summer/fall).



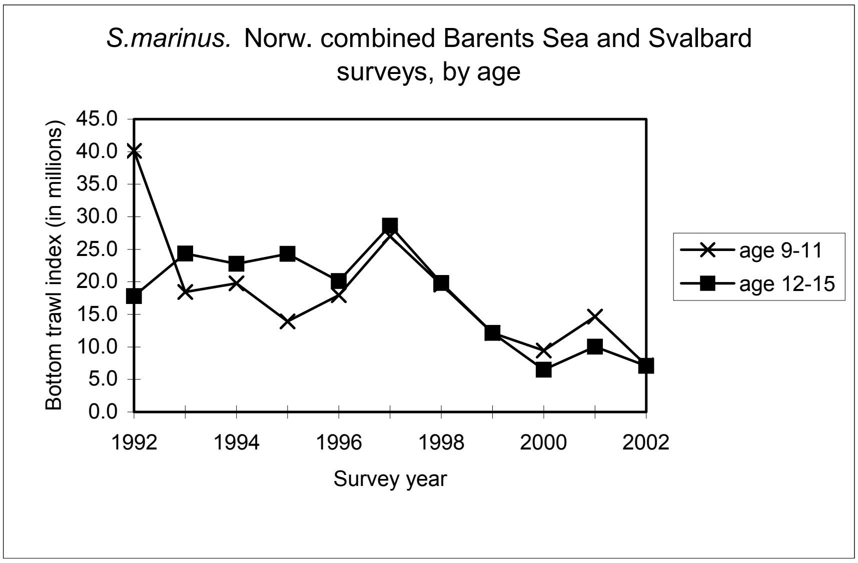


Figure 7.3b. *Sebastes marinus.* Abundance indices (**by age**) when combining the Norwegian bottom trawl surveys 1992-2002 in the Barents Sea (winter) and at Svalbard (summer/fall).

Table D10. *Sebastes marinus*. Catch and catch per unit effort for Norwegian stern trawlers (ISSCFV - Code 07, 250-499,9 GRT), and total international effort (Norwegian trawl units).[1]

Year	Trawlcatch (t) as basis for the analysis	% of total international catch	CPUE (t/hour)	Effort hours trawling
1981	1,315	6.3	0.58	36,194
1982	2,014	12.3	0.73	22,538
1983	1,588	8.3	0.64	30,188
1984	3,960	14.0	0.77	36,960
1985	3,086	10.5	0.50	58,801
1986	4,502	14.9	0.75	40,271
1987	2,168	9.0	0.68	35,407
1988	4,349	16.8	0.77	33,647
1989	3,044	13.1	0.59	39,380
1990	3,589	12.8	1.08	25,993
1991	4,943	26.0	0.92	20,697
1992	2,265	14.0	0.65	24,900
1993	1,426	8.6	0.75	22,201
1994	1,241	6.8	0.87	20,828
1995	928	5.9	0.66	23,661
1996	1,831	10,1	0.79	22,839
1997	1,313	7.4	0.66	26,532
1998	1,681	8,7	0.57	33,605
1999	1,155	6.1	0.55	34,520
2000	2,181	15.0	0.81	17,910
2001	481	4.6	0.50	21,102
2002[2]	308	3.3	0.42	22,505

[1] Only including days with more than 50% *S. marinus* in the catches, and analysed by a GLM-analysis.
[2]Provisional figures.

Table D11a *Sebastes marinus*. Abundance indices **(on length)** from the bottom trawl surveys in the Barents Sea in the winter 1986-2003 (numbers in millions). The area coverage was extended from 1993.

Year	Length group (cm)									Total
	5.0-9.9	10.0-14.9	15.0-19.9	20.0-24.9	25.0-29.9	30.0-34.9	35.0-39.9	40.0-44.9	>45.0	
1986	3.0	11.7	26.4	34.3	17.7	21.0	12.8	4.4	2.6	133.9
1987	7.7	12.7	32.8	7.7	6.4	3.4	3.8	3.8	4.2	82.5
1988	1.0	5.6	5.5	14.2	12.6	7.3	5.2	4.1	3.7	59.2
1989	48.7	4.9	4.3	11.8	15.9	12.2	6.6	4.8	3.0	112.2
1990	9.2	5.3	6.5	9.4	15.5	14.0	8.0	4.0	3.4	75.3
1991	4.2	13.6	8.4	19.4	18.0	16.1	14.8	6.0	4.0	104.5
1992	1.8	3.9	7.7	20.6	19.7	13.7	10.5	6.6	5.8	90.3
1993	0.1	1.2	3.5	6.9	10.3	14.5	12.5	8.6	6.3	63.9
1994	0.7	6.5	9.3	11.7	11.5	19.4	9.1	4.4	2.8	75.4
1995	0.6	5.0	13.1	11.5	9.1	15.9	17.2	10.9	4.7	88.0
1996	+	0.7	3.5	6.4	9.4	11.7	16.6	7.9	3.9	60.1
1997[1]	-	0.5	1.3	2.7	6.9	21.4	28.2	8.5	3.3	72.7
1998[1]	0.1	3.9	2.0	7.4	5.8	25.3	13.2	7.0	2.3	67.0
1999	0.2	0.9	2.1	4.0	4.6	6.4	6.0	5.3	3.5	33.0
2000	0.5	1.1	1.5	4.2	4.7	5.0	3.5	1.8	1.2	24.0
2001	0.1	0.4	0.4	2.4	5.8	5.6	5.0	3.5	1.8	25.0
2002	0.1	1.0	1.9	1.7	3.7	4.1	3.3	3.6	2.5	22.0
2003	0.0	0.5	1.2	1.5	4.3	3.8	2.7	3.3	2.9	20.2

[1] - Adjusted indices to account for not covering the Russian EEZ in Subarea I.

Table D11b *Sebastes marinus* in Subareas I and II. Norwegian bottom trawl indices **(on age)** from the annual Barents Sea survey in February 1992-2003 (numbers in thousands). The area coverage was extended from 1993 onwards.

	Age												
Year	3	4	5	6	7	8	9	10	11	12	13	14	15	Total
1992	2,295	4,261	10,760	2,043	1,474	13,178	4,230	6,302	8,251	3,751	3,865	3,064	3,568	67,042
1993	468	1,218	1,424	2,020	979	5,048	2,968	4,230	2,142	4,634	3,338	2,951	9,148	40,568
1994	2,951	4,485	2,573	3,801	8,338	3,254	1,297	7,231	6,443	248	10,192	6,341	2,612	59,766
1995	2,540	7,450	6,090	7,150	5,820	6,590	5,670	2,000	4,440	6,500	4,320	5,330	6,030	69,930
1996	310	1,300	2,340	3,520	3,660	8,720	5,650	3,960	6,590	5,730	6,230	4,070	2,950	55,030
1997	190	80	360	1,320	2,530	5,370	10,570	6,840	5,810	7,390	8,790	9,740	1,980	60,980
1998	2,380	1,930	850	660	1,140	7,090	6,124	4,962	4,091	5,190	8,790	2,730	2,560	48,487
1999	737	916	1,246	3,469	1,650	1,826	1,679	3,084	2,371	2,953	3,837	2,132	1,979	27,879
2000	490	720	900	1,310	1,800	2,440	2,020	2,710	2,090	940	1,440	2,940	430	20,230
2001	320	170	190	940	1,360	2,220	3,110	2,400	2,690	2,230	2,180	1,200	1,370	20,380
2002	130	910	902	1,590	544	1,546	2,153	1,822	1,900	2,220	1,073	1,294	1,730	17,814
2003[1]	220	250	590	1,080	680	1,020	2,910	1,180	2,250	1,370	1,530	840	1,310	15,230

[1] Preliminary

Table D12a *Sebastes marinus* in Division IIb. Abundance indices (**on length**) from the bottom trawl survey in the Svalbard area (Division IIb) in summer/fall 1985-2002 (numbers in thousands).

	Length group (cm)									
Year	5.0-9.9	10.0-14.9	15.0-19.9	20.0-24.9	25.0-29.9	30.0-34.9	35.0-39.9	40.0-44.9	>45.0	Total
1985[1]	158	1,307	795	1,728	2,273	1,417	311	142	194	8,325
1986[1]	200	2,961	1,768	547	643	1,520	639	467	196	8,941
1987[1]	124	1,343	1,964	1,185	1,367	652	352	29	44	7,060
1988[1]	520	1,001	1,953	1,609	684	358	158	68	95	6,450
1989	197	1,629	2,963	2,374	1,320	846	337	323	104	10,100
1990	1,673	3,886	4,478	4,047	2,972	1,509	365	140	122	19,185
1991	127	5,371	5,821	9,171	8,523	4,499	1,531	982	395	36,420
1992	1,689	10,228	8,858	5,330	13,960	12,720	4,547	494	346	58,172
1993	205	10,160	9,078	5,855	7,071	4,327	2,088	1,552	948	41,284
1994	51	3,340	5,883	4,185	3,922	3,315	1,021	845	423	22,985
1995	470	2,000	9,100	5,070	3,060	2,400	1,040	920	780	24,840
1996	80	130	1,260	2,480	1,030	480	550	990	400	7,400
1997	40	810	1,980	5,470	5,560	2,340	590	190	450	17,430
1998	210	2,698	1,741	4,620	4,053	1,761	535	545	241	16,403
1999	0	794	7,057	3,698	4,563	2,449	467	619	369	20,017
2000	40	360	1,240	1,390	2,010	760	400	160	390	6,750
2001	10	110	790	1,470	3,710	4,600	1,880	680	370	13,660
2002	0	0	64	415	459	880	620	565	519	3,522

[1] - Old trawl equipment (bobbins gear and 80 meter sweep length)

Table D12b *Sebastes marinus* in Subareas I and II. Norwegian bottom trawl survey indices **(on age)** in the Svalbard area (Division IIb) in summer/fall 1992-2002 (numbers in thousands).

	Age													
Year	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total
1992	284	12,378	5,576	2,279	371	2,064	3,687	5,704	9,215	6,413	1,454	1,387	696	22	51,530
1993	32	10,704	5,710	5,142	1,855	1,052	1,314	3,520	2,847	2,757	2,074	1,245	844	119	39,215
1994	429	1,150	3,418	2,393	1,723	1,106	1,714	1,256	1,938	1,596	2,039	484	550	319	20,115
1995	600	1,600	6,400	5,100	1,800	2,200	1,800	700	700	400	700	500	400	500	23,400
1996	40	110	+	560	1,050	940	930	400	1,050	280	320	590	160	70	6,500
1997	320	490	+	480	1,500	6,950	2,720	1,680	800	1,310	550	30	+	120	16,950
1998	210	1,817	881	202	1,555	2,187	4,551	1,913	1,010	797	49	264	73	187	15,696
1999	0	760	2,893	1,339	3,534	1,037	3,905	2,603	762	1,663	481	361	258	152	19,748
2000	40	20	400	350	840	480	730	1,670	620	340	510	100	80	70	6,250
2001	0	40	50	450	330	790	1,760	1,970	3,300	1,200	1,810	150	660	430	12,940
2002	0	0	+	+	65	160	204	326	364	614	442	328	15	0	2,518

8 GREENLAND HALIBUT IN SUBAREAS I AND II

8.1 Status of the fisheries

8.1.1 Landings prior to 2002 (Tables 8.1 - 8.5, E10)

Nominal catches by country for Subareas I and II combined are presented in Table 8.1. Tables 8.2–8.4 give the catches for Subarea I and Divisions IIa and IIb separately. For most countries the catches listed in the tables are similar to those officially reported to ICES. Some of the values in the tables vary slightly from the official statistics, and represents those presented to the Working Group by the members. The tables also incorporate data presented to the Working Group on Spanish survey catches. Landings separated by gear type are presented in Table 8.5.

The revised total catch for 2001 is 16,307 t, which is about 300 t more than used in the previous assessment. The preliminary estimate of the total catch for 2002 is 13,140 t. This is 4,000 t below the projected catch for 2002 estimated by the Working Group during its 2002 meeting.

In recent years, some fishing for Greenland halibut has taken place in the northern part of Division IVa. In the period 1973–1990, the annual catch in Division IVa was usually well below 100 t, occasionally reaching 200 t. Since then, catches increased sharply from 558 t in 1991 to 2,010 t in 1996 (Table E10). Catches remained comparatively high until they dropped to below 900 t in 2000. The increase from 1973 to 1991 was due mainly to a gillnet fishery. In recent years most of the catch has been taken by trawl. This fishery is in another management area and is not restricted by any TAC regulations. Although there is a continuous distribution of this species from the southern part of Division IIa along the continental slope towards the Shetland area, little is known about the stock structure and the catch taken from this area has therefore not been added to the catch from Subareas I and II.

Around Jan Mayen, small catches of Greenland halibut have been taken in some years. In the period 1992–97 the reported annual catches were 56, 0, 140, 270, 59, and 54 respectively. In the period 1998 – 1999 no catches were reported from this area. In the period 2000 - 2002 catches in this area were around 60 t. Jan Mayen is within Subarea IIa, but little is known about the relationship with the stock assessed by the Arctic Fisheries Working Group. Catches from this area have therefore not been included in the catches given for Subarea II.

8.1.2 Expected landings in 2003

The fishery for Greenland halibut is regulated by quotas that should be taken by gillnetters and longliners within a restricted time period, and by restricting allowed by-catch in the trawl fishery. The total Norwegian catch in 2003 is expected to be 9,400 t. In addition 5,000 t is expected to be caught by Russian vessels and 600 t by other countries. Expected total landings (officially) for 2003 are thus 15,000 t. It is believed that there may be additional landings that are not reported.

The catches from Division IVa are expected to be maintained at the same level as last year.

8.2 Status of research

8.2.1 Survey results (Tables A14, E1-E8)

Over the last several years the Working Group has been concerned about trends in catchability within individual surveys used for tuning of the XSA. The trends were seen for younger ages of year classes in the late 80's and early 90's that were initially estimated very low in abundance. With increasing age these year classes were estimated much closer to the mean abundance. In previous meetings the Working Group therefore increased the lower age used in tuning to five years in order to reduce the problem. This only partly solved the problem though, and in all subsequent assessments estimated recruitment of the last 2-3 years has increased from one year to the next.

Most of the surveys considered by the Working Group in 2002 cover either the adult population in the slope area or juvenile distribution in northern areas. The problem of underestimation of recruitment in the last few years included in the analyses has been attributed to shortcomings in survey coverage. The Working Group has at previous meetings noted the need for annual surveys that sample most of the population within a short period of time. Prior to the 2002 WG meeting effort was therefore made to combine some of these surveys into a new total index. The new index is termed the Norwegian Combined Survey Index and is established back to 1996, the first year with survey coverage northeast of Svalbard. It includes bottom trawls from the Norwegian bottom trawl survey in August in the Barents Sea and Svalbard (Tables E1 and E2), the Norwegian Greenland halibut survey in August along the continental slope (Table E3), and the Norwegian bottom trawl survey in August-September north and east of Svalbard (Table E4). Prior to the meeting in 2003 work was done to evaluate the combination of these survey series into one index and this was reported to the Working Group (Pennington, WD 5). Based on these results it was decided to use the combined index in this years assessment.

The Norwegian Combined Survey Index (Table E5) indicates a significant increase in the total stock during the last three years and a stock size in 2002, nearly 40% above last years index. However, there is no clear year class pattern in the data and some ages are consistently underestimated relative to adjacent age groups (e.g. age 9 and partly age 4). The highest indices were observed for age seven, with exception of the two last years when age 1 was most abundant. That indicates that the catchability of younger ages (i.e. those primarily from northern surveys) are not comparable with the older ones (i.e. those primarily from the slope). This is probably a result of pooling different surveys using different gears. These weaknesses reduce the applicability of the combined surveys, and the Working Group advises that further work be done to improve the combined index in the future.

Also in the Russian bottom trawl surveys in October-December (Table E6) it is difficult to identify year classes that appear consistently either strong or weak across ages. In previous Working Group reports this survey series was the one with the clearest and strongest trends in catchability with age. These surveys usually cover large parts of the total known distribution of the Greenland halibut within 100–900 m depth. In 2002, no observations were made in the Exclusive Economic Zone of Norway (NEZ). Greenland halibut abundance for 2002 over the whole standard area was estimated based on the assumption that in 2002 the Greenland halibut stock was proportionately distributed the same as in 2001 (Smirnov, WD 22). As is seen from Table 1 in WD 22 conversion factors of the Greenland halibut abundance are lowest for smaller fish and highest (>4) for larger fish. This is believed to be a result of mature individuals migrating to the spawning area in the NEZ during the survey period. The results indicate a continuing increase in abundance and biomass of Greenland halibut in the Barents Sea and adjacent waters. Nevertheless, the magnitude of the increase should be treated with caution given the high conversion factors associated with the larger fish.

The Spanish bottom trawl survey results (Table E7) differ from the two survey series above and indicate reduced abundance in this area during the last three years. The Norwegian Bottom trawl Survey in the Barents Sea in winter (Table E8) shows no clear trend in the total abundance.

Although representing a larger part of the stock, the new combined survey indices were not successful in establishing consistency in the relative size of year classes at age. Future inclusion of northern parts of the Russian zone may improve the index. Also the joint Russian-Norwegian research program on Greenland halibut may eventually contribute by increasing our understanding of the processes involved. The main objectives are to clarify the migration dynamics of the stock, including vertical distribution and relations with Greenland halibut in other areas. The results may improve both biological sampling and the subsequent assessments.

Abundance indices of 0-group Greenland halibut are shown in Table A14. There has been a significant increase of this index the last three years.

8.2.2 Commercial catch-per-unit-effort (Table 8.6 and E9)

The CPUE from the experimental fishery was found to be considerably higher than in the traditional fishery and has exhibited an increasing trend from 1992–1996. After 1996 the Norwegian CPUE series has varied between 1200 and 1650 kg/h with the highest value in 2000 (Table E9). The Russian experimental CPUE series shows an increasing trend since 1997, and this series also shows the highest value in 2000.

8.2.3 Age readings

In the current assessment of the Greenland halibut stock, the problem of low abundance at age 9 in the Norwegian data from surveys and catches remains unresolved. Analysis of size composition suggested that the problem is more likely to be related to age reading uncertainties rather than to peculiarities in distribution and migration. At present, work is underway to address this problem for the future including comparative age reading by Russian and Norwegian experts. In addition, work will be done to revise the historical time-series and results from this work will be submitted to the next AFWG meeting for review.

8.3 Data used in the assessment

Based on the arguments in Section 8.2.1 the Working Group also this year considers the survey indices for ages below age 5 not appropriate for inclusion in the tuning data. Consequently, a standard XSA was run for age 5 and above.

8.3.1 Catch-at-age (Table 8.7 – 8.8)

The catch-at-age data for 2001 were updated using revised catch figures and revised Norwegian age composition. Catch-at-age data for 2002 were available from both the Norwegian and Russian fisheries. The combined Norwegian and Russian catch-at-age were used to allocate catches from other countries by age groups. Total international catch-at-age is given in Table 8.7. Greenland halibut are usually caught in the range of 3–16 years old, but the catch is mainly dominated by ages 5–10. Generally, fish older than age 10 comprise a very low proportion of the catches. The Working Group noted that similar low numbers of age 9 were observed in the catches.

8.3.2 Weight-at-age (Table 8.7, 8.8)

For the years 1964-1969 separate weight-at-age data were used for the Norwegian and the Russian catches. Both data sets were mean values for the period and were combined as a weighted average for each year. A constant set of weight-at-age data was used for the total catches in the years 1970–1978. For subsequent years annual estimates were used. The mean weight-at-age in the catch in 2002 (Table 8.8) was calculated as a weighted average of the weight in the catch from Norway and Russia. The weight-at-age in the stock was set equal to the weight-at-age in the catch for all years.

8.3.3 Natural mortality

Natural mortality of Greenland halibut was set to 0.15 for all ages and years. This is the same assumption as was used in previous years.

8.3.4 Maturity-at-age (Tables 8.9)

Annual ogives were derived to estimate the spawning stock biomass based on females only using Russian survey data for the years 1984–2002, except for the year 1991. An average ogive computed for 1984–1987 was applied to 1964–1983. The average of 1990 and 1992 was used to represent the maturity ogive for 1991. For 1984-2002 a three-year running average was applied. In previous assessments a similar procedure using the same data set was implemented but was based on sexes combined.

8.3.5 Tuning data

The XSA was run with the same tuning series as used in last year's assessment :

Fleet 4: Experimental commercial fishery CPUE from 1992–2002 for ages 5–14.
Fleet 7: Russian trawl survey from 1992-2002 for ages 5-14.
Fleet 8: Norwegian Combined Survey from 1996-2002 for ages 5-15.

A XSA-run with the Norwegian tuning series truncated to ages 5-9 with no plus group was done (xsaaag47), but the diagnostics did not improve and there were only minor changes in the result. It was therefore decided to use the same tuning data as last year.

8.3.6 Recruitment indices (Tables A14, E1-E9)

In addition to the indices mentioned in Section 8.3.5, all surveys in Section 8.2.1 may provide information on recruitment. However, because the dynamics of migration and distribution patterns are not well understood for this stock, it is not known which age should be used for a reliable recruitment estimate. As outlined in previous Working Group reports there is no longer evidence for a major recruitment failure in the 1990's. Nevertheless, the relative size of the individual year classes is still poorly estimated, especially at ages below 5 years and for the most recent years. Since recruitment appears remarkably stable for this stock, the short-term prediction was therefore based on mean numbers-at-age 5 for the years 1990-2000 from the XSA.

8.4 Methods used in the assessment

8.4.1 VPA and tuning

The Extended Survivors Analysis (XSA) was used to tune the VPA to the fleets as mentioned in Section 8.3.5. The analyses used survivor estimates shrunk towards the mean of the final 2 years and 5 ages and the standard error of the mean to which the estimates were shrunk was set to 0.5. The catchability was considered to be independent of stock size for all ages and independent of age for ages 10 and older. These are the same settings as used in last years assessment.

Input data and diagnostics of the final XSA run are given in Tables 8.7-8.10 and log catchability residuals for the three fleets used in the tuning are shown in Figure 8.1. Figure 8.2 shows that the three fleets gave similar trends when used separately for tuning.

8.5 Results of the Assessment

The diagnostics of the assessment indicate that it is generally unbiased, and describes the trend in stock development reasonably well. The survivor estimates for 2003 for most of the important year classes are determined primarily from the tuning fleet data and in most instances each tuning fleet contributes significantly to the determinations with little effect from inclusion of F shrinkage means in the tuning process. Nevertheless, the assessment diagnostics also indicated substantial uncertainties in absolute values of the survivor estimates determined by the analysis shown by instances of very high residuals, large S.E. (log q)'s and low R^2's in the regression statistics for certain fleets and ages.

8.5.1 Results of the VPA (Figures 8.3-8.4, Tables 8.11-8.15)

The fishing mortality (F) matrix indicates that historically Greenland halibut were fully recruited to the fishery at approximately age 6–7. Since 1991 the age of full recruitment appears closer to age 10 (Table 8.11). This is likely due to a substantial proportional reduction in trawler effort since 1991 combined with reduced catchability of some year classes in the fishing areas. Trawlers catch more young fish compared to gillnetters and longliners. Nevertheless, F on ages 6–10 continues to represent the average fishing mortality on the major age groups procecuted by the fishery.

Until 1976 the female spawning stock varied between 60,000 and 140,000 t, then it was relatively stable at around 40,000 t until the late 1980's after which it declined markedly. It reached an all time low of 14,000 t by 1995-96 but has been increasing since then to an estimate of 28,000 by 2002, the highest estimated since the late 1980's. .

Prior to the reduction in the early 1990's the fishing mortality had increased continuously for more than a decade and peaked in 1991 at 0.66. After the reduction the fishing mortality has averaged around 0.3. The high catch in 1999 resulted in an increase in fishing mortality to 0.40 but since then has declined to 0.20 by 2002, the lowest value estimated for the last 20 years.

Recruitment-at-age 5 has been relatively low in recent years compared to the long-term average, and since 1990 lower than in all previous years. Nevertheless, the reduction is not especially dramatic and the 1990-2002 average is about 80% of the average during the 1980's. The 2001 and 2002 values are near the average of the last 13 years

8.5.2 Biological reference points

In its previous assessment of Greenland halibut the WG attempted to compute preliminary biological reference points using the traditional PA Software Package. The Working Group emphasised that this analysis was meant only to illustrate a first attempt at moving towards appropriate reference points for this stock. Given the continuing levels of uncertainty in the current assessment no further attempts were made to develop reference points for this stock. The WG reiterates that a major joint three-year scientific program on Greenland halibut is currently under way between Russia and Norway and is in the second year of the program. As one of its terms of reference the program aims to develop appropriate biological reference points for this stock to be proposed for management of this important resource.

8.5.3 Catch options for 2004

The input data for the prediction based on the results from the XSA-analysis are as follows (Table 8.16):

The stock numbers-at-age in 2003 were taken from the XSA for ages 6 and older. The recruitment-at-age 5 in 2003 was estimated using the mean from 1990 to 2000 following the argument that recruitment-at-age 5 shows a sharp reduction in the most recent years in the previous assessments, which is not believed to reflect the true recruitment. The natural mortality and the maturity ogive are the same as used in the assessment. For the exploitation pattern the average of 2000-2002 has been used. For weight-at-age in the catch and stock, the average weight-at-age for the last three years in the VPA has been used.

The management option table (8.17) shows that the expected catch of 15,000 t in 2003 will decrease the fishing mortality (F_{2003}=0.22) slightly in comparison with $F_{Bar00-02}$. The total stock biomass and SSB will be slightly increased

(90,000 t and 34,800 t respectively). To further rebuild the stock and SSB, future fishing mortality should not exceed current level.

8.6 Comparison of this years assessment with last years assessment

Compared to last years assessment, the current one has revised previous year's fishing mortality for 2002 downwards and the stock level upwards. This is mainly because the youngest age groups in the tuning are estimated to be slightly higher in abundance than in previous years.

	Total stock (5+) by 1 January 2002	SSB by 1 January 2002	F6-10 in 2002	F6-10 in 2001
WG 2002	77161	23344	0.31*	0.27
WG 2003	82474	28497	0.20	0.27

*Prediction

8.7 Comments to the assessment

The current assessment was conducted using the same catch matrix, surveys series and settings as in the previous year with only the updated data for 2002. The assessment is considered uncertain due to age-reading problems and evidence of unreported landings that could not be taken into account. Despite the continuing uncertainties in the assessment of this stock as noted above, the current analysis indicated only marginal differences in the stock size and fishing mortality values for 2005 compared to the previous assessment.

Table 8.1 GREENLAND HALIBUT in Sub-areas I and II.
Nominal catch (t) by countries (Subarea I,Divisions IIa and IIb combined) as officially reported to ICES.

Year	Den-mark	Estonia	Faroe Isl.	France	Fed. Rep. Germany	Greenl.	Iceland	Ireland	Lithuania	Norway	Poland	Portugal	Russia[3]	Spain	UK (Engl. & Wales)	UK (Scotland)	Total
1984	0	0	0	138	2 165	0	0	0	0	4 376	0	0	15 181	0	23	0	21 883
1985	0	0	0	239	4 000	0	0	0	0	5 464	0	0	10 237	0	5	0	19 945
1986	0	0	42	13	2 718	0	0	0	0	7 890	0	0	12 200	0	10	2	22 875
1987	0	0	0	13	2 024	0	0	0	0	7 261	0	0	9 733	0	61	20	19 112
1988	0	0	186	67	744	0	0	0	0	9 076	0	0	9 430	0	82	2	19 587
1989	0	0	67	31	600	0	0	0	0	10 622	0	0	8 812	0	6	0	20 138
1990	0	0	163	49	954	0	0	0	0	17 243	0	0	4 764 [2]	0	10	0	23 183
1991	11	2564	314	119	101	0	0	0	0	27 587	0	0	2 490 [2]	132	0	2	33 320
1992	0	0	16	111	13	13	0	0	0	7 667	0	31	718	23	10	0	8 602
1993	2	0	61	80	22	8	56	0	30	10 380	0	43	1 235	0	16	0	11 933
1994	4	0	18	55	296	3	15	5	4	8 428	0	36	283	1	76	2	9 226
1995	0	0	12	174	35	12	25	2	0	9 368	0	84	794	1 106	115	7	11 734
1996	0	0	2	219	81	123	70	0	0	11 623	0	79	1 576	200	317	57	14 347
1997	0	0	27	253	56	0	62	2	0	7 661	12	50	1 038	157 [2]	67	25	9 410
1998	0	0	57	67	34	0	23	2	0	8 435	31	99	2 659	259 [2]	182	45	11 893
1999 [1]	0	0	94	0	34	38	7	2	0	15 004	8	49	3 823	319 [2]	94	45	19 517
2000 [1]	0	0	0	45	15	0	16	0	0	9 223 [2]	3	37	4 568	375 [2]	112	43	14 437
2001 [1]	0	0	0	122	58	0	9	1	0	10 843 [2]	2	35	4 694	413 [2]	100	30	16 307
2002 [1]	0	219	0	6	42	0	0	0	0	7 013 [2]	5	16	5 584	186 [2]	41	28	13 140

[1] Provisional figures.
[2] Working Group figures.
[3] USSR prior to 1991.

TABLE 8.2 GREENLAND HALIBUT in Sub-areas I and II. Nominal catch (t) by countries in Sub-area I as officially reported to ICES.

Year	Estonia	Faroe Islands	Fed. Rep. Germany	Greenland	Iceland	Norway	Russia[3]	Spain	UK (England & Wales)	UK (Scotland)	Total
1984	-	-	-		-	593	81	-	17	-	691
1985	-	-	-		-	602	122	-	1	-	725
1986	-	-	1		-	557	615	-	5	1	1 179
1987	-	-	2		-	984	259	-	10	+	1 255
1988	-	9	4		-	978	420	-	7	-	1 418
1989	-	-	-		-	2039	482	-	+	-	2 521
1990	-	7	-		-	1304	321 [2]	-	-	-	1 632
1991	164	-	-		-	2 029	522 [2]	-	-	-	2 715
1992	-	-	+	-	-	2 349	467	-	-	-	2 816
1993	-	32	-	-	56	1 754	867	-	-	-	2 709
1994	-	17	217	-	15	1 165	175	-	+	-	1 589
1995	-	12	-	-	25	1 352	270	84	-	-	1 743
1996	-	2	+	-	70	911	198	-	+	-	1 181
1997	-	15	-	-	62	610	170	-	+	-	857
1998	-	47	+	-	23	859	491	-	2	-	1 422
1999 [1]	-	91	-	13	7	1101	1203	-	+	-	2 415
2000 [1]	-	-	+	-	16	920	1169	-	1	-	2 106
2001 [1]	-	-	-	-	9	821 [2]	951	-	2	-	1 783
2002 [1]	-	-	3	-	+	792 [2]	1167	-	+	-	1 962

[1] Provisional figures.

[2] Working Group figures.

[3] USSR prior to 1991.

Table 8.3. GREENLAND HALIBUT in Sub areas I and II. Nominal catch (t) by countries in Division IIa as officially reported to ICES.

Year	Estonia	Faroe Islands	France	Fed. Rep. Germ.	Green-land	Ire-land	Norway	Portu-gal	Russia[5]	Spain	UK (Engl. & Wales)	UK (Scot-land)	Total
1984		-	138	265	-	-	3 703	-	5 459	-	1	-	9 566
1985		-	239	254	-	-	4 791	-	6 894	-	2	-	12 180
1986		6	13	97	-	-	6 389	-	5 553	-	5	1	12 064
1987		-	13	75	-	-	5 705	-	4 739	-	44	10	10 586
1988		177	67	150	-	-	7 859	-	4 002	-	56	2	12 313
1989		67	31	104	-	-	8 050	-	4 964	-	6	-	13 222
1990		133	49	12	-	-	8 233	-	1 246 [2]	-	1	-	9 674
1991	1 400	314	119	21	-	-	11 189	-	305 [2]	-	+	1	13 349
1992	-	16	108	1	13 [4]	-	3 586	15 [3]	58	-	1	-	3 798
1993	-	29	78	14	8 [4]	-	7 977	17	210	-	2	-	8 335
1994	-	-	47	33	3 [4]	4	6 382	26	67	+	14	-	6 576
1995	-	-	174	30	12 [4]	2	6 354	60	227	-	83	2	6 944
1996	-	-	219	34	123 [4]	-	9 508	55	466	4	278	57	10 744
1997	-	-	253	23	- [4]	-	5 702	41	334	1	21	25	6 400
1998	-	-	67	16	- [4]	1	6 661	80	530	5	74	41	7 475
1999 [1]				20	25 [4]	2	13 064	33	734	1	63	45	13 987
2000 [1]			43	10	[4]		7 774	18	690	1	65	43	8 644
2001 [1]			122	49	[4]	1	8 895 [2]	13	726		56	30	9 892
2002 [1]			6	9	[4]		5 776 [2]	5	849	8	12	28	6 693

[1] Provisional figures.

[2] Working Group figure.

[3] As reported to Norwegian authorities.

[4] Includes Division IIb.

[5] USSR prior to 1991.

Table 8.4 GREENLAND HALIBUT in Sub-areas I and II.
Nominal catch (t) by countries in Division IIb as officially reported to ICES.

Year	Den mark	Estoni a	Faroe Islands	Franc e	Fed. rep. Germ.	Irela nd	Lithu ania	Norway	Pola nd	Portug al	Russia[4]	Spain	UK (Engl. & Wales)	UK (Scot land)	Total
1984	-		-	-	1 900	-		80	-	-	9 641	-	5	-	11 626
1985	-		-	-	3 746	-		71	-	-	3 221	-	2	-	7 040
1986	-		36	-	2 620	-		944	-	-	6 032	-	+	-	9 632
1987	+		-	-	1 947	-		572	-	-	4 735	-	7	10	7 271
1988	-		-	-	590	-		239	-	-	5 008	-	19	+	5 856
1989	-		-	-	496	-		533	-	-	3 366	-	-	-	4 395
1990	-		23 [2]	-	942	-		7 706	-	-	3 197 [2]	-	9	-	11 877
1991	11	1 000	-	-	80	-	-	14 369	-	-	1 663 [2]	132	+	1	17 256
1992	-	-	-	3 [2]	12	-	-	1 732	-	16	193	23	9	-	1 988
1993	2 [3]	-	-	2 [3]	8	-	30 [3]	649	-	26	158	-	14	-	889
1994	4	-	1 [3]	8 [3]	46	1	4 [3]	881	-	10	41	1	62	2	1 061
1995	-	-	-	-	5	-	-	1 662	-	24	297	1022	32	5	3 047
1996	+	-	-	-	47	-	-	1 204	-	24	912	196	39	+	2 422
1997	-	-	12	-	33	2	-	1 349	12	9	534	156 [2]	46	+	2 153
1998	-	-	10	-	18	1	-	915	31	19	1 638	254 [2]	106	4	2 996
1999 [1]	-	-	3	-	14	-	-	839	8	16	1 886	318 [2]	31	-	3 115
2000 [1]	-	-		2	5		-	529	3	19	2 709	374 [2]	46	-	3 687
2001 [1]	-	-		+	9	-	-	1 127 [2]	2	22	3 017	413 [2]	42	-	4 632
2002 [1]	-	219		+	30	-	-	445 [2]	5	11	3 568	178 [2]	29	-	4 485

[1] Provisional figures.

[2] Working Group figure.

[3] As reported to Norwegian authorities.

[4] USSR prior to 1991.

Table 8.5 GREENLAND HALIBUT in the Sub-areas I and II.
Landings by gear (tonnes). Approximate figures, the total may differ slightly from Table 8.1

Year	Gillnet	Longline	Trawl	Total
1980	1 189	336	11 759	13 284
1981	730	459	13 829	15 018
1982	748	679	15 362	16 789
1983	1 648	1 388	19 111	22 147
1984	1 200	1 453	19 230	21 883
1985	1 668	750	17 527	19 945
1986	1 677	497	20 701	22 875
1987	2 239	588	16 285	19 112
1988	2 815	838	15 934	19 587
1989	1 342	197	18 599	20 138
1990	1 372	1 491	20 325	23 188
1991	1 904	4 552	26 864	33 320
1992	1 679	1 787	5 787	9 253
1993	1 497	2 493	7 889	11 879
1994	1 403	2 392	5 353	9 148
1995	1 500	4 034	5 494	11 028
1996	1 480	4 616	7 977	14 073
1997	998	3 378	5 198	9 574
1998	1 327	3 891	6 708	11 926
1999	2 565	6 804	9 981	19 350
2000	1 707	5 029	7 656	14 393
2001	2 041	6 303	7 635	15 979
2002	1 737	5 309	6 350	13 396

Table 8.6. GREENLAND HALIBUT in Sub-areas I and II. Catch per unit effort and total effort.

Year	USSR catch/hour trawling (t)		Norway[10] catch/hour trawling (t)		Average CPUE		Total effort (in '000 hrs trawling)[5]	CPUE 7+[6]	GDR[7] (catch/day tonnage (kg)
	RT[1]	PST[2]	A[8]	B[9]	A[3]	B[4]			
1965	0.80	-	-	-	0.80	-	-	-	-
1966	0.77	-	-	-	0.77	-	-	-	-
1967	0.70	-	-	-	0.70	-	-	-	-
1968	0.65	-	-	-	0.65	-	-	-	-
1969	0.53	-	-	-	0.53	-	-	-	-
1970	0.53	-	-	-	0.53	-	169	0.50	-
1971	0.46	-	-	-	0.46	-	172	0.43	-
1972	0.37	-	-	-	0.37	-	116	0.33	-
1973	0.37	-	0.34	-	0.36	-	83	0.36	-
1974	0.40	-	0.36	-	0.38	-	100	0.36	-
1975	0.39	0.51	0.38	-	0.39	0.45	99	0.37	-
1976	0.40	0.56	0.33	-	0.37	0.45	100	0.34	-
1977	0.27	0.41	0.33	-	0.30	0.37	96	0.26	-
1978	0.21	0.32	0.21	-	0.21	0.27	123	0.17	-
1979	0.23	0.35	0.28	-	0.26	0.32	67	0.19	-
1980	0.24	0.33	0.32	-	0.28	0.33	47	0.25	-
1981	0.30	0.36	0.36	-	0.33	0.36	42	0.28	-
1982	0.26	0.45	0.41	-	0.34	0.43	39	0.37	-
1983	0.26	0.40	0.35	-	0.31	0.38	58	0.32	-
1984	0.27	0.41	0.32	-	0.30	0.37	59	0.30	-
1985	0.28	0.52	0.37	-	0.33	0.45	44	0.37	-
1986	0.23	0.42	0.37	-	0.30	0.40	57	0.32	-
1987	0.25	0.50	0.35	-	0.30	0.43	44	0.35	-
1988	0.20	0.30	0.31	-	0.26	0.31	63	0.26	4.26
1989	0.20	0.30	0.26	-	0.23	0.28	73	0.19	2.95
1990	-	0.20	0.27	-	-	0.24	95	0.16	1.66
1991	-	-	0.24	-	-	-	134	0.18	-
1992	-	-	0.46	0.72	-	-	20	0.29	-
1993	-	-	0.79	1.22	-	-	15	0.65	-
1994	-	-	0.77	1.27	-	-	11	0.70	-
1995	-	-	1.03	1.48	-	-	-	-	-
1996	-	-	1.45	1.82	-	-	-	-	-
1997	0.71	-	1.23	1.60	-	-	-	-	-
1998	0.71	-	0.98	1.35	-	-	-	-	-
1999	0.84	-	0.82	1.77	-	-	-	-	-
2000	0.94	-	1.38	1.92	-	-	-	-	-
2001	0.82 [11]	-	1.18	1.57	-	-	-	-	-
2002		-	1.07	1.82	-	-	-	-	-

1 Side trawlers, 800-1000 hp. From 1983 onwards, side trawlers (SRTM), 1,000 hp. From 1997 based on research fishing.

2 Stern trawlers, up to 2,000 HP.

3 Arithmetic average of CPUE from USSR RT (or SRTM trawlers) and Norwegian trawlers.

4 Arithmetic average of CPUE from USSR PST and Norwegian trawlers.

5 For the years 1981-1990, based on average CPUE type B. For 1991-1993, based on the Norwegian CPUE, type A.

6 Total catch (t) of seven years and older fish divided by total effort.

7 For the years 1988-1989, frost-trawlers 995 BRT (FAO Code 095). For 1990, factory trawlers FVS IV, 1943 BRT (FAO Code 090).

8 Norwegian trawlers, ISSCFV-code 07, 250-499.9 GRT.

9 Norwegian factory trawlers, ISSCFV-code 09, 1000-1999.9 GRT

10 From 1992 based on research fishing. 1992-1993: two weeks in May/June and October; 1994-1995: 10 days in May/June

11 Based on fishery from april-october only, a period with relatively low CPUE. In previous years fishery was carried out throughout the whole year.

Table 8.7

Run title : Arctic Green.halibut (run: XSAAAG46/X46)
At 25/04/2003 12:23

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

YEAR,	1964,	1965,	1966,	1967,	1968,	1969,	1970,	1971,	1972,
AGE									
5,	372,	253,	170,	156,	114,	1064,	526,	80,	1109,
6,	1480,	853,	563,	332,	283,	2420,	2792,	4486,	3521,
7,	2808,	1735,	1106,	623,	452,	3208,	10464,	12712,	9605,
8,	5674,	3868,	2715,	2006,	1976,	6288,	18562,	12283,	6438,
9,	4951,	4203,	4054,	3237,	3923,	4921,	10034,	6130,	2775,
10,	3981,	3799,	2499,	2409,	2950,	4431,	6671,	4339,	1734,
11,	1853,	1799,	1284,	1718,	2234,	2381,	2517,	2703,	1368,
12,	1018,	1002,	783,	871,	792,	812,	1250,	1660,	1234,
13,	364,	372,	246,	315,	146,	229,	616,	1044,	675,
14,	251,	282,	261,	155,	43,	100,	1104,	300,	200,
+gp,	76,	50,	28,	19,	7,	30,	281,	143,	80,
0 TOTALNUM,	22828,	18216,	13709,	11841,	12920,	25884,	54817,	45880,	28739,
TONSLAND,	40391,	34751,	26321,	24267,	26168,	43789,	89484,	79034,	43055,
SOPCOF %,	100,	100,	101,	100,	100,	103,	94,	104,	98,

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

YEAR,	1973,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,	1982,
AGE										
5,	212,	917,	840,	830,	2037,	1897,	2218,	731,	1896,	1304,
6,	1117,	2519,	2337,	2982,	3255,	3589,	3155,	1138,	1917,	1494,
7,	3923,	6204,	6520,	5824,	4200,	4118,	2727,	1665,	1919,	1276,
8,	3515,	3838,	4118,	5002,	2524,	2365,	1234,	1341,	933,	1208,
9,	2551,	1834,	2265,	3000,	1610,	1509,	495,	944,	484,	1493,
10,	1919,	1942,	1654,	1350,	1104,	946,	319,	473,	448,	1258,
11,	1536,	1622,	1857,	915,	1062,	934,	296,	511,	482,	838,
12,	1127,	1338,	1536,	1212,	858,	438,	243,	275,	380,	502,
13,	716,	734,	1122,	698,	595,	349,	103,	242,	384,	324,
14,	251,	531,	600,	526,	384,	147,	45,	145,	150,	108,
+gp,	126,	216,	368,	358,	180,	112,	51,	78,	62,	46,
0 TOTALNUM,	16993,	21695,	23217,	22697,	17809,	16404,	10886,	7543,	9055,	9851,
TONSLAND,	29938,	37763,	38172,	36074,	28827,	24617,	17312,	13284,	15018,	16789,
SOPCOF %,	92,	98,	88,	93,	101,	105,	104,	109,	107,	100,

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

YEAR,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,
AGE										
5,	1543,	915,	1219,	1672,	1212,	907,	2080,	2139,	3312,	1098,
6,	1864,	3698,	2874,	3335,	2972,	2540,	4453,	5163,	3889,	1195,
7,	1851,	3350,	2561,	2712,	3572,	3141,	3655,	4642,	4716,	1069,
8,	2287,	1938,	1548,	1531,	1746,	2096,	1657,	1932,	2355,	778,
9,	1491,	1064,	972,	1128,	752,	1182,	801,	1221,	1031,	360,
10,	1228,	1191,	1037,	997,	828,	860,	318,	499,	1284,	600,
11,	713,	602,	614,	530,	362,	481,	228,	264,	774,	188,
12,	488,	340,	363,	434,	202,	313,	126,	314,	673,	150,
13,	247,	171,	161,	314,	186,	133,	120,	42,	177,	79,
14,	201,	132,	120,	305,	63,	140,	140,	96,	266,	89,
+gp,	64,	71,	63,	239,	7,	47,	28,	44,	517,	56,
0 TOTALNUM,	11977,	13472,	11532,	13197,	11902,	11840,	13606,	16356,	18994,	5662,
TONSLAND,	22147,	21883,	19945,	22875,	19112,	19587,	20138,	23183,	33320,	8602,
SOPCOF %,	98,	100,	99,	98,	101,	100,	103,	102,	105,	95,

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

YEAR,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,
AGE										
5,	1140,	631,	846,	1034,	330,	359,	433,	380,	441,	288,
6,	1088,	708,	992,	2083,	921,	1116,	1905,	735,	1347,	944,
7,	1608,	1252,	1719,	3795,	1822,	2466,	3955,	1926,	2338,	1632,
8,	1118,	817,	990,	1426,	953,	1464,	1810,	1464,	1325,	1043,
9,	140,	310,	405,	262,	342,	527,	914,	743,	788,	550,
10,	976,	642,	726,	655,	822,	924,	1905,	1318,	1140,	958,
11,	444,	416,	461,	270,	231,	237,	380,	457,	519,	500,
12,	144,	330,	371,	132,	150,	122,	237,	330,	372,	336,
13,	36,	88,	154,	29,	18,	15,	67,	49,	115,	148,
14,	20,	39,	56,	22,	41,	29,	42,	37,	54,	67,
+gp,	4,	3,	8,	1,	1,	15,	7,	14,	12,	43,
0 TOTALNUM,	6718,	5236,	6728,	9709,	5631,	7274,	11655,	7453,	8451,	6509,
TONSLAND,	11933,	9226,	11734,	14347,	9410,	11893,	19517,	14437,	16307,	13140,
SOPCOF %,	102,	99,	101,	101,	99,	100,	102,	101,	100,	100,

Table 8.8

Run title : Arctic Green.halibut (run: XSAAAG46/X46)

At 25/04/2003 12:23

Table 2 Catch weights-at-age (kg)

	YEAR,	1964,	1965,	1966,	1967,	1968,	1969,	1970,	1971,	1972,
	AGE									
	5,	.4200,	.4200,	.4200,	.4200,	.4200,	.4200,	.5670,	.5670,	.5670,
	6,	.6400,	.6400,	.6400,	.6500,	.6600,	.6400,	.7370,	.7370,	.7370,
	7,	.9000,	.9000,	.9100,	.9300,	.9600,	.9100,	1.0790,	1.0790,	1.0790,
	8,	1.2000,	1.2200,	1.2400,	1.2700,	1.3100,	1.2500,	1.4210,	1.4210,	1.4210,
	9,	1.6300,	1.6600,	1.7000,	1.7100,	1.7400,	1.6400,	1.8480,	1.8480,	1.8480,
	10,	2.2600,	2.2300,	2.2200,	2.2000,	2.1900,	2.2500,	2.2810,	2.2810,	2.2810,
	11,	3.1100,	3.0000,	2.9400,	2.8400,	2.7900,	2.9900,	2.8870,	2.8870,	2.8870,
	12,	3.7400,	3.4900,	3.3900,	3.3000,	3.1900,	3.6300,	3.2470,	3.2470,	3.2470,
	13,	4.5700,	4.4000,	4.3800,	4.2700,	4.2700,	4.6800,	4.3030,	4.3030,	4.3030,
	14,	5.0100,	4.9100,	4.8400,	4.8800,	5.0000,	5.3800,	4.9310,	4.9310,	4.9310,
	+gp,	5.9400,	5.8900,	5.8800,	5.8000,	5.9900,	5.9900,	5.7940,	5.8410,	6.0370,
0	SOPCOFAC,	.9986,	1.0046,	1.0054,	1.0024,	.9994,	1.0262,	.9436,	1.0434,	.9752,

Table 2 Catch weights-at-age (kg)

	YEAR,	1973,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,	1982,
	AGE										
	5,	.5670,	.5670,	.5670,	.5670,	.5670,	.5670,	.9000,	.7020,	.6600,	.6900,
	6,	.7370,	.7370,	.7370,	.7370,	.7370,	.7370,	1.2000,	.8720,	.8400,	.8400,
	7,	1.0790,	1.0790,	1.0790,	1.0790,	1.0790,	1.0790,	1.5000,	1.1410,	1.1500,	1.0300,
	8,	1.4210,	1.4210,	1.4210,	1.4210,	1.4210,	1.4210,	1.8000,	1.4680,	1.5600,	1.3100,
	9,	1.8480,	1.8480,	1.8480,	1.8480,	1.8480,	1.8480,	2.2000,	1.7780,	2.0400,	1.7400,
	10,	2.2810,	2.2810,	2.2810,	2.2810,	2.2810,	2.2810,	2.6000,	2.3020,	2.5700,	2.2400,
	11,	2.8870,	2.8870,	2.8870,	2.8870,	2.8870,	2.8870,	3.0000,	2.6640,	2.9800,	2.7700,
	12,	3.2470,	3.2470,	3.2470,	3.2470,	3.2470,	3.2470,	3.5000,	3.0460,	3.4300,	3.3700,
	13,	4.3030,	4.3030,	4.3030,	4.3030,	4.3030,	4.3030,	4.1000,	3.3680,	4.1300,	4.3200,
	14,	4.9310,	4.9310,	4.9310,	4.9310,	4.9310,	4.9310,	4.8000,	4.2850,	4.6800,	5.3500,
	+gp,	6.0060,	5.9640,	5.9100,	5.9230,	6.0270,	5.9060,	6.1760,	5.3460,	5.9990,	5.8330,
0	SOPCOFAC,	.9231,	.9825,	.8805,	.9255,	1.0095,	1.0485,	1.0364,	1.0894,	1.0680,	1.0038,

Table 2 Catch weights-at-age (kg)

	YEAR,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,
	AGE										
	5,	.7500,	.6300,	.6000,	.6200,	.7090,	.7400,	.7600,	.7100,	.7700,	.6800,
	6,	1.0400,	.9600,	.8900,	.9200,	1.0030,	.9620,	1.0300,	1.0600,	1.0500,	.9700,
	7,	1.3400,	1.1800,	1.2000,	1.2800,	1.2660,	1.2490,	1.3200,	1.2900,	1.3800,	1.2700,
	8,	1.5700,	1.5300,	1.8500,	1.9000,	1.6830,	1.6260,	1.8000,	1.7000,	1.7500,	1.7600,
	9,	1.9700,	2.3100,	2.5900,	2.4800,	2.4820,	2.1640,	2.4200,	2.1000,	2.2000,	2.2100,
	10,	2.7300,	2.8700,	3.1800,	3.1100,	2.9820,	2.8970,	3.1300,	2.6100,	2.6000,	2.5600,
	11,	3.2900,	3.4600,	3.6200,	3.3500,	3.5470,	3.4060,	3.3700,	2.8700,	2.7900,	3.1100,
	12,	4.2200,	3.7700,	3.9500,	3.7200,	3.8000,	3.6610,	4.0500,	3.4500,	3.2800,	3.5900,
	13,	4.7100,	3.9900,	4.4800,	4.0000,	4.5600,	4.2470,	4.2900,	3.7200,	3.8900,	3.8300,
	14,	6.0800,	4.3500,	4.2500,	4.1800,	5.0020,	4.1870,	4.5000,	4.0900,	4.3800,	4.2500,
	+gp,	6.1220,	4.5250,	4.8250,	4.5260,	5.9530,	4.4630,	4.7200,	4.5200,	5.2900,	4.8000,
0	SOPCOFAC,	.9783,	1.0009,	.9858,	.9782,	1.0116,	.9973,	1.0346,	1.0204,	1.0470,	.9519,

Table 2 Catch weights-at-age (kg)

	YEAR,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,
	AGE										
	5,	.7900,	.7200,	.7300,	.7700,	.7700,	.7300,	.7000,	.7600,	.7400,	.7200,
	6,	1.0200,	.9400,	.9400,	.9700,	.9400,	.9300,	.9500,	.9700,	1.0300,	.9600,
	7,	1.3500,	1.2700,	1.2500,	1.3100,	1.2800,	1.3000,	1.2700,	1.3300,	1.3900,	1.3900,
	8,	1.8800,	1.7200,	1.7400,	1.7400,	1.6400,	1.6100,	1.5500,	1.6300,	1.7500,	1.7000,
	9,	2.4600,	2.1900,	2.0900,	2.2400,	2.0700,	2.1200,	2.0000,	2.1100,	2.2900,	2.2200,
	10,	2.6700,	2.5200,	2.5100,	2.5900,	2.5900,	2.5700,	2.4600,	2.6100,	2.6800,	2.6400,
	11,	3.4300,	2.9700,	2.9500,	3.2900,	3.3000,	3.2500,	3.2200,	3.3500,	3.3300,	3.2000,
	12,	4.2900,	3.2900,	3.3400,	4.0200,	4.0100,	3.9100,	3.8500,	3.9700,	3.9200,	3.8400,
	13,	5.0800,	3.8400,	3.8300,	4.7500,	4.8300,	4.9000,	4.6100,	4.9700,	4.8100,	4.5100,
	14,	6.3300,	4.9500,	4.9800,	6.2400,	5.9500,	5.6600,	5.8400,	5.8200,	5.8100,	5.4800,
	+gp,	8.9100,	6.6800,	8.1500,	6.0900,	6.2600,	4.9100,	5.9800,	7.2200,	7.4100,	6.2600,
0	SOPCOFAC,	1.0183,	.9937,	1.0095,	1.0066,	.9851,	.9983,	1.0172,	1.0055,	1.0014,	1.0031,

Table 8.9

Run title : Arctic Green.halibut (run: XSAAAG46/X46)

At 25/04/2003 12:23

Table 5 Proportion mature at age

YEAR,	1964,	1965,	1966,	1967,	1968,	1969,	1970,	1971,	1972,
AGE									
5,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
6,	.0300,	.0300,	.0300,	.0300,	.0300,	.0300,	.0300,	.0300,	.0300,
7,	.0300,	.0300,	.0300,	.0300,	.0300,	.0300,	.0300,	.0300,	.0300,
8,	.2100,	.2100,	.2100,	.2100,	.2100,	.2100,	.2100,	.2100,	.2100,
9,	.6700,	.6700,	.6700,	.6700,	.6700,	.6700,	.6700,	.6700,	.6700,
10,	.8600,	.8600,	.8600,	.8600,	.8600,	.8600,	.8600,	.8600,	.8600,
11,	.9800,	.9800,	.9800,	.9800,	.9800,	.9800,	.9800,	.9800,	.9800,
12,	.9800,	.9800,	.9800,	.9800,	.9800,	.9800,	.9800,	.9800,	.9800,
13,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
14,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
+gp,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,

Table 5 Proportion mature at age

YEAR,	1973,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,	1982,
AGE										
5,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
6,	.0300,	.0300,	.0300,	.0300,	.0300,	.0300,	.0300,	.0300,	.0300,	.0300,
7,	.0300,	.0300,	.0300,	.0300,	.0300,	.0300,	.0300,	.0300,	.0300,	.0300,
8,	.2100,	.2100,	.2100,	.2100,	.2100,	.2100,	.2100,	.2100,	.2100,	.2100,
9,	.6700,	.6700,	.6700,	.6700,	.6700,	.6700,	.6700,	.6700,	.6700,	.6700,
10,	.8600,	.8600,	.8600,	.8600,	.8600,	.8600,	.8600,	.8600,	.8600,	.8600,
11,	.9800,	.9800,	.9800,	.9800,	.9800,	.9800,	.9800,	.9800,	.9800,	.9800,
12,	.9800,	.9800,	.9800,	.9800,	.9800,	.9800,	.9800,	.9800,	.9800,	.9800,
13,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
14,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
+gp,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,

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Table 5 Proportion mature at age

YEAR,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,
AGE										
5,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
6,	.0300,	.0400,	.0400,	.0300,	.0100,	.0100,	.0100,	.0100,	.0100,	.0100,
7,	.0300,	.0300,	.0400,	.0300,	.0200,	.0100,	.0200,	.0200,	.0400,	.0600,
8,	.1800,	.1800,	.1900,	.2400,	.2200,	.2100,	.1800,	.1700,	.1500,	.2800,
9,	.6000,	.6100,	.6500,	.7400,	.6600,	.5300,	.4900,	.5100,	.5400,	.6600,
10,	.8200,	.8300,	.8500,	.9100,	.9000,	.8700,	.8000,	.7700,	.7700,	.8600,
11,	.9600,	.9700,	.9700,	.9900,	.9500,	.8900,	.8900,	.9100,	.8900,	.8700,
12,	.9800,	.9800,	.9900,	.9800,	.9800,	.9800,	1.0000,	1.0000,	1.0000,	1.0000,
13,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
14,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
+gp,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,

Table 5 Proportion mature at age

YEAR,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,
AGE										
5,	.0100,	.0100,	.0100,	.0000,	.0000,	.0000,	.0000,	.0000,	.0100,	.0200,
6,	.0100,	.0100,	.0100,	.0000,	.0000,	.0000,	.0000,	.0100,	.0300,	.0400,
7,	.0800,	.0700,	.0800,	.0700,	.0700,	.0400,	.0200,	.0300,	.0600,	.0900,
8,	.3200,	.3400,	.2900,	.2500,	.2100,	.1000,	.0700,	.1000,	.1900,	.2600,
9,	.6800,	.6900,	.5800,	.5800,	.5300,	.4500,	.3300,	.3700,	.4900,	.6300,
10,	.8300,	.8100,	.7900,	.8800,	.8500,	.8200,	.6600,	.6300,	.6500,	.7200,
11,	.8800,	.9500,	.9600,	.9700,	.9400,	.9200,	.8600,	.8700,	.8400,	.9100,
12,	.9400,	.9400,	.8900,	.9400,	.9400,	1.0000,	.9900,	.9600,	.9600,	.9600,
13,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
14,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
+gp,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,

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Table 8.10

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Lowestoft VPA Version 3.1
   25/04/2003  12:21

 Extended Survivors Analysis

 Arctic Green.halibut (run: XSAAAG46/X46)

 CPUE data from file fleet

 Catch data for  39 years. 1964 to 2002. Ages  5 to  15.

      Fleet,            First, Last, First, Last, Alpha,  Beta
                    ,    year, year,  age ,  age
 FLT04: Norw. Exp. CP,   1992, 2002,   5,    14,   .380,   .440
 FLT07: Russ.Surv. ne,   1992, 2002,   5,    14,   .750,   .920
 FLT08: Norw.Comb.Sur,   1996, 2002,   5,    14,   .550,   .720

 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 >=   10

 Terminal population estimation :

      Survivor estimates shrunk towards the mean F
      of the final   2 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   39 iterations

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

 Fishing mortalities
    Age,  1993,  1994,  1995,  1996,  1997,  1998,  1999,  2000,  2001,  2002

      5,  .100,  .038,  .055,  .067,  .020,  .024,  .032,  .022,  .030,  .019
      6,  .159,  .079,  .074,  .175,  .075,  .084,  .163,  .067,  .097,  .079
      7,  .371,  .261,  .264,  .415,  .217,  .275,  .446,  .234,  .295,  .154
      8,  .397,  .308,  .320,  .345,  .163,  .256,  .315,  .276,  .237,  .196
      9,  .075,  .171,  .233,  .123,  .122,  .121,  .238,  .195,  .222,  .138
     10,  .596,  .532,  .707,  .680,  .651,  .522,  .772,  .597,  .482,  .432
     11,  .507,  .516,  .883,  .587,  .510,  .367,  .397,  .392,  .468,  .380
     12,  .494,  .845, 1.206,  .639,  .725,  .524,  .725,  .676,  .606,  .596
     13,  .319,  .604, 1.272,  .239,  .153,  .132,  .579,  .295,  .496,  .486
     14,  .455,  .640,  .951,  .556,  .586,  .369,  .615,  .700,  .580,  .571

XSA population numbers (Thousands)

                                AGE
 YEAR ,          5,           6,           7,           8,           9,          10,          11,
12,          13,          14,

 1993 ,    1.29E+04, 8.00E+03, 5.59E+03, 3.68E+03, 2.10E+03, 2.34E+03, 1.20E+03, 3.98E+02, 1.42E+02, 5.90E+01,
 1994 ,    1.82E+04, 1.00E+04, 5.87E+03, 3.32E+03, 2.13E+03, 1.68E+03, 1.11E+03, 6.24E+02, 2.09E+02, 8.89E+01,
 1995 ,    1.71E+04, 1.51E+04, 7.98E+03, 3.89E+03, 2.10E+03, 1.54E+03, 8.47E+02, 5.71E+02, 2.31E+02, 9.83E+01,
 1996 ,    1.72E+04, 1.40E+04, 1.20E+04, 5.27E+03, 2.43E+03, 1.43E+03, 6.55E+02, 3.01E+02, 1.47E+02, 5.56E+01,
 1997 ,    1.78E+04, 1.38E+04, 1.01E+04, 6.84E+03, 3.21E+03, 1.85E+03, 6.23E+02, 3.13E+02, 1.37E+02, 9.97E+01,
 1998 ,    1.62E+04, 1.50E+04, 1.10E+04, 6.99E+03, 5.00E+03, 2.45E+03, 8.31E+02, 3.22E+02, 1.31E+02, 1.01E+02,
 1999 ,    1.47E+04, 1.36E+04, 1.19E+04, 7.22E+03, 4.66E+03, 3.82E+03, 1.25E+03, 4.95E+02, 1.64E+02, 9.85E+01,
 2000 ,    1.87E+04, 1.22E+04, 9.95E+03, 6.54E+03, 4.53E+03, 3.16E+03, 1.52E+03, 7.24E+02, 2.07E+02, 7.92E+01,
 2001 ,    1.60E+04, 1.58E+04, 9.86E+03, 6.78E+03, 4.27E+03, 3.21E+03, 1.50E+03, 8.83E+02, 3.17E+02, 1.32E+02,
 2002 ,    1.64E+04, 1.34E+04, 1.23E+04, 6.31E+03, 4.60E+03, 2.94E+03, 1.71E+03, 8.07E+02, 4.15E+02, 1.66E+02,

 Estimated population abundance at 1st Jan 2003

   ,     0.00E+00, 1.38E+04, 1.06E+04, 9.08E+03, 4.47E+03, 3.45E+03, 1.64E+03, 1.00E+03, 3.83E+02, 2.19E+02,
 Taper weighted geometric mean of the VPA populations:

   ,     1.61E+04, 1.29E+04, 9.39E+03, 5.52E+03, 3.40E+03, 2.31E+03, 1.09E+03, 5.55E+02, 2.36E+02, 1.31E+02,
 Standard error of the weighted Log(VPA populations) :

   ,       .1740,    .2366,    .2820,    .2865,    .3243,    .3108,    .3597,    .4585,    .5784,    .7141,
```

Table 8.10 (Continued)

Log catchability residuals.

Fleet : FLT04: Norw. Exp. CP

Age	1992
5	-.06
6	-.32
7	-.65
8	-.34
9	-1.27
10	-.64
11	-.41
12	-.10
13	-.55
14	-1.54

Age	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
5	.51	.26	.42	.69	.68	-.84	-.54	-.18	-.45	-.22
6	-.06	.06	-.22	.66	.10	-.16	-.10	-.06	-.01	.01
7	-.06	-.04	-.04	.19	-.07	-.04	-.13	.31	.06	.23
8	.02	.12	.13	.02	-.36	-.21	-.24	-.06	.70	.12
9	-1.23	-.74	.48	-.03	.18	.00	-.86	.44	1.19	1.03
10	-.10	.10	.57	-.16	.30	-1.24	.03	.29	.19	.49
11	-.33	-.40	.02	-.84	.37	-1.17	-1.31	-1.31	-.44	-.36
12	-.38	-1.02	.00	-.89	.31	-1.00	.38	-.28	.10	-.16
13	-.27	-.94	-.36	99.99	-.01	99.99	-.71	.20	-.71	-1.68
14	-.43	-.77	-.05	-.33	-.21	99.99	-.19	99.99	-.49	.37

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

Age	5	6	7	8	9	10	11	12	13	14
Mean Log q	-4.7006	-3.9282	-3.0999	-3.5435	-4.7144	-3.3981	-3.3981	-3.3981	-3.3981	-3.3981
S.E(Log q)	.5355	.2497	.2354	.3069	.8398	.5330	.8296	.5818	.8373	.6310

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
5	.68	.385	6.27	.16	11	.39	-4.70
6	.80	.658	5.00	.59	11	.21	-3.93
7	.69	2.000	4.97	.84	11	.14	-3.10
8	1.02	-.054	3.45	.50	11	.33	-3.54
9	.52	1.187	6.34	.44	11	.43	-4.71
10	.96	.084	3.59	.30	11	.54	-3.40
11	1.93	-.955	1.23	.12	11	1.08	-3.98
12	.77	.718	4.26	.54	11	.40	-3.66
13	-29.62	-2.347	46.30	.00	9	13.39	-3.96
14	1.15	-.267	3.62	.33	9	.62	-3.75

Fleet : FLT07: Russ.Surv. ne

Age	1992
5	1.77
6	.79
7	.42
8	.19
9	-.70
10	-.55
11	.26
12	.15
13	-.55
14	-5.11

Age	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
5	.63	-.07	-.53	-.38	-.96	-.20	-.37	-.03	.62	.11
6	.49	.08	-.29	-.10	-.61	-.43	-.51	-.24	.41	.72
7	.46	-.05	-.07	.00	-.30	-.29	-.38	-.11	.34	.20
8	.17	-.09	.16	.02	-.18	-.05	-.13	.21	-.26	.06
9	-.14	-.06	.26	.68	-.22	.09	.06	.19	-.06	-.30
10	-.12	.17	.11	-.92	-.10	.09	.02	.24	.23	.59
11	-.25	-.57	-.12	-.73	.26	.66	-.32	.47	.23	-.41
12	.29	-.14	.01	-.90	-.44	.56	.21	.51	.78	.95
13	-.44	-.49	-.34	-.43	.42	.39	.72	-.79	1.10	1.58
14	.62	.40	-1.79	-.36	-.31	-.25	-.16	.71	.59	-.93

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

Age	5	6	7	8	9	10	11	12	13	14
Mean Log q	-.3850	.6698	1.0637	1.3194	.7994	.5130	.5130	.5130	.5130	.5130
S.E(Log q)	.6861	.4988	.2911	.1638	.3368	.4108	.4604	.5935	.8166	1.5924

Table 8.10 (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
5,	-.43,	-3.336,	13.65,	.41,	11,	.20,	-.38,
6,	-16.14,	-1.616,	172.65,	.00,	11,	7.41,	.67,
7,	1.93,	-1.634,	-10.52,	.28,	11,	.52,	1.06,
8,	1.33,	-1.542,	-4.63,	.73,	11,	.20,	1.32,
9,	1.20,	-.510,	-2.60,	.44,	11,	.42,	.80,
10,	.59,	1.920,	2.86,	.74,	11,	.21,	.51,
11,	1.06,	-.139,	-.95,	.37,	11,	.52,	.47,
12,	.53,	2.491,	2.54,	.78,	11,	.23,	.71,
13,	.47,	1.829,	2.48,	.60,	11,	.33,	.67,
14,	-.75,	-1.969,	8.09,	.14,	11,	.99,	.02,

Fleet : FLT08: Norw.Comb.Sur

Age	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
5	99.99	99.99	99.99	.31	.02	-.15	-.21	-.01	-.11	.16
6	99.99	99.99	99.99	.30	.18	-.24	.08	-.09	-.10	-.10
7	99.99	99.99	99.99	.17	-.05	.09	-.02	-.13	.09	-.13
8	99.99	99.99	99.99	.34	-.51	-.26	.24	.03	.10	.06
9	99.99	99.99	99.99	.01	-.44	-.67	-.30	.56	.13	.67
10	99.99	99.99	99.99	.49	.04	.00	.08	-.46	.02	-.13
11	99.99	99.99	99.99	-.20	-.23	-.24	-.67	-1.23	-.80	-.18
12	99.99	99.99	99.99	.00	.15	.54	.53	-.57	-.31	.27
13	99.99	99.99	99.99	-.63	-1.31	-3.18	-.08	-.78	-.81	-.25
14	99.99	99.99	99.99	-.02	-.08	.15	.05	-.57	-.28	-.16

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

Age ,	5,	6,	7,	8,	9,	10,	11,	12,	13,	14
Mean Log q,	-.2352,	.3681,	1.1063,	.6318,	-.1108,	1.0513,	1.0513,	1.0513,	1.0513,	1.0513,
S.E(Log q),	.1818,	.1885,	.1144,	.2895,	.5035,	.2810,	.6880,	.4294,	1.5048,	.2788,

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
5,	.48,	1.205,	5.21,	.52,	7,	.08,	-.24,
6,	1.76,	-.421,	-7.91,	.06,	7,	.36,	.37,
7,	.89,	.237,	.06,	.48,	7,	.11,	1.11,
8,	-3.03,	-1.171,	37.33,	.02,	7,	.85,	.63,
9,	.85,	.192,	1.30,	.26,	7,	.47,	-.11,
10,	2.07,	-1.787,	-10.58,	.37,	7,	.50,	1.05,
11,	2.22,	-1.523,	-9.74,	.24,	7,	.82,	.54,
12,	1.74,	-1.215,	-6.61,	.36,	7,	.70,	1.14,
13,	.46,	1.280,	2.83,	.54,	7,	.46,	.05,
14,	1.02,	-.070,	-1.04,	.67,	7,	.27,	.92,

Terminal year survivor and F summaries :

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

Year class = 1997

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
FLT04: Norw. Exp. CP,	11151.,	.562,	.000,	.00,	1,	.156,	.024
FLT07: Russ.Surv. ne,	15393.,	.720,	.000,	.00,	1,	.095,	.017
FLT08: Norw.Comb.Sur,	16234.,	.300,	.000,	.00,	1,	.548,	.016
F shrinkage mean ,	10078.,	.50,,,,				.201,	.026

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
13840.,	.22,	.13,	4,	.574,	.019

Table 8.10 (Continued)

```
Age  6   Catchability constant w.r.t. time and dependent on age
 Year class = 1996

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                  Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 FLT04: Norw. Exp. CP,      9749.,   .265,       .192,    .73,   2,  .309,     .086
 FLT07: Russ.Surv. ne,     21058.,   .423,       .048,    .11,   2,  .120,     .041
 FLT08: Norw.Comb.Sur,      9533.,   .212,       .004,    .02,   2,  .477,     .088

   F shrinkage mean  ,     10257.,    .50,,,,                        .094,     .082

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
     10632.,       .15,      .11,    7,    .764,   .079

 Age  7   Catchability constant w.r.t. time and dependent on age
 Year class = 1995
 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                  Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 FLT04: Norw. Exp. CP,      9854.,   .199,       .104,    .52,   3,  .318,     .143
 FLT07: Russ.Surv. ne,     11291.,   .248,       .086,    .35,   3,  .209,     .126
 FLT08: Norw.Comb.Sur,      8363.,   .174,       .034,    .20,   3,  .411,     .166

   F shrinkage mean  ,      4976.,    .50,,,,                        .062,     .266

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
      9084.,       .11,      .07,   10,    .659,   .154

Age  8   Catchability constant w.r.t. time and dependent on age
 Year class = 1994

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                  Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 FLT04: Norw. Exp. CP,      4477.,   .171,       .099,    .58,   4,  .311,     .196
 FLT07: Russ.Surv. ne,      4933.,   .194,       .124,    .64,   4,  .257,     .179
 FLT08: Norw.Comb.Sur,      4354.,   .154,       .067,    .43,   4,  .378,     .201

   F shrinkage mean  ,      3296.,    .50,,,,                        .054,     .257

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
      4467.,       .10,      .05,   13,    .549,   .196

 Age  9   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
 FLT04: Norw. Exp. CP,      4649.,   .170,       .230,   1.36,   5,  .276,     .104
 FLT07: Russ.Surv. ne,      2685.,   .172,       .051,    .30,   5,  .313,     .174
 FLT08: Norw.Comb.Sur,      3664.,   .150,       .121,    .81,   5,  .357,     .130

   F shrinkage mean  ,      2197.,    .50,,,,                        .055,     .209

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
      3453.,       .09,      .10,   16,   1.036,   .138

Age 10   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
 FLT04: Norw. Exp. CP,      1829.,   .172,       .167,    .97,   6,  .235,     .396
 FLT07: Russ.Surv. ne,      1748.,   .167,       .171,   1.02,   6,  .300,     .411
 FLT08: Norw.Comb.Sur,      1555.,   .145,       .048,    .33,   6,  .390,     .452

   F shrinkage mean  ,      1232.,    .50,,,,                        .075,     .543

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
      1644.,       .09,      .07,   19,    .768,   .432
```

Table 8.10 (Continued)

Age 11 Catchability constant w.r.t. time and age (fixed at the value for age) 10

Year class = 1991

Fleet,	Estimated,	Int,	Ext,	Var,	N,	Scaled,	Estimated
,	Survivors,	s.e,	s.e,	Ratio,	,	Weights,	F
FLT04: Norw. Exp. CP,	1002.,	.174,	.107,	.62,	7,	.225,	.381
FLT07: Russ.Surv. ne,	895.,	.166,	.111,	.67,	7,	.321,	.418
FLT08: Norw.Comb.Sur,	1160.,	.144,	.073,	.51,	7,	.361,	.336
F shrinkage mean ,	858.,	.50,,,,				.094,	.432

Weighted prediction :

Survivors,	Int,	Ext,	N,	Var,	F
at end of year,	s.e,	s.e,	,	Ratio,	
1004.,	.10,	.06,	22,	.579,	.380

1

Age 12 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
FLT04: Norw. Exp. CP,	376.,	.204,	.136,	.66,	8,	.221,	.603
FLT07: Russ.Surv. ne,	469.,	.180,	.152,	.84,	8,	.293,	.510
FLT08: Norw.Comb.Sur,	341.,	.177,	.146,	.83,	7,	.335,	.650
F shrinkage mean ,	344.,	.50,,,,				.152,	.645

Weighted prediction :

Survivors,	Int,	Ext,	N,	Var,	F
at end of year,	s.e,	s.e,	,	Ratio,	
383.,	.12,	.08,	24,	.652,	.596

Age 13 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
FLT04: Norw. Exp. CP,	143.,	.235,	.246,	1.05,	9,	.227,	.672
FLT07: Russ.Surv. ne,	334.,	.202,	.207,	1.02,	9,	.294,	.344
FLT08: Norw.Comb.Sur,	163.,	.201,	.154,	.77,	7,	.266,	.611
F shrinkage mean ,	281.,	.50,,,,				.212,	.398

Weighted prediction :

Survivors,	Int,	Ext,	N,	Var,	F
at end of year,	s.e,	s.e,	,	Ratio,	
219.,	.14,	.12,	26,	.864,	.486

1

Age 14 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
FLT04: Norw. Exp. CP,	73.,	.275,	.175,	.64,	10,	.185,	.617
FLT07: Russ.Surv. ne,	90.,	.211,	.174,	.83,	10,	.169,	.526
FLT08: Norw.Comb.Sur,	67.,	.222,	.085,	.38,	7,	.444,	.657
F shrinkage mean ,	123.,	.50,,,,				.201,	.408

Weighted prediction :

Survivors,	Int,	Ext,	N,	Var,	F
at end of year,	s.e,	s.e,	,	Ratio,	
81.,	.15,	.08,	28,	.535,	.571

1

Table 8.11

Run title : Arctic Green.halibut (run: XSAAAG46/X46)

At 25/04/2003 12:23

Table 8 Fishing mortality (F) at age

YEAR,	1964,	1965,	1966,	1967,	1968,	1969,	1970,	1971,	1972,
AGE									
5,	.0094,	.0053,	.0032,	.0024,	.0019,	.0207,	.0139,	.0027,	.0363,
6,	.0484,	.0255,	.0138,	.0072,	.0051,	.0484,	.0659,	.1491,	.1510,
7,	.1146,	.0699,	.0397,	.0180,	.0116,	.0691,	.2864,	.4473,	.5110,
8,	.2531,	.2160,	.1411,	.0891,	.0694,	.2081,	.6556,	.6021,	.4033,
9,	.4566,	.2848,	.3476,	.2356,	.2381,	.2332,	.5603,	.4392,	.2444,
10,	.7003,	.7254,	.2583,	.3382,	.3302,	.4350,	.5339,	.4739,	.1999,
11,	.6375,	.7606,	.5421,	.2684,	.5685,	.4571,	.4457,	.4037,	.2511,
12,	.5666,	.8214,	.8585,	.8373,	.1802,	.3905,	.4362,	.5627,	.3063,
13,	.4065,	.3910,	.4515,	1.0092,	.2945,	.0686,	.5465,	.7562,	.4414,
14,	.5568,	.6004,	.4943,	.5409,	.3237,	.3182,	.5074,	.5302,	.2898,
+gp,	.5568,	.6004,	.4943,	.5409,	.3237,	.3182,	.5074,	.5302,	.2898,
0 FBAR 6-10,	.3146,	.2643,	.1601,	.1376,	.1309,	.1988,	.4204,	.4223,	.3019,

Table 8 Fishing mortality (F) at age

YEAR,	1973,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,	1982,
AGE										
5,	.0074,	.0378,	.0410,	.0413,	.0973,	.1046,	.1294,	.0433,	.1214,	.0771,
6,	.0442,	.1079,	.1211,	.1895,	.2135,	.2346,	.2396,	.0859,	.1447,	.1257,
7,	.2370,	.3447,	.4197,	.4666,	.4176,	.4305,	.2658,	.1815,	.1933,	.1283,
8,	.3335,	.3623,	.3818,	.6251,	.3557,	.4142,	.2074,	.1911,	.1387,	.1695,
9,	.2597,	.2744,	.3558,	.5001,	.3927,	.3521,	.1333,	.2292,	.0925,	.3239,
10,	.2516,	.3041,	.4017,	.3509,	.3249,	.3980,	.1094,	.1723,	.1532,	.3461,
11,	.2585,	.3298,	.5023,	.3824,	.4847,	.4738,	.1957,	.2423,	.2518,	.4461,
12,	.3191,	.3546,	.5617,	.6829,	.7082,	.3551,	.2024,	.2657,	.2704,	.4255,
13,	.2765,	.3347,	.5355,	.5074,	.8180,	.6672,	.1238,	.3004,	.6806,	.3676,
14,	.2741,	.3208,	.4740,	.4874,	.5490,	.4516,	.1533,	.2429,	.2909,	.3836,
+gp,	.2741,	.3208,	.4740,	.4874,	.5490,	.4516,	.1533,	.2429,	.2909,	.3836,
0 FBAR 6-10,	.2252,	.2787,	.3360,	.4264,	.3409,	.3659,	.1911,	.1720,	.1445,	.2187,

1

Table 8 Fishing mortality (F) at age

YEAR,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,
AGE										
5,	.0916,	.0570,	.0682,	.0951,	.0696,	.0435,	.1146,	.1732,	.3328,	.1199,
6,	.1429,	.3106,	.2407,	.2541,	.2308,	.1931,	.2926,	.4310,	.5099,	.1810,
7,	.2143,	.3869,	.3468,	.3543,	.4462,	.3839,	.4401,	.5306,	.8481,	.2388,
8,	.3356,	.3435,	.2925,	.3396,	.3827,	.4836,	.3380,	.4148,	.5320,	.2956,
9,	.3078,	.2428,	.2729,	.3392,	.2623,	.4568,	.3231,	.4221,	.3838,	.1332,
10,	.4551,	.4073,	.3727,	.4682,	.4222,	.5084,	.1997,	.3231,	1.0263,	.3803,
11,	.3178,	.3978,	.3583,	.3123,	.2902,	.4378,	.2283,	.2397,	1.1624,	.3633,
12,	.4786,	.2323,	.4190,	.4367,	.1771,	.4128,	.1829,	.5282,	1.6217,	.6829,
13,	.3612,	.2876,	.1553,	.7403,	.3183,	.1604,	.2583,	.0809,	.6083,	.8073,
14,	.3859,	.3149,	.3170,	.4618,	.2952,	.3972,	.2393,	.3201,	.9684,	.6716,
+gp,	.3859,	.3149,	.3170,	.4618,	.2952,	.3972,	.2393,	.3201,	.9684,	.6716,
0 FBAR 6-10,	.2911,	.3382,	.3051,	.3511,	.3489,	.4052,	.3187,	.4243,	.6600,	.2458,

Table 8 Fishing mortality (F) at age

YEAR,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	FBAR **-**
AGE											
5,	.1002,	.0381,	.0547,	.0671,	.0202,	.0242,	.0323,	.0221,	.0301,	.0191,	.0238,
6,	.1586,	.0791,	.0737,	.1753,	.0745,	.0837,	.1635,	.0669,	.0967,	.0792,	.0809,
7,	.3712,	.2610,	.2643,	.4153,	.2166,	.2754,	.4455,	.2340,	.2953,	.1542,	.2278,
8,	.3971,	.3084,	.3202,	.3447,	.1627,	.2559,	.3153,	.2763,	.2366,	.1961,	.2363,
9,	.0746,	.1708,	.2332,	.1233,	.1218,	.1205,	.2377,	.1945,	.2219,	.1378,	.1847,
10,	.5959,	.5324,	.7070,	.6804,	.6511,	.5220,	.7721,	.5971,	.4825,	.4321,	.5039,
11,	.5071,	.5165,	.8832,	.5873,	.5098,	.3673,	.3968,	.3923,	.4679,	.3798,	.4133,
12,	.4940,	.8448,	1.2059,	.6385,	.7253,	.5243,	.7249,	.6760,	.6057,	.5957,	.6258,
13,	.3190,	.6044,	1.2723,	.2389,	.1527,	.1321,	.5794,	.2953,	.4961,	.4859,	.4258,
14,	.4545,	.6405,	.9514,	.5558,	.5856,	.3693,	.6153,	.7004,	.5796,	.5706,	.6169,
+gp,	.4545,	.6405,	.9514,	.5558,	.5856,	.3693,	.6153,	.7004,	.5796,	.5706,	
0 FBAR 6-10,	.3195,	.2704,	.3197,	.3478,	.2454,	.2515,	.3868,	.2738,	.2666,	.1999,	

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Table 8.12

Run title : Arctic Green.halibut (run: XSAAAG46/X46)

At 25/04/2003 12:23

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

YEAR,	1964,	1965,	1966,	1967,	1968,	1969,	1970,	1971,	1972,
AGE									
5,	42840,	51686,	57828,	70443,	64280,	55932,	41112,	31550,	33556,
6,	33792,	36528,	44251,	49616,	60486,	55221,	47154,	34898,	27081,
7,	27961,	27712,	30648,	37565,	42397,	51798,	45284,	37995,	25875,
8,	27353,	21461,	22243,	25353,	31755,	36072,	41607,	29268,	20909,
9,	14559,	18279,	14883,	16626,	19961,	25498,	25214,	18591,	13796,
10,	8521,	7938,	11833,	9049,	11307,	13541,	17381,	12393,	10314,
11,	4237,	3641,	3307,	7867,	5554,	6995,	7544,	8771,	6641,
12,	2537,	1928,	1465,	1656,	5177,	2707,	3812,	4158,	5042,
13,	1175,	1239,	730,	534,	617,	3721,	1577,	2121,	2039,
14,	634,	673,	721,	400,	168,	395,	2990,	786,	857,
+gp,	190,	118,	77,	49,	27,	118,	756,	372,	341,
0 TOTAL,	163799,	171203,	187987,	219156,	241727,	251999,	234430,	180902,	146451,

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

YEAR,	1973,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,	1982,
AGE										
5,	31061,	26642,	22540,	22099,	23689,	20593,	19702,	18606,	17878,	18932,
6,	27853,	26538,	22080,	18621,	18250,	18499,	15964,	14900,	15336,	13629,
7,	20042,	22937,	20505,	16837,	13261,	12688,	12593,	10814,	11769,	11421,
8,	13360,	13611,	13986,	11600,	9088,	7517,	7101,	8309,	7763,	8349,
9,	12024,	8238,	8155,	8218,	5343,	5481,	4276,	4967,	5907,	5816,
10,	9300,	7983,	5389,	4917,	4290,	3105,	3317,	3221,	3399,	4635,
11,	7269,	6224,	5069,	3104,	2980,	2668,	1795,	2559,	2334,	2510,
12,	4447,	4831,	3852,	2640,	1823,	1580,	1430,	1271,	1729,	1561,
13,	3195,	2782,	2917,	1891,	1148,	773,	953,	1005,	838,	1135,
14,	1128,	2085,	1713,	1470,	980,	436,	341,	725,	641,	365,
+gp,	564,	844,	1044,	993,	456,	330,	386,	388,	264,	155,
0 TOTAL,	130243,	122715,	107250,	92389,	81307,	73670,	67858,	66765,	67857,	68510,

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

YEAR,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,
AGE										
5,	19010,	17813,	19928,	19860,	19425,	22958,	20708,	14498,	12611,	10476,
6,	15085,	14930,	14483,	16022,	15542,	15594,	18918,	15894,	10494,	7781,
7,	10345,	11255,	9420,	9799,	10696,	10620,	11066,	12152,	8890,	5425,
8,	8647,	7186,	6579,	5732,	5918,	5892,	6227,	6134,	6153,	3277,
9,	6066,	5320,	4387,	4227,	3513,	3474,	3127,	3822,	3487,	3111,
10,	3621,	3837,	3592,	2874,	2591,	2326,	1894,	1948,	2157,	2045,
11,	2823,	1977,	2198,	2130,	1549,	1462,	1204,	1335,	1214,	665,
12,	1383,	1768,	1143,	1322,	1341,	998,	812,	825,	904,	327,
13,	878,	738,	1206,	647,	735,	967,	568,	582,	419,	154,
14,	677,	527,	476,	889,	266,	460,	709,	378,	462,	196,
+gp,	214,	282,	249,	692,	29,	154,	141,	172,	887,	122,
0 TOTAL,	68747,	65634,	63663,	64193,	61606,	64905,	65375,	57740,	47677,	33578,

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

YEAR,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003,	GMST 64-**	AMST 64-**
AGE													
5,	12883,	18171,	17131,	17171,	17760,	16204,	14691,	18718,	16010,	16390,	0,	23396,	26513,
6,	7998,	10031,	15054,	13960,	13820,	14980,	13614,	12243,	15758,	13371,	13840,	19306,	22355,
7,	5589,	5874,	7977,	12037,	10083,	11041,	11858,	9950,	9855,	12313,	10632,	14659,	17681,
8,	3677,	3319,	3895,	5271,	6840,	6988,	7215,	6537,	6778,	6314,	9084,	9647,	12492,
9,	2098,	2128,	2098,	2434,	3214,	5003,	4656,	4531,	4268,	4604,	4467,	6213,	8176,
10,	2343,	1676,	1544,	1430,	1852,	2449,	3817,	3160,	3210,	2943,	3453,	4148,	5324,
11,	1203,	1112,	847,	655,	623,	831,	1251,	1518,	1497,	1706,	1644,	2356,	3126,
12,	398,	624,	571,	301,	313,	322,	495,	724,	883,	807,	1004,	1348,	1844,
13,	142,	209,	231,	147,	137,	131,	164,	207,	317,	415,	383,	698,	1045,
14,	59,	89,	98,	56,	100,	101,	99,	79,	132,	166,	219,	403,	628,
+gp,	12,	7,	14,	3,	2,	52,	16,	30,	29,	106,	132,		
0 TOTAL,	36403,	43239,	49460,	53465,	54745,	58102,	57877,	57696,	58738,	59134,	44859,		

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Table 8.13

Run title : Arctic Green.halibut (run: XSAAAG46/X46)

At 25/04/2003 12:23

Table 12   Stock biomass at age (start of year)   Tonnes

YEAR,	1964,	1965,	1966,	1967,	1968,	1969,	1970,	1971,	1972,
AGE									
5,	17993,	21708,	24288,	29586,	26998,	23491,	23311,	17889,	19026,
6,	21627,	23378,	28321,	32250,	39921,	35341,	34752,	25720,	19959,
7,	25165,	24941,	27890,	34936,	40701,	47136,	48861,	40997,	27919,
8,	32824,	26182,	27581,	32199,	41599,	45090,	59123,	41590,	29712,
9,	23731,	30343,	25301,	28430,	34732,	41817,	46595,	34356,	25495,
10,	19258,	17701,	26270,	19908,	24761,	30467,	39646,	28267,	23526,
11,	13178,	10923,	9724,	22342,	15494,	20915,	21779,	25322,	19172,
12,	9488,	6728,	4965,	5463,	16515,	9828,	12376,	13501,	16370,
13,	5368,	5452,	3196,	2281,	2634,	17415,	6786,	9127,	8772,
14,	3175,	3306,	3491,	1952,	838,	2128,	14746,	3875,	4226,
+gp,	1131,	697,	452,	282,	163,	707,	4378,	2171,	2060,
0 TOTALBIO,	172936,	171359,	181480,	209627,	244355,	274335,	312354,	242814,	196238,

Table 12   Stock biomass at age (start of year)   Tonnes

YEAR,	1973,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,	1982,
AGE										
5,	17612,	15106,	12780,	12530,	13432,	11676,	17732,	13061,	11800,	13063,
6,	20527,	19559,	16273,	13724,	13451,	13634,	19157,	12993,	12882,	11448,
7,	21626,	24749,	22125,	18167,	14309,	13691,	18889,	12338,	13534,	11764,
8,	18984,	19341,	19874,	16483,	12914,	10682,	12781,	12197,	12110,	10938,
9,	22221,	15223,	15070,	15186,	9874,	10128,	9407,	8831,	12051,	10119,
10,	21213,	18208,	12292,	11216,	9785,	7083,	8625,	7415,	8736,	10383,
11,	20985,	17969,	14634,	8960,	8603,	7702,	5385,	6818,	6954,	6953,
12,	14438,	15687,	12508,	8572,	5918,	5129,	5004,	3870,	5930,	5262,
13,	13746,	11970,	12552,	8136,	4940,	3325,	3908,	3385,	3463,	4905,
14,	5565,	10283,	8448,	7247,	4831,	2150,	1638,	3106,	2998,	1955,
+gp,	3388,	5034,	6168,	5883,	2747,	1949,	2382,	2076,	1581,	903,
0 TOTALBIO,	180304,	173129,	152725,	126105,	100803,	87150,	104910,	86092,	92039,	87693,

Table 12   Stock biomass at age (start of year)   Tonnes

YEAR,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,
AGE										
5,	14257,	11222,	11957,	12313,	13772,	16989,	15738,	10294,	9710,	7123,
6,	15689,	14333,	12890,	14740,	15589,	15002,	19486,	16848,	11019,	7548,
7,	13862,	13281,	11304,	12543,	13541,	13264,	14607,	15676,	12269,	6889,
8,	13575,	10995,	12172,	10890,	9961,	9581,	11208,	10427,	10767,	5767,
9,	11949,	12290,	11363,	10482,	8719,	7518,	7567,	8026,	7671,	6875,
10,	9884,	11013,	11423,	8940,	7728,	6738,	5927,	5085,	5608,	5234,
11,	9287,	6840,	7957,	7135,	5495,	4981,	4058,	3831,	3387,	2069,
12,	5836,	6665,	4515,	4918,	5097,	3652,	3290,	2846,	2965,	1173,
13,	4137,	2943,	5404,	2588,	3353,	4108,	2437,	2166,	1629,	589,
14,	4114,	2291,	2024,	3716,	1329,	1928,	3191,	1545,	2025,	834,
+gp,	1311,	1276,	1200,	3132,	175,	686,	667,	779,	4692,	587,
0 TOTALBIO,	103901,	93151,	92209,	91397,	84759,	84445,	88176,	77522,	71741,	44688,

Table 12   Stock biomass at age (start of year)   Tonnes

YEAR,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,
AGE										
5,	10178,	13083,	12506,	13222,	13675,	11829,	10283,	14226,	11847,	11801,
6,	8158,	9429,	14151,	13541,	12991,	13932,	12933,	11875,	16231,	12836,
7,	7545,	7460,	9971,	15769,	12906,	14353,	15060,	13234,	13699,	17116,
8,	6913,	5708,	6777,	9172,	11217,	11251,	11183,	10656,	11861,	10733,
9,	5162,	4660,	4386,	5451,	6653,	10606,	9313,	9560,	9775,	10221,
10,	6257,	4224,	3875,	3705,	4796,	6294,	9390,	8247,	8604,	7769,
11,	4127,	3301,	2499,	2156,	2057,	2701,	4027,	5085,	4985,	5458,
12,	1708,	2052,	1907,	1212,	1257,	1260,	1907,	2874,	3460,	3099,
13,	722,	803,	883,	699,	662,	640,	757,	1027,	1524,	1869,
14,	373,	440,	490,	347,	593,	573,	575,	461,	769,	910,
+gp,	104,	45,	113,	15,	15,	256,	97,	214,	216,	662,
0 TOTALBIO,	51247,	51206,	57557,	65288,	66823,	73694,	75527,	77459,	82970,	82474,

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Table 8.14

Run title : Arctic Green.halibut (run: XSAAAG46/X46)

At 25/04/2003 12:23

Table 13 Spawning stock biomass at age (spawning time) Tonnes

YEAR,	1964,	1965,	1966,	1967,	1968,	1969,	1970,	1971,	1972,
AGE									
5,	0,	0,	0,	0,	0,	0,	0,	0,	0,
6,	649,	701,	850,	968,	1198,	1060,	1043,	772,	599,
7,	755,	748,	837,	1048,	1221,	1414,	1466,	1230,	838,
8,	6893,	5498,	5792,	6762,	8736,	9469,	12416,	8734,	6240,
9,	15900,	20330,	16952,	19048,	23270,	28018,	31218,	23018,	17082,
10,	16562,	15223,	22592,	17121,	21295,	26201,	34096,	24310,	20233,
11,	12914,	10704,	9529,	21895,	15184,	20496,	21343,	24816,	18789,
12,	9298,	6594,	4866,	5354,	16185,	9631,	12129,	13231,	16043,
13,	5368,	5452,	3196,	2281,	2634,	17415,	6786,	9127,	8772,
14,	3175,	3306,	3491,	1952,	838,	2128,	14746,	3875,	4226,
+gp,	1131,	697,	452,	282,	163,	707,	4378,	2171,	2060,
0 TOTSPBIO,	72644,	69254,	68557,	76709,	90723,	116540,	139620,	111283,	94880,

Table 13 Spawning stock biomass at age (spawning time) Tonnes

YEAR,	1973,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,	1982,
AGE										
5,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
6,	616,	587,	488,	412,	404,	409,	575,	390,	386,	343,
7,	649,	742,	664,	545,	429,	411,	567,	370,	406,	353,
8,	3987,	4062,	4174,	3461,	2712,	2243,	2684,	2561,	2543,	2297,
9,	14888,	10200,	10097,	10175,	6616,	6786,	6303,	5917,	8074,	6780,
10,	18243,	15659,	10571,	9646,	8415,	6092,	7418,	6377,	7513,	8930,
11,	20565,	17610,	14341,	8781,	8431,	7548,	5278,	6682,	6815,	6814,
12,	14150,	15373,	12258,	8401,	5799,	5026,	4904,	3793,	5811,	5157,
13,	13746,	11970,	12552,	8136,	4940,	3325,	3908,	3385,	3463,	4905,
14,	5565,	10283,	8448,	7247,	4831,	2150,	1638,	3106,	2998,	1955,
+gp,	3388,	5034,	6168,	5883,	2747,	1949,	2382,	2076,	1581,	903,
0 TOTSPBIO,	95795,	91519,	79761,	62687,	45323,	35939,	35656,	34657,	39591,	38436,

Table 13 Spawning stock biomass at age (spawning time) Tonnes

YEAR,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,
AGE										
5,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
6,	471,	573,	516,	442,	156,	150,	195,	168,	110,	75,
7,	416,	398,	452,	376,	271,	133,	292,	314,	491,	413,
8,	2444,	1979,	2313,	2614,	2191,	2012,	2017,	1773,	1615,	1615,
9,	7170,	7497,	7386,	7757,	5755,	3985,	3708,	4093,	4142,	4537,
10,	8105,	9141,	9710,	8135,	6955,	5862,	4742,	3915,	4318,	4501,
11,	8915,	6635,	7718,	7063,	5220,	4433,	3612,	3486,	3014,	1800,
12,	5719,	6532,	4470,	4820,	4995,	3579,	3290,	2846,	2965,	1173,
13,	4137,	2943,	5404,	2588,	3353,	4108,	2437,	2166,	1629,	589,
14,	4114,	2291,	2024,	3716,	1329,	1928,	3191,	1545,	2025,	834,
+gp,	1311,	1276,	1200,	3132,	175,	686,	667,	779,	4692,	587,
0 TOTSPBIO,	42801,	39266,	41193,	40643,	30400,	26874,	24151,	21085,	25001,	16125,

Table 13 Spawning stock biomass at age (spawning time) Tonnes

YEAR,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,
AGE										
5,	102,	131,	125,	0,	0,	0,	0,	0,	118,	236,
6,	82,	94,	142,	0,	0,	0,	0,	119,	487,	513,
7,	604,	522,	798,	1104,	903,	574,	301,	397,	822,	1540,
8,	2212,	1941,	1965,	2293,	2356,	1125,	783,	1066,	2254,	2791,
9,	3510,	3215,	2544,	3162,	3526,	4773,	3073,	3537,	4790,	6439,
10,	5193,	3422,	3061,	3260,	4076,	5161,	6197,	5196,	5592,	5594,
11,	3632,	3136,	2399,	2091,	1934,	2485,	3463,	4424,	4187,	4967,
12,	1606,	1929,	1697,	1139,	1182,	1260,	1888,	2759,	3321,	2975,
13,	722,	803,	883,	699,	662,	640,	757,	1027,	1524,	1869,
14,	373,	440,	490,	347,	593,	573,	575,	461,	769,	910,
+gp,	104,	45,	113,	15,	15,	256,	97,	214,	216,	662,
0 TOTSPBIO,	18139,	15678,	14216,	14110,	15247,	16847,	17136,	19199,	24081,	28497,

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Table 8.15

Run title : Arctic Green.halibut (run: XSAAAG46/X46) ,

At 25/04/2003 12:23

Table 16 Summary (without SOP correction)

,	RECRUITS, Age 5	TOTALBIO,	TOTSPBIO,	LANDINGS,	YIELD/SSB,	FBAR 6-10,
1964,	42840,	172936,	72644,	40391,	.5560,	.3146,
1965,	51686,	171359,	69254,	34751,	.5018,	.2643,
1966,	57828,	181480,	68557,	26321,	.3839,	.1601,
1967,	70443,	209627,	76709,	24267,	.3163,	.1376,
1968,	64280,	244355,	90723,	26168,	.2884,	.1309,
1969,	55932,	274335,	116540,	43789,	.3757,	.1988,
1970,	41112,	312354,	139620,	89484,	.6409,	.4204,
1971,	31550,	242814,	111283,	79034,	.7102,	.4223,
1972,	33556,	196238,	94880,	43055,	.4538,	.3019,
1973,	31061,	180304,	95795,	29938,	.3125,	.2252,
1974,	26642,	173129,	91519,	37763,	.4126,	.2787,
1975,	22540,	152725,	79761,	38172,	.4786,	.3360,
1976,	22099,	126105,	62687,	36074,	.5755,	.4264,
1977,	23689,	100803,	45323,	28827,	.6360,	.3409,
1978,	20593,	87150,	35939,	24617,	.6850,	.3659,
1979,	19702,	104910,	35656,	17312,	.4855,	.1911,
1980,	18606,	86092,	34657,	13284,	.3833,	.1720,
1981,	17878,	92039,	39591,	15018,	.3793,	.1445,
1982,	18932,	87693,	38436,	16789,	.4368,	.2187,
1983,	19010,	103901,	42801,	22147,	.5174,	.2911,
1984,	17813,	93151,	39266,	21883,	.5573,	.3382,
1985,	19928,	92209,	41193,	19945,	.4842,	.3051,
1986,	19860,	91397,	40643,	22875,	.5628,	.3511,
1987,	19425,	84759,	30400,	19112,	.6287,	.3489,
1988,	22958,	84445,	26874,	19587,	.7288,	.4052,
1989,	20708,	88176,	24151,	20138,	.8338,	.3187,
1990,	14498,	77522,	21085,	23183,	1.0995,	.4243,
1991,	12611,	71741,	25001,	33320,	1.3327,	.6600,
1992,	10476,	44688,	16125,	8602,	.5335,	.2458,
1993,	12883,	51247,	18139,	11933,	.6579,	.3195,
1994,	18171,	51206,	15678,	9226,	.5885,	.2704,
1995,	17131,	57557,	14216,	11734,	.8254,	.3197,
1996,	17171,	65288,	14110,	14347,	1.0168,	.3478,
1997,	17760,	66823,	15247,	9410,	.6172,	.2454,
1998,	16204,	73694,	16847,	11893,	.7059,	.2515,
1999,	14691,	75527,	17136,	19517,	1.1389,	.3868,
2000,	18718,	77459,	19199,	14437,	.7520,	.2738,
2001,	16010,	82970,	24081,	16307,	.6772,	.2666,
2002,	16390,	82474,	28497,	13140,	.4611,	.1999,
Arith. Mean ,	25984,	120838,	48468,	25841,	.6085,	.2979,
0 Units,	(Thousands),	(Tonnes),	(Tonnes),	(Tonnes),		

1

Table 8.16

MFDP version 1a
Run: MFDPGrHal03
Time and date: 14:37 29.04.2003
Fbar age range: 6-10

2003

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
5	15483	0.15	0.02	0	0	0.740	0.024	0.740
6	13840	0.15	0.04	0	0	0.987	0.081	0.987
7	10632	0.15	0.09	0	0	1.370	0.228	1.370
8	9084	0.15	0.26	0	0	1.693	0.236	1.693
9	4467	0.15	0.63	0	0	2.207	0.185	2.207
10	3453	0.15	0.72	0	0	2.643	0.504	2.643
11	1644	0.15	0.91	0	0	3.293	0.413	3.293
12	1004	0.15	0.96	0	0	3.910	0.626	3.910
13	383	0.15	1	0	0	4.763	0.426	4.763
14	219	0.15	1	0	0	5.703	0.617	5.703
15	132	0.15	1	0	0	6.963	0.617	6.963

2004

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
5	15483	0.15	0.02	0	0	0.740	0.024	0.740
6	.	0.15	0.04	0	0	0.987	0.081	0.987
7	.	0.15	0.09	0	0	1.370	0.228	1.370
8	.	0.15	0.26	0	0	1.693	0.236	1.693
9	.	0.15	0.63	0	0	2.207	0.185	2.207
10	.	0.15	0.72	0	0	2.643	0.504	2.643
11	.	0.15	0.91	0	0	3.293	0.413	3.293
12	.	0.15	0.96	0	0	3.910	0.626	3.910
13	.	0.15	1	0	0	4.763	0.426	4.763
14	.	0.15	1	0	0	5.703	0.617	5.703
15	.	0.15	1	0	0	6.963	0.617	6.963

2005

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
5	15483	0.15	0.02	0	0	0.740	0.024	0.740
6	.	0.15	0.04	0	0	0.987	0.081	0.987
7	.	0.15	0.09	0	0	1.370	0.228	1.370
8	.	0.15	0.26	0	0	1.693	0.236	1.693
9	.	0.15	0.63	0	0	2.207	0.185	2.207
10	.	0.15	0.72	0	0	2.643	0.504	2.643
11	.	0.15	0.91	0	0	3.293	0.413	3.293
12	.	0.15	0.96	0	0	3.910	0.626	3.910
13	.	0.15	1	0	0	4.763	0.426	4.763
14	.	0.15	1	0	0	5.703	0.617	5.703
15	.	0.15	1	0	0	6.963	0.617	6.963

Input units are thousands and kg - output in tonnes

Table 8.17

MFDP version 1a
Run: MFDPGrHal03
Arctic Green.halibut
Time and date: 14:37 29.04.2003
Fbar age range: 6-10

2003 Biomass	SSB	FMult	FBar	Landings
87378	31556	0.8699	0.2146	15000

2004 Biomass	SSB	FMult	FBar	Landings	2005 Biomass	SSB
90051	34868	0.0000	0.0000	0	109585	49329
.	34868	0.1000	0.0247	2038	107257	47663
.	34868	0.2000	0.0493	4004	105011	46065
.	34868	0.3000	0.0740	5902	102845	44533
.	34868	0.4000	0.0987	7735	100754	43063
.	34868	0.5000	0.1234	9505	98736	41654
.	34868	0.6000	0.1480	11215	96787	40301
.	34868	0.7000	0.1727	12867	94905	39003
.	34868	0.8000	0.1974	14465	93086	37757
.	34868	0.9000	0.2221	16009	91328	36560
.	34868	1.0000	0.2467	17503	89629	35411
.	34868	1.1000	0.2714	18949	87985	34306
.	34868	1.2000	0.2961	20348	86396	33245
.	34868	1.3000	0.3208	21702	84858	32224
.	34868	1.4000	0.3454	23014	83369	31243
.	34868	1.5000	0.3701	24284	81927	30299
.	34868	1.6000	0.3948	25515	80531	29392
.	34868	1.7000	0.4195	26708	79179	28518
.	34868	1.8000	0.4441	27865	77869	27677
.	34868	1.9000	0.4688	28987	76599	26868
.	34868	2.0000	0.4935	30075	75367	26088

Input units are thousands and kg - output in tonnes

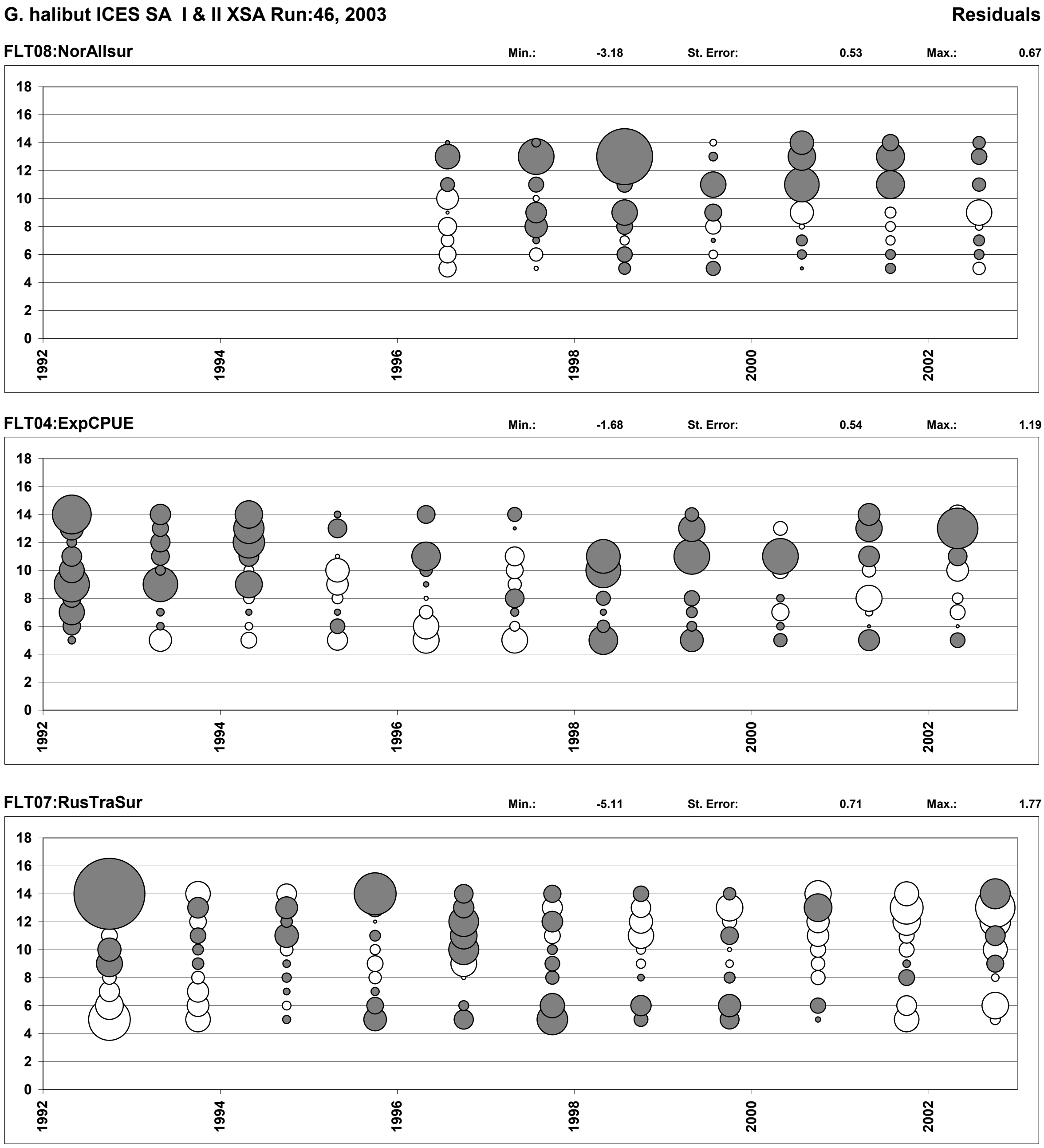

Figure 8.1. Log catchability residuals by age and year for the tuning fleets included in the assessments. For each graph all bubbles are normalized to the same maximum bubble-size. Open bubbles represent positive values; filled bubbles represent negative values.

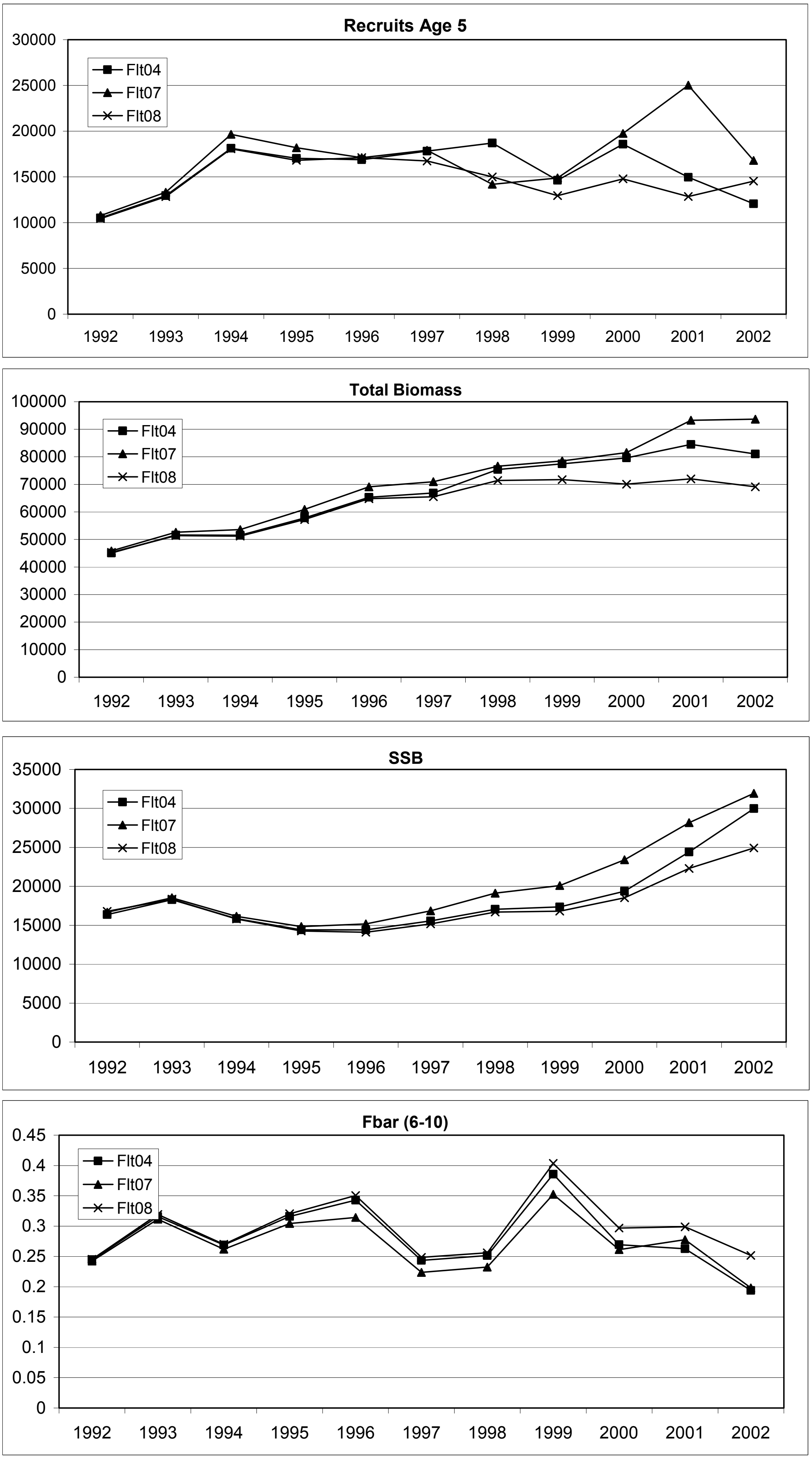

Figure 8.2. Plots of XSA results by tuning separately with individual fleets for Greenland halibut.

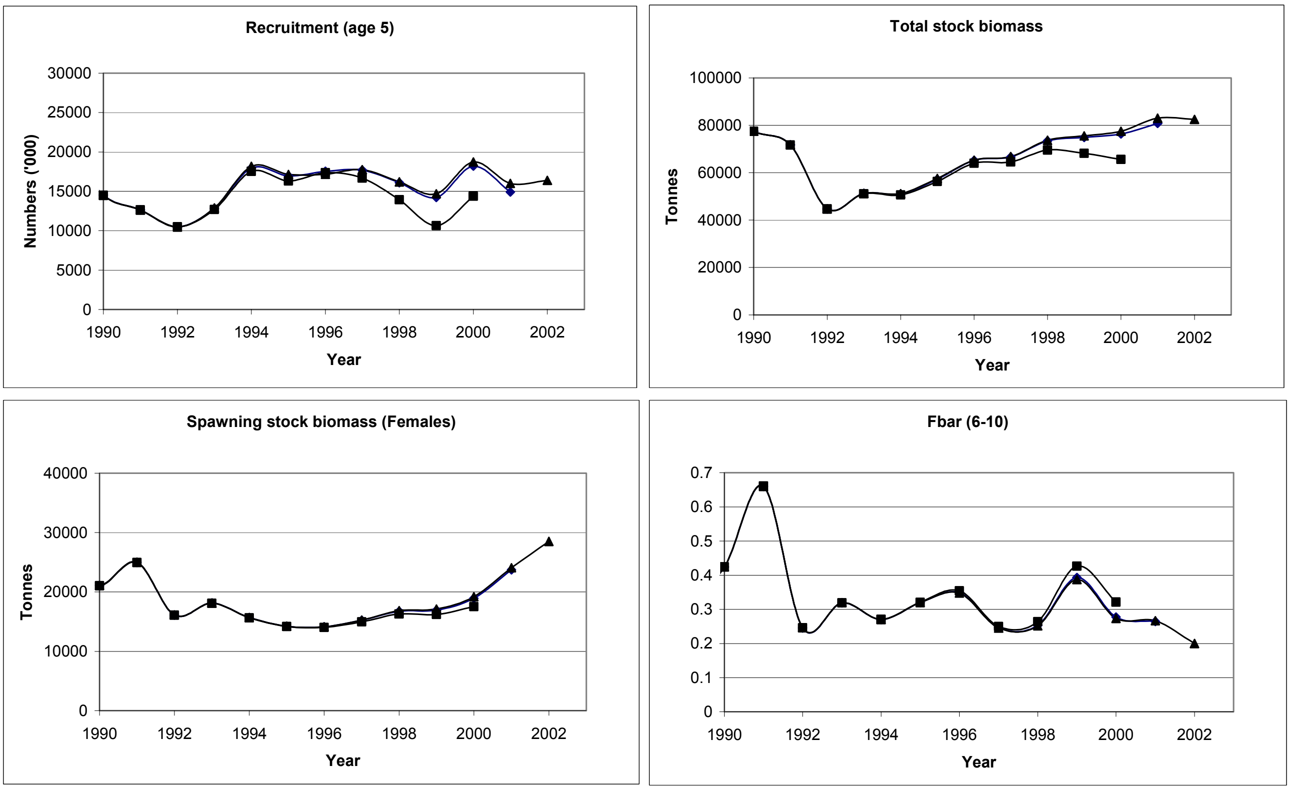

Figure 8.3. Retrospective analysis based on current assessment.

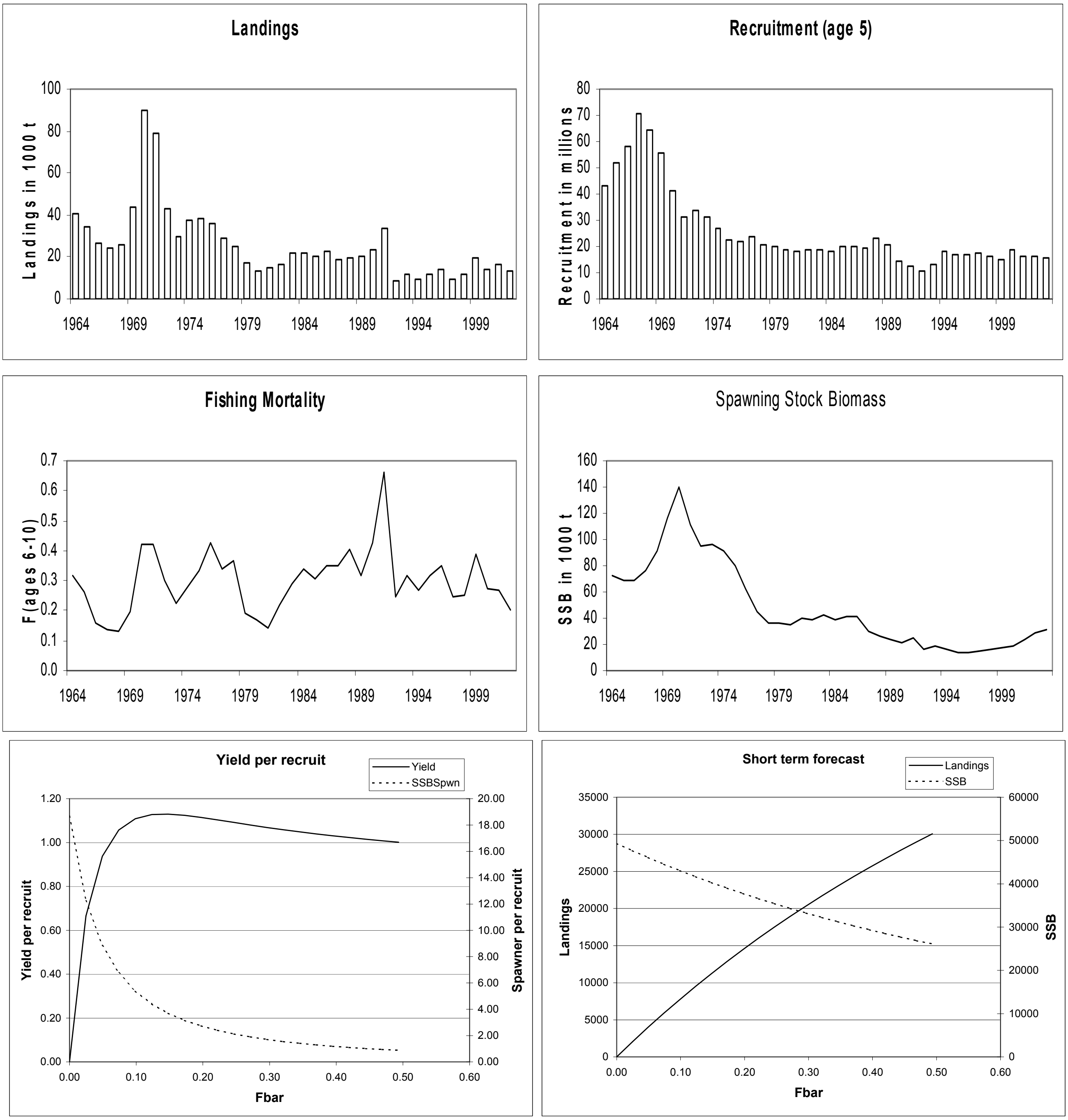

Figure 8.4. Historical landings, recruitment, fishing mortality and spawning stock biomass. Long term yield pr recruit and spawning stock biomass per recruit. Short term yield and spawning stock biomass .

Table E1. GREENLAND HALIBUT in Sub-area I and II. Norwegian bottom trawl survey indices (numbers in thousands) in the Svalbard area (Division IIb).

Year	Fish <20 cm [2]	Age									Total
		1	2	3	4	5	6	7	8	9+	
1981	2.1	No age data									20 100
1982	0.7										2 600
1983	5.9										26 690
1984	3.2	550	3 042	2 924	8 573	6 847	5 657	4 345	2 796	1 896	36 630
1985	1.6	884	3 921	4 294	6 674	8 793	8 622	3 920	1 817	525	39 450
1986	0.1	49	1 005	1 967	7 314	4 671	1 754	2 301	372	37	19 470
1987	1	630	1 014	3 076	4 409	4 786	3 141	964	364	116	18 500
1988	2.5	818	4 298	6 191	6 696	12 289	2 396	6 015	338	1 277	40 318
1989 [1]	1.4	712	3 232	8 158	7 493	7 069	2 374	1 753	353	744	31 888
1990 [1]	0.4	115	336	5 050	7 130	7 730	4 490	2 330	918	544	28 643
1991 [1]	0.1	71	877	3 080	6 720	9 270	5 450	2 800	1 660	524	30 452
1992 [1]	+	33	30	338	1 190	3 520	4 420	2 280	1 280	474	13 565
1993 [1]	+	25	60	51	1 049	2 369	2 056	2 772	1 114	665	10 161
1994 [1]	+	4	238	296	652	2 775	2 371	2 593	531	844	10 304
1995 [1]	0.1	76	+	+	322	886	1 200	1 950	487	497	5 418
1996 [1]	0.4	410	61	104	171	881	2 052	2 587	862	976	8 104
1997 [1]	0.4	268	484	21	65	284	2 089	2 143	379	295	6 028
1998 [1]	2.5	1 999	2 351	2 715	493	609	2 192	2 814	1 252	822	15 247
1999 [1]	1.3	126	+	995	1 789	415	709	2 501	507	674	7 716
2000 [1]	2	2 009	540	323	1 347	2 135	2 634	1 784	1 197	530	12 499
2001 [1]	4.3	4 258	1 235	873	1 506	2 456	1 718	1 504	558	1 079	15 187
2002 [1]	2.3	1 435	2 019	1 176	2 437	3 413	2 685	3 304	847	2 229	19 545

[1] New standard trawl equipment (rockhopper gear and 40 meter sweep length).

[2] In millions.

Table E2. GREENLAND HALIBUT in Sub-area I and II. Abundance indices from bottom trawl surveys in the Barents Sea and Svalbard area in August (in thousands).

A: The Barents Sea area; **B**: The expanded Svalbard area.

A	Age													Total
Year	1	2	3	4	5	6	7	8	9	10	11	12	13+	
1995	42	-	-	596	989	1 239	1 673	1 020	-	195	-	-	-	5 754
1996	12 028	900	-	-	-	415	829	861	85	261	118	82	-	15 579
1997 [1]	143	1 162	53	331	589	1 579	2 736	1 120	550	44	-	-	-	8 307
1998 [1]	46	446	328	416	481	323	1 828	924	432	234	-	-	-	5 458
1999	11 637	5 910	384	280	201	1 508	1 729	215	134	661	255	218	-	23 132
2000	-	619	302	417	816	620	1 163	844	605	270	54	221	-	5 931
2001	-	-	259	203	743	1 120	293	697	-	215	107	-	-	3 637
2002	-	-	-	85	773	2 509	3 047	165	290	839	-	255	-	7 963

B	Age													Total
Year	1	2	3	4	5	6	7	8	9	10	11	12	13+	
1995	77	-	-	429	1 255	1 720	2 535	665	135	281	136	95	-	7 328
1996	1 760	360	105	291	1 144	2 717	3 525	1 290	309	603	30	92	45	12 271
1997	593	2 357	311	116	593	3 053	3 019	478	312	20	-	-	-	10 852
1998	2 295	2 836	2 918	540	770	2 477	3 248	1 472	340	346	130	-	65	17 437
1999	387	263	1 516	3 095	809	836	2 773	486	333	360	-	87	140	11 085
2000	1 976	818	1 280	2 836	3 946	3 216	2 112	1 560	460	199	-	95	-	18 498
2001	4 659	1 690	1 789	2 517	3 536	2 474	1 889	690	383	773	134	27	50	20 611
2002	2 174	2 475	1 718	2 962	4 291	3 620	4 205	1 031	293	1 267	453	304	212	25 005

[1] Only Norwegian and international zones covered. Adjusted (according to the mean distribution in the period 1991-1999) to include the Russian EEZ.

Table E3. GREENLAND HALIBUT in Sub-area I and II. Abundance indices on age from the Norwegian stratified bottom trawl survey in August using a hired commercial vessel (numbers in thousands). Trawls were made at 400-1500 m depth along the continental slope from 68-80°N.

Year	Age															Total
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+	
1994	0	0	1	2 001	16 980	11 008	15 552	6 173	1 241	3 628	1 460	443	129	81	11	58 708
1995	0	0	0	1 432	16 945	12 946	20 925	6 737	1 975	4 393	1 385	648	152	103	21	67 662
1996	0	0	10	704	13 623	18 538	24 908	8 114	1 473	3 223	820	396	131	100	2	72 042
1997	0	0	16	1 446	11 738	17 005	18 927	5 383	1 107	3 261	936	600	87	165	16	60 687
1998	0	0	66	1 726	7 868	12 399	23 487	6 243	1 458	4 317	1 238	969	13	183	14	59 981
1999	0	0	27	1 300	5 901	15 383	20 209	12 019	1 872	5 913	1 167	1 198	273	183	15	65 460
2000	0	0	383	1 920	6 901	10 352	17 885	7 795	5 038	3 284	867	458	204	75	16	55 178
2001	0	10	95	986	6 107	15 068	22 584	10 086	3 130	5 442	1 146	1 147	267	180	67	66 315
2002	0	3	427	2 492	7 730	10 913	21 660	9 847	6 327	4 248	2 468	1 642	619	208	183	68 767

Table E4. GREENLAND HALIBUT in Sub-area I and II. Abundance indices on age from the Norwegian bottom trawl survey north and east of Spitsbergen in September (numbers in thousands).

A: Survey area, Russian EEZ excluded **B:** Including Russian EEZ

A	Age						Total
Year	1	2	3	4	5	6+	
1996	15 655	14 510	10 025	3 487	1 593	3 349	48 619
1997	3 415	15 271	14 140	2 803	403	434	36 466
1998	8 482	18 718	9 463	5 161	1 166	932	43 922
1999	5 370	9 074	3 328	2 271	1 492	954	22 489
2000	9 529	16 844	8 007	6 274	1 746	722	43 122
2001	26 206	15 765	4 515	1 767	802	465	49 520
2002	40 186	34 065	15 441	3 862	1 320	556	95 430

B	Age						Total
Year	1	2	3	4	5	6+	
1998	10 210	28 020	17 186	6 380	1 551	932	64 279
1999	7 514	16 159	8 045	3 067	2 401	954	38 140
2000			No coverage in Russian EEZ				
2001	38 112	40 377	7 960	4 300	1 215	510	92 475
2002	96 231	58 113	31 500	5 665	1 576	556	193 641

Table E5. GREENLAND HALIBUT in Sub-area I and II. Abundance indices from three Norwegian bottom trawl surveys in the Barents Sea in August - September combined to one index (in thousands).

Antall i tusen

Year	Age															Total
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+	
1996	17 926	14 906	10 134	4 486	16 194	22 217	30 014	10 163	1 857	3 954	957	523	175	100	2	133 608
1997	4 050	18 107	14 547	4 481	12 917	20 753	22 984	6 362	1 563	3 312	936	600	87	165	16	110 880
1998	10 704	21 705	12 521	7 603	9 915	14 680	27 784	7 800	1 937	4 586	1 353	1 027	13	241	14	121 883
1999	5 895	9 451	5 200	7 116	8 412	17 437	24 175	12 857	2 407	6 595	1 294	1 387	273	183	144	102 826
2000	11 474	17 755	9 870	11 359	13 093	14 139	20 608	9 704	5 707	3 548	901	695	204	75	16	119 148
2001	30 631	17 452	6 521	5 115	10 077	17 548	24 465	10 973	3 440	6 280	1 302	1 147	267	180	67	135 464
2002	42 348	36 537	17 472	9 105	13 649	15 040	27 076	10 130	6 679	5 104	2 909	1 893	619	257	183	188 999

Table E6. GREENLAND HALIBUT in Sub-area I and II. Russian autumn bottom trawl surveys: Abundance indices at different age (numbers in thousands).

Year	Age-group													Total
	≤ 3	4	5	6	7	8	9	10	11	12	13	14	15+	
1984	4 124	5 359	7 788	24 951	19 863	11 499	6 750	5 416	2 420	1 196	247	146	143	89 902
1985	3 331	4 371	17 076	35 648	27 826	11 717	5 722	4 090	1 937	895	311	31	131	113 086
1986	2 687	6 600	15 853	25 696	16 468	5 436	3 811	2 660	974	539	184	72	6	80 986
1987	289	6 761	9 724	12 703	7 633	3 867	1 903	1 627	721	416	110	0	38	45 792
1988	2 591	4 409	7 891	14 181	11 311	4 308	2 253	1 756	820	307	125	163	54	50 169
1989	1 429	11 310	13 124	25 881	12 782	5 989	2 381	1 285	334	271	98	102	118	75 104
1990	2 820	8 360	16 252	15 621	11 393	4 120	1 911	1 158	307	198	58	36	0	62 234
1991 [1]	1 422	8 455	25 408	21 843	15 235	9 419	2 369	1 211	655	142	95	16	26	86 296
1992	685	7 461	33 341	25 498	17 272	10 178	2 720	1 262	938	318	67	0	0	99 740
1993	114	2 166	13 317	19 752	16 528	10 305	3 370	1 868	903	519	103	111	111	69 167
1994	49	1 604	9 868	17 549	11 533	7 746	3 401	1 876	605	394	114	114	57	54 910
1995	19	467	5 759	18 222	15 296	11 539	4 393	1 413	529	312	84	11	32	58 076
1996 [2]	0	1 670	6 680	18 722	21 714	13 354	8 512	476	284	106	115	36	20	71 689
1997	235	1 575	4 023	12 165	15 919	16 452	4 591	1 432	779	162	271	66	88	57 758
1998	3 917	5 542	7 768	15 589	16 842	17 727	9 676	2 548	1 752	535	254	85	72	82 307
1999	4 057	4 961	5 951	12 350	14 255	16 078	7 952	3 009	965	494	307	74	-	70 453
2000	2 841	5 327	10 718	15 719	18 694	21 235	9 155	3 593	2 580	1 011	108	133	120	91 234
2001	1 592	6 884	17 365	37 881	27 661	14 163	6 576	3 988	1 875	1 713	929	217	180	121 024
2002 [3]	2 145	7 127	10 771	44 220	33 675	18 747	5 947	5 477	1 216	1 877	1 973	60	120	133 355

[1] Age composition based on combined age-length-keys for 1990 and 1992.

[2] Only half of standard area investigated

[3] Adjusted (according to the 2001 distribution) to include the Norwegian EEZ which was not covered by the survey.

Table E7.- Greenland halibut catch in weight, numbers, and Biomass and abundance estimated from Spanish survey 1997-2002.

Year	Catch (Kg)	Catch (numbers)	Biomass™	Abundance ('000)
1997	195 056	211 533	344 014	379 444
1998	180 974	187 259	351 466	373 149
1999	198 781	172 687	436 956	377 792
2000	169 389	140 355	340 619	291 265
2001	152 681	129 289	283 511	249 219
2002	144 335	115 213	256 460	207 466

Table E8. GREENLAND HALIBUT in Sub-area I and II. Abundance indices from bottom trawl surveys in the Barents Sea in winter (in thousands).

A: Restricted area surveyed every year; **B**: Enlarged area (includes the restricted one) surveyed since 1993

A	Age													Total
Year	1	2	3	4	5	6	7	8	9	10	11	12	13+	
1989	1 078	788	1 056	2 284	3 655	2 655	864	971	210	-	19	76	56	13 712
1990	66	907	2 071	1 716	1 996	2 262	1 046	365	175	-	30	119	165	10 918
1991	-	279	755	1 323	1 257	1 526	2 440	906	450	457	-	55	127	9 575
1992	63	128	719	897	1 554	543	1 069	791	-	648	135	40	53	6 640
1993	-	17	168	502	1 730	868	1 490	758	88	655	382	31	35	6 724
1994	-	16	142	1 178	2 259	1 644	1 750	885	-	506	38	25	-	8 443
1995	-	-	-	168	786	749	1 331	760	359	486	60	199	-	4 898
1996	1 816	-	28	40	709	1 510	2 964	1 000	307	808	154	152	45	9 533
1997	-	21	-	21	176	812	1 788	1 440	653	209	94	73	-	5 287
1998	-	-	-	67	474	1 172	2 491	1 144	302	401	89	19	4	6 163
1999	-	77	276	243	495	485	1 058	555	408	152	75	56	-	3 880
2000	-	40	56	396	719	519	1 187	261	290	531	131	23	55	4 208
2001	19	36	112	558	517	260	497	697	267	478	43	42	30	3 556
2002	-	-	32	609	1 019	1 148	989	362	139	591	106	54	54	5 103

B	Age													Total
Year	1	2	3	4	5	6	7	8	9	10	11	12	13+	
1993	-	17	279	1 002	3 129	2 818	3 895	1 632	309	1 406	616	31	35	15 169
1994	-	16	152	1 482	3 768	2 698	3 420	1 615	-	1 171	135	25	-	14 482
1995	-	-	-	216	2 824	6 229	10 624	2 727	1 250	1 902	172	718	57	26 719
1996	3 149	-	28	102	1 547	3 043	4 991	1 599	472	1 211	317	250	72	16 781
1997 [1]	-	163	-	203	624	2 742	5 759	4 170	1 653	562	240	181	66	16 363
1998 [1]	220	501	2 797	1 011	1 847	3 477	6 539	3 057	867	1 179	301	96	57	21 949
1999	41	195	691	825	829	1 531	3 130	1 496	1 011	500	115	129	101	10 594
2000	169	482	947	5 425	2 575	1 310	3 035	553	796	1 109	284	27	55	16 767
2001	69	250	363	2 046	4 250	2 730	2 983	1 123	416	1 148	111	137	94	15 720
2002	233	104	248	1 373	2 748	3 265	3 641	932	449	1 714	365	177	178	15 427
2003	50	89	151	785	1 786	2 860	5 411	1 313	289	951	356	189	92	14 322

[1] Adjusted (according to the 1996 distribution) to include the Russian EEZ which was not covered by the survey.

Table E9. GREENLAND HALIBUT in Sub-areas I and II. Results from a research program using trawlers in a limited commercial fishery 1992-2002. All areas combined. Spring and autumn combined in 1992-1993, otherwise only spring-data.

Catch in numbers on age (%)

Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
1											
2											
3	0.1			0.1		0.0	0.0	0.0			
4	4.6	4.2	3.2	0.7	0.5	0.9	0.2	0.7	1.2	1.3	0.7
5	19.1	25.0	24.7	22.5	19.5	24.8	6.6	7.7	10.8	6.3	7.7
6	23.0	18.4	23.8	22.6	31.6	22.9	25.5	23.0	17.1	20.2	16.8
7	25.9	27.1	26.8	30.2	35.6	30.5	44.5	39.6	43.0	28.5	42.5
8	13.3	12.4	11.2	11.0	8.7	10.1	15.5	14.5	12.3	24.5	12.4
9	1.7	0.7	1.0	2.7	1.3	2.6	4.5	1.6	4.5	7.8	7.1
10	6.8	7.4	5.9	6.6	2.0	5.0	2.0	9.7	8.5	7.3	8.8
11	2.9	3.1	2.4	2.0	0.5	1.9	0.8	1.0	0.9	1.9	2.2
12	1.7	1.0	0.6	1.1	0.2	0.8	0.3	1.8	1.1	1.7	1.2
13	0.5	0.4	0.2	0.3	0.0	0.3		0.2	0.6	0.3	0.2
14	0.2	0.2	0.1	0.2	0.1	0.2		0.2	0.0	0.2	0.4
15	0.1					0.0		0.0	0.0	0.2	0

Mean individual weight (kg)

Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
1											
2											
3	0.26			0.40		0.39					
4	0.50	0.53	0.52	0.47	0.48	0.45	0.41	0.51	0.5	0.60	0.44
5	0.71	0.76	0.73	0.70	0.74	0.69	0.76	0.74	0.69	0.66	0.69
6	0.96	0.98	0.95	0.94	0.94	0.88	0.96	0.92	0.98	0.94	0.93
7	1.29	1.33	1.28	1.24	1.23	1.15	1.19	1.25	1.23	1.12	1.22
8	1.77	1.85	1.79	1.71	1.66	1.55	1.79	1.64	1.57	1.48	1.39
9	2.00	2.28	2.23	2.03	2.00	1.87	2.26	2.18	1.9	1.84	1.69
10	2.46	2.65	2.55	2.50	2.50	2.34	2.54	2.38	2.4	2.30	2.31
11	3.10	3.43	3.37	3.28	3.16	2.95	3.47	3.17	3.13	2.92	3.19
12	3.86	4.32	4.22	3.71	3.70	3.46	4.16	3.79	4.04	3.82	3.91
13	4.44	5.18	5.01	4.62		4.52		5.07	4.47	3.68	5.20
14	6.00	6.44	6.29	5.59		5.47		5.60	6.00	5.74	5.59
15	5.22								8.79	5.52	7

CPUE (N) on age

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
1											
2											
3	0			1	0	0	0	0	0	0	0
4	19	30	26	7	7	11	2	7	14	17	10
5	80	176	198	219	286	298	59	72	132	86	112
6	97	130	191	220	463	275	229	214	208	278	243
7	109	191	215	294	521	366	400	369	524	392	616
8	56	87	90	107	127	121	139	135	150	337	179
9	7	5	8	26	19	31	40	15	55	108	103
10	29	52	47	64	29	60	18	90	104	100	127
11	12	22	19	19	7	23	7	9	11	25	32
12	7	7	5	11	3	10	3	17	13	24	17
13	2	3	2	3	0	4	0	2	7	4	2
14	1	1	1	2	1	2	0	2	0	2	6
15	0			0	0	0	0	0	0	3	1

CPUE (kg) on age

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
1											
2											
3	0			0	0	0	0	0	0	0	0
4	10	16	13	3	4	5	1	3	7	10	4
5	57	134	145	153	211	207	45	53	91	57	77
6	93	127	182	207	435	243	220	197	204	261	226
7	140	254	276	364	641	423	476	461	645	439	749
8	99	162	161	183	211	189	249	221	236	499	249
9	14	11	18	53	38	59	91	32	105	198	175
10	70	138	121	161	73	141	46	215	250	231	293
11	38	75	65	64	23	68	25	30	33	74	101
12	28	30	20	40	11	33	11	64	53	90	67
13	9	15	8	13	0	16	0	9	32	15	13
14	5	9	5	11	0	13		10	2	13	33
15	2			0	0	0			3	15	5

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Overall mean individual weight (kg)	1.35	1.38	1.27	1.29	1.12	1.16	1.30	1.39	1.35	1.38	1.38
CPUE (kg round weight per trawlhour)*	567	973	1020	1255	1640	1393	1169	1294	1647	1377	1449
CPUE (Number fish per trawlhour)*	420	705	803	973	1464	1201	899	931	1220	998	1050
Catch (in tonnes)	695	862	811	368	436	274	272	269	295	297	288

*) Average for freezer- and factorytrawler

Table E10. GREENLAND HALIBUT in ICES Sub-area IV (North Sea. Nominal catch (t) by countries as officially reported to ICES. Not included in the assessment .

Year	Denmark	Faroe Islands	France	Germany	Ireland	Norway	Russia	UK England & Wales	UK Scotland	Total
1973	-	-	-	4	-	9	8	28	-	49
1974	-	-	-	2	-	2	-	30	-	34
1975	-	-	-	1	-	4	-	12	-	17
1976	-	-	-	1	-	2	-	18	-	21
1977	-	-	-	2	-	2	-	8	-	12
1978	-	-	2	30	-	-	-	1	-	33
1979	-	-	2	16	-	2	-	1	-	21
1980	-	177	-	34	-	5	-	-	-	216
1981	-	-	-	-	-	7	-	-	-	7
1982	-	-	2	26	-	17	-	-	-	45
1983	-	-	1	64	-	89	-	-	-	154
1984	-	-	3	50	-	32	-	-	-	85
1985	-	1	2	49	-	12	-	-	-	64
1986	-	-	30	2	-	34	-	-	-	66
1987	-	28	16	1	-	35	-	-	-	80
1988	-	71	62	3	-	19	-	1	-	156
1989	-	21	14 [1]	1	-	197	-	5	-	238
1990	-	10	30 [1]	3	-	29	-	4	-	76
1991	-	48	291 [1]	1	-	216	-	2	-	558
1992	1	15	416 [1]	3	-	626	-	+	1	1 062
1993	1	-	78 [1]	1	-	858	-	10	+	948
1994	+	103	84 [1]	4	-	724	-	6	-	921
1995	+	706	165	2	-	460	-	52	283	1 668
1996	+	-	249	1	-	1 496	-	105	159	2 010
1997	+	-	316	3	-	873	-	1	162	1 355
1998	+	-	71 [1]	10	10	804	-	35	435	1 365
1999	+	-		1	18	2 157	-	43	358	2 577
2000	+		41	10	19	498 [1]	-	67	192	827
2001 [1]	+		43	-	10	470	-	122	202	847
2002 [1]	+		8	+		200	-		249	457

[1] Provisional figures

9 SHRIMP (*PANDALUS BOREALIS*) (SUBAREAS I AND II)

9.1 Status of the Fisheries

9.1.1 Historical development of the fisheries (Table 9.1, Figure 9.1)

Norwegian vessels began to exploit the shrimp fisheries in the Barents Sea and Svalbard area in 1970. Russian vessels entered the shrimp fishery in 1974. The catches increased continuously (Table 9.1 and Figure 9.1) until 1984 when the total catch reached a maximum of 128,000 t. By that time vessels from other countries had entered the fishery. Since then, biomass and catch levels have fluctuated because there were different recruitments, cod consumption and effort in the fisheries due to price of shrimp. The catch peaked at 81,164t in 1990 and at 82,816 t in 2000, and the lowest catches are 43,367t in 1987 and 25,220t in 1995.

9.1.2 Regulation

In the Svalbard area the shrimp fisheries are regulated by number of effective fishing days and number of vessels by country. In the Barents Sea and Svalbard area, Norwegian rules are that the fisheries be regulated by smallest allowable shrimp size (maximum 10% of catch weight may be < 15 mm carapace length, CL) and by provisions of the fishing licences. In the Russian Economic Zone, a TAC is established each year by Russian authorities. Fishing grounds are closed if by-catch limits given as number of individuals in 10 kg of shrimp are exceeded. In 2003 the values of allowed by-catch are set at eight for the sum of cod and haddock, ten for redfish and three for Greenland halibut per catch of 10 kg shrimp.

9.1.3 Landings (Table 9.1, Figure 9.1)

Preliminary reported landings for all countries show a substantial decrease of catches to 55,198t in 2001 and a catch of 59,853 in 2002 (Table 9.1 and Figure 9.1) which is a increase of 9 % from 2001.

9.2 Status of Research

9.2.1 Surveys (Tables 9.3, 9.4)

In the Barents Sea and the Svalbard area, standard shrimp surveys have been conducted by Norway since 1982 and by Russia since 1984 (Tables 9.3,9.4). However, during the 90's, both surveys have suffered from reductions in survey time. The Russian vessels did not surveyed the Svalbard area for many years but have carried out surveys in this area in 2001 and 2002. The amount of time available for the Norwegian survey has been reduced from 50 days to 27 days. Detailed information pertaining to the status of the stock is described in 1981–1991 Norwegian reports (Tavares and Øynes 1980, Teigsmark and Øynes 1981, 1982, 1983a, 1983b, Hylen *et al.* 1984, Tveranger and Øynes 1985, Hylen and Øynes 1986, Hylen *et al.* 1987, Hylen and Øynes 1988, Hylen *et al.* 1989, Hylen and Ågotnes 1990) and Russian reports (Berenboim *et al.* 1986, Berenboim *et al.* 1989, Berenboim *et al.* 1990, Mukhin and Sheveleva 1991). Annual joint Norwegian-Russian papers have been produced since 1991 (Berenboim *et al.* 1992, Aschan *et al.* 1993,1994,1995, 1996). Since 1997 the status of the stock has been summarised in annual protocols (Anon 1997, 1998, 1999, ICES 2000/ACFM:3, 2001/ACFM:02, 2001/ACFM:19). Additionally evaluations of the Norwegian surveys have been conducted (Aschan and Sunnanå 1997, Harbitz *et al.* 1998).

9.2.2 Samples from commercial catches

In 2002 observers collected samples on board commercial Spanish vessels in the Svalbard zone. Length and sex distribution data and data on by-catch was obtained (Casas, WD 17). Length distribution data and by-catch data is collected by the Norwegian surveillance since 1995. However, this sampling is not continuous in time and space.

9.2.3 Fishing effort and CPUE (Table 9.2, Figure 9.3)

Catch, effort, and annual CPUE series for Norway and Russia are presented in Table 9.2 and Figure 9.3. The Norwegian shrimp fleet has since late 90's been upgraded both concerning vessels and the use of double and triple trawls. In the logbooks the use of these trawl types have been difficult to register and to make available for further use. This problem has now been overcome and this year a revised series of catch per unit of effort (CPUE), effort and corresponding catch have been given (Sunnanå, WD-26) The Norwegian data show a a peak in the effort in 2000 at the same level as the earlier peaks in 1985 and 1990. The Norwegian effort decreased in 2001. The Russian series of effort data is unchanged and both series show an increase in effort in 2002. The CPUE series indicate an increase of CPUE in 2002 (Table 9.2

and Figure 9.3). The CPUE of the Russian fleet (vessels<1300hp) has fluctuated in accordance with the shrimp biomass (Berenboim *et al.* 2001, figure 9.3). and the revised Norwegian series show the same picture. It should be noted that the Russian fleet is also under development.

9.2.4 Survey results (Tables 9.3–9.5, Figures 9.2–9.5)

There is a strong correlation between the Norwegian and the Russian survey results (Figure 9.2). Biomass indices were highest during 1984, and have since fluctuated between 30% and 60% of this level (Tables 9.3 and 9.4 and Figures 9.2-9.3) with peaks in 1991 and 1998-1990 and low values in 1987-1988, 1994-1995 and 2001. Norwegian and Russian bottom trawl surveys indicate an increase in shrimp biomass in the Barents Sea and Svalbard area of 6% and 109% respectively from 2001 to 2002 (Tables 9.3–9.4 and Figure 9.2). The main survey areas are shown in Figure 9.4. Increase in biomass may be explained by the appeared average strength 1998 and 1999 year classes following the weak 1996 and 1997 year classes (Table 9.5 , Aschan *et al.* 2000) and a decline of cod consumption (Korzhev and Berenboim, WD 17; Berenboim *et al*., 2001) (Figure 9.5).

9.2.5 Population structure

Genetic investigations have been conducted by Kartavtsev *et al.* (1991) on *Pandalus borealis* in the Barents Sea and the Bering Sea. Norwegian scientists conducted both allozyme electrophoresis and DNA-fingerprinting in an attempt to identify potential sub-populations of shrimp in the Northeast-Atlantic including the Jan Mayen area, the Norwegian coast, the Barents Sea, and the Svalbard area (Rasmussen *et al*. 1993, Drengstig *et al.* 2000, Martinez *et al*. 1997). These analyses showed that there are no distinct sub-populations in the open sea, and that there is a high degree of genetic variance between individuals within each location. However, genetic gradients related to geographic distance and sea currents have been identified. There may be mother populations responsible for the recruitment to other areas, as is claimed by Russian scientists (Lysy 1981, 1983). Knowledge pertaining to the presence of such mother populations is of great importance when managing the shrimp resources. Current models have been developed for dispersal of particles (e.g., plankton) in the sea. Data on larval hatching, development, and behaviour of shrimp larvae have been obtained from field and laboratory experiments and will be used as input data for particle tracking and biological models (Ådlandsvik and Sundby 1994, Hanssen and Ådlandsvik 1996). Preliminary results reveal that the majority of shrimp larvae settle approximately 80 km from the spot where hatched (Pedersen *et al*. in prep).

9.2.6 Age determination

The Norwegian and Russian scientists agreed upon the procedures for obtaining shrimp biological data in 1993 (Aschan *et al.* 1993). In order to obtain good length frequency distributions for age analyses, oblique carapace lengths (CL) (from the posterior margin of eyestalk to the posterior mid-dorsal edge) of approximately 300 individuals from each trawl station are measured to the nearest 0.01 mm with an electronic calliper (Mitutoyo, Japan). The data are saved in the database in intervals of 0.1 mm. Shrimp ageing is completed by modal analysis using MIX 3.0 (MacDonald and Pitcher 1979). Annual age determinations have been conducted for 15 areas in the Barents Sea and 7 areas in the Svalbard area since 1991 (Aschan 2001, Hansen and Aschan 2001). Scientists agree on how the available length-at-age data should be implemented in the production of recruitment indices, maturity-at-age and catch-at-age data.

9.2.7 Maturity-at-age

The biological development of shrimp is divided into several stages. Shrimp starts off as males (Stage 2) after the juvenile stage (Stage 1). Thereafter they reach intersex (Stage 3) before they develop into first time spawning females with headroe (Stage 4). When the females mate, the roe is moved under the abdomen (Stage 5) where the eggs stay until hatched (Stage 6). Some females then take a resting period (Stage 7), but the majority starts on a new cycle with headroe (Stage 8). The Russian and the Norwegian coding of the stages are given in Aschan *et al.* (1993). The life history of shrimp varies geographically, from the south to the north, as well as over time (Berenboim 1982, Teigsmark 1983, Hansen and Aschan 2001). Nilssen and Hopkins (1991) show that, although significant latitudinal trends are present, the effects of specific environmental conditions (e.g., warm or cold current systems at a given latitude, seasonal production cycles, and more recent trends toward increased fishing effort on previously unexploited stocks at high latitudes) are important factors modifying “latitudinal life cycle strategies” of this species. Analyses of data from the 90’s suggest that shrimp in the southern Barents Sea (area A) grew quickly and changed sex at an age of four years, whereas shrimp in the central and northern Barents Sea grew slowly (areas B, C and E) and changed sex at an age of 5 years or greater (Aschan 2001). In the Svalbard area, shrimp were between 6 and 10 years at sex change (Hansen and Aschan 2001). Data from Spanish commercial catches indicate a sex change at 5-6 years in the Svalbard zone. The life strategy has changed over time. In the 80’s, when the water was cold, the shrimp in the Barents Sea grew slowly and changed sex later than in the 90’s when the water was warmer (Teigsmark 1983, Grimsmo 1993). These large variations in life history cause problems when applying traditional fishery models based on time-series.

9.2.8 Recruitment (Table 9.5)

Since the growth of shrimp varies in time and space, it is difficult to decide on a good recruitment index. An age-length key constructed from the Norwegian Barents sea survey has been used to define the number of recruits of 1, 2, 3 and 4 year old shrimp in the whole area (Table 9.5) (Aschan *et al.* 2000). A common procedure for dividing shrimp into age groups has been agreed upon. Since very few shrimp < 15 mm CL are caught in the trawl, it is suggested that a mesh bag is attached to the underbelly of the survey trawl (Aschan and Sunnanå 1997, Nilssen *et al.* 1986).

9.2.9 Natural mortality and predation (Figure 9.5)

Predation by cod is the main source of natural mortality. However, it should be noted that other fish species such as Greenland halibut (*Reinhardtius hippoglossoides*), long rough dab (*Hippoglossoides platessoides*), thorny skate (*Raja radiata*) and blue whiting (*Micromesistius poutassou*) also prey on shrimp (Dolgov 1997, Dolgova and Dolgov 1997. The methods used in estimating cod consumption are described by Bogstad and Mehl (1997), and dos Santos and Jobling (1995). In the Barents Sea, the annual consumption of shrimp was estimated to be above 200,000 t throughout the period 1994–2001 (Figure 9.5, Table 1.3 and 1.4). Shrimp consumption rates may, however, have been overestimated. Since all future shrimp assessments have to include cod as predator, it is important to identify and study possible problems with the cod consumption estimates.

9.3 Evaluation of the Stock (Table 9.6)

9.3.1 Assessment methods under progress.

The great plasticity in growth of shrimp and age at sex change, as well as a lack of biological data and length distributions from the catches make it difficult to apply traditional analytical fishery assessment methods to the data. Therefore a spreadsheet performance report (Caddy 1999, Koeller *et al.* 2001) has been used to assess the available information (Table 9.6).

Other models have been used in assessing shrimp and some of these are listed below together with the experience achieved by using them.

<u>Production models</u>

1) Shaefer and Fox stock models;

2) stock production model including predation (Stefánsson *et al.* 1994, Berenboim and Korzhev 1997);

3) age-structured production model (Shepherd 1991);

4) biomass dynamic models (Hilborn and Walters 1996).

5) dynamic production model (Babayan and Kizner, 1998).

Babayan and Kizner production models were used to assess the MSY of the Barents Sea shrimp (Korzhev and Berenboim, WD 17). Since cod consumption is not included in this model the Stefánsson production model is to be preferred.

The production model elaborated by Stefánsson *et al*. (1994) for shrimp of north Icelandic water was applied to Barents Sea shrimp data (Berenboim and Korzhev, 1997). This model considers cod and shrimp populations without dividing them into age or length groups.

<u>Catch-at-age analysis (cohort models)</u>

1) single-species virtual population analysis;

2) multi species virtual population analysis.

For these models it is important to apply reasonable values for the natural mortality coefficient as a function of age and year, because these parameters are important in shrimp models due to high cod consumption.

Single-species VPA

Single VPA (Lowestoft ICES) may be used in two variants:

- to estimate total natural mortality in advance (for example with the help of multispecies model), or

- to introduce the predator as an additional fleet.

Multispecies model MSVPA

The MSVPA is developed in the MAWG ICES (Sparre 1984). Cod stomach data is obtained from the Joint Russian-Norwegian stomach data base. Methods used in parameter estimation and preparation of input files are described in Bulgakova *et al.* (1995 a,b,c) and ICES (1996/Assess:3).

<u>Length-at-age analysis</u>

1) Jones´ analysis (for sustainable stock);

2) analysis including stochastic growth (Sullivan et al. 1991, Kunzlik 1991);

3) Fleksibest (Froeysa *et al.* 2002);

4) Bormicon – multispecies analysis (Stefánsson and Pálsson 1997).

9.4 Status of the Stock (Table 9.2–9.4, Figures 9.3, 9.5)

Norwegian and Russian CPUE and survey biomass indices indicate an increase in the CPUE and the stock from 2001 to 2002 (Table 9.2, Figure 9.3). Russian survey biomass index in 2002 is above the long-term mean (1984 – 2002) where as the Norwegian index is still below this level. The CPUE series show that the Norwegian series is above the average and the Russian is below the average. The average strength 1998 and 1999 year classes have probably resulted in the growth of the survey index in year 2002. The 2000-2001 year classes are of uncertain strength but may contribute to some increase in shrimp stock in 2003-2004 if they turn out to be of average size. The decreased shrimp consumption by cod will probably also result in an increase in the shrimp stock biomass (Figure 9.5).

9.5 Recommendations for further work

- Scientists should evaluate the procedures used in estimating the shrimp consumed by cod;

- Length and sex data from commercial catches should be provided by all nations involved in the fishery;

- Authorities should enforce the accurate completion of logbook data in Norway, especially the use of single, double and triple trawls;

- Work on developing and evaluating assessment methods should be continued;

- National shrimp cruises should survey the entire area of shrimp distribution in the Barents Sea and the Svalbard area; therefore, more vessel time is necessary.

- Catch and effort statistics should be delivered to the ICES by all countries involved in the shrimp fishery in the Barents Sea and the Svalbard area. Now there are available Norwegian, Russian and Spanish data only.

9.6 Organising the assessment work of shrimp in ICES subareas I and II.

The Institute of Marine Research (IMR) and PINRO are responsible for providing the necessary research results to manage the stock of shrimp (*Pandalus borealis*) in the Barents Sea and Svalbartd area (ICES sub areas I and II.

In addition, talks between the responsible parties on shrimp research in the North Atlantic have led to a suggestion of putting all the assessment work on shrimp into a joint NAFO / ICES Working Group. However, the shrimp stock in the Barents Sea and Svalbard area was included in the terms of reference for the ICES Arctic Fisheries WG meeting in August 2000. The main argument was the ecosystem approach and the intense predation by cod on the shrimp stock.

During the AFWG meeting in 2000 the establishing of such an ICES/NAFO Shrimp Working Group was taken forward and it was indicated that October would be a suitable time for such a WG. One reason was the new timing for the AFWG that in 2001 and in the future will meet in late April. As this is also the timing of the Russian and Norwegian shrimp surveys in the Barents Sea, conducted since 1982, this will obviously create problems for the Russian and Norwegian scientists.

These topics have been discussed in the AFWG this year and an ICES/NAFO Shrimp WG to meet in October 2003 is being regarded as a good solution. Other arguments for the North Atlantic shrimp WG were the low number of shrimp scientists in the AFWG, the need for broader competence within shrimp assessment.

AFWG would like to ask ICES to proceed in the intention to establish a joint NAFO / ICES North Atlantic Shrimp Working Group to meet, preferable, in October.

Table 9.1 Nominal shrimp catches (t) by country (Subareas I and II combined). Data were provided by ICES and Working Group members.

Year	Norway	Russia	Others	Total
1970	5,508	0	0	5,508
1971	5,116	0	0	5,116
1972	6,772	0	0	6,772
1973	6,921	0	0	6,921
1974	8,008	992	0	9,000
1975	8,197	0	2	8,199
1976	9,752	548	0	10,300
1977	6,780	12,774	4,854	24,408
1978	20,484	15,859	0	36,343
1979	25,435	10,864	390	36,689
1980	35,061	11,219	0	46,280
1981	32,713	10,897	1,011	44,621
1982	43,451	15,552	3,835	62,838
1983	70,798	29,105	4,903	104,806
1984	76,636	43,180	8,246	128,062
1985	82.123	32,104	10,262	124,489
1986	48,569	10,216	6,538	65,323
1987	31,353	6,690	5,324	43,367
1988	32,021	12,320	4,348	48,689
1989	47,064	12,252	3,432	62,748
1990	54,182	20,295	6,687	81,164
1991	39,663	29,434	6,156	75,253
1992	39,657	20,944	8,021	68,622
1993	32,663	22,397	806	55,866
1994	20,116	7,108	1,063	28,287
1995	19,337	3,564	2,319	25,220
1996	25,445	5,747	3,320	34,512
1997	29,079	1,493	5,164	35,736
1998	44,792	4,895	6,103[1]	55,790
1999	52,612	10,765	12,292[2]	75,669
2000	54,979	19,596	8,241[3]	82,816
2001[6]	41,216	5,846	8,136[4]	55,198
2002[6]	48,004	3,745	8,104[5]	59,853

[1] Catches reported by Estonia, Faroe Island, Iceland, Lithuania, Portugal, Spain and UK(Eng.Wal.NI)
[2] Catches reported by Estonia, Faroe Islands, Germany, Greenland, Iceland, Lithuania, Portugal Spain and UK(Eng.Wal.NI)
[3] Catches reported by Estonia, Faroe Islands, Iceland, Lithuania, Portugal, Spain and UK.
[4] Catches reported by Estonia, Faroe Islands, Lithuania, Portugal, Spain and UK
[5] Catches reported by Estonia, Faroe Islands, Lithuania, Spain and UK
[6] Preliminary data

Table 9.2 Catch (t), effort (h) and CPUE (kg/h) data in ICES subareas I, IIa and IIb. Norwegian data based on log books from all vessels and scaled to the level of vessels fishing with single trawl at the size of between 1000hp and 1500hp. Russian data based on daily reports from vessels smaller than 1300hp.

Norway				**Russia**			
Year	Catch	Effort	N-CPUE	Year	Catch	Effort	R-CPUE
1980	20,748	85,844	242	1980			
1981	21,865	77,736	281	1981	2,341	8,1	289
1982	30,053	118,314	254	1982	4,966	20,4	243
1983	50,909	174,39	292	1983	13,223	48	276
1984	55,254	177,382	311	1984	33,403	118,9	281
1985	57,063	200,852	284	1985	27,974	110,9	252
1986	32,212	170,747	189	1986	7,912	33,5	236
1987	17,192	128,191	134	1987	3,818	23,9	160
1988	20,803	155,67	134	1988	9,01	61,6	146
1989	33,775	202,419	167	1989	7,928	53,5	148
1990	39,722	224,61	177	1990	17,126	94,5	181
1991	32,922	164,865	200	1991	15,532	74,1	210
1992	36,449	151,899	240	1992	13,025	57	229
1993	27,376	106,634	257	1993	11,39	60	190
1994	11,636	55,81	208	1994	4,521	27,5	164
1995	10,480	59,527	176	1995	3,347	26,1	128
1996	15,077	70,981	212	1996	5,68	35,3	161
1997	21,303	94,931	224	1997	1,507	7,6	198
1998	30,985	102,512	302	1998	4,9	21,212	231
1999	45,137	194,948	231	1999	6,238	30,9	202
2000	48,459	232,6	208	2000	12,204	71,784	170
2001	41,175	181,872	226	2001	2,484	16,609	150
2002	47,203	204,926	230	2002	3,745	16,528	172

Table 9.3 Indices of shrimp biomass from Norwegian surveys in the years 1982-2002 by main areas.

Main area	A East Finnmark	B Tiddly Bank	C Thor Iversen Bank	D BeaIsland Trench	E Hopen	F Bear Island	G Storfjord Trench	H Spits-bergen	Total	Sum. A,B,C, E
Strata	1 - 4	6 - 7	10 - 12	5, 8, 9, 13	14 - 18, 24	19 - 22 31 - 40	41 - 50	51 - 70		
1982	35	34	44	53	66	56	17	22	327	179
1983	40	57	61	53	112	52	21	33	429	270
1984	40	51	64	60	141	66	20	29	471	296
1985	23	17	27	18	96	31	17	17	246	163
1986	10	7	13	25	57	34	10	10	166	87
1987	29	13	18	23	31	10	9	13	146	91
1988	26	18	18	36	32	24	13	14	181	94
1989	41	17	13	17	33	53	22	20	216	104
1990	31	13	25	42	58	43	27	23	262	127
1991	22	28	22	54	120	44	21	10	321	192
1992	18	22	33	37	62	38	14	15	239	135
1993	17	19	32	29	85	20	12	19	233	153
1994	19	8	13	15	52	33	9	12	161	92
1995	10	10	11	17	83	33	16	13	193	114
1996	21	8	26	26	110	42	21	22	276	165
1997	24	34	20	34	116	44	12	16	300	194
1998	18	24	41	26	120	72	12	28	341	203
1999	17	19	23	21	169	31	21	16	316	227
2000	14	29	25	26	102	29	10	12	247	170
2001	*18*	10	30	15	61	25	*10*	*17*	**184**	118
2002	*11*	18	28	16	86	18	*9*	*10*	**196**	143
% 01/00	26	-67	21	-43	-41	-15	0	39	**-25**	-31
% 02/01	*-38*	88	-7	5	42	-27	-7	-41	**6**	21

Table 9.4 Indices of shrimp biomass (1000 t) from Russian survey in the 1984-2002 by main areas. Catchability of 0.182 is used in the estimate.

Main Area	A East Finmark	B Tiddly Bank	C Thor Iversen Bank	E Hopen	F Bear Island	G Storfiord Trench	H Spits-bergen	I Kola coast	K Goose Bank	Total	Sum. A,B,C,E
Strata	1-4	6,7,1s	10-12,25	14-18	38-40, 43-45	48-50	53-55,58-60,63-65, 58-70	2s-6s	7s-8s		
1984	38	137	99	254				133		661	528
1985	14	45	74	255		6	46	19	9	468	388
1986	9	19	44	140		42	127	9	9	399	212
1987	16	17	59	107	45	36	27	25	14	346	199
1988	14	31	39	49		22	29	36	13	233	133
1989	70	128	57	132	6	60	25	105	20	603	387
1990	90	195	119	259	14	110	30	196	15	1028	663
1991	90	153	104	541	9	70	27	155	43	1192	888
1992	80	153	92	409				65	77	876	734
1993	45	91	159	382	9		58	37	111	892	677
1994	4	35	48	255	21			14	27	404	342
1995	5	28	15	80	33	53		16	18	248	128
1996	20	98	127		21			67	108	441	245
1997	26	108	130	341				108	52	765	605
1998	14	106	136	172				108	41	576	427
1999	43	139	107	523				93	61	966	812
2000	29	73	109	328	9	39		72	141	800	539
2001	11	52	105	185	19	14	13	14	55	468	353
2002	30	129	198	353	15	39	51	70	105	980	710
% 01\00	-62	-29	-4	-44	111	-64		-81	-61	-42	-35
% 02/01	173	148	89	91	-21	179	292	400	91	109	101

Table 9.5 Recruitment index for shrimp in the Barents Sea defined as index of numbers in size groups according to carapace length-at-age in the Norwegian Barents sea survey (whole mm).

CL (mm)	age	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
<9	1	0.2	4.2	2.8	3.8	4.2	0.1	0.2	0.2	0.1	0.9
9<cl<12	2	4.5	28.1	42.9	31.7	16.1	12.3	14.0	13.7	2.8	7.4
12<cl<15	3	32.6	92.1	127.9	112.8	60.6	66.9	77.9	84.4	85.7	26.4
15<cl<18	4	343.0	299.6	361.9	415.7	247.2	305.5	468.0	561.2	544.7	342.5

CL (mm)	age	2000	2001	2002
<9	1	0.5	0.0	0.2
9<cl<12	2	21.1	12.2	14.6
12<cl<15	3	70.6	44.6	54.7
15<cl<18	4	191.2	163.3	323.2

Table 9.6 Evaluation of the shrimp (*Pandalus borealis*) stock in Barents Sea and Svalbard area, ICES Sub areas I, IIa and IIb.

Catch	Increased to 128,000 t in 84 followed by a drop to 43,000 t in 87. Catches fluctuated between 81,000 t in 90 and 25,000 in 95. During 96–00 catches increased continuously to 83,000 t. In 2001 the catches were reduced by 33% to 55,000 t and increased somewhat in 2002 (60,000 t)
Effort	The total Norwegian and Russian effort (measured as hours fishing equivalent to medium sized vessel using single trawl) was at its lowest in 94 to 97 (approx. 100,000 h) but increased to above 300,000 h in 2000, which is at the same level as in 85 and 90 which represent an all time high. In 2001 the effort was reduced to a level at about 200,000 h and has increased by 10% in 2002. Since 97 the number of Norwegian vessels using double and triple trawl has increased. The Norwegian increase in effort is estimated close to a four time increase over the last 8 years where as the Russian effort is at a low level.
By Catch	The mandatory use of 19 mm sorting grates excludes most fish >18 cm. Areas are closed if the following criteria are exceeded: 8 cod and haddock or 10 redfish or 3 Greenland halibut per 10 kg of shrimp. In 2002 the northeastern Hopen area and the Svalbard fjords were closed due to juvenile shrimp in and areas in the central and southern Barents Sea were closed due to juvenile haddock and cod. In autumn areas northeast of Svalbard were closed due to juveniles of Greenland halibut.

INDEX	OBSERVATION	INTERPRETATION	EVALUATION
FISHERY DATA			
CPUE index	Increased for the Norwegian and the Russian fleet from 1995 to 1998 (302 and 231 kg/h respectively) but show a decrease in the years 99 and 00 for both fleets. In 2001 the Russian index was further reduced, but increased again in 2002 (172 kg/h). The Norwegian index has been revised to take into account double and triple trawling, and this index showed a lower value in 2000 but increased again in 2001 and 2002 (230 kg/h).	Between 95 and 98 the shrimp biomass and usage of new technology increased, however, the biomass decreased in 99, 00 and 01 whereas there is signs for an increase in 2002, even when technological improvements has been accounted for. The Norwegian index is at the average Norwegian level of 224 kg/h but the Russian index is below the average Russian level of 200 kg/h.	?
Spatial pattern	The Hopen deep remains the most important fishing area.	Reflects a stable situation for the fishery	+
Temporal pattern	This is an all year fishery with the best catches in March-August and the lowest catches in November-February.	Monthly variation is due to seasonal vertical migrations, presence of ice and weather conditions rather than shrimp abundance.	+
Male/female abundance	Only biological data from commercial catches in a small area west of Svalbard is available.		?
Sex inversion	5-6 years is the age range at sex change from Spanish commercial catch in 2000, 2001 and 2002	The lack of previous information in commercial catches does not permit any interpretation.	?

Table 9.6 cont.

RESEARCH DATA			
Biomass index	Norwegian and Russian biomass indices are well correlated and agree with the commercial CPUE. The Norwegian index indicates a reduction from 1998 to 2001 (46%). The Russian index indicates a reduction from 1999 to 2001 (52%). In 2002 both indices show an increase. Norway 6% and Russia 109 %	Biomass shows an increase.	+
Spatial pattern	Widely distributed throughout the management area. Distribution/density patterns vary between years. The surveys do not cover the north–eastern part of the distribution area.	Area of distribution appears to be constant.	?
Recruitment (male age structure)	The 2001 year class show strength below average as 1 year olds, while the 1998, 1999 and 2000 year classes appeared to be of average strength.	The fishable shrimp biomass may increase as the 1999 and 2000 year classes enter the stock.	?
Spawning stock (females)	Has been a stable proportion of the stock through the 90's; female abundances vary with the biomass index. The decrease in 2001 SSB index was due to the weak 96 year class.	The 97 and 98 year classes have contribute to some increase in the SSB in 2002.	?
Sex inversion	The majority of shrimp change sex at five years. Temporal and spatial distribution of mean length at sex change will be calculated using L_{50} or Lt.	M suggest that we try to use Lt (Skuladottir, Koeler). Identify first time spawners as intersex with head roe (stage)	?

Table 9.6 cont.

OTHER FACTORS			
Predation	Cod consumption since 1992 has been approximately 10 times higher than the landings. The decline in the cod stock has resulted in a decline in the consumption from 325,000t in 98 to 256,000t in 99. Cod consumption has increased to 459,000 t in 2000 but again reduced in 2001 to 283,0000t. The number for 2002 is estimated to be 186 thousand t.. Other predators are Greenland halibut and thorny skate.	Consumption by cod is declining and this may improve the level of the shrimp stock.	?
Environment	The 95–98 temperatures in the Barents Sea were below the long-term mean. Since the beginning of 1998, temperatures have increased and this could impact growth, survival and sex change.	Possibly a positive effect on growth and recruitment and thereby on stock size.	?
Industry perspectives	In 2001 the Russian shrimp fishery indicates that the catch rate is lower than 2000. In the Norwegian fishery the catch rates are maintained using double or triple trawl. The price of shrimp has declined and has led to a reduction in the numbers of vessels fishing and in fishing hours. However, the catches seem to be good in April 2003.	Technological development is necessary to maintain the fishery. An effort increase in the Norwegian fleet of close to four times is estimated for the last decade.	?

Table 9.6 cont.

ASSESSMENT			
Exploitation Rate	In the 80's the ratio of catch to the combined Norwegian and Russian survey biomass index was above the long-term mean (1984 – 2002). During the mid 90's the ratio was close to half of the mean. However, in 2000 and 2001 it was some 30% above the mean and in 2002 it is just above and close to the mean. This is the same trend as shown by the total effort.	The Norwegian and Russian surveys uses different catchability in their calculations and the exact stock level is unknown. Norwegian and Russian surveys do not cover the entire area of distribution.	?

Stock Status	**Current status: Biomass and CPUE indices are at an average level and show a slight increase.**	+
	Prospects: Over the next few years, residual female stock and average year classes may contribute to some increase of the stock. There is concern that an increase in the effort will increase the level of exploitation.	?

Concerns for current status/future prospects **—**

Uncertainty regarding index quality or impact ?

Positive evaluation **+**

<u>**Uncertainty about the absolute stock size and the cod consumption**</u>

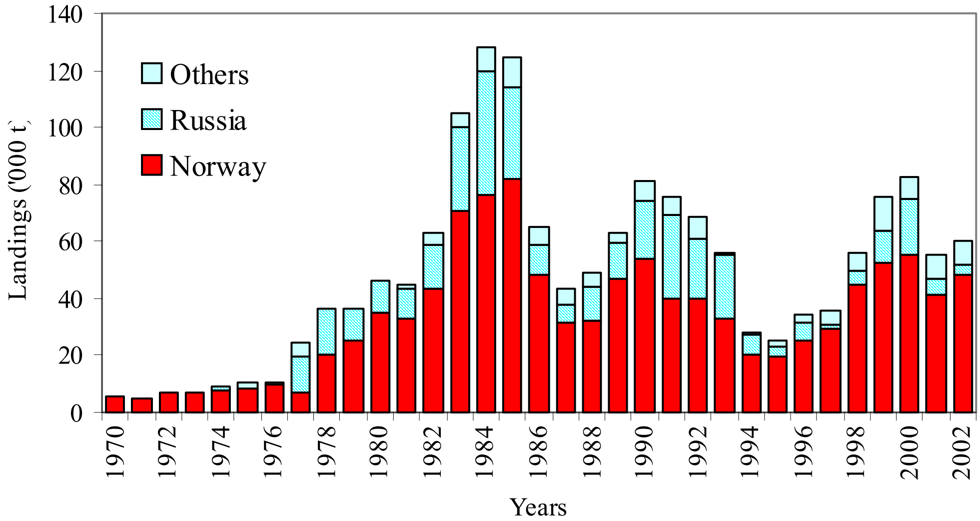

Figure 9.1. Shrimp landings from ICES areas I, IIa and IIb by Norway, Russia and other countries in the period 1970–2002

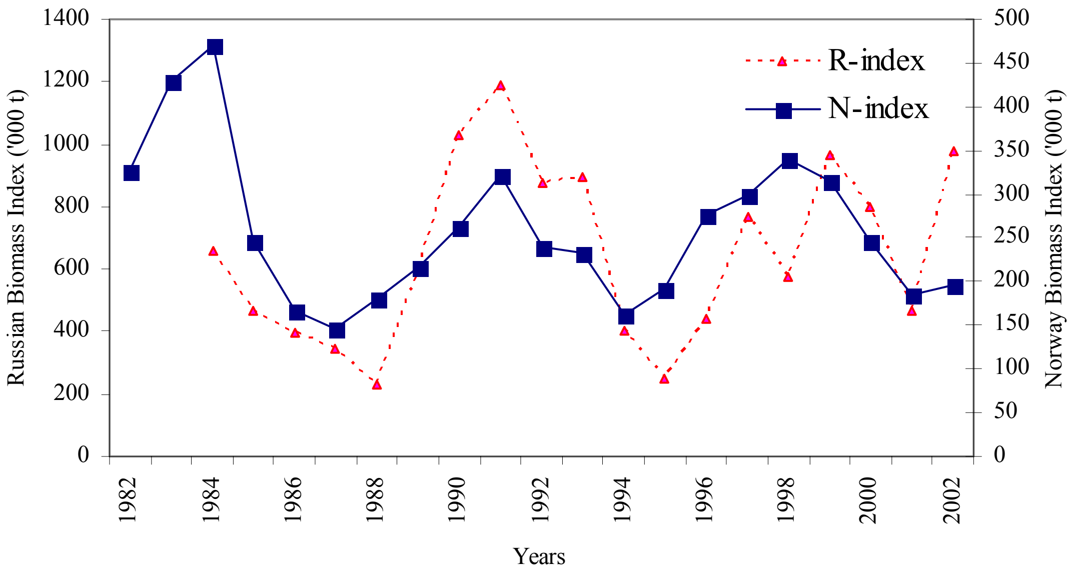

Figure 9.2 Shrimp biomass indices from Norwegian and Russian surveys in the Barents Sea and Spitsbergen area in 1982-2002.

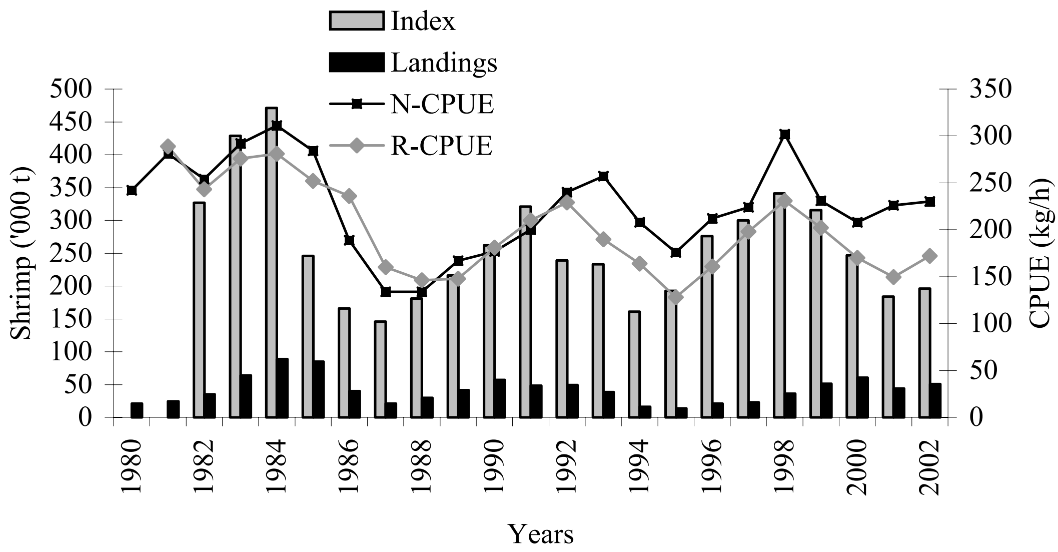

Figure 9.3 Biomass indices from the Norwegian surveys, total landings and Norwegian and Russian CPUE for ICES areas I, IIa and IIb.

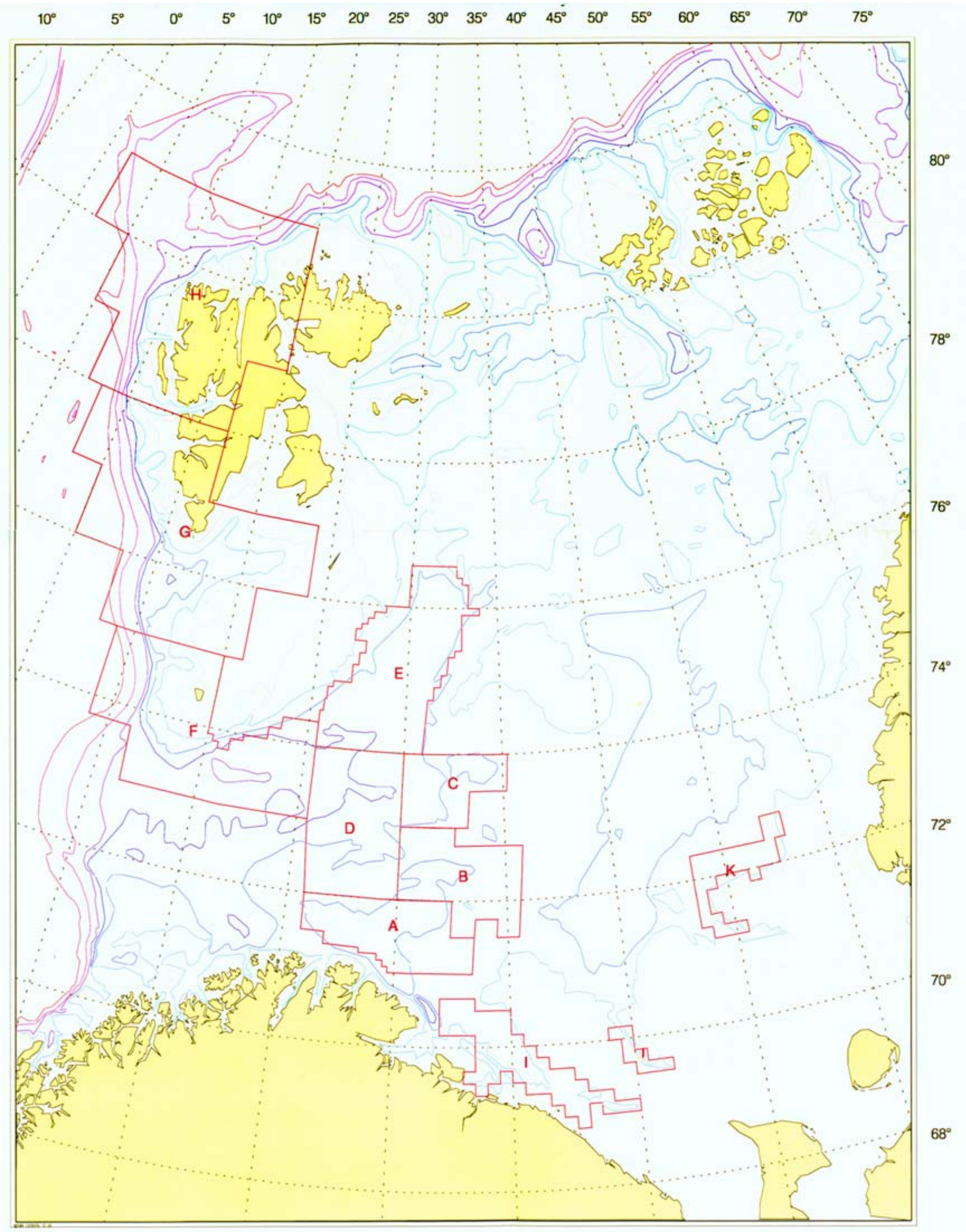

Figure 9.4 Survey strata are combined to 10 larger areas marked with letters A to K.East Finnmark (A), Tiddly Bank (B), Thor Iversen Bank (C), Hopen (E), Bear Island (F), Storfjord Trench (G), Spitsbergen (H), Kola coast (I) and the Goose Bank (K).

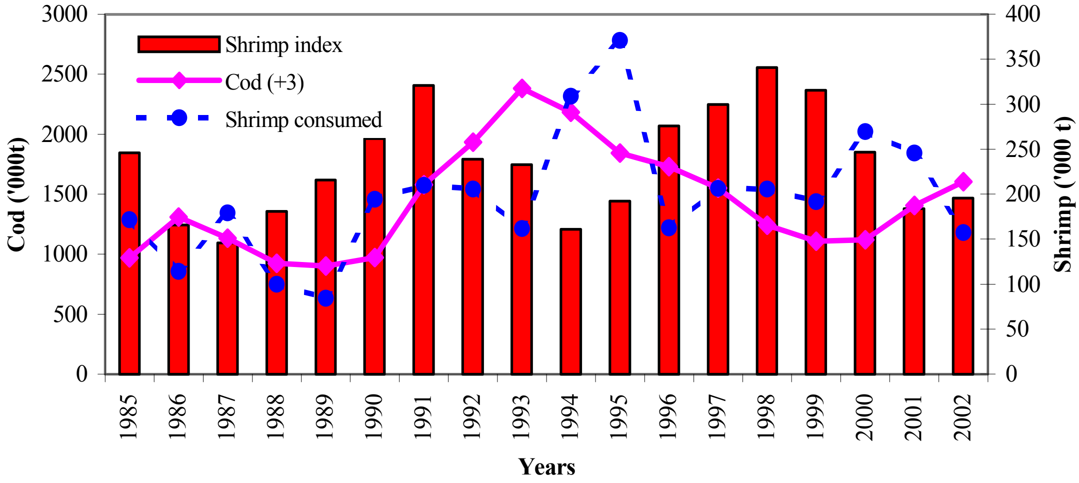

Figure 9.5 Biomass indices from the Norwegian surveys, biomass estimate for cod (age 3 years and older) and the shrimp consumed by the cod in the Barents Sea.

10 WORKING DOCUMENTS

WD#	Title	Authors
1	Ecological conditions in the Barents Sea, 2002-2003	Stiansen, J. E, Ottersen, G., Dalpadado, P., Loeng, H and Ingvaldsen, R.
2	Software implementation of process models	Needle, C. and Marshall, C.T.
3	Application of age/length keys for Northeast Arctic cod to growth modelling	Marshall, C.T. and Needle, C.
4	Abundance dynamics of the Barents Sea euphausiids and their importance as a component of cod food supply	Drobysheva, S., Nesterova, V. and Zhukova, N.
5	On estimating an index of abundance for Greenland halibut	Pennington, M.
6	Consumption of various prey species by cod in 1984-2002.	Dolgov, A.
7	NEA cod dynamic simulation for the testing of various management scenarios	Borisov, V. and Bulgakova, T.
8	A regression model for recruitment of 3-year-old NEA cod based on capelin biomass, survey index and climate	Stiansen, J.E, Aglen, A., Bogstad, B., Mehl, S. and Nakken, O.
9	Estimation of cod discards in the Barents Sea and adjacent waters in 1993-2002. Comparison of results obtained using different methods	Sokolov, K.
10	Assessing cod by-catch in the Norwegian shrimp fishery	Ajiad, A., and Nedreaas, K.
11	Short status report of the results from the Norwegian-Russian cod and haddock comparative age readings	Nedreaas, K., and Yaragina, N.
12	Forecasting of growth rate in Northeast Arctic cod in 2002-2004	Filin, A.
13	The Spanish NE Arctic cod fishery in 2002	Casas, J.M., and Murua, H.
14	Retrospective NEA saithe analysis	Mehl, S. and Fotland, Å.
15	Norwegian trawl CPUE analysis for NEA saithe	Mehl, S. and Fotland, Å.
16	Results of Russian research on saithe in 2002	Drevetnyak, K., and Russkikh, A.
17	The use of production models to estimate the northern shrimp stock in the Barents Sea	Korzhev, V.A., and Berenboim, B.I.
18	The Spanish NE Arctic shrimp fishery in 2002	Casas, J.M.
19	Investigations on demersal fish in the Barents Sea winter 2003	Aglen, A., Alvsvåg, J., Halland , T.I, Høines, Å., Nakken, O., Russkikh, A. and Smirnov, O.
20	Abundance of saithe Finnmark – Møre autumn 2003	Korsbrekke, K. and Mehl, S.
21	Acoustic abundance of spawning Northeast Arctic cod in the Lofoten survey spring 2003. Preliminary results	Mehl, S., Nedreaas, K. and Salthaug, A.
22	Results from the Russian survey for Greenland halibut in the Barents Sea and adjacent waters in 2002	Smirnov, O.
23	The demersal fish survey in the Barents Sea and Svalbard area during summer 2002	Høines, Å.
24	Results of Russian autumn surveys of cod and haddock in 1984-2002	Sokolov, A., Gusev, E. And Yaragina, N.

25	Spanish bottom trawl survey ”FLETAN ARTICO 2002” in the slope of Svalbard Area, ICES Division IIb.	Paz X., Casas, J.M., and Román E.
26	Norwegian catch and effort series – an update.	Sunnanå, K

11 REFERENCES

Ajiad, A., Jakobsen, T., and Nakken, O. 1999. Sexual difference in maturation of Northeast Arctic cod. J. Northw. Atl. Fish. Sci. 25: 1–15.

Anon. 1997. Protocol of the co-operation meeting held in Tromsø 12–13 June 1997.

Anon. 1998. Protocol of the co-operation meeting held in Tromsø 18–19 June 1998.

Anon. 1999. Protocol of the co-operation meting held in Kirkenes, 11–13 October, 1999.

Anon. 2001. dst2. Development of structurally detailed statistically testable models of marine populations. QLK5-CT1999–01609. Progress report for 1 January 2000 to 31 December 2000. Marine Research Institute Technical Report nr. 78, Marine Research Institute, Reykjavik, Iceland.

Anon. 2002a. dst2. Development of structurally detailed statistically testable models of marine populations. QLK5-CT1999–01609. Progress report for 1 January 2001 to 31 December 2001. Marine Research Institute Technical Report nr. 87, Marine Research Institute, Reykjavik, Iceland.

Anon., 2002b. Report from the 2002 joint Russian-Norwegian meeting to assess the Barents Sea capelin stock, Kirkenes 7–9 October 2002.

Aschan, M. 2001. Spatial variability in length frequency distribution and growth of shrimp (*Pandalus borealis* Krøyer 1838) in the Barents Sea. J. Northw. Atl. Fish. Sci. Vol.27: 77–89.

Aschan, M., Berenhoim, B., Mukhin, S. and Sunnanå, K. 1993. Results of Norwegian and Russian investigations of shrimp (*Pandalus borealis)* in the Barents Sea and Svalbard area in 1992. ICES CM 1993/K:9.

Aschan, M., Berenboim, B. and Mukhin, S. 1994. Results of Norwegian and Russian investigations of shrimp (*Pandalus borealis*) in the Barents Sea and the Svalbard area 1993, compared with earlier studies. ICES CM 1994/K:37.

Aschan, M., Berenboim, B. and Mukhin, S. 1995. Results of Norwegian and Russian investigations of shrimp (*Pandalus borealis*) in the Barents Sea and the Svalbard area 1994. ICES CM 1995/K:11.

Aschan, M., Berenboim, B. and Mukhin, S. 1996. Results of Norwegian and Russian investigations of Shrimp (*Pandalus borealis*) in the Barents Sea and in the Svalbard area 1995. ICES CM 1996/K:6.

Aschan, M., Ådlandsvik, B. and Tjelmeland, S. 2000. Spatial and temporal patterns in Recruitment of shrimp *Pandalus borealis* in the Barents Sea. ICES CM 2000/N:32.

Aschan, M. and Sunnanå, K. 1997. Evaluation of the Norwegian Shrimp Surveys conducted in the Barents Sea and the Svalbard area 1980–1997. ICES CM 1997/Y:07.

Asplin, L. and E. Dahl (Editors) 2003. Havets Miljø 2003. Fisken og Havet, særnr. 2- 2003. Institute of Marine Research, Bergen, Norway. In Norwegian with English subtitles.

Babayan V.K. and Kizner Z.I.1998. Dynamic models for NFC assessment. Logic, Notentialities, development //CSEAP, Colin. Sci. Pap. ICSEAF, v.15 (1): p.69–83.

Berenboim B.I.1982. Reproduction of the shrimp *Pandalus borealis* in the Barents Sea. Oceanology 22(1): 85–89.

Berenboim, B.I., Lysy, A. Yu. and Salmov, V.Z. 1986. Soviet investigations on shrimp (*Pandalus borealis*) in the Barents Sea and Spitsbergen area in May 1985. ICES CM 1986/K:11.

Berenboim, B.I., Mukhin, S.G. and Sheveleva, G.K. 1989. Soviet investigations of shrimp *Pandalus borealis* in the Barents Sea and off the Spitsbergen in 1988. ICES CM 1989/K:14.

Berenboim, B.I., Mukhin, S.G. and Sheveleva, G.K. 1990. Soviet investigations of shrimp *Pandalus borealis* in the Barents Sea and off the Spitsbergen in 1989. ICES CM 1990/K: 4.

Berenboim, B., Mukhin, S. and Sunnanå, K. 1992. Results from Norwegian and Soviet investigations of shrimp *Pandalus borealis* in the Barents Sea. ICES CM 1991/K:14.

Berenboim, B. and Korzhev, V. 1997. On possibility of using Stefansson's production model to assess the northern shrimp (*Pandalus borealis*) stock in the Barents Sea. ICES CM 1997/Y.

Berenboim, B.I., Dolgov, A.V., Korzhev, V.A. and Yaragina N.A. 2001. The impact of cod on the dynamics of Barents Sea shrimp (*Pandalus borealis*) as determined by multispecies models. J. Northw. Atl. Fish. Sci. 27: 1–7.

Björnsson, H., and Sigurdsson, T. 2003. Assessment of golden redfish (*Sebastes marinus* L.) in Icelandic waters. Scienta Marina 67 (Suppl. 1):301–314.

Bogstad, B., Hiis Hauge, K., and Ulltang, Ø. 1997. MULTSPEC – A Multi-Species Model for Fish and Marine Mammals in the Barents Sea. J. Northw. Atl. Fish. Sci. 22: 317–341.

Bogstad, B. and Mehl, S. (MS) 1997. Interactions Between Cod (*Gadus morhua*) and Its Prey Species in the Barents Sea. *Forage Fishes in Marine Ecosystems*. Proceedings of the International Symposium on the Role of Forage Fishes in Marine Ecosystems. Alaska Sea Grant College Program Report No. 97–01: 591–615. University of Alaska Fairbanks.

Brander, K. 2002. Predicting weight at age. Internal ICES note to Assessment Working Groups.

Bulgakova, T., D.Vasilyev, V.Korzhev, V.Tretyak 1995a. The results of multispecies analysis for the Barents Sea fishery community (cod, capelin, shrimp and herring)// ICES C.M. 1995/D:14. 24p.

Bulgakova, T., D.Vasilyev and A.Dolgov 1995b Some special algorithms for the Barents Sea fish stomach content data base processing// ICES CM 1995/D:13 Ref. G,H,K.

Bulgakova T., D.Vasilyev et al. 1995 c Seasonal and yearly dynamics of the Barents Sea cod rations. ICES CM 1995/G:32 Ref. D,H,K.

Caddy, J.F. 1999. Deciding on precautionary management measures for a stock based on a suite of limit reference points (LRPs) as a basis for a multi-LRP harvest law. NAFO Sci. Coun. Studies, 32: 55–68.

Dalpadado, P. B. Bogstad, H. Gjøsæter, S. Mehl and H. R. Skjoldal. 2002. Zooplankton-fish interactions in the Barents Sea. In Large Marine Ecosystems, pp.269–291. Blackwell Science Inc.

Deriso, R. B., Quinn, T. J. and Neal, P. R. 1985. Catch-age analysis with auxiliary information. Can. J. fish. Aquat. Sci., 42: 815–824.

Dingsør, G. E. 2001. Estimation of discards in the commercial trawl fishery for Northeast Arctic cod (*Gadus morhua* L.) and some effects on assessment. Cand. Scient thesis, University of Bergen, 2001

Dolgov A.V. 1997. Distribution, abundance, biomass and feeding of thorny skate, *Raja radiata*, in the Barents Sea. ICES CM 1997/GG: 04.

Dolgova N.V and Dolgov A.V. 1997. Stock status and predation of long rough dab (*Hippoglossoides platessoides*) in the Barents and Norwegian Seas. (In: International Symposium on the Role of Forage Fishes in Marine Ecosystems, Anchorage, Alaska 13–16 November 1996.

Drengstig, A., Fevolden S.E, Galand P.E, and Aschan, M.M. 2000. Population structuring of the deep sea shrimp (*Pandalus borealis*) in the NE Atlantic based on allozymic differentiation. Aquat. Living Resour. 13:1–9.

Ellertsen B., Solemdal P., and Stromme T. 1981. Spawning period, transport and dispersal of eggs from spawning area of Arcto-Norwegian cod, *Gadus morhua* L. Rapp. P.-v. Reun.Cons.int.Explor.Mer 178:.260–267.

Folkow, L. P., Haug, T., Nilssen, K.T., and Nordøy, E. S. 2000. Estimated food consumption of minke whales *Balaenoptera acutorostrata* in Northeast Atlantic waters in 1992–1995. NAMMCO Scientific Publications 2: 65–81.

Fournier, D. and Archibald, C. P. 1982. A general theory for analysing catch at age data. Can. J. Fish. Aquat. Sci., 39: 1195–1207.

Frøysa, K.G., Bogstad, B., and Skagen, D.W. 2002. Fleksibest – an age-length structured fish stock assessment tool with application to North-east Arctic cod (*Gadus morhua* L.) Fisheries research 55:87–101.

Grimsmo, L.1993. Biology and management of *Pandalus borealis* in the Barents Sea. Thesis at the University of Tromsø. -86 pp. (in Norwegian).

Hansen, H.Ø., and Aschan, M. 2001. Growth performance, size and age at maturity of shrimp *Pandalus borealis*, in the Svalbard area related to environment. J. Northw. Atl. Fish. Sci.

Hansen, R. and Ådlandsvik B. 1996. Application of a hydrodynamical model on transport of larvae of polar cod in the northern Barents Sea. Fisken og Havet nr.27–1996. 65 pp.

Harbitz, A., Aschan, M. and Sunnanå, K. 1998. Optimum stratified sampling design for biomass estimates in large area trawl surveys - exemplified by shrimp surveys in the Barents Sea. Fisheries research 37:107–113.

Hilborn, R. and Walters, C.J. 1996. Biomass dynamic models. User's manual. FAO computerized information series (fisheries). No. 10. Rome, FAO. 62p.

Hylen, A., Tveranger, B. and Øynes, P. 1984. Norwegian investigations on the deep Sea shrimp (*Pandalus borealis*) in the Barents Sea in April - May 1984 and in the Spitsbergen area in July - August 1984. ICES CM 1984/K:21.

Hylen, A. and Øynes, P. 1986. Results of stratified trawl surveys for shrimps (*Pandalus borealis*) in the Barents Sea and in the Svalbard region in 1986. ICES CM 1986/K:34.

Hylen, A., Jacobsen, J. A. and Øynes, P. 1987. Results of stratified trawl surveys for shrimps (*Pandalus borealis*) in the Barents Sea and the Svalbard region in 1987. ICES CM 1987/K:39.

Hylen, A. and Øynes, P. 1988. Results of stratified trawl surveys for shrimps (*Pandalus borealis*) in the Barents Sea and the Svalbard region in 1988. ICES CM 1988/K:18.

Hylen, A., Sunnanå, K. and Øynes, P. 1989. Results of stratified trawl surveys for shrimps (*Pandalus borealis*) in the Barents Sea and the Svalbard region in 1989. ICES CM 1989/K:26.

Hylen, A. and Ågotnes, P. 1990. Results of stratified shrimp trawl surveys for shrimps (*Pandalus borealis*) in the Barents Sea and the Svalbard region in 1990. Survey Report.

ICES. 1996. Report of the multispecies assessment working group. Bergen, Norway, 21 – 28 June 1995. ICES CM 1996/Assess:3.

ICES 1996. Report of the Arctic Fisheries Working Group. ICES CM 1996/Assess: 4. 311 pp.

ICES. 1997. Report of the Northern Pelagic and Blue Whiting Fisheries Working Group. ICES CM 1997/Assess: 14

ICES 1998. Study Group on the Precautionary Approach to Fisheries Management. ICES CM 1998/ACFM:10.

ICES. 1998. Technical minutes of ACFM meeting, ICES 20–29 October 1998. Internal document.

ICES. 1999. Report of the Joint ICES/NAFO Working Group on harp and hooded seals. Tromsø, Norway, 29 September – 2 October 1998. ICES CM 1999/ACFM:7, 36 pp.

ICES 2000. Report of the Arctic Fisheries Working Group. ICES CM 2000/ACFM: 3. 312 pp.

ICES 2001. Report of the Arctic Fisheries Working Group. ICES Headquarters August 2000. ICES CM 2001/ACFM:02. 340 pp.

ICES 2001. Report of the Arctic Fisheries Working Group. Bergen, Norway, 24 April – 3 May 2001. ICES CM 2001/ACFM:19. 380 pp.

ICES 2002. Report of the Arctic Fisheries Working Group. ICES Headquarters 16–25 April 2002. ICES CM 2002/ACFM:18. 451 pp.

ICES ACFM. 2003. Report of the Study Group on Growth, Maturity and Condition in Stock Projections. ICES CM 2003/D:01.

ICES 2003. Report of the Study Group on the Further Development of the Precautionary Approach to Fisheries Management. ICES Headquarters 2–6 December 2002. ICES CM 2003/ACFM: (in prep.).

ICES 2003. Study Group on Biological Reference Points for Northeast Arctic Cod. Svanhovd, Norway 13–17 January 2003. ICES CM 2003/ACFM:11.

ICES 2003. Study Group on Precautionary Reference Points for Advice on Fisheries Management. ICES Headquarters 24–26 February 2003. ICES CM 2003/ACFM:15.

Ingvaldsen, R., Loeng, H, Ottersen, G, and Ådlandsvik, B. 2002. Climatic variability in the Barents Sea during the 20th century with focus on the 1990s. ICES Marine Science Symposium (in press).

Jakobsen, T., Korsbrekke, K., Mehl, S., and Nakken, O. 1997. Norwegian combined acoustic and bottom trawl surveys for demersal fish in the Barents Sea during winter. ICES CM 1997/Y:17.

Johansen, G. O., Bogstad, B., Mehl, S., and Ulltang, Ø. 2002. Consumption of juvenile herring (*Clupea harengus* L.) by Northeast Arctic cod (*Gadus morhua* L.) in the Barents Sea: a new approach to estimating consumption in piscivorous fish. In: Johansen, G. O. (2002). The predator-prey interaction between Northeast Arctic cod (*Gadus morhua* L.) and juvenile Norwegian spring-spawning herring (*Clupea harengus* L.). Dr scient thesis, Department of Fisheries and Marine Biology, University of Bergen.

Kartavtsev, V.P., Berenboim, B. and Zugurovsky, K.I. 1991. Population genetic differentiation on the pink shrimp *Pandalus borealis* Krøyer 1838, from the Barents and Bering Seas. J. Shell. Res. 10 (2): 333–339.

Koeller, P., Savard, L., Parsons, D.G. and Fu, C. 2001. A precautionary approach to assessment and management of shrimp stocks in the Northwest Atlantic. J. Northw. Atl. Fish. Sci.

Korsbrekke, K. 1997. Norwegian acoustic survey of Northeast Arctic cod on the spawning grounds off Lofoten. ICES C.M 1997/Y:18.

Köster, F.W., H.-H. Hinrichsen, M.A. St. John, D. Schnack, B.R. MacKenzie, J. Tomkiewicz, and M. Plikshs. 2001. Developing Baltic cod recruitment models II: Incorporation of environmental variability and species interaction. Can. J. Fish. Aquat. Sci. 58: 1535–1557.

Kunzlik, P.A. 1991. An Itroduction to Sullivan, Lai and Gallucci's Catch at Size Analysis (CASA). Working Paper to the 1991 *Nephrops* Assessment Working Group. 21 pp.

Kvamme, C. and Frøysa, K. G. 2003. Assessing the stock effects of selectivity changes in a fishery. Fisheries Research (submitted).

Lindstrøm, U., Haug, T. and Røttingen, I. 2002. Predation on herring, *Clupea harengus*, by minke whales, *Balaenoptera acutorostrata*, in the Barents Sea. ICES Journal of Marine Science, 59: 58–70.

Lysy, A.Y. 1981. Distribution of larvae of deep-sea prawn (*Pandalus borealis* Krøyer) in Norwegian and Barents Seas in 1979. Annales biol., 3:107–108.

Lysy, A.Y. 1983. Distribution, abundance, and development of deep-water shrimp (*Pandalus borealis*) larvae in the Norwegian and Barents Seas in 1980. Ann. Biol. Copenh. 37:107–108.

Macdonald, P.D.M., and T.J. Pitcher. 1979. Age groups from size-frequency data: a versatile and efficient method of analysing distribution mixtures. J. Fish. Res. Board Can., 36: 987–1001.

Marshall, C.T., Kjesbu, O.S., Yaragina, N.A., Solemdal, P., and Ulltang, Ø. 1998. Is spawner biomass a sensitive measure of the reproductive and recruitment potential of Northeast Arctic cod? Can. J. Fish. Aquat. Sci. 55: 1766–1783.

Martinez, I., Skjeldal, T.O., Dreyer, B. and Aljanabi, S.M. 1997. Genetic structuring of *Pandalus borealis* in the NE-Atlantic. II. RAPD analysis. ICES CM 1997/T:24.

Mehl, S. 1999. Demersal fish investigations in the Barents Sea winter 1999. Fisken og Havet 13–1999. (In Norwegian with table and figure text also in English).

Mehl, S., and Yaragina, N. A. 1992. Methods and results in the joint PINRO-IMR stomach sampling program. In: Bogstad, B. and Tjelmeland, S. (eds.), *Interrelations between fish populations in the Barents Sea*. Proceedings of the fifth PINRO-IMR Symposium. Murmansk, 12–16 August 1991. Institute of Marine Research, Bergen, Norway, 5–16.

Mukhin, S.G. and Sheveleva, G.K. 1991. Soviet investigations on shrimp in the Barents Sea and off the Spitsbergen in 1990. ICES CM 1991/K:14.

Nakken, O. and A.Raknes 1996. Corrections of indices of abundance of 0-group fish in the Barents Sea for varying capture efficiency. ICES CM 1996/G:12.

Nilssen, E.M. and Hopkins, C.C.E. 1991. Population parameters and life histories of the deep-water prawn *Pandalus borealis* from different regions. ICES CM 1991/K:2.

Nilssen, E.M., Larsen, R.B. and Hopkins, C.C.E. 1986. Catch and size selection of *Pandalus borealis* in a bottom trawl and implications for population dynamic analyses. ICES CM 1986/K:4.

Nilssen, K.T., Pedersen, O-P., Folkow, L. and Haug, T. 2000. Food consumption estimates of Barents Sea harp seals. NAMMCO Scientific Publications 2: 9–27.

Ottersen G., Ådlandsvik B., and Loeng, H. 2000. Predictability of Barents Sea temperature. Fisheries Oceanography 9: 121–135

Pedersen, T. 1984. Variation of peak spawning of Arcto-Norwegian cod (*Gadus morhua* L.) during the time period 1929–1982 based on indices estimated from fishery statistics. The Propagation of cod *Gadus morhua* L. Flødevigen rapportser., 1, Part 1, p.301–316.

Pedersen, O. P., Aschan, M., Tande, K., Slagstad, D. and Rasmussen, T. In prep. The advection and population dynamics of *Pandalus borealis* investigated by a Lagrangian particle tracking model.

Rasmussen, T., Thollesson, M. and Nilssen, E.M. 1993. Preliminary investigations on the population genetic differentiation of the deep water prawn, *Pandalus borealis* Krøyer 1838, from Northern Norway and the Barents Sea. ICES CM 1993/K:11.

dos Santos, J and Jobling, M. 1995. Test of a food consumption model for the Atlantic cod. ICES J. mar. Sci., 52:209–219.

Schweder, T., Skaug, H.J., Dimakos, X.K., Langaas, M. and Øien, N. 1997. Abundance of northeastern Atlantic minke whales, estimates for 1989 and 1995. *Rep. Int. Whal. Commn* 47: 453–483.

Shepherd, J.G. 1991. Simple methods for short-term forecasting of catch and biomass. ICES J. mar. Sci., 48: 67–78.

Stefánsson, G. and Pálsson, Ó.K. 1997. Bormicon. A boreal migration and consumption model. Report no. 58, Marine Research Institute, Reykjavik, Iceland.

Stefánsson, G. and Pálsson, Ó. K.1998. A framework for multispecies modelling of Arcto-boreal systems. Rev. Fish. Biol. Fish. 8,101–104.

Stefánsson, G., Skúladóttir, U. and Pétursson, G. 1994. The use of a stock production type model in evaluating the offshore *Pandalus borealis* stock of North Icelandic waters, including the predation of Northern shrimp by cod. ICES CM 1994/K:25.

Sparre P. 1984. A computer program for estimation of food suitability coefficients from stomach content data and multispecies VPA// ICES C.M. 1984/G:25.

Sullivan,P.J., Lai H.L., Gallucci V.F. 1991. A catch-at-length analysis that incorporates a stochastic model of growth.Can. J. Fish. Aquat. Sci. 47: 184–198.

Tavares, A. M. and Øynes, P. 1980. Results of a stratified bottom trawl survey for shrimps (*Pandalus borealis*) in the Barents Sea and the Spitsbergen area in May-June 1980. ICES CM 1980/K:22.

Teigsmark G.1983. Populations of the deep-sea shrimp (*Pandalus borealis* Krøyer) in the Barents Sea. Fiskedir. Skr. Ser. HavUnders., 17: 377–430.

Teigsmark, G. and Øynes, P. 1981. Results of a stratified bottom trawl survey for shrimps *(Pandalus borealis*) in the Barents Sea in May - June 1981. ICES CM 1981/K:21.

Teigsmark, G. and Øynes, P. 1982. Norwegian investigations on the deep Sea shrimp(*Pandalus borealis*) in the Barents Sea in 1982. ICES CM 1982/K:12.

Teigsmark, G. and Øynes, P. 1983a. Results of a stratified bottom trawl survey for shrimps (*Pandalus borealis*) in the Spitsbergen area in July 1982. ICES CM 1983/K:17.

Teigsmark, G. and Øynes, P. 1983b. Norwegian investigations on the deep Sea shrimp (*Pandalus borealis*) in the Barents Sea in April - May 1983 and in the Spitsbergen area in July 1983. ICES CM 1983/K:46.

Tomkiewicz, J., M. Eriksson, T. Baranova, V. Feldman, and H. Müller. 1997. Maturity ogives and sex ratios for Baltic cod: establishment of a database and time series. ICES CM 1997/CC:20.

Trenkel, V. O'Brien, C. M. and Bogstad, B. 2002. Length-based population dynamics in state space form. Appendix C.3 in dst2. Development of structurally detailed statistically testable models of marine populations. QLK5-CT1999–01609. Progress report for 1 January 2001 to 31 December 2001. Marine Research Institute Technical Report nr. 87, Marine Research Institute, Reykjavik, Iceland.

Tveranger, P. and Øynes, P. 1985. Results of stratified trawl surveys for shrimps (*Pandalus borealis*) in the Barents Sea in May and in the Svalbard region in July - August 1985. ICES CM 1985/K:50.

Yaragina N. A. and Marshall C. T. 2000. Trophic influences on interannual and seasonal variation in the liver condition index of Northeast Arctic cod (*Gadus morhua*). ICES Journal of Marine Science, 57: 42–55.

Ådlandsvik, B. and Sundby, S. 1994. Modelling the transport of cod larvae from the Lofoten area. ICES Mar. Sci. Symp. 198: 379–392.

ANNEX 1

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Standard Procedure for Assessment

XSA/ICA Type

Stock specific documentation of standard assessment procedures used by ICES.

Stock:…Norwegian Coastal cod ………………………………………………….

Working Group:…Arctic Fisheries Working Group…………………………………

Date: 30-04-03………………….

A General

A.1. Stock definition

Cod in the Barents Sea, the Norwegian Sea and in the coastal areas living under variable environmental conditions form groups with some peculiarities in geographical distribution, migration pattern, growth, maturation rates, genetics features, etc. The degree of intermingle of different groups is uncertain (Borisov, Ponomarenko and Yaragina, 1999). However, taking into account some biological characteristics of cod in the coastal zone and the specifics of the coastal fishery, the Working Group considered it acceptable to assess the Norwegian coastal cod stock (in the frame of ICES) separately from North-East Arctic cod.

Both types of cod (the Norwegian Coastal cod and the North-East Arctic cod) can be met together on spawning grounds during spawning period as well as in catches all the year round both inshore and offshore in variable proportions.

The Norwegian Coastal cod (NCC) is distributed in the fjords and along the coast of Norway from the Kola peninsula in northeast and south to Møre at 62º N. Spawning areas are located in fjords as well as offshore along the coast. Spawning season extents from March to late June. The 0 and 1-group of NCC inhabit shallow water both in fjords and in coastal areas and are hardly found in deeper trawling areas until reaching about 25 cm. Afterwards they gradually move towards deeper water. NCC starts on average to mature at age 4-6 and migrates towards spawning grounds in early winter. The majority of the biomass (about 75 %) is located in the northern part of the area (North of 67º N).

Tagging experiments of cod inhabiting fjords indicate only short migrations (Jakobsen 1987, Nøstvik and Pedersen 1999, Skreslet, et al. 1999). From these experiments very few tagged cod migrated into the Barents Sea (<1%). Investigations based on genetics find large difference between NCC and North-East Arctic cod (NEAC) (Fevolden and Pogson 1995, Fevolden and Pogson 1997, Jørstad and Nævdal 1989, Møller 1969), while others do not find any difference (Árnason and Pálsson 1996, Mork, et al. 1984, Artemjeva and Novikov, 1990). Investigations also indicate that NCC probably consists of several separate populations.

Ongoing investigations on the genetic structure of cod along the Norwegian coast, the Murman coast and in the White Sea will hopefully further elucidate the stock structure of cod in these areas.

A.2. Fishery

The fishery is conducted both with trawlers and with smaller coastal vessels using traditional fishing gears like gillnet, longline, hand line and danish seine. In addition to quotas, the fishery is regulated by the same minimum catch size, minimum mesh size on the fishing gears as for the North-East Arctic cod, maximum by-catch of undersized fish, closure of areas having high densities of juveniles and by seasonal and area restrictions. The fishery is dominated by gillnet (50%), while longline/hand line account for about 20%, Danish seine 20% and Trawl 10% of the total catch. There was a shift around 1995 in the portion caught by the different gears. After 1995 the portion taken by longline and hand line has decreased, while the portion taken by danish seine has increased. Norwegian vessels take all the reported catch. However, trawlers from other countries probably take a small amount of NCC when fishing near the Norwegian coast fishing for North-East Arctic cod and North-East Arctic haddock.

A.3. Ecosystem aspects

Not investigated

B. Data

B.1 Commercial catch

From 1996, cod caught inside the 12 n.mile zone have been separated into Norwegian coastal cod and Northeast Arctic cod based on biological sampling (Berg, et al. 1998) The method is based on otolith-typing. This is the same method as is used in separating the two stocks in the surveys targeting NEAC. The catches of Norwegian coastal cod (NCC) have been calculated back to 1984. During this period the catches have been between 25,000 and 75,000 t.

The separation of the Norwegian catches into NEAC and NCC is based on:

- No catches outside the 12 n.mile zone have been allocated to the NCC catches.
- The catches inside 12 n.mile zone are separated into quarter, fishing gear and Norwegian statistical areas.
- From the otolith structure, catches inside the 12 n.mile zone have been allocated to NCC and NEAC. The Institute of Marine Research in Bergen has been taking samples of commercial catches along the coast for a long period.

Norwegian commercial catch in tonnes by quarter, area and gear are derived from the sales notes statistics of The Directorate of Fisheries. Data from 8 sub areas are aggregated on 6 main areas for the gears gillnet, long line, hand line, Danish seine and trawl. No discards are reported or accounted for, but there are reports of discards and incorrect landings with respect to fish species and amount of catch. The scientific sampling strategy from the commercial fishing is to have age-length samples from all major gears in each area and quarter.

There are at present no defined criteria on how to allocate samples of catch numbers, mean length and mean weight at age to unsampled catches. The following general process has been applied: First look for samples from a neighbouring area if the fishery extends to this area in the same quarter. If there are no samples available in neighbouring areas, search for samples from other gears with the most similar selectivity in the same area or in neighbouring areas. The last option is to search in neighbouring quarters, first from the same gear in the same area, and than from neighbouring areas and similar gears. Age-length keys from research surveys with shrimp trawl (Norwegian coastal survey) are also used to fill holes.

Weight at age is calculated from the commercial catch back to 1984.

Proportions mature at age from 1984 to 1994 are obtained from the commercial catch data. From 1995-2001 the proportions mature at age are obtained from the Norwegian coastal survey.

Norway is assumed to account for most of the NCC landings. The text table below shows which kind of data are collected:

	Kind of data				
Country	Caton (catch in weight)	Canum (catch at age in numbers)	Weca (weight at age in the catch)	Matprop (proportion mature by age)	Length composition in catch
Norway	X	X	X	X	X

The result files (FAD data) can be found at ICES and with the stock co-ordinator, either in the IFAP system as SAS datasets or as ASCII files on the Lowestoft format, either under **w:\acfm\afwg\year\stock\coas_cod** or **w:\ifapdata\eximport\afwg\coas_cod**.

B.2. Biological

Weight at age in the stock is obtained from the Norwegian coastal survey in the period 1995 to 2001. From 1984 to 1994 weight at age in stock is taken from weight at age in the catch because no survey data from this period are available.

A fixed natural mortality of 0.2 is used both in the assessment and the forecast.

Both the proportion of natural mortality before spawning (Mprop) and the proportion of fishing moratlity before spawning (Fprop) are to 0.

B.3. Survey

Since 1995 a Norwegian trawl-acoustic survey (Norwegian coastal survey) specially designed for coastal cod has been conducted annually in October-November (28 days). The survey covers the fjords and coastal areas from the Varangerfjord close to the Russian border and southwards to 62° N. The aim of conducting a acoustic survey targeting Norwegian coastal cod has been to support the stock assessment with fishery-independent data of the abundance of both the commercial size cod as well as the youngest pre-recruit coastal cod. The survey therefore covers the main areas where the commercial fishery takes place, normally dominated by 4 - 7 year old fish.

The 0- and 1 year-old coastal cod, mainly inhabiting shallow water (0-50 meter) near the coast and in the fjords, are also represented in the survey, although highly variable from year to year. However, the 0-group cod caught in the survey is impossible to classify to NCC or NEAC by the otoliths since the first winter zone is used in this separation. A total number of more than 200 trawl hauls are conducted during the survey (100 bottom trawl, 100 pelagic trawl).

The survey abundance indexes at age are total numbers (in thousands) computed from the acoustics.

Ages 2-8 are used in the XSA-tuning.

B.4. Commercial CPUE

No commercial CPUE are available for this stock.

B.5. Other relevant data

None

C. Historical stock development

Model used: XSA

Software used: IFAP / Lowestoft VPA suite

Model Options chosen:

Tapered time weighting applied, power = 3 over 20 years

Catchability independent of stock size for all ages

Catchability independent of age for ages >= 8

Survivor estimates shrunk towards the mean F of the final 2 years or the 4 oldest ages

S.E. of the mean to which the estimate are shrunk = 1.0

Minimum standard error for population estimates derived from each fleet = 0.300

Prior weighting not applied

Input data types and characteristics:

Type	Name	Year range	Age range	Variable from year to year Yes/No
Caton	Catch in tonnes	1984 – last data year	2 – 10+	Yes
Canum	Catch at age in numbers	1984 – last data year	2 – 10+	Yes
Weca	Weight at age in the commercial catch	1984 – last data year	2 – 10+	Yes
West	Weight at age of the spawning stock at spawning time.	1984 – last data year	2 – 10+	Yes/No - assumed to be the same as weight at age in the catch from 1984-1994
Mprop	Proportion of natural mortality before spawning	1984 – last data year	2 – 10+	No – set to 0 for all ages in all years
Fprop	Proportion of fishing mortality before spawning	1984 – last data year	2 – 10+	No – set to 0 for all ages in all years
Matprop	Proportion mature at age	1984 – last data year	2 – 10+	Yes
Natmor	Natural mortality	1984 – last data year	2 – 10+	No – set to 0.2 for all ages in all years

Tuning data:

Type	Name	Year range	Age range
Tuning fleet 1	Norwegian coastal survey	1995 – last data year	2-8

D. Short-term projection

Model used: Age structured

Software used: MFDP- prediction with management option table and MFYPR- yield per recruit.

Initial stock size. Taken from the XSA for age 3 and older. The recruitment at age 2 in intermediate year is estimated using the RCT-3 software and indices from the Norwegian Acoustic survey. The same recruitment is used for age 2 in all projection years.

Natural mortality: Set to 0.2 for all ages in all years

Maturity: Geometric average of the last three years.

F and M before spawning: Set to 0 for all ages in all years

Weight at age in the stock: Geometric average of the last three years.

Weight at age in the catch: Geometric average of the last three years.

Exploitation pattern: Average of the three last years, scaled by the Fbar (4-7) to the level of the last year

Intermediate year assumptions: F status quo

Stock recruitment model used: RCT3

Procedures used for splitting projected catches: Not relevant

E. Medium-term projections

Not done.

F. Long-term projections

Not done.

G. Biological reference points

Not available.

H. Other issues

I. References

Árnason, E. and Pálsson, S. 1996. Mitochondrial cytochrome b DNA sequence variation of Atlantic cod Gadus morhua, from Norway. Molecular Ecology 5: 715-724.

Artemjeva, K.F. and G.G. Novikov. 1990. Peculiarities of population structure of the Northeast Atlantic cod. In: Eco;ogy, reproduction and conservation of biological resources in seas of the Northern Europe. Murmansk, p.162-164 (in Russian)

Berg, E., Eriksen, I. A. and Eliassen, J.-E. 1998. Catch-statistics for Norwegian Coastal cod 1984-1997, -data and methods. Fiskeriforskning,10/1998.

Borisov, V. M., Ponomarenko, V. P. and Yaragina, N. A. (1999). A Critical Review of the Population Status in Coastal cod (Gadus morhua) from Barents Sea Region of Norway. Journal of Ichthyology 39: 18-28.

Fevolden, S. E. and Pogson, G. H. 1995. Difference in nuclear DNA RFLPs between the Norwegian coastal and the Northeast Arctic population of Atlantic cod. pp. 403-415. In: Skjoldal, H. R., Hopkins, C., Erikstad, K. E. and Leinaas, H. P. (ed.) Ecology of Fjords and Coastal Waters, Elsevier Science B. V.

Fevolden, S. E. and Pogson, G. H. 1997. Genetic divergence at the synoptophysin (Syp I) locus among Norwegian coastal and north-east Arctic populations of Atlantic cod. Journal of Fish Biology 51: 895-908.

Jakobsen, T. 1987. Coastal Cod in Northern Norway. Fisheries Research 5: 223-234.

Jørstad, K. E. and Nævdal, G. 1989. Genetic variation and population structure of cod, Gadus morhua L., in some fjords in northern Norway. Journal of Fish Biology 35: 245-252.

Mork, J., Giskeødegård, R. and Sundnes, G. 1984. Population genetics studies in cod (Gadus morhua L.) by means of the haemoglobin polymorphism; observations in a Norwegian coastal population. Fiskeridirektoratets Skrifter Serie Havundersøkelser 17, No. 12: 449-471.

Møller, D. 1969. The relationship between Arctic and coastal cod in their immature stages illustrated by frequencies of genetic charaters. Fiskeridirektoratets Skrifter Serie Havundersøkelser 15: 220-233.

Nøstvik, F. and Pedersen, T. 1999. Movement pattern and growth of wild cod (Gadus morhua L.) and hatchery-reared cod released as 1-group. pp. 315-333. In: Howell, E., Moksness, E. and Svåsand, T. (ed.) Stock Enhancement and Sea Ranching, Fishing News Books, Oxford.

Skreslet, S., Albrigtsen, I., Andersen, A. P., Kolbeinshavn, A., Pedersen, T. and Unstad, K. 1999. Migration, growth and survival in stocked and wild cod (Gadus morhua L.) in the Vestfjord region, North Norway. pp. 306-314. In: Howell, E., Moksness, E. and Svåsand, T. (ed.) Stock Enhancement and Sea Ranching, Fishing News Books, Oxford.

Standard Procedure for Assessment

XSA/ICA Type

Stock specific documentation of standard assessment procedures used by ICES.

Stock:…North-East Arctic Cod ………………………………………………….

Working Group:…Arctic Fisheries Working Group…………………………………

Date: 20-02-02………………….

General

Stock definition

The North-East Arctic cod (*Gadus morhua*) is distributed in the Barents Sea and adjacent waters, mainly in waters above 0° Celsius. The main spawning areas are along the Norwegian coast between N 67°30' and 70°. The 0-group cod drifts from the spawning grounds eastwards and northwards and during the international 0-group survey in august it is observed over wide areas in the Barents Sea.

Fishery

The fishery for North-east Arctic cod is conducted both by an international trawler fleet operating in offshore waters and by vessels using gillnets, longlines, handlines and Danish seine operating both offshore and in the coastal areas. 60-80% of the annual landings are from trawlers. Catch quotas were introduced in the trawl fishery in 1978 and for the fisheries with conventional gears in 1989. In addition to quotas the fisheries are regulated by mesh size limitations including sorting grids, a minimum catching size, a maximum by-catch of undersized fish, maximum by-catch of non-target species, closure of areas with high densities of juveniles and by seasonal and area restrictions. Since January 1997 sorting grids have been mandatory for the trawl fisheries in most of the Barents Sea and Svalbard area. Discarding is prohibited. The minimum catching size of cod is 42 cm in the Russian Economic zone, 47 cm in Norwegian Economic zone; both minimum landing sizes are used by respective fleets in the Svalbard area pursuant to the Svalbard Treaty 1920). The fisheries are controlled by inspections at sea, requirement of reporting to catch control points when entering and leaving the EEZs and by inspections when landing the fish for all fishing vessels. Keeping a detailed fishing log-book on board is mandatory for most vessels, and large parts of the fleet report to the authorities on a daily basis. There is some evidence that the present catch control and reporting systems are not sufficient to prevent discarding and under-reporting of catches, but it has considerably improved in comparison with historical period.

Ecosystem aspects

Considerable effort has been devoted to investigate multispecies interactions in the Northeast Arctic. Some of these investigations have reached the stage where quantitative results are available for use in assessments. Growth of cod depends on availability of prey such as capelin (*Mallotus villosus*), and variability in cod growth has had major impacts on the cod fishery. Cod are able to compensate only partially for low capelin abundance, by switching to other prey species. This may lead to periods of high cannibalism on young cod, and may result in impacts on other prey species which are greater than those estimated for periods when capelin are abundant. In a situation with low capelin abundance, juvenile herring (*Clupea harengus)* experience increased predation mortality by cod. The timing of cod spawning migrations is influenced by the presence of spawning herring in the relevant area. The interaction between capelin and herring is illustrated by the recruitment failure of capelin coinciding with years of high abundance of young herring in the Barents Sea. Herring predation on capelin larvae is believed to be partially responsible for the recruitment failure of capelin when young herring are abundant in the Barents Sea.

The composition and distribution of species in the Barents Sea depend considerably on the position of the polar front which separates warm and salty Atlantic waters from colder and fresher waters of arctic origin. Variation in the recruitment of some species including cod and capelin has been associated with the changes in the influx of Atlantic waters to the large areas of the Barents Sea shelf.

The annual consumption of herring, capelin and cod by marine mammals (mainly harp seals and minke whales) has been estimated to be in the order of 1.5-2.0 million t (Bogstad, Haug and Mehl, 2000; See also Section 1.3.4 AFWG Report 2003).

However, estimates of total annual food consumption of Barents Sea harp seals are in the range of about 3.3-5 million tons (depending on choice of input parameters, ICES 2000d). The applied model used different values for the field metabolic rate of the seals (corresponding to two or three times their predicted basal metabolic rate) and under two scenarios: with an abundant capelin stock and with a very low capelin stock.

1. If capelin was abundant the total harp seal consumption was estimated to be about 3.3 million tons (using lowest field metabolic rate). The estimated consumption of various commercially important species was as follows (in tons): capelin approximately 800,000, polar cod (*Boreogadus saida*) 600,000, herring 200,000 and Atlantic cod 100,000.

2. A low capelin stock in the Barents Sea (as it was in 1993-1996) led to switches in seal diet composition, with estimated increased consumption of polar cod (870,000 tons), other codfishes (mainly Atlantic cod; 360,000 tons), and herring (390,000 tons).

DATA

Commercial catch

Norway

Norwegian commercial catch in tonnes by quarter, area and gear are derived from the sales notes statistics of The Directorate of Fisheries. Data from about 20 sub areas are aggregated on 6 main areas for the gears gill net, long line, hand line, purse seine, Danish seine, bottom trawl, shrimp trawl and trap. For bottom trawl the quarterly area distribution of the catches is adjusted by logbook data from The Directorate of Fisheries and the total bottom trawl catch by quarter and area is adjusted so that the total annual catch for all gears is the same as the official total catch reported to ICES.

No discards are reported or accounted for, but there are several reports of discards. In later years there are also reports of misreporting, saithe is landed as cod in a period with decreasing quotas and availability of cod and good availability of saithe.

The sampling strategy is to have age and length samples from all major gears in each main area and quarter. The main sampling program is sampling the landings. Additional samples from catches are obtained from the coast guard, from observers and from crew members reporting according to an agreed sampling procedure.

There are at present no defined criteria on how to allocate samples to unsampled catches, but the following general procedure has been applied: First look for samples from a neighbouring area if the fishery extends to this area in the same quarter. If there are no samples available in neighbouring areas, search for samples from other gears with the most similar selectivity in the same area or in neighbouring areas. The last option is to search in neighbouring quarters, first from the same gear in the same area, and than from neighbouring areas and similar gears. For some gears, areas and quarters length samples taken by the coast guard are applied and combined with an ALK from a neighbouring area, gear or quarter. ALKs from research surveys (shrimp trawl) are also used to fill holes.

Russia

Russian commercial catch in tonnes by quarter and area are derived from the All-Russian Institute of fishery and oceanography (Moscow) statistics department. Data from each fishing vessel are aggregated on three ICES sub-Division (1, IIa and IIb).Russian fishery by passive gears was almost stopped by the end of the 1940s. At present bottom trawl fishery constitutes more than 95 % cod catch.

The sampling strategy was to conduct mass measurements and collect age samples directly at sea, onboard of both research and commercial vessels to have age and length distributions from each area and quarter. Data on length distribution of cod in catches were collected in areas of cod fishery all the year round by a "standard" fishery trawl (mesh size is 125 mm in the Russian Economic zone and Svalbard area and 135 mm in the Norwegian Economic zone) and summarized by three ICES sub-areas (1, IIa and IIb). Previously the PINRO area divisions were used, differed from the ICES sub-Divisions.

Age sampling was carried out by two ways: without any selection (otoliths were taken from any fish caught in one trawl, usually from 100-300 sp.) or using a stratified by length sampling method (i.e. approximately 10-15 sp. per each 10-cm length group). The last method has been used since 1988.

All fish taken for age-reading were measured and weighted individually.

Catch at age are reported to ICES AFWG by sub-Division (1, IIa and IIb) and quarter (before 1984 – by sub-Division and year). Data on length distribution of cod in catches, as well as age-length keys, are formed for each quarter and area. In the case when a catch is present in the area/quarter but a length frequency is absent, a length frequency for the corresponding quarter, summarised for the whole sea is used. If there is no data on length composition of cod in catches per a quarter within the whole sea, a frequency summarised for the whole year and whole sea is used. Gaps in age-length distributions in sub-Divisions are filled in with data from the corresponding quarter, summarised for the whole sea. Rest gaps are filled in with information from the age-length key formed for the long-term period (1984-1997) for each quarter and for the whole sea. (Kovalev and Yaragina, 1999). Before 1984 calculation of annually catch cod numbers in sub-Divisions was derived from summarized for both the whole year age-length keys and length distribution in catches.

Germany and Spain

Catch at age reported to the WG by ICES sub-Division (I, IIa and IIb) and quarter, according to national sampling. Missing quarters/sub-Divisions filled in by use of Russian or Norwegian sampling data.

Other nations

Total annual catch in tonnes is reported by ICES sub-Divisions. All caches by other nations are taken by trawl. The age composition from the sampled trawl fleets is therefore applied to the catches by other nations.

The text table below shows which country supplied which kind of data for 2000:

	Kind of data				
Country	Caton (catch in weight)	Canum (catch at age in numbers)	Weca (weight at age in the catch)	Matprop (proportion mature by age)	Length composition in catch
Norway	x	x	x	x	x
Russia	x	x	x	x	x
Germany	x	x	x		x
United Kingdom	x				
France[1]	x				
Spain	x	x	x		x
Portugal[1]	x				
Ireland[1]	x				
Greenland[1]	x				
Faroe Islands[1]	x				
Iceland[1]	x				

[1] As reported to Norwegian and Russian authorities

The nations that sample the catches, provide the catch at age data and mean weights at age on Excel spreadsheet files, and the national catches are combined in Excel spreadsheet files. The data should be found in the national laboratories and with the stock co-ordinator.

For 1983 and later years mean weight at age in the catch is calculated as the weighted average for the sampled catches. For the earlier period (1946-1982) mean weight at age in catches is set equal to mean weight at age in the stock (ICES 2001).

The Excel spreadsheet files used for age distribution, adjustments and aggregations can be found with the stock co-ordinator and for the current and previous year in the ICES computer system under **w:\acfm\afwg\year\personal\name** (of stock co-ordinator).

The result files (FAD data) can be found at ICES and with the stock co-ordinator, either in the IFAP system as SAS datasets or as ASCII files on the Lowestoft format, either under **w:\acfm\afwg\2000\data\cod_arct** or **w:\ifapdata\eximport\afwg\cod_arct**.

Biological

For 1983 and later years weight at age in the stock and maturity at age is calculated as weighted averages from Russian and Norwegian surveys during the winter season. Stock weights at age a (W_a) at the start of year y are calculated as follows:

$$W_a = 0.5(W_{rus,a-1} + (\frac{N_{nbar,a}W_{nbar,a} + N_{lof,a}W_{lof,a}}{N_{nbar,a} + N_{lof,a}}))$$

where

$W_{rus,a-1}$: Weight at age a-1 in the Russian survey in year y-1

$N_{nbar,a}$: Abundance at age a in the Norwegian Barents Sea acoustic survey in year y

$W_{nbar,a}$: Weight at age a in the Norwegian Barents Sea acoustic survey in year y

$N_{lof,a}$: Abundance at age a in the Lofoten survey in year y

$W_{lof,a}$: Weight at age a in the Lofoten survey in year y

Maturity at age is estimated from the same surveys by the same formulae, replacing weight by proportion mature.

For age groups 12 and older, the stock weights is set equal to the catch weights, since most of this fish is taken during the spawning fisheries, and in most years considerably more fish from these ages are sampled from the catches than from the surveys.

For the earlier period (1946-1982) the maturity at age and weight at age in the stock is based on Russian sampling in late autumn (both from fisheries and from surveys) and Norwegian sampling in the Lofoten spawning fishery. These data were introduced and described in the 2001 assessment report (ICES 2001).

A fixed natural mortality of 0.2 is used both in the assessment and the forecast.

Both the proportion of natural mortality before spawning (Mprop) and the proportion of fishing mortality before spawning (Fprop) are set to 0. The peak spawning in the Lofoten area occurs most years in late March-early April.

Surveys

Russia

Russian surveys of cod in the southern Barents Sea started in the late 1940s as trawl surveys of young demersal fishes. Since 1957 such surveys have been conducted over the whole feeding area including the Bear Island - Spitbergen area (Baranenkova, 1964; Trambachev, 1981), both young and adult cod have been surveyed simultaneously. In 1984, acoustic methods started to be implemented during surveys of fish stocks (Zaferman, Serebrov, 1984; Lepesevich, Shevelev, 1997; Lepesevich *et al.,* 1999). In 1995 a new acoustic assessment method was applied for the first time, which allowed the differentiation and registration of echo intensities from fish of different length (Shevelev *et al.,* 1998). Methods of calculations of survey indices also changed, e.g. due to the necessity to derive length-based indices for the FLEKSIBEST model (Bogstad *et al.*1999; Gusev, Yaragina, 2000).

Time of survey conducting has reduced from 5-6 months (September-February) in 1946-1981 to 2-2.5 months (October-December) since 1982. The aim of conducting a survey is to investigate both the commercial size cod as well as the young cod. The survey covers the main areas where fries settle down as well as the commercial fishery takes place, included cod at age 0+ - 10+ years. A total number of more than 400 trawl hauls are conducted during the survey (mainly bottom trawl, a few pelagic trawl).

There are two survey abundance indices at age: 1). absolute numbers (in thousands) computed from the acoustics and 2). trawl indices, calculated as relative numbers per hour trawling.

Ages 3-8 are used in the XSA-tuning.

Joint Russian-Norwegian winter (February) survey

The survey started in 1981 and covers the ice-free part of the Barents see. Both swept area estimates from bottom trawl and acoustic estimates are produced. The swept area estimates are used in the tuning for ages 3-8, and the acoustic estimate are added to the Norwegian acoustic survey in Lofoten and used for tuning for ages 3-11. The survey is described in Jakobsen et al (1997) and Aglen et al. (2002).

Norwegian Lofoten survey

Acoustic estimates from the Lofoten survey extends back to 1984. The survey is described by Korsbrekke (1997).

Commercial CPUE

Russia

Two CPUE data series exist, one is historical series, based on RT vessel type (side trawler, 800-1000 HP), which stopped operating in the Barents Sea in the middle of the 1970-s, and other one is presently used, based on PST vessel type (stern trawler, 2000 HP). Information from each fishing trawler was daily transferred to PINRO, including data on each haul (timing, location, gear and catch by species). Yearly catch f cod by the PST trawlers as well as number of hour trawling were summarized and CPUE index (catch on tons per hour fishing) was calculated.

The effort (hours trawling) was scaled to the whole Russian catch. The CPUE indices are split on age groups by age data from the trawl fishery. Data on ages 9-13+ are used in the XSA-tuning.

ESTIMATION OF HISTORICAL STOCK DEVELOPMENT

Model used: XSA

Software used: IFAP / Lowestoft VPA suite

Model Options chosen:

Tapered time weighting applied, power = 3 over 10 years

Catchability independent of stock size for ages >6

Catchability independent of age for ages >= 10

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 estimate are shrunk = 1.000

Minimum standard error for population estimates derived from each fleet = 0.300

Prior weighting not applied

Input data types and characteristics:

Type	Name	Year range	Age range	Variable from year to year Yes/No
Caton	Catch in tonnes	1946 – last data year	3 – 13+	Yes
Canum	Catch at age in numbers	1946 – last data year	3 – 13+	Yes
Weca	Weight at age in the commercial catch	1982 – last data year	3 – 13+	Yes, set equal to west for 1946-1981
West	Weight at age of the spawning stock at spawning time.	1946 – last data year	3 – 13+	Yes
Mprop	Proportion of natural mortality before spawning	1946 – last data year	3 – 13+	No – set to 0 for all ages in all years
Fprop	Proportion of fishing mortality before spawning	1960 – last data year	3 – 13+	No – set to 0 for all ages in all years
Matprop	Proportion mature at age	1960 – last data year	3 – 13+	yes
Natmor	Natural mortality	1960 – last data year	3 – 13+	Includes annual est. of cannibalism from 1984, otherwise set to 0.2 for all ages in all years

Tuning data:

Type	Name	Year range	Age range
Tuning fleet 1	Russian com. CPUE, trawl	1985 – last data year	9 –13+
Tuning fleet 2	Joint Barents Sea trawl survey, february	1981– last data year	3 - 8
Tuning fleet 3	Joint Barents Sea Acoustic, February+ Lofoten Acoustic survey	1985 – last data year	3 -11
Tuning fleet 4	Russian bottom trawl survey, November	1984 – last data year	3-8

XSA-settings

Type of setting	Settings last year	Used this year (why changed)
Time series weighting	Tapered time weighting power = 3 over 10 years	The same
Recruitment regression model (catchability analysis)	Catchability dependent of stock size for ages < 6 Regression type = C Min. 5 points used Survivor estimates shrunk to the population mean for ages < 6 Catchability independent of age for ages >= 10	The same
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 estimate are shrunk = 1.0. Minimum standard error for population estimates derived from each fleet = 0.300.	The same
Prior fleet weighting	Prior weighting not applied	The same

SHORT-TERM PROJECTION

Model used: Age structured

Software used*:* IFAP prediction with management option table and yield per recruit routines

Initial stock size. Taken from the XSA for age 4 and older. The recruitment at age 3 for the initial stock and the following 2 years are estimated from survey data and….(have to decide)

Natural mortality: Set equal to the values estimated for the terminal year.

Maturity: average of the three last years

F and M before spawning: Set to 0 for all ages in all years

Weight at age in the stock: Predicted by applying (10yr average) annual increments by cohort on last years observations.

Weight at age in the catch: Predicted by applying (10yr average) annual increments by cohort on last years observations.

Exploitation pattern: Average of the three last years, scaled by the Fbar (3-6) to the level of the last year

Intermediate year assumptions: F constraint

Stock recruitment model used: None

Procedures used for splitting projected catches: Not relevant

MEDIUM-TERM PROJECTIONS

Model used: Age structured

Software used: ????

Initial stock size: Same as in the short-term projections.

Natural mortality: Same as in the short-term projections

Maturity: Same as in the short-term projections

F and M before spawning: Same as in the short-term projections

Weight at age in the stock: Same as last year in the short-term projections

Weight at age in the catch: Same as last year in the short-term projections

Exploitation pattern: Same as in the short-term projections

Intermediate year assumptions: Same as in the short-term projections

Stock recruitment model used: ????

Uncertainty models used: @RISK for excel, Latin Hypercubed, 500 iterations, fixed random number generator

1. Initial stock size: Lognormal distribution, LOGNORM(mean, standard deviation), with mean as in the short-term projections and standard deviation calculated by multiplying the mean by the external standard error from the XSA diagnostics

2. Natural mortality:

3. Maturity:

4. F and M before spawning:

5. Weight at age in the stock:

6. Weight at age in the catch:

7. Exploitation pattern: Average of the three last years, scaled by the Fbar to the level of the last year

8. Intermediate year assumptions: F-constraint

9. Stock recruitment model used: Truncated lognormal distribution, TLOGNORM(mean, standard deviation, minimum, maximum), is used for recruitment age 2, also in the initial year. The long term geometric mean, standard deviation, minimum, maximum are taken from the XSA for the period 1960 – 4th last year.

LONG-TERM PROJECTIONS

SPR and YPR calculations

BIOLOGICAL REFERENCE POINTS

Introduced 1998: $\mathbf{B}_{lim}$=112000t, $\mathbf{B}_{pa}$=500000t, $\mathbf{F}_{lim}$=0.7, $\mathbf{F}_{pa}$=0.42

Proposed SGBRP 2003: $\mathbf{B}_{lim}$=220000t, $\mathbf{B}_{pa}$=460000t, $\mathbf{F}_{lim}$=0.74, $\mathbf{F}_{pa}$=0.40

OTHER ISSUES

Since the 1999 AFWG a new assessment model (Fleksibest) has been used to provide alternative assessments and to describe characteristics of the data for this stock.

REFERENCES

Aglen, A., Alvsvåg, J., Lepesevich, Y., Korsbrekke, K., Mehl, S., Nedreaas, K.H., Sokolov, K., and Ågotnes, P. 2002. Investigations on demersal fish in the Barents Sea winter 2001. Detailed report. IMR/PINRO Joint report series no 2, 2002. 66pp.

Anon. 2001. dst2. Development of structurally detailed statistically testable models of marine populations. QLK5-CT1999-01609. Progress report for 1 January 2000 to 31 December 2000. Marine Research Institute Technical Report nr. 78, Marine Research Institute, Reykjavik, Iceland.

Anon. 2002. dst2. Development of structurally detailed statistically testable models of marine populations. QLK5-CT1999-01609. Progress report for 1 January 2001 to 31 December 2001. Marine Research Institute Technical Report nr. 87, Marine Research Institute, Reykjavik, Iceland.

Babayan V.K. and Kizner Z.I.1998. Dynamic models for NFC assessment. Logic, Notentialities, development //CSEAP, Colin. Sci. Pap. ICSEAF, v.15 (1): p.69-83.

Baranenkova, A.S. 1964. Some results of estimation of cod fry in the Barents Sea during 1946-1961. *In:* Materials of PINRO Scientific Council Meeting by the results of investigations conducted in 1962-63. PINRO, Murmansk, 3:72-107 (in Russian).

Beckett, J. S. and Serra, R. 2001. Scientific peer review of Northeast Arcic cod assessment. Internal report to ICES, 9 October 2001, Oslo, Norway.

Berg, E., Eriksen, I.A. and Eliassen, J.E. 1998. Catch-statistics on Norwegian Coastal cod 1984-1997, data and methods. Fiskeriforskning Tromsø, report 10/1998. 13 pp.

Berenboim, B. and Korzhev, V. 1997. On possibility of using Stefansson's production model to assess the northern shrimp (*Pandalus borealis*) stock in the Barents Sea. ICES CM 1997/Y.

Berenboim, B.I., Dolgov, A.V., Korzhev, V.A. and Yaragina N.A. 2001. The impact of cod on the dynamics of Barents Sea shrimp (*Pandalus borealis*) as determined by multispecies models. J. Northw. Atl. Fish. Sci. 27: 1–7.

Bogstad B., Fotland Aa., Mehl S., 1999. A revision of the abundance indices for cod and haddock from the Norwegian winter survey in the Barents Sea, 1983-1999. . Working Document N 16 for the Arctic Fisheries Working Group, August 1999, 14 pp.

Bogstad, B., Haug, T. and Mehl, S. 2000. Who eats whom in the Barents Sea? NAMMCO Scientific Publications 2: 98-119.

Bogstad, B., Lilly, G. R., Mehl, S., Pálsson, Ó. K., and Stefánsson, G. 1994. Cannibalism and year-class strength in Atlantic cod (*Gadus morhua* L.) in Arcto-boreal ecosystems (Barents Sea, Iceland and eastern Newfoundland). ICES mar. Sci, Symp. 198: 576-599.

Bogstad, B. and Mehl, S. (MS) 1997. Interactions Between Cod (*Gadus morhua*) and Its Prey Species in the Barents Sea. *Forage Fishes in Marine Ecosystems*. Proceedings of the International Symposium on the Role of Forage Fishes in Marine Ecosystems. Alaska Sea Grant College Program Report No. 97-01: 591-615. University of Alaska Fairbanks.

Bulgakova , T., D.Vasilyev and A.Dolgov 1995b Some special algorithms for the Barents Sea fish stomach content data base processing// ICES CM 1995/D:13 Ref. G,H,K.

Bulgakova T., D.Vasilyev et al. 1995 c Seasonal and yearly dynamics of the Barents Sea cod rations. ICES CM 1995/G:32 Ref. D,H,K.

Caddy, J.F. 1999. Deciding on precautionary management measures for a stock based on a suite of limit reference points (LRPs) as a basis for a multi-LRP harvest law. NAFO Sci. Coun. Studies, 32: 55–68.

CEFAS 1999. PA software users guide. The Centre for Environment, Fisheries and Aquaculture Science, CEFAS, Lowestoft, United Kingdom, 22 April 1999.

Deriso, R. B., Quinn, T. J. and Neal, P. R. 1985. Catch-age analysis with auxiliary information. Can. J. fish. Aquat. Sci., 42: 815–824.

Dingsør, G. E. 2001. Estimation of discards in the commercial trawl fishery for Northeast Arctic cod (*Gadus morhua* L.) and some effects on assessment. Cand. Scient thesis, University of Bergen, 2001

Folkow, L.P., Haug, T., Nilssen, K.T. and Nordøy, E.S. 2000. Estimated food consumption of minke whales *Balaenoptera acutorostrata* in Northeast Atlantic waters in 1992-1995. NAMMCO Scientific Publications 2: 65-81.

Fournier, D. and Archibald, C. P. 1982. A general theory for analysing catch at age data. Can. J. Fish. Aquat. Sci., 39: 1195–1207.

Frøysa, K. G. 2002. Results and recommendations on test runs of Fleksibest with simulated annealing (SA). Appendix D.6 in dst2. Development of structurally detailed statistically testable models of marine populations. QLK5-CT1999-01609. Progress report for 1 January 2001 to 31 December 2001. Marine Research Institute Technical Report nr. 87, Marine Research Institute, Reykjavik, Iceland.

Frøysa, K.G., Bogstad, B., and Skagen, D.W. 2002. Fleksibest – an age-length structured fish stock assessment tool with application to North-east Arctic cod (*Gadus morhua* L.) Fisheries research 55:87-101.

Gusev E.V. and Yaragina N.A. 2000. A conversion of cod abundance from the trawl-acoustic survey data to a number of cod in different age-length groups to be used in the Flexibest model. Working Document N 35 for the Arctic Fisheries Working Group, August 2000, 9 pp.

Harbitz, A., Aschan, M. and Sunnanå, K. 1998. Optimum stratified sampling design for biomass estimates in large area trawl surveys - exemplified by shrimp surveys in the Barents Sea. Fisheries research 37:107–113.

Hilborn, R. and Walters, C.J. 1996. Biomass dynamic models. User’s manual. FAO computerized information series (fisheries). No. 10. Rome, FAO. 62p.

ICES. 1996. Report of the multispecies assessment working group. Bergen, Norway, 21 – 28 June 1995. ICES CM 1996/Assess:3.

ICES 1996. Report of the Arctic Fisheries Working Group. ICES CM 1996/Assess: 4. 311 pp.

ICES 1997. Report of the Arctic Fisheries Working Group. ICES CM 1997/ACFM: 4. 326 pp.

ICES. 1997. Report of the Northern Pelagic and Blue Whiting Fisheries Working Group. ICES CM 1997/ACFM: 14

ICES 1998. Report of the Arctic Fisheries Working Group. ICES CM 1998/ACFM: 2. 366 pp.

ICES 1998a. Report of the Study Group on the Precautionary Approach to Fisheries Management. ICES CM 1998/ACFM:10. 39 pp.

ICES 1998b. Report to the ICES Advisory Committee on Fishery Management, 1998. ICES Cooperative Research Report No. 29.

ICES 1998. Study Group on the Precautionary Approach to Fisheries Management. ICES CM 1998/ACFM:10.

ICES. 1998. Technical minutes of ACFM meeting, ICES 20–29 October 1998. Internal document.

ICES 1999. Report of the Arctic Fisheries Working Group. ICES CM 1999/ACFM: 3. 276 pp.

ICES. 1999. Report of the Joint ICES/NAFO Working Group on harp and hooded seals. Tromsø, Norway, 29 September – 2 October 1998. ICES CM 1999/ACFM:7, 36 pp.

ICES 2000. Report of the Arctic Fisheries Working Group. ICES CM 2000/ACFM: 3. 312 pp.

ICES 2001. ICES Annual Report for 2000. ISSN 0906-0596. 276 pp.

ICES 2001. Report of the ICES Advisory Committee on Fishery Management, 2001. ICES Cooperative Research Report No. 246.

ICES 2001. Report of the Arctic Fisheries Working Group. ICES Headquarters August 2000. ICES CM 2001/ACFM:02. 340 pp.

ICES 2001. Report of the Workshop on Fleksibest – an age and length based assessment tool. ICES CM 2001/ACFM:09. 61 pp.

ICES 2001. Report of the Arctic Fisheries Working Group. Bergen, Norway, 24 April – 3 May 2001. ICES CM 2001/ACFM:19. 340 pp.

ICES 2002. Report of the Working Group on Methods on Fish Stock Assessments. ICES Headquarters 3-3 December 2001. ICES CM/D:01. 98 pp.

ICES 2002. Report of the Study Group on the Further Development of the Precautionary Approach to Fisheries Management. Lisbon, Portugal, 4-8 March 2002. ICES CM 1998/ACFM: (in prep.).

Ingvaldsen, R., Loeng, H, Ottersen, G, and Ådlandsvik, B. 2002. The Barents Sea climate during the 1990s. ICES Marine Science Symposia (in press)

Jakobsen, T., Korsbrekke, K., Mehl, S., and Nakken, O. 1997. Norwegian combined acoustic and bottom trawl surveys for demersal fish in the Barents Sea during winter. ICES CM 1997/Y:17.

Korsbrekke, K. 1997. Norwegian acoustic survey of Northeast Arctic cod on the spawning grounds off Lofoten. ICES C.M 1997/Y:18.

Korsbrekke, K., Mehl, S., Nakken, O. and Pennington, M. 2001. A survey-based assessment of the Northeast Arctic cod stock. *ICES Journal of Marine Science, 58*: 763-769, 2001.

Kovalev Yu., Yaragina N.A., 1999. Scheme of recalculation of cod commercial catch weight into number of fish of different length-age groups accepted in PINRO (Russia) for the Flexibest model. Working Document N 10 for the Arctic Fisheries Working Group, August 1999, 9 pp.

Kunzlik P.A. 1991. An Introduction to Sullivan, Lai and Gallucci's Catch at Size Analysis (CASA). Working Paper to the 1991 Nephrops Ass.WG. : 21pp.

Lepesevich, Yu. M. and Shevelev, M. S. 1997. Evolution of the Russian survey for demersal fish: From ideal to reality. ICES C. M. 1997/Y:09.

Lepesevich Yu1.M., Smirnov O.V. and K.V. Drevetnyak, 1999. The Russian trawl acoustic survey on demersal adult and young fish stock assessments in the Barents Sea in autumn/winter. Working Document N 7 for the Arctic Fisheries Working Group, August 1999, 11 pp.

Macdonald, P.D.M., and T.J. Pitcher. 1979. Age groups from size-frequency data: a versatile and efficient method of analysing distribution mixtures. J. Fish. Res. Board Can., 36: 987–1001.

Marshall, C.T., Kjesbu, O.S., Yaragina, N.A., Solemdal, P., and Ulltang, Ø. 1998. Is spawner biomass a sensitive measure of the reproductive and recruitment potential of Northeast Arctic cod? Can. J. Fish. Aquat. Sci. 55: 1766–1783.

Mehl, S. 1999. Demersal fish investigations in the Barents Sea winter 1999. Fisken og Havet 13-1999. (In Norwegian with table and figure text also in English).

Mehl, S., and Yaragina, N. A. 1992. Methods and results in the joint PINRO-IMR stomach sampling program. In: Bogstad, B. and Tjelmeland, S. (eds.), *Interrelations between fish populations in the Barents Sea*. Proceedings of the fifth PINRO-IMR Symposium. Murmansk, 12–16 August 1991. Institute of Marine Research, Bergen, Norway, 5–16.

MRAG. 1997. Core program development for the modelling management strategies. Final Report of EC Study Project 94/110.

Nilssen, K.T., Pedersen, O-P., Folkow, L. and Haug, T. 2000. Food consumption estimates of Barents Sea harp seals. NAMMCO Scientific Publications 2: 9-27.

Ottersen G., Ådlandsvik B., and Loeng, H. 2000. Predictability of Barents Sea temperature. Fisheries Oceanography 9: 121-135

Pennington, M. (ed). 1999. Report of the workshop on comparison of stock assessment model strategies, with application to Northeast Arctic cod, Bergen 1–4 December 1998. Fisken og havet 4–1999, Institute of Marine Research, Bergen, Norway.

Richards, L.J., Schnute, J.T., Kronlund, A.R., and Beamish, R.J. 1992. Statistical models for the analysis of ageing error," *Canadian Journal of Fisheries and Aquatic Sciences*, 49, 1801-1815.

dos Santos, J and Jobling, M. 1995. Test of a food consumption model for the Atlantic cod. ICES J. mar. Sci., 52:209–219.

Schweder, T., Skaug, H.J., Dimakos, X.K., Langaas, M. and Øien, N. 1997. Abundance of northeastern Atlantic minke whales, estimates for 1989 and 1995. *Rep. Int. Whal. Commn* 47: 453-483.

Shepherd, J.G. 1991. Simple methods for short-term forecasting of catch and biomass. ICES J. mar. Sci., 48: 67–78.

Shevelev M.S., Mamylov V.S., Ratushny S.V., and E.N. Gavrilov, 1998. Technique of Russian bottom trawl and acoustic surveys of the Barents Sea and how to improve them. NAFO Scientific Council Studies, No. 31, p.13-19.

Skagen, D.W. 2002. Programs for stochastic prediction and management simulation (STPR3 and LTEQ). Program description and instructions for use. (version dated 6-3-2002).

Sokolov, K. M. 2001. On feasibility of assessment of discards of small cod in trawl fishery for *Gadidae* in the Barents Sea and adjacent waters in 1996-2000. 9th joint Russian-Norwegian symposium "Technical regulations and by-catch criteria in the Barents Sea Fisheries" (PINRO, Murmansk, 14-15 August 2001).

Stefánsson, G. and Pálsson, Ó.K. 1997. Bormicon. A boreal migration and consumption model. Report no. 58, Marine Research Institute, Reykjavik, Iceland.

Stefánsson, G. and Pálsson, Ó. K.1998. A framework for multispecies modelling of Arcto-boreal systems. Rev. Fish. Biol. Fish. 8,101–104.

Stefánsson, G., Skúladóttir, U. and Pétursson, G. 1994. The use of a stock production type model in evaluating the offshore *Pandalus borealis* stock of North Icelandic waters, including the predation of Northern shrimp by cod. ICES CM 1994/K:25.

Trenkel, V. O'Brien, C. M. and Bogstad, B. 2002. Length-based population dynamics in state space form. Appendix C.3 in dst2. Development of structurally detailed statistically testable models of marine populations. QLK5-CT1999-01609. Progress report for 1 January 2001 to 31 December 2001. Marine Research Institute Technical Report nr. 87, Marine Research Institute, Reykjavik, Iceland.

Trambachev, M.F. 1981. Young cod in the Barents Sea and Bear Island-Spitsbergen area in the in the autumn and winter 1978-1979. Annls.biol., Copenh., 1981(1979), 36: 107-109.

Zaferman M.L. and L.I., Serebrov. 1984. On the instrumental methods for estimating bottom and demersal fish stocks in the Barents and Norwegian Seas. – In: Reproduction and recruitment of Arctic cod. Reports of the 1st Soviet/Norwegian Symposium, Moscow, P. 359-370 (in Russian).

Stock specific documentation of standard assessment procedures used by ICES.

Stock:… Northeast Arctic Saithe

Working Group:… Arctic Fisheries Working Group

Date: 28.04.2003

A. General

A.1. Stock definition

The Northeast Arctic saithe is mainly distributed along the coast of Norway from the Kola peninsula in northeast and south to Møre at 62º N. The 0-group saithe drifts from the spawning grounds to inshore waters. 2-3 years old the saithe gradually moves to deeper waters, and at age 3-6 it is found at typical saithe grounds. It starts to mature at age 5-7, and in early winter a migration towards the spawning grounds further out and south starts.

The stock boundary 62º N is more for management purposes than a biological basis for stock separation. Tagging experiments show a regular annual migration of mature fish from the North-Norwegian coast to the spawning areas off the west coast of Norway and also to a lesser extent to the northern North Sea (ICES 1965). There is also a substantial migration of immature saithe to the North Sea from the Norwegian coast between 62º and 66º N (Jakobsen 1981). In some years there are also examples of mass migration from northern Norway to Iceland and to a lesser extent to the Faroe Islands (Jakobsen 1987). 0-group saithe, on the other side, drifts from the northern North Sea to the coast of Norway north of 62º N.

A.2. Fishery

Since the early 1960s the fishery has been dominated by purse seine and trawl fisheries accounting for 60% in 2000. A traditional gillnet fishery for spawning saithe accounts for about 22%. The remaining catches are taken by Danish seine and hand line in addition to minor by-catches in the long line fishery for other species. Some changes in recent regulations have led to fewer amounts taken by purse seine. Catches declined sharply after 1976. This was partly caused by the introduction of national economic zones in 1977. The stock was accepted as exclusively Norwegian and quota restrictions were put on fishing by other countries while the Norwegian fishery for some years remained unrestricted. In recent years the purse seine and trawl fisheries have been regulated by quotas where account has been taken of expected landings from other gears. Quotas can be transferred between purse seine and trawl fisheries if the quota allocated to one of the gears will not be taken. The target set for the total landings has generally been consistent with the scientific recommendations. Norway presently accounts for about 93% of the landings.

The number of vessels taking part in the purse seine fishery has varied between 112 and 429 since 1977, with the highest participation in the first part of the period. There have been some variations from year to year, and many of the vessels that have taken part in the fishery the last decade have accounted for only a small fraction of the purse seine catches. The annual effort in the Norwegian trawl fishery has varied between 12 000 and 77 000 hours, with the highest effort from 1989 to 1995. Like in the purse seine fishery there have been rather large changes from year to year.

1 March 1999 the minimum landing size was increased from 35-40 cm to 45 cm for trawl and conventional gears, and to 42 cm (north of Lofoten) and 40 cm (between 62° N and Lofoten) for purse seine, with an exception for the first 3000 t purse seine catch between 62° N and 65° 30 N, where the minimum landing size still is 35 cm.

A.3. Ecosystem aspects

The recruitment of saithe may suffer in years with reduced in$\mathbf{F}_{low}$ of Atlantic water (Jakobsen 1986).

B. Data

B.1. Commercial catch

Norwegian commercial catch in tonnes by quarter, area and gear are derived from the sales notes statistics of The Directorate of Fisheries. Data from about 20 sub areas are aggregated on 6 main areas for the gears gillnet, long line, hand line, purse seine, Danish seine, bottom trawl, shrimp trawl and trap. For bottom trawl the quarterly area distribution of the catches is adjusted by logbook data from The Directorate of Fisheries and the total bottom trawl catch by quarter and area is adjusted so that the total annual catch for all gears is the same as the official total catch reported to ICES. No discards are reported or accounted for, but there are several reports of discards. In later years there are also reports of misreporting, saithe is landed as cod in a period with decreasing quotas and availability of cod and good availability of saithe.

The sampling strategy is to have age-length samples from all major gears in each area and quarter. There are at present no defined criteria on how to allocate samples of catch numbers, mean length and mean weight-at-age to unsampled catches, but the following general process has been applied: First look for samples from a neighbouring area if the fishery extends to this area in the same quarter. If there are no samples available in neighbouring areas, search for samples from other gears with the most similar selectivity in the same area or in neighbouring areas. The last option is to search in neighbouring quarters, first from the same gear in the same area, and than from neighbouring areas and similar gears. For some gears, areas and quarters length samples taken by the coast guard are applied and combined with an ALK from a neighbouring area, gear or quarter. ALKs from research surveys (shrimp trawl) are also used to fill holes.

Constant weight-at-age values is used for the period 1960 – 1979. For subsequent years, Norwegian weights-at-age in the catch are estimated from length-at-age by the formula:

weight (kg) = $(l^3 *5.0+l^2 *37.5+l*123.75+153.125)*0.0000017$,

where

l = length in cm.

Norway have on average accounted for about 95% of the saithe landings. Data on catch in tonnes from other countries are either taken from ICES official statistics (by ICES area) or from reports to Norwegian authorities. A few countries also supply some additional data. The text table below shows which country supply which kind of data:

	Kind of data				
Country	Caton (catch in weight)	Canum (catch-at-age in numbers)	Weca (weight-at-age in the catch)	Matprop (proportion mature by age)	Length composition in catch
Norway	x	x	x	x	x
Russia	x				x
Germany	x	x	x		
United Kingdom	x				
France[1]	x				
Spain[1]	x				
Portugal[1]	x				
Ireland[1]	x				
Greenland[1]	x				
Faroe Islands[1]	x				
Iceland[1]	x				

[1] As reported to Norwegian authorities

The Norwegian, Rusian and German input files are Excel spreadsheet files. Russian input data earlier than 2002 are supplied on paper and later punched into Excel spreadsheet files before aggregation to international data. The data should be found in the national laboratories and with the Norwegian stock co-ordinator.

The national data have been aggregated to international data on Excel spreadsheet files. Age composition data for 2002 was available from Norway, Russia (Subarea I and Division IIA) and Germany (Division IIA). Generally the Russian length composition has been applied on the Russian landings together with an age-length-key (ALK) and weight-at-age data from the Norwegian trawl landings. In 2002 Russian length compositions were available for Division IIB, and were applied on the Russian landings together with an age-length-key from the Norwegian trawl landings. Catches from the other countries were assumed to have the same age composition and weight-at-age as the Norwegian trawl landings. In some years the final German and Russian numbers-at-age have been adjusted to remove SOP discrepancies before aggregation to international data. The Excel spreadsheet files used for age distribution, adjustments and aggregations can be found with the Norwegian stock co-ordinator and for the current and previous year in the ICES computer system under **w:\acfm\afwg\year\personal\name** (of stock co-ordinator).

The result files (FAD data) can be found at ICES and with the stock co-ordinator, either in the IFAP system as SAS datasets or as ASCII files on the Lowestoft format, either under **w:\acfm\afwg\2000\data\sai_arct** or **w:\ifapdata\eximport\afwg\sai_arct**.

B.2. Biological

Weight-at-age in the stock is assumed to be the same as weight-at-age in the catch.

A fixed natural mortality of 0.2 is used both in the assessment and the forecast.

Both the proportion of natural mortality before spawning (Mprop) and the proportion of fishing mortality before spawning (Fprop) are set to 0.

Regarding the proportion mature at age, until 1995 knife-edge maturity-at-age 6 was used for this stock. When data on spawning zones recorded in otoliths in Norway were investigated, no evidence of change in maturation rates over the period in the assessment was found and it was decided to use the same ogive for all years. This ogive is based on the distribution of age at first spawning among 8 year and older fish. It represents an approximation of the data from 1973 to 1994, with most weight given to recent observations.

B.3. Surveys

Since 1985 a Norwegian acoustic survey specially designed for saithe has been conducted annually in October-November (Nedreaas 1997). The survey covers the near coastal banks from the Varangerfjord close to the Russian border and southwards to 62° N. The whole area has been covered since 1992, and the major parts since 1988. The aim of conducting an acoustic survey targeting Northeast Arctic saithe has been to support the stock assessment with fishery-independent data of the abundance of the youngest saithe. The survey mainly covers the grounds where the trawl fishery takes place, normally dominated by 3 - 5(6) year old fish. 2-year-old saithe, mainly inhabiting the fjords and more coastal areas, are also represented in the survey, although highly variable from year to year. In 1997 and 1998 there was a large increase in the abundance of age 5 and older saithe, confirming reports from the fishery. In 1999 the abundance of these age groups decreased somewhat, but was still at a high level compared to years before 1997 (Mehl 2000). Abundance indices for ages 2-5 from 1988 and onwards have traditionally been used for tuning, but including older ages as a 6+ group in the tuning series improved the scaled weights a little and at the 2000 WG meeting it was decided to apply the extended series in the assessment. The results from the survey autumn 2000 showed a further decrease in the abundance of age 5 and older saithe (Korsbrekke and Mehl 2000). It is not known how well the survey covers the oldest age groups from year to year, but at least for precautionary reasons the 6+ group was kept in the tuning series.

Since 1995 a Norwegian acoustic survey for coastal cod has been conducted along the coast and in the fjords from Varanger to Stad in September, just prior to the saithe survey described above. This survey covers coastal areas not included in the regular saithe survey. Because saithe is also acoustically registered, this survey provides supplementary information, especially about 2- and 3-year-old saithe that have not yet migrated out to the banks. At the WG meeting in 2000 analyses were done on combining these indices with indices from the regular saithe survey in the tuning series, but it did not influence the assessment much. The WG therefore decided, for the time being, to only apply indices from the regular saithe survey in the assessment since this series is longer.

B.4. Commercial CPUE

Two CPUE data series are used, one from the Norwegian purse seine fishery and one from the Norwegian trawl fishery.

Until 1999 indices of fishing effort in the purse seine fishery was based on the number of vessels of 20-24.9 m length and the effort (number of vessels) of this length category was raised by the catches to represent the total purse seine effort. The number of vessels taking part in the fishery almost doubled from 1997 to 1998, but due to regulations the catches were almost the same as in 1997. In such a situation the total number of vessels participating in a fishery is perhaps not a good measure of effort. Many of the vessels that have taken part in the fishery the last decade have accounted for only a small fraction of the purse seine catches. Roughly half of the vessels have caught less than 100 tonnes per year, and the sum of these catches represents only about 5 – 10% of the total purse seine catch. Therefore the number of vessels catching more than 100 tonnes annually seems to be a more representative and more stable measure of effort in the purse seine fishery. These numbers are raised to the total purse seine catch. The new effort series show a smaller decrease in later years than the old one and in XSA runs it gets higher scaled weights. The 2000 WG meeting therefore decided to use the new CPUE data series in the assessment.

Catch and effort data for Norwegian trawlers were until 2000 taken from hauls where the effort almost certainly had been directed towards saithe, i.e., days with more than 50% saithe and only on trips with more than 50% saithe in the catch. The effort estimated for the directed fishery was raised by the catches to give the total effort of Norwegian trawlers. From 1997 to 1998 the effort increased by more than 50%, but due to regulations the catches were slightly lower in 1998 and the CPUE decreased by almost 40% from 1997 to 1998 and stayed low in 1999. This may at least partly be explained by change in fishing strategies in a period with increasing problems with by-catch of saithe in the declining cod fishery due to good availability of saithe. In 2001 new CPUE indices by age were estimated based on the logbook database of the Directorate of Fisheries, which has a daily resolution (Salthaug and Godø 2000). After some initial analyses it was decided to only include data from vessels larger than the median length since they showed the least noisy trends. One single CPUE observation from a given vessel is the total catch per day divided by the duration of all the trawl hauls that day. To increase the number of observations during a time period with decreasing directed saithe fishery, all days with 20% or more saithe were included. The effort (hours trawling) for each CPUE observation is standardised or calibrated to a standard vessel. Until 1992, a yearly index was calculated by first averaging all CPUE observations for each month, and then averaging over the year. The CPUE indices were splitted on age groups by quarterly weight, length and age data from the trawl fishery. From 2003, a yearly index is calculated by first averaging all CPUE observations for each quarter, and then averaging over the year. The CPUE indices are finally splitted on age groups by yearly catch in numbers and weight-at-age data from the trawl fishery. The new approach is less influenced by short periods with poor data, while it still evens out seasonal variations.

Due to rather large negative log q residuals in the first part of the new time-series, it was shortened to only cover the period after 1993.

B.5. Other relevant data

None.

C. Historical Stock Development

Model used: XSA

Software used: IFAP / Lowestoft VPA suite

Model Options chosen:

Tapered time weighting applied, power = 3 over 20 years

Catchability independent of stock size for all ages

Catchability independent of age for ages >= 8

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

S.E. of the mean to which the estimate are shrunk = 0.500

Minimum standard error for population estimates derived from each fleet = 0.300

Prior weighting not applied

Input data types and characteristics:

Type	Name	Year range	Age range	Variable from year to year Yes/No
Caton	Catch in tonnes	1960 – last data year	2 – 11+	Yes
Canum	Catch-at-age in numbers	1960 – last data year	2 – 11+	Yes
Weca	Weight-at-age in the commercial catch	1960 – last data year	2 – 11+	Yes/No - constant at age from 1960 - 1979
West	Weight-at-age of the spawning stock at spawning time.	1960 – last data year	2 – 11+	Yes/No - assumed to be the same as weight-at-age in the catch
Mprop	Proportion of natural mortality before spawning	1960 – last data year	2 – 11+	No – set to 0 for all ages in all years
Fprop	Proportion of fishing mortality before spawning	1960 – last data year	2 – 11+	No – set to 0 for all ages in all years
Matprop	Proportion mature at age	1960 – last data year	2 – 11+	No – the same ogive for all years
Natmor	Natural mortality	1960 – last data year	2 – 11+	No – set to 0.2 for all ages in all years

Tuning data:

Type	Name	Year range	Age range
Tuning fleet 1	Norway ac survey extended 2000	1992 – last data year	3 – 6+
Tuning fleet 2	Norway purse seine revised 2000	1989 – last data year	3 - 7
Tuning fleet 3	Nor new trawl revised 2001	1994 – last data year	5 - 9

For analysis of alternative procedures see WG reports from AFWG 1997-2002.

D. Short-Term Projection

Model used: Age structured

Software used*:* IFAP prediction with management option table and yield-per-recruit routines, until 2002.

Software used*:* MFDP prediction with management option table and yield-per-recruit routines, MFYPR.

Initial stock size. Taken from the XSA for age 5 and older. The recruitment at age 2 and 3 in the last data year is estimated using RCT3 and the corresponding numbers-at-age 3 and 4 in the start year of the projection is calculated applying a natural mortality of 0.2 and fishing mortality according to the catches taken of these age groups. The long-term geometric mean recruitment is used for age 2 in all projection years.

Natural mortality: Set to 0.2 for all ages in all years

Maturity: The same ogive as in the assessment is used for all years

F and M before spawning: Set to 0 for all ages in all years

Weight-at-age in the stock: Assumed to be the same as weight-at-age in the catch

Weight-at-age in the catch: Average weight of the three last years

Exploitation pattern: Average of the three last years, scaled by the Fbar (3-6) to the level of the last year

Intermediate year assumptions: TAC constraint

Stock recruitment model used: None, the long-term geometric mean recruitment at age 2 is used

Procedures used for splitting projected catches: Not relevant

E. Medium-Term Projections

Model used: Age structured

Software used: IFAP single option prediction, until 2002

Software used: MFDP single option prediction

Initial stock size: Same as in the short-term projections.

Natural mortality: Set to 0.2 for all ages in all years

Maturity: The same ogive as in the assessment is used for all years

F and M before spawning: Set to 0 for all ages in all years

Weight-at-age in the stock: Assumed to be the same as weight-at-age in the catch

Weight-at-age in the catch: Average weight of the three last years

Exploitation pattern: Average of the three last years, scaled by the Fbar (3-6) to the level of the last year

Intermediate year assumptions: F-factor from the management option table corresponding to the TAC

Stock recruitment model used: None, the long-term geometric mean recruitment at age 2 is used

Uncertainty models used: @RISK for excel, Latin Hypercubed, 500 iterations, fixed random number generator

- Initial stock size: Lognormal distribution, LOGNORM(mean, standard deviation), with mean as in the short-term projections and standard deviation calculated by multiplying the mean by the external standard error from the XSA diagnostics (except for age 2, see recruitment below)
- Natural mortality: Set to 0.2 for all ages in all years
- Maturity: The same ogive as in the assessment is used for all years
- F and M before spawning: Set to 0.2 for all ages in all years
- Weight-at-age in the stock: Assumed to be the same as weight-at-age in the catch
- Weight-at-age in the catch: Average weight of the three last years
- Exploitation pattern: Average of the three last years, scaled by the Fbar (3-6) to the level of the last year
- Intermediate year assumptions: F-factor from the management option table corresponding to the TAC

- Stock recruitment model used: Truncated lognormal distribution, TLOGNORM(mean, standard deviation, minimum, maximum), is used for recruitment age 2, also in the initial year. The long-term geometric mean, standard deviation, minimum, maximum are taken from the XSA for the period 1960 – 4th last year.

F. Long-Term Projections

Not done

G. Biological Reference Points

In 1994 the WG proposed a MBAL of 150,000 t, based on the frequent occurrence of poor year classes below this level of SSB. The new maturity ogive introduced in 1995 gave somewhat higher historical SSB estimates. 150,000 t was considered to represent a less restrictive MBAL and 170,000 t was found to correspond better with the arguments used in 1994. The Study Group on the Precautionary Approach to Fisheries Management (SGPAFM, ICES 1998/ACFM:10) also found this to be a suitable level for $\mathbf{B}_{pa}$. However, based on a visual examination of the stock-recruitment plot ACFM later reduced the $\mathbf{B}_{pa}$ to 150,000 t (ICES 1998b).

$\mathbf{F}_{0.1}$ and $\mathbf{F}_{max}$ are estimated by the MFDP yield-per-recruit routine, and increased from 0.08 to 0.11 and from 0.14 to 0.24 for $\mathbf{F}_{0.1}$ and $\mathbf{F}_{max}$, respectively, in the 1999 - 2003 assessments.

The SGPAFM (ICES 1998/ACFM:10) suggested the limit reference point $\mathbf{F}_{lim} = \mathbf{F}_{med}$ for Northeast Arctic cod, haddock and saithe. A precautionary fishing mortality ($\mathbf{F}_{pa}$) was defined as $\mathbf{F}_{pa} = \mathbf{F}_{lim} \cdot e^{-1.645\sigma}$ (σ = 0.2-0.3). The 1998 WG, however, found that setting $\mathbf{F}_{lim} = \mathbf{F}_{med}$ did not correspond very well with the exploitation history for those fish stocks. It was therefore decided to estimate $\mathbf{F}_{pa}$ and other reference points by the PASoft program package (MRAG 1997). The estimates for $\mathbf{F}_{0.1}$, $\mathbf{F}_{max}$, and $\mathbf{F}_{med}$ were exactly the same as the values already estimated by other routines. The median value for $\mathbf{F}_{loss}$ was estimated at 0.43. $\mathbf{F}_{lim}$ can be set at $\mathbf{F}_{loss}$ (ICES 1998/ACFM:10). The probability of exceeding $\mathbf{F}_{lim}$ should be no more than 5 % (ICES 1997/Assess: 7). The 5th percentile of the $\mathbf{F}_{loss}$ estimated here was 0.30 and the 1998 WG recommended using this value for $\mathbf{F}_{pa}$. ACFM considered the 5th percentile calculated from the PASoft program package to be too unstable for long-term use and re-estimated $\mathbf{F}_{pa}$ using the formula $\mathbf{F}_{pa} = \mathbf{F}_{lim} \cdot e^{-1.645\sigma}$ with σ = 0.3 giving a $\mathbf{F}_{pa}$ = 0.26, based on an estimated $\mathbf{F}_{lim}$ = 0.45 (ICES 1998c). An updated version of the PASoft program package (CEFAS 1999) was available at the 1999 WG and $\mathbf{F}_{pa}$ was re-estimated to 0.26. The WG therefore agreed to use this value for a precautionary fishing mortality for saithe ($\mathbf{F}_{pa}$ = 0.26).

Recent increments in minimum landing size and an improved exploitation pattern indicate that the PA fishing mortality reference point ($\mathbf{F}_{pa}$) should be re-estimated in the near future.

H. Other Issues

None.

I. References

CEFAS 1999. PA software users guide. The Centre for Environment, Fisheries and Aquaculture Science, CEFAS, Lowestoft, United Kingdom, 22 April 1999.

ICES 1965. Report of the Coalfish Working Group. Co-op. Res. Rep. Int. Counc. Explor. Sea ser. A. 6: 1-23.

ICES 1998a. Report of the Study Group on the Precautionary Approach to Fisheries Management. ICES CM 1998/ACFM:10. 39 pp.

ICES 1998b. Report to the ICES Advisory Committee on Fishery Management, 1998. ICES Cooperative Research Report No. 29.

ICES 1998c. Technical minutes of ACFM meeting, ICES 20-29 October 1998. Internal document.

Jakobseen, T. 1981. Preliminary results of saithe tagging experiments on the Norwegian coast 1975-77. ICES CM 1981/G:35.

Jakobsen, T. 1986. Recruitment and distribution of Northeast Arctic saithe in relation to changes in the environment. Pp 213-223 in Loeng, H. (ed.) The effect of oceanographic conditions on distribution and population dynamics of commercial fish stocks in the Barents Sea. Proceedings of the third Soviet-Norwegian Symposium, Murmansk 26-28 May 1986. Institute of Marine Research, Bergen, 1987.

Jakobsen, T. 1987. Variation in rates of migration of saithe from Norwegian waters to Iceland and Faroe Islands. Fisheries Research, 5:217-222.

Mehl, S. 2000. Mengdemåling av sei Finnmark – Møre, hausten 1999 (Abundance of saithe Finnmark – Møre autumn 1999). Fisken og Havet 5 – 2000. 21 pp (in Norwegian with table and figure text also in English).

Korsbrekke, K. og Mehl, S. 2001. Mengdemåling av sei Finnmark – Møre, hausten 2000 (Abundance of saithe Finnmark – Møre autumn 2000). Havforskningsinstituttet, Bergen. Intern. Web rep. http://ressurs.imr.no/bunnfisk/rapporter/seirap00.htm. 21 pp (in Norwegian with table and figure text also in English).

MRAG. 1997. Core program development for the modelling of fishery management strategies. Final Report of EC Study Project 94/110.

Nedreaas, K. 1997. Evaluation of the Northeast Arctic saithe (Pollachius virens) acoustic survey. ICES CM 1997/Y:20.

Salthaug, A. and Godø, O.R. 2000. Analysis of CPUE from the Norwegian bottom trawl fleet. ICES CM 2000 /W: 14.

Stock specific documentation of standard assessment procedures used by ICES.

Stock: *Sebastes Mentella* (Deep-Sea Redfish) In Subareas I and II

Working Group: Arctic Fisheries Working Group ((Afwg)

Date: 01.05.03

A. General

A.1. Stock definition

The stock of *Sebastes mentella* (deep-sea redfish) in ICES Subareas I and II is found in the northeast Arctic from 62ºN in the south to the Arctic ice north and east of Spitsbergen. The south-western Barents Sea and the Spitsbergen areas are first of all nursery areas. Although some adult fish may be found in smaller subareas, the main behaviour of *S. mentella* is to migrate westwards and south-westwards towards the continental slope as it grows and becomes adult. South of 70°N only few specimens less than 28 cm are observed, and south of this latitude *S. mentella* are only found along the slope from about 450 m down to about 650 m depth. The southern limit of its distribution is not well defined but is believed to be somewhere on the slope northwest of Shetland. The stock boundary 62º N is therefore more for management purposes than a biological basis for stock separation, although the abundance of this species south of this latitude becomes less. The main areas of larval extrusion are along the slope from north of Shetland to west of Bear Island. The peak of larval extrusion takes place during the first half of April. Genetic studies have not revealed any hybridisation with *S. marinus* or *S. viviparus* in the area.

A.2. Fishery

The only directed fisheries for *Sebastes mentella* (deep-sea redfish) are trawl fisheries. By-catches are taken in the cod fishery and as juveniles in the shrimp trawl fisheries. Traditionally, the fishery for *S. mentella* was conducted by Russia and other East European countries on grounds located south of Bear Island towards Spitsbergen. The highest landings of *S. mentella* were 269,000 t in 1976. This was followed by a rapid decline to 80,000 t in 1980–1981 then a second peak of 115,000 t in 1982. The fishery in the Barents Sea decreased in the mid-1980s to the low level of 10,500 t in 1987. At this time Norwegian trawlers showed interest in fishing *S. mentella* and started fishing further south, along the continental slope at approximately 500 m depth. These grounds had never been harvested before and were inhabited primarily by mature redfish. After an increase to 49,000 t in 1991 due to this new fishery, landings have been at a level of 10,000–15,000 t, except in 1996-1997 when they dropped to 8,000 t. Since 1991 the fishery has been dominated by Norway and Russia. Since 1997 ACFM has advised that there should be no directed fishery and that the by-catch should be reduced to the lowest possible level.

The redfish population in Subarea IV (North Sea) is believed to belong to the Northeast Arctic stock. Since this area is outside the traditional areas handled by this Working Group, the catches are not included in the assessment. The landings from Subarea IV have been 1,000–3,000 t per year. Historically, these landings have been *S. marinus*, but since the mid-1980s trawlers have also caught *S. mentella* in Subarea IV along the northern slope of the North Sea. Approximately 80% of the Norwegian catches are considered to be *S. mentella*.

Strong regulations were enforced in the fishery in 1997. Since then it has been forbidden to fish redfish (both *S.marinus* and *S. mentella*) in the Norwegian EEZ north and west of straight lines through the positions:

1. N 7000’ E 0521’
2. N 7000’ E 1730’
3. N 7330’ E 1800’
4. N 7330’ E 3556’

and in the Svalbard area (Division IIb). When fishing for other species in these areas, a maximum 25% by-catch (in weight) of redfish in each trawl haul is allowed.

To provide additional protection of the adult *S. mentella* stock, two areas south of Lofoten have been closed for all trawl fishing since 1 March 2000. The two areas (A and B) are delineated by straight lines between the following positions:

A	B
1. N 6630’ E 0659’	1. N 6236’ E 0300’
2. N 6621’ E 0644’	2. N 6210’ E 0115’
3. N 6543’ E 0600’	3. N 6240’ E 0052’
4. N 6520’ E 0600’	4. N 6300’ E 0300’
5. N 6520’ E 0530’	
6. N 6600’ E 0530’	
7. N 6630’ E 0634.27’	

Area A has recently been enlarged to include the continental slope north to N 67º10’.

Since 1 January 2003 all directed trawl fishery for redfish (both *S. marinus* and *S. mentella*) is forbidden in the Norwegian Economic Zone north of 62°N. When fishing for other species it is legal to have up to 20% redfish (both species together) in round weight as by-catch per haul and on board at any time.

Since 1 January 2000 a maximum legal by-catch criterion of 10 juvenile redfish (both *S.marinus*, *S. mentella* and *S. viviparus*) per 10 kg shrimp has been enforced in the shrimp fishery.

A.3. Ecosystem aspect

As 0-group and juvenile this stock is an important plankton eater in the Barents Sea, and when this stock was sound, 0-group were observed in great abundance in the upper layers utilizing the plankton production. Especially during the first five-six years of life *S. mentella* is also preyed upon by other species, of which its contribution to the cod diet is well documented.

B. Data

B.1. Commercial catch

The landings statistics used by the Arctic Fisheries Working Group (AFWG) are those officially reported to ICES. In cases where such reportings to ICES do not exist, reportings made directly to Norwegian authorities during the fishery have been used as preliminary figures. Norwegian commercial catch in tonnes by quarter, area and gear are derived from the sales notes statistics of The Directorate of Fisheries. Data are aggregated on 17 areas for bottom trawl. For bottom trawl the quarterly area distribution of the catches is area adjusted by logbook data from The Directorate of Fisheries. No discards are reported or accounted for. Reliable estimates of species breakdown (*S. mentella* vs. *S. marinus*) by area are available back to 1989. The national landings of redfish for Norway and Russia are split into species by the respective national laboratories. For other countries (and areas) the AFWG has split the landings into *S. mentella* and *S. marinus* based on reports from different fleets to the Norwegian fisheries authorities.

The Norwegian sampling strategy is to have age-length samples from all major gears in each area and quarter. There are at present no defined criteria on how to allocate samples of catch numbers, mean length and mean weight-at-age to unsampled catches, but the following general process has been applied: First look for samples from a neighbouring area if the fishery extends to this area in the same quarter. If there are no samples available in neighbouring areas, search in neighbouring quarters, first from the same gear in the same area, and than from neighbouring areas and similar gears. The last option is to search for samples from other gears with the most similar selectivity in the same area or in neighbouring areas. For some gears, areas and quarters <u>length</u> samples taken by the coast guard are applied and combined with an ALK from a neighbouring area, gear or quarter. ALKs from research surveys (shrimp trawl) are also used to fill holes.

For Norway, weights-at-age in the catch are estimated according to the formula which gives the best fit to the length-weight data pairs collected during the year and applied to the mean length-at-age

The text table below shows which country supply which kind of data:

	Kind of data					
Country	Caton (catch in weight) on unidentified redfish	Caton (catch in weight) on *S. mentella*	Canum (catch-at-age in numbers)	Weca (weight-at-age in the catch)	Matprop (proportion mature by age)	Length composition in catch
Norway		x	x	x		x
Russia		x	x[2]	x[2]	x	x
Germany	x	x[3]				x[3]
United Kingdom	x	[1]				
France	x	[1]				
Spain	x	[1]				
Portugal	x	[1]				
Ireland	x	[1]				
Greenland	x	[1]				
Faroe Islands[1]						
Iceland	x	[1]				

[1] As reported to Norwegian authorities during the fishery (only for the Norwegian Economic Zone and Svalbard)
[2] For main fishing area until 2001
[3] Irregularly

The Norwegian and German input files are Excel spreadsheet files, while the Russian input data are supplied on paper and later punched into Excel spreadsheet files before aggregation to international data. The data should be found in the national laboratories and with the stock co-ordinator.

The national data have been aggregated to international data on Excel spreadsheet files. The Russian and German length composition has been applied on the Russian and German landings, respectively, using an age-length-key (ALK) and weight-at-age data from the Norwegian trawl landings. Catches from the other countries were assumed to have the same age composition and weight-at-age as the Norwegian trawl landings. In some years the final German and Russian numbers-at-age have been adjusted to remove SOP discrepancies before aggregation to international data. The Excel spreadsheet files used for age distribution, adjustments and aggregations can be found with the Norwegian stock co-ordinator and for the current and previous year in the ICES computer system under **w:\acfm\afwg\<year>\personal\name** (of stock co-ordinator).

The result files (FAD data) can be found at ICES and with the stock co-ordinator, either in the IFAP system as SAS datasets or as ASCII files on the Lowestoft format, either under **w:\acfm\afwg\<year>\data\smn_arct** or **w:\ifapdata\eximport\afwg\smn_arct**.

B.2. Biological

Since 1991, the catch in numbers-at-age of *S. mentella* from Russia is based on otolith readings. The Norwegian catch-at-age is based on otoliths back to 1990. Before 1990, when the Norwegian catches of *S. mentella* were smaller, Russian scale-based age-length keys were used to convert the Norwegian length distribution to age.

As input to trial analytical assessments, weight-at-age in the stock is assumed to be the same as weight-at-age in the catch.

A fixed natural mortality of 0.1 is used both in the assessment and the forecast.

Both the proportion of natural mortality before spawning (Mprop) and the proportion of fishing mortality before spawning (Fprop) are set to 0.

Age-based maturity ogives for *S. mentella* (sexes combined) are available for 1986–1993, 1995 and 1997–2001 from Russian research vessel observations in spring. Average ogives for 1966-1972 and 1975-1983 have been used for the periods 1965-1975 and 1976-1983, respectively. Average ogives for 1975-1983, 1984-1985 and data for 1986-1993 (Table D8) were used to generate a smoothed maturity ogive for 1984-1992 (3 year running average). The 1992-1993 average was used for 1993 and 1994, the 1995 data for 1995, the average for 1995 and 1997 for 1996, and the collected material for the subsequent years up to 2001 were taken as representative for these years.

B.3. Surveys

The results from the following research vessel survey series have annually been evaluated by the AFWG:

1) The international 0-group survey in the Svalbard and Barents Sea areas in August-September since 1980 (incl.).

2) Russian bottom trawl survey in the Svalbard and Barents Sea areas in October-December since 1978 (incl.) in fishing depths of 100–900 m.

3) Norwegian Svalbard (Division IIb) bottom trawl survey (August-September) since 1986 (incl.) in fishing depths of 100–500 m. Data disaggregated on age only since1992.

4) Norwegian Barents Sea bottom trawl survey (February) since 1986 (incl.) in fishing depths of 100–500 m. Data disaggregated on age only since 1992.

Although the Norwegian Svalbard (August-September) and Barents Sea (February) groundfish surveys are conducted at different times of the year and may overlap in the south of Bear Island area, the two series can be combined to get an approximate total estimate for the whole area.

5) A new Norwegian survey designed for redfish and Greenland halibut is covering the Norwegian Economic Zone (NEZ) and Svalbard incl. north and east of Spitsbergen in August since 1996 from less than 100 m to 500 m depth. The results from this survey includes survey no. 3) above.

6) Russian acoustic survey in April-May since 1992 (except 1994, 1996 and 2002) on spawning grounds in the western Barents Sea .

The international 0-group fish survey carried out in the Barents Sea in August-September since 1965 does not distinguish between the species of redfish but it is believed to be mostly *S. mentella*. The survey design has improved and the indices earlier than 1980 are not directly comparable with subsequent years. A considerable reduction in the abundance of 0-group redfish was observed in the 1991 survey: abundance decreased to only 20% of the 1979–1990 average. With the exception of an abundance index of twice the 1991-level in 1994, the indices have remained very low. Record low levels of less than 20% of the 1991–1995 average have been observed for the 1996-1999 year classes. The 2000 year class was stronger than the preceding four year classes, whereas the estimate of the 2001 and 2002 year classes are among the lowest on record.

Russian acoustic surveys estimating the commercially sized and mature part of the *S. mentella* stock have been conducted in April-May on the Malangen, Kopytov, and Bear Island Banks since 1986. In 1992 the area covered was extended, and data on age are available for 1992–1993, 1995 and 1997–2001. This is the only survey targeting commercially sized *S. mentella*, but only a limited area of its distribution.

B.4. Commercial CPUE

Revised catch-per-hour-trawling data for the *S. mentella* fishery have been available from Russian PST- and BMRT-trawlers fishing in ICES Division IIa in March-May 1975-2002, representative for the directed Russian fishery accounting for 60-80% of the total Russian catch. The Working Group mean that the Russian trawl CPUE series do not represent the trend in stock size but is more a reflection of stock density. This is because the fishery on which these data are based since 1996 was carried out by one or two vessels on localised concentrations in the Kopytov area southwest of Bear Island. This is also reflected by the relative low effort at present. Due to this change in fishing behaviour/effort, CPUEs have been plotted only for the period after 1991.

B.5. Other relevant data

None

C. Historical Stock Development

Model used:

Software used:

Model Options chosen:

Input data types and characteristics:

Type	Name	Year range	Age range	Variable from year to year Yes/No
Caton	Catch in tonnes	1965-2002	6-19+	yes
Canum	Catch-at-age in numbers	1965-2002[1]	6-19+	yes
Weca	Weight-at-age in the commercial catch	1965-2002	6-19+	yes
West	Weight-at-age of the spawning stock at spawning time.	1965-2002	6-19+	yes
Mprop	Proportion of natural mortality before spawning	1965-2002	6-19+	Constant=0
Fprop	Proportion of fishing mortality before spawning	1965-2002	6-19+	Constant=0
Matprop	Proportion mature at age	1965-2002	6-19+	1965-1975, const. 1976-1983, const. 1984-variable
Natmor	Natural mortality	1965-2002	6-19+	Constant=0.1

[1] Based on otoliths since 1991

Tuning data:

Type	Name	Year range	Age range
Tuning fleet 1	FLT10 Rus young	1991-2002	6-8
Tuning fleet 2	FLT13 Rus acous	1995-2001	6-14
Tuning fleet 3	FLT14 Norw bottom	1996-2002	2-11
….			

D. Short-Term Projection

Model used: Visual analysis of survey results.

Software used*:* none

Initial stock size:

Maturity:

F and M before spawning:

Weight-at-age in the stock:

Weight-at-age in the catch:

Exploitation pattern:

Intermediate year assumptions:

Stock recruitment model used:

Procedures used for splitting projected catches:

E. Medium-Term Projections

Model used: Visual analysis of survey results.

Software used: none

Initial stock size:

Natural mortality:

Maturity:

F and M before spawning:

Weight-at-age in the stock:

Weight-at-age in the catch:

Exploitation pattern:

Intermediate year assumptions:

Stock recruitment model used:

Uncertainty models used:

1. Initial stock size:
2. Natural mortality:
3. Maturity:
4. F and M before spawning:
5. Weight-at-age in the stock:
6. Weight-at-age in the catch:
7. Exploitation pattern:
8. Intermediate year assumptions:
9. Stock recruitment model used:

F. Long-Term Projections

Model used:

Software used:

Maturity:

F and M before spawning:

Weight-at-age in the stock:

Weight-at-age in the catch:

Exploitation pattern:

Procedures used for splitting projected catches:

G. Biological Reference Points

H. Other Issues

I. References

Stock specific documentation of standard assessment procedures used by ICES.

Stock:… *Sebastes marinus* in ICES Subareas I and II

Working Group:… Arctic Fisheries Working Group

Date: 28.04.03

A. General

A.1. Stock definition

The stock of *Sebastes marinus* (golden redfish) in ICES Subareas I and II is found in the northeast Arctic from 62ºN in the south to north of Spitsbergen. The Barents Sea area is first of all a nursery areas, and relatively few fish are distributed outside Spitsbergen. S. marinus are distributed all over the continental shelf southwards to beyond 62ºN, and also along the coast and in the fjords. The main areas of larval extrusion are outside Vesterålen, on the Halten Bank area and on the banks outside Møre. The peak of larval extrusion takes place ca. one month later than S. mentella, i.e. during beginning of May. Genetic studies have not revealed any hybridisation with *S. marinus* or *S. viviparus* in the area.

A.2. Fishery

The fishery for *Sebastes marinus* (golden redfish) is mainly conducted by Norway which accounts for 80–90% of the total catch. Germany also has a long tradition of a trawl fishery for this species. The fish are caught mainly by trawl and gillnet, and to a lesser extent by longline and handline. The trawl and gillnet fishery have benefited from the females concentrating on the "spawning" grounds during spring. Some of the catches, and most of the catches taken by other countries, are taken in mixed fisheries together with saithe and cod. Important fishing grounds are the Møre area (Svinøy), Halten Bank, the banks outside Lofoten and Vesterålen, and Sleppen outside Finnmark. Traditionally, *S. marinus* has been the most popular and highest priced redfish species.

Until 1 January 2003 there were no regulations particular for the *S. marinus* fishery, and the regulations aimed at *S. mentella* (see chapter 6.1.1) had only marginal effects on the *S. marinus* stock. After this date, all directed trawl fishery for redfish (both *S. marinus* and *S. mentella*) is forbidden in the Norwegian Economic Zone north of 62°N. When fishing for other species it is legal to have up to 20% redfish (both species together) in round weight as by-catch per haul and on board at any time.

A.3. Ecosystem aspects

B. Data

B.1. Commercial catch

The landings statistics used by the Arctic Fisheries Working Group (AFWG) are those officially reported to ICES. In cases where such reportings to ICES do not exist, reportings made directly to Norwegian authorities during the fishery have been used as preliminary figures. Norwegian commercial catch in tonnes by quarter, area and gear are derived from the sales notes statistics of The Directorate of Fisheries. Data from about 20 sub areas are aggregated for the gears gillnet, long line, hand line, Danish seine and bottom trawl. For bottom trawl the quarterly area distribution of the catches is area adjusted by logbook data from The Directorate of Fisheries. No discards are reported or accounted for. Reliable estimates of species breakdown (*S. mentella* vs. *S. marinus*) by area are available back to 1989. The national landings of redfish for Norway and Russia are split into species by the respective national laboratories. For other countries (and areas) the AFWG has split the landings into *S. mentella* and *S. marinus* based on reports from different fleets to the Norwegian fisheries authorities.

The Norwegian sampling strategy is to have age-length samples from all major gears in each area and quarter. There are at present no defined criteria on how to allocate samples of catch numbers, mean length and mean weight-at-age to unsampled catches, but the following general process has been applied: First look for samples from a neighbouring area if the fishery extends to this area in the same quarter. If there are no samples available in neighbouring areas, search in neighbouring quarters, first from the same gear in the same area, and than from neighbouring areas and similar gears. The last option is to search for samples from other gears with the most similar selectivity in the same area or in neighbouring areas. For some gears, areas and quarters length samples taken by the coast guard are applied and combined with an ALK from a neighbouring area, gear or quarter. ALKs from research surveys (shrimp trawl) are also used to fill holes.

For Norway, weights-at-age in the catch are estimated according to the formula which gives the best fit to the length-weight data pairs collected during the year and applied to the mean length-at-age.

The text table below shows which country supply which kind of data:

	Kind of data					
Country	Caton (catch in weight) on unidentified redfish	Caton (catch in weight) on *S. marinus*	Canum (catch-at-age in numbers)	Weca (weight-at-age in the catch)	Matprop (proportion mature by age)	Length composition in catch
Norway		x	x	x		x
Russia		x				x
Germany	x	x[3]				x
United Kingdom	x	[1]				
France	x	[1]				
Spain	x	[1]				
Portugal	x	[1]				
Ireland	x	[1]				
Greenland	x	[1]				
Faroe Islands[1]						
Iceland	x	[1]				

[1] As reported to Norwegian authorities during the fishery (only for the Norwegian Economic Zone and Svalbard)
[2] For main fishing area until 2001
[3] Irregularly

The Norwegian and German input files are Excel spreadsheet files, while the Russian input data are supplied on paper and later punched into Excel spreadsheet files before aggregation to international data. The data should be found in the national laboratories and with the stock co-ordinator.

The national data have been aggregated to international data on Excel spreadsheet files. The Russian and German length composition has been applied on the Russian and German landings, respectively, using an age-length-key (ALK) and weight-at-age data from the Norwegian trawl landings. Catches from the other countries were assumed to have the same age composition and weight-at-age as the Norwegian trawl landings. In some years the final German and Russian numbers-at-age have been adjusted to remove SOP discrepancies before aggregation to international data. The Excel spreadsheet files used for age distribution, adjustments and aggregations can be found with the Norwegian stock co-ordinator and for the current and previous year in the ICES computer system under **w:\acfm\afwg\<year>\personal\name** (of stock co-ordinator).

The result files (FAD data) can be found at ICES and with the stock co-ordinator, either in the IFAP system as SAS datasets or as ASCII files on the Lowestoft format, either under **w:\acfm\afwg\<year>\data\smr-arct** or **w:\ifapdata\eximport\afwg\smr-arct**.

B.2. Biological

The total catch-at-age data back to 1991 are based on Norwegian otolith readings. In 1989–1990 it was a combination of the German scale readings on the German catches, and Norwegian otolith readings for the rest. In 1984–1989 only German scale readings were available, while in the years prior to 1984 Russian scale readings exist.

Weight-at-age in the stock is assumed to be the same as weight-at-age in the catch.

When an analytical assessment is made, a fixed natural mortality of 0.1 is used both in the assessment and the forecast.

Both the proportion of natural mortality before spawning (Mprop) and the proportion of fishing mortality before spawning (Fprop) are set to 0.

A knife-edge maturity-at-age 15 has been used for this stock.

B.3. Surveys

The results from the following research vessel survey series have annually been evaluated by the Working Group:

1) Norwegian Barents Sea bottom trawl survey (February) from 1986–2003 in fishing depths of 100–500 m. Data are available on length for the years 1986–2003, and on age for the years 1992–2003. This survey covers important nursery areas for the stock

2) Norwegian Svalbard (Division IIb) bottom trawl survey (August-September) from 1985–2002 in fishing depths of 100–500 m. This survey covers the northernmost part of the species' distribution.

Data on length and age from both these surveys have been simply added together and used in the assessments.

3) Catch rates (numbers/nautical mile) and acoustic indices of *Sebastes marinus* from the Norwegian Coastal and Fjord survey in 1995-2002 from Finnmark to Møre.

B.4. Commercial CPUE

Data for *S. marinus* were available for Norwegian freezer trawlers (ISSCFV-code 07, 250–499.9 GRT) since 1981. The total international effort was estimated from these data. This series is based on statistical (GLM) analysis of monthly data from five Norwegian statistical areas along the Norwegian coast. Although typical *S. mentella* grounds have been excluded, errors related to the splitting of the redfish species in the catches may contribute to fluctuations in the time trend.

Although the trawl fishery up to 2002 has been almost unregulated, it is worrying that fewer and fewer fishing days meet the input data requirements when only including days with more than 50% *S marinus* in the catches (from 200-300 days in 1998-2000 to less than 40 days in 2002).

B.5. Other relevant data

None.

C. Historical Stock Development

The development of the stock has annually been discussed and evaluated based on the research survey series, and information from the fishery.

In some years trial analytical XSA assessments have been made and discussed by the Working Group. In such cases the following settings have been used/recommended, but NOTE that this is subject to further improvement and evaluation before being adopted:

Model used: XSA

Software used: IFAP / Lowestoft VPA suite

Model Options chosen:

Tapered time weighting applied, power = 3 over 20 years

Catchability independent of stock size for all ages

Catchability independent of age for ages >= 24

Survivor estimates shrunk towards the mean F of the final 2 years or the 5 oldest ages

S.E. of the mean to which the estimate are shrunk = 2.00

Minimum standard error for population estimates derived from each fleet = 0.300

Prior weighting not applied

Input data types and characteristics:

Type	Name	Year range	Age range	Variable from year to year Yes/No
Caton	Catch in tonnes	1965 – last data year	2 – 24+	Yes
Canum	Catch-at-age in numbers	1965 – last data year [1)]	2 – 24+	Yes
Weca	Weight-at-age in the commercial catch	1965 – last data year [1)]	2 – 24+	Yes/No - constant at age in begiining of time-series
West	Weight-at-age of the stock	1965 – last data year [1)]	2 – 24+	Yes/No - assumed to be the same as weight-at-age in the catch
Mprop	Proportion of natural mortality before spawning	1965 – last data year	2 – 24+	No – set to 0 for all ages in all years
Fprop	Proportion of fishing mortality before spawning	1965 – last data year	2 – 24+	No – set to 0 for all ages in all years
Matprop	Proportion mature at age	1965 – last data year	2 – 24+	No – knife edged at age 15
Natmor	Natural mortality	1965 – last data year	2 – 24+	No – set to 0.1 for all ages in all years

[1)] Age reading based on only otoliths since 1991 (incl.).

Tuning data:

Type	Name	Year range	Age range
Tuning fleet 1	Norway bottom trawl, Svalbard, fall	1992 – last data year	2-15
Tuning fleet 2	Norway bottom trawl, Barents Sea, winter	1992 – last data year	3-15
Tuning fleet 3	Norway trawl CPUE	1989 – last data year	9-23

D. Short-Term Projection

Model used: Visual inspection/analysis of survey results together with information from the fishery.

No analytical short-term projection has been made for this stock.

E. Medium-Term Projections

Model used: Visual inspection/analysis of survey results together with information from the fishery.

No analytical short-term projection has been made for this stock.

Uncertainty models used: None

F. Long-Term Projections

Not done

G. Biological Reference Points

It is proposed to adopt the average biomass level of *S. marinus* above 25 cm estimated by the combined Norwegian Barents Sea –Svalbard bottom trawl survey for the time period 1986-1997 as a limit reference point for the biomass (U_{lim}).

Stock specific documentation of standard assessment procedures used by ICES.

Stock: Northeast Arctic Greenland Halibut

Working Group: Arctic Fisheries Working Group

Date: 30-04-03

General

Stock definition

Greenland halibut (*Reinhardtius hippoglossoides,* Walbaum) is distributed in the Arctic and boreal waters in the North Atlantic and in the North Pacific (Fedorov 1971; Godø and Haug 1989; Bowering and Brodie 1995; Bowering and Nedreaas 2000). In the northeastern Atlantic the distribution is more or less continuous along the continental slope from the Faeroe Islands and Shetland to north of Spitsbergen (Whitehead et al. 1986; Godø and Haug 1989; Nizovtsev, 1989), with the highest concentrations from 500 to 800 m depth between Norway and Bear Island, which is also regarded as the main spawning area (Nizovtsev, 1968; Godø and Haug 1987; Albert et al. 2001b). Peak spawning occurs in December in the main spawning area, but also in nearby localities during summer (Nizovtsev, 1989; Albert et al. 2001b). Atlantic currents transport eggs and larvae northwards and the juveniles are distributed around Svalbard and in the northeastern Barents Sea, to the waters around Franz Josef Land and Novaja Zemlya area (Borkin, 1983; Nizovtsev, 1983; Godø and Haug 1987; Godø and Haug 1989; Albert et al. 2001a). As they grow older they gradually move southwards and eventually alternate between the spawning area and feeding areas in the central-western Barents Sea (Nizovtsev, 1989).

The Northeast arctic Greenland halibut stock is a pragmatically defined management unit. The degree of exchange with other stocks is not resolved, but is believed to be low. Potential routes of exchange may be drift of larvae towards Greenland and migration of adults between the Barents Sea and the Iceland-Faeroe Islands area.

Fishery

Before the mid 1960s the fishery for Greenland halibut was mainly a coastal long line fishery off the coasts of eastern Finnmark and Vesterålen in Norway. The annual catch of the coastal fishery was about 3,000 t. In recent years this fishery has landed 3,000–6,000 t although now gillnets are also used in the fishery. In 1964 dense Greenland halibut concentrations were found by Soviet trawlers in the slope area to the west of the Bear Island (Nizovtsev, 1989). Following the introduction of international trawlers in the fishery in the mid 1960s, the total landings increased to about 80,000 t in the early 1970s.The total Greenland halibut landings decreased steadily to about 20,000 t during the early 1980s. This level was maintained until 1991, when the catch increased sharply to 33,000 t. From 1992 total landings varied between 9 000-19 000 t with a peak in 1999.

From 1992 the fishery has been regulated by allowing only the long line and gillnet fisheries by vessels smaller than 28 m to be directed for Greenland halibut. This fishery is also regulated by seasonal closure. Target trawl fishery has been prohibited and trawl catches are limited to by-catch only. From 1992 to autumn 1994 by-catch in each haul was not to exceed 10% by weight. In autumn 1994 this was changed to 5% by-catch of Greenland halibut onboard at any time. In autumn 1996 it was changed to 5% by-catch in each haul, and from January 1999 this percentage was increased to 10%. In August 1999 it was adjusted further to 10% in each haul but only 5% of the landed catch. From 2001 the by-catch regulations again was changed to 12% in each haul and 7% of the landed catch.

The regulations enforced in 1992 reduced the total landings of Greenland halibut by trawlers from 20,000 to about 6,000 t. Since then and until 1998 annual trawler landings have varied between 5,000 and 8,000 t without any clear trend attributable to changes in allowable by-catch. However, the increase of trawler landings in 1999 to 10 000 t may be attributable partly to the less restrictive by-catch regulations. Landings of Greenland halibut from the directed longline and gillnet fisheries have also increased in recent years to well above the level of 2,500 t set by the Norwegian authorities. This is attributed to the increased difficulties of regulating a fishery that only lasts for a few weeks.

Ecosystem aspects

Greenland halibut is a very tolerant species. It occurs in the wide range of depths (from 20 to 2200 m) and temperatures (from -1.5 to 10º C) (Boje and Hareide, 1993; Shuntov, 1965; Nizovtsev, 1989).

Young Greenland halibut occur mostly in the northeastern Barents Sea where the presence of their adult individuals or other predators seems to be minimal.

Based on the peculiarities mentioned above, natural mortality of the Greenland halibut should be rather stable and not high, at least after its youngest stages settling down at the bottom.

DATA

Commercial catch

Norwegian commercial catch in tonnes by quarter, area and gear are derived from the sales notes statistics of the Directorate of Fisheries. Data from about 20 sub areas are aggregated on 6 main areas for the gears gillnet, long line, bottom trawl and shrimp trawl. For bottom trawl the quarterly area distribution of the catches is adjusted by logbook data from The Directorate of Fisheries and the total bottom trawl catch by quarter and area is adjusted so that the total annual catch for all gears is the same as the official total catch reported to ICES. No discards are reported or accounted for in the catch statistics.

Russian catch based on daily reports from the vessels are combined in the statistics of the All-Russian Research Institute of Fisheries and Oceanography (VNIRO, Moscow). Data are provided separately by ICES areas and gears.

The sampling strategy is to have age-length samples from all major gears in each area and quarter. There are at present no defined criteria on how to allocate samples of catch numbers, mean length and mean weight-at-age to unsampled catches, but the following general process has been applied: First look for samples from a neighbouring area if the fishery extends to this area in the same quarter. If there are no samples available in neighbouring areas, search for samples from other gears with the most similar selectivity in the same area or in neighbouring areas. The last option is to search in neighbouring quarters, first from the same gear in the same area, and then from neighbouring areas and similar gears. ALKs from research surveys (shrimp trawl) are also used to fill gaps in age sampling data.

Norway and Russia, on average, have accounted for about 90-95% of the Greenland halibut landings during more recent years. Data on catch in tonnes from other countries are either taken from ICES official statistics (by ICES area) or from reports to Norwegian authorities. A few countries also supply some additional data. The text table below indicates the type of data provided by country:

	Kind of data				
Country	Caton (catch in weight)	Canum (catch-at-age in numbers)	Weca (weight-at-age in the catch)	Matprop (proportion mature by age)	Length composition in catch
Norway	x	x	x		x
Russia	x	x	x	x	x
Germany	x				
United Kingdom	x				
France[1]	x				
Spain[1]	x				
Portugal[1]	x				
Ireland[1]	x				
Greenland[1]	x				
Faroe Islands[1]	x				
Iceland[1]	x				
Poland[1]	x				

[1] As reported to Norwegian authorities

The Norwegian input files are Excel spreadsheet files, while the Russian input data are supplied on paper and later input to Excel spreadsheet files before aggregation to international data. The data are archived in the national laboratories and with the Norwegian stock co-ordinator.

The national data have been aggregated with international data on Excel spreadsheet files. The Russian length composition has been applied to Russian landings together with an age-length-key (ALK) and weight-at-age data from the Norwegian landings. Catches from the other countries were assumed to have the same age composition and weight-at-age as the Norwegian landings. The Excel spreadsheet files used for age distribution, adjustments and aggregations are held by the Norwegian stock co-ordinator and for the current and previous year in the ICES computer system under **w:\acfm\afwg\year\personal\name** (of stock co-ordinator).

The result files (FAD data) can be found at ICES and with the stock co-ordinator, either in the IFAP system as SAS datasets or as ASCII files on the Lowestoft format, under **w:\acfm\afwg\year\data\grh_arct**.

Biological

For 1964-1969, separate weight-at-age data are used for the Norwegian and the Russian catches. Both data sets are mean values for the period and are combined as a weighted average for each year. A constant set of weight-at-age data is used for the total catches in 1970–1978. For subsequent years annual estimates are used. The mean weight-at-age in the catch is calculated as a weighted average of the weight in the catch from Norway and Russia. The weight-at-age in the stock is set equal to the weight-at-age in the catch for all years.

A fixed natural mortality of 0.15 is used both in the assessment and the forecast.

Both the proportion of natural mortality before spawning (Mprop) and the proportion of fishing mortality before spawning (Fprop) are set to 0.

Annual ogives based on sexes combined using Russian survey data are given for the years 1984–1990 and 1992–last data year. An average ogive derived from 1984–1987 is used for 1964–1983. For 1984 to the last data year a three-year running average is used.

Surveys

The results from the following research vessel survey series are evaluated by the Working Group:

1. Norwegian bottom trawl survey in August in the Barents Sea and Svalbard from 1984 in fishing depths of less than 100 m and down to 500 m. (Table E1 and E2).

2. Norwegian Greenland halibut surveys in August from 1994. The surveys cover the continental slope from 68 to 80ºN, in depths of 400–1500 m north of 70º30'N, and 400–1000 m south of this latitude. This series has in 2000 been revised to also include depths between 400 – 500 m in all years (Table E3).

3. Norwegian bottom trawl surveys east and north of Svalbard in autumn from 1996 (Table E4).

4. The Norwegian Combined Survey index Table E5, combination of the results from Tables E1-E4.

5. Russian bottom trawl surveys in the Barents Sea from 1984 in fishing depths of 100–900 m. This series has been revised substantially since the 1998 assessment in order to make the years more comparable with respect to area coverage and gear type (Table E6).

6. Spanish bottom trawl survey in the slope of Svalbard area in October, ICES Division IIb: from 1997 (Table E7).

7. Norwegian Barents Sea bottom trawl survey (winter) from 1989 in fishing depths of less than 100 m and down to 500 m. In order to utilise the last year values in the VPA calibration, this series was adjusted back by one year and one age group to reflect sampling as if it occurred in the autumn of the previous year (Table E8).

8. International pelagic 0-group surveys from 1970. (Table A14).

Over the last several years the Working Group has been concerned about trends in catchability within individual surveys used for tuning of the XSA. The trends were seen for younger ages of year classes in the late 80's and early 90's that were initially estimated to be very low in abundance. With increasing age these year classes were estimated to be much closer to the mean abundance. In previous meetings the Working Group therefore increased the lower age used in tuning to five years in order to reduce the problem. This only partly resolved the problem though, and in all subsequent assessments estimated recruitment of the last 2-3 years has increased from one year to the next.

The Norwegian bottom trawl survey in the Barent Sea and Svalbard catch Greenland halibut mainly in the range of ages 1–8, although in most years age 1 is poorly represented and all age group younger than five years are not considered to be well represented in this survey due to the limited depth range covered. The relative strength of the year classes varies considerably with age. In more recent years there has been low but somewhat better representation of young fish in this survey.

The Norwegian juvenile Greenland halibut survey north and east of Svalbard were started in 1996 and from 2000 this survey is conducted as a joint survey between Norway and Russia. As a result it is expected that the area coverage will improve, better representing the distribution of juveniles and will provide a more comparable time-series. Only the Norwegian part of these northern surveys is currently included in the Norwegian Combined Survey index (see below) . In future, when the extended coverage in the Russian zone has been repeated for at least five years the Working Group will consider revising the combined index.

The Norwegian Greenland halibut survey along the deep continental slope south and west of Spitsbergen began in 1994. Although Greenland halibut older than 15 years are caught, few fish are represented in the catch over age 12 or less than age 5 (Table E4). Most of the abundance indices are dominated by ages 5–8.

Most of the surveys considered by the Working Group in 2002 cover either the adult population in the slope area or juvenile distribution in northern areas. The problem of underestimation of recruitment in the last few years included in the analyses has been attributed to shortcomings in survey coverage. The Working Group at previous meetings has noted the need for annual surveys that sample most of the population within a short period of time. Prior to the 2002 WG meeting effort was therefore made to combine some of these surveys into a new total index. The new index is termed the Norwegian Combined Survey Index and is established back to 1996, the first year with survey coverage northeast of Svalbard. It includes bottom trawls from the Norwegian bottom trawl survey in August in the Barents Sea and Svalbard (Tables E1 and E2), the Norwegian Greenland halibut survey in August along the continental slope (Table E3), and the Norwegian bottom trawl survey in August-September north and east of Svalbard (Table E4). Prior to the meeting in 2003 work was done to evaluate the combination of these survey series into one index and this was reported in Working Document 5 to the Working Group. Based on these results it was decided to use this combined index in this years assessment.

The Norwegian Combined Survey Index (Table E5) indicates a significant increase in the total stock during the last three years and a stock size in 2002, nearly 40% above last years index. However, there is no clear year class pattern in the data and some ages are consistently underestimated relative to adjacent age groups (e.g. age 9 and partly age 4). The highest indices were observed for age seven, with exception of the two last years when age 1 was most abundant. That indicates that the catchability of younger ages (i.e. those primarily from northern surveys) are not comparable with the older ones (i.e. those primarily from the slope). This is probably a result of pooling different surveys using different gears. These weaknesses reduce the applicability of the combined surveys, and the Working Group advises that further work be done to improve the combined index in the future.

The Russian Barents Sea bottom trawl survey, which extends back to 1984 catch fish mainly in the range of 4–10 years old. The relative abundance of the year classes against age is similar to the surveys above. This survey covers the Barents Sea including the continental slope of the Norwegian Sea. Total abundance indices from this survey show trend to grow since 1996.

The Spanish bottom trawl surveys along the continental slope north of 73°30' N from 1997 (Table E7) differ from the other survey series indicating reduced abundance in this area since 1999.

The Norwegian bottom trawl survey during winter in the Barents Sea catch Greenland halibut older than 12 years, but are not particularly effective in catching fish older than 7 years. This is likely due to the limited depth distribution of the survey area. Nevertheless, the survey appears very effective at catching Greenland halibut up to age 6. The relative abundance of the year classes against age is comparable with the survey above.

The strengths of the Greenland halibut year classes of 1970–1997 from the International pelagic 0-group surveys in the Barents Sea are shown in Table A14. The results are highly variable over the time period. However, most of the 1970's and 1980's year classes are represented in reasonably high numbers. In recent years the 1988–1992 and the 1996 year classes have been well below the long-term average. The 1993–1995 and 1997-1999 year classes are closer to the average. Significant increase of 0-group abundance indices with compare to previous years was observed in 2000-2002.

All in all, the surveys seem to indicate that the catchability of the 1990–1995 year classes increased considerably as the fish becomes five years and older. Based on extremely low catch rates in the surveys, these year classes were considered very poor in previous assessments by the Working Group, but improved considerably at older ages. The reason for this change in catchability is not clear. However, it is known that important areas for young Greenland halibut may be found north and east of Svalbard (Table E4). Albert *et al*. (2001a) showed that the south-western end of the distribution area of age 1 fish was gradually displaced northwards along west Spitsbergen in the period 1989–92 and southwards in the period 1994–1996. These displacements corresponded to changes in hydrography and may be explained by increased migration of the 1990–1995 year classes to areas outside the survey area.

Commercial CPUE

The restrictive regulations imposed on the trawl fishery after 1991 disrupted the traditional time-series of commercial CPUE data. However, an attempt to continue the series was made through a research program using two Norwegian trawlers in a limited commercial fishery (Tables 8.6 and E9). This comprises fishing during two weeks in May-June and October, representing an effort somewhat less than 20% of the 1991 level. Since 1994 the fishery has been restricted to May-June. This fishery was conducted, as much as possible, in the same way as the commercial fishery in the previous years. Since 1997 also two Russian trawlers conducted a limited research fishery for Greenland halibut.

The CPUE from the experimental fishery was found, however, to be considerably higher than in the traditional fishery and has exhibited an increasing trend from 1992–1996. After 1996 the Norwegian CPUE series has varied between 1200 and 1650 kg/h with the highest value in 2000 (Table E9). The Russian experimental CPUE series shows an increasing trend since 1997, and this series also shows the highest value in 2000.

Other relevant data

None

HISTORICAL STOCK DEVELOPMENT

Model used: XSA

Software used: IFAP / Lowestoft VPA suite

Model Options chosen:

Tapered time weighting applied, power = 3 over 20 years

Catchability independent of stock size for all ages

Catchability independent of age for ages >= 10

Survivor estimates shrunk towards the mean F of the final 2 years or the 5 oldest ages

S.E. of the mean to which the estimate are shrunk = 0.500

Minimum standard error for population estimates derived from each fleet = 0.300

Prior weighting not applied

Input data types and characteristics:

Type	Name	Year range	Age range	Variable from year to year Yes/No
Caton	Catch in tonnes	1964 – last data year	- (total)	Yes
Canum	Catch-at-age in numbers	1964 – last data year	5 – 15+	Yes
Weca	Weight-at-age in the commercial catch	1964 – last data year	5 – 15+	Yes/No - constant at age from 1964 - 1978
West	Weight-at-age of the spawning stock at spawning time.	1964 – last data year	5 – 15+	Yes/No - assumed to be the same as weight-at-age in the catch
Mprop	Proportion of natural mortality before spawning	1964 – last data year	5 – 15+	No – set to 0 for all ages in all years
Fprop	Proportion of fishing mortality before spawning	1964 – last data year	5 – 15+	No – set to 0 for all ages in all years
Matprop	Proportion mature at age	1964 – last data year	5 – 15+	Yes/No – three year running mean, constant at age from 1964 - 1983
Natmor	Natural mortality	1964 – last data year	5 – 15+	No – set to 0.15 for all ages in all years

Tuning data:

Type	Name	Year range	Age range
Tuning fleet 1	Norwegian Combined survey index	1996 – last data year	5 – 15+
Tuning fleet 2	Norwegian experimental CPUE	1992 – last data year	5 - 14
Tuning fleet 3	Russian trawl survey from 1992	1992 – last data year	5 – 15+

SHORT-TERM PROJECTION

Model used: Age structured

Software used: IFAP prediction with management option table and yield-per-recruit routines

Initial stock size. Taken from the XSA for age 6 and older. The recruitment at age 5 in the last data year is estimated using the mean from 1990 to two years before the last data year following the argument that recruitment at age 5 shows a sharp reduction in the most recent years in the previous assessments, which is not believed to reflect the true recruitment.

Natural mortality: Set to 0.15 for all ages in all years

Maturity: The same ogive as in the assessment is used for all years

F and M before spawning: Set to 0 for all ages in all years

Weight-at-age in the stock: Average weight-at-age for the last three years used in the assessment

Weight-at-age in the catch: Average weight-at-age for the last three years used in the assessment

Exploitation pattern: Average of the three last years

Intermediate year assumptions: Catch constraint

Stock recruitment model used: Constant recruitment as described earlier

Procedures used for splitting projected catches: Not relevant

MEDIUM-TERM PROJECTIONS

Not done

LONG-TERM PROJECTIONS

Not done

BIOLOGICAL REFERENCE POINTS

No limit or precautionary reference points for the fishing mortality or the spawning stock biomass are proposed.

OTHER ISSUES

REFERENCES

Albert, O.T., E.M. Nilssen, K.H. Nedreaas & A.C. Gundersen 2001a. Distribution and abundance of juvenile Northeast Arctic Greenland halibut (*Reinhardtius hippoglossoides*) in relation to survey coverage and physical environment. *ICES Journal of Marine Science* 58: 000-000.

Albert, O.T., E.M. Nilssen, A. Stene, A.C. Gundersen & K.H. Nedreaas 2001b. Maturity classes and spawning behaviour of Greenland halibut (*Reinhardtius hippoglossoides*). *Fisheries Research* 51: 217-228.

Boje, J., & N.R. Hareide 1993. Trial deepwater longline fishery in Davis Strait, May-June 1992. NAFO SCR Doc. 93/53, Serial No. N2236, 6 pp.

Borkin, I.V. 1983. Results from research on ichthyophauna in the Frantz-Josef Land area and north of Svalbard. In: Research into biology, morphology and physiology of marine organisms. USSR Academy of Science Publishers, Apatity, pp. 34-42 (in Russian).

Bowering, W.R. & W.B. Brodie 1995. Greenland halibut (*Reinhardtius hippoglossoides*). A review of the dynamics of its distribution and fisheries off eastern Canada and Greenland. -Pp. 113-160 in: Hopper, A.G. (ed.). *Deep-Water Fisheries of the North Atlantic Oceanic Slope*. Kluwer Academic Publishers, Boston, USA.

Bowering, W.R. & K.H. Nedreaas 2000. A comparison of Greenland halibut (*Reinhardtius hippoglossoides,* Walbaum) fisheries and distribution in the Nortwest and Northeast Atlantic. *Sarsia* 85: 61-76.

Fedorov, K.Y. 1971. Zoogeographic characteristics of the Greenland halibut (*Reinhardtius hippoglossoides*, Walbaum). *Journal of Ichthyology* 11: 971-976.

Godø, O.R. & T. Haug 1987. Migration and recruitment to the commercial stock of Greenland halibut, *Reinhardtius hippoglossoides* (Walbaum), in the Svalbard area. *FiskeridirektoratetsSkrifterSerieHavundersøkelser* 18: 311-328.

Godø, O.R. & T. Haug 1989. A review of the natural history, fisheries and management of Greenland halibut (*Reinhardtius hippoglossoides*) in the eastern Norwegian and Barents Seas. *Journal du Conseil. Conseil international pour l'Exploration de la Mer* 46: 62-75.

Nizovtsev, G.P. 1968. Distribution and age-length characteristics of Greenland halibut (*Reinhardtius hippoglossoides* Walbaum) catches in the Barents sea in 1996. *Trudy PINRO*,23: 402-413. (in Russian).

Nizovtsev, G.P. 1983. Distribution of young Greenland halibut in the Barents Sea and in the eastern Norwegian Sea. *Rybnoye khozyaistvo*, 12:26-28 (in Russian).

Nizovtsev, G.P. 1989. Recommendations on rational exploitation of Greenland halibut stocks in the Barents and Norwegian seas. *USSR Ministry of Fisheries, PINRO, Murmansk*, 93 pp. (in Russian).

Shuntov, V.P. 1965. Distribution of Greenland halibut and arrowtooth flounder in the northern Pacific.*Trudy VNIRO*, 58: 155-164 (in Russian).

Whitehead, P.J.P., M.-L. Bauchot, J.-C. Hureau, J. Nielsen & E. Tortonese 1986. *Fishes of the Northeastern Atlantic and the Mediterranean.* UNESCO, Paris, France, 1473 pp.