Advisory Committee on Fishery Management **ICES CM 2002/ACFM:18**

REPORT OF THE

Arctic Fisheries Working Group

ICES Headquarters
16–25 April 2002

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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 Meeting May 2002

General comments

In order to compare changes from year to year a table which shows the changes in SSB, F´s, etc. between the present and the last year´s assessment should be given in the text.

Similarly a table showing all the settings in XSA and changes made from the previous years' assessment should be explained and justified. (Example: Northern Shelf WG Report).

NEA Cod

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.

The AFWG is encouraged to continue the development of a FLEKSIBEST model for this stock and is further encouraged to contribute this as a case study to WGMG.

Coastal Cod

The AFWG presented a catch-constrained forecast having previously estimated the catch to be used as a constraint from a status quo forecast. It would be more transparent and straightforward to present the status quo forecast itself.

The years in the projection Table 2.22 have to be shifted by one year upwards!

It is proposed to exclude age group 9 from the tuning fleet due to high S.E. (log q) for this age group.

Haddock

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.

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.

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.

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.

Comments were made that the standard plots summary figures (A-D) are missing.

In the assessment made by the AFWG age group 1 and 2 were included in the XSA tuning. Due to low catches and uncertain predation mortality at these ages ACFM revised this XSA by excluding age groups 1 & 2 from tuning. The tables below show the differences that this leads to in terms of fishing mortality in the terminal year of the XSA and the corresponding estimates of survivors. The shaded rows correspond to the year-class (1996) for which tuning indices were excluded by the AFWG and which ACFM also excluded. NB these values refer to the XSA, not the SVPA.

Fishing mortality at age			
Age	With age 1 & 2 in tuning	Excluding ages 1 & 2 from tuning	% difference
3	0.044	0.053	20.5
4	0.138	0.125	-9.4
5	0.685	0.674	-1.6
6	0.527	0.468	-11.2
7	0.648	0.579	-10.6
8	0.894	0.677	-24.3
9	0.755	0.785	4.0
10	0.707	0.704	-0.4
4-7	0.500	0.462	-7.6

Survivors at (age + 1)			
Age	With age 1 & 2 in tuning	Excluding ages 1 & 2 from tuning	% difference
3	239684	197038	-17.8
4	32089	35655	11.1
5	32320	33078	2.3
6	5196	6051	16.5
7	2408	2803	16.4
8	559	840	50.3
9	383	363	-5.2
10	720	730	1.4

This will affect the assessment and a new forecast was accordingly carried out:

New runs are included below:

NEA Haddock

Final XSA predation mortality included in M. Age 3-11+.

Run title : Arctic Haddock (run: XSAHS38/X38)
At 24/05/2002 18:01
Table 4 Natural Mortality (M) at age

YEAR, 1950, 1951,

AGE
3, 2000, .2000,
4, 2000, .2000,
5, 2000, .2000,
6, 2000, .2000,
7, 2000, .2000,
8, 2000, .2000,
9, 2000, .2000,
10, 2000, .2000,
+gp, 2000, .2000,

Table 4 Natural Mortality (M) at age

YEAR,	1952,	1953,	1954,	1955,	1956,	1957,	1958,	1959,	1960,	1961,
AGE										
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,
+gp,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,

Run title : Arctic Haddock (run: XSAHS38/X38)
At 24/05/2002 18:01

Table 4 Natural Mortality (M) at age

YEAR,	1962,	1963,	1964,	1965,	1966,	1967,	1968,	1969,	1970,	1971,
AGE										
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,
+gp,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,

Table 4 Natural Mortality (M) at age

YEAR,	1972,	1973,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,
AGE										
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,
+gp,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,

Table 4 Natural Mortality (M) at age

YEAR,	1982,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,
AGE										
3,	.2000,	.2000,	.2103,	.2000,	.6434,	.2000,	.4776,	.2000,	.3748,	.2000,
4,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
5,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2024,	.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,
+gp,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,

Table 4 Natural Mortality (M) at age

YEAR,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,
AGE										
3,	.2063,	.2673,	.3047,	.3831,	.8417,	.5306,	.2501,	.2021,	.2385,	.2285,
4,	.2000,	.2286,	.2190,	.3850,	.2572,	.2581,	.2653,	.2000,	.2122,	.2024,
5,	.2000,	.3033,	.2135,	.3160,	.2248,	.2326,	.2303,	.2000,	.2129,	.2000,
6,	.2000,	.2000,	.2009,	.2106,	.2090,	.2115,	.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,
+gp,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	

Lowestoft VPA Version 3.1

Table 7 Proportion of F before Spawning

YEAR,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,

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Extended Survivors Analysis
Arctic Haddock (run: XSAHS38/X38)
CPUE data from file fleet
Catch data for  52 years. 1950 to 2001. Ages  3 to  11.

     Fleet,            First, Last, First, Last, Alpha,  Beta
                   ,    year, year,  age ,  age
FLT06: Russian botto,   1983, 2001,   3,     7,   .900,  1.000
FLT07: Norway acoust,   1980, 2001,   3,     7,   .990,  1.000
FLT08: Norway bottom,   1982, 2001,   3,     8,   .990,  1.000


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 90 iterations

Total absolute residual between iterations
89 and 90 = .01379

Final year F values

Age	3,	4,	5,	6,	7,	8,	9,	10
Iteration 89,	.0529,	.1249,	.6746,	.4683,	.5789,	.6885,	.7850,	.7072
Iteration 90,	.0529,	.1249,	.6742,	.4675,	.5771,	.6805,	.7848,	.7048

Regression weights

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

Fishing mortalities

Age,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001
3,	.072,	.024,	.013,	.021,	.028,	.028,	.061,	.131,	.017,	.053
4,	.247,	.216,	.108,	.080,	.133,	.201,	.307,	.292,	.293,	.125
5,	.259,	.469,	.476,	.278,	.363,	.479,	.489,	.783,	.348,	.674
6,	.386,	.539,	.669,	.629,	.539,	.705,	.663,	.796,	.511,	.467
7,	.355,	.388,	.712,	.635,	.796,	.880,	.630,	.826,	.570,	.577
8,	.332,	.395,	.498,	.337,	.935,	1.079,	1.046,	1.002,	.753,	.681
9,	.282,	.497,	.734,	.434,	.812,	.758,	.865,	.431,	.532,	.785
10,	.223,	.346,	1.042,	.731,	1.001,	1.114,	.898,	.483,	.572,	.705

XSA population numbers (Thousands)

	AGE							
YEAR ,	3,	4,	5,	6,	7,	8,	9,	10,
1992 ,	1.97E+05,	6.39E+04,	1.17E+04,	6.01E+03,	7.66E+03,	1.02E+04,	1.23E+04,	1.33E+03,
1993 ,	6.35E+05,	1.49E+05,	4.09E+04,	7.39E+03,	3.35E+03,	4.40E+03,	6.02E+03,	7.59E+03,
1994 ,	2.80E+05,	4.75E+05,	9.58E+04,	1.89E+04,	3.53E+03,	1.86E+03,	2.43E+03,	3.00E+03,
1995 ,	7.51E+04,	2.04E+05,	3.42E+05,	4.81E+04,	7.90E+03,	1.42E+03,	9.26E+02,	9.53E+02,
1996 ,	9.00E+04,	5.02E+04,	1.28E+05,	1.89E+05,	2.08E+04,	3.43E+03,	8.29E+02,	4.91E+02,
1997 ,	1.03E+05,	3.77E+04,	3.39E+04,	7.10E+04,	8.93E+04,	7.67E+03,	1.10E+03,	3.01E+02,
1998 ,	4.61E+04,	5.88E+04,	2.38E+04,	1.67E+04,	2.84E+04,	3.03E+04,	2.13E+03,	4.23E+02,
1999 ,	1.83E+05,	3.37E+04,	3.32E+04,	1.16E+04,	7.03E+03,	1.24E+04,	8.73E+03,	7.36E+02,
2000 ,	6.39E+04,	1.31E+05,	2.06E+04,	1.24E+04,	4.29E+03,	2.52E+03,	3.72E+03,	4.65E+03,
2001 ,	2.62E+05,	4.95E+04,	7.92E+04,	1.18E+04,	6.10E+03,	1.98E+03,	9.71E+02,	1.79E+03,

Estimated population abundance at 1st Jan 2002

,	0.00E+00,	1.98E+05,	3.57E+04,	3.31E+04,	6.05E+03,	2.81E+03,	8.34E+02,	3.63E+02,

Taper weighted geometric mean of the VPA populations:

,	1.09E+05,	6.59E+04,	4.15E+04,	1.95E+04,	8.88E+03,	3.94E+03,	1.75E+03,	8.06E+02,

Standard error of the weighted Log(VPA populations) :

,	.9676,	1.0337,	1.1113,	1.1472,	1.1879,	1.2126,	1.1498,	1.2911,

Log catchability residuals.

Fleet : FLT06: Russian botto

Age ,	1982,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991
3 ,	99.99,	.96,	1.14,	.74,	-.38,	.08,	-.22,	-.52,	1.31,	-.12
4 ,	99.99,	.08,	-.03,	-.16,	-.04,	-.10,	-.48,	-.46,	1.14,	-.44
5 ,	99.99,	-1.72,	-.13,	.38,	-.42,	-.15,	-.54,	-.03,	1.19,	-.46
6 ,	99.99,	99.99,	-1.44,	.38,	-.88,	-1.81,	-.44,	.10,	.72,	-.36
7 ,	99.99,	99.99,	99.99,	99.99,	-1.62,	-1.24,	-2.40,	.96,	.88,	.39
8 ,	No data for this fleet at this age									

Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
3	.28	.39	.14	-.43	-.36	-.61	.14	99.99	.11	-.03
4	-.20	.69	.36	-.54	-.02	-.05	-.08	.26	99.99	-.24
5	-.45	.34	.08	-.41	.55	-.67	-.48	.50	.42	99.99
6	.44	.56	.18	-.04	.10	-.67	-.52	.29	.26	.28
7	.54	.59	-.54	.19	1.13	-1.31	.00	-.03	-.18	.17
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	-6.7596
S.E(Log q)	.8528

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	.73	1.731	8.01	.82	18	.50	-6.70
4	.88	.828	7.03	.85	18	.47	-6.51
5	.73	1.682	7.57	.82	18	.57	-6.49
6	.74	1.765	7.40	.83	18	.55	-6.54

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	.88	.579	7.03	.72	16	.78	-6.76

Fleet : FLT07: Norway acoust

Age	1980	1981
3	99.99	99.99
4	99.99	99.99
5	99.99	99.99
6	99.99	99.99
7	99.99	99.99
8	No data for this fleet at this age	

Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
3	.51	.78	.99	.17	-.14	-.38	-.04	-.23	.15	-.40
4	.46	.34	-.03	-.76	-.25	-.74	-.15	-.27	-.14	-.37
5	.31	.72	.62	1.13	.33	-.59	-.46	-.08	-.03	-.50
6	.30	-.19	.83	.94	1.40	.46	.01	.08	-.52	-1.14
7	.77	-1.76	.75	.58	.95	1.33	.16	.05	-.31	-1.04
8	No data for this fleet at this age									

Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
3	.02	.13	-.19	.18	.10	.21	-.07	99.99	.00	.02
4	-.47	.18	.13	-.13	.03	.37	-.05	.67	99.99	.05
5	-.71	.23	.30	-.22	.07	.20	.31	.70	-.49	99.99
6	-.33	-.43	.15	.23	.11	.26	-.25	.73	-.07	-.05
7	-.19	-.53	-.26	.06	.35	.77	-.53	.36	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	-5.8984
S.E(Log q)	.5775

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,   .78,   3.398,   6.65,   .96,   19,   .21,   -5.23,
 4,   .73,   2.483,   6.90,   .90,   19,   .36,   -5.39,
 5,   .61,   3.052,   7.71,   .87,   19,   .47,   -5.87,
 6,   .75,   1.912,   7.11,   .85,   20,   .51,   -6.17,

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,   1.03,   -.208,   5.79,   .82,   18,   .63,   -5.90,

Fleet : FLT08: Norway bottom

 Age , 1982, 1983, 1984, 1985, 1986, 1987, 1988, 1989, 1990, 1991
    3 ,   .19,   .41, 1.55, -.25,   .06,   .44,   .42, -.28, -.24, -.35
    4 ,   .36,   .16,   .33, -.27, -.20,   .04,   .32, -.13,   .38, -.35
    5 ,   .72,   .51,   .96,   .92, 99.99, -.09, -.14,   .08,   .16, -.05
    6 , -.03, -.59,   .44,   .52, 99.99,   .06,   .34,   .00, -.52, -.30
    7 ,   .37, -.83, -.90,   .13, 99.99, 99.99, -.29, 1.28,   .38,   .08
    8 , 99.99, -.90, -.02, -.05, 99.99, 99.99, 99.99, 99.99, 99.99,   .39

 Age , 1992, 1993, 1994, 1995, 1996, 1997, 1998, 1999, 2000, 2001
    3 , -.06, -.12,   .00,   .39,   .15, -.09, -.26, 99.99,   .05,   .09
    4 , -.46, -.18, -.02,   .32,   .19,   .24, -.31,   .05, 99.99,   .04
    5 , -.26, -.29,   .20,   .07,   .03, -.14,   .10,   .15, -.15, 99.99
    6 ,   .14, -.41,   .41,   .36,   .00, -.22, -.12,   .18,   .01, -.04
    7 , -.75, -.99, 99.99,   .60, 1.15,   .61, -.05, -.19, -1.05, -.30
    8 , -.65, -.43, -.16, 99.99, -.34,   .94, -.01,   .39, -.21, 99.99

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

   Age ,   7,   8
Mean Log q,   -6.5437,   -6.6695,
S.E(Log q),   .7445,   .4973,

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,   .78,   2.558,   6.50,   .94,   19,   .27,   -5.06,
 4,   .73,   3.283,   6.90,   .94,   19,   .28,   -5.35,
 5,   .60,   6.434,   7.75,   .97,   18,   .22,   -5.85,
 6,   .64,   4.544,   7.59,   .94,   19,   .29,   -6.25,

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

Age, Slope , t-value , Intercept, RSquare, No Pts, Reg s.e, Mean Q

 7,   .72,   2.044,   7.31,   .86,   17,   .46,   -6.54,
 8,   .85,   .916,   6.99,   .86,   12,   .43,   -6.67,

Terminal year survivor and F summaries :

Age 3   Catchability dependent on age and year class strength

Year class = 1998

Fleet,   Estimated,   Int,   Ext,   Var,   N, Scaled, Estimated
     ,   Survivors,   s.e,   s.e,   Ratio,   , Weights,   F
FLT06: Russian botto,   192010.,   .533,   .000,   .00,   1, .127,   .054
FLT07: Norway acoust,   201607.,   .300,   .000,   .00,   1, .400,   .052
FLT08: Norway bottom,   216062.,   .300,   .000,   .00,   1, .400,   .049

  P shrinkage mean ,   65853.,   1.03,,,,   .036,   .151

  F shrinkage mean ,   197005.,   1.00,,,,   .038,   .053

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
197794.,	.19,	.11,	5,	.577,	.053

Age 4 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
FLT06: Russian botto,	33141.,	.359,	.175,	.49,	2,	.155,	.134
FLT07: Norway acoust,	36307.,	.235,	.023,	.10,	2,	.360,	.123
FLT08: Norway bottom,	37335.,	.212,	.007,	.03,	2,	.443,	.120
P shrinkage mean ,	41494.,	1.11,,,,				.018,	.108
F shrinkage mean ,	16977.,	1.00,,,,				.023,	.247

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
35708.,	.14,	.05,	8,	.378,	.125

Age 5 Catchability dependent on age and year class strength

Year class = 1996

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
FLT06: Russian botto,	1.,	.000,	.000,	.00,	0,	.000,	.000
FLT07: Norway acoust,	1.,	.000,	.000,	.00,	0,	.000,	.000
FLT08: Norway bottom,	1.,	.000,	.000,	.00,	0,	.000,	.000
P shrinkage mean ,	19459.,	1.15,,,,				.432,	.969
F shrinkage mean ,	49481.,	1.00,,,,				.568,	.496

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
33070.,	.75,	10.42,	2,	13.819,	.674

Age 6 Catchability dependent on age and year class strength

Year class = 1995

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
FLT06: Russian botto,	7991.,	.284,	.053,	.18,	4,	.156,	.372
FLT07: Norway acoust,	6269.,	.206,	.225,	1.09,	4,	.271,	.454
FLT08: Norway bottom,	5518.,	.157,	.060,	.38,	4,	.524,	.502
P shrinkage mean ,	8884.,	1.19,,,,				.020,	.340
F shrinkage mean ,	3945.,	1.00,,,,				.028,	.649

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
6053.,	.12,	.07,	14,	.652,	.467

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

Year class = 1994

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, Weights,	Scaled, F	Estimated F
FLT06: Russian botto,	3118.,	.316,	.161,	.51,	5,	.182,	.532
FLT07: Norway acoust,	3261.,	.223,	.157,	.70,	4,	.230,	.514
FLT08: Norway bottom,	2651.,	.173,	.079,	.46,	5,	.527,	.602
F shrinkage mean ,	1968.,	1.00,,,,				.060,	.748

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
2813.,	.13,	.07,	15,	.513,	.577

Age 8 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, Weights,	Scaled, F	Estimated F
FLT06: Russian botto,	744.,	.312,	.136,	.44,	5,	.170,	.731
FLT07: Norway acoust,	1168.,	.208,	.139,	.67,	4,	.225,	.523
FLT08: Norway bottom,	846.,	.167,	.196,	1.17,	5,	.487,	.666
F shrinkage mean ,	486.,	1.00,,,,				.118,	.974

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
834.,	.16,	.11,	15,	.684,	.681

Age 9 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, Weights,	Scaled, F	Estimated F
FLT06: Russian botto,	264.,	.302,	.130,	.43,	5,	.109,	.970
FLT07: Norway acoust,	413.,	.220,	.102,	.47,	5,	.204,	.716
FLT08: Norway bottom,	340.,	.207,	.091,	.44,	6,	.480,	.820
F shrinkage mean ,	439.,	1.00,,,,				.207,	.686

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
363.,	.24,	.06,	17,	.264,	.785

1

Age 10 Catchability constant w.r.t. time and age (fixed at the value for age) 9

Year class = 1991

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, Weights,	Scaled, F	Estimated F
FLT06: Russian botto,	601.,	.305,	.218,	.71,	5,	.099,	.804
FLT07: Norway acoust,	610.,	.224,	.131,	.59,	5,	.185,	.795
FLT08: Norway bottom,	808.,	.194,	.106,	.55,	6,	.406,	.651
F shrinkage mean ,	750.,	1.00,,,,				.311,	.687

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
728.,	.33,	.07,	17,	.201,	.705

Run title : Arctic Haddock (run: XSAHS38/X38)

At 24/05/2002 18:01

Table 8 Fishing mortality (F) at age

YEAR,	1950,	1951,
AGE		
3,	.0543,	.1390,
4,	.5926,	.2184,
5,	.8235,	.6327,
6,	.8113,	.9129,
7,	1.1580,	.8026,
8,	1.0019,	1.0019,
9,	.6471,	1.4279,
10,	.9460,	1.0901,
+gp,	.9460,	1.0901,
0 FBAR 4- 7,	.8463,	.6417,

Table 8 Fishing mortality (F) at age

YEAR,	1952,	1953,	1954,	1955,	1956,	1957,	1958,	1959,	1960,	1961,
AGE										
3,	.1157,	.0714,	.0614,	.0252,	.1133,	.0450,	.0284,	.0712,	.1994,	.1683,
4,	.5477,	.3920,	.2444,	.1346,	.1743,	.2488,	.1747,	.1737,	.3777,	.4843,
5,	.5851,	.5358,	.3081,	.4880,	.2774,	.3737,	.5781,	.3362,	.5174,	.6947,
6,	.8903,	.4892,	.4116,	.4682,	.8123,	.4045,	.5202,	.5567,	.6510,	.7510,
7,	.9968,	.7142,	.6141,	1.0146,	.6250,	.8164,	.9655,	.6009,	.5177,	.8315,
8,	1.2555,	.6549,	.8635,	.6215,	.9362,	.4499,	.8697,	.4285,	.7005,	.8803,
9,	1.3781,	.5133,	1.3660,	.4287,	.3972,	.6280,	.7440,	.8451,	1.1504,	.9639,
10,	1.2251,	.6331,	.9584,	.6948,	.6588,	.6371,	.8688,	.6304,	.7976,	.9015,
+gp,	1.2251,	.6331,	.9584,	.6948,	.6588,	.6371,	.8688,	.6304,	.7976,	.9015,
0 FBAR 4- 7,	.7550,	.5328,	.3945,	.5264,	.4723,	.4608,	.5596,	.4168,	.5160,	.6904,
1										

YEAR,	1962,	1963,	1964,	1965,	1966,	1967,	1968,	1969,	1970,	1971,
AGE										
3,	.1980,	.1212,	.0806,	.0667,	.1295,	.0611,	.0418,	.1008,	.1693,	.0231,
4,	.5939,	.6783,	.3181,	.2389,	.3872,	.3080,	.3965,	.1700,	.2339,	.2667,
5,	1.0631,	.9383,	.6929,	.4670,	.5965,	.4222,	.5794,	.4980,	.2474,	.1802,
6,	1.0625,	1.0295,	.8734,	.6986,	.7451,	.5203,	.4594,	.5825,	.5040,	.1805,
7,	.6982,	1.0018,	.8462,	.6772,	.8262,	.5325,	.7045,	.4046,	.5303,	.4024,
8,	.9005,	.6493,	.9610,	.5958,	.5276,	.5813,	.7180,	.5031,	.4133,	.3891,
9,	1.1829,	1.3618,	1.3891,	1.0533,	.5931,	.3826,	.4947,	.5020,	.3947,	.2965,
10,	.9374,	1.0158,	1.0779,	.7832,	.6549,	.5027,	.6449,	.4734,	.4494,	.3650,
+gp,	.9374,	1.0158,	1.0779,	.7832,	.6549,	.5027,	.6449,	.4734,	.4494,	.3650,
0 FBAR 4- 7,	.8544,	.9120,	.6827,	.5204,	.6388,	.4457,	.5349,	.4138,	.3789,	.2575,

Table 8 Fishing mortality (F) at age

YEAR,	1972,	1973,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,
AGE										
3,	.2847,	.3376,	.2238,	.2555,	.3177,	.7667,	.3599,	.1530,	.0372,	.0899,
4,	.3895,	.6046,	.3416,	.5900,	.6475,	1.2711,	.6409,	.5021,	.3056,	.2096,
5,	1.0753,	.9948,	.4203,	.5175,	.6437,	.9396,	.8658,	.9698,	.6771,	.5484,
6,	.9545,	.4774,	.6968,	.4462,	.7098,	.5430,	.4447,	.8905,	.8168,	.8668,
7,	.5517,	.2968,	.5924,	.5989,	.8063,	.6394,	.8072,	.5106,	.3666,	.7700,
8,	.5812,	.2715,	.4813,	.3494,	.8798,	.5402,	.4539,	.7118,	.7034,	.4316,
9,	.6962,	.2758,	.8046,	.2007,	.8164,	.5614,	.6782,	.5045,	.7634,	.5119,
10,	.6151,	.2829,	.6317,	.3856,	.8429,	.5854,	.6524,	.5807,	.6167,	.5762,
+gp,	.6151,	.2829,	.6317,	.3856,	.8429,	.5854,	.6524,	.5807,	.6167,	.5762,
0 FBAR 4- 7,	.7427,	.5934,	.5128,	.5381,	.7018,	.8483,	.6896,	.7182,	.5415,	.5987,

Table 8 Fishing mortality (F) at age

YEAR,	1982,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,
AGE										
3,	.1240,	.1751,	.0606,	.1346,	.0684,	.0532,	.0242,	.0712,	.0257,	.0547,
4,	.2391,	.4344,	.3201,	.2204,	.4557,	.4654,	.1666,	.1863,	.1065,	.1417,
5,	.4702,	.3916,	.3317,	.3638,	.3073,	.9250,	.5405,	.3569,	.1264,	.2499,
6,	.6775,	.3549,	.2223,	.5430,	.4605,	.2933,	1.1639,	.5026,	.1942,	.2925,
7,	.5343,	.3832,	.3341,	.3845,	.5555,	.4997,	.3166,	.6364,	.2670,	.3310,
8,	.6373,	.3534,	.4835,	.5269,	.3024,	.3894,	.2858,	.3467,	.3158,	.2816,
9,	.3641,	.1798,	.3277,	.6008,	.5013,	.2506,	.1809,	.0708,	1.6009,	.2391,
10,	.5162,	.3074,	.3845,	.5157,	.4637,	.3866,	.2317,	.2864,	.5236,	.3033,
+gp,	.5162,	.3074,	.3845,	.5157,	.4637,	.3866,	.2317,	.2864,	.5236,	.3033,
0 FBAR 4- 7,	.4803,	.3910,	.3021,	.3779,	.4448,	.5459,	.5469,	.4206,	.1735,	.2538,

Table 8 Fishing mortality (F) at age

YEAR,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	FBAR 99-**
AGE											
3,	.0718,	.0244,	.0128,	.0209,	.0278,	.0282,	.0611,	.1310,	.0167,	.0529,	.0669,
4,	.2470,	.2160,	.1085,	.0801,	.1335,	.2012,	.3071,	.2915,	.2934,	.1249,	.2366,
5,	.2587,	.4693,	.4760,	.2785,	.3632,	.4794,	.4890,	.7831,	.3482,	.6742,	.6019,
6,	.3855,	.5387,	.6695,	.6292,	.5393,	.7048,	.6629,	.7962,	.5105,	.4675,	.5914,
7,	.3549,	.3875,	.7122,	.6348,	.7964,	.8798,	.6296,	.8258,	.5705,	.5771,	.6578,
8,	.3321,	.3946,	.4978,	.3370,	.9349,	1.0793,	1.0460,	1.0024,	.7530,	.6805,	.8120,
9,	.2823,	.4967,	.7344,	.4342,	.8124,	.7576,	.8646,	.4307,	.5323,	.7848,	.5826,
10,	.2228,	.3463,	1.0423,	.7306,	1.0012,	1.1141,	.8984,	.4831,	.5716,	.7048,	.5865,
+gp,	.2228,	.3463,	1.0423,	.7306,	1.0012,	1.1141,	.8984,	.4831,	.5716,	.7048,	
0 FBAR 4- 7,	.3115,	.4029,	.4915,	.4056,	.4581,	.5663,	.5222,	.6741,	.4306,	.4609,	

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

YEAR,	1950,	1951,
AGE		
3,	66659,	559068,
4,	93807,	51690,
5,	69616,	42465,
6,	37485,	25017,
7,	46516,	13635,
8,	16065,	11963,
9,	4591,	4830,
10,	1975,	1968,
+gp,	5287,	2201,
0 TOTAL,	342001,	712836,

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

YEAR,	1952,	1953,	1954,	1955,	1956,	1957,	1958,	1959,	1960,	1961,
AGE										
3,	60807,	1034439,	121819,	51259,	169575,	52103,	68171,	326744,	244019,	110098,
4,	398330,	44345,	788540,	93799,	40923,	123963,	40782,	54251,	249131,	163674,
5,	34016,	188593,	24532,	505627,	67124,	28146,	79140,	28038,	37336,	139807,
6,	18468,	15513,	90362,	14760,	254108,	41644,	15858,	36348,	16402,	18220,
7,	8220,	6208,	7787,	49017,	7567,	92336,	22753,	7717,	17055,	7004,
8,	5003,	2484,	2488,	3450,	14550,	3316,	33416,	7094,	3465,	8321,
9,	3596,	1167,	1056,	859,	1517,	4671,	1731,	11465,	3784,	1408,
10,	948,	742,	572,	221,	458,	835,	2041,	674,	4032,	980,
+gp,	1348,	2339,	957,	218,	418,	408,	1126,	1168,	1201,	2624,
0 TOTAL,	530736,	1295830,	1038113,	719210,	556239,	347422,	265017,	473498,	576424,	452136,

1

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

YEAR,	1962,	1963,	1964,	1965,	1966,	1967,	1968,	1969,	1970,	1971,
AGE										
3,	243007,	275625,	319121,	101722,	239634,	296489,	17718,	17567,	166355,	95566,
4,	76180,	163214,	199906,	241039,	77912,	172358,	228352,	13912,	13004,	114987,
5,	82560,	34440,	67814,	119070,	155401,	43311,	103703,	125762,	9610,	8426,
6,	57142,	23345,	11033,	27768,	61111,	70068,	23249,	47565,	62579,	6143,
7,	7040,	16168,	6827,	3772,	11305,	23749,	34095,	12024,	21749,	30952,
8,	2497,	2867,	4861,	2398,	1569,	4052,	11417,	13800,	6569,	10478,
9,	2825,	831,	1226,	1522,	1082,	758,	1855,	4559,	6832,	3557,
10,	440,	709,	174,	250,	435,	490,	423,	926,	2259,	3769,
+gp,	1350,	638,	1040,	1609,	550,	751,	657,	316,	886,	1915,
0 TOTAL,	473040,	517837,	612002,	499149,	548999,	612025,	421469,	236432,	289843,	275793,

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

YEAR,	1972,	1973,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,
AGE										
3,	1030295,	272646,	53376,	49193,	56822,	115516,	172972,	136676,	18971,	6250,
4,	76453,	634569,	159271,	34937,	31194,	33860,	43936,	98809,	96030,	14965,
5,	72104,	42403,	283813,	92663,	15857,	13366,	7777,	18950,	48966,	57922,
6,	5761,	20143,	12838,	152632,	45218,	6821,	4276,	2679,	5883,	20370,
7,	4199,	1816,	10231,	5236,	79984,	18204,	3244,	2244,	900,	2128,
8,	16945,	1980,	1105,	4632,	2355,	29240,	7864,	1185,	1103,	511,
9,	5813,	7759,	1236,	559,	2674,	800,	13948,	4089,	476,	447,
10,	2165,	2373,	4821,	452,	375,	968,	374,	5796,	2022,	182,
+gp,	3928,	2603,	4360,	3200,	3065,	935,	911,	801,	3464,	2403,
0 TOTAL,	1217663,	986290,	531050,	343505,	237544,	219710,	255301,	271230,	177815,	105178,

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

YEAR,	1982,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,
AGE										
3,	8370,	4844,	8447,	259365,	534320,	83800,	42214,	16798,	24553,	82431,
4,	4678,	6054,	3329,	6442,	185614,	262218,	65055,	25560,	12808,	16450,
5,	9935,	3015,	3210,	1979,	4231,	96347,	134794,	45091,	17369,	9426,
6,	27404,	5083,	1669,	1886,	1126,	2548,	31280,	64125,	25837,	12532,
7,	7009,	11395,	2918,	1094,	897,	582,	1556,	7997,	31760,	17420,
8,	807,	3363,	6360,	1711,	610,	421,	289,	928,	3465,	19910,
9,	272,	349,	1934,	3211,	827,	369,	234,	178,	537,	2069,
10,	219,	155,	239,	1141,	1442,	410,	235,	160,	136,	89,
+gp,	1761,	713,	975,	307,	463,	974,	1647,	291,	81,	71,
0 TOTAL,	60454,	34971,	29080,	277135,	729530,	447670,	277305,	161128,	116545,	160398,

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

YEAR,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	GMST 50-99	AMST 50-99
AGE													
3,	197383,	635492,	279527,	75138,	89996,	102792,	46071,	183240,	63912,	262041,	0,	95387,	184501,
4,	63898,	149459,	474703,	203500,	50165,	37721,	58787,	33750,	131332,	49516,	197794,	65612,	126566,
5,	11688,	40868,	95815,	342143,	127819,	33941,	23829,	33164,	20645,	79214,	35708,	38716,	73660,
6,	6011,	7388,	18873,	48081,	188811,	70990,	16654,	11606,	12408,	11780,	33070,	18708,	35854,
7,	7658,	3347,	3530,	7904,	20763,	89336,	28395,	7027,	4286,	6097,	6053,	8669,	16645,
8,	10243,	4397,	1860,	1418,	3430,	7666,	30345,	12387,	2519,	1984,	2813,	3908,	6973,
9,	12300,	6017,	2426,	926,	829,	1103,	2133,	8729,	3722,	971,	834,	1734,	2959,
10,	1333,	7594,	2998,	953,	491,	301,	423,	736,	4645,	1790,	363,	720,	1278,
+gp,	99,	1439,	3165,	2025,	2111,	865,	416,	397,	821,	2100,	1578,		
0 TOTAL,	310614,	856000,	882896,	682088,	484413,	344714,	207053,	291036,	244290,	415493,	278213,		

1

Run title : Arctic Haddock (run: XSAHS38/X38) ,

At 24/05/2002 18:01

Table 17 Summary (with SOP correction)

,	RECRUITS, Age 3	TOTALBIO,	TOTSPBIO,	LANDINGS,	YIELD/SSB,	SOPCOFAC,	FBAR 4- 7,
1950,	66659,	274046,	141935,	132125,	.9309,	.4545,	.8463,
1951,	559068,	441834,	108612,	120077,	1.1056,	.6514,	.6417,
1952,	60807,	318981,	62334,	127660,	2.0480,	.5127,	.7550,
1953,	1034439,	661878,	84356,	123920,	1.4690,	.5742,	.5328,
1954,	121819,	719534,	123672,	156788,	1.2678,	.6021,	.3945,
1955,	51259,	580969,	175946,	202286,	1.1497,	.4731,	.5264,
1956,	169575,	530535,	236247,	213924,	.9055,	.5529,	.4723,
1957,	52103,	346657,	191645,	123583,	.6449,	.5679,	.4608,
1958,	68171,	286345,	150055,	112672,	.7509,	.6146,	.5596,
1959,	326744,	406200,	125043,	88211,	.7054,	.8007,	.4168,
1960,	244019,	522733,	119949,	154651,	1.2893,	.8379,	.5160,
1961,	110098,	489718,	129477,	193224,	1.4923,	.8026,	.6904,
1962,	243007,	427196,	117497,	187408,	1.5950,	.7459,	.8544,
1963,	275625,	397126,	83849,	146224,	1.7439,	.7442,	.9120,
1964,	319121,	378634,	60371,	99158,	1.6425,	.6183,	.6827,
1965,	101722,	440469,	91817,	118578,	1.2915,	.6978,	.5204,
1966,	239634,	468221,	124337,	161778,	1.3011,	.6601,	.6388,
1967,	296489,	561452,	156951,	136397,	.8690,	.7919,	.4457,
1968,	17718,	504308,	174348,	181726,	1.0423,	.7921,	.5349,
1969,	17567,	375487,	169326,	130820,	.7726,	.8028,	.4138,
1970,	166355,	313024,	151760,	88257,	.5816,	.7547,	.3789,
1971,	95566,	381550,	173993,	78905,	.4535,	1.0105,	.2575,
1972,	1030295,	883367,	141625,	266153,	1.8793,	.8593,	.7427,
1973,	272646,	849852,	118951,	322226,	2.7089,	.8281,	.5934,
1974,	53376,	715613,	196005,	221157,	1.1283,	.8657,	.5128,
1975,	49193,	531557,	233119,	175758,	.7539,	.8127,	.5381,
1976,	56822,	298987,	193162,	137264,	.7106,	.6296,	.7018,
1977,	115516,	242298,	131602,	110158,	.8371,	.7708,	.8483,
1978,	172972,	264772,	99070,	95422,	.9632,	.9507,	.6896,
1979,	136676,	325768,	81189,	103623,	1.2763,	1.1278,	.7182,
1980,	18971,	262753,	75448,	87889,	1.1649,	1.0352,	.5415,
1981,	6250,	197306,	129398,	77153,	.5962,	.9942,	.5987,
1982,	8370,	123773,	107261,	46955,	.4378,	.9510,	.4803,
1983,	4844,	66069,	62549,	21607,	.3454,	.9205,	.3910,
1984,	8447,	54804,	42839,	17318,	.4043,	.9405,	.3021,
1985,	259365,	149019,	36304,	41270,	1.1368,	.9689,	.3779,
1986,	534320,	295709,	48421,	96585,	1.9947,	.9019,	.4448,
1987,	83800,	230620,	34976,	150654,	4.3074,	.9836,	.5459,
1988,	42214,	168656,	62577,	91745,	1.4661,	.9950,	.5469,
1989,	16798,	124259,	63620,	54859,	.8623,	.9634,	.4206,
1990,	24553,	120806,	67047,	25741,	.3839,	.9651,	.1735,
1991,	82431,	146124,	78391,	33605,	.4287,	.9589,	.2538,
1992,	197383,	227457,	89290,	53887,	.6035,	1.0132,	.3115,
1993,	635492,	460968,	134714,	77621,	.5762,	1.0021,	.4029,
1994,	279527,	553570,	75436,	128703,	1.7061,	1.1128,	.4915,
1995,	75138,	493357,	96989,	138677,	1.4298,	1.0546,	.4056,
1996,	89996,	416293,	138077,	173264,	1.2548,	1.0524,	.4581,
1997,	102792,	316817,	133994,	148756,	1.1102,	1.0498,	.5663,
1998,	46071,	198448,	103797,	93946,	.9051,	1.0595,	.5222,
1999,	183240,	199163,	91890,	82346,	.8961,	1.0552,	.6741,
2000,	63912,	178563,	55669,	61292,	1.1010,	1.0019,	.4306,
2001,	262041,	249474,	94201,	81280,	.8628,	1.0038,	.4609,
Arith. Mean ,	183673,	368714,	114829,	121063,	1.1401		.5307,
0 Units,	(Thousands),	(Tonnes),	(Tonnes),	(Tonnes),			

1

Revised short-term forecast

MFDP version 1
Run: hs
Time and date: 11:42 25/05/2002
Fbar age range: 4-7

	2002							
Age	N	M	Mat	PF	PM	SWt	Sel	CWt
3	252000	0.28996	0.0028	0	0	0.283333	0.0669	0.653333
4	197794	0.2276	0.082	0	0	0.607667	0.2366	1.036667
5	35708	0.21516	0.348	0	0	1.094667	0.6019	1.353333
6	33070	0.2023	0.562	0	0	1.492667	0.5914	1.636667
7	6053	0.2	0.732	0	0	1.773333	0.6578	1.81
8	2813	0.2	0.884	0	0	1.936667	0.812	1.943333
9	834	0.2	0.934	0	0	2.293333	0.5826	2.153333
10	363	0.2	0.958	0	0	2.514667	0.5865	2.406667
11	1578	0.2	0.982	0	0	3.646667	0.5865	2.63

	2003							
Age	N	M	Mat	PF	PM	SWt	Sel	CWt
3	227000	0.28996	0.0028	0	0	0.283333	0.0669	0.653333
4 .		0.2276	0.082	0	0	0.607667	0.2366	1.036667
5 .		0.21516	0.348	0	0	1.094667	0.6019	1.353333
6 .		0.2023	0.562	0	0	1.492667	0.5914	1.636667
7 .		0.2	0.732	0	0	1.773333	0.6578	1.81
8 .		0.2	0.884	0	0	1.936667	0.812	1.943333
9 .		0.2	0.934	0	0	2.293333	0.5826	2.153333
10 .		0.2	0.958	0	0	2.514667	0.5865	2.406667
11 .		0.2	0.982	0	0	3.646667	0.5865	2.63

	2004							
Age	N	M	Mat	PF	PM	SWt	Sel	CWt
3	226000	0.28996	0.0028	0	0	0.283333	0.0669	0.653333
4 .		0.2276	0.082	0	0	0.607667	0.2366	1.036667
5 .		0.21516	0.348	0	0	1.094667	0.6019	1.353333
6 .		0.2023	0.562	0	0	1.492667	0.5914	1.636667
7 .		0.2	0.732	0	0	1.773333	0.6578	1.81
8 .		0.2	0.884	0	0	1.936667	0.812	1.943333
9 .		0.2	0.934	0	0	2.293333	0.5826	2.153333
10 .		0.2	0.958	0	0	2.514667	0.5865	2.406667
11 .		0.2	0.982	0	0	3.646667	0.5865	2.63

Input units are thousands and kg - output in tonnes

MFDP version 1
Run: hs
North East Arctic Haddock
Time and date: 11:42 25/05/2002
Fbar age range: 4-7

2002 Biomass	SSB	FMult	FBar	Landings
304805	72385	0.8182	0.4271	85000

2003 Biomass	SSB	FMult	FBar	Landings	2004 Biomass	SSB
383660	106934	0.0000	0.0000	0	543111	204153
.	106934	0.1000	0.0522	17928	525710	194381
.	106934	0.2000	0.1044	35006	509178	185146
.	106934	0.3000	0.1566	51279	493466	176416
.	106934	0.4000	0.2088	66792	478528	168164
.	106934	0.5000	0.2610	81585	464321	160361
.	106934	0.6000	0.3132	95698	450804	152980
.	106934	0.7000	0.3653	109168	437940	145998
.	106934	0.8000	0.4175	122030	425692	139391
.	106934	0.9000	0.4697	134314	414026	133139
.	106934	1.0000	0.5219	146054	402910	127219
.	106934	1.1000	0.5741	157277	392315	121614
.	106934	1.2000	0.6263	168010	382212	116305
.	106934	1.3000	0.6785	178281	372575	111275
.	106934	1.4000	0.7307	188112	363377	106509
.	106934	1.5000	0.7829	197527	354597	101991
.	106934	1.6000	0.8351	206548	346210	97707
.	106934	1.7000	0.8873	215195	338197	93645
.	106934	1.8000	0.9395	223487	330537	89790
.	106934	1.9000	0.9917	231442	323211	86133
.	106934	2.0000	1.0439	239078	316203	82661

Input units are thousands and kg - output in tonnes

MFDP version 1
Run: hs2
North East Arctic Haddock
Time and date: 11:51 25/05/2002
Fbar age range: 4-7

2002							
Biomass	SSB		FMult	FBar	Landings		
304805	72385		0.8182	0.4271	85000		

2003					2004		
Biomass	SSB	FMult	FBar	Landings	Biomass	SSB	
383660	106934	0.5	0.261	81585	464321	160361	
.	106934	0.55	0.2871	88724	457479	156619	
.	106934	0.6	0.3132	95698	450804	152980	
.	106934	0.65	0.3393	102512	444293	149441	
.	106934	0.7	0.3653	109168	437940	145998	
.	106934	0.75	0.3914	115673	431741	142649	
.	106934	0.8	0.4175	122030	425692	139391	
.	106934	0.85	0.4436	128242	419788	136222	
.	106934	0.9	0.4697	134314	414026	133139	
.	106934	0.95	0.4958	140250	408401	130138	
.	106934	1	0.5219	146054	402910	127219	
.	106934	1.05	0.548	151728	397550	124378	
.	106934	1.1	0.5741	157277	392315	121614	
.	106934	1.15	0.6002	162703	387204	118923	
.	106934	1.2	0.6263	168010	382212	116305	
.	106934	1.25	0.6524	173202	377337	113756	
.	106934	1.3	0.6785	178281	372575	111275	
.	106934	1.35	0.7046	183250	367923	108860	
.	106934	1.4	0.7307	188112	363377	106509	
.	106934	1.45	0.7568	192870	358936	104220	
.	106934	1.5	0.7829	197527	354597	101991	

Input units are thousands and kg - output in tonnes

MFDP version 1
Run: sm
North East Arctic Haddock
Time and date: 14:50 5/25/02
Fbar age range: 4-7

2002 Biomass	SSB	FMult	FBar	Landings
304805	72385	1.0000	0.5219	100439

2003 Biomass	SSB	FMult	FBar	Landings	2004 Biomass	SSB
369161	99647	0.0000	0.0000	0	527948	194180
.	99647	0.2000	0.1044	33353	495651	176298
.	99647	0.4000	0.2088	63667	466450	160311
.	99647	0.6000	0.3132	91261	440012	146006
.	99647	0.8000	0.4175	116422	416040	133195
.	99647	1.0000	0.5219	139401	394271	121710
.	99647	1.2000	0.6263	160424	374473	111404
.	99647	1.4000	0.7307	179691	356438	102147
.	99647	1.6000	0.8351	197380	339981	93822
.	99647	1.8000	0.9395	213650	324940	86327
.	99647	2.0000	1.0439	228642	311169	79572
.	99647	2.2000	1.1482	242481	298539	73476
.	99647	2.4000	1.2526	255281	286935	67968
.	99647	2.6000	1.3570	267141	276253	62985
.	99647	2.8000	1.4614	278151	266404	58471
.	99647	3.0000	1.5658	288392	257305	54376
.	99647	3.2000	1.6702	297934	248884	50656
.	99647	3.4000	1.7745	306841	241076	47272
.	99647	3.6000	1.8789	315172	233823	44188
.	99647	3.8000	1.9833	322977	227073	41375
.	99647	4.0000	2.0877	330302	220781	38804

Input units are thousands and kg - output in tonnes

RCT3

NORTHEAST ARCTIC HADDOCK : recruits as 3 year-olds

```
7 22 2
'Year' 'VPA' 'RT2' 'RT3' 'NT2' 'NT3' 'NT4' 'NT1' 'NA1'
1980   4.8 -11     0.5    1.5   3.1   1.5    3.1    7.0
1981   8.4   9.5   1.5    4.8  18.9  14.7    3.9    9.0
1982 259.4  58.4  90.0  514.6 475.9 110.8 2919.3    0.3
1983 534.3 134.3  36.3 1593.8 384.6 290.2 3832.6 1685.0
1984  83.8  10.7   8.3  370.3 154.4  68.9 1901.1 1809.0
1985  42.2   1.7   1.7   79.9  25.3  21.6  665.0  680.0
1986  16.8   0.7   0.4   15.3  14.1   3.4  163.8  111.0
1987  24.6   2.4   7.3    9.5   4.5   5.1   35.4   20.0
1988  82.4  10.6   6.2   54.6  33.4  24.4   81.2   58.0
1989 197.4  17.6  34.6  300.3 150.5 105.6  644.1  493.0
1990 635.5 128.6 198.5 1375.5 507.7 436.6 2006.0 1938.0
1991 279.5  35.7  44.2  599.0 339.5 171.1 1659.4  859.0
1992  75.1   5.8   3.1  228.0  53.6  48.1  727.9 1424.0
1993  90.0   4.2   2.8  179.3  52.5  28.0  603.2  848.0
1994 102.8   5.7   3.2  263.6  86.1  33.2 1463.6 1380.0
1995  46.1   1.9   3.8   67.9  22.7  12.2  309.5  249.0
1996 183.2  11.5  19.6  137.9  59.8  35.4 1268.0  798.0
1997  63.9   6.1   6     57.6  27.2  29.4  212.9  256.0
1998 262.0  26.2  33.4  452.2 297.0 183.9 1244.9  856.0
1999 -11    26.1 -11    460.4 298.5 -11    847.2 1024.0
2000 -11   -11   -11    530.7 -11   -11   1216.5  976.0
2001 -11   -11   -11    -11   -11   -11   1704.3 2065.0
1996 yearclass also removed from XSA tuning
RT2 Russian bottom trawl survey age 2
RT3 Russian bottom trawl survey age 3
NT2 Norwegian bottom trawl survey age 2
NT3 Norwegian bottom trawl survey age 3
NT4 Norwegian bottom trawl survey age 4
RT1 Russian bottom trawl survey age 1
NT1 Norwegian bottom trawl survey age 1
NA1 Norwegian acoustic survey age 1

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

tab45pk1.rvs

NORTHEAST ARCTIC HADDOCK : recruits as 3 year-olds

```
 Data for    7 surveys over   22 years :  1980 - 2001

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

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

 Forecast/Hindcast variance correction used.

 Yearclass =   1997

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

Survey/ Series	Slope	Inter-cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
RT2	.90	2.51	.52	.816	16	1.96	4.28	.597	.164
RT3	.88	2.52	.65	.752	17	1.95	4.24	.745	.105
NT2	.78	.67	.47	.851	17	4.07	3.86	.549	.194
NT3	.90	.84	.50	.836	17	3.34	3.84	.581	.173
NT4	.88	1.34	.43	.874	17	3.41	4.35	.490	.243
NT1	.91	-1.15	.87	.631	17	5.37	3.75	1.005	.058
NA1	1.19	-2.54	1.87	.267	17	5.55	4.08	2.143	.013
					VPA Mean =		4.61	1.079	.050

Yearclass = 1998

	I----------Regression----------I					I----------Prediction---------I			
Survey/ Series	Slope	Inter-cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
RT2	.89	2.57	.45	.840	17	3.30	5.49	.526	.188
RT3	.85	2.61	.59	.757	18	3.54	5.63	.697	.107
NT2	.78	.69	.46	.836	18	6.12	5.49	.542	.178
NT3	.87	1.00	.45	.841	18	5.70	5.96	.550	.172
NT4	.87	1.40	.39	.877	18	5.22	5.92	.474	.232
NT1	.94	-1.33	.84	.610	18	7.13	5.40	.968	.056
NA1	1.19	-2.61	1.66	.284	18	6.75	5.46	1.910	.014
					VPA Mean =		4.60	.998	.052

Yearclass = 1999

	I----------Regression----------I					I----------Prediction---------I			
Survey/ Series	Slope	Inter-cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
RT2	.87	2.64	.38	.870	18	3.30	5.51	.448	.323
RT3									
NT2	.80	.62	.45	.832	19	6.13	5.53	.526	.235
NT3	.83	1.17	.41	.859	19	5.70	5.89	.487	.273
NT4									
NT1	1.00	-1.68	.81	.603	19	6.74	5.07	.928	.075
NA1	1.21	-2.79	1.47	.316	19	6.93	5.63	1.695	.023
					VPA Mean =		4.70	.953	.071

Yearclass = 2000

	I----------Regression----------I					I----------Prediction---------I			
Survey/ Series	Slope	Inter-cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
RT2									
RT3									
NT2	.81	.57	.45	.819	19	6.28	5.66	.544	.554
NT3									
NT4									
NT1	1.04	-1.92	.80	.591	19	7.10	5.45	.943	.184
NA1	1.22	-2.88	1.33	.346	19	6.88	5.52	1.554	.068
					VPA Mean =		4.72	.918	.194

Yearclass = 2001

Survey/ Series	Slope	Inter-cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I----------Regression----------I					I----------Prediction---------I			
RT2									
RT3									
NT2									
NT3									
NT4									
NT1	1.06	-2.04	.79	.590	19	7.44	5.81	.960	.389
NA1	1.22	-2.96	1.21	.379	19	7.63	6.39	1.502	.159
					VPA Mean =		4.74	.889	.453

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
1997	61	4.12	.24	.10	.16	64	4.17
1998	280	5.64	.23	.12	.29	263	5.57
1999	252	5.53	.25	.14	.31		
2000	227	5.43	.40	.21	.26		
2001	226	5.42	.60	.46	.58		

Saithe

It was not clear to ACFM if the historical SSB calculations were based on knife-edge maturity ogive or for which year the maturity at age was changed to the values given in Table 5.14.

The AFWG is asked to investigate the reason for the retrospective problems in the assessment, particularly to see whether this is a consequence of any single tuning series.

It is proposed to exclude age group 2 from the acoustic survey due to the high value of the S.E. (log q).

It was noted that the RCT3 results (Table 5.13.) are more-or-less estimated by the VPA mean and do not reflect year class strength.

Sebastes marinus

No comments were made.

Sebastes mentella

The size of the plus-group catches seems to be a problem in the algorithm of XSA. How to handle this in XSA is not quite obvious and guidelines from WGMG would be welcomed. The AFWG is encouraged to explore the possibilities of using length-based models like FLEXIBEST in the near future.

Greenland halibut

In the technical minutes from last year it was pointed out that aging problems are quite apparent for this stock and have still to be resolved. The XSA suffers from this. The AFWG was therefore encouraged to investigate if it will produce more reliable results by using only age-groups less than 10 years in the **tuning.** ACFM reiterates this, but wishes to make clear that this was intended to be done without changing the plus-group in the assessment.

Comments were made on the Norwegian Combined Survey Index (Table E5). It can be wrong or a least very misleading to combine tuning fleets using different gears. It would be more wise to delete those age groups from the tuning fleets if they are not well reflected in the catches. A note was made that application of some modelling in combining the different fleets may help.

Standard plots (summary figures) (A-D) are missing!

Shrimp

As listed in the AFWG report many models have been developed and used in recent years to assess shrimp stocks. The use of length-based models such as BORMICON and FLEXIBEST seems to be a promising approach and should therefore be further considered. A joint ICES/NAFO Working Group as mentioned in AFWG report has the great benefit that scientists with experience in shrimp assessments in other areas will be involved with their expertise and knowledge.

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INTRODUCTION

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Terms of Reference

At its October 2001 meeting ACFM decided the following:

"The **Arctic Fisheries Working Group** [AFWG] (Chair: S. Mehl, Norway) will meet at ICES Headquarters from 16–25 April 2002 to:

a) assess the status of and provide catch options for the year 2003 for the stocks of cod, haddock, saithe, Greenland halibut, and redfish in Sub-areas 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) consider the results presented in the reports of the WGMG and the SGPA with a view to apply these in the assessments;

g) review the draft Quality Handbook.

AFWG will report by 26 April 2002 for the attention of ACFM."

General Comments

The Working Group this year met even earlier than last year, and this causes some serious problems and concerns compared to having the meeting in August. The work on compiling the national and international catch data were not ready before the meeting and the Norwegian survey covering spawning Northeast Arctic cod ended just one week before the WG. This affects the quality checking of important input data as well as the possibility to have test runs ready prior to the meeting. At the WG a lot of time was spent on preparing input data and doing exploratory runs, time that could have been spent on e.g. discussions on inadequacies in the data and available software, resulting deficiencies in the assessments and how to improve these shortcomings.

The WG has, however, made some progress regarding some of these issues over the last couple of years. This is reflected both in presented working documents as well as in how ToR points b, d, e and f are dealt with.

Management strategy and reference points for NEA cod

The State Committee for Fisheries of the Russian Federation August 2000 requested that ICES reviewed the MBAL of 500 thousand tonnes. A revision of historic data on maturity and weights at age was ready during the first part of the 2001 WG, and the new data were applied in the assessment (ICES 2001/ACFM:19). This affected the historic stock-recruitment relationship, and spawning biomasses associated with some historic recruitment were estimated to be lower, suggesting that the current biomass reference points could be too high. The WG proposed a $\mathbf{B}_{lim}$ at 140,000 tons, since SSBs below that value had produced only poor year classes. It was further argued that the safety margin between $\mathbf{B}_{lim}$ and $\mathbf{B}_{pa}$ should take due account of the consistent pattern of overestimating the stock seen for many years. $\mathbf{B}_{pa}$ was therefore estimated by the formulae: $\mathbf{B}_{pa} = \mathbf{B}_{lim}\, e^{1.645\,\sigma} \times 1.4$ where 1.4 is a bias correction factor reflecting the degree to which the converged SSB values had deviated from the unconverged values on average. σ represents the fractional coefficient of variation of the assessment. By assuming a value of 0.4 for σ the estimated value of $\mathbf{B}_{pa}$ was 378,000 tonnes. On this basis a $\mathbf{B}_{pa}$ of 375,000 tons was proposed.

ACFM at its May 2001 meeting (ICES 2001), however, pointed out that the new data appeared better to separate the strong environmental impact on recruitment from the biological productivity of the stock, and that the pattern suggested that the biological productivity of the stock at low SSB may be lower than previously thought, and this way may affect the selection of the reference points. ACFM therefore decided that rather than revising the reference points that year and again next year when new analysis would further separate environmental and biological contributions to stock productivity, ICES would continue to advise using the previous reference points.

A scientific peer review of the 2001 assessment for NEA cod (Beckett and Serra 2001), requested by The Norwegian Ministry of Fisheries, commented that "there appear to have been signified changes in growth and maturation rates during this period. In consequence, if these changes are real, it would seem questionable as to whether the full time-series of SSB values should be used, at least until more is known of the biological and physical processes". They also illustrated that the SSB/R plot for the period after 1980 differed from the earlier period. However, "The reviewers would endorse ACFM's advice to delay adopting a new value for $\mathbf{B}_{pa}$ until further analyses have been undertaken."

In December 2001 The State Committee for Fisheries of the Russian Federation requested a revision of $\mathbf{F}_{pa}$ for NEA cod. It was referred to the proposed new $\mathbf{B}_{pa}$ of 375,000 tons and argued that since $\mathbf{B}_{pa}$ and $\mathbf{F}_{pa}$ are interrelated mathematically it is natural to "specify $\mathbf{F}_{pa}$ with reference to the adjusted $\mathbf{B}_{pa}$". The present values of $\mathbf{B}_{pa}$ and $\mathbf{F}_{pa}$ for NEA cod are, however, not interrelated mathematically, as is the case for a number of stocks. Neither is it straight forward to make them mathematically interrelated. The revision of historic data was on the maturity ogives and weights, while all the numbers are unchanged and the proposed new $\mathbf{B}_{pa}$ does not necessarily warrant any change in $\mathbf{F}_{pa}$.

During the last meeting of the Study Group on the Further Development of the Precautionary Approach to Fishery Management (ICES 2002/ACFM:10) both reference points and environmental effects were on the agenda. A new objective method for identifying the value of SSB below which recruitment is impaired (change-point) was presented (O'Brien and Maxwell, WD ** SGPA 2002), and the method was applied to NEA cod for both the whole time-series of stock-recruitment data (1946-1997) and the first and second part separately, split in 1975. The splitting of the time-series had a considerable effect on the value of the estimated change-points, the one for the last period was about the double of the first one. Splitting of a time-series, however, requires a good justification, i.e. plausible hypotheses for mechanisms or, better, some evidence for the hypotheses. The method and the results were presented at the beginning of the AFWG. The WG was also briefly informed about how ICES will follow up the work on calculation of PA reference points over the next couple of years.

In ToR b) the WG is asked to evaluate the agreed management strategy for cod, with special attention to the reference points for spawning stock biomass and fishing mortality. A group of scientists and managers, nominated by the

Russian-Norwegian Fishery Commission, is presently dealing with the management strategy and the present WG did not address that issue. Some of the other issues mentioned above are dealt with in several working documents (Borisov and Bulgakova, WD 2; Ajiad and Jakobsen, WD 3; Kovalev, WD 4; Filin, WD 6; Tretyak, WD 7, 34) and discussed further in Section 10 of the report. At the end of the meeting the WG was informed about a new working paper intended for the AFWG: "Estimating biomass limit reference points for Northeast Arctic cod with non-parametric density estimation methods" by Jake Rice. The paper was distributed, but due to the late arrival the WG was not able to deal with it as an ordinary WD during this meeting.

Inadequacies in the data and possible deficiencies in the assessments

One of the conclusions in the report from the last Working Group on Methods on Fish Stock Assessment (ICES 2002/D:1), was that "working groups should favour fewer data of good quality (as evaluated independently of the assessment model) instead of large quantities of data of unknown properties". The WG has tried to follow up this conclusion as well as ToR f) in the assessment of several stocks.

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 2001/ACFM:02, ICES CM 2001/ACFM:19, Nakken WD 10, 2001 WG, Nakken WD8, 2000 WG, Schöne WD4, 1999 WG). During the present meeting a *Cand. Scient* thesis on estimation of discards in the commercial trawl fishery for Northeast Arctic cod and some effects on assessment was presented (Dingsør, WD 13). Hareide and Garnes (WD 14) addressed the problem on misreporting. These issues are further dealt with in the respective stock sections.

Inaccuracies in 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 16). 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. Another working document (Aanes, WD 15) addresses the precision in Norwegian age determination of cod. He found the observed ages to be quite precise, with a somewhat decrease in precision for increasing age. But since even a small probability of misclassification may give rise to a substantial bias and increase in variation in a final estimate of an age structure based on error prone age determination (e.g. Worthington et al. 1995; Richards et al., 1992), he concludes that further analysis are required.

Alternative models for assessment model for NEA cod (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, 2002) 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).

It was planned to take this model in use as the main assessment model for Northeast Arctic cod once it had been scientifically approved. However, Fleksibest has received considerable criticism when it has been presented at international workshops (Pennington, 1999; ICES, 2001/ACFM:09). It will be quite demanding to investigate all the issues that were listed in the 2001 Workshop report (ICES, 2001/ACFM:09). One issue that has been addressed is the choice of search algorithms for finding the best fit of models to data. Most of the problems with ending up at local minima have been solved (Frøysa, 2002). However, at the moment it does not seem appropriate to suggest a date at which Fleksibest could be taken into use as the main model for assessment of the current stock size of Northeast Arctic cod.

As far as predictions are considered, the situation is different. Adding length structure makes it easier to include biological realism in prediction models 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. The SGGROMAT study group, which is scheduled for December 2002, should be a good opportunity to present studies of the effect of adding length structure in prediction models.

A framework for comparing the difference in the results of predictions (deterministic and stochastic) using Fleksibest vs. age-structured prediction models should be established. The effect of including length structure in the calculation of yield-based biological reference points ($\mathbf{F}_{0.1}$, $\mathbf{F}_{max}$) could also be investigated. The application of Fleksibest to Northeast Arctic cod should also be extended down to age 0, in order to have an integrated model for assessment of all age groups (which XSA does not provide at the moment). Some of the parameters needed for making predictions with Fleksibest have to be estimated by running Fleksibest as an assessment model using historical data.

Further work on Fleksibest as an assessment model for Northeast Arctic cod should be carried out together with an investigation of less complex models (CAGEAN type and VPA type models). A comparison of the models with different complexity is the only way to find out which level of complexity is appropriate for the assessment of a particular stock. Some of the criticism Fleksibest has received probably also applies to less complex models.

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 multi-fleet model where the catches are modelled. Work on describing in precise mathematical terms models with age-length-area-multispecies-multifleet-structure is in progress within the EU project 'Development of structurally testable models of marine populations' (Trenkel *et al*., 2002). This will also provide a better theoretical framework for further work on Fleksibest.

It should also be noted that there has been considerable interest in Fleksibest from researchers working on length-based models.

ICES Quality Handbook

According to ToR g) the WG should review the draft Quality Handbook. The plan was that prior to the meeting the stock co-ordinators should prepare stock-specific annexes following the template proposed by ICES in 2001 and distribute them to the WG members. This was done for Norwegian coastal cod, Northeast Arctic saithe and Greenland halibut. A while before the AFWG meeting, however, ICES signalised that due to feedback from different WGs the further process with the Quality Handbook might differ from the original plan. Generally, WGs were worried about the extra workload a separate handbook would mean and favoured that the present WG report system should be improved instead. Many were in favour of merging the two, which would mean having the annexes as annexes to the WG report or as an integrated part of it. Some expressed that a particularly urgent matter is improvements on the compilation procedures and quality control of aggregation of national catch data.

Stock-specific annexes were therefore not prepared for the other AFWG stocks (NEA cod, NEA haddock, redfish species and shrimp). At the meeting ICES first informed the WG about the present situation, and then the further process was discussed in a sub-group consisting mainly of the stock co-ordinators. The sub-group was in favour of having the stock-specific annexes as annexes to the WG report, and the annex should perhaps be the main document on each stock, including at least what was proposed in the original ICES template. It was stressed that the document should describe in detail the collection and preparation of input data, data aggregation, model parameter settings etc. All changes with justifications should be documented and a plan for future improvements could perhaps be incorporated. The annual report could then be reduced to mainly give input data, present model settings and results with comments. It was decided that the sub-group should meet later this year, and discuss and agree upon a proposal for layout and content for two linked documents and report back to ICES, preferably before the October ACFM meeting. Depending on ICES's final conclusions, new drafts could then be prepared and reviewed at the next WG meeting.

Scientific Presentations

WD 1 (presented by H. Loeng) describes the current 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 (presented by T. Bulgakova) describes a modification of the Ricker model applied to NEA cod, which beside cannibalism includes two complementary factors. The first factor is population fecundity divided by SSB and variable by years. This parameter reflects the effect of cod spawning stock reproductive structure. The second parameter reflects the duration of relative stability of the Atlantic water inflow within every year and is calculated as a number of months in a year with positive temperature anomalies. The incorporation of these factors leads to an increase of correlation coefficient up to 0.872. This means that as much as 76% of the variability in the recruitment can be explained by the above-mentioned factors.

WD 3 (presented by S. Mehl) presents a novel model that is developed to analyse the stock-recruitment relationship for Northeast Arctic cod. It incorporates spawning stock biomass, an age diversity index for cod from the spawning grounds and temperature from the Kola section during August to December. The general fit seemed to improve after 1970 and the model accounts for 70% of the variation in the Northeast Arctic cod recruitment in the period 1971-1995. SSB alone explained 33%, while 67% of the variance was explained by adding temperature and just 3% more by also including the age diversity index. The model can also be used for prediction purposes based on climate forecast.

WD 4 (presented by Yu. Kovalev) - Investigation of the cod growth and maturation indicated two periods with considerable differences in cod biology. The first is from 1946 to 1981 when increasing trends in weights-at-age and a decreasing trend in age of 50 % maturation were observed. The second period is after 1981 when these parameters have varied without clear trends. Estimates of F reference points made using data for different periods changed according to changes in the biological parameters of the cod population. Those estimated using data for the whole time-series are considerably lower. It was shown that data for the period 1982-2000 shows more clear dependence of recruitment on SSB. A $\mathbf{B}_{pa}$ equal to 350 000 tonnes was proposed using the stock recruitment plot for that period.

WD 5 (presented by Erik Berg). Reference points for Norwegian coastal cod were calculated. Fishing mortality reference points were obtained using the PA-software, while biomass reference points were based on SSB-recruitment plot. $\mathbf{F}_{lim}$ was set equal to median $\mathbf{F}_{loss}$ and $\mathbf{F}_{pa}$ was set to the 5th percentile of $\mathbf{F}_{loss}$. This gave $\mathbf{F}_{lim} = 0.51$ and $\mathbf{F}_{pa} = 0.35$. Although there are relative few points in the SSB-recruitment plot, the recruitment seems to be impaired at SSBs below 100,000 t. The recruitment from SSBs above 130,000 t. is at an average level. $\mathbf{B}_{lim}$ and $\mathbf{B}_{pa}$ were therefore set to 100,000 t and 130,000 t, respectively.

WD6 (presented by A. Filin) presents a model aimed at evaluation of feeding, growth and maturity rate of the Barents Sea cod on the basis of food supply and water temperature data. For the model tuning data for 1984-1998 were used. The general results of simulation suggest that the growth rate of cod in the Barents Sea depends more on temperature than on feeding. Conversely, the diet composition, and consequently the consumption of prey by cod, depends mostly on food supply and it's composition. In particular, the simulations adequately depict the dependence of cod cannibalism on the capelin stock.

WD 7 (presented by V. Tretyak) shows that it is expedient to base estimation of reference points for NEA cod on the period after 1975. An attempt is made to estimate possible $\mathbf{B}_{pa}$ with the account for early and late maturing cod and variation in the cod natural mortality rates by years and ages.

WD 8 (presented by Yu. Lepesevich) shows that the currently applied method to estimate a proportion of mature haddock in the stock has some serious shortcomings. To a high degree the maturity ogives used by the AFWG depend on seasonal and temporal peculiarities of data sampling and do not reflect the true maturity rates. Based on the long-term mean percentage of age samples collected during different seasons and in various areas of the sea a new method to determine maturity ogives is proposed.

WD 10 (presented by B. Bogstad) – The biomass of capelin in 2002 is predicted based on surveys in 2001 and assumptions (mostly status quo) about mortality, maturation and growth. A slight decrease from 3.6 million tonnes in 2001 to 3.4 million tonnes in 2002 is predicted. The prediction may be utilised when predicting cod growth and cannibalism.

WD 11 (presented by Yu. Kovalev) - An increase in blue whiting stock biomass in the Barents Sea from $110x10^3$t in 1998 to $875x10^3$t in 2001 has been observed. The analysis of its feeding and distribution suggest that blue whiting predation will not have a significant impact on the recruitment of cod and other commercial fishes (haddock and redfishes). Increased competition between blue whiting and juvenile commercial fishes grazing on zooplankton is possible. In addition increased predation by blue whiting and pelagic fishes such as capelin and polar cod may be expected.

WD13 (presented by A. Aglen) is a thesis by Gjert Dingsør, dealing with methods for estimating discards of cod in the fisheries for the time-series since 1946. Three main approaches were used; 1): -assuming that one of the fleets had no discards and scale relative to that fleet the reported landings by age in other fleets, to obtain estimates by age in the "real" catch, 2): -take account of the actual mesh size used for each fleet over the history and apply theoretical selection curves on the length distribution of the stock derived from the historic VPA stock and 3): –apply theoretical selection curves on the length distribution of the stock based on the length distribution in scientific surveys. Some results are presented in Figure 3 and Table 3 of the Working Document. High discard rates were estimated (mainly age 3), particularly in the early years when small mesh sizes were applied. The WD also indicates the effect of using estimated discards in a VPA. Some increase in number of recruits is observed, while the impact on the stock recruitment plot was

minor. The WG felt a need for further studying the methods applied before such estimates could be used in the assessment.

WD14 (presented by K. Nedreaas) presents the results from interviewing 37 vessels/skippers/crew about misreporting of groundfish catches in the Northeast Arctic provided by the fishermen. All the interviewees had knowledge of irregular catch reporting, and 16 (43%) of them admitted that they had been involved in such activities. The different ways of cheating were misreporting by species, fishing other vessels quotas, misreporting by length and/or weight and misreporting by area (from 62°N to south of 62°N). The investigation concludes that landing figures for cod and saithe for the coastal gillnetters should be increased by respectively 8-12% and 20% for 1999 and 2000, for the area north of 62°N.

WD 15 (presented by K. Nedreaas) describes an analysis where Northeast Arctic cod parallel readings of otoliths have been used to estimate the precision in age determination within IMR. The observed ages seem to be quite precise, with a somewhat decrease in precision for increasing age. However, it is known that even a small probability of misclassification may give rise to a substantial bias and increase in variation in a final estimate of an age structure based on error prone age determination, and further analysis of aging error for Northeast Arctic cod is required.

WD 16 (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 percentage age readings showing a different result has decreased from about 30% in 1992 to less than 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. 3%. A similar positive development is also seen for haddock age readings. Differences in age reading may also cause different mean-weight-at-age. Based on the comparative age readings in 2000, consequences for mean-weight-at-age are shown.

WD 17 (presented by S. Mehl) gives the time-series of Russian trawl CPUE-indices for NEA cod. High CPUE-values coincide with high abundance of 4-6 years olds and low CPUE-values appear in years when the stock biomass of these age groups has been low; i.e. the years 1971-1972 and 1981-1983 when stock biomasses of 4-6 years old were between 300 and 400 thousand tonnes. CPUE-values in recent years, 1999-2000 are at the same level as in 1971-1972 and 1981-1983, while estimated stock biomasses of 4-6 years old cod in 2000 in the 2001 assessment was 750 thousand tonnes and thus considerably higher than indicated by the CPUE-series. Was the stock biomass of 4-6 year old cod overestimated by the 2001 assessment of the Working Group?

WD 18 (presented by S. Mehl) shows that the Working Group has underestimated the fishing mortality (F_{5-10}) almost every year during the past 20 years for NEA cod. The mean F_{5-10} for a given year tends to increase year by year in successive assessments and it stabilizes after 4-5 years when the XSA is converged. The associated estimated current stock numbers have been too high and thus subject to reductions in later years assessments. Korsbrekke *et al.* (2001) estimated stock numbers directly from the Norwegian swept area survey indices by carrying out linear regressions of converged VPA numbers at age on associated indices and estimated current and most recent years stock numbers by using the calibrations on current and most recent years indices. The stock numbers they arrived at by this procedure were considerably closer to the converged XSA figures than were the annually estimated numbers generated by the tuning procedure. However, large intercepts resulting from this calibration indicated substantial stock numbers of fish for zero values of swept area indices. Nakken and Pennington (WD 17, 2001) excluded low survey indices from the calibration and forced the regression line through origin. The stock numbers arrived at by this method are even closer to the converged XSA figures.

WD 34 (presented by V. Tretyak) makes a proposal on a method to estimate $\mathbf{F}_{lim}$ and $\mathbf{B}_{lim}$ with the account for early and late maturing cod. The estimation is based on mean values of biological characteristics of the cod population for 1976-1997 calculated by AFWG in 2001. Cannibalism is not taken into account.

Time of Next Meeting

The Working Group proposes the dates of May 5 - 14 2003 for it's next meeting.

1 ECOLOGICAL CONSIDERATIONS IN THE BARENTS SEA

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 the whole decade was warm; it was only the third warmest decade in the 20th century (Ingvaldsen *et al.* 2002).

In the first half of 2001, the temperature in the Atlantic water in the western and central areas of the Barents Sea was 0.6° - 0.8°C higher than the long-term average (Figure 1.1). This was also somewhat higher than the year before. The temperature decreased during summer, and in late August the temperature was only 0.1°C higher than the long-term mean. In January 2002, the conditions were exactly the same, which means that we had the lowest January temperature since 1997 (Anon. 2002).

During the first half of 2001 the temperature in the eastern Barents Sea was 0.7-0.8°C above the long-term average, while in the second half of the year, the temperature was less than 0.5°C above the average. It is expected that the temperature in the eastern Barents Sea will continue to decrease in 2002 because of decreasing temperature in the western 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. During the winter of 2001 there was slightly more ice than the year before, but the ice melt during summer was extremely high. The winter of 2002 will have more ice than 2001 since the water temperature is expected to decrease in the Barents Sea in 2002.

Conclusions:

- 2001 was warmer than average, especially in the eastern Barents Sea. There was a clear signal of decreasing temperature during fall.

- The temperature in 2002 is expected to be lower than in 2001, and will be close to the long-term mean in most of the Barents Sea.

1.2 Predicting Barents Sea temperature

Prediction of Barents Sea temperature is complicated by the variation being governed by processes of both external and local origin that operate on different time scales (Loeng *et al*, WD 1). 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 2002 allow for a six-month forecast for August 2002. The value for February 2002 of 3.6 ºC is inserted into the equation $T_{August} = 2.37 + 0.67* T_{February}$, statistically derived from data for the years 1921-1997 (Loeng *et al*, WD 1). This gives an objective temperature forecast for August 2002 of 4.8 ºC. This will be slightly above the 1921-1999 mean of 4.67 ºC. We conclude that summer sea temperatures in the southern Barents Sea are expected to lie around, or marginally above 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 Anon. (2002) indicate a decrease in Barents Sea temperatures towards a minimum in 2002-2003, followed by temperatures around or below the long-term mean. A Russian prognosis (V. K. Ozhigin, PINRO, Murmansk, pers. comm.) to 2006 shows much the same development, but with a minimum in 2003, a year later than

that of Anon. (2002). However, the 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 Anon. (2002). With this in mind these predictions should be treated with caution.

Conclusions:

- Summer sea temperatures in the southern Barents Sea in 2002 are predicted to lie around, or marginally above the long-term mean.

- A relatively uncertain long-term prediction indicates that the temperature will decrease for another 1-2 years.

1.3 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 spring 2001, the net inflow was much lower than earlier years. Results from a wind driven model shows similar results. The inflow during the first four months were stronger than average, while the model gave reduced inflow during late spring and summer. The reduced inflow in the period May-August may explain the westerly distribution of 0-group fish in the Barents Sea during the 0-group survey in August/September 2001 (Fossum *et al.* 2002).

Conclusion:

- The inflow of Atlantic water was lower in 2001 than observed earlier. This may explain westerly distribution of 0-group fish in 2001.

1.4 Zooplankton

The standing stock of zooplankton has been monitored in the Barents Sea from the early eighties 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.

The mean biomass (gm^{-2}) values from 1988 to present are estimated for the 7 different areas in the Barents Sea. There is a marked increase in zooplankton biomass during the period 1991-94. The highest biomass values were observed in 1994 when the capelin stock was at an extremely low level. Though the biomass has decreased since 1994 to present, the average biomass values during 1995 to 2001 are still higher than in the 1988-1992 period. From 2000 to 2001 a slight decrease in biomass was observed in all areas.

Figure 1.2 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 1.2 indicating capelin to exercise strong feedback control on the system through its predation pressure on zooplankton.

Conclusion:

- Expected temperatures close to the long-term mean in 2002 together with an overwintering zooplankton biomass close to the average will create the basis for average zooplankton production and feeding conditions for capelin, and juvenile fish in the Barents Sea.

1.5 Prediction of fish recruitment

Predictions of the recruitment in fish stocks are essential for future harvesting of the fish stocks. Traditionally predictions 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 prognostic prediction.

Models (Loeng *et al*., WD 1), based on climate (e.g. NAO winter index and skin temperature in the Barents Sea) and fish parameters (e.g. SSB from VPA, maturing biomass, 0-group index), for prediction of recruitment have been given for 0-group index (with 2-year prognoses) and the number of three-year-old-fish for North East Arctic Cod (with 3-year prognoses) and for the number of one-year-old fish for Barents Sea Capelin (with one-year prognoses) (Table 1.1).

The models are novice, and are still under evaluation in search for better fit. However, the fit of the model are encouraging, and the models might at present prove useful as background information in stock assessment.

Other models that include ecological factors in the traditional Ricker's stock-recruitment relationship are also under development (Borisov and Bulgakova, WD2). These models include indices for egg abundance per SSB-unit and for Atlantic inflow to the Barents Sea. The models give a good approximation of recruitment time series up to date, and will be developed to prediction models in the near future.

The predictions for the 1999 year class at age 3 (480 million individuals) is not supported by observations from the joint Norwegian-Russian survey at age 1-3, where this year class is found to be poor, while the Russian survey indicated this year class to be close to average (Section 3.3.6).

Conclusions:

- The 0-group index of North East Arctic cod is expected to be at a medium level in 2002 and decrease in 2003.
- The number of recruits (age 3) of North East Arctic cod is expected to be at a medium level in 2003, followed by a decrease in 2004.
- The number of recruits of Barents Sea capelin is expected to be at a medium level in 2002.

1.6 Prognosis for development of the Barents Sea capelin stock

A recovery of the Barents Sea capelin stock from its very low levels during 1994-1996 is evident, and the stock decreased somewhat from 2000 to 2001 due to the weak 2000 year class entering the stock.

The individual size-at-age of capelin has been large during recent years, but is now showing a decreasing trend. Adding the prognoses of the 1998-2001 year classes (Gjøsæter, WD10) yields a total biomass of age 1 and older fish of about 3.4 million tonnes by autumn 2002, which is at the same level as the stock size measured during autumn 2001. The observed biomass in 2001 of 3.6 million tonnes is close to the prediction made last year (4.1 million tonnes) using the same method.

Conclusion:

- A slight decrease in the capelin biomass is expected in 2002.

1.7 Consumption by cod, saithe, blue whiting, harp seals and minke whales

Bogstad *et al.* (2000) reviewed the consumption of fish in the Barents Sea by various predators. The three most important predator species are cod, harp seal and minke whale. The consumption by cod of various prey species for the period 1984-2001 is given in Table 1.3, using the same method as described by Bogstad and Mehl (1997). The changes in the diet of cod from 2000 to 2001 were moderate. The consumption of shrimp decreased by about 40%, while the consumption of blue whiting increased to 159 000 tonnes, the highest value in the 18-year time series. There was also some decrease in the consumption of capelin by cod. 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 9, Table 1.4) also calculated the consumption by cod based on the same data. The results from the two calculation methods for 2001 are fairly similar, although there are notable differences in the number at age of cod and haddock consumed by cod. It is important to agree on a joint methodology for consumption calculations. The annual consumption per age group of cod (kg/year), based on the consumption calculations shown in Table 1.3, is given in Table 1.5. The consumption per cod has been fairly stable for all age groups in the period 1999-2001.

Dolgov *et al*. (WD 11) 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 (WD 12). The diet of saithe > 40 cm is dominated by capelin, with herring and euphausiids being next in order of importance. For saithe < 40cm, the diet is dominated by euphausiids. In some areas and time periods there are significant amounts of blue whiting and haddock juveniles.

The consumption by minke whale (Folkow *et al.* 2000) and by harp seal (Nilssen *et al.* 2000) is given in Table 1.6. 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 (640-118 000 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 and 74 000t, corresponding to 14.6 and 2.8×10^9 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.

According to Bogstad *et al.* (2000), the total consumption of capelin by these three predators is higher than both the acoustic abundance estimates of capelin and the calculated MOB (M-output-biomass, i.e. the biomass output through natural mortality, see (Gjøsæter 1997)) in several of the years with low capelin abundance. However, the total consumption of herring by the three main predators is much lower than the MOB (based on M=0.9 on ages 1 and 2) in those years. These discrepancies merit consideration in the assessment of the capelin and herring stocks in the Barents Sea.

The consumption estimates in Table 1.3 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).

Conclusion:

- The changes in the diet of cod from 2000 to 2001 were moderate. The consumption of shrimp decreased by about 40%, while the consumption of blue whiting increased to 159 000 tonnes, the highest value in the 18-year time series. There was also some decrease in the consumption of capelin by cod.

Table 1.1 Overview of the different models, with prognoses estimates of the variable in question. The given month indicate when the prognoses can be extended for another year.

Species	Variable	Prognoses year	Prognoses available	2002 Prognoses	2003 Prognoses	2004 Prognoses
North East Arctic cod	0-group, log (0 year olds)	2	April	1.3	0.6	X
North East Arctic cod	Recruits (3 year olds, million)	4	April	480	500	280
Barents Sea capelin	Recruits (1 year olds, billion)	1	September	206	X	X

Table 1.2 Prognosis for the development of the stock biomass of capelin in 2002 is given in the text table below, together with the stock history from 1984. 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 kilotonnes (Oct. 1)	M output biomass during year (kilotonnes)
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	2067
2000	595	4373	2516
2001	364	3630	4520
2002*	253	3365	2460

- Estimate, includes the 2001 year class, which size is estimated from a regression on an 0-group index

Table 1.3 Consumption by Northeast Arctic cod (thousand tonnes*)*

Year	Other	Amphipods	Krill	Shrimp	Capelin	Herring	Polar cod	Cod	Haddock	Redfish	G. halibut	Blue whiting	Total
1984	501	27	112	431	713	77	15	21	50	359	0	0	2306
1985	1148	169	58	154	1602	181	3	31	47	222	0	1	3616
1986	658	1212	107	141	828	132	140	81	109	310	0	0	3718
1987	674	1075	67	189	227	32	203	25	4	319	1	0	2816
1988	403	1226	314	128	336	8	91	9	3	221	0	4	2742
1989	719	794	239	131	575	3	32	8	10	230	0	0	2742
1990	1433	135	82	192	1578	7	6	19	15	240	0	85	3792
1991	1065	65	75	186	2870	8	12	26	20	309	7	10	4652
1992	1003	101	155	369	2428	328	96	54	105	187	19	2	4847
1993	774	250	702	312	3010	162	275	282	71	99	2	2	5940
1994	669	564	705	518	1086	147	581	225	49	79	0	1	4623
1995	853	979	514	362	629	116	254	392	116	194	1	0	4410
1996	640	633	1162	341	537	47	104	534	68	96	0	10	4173
1997	433	389	522	313	905	5	113	341	41	36	0	56	3154
1998	449	363	466	331	746	92	149	173	34	11	0	15	2828
1999	395	144	278	251	1715	133	217	71	26	19	1	32	3284
2000	375	152	301	407	1619	51	181	74	49	7	0	35	3251
2001	565	151	362	233	1354	57	188	47	77	4	0	159	3188

Table 1.4 Consumption by Northeast Arctic cod, thousand tonnes (by A.V.Dolgov, WD#9).

	Euphausiids	Hyperiids	Shrimp	Herring	Capelin	Polar cod	Cod	Haddock	Redfish	Long rough dab	Greenland halibut	Other fish	Other food	Total food biomass
1984	50.2	16.7	319.4	44.0	627.9	12.4	18.1	55.3	199.3	43.1	0.0	69.5	262.7	1718.8
1985	18.9	245.1	197.3	38.5	1329.4	0.0	39.4	47.1	202.6	29.3	0.0	124.4	208.2	2480.2
1986	49.8	530.8	124.4	57.0	925.2	143.4	49.2	35.2	121.2	31.4	0.0	112.2	694.0	2874.0
1987	50.6	308.5	190.1	17.9	243.4	80.8	44.5	3.8	161.6	144.5	0.0	145.5	330.7	1721.9
1988	138.4	100.6	104.9	15.3	273.4	0.0	15.7	108.5	105.6	21.6	0.0	225.7	375.1	1485.0
1989	120.7	191.1	90.6	2.5	726.1	22.5	21.2	2.8	135.4	56.1	0.0	112.5	368.9	1850.3
1990	37.9	21.1	171.4	39.8	999.0	10.6	63.0	14.0	170.7	99.5	0.0	206.2	361.4	2194.7
1991	45.2	20.5	85.8	15.8	3454.8	8.1	110.6	26.6	125.7	60.3	0.0	172.6	566.1	4692.0
1992	137.0	19.8	215.8	365.9	1832.9	102.1	72.4	40.2	87.6	47.9	0.0	265.0	550.9	3737.4
1993	40.1	95.1	157.6	190.7	2777.6	99.8	139.1	166.2	29.5	50.8	5.0	168.5	741.7	4661.7
1994	484.2	90.7	457.4	127.9	1585.3	287.7	290.8	98.7	17.7	41.5	0.0	42.6	715.7	4240.2
1995	846.7	270.9	417.3	203.8	755.1	96.1	493.4	139.5	124.9	75.8	0.4	68.8	774.6	4267.5
1996	784.4	232.8	177.0	127.7	589.4	54.7	497.4	91.2	72.6	63.8	0.2	328.3	484.9	3504.3
1997	417.2	88.6	237.6	78.5	695.7	87.6	438.1	41.6	40.0	34.8	5.2	89.0	470.3	2724.2
1998	424.4	136.2	249.3	85.1	789.9	83.9	186.6	31.3	23.0	39.9	0.0	82.1	520.7	2652.4
1999	558.4	56.0	242.3	79.4	1587.9	106.7	72.9	16.2	14.5	17.0	0.9	102.4	218.8	3073.3
2000	541.4	84.9	349.3	58.5	1745.4	99.2	78.8	30.0	4.6	38.0	0.2	70.5	359.6	3460.2
2001	365.7	40.9	263.7	98.3	1336.8	63.6	48.3	55.6	2.4	57.0	2.8	403.5	635.3	3373.9
Mean	284.0	141.7	225.1	91.5	1237.5	75.5	148.9	55.8	91.1	52.9	0.8	155.0	480.0	3039.6

Table 1.5 **Total 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	2.184	3.556	5.342	7.095	9.469	10.237	11.291	12.337	11.981
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	11.959
1994	0.130	0.407	0.922	2.520	3.512	4.540	6.412	8.923	9.731	10.038	10.238
1995	0.103	0.297	0.922	1.802	3.362	5.272	7.734	10.459	12.411	12.816	13.263
1996	0.108	0.355	0.931	1.849	3.055	4.437	7.426	11.255	15.010	15.207	15.585
1997	0.138	0.311	0.935	1.768	2.694	3.539	5.242	8.222	12.757	13.667	13.279
1998	0.117	0.398	0.985	1.940	2.924	4.189	5.749	8.078	11.573	12.099	12.147
1999	0.163	0.505	1.093	2.717	3.721	5.162	6.987	9.125	11.234	12.079	12.128
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	0.430	1.076	2.276	3.747	6.220	7.221	11.008	12.304	13.266	13.423

Table 1.6 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

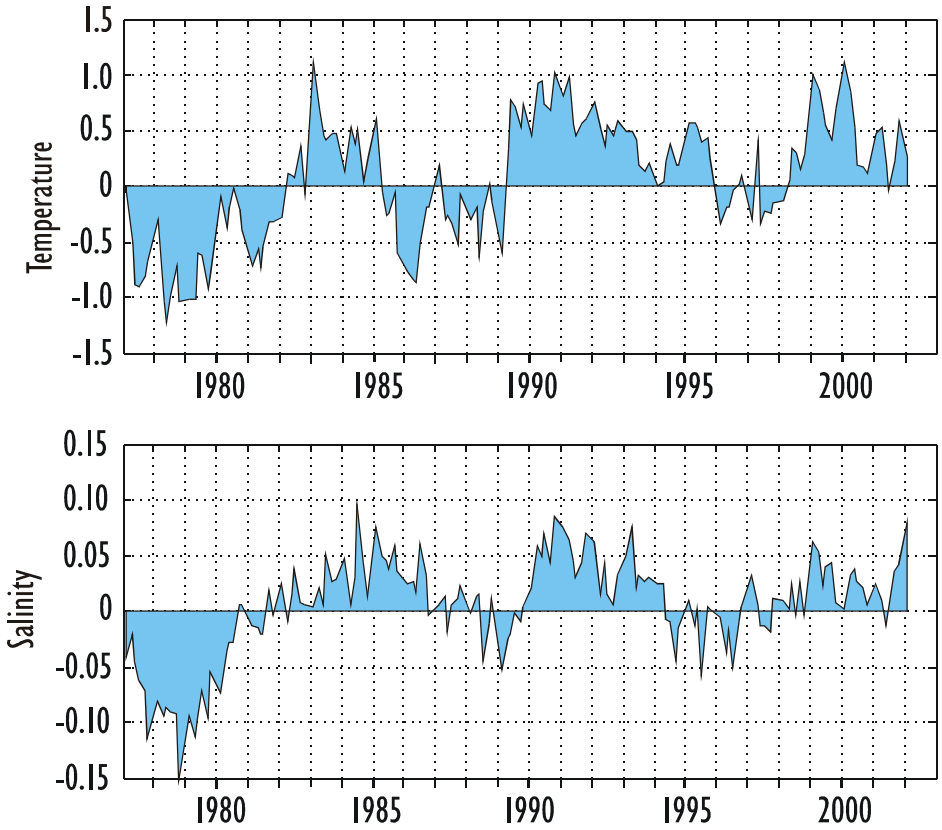

Figure 1.1 Temperature anomalies (upper panel) and salinity anomalies (lower panel) in the section Fugløya – Bear Island (Anon., 2002).

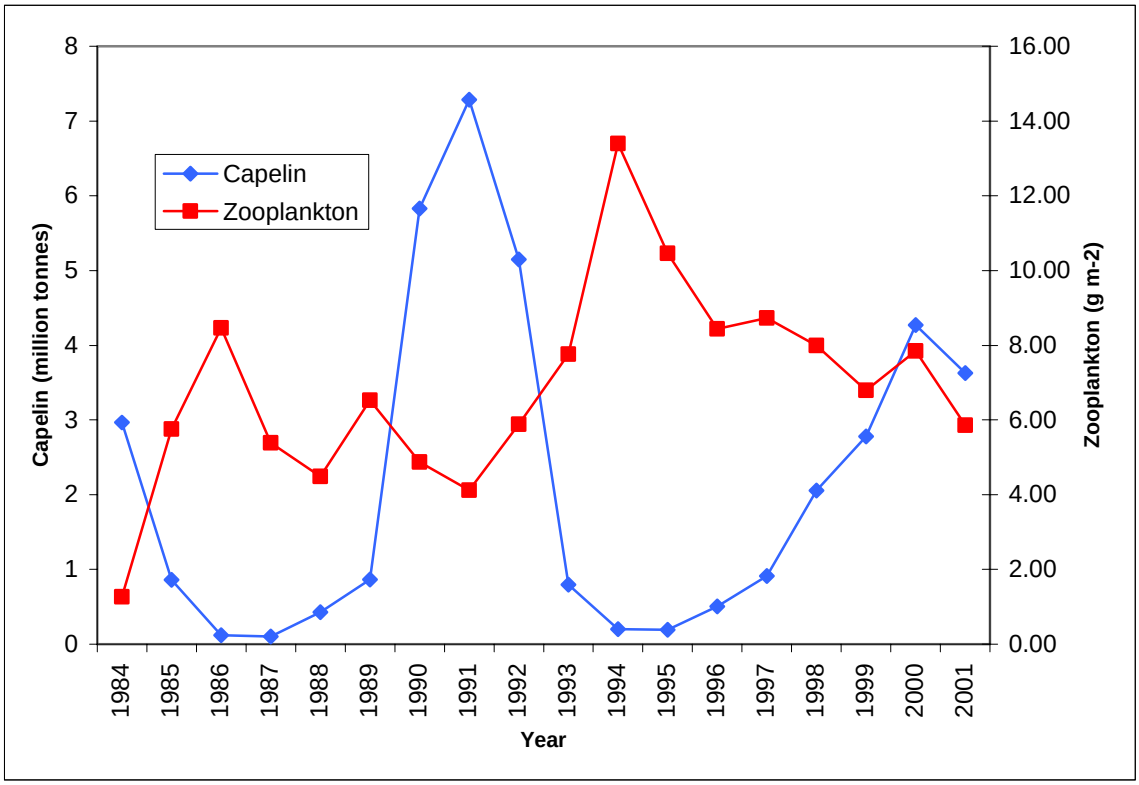

Figure 1.2 Average zooplankton biomass (g m^{-2}) together with biomass of one year and older capelin (million tonnes) during 1973 – 2001, in the Barents Sea (capelin data from Gjøsæter *et al.* (2000) updated to 2001). (Dalpadado *et al.* 2002)

2 NORWEGIAN COASTAL COD IN SUB-AREAS I AND II

2.1 Status of the Fisheries

2.1.1 Historical development of the fisheries

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 still uncertain. 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 coastal cod stock (in the frame of ICES) separately from NEA cod. The WG noted that several investigations are presently in progress with the aim of defining stock structure of cod along the coast of Norway and Russia in relation to Northeast Arctic cod. The WG will re-visit the question of stock structure as results of these studies become available.

The fishery is conducted both with trawlers and with smaller coastal vessels using traditional fishing gears like gillnet, longline, jig and purse 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 Northeast Arctic cod (NEAC), maximum by-catch of undersized fish, closure of areas having high densities of juveniles, and by seasonal and area restrictions.

2.1.2 Landings prior to 2002 (Table 2.9, Figure 2.2)

From 1996, the Norwegian Institute of Fisheries and Aquaculture Ltd (Fiskeriforskning) has separated the catches into the two types 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 estimated landings of NCC in 2000 reported to the Working Group is 36,715 t and the provisional figure for 2001 is 29,699 t (Table 2.9, Figure 2.2).

2.1.3 Expected landings in 2002

The expected landings for 2002 is calculated from running a short-term prediction with F-factor=1 ($F_{status\ quo}$) in 2002 and assuming the same exploitation pattern as in the period 1998-2001 scaled to the 2001 level. The fishing mortality (F_{4-7}) for Norwegian coastal cod has been stabile in the period 1998-2001, and the agreed quota in 2002 for both Northeast Arctic cod and Norwegian coastal cod is equal to the quotas in 2001. Using this assumption the expected landings of NCC in 2002 is 26818 t.

2.2 Status of Research

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

A Norwegian trawl-acoustic survey was conducted along the coast from Varanger to Stadt in October-November 2000 using RV Jan Mayen. In 2001 the survey covered the same areas as the coastal surveys in 1995-2000.

The trawl-acoustic coastal survey in 2001 estimated a total survey biomass of NCC of about 54,000 t (49 million fish) for the coastal area from Varanger to Stadt at 62° N (Tables 2.1, 2.2, 2.7). The spawning biomass accounted for 23,000 t (6 million fish) of the total (Tables 2.3, 2.4). Thus, spawners make up about 43% of the total biomass. Seventy-five percent of the total coastal biomass was distributed from the Russian border to 67° N and 25% south of 67° 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° N) nearly all otoliths collected were of the NCC type, which is similar to the results of the 1995-2000 surveys (ICES 1996/ACFM:4; ICES 1997/ACFM:4; ICES 1998/ACFM:2; ICES 1999/ACFM:3; ICES 2000/ACFM:3; ICES 2001/ACFM:2).

The numbers of NCC per year class from all the coastal surveys is given in Table 2.7. The total numbers decreased in 2001 compared with the 2000 survey. For age groups 2 and older (except for the age group 9) the biomass and numbers decreased considerably from 2000 to 2001.

The Norwegian 2002 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. Co-operation should be established between the Fiskeriforskning in Tromsø, the Institute of Marine Research in Bergen, and PINRO in Murmansk regarding the otolith reading. Ongoing investigations on the genetic structure of cod along the Norwegian coast, the Murmansk coast, and in the White Sea will hopefully elucidate the stock structure of cod in these areas.

A total of 3183 cod otoliths were sampled during the 2001 survey. These were separated into NCC type (2189) and NEAC (994). As in previous years, NCC was found throughout the survey area. The 2001 survey data shows the same pattern as the 1995-2000 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 2.5)

The weight-at-age (weighted average) from the trawl-acoustic survey in 2001 was at the same level as in 2000 for ages younger than 5 years. The differences in weight-at-age between 2000 and 2001 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 2.5). The same tendency was found for the surveys in 1995-2000.

2.2.4 Maturity-at-age (Table 2.6)

The maturity-at-age is estimated from the data collected at the Norwegian coastal survey. This is not an optimal way to do it because the survey is conducted in the late autumn when the stage at the maturity scale can be hard to define. Further improvement of maturity ogives is recommended. The age at 50% maturity (M_{50}) for the NCC was estimated to be between 5 and 6 years on average for the surveyed area in 2001 (Table 2.6). There are some variations between the different areas. The 2001 data show that the average M_{50} has slightly decreased compared with that found in the 2000 survey (ICES 2001/ACFM:19). 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)

A detailed breakdown of the Norwegian catches of cod for the period 1984 to 2001 has been done to form the basis of a VPA. This was carried out by analysing Norwegian landings of cod by vessel size, area caught, and time of the year of capture as given by the Norwegian Directorate for Fisheries. Cod samplings from commercial catches done by the Institute of Marine Research, Bergen were used to separate NCC and NEAC by otolith type.

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 the 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.

This new method of splitting the catches between NCC and NEAC is described in a working document submitted to AFWG in 1998 (Berg *et al*. 1998).

The catch-at-age (0-10+) for the period 1984-2001 is given in Table 2.9.

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. Weight-at-age in the stock from 1984-1994 was set as an average of weight-at-age from the coastal survey 1995-1996. This was done because no survey data from this period are available. Since the numbers used to calculate the weight-at-age for cod older than 7 years from the 2001 survey were low, the weight-at-age in the stock for these ages were recalculated as an average of 1998-2000.

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-at-age data from 1995-2001 are obtained from the Norwegian coastal survey. In the period from 1984-1994 no maturity-at-age data are available. The maturity-at-age values for these years were calculated using an average of the data from the coastal survey 1995-1999. The maturity ogives increased from the 1999 survey to the 2000 survey by approximately half a year. Such an increase in only one year is rather unlikely. Therefore, the maturity ogive in 2000 was set as an average of 1995-1999. The maturity ogive in 2001 is obtained from the survey data and the trend goes towards higher age at maturation. The proportion mature-at-age is given in Table 2.12.

2.3.5 Tuning data (Table 2.7)

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).

2.3.6 Prediction data (Table 2.20)

The input data to the short-term prediction with management option table (2002-2004) are given in Table 2.20. For 2002-2004 the weight in stock, weight in catch, and maturity-at-age were set to an average of 1999-2001. The recruitment in 2002, 2003, and 2004 was set to the same level as in 2001. 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 1999 to 2001 scaled to the fishing mortality (age 4-7) in 2001.

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 independent of stock size dependent for all ages and independent of age 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).

2.4.2 Recruitment

The only recruitment indices (<2 year) available for this stock is the trawl acoustic estimate from the Norwegian coastal survey. However, the abundance of cod less than 25 cm is difficult to estimate from a trawl acoustic survey because this length group tends to inhabit shallow water close to the shore where trawling is impossible. Therefore the estimates are rather uncertain.

2.5 Results of the Assessment

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

The average age 4-7 fishing mortality in 2001 was estimated to be 0.48 (Table 2.13). The highest fishing mortalities estimated for these age groups were from 1984-1988 (0.49-0.62). In 1990 and 1991 the lowest F-values were estimated (0.18 and 0.17). However, the fishing mortality has increased steadily from 1991 to 1998, and has since been at a level of about 0.46-0.48. The total biomass of the stock in the period from 1984-2001 has been between 102,000 t and 310,000 t (Tables 2.17, 2.19). At the end of 2001 the biomass was estimated to be the lowest observed and less than half the biomass estimated five years ago in 1996. The spawning stock biomass has been between 57,000 t and 184,000 t (Tables 2.18, 2.19, Figure 2.2). As for the total stock biomass, the lowest observed SSB was estimated in 2001. The SSB has declined steadily from 1994 to present. The SSB in 2001 was only less than half of the average in the period 1984-1999 and was reduced by 16% from 2000 to 2001.

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)

Both the survey estimates of abundance in 2001 (ages 1-4, Table 2.7) and the XSA-estimate (ages 2 and 3, Tables 2.15, 2.19) indicate lower-than-average year classes from 1996-2000. The 1999 year class is the lowest observed in the time-series. Since 1999 the SSB has decreased further, and the probability of weak year classes after 1999 is high.

2.6 Reference Points and Safe Biological Limits (Table 2.23)

No reference points have previously been calculated for NCC. Some members of AFWG consider that the question whether this part of the stock is independent of NEA cod is not clear yet and that the NEA cod substantially contribute to the recruitment of NCC; thus, the determination of reference points for NCC seems to be problematic. However, since it was an ACFM request, AFWG has made an attempt to estimate reference points for NCC.

$\mathbf{F}_{loss}$ was calculated using the PA-software where $\mathbf{F}_{lim}$ was set to $\mathbf{F}_{loss}$ (Table 2.23). The input data for stock number, natural mortality, catch weight, stock weight, and F-values were calculated using the whole time-series. The coefficient of variation for these parameters was also calculated using the whole time-series. The input data was then used in the PA-software as direct input from an excel file. $\mathbf{F}_{pa}$ was then obtained by $\mathbf{F}_{pa} = \mathbf{F}_{lim} * \exp(-1.645*\sigma)$, where σ was set to 0.3. The values estimated for $\mathbf{F}_{lim}$ and $\mathbf{F}_{pa}$ were respectively 0.44 and 0.27 (Table 2.23).

$\mathbf{B}_{lim}$ and $\mathbf{B}_{pa}$ were selected from the SSB-recruitment plot. Although the SSB-recruitment plot does not show a clear trend, both the recruitment and SSB are at present at the lowest observed level. The points below 100,000 t SSB are few. However, the two year classes produced by SSB below 100,000 t are the lowest observed in the time-series. Assuming the trend is real and recruitment is impaired at a SSB level below 100,000 t, $\mathbf{B}_{lim}$ was set to 100,000. Using the equation $\mathbf{B}_{pa} = \mathbf{B}_{lim} * \exp(1.645*\sigma)$, where $\sigma = 0.3$, gives a $\mathbf{B}_{pa}$ = 164,000 t.

The time-series is rather short and the reference points have to be recalculated when the time-series extends. However, the fishing mortality is at present above the calculated $\mathbf{F}_{lim}$ and both the SSB and the recruitment are at the lowest observed levels, and SSB is far below $\mathbf{B}_{lim}$.

Limit reference points	**Pa-reference points**
$\mathbf{B}_{lim}$ is 100.000 t	$\mathbf{B}_{pa}$ is 164.000 t.
$\mathbf{F}_{lim}$ is 0.44	$\mathbf{F}_{pa}$ is set at 0.27.
Technical basis	**Technical basis**
$\mathbf{B}_{lim}$ = examination of stock-recruit plot	($\mathbf{B}_{pa} = \mathbf{B}_{lim}$ x exp (1.645 x σ) where $\sigma = 0.3$) = $\mathbf{B}_{lim}$ x 1.64
$\mathbf{F}_{lim}$ = Deterministic value of $\mathbf{F}_{loss}$	$\mathbf{F}_{pa} = \mathbf{F}_{lim}$ x exp (-1.645 x σ) where $\sigma = 0.3$)$_s$ = $\mathbf{F}_{lim}$ x 0.61

2.7 Catch Options for 2003 and Management Scenarios (Tables 2.21-2.22, Figure 2.2)

The total stock biomass and the SSB were further reduced during 2001 (90,000 t and 54,000 t). The management option table (2.21) shows that the expected catch of 26,818 t in 2002 will give an unchanged fishing mortality (F_{2002}=0.48). The total stock biomass and the SSB will however be further reduced (74,000 t and 45,000 t). The *status quo* catch in 2003 (F_{2001}) is 22,000 t, and leads to a further decrease of the total stock biomass (62,000 t) and the SSB (36,000 t) at

the beginning of 2004. The SSB will not be rebuilt to the 2000 level even if the fishing mortality is set to zero (Table 2.21). A catch of 5,000 t (F=0.10) brings the SSB up to the level in 2002 (Table 2.21, Figure 2.2). According to the suggested reference points the fishing mortality is at present above $\mathbf{F}_{lim}$ and the SSB below $\mathbf{B}_{lim}$.

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 1995-2001 show a declining stock. For ages 2-8 the survey indexes 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

Last year the catchability for age-2 was set to be dependent on stock size. In this years assessment the diagnostics from a run with all ages independent of stock size did not support the need for applying stock size dependent catchability for age-2. It was therefore decided to let catchability be independent for all ages. The diagnostics became better with the new setting.

The calculated fishing mortality F_{4-7} and SSB in 2000 are almost the same for last years assessment and this years assessment (F- 0.49, 0.48 SSB- 65.000 t, 67.000 t). The recruitment in 2000 is 30 % reduced in this years assessment (21.7 mill, 14.6 mill). The change in catchability dependent on stock for age-2 causes most of the difference in recruitment. This is also more in accordance with the survey data.

Assessment year	F_{4-7} year 2000	SSB year 2000	Total stock biomass	Recruits age 2 year 2000
2001	0.49	65	121	22
2002	0.48	67	121	15

Table 2.1 Estimated survey number (x1000) of Norwegian Coastal cod at age from the Norwegian coastal survey during the autumn 2001.

	Age											
Area	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10+**	**Total**
03 East Finnmark	9026	6431	1510	1633	1214	815	469	264	95	43	4	**21504**
04 West Finnmark/Tromsø	253	1359	3044	2929	2594	1014	919	832	105	140	109	**13299**
05 Lofoten/Vesterålen	14	377	809	1122	682	772	358	79	14	7	3	**4237**
00 Vestfjord		137	335	1245	859	672	626	46				**3921**
06 Nordland		61	794	810	1927	1205	193	272	183			**5446**
07 Møre			237	254	302	273			90			**1155**
Total	**9292**	**8366**	**6729**	**7994**	**7578**	**4751**	**2567**	**1493**	**487**	**189**	**116**	**49562**

Table 2.2 Estimated survey biomass (tonnes) of Norwegian Coastal cod at age from the Norwegian coastal survey during the autumn 2001.

	Age											
Area	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10+**	**Total**
03 East Finnmark	62	229	491	1485	1787	1704	1059	562	339	493	33	**8246**
04 West Finnmark/Troms	2	132	1244	2766	4372	2388	2343	2720	527	1166	1843	**19504**
05 Lofoten/Vesterålen	1	42	407	1113	991	1791	1314	415	78	45	41	**6238**
00 Vestfjord		13	120	1299	1448	1854	2993	450				**8177**
06 Nordland		9	281	682	2294	2227	812	1369	1257			**8931**
07 Møre			119	379	656	1028			810			**2991**
Total	**65**	**425**	**2662**	**7724**	**11548**	**10993**	**8521**	**5517**	**3010**	**1705**	**1917**	**54087**

Table 2.3 Estimated survey spawning stock number (x1000) of Norwegian Coastal cod at age from the Norwegian coastal survey during the autumn 2001.

	Age											
Area	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10+**	**Total**
03 East Finnmark	0	0	0	16	12	163	329	251	88	38	4	**901**
04 West Finnmark/Troms	0	0	0	0	182	345	772	807	104	140	109	**2459**
05 Lofoten/Vesterålen	0	0	0	0	0	224	294	77	14	7	3	**619**
00 Vestfjord	0	0	0	0	0	175	457	46	0	0	0	**678**
06 Nordland	0	0	0	0	0	759	164	272	183	0	0	**1378**
07 Møre	0	0	0	0	85	145	0	0	90	0	0	**320**
Total	**0**	**0**	**0**	**16**	**279**	**1811**	**2016**	**1453**	**479**	**185**	**116**	**6355**

Table 2.4 Estimated survey spawning stock biomass (tonnes) of Norwegian Coastal cod at age from the Norwegian coastal survey during the autumn 2001.

	Age											
Area	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10+**	**Total**
03 East Finnmark	0	0	0	15	18	341	742	534	312	439	33	**2434**
04 West Finnmark/Troms	0	0	0	0	306	812	1968	2638	521	1166	1843	**9254**
05 Lofoten/Vesterålen	0	0	0	0	0	519	1077	407	78	45	41	**2167**
00 Vestfjord	0	0	0	0	0	482	2185	450	0	0	0	**3117**
06 Nordland	0	0	0	0	0	1403	690	1369	1257	0	0	**4719**
07 Møre	0	0	0	0	184	545	0	0	810	0	0	**1539**
Total	**0**	**0**	**0**	**15**	**508**	**4102**	**6662**	**5398**	**2978**	**1650**	**1917**	**23230**

Table 2.5 Weight (gram)-at-age (year) for Norwegian Coastal cod from the Norwegian coastal survey during the autumn 2001.

	Age										
Area	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10+**
03 East Finnmark	7	36	326	909	1471	2092	2257	2127	3555	11600	9355
04 West Finnmark/Troms	8	97	409	944	1686	2354	2549	3268	4995	8346	16885
05 Lofoten/Vesterålen	50	111	503	992	1453	2319	3666	5278	5725	6669	12059
00 Vestfjord		94	358	1043	1686	2758	4779	9849			
06-07 Nordland/Møre		142	388	996	1323	2202	4200	5034	7581		
Weighted average	7	51	396	966	1524	2314	3320	3695	6181	9017	16514

Table 2.6 Percent mature at age for Norwegian Coastal cod at age from the Norwegian coastal survey during the autumn 2001.

	Age										
Area	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10+**
03 East Finnmark	0	0	0	1	1	20	70	95	92	89	100
04 West Finnmark/Troms	0	0	0	0	7	34	84	97	99	100	100
05 Lofoten/Vesterålen	0	0	0	0	0	29	82	98	100	100	100
00 Vestfjord	0	0	0	0	0	26	73	100	100	100	100
06-07 Nordland/Møre	0	0	0	0	16	59	88	100	100	100	100
Weighted average	0	0	0	0	7	37	79	97	98	98	100

Table 2.7 Estimated survey numbers at age (x1000) of Norwegian Coastal cod from the coastal surveys from 1995-2001.

	Age											
YEAR	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

Table 2.8

```
Lowestoft VPA Version 3.1

   20/04/2002  17:09

 Extended Survivors Analysis

 Coastal cod (run: XSANCC20/X20)

 CPUE data from file fleet

 Catch data for  18 years. 1984 to 2001. Ages  2 to  10.

      Fleet,            First, Last, First, Last, Alpha,  Beta
                   ,     year, year,  age ,  age
 FLT04: Norw. Coast. ,    1995, 2001,   2,     9,   .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   57 iterations



 Regression weights
       ,  .921,  .954,  .976,  .990,  .997, 1.000, 1.000



 Fishing mortalities
    Age,  1995,  1996,  1997,  1998,  1999,  2000,  2001

      2,  .027,  .035,  .053,  .028,  .016,  .012,  .005
      3,  .051,  .105,  .133,  .153,  .087,  .079,  .048
      4,  .140,  .193,  .197,  .276,  .185,  .366,  .210
      5,  .259,  .489,  .270,  .414,  .424,  .514,  .577
      6,  .350,  .392,  .492,  .479,  .564,  .519,  .563
      7,  .521,  .483,  .685,  .658,  .754,  .460,  .576
      8,  .460,  .757,  .927,  .815,  .803,  .328,  .431
      9,  .349,  .580, 1.014,  .797, 1.056,  .307,  .318
```

Table 2.8 (continued)

XSA population numbers (Thousands)

	AGE							
YEAR ,	2,	3,	4,	5,	6,	7,	8,	9,
1995 ,	3.32E+04,	2.01E+04,	1.98E+04,	2.51E+04,	2.08E+04,	8.91E+03,	4.36E+03,	2.09E+03,
1996 ,	3.87E+04,	2.65E+04,	1.56E+04,	1.41E+04,	1.58E+04,	1.20E+04,	4.33E+03,	2.25E+03,
1997 ,	2.82E+04,	3.06E+04,	1.95E+04,	1.06E+04,	7.08E+03,	8.77E+03,	6.06E+03,	1.66E+03,
1998 ,	2.21E+04,	2.19E+04,	2.19E+04,	1.31E+04,	6.59E+03,	3.54E+03,	3.62E+03,	1.96E+03,
1999 ,	1.76E+04,	1.76E+04,	1.54E+04,	1.36E+04,	7.11E+03,	3.34E+03,	1.50E+03,	1.31E+03,
2000 ,	1.46E+04,	1.41E+04,	1.32E+04,	1.05E+04,	7.30E+03,	3.31E+03,	1.29E+03,	5.51E+02,
2001 ,	9.54E+03,	1.18E+04,	1.07E+04,	7.50E+03,	5.13E+03,	3.56E+03,	1.71E+03,	7.60E+02,

Estimated population abundance at 1st Jan 2002

, 0.00E+00, 7.77E+03, 9.23E+03, 7.10E+03, 3.45E+03, 2.39E+03, 1.64E+03, 9.10E+02,

Taper weighted geometric mean of the VPA populations:

, 2.75E+04, 2.51E+04, 2.12E+04, 1.60E+04, 1.05E+04, 6.27E+03, 3.02E+03, 1.37E+03,

Standard error of the weighted Log(VPA populations) :

, .5248, .4363, .4117, .4327, .4500, .4812, .5550, .6417,

Log catchability residuals.

Fleet : FLT04: Norw. Coast.

Age ,	1995,	1996,	1997,	1998,	1999,	2000,	2001
2 ,	-.04,	-.34,	.07,	-.02,	.01,	.21,	.09
3 ,	-.15,	.14,	.25,	-.06,	-.10,	.07,	-.15
4 ,	.02,	.06,	.18,	-.14,	-.13,	.05,	-.03
5 ,	-.23,	.27,	.37,	-.24,	-.30,	.14,	.00
6 ,	-.34,	-.38,	.95,	-.21,	-.24,	.28,	-.09
7 ,	-.08,	-.40,	.28,	.26,	-.23,	.02,	.13
8 ,	.09,	-.09,	.40,	-.74,	-.14,	.34,	.14
9 ,	.34,	-.72,	-2.30,	-.77,	-.57,	-.57,	-.09

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

Age ,	2,	3,	4,	5,	6,	7,	8,	9
Mean Log q,	-.2759,	-.0404,	.0177,	.1636,	.0060,	-.3786,	-.8891,	-.8891,
S.E(Log q),	.1690,	.1542,	.1141,	.2688,	.4742,	.2523,	.3866,	1.0951,

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,	1.32,	-2.161,	-2.78,	.91,	7,	.17,	-.28,
3,	.76,	2.004,	2.36,	.94,	7,	.10,	-.04,
4,	.99,	.034,	.05,	.83,	7,	.12,	.02,
5,	1.44,	-1.018,	-4.41,	.52,	7,	.39,	.16,
6,	1.62,	-.995,	-5.67,	.34,	7,	.77,	.01,
7,	1.17,	-.752,	-1.00,	.81,	7,	.31,	-.38,
8,	1.06,	-.213,	.44,	.70,	7,	.45,	-.89,
9,	1.30,	-.347,	-.16,	.21,	7,	1.16,	-1.56,

Table 2.8 (continued)

```
Terminal year survivor and F summaries :

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

Year class = 1999

Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
FLT04: Norw. Coast. ,      8510.,   .300,       .000,    .00,   1,  .917,     .005

  F shrinkage mean  ,      2833.,   1.00,,,,                         .083,     .014

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
     7768.,       .29,      .32,    2,   1.102,   .005


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

Year class = 1998

Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
FLT04: Norw. Coast. ,      9474.,   .212,       .180,    .85,   2,  .955,     .047

  F shrinkage mean  ,      5277.,   1.00,,,,                         .045,     .083

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
     9226.,       .21,      .15,    3,    .735,   .048


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

Year class = 1997

Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
FLT04: Norw. Coast. ,      7187.,   .173,       .029,    .17,   3,  .962,     .208

  F shrinkage mean  ,      5210.,   1.00,,,,                         .038,     .277

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
     7100.,       .17,      .04,    4,    .252,   .210


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

Year class = 1996

Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
FLT04: Norw. Coast. ,      3399.,   .154,       .029,    .19,   4,  .948,     .583

  F shrinkage mean  ,      4452.,   1.00,,,,                         .052,     .473

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
     3447.,       .15,      .04,    5,    .255,   .577
```

Table 2.8 (continued)

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

Year class = 1995

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, Scaled, Weights,	Estimated F
FLT04: Norw. Coast. ,	2382.,	.151,	.053,	.35,	5, .935,	.565
F shrinkage mean ,	2490.,	1.00,,,,			.065,	.546

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
2389.,	.16,	.05,	6,	.296,	.563

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

Year class = 1994

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, Scaled, Weights,	Estimated F
FLT04: Norw. Coast. ,	1646.,	.154,	.099,	.65,	6, .937,	.574
F shrinkage mean ,	1509.,	1.00,,,,			.063,	.612

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
1637.,	.16,	.09,	7,	.561,	.576

Age 8 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
FLT04: Norw. Coast. ,	932.,	.156,	.057,	.37,	7, .936,	.423
F shrinkage mean ,	638.,	1.00,,,,			.064,	.570

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
910.,	.16,	.06,	8,	.393,	.431

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

Year class = 1992

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, Scaled, Weights,	Estimated F
FLT04: Norw. Coast. ,	483.,	.173,	.106,	.61,	7, .910,	.300
F shrinkage mean ,	236.,	1.00,,,,			.090,	.541

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
453.,	.18,	.12,	8,	.683,	.318

Table 2.9

Run title : Coastal cod (run: XSANCC20/X20)

At 20/04/2002 17:10

Table 1 Catch numbers at age								Numbers*10**-3
YEAR,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,
AGE								
2,	829,	396,	4095,	170,	110,	41,	7,	125,
3,	3478,	7848,	4095,	940,	1921,	1159,	349,	607,
4,	6954,	7367,	12662,	8236,	3343,	1434,	1233,	1452,
5,	7278,	8699,	8906,	12430,	6451,	2299,	1330,	3114,
6,	6004,	7085,	5750,	4427,	6626,	5197,	1129,	1873,
7,	4964,	3066,	3868,	2649,	4687,	2720,	3456,	1297,
8,	2161,	705,	1270,	1127,	1461,	949,	773,	873,
9,	819,	433,	342,	313,	497,	236,	141,	132,
+gp,	624,	264,	407,	149,	333,	86,	73,	94,
TOTALNUM,	33111,	35863,	41395,	30441,	25429,	14121,	8491,	9567,
TONSLAND,	74824,	75451,	68905,	60972,	59294,	40285,	28127,	24822,
SOPCOF %,	100,	100,	100,	100,	100,	100,	100,	100,

Table 2.9 (continued)

Table 1 Catch numbers at age									Numbers*10**-3	
YEAR,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,
AGE										
2,	40,	4,	332,	810,	1193,	1326,	554,	252,	156,	44,
3,	665,	369,	573,	896,	2376,	3438,	2819,	1322,	971,	505,
4,	3160,	1706,	1693,	2345,	2480,	3150,	4786,	2346,	3664,	1837,
5,	4422,	2343,	4302,	5188,	4930,	2258,	4023,	4263,	3807,	2974,
6,	2992,	2684,	2467,	5546,	4647,	2490,	2272,	2773,	2671,	1998,
7,	1945,	3072,	3337,	3270,	4160,	3935,	1546,	1602,	1104,	1409,
8,	898,	1871,	1514,	1455,	2082,	3312,	1826,	751,	326,	542,
9,	837,	627,	777,	557,	898,	959,	975,	774,	132,	187,
+gp,	279,	690,	798,	433,	543,	684,	343,	320,	152,	119,
TOTALNUM,	15238,	13366,	15793,	20500,	23309,	21552,	19144,	14403,	12983,	9615,
TONSLAND,	41690,	52557,	54562,	57207,	61776,	63319,	51572,	40732,	36715,	29699,
SOPCOF %,	100,	100,	100,	100,	100,	100,	99,	100,	100,	100,

Table 2.10

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

Table 2.10 (continued)

Table 2 Catch weights-at-age (kg)										
YEAR,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,
AGE										
2,	.1680,	.2410,	.2540,	.3020,	.2740,	.2770,	.3760,	.4670,	.5150,	.1640,
3,	.5560,	.6450,	.8050,	.7100,	.9210,	.9700,	.9780,	1.1550,	1.3050,	.9520,
4,	1.3590,	1.7100,	1.4760,	1.3350,	1.4640,	1.5540,	1.5180,	1.6330,	2.2720,	1.6370,
5,	2.2670,	2.5910,	2.0970,	1.8420,	1.9790,	1.9700,	2.2810,	2.1710,	2.5550,	2.8810,
6,	2.9570,	3.5880,	3.2870,	2.4670,	2.5160,	2.8970,	3.1250,	3.2490,	3.2830,	3.4240,
7,	3.9030,	4.3660,	4.0950,	4.1910,	3.4610,	3.7160,	3.9000,	4.0950,	4.5040,	4.0380,
8,	5.3170,	5.8990,	5.5920,	5.7780,	4.8660,	4.8290,	5.5200,	5.0130,	5.4000,	5.3970,
9,	4.5580,	6.4940,	7.2170,	6.3760,	5.3910,	6.3490,	6.3330,	6.0180,	6.3790,	7.2080,
+gp,	7.0320,	7.5090,	8.3310,	9.9030,	8.8540,	9.2670,	9.3370,	6.2550,	6.4200,	6.8810,
SOPCOFAC,	1.0001,	1.0000,	1.0000,	1.0001,	1.0001,	1.0003,	.9919,	1.0002,	.9999,	1.0004,

Table 2.11

Run title : Coastal cod (run: XSANCC20/X20)

At 20/04/2002 17:10

Table 3 Stock weights-at-age (kg)

YEAR,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,
AGE								
2,	.3210,	.3210,	.3210,	.3210,	.3210,	.3210,	.3210,	.3210,
3,	.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,
5,	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,
7,	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,
9,	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,

Table 2.11 (continued)

Table 3 Stock weights-at-age (kg)

YEAR,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,
AGE										
2,	.3210,	.3210,	.3210,	.3900,	.2520,	.2400,	.3720,	.3230,	.3650,	.3960,
3,	.7580,	.7580,	.7580,	.7910,	.7240,	.6830,	.8830,	.8410,	.8090,	.9660,
4,	1.4790,	1.4790,	1.4790,	1.5250,	1.4330,	1.3640,	1.4560,	1.6750,	1.5540,	1.5240,
5,	2.1370,	2.1370,	2.1370,	2.2220,	2.0530,	1.8930,	2.1070,	2.1920,	2.5390,	2.3140,
6,	2.8140,	2.8140,	2.8140,	2.8810,	2.7480,	2.8160,	2.9500,	2.8570,	3.0490,	3.3200,
7,	4.7220,	4.7220,	4.7220,	4.6650,	4.7220,	4.4260,	4.3190,	4.5400,	4.3520,	3.6950,
8,	6.6850,	6.6850,	6.6850,	6.9790,	6.6850,	6.4060,	5.6250,	6.5790,	6.2030,	6.1440,
9,	6.9800,	6.9800,	6.9800,	6.7590,	6.9320,	7.8050,	8.3230,	9.4540,	8.5270,	8.7680,
+gp,	9.7230,	9.7230,	9.7230,	9.8970,	9.7230,	10.8270,	12.4680,	12.9020,	12.0660,	12.4680,

Table 2.12

Run title : Coastal cod (run: XSANCC20/X20)

At 20/04/2002 17:10

Table 5 Proportion mature at age

YEAR,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,
AGE								
2,	.0100,	.0100,	.0100,	.0100,	.0100,	.0100,	.0100,	.0100,
3,	.0600,	.0600,	.0600,	.0600,	.0600,	.0600,	.0600,	.0600,
4,	.2400,	.2400,	.2400,	.2400,	.2400,	.2400,	.2400,	.2400,
5,	.4900,	.4900,	.4900,	.4900,	.4900,	.4900,	.4900,	.4900,
6,	.7200,	.7200,	.7200,	.7200,	.7200,	.7200,	.7200,	.7200,
7,	.8800,	.8800,	.8800,	.8800,	.8800,	.8800,	.8800,	.8800,
8,	.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,
+gp,	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,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,
AGE										
2,	.0100,	.0100,	.0100,	.0000,	.0000,	.0000,	.0200,	.0100,	.0100,	.0000,
3,	.0600,	.0600,	.0600,	.0100,	.0300,	.0600,	.1500,	.0300,	.0600,	.0000,
4,	.2400,	.2400,	.2400,	.2000,	.2400,	.2900,	.2500,	.2100,	.2400,	.0700,
5,	.4900,	.4900,	.4900,	.4700,	.5600,	.4500,	.5300,	.4400,	.4900,	.3700,
6,	.7200,	.7200,	.7200,	.6700,	.8000,	.7600,	.7400,	.6500,	.7200,	.7900,
7,	.8800,	.8800,	.8800,	.8500,	.9200,	.9700,	.8700,	.7700,	.8800,	.9700,
8,	.9500,	.9500,	.9500,	.8600,	.9900,	1.0000,	.8900,	1.0000,	.9500,	.9800,
9,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	.9800,
+gp,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,

Table 2.13

Run title : Coastal cod (run: XSANCC20/X20)

At 20/04/2002 17:10

Terminal Fs derived using XSA (With F shrinkage)

Table 8 Fishing mortality (F) at age

YEAR,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,
AGE								
2,	.0105,	.0059,	.1358,	.0051,	.0030,	.0011,	.0002,	.0024,
3,	.0744,	.1298,	.0776,	.0416,	.0737,	.0394,	.0110,	.0202,
4,	.2169,	.2229,	.3190,	.2208,	.2042,	.0723,	.0537,	.0581,
5,	.3337,	.4622,	.4601,	.5989,	.2697,	.2111,	.0887,	.1864,
6,	.6283,	.6366,	.6431,	.4380,	.7634,	.3632,	.1520,	.1739,
7,	1.3095,	.7883,	.9003,	.7087,	1.2405,	.8542,	.4396,	.2618,
8,	1.0724,	.6332,	.9339,	.7334,	1.1867,	.9357,	.6319,	.1867,
9,	.8447,	.6357,	.7415,	.6253,	.8743,	.5962,	.3301,	.2031,
+gp,	.8447,	.6357,	.7415,	.6253,	.8743,	.5962,	.3301,	.2031,
FBAR 4- 7,	.6221,	.5275,	.5806,	.4916,	.6195,	.3752,	.1835,	.1700,

Table 2.13 (continued)

Table 8 Fishing mortality (F) at age

YEAR,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	FBAR 99-**
AGE											
2,	.0009,	.0001,	.0149,	.0273,	.0347,	.0533,	.0281,	.0160,	.0119,	.0051,	.0110,
3,	.0154,	.0102,	.0258,	.0506,	.1045,	.1327,	.1535,	.0867,	.0789,	.0483,	.0713,
4,	.1388,	.0500,	.0593,	.1402,	.1928,	.1965,	.2760,	.1846,	.3662,	.2103,	.2537,
5,	.2517,	.1448,	.1717,	.2594,	.4885,	.2699,	.4136,	.4244,	.5140,	.5770,	.5052,
6,	.2750,	.2385,	.2237,	.3495,	.3917,	.4920,	.4792,	.5644,	.5185,	.5635,	.5488,
7,	.2756,	.5056,	.5261,	.5205,	.4834,	.6849,	.6578,	.7540,	.4601,	.5760,	.5967,
8,	.2918,	.4664,	.5044,	.4599,	.7573,	.9274,	.8152,	.8033,	.3281,	.4312,	.5209,
9,	.2750,	.3410,	.3587,	.3492,	.5802,	1.0136,	.7971,	1.0561,	.3074,	.3176,	.5604,
+gp,	.2750,	.3410,	.3587,	.3492,	.5802,	1.0136,	.7971,	1.0561,	.3074,	.3176,	
FBAR 4- 7,	.2353,	.2347,	.2452,	.3174,	.3891,	.4108,	.4567,	.4818,	.4647,	.4817,	

Table 2.14

Run title : Coastal cod (run: XSANCC20/X20)

At 20/04/2002 17:10

Terminal Fs derived using XSA (With F shrinkage)

Table 9 Relative F at age

YEAR,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,
AGE								
2,	.0168,	.0112,	.2340,	.0104,	.0048,	.0028,	.0010,	.0138,
3,	.1196,	.2461,	.1336,	.0847,	.1190,	.1050,	.0602,	.1187,
4,	.3487,	.4226,	.5494,	.4491,	.3297,	.1926,	.2924,	.3418,
5,	.5364,	.8761,	.7924,	1.2182,	.4353,	.5627,	.4835,	1.0960,
6,	1.0100,	1.2069,	1.1076,	.8910,	1.2324,	.9680,	.8283,	1.0226,
7,	2.1050,	1.4944,	1.5506,	1.4416,	2.0026,	2.2767,	2.3958,	1.5396,
8,	1.7238,	1.2004,	1.6084,	1.4918,	1.9157,	2.4939,	3.4440,	1.0983,
9,	1.3578,	1.2052,	1.2771,	1.2719,	1.4114,	1.5890,	1.7988,	1.1946,
+gp,	1.3578,	1.2052,	1.2771,	1.2719,	1.4114,	1.5890,	1.7988,	1.1946,
REFMEAN,	.6221,	.5275,	.5806,	.4916,	.6195,	.3752,	.1835,	.1700,

Table 2.14 (continued)

Table 9 Relative F at age

YEAR,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	EAN 99-**
AGE											
2,	.0038,	.0006,	.0606,	.0861,	.0891,	.1298,	.0615,	.0332,	.0255,	.0106,	.0231,
3,	.0656,	.0435,	.1054,	.1593,	.2686,	.3229,	.3360,	.1800,	.1698,	.1004,	.1500,
4,	.5899,	.2128,	.2417,	.4417,	.4956,	.4783,	.6044,	.3832,	.7880,	.4367,	.5360,
5,	1.0700,	.6169,	.7004,	.8174,	1.2556,	.6569,	.9057,	.8808,	1.1061,	1.1979,	1.0616,
6,	1.1688,	1.0162,	.9122,	1.1011,	1.0065,	1.1976,	1.0494,	1.1712,	1.1158,	1.1697,	1.1523,
7,	1.1713,	2.1541,	2.1457,	1.6398,	1.2423,	1.6671,	1.4405,	1.5648,	.9900,	1.1957,	1.2502,
8,	1.2402,	1.9870,	2.0572,	1.4490,	1.9461,	2.2574,	1.7851,	1.6671,	.7061,	.8952,	1.0895,
9,	1.1689,	1.4525,	1.4632,	1.1002,	1.4911,	2.4672,	1.7455,	2.1917,	.6616,	.6593,	1.1709,
+gp,	1.1689,	1.4525,	1.4632,	1.1002,	1.4911,	2.4672,	1.7455,	2.1917,	.6616,	.6593,	
REFMEAN,	.2353,	.2347,	.2452,	.3174,	.3891,	.4108,	.4567,	.4818,	.4647,	.4817,	

Table 2.15

Run title : Coastal cod (run: XSANCC20/X20)

At 20/04/2002 17:10

Terminal Fs derived using XSA (With F shrinkage)

Table 10 Stock number at age (start of year)							Numbers*10**-3	
YEAR,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,
AGE								
2,	87940,	74505,	35630,	36691,	40602,	42923,	41032,	58757,
3,	53606,	71249,	60642,	25466,	29886,	33142,	35105,	33588,
4,	39415,	40742,	51233,	45944,	20000,	22730,	26086,	28426,
5,	28351,	25978,	26691,	30489,	30163,	13349,	17313,	20242,
6,	14224,	16627,	13398,	13794,	13715,	18859,	8849,	12971,
7,	7515,	6213,	7202,	5766,	7288,	5234,	10738,	6224,
8,	3631,	1661,	2312,	2397,	2324,	1726,	1824,	5664,
9,	1587,	1017,	722,	744,	942,	581,	554,	794,
+gp,	1191,	613,	847,	350,	621,	209,	285,	562,
TOTAL,	237459,	238605,	198677,	161641,	145542,	138753,	141786,	167227,

Table 2.15 (continued)

Table 10 Stock number at age (start of year)								Numbers*10**-3			
YEAR,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	GMST 84-99
AGE												
2,	49051,	30332,	24889,	33212,	38672,	28213,	22098,	17556,	14617,	9536,	0,	37979,
3,	47993,	40123,	24830,	20077,	26459,	30582,	21899,	17591,	14145,	11827,	7768,	33085,
4,	26950,	38691,	32516,	19810,	15627,	19513,	21928,	15379,	13206,	10703,	9226,	27166,
5,	21959,	19206,	30134,	25090,	14098,	10550,	13125,	13622,	10468,	7497,	7100,	20113,
6,	13755,	13978,	13604,	20779,	15848,	7081,	6595,	7106,	7296,	5126,	3447,	12534,
7,	8925,	8554,	9015,	8906,	11994,	8770,	3545,	3344,	3309,	3556,	2389,	7056,
8,	3922,	5547,	4224,	4362,	4333,	6056,	3620,	1503,	1288,	1710,	1637,	3117,
9,	3847,	2398,	2849,	2088,	2254,	1664,	1961,	1312,	551,	760,	910,	1342,
+gp,	1275,	2620,	2903,	1611,	1348,	1165,	680,	532,	630,	480,	739,	
TOTAL,	177677,	161450,	144966,	135937,	130633,	113595,	95451,	77944,	65511,	51194,	33216,	

Table 2.16

Run title : Coastal cod (run: XSANCC20/X20)

At 20/04/2002 17:10

Terminal Fs derived using XSA (With F shrinkage)

Table 11 Spawning stock number at age (spawning time)							Numbers*10**-3	
YEAR,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,
AGE								
2,	879,	745,	356,	367,	406,	429,	410,	588,
3,	3216,	4275,	3638,	1528,	1793,	1989,	2106,	2015,
4,	9459,	9778,	12296,	11027,	4800,	5455,	6261,	6822,
5,	13892,	12729,	13078,	14940,	14780,	6541,	8483,	9918,
6,	10241,	11971,	9646,	9932,	9875,	13578,	6371,	9339,
7,	6613,	5467,	6338,	5074,	6413,	4605,	9449,	5477,
8,	3449,	1578,	2197,	2277,	2208,	1640,	1733,	5381,
9,	1587,	1017,	722,	744,	942,	581,	554,	794,
+gp,	1191,	613,	847,	350,	621,	209,	285,	562,

Table 2.16 (continued)

Table 11 Spawning stock number at age (spawning time)								Numbers*10**-3		
YEAR,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,
AGE										
2,	491,	303,	249,	0,	0,	0,	442,	176,	146,	0,
3,	2880,	2407,	1490,	201,	794,	1835,	3285,	528,	849,	0,
4,	6468,	9286,	7804,	3962,	3751,	5659,	5482,	3230,	3169,	749,
5,	10760,	9411,	14766,	11792,	7895,	4748,	6956,	5994,	5129,	2774,
6,	9904,	10064,	9795,	13922,	12678,	5382,	4880,	4619,	5253,	4050,
7,	7854,	7528,	7933,	7570,	11035,	8507,	3084,	2575,	2912,	3450,
8,	3726,	5270,	4013,	3751,	4290,	6056,	3222,	1503,	1224,	1676,
9,	3847,	2398,	2849,	2088,	2254,	1664,	1961,	1312,	551,	744,
+gp,	1275,	2620,	2903,	1611,	1348,	1165,	680,	532,	630,	480,

Table 2.17

Run title : Coastal cod (run: XSANCC20/X20)

At 20/04/2002 17:10

Terminal Fs derived using XSA (With F shrinkage)

Table 14 Stock biomass at age with SOP (start of year) Tonnes YEAR,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,
AGE								
2,	28234,	23917,	11438,	11778,	13034,	13778,	13174,	18866,
3,	40640,	54009,	45969,	19305,	22655,	25122,	26614,	25467,
4,	58304,	60259,	75778,	67955,	29581,	33618,	38588,	42054,
5,	60597,	55516,	57042,	65159,	64464,	28527,	37003,	43269,
6,	40033,	46789,	37703,	38819,	38597,	53068,	24906,	36511,
7,	35490,	29338,	34010,	27229,	34416,	24713,	50712,	29397,
8,	24275,	11103,	15460,	16022,	15537,	11537,	12193,	37876,
9,	11080,	7100,	5039,	5194,	6579,	4054,	3870,	5541,
+gp,	11578,	5957,	8238,	3403,	6043,	2034,	2771,	5469,
TOTALBIO,	310229,	293988,	290676,	254865,	230905,	196451,	209830,	244452,

Table 2.17 (continued)

Table 14 Stock biomass at age with SOP (start of year) Tonnes YEAR,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,
AGE										
2,	15747,	9736,	7990,	12954,	9746,	6773,	8154,	5672,	5335,	3778,
3,	36382,	30412,	18821,	15883,	19157,	20893,	19180,	14796,	11442,	11430,
4,	39864,	57222,	48092,	30214,	22395,	26622,	31668,	25764,	20520,	16318,
5,	46932,	41041,	64397,	55757,	28944,	19977,	27431,	29866,	26576,	17355,
6,	38710,	39331,	38283,	59871,	43553,	19946,	19297,	20305,	22243,	17026,
7,	42147,	40391,	42570,	41552,	56641,	38828,	15185,	15183,	14398,	13147,
8,	26220,	37081,	28238,	30443,	28967,	38805,	20198,	9891,	7989,	10511,
9,	26858,	16740,	19884,	14117,	15629,	12988,	16193,	12402,	4699,	6663,
+gp,	12393,	25475,	28231,	15950,	13107,	12619,	8408,	6867,	7606,	5987,
TOTALBIO,	285254,	297430,	296505,	276742,	238140,	197451,	165715,	140747,	120808,	102214,

Table 2.18

Run title : Coastal cod (run: XSANCC20/X20)

At 20/04/2002 17:10

Terminal Fs derived using XSA (With F shrinkage)

Table 15 Spawning stock biomass with SOP (spawning time) Tonnes YEAR,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,
AGE								
2,	282,	239,	114,	118,	130,	138,	132,	189,
3,	2438,	3241,	2758,	1158,	1359,	1507,	1597,	1528,
4,	13993,	14462,	18187,	16309,	7100,	8068,	9261,	10093,
5,	29692,	27203,	27950,	31928,	31587,	13978,	18131,	21202,
6,	28823,	33688,	27146,	27950,	27790,	38209,	17932,	26288,
7,	31231,	25817,	29929,	23962,	30286,	21747,	44626,	25869,
8,	23061,	10548,	14687,	15221,	14760,	10960,	11584,	35982,
9,	11080,	7100,	5039,	5194,	6579,	4054,	3870,	5541,
+gp,	11578,	5957,	8238,	3403,	6043,	2034,	2771,	5469,
TOTSPBIO,	152179,	128255,	134048,	125243,	125633,	100696,	109904,	132162,

Table 2.18 (continued)

Table 15 Spawning stock biomass with SOP (spawning time) Tonnes YEAR,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,
AGE										
2,	157,	97,	80,	0,	0,	0,	163,	57,	53,	0,
3,	2183,	1825,	1129,	159,	575,	1254,	2877,	444,	687,	0,
4,	9567,	13733,	11542,	6043,	5375,	7720,	7917,	5410,	4925,	1142,
5,	22997,	20110,	31555,	26206,	16209,	8990,	14538,	13141,	13022,	6421,
6,	27871,	28318,	27564,	40114,	34842,	15159,	14280,	13198,	16015,	13450,
7,	37090,	35545,	37462,	35319,	52110,	37663,	13211,	11691,	12670,	12752,
8,	24909,	35227,	26826,	26181,	28678,	38805,	17976,	9891,	7589,	10301,
9,	26858,	16740,	19884,	14117,	15629,	12988,	16193,	12402,	4699,	6529,
+gp,	12393,	25475,	28231,	15950,	13107,	12619,	8408,	6867,	7606,	5987,
TOTSPBIO,	164026,	177070,	184271,	164088,	166524,	135197,	95564,	73102,	67267,	56584,

Table 2.19

Run title : Coastal cod (run: XSANCC20/X20)

At 20/04/2002 17:10

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,	87940,	310229,	152179,	74824,	.4917,	1.0002,	.6221,
1985,	74505,	293988,	128255,	75451,	.5883,	1.0000,	.5275,
1986,	35630,	290676,	134048,	68905,	.5140,	1.0001,	.5806,
1987,	36691,	254865,	125243,	60972,	.4868,	1.0001,	.4916,
1988,	40602,	230905,	125633,	59294,	.4720,	1.0001,	.6195,
1989,	42923,	196451,	100696,	40285,	.4001,	1.0000,	.3752,
1990,	41032,	209830,	109904,	28127,	.2559,	1.0002,	.1835,
1991,	58757,	244452,	132162,	24822,	.1878,	1.0003,	.1700,
1992,	49051,	285254,	164026,	41690,	.2542,	1.0001,	.2353,
1993,	30332,	297430,	177070,	52557,	.2968,	1.0000,	.2347,
1994,	24889,	296505,	184271,	54562,	.2961,	1.0000,	.2452,
1995,	33212,	276742,	164088,	57207,	.3486,	1.0001,	.3174,
1996,	38672,	238140,	166524,	61776,	.3710,	1.0001,	.3891,
1997,	28213,	197451,	135197,	63319,	.4683,	1.0003,	.4108,
1998,	22098,	165715,	95564,	51572,	.5397,	.9919,	.4567,
1999,	17556,	140747,	73102,	40732,	.5572,	1.0002,	.4818,
2000,	14617,	120808,	67267,	36715,	.5458,	.9999,	.4647,
2001,	9536,	102214,	56584,	29699,	.5249,	1.0004,	.4817,
Arith. Mean ,	38125,	230689,	127323,	51251,	.4222		.4049,
Units ,	(Thousands),	(Tonnes),	(Tonnes),	(Tonnes),			

Table 2.20

Prediction with management option table: Input data

Year: 2002								
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	9536	0.2	0.0067	0.2	0.2	361	0.0111	382
3	7768	0.2	0.0300	0.2	0.2	872	0.0721	1137
4	9226	0.2	0.1733	0.2	0.2	1584	0.2567	1847
5	7100	0.2	0.4333	0.2	0.2	2348	0.5111	2535
6	3447	0.2	0.7200	0.2	0.2	3075	0.5553	3318
7	2389	0.2	0.8733	0.2	0.2	4195	0.6037	4212
8	1637	0.2	0.9767	0.2	0.2	6308	0.5270	5270
9	910	0.2	0.9933	0.2	0.2	8916	0.5670	6535
10+	739	0.2	1.0000	0.2	0.2	12478	0.5670	6518
Unit	Thousands	-	-	-	-	Grams	-	Grams

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
2	9536	0.2	0.0067	0.2	0.2	361	0.0111	382
3		0.2	0.0300	0.2	0.2	872	0.0721	1137
4		0.2	0.1733	0.2	0.2	1584	0.2567	1847
5		0.2	0.4333	0.2	0.2	2348	0.5111	2535
6		0.2	0.7200	0.2	0.2	3075	0.5553	3318
7		0.2	0.8733	0.2	0.2	4195	0.6037	4212
8		0.2	0.9767	0.2	0.2	6308	0.5270	5270
9		0.2	0.9933	0.2	0.2	8916	0.5670	6535
10+		0.2	1.0000	0.2	0.2	12478	0.5670	6518
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	9536	0.2	0.0067	0.2	0.2	361	0.0111	382
3		0.2	0.0300	0.2	0.2	872	0.0721	1137
4		0.2	0.1733	0.2	0.2	1584	0.2567	1847
5		0.2	0.4333	0.2	0.2	2348	0.5111	2535
6		0.2	0.7200	0.2	0.2	3075	0.5553	3318
7		0.2	0.8733	0.2	0.2	4195	0.6037	4212
8		0.2	0.9767	0.2	0.2	6308	0.5270	5270
9		0.2	0.9933	0.2	0.2	8916	0.5670	6535
10+		0.2	1.0000	0.2	0.2	12478	0.5670	6518
Unit	Thousands	-	-	-	-	Grams	-	Grams

Notes: Run name : MANNCC12
Date and time: 24APR02:19:08

Table 2.21

Prediction with management option table

Year: 2002					Year: 2003					Year: 2004	
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
1.0000	0.4817	89797	53739	26818	0.00	0	74153	44606	0	90418	59781
					0.05	0.0241	74153	44606	1358	88638	58269
					0.10	0.0482	74153	44606	2682	86903	56797
					0.15	0.0723	74153	44606	3974	85212	55364
					0.20	0.0963	74153	44606	5235	83564	53970
					0.25	0.1204	74153	44606	6465	81958	52612
					0.30	0.1445	74153	44606	7666	80393	51291
					0.35	0.1686	74153	44606	8837	78867	50005
					0.40	0.1927	74153	44606	9980	77380	48753
					0.45	0.2168	74153	44606	11096	75931	47534
					0.50	0.2409	74153	44606	12184	74519	46347
					0.55	0.2649	74153	44606	13247	73142	45192
					0.60	0.2890	74153	44606	14284	71799	44068
					0.65	0.3131	74153	44606	15296	70491	42974
					0.70	0.3372	74153	44606	16284	69215	41908
					0.75	0.3613	74153	44606	17249	67972	40871
					0.80	0.3854	74153	44606	18190	66759	39861
					0.85	0.4094	74153	44606	19109	65577	38878
					0.90	0.4335	74153	44606	20007	64425	37920
					0.95	0.4576	74153	44606	20883	63301	36988
					1.00	0.4817	74153	44606	21738	62205	36081
					1.05	0.5058	74153	44606	22574	61137	35198
					1.10	0.5299	74153	44606	23389	60095	34338
					1.15	0.5540	74153	44606	24186	59078	33500
					1.20	0.5780	74153	44606	24964	58088	32685
					1.25	0.6021	74153	44606	25724	57121	31891
					1.30	0.6262	74153	44606	26466	56178	31118
					1.35	0.6503	74153	44606	27191	55259	30365
					1.40	0.6744	74153	44606	27899	54362	29632
					1.45	0.6985	74153	44606	28590	53487	28918
					1.50	0.7226	74153	44606	29266	52634	28223
					1.55	0.7466	74153	44606	29926	51802	27546
					1.60	0.7707	74153	44606	30571	50989	26887
					1.65	0.7948	74153	44606	31201	50197	26245
					1.70	0.8189	74153	44606	31817	49424	25620
					1.75	0.8430	74153	44606	32419	48670	25011
					1.80	0.8671	74153	44606	33007	47934	24418
					1.85	0.8911	74153	44606	33581	47215	23841
					1.90	0.9152	74153	44606	34143	46515	23278
					1.95	0.9393	74153	44606	34692	45831	22731
					2.00	0.9634	74153	44606	35229	45163	22197
-	-	Tonnes	Tonnes	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes

Notes: Run name : MANNCC12
Date and time: 24APR02:19:08
Computation of ref. F: Simple mean, age 4 - 7
Basis for 2002 : TAC constraints

Table 2.22 Catch options for 2002 with corresponding total stock biomasses and spawning stock biomasses in 2003.

F	Basis	Catch 2002 (t)	Total stock biomass 2003 (t)	SSB 2003 (t)
0	$0*\mathbf{F}_{sq}$	0	90	60
0.10	$0.2*\mathbf{F}_{sq}$	5	84	54
0.19	$0.4*\mathbf{F}_{sq}$	10	77	49
0.27	$0.56*\mathbf{F}_{sq}= \mathbf{F}_{pa}$	13	73	45
0.29	$0.6*\mathbf{F}_{sq}$	14	72	44
0.38	$0.8*\mathbf{F}_{sq}$	18	67	40
0.48	$1.0*\mathbf{F}_{sq}$	22	62	36

Table 2.23 Output from the PA-software for Norwegian coastal cod.

Reference point	Deterministic	Median	75th percentile	95th percentile	Hist SSB < ref pt %
MedianRecruits	36161	36161	38672	41032	
MBAL	0				0.00
$\mathbf{B}_{loss}$	56559				
SSB90%R90%Surv	118599	118599	125499	134040	33.33
SPR%ofVirgin	13.17	13.60	15.98	20.44	
VirginSPR	18.56	18.52	21.69	26.89	
SPRloss	2.25	2.52	5.09	7.04	
	Deterministic	**Median**	**25th percentile**	**5th percentile**	**Hist F > ref pt %**
FBar	0.40	0.40	0.33	0.25	55.56
$\mathbf{F}_{max}$	0.24	0.25	0.20	0.14	77.78
$\mathbf{F}_{0.1}$	0.13	0.12	0.10	0.07	100.00
$\mathbf{F}_{low}$	0.12	0.13	0.10	0.07	100.00
$\mathbf{F}_{med}$	0.22	0.22	0.18	0.14	88.89
$\mathbf{F}_{high}$	0.39	0.39	0.33	0.26	61.11
F35%SPR	0.15	0.15	0.13	0.10	100.00
$\mathbf{F}_{loss}$	0.44	0.39	0.20	0.11	50.00

For estimation of G_{loss} and F_{loss}:
A LOWESS smoother with a span of 1 was used.
Stock recruit data were log-transformed.
A point representing the origin was included in the stock recruit data.
For estimation of the stock recruitment relationship used in equilibrium calculations:
A LOWESS smoother with a span of 1 was used.
Stock recruit data were log-transformed.
A point representing the origin was included in the stock recruit data.
Steady state selection provided as input.
FBar averaged from age 4 to 7.

Number of iterations = 1000
Random number seed = -99
Stock recruitment data Monte Carloed using stock recruit pairs

Data source:
PA-input-manualy.xls

FishLab DLL used
FLVB32.DLL built on Jun 14 1999 at 11:53:37
PASoft 4 October 1999

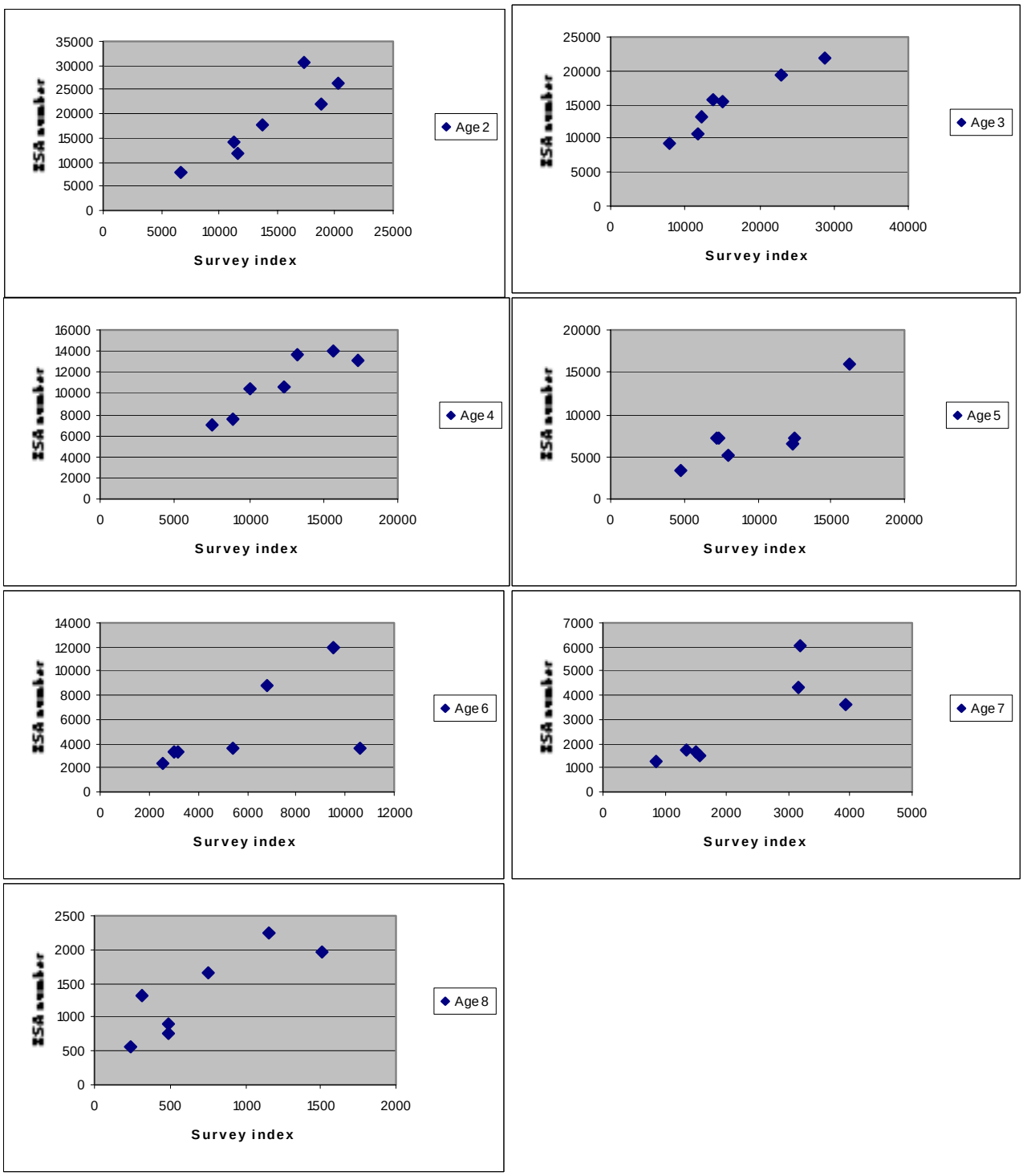

Figure 2.1 Norwegian Coastal cod – Coastal acoustic survey vs XSA. Age (n) in survey = age (n+1) from XSA the year after because the surveys are conducted late autumn (1995-2001).

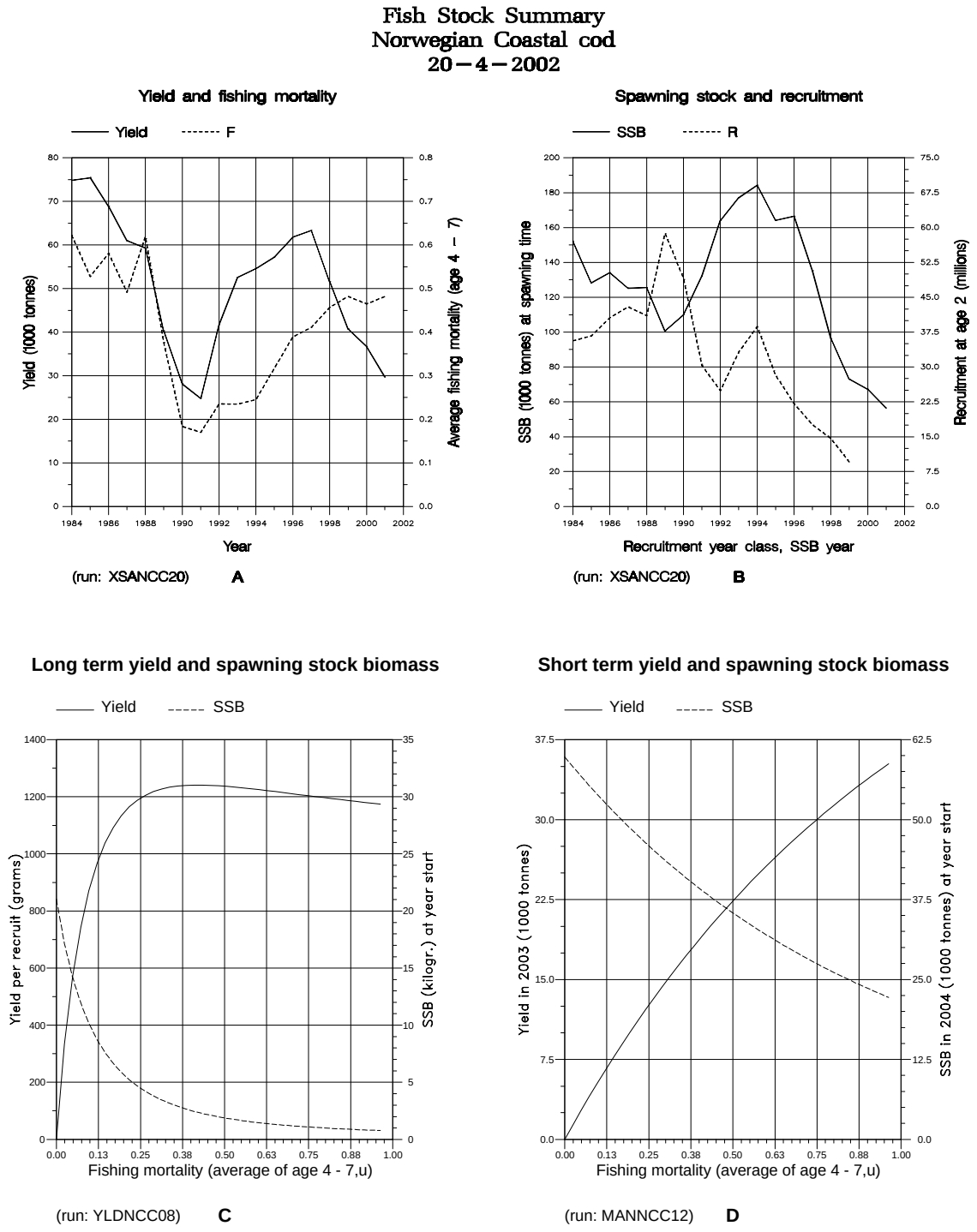

Figure 2.2 Norwegian Coastal cod: Historical yield and fishing mortality (A). Spawning stock biomass and recruitment (B). Long-term yield per recruit and spawning stock biomass per recruit (C). Short-term yield and spawning stock biomass (D).

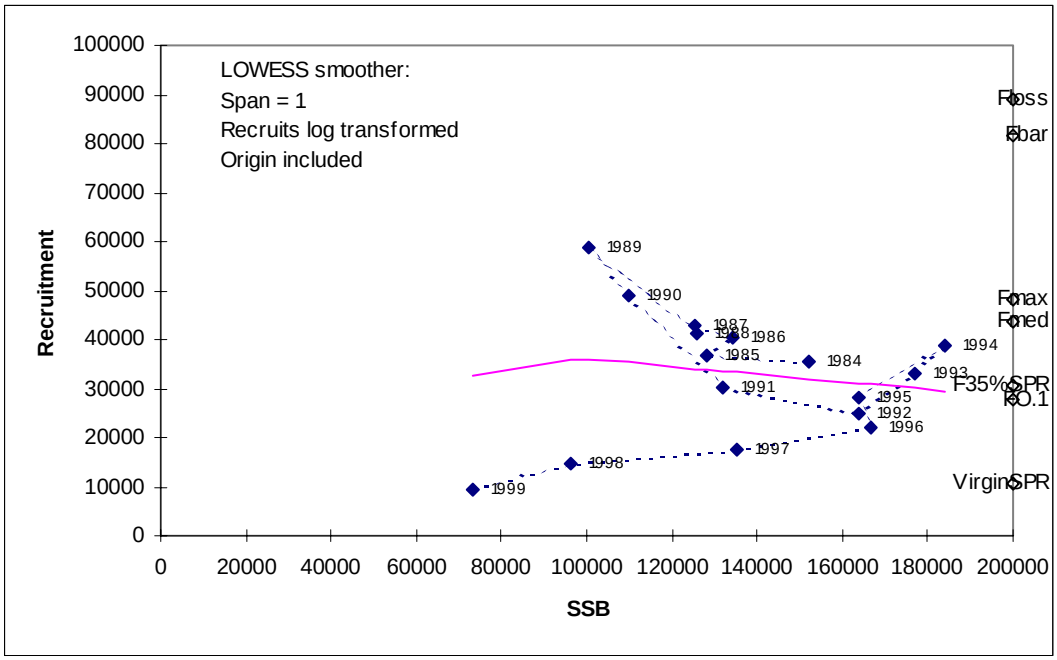

Figure 2.3 Spawning stock – recruitment plot for Norwegian coastal cod (from the PA-software).

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 2001 was 426,000 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 2002 (Tables 3.1-3.3, Figure 3.1A)

Final reported landings for 2000 amount to 414,870 t (Table 3.1), excluding 19,234 t of Norwegian coastal cod. The provisional figures for 2001 are 426,347 t, excluding 14,217 t of Norwegian coastal cod. This is 11,347 t higher than the catch assumed by the Working Group last year. The catch by area, split into trawl and other gears, is given in Table 3.2, and the nominal catch by country is given in Table 3.3. Compared to 2000, the catches in 2001 decreased in Division IIa and increased in Subarea I (Table 3.1).

3.1.3 Expected landings in 2002

The mixed Norwegian-Russian fisheries commission agreed on a TAC of 435,000 t for 2002, including 40,000 t Norwegian coastal cod. Since this quota is equal to the 2001 quota, it is reasonable to assume a catch in 2002 similar to that in 2001 (426,000 t).

The Working Group has no information on the size of expected unreported landings in 2002 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)

With respect to year-class strength, the overall picture seen in the surveys is summarized as follows: The 1999 year class is close to average in the Russian surveys and weak in the Norwegian surveys. 2000 is close to average, and 2001 is weak. Regarding the fishable stock, the abundance of age groups 5 -7 had increased in 2002 compared to 2001, while the abundance of older fish has declined further.

Joint Barents Sea winter survey (bottom trawl and acoustics)

The preliminary swept area estimates and acoustic estimates from the Joint winter survey on demersal fish in the Barents Sea in winter 2002 are given in Tables A2 and A3. Both the swept area estimates and the acoustic estimates show decreased abundance of ages 1, 3 and 4 and some increase for ages 2 and 5+. Results are preliminary, because Russian cod age-length keys for the survey are not used. It should be noted that the age 1 indices in 2002 are extremely low; less than 1 % of the average level in the period 1995-1998.

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

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, and 6- and 7-year-olds represents more than 75% of the estimated number of spawners.

Norwegian summer/autumn survey

Table A5 gives the results of the Norwegian bottom trawl survey in the Svalbard and Barents Sea area in August/September (Michalsen *et al*., WD30). The results for the Svalbard area (Division IIb) have been used earlier in the XSA tuning but have been left out in the two 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

Abundance estimates from the Russian autumn survey (November-December) are given in Table A10 (acoustic estimates) and Table A11 (bottom trawl estimates). The main results of this survey in autumn 2001 are close to the results of the joint survey in winter 2002. The time-series was revised in 2000, (Gusev and Yaragina WD 35 at AFWG 2000).

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 not fully comparable to the later part. The abundance of 0-group cod has been low in the three latest years. 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 15 and 16. This is further described in the Introduction chapter.

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.

The data on weight-at-age from the autumn 2001 Russian survey and the winter 2002 joint Norwegian –Russian survey were in general agreement with each other. There was a notable discrepancy for the 1998 year class (6.5 cm difference in mean length).

Both the joint winter survey in 2002 and the Russian autumn survey in 2001 show little change in weights for most ages (Table A7 and A13).

3.2.5 Maturity-at-age (Table 3.5)

Russian maturity ogives from the autumn survey are available from 1984 until present. For the years 1985-2002, 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). 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. To represent the maturity composition of the stock, the percent mature at age for the Russian and Norwegian surveys have been arithmetically averaged for 1985 and later years. This is consistent with the approach used to estimate the weight-at-age in the stock (described in Section 3.3.2).

Maturity data used for the period prior to 1982 was introduced last year and is further discussed in Section 10.2.2.

3.3 Data used in the assessment

3.3.1 Catch-at-age (Table 3.8 and 3.10)

For 2000 final total landings for all countries were 414,870 t, compared to 414,144 t used in last year's assessment. This lead to very minor adjustments of the number-at-age in the 2000 landings. For 2001, age compositions for all areas were available from Norway (by gears) Russia and Germany. From Division IIa and Division IIb, age compositions were available for Spain. 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 shows available catch-at-age data for all ages 1-15+. The catch numbers shown in Table 3.10 together with cannibalism figures (Table 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+ have 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 a plus group, the 13+ weights are 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) was 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 (Table 3.14)

As in the 2001 assessment the following surveys and commercial CPUE data series were used for initial tuning runs by single fleets:

Name	Place	Season	Age	Years
Russian bottom trawl surv.	Total area	Autumn	3-8	1982-2001
Norwegian trawl CPUE	Total area	All year	9-12	1985-2001
Russian trawl CPUE	Total area	All year	9-12	1985-2001
Joint bottom trawl survey	Barents Sea	Winter	3-8	1981-2002
Joint acoustic survey	Barents Sea + Lofoten	Winter	3-11	1985-2002 (Table A16)

Table 3.15 shows a comparison between the fleets. The Norwegian trawl CPUE value for 2001 could be somewhat influenced by a seasonal shift compared to earlier years. Most Norwegian trawlers reached their vessel quota earlier than usual. The effort was therefore concentrated to the first half of the year, when the large fish are more available than later in the year. Since this tuning series contains ages 9-12, the 2001 value is likely upward biased due to this seasonal shift. It was decided to leave out this fleet in the tuning. The resulting retrospective pattern show improvement compared to last years' retrospective pattern.

As in last years' assessment the Svalbard survey was left out, the age groups 1 and 2 were excluded from the tuning fleets used, and age groups 13 and 14 were included in the plus group. 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 2002 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. The sum of the Lofoten survey and the Joint Barents Sea Acoustic survey is shown in Table A16. These values are multiplied by 10 and shifted to the end of the previous year to make tuning fleet 16 (Table 3.14).

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.

The ACFM technical minutes, June 2001, raised doubts about treatment of zeros in the XSA. The program handles zeros as missing values (Chris Darby, personal communication). With last years' data 2 alternative runs were compared with the standard run (including zero values); -one run where 0 was replaced by 1, and one run where entire age groups were removed if zeroes occurred (WD 19). The differences were marginal (1-5% decrease in reference F and less than 1% increase in SSB), and the standard procedure was kept.

3.3.6 Recruitment indices (Table 3.6-3.7)

At the last 2000 AFWG meeting it was decided that survey estimates of ages 1 and 2 should not be used in the XSA-tuning, since the noise in those values, together with the noise in cannibalism estimates, is carried over to the XSA-estimates of older ages. Those survey data, not used in the XSA, is therefore 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 (shrunk towards the VPA-mean). The RCT3 estimate of the 2001 year class was heavily influenced by the shrinkage towards the mean. For this year class the swept area estimate and the acoustic estimate from the 2002 joint winter survey are well below the lowest values observed since the survey area was increased in 1993. In the Russian survey only 5 of the values since 1985 are lower than the 2002 estimate. It was therefore not considered appropriate to use an estimate that was strongly shrunk towards the mean, and the RCT3 estimate was replaced by the average of the 10 lowest year classes in the entire VPA time-series (165 millions).

3.3.7 Cannibalism

The method used for calculation of the consumption is described by Bogstad and Mehl (1997). 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). About 7,500 cod stomachs from the Barents Sea are 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 2001 as well as additional data for 2000. 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 3.4.3). 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 9.

3.3.8 Prediction data (Table 3.28, Figure 3.2A)

The input data to the short-term prediction with management option table (2002-2004) are given in Table 3.28. For 2002 stock weights and maturity were taken from surveys as described in Sections 3.3.2 and 3.3.4. It is assumed that the weights and maturity ogives remain stable in the near future.

Stock weights and maturity in 2003 and later years were thus set equal to the 2000-2002 average, while catch weights and exploitation pattern in 2002 and later years were set equal to the 1999-2001 average.

The stock number-at-age in 2002 was taken from the final VPA (Table 3.23) for ages 4 and older. The recruitment-at-age 3 in year 2002 and later was estimated from surveys (section 3.3.6). Fig. 3.2A 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 1984-2001. It is seen that the level of cannibalism is inversely related to the capelin abundance. Because the capelin abundance is expected to change very little from 2001 to 2002, the natural mortality due to cannibalism (M2) in 2002 and later years was set equal to the 2001 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 for the latest year are also better.

The only change in the present assessment method compared to last year is the removal of the Norwegian trawl CPUE from the tuning data.

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 leads to new estimates of consumption. This procedure was repeated until the revision of consumed numbers differed less than 1% for the latest year.

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 1984-2001 are given in Tables 3.20 and 3.22. The values for the 1999 and 2000 year classes (age 1 in 2000 and ages 1 and 2 in 2001) 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 3.2B 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 3.1A-B)

The estimated F_{5-10} in 2001 is higher than predicted with the TAC constraint last year (0.84 vs. 0.66), while the spawning stock biomass in 2001 is estimated to be 298,000 t, which is very close to last year's assessment (300,000 t). The SSB in 2002 is 429,000 t, compared to 330,000 t in the WG-prediction and 272,000 t in the ACFM-prediction. Compared to the WG-prediction the main difference is the increased maturity-at-age, while compared to the ACFM-prediction there is in addition an upward revision of stock numbers.

Figures 3.7a, 3.7b -3.9 show 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.

For the historic time-series (prior to 1982) improved data on maturity and weights-at-age were introduced last year. This lead to considerable changes to the historic estimates of stock biomass, particularly the spawning stock. The new weights were considered as the best available estimates of weight-at-age in stock. Therefore, the sum of product corrections (based on discrepancies between landings and weights-at-age in catch) should not be applied to the stock biomass.

3.5.2 Recruitment (Table 3.6- 3.7)

From the RCT3 calculations the estimated number (millions) of recruits at age 3 is 278 millions for the 1999 year class and 468 millions for the 2000 year class. For the abundance of the 2001 year class at age 3 a value of 165 millions was chosen (Section 3.3.6).

3.6 Reference points

During the 2001 WG considerable revisions of maturity-at-age and weights-at-age were introduced. As a consequence the 2001 WG proposed new values of $\mathbf{B}_{pa}$ (375,000t) and $\mathbf{B}_{lim}$ (140,000t). ACFM (June 2001) considered that more detailed analyses were required as a basis for new reference points and recommended the old values to be used until such studies were completed. The status of the further development of biological reference point for this stock can be reviewed in detail in chapter 10.

3.6.1 Biomass reference points (Figure 3.3)

The stock-recruitment plot with cannibalism included is given in Figure 3.3. 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).

3.6.2 Fishing mortality reference points

At the 1998 WG meeting, the following values were estimated for the fishing mortality references points $\mathbf{F}_{0.1}$ = 0.13, $\mathbf{F}_{max}$ = 0.24, $\mathbf{F}_{low}$ =0.27, $\mathbf{F}_{med}$ =0.46, and $\mathbf{F}_{high}$ = 0.91 (median values). This was done using the PASoft program package (MRAG 1997). Data input and analysis performed were described by Motos (WD 1998).

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 $\mathbf{F}_{pa}$= Flime$^{-1.645\sigma}$ (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 last years' revisions of the time-series, the F reference points relating to the stock-recruitment–plot needs to be reconsidered. Calculations based on the new time-series (Appendix 1) revealed that the results are rather sensitive to the period chosen both for the stock recruitment plot and for averaging of exploitation pattern, maturity, natural mortality and weights-at-age.

Last year $F_{0.1}$ was estimated to 0.12 and $\mathbf{F}_{max}$ to 0.24. A new yield-per-recruit calculation with 3-year (1999-2001) averaging of input data (Table 3.33) is shown in Table 3.34.

3.7 Catch options (Table 3.31-3.32)

Two management option tables (Table 3.31 and 3.32) are presented. The first assumes F *status quo* in 2002 and the second assumes a TAC constraint of 426,000 t in 2002 (=assumed catch, see section 3.1.3). The F_{5-10} corresponding to the assumed catch in 2002 is 0.65. The detailed outputs corresponding to $\mathbf{F}_{sq}$ in 2002 and $\mathbf{F}_{pa}$ in 2003 is given in Table 3.30, those corresponding to 426,000 t catch in both years in Table 3.29.

In Figure 3.1D the catch level in 2003 and spawning stock biomass level in 2004 are plotted against the fishing mortality in 2003, assuming a catch constraint (426,000t).

3.8 Medium-term forecasts and management scenarios

3.8.1 Input data (Table 3.28)

The simulation period was 2002-2006. The input data were the same as used for the short-term predictions, using the same data for the years after 2004 as for 2004 (Table 3.28). The abundance of the 2002 and 2003 year classes at age 3 was as a first assumption set equal to the value for the 2000 year class (468 million). According to the prognosis given in Section 1, the 0-group index of Northeast Arctic cod is expected to be at a medium level in 2002 and to decrease in 2003. Although the correlation between the 0-group index and the abundance at age 3 is relatively weak, this prognosis supports the assumption of the 2002 year class as somewhat below the long-term average of 600 million individuals. In order to be in accordance with the prognosis of the 2003 year class given in Section 1, a lower value than 468 million should, however, have been used here.

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 2002 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 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. Predictions were made for F = 0.25, $\mathbf{F}_{pa}$ = 0.42, $\mathbf{F}_{status\ quo}$ = 0.84, and for a fixed catch of 426 000 tonnes, equal to the reported catch in 2001.

3.8.3 Results

Two sets of runs were made. In the first set of runs F *status quo* was used in 2002, with various options for 2003 and later years. In the second set of runs, a catch of 426 000 tonnes in 2002 and 2003 was assumed, with various options for later years. This was done because the Mixed Russian-Norwegian Fisheries Commission has agreed on a fixed catch level for the period 2001-2003. The text tables below show the probability of SSB being above $\mathbf{B}_{pa}$ = 500 000 tonnes in 2006 for the various catch options. Risk profiles for the total stock biomass, spawning stock biomass and catch (F for the fixed catch runs) are shown in Figs 3.10a-h.

Basis 2002: F *status quo*

F	Basis, 2003-2005	Average catch 2003-2005	P(SSB>$\mathbf{B}_{pa}$) in 2006
0.25		255	0.00
0.42	$\mathbf{F}_{pa}$	356	0.05
0.84	$\mathbf{F}_{status\ quo}$	485	0.84
	Fixed catch = 426000	426	0.47

Basis 2002: Catch constraint (426,000 t)

F	Basis, 2004-2005	Average catch 2003-2005	P(SSB>$\mathbf{B}_{pa}$) in 2006
0.25		314	0.00
0.42	$\mathbf{F}_{pa}$	395	0.08
0.84	$\mathbf{F}_{status\ quo}$	519	0.73
	Fixed catch = 426000	426	0.30

It should be noted that a deterministic projection shows that fishing at $\mathbf{F}_{pa}$ in the period 2003-2006 will give a higher catch in 2006 than fishing at $\mathbf{F}_{status\ quo}$ during this period. The text table below shows some of the results of the short-term prediction and the risk analysis.

Short-term catch forecast based on status quo fishing mortality in 2002:

Basis 2002: F=$\mathbf{F}_{sq}$=0.84, Catch=523000 t, leads to SSB2003=429000 t

F	Basis	Landings 2003	SSB 2004	P (SSB< $\mathbf{B}_{pa}$) in 2006
0.00	0	0	850	<5%
0.17	0.2*$\mathbf{F}_{sq}$	134	740	<5%
0.34	0.4*$\mathbf{F}_{sq}$	251	647	<5%
0.42	$\mathbf{F}_{pa}$ (=0.5*$\mathbf{F}_{sq}$)	304	604	5%
0.51	0.6*$\mathbf{F}_{sq}$	355	566	20%
0.63	Catch2003=Catch2001 (0.75*$\mathbf{F}_{sq}$)	426*	511	47%
0.84	1.0*$\mathbf{F}_{sq}$	529	435	84%

*Corresponding to the pre-agreed quota of 435 000t Northeast Arctic cod + Norwegian coastal cod prolonged until 2006.

Short-term catch forecast based on catch constraint in 2002:

Basis 2002: Catch=426000 t, F=0.65, leads to SSB2003=494000t

F	Basis	Landings 2003	SSB 2004	P(SSB< $\mathbf{B}_{pa}$) in 2006**
0.00	0	0	954	<5%
0.17	0.2*$\mathbf{F}_{sq}$	149	830	<5%
0.34	0.4*$\mathbf{F}_{sq}$	280	723	<5%
0.42	$\mathbf{F}_{pa}$ (=0.5*$\mathbf{F}_{sq}$)	339	675	<5%
0.51	0.6*$\mathbf{F}_{sq}$	395	631	16%
0.55	Catch2003=Catch2001 (0.66*$\mathbf{F}_{sq}$)	426*	608	30%
0.84	1.0*$\mathbf{F}_{sq}$	587	483	81%

*Corresponding to the pre-agreed quota of 435 000t Northeast Arctic cod + Norwegian coastal cod prolonged until 2006.

**Based on an additional medium-term analysis assuming catch constraint in 2002 and fixed F in 2003-2006.

3.8.4 Management considerations

The spawning stock in 2002 is below the $\mathbf{B}_{pa}$, but above $\mathbf{B}_{lim}$. The fishing mortality has been above $\mathbf{F}_{lim}$ throughout the 8 latest years. The F in 2002 induced by the expected catch should result in a large reduction in F, but F will still be above $\mathbf{F}_{pa}$ in 2002 and the resulting SSB in 2003 will be near $\mathbf{B}_{pa}$. Assuming F status quo in 2002, as recommended by ACFM, gives a less optimistic view (Figures 3.10 a-d).

Both forecasts indicate that fishing at $\mathbf{F}_{pa}$ in 2003 (304,000 t or 339,000 t, in the two versions) allows for reaching a spawning stock above $\mathbf{B}_{pa}$ in 2004, and the medium-term projections indicate that there is high probability that the stock will remain above $\mathbf{B}_{pa}$ the following two years. It is thus recommended that catches in 2003 should not exceed the catch corresponding to $\mathbf{F}_{pa}$.

The catch (426 kt) corresponding to the current quota agreement will, if maintained until 2006, lead to considerable risk of falling below $\mathbf{B}_{pa}$, and the corresponding F has a high probability of exceeding both $\mathbf{F}_{pa}$ and $\mathbf{F}_{lim}$ (Figure 3.10 h). Bearing in mind the recent decreasing trend in recruitment, it is important to rebuild a large buffer stock, until better year classes are evident in surveys.

3.9 Comments to the assessment (Figures 3.4-3.9 and 3.11-3.12, Table 3.35).

WD 18 raises concerns about bias in the assessment and suggests correction factors for ages 4, 5, and 6 based on the Joint bottom trawl winter survey. For the recent period (since 1997) this survey shows very similar trends to the current VPA, both with respect to stock number and mortalities (Figures 3.11 and 3.12). Survey mortalities tend to show higher values than the VPA (which is most likely caused by decreasing survey catchability by age), while the trends seen in these plots do not give strong reasons for concern.

Previous Working Groups have been concerned about possible discarding and under-reporting (Section 1.7, in the ACFM CM 2001/ACFM:02). The Working Group expresses serious concerns that mis-reporting and discarding of similar magnitude still continues (WD 14 and Sokolov 2001). 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 (Dingsør, WD13). Some results are shown in Table 3.35 and Figure 3.13. The method used in this work should be further evaluated and the results considered again at the next WG meeting.

It is essential that research pertaining to the influence of environmental and ecological factors upon recruitment, growth, maturation, fecundity, and mortality be continued with the aim of making the results of practical use in stock assessment.

Comparison of this years assessment with last years assessment

The text table compares this years estimates with last years estimate for the year 2001 for number-at-age, total biomass, spawning biomass, and reference F-values, as well as reference F for the year 2000.

		2001										
	F(2000)	age3	age4	age5	age6	age7	age8	age9	age10	TSB	SSB	F(2001)
2001 ass	0.91	474	451	268	161	42	6.2	3.1	3.1	1278	300	0.66
2002 ass	0.92	462	438	262	158	44	8.3	3.2	1.8	1260	298	0.84
ratio	1.01	0.97	0.97	0.98	0.98	1.05	1.34	1.03	0.58	0.99	0.99	1.27

According to the plots of retrospective patterns in F(5-10), SSB, and recruitment (Figures 3.7a -3.9) and the plots of tuning fleet catchabilities (Figures 3.4-3.6) there is some evidence that the assessments have improved in the recent years. It should however be noticed that this year's assessment still shows some upward revision of the F in 2001, compared to the prediction made last year based on a catch constraint. The relative changes in stock number in 2001 are much less than the relative change in F. It seems that this could be caused by a shift in exploitation pattern towards older fish, compared to the pattern used in last year's prediction.

For comparison the retrospective pattern for F(4-8) is also shown (Figure 3.7b). This shows a 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 Background

An outline of the plans for future work on Fleksibest is given in the Introduction section. As last year, a complete assessment including a medium-term prediction is presented for comparison with the XSA assessment.

3.10.2 Model description

A complete description of the mathematical formulations used in Fleksibest is given in Frøysa *et al*. (2002). Fleksibest is an extension of the type of age-structured assessment models sometimes termed 'statistical catch-at-age analysis' (Fournier and Archibald, 1982; Deriso *et al*., 1985).

The main features of Fleksibest are:

A population model, which describes the numbers-at-age and length in the stock, and the associated mortalities, over time.

All the main population dynamics processes except recruitment (growth, maturation, natural mortality, fishing mortality) are explicitly modelled. They are modelled as functions of length, not of age, since most biological processes are more dependent on length (weight) than on age. This is particularly important because of the large variation in size-at-age in this stock.

The stock is divided into an immature and a mature stock, which may have different population dynamics. A length-dependent maturation function is used to describe the transition from the immature to the mature stock.

In Fleksibest, the population, the catches (for each fleet) and the consumption are modelled, and compared to observations. This will allow for taking the uncertainty in both data sources into account.

As a minimum, stock numbers in the initial year, annual recruitments, partial fishing mortalities for each fishing fleet, and survey catchabilities have to be estimated. Growth in length, natural mortality, mean length and standard deviation of mean length of cohorts in the initial year and at the youngest age, maturation, fleet selectivity, and cannibalism parameters may be estimated, or they may be taken from other sources.

3.10.3 Stock assessment using Fleksibest

3.10.3.1 Model structure

A quarterly time step is used. The model is run for the period 1st quarter 1985- 1st quarter 2002.

The cod stock is divided into an immature (ages 3-10, lengths 20-105 cm) and a mature part (ages 4-12+, lengths 45-135 cm). Maturation takes part in the fourth quarter each year. 2.5 cm wide length groups are used in the model, and 5 cm wide length groups in the survey and catch data files.

3.10.3.2 Data used

Survey data

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 age, length and year 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	1994-2002	3-9	20-90 cm	Immature
Norwegian winter acoustic	1	1985-1993	3-9	20-90 cm	Immature
Norwegian winter acoustic	1	1994-2002	3-9	20-90 cm	Immature
Lofoten acoustic	1	1985-1989	5-12+	55-110 cm	Mature
Lofoten acoustic	1	1990-2002	5-12+	55-110 cm	Mature
Russian bottom trawl	4	1985-1993 and 1995-2001	3-8	20-105 cm	Immature and mature
Norwegian summer bottom trawl	3	1995-2001	3-8	20-105 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 (Lepesevich and Shevelev, 1997) gave extremely high residuals and were removed. The XSA also indicates a bad fit for this survey in 1994. The Norwegian summer trawl survey in the Barents Sea is described by Aglen (1999).

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. Thus, we use catch in numbers-at-age and length by quarter from the following two fleets:

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

Data for 1985-2001 are used, for length groups 20-135 cm and ages 3-12+.

In addition, two fleets contribute to the fishing mortality in the model, with assumed mortality parameters, but without data to support estimation of these parameters:

Third countries. The ratio between partial F for this fleet and for 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 a given selection and F) in these years. The F values are set so that the catches taken by this fleet are approximately equal to the estimates of unreported landings used by the Working Group for those years.

Consumption data

Data on the consumption (kg/time step) of cod by cod for the period 1985-2001 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. Fleksibest does not use the commercial CPUE series, but it would not be much work to enable the model to use such series. The Norwegian winter bottom trawl survey is split into two time-series in Fleksibest, while in XSA, the older part of the time-series is downweighted. This also applies to the Norwegian winter acoustic survey and the Lofoten survey, and in addition these surveys are combined in XSA, but not in Fleksibest. Also, the Norwegian summer bottom trawl survey is included in Fleksibest, but not in XSA. This survey is adjusted for variable area coverage, assuming the area distribution to be the same in 2001 as in 2000.

3.10.3.3 Model assumptions

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

A linear relationship between survey indices $I(y,a,l)$ and population numbers $N(y,a,l)$ has been used in all the runs presented here.

The relation between the stock number and survey index is given as:

$$I(y,a,l) = q(y)s(l)N(y,a,l)$$

For the length selectivity there are two possible formulations:

Linear model: $s(l) = al + b$

Logistic model: $s(l) = \dfrac{1}{1+\exp(-4\alpha(l-l_{50}))}$

In the linear model a) a is the slope and b is the intercept. If $q(y)$ is equal for all years, $q(y)$ should be set to one, because $q(y)(al+b) = a'l + b'$ in this case.

In b) α is the slope at l_{50}.

The linear formulation given by a) is used for all surveys except for the Lofoten survey, which has a logistic length selection curve. The slope is close to zero in all the linear selection curves used in the assessments presented here.

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 as 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 cannibalism parameters were not estimated, but were adjusted to give approximately the same level as indicated by the XSA. Also, consumption data were downweighted in the estimations, for the same reasons as given in last years' report.

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. This is the key run from Fleksibest. The effect of changing the weighting of the different data sources was investigated during last year's Working Group meeting and was not studied this year.

3.10.3.4 Optimization algorithm

Frøysa (2002) investigated the use of the Simulated Annealing global optimization method to find the optimal fit of the Fleksibest model. It was found that the Fleksibest assessment presented to last year's Working Group, where the Hooke & Jeeves algorithm was used, was not the optimal solution. Runs with Simulated Annealing on the same data set gave a lower total likelihood score than obtained using Hooke & Jeeves ($1.67 \cdot 10^7$ vs. $1.72 \cdot 10^7$). Thus, Simulated Annealing is used in all runs presented in this year's report. The Simulated Annealing method is much slower than Hooke & Jeeves, thus limiting the number of runs that could be made during the Working Group meeting. Within the EU project "Development of structurally detailed statistically testable models of marine populations" (QLK5-CT1999-01609), working on joining together Simulated Annealing, Hooke and Jeeves and a quasi-Newton algorithm is almost completed. (Anon., 2002). There are also plans for incorporating automatic differentiation. These approaches may reduce the computing time by several orders of magnitude.

3.10.4 Results from the assessment

Likelihood components, input data, and parameter estimates for the key run are given in Table 3.36a-c. The parameter values obtained during last year's assessment are given for comparison. Also, the effect on the total likelihood score of changing each parameter with +/- 5% is given.

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. The likelihood score is less sensitive to the number of each cohort at age 3 than to the mean length of a cohort at age 3. This may indicate that it is not appropriate to do the comparison of observed and modelled values for each age-length cell, but that the data should be somewhat aggregated before the comparison is made. This issue should be further investigated.

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 3.37. 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. 3.14a-f. The total annual catch in weight as estimated by the model is somewhat higher than the reported catches in almost all years, but are in general in good agreement with the reported catches in tons. The maximum discrepancy is about 120 000 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 $F_{5\text{-}10}$ 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 XSA gives in the years 1993-1995. Otherwise the SSB trends are very similar.

Compared to the stock weights used in the XSA, the mean weight-at-age is generally higher for younger ages and lower for older ages in Fleksibest. The discrepancy is higher for weight-at-age in the stock than for weight-at-age in the catch.

Figure 3.15a-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 are very similar. The fishing mortality ($F_{5\text{-}10}$) in 2000 is increased from 0.73 in last year's assessment to 0.79 in this year's assessment, while the SSB in 2001 changed very little, from 274 thousand tonnes to 269 thousand tonnes.

It was attempted to exclude the Norwegian summer-autumn survey, as this survey is at the moment not used in the XSA tuning and the area adjustment probably is too much of an extrapolation. This led to slightly lower values of F and slightly higher values of SSB in 2001. The changes were less than 7%.

3.10.4.1 Retrospective analysis

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 3.16a-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 1998. The recruitment and the spawning stock biomass are somewhat underestimated in the assessment year, while F is overestimated. This pattern is the opposite of what XSA shows for the most recent years.

3.10.5 Use of Fleksibest for predictions

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 2002-2007, the same values as in the key run were used for most parameters. For the parameters that are variable by year, the values for 2001 were used for all years in the prognosis, except for recruitment and fishing mortality.

The recruitment-at-age 3 in 2003 and 2004 is set to the values obtained from the RCT3 analysis. The recruitment-at-age 3 in 2005 and later is assumed to be equal to the recruitment in 2003, as is done in the medium-term predictions given in Section 3.8. 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 $F_{status\ quo}$, $\mathbf{F}_{pa}$ and constant catch = 426 000 t, for the period 2002-2006. In the $\mathbf{F}_{pa}$ run $F_{status\ quo}$ was assumed for 2002, as a catch corresponding to $\mathbf{F}_{pa}$ in 2002 was considered to be unrealistically low. The values of recruitment, catch weight, stock weight, maturity, natural mortality, and fishing mortality at age for the $F_{status\ quo}$ run are given in Table 3.38. This is comparable to the usual prediction input table (Table 3.28). The management option table for the Fleksibest prediction is given in Table 3.39, and results of medium-term projections with these different fishing mortalities are shown in Figure 3.17a-f.

3.10.5.1 Comments to the prognosis

From Figures 3.17a-f it is seen that the three alternatives give very similar results for stock numbers, but large differences for the spawning stock biomass and significant differences in the stock biomass. Both fishing at $\mathbf{F}_{pa}$ and a constant catch of 426 000 tonnes give a SSB higher than $\mathbf{B}_{pa}$ from 2004 onwards, while $\mathbf{B}_{pa}$ is never reached when fishing at $F_{status\ quo}$. One should also note that the catch in 2006 is higher for the $\mathbf{F}_{pa}$ run and the run with a fixed catch of 426 000 tonnes than for the $F_{status\ quo}$ run. This indicates that much can be gained if $F_{5\text{-}10}$ is kept as low as possible over the next years.

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 7-9 compared to the XSA assessment. The reference F in 2001 estimated by Fleksibest is lower (0.67 vs. 0.84), while the spawning stock biomass in 2002 is somewhat lower in Fleksibest than in XSA, 376 vs. 430 thousand tonnes. The declining trend in fishing mortality from 1999 to 2001 is the same in both assessments.

3.11.2 Comparison of the predictions

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 by using standard predictions. This may be important for medium-term predictions.

The population parameters at age in the Fleksibest prediction (Table 3.38) is 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 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 2002 is not very different (523 thousand tonnes with Fleksibest and 499 thousand tonnes with XSA). The run with constant catch of 426 000 tonnes in the period 2002-2006 shows higher fishing mortalities and lower stock sizes than a medium-term prediction with the same catch, but based on the XSA assessment. The difference in the stock size and F in 2006 is shown in the text table below. The development of fishing mortality, total stock biomass, and spawning stock biomass in Fleksibest and XSA for this constant catch level is compared in Fig. 3.18.

	SSB 2006	TSB 2006	F 2006, catch of 426 000 t.
XSA	682	1458	0.50
Fleksibest	567	1371	0.59

The main reason for these differences are the lower abundance of the younger age groups in 2002 in Fleksibest compared to XSA.

Table 3.1 NortheastNortheast 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	Unreportedcatches	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 [1]	146,461	182,121	97,766		426,347

[1] Provisional figures.

Table 3.2 NortheastNortheast 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 [1]	122.9	23.5	79.3	102.8	95.2	2.5

[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 [1]	12,500	2,910	5,727	4,521	188,420	9,196	8,698	183,572	5,835	4,968	426,347

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

Table 3.4 NortheastNortheast 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	10.23	11.10	13.03	18.85

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	0.31	0.62	1.00	1.53	2.30	3.31	4.57	6.55	8.11	9.52	11.99			

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	7.16	7.32	11.72	9.11	6.60	

[1] Division IIa only

[2] IIa and IIb combined

Table 3.4 (Continued)

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			

[1] IIa and IIb combined

Iceland (Sub-area I)

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)

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 NortheastNortheast 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

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

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),,,,
9,17,2              (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,   658,  32,    3,  13,    -11,     -11,   535.8, 577.2, 274.6, 166.2
1993,   433,   3,    4,   6, 1035.9,   858.3,   541.5, 292.9, 170.0,  92.9
1994,   702,  12,    8,  10, 5253.1,  2619.2,   707.6, 339.8, 238.0, 188.3
1995,   819,  30,   13,  26, 5768.5,  2396.0,  1045.1, 430.5, 396.0, 427.7
1996,   522,  10,    7,  27, 4815.5,  1623.5,   643.7, 632.9, 211.8, 150.0
1997,   580,  16,    6,  18, 2418.5,  3401.3,   340.1, 304.3, 235.2, 245.1
1998,   462,   2,    4,  12,  484.6,   358.3,   248.3, 221.4, 191.1, 138.2
1999,   -11,   1,    1,  13,  128.8,   154.1,    76.6,  63.9,  88.3,  58.7
2000,   -11,   6,    7, -11,  657.9,   629.9,   443.9, 229.1,   -11,   -11
2001,   -11,   2,  -11, -11,   35.3,    18.5,     -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 :

 age3.rct

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

 Data for    9 surveys over   17 years :  1985 - 2001

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

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

 Forecast/Hindcast variance correction used.

 Yearclass =   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

 R-0       1.96   3.28   1.86   .111      9   2.56    8.32    2.429     .003
 R-1       1.55   4.12    .57   .574      9   2.20    7.52     .799     .032
 R-2        .79   4.43    .43   .705      9   2.40    6.34     .517     .076
 N-BST1
 N-BSA1
 N-BST2
 N-BSA2
 N-BST3    1.08    .51    .09   .961      3   5.48    6.41     .182     .505
 N-BSA3     .50   3.85    .12   .930      3   5.24    6.45     .247     .331

                                        VPA Mean =    6.10     .612     .054


 Yearclass =   1995

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

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

 R-0       1.56   3.73   1.46   .156     10   3.43    9.07    2.060     .006
 R-1       1.36   4.28    .55   .569     10   2.64    7.86     .800     .037
 R-2        .81   4.42    .41   .699     10   3.30    7.09     .533     .083
 N-BST1
 N-BSA1
 N-BST2    2.89 -12.04    .53   .332      3   6.95    8.02    2.564     .004
 N-BSA2    1.29  -1.30    .53   .327      3   6.07    6.51    1.083     .020
 N-BST3    1.16    .11    .12   .889      4   5.98    7.03     .267     .332
 N-BSA3     .52   3.74    .11   .897      4   6.06    6.91     .229     .450

                                        VPA Mean =    6.16     .588     .068
```

Table 3.7 (Continued)

Yearclass = 1996

Survey/ Series	Slope	Inter-cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
R-0	1.11	4.28	1.12	.229	11	2.40	6.93	1.333	.006
R-1	1.14	4.50	.53	.568	11	2.08	6.86	.643	.024
R-2	.76	4.51	.38	.724	11	3.33	7.03	.471	.045
N-BST1	.35	3.63	.09	.966	3	8.48	6.59	.183	.251
N-BSA1	.56	2.25	.15	.909	3	7.39	6.40	.298	.113
N-BST2	1.16	-1.10	.29	.563	4	6.47	6.39	.468	.046
N-BSA2	1.66	-3.46	.50	.310	4	6.45	7.23	1.020	.010
N-BST3	.93	1.34	.14	.816	5	5.36	6.30	.212	.223
N-BSA3	.45	4.07	.11	.876	5	5.02	6.35	.165	.251
					VPA Mean =		6.23	.573	.031

Yearclass = 1997

Survey/ Series	Slope	Inter-cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
R-0	1.07	4.27	1.05	.224	12	2.83	7.31	1.269	.008
R-1	1.12	4.46	.53	.530	12	1.95	6.64	.626	.031
R-2	.74	4.46	.43	.636	12	2.94	6.66	.504	.048
N-BST1	.43	2.86	.25	.660	4	7.79	6.24	.410	.072
N-BSA1	.61	1.84	.15	.853	4	8.13	6.82	.282	.153
N-BST2	1.26	-1.79	.27	.538	5	5.83	5.56	.583	.036
N-BSA2	4.29	-19.66	1.61	.032	5	5.72	4.89	2.553	.002
N-BST3	.95	1.21	.13	.831	6	5.46	6.39	.170	.304
N-BSA3	.48	3.91	.11	.867	6	5.51	6.56	.149	.304
					VPA Mean =		6.25	.533	.043

Yearclass = 1998

Survey/ Series	Slope	Inter-cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
R-0	1.01	4.29	.98	.221	13	1.10	5.40	1.163	.010
R-1	1.10	4.47	.50	.519	13	1.61	6.23	.579	.042
R-2	.73	4.47	.41	.622	13	2.56	6.35	.469	.064
N-BST1	.43	2.93	.21	.643	5	6.19	5.58	.476	.062
N-BSA1	.65	1.48	.28	.517	5	5.88	5.29	.699	.029
N-BST2	1.10	-.63	.38	.306	6	5.52	5.44	.714	.028
N-BSA2	3.48	-14.51	1.26	.039	6	5.40	4.28	2.118	.003
N-BST3	.95	1.19	.11	.832	7	5.26	6.19	.157	.352
N-BSA3	.51	3.75	.13	.784	7	4.94	6.25	.178	.352
					VPA Mean =		6.28	.494	.058

Table 3.7 (Continued)

Yearclass = 1999

Survey/ Series	Slope	Inter-cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
R-0	.93	4.49	.88	.228	14	.69	5.14	1.075	.014
R-1	1.09	4.47	.47	.505	14	.69	5.22	.608	.043
R-2	.73	4.44	.39	.599	14	2.64	6.38	.450	.078
N-BST1	.31	3.98	.21	.625	6	4.87	5.46	.441	.081
N-BSA1	.40	3.41	.27	.516	6	5.04	5.44	.529	.056
N-BST2	.72	1.85	.28	.446	7	4.35	4.99	.663	.036
N-BSA2	1.47	-2.35	.56	.170	7	4.17	3.79	1.458	.007
N-BST3	.98	1.02	.11	.852	8	4.49	5.42	.229	.301
N-BSA3	.55	3.52	.14	.782	8	4.09	5.75	.226	.308
					VPA Mean =		6.29	.455	.076

Yearclass = 2000

Survey/ Series	Slope	Inter-cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
R-0	.89	4.57	.84	.229	14	1.95	6.29	.974	.030
R-1	1.07	4.48	.47	.490	14	2.08	6.71	.553	.093
R-2									
N-BST1	.30	3.98	.21	.622	6	6.49	5.96	.323	.274
N-BSA1	.40	3.42	.27	.514	6	6.45	6.01	.387	.191
N-BST2	.71	1.89	.28	.449	7	6.10	6.25	.364	.216
N-BSA2	1.47	-2.37	.57	.168	7	5.44	5.65	.808	.044
N-BST3									
N-BSA3									
					VPA Mean =		6.31	.434	.152

Yearclass = 2001

Survey/ Series	Slope	Inter-cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
R-0	.83	4.66	.79	.231	14	1.10	5.57	.966	.094
R-1									
R-2									
N-BST1	.30	3.99	.22	.620	6	3.59	5.08	.581	.260
N-BSA1	.40	3.44	.27	.512	6	2.97	4.63	.856	.120
N-BST2									
N-BSA2									
N-BST3									
N-BSA3									
					VPA Mean =		6.33	.409	.526

Table 3.7 (Continued)

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
1994	628	6.44	.14	.11	.56	703	6.56
1995	1051	6.96	.15	.13	.67	819	6.71
1996	637	6.46	.10	.07	.46	523	6.26
1997	654	6.48	.11	.09	.65	581	6.36
1998	457	6.13	.12	.09	.63	463	6.14
1999	278	5.63	.13	.13	1.05		
2000	468	6.15	.17	.10	.35		
2001	307	5.73	.30	.39	1.70		

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

	A G E														
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	242	5120	35378	62325	62306	22689	5250	1776	1167	344	85	6	7	22

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	412	21	0	0	0	0
1985	1498	371	66	0	0	0	0
1986	53	408	385	97	0	0	0
1987	674	180	277	14	0	0	0
1988	29	407	22	2	0	0	0
1989	910	143	0	0	0	0	0
1990	0	61	28	0	0	0	0
1991	122	151	214	2	0	0	0
1992	4303	1028	155	4	0	0	0
1993	3814	20278	512	52	1	0	0
1994	8343	6939	646	132	54	8	0
1995	8325	15374	757	251	86	3	0
1996	9907	21735	1501	142	56	20	1
1997	2955	16180	1923	177	17	1	0
1998	77	4765	579	208	25	2	1
1999	578	1790	295	54	4	0	0
2000	1562	2085	163	36	14	0	0
2001	324	1953	48	14	13	1	0

Table 3.10

Run title : Arctic Cod (run: SVPASA14/V14)

At 22/04/2002 15:00

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

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

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

YEAR	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961
AGE										
3	24099	47413	11473	3902	10614	17321	31219	32308	37882	45478
4	120704	107659	155171	37652	24172	33931	133576	77942	97865	132655
5	113203	112040	146395	201834	129803	27182	71051	148285	64222	123458
6	73827	55500	100751	161336	250472	70702	40737	53480	67425	51167
7	49389	22742	40635	84031	86784	87033	38380	18498	23117	38740
8	20562	16863	10713	30451	51091	39213	35786	17735	8429	17376
9	24367	10559	11791	13713	14987	17747	13338	23118	7240	5791
10	15651	10553	8557	9481	7465	6219	10475	9483	11675	6778
11	8327	5637	6751	4140	3952	3232	3289	3748	4504	5560
12	3565	752	2370	2406	1655	1220	1070	997	1843	1682
+gp	2158	797	1287	1350	1906	819	433	513	682	1298
0TOTALNUM	455852	391515	495894	550296	582901	304619	379354	386107	324884	429983
TONSLAND	876795	695546	826021	1147841	1343068	792557	769313	744607	622042	783221
SOPCOF %	93	105	93	106	105	100	112	93	104	1 10

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Run title : Arctic Cod (run: SVPASA14/V14)

At 22/04/2002 15:00

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

YEAR	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
AGE										
3	42416	13196	5298	15725	55937	34467	3709	2307	7164	7754
4	170566	106984	45912	25999	55644	160048	174585	24545	10792	13739
5	167241	205549	97950	78299	34676	69235	267961	238511	25813	11831
6	89460	95498	58575	68511	42539	22061	107051	181239	137829	9527
7	28297	35518	19642	25444	37169	26295	26701	79363	96420	59290
8	21996	16221	9162	8438	18500	25139	16399	26989	31920	52003
9	7956	11894	6196	3569	5077	11323	11597	13463	8933	12093
10	2728	3884	3553	1467	1495	2329	3657	5092	3249	2434
11	2603	1021	783	1161	380	687	657	1913	1232	762
12	1647	1025	172	131	403	316	122	414	60	418
+gp	775	784	782	337	156	279	240	190	180	216
TOTALNUM	535685	491574	248025	229081	251976	352179	612679	574026	323792	170067
TONSLAND	909266	776337	437695	444930	483711	572605	1074084	1197226	933246	689048
SOPCOF %	124	102	103	129	123	109	108	105	112	124

Table 3.10 (Continued)

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

YEAR	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
AGE										
3	35536	294262	91855	45282	85337	39594	78822	8600	3911	3407
4	45431	131493	437377	59798	114341	168609	45400	77484	17086	9466
5	26832	61000	203772	226646	79993	136335	88495	43677	81986	20803
6	12089	20569	47006	118567	118236	52925	56823	31943	40061	63433
7	7918	7248	12630	29522	47872	61821	25407	16815	17664	21788
8	34885	8328	4370	9353	13962	23338	31821	8274	7442	9933
9	22315	19130	2523	2617	4051	5659	9408	10974	3508	4267
10	4572	4499	5607	1555	936	1521	1227	1785	3196	1311
11	1215	677	2127	1928	558	610	913	427	678	882
12	353	195	322	575	442	71	446	03	79	109
+gp	476	195	296	283	218	268	847	142	58	41
TOTALNUM	191622	547596	807885	496126	465946	490951	339609	200224	175669	135440
TONSLAND	565254	792685	1102433	829377	867463	905301	698715	440538	380434	399038
SOPCOF %	118	130	137	115	127	107	109	121	127	118

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

YEAR	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
AGE										
3	8948	3108	6942	24634	28968	13648	9828	5085	1911	4963
4	20933	19594	14240	45769	70993	137106	22774	1 7313	7551	10933
5	19345	20473	18807	27806	78672	98210	135347	32165	12999	16467
6	28084	17656	20086	19418	25215	61407	54379	81756	17827	20342
7	42496	17004	15145	11369	11711	13707	21015	27854	30007	19479
8	8395	18329	8287	3747	4063	3866	3304	5501	6810	25193
9	2878	2545	5988	1557	976	910	1236	827	828	3888
10	708	646	783	768	726	455	519	290	179	428
11	271	229	232	137	557	187	106	41	59	48
12	260	74	153	36	136	227	69	13	15	12
+gp	37	83	69	71	76	100	62	28	13	4
TOTALNUM	132355	99741	90732	135312	222093	329823	248639	170873	78199	101757
TONSLAND	363730	289992	277651	307920	430113	523071	434939	332481	212000	319158
SOPCOF %	125	90	95	102	102	102	100	99	101	95

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

YEAR	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
AGE										
3	21835	10094	6531	4879	7655	12827	31887	7501	4701	5120
4	36015	46182	59444	42587	28782	36491	88874	77714	33094	35378
5	27494	63578	102548	115329	80711	69633	48972	92816	93044	62325
6	23392	33623	59766	98485	100509	83017	40493	31139	47210	62306
7	18351	14866	32504	32036	54590	65768	34513	15778	12671	22689
8	13541	9449	10019	7334	10545	28392	26354	15851	6677	5250
9	18321	6571	6163	3014	2023	651	6583	8828	787	1777
10	2529	12593	3671	1725	930	1151	965	1837	1647	1167
11	264	1749	7528	1174	462	373	197	195	321	344
12 +gp	13	86	144	264	894	383	117	72	26	35
TOTALNUM	161837	199168	289313	308747	287331	302899	279024	251771	204249	196476
TONSLAND	513234	581611	771086	739999	732228	762403	592624	484910	414868	426347
SOPCOF %	103	101	101	100	101	100	101	100	100	100

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Table 3.11

Run title : Arctic Cod (run: SVPASA14/V14)

At 22/04/2002 15:00

Table 2 Catch weights-at-age (kg)

YEAR	1946	1947	1948	1949	1950	1951
AGE						
3	0,35	0,32	0,34	0,37	0,39	0,4
4	0,59	0,56	0,53	0,67	0,64	0,83
5	1,11	0,95	1,26	1,11	1,29	1,39
6	1,69	1,5	1,93	1,66	1,7	1,88
7	2,37	2,14	2,46	2,5	2,36	2,54
8	3,17	2,92	3,36	3,23	3,48	3,46
9	3,98	3,65	4,22	4,07	4,52	4,88
10	5,05	4,56	5,31	5,27	5,62	5,2
11	5,92	5,84	5,92	5,99	6,4	7,14
12	7,2	7,42	7,09	7,08	7,96	8,22
+gp	8,146	8,848	8,43	8,218	8,891	9,389
SOPCOFAC	1,03	0,9143	0,8915	0,992	1,088	1,1483

Table 2 Catch weights-at-age (kg)

YEAR	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961
AGE										
3	0,44	0,4	0,44	0,32	0,33	0,33	0,34	0,35	0,34	0,31
4	0,8	0,76	0,77	0,57	0,58	0,59	0,52	0,72	0,51	0,55
5	1,33	1,28	1,26	1,13	1,07	1,02	0,95	1,47	1,09	1,05
6	1,92	1,93	1,97	1,73	1,83	1,82	1,92	2,68	2,13	2,2
7	2,64	2,81	3,03	2,75	2,89	2,89	2,94	3,59	3,38	3,23
8	3,71	3,72	4,33	3,94	4,25	4,28	4,21	4,32	4,87	5,11
9	5,06	5,06	5,4	4,9	5,55	5,49	5,61	5,45	6,12	6,15
10	6,05	6,34	6,75	7,04	7,28	7,51	7,35	6,44	8,49	8,15
11	7,42	7,4	7,79	7,2	8	8,24	8,67	7,17	7,79	8,68
12	8,43	8,67	10,67	8,78	8,35	9,25	9,58	8,63	8,3	9,6
+gp	10,185	10,238	9,68	10,077	9,944	10,605	11,631	11,621	11,422	11,952
SOPCOFAC1	0,9348	1,0485	0,9294	1,0634	1,0455	1,0004	1,1232	0,9305	1,0416	1,097

Run title : Arctic Cod (run: SVPASA14/V14)

At 22/04/2002 15:00

Table 2 Catch weights-at-age (kg)

YEAR	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
AGE										
3	0,32	0,32	0,33	0,38	0,44	0,29	0,33	0,44	0,37	0,45
4	0,55	0,61	0,55	0,68	0,74	0,81	0,7	0,79	0,91	0,88
5	0,93	0,96	0,95	1,03	1,18	1,35	1,48	1,23	1,34	1,38
6	1,7	1,73	1,86	1,49	1,78	2,04	2,12	2,03	2	2,16
7	3,03	3,04	3,25	2,41	2,46	2,81	3,14	2,9	3	3,07
8	5,03	4,96	4,97	3,52	3,82	3,48	4,21	3,81	4,15	4,22
9	6,55	6,44	6,41	5,73	5,36	4,89	5,27	5,02	5,59	5,81
10	7,7	7,91	8,07	7,54	7,27	7,11	6,65	6,43	7,6	7,13
11	9,27	9,62	9,34	8,47	8,63	9,03	9,01	8,33	8,97	8,62
12	10,56	11,31	10,16	11,17	10,66	10,59	9,66	10,71	10,99	10,83
+gp	12,717	12,737	12,886	13,722	14,148	13,829	14,848	14,211	14,074	12,945
SOPCOFAC1	1,2356	1,0226	1,0277	1,2903	1,2327	1,0911	1,0785	1,052	1,117	1,2405

Table 3.11 (Continued)

Table 2 Catch weights-at-age (kg)

YEAR	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
AGE										
3	0,38	0,38	0,32	0,41	0,35	0,49	0,49	0,35	0,27	0,49
4	0,77	0,91	0,66	0,64	0,73	0,9	0,81	0,7	0,56	0,98
5	1,43	1,54	1,17	1,11	1,19	1,43	1,45	1,24	1,02	1,44
6	2,12	2,26	2,22	1,9	2,01	2,05	2,15	2,14	1,72	2,09
7	3,23	3,29	3,21	2,95	2,76	3,3	3,04	3,15	3,02	2,98
8	4,38	4,61	4,39	4,37	4,22	4,56	4,46	4,29	4,2	4,85
9	5,83	6,57	5,52	5,74	5,88	6,46	6,54	6,58	5,84	6,57
10	7,62	8,37	7,86	8,77	9,3	8,63	7,98	8,61	7,26	9,16
11	9,52	10,54	9,82	9,92	10,28	9,93	10,15	9,22	8,84	10,82
12	12,09	11,62	11,41	11,81	11,86	10,9	10,85	10,89	9,28	10,77
+gp	13,673	13,904	13,242	13,107	13,544	13,668	13,177	14,344	14,448	13,932
SOPCOFAC1,	1822	1,3003	1,366	1,152	1,2688	1,0683	1,089	1,2139	1,2723	1,1809

Table 2 Catch weights-at-age (kg)

YEAR	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
AGE										
3	0,37	0,84	1,42	0,94	0,64	0,49	0,54	0,74	0,81	1,05
4	0,66	1,37	1,93	1,37	1,27	0,88	0,85	0,96	1,22	1,45
5	1,35	2,09	2,49	2,02	1,88	1,55	1,32	1,31	1,64	2,15
6	1,99	2,86	3,14	3,22	2,79	2,33	2,24	1,92	2,22	2,89
7	2,93	3,99	3,91	4,63	4,49	3,44	3,52	2,93	3,24	3,75
8	4,24	5,58	4,91	6,04	5,84	5,92	5,35	4,64	4,68	4,71
9	6,46	7,77	6,02	7,66	6,83	8,6	8,06	7,52	7,3	6,08
10	8,51	9,29	7,4	9,81	7,69	9,6	9,51	9,12	9,84	8,82
11	12,24	11,55	8,13	11,8	9,81	12,17	11,36	11,08	13,25	11,8
12	10,78	16,2	8,57	14,16	10,71	13,72	14,09	11,47	16,88	16,58
+gp	14,041	17,034	8,609	14,008	12,051	13,38	16,706	16,484	11,617	16,69
SOPCOFAC	1,2521	0,8953	0,9483	1,0182	1,016	1,0224	1,0001	0,9879	1,0108	0,9521

Table 2 Catch weights-at-age (kg)

YEAR	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
AGE										
3	1,16	0,81	0,82	0,77	0,79	0,67	0,68	0,63	0,572	0,66
4	1,57	1,52	1,3 1,2	1,11	1,04	1,05	1,01	1,036	1,04	
5	2,21	2,16	2,06	1,78	1,61	1,53	1,62	1,54	1,609	1,62
6	3,1	2,79	2,89	2,59	2,46	2,22	2,3	2,34	2,344	2,5
7	4,27	4,07	3,21	3,81	3,82	3,42	3,3	3,21	3,341	3,5
8	5,19	5,53	5,2	4,99	5,72	5,2	4,86	4,29	4,476	4,77
9	6,14	6,47	6,8	6,23	6,74	7,19	6,87	6	5,724	6,02
10	7,77	7,19	7,57	8,05	8,04	7,73	9,3	6,73	7,523	7,51
11	10,12	7,98	8,01	8,74	9,28	8,61	10,3	10,08	8,021	8,97
12	11,54	10,11	9,48	9,22	10,4	11,07	15,05	13,88	12,478	10,46
+gp	14,332	14,183	11,978	12,319	10,966	11,117	14,524	14,036	17,241	16,121
SOPCOAC	1,027	1,0127	1,009	1,003	1,0147	1,0004	1,0072	0,9967	1,0039	1,0023

Table 3.12

Run title : Arctic Cod (run: SVPASA14/V14)

At 22/04/2002 15:00

Table 3 Stock weights-at-age (kg)

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

Table 3 Stock weights-at-age (kg)

YEAR,	1952,	1953,	1954,	1955,	1956,	1957,	1958,	1959,	1960,	1961,
AGE										
3,	.4400,	.4000,	.4400,	.3200,	.3300,	.3300,	.3400,	.3500,	.3400,	.3100,
4,	.8000,	.7600,	.7700,	.5700,	.5800,	.5900,	.5200,	.7200,	.5100,	.5500,
5,	1.3300,	1.2800,	1.2600,	1.1300,	1.0700,	1.0200,	.9500,	1.4700,	1.0900,	1.0500,
6,	1.9200,	1.9300,	1.9700,	1.7300,	1.8300,	1.8200,	1.9200,	2.6800,	2.1300,	2.2000,
7,	2.6400,	2.8100,	3.0300,	2.7500,	2.8900,	2.8900,	2.9400,	3.5900,	3.3800,	3.2300,
8,	3.7100,	3.7200,	4.3300,	3.9400,	4.2500,	4.2800,	4.2100,	4.3200,	4.8700,	5.1100,
9,	5.0600,	5.0600,	5.4000,	4.9000,	5.5500,	5.4900,	5.6100,	5.4500,	6.1200,	6.1500,
10,	6.0500,	6.3400,	6.7500,	7.0400,	7.2800,	7.5100,	7.3500,	6.4400,	8.4900,	8.1500,
11,	7.4200,	7.4000,	7.7900,	7.2000,	8.0000,	8.2400,	8.6700,	7.1700,	7.7900,	8.6800,
12,	8.4300,	8.6700,	10.6700,	8.7800,	8.3500,	9.2500,	9.5800,	8.6300,	8.3000,	9.6000,
+gp,	10.1850,	10.2380,	9.6800,	10.0770,	9.9440,	10.6050,	11.6310,	11.6210,	11.4220,	11.9520,

Run title : Arctic Cod (run: SVPASA14/V14)

At 22/04/2002 15:00

Table 3 Stock weights-at-age (kg)

YEAR,	1962,	1963,	1964,	1965,	1966,	1967,	1968,	1969,	1970,	1971,
AGE										
3,	.3200,	.3200,	.3300,	.3800,	.4400,	.2900,	.3300,	.4400,	.3700,	.4500,
4,	.5500,	.6100,	.5500,	.6800,	.7400,	.8100,	.7000,	.7900,	.9100,	.8800,
5,	.9300,	.9600,	.9500,	1.0300,	1.1800,	1.3500,	1.4800,	1.2300,	1.3400,	1.3800,
6,	1.7000,	1.7300,	1.8600,	1.4900,	1.7800,	2.0400,	2.1200,	2.0300,	2.0000,	2.1600,
7,	3.0300,	3.0400,	3.2500,	2.4100,	2.4600,	2.8100,	3.1400,	2.9000,	3.0000,	3.0700,
8,	5.0300,	4.9600,	4.9700,	3.5200,	3.8200,	3.4800,	4.2100,	3.8100,	4.1500,	4.2200,
9,	6.5500,	6.4400,	6.4100,	5.7300,	5.3600,	4.8900,	5.2700,	5.0200,	5.5900,	5.8100,
10,	7.7000,	7.9100,	8.0700,	7.5400,	7.2700,	7.1100,	6.6500,	6.4300,	7.6000,	7.1300,
11,	9.2700,	9.6200,	9.3400,	8.4700,	8.6300,	9.0300,	9.0100,	8.3300,	8.9700,	8.6200,
12,	10.5600,	11.3100,	10.1600,	11.1700,	10.6600,	10.5900,	9.6600,	10.7100,	10.9900,	10.8300,
+gp,	12.7170,	12.7370,	12.8860,	13.7220,	14.1480,	13.8290,	14.8480,	14.2110,	14.0740,	12.9450,

Table 3 Stock weights-at-age (kg)

YEAR,	1972,	1973,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,
AGE										
3,	.3800,	.3800,	.3200,	.4100,	.3500,	.4900,	.4900,	.3500,	.2700,	.4900,
4,	.7700,	.9100,	.6600,	.6400,	.7300,	.9000,	.8100,	.7000,	.5600,	.9800,
5,	1.4300,	1.5400,	1.1700,	1.1100,	1.1900,	1.4300,	1.4500,	1.2400,	1.0200,	1.4400,
6,	2.1200,	2.2600,	2.2200,	1.9000,	2.0100,	2.0500,	2.1500,	2.1400,	1.7200,	2.0900,
7,	3.2300,	3.2900,	3.2100,	2.9500,	2.7600,	3.3000,	3.0400,	3.1500,	3.0200,	2.9800,
8,	4.3800,	4.6100,	4.3900,	4.3700,	4.2200,	4.5600,	4.4600,	4.2900,	4.2000,	4.8500,
9,	5.8300,	6.5700,	5.5200,	5.7400,	5.8800,	6.4600,	6.5400,	6.5800,	5.8400,	6.5700,
10,	7.6200,	8.3700,	7.8600,	8.7700,	9.3000,	8.6300,	7.9800,	8.6100,	7.2600,	9.1600,
11,	9.5200,	10.5400,	9.8200,	9.9200,	10.2800,	9.9300,	10.1500,	9.2200,	8.8400,	10.8200,
12,	12.0900,	11.6200,	11.4100,	11.8100,	11.8600,	10.9000,	10.8500,	10.8900,	9.2800,	10.7700,
+gp,	13.6730,	13.9040,	13.2420,	13.1070,	13.5440,	13.6680,	13.1770,	14.3440,	14.4480,	13.9320,

Table 3.12 (Continued)

```
Table  3    Stock weights-at-age (kg)
YEAR,       1982,    1983,    1984,    1985,    1986,    1987,    1988,    1989,    1990,    1991,

AGE
  3,         .3700,   .3700,   .4200,   .4100,   .3100,   .1900,   .2100,   .3000,   .4000,   .5200,
  4,         .6600,   .9200,  1.1600,   .8800,   .8800,   .5100,   .4000,   .5200,   .7100,  1.1400,
  5,        1.3500,  1.6000,  1.8100,  1.6000,  1.4700,  1.2800,   .7900,   .8700,  1.1800,  1.7400,
  6,        1.9900,  2.4400,  2.7900,  2.8100,  2.4700,  1.9400,  1.9000,  1.4800,  1.7200,  2.4300,
  7,        2.9300,  3.8200,  3.7800,  4.0600,  3.9200,  3.2800,  2.9800,  2.6900,  2.4600,  3.2100,
  8,        4.2400,  4.7600,  4.5700,  5.8300,  5.8100,  5.1700,  4.3900,  4.6300,  3.5700,  4.5400,
  9,        6.4600,  6.1700,  6.1700,  7.6900,  6.5800,  6.5200,  7.8100,  7.0500,  4.7100,  6.8800,
 10,        8.5100,  7.7000,  7.7000, 10.1200,  6.8300,  9.3000, 12.1100,  9.9800,  7.8000, 10.7200,
 11,       12.2400,  9.2500,  9.2500, 14.2900, 11.0000, 13.1500, 13.1100,  9.2500,  8.9600,  9.4500,
 12,       10.7800, 10.8500, 10.8500, 10.8500, 10.8500, 10.8500, 10.8500, 10.8500, 10.8500, 10.8500,
+gp,       14.0410, 12.9880, 13.0330, 13.4130, 13.5870, 13.8260, 13.0180, 14.4790, 13.4230, 14.1000,
```

```
Table  3    Stock weights-at-age (kg)
YEAR,       1992,    1993,    1994,    1995,    1996,    1997,    1998,    1999,    2000,    2001,

AGE
  3,         .4400,   .3400,   .2300,   .2000,   .2000,   .2000,   .2200,   .2000,   .1900,   .2900,
  4,         .9300,  1.1700,   .7500,   .4900,   .4900,   .5200,   .5300,   .5200,   .4700,   .5100,
  5,        1.8100,  1.8200,  1.4200,  1.1400,   .9700,  1.0800,  1.1600,  1.1700,  1.2100,  1.2100,
  6,        2.7200,  2.8200,  2.4100,  2.1200,  2.0500,  1.8800,  1.9400,  2.0300,  1.9800,  2.2600,
  7,        3.9000,  4.0300,  3.8300,  3.4700,  3.5300,  3.3700,  2.9500,  3.0300,  3.1200,  3.2800,
  8,        5.1800,  5.5000,  5.4200,  4.9400,  5.5000,  5.2600,  4.5700,  4.4600,  4.1600,  4.9700,
  9,        6.7700,  6.7700,  6.6300,  7.1600,  7.7700,  8.9300,  7.4200,  6.4800,  5.4700,  6.1600,
 10,        9.6000,  8.5700,  7.6300,  9.1200, 10.1600, 12.1500, 10.3700, 10.2700,  8.3400,  9.1000,
 11,       12.4300,  9.2500,  8.1100, 10.1000, 10.6700, 10.9000, 11.7400, 10.8800,  9.8100, 11.2500,
 12,       10.8500, 10.8500, 10.8500, 10.8500, 10.8500, 10.8500, 10.8500, 10.8500, 10.8500, 10.8500,
+gp,       13.6620, 12.8870, 12.7540, 12.7270, 12.6340, 13.3770, 13.8960, 13.6970, 13.9000, 14.3510,
1
```

Table 3.13

Run title : Arctic Cod (run: SVPASA14/V14)

At 22/04/2002 15:00

Table 5 Proportion mature at age

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

Table 5 Proportion mature at age

YEAR,	1952,	1953,	1954,	1955,	1956,	1957,	1958,	1959,	1960,	1961,
AGE										
3,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
4,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0100,	.0000,
5,	.0100,	.0100,	.0100,	.0100,	.0100,	.0100,	.0100,	.0100,	.0300,	.0100,
6,	.0300,	.0300,	.0300,	.0300,	.0300,	.0300,	.0300,	.0400,	.0600,	.0600,
7,	.0800,	.0700,	.0800,	.0700,	.0600,	.0600,	.0600,	.1200,	.1000,	.1200,
8,	.2200,	.1900,	.1600,	.1300,	.1200,	.0900,	.1000,	.3400,	.1900,	.3100,
9,	.4100,	.4000,	.3700,	.2600,	.1400,	.1200,	.1000,	.4900,	.4500,	.6500,
10,	.6300,	.6400,	.6800,	.5300,	.4100,	.2200,	.3000,	.6700,	.6900,	.9100,
11,	.8200,	.8400,	.8700,	.8300,	.6700,	.6000,	.5000,	.8400,	.7700,	.9800,
12,	.9200,	.9400,	.9300,	.9200,	.9100,	.8200,	.8200,	.8700,	.8500,	.9800,
+gp,	.9700,	.9700,	.9600,	.9700,	.9600,	.9700,	.9700,	1.0000,	.9900,	1.0000,

1

Run title : Arctic Cod (run: SVPASA14/V14)

At 22/04/2002 15:00

Table 5 Proportion mature at age

YEAR,	1962,	1963,	1964,	1965,	1966,	1967,	1968,	1969,	1970,	1971,
AGE										
3,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
4,	.0000,	.0100,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0100,	.0000,
5,	.0100,	.0100,	.0000,	.0000,	.0100,	.0000,	.0300,	.0000,	.0000,	.0100,
6,	.0500,	.0300,	.0300,	.0100,	.0200,	.0300,	.0500,	.0200,	.0100,	.0500,
7,	.1500,	.0700,	.1300,	.0600,	.0600,	.0700,	.0900,	.0400,	.0700,	.1100,
8,	.3400,	.2800,	.3700,	.2000,	.2200,	.1400,	.1900,	.1200,	.2300,	.3000,
9,	.6100,	.4200,	.6600,	.5500,	.3500,	.3800,	.3900,	.3400,	.5800,	.5900,
10,	.8100,	.8100,	.8900,	.7300,	.7400,	.6400,	.5800,	.5500,	.8100,	.7900,
11,	.9200,	.9800,	.9500,	.9900,	.9400,	.8900,	.8200,	.7400,	.8900,	.8600,
12,	.9700,	.9800,	.9900,	.9800,	.9400,	.9000,	1.0000,	.9500,	.9100,	.8800,
+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,	1972,	1973,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,
AGE										
3,	.0100,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
4,	.0200,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
5,	.0200,	.0000,	.0000,	.0100,	.0000,	.0200,	.0000,	.0000,	.0000,	.0200,
6,	.0100,	.0200,	.0100,	.0200,	.0500,	.0800,	.0200,	.0300,	.0200,	.0700,
7,	.1000,	.1600,	.0300,	.0900,	.1200,	.2600,	.1300,	.1300,	.1300,	.2000,
8,	.3400,	.5300,	.2100,	.2100,	.2900,	.5400,	.4400,	.3900,	.3500,	.5400,
9,	.6400,	.8100,	.5000,	.5600,	.4500,	.7600,	.7100,	.7700,	.6500,	.8000,
10,	.8100,	.9200,	.9600,	.7800,	.8400,	.8700,	.7700,	.8900,	.8200,	.9700,
11,	.9400,	.9500,	1.0000,	.7900,	.8300,	.9300,	.8100,	.8300,	1.0000,	1.0000,
12,	1.0000,	.9800,	.9600,	.9500,	1.0000,	.9400,	.8900,	.7800,	.9000,	1.0000,
+gp,	1.0000,	1.0000,	1.0000,	1.0000,	.9000,	.9000,	.8000,	.9000,	.9000,	1.0000,

Table 3.13 (Continued)

Table 5 Proportion mature at age

YEAR,	1982,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,
AGE										
3,	.0000,	.0100,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
4,	.0500,	.0800,	.0500,	.0100,	.0500,	.0100,	.0200,	.0000,	.0100,	.0400,
5,	.1000,	.1000,	.1800,	.0900,	.0800,	.0700,	.0500,	.0500,	.0500,	.0600,
6,	.3400,	.3000,	.3100,	.3600,	.1900,	.1800,	.3300,	.1800,	.2100,	.2800,
7,	.6500,	.7300,	.5600,	.5500,	.5300,	.2200,	.5300,	.4100,	.5800,	.6500,
8,	.8200,	.8800,	.9000,	.8500,	.7100,	.4600,	.6200,	.6900,	.7700,	.8300,
9,	.9200,	.9700,	.9900,	.9600,	.6200,	.5000,	1.0000,	.8500,	.8600,	.9700,
10,	1.0000,	1.0000,	1.0000,	.9000,	.9000,	.7500,	1.0000,	1.0000,	.9800,	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,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,
AGE										
3,	.0100,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
4,	.0100,	.0300,	.0100,	.0000,	.0000,	.0000,	.0100,	.0000,	.0000,	.0100,
5,	.1200,	.0900,	.1100,	.0700,	.0200,	.0200,	.0400,	.0100,	.0600,	.0500,
6,	.4300,	.3000,	.3300,	.3300,	.2600,	.1400,	.1900,	.1000,	.2200,	.3400,
7,	.7500,	.6100,	.6000,	.6200,	.6300,	.5600,	.4400,	.4500,	.6400,	.5800,
8,	.9300,	.9100,	.8100,	.7400,	.8300,	.8200,	.8200,	.7900,	.8300,	.7700,
9,	.9700,	.9700,	.9700,	.9500,	.9800,	.9500,	.9300,	.8800,	.9700,	.9800,
10,	1.0000,	.9900,	.9900,	.9800,	1.0000,	.9500,	.9800,	1.0000,	1.0000,	1.0000,
11,	1.0000,	1.0000,	.9900,	1.0000,	1.0000,	.9500,	1.0000,	1.0000,	1.0000,	.9700,
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,

1

Table 3.14

```
Northeast Arctic cod (Sub-areas I and II) (run name: XSAASA19)
104
FLT09: Russian trawl  catch and effort  ages 9 - 14 (Catch: Thousa (Catch: Unknown) (Effort: Unknown)
1985 2001
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
   3.49     235      95      35       7       0
FLT15: NorBarTrSur rev99 (Catch: Unknown) (Effort: Unknown)
1984 2001
1 1 0.99 1.00
3 8
   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
FLT16: NorBarLofAcSur rev99 (Catch: Unknown) (Effort: Unknown)
1984 2001
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     339     247      49       8       2       0
   1     964     453     123     113     187      92      10       2       2
   1    1588    1456     492     127      68      51      11       6       2
   1    1716     812     554     190      22       8       5       2       1
   1    1131    1013     579     290      72      10       5       3       0
FLT17: RusSurCatch/hr rev00 (ages 1-8) (Catch: Unknown) ( (Catch: Unknown) (Effort: Unknown)
1984 2001
1 1 0.90 1.00
3 8
   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    275    219    169     58      8      3
   1    277    372    206    115     22      3
```

Table 3.15. Compared diagnostics and results for xsa tuned by single fleets and combination of fleets.
All except the final run were based on initial cannibalism data which were slightly different from the final.

		FLT 08 Nor trawl CPUE	FLT 09 Rus trawl CPUE	FLT 15 Joint BT survey	FLT 16 Joint+Lof Ac survey	FLT 17 Rus BT survey	ALL Fleets	Final run F09,15,16,17 final cannibalism
ages with fleet data		9 to 12	9 to 12	3 to 8	3 to 11	3 to 8	3 to 12	3 to 12
# of iterations to convergence		21	18	22	17	19	>50	23
age3	PshrinkW	**0.91**	**0.91**	0.49	**0.74**	**0.76**	0.36	0.36
	FshrinkW	0.09	0.09	0.04	0.07	0.08	0.03	0.03
age4	PshrinkW	**0.88**	**0.87**	0.26	0.34	0.34	0.13	0.13
	FshrinkW	0.12	0.13	0.04	0.05	0.05	0.02	0.02
age5	PshrinkW	**0.80**	**0.80**	0.16	0.18	0.24	0.07	0.07
	FshrinkW	0.20	0.20	0.04	0.05	0.07	0.02	0.02
age6	FshrinkW	**1.00**	**1.00**	0.07	0.07	0.12	0.03	0.03
age7	FshrinkW	**1.00**	**1.00**	0.10	0.12	0.21	0.05	0.05
age8	FshrinkW	**1.00**	**1.00**	0.14	0.26	0.38	0.08	0.08
age9	FshrinkW	0.14	0.44	0.31	0.22	**0.72**	0.06	0.11
age10	FshrinkW	0.16	0.35	**0.63**	0.35	0.90	0.11	0.18
age11	FshrinkW	0.26	0.33	**0.89**	**0.69**	**0.98**	0.18	0.29
age12	FshrinkW	0.12	**0.61**	**0.97**	**0.86**	**0.99**	0.19	**0.56**
N2001	age3	38862	38600	43091	41066	44905	46673	46517
N2001	age4	32014	31776	39711	39578	41151	44121	43991
N2001	age5	21326	21123	23784	25578	25496	26438	26364
N2001	age6	13823	13620	14593	15473	18969	16030	15958
N2001	age7	4612	4501	4237	4444	5288	4493	4466
N2001	age8	920	881	846	816	904	852	843
2001	F(5-10)	0.67	0.88	0.89	0.88	0.83	0.76	0.84
TSB2001		1176	1140	1238	1277	1406	1356	1346
SSB2001		313	301	284	295	339	311	302

Table 3.16

```
 Lowestoft VPA Version 3.1

   22/04/2002  12:39

 Extended Survivors Analysis

 Arctic Cod (run: XSAASA19/X19)

 CPUE data from file fleet

 Catch data for  18 years. 1984 to 2001. Ages  1 to  13.

      Fleet,           First, Last, First, Last, Alpha,  Beta
                  ,    year, year,  age ,  age
 FLT09: Russian trawl,   1992, 2001,   9,    12,   .000,  1.000
 FLT15: NorBarTrSur r,   1992, 2001,   3,     8,   .990,  1.000
 FLT16: NorBarLofAcSu,   1992, 2001,   3,    11,   .990,  1.000
 FLT17: RusSurCatch/h,   1992, 2001,   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   23 iterations

1

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

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

      1,  .467, 2.566, 1.718, 1.872, 1.984, 2.519, 1.640, 1.152, 1.325, 1.058
      2,  .145,  .450,  .630,  .942, 1.069, 1.133,  .693,  .378,  .275,  .082
      3,  .041,  .079,  .208,  .553,  .476,  .349,  .387,  .139,  .080,  .047
      4,  .127,  .096,  .202,  .302,  .353,  .307,  .366,  .220,  .150,  .131
      5,  .221,  .347,  .339,  .336,  .412,  .570,  .539,  .580,  .438,  .308
      6,  .443,  .460,  .646,  .576,  .544,  .725,  .782,  .770,  .672,  .565
      7,  .540,  .566, 1.168,  .892,  .750,  .846,  .775,  .815,  .859,  .824
      8,  .599,  .598,  .986,  .943,  .864, 1.236, 1.052, 1.070, 1.053, 1.165
      9,  .459,  .666, 1.055,  .961,  .752, 1.345, 1.177, 1.436, 1.226,  .933
     10,  .465,  .672, 1.036, 1.022,  .938, 1.510, 1.271, 1.447, 1.311, 1.263
     11,  .256,  .694, 1.204, 1.240,  .872, 1.436, 1.337, 1.002, 1.183, 1.175
     12,  .364,  .710, 1.192, 1.298,  .886, 1.534, 1.288, 1.192, 1.456, 1.317

1
 XSA population numbers (Thousands)

                              AGE
 YEAR ,      1,         2,         3,         4,         5,       6,         7,         8,      9,        10,

 1992 ,    3.05E+06, 1.28E+06, 7.29E+05, 3.35E+05, 1.54E+05, 7.23E+04, 4.86E+04, 3.32E+04, 5.50E+04, 7.51E+03,
 1993 ,    2.43E+07, 1.57E+06, 9.04E+05, 5.73E+05, 2.42E+05, 1.01E+05, 3.80E+04, 2.32E+04, 1.49E+04, 2.84E+04,
 1994 ,    9.35E+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, 6.29E+03,
 1995 ,    2.01E+07, 1.37E+06, 6.66E+05, 5.43E+05, 4.58E+05, 2.49E+05, 6.00E+04, 1.33E+04, 5.39E+03, 2.98E+03,
 1996 ,    2.79E+07, 2.53E+06, 4.38E+05, 3.14E+05, 3.29E+05, 2.68E+05, 1.14E+05, 2.01E+04, 4.23E+03, 1.69E+03,
 1997 ,    1.94E+07, 3.14E+06, 7.10E+05, 2.23E+05, 1.80E+05, 1.78E+05, 1.27E+05, 4.42E+04, 6.95E+03, 1.63E+03,
 1998 ,    6.53E+06, 1.28E+06, 8.27E+05, 4.10E+05, 1.34E+05, 8.35E+04, 7.07E+04, 4.48E+04, 1.05E+04, 1.48E+03,
 1999 ,    2.89E+06, 1.04E+06, 5.25E+05, 4.60E+05, 2.33E+05, 6.41E+04, 3.13E+04, 2.67E+04, 1.28E+04, 2.65E+03,
 2000 ,    3.14E+06, 7.48E+05, 5.82E+05, 3.74E+05, 3.02E+05, 1.07E+05, 2.43E+04, 1.13E+04, 7.49E+03, 2.49E+03,
 2001 ,    3.30E+06, 6.83E+05, 4.65E+05, 4.40E+05, 2.64E+05, 1.60E+05, 4.47E+04, 8.43E+03, 3.24E+03, 1.80E+03,

 Estimated population abundance at 1st Jan 2002

    ,     0.00E+00, 9.39E+05, 5.15E+05, 3.63E+05, 3.16E+05, 1.59E+05, 7.43E+04, 1.60E+04, 2.15E+03, 1.04E+03,

 Taper weighted geometric mean of the VPA populations:

    ,     7.00E+06, 1.27E+06, 6.00E+05, 3.93E+05, 2.48E+05, 1.29E+05, 5.34E+04, 2.01E+04, 7.04E+03, 2.23E+03,


 Standard error of the weighted Log(VPA populations) :

    ,        .9587,    .5687,    .2461,    .3056,    .3888,    .5145,    .6197,    .6676,    .5341,    .5329,
```

Table 3.16 (Continued)

```
                              AGE
YEAR ,          11,           12,

1992 ,    1.29E+03, 2.97E+02,
1993 ,    3.86E+03, 8.20E+02,
1994 ,    1.19E+04, 1.58E+03,
1995 ,    1.83E+03, 2.92E+03,
1996 ,    8.77E+02, 4.33E+02,
1997 ,    5.41E+02, 3.00E+02,
1998 ,    2.95E+02, 1.05E+02,
1999 ,    3.40E+02, 6.35E+01,
2000 ,    5.11E+02, 1.02E+02,
2001 ,    5.50E+02, 1.28E+02,

Estimated population abundance at 1st Jan 2002

   ,     4.16E+02, 1.39E+02,

Taper weighted geometric mean of the VPA populations:

   ,     6.33E+02, 2.02E+02,

Standard error of the weighted Log(VPA populations) :

   ,        .9163,   1.2109,
1

Log catchability residuals.


Fleet : FLT09: Russian trawl

 Age  ,  1992,  1993,  1994,  1995,  1996,  1997,  1998,  1999,  2000,  2001
    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 ,   .20,   .90,   .81,   .57,   .14,  -.11,  -.77,  -.35,   .34,   .11
   10 ,   .55,   .21,   .66,   .58,   .41,  -.12,  -.55,  -.34,   .16,   .00
   11 ,  -.19, -1.05, -1.19,   .30,  -.53,  -.11,   .14, 99.99,  -.31,   .15
   12 ,  -.50, -1.15,  -.60, -2.09, -1.05,  -.71,   .19, 99.99, -1.82,   .05



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,   -3.4658,   -3.5435,   -3.5435,   -3.5435,
S.E(Log q),     .4870,     .3971,     .4588,    1.2589,




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,    1.49,    -.800,       .83,     .38,     10,     .75,   -3.47,
10,     .76,     .951,      4.53,     .79,     10,     .31,   -3.54,
11,    1.39,   -1.495,      2.57,     .81,      9,     .53,   -3.69,
12,    1.48,    -.860,      3.76,     .50,      9,    1.38,   -4.33,
1



Fleet : FLT15: NorBarTrSur r

 Age  ,  1992,  1993,  1994,  1995,  1996,  1997,  1998,  1999,  2000,  2001
    3 ,  -.37,   .03,   .04,  -.05,  -.13,   .07,  -.08,  -.02,   .08,   .05
    4 ,  -.03,  -.08,   .21,   .07,   .18,   .02,  -.22,   .01,  -.02,   .00
    5 ,  -.30,   .23,  -.02,   .15,   .00,   .18,  -.05,  -.04,  -.14,  -.02
    6 ,  -.25,  -.16,   .38,   .00,   .06,   .18,  -.01,  -.17,  -.05,  -.03
    7 ,   .06,  -.16,   .13,  -.10,  -.21,   .19,   .19,   .10,  -.20,  -.06
    8 ,   .20,   .23,   .20,  -.25,   .07,  -.25,  -.26,   .28,   .02,   .14
    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,   -6.1686,   -6.4491,   -6.7203,
S.E(Log q),     .1429,     .1718,     .2204,
```

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,	.75,	1.572,	7.53,	.90,	10,	.09,	-5.58,
4,	.72,	1.440,	7.75,	.86,	10,	.14,	-5.71,
5,	.77,	1.650,	7.44,	.92,	10,	.13,	-5.92,

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

Age, Slope , t-value , Intercept, RSquare, No Pts, Reg s.e, Mean Q

6,	.87,	1.396,	6.92,	.96,	10,	.11,	-6.17,
7,	.92,	.730,	6.82,	.95,	10,	.16,	-6.45,
8,	1.18,	-1.057,	6.16,	.89,	10,	.26,	-6.72,

1

Fleet : FLT16: NorBarLofAcSu

Age ,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001
3 ,	.08,	.78,	-.05,	-.39,	-.42,	.41,	-.44,	.31,	.23,	-.07
4 ,	.35,	.31,	.22,	-.20,	-.06,	.12,	-.39,	.31,	.00,	-.01
5 ,	.14,	.51,	.06,	-.14,	-.33,	.22,	-.30,	.26,	-.01,	.06
6 ,	.45,	.01,	.13,	-.09,	-.08,	.12,	-.17,	.20,	.00,	-.09
7 ,	.86,	.39,	-.35,	-.37,	.01,	.18,	.42,	.27,	-.57,	-.02
8 ,	1.41,	.69,	.57,	-.65,	-.35,	.03,	.46,	.41,	-.60,	.03
9 ,	1.36,	.44,	.95,	-.53,	-.27,	.29,	-.06,	.09,	-.37,	.18
10 ,	.57,	.74,	.68,	.35,	99.99,	-.07,	-.21,	.48,	-.69,	.00
11 ,	.17,	.86,	1.35,	1.57,	1.31,	99.99,	1.47,	1.00,	.08,	99.99
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,	-5.4621,	-5.3872,	-5.4062,	-5.5244,	-4.9376,	-4.9376,
S.E(Log q),	.1388,	.3679,	.4765,	.3765,	.4659,	1.3052,

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,	1.16,	-.215,	4.57,	.31,	10,	.41,	-5.75,
4,	.80,	.540,	7.20,	.63,	10,	.26,	-5.77,
5,	.78,	.729,	7.17,	.72,	10,	.27,	-5.71,

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,	-.764,	4.81,	.93,	10,	.16,	-5.46,
7,	.80,	.986,	6.51,	.85,	10,	.29,	-5.39,
8,	.72,	1.374,	6.68,	.85,	10,	.32,	-5.41,
9,	.87,	.451,	5.96,	.74,	10,	.36,	-5.52,
10,	.71,	1.053,	5.74,	.79,	9,	.33,	-4.94,
11,	.90,	.311,	4.17,	.81,	8,	.65,	-3.92,

1

Fleet : FLT17: RusSurCatch/h

Age ,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001
3 ,	-.05,	.19,	-.29,	-.39,	-.44,	-.81,	.58,	.28,	.10,	.30
4 ,	-.48,	-.02,	-.29,	-.31,	-.22,	-.02,	.21,	.21,	-.06,	.07
5 ,	-1.29,	1.09,	.53,	-.10,	-.52,	-.63,	.19,	.34,	-.04,	.19
6 ,	.11,	.68,	1.67,	-.22,	-.52,	-.79,	.02,	.10,	.12,	.30
7 ,	.17,	.99,	2.22,	.17,	-.16,	-.87,	-.47,	.10,	-.02,	.35
8 ,	.41,	1.10,	2.01,	.46,	.22,	-.80,	-.65,	.02,	-.12,	.28
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,	-6.8136,	-6.9973,	-6.9248,
S.E(Log q),	.5640,	.6892,	.6781,

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,     .92,     .084,      7.96,     .20,     10,     .54,   -7.50,
  4,     .57,    1.382,      9.48,     .71,     10,     .22,   -6.97,
  5,    1.26,    -.495,      5.35,     .46,     10,     .47,   -6.81,

 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,    1.66,    -.803,      3.56,     .26,     10,     .97,   -6.81,
  7,    1.92,    -.990,      3.41,     .21,     10,    1.33,   -7.00,
  8,    2.25,   -1.351,      3.20,     .21,     10,    1.42,   -6.92,
1
 Terminal year survivor and F summaries :

 Age  1   Catchability dependent on age and year class strength

 Year class = 2000

 Fleet,                Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 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  ,   1265971.,    .57,,,,                         .756,     .874

   F shrinkage mean  ,    372602.,   1.00,,,,                         .244,    1.748

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
    938891.,       .49,    13.76,    2,  27.840,  1.058
1
 Age  2   Catchability dependent on age and year class strength

 Year class = 1999

 Fleet,                Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 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  ,    599737.,    .25,,,,                         .943,     .071

   F shrinkage mean  ,     41868.,   1.00,,,,                         .057,     .717

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
    515135.,       .24,    13.17,    2,  55.089,   .082

 Age  3   Catchability dependent on age and year class strength

 Year class = 1998

 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,    382839.,   .300,       .000,    .00,   1,  .358,     .045
 FLT16: NorBarLofAcSu,    339218.,   .462,       .000,    .00,   1,  .151,     .051
 FLT17: RusSurCatch/h,    490637.,   .583,       .000,    .00,   1,  .095,     .035

   P shrinkage mean  ,    392606.,    .31,,,,                         .362,     .044

   F shrinkage mean  ,     52861.,   1.00,,,,                         .034,     .288

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
    363227.,       .18,      .19,    5,   1.039,   .047
1
 Age  4   Catchability dependent on age and year class strength

 Year class = 1997
 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,    327952.,   .212,       .041,    .19,   2,  .359,     .126
 FLT16: NorBarLofAcSu,    336299.,   .250,       .106,    .42,   2,  .263,     .123
 FLT17: RusSurCatch/h,    340620.,   .267,       .012,    .04,   2,  .232,     .122

   P shrinkage mean  ,    247842.,    .39,,,,                         .127,     .164

   F shrinkage mean  ,    136116.,   1.00,,,,                         .019,     .281

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
    316066.,       .13,      .07,    8,    .509,   .131
```

Table 3.16 (Continued)

Age 5 Catchability dependent on age and year class strength

Year class = 1996

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, Weights,	Scaled, F	Estimated F
FLT09: Russian trawl,	1.,	.000,	.000,	.00,	0,	.000,	.000
FLT15: NorBarTrSur r,	155595.,	.175,	.002,	.01,	3,	.384,	.314
FLT16: NorBarLofAcSu,	170155.,	.193,	.073,	.38,	3,	.324,	.290
FLT17: RusSurCatch/h,	166226.,	.239,	.101,	.42,	3,	.206,	.296
P shrinkage mean ,	128896.,	.51,,,,				.069,	.368
F shrinkage mean ,	85700.,	1.00,,,,				.018,	.512

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
158553.,	.11,	.05,	11,	.406,	.308

1

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

Year class = 1995

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, Weights,	Scaled, F	Estimated F
FLT09: Russian trawl,	1.,	.000,	.000,	.00,	0,	.000,	.000
FLT15: NorBarTrSur r,	70065.,	.162,	.031,	.19,	4,	.418,	.590
FLT16: NorBarLofAcSu,	73714.,	.174,	.109,	.63,	4,	.380,	.568
FLT17: RusSurCatch/h,	90915.,	.238,	.088,	.37,	4,	.175,	.482
F shrinkage mean ,	55050.,	1.00,,,,				.027,	.705

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
74273.,	.11,	.05,	13,	.466,	.565

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

Year class = 1994

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, Weights,	Scaled, F	Estimated F
FLT09: Russian trawl,	1.,	.000,	.000,	.00,	0,	.000,	.000
FLT15: NorBarTrSur r,	15066.,	.170,	.029,	.17,	5,	.467,	.860
FLT16: NorBarLofAcSu,	16088.,	.185,	.093,	.50,	5,	.355,	.822
FLT17: RusSurCatch/h,	19741.,	.276,	.116,	.42,	5,	.132,	.713
F shrinkage mean ,	16238.,	1.00,,,,				.046,	.817

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
16036.,	.12,	.04,	16,	.367,	.824

1

Age 8 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, Weights,	Scaled, F	Estimated F
FLT09: Russian trawl,	1.,	.000,	.000,	.00,	0,	.000,	.000
FLT15: NorBarTrSur r,	2167.,	.183,	.068,	.37,	6,	.532,	1.161
FLT16: NorBarLofAcSu,	1917.,	.230,	.134,	.58,	6,	.268,	1.246
FLT17: RusSurCatch/h,	2463.,	.354,	.068,	.19,	6,	.115,	1.075
F shrinkage mean ,	2490.,	1.00,,,,				.084,	1.067

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
2153.,	.15,	.05,	19,	.343,	1.165

Age 9 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, Weights,	Scaled, F	Estimated F
FLT09: Russian trawl,	1160.,	.524,	.000,	.00,	1,	.150,	.869
FLT15: NorBarTrSur r,	1094.,	.187,	.025,	.14,	6,	.286,	.904
FLT16: NorBarLofAcSu,	1095.,	.268,	.114,	.43,	7,	.400,	.903
FLT17: RusSurCatch/h,	932.,	.380,	.078,	.20,	6,	.059,	1.002
F shrinkage mean ,	691.,	1.00,,,,				.105,	1.202

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
1042.,	.18,	.05,	21,	.302,	.933

Table 3.16 (Continued)

Age 10 Catchability constant w.r.t. time and dependent on age

Year class = 1991

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, Weights,	Scaled, F	Estimated F
FLT09: Russian trawl,	439.,	.368,	.126,	.34,	2,	.341,	1.226
FLT15: NorBarTrSur r,	519.,	.189,	.035,	.18,	6,	.103,	1.110
FLT16: NorBarLofAcSu,	391.,	.315,	.085,	.27,	8,	.351,	1.308
FLT17: RusSurCatch/h,	318.,	.377,	.129,	.34,	6,	.022,	1.464
F shrinkage mean ,	389.,	1.00,,,,				.184,	1.312

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
416.,	.25,	.04,	23,	.161,	1.263

Age 11 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, Weights,	Scaled, F	Estimated F
FLT09: Russian trawl,	159.,	.369,	.070,	.19,	3,	.516,	1.086
FLT15: NorBarTrSur r,	127.,	.202,	.091,	.45,	6,	.036,	1.237
FLT16: NorBarLofAcSu,	94.,	.342,	.152,	.44,	8,	.148,	1.465
FLT17: RusSurCatch/h,	78.,	.414,	.104,	.25,	6,	.007,	1.604
F shrinkage mean ,	138.,	1.00,,,,				.293,	1.180

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
139.,	.35,	.05,	24,	.151,	1.175

1

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

Year class = 1989

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, Weights,	Scaled, F	Estimated F
FLT09: Russian trawl,	22.,	.437,	.106,	.24,	4,	.332,	1.502
FLT15: NorBarTrSur r,	23.,	.226,	.036,	.16,	6,	.014,	1.470
FLT16: NorBarLofAcSu,	35.,	.439,	.085,	.19,	9,	.089,	1.154
FLT17: RusSurCatch/h,	18.,	.496,	.173,	.35,	6,	.003,	1.683
F shrinkage mean ,	32.,	1.00,,,,				.561,	1.234

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
28.,	.58,	.05,	26,	.092,	1.317

1

Table 3.17 Fishing mortality when cannibalism added to catch for the period 1984-2000.

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 Run title : Arctic Cod (run: XSAASA19/X19)

    At 22/04/2002  12:40

                   Terminal Fs derived using XSA (With F shrinkage)

       Table  8    Fishing mortality (F) at age
       YEAR,       1984,    1985,    1986,    1987,    1988,    1989,    1990,    1991,

       AGE
         1,        .2436,   .3583,   .5068,   .5205,   .7997,   .2148,   .0481,   .1020,
         2,        .0368,   .0570,   .7923,   .7958,   .1095,   .0020,   .0591,   .2359,
         3,        .0199,   .0533,   .1432,   .1128,   .0629,   .0327,   .0086,   .0183,
         4,        .1236,   .1702,   .2123,   .2288,   .1269,   .1284,   .0622,   .0624,
         5,        .3075,   .3764,   .4936,   .5103,   .3711,   .2659,   .1342,   .1875,
         6,        .6275,   .6052,   .7056,   .9377,   .5983,   .4027,   .2309,   .3210,
         7,       1.1361,   .9249,   .9483,  1.1413,  1.0486,   .7183,   .2514,   .4257,
         8,       1.2112,  1.0189,  1.0913,  1.0151,   .9871,   .8980,   .3766,   .3469,
         9,       1.2624,   .7786,   .8283,   .7790,  1.1620,   .7228,   .3112,   .3841,
        10,        .9580,   .5057,  1.1123,  1.3249,  1.7234,   .9926,   .3289,   .2620,
        11,       1.0877,   .4205,   .8747,  1.0277,  1.5412,   .5873,   .5482,   .1365,
        12,       1.0346,   .4666,  1.0048,  1.1907,  1.6545,   .7980,   .4417,   .2001,
       +gp,       1.0346,   .4666,  1.0048,  1.1907,  1.6545,   .7980,   .4417,   .2001,
0  FBAR  5-10,     .9171,   .7016,   .8632,   .9514,   .9817,   .6667,   .2722,   .3212,


       Table  8    Fishing mortality (F) at age
       YEAR,       1992,    1993,    1994,    1995,    1996,    1997,    1998,    1999,    2000,    2001,       FBAR 99-**

       AGE
         1,        .4668,  2.5659,  1.7185,  1.8723,  1.9837,  2.5190,  1.6403,  1.1520,  1.3252,  1.0584,      1.1785,
         2,        .1449,   .4498,   .6301,   .9420,  1.0691,  1.1334,   .6931,   .3780,   .2754,   .0817,       .2450,
         3,        .0405,   .0789,   .2080,   .5531,   .4756,   .3489,   .3871,   .1393,   .0798,   .0474,       .0889,
         4,        .1265,   .0964,   .2018,   .3018,   .3530,   .3072,   .3660,   .2198,   .1495,   .1306,       .1666,
         5,        .2205,   .3468,   .3394,   .3359,   .4123,   .5701,   .5389,   .5803,   .4382,   .3085,       .4423,
         6,        .4428,   .4597,   .6459,   .5763,   .5435,   .7253,   .7822,   .7698,   .6716,   .5648,       .6687,
         7,        .5398,   .5663,  1.1682,   .8916,   .7500,   .8457,   .7753,   .8153,   .8585,   .8243,       .8327,
         8,        .5989,   .5979,   .9862,   .9435,   .8640,  1.2362,  1.0519,  1.0701,  1.0533,  1.1651,      1.0962,
         9,        .4593,   .6656,  1.0552,   .9613,   .7520,  1.3452,  1.1767,  1.4364,  1.2263,   .9328,      1.1985,
        10,        .4653,   .6723,  1.0365,  1.0222,   .9384,  1.5101,  1.2710,  1.4469,  1.3110,  1.2629,      1.3403,
        11,        .2557,   .6942,  1.2039,  1.2399,   .8724,  1.4362,  1.3370,  1.0022,  1.1829,  1.1754,      1.1202,
        12,        .3640,   .7098,  1.1916,  1.2976,   .8856,  1.5336,  1.2876,  1.1917,  1.4561,  1.3174,      1.3217,
       +gp,        .3640,   .7098,  1.1916,  1.2976,   .8856,  1.5336,  1.2876,  1.1917,  1.4561,  1.3174,
0  FBAR  5-10,     .4544,   .5514,   .8719,   .7885,   .7100,  1.0387,   .9327,  1.0198,   .9265,   .8431,
1
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Table 3.18

Run title : Arctic Cod (run: XSAASA19/X19)

At 22/04/2002 12:40

Terminal Fs derived using XSA (With F shrinkage)

Table 10 Stock number-at-age (start of year) Numbers*10**-4								
YEAR,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,
AGE								
1,	210407,	136084,	113375,	48915,	81790,	81716,	144486,	172673,
2,	66953,	135023,	77863,	55917,	23798,	30097,	53971,	112743,
3,	40264,	52838,	104424,	28866,	20657,	17464,	24593,	41653,
4,	13540,	32317,	41015,	74085,	21113,	15882,	13838,	19962,
5,	7851,	9797,	22318,	27156,	48250,	15225,	11436,	10646,
6,	4763,	4726,	5505,	11154,	13347,	27257,	9555,	8187,
7,	2465,	2082,	2113,	2226,	3576,	6007,	14919,	6210,
8,	1304,	648,	676,	670,	582,	1026,	2398,	9499,
9,	923,	318,	192,	186,	199,	178,	342,	1347,
10,	140,	214,	120,	68,	70,	51,	71,	205,
11,	39,	44,	106,	32,	15,	10,	15,	42,
12,	26,	11,	24,	36,	9,	3,	5,	7,
+gp,	12,	21,	13,	16,	8,	6,	4,	2,
0 TOTAL,	348689,	374124,	367742,	249327,	213413,	194921,	275633,	383177,

Table 10 Stock number-at-age (start of year) Numbers*10**-4													
YEAR,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	GMST 84-99	AMST 84-99
AGE													
1,	304885,	2427683,	934522,	2007828,	2785229,	1944871,	653363,	289226,	313795,	330478,	0,	343542,	771066,
2,	127665,	156506,	152745,	137216,	252769,	313676,	128252,	103732,	74831,	68275,	93889,	98281,	120558,
3,	72910,	90428,	81723,	66597,	43795,	71049,	82679,	52504,	58195,	46517,	51514,	49120,	55778,
4,	33485,	57323,	68417,	54343,	31362,	22284,	41036,	45966,	37395,	43991,	36323,	31915,	36623,
5,	15354,	24157,	42621,	45780,	32902,	18041,	13420,	23300,	30208,	26364,	31607,	19805,	23016,
6,	7226,	10083,	13983,	24853,	26787,	17836,	8353,	6410,	10677,	15958,	15855,	10602,	12502,
7,	4862,	3800,	5213,	6001,	11435,	12735,	7071,	3128,	2430,	4466,	7427,	4836,	5865,
8,	3321,	2320,	1766,	1327,	2014,	4422,	4476,	2666,	1133,	843,	1604,	1778,	2445,
9,	5498,	1494,	1045,	539,	423,	695,	1052,	1280,	749,	324,	215,	604,	982,
10,	751,	2843,	629,	298,	169,	163,	148,	265,	249,	180,	104,	198,	388,
11,	129,	386,	1189,	183,	88,	54,	30,	34,	51,	55,	42,	60,	150,
12,	30,	82,	158,	292,	43,	30,	11,	6,	10,	13,	14,	21,	48,
+gp,	5,	18,	22,	39,	165,	53,	17,	11,	4,	5,	4,		
0 TOTAL,	576123,	2777125,	1304032,	2345297,	3187180,	2405910,	939907,	528529,	529729,	537469,	238597,		

1

Table 3.19 Natural mortality, including cannibalism for the period 1984-2000

Run title : Arctic Cod (run: SVPASA14/V14)

At 22/04/2002 15:00

Table 4 Natural Mortality (M) at age

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

Table 4 Natural Mortality (M) at age

YEAR,	1952,	1953,	1954,	1955,	1956,	1957,	1958,	1959,	1960,	1961,
AGE										
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,

1

Run title : Arctic Cod (run: SVPASA14/V14)

At 22/04/2002 15:00

Table 4 Natural Mortality (M) at age

YEAR,	1962,	1963,	1964,	1965,	1966,	1967,	1968,	1969,	1970,	1971,
AGE										
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,	1972,	1973,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,
AGE										
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,	1982,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,
AGE										
3,	.2000,	.2000,	.2006,	.2004,	.3103,	.2575,	.2086,	.2000,	.2000,	.2050,
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,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,
AGE										
3,	.2067,	.2661,	.3982,	.7426,	.6513,	.5253,	.5357,	.3224,	.2705,	.2349,
4,	.2000,	.2030,	.2958,	.4015,	.4326,	.2970,	.2802,	.2116,	.2442,	.2358,
5,	.2000,	.2026,	.2258,	.2081,	.2815,	.2104,	.2172,	.2000,	.2178,	.2049,
6,	.2000,	.2000,	.2047,	.2001,	.2060,	.2020,	.2099,	.2000,	.2006,	.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,

1

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	0.2436	0.0351	0.0006	0.0000	0.0000	0.0000
1985	0.3562	0.0555	0.0004	0.0000	0.0000	0.0000
1986	0.5067	0.7905	0.1103	0.0000	0.0000	0.0000
1987	0.5205	0.7947	0.0575	0.0000	0.0000	0.0000
1988	0.7997	0.1086	0.0086	0.0000	0.0000	0.0000
1989	0.2148	0.0011	0.0000	0.0000	0.0000	0.0000
1990	0.0481	0.0587	0.0000	0.0000	0.0000	0.0000
1991	0.1020	0.2352	0.0050	0.0000	0.0000	0.0000
1992	0.4664	0.1438	0.0067	0.0000	0.0000	0.0000
1993	2.5659	0.4492	0.0661	0.0030	0.0026	0.0000
1994	1.7185	0.6298	0.1982	0.0958	0.0258	0.0047
1995	1.8723	0.9417	0.5426	0.2015	0.0081	0.0001
1996	1.9837	1.0685	0.4513	0.2316	0.0815	0.0060
1997	2.5190	1.1327	0.3253	0.0970	0.0104	0.0020
1998	1.6403	0.6912	0.3357	0.0802	0.0172	0.0099
1999	1.1520	0.3776	0.1224	0.0116	0.0000	0.0000
2000		0.2750	0.0705	0.0442	0.0178	0.0006
2001			0.0349	0.0358	0.0049	0.0000

Table 3.21 Fishing mortality when cannibalism treated as natural mortality.

```
    Run title : Arctic Cod (run: SVPASA14/V14)

    At 22/04/2002  15:00

                  Traditional vpa  using file input  for terminal F

       Table  8    Fishing mortality (F) at age
       YEAR,       1946,    1947,    1948,    1949,    1950,    1951,

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


       Table  8    Fishing mortality (F) at age
       YEAR,       1952,    1953,    1954,    1955,    1956,    1957,    1958,    1959,    1960,    1961,

       AGE
         3,        .0225,   .0334,   .0199,   .0159,   .0270,   .0240,   .0718,   .0535,   .0543,   .0562,
         4,        .1667,   .1325,   .1457,   .0840,   .1291,   .1128,   .2589,   .2564,   .2266,   .2717,
         5,        .3700,   .2299,   .2676,   .2859,   .4568,   .2094,   .3626,   .5093,   .3477,   .4944,
         6,        .5501,   .3125,   .3333,   .5297,   .6900,   .4862,   .5517,   .5121,   .4607,   .5168,
         7,        .5311,   .3243,   .3969,   .5139,   .6129,   .5494,   .5357,   .5251,   .4363,   .5279,
         8,        .4175,   .3469,   .2494,   .5880,   .6880,   .6287,   .4593,   .5111,   .4855,   .6931,
         9,        .5790,   .3932,   .4364,   .5805,   .6551,   .5463,   .4535,   .6141,   .4053,   .7389,
        10,        .7613,   .5364,   .6441,   .7645,   .7380,   .6333,   .7388,   .6860,   .7381,   .8379,
        11,       1.0260,   .6980,   .8035,   .7621,   .8756,   .8584,   .8415,   .6511,   .8449,  1.0011,
        12,        .9056,   .6217,   .7304,   .7704,   .8152,   .7529,   .7990,   .6734,   .7981,   .9284,
       +gp,        .9056,   .6217,   .7304,   .7704,   .8152,   .7529,   .7990,   .6734,   .7981,   .9284,
0  FBAR  5-10,     .5348,   .3572,   .3879,   .5437,   .6401,   .5089,   .5169,   .5596,   .4789,   .6348,
   FBAR  4- 8,     .4071,   .2692,   .2786,   .4003,   .5154,   .3973,   .4337,   .4628,   .3914,   .5008,
1

    Run title : Arctic Cod (run: SVPASA14/V14)

    At 22/04/2002  15:00

                  Traditional vpa  using file input  for terminal F
       Table  8    Fishing mortality (F) at age

       YEAR,       1962,    1963,    1964,    1965,    1966,    1967,    1968,    1969,    1970,    1971,

       AGE
         3,        .0663,   .0313,   .0174,   .0226,   .0398,   .0298,   .0251,   .0230,   .0409,   .0214,
         4,        .3063,   .2366,   .1449,   .1110,   .1037,   .1525,   .2064,   .2292,   .1422,   .1028,
         5,        .6498,   .7420,   .3537,   .3909,   .2119,   .1814,   .4087,   .4792,   .4004,   .2285,
         6,        .8279,  1.0069,   .4854,   .4494,   .3818,   .2026,   .4683,   .5382,   .5680,   .2517,
         7,        .6094,   .9764,   .5787,   .4033,   .4713,   .4320,   .4019,   .7725,   .6211,   .5144,
         8,        .6564,   .8798,   .7409,   .5303,   .5797,   .6844,   .5291,   .9302,   .8479,   .8330,
         9,        .8167,   .9416,  1.0674,   .7389,   .7183,   .8781,   .8041,  1.1783,   .9682,   .9584,
        10,        .9855,  1.3731,   .8476,   .8074,   .8182,   .8850,   .8105,  1.0769,  1.0900,   .7876,
        11,        .9522,  1.4366,  1.2968,   .7617,   .5024,  1.2253,   .6772,  1.5554,   .8533,   .8388,
        12,        .9756,  1.4264,  1.0883,   .7927,   .6634,  1.0696,   .7458,  1.3377,   .9829,   .8179,
       +gp,        .9756,  1.4264,  1.0883,   .7927,   .6634,  1.0696,   .7458,  1.3377,   .9829,   .8179,
0  FBAR  5-10,     .7576,   .9866,   .6789,   .5533,   .5302,   .5439,   .5704,   .8292,   .7493,   .5956,
   FBAR  4- 8,     .6100,   .7683,   .4607,   .3770,   .3497,   .3306,   .4029,   .5899,   .5159,   .3861,

       Table  8    Fishing mortality (F) at age
       YEAR,       1972,    1973,    1974,    1975,    1976,    1977,    1978,    1979,    1980,    1981,

       AGE
         3,        .0394,   .1959,   .2141,   .0837,   .1660,   .1338,   .1460,   .0489,   .0318,   .0252,
         4,        .1673,   .1996,   .4959,   .2106,   .3121,   .5671,   .2234,   .2090,   .1296,   .1003,
         5,        .2976,   .3536,   .5375,   .5211,   .4800,   .7544,   .6703,   .3475,   .3562,   .2300,
         6,        .3849,   .3917,   .5078,   .7021,   .5715,   .6857,   .8497,   .5478,   .6225,   .5163,
         7,        .3427,   .4210,   .4451,   .7050,   .6973,   .6763,   .8581,   .6643,   .6766,   .8475,
         8,        .6583,   .7375,   .4863,   .7032,   .8908,   .9121,   .9296,   .7789,   .7123,  1.0789,
         9,       1.1338,   .9698,   .5192,   .6109,   .7746,  1.2298,  1.3057,  1.0352,   .9390,  1.2765,
        10,       1.3393,   .7386,   .8842,   .7149,   .4600,   .7689,  1.0301,   .9848,  1.0380,  1.2299,
        11,       1.2904,   .7222,   .9905,   .9079,   .6132,   .6231,  1.8042,  1.4314,  1.4798,   .9557,
        12,       1.3377,   .7358,   .9492,   .8218,   .5389,   .6958,  1.4375,  1.2219,  1.2775,  1.1082,
       +gp,       1.3377,   .7358,   .9492,   .8218,   .5389,   .6958,  1.4375,  1.2219,  1.2775,  1.1082,
0  FBAR  5-10,     .6928,   .6020,   .5633,   .6595,   .6457,   .8379,   .9406,   .7264,   .7241,   .8632,
   FBAR  4- 8,     .3702,   .4207,   .4945,   .5684,   .5904,   .7191,   .7062,   .5095,   .4994,   .5546,
```

Table 3.21 (Continued)

```
       Table  8    Fishing mortality (F) at age
       YEAR,       1982,    1983,    1984,    1985,    1986,    1987,    1988,    1989,    1990,    1991,

       AGE
         3,        .0672,   .0208,   .0194,   .0533,   .0331,   .0556,   .0546,   .0330,   .0087,   .0134,
         4,        .2121,   .2050,   .1247,   .1717,   .2135,   .2296,   .1276,   .1292,   .0627,   .0631,
         5,        .3045,   .3308,   .3097,   .3789,   .4964,   .5110,   .3718,   .2670,   .1352,   .1888,
         6,        .5518,   .5033,   .6302,   .6079,   .7082,   .9376,   .5986,   .4035,   .2323,   .3228,
         7,        .7996,   .7821,  1.1350,   .9265,   .9490,  1.1378,  1.0452,   .7170,   .2528,   .4275,
         8,        .9846,  1.0295,  1.2084,  1.0192,  1.0913,  1.0152,   .9825,   .8939,   .3780,   .3489,
         9,       1.1589,   .9701,  1.2573,   .7819,   .8327,   .7848,  1.1575,   .7196,   .3121,   .3861,
        10,        .7508,   .9204,   .9565,   .5089,  1.1137,  1.3254,  1.7081,   .9860,   .3290,   .2633,
        11,        .9516,   .5854,  1.0812,   .4238,   .8776,  1.0337,  1.5323,   .5862,   .5457,   .1370,
        12,        .8607,   .7590,  1.0346,   .4666,  1.0048,  1.1907,  1.6545,   .7980,   .4417,   .2001,
       +gp,        .8607,   .7590,  1.0346,   .4666,  1.0048,  1.1907,  1.6545,   .7980,   .4417,   .2001,
0  FBAR  5-10,     .7583,   .7560,   .9162,   .7039,   .8652,   .9520,   .9773,   .6645,   .2732,   .3229,
   FBAR  4- 8,     .5705,   .5701,   .6816,   .6209,   .6917,   .7662,   .6251,   .4821,   .2122,   .2702,
```

```
       Table  8    Fishing mortality (F) at age
       YEAR,       1992,    1993,    1994,    1995,    1996,    1997,    1998,    1999,    2000,    2001,       FBAR 99-**

       AGE
         3,        .0341,   .0129,   .0099,   .0106,   .0243,   .0237,   .0515,   .0170,   .0093,   .0125,       .0129,
         4,        .1276,   .0942,   .1068,   .1010,   .1211,   .2115,   .2871,   .2091,   .1056,   .0948,       .1365,
         5,        .2226,   .3464,   .3156,   .3299,   .3327,   .5615,   .5239,   .5815,   .4211,   .3036,       .4354,
         6,        .4449,   .4635,   .6436,   .5790,   .5405,   .7250,   .7733,   .7717,   .6722,   .5648,       .6695,
         7,        .5418,   .5693,  1.1663,   .8931,   .7540,   .8486,   .7783,   .8169,   .8613,   .8243,       .8342,
         8,        .6008,   .6012,   .9865,   .9448,   .8681,  1.2363,  1.0552,  1.0718,  1.0517,  1.1651,      1.0962,
         9,        .4623,   .6687,  1.0554,   .9628,   .7577,  1.3441,  1.1789,  1.4345,  1.2267,   .9328,      1.1980,
        10,        .4682,   .6766,  1.0374,  1.0234,   .9427,  1.5077,  1.2699,  1.4443,  1.3095,  1.2629,      1.3389,
        11,        .2574,   .6981,  1.2049,  1.2360,   .8783,  1.4345,  1.3354,  1.0066,  1.1843,  1.1754,      1.1221,
        12,        .3640,   .7098,  1.1916,  1.2976,   .8856,  1.5336,  1.2876,  1.1917,  1.4561,  1.3174,      1.3217,
       +gp,        .3640,   .7098,  1.1916,  1.2976,   .8856,  1.5336,  1.2876,  1.1917,  1.4561,  1.3174,
0  FBAR  5-10,     .4568,   .5543,   .8675,   .7888,   .6993,  1.0372,   .9299,  1.0201,   .9237,   .8423,
   FBAR  4- 8,     .3876,   .4149,   .6438,   .5696,   .5233,   .7166,   .6836,   .6902,   .6224,   .5905,
1
```

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	0.0193	0.1236	0.3075	0.6275
1985	0.0001	0.0015	0.0529	0.1702	0.3764	0.6052
1986	0.0001	0.0018	0.0329	0.2123	0.4936	0.7056
1987	0.0000	0.0011	0.0553	0.2288	0.5103	0.9377
1988	0.0000	0.0009	0.0543	0.1269	0.3711	0.5983
1989	0.0000	0.0009	0.0327	0.1284	0.2659	0.4027
1990	0.0000	0.0004	0.0086	0.0622	0.1342	0.2309
1991	0.0000	0.0007	0.0133	0.0624	0.1875	0.3210
1992	0.0004	0.0011	0.0338	0.1265	0.2205	0.4428
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	0.0105	0.1003	0.3278	0.5762
1996	0.0000	0.0006	0.0243	0.1204	0.3308	0.5375
1997	0.0000	0.0007	0.0236	0.2102	0.5597	0.7233
1998	0.0000	0.0019	0.0514	0.2858	0.5217	0.7723
1999	0.0000	0.0004	0.0169	0.2082	0.5803	0.7698
2000		0.0004	0.0093	0.1053	0.4204	0.6710
2001			0.0125	0.0948	0.3036	0.5648

Table 3.23

Run title : Arctic Cod (run: SVPASA14/V14)

At 22/04/2002 15:00

Traditional vpa using file input for terminal F

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

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

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

YEAR,	1952,	1953,	1954,	1955,	1956,	1957,	1958,	1959,	1960,	1961,
AGE										
3,	1193111,	1590377,	641584,	272778,	439602,	804781,	496824,	683690,	789653,	916842,
4,	865011,	955076,	1259285,	514924,	219807,	350332,	643259,	378598,	530599,	612324,
5,	401364,	599477,	684912,	891184,	387619,	158175,	256234,	406511,	239862,	346346,
6,	190765,	226975,	389987,	429102,	548181,	200984,	105033,	145989,	199996,	138702,
7,	131099,	90099,	135956,	228785,	206850,	225110,	101196,	49529,	71623,	103298,
8,	66016,	63110,	53333,	74845,	112048,	91748,	106395,	48488,	23986,	37908,
9,	60583,	35603,	36525,	34028,	34036,	46105,	40060,	55027,	23813,	12084,
10,	32000,	27799,	19673,	19329,	15591,	14474,	21860,	20840,	24380,	13000,
11,	14083,	12237,	13311,	8459,	7368,	6103,	6291,	8550,	8592,	9541,
12,	6506,	4133,	4985,	4880,	3232,	2513,	2118,	2220,	3650,	3022,
+gp,	3938,	1880,	2707,	2738,	3722,	1687,	857,	1142,	1351,	2332,
0 TOTAL,	2964476,	3606766,	3242259,	2481052,	1978057,	1902013,	1780129,	1800584,	1917505,	2195401,

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Run title : Arctic Cod (run: SVPASA14/V14)

At 22/04/2002 15:00

Traditional vpa using file input for terminal F

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

YEAR,	1962,	1963,	1964,	1965,	1966,	1967,	1968,	1969,	1970,	1971,
AGE										
3,	728338,	472064,	338678,	776941,	1582560,	1295416,	164955,	112039,	197105,	404774,
4,	709603,	558039,	374580,	272501,	621906,	1245195,	1029477,	131705,	89647,	154909,
5,	382037,	427678,	360621,	265306,	199663,	458995,	875269,	685697,	85743,	63671,
6,	172949,	163321,	166726,	207288,	146941,	132256,	313440,	476187,	347649,	47037,
7,	67732,	61876,	48854,	84015,	108284,	82121,	88421,	160667,	227600,	161288,
8,	49883,	30149,	19083,	22424,	45954,	55340,	43651,	48433,	60756,	100131,
9,	15518,	21185,	10240,	7448,	10803,	21072,	22854,	21054,	15642,	21306,
10,	4726,	5614,	6764,	2883,	2913,	4313,	7170,	8373,	5306,	4863,
11,	4605,	1444,	1164,	2373,	1053,	1052,	1457,	2610,	2335,	1461,
12,	2871,	1455,	281,	261,	907,	522,	253,	606,	451,	815,
+gp,	1351,	1113,	1278,	670,	351,	461,	498,	278,	312,	421,
0 TOTAL,	2139612,	1743938,	1328269,	1642109,	2721334,	3296742,	2547445,	1647648,	1032545,	960676,

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

YEAR,	1972,	1973,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,
AGE										
3,	1015319,	1818949,	523916,	621616,	613942,	348054,	638490,	198489,	137734,	150865,
4,	324399,	799193,	1224278,	346265,	468089,	425778,	249276,	451722,	154747,	109236,
5,	114439,	224670,	535936,	610486,	229669,	280485,	197708,	163230,	300087,	111295,
6,	41482,	69576,	129164,	256342,	296843,	116349,	108003,	82807,	94414,	172067,
7,	29940,	23112,	38504,	63643,	104000,	137232,	47987,	37806,	39202,	41481,
8,	78947,	17401,	12421,	20199,	25746,	42398,	57130,	16658,	15929,	16316,
9,	35642,	33463,	6815,	6253,	8186,	8650,	13943,	18463,	6259,	6397,
10,	6690,	9391,	10388,	3320,	2779,	3089,	2070,	3093,	5368,	2004,
11,	1811,	1435,	3673,	3513,	1330,	1436,	1172,	605,	946,	1557,
12,	517,	408,	571,	1117,	1160,	590,	631,	158,	118,	176,
+gp,	697,	408,	525,	550,	572,	583,	1198,	218,	87,	66,
0 TOTAL,	1649883,	2998007,	2486189,	1933303,	1752317,	1364643,	1317607,	973248,	754891,	611459,

Table 3.23 (Continued)

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

YEAR,	1982,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,
AGE										
3,	151821,	166793,	397650,	523306,	1035454,	286148,	204602,	172786,	242748,	411773,
4,	120441,	116227,	133752,	319106,	406047,	734538,	209235,	157249,	136874,	197019,
5,	80898,	79766,	77519,	96670,	220035,	268540,	478009,	150779,	113139,	105249,
6,	72400,	48847,	46914,	46565,	54186,	109664,	131892,	269849,	94520,	80915,
7,	84062,	34137,	24176,	20453,	20758,	21850,	35158,	59345,	147573,	61345,
8,	14551,	30937,	12785,	6362,	6630,	6579,	5734,	10121,	23721,	93830,
9,	4542,	4451,	9047,	3127,	1880,	1823,	1952,	1758,	3390,	13308,
10,	1461,	1167,	1381,	2107,	1171,	669,	681,	502,	701,	2031,
11,	480,	565,	381,	435,	1037,	315,	146,	101,	153,	413,
12,	490,	152,	257,	106,	233,	353,	92,	26,	46,	73,
+gp,	70,	170,	116,	208,	130,	156,	82,	55,	40,	24,
0 TOTAL,	531217,	483212,	703978,	1018444,	1747562,	1430635,	1067583,	822571,	762905,	965980,

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

YEAR,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	GMST 46-99	AMST 46-99
AGE													
3,	720655,	893685,	806991,	657537,	432544,	702402,	819138,	521661,	579764,	462355,	0,	494955,	610560,
4,	330979,	566438,	676079,	536602,	309618,	220090,	405643,	455358,	371542,	438266,	361020,	375251,	461848,
5,	151440,	238519,	420784,	452009,	324664,	177982,	132360,	230026,	298991,	261885,	314891,	257049,	314011,
6,	71342,	99244,	137753,	244868,	263932,	175665,	82255,	63083,	105287,	157825,	157497,	148245,	182024,
7,	47970,	37435,	51114,	58978,	112347,	125114,	69518,	30771,	23874,	43988,	73456,	74393,	93366,
8,	32753,	22845,	17346,	13036,	19768,	43277,	43845,	26136,	11130,	8261,	15794,	33739,	45388,
9,	54195,	14705,	10253,	5295,	4149,	6794,	10292,	12496,	7327,	3184,	2109,	14470,	25362,
10,	7406,	27947,	6168,	2922,	1655,	1592,	1451,	2592,	2437,	1759,	1026,	5715,	13542,
11,	1278,	3797,	11632,	1790,	860,	528,	289,	334,	501,	539,	407,	2185,	7005,
12,	295,	809,	1547,	2854,	426,	292,	103,	62,	100,	125,	136,	810,	3577,
+gp,	47,	185,	224,	392,	1655,	526,	175,	112,	37,	52,	39,		
0 TOTAL,	1418360,	1905608,	2139890,	1976283,	1471618,	1454262,	1565067,	1342630,	1400988,	1378238,	926374,		

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Table 3.24

Run title : Arctic Cod (run: SVPASA14/V14)

At 22/04/2002 15:00

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

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

YEAR,	1952,	1953,	1954,	1955,	1956,	1957,	1958,	1959,	1960,	1961,
AGE										
3,	524969,	636151,	282297,	87289,	145069,	265578,	168920,	239291,	268482,	284221,
4,	692009,	725857,	969649,	293507,	127488,	206696,	334495,	272591,	270606,	336778,
5,	533814,	767331,	862989,	1007038,	414753,	161338,	243423,	597571,	261449,	363663,
6,	366270,	438062,	768275,	742347,	1003170,	365792,	201664,	391251,	425991,	305145,
7,	346101,	253178,	411947,	629160,	597796,	650567,	297518,	177809,	242086,	333654,
8,	244919,	234769,	230934,	294890,	476204,	392683,	447924,	209470,	116810,	193710,
9,	306548,	180151,	197233,	166739,	188902,	253117,	224738,	299899,	145737,	74320,
10,	193600,	176245,	132792,	136079,	113501,	108698,	160673,	134210,	206985,	105953,
11,	104495,	90555,	103693,	60902,	58944,	50286,	54540,	61300,	66934,	82819,
12,	54844,	35831,	53190,	42844,	26988,	23247,	20287,	19159,	30297,	29013,
+gp,	40110,	19247,	26204,	27591,	37015,	17892,	9967,	13275,	15429,	27875,
0 TOTALBIO,	3407679,	3557376,	4039204,	3488383,	3189831,	2495895,	2164149,	2415826,	2050805,	2137149,

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Run title : Arctic Cod (run: SVPASA14/V14)

At 22/04/2002 15:00

Traditional vpa using file input for terminal F

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

YEAR,	1962,	1963,	1964,	1965,	1966,	1967,	1968,	1969,	1970,	1971,
AGE										
3,	233068,	151061,	111764,	295238,	696327,	375671,	54435,	49297,	72929,	182148,
4,	390282,	340404,	206019,	185301,	460210,	1008608,	720634,	104047,	81578,	136320,
5,	355294,	410571,	342590,	273265,	235602,	619644,	1295399,	843407,	114895,	87866,
6,	294013,	282545,	310111,	308859,	261555,	269803,	664492,	966659,	695298,	101599,
7,	205229,	188104,	158775,	202475,	266378,	230760,	277642,	465934,	682799,	495154,
8,	250910,	149537,	94841,	78931,	175545,	192584,	183771,	184531,	252138,	422555,
9,	101645,	136428,	65640,	42675,	57905,	103040,	120443,	105690,	87437,	123791,
10,	36390,	44408,	54588,	21740,	21174,	30662,	47678,	53839,	40323,	34676,
11,	42684,	13894,	10875,	20098,	9087,	9500,	13129,	21742,	20948,	12590,
12,	30314,	16454,	2856,	2911,	9669,	5524,	2444,	6492,	4958,	8822,
+gp,	17178,	14173,	16470,	9201,	4967,	6369,	7389,	3953,	4396,	5449,
0 TOTALBIO,	1957006,	1747579,	1374529,	1440693,	2198418,	2852164,	3387455,	2805591,	2057698,	1610969,

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

YEAR,	1972,	1973,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,
AGE										
3,	385821,	691201,	167653,	254863,	214880,	170546,	312860,	69471,	37188,	73924,
4,	249787,	727266,	808024,	221610,	341705,	383200,	201913,	316205,	86658,	107051,
5,	163647,	345992,	627045,	677639,	273307,	401093,	286676,	202406,	306089,	160265,
6,	87943,	157241,	286743,	487049,	596655,	238515,	232207,	177207,	162392,	359619,
7,	96707,	76038,	123596,	187748,	287041,	452865,	145879,	119088,	118389,	123612,
8,	345787,	80219,	54527,	88269,	108649,	193334,	254800,	71461,	66900,	79133,
9,	207793,	219854,	37616,	35894,	48132,	55876,	91184,	121484,	36552,	42028,
10,	50977,	78601,	81651,	29113,	25849,	26656,	16521,	26635,	38975,	18354,
11,	17245,	15127,	36074,	34848,	13669,	14264,	11898,	5579,	8362,	16843,
12,	6248,	4742,	6512,	13192,	13760,	6427,	6843,	1720,	1099,	1899,
+gp,	9529,	5674,	6947,	7206,	7750,	7970,	15783,	3124,	1256,	924,
0 TOTALBIO,	1621485,	2401955,	2236387,	2037430,	1931396,	1950747,	1576565,	1114380,	863860,	983653,

Table 3.24 (Continued)

	Table 12	Stock biomass at age (start of year)						Tonnes			
	YEAR,	1982,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,
	AGE										
	3,	56174,	61714,	167013,	214555,	320991,	54368,	42966,	51836,	97099,	214122,
	4,	79491,	106928,	155153,	280813,	357321,	374614,	83694,	81770,	97181,	224602,
	5,	109213,	127626,	140309,	154673,	323452,	343731,	377627,	131177,	133504,	183134,
	6,	144076,	119187,	130891,	130848,	133840,	212748,	250596,	399376,	162574,	196622,
	7,	246303,	130405,	91384,	83041,	81373,	71669,	104770,	159638,	363030,	196917,
	8,	61697,	147260,	58428,	37090,	38522,	34015,	25173,	46862,	84685,	425988,
	9,	29339,	27462,	55822,	24043,	12368,	11884,	15243,	12390,	15965,	91560,
	10,	12436,	8986,	10636,	21320,	8000,	6224,	8244,	5012,	5465,	21774,
	11,	5870,	5224,	3521,	6209,	11406,	4141,	1909,	934,	1374,	3901,
	12,	5283,	1645,	2794,	1147,	2527,	3830,	995,	279,	499,	789,
	+gp,	979,	2209,	1513,	2796,	1768,	2150,	1073,	803,	535,	342,
0	TOTALBIO,	750862,	738645,	817462,	956536,	1291568,	1119375,	912289,	890079,	961913,	1559751,

	Table 12	Stock biomass at age (start of year)						Tonnes			
	YEAR,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,
	AGE										
	3,	317088,	303853,	185608,	131507,	86509,	140480,	180210,	104332,	110155,	134083,
	4,	307811,	662733,	507059,	262935,	151713,	114447,	214991,	236786,	174625,	223516,
	5,	274106,	434104,	597514,	515290,	314924,	192221,	153537,	269130,	361779,	316881,
	6,	194051,	279868,	331986,	519119,	541061,	330250,	159574,	128059,	208468,	356685,
	7,	187082,	150861,	195765,	204654,	396587,	421633,	205077,	93237,	74487,	144280,
	8,	169661,	125648,	94013,	64397,	108725,	227637,	200371,	116565,	46302,	41055,
	9,	366901,	99550,	67975,	37915,	32240,	60667,	76365,	80974,	40077,	19610,
	10,	71098,	239510,	47065,	26646,	16818,	19347,	15042,	26620,	20326,	16008,
	11,	15886,	35120,	94335,	18076,	9172,	5755,	3389,	3629,	4911,	6060,
	12,	3198,	8776,	16781,	30970,	4619,	3173,	1117,	675,	1083,	1361,
	+gp,	638,	2378,	2855,	4995,	20905,	7034,	2427,	1533,	508,	741,
0	TOTALBIO,	1907521,	2342401,	2140955,	1816505,	1683272,	1522644,	1212101,	1061539,	1042720,	1260280,
1											

Table 3.25

Run title : Arctic Cod (run: SVPASA14/V14)

At 22/04/2002 15:00

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

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

YEAR,	1952,	1953,	1954,	1955,	1956,	1957,	1958,	1959,	1960,	1961,
AGE										
3,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
4,	0,	0,	0,	0,	0,	0,	0,	0,	2706,	0,
5,	5338,	7673,	8630,	10070,	4148,	1613,	2434,	5976,	7843,	3637,
6,	10988,	13142,	23048,	22270,	30095,	10974,	6050,	15650,	25559,	18309,
7,	27688,	17722,	32956,	44041,	35868,	39034,	17851,	21337,	24209,	40038,
8,	53882,	44606,	36949,	38336,	57144,	35341,	44792,	71220,	22194,	60050,
9,	125685,	72060,	72976,	43352,	26446,	30374,	22474,	146950,	65582,	48308,
10,	121968,	112796,	90299,	72122,	46535,	23914,	48202,	89921,	142819,	96417,
11,	85686,	76066,	90213,	50549,	39492,	30172,	27270,	51492,	51539,	81163,
12,	50457,	33681,	49467,	39416,	24559,	19063,	16635,	16668,	25753,	28433,
+gp,	38907,	18670,	25156,	26763,	35534,	17356,	9668,	13275,	15274,	27875,
0 TOTSPBIO,	520599,	396417,	429694,	346919,	299823,	207840,	195377,	432489,	383479,	404228,

1

Run title : Arctic Cod (run: SVPASA14/V14)

At 22/04/2002 15:00

Traditional vpa using file input for terminal F

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

YEAR,	1962,	1963,	1964,	1965,	1966,	1967,	1968,	1969,	1970,	1971,
AGE										
3,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
4,	0,	3404,	0,	0,	0,	0,	0,	0,	816,	0,
5,	3553,	4106,	0,	0,	2356,	0,	38862,	0,	0,	879,
6,	14701,	8476,	9303,	3089,	5231,	8094,	33225,	19333,	6953,	5080,
7,	30784,	13167,	20641,	12149,	15983,	16153,	24988,	18637,	47796,	54467,
8,	85309,	41870,	35091,	15786,	38620,	26962,	34917,	22144,	57992,	126766,
9,	62004,	57300,	43323,	23471,	20267,	39155,	46973,	35935,	50714,	73036,
10,	29476,	35970,	48583,	15870,	15669,	19624,	27653,	29611,	32662,	27394,
11,	39269,	13616,	10332,	19897,	8542,	8455,	10766,	16089,	18644,	10827,
12,	29404,	16125,	2828,	2853,	9089,	4972,	2444,	6167,	4512,	7763,
+gp,	17178,	14173,	16470,	9201,	4967,	6369,	7389,	3953,	4396,	5449,
0 TOTSPBIO,	311678,	208207,	186570,	102315,	120722,	129784,	227215,	151870,	224482,	311662,

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

YEAR,	1972,	1973,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,
AGE										
3,	3858,	0,	0,	0,	0,	0,	0,	0,	0,	0,
4,	4996,	0,	0,	0,	0,	0,	0,	0,	0,	0,
5,	3273,	0,	0,	6776,	0,	8022,	0,	0,	0,	3205,
6,	879,	3145,	2867,	9741,	29833,	19081,	4644,	5316,	3248,	25173,
7,	9671,	12166,	3708,	16897,	34445,	117745,	18964,	15481,	15391,	24722,
8,	117567,	42516,	11451,	18536,	31508,	104400,	112112,	27870,	23415,	42732,
9,	132988,	178082,	18808,	20100,	21659,	42466,	64741,	93543,	23759,	33622,
10,	41292,	72313,	78385,	22708,	21713,	23191,	12721,	23705,	31960,	17804,
11,	16210,	14370,	36074,	27530,	11345,	13266,	9637,	4630,	8362,	16843,
12,	6248,	4647,	6251,	12532,	13760,	6041,	6090,	1342,	989,	1899,
+gp,	9529,	5674,	6947,	7206,	6975,	7173,	12626,	2812,	1130,	924,
0 TOTSPBIO,	346511,	332913,	164491,	142028,	171238,	341385,	241536,	174699,	108253,	166925,

Table 3.25 (Continued)

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

YEAR,	1982,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,
AGE										
3,	0,	617,	0,	0,	0,	0,	0,	0,	0,	0,
4,	3975,	8554,	7758,	2808,	17866,	3746,	1674,	0,	972,	8984,
5,	10921,	12763,	25256,	13921,	25876,	24061,	18881,	6559,	6675,	10988,
6,	48986,	35756,	40576,	47105,	25430,	38295,	82697,	71888,	34141,	55054,
7,	160097,	95196,	51175,	45672,	43128,	15767,	55528,	65452,	210557,	127996,
8,	50592,	129589,	52585,	31526,	27350,	15647,	15607,	32335,	65208,	353570,
9,	26992,	26638,	55263,	23081,	7668,	5942,	15243,	10532,	13730,	88814,
10,	12436,	8986,	10636,	19188,	7200,	4668,	8244,	5012,	5356,	21774,
11,	5870,	5224,	3521,	6209,	11406,	4141,	1909,	934,	1374,	3901,
12,	5283,	1645,	2794,	1147,	2527,	3830,	995,	279,	499,	789,
+gp,	979,	2209,	1513,	2796,	1768,	2150,	1073,	803,	535,	342,
0 TOTSPBIO,	326131,	327176,	251077,	193455,	170219,	118247,	201850,	193794,	339048,	672212,

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

YEAR,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,
AGE										
3,	3171,	0,	0,	0,	0,	0,	0,	0,	0,	0,
4,	3078,	19882,	5071,	0,	0,	0,	2150,	0,	0,	2235,
5,	32893,	39069,	65727,	36070,	6298,	3844,	6141,	2691,	21707,	15844,
6,	83442,	83960,	109555,	171309,	140676,	46235,	30319,	12806,	45863,	121273,
7,	140312,	92025,	117459,	126886,	249850,	236115,	90234,	41956,	47671,	83682,
8,	157785,	114340,	76151,	47654,	90241,	186662,	164304,	92086,	38431,	31612,
9,	355894,	96564,	65936,	36019,	31595,	57634,	71019,	71257,	38875,	19218,
10,	71098,	237115,	46594,	26113,	16818,	18380,	14741,	26620,	20326,	16008,
11,	15886,	35120,	93391,	18076,	9172,	5467,	3389,	3629,	4911,	5878,
12,	3198,	8776,	16781,	30970,	4619,	3173,	1117,	675,	1083,	1361,
+gp,	638,	2378,	2855,	4995,	20905,	7034,	2427,	1533,	508,	741,
0 TOTSPBIO,	867395,	729229,	599519,	498092,	570175,	564544,	385842,	253253,	219375,	297853,

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Table 3.26 Summary, including cannibalism for the period 1984-2001

Run title : Arctic Cod (run: SVPASA14/V14)

At 22/04/2002 15:00

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,	1950747,	341385,	905301,	2.6518,	.8379,	.7191,
1978,	638490,	1576565,	241536,	698715,	2.8928,	.9406,	.7062,
1979,	198489,	1114380,	174699,	440538,	2.5217,	.7264,	.5095,
1980,	137734,	863860,	108253,	380434,	3.5143,	.7241,	.4994,
1981,	150865,	983653,	166925,	399038,	2.3905,	.8632,	.5546,
1982,	151821,	750862,	326131,	363730,	1.1153,	.7583,	.5705,
1983,	166793,	738645,	327176,	289992,	.8863,	.7560,	.5701,
1984,	397650,	817462,	251077,	277651,	1.1058,	.9162,	.6816,
1985,	523306,	956536,	193455,	307920,	1.5917,	.7039,	.6209,
1986,	1035454,	1291568,	170219,	430113,	2.5268,	.8652,	.6917,
1987,	286148,	1119375,	118247,	523071,	4.4236,	.9520,	.7662,
1988,	204602,	912289,	201850,	434939,	2.1548,	.9773,	.6251,
1989,	172786,	890079,	193794,	332481,	1.7156,	.6645,	.4821,
1990,	242748,	961913,	339048,	212000,	.6253,	.2732,	.2122,
1991,	411773,	1559751,	672212,	319158,	.4748,	.3229,	.2702,
1992,	720655,	1907521,	867395,	513234,	.5917,	.4568,	.3876,
1993,	893685,	2342401,	729229,	581611,	.7976,	.5543,	.4149,
1994,	806991,	2140955,	599519,	771086,	1.2862,	.8675,	.6438,
1995,	657537,	1816505,	498092,	739999,	1.4857,	.7888,	.5696,
1996,	432544,	1683272,	570175,	732228,	1.2842,	.6993,	.5233,
1997,	702402,	1522644,	564544,	762403,	1.3505,	1.0372,	.7166,
1998,	819138,	1212101,	385842,	592624,	1.5359,	.9299,	.6836,
1999,	521661,	1061539,	253253,	484910,	1.9147,	1.0201,	.6902,
2000,	579764,	1042720,	219375,	414868,	1.8911,	.9237,	.6224,
2001,	462355,	1260280,	297853,	426347,	1.4314,	.8423,	.5905,
Arith. Mean ,	607363,	2029436,	370905,	666649,	2.4748,	.6512,	.4819,
0 Units,	(Thousands),	(Tonnes),	(Tonnes),	(Tonnes),			
1							

Table 3.27 Summary, no cannibalism included

Run title : Arctic Cod (run: SVPASA14/V14)

At 24/04/2002 19:44

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,	1950747,	341385,	905301,	2.6518,	.8379,	.7191,
1978,	638490,	1576565,	241536,	698715,	2.8928,	.9406,	.7062,
1979,	198489,	1114380,	174699,	440538,	2.5217,	.7264,	.5095,
1980,	137734,	863860,	108253,	380434,	3.5143,	.7241,	.4994,
1981,	150865,	983653,	166925,	399038,	2.3905,	.8632,	.5546,
1982,	151821,	750862,	326131,	363730,	1.1153,	.7583,	.5705,
1983,	166793,	738645,	327176,	289992,	.8863,	.7560,	.5701,
1984,	397414,	817363,	251077,	277651,	1.1058,	.9162,	.6816,
1985,	523102,	956452,	193455,	307920,	1.5917,	.7039,	.6209,
1986,	929109,	1258601,	170219,	430113,	2.5268,	.8652,	.6917,
1987,	270605,	1116422,	118247,	523071,	4.4236,	.9520,	.7662,
1988,	202899,	911931,	201850,	434939,	2.1548,	.9773,	.6251,
1989,	172786,	890079,	193794,	332481,	1.7156,	.6645,	.4821,
1990,	242748,	961913,	339048,	212000,	.6253,	.2732,	.2122,
1991,	408093,	1557838,	672212,	319158,	.4748,	.3229,	.2702,
1992,	700256,	1897296,	867293,	513234,	.5918,	.4568,	.3877,
1993,	758583,	2279454,	728599,	581611,	.7983,	.5545,	.4156,
1994,	516200,	2011810,	597228,	771086,	1.2911,	.8683,	.6461,
1995,	306484,	1682302,	497714,	739999,	1.4868,	.7893,	.5737,
1996,	252286,	1592608,	569105,	732228,	1.2866,	.7017,	.5295,
1997,	476396,	1464091,	564434,	762403,	1.3507,	1.0382,	.7203,
1998,	579155,	1141785,	385410,	592624,	1.5376,	.9311,	.6872,
1999,	442602,	1040482,	253252,	484910,	1.9147,	1.0202,	.6910,
2000,	531479,	1020779,	219044,	414868,	1.8940,	.9243,	.6236,
2001,	454660,	1253578,	297780,	426347,	1.4317,	.8423,	.5905,
Arith. Mean ,	576893,	2017933,	370809,	666649,	2.4751,	.6513,	.4823,
0 Units,	(Thousands),	(Tonnes),	(Tonnes),	(Tonnes),			
1							

Table 3.28

The SAS System 12:33 Monday, April 22, 2002

Northeast Arctic cod (Sub-areas I and II)

Prediction with management option table: Input data

Year: 2002								
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	278000.00	0.2349	0.0000	0.0000	0.0000	0.250	0.0117	0.621
4	361020.00	0.2358	0.0150	0.0000	0.0000	0.604	0.1238	1.029
5	314891.00	0.2049	0.0800	0.0000	0.0000	1.187	0.3949	1.590
6	157497.00	0.2000	0.4000	0.0000	0.0000	2.114	0.6072	2.395
7	73456.000	0.2000	0.6950	0.0000	0.0000	3.306	0.7566	3.350
8	15794.000	0.2000	0.8600	0.0000	0.0000	4.744	0.9942	4.512
9	2109.000	0.2000	0.9750	0.0000	0.0000	6.892	1.0865	5.915
10	1026.000	0.2000	1.0000	0.0000	0.0000	8.956	1.2143	7.254
11	407.000	0.2000	1.0000	0.0000	0.0000	11.788	1.0177	9.024
12	136.000	0.2000	1.0000	0.0000	0.0000	10.850	1.1987	12.273
13+	39.000	0.2000	1.0000	0.0000	0.0000	13.700	1.1987	13.089
Unit	Thousands	-	-	-	-	Kilograms	-	Kilograms

Year: 2003								
Age	Recruitment	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
3	468000.00	0.2349	0.0000	0.0000	0.0000	0.243	0.0117	0.621
4	.	0.2358	0.0070	0.0000	0.0000	0.530	0.1238	1.029
5	.	0.2049	0.0650	0.0000	0.0000	1.196	0.3949	1.590
6	.	0.2000	0.3200	0.0000	0.0000	2.111	0.6072	2.395
7	.	0.2000	0.6350	0.0000	0.0000	3.250	0.7566	3.350
8	.	0.2000	0.8200	0.0000	0.0000	4.650	0.9942	4.512
9	.	0.2000	0.9770	0.0000	0.0000	6.250	1.0865	5.915
10	.	0.2000	1.0000	0.0000	0.0000	8.800	1.2143	7.254
11	.	0.2000	1.0000	0.0000	0.0000	10.960	1.0177	9.024
12	.	0.2000	1.0000	0.0000	0.0000	10.850	1.1987	12.273
13+	.	0.2000	1.0000	0.0000	0.0000	13.770	1.1987	13.089
Unit	Thousands	-	-	-	-	Kilograms	-	Kilograms

(cont.)

The SAS System 12:33 Monday, April 22, 2002

Northeast Arctic cod (Sub-areas I and II)

Prediction with management option table: Input data

(cont.)

Year: 2004								
Age	Recruitment	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
3	165000.00	0.2349	0.0000	0.0000	0.0000	0.243	0.0117	0.621
4	.	0.2358	0.0070	0.0000	0.0000	0.530	0.1238	1.029
5	.	0.2049	0.0650	0.0000	0.0000	1.196	0.3949	1.590
6	.	0.2000	0.3200	0.0000	0.0000	2.111	0.6072	2.395
7	.	0.2000	0.6350	0.0000	0.0000	3.250	0.7566	3.350
8	.	0.2000	0.8200	0.0000	0.0000	4.650	0.9942	4.512
9	.	0.2000	0.9770	0.0000	0.0000	6.250	1.0865	5.915
10	.	0.2000	1.0000	0.0000	0.0000	8.800	1.2143	7.254
11	.	0.2000	1.0000	0.0000	0.0000	10.960	1.0177	9.024
12	.	0.2000	1.0000	0.0000	0.0000	10.850	1.1987	12.273
13+	.	0.2000	1.0000	0.0000	0.0000	13.770	1.1987	13.089
Unit	Thousands	-	-	-	-	Kilograms	-	Kilograms

Notes: Run name : MANASA06
Date and time: 22APR02:15:25

Table 3.29

18:48 Wednesday, April 24, 2002
Northeast Arctic cod (Sub-areas I and II)

Single option prediction: Detailed tables

Year: 2002 F-factor: 0.7664 Reference F: 0.6456 — 1 January — Spawning time

Age	F	Absolute numbers	Catch in weight	Catch in size	Stock biomass	Stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
3	0.0090	2212	1373	278000	69500	0	0	0	0
4	0.0949	29167	30003	361020	218056	5415	3271	5415	3271
5	0.3027	74741	118813	314891	373776	25191	29902	25191	29902
6	0.4654	53527	128180	157497	332949	62999	133179	62999	133179
7	0.5799	29578	99096	73456	242846	51052	168778	51052	168778
8	0.7620	7730	34877	15794	74927	13583	64437	13583	64437
9	0.8327	1095	6477	2109	14535	2056	14172	2056	14172
10	0.9307	572	4149	1026	9189	1026	9189	1026	9189
11	0.7800	202	1826	407	4798	407	4798	407	4798
12	0.9187	75	923	136	1476	136	1476	136	1476
13+	0.9187	22	282	39	534	39	534	39	534
Total		198922	426000	1204375	1342584	161904	429735	161904	429735
Unit	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Year: 2003 F-factor: 0.6582 Reference F: 0.5544 — 1 January — Spawning time

Age	F	Absolute numbers	Catch in weight	Catch in size	Stock biomass	Stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
3	0.0077	3200	1986	468000	112320	0	0	0	0
4	0.0815	15210	15646	217838	115454	1525	808	1525	808
5	0.2599	53917	85711	259368	311242	16859	20231	16859	20231
6	0.3997	56976	136438	189552	399954	60657	127985	60657	127985
7	0.4980	29023	97236	80966	263139	51413	167093	51413	167093
8	0.6544	14817	66855	33677	156596	27615	128409	27615	128409
9	0.7151	2828	16725	6035	37721	5897	36854	5897	36854
10	0.7993	379	2753	751	6608	751	6608	751	6608
11	0.6698	148	1337	331	3630	331	3630	331	3630
12	0.7890	77	939	153	1657	153	1657	153	1657
13+	0.7890	29	375	57	787	57	787	57	787
Total		176604	426000	1256728	1409108	165257	494062	165257	494062
Unit	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

(cont.)

18:48 Wednesday, April 24, 2002
Northeast Arctic cod (Sub-areas I and II)

Single option prediction: Detailed tables

(cont.)

Year: 2004 F-factor: 0.6098 Reference F: 0.5136 — 1 January — Spawning time

Age	F	Absolute numbers	Catch in weight	Catch in size	Stock biomass	Stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
3	0.0071	1046	649	165000	39600	0	0	0	0
4	0.0755	23821	24504	367186	194608	2570	1362	2570	1362
5	0.2408	30820	48993	158613	190336	10310	12372	10310	12372
6	0.3703	45985	110118	162947	343818	52143	110022	52143	110022
7	0.4614	35127	117686	104064	338207	66080	214761	66080	214761
8	0.6063	16767	75654	40287	187335	33035	153615	33035	153615
9	0.6626	6362	37628	14331	89568	14001	87508	14001	87508
10	0.7405	1160	8415	2417	21269	2417	21269	2417	21269
11	0.6206	117	1056	276	3030	276	3030	276	3030
12	0.7310	66	810	139	1506	139	1506	139	1506
13+	0.7310	37	486	78	1075	78	1075	78	1075
Total		161307	426000	1015338	1410353	181051	606520	181051	606520
Unit	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Notes: Run name : SPRASA02
Date and time : 24APR02:18:56
Computation of ref. F: Simple mean, age 5 - 10
Prediction basis : TAC constraints

Table 3.30

18:48 Wednesday, April 24, 2002
Northeast Arctic cod (Sub-areas I and II)

Single option prediction: Detailed tables

Year: 2002	F-factor: 1.0000	Reference F: 0.8423	1 January		Spawning time	
Age	F	Absolute numbers	Catch in weight	Catch in size	Stock biomass	Stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
3	0.0117	2883	1789	278000	69500	0	0	0	0
4	0.1238	37541	38617	361020	218056	5415	3271	5415	3271
5	0.3949	93518	148662	314891	373776	25191	29902	25191	29902
6	0.6072	65622	157143	157497	332949	62999	133179	62999	133179
7	0.7566	35777	119865	73456	242846	51052	168778	51052	168778
8	0.9942	9165	41355	15794	74927	13583	64437	13583	64437
9	1.0865	1289	7625	2109	14535	2056	14172	2056	14172
10	1.2143	667	4837	1026	9189	1026	9189	1026	9189
11	1.0177	239	2161	407	4798	407	4798	407	4798
12	1.1987	88	1077	136	1476	136	1476	136	1476
13+	1.1987	25	329	39	534	39	534	39	534
Total		246814	523460	1204375	1342584	161904	429735	161904	429735
Unit	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Year: 2003	F-factor: 0.4986	Reference F: 0.4200	1 January		Spawning time	
Age	F	Absolute numbers	Catch in weight	Catch in size	Stock biomass	Stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
3	0.0058	2426	1506	468000	112320	0	0	0	0
4	0.0617	11599	11931	217244	115139	1521	806	1521	806
5	0.1969	40857	64949	251976	302371	16378	19654	16378	19654
6	0.3027	41129	98490	172850	364714	55312	116709	55312	116709
7	0.3772	20137	67466	70260	228346	44615	145000	44615	145000
8	0.4957	10080	45481	28222	131230	23142	107609	23142	107609
9	0.5417	1830	10825	4785	29905	4675	29217	4675	29217
10	0.6054	242	1757	583	5127	583	5127	583	5127
11	0.5074	91	819	249	2734	249	2734	249	2734
12	0.5977	50	609	120	1307	120	1307	120	1307
13+	0.5977	18	233	43	595	43	595	43	595
Total		128459	304065	1214332	1293788	146639	428756	146639	428756
Unit	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

(cont.)

18:48 Wednesday, April 24, 2002
Northeast Arctic cod (Sub-areas I and II)

Single option prediction: Detailed tables

(cont.)

Year: 2004	F-factor: 0.4986	Reference F: 0.4200	1 January		Spawning time	
Age	F	Absolute numbers	Catch in weight	Catch in size	Stock biomass	Stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
3	0.0058	855	531	165000	39600	0	0	0	0
4	0.0617	19641	20204	367872	194972	2575	1365	2575	1365
5	0.1969	26160	41586	161337	193604	10487	12584	10487	12584
6	0.3027	40118	96069	168601	355749	53952	113840	53952	113840
7	0.3772	29965	100393	104551	339791	66390	215767	66390	215767
8	0.4957	14090	63572	39447	183430	32347	150413	32347	150413
9	0.5417	5384	31842	14075	87967	13751	85944	13751	85944
10	0.6054	948	6874	2279	20054	2279	20054	2279	20054
11	0.5074	95	855	260	2853	260	2853	260	2853
12	0.5977	51	621	123	1334	123	1334	123	1334
13+	0.5977	30	397	74	1015	74	1015	74	1015
Total		137336	362943	1023619	1420370	182238	605169	182238	605169
Unit	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Notes: Run name : SPRASA02
Date and time : 24APR02:18:56
Computation of ref. F: Simple mean, age 5 - 10
Prediction basis : F factors

Table 3.31

The SAS System 12:33

Monday, April 22, 2002

Northeast Arctic cod (Sub-areas I and II)

Prediction with management option table

Year: 2002						Year: 2003						Year: 2004	
F	Reference	Stock	Sp.stock	Catch in		F	Reference	Stock	Sp.stock	Catch in		Stock	Sp.stock
Factor	F	biomass	biomass	weight		Factor	F	biomass	biomass	weight		biomass	biomass
0.7664	0.6456	1342584	429735	426000		0.0000	0.0000	1409797	494070	0		1928573	954427
.	.	.	.	.		0.0250	0.0211	.	494070	19699		1904383	937779
.	.	.	.	.		0.0500	0.0421	.	494070	39077		1880605	921448
.	.	.	.	.		0.0750	0.0632	.	494070	58140		1857232	905429
.	.	.	.	.		0.1000	0.0842	.	494070	76893		1834256	889714
.	.	.	.	.		0.1250	0.1053	.	494070	95343		1811670	874299
.	.	.	.	.		0.1500	0.1263	.	494070	113496		1789466	859176
.	.	.	.	.		0.1750	0.1474	.	494070	131356		1767637	844341
.	.	.	.	.		0.2000	0.1685	.	494070	148929		1746176	829786
.	.	.	.	.		0.2250	0.1895	.	494070	166220		1725076	815506
.	.	.	.	.		0.2500	0.2106	.	494070	183235		1704330	801496
.	.	.	.	.		0.2750	0.2316	.	494070	199978		1683932	787750
.	.	.	.	.		0.3000	0.2527	.	494070	216455		1663875	774264
.	.	.	.	.		0.3250	0.2737	.	494070	232670		1644153	761030
.	.	.	.	.		0.3500	0.2948	.	494070	248628		1624759	748046
.	.	.	.	.		0.3750	0.3159	.	494070	264335		1605687	735304
.	.	.	.	.		0.4000	0.3369	.	494070	279793		1586932	722802
.	.	.	.	.		0.4250	0.3580	.	494070	295009		1568487	710533
.	.	.	.	.		0.4500	0.3790	.	494070	309986		1550346	698493
.	.	.	.	.		0.4750	0.4001	.	494070	324729		1532505	686677
.	.	.	.	.		0.5000	0.4211	.	494070	339241		1514957	675082
.	.	.	.	.		0.5250	0.4422	.	494070	353528		1497697	663702
.	.	.	.	.		0.5500	0.4633	.	494070	367592		1480720	652534
.	.	.	.	.		0.5750	0.4843	.	494070	381439		1464020	641572
.	.	.	.	.		0.6000	0.5054	.	494070	395072		1447592	630814
.	.	.	.	.		0.6250	0.5264	.	494070	408494		1431432	620254
.	.	.	.	.		0.6500	0.5475	.	494070	421710		1415534	609889
.	.	.	.	.		0.6750	0.5685	.	494070	434723		1399894	599715
.	.	.	.	.		0.7000	0.5896	.	494070	447538		1384507	589729
.	.	.	.	.		0.7250	0.6107	.	494070	460156		1369368	579926
.	.	.	.	.		0.7500	0.6317	.	494070	472583		1354473	570303
.	.	.	.	.		0.7750	0.6528	.	494070	484820		1339817	560856
.	.	.	.	.		0.8000	0.6738	.	494070	496873		1325397	551582
.	.	.	.	.		0.8250	0.6949	.	494070	508743		1311207	542477
.	.	.	.	.		0.8500	0.7159	.	494070	520434		1297243	533539
.	.	.	.	.		0.8750	0.7370	.	494070	531950		1283502	524764
.	.	.	.	.		0.9000	0.7581	.	494070	543293		1269980	516148
.	.	.	.	.		0.9250	0.7791	.	494070	554466		1256672	507688
.	.	.	.	.		0.9500	0.8002	.	494070	565472		1243574	499383
.	.	.	.	.		0.9750	0.8212	.	494070	576315		1230684	491227
.	.	.	.	.		1.0000	0.8423	.	494070	586997		1217997	483219
.	.	.	.	.		1.0250	0.8633	.	494070	597521		1205509	475356
.	.	.	.	.		1.0500	0.8844	.	494070	607889		1193217	467634
.	.	.	.	.		1.0750	0.9055	.	494070	618104		1181118	460052
.	.	.	.	.		1.1000	0.9265	.	494070	628170		1169207	452606
.	.	.	.	.		1.1250	0.9476	.	494070	638088		1157483	445293
.	.	.	.	.		1.1500	0.9686	.	494070	647861		1145940	438112
.	.	.	.	.		1.1750	0.9897	.	494070	657492		1134577	431059
.	.	.	.	.		1.2000	1.0107	.	494070	666982		1123390	424133
-	-	Tonnes	Tonnes	Tonnes		-	-	Tonnes	Tonnes	Tonnes		Tonnes	Tonnes

Notes: Run name : MANASA06
Date and time : 22APR02:15:25
Computation of ref. F: Simple mean, age 5 - 10
Basis for 2002 : TAC constraints

Table 3.32

The SAS System 12:33 Monday, April 22, 2002

Northeast Arctic cod (Sub-areas I and II)

Prediction with management option table

Year: 2002					Year: 2003					Year: 2004	
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
1.0000	0.8423	1342584	429735	523460	0.0000	0.0000	1294486	428759	0	1790418	849642
.	.	.	.	.	0.0250	0.0211	.	428759	17644	1768793	835074
.	.	.	.	.	0.0500	0.0421	.	428759	35007	1747529	820781
.	.	.	.	.	0.0750	0.0632	.	428759	52093	1726620	806756
.	.	.	.	.	0.1000	0.0842	.	428759	68908	1706059	792995
.	.	.	.	.	0.1250	0.1053	.	428759	85457	1685840	779492
.	.	.	.	.	0.1500	0.1263	.	428759	101744	1665956	766241
.	.	.	.	.	0.1750	0.1474	.	428759	117774	1646401	753238
.	.	.	.	.	0.2000	0.1685	.	428759	133552	1627169	740478
.	.	.	.	.	0.2250	0.1895	.	428759	149082	1608254	727956
.	.	.	.	.	0.2500	0.2106	.	428759	164369	1589650	715667
.	.	.	.	.	0.2750	0.2316	.	428759	179418	1571352	703606
.	.	.	.	.	0.3000	0.2527	.	428759	194232	1553353	691769
.	.	.	.	.	0.3250	0.2737	.	428759	208815	1535648	680151
.	.	.	.	.	0.3500	0.2948	.	428759	223173	1518232	668749
.	.	.	.	.	0.3750	0.3159	.	428759	237309	1501100	657557
.	.	.	.	.	0.4000	0.3369	.	428759	251226	1484245	646572
.	.	.	.	.	0.4250	0.3580	.	428759	264930	1467664	635789
.	.	.	.	.	0.4500	0.3790	.	428759	278423	1451351	625204
.	.	.	.	.	0.4750	0.4001	.	428759	291709	1435302	614814
.	.	.	.	.	0.5000	0.4211	.	428759	304793	1419510	604615
.	.	.	.	.	0.5250	0.4422	.	428759	317677	1403973	594602
.	.	.	.	.	0.5500	0.4633	.	428759	330365	1388685	584773
.	.	.	.	.	0.5750	0.4843	.	428759	342861	1373641	575123
.	.	.	.	.	0.6000	0.5054	.	428759	355168	1358838	565649
.	.	.	.	.	0.6250	0.5264	.	428759	367289	1344270	556348
.	.	.	.	.	0.6500	0.5475	.	428759	379228	1329934	547215
.	.	.	.	.	0.6750	0.5685	.	428759	390987	1315826	538249
.	.	.	.	.	0.7000	0.5896	.	428759	402571	1301941	529445
.	.	.	.	.	0.7250	0.6107	.	428759	413982	1288275	520801
.	.	.	.	.	0.7500	0.6317	.	428759	425222	1274825	512313
.	.	.	.	.	0.7750	0.6528	.	428759	436296	1261586	503978
.	.	.	.	.	0.8000	0.6738	.	428759	447205	1248555	495794
.	.	.	.	.	0.8250	0.6949	.	428759	457954	1235728	487756
.	.	.	.	.	0.8500	0.7159	.	428759	468543	1223102	479863
.	.	.	.	.	0.8750	0.7370	.	428759	478978	1210672	472112
.	.	.	.	.	0.9000	0.7581	.	428759	489259	1198436	464500
.	.	.	.	.	0.9250	0.7791	.	428759	499389	1186390	457024
.	.	.	.	.	0.9500	0.8002	.	428759	509372	1174530	449682
.	.	.	.	.	0.9750	0.8212	.	428759	519209	1162854	442470
.	.	.	.	.	1.0000	0.8423	.	428759	528904	1151358	435387
.	.	.	.	.	1.0250	0.8633	.	428759	538458	1140038	428430
.	.	.	.	.	1.0500	0.8844	.	428759	547875	1128893	421597
.	.	.	.	.	1.0750	0.9055	.	428759	557155	1117918	414885
.	.	.	.	.	1.1000	0.9265	.	428759	566303	1107111	408292
.	.	.	.	.	1.1250	0.9476	.	428759	575319	1096469	401815
.	.	.	.	.	1.1500	0.9686	.	428759	584207	1085989	395453
.	.	.	.	.	1.1750	0.9897	.	428759	592968	1075668	389202
.	.	.	.	.	1.2000	1.0107	.	428759	601604	1065503	383062
-	-	Tonnes	Tonnes	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes

Notes: Run name : MANASA06
Date and time : 22APR02:15:25
Computation of ref. F: Simple mean, age 5 - 10
Basis for 2002 : F factors

Table 3.33

Monday, April 22, 2002
Northeast Arctic cod (Sub-areas I and II)

Yield per recruit: Input data

Age	Recruitment	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
3	1.000	0.2349	0.0000	0.0000	0.0000	0.240	0.0117	0.620
4	.	0.2358	0.0000	0.0000	0.0000	0.530	0.1238	1.030
5	.	0.2049	0.0400	0.0000	0.0000	1.200	0.3949	1.590
6	.	0.2000	0.2200	0.0000	0.0000	2.110	0.6072	2.390
7	.	0.2000	0.5600	0.0000	0.0000	3.250	0.7566	3.350
8	.	0.2000	0.8000	0.0000	0.0000	4.650	0.9942	4.510
9	.	0.2000	0.9400	0.0000	0.0000	6.250	1.0865	5.910
10	.	0.2000	1.0000	0.0000	0.0000	8.800	1.2143	7.250
11	.	0.2000	1.0000	0.0000	0.0000	10.960	1.0177	9.020
12	.	0.2000	1.0000	0.0000	0.0000	10.850	1.1987	12.270
13+	.	0.2000	1.0000	0.0000	0.0000	12.500	1.1987	12.500
Unit	Numbers	-	-	-	-	Kilograms	-	Kilograms

Notes: Run name : YLDASA05
Date and time: 22APR02:18:28

Table 3.34

Northeast Arctic cod (Sub-areas I and II)

Yield per recruit: Summary table

					1 January		Spawning time	
F Factor	F	Reference numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
0.0000	0.0000	0.000	0.000	5.222	21547.232	2.167	18313.526	2.167	18313.526
0.0250	0.0211	0.062	408.034	4.915	18310.094	1.877	15128.648	1.877	15128.648
0.0500	0.0421	0.110	682.586	4.674	15864.672	1.652	12733.676	1.652	12733.676
0.0750	0.0632	0.149	870.655	4.479	13961.137	1.474	10878.864	1.474	10878.864
0.1000	0.0842	0.182	1000.804	4.318	12443.724	1.327	9408.525	1.327	9408.525
0.1250	0.1053	0.210	1091.181	4.181	11210.397	1.206	8220.696	1.206	8220.696
0.1500	0.1263	0.234	1153.721	4.063	10191.611	1.103	7245.902	1.103	7245.902
0.1750	0.1474	0.254	1196.489	3.961	9338.399	1.015	6435.241	1.015	6435.241
0.2000	0.1685	0.273	1225.057	3.870	8615.335	0.939	5753.352	0.939	5753.352
0.2250	0.1895	0.289	1243.344	3.790	7996.196	0.872	5174.069	0.872	5174.069
0.2500	0.2106	0.304	1254.148	3.718	7461.179	0.814	4677.647	0.814	4677.647
0.2750	0.2316	0.317	1259.490	3.652	6995.078	0.761	4248.932	0.761	4248.932
0.3000	0.2527	0.329	1260.842	3.593	6586.033	0.715	3876.117	0.715	3876.117
0.3250	0.2737	0.340	1259.289	3.538	6224.677	0.673	3549.881	0.673	3549.881
0.3500	0.2948	0.350	1255.632	3.488	5903.520	0.635	3262.782	0.635	3262.782
0.3750	0.3159	0.360	1250.468	3.442	5616.511	0.600	3008.811	0.600	3008.811
0.4000	0.3369	0.369	1244.241	3.398	5358.715	0.569	2783.075	0.569	2783.075
0.4250	0.3580	0.377	1237.284	3.358	5126.069	0.540	2581.552	0.540	2581.552
0.4500	0.3790	0.385	1229.846	3.320	4915.208	0.514	2400.913	0.514	2400.913
0.4750	0.4001	0.392	1222.113	3.285	4723.318	0.489	2238.379	0.489	2238.379
0.5000	0.4211	0.399	1214.224	3.252	4548.033	0.467	2091.620	0.467	2091.620
0.5250	0.4422	0.405	1206.282	3.221	4387.353	0.446	1958.668	0.446	1958.668
0.5500	0.4633	0.412	1198.364	3.191	4239.575	0.427	1837.849	0.427	1837.849
0.5750	0.4843	0.417	1190.525	3.163	4103.241	0.409	1727.738	0.409	1727.738
0.6000	0.5054	0.423	1182.806	3.136	3977.100	0.392	1627.109	0.392	1627.109
0.6250	0.5264	0.428	1175.234	3.111	3860.071	0.376	1534.908	0.376	1534.908
0.6500	0.5475	0.433	1167.830	3.086	3751.214	0.361	1450.222	0.361	1450.222
0.6750	0.5685	0.438	1160.605	3.063	3649.713	0.348	1372.259	0.348	1372.259
0.7000	0.5896	0.443	1153.567	3.041	3554.852	0.335	1300.326	0.335	1300.326
0.7250	0.6107	0.447	1146.720	3.020	3466.004	0.322	1233.819	0.322	1233.819
0.7500	0.6317	0.451	1140.064	2.999	3382.618	0.311	1172.206	0.311	1172.206
0.7750	0.6528	0.455	1133.598	2.980	3304.203	0.300	1115.019	0.300	1115.019
0.8000	0.6738	0.459	1127.319	2.961	3230.328	0.290	1061.845	0.290	1061.845
0.8250	0.6949	0.463	1121.222	2.943	3160.607	0.280	1012.316	0.280	1012.316
0.8500	0.7159	0.467	1115.304	2.925	3094.696	0.271	966.108	0.271	966.108
0.8750	0.7370	0.470	1109.559	2.909	3032.290	0.262	922.929	0.262	922.929
0.9000	0.7581	0.474	1103.981	2.892	2973.111	0.253	882.522	0.253	882.522
0.9250	0.7791	0.477	1098.565	2.877	2916.913	0.245	844.653	0.245	844.653
0.9500	0.8002	0.480	1093.304	2.861	2863.473	0.238	809.116	0.238	809.116
0.9750	0.8212	0.483	1088.193	2.847	2812.588	0.231	775.721	0.231	775.721
1.0000	0.8423	0.486	1083.227	2.832	2764.077	0.224	744.300	0.224	744.300
1.0250	0.8633	0.489	1078.399	2.819	2717.773	0.217	714.702	0.217	714.702
1.0500	0.8844	0.492	1073.704	2.805	2673.527	0.211	686.787	0.211	686.787
1.0750	0.9055	0.495	1069.138	2.792	2631.200	0.205	660.431	0.205	660.431
1.1000	0.9265	0.498	1064.695	2.780	2590.667	0.199	635.520	0.199	635.520
1.1250	0.9476	0.500	1060.370	2.767	2551.815	0.194	611.950	0.194	611.950
1.1500	0.9686	0.503	1056.159	2.755	2514.538	0.189	589.627	0.189	589.627
1.1750	0.9897	0.505	1052.057	2.744	2478.739	0.184	568.465	0.184	568.465
1.2000	1.0107	0.508	1048.061	2.732	2444.330	0.179	548.385	0.179	548.385
-	-	-	-	-	-	-	-	-	-

Notes: Run name : YLDASA05
Date and time : 22APR02:18:28
Computation of ref. F: Simple mean, age 5 - 10
F-0.1 factor : 0.1523
F-max factor : 0.2978
F-0.1 reference F : 0.1283
F-max reference F : 0.2509
Recruitment : Single recruit

Table 3.35 Northeast 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). The discard numbers applied correspond to method II (1946-1982) and IIIb (1983-1998) shown in Figure 3.13.

	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 3.36a Likelihood components at end of keyrun

Name	Unweighted Likelihood	Weight	Weighted Likelihood	Prop.
totalcatchD.cod	373863	20	7477264	0.4311
gillnetD.cod	96616	20	1932316	0.1114
bartrawlwin8593.cod	1610232	1	1610232	0.0928
bartrawlwin9402.cod	794985	1	794985	0.0458
lofoten8589.cod	87933	1	87933	0.0051
lofoten9002.cod	555611	1	555611	0.032
baracwin8593.cod	1282978	1	1282978	0.074
baracwin9402.cod	1189236	1	1189236	0.0686
rustrawl8501.cod	1243521	1	1243521	0.0717
bartrawlaut.9501.cod	997448	1	997448	0.0575
stomach.cod	1746	100	174616	0.0101
Surveys, total	7761943		7761943	0.4475
Catches, total	470479		9409580	0.5425
Stomach, total	1746		174616	0.0101
Total	8234169		17346140	1

Table 3.36b Parameter values at end of keyrun, 2001 values, and sensitivity

Parameter	Value	2001 Value	Likelihood sensitivity	
			-5%	+5%
ba1ac.b	0.0783	0.2469	0.000059	0.000008
ba1ac.slope	0.0053	0.0014	0.000374	0.000200
ba1tr.b	0.4065	0.4062	0.000699	0.000631
ba1tr.slope	0	-0.0002	0.000000	0.000000
ba2ac.b	0.2332	0.3993	0.000208	0.000177
ba2ac.slope	0.0058	0.0016	0.000224	0.000189
ba2tr.b	0.3758	0.4276	0.000388	0.000529
ba2tr.slope	0.003	0.0014	0.000022	0.000085
gil.f1985	0.6769	0.5679	0.000054	0.000053
gil.f1986	0.3928	0.3032	0.000033	0.000032
gil.f1987	0.4278	0.2589	0.000027	0.000029
gil.f1988	0.5144	0.3785	0.000025	0.000029
gil.f1989	0.9582	0.6628	0.000036	0.000040
gil.f1990	0.2082	0.1485	0.000018	0.000017
gil.f1991	0.1842	0.1282	0.000027	0.000027
gil.f1992	0.1359	0.0967	0.000026	0.000026
gil.f1993	0.1679	0.1287	0.000028	0.000033
gil.f1994	0.2222	0.1774	0.000032	0.000034
gil.f1995	0.4294	0.3106	0.000058	0.000060
gil.f1996	0.4368	0.3323	0.000054	0.000055
gil.f1997	0.5145	0.3709	0.000060	0.000064
gil.f1998	0.5586	0.4538	0.000054	0.000052
gil.f1999	0.6272	0.4633	0.000040	0.000038
gil.f2000	0.626	0.4804	0.000036	0.000033
gil.f2001	0.5014		0.000037	0.000032
gil.l50	83.3239	80.0000	0.049080	0.052931
gil.slope	0.0367	0.0387	0.003229	0.002878
growth.1985	8.3317	8.7728	0.000000	0.010946
growth.1986	6.2809	7.3012	0.000787	0.016489
growth.1987	8.3566	6.9926	0.001791	0.020959
growth.1988	7.15	7.3956	0.000454	0.005800
growth.1989	13.0489	13.1577	0.009123	0.004089
growth.1990	10.5856	11.8511	0.006090	0.000847
growth.1991	10.5828	9.8304	0.005754	0.001124
growth.1992	8.8248	8.0952	0.031823	0.000000
growth.1993	6.7464	6.6638	0.023357	0.001280
growth.1994	9.561	10.2580	0.015548	0.000807
growth.1995	8.4603	7.5524	0.001431	0.013932
growth.1996	11.1062	10.7937	0.001333	0.007657
growth.1997	10.6062	9.6489	0.009188	0.000829
growth.1998	8.5245	9.7260	0.014457	0.008708
growth.1999	11.8582	10.5666	0.005050	0.000441
growth.2000	12.0683	11.7000	0.002911	0.006843
growth.2001	10.8442		0.001902	0.000241
growth.k0	0.1531	-0.0415	0.000000	0.008708
growth.k1	0.5123	0.6596	0.021208	0.021881
growth.ratio	0.7792	0.7957	0.006610	0.009064
imm.n_age3	55.2526	55.6596	0.000988	0.000842
imm.n_age4	37.608	37.1615	0.000756	0.000642
imm.n_age5	10.5822	10.7376	0.000212	0.000180
imm.n_age6	3.5504	3.4023	0.000053	0.000054

Table 3.36b (Cont'd)

imm.n_age7	1.2868	1.0011	0.000017	0.000018
imm.n_age8	0.2046	0.1865	0.000001	0.000002
imm.n_age9	0.1365	0.1335	0.000001	0.000002
l_minage.1986	34.3425	34.1084	0.052684	0.047907
l_minage.1987	31.6591	32.1017	0.016040	0.013700
l_minage.1988	32.1587	32.1236	0.015532	0.016775
l_minage.1989	32.303	32.6073	0.006177	0.005195
l_minage.1990	33.5965	34.0210	0.009171	0.007590
l_minage.1991	37.8337	39.7212	0.012545	0.012339
l_minage.1992	38.8367	39.7733	0.037531	0.035719
l_minage.1993	36.396	36.5644	0.039569	0.037606
l_minage.1994	30.6195	30.8819	0.020323	0.017031
l_minage.1995	29.6721	30.0620	0.009604	0.008490
l_minage.1996	29.3409	29.7766	0.008609	0.008101
l_minage.1997	30.3504	30.9709	0.021492	0.020619
l_minage.1998	31.3425	31.0328	0.030194	0.029982
l_minage.1999	28.4458	28.9558	0.009611	0.009115
l_minage.2000	28.8552	28.7652	0.010964	0.010585
l_minage.2001	32.8703	33.2432	0.006526	0.006459
l_minage.2002	31.5538		0.001266	0.001174
lof1ac.cbt	0.7317	0.6775	0.000022	0.000017
lof1ac.l50	51.2518	43.1426	0.000007	0.000009
lof1ac.slope	0.0103	0.0081	0.000001	0.000001
lof2ac.cbt	2.01	1.0100	0.000172	0.000119
lof2ac.l50	87.8967	64.5238	0.000853	0.000957
lof2ac.slope	0.0117	0.0219	0.000040	0.000031
n_minage.1986	123.5562	125.8591	0.001805	0.001550
n_minage.1987	36.8587	38.5834	0.000502	0.000427
n_minage.1988	28.0084	28.7296	0.000392	0.000335
n_minage.1989	19.4994	19.8993	0.000282	0.000239
n_minage.1990	30.325	30.0839	0.000426	0.000370
n_minage.1991	49.2732	50.1210	0.000765	0.000653
n_minage.1992	79.876	81.5620	0.001229	0.001084
n_minage.1993	104.5486	106.2583	0.001486	0.001330
n_minage.1994	88.6541	90.1468	0.001070	0.001000
n_minage.1995	56.803	57.1602	0.000701	0.000648
n_minage.1996	36.2454	36.1087	0.000552	0.000496
n_minage.1997	59.7255	61.0898	0.001000	0.000884
n_minage.1998	69.9894	72.7707	0.001126	0.001007
n_minage.1999	43.4426	42.7957	0.000506	0.000474
n_minage.2000	51.1067	54.4713	0.000346	0.000336
n_minage.2001	31.8426	37.4844	0.000118	0.000124
n_minage.2002	17.8735		0.000022	0.000022

Table 3.36b (Cont'd)

nortr.b	0.6261	0.6963	0.000660	0.000600
nortr.slope	0	-0.0010	0.000000	0.000000
rustr.b	0.0705	0.0836	0.000214	-0.000022
rustr.slope	0.0009	0.0008	0.000118	-0.000038
tot.f1985	0.3171	0.3202	0.000307	0.000288
tot.f1986	0.5069	0.4952	0.000515	0.000460
tot.f1987	0.9153	0.8641	0.000775	0.000732
tot.f1988	0.7756	0.7614	0.000575	0.000549
tot.f1989	0.5318	0.5163	0.000387	0.000371
tot.f1990	0.1805	0.1731	0.000175	0.000161
tot.f1991	0.1824	0.1721	0.000206	0.000196
tot.f1992	0.2055	0.1940	0.000317	0.000292
tot.f1993	0.2829	0.2743	0.000488	0.000450
tot.f1994	0.427	0.4139	0.000681	0.000620
tot.f1995	0.4866	0.4670	0.000718	0.000654
tot.f1996	0.587	0.5655	0.000703	0.000641
tot.f1997	0.8436	0.8191	0.000780	0.000717
tot.f1998	0.9528	0.9394	0.000744	0.000672
tot.f1999	0.8989	0.8454	0.000598	0.000548
tot.f2000	0.595	0.5622	0.000403	0.000357
tot.f2001	0.5042		0.000342	0.000303
tot.l50	52.9363	52.8097	0.162960	0.213110
tot.slope	0.0501	0.0500	0.005477	0.005426

Table 3.36c Fixed parameter values used in keyrun

Constant parameters (not optimized)	
growth.exponent	0
cann_beta	0.001033
cann_gamma	0.0001
cann_delta	0.309428
cann_alpha	7.00E-06
imm.mort1	0.05
imm.mort2	0.05
imm.mort3	0.05
imm.n_age10	0
imm.l_age3	40.6
imm.l_age4	48.7
imm.l_age5	61.3
imm.l_age6	71.1
imm.l_age7	81.2
imm.l_age8	85.7
imm.l_age9	90
imm.l_age10	90
imm.d_age3	5.1
imm.d_age4	4.1
imm.d_age5	4.9
imm.d_age6	5.3
imm.d_age7	5.4
imm.d_age8	8.7
imm.d_age9	8.7
imm.d_age10	8.7
maturation.slope	0.03
maturation.l50	76
d_minage.1986	4.4
d_minage.1987	3.5
d_minage.1988	3.1
d_minage.1989	2.9
d_minage.1990	4.3
d_minage.1991	5.8
d_minage.1992	4.8
d_minage.1993	4.4
d_minage.1994	5
d_minage.1995	5.9
d_minage.1996	5
d_minage.1997	3.9
d_minage.1998	4.4
d_minage.1999	4.2
d_minage.2000	4.1
d_minage.2001	4.1
d_minage.2002	4.6
mat.mort1	0.05
mat.mort2	0.05
mat.mort3	0.05
mat.n_age4	0
mat.n_age5	0.868
mat.n_age6	1.68
mat.n_age7	1.13
mat.n_age8	0.54

Table 3.36c (Cont'd)

mat.n_age9	0.3
mat.n_age10	0.19
mat.n_age11	0.04
mat.n_age12	0.03
mat.l_age4	51
mat.l_age5	59.6
mat.l_age6	71.1
mat.l_age7	79
mat.l_age8	88.2
mat.l_age9	97.3
mat.l_age10	105.2
mat.l_age11	114
mat.l_age12	114
mat.d_age4	14.9
mat.d_age5	1.1
mat.d_age6	6.74503
mat.d_age7	3.184107
mat.d_age8	5.107078
mat.d_age9	3.064587
mat.d_age10	5.437319
mat.d_age11	10.62126
mat.d_age12	3.265886
ovr.f1985	0
ovr.f1986	0
ovr.f1987	0
ovr.f1988	0
ovr.f1989	0
ovr.f1990	0.026
ovr.f1991	0.037
ovr.f1992	0.085
ovr.f1993	0.031
ovr.f1994	0.018
ovr.f1995	0
ovr.f1996	0
ovr.f1997	0
ovr.f1998	0
ovr.f1999	0
ovr.f2000	0
ovr.f2001	0
ba1tr.cbt	1
ba1tr.b0	1
ba2tr.cbt	1
ba2tr.b0	1
lof1ac.b0	1
lof2ac.b0	1
ba1ac.cbt	1
ba1ac.b0	1
ba2ac.cbt	1
ba2ac.b0	1
rustr.cbt	1
rustr.b0	1
nortr.cbt	1
nortr.b0	1

Table 3.37. Results from the key run

runid skrei Tue Apr 23 16:30:57 2002
stocks cod.imm cod.mat
areas 0

Total fishing mortality at age

Year	1985	1986	1987
Age			
3	0.0644	0.0318	0.0377
4	0.1605	0.2301	0.1782
5	0.3429	0.4122	0.6276
6	0.4720	0.5986	0.9028
7	0.6366	0.7057	1.1169
8	0.7918	0.8163	1.2395
9	0.9166	0.8812	1.3520
10	1.0152	0.9304	1.4013
11	1.0277	0.9640	1.4380
12+	1.0411	0.9688	1.4611
F 5-10	0.6959	0.7241	1.1067

Total fishing mortality at age

Year	1988	1989	1990	1991	1992	1993	1994
Age							
3	0.0293	0.0298	0.0170	0.0358	0.0456	0.0289	0.0240
4	0.1206	0.0972	0.0822	0.0786	0.1444	0.1392	0.1500
5	0.3295	0.2311	0.1400	0.1759	0.2179	0.2589	0.3597
6	0.7003	0.4045	0.1940	0.2194	0.3040	0.3226	0.4904
7	0.8865	0.6561	0.2375	0.2546	0.3336	0.3911	0.5541
8	1.0768	0.8521	0.2992	0.2882	0.3600	0.4217	0.6302
9	1.2051	1.1699	0.3475	0.3403	0.3845	0.4504	0.6664
10	1.3096	1.3652	0.4020	0.3757	0.4155	0.4748	0.6979
11	1.3429	1.5100	0.4257	0.4067	0.4327	0.5016	0.7241
12+	1.3707	1.5543	0.4416	0.4189	0.4452	0.5148	0.7507
F 5-10	0.9180	0.7798	0.2700	0.2757	0.3359	0.3866	0.5665

Total fishing mortality at age

Year	1995	1996	1997	1998	1999	2000	2001	1999-2001
Age								
3	0.0231	0.0268	0.0387	0.0446	0.0309	0.0201	0.0306	0.0272
4	0.1244	0.1241	0.2131	0.2215	0.2010	0.1320	0.1132	0.1487
5	0.3614	0.3355	0.4829	0.5601	0.5044	0.3837	0.3249	0.4043
6	0.5482	0.5909	0.7841	0.8415	0.7945	0.5923	0.5316	0.6395
7	0.6600	0.7405	1.0100	1.0802	0.9885	0.7369	0.6523	0.7926
8	0.7343	0.8457	1.1602	1.2696	1.1780	0.8628	0.7542	0.9317
9	0.8500	0.9195	1.2689	1.4090	1.3652	1.0219	0.8482	1.0784
10	0.9033	1.0195	1.3389	1.4961	1.4902	1.1699	0.9544	1.2048
11	0.9476	1.0598	1.4156	1.5498	1.5596	1.2494	1.0339	1.2810
12+	0.9812	1.0995	1.4522	1.6089	1.6119	1.2936	1.0716	1.3257
F 5-10	0.6762	0.7419	1.0075	1.1094	1.0535	0.7946	0.6776	

Table 3.37 (Cont'd)

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stocks cod.imm cod.mat
areas 0

Residual natural mortality (M1)

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

Residual natural mortality (M1)

Year	1988	1989	1990	1991	1992	1993	1994
Age							
3	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
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	0.2000	0.1999	0.2000	0.2000	0.2000	0.2000	0.2000
9	0.2000	0.1999	0.2000	0.2000	0.2000	0.2000	0.2000
10	0.2000	0.1999	0.2000	0.2000	0.2000	0.2000	0.2000
11	0.2000	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	1995	1996	1997	1998	1999	2000	2001	1999-2001
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	0.2000	0.1999	0.1999	0.1999	0.2000	0.2000	0.2000
6	0.2000	0.2000	0.2000	0.1999	0.1999	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	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
10	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
11	0.2000	0.2000	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	0.2000

Predation mortality (M2)

Year	1985	1986	1987
Age			
3	0.0337	0.1224	0.1397
4	0.0066	0.0139	0.0351

Predation mortality (M2)

Year	1988	1989	1990	1991	1992	1993	1994
Age							
3	0.0754	0.0481	0.0640	0.0563	0.0810	0.1766	0.3636
4	0.0188	0.0119	0.0054	0.0157	0.0200	0.0446	0.0849

Predation mortality (M2)

Year	1995	1996	1997	1998	1999	2000	2001	1999-2001
Age								
3	0.4302	0.2685	0.1606	0.0739	0.0567	0.0660	0.0545	0.0591
4	0.1110	0.0904	0.0475	0.0204	0.0102	0.0085	0.0134	0.0107

Table 3.37 (Cont'd)

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stocks cod.imm cod.mat
areas 0

Stock numbers (thousands) at age by Jan. 1

Year	1985	1986	1987	1988
Age				
3	552360	1235137	368525	280045
4	376048	409984	866812	252667
5	114505	255204	256342	556526
6	52293	66481	137115	110284
7	24146	26706	29910	45444
8	7432	10459	10796	8014
9	4363	2756	3785	2559
10	1900	1427	938	802
11	400	564	458	189
12+	300	204	239	134
Total	1133747	2008921	1674920	1256664

Stock numbers (thousands) at age by Jan. 1

Year	1989	1990	1991	1992	1993	1994	1995
Age							
3	195045	303192	492669	798515	1045191	885189	564194
4	206479	147718	228933	367843	576016	696793	491838
5	174900	147227	108455	166825	251145	383280	439287
6	318011	111679	103884	74199	108702	156054	213860
7	44596	172899	75177	68251	44801	64238	77868
8	15325	18926	111596	47706	40022	24802	30196
9	2235	5348	11485	68474	27246	21489	10811
10	628	568	3093	6697	38175	14380	9078
11	177	131	311	1733	3599	19262	5812
12+	68	44	93	219	1035	2291	8530
Total	957464	907733	1135696	1600460	2135933	2267779	1851474

Stock numbers (thousands) at age by Jan. 1

Year	1996	1997	1998	1999	2000	2001	2002
Age							
3	361684	597197	699661	433932	510628	318383	178628
4	293372	220376	400597	508788	325487	383597	239406
5	309189	188576	135258	249767	327478	225005	268895
6	242950	175029	92647	61926	121752	181053	131735
7	100728	109688	65109	32507	22837	55072	87037
8	32916	39297	32690	18088	9896	8944	23477
9	11857	11561	10080	7516	4557	3416	3443
10	3799	3873	2665	2019	1572	1344	1199
11	2994	1118	826	486	371	398	421
12+	4463	2066	618	245	124	115	148
Total	1363952	1348781	1440152	1315274	1324702	1177327	934389

Table 3.37 (Cont'd)

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

Spawning stock biomass (tons) at Jan. 1
Year         1985    1986
Age
  4             0       0
  5         15242   39631
  6         52597   72524
  7         47491   77697
  8         31919   50737
  9         23752   17546
 10         19198   11355
 11          5165    6127
 12+         3854    2718

SSB total  199217  278336


Spawning stock biomass (tons) at Jan. 1
Year         1987    1988    1989    1990    1991    1992    1993    1994
Age
  4             0       0       0       0       0       0       0       0
  5         27125   11944    1999   11291   21585   31808   70665   57246
  6         69517   46592   44255   34746   64599   80516   89725  138916
  7         69088   60202   49068  155994  107477  145862  117321  118193
  8         49678   30920   40620   53706  299696  168184  161136  102808
  9         26423   15479   12244   25884   58877  346026  150745  119441
 10          8367    6741    4746    4372   21791   49539  268938   99557
 11          5358    1966    1784    1335    3065   16135   34504  165679
 12+         4228    2028     945     648    1268    2899   12751   27323

SSB total  259783  175871  155660  287977  578358  840969  905786  829163

Spawning stock biomass (tons) at Jan. 1
Year         1995    1996    1997    1998    1999    2000    2001    2002
Age
  4             0       0       0       0       0       0       0       0
  5         50232   15106   11619   10429    9988   24093   18853   20929
  6        167790  125493   68633   37181   21377   49804  102034   73135
  7        174722  193802  181439   90497   35845   30381   88558  164752
  8        108657  126364  148458  117430   50307   27394   28426   84715
  9         65549   63458   66977   59865   40041   22798   16591   18156
 10         67252   29884   28355   21154   15396   11934    9484    8160
 11         52270   28400   11274    8007    4785    3731    3882    3784
 12+        94518   56902   28952    9651    3534    1716    1539    1856

SSB total  780989  639408  545706  354213  181273  171850  269367  375487
```

Table 3.37 (Cont'd)

```
runid skrei Tue Apr 23 16:30:57 2002
stocks cod.imm cod.mat
areas 0

Total stock biomass (tons) at Jan. 1
Year        1985    1986
Age
  3       317870  488192
  4       366491  406892
  5       222803  392405
  6       162008  183134
  7       106699  106974
  8        43014   56471
  9        32202   18257
 10        19198   11707
 11         5165    6127
 12+        3854    2718

Total    1279304 1672877


Total stock biomass (tons) at Jan. 1
Year        1987    1988    1989    1990    1991    1992    1993    1994
Age
  3       113956   85215   66656  119434  297012  474529  489215  252690
  4       393036  132287  118305  131697  215713  426579  572807  505327
  5       300208  506237  164081  194328  190718  280185  444311  563329
  6       253112  196395  459176  208821  245155  210840  264419  375218
  7       101727  119961  114704  444739  232928  250027  173714  205251
  8        54430   35546   56826   76088  446155  219942  194265  119914
  9        26841   15810   12806   28793   65220  388328  162578  126960
 10         8440    6756    4767    4413   22257   50640  276061  102450
 11         5358    1966    1784    1335    3065   16135   34504  165679
 12+        4228    2028     945     648    1268    2899   12751   27323

Total    1261333 1102201 1000049 1210294 1719490 2320104 2624624 2444141

Total stock biomass (tons) at Jan. 1
Year        1995    1996    1997    1998    1999    2000    2001    2002
Age
  3       154214   92529  159464  209937   95827  117137  110060   53735
  4       318632  160943  137807  254092  296465  193652  239318  186815
  5       612917  345193  214086  163216  272117  405578  281239  336146
  6       517959  507983  333334  174371  110508  241919  388830  281613
  7       278804  337248  344598  191246   84689   66945  173313  292817
  8       136294  154426  182703  148931   70492   39678   38280  107217
  9        68566   68730   71428   63602   43228   25505   18712   19824
 10        68506   30303   28950   21520   15638   12149    9740    8415
 11        52270   28400   11274    8007    4785    3731    3882    3784
 12+       94518   56902   28952    9651    3534    1716    1539    1856

Total    2302679 1782657 1512594 1244572  997283 1108010 1264915 1292223
```

Table 3.37 (Cont'd)

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stocks cod.imm cod.mat
areas 0

Weight (kg) in catch (Observed)

Year	1985	1986	1987	1988	1989	1990	1991	1992
Age								
3	0.96	0.64	0.50	0.55	0.76	0.83	1.09	1.17
4	1.37	1.27	0.88	0.86	0.96	1.23	1.48	1.57
5	2.00	1.87	1.55	1.31	1.31	1.66	2.17	2.22
6	3.20	2.79	2.31	2.23	1.92	2.22	2.89	3.11
7	4.63	4.49	3.48	3.52	2.92	3.24	3.72	4.26
8	6.04	5.83	5.92	5.32	4.61	4.65	4.70	5.18
9	7.66	6.82	8.52	8.00	7.50	7.26	6.05	6.11
10	9.80	7.66	9.57	9.14	9.13	9.80	8.81	7.79
11	11.79	9.81	12.24	11.30	11.17	13.30	11.94	10.82
12+	14.09	11.16	13.64	15.41	14.94	14.25	16.61	12.65

Weight (kg) in catch (Observed)

Year	1993	1994	1995	1996	1997	1998	1999	2000	2001	1999-2001
Age										
3	0.82	0.85	0.82	0.85	0.73	0.70	0.65	0.57	0.66	0.63
4	1.52	1.30	1.26	1.13	1.06	1.05	1.03	1.03	1.04	1.03
5	2.15	1.98	1.79	1.63	1.54	1.60	1.49	1.59	1.61	1.56
6	2.80	2.85	2.57	2.45	2.21	2.28	2.26	2.31	2.51	2.36
7	4.14	3.28	3.79	3.82	3.41	3.28	3.19	3.31	3.51	3.34
8	5.53	5.28	4.96	5.81	5.30	4.86	4.32	4.46	4.77	4.52
9	6.48	6.88	6.15	6.87	7.31	6.90	6.01	5.70	6.00	5.91
10	7.20	7.64	7.99	8.13	7.86	9.43	6.86	7.50	7.45	7.27
11	8.07	8.10	9.15	9.74	10.20	11.31	11.52	8.94	9.02	9.83
12+	11.67	10.18	9.75	11.19	11.42	15.15	14.52	13.82	13.54	13.96

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areas 0

Weight (kg) in catch (Model)

Year	1985	1986	1987	1988	1989	1990	1991	1992
Age								
3	1.00	0.61	0.49	0.53	0.69	0.84	1.13	1.00
4	1.35	1.33	0.91	0.93	1.05	1.45	1.48	1.68
5	2.33	1.78	1.60	1.36	1.44	1.90	2.28	2.14
6	3.57	2.94	2.14	2.20	1.93	2.45	2.90	3.23
7	4.92	4.23	3.56	3.02	3.05	3.18	3.67	4.05
8	6.41	5.61	5.10	4.83	4.15	4.66	4.62	5.01
9	8.09	6.86	6.96	6.58	6.12	5.95	6.29	6.07
10	10.83	8.43	8.67	8.76	7.92	8.20	7.69	7.92
11	13.02	10.41	10.94	10.58	10.19	10.33	9.90	9.56
12+	13.28	11.58	15.33	13.09	13.34	13.27	12.10	12.57

Weight (kg) in catch (Model)

Year	1993	1994	1995	1996	1997	1998	1999	2000	2001	1999-2001
Age										
3	0.79	0.67	0.65	0.66	0.63	0.66	0.58	0.57	0.65	0.60
4	1.50	1.22	1.13	1.12	1.20	1.11	1.07	1.11	1.09	1.09
5	2.27	1.88	1.77	1.61	1.69	1.66	1.54	1.68	1.68	1.64
6	2.86	2.70	2.70	2.44	2.36	2.26	2.21	2.35	2.51	2.36
7	4.25	3.39	3.84	3.67	3.54	3.23	3.04	3.30	3.50	3.28
8	5.20	4.97	4.73	5.05	5.05	4.79	4.35	4.41	4.66	4.47
9	6.26	6.02	6.50	6.14	6.57	6.51	6.22	5.97	5.84	6.01
10	7.43	7.19	7.65	8.25	7.84	8.24	8.24	7.99	7.51	7.91
11	9.55	8.56	8.98	9.69	10.30	9.80	10.35	10.00	9.75	10.03
12+	11.83	11.46	10.78	12.65	12.67	15.02	14.46	12.75	12.87	13.36

Table 3.37 (Cont'd)

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stocks cod.imm cod.mat
areas 0

Weight (kg) in stock at Jan. 1

Year	1985	1986	1987	1988	1989	1990	1991	1992	1993
Age									
3	0.58	0.40	0.31	0.30	0.34	0.39	0.60	0.59	0.47
4	0.97	0.99	0.45	0.52	0.57	0.89	0.94	1.16	0.99
5	1.95	1.54	1.17	0.91	0.94	1.32	1.76	1.68	1.77
6	3.10	2.75	1.85	1.78	1.44	1.87	2.36	2.84	2.43
7	4.42	4.01	3.40	2.64	2.57	2.57	3.10	3.66	3.88
8	5.79	5.40	5.04	4.44	3.71	4.02	4.00	4.61	4.85
9	7.38	6.62	7.09	6.18	5.73	5.38	5.68	5.67	5.97
10	10.10	8.20	9.00	8.42	7.59	7.77	7.20	7.56	7.23
11	12.91	10.86	11.70	10.40	10.08	10.19	9.85	9.31	9.59
12+	12.85	13.33	17.69	15.14	13.90	14.72	13.63	13.24	12.32

Weight (kg) in stock at Jan. 1

Year	1994	1995	1996	1997	1998	1999	2000	2001	2002	1999-2001
Age										
3	0.29	0.27	0.26	0.27	0.30	0.22	0.23	0.35	0.30	0.27
4	0.73	0.65	0.55	0.63	0.63	0.58	0.59	0.62	0.78	0.60
5	1.47	1.40	1.12	1.14	1.21	1.09	1.24	1.25	1.25	1.19
6	2.40	2.42	2.09	1.90	1.88	1.78	1.99	2.15	2.14	1.97
7	3.20	3.58	3.35	3.14	2.94	2.61	2.93	3.15	3.36	2.89
8	4.83	4.51	4.69	4.65	4.56	3.90	4.01	4.28	4.57	4.06
9	5.91	6.34	5.80	6.18	6.31	5.75	5.60	5.48	5.76	5.61
10	7.12	7.55	7.98	7.47	8.08	7.75	7.73	7.25	7.02	7.57
11	8.60	8.99	9.49	10.08	9.69	9.85	10.06	9.75	8.99	9.89
12+	11.93	11.08	12.75	14.01	15.62	14.43	13.84	13.38	12.54	13.88

runid skrei Tue Apr 23 16:30:57 2002
stocks cod.imm cod.mat
areas 0

Proportion mature at age

Year	1985	1986	1987	1988	1989	1990	1991	1992	1993
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	0.076	0.079	0.053	0.011	0.006	0.037	0.082	0.078	0.109
6	0.320	0.367	0.219	0.166	0.060	0.125	0.211	0.320	0.267
7	0.477	0.705	0.632	0.429	0.332	0.284	0.396	0.518	0.609
8	0.717	0.892	0.894	0.834	0.643	0.635	0.607	0.713	0.781
9	0.664	0.948	0.981	0.971	0.936	0.870	0.869	0.859	0.900
10	1.000	0.955	0.985	0.997	0.993	0.987	0.971	0.969	0.962
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	1994	1995	1996	1997	1998	1999	2000	2001	2002	1999-2001
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	0.066	0.051	0.022	0.028	0.034	0.019	0.033	0.037	0.034	0.0297
6	0.283	0.252	0.182	0.144	0.143	0.129	0.149	0.197	0.191	0.1583
7	0.493	0.537	0.485	0.443	0.382	0.323	0.360	0.431	0.484	0.3713
8	0.812	0.737	0.743	0.746	0.725	0.627	0.597	0.667	0.736	0.6303
9	0.916	0.937	0.885	0.901	0.913	0.891	0.848	0.838	0.883	0.8590
10	0.958	0.973	0.977	0.966	0.971	0.974	0.972	0.960	0.955	0.9687
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 3.37 (Cont'd)

```
runid skrei Tue Apr 23 16:30:57 2002
stocks cod.imm cod.mat
areas 0
fleets  totalcatchD.cod gillnetD.cod

Model catch in numbers (thousands) at age
Year        1985
Age
  3        27223
  4        44829
  5        27166
  6        16615
  7         9957
  8         3643
  9         2378
 10         1109
 11          235
 12+         178

Total     133334


Model catch in numbers (thousands) at age
Year        1986    1987    1988    1989    1990    1991    1992    1993
Age
  3        28911    9798    6202    4350    3338   11570   20197   19753
  4        67536  110475   22970   15110    8099   11928   29468   53741
  5        69776   97487  127644   29171   13607   12395   19792   42212
  6        24628   67463   46258   86959   14170   14730   12130   22347
  7        11366   16977   22539   18149   26902   12439   12378   11080
  8         5010    6580    4569    7628    3771   21151    9496   10691
  9         1401    2441    1575    1382    1249    2611   14806    7786
 10          755     618     520     425     154     781    1594   11510
 11          306     306     124     127      38      85     433    1146
 12+         111     162      90      49      13      26      57     338

Total     209799  312308  232490  163349   71340   87716  120351  180604


Model catch in numbers (thousands) at age
Year        1994    1995    1996    1997    1998    1999    2000    2001
Age
  3        12016    7333    6049   15951   23119   10104    7710    7266
  4        66746   40767   24995   32801   63313   74352   31953   32295
  5        83829  101072   68556   58004   47246   80840   83764   50206
  6        44727   70304   86684   77831   43480   28093   44065   60960
  7        20481   30040   43094   58148   35995   17097    9798   21929
  8         8922   12765   15693   22955   20082   10679    4800    4016
  9         8157    5166    6037    7172    6613    4875    2505    1684
 10         5702    4554    2091    2487    1812    1379     948     723
 11         7905    3025    1695     743     573     340     233     227
 12+         972    4558    2593    1394     438     175      79      67

Total     259457  279583  257487  277486  242670  227933  185855  179372
```

Table 3.37 (Cont'd)

```
runid skrei Tue Apr 23 16:30:57 2002
stocks cod.imm cod.mat
areas 0
fleets  totalcatchD.cod gillnetD.cod

Observed catch in numbers (thousands) at age
Year        1985
Age
  3        19827
  4        41156
  5        24947
  6        16756
  7        10562
  8         3509
  9         1437
 10          713
 11          132
 12+          97

Total     119136


Observed catch in numbers (thousands) at age
Year        1986    1987    1988    1989    1990    1991    1992    1993
Age
  3        24601   10451    9320    4905    1318    3498   14281    7684
  4        59095  117702   19556   15829    5815    8518   22808   37104
  5        71522   84258  117466   28910    9871   12313   18690   54335
  6        23485   57247   48956   66518   13789   15180   17119   28253
  7        10443   13079   19909   24998   23675   14196   12909   11530
  8         3796    3576    3153    5194    5160   18101    9545    7452
  9          890     872    1163     795     607    2706   12829    5190
 10          696     450     384     275     127     270    1766    9814
 11          517     184     105      41      49      36     179    1290
 12+         206     308     128      40      20      14      45     290

Total     195251  288127  220140  147505   60431   74832  110171  162942


Observed catch in numbers (thousands) at age
Year        1994    1995    1996    1997    1998    1999    2000    2001
Age
  3         5557    4744    7029   10454   28163    8086    4267    4240
  4        49637   35103   25578   32825   78276   72596   27993   30037
  5        79313   95626   70977   63737   42661   81445   76991   52855
  6        50250   79442   87255   75833   35607   27626   40926   53586
  7        28783   28300   46093   60404   29470   13875   11508   20180
  8         7686    6796    8735   22662   23807   14380    6318    4728
  9         4522    2499    1797    3198    6147    7971    4563    1640
 10         2497    1441     817     817     886    1815    1517    1071
 11         5407     770     352     286     161     191     208     275
 12+         834    1832     831     413     136      91      53      60

Total     234486  256553  249464  270629  245314  228076  174344  168672
```

Table 3.37 (Cont'd)

runid skrei Tue Apr 23 16:30:57 2002
stocks cod.imm cod.mat
areas 0
fleets totalcatchD.cod gillnetD.cod

Model catch in biomass (tons) at age

Year	1985
Age	
3	27171
4	60318
5	63404
6	59387
7	48991
8	23345
9	19237
10	12009
11	3063
12+	2362
Total	319286
Total+	348963

(++ Also includes: overfish thirdcountries)

Model catch in biomass (tons) at age

Year	1986	1987	1988	1989	1990	1991	1992	1993
Age								
3	17776	4779	3305	3007	2812	13114	20153	15663
4	90078	100619	21403	15811	11752	17702	49594	80722
5	124039	155746	173663	41999	25853	28210	42274	95678
6	72504	144534	101828	167819	34748	42650	39163	63814
7	48065	60410	68139	55265	85530	45696	50139	47107
8	28130	33571	22075	31623	17565	97722	47557	55619
9	9615	16992	10366	8463	7425	16429	89901	48712
10	6363	5362	4560	3368	1263	6004	12625	85476
11	3186	3354	1314	1290	389	842	4141	10947
12+	1287	2480	1173	659	172	318	712	4002
Total	401043	527846	407825	329304	187510	268687	356260	507741
Total+	448491	589245	451779	368822	234330	334698	509196	615353

(++ Also includes: overfish thirdcountries)

Model catch in biomass (tons) at age

Year	1994	1995	1996	1997	1998	1999	2000	2001
Age								
3	8069	4774	3974	10116	15198	5867	4426	4746
4	81446	46118	27924	39423	70392	79901	35476	35085
5	157508	178502	110547	97909	78546	124672	140891	84563
6	120555	189957	211121	183326	98407	62026	103460	153108
7	69454	115444	158160	205763	116317	51891	32372	76849
8	44365	60442	79284	115877	96278	46473	21159	18719
9	49138	33580	37070	47154	43046	30312	14961	9841
10	40992	34831	17262	19493	14930	11358	7576	5434
11	67696	27168	16422	7649	5616	3522	2333	2209
12+	11134	49153	32794	17658	6577	2525	1012	863
Total	650356	739969	694558	744367	545306	418546	363665	391416
Total+	800460	861874	790406	824616	600204	462339	412294	445047

(++ Also includes: overfish thirdcountries)

Table 3.37 (Cont'd)

```
runid skrei Tue Apr 23 16:30:57 2002
stocks cod.imm cod.mat
areas 0
fleets  totalcatchD.cod gillnetD.cod

Observed catch in biomass (tons) at age
Year        1985
Age
  3        19126
  4        56292
  5        49948
  6        53648
  7        48885
  8        21186
  9        11015
 10         6988
 11         1556
 12+        1367

Total     270010
Total+    304376
(++ Also includes: overfish thirdcountries )


Observed catch in biomass (tons) at age
Year        1986    1987    1988    1989    1990    1991    1992    1993
Age
  3        15739    5248    5132    3707    1099    3826   16749    6294
  4        75093  104014   16881   15212    7159   12624   35861   56265
  5       133755  130298  154400   37888   16352   26754   41536  116878
  6        65634  132331  109286  127798   30610   43802   53174   79022
  7        46842   45483   70098   72902   76661   52765   54981   47752
  8        22116   21179   16788   23943   23996   85114   49432   41237
  9         6070    7433    9300    5963    4406   16364   78443   33606
 10         5334    4306    3508    2510    1245    2379   13749   70613
 11         5072    2253    1187     458     652     430    1937   10413
 12+        2298    4201    1972     598     285     233     569    3384

Total     377952  456746  388552  290977  162464  244290  346430  465465
Total+    425428  509500  430714  330181  211119  317795  508889  581165
(++ Also includes: overfish thirdcountries )


Observed catch in biomass (tons) at age
Year        1994    1995    1996    1997    1998    1999    2000    2001
Age
  3         4712    3876    5989    7672   19667    5237    2453    2809
  4        64514   44148   29018   34939   82504   74521   28911   31369
  5       156739  171213  115706   97997   68416  121197  122038   85142
  6       143091  203914  213388  167787   81190   62557   94654  134274
  7        94529  107134  176041  206093   96655   44266   38146   70840
  8        40587   33702   50747  120026  115693   62141   28183   22554
  9        31118   15362   12354   23384   42403   47940   26023    9843
 10        19078   11519    6640    6424    8357   12449   11378    7982
 11        43820    7048    3430    2918    1821    2201    1860    2480
 12+        8491   17868    9299    4717    2060    1321     732     812

Total     606679  615784  622612  671956  518766  433830  354377  368105
Total+    767445  739638  730365  763190  582628  483679  409578  425805
(++ Also includes: overfish thirdcountries )
```

Table 3.38 Fleksibest equivalent to standard prediction input table (3.28)

Year: 2002								
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	178711	0.2801	0.0000	0.0000	0.0000	0.3000	0.0260	0.6400
4	239435	0.2104	0.0000	0.0000	0.0000	0.7800	0.1608	1.2100
5	268994	0.2000	0.0340	0.0000	0.0000	1.2500	0.3172	1.6600
6	131775	0.2000	0.1910	0.0000	0.0000	2.1400	0.5220	2.4700
7	87064	0.2000	0.4840	0.0000	0.0000	3.3600	0.6682	3.6800
8	23482	0.2000	0.7360	0.0000	0.0000	4.5700	0.7778	4.8900
9	3445	0.2000	0.8830	0.0000	0.0000	5.7600	0.8699	6.1100
10	1201	0.2000	0.9550	0.0000	0.0000	7.0200	0.9436	7.3600
11	422	0.2000	1.0000	0.0000	0.0000	9.0000	1.0165	9.2400
12+	149	0.2000	1.0000	0.0000	0.0000	12.5700	1.0638	12.5400
Unit	Thousands	-	-	-	-	Kilograms	-	Kilograms

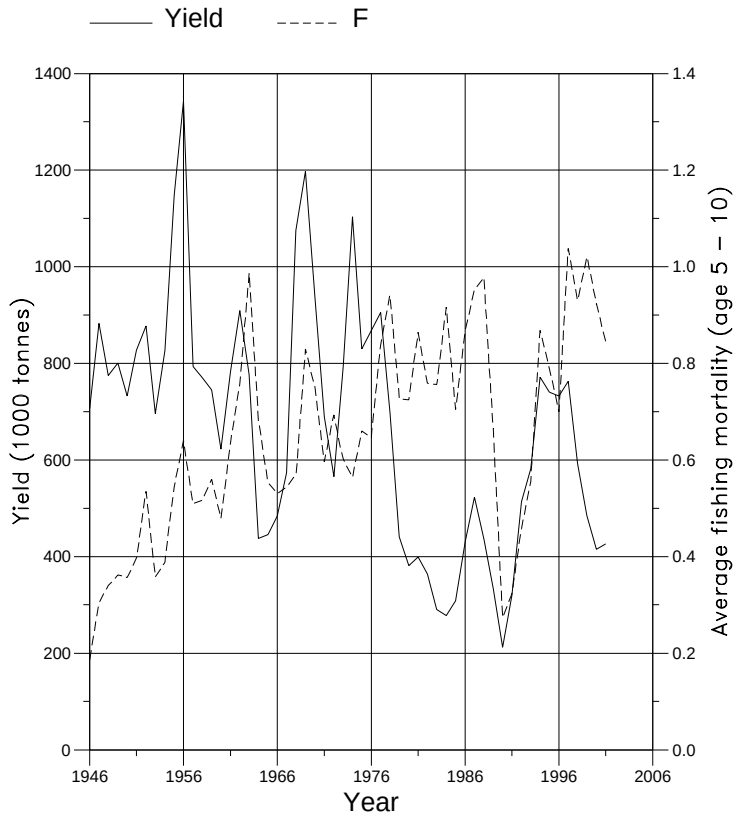
Year: 2003								
Age	Stock size	Natural Mortality	Maturity ogive	Prop. of F bef.spaw.	Prop. Of M bef.spaw.	Weight in stock	Exploit pattern	Weight in catch
3	467937	0.2833	0.0000	0.0000	0.0000	0.3000	0.0260	0.6300
4	131579	0.2175	0.0000	0.0000	0.0000	0.7200	0.1420	1.1700
5	161125	0.2000	0.0600	0.0000	0.0000	1.4600	0.3811	1.8400
6	158449	0.2000	0.1840	0.0000	0.0000	2.1000	0.5152	2.4400
7	63947	0.2000	0.4680	0.0000	0.0000	3.2900	0.6607	3.6100
8	36530	0.2000	0.7700	0.0000	0.0000	4.7500	0.7932	5.0800
9	8830	0.2000	0.9210	0.0000	0.0000	6.0500	0.8936	6.3900
10	1184	0.2000	0.9710	0.0000	0.0000	7.3500	0.9626	7.6800
11	380	0.2000	1.0000	0.0000	0.0000	8.8200	1.0123	9.0800
12+	167	0.2000	1.0000	0.0000	0.0000	12.1300	1.0596	12.1400
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	164978	0.2763	0.0000	0.0000	0.0000	0.3000	0.0259	0.6300
4	343431	0.2185	0.0000	0.0000	0.0000	0.7200	0.1418	1.1700
5	89486	0.2000	0.0500	0.0000	0.0000	1.3700	0.3533	1.7800
6	89490	0.2000	0.2510	0.0000	0.0000	2.4000	0.5600	2.7200
7	77393	0.2000	0.4570	0.0000	0.0000	3.2500	0.6554	3.5700
8	27031	0.2000	0.7540	0.0000	0.0000	4.6600	0.7855	5.0000
9	13526	0.2000	0.9330	0.0000	0.0000	6.2500	0.9056	6.5800
10	2959	0.2000	0.9840	0.0000	0.0000	7.7100	0.9808	8.0200
11	369	0.2000	1.0000	0.0000	0.0000	9.2200	1.0243	9.4500
12+	160	0.2000	1.0000	0.0000	0.0000	12.0400	1.0585	12.0400
Unit	Thousands	-	-	-	-	Kilograms	-	Kilograms

Table 3.39 Management options table from Fleksibest

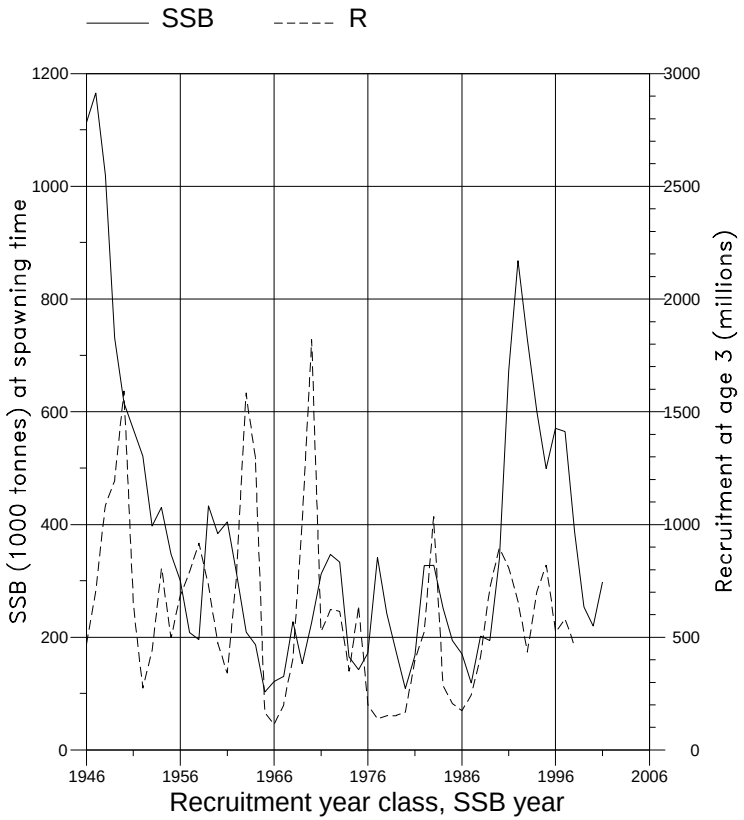
Year: 2002					Year: 2003					Year: 2004	
F Factor	Reference F	Stock biomass	Sp.stock biomass	Catch in weight	F Factor	Reference F	Stock biomass	Sp.stock biomass	Catch in weight	Stock biomass	Sp.stock biomass
1.0000	0.6776	1292673	375661	499063	0.0000	0.0000	1259878	430736	0	1729820	842321
.	.	.	.	.	0.0250	0.0176	.	430736	16870	1709714	827963
.	.	.	.	.	0.0500	0.0351	.	430736	33457	1689934	813865
.	.	.	.	.	0.0750	0.0527	.	430736	49765	1670475	800023
.	.	.	.	.	0.1000	0.0702	.	430736	65800	1651329	786431
.	.	.	.	.	0.1250	0.0877	.	430736	81566	1632492	773086
.	.	.	.	.	0.1500	0.1052	.	430736	97069	1613957	759982
.	.	.	.	.	0.1750	0.1227	.	430736	112313	1595721	747115
.	.	.	.	.	0.2000	0.1402	.	430736	127302	1577777	734480
.	.	.	.	.	0.2250	0.1577	.	430736	142042	1560120	722072
.	.	.	.	.	0.2500	0.1752	.	430736	156538	1542746	709888
.	.	.	.	.	0.2750	0.1927	.	430736	170792	1525648	697924
.	.	.	.	.	0.3000	0.2101	.	430736	184810	1508823	686174
.	.	.	.	.	0.3250	0.2276	.	430736	198597	1492266	674635
.	.	.	.	.	0.3500	0.2450	.	430736	212155	1475971	663303
.	.	.	.	.	0.3750	0.2625	.	430736	225490	1459934	652174
.	.	.	.	.	0.4000	0.2799	.	430736	238605	1444151	641245
.	.	.	.	.	0.4250	0.2973	.	430736	251504	1428617	630511
.	.	.	.	.	0.4500	0.3147	.	430736	264192	1413328	619969
.	.	.	.	.	0.4750	0.3321	.	430736	276671	1398279	609615
.	.	.	.	.	0.5000	0.3495	.	430736	288947	1383467	599445
.	.	.	.	.	0.5250	0.3669	.	430736	301021	1368887	589457
.	.	.	.	.	0.5500	0.3843	.	430736	312899	1354535	579646
.	.	.	.	.	0.5750	0.4016	.	430736	324582	1340407	570010
.	.	.	.	.	0.6000	0.4190	.	430736	336076	1326500	560544
.	.	.	.	.	0.6250	0.4363	.	430736	347384	1312809	551247
.	.	.	.	.	0.6500	0.4537	.	430736	358508	1299331	542115
.	.	.	.	.	0.6750	0.4710	.	430736	369451	1286061	533144
.	.	.	.	.	0.7000	0.4883	.	430736	380217	1272998	524331
.	.	.	.	.	0.7250	0.5056	.	430736	390810	1260136	515675
.	.	.	.	.	0.7500	0.5229	.	430736	401232	1247472	507171
.	.	.	.	.	0.7750	0.5402	.	430736	411486	1235004	498817
.	.	.	.	.	0.8000	0.5576	.	430736	421576	1222727	490610
.	.	.	.	.	0.8250	0.5748	.	430736	431504	1210638	482548
.	.	.	.	.	0.8500	0.5921	.	430736	441273	1198735	474627
.	.	.	.	.	0.8750	0.6093	.	430736	450885	1187013	466846
.	.	.	.	.	0.9000	0.6266	.	430736	460345	1175470	459200
.	.	.	.	.	0.9250	0.6438	.	430736	469652	1164103	451689
.	.	.	.	.	0.9500	0.6610	.	430736	478812	1152909	444310
.	.	.	.	.	0.9750	0.6783	.	430736	487827	1141885	437059
.	.	.	.	.	1.0000	0.6955	.	430736	496699	1131028	429935
.	.	.	.	.	1.0250	0.7127	.	430736	505431	1120334	422935
.	.	.	.	.	1.0500	0.7299	.	430736	514024	1109802	416058
.	.	.	.	.	1.0750	0.7471	.	430736	522481	1099429	409300
.	.	.	.	.	1.1000	0.7642	.	430736	530806	1089211	402659
.	.	.	.	.	1.1250	0.7814	.	430736	538999	1079147	396134
.	.	.	.	.	1.1500	0.7986	.	430736	547064	1069233	389723
.	.	.	.	.	1.1750	0.8157	.	430736	555002	1059468	383423
.	.	.	.	.	1.2000	0.8329	.	430736	562818	1049848	377231

Yield and fishing mortality



(run: SVPASA14) **A**

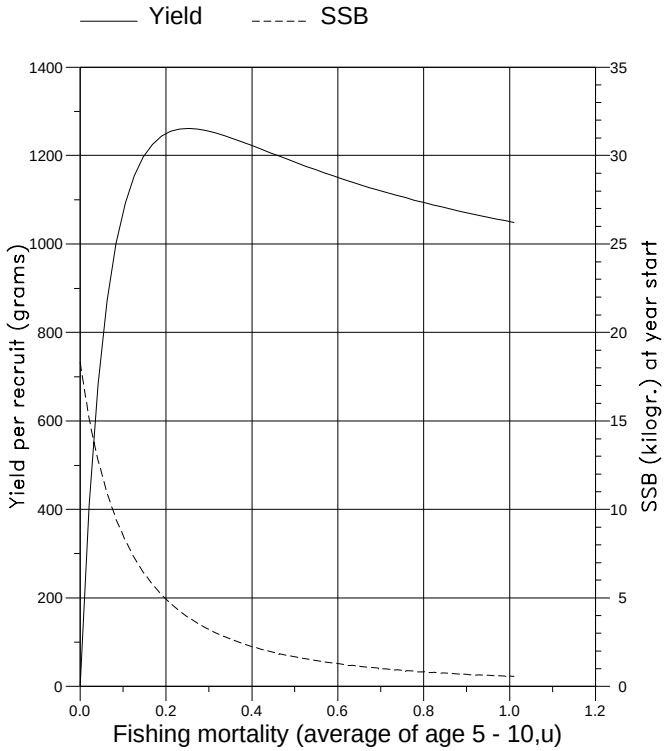
Spawning stock and recruitment



(run: SVPASA14) **B**

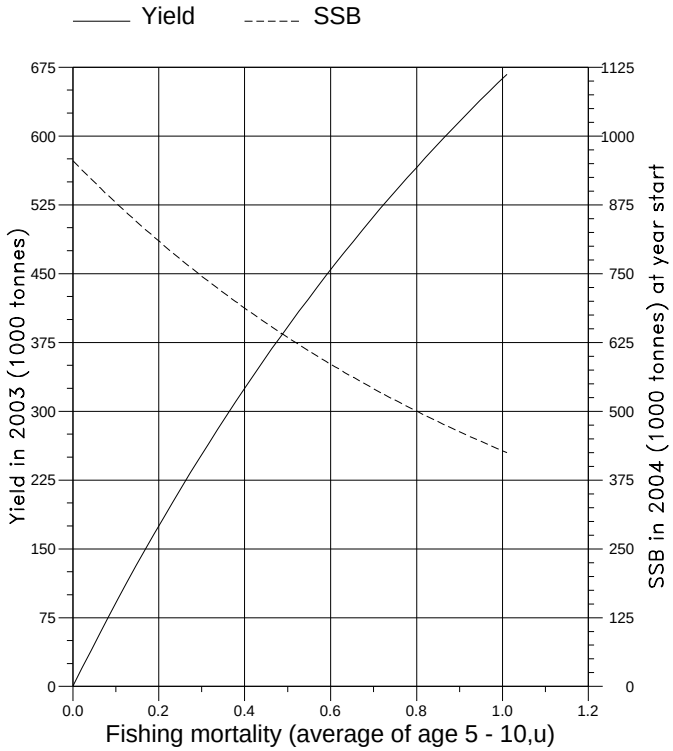
Figure 3.1 a,b

Long term yield and spawning stock biomass



(run: YLDASA06) **C**

Short term yield and spawning stock biomass



(run: MANASA06) **D**

Figure 3.1c,d

Fig 3.2a. Northeast arctic cod, M2 from cannibalism vs. capelin stock size

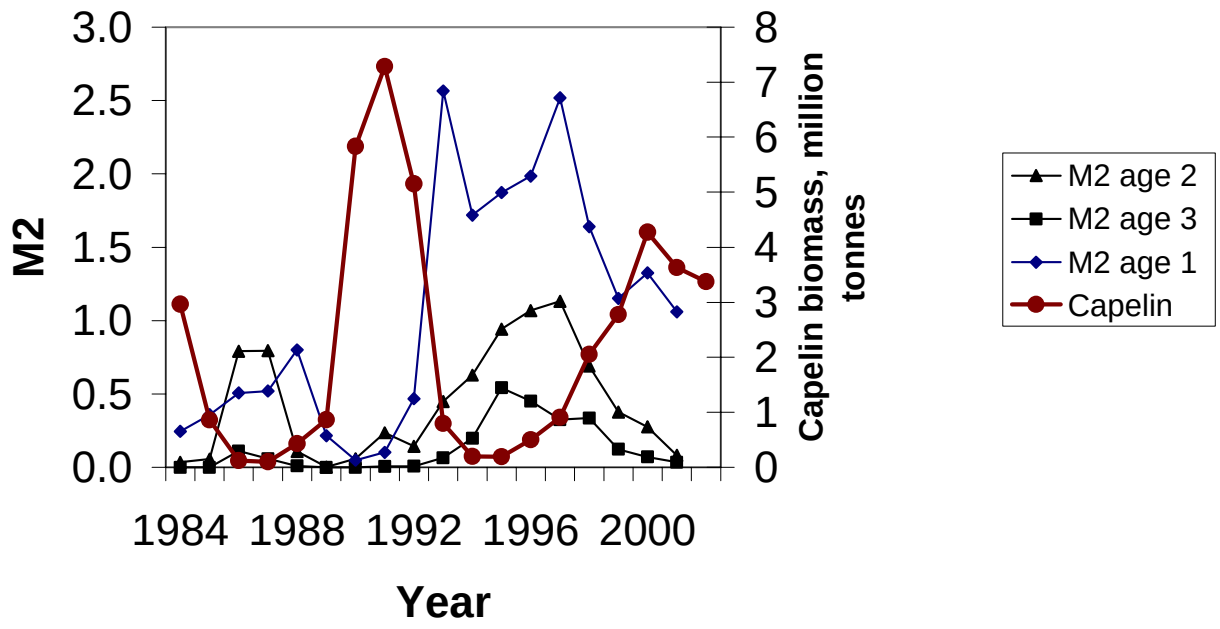
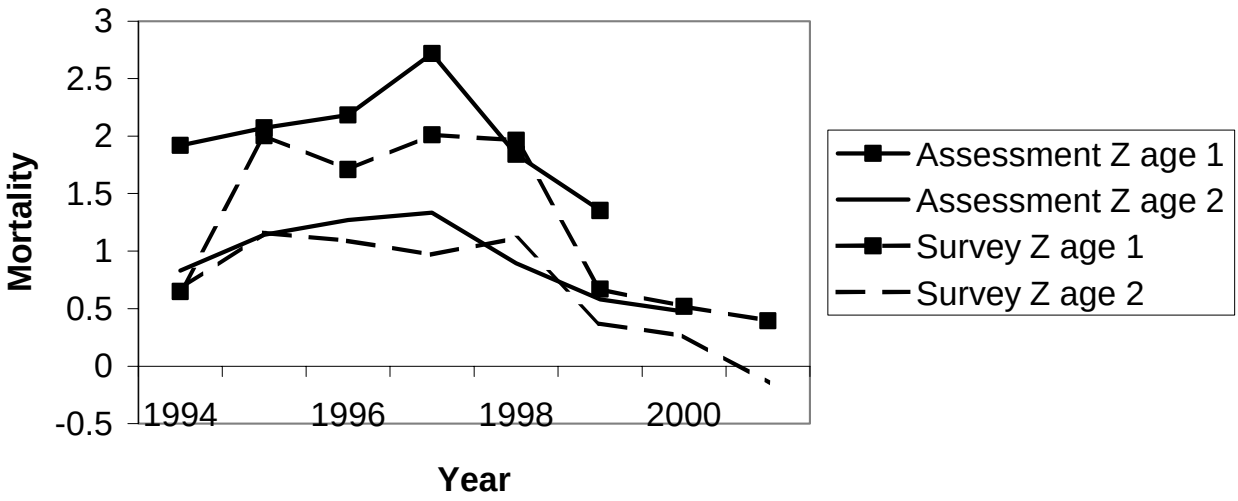


Fig 3.2b. NEA cod. Z from the assessment vs. survey mortality (Norwegian bottom trawl winter survey)



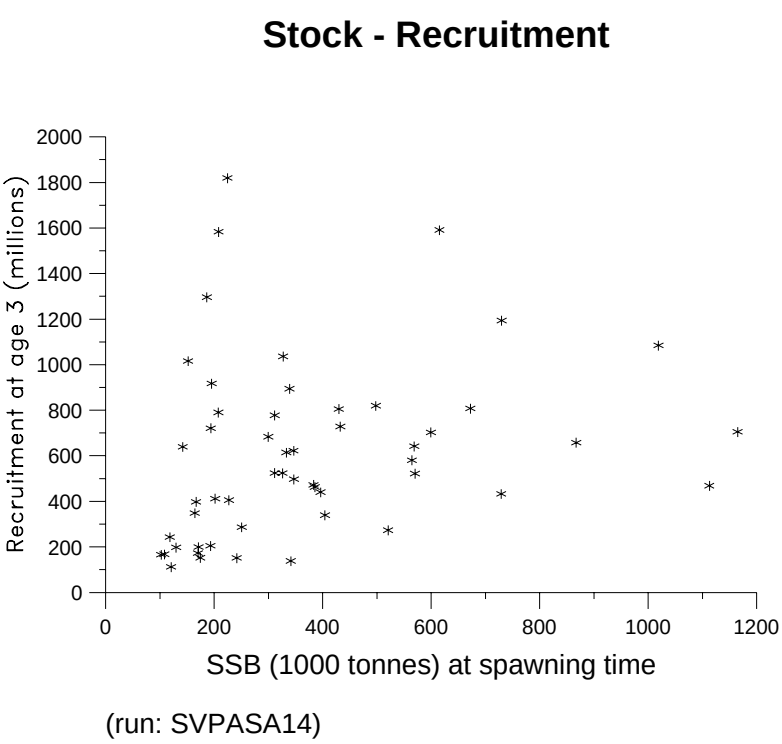

Stock - Recruitment
Recruitment at age 3 (millions)
2000
1800
1600
1400
1200
1000
800
600
400
200
0
0
200
400
600
800
1000
1200
SSB (1000 tonnes) at spawning time
(run: SVPASA14)

Figure 3.3

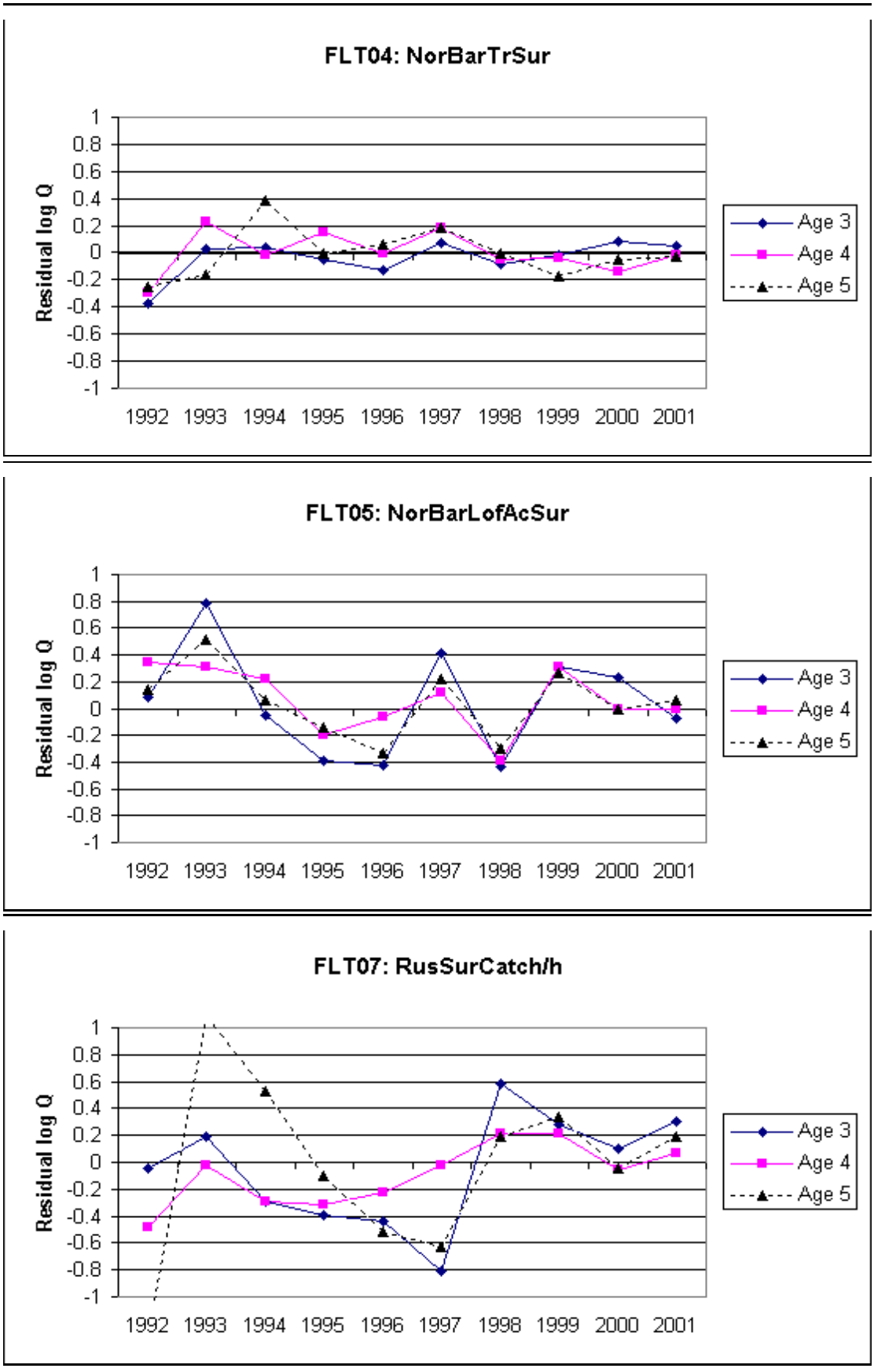


Figure 3.4 Northeast Arctic cod. Residual log catchability by fleet and age from the XSA output in the 2002 assessment.

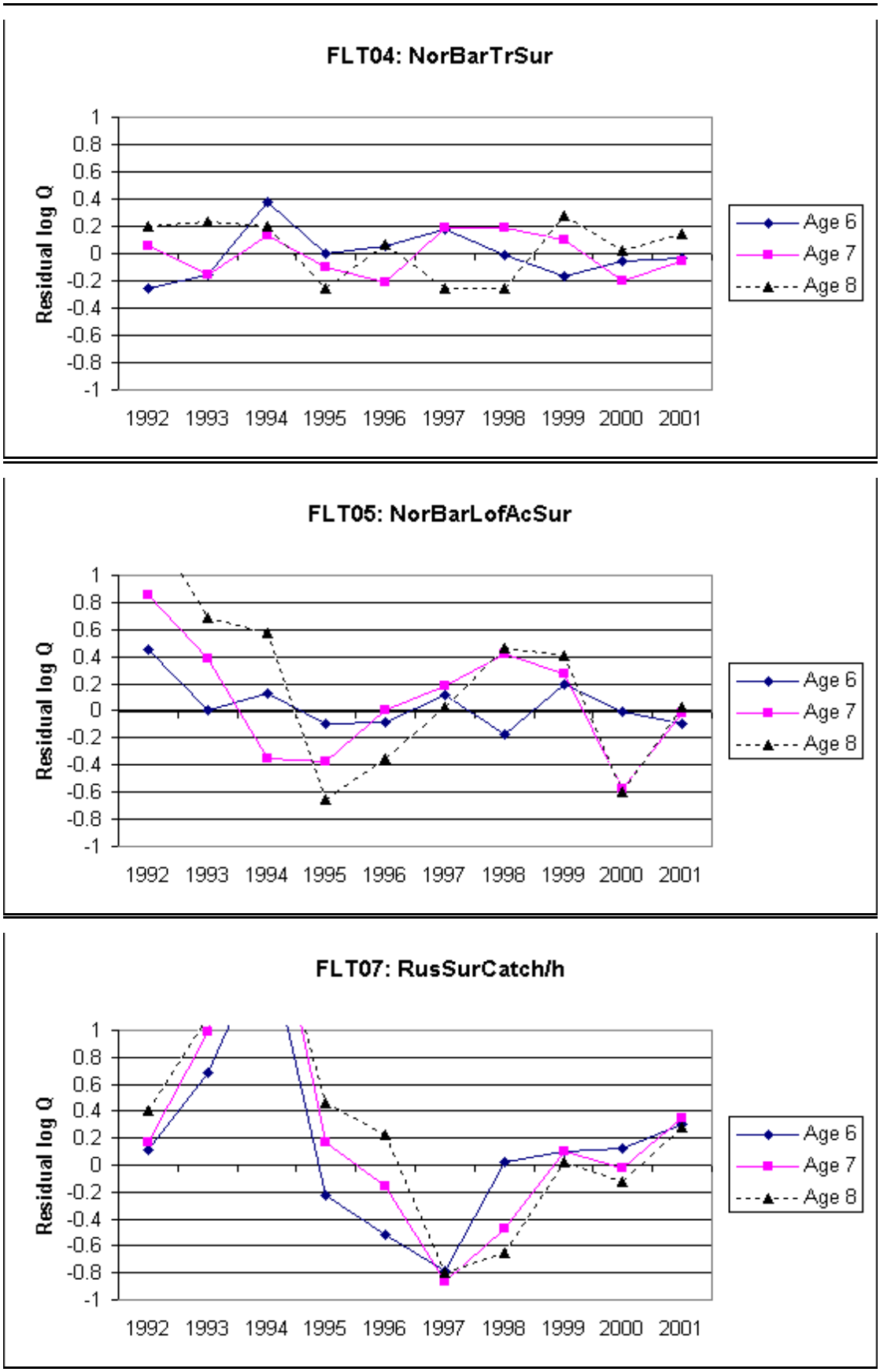


Figure 3.5 Northeast Arctic cod. Residual log catchability by fleet and age from the XSA output in the 2002 assessment.

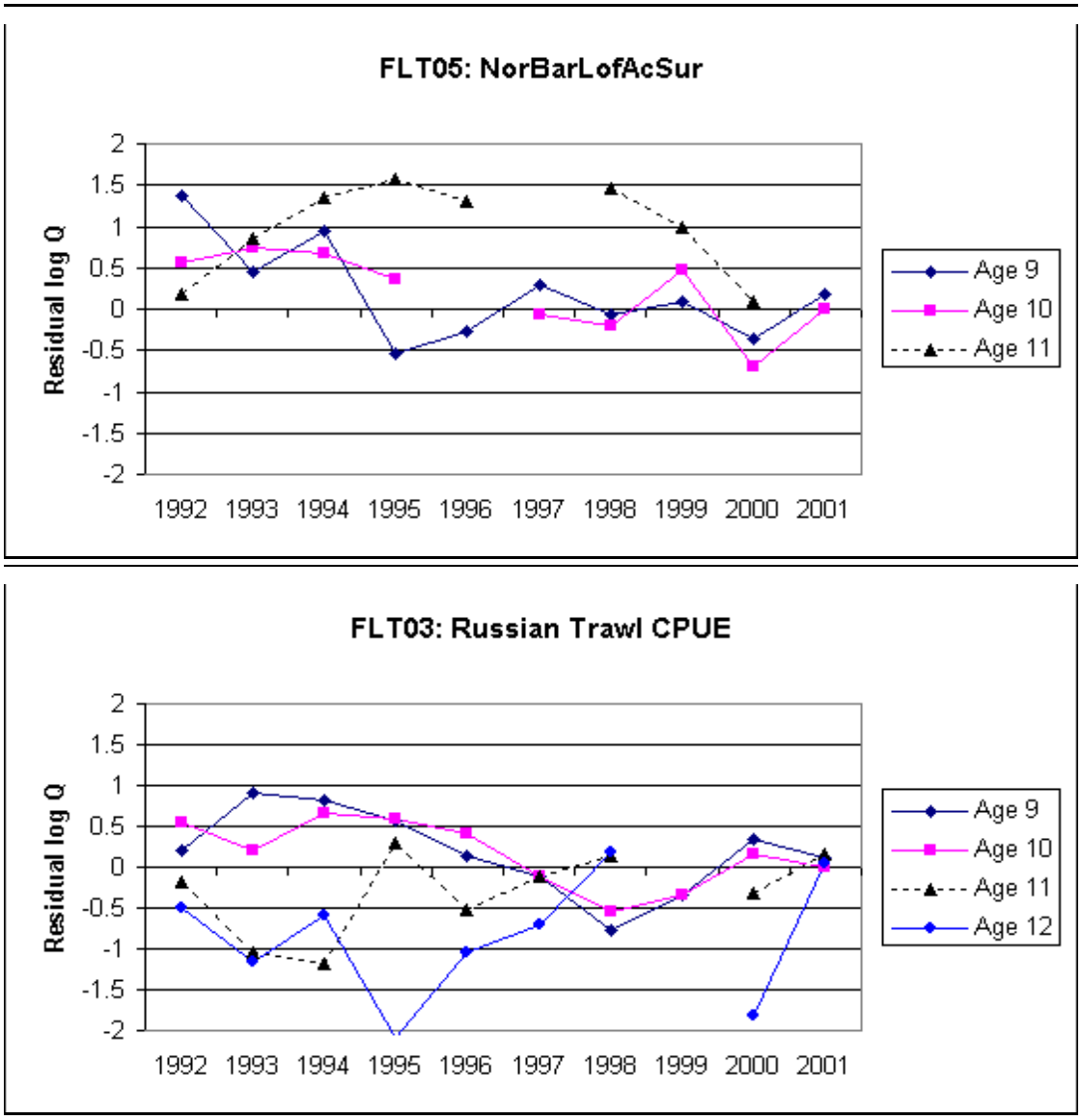


Figure 3.6 Northeast Arctic cod. Residual log catchability by fleet and age from the XSA output in the 2002 assessment.

Figure 3.7a. NEA Cod, retrospective F6-10

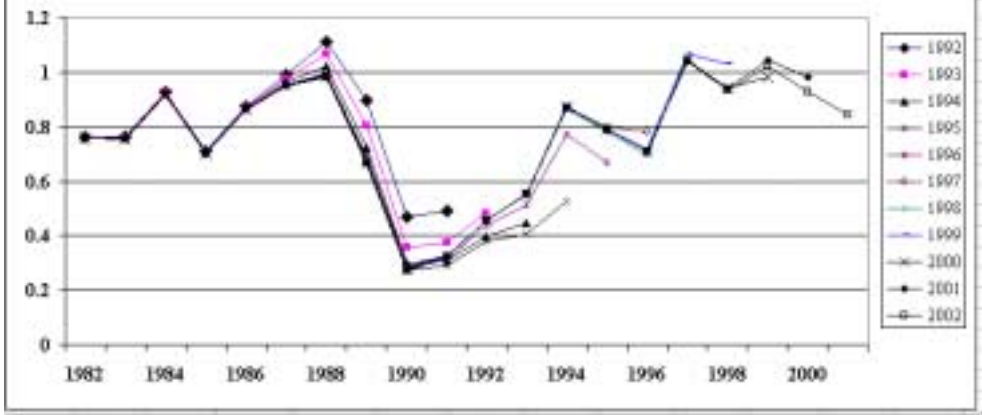


Figure 3.7b. NEA Cod, retrospective F4-6

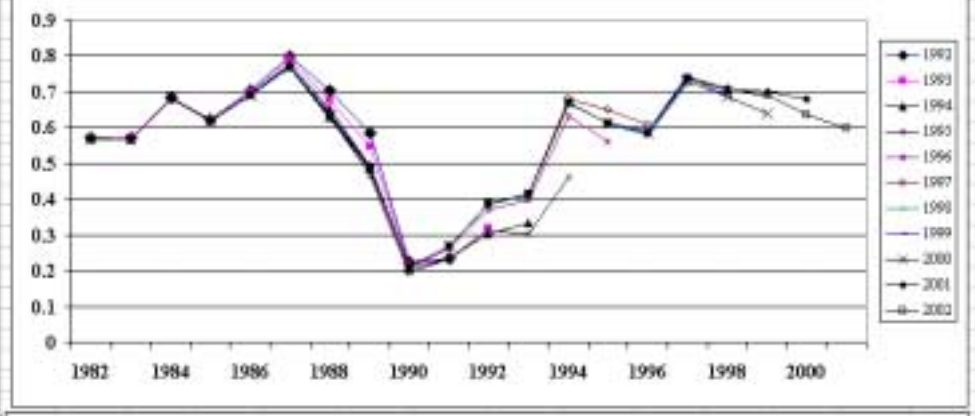


Figure 3.8. NEA Cod, retrospective SSB

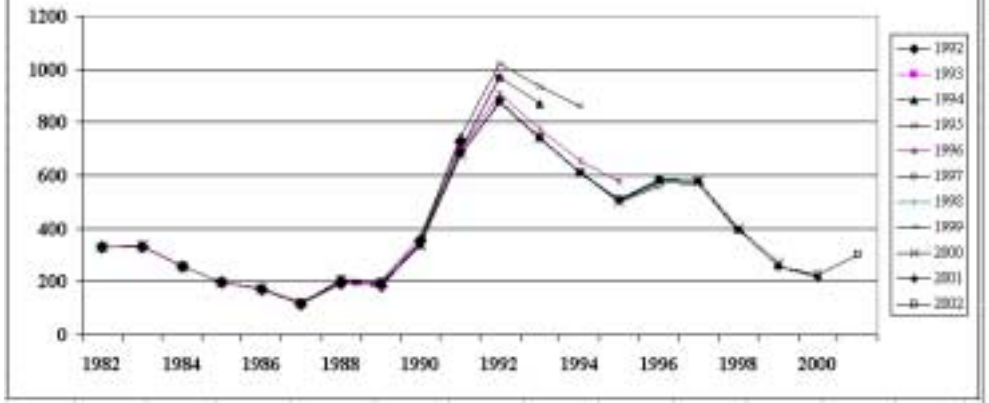
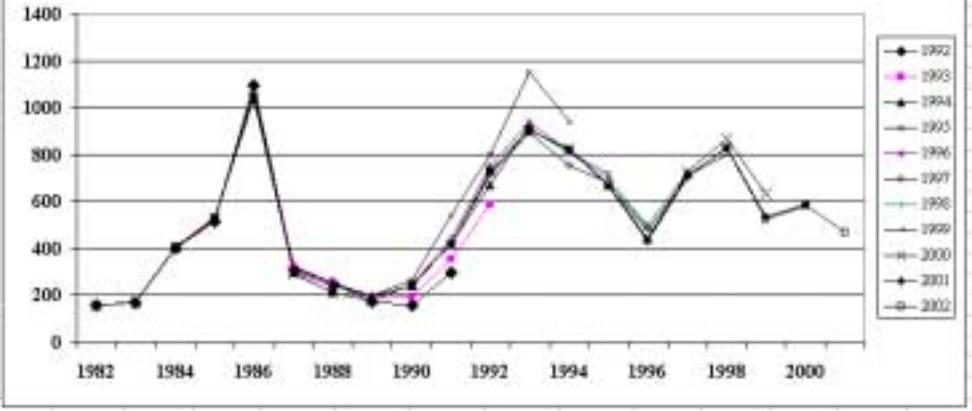
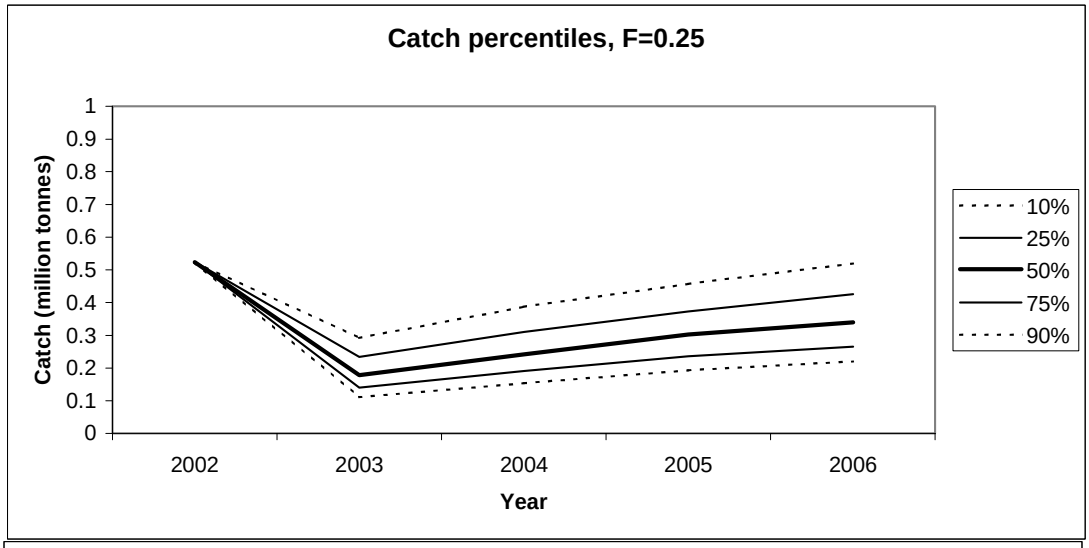
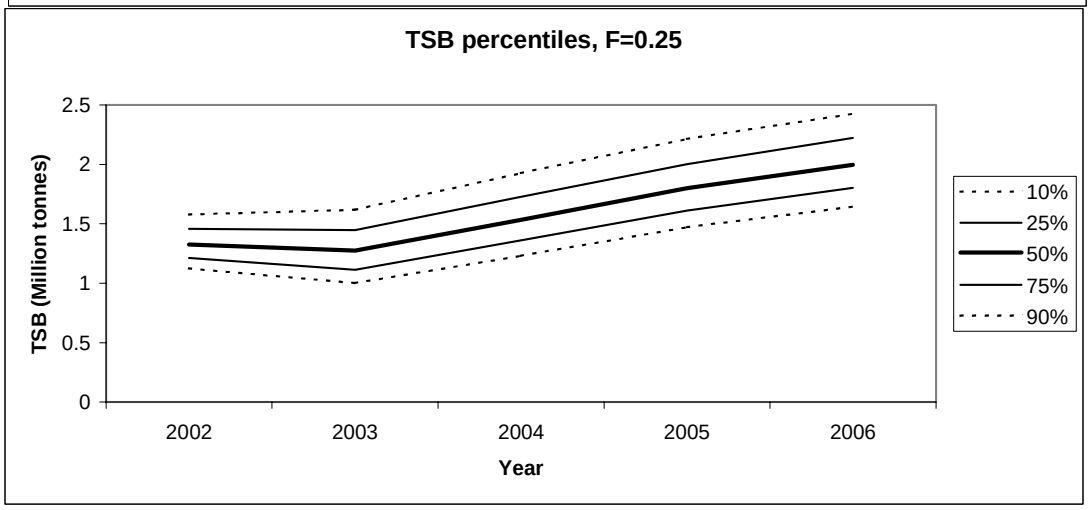


Figure 3.9. NEA Cod, retrospective recruitment age 3







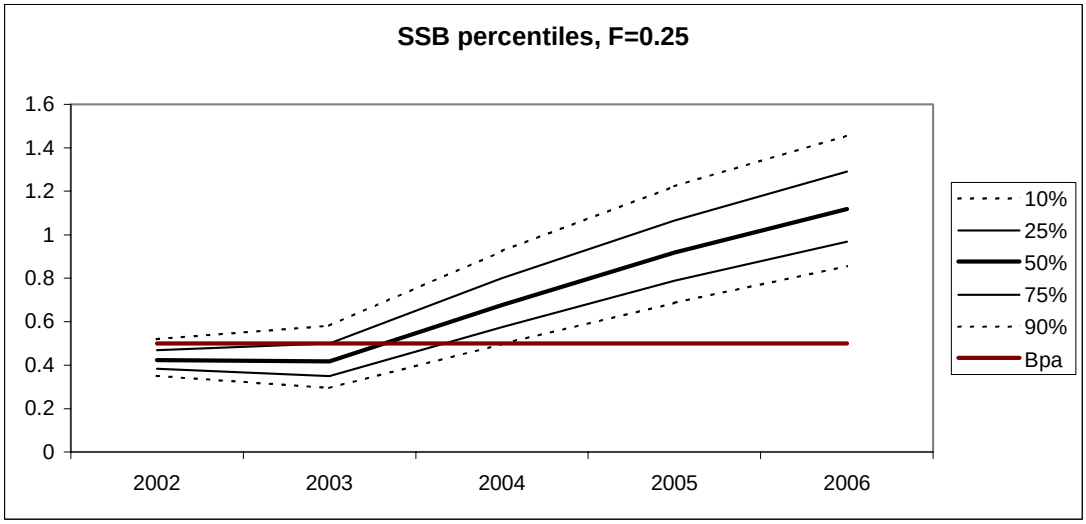


Figure 3.10 a. Medium-term predictions, assuming F status quo in 2002

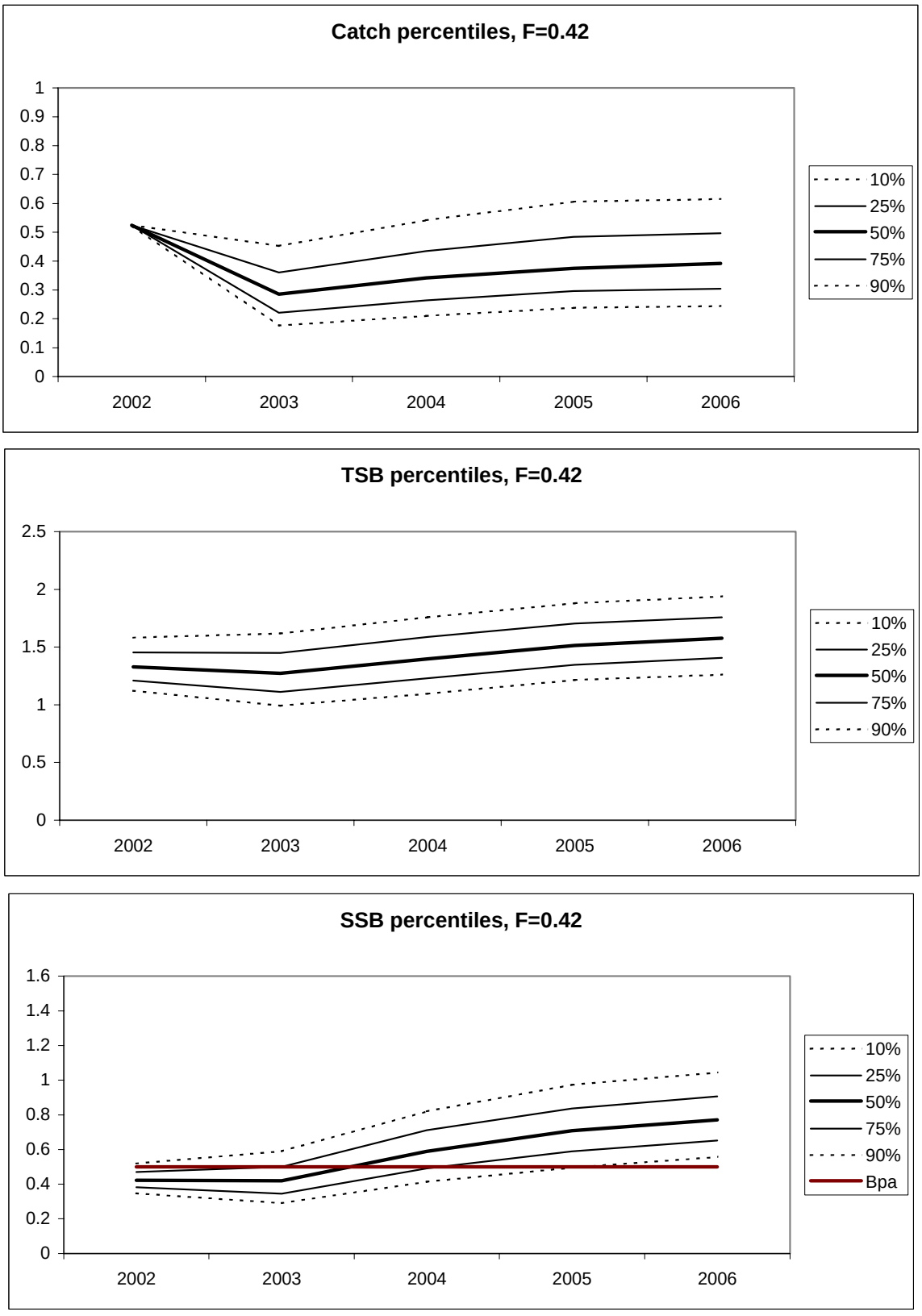
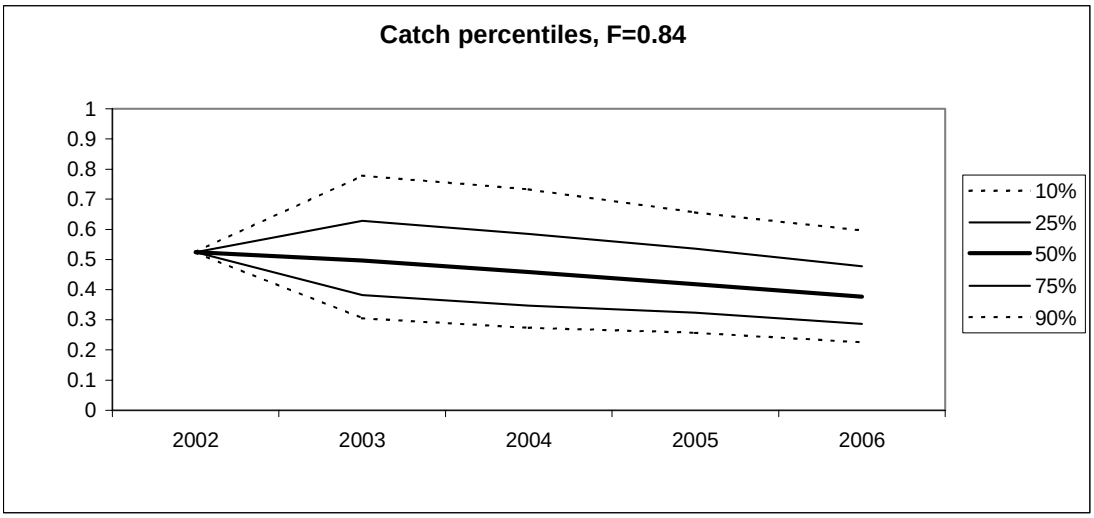
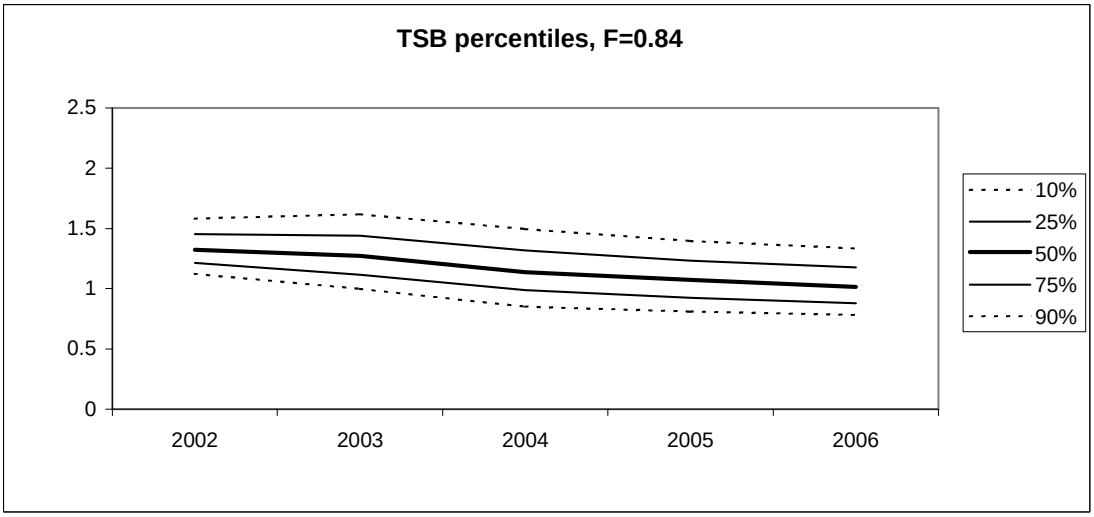


Figure 3.10 b. Medium-term predictions, assuming F status quo in 2002





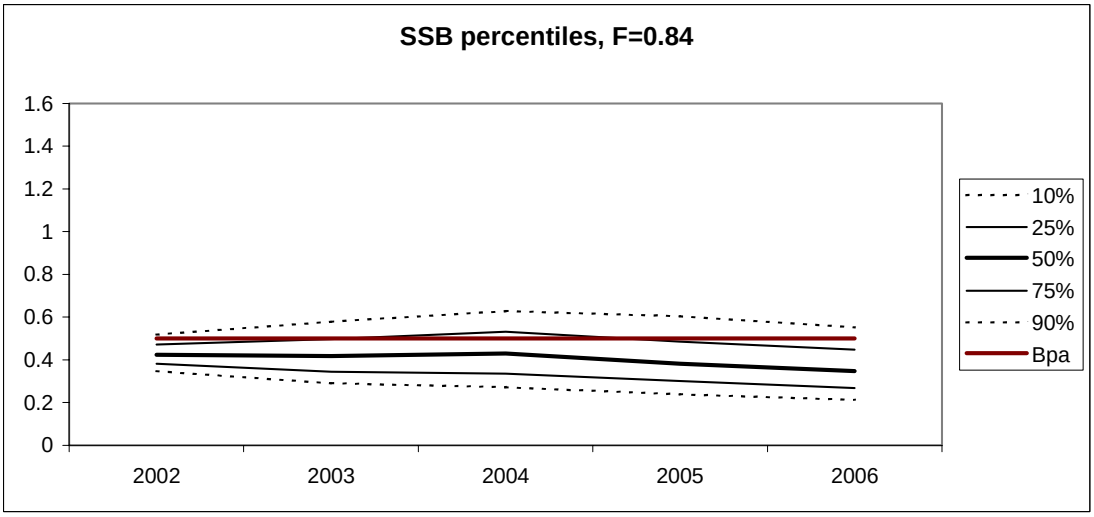
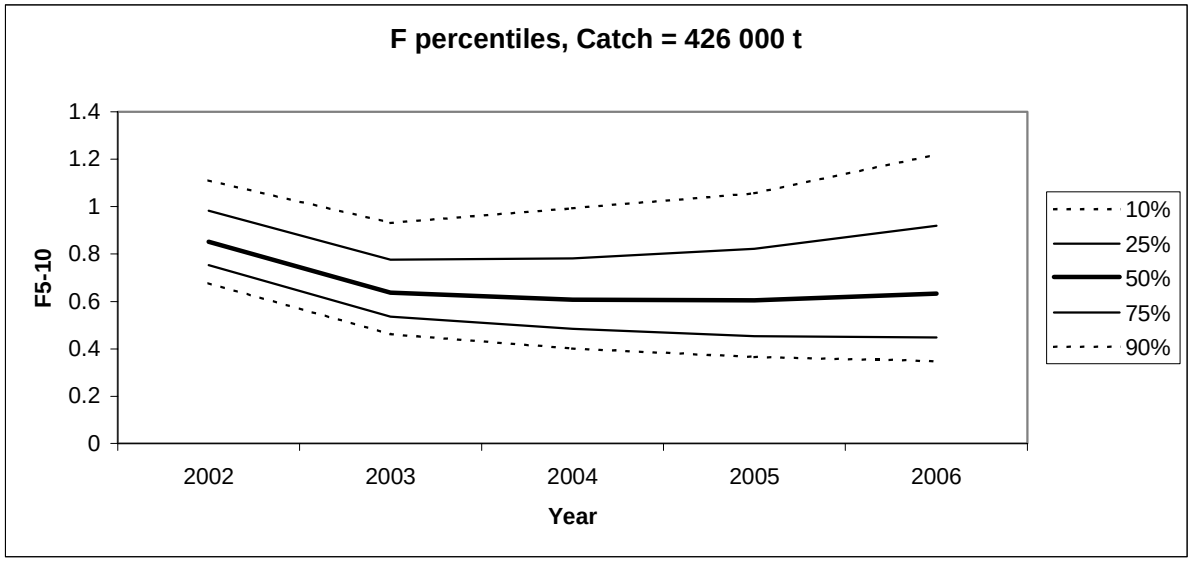
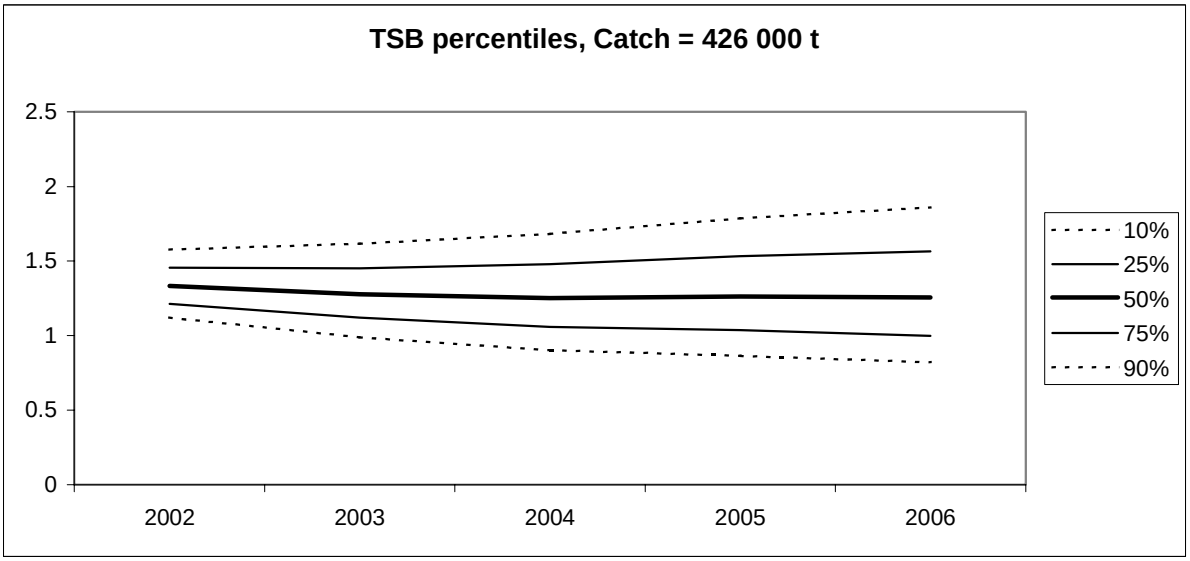


Figure 3.10 c. Medium-term predictions, assuming F status quo in 2002





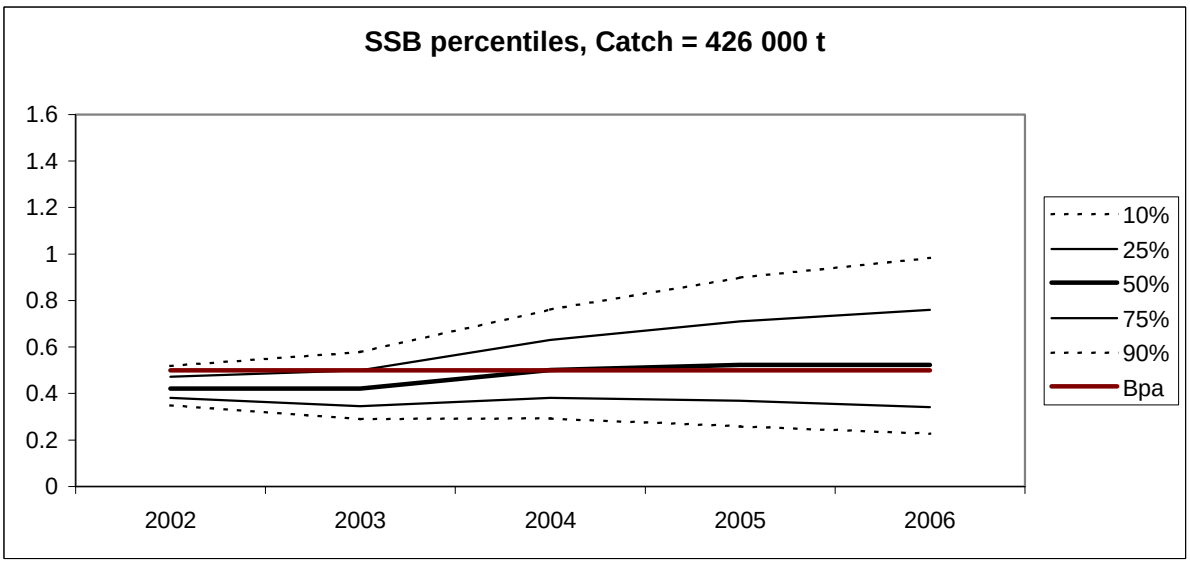


Figure 3.10 d. Medium-term predictions, assuming F status quo in 2002

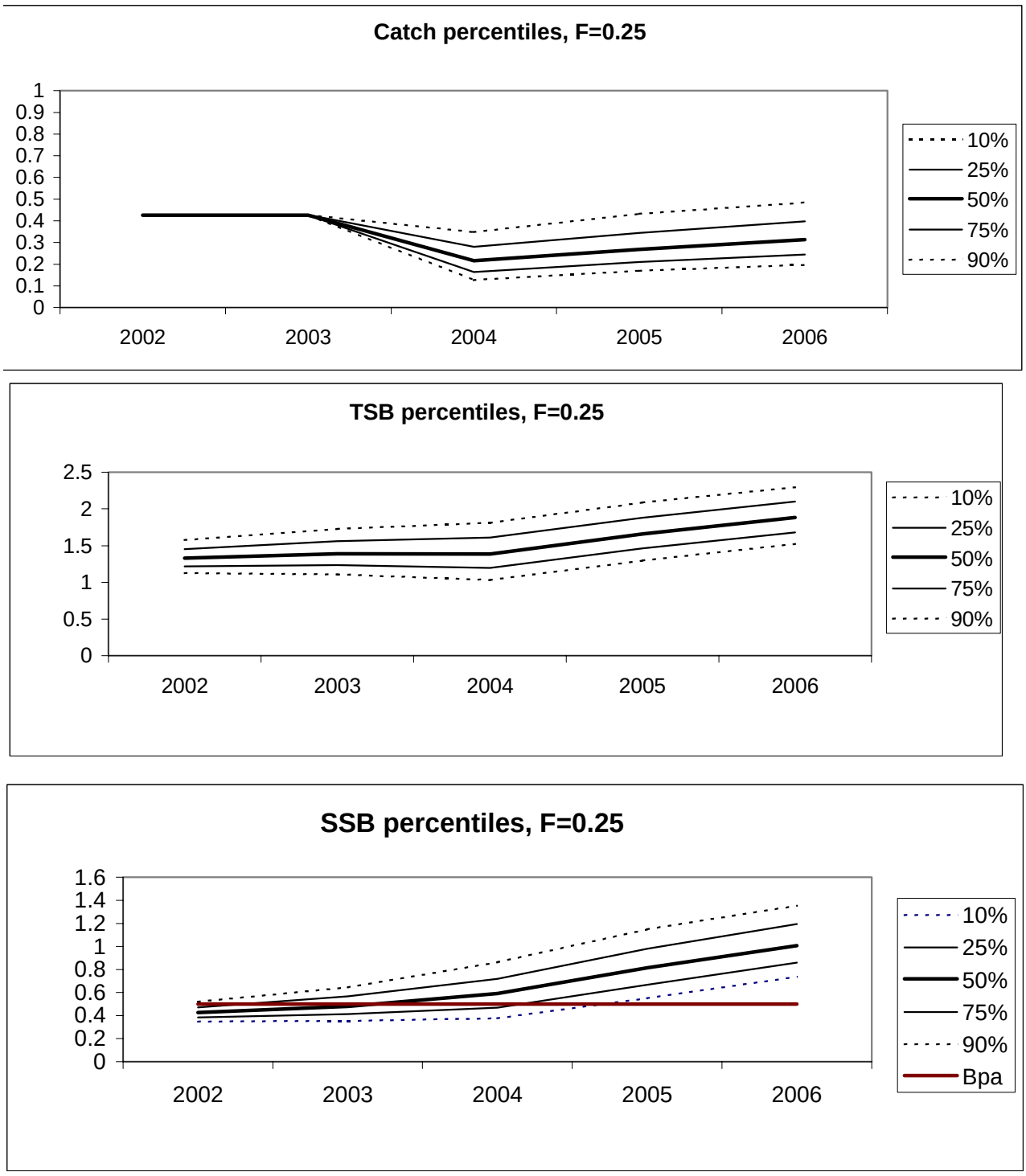
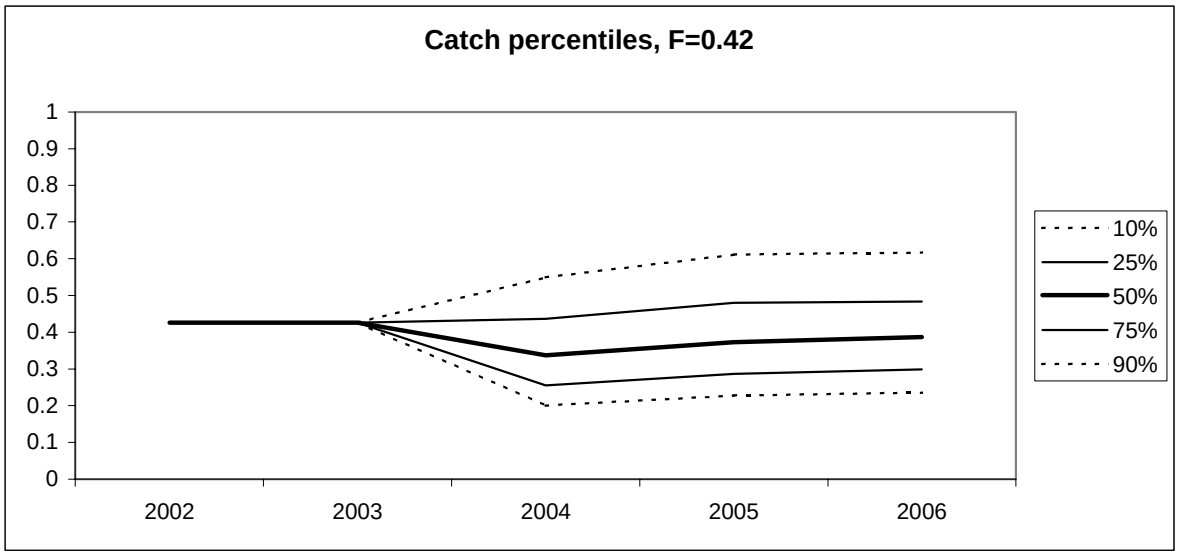
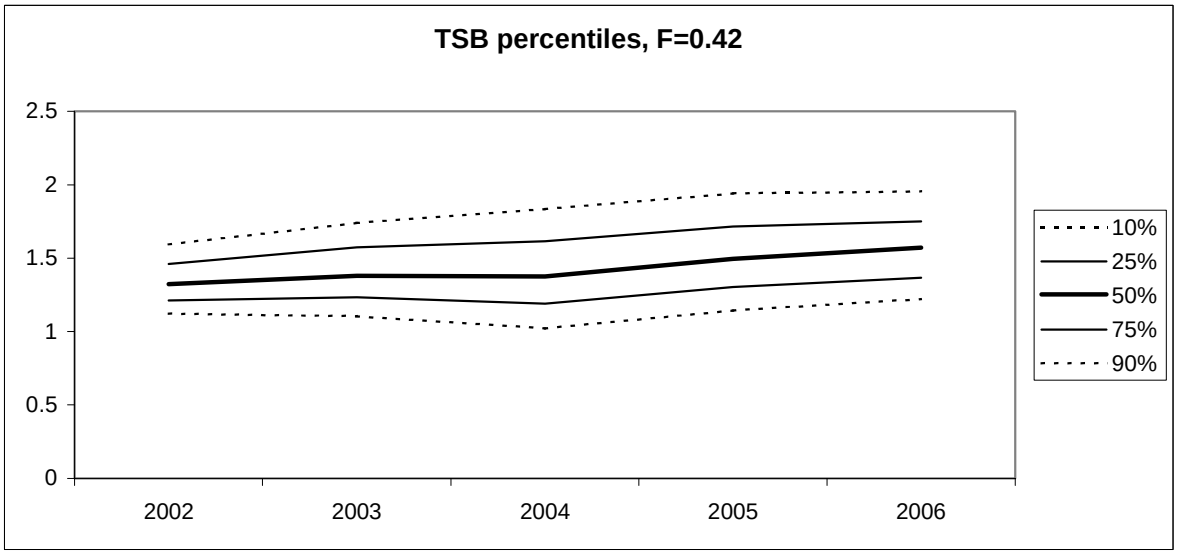


Figure 3.10 e. Medium-term predictions, assuming a catch of 426 000 t in 2002 and 2003.





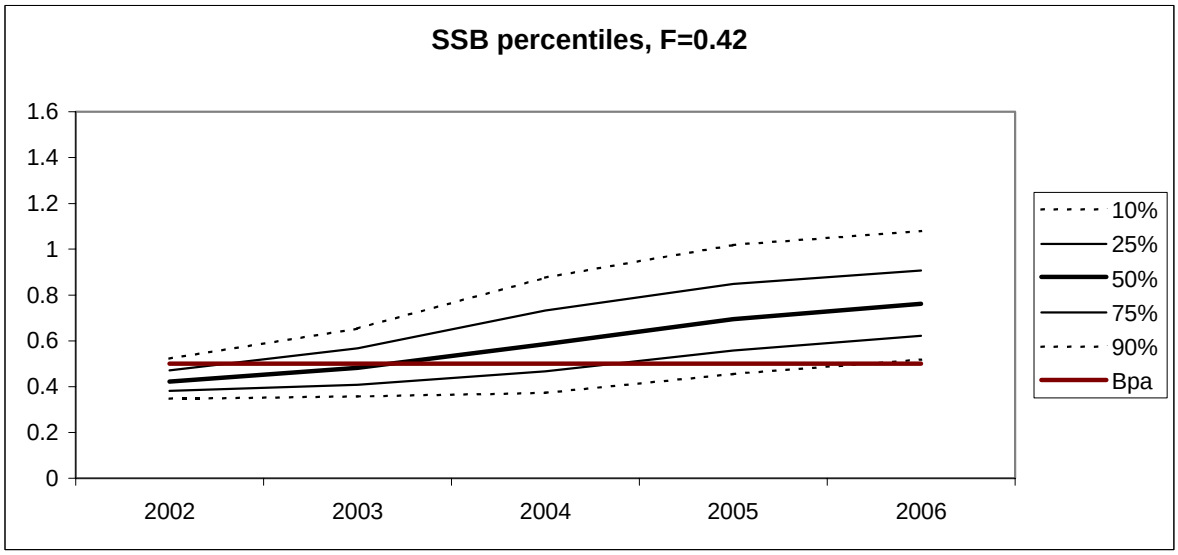
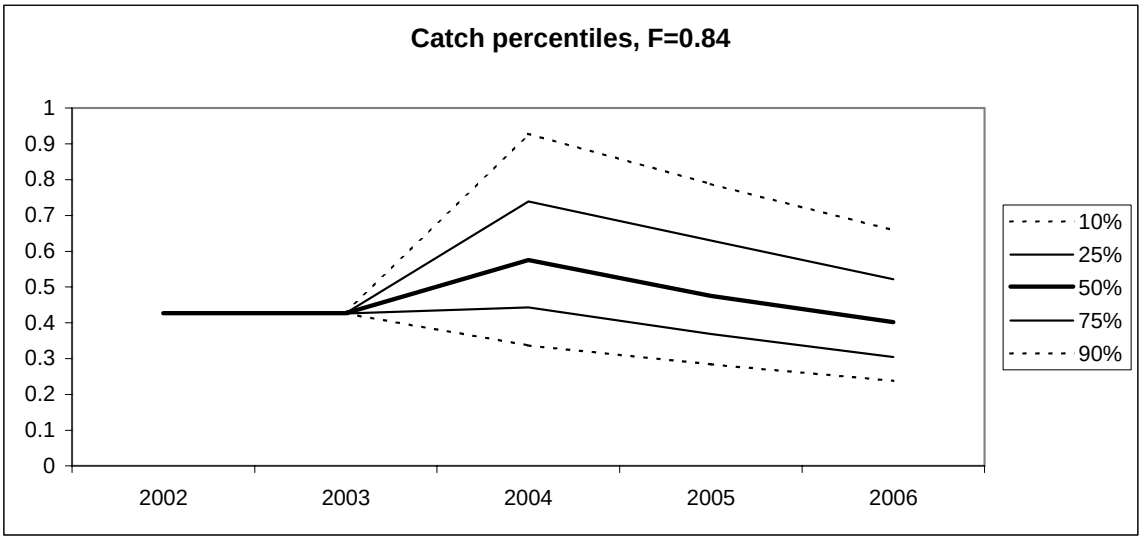
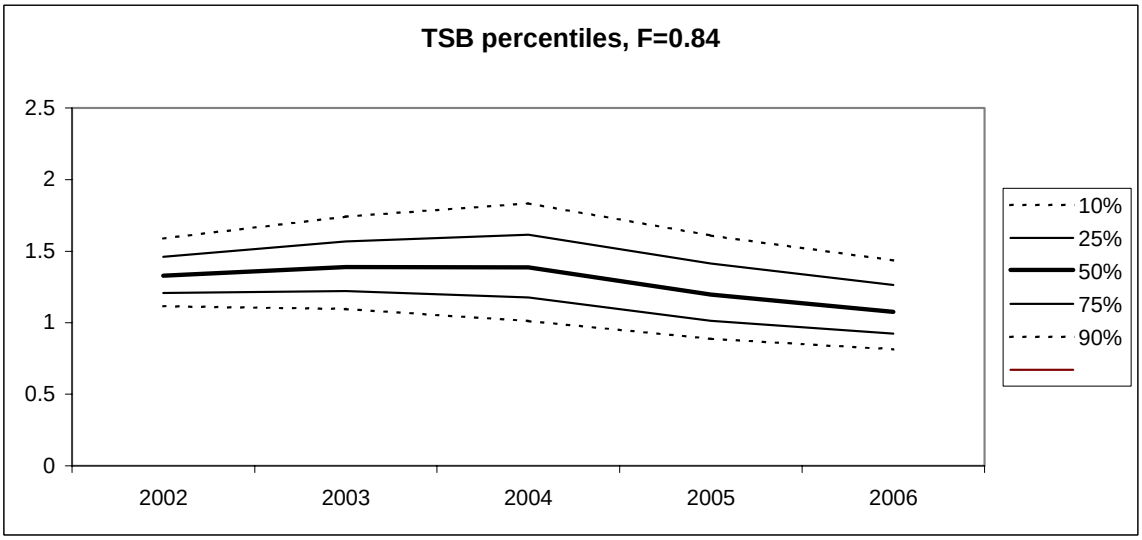


Figure 3.10 f. Medium-term predictions, assuming a catch of 426 000 t in 2002 and 2003.





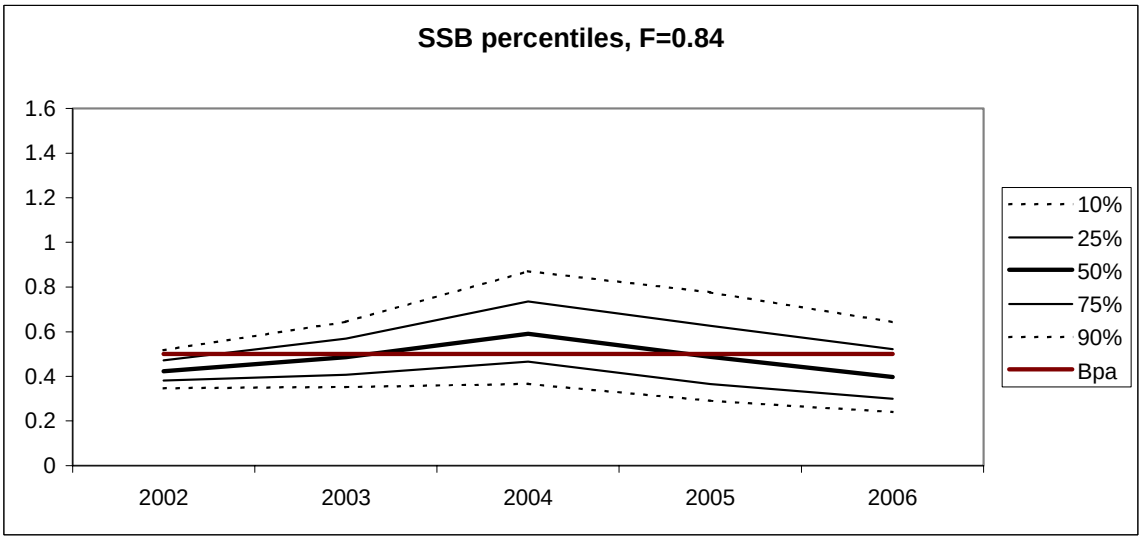
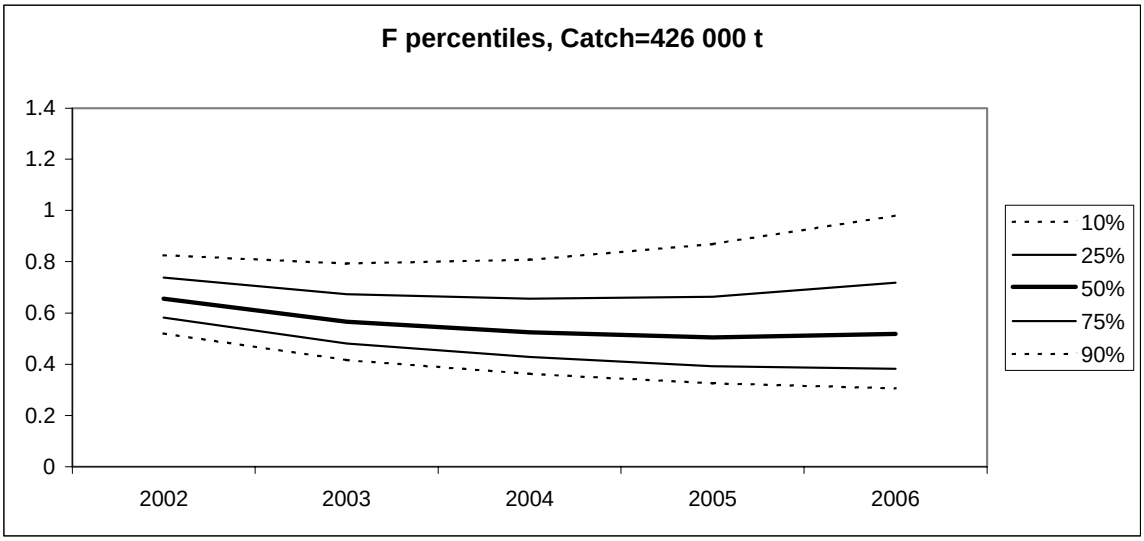
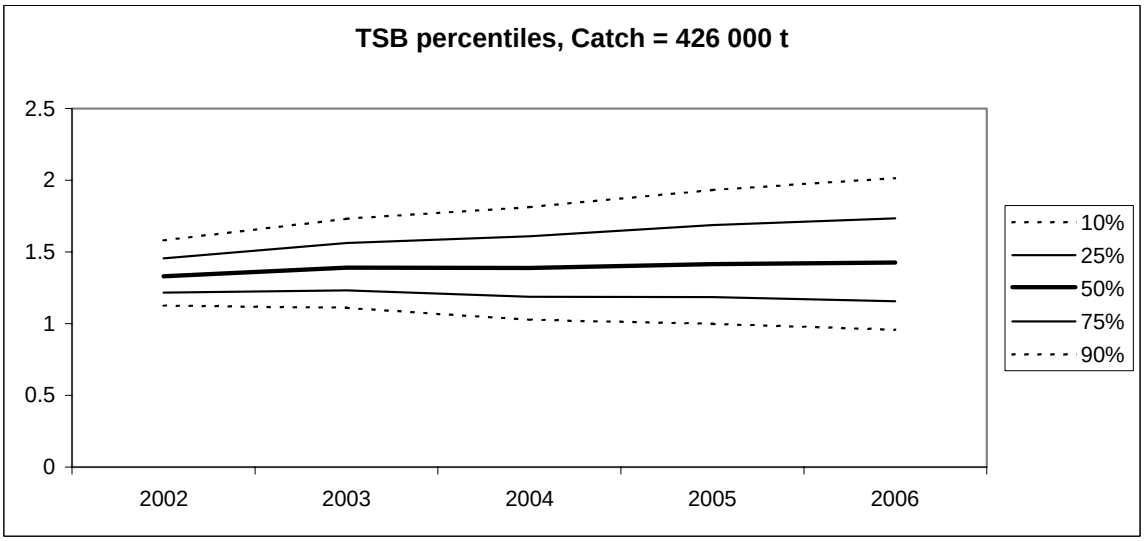


Figure 3.10 g. Medium-term predictions, assuming a catch of 426 000 t in 2002 and 2003.





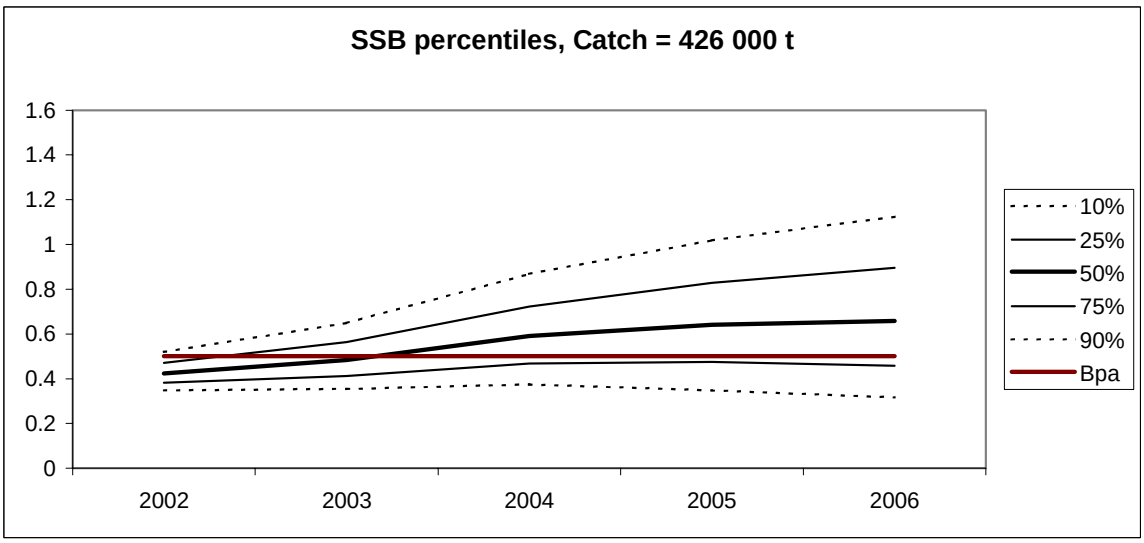


Figure 3.10 h. Medium-term predictions, assuming a catch of 426 000 t in 2002 and 2003.

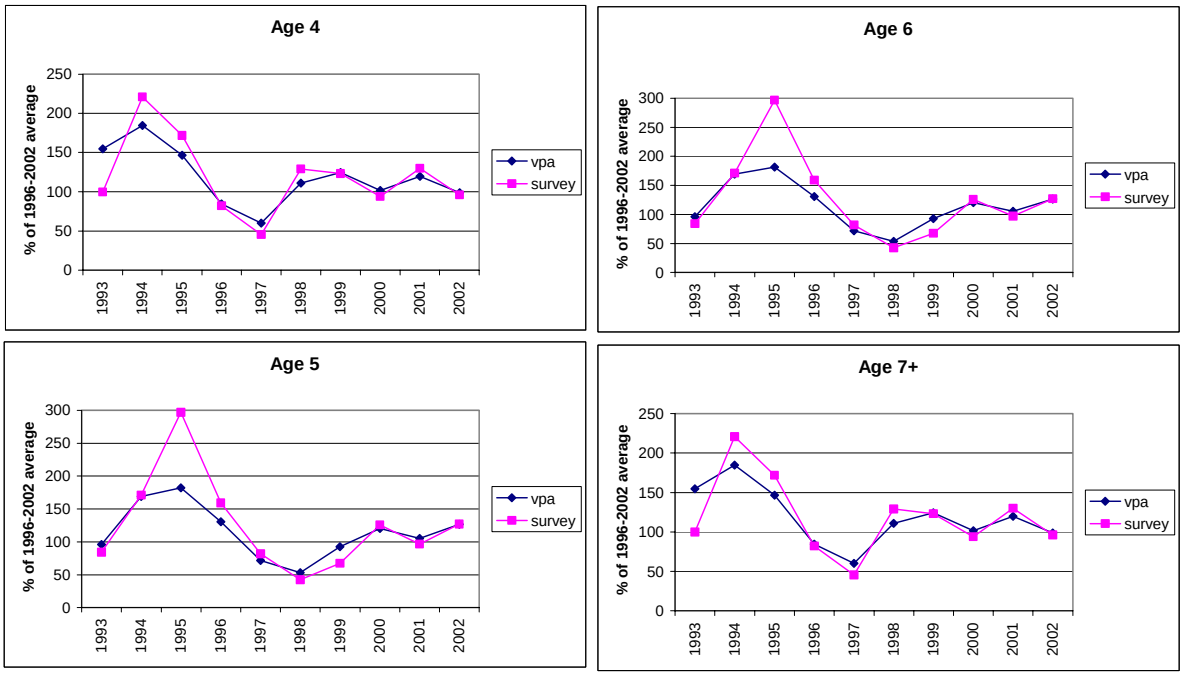


Figure 3.11. NEA cod. Stock numbers by age relative to the average for the period 1996-2002 for the vpa and the Joint winter bottom trawl survey.

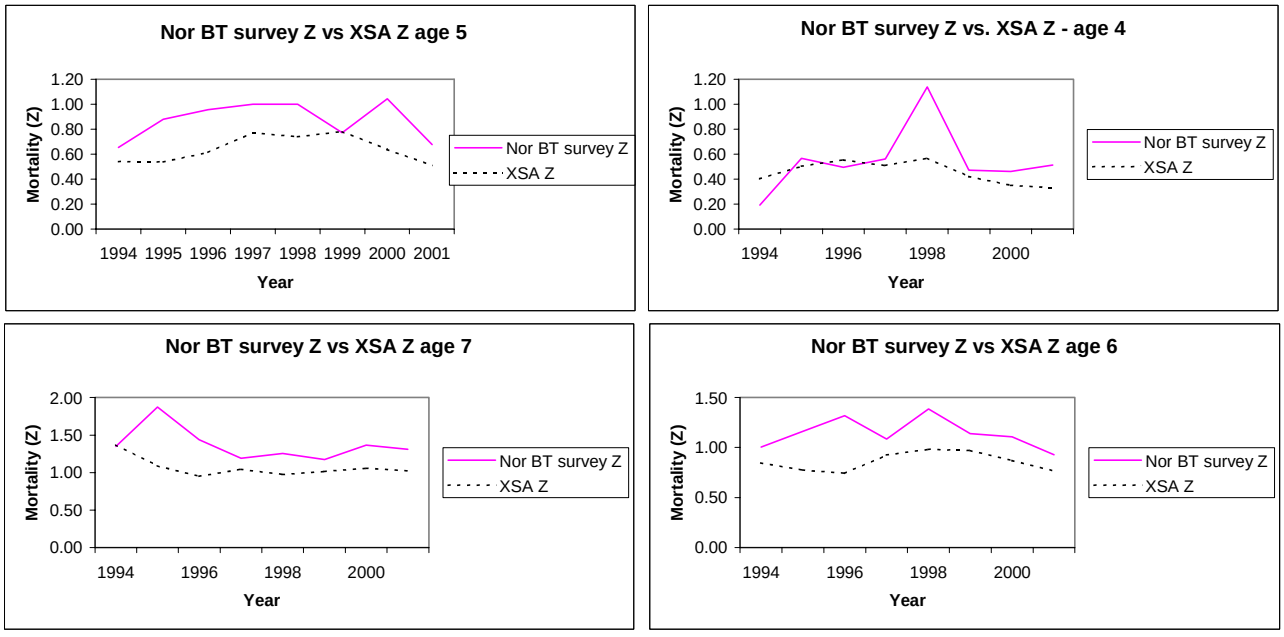


Figure 3.12. NEA cod. Survey mortalities in the Joint winter bottom trawl survey, compared to vpa total mortalities.

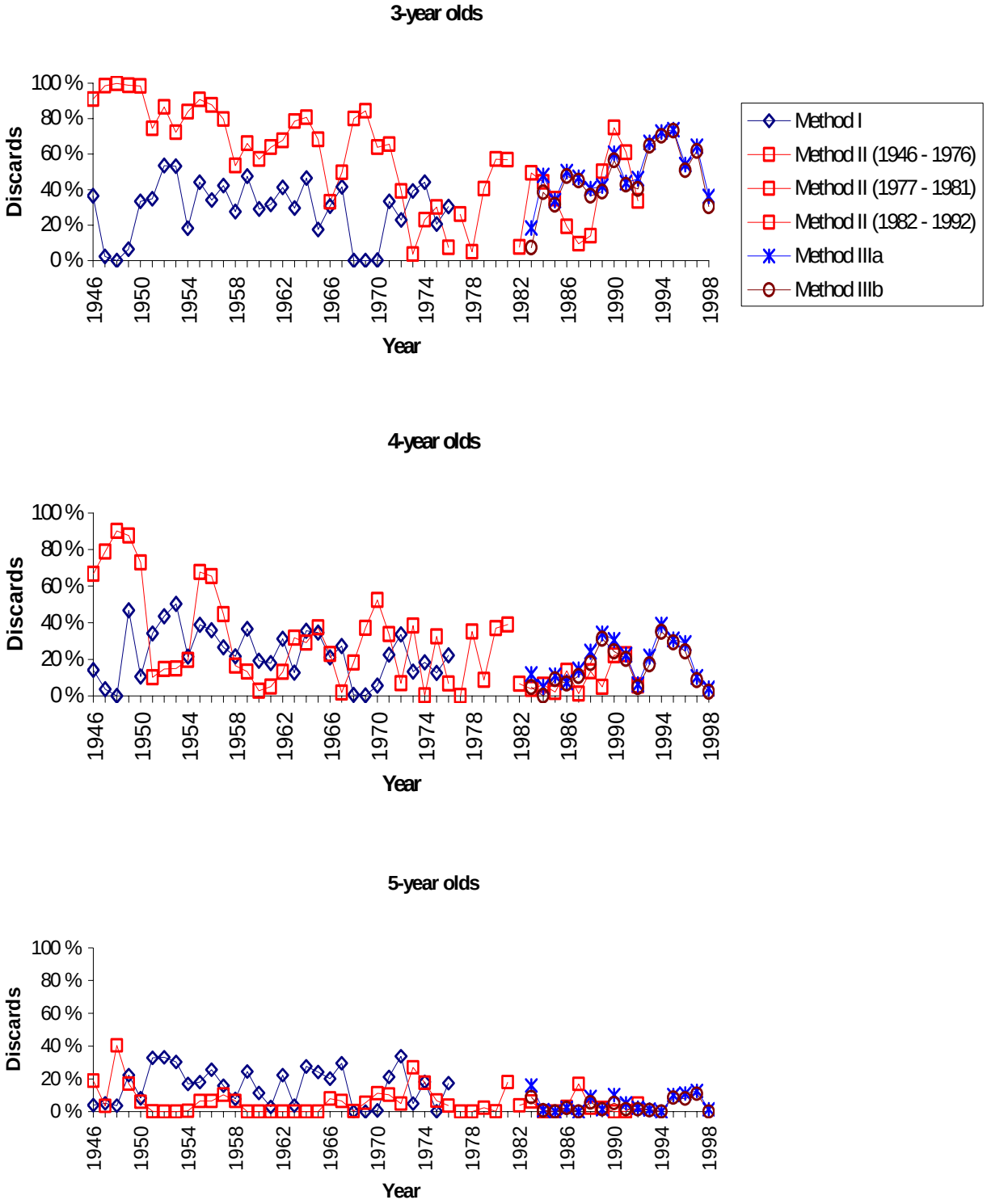


Figure 3.13. Estimated discards of cod by 3 different methods for ages 3,4 and 5. Total discards in % of total international catch including discards. From Dingsør (WD 13).

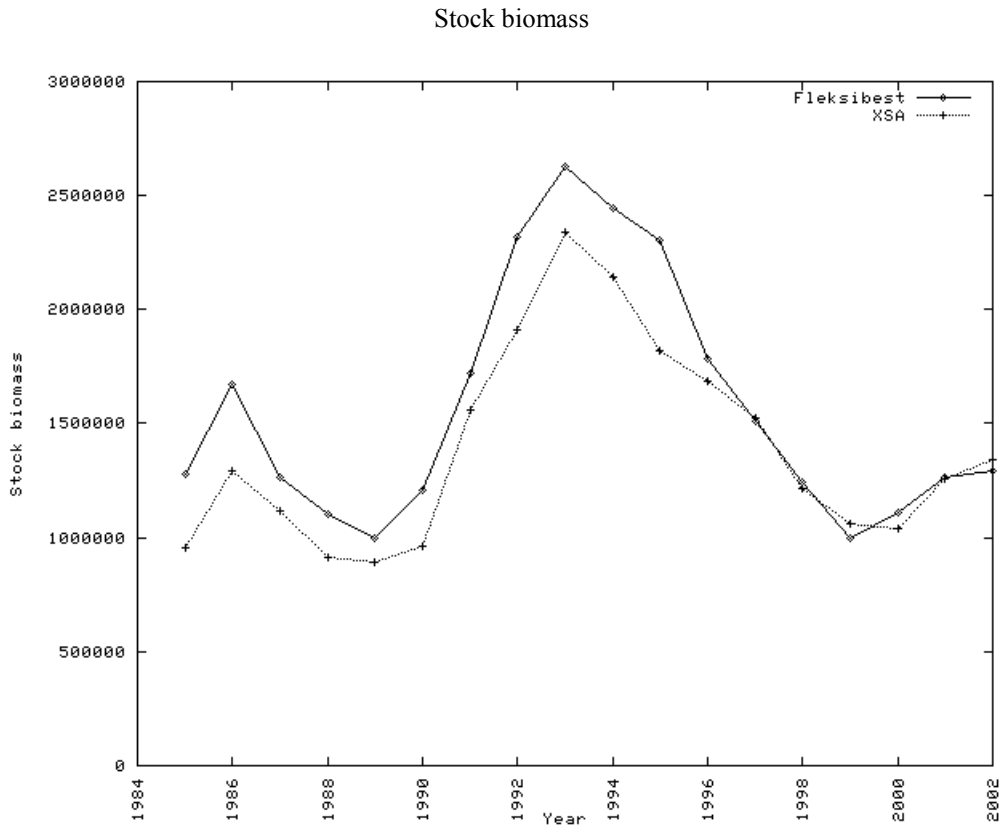


Figure 3.14a (stock biomass in key run, and XSA from 2002)

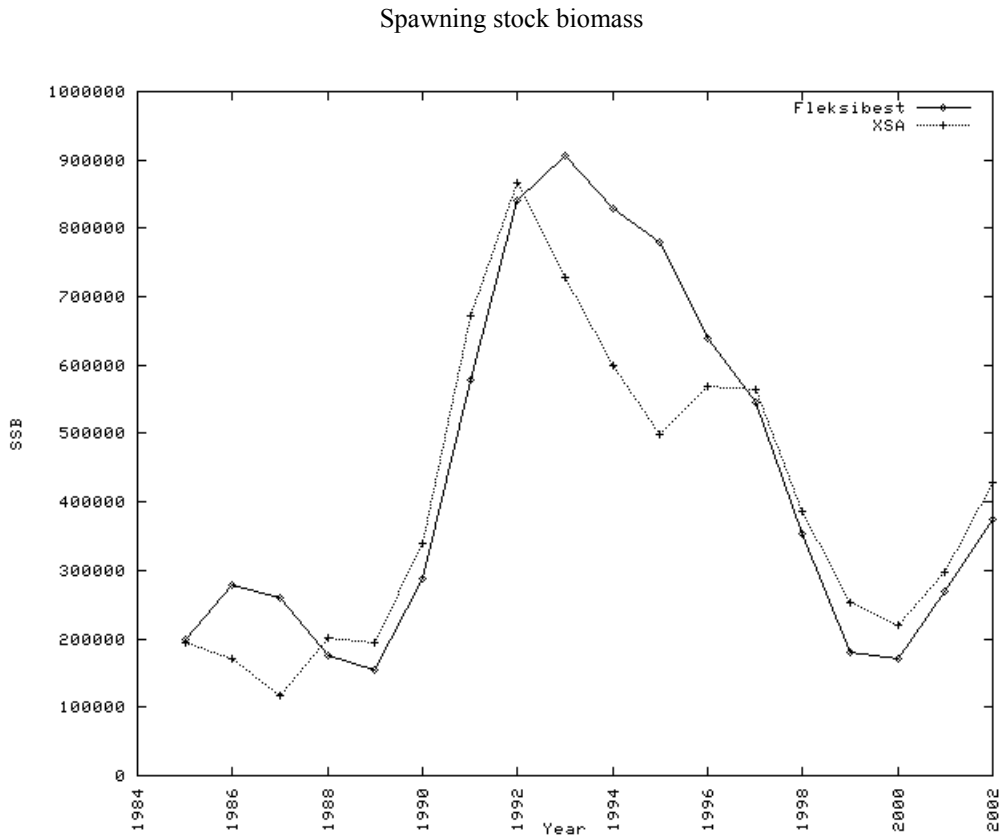


Figure 3.14b (SSB in key run, and XSA from 2002)

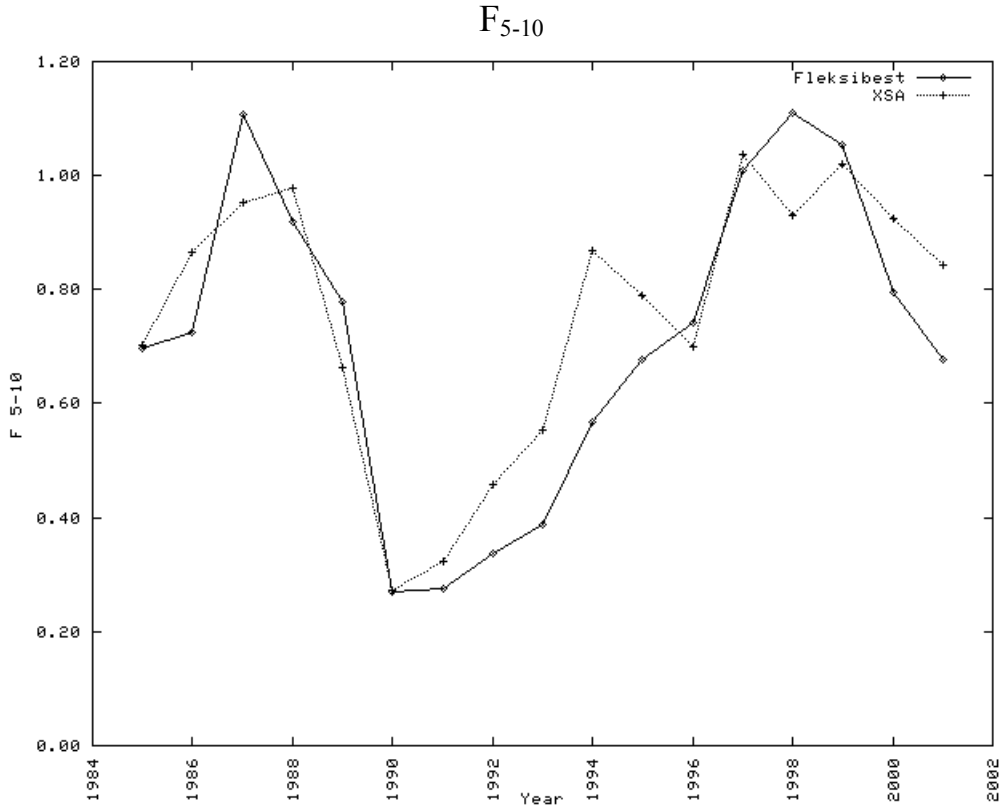


Figure 3.14c (F5-10 in key run, and XSA from 2002)

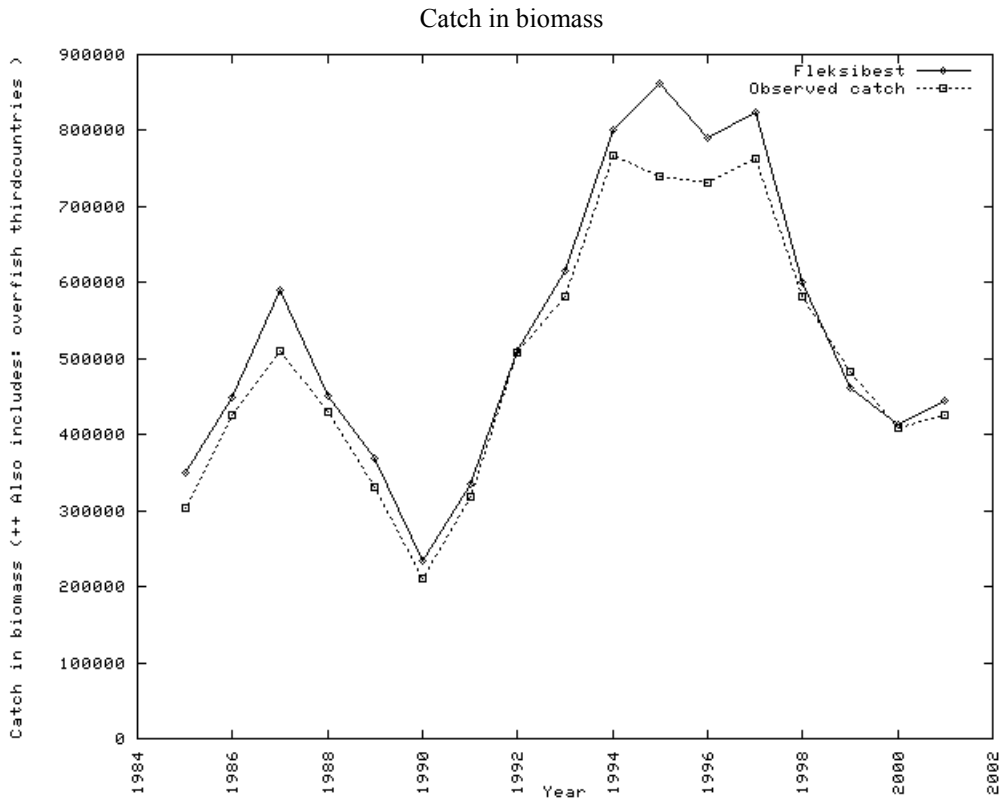


Figure 3.14d (Catch in biomass in key run, and observed catches)

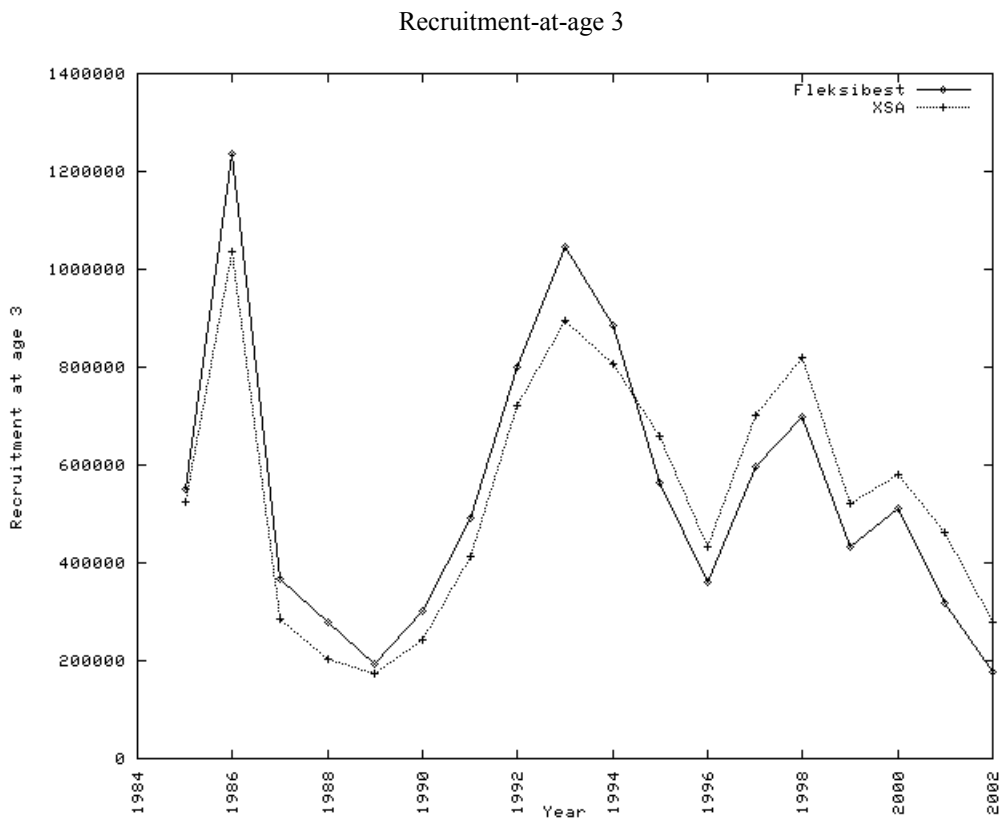


Figure 3.14e (Recruitment (number of 3 year old) in key run, and XSA from 2002)

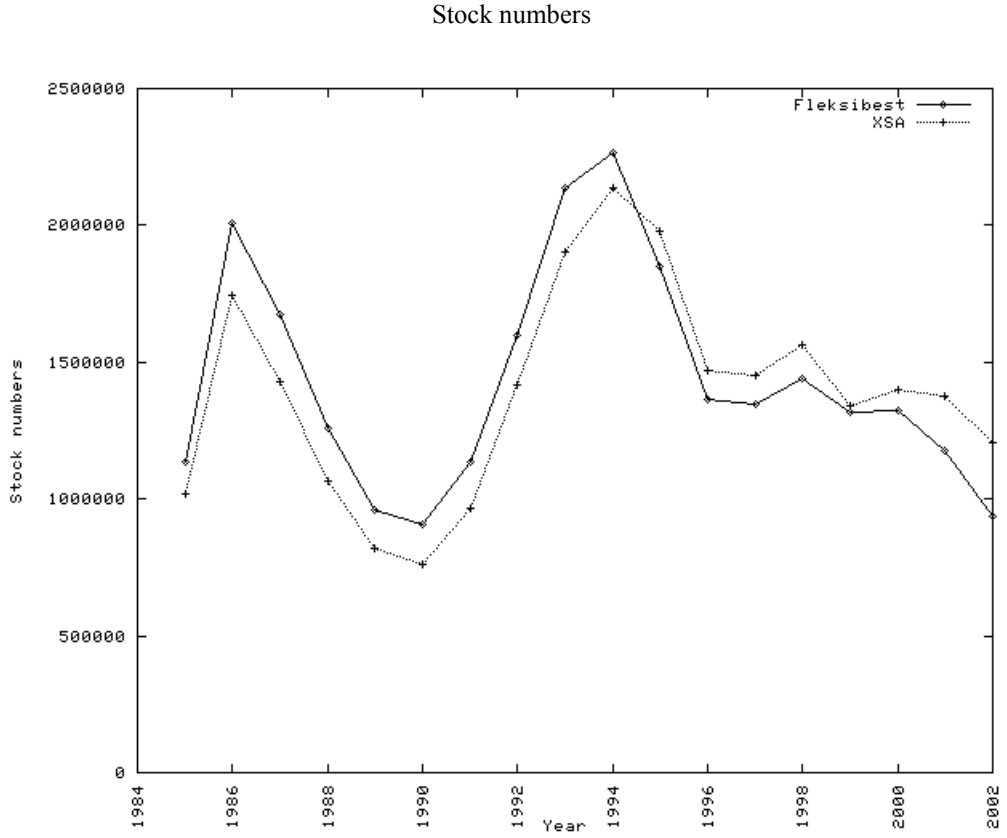


Figure 3.14f (Stock numbers in key run, and XSA from 2002)

Observed and modeled indices, Winter survey and Lofoten survey

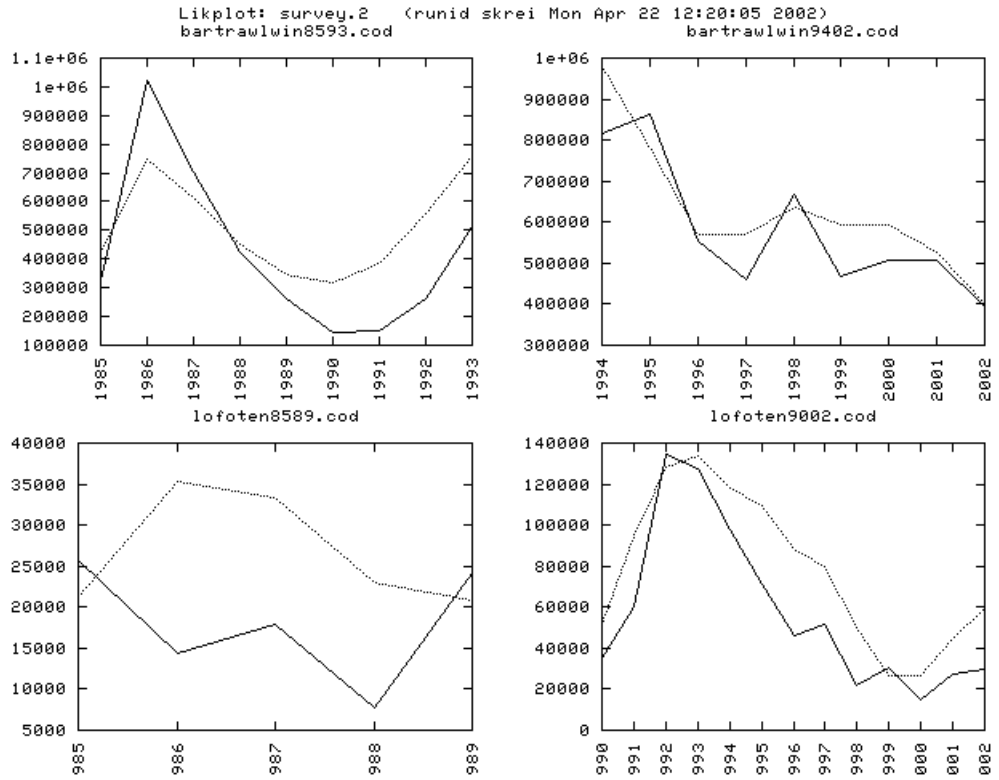


Figure 3.15a (Observed and modeled survey indices, solid line is observed)

Likelihood contribution, Winter survey and Lofoten survey

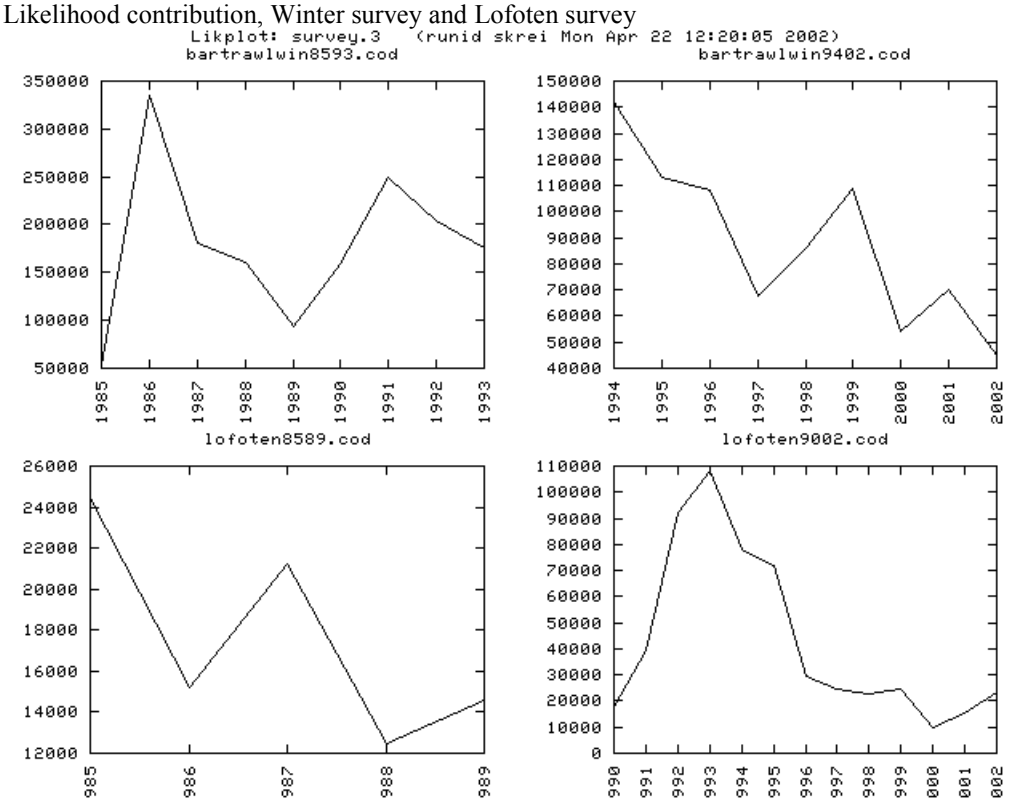


Figure 3.15b (Unweighted likelihood contribution from surveys)

Observed and modeled indices, acoustic survey, Russian survey, and autumn survey

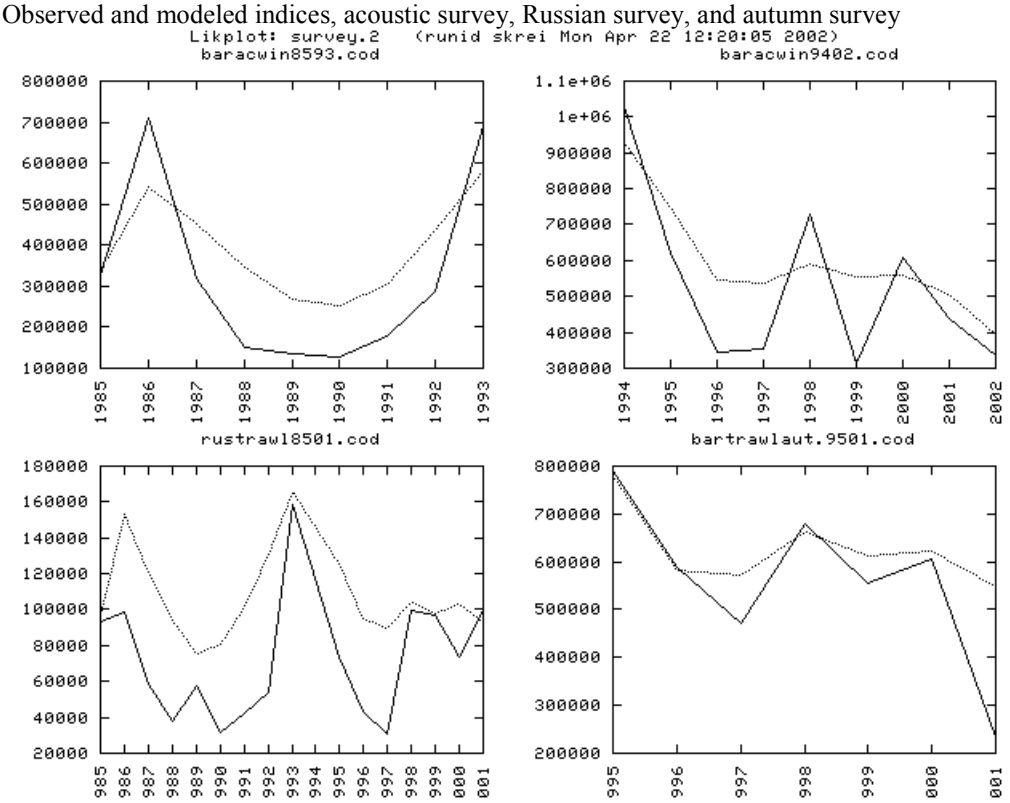


Figure 3.15c (Observed and modeled survey indices, solid line is observed

Likelihood contribution, acoustic survey, Russian survey, autumn survey

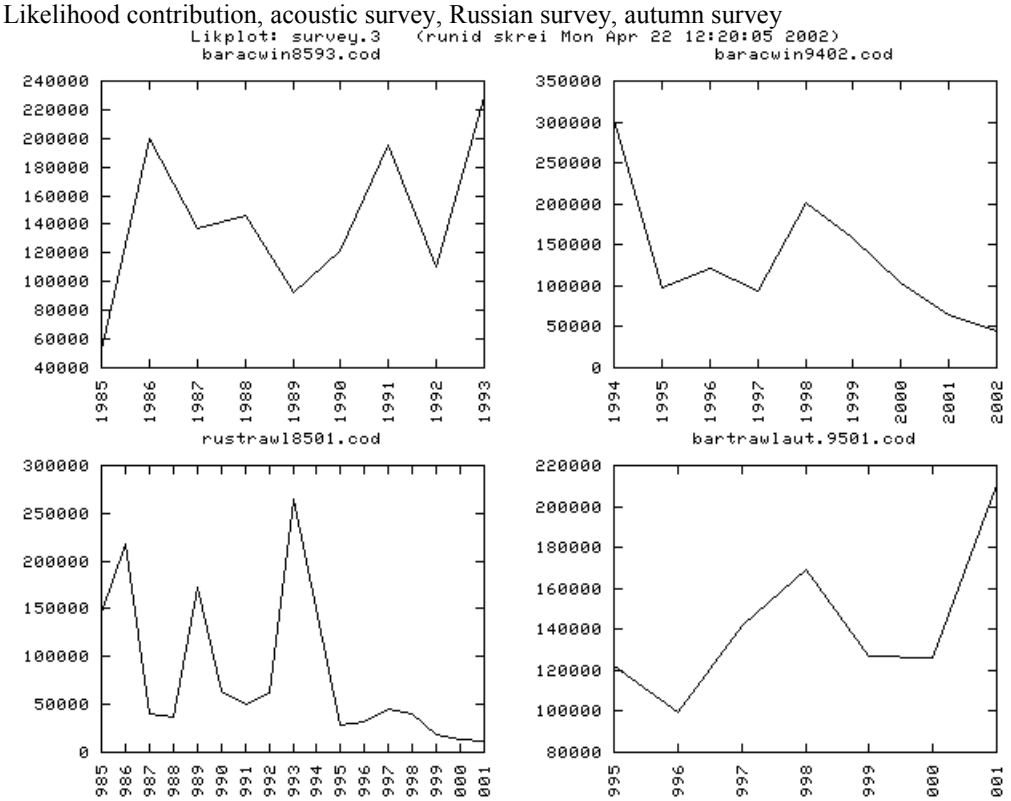


Figure 3.15d (Unweighted likelihood contribution from surveys)

Observed and Modeled Catches, totalfleet and gillnet

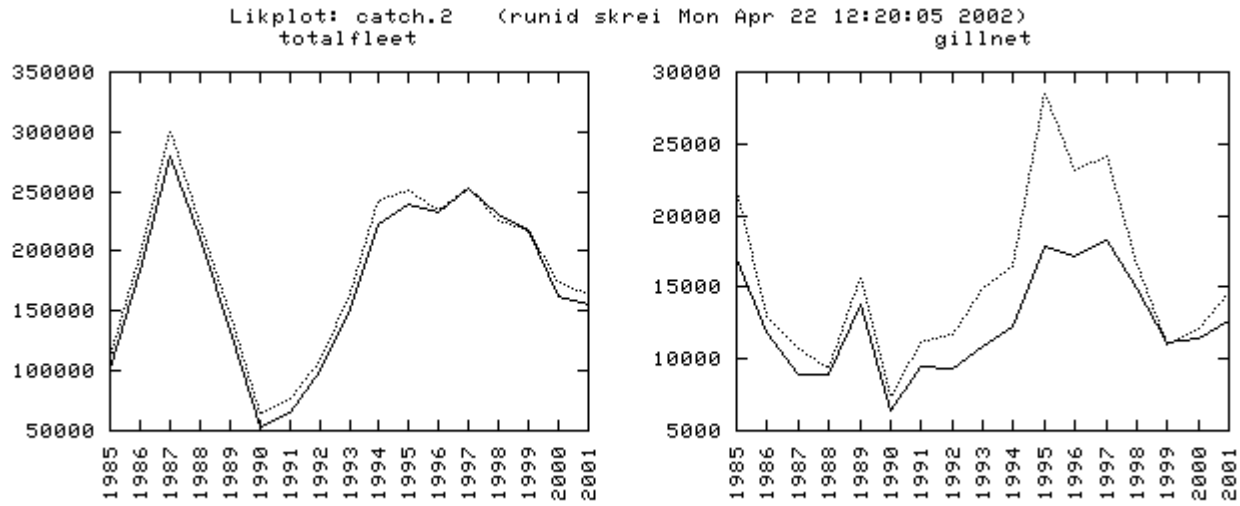


Figure 3.15e (Observed and Modeled catches, solid line is observed)

Likelihood contribution from totalfleet and gillnet

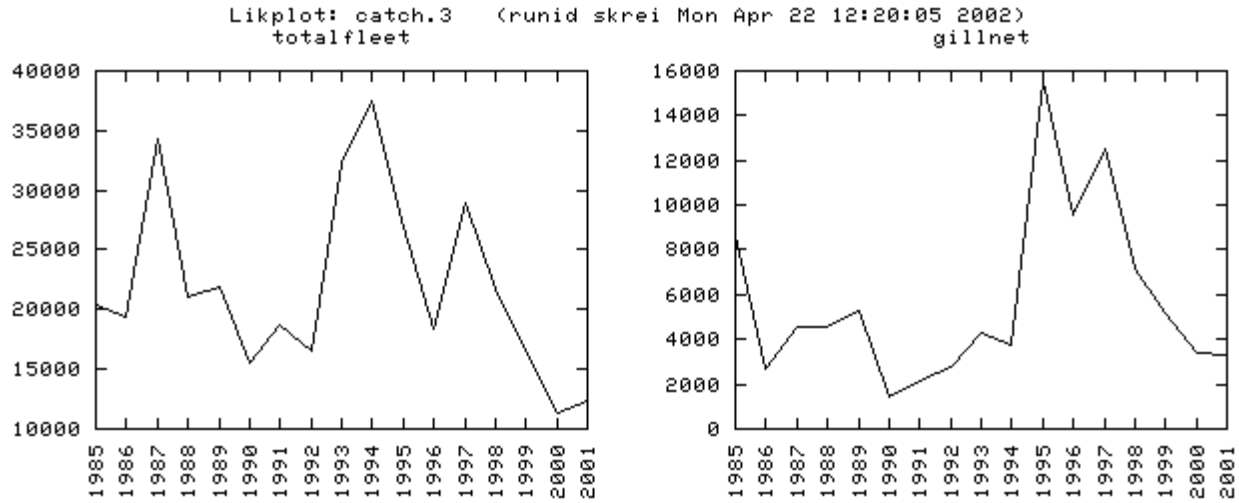


Figure 3.15f (Unweighted likelihood contribution from catches)

Retrospective analysis

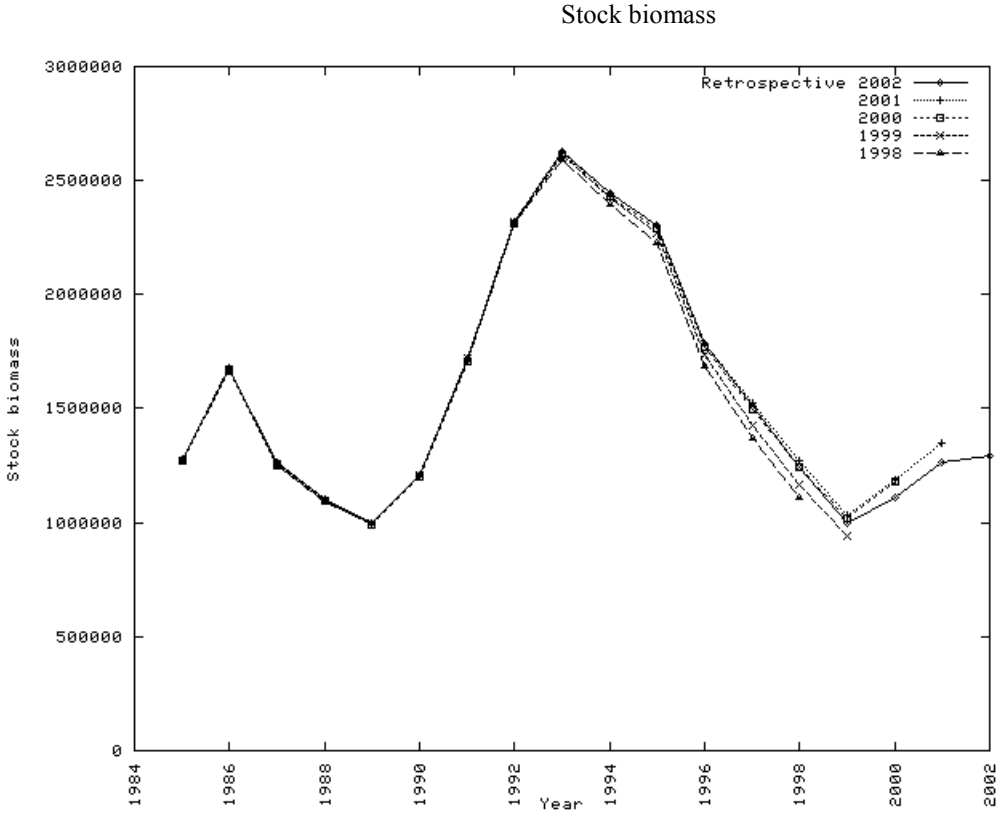


Figure 3.16a (Retrospective pattern for Stock biomass in key run)

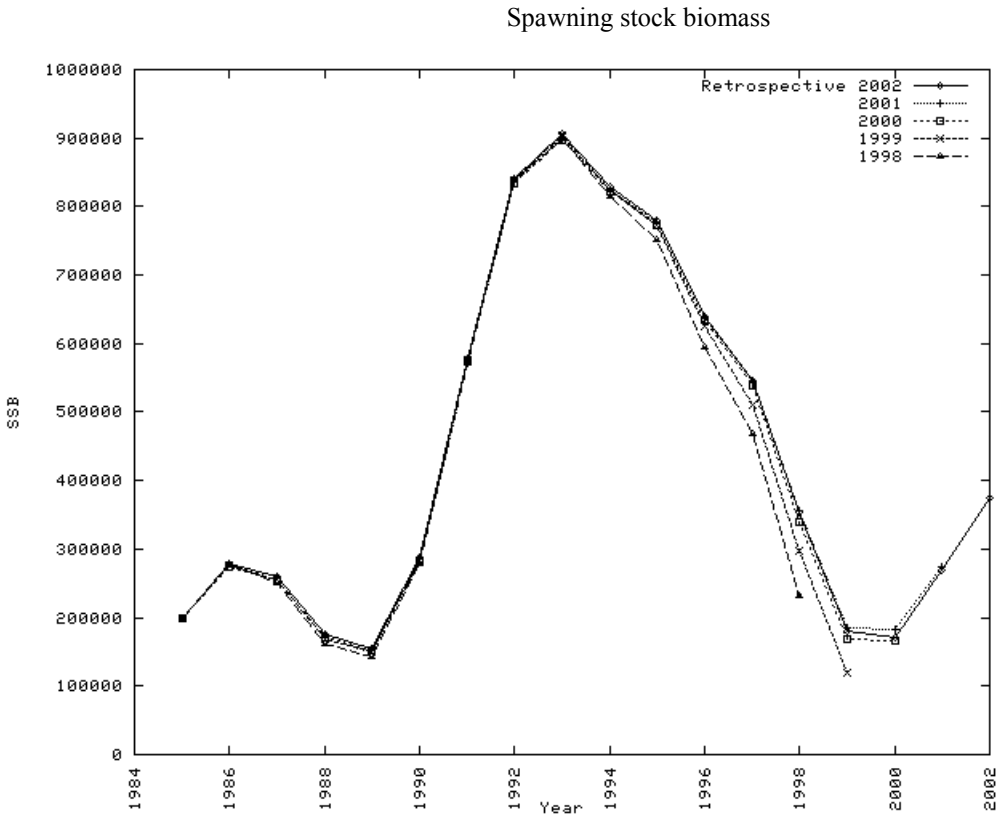


Figure 3.16b (retrospective pattern for SSB in key run)

F_{5-10}

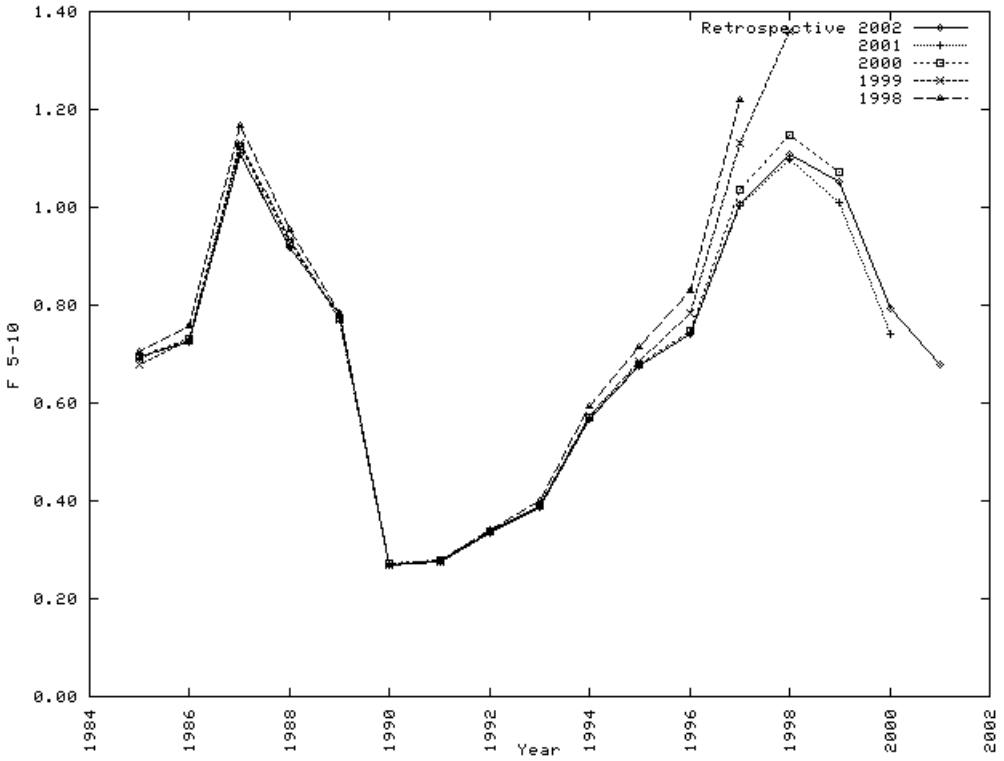


Figure 3.16c (Retrospective pattern for F_{5-10} in key run)

Catch in biomass

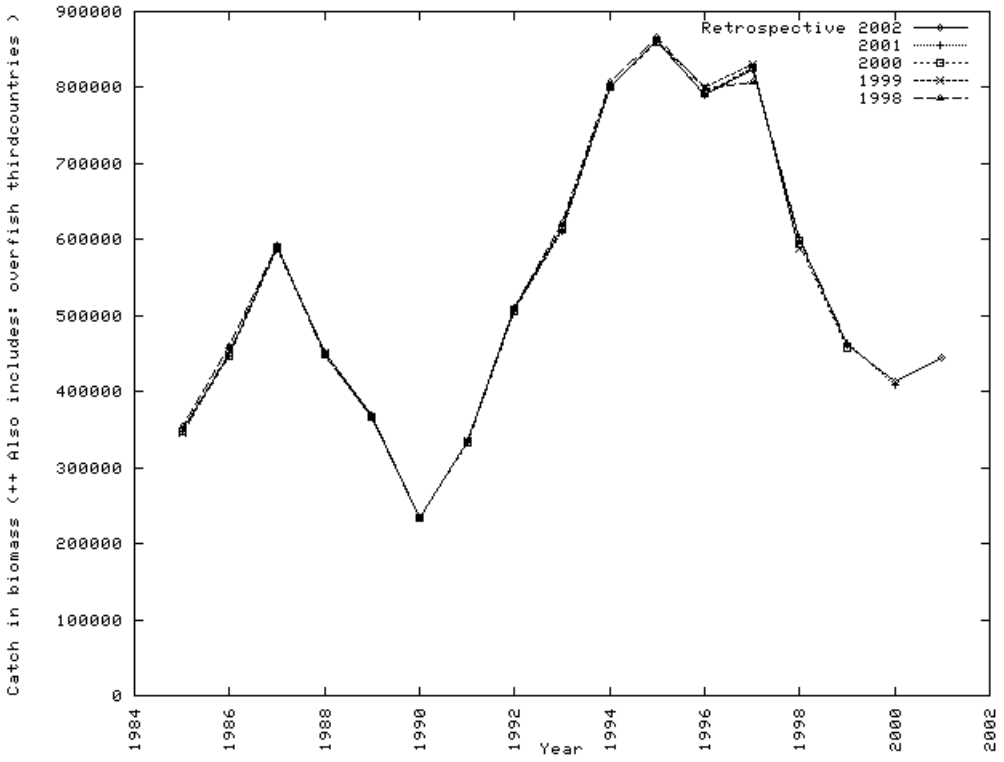


Figure 3.16d (Retrospective pattern for Catch in biomass in key run, and observed catches)

Recruitment-at-age 3

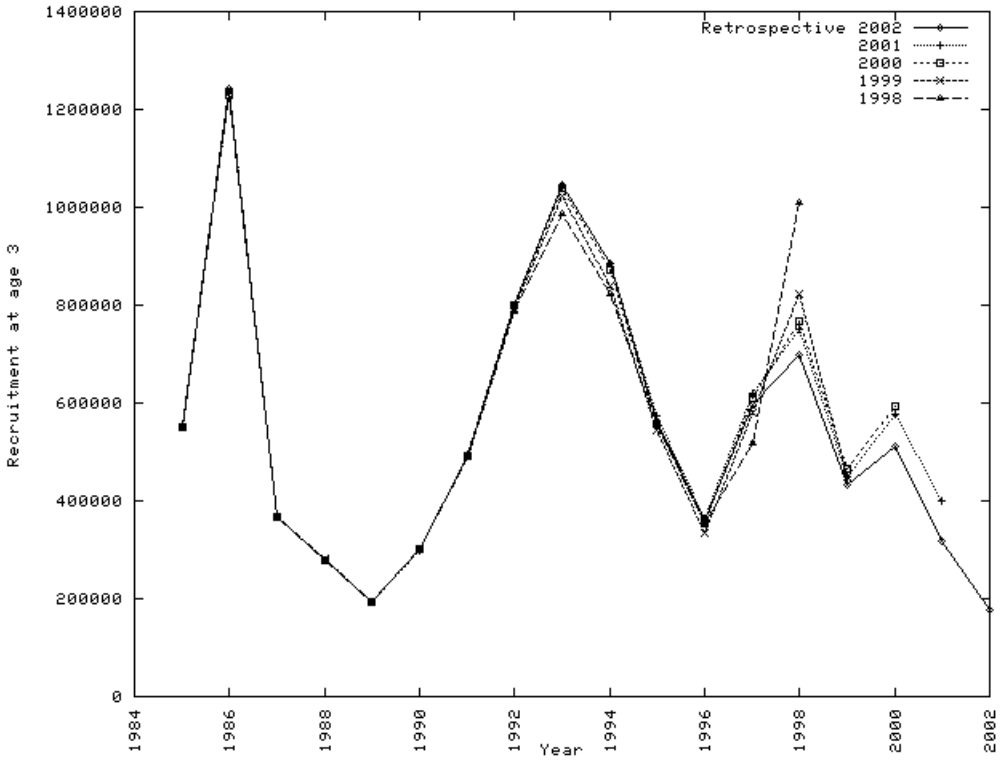


Figure 3.16e (Retrospective pattern for recruitment in key run)

Stock numbers

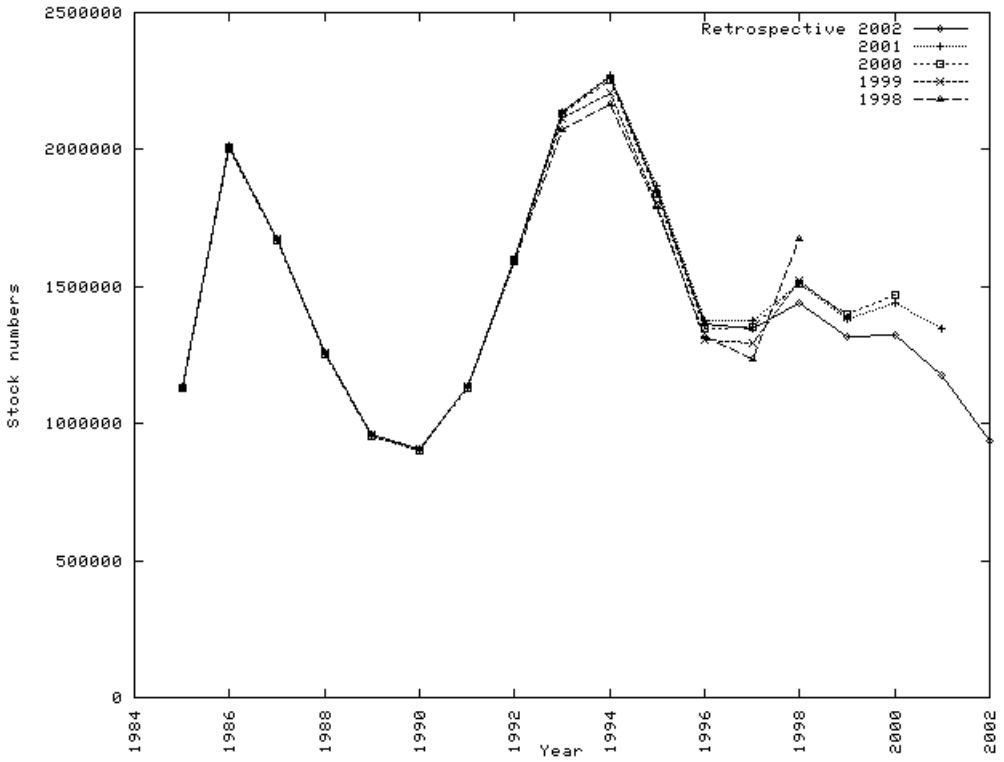


Figure 3.16f (Retrospective pattern for stock numbers in key run)

Prognosis with Fleksibest

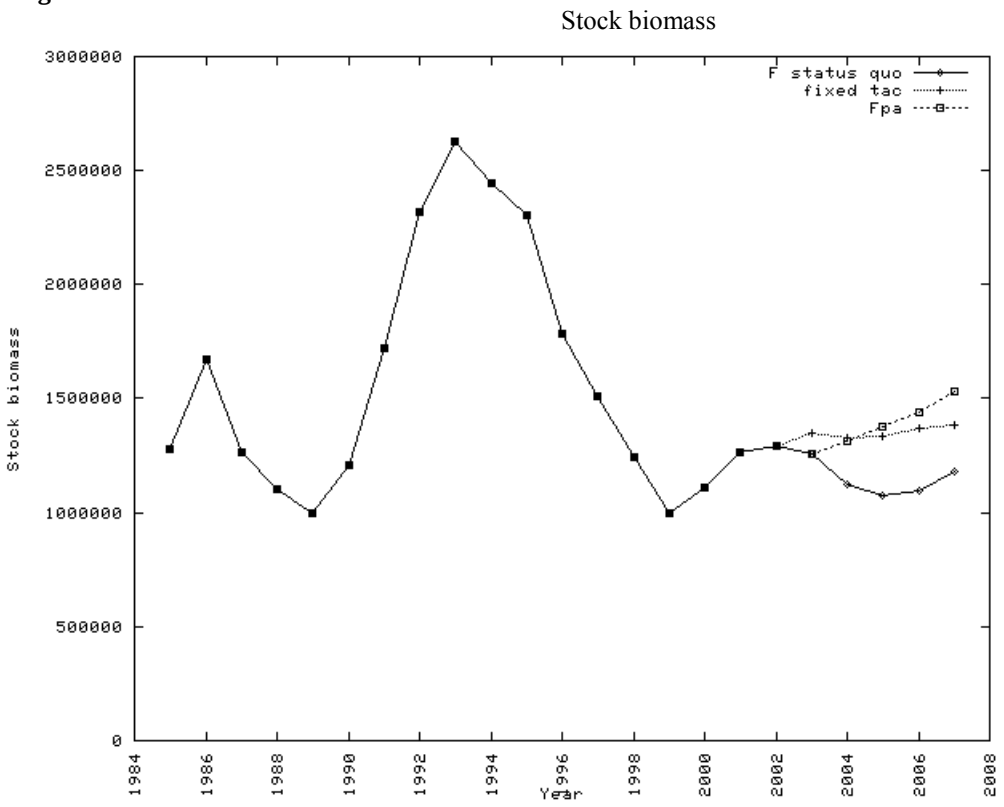


Figure 3.17a (Prediction of stock biomass)

Spawning stock biomass

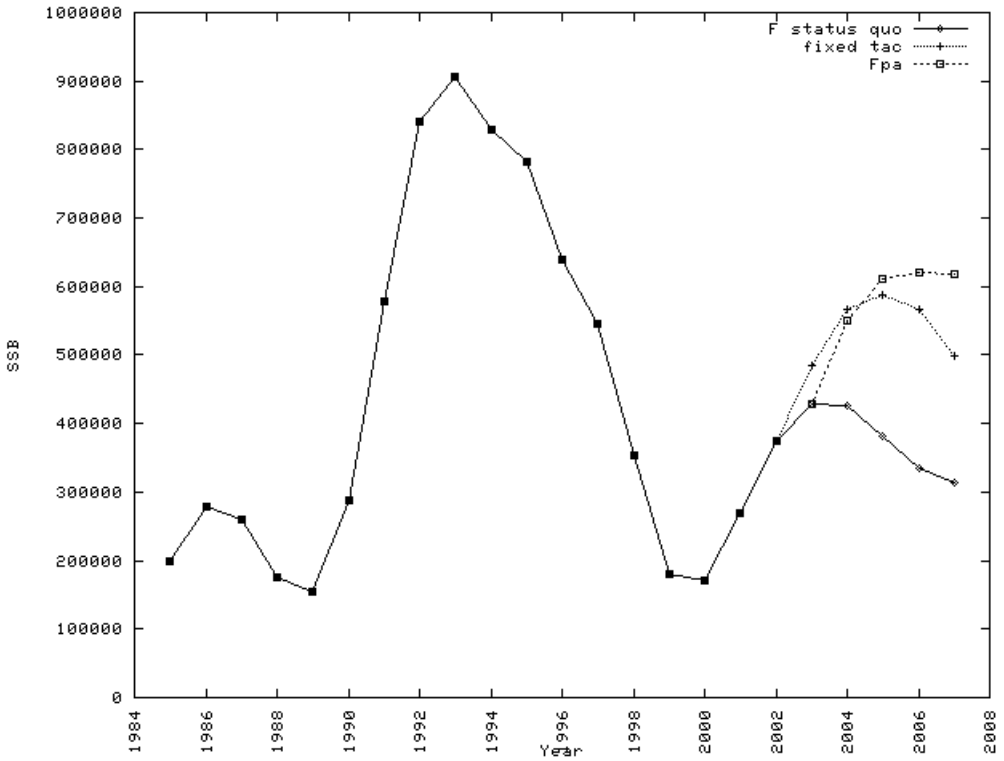


Figure 3.17b (Prediction of SSB)

$F_{5\text{-}10}$

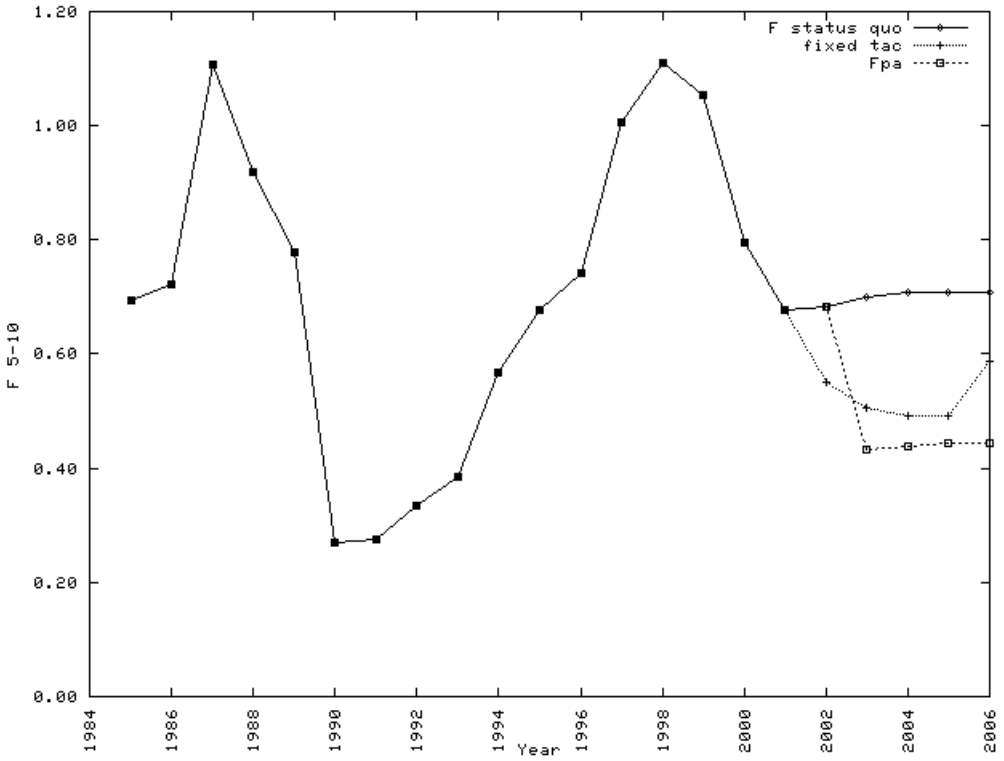


Figure 3.17c ($F_{5\text{-}10}$ in prediction with F status quo, fixed tac, and $\mathbf{F}_{pa}$)

Catch in biomass

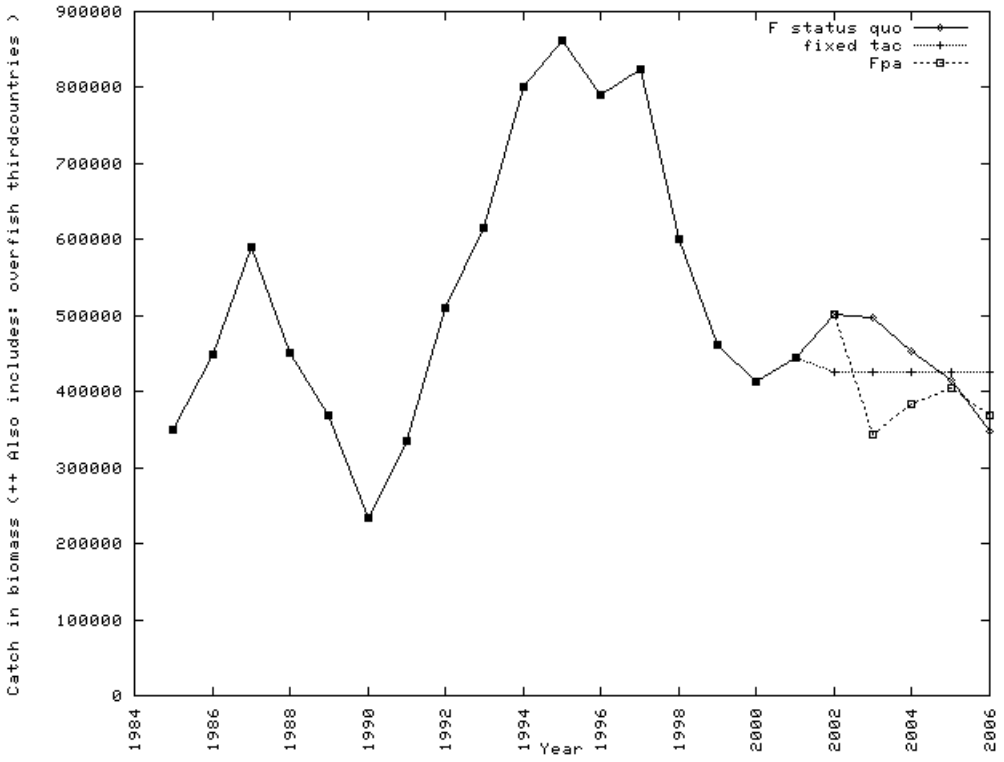


Figure 3.17d (Prediction of Catch in biomass)

Recruitment-at-age 3

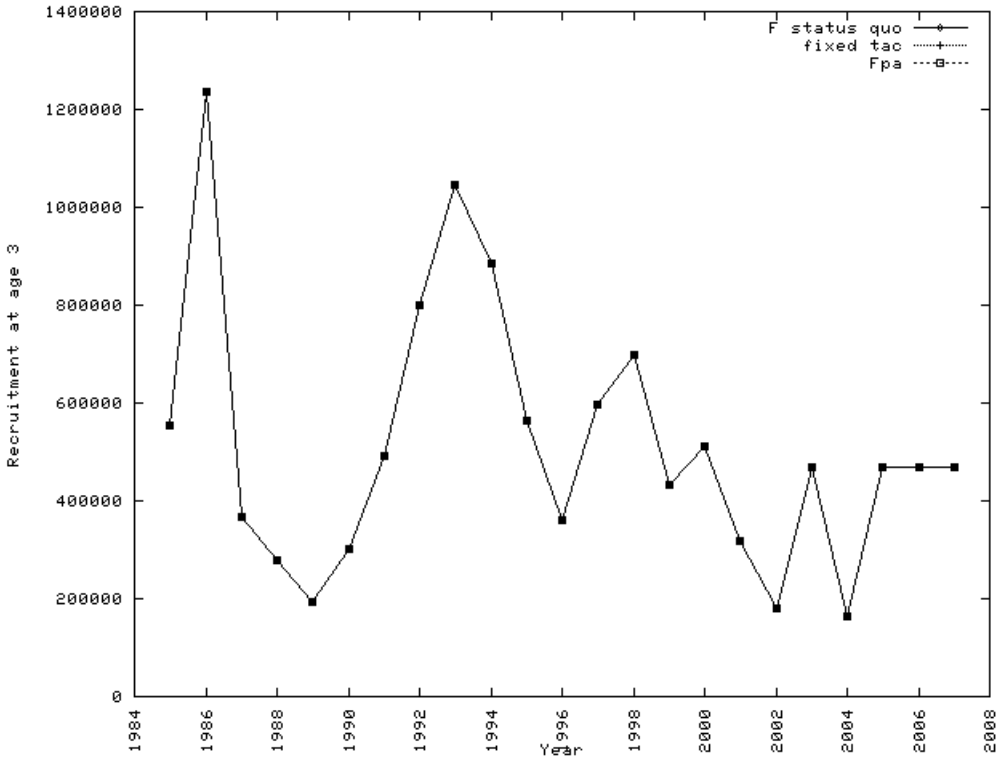


Figure 3.17e (Recruitment numbers for all prognosis scenarios)

Stock numbers

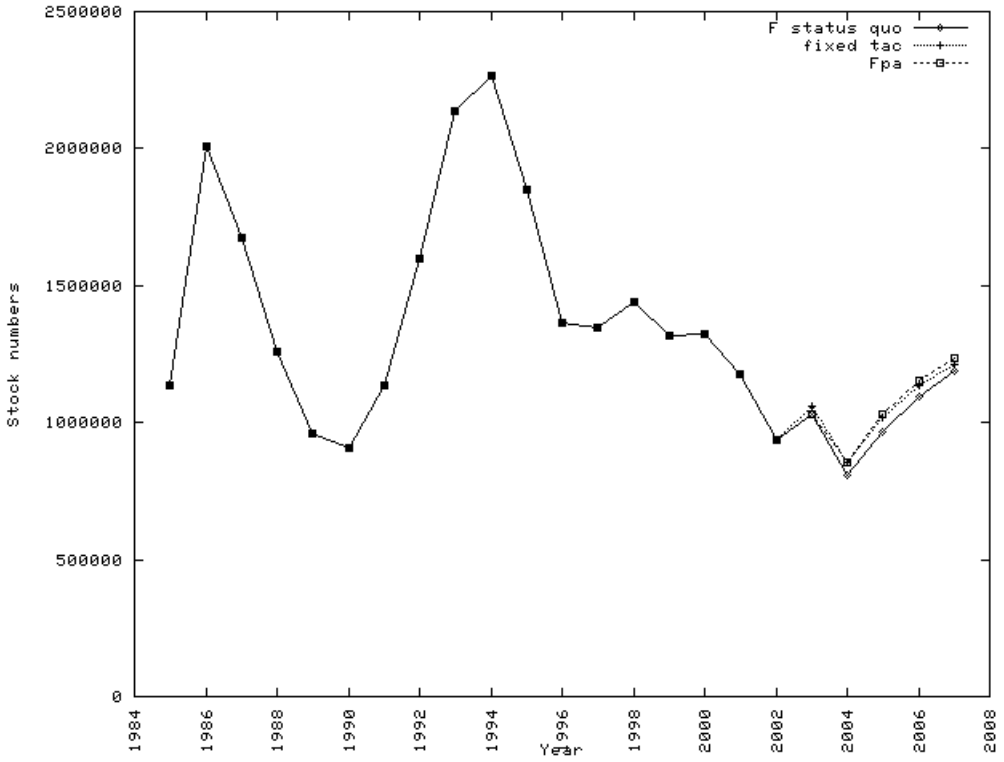
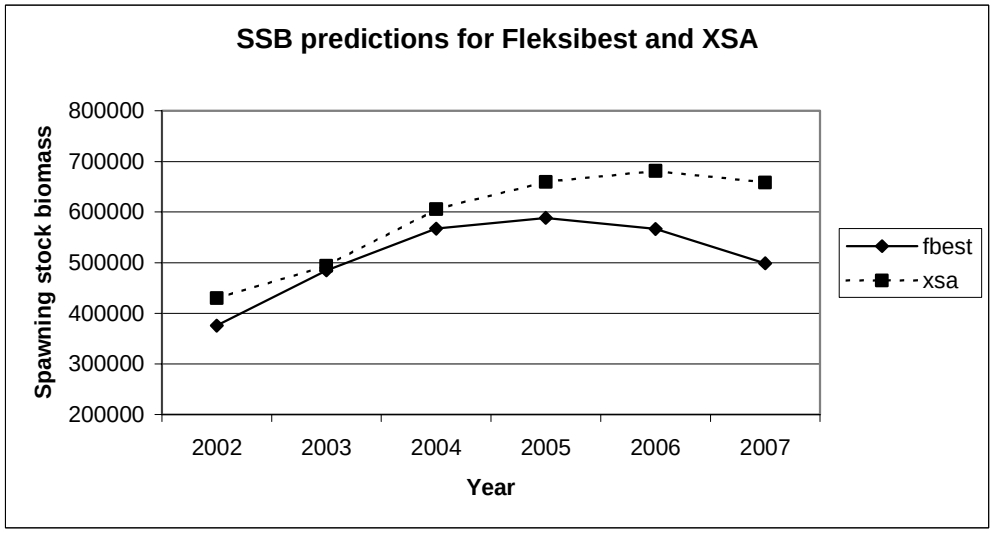
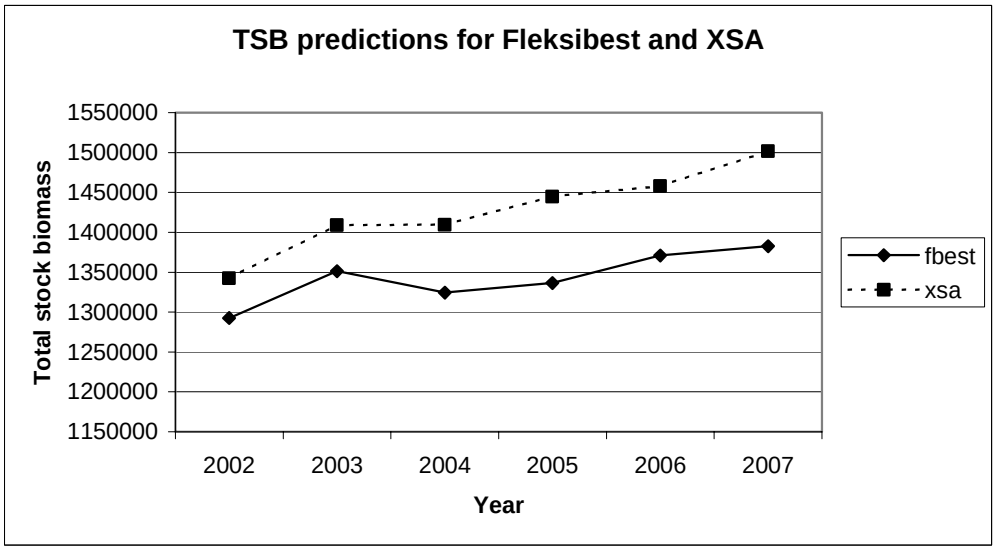


Figure 3.17f (Prediction of Stock numbers)





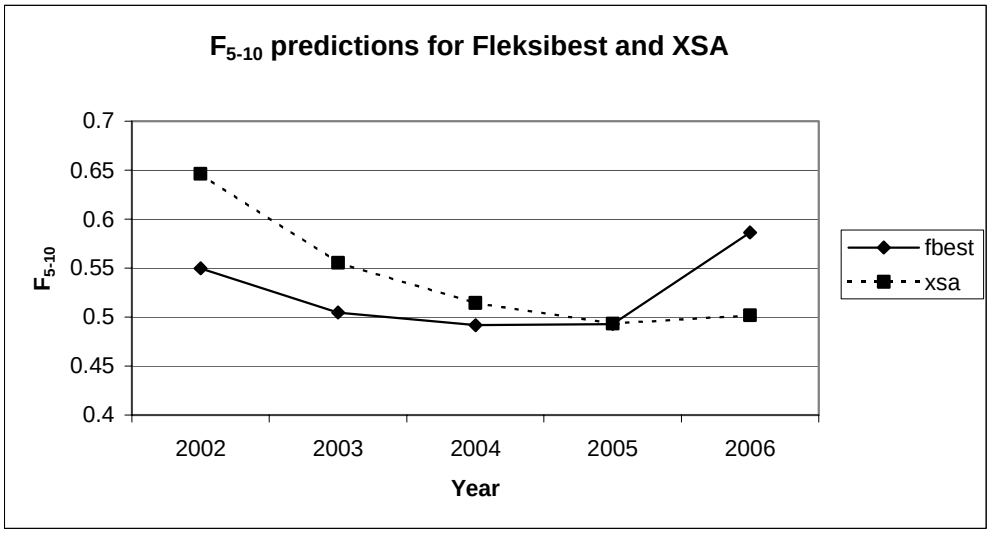


Figure 3.18. Comparison of F, SSB and TSB in the period 2002-2006 for Fleksibest and XSA predictions. Constant catch of 426 000 t assumed throughout the period.

Table A1 Northeast 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[1]			0,46			0,46		0,69	1.18

[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.
[5]Spanish 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. Northeast 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 [1]	358.3	304.3	150.0	96.4	45.1	10.3	6.4	4.1	0.8	0.3	976.1
2000[1]	154.1	221.4	245.1	158.8	142.0	45.3	9.5	4.6	2.9	1.0	984.7
2001[1]	629.9	63.9	138.2	171.6	77.3	39.7	11.8	1.4	0.5	0.2	1134.5
2002[1]	18.5	229.1	58.7	113.1	99.7	45.5	17.6	3.0	0.4	0.3	585.9

[1] Survey covered a larger area

[2] Adjusted indices

Table A3. Northeast 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.

	Age										
Year	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 [1]	128.8	248.3	235.2	132.1	108.3	26.9	4.3	2.0	1.2	0.4	887.5
2001 [1]	657.9	76.6	191.1	182.8	83.4	38.2	8.9	1.1	0.4	0.2	1240.6
2002 [1]	35.3	443.9	88.3	135.0	109.6	42.5	15.1	2.4	0.3	0.2	872.8

[1] Survey covered a larger area

[2] Adjusted indices

Table A4. Northeast 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	1.57	12.4	11.36	4.23	0.57	0.2	0.28		30.61

Table A5. Northeast Arctic COD.
Abundance indices (millions) from the Norwegian Bottom Trawl
survey in the Svalbard area in September-October (1983-1994) and July-August (1995-2001).
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

Abundance indices (millions) from the Norwegian Bottom Trawl
survey in the Svalbard and Barents Sea area in July-August (1995-2001).
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 northeastern 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

Table A6. Northeast 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	12.4	19.9	31.4	43.8	52.4	62.1	71.6	78.0

[1] Adjusted lengths

Table A7. Northeast 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	104	338	664	1257	2186	3145	4463
2002	16	68	280	750	1240	2047	3169	4308

[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'	58.3	65.8	72.8	80.9	88.2	101.9		

' - 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	1.82	2.53	3.46	4.70	6.17	10.57		

' - preliminary

Table A10 Northeast Arctic COD. Results from the Russian trawl-acoustic survey in the Barents Sea and adjacent waters 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. Northeast 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

[1] Adjusted assuming area distribution as 1984-1995 average.

Table A12 Northeast 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

Table A13 Northeast 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	378	1,102	2,128	3,341	5,053	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

Table A14 Abundance indices of 0-group fish in the Barents Sea and adjacent waters in 1965–2001.

Year	Cod	Haddock	Polar cod		Redfish	Greenland halibut	Long rough dab
			West	East			
1965	6	7		0	159		66
1966	1	1		129	236		97
1967	34	42		165	44		73
1968	25	8		60	21		17
1969	93	82		208	295		26
1970	606	115		197	247	1	12
1971	157	73		181	172	1	81
1972	140	46		140	177	8	65
1973	684	54		(26)	385	3	67
1974	51	147		227	468	13	83
1975	343	170		75	315	21	113
1976	43	112		131	447	16	96
1977	173	116	157	70	472	9	72
1978	106	61	107	144	460	35	76
1979	94	69	23	302	980	22	69
1980	49	54	79	247	651	12	108
1981	65	30	149	73	861	38	95
1982	114	90	14	50	694	17	150
1983	386	184	48	39	851	16	80
1984	486	255	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

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 1965–2001.

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

[1]Assessment for 1965–1984 made by Toresen (1985).

Table A16. Sum of acoustic abundance estimates (millions) in the Joint winter Barents sea survey (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	0.2	0.1
2002	18.5	229.1	58.7	113.1	101.3	57.9	29.0	7.2	1.0	0.5	0.3	0.0

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 long line, which are used almost exclusively by Norway. Part of the long line 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 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 2002 (Tables 4.1–4.3, Figure 4.1A)

Final reported landings in 2000 are 61,292 t (Table 4.1), which is below the figure used in last year's assessment. This revision was made due to an error in the calculations of total landings in last year's assessment. The provisional landings for 2001 are 81,280 t, which is nearly 4000 t less than the 85,000 t landings expected by the Working Group last year. The agreed TAC was 85,000 t. Catches increased in all Subareas. 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 2000 and 2001 were revised according to official statistics from ICES.

4.1.3 Expected landings in 2002

The 85,000 t TAC agreed for 2001 was not exceeded. ACFM recommended to set a TAC lower than 67,000 t for 2002. The agreed TAC for 2002 is 85,000 t. The Norwegian quota of 40,300 t is expected to be taken. Russia has transferred 6,000 t of their quota to Norway and expects to take all the remaining 34,300 t. On this basis the landings in 2002 are estimated to be equal to the 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 is now 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 estimated trawl effort for 2001 was reduced by more than 40% compared to 2000. The CPUE series was not used for tuning the XSA in this year's assessment (see Section 4.4.1).

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. 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 2001 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, 1999, and 2000 have been observed as somewhat stronger at age 2 than the year classes 1992-1997. And this observation has been confirmed for the 1998 and 1999 year classes observed at age 3. The 2001 year class has been observed only once, but the results suggest a year class even stronger and possibly as strong as the 1990 and 1991 year classes.

Russian bottom trawl and acoustic survey

Russia provided indices from the 2001 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 are 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.

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 1996 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 2001 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 2001.

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 2001 continue to show an increase nearly for all age groups, but are still below the level of the early 1990s.

Stock weights (Table 4.9) used from 1985 to 2001 were 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. For the time period 1989 to 2001 the Norwegian weights are from the Lofoten and the Barents Sea (combined).

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 1981-2001 (Table 4.4). The ogive showes a change towards later maturation in the last year but an earlier maturation than 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 and CPUE series are included in the data for tuning:

Name	Place	Season	Age	Year	prior weight
Russian bottom trawl	Total area	Autumn	1–7	1983–2001	1
Norwegian bottom trawl	Barents Sea	Winter	1–8	1982–2001	1
Norwegian acoustic	Barents Sea	Winter	1–7	1980–2001	1

The indices for the 1996 year class was not used for tuning the XSA. See Section 4.4.1.

4.3.6 Recruitment indices (Table 4.5)

The table with recruitment indices was shortened to cover the year classes 1980 and later. The logarithmic 0-group series was discontinued and replaced with the area-based index series from the same survey. Due to the need to estimate the 1998 year class we replaced Table 4.5 with two tables called 4.5A and 4.5B. The first gives the input used to estimate the strength of the 2001 year class, while Table 4.5B gives the input used in estimating the year classes 1998-2000. Since the indices of the 1996 year classes were removed from the tuning of the XSA, they were also removed from recruitment estimation. Table 4.5B contains indices of older age groups than have been used previously (age groups 2-4).

4.3.7 Prediction data (Table 4.19)

The input data for making this prediction was:

- The estimated recruitment given in Tables 4.6A and 4.6B.
- The average fishing pattern observed in the 3 last years.
- Maturity and weight-at-age averaged over 5 years.
- And stock numbers and fishing mortalities from the standard VPA.

4.4 Methods Used in the Assessment

4.4.1 VPA and tuning

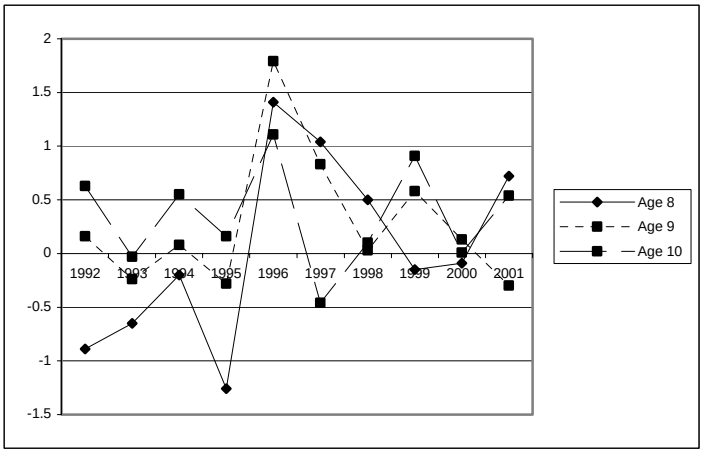
The Extended Survivors Analysis (XSA) was used to tune the VPA to the available index series (Table 4.12). The settings made by the AFWG in 2001 were accepted. We quote from the 2001 WG report: “The catchability dependent on stock size for ages <7 was used instead of 6 because the diagnostics show the 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	2115.3	151.2	1.1	0.0	0.0	0.0
1993	1375.8	167.6	37.3	3.4	2.9	0.0
1994	1408.1	80.8	25.0	7.7	0.9	0.0
1995	2898.3	163.9	12.0	30.0	30.0	0.3
1996	1583.2	161.2	40.0	5.4	2.6	3.4
1997	896.4	35.4	25.9	1.7	0.8	0.5
1998	1492.4	27.9	2.0	2.9	0.5	0.0
1999	872.8	22.9	0.3	0.0	0.0	0.0
2000	1139.0	61.6	2.2	1.2	0.2	0.1
2001	674.1	102.1	7.1	0.1	0.0	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.

Single fleet tuning gave the following picture in log catchability residuals for the Norwegian trawl CPUE series:



The removal of this tuning series stabilised the fishing mortalities of the older age groups and we decided not to use this series for the final run.

The retrospective analysis (Figures 4.5-4.7) showed in 2000 showed that changes from one year to the next in the assessment can be considerable. The following paragraph explains how the tuning series can contribute to such effects:

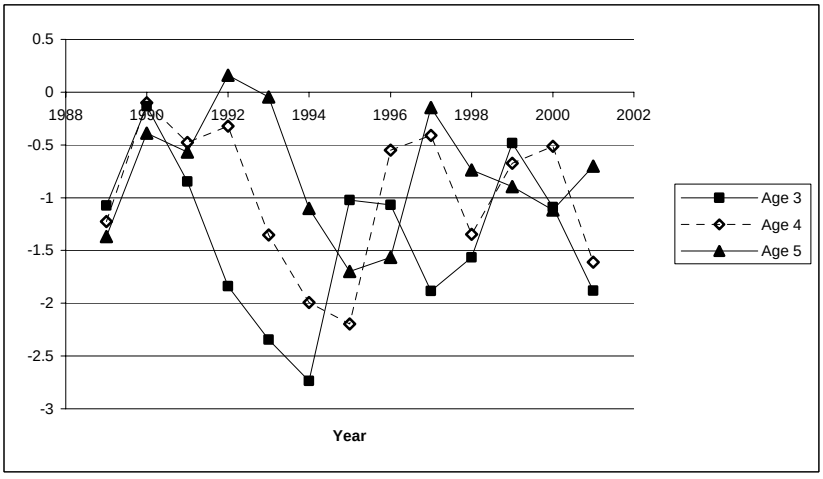
This years assessment focused its attention mainly on the 1996 year class. Preliminary runs indicated fishing at a mortality of around 1.2 for this year class in 2001. This is clearly far too high and there is clearly a lack of consistency between the catches and the tuning surveys. An incomplete coverage by the surveys could give such an effect, and this hypothesis is supported by observations from other surveys not targeting haddock. Swept area estimates of haddock are routinely calculated for the trawl samples taken during the acoustic survey aiming at spawning cod off Lofoten. The following table shows that the 1996 year class is one of the more abundant in this area.

	Numbers-at-age									
	3	4	5	6	7	8	9	10	11	12+
Year										
1989	1.34	1.24	1.67	5.02	0.22	0.07				0.02
1990	4.09	2.65	2.46	1.67	2.51					
1991	4.92	1.76	1.06	1.96	0.98	1.30	0.09			
1992	2.24	12.49	3.57	0.13	1.00	0.71	1.62	0.14	0.03	0.16
1993	2.64	5.28	9.25	1.68	0.05	0.83	0.23	0.68	0.13	
1994	0.67	5.30	4.21	3.81	0.60	0.10	0.31	0.18	0.37	
1995	5.15	1.14	6.99	2.80	3.05	0.18	0.20	0.08	0.14	0.09
1996	4.74	15.24	4.07	22.17	3.49	0.67	0.20	0.21	0.08	0.08
1997	0.84	7.62	8.02	5.29	14.74	0.66	0.05	0.10	0.04	0.05
1998	0.50	0.97	1.66	1.60	0.77	1.55	0.21	0.04	0.07	0.03
1999	21.50	2.66	1.34	4.56	1.39	0.41	1.60	0.81	0.17	0.04
2000	2.84	13.67	0.53	1.01	0.98	0.55	0.17	0.12	0.08	
2001	4.73	0.86	5.51	0.19	0.18	0.26	0.23	0.09	0.07	0.04

The Norwegian acoustic saithe survey shows a similar pattern off the Finnmark coast :

År (Year)	Alder/*Age* 0	1	2	3	4	5	6	7+	Total
1996	70.2	6.2	8.5	4.9	2.2	3.2	7.1	2.4	104.7
1997	34.1	51.1	5.8	6.0	4.0	1.5	3.9	6.3	112.7
1998	62.0	20.5	29.8	3.3	4.0	1.2	0.4	1.2	122.4
1999	38.7	37.5	7.3	50.6	4.4	2.1	1.6	1.4	143.6
2000	40.5	56.4	26.1	3.6	21.0	0.8	0.2	1.5	150.2
2001	9.6	6.9	5.6	19.8	4.2	4.7	1.0	0.4	52.2

This shows clearly that the traditional tuning series does not have a sufficient coverage of all the year classes of haddock. The following figure gives the log relationship between Norwegian bottom trawl indices off Lofoten and in the Barents Sea: $Log\left(\frac{I_{LOF}}{I_{BAR}}\right)$:



This can clearly be one of the major problems with assessing this stock. The solution chosen for this assessment was the removal of the 1996 year class from all the tuning series. The estimate of this year class is then based on shrinkage to the mean F and population shrinkage:

```
Age  5   Catchability dependent on age and year class strength

 Year class = 1996

 Fleet                 Estimated    Int       Ext    Var    N Scaled  Estimated
                       Survivors    s.e       s.e   Ratio     Weights    F
 FLT01: Russian botto         1.   .000       .000    .00   0  .000     .000
 FLT02: Norway acoust         1.   .000       .000    .00   0  .000     .000
 FLT04: Norway bottom         1.   .000       .000    .00   0  .000     .000

   P shrinkage mean       19192.   1.16                        .428     .977

   F shrinkage mean       47737.   1.00                        .572     .511

 Weighted prediction :

 Survivors        Int      Ext    N    Var     F
 at end of year   s.e      s.e        Ratio
     32320.       .76    10.39    2  13.742   .685
```

See also Table 4.12. The estimated fishing mortality is relatively high when comparing the time-series of fishing mortalities at age 5, but since this year class can be distributed in smaller areas and at higher densities relative to the Barents Sea, the fishermen may be targeting this year class in a more directed fishery, thus inflicting relatively high fishing mortalities.

4.4.2 Recruitment (Tables 4.6)

The recruiting year classes 1998-2001 were estimated using RCT3 (input given in Tables 4.5A and 4.5B and output given in 4.6A and 4.6B). XSA has previously been used to estimate the strength of the incoming year class at age 3, but we found that this solution was highly sensitive to the level of shrinkage.

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 fishing mortalities slightly upwards. $F_{4\text{-}7}$ 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 2001 was well above $\mathbf{F}_{pa}$ (0.35).

The fishery has since 1999 mainly been targeting the 1996 year class, and the catches in 2001 also show quite a high number of the 1998 year class.

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 should increase in the short term.

A retrospectiv run was made using the program RETVPA95 (Lowestoft). The program was run with the same settings as in the “final XSA run”. The results are given in Figure 4.5 showing the retrospective pattern in estimated fishing mortalities by cohort, while Figure 4.6 show the retrospective pattern by age groups 4 to 7. Figure 4.7 shows the retrospective pattern in $\overline{F}_{4-7}$. The cohorts 1986 to 1988 shows a pattern with a clear tendency to overestimate the F’s while especially the later (and much stronger cohorts) has a tendency to underestimate the F’s. If only weak year classes are underestimated while large year classes are overestimated the overall picture will be a tendency to overestimate the size of the stock. Using average weight in stock over the period 1990-1999 and stock sizes from the retrospective assessments (1993-1998) the estimated biomass for age groups 4-10 was estimated for each of the assessment years. These were then compared with the latest assessment. There was an overall bias (overestimation) of stock biomass of

25%. One possible source for the retrospective pattern can be the changes in geographical distribution (and thus survey coverage) between year classes.

4.5.2 Recruitment (Tables 4.6A, 4.6B, 4.15 and Figure 4.1C)

The estimate of the 1997 year class at age 3, derived from the XSA (Table 4.18), are 58 mill. This is almost equal to last years estimate of 59 mill. As mentioned earlier we changed the practice of letting the XSA estimate the recruiting year class (at age 3). The XSA estimate of 313 millions was replaced with the RCT3 estimate of 265 millions. The RCT3 program estimated the 1999-2001 year classes to be 241, 199, and 284 millions respectively. We must go back to the year classes in the early 1960's to find four consecutive year classes of such magnitude. The standard deviations given for the 2000 and 2001 year class estimates are quite high and large revisions must be expected.

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. **Table 4.20 was not updated (IFAP was not run) and is not included in the report. The numbering makes a "jump".**

4.5.4 Catch options for 2001 (Table 4.21)

The expected catch of 85,000 t in 2001 gives F = 0.54, and the spawning stock biomass will be 67,000 t in 2002. This decline from 1991 is due to the use of a 5-year average of maturity ogives instead of the "optimistic" one from 2001. The deterministic projection suggests an increase in SSB to 98,000 t in the beginning of 2003 (which is above $\mathbf{B}_{pa}$). Fishing at $\mathbf{F}_{pa}$ in 2003 corresponds to total landings of around 101,000 t, with a further strenghtening of the SSB to 138,000 t in the beginning of 2004.

4.6 Biological reference points.

4.6.1 Biomass reference points (Figures 4.2 and 4.4)

Reference points were not discussed at this meeting and we quote from last years Working Group: "Historically, a SSB below 50,000 t has produced only poor year classes (Figure 4.2) and ACFM proposes this as $\mathbf{B}_{lim}$. $\mathbf{B}_{pa}$ is proposed at 80,000 t, which gives a 95% probability of maintaining SSB above $\mathbf{B}_{lim}$ taking into account, the uncertainty in the assessments and stock dynamics. The Working Group agrees with the approach and the values proposed by ACFM. "

4.6.2 Fishing mortality reference points (Figure 4.4)

Quoting from last years report: "A $\mathbf{F}_{pa}$ of 0.35, corresponding to $\mathbf{F}_{med}$, was accepted by the ACFM. The stock has sustained higher fishing mortality for most of the period after 1950 without collapsing, however a low SSB has often resulted. ACFM also estimated $\mathbf{F}_{loss}$ and used the median value of 0.49 as $\mathbf{F}_{lim}$. The value of $\mathbf{F}_{pa}$ is considered to have a high probability of keeping F below $\mathbf{F}_{lim}$. The Working Group also agrees with the approach and the value proposed by ACFM for $\mathbf{F}_{lim}$."

4.7 Medium-term stochastic simulations (Table 4.23 and Figures 4.8-4.9)

The stochastic simulations were made using STPR3 (Skagen 2002). The results are given in Table 4.23 and in Figures 4.8 and 4.9.

4.7.1 Input data

Input data are numbers at age in the beginning of 2002. Year classes 1998-2001 was adjusted as to give the RCT3 prediction of numbers at age 3. (That is: The average prediction of year class 2000 in 2003 and 2001 in 2004 equals the RCT3 predictions of recruitment. Natural mortality is set to the average of the period 1984-2001 while fishing pattern, weight at age and maturity are set to the average 1992-2001. A shepherd function is used to estimate future recruitment at age 1. The parameters in the function was estimated using data only for the period 1984-2001. A TAC constraint of 85 000 tonnes was assumed for 2002 and future catches were set to correspond to perceived fishing mortalities of 0.35 (0 below B_{lim}). An important setting is the use of a bias multiplier assuming a 25% bias in the current assessment. This correspond to aiming at an F=0.35, but ending up at F around 0.47 which is close to F_{lim}.

4.7.2 Results

The results are very much depending on the setting used. Assuming another functional relationship between SSB and recruitment will give quite different results. The assessment bias assumption is also quite determining for the result as are the averaging period chosen for weights and maturity. The overall picture is an increase in SSB and catches the next few years.

4.8 Comments to the assessment and forecasts

As shown by the retrospective analysis the assessment is unstable. The problem with the survey coverage of the 1996 year class is not new and can be a contributing factor to previous assessment problems for this stock.

The size of the 1996 year class has been revised upwards and that has contributed to reduction in F_{4-7} in 2001 from the 0.67 estimated in last years assessment to this years 0.50 (and the reported landings in 2001 added up to less than 85,000 t). The decline in the predicted SSB in 2002 of 67,000 t from the 2001 level of 89,000 t is mainly due to the use of a 5-year average of maturity ogives in the prediction.

4.8.1 Changes from last year

The following changes was made to the assessment compared to last year:

1) Total landings in 2000 were revised downwards due to a mistake made last year. The landings are now more in accordance with the TAC for 2000.
2) The Norwegian Trawl CPUE series was removed from the tuning.
3) The tuning data for the 1996 year class was removed.
4) The XSA estimate of the recruiting year class (1998) was not accepted and was replaced with a RCT3 estimate.
5) Point 4) had implications for the standard VPA run. F at age 3 in the terminal year was increased to the level where recruitment in the VPA was equal to the RCT3 estimate of 265 millions (To be detailed: the file fnewmor was updated and the F at age 3 was set higher than the output from the XSA).
6) Age groups 2-4 in the bottom trawl tuning series were used in RCT3 estimates. The last assessment used only indices for 0 and 1-year-olds.

Table 4.1 Northeast 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	61,292
2001[1] .	34,964	39,464	6,851	81,280

[1] Provisional figures, Norwegian catches on Russian quotas are included

Table 4.2 Northeast 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[1]	28.3	6.7	21.5	17.9	6.6

[1] Provisional

Table 4.3 Northeast 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]	1,210	223	547	552	41,307	1,030	1,061	34,307	1043	81,280

[1] Provisional figures, Norwegian catches on Russian quotas are included.
[2] USSR prior to 1991.

Table 4.4 Northeast 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*	0	8	37	77	81	97	100	100	100	80

* Preliminary data, revised in april/may meeting.
(Data provided by Working Group members).

TABLE 4.5A

NORTHEAST ARCTIC HADDOCK : recruits as 3 year-olds

	4	22	2			
Year	VPA	RT1	0GP_A	NT1	NA1	
1980	4.8	0.3	68	3.1	7.0	
1981	8.5	0.3	30	3.9	9.0	
1982	259.5	23	107	2919.3	0,3	
1983	530.2	40	219	3832.6	1685.0	
1984	83.9	9	293	1901.1	1809.0	
1985	41.9	5	156	665.0	680.0	
1986	16.8	0.2	160	163.8	111.0	
1987	24.5	0.4	72	35.4	20.0	
1988	82.3	2	86	81.2	58.0	
1989	197.4	3	112	644.1	493.0	
1990	633.4	81	227	2006.0	1938.0	
1991	277.1	17	472	1659.4	859.0	
1992	75.0	20	313	727.9	1424.0	
1993	85.8	6	240	603.2	848.0	
1994	100.6	14	282	1463.6	1380.0	
1995	44.0	10	148	309.5	249.0	
1996	181.8	-11	-11	-11	-11	
1997	58.2	-11	150	212.9	256.0	
1998	265.0	11	593	1244.9	856.0	
1999	-11	12	184	847.2	1024.0	
2000	-11	15	417	1216.5	976.0	
2001	-11	52	394	1704.3	2065.0	

1996 yearclass also removed from XSA tuning

RT1	Russian bottom trawl survey age 1
0GP_A	International 0 Group Survey area based index
NT1	Norwegian bottom trawl survey age 1
NA1	Norwegian acoustic survey age 1

TABLE 4.5B

NORTHEAST ARCTIC HADDOCK: recruits as 3 year-olds

	5	21	2			
Year	VPA	RT2	RT3	NT2	NT3	NT4
1980	4.8	-11	0.5	1.5	3.1	1.5
1981	8.5	9.5	1.5	4.8	18.9	14.7
1982	259.5	58.4	90.0	514.6	475.9	110.8
1983	530.2	134.3	36.3	1593.8	384.6	290.2
1984	83.9	10.7	8.3	370.3	154.4	68.9
1985	41.9	1.7	1.7	79.9	25.3	21.6
1986	16.8	0.7	0.4	15.3	14.1	3.4
1987	24.5	2.4	7.3	9.5	4.5	5.1
1988	82.3	10.6	6.2	54.6	33.4	24.4
1989	197.4	17.6	34.6	300.3	150.5	105.6
1990	633.4	128.6	198.5	1375.5	507.7	436.6
1991	277.1	35.7	44.2	599.0	339.5	171.1
1992	75.0	5.8	3.1	228.0	53.6	48.1
1993	85.8	4.2	2.8	179.3	52.5	28.0
1994	100.6	5.7	3.2	263.6	86.1	33.2
1995	44.0	1.9	3.8	67.9	22.7	12.2
1996	181.8	-11	-11	-11	-11	-11
1997	58.2	6.1	6	57.6	27.2	29.4
1998	-11	26.2	33.4	452.2	297.0	183.9
1999	-11	26.1	-11	460.4	298.5	-11
2000	-11	-11	-11	530.7	-11	-11

1996 yearclass also removed from XSA tuning

RT2 Russian bottom trawl survey age 2
RT3 Russian bottom trawl survey age 3
NT2 Norwegian bottom trawl survey age 2
NT3 Norwegian bottom trawl survey age 3
NT4 Norwegian bottom trawl survey age 4

Table 4.6A

Analysis by RCT3 ver3.1 of data from file :

tab45.prn

NORTHEAST ARCTIC HADDOCK : recruits as 3 year-olds

Data for 4 surveys over 22 years : 1980 - 2001

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

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

Forecast/Hindcast variance correction used.

Yearclass = 2001

	I----------Regression----------I				I----------Prediction---------I			
Survey/ Series	Slope	Inter-cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
RT1	1.33	1.62	1.12	.468	17	3.97	6.91	1.555	.132
0GP_A	2.75	-10.16	1.51	.306	18	5.98	6.26	1.889	.089
NT1	1.09	-2.27	.86	.577	18	7.44	5.86	1.076	.275
NA1	1.25	-3.13	1.32	.365	18	7.63	6.41	1.682	.113
					VPA Mean =		4.72	.902	.391

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
2001	284	5.65	.56	.41	.52		

Table 4.6B

```
Analysis by RCT3 ver3.1 of data from file :
 tab45b.prn

 NORTHEAST ARCTIC HADDOCK : recruits as 3 year-olds

 Data for    5 surveys over   21 years :  1980 - 2000
 Regression type = C
 Tapered time weighting applied
 power =    3 over  20 years
 Survey weighting not applied

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

 Yearclass =   1998
         I-----------Regression----------I  I-----------Prediction---------I

 Survey/  Slope  Inter-   Std  Rsquare  No.  Index Predicted   Std     WAP
 Series           cept   Error          Pts  Value   Value    Error   Weights
 RT2        .86   2.56    .43   .860     16   3.30    5.42     .512     .175
 RT3        .86   2.58    .62   .756     17   3.54    5.61     .740     .084
 NT2        .76    .75    .41   .874     17   6.12    5.38     .489     .192
 NT3        .84   1.05    .40   .882     17   5.70    5.83     .487     .193
 NT4        .83   1.44    .31   .923     17   5.22    5.79     .384     .311
                                         VPA Mean =    4.58    1.004     .046

 Yearclass =   1999
         I-----------Regression----------I  I-----------Prediction---------I

 Survey/  Slope  Inter-   Std  Rsquare  No.  Index Predicted   Std     WAP
 Series           cept   Error          Pts  Value   Value    Error   Weights
 RT2        .84   2.63    .38   .882     16   3.30    5.42     .463     .321
 RT3
 NT2        .76    .71    .42   .866     17   6.13    5.40     .502     .273
 NT3        .82   1.15    .36   .894     17   5.70    5.82     .455     .332
 NT4
                                         VPA Mean =    4.60     .965     .074

 Yearclass =   2000
         I-----------Regression----------I  I-----------Prediction---------I

 Survey/  Slope  Inter-   Std  Rsquare  No.  Index Predicted   Std     WAP
 Series           cept   Error          Pts  Value   Value    Error   Weights
 RT2
 RT3
 NT2        .77    .68    .42   .859     17   6.28    5.51     .520     .762
 NT3
 NT4
                                         VPA Mean =    4.62     .930     .238

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

 1998         265      5.58     .21     .13      .36
 1999         241      5.49     .26     .18      .48
 2000         199      5.30     .45     .38      .70
```

TABLE 4.7

Run title : Arctic Haddock (Final XSA AFWG02)

At 25/04/2002 9:38

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

YEAR	1950	1951
AGE		
1	0	4069
2	4446	222
3	3189	65643
4	37949	9178
5	35344	18014
6	18849	13551
7	28868	6808
8	9199	6850
9	1979	3322
10	1093	1182
+gp	2977	1348
0 TOTAL	143893	130187
TONSL/	132125	120077
SOPCC	45	65

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

YEAR	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961
AGE										
1	0	392	1726	0	97	828	153	169	2319	362
2	13674	8031	493	989	3012	243	2312	2425	3613	5531
3	6012	64528	6563	1154	16437	2074	1727	20318	39910	15429
4	151996	13013	154696	10689	5922	24704	5914	7826	70912	56855
5	13634	70781	5885	176678	14713	7942	31438	7243	13647	63351
6	9850	5431	27590	4993	127879	12535	5820	14040	7101	8706
7	4693	2867	3233	28273	3182	46619	12748	3154	6236	3578
8	3237	1080	1302	1445	8003	1087	17565	2237	1579	4407
9	2434	424	712	271	450	1971	822	5918	2340	788
10	606	315	319	100	200	356	1072	285	2005	527
+gp	880	1005	543	100	185	176	601	500	606	1434
0 TOTAL	207016	167867	203062	224692	180080	98535	80172	64115	150268	160968
TONSL/	127660	123920	156788	202286	213924	123583	112672	88211	154651	193224
SOPCC	51	57	60	47	55	57	61	80	84	80

Run title : Arctic Haddock (Final XSA AFWG02)

At 25/04/2002 9:38

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

YEAR	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
AGE										
1	0	3	149	0	0	0	0	0	480	15
2	4524	2143	834	3498	2577	53	33	1061	281	3535
3	39503	28466	22363	5936	26345	15907	657	1524	23444	1978
4	30868	72736	49290	46356	22631	41346	67632	1968	2454	24358
5	48903	18969	30672	40201	63176	13496	41267	44634	1906	1257
6	33836	13579	5815	12631	29048	25719	7748	19002	22417	918
7	3201	9257	3527	1679	5752	8872	15599	3620	8100	9279
8	1341	1239	2716	974	582	1616	5292	4937	2012	3056
9	1773	559	833	897	438	218	655	1628	2016	826
10	242	409	104	123	189	175	182	316	740	1043
+gp	756	375	633	802	242	271	286	109	293	534
0 TOTAL	164947	147735	116936	113097	150980	107673	139351	78799	64143	46799
TONSL/	187408	146224	99158	118578	161778	136397	181726	130820	88257	78905
SOPCC	75	74	62	70	66	79	79	80	75	101

Table 4.7 (Cont'd)

Table 1	Catch numbers at age				Numbers*10**-3					
YEAR	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
AGE										
1	133	0	281	1321	3475	184	46	0	0	1
2	9399	5956	3713	4355	7499	18456	2033	48	0	68
3	230942	70679	9685	10037	13994	55967	47311	17540	627	486
4	22315	260520	41706	14088	13454	22043	18812	35290	22878	2561
5	42981	24180	88120	33871	6810	7368	4076	10645	21794	22124
6	3206	6919	5829	49711	20796	2586	1389	1429	2971	10685
7	1611	422	4138	2135	40057	7781	1626	812	250	1034
8	6758	426	382	1236	1247	11043	2596	546	504	162
9	2638	1692	618	92	1350	311	6215	1466	230	162
10	900	529	2043	131	193	388	162	2310	842	72
+gp	1652	584	1870	934	1604	379	400	323	1460	963
0 TOTAL	322535	371907	158385	117911	110479	126506	84666	70409	51556	38318
TONSL	266153	322226	221157	175758	137264	110158	95422	103623	87889	77153
SOPCC	86	83	87	81	63	77	95	113	104	99

Table 1	Catch numbers at age				Numbers*10**-3					
YEAR	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
AGE										
1	2	0	0	1	96	8	0	0	6	21
2	29	162	247	2288	690	154	46	179	293	329
3	883	704	447	29548	25596	3928	794	1045	516	3968
4	900	1930	825	1153	61470	88294	9031	3932	1171	1967
5	3372	884	820	546	1013	52609	50869	12246	1866	1886
6	12203	1374	301	715	376	586	19465	22922	4126	2876
7	2625	3282	750	316	346	207	382	3407	6734	4442
8	344	906	2206	634	144	123	65	246	849	4422
9	75	52	489	1312	295	74	35	11	388	398
10	80	37	69	416	484	119	44	36	50	21
+gp	649	172	284	113	157	285	310	66	30	17
0 TOTAL	21162	9503	6438	37042	90667	146387	81041	44090	16029	20347
TONSL	46955	21607	17318	41270	96585	150654	91745	54859	25741	33605
SOPCC	95	92	94	97	90	98	99	96	96	96

Table 1	Catch numbers at age				Numbers*10**-3					
YEAR	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
AGE										
1	1258	117	11	33	69	75	11	136	88	37
2	2668	455	369	196	393	253	2036	451	585	826
3	12342	13398	3048	1282	1622	2193	2411	20329	939	12051
4	12652	25902	43740	12915	5512	6043	13615	7722	30029	5254
5	2411	13154	32614	71007	34791	11506	8214	16295	5458	35153
6	1740	2784	8330	20209	70893	32302	7303	5765	4489	3980
7	2070	973	1627	3361	10315	47298	12003	3574	1686	2419
8	2619	1297	660	367	1885	4579	17811	7095	1206	886
9	2737	2131	1142	295	417	530	1117	2764	1390	478
10	241	2011	1756	447	281	183	227	255	1830	819
+gp	18	384	1889	963	1230	536	227	139	327	974
0 TOTAL	40756	62606	95186	111075	127408	105498	64975	64525	48027	62877
TONSL	53887	77621	128703	138677	173264	148756	93946	82346	61292	81280
SOPCC	100	100	111	105	105	105	105	105	100	100

TABLE 4.8

Run title : Arctic Haddock (Final XSA AFWG02)

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Table 2 Catch weights at age (kg)

	YEAR	1950	1951
	AGE		
	1	0	0
	2	0	0
	3	0.66	0.66
	4	1.03	1.03
	5	1.79	1.79
	6	2.38	2.38
	7	2.86	2.86
	8	3.33	3.33
	9	3.7	3.7
	10	4.41	4.41
	+gp	5.4	5.4
0	SOPCO	0.4545	0.6514

Table 2 Catch weights at age (kg)

	YEAR	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961
	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
0	SOPCO	0.5127	0.5742	0.6021	0.4731	0.5529	0.5679	0.6146	0.8007	0.8379	0.8026

Run title : Arctic Haddock (Final XSA AFWG02)

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Table 2 Catch weights at age (kg)

	YEAR	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
	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
0	SOPCO	0.7459	0.7442	0.6183	0.6978	0.6601	0.7919	0.7921	0.8028	0.7547	1.0105

Table 4.8 (Cont'd)

	Table 2	Catch weights at age (kg)								
	YEAR	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
	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
0	SOPCC	0.8593	0.8281	0.8657	0.8127	0.6296	0.7708	0.9507	1.1278	1.0352	0.9942

	Table 2	Catch weights at age (kg)								
	YEAR	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
	AGE										
	1	0	0	0	0	0	0	0	0	0.25	0
	2	0	0	0	0	0	0	0	0	0.64	0
	3	0.66	1.52	1.57	0.92	0.86	0.64	0.58	0.8	0.89	0.77
	4	1.03	1.86	1.99	1.66	1.25	0.86	0.84	0.89	1.22	1.31
	5	1.79	2.1	2.42	2.39	1.88	1.33	1.05	1.17	1.4	1.61
	6	2.38	2.38	2.68	2.71	2.41	2.45	1.43	1.37	1.6	1.86
	7	2.86	2.86	2.93	2.89	2.66	2.98	1.97	1.71	1.77	2.11
	8	3.33	3.33	3.37	3.22	3.04	2.98	2.52	2.01	2.16	2.34
	9	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	2.93
	10	4.41	4.41	4.41	4.41	4.41	4.41	4.41	4.41	4.41	2.34
	+gp	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4
0	SOPCC	0.951	0.9205	0.9405	0.9689	0.9019	0.9836	0.995	0.9634	0.9583	0.9589

	Table 2	Catch weights at age (kg)								
	YEAR	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
	AGE										
	1	0.04	0.09	0.25	0.19	0.1	0.1	0.12	0.1	0.1	0.1
	2	0.28	0.3	0.44	0.31	0.24	0.39	0.53	0.23	0.28	0.34
	3	0.84	0.59	0.54	0.63	0.64	0.66	0.71	0.73	0.6	0.63
	4	1.36	1.06	0.88	0.66	0.79	0.99	0.9	1.06	1.09	0.96
	5	1.7	1.52	1.33	1.06	1.04	1.09	1.27	1.27	1.39	1.4
	6	1.96	1.84	1.74	1.68	1.34	1.22	1.38	1.55	1.59	1.77
	7	2.29	2.18	2.06	2.11	1.81	1.48	1.54	1.66	1.82	1.95
	8	2.39	2.3	2.2	2.34	2.29	1.99	1.79	1.79	1.91	2.13
	9	2.32	2.52	2.5	2.67	2.31	2.26	2.37	2.06	2.07	2.33
	10	2.88	2.64	2.58	2.91	3.18	2.26	2.51	2.6	2.22	2.4
	+gp	3.14	3.11	2.89	3.02	2.62	2.98	2.68	2.85	2.58	2.46
0	SOPCC	0.9983	1.0002	1.1112	1.0541	1.0517	1.049	1.0468	1.0536	0.9991	1.0003

TABLE 4.9

Run title : Arctic Haddock (Final XSA AFWG02)

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Table 3 Stock weights at age (kg)

YEAR	1950	1951
AGE		
1	0	0
2	0	0
3	0.66	0.66
4	1.03	1.03
5	1.79	1.79
6	2.38	2.38
7	2.86	2.86
8	3.33	3.33
9	3.7	3.7
10	4.41	4.41
+gp	6.875	6.875

Table 3 Stock weights at age (kg)

YEAR	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961
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

Run title : Arctic Haddock (Final XSA AFWG02)

At 25/04/2002 9:38

Table 3 Stock weights at age (kg)

YEAR	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
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 (Cont'd)

Table 3	Stock weights at age (kg)									
YEAR	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
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	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
AGE										
1	0	0.052	0.036	0.036	0.042	0.038	0.023	0.039	0.043	0.052
2	0	0.133	0.196	0.133	0.103	0.088	0.117	0.116	0.127	0.141
3	0.66	0.48	0.289	0.435	0.296	0.209	0.214	0.274	0.296	0.384
4	1.03	1.043	0.964	0.773	0.776	0.419	0.386	0.439	0.718	0.769
5	1.79	1.641	1.81	1.874	1.53	0.919	0.62	0.684	0.947	1.319
6	2.38	2.081	2.506	2.456	2.262	2.24	1.124	1.009	1.289	1.442
7	2.86	2.592	2.24	2.688	2.263	2.86	1.569	1.416	1.569	1.794
8	3.33	3.33	3.33	3.33	3.33	3.1	3.33	3.33	1.917	2.027
9	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	2.493	2.516
10	4.41	4.41	4.41	4.41	4.41	4.41	4.41	4.41	4.41	3.092
+gp	6.875	6.875	6.875	6.875	6.875	6.875	6.875	6.305	6.875	6.875

Table 3	Stock weights at age (kg)									
YEAR	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
AGE										
1	0.045	0.033	0.028	0.029	0.029	0.032	0.023	0.027	0.032	0.028
2	0.135	0.101	0.091	0.089	0.094	0.096	0.114	0.09	0.106	0.108
3	0.346	0.3	0.244	0.218	0.218	0.21	0.239	0.305	0.236	0.309
4	0.83	0.81	0.543	0.364	0.433	0.439	0.489	0.625	0.704	0.494
5	1.475	1.491	1.064	0.806	0.679	0.782	0.896	1.054	1.045	1.185
6	2.002	2.045	1.592	1.451	1.112	1.106	1.223	1.581	1.326	1.571
7	2.123	2.412	2.092	2.008	1.819	1.505	1.502	1.795	1.497	2.028
8	2.23	2.778	2.405	2.252	2.19	2.116	1.813	1.787	1.784	2.239
9	2.429	3.106	2.752	2.652	2.815	3.014	2.618	2.35	1.987	2.543
10	3.303	3.155	2.726	2.712	2.602	3.333	2.468	2.31	2.355	2.879
+gp	5.065	6.461	4.04	3.814	4.071	4.155	3.668	3.79	4.15	3

TABLE 4.10

Run title : Arctic Haddock (Final XSA AFWG02)

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Table 4 Natural Mortality (M) at age

YEAR	1950	1951
AGE		
1	0.2	0.2
2	0.2	0.2
3	0.2	0.2
4	0.2	0.2
5	0.2	0.2
6	0.2	0.2
7	0.2	0.2
8	0.2	0.2
9	0.2	0.2
10	0.2	0.2
+gp	0.2	0.2

Table 4 Natural Mortality (M) at age

YEAR	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961
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

Run title : Arctic Haddock (Final XSA AFWG02)

At 25/04/2002 9:38

Table 4 Natural Mortality (M) at age

YEAR	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
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 (Cont'd)

Table 4	Natural Mortality (M) at age									
YEAR	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
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	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
AGE										
1	0.2	0.2	1.0389	1.5619	2.5728	3.6711	0.6125	1.1157	0.5873	0.5579
2	0.2	0.2	0.2499	0.2085	1.4821	0.2	0.2255	0.2	0.5318	0.2603
3	0.2	0.2	0.2102	0.2	0.6318	0.2	0.4726	0.2	0.3734	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	0.2022	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	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
AGE										
1	1.7198	2.229	1.8668	2.4581	2.9555	1.6173	2.8166	1.2482	1.3699	1.1447
2	0.3898	0.6246	0.8435	1.144	1.0691	0.7168	0.3269	0.4727	0.3742	0.479
3	0.2059	0.2659	0.3022	0.3812	0.8169	0.5248	0.2487	0.2021	0.2373	0.2278
4	0.2	0.2266	0.2185	0.3796	0.2564	0.2564	0.2636	0.2	0.2119	0.2023
5	0.2	0.3004	0.2122	0.3125	0.2238	0.232	0.2277	0.2	0.2123	0.2
6	0.2	0.2	0.2009	0.2102	0.2083	0.2113	0.2	0.2	0.2048	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 4.11

Run title : Arctic Haddock (Final XSA AFWG02)

At 25/04/2002 9:38

Table 5 Proportion mature at age

YEAR	1950	1951
AGE		
1	0	0
2	0	0
3	0	0
4	0.05	0.05
5	0.23	0.23
6	0.53	0.53
7	0.88	0.88
8	0.98	0.98
9	1	1
10	1	1
+gp	1	1

Table 5 Proportion mature at age

YEAR	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961
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

Run title : Arctic Haddock (Final XSA AFWG02)

At 25/04/2002 9:38

Table 5 Proportion mature at age

YEAR	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
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 4.11 (Cont'd)

Table 5 Proportion mature at age

YEAR	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
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	0.01
4	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.12
5	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.64
6	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.73
7	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.96
8	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	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 5 Proportion mature at age

YEAR	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
AGE										
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0.09	0.17	0.07	0.02	0	0	0	0	0	0
4	0.55	0.7	0.14	0.08	0.22	0.01	0.03	0.04	0.02	0.07
5	0.73	1	0.35	0.8	0.53	0.21	0.33	0.3	0.3	0.3
6	0.93	1	0.47	0.93	0.86	0.53	0.51	0.63	0.54	0.5
7	0.96	1	0.74	0.96	0.86	1	1	0.82	0.77	0.8
8	1	1	1	1	1	1	1	1	0.87	0.92
9	1	1	1	1	1	1	1	1	0.8	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	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
AGE										
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0.02	0.015	0	0	0	0	0	0.01	0	0.004
4	0.13	0.219	0.017	0.02	0	0.03	0.05	0.17	0.1	0.06
5	0.5	0.49	0.13	0.12	0.1	0.1	0.28	0.5	0.32	0.54
6	0.62	0.76	0.41	0.42	0.36	0.29	0.5	0.71	0.59	0.72
7	0.77	0.79	0.9	0.81	0.78	0.6	0.66	0.81	0.72	0.87
8	0.8	0.88	0.88	0.88	0.86	0.82	0.81	0.91	0.94	0.94
9	0.94	0.88	1	1	0.9	1	0.91	0.92	0.94	0.9
10	1	0.87	1	0.87	0.93	0.83	1	1	0.96	1
+gp	1	1	0.97	1	0.9	1	1	1	1	0.91

Table 4.12

```
Northeast Arctic haddock (Sub-areas I and II) (Final XSA AFWG02)
103
FLT01: Russian bottom trawl, Nov-Dec, indices age 1-7
1983 2001
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       .0     19.0     32.0     32.0     10.0     27.0     10.0
   1     29.0       .0     38.0     46.0      8.0      5.0     15.0
   1    289.0     61.0       .0     39.0     37.0      8.0      3.0
   1    207.0    262.0     60.0       .0     26.0     11.0      2.0
   1    149.0    261.0    334.0     40.0       .0     11.0      4.0

FLT02: Norway acoustic surv, Barents sea, Jan-Mar, indices age 1-7, shifted to
end prev. year
1980 2001
1 1 0.99 1.00
1 7
   1     140      50     210     600     180      10       3
   1      20      30      40      40     100      60       3
   1      50      20      30      10      10      40      20
   1    1730      60      20      10       3       3       3
   1    8390    2740      60       3       3       3      10
   1    3120    4880    1620       3       3       3       3
   1     260     710    1900     470       3       3       3
   1      50      80     200     380      60       3       3
   1      60      80     100     170     190      20       3
   1     440      40      30      40      70     110      10
   1    2650     490      70      20      20      20      40
   1    6850    1100     190      20       3       3      10
   1    6900    5650     990     100       3       3      10
   1    2280    2400    5060     770      80       3       3
   1    2850     360    1130    3910     400      20       3
   1    2290     440     310     760    1500      80      10
   1     320     660     220     150     480     470      30
   1       0     290     410     150      60     130     180
   1     460       0     130     140      40      10      20
   1    5090     320       0     190     100      20      10
   1    3160    2100     230       0      10      10       0
   1    2800    2090    1420     160       0      10       0
```

Table 4.12 (Cont'd)

```
FLT04: Norway bottom trawl survey, Jan-Mar, indices age 1-7, shifted to end prev. year
1982 2001
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        0      227      332      132       34       80       81        7
   1      576        0      122      102       28       10       17       11
   1     4522      272        0       84       40        8        3        7
   1     4604     2970      294        0       17        9        1        1
   1     5307     2985     1839      165        0        8        3        0
```

TABLE 4.13

Lowestoft VPA Version 3.1
23/04/2002 10:38

Extended Survivors Analysis

Arctic Haddock (Final XSA AFWG02)

CPUE data from file fleet

Catch data for 52 years. 1950 to 2001. Ages 1 to 11.

Fleet	First year	Last year	First age	Last age	Alpha	Beta
FLT01: Ru	1983	2001	1	7	0.9	1
FLT02: Nc	1980	2001	1	7	0.99	1
FLT04: Nc	1982	2001	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 70 iterations

Total absolute residual between iterations
69 and 70 = .00851

Final year F values

Age	1	2	3	4	5	6	7	8	9	10
Iteration 6	0	0.0023	0.0439	0.1381	0.6856	0.5288	0.6488	0.8993	0.7551	0.7068
Iteration 7	0	0.0023	0.0439	0.1381	0.6854	0.5275	0.6476	0.8943	0.7552	0.7074

1

Regression weights

0.751	0.82	0.877	0.921	0.954	0.976	0.99	0.997	1	1

Table 4.13 (Cont'd)

Fishing mortalities

Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	0.001	0	0	0	0	0	0	0	0	0
2	0.003	0.001	0.003	0.001	0.002	0.004	0.009	0.006	0.002	0.002
3	0.072	0.024	0.013	0.021	0.029	0.029	0.064	0.132	0.018	0.044
4	0.247	0.216	0.109	0.08	0.133	0.207	0.313	0.308	0.296	0.138
5	0.259	0.47	0.474	0.278	0.363	0.478	0.506	0.808	0.377	0.685
6	0.385	0.54	0.669	0.624	0.538	0.705	0.66	0.851	0.544	0.527
7	0.357	0.387	0.715	0.634	0.782	0.874	0.63	0.819	0.653	0.648
8	0.33	0.398	0.497	0.339	0.933	1.03	1.028	1.003	0.74	0.894
9	0.273	0.493	0.746	0.434	0.823	0.754	0.769	0.416	0.533	0.755
10	0.215	0.331	1.023	0.754	0.998	1.154	0.888	0.39	0.539	0.707

1

XSA population numbers (Thousands)

	AGE									
YEAR	1	2	3	4	5	6	7	8	9	10
1992	2.90E+06	9.39E+05	1.97E+05	6.38E+04	1.17E+04	6.01E+03	7.62E+03	1.03E+04	1.27E+04	1.38E+03
1993	1.63E+06	5.18E+05	6.33E+05	1.50E+05	4.08E+04	7.38E+03	3.35E+03	4.37E+03	6.05E+03	7.90E+03
1994	1.74E+06	1.75E+05	2.77E+05	4.74E+05	9.61E+04	1.89E+04	3.52E+03	1.86E+03	2.40E+03	3.03E+03
1995	3.43E+06	2.70E+05	7.50E+04	2.02E+05	3.42E+05	4.84E+04	7.91E+03	1.41E+03	9.27E+02	9.33E+02
1996	1.74E+06	2.94E+05	8.58E+04	5.02E+04	1.28E+05	1.89E+05	2.10E+04	3.43E+03	8.22E+02	4.92E+02
1997	1.28E+06	9.04E+04	1.01E+05	3.68E+04	3.40E+04	7.10E+04	8.97E+04	7.87E+03	1.11E+03	2.95E+02
1998	1.57E+06	2.55E+05	4.40E+04	5.78E+04	2.32E+04	1.67E+04	2.84E+04	3.07E+04	2.30E+03	4.26E+02
1999	1.60E+06	9.40E+04	1.82E+05	3.22E+04	3.25E+04	1.11E+04	7.06E+03	1.24E+04	8.98E+03	8.73E+02
2000	1.83E+06	4.58E+05	5.82E+04	1.30E+05	1.93E+04	1.19E+04	3.89E+03	2.55E+03	3.72E+03	4.85E+03
2001	1.42E+06	4.65E+05	3.15E+05	4.51E+04	7.83E+04	1.07E+04	5.61E+03	1.66E+03	9.97E+02	1.79E+03

Estimated population abundance at 1st Jan 2002

0.00E+00	4.53E+05	2.87E+05	2.40E+05	3.21E+04	3.23E+04	5.20E+03	2.41E+03	5.59E+02	3.83E+02

Taper weighted geometric mean of the VPA populations:

1.37E+06	2.15E+05	1.08E+05	6.48E+04	4.11E+04	1.92E+04	8.77E+03	3.90E+03	1.77E+03	8.23E+02

Standard error of the weighted Log(VPA populations) :

0.7957	0.9556	0.9925	1.0395	1.1165	1.156	1.199	1.228	1.1585	1.3025

Table 4.13 (Cont'd)

Log catchability residuals.

Fleet : FLT01: Russian botto

Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
1	99.99	1.68	0.81	0.11	-0.05	0.23	-0.34	-0.52	0.69	0.3
2	99.99	2.69	0.75	0.73	0.21	-0.32	-0.14	0.5	0.43	0.04
3	99.99	0.9	1.09	0.79	-0.35	0.07	-0.25	-0.58	1.31	-0.13
4	99.99	0.05	-0.06	-0.19	-0.05	-0.11	-0.5	-0.48	1.12	-0.47
5	99.99	-1.77	-0.17	0.34	-0.46	-0.16	-0.55	-0.04	1.18	-0.49
6	99.99	99.99	-1.52	0.33	-0.96	-1.9	-0.47	0.08	0.71	-0.39
7	99.99	99.99	99.99	99.99	-1.64	-1.27	-2.43	0.92	0.84	0.36
8	No data for this fleet at this age									

Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	0.29	-0.19	-0.52	-0.42	-0.29	99.99	-0.11	0.54	0.23	0.03
2	0.47	0.2	-0.04	-0.5	-0.39	-0.39	99.99	0.34	-0.13	-0.06
3	0.3	0.46	0.17	-0.45	-0.35	-0.61	0.17	99.99	0.19	-0.19
4	-0.22	0.67	0.35	-0.56	-0.04	-0.05	-0.08	0.3	99.99	-0.16
5	-0.48	0.33	0.07	-0.41	0.56	-0.69	-0.46	0.53	0.49	99.99
6	0.41	0.53	0.16	-0.06	0.12	-0.68	-0.55	0.35	0.31	0.39
7	0.52	0.56	-0.56	0.16	1.08	-1.34	-0.02	-0.06	-0.03	0.3
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	-6.7372
S.E(Log q)	0.8509

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	0.82	1.147	9.21	0.82	18	0.41	-8.12
2	0.82	1.462	8.04	0.88	18	0.39	-7.12
3	0.75	1.576	7.91	0.81	18	0.52	-6.7
4	0.89	0.792	6.99	0.85	18	0.47	-6.49
5	0.74	1.605	7.53	0.81	18	0.59	-6.47
6	0.76	1.618	7.33	0.81	18	0.58	-6.52

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

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
7	0.9	0.498	6.98	0.71	16	0.79	-6.74

Fleet : FLT02: Norway acoust

Age	1980	1981
1	99.99	99.99
2	99.99	99.99
3	99.99	99.99
4	99.99	99.99
5	99.99	99.99
6	99.99	99.99
7	99.99	99.99
8	No data for this fleet at this age	

Table 4.13 (Cont'd)

Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
1	0.94	0.11	0.38	0.08	-0.05	-0.67	-0.09	-0.28	0.59	0
2	0.54	0.83	0.36	0.1	0.16	-0.54	0.36	-0.54	0.11	-0.08
3	0.45	0.71	0.95	0.2	-0.09	-0.4	-0.07	-0.29	0.11	-0.42
4	0.41	0.3	-0.08	-0.82	-0.26	-0.76	-0.18	-0.29	-0.18	-0.4
5	0.29	0.7	0.6	1.1	0.31	-0.61	-0.47	-0.1	-0.05	-0.53
6	0.29	-0.23	0.78	0.9	1.35	0.41	-0.01	0.06	-0.55	-1.18
7	0.78	-1.76	0.76	0.59	0.96	1.33	0.16	0.03	-0.33	-1.03
8	No data for this fleet at this age									

Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	0.3	0.43	0.26	-0.15	-0.56	99.99	-0.29	0.32	-0.08	-0.09
2	-0.01	0.1	-0.11	-0.16	0.01	0.29	99.99	0.14	-0.07	-0.01
3	0.04	0.19	-0.16	0.18	0.12	0.23	-0.05	99.99	0.08	-0.14
4	-0.49	0.17	0.13	-0.13	0.01	0.37	-0.05	0.72	99.99	0.13
5	-0.74	0.22	0.29	-0.22	0.06	0.19	0.33	0.72	-0.42	99.99
6	-0.38	-0.47	0.13	0.21	0.12	0.26	-0.28	0.79	-0.02	0.06
7	-0.18	-0.53	-0.25	0.06	0.33	0.76	-0.53	0.36	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	-5.9045
S.E(Log q)	0.5749

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	1.907	7.35	0.86	19	0.36	-4.99
2	0.77	3.188	6.76	0.96	19	0.23	-5.15
3	0.8	2.914	6.5	0.96	19	0.23	-5.23
4	0.74	2.281	6.83	0.9	19	0.38	-5.37
5	0.61	3.017	7.68	0.87	19	0.47	-5.85
6	0.76	1.779	7.05	0.84	20	0.52	-6.15

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

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
7	1.04	-0.233	5.78	0.82	18	0.63	-5.9

Fleet : FLT04: Norway bottom

Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
1	0.37	0.68	0.75	0.04	0.58	-0.08	-0.21	-0.44	0.43	0.37
2	0.77	1.59	0.63	-0.24	0.6	0.22	0.68	-0.57	-0.32	0.02
3	0.12	0.33	1.52	-0.24	0.11	0.45	0.41	-0.34	-0.29	-0.36
4	0.33	0.12	0.29	-0.31	-0.21	0.03	0.3	-0.15	0.35	-0.38
5	0.7	0.49	0.94	0.89	99.99	-0.1	-0.15	0.07	0.15	-0.08
6	-0.05	-0.64	0.39	0.47	99.99	0.01	0.32	-0.02	-0.55	-0.33
7	0.34	-0.85	-0.93	0.11	99.99	99.99	-0.32	1.24	0.33	0.05
8	99.99	-0.88	0	-0.03	99.99	99.99	99.99	99.99	99.99	0.37

Table 4.13 (Cont'd)

Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	0.06	0.27	-0.28	-0.18	-0.19	99.99	-0.33	0.05	0.03	0.21
2	-0.25	0.22	0.06	-0.16	0.07	-0.04	99.99	-0.12	0.05	0.12
3	-0.05	-0.07	0.03	0.39	0.18	-0.08	-0.24	99.99	0.13	-0.07
4	-0.48	-0.2	-0.02	0.32	0.17	0.25	-0.31	0.09	99.99	0.12
5	-0.29	-0.3	0.19	0.07	0.03	-0.16	0.12	0.17	-0.08	99.99
6	0.1	-0.45	0.39	0.35	0.01	-0.22	-0.15	0.23	0.05	0.06
7	-0.77	-1.01	99.99	0.57	1.1	0.58	-0.08	-0.23	-0.9	-0.17
8	-0.64	-0.41	-0.15	99.99	-0.33	0.89	-0.02	0.41	-0.22	99.99

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	-6.519	-6.6872
S.E(Log q)	0.7072	0.4781

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	1.758	6.55	0.9	19	0.29	-4.73
2	0.77	2.66	6.67	0.93	19	0.28	-4.96
3	0.8	2.312	6.35	0.94	19	0.28	-5.06
4	0.73	3.15	6.84	0.94	19	0.29	-5.33
5	0.6	6.342	7.72	0.97	18	0.22	-5.83
6	0.64	4.324	7.54	0.94	19	0.3	-6.23

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	0.73	2.038	7.26	0.87	17	0.45	-6.52
8	0.85	0.931	7	0.87	12	0.41	-6.69
1							

Terminal year survivor and F summaries :

Age 1 Catchability dependent on age and year class strength

Year class = 2000

Fleet		Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT01: Ru	467659	0.432	0	0	1	0.212	0
FLT02: Nc	415242	0.375	0	0	1	0.283	0
FLT04: Nc	561123	0.306	0	0	1	0.422	0
P shrinka	214943	0.96				0.043	0
F shrinka	167993	1				0.04	0

Weighted prediction :

Survivors at end of y	Int s.e	Ext s.e	N	Var Ratio	F
453385	0.2	0.15	5	0.757	0

Table 4.13 (Cont'd)

Age 2 Catchability dependent on age and year class strength

Year class = 1999

Fleet	I S	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT01: Ru	308798	0.301	0.145	0.48	2	0.208	0.002
FLT02: Nc	276895	0.234	0.036	0.15	2	0.344	0.002
FLT04: Nc	309300	0.215	0.044	0.2	2	0.409	0.002
P shrinka	108068	0.99				0.019	0.006
F shrinka	137216	1				0.019	0.005

Weighted prediction :

Survivors at end of y	Int s.e	Ext s.e	N	Var Ratio	F
287209	0.14	0.07	8	0.545	0.002

Age 3 Catchability dependent on age and year class strength

Year class = 1998

Fleet	I S	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT01: Ru	263790	0.265	0.236	0.89	3	0.182	0.04
FLT02: Nc	238285	0.185	0.13	0.7	3	0.375	0.044
FLT04: Nc	242002	0.176	0.041	0.24	3	0.417	0.043
P shrinka	64775	1.04				0.012	0.154
F shrinka	191655	1				0.013	0.055

Weighted prediction :

Survivors at end of y	Int s.e	Ext s.e	N	Var Ratio	F
239684	0.11	0.08	11	0.674	0.044

Age 4 Catchability dependent on age and year class strength

Year class = 1997

Fleet	I S	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT01: Ru	34630	0.231	0.124	0.54	4	0.187	0.129
FLT02: Nc	33124	0.168	0.094	0.56	4	0.354	0.134
FLT04: Nc	30654	0.151	0.11	0.73	4	0.438	0.144
P shrinka	41066	1.12				0.009	0.109
F shrinka	16506	1				0.012	0.253

Weighted prediction :

Survivors at end of y	Int s.e	Ext s.e	N	Var Ratio	F
32089	0.1	0.06	14	0.568	0.138

Table 4.13 (Cont'd)

Age 5 Catchability dependent on age and year class strength

Year class = 1996

Fleet		Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT01: Ru	1	0	0	0	0	0	0
FLT02: Nc	1	0	0	0	0	0	0
FLT04: Nc	1	0	0	0	0	0	0
P shrinka	19192	1.16				0.428	0.977
F shrinka	47737	1				0.572	0.511

Weighted prediction :

Survivors at end of y	Int s.e	Ext s.e	N	Var Ratio	F
32320	0.76	10.39	2	13.742	0.685

Age 6 Catchability dependent on age and year class strength

Year class = 1995

Fleet		Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT01: Ru	5679	0.217	0.155	0.71	6	0.171	0.491
FLT02: Nc	5356	0.16	0.176	1.1	6	0.295	0.514
FLT04: Nc	4937	0.132	0.052	0.4	6	0.497	0.548
P shrinka	8774	1.2				0.015	0.344
F shrinka	3808	1				0.022	0.666

Weighted prediction :

Survivors at end of y	Int s.e	Ext s.e	N	Var Ratio	F
5196	0.09	0.07	20	0.704	0.527

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

Year class = 1994

Fleet		Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT01: Ru	2405	0.252	0.156	0.62	7	0.189	0.647
FLT02: Nc	2675	0.173	0.112	0.65	6	0.254	0.598
FLT04: Nc	2339	0.149	0.061	0.41	7	0.504	0.661
F shrinka	1927	1				0.053	0.759

Weighted prediction :

Survivors at end of y	Int s.e	Ext s.e	N	Var Ratio	F
2408	0.11	0.06	21	0.492	0.648

Table 4.13 (Cont'd)

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

Year class = 1993

Fleet	I S	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT01: Ru	460	0.246	0.129	0.53	7	0.175	1.009
FLT02: Nc	705	0.163	0.134	0.82	6	0.243	0.759
FLT04: Nc	548	0.142	0.144	1.01	7	0.459	0.901
F shrinka	500	1				0.124	0.957

Weighted prediction :

Survivors at end of y	Int s.e	Ext s.e	N	Var Ratio	F
559	0.15	0.08	21	0.507	0.894

Age 9 Catchability constant w.r.t. time and dependent on age

Year class = 1992

Fleet	I S	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT01: Ru	295	0.233	0.1	0.43	7	0.128	0.902
FLT02: Nc	429	0.176	0.093	0.53	7	0.23	0.697
FLT04: Nc	367	0.177	0.081	0.45	8	0.481	0.779
F shrinka	458	1				0.161	0.665

Weighted prediction :

Survivors at end of y	Int s.e	Ext s.e	N	Var Ratio	F
383	0.19	0.05	23	0.277	0.755

Age 10 Catchability constant w.r.t. time and age (fixed at the value for age) 9

Year class = 1991

Fleet	I S	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT01: Ru	684	0.24	0.17	0.71	7	0.116	0.734
FLT02: Nc	673	0.179	0.111	0.62	7	0.212	0.742
FLT04: Nc	819	0.168	0.085	0.5	8	0.413	0.644
F shrinka	635	1				0.259	0.773

Weighted prediction :

Survivors at end of y	Int s.e	Ext s.e	N	Var Ratio	F
720	0.27	0.06	23	0.208	0.707

Table 4.14

Run title : Arctic Haddock (run: Standard VPA AFWG02)

At 25/04/2002 16:52

Traditional vpa using file input for terminal F

Table 8 Fishing mortality (F) at age

YEAR	1950	1951
AGE		
3	0.0547	0.14
4	0.5936	0.2196
5	0.8245	0.6341
6	0.8125	0.9135
7	1.157	0.8053
8	1.0055	1.0036
9	0.6504	1.4256
10	0.946	1.0901
+gp	0.946	1.0901
0 FBAR 4- 7	0.8469	0.6431

Table 8 Fishing mortality (F) at age

YEAR	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961
AGE										
3	0.1163	0.072	0.0619	0.0254	0.1141	0.0454	0.0287	0.0719	0.2012	0.1697
4	0.5485	0.3926	0.246	0.1356	0.1753	0.2502	0.176	0.175	0.3802	0.4876
5	0.5849	0.5373	0.3091	0.4901	0.2792	0.3751	0.5789	0.3383	0.5192	0.6974
6	0.8887	0.4899	0.4146	0.4691	0.8125	0.4072	0.5215	0.5583	0.6531	0.7516
7	0.9961	0.7145	0.6139	1.0131	0.6249	0.8167	0.9643	0.6025	0.5207	0.8335
8	1.2502	0.6589	0.8609	0.6211	0.9345	0.4513	0.8693	0.4321	0.7026	0.8825
9	1.3695	0.5162	1.3582	0.43	0.3985	0.6298	0.743	0.8446	1.1478	0.9636
10	1.2251	0.6331	0.9584	0.6948	0.6588	0.6371	0.8688	0.6304	0.7976	0.9015
+gp	1.2251	0.6331	0.9584	0.6948	0.6588	0.6371	0.8688	0.6304	0.7976	0.9015
0 FBAR 4- 7	0.7546	0.5336	0.3959	0.527	0.473	0.4623	0.5602	0.4185	0.5183	0.6925
1										

Run title : Arctic Haddock (run: Standard VPA AFWG02)

At 25/04/2002 16:52

Traditional vpa using file input for terminal F

Table 8 Fishing mortality (F) at age

YEAR	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
AGE										
3	0.1995	0.1219	0.0811	0.0671	0.1303	0.0615	0.0421	0.1016	0.1708	0.0234
4	0.5958	0.6784	0.3193	0.2401	0.3875	0.3091	0.3971	0.1707	0.2355	0.2691
5	1.0616	0.9366	0.6929	0.4682	0.5962	0.4224	0.5791	0.498	0.2483	0.1818
6	1.0617	1.0265	0.871	0.6985	0.7436	0.5206	0.4594	0.5818	0.504	0.1815
7	0.7002	1.0012	0.8437	0.6762	0.8235	0.5329	0.7022	0.4051	0.5298	0.4033
8	0.904	0.6536	0.9605	0.5955	0.5278	0.5805	0.716	0.5023	0.4139	0.3896
9	1.1812	1.3586	1.3821	1.0492	0.5925	0.384	0.4946	0.5017	0.3945	0.2979
10	0.9374	1.0158	1.0779	0.7832	0.6549	0.5027	0.6449	0.4734	0.4494	0.365
+gp	0.9374	1.0158	1.0779	0.7832	0.6549	0.5027	0.6449	0.4734	0.4494	0.365
0 FBAR 4- 7	0.8548	0.9107	0.6817	0.5208	0.6377	0.4462	0.5344	0.4139	0.3794	0.2589

Table 4.14 (Cont'd)

Table 8 Fishing mortality (F) at age

YEAR		1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
AGE											
	3	0.2858	0.3384	0.2251	0.2572	0.3212	0.7667	0.3612	0.1538	0.0374	0.0903
	4	0.392	0.6042	0.3428	0.5904	0.6485	1.2657	0.6428	0.5033	0.3067	0.2104
	5	1.0698	0.9918	0.4214	0.5183	0.6438	0.9356	0.864	0.9675	0.6774	0.5487
	6	0.9505	0.4782	0.6967	0.4477	0.7088	0.5445	0.4454	0.8857	0.8153	0.8636
	7	0.5516	0.2982	0.5925	0.6002	0.8044	0.6386	0.8063	0.5113	0.3668	0.7678
	8	0.5809	0.2728	0.4828	0.3512	0.8773	0.5408	0.4546	0.7116	0.702	0.4312
	9	0.6928	0.2772	0.8009	0.2026	0.8143	0.5621	0.6774	0.5053	0.762	0.5122
	10	0.6151	0.2829	0.6317	0.3856	0.8429	0.5854	0.6524	0.5807	0.6169	0.5765
+gp		0.6151	0.2829	0.6317	0.3856	0.8429	0.5854	0.6524	0.5807	0.6169	0.5765
0 FBAR 4- 7		0.741	0.5931	0.5134	0.5392	0.7014	0.8461	0.6896	0.717	0.5416	0.5977

Table 8 Fishing mortality (F) at age

YEAR		1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
AGE											
	3	0.1247	0.1758	0.061	0.1357	0.0678	0.0534	0.0242	0.0716	0.0258	0.0553
	4	0.2399	0.4349	0.3207	0.2213	0.458	0.4631	0.167	0.1876	0.1071	0.1428
	5	0.4701	0.3922	0.3329	0.3645	0.3085	0.923	0.5351	0.3568	0.1275	0.2508
	6	0.6763	0.3556	0.2235	0.5434	0.4609	0.2949	1.1491	0.4946	0.1947	0.2948
	7	0.5341	0.3842	0.3351	0.386	0.5562	0.5	0.3188	0.6249	0.262	0.3313
	8	0.6355	0.3545	0.4844	0.5273	0.3045	0.3914	0.2872	0.3499	0.3086	0.2747
	9	0.3641	0.1806	0.3294	0.6013	0.5021	0.2531	0.1828	0.0715	1.5686	0.2323
	10	0.5166	0.3078	0.3851	0.5176	0.4657	0.3885	0.2348	0.2898	0.5251	0.2961
+gp		0.5166	0.3078	0.3851	0.5176	0.4657	0.3885	0.2348	0.2898	0.5251	0.2961
0 FBAR 4- 7		0.4801	0.3917	0.3031	0.3788	0.4459	0.5453	0.5425	0.416	0.1728	0.255

Table 8 Fishing mortality (F) at age

YEAR		1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	FBAR 99-**
AGE												
	3	0.0724	0.0247	0.013	0.021	0.0284	0.0288	0.0644	0.133	0.0184	0.0521	0.0678
	4	0.2493	0.2169	0.1096	0.0807	0.1343	0.2078	0.3139	0.3093	0.2978	0.1381	0.2484
	5	0.2606	0.469	0.4754	0.279	0.3651	0.4793	0.5077	0.8064	0.3773	0.6854	0.623
	6	0.3864	0.5413	0.6699	0.6248	0.5396	0.705	0.6613	0.8504	0.5444	0.5275	0.6408
	7	0.3583	0.3888	0.7158	0.6361	0.7827	0.8735	0.6316	0.8183	0.6547	0.6476	0.7069
	8	0.3325	0.3998	0.4993	0.3423	0.9318	1.0254	1.0223	0.9997	0.7397	0.8943	0.8779
	9	0.2731	0.4959	0.7458	0.4367	0.8258	0.7551	0.7658	0.4164	0.5345	0.7552	0.5687
	10	0.215	0.3306	1.0235	0.7544	0.9981	1.1537	0.8885	0.3898	0.5393	0.7074	0.5455
+gp		0.215	0.3306	1.0235	0.7544	0.9981	1.1537	0.8885	0.3898	0.5393	0.7074	
0 FBAR 4- 7		0.3137	0.404	0.4927	0.4052	0.4554	0.5664	0.5286	0.6961	0.4685	0.4997	

Table 4.15

Run title : Arctic Haddock (run: Standard VPA AFWG02)

At 25/04/2002 16:52

Traditional vpa using file input for terminal F

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

	YEAR	1950	1951
	AGE		
	3	66026	553019
	4	92622	51179
	5	68513	41886
	6	36893	24596
	7	45596	13404
	8	15745	11738
	9	4518	4716
	10	1941	1930
	+gp	5287	2201
0	TOTAL	337141	704669

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

	YEAR	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961
	AGE										
	3	60283	1023249	120542	50765	167878	51537	67410	322648	240840	108736
	4	393614	43935	779545	92769	40521	122627	40323	53631	245830	161251
	5	33641	186200	24292	499066	66319	27842	78175	27687	36860	137614
	6	18190	15346	89074	14600	250291	41068	15665	35875	16162	17956
	7	8078	6123	7697	48176	7478	90933	22377	7613	16806	6886
	8	4905	2442	2454	3411	14321	3277	32898	6985	3412	8175
	9	3523	1150	1035	849	1501	4605	1709	11292	3712	1384
	10	928	733	562	218	452	825	2009	665	3973	964
	+gp	1348	2339	957	218	418	408	1126	1168	1201	2624
0	TOTAL	524510	1281518	1026158	710071	549179	343123	261691	467564	568796	445591

Run title : Arctic Haddock (run: Standard VPA AFWG02)

At 25/04/2002 16:52

Traditional vpa using file input for terminal F

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

	YEAR	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
	AGE										
	3	240221	273037	316145	100872	237489	293827	17580	17380	164305	94307
	4	75127	161110	197881	238663	77231	170693	226211	13800	12856	113404
	5	81075	33898	66932	117722	153693	42919	102594	124512	9526	8317
	6	56095	22960	10878	27406	60348	69323	23033	47073	61954	6084
	7	6934	15885	6735	3728	11159	23488	33723	11912	21540	30641
	8	2450	2818	4779	2372	1552	4010	11286	13681	6504	10382
	9	2769	812	1200	1497	1070	750	1837	4516	6778	3520
	10	432	696	171	247	429	485	418	917	2239	3740
	+gp	1350	638	1040	1609	550	750	657	316	886	1915
0	TOTAL	466454	511854	605761	494116	543522	606244	417338	234109	286587	272311

Table 4.15 (Cont'd)

	Table 10	Stock number-at-agenumber-at-age (start of year)				Numbers*10**-3					
	YEAR	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
	AGE										
	3	1020079	270088	52809	48620	55897	113879	171144	135427	18815	6200
	4	75426	627541	157640	34520	30778	33190	43313	97638	95074	14839
	5	70942	41726	280786	91604	15660	13175	7664	18647	48325	57279
	6	5677	19926	12671	150841	44664	6735	4232	2645	5802	20097
	7	4155	1797	10113	5168	78924	18000	3199	2219	893	2102
	8	16761	1959	1092	4578	2322	28907	7782	1169	1090	507
	9	5757	7676	1221	552	2638	791	13781	4044	470	442
	10	2140	2358	4763	449	369	957	369	5731	1997	180
	+gp	3927	2603	4360	3200	3065	935	911	801	3464	2402
0	TOTAL	1204865	975675	525456	339532	234317	216568	252394	268321	175930	104046

	Table 10	Stock number-at-agenumber-at-age (start of year)				Numbers*10**-3					
	YEAR	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
	AGE										
	3	8295	4805	8372	256266	524979	83235	41552	16663	24246	81331
	4	4637	5995	3300	6384	183181	260805	64602	25282	12700	16265
	5	9843	2987	3177	1961	4189	94868	134380	44756	17158	9342
	6	27091	5037	1652	1865	1115	2519	30860	64288	25646	12366
	7	6937	11279	2890	1082	887	576	1536	8007	32097	17282
	8	799	3329	6288	1692	602	416	286	914	3509	20222
	9	269	346	1912	3172	818	364	230	176	527	2110
	10	217	153	237	1126	1423	405	231	157	134	90
	+gp	1760	713	974	306	462	971	1628	288	80	73
0	TOTAL	59848	34644	28803	273853	717655	444158	275303	160531	116098	159081

	Table 10	Stock number-at-agenumber-at-age (start of year)				Numbers*10**-3								
	YEAR	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	GMST 50-99	AMST
	AGE													
	3	195277	625830	273813	74137	84642	99327	43582	179921	57963	265185	0	94095	182146
	4	63007	147838	468020	199790	49587	36348	57104	31865	128695	44887	200442	64757	125030
	5	11544	40204	94878	337101	126092	33550	22849	32054	19149	77301	31936	38208	72720
	6	5952	7283	18625	47705	186575	69974	16474	10952	11717	10619	31891	18464	35403
	7	7539	3311	3471	7797	20697	88316	27990	6962	3831	5539	5130	8567	16443
	8	10159	4314	1838	1389	3379	7747	30188	12186	2515	1630	2373	3863	6900
	9	12580	5965	2368	913	807	1090	2275	8892	3672	983	546	1716	2939
	10	1370	7839	2974	920	483	289	419	866	4801	1761	378	714	1272
	+gp	102	1497	3199	1981	2115	848	419	472	858	2095	1556		
0	TOTAL	307530	844080	869185	671734	474377	337489	201300	284170	233200	410000	274253		
	1													

Table 4.16

Run title : Arctic Haddock (run: Standard VPA AFWG02)

At 25/04/2002 16:52

Traditional vpa using file input for terminal F

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

	YEAR	1950	1951
	AGE		
	3	19804	237753
	4	43355	34338
	5	55734	48839
	6	39904	38131
	7	59263	24971
	8	23827	25461
	9	7596	11367
	10	3890	5545
	+gp	16519	9858
0	TOTALBIO	269894	436263

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

	YEAR	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961
	AGE										
	3	20398	387813	47898	15852	61258	19316	27344	170497	133185	57597
	4	207854	25986	483407	45207	23075	71725	25527	44228	212155	133299
	5	30873	191395	26179	422644	65632	28301	86005	39680	55284	197698
	6	22195	20973	127633	16440	329341	55505	22915	68363	32229	34299
	7	11844	10057	13254	65187	11824	147685	39334	17433	40273	15807
	8	8374	4671	4920	5374	26366	6198	67331	18622	9521	21848
	9	6682	2444	2305	1487	3070	9677	3886	33452	11508	4109
	10	2098	1857	1492	454	1103	2066	5444	2350	14680	3414
	+gp	4751	9236	3960	708	1591	1592	4758	6427	6917	14481
0	TOTALBIO	315070	654431	711048	573353	523259	342063	282543	401051	515752	482552

Run title : Arctic Haddock (run: Standard VPA AFWG02)

At 25/04/2002 16:52

Traditional vpa using file input for terminal F

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

	YEAR	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
	AGE										
	3	118254	134114	129020	46459	103472	153560	9191	9209	81846	62898
	4	57716	123501	126029	171543	52513	139218	184568	11411	9994	118036
	5	108244	45158	74082	147049	181611	60834	145472	178929	12869	15044
	6	99578	40668	16009	45518	94815	130647	43424	89943	111287	14633
	7	14791	33811	11910	7440	21068	53192	76402	27350	46495	88557
	8	6085	6985	9840	5511	3412	10574	29771	36575	16347	34936
	9	7642	2237	2746	3866	2615	2196	5385	13414	18929	13162
	10	1422	2284	466	759	1250	1692	1460	3248	7452	16669
	+gp	6924	3264	4422	7717	2495	4086	3577	1746	4600	13304
0	TOTALBIO	420654	392021	374524	435861	463250	555999	499251	371825	309818	377239

Table 4.16 (Cont'd)

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

	YEAR	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
	AGE										
	3	578522	147619	30174	26079	23229	57931	107388	100809	12855	4068
	4	66758	535270	140568	28897	19961	26349	42413	113425	101372	15195
	5	109118	61853	435121	133263	17650	18177	13043	37646	89546	101932
	6	11611	39273	26107	291766	66931	12354	9576	7099	14294	47552
	7	10210	4256	25040	12013	142126	39678	8698	7159	2644	5976
	8	47961	5403	3148	12390	4868	74195	24636	4392	3757	1677
	9	18304	23520	3912	1659	6147	2255	48476	16875	1800	1627
	10	8108	8610	18186	1609	1024	3252	1547	28504	9119	787
	+gp	23202	14818	25950	17881	13266	4952	5955	6213	24649	16418
0	TOTALBIO	873794	840622	708205	525557	295202	239144	261732	322121	260034	195232

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

	YEAR	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
	AGE										
	3	5206	2123	2276	108009	140147	17110	8847	4399	6926	29948
	4	4542	5755	2992	4781	128201	107480	24811	10693	8800	11994
	5	16756	4512	5409	3560	5780	85749	82897	29493	15681	11815
	6	61314	9648	3894	4438	2274	5550	34512	62493	31903	17099
	7	18867	26909	6088	2818	1810	1619	2397	10923	48601	29730
	8	2529	10205	19695	5460	1808	1269	947	2932	6492	39306
	9	948	1179	6654	11370	2729	1323	848	626	1269	5091
	10	910	622	982	4812	5661	1758	1014	668	570	267
	+gp	11505	4510	6299	2038	2863	6562	11137	1750	533	480
0	TOTALBIO	122577	65463	54288	147285	291273	228421	167411	123976	120775	145730

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

	YEAR	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
	AGE										
	3	68460	188151	74347	17044	19419	21897	11036	57902	13705	82251
	4	52988	120005	282803	76694	22596	16751	29586	21014	90775	22258
	5	17253	60072	112338	286538	90102	27542	21692	35648	20049	91948
	6	12073	14926	32996	72999	218341	81244	21347	18269	15567	16746
	7	16217	8003	8079	16511	39621	139532	44544	13186	5746	11276
	8	22954	12009	4918	3299	7788	17208	57989	22977	4495	3663
	9	30962	18566	7251	2554	2392	3448	6310	22050	7309	2508
	10	4584	24784	9022	2630	1323	1013	1096	2111	11328	5090
	+gp	525	9692	14384	7969	9059	3699	1629	1888	3567	6308
0	TOTALBIO	226016	456208	546138	486239	410642	312334	195231	195046	172541	242048

Table 4.17

Run title : Arctic Haddock (run: Standard VPA AFWG02)

At 25/04/2002 16:52

Traditional vpa using file input for terminal F

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

	YEAR	1950	1951
	AGE		
	3	0	0
	4	2168	1717
	5	12819	11233
	6	21149	20209
	7	52152	21975
	8	23351	24952
	9	7596	11367
	10	3890	5545
	+gp	16519	9858
0	TOTSPBIO	139644	106855

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

	YEAR	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961
	AGE										
	3	0	0	0	0	0	0	0	0	0	0
	4	10393	1299	24170	2260	1154	3586	1276	2211	10608	6665
	5	7101	44021	6021	97208	15095	6509	19781	9126	12715	45471
	6	11764	11116	67646	8713	174551	29417	12145	36232	17082	18179
	7	10423	8850	11664	57364	10405	129963	34613	15341	35440	13910
	8	8207	4577	4821	5267	25839	6074	65985	18250	9330	21411
	9	6682	2444	2305	1487	3070	9677	3886	33452	11508	4109
	10	2098	1857	1492	454	1103	2066	5444	2350	14680	3414
	+gp	4751	9236	3960	708	1591	1592	4758	6427	6917	14481
0	TOTSPBIO	61418	83400	122079	173462	232807	188884	147888	123389	118280	127639

Run title : Arctic Haddock (run: Standard VPA AFWG02)

At 25/04/2002 16:52

Traditional vpa using file input for terminal F

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

	YEAR	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
	AGE										
	3	0	0	0	0	0	0	0	0	0	0
	4	2886	6175	6301	8577	2626	6961	9228	571	500	5902
	5	24896	10386	17039	33821	41771	13992	33459	41154	2960	3460
	6	52776	21554	8485	24124	50252	69243	23015	47670	58982	7756
	7	13016	29754	10481	6547	18540	46809	67233	24068	40915	77930
	8	5963	6845	9643	5401	3344	10362	29176	35843	16020	34237
	9	7642	2237	2746	3866	2615	2196	5385	13414	18929	13162
	10	1422	2284	466	759	1250	1692	1460	3248	7452	16669
	+gp	6924	3264	4422	7717	2495	4086	3577	1746	4600	13304
0	TOTSPBIO	115524	82499	59583	90813	122891	155341	172533	167713	150358	172420

Table 4.17 (Cont'd)

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

YEAR	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
AGE										
3	0	0	0	0	0	0	0	0	0	41
4	3338	26763	7028	1445	998	1317	2121	5671	5069	1823
5	25097	14226	100078	30650	4059	4181	3000	8658	20595	65236
6	6154	20814	13837	154636	35474	6548	5075	3762	7576	34713
7	8985	3745	22035	10572	125071	34917	7654	6300	2326	5737
8	47001	5295	3085	12143	4771	72711	24143	4304	3681	1677
9	18304	23520	3912	1659	6147	2255	48476	16875	1800	1627
10	8108	8610	18186	1609	1024	3252	1547	28504	9119	787
+gp	23202	14818	25950	17881	13266	4952	5955	6213	24649	16418
0 TOTSPBIO	140189	117793	194110	230594	190810	130133	97971	80288	74816	128060

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

YEAR	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
AGE										
3	469	361	159	2160	0	0	0	0	0	0
4	2498	4029	419	382	28204	1075	744	428	176	840
5	12232	4512	1893	2848	3063	18007	27356	8848	4704	3545
6	57022	9648	1830	4127	1956	2941	17601	39371	17228	8549
7	18113	26909	4505	2705	1556	1619	2397	8957	37423	23784
8	2529	10205	19695	5460	1808	1269	947	2932	5648	36162
9	948	1179	6654	11370	2729	1323	848	626	1015	5091
10	910	622	982	4812	5661	1758	1014	668	570	267
+gp	11505	4510	6299	2038	2863	6562	11137	1750	533	480
0 TOTSPBIO	106224	61975	42436	35903	47841	34555	62045	63579	67297	78718

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

YEAR	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
AGE										
3	1369	2822	0	0	0	0	0	579	0	329
4	6888	26281	4808	1534	0	503	1479	3572	9077	1335
5	8627	29435	14604	34385	9010	2754	6074	17824	6416	49652
6	7485	11344	13528	30660	78603	23561	10674	12971	9184	12057
7	12487	6323	7271	13374	30904	83719	29399	10681	4137	9810
8	18363	10568	4328	2903	6698	14111	46971	20909	4225	3443
9	29104	16338	7251	2554	2153	3448	5742	20286	6871	2257
10	4584	21562	9022	2288	1230	841	1096	2111	10874	5090
+gp	525	9692	13952	7969	8154	3699	1629	1888	3567	5740
0 TOTSPBIO	89433	134364	74765	95666	136752	132634	103065	90821	54352	89715

Table 4.18

Run title : Arctic Haddock (run: Standard VPA AFWG02)

At 25/04/2002 16:52

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	392021	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	463250	122891	161778	1.3164	0.6601	0.6377
1967	293827	555999	155341	136397	0.878	0.7919	0.4462
1968	17580	499251	172533	181726	1.0533	0.7921	0.5344
1969	17380	371825	167713	130820	0.78	0.8028	0.4139
1970	164305	309818	150358	88257	0.587	0.7547	0.3794
1971	94307	377239	172420	78905	0.4576	1.0105	0.2589
1972	1020079	873794	140189	266153	1.8985	0.8593	0.741
1973	270088	840622	117793	322226	2.7355	0.8281	0.5931
1974	52809	708205	194110	221157	1.1393	0.8657	0.5134
1975	48620	525557	230594	175758	0.7622	0.8127	0.5392
1976	55897	295202	190810	137264	0.7194	0.6296	0.7014
1977	113879	239144	130133	110158	0.8465	0.7708	0.8461
1978	171144	261732	97971	95422	0.974	0.9507	0.6896
1979	135427	322121	80288	103623	1.2906	1.1278	0.717
1980	18815	260034	74816	87889	1.1747	1.0352	0.5416
1981	6200	195232	128060	77153	0.6025	0.9942	0.5977
1982	8295	122577	106224	46955	0.442	0.951	0.4801
1983	4805	65463	61975	21607	0.3486	0.9205	0.3917
1984	8372	54288	42436	17318	0.4081	0.9405	0.3031
1985	256266	147285	35903	41270	1.1495	0.9689	0.3788
1986	524979	291273	47841	96585	2.0189	0.9019	0.4459
1987	83235	228421	34555	150654	4.3598	0.9836	0.5453
1988	41552	167411	62045	91745	1.4787	0.995	0.5425
1989	16663	123976	63579	54859	0.8629	0.9634	0.416
1990	24246	120775	67297	25741	0.3825	0.9651	0.1728
1991	81331	145730	78718	33605	0.4269	0.9589	0.255
1992	195277	226016	89433	53887	0.6025	1.0132	0.3137
1993	625830	456208	134364	77621	0.5777	1.0021	0.404
1994	273813	546138	74765	128703	1.7214	1.1128	0.4927
1995	74137	486239	95666	138677	1.4496	1.0546	0.4052
1996	84642	410642	136752	173264	1.267	1.0524	0.4554
1997	99327	312334	132634	148756	1.1215	1.0498	0.5664
1998	43582	195231	103065	93946	0.9115	1.0595	0.5286
1999	179921	195046	90821	82346	0.9067	1.0552	0.6961
2000	57963	172541	54352	61292	1.1277	1.0019	0.4685
2001	265185	242048	89715	81280	0.906	1.0038	0.4997
Arith. Mean	181355	364212	113506	121063	1.1540	.5328	
0 Units	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)			

TABLE 4.19

Prediction with management option table: Input data

MFDP version 1a
Run: NEA_HAD_C_
Time and date: 17:09 25/04/2002
Fbar age range: 4-7

2002

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
3	241000	0.28814	0.0028	0	0	0.2833333	0.0521	0.6533333
4	200000	0.22684	0.082	0	0	0.6076667	0.1381	1.0366667
5	31936	0.2144	0.348	0	0	1.0946667	0.6854	1.3533333
6	31891	0.20322	0.562	0	0	1.4926667	0.5275	1.6366667
7	5130	0.2	0.732	0	0	1.7733333	0.6476	1.81
8	2373	0.2	0.884	0	0	1.9366667	0.8943	1.9433333
9	546	0.2	0.934	0	0	2.2933333	0.7552	2.1533333
10	378	0.2	0.958	0	0	2.5146667	0.7074	2.4066667
11	1556	0.2	0.982	0	0	3.6466667	0.7074	2.63

2003

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
3	199000	0.28814	0.0028	0	0	0.2833333	0.0521	0.6533333
4 .		0.22684	0.082	0	0	0.6076667	0.1381	1.0366667
5 .		0.2144	0.348	0	0	1.0946667	0.6854	1.3533333
6 .		0.20322	0.562	0	0	1.4926667	0.5275	1.6366667
7 .		0.2	0.732	0	0	1.7733333	0.6476	1.81
8 .		0.2	0.884	0	0	1.9366667	0.8943	1.9433333
9 .		0.2	0.934	0	0	2.2933333	0.7552	2.1533333
10 .		0.2	0.958	0	0	2.5146667	0.7074	2.4066667
11 .		0.2	0.982	0	0	3.6466667	0.7074	2.63

2004

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
3	284000	0.28814	0.0028	0	0	0.2833333	0.0521	0.6533333
4 .		0.22684	0.082	0	0	0.6076667	0.1381	1.0366667
5 .		0.2144	0.348	0	0	1.0946667	0.6854	1.3533333
6 .		0.20322	0.562	0	0	1.4926667	0.5275	1.6366667
7 .		0.2	0.732	0	0	1.7733333	0.6476	1.81
8 .		0.2	0.884	0	0	1.9366667	0.8943	1.9433333
9 .		0.2	0.934	0	0	2.2933333	0.7552	2.1533333
10 .		0.2	0.958	0	0	2.5146667	0.7074	2.4066667
11 .		0.2	0.982	0	0	3.6466667	0.7074	2.63

Input units are thousands and kg - output in tonnes

Table 4.21

Prediction with management option table

MFDP version 1a
Run: NEA_HAD_C_
Northeast Arctic Haddock
Time and date: 17:09 25/04/2002
Fbar age range: 4-7

2002 Biomass	SSB	FMult	FBar	Landings
293948	67449	1.087	0.5431	85000

2003 Biomass	SSB	FMult	FBar	Landings	2004 Biomass	SSB
363454	98463	0.5	0.2498	75615	461023	151842
.	98463	0.55	0.2748	82097	454779	148331
.	98463	0.6	0.2998	88406	448710	144927
.	98463	0.65	0.3248	94549	442811	141626
.	98463	0.7	0.3498	100531	437076	138426
.	98463	0.75	0.3747	106356	431499	135323
.	98463	0.8	0.3997	112030	426076	132314
.	98463	0.85	0.4247	117557	420802	129395
.	98463	0.9	0.4497	122942	415672	126564
.	98463	0.95	0.4747	128189	410681	123818
.	98463	1	0.4997	133303	405825	121154
.	98463	1.05	0.5246	138288	401100	118569
.	98463	1.1	0.5496	143148	396501	116061
.	98463	1.15	0.5746	147887	392024	113627
.	98463	1.2	0.5996	152508	387665	111266
.	98463	1.25	0.6246	157015	383422	108974
.	98463	1.3	0.6495	161412	379289	106749
.	98463	1.35	0.6745	165702	375264	104589
.	98463	1.4	0.6995	169888	371342	102492
.	98463	1.45	0.7245	173974	367522	100457
.	98463	1.5	0.7495	177962	363799	98480

Input units are thousands and kg - output in tonnes

Table 4.22

Single option prediction: Summary table

MFDP version 1a
Run: NEA_HAD_C_
Time and date: 17:09 25/04/2002
Fbar age range: 4-7

Year: 2002 F multiplier: 1.087 Fbar: 0.5431

Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
3	0.0566	11545	7542	241000	68283	675	191	675	191
4	0.1501	25014	25931	200000	121533	16400	9966	16400	9966
5	0.745	15299	20704	31936	34959	11114	12166	11114	12166
6	0.5734	12716	20812	31891	47603	17923	26753	17923	26753
7	0.704	2377	4303	5130	9097	3755	6659	3755	6659
8	0.9721	1359	2640	2373	4596	2098	4063	2098	4063
9	0.8209	281	605	546	1252	510	1170	510	1170
10	0.769	186	448	378	951	362	911	362	911
11	0.769	766	2015	1556	5674	1528	5572	1528	5572
Total		69542	85000	514810	293948	54364	67449	54364	67449

Year: 2003 F multiplier: 1 Fbar: 0.4997

Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
3	0.0521	8788	5742	199000	56383	557	158	557	158
4	0.1381	19753	20478	170720	103741	13999	8507	13999	8507
5	0.6854	62005	83914	137189	150176	47742	52261	47742	52261
6	0.5275	4579	7494	12235	18263	6876	10264	6876	10264
7	0.6476	6406	11594	14668	26012	10737	19041	10737	19041
8	0.8943	1129	2195	2077	4023	1836	3557	1836	3557
9	0.7552	358	770	735	1685	686	1574	686	1574
10	0.7074	91	220	197	495	188	474	188	474
11	0.7074	341	897	734	2676	721	2628	721	2628
Total		103451	133303	537555	363454	83343	98463	83343	98463

Year: 2004 F multiplier: 1 Fbar: 0.4997

Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
3	0.0521	12542	8194	284000	80467	795	225	795	225
4	0.1381	16385	16986	141608	86051	11612	7056	11612	7056
5	0.6854	53567	72495	118520	129740	41245	45150	41245	45150
6	0.5275	20879	34172	55788	83273	31353	46799	31353	46799
7	0.6476	2573	4657	5892	10448	4313	7648	4313	7648
8	0.8943	3417	6640	6285	12171	5556	10759	5556	10759
9	0.7552	338	728	695	1595	650	1490	650	1490
10	0.7074	131	316	283	711	271	681	271	681
11	0.7074	175	459	376	1370	369	1345	369	1345
Total		110007	144647	613447	405825	96163	121154	96163	121154

Input units are thousands and kg - output in tonnes

Table 4.23: Output from STPR3

```
Run id 20020507  114024.193
 ************************************************
 *  Results of stochastic medium term simulation  *
 *                                                *
 ************************************************

 Options from file had.opt:
 **************************
 For each of the SSB-levels below, the catch
 corresponding to the f-value is taken, unless
 this catch is larger than the maximum permitted catch

        Lower   Standard F level       Max. catch
 Level   SSB    Fleet 1  Fleet 2    Fleet 1  Fleet 2

  1     0.0      0.000    0.000     1000.0   1000.0
  2    50.0      0.350    0.000     1000.0   1000.0
  3    80.0      0.350    0.000     1000.0   1000.0

 Total catch shall increase not more than 1.50000000  per year
 Total catch shall decrease not more than 0.500000000  per year,
 within the bounds F < Max. permissible F
 SSB shall increase at least with a factor  0.100000001  per year at levels 1 and 2

 For the intermediate year  2002
 the following assumptions were made:
 For fleet 1: Catch-constraint =  85.0000000
 For fleet 2: Catch-constraint =  0.00000000E+00

 Maximum possible fishing mortality is assumed to be:
 1.000 for Fleet 1
 0.000 for Fleet 2

 Maximum permitted fishing mortality is assumed to be:
 0.700 for Fleet 1
 0.000 for Fleet 2

 Shepherd stock recruit function
a=        21.
b=    138.276
c=     11.037
Stochastic term x has normal distribution with sigma= 0.3000

 Stock-recruit function not applied in year 0
 Weights at age and maturity ogive were drawn from historical values
Assumed faulty assessment with factor:  1.250 +/- 0.200
Assumed overfishing of quotas with factor:  1.000 +/- 0.100
 Stochastic initial stock numbers - lognormal distribution

 ************************************************


 Probabilities of APPLIED levels and limits:

 Year  %Level 1  %Level 2  %Level 3  %Max c1  %Max c2
 2003      4.9      13.6      81.5      0.0      0.0
 2004      1.7       5.7      92.6      0.0      0.0
 2005      0.1       1.4      98.5      0.0      0.0
 2006      0.4       2.0      97.6      0.0      0.0
 2007      0.7       4.4      94.9      0.0      0.0
 2008      2.6       8.7      88.7      0.0      0.0
 2009      9.4      15.0      75.6      0.0      0.0
 2010     20.8      15.7      63.5      0.0      0.0
 2011     30.7      16.2      53.1      0.0      0.0
 2012     32.8      17.4      49.8      0.0      0.0


 Probabilities of TRUE levels and limits:

 Year  %Level 1  %Level 2  %Level 3  %>Max c1 %>Max c2
```

Table 4.23 (Cont'd)

Probabilities of shifts of APPLIED level:
(from previous year to present year)

Year	%L 1=>2	%L 1=>3	%L 2=>3	%L 2=>1	%L 3=>1	%L3=>2
2004	0.5	4.3	11.7	0.5	1.1	3.8
2005	0.0	1.7	5.5	0.0	0.1	1.2
2006	0.0	0.1	1.3	0.0	0.4	1.9
2007	0.0	0.3	1.5	0.3	0.3	4.2
2008	0.1	0.4	2.8	0.8	1.6	7.8
2009	0.1	0.4	3.6	2.9	4.4	12.7
2010	0.8	1.3	5.8	6.7	6.8	12.4
2011	2.8	2.1	5.3	7.0	7.8	10.0
2012	4.4	5.7	5.7	6.7	5.5	9.2

Percent prob. of level 2,3 => level 1 at least once: 51.2
Percent prob. of level 3 => level 2 at least once: 55.6

Probabilities of shifts of TRUE level:
(from previous year to present year)

Year	%L 1=>2	%L 1=>3	%L 2=>3	%L 2=>1	%L 3=>1	%L3=>2
2004	0.8	7.1	16.0	0.8	1.1	5.3
2005	0.1	2.0	8.1	0.1	0.1	2.7
2006	0.0	0.2	3.3	0.1	0.7	2.6
2007	0.0	0.4	2.2	0.4	0.7	6.4
2008	0.4	0.4	3.7	1.7	2.3	11.1
2009	0.9	0.6	4.0	5.4	5.3	14.8
2010	1.8	1.3	6.3	8.6	6.7	16.4
2011	3.8	2.6	5.7	9.6	5.6	11.1
2012	5.5	5.0	6.6	7.9	4.9	8.6

Percent prob. of level 2,3 => level 1 at least once: 33.8
Percent prob. of level 3 => level 2 at least once: 66.8

Fractiles for SSB:

Year	5%	25%	50%	75%	95%
2002	34.0	55.2	81.3	126.3	225.0
2003	41.2	75.7	120.5	195.0	335.3
2004	61.2	105.8	159.0	254.9	436.2
2005	82.3	127.7	186.6	277.9	477.6
2006	83.4	132.1	191.3	271.3	437.8
2007	68.8	113.5	163.9	233.2	353.3
2008	50.4	92.4	131.0	192.3	301.1
2009	29.5	67.3	106.1	156.4	249.1
2010	12.5	48.1	82.8	130.9	243.1
2011	8.1	31.4	70.3	113.9	212.8
2012	6.2	30.1	65.8	120.6	232.1

Fractiles for first year Bpa is reached:
(year 2013 means not earler than that year)

5%	25%	50%	75%	95%
2003	2003	2003	2004	2004

Fractiles for Recruitment:

Year	5%	25%	50%	75%	95%
2002	549.3	1039.2	1575.6	2411.2	4294.7
2003	21.2	749.2	1272.7	1811.2	2629.6
2004	0.3	83.1	1043.0	1710.1	2639.0
2005	0.0	6.8	606.9	1720.0	2681.1
2006	0.0	2.6	125.6	1422.7	2543.1
2007	0.0	3.5	98.0	1330.2	2614.5
2008	0.2	15.5	445.6	1577.1	2624.9
2009	1.3	97.3	1030.3	1754.5	2837.8
2010	6.6	438.8	1146.3	1778.2	2543.4
2011	11.9	378.3	1113.3	1745.6	2685.6
2012	33.6	356.8	960.0	1661.6	2725.3

Table 4.23 (Cont'd)

Fractiles for Catches, FLEET 1:

Year	5%	25%	50%	75%	95%
2002	85.0	85.0	85.0	85.0	85.0
2003	51.0	100.4	118.9	130.0	147.8
2004	67.3	108.8	143.5	176.3	208.3
2005	79.1	111.5	145.5	191.7	271.6
2006	73.2	110.8	138.6	179.9	271.7
2007	62.3	91.7	123.0	156.1	226.3
2008	39.5	72.1	98.9	134.9	200.3
2009	20.0	50.7	79.5	110.0	157.7
2010	8.7	32.1	62.5	99.7	151.5
2011	4.5	18.7	50.6	87.8	146.4
2012	2.7	12.5	43.1	86.2	149.4

Fractiles for Catches, FLEET 2:

Year	5%	25%	50%	75%	95%
2002	0.0	0.0	0.0	0.0	0.0
2003	0.0	0.0	0.0	0.0	0.0
2004	0.0	0.0	0.0	0.0	0.0
2005	0.0	0.0	0.0	0.0	0.0
2006	0.0	0.0	0.0	0.0	0.0
2007	0.0	0.0	0.0	0.0	0.0
2008	0.0	0.0	0.0	0.0	0.0
2009	0.0	0.0	0.0	0.0	0.0
2010	0.0	0.0	0.0	0.0	0.0
2011	0.0	0.0	0.0	0.0	0.0
2012	0.0	0.0	0.0	0.0	0.0

Fractiles for catch variation (range yr 5-10)/mean in%:

Fleet	5%	25%	50%	75%	95%
1	59.2	92.9	149.9	227.9	391.8
2	0.0	0.0	0.0	0.0	0.0

Fractiles for mean catch (year 1-5)

Fleet	5%	25%	50%	75%	95%
1	90.0	116.2	134.9	158.1	194.3
2	0.0	0.0	0.0	0.0	0.0

Fractiles for mean catch (year 1-5)

Fleet	5%	25%	50%	75%	95%
1	155.8	190.5	211.6	235.6	273.5
2	0.0	0.0	0.0	0.0	0.0

Fractiles for fishing mortalities, FLEET 1:

Year	5%	25%	50%	75%	95%
2002	0.174	0.299	0.403	0.522	0.721
2003	0.183	0.283	0.365	0.450	0.582
2004	0.194	0.302	0.389	0.465	0.621
2005	0.218	0.337	0.416	0.512	0.685
2006	0.268	0.367	0.444	0.544	0.750
2007	0.292	0.384	0.469	0.577	0.834
2008	0.287	0.394	0.487	0.610	0.925
2009	0.277	0.387	0.484	0.615	1.000
2010	0.224	0.371	0.471	0.615	1.000
2011	0.081	0.320	0.436	0.587	0.991
2012	0.029	0.187	0.367	0.515	0.802

Fractiles for fishing mortalities, FLEET 2:

Year	5%	25%	50%	75%	95%
2002	0.000	0.000	0.000	0.000	0.000
2003	0.000	0.000	0.000	0.000	0.000
2004	0.000	0.000	0.000	0.000	0.000
2005	0.000	0.000	0.000	0.000	0.000
2006	0.000	0.000	0.000	0.000	0.000
2007	0.000	0.000	0.000	0.000	0.000
2008	0.000	0.000	0.000	0.000	0.000
2009	0.000	0.000	0.000	0.000	0.000
2010	0.000	0.000	0.000	0.000	0.000
2011	0.000	0.000	0.000	0.000	0.000
2012	0.000	0.000	0.000	0.000	0.000

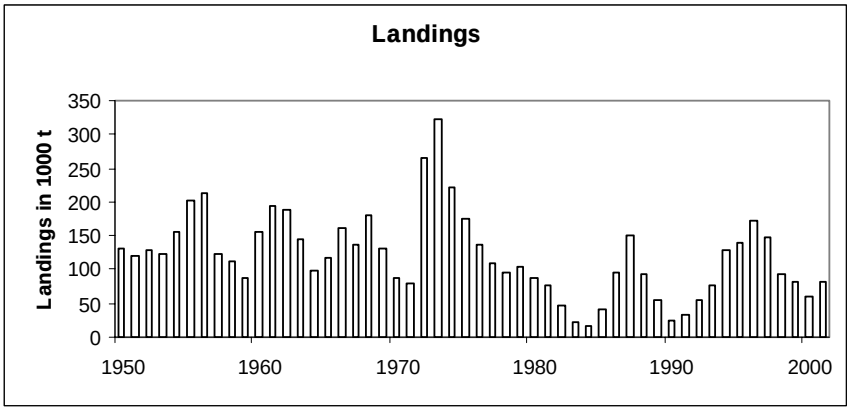


Figure 4.1 A Landings of Northeast Arctic Haddock

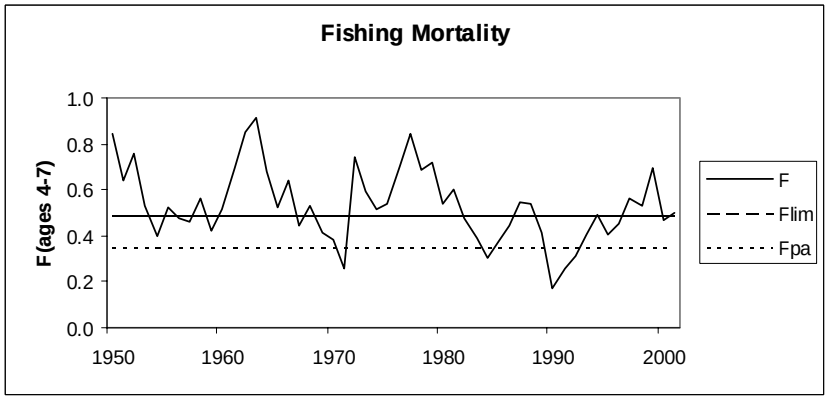


Figure 4.1 B Fishing mortality of Northeast Arctic Haddock

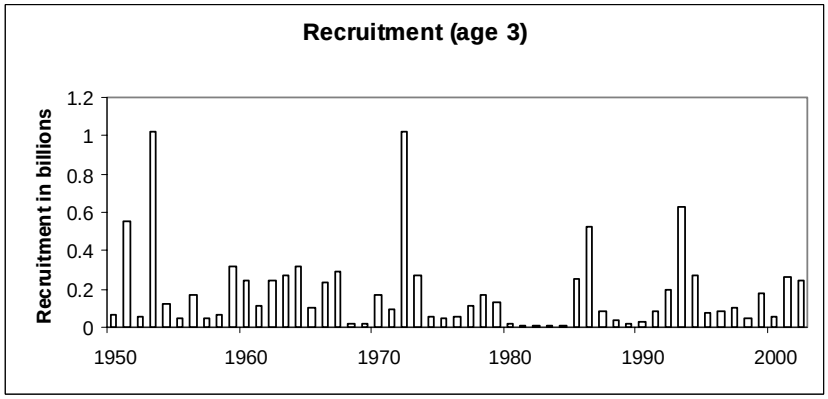


Figure 4.1C Recruitment of Northeast Arctic Haddock

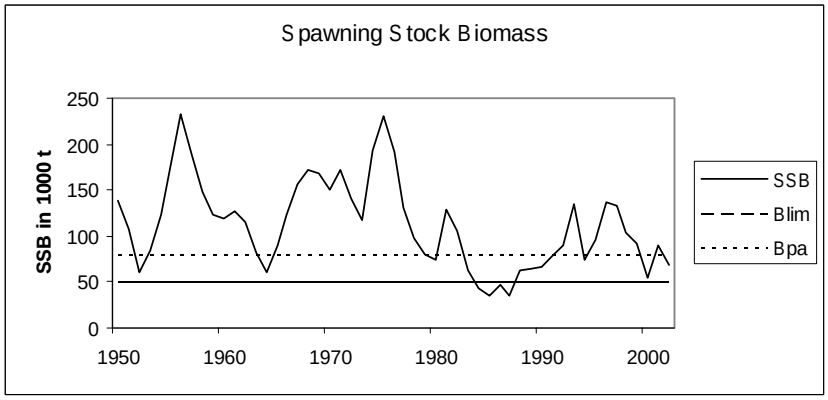


Figure 4.1D Spawning stock biomass of Northeast Arctic haddock

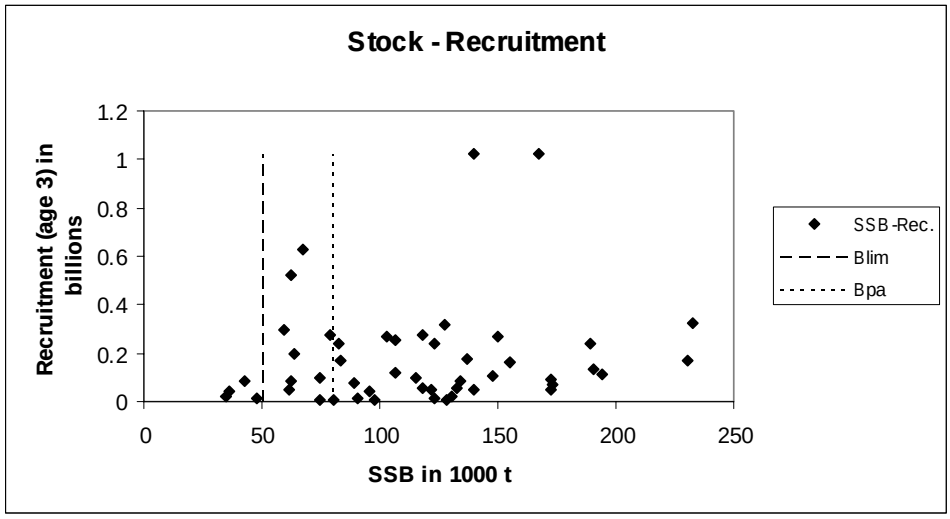


Figure 4.2 Northeast Arctic haddock

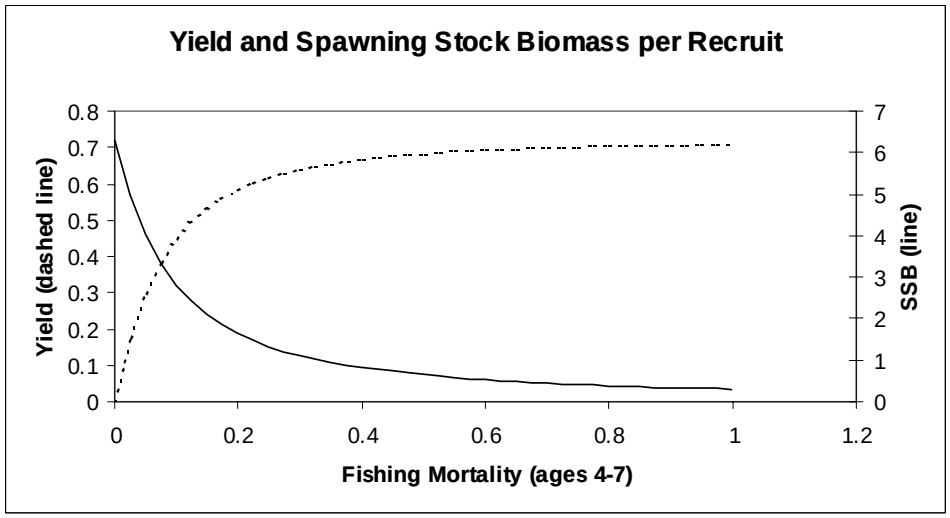


Figure 4.3 Northeast Arctic haddock

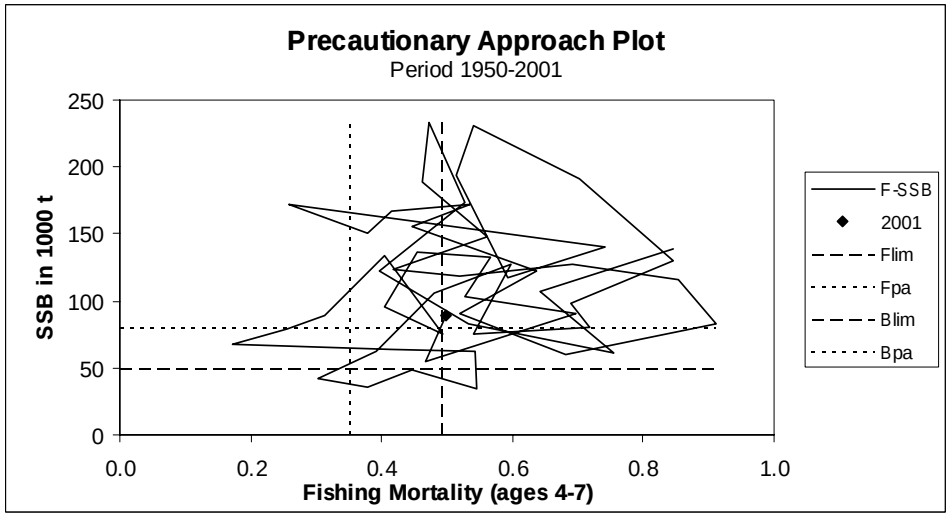
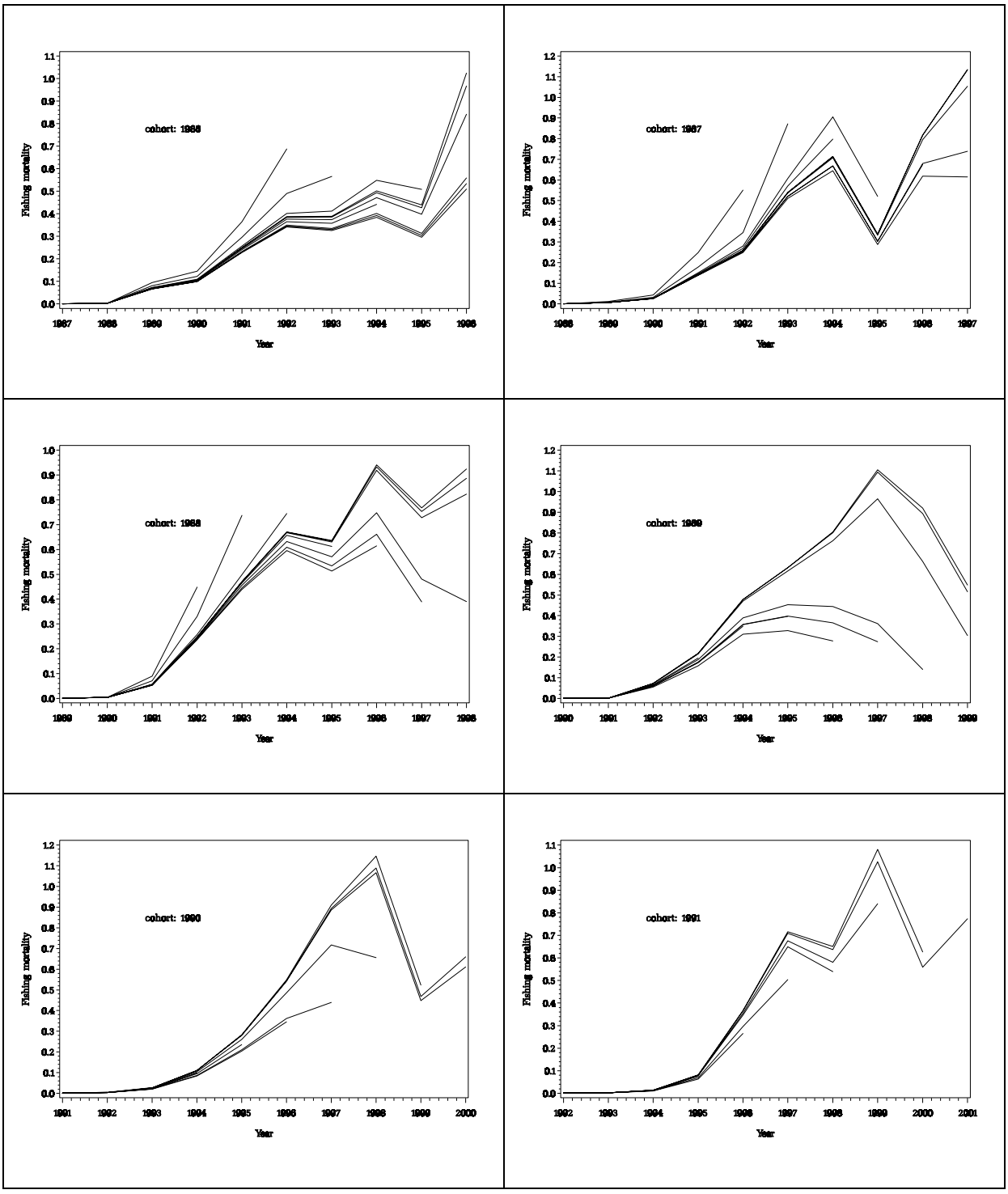


Figure 4.4 Northeast Arctic haddock


cohort: 1986
cohort: 1987
cohort: 1988
cohort: 1989
cohort: 1990
cohort: 1991
Fishing mortality
Year

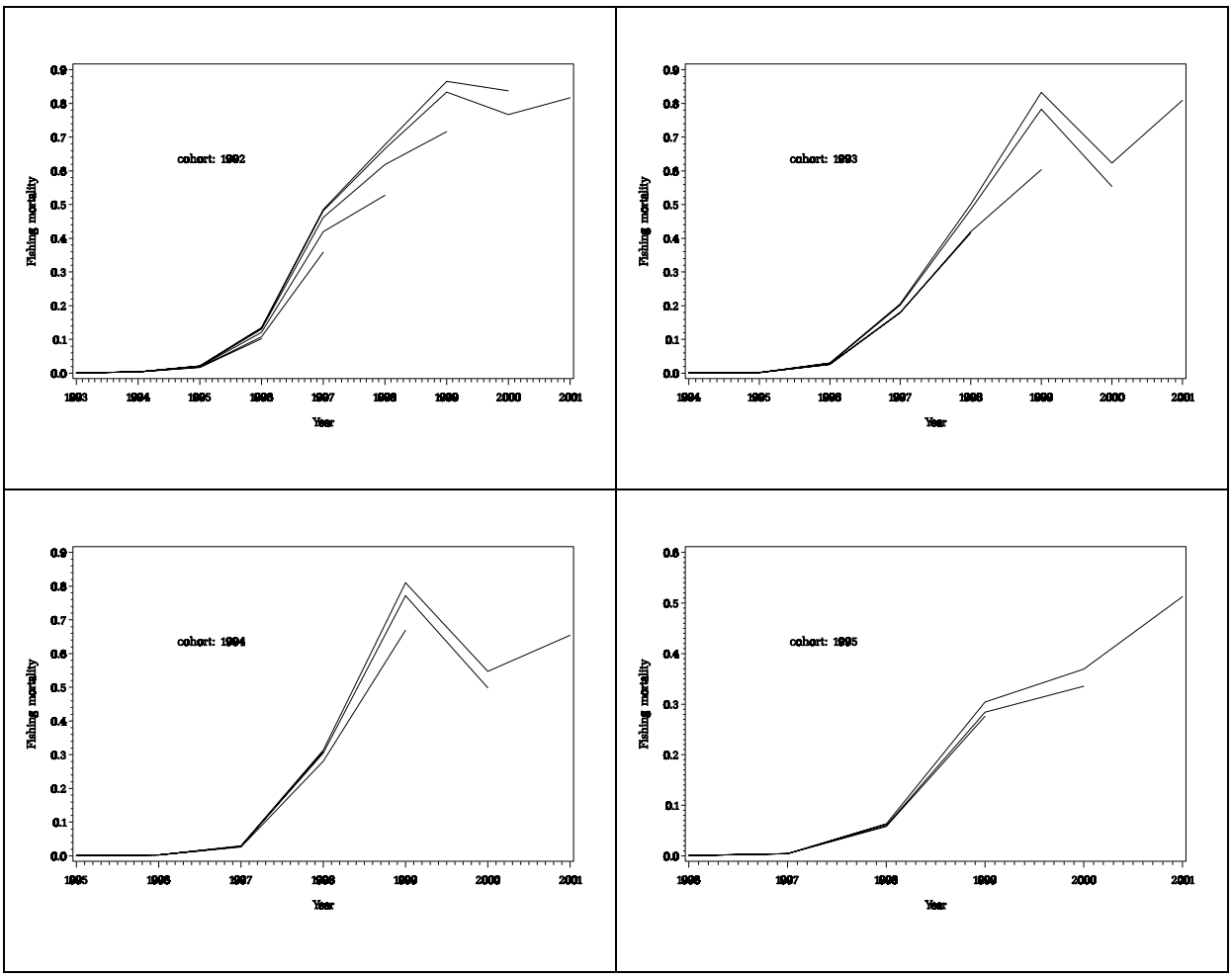


Figure 4.5 Retrospective pattern of estimated fishing mortlalities by cohort .

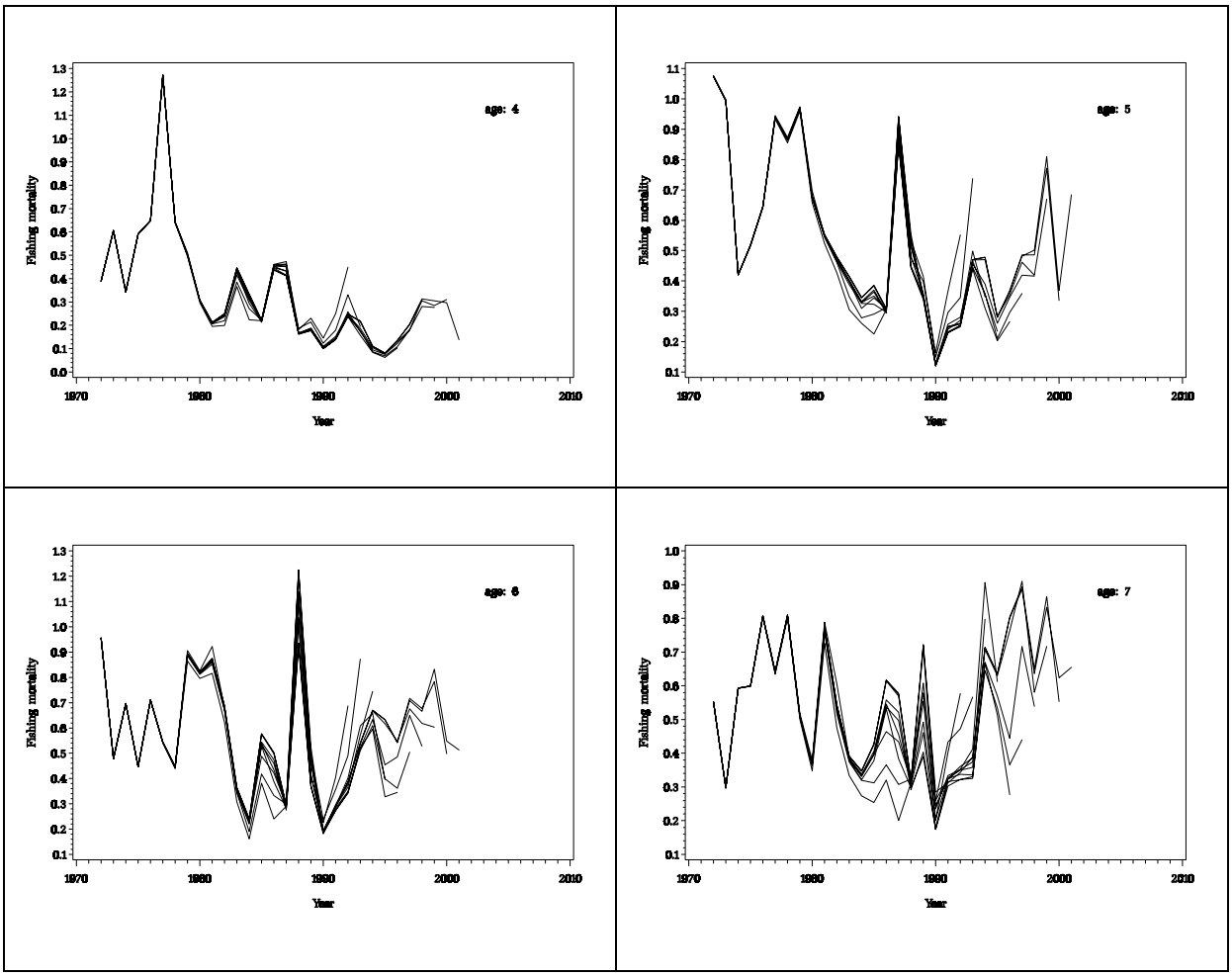


Figure 4.6 Retrospective pattern of fishing mortalities agegroups 4 to 7.

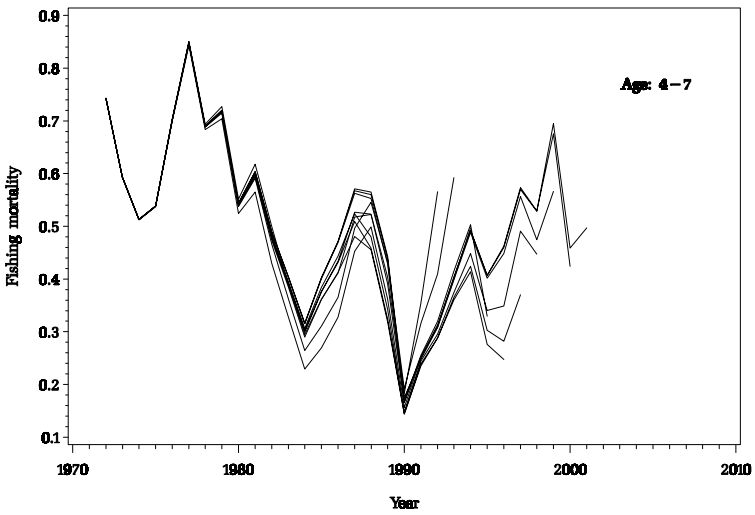


Figure 4.7 Retrospective pattern of fishing mortalities agegroups 4 to 7 combined**.**

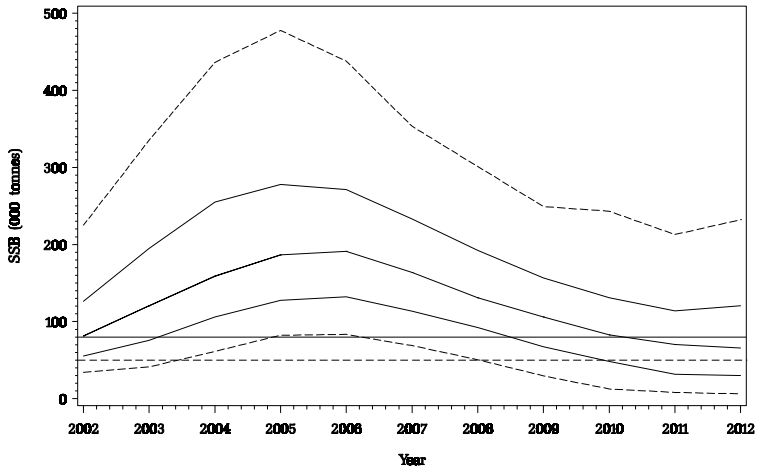


Figure 4.8 Medium term simulation of SSB with lines representing 5, 25, 50, 75 and 95 percentiles**.**

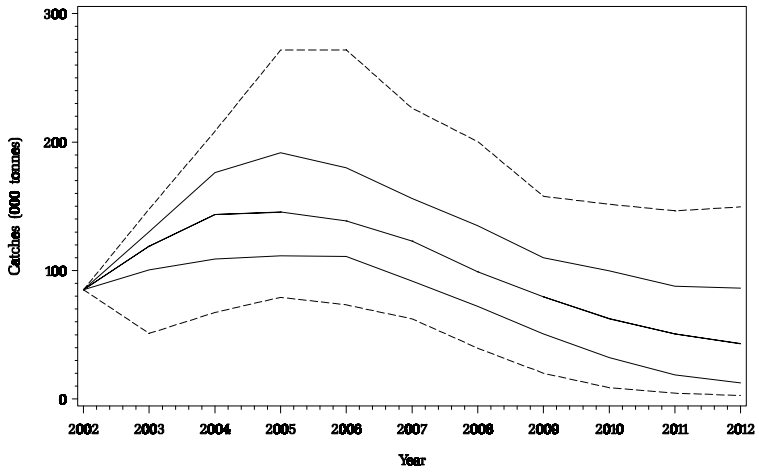


Figure 4.9 Medium term simulation of catches. Lines are representing 5, 25, 50, 75 and 95 percentiles**.**

Table B1 Northeast 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	-	-	2935.5
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	-	-	-	-	0.3	741.6
1988	35.4	15.3	25.3	68.9	116.4	13.8	0.1	-	-	-	275.0
1989	81.2	9.5	14.1	21.6	34.0	32.7	3.4	0.1	-	-	196.5
1990	644.1	54.6	4.5	3.4	5.0	9.2	11.8	1.8	0.0	0.0	734.5
1991	2006.0	300.3	33.4	5.1	4.2	2.7	1.7	4.2	0.0	-	2357.7
1992	1659.4	1375.5	150.5	24.4	2.1	0.6	0.7	1.6	2.3	0.0	3217.0
1993	727.9	599.0	507.7	105.6	10.5	0.6	0.4	0.3	0.4	1.1	1953.4
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	0.0	0.1	0.0	2244.6
1996	309.5	263.6	52.5	48.1	148.6	252.8	11.6	0.9	-	0.1	1087.6
1997[1]	1268.0	67.9	86.1	28.0	19.4	46.7	62.2	3.5	0.1	-	1581.8
1998[1]	212.9	137.9	22.7	33.2	13.2	3.4	8.0	8.1	0.7	0.1	440.0
1999	1244.9	57.6	59.8	12.2	10.2	2.8	1.0	1.7	1.1	0.0	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	1216.5	460.4	297.0	29.4	25.4	1.7	0.9	0.1	0.1	0.3	2031.8
2002	1704.3	530.7	298.5	183.9	16.5	9.6	0.8	0.3	-	0.3	2744.9

[1] Indices adjusted to account for limited area coverage.
Survey area extended from 1993 onwards.

Table B2 Northeast Arctic HADDOCK. Results from the Russian trawl survey in the Barents Sea and adjacent waters in late autumn (numbers per hour trawling).

	Age											
Year	0	1	2	3	4	5	6	7	8	9	Older	Total
						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
						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

Cont'd

Table B2 (continued)

Year	Age 0	1	2	3	4	5	6	7	8	9	Older	Total
						Division IIb						
1983	22.1	9.9	0.2	0.1	+	+					0.1	32.4
1984	2.2	14.3	1.8	-	-	-	-				+	18.3
1985	1.4	10.2	61.4	5.1	+	+	+	-			+	78.1
1986	+	0.2	3.1	7.2	1.4	-	-	+	+		-	12.0
1987	-	-	0.1	0.7	1.4	0.5	+	-	-	-		2.8
1988	0.2	-	-	+	0.3	1.1	0.2	-	+	-		1.8
1989	0.7	0.1	0.2	+	0.1	0.3	0.6	0.1	+	-		2.1
1990	12.9	5.4	0.8	+	+	0.2	0.1	0.1	+	-		19.5
1991	20.0	22.9	6.2	0.4	0.1	0.1	0.1	+	+	-		49.8
1992	13.3	9.1	69.8	13.9	0.5	+	+	-	+	+		106.6
1993	0.7	0.9	1.9	24.7	1.9	0.2	+	+	+	+		30.4
1994	0.4	1.7	1.7	2.3	15.7	2.7	0.8	0.2	+	+		25.5
1995	0.1	0.4	0.4	0.8	0.6	1.6	0.4	+	+	+		4.3
1996[1]	4.3	0.6	0.5	0.3	0.2	0.4	0.5	0.3	-	-		7.1
1997	0.4	1.1	0.1	0.1	0.1	0.1	0.1	0.1	+	+		2.1
1998	5.8	1.1	0.2	+		0.1	0.1	+		0.1	+	-		7.5
1999	8.6	20.1	1.8	1.2	0.5	0.3	0.1	-		0.2	0.1		7.5
2000	7.9	10.0	13.4	1.3	5.5	2.2	1.2	0.4	0.2	0.3		42.4
2001	2.7	13.1	15.9	11.4	0.8	4.7	1.2	0.4	0.1	0.6		51.0
						Total - Sub-area I and Divisions IIa and IIb						
1983	29.8	59.2	9.5	0.5	0.4	+					0.8	100.2
1984	6.4	58.6	58.4	1.5	0.2	0.1	+				0.3	125.5
1985	3.0	14.4	134.3	90.0	0.4	0.1	0.1	-			0.2	242.7
1986	0.2	1.4	10.7	36.3	16.4	0.1	+	+	+		+	65.1
1987	0.3	0.9	1.7	8.3	22.5	5.7	+	+	-	+		39.4
1988	1.3	0.3	0.7	1.7	4.0	7.6	0.8	+	+	+		16.4
1989	2.2	1.8	2.4	0.4	1.4	4.1	8.1	1.1	0.1	+		21.6
1990	44.8	14.3	10.6	7.3	4.2	7.3	7.4	5.7	0.3	0.1		102.0
1991	16.7	42.9	17.6	6.2	0.9	0.3	0.6	1.8	1.5	0.2		88.7
1992	16.4	28.2	128.6	34.6	5.0	0.4	0.6	0.9	0.8	0.1		215.6
1993	3.5	4.8	35.7	198.5	35.6	4.8	0.8	0.4	0.4	-		284.5
1994	9.1	4.9	5.8	44.2	101.4	11.6	1.5	0.1	0.1	0.5		179.2
1995	6.4	7.2	4.2	3.1	12.3	37.0	4.0	0.5	0.1	0.3		75.1
1996[1]	6.0	2.3	5.7	2.8	4.9	36.2	33.4	2.9	0.3	0.3		94.8
1997[1]	1.8	4.6	1.9	3.2	3.2	1.0	2.7	1.0	0.8	-		20.2
1998	10.7	2.9	11.5	3.8	4.6	0.8	0.5	1.5	0.5	+		36.8
1999	11.7	28.9	6.1	19.6	3.9	3.7	0.8	0.3	0.7	0.7		76.4
2000	15.1	20.7	26.2	6	10.9	2.6	1.1	0.2	0.1	0.4		83.3
2001	20.8	14.9	26.1	33.4	4.0	6.5	1.1	0.4	0.1	0.3		107.5

[1] Adjusted data based on average 1985-1995 distribution.

Table B3. Northeast 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			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	-	5	2	3	1	1	4	2	+	+	18
1984	1,685	173	6	2	1	+	+	+	+	+	1,867
1985	1,809	839	274	6	+	+	+	1	+	+	2,929
1986	680	312	488	162	+	+	+	+	+	+	1,642
1987	111	26	71	190	47	+	+	+	-	+	445
1988	20	5	8	20	38	6	+	+	-	+	97
1989	58	6	8	10	17	19	2	+	-	+	120
1990	493	44	4	3	4	7	11	1	+	+	567
1991	1,938	265	49	7	2	2	2	4	+	-	2,269
1992	859	685	110	19	2	+	+	1	2	+	1,678
1993	1,424	690	565	99	10	+	+	1	+	2	2,791
1994	848	228	240	506	77	8	+	+	+	+	1,907
1995	1,380	285	36	113	391	40	2	+	+	1	2,248
1996	249	229	44	31	76	150	8	1	-	+	788
1997[1]	798	32	66	22	15	48	47	3	+	+	1,031
1998[1]	256	156	29	41	15	6	13	18	1	+	535
1999	856	46	57	13	14	4	1	2	2	+	995
2000	1,024	509	32	65	19	10	2	1	2	+	1,664
2001	976	316	210	23	22	1	1	+	+	1	1,550
2002	2065	280	209	142	16	12	1	+	+	1	2,726

[1] Indices adjusted to account for limited area coverage.
Survey area extended from 1993 onwards.

Table B4a. Northeast 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.

	Age											
Year	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]	281	44	148	93	69	280	242	19	3	1	1	1,181
1997[1]	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

[1] October-December
[2] September-October
[3] November-January

Table B4b. Northeast 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.

	Age											
Year	0	1	2	3	4	5	6	7	8	9	10+	Total
1996[1]	992	245	291	91	63	206	187	17	1	+	+	2,092
1997[1]	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

[1] October-December
[2] November-January

Table B5 Northeast 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[1]	16.1	21.1	27.7	35.4	39.7	47.5	50.1			
	1998[1]	14.4	22.9	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	14.6	22.5	32.2	37.8	47.2	51.3	58.6			
	2002	15.5	21.5	30.0	40.0	45.8	48.5	58.1			
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

[1] Lengths adjusted to account for limited area coverage.
[2] Limited area coverage.

Table B6 Northeast 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	-	-	-	-	-	-	-				
	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[1]	35	88	200	429	625	1,063	1,286				
	1998[1]	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	557	1,100	1,439	2,073				
	2002	31	85	250	611	923	1,192	2,078				
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	-

[1] Lengths adjusted to account for limited area coverage.
[2] Limited area coverage.

Table B6, continued

Northeast Arctic HADDOCK. Weight data (g) from combining Norwegian surveys in January-March in the Barents Sea and in March in Lofoten.

Year	Age									
	3	4	5	6	7	8	9	10	11	12
1989	0.300	0.480	0.740	1.020	1.400	2.340				4.420
1990	0.410	0.830	0.990	1.290	1.550	1.830	2.270			
1991	0.480	0.870	1.300	1.350	1.810	1.820	2.300			
1992	0.400	0.970	1.380	2.140	2.040	2.140	2.290	3.080	2.260	2.600
1993	0.320	0.770	1.440	1.890	2.460	2.510	2.820	2.910	3.290	
1994	0.270	0.550	1.050	1.690	2.090	2.300	2.770	2.830	2.580	3.890
1995	0.230	0.390	0.770	1.300	1.760	1.590	2.370	2.390	2.550	3.000
1996	0.240	0.520	0.730	0.990	1.730	1.950	2.020	1.880	2.730	3.780
1997	0.210	0.530	0.820	1.060	1.360	1.790	2.810	2.800	2.610	3.590
1998	0.250	0.530	0.880	1.230	1.420	1.660	2.080	2.120	2.130	3.140
1999	0.380	0.680	1.020	1.680	1.900	1.660	2.160	2.310	2.780	2.980
2000	0.280	0.760	1.040	1.400	1.450	1.960	2.160	2.500	2.540	4.440
2001	0.340	0.560	1.120	1.460	2.090	1.990	2.460	3.110	2.790	3.410
2002	0.270	0.630	0.960	1.210	1.950	2.140	2.350	2.930	2.830	3.790

5 NORTHEAST ARCTIC SAITHE (SUB-AREAS I AND II)

5.1 Status of the Fishery

5.1.1 Historical development of the fisheries (Tables 5.1-5.2)

Since the early 1960s the fishery has been dominated by purse seine and trawl fisheries accounting for 61% in 2001 (Table 5.2). A traditional gill net fishery for spawning saithe accounts for about 21%. The remaining catches are taken by Danish seine and handline in addition to minor by-catches in the longline fishery for other species. Some changes in recent regulations have led to less amounts taken by purse seine. Catches declined sharply after 1976 (Table 5.1). 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 92% of the landings.

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.

5.1.2 Landings prior to 2002 (Table 5.1, Figure 5.1A)

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 67,000-122,000 t (Table 5.1). An increasing trend was seen after 1990 to 171,498 t in 1996. Since then the annual landings have been 134,000-154,000 t.

The TAC for 2001 was set at 135,000 t. Provisional figures show that the landings in 2001 were approximately 135,000 t, which is also at the level expected by the WG last year.

Results from Norwegian investigations on coastal gillnet fisheries (WD 14 – Hareide and Garnes 2002) report that landing figures for saithe for the coastal gillnetters should be increased by 20% for 1999 and 2000, for the area north of 62°N, Table 5.1 and the catch figures included in the assessment have not been corrected for this. Similar information from other gears and fleets was not available to the Working Group.

5.1.3 Expected landings in 2002

ACFM advised last year that the fishing mortality should be reduced to below $\mathbf{F}_{pa}$, corresponding to a catch in 2002 of less than 152,000 t. Norwegian authorities followed this advice and set the TAC for 2002 to 152,000 t. Official landings in 2002 are expected to be around the TAC of 152,000 t, but there are several unofficial reports of increasing problems with bycatch 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 1999 the 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 (Table C1), 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 are 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 have been raised to the total purse seine catch (Table C1), and the new effort series shows a smaller decrease in later years than the old one. Exploratory XSA runs showed higher scaled weights for the CPUE-series based on the new effort data (Mehl, WD 20 2000), and at the 2000 WG meeting it was decided to use the new data in the assessment.

In 2000 new estimates of CPUE indices by age based on the logbook database having daily resolution were presented (Mehl, WD 20 2000). These estimates have been further refined and are presented in Table C2. 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. The CPUE indices are splitted on age groups by quarterly weight, length, and age data from the trawl fishery. A yearly index is than calculated by first averaging all CPUE observations for each month, and then averaging over the year. The trawl CPUE indices by age introduced in 2001, were used in XSA runs at the present WG meeting.

5.2.2 Survey results (Tables C3-C4)

Since 1985 a Norwegian acoustic survey specially designed for saithe has been conducted annually in October-November. 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 year old fish (Table C3). 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 (Korsbrekke and 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 (Mehl, WD 20 2000). At the previous WG meeting it was therefore decided to apply the extended series in the assessment. The results from the survey in autumn 2001 showed a stock in sound condition with some year class differences, e.g., less 4- and 6+ year-old fish than the recent average (WD 29-Korsbrekke and Mehl 2002). It is not known how well the survey covers and estimates 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-October (Berg and Albert, WD 33 2000), at about the same time as 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 may provide supplementary information, especially about 2- and 3-year-old saithe that have not yet migrated out to the banks. Results from the coastal cod survey from the areas not overlapping with the saithe survey are shown in Table C4. At the WG meeting in 2000 analyses were done 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 to continue only applying indices from the regular saithe survey in the assessment since this series is longer.

5.3 Data used in the Assessment

5.3.1 Catch numbers-at-age (Table 5.3)

The age composition of Norwegian landings in 2000 was revised, resulting in only minor changes. Age composition data for 2001 was available from Norway, Russia (Sub-area I), and Germany, accounting for 96% of the landings. A Russian length composition was also available for Division IIA and Division IIB, and was applied to 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 2-4, while a decrease is observed for the older age groups compared with recent 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)

Traditionally, knife-edge maturity-at-age 6 has been used for this stock. In 1995, data on spawning zones recorded in otoliths in Norway were investigated. There was no evidence of change in maturation rates over the period in the assessment 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.

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 tuning series, and a CPUE series from the trawl fisheries (see chapter 5.2.1). The time span in the Norwegian acoustic survey series was set to 1992 – 2001 according to an enlargement in area coverage from 1992 and onwards. The CPUE series from the Norwegian trawl fishery, used in WG 2001, was updated 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 aiming at establishing a 0-group index series has just started (2000) (WD 21 – Borge and Mehl 2002). It varies from year to year to what extent the 2-year-old saithe (and in some years even 3-year-olds) have migrated out from the near coast areas and are available for 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 2002 was taken from the XSA for age 5 and older. The recruitment at ages 2 and 3 in 2001 (1998 and 1999 year classes) was estimated using RCT3 (Section 5.5.2). The corresponding numbers-at-age 3 and 4 in 2002 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 (1960-1997) of 212 million was used for the 2000 and subsequent year classes. The natural mortality and the maturity ogive are the same as used in the assessment. For the exploitation pattern the average of 1999-2001 has been used, scaled to the 2001 level. 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, 5.6)

Extended Survivors Analysis (XSA) was used for the assessment with the same settings as last year in the analyses. Catchability was assumed to be independent of stock size for all ages. The same three fleets as used for last year's assessment were also used this year. It was, however, decided to reduce the time-series in the Norwegian acoustic survey series to 1992-2001 due to a more uniform area coverage since then. The log-q residuals for the acoustic survey show some trends and high values for the 2- and 3-year-olds, especially in the two last years (Figure 5.3). This is caused by variable recruitment of these age groups to the survey area, but since the 2- and 3-year-olds are estimated separately by RCT3, the Working Group considered the acoustic survey series to give a reliable contribution to the assessment. Generally the trawl CPUE series shows clear trends probably not reflecting the stock development, i.e., from positive to negative to positive residuals in the two recent years. However, excluding this series from the tuning did not improve the diagnostics, although such commercial CPUE series are difficult to use due to regulations of the fishery and schooling behaviour of the saithe. Until ongoing improvement of this trawl CPUE series has been finished and its usefulness analysed, the Working Group decided to use it in the same manner as at last year's assessment. The commercial purse seine CPUE series was updated but otherwise unchanged. Figures 5.2A-C show plots of the tuning indices versus stock numbers from the XSA, and Figure 5.6 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, Figures 5.3 B-C)

Estimates of the recruiting year classes up to the 1997 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). Also, the quality control sheets show that estimates of recruitment at age 2 in the last VPA year have been unreliable, and this is also shown by the retrospective analysis (Figures 5.5). Estimates of recruitment at age 3 have been somewhat more precise. However, in the later years catches of 3-year-olds have also been reduced due to

fishermen targeting the bigger and more valuable fish which are now available in the stock, and due to the new minimum landing size introduced in 1999. RCT3-runs were therefore conducted to estimate both the 1998 and 1999 year classes, with 2- and 3-year-olds from the survey as input for the estimation. The RCT3 analysis shows little dynamics in the estimates of these age groups.

5.5 Results of the Assessment

5.5.1 Fishing mortalities and VPA (Tables 5.7-5.11, Figures 5.1A-B, 5.5)

The fishing mortality (F_{3-6}) in 2000 was 0.21, which is well below the value of 0.26 from last year's assessment (Figure 5.5). Using the RCT3 estimation of the 1998 year class gives a fishing mortality (F_{3-6}) in 2001 of 0.22, i.e lower than the current $\mathbf{F}_{pa}$. Fishing mortalities and stock size tend to be over- and underestimated, respectively, in the assessment year, and this is illustrated by the retrospective plots in Figure 5.5.

The XSA-estimates of the 1998-1999 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 which all years have been well represented in the catches, also come out as strong and above average year classes, respectively, in the current assessment. The 1997 year class has shown up much weaker than the 1996 year class in the catches and in the assessment, and this is in accordance with the survey results.

The stock and spawning stock biomass (SSB) tables are included (Tables 5.9-5.11). The total biomass (ages 2+) has been at a stable and high level above the long-term (1960-2001) mean since 1993, and, likewise, the SSB since 1996.

5.5.2 Recruitment (Tables 5.12-5.13)

The RCT3 estimates (with 2-year-olds as input, Table 5.12) of the 1999 year class is 240 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 1998 year class gives 260 million individuals. Thus, the 1998-year class is estimated to be of similar strength as the 1996-year class at age 2, while the 1999 year class is estimated to be somewhat weaker but above the long-term mean. This is in accordance with the survey results (Table C3). It was decided to use the RCT3 estimates for ages 2 and 3 in 2001, and the long-term geometric mean of 212 million individuals for the 2000 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 1998A).

5.6.2 Fishing mortality reference points (Tables 5.14, 5.15, Figures 5.1C, 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 0.26, respectively, which is slightly above the values of 0.11 and 0.23 obtained last year. The plot of SSB versus recruitment is shown in Figure 5.4. $\mathbf{F}_{low}$, $\mathbf{F}_{med}$, and $\mathbf{F}_{high}$ were recalculated. The values obtained in 1999 were 0.18, 0.34, and 0.70, respectively, while the new values calculated this year 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 1998b). Since then the fishing pattern has changed due to the introduction of new minimum catch sizes 1 March 1999 (see chapter 5.1.1). A revision of the present fishing mortality reference points will therefore be conducted as soon as the new regulations have manifested themselves in a stable improvement of the actual fishing pattern.

5.7 Catch Options for 2003 (Short-Term Predictions) (Table 5.16)

The management option table (Table 5.16) shows that the expected catch of 152,000 t in 2002 will keep the fishing mortality below $\mathbf{F}_{pa}$. A catch in 2003 corresponding to F_{01} *(status quo)* level of 0.22 will give 144,000 t, while a catch corresponding to $\mathbf{F}_{pa}$, which is also close to $\mathbf{F}_{max}$, in 2003, will give 168,000 t. It may also be kept in mind when deciding upon the catch level for 2003 that the fishing mortality in the assessment year still tends to be overestimated

for this stock. The SSB is expected to increase in 2002 from 360,000 t to 370,000 t in the beginning of 2003, which is close to the prediction given by last year's Working Group.

5.8 Medium-term forecasts and management scenarios (Table 5.17a,b, Figures 5.1D, 5.7A,B)

The input data were the same as used for the short-term predictions (Table 5.14). Single option predictions (detailed tables in Table 5.17b) for $F_{status\ quo}$ (= F_{2001}) and $\mathbf{F}_{pa}$ are given in Table 5.17a,b for the period 2001-2007. At $F_{status\ quo}$ the catch will increase to 155,000 t in 2006-2007. The SSB will at the same fishing mortality increase to about 427,000 t in the years 2007. At $\mathbf{F}_{pa}$ the catch will increase to 168,000 t in 2003, and stay above 160,000 t during the forecast period. The SSB will at the same fishing mortality and during the same period stay at a stable level of about 360,000-370,000 t. Results from a projection with RISK is shown for $\mathbf{F}_{pa}$ for SSB and catch up to 2006 (Figure 5.7 a,b).

A risk analyses was performed where only uncertainty in the initial stock estimate and the recruitment was taken into account. The program @RISK was performed, using 1000 iterations and fixed seed for the random number generator. Two probability distribution functions were used to add uncertainty and sample sets of possible values during the simulations. For the initial stock size a lognormal distribution was applied, LOGNORM(mean, standard deviation), with the initial stock numbers by age from the RCT3 and XSA as mean and standard deviation calculated by multiplying the mean by the external standard error from the XSA diagnostics. A truncated lognormal distribution, TLOGNORM(mean, standard deviation, minimum, maximum), was used for the recruitment at age 2. The mean, standard deviation, minimum, and maximum were found from the XSA for the years 1962-1997, and the corresponding values were 212, 104, 79, and 481 million, respectively.

5.9 Comparison of this years assessment with last years assessment

Compared to last year's assessment the only input change in addition to regular updating has been the shortening of the acoustic survey tuning series which in the current assessment goes back to 1992, while in last year's assessment it went back to 1988. Updating of the trawl CPUE led to a great increase in the CPUE for 2000 compared to the preliminary available value last year.

The current assessment has also this year revised the most recent previous year's fishing mortalities downwards and the stock level upwards.

	Total stock (2+) by 1 January 2001	SSB by 1 January 2001	F3-6 in 2001	F3-6 in 2000
WG 2001	752693	287730	0.26 (prediction)	0.26
WG 2002	798380	388289	0.22	0.21

5.10 Comments on the assessment and the forecast

The suitability of the trawl CPUE series to show stock trends should be further explored. Trial XSA-runs using only the fishery independent acoustic survey series gave positive log q residuals. Only relying on the acoustic series therefore tended to overestimate the stock. In general, the Working Group tended to put more reliance in the survey, especially for ages 4 and 5, compared with commercial CPUEs. The applicability of only using the survey should therefore be further investigated.

In order to enhance the reliability of the assessment, as wide an area of saithe distribution as possible should be covered by the acoustic surveys. This includes the Russian EEZ where much saithe were distributed in 2001 (WD 26 – Drevetnyak 2002). Standardization of trawling performance, acoustic method, scrutinizing, and estimation methods needs to be conducted before different surveys can be combined.

The exploitation patterns are now better than in the past and 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.

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[1]	519[2]	315[2]	701[2]	2,680[6]	124,510	-	75	4,951	89[2]	202		58[2]	134,100

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 [1]	28.1	54.9	28.1	23.0	134.1

[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 : Arctic Saithe (run: XSAAAF22/X22) At 22/04/2002 10:28

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

	YEAR	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
	AGE												
	2	7381	4936	1246	2815	20308	30430	7450	6952	5297	4090	25952	19842
	3	10509	17824	37266	42050	9001	37115	22392	29664	25196	77333	43540	77019
	4	13083	9131	11131	28925	59601	5001	54537	24836	18384	11949	62846	59280
	5	13545	12506	4421	5888	13154	26300	13124	35956	5101	16939	13987	26961
	6	5064	3799	8290	4650	2718	10142	12899	4125	8282	4747	16189	9556
	7	4883	1332	2427	3861	3472	2861	4652	5616	787	4798	5122	9592
	8	2401	968	1024	1099	2655	2110	1374	2916	1913	1126	7950	2901
	9	1315	520	938	1075	1251	2733	933	1413	900	1711	2504	4352
	10	743	405	451	697	1221	699	965	1397	577	675	3697	2195
	+gp	1525	1229	1728	1777	3559	3593	2900	3493	1166	511	2799	5490
0	TOTALNUM	60449	52650	68922	92837	116940	120984	121226	116368	67603	123879	184586	217188
	TONSLAND	133515	105951	120707	148627	197426	185600	203788	181326	110247	140060	264924	241272
	SOPCOF %	126	138	123	121	116	108	111	95	117	97	97	78

Run title : Arctic Saithe (run: XSAAAF22/X22)
At 22/04/2002 10:28

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

	YEAR	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
	AGE										
	2	11608	13829	21159	81601	54151	31662	45758	28334	18226	10467
	3	65178	76296	36782	60832	125030	99049	48969	61963	40796	83954
	4	52389	25206	44027	11691	30576	34317	27685	23328	36644	21822
	5	29146	26911	15671	16366	7947	10140	12476	14122	9211	21528
	6	10186	16031	20419	4436	8712	2062	4534	4400	6379	3619
	7	5616	7114	12148	7808	3435	4332	1468	2901	3200	2550
	8	3547	3935	4802	6789	3212	1456	1848	963	1338	2008
	9	1865	2871	3258	2914	2679	1606	938	1356	147	369
	10	2140	2610	2505	2350	1724	963	976	438	730	279
	+gp	3149	3924	3821	4140	2880	1134	2150	1192	1629	629
0	TOTALNUM	184824	178727	164592	198927	240346	186721	146802	138997	118300	147225
	TONSLAND	214334	213859	274121	233453	242486	182817	154464	164180	144554	175516
	SOPCOF %	84	81	101	102	100	101	103	114	94	100

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

	YEAR	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
	AGE										
	2	17225	11638	14624	2216	3311	3867	5017	11157	11543	6135
	3	34733	17244	41466	48917	22115	17869	8126	12378	21002	73878
	4	65052	23768	33233	11974	12895	49829	35847	19915	13463	11619
	5	13060	32700	12064	7189	6062	4339	32827	32643	8996	5395
	6	8212	3226	11204	5279	4525	3118	4560	18751	9152	5066
	7	1054	3008	1135	3740	2805	3490	2328	1939	7735	2988
	8	1251	1177	1772	775	1399	755	1219	377	1126	2009
	9	461	760	560	878	351	620	966	191	154	272
	10	263	247	557	134	454	257	320	179	121	81
	+gp	448	760	897	701	285	797	102	149	253	132
0	TOTALNUM	141759	94528	117512	81803	54202	84941	91312	97679	73545	107575
	TONSLAND	168034	156936	158786	107183	70458	92391	114242	122310	95848	107326
	SOPCOF %	98	101	100	99	99	102	99	99	100	99

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

	YEAR	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
	AGE										
	2	14333	3379	1432	70	961	326	35	91	1192	202
	3	49750	26933	9369	16402	10225	14827	3100	9644	9397	3952
	4	26640	63451	38499	48351	57448	13295	16261	12220	22921	8352
	5	4865	26254	48587	37268	18667	43309	11981	22804	7865	26697
	6	5594	3427	17617	32240	17805	13029	31918	10321	11282	8189
	7	4850	1636	1772	4842	17861	11219	8405	18932	5806	6502
	8	3353	1263	517	572	2765	5837	5556	3384	8177	3131
	9	1480	950	305	139	485	755	2881	3335	2330	4945
	10	291	650	275	280	202	63	731	2293	2526	1810
	+gp	267	106	697	305	443	160	397	589	1210	2129
0	TOTALNUM	111423	128049	119070	140469	126862	102820	81265	83613	72706	65909
	TONSLAND	127516	153584	146544	168174	171498	143760	153822	150274	135170	134100
	SOPCOF %	100	100	100	100	100	100	100	100	100	100

Table 5.4 Catch weights-at-age

Run title : Arctic Saithe (run: XSAAAF22/X22)

At 22/04/2002 10:28

Table 2 Catch weights-at-age (kg)

	YEAR	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
	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
	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
	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
	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
	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
	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
	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
	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
	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
	+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
0	SOPCOFAC	1.2559	1.3848	1.2272	1.2075	1.1644	1.0782	1.1067	0.9475	1.1662	0.9734	0.9741	0.7841

Table 2 Catch weights-at-age (kg)

	YEAR	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
	AGE										
	2	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.45	0.43
	3	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.79	0.73
	4	1.11	1.11	1.11	1.11	1.11	1.11	1.11	1.11	1.27	1.4
	5	1.63	1.63	1.63	1.63	1.63	1.63	1.63	1.63	2.03	2.05
	6	2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.55	2.76
	7	3.16	3.16	3.16	3.16	3.16	3.16	3.16	3.16	3.29	3.3
	8	4.03	4.03	4.03	4.03	4.03	4.03	4.03	4.03	4.34	4.38
	9	4.87	4.87	4.87	4.87	4.87	4.87	4.87	4.87	5.15	5.95
	10	5.63	5.63	5.63	5.63	5.63	5.63	5.63	5.63	5.75	6.39
	+gp	7.477	7.385	7.217	7.127	7.32	7.394	7.527	7.809	6.937	6.841
0	SOPCOFAC	0.8362	0.8099	1.0131	1.0155	1.002	1.0062	1.0278	1.1384	0.9355	0.9975

Table 2 Catch weights-at-age (kg)

	YEAR	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
	AGE										
	2	0.51	0.6	0.53	0.38	0.32	0.34	0.33	0.45	0.54	0.4
	3	0.77	1.05	0.71	0.75	0.59	0.53	0.62	0.74	0.76	0.72
	4	1.12	1.33	1.26	1.33	1.22	0.84	0.87	0.97	1.08	1.19
	5	2.02	1.86	2.02	2.07	1.97	1.66	1.31	1.39	1.56	1.78
	6	2.61	2.8	2.7	2.63	2.3	2.32	2.43	1.81	2.12	2.24
	7	3.27	4	3.88	3.28	2.87	2.97	3.87	3.02	2.4	2.86
	8	3.91	4.18	4.47	3.96	3.72	4	5.38	3.76	3.65	3.32
	9	4.69	5.33	5.36	4.54	4.3	4.72	5.83	4.64	3.6	4.53
	10	5.63	5.68	6.06	5.55	4.69	5.44	5.36	4.75	6.37	5.7
	+gp	7.558	8.665	7.19	8.012	6.597	6.904	7.448	7.5	4.795	7.125
0	SOPCOFAC	0.9794	1.0089	0.9997	0.9933	0.9929	1.0233	0.9879	0.9949	1.0049	0.9912

Table 2 Catch weights-at-age (kg)

	YEAR	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
	AGE										
	2	0.45	0.46	0.35	0.5	0.4	0.38	0.35	0.64	0.37	0.44
	3	0.7	0.63	0.52	0.56	0.59	0.62	0.68	0.67	0.61	0.75
	4	1.1	1.02	0.74	0.78	0.82	0.92	1	1.05	1.02	1.12
	5	1.98	1.7	1.22	1.21	1.32	1.19	1.48	1.45	1.61	1.54
	6	2.34	2.5	2.16	1.74	1.83	1.66	1.87	1.93	2.12	2.05
	7	2.81	2.88	3.19	2.8	2.47	2.31	2.58	2.28	2.66	2.61
	8	3.25	3.09	3.97	3.74	3.72	3.1	3.07	2.97	3.21	3.13
	9	4.06	3.7	4.62	4.4	4.49	4.34	4.12	3.6	3.74	3.59
	10	6.19	6.19	5.28	5.28	5.3	6.04	5.45	4.11	4.35	4.52
	+gp	7.376	8.175	6.072	7.451	7.016	7.62	8.052	5.513	5.975	5.179
0	SOPCOFAC	0.9993	1.0008	1.0038	0.9999	0.9999	1.0011	1.0015	1.0003	1.0031	1.0005

Table 5.5 Tuning data

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Northeast Arctic saithe (Sub-areas I and II) (run name: XSAAAF22)
103
FLT08: Norway Purse Seine reviced 2000 (Catch: Unknown) (Effort: Unknown)
1989 2001
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     2422     4328    11508      653      274

FLT12: Nor trawl updated 2002 (Catch: Unknown) (Effort: Unknown)
1994 2001
1 1 0.00 1.00
5 9
   1      377      313       52       25        5
   1      230      557       75       10        0
   1      141      487      196       12        1
   1      309      253      300      124        6
   1       48      250       89       63       38
   1      176       87      184       43       20
   1      161      282      119      194       71
   1      452      268      270      159      100

FLT13: Norway Ac Survey extended 2000 (Catch: Unknown) (Effort: Unknown)
1992 2001
1 1 0.75 0.85
2 6
   1   163.5   273.6    57.5     6.2     8.8
   1   106.9   227.7   103.9    12.7     3.2
   1    34.4    87.8   112.4    39.5    10.0
   1    38.7   165.2    87.0    46.8    20.0
   1    37.0   118.9   214.7    32.1    19.3
   1     5.1    36.7   185.8    79.8    61.7
   1    43.6    96.5   200.6    70.0    96.7
   1    61.1   233.8    72.9    62.2    47.8
   1   164.8   142.5   176.3    11.6    26.5
   1   104.7   275.9    45.9    53.8    20.1
```

Table 5.6 Tuning diagnostics

Lowestoft VPA Version 3,1

22/04/2002 10:28

Extended Survivors Analysis

Arctic Saithe (run: XSAAAF22/X22)

CPUE data from file fleet

Catch data for 42 years, 1960 to 2001, Ages 2 to 11,

Fleet	First year	Last year	First age	Last age	Alpha	Beta
FLT08: Norway Purse	1989	2001	3	7	0	1
FLT12: Nor new trawl	1994	2001	5	9	0	1
FLT13: Norway Ac Sur	1992	2001	2	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 34 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	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
2	0.047	0.015	0.004	0.001	0.006	0.003	0	0.001	0.013	0.004
3	0.153	0.116	0.054	0.052	0.1	0.11	0.041	0.05	0.141	0.055
4	0.28	0.297	0.242	0.426	0.261	0.182	0.169	0.228	0.16	0.18
5	0.412	0.493	0.39	0.391	0.288	0.32	0.249	0.379	0.225	0.283
6	0.854	0.576	0.74	0.489	0.327	0.335	0.415	0.353	0.327	0.386
7	0.879	0.658	0.678	0.459	0.556	0.354	0.377	0.467	0.344	0.317
8	0.928	0.594	0.445	0.482	0.52	0.352	0.297	0.255	0.377	0.315
9	0.612	0.754	0.273	0.203	1.025	0.258	0.293	0.292	0.28	0.412
10	0.757	0.604	0.508	0.434	0.512	0.334	0.429	0.403	0.377	0.366

Table 5.6 Tuning diagnostics (Cont'd)

XSA population numbers (Thousands)

YEAR \ AGE	2	3	4	5	6	7	8	9	10
1992	3.48E+05	3.89E+05	1.20E+05	1.59E+04	1.08E+04	9.17E+03	6.13E+03	3.57E+03	6.06E+02
1993	2.46E+05	2.72E+05	2.73E+05	7.45E+04	8.65E+03	3.75E+03	3.12E+03	1.98E+03	1.59E+03
1994	4.37E+05	1.99E+05	1.98E+05	1.66E+05	3.72E+04	3.98E+03	1.59E+03	1.41E+03	7.63E+02
1995	1.45E+05	3.56E+05	1.54E+05	1.27E+05	9.22E+04	1.45E+04	1.65E+03	8.34E+02	8.79E+02
1996	1.93E+05	1.19E+05	2.77E+05	8.24E+04	7.05E+04	4.63E+04	7.53E+03	8.36E+02	5.57E+02
1997	1.03E+05	1.57E+05	8.81E+04	1.75E+05	5.06E+04	4.16E+04	2.17E+04	3.66E+03	2.45E+02
1998	2.69E+05	8.43E+04	1.16E+05	6.01E+04	1.04E+05	2.96E+04	2.39E+04	1.25E+04	2.32E+03
1999	9.65E+04	2.20E+05	6.62E+04	7.99E+04	3.84E+04	5.61E+04	1.66E+04	1.45E+04	7.64E+03
2000	1.02E+05	7.89E+04	1.72E+05	4.32E+04	4.47E+04	2.21E+04	2.88E+04	1.06E+04	8.89E+03
2001	6.21E+04	8.22E+04	5.61E+04	1.20E+05	2.82E+04	2.64E+04	1.28E+04	1.62E+04	6.53E+03

Estimated population abundance at 1st Jan 2002

0.00E+00	5.06E+04	6.37E+04	3.84E+04	7.38E+04	1.57E+04	1.58E+04	7.66E+03	8.77E+03

Taper weighted geometric mean of the VPA populations:

1.68E+05	1.47E+05	1.07E+05	6.54E+04	3.30E+04	1.57E+04	6.60E+03	2.91E+03	1.21E+03

Standard error of the weighted Log(VPA populations) :

1									
	0.6578	0.616	0.6817	0.7724	0.8096	0.9494	1.1106	1.2409	1.2695

Log catchability residuals,

Fleet : FLT08: Norway Purse

Age	1989	1990	1991
2	No data for this fleet at this age		
3	0.47	1.59	1.52
4	0.38	0.64	-0.3
5	1.62	0.98	-0.86
6	0.84	1.65	-1.09
7	-1.41	1.6	-0.64
8	No data for this fleet at this age		
9	No data for this fleet at this age		

Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
2	No data for this fleet at this age									
3	0.58	-0.17	-0.22	-0.53	-0.17	0.31	-1.02	-0.83	0.51	-0.58
4	-0.61	0.33	0.12	0.68	0.57	-0.13	-0.38	-0.3	-0.42	-0.24
5	-2.19	-0.8	0.19	0.15	0.41	0.67	0.12	0.55	-0.93	0.44
6	-1.63	-1.46	0.44	-0.01	0.4	0.28	0.97	0.4	-0.32	-0.28
7	-1.07	-0.56	0.65	-0.17	-0.01	0.71	0.63	0.82	-0.54	-0.56
8	No data for this fleet at this age									
9	No data for this fleet at this age									

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

Age	3	4	5	6	7
Mean Log q	-7.4706	-6.7882	-7.1976	-7.8536	-8.4093
S,E(Log q)	0.7816	0.4433	0.9185	0.9001	0.7989

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	1.11	-0.235	6.99	0.35	13	0.91	-7.47
4	0.85	0.885	7.53	0.78	13	0.38	-6.79
5	0.57	2.353	8.9	0.77	13	0.43	-7.2
6	0.55	2.888	9.05	0.82	13	0.38	-7.85
7	0.75	1.282	8.75	0.74	13	0.58	-8.41
1							

Fleet : FLT12: Nor new trawl

Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
2	No data for this fleet at this age									
3	No data for this fleet at this age									
4	No data for this fleet at this age									
5	99.99	99.99	0.13	-0.09	-0.19	-0.14	-0.97	0.1	0.56	0.6
6	99.99	99.99	0.62	0.18	0.24	-0.07	-0.77	-0.86	0.15	0.59
7	99.99	99.99	0.94	-0.08	-0.24	0.21	-0.66	-0.53	-0.09	0.54
8	99.99	99.99	1.16	0.22	-1.1	0.1	-0.69	-0.73	0.28	0.86
9	99.99	99.99	-0.41	99.99	-1.17	-1.19	-0.55	-1.35	0.24	0.21

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 q	-5.9435	-4.9675	-4.8747	-5.0064	-5.0064
S,E(Log q)	0.502	0.5621	0.5305	0.7924	0.9332

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	0.94	0.149	6.27	0.52	8	0.51	-5.94
6	1.84	-0.974	0	0.19	8	1.04	-4.97
7	1.8	-2.261	0.71	0.59	8	0.75	-4.87
8	1.36	-0.984	3.51	0.57	8	1.08	-5.01
9	0.83	0.894	6.13	0.85	7	0.56	-5.61
1							

Fleet : FLT13: Norway Ac Sur

Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
2	0.4	0.3	-1.42	-0.2	-0.53	-1.89	-0.7	0.66	1.61	1.65
3	-0.16	-0.02	-0.71	-0.66	0.15	-1.3	0.24	0.17	0.77	1.32
4	-0.55	-0.77	-0.41	-0.27	-0.08	0.85	0.65	0.24	0.12	-0.1
5	0	-0.76	-0.51	-0.07	-0.1	0.09	0.97	0.67	-0.52	0.04
6	0.68	-0.34	-0.53	-0.94	-0.84	0.66	0.46	0.7	-0.07	0.17
7	No data for this fleet at this age									
8	No data for this fleet at this age									
9	No data for this fleet at this age									

Table 5.6 Tuning diagnostics (Cont'd)

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

Age	2	3	4	5	6
Mean Log q	-7.8679	-6.8149	-6.7091	-7.3626	-6.9439
S,E(Log q)	1.2019	0.7734	0.5087	0.5343	0.6332

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	19.03	-1.56	-66.51	0	10	21.12	-7.87
3	4.21	-1.982	-9.78	0.05	10	2.8	-6.81
4	1.79	-1.495	2.7	0.33	10	0.85	-6.71
5	1.05	-0.169	7.16	0.6	10	0.6	-7.36
6	1.21	-0.594	6.19	0.53	10	0.8	-6.94
1							

Terminal year survivor and F summaries :

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

Year class = 1999

Fleet	Estimated Survivors	Int s,e	Ext s,e	Var Ratio	N	Scaled Weights	Estimated F
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	262572	1.265	0	0	1	0.135	0.001
F shrinkage mean	39196	0.5				0.865	0.005

Weighted prediction :

Survivors at end of year	Int s,e	Ext s,e	N	Var Ratio	F
50641	0.46	1.77	2	3.805	0.004

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

Year class = 1998

Fleet	Estimated Survivors	Int s,e	Ext s,e	Var Ratio	N	Scaled Weights	Estimated F
FLT08: Norway Purse	35730	0.816	0	0	1	0.191	0.095
FLT12: Nor new trawl	1	0	0	0	0	0	0
FLT13: Norway Ac Sur	260016	0.685	0.132	0.19	2	0.271	0.014
F shrinkage mean	38568	0.5				0.538	0.089

Weighted prediction :

Survivors at end of year	Int s,e	Ext s,e	N	Var Ratio	F
63726	0.36	0.6	4	1.659	0.055

Table 5.6 Tuning diagnostics (Cont'd)

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

Year class = 1997

Fleet	Estimated Survivors	Int s,e	Ext s,e	Var Ratio	N	Scaled Weights	Estimated F
FLT08: Norway Purse	35550	0.403	0.308	0.76	2	0.371	0.193
FLT12: Nor new trawl	1	0	0	0	0	0	0
FLT13: Norway Ac Sur	46588	0.423	0.282	0.67	3	0.332	0.15
F shrinkage mean	33965	0.5				0.297	0.201

Weighted prediction :

Survivors at end of year	Int s,e	Ext s,e	N	Var Ratio	F
38362	0.25	0.15	6	0.584	0.18

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

Year class = 1996

Fleet	Estimated Survivors	Int s,e	Ext s,e	Var Ratio	N	Scaled Weights	Estimated F
FLT08: Norway Purse	52071	0.372	0.279	0.75	3	0.273	0.381
FLT12: Nor new trawl	134052	0.534	0	0	1	0.153	0.166
FLT13: Norway Ac Sur	77018	0.339	0.115	0.34	4	0.342	0.273
F shrinkage mean	70689	0.5				0.231	0.294

Weighted prediction :

Survivors at end of year	Int s,e	Ext s,e	N	Var Ratio	F
73848	0.21	0.13	9	0.643	0.283

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

Year class = 1995

Fleet	Estimated Survivors	Int s,e	Ext s,e	Var Ratio	N	Scaled Weights	Estimated F
FLT08: Norway Purse	9514	0.352	0.182	0.52	4	0.229	0.576
FLT12: Nor new trawl	27854	0.401	0.016	0.04	2	0.219	0.236
FLT13: Norway Ac Sur	14095	0.307	0.255	0.83	5	0.323	0.422
F shrinkage mean	17461	0.5				0.23	0.354

Weighted prediction :

Survivors at end of year	Int s,e	Ext s,e	N	Var Ratio	F
15707	0.19	0.15	12	0.771	0.386

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

Year class = 1994

Fleet	Estimated Survivors	Int s,e	Ext s,e	Var Ratio	N	Scaled Weights	Estimated F
FLT08: Norway Purse	12226	0.345	0.18	0.52	5	0.228	0.393
FLT12: Nor new trawl	21604	0.339	0.145	0.43	3	0.299	0.241
FLT13: Norway Ac Sur	19078	0.312	0.312	1	5	0.234	0.269

Table 5.6 Tuning diagnostics (Cont'd)

F shrinkage mean	11196	0.5		0.238	0.422

Weighted prediction :

Survivors at end of year	Int s,e	Ext s,e	N	Var Ratio	F
15754	0.19	0.13	14	0.695	0.317

1

Age 8 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
FLT08: Norway Purse	6689	0.341	0.151	0.44	5	0.197	0.353
FLT12: Nor new trawl	6065	0.321	0.397	1.24	4	0.323	0.383
FLT13: Norway Ac Sur	15832	0.31	0.153	0.49	5	0.204	0.165
F shrinkage mean	6485	0.5				0.277	0.362

Weighted prediction :

Survivors at end of year	Int s,e	Ext s,e	N	Var Ratio	F
7658	0.2	0.15	15	0.783	0.315

Age 9 Catchability constant w,r,t, time and age (fixed at the value for age) 8

Year class = 1992

Fleet	Estimated Survivors	Int s,e	Ext s,e	Var Ratio	N	Scaled Weights	Estimated F
FLT08: Norway Purse	16082	0.357	0.203	0.57	5	0.138	0.245
FLT12: Nor new trawl	7211	0.336	0.204	0.61	5	0.321	0.483
FLT13: Norway Ac Sur	8963	0.317	0.218	0.69	5	0.139	0.405
F shrinkage mean	8260	0.5				0.402	0.433

Weighted prediction :

Survivors at end of year	Int s,e	Ext s,e	N	Var Ratio	F
8768	0.24	0.11	16	0.446	0.412

1

Age 10 Catchability constant w,r,t, time and age (fixed at the value for age) 8

Year class = 1991

Fleet	Estimated Survivors	Int s,e	Ext s,e	Var Ratio	N	Scaled Weights	Estimated F
FLT08: Norway Purse	6024	0.365	0.135	0.37	5	0.135	0.24
FLT12: Nor new trawl	2659	0.321	0.182	0.57	5	0.311	0.48
FLT13: Norway Ac Sur	3962	0.327	0.226	0.69	5	0.142	0.346
F shrinkage mean	3976	0.5				0.412	0.345

Weighted prediction :

Survivors at end of year	Int s,e	Ext s,e	N	Var Ratio	F
3710	0.24	0.1	16	0.42	0.366

Table 5.7 Fishing mortality (f) at age

Run title : Arctic Saithe (run: XSAAAF22/X22)

At 22/04/2002 10:28

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
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
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
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
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
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
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
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
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
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
+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 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

Terminal Fs derived using XSA (With F shrinkage)

Table 8 Fishing mortality (F) at age

YEAR	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
AGE										
2	0.0472	0.1396	0.1204	0.2763	0.2181	0.2178	0.1964	0.2067	0.0582	0.0788
3	0.5893	0.4905	0.6669	0.5962	0.9053	0.786	0.6157	0.4446	0.5172	0.4112
4	0.4299	0.4766	0.5911	0.459	0.6942	0.6807	0.524	0.6834	0.5183	0.5842
5	0.3782	0.411	0.6231	0.4556	0.6609	0.5207	0.5675	0.5606	0.6404	0.6681
6	0.2894	0.3693	0.637	0.3552	0.4704	0.3522	0.467	0.399	0.5356	0.5631
7	0.2409	0.3373	0.5334	0.5379	0.5163	0.4538	0.4574	0.6257	0.572	0.4245
8	0.2451	0.2654	0.4017	0.656	0.4431	0.4306	0.3556	0.6249	0.673	0.8954
9	0.1569	0.321	0.3673	0.4563	0.592	0.4163	0.5508	0.4824	0.1765	0.3907
10	0.2635	0.3429	0.5166	0.496	0.5409	0.4378	0.4833	0.5429	0.5237	0.5934
+gp	0.2635	0.3429	0.5166	0.496	0.5409	0.4378	0.4833	0.5429	0.5237	0.5934
0 FBAR 3	0.4217	0.4369	0.6295	0.4665	0.6827	0.5849	0.5435	0.5219	0.5529	0.5567

Table 8 Fishing mortality (F) at age

YEAR	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
AGE										
2	0.1461	0.1145	0.125	0.0091	0.0181	0.0421	0.0725	0.1494	0.0446	0.0142
3	0.4041	0.2136	0.7503	0.7849	0.1175	0.128	0.1171	0.257	0.4626	0.4415
4	0.6566	0.5382	0.8221	0.5012	0.4842	0.4202	0.4073	0.4648	0.4932	0.5066
5	0.8678	0.8439	0.5834	0.4109	0.5148	0.2957	0.5451	0.819	0.3951	0.374
6	0.5849	0.5394	0.8089	0.5506	0.4954	0.5498	0.5829	0.7045	0.5697	0.4054
7	0.3133	0.4394	0.367	0.7088	0.6473	0.9263	1.1038	0.5292	0.7242	0.3655
8	0.3811	0.6969	0.5058	0.4618	0.6373	0.3556	1.0515	0.5086	0.6827	0.4114
9	0.5211	0.422	0.8806	0.5082	0.3925	0.6588	1.101	0.4406	0.4016	0.341
10	0.538	0.5934	0.6348	0.5323	0.5418	0.5619	0.8862	0.6056	0.5593	0.382
+gp	0.538	0.5934	0.6348	0.5323	0.5418	0.5619	0.8862	0.6056	0.5593	0.382
0 FBAR 3	0.6284	0.5338	0.7412	0.5619	0.403	0.3484	0.4131	0.5613	0.4802	0.4319

Table 8 Fishing mortality (F) at age

YEAR	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	FBAR 99-**
AGE											
2	0.0466	0.0153	0.0036	0.0005	0.0055	0.0035	0.0001	0.001	[0,013]	[0,0036]	0.0059
3	0.1525	0.1161	0.0536	0.0522	0.0999	0.1099	0.0415	0.0496	0.1412	[0,0546]	0.0818
4	0.2803	0.2966	0.2419	0.426	0.2606	0.1825	0.1691	0.228	0.1598	0.1798	0.1892
5	0.4116	0.4934	0.39	0.3909	0.2883	0.3203	0.2489	0.3792	0.2248	0.283	0.2957
6	0.8542	0.5764	0.7398	0.4886	0.3273	0.3352	0.4154	0.3529	0.3266	0.3865	0.3553
7	0.8785	0.6579	0.678	0.4585	0.5558	0.3539	0.3766	0.4669	0.3436	0.3173	0.3759
8	0.9284	0.5936	0.4451	0.482	0.5205	0.3519	0.2968	0.2548	0.3767	0.3148	0.3154
9	0.6123	0.7542	0.2732	0.2035	1.0253	0.2584	0.2934	0.2921	0.2797	0.4123	0.3281
10	0.757	0.6036	0.5076	0.4342	0.5116	0.3336	0.4288	0.4027	0.3767	0.3656	0.3817
+gp	0.757	0.6036	0.5076	0.4342	0.5116	0.3336	0.4288	0.4027	0.3767	0.3656	
0 FBAR 3	0.4246	0.3706	0.3563	0.3394	0.244	0.237	0.2187	0.2524	0.2131	[0,226]	

Table 5.8 Stock number at age

Run title : Arctic Saithe (run: XSAAAF22/X22)

At 22/04/2002 10:28

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
AGE												
2	121650	213269	355505	121815	368899	210354	241202	191872	367843	347431	379815	219524
3	88173	92920	170143	289935	97186	283654	144689	190738	150801	296372	280751	287484
4	85921	62681	59948	105582	199330	71425	198653	98200	129322	100667	172675	190463
5	38001	58508	43057	39010	60271	109269	53953	113296	57927	89246	71608	84509
6	26165	18857	36586	31252	26611	37443	65664	32298	60225	42811	57741	45971
7	16897	16840	12001	22453	21379	19328	21479	42090	22711	41814	30755	32626
8	7761	9416	12582	7630	14890	14362	13236	13376	29379	17882	29893	20546
9	4823	4181	6833	9375	5252	9788	9850	9593	8313	22322	13622	17281
10	2580	2759	2953	4746	6703	3168	5541	7220	6576	5992	16728	8887
+gp	5253	8334	11260	12044	19432	16183	16565	17951	13243	4518	12585	22073
0 TOTA	397223	487765	710869	643841	819953	774974	770831	716635	846340	969055	1066173	929364

Terminal Fs derived using XSA (With F shrinkage)

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

YEAR	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
AGE										
2	278465	117299	206220	373549	305466	178776	283592	167695	356256	152601
3	161778	217485	83523	149693	232001	201097	117721	190782	111659	275186
4	165683	73477	109026	35101	67515	76814	75021	52073	100133	54505
5	102299	88246	37350	49426	18160	27611	31839	36371	21525	48825
6	44795	57383	47900	16400	25658	7677	13431	14779	17000	9289
7	28992	27458	32476	20741	9413	13124	4420	6893	8119	8147
8	18033	18655	16044	15597	9916	4599	6825	2290	3019	3751
9	14197	11554	11713	8790	6627	5212	2448	3916	1004	1261
10	10210	9936	6862	6642	4560	3002	2814	1155	1979	689
+gp	14934	14828	10361	11585	7538	3503	6140	3111	4371	1535
0 TOTA	839385	636321	561474	687525	686854	521415	544250	479066	625065	555789

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

YEAR	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
AGE										
2	140072	118917	137583	271774	204445	103576	79269	88874	292154	481538
3	115468	99095	86831	99411	220505	164390	81302	60360	62669	228751
4	149339	63109	65529	33571	37129	160524	118422	59212	38219	32305
5	24879	63407	30163	23580	16651	18731	86339	64520	30459	19109
6	20495	8552	22325	13780	12801	8148	11409	40985	23288	16797
7	4331	9349	4083	8140	6505	6386	3849	5215	16589	10786
8	4363	2592	4933	2316	3281	2788	2071	1045	2515	6583
9	1254	2440	1057	2435	1195	1420	1600	592	515	1040
10	699	610	1310	359	1199	661	602	435	312	282
+gp	1177	1855	2084	1857	745	2027	189	358	646	456
0 TOTA	462077	369927	355898	457224	504456	468650	385051	321598	467364	797648

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

YEAR	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	GMST 60-99	AMST 60-99
AGE													
2	347604	246197	436623	145294	193393	103367	268957	96455	[101718]	[62075]	[0]	208328	232880
3	388699	271625	198512	356181	118894	157467	84335	220172	78888	[82201]	[50641]	158595	178211
4	120438	273224	198017	154050	276775	88090	115507	66243	171535	56085	[63726]	92371	108348
5	15936	74501	166284	127288	82376	174623	60092	79856	43178	119701	38362	50043	60977
6	10764	8645	37241	92179	70493	50553	103782	38358	44746	28234	73848	26116	33163
7	9169	3751	3977	14550	46298	41604	29600	56089	22066	26427	15707	13858	18511
8	6127	3118	1591	1653	7531	21744	23911	16629	28791	12813	15754	7042	10112
9	3572	1982	1410	834	836	3664	12521	14549	10553	16173	7658	3712	6022
10	606	1585	763	879	557	245	2317	7644	8894	6532	8768	1984	3569
+gp	548	256	1916	949	1210	619	1247	1947	4227	7624	8041		
0 TOTA	903461	884884	1046334	893856	798362	641976	702269	597942	[514598]	[417866]	[282503]		

Table 5.9 Stock biomass at age

Run title : Arctic Saithe (run: XSAAAF22/X22)

At 22/04/2002 10:28

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
	AGE												
	2	41361	72511	120872	41417	125426	71520	82009	65237	125067	118126	129137	74638
	3	62603	65973	120802	205854	69002	201394	102729	135424	107069	210424	199334	204114
	4	95372	69576	66543	117196	221257	79282	220505	109002	143548	111741	191669	211414
	5	61942	95368	70183	63586	98241	178108	87943	184673	94421	145470	116720	137749
	6	60964	43936	85246	72817	62003	87243	152998	75254	140323	99750	134537	107113
	7	53395	53214	37924	70952	67559	61076	67874	133004	71766	132132	97187	103098
	8	31275	37946	50706	30748	60005	57880	53339	53906	118396	72064	120468	82800
	9	23490	20363	33278	45655	25578	47668	47968	46718	40485	108710	66337	84157
	10	14524	15534	16625	26719	37737	17837	31196	40649	37021	33734	94178	50032
	+gp	42179	66999	89226	94556	151201	128800	134275	143498	102186	33794	93178	155657
0	TOTAL	487106	541421	691403	769500	918009	930808	980835	987365	980281	1065944	1242746	1210773

Terminal Fs derived using XSA (With F shrinkage)

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

	YEAR	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
	AGE										
	2	94678	39882	70115	127007	103858	60784	96421	57016	160315	65618
	3	114862	154414	59301	106282	164721	142779	83582	135455	88211	200886
	4	183908	81559	121019	38962	74942	85264	83273	57801	127168	76307
	5	166748	143841	60881	80564	29601	45005	51897	59285	43697	100091
	6	104371	133703	111606	38212	59783	17888	31293	34434	43351	25638
	7	91613	86767	102624	65541	29747	41471	13967	21783	26710	26884
	8	72672	75179	64656	62856	39963	18534	27505	9231	13102	16431
	9	69137	56270	57041	42809	32273	25384	11921	19070	5170	7503
	10	57485	55938	38634	37392	25675	16899	15845	6505	11379	4402
	+gp	111662	109507	74775	82570	55176	25903	46217	24295	30321	10504
0	TOTAL	1067137	937059	760652	682197	615737	479911	461922	424876	549424	534264

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

	YEAR	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
	AGE										
	2	71436	71350	72919	103274	65423	35216	26159	39993	157763	192615
	3	88910	104050	61650	74558	130098	87127	50407	44667	47628	164700
	4	167259	83936	82567	45656	45297	134840	103028	57435	41276	38443
	5	50257	117937	60930	49283	32803	31093	113103	89683	47515	34014
	6	53492	23947	60277	36241	29442	18902	27724	74183	49371	37626
	7	14161	37397	15843	26700	18670	18967	14897	15749	39814	30847
	8	17058	10834	22050	9194	12204	11152	11140	3909	9181	21856
	9	5884	13004	5666	11032	5138	6703	9325	2749	1852	4713
	10	3933	3465	7938	1988	5625	3594	3225	2069	1988	1607
	+gp	8899	16077	14984	15212	4915	13992	1405	2687	3096	3248
0	TOTAL	481289	481997	404823	373139	349615	361586	360414	333124	399485	529670

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

	YEAR	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
	AGE										
	2	156422	113251	152818	72647	77357	39280	94135	61731	[37636]	[27313]
	3	272089	171124	103226	199461	70147	97630	57348	147515	48122	[61651]
	4	132481	278689	146533	120159	226955	81043	115507	69555	174966	62816
	5	31553	126652	202867	154018	108736	207801	88936	115791	69516	184340
	6	25187	21613	80440	160391	129002	83918	194072	74032	94862	57880
	7	25764	10802	12688	40739	114355	96105	76369	127882	58696	68974
	8	19913	9635	6315	6182	28015	67406	73407	49389	92419	42411
	9	14502	7335	6515	3672	3753	15902	51586	52378	39468	58062
	10	3749	9813	4031	4639	2954	1482	12626	31418	38691	29524
	+gp	4042	2089	11632	7068	8490	4716	10042	10735	25257	39484
0	TOTAL	685702	751002	727064	768976	769766	695283	774028	740427	[679634]	[632455]

Table 5.10 Spawning stock biomass

Run title : Arctic Saithe (run: XSAAAF22/X22)
At 22/04/2002 10:28

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
AGE												
2	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
4	954	696	665	1172	2213	793	2205	1090	1435	1117	1917	2114
5	34068	52452	38601	34972	54033	97959	48369	101570	51932	80009	64196	75762
6	51820	37346	72459	61894	52703	74156	130048	63966	119275	84787	114356	91046
7	52327	52150	37165	69533	66208	59854	66516	130344	70331	129489	95244	101036
8	31275	37946	50706	30748	60005	57880	53339	53906	118396	72064	120468	82800
9	23490	20363	33278	45655	25578	47668	47968	46718	40485	108710	66337	84157
10	14524	15534	16625	26719	37737	17837	31196	40649	37021	33734	94178	50032
+gp	42179	66999	89226	94556	151201	128800	134275	143498	102186	33794	93178	155657
0	250637	283486	338725	365250	449676	484948	513916	581741	541060	543704	649874	642605
TOTSPBIO												

Terminal Fs derived using XSA (With F shrinkage)

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

YEAR	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
AGE										
2	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0
4	1839	816	1210	390	749	853	833	578	1272	763
5	91711	79112	33485	44310	16280	24753	28544	32607	24033	55050
6	88716	113647	94865	32481	50815	15205	26599	29269	36848	21792
7	89781	85032	100572	64231	29152	40642	13688	21348	26176	26346
8	72672	75179	64656	62856	39963	18534	27505	9231	13102	16431
9	69137	56270	57041	42809	32273	25384	11921	19070	5170	7503
10	57485	55938	38634	37392	25675	16899	15845	6505	11379	4402
+gp	111662	109507	74775	82570	55176	25903	46217	24295	30321	10504
0	583004	575501	465237	367038	250083	168172	171151	142902	148301	142792
TOTSPBIO										

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

YEAR	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
AGE										
2	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0
4	1673	839	826	457	453	1348	1030	574	413	384
5	27641	64865	33512	27106	18041	17101	62207	49326	26133	18708
6	45468	20355	51236	30805	25026	16067	23566	63055	41965	31982
7	13878	36649	15526	26166	18297	18588	14599	15434	39017	30230
8	17058	10834	22050	9194	12204	11152	11140	3909	9181	21856
9	5884	13004	5666	11032	5138	6703	9325	2749	1852	4713
10	3933	3465	7938	1988	5625	3594	3225	2069	1988	1607
+gp	8899	16077	14984	15212	4915	13992	1405	2687	3096	3248
0	124433	166089	151736	121959	89699	88546	126498	139803	123646	112728
TOTSPBIO										

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

YEAR	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
AGE										
2	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0
4	1325	2787	1465	1202	2270	810	1155	696	1750	628
5	17354	69659	111577	84710	59805	114291	48915	63685	38234	101387
6	21409	18371	68374	136332	109652	71330	164961	62927	80633	49198
7	25249	10586	12434	39924	112068	94183	74841	125324	57523	67595
8	19913	9635	6315	6182	28015	67406	73407	49389	92419	42411
9	14502	7335	6515	3672	3753	15902	51586	52378	39468	58062
10	3749	9813	4031	4639	2954	1482	12626	31418	38691	29524
+gp	4042	2089	11632	7068	8490	4716	10042	10735	25257	39484
0	107543	130275	222342	283728	327007	370121	437533	396553	373975	388289
TOTSPBIO										

Table 5.11 Summary

Run title : Arctic Saithe (run: XSAAAF22/X22)

At 22/04/2002 10:28

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	691403	338725	120707	0.3564	0.2289
1963	121815	769500	365250	148627	0.4069	0.2244
1964	368899	918009	449676	197426	0.439	0.2262
1965	210354	930808	484948	185600	0.3827	0.2254
1966	241202	980835	513916	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	379815	1242746	649874	264924	0.4077	0.3292
1971	219524	1210773	642605	241272	0.3755	0.3671
1972	278465	1067137	583004	214334	0.3676	0.4217
1973	117299	937059	575501	213859	0.3716	0.4369
1974	206220	760652	465237	274121	0.5892	0.6295
1975	373549	682197	367038	233453	0.636	0.4665
1976	305466	615737	250083	242486	0.9696	0.6827
1977	178776	479911	168172	182817	1.0871	0.5849
1978	283592	461922	171151	154464	0.9025	0.5435
1979	167695	424876	142902	164180	1.1489	0.5219
1980	356256	549424	148301	144554	0.9747	0.5529
1981	152601	534264	142792	175516	1.2292	0.5567
1982	140072	481289	124433	168034	1.3504	0.6284
1983	118917	481997	166089	156936	0.9449	0.5338
1984	137583	404823	151736	158786	1.0465	0.7412
1985	271774	373139	121959	107183	0.8788	0.5619
1986	204445	349615	89699	70458	0.7855	0.403
1987	103576	361586	88546	92391	1.0434	0.3484
1988	79269	360414	126498	114242	0.9031	0.4131
1989	88874	333124	139803	122310	0.8749	0.5613
1990	292154	399485	123646	95848	0.7752	0.4802
1991	481538	529670	112728	107326	0.9521	0.4319
1992	347604	685702	107543	127516	1.1857	0.4246
1993	246197	751002	130275	153584	1.1789	0.3706
1994	436623	727064	222342	146544	0.6591	0.3563
1995	145294	768976	283728	168174	0.5927	0.3394
1996	193393	769766	327007	171498	0.5244	0.244
1997	103367	695283	370121	143760	0.3884	0.237
1998	268957	774028	437533	153822	0.3516	0.2187
1999	96455	740427	396553	150274	0.379	0.2524
2000	260052	837968	373975	135170	0.3614	0.2131
2001	228000	798380	388289	134100	0.3454	0.2175
Arith, Mean	233411	689122	308150	159790	0.6724	0.3907
0 Units	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)		

Table 5.12 Input to RCT3 analysis program

```
NORTHEAST ARCTIC SAITHE : recruits as 2 year-olds
1 10 2  (No. of surveys   No. of years   VPA Column No.)
'Yearcl' 'VPA' 'Ac-surv'
1990       348    163.5
1991   246    106.9
1992   437    34.4
1993   145    38.7
1994   193    37.0
1995       103   5.1
1996   269    43.6
1997    97    61.1
1998       -11    164.8
1999   -11   104.7


NORTHEAST ARCTIC SAITHE : recruits as 3 year-olds
1 10 2  (No. of surveys, No. of years, VPA Column No.)
'Yearcl' 'VPA' 'Ac-surv'
1989       389    273.6
1990       272    227.7
1991       199    87.8
1992       356    165.2
1993       119    118.9
1994   158   36.7
1995        84    96.5
1996       220    233.8
1997    79   142.5
1998   -11   275.9
```

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 10 years : 1990 - 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.

Yearclass = 1993

	I----------Regression----------I				I----------Prediction---------I			
Survey/ Series	Slope	Inter-cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
Ac-sur	-.59	8.45	.53	.376	3	3.68	6.27	1.226	.053
					VPA Mean =		5.82	.289	.947

Yearclass = 1994

	I----------Regression----------I				I----------Prediction---------I			
Survey/ Series	Slope	Inter-cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
Ac-sur	3.47	-9.16	3.15	.034	4	3.64	3.46	5.423	.008
					VPA Mean =		5.61	.479	.992

Yearclass = 1995

	I----------Regression----------I				I----------Prediction---------I			
Survey/ Series	Slope	Inter-cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
Ac-sur	2.14	-3.31	1.68	.085	5	1.81	.57	4.294	.010
					VPA Mean =		5.54	.442	.990

Table 5.13 (Cont'd)

Yearclass = 1996

Survey/ Series	Slope	Inter-cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I----------Regression----------I					I----------Prediction---------I			
Ac-sur	.69	2.81	.64	.468	6	3.80	5.43	.856	.284
					VPA Mean =		5.39	.539	.716

Yearclass = 1997

Survey/ Series	Slope	Inter-cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I----------Regression----------I					I----------Prediction---------I			
Ac-sur	.71	2.78	.59	.462	7	4.13	5.69	.761	.301
					VPA Mean =		5.41	.499	.699

Yearclass = 1998

Survey/ Series	Slope	Inter-cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I----------Regression----------I					I----------Prediction---------I			
Ac-sur	1.16	.91	1.07	.235	8	5.11	6.86	1.480	.121
					VPA Mean =		5.30	.549	.879

Yearclass = 1999

Survey/ Series	Slope	Inter-cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I----------Regression----------I					I----------Prediction---------I			
Ac-sur	1.17	.88	1.09	.232	8	4.66	6.35	1.427	.129
					VPA Mean =		5.29	.550	.871

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
1992	No valid surveys						
1993	343	5.84	.28	.10	.13	146	4.98
1994	267	5.59	.48	.19	.16	193	5.27
1995	241	5.49	.44	.51	1.33	104	4.64
1996	221	5.40	.46	.02	.00	270	5.60
1997	243	5.50	.42	.13	.09	98	4.58
1998	242	5.49	.51	.51	.97		
1999	228	5.43	.51	.35	.48		

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 10 years : 1989 - 1998

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

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

Forecast/Hindcast variance correction used.

Yearclass = 1992

	I----------Regression----------I				I----------Prediction---------I			
Survey/ Series	Slope	Inter-cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
Ac-sur	.60	2.51	.21	.840	3	5.11	5.59	.414	.394
					VPA Mean =		5.62	.334	.606

Yearclass = 1993

	I----------Regression----------I				I----------Prediction---------I			
Survey/ Series	Slope	Inter-cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
Ac-sur	.76	1.78	.27	.643	4	4.79	5.40	.468	.293
					VPA Mean =		5.69	.301	.707

Yearclass = 1994

	I----------Regression----------I				I----------Prediction---------I			
Survey/ Series	Slope	Inter-cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
Ac-sur	1.47	-1.96	.55	.504	5	3.63	3.37	1.376	.109
					VPA Mean =		5.51	.480	.891

Table 5.13 (Cont'd)

Yearclass = 1995

Survey/ Series	Slope	Inter-cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I----------Regression----------I					I----------Prediction---------I			
Ac-sur	.94	.91	.55	.472	6	4.58	5.19	.741	.283
					VPA Mean =		5.43	.466	.717

Yearclass = 1996

Survey/ Series	Slope	Inter-cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I----------Regression----------I					I----------Prediction---------I			
Ac-sur	1.41	-1.48	.83	.362	7	5.46	6.22	1.127	.202
					VPA Mean =		5.28	.567	.798

Yearclass = 1997

Survey/ Series	Slope	Inter-cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I----------Regression----------I					I----------Prediction---------I			
Ac-sur	1.36	-1.33	.79	.341	8	4.97	5.42	.980	.224
					VPA Mean =		5.29	.526	.776

Yearclass = 1998

Survey/ Series	Slope	Inter-cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I----------Regression----------I					I----------Prediction---------I			
Ac-sur	2.04	-4.75	1.20	.212	9	5.62	6.70	1.572	.120
					VPA Mean =		5.18	.580	.880

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
1992	272	5.61	.26	.02	.01	356	5.88
1993	271	5.60	.25	.13	.26	120	4.79
1994	195	5.27	.45	.67	2.15	159	5.07
1995	213	5.36	.39	.11	.07	85	4.44
1996	237	5.47	.51	.38	.55	221	5.40
1997	204	5.32	.46	.05	.01	80	4.38
1998	212	5.36	.54	.49	.82		

Table 5.14

Northeast Arctic saithe (Sub-areas I and II)

Prediction with management option table: Input data

Year: 2002								
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
Unit	Thousands	-	-	-	-	Kilograms	-	Kilograms
2	212000.00	0.2000	0.0000	0.0000	0.0000	0.483	0.0022	0.483
3	186488.00	0.2000	0.0000	0.0000	0.0000	0.677	0.0674	0.677
4	170002.00	0.2000	0.0100	0.0000	0.0000	1.063	0.1808	1.063
5	38362.000	0.2000	0.5500	0.0000	0.0000	1.533	0.2825	1.533
6	73848.000	0.2000	0.8500	0.0000	0.0000	2.033	0.3395	2.033
7	15707.000	0.2000	0.9800	0.0000	0.0000	2.517	0.3592	2.517
8	15754.000	0.2000	1.0000	0.0000	0.0000	3.103	0.3014	3.103
9	7658.000	0.2000	1.0000	0.0000	0.0000	3.643	0.3134	3.643
10	8768.000	0.2000	1.0000	0.0000	0.0000	4.327	0.3646	4.327
11+	8041.000	0.2000	1.0000	0.0000	0.0000	5.556	0.3646	5.556

Year: 2003								
Age	Recruitment	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
Unit	Thousands	-	-	-	-	Kilograms	-	Kilograms
2	212000.00	0.2000	0.0000	0.0000	0.0000	0.483	0.0022	0.483
3	.	0.2000	0.0000	0.0000	0.0000	0.677	0.0674	0.677
4	.	0.2000	0.0100	0.0000	0.0000	1.063	0.1808	1.063
5	.	0.2000	0.5500	0.0000	0.0000	1.533	0.2825	1.533
6	.	0.2000	0.8500	0.0000	0.0000	2.033	0.3395	2.033
7	.	0.2000	0.9800	0.0000	0.0000	2.517	0.3592	2.517
8	.	0.2000	1.0000	0.0000	0.0000	3.103	0.3014	3.103
9	.	0.2000	1.0000	0.0000	0.0000	3.643	0.3134	3.643
10	.	0.2000	1.0000	0.0000	0.0000	4.327	0.3646	4.327
11+	.	0.2000	1.0000	0.0000	0.0000	5.556	0.3646	5.556

Year: 2004								
Age	Recruitment	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
Unit	Thousands	-	-	-	-	Kilograms	-	Kilograms
2	212000.00	0.2000	0.0000	0.0000	0.0000	0.483	0.0022	0.483
3	.	0.2000	0.0000	0.0000	0.0000	0.677	0.0674	0.677
4	.	0.2000	0.0100	0.0000	0.0000	1.063	0.1808	1.063
5	.	0.2000	0.5500	0.0000	0.0000	1.533	0.2825	1.533
6	.	0.2000	0.8500	0.0000	0.0000	2.033	0.3395	2.033
7	.	0.2000	0.9800	0.0000	0.0000	2.517	0.3592	2.517
8	.	0.2000	1.0000	0.0000	0.0000	3.103	0.3014	3.103
9	.	0.2000	1.0000	0.0000	0.0000	3.643	0.3134	3.643
10	.	0.2000	1.0000	0.0000	0.0000	4.327	0.3646	4.327
11+	.	0.2000	1.0000	0.0000	0.0000	5.556	0.3646	5.556

Notes: Run name : MANAAF08
Date and time: 23APR02:18:24

Table 5.15

Northeast Arctic saithe (Sub-areas I and II)

Yield per recruit: Summary table

							1 January		Spawning time	
F	Reference	Catch in	Catch in	Stock	Stock	Sp.stock	Sp.stock	Sp.stock	Sp.stock	Sp.stock
Factor	F	numbers	weight	size	biomass	size	biomass	size	biomass	
0.0000	0.0000	0.000	0.000	5.517	12203.937	2.713	9926.746	2.713	9926.746	
0.0500	0.0109	0.050	151.354	5.269	11055.834	2.472	8790.261	2.472	8790.261	
0.1000	0.0218	0.092	269.975	5.058	10099.736	2.269	7845.585	2.269	7845.585	
0.1500	0.0326	0.129	363.844	4.875	9293.340	2.093	7050.419	2.093	7050.419	
0.2000	0.0435	0.161	438.711	4.716	8605.728	1.941	6373.851	1.941	6373.851	
0.2500	0.0544	0.189	498.802	4.575	8013.794	1.808	5792.780	1.808	5792.780	
0.3000	0.0653	0.214	547.278	4.450	7499.940	1.689	5289.611	1.689	5289.611	
0.3500	0.0761	0.237	586.535	4.338	7050.536	1.584	4850.718	1.584	4850.718	
0.4000	0.0870	0.257	618.419	4.237	6654.871	1.490	4465.395	1.490	4465.395	
0.4500	0.0979	0.276	644.361	4.145	6304.420	1.405	4125.120	1.405	4125.120	
0.5000	0.1088	0.293	665.487	4.061	5992.315	1.328	3823.030	1.328	3823.030	
0.5500	0.1197	0.308	682.688	3.985	5712.973	1.258	3553.544	1.258	3553.544	
0.6000	0.1305	0.322	696.673	3.914	5461.804	1.194	3312.078	1.194	3312.078	
0.6500	0.1414	0.336	708.015	3.849	5235.012	1.136	3094.837	1.136	3094.837	
0.7000	0.1523	0.348	717.175	3.789	5029.425	1.082	2898.655	1.082	2898.655	
0.7500	0.1632	0.359	724.527	3.733	4842.382	1.032	2720.872	1.032	2720.872	
0.8000	0.1740	0.370	730.378	3.680	4671.628	0.986	2559.237	0.986	2559.237	
0.8500	0.1849	0.380	734.979	3.631	4515.248	0.943	2411.838	0.943	2411.838	
0.9000	0.1958	0.389	738.537	3.586	4371.601	0.903	2277.038	0.903	2277.038	
0.9500	0.2067	0.398	741.224	3.542	4239.278	0.866	2153.431	0.866	2153.431	
1.0000	0.2176	0.406	743.181	3.502	4117.062	0.831	2039.800	0.831	2039.800	
1.0500	0.2284	0.414	744.526	3.464	4003.896	0.799	1935.094	0.799	1935.094	
1.1000	0.2393	0.421	745.359	3.427	3898.858	0.768	1838.393	0.768	1838.393	
1.1500	0.2502	0.428	745.762	3.393	3801.144	0.739	1748.896	0.739	1748.896	
1.2000	0.2611	0.435	745.803	3.360	3710.047	0.712	1665.897	0.712	1665.897	
1.2500	0.2719	0.441	745.541	3.329	3624.944	0.687	1588.777	0.687	1588.777	
1.3000	0.2828	0.447	745.026	3.300	3545.285	0.663	1516.987	0.663	1516.987	
1.3500	0.2937	0.453	744.298	3.272	3470.582	0.640	1450.043	0.640	1450.043	
1.4000	0.3046	0.458	743.393	3.245	3400.401	0.619	1387.513	0.619	1387.513	
1.4500	0.3154	0.464	742.340	3.219	3334.356	0.598	1329.012	0.598	1329.012	
1.5000	0.3263	0.469	741.164	3.195	3272.101	0.579	1274.198	0.579	1274.198	
1.5500	0.3372	0.474	739.886	3.171	3213.327	0.560	1222.762	0.560	1222.762	
1.6000	0.3481	0.478	738.526	3.148	3157.754	0.543	1174.429	0.543	1174.429	
1.6500	0.3590	0.483	737.097	3.127	3105.134	0.526	1128.950	0.526	1128.950	
1.7000	0.3698	0.487	735.613	3.106	3055.239	0.510	1086.101	0.510	1086.101	
1.7500	0.3807	0.491	734.085	3.086	3007.865	0.495	1045.680	0.495	1045.680	
1.8000	0.3916	0.495	732.523	3.066	2962.828	0.481	1007.503	0.481	1007.503	
1.8500	0.4025	0.499	730.935	3.048	2919.958	0.467	971.404	0.467	971.404	
1.9000	0.4133	0.503	729.328	3.030	2879.104	0.454	937.232	0.454	937.232	
1.9500	0.4242	0.506	727.707	3.012	2840.126	0.441	904.850	0.441	904.850	
2.0000	0.4351	0.510	726.077	2.995	2802.896	0.429	874.131	0.429	874.131	
-	-	Numbers	Grams	Numbers	Grams	Numbers	Grams	Numbers	Grams	

Notes: Run name : YLDAAF06
Date and time : 24APR02:17:46
Computation of ref. F: Simple mean, age 3 - 6
F-0.1 factor : 0.5258
F-max factor : 1.1810
F-0.1 reference F : 0.1144
F-max reference F : 0.2569
Recruitment : Single recruit

Table 5.16

Northeast Arctic saithe (Sub-areas I and II)

Prediction with management option table

	Year: 2002					Year: 2003					Year: 2004	
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
1.1025	0.2398	817324	359930	152000	0.0000	0.0000	827539	370905	0	1012136	533493
.	.	.	.	.	0.0500	0.0109	.	370905	8214	1002657	525664
.	.	.	.	.	0.1000	0.0218	.	370905	16313	993312	517956
.	.	.	.	.	0.1500	0.0326	.	370905	24299	984099	510367
.	.	.	.	.	0.2000	0.0435	.	370905	32173	975017	502893
.	.	.	.	.	0.2500	0.0544	.	370905	39937	966062	495535
.	.	.	.	.	0.3000	0.0653	.	370905	47593	957235	488289
.	.	.	.	.	0.3500	0.0761	.	370905	55142	948531	481154
.	.	.	.	.	0.4000	0.0870	.	370905	62585	939950	474129
.	.	.	.	.	0.4500	0.0979	.	370905	69926	931490	467211
.	.	.	.	.	0.5000	0.1088	.	370905	77164	923148	460399
.	.	.	.	.	0.5500	0.1197	.	370905	84303	914923	453691
.	.	.	.	.	0.6000	0.1305	.	370905	91342	906813	447086
.	.	.	.	.	0.6500	0.1414	.	370905	98284	898817	440581
.	.	.	.	.	0.7000	0.1523	.	370905	105130	890933	434176
.	.	.	.	.	0.7500	0.1632	.	370905	111882	883158	427869
.	.	.	.	.	0.8000	0.1740	.	370905	118541	875492	421657
.	.	.	.	.	0.8500	0.1849	.	370905	125108	867932	415541
.	.	.	.	.	0.9000	0.1958	.	370905	131585	860478	409517
.	.	.	.	.	0.9500	0.2067	.	370905	137973	853127	403586
.	.	.	.	.	1.0000	0.2176	.	370905	144274	845878	397744
.	.	.	.	.	1.0500	0.2284	.	370905	150488	838729	391992
.	.	.	.	.	1.1000	0.2393	.	370905	156618	831679	386326
.	.	.	.	.	1.1500	0.2502	.	370905	162664	824727	380747
.	.	.	.	.	1.2000	0.2611	.	370905	168628	817870	375253
.	.	.	.	.	1.2500	0.2719	.	370905	174511	811108	369842
.	.	.	.	.	1.3000	0.2828	.	370905	180314	804439	364513
.	.	.	.	.	1.3500	0.2937	.	370905	186038	797861	359265
.	.	.	.	.	1.4000	0.3046	.	370905	191685	791374	354096
.	.	.	.	.	1.4500	0.3154	.	370905	197255	784975	349005
.	.	.	.	.	1.5000	0.3263	.	370905	202750	778664	343992
-	-	Tonnes	Tonnes	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes

Notes: Run name : MANAAF08
Date and time : 23APR02:18:24
Computation of ref. F: Simple mean, age 3 - 6
Basis for 2002 : TAC constraints

Table 5.17a

F_{sq} option

Northeast Arctic saithe (Sub-areas I and II)

Single option prediction: Summary table

						1 January		Spawning time			
Year	F	Reference	Catch in	Catch in	Stock	Stock	Sp.stock	Sp.stock	Sp.stock	Sp.stock	
	Factor	F	numbers	weight	size	biomass	size	biomass	size	biomass	
2002	1.1025	0.2398	86766	152000	736628	817324	141184	359930	141184	359930	
2003	1.0000	0.2176	83128	144274	737069	827540	155991	370905	155991	370905	
2004	1.0000	0.2176	85079	149293	740678	845878	169877	397744	169877	397744	
2005	1.0000	0.2176	86194	153735	741882	856110	174926	414137	174926	414137	
2006	1.0000	0.2176	85944	154611	741872	861647	175614	421158	175614	421158	
2007	1.0000	0.2176	85838	155476	742086	867234	175872	426855	175872	426855	
Unit	-	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	

Notes: Run name : SPRAAF04
Date and time : 23APR02:18:33
Computation of ref. F: Simple mean, age 3 - 6
Prediction basis : F factors

F_{pa} option

Northeast Arctic saithe (Sub-areas I and II)

Single option prediction: Summary table

						1 January		Spawning time			
Year	F	Reference	Catch in	Catch in	Stock	Stock	Sp.stock	Sp.stock	Sp.stock	Sp.stock	
	Factor	F	numbers	weight	size	biomass	size	biomass	size	biomass	
2002	1.1025	0.2398	86766	152000	736628	817324	141184	359930	141184	359930	
2003	1.1949	0.2600	97158	168024	737069	827540	155991	370905	155991	370905	
2004	1.1949	0.2600	95990	166069	728124	818565	161202	375810	161202	375810	
2005	1.1949	0.2600	94973	165067	721855	809006	159534	373724	159534	373724	
2006	1.1949	0.2600	93457	162036	717640	800869	156091	367216	156091	367216	
2007	1.1949	0.2600	92683	160357	715548	797097	154047	363563	154047	363563	
Unit	-	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	

Notes: Run name : SPRAAF04
Date and time : 23APR02:18:33
Computation of ref. F: Simple mean, age 3 - 6
Prediction basis : F factors

Table 5.17b

Northeast Arctic saithe (Sub-areas I and II)

Single option prediction: Detailed tables

Year: 2002	F-factor: 1.1025	Reference F: 0.2398	1 January		Spawning time	
	Absolute	Catch in	Catch in	Stock	Stock	Sp.stock	Sp.stock	Sp.stock	Sp.stock
Age	F	numbers	weight	size	biomass	size	biomass	size	biomass
2	0.0024	466	225	212000	102460	0	0	0	0
3	0.0743	12120	8201	186488	126196	0	0	0	0
4	0.1993	27938	29707	170002	180763	1700	1808	1700	1808
5	0.3115	9353	14341	38362	58820	21099	32351	21099	32351
6	0.3743	21028	42757	73848	150155	62771	127632	62771	127632
7	0.3960	4686	11793	15707	39530	15393	38739	15393	38739
8	0.3323	4059	12597	15754	48889	15754	48889	15754	48889
9	0.3455	2039	7430	7658	27900	7658	27900	7658	27900
10	0.4020	2648	11457	8768	37937	8768	37937	8768	37937
11+	0.4020	2428	13492	8041	44673	8041	44673	8041	44673
Total		86766	152000	736628	817324	141184	359930	141184	359930
Unit	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Year: 2003	F-factor: 1.0000	Reference F: 0.2176	1 January		Spawning time	
	Absolute	Catch in	Catch in	Stock	Stock	Sp.stock	Sp.stock	Sp.stock	Sp.stock
Age	F	numbers	weight	size	biomass	size	biomass	size	biomass
2	0.0022	422	204	212000	102460	0	0	0	0
3	0.0674	10240	6930	173150	117171	0	0	0	0
4	0.1808	21313	22662	141749	150722	1417	1507	1417	1507
5	0.2825	25555	39183	114032	174845	62718	96165	62718	96165
6	0.3395	6036	12272	23003	46771	19552	39756	19552	39756
7	0.3592	11441	28794	41584	104654	40752	102561	40752	102561
8	0.3014	2051	6366	8655	26858	8655	26858	8655	26858
9	0.3134	2268	8262	9252	33706	9252	33706	9252	33706
10	0.3646	1236	5350	4438	19202	4438	19202	4438	19202
11+	0.3646	2565	14250	9207	51150	9207	51150	9207	51150
Total		83128	144274	737069	827540	155991	370905	155991	370905
Unit	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Table 5.17b (Cont'd)

Year: 2004	F-factor: 1.0000	Reference F: 0.2176	1 January	Spawning time

		Absolute	Catch in	Catch in	Stock	Stock	Sp.stock	Sp.stock	Sp.stock	Sp.stock
Age	F	numbers	weight	size	biomass	size	biomass	size	biomass	
2	0.0022	422	204	212000	102460	0	0	0	0	
3	0.0674	10243	6931	173189	117197	0	0	0	0	
4	0.1808	19926	21187	132524	140912	1325	1409	1325	1409	
5	0.2825	21707	33283	96859	148514	53273	81683	53273	81683	
6	0.3395	18468	37551	70385	143114	59827	121647	59827	121647	
7	0.3592	3690	9287	13411	33753	13143	33078	13143	33078	
8	0.3014	5635	17486	23772	73772	23772	73772	23772	73772	
9	0.3134	1285	4681	5242	19098	5242	19098	5242	19098	
10	0.3646	1542	6674	5537	23956	5537	23956	5537	23956	
11+	0.3646	2161	12008	7758	43103	7758	43103	7758	43103	
Total		85079	149293	740678	845878	169877	397744	169877	397744	
Unit	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	

(cont.)

Northeast Arctic saithe (Sub-areas I and II)

Single option prediction: Detailed tables

(cont.)

Year: 2005	F-factor: 1.0000	Reference F: 0.2176	1 January	Spawning time

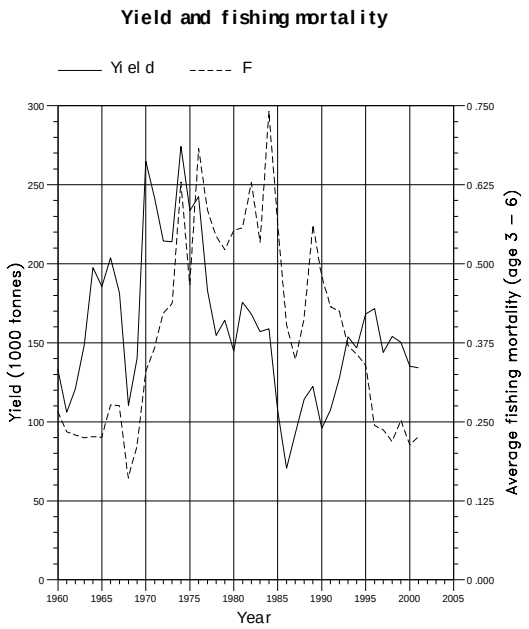
		Absolute	Catch in	Catch in	Stock	Stock	Sp.stock	Sp.stock	Sp.stock	Sp.stock
Age	F	numbers	weight	size	biomass	size	biomass	size	biomass	
2	0.0022	422	204	212000	102460	0	0	0	0	
3	0.0674	10243	6931	173189	117197	0	0	0	0	
4	0.1808	19931	21192	132553	140944	1326	1409	1326	1409	
5	0.2825	20294	31116	90555	138848	49805	76367	49805	76367	
6	0.3395	15687	31896	59785	121561	50817	103327	50817	103327	
7	0.3592	11291	28416	41037	103278	40216	101213	40216	101213	
8	0.3014	1817	5640	7667	23793	7667	23793	7667	23793	
9	0.3134	3529	12858	14398	52457	14398	52457	14398	52457	
10	0.3646	874	3781	3137	13573	3137	13573	3137	13573	
11+	0.3646	2106	11700	7559	41998	7559	41998	7559	41998	
Total		86194	153735	741882	856110	174926	414137	174926	414137	
Unit	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	

Table 5.17b (Cont'd)

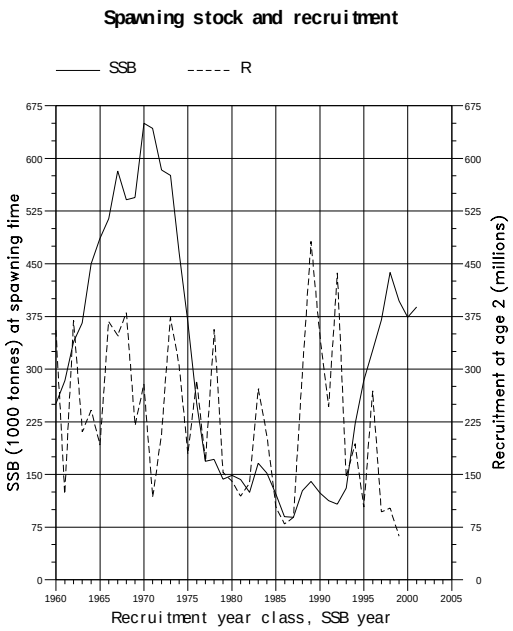
Year: 2006	F-factor: 1.0000	Reference F: 0.2176	1 January		Spawning time	
	Absolute	Catch in	Catch in	Stock	Stock	Sp.stock	Sp.stock	Sp.stock	Sp.stock
Age	F	numbers	weight	size	biomass	size	biomass	size	biomass
2	0.0022	422	204	212000	102460	0	0	0	0
3	0.0674	10243	6931	173189	117197	0	0	0	0
4	0.1808	19931	21192	132553	140944	1326	1409	1326	1409
5	0.2825	20298	31124	90576	138880	49817	76384	49817	76384
6	0.3395	14666	29820	55894	113650	47510	96602	47510	96602
7	0.3592	9591	24137	34857	87725	34160	85970	34160	85970
8	0.3014	5561	17256	23460	72802	23460	72802	23460	72802
9	0.3134	1138	4147	4644	16918	4644	16918	4644	16918
10	0.3646	2401	10387	8617	37282	8617	37282	8617	37282
11+	0.3646	1694	9413	6082	33789	6082	33789	6082	33789
Total		85944	154611	741872	861647	175614	421158	175614	421158
Unit	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Year: 2007	F-factor: 1.0000	Reference F: 0.2176	1 January		Spawning time	
	Absolute	Catch in	Catch in	Stock	Stock	Sp.stock	Sp.stock	Sp.stock	Sp.stock
Age	F	numbers	weight	size	biomass	size	biomass	size	biomass
2	0.0022	422	204	212000	102460	0	0	0	0
3	0.0674	10243	6931	173189	117197	0	0	0	0
4	0.1808	19931	21192	132553	140944	1326	1409	1326	1409
5	0.2825	20298	31124	90576	138880	49817	76384	49817	76384
6	0.3395	14669	29827	55907	113675	47521	96624	47521	96624
7	0.3592	8966	22566	32589	82016	31937	80375	31937	80375
8	0.3014	4723	14658	19927	61838	19927	61838	19927	61838
9	0.3134	3483	12689	14209	51768	14209	51768	14209	51768
10	0.3646	774	3350	2779	12024	2779	12024	2779	12024
11+	0.3646	2328	12935	8357	46432	8357	46432	8357	46432
Total		85838	155476	742086	867234	175872	426855	175872	426855
Unit	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

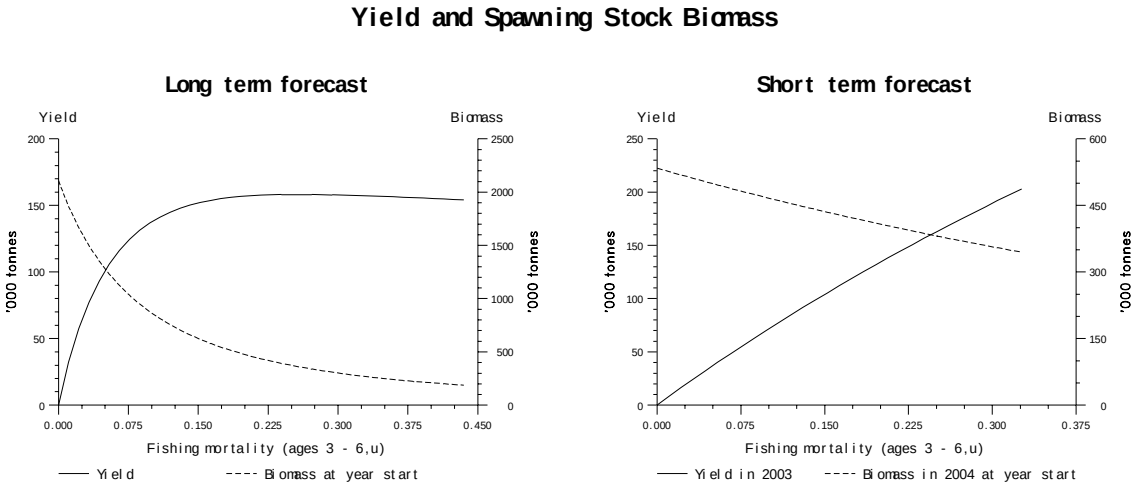
Notes: Run name : SPRAAF04
Date and time : 23APR02:18:33
Computation of ref. F: Simple mean, age 3 - 6
Prediction basis : F factors



(run: XSAAAF22) **A**



(run: XSAAAF22) **B**



(run YLDAAF06) C run MANAAF08) D

Figure 5.1 A-D NeA saithe

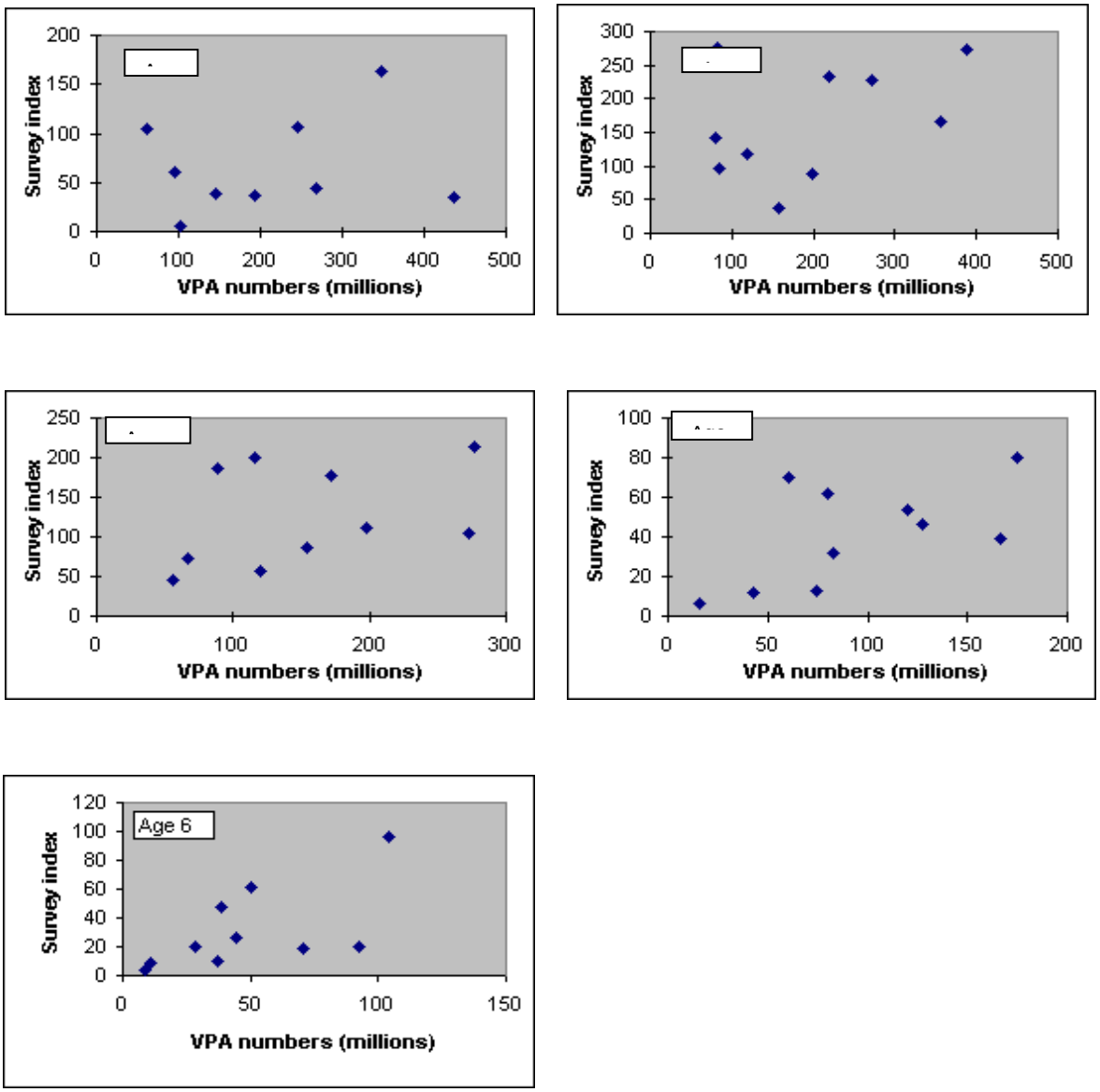


Figure 5.2A. Northeast Arctic Saithe - Acoustic survey vs VPA

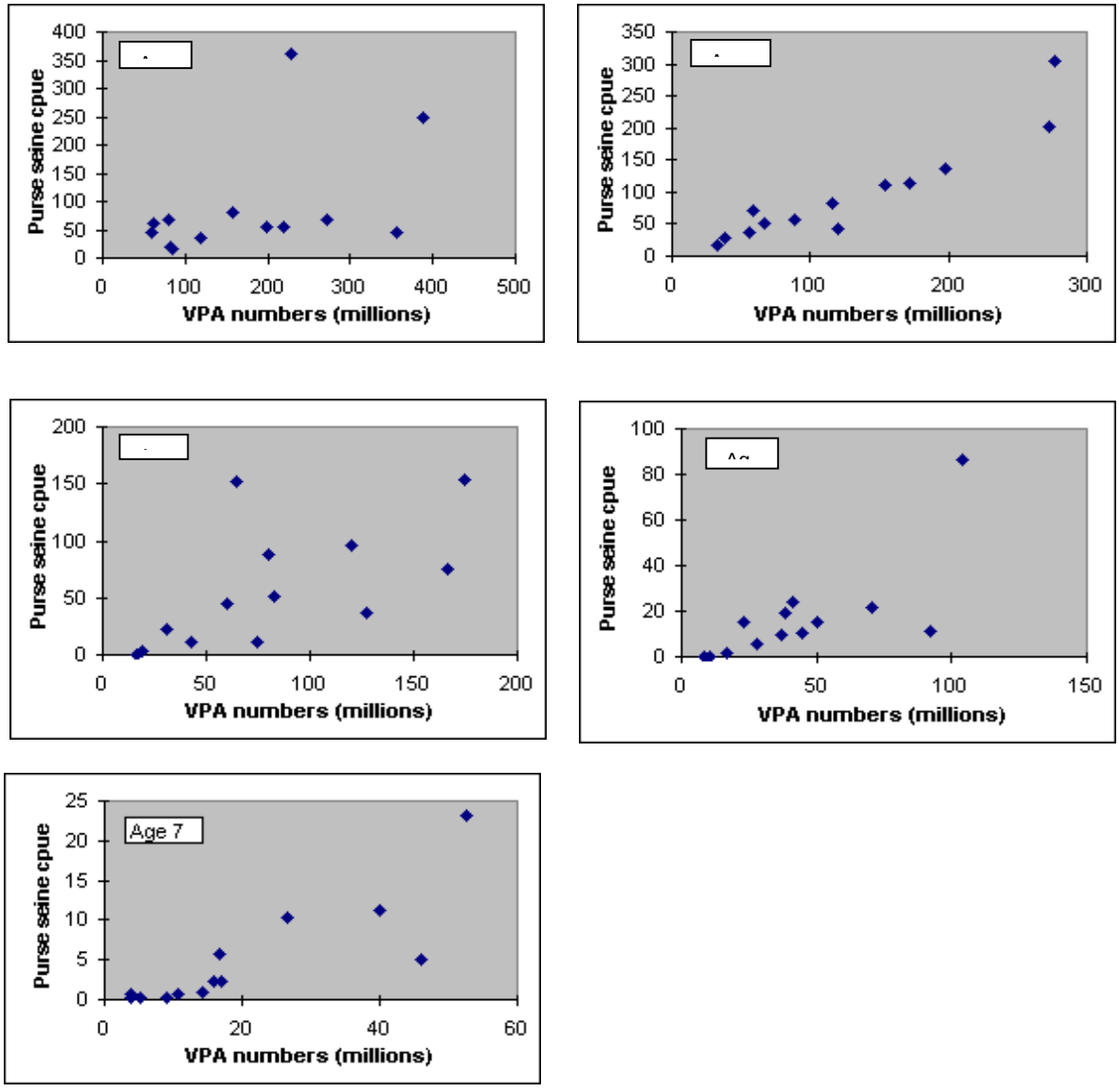


Figure 5.2B. Northeast Arctic Saithe - Norwegian purse seine vs VPA

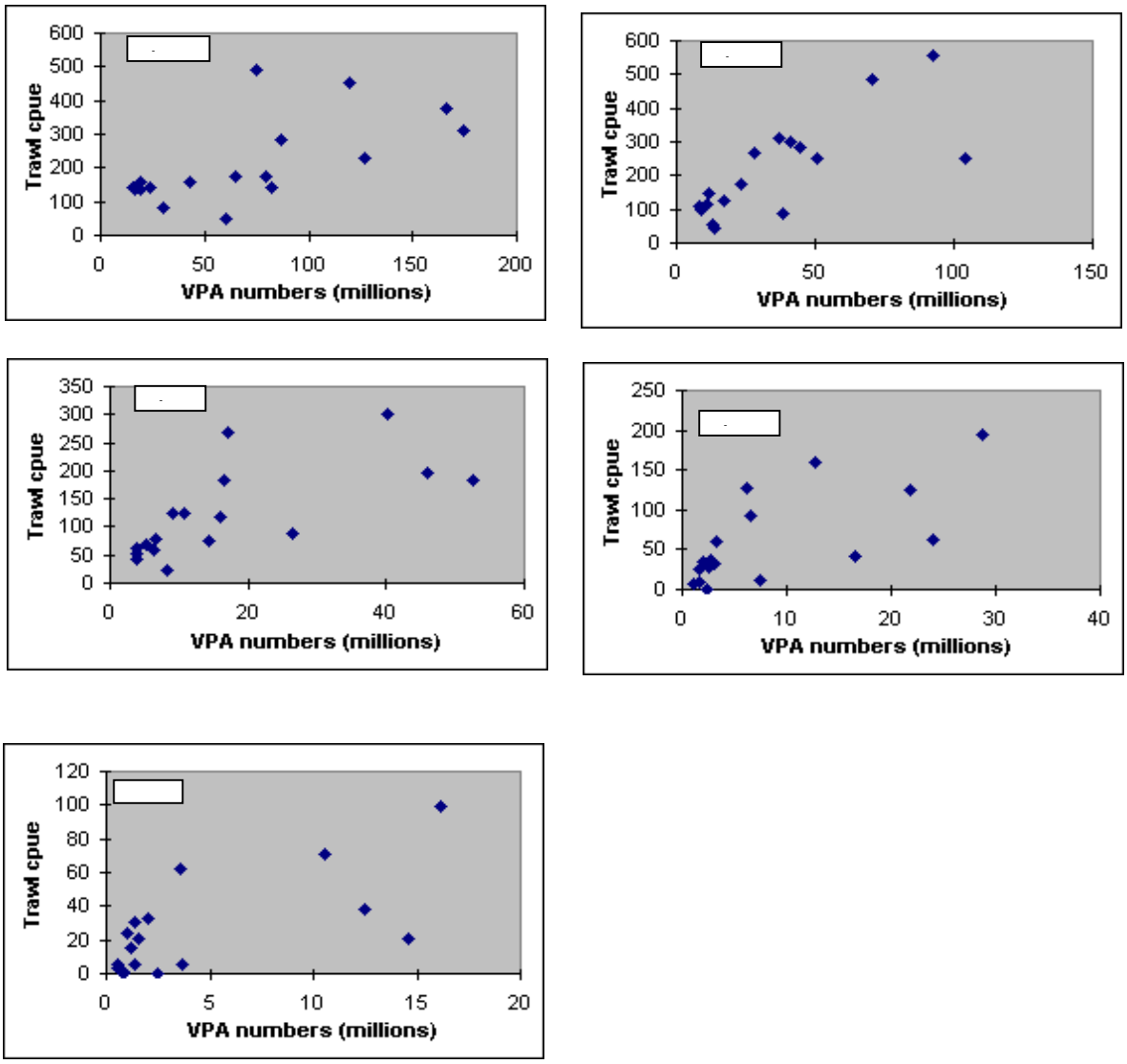
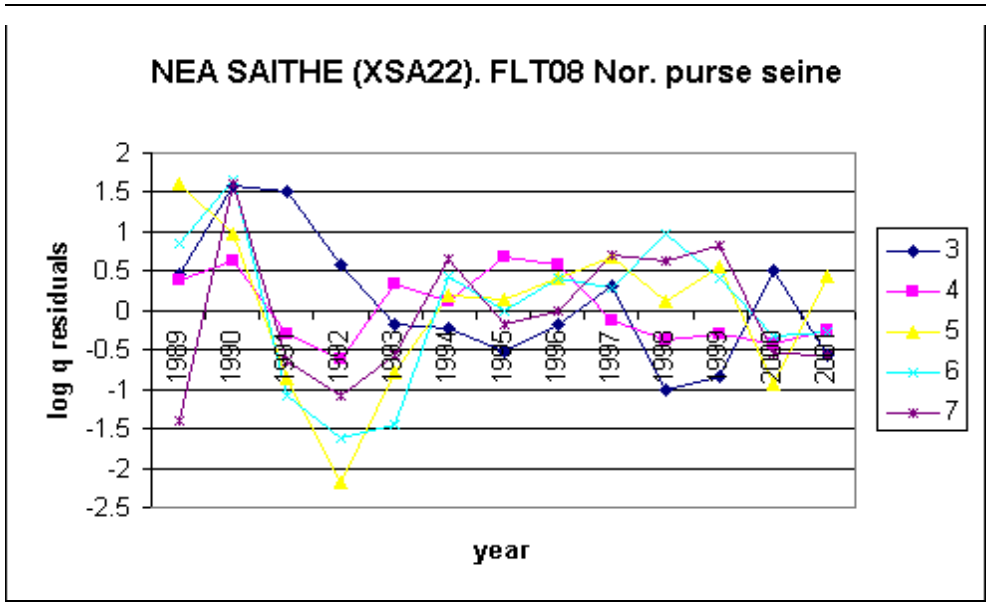


Figure 5.2C. Northeast Arctic Saithe - Norwegian trawl vs VPA

A



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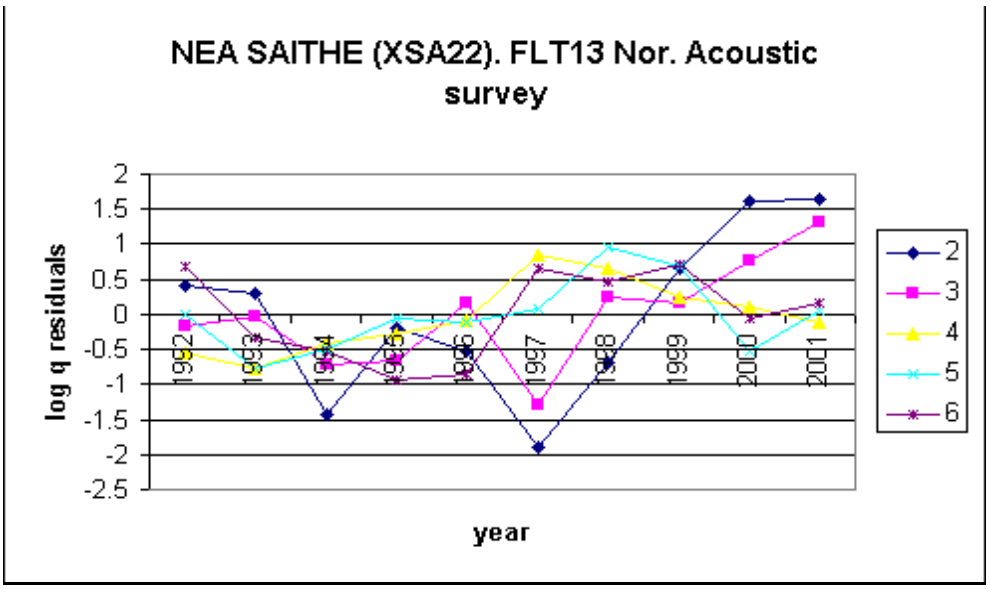


C

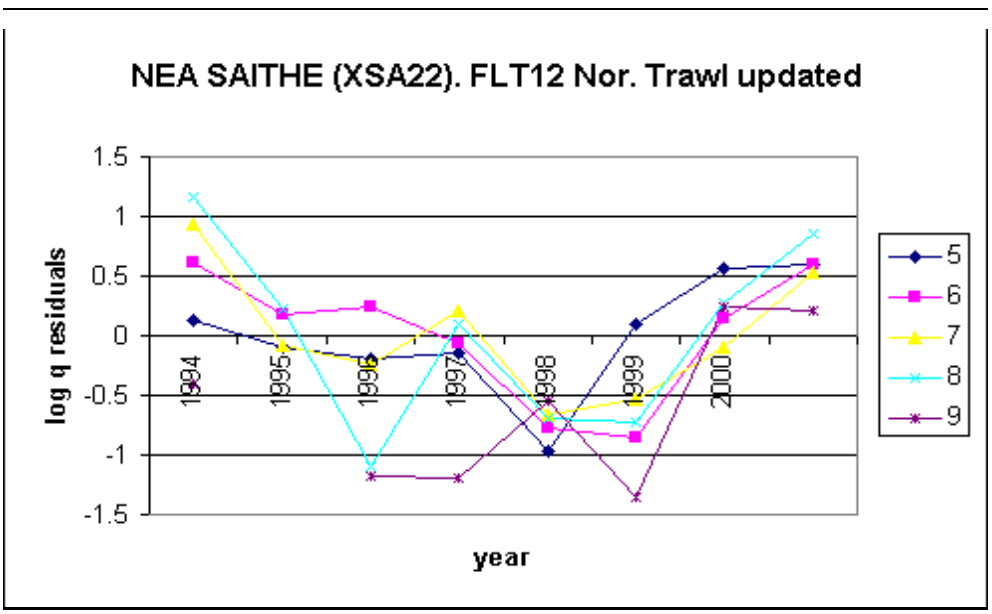


Figure 5.3 log q residuals, per tuning fleet

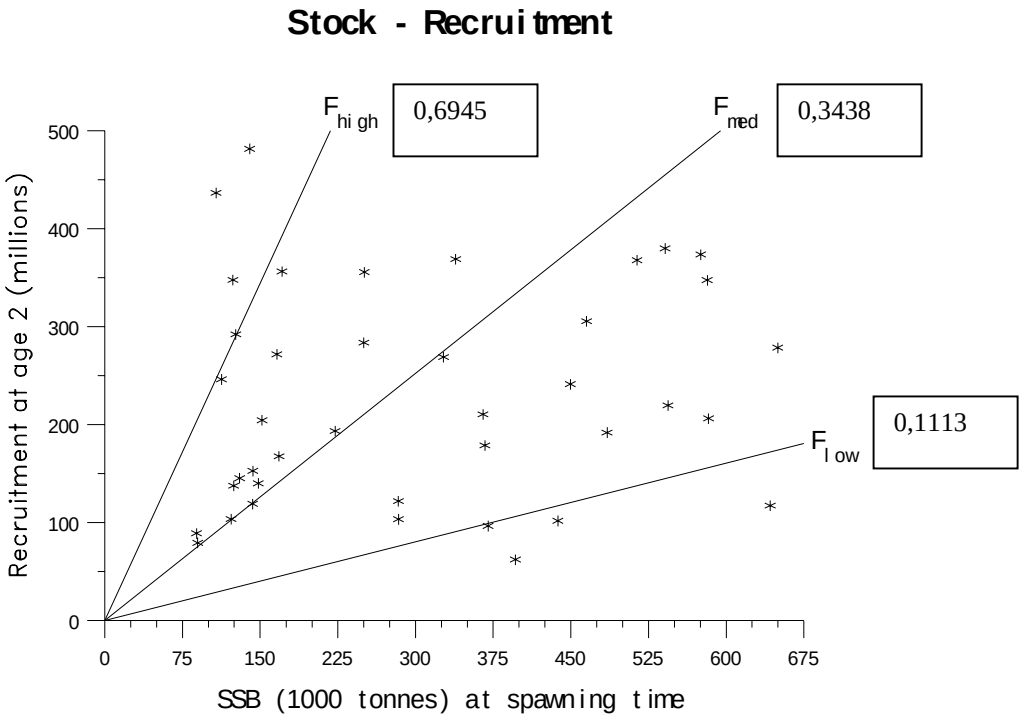
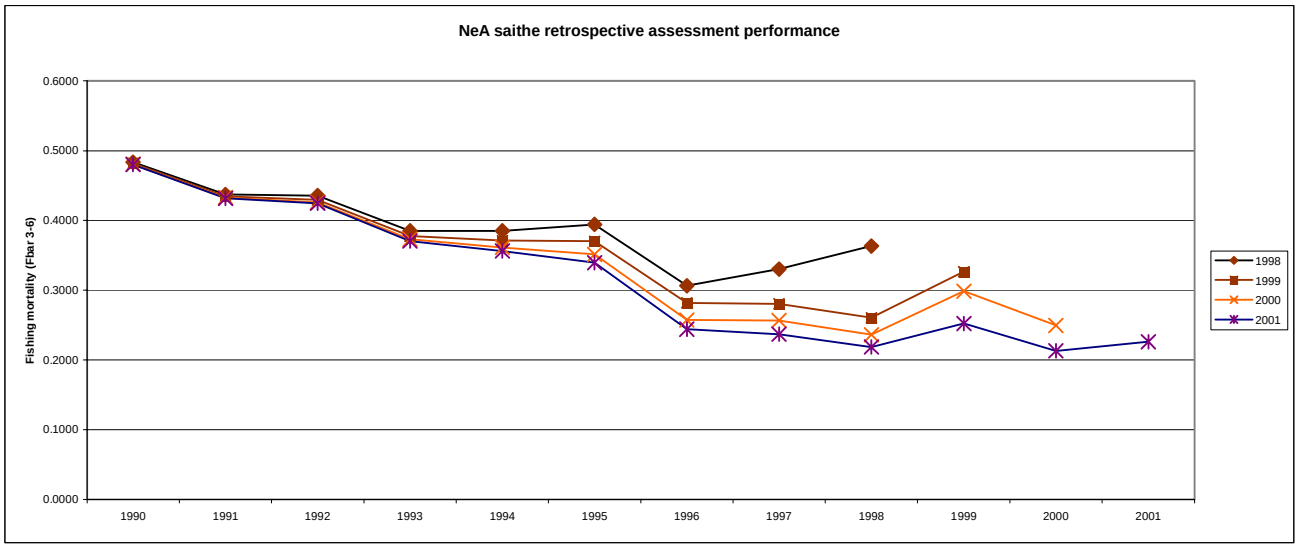
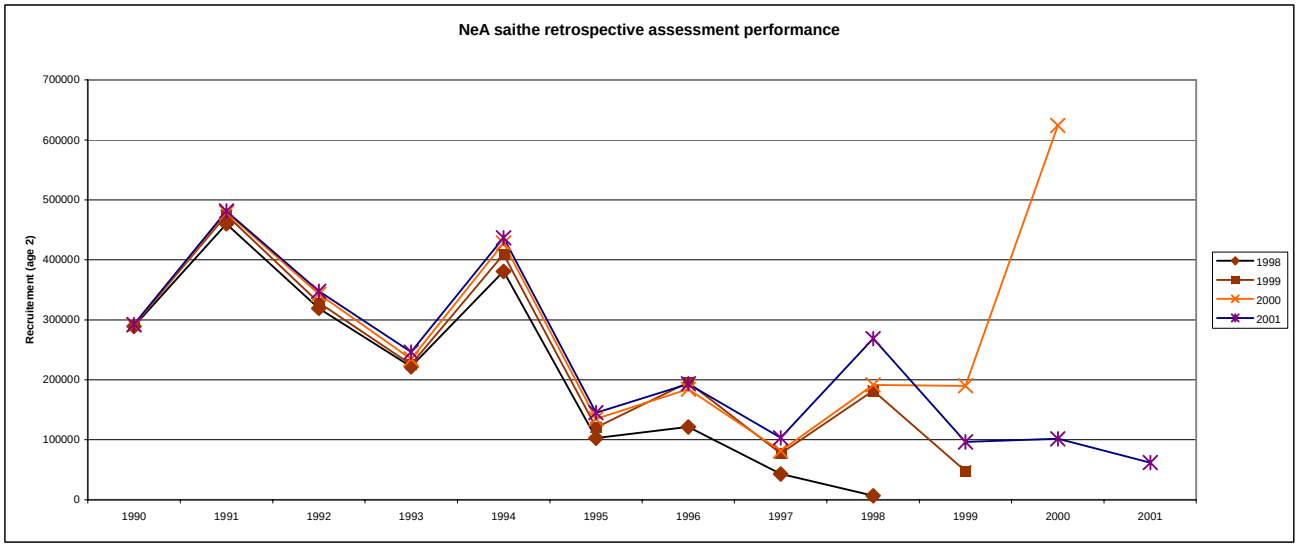


Figure 5.4 NeA saithe





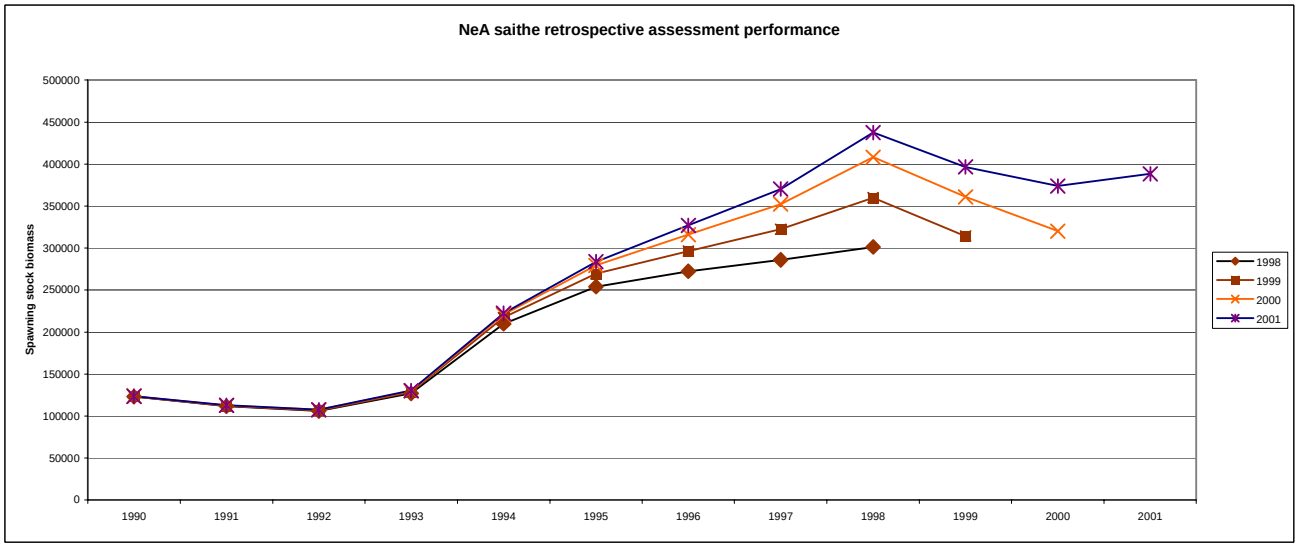


Figure 5.5 Retrospective analysis of Fbar3-6.

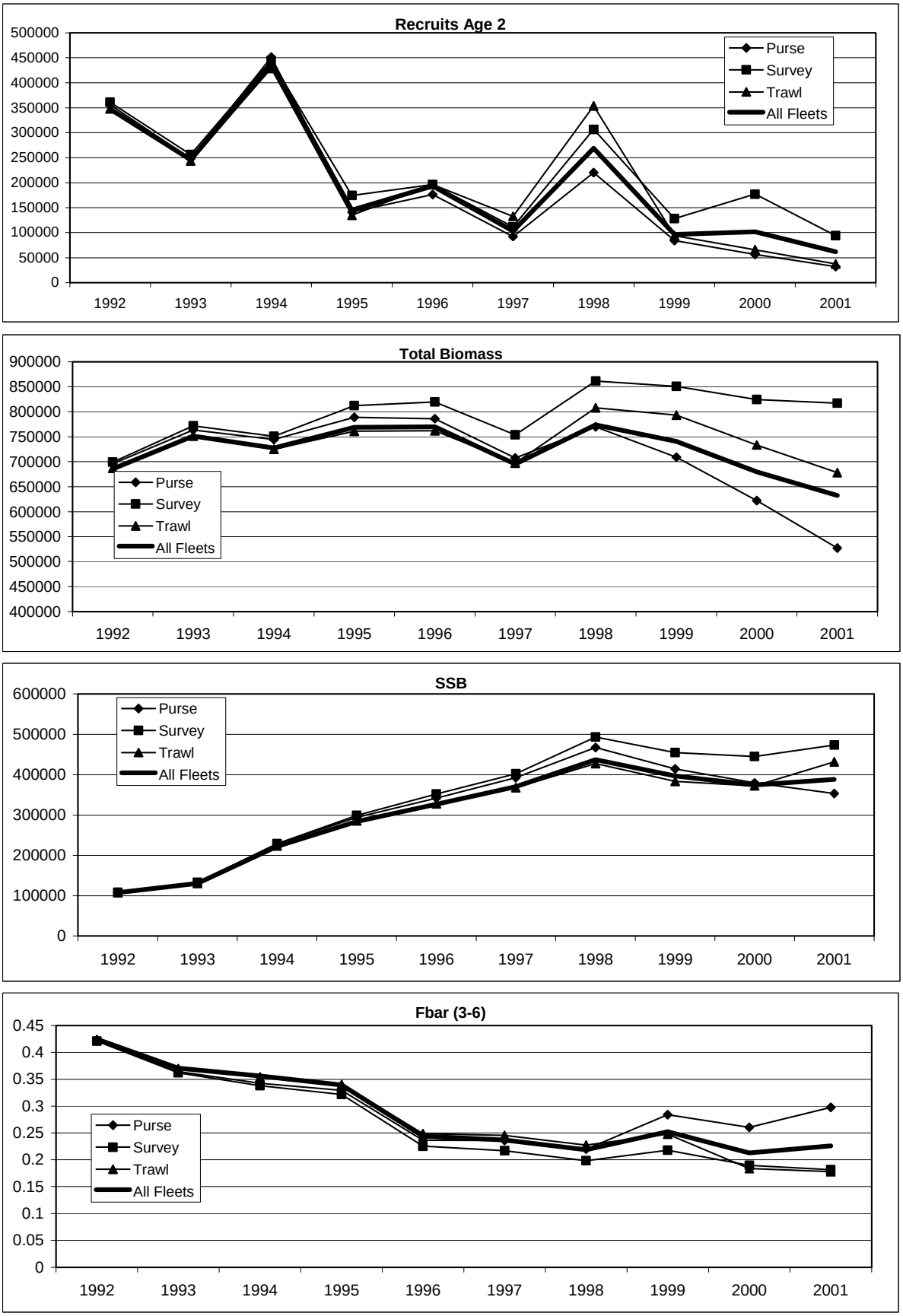
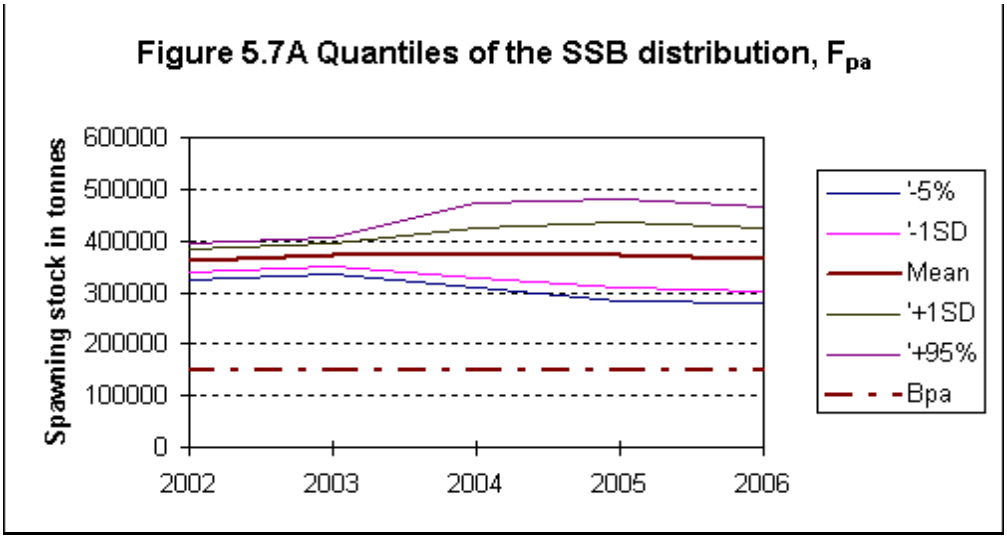


Figure 5.6 Plots of XSA results for saithe by tuning separately with individual fleets as well as including all three fleets.



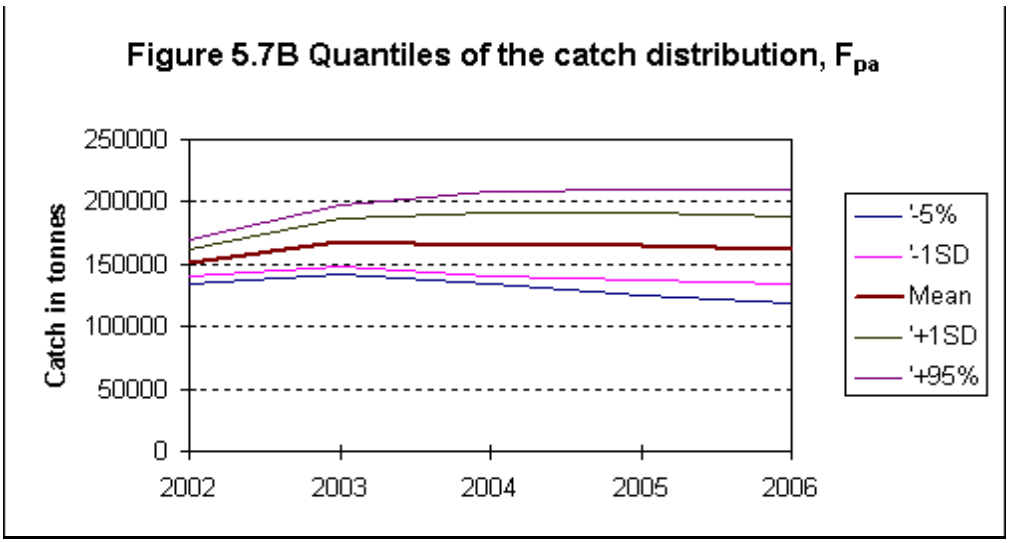


Figure 5.7 Medium-term forecast with risk analyses**.**

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			No. of vessels in % with catch		Catch from vessel with catch			Catch in % by vessel		Catch per vessel by vessel		effort, by vessel>100(t) scaled to total
	< 100 (t)	> 100 (t)	total	< 100 (t)	> 100 (t)	< 100 (t)	> 100 (t)	total	< 100 (t)	> 100 (t)	< 100 (t)	> 100 (t)	
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 [1]	215	87	302	71%	29%	4,715.0	23,396.0	28,111.0	17%	83%	21.9	268.9	104.5
Mean	123.5	85.6	#####	56%	44%	3,038.7	31,909.7	34,948.4	9%	91%	25.4	382.5	94.9

[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
1985	1	158.4	268.7	140.2	43.6	22.0	0.0	0.0
1986	1	35.6	206.8	134.6	54.0	78.7	59.4	14.8
1987	1	17.3	293.8	159.1	110.6	59.4	36.7	30.8
1988	1	5.1	61.8	286.0	144.6	63.5	33.8	21.2
1989	1	34.7	43.4	172.9	302.5	68.8	7.0	3.4
1990	1	30.0	66.4	84.0	175.8	182.8	27.6	5.2
1991	1	31.3	97.5	137.6	124.1	125.3	92.4	24.0
1992	1	0.8	285.0	144.1	115.4	124.1	126.2	62.6
1993	1	10.0	180.6	493.4	100.2	41.1	32.4	32.7
1994	1	1.6	17.4	376.8	312.8	51.5	25.2	5.1
1995	1	2.9	72.7	230.3	557.4	74.9	9.5	0.0
1996	1	6.9	41.6	140.9	486.6	196.4	12.2	1.4
1997	1	2.0	6.8	308.7	253.1	299.6	123.9	5.9
1998	1	0.2	15.9	48.1	249.7	88.9	63.2	38.2
1999	1	0.5	31.6	176.0	86.6	184.0	42.8	20.2
2000	1	28.1	158.3	160.5	282.0	118.9	193.8	71.0
2001 [2]	1	21.8	212.8	452.3	267.5	269.8	158.6	99.6

[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

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

5 NORTHEAST ARCTIC SAITHE (SUB-AREAS I AND II)

5.1 Status of the Fishery

5.1.1 Historical development of the fisheries (Tables 5.1-5.2)

Since the early 1960s the fishery has been dominated by purse seine and trawl fisheries accounting for 61% in 2001 (Table 5.2). A traditional gill net fishery for spawning saithe accounts for about 21%. The remaining catches are taken by Danish seine and handline in addition to minor by-catches in the longline fishery for other species. Some changes in recent regulations have led to less amounts taken by purse seine. Catches declined sharply after 1976 (Table 5.1). 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 92% of the landings.

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.

5.1.2 Landings prior to 2002 (Table 5.1, Figure 5.1A)

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 67,000-122,000 t (Table 5.1). An increasing trend was seen after 1990 to 171,498 t in 1996. Since then the annual landings have been 134,000-154,000 t.

The TAC for 2001 was set at 135,000 t. Provisional figures show that the landings in 2001 were approximately 135,000 t, which is also at the level expected by the WG last year.

Results from Norwegian investigations on coastal gillnet fisheries (WD 14 – Hareide and Garnes 2002) report that landing figures for saithe for the coastal gillnetters should be increased by 20% for 1999 and 2000, for the area north of 62°N, Table 5.1 and the catch figures included in the assessment have not been corrected for this. Similar information from other gears and fleets was not available to the Working Group.

5.1.3 Expected landings in 2002

ACFM advised last year that the fishing mortality should be reduced to below $\mathbf{F}_{pa}$, corresponding to a catch in 2002 of less than 152,000 t. Norwegian authorities followed this advice and set the TAC for 2002 to 152,000 t. Official landings in 2002 are expected to be around the TAC of 152,000 t, but there are several unofficial reports of increasing problems with bycatch 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 1999 the 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 (Table C1), 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 are 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 have been raised to the total purse seine catch (Table C1), and the new effort series shows a smaller decrease in later years than the old one. Exploratory XSA runs showed higher scaled weights for the CPUE-series based on the new effort data (Mehl, WD 20 2000), and at the 2000 WG meeting it was decided to use the new data in the assessment.

In 2000 new estimates of CPUE indices by age based on the logbook database having daily resolution were presented (Mehl, WD 20 2000). These estimates have been further refined and are presented in Table C2. 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. The CPUE indices are splitted on age groups by quarterly weight, length, and age data from the trawl fishery. A yearly index is than calculated by first averaging all CPUE observations for each month, and then averaging over the year. The trawl CPUE indices by age introduced in 2001, were used in XSA runs at the present WG meeting.

5.2.2 Survey results (Tables C3-C4)

Since 1985 a Norwegian acoustic survey specially designed for saithe has been conducted annually in October-November. 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 year old fish (Table C3). 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 (Korsbrekke and 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 (Mehl, WD 20 2000). At the previous WG meeting it was therefore decided to apply the extended series in the assessment. The results from the survey in autumn 2001 showed a stock in sound condition with some year class differences, e.g., less 4- and 6+ year-old fish than the recent average (WD 29-Korsbrekke and Mehl 2002). It is not known how well the survey covers and estimates 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-October (Berg and Albert, WD 33 2000), at about the same time as 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 may provide supplementary information, especially about 2- and 3-year-old saithe that have not yet migrated out to the banks. Results from the coastal cod survey from the areas not overlapping with the saithe survey are shown in Table C4. At the WG meeting in 2000 analyses were done 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 to continue only applying indices from the regular saithe survey in the assessment since this series is longer.

5.3 Data used in the Assessment

5.3.1 Catch numbers-at-age (Table 5.3)

The age composition of Norwegian landings in 2000 was revised, resulting in only minor changes. Age composition data for 2001 was available from Norway, Russia (Sub-area I), and Germany, accounting for 96% of the landings. A Russian length composition was also available for Division IIA and Division IIB, and was applied to 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 2-4, while a decrease is observed for the older age groups compared with recent 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)

Traditionally, knife-edge maturity-at-age 6 has been used for this stock. In 1995, data on spawning zones recorded in otoliths in Norway were investigated. There was no evidence of change in maturation rates over the period in the assessment 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.

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 tuning series, and a CPUE series from the trawl fisheries (see chapter 5.2.1). The time span in the Norwegian acoustic survey series was set to 1992 – 2001 according to an enlargement in area coverage from 1992 and onwards. The CPUE series from the Norwegian trawl fishery, used in WG 2001, was updated 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 aiming at establishing a 0-group index series has just started (2000) (WD 21 – Borge and Mehl 2002). It varies from year to year to what extent the 2-year-old saithe (and in some years even 3-year-olds) have migrated out from the near coast areas and are available for 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 2002 was taken from the XSA for age 5 and older. The recruitment at ages 2 and 3 in 2001 (1998 and 1999 year classes) was estimated using RCT3 (Section 5.5.2). The corresponding numbers-at-age 3 and 4 in 2002 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 (1960-1997) of 212 million was used for the 2000 and subsequent year classes. The natural mortality and the maturity ogive are the same as used in the assessment. For the exploitation pattern the average of 1999-2001 has been used, scaled to the 2001 level. 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, 5.6)

Extended Survivors Analysis (XSA) was used for the assessment with the same settings as last year in the analyses. Catchability was assumed to be independent of stock size for all ages. The same three fleets as used for last year's assessment were also used this year. It was, however, decided to reduce the time-series in the Norwegian acoustic survey series to 1992-2001 due to a more uniform area coverage since then. The log-q residuals for the acoustic survey show some trends and high values for the 2- and 3-year-olds, especially in the two last years (Figure 5.3). This is caused by variable recruitment of these age groups to the survey area, but since the 2- and 3-year-olds are estimated separately by RCT3, the Working Group considered the acoustic survey series to give a reliable contribution to the assessment. Generally the trawl CPUE series shows clear trends probably not reflecting the stock development, i.e., from positive to negative to positive residuals in the two recent years. However, excluding this series from the tuning did not improve the diagnostics, although such commercial CPUE series are difficult to use due to regulations of the fishery and schooling behaviour of the saithe. Until ongoing improvement of this trawl CPUE series has been finished and its usefulness analysed, the Working Group decided to use it in the same manner as at last year's assessment. The commercial purse seine CPUE series was updated but otherwise unchanged. Figures 5.2A-C show plots of the tuning indices versus stock numbers from the XSA, and Figure 5.6 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, Figures 5.3 B-C)

Estimates of the recruiting year classes up to the 1997 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). Also, the quality control sheets show that estimates of recruitment at age 2 in the last VPA year have been unreliable, and this is also shown by the retrospective analysis (Figures 5.5). Estimates of recruitment at age 3 have been somewhat more precise. However, in the later years catches of 3-year-olds have also been reduced due to

fishermen targeting the bigger and more valuable fish which are now available in the stock, and due to the new minimum landing size introduced in 1999. RCT3-runs were therefore conducted to estimate both the 1998 and 1999 year classes, with 2- and 3-year-olds from the survey as input for the estimation. The RCT3 analysis shows little dynamics in the estimates of these age groups.

5.5 Results of the Assessment

5.5.1 Fishing mortalities and VPA (Tables 5.7-5.11, Figures 5.1A-B, 5.5)

The fishing mortality (F_{3-6}) in 2000 was 0.21, which is well below the value of 0.26 from last year's assessment (Figure 5.5). Using the RCT3 estimation of the 1998 year class gives a fishing mortality (F_{3-6}) in 2001 of 0.22, i.e lower than the current $\mathbf{F}_{pa}$. Fishing mortalities and stock size tend to be over- and underestimated, respectively, in the assessment year, and this is illustrated by the retrospective plots in Figure 5.5.

The XSA-estimates of the 1998-1999 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 which all years have been well represented in the catches, also come out as strong and above average year classes, respectively, in the current assessment. The 1997 year class has shown up much weaker than the 1996 year class in the catches and in the assessment, and this is in accordance with the survey results.

The stock and spawning stock biomass (SSB) tables are included (Tables 5.9-5.11). The total biomass (ages 2+) has been at a stable and high level above the long-term (1960-2001) mean since 1993, and, likewise, the SSB since 1996.

5.5.2 Recruitment (Tables 5.12-5.13)

The RCT3 estimates (with 2-year-olds as input, Table 5.12) of the 1999 year class is 240 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 1998 year class gives 260 million individuals. Thus, the 1998-year class is estimated to be of similar strength as the 1996-year class at age 2, while the 1999 year class is estimated to be somewhat weaker but above the long-term mean. This is in accordance with the survey results (Table C3). It was decided to use the RCT3 estimates for ages 2 and 3 in 2001, and the long-term geometric mean of 212 million individuals for the 2000 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 1998A).

5.6.2 Fishing mortality reference points (Tables 5.14, 5.15, Figures 5.1C, 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 0.26, respectively, which is slightly above the values of 0.11 and 0.23 obtained last year. The plot of SSB versus recruitment is shown in Figure 5.4. $\mathbf{F}_{low}$, $\mathbf{F}_{med}$, and $\mathbf{F}_{high}$ were recalculated. The values obtained in 1999 were 0.18, 0.34, and 0.70, respectively, while the new values calculated this year 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 1998b). Since then the fishing pattern has changed due to the introduction of new minimum catch sizes 1 March 1999 (see chapter 5.1.1). A revision of the present fishing mortality reference points will therefore be conducted as soon as the new regulations have manifested themselves in a stable improvement of the actual fishing pattern.

5.7 Catch Options for 2003 (Short-Term Predictions) (Table 5.16)

The management option table (Table 5.16) shows that the expected catch of 152,000 t in 2002 will keep the fishing mortality below $\mathbf{F}_{pa}$. A catch in 2003 corresponding to F_{01} *(status quo)* level of 0.22 will give 144,000 t, while a catch corresponding to $\mathbf{F}_{pa}$, which is also close to $\mathbf{F}_{max}$, in 2003, will give 168,000 t. It may also be kept in mind when deciding upon the catch level for 2003 that the fishing mortality in the assessment year still tends to be overestimated

for this stock. The SSB is expected to increase in 2002 from 360,000 t to 370,000 t in the beginning of 2003, which is close to the prediction given by last year's Working Group.

5.8 Medium-term forecasts and management scenarios (Table 5.17a,b, Figures 5.1D, 5.7A,B)

The input data were the same as used for the short-term predictions (Table 5.14). Single option predictions (detailed tables in Table 5.17b) for $F_{status\ quo}$ (= F_{2001}) and $\mathbf{F}_{pa}$ are given in Table 5.17a,b for the period 2001-2007. At $F_{status\ quo}$ the catch will increase to 155,000 t in 2006-2007. The SSB will at the same fishing mortality increase to about 427,000 t in the years 2007. At $\mathbf{F}_{pa}$ the catch will increase to 168,000 t in 2003, and stay above 160,000 t during the forecast period. The SSB will at the same fishing mortality and during the same period stay at a stable level of about 360,000-370,000 t. Results from a projection with RISK is shown for $\mathbf{F}_{pa}$ for SSB and catch up to 2006 (Figure 5.7 a,b).

A risk analyses was performed where only uncertainty in the initial stock estimate and the recruitment was taken into account. The program @RISK was performed, using 1000 iterations and fixed seed for the random number generator. Two probability distribution functions were used to add uncertainty and sample sets of possible values during the simulations. For the initial stock size a lognormal distribution was applied, LOGNORM(mean, standard deviation), with the initial stock numbers by age from the RCT3 and XSA as mean and standard deviation calculated by multiplying the mean by the external standard error from the XSA diagnostics. A truncated lognormal distribution, TLOGNORM(mean, standard deviation, minimum, maximum), was used for the recruitment at age 2. The mean, standard deviation, minimum, and maximum were found from the XSA for the years 1962-1997, and the corresponding values were 212, 104, 79, and 481 million, respectively.

5.9 Comparison of this years assessment with last years assessment

Compared to last year's assessment the only input change in addition to regular updating has been the shortening of the acoustic survey tuning series which in the current assessment goes back to 1992, while in last year's assessment it went back to 1988. Updating of the trawl CPUE led to a great increase in the CPUE for 2000 compared to the preliminary available value last year.

The current assessment has also this year revised the most recent previous year's fishing mortalities downwards and the stock level upwards.

	Total stock (2+) by 1 January 2001	SSB by 1 January 2001	F3-6 in 2001	F3-6 in 2000
WG 2001	752693	287730	0.26 (prediction)	0.26
WG 2002	798380	388289	0.22	0.21

5.10 Comments on the assessment and the forecast

The suitability of the trawl CPUE series to show stock trends should be further explored. Trial XSA-runs using only the fishery independent acoustic survey series gave positive log q residuals. Only relying on the acoustic series therefore tended to overestimate the stock. In general, the Working Group tended to put more reliance in the survey, especially for ages 4 and 5, compared with commercial CPUEs. The applicability of only using the survey should therefore be further investigated.

In order to enhance the reliability of the assessment, as wide an area of saithe distribution as possible should be covered by the acoustic surveys. This includes the Russian EEZ where much saithe were distributed in 2001 (WD 26 – Drevetnyak 2002). Standardization of trawling performance, acoustic method, scrutinizing, and estimation methods needs to be conducted before different surveys can be combined.

The exploitation patterns are now better than in the past and 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.

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[1]	519[2]	315[2]	701[2]	2,680[6]	124,510	-	75	4,951	89[2]	202		58[2]	134,100

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 [1]	28.1	54.9	28.1	23.0	134.1

[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 : Arctic Saithe (run: XSAAAF22/X22) At 22/04/2002 10:28

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

	YEAR	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
	AGE												
	2	7381	4936	1246	2815	20308	30430	7450	6952	5297	4090	25952	19842
	3	10509	17824	37266	42050	9001	37115	22392	29664	25196	77333	43540	77019
	4	13083	9131	11131	28925	59601	5001	54537	24836	18384	11949	62846	59280
	5	13545	12506	4421	5888	13154	26300	13124	35956	5101	16939	13987	26961
	6	5064	3799	8290	4650	2718	10142	12899	4125	8282	4747	16189	9556
	7	4883	1332	2427	3861	3472	2861	4652	5616	787	4798	5122	9592
	8	2401	968	1024	1099	2655	2110	1374	2916	1913	1126	7950	2901
	9	1315	520	938	1075	1251	2733	933	1413	900	1711	2504	4352
	10	743	405	451	697	1221	699	965	1397	577	675	3697	2195
	+gp	1525	1229	1728	1777	3559	3593	2900	3493	1166	511	2799	5490
0	TOTALNUM	60449	52650	68922	92837	116940	120984	121226	116368	67603	123879	184586	217188
	TONSLAND	133515	105951	120707	148627	197426	185600	203788	181326	110247	140060	264924	241272
	SOPCOF %	126	138	123	121	116	108	111	95	117	97	97	78

Run title : Arctic Saithe (run: XSAAAF22/X22)
At 22/04/2002 10:28

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

	YEAR	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
	AGE										
	2	11608	13829	21159	81601	54151	31662	45758	28334	18226	10467
	3	65178	76296	36782	60832	125030	99049	48969	61963	40796	83954
	4	52389	25206	44027	11691	30576	34317	27685	23328	36644	21822
	5	29146	26911	15671	16366	7947	10140	12476	14122	9211	21528
	6	10186	16031	20419	4436	8712	2062	4534	4400	6379	3619
	7	5616	7114	12148	7808	3435	4332	1468	2901	3200	2550
	8	3547	3935	4802	6789	3212	1456	1848	963	1338	2008
	9	1865	2871	3258	2914	2679	1606	938	1356	147	369
	10	2140	2610	2505	2350	1724	963	976	438	730	279
	+gp	3149	3924	3821	4140	2880	1134	2150	1192	1629	629
0	TOTALNUM	184824	178727	164592	198927	240346	186721	146802	138997	118300	147225
	TONSLAND	214334	213859	274121	233453	242486	182817	154464	164180	144554	175516
	SOPCOF %	84	81	101	102	100	101	103	114	94	100

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

	YEAR	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
	AGE										
	2	17225	11638	14624	2216	3311	3867	5017	11157	11543	6135
	3	34733	17244	41466	48917	22115	17869	8126	12378	21002	73878
	4	65052	23768	33233	11974	12895	49829	35847	19915	13463	11619
	5	13060	32700	12064	7189	6062	4339	32827	32643	8996	5395
	6	8212	3226	11204	5279	4525	3118	4560	18751	9152	5066
	7	1054	3008	1135	3740	2805	3490	2328	1939	7735	2988
	8	1251	1177	1772	775	1399	755	1219	377	1126	2009
	9	461	760	560	878	351	620	966	191	154	272
	10	263	247	557	134	454	257	320	179	121	81
	+gp	448	760	897	701	285	797	102	149	253	132
0	TOTALNUM	141759	94528	117512	81803	54202	84941	91312	97679	73545	107575
	TONSLAND	168034	156936	158786	107183	70458	92391	114242	122310	95848	107326
	SOPCOF %	98	101	100	99	99	102	99	99	100	99

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

	YEAR	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
	AGE										
	2	14333	3379	1432	70	961	326	35	91	1192	202
	3	49750	26933	9369	16402	10225	14827	3100	9644	9397	3952
	4	26640	63451	38499	48351	57448	13295	16261	12220	22921	8352
	5	4865	26254	48587	37268	18667	43309	11981	22804	7865	26697
	6	5594	3427	17617	32240	17805	13029	31918	10321	11282	8189
	7	4850	1636	1772	4842	17861	11219	8405	18932	5806	6502
	8	3353	1263	517	572	2765	5837	5556	3384	8177	3131
	9	1480	950	305	139	485	755	2881	3335	2330	4945
	10	291	650	275	280	202	63	731	2293	2526	1810
	+gp	267	106	697	305	443	160	397	589	1210	2129
0	TOTALNUM	111423	128049	119070	140469	126862	102820	81265	83613	72706	65909
	TONSLAND	127516	153584	146544	168174	171498	143760	153822	150274	135170	134100
	SOPCOF %	100	100	100	100	100	100	100	100	100	100

Table 5.4 Catch weights-at-age

Run title : Arctic Saithe (run: XSAAAF22/X22)

At 22/04/2002 10:28

Table 2 Catch weights-at-age (kg)

	YEAR	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
	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
	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
	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
	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
	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
	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
	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
	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
	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
	+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
0	SOPCOFAC	1.2559	1.3848	1.2272	1.2075	1.1644	1.0782	1.1067	0.9475	1.1662	0.9734	0.9741	0.7841

Table 2 Catch weights-at-age (kg)

	YEAR	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
	AGE										
	2	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.45	0.43
	3	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.79	0.73
	4	1.11	1.11	1.11	1.11	1.11	1.11	1.11	1.11	1.27	1.4
	5	1.63	1.63	1.63	1.63	1.63	1.63	1.63	1.63	2.03	2.05
	6	2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.55	2.76
	7	3.16	3.16	3.16	3.16	3.16	3.16	3.16	3.16	3.29	3.3
	8	4.03	4.03	4.03	4.03	4.03	4.03	4.03	4.03	4.34	4.38
	9	4.87	4.87	4.87	4.87	4.87	4.87	4.87	4.87	5.15	5.95
	10	5.63	5.63	5.63	5.63	5.63	5.63	5.63	5.63	5.75	6.39
	+gp	7.477	7.385	7.217	7.127	7.32	7.394	7.527	7.809	6.937	6.841
0	SOPCOFAC	0.8362	0.8099	1.0131	1.0155	1.002	1.0062	1.0278	1.1384	0.9355	0.9975

Table 2 Catch weights-at-age (kg)

	YEAR	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
	AGE										
	2	0.51	0.6	0.53	0.38	0.32	0.34	0.33	0.45	0.54	0.4
	3	0.77	1.05	0.71	0.75	0.59	0.53	0.62	0.74	0.76	0.72
	4	1.12	1.33	1.26	1.33	1.22	0.84	0.87	0.97	1.08	1.19
	5	2.02	1.86	2.02	2.07	1.97	1.66	1.31	1.39	1.56	1.78
	6	2.61	2.8	2.7	2.63	2.3	2.32	2.43	1.81	2.12	2.24
	7	3.27	4	3.88	3.28	2.87	2.97	3.87	3.02	2.4	2.86
	8	3.91	4.18	4.47	3.96	3.72	4	5.38	3.76	3.65	3.32
	9	4.69	5.33	5.36	4.54	4.3	4.72	5.83	4.64	3.6	4.53
	10	5.63	5.68	6.06	5.55	4.69	5.44	5.36	4.75	6.37	5.7
	+gp	7.558	8.665	7.19	8.012	6.597	6.904	7.448	7.5	4.795	7.125
0	SOPCOFAC	0.9794	1.0089	0.9997	0.9933	0.9929	1.0233	0.9879	0.9949	1.0049	0.9912

Table 2 Catch weights-at-age (kg)

	YEAR	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
	AGE										
	2	0.45	0.46	0.35	0.5	0.4	0.38	0.35	0.64	0.37	0.44
	3	0.7	0.63	0.52	0.56	0.59	0.62	0.68	0.67	0.61	0.75
	4	1.1	1.02	0.74	0.78	0.82	0.92	1	1.05	1.02	1.12
	5	1.98	1.7	1.22	1.21	1.32	1.19	1.48	1.45	1.61	1.54
	6	2.34	2.5	2.16	1.74	1.83	1.66	1.87	1.93	2.12	2.05
	7	2.81	2.88	3.19	2.8	2.47	2.31	2.58	2.28	2.66	2.61
	8	3.25	3.09	3.97	3.74	3.72	3.1	3.07	2.97	3.21	3.13
	9	4.06	3.7	4.62	4.4	4.49	4.34	4.12	3.6	3.74	3.59
	10	6.19	6.19	5.28	5.28	5.3	6.04	5.45	4.11	4.35	4.52
	+gp	7.376	8.175	6.072	7.451	7.016	7.62	8.052	5.513	5.975	5.179
0	SOPCOFAC	0.9993	1.0008	1.0038	0.9999	0.9999	1.0011	1.0015	1.0003	1.0031	1.0005

Table 5.5 Tuning data

```
Northeast Arctic saithe (Sub-areas I and II) (run name: XSAAAF22)
103
FLT08: Norway Purse Seine reviced 2000 (Catch: Unknown) (Effort: Unknown)
1989 2001
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     2422     4328    11508      653      274

FLT12: Nor trawl updated 2002 (Catch: Unknown) (Effort: Unknown)
1994 2001
1 1 0.00 1.00
5 9
   1      377      313       52       25        5
   1      230      557       75       10        0
   1      141      487      196       12        1
   1      309      253      300      124        6
   1       48      250       89       63       38
   1      176       87      184       43       20
   1      161      282      119      194       71
   1      452      268      270      159      100

FLT13: Norway Ac Survey extended 2000 (Catch: Unknown) (Effort: Unknown)
1992 2001
1 1 0.75 0.85
2 6
   1   163.5   273.6    57.5     6.2     8.8
   1   106.9   227.7   103.9    12.7     3.2
   1    34.4    87.8   112.4    39.5    10.0
   1    38.7   165.2    87.0    46.8    20.0
   1    37.0   118.9   214.7    32.1    19.3
   1     5.1    36.7   185.8    79.8    61.7
   1    43.6    96.5   200.6    70.0    96.7
   1    61.1   233.8    72.9    62.2    47.8
   1   164.8   142.5   176.3    11.6    26.5
   1   104.7   275.9    45.9    53.8    20.1
```

Table 5.6 Tuning diagnostics

Lowestoft VPA Version 3,1

22/04/2002 10:28

Extended Survivors Analysis

Arctic Saithe (run: XSAAAF22/X22)

CPUE data from file fleet

Catch data for 42 years, 1960 to 2001, Ages 2 to 11,

Fleet	First year	Last year	First age	Last age	Alpha	Beta
FLT08: Norway Purse	1989	2001	3	7	0	1
FLT12: Nor new trawl	1994	2001	5	9	0	1
FLT13: Norway Ac Sur	1992	2001	2	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 34 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	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
2	0.047	0.015	0.004	0.001	0.006	0.003	0	0.001	0.013	0.004
3	0.153	0.116	0.054	0.052	0.1	0.11	0.041	0.05	0.141	0.055
4	0.28	0.297	0.242	0.426	0.261	0.182	0.169	0.228	0.16	0.18
5	0.412	0.493	0.39	0.391	0.288	0.32	0.249	0.379	0.225	0.283
6	0.854	0.576	0.74	0.489	0.327	0.335	0.415	0.353	0.327	0.386
7	0.879	0.658	0.678	0.459	0.556	0.354	0.377	0.467	0.344	0.317
8	0.928	0.594	0.445	0.482	0.52	0.352	0.297	0.255	0.377	0.315
9	0.612	0.754	0.273	0.203	1.025	0.258	0.293	0.292	0.28	0.412
10	0.757	0.604	0.508	0.434	0.512	0.334	0.429	0.403	0.377	0.366

Table 5.6 Tuning diagnostics (Cont'd)

XSA population numbers (Thousands)

YEAR \ AGE	2	3	4	5	6	7	8	9	10
1992	3.48E+05	3.89E+05	1.20E+05	1.59E+04	1.08E+04	9.17E+03	6.13E+03	3.57E+03	6.06E+02
1993	2.46E+05	2.72E+05	2.73E+05	7.45E+04	8.65E+03	3.75E+03	3.12E+03	1.98E+03	1.59E+03
1994	4.37E+05	1.99E+05	1.98E+05	1.66E+05	3.72E+04	3.98E+03	1.59E+03	1.41E+03	7.63E+02
1995	1.45E+05	3.56E+05	1.54E+05	1.27E+05	9.22E+04	1.45E+04	1.65E+03	8.34E+02	8.79E+02
1996	1.93E+05	1.19E+05	2.77E+05	8.24E+04	7.05E+04	4.63E+04	7.53E+03	8.36E+02	5.57E+02
1997	1.03E+05	1.57E+05	8.81E+04	1.75E+05	5.06E+04	4.16E+04	2.17E+04	3.66E+03	2.45E+02
1998	2.69E+05	8.43E+04	1.16E+05	6.01E+04	1.04E+05	2.96E+04	2.39E+04	1.25E+04	2.32E+03
1999	9.65E+04	2.20E+05	6.62E+04	7.99E+04	3.84E+04	5.61E+04	1.66E+04	1.45E+04	7.64E+03
2000	1.02E+05	7.89E+04	1.72E+05	4.32E+04	4.47E+04	2.21E+04	2.88E+04	1.06E+04	8.89E+03
2001	6.21E+04	8.22E+04	5.61E+04	1.20E+05	2.82E+04	2.64E+04	1.28E+04	1.62E+04	6.53E+03

Estimated population abundance at 1st Jan 2002

0.00E+00	5.06E+04	6.37E+04	3.84E+04	7.38E+04	1.57E+04	1.58E+04	7.66E+03	8.77E+03

Taper weighted geometric mean of the VPA populations:

1.68E+05	1.47E+05	1.07E+05	6.54E+04	3.30E+04	1.57E+04	6.60E+03	2.91E+03	1.21E+03

Standard error of the weighted Log(VPA populations) :

1									
	0.6578	0.616	0.6817	0.7724	0.8096	0.9494	1.1106	1.2409	1.2695

Log catchability residuals,

Fleet : FLT08: Norway Purse

Age	1989	1990	1991
2	No data for this fleet at this age		
3	0.47	1.59	1.52
4	0.38	0.64	-0.3
5	1.62	0.98	-0.86
6	0.84	1.65	-1.09
7	-1.41	1.6	-0.64
8	No data for this fleet at this age		
9	No data for this fleet at this age		

Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
2	No data for this fleet at this age									
3	0.58	-0.17	-0.22	-0.53	-0.17	0.31	-1.02	-0.83	0.51	-0.58
4	-0.61	0.33	0.12	0.68	0.57	-0.13	-0.38	-0.3	-0.42	-0.24
5	-2.19	-0.8	0.19	0.15	0.41	0.67	0.12	0.55	-0.93	0.44
6	-1.63	-1.46	0.44	-0.01	0.4	0.28	0.97	0.4	-0.32	-0.28
7	-1.07	-0.56	0.65	-0.17	-0.01	0.71	0.63	0.82	-0.54	-0.56
8	No data for this fleet at this age									
9	No data for this fleet at this age									

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

Age	3	4	5	6	7
Mean Log q	-7.4706	-6.7882	-7.1976	-7.8536	-8.4093
S,E(Log q)	0.7816	0.4433	0.9185	0.9001	0.7989

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	1.11	-0.235	6.99	0.35	13	0.91	-7.47
4	0.85	0.885	7.53	0.78	13	0.38	-6.79
5	0.57	2.353	8.9	0.77	13	0.43	-7.2
6	0.55	2.888	9.05	0.82	13	0.38	-7.85
7	0.75	1.282	8.75	0.74	13	0.58	-8.41
1							

Fleet : FLT12: Nor new trawl

Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
2	No data for this fleet at this age									
3	No data for this fleet at this age									
4	No data for this fleet at this age									
5	99.99	99.99	0.13	-0.09	-0.19	-0.14	-0.97	0.1	0.56	0.6
6	99.99	99.99	0.62	0.18	0.24	-0.07	-0.77	-0.86	0.15	0.59
7	99.99	99.99	0.94	-0.08	-0.24	0.21	-0.66	-0.53	-0.09	0.54
8	99.99	99.99	1.16	0.22	-1.1	0.1	-0.69	-0.73	0.28	0.86
9	99.99	99.99	-0.41	99.99	-1.17	-1.19	-0.55	-1.35	0.24	0.21

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 q	-5.9435	-4.9675	-4.8747	-5.0064	-5.0064
S,E(Log q)	0.502	0.5621	0.5305	0.7924	0.9332

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	0.94	0.149	6.27	0.52	8	0.51	-5.94
6	1.84	-0.974	0	0.19	8	1.04	-4.97
7	1.8	-2.261	0.71	0.59	8	0.75	-4.87
8	1.36	-0.984	3.51	0.57	8	1.08	-5.01
9	0.83	0.894	6.13	0.85	7	0.56	-5.61
1							

Fleet : FLT13: Norway Ac Sur

Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
2	0.4	0.3	-1.42	-0.2	-0.53	-1.89	-0.7	0.66	1.61	1.65
3	-0.16	-0.02	-0.71	-0.66	0.15	-1.3	0.24	0.17	0.77	1.32
4	-0.55	-0.77	-0.41	-0.27	-0.08	0.85	0.65	0.24	0.12	-0.1
5	0	-0.76	-0.51	-0.07	-0.1	0.09	0.97	0.67	-0.52	0.04
6	0.68	-0.34	-0.53	-0.94	-0.84	0.66	0.46	0.7	-0.07	0.17
7	No data for this fleet at this age									
8	No data for this fleet at this age									
9	No data for this fleet at this age									

Table 5.6 Tuning diagnostics (Cont'd)

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

Age	2	3	4	5	6
Mean Log q	-7.8679	-6.8149	-6.7091	-7.3626	-6.9439
S,E(Log q)	1.2019	0.7734	0.5087	0.5343	0.6332

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	19.03	-1.56	-66.51	0	10	21.12	-7.87
3	4.21	-1.982	-9.78	0.05	10	2.8	-6.81
4	1.79	-1.495	2.7	0.33	10	0.85	-6.71
5	1.05	-0.169	7.16	0.6	10	0.6	-7.36
6	1.21	-0.594	6.19	0.53	10	0.8	-6.94
1							

Terminal year survivor and F summaries :

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

Year class = 1999

Fleet	Estimated Survivors	Int s,e	Ext s,e	Var Ratio	N	Scaled Weights	Estimated F
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	262572	1.265	0	0	1	0.135	0.001
F shrinkage mean	39196	0.5				0.865	0.005

Weighted prediction :

Survivors at end of year	Int s,e	Ext s,e	N	Var Ratio	F
50641	0.46	1.77	2	3.805	0.004

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

Year class = 1998

Fleet	Estimated Survivors	Int s,e	Ext s,e	Var Ratio	N	Scaled Weights	Estimated F
FLT08: Norway Purse	35730	0.816	0	0	1	0.191	0.095
FLT12: Nor new trawl	1	0	0	0	0	0	0
FLT13: Norway Ac Sur	260016	0.685	0.132	0.19	2	0.271	0.014
F shrinkage mean	38568	0.5				0.538	0.089

Weighted prediction :

Survivors at end of year	Int s,e	Ext s,e	N	Var Ratio	F
63726	0.36	0.6	4	1.659	0.055

Table 5.6 Tuning diagnostics (Cont'd)

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

Year class = 1997

Fleet	Estimated Survivors	Int s,e	Ext s,e	Var Ratio	N	Scaled Weights	Estimated F
FLT08: Norway Purse	35550	0.403	0.308	0.76	2	0.371	0.193
FLT12: Nor new trawl	1	0	0	0	0	0	0
FLT13: Norway Ac Sur	46588	0.423	0.282	0.67	3	0.332	0.15
F shrinkage mean	33965	0.5				0.297	0.201

Weighted prediction :

Survivors at end of year	Int s,e	Ext s,e	N	Var Ratio	F
38362	0.25	0.15	6	0.584	0.18

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

Year class = 1996

Fleet	Estimated Survivors	Int s,e	Ext s,e	Var Ratio	N	Scaled Weights	Estimated F
FLT08: Norway Purse	52071	0.372	0.279	0.75	3	0.273	0.381
FLT12: Nor new trawl	134052	0.534	0	0	1	0.153	0.166
FLT13: Norway Ac Sur	77018	0.339	0.115	0.34	4	0.342	0.273
F shrinkage mean	70689	0.5				0.231	0.294

Weighted prediction :

Survivors at end of year	Int s,e	Ext s,e	N	Var Ratio	F
73848	0.21	0.13	9	0.643	0.283

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

Year class = 1995

Fleet	Estimated Survivors	Int s,e	Ext s,e	Var Ratio	N	Scaled Weights	Estimated F
FLT08: Norway Purse	9514	0.352	0.182	0.52	4	0.229	0.576
FLT12: Nor new trawl	27854	0.401	0.016	0.04	2	0.219	0.236
FLT13: Norway Ac Sur	14095	0.307	0.255	0.83	5	0.323	0.422
F shrinkage mean	17461	0.5				0.23	0.354

Weighted prediction :

Survivors at end of year	Int s,e	Ext s,e	N	Var Ratio	F
15707	0.19	0.15	12	0.771	0.386

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

Year class = 1994

Fleet	Estimated Survivors	Int s,e	Ext s,e	Var Ratio	N	Scaled Weights	Estimated F
FLT08: Norway Purse	12226	0.345	0.18	0.52	5	0.228	0.393
FLT12: Nor new trawl	21604	0.339	0.145	0.43	3	0.299	0.241
FLT13: Norway Ac Sur	19078	0.312	0.312	1	5	0.234	0.269

Table 5.6 Tuning diagnostics (Cont'd)

F shrinkage mean	11196	0.5		0.238	0.422

Weighted prediction :

Survivors at end of year	Int s,e	Ext s,e	N	Var Ratio	F
15754	0.19	0.13	14	0.695	0.317

1

Age 8 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
FLT08: Norway Purse	6689	0.341	0.151	0.44	5	0.197	0.353
FLT12: Nor new trawl	6065	0.321	0.397	1.24	4	0.323	0.383
FLT13: Norway Ac Sur	15832	0.31	0.153	0.49	5	0.204	0.165
F shrinkage mean	6485	0.5				0.277	0.362

Weighted prediction :

Survivors at end of year	Int s,e	Ext s,e	N	Var Ratio	F
7658	0.2	0.15	15	0.783	0.315

Age 9 Catchability constant w,r,t, time and age (fixed at the value for age) 8

Year class = 1992

Fleet	Estimated Survivors	Int s,e	Ext s,e	Var Ratio	N	Scaled Weights	Estimated F
FLT08: Norway Purse	16082	0.357	0.203	0.57	5	0.138	0.245
FLT12: Nor new trawl	7211	0.336	0.204	0.61	5	0.321	0.483
FLT13: Norway Ac Sur	8963	0.317	0.218	0.69	5	0.139	0.405
F shrinkage mean	8260	0.5				0.402	0.433

Weighted prediction :

Survivors at end of year	Int s,e	Ext s,e	N	Var Ratio	F
8768	0.24	0.11	16	0.446	0.412

1

Age 10 Catchability constant w,r,t, time and age (fixed at the value for age) 8

Year class = 1991

Fleet	Estimated Survivors	Int s,e	Ext s,e	Var Ratio	N	Scaled Weights	Estimated F
FLT08: Norway Purse	6024	0.365	0.135	0.37	5	0.135	0.24
FLT12: Nor new trawl	2659	0.321	0.182	0.57	5	0.311	0.48
FLT13: Norway Ac Sur	3962	0.327	0.226	0.69	5	0.142	0.346
F shrinkage mean	3976	0.5				0.412	0.345

Weighted prediction :

Survivors at end of year	Int s,e	Ext s,e	N	Var Ratio	F
3710	0.24	0.1	16	0.42	0.366

Table 5.7 Fishing mortality (f) at age

Run title : Arctic Saithe (run: XSAAAF22/X22)

At 22/04/2002 10:28

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
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
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
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
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
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
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
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
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
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
+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 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

Terminal Fs derived using XSA (With F shrinkage)

Table 8 Fishing mortality (F) at age

YEAR	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
AGE										
2	0.0472	0.1396	0.1204	0.2763	0.2181	0.2178	0.1964	0.2067	0.0582	0.0788
3	0.5893	0.4905	0.6669	0.5962	0.9053	0.786	0.6157	0.4446	0.5172	0.4112
4	0.4299	0.4766	0.5911	0.459	0.6942	0.6807	0.524	0.6834	0.5183	0.5842
5	0.3782	0.411	0.6231	0.4556	0.6609	0.5207	0.5675	0.5606	0.6404	0.6681
6	0.2894	0.3693	0.637	0.3552	0.4704	0.3522	0.467	0.399	0.5356	0.5631
7	0.2409	0.3373	0.5334	0.5379	0.5163	0.4538	0.4574	0.6257	0.572	0.4245
8	0.2451	0.2654	0.4017	0.656	0.4431	0.4306	0.3556	0.6249	0.673	0.8954
9	0.1569	0.321	0.3673	0.4563	0.592	0.4163	0.5508	0.4824	0.1765	0.3907
10	0.2635	0.3429	0.5166	0.496	0.5409	0.4378	0.4833	0.5429	0.5237	0.5934
+gp	0.2635	0.3429	0.5166	0.496	0.5409	0.4378	0.4833	0.5429	0.5237	0.5934
0 FBAR 3	0.4217	0.4369	0.6295	0.4665	0.6827	0.5849	0.5435	0.5219	0.5529	0.5567

Table 8 Fishing mortality (F) at age

YEAR	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
AGE										
2	0.1461	0.1145	0.125	0.0091	0.0181	0.0421	0.0725	0.1494	0.0446	0.0142
3	0.4041	0.2136	0.7503	0.7849	0.1175	0.128	0.1171	0.257	0.4626	0.4415
4	0.6566	0.5382	0.8221	0.5012	0.4842	0.4202	0.4073	0.4648	0.4932	0.5066
5	0.8678	0.8439	0.5834	0.4109	0.5148	0.2957	0.5451	0.819	0.3951	0.374
6	0.5849	0.5394	0.8089	0.5506	0.4954	0.5498	0.5829	0.7045	0.5697	0.4054
7	0.3133	0.4394	0.367	0.7088	0.6473	0.9263	1.1038	0.5292	0.7242	0.3655
8	0.3811	0.6969	0.5058	0.4618	0.6373	0.3556	1.0515	0.5086	0.6827	0.4114
9	0.5211	0.422	0.8806	0.5082	0.3925	0.6588	1.101	0.4406	0.4016	0.341
10	0.538	0.5934	0.6348	0.5323	0.5418	0.5619	0.8862	0.6056	0.5593	0.382
+gp	0.538	0.5934	0.6348	0.5323	0.5418	0.5619	0.8862	0.6056	0.5593	0.382
0 FBAR 3	0.6284	0.5338	0.7412	0.5619	0.403	0.3484	0.4131	0.5613	0.4802	0.4319

Table 8 Fishing mortality (F) at age

YEAR	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	FBAR 99-**
AGE											
2	0.0466	0.0153	0.0036	0.0005	0.0055	0.0035	0.0001	0.001	[0,013]	[0,0036]	0.0059
3	0.1525	0.1161	0.0536	0.0522	0.0999	0.1099	0.0415	0.0496	0.1412	[0,0546]	0.0818
4	0.2803	0.2966	0.2419	0.426	0.2606	0.1825	0.1691	0.228	0.1598	0.1798	0.1892
5	0.4116	0.4934	0.39	0.3909	0.2883	0.3203	0.2489	0.3792	0.2248	0.283	0.2957
6	0.8542	0.5764	0.7398	0.4886	0.3273	0.3352	0.4154	0.3529	0.3266	0.3865	0.3553
7	0.8785	0.6579	0.678	0.4585	0.5558	0.3539	0.3766	0.4669	0.3436	0.3173	0.3759
8	0.9284	0.5936	0.4451	0.482	0.5205	0.3519	0.2968	0.2548	0.3767	0.3148	0.3154
9	0.6123	0.7542	0.2732	0.2035	1.0253	0.2584	0.2934	0.2921	0.2797	0.4123	0.3281
10	0.757	0.6036	0.5076	0.4342	0.5116	0.3336	0.4288	0.4027	0.3767	0.3656	0.3817
+gp	0.757	0.6036	0.5076	0.4342	0.5116	0.3336	0.4288	0.4027	0.3767	0.3656	
0 FBAR 3	0.4246	0.3706	0.3563	0.3394	0.244	0.237	0.2187	0.2524	0.2131	[0,226]	

Table 5.8 Stock number at age

Run title : Arctic Saithe (run: XSAAAF22/X22)

At 22/04/2002 10:28

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
AGE												
2	121650	213269	355505	121815	368899	210354	241202	191872	367843	347431	379815	219524
3	88173	92920	170143	289935	97186	283654	144689	190738	150801	296372	280751	287484
4	85921	62681	59948	105582	199330	71425	198653	98200	129322	100667	172675	190463
5	38001	58508	43057	39010	60271	109269	53953	113296	57927	89246	71608	84509
6	26165	18857	36586	31252	26611	37443	65664	32298	60225	42811	57741	45971
7	16897	16840	12001	22453	21379	19328	21479	42090	22711	41814	30755	32626
8	7761	9416	12582	7630	14890	14362	13236	13376	29379	17882	29893	20546
9	4823	4181	6833	9375	5252	9788	9850	9593	8313	22322	13622	17281
10	2580	2759	2953	4746	6703	3168	5541	7220	6576	5992	16728	8887
+gp	5253	8334	11260	12044	19432	16183	16565	17951	13243	4518	12585	22073
0 TOTA	397223	487765	710869	643841	819953	774974	770831	716635	846340	969055	1066173	929364

Terminal Fs derived using XSA (With F shrinkage)

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

YEAR	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
AGE										
2	278465	117299	206220	373549	305466	178776	283592	167695	356256	152601
3	161778	217485	83523	149693	232001	201097	117721	190782	111659	275186
4	165683	73477	109026	35101	67515	76814	75021	52073	100133	54505
5	102299	88246	37350	49426	18160	27611	31839	36371	21525	48825
6	44795	57383	47900	16400	25658	7677	13431	14779	17000	9289
7	28992	27458	32476	20741	9413	13124	4420	6893	8119	8147
8	18033	18655	16044	15597	9916	4599	6825	2290	3019	3751
9	14197	11554	11713	8790	6627	5212	2448	3916	1004	1261
10	10210	9936	6862	6642	4560	3002	2814	1155	1979	689
+gp	14934	14828	10361	11585	7538	3503	6140	3111	4371	1535
0 TOTA	839385	636321	561474	687525	686854	521415	544250	479066	625065	555789

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

YEAR	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
AGE										
2	140072	118917	137583	271774	204445	103576	79269	88874	292154	481538
3	115468	99095	86831	99411	220505	164390	81302	60360	62669	228751
4	149339	63109	65529	33571	37129	160524	118422	59212	38219	32305
5	24879	63407	30163	23580	16651	18731	86339	64520	30459	19109
6	20495	8552	22325	13780	12801	8148	11409	40985	23288	16797
7	4331	9349	4083	8140	6505	6386	3849	5215	16589	10786
8	4363	2592	4933	2316	3281	2788	2071	1045	2515	6583
9	1254	2440	1057	2435	1195	1420	1600	592	515	1040
10	699	610	1310	359	1199	661	602	435	312	282
+gp	1177	1855	2084	1857	745	2027	189	358	646	456
0 TOTA	462077	369927	355898	457224	504456	468650	385051	321598	467364	797648

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

YEAR	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	GMST 60-99	AMST 60-99
AGE													
2	347604	246197	436623	145294	193393	103367	268957	96455	[101718]	[62075]	[0]	208328	232880
3	388699	271625	198512	356181	118894	157467	84335	220172	78888	[82201]	[50641]	158595	178211
4	120438	273224	198017	154050	276775	88090	115507	66243	171535	56085	[63726]	92371	108348
5	15936	74501	166284	127288	82376	174623	60092	79856	43178	119701	38362	50043	60977
6	10764	8645	37241	92179	70493	50553	103782	38358	44746	28234	73848	26116	33163
7	9169	3751	3977	14550	46298	41604	29600	56089	22066	26427	15707	13858	18511
8	6127	3118	1591	1653	7531	21744	23911	16629	28791	12813	15754	7042	10112
9	3572	1982	1410	834	836	3664	12521	14549	10553	16173	7658	3712	6022
10	606	1585	763	879	557	245	2317	7644	8894	6532	8768	1984	3569
+gp	548	256	1916	949	1210	619	1247	1947	4227	7624	8041		
0 TOTA	903461	884884	1046334	893856	798362	641976	702269	597942	[514598]	[417866]	[282503]		

Table 5.9 Stock biomass at age

Run title : Arctic Saithe (run: XSAAAF22/X22)

At 22/04/2002 10:28

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
	AGE												
	2	41361	72511	120872	41417	125426	71520	82009	65237	125067	118126	129137	74638
	3	62603	65973	120802	205854	69002	201394	102729	135424	107069	210424	199334	204114
	4	95372	69576	66543	117196	221257	79282	220505	109002	143548	111741	191669	211414
	5	61942	95368	70183	63586	98241	178108	87943	184673	94421	145470	116720	137749
	6	60964	43936	85246	72817	62003	87243	152998	75254	140323	99750	134537	107113
	7	53395	53214	37924	70952	67559	61076	67874	133004	71766	132132	97187	103098
	8	31275	37946	50706	30748	60005	57880	53339	53906	118396	72064	120468	82800
	9	23490	20363	33278	45655	25578	47668	47968	46718	40485	108710	66337	84157
	10	14524	15534	16625	26719	37737	17837	31196	40649	37021	33734	94178	50032
	+gp	42179	66999	89226	94556	151201	128800	134275	143498	102186	33794	93178	155657
0	TOTAL	487106	541421	691403	769500	918009	930808	980835	987365	980281	1065944	1242746	1210773

Terminal Fs derived using XSA (With F shrinkage)

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

	YEAR	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
	AGE										
	2	94678	39882	70115	127007	103858	60784	96421	57016	160315	65618
	3	114862	154414	59301	106282	164721	142779	83582	135455	88211	200886
	4	183908	81559	121019	38962	74942	85264	83273	57801	127168	76307
	5	166748	143841	60881	80564	29601	45005	51897	59285	43697	100091
	6	104371	133703	111606	38212	59783	17888	31293	34434	43351	25638
	7	91613	86767	102624	65541	29747	41471	13967	21783	26710	26884
	8	72672	75179	64656	62856	39963	18534	27505	9231	13102	16431
	9	69137	56270	57041	42809	32273	25384	11921	19070	5170	7503
	10	57485	55938	38634	37392	25675	16899	15845	6505	11379	4402
	+gp	111662	109507	74775	82570	55176	25903	46217	24295	30321	10504
0	TOTAL	1067137	937059	760652	682197	615737	479911	461922	424876	549424	534264

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

	YEAR	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
	AGE										
	2	71436	71350	72919	103274	65423	35216	26159	39993	157763	192615
	3	88910	104050	61650	74558	130098	87127	50407	44667	47628	164700
	4	167259	83936	82567	45656	45297	134840	103028	57435	41276	38443
	5	50257	117937	60930	49283	32803	31093	113103	89683	47515	34014
	6	53492	23947	60277	36241	29442	18902	27724	74183	49371	37626
	7	14161	37397	15843	26700	18670	18967	14897	15749	39814	30847
	8	17058	10834	22050	9194	12204	11152	11140	3909	9181	21856
	9	5884	13004	5666	11032	5138	6703	9325	2749	1852	4713
	10	3933	3465	7938	1988	5625	3594	3225	2069	1988	1607
	+gp	8899	16077	14984	15212	4915	13992	1405	2687	3096	3248
0	TOTAL	481289	481997	404823	373139	349615	361586	360414	333124	399485	529670

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

	YEAR	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
	AGE										
	2	156422	113251	152818	72647	77357	39280	94135	61731	[37636]	[27313]
	3	272089	171124	103226	199461	70147	97630	57348	147515	48122	[61651]
	4	132481	278689	146533	120159	226955	81043	115507	69555	174966	62816
	5	31553	126652	202867	154018	108736	207801	88936	115791	69516	184340
	6	25187	21613	80440	160391	129002	83918	194072	74032	94862	57880
	7	25764	10802	12688	40739	114355	96105	76369	127882	58696	68974
	8	19913	9635	6315	6182	28015	67406	73407	49389	92419	42411
	9	14502	7335	6515	3672	3753	15902	51586	52378	39468	58062
	10	3749	9813	4031	4639	2954	1482	12626	31418	38691	29524
	+gp	4042	2089	11632	7068	8490	4716	10042	10735	25257	39484
0	TOTAL	685702	751002	727064	768976	769766	695283	774028	740427	[679634]	[632455]

Table 5.10 Spawning stock biomass

Run title : Arctic Saithe (run: XSAAAF22/X22)
At 22/04/2002 10:28

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
AGE												
2	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
4	954	696	665	1172	2213	793	2205	1090	1435	1117	1917	2114
5	34068	52452	38601	34972	54033	97959	48369	101570	51932	80009	64196	75762
6	51820	37346	72459	61894	52703	74156	130048	63966	119275	84787	114356	91046
7	52327	52150	37165	69533	66208	59854	66516	130344	70331	129489	95244	101036
8	31275	37946	50706	30748	60005	57880	53339	53906	118396	72064	120468	82800
9	23490	20363	33278	45655	25578	47668	47968	46718	40485	108710	66337	84157
10	14524	15534	16625	26719	37737	17837	31196	40649	37021	33734	94178	50032
+gp	42179	66999	89226	94556	151201	128800	134275	143498	102186	33794	93178	155657
0	250637	283486	338725	365250	449676	484948	513916	581741	541060	543704	649874	642605
TOTSPBIO												

Terminal Fs derived using XSA (With F shrinkage)

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

YEAR	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
AGE										
2	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0
4	1839	816	1210	390	749	853	833	578	1272	763
5	91711	79112	33485	44310	16280	24753	28544	32607	24033	55050
6	88716	113647	94865	32481	50815	15205	26599	29269	36848	21792
7	89781	85032	100572	64231	29152	40642	13688	21348	26176	26346
8	72672	75179	64656	62856	39963	18534	27505	9231	13102	16431
9	69137	56270	57041	42809	32273	25384	11921	19070	5170	7503
10	57485	55938	38634	37392	25675	16899	15845	6505	11379	4402
+gp	111662	109507	74775	82570	55176	25903	46217	24295	30321	10504
0	583004	575501	465237	367038	250083	168172	171151	142902	148301	142792
TOTSPBIO										

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

YEAR	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
AGE										
2	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0
4	1673	839	826	457	453	1348	1030	574	413	384
5	27641	64865	33512	27106	18041	17101	62207	49326	26133	18708
6	45468	20355	51236	30805	25026	16067	23566	63055	41965	31982
7	13878	36649	15526	26166	18297	18588	14599	15434	39017	30230
8	17058	10834	22050	9194	12204	11152	11140	3909	9181	21856
9	5884	13004	5666	11032	5138	6703	9325	2749	1852	4713
10	3933	3465	7938	1988	5625	3594	3225	2069	1988	1607
+gp	8899	16077	14984	15212	4915	13992	1405	2687	3096	3248
0	124433	166089	151736	121959	89699	88546	126498	139803	123646	112728
TOTSPBIO										

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

YEAR	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
AGE										
2	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0
4	1325	2787	1465	1202	2270	810	1155	696	1750	628
5	17354	69659	111577	84710	59805	114291	48915	63685	38234	101387
6	21409	18371	68374	136332	109652	71330	164961	62927	80633	49198
7	25249	10586	12434	39924	112068	94183	74841	125324	57523	67595
8	19913	9635	6315	6182	28015	67406	73407	49389	92419	42411
9	14502	7335	6515	3672	3753	15902	51586	52378	39468	58062
10	3749	9813	4031	4639	2954	1482	12626	31418	38691	29524
+gp	4042	2089	11632	7068	8490	4716	10042	10735	25257	39484
0	107543	130275	222342	283728	327007	370121	437533	396553	373975	388289
TOTSPBIO										

Table 5.11 Summary

Run title : Arctic Saithe (run: XSAAAF22/X22)

At 22/04/2002 10:28

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	691403	338725	120707	0.3564	0.2289
1963	121815	769500	365250	148627	0.4069	0.2244
1964	368899	918009	449676	197426	0.439	0.2262
1965	210354	930808	484948	185600	0.3827	0.2254
1966	241202	980835	513916	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	379815	1242746	649874	264924	0.4077	0.3292
1971	219524	1210773	642605	241272	0.3755	0.3671
1972	278465	1067137	583004	214334	0.3676	0.4217
1973	117299	937059	575501	213859	0.3716	0.4369
1974	206220	760652	465237	274121	0.5892	0.6295
1975	373549	682197	367038	233453	0.636	0.4665
1976	305466	615737	250083	242486	0.9696	0.6827
1977	178776	479911	168172	182817	1.0871	0.5849
1978	283592	461922	171151	154464	0.9025	0.5435
1979	167695	424876	142902	164180	1.1489	0.5219
1980	356256	549424	148301	144554	0.9747	0.5529
1981	152601	534264	142792	175516	1.2292	0.5567
1982	140072	481289	124433	168034	1.3504	0.6284
1983	118917	481997	166089	156936	0.9449	0.5338
1984	137583	404823	151736	158786	1.0465	0.7412
1985	271774	373139	121959	107183	0.8788	0.5619
1986	204445	349615	89699	70458	0.7855	0.403
1987	103576	361586	88546	92391	1.0434	0.3484
1988	79269	360414	126498	114242	0.9031	0.4131
1989	88874	333124	139803	122310	0.8749	0.5613
1990	292154	399485	123646	95848	0.7752	0.4802
1991	481538	529670	112728	107326	0.9521	0.4319
1992	347604	685702	107543	127516	1.1857	0.4246
1993	246197	751002	130275	153584	1.1789	0.3706
1994	436623	727064	222342	146544	0.6591	0.3563
1995	145294	768976	283728	168174	0.5927	0.3394
1996	193393	769766	327007	171498	0.5244	0.244
1997	103367	695283	370121	143760	0.3884	0.237
1998	268957	774028	437533	153822	0.3516	0.2187
1999	96455	740427	396553	150274	0.379	0.2524
2000	260052	837968	373975	135170	0.3614	0.2131
2001	228000	798380	388289	134100	0.3454	0.2175
Arith, Mean	233411	689122	308150	159790	0.6724	0.3907
0 Units	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)		

Table 5.12 Input to RCT3 analysis program

```
NORTHEAST ARCTIC SAITHE : recruits as 2 year-olds
1 10 2  (No. of surveys   No. of years   VPA Column No.)
'Yearcl' 'VPA' 'Ac-surv'
1990       348    163.5
1991   246    106.9
1992   437    34.4
1993   145    38.7
1994   193    37.0
1995       103   5.1
1996   269    43.6
1997    97    61.1
1998       -11    164.8
1999   -11   104.7


NORTHEAST ARCTIC SAITHE : recruits as 3 year-olds
1 10 2  (No. of surveys, No. of years, VPA Column No.)
'Yearcl' 'VPA' 'Ac-surv'
1989       389    273.6
1990       272    227.7
1991       199    87.8
1992       356    165.2
1993       119    118.9
1994   158   36.7
1995        84    96.5
1996       220    233.8
1997    79   142.5
1998   -11   275.9
```

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 10 years : 1990 - 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.

Yearclass = 1993

	I----------Regression----------I				I----------Prediction---------I			
Survey/ Series	Slope	Inter-cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
Ac-sur	-.59	8.45	.53	.376	3	3.68	6.27	1.226	.053
					VPA Mean =		5.82	.289	.947

Yearclass = 1994

	I----------Regression----------I				I----------Prediction---------I			
Survey/ Series	Slope	Inter-cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
Ac-sur	3.47	-9.16	3.15	.034	4	3.64	3.46	5.423	.008
					VPA Mean =		5.61	.479	.992

Yearclass = 1995

	I----------Regression----------I				I----------Prediction---------I			
Survey/ Series	Slope	Inter-cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
Ac-sur	2.14	-3.31	1.68	.085	5	1.81	.57	4.294	.010
					VPA Mean =		5.54	.442	.990

Table 5.13 (Cont'd)

Yearclass = 1996

Survey/ Series	Slope	Inter-cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I----------Regression----------I					I----------Prediction---------I			
Ac-sur	.69	2.81	.64	.468	6	3.80	5.43	.856	.284
					VPA Mean =		5.39	.539	.716

Yearclass = 1997

Survey/ Series	Slope	Inter-cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I----------Regression----------I					I----------Prediction---------I			
Ac-sur	.71	2.78	.59	.462	7	4.13	5.69	.761	.301
					VPA Mean =		5.41	.499	.699

Yearclass = 1998

Survey/ Series	Slope	Inter-cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I----------Regression----------I					I----------Prediction---------I			
Ac-sur	1.16	.91	1.07	.235	8	5.11	6.86	1.480	.121
					VPA Mean =		5.30	.549	.879

Yearclass = 1999

Survey/ Series	Slope	Inter-cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I----------Regression----------I					I----------Prediction---------I			
Ac-sur	1.17	.88	1.09	.232	8	4.66	6.35	1.427	.129
					VPA Mean =		5.29	.550	.871

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
1992	No valid surveys						
1993	343	5.84	.28	.10	.13	146	4.98
1994	267	5.59	.48	.19	.16	193	5.27
1995	241	5.49	.44	.51	1.33	104	4.64
1996	221	5.40	.46	.02	.00	270	5.60
1997	243	5.50	.42	.13	.09	98	4.58
1998	242	5.49	.51	.51	.97		
1999	228	5.43	.51	.35	.48		

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 10 years : 1989 - 1998

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

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

Forecast/Hindcast variance correction used.

Yearclass = 1992

	I----------Regression----------I				I----------Prediction---------I			
Survey/ Series	Slope	Inter-cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
Ac-sur	.60	2.51	.21	.840	3	5.11	5.59	.414	.394
					VPA Mean =		5.62	.334	.606

Yearclass = 1993

	I----------Regression----------I				I----------Prediction---------I			
Survey/ Series	Slope	Inter-cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
Ac-sur	.76	1.78	.27	.643	4	4.79	5.40	.468	.293
					VPA Mean =		5.69	.301	.707

Yearclass = 1994

	I----------Regression----------I				I----------Prediction---------I			
Survey/ Series	Slope	Inter-cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
Ac-sur	1.47	-1.96	.55	.504	5	3.63	3.37	1.376	.109
					VPA Mean =		5.51	.480	.891

Table 5.13 (Cont'd)

Yearclass = 1995

Survey/ Series	Slope	Inter-cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I----------Regression----------I					I----------Prediction---------I			
Ac-sur	.94	.91	.55	.472	6	4.58	5.19	.741	.283
					VPA Mean =		5.43	.466	.717

Yearclass = 1996

Survey/ Series	Slope	Inter-cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I----------Regression----------I					I----------Prediction---------I			
Ac-sur	1.41	-1.48	.83	.362	7	5.46	6.22	1.127	.202
					VPA Mean =		5.28	.567	.798

Yearclass = 1997

Survey/ Series	Slope	Inter-cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I----------Regression----------I					I----------Prediction---------I			
Ac-sur	1.36	-1.33	.79	.341	8	4.97	5.42	.980	.224
					VPA Mean =		5.29	.526	.776

Yearclass = 1998

Survey/ Series	Slope	Inter-cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I----------Regression----------I					I----------Prediction---------I			
Ac-sur	2.04	-4.75	1.20	.212	9	5.62	6.70	1.572	.120
					VPA Mean =		5.18	.580	.880

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
1992	272	5.61	.26	.02	.01	356	5.88
1993	271	5.60	.25	.13	.26	120	4.79
1994	195	5.27	.45	.67	2.15	159	5.07
1995	213	5.36	.39	.11	.07	85	4.44
1996	237	5.47	.51	.38	.55	221	5.40
1997	204	5.32	.46	.05	.01	80	4.38
1998	212	5.36	.54	.49	.82		

Table 5.14

Northeast Arctic saithe (Sub-areas I and II)

Prediction with management option table: Input data

Year: 2002								
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
Unit	Thousands	-	-	-	-	Kilograms	-	Kilograms
2	212000.00	0.2000	0.0000	0.0000	0.0000	0.483	0.0022	0.483
3	186488.00	0.2000	0.0000	0.0000	0.0000	0.677	0.0674	0.677
4	170002.00	0.2000	0.0100	0.0000	0.0000	1.063	0.1808	1.063
5	38362.000	0.2000	0.5500	0.0000	0.0000	1.533	0.2825	1.533
6	73848.000	0.2000	0.8500	0.0000	0.0000	2.033	0.3395	2.033
7	15707.000	0.2000	0.9800	0.0000	0.0000	2.517	0.3592	2.517
8	15754.000	0.2000	1.0000	0.0000	0.0000	3.103	0.3014	3.103
9	7658.000	0.2000	1.0000	0.0000	0.0000	3.643	0.3134	3.643
10	8768.000	0.2000	1.0000	0.0000	0.0000	4.327	0.3646	4.327
11+	8041.000	0.2000	1.0000	0.0000	0.0000	5.556	0.3646	5.556

Year: 2003								
Age	Recruitment	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
Unit	Thousands	-	-	-	-	Kilograms	-	Kilograms
2	212000.00	0.2000	0.0000	0.0000	0.0000	0.483	0.0022	0.483
3	.	0.2000	0.0000	0.0000	0.0000	0.677	0.0674	0.677
4	.	0.2000	0.0100	0.0000	0.0000	1.063	0.1808	1.063
5	.	0.2000	0.5500	0.0000	0.0000	1.533	0.2825	1.533
6	.	0.2000	0.8500	0.0000	0.0000	2.033	0.3395	2.033
7	.	0.2000	0.9800	0.0000	0.0000	2.517	0.3592	2.517
8	.	0.2000	1.0000	0.0000	0.0000	3.103	0.3014	3.103
9	.	0.2000	1.0000	0.0000	0.0000	3.643	0.3134	3.643
10	.	0.2000	1.0000	0.0000	0.0000	4.327	0.3646	4.327
11+	.	0.2000	1.0000	0.0000	0.0000	5.556	0.3646	5.556

Year: 2004								
Age	Recruitment	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
Unit	Thousands	-	-	-	-	Kilograms	-	Kilograms
2	212000.00	0.2000	0.0000	0.0000	0.0000	0.483	0.0022	0.483
3	.	0.2000	0.0000	0.0000	0.0000	0.677	0.0674	0.677
4	.	0.2000	0.0100	0.0000	0.0000	1.063	0.1808	1.063
5	.	0.2000	0.5500	0.0000	0.0000	1.533	0.2825	1.533
6	.	0.2000	0.8500	0.0000	0.0000	2.033	0.3395	2.033
7	.	0.2000	0.9800	0.0000	0.0000	2.517	0.3592	2.517
8	.	0.2000	1.0000	0.0000	0.0000	3.103	0.3014	3.103
9	.	0.2000	1.0000	0.0000	0.0000	3.643	0.3134	3.643
10	.	0.2000	1.0000	0.0000	0.0000	4.327	0.3646	4.327
11+	.	0.2000	1.0000	0.0000	0.0000	5.556	0.3646	5.556

Notes: Run name : MANAAF08
Date and time: 23APR02:18:24

Table 5.15

Northeast Arctic saithe (Sub-areas I and II)

Yield per recruit: Summary table

							1 January		Spawning time	
F	Reference	Catch in	Catch in	Stock	Stock	Sp.stock	Sp.stock	Sp.stock	Sp.stock	Sp.stock
Factor	F	numbers	weight	size	biomass	size	biomass	size	biomass	
0.0000	0.0000	0.000	0.000	5.517	12203.937	2.713	9926.746	2.713	9926.746	
0.0500	0.0109	0.050	151.354	5.269	11055.834	2.472	8790.261	2.472	8790.261	
0.1000	0.0218	0.092	269.975	5.058	10099.736	2.269	7845.585	2.269	7845.585	
0.1500	0.0326	0.129	363.844	4.875	9293.340	2.093	7050.419	2.093	7050.419	
0.2000	0.0435	0.161	438.711	4.716	8605.728	1.941	6373.851	1.941	6373.851	
0.2500	0.0544	0.189	498.802	4.575	8013.794	1.808	5792.780	1.808	5792.780	
0.3000	0.0653	0.214	547.278	4.450	7499.940	1.689	5289.611	1.689	5289.611	
0.3500	0.0761	0.237	586.535	4.338	7050.536	1.584	4850.718	1.584	4850.718	
0.4000	0.0870	0.257	618.419	4.237	6654.871	1.490	4465.395	1.490	4465.395	
0.4500	0.0979	0.276	644.361	4.145	6304.420	1.405	4125.120	1.405	4125.120	
0.5000	0.1088	0.293	665.487	4.061	5992.315	1.328	3823.030	1.328	3823.030	
0.5500	0.1197	0.308	682.688	3.985	5712.973	1.258	3553.544	1.258	3553.544	
0.6000	0.1305	0.322	696.673	3.914	5461.804	1.194	3312.078	1.194	3312.078	
0.6500	0.1414	0.336	708.015	3.849	5235.012	1.136	3094.837	1.136	3094.837	
0.7000	0.1523	0.348	717.175	3.789	5029.425	1.082	2898.655	1.082	2898.655	
0.7500	0.1632	0.359	724.527	3.733	4842.382	1.032	2720.872	1.032	2720.872	
0.8000	0.1740	0.370	730.378	3.680	4671.628	0.986	2559.237	0.986	2559.237	
0.8500	0.1849	0.380	734.979	3.631	4515.248	0.943	2411.838	0.943	2411.838	
0.9000	0.1958	0.389	738.537	3.586	4371.601	0.903	2277.038	0.903	2277.038	
0.9500	0.2067	0.398	741.224	3.542	4239.278	0.866	2153.431	0.866	2153.431	
1.0000	0.2176	0.406	743.181	3.502	4117.062	0.831	2039.800	0.831	2039.800	
1.0500	0.2284	0.414	744.526	3.464	4003.896	0.799	1935.094	0.799	1935.094	
1.1000	0.2393	0.421	745.359	3.427	3898.858	0.768	1838.393	0.768	1838.393	
1.1500	0.2502	0.428	745.762	3.393	3801.144	0.739	1748.896	0.739	1748.896	
1.2000	0.2611	0.435	745.803	3.360	3710.047	0.712	1665.897	0.712	1665.897	
1.2500	0.2719	0.441	745.541	3.329	3624.944	0.687	1588.777	0.687	1588.777	
1.3000	0.2828	0.447	745.026	3.300	3545.285	0.663	1516.987	0.663	1516.987	
1.3500	0.2937	0.453	744.298	3.272	3470.582	0.640	1450.043	0.640	1450.043	
1.4000	0.3046	0.458	743.393	3.245	3400.401	0.619	1387.513	0.619	1387.513	
1.4500	0.3154	0.464	742.340	3.219	3334.356	0.598	1329.012	0.598	1329.012	
1.5000	0.3263	0.469	741.164	3.195	3272.101	0.579	1274.198	0.579	1274.198	
1.5500	0.3372	0.474	739.886	3.171	3213.327	0.560	1222.762	0.560	1222.762	
1.6000	0.3481	0.478	738.526	3.148	3157.754	0.543	1174.429	0.543	1174.429	
1.6500	0.3590	0.483	737.097	3.127	3105.134	0.526	1128.950	0.526	1128.950	
1.7000	0.3698	0.487	735.613	3.106	3055.239	0.510	1086.101	0.510	1086.101	
1.7500	0.3807	0.491	734.085	3.086	3007.865	0.495	1045.680	0.495	1045.680	
1.8000	0.3916	0.495	732.523	3.066	2962.828	0.481	1007.503	0.481	1007.503	
1.8500	0.4025	0.499	730.935	3.048	2919.958	0.467	971.404	0.467	971.404	
1.9000	0.4133	0.503	729.328	3.030	2879.104	0.454	937.232	0.454	937.232	
1.9500	0.4242	0.506	727.707	3.012	2840.126	0.441	904.850	0.441	904.850	
2.0000	0.4351	0.510	726.077	2.995	2802.896	0.429	874.131	0.429	874.131	
-	-	Numbers	Grams	Numbers	Grams	Numbers	Grams	Numbers	Grams	

Notes: Run name : YLDAAF06
Date and time : 24APR02:17:46
Computation of ref. F: Simple mean, age 3 - 6
F-0.1 factor : 0.5258
F-max factor : 1.1810
F-0.1 reference F : 0.1144
F-max reference F : 0.2569
Recruitment : Single recruit

Table 5.16

Northeast Arctic saithe (Sub-areas I and II)

Prediction with management option table

	Year: 2002					Year: 2003					Year: 2004	
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
1.1025	0.2398	817324	359930	152000	0.0000	0.0000	827539	370905	0	1012136	533493
.	.	.	.	.	0.0500	0.0109	.	370905	8214	1002657	525664
.	.	.	.	.	0.1000	0.0218	.	370905	16313	993312	517956
.	.	.	.	.	0.1500	0.0326	.	370905	24299	984099	510367
.	.	.	.	.	0.2000	0.0435	.	370905	32173	975017	502893
.	.	.	.	.	0.2500	0.0544	.	370905	39937	966062	495535
.	.	.	.	.	0.3000	0.0653	.	370905	47593	957235	488289
.	.	.	.	.	0.3500	0.0761	.	370905	55142	948531	481154
.	.	.	.	.	0.4000	0.0870	.	370905	62585	939950	474129
.	.	.	.	.	0.4500	0.0979	.	370905	69926	931490	467211
.	.	.	.	.	0.5000	0.1088	.	370905	77164	923148	460399
.	.	.	.	.	0.5500	0.1197	.	370905	84303	914923	453691
.	.	.	.	.	0.6000	0.1305	.	370905	91342	906813	447086
.	.	.	.	.	0.6500	0.1414	.	370905	98284	898817	440581
.	.	.	.	.	0.7000	0.1523	.	370905	105130	890933	434176
.	.	.	.	.	0.7500	0.1632	.	370905	111882	883158	427869
.	.	.	.	.	0.8000	0.1740	.	370905	118541	875492	421657
.	.	.	.	.	0.8500	0.1849	.	370905	125108	867932	415541
.	.	.	.	.	0.9000	0.1958	.	370905	131585	860478	409517
.	.	.	.	.	0.9500	0.2067	.	370905	137973	853127	403586
.	.	.	.	.	1.0000	0.2176	.	370905	144274	845878	397744
.	.	.	.	.	1.0500	0.2284	.	370905	150488	838729	391992
.	.	.	.	.	1.1000	0.2393	.	370905	156618	831679	386326
.	.	.	.	.	1.1500	0.2502	.	370905	162664	824727	380747
.	.	.	.	.	1.2000	0.2611	.	370905	168628	817870	375253
.	.	.	.	.	1.2500	0.2719	.	370905	174511	811108	369842
.	.	.	.	.	1.3000	0.2828	.	370905	180314	804439	364513
.	.	.	.	.	1.3500	0.2937	.	370905	186038	797861	359265
.	.	.	.	.	1.4000	0.3046	.	370905	191685	791374	354096
.	.	.	.	.	1.4500	0.3154	.	370905	197255	784975	349005
.	.	.	.	.	1.5000	0.3263	.	370905	202750	778664	343992
-	-	Tonnes	Tonnes	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes

Notes: Run name : MANAAF08
Date and time : 23APR02:18:24
Computation of ref. F: Simple mean, age 3 - 6
Basis for 2002 : TAC constraints

Table 5.17a

F_{sq} option

Northeast Arctic saithe (Sub-areas I and II)

Single option prediction: Summary table

						1 January		Spawning time			
Year	F	Reference	Catch in	Catch in	Stock	Stock	Sp.stock	Sp.stock	Sp.stock	Sp.stock	
	Factor	F	numbers	weight	size	biomass	size	biomass	size	biomass	
2002	1.1025	0.2398	86766	152000	736628	817324	141184	359930	141184	359930	
2003	1.0000	0.2176	83128	144274	737069	827540	155991	370905	155991	370905	
2004	1.0000	0.2176	85079	149293	740678	845878	169877	397744	169877	397744	
2005	1.0000	0.2176	86194	153735	741882	856110	174926	414137	174926	414137	
2006	1.0000	0.2176	85944	154611	741872	861647	175614	421158	175614	421158	
2007	1.0000	0.2176	85838	155476	742086	867234	175872	426855	175872	426855	
Unit	-	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	

Notes: Run name : SPRAAF04
Date and time : 23APR02:18:33
Computation of ref. F: Simple mean, age 3 - 6
Prediction basis : F factors

F_{pa} option

Northeast Arctic saithe (Sub-areas I and II)

Single option prediction: Summary table

						1 January		Spawning time			
Year	F	Reference	Catch in	Catch in	Stock	Stock	Sp.stock	Sp.stock	Sp.stock	Sp.stock	
	Factor	F	numbers	weight	size	biomass	size	biomass	size	biomass	
2002	1.1025	0.2398	86766	152000	736628	817324	141184	359930	141184	359930	
2003	1.1949	0.2600	97158	168024	737069	827540	155991	370905	155991	370905	
2004	1.1949	0.2600	95990	166069	728124	818565	161202	375810	161202	375810	
2005	1.1949	0.2600	94973	165067	721855	809006	159534	373724	159534	373724	
2006	1.1949	0.2600	93457	162036	717640	800869	156091	367216	156091	367216	
2007	1.1949	0.2600	92683	160357	715548	797097	154047	363563	154047	363563	
Unit	-	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	

Notes: Run name : SPRAAF04
Date and time : 23APR02:18:33
Computation of ref. F: Simple mean, age 3 - 6
Prediction basis : F factors

Table 5.17b

Northeast Arctic saithe (Sub-areas I and II)

Single option prediction: Detailed tables

Year: 2002	F-factor: 1.1025	Reference F: 0.2398	1 January		Spawning time	
	Absolute	Catch in	Catch in	Stock	Stock	Sp.stock	Sp.stock	Sp.stock	Sp.stock
Age	F	numbers	weight	size	biomass	size	biomass	size	biomass
2	0.0024	466	225	212000	102460	0	0	0	0
3	0.0743	12120	8201	186488	126196	0	0	0	0
4	0.1993	27938	29707	170002	180763	1700	1808	1700	1808
5	0.3115	9353	14341	38362	58820	21099	32351	21099	32351
6	0.3743	21028	42757	73848	150155	62771	127632	62771	127632
7	0.3960	4686	11793	15707	39530	15393	38739	15393	38739
8	0.3323	4059	12597	15754	48889	15754	48889	15754	48889
9	0.3455	2039	7430	7658	27900	7658	27900	7658	27900
10	0.4020	2648	11457	8768	37937	8768	37937	8768	37937
11+	0.4020	2428	13492	8041	44673	8041	44673	8041	44673
Total		86766	152000	736628	817324	141184	359930	141184	359930
Unit	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Year: 2003	F-factor: 1.0000	Reference F: 0.2176	1 January		Spawning time	
	Absolute	Catch in	Catch in	Stock	Stock	Sp.stock	Sp.stock	Sp.stock	Sp.stock
Age	F	numbers	weight	size	biomass	size	biomass	size	biomass
2	0.0022	422	204	212000	102460	0	0	0	0
3	0.0674	10240	6930	173150	117171	0	0	0	0
4	0.1808	21313	22662	141749	150722	1417	1507	1417	1507
5	0.2825	25555	39183	114032	174845	62718	96165	62718	96165
6	0.3395	6036	12272	23003	46771	19552	39756	19552	39756
7	0.3592	11441	28794	41584	104654	40752	102561	40752	102561
8	0.3014	2051	6366	8655	26858	8655	26858	8655	26858
9	0.3134	2268	8262	9252	33706	9252	33706	9252	33706
10	0.3646	1236	5350	4438	19202	4438	19202	4438	19202
11+	0.3646	2565	14250	9207	51150	9207	51150	9207	51150
Total		83128	144274	737069	827540	155991	370905	155991	370905
Unit	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Table 5.17b (Cont'd)

Year: 2004	F-factor: 1.0000	Reference F: 0.2176	1 January	Spawning time

		Absolute	Catch in	Catch in	Stock	Stock	Sp.stock	Sp.stock	Sp.stock	Sp.stock
Age	F	numbers	weight	size	biomass	size	biomass	size	biomass	
2	0.0022	422	204	212000	102460	0	0	0	0	
3	0.0674	10243	6931	173189	117197	0	0	0	0	
4	0.1808	19926	21187	132524	140912	1325	1409	1325	1409	
5	0.2825	21707	33283	96859	148514	53273	81683	53273	81683	
6	0.3395	18468	37551	70385	143114	59827	121647	59827	121647	
7	0.3592	3690	9287	13411	33753	13143	33078	13143	33078	
8	0.3014	5635	17486	23772	73772	23772	73772	23772	73772	
9	0.3134	1285	4681	5242	19098	5242	19098	5242	19098	
10	0.3646	1542	6674	5537	23956	5537	23956	5537	23956	
11+	0.3646	2161	12008	7758	43103	7758	43103	7758	43103	
Total		85079	149293	740678	845878	169877	397744	169877	397744	
Unit	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	

(cont.)

Northeast Arctic saithe (Sub-areas I and II)

Single option prediction: Detailed tables

(cont.)

Year: 2005	F-factor: 1.0000	Reference F: 0.2176	1 January	Spawning time

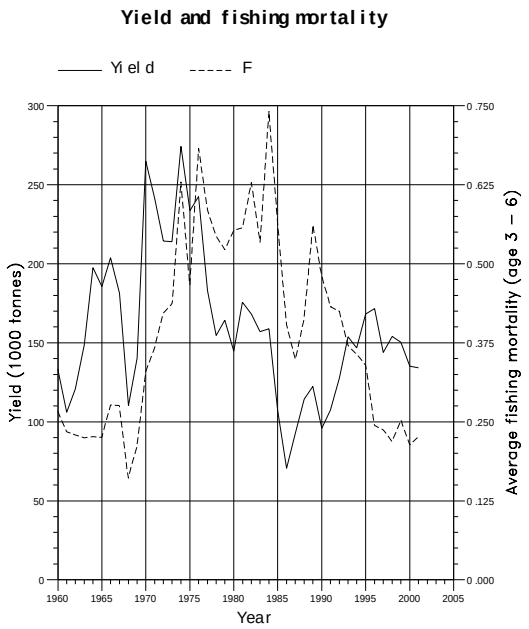
		Absolute	Catch in	Catch in	Stock	Stock	Sp.stock	Sp.stock	Sp.stock	Sp.stock
Age	F	numbers	weight	size	biomass	size	biomass	size	biomass	
2	0.0022	422	204	212000	102460	0	0	0	0	
3	0.0674	10243	6931	173189	117197	0	0	0	0	
4	0.1808	19931	21192	132553	140944	1326	1409	1326	1409	
5	0.2825	20294	31116	90555	138848	49805	76367	49805	76367	
6	0.3395	15687	31896	59785	121561	50817	103327	50817	103327	
7	0.3592	11291	28416	41037	103278	40216	101213	40216	101213	
8	0.3014	1817	5640	7667	23793	7667	23793	7667	23793	
9	0.3134	3529	12858	14398	52457	14398	52457	14398	52457	
10	0.3646	874	3781	3137	13573	3137	13573	3137	13573	
11+	0.3646	2106	11700	7559	41998	7559	41998	7559	41998	
Total		86194	153735	741882	856110	174926	414137	174926	414137	
Unit	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	

Table 5.17b (Cont'd)

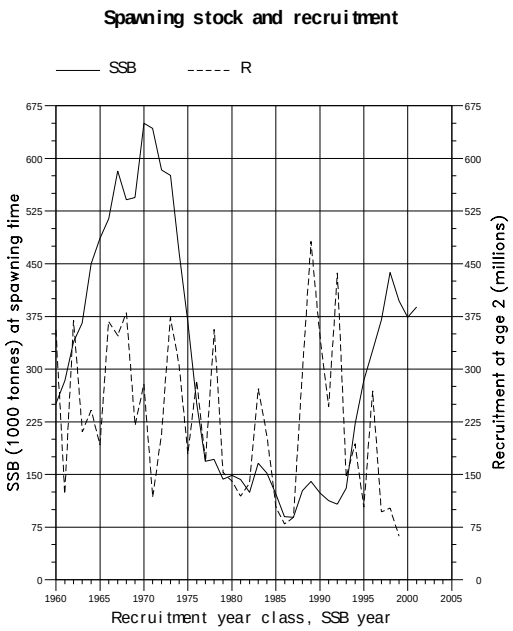
Year: 2006	F-factor: 1.0000	Reference F: 0.2176	1 January		Spawning time	
	Absolute	Catch in	Catch in	Stock	Stock	Sp.stock	Sp.stock	Sp.stock	Sp.stock
Age	F	numbers	weight	size	biomass	size	biomass	size	biomass
2	0.0022	422	204	212000	102460	0	0	0	0
3	0.0674	10243	6931	173189	117197	0	0	0	0
4	0.1808	19931	21192	132553	140944	1326	1409	1326	1409
5	0.2825	20298	31124	90576	138880	49817	76384	49817	76384
6	0.3395	14666	29820	55894	113650	47510	96602	47510	96602
7	0.3592	9591	24137	34857	87725	34160	85970	34160	85970
8	0.3014	5561	17256	23460	72802	23460	72802	23460	72802
9	0.3134	1138	4147	4644	16918	4644	16918	4644	16918
10	0.3646	2401	10387	8617	37282	8617	37282	8617	37282
11+	0.3646	1694	9413	6082	33789	6082	33789	6082	33789
Total		85944	154611	741872	861647	175614	421158	175614	421158
Unit	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Year: 2007	F-factor: 1.0000	Reference F: 0.2176	1 January		Spawning time	
	Absolute	Catch in	Catch in	Stock	Stock	Sp.stock	Sp.stock	Sp.stock	Sp.stock
Age	F	numbers	weight	size	biomass	size	biomass	size	biomass
2	0.0022	422	204	212000	102460	0	0	0	0
3	0.0674	10243	6931	173189	117197	0	0	0	0
4	0.1808	19931	21192	132553	140944	1326	1409	1326	1409
5	0.2825	20298	31124	90576	138880	49817	76384	49817	76384
6	0.3395	14669	29827	55907	113675	47521	96624	47521	96624
7	0.3592	8966	22566	32589	82016	31937	80375	31937	80375
8	0.3014	4723	14658	19927	61838	19927	61838	19927	61838
9	0.3134	3483	12689	14209	51768	14209	51768	14209	51768
10	0.3646	774	3350	2779	12024	2779	12024	2779	12024
11+	0.3646	2328	12935	8357	46432	8357	46432	8357	46432
Total		85838	155476	742086	867234	175872	426855	175872	426855
Unit	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

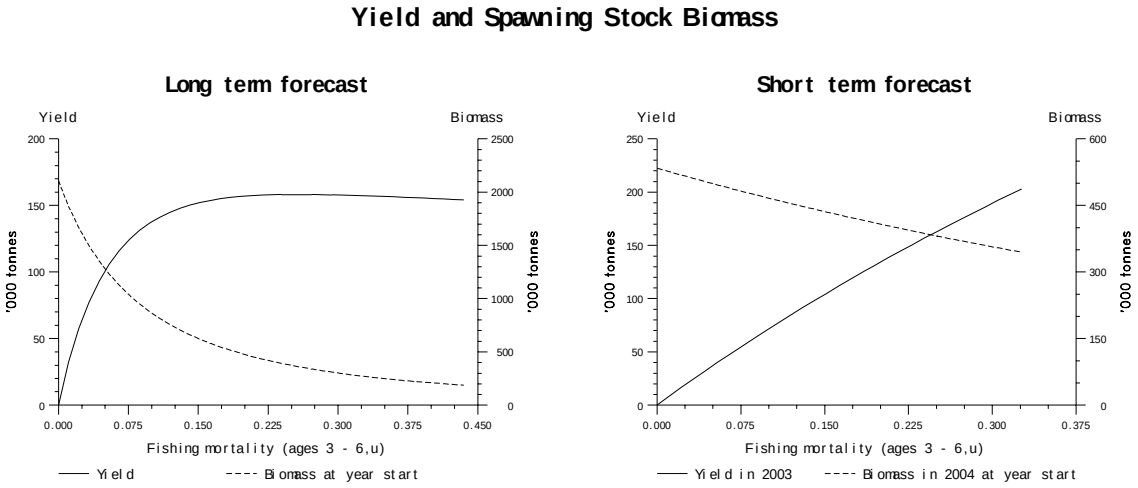
Notes: Run name : SPRAAF04
Date and time : 23APR02:18:33
Computation of ref. F: Simple mean, age 3 - 6
Prediction basis : F factors



(run: XSAAAF22) **A**



(run: XSAAAF22) **B**



(run YLDAAF06) C run MANAAF08) D

Figure 5.1 A-D NeA saithe

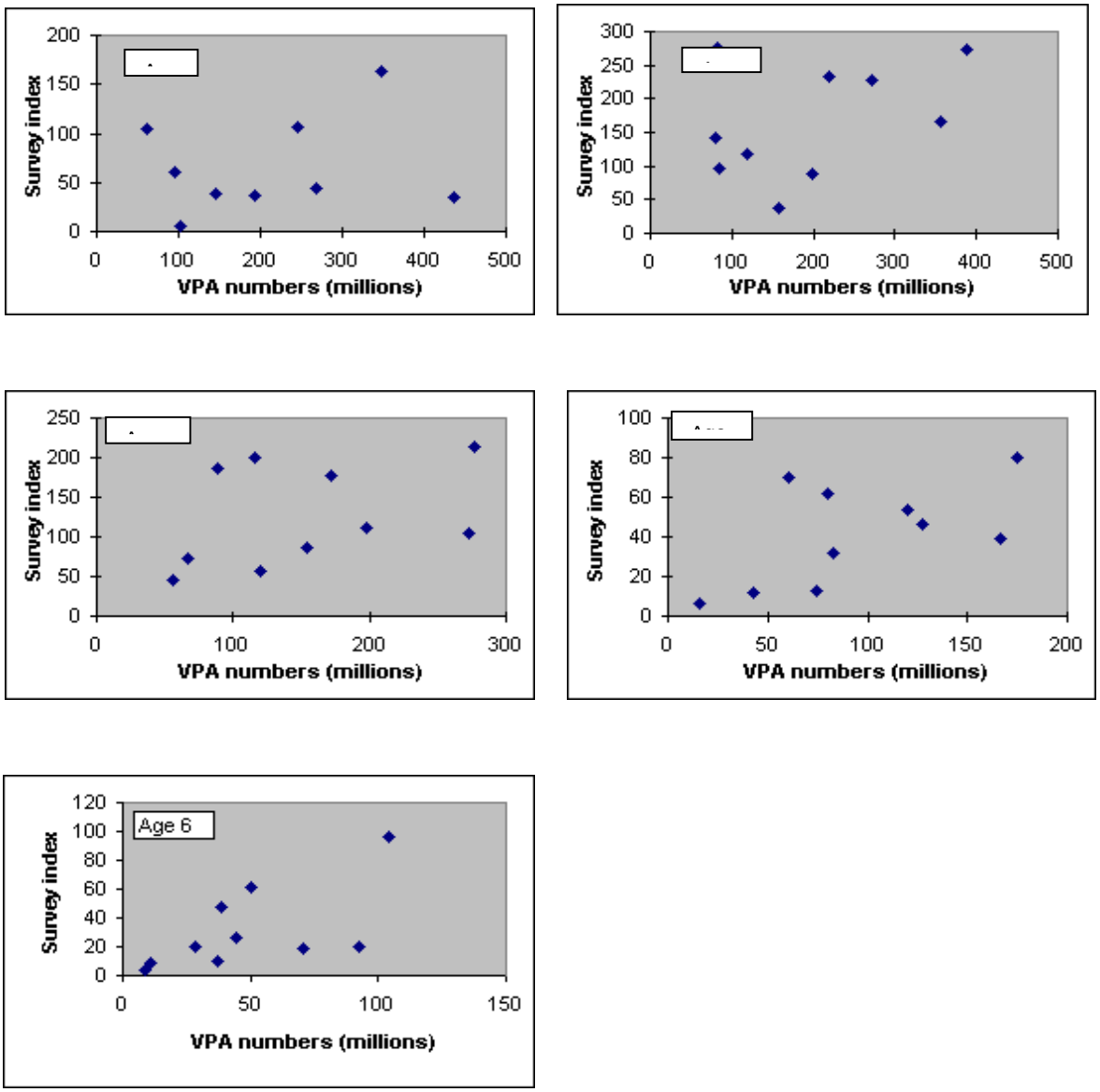


Figure 5.2A. Northeast Arctic Saithe - Acoustic survey vs VPA

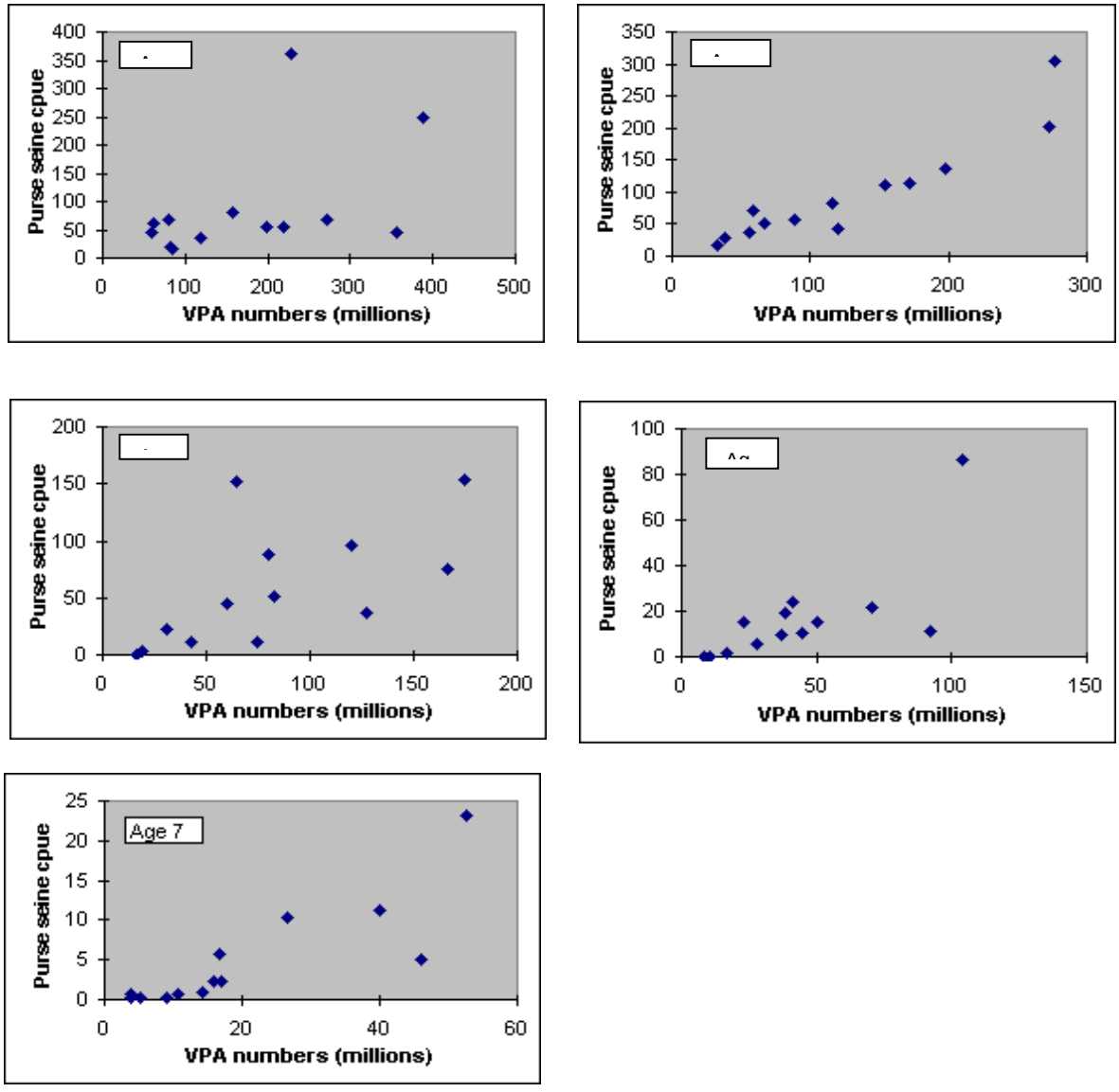


Figure 5.2B. Northeast Arctic Saithe - Norwegian purse seine vs VPA

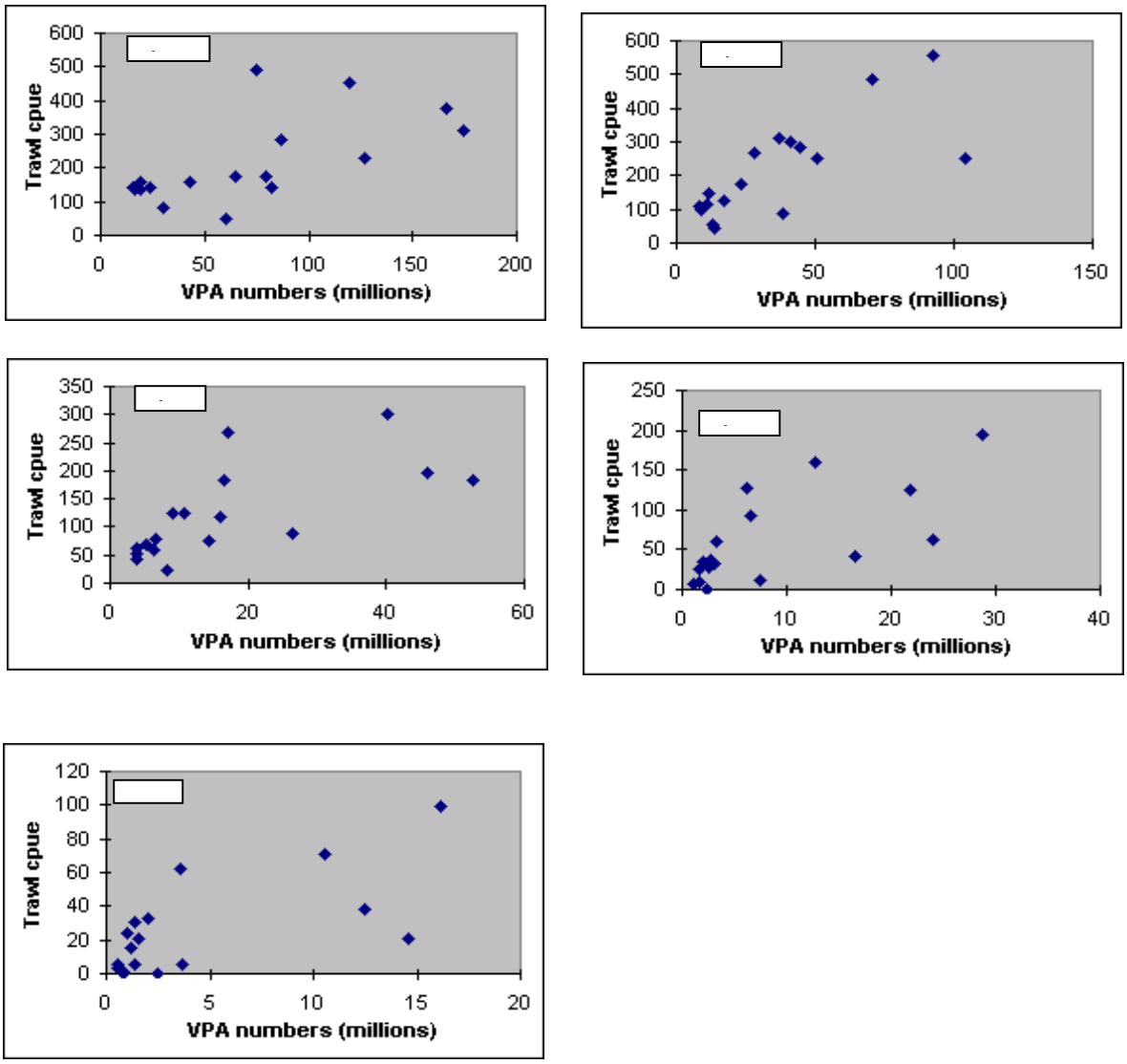
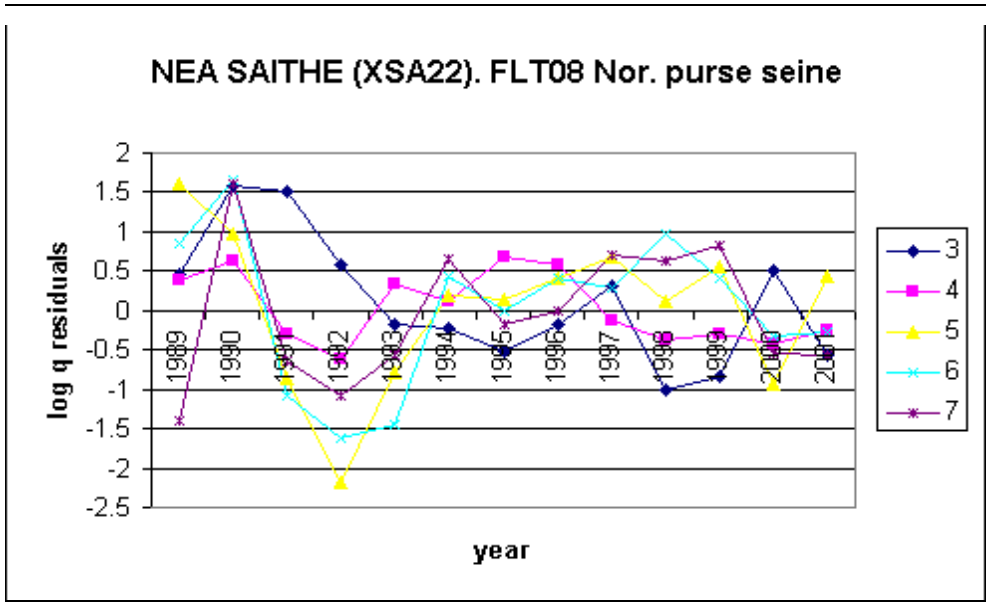
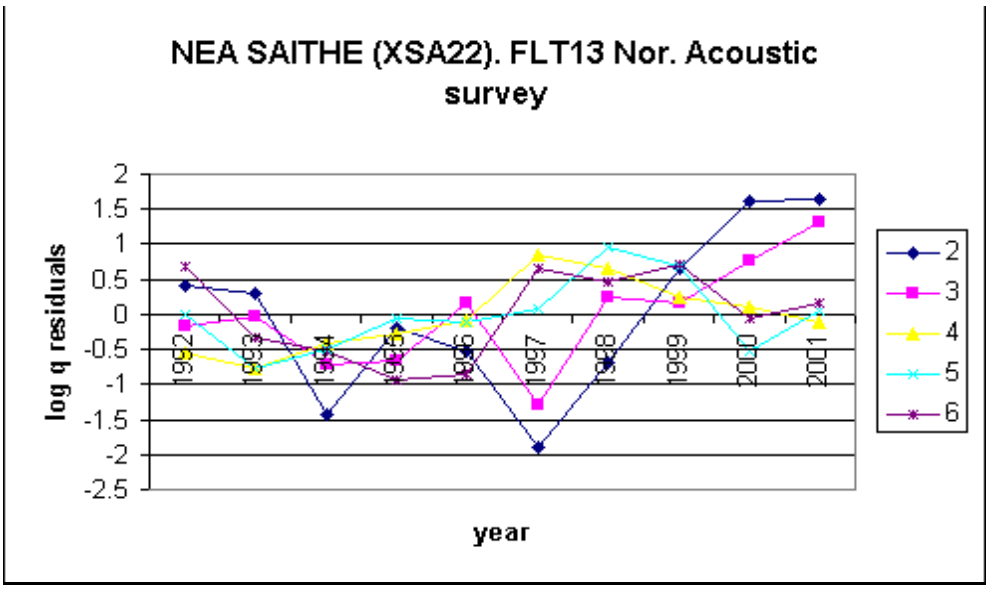


Figure 5.2C. Northeast Arctic Saithe - Norwegian trawl vs VPA

A



B



C

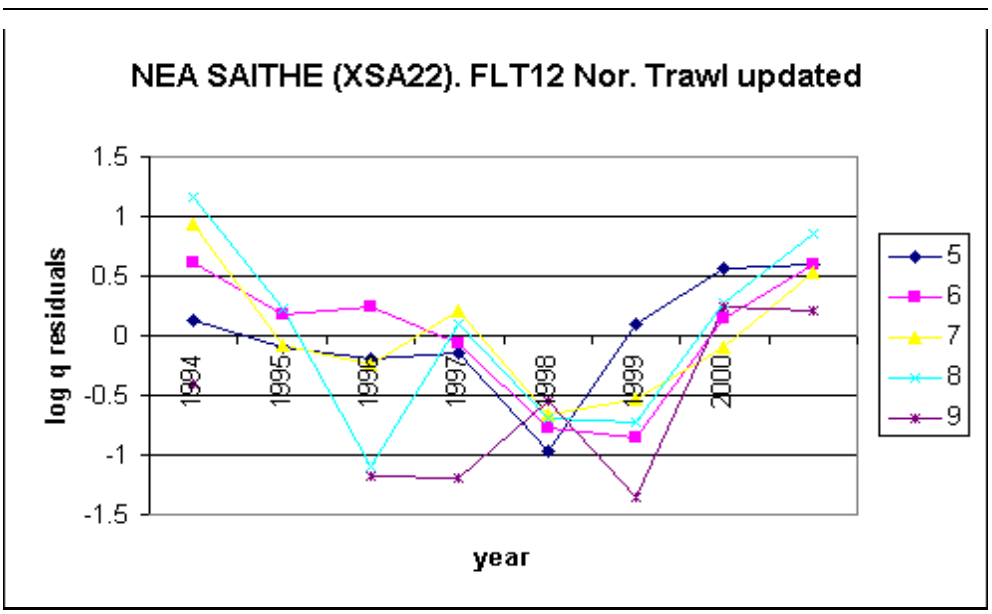


Figure 5.3 log q residuals, per tuning fleet

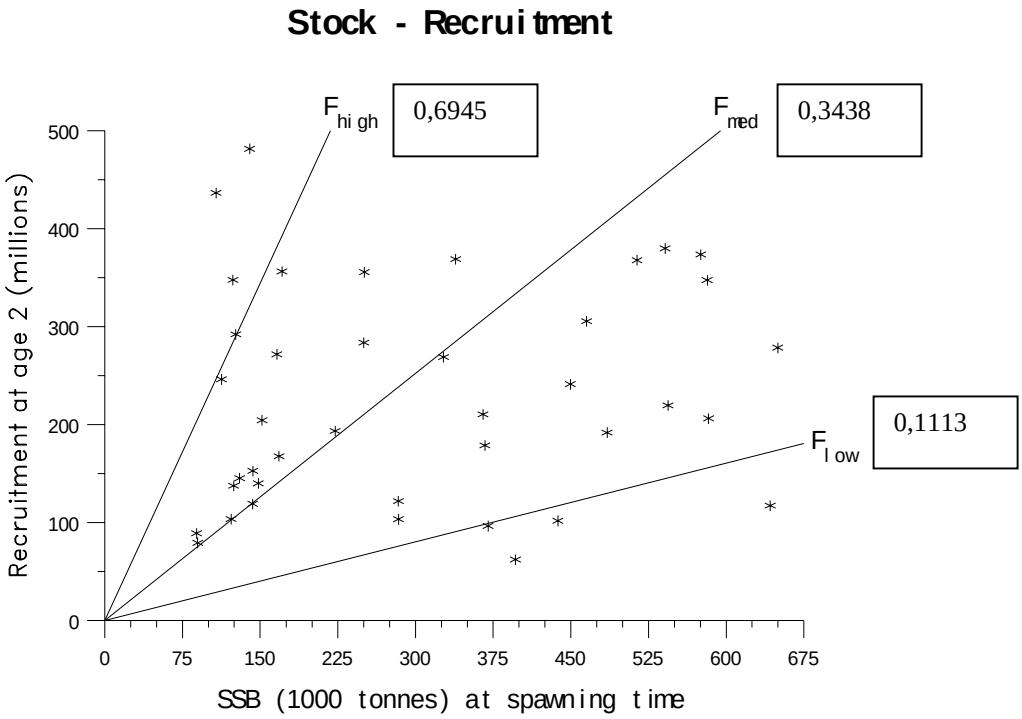
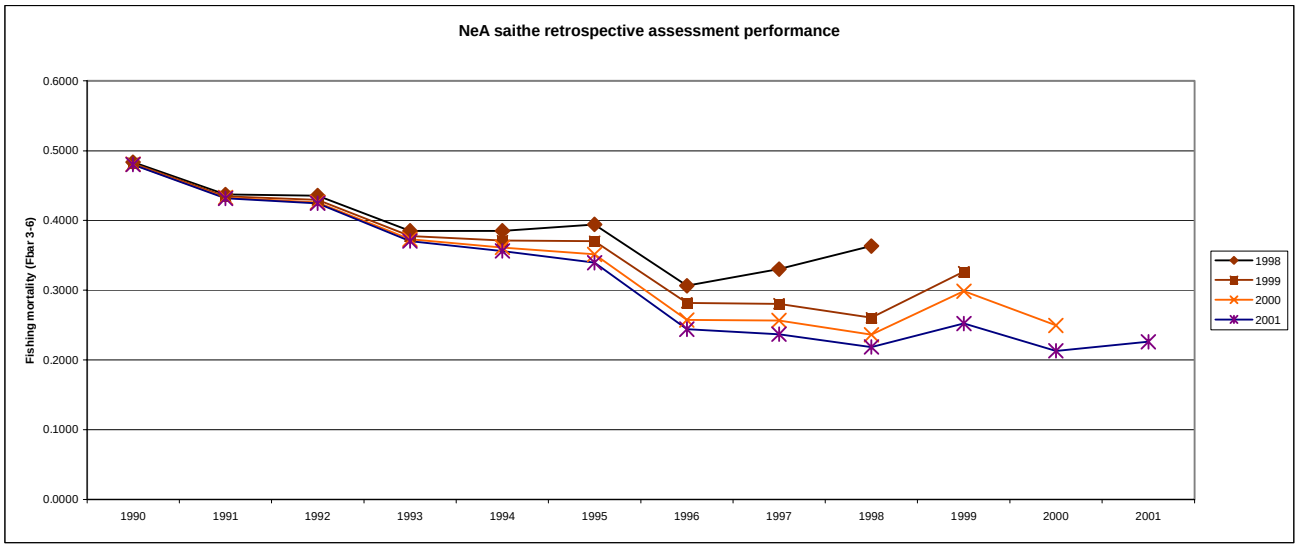
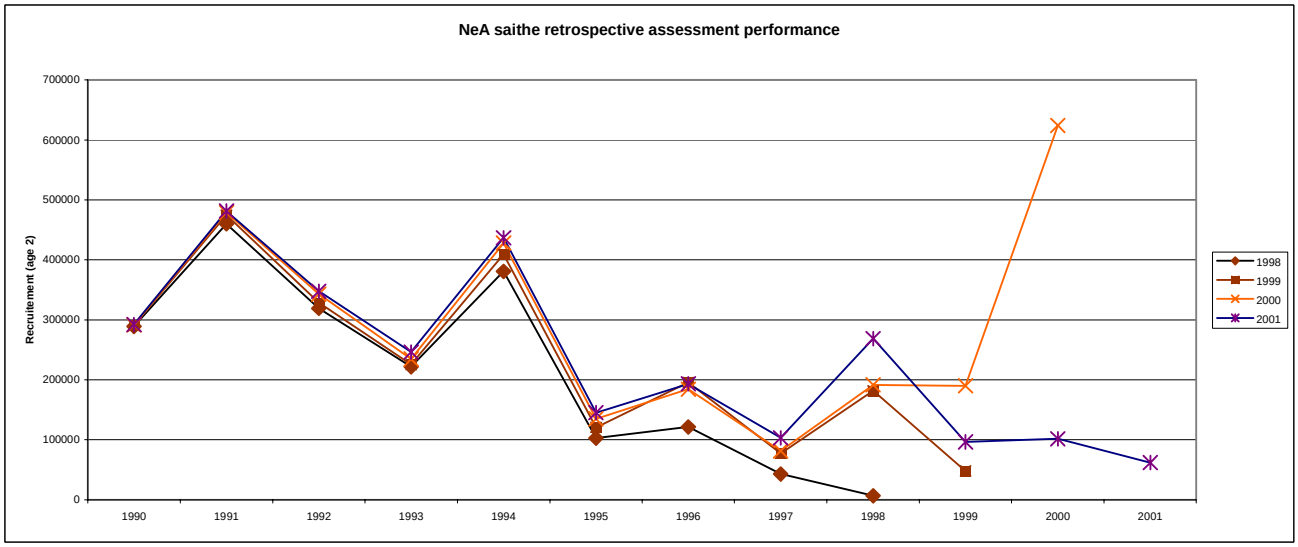


Figure 5.4 NeA saithe





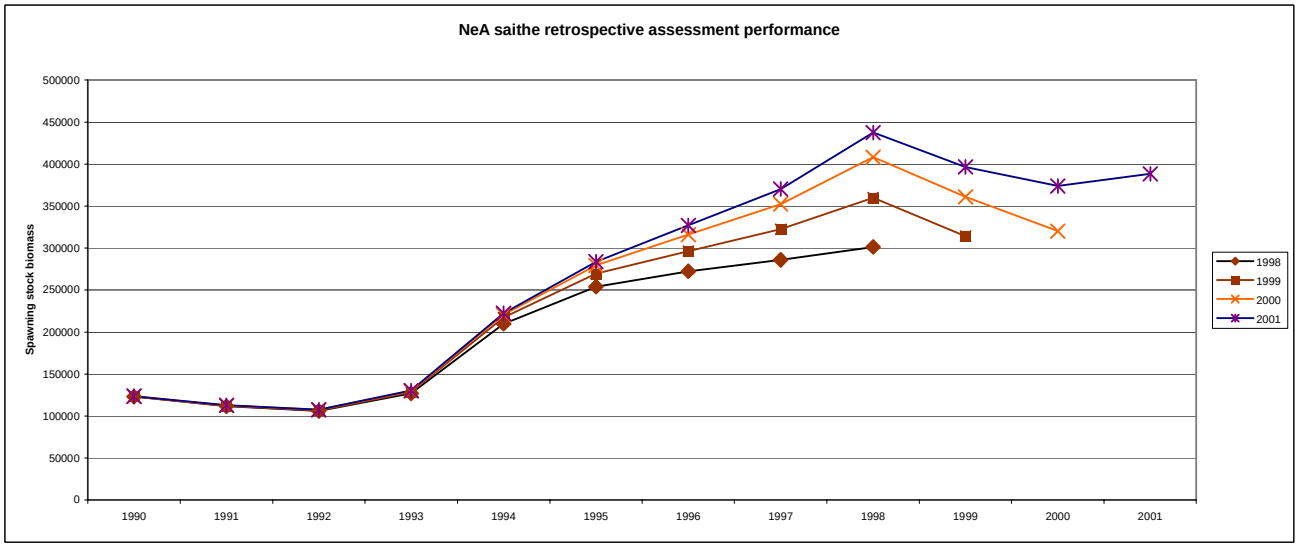


Figure 5.5 Retrospective analysis of Fbar3-6.

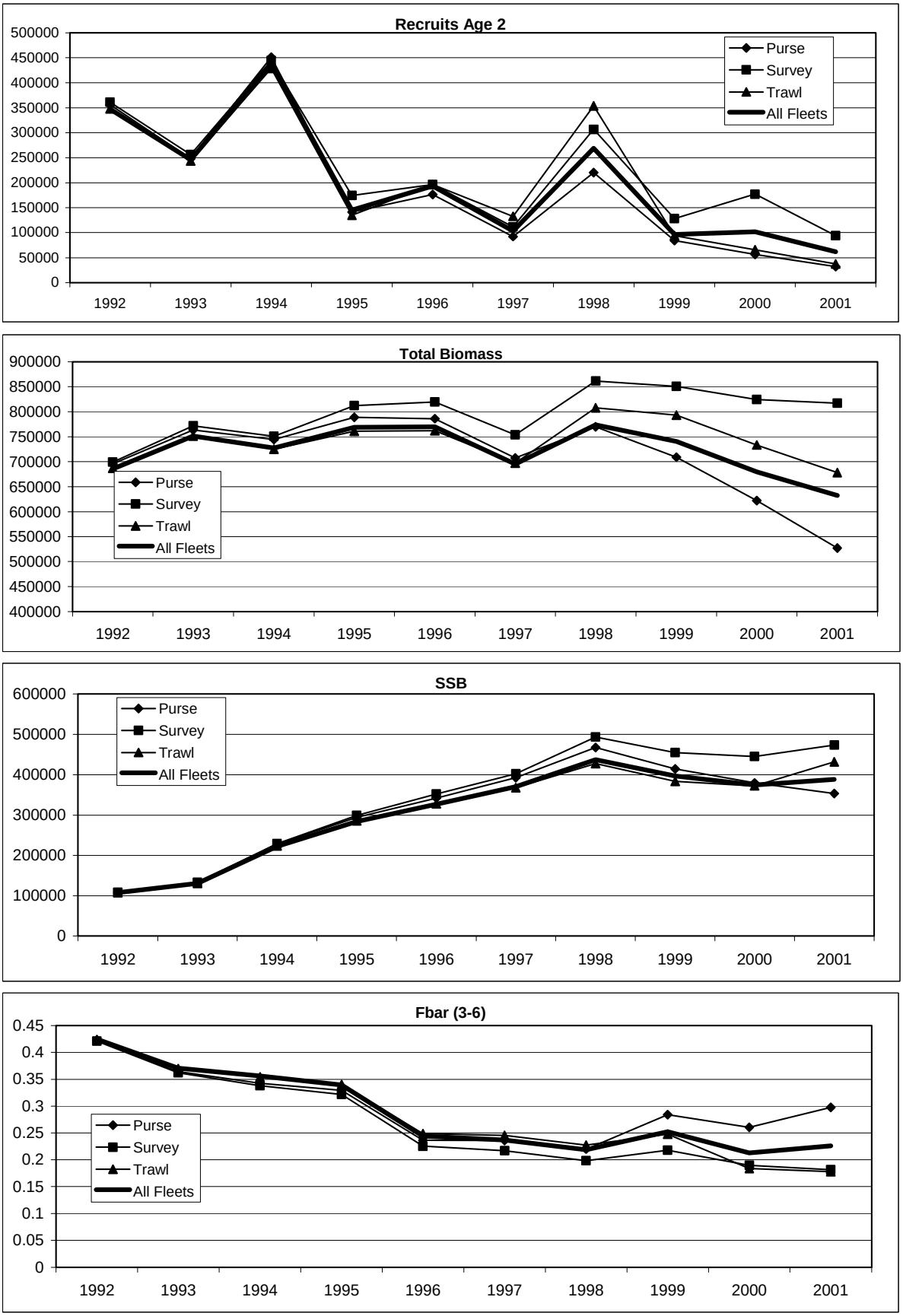
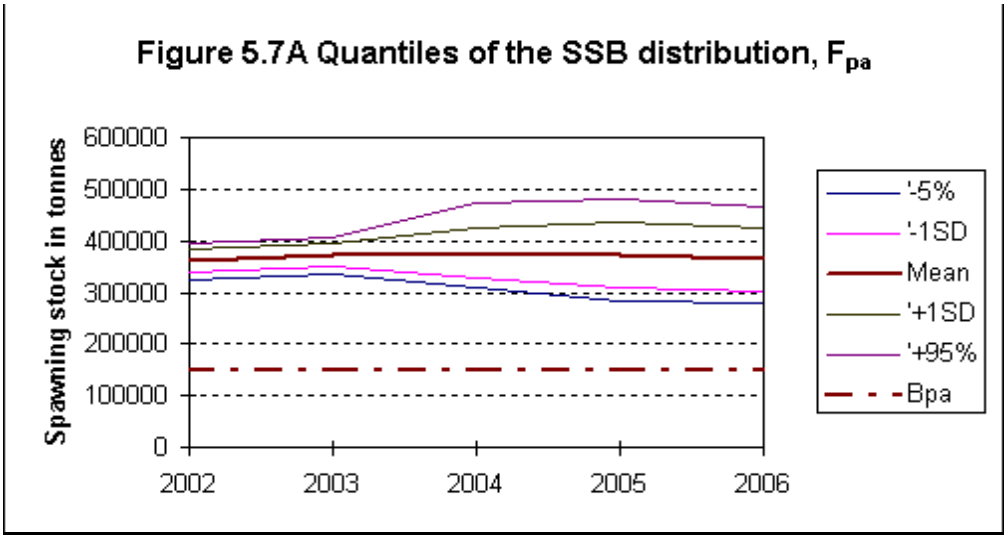


Figure 5.6 Plots of XSA results for saithe by tuning separately with individual fleets as well as including all three fleets.



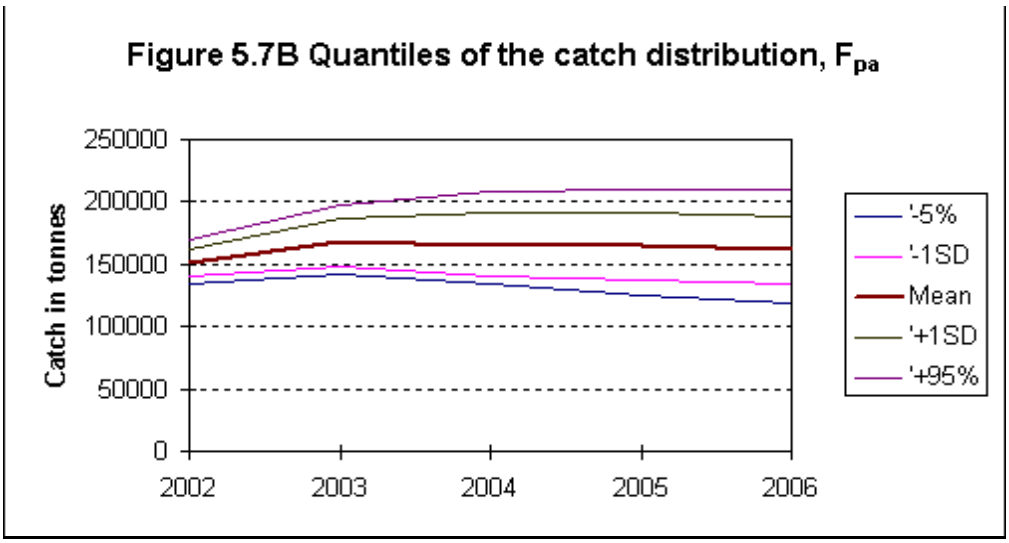


Figure 5.7 Medium-term forecast with risk analyses**.**

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			No. of vessels in % with catch		Catch from vessel with catch			Catch in % by vessel		Catch per vessel by vessel		effort, by vessel>100(t) scaled to total
	< 100 (t)	> 100 (t)	total	< 100 (t)	> 100 (t)	< 100 (t)	> 100 (t)	total	< 100 (t)	> 100 (t)	< 100 (t)	> 100 (t)	
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 [1]	215	87	302	71%	29%	4,715.0	23,396.0	28,111.0	17%	83%	21.9	268.9	104.5
Mean	123.5	85.6	#####	56%	44%	3,038.7	31,909.7	34,948.4	9%	91%	25.4	382.5	94.9

[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
1985	1	158.4	268.7	140.2	43.6	22.0	0.0	0.0
1986	1	35.6	206.8	134.6	54.0	78.7	59.4	14.8
1987	1	17.3	293.8	159.1	110.6	59.4	36.7	30.8
1988	1	5.1	61.8	286.0	144.6	63.5	33.8	21.2
1989	1	34.7	43.4	172.9	302.5	68.8	7.0	3.4
1990	1	30.0	66.4	84.0	175.8	182.8	27.6	5.2
1991	1	31.3	97.5	137.6	124.1	125.3	92.4	24.0
1992	1	0.8	285.0	144.1	115.4	124.1	126.2	62.6
1993	1	10.0	180.6	493.4	100.2	41.1	32.4	32.7
1994	1	1.6	17.4	376.8	312.8	51.5	25.2	5.1
1995	1	2.9	72.7	230.3	557.4	74.9	9.5	0.0
1996	1	6.9	41.6	140.9	486.6	196.4	12.2	1.4
1997	1	2.0	6.8	308.7	253.1	299.6	123.9	5.9
1998	1	0.2	15.9	48.1	249.7	88.9	63.2	38.2
1999	1	0.5	31.6	176.0	86.6	184.0	42.8	20.2
2000	1	28.1	158.3	160.5	282.0	118.9	193.8	71.0
2001 [2]	1	21.8	212.8	452.3	267.5	269.8	158.6	99.6

[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

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

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

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.

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

1. N 6630’ E 0659’
2. N 6621’ E 0644’
3. N 6543’ E 0600’
4. N 6520’ E 0600’
5. N 6520’ E 0530’
6. N 6600’ E 0530’
7. N 6630’ E 0634.27’

B

1. N 6236’ E 0300’
2. N 6210’ E 0115’
3. N 6240’ E 0052’
4. N 6300’ E 0300’

Area A has recently been enlarged to include the continental slope north to N 6710.

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.

6.1.2 Landings prior to 2002 (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* and *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. The landings used by the Working Group (WG) are those officially reported to ICES, except where such reporting has been made directly to Norwegian authorities during the fishery. In such cases the reportings to Norwegian authorities have been treated as preliminary figures. For Norway some area adjustments of the official statistics were made prior to the Working Group. Reliable estimates of species breakdown by area were available to the Working Group 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 Working Group has split the landings into *S. mentella* and *S. marinus* based on reports from different fleets to the Norwegian fisheries authorities.

After a continuous decrease in the total landings from 48,727 t in 1991 to a historical low of about 8,000 t in 1996 and 1997, the landings increased to 14,045 t in 1998 before a temporary decrease. Provisional statistics for 2001 show 18,887 t, which is close to the expected value by last year's Working Group. This high catch level was caused by Norwegian trawlers obtaining very good catch rates along the continental slope outside the closed areas in winter 2001. The regulations enforced in the fishery in 1997 (see chapter 6.1.1) have therefore not been sufficient to reduce the catches. Stronger regulations were therefore introduced in 2000 and further 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 landings from Subarea IV have been 1,000–3,000 t per year (Table D2). 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*.

6.1.3 Expected landings in 2002

The only directed Russian fishery for *S. mentella* at present is within the Norwegian EEZ where Russia received a quota of 2,000 t for 2002. In addition to this, and based on reports from the first months in 2002, a by-catch of approx. 2,000 t in other fisheries and areas should give an expected total Russian catch in 2002 of about 4,000 t. During winter 2002, Norwegian fishermen have not nearly got the same good catch rates along the continental slope compared with last year, and the landings are therefore expected to decrease substantially. Based on the landings of *S. mentella* from the three first months of the year, Norwegian landings in 2002 are therefore expected to be about 5,000 t. On this basis, and assuming unchanged catch level for other countries, the total landings of *S. mentella* for 2002 is expected to be **10,000 t**.

6.2 Data used in the Assessment

All input data sets were updated up to and including 2001.

6.2.1 Fishing effort and catch-per-unit-effort (Table D3, Figure 6.7)

Revised catch-per-hour-trawling data for the *S. mentella* fishery were available from Russian PST-trawlers fishing in ICES Division IIa in March-May 1975-2001, representative for the directed Russian fishery accounting for 60-80% of the total Russian catch (Table D3). However, the Working Group considers that the Russian trawl CPUE series does 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 relatively low effort at present (Table D3). Because of this, the CPUEs have been plotted in Figure 6.7 only for the period after 1991. However, the commercial trawl CPUEs are confirmed by the Russian trawl-acoustic spring survey also covering the same area.

6.2.2 Catch-at-age (Table 6.5)

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.

Catch-at-age for 1997–2000 was revised according to new catch data. Data on age for 2001 for *S. mentella* were only available from Russia in Division IIa and Norway. For Division IIa, a German length distribution was available, and was converted to age using the Norwegian age-length key from trawl in the same Division. The landings from other countries were distributed on age according to the Norwegian age distribution.

Based on data collected from the good Norwegian fishery along the slope outside Lofoten in winter 2001, it is concluded that most of these fish were older than 18 years, making a big plus-group in the catch-at-age matrix.

6.2.3 Weight-at-age (Table 6.6)

Catch weight-at-age data for 2001 were available from Russia in Division IIa and 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 further investigated 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 D8)

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 (Table D8). 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 was taken as representative for these years.

6.2.5 Survey results (Tables A14, D4-D7, Figures 6.1–6.6)

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 1986–2001 in fishing depths of 100–500 m. Data disaggregated on age only for the years 1992–2001 (Table D5a,b and Figure 6.3a,b).

4) Norwegian Barents Sea bottom trawl survey (February) from 1986–2002 in fishing depths of 100–500 m. Data disaggregated on age only for the years 1992–2002 (Tables D6a,b and Figures 6.4a,b).

5) Russian acoustic survey in April-May from 1992–2001 (except 1994 and 1996) on spawning grounds in the western Barents Sea (Table D7, Figure 6.6).

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* (Table A14, Figure 6.1). 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 year class was 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 relative 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. The results for *S. mentella* are available on length from 1986–2000 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- to 3-year-olds have decreased since then and must now be considered poor.

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.

A new time-series is about to be established from a new designed survey covering Svalbard and the Norwegian Economic Zone (NEZ) in August.

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 and 1.4).

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. Table D7 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 half matured (males before females), and these year classes contributed in the 2001 survey to a three times increase in the survey abundance of mature fish (Table D7, Figure 6.6). This is the only survey targeting commercially-sized *S. mentella*, but only in a limited area of its distribution. These results are supported by the observations of *S.mentella* along the continental slope during the Norwegian Greenland halibut survey (1996-2001) covering depths greater than 400 m in August.

6.3 Results of the Assessment (Tables 6.8-6.15 , Figures 6.8-6.11)

All available information since last year's assessment confirms the bad situation for this stock. The surveys have not detected any improved recruitment, rather the contrary.

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 as the 1982–1983 ones. 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 some increase in the fishable stock due to the 1987–1990 year classes.

According to the last (1997) analytical assessment the spawning stock biomass has been low for several years despite the relative strong 1982–1983 year classes. Due to the 1987–1990 year classes the spawning stock biomass is expected to increase in near future, but according to the assessment the spawning stock biomass will remain well below the previously defined MBAL of 300,000 tonnes. Since these are the last relatively rich year classes in the stock they should be protected from fishing to conserve the reproductive potential of the stock.

Any improvement of the stock condition is not expected until an improved recruitment in the surveys is detected. 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. 29–36 cm) which currently have recruited more than 50% to the spawning stock are protected. These year classes are the main cause for the current improved catch rates in the fisheries.

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 was asked by ACFM to provide results of last year's exploratory XSA analysis. A XSA was therefore run with settings similar to last year and recommended by people analysing previous trial analytical assessments. 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. Log catchability residuals are shown in Figure 6.8 from separate runs for each fleet, also for the Russian commercial trawl CPUE series, and these seem to be reasonable except for high residuals for some of the ages. Results from the separate runs, excluding the commercial CPUE, are shown in Table 6.8. The two Norwegian survey series (FLT07 and FLT08) produced an unlikely stock development. This is most probably caused by their limited area coverage, partly overlapping, and they are therefore not easy to combine directly. A more refined estimation and analysis should therefore be done before using these survey data in XSA tuning.

The Working Group therefore decided to run XSA with the two Russian survey fleets only, covering different age groups. The resulting stock estimates from this run did, however, not deviate much from the trial run with all four fleets. Input tuning data for the final run are given in Table 6.9. Results from the XSA run are shown graphically in Figures 6.9-6.10, and the diagnostics are presented in Table 6.10. Results from a retrospective analysis are shown in Figure 6.11. The XSA output results are shown in Tables 6.11-6.15. Except for some age groups, the VPA-survey plots show a reasonably good fit (Figure 6.9). The stock trends fit with observations in the surveys, including confirming the relative strength of the 1987-1991 year classes. The two survey series estimate similar numbers of survivors of different age groups, and this is seen upon as a strength of the analysis (Figure 6.10). The big plus-group fish caught in 2001 caused a peak in SSB in 2000, followed by a decrease in SSB in 2001. This peak is probably an artefact caused by the analytical handling of the plus-group. A temporary increase in SSB in 2001 and in the short term is expected.

6.4 Comments to the assessment

The origin of the plus-group fish, which is not seen on the fishing fields in 2002 to nearly the same extent as in winter 2001, is difficult to tell. The current most likely explanation is that this old fish some years may migrate in from the Norwegian Sea and settle along the continental slope. However, this must be 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 request ICES to have a closer look at the algorithm for how a plus-group is handled by XSA. This matter is especially important for long-lived species, and in cases where the relative contribution from plus-group fish may vary.

Work is already planned to be done until next AFWG to improve the survey tuning series. 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 based on the BORMICON model which is currently used by the ICES North-Western WG on *S. marinus*. 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} and U_{pa}) 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 recent ICES Study Group on the Precautionary Approach.

6.6 Management advice

ICES recommended last year that no directed fishing should be carried out on this stock until improved recruitment is observed in the surveys for this stock, and a significant increase in spawning stock biomass has been detected. The current assessment indicates no improvement in recruitment, while a 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. 29–36 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 to ensure that they can contribute as much as possible to the stock rebuilding.

Therefore the same advice should be maintained for 2003. 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 Sub-area 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	-	50	12	62	29	1
2001[1]	33	-	52	16	198	17	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	10,518
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	-	12,866
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	8,597
1998	9,733	13	125	3,646	177	93	41	14,045
1999	7,884	6	65	2,731	29	112	28	11,208
2000	6,151	2	115	3,519	87		130[5]	10,206
2001[1]	14,291	5	179	3,775	198		120[5]	18,887

[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 Sub-area 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	-	-	626
2000	-	-	-	43	406	-	48[2]	497
2001[1]	-	-	-	4	296	-	33[2]	333

[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]	11[2]	35[2]	29[2]	-	5,975
2001[1]	33[2]	12[2]	161[2]	17[2]	4[2]	13,987

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]	12,241
1999	56[2]	1,340	14[2]	94[2]	26[2]	9,117
2000	98[2]	2,167	18[2]		103[6]	8,486
2001[1]	105[2]	2,716	6[2]		95[6]	17,136

[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	-	-	-	1[2]	27[2]	-	1[2]
2001[1]	-	-	19[2]	4[2]	37[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]	2,826
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	2[2]	17[2]	946	69[2]		27[7]	1,223
2001[1]	300	5[2]	74[2]	763	192[2]		25[7]	1,419

[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 6.5. Catch numbers-at-age

Run title : Arctic S. mentella (run: XSAKHN19/X19) At 23/04/2002 10:00

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

YEAR / AGE	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
6	1653	1873	159	738	662	223	125	37	9	1	134
7	5453	2498	159	730	941	634	533	882	83	24	432
8	7994	1898	174	722	1279	1699	1287	2904	441	396	704
9	6781	1622	512	992	719	1554	1247	4236	1511	1255	1031
10	8226	1780	2094	2561	740	1236	1297	3995	2250	2480	972
11	5344	1531	3139	2734	1230	1078	1244	2741	3262	2157	1940
12	6227	2108	2631	3060	2013	1146	876	1877	1867	1833	2637
13	9880	2288	2308	1535	4297	1413	1416	1373	1454	1212	2584
14	10824	2258	2987	2253	3300	1865	1784	1277	1447	1013	1834
15	4049	2506	1875	2182	2162	880	1217	1595	1557	1002	1613
16	2105	2137	1514	3336	1454	621	537	1117	1418	944	1161
17	9603	1512	1053	1284	757	498	1177	784	1317	510	804
18	6522	677	527	734	794	700	342	786	658	604	569
+gp	19299	9258	6022	3257	2404	2247	3568	6241	3919	5798	16072
TOTALNUM	103960	33946	25154	26118	22752	15794	16650	29845	21193	19229	32487
TONSLAND	48727	15590	12866	12721	10284	8075	8597	14045	11209	10206	18888
SOPCOF %	100	103	101	104	100	95	101	101	102	101	100

Table 6.6. Catch weights-at-age

Run title : Arctic S. mentella (run: XSAKHN19/X19) At 23/04/2002 10:00

Catch weights-at-age (kg)

YEAR	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
AGE											
6	0.13	0.19	0.17	0.16	0.14	0.2	0.18	0.14	0.15	0.1	0.11
7	0.18	0.22	0.23	0.22	0.16	0.2	0.21	0.19	0.22	0.15	0.15
8	0.21	0.26	0.25	0.24	0.19	0.25	0.25	0.23	0.22	0.22	0.2
9	0.27	0.28	0.28	0.3	0.21	0.31	0.29	0.29	0.28	0.26	0.25
10	0.34	0.31	0.33	0.34	0.28	0.42	0.33	0.33	0.33	0.31	0.3
11	0.35	0.33	0.38	0.37	0.32	0.44	0.38	0.38	0.37	0.36	0.34
12	0.42	0.38	0.44	0.4	0.37	0.47	0.46	0.43	0.44	0.42	0.4
13	0.46	0.46	0.47	0.44	0.41	0.59	0.48	0.48	0.49	0.44	0.45
14	0.51	0.43	0.5	0.45	0.47	0.67	0.51	0.54	0.53	0.51	0.48
15	0.58	0.43	0.57	0.49	0.53	0.69	0.55	0.59	0.56	0.56	0.54
16	0.59	0.45	0.58	0.55	0.58	0.71	0.6	0.61	0.62	0.62	0.59
17	0.58	0.52	0.62	0.58	0.66	0.74	0.66	0.64	0.66	0.63	0.61
18	0.59	0.57	0.65	0.67	0.71	0.74	0.65	0.66	0.67	0.67	0.68
+gp	0.7	0.67	0.662	0.79	0.806	0.847	0.787	0.753	0.805	0.775	0.743
SOPCOFAC	1.0032	1.0291	1.0052	1.0377	0.9998	0.9465	1.0103	1.0085	1.0184	1.0057	0.9993

Table 6.7. Proportion mature at age

Run title : Arctic S. mentella (run: XSAKHN19/X19) At 23/04/2002 10:00

Table 5 Proportion mature at age

YEAR	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
AGE											
6	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0.018	0.021	0	0	0
8	0.015	0.015	0	0	0	0	0	0.014	0.016	0	0
9	0.055	0.062	0.023	0.023	0	0.014	0.027	0	0.059	0.048	0.082
10	0.132	0.133	0.113	0.113	0.055	0.093	0.13	0.074	0.11	0.087	0.196
11	0.202	0.224	0.267	0.267	0.111	0.212	0.312	0.171	0.333	0.202	0.405
12	0.481	0.411	0.438	0.438	0.368	0.325	0.281	0.276	0.579	0.375	0.442
13	0.545	0.539	0.574	0.574	0.587	0.577	0.566	0.622	0.689	0.489	0.442
14	0.741	0.774	0.843	0.843	0.696	0.716	0.736	0.714	0.788	0.742	0.648
15	0.85	0.888	0.951	0.951	0.729	0.78	0.831	0.871	0.813	0.833	0.775
16	0.962	0.946	0.92	0.92	0.789	0.874	0.958	0.919	0.903	0.904	0.865
17	1	0.992	0.989	0.989	1	0.975	0.95	1	0.923	1	0.909
18	1	1	1	1	1	1	1	1	1	1	1
+gp	1	1	1	1	1	1	1	1	1	1	1

Table 6.8 Sebastes mentella

XSA runs by one fleet at a time:

FLT07 Norw. Barents Sea February only:

	RECRUITS Age 6	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	SOPCOFAC	FBAR 10-16
1991	72303	219021	104292	48727	0.4672	1.0032	0.2756
1992	205523	225577	87691	15590	0.1778	1.0291	0.1071
1993	704778	340543	94937	12866	0.1355	1.0052	0.0974
1994	640023	445651	86877	12721	0.1464	1.0377	0.1087
1995	640840	554689	75523	10284	0.1362	0.9998	0.0988
1996	355235	666350	124432	8075	0.0649	0.9465	0.0415
1997	285565	731472	152938	8597	0.0562	1.0103	0.0405
1998	137399	782561	198738	14045	0.0707	1.0085	0.0429
1999	195161	802916	307439	11209	0.0365	1.0184	0.0532
2000	105566	987284	514846	10206	0.0198	1.0057	0.0385
2001	89804	1143686	759781	18888	0.0249	0.9993	0.018

FLT08 Norw. Svalbard survey only:

	RECRUITS Age 6	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	SOPCOFAC	FBAR 10-16
1991	67606	175022	90347	48727	0.5393	1.0032	0.3308
1992	185188	174463	68671	15590	0.227	1.0291	0.1387
1993	279968	213662	69757	12866	0.1844	1.0052	0.1331
1994	580932	297419	59373	12721	0.2143	1.0377	0.1511
1995	408160	367193	46239	10284	0.2224	0.9998	0.1469
1996	338426	453016	73977	8075	0.1092	0.9465	0.0629
1997	155192	495310	96314	8597	0.0893	1.0103	0.0589
1998	46586	521234	126446	14045	0.1111	1.0085	0.0626
1999	111468	524888	191134	11209	0.0586	1.0184	0.0626
2000	111809	529413	209936	10206	0.0486	1.0057	0.0443
2001	31497	774666	517814	18888	0.0365	0.9993	0.0224

FLT10 Russian youngfish survey only:

	RECRUITS Age 6	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	SOPCOFAC	FBAR 10-16
1991	34263	160985	86993	48727	0.5601	1.0032	0.3516
1992	40808	128900	64065	15590	0.2433	1.0291	0.1493
1993	84386	131795	63698	12866	0.202	1.0052	0.1478
1994	170774	141291	52603	12721	0.2418	1.0377	0.1671
1995	103521	144385	39627	10284	0.2595	0.9998	0.1696
1996	179053	188277	56997	8075	0.1417	0.9465	0.0823
1997	76571	201314	64555	8597	0.1332	1.0103	0.081
1998	47019	214057	79058	14045	0.1777	1.0085	0.1024
1999	68099	202254	77913	11209	0.1439	1.0184	0.1069
2000	102246	222577	99294	10206	0.1028	1.0057	0.0746
2001	82244	315987	205327	18888	0.092	0.9993	0.0945

FLT10 Russian trawl-acoustic survey only:

	RECRUITS Age 6	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	SOPCOFAC	FBAR 10-16
1991	26279	162370	88027	48727	0.5535	1.0032	0.3424
1992	29991	126140	65148	15590	0.2393	1.0291	0.1446
1993	47773	123017	65406	12866	0.1967	1.0052	0.1436
1994	82844	116216	54770	12721	0.2323	1.0377	0.1753
1995	116096	119199	43198	10284	0.2381	0.9998	0.1665
1996	119094	151162	59425	8075	0.1359	0.9465	0.0906
1997	69797	155821	59069	8597	0.1455	1.0103	0.1027
1998	25094	161637	68054	14045	0.2064	1.0085	0.1575
1999	22216	165471	82106	11209	0.1365	1.0184	0.1971
2000	34544	203371	125675	10206	0.0812	1.0057	0.1498
2001	31450	163118	100080	18888	0.1887	0.9993	0.2111

Table 6.9. Tuning data

Sebastes mentella in Sub-areas I & II (run name: XSAKHN19)

102

FLT10: Rus young SURVEY. Effort and catch rates. S.mentella (Catch: Number) (Effort: Unknown)

1991 2001

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

FLT13: Rus acous spring survey (Catch: Number) (Effort: Unknown)

1995 2001

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

Table 6.10. Tuning diagnostics

Lowestoft VPA Version 3.1
23/04/2002 9:59
Extended Survivors Analysis
Arctic S. mentella (run: XSAKHN19/X19)
CPUE data from file fleet
Catch data for 11 years. 1991 to 2001. Ages 6 to 19.

Fleet	First year	Last year	First age	Last age	Alpha	Beta
FLT10: Rus young SUR	1991	2001	6	8	0.85	0.95
FLT13: Rus acous spr	1995	2001	6	14	0.3	0.5

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 had not converged after 110 iterations

Total absolute residual between iterations
109 and 110 = .00737

Final year F values

Age	6	7	8	9	10	11	12	13	14	15
Iteration **	0.0033	0.0099	0.0286	0.0476	0.023	0.0317	0.0571	0.0906	0.1492	0.3958
Iteration **	0.0033	0.0099	0.0286	0.0476	0.023	0.0316	0.057	0.0905	0.149	0.3949

Age	16	17	18
Iteration **	0.7927	0.4644	0.2283
Iteration **	0.7896	0.4626	0.2273

Table 6.10. (Continued)

1
Regression weights

	0.751	0.82	0.877	0.921	0.954	0.976	0.99	0.997	1	1

Fishing mortalities

Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
6	0.068	0.003	0.009	0.006	0.002	0.002	0.001	0	0	0.003
7	0.128	0.007	0.018	0.013	0.007	0.005	0.015	0.003	0.001	0.01
8	0.082	0.011	0.034	0.035	0.027	0.016	0.032	0.008	0.016	0.029
9	0.058	0.026	0.069	0.039	0.049	0.022	0.059	0.019	0.026	0.048
10	0.036	0.089	0.155	0.061	0.078	0.047	0.083	0.037	0.035	0.023
11	0.052	0.074	0.144	0.093	0.106	0.094	0.12	0.081	0.04	0.032
12	0.097	0.106	0.086	0.135	0.106	0.106	0.18	0.101	0.054	0.057
13	0.159	0.132	0.075	0.15	0.119	0.166	0.216	0.185	0.08	0.09
14	0.117	0.287	0.164	0.204	0.081	0.193	0.199	0.33	0.17	0.149
15	0.238	0.121	0.312	0.21	0.069	0.063	0.237	0.352	0.355	0.395
16	0.314	0.198	0.291	0.314	0.077	0.049	0.068	0.305	0.332	0.79
17	0.375	0.224	0.23	0.089	0.15	0.184	0.085	0.096	0.153	0.463
18	0.241	0.193	0.215	0.194	0.099	0.132	0.161	0.086	0.052	0.227

1
XSA population numbers (Thousands)

	AGE									
YEAR	6	7	8	9	10	11	12	13	14	15
1992	3.00E+04	2.19E+04	2.54E+04	3.03E+04	5.32E+04	3.20E+04	2.40E+04	1.63E+04	2.15E+04	1.24E+04
1993	4.88E+04	2.54E+04	1.74E+04	2.12E+04	2.59E+04	4.65E+04	2.75E+04	1.97E+04	1.26E+04	1.73E+04
1994	8.45E+04	4.40E+04	2.28E+04	1.56E+04	1.87E+04	2.14E+04	3.90E+04	2.24E+04	1.56E+04	8.56E+03
1995	1.07E+05	7.57E+04	3.91E+04	2.00E+04	1.32E+04	1.45E+04	1.68E+04	3.24E+04	1.88E+04	1.20E+04
1996	1.19E+05	9.66E+04	6.76E+04	3.42E+04	1.74E+04	1.12E+04	1.19E+04	1.33E+04	2.52E+04	1.39E+04
1997	7.07E+04	1.07E+05	8.68E+04	5.96E+04	2.94E+04	1.45E+04	9.13E+03	9.72E+03	1.07E+04	2.11E+04
1998	3.21E+04	6.38E+04	9.64E+04	7.73E+04	5.27E+04	2.54E+04	1.20E+04	7.43E+03	7.44E+03	7.95E+03
1999	3.21E+04	2.91E+04	5.69E+04	8.44E+04	6.59E+04	4.39E+04	2.04E+04	9.05E+03	5.42E+03	5.52E+03
2000	5.08E+04	2.90E+04	2.62E+04	5.11E+04	7.50E+04	5.75E+04	3.66E+04	1.67E+04	6.81E+03	3.52E+03
2001	4.26E+04	4.59E+04	2.62E+04	2.33E+04	4.50E+04	6.55E+04	5.00E+04	3.14E+04	1.39E+04	5.20E+03

Estimated population abundance at 1st Jan 2002

0.00E+00	3.85E+04	4.12E+04	2.31E+04	2.02E+04	3.99E+04	5.75E+04	4.28E+04	2.60E+04	1.09E+04

Taper weighted geometric mean of the VPA populations:

5.24E+04	4.65E+04	4.05E+04	3.80E+04	3.50E+04	2.85E+04	2.15E+04	1.66E+04	1.27E+04	9.39E+03

Standard error of the weighted Log(VPA populations) :

0.527	0.5539	0.5875	0.6038	0.595	0.6127	0.5615	0.5394	0.5371	0.5708

	AGE		
YEAR	16	17	18
1992	8.34E+03	5.08E+03	3.32E+03
1993	8.87E+03	5.51E+03	3.16E+03
1994	1.39E+04	6.58E+03	3.99E+03
1995	5.67E+03	9.38E+03	4.73E+03
1996	8.79E+03	3.75E+03	7.77E+03
1997	1.17E+04	7.36E+03	2.92E+03
1998	1.79E+04	1.01E+04	5.54E+03
1999	5.68E+03	1.51E+04	8.40E+03
2000	3.51E+03	3.79E+03	1.24E+04
2001	2.24E+03	2.28E+03	2.94E+03

Estimated population abundance at 1st Jan 2002

3.18E+03	9.23E+02	1.31E+03

Table 6.10. (Continued)

Taper weighted geometric mean of the VPA populations:

7.30E+03 6.38E+03 5.37E+03

Standard error of the weighted Log(VPA populations) :

0.6266 0.5943 0.5768

1

Log catchability residuals.

Fleet : FLT10: Rus young SUR

Age	1991
6	-0.02
7	-0.15
8	0.18
9	No data for this fleet at this age
10	No data for this fleet at this age
11	No data for this fleet at this age
12	No data for this fleet at this age
13	No data for this fleet at this age
14	No data for this fleet at this age

Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
6	0.04	-0.55	0.37	-0.64	0.31	-0.25	-0.13	0.27	0.36	0.15
7	-0.02	-0.63	1.01	0.52	-0.26	-0.38	-0.53	-0.12	0.48	0.06
8	0.04	-1.03	0.95	0.95	-0.84	-0.24	-0.51	-0.18	0.66	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									

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	-7.1579	-6.9313	-6.8407
S.E(Log q)	0.3579	0.4976	0.6666

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	1.08	-0.32	6.85	0.65	11	0.41	-7.16
7	1.12	-0.335	6.48	0.5	11	0.59	-6.93
8	1.63	-1.02	4.47	0.25	11	1.08	-6.84

1

Fleet : FLT13: Rus acous spr

Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
6	99.99	99.99	99.99	0.45	99.99	0.11	-0.2	-0.08	-0.09	-0.16
7	99.99	99.99	99.99	0.5	99.99	0.36	0.1	-0.33	-0.26	-0.33
8	99.99	99.99	99.99	0.52	99.99	0.23	-0.54	-0.32	0.54	-0.4
9	99.99	99.99	99.99	0.35	99.99	-0.49	-0.57	-0.5	0.3	0.92
10	99.99	99.99	99.99	0.32	99.99	-0.05	-0.23	-0.59	0.1	0.46
11	99.99	99.99	99.99	0.13	99.99	-0.13	-0.03	-0.13	0.1	0.06
12	99.99	99.99	99.99	0.18	99.99	0.06	0.12	-0.31	-0.36	0.32
13	99.99	99.99	99.99	0.06	99.99	-0.01	-0.04	0.03	-0.32	0.27
14	99.99	99.99	99.99	0.05	99.99	-0.09	-0.18	-0.11	-0.06	0.39

Table 6.10. (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	9	10	11	12	13	14
Mean Log q	-8.0612	-7.2707	-6.5439	-6.4831	-6.311	-6.1997	-6.1024	-5.807	-5.4804
S.E(Log q)	0.2389	0.3633	0.4843	0.6135	0.3822	0.1131	0.2742	0.1923	0.2097

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	0.68	4.506	8.94	0.98	6	0.07	-8.06
7	0.62	3.59	8.61	0.96	6	0.12	-7.27
8	1.42	-0.734	4.78	0.45	6	0.72	-6.54
9	7.6	-3.361	-21.63	0.06	6	2.65	-6.48
10	1.39	-1.04	4.61	0.64	6	0.53	-6.31
11	0.97	0.398	6.33	0.97	6	0.12	-6.2
12	1.03	-0.155	5.97	0.84	6	0.32	-6.1
13	0.9	0.803	6.19	0.94	6	0.18	-5.81
14	0.78	1.556	6.28	0.93	6	0.14	-5.48

1

Terminal year survivor and F summaries :

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

Year class = 1995

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT10: Rus young SUR	44485	0.375	0	0	1	0.384	0.003
FLT13: Rus acous spr	32765	0.3	0	0	1	0.602	0.004
F shrinkage mean	807348	2				0.014	0

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
38492	0.23	0.28	3	1.182	0.003

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

Year class = 1994

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT10: Rus young SUR	53331	0.305	0.146	0.48	2	0.376	0.008
FLT13: Rus acous spr	34335	0.238	0.113	0.47	2	0.615	0.012
F shrinkage mean	211636	2				0.009	0.002

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
41179	0.19	0.15	5	0.781	0.01

Table 6.10. (Continued)

Age 8 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
FLT10: Rus young SUR	31027	0.28	0.102	0.37	3	0.373	0.021
FLT13: Rus acous spr	19116	0.217	0.088	0.41	3	0.619	0.034
F shrinkage mean	55000	2				0.008	0.012

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
23088	0.17	0.11	7	0.667	0.029

Age 9 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
FLT10: Rus young SUR	20128	0.28	0.206	0.73	3	0.35	0.048
FLT13: Rus acous spr	19996	0.207	0.242	1.17	4	0.643	0.048
F shrinkage mean	42915	2				0.007	0.023

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
20155	0.17	0.15	8	0.874	0.048

Age 10 Catchability constant w.r.t. time and dependent on age

Year class = 1991

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT10: Rus young SUR	28857	0.282	0.097	0.34	3	0.298	0.032
FLT13: Rus acous spr	45963	0.186	0.112	0.6	5	0.695	0.02
F shrinkage mean	25231	2				0.006	0.036

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
39851	0.15	0.1	9	0.674	0.023

Age 11 Catchability constant w.r.t. time and dependent on age

Year class = 1990

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT10: Rus young SUR	56036	0.284	0.262	0.92	3	0.286	0.032
FLT13: Rus acous spr	58390	0.185	0.143	0.77	5	0.708	0.031
F shrinkage mean	29430	2				0.007	0.061

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
57450	0.15	0.11	9	0.724	0.032

Table 6.10. (Continued)

Age 12 Catchability constant w.r.t. time and dependent on age

Year class = 1989

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT10: Rus young SUR	26887	0.288	0.138	0.48	3	0.199	0.089
FLT13: Rus acous spr	48164	0.151	0.157	1.04	6	0.796	0.051
F shrinkage mean	31036	2				0.005	0.078

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
42783	0.13	0.13	10	1	0.057

Age 13 Catchability constant w.r.t. time and dependent on age

Year class = 1988

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT10: Rus young SUR	31836	0.294	0.338	1.15	3	0.17	0.074
FLT13: Rus acous spr	24992	0.146	0.138	0.95	6	0.825	0.094
F shrinkage mean	17362	2				0.005	0.132

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
25991	0.13	0.12	10	0.907	0.09
1					

Age 14 Catchability constant w.r.t. time and dependent on age

Year class = 1987

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT10: Rus young SUR	12909	0.303	0.542	1.79	3	0.133	0.127
FLT13: Rus acous spr	10631	0.138	0.137	0.99	6	0.861	0.152
F shrinkage mean	6130	2				0.006	0.25

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
10876	0.13	0.14	10	1.075	0.149

Age 15 Catchability constant w.r.t. time and dependent on age

Year class = 1986

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT10: Rus young SUR	3182	0.314	0.381	1.21	3	0.127	0.394
FLT13: Rus acous spr	3172	0.15	0.054	0.36	5	0.863	0.395
F shrinkage mean	3608	2				0.011	0.354

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
3177	0.14	0.08	9	0.559	0.395

Table 6.10. (Continued)

Age 16 Catchability constant w.r.t. time and dependent on age

Year class = 1985

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT10: Rus young SUR	727	0.331	0.291	0.88	3	0.123	0.924
FLT13: Rus acous spr	918	0.164	0.075	0.46	4	0.847	0.79
F shrinkage mean	2939	2				0.03	0.319

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
923	0.16	0.11	8	0.698	0.79

Age 17 Catchability constant w.r.t. time and dependent on age

Year class = 1984

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT10: Rus young SUR	1213	0.503	0.093	0.19	2	0.063	0.489
FLT13: Rus acous spr	1247	0.178	0.089	0.5	3	0.905	0.478
F shrinkage mean	5771	2				0.032	0.124

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
1307	0.18	0.13	6	0.759	0.463

1

Age 18 Catchability constant w.r.t. time and age (fixed at the value for age) 17

Year class = 1983

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT10: Rus young SUR	2534	0.854	0	0	1	0.031	0.194
FLT13: Rus acous spr	2170	0.22	0.136	0.62	2	0.931	0.223
F shrinkage mean	1177	2				0.038	0.378

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
2131	0.22	0.1	4	0.473	0.227

Table 6.11. Fishing mortality (F)at age

Run title : Arctic S. mentella (run: XSAKHN19/X19)
At 23/04/2002 10:00
Terminal Fs derived using XSA (With F shrinkage)
Table 8 Fishing mortality (F) at age

YEAR	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	FBAR 99-**
AGE												
6	0.0693	0.0678	0.0034	0.0092	0.0065	0.002	0.0019	0.0012	0.0003	0	0.0033	0.0012
7	0.1856	0.1278	0.0066	0.0176	0.0131	0.0069	0.0052	0.0146	0.003	0.0009	0.0099	0.0046
8	0.2239	0.0817	0.0105	0.0338	0.035	0.0268	0.0157	0.0322	0.0082	0.016	0.0286	0.0176
9	0.1144	0.0579	0.0257	0.0691	0.0386	0.049	0.0222	0.0593	0.019	0.0262	0.0476	0.0309
10	0.2185	0.0358	0.0889	0.1554	0.0608	0.0777	0.0474	0.083	0.0365	0.0354	0.023	0.0316
11	0.1923	0.0515	0.0737	0.1441	0.0935	0.1064	0.0942	0.1204	0.0813	0.0402	0.0316	0.0511
12	0.3095	0.097	0.1058	0.086	0.1348	0.1063	0.1063	0.18	0.1012	0.054	0.057	0.0708
13	0.3626	0.1593	0.1316	0.0747	0.1501	0.1187	0.1663	0.216	0.1849	0.0795	0.0905	0.1183
14	0.6033	0.117	0.2866	0.1645	0.2037	0.0808	0.1935	0.1989	0.3297	0.1701	0.149	0.2163
15	0.3796	0.2381	0.1209	0.3119	0.2103	0.0689	0.0626	0.2369	0.3516	0.3551	0.3949	0.3672
16	0.3321	0.3138	0.1979	0.2913	0.3141	0.0772	0.0493	0.0678	0.3047	0.3318	0.7896	0.4754
17	1.3223	0.375	0.2241	0.2295	0.0886	0.1505	0.184	0.0851	0.0959	0.1527	0.4626	0.237
18	0.6027	0.2413	0.1927	0.215	0.194	0.0995	0.1315	0.1615	0.0859	0.0524	0.2273	0.1219
+gp	0.6027	0.2413	0.1927	0.215	0.194	0.0995	0.1315	0.1615	0.0859	0.0524	0.2273	
0 FBAR 1(	0.3426	0.1447	0.1436	0.1754	0.1668	0.0909	0.1028	0.1576	0.1986	0.1523	0.2194	

Table 6.12. Stock number at age

Run title : Arctic S. mentella (run: XSAKHN19/X19)
At 23/04/2002 10:00
Terminal Fs derived using XSA (With F shrinkage)
Table 10 Stock number at age (start of year) Numbers*10**-3

YEAR	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	GMST 91-99	AMST 91-99
AGE														
6	25938	30024	48789	84488	107470	118552	70668	32145	32078	50753	42642	0	52404	61128
7	33848	21897	25385	43995	75746	96613	107058	63824	29051	29017	45922	38492	47376	55268
8	41889	25440	17437	22818	39114	67642	86816	96363	56911	26207	26233	41179	43292	50492
9	65933	30299	21214	15612	19960	34175	59589	77330	84430	51076	23337	23088	38258	45394
10	44065	53208	25873	18708	13183	17376	29444	52732	65942	74958	45022	20155	31023	35615
11	32109	32047	46451	21419	14492	11224	14547	25409	43914	57526	65466	39851	24061	26846
12	24595	23970	27541	39045	16780	11942	9131	11979	20383	36632	50000	57450	18727	20596
13	34150	16331	19684	22417	32419	13268	9716	7429	9054	16668	31403	42783	16012	18274
14	25119	21502	12601	15615	18824	25246	10661	7444	5416	6809	13929	25991	14077	15825
15	13475	12433	17308	8560	11986	13893	21070	7950	5521	3524	5198	10876	11607	12466
16	7830	8341	8866	13877	5670	8789	11734	17907	5676	3515	2235	3177	9212	9854
17	13764	5083	5514	6582	9383	3747	7362	10107	15140	3787	2282	923	7748	8520
18	15147	3319	3161	3988	4734	7770	2917	5542	8399	12447	2942	1307	5276	6109
+gp	44580	45282	36046	17657	14305	24911	30386	43924	49968	119379	82897	61886		
0 TOT/	422441	329175	315868	334781	384064	455150	471100	460084	431884	492299	439507	367159		

Table 6.13. Stock biomass at age

At 23/04/2002 10:00
Terminal Fs derived using XSA (With F shrinkage)
Table 12 Stock biomass at age (start of year) Tonnes

YEAR	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
AGE											
6	3372	5704	8294	13518	18592	23710	12720	4500	4812	5075	4691
7	6093	4817	5839	9679	16891	19323	22482	12127	6391	4353	6888
8	8797	6614	4359	5476	9778	16911	21704	22163	12521	5766	5247
9	17802	8484	5940	4684	5728	10594	17281	22426	23640	13280	5834
10	14982	16494	8538	6361	4311	7298	9717	17402	21761	23237	13507
11	11238	10575	17652	7925	5217	4939	5528	9655	16248	20709	22258
12	10330	9109	12118	15618	6829	5613	4200	5151	8969	15386	20000
13	15709	7512	9251	9864	14815	7828	4664	3566	4436	7334	14131
14	12811	9246	6174	7027	8659	16915	5437	4020	2870	3473	6686
15	7815	5346	9865	4194	5957	9586	11588	4690	3092	1973	2807
16	4620	3753	5142	7632	2988	6240	7040	10923	3519	2179	1319
17	8121	2643	3419	3818	5377	2773	4859	6468	9993	2386	1392
18	8937	1892	2055	2672	2983	5750	1896	3657	5627	8339	2000
+gp	31206	30339	23862	13949	10113	21100	23914	33075	40224	92519	61593
0 TOTAI	161831	122530	122508	112416	118239	158580	153031	159824	164104	206008	168353

Table 6.14. Spawning stock biomass at age

Run title : Arctic S. mentella (run: XSAKHN19/X19)
At 23/04/2002 10:00
Terminal Fs derived using XSA (With F shrinkage)
Table 13 Spawning stock biomass at age (spawning time) Tonnes

YEAR	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
AGE											
6	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	405	255	0	0	0
8	132	99	0	0	0	0	0	310	200	0	0
9	979	526	137	108	0	148	467	0	1395	637	478
10	1978	2194	965	719	237	679	1263	1288	2394	2022	2647
11	2270	2369	4713	2116	579	1047	1725	1651	5411	4183	9015
12	4969	3744	5308	6841	2513	1824	1180	1422	5193	5770	8840
13	8561	4049	5310	5662	8697	4517	2640	2218	3057	3586	6246
14	9493	7156	5205	5924	6027	12111	4002	2870	2262	2577	4332
15	6643	4747	9382	3989	4343	7477	9630	4085	2514	1644	2175
16	4444	3551	4731	7022	2358	5454	6745	10038	3178	1970	1141
17	8121	2622	3381	3776	5377	2704	4616	6468	9223	2386	1266
18	8937	1892	2055	2672	2983	5750	1896	3657	5627	8339	2000
+gp	31206	30339	23862	13949	10113	21100	23914	33075	40224	92519	61593
0 TOTSPBIO	87732	63288	65048	52776	43225	62811	58481	67338	80677	125633	99733

Table 6.15. Summary

Run title : Arctic S. mentella (run: XSAKHN19/X19)
At 23/04/2002 10:00
Summary (without SOP correction)
Terminal Fs derived using XSA (With F shrinkage)

	RECRUITS	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	FBAR 10-16
	Age 6					
1991	25938	161831	87732	48727	0.5554	0.3426
1992	30024	122530	63288	15590	0.2463	0.1447
1993	48789	122508	65048	12866	0.1978	0.1436
1994	84488	112416	52776	12721	0.241	0.1754
1995	107470	118239	43225	10284	0.2379	0.1668
1996	118552	158580	62811	8075	0.1286	0.0909
1997	70668	153031	58481	8597	0.147	0.1028
1998	32145	159824	67338	14045	0.2086	0.1576
1999	32078	164104	80677	11209	0.1389	0.1986
2000	50753	206008	125633	10206	0.0812	0.1523
2001	42642	168353	99733	18888	0.1894	0.2194
Arith. Mean	58504	149766	73340	15564	0.2157	0.1722
0 Units	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)		

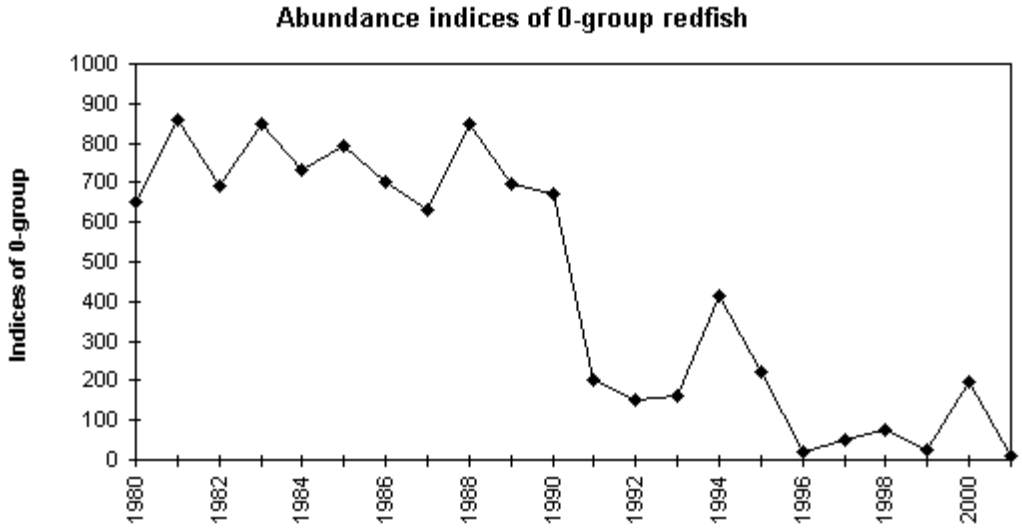


Figure 6.1. Abundance indices of 0-group redfish (believed to be mostly S.mentella) in the international 0-group survey in the Barents Sea and Svalbard areas in August-September 1980-2001.

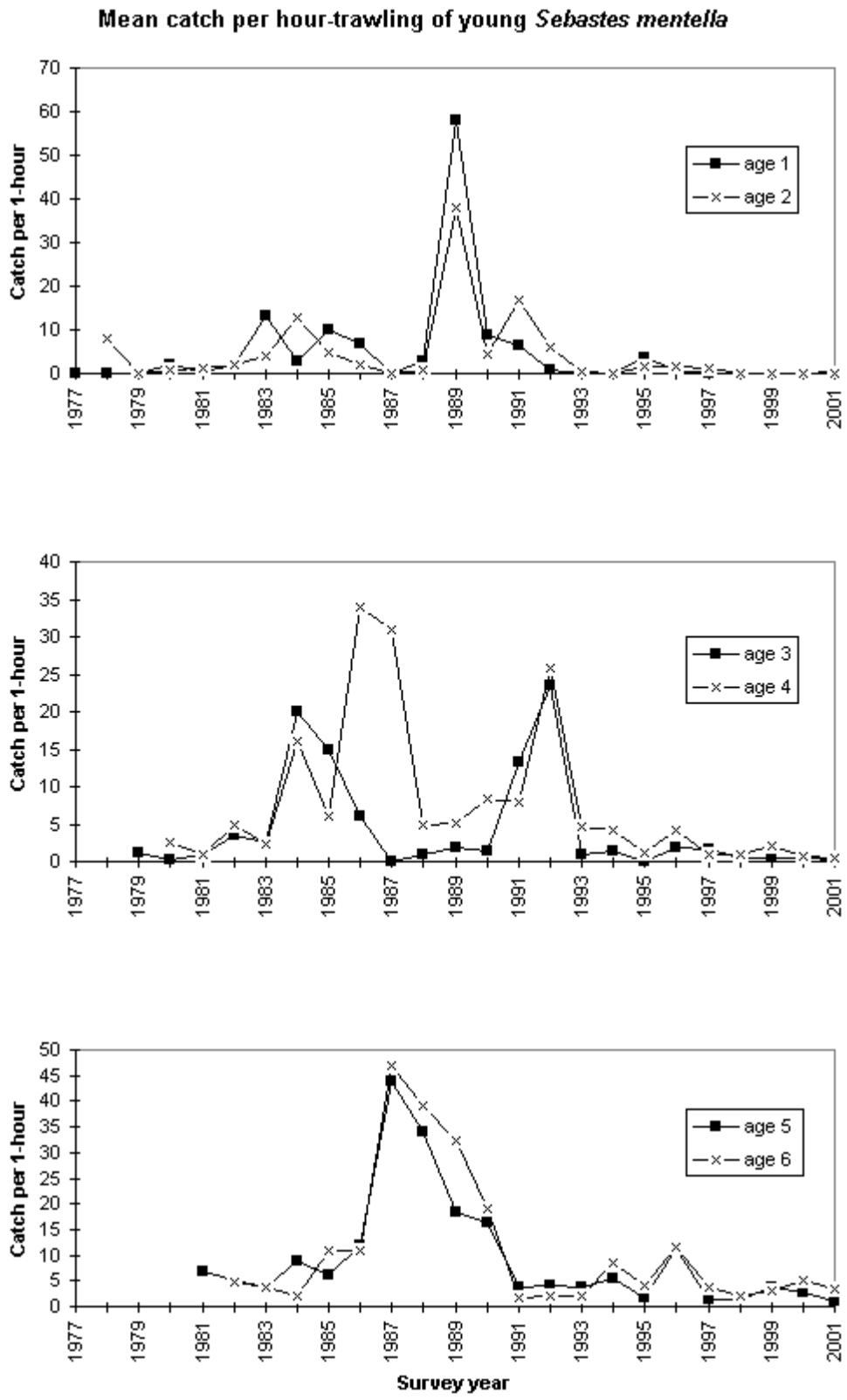


Figure 6.2. Catch (numbers of specimens) per hour trawling of different ages of Sebastes mentella in the Russian groundfish survey in the Barents Sea and Svalbard areas (ref. Table D4).

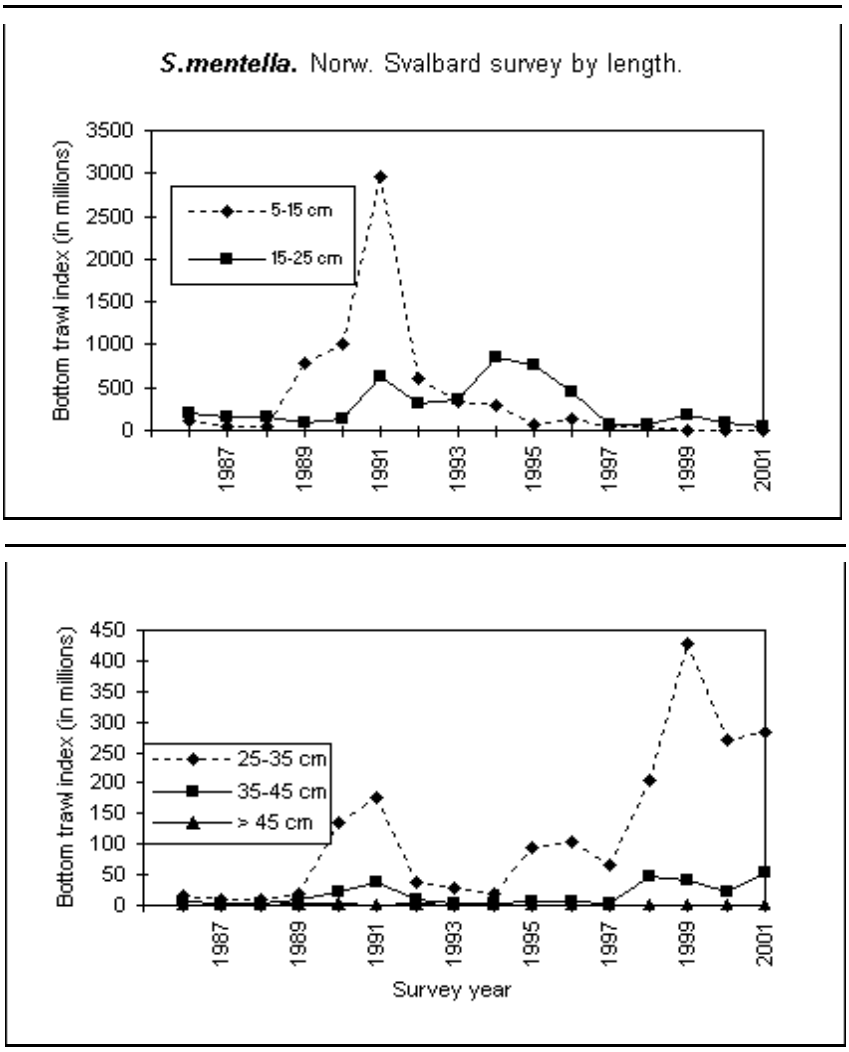


Figure 6.3a. *Sebastes mentella.* Abundance indices (on length) from the Norwegian bottom trawl survey in the Svalbard area (Division IIb) in summer/fall 1986-2001 (ref. Table D5a).

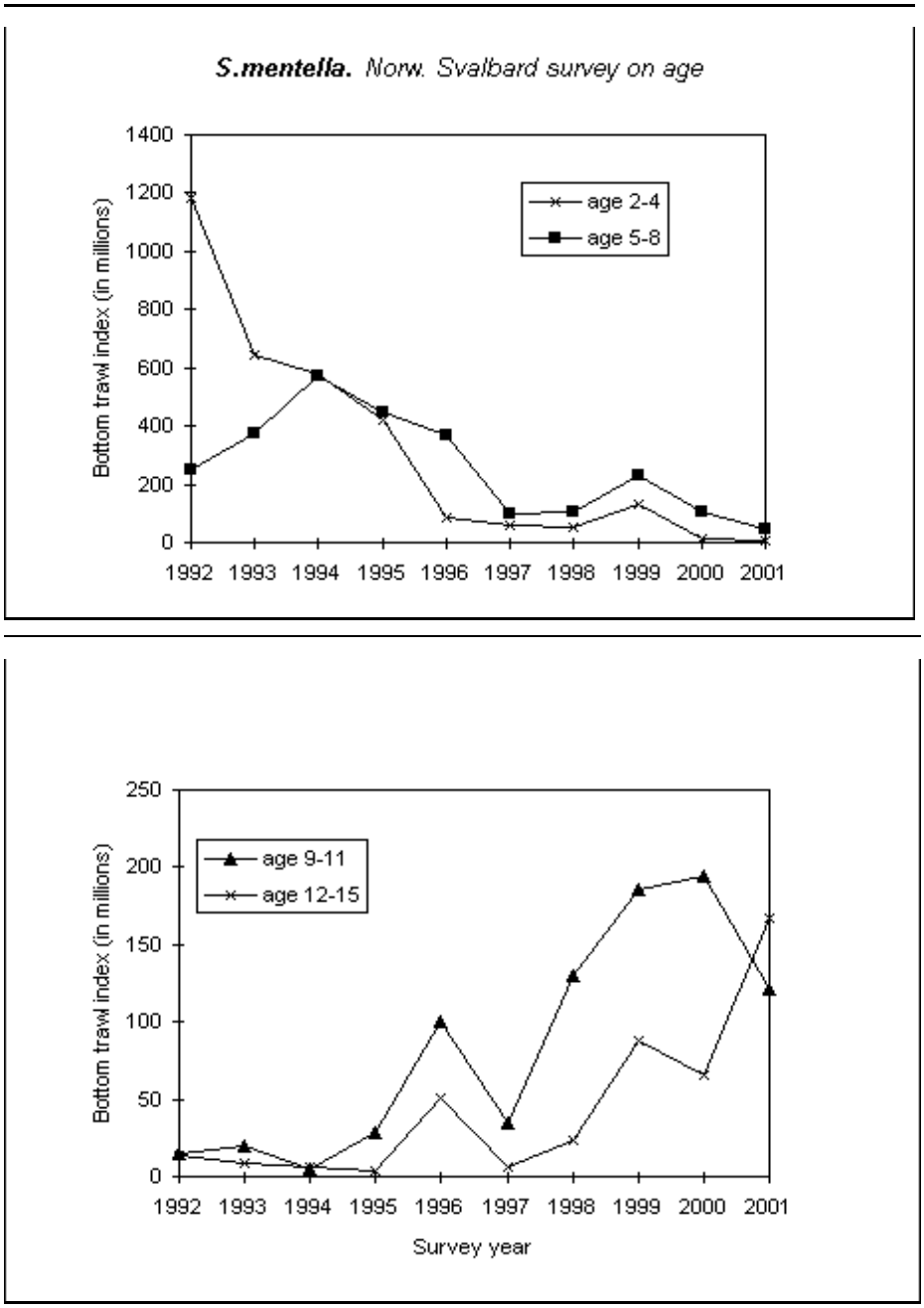
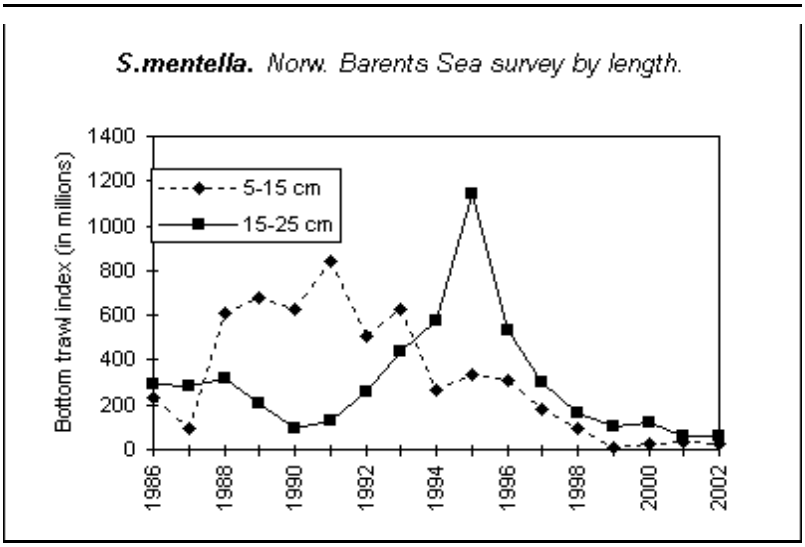


Figure 6.3b. *Sebastes mentella.* Abundance indices (on age) from the Norwegian bottom trawl survey in the Svalbard area (Division IIb) in summer/fall 1992-2001 (ref. Table D5b).



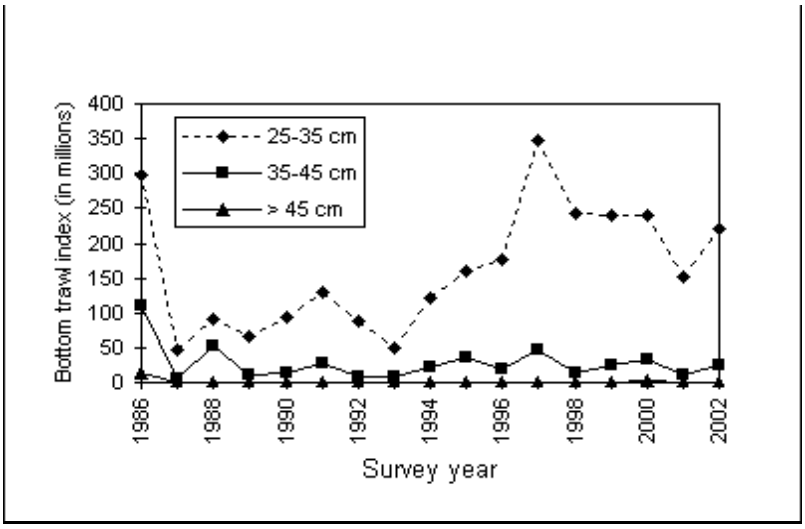
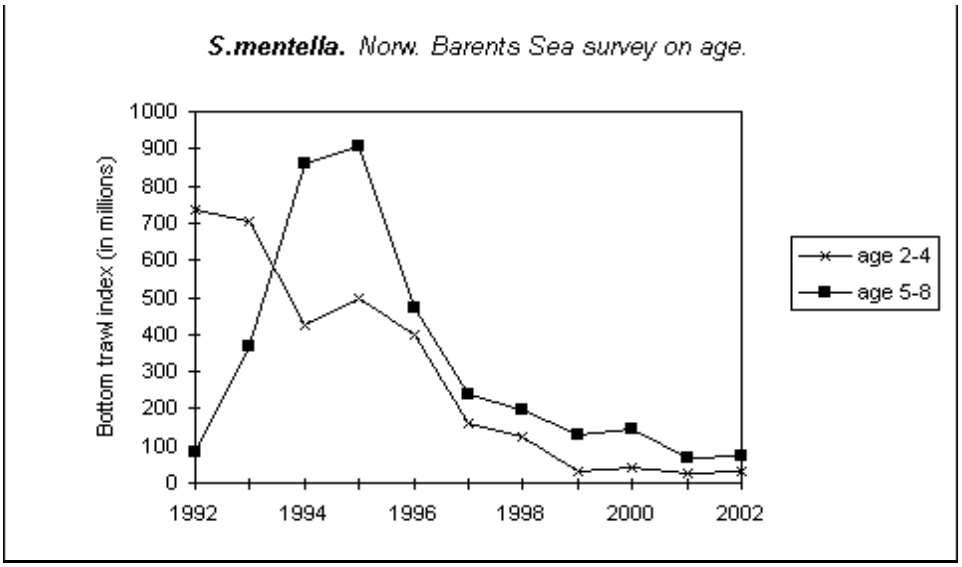


Figure 6.4a. *Sebastes mentella.* Abundance indices (**on length**) from the Norwegian bottom trawl survey in the Barents Sea in winter 1986-2002 (ref. Table D6a).



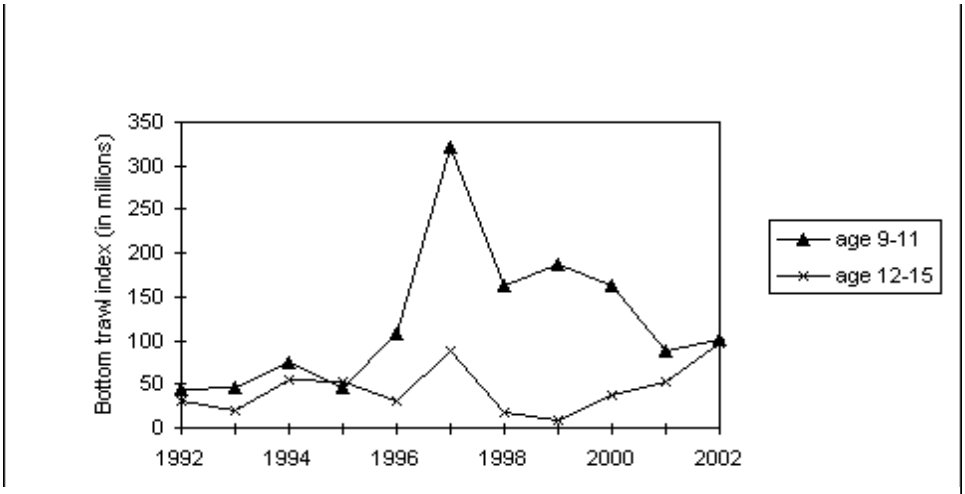


Figure 6.4b. *Sebastes mentella*. Abundance indices (**on age**) from the Norwegian bottom trawl survey in the Barents Sea in winter 1992-2002 (ref. Table D6b).

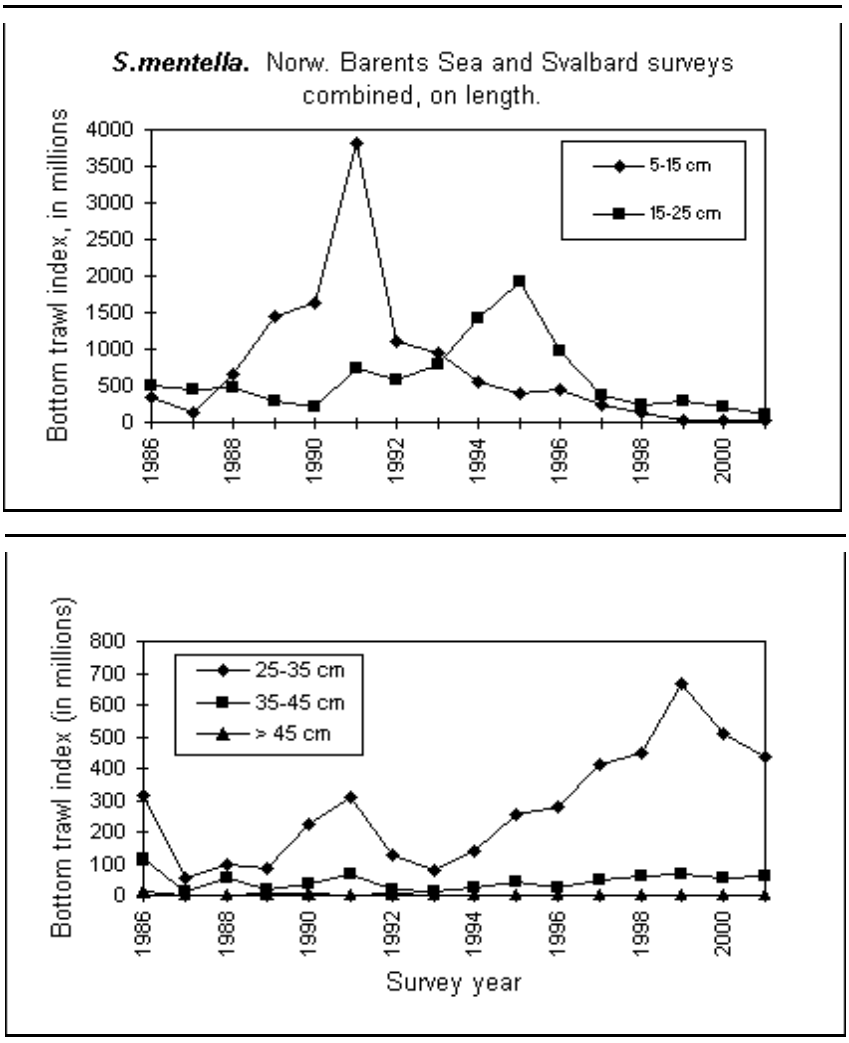
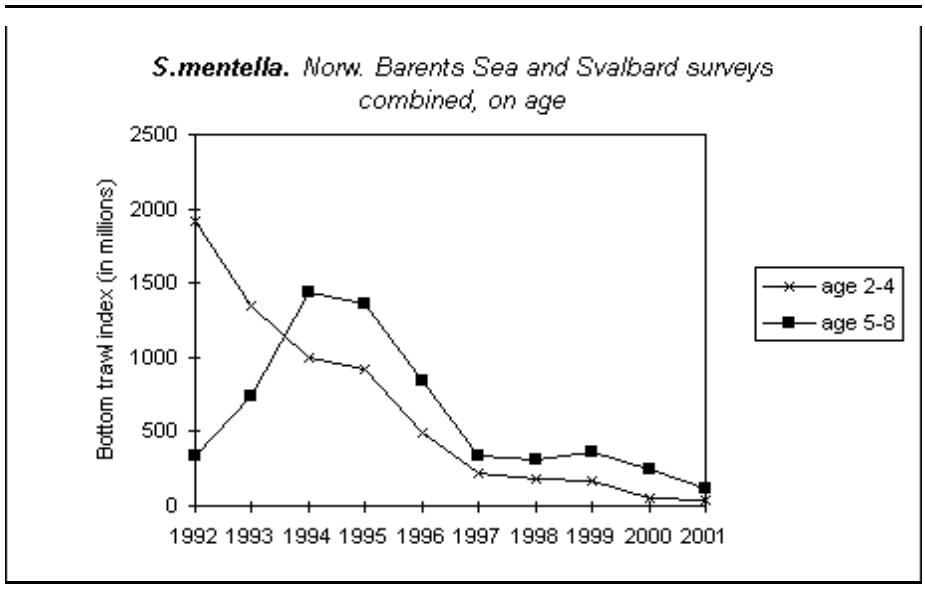


Figure 6.5a. *Sebastes mentella.* Abundance indices (**on length**) when combining the Norwegian bottom trawl surveys 1986-2001 at Svalbard (summer/fall) and in the Barents Sea (winter).



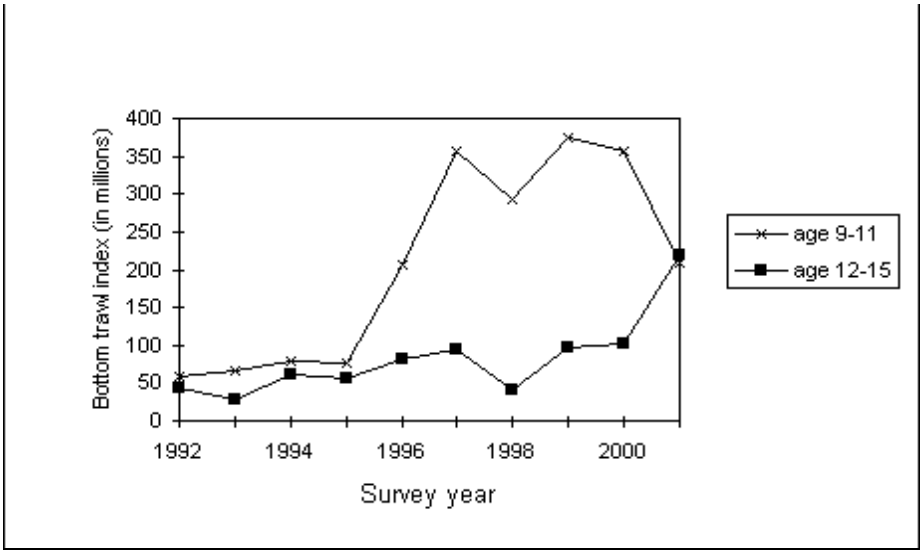


Figure 6.5b. *Sebastes mentella*. Abundance indices (**on age**) when combining the Norwegian bottom trawl surveys 1992-2001 at Svalbard (summer/fall) and in the Barents Sea (winter).

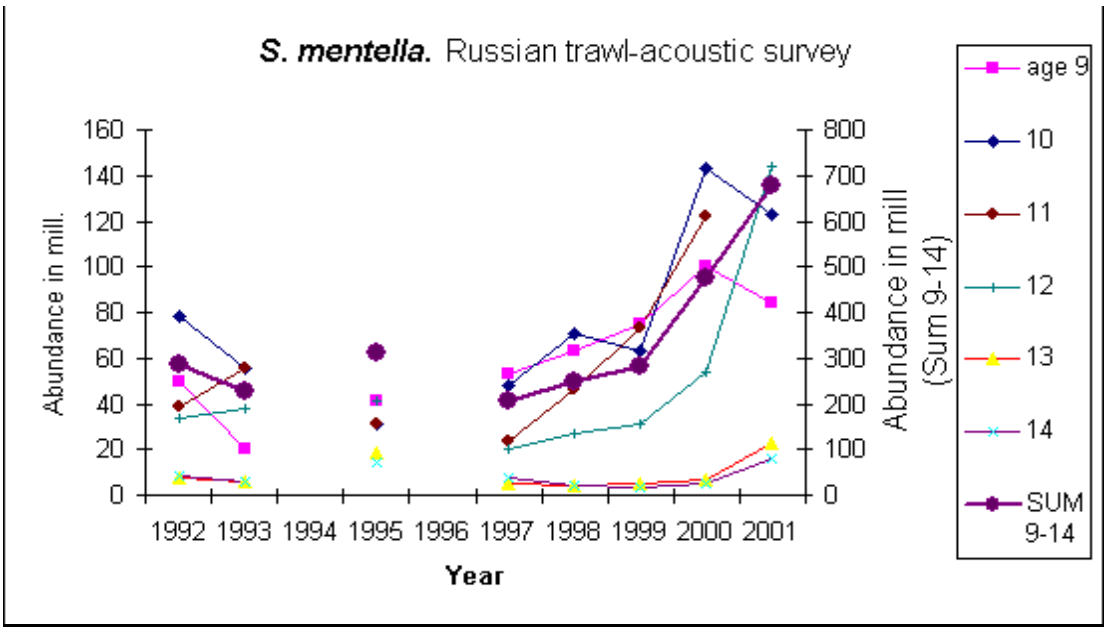


Figure 6.6. Results of the Russian trawl/acoustic redfish survey for ages 9-14 (ref. Table D7).

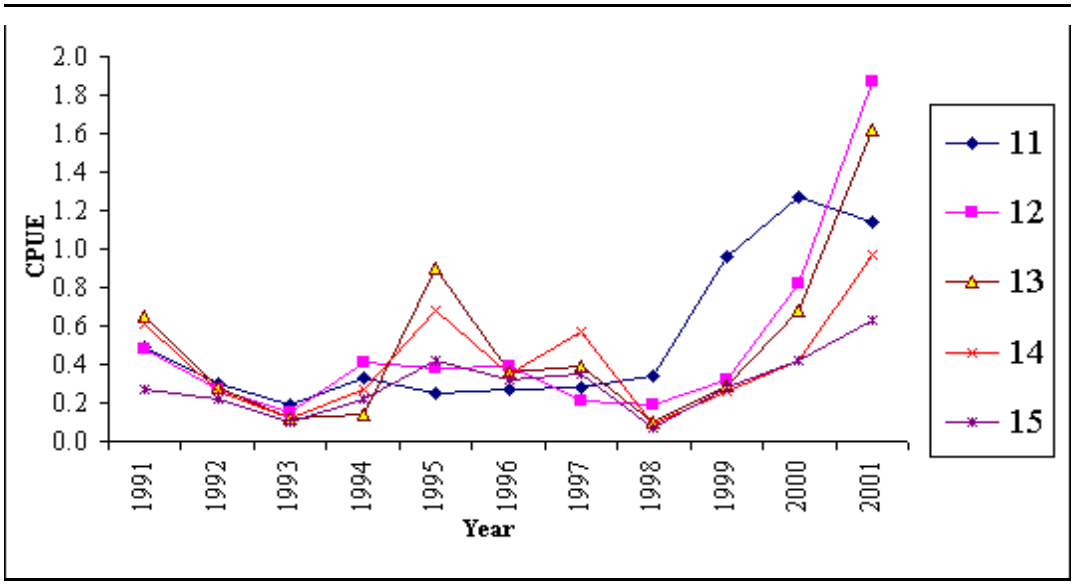


Figure 6.7. Russian trawl (BMRT) CPUE for ages 11-15.

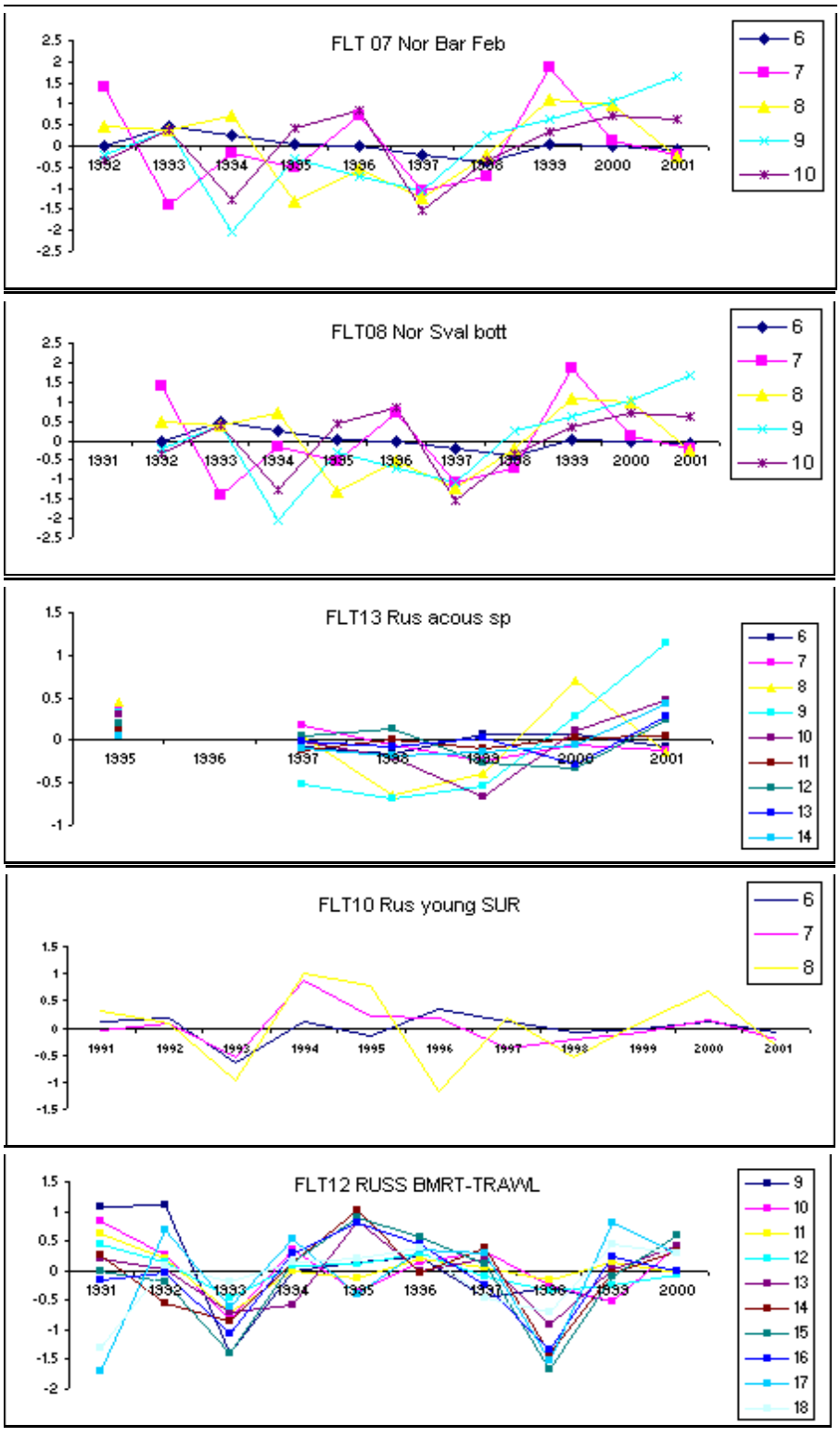
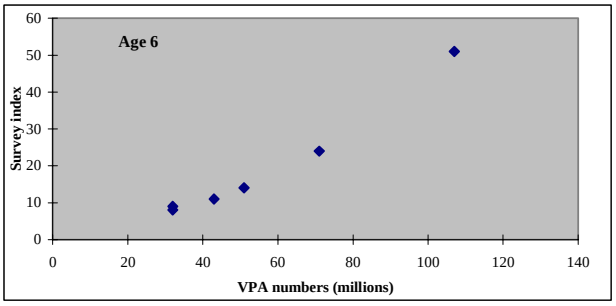
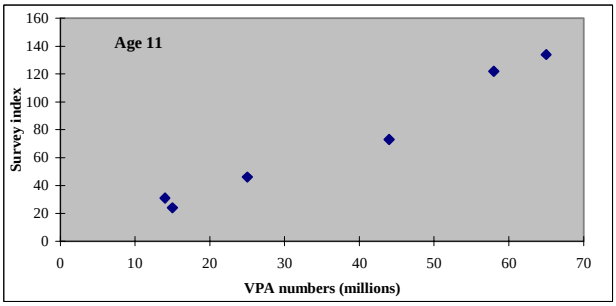
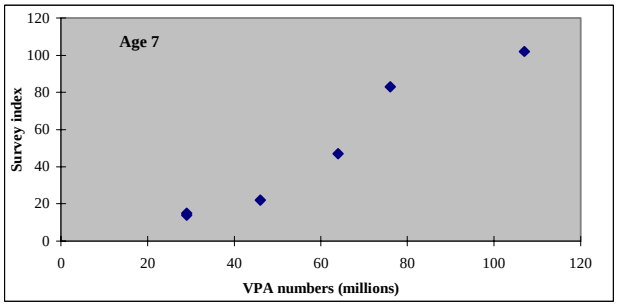
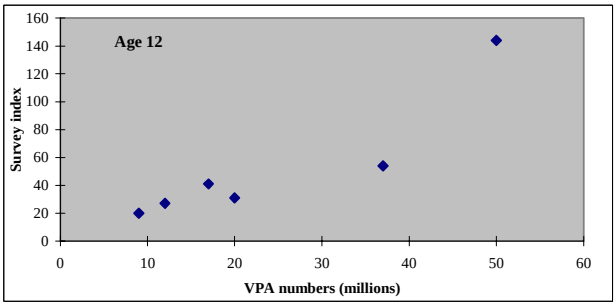


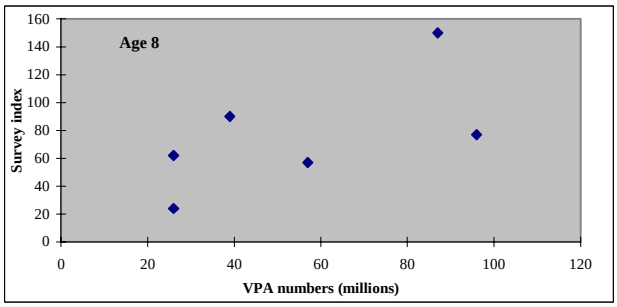
Figure 6.8. Log q residuals from different fleets included in the exploratory XSA runs.

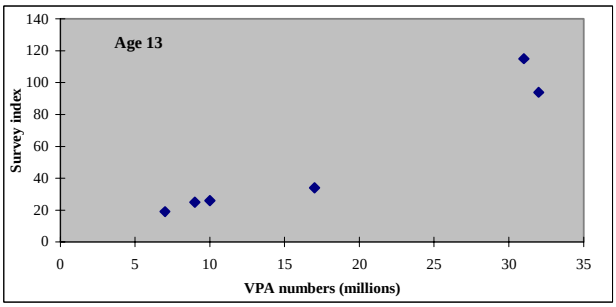


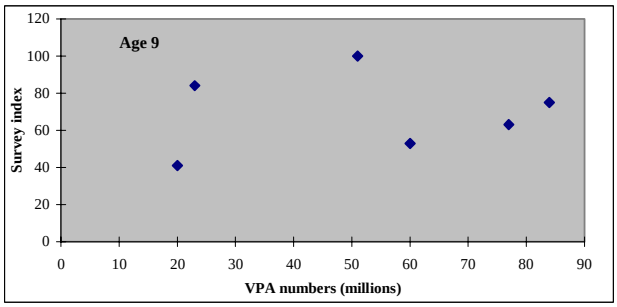


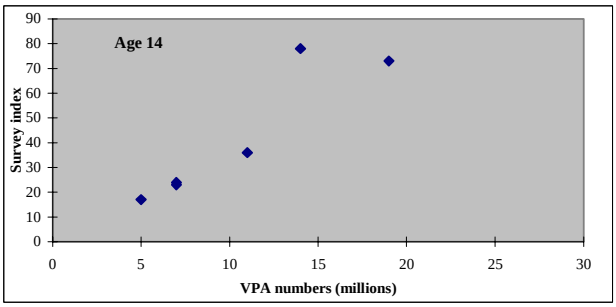












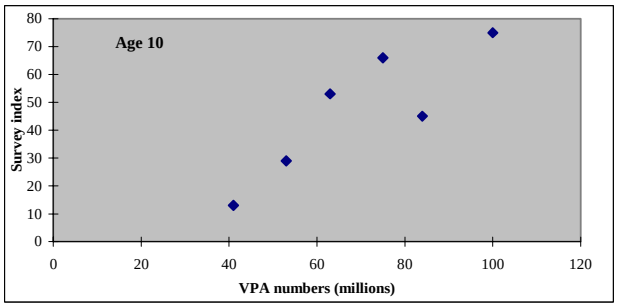
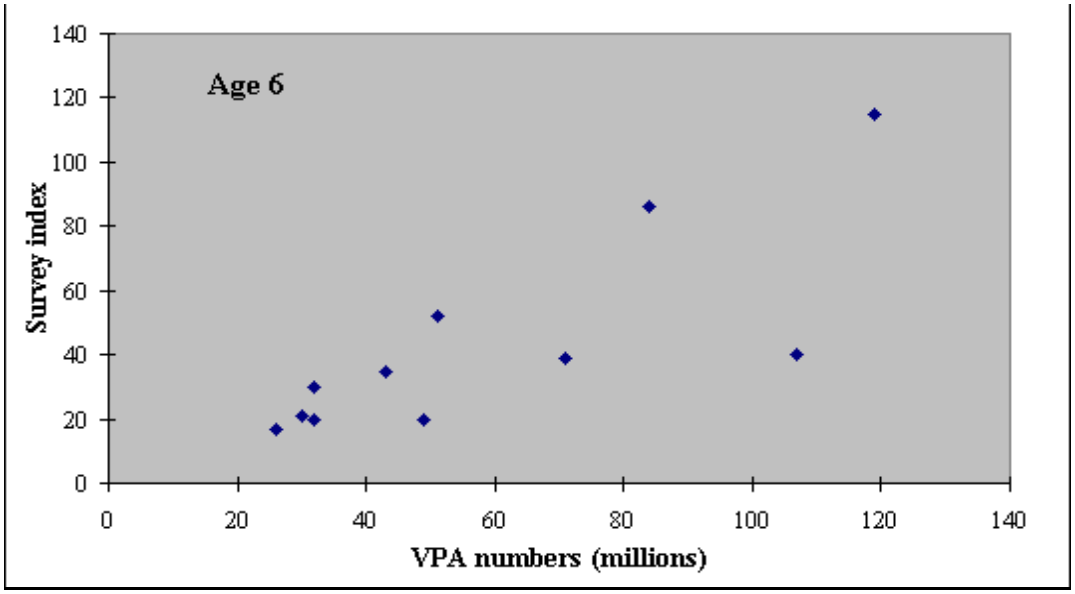
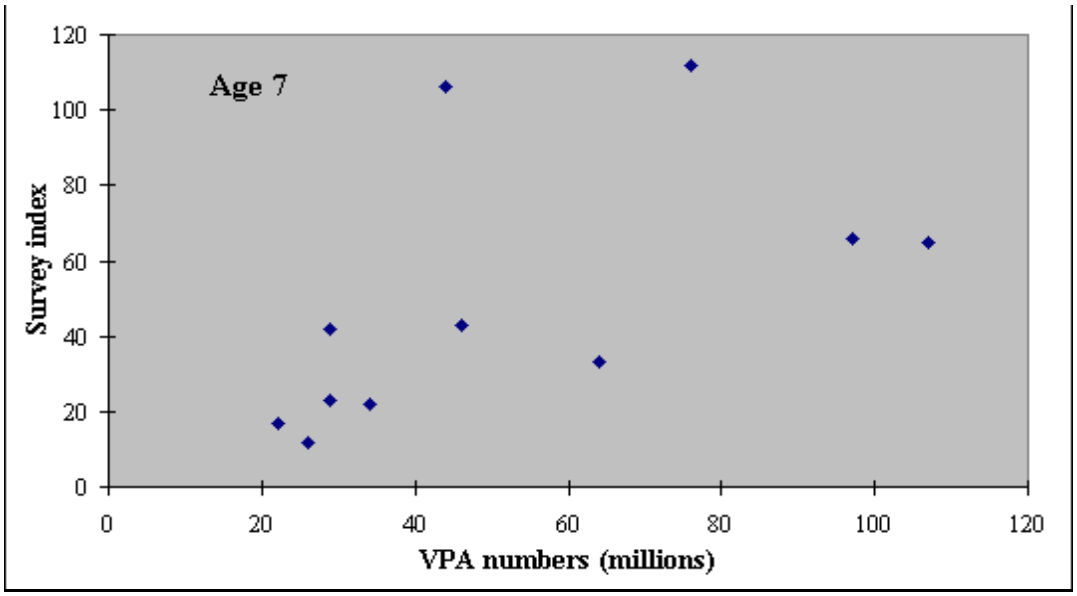


Figure 6.9. Sebastes mentella - Russian acoustic spring survey vs VPA





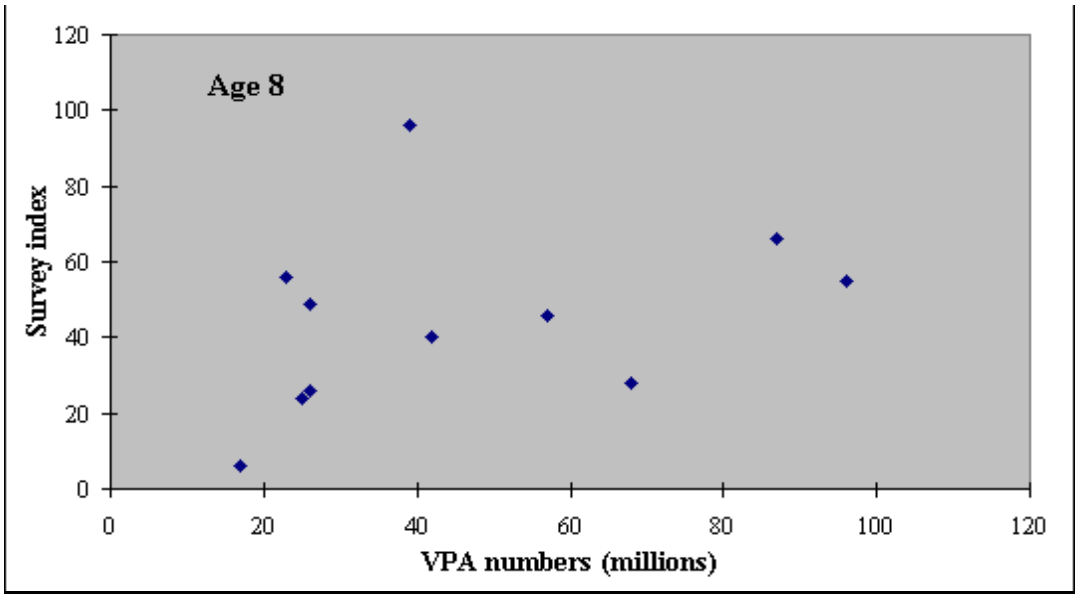


Figure 6.9. (Continued) Sebastes mentella - Russian young survey vs VPA

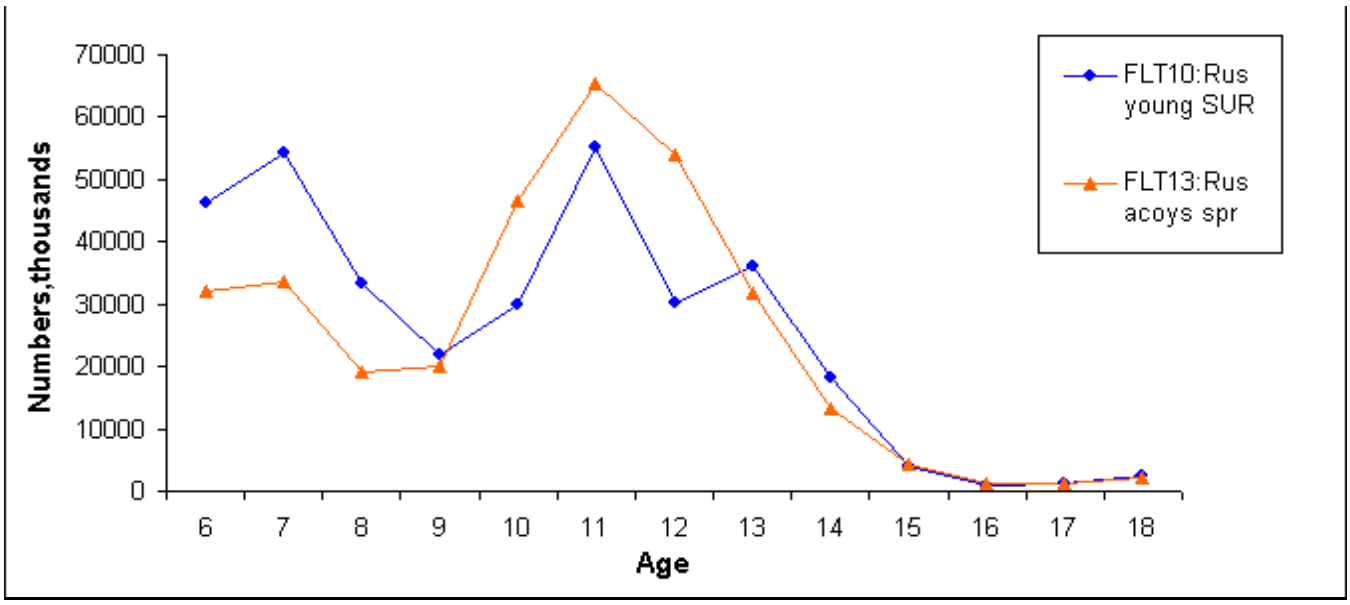


Figure 6.10. Estimated survivors by the different survey series from the exploratory XSA run.

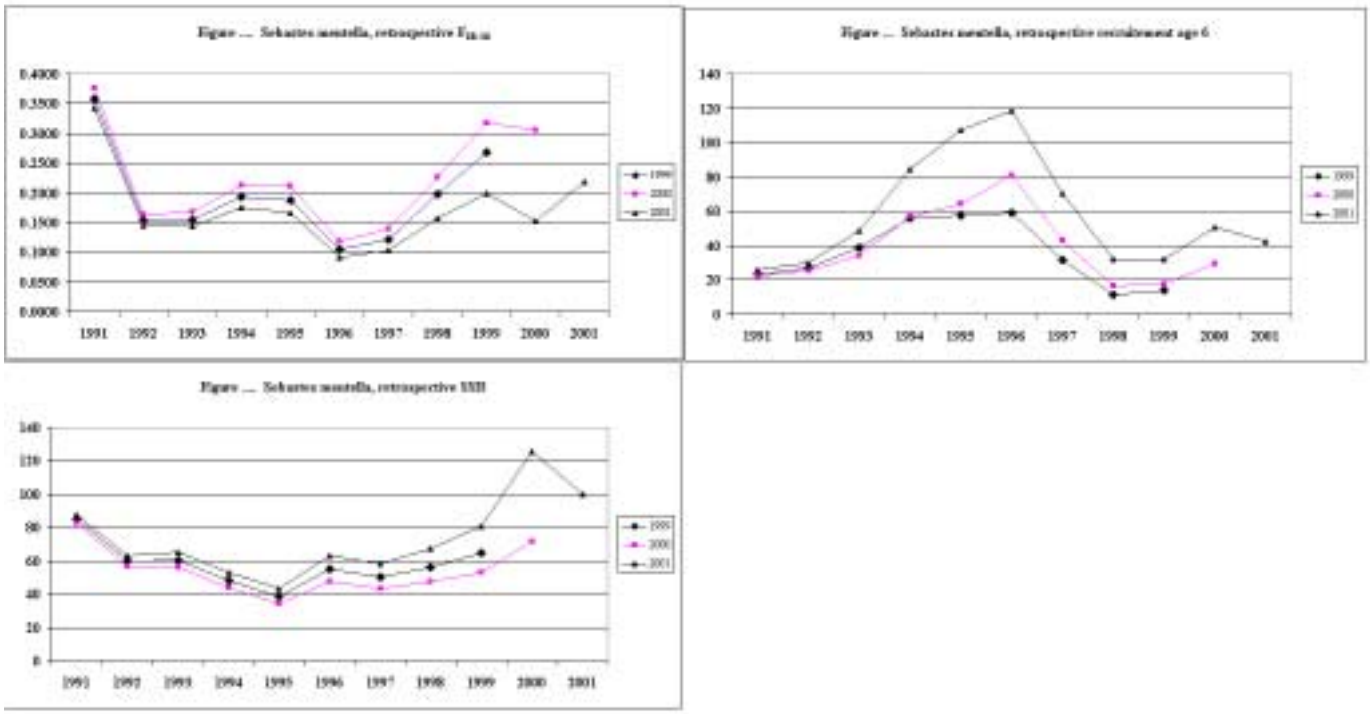


Figure 6.11 Sebastes mentella. Retrospective analysis

Table D1 REDFISH in Sub-areas I and II. Nominal catch (t) by countries in Sub-area 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]	25[3]	222	51[3]	65	1[3]	-	19,187[2]	2	131	4,631	87		203[6]	24,672
2001[1]	-	-	69[3]	46[3]	436	34[3]	38	5	-	23,122[2]	5	186	4,738	199[2]		239[6]	29,117

[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 Sub-area 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	2,347
1998	2	27	12	570	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.	n.a.	19	n.a.	19	350[1]	132	486	1,052
2001[1]	5	96	n.a.	n.a.	12	19	n.a.	422		535[3]	1,089

[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		17,556	
1999	1.7		6,593	
2000	2.5		4,082	
2001	3.8		4,970	

[1]Stern trawlers, 1900-2400 HP.
[2]Stern trawlers, 2200 HP.
[3] Average 1995 and 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	-
1992	0.6	+	0.2	0.1	4.3	1.3	2.0	2.3	4.9	2.3	-	-
1993[1]	-	+	1.5	1.8	1.0	1.2	3.0	4.2	2.6	-	-	-
1994	0.3	3.5	1.7	1.7	0.9	3.6	5.2	4.3	-	-	-	-
1995	2.8	1.0	1.1	0.4	2.2	2.6	3.5	-	-	-	-	-
1996[2]	+	0.1	0.1	0.4	0.7	1.1	-	-	-	-	-	-
1997	-	-	+	0.4	0.5	-	-	-	-	-	-	-
1998	-	0.1	0.2	0.3	-	-	-	-	-	-	-	-
1999	0.1	-	0.1	-	-	-	-	-	-	-	-	-
2000	-	0.6	-	-	-	-	-	-	-	-	-	-
2001	-	-	-	-	-	-	-	-	-	-	-	-

[1] - Not complete area coverage of Division IIb.
[2] - Area surveyed restricted to Subarea I and Division IIa 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 1986-2001 (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

[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 1992-2001 (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

[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 1986-2002 (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	1068.2
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	1126.5
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	+	1116.5
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	1674.0
1996	213.1	100.2	191.2	337.6	134.3	41.9	16.6	1.4	0.3	1036.6
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	7,1	19,2	42,6	105,6	115,5	23,4	1,4	0,0	330,9

[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 Sub-areas I and II. Preliminary Norwegian bottom trawl indices (**on age**) from the annual Barents Sea survey in February 1992-2002 (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

[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 Sub-areas 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

Table D8. *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.

Age	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

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. 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.

There are at present no regulations particular for the *S. marinus* fishery. The regulations aimed at *S. mentella* (see Section 6.1.1) only have marginal effects on the *S. marinus* stock.

7.1.2 Landings prior to 2002 (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 1991–1992 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, and the provisional total landings figure for *S. marinus* in 2001 of 10,230 t is the lowest since the mid-1940s (!), and 5,000 t less than expected.

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 show a long-term (1908-2001) mean of 17,320 t.

7.1.3 Expected landings in 2002

On the basis of reports from the first months of the year, the Norwegian landings in 2002 are expected to further decrease to around 7,000 t. The Russian catch is expected to be 1,000 t. On this basis landings of 9,000 t are expected in 2002, which is a dramatic and rapid decrease compared with the stable catch level in the 1990-ies. The expected decrease in landings reflects a decrease of the stock, and confirms the concern earlier expressed both by fishermen and scientists, including ACFM.

7.2 Data Used in the Assessment

7.2.1 Fishing effort and catch-per-unit-effort (Tables D9, Figure 7.1)

Data for *S. marinus* were available for Norwegian freezer trawlers (ISSCFV-code 07, 250–499.9 GRT) since 1981 (Table D9). 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. Mean CPUEs together with standard errors are presented in Table D9 and Figure 7.1. 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.

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 the last two years the effort has again been reduced to the 1991-1997 level. The year, area, and month effects are all significant. The provisional figure for 2001 of 0.48 t/hour is the lowest in the time-series. The decrease in CPUE observed in 1998 and 1999, related by previous Working Groups to a simultaneous increase in effort, may have been just the first signs (in this data series) of a reduction in fishable biomass.

7.2.2 Catch-at-age (Table 7.8)

Catch-at-age data for 1997-2000 were revised. Age composition data for 2001 were only provided by Norway, accounting for 86% 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 key for trawlers in Division IIa. Other countries were assumed to have the same relative age distribution and mean weight as Norway.

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.

7.2.3 Weight-at-age (Table 7.9).

Weight-at-age data for ages 7–24+ were available from the Norwegian landings in 2001.

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, D10a,b-D11a,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 1986–2002 in fishing depths of 100–500 m. Data on length for the years 1986–2002 are shown in Table D10a and Figure 7.2a. Data disaggregated on age for the years 1992–2002 are shown in Table D10b and Figure 7.2b. This survey covers important nursery areas for the stock.

2) Norwegian Svalbard (Division IIb) bottom trawl survey (August-September) from 1985–2001 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 added together 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 1995-2001 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, few pre-recruit sized fish (< 25 cm) is a sign of poor recruitment.

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 the biggest fish > 40 cm). An increase of 15-24 cm fish in the 1999 survey may be due to extra trawl stations taken in some areas, and fewer stations in 2001 may likewise have influenced the lower estimate this year (Table 7.6).

7.3 Results of the Assessment

The current assessment is just an update of last year's assessment, and all present available information confirms last year's evaluation of the 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 2001 for all sizes less than 40 cm. Concerns are again expressed about the low number of pre-recruit size groups in the recent surveys, suggesting that future recruitment to the fishery may be poor. If this is the case then further declines in the stock can 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 discussed also for this redfish stock. This model is based on the BORMICON model which is currently used by the ICES North-Western WG on *S. marinus*. Preparatory work should be done in order to explore these possibilities.

7.4 Biological reference points

As a candidate limit reference point for the biomass (U_{lim}), the Working Group proposes to adopt the maximum biomass level estimated by the combined Norwegian Barents Sea – Svalbard bottom trawl survey since 1986.

7.5 Management advice

The stock is expected to decline over the next several years as a series of poor year classes recruit to the fishery. Neither is the current fishing effort sustainable as the recent catch level continues to decline. The concern about the stock is also expressed by the fishermen. Since both the fishermen are concerned about the current fishable biomass, and the survey show poor recruitment, then we already may be late in enforcing a strategy to rebuild the stock to obtain the highest possible sustainable yields. The fishing should therefore be kept at the lowest possible level until U_{lim} is reached.

Except for some area restriction and bycatch regulations most of the fishery for *S. marinus* is at present a free fishery. This is not in line with the current stock situation. In this regard, it is recommended that a management plan consistent with the precautionary approach be immediately developed and implemented as a pre-requisite to continued fishing. Such a plan may consider an enlargement of the current bycatch regime, restricted fishing periods, closure of areas, and TAC.

Table 7.1 *Sebastes marinus*. Nominal catch (t) by countries in Sub-area 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	13	160	22	16	-	-
2001[1]	17	30	238	17	5	1	-

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	17,512
1998	16,540	6	1,632	51	118	53	19,154
1999	16,750	3	1,691	7	135	34	18,987
2000	13,036	16	1,112	-		73[4]	14,465
2001[1]	8,831	7	963	1		119[4]	10,230

[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 Sub-area 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]	-	2,562
2000	-	1[2]	-	16[2]	1,843	146		12[6]	2,018
2001[1]	-	11[2]	-	5[2]	1,067	128		16[6]	1,227

[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	Ger-many[4]	Green-land	Ire-land	Nether-lands	Norway	Port-ugal	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]	16,261
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]	13[2]	159[2]	22[2]	-	-	11,176	16[2]	658	-		61[6]	12,122
2001[1]	17[2]	30[2]	227[2]	17[2]	1[2]	-	7,693	6[2]	612	1[2]		103[6]	8,707

[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	-	308	-	-	-	325
2001[1]	-	-	-	71	1[2]	223	-	-	-	295

[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.

Table 7.5 *Sebastes marinus* in Sub-areas I and II. Total international landings 1908-2001 (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	10.23
1953	34.83	Average	17.32
1954	35.78		
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 1995-2001 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							Area 4 - W.Finnmark/Troms							Area 5 - Lofoten/Vesterålen						
Length range (cm)	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**
0-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5-9	244	322	39	0	0	0	3	107	19	0	0	0	0	0	0	0	0	0	0	0	0
10-14	152	273	98	0	0	17	15	318	331	0	2	4	2	5	219	21	0	0	31	0	0
15-19	19	157	112	28	2	93	43	135	574	10	6	2	26	23	149	49	0	0	314	0	0
20-24	69	287	77	33	2	33	52	62	698	7	2	8	16	38	162	6	0	16	136	3	10
25-29	169	476	268	42	4	50	84	24	64	20	50	10	18	28	72	27	17	8	9	3	3
30-34	299	333	255	28	15	20	56	7	696	40	43	39	49	28	133	88	54	18	62	8	16
35-39	112	200	19	8	47	56	24	21	796	30	43	55	83	69	92	529	324	341	295	239	71
40-44	38	53	27	6	50	43	19	7	238	23	22	25	81	57	60	133	385	291	263	269	154
45-49	2	16	12	0	11	12	7	3	48	3	2	23	56	34	11	24	83	50	40	43	61
50-54	2	3	0	0	2	0	2	0	0	3	0	8	2	0	0	0	0	8	5	3	0
55-59	0	0	0	0	0	0	0	0	0	7	0	4	2	2	4	0	0	0	0	0	0
60-64	0	0	4	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	1106	2120	911	144	134	326	305	684	3463	142	170	178	335	284	903	878	864	731	1156	568	315
Measured	398	602	230	52	62	139	111	198	243	43	54	87	108	92	168	185	70	97	148	156	53
# trawls	23	17	19	16	25	25	22	15	16	20	21	25	25	24	13	14	17	15	22	19	16
# trawl with species	18	12	16	7	10	8	13	10	15	9	10	9	10	11	9	13	9	9	13	15	6
Area nm^2	4205							7303							9962						

Table 7.6 (Cont'd)

	Area 0 - Vestfjord							Area 6 - Nordland							Area 7 - Møre						
Length range (cm)	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**
0-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5-9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10-14	0	0	0	0	55	0	0	0	0	0	0	0	0	0	0	0	0	0	26	0	0
15-19	0	0	0	6	711	0	0	0	7	0	0	0	0	8	0	0	0	0	479	0	10
20-24	0	0	430	26	273	0	0	0	25	5	7	0	0	0	0	0	0	0	557	0	0
25-29	0	8	587	6	88	8	0	5	15	21	4	0	0	16	0	0	0	0	111	4	29
30-34	18	41	286	0	88	132	0	28	167	75	15	0	0	8	0	0	0	0	57	9	0
35-39	454	206	380	58	328	136	366	564	526	225	78	44	20	31	5	14	3	0	114	388	0
40-44	442	33	361	64	230	182	683	373	599	229	81	61	133	117	14	10	3	0	31	147	10
45-49	53	8	88	13	0	8	25	52	217	59	19	4	31	31	0	7	3	4	0	9	0
50-54	9	0	6	6	0	8	12	3	0	5	0	4	0	0	0	0	0	0	0	9	0
55-59	0	0	0	0	0	0	0	3	0	0	0	4	0	0	0	0	0	0	0	0	0
60-64	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	976	296	2138	180	1772	474	1086	1028	1556	620	204	118	184	211	19	31	10	4	1374	566	49
Measured	75	22	162	28	40	38	38	183	172	91	55	27	36	27	4	9	3	1	95	26	5
# trawls	10	6	11	7	5	6	4	22	16	12	15	13	12	7	11	15	16	13	12	12	7
# trawl with species	7	3	11	4	3	5	4	15	12	9	6	4	7	5	2	5	3	4	3	5	2
Area nm^2				5542							9316							7246			

	Total						
Length range (cm)	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**
0-4	0	0	0	0	0	0	0
5-9	41	34	4	0	0	0	0
10-14	118	87	9	0	19	2	2
15-19	59	124	12	4	242	13	11
20-24	54	151	64	12	160	7	14
25-29	38	67	112	16	34	10	22
30-34	69	210	96	17	43	30	15
35-39	214	415	178	110	151	160	83
40-44	157	209	190	96	117	155	160
45-49	21	64	45	18	15	30	30
50-54	2	0	2	3	4	4	2
55-59	1	0	1	0	2	0	0
60-64	0	0	0	0	0	0	0
Total	775	1361	715	277	786	411	340
Measured	1026	1233	599	287	459	326	558
# trawls	94	84	95	87	102	80	68
# trawl with species	61	60	57	40	42	41	38

Table 7.7 Acoustic index (numbers) of *Sebastes marinus* from the Norwegian Coastal Surveys in 1995-2001, within 5-cm length-groups and total for six subareas.

Areas 00 and 03-07							
Length (cm)	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**
5-9	40519	1908	232	0	0	31	4
10-14	13627	7656	706	24	519	221	45
15-19	8161	11057	1207	96	6926	1112	488
20-24	9396	7983	6171	1500	5679	2661	262
25-29	4229	10275	12113	81	1183	4310	825
30-34	3914	10504	7382	2090	2423	3797	1564
35-39	15711	34437	22440	9914	9082	14036	5391
40-44	13960	19171	28846	5477	7881	14680	12310
45-49	3431	4539	5653	499	1587	2278	1612
50-54	657	8	230	0	376	709	97
55-59	519	0	147	0	179	40	33
60-64	0	0	20	0	0	18	0

Table 7.8 *Sebastes marinus.* Catch numbers-at-age Numbers*10**-3

	YEAR		1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
	AGE											
		7	5	0	46	60	9	9	28	78	4	22
		8	22	24	7	85	119	98	51	593	13	22
		9	78	193	292	230	313	156	206	855	69	53
		10	114	359	640	672	361	321	470	572	239	195
		11	394	406	816	908	879	686	721	1006	900	355
		12	549	1036	1930	1610	1234	1065	968	1230	945	487
		13	783	1022	2096	2038	1638	1781	1512	1618	1770	1105
		14	1718	1523	2030	2295	2134	2276	1736	1480	1411	1316
		15	3102	2353	1601	1783	1675	2172	1582	1612	2126	1656
		16	2495	1410	2725	1406	1614	1848	1045	1239	2206	1602
		17	2104	1655	2668	785	1390	1421	1277	1407	1718	1197
		18	1837	1678	1409	563	952	851	970	1558	752	527
		19	998	745	617	670	679	804	1018	1019	483	115
		20	858	716	733	593	439	608	846	394	462	168
		21	688	534	514	419	560	511	443	197	133	136
		22	547	528	256	368	334	205	764	459	230	101
		23	268	576	177	250	490	334	486	174	226	124
	+gp		3110	3482	1508	3232	3135	2131	3389	2131	900	233
0	TOTALNUM		19670	18240	20065	17967	17955	17277	17512	17622	14587	9414
	TONSLAND		16185	16651	18120	15616	18043	17512	19154	18987	14465	10229
	SOPCOF %		97	104	100	100	105	100	99	103	101	99

Table 7.9 *Sebastes marinus.* Catch weights-at-age (kg)

	YEAR		1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
	AGE											
		7	0.18	0.00	0.25	0.33	0.22	0.23	0.37	0.14	0.19	0.16
		8	0.29	0.33	0.37	0.43	0.49	0.51	0.21	0.26	0.24	0.34
		9	0.48	0.36	0.38	0.64	0.56	0.53	0.47	0.44	0.32	0.41
		10	0.42	0.43	0.49	0.61	0.65	0.74	0.62	0.57	0.44	0.54
		11	0.50	0.51	0.51	0.59	0.71	0.72	0.67	0.69	0.54	0.58
		12	0.59	0.51	0.64	0.65	0.81	0.78	0.77	0.78	0.64	0.67
		13	0.58	0.64	0.74	0.74	0.84	0.80	0.77	0.86	0.73	0.80
		14	0.65	0.64	0.76	0.79	0.88	0.86	0.85	1.04	0.84	0.89
		15	0.65	0.76	0.86	0.84	0.96	0.91	1.05	1.07	0.96	1.02
		16	0.71	0.86	0.95	0.92	1.00	0.99	0.96	1.12	1.11	1.15
		17	0.82	0.89	1.03	1.12	1.02	1.16	1.25	1.18	1.25	1.33
		18	0.84	0.98	1.07	1.01	1.01	1.18	1.28	1.71	1.32	1.44
		19	0.94	1.00	1.11	1.01	1.00	1.21	1.30	1.09	1.53	1.65
		20	1.02	1.03	1.16	1.21	1.03	1.34	1.23	1.18	1.06	1.60
		21	1.03	1.21	1.15	1.14	1.04	1.28	1.87	1.04	1.29	1.48
		22	1.15	1.03	1.13	1.09	1.14	1.54	1.46	1.34	1.32	1.96
		23	1.27	1.20	1.02	1.30	1.09	1.19	1.73	1.18	1.12	2.70
	+gp		1.27	1.14	1.36	1.01	1.16	1.29	1.29	1.34	1.20	2.33
0	SOPCOFAC		0.9702	1.0376	1.0038	0.9999	1.0482	1.004	0.9924	1.035	1.0069	0.989

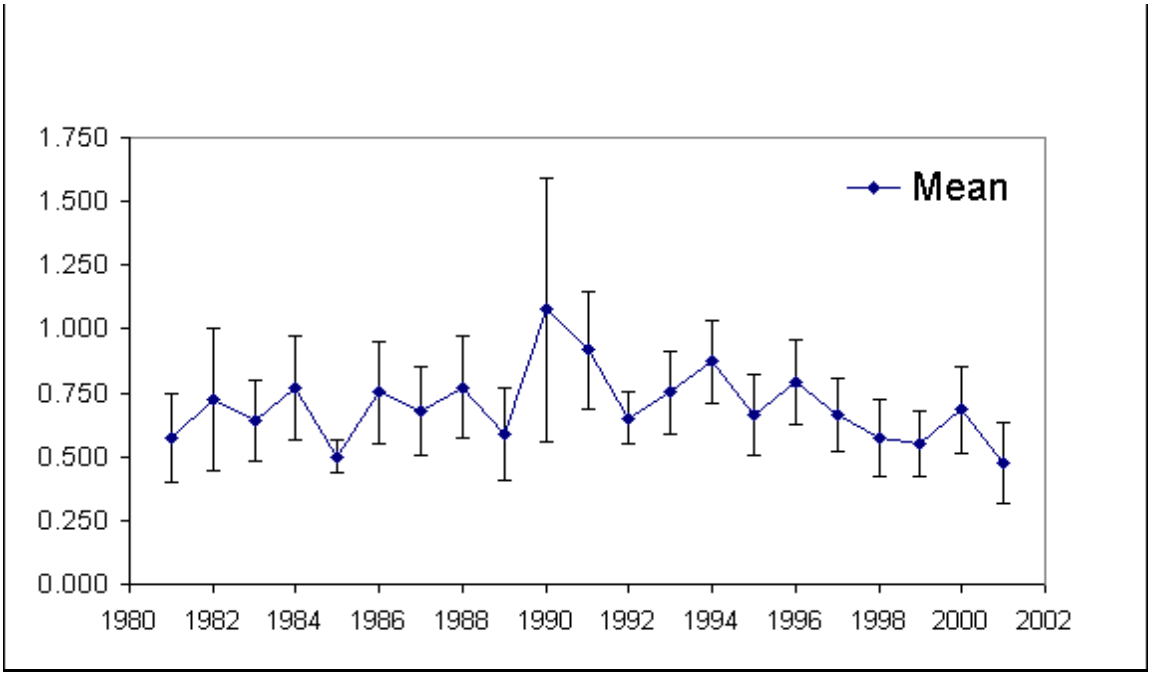
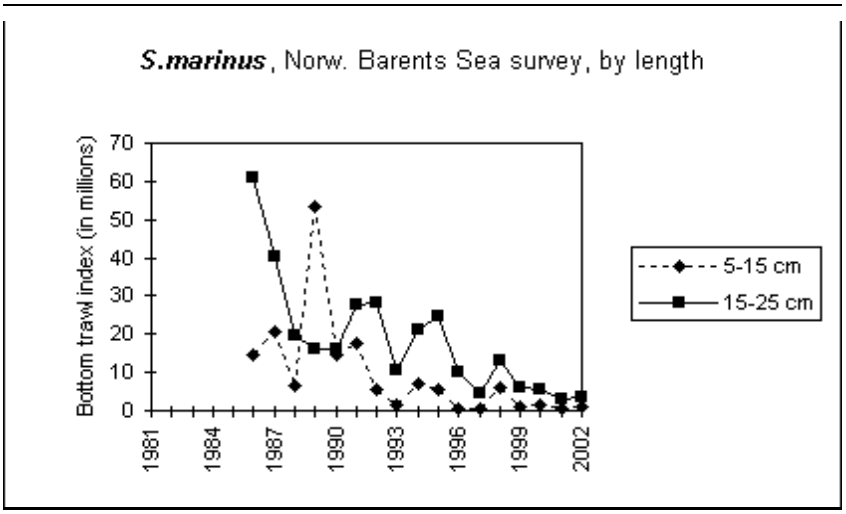


Figure 7.1 *Sebastes marinus.* Plot of simple mean CPUEs with 2 standard errors from the Norwegian trawl fishery. The figure is an illustration of the data given in Table D9.



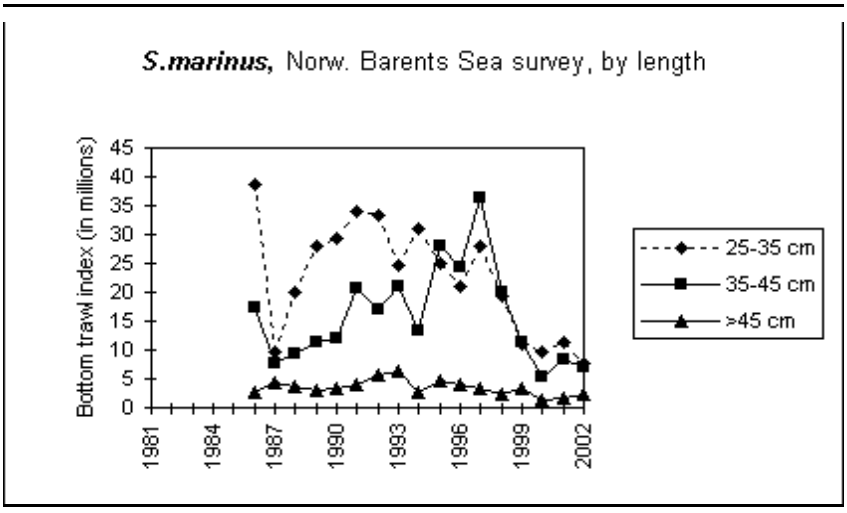
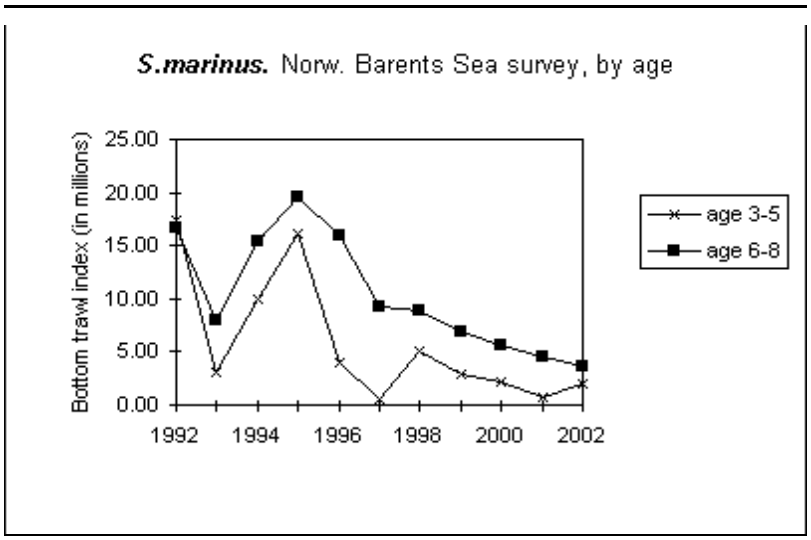


Figure 7.2a *Sebastes marinus.* Abundance indices **(by length)** from the Norwegian bottom trawl survey in the Barents Sea in winter 1986-2002 (ref. Table D10a).



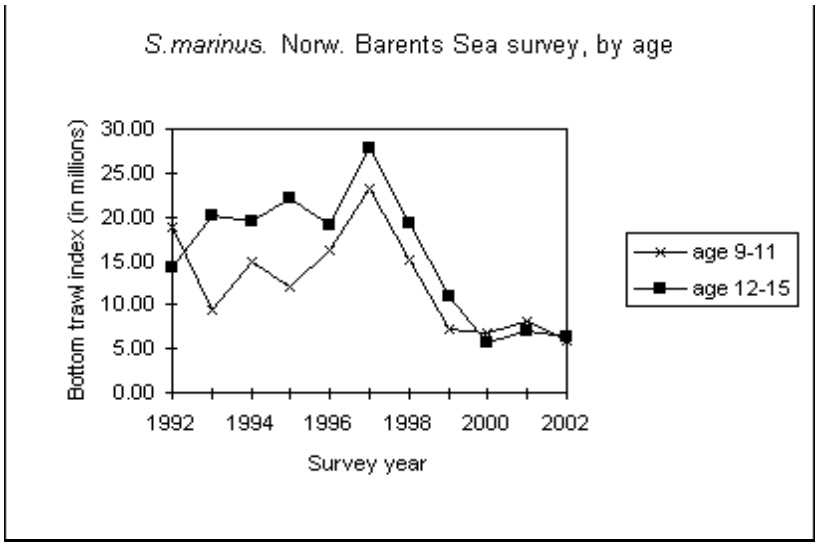
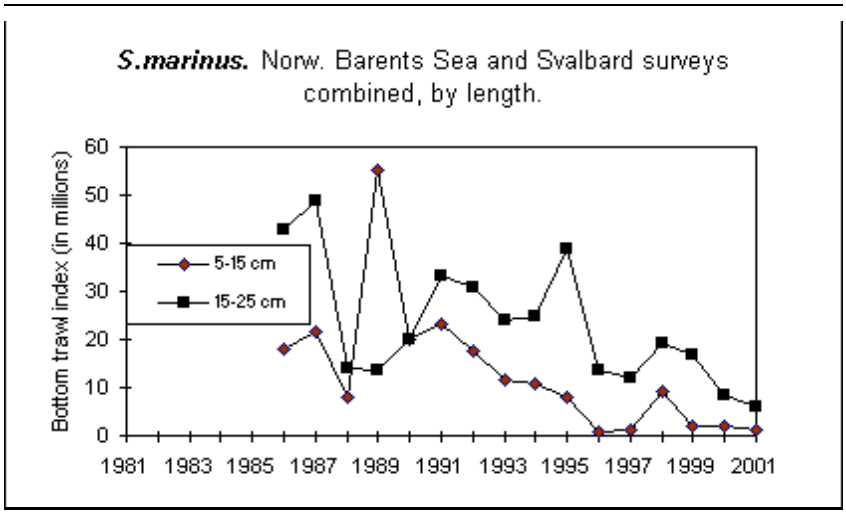


Figure 7.2b *Sebastes marinus.* Abundance indices (by age) from the Norwegian bottom trawl surveys 1992-2002 in the Barents Sea (ref. Table D10b).



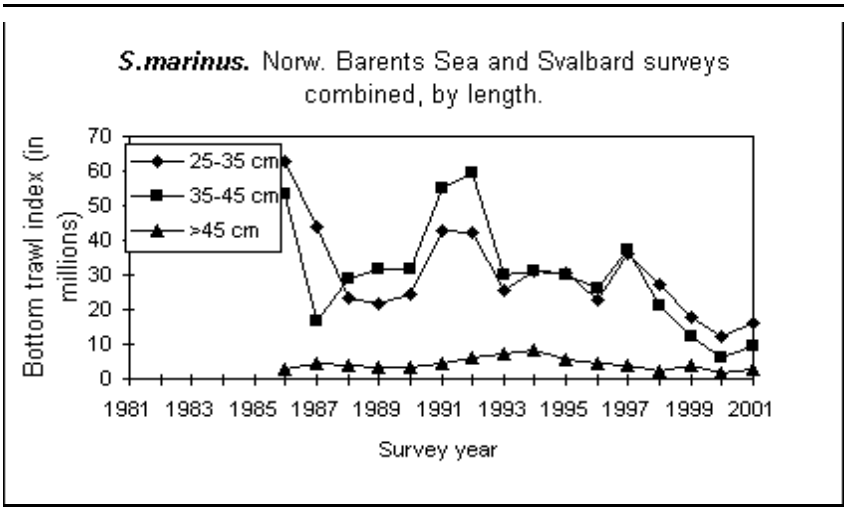
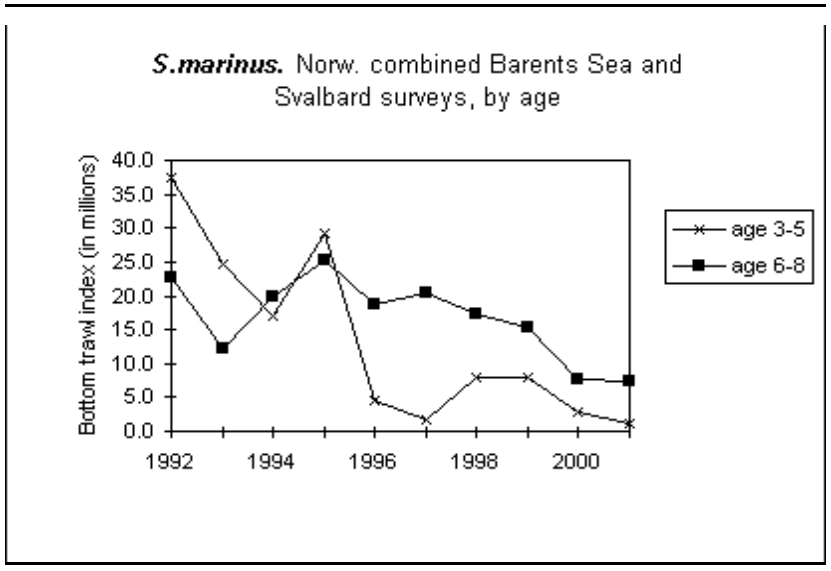


Figure 7.3a *Sebastes marinus.* Abundance indices (**by length**) when combining the Norwegian bottom trawl surveys 1986-2001 in the Barents Sea (winter) and at Svalbard (summer/fall).



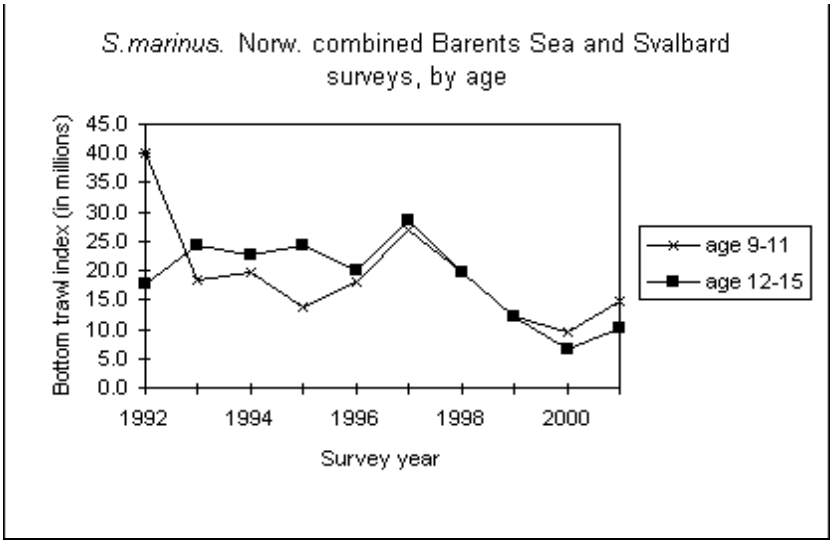


Figure 7.3b *Sebastes marinus.* Abundance indices (**by age**) when combining the Norwegian bottom trawl surveys 1992-2001 in the Barents Sea (winter) and at Svalbard (summer/fall).

Table D9. *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).

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	40,134
1987	2,168	9.0	0.68	35,532
1988	4,349	16.8	0.77	33,560
1989	3,044	13.1	0.59	39,451
1990	3,589	12.8	1.08	26,031
1991	4,943	26.0	0.92	20,756
1992	2,265	14.0	0.65	24,815
1993	1,426	8.6	0.75	22,164
1994	1,241	6.8	0.87	20,767
1995	928	5.9	0.66	23,516
1996	1,831	10,1	0.79	22,769
1997	1,313	7.4	0.66	26,486
1998	1,681	8,7	0.57	33,667
1999	1,155	6.1	0.55	34,628
2000	2,181	15.1	0.68	21,138
2001[2]	477	4.7	0.48	21,537

[1] Only including days with more than 50% *S. marinus* in the catches, and analysed by a GLM-analysis.
[2]Provisional figures.

Table D10a. *Sebastes marinus*. Abundance indices **(on length)** from the bottom trawl surveys in the Barents Sea in the winter 1986-2002 (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	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

[1] - Adjusted indices to account for not covering the Russian EEZ in Subarea I.

Table D10b *Sebastes marinus* in Sub-areas I and II. Norwegian bottom trawl indices **(on age)** from the annual Barents Sea survey in February 1992-2002 (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[1]	130	910	902	1,590	544	1,546	2,153	1,822	1,900	2,220	1,073	1,294	1,730	17,903

[1] Preliminary

Table D11a *Sebastes marinus* in Division IIb. Abundance indices (**on length**) from the bottom trawl survey in the Svalbard area (Division IIb) in summer/fall 1985-2001 (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

[1] - Old trawl equipment (bobbins gear and 80 meter sweep length)

Table D11b. *Sebastes marinus* in Subareas I and II. Norwegian bottom trawl survey indices **(on age)** in the Svalbard area (Division IIb) in summer/fall 1992-2001 (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

8 GREENLAND HALIBUT IN SUBAREAS I AND II

8.1 Status of the fisheries

8.1.1 Historical development of the fisheries

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 it has been 3,000–6,000 t, although now gillnets are also used in the fishery. 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 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 to 1998 total landings varied between 9,000-14,000 t with a mean of 11,000 t. Since 1999 landings have varied between 14,000-19,000 t, with a mean of 16,500 t.

From 1992 this 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. Trawl catches are limited to bycatch only. From 1992 to autumn 1994 bycatch in each haul was not to exceed 10% by weight. In autumn 1994 this was changed to 5% bycatch of Greenland halibut onboard at any time. In autumn 1996 it was changed to 5% bycatch 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 bycatch regulations were changed again 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 annual trawler landings have varied between 5,000 and 10,000 t without any clear trend attributable to changes in allowable bycatch. Landings of Greenland halibut from the directed longline and gillnet fisheries have increased in recent years to well above the level of 2,500 t set by the Norwegian authorities. In 2001 these catches were close to 5,000 t. This is attributed to the increased difficulties of regulating a fishery that only lasts for a few weeks.

8.1.2 Landings prior to 2001 (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 2000 is 14,392 t, which is about 250 t more than used in the previous assessment. The preliminary estimate of the total catch for 2001 is 16,011 t. This is 3,000 t below the projected catch for 2001 estimated by the Working Group during its 2001 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 800 t in 1999. 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 2000 and 2001 catches in this area were 60 and 65 t, respectively. 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.

8.1.3 Expected landings in 2002

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 bycatch in the trawl fishery. The total Norwegian catch in 2002 is expected to be 11,000 t. In addition 5,500 t is expected to be caught by Russian vessels and 500 t by other countries.

Expected total landings (officially) for 2001 are thus 17,000 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 last year 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 this years 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). A report describing the new combined index and how the different parts were combined will be presented for the Working Group at its meeting in 2003.

The Norwegian Combined Survey Index (Table E5) indicates a 35% increase in the total stock during the last two years and a stock size in 2001 at the same level as in 1996. 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. 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.

From 2000 the survey north and east of Svalbard has been conducted as a joint Russian-Norwegian survey with increased survey coverage in the Russian zone. The new area included in the joint surveys was also surveyed by the Russians in 1999. Only the Norwegian part of these northern surveys is currently included in the Norwegian Combined Survey index. In the future, when the extended coverage in the Russian zone has been repeated for at least five years the Working Group will consider revising the total index.

Also the Russian bottom trawl surveys in October-December (Table E6) cover large parts of the total known distribution of Greenland halibut within 100–900 m depth. They sample the eastern Barents Sea better than the Norwegian Combined Survey although they don't cover the young-fish areas in the northeastern Barents Sea. Although variable these surveys indicate a general increase in both spawning stock and total fishable stock since 1990, with a particularly steep increase since 1999. Also in this survey series is it 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. The figures for 2001 are consistent with the trends seen in recent years. The increase may thus partly be attributable to larger parts of the stock being distributed within the survey area.

The Spanish bottom trawl surveys along the continental slope north of 73°30' N in October 1997-2001 (Table E7) differ from the two survey series above and indicate reduced abundance in this area during the last two years. The Norwegian Bottom trawl Survey in the Barents Sea in winter (Table E8) shows no clear trend in the total abundance.

In the last few years, when most of the year classes since 1989 have been established in the assessments as closer to the mean, the previous four year classes (1985-88) stand out as clearly below average. As these year classes have passed through the ages that constitute the bulk of the spawning stock, the spawning stock first went down and then gradually increased. The trends in the surveys, possible causes, relation with the physical environment and implications for the assessments were discussed by Albert *et al.* (2001) and Albert and Høines (in press).

The surveys seem to indicate that these trends in catchability of younger ages continue into 2001. 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 a joint Russian-Norwegian research program is currently being prepared and may eventually contribute by increasing our understanding of the processes involved. The main objectives will be 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. The indices 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, while the 2000 and 2001 year classes have the highest values since 1987.

8.2.2 Fishing effort and catch-per-unit-effort (Table 8.6 and E9)

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.

8.2.3 Age readings

With respect to the current assessment of Greenland halibut in the NE Arctic, the problem of unusually low numbers of cohorts at age 9 in data sets from the 1990's continues into 2001 data. The low catches of nine-year-olds in the data correspond also to low catches of the length groups associated with that age. This may indicate that the problem is a combination of catchability, survey coverage, and stock composition and distribution by sex. In 2001 joint Norwegian-Russian work started on exchanging otoliths on a regular basis. This effort may hopefully improve precision and accuracy of the age reading.

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. Although only age 5 and older was used in the assessment, input data for ages 3-4 are reported separately in Table 8.7.

8.3.1 Catch-at-age (Table 8.7 – 8.8)

The catch-at-age data for 2000 were updated using revised catch figures and revised Norwegian age composition. Catch-at-age data for 2001 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 8.8. 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, as seen in some of the surveys, were also observed in the catches.

8.3.2 Weight-at-age (Table 8.7, 8.9)

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 2001 (Table 8.9) 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 8.7, 8.10)

Annual ogives were derived to estimate the spawning stock biomass based on females only using Russian survey data for the years 1984–2001, except for the years 1991 and 2000. 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, and the average of 1999 and 2001 was used for 2000. For 1984-2001 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

In a preliminary XSA run the same tuning series as used in last year's assessment were used. These included:

Fleet 3: Norwegian Greenland halibut surveys using a commercial vessel along the continental slope from 1994–2001 for ages 5–14.
Fleet 4: Experimental commercial fishery CPUE from 1992–2001 for ages 5–14.
Fleet 7: Russian trawl survey from 1992-2001 for ages 5-14.

This run was compared with a run using Fleet 4 and 7 above in addition to:

Fleet 8: Norwegian Combined Survey from 1996-2001 for ages 5-15.

A thorough examination of the tuning diagnostics revealed that the last combination of fleets gave improved fit and they were used in the run presented.

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 1990-1998 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.

Four XSA-runs are presented below in order to document separately the effects of each of the changes that were done with input data compared to last years assessment. Output from the individual runs are shown in Figure 8.1. Initially last years XSA-run was redone with updated catch data for 2000. This resulted in only minor changes in the output. The next run was also made with the same fleets and settings as last year and with data for 2001 included. As in previous assessments the inclusion of a new year resulted in increased estimates of recruiting year classes in the last 2-3 years. Then the new Fleet 8 was substituted for the old Fleet 3 (see Section 8.3.5), thereby including larger parts of the younger age groups. This further improved recruitment estimates for the last two years. The final run included the new maturity ogive (se Section 8.3.4), representing only the female spawning stock.

Input data and diagnostics of the final XSA run are given in Tables 8.8-8.11 and log catchability residuals for the three fleets used in the tuning are shown in Figure 8.2. Figure 8.3 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 rather robust, largely unbiased, and describes the development of the stock reasonably well. The survivor estimates for 2002 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. Varying settings such as catchability constraints and standard error thresholds also did not introduce either instability or high variability in the overall estimates.

8.5.1 Results of the VPA (Tables 8.12–8.16)

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 8.12). 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 still represents 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 16,000 t in 1992 and remained stable around 14,000-18,000 t until the last couple of years when it again increased. For 2001 the female spawning stock was estimated at near 23,000 t, the highest level observed over the last 10 years.

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 before declining to 0.27 in 2001.

Recruitment-at-age 5 has been relatively low in recent years, and since 1990 lower than in all previous years. However, the reduction is not especially dramatic and the 1990-2000 average is about 70% of the average during the 1980's. The result shows a minor reduction in the most recent year. Although the new survey coverage includes larger parts of the young fish distribution, the problems discussed in recent Working Group reports about survey coverage in relation to the distribution of the youngest age groups may still be relevant to some extent. If so, the decreased recruitment estimated for 2001 may not reflect the development of the stock.

8.5.2 Biological reference points

The Working Group has been requested to provide biological reference points for this stock for the last several years. However, it has been unable to do so due to unacceptable levels of uncertainty in the assessments. These uncertainties have been driven primarily by the inability to provide reliable recruitment indices as well as a more appropriate representation of trends in the SSB, as illustrated by mature female SSB only. Although uncertainties still exist, the current assessment is believed to have advanced knowledge considerably on both these issues, and the Working Group has therefore attempted to compute preliminary biological reference points using the traditional PA Software Package. The results of this analysis are shown in Figures 8.5 a-c.

The Working Group emphasises that this analysis is meant only to illustrate a first attempt at moving towards appropriate reference points for this stock, and time at the present meeting did not allow for a detailed review. It should be noted also that a major joint three-year scientific program on Greenland halibut is currently under way between the Russian Federation and Norway. 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 2002

The input data for the prediction based on the results from the XSA-analysis are as follows (Table 8.17):

The stock numbers-at-age in 2002 were taken from the XSA for ages 6 and older. The recruitment-at-age 5 in 2002 was estimated using the mean from 1990 to 1998 following the argument that recruitment-at-age 5 shows a sharp reduction in the most recent 2-3 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 1998-2001 has been used, scaled to the 2001 level. 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 (8.18) shows that the expected catch of 17,000 t in 2002 will increase the fishing mortality (F_{2002}=0.31) slightly. The total stock biomass will be slightly reduced while the SSB will slightly increase (79,000 t and 23,000 t respectively). The *status quo* catch in 2002 (F_{2001}) is 15,000 t, and leads to no change in the total biomass and a slight increase of the SSB. To rebuild the SSB to the mean level of the 1980s, future fishing mortality has to be reduced below the present level.

8.6 Comparison of this years assessment with last years assessment

Compared to last year's assessment changes in input, other than regular updating, include replacement of the Norwegian Greenland halibut survey along the slope with the new Norwegian Combined Survey Index. In addition, the maturity ogive was changed to represent only the female part of the spawning stock.

The new index includes data from the Greenland halibut survey as well as from surveys in the young fish areas around Svalbard. Updating last years assessment with data from 2001 resulted in increased recruitment estimates for the last few years compared to the previous estimates. Substituting survey series for tuning further increased recruitment estimates for the last two years.

Compared to last years assessment, the current one has revised previous year's fishing mortality for 2001 downwards and the stock level upwards. This is mainly due to the youngest few year classes in the tuning that are estimated higher in abundance than in previous years.

	Total stock (5+) by 1 January 2001	SSB by 1 January 2001	F6-10 in 2001	F6-10 in 2000
WG 2001 (prediction)	56446	N/A[1]	0.57	0.34
WG 2002	79109	22695	0.27	0.28

[1] SSB based on sexes combined, whereas the current assessment used females only.

8.7 Comments to the assessment

The retrospective analysis needs five years of tuning data for the oldest time-series. Since the new combined survey indices were only available for six years, the retrospective analysis could only compare two series. Figure 8.4 shows the effect of including data for the last year. Both recruitment and total biomass increased considerably for the last few years when data from 2001 were included, compared to when the time-series ended with 2000. For SSB and fishing mortality only minor changes were found. One reason for these changes is that several surveys in 2001 clearly indicate that the last few recruiting year classes (age 5) were larger than estimated in previous assessments.

The present assessment was tuned with survey data representing a larger part of the total distribution area of Greenland halibut. The diagnostics were generally reasonable and estimation of female SSB clearly improved. As a result the Working Group is confident that the quality of the assessment has improved compared to recent assessments of this stock. Nevertheless, improvements are still needed, especially in the way the combined survey indices are calculated. This involves consideration of sampling efficiency of different trawls, inclusion of even larger parts of the juvenile distribution area, and knowledge of vertical and geographical distribution of Greenland halibut with respect to growth and maturation. There is also continued concern with the difficulty in tracking year classes throughout the various time-series used in the assessment. These are all topics for a joint Russian-Norwegian research program for 2002-2004. At the end of the program period it is intended to arrange a workshop that may advise on improvement of surveys and assessments in view of new results.

The Working Group was asked to investigate the inclusion of age 10 and older in the plus-group. This resulted in extremely high historical stock numbers and unrealistically low present stock size. This is likely due to the fact that fish 10 years and older often contribute significantly to the catch in many years. Therefore, it was not pursued further.

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	Est onia	Faroe Isl.	France	Fed. Rep. Germ any	Gre enl.	Ice land	Ire land	Lithu ania	Norway	Pola nd	Portu gal	Rus sia[3]	Spain	UK (Engl. & Wales)	UK (Scot land)	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	0	15	0	16	0	0	9 223 [2]	3	37	4 568	375 [2]	112	43	14 392
2001 [1]	0	0	0	0	58	0	18	1	0	10 875 [2]	2	35	4 694	198 [2]	100	30	16 011

[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 [2]	1169	-	1	-	2 106
2001 [1]	-	-	+	-	18	844 [2]	951	-	2	-	1 815

[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]				10	[4]		7 774 [2]	18	690	1	65	43	8 601
2001 [1]				49	[4]	1	8 923 [2]	13	726		56	30	9 798

[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	Denmark	Estonia	Faroe Islands	France	Fed. rep. Germ.	Ireland	Lithuania	Norway	Poland	Portugal	Russia[4]	Spain	UK (Engl. & Wales)	UK (Scotland)	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]	-	-		-	5		-	529 [2]	3	19	2 709	374 [2]	46	-	3 685
2001 [1]	-	-		-	9	-	-	1 108 [2]	2	22	3 017	198 [2]	42	-	4 398

[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	2 044	6 303	7 665	16 011

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	-	-	-	-	-

[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. Input data for the youngest age groups, which were not used in the XSA.

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Run title : Arctic Green.halibut (run: XSAAAG41/X41)
At 19/04/2002  15:03
   Table  1    Catch numbers-at-age                              Numbers*10**-3
   YEAR,        1964,    1965,    1966,    1967,    1968,    1969,    1970,    1971,
   AGE
     3,           18,      44,      54,      54,      12,      27,       1,       1,
     4,          101,      91,      69,     121,      57,     233,      34,       1,

   YEAR,        1972,    1973,    1974,    1975,    1976,    1977,    1978,    1979,    1980,    1981,
   AGE
     3,            1,       1,       1,      22,       1,      62,      78,      88,      64,     664,
     4,          461,      19,     276,     334,      98,     755,     532,     887,     275,    1146,

   YEAR,        1982,    1983,    1984,    1985,    1986,    1987,    1988,    1989,    1990,    1991,
   AGE
     3,           48,     314,       0,      88,     141,      50,       5,     214,     155,     389,
     4,          551,    1212,      36,     461,     985,     435,     233,     924,     793,    2084,

   YEAR,        1992,    1993,    1994,    1995,    1996,    1997,    1998,    1999,    2000,    2001,
   AGE
     3,           98,      10,       0,       0,       3,       2,       1,     104,      12,       3,
     4,          437,     224,      73,      75,      48,      32,      79,     122,      87,      46,


   Table  2    Catch weights-at-age (kg)
   YEAR,        1964,    1965,    1966,    1967,    1968,    1969,    1970,    1971,
   AGE
     3,        .1400,   .1400,   .1400,   .1400,   .1400,   .1400,   .2000,   .2000,
     4,        .2600,   .2600,   .2600,   .2600,   .2600,   .2600,   .4410,   .4410,

   YEAR,        1972,    1973,    1974,    1975,    1976,    1977,    1978,    1979,    1980,    1981,
   AGE
     3,        .2000,   .2000,   .2000,   .2000,   .2000,   .2000,   .2000,   .3000,   .2000,   .2000,
     4,        .4410,   .4410,   .4410,   .4410,   .4410,   .4410,   .4410,   .6000,   .4820,   .5000,

   YEAR,        1982,    1983,    1984,    1985,    1986,    1987,    1988,    1989,    1990,    1991,
   AGE
     3,        .2700,   .3100,   .3000,   .3000,   .3400,   .3070,   .4140,   .3100,   .2800,   .2900,
     4,        .6200,   .4500,   .4800,   .3800,   .4700,   .5740,   .5540,   .6300,   .5500,   .6000,

   YEAR,        1992,    1993,    1994,    1995,    1996,    1997,    1998,    1999,    2000,    2001,
   AGE
     3,        .2200,   .3400,   .2600,   .4400,   .1800,   .3000,   .3000,   .2200,   .3000,   .3900,
     4,        .4600,   .5400,   .5200,   .5600,   .4700,   .5000,   .5200,   .4700,   .5200,   .4600,


   Table  5    Proportion mature at age
   YEAR,        1964,    1965,    1966,    1967,    1968,    1969,    1970,    1971,
   AGE
     3,        .0000,   .0000,   .0000,   .0000,   .0000,   .0000,   .0000,   .0000,
     4,        .0000,   .0000,   .0000,   .0000,   .0000,   .0000,   .0000,   .0000,

   YEAR,        1972,    1973,    1974,    1975,    1976,    1977,    1978,    1979,    1980,    1981,
   AGE
     3,        .0000,   .0000,   .0000,   .0000,   .0000,   .0000,   .0000,   .0000,   .0000,   .0000,
     4,        .0000,   .0000,   .0000,   .0000,   .0000,   .0000,   .0000,   .0000,   .0000,   .0000,

   YEAR,        1982,    1983,    1984,    1985,    1986,    1987,    1988,    1989,    1990,    1991,
   AGE
     3,        .0000,   .0000,   .0000,   .0000,   .0000,   .0000,   .0000,   .0000,   .0000,   .0000,
     4,        .0000,   .0000,   .0000,   .0000,   .0000,   .0000,   .0000,   .0000,   .0000,   .0000,

   YEAR,        1992,    1993,    1994,    1995,    1996,    1997,    1998,    1999,    2000,    2001,
   AGE
     3,        .0000,   .0000,   .0000,   .0000,   .0000,   .0000,   .0000,   .0000,   .0000,   .0000,
     4,        .0000,   .0000,   .0000,   .0000,   .0000,   .0000,   .0000,   .0000,   .0000,   .0000,
```

Table 8.8

Run title : Arctic Green.halibut (run: XSAAAG44/X44)

At 23/04/2002 14:52

	Table 1	Catch numbers-at-age					Numbers*10**-3		
	YEAR,	1964,	1965,	1966,	1967,	1968,	1969,	1970,	1971,
	AGE								
	5,	372,	253,	170,	156,	114,	1064,	526,	80,
	6,	1480,	853,	563,	332,	283,	2420,	2792,	4486,
	7,	2808,	1735,	1106,	623,	452,	3208,	10464,	12712,
	8,	5674,	3868,	2715,	2006,	1976,	6288,	18562,	12283,
	9,	4951,	4203,	4054,	3237,	3923,	4921,	10034,	6130,
	10,	3981,	3799,	2499,	2409,	2950,	4431,	6671,	4339,
	11,	1853,	1799,	1284,	1718,	2234,	2381,	2517,	2703,
	12,	1018,	1002,	783,	871,	792,	812,	1250,	1660,
	13,	364,	372,	246,	315,	146,	229,	616,	1044,
	14,	251,	282,	261,	155,	43,	100,	1104,	300,
	+gp,	76,	50,	28,	19,	7,	30,	281,	143,
0	TOTALNUM,	22828,	18216,	13709,	11841,	12920,	25884,	54817,	45880,
	TONSLAND,	40391,	34751,	26321,	24267,	26168,	43789,	89484,	79034,
	SOPCOF %,	100,	100,	101,	100,	100,	103,	94,	104,

	Table 1	Catch numbers-at-age					Numbers*10**-3				
	YEAR,	1972,	1973,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,
	AGE										
	5,	1109,	212,	917,	840,	830,	2037,	1897,	2218,	731,	1896,
	6,	3521,	1117,	2519,	2337,	2982,	3255,	3589,	3155,	1138,	1917,
	7,	9605,	3923,	6204,	6520,	5824,	4200,	4118,	2727,	1665,	1919,
	8,	6438,	3515,	3838,	4118,	5002,	2524,	2365,	1234,	1341,	933,
	9,	2775,	2551,	1834,	2265,	3000,	1610,	1509,	495,	944,	484,
	10,	1734,	1919,	1942,	1654,	1350,	1104,	946,	319,	473,	448,
	11,	1368,	1536,	1622,	1857,	915,	1062,	934,	296,	511,	482,
	12,	1234,	1127,	1338,	1536,	1212,	858,	438,	243,	275,	380,
	13,	675,	716,	734,	1122,	698,	595,	349,	103,	242,	384,
	14,	200,	251,	531,	600,	526,	384,	147,	45,	145,	150,
	+gp,	80,	126,	216,	368,	358,	180,	112,	51,	78,	62,
0	TOTALNUM,	28739,	16993,	21695,	23217,	22697,	17809,	16404,	10886,	7543,	9055,
	TONSLAND,	43055,	29938,	37763,	38172,	36074,	28827,	24617,	17312,	13284,	15018,
	SOPCOF %,	98,	92,	98,	88,	93,	101,	105,	104,	109,	107,

	Table 1	Catch numbers-at-age					Numbers*10**-3				
	YEAR,	1982,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,
	AGE										
	5,	1304,	1543,	915,	1219,	1672,	1212,	907,	2080,	2139,	3312,
	6,	1494,	1864,	3698,	2874,	3335,	2972,	2540,	4453,	5163,	3889,
	7,	1276,	1851,	3350,	2561,	2712,	3572,	3141,	3655,	4642,	4716,
	8,	1208,	2287,	1938,	1548,	1531,	1746,	2096,	1657,	1932,	2355,
	9,	1493,	1491,	1064,	972,	1128,	752,	1182,	801,	1221,	1031,
	10,	1258,	1228,	1191,	1037,	997,	828,	860,	318,	499,	1284,
	11,	838,	713,	602,	614,	530,	362,	481,	228,	264,	774,
	12,	502,	488,	340,	363,	434,	202,	313,	126,	314,	673,
	13,	324,	247,	171,	161,	314,	186,	133,	120,	42,	177,
	14,	108,	201,	132,	120,	305,	63,	140,	140,	96,	266,
	+gp,	46,	64,	71,	63,	239,	7,	47,	28,	44,	517,
0	TOTALNUM,	9851,	11977,	13472,	11532,	13197,	11902,	11840,	13606,	16356,	18994,
	TONSLAND,	16789,	22147,	21883,	19945,	22875,	19112,	19587,	20138,	23183,	33320,
	SOPCOF %,	100,	98,	100,	99,	98,	101,	100,	103,	102,	105,

	Table 1	Catch numbers-at-age					Numbers*10**-3				
	YEAR,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,
	AGE										
	5,	1098,	1140,	631,	846,	1034,	330,	359,	433,	380,	387,
	6,	1195,	1088,	708,	992,	2083,	921,	1116,	1905,	735,	1231,
	7,	1069,	1608,	1252,	1719,	3795,	1822,	2466,	3955,	1926,	2208,
	8,	778,	1118,	817,	990,	1426,	953,	1464,	1810,	1464,	1542,
	9,	360,	140,	310,	405,	262,	342,	527,	914,	743,	837,
	10,	600,	976,	642,	726,	655,	822,	924,	1905,	1318,	1077,
	11,	188,	444,	416,	461,	270,	231,	237,	380,	457,	496,
	12,	150,	144,	330,	371,	132,	150,	122,	237,	330,	368,
	13,	79,	36,	88,	154,	29,	18,	15,	67,	49,	112,
	14,	89,	20,	39,	56,	22,	41,	29,	42,	37,	53,
	+gp,	56,	4,	3,	8,	1,	1,	15,	7,	14,	13,
0	TOTALNUM,	5662,	6718,	5236,	6728,	9709,	5631,	7274,	11655,	7453,	8324,
	TONSLAND,	8602,	11933,	9226,	11734,	14347,	9628,	12507,	19350,	14392,	16011,
	SOPCOF %,	95,	102,	99,	101,	101,	101,	105,	101,	100,	100,

Table 8.9

Run title : Arctic Green.halibut (run: XSAAAG44/X44)

At 23/04/2002 14:52

Table 2 Catch weights-at-age (kg)

	YEAR,	1964,	1965,	1966,	1967,	1968,	1969,	1970,	1971,
	AGE								
	5,	.4200,	.4200,	.4200,	.4200,	.4200,	.4200,	.5670,	.5670,
	6,	.6400,	.6400,	.6400,	.6500,	.6600,	.6400,	.7370,	.7370,
	7,	.9000,	.9000,	.9100,	.9300,	.9600,	.9100,	1.0790,	1.0790,
	8,	1.2000,	1.2200,	1.2400,	1.2700,	1.3100,	1.2500,	1.4210,	1.4210,
	9,	1.6300,	1.6600,	1.7000,	1.7100,	1.7400,	1.6400,	1.8480,	1.8480,
	10,	2.2600,	2.2300,	2.2200,	2.2000,	2.1900,	2.2500,	2.2810,	2.2810,
	11,	3.1100,	3.0000,	2.9400,	2.8400,	2.7900,	2.9900,	2.8870,	2.8870,
	12,	3.7400,	3.4900,	3.3900,	3.3000,	3.1900,	3.6300,	3.2470,	3.2470,
	13,	4.5700,	4.4000,	4.3800,	4.2700,	4.2700,	4.6800,	4.3030,	4.3030,
	14,	5.0100,	4.9100,	4.8400,	4.8800,	5.0000,	5.3800,	4.9310,	4.9310,
	+gp,	5.9400,	5.8900,	5.8800,	5.8000,	5.9900,	5.9900,	5.7940,	5.8410,
0	SOPCOFAC,	.9986,	1.0046,	1.0054,	1.0024,	.9994,	1.0262,	.9436,	1.0434,

Table 2 Catch weights-at-age (kg)

	YEAR,	1972,	1973,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,
	AGE										
	5,	.5670,	.5670,	.5670,	.5670,	.5670,	.5670,	.5670,	.9000,	.7020,	.6600,
	6,	.7370,	.7370,	.7370,	.7370,	.7370,	.7370,	.7370,	1.2000,	.8720,	.8400,
	7,	1.0790,	1.0790,	1.0790,	1.0790,	1.0790,	1.0790,	1.0790,	1.5000,	1.1410,	1.1500,
	8,	1.4210,	1.4210,	1.4210,	1.4210,	1.4210,	1.4210,	1.4210,	1.8000,	1.4680,	1.5600,
	9,	1.8480,	1.8480,	1.8480,	1.8480,	1.8480,	1.8480,	1.8480,	2.2000,	1.7780,	2.0400,
	10,	2.2810,	2.2810,	2.2810,	2.2810,	2.2810,	2.2810,	2.2810,	2.6000,	2.3020,	2.5700,
	11,	2.8870,	2.8870,	2.8870,	2.8870,	2.8870,	2.8870,	2.8870,	3.0000,	2.6640,	2.9800,
	12,	3.2470,	3.2470,	3.2470,	3.2470,	3.2470,	3.2470,	3.2470,	3.5000,	3.0460,	3.4300,
	13,	4.3030,	4.3030,	4.3030,	4.3030,	4.3030,	4.3030,	4.3030,	4.1000,	3.3680,	4.1300,
	14,	4.9310,	4.9310,	4.9310,	4.9310,	4.9310,	4.9310,	4.9310,	4.8000,	4.2850,	4.6800,
	+gp,	6.0370,	6.0060,	5.9640,	5.9100,	5.9230,	6.0270,	5.9060,	6.1760,	5.3460,	5.9990,
0	SOPCOFAC,	.9752,	.9231,	.9825,	.8805,	.9255,	1.0095,	1.0485,	1.0364,	1.0894,	1.0680,

Table 2 Catch weights-at-age (kg)

	YEAR,	1982,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,
	AGE										
	5,	.6900,	.7500,	.6300,	.6000,	.6200,	.7090,	.7400,	.7600,	.7100,	.7700,
	6,	.8400,	1.0400,	.9600,	.8900,	.9200,	1.0030,	.9620,	1.0300,	1.0600,	1.0500,
	7,	1.0300,	1.3400,	1.1800,	1.2000,	1.2800,	1.2660,	1.2490,	1.3200,	1.2900,	1.3800,
	8,	1.3100,	1.5700,	1.5300,	1.8500,	1.9000,	1.6830,	1.6260,	1.8000,	1.7000,	1.7500,
	9,	1.7400,	1.9700,	2.3100,	2.5900,	2.4800,	2.4820,	2.1640,	2.4200,	2.1000,	2.2000,
	10,	2.2400,	2.7300,	2.8700,	3.1800,	3.1100,	2.9820,	2.8970,	3.1300,	2.6100,	2.6000,
	11,	2.7700,	3.2900,	3.4600,	3.6200,	3.3500,	3.5470,	3.4060,	3.3700,	2.8700,	2.7900,
	12,	3.3700,	4.2200,	3.7700,	3.9500,	3.7200,	3.8000,	3.6610,	4.0500,	3.4500,	3.2800,
	13,	4.3200,	4.7100,	3.9900,	4.4800,	4.0000,	4.5600,	4.2470,	4.2900,	3.7200,	3.8900,
	14,	5.3500,	6.0800,	4.3500,	4.2500,	4.1800,	5.0020,	4.1870,	4.5000,	4.0900,	4.3800,
	+gp,	5.8330,	6.1220,	4.5250,	4.8250,	4.5260,	5.9530,	4.4630,	4.7200,	4.5200,	5.2900,
0	SOPCOFAC,	1.0038,	.9783,	1.0009,	.9858,	.9782,	1.0116,	.9973,	1.0346,	1.0204,	1.0470,

Table 2 Catch weights-at-age (kg)

	YEAR,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,
	AGE										
	5,	.6800,	.7900,	.7200,	.7300,	.7700,	.7700,	.7300,	.7000,	.7600,	.7400,
	6,	.9700,	1.0200,	.9400,	.9400,	.9700,	.9400,	.9300,	.9500,	.9700,	1.0300,
	7,	1.2700,	1.3500,	1.2700,	1.2500,	1.3100,	1.2800,	1.3000,	1.2700,	1.3300,	1.3600,
	8,	1.7600,	1.8800,	1.7200,	1.7400,	1.7400,	1.6400,	1.6100,	1.5500,	1.6300,	1.7300,
	9,	2.2100,	2.4600,	2.1900,	2.0900,	2.2400,	2.0700,	2.1200,	2.0000,	2.1100,	2.2800,
	10,	2.5600,	2.6700,	2.5200,	2.5100,	2.5900,	2.5900,	2.5700,	2.4600,	2.6100,	2.6500,
	11,	3.1100,	3.4300,	2.9700,	2.9500,	3.2900,	3.3000,	3.2500,	3.2200,	3.3500,	3.2900,
	12,	3.5900,	4.2900,	3.2900,	3.3400,	4.0200,	4.0100,	3.9100,	3.8500,	3.9700,	3.8900,
	13,	3.8300,	5.0800,	3.8400,	3.8300,	4.7500,	4.8300,	4.9000,	4.6100,	4.9700,	4.7500,
	14,	4.2500,	6.3300,	4.9500,	4.9800,	6.2400,	5.9500,	5.6600,	5.8400,	5.8200,	5.5900,
	+gp,	4.8000,	8.9100,	6.6800,	8.1500,	6.0900,	6.2600,	4.9100,	5.9800,	7.2200,	7.1000,
0	SOPCOFAC,	.9519,	1.0183,	.9937,	1.0095,	1.0066,	1.0079,	1.0498,	1.0085,	1.0023,	1.0025,

Table 8.10

Run title : Arctic Green.halibut (run: XSAAAG44/X44)

At 23/04/2002 14:52

Table 5 Proportion mature at age

YEAR,	1964,	1965,	1966,	1967,	1968,	1969,	1970,	1971,
AGE								
5,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
6,	.0300,	.0300,	.0300,	.0300,	.0300,	.0300,	.0300,	.0300,
7,	.0300,	.0300,	.0300,	.0300,	.0300,	.0300,	.0300,	.0300,
8,	.2100,	.2100,	.2100,	.2100,	.2100,	.2100,	.2100,	.2100,
9,	.6700,	.6700,	.6700,	.6700,	.6700,	.6700,	.6700,	.6700,
10,	.8600,	.8600,	.8600,	.8600,	.8600,	.8600,	.8600,	.8600,
11,	.9800,	.9800,	.9800,	.9800,	.9800,	.9800,	.9800,	.9800,
12,	.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,
14,	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,

Table 5 Proportion mature at age

YEAR,	1972,	1973,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,
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,

Table 5 Proportion mature at age

YEAR,	1982,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,
AGE										
5,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
6,	.0300,	.0300,	.0400,	.0400,	.0300,	.0100,	.0100,	.0100,	.0100,	.0100,
7,	.0300,	.0300,	.0300,	.0400,	.0300,	.0200,	.0100,	.0200,	.0200,	.0400,
8,	.2100,	.1800,	.1800,	.1900,	.2400,	.2200,	.2100,	.1800,	.1700,	.1500,
9,	.6700,	.6000,	.6100,	.6500,	.7400,	.6600,	.5300,	.4900,	.5100,	.5400,
10,	.8600,	.8200,	.8300,	.8500,	.9100,	.9000,	.8700,	.8000,	.7700,	.7700,
11,	.9800,	.9600,	.9700,	.9700,	.9900,	.9500,	.8900,	.8900,	.9100,	.8900,
12,	.9800,	.9800,	.9800,	.9900,	.9800,	.9800,	.9800,	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,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,
AGE										
5,	.0000,	.0100,	.0100,	.0100,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
6,	.0100,	.0100,	.0100,	.0100,	.0000,	.0000,	.0000,	.0100,	.0100,	.0200,
7,	.0600,	.0800,	.0700,	.0800,	.0700,	.0700,	.0400,	.0200,	.0400,	.0500,
8,	.2800,	.3200,	.3400,	.2900,	.2500,	.2100,	.1000,	.1000,	.1300,	.1500,
9,	.6600,	.6800,	.6900,	.5800,	.5800,	.5300,	.4500,	.4000,	.4500,	.4800,
10,	.8600,	.8300,	.8100,	.7900,	.8800,	.8500,	.8200,	.7300,	.7000,	.6600,
11,	.8700,	.8800,	.9500,	.9600,	.9700,	.9400,	.9200,	.9300,	.9400,	.9400,
12,	1.0000,	.9400,	.9400,	.8900,	.9400,	.9400,	1.0000,	.9900,	.9600,	.9400,
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 8.11

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Lowestoft VPA Version 3.1

   23/04/2002  14:51

 Extended Survivors Analysis

 Arctic Green.halibut (run: XSAAAG44/X44)

 CPUE data from file fleet

 Catch data for  38 years. 1964 to 2001. Ages  5 to  15.

      Fleet,           First, Last, First, Last, Alpha,  Beta
                  ,    year, year,  age ,  age
 FLT04: Norw. Exp. CP,   1992, 2001,   5,    14,   .380,   .440
 FLT07: Russ.Surv. ne,   1992, 2001,   5,    14,   .750,   .920
 FLT08: Norw.Comb.Sur,   1996, 2001,   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   55 iterations


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



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

      5,  .120,  .101,  .039,  .056,  .066,  .020,  .024,  .034,  .023,  .030
      6,  .181,  .158,  .080,  .075,  .179,  .074,  .084,  .163,  .070,  .092
      7,  .239,  .370,  .261,  .266,  .424,  .222,  .271,  .448,  .232,  .292
      8,  .296,  .397,  .307,  .320,  .349,  .167,  .263,  .308,  .279,  .279
      9,  .133,  .075,  .171,  .232,  .123,  .124,  .124,  .247,  .189,  .240
     10,  .380,  .595,  .533,  .706,  .676,  .649,  .532,  .812,  .633,  .432
     11,  .365,  .507,  .516,  .885,  .586,  .504,  .365,  .409,  .429,  .488
     12,  .686,  .497,  .846, 1.202,  .641,  .722,  .514,  .718,  .714,  .696
     13,  .821,  .322,  .612, 1.277,  .237,  .154,  .131,  .561,  .290,  .529
     14,  .682,  .469,  .650,  .977,  .560,  .580,  .372,  .609,  .659,  .551



1
 XSA population numbers (Thousands)

                               AGE
 YEAR ,           5,            6,            7,            8,            9,           10,           11,           12,           13,
14,

 1992 ,    1.05E+04, 7.79E+03, 5.43E+03, 3.28E+03, 3.11E+03, 2.04E+03, 6.63E+02, 3.26E+02, 1.52E+02, 1.94E+02,
 1993 ,    1.28E+04, 8.01E+03, 5.60E+03, 3.68E+03, 2.10E+03, 2.34E+03, 1.20E+03, 3.96E+02, 1.41E+02, 5.76E+01,
 1994 ,    1.79E+04, 9.97E+03, 5.88E+03, 3.33E+03, 2.13E+03, 1.68E+03, 1.11E+03, 6.23E+02, 2.07E+02, 8.80E+01,
 1995 ,    1.69E+04, 1.48E+04, 7.92E+03, 3.90E+03, 2.11E+03, 1.55E+03, 8.46E+02, 5.72E+02, 2.30E+02, 9.68E+01,
 1996 ,    1.74E+04, 1.37E+04, 1.18E+04, 5.22E+03, 2.44E+03, 1.44E+03, 6.56E+02, 3.01E+02, 1.48E+02, 5.53E+01,
 1997 ,    1.77E+04, 1.40E+04, 9.88E+03, 6.67E+03, 3.17E+03, 1.86E+03, 6.29E+02, 3.14E+02, 1.36E+02, 1.00E+02,
 1998 ,    1.63E+04, 1.49E+04, 1.12E+04, 6.81E+03, 4.86E+03, 2.41E+03, 8.35E+02, 3.27E+02, 1.32E+02, 1.01E+02,
 1999 ,    1.41E+04, 1.37E+04, 1.18E+04, 7.35E+03, 4.51E+03, 3.69E+03, 1.22E+03, 4.99E+02, 1.68E+02, 9.93E+01,
 2000 ,    1.79E+04, 1.17E+04, 1.00E+04, 6.48E+03, 4.65E+03, 3.03E+03, 1.41E+03, 6.97E+02, 2.10E+02, 8.27E+01,
 2001 ,    1.43E+04, 1.50E+04, 9.40E+03, 6.83E+03, 4.22E+03, 3.31E+03, 1.39E+03, 7.91E+02, 2.94E+02, 1.35E+02,

 Estimated population abundance at 1st Jan 2002

    ,     0.00E+00, 1.20E+04, 1.18E+04, 6.04E+03, 4.45E+03, 2.86E+03, 1.85E+03, 7.32E+02, 3.40E+02, 1.49E+02,

 Taper weighted geometric mean of the VPA populations:

    ,     1.59E+04, 1.28E+04, 9.11E+03, 5.43E+03, 3.30E+03, 2.25E+03, 1.05E+03, 5.46E+02, 2.36E+02, 1.37E+02,

 Standard error of the weighted Log(VPA populations) :

    ,        .1893,    .2479,    .2786,    .2919,    .3148,    .3041,    .3387,    .4682,    .6157,    .7895,
```

Table 8.11 (Continued)

Log catchability residuals.

Fleet : FLT04: Norw. Exp. CP

Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
5	-.12	.46	.22	.38	.63	.63	-.90	-.56	-.19	-.40
6	-.33	-.07	.06	-.21	.67	.08	-.16	-.11	-.02	.03
7	-.63	-.04	-.02	-.01	.23	-.02	-.04	-.10	.33	.13
8	-.33	.03	.13	.14	.04	-.33	-.17	-.26	-.04	.72
9	-1.14	-1.11	-.61	.60	.10	.33	.15	-.70	.54	1.34
10	-.59	-.05	.16	.62	-.12	.34	-1.17	.13	.40	.19
11	-.35	-.28	-.35	.08	-.79	.41	-1.12	-1.23	-1.17	-.30
12	-.05	-.32	-.97	.05	-.83	.36	-.97	.43	-.18	.30
13	-.48	-.21	-.88	-.31	99.99	.05	99.99	-.69	.23	-.57
14	-1.48	-.35	-.70	.03	-.27	-.17	99.99	-.14	99.99	-.47

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

Age	5	6	7	8	9	10	11	12	13	14
Mean Log q	-4.6443	-3.9194	-3.1227	-3.5531	-4.8412	-3.4491	-3.4491	-3.4491	-3.4491	-3.4491
S.E(Log q)	.5421	.2684	.2416	.3179	.8032	.5298	.7953	.5949	.5377	.6322

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	.56	.669	6.82	.24	10	.32	-4.64
6	.78	.701	5.11	.59	10	.22	-3.92
7	.70	1.738	4.92	.82	10	.15	-3.12
8	1.01	-.023	3.51	.51	10	.34	-3.55
9	.57	.926	6.22	.39	10	.47	-4.84
10	1.06	-.101	3.18	.26	10	.60	-3.45
11	3.31	-1.158	-2.69	.03	10	1.84	-3.98
12	.71	.767	4.38	.49	10	.40	-3.66
13	1.57	-.617	2.98	.18	8	.63	-3.80
14	2.77	-1.590	2.64	.13	8	1.11	-3.86

1

Fleet : FLT07: Russ.Surv. ne

Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
5	1.74	.61	-.08	-.54	-.42	-.98	-.24	-.35	-.01	.70
6	.85	.55	.15	-.22	-.03	-.57	-.37	-.45	-.13	.51
7	.43	.46	-.04	-.05	.03	-.27	-.30	-.37	-.11	.39
8	.18	.16	-.10	.15	.03	-.16	-.02	-.16	.22	-.24
9	-.73	-.17	-.10	.22	.64	-.24	.08	.06	.12	-.07
10	-.49	-.06	.23	.17	-.87	-.04	.17	.15	.37	.22
11	.33	-.19	-.50	-.06	-.67	.31	.72	-.22	.64	.38
12	.22	.36	-.08	.07	-.83	-.39	.60	.26	.64	1.03
13	-.46	-.37	-.41	-.27	-.38	.49	.44	.74	-.74	1.27
14	-5.02	.72	.48	-1.69	-.29	-.26	-.18	-.11	.70	.61

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	-.3596	.6113	1.0559	1.3244	.8361	.4496	.4496	.4496	.4496	.4496
S.E(Log q)	.7473	.4645	.3058	.1670	.3406	.3828	.4883	.5867	.6743	1.6750

Table 8.11 (Continued)

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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,    -.38,   -3.943,     13.16,     .53,     10,     .17,    -.36,
  6,   -3.69,   -2.437,     46.46,     .04,     10,    1.36,     .61,
  7,    2.90,   -2.295,    -20.33,     .17,     10,     .72,    1.06,
  8,    1.34,   -1.561,     -4.72,     .74,     10,     .21,    1.32,
  9,    1.06,    -.146,     -1.33,     .49,     10,     .38,     .84,
 10,     .62,    1.725,      2.66,     .74,     10,     .21,     .45,
 11,     .84,     .357,       .68,     .39,     10,     .42,     .53,
 12,     .53,    2.038,      2.55,     .72,     10,     .25,     .65,
 13,     .68,     .522,      1.30,     .27,     10,     .48,     .51,
 14,    -.56,   -2.050,      7.12,     .19,     10,     .77,     .04,
1



 Fleet : FLT08: Norw.Comb.Sur

  Age  ,  1992,  1993,  1994,  1995,  1996,  1997,  1998,  1999,  2000,  2001
     5 , 99.99, 99.99, 99.99, 99.99,   .30,   .02,  -.16,  -.17,   .03,  -.01
     6 , 99.99, 99.99, 99.99, 99.99,   .29,   .13,  -.27,   .04,  -.08,  -.10
     7 , 99.99, 99.99, 99.99, 99.99,   .15,  -.06,   .04,  -.04,  -.18,   .10
     8 , 99.99, 99.99, 99.99, 99.99,   .35,  -.48,  -.24,   .22,   .04,   .11
     9 , 99.99, 99.99, 99.99, 99.99,   .11,  -.32,  -.53,  -.16,   .63,   .26
    10 , 99.99, 99.99, 99.99, 99.99,   .45,   .00,  -.01,   .10,  -.43,  -.08
    11 , 99.99, 99.99, 99.99, 99.99,  -.24,  -.28,  -.28,  -.67, -1.17,  -.75
    12 , 99.99, 99.99, 99.99, 99.99,  -.03,   .11,   .48,   .48,  -.54,  -.18
    13 , 99.99, 99.99, 99.99, 99.99,  -.67, -1.34, -3.22,  -.15,  -.84,  -.75
    14 , 99.99, 99.99, 99.99, 99.99,  -.04,  -.13,   .12,   .00,  -.67,  -.35



 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,    -.2291,     .4035,    1.1404,     .6337,    -.2139,    1.0880,    1.0880,    1.0880,    1.0880,    1.0880,
 S.E(Log q),     .1672,     .1935,     .1186,     .3049,     .4247,     .2840,     .7251,     .4036,    1.6737,     .3521,



 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,     .54,    1.288,      4.56,     .67,      6,     .09,    -.23,
  6,    1.69,    -.385,     -7.24,     .07,      6,     .36,     .40,
  7,     .75,     .578,      1.47,     .58,      6,     .10,    1.14,
  8,   36.18,    -.786,    ******,     .00,      6,   11.49,     .63,
  9,     .98,     .021,       .34,     .29,      6,     .47,    -.21,
 10,    1.87,   -1.467,     -8.86,     .42,      6,     .48,    1.09,
 11,    9.51,   -3.967,    -63.51,     .05,      6,    1.76,     .52,
 12,    2.09,   -1.333,     -9.04,     .28,      6,     .78,    1.14,
 13,     .38,    1.065,      3.25,     .43,      6,     .40,    -.08,
 14,    1.09,    -.167,     -1.40,     .47,      6,     .35,     .91,
1


 Terminal year survivor and F summaries :

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

 Year class = 1996

 Fleet,                Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
      ,                Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 FLT04: Norw. Exp. CP,      8044.,   .571,       .000,    .00,   1,  .154,     .044
 FLT07: Russ.Surv. ne,     24154.,   .787,       .000,    .00,   1,  .081,     .015
 FLT08: Norw.Comb.Sur,     11866.,   .300,       .000,    .00,   1,  .558,     .030

   F shrinkage mean  ,     12433.,    .50,,,,                        .207,     .028

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
     11954.,       .22,      .15,    4,    .654,   .030
```

Table 8.11 (Continued)

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

Year class = 1995

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, Weights,	Scaled, F	Estimated F
FLT04: Norw. Exp. CP,	11580.,	.266,	.091,	.34,	2,	.305,	.094
FLT07: Russ.Surv. ne,	17114.,	.415,	.233,	.56,	2,	.125,	.065
FLT08: Norw.Comb.Sur,	11399.,	.212,	.061,	.29,	2,	.475,	.095
F shrinkage mean ,	9237.,	.50,,,,				.095,	.117

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
11811.,	.15,	.08,	7,	.521,	.092

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

Year class = 1994

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, Weights,	Scaled, F	Estimated F
FLT04: Norw. Exp. CP,	5957.,	.199,	.146,	.73,	3,	.319,	.296
FLT07: Russ.Surv. ne,	7263.,	.255,	.202,	.79,	3,	.197,	.248
FLT08: Norw.Comb.Sur,	5780.,	.173,	.078,	.45,	3,	.414,	.303
F shrinkage mean ,	5024.,	.50,,,,				.070,	.342

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
6045.,	.11,	.07,	10,	.621,	.292

1

Age 8 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, Weights,	Scaled, F	Estimated F
FLT04: Norw. Exp. CP,	5689.,	.173,	.264,	1.52,	4,	.310,	.224
FLT07: Russ.Surv. ne,	3563.,	.196,	.060,	.31,	4,	.258,	.338
FLT08: Norw.Comb.Sur,	4265.,	.156,	.073,	.47,	4,	.372,	.289
F shrinkage mean ,	4172.,	.50,,,,				.060,	.295

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
4446.,	.10,	.09,	13,	.951,	.279

Age 9 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, Weights,	Scaled, F	Estimated F
FLT04: Norw. Exp. CP,	3027.,	.175,	.199,	1.14,	5,	.263,	.228
FLT07: Russ.Surv. ne,	2652.,	.179,	.141,	.79,	5,	.312,	.257
FLT08: Norw.Comb.Sur,	2865.,	.154,	.081,	.52,	5,	.356,	.240
F shrinkage mean ,	3178.,	.50,,,,				.068,	.219

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
2857.,	.10,	.07,	16,	.750,	.240

1

Age 10 Catchability constant w.r.t. time and dependent on age

Year class = 1991

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, Weights,	Scaled, F	Estimated F
FLT04: Norw. Exp. CP,	1921.,	.169,	.111,	.66,	6,	.238,	.419
FLT07: Russ.Surv. ne,	1750.,	.165,	.109,	.66,	6,	.300,	.452
FLT08: Norw.Comb.Sur,	2137.,	.141,	.099,	.70,	6,	.392,	.384
F shrinkage mean ,	934.,	.50,,,,				.071,	.727

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
1851.,	.09,	.07,	19,	.800,	.432

Table 8.11 (Continued)

```
 Age 11   Catchability constant w.r.t. time and age (fixed at the value for age) 10

 Year class = 1990

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                  Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 FLT04: Norw. Exp. CP,       797.,   .180,       .156,    .86,   7,  .228,     .456
 FLT07: Russ.Surv. ne,       820.,   .171,       .101,    .59,   7,  .326,     .445
 FLT08: Norw.Comb.Sur,       574.,   .160,       .126,    .79,   6,  .323,     .589

   F shrinkage mean  ,       878.,    .50,,,,                        .123,     .421

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
       732.,       .11,      .07,   21,    .695,   .488


1
 Age 12   Catchability constant w.r.t. time and age (fixed at the value for age) 10

 Year class = 1989

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                  Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 FLT04: Norw. Exp. CP,       319.,   .212,       .164,    .77,   8,  .218,     .728
 FLT07: Russ.Surv. ne,       468.,   .186,       .166,    .89,   8,  .292,     .547
 FLT08: Norw.Comb.Sur,       270.,   .199,       .157,    .79,   6,  .311,     .817

   F shrinkage mean  ,       323.,    .50,,,,                        .178,     .721

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
       340.,       .13,      .09,   23,    .704,   .696


 Age 13   Catchability constant w.r.t. time and age (fixed at the value for age) 10

 Year class = 1988

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                  Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 FLT04: Norw. Exp. CP,       105.,   .241,       .152,    .63,   9,  .267,     .688
 FLT07: Russ.Surv. ne,       207.,   .204,       .197,    .96,   9,  .295,     .407
 FLT08: Norw.Comb.Sur,       115.,   .213,       .156,    .73,   6,  .226,     .645

   F shrinkage mean  ,       195.,    .50,,,,                        .212,     .428

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
       149.,       .15,      .11,   25,    .724,   .529


1
 Age 14   Catchability constant w.r.t. time and age (fixed at the value for age) 10

 Year class = 1987

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                  Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 FLT04: Norw. Exp. CP,        64.,   .257,       .132,    .51,  10,  .247,     .568
 FLT07: Russ.Surv. ne,        76.,   .217,       .178,    .82,  10,  .210,     .500
 FLT08: Norw.Comb.Sur,        57.,   .251,       .148,    .59,   6,  .337,     .620

   F shrinkage mean  ,        80.,    .50,,,,                        .206,     .479

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
        67.,       .15,      .08,   27,    .500,   .551


1
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Table 8.12

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    Run title : Arctic Green.halibut (run: XSAAAG44/X44)

    At 23/04/2002  14:52


       Table  8    Fishing mortality (F) at age
       YEAR,       1964,    1965,    1966,    1967,    1968,    1969,    1970,    1971,

       AGE
         5,        .0094,   .0053,   .0032,   .0024,   .0019,   .0207,   .0139,   .0027,
         6,        .0484,   .0255,   .0138,   .0072,   .0051,   .0484,   .0659,   .1491,
         7,        .1146,   .0699,   .0397,   .0180,   .0116,   .0691,   .2864,   .4473,
         8,        .2531,   .2160,   .1411,   .0891,   .0694,   .2081,   .6556,   .6021,
         9,        .4566,   .2848,   .3476,   .2356,   .2381,   .2332,   .5603,   .4392,
        10,        .7003,   .7254,   .2583,   .3382,   .3302,   .4350,   .5339,   .4739,
        11,        .6375,   .7606,   .5421,   .2684,   .5685,   .4571,   .4457,   .4037,
        12,        .5666,   .8214,   .8585,   .8373,   .1802,   .3905,   .4362,   .5627,
        13,        .4065,   .3910,   .4515,  1.0092,   .2945,   .0686,   .5465,   .7562,
        14,        .5568,   .6004,   .4943,   .5409,   .3237,   .3182,   .5074,   .5302,
       +gp,        .5568,   .6004,   .4943,   .5409,   .3237,   .3182,   .5074,   .5302,
0  FBAR  6-10,     .3146,   .2643,   .1601,   .1376,   .1309,   .1988,   .4204,   .4223,




       Table  8    Fishing mortality (F) at age
       YEAR,       1972,    1973,    1974,    1975,    1976,    1977,    1978,    1979,    1980,    1981,

       AGE
         5,        .0363,   .0074,   .0378,   .0410,   .0413,   .0973,   .1046,   .1294,   .0433,   .1214,
         6,        .1510,   .0442,   .1079,   .1211,   .1895,   .2135,   .2346,   .2396,   .0859,   .1448,
         7,        .5110,   .2370,   .3447,   .4197,   .4666,   .4176,   .4305,   .2658,   .1815,   .1933,
         8,        .4033,   .3335,   .3623,   .3818,   .6251,   .3558,   .4142,   .2074,   .1911,   .1388,
         9,        .2444,   .2597,   .2744,   .3558,   .5001,   .3927,   .3521,   .1333,   .2293,   .0925,
        10,        .1999,   .2516,   .3041,   .4017,   .3509,   .3249,   .3980,   .1094,   .1723,   .1532,
        11,        .2511,   .2585,   .3298,   .5023,   .3824,   .4848,   .4738,   .1957,   .2424,   .2519,
        12,        .3063,   .3191,   .3546,   .5617,   .6829,   .7082,   .3551,   .2024,   .2657,   .2704,
        13,        .4414,   .2765,   .3347,   .5355,   .5074,   .8180,   .6673,   .1238,   .3005,   .6807,
        14,        .2898,   .2741,   .3208,   .4740,   .4874,   .5490,   .4516,   .1533,   .2429,   .2909,
       +gp,        .2898,   .2741,   .3208,   .4740,   .4874,   .5490,   .4516,   .1533,   .2429,   .2909,
0  FBAR  6-10,     .3019,   .2252,   .2787,   .3360,   .4264,   .3409,   .3659,   .1911,   .1720,   .1445,
1

    Run title : Arctic Green.halibut (run: XSAAAG44/X44)

    At 23/04/2002  14:52


       Table  8    Fishing mortality (F) at age
       YEAR,       1982,    1983,    1984,    1985,    1986,    1987,    1988,    1989,    1990,    1991,

       AGE
         5,        .0772,   .0916,   .0570,   .0682,   .0952,   .0696,   .0435,   .1146,   .1732,   .3324,
         6,        .1258,   .1430,   .3107,   .2408,   .2541,   .2309,   .1931,   .2926,   .4311,   .5097,
         7,        .1284,   .2143,   .3870,   .3471,   .3544,   .4464,   .3841,   .4401,   .5305,   .8484,
         8,        .1696,   .3357,   .3436,   .2926,   .3399,   .3830,   .4838,   .3383,   .4149,   .5318,
         9,        .3240,   .3079,   .2429,   .2730,   .3394,   .2627,   .4574,   .3234,   .4226,   .3839,
        10,        .3461,   .4551,   .4074,   .3730,   .4685,   .4226,   .5095,   .2000,   .3234,  1.0286,
        11,        .4462,   .3179,   .3979,   .3584,   .3126,   .2904,   .4384,   .2290,   .2402,  1.1649,
        12,        .4255,   .4787,   .2324,   .4191,   .4370,   .1773,   .4133,   .1833,   .5305,  1.6305,
        13,        .3676,   .3613,   .2877,   .1554,   .7408,   .3187,   .1607,   .2588,   .0811,   .6131,
        14,        .3837,   .3860,   .3150,   .3171,   .4621,   .2955,   .3978,   .2397,   .3209,   .9721,
       +gp,        .3837,   .3860,   .3150,   .3171,   .4621,   .2955,   .3978,   .2397,   .3209,   .9721,
0  FBAR  6-10,     .2188,   .2912,   .3383,   .3053,   .3513,   .3491,   .4056,   .3189,   .4245,   .6605,




       Table  8    Fishing mortality (F) at age
       YEAR,       1992,    1993,    1994,    1995,    1996,    1997,    1998,    1999,    2000,    2001,       FBAR 99-**

       AGE
         5,        .1198,   .1009,   .0387,   .0556,   .0663,   .0203,   .0241,   .0337,   .0232,   .0296,       .0288,
         6,        .1807,   .1584,   .0797,   .0748,   .1786,   .0735,   .0841,   .1626,   .0700,   .0923,       .1083,
         7,        .2387,   .3704,   .2606,   .2665,   .4237,   .2216,   .2709,   .4485,   .2325,   .2918,       .3243,
         8,        .2958,   .3968,   .3075,   .3196,   .3486,   .1672,   .2635,   .3084,   .2789,   .2790,       .2888,
         9,        .1332,   .0747,   .1707,   .2323,   .1231,   .1235,   .1243,   .2467,   .1891,   .2404,       .2254,
        10,        .3804,   .5954,   .5329,   .7061,   .6761,   .6488,   .5323,   .8117,   .6326,   .4316,       .6253,
        11,        .3649,   .5074,   .5158,   .8849,   .5859,   .5041,   .3652,   .4092,   .4291,   .4876,       .4420,
        12,        .6865,   .4974,   .8458,  1.2020,   .6412,   .7218,   .5145,   .7176,   .7138,   .6957,       .7090,
        13,        .8210,   .3217,   .6116,  1.2767,   .2374,   .1536,   .1312,   .5608,   .2905,   .5289,       .4601,
        14,        .6818,   .4690,   .6495,   .9769,   .5604,   .5799,   .3722,   .6088,   .6588,   .5509,       .6062,
       +gp,        .6818,   .4690,   .6495,   .9769,   .5604,   .5799,   .3722,   .6088,   .6588,   .5509,
0  FBAR  6-10,     .2457,   .3191,   .2703,   .3199,   .3500,   .2469,   .2550,   .3956,   .2806,   .2670,
1
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Table 8.13

Run title : Arctic Green.halibut (run: XSAAAG44/X44)

At 23/04/2002 14:52

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

YEAR,	1964,	1965,	1966,	1967,	1968,	1969,	1970,	1971,
AGE								
5,	42840,	51686,	57828,	70443,	64280,	55932,	41112,	31550,
6,	33792,	36528,	44251,	49616,	60486,	55221,	47154,	34898,
7,	27961,	27712,	30648,	37565,	42397,	51798,	45284,	37995,
8,	27353,	21461,	22243,	25353,	31755,	36072,	41607,	29268,
9,	14559,	18279,	14883,	16626,	19961,	25498,	25214,	18591,
10,	8521,	7938,	11833,	9049,	11307,	13541,	17381,	12393,
11,	4237,	3641,	3307,	7867,	5554,	6995,	7544,	8771,
12,	2537,	1928,	1465,	1656,	5177,	2707,	3812,	4158,
13,	1175,	1239,	730,	534,	617,	3721,	1577,	2121,
14,	634,	673,	721,	400,	168,	395,	2990,	786,
+gp,	190,	118,	77,	49,	27,	118,	756,	372,
0 TOTAL,	163799,	171203,	187987,	219156,	241727,	251998,	234430,	180902,

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

YEAR,	1972,	1973,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,
AGE										
5,	33555,	31061,	26642,	22540,	22098,	23687,	20592,	19700,	18602,	17875,
6,	27081,	27852,	26538,	22080,	18621,	18250,	18498,	15963,	14898,	15332,
7,	25875,	20042,	22937,	20504,	16836,	13261,	12688,	12591,	10813,	11767,
8,	20909,	13360,	13611,	13986,	11599,	9088,	7517,	7100,	8308,	7762,
9,	13796,	12024,	8238,	8154,	8217,	5343,	5480,	4276,	4966,	5906,
10,	10314,	9300,	7983,	5389,	4917,	4290,	3105,	3317,	3221,	3399,
11,	6641,	7269,	6224,	5069,	3104,	2980,	2668,	1795,	2559,	2333,
12,	5042,	4447,	4831,	3852,	2640,	1822,	1580,	1430,	1270,	1729,
13,	2039,	3195,	2782,	2917,	1891,	1148,	773,	953,	1005,	838,
14,	857,	1128,	2085,	1713,	1470,	980,	436,	341,	725,	641,
+gp,	341,	564,	844,	1044,	993,	456,	330,	386,	388,	264,
0 TOTAL,	146450,	130242,	122714,	107249,	92386,	81304,	73666,	67853,	66756,	67847,

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

YEAR,	1982,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,
AGE										
5,	18928,	19002,	17808,	19925,	19854,	19423,	22960,	20706,	14501,	12624,
6,	13626,	15082,	14923,	14478,	16019,	15537,	15593,	18921,	15892,	10497,
7,	11418,	10342,	11252,	9414,	9795,	10693,	10616,	11065,	12154,	8888,
8,	8348,	8644,	7184,	6577,	5727,	5915,	5890,	6223,	6133,	6154,
9,	5815,	6064,	5318,	4386,	4224,	3509,	3471,	3125,	3819,	3486,
10,	4635,	3620,	3836,	3590,	2873,	2589,	2322,	1891,	1947,	2154,
11,	2510,	2822,	1977,	2197,	2128,	1548,	1461,	1201,	1333,	1213,
12,	1561,	1383,	1767,	1143,	1321,	1340,	996,	811,	822,	902,
13,	1135,	878,	737,	1206,	647,	735,	966,	567,	581,	416,
14,	365,	677,	527,	476,	888,	265,	460,	708,	377,	461,
+gp,	155,	214,	282,	249,	692,	29,	153,	141,	172,	885,
0 TOTAL,	68497,	68728,	65612,	63640,	64168,	61584,	64889,	65358,	57730,	47681,

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

YEAR,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	GMST 64-99	AMST 64-99
AGE													
5,	10485,	12807,	17910,	16857,	17385,	17676,	16283,	14080,	17894,	14306,	0,	23497,	26701,
6,	7793,	8006,	9965,	14830,	13724,	14004,	14907,	13682,	11717,	15049,	11954,	19539,	22626,
7,	5427,	5599,	5882,	7921,	11844,	9880,	11199,	11796,	10009,	9403,	11811,	14803,	17885,
8,	3275,	3679,	3327,	3901,	5222,	6673,	6813,	7352,	6483,	6828,	6045,	9741,	12650,
9,	3112,	2097,	2129,	2106,	2439,	3172,	4860,	4506,	4648,	4222,	4446,	6255,	8268,
10,	2044,	2345,	1675,	1545,	1437,	1856,	2413,	3694,	3030,	3312,	2857,	4174,	5380,
11,	663,	1203,	1113,	846,	656,	629,	835,	1220,	1412,	1386,	1851,	2383,	3170,
12,	326,	396,	623,	572,	301,	314,	327,	499,	697,	791,	732,	1371,	1875,
13,	152,	141,	207,	230,	148,	136,	132,	168,	210,	294,	340,	722,	1068,
14,	194,	58,	88,	97,	55,	100,	101,	99,	83,	135,	149,	421,	643,
+gp,	121,	11,	7,	14,	2,	2,	52,	16,	31,	33,	83,		
0 TOTAL,	33592,	36342,	42927,	48917,	53214,	54444,	57922,	57111,	56214,	55758,	40269,		

1

Table 8.14

Run title : Arctic Green.halibut (run: XSAAAG44/X44)

At 23/04/2002 14:52

	Table 12	Stock biomass at age (start of year)						Tonnes	
	YEAR,	1964,	1965,	1966,	1967,	1968,	1969,	1970,	1971,
	AGE								
	5,	17993,	21708,	24288,	29586,	26998,	23491,	23311,	17889,
	6,	21627,	23378,	28321,	32250,	39921,	35341,	34752,	25719,
	7,	25165,	24941,	27890,	34936,	40701,	47136,	48861,	40997,
	8,	32824,	26182,	27581,	32199,	41599,	45090,	59123,	41590,
	9,	23731,	30343,	25301,	28430,	34732,	41817,	46595,	34355,
	10,	19258,	17701,	26270,	19908,	24761,	30467,	39646,	28267,
	11,	13178,	10923,	9724,	22341,	15494,	20915,	21779,	25322,
	12,	9488,	6728,	4965,	5463,	16515,	9828,	12376,	13501,
	13,	5368,	5452,	3196,	2281,	2634,	17415,	6786,	9127,
	14,	3175,	3306,	3491,	1952,	838,	2128,	14746,	3875,
	+gp,	1131,	697,	452,	282,	163,	707,	4378,	2171,
0	TOTALBIO,	172936,	171359,	181480,	209627,	244355,	274335,	312353,	242814,

	Table 12	Stock biomass at age (start of year)						Tonnes			
	YEAR,	1972,	1973,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,
	AGE										
	5,	19026,	17612,	15106,	12780,	12529,	13430,	11675,	17730,	13058,	11798,
	6,	19959,	20527,	19559,	16273,	13724,	13450,	13633,	19156,	12991,	12879,
	7,	27919,	21626,	24749,	22124,	18166,	14308,	13690,	18887,	12337,	13532,
	8,	29712,	18984,	19341,	19874,	16483,	12914,	10682,	12780,	12196,	12109,
	9,	25495,	22220,	15223,	15069,	15186,	9874,	10128,	9407,	8830,	12049,
	10,	23526,	21213,	18208,	12292,	11216,	9784,	7083,	8624,	7415,	8735,
	11,	19172,	20985,	17969,	14634,	8960,	8603,	7702,	5385,	6817,	6954,
	12,	16370,	14438,	15687,	12508,	8572,	5918,	5129,	5004,	3870,	5929,
	13,	8772,	13746,	11970,	12551,	8136,	4939,	3325,	3908,	3385,	3462,
	14,	4226,	5565,	10283,	8448,	7247,	4831,	2150,	1638,	3106,	2998,
	+gp,	2060,	3388,	5034,	6168,	5883,	2747,	1949,	2382,	2076,	1581,
0	TOTALBIO,	196238,	180303,	173128,	152723,	126103,	100799,	87145,	104901,	86082,	92026,
1											

	Table 12	Stock biomass at age (start of year)						Tonnes			
	YEAR,	1982,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,
	AGE										
	5,	13061,	14251,	11219,	11955,	12309,	13771,	16991,	15736,	10296,	9721,
	6,	11446,	15685,	14326,	12886,	14737,	15584,	15001,	19488,	16845,	11022,
	7,	11761,	13859,	13277,	11297,	12538,	13538,	13259,	14606,	15679,	12266,
	8,	10936,	13571,	10992,	12167,	10881,	9955,	9577,	11201,	10426,	10770,
	9,	10119,	11947,	12285,	11359,	10477,	8708,	7512,	7563,	8020,	7669,
	10,	10381,	9883,	11011,	11417,	8935,	7722,	6727,	5919,	5081,	5601,
	11,	6952,	9284,	6839,	7953,	7129,	5491,	4975,	4047,	3825,	3383,
	12,	5261,	5835,	6663,	4514,	4916,	5092,	3648,	3284,	2836,	2959,
	13,	4904,	4136,	2942,	5402,	2587,	3350,	4102,	2434,	2162,	1619,
	14,	1954,	4113,	2291,	2023,	3714,	1328,	1925,	3186,	1542,	2020,
	+gp,	902,	1311,	1275,	1200,	3130,	175,	685,	666,	777,	4681,
0	TOTALBIO,	87678,	103875,	93120,	92172,	91353,	84713,	84402,	88130,	77487,	71710,

	Table 12	Stock biomass at age (start of year)						Tonnes			
	YEAR,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,
	AGE										
	5,	7130,	10118,	12895,	12305,	13387,	13610,	11887,	9856,	13600,	10586,
	6,	7559,	8166,	9368,	13940,	13312,	13164,	13864,	12998,	11365,	15501,
	7,	6892,	7558,	7470,	9901,	15515,	12646,	14559,	14980,	13312,	12788,
	8,	5764,	6917,	5723,	6788,	9087,	10944,	10969,	11395,	10568,	11812,
	9,	6878,	5159,	4663,	4401,	5463,	6566,	10302,	9012,	9808,	9626,
	10,	5233,	6261,	4221,	3878,	3721,	4808,	6201,	9087,	7909,	8776,
	11,	2061,	4125,	3305,	2496,	2160,	2075,	2714,	3927,	4730,	4558,
	12,	1169,	1699,	2050,	1910,	1208,	1261,	1278,	1921,	2768,	3078,
	13,	582,	717,	796,	882,	703,	658,	644,	776,	1041,	1396,
	14,	825,	364,	436,	482,	345,	598,	569,	580,	481,	754,
	+gp,	581,	102,	45,	111,	15,	15,	254,	98,	224,	233,
0	TOTALBIO,	44674,	51185,	50971,	57094,	64917,	66346,	73243,	74629,	75806,	79109,
1											

Table 8.15

Run title : Arctic Green.halibut (run: XSAAAG44/X44)

At 23/04/2002 14:52

	Table 13	Spawning stock biomass at age (spawning time)					Tonnes		
	YEAR,	1964,	1965,	1966,	1967,	1968,	1969,	1970,	1971,
	AGE								
	5,	0,	0,	0,	0,	0,	0,	0,	0,
	6,	649,	701,	850,	968,	1198,	1060,	1043,	772,
	7,	755,	748,	837,	1048,	1221,	1414,	1466,	1230,
	8,	6893,	5498,	5792,	6762,	8736,	9469,	12416,	8734,
	9,	15900,	20330,	16952,	19048,	23270,	28018,	31218,	23018,
	10,	16562,	15223,	22592,	17121,	21295,	26201,	34096,	24310,
	11,	12914,	10704,	9529,	21895,	15184,	20496,	21343,	24816,
	12,	9298,	6594,	4866,	5354,	16185,	9631,	12129,	13231,
	13,	5368,	5452,	3196,	2281,	2634,	17415,	6786,	9127,
	14,	3175,	3306,	3491,	1952,	838,	2128,	14746,	3875,
	+gp,	1131,	697,	452,	282,	163,	707,	4378,	2171,
0	TOTSPBIO,	72644,	69254,	68557,	76709,	90723,	116540,	139620,	111283,

	Table 13	Spawning stock biomass at age (spawning time)					Tonnes			
	YEAR,	1972,	1973,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,
	AGE										
	5,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
	6,	599,	616,	587,	488,	412,	404,	409,	575,	390,	386,
	7,	838,	649,	742,	664,	545,	429,	411,	567,	370,	406,
	8,	6240,	3987,	4062,	4174,	3461,	2712,	2243,	2684,	2561,	2543,
	9,	17082,	14888,	10200,	10096,	10174,	6616,	6786,	6302,	5916,	8073,
	10,	20233,	18243,	15659,	10571,	9646,	8415,	6091,	7417,	6377,	7512,
	11,	18789,	20565,	17609,	14341,	8781,	8431,	7548,	5278,	6681,	6815,
	12,	16043,	14150,	15373,	12258,	8401,	5799,	5026,	4904,	3792,	5810,
	13,	8772,	13746,	11970,	12551,	8136,	4939,	3325,	3908,	3385,	3462,
	14,	4226,	5565,	10283,	8448,	7247,	4831,	2150,	1638,	3106,	2998,
	+gp,	2060,	3388,	5034,	6168,	5883,	2747,	1949,	2382,	2076,	1581,
0	TOTSPBIO,	94880,	95795,	91519,	79760,	62686,	45322,	35938,	35653,	34654,	39586,
1											

	Table 13	Spawning stock biomass at age (spawning time)					Tonnes			
	YEAR,	1982,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,
	AGE										
	5,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
	6,	343,	471,	573,	515,	442,	156,	150,	195,	168,	110,
	7,	353,	416,	398,	452,	376,	271,	133,	292,	314,	491,
	8,	2297,	2443,	1979,	2312,	2611,	2190,	2011,	2016,	1772,	1616,
	9,	6779,	7168,	7494,	7383,	7753,	5748,	3981,	3706,	4090,	4141,
	10,	8928,	8104,	9139,	9705,	8131,	6950,	5853,	4735,	3912,	4313,
	11,	6813,	8913,	6634,	7715,	7058,	5216,	4428,	3602,	3480,	3011,
	12,	5156,	5718,	6530,	4469,	4817,	4990,	3575,	3284,	2836,	2959,
	13,	4904,	4136,	2942,	5402,	2587,	3350,	4102,	2434,	2162,	1619,
	14,	1954,	4113,	2291,	2023,	3714,	1328,	1925,	3186,	1542,	2020,
	+gp,	902,	1311,	1275,	1200,	3130,	175,	685,	666,	777,	4681,
0	TOTSPBIO,	38430,	42792,	39254,	41175,	40620,	30373,	26843,	24116,	21053,	24960,

	Table 13	Spawning stock biomass at age (spawning time)					Tonnes			
	YEAR,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,
	AGE										
	5,	0,	101,	129,	123,	0,	0,	0,	0,	0,	0,
	6,	76,	82,	94,	139,	0,	0,	0,	130,	114,	310,
	7,	414,	605,	523,	792,	1086,	885,	582,	300,	532,	639,
	8,	1614,	2213,	1946,	1968,	2272,	2298,	1097,	1139,	1374,	1772,
	9,	4540,	3508,	3218,	2553,	3169,	3480,	4636,	3605,	4414,	4621,
	10,	4500,	5196,	3419,	3064,	3274,	4087,	5085,	6633,	5536,	5792,
	11,	1793,	3630,	3139,	2396,	2095,	1951,	2497,	3652,	4446,	4285,
	12,	1169,	1597,	1927,	1700,	1136,	1185,	1278,	1901,	2657,	2893,
	13,	582,	717,	796,	882,	703,	658,	644,	776,	1041,	1396,
	14,	825,	364,	436,	482,	345,	598,	569,	580,	481,	754,
	+gp,	581,	102,	45,	111,	15,	15,	254,	98,	224,	233,
0	TOTSPBIO,	16093,	18115,	15671,	14210,	14095,	15157,	16643,	18814,	20819,	22695,
1											

Table 8.16

Run title : Arctic Green.halibut (run: XSAAAG44/X44)

At 23/04/2002 14:52

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,	.3164,	.1376,
1968,	64280,	244355,	90723,	26168,	.2884,	.1309,
1969,	55932,	274335,	116540,	43789,	.3757,	.1988,
1970,	41112,	312353,	139620,	89484,	.6409,	.4204,
1971,	31550,	242814,	111283,	79034,	.7102,	.4223,
1972,	33555,	196238,	94880,	43055,	.4538,	.3019,
1973,	31061,	180303,	95795,	29938,	.3125,	.2252,
1974,	26642,	173128,	91519,	37763,	.4126,	.2787,
1975,	22540,	152723,	79760,	38172,	.4786,	.3360,
1976,	22098,	126103,	62686,	36074,	.5755,	.4264,
1977,	23687,	100799,	45322,	28827,	.6360,	.3409,
1978,	20592,	87145,	35938,	24617,	.6850,	.3659,
1979,	19700,	104901,	35653,	17312,	.4856,	.1911,
1980,	18602,	86082,	34654,	13284,	.3833,	.1720,
1981,	17875,	92026,	39586,	15018,	.3794,	.1445,
1982,	18928,	87678,	38430,	16789,	.4369,	.2188,
1983,	19002,	103875,	42792,	22147,	.5175,	.2912,
1984,	17808,	93120,	39254,	21883,	.5575,	.3383,
1985,	19925,	92172,	41175,	19945,	.4844,	.3053,
1986,	19854,	91353,	40620,	22875,	.5632,	.3513,
1987,	19423,	84713,	30373,	19112,	.6293,	.3491,
1988,	22960,	84402,	26843,	19587,	.7297,	.4056,
1989,	20706,	88130,	24116,	20138,	.8351,	.3189,
1990,	14501,	77487,	21053,	23183,	1.1011,	.4245,
1991,	12624,	71710,	24960,	33320,	1.3349,	.6605,
1992,	10485,	44674,	16093,	8602,	.5345,	.2457,
1993,	12807,	51185,	18115,	11933,	.6587,	.3191,
1994,	17910,	50971,	15671,	9226,	.5887,	.2703,
1995,	16857,	57094,	14210,	11734,	.8257,	.3199,
1996,	17385,	64917,	14095,	14347,	1.0179,	.3500,
1997,	17676,	66346,	15157,	9628,	.6352,	.2469,
1998,	16283,	73243,	16643,	12507,	.7515,	.2550,
1999,	14080,	74629,	18814,	19350,	1.0285,	.3956,
2000,	17894,	75806,	20819,	14392,	.6913,	.2806,
2001,	14306,	79109,	22695,	16011,	.7055,	.2670,
Arith. Mean	26143,	121614,	49028,	26184,	.6106,	.3012,
0 Units,	(Thousands),	(Tonnes),	(Tonnes),	(Tonnes),		
1						

Table 8.17

The SAS System 10:33 Monday, April 22, 2002
Greenland halibut in Sub-areas I & II

Prediction with management option table: Input data

Year: 2002									
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
5	15169.000	0.1500	0.0000	0.0000	0.0000	0.733	0.0248	0.733
6	11954.000	0.1500	0.0200	0.0000	0.0000	0.983	0.0896	0.983
7	11811.000	0.1500	0.0500	0.0000	0.0000	1.320	0.2719	1.320
8	6045.000	0.1500	0.1500	0.0000	0.0000	1.637	0.2508	1.637
9	4446.000	0.1500	0.4800	0.0000	0.0000	2.130	0.1956	2.130
10	2857.000	0.1500	0.6600	0.0000	0.0000	2.573	0.5271	2.573
11	1851.000	0.1500	0.9400	0.0000	0.0000	3.287	0.3907	3.287
12	732.000	0.1500	0.9400	0.0000	0.0000	3.903	0.6197	3.903
13	340.000	0.1500	1.0000	0.0000	0.0000	4.777	0.3946	4.777
14	149.000	0.1500	1.0000	0.0000	0.0000	5.750	0.5296	5.750
15+	83.000	0.1500	1.0000	0.0000	0.0000	6.767	0.5296	6.767
Unit	Thousands	-	-	-	-	Kilograms	-	Kilograms

Year: 2003									
Age	Recruitment	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
5	15169.000	0.1500	0.0000	0.0000	0.0000	0.733	0.0248	0.733
6	.	0.1500	0.0200	0.0000	0.0000	0.983	0.0896	0.983
7	.	0.1500	0.0500	0.0000	0.0000	1.320	0.2719	1.320
8	.	0.1500	0.1500	0.0000	0.0000	1.637	0.2508	1.637
9	.	0.1500	0.4800	0.0000	0.0000	2.130	0.1956	2.130
10	.	0.1500	0.6600	0.0000	0.0000	2.573	0.5271	2.573
11	.	0.1500	0.9400	0.0000	0.0000	3.287	0.3907	3.287
12	.	0.1500	0.9400	0.0000	0.0000	3.903	0.6197	3.903
13	.	0.1500	1.0000	0.0000	0.0000	4.777	0.3946	4.777
14	.	0.1500	1.0000	0.0000	0.0000	5.750	0.5296	5.750
15+	.	0.1500	1.0000	0.0000	0.0000	6.767	0.5296	6.767
Unit	Thousands	-	-	-	-	Kilograms	-	Kilograms

Year: 2004									
Age	Recruitment	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
5	15169.000	0.1500	0.0000	0.0000	0.0000	0.733	0.0248	0.733
6	.	0.1500	0.0200	0.0000	0.0000	0.983	0.0896	0.983
7	.	0.1500	0.0500	0.0000	0.0000	1.320	0.2719	1.320
8	.	0.1500	0.1500	0.0000	0.0000	1.637	0.2508	1.637
9	.	0.1500	0.4800	0.0000	0.0000	2.130	0.1956	2.130
10	.	0.1500	0.6600	0.0000	0.0000	2.573	0.5271	2.573
11	.	0.1500	0.9400	0.0000	0.0000	3.287	0.3907	3.287
12	.	0.1500	0.9400	0.0000	0.0000	3.903	0.6197	3.903
13	.	0.1500	1.0000	0.0000	0.0000	4.777	0.3946	4.777
14	.	0.1500	1.0000	0.0000	0.0000	5.750	0.5296	5.750
15+	.	0.1500	1.0000	0.0000	0.0000	6.767	0.5296	6.767
Unit	Thousands	-	-	-	-	Kilograms	-	Kilograms

Notes: Run name : MANAAG02
Date and time: 22APR02:15:59

Table 8.18

The SAS System 10:33 Monday, April 22, 2002
Greenland halibut in Sub-areas I & II

Prediction with management option table

Year: 2002					Year: 2003					Year: 2004	
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
1.1455	0.3058	77161	23344	17000	0.0000	0.0000	75904	23054	0	94358	35016
.	.	.	.	.	0.0500	0.0134	.	23054	887	93331	34353
.	.	.	.	.	0.1000	0.0267	.	23054	1759	92324	33704
.	.	.	.	.	0.1500	0.0401	.	23054	2615	91335	33069
.	.	.	.	.	0.2000	0.0534	.	23054	3455	90364	32449
.	.	.	.	.	0.2500	0.0668	.	23054	4281	89410	31842
.	.	.	.	.	0.3000	0.0801	.	23054	5092	88474	31248
.	.	.	.	.	0.3500	0.0935	.	23054	5888	87555	30668
.	.	.	.	.	0.4000	0.1068	.	23054	6671	86652	30100
.	.	.	.	.	0.4500	0.1202	.	23054	7440	85765	29544
.	.	.	.	.	0.5000	0.1335	.	23054	8195	84894	29000
.	.	.	.	.	0.5500	0.1469	.	23054	8937	84039	28469
.	.	.	.	.	0.6000	0.1602	.	23054	9666	83198	27948
.	.	.	.	.	0.6500	0.1736	.	23054	10383	82373	27439
.	.	.	.	.	0.7000	0.1869	.	23054	11088	81562	26941
.	.	.	.	.	0.7500	0.2003	.	23054	11780	80765	26454
.	.	.	.	.	0.8000	0.2136	.	23054	12461	79982	25977
.	.	.	.	.	0.8500	0.2270	.	23054	13130	79213	25510
.	.	.	.	.	0.9000	0.2403	.	23054	13787	78456	25053
.	.	.	.	.	0.9500	0.2537	.	23054	14434	77713	24606
.	.	.	.	.	1.0000	0.2670	.	23054	15070	76983	24168
.	.	.	.	.	1.0500	0.2804	.	23054	15695	76265	23740
.	.	.	.	.	1.1000	0.2937	.	23054	16309	75559	23320
.	.	.	.	.	1.1500	0.3071	.	23054	16914	74865	22909
.	.	.	.	.	1.2000	0.3204	.	23054	17508	74183	22507
.	.	.	.	.	1.2500	0.3338	.	23054	18093	73513	22114
.	.	.	.	.	1.3000	0.3471	.	23054	18668	72853	21728
.	.	.	.	.	1.3500	0.3605	.	23054	19234	72205	21351
.	.	.	.	.	1.4000	0.3738	.	23054	19790	71567	20981
.	.	.	.	.	1.4500	0.3872	.	23054	20338	70940	20619
.	.	.	.	.	1.5000	0.4005	.	23054	20877	70323	20265
.	.	.	.	.	1.5500	0.4139	.	23054	21407	69716	19918
.	.	.	.	.	1.6000	0.4272	.	23054	21928	69120	19578
.	.	.	.	.	1.6500	0.4406	.	23054	22442	68533	19245
.	.	.	.	.	1.7000	0.4539	.	23054	22947	67955	18918
.	.	.	.	.	1.7500	0.4673	.	23054	23444	67387	18599
.	.	.	.	.	1.8000	0.4806	.	23054	23933	66828	18286
.	.	.	.	.	1.8500	0.4940	.	23054	24415	66278	17979
.	.	.	.	.	1.9000	0.5073	.	23054	24889	65736	17678
.	.	.	.	.	1.9500	0.5207	.	23054	25356	65204	17384
.	.	.	.	.	2.0000	0.5340	.	23054	25815	64679	17095
-	-	Tonnes	Tonnes	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes

Notes: Run name : MANAAG02
Date and time : 22APR02:15:59
Computation of ref. F: Simple mean, age 6 - 10
Basis for 2002 : TAC constraints

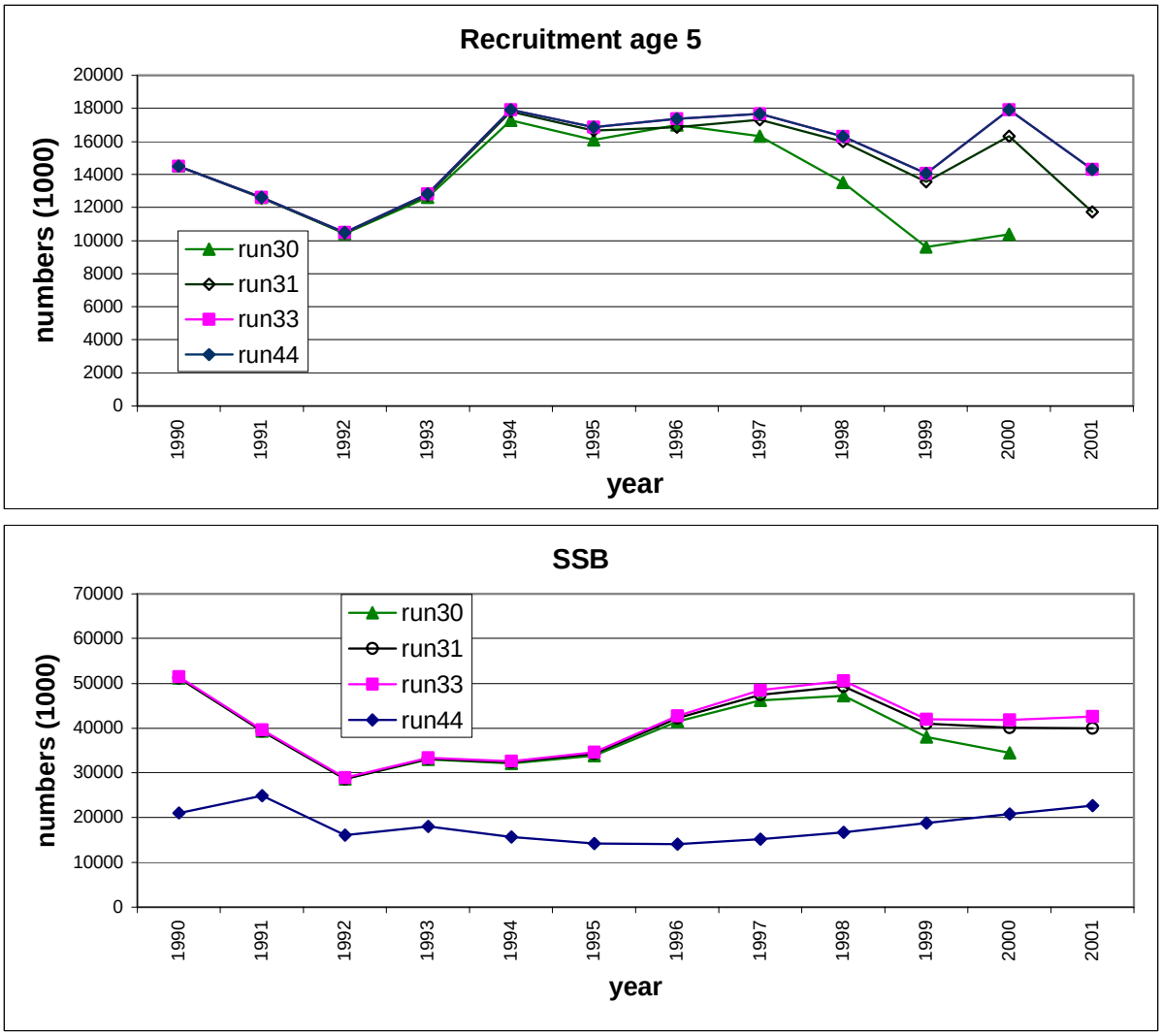


Figure 8.1. Results of individual XSA-runs. *Run30* : Same fleets and settings previous assessment with updated catches from 2000. *Run31* : As run 30 with data included for 2001. *Run33* : As run 31 with Fleet 03 replaced by Fleet 08. *Run44* : As run33 with new maturity ogive representing the female part of the mature stock.

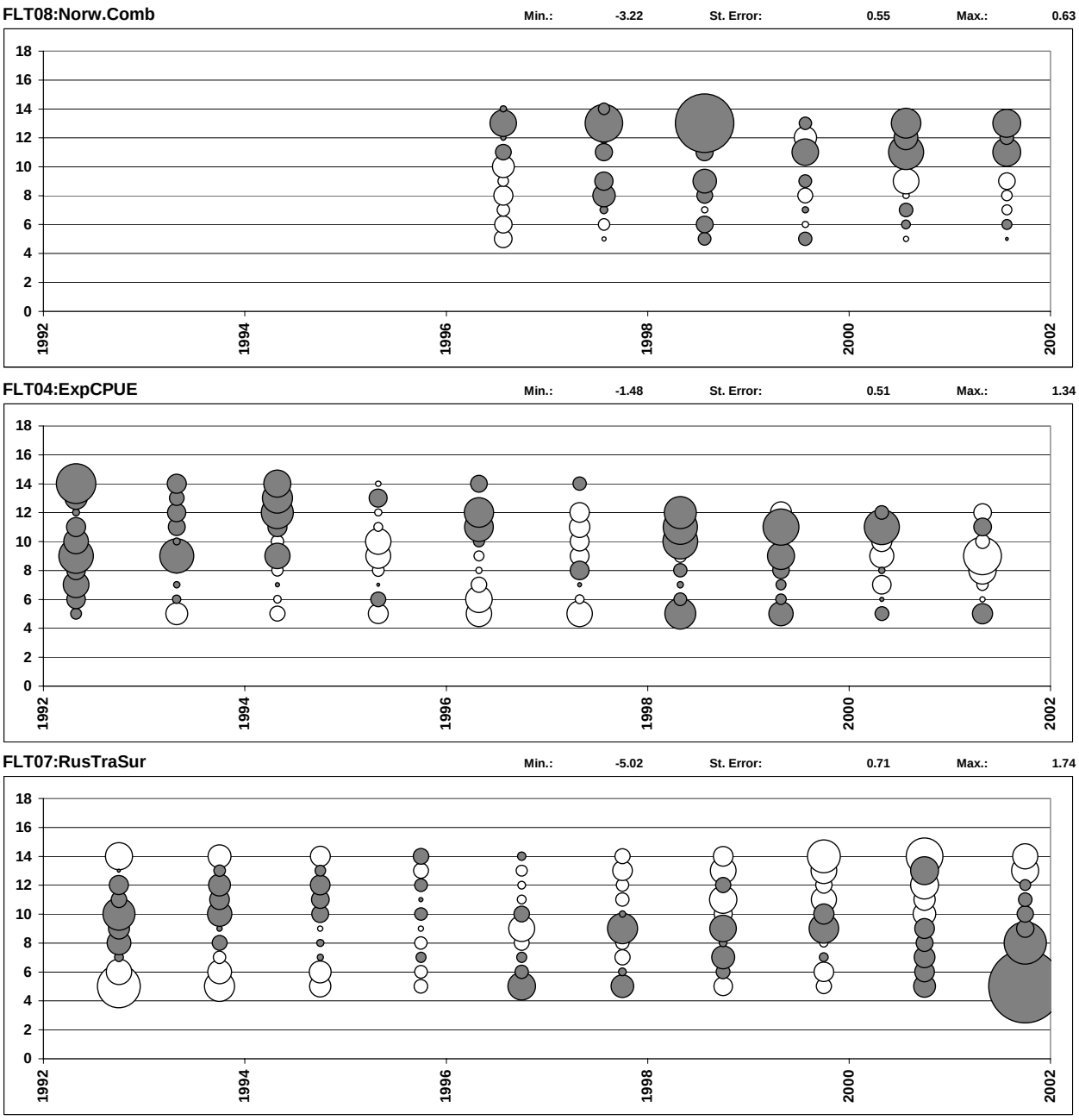
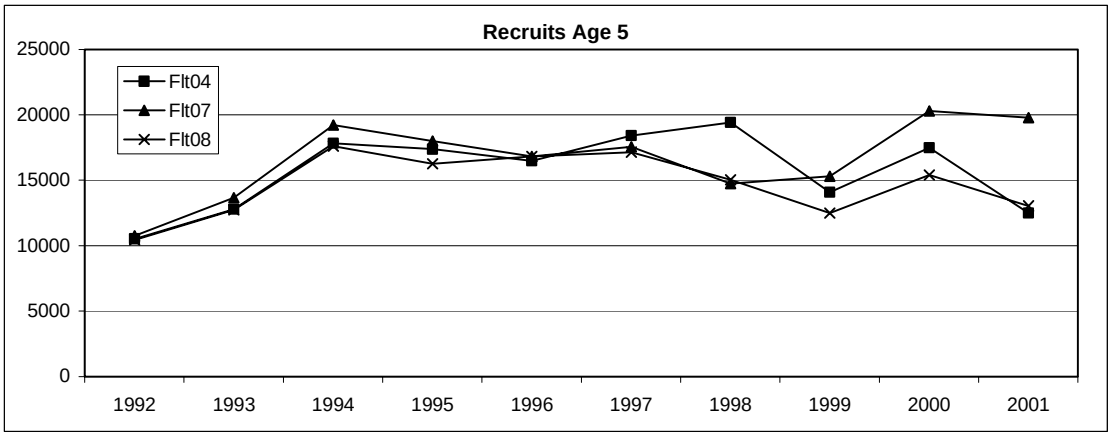
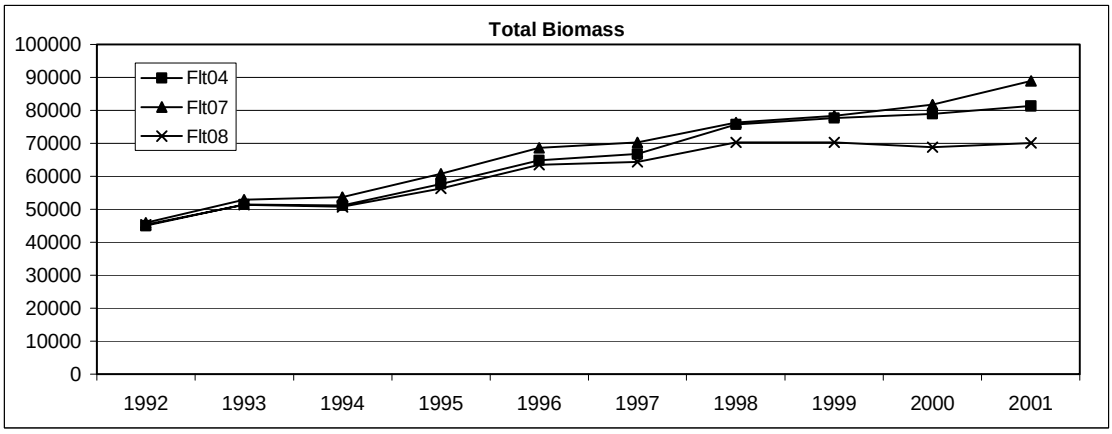
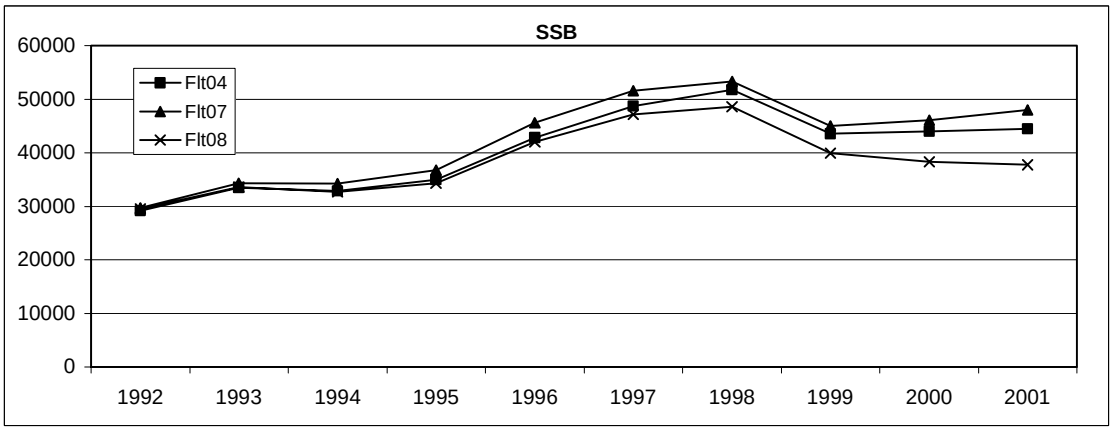


Figure 8.2. Log catchability residuals by age and year for the tuning fleets included in the assessments. For each graph all bubbles are normalized to the same maximum bubble-size. Open bubbles represent positive values; filled bubbles represent negative values.







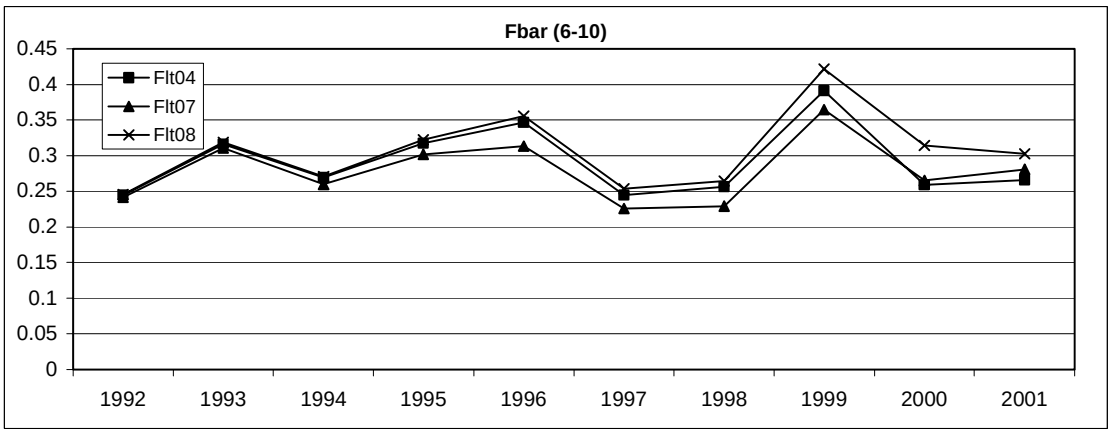


Figure 8.3. XSA results from three runs tuned with each individual fleet.

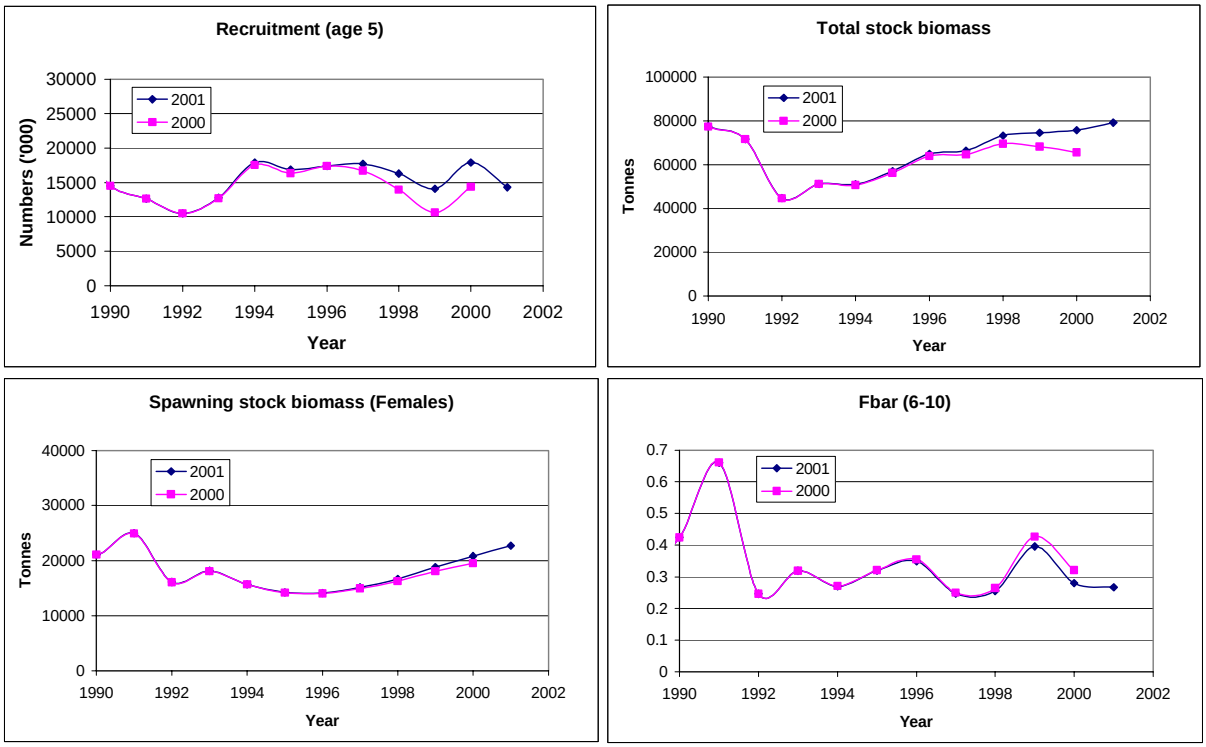
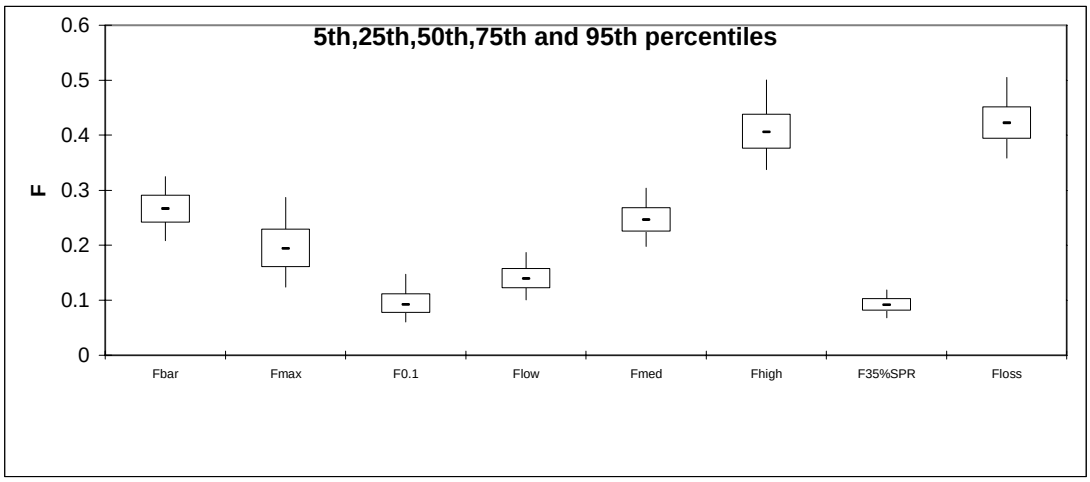


Figure 8.4. Retrospective analysis based on current assessment.



Reference point	Deterministic	Median	75th percentile	95th percentile	Hist SSB < ref pt %
MedianRecruits	19777	19777	20258	22319	
MBAL	0				0.00
Bloss	14095				
SSB90%R90%Surv	34993	35850	40322	47766	42.11
SPR%ofVirgin	10.10	10.36	12.01	14.84	
VirginSPR	16.13	15.94	18.63	24.27	
SPRloss	0.91	0.79	0.82	0.88	

	Deterministic	Median	25th percentile	5th percentile	Hist F > ref pt %
FBar	0.27	0.27	0.24	0.21	63.16
Fmax	0.19	0.19	0.16	0.12	86.84
F0.1	0.09	0.09	0.08	0.06	100.00
Flow	0.11	0.14	0.12	0.10	100.00
Fmed	0.23	0.25	0.23	0.20	76.32
Fhigh	0.34	0.41	0.38	0.34	31.58
F35%SPR	0.09	0.09	0.08	0.07	100.00
Floss	0.38	0.42	0.39	0.36	18.42

For estimation of Gloss and Floss:
A LOWESS smoother with a span of 1 was used.
Stock recruit data were log-transformed
A point representing the origin was included in the stock recruit data.
For estimation of the stock recruitment relationship used in equilibrium calculations:
A LOWESS smoother with a span of 1 was used.
Stock recruit data were log-transformed
A point representing the origin was included in the stock recruit data.

Arctic Green.halibut (run: XSAAAG44/X44)

Steady state selection averaged over 20 years.
FBar averaged from age 6 to 10

Number of iterations = 1000
Random number seed = -99
Stock recruitment data Monte Carloed using residuals from the equilibrium LOWESS fit

Data source:
C:\ifapdata\work\AFWG\ghl_arct\xsaaag44\padata.csv

FishLab DLL used
FLVB32.DLL built on Jun 14 1999 at 11:53:37
PASoft 4 October 1999

23/04/2002 14:56:27

Figure 8.5 A. Biological reference points

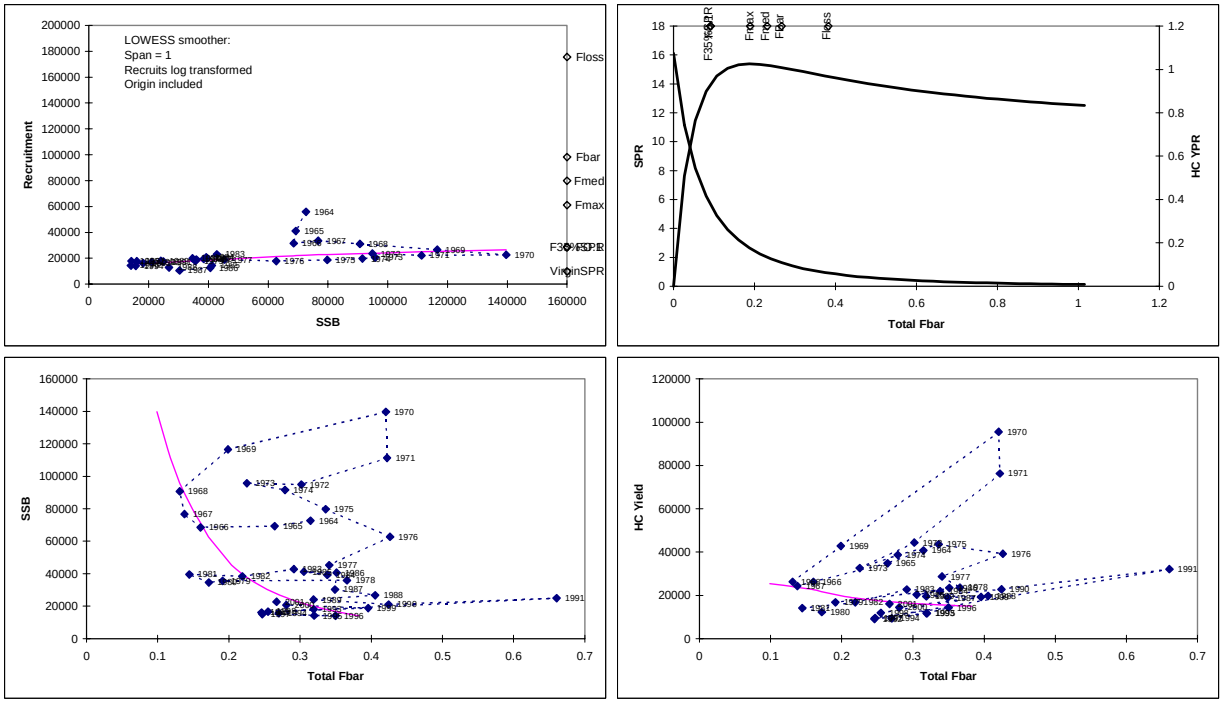
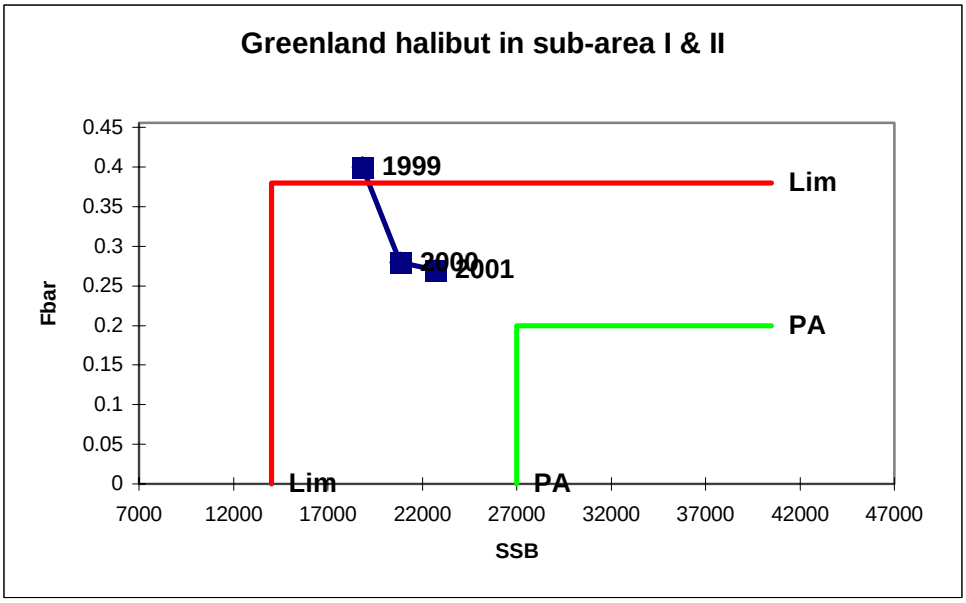


Figure 8.5 B. Biological reference points



Standard computations of the Pa-points using the formulas recommended by ICES:

$\mathbf{F}_{pa} = \mathbf{F}_{loss} * Exp(-1.645 * \sigma)$; $\mathbf{B}_{pa} = \mathbf{B}_{loss} * Exp(1.645 * \sigma)$; where σ was set to 0.4.

This gives: $\mathbf{F}_{pa}$: 0.20 and $\mathbf{B}_{pa}$: 27,216 t

Figure 8.5 C. Biological reference points

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

[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

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

[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

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

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

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

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

[1] Age composition based on combined age-length-keys for 1990 and 1992.

[2] Only half of standard area investigated

Table E7.- Greenland halibut catch in weight, numbers, and Biomass and abundance estimated from Spanish survey 1997-2001.

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

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

[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 1992-2001. 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
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
5	19.1	25.0	24.7	22.5	19.5	24.8	6.6	7.7	10.8	6.3
6	23.0	18.4	23.8	22.6	31.6	22.9	25.5	23.0	17.1	20.2
7	25.9	27.1	26.8	30.2	35.6	30.5	44.5	39.6	43.0	28.5
8	13.3	12.4	11.2	11.0	8.7	10.1	15.5	14.5	12.3	24.5
9	1.7	0.7	1.0	2.7	1.3	2.6	4.5	1.6	4.5	7.8
10	6.8	7.4	5.9	6.6	2.0	5.0	2.0	9.7	8.5	7.3
11	2.9	3.1	2.4	2.0	0.5	1.9	0.8	1.0	0.9	1.9
12	1.7	1.0	0.6	1.1	0.2	0.8	0.3	1.8	1.1	1.7
13	0.5	0.4	0.2	0.3	0.0	0.3		0.2	0.6	0.3
14	0.2	0.2	0.1	0.2	0.1	0.2		0.2	0.0	0.2
15	0.1					0.0		0.0	0.0	0.2

Mean individual weight (kg)

Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
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
5	0.71	0.76	0.73	0.70	0.74	0.69	0.76	0.74	0.69	0.66
6	0.96	0.98	0.95	0.94	0.94	0.88	0.96	0.92	0.98	0.94
7	1.29	1.33	1.28	1.24	1.23	1.15	1.19	1.25	1.23	1.12
8	1.77	1.85	1.79	1.71	1.66	1.55	1.79	1.64	1.57	1.48
9	2.00	2.28	2.23	2.03	2.00	1.87	2.26	2.18	1.9	1.84
10	2.46	2.65	2.55	2.50	2.50	2.34	2.54	2.38	2.4	2.30
11	3.10	3.43	3.37	3.28	3.16	2.95	3.47	3.17	3.13	2.92
12	3.86	4.32	4.22	3.71	3.70	3.46	4.16	3.79	4.04	3.82
13	4.44	5.18	5.01	4.62		4.52		5.07	4.47	3.68
14	6.00	6.44	6.29	5.59		5.47		5.60	6.00	5.74
15	5.22								8.79	5.52

CPUE (N) on age

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1										
2										
3	0			1	0	0	0	0	0	0
4	19	30	26	7	7	11	2	7	14	17
5	80	176	198	219	286	298	59	72	132	86
6	97	130	191	220	463	275	229	214	208	278
7	109	191	215	294	521	366	400	369	524	392
8	56	87	90	107	127	121	139	135	150	337
9	7	5	8	26	19	31	40	15	55	108
10	29	52	47	64	29	60	18	90	104	100
11	12	22	19	19	7	23	7	9	11	25
12	7	7	5	11	3	10	3	17	13	24
13	2	3	2	3	0	4	0	2	7	4
14	1	1	1	2	1	2	0	2	0	2
15	0			0	0	0	0	0	0	3

CPUE (kg) on age

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1										
2										
3	0			0	0	0	0	0	0	0
4	10	16	13	3	4	5	1	3	7	10
5	57	134	145	153	211	207	45	53	91	57
6	93	127	182	207	435	243	220	197	204	261
7	140	254	276	364	641	423	476	461	645	439
8	99	162	161	183	211	189	249	221	236	499
9	14	11	18	53	38	59	91	32	105	198
10	70	138	121	161	73	141	46	215	250	231
11	38	75	65	64	23	68	25	30	33	74
12	28	30	20	40	11	33	11	64	53	90
13	9	15	8	13	0	16	0	9	32	15
14	5	9	5	11	0	13		10	2	13
15	2			0	0	0			3	

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
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
CPUE (kg round weight per trawlhour)*	567	973	1020	1255	1640	1393	1169	1294	1647	1377
CPUE (Number fish per trawlhour)*	420	705	803	973	1464	1201	899	931	1220	998
Catch (in tonnes)	695	862	811	368	436	274	272	269	295	297

*) 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	10	10	804	-	35	435	1 365
1999	+	-		1	18	2 157	-	43	358	2 577
2000	+			10		498 [1]	-	67	192	767
2001 [1]	+			+	10	478 [1]	-		250	738

[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 the price of shrimp. The catch in 2000 peaked at 82,816 t, the highest since 1990.

9.1.2 Regulation

In the Svalbard area the shrimp fisheries are regulated by the number of effective fishing days and the number of vessels by country. In the Barents Sea and Svalbard area, Norwegian rules are that the fisheries be regulated by the 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 2002 the values are set at eight for the sum of cod and haddock, ten for redfish, and three for Greenland halibut.

9.1.3 Landings (Table 9.1, Figure 9.1)

Preliminary reported landings for all countries show a substantial decrease of catches in 2001 (Table 9.1 and Figure 9.1). The catch was at a total of 55,198 t, which is a decrease of 33,3 % from 2000.

9.2 Status of Research

9.2.1 Surveys

In the Barents Sea and the Svalbard area, standard shrimp surveys have been conducted by Norway since 1982 and by Russia since 1984. However, during the 90's, both surveys have suffered from reductions in survey time. The Russian vessels have not surveyed the Svalbard area for many years. 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 2001). 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 2001 observers collected samples on board commercial Spanish vessels in the Svalbard zone. Length and sex distribution data and data on by-catch were obtained (Casas, WD 23 and 24). Length distribution data and by-catch data have been 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. Data from Russia and Norway show a decline of effort in 2001. The Russian CPUE also declined in 2001. However, the Norwegian CPUE does not follow the survey index as does the Russian CPUE (vessels < 1300hp). Probably this is a consequence of the use of double and triple trawls.

Catch increases from 1994–2000 encouraged Norwegian ship owners to invest in larger vessels and new technology. During 1996 only three vessels used double trawls; in 1998, 12 vessels used this technology, and now more than 24 vessels are using double or triple trawls. Due to improved technology, the Norwegian catch per hour (CPUE) has increased at a rate that exceeds the rate at which shrimp biomass has changed (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). It should be noted that the Russian fleet is also under development.

Two new lines are added in Table 9.2 giving the CPUE of Norwegian trawlers with 1000 to 1500 hp and using single trawl. The Norwegian CPUE increased from 2000 to 2001, as did also the CPUE for vessels using double and trippel trawls. The whole Norwegian CPUE-series are being evaluated.

9.2.4 Survey results (Tables 9.3–9.4, Figures 9.2–9.5)

There is a strong correlation between the Norwegian and the Russian survey results. 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).

Norwegian bottom trawl surveys indicate that shrimp biomasses in the Barents Sea and Svalbard area have decreased since 1998 while the Russian indices for the Barents Sea show decreases since 1999 (Tables 9.3–9.4 and Figure 9.2). The main survey areas are shown in Figure 9.4. Decreases in the shrimp biomass indices by both countries surveys took place in almost every area in 2001. Reductions in biomass may be explained by the weak 1996 year class (Aschan *et al.* 2000) and high cod consumption (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 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 the 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 start 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 start 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 (Casas, WD 24). 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. It may be reasonable to use an age-length key constructed from the Hopen area 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). Russian scientists have used these age-length data in further modelling of the stock. 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, Dolgov *et.al.*, WD 11).

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. The following potential problems have been identified (Aschan, WD 6, 2000 WG):

1) cod feeding on shrimp while in the survey trawl;
2) calibrating the use of digestion rate;
3) the effect of spatial and temporal aggregation level;
4) the impact of no longer collecting cod stomach data during the April–May Norwegian shrimp cruise; and
5) the effect of not including ambient temperatures in digestion rate 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.

Production models

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 20). 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.

Catch-at-age analysis (cohort models)

1) single-species virtual population analysis;
2) multispecies 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).

Length-at-age analysis

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)

Russian CPUE indices indicated a decline in the stock from 1998 to 2001 (Table 9.2, Figure 9.3). The Norwegian biomass index shows a decrease from 1998 to 2001 and is now lower than the long-term mean (1984–2001)(Table 9.3 and Figure 9.3). The Russian biomass index shows a decrease from 1999 to 2001. It is also lower than the long-term mean (Table 9.4). A weak 1996 year class has probably resulted in a lower survey index in year 2001. However, the 1997-1999 year classes appear to be of average strength and will probably contribute to some increase in the shrimp stock in 2002-2003. The decreased shrimp consumption by cod will probably also result in an increased shrimp stock biomass in 2002-2003 (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 department of Marine Resources (MAR) at the Institute of Fisheries and Aquaculture Research (Fiskeriforskning) in Tromsø has the responsibility of providing the necessary research results to manage the stock of shrimp (*Pandalus borealis*) in the Barents Sea and Svalbard area (ICES Subareas I and II) together with PINRO in Murmansk. As a result of reorganising the marine institute sector in Norway, MAR will at the start of year 2003 be a branch in Tromsø of Institute of Marine Research (IMR). Thus, IMR and PINRO will be responsible for the research of shrimp.

Parallel to this, 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 meeting in October 2003 is regarded as being 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 with the intention of establishing a joint NAFO / ICES North Atlantic Shrimp Working Group to meet, preferably, in October.

Table 9.1 Nominal shrimp catches (t) by country (Sub-areas 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[5]	52,612	10,765	12,292[2]	75,669
2000[5]	54,979	19,596	8,241[3]	82,816
2001[5]	41,216	5,846	8,136[4]	55,198

[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] Preliminary data

Table 9.2 Catch (t), effort (h) and CPUE (kg/h) data in ICES sub-areas I, IIa and IIb. Norwegian data based on log books and Russian data based on daily reports from vessels smaller than 1300hp.

Norway

Year	Catch	Effort	CPUE
1980	23,417	126,157	186
1981	23,083	106,424	217
1982	31,088	156,770	198
1983	54,754	240,275	228
1984	60,063	246,738	243
1985	63,715	277,935	229
1986	37,432	245,739	152
1987	22,997	200,545	115
1988	22,803	206,007	111
1989	37,172	264,148	141
1990	44,824	294,896	152
1991	34,541	203,071	170
1992	36,961	176,397	210
1993	60,728	291,435	208
1994	19,539	107,436	182
1995	17,079	113,325	151
1996	22,045	119,298	185
1997	25,298	111,177	228
1998	34,153	112,213	304
1999	47,816	164,319	291
2000	52,506	189,383	277
2001	41,467	118,713	349
2000[1]	7,768	44,930	172
2001[1]	3,071	14,720	208

[1] Vessels with 1000 - 1500 hp and using single trawl.

Russia

Year	Catch	Effort	CPUE
1981	2,341	8,100	289
1982	4,966	20,400	243
1983	13,223	48,000	276
1984	33,403	118,900	281
1985	27,974	110,900	252
1986	7,912	33,500	236
1987	3,818	23,900	160
1988	9,010	61,600	146
1989	7,928	53,500	148
1990	17,126	94,500	181
1991	15,532	74,100	210
1992	13,025	57,000	229
1993	11,390	60,000	190
1994	4,521	27,500	164
1995	3,347	26,100	128
1996	5,680	35,300	161
1997	1,507	7,600	198
1998	4,900	21,212	231
1999	6,238	30,900	202
2000	12,204	71,784	170
2001	2,484	16,609	150

Table 9.3 Indices of shrimp biomass from Norwegian surveys in the years 1982-2001 by main areas.

Main area	A	B	C	D	E	F	G	H	Total	Sum. A,B,C, E
	East Finnmark	Tiddly Bank	Thor Iversen Bank	BeaIsland Trench	Hopen	Bear Island	Storfjord Trench	Spits-bergen		
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
% 00/99	-18	58	9	23	-40	-7	-52	-23	-22	-25
% 01/00	*26*	-67	21	-43	-41	-15	0	39	**-25**	-31

Table 9.4 Indices of shrimp biomass (1000 t) from Russian survey in the 1984-2001 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
% 00/99	-33	-47	2	-37				-23	131	-17	-34
% 01/00	-62	-29	-4	-44	111	-64		-81	-61	-42	-35

Table 9.5 Recruitment index for shrimp in the Barents Sea defined as size groups according to carapace length-at-age in the Hopen area (whole mm). Norwegian survey data.

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
<9	1	0.5	
9<cl<12	2	21.1	
12<cl<15	3	70.6	
15<cl<18	4	191.2	

Table 9.6 Evaluation of the shrimp (*Pandalus borealis*) stock in Barents Sea and Svalbard area, ICES Subareas 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.
Effort	The total Norwegian and Russian effort was stable (approx. 140,000 h) from 94–98 but increased in 99 and 00 to 260,000 h. In 2001 the effort was reduced to the mid-90's level again. Since 97 the number of Norwegian vessels using double and triple trawl has increased and the Russian shrimp fleet is beginning to introduce modern technology.
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. Low surveillance effort as well as low cod recruitment and a large shrimp stock resulted in very few closed areas during the last year.

INDEX	OBSERVATION	INTERPRETATION	EVALUATION
FISHERY DATA			
CPUE index	Increased for the Norwegian and the Russian fleet from 1995 to 1998 (304 and 231 kg/h respectively), but showed a decrease in the years 99 and 00 for both fleets. In 2001 the Russian index is further reduced. There is concern that double and triple trawling is not taken into account in the CPUE index.	Between 95 and 98 the shrimp biomass and usage of new technology increased, however, the biomass decreased in 99, 00, and 01 whereas the technological improvements still go on.	–
Spatial pattern	The Hopen deep remains the most important fishing area but the role of the areas North of Svalbard increases as the vessels get larger.	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 and 2001.	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 98 to 2001 (46%). The Russian index indicates a reduction from 99 to 2001 (52%).	Biomass declining.	–
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 97 year class is average whereas the 98 and 99 year classes appear strong.	Probably shrimp biomass should increase when the 97, 98 and 99 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. Possible decrease in 2001 SSB index due to the weak 96 year class.	The 97 and 98 yearclasses will contribute to some increase in the SSB.	?
Sex inversion	The majority of shrimp change sex at five years. Temporal and spatial distribution of mean length at sex change will be calculated (L_{50}).		?

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 369 in 98 to 251 thousand t in 99. Cod consumption have increased to 400 thousand t in 2000 but again reduced in 2001 to 233 thousand t. Other predators are Greenland halibut and thorny skate.	Consumption by cod is declining due to a reduced cod stock 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	Catch rates in 2000 were good, though somewhat lower than 1999. 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 strong reduction in the numbers of vessels fishing and in fishing hours.	Technological development is necessary to maintain the fishery and it is uncertain if the reduced fishing time may constitute a reduced effort.	?

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 – 2001). During the mid-90's the ratio was close to half of the mean. However, in 2000 and 2001 it is again above the mean.	The Norwegian and Russian surveys use 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 show a decline. Both Russian and Norwegian biomass index is below the long-term mean (1984–2001).**		-
	Prospects: Over the next few years, residual female stock and stronger 97 and 98 year classes will probably contribute to some increase of SSB.		?

Concerns for current status/future prospects -

Uncertainty regarding index quality or impact ?

Positive evaluation +

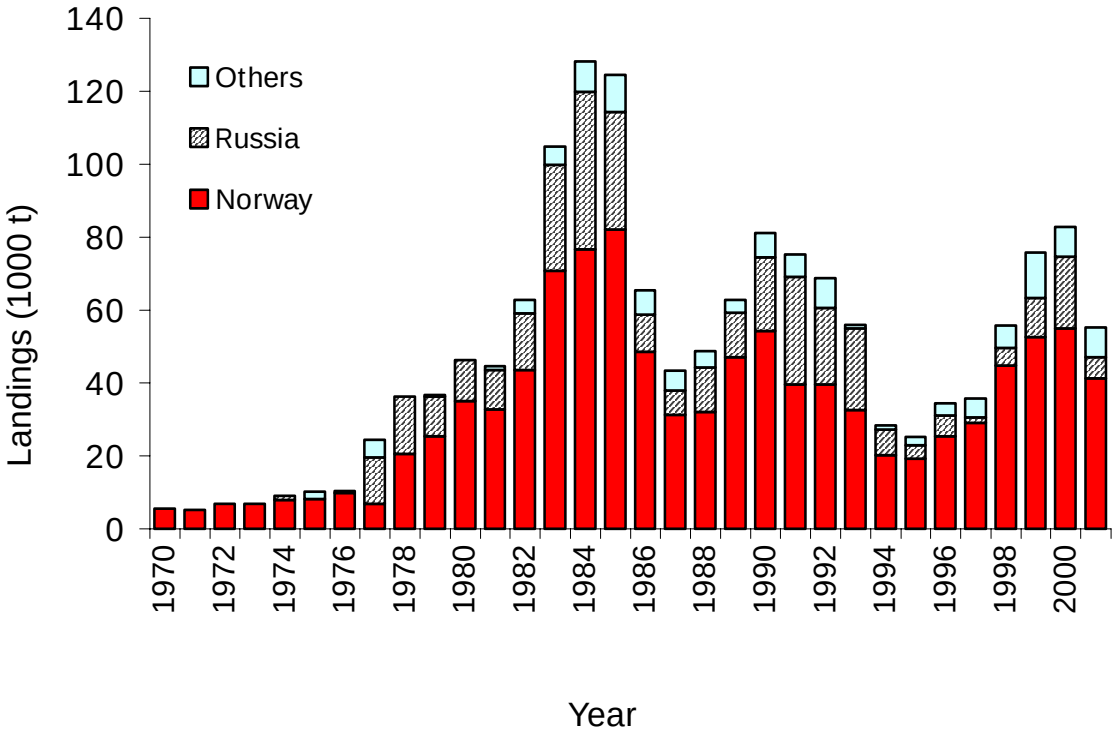


Figure 9.1. Shrimp landings from ICES areas I, IIa and IIb by Norway, Russia and other countries in the period 1970–2001.

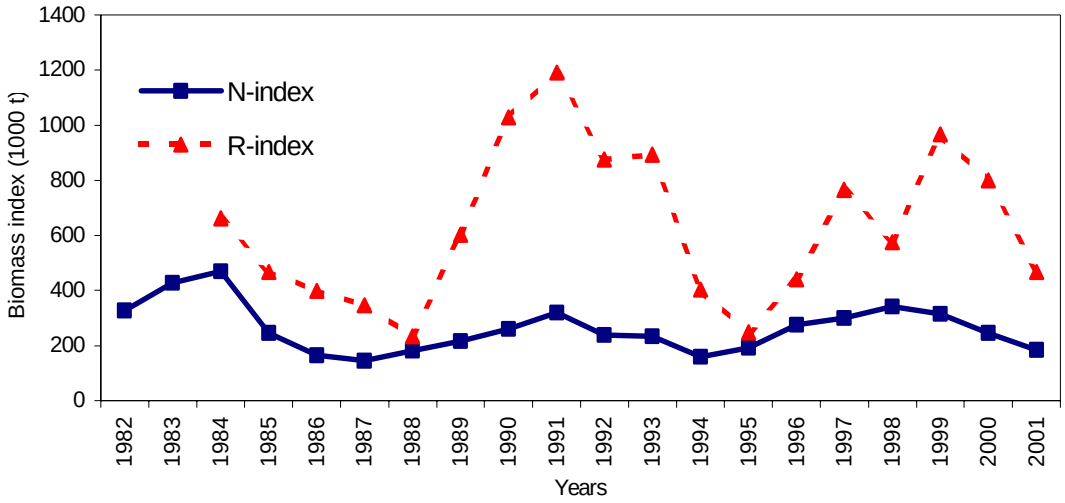


Figure 9.2 Shrimp biomass indices from Norwegian and Russian surveys in the Barents Sea and Spitsbergen area in 1982-2001.

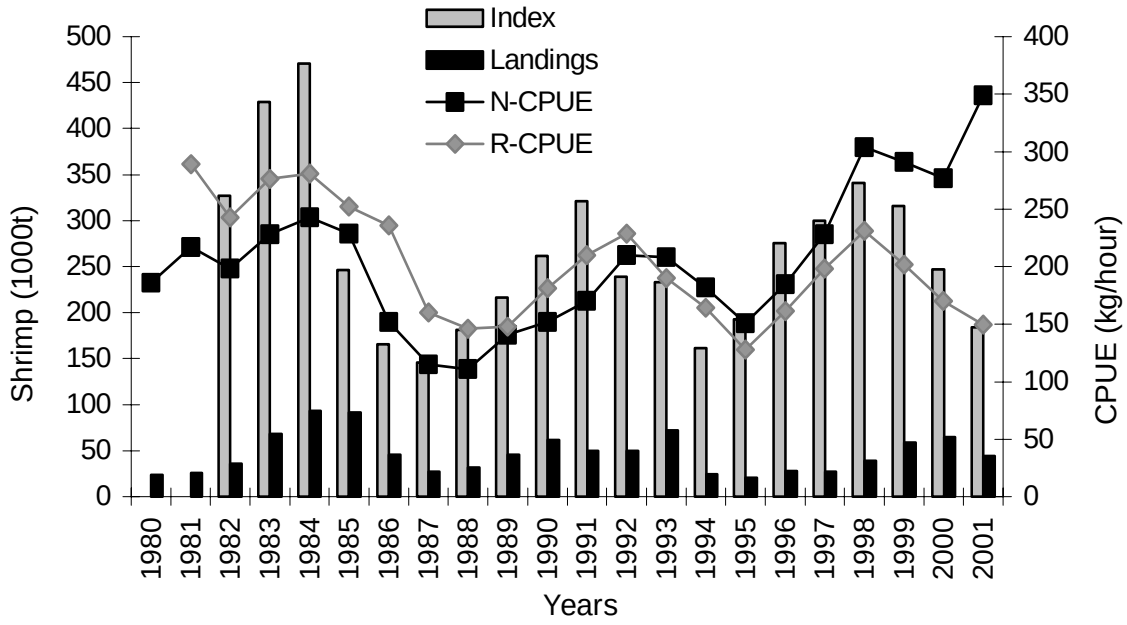


Figure 9.3 Biomass indices from the Norwegian surveys, total landings and Norwegian and Russian CPUE for ICES areas I, IIa and IIb.

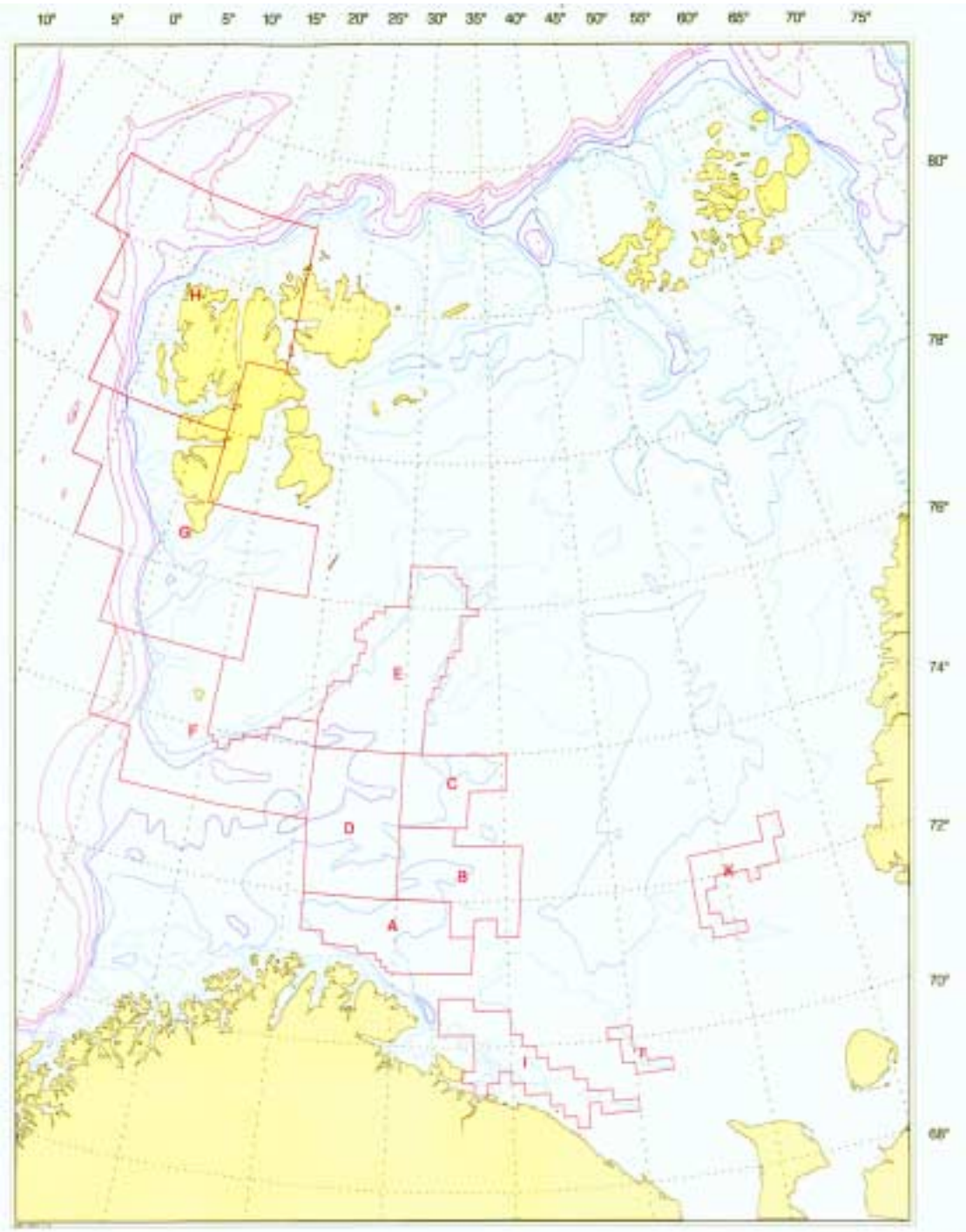


Figure 9.4 Survey strata are combined to 10 larger areas marked with letters A to K.East Finnmark (A), Tiddly Bank (B), Thor Iversen Bank (C), Hopen (E), Bear Island (F), Storfjord Trench (G), Spitsbergen (H), Kola coast (I) and the Goose Bank (K).

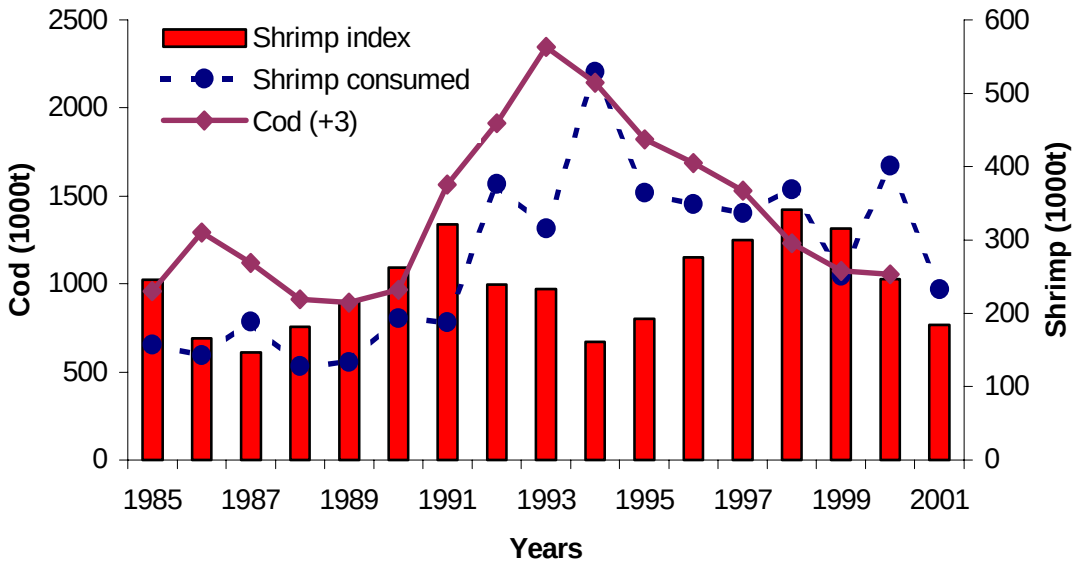


Figure 9.5 Biomass indices from the Norwegian surveys, biomass estimate for cod (age 3 years and older) and the shrimp consumed by the cod in the Barents Sea .

10 BIOLOGICAL REFERENCE POINTS FOR NA COD

The biomass reference points used for Northeast Arctic cod are being reviewed in light of substantial changes to the SSB time-series. Given the dependency of the F reference points on the SSB/R relationship, the appropriateness of current values of $\mathbf{F}_{lim}$ and $\mathbf{F}_{pa}$ must also be reviewed.

10.1 Background

In 2001, the AFWG replaced the constant values for maturity-at-age (1946-1981) and weight-at age (1946-1982) with year-specific values estimated by combining historical information from Russian and Norwegian sources. This caused the long-term mean SSB to decrease from 577,425 t to 372,934 t. The appropriateness of the reference points was then evaluated. New values of $\mathbf{B}_{lim}$ and $\mathbf{B}_{pa}$ were proposed by the AFWG, however, they were not adopted by ACFM.

ACFM commissioned a peer review of the 2001 assessment of Northeast Arctic cod to be undertaken at the ICES Annual Science Conference (Beckett and Serra 2001). As one of three terms of reference the peer review was asked to address whether the biomass reference point ($\mathbf{B}_{pa}$) of 500,000 t was in accordance with the information available to the 2001 assessment. The peer review concluded that: "the existing analysis indicate that 500,000 t is unlikely to be the level appropriate for the $\mathbf{B}_{pa}$ but further work is needed before selecting a new value, particularly as it is assumed that the values of the biomass reference levels should not be altered every year without clear reason.".

With respect to determining new $\mathbf{B}_{pa}$ values the peer review expressed the following concerns:

- temporal trends in maturity-at-age (Fig. 10.1) and weight-at-age require further study to determine their cause(s);
- the SSB/R relationship for the recent time period (1980-1997 year classes; Figure 10.2b) shows a different trend compared to the relationship for the previous time period (1946-1979 year classes; Fig. 10.2a);
- a non-stationarity in the recruitment time-series caused by the introduction of cannibalism mortality in 1984 could have contributed to differences between the SSB/R relationships for the two time periods;
- the true magnitude of variation in total egg production may not be accurately reflected using SSB as an index of reproductive potential.

In addition to these concerns, ACFM expressed the opinion that environmental influences were affecting the SSB/R relationship and recommended further work on this issue prior to adopting new values for the reference points.

While both ACFM and the peer review were in agreement that further study on several issues was required, they did not specify details on how this should be done. The Terms of Reference for the AFWG in 2002 were similar to previous years in requesting only that the WG evaluate the agreed management strategy for cod, with special attention to the reference points for SSB and F. The AFWG interpreted this to mean discussing the concerns raised by ACFM and the peer review and developing a plan for addressing specific concerns so that in future any new proposals for reference points could avoid the same criticisms.

Several relevant WDs were presented to the WG (Ajiad and Jakobsen WD3, Kovalev WD4, Tretyak WD7 and Tretyak WD34). These are included in this report in Appendix 1. In addition, a draft of the report of the Study Group on the Precautionary Approach was available. A sub-group of the WG met to discuss the concerns raised by ACFM and the peer review, review material from the WDs and the Study Group on the Precautionary Approach and develop specific recommendations for future work. These discussions are summarized below.

10.2 Addressing the concerns of ACFM and peer review

10.2.1 Concerns regarding the need to split the time-series

The peer review concluded that there were important qualitative differences between the SSB/R relationships for the time periods 1946-1979 and 1980-1997 (Figure 10.2). Accordingly, several of the WDs split the time-series (Borisov and Bulgakova WD2, Ajiad and Jakobsen WD3, Kovalev WD4, Tretyak WD7 and Tretyak WD34). Among ICES stocks there are several examples of the SSB/R relationship being into split into different time periods (or "regimes").

Consequently, the report of the Study Group on the Precautionary Approach has summarized different approaches for setting reference points in such cases.

Ideally, the mechanisms responsible for generating relatively abrupt changes need to be identified. In the case of Northeast Arctic cod there are several possible causes of a "regime shift" in the late 1970s/early 1980's. These include:

- a large-scale environmental signal generated by the North Atlantic current and/or NAO index;
- changes in the Barents Sea ecosystem structure (e.g., prey species replacement);
- changes in stock structure, e.g., shifts towards early-maturation (Tretyak WD7), reduction in age diversity (Ajiad and Jakobsen WD3), loss of large, repeat spawners;
- changes in stock productivity (growth, maturation rate, relative fecundity);
- shifts in management protocols;
- changes in sampling programs and the introduction of new surveys and methodology.

Research to identify a process or processes causing an abrupt change in the production dynamics falls outside the mandate of the WG but is nevertheless encouraged because of its importance to management.

Given that the cause(s) could not presently be identified, it was not possible to provide an objective rationale for preferring one time period over another for the purposes of estimating reference points. The recent time period is clearly more relevant to current management. However, if reference points were developed for the recent time period this would amount to using a management strategy that was based on the generally lower SSB and recruitment, thus, ignoring that historically the stock is capable of achieving higher levels. A comparative approach should be used to evaluate the effects of using different time periods to determine the reference points. For example, Kovalev (WD4) examined differences in the reference points determined for SSB/R relationships for the full time period (1946-2000) and a restricted time period (1982-2000).

Recommendation: Any future proposals for reference points that are based on a shorter time period will have to include a comparison with the full time period.

10.2.2 Concerns about the maturity and weight time-series

Replacing the constant values for maturity-at-age (used from 1946-1981) and weight-at-age (used from 1946-1982) with empirically derived values the revised time-series for SSB is, without doubt, an improvement. However, the precision and accuracy of these revised time-series deserve further scrutiny.

The new values of maturity- and weight-at-age are arithmetic averages of the Russian and Norwegian time-series. A complete description of the data sources is given in Sections 10.2 and 10.3 of last years AFWG report. Briefly, the historical Russian data were obtained from surveys supplemented with some observations from sampling of the commercial catch. The historical Norwegian data were primarily obtained from sampling of the commercial catch in Lofoten; however, limited data from sampling of the commercial catch taken in the spring around Finnmark were also used. Russian and Norwegian time-series for weight-at-age cover the entire historical period, whereas, only Norwegian values of maturity-at-age are available for the time period 1946-1958.

The degree of synchrony between the Russian and Norwegian time-series is relevant to assessing the accuracy of the trends. The Russian and Norwegian estimates of weight-at-age for the historical period are uncorrelated except for age 9 (Table 10.1). However, the long-term trends in the data are in reasonable agreement, particularly for the older age-classes (Figure 10.3).

The degree of synchrony between Russian and Norwegian maturity-at-age time-series varies for different age classes (Table 10.2). The younger age-classes (ages 3-5) show a higher degree of synchrony for both the historical and recent time periods. For the older age-classes, the synchrony is higher from 1969 onwards (Fig. 10.4).

Given that long-term changes in growth are frequently observed in stocks experience sustained high rates of fishing mortality, the group did not feel that further research into technical aspects of how the Russian and Norwegian time-series were combined was required at the present time.

10.2.3 Concerns about the recruitment time-series

In general, it was felt that assessing the accuracy and precision of the recruitment time-series is important for evaluating whether or not there have been "regime shifts" in the SSB/R relationship. Two possible sources of error were identified: discarding mortality and cannibalism mortality.

A newly available time-series of discarding mortality has been used in exploratory VPA runs and was found not to change the SSB/R relationship very dramatically (Dingsør WD13). Russian investigations into this topic are also planned for the future.

In 2001 separate VPA runs were performed, including cannibalism mortality from 1984 onwards and assuming no cannibalism mortality. The recruitment time-series generated by the run without cannibalism mortality was used in the SSB/R relationship last year.

Another alternative is to hindcast cannibalism mortality rates for the years before 1984. In last years WG report, a model was described for predicting cannibalism mortality using information on the length-at-age, capelin stock biomass, and the biomass of age-classes that are assumed to prey on young cod. There is sufficient data (observations and model estimates) currently available to use this model to hindcast cannibalism mortality for the 1946-1983 time period.

Recommendation: There are inconsistencies in how mortality is incorporated into the assessment. However, there is considerable uncertainty associated with modelling mortality. The effect of different sources of pre-recruit mortality on the SSB/R relationship must be assessed using a comparative approach. For example, the SSB/R relationship assuming no cannibalism mortality should be compared to relationships estimated assuming cannibalism mortality from 1984 onwards and cannibalism mortality for the full time period. The comparative approach taken by Dingsør (WD13) to assess the SSB/R relationship with and without discarding mortality should also be reviewed in more detail.

10.2.4 Concerns about the possibility of age biases

The peer review recommended investigating the possibility that biases in age reading contributed to the long-term trends observed in growth (Figures 10.3 and 10.4). Limited data were available to assess this possibility. A sub-sample of otoliths from 1965, 1966, 1967 and 1968 were re-read in 2002 as a check on the historic ages. The present ages were identical to the historic ages in 72% of the cases with little evidence of an age effect (Table 10.3). In cases of disagreement, there was a clear tendency for the present age to be one year higher than the historic age (25.29% overall; Table 10.3). This tendency is reverse to what would be expected if age biases contributed to generating a long-term trend towards increasing weights and maturities. Thus, if present ages are biased relative to historic ages (or vice versa), then the long-term trends have been under-, not over-represented.

Recommendation: Norway has a collection of cod otoliths dating back to the 1930's. To assess whether changes in age reading are influencing the time-series, historic material from 1980 to 1985 and representative time periods prior to 1980 should be re-aged by both IMR and PINRO. These results should be reported to the planned study group on reference points (Section 10.3) and the AFWG in 2003.

10.2.5 Concerns about whether SSB is a sensitive measure of reproductive potential

The large changes in size composition and growth rates that have been observed will directly impact the reproductive potential. The results of ongoing research quantifying the reproductive potential of Northeast Arctic cod at the individual-level are being used to develop alternative indices of reproductive potential at the stock-level. The relationship between SSB and total egg production is suggestive of a "regime shift" such that since the early 1980's the levels of total egg production for a given level of SSB are approximately half what they were prior to 1980 (Figure 10.5). Thus, the current spawning stock that is composed of fast-growing, smaller spawners does not appear to have the same reproductive potential as the historic stock which was composed of slow-growing, larger spawners. Similarly, Borisov and Bulgakova (WD2) demonstrated a long-term shift towards lower egg production per unit SSB (Figure 10.6). The importance of late-maturing spawners to recruitment dynamics was also indicated by Tretyak (WD7). However, Ajiad and Jakobsen (WD3) found that including age diversity of the spawning stock in a multivariate recruitment model led to only a small improvement in the amount of variation that could be explained by the model.

Recommendation: The possibility that, for a given level of SSB, current levels of total egg production are lower than historic levels should be examined in more detail. Simulation analyses should be undertaken in order to determine how different aspects of stock structure (size, maturity, sex ratio, fecundity) impact reproductive potential.

10.2.6 Concerns about environmental effects on the SSB/R relationship

A number of WDs addressed the issue of whether environmental effects could explain residual variation in the SSB/R relationship. Ajiad and Jakobsen (WD3) and Tretyak (WD7) both included temperature in multivariate recruitment models. Section 1.5 presents temperature-based recruitment forecasts for 2002-2004. While such approaches have been discussed for many years, a functional recruitment model has yet to be implemented in the medium-term projections. This is partly due to problems with the reliability of temperature projections (see Section 1.2).

The influence of environmental conditions on growth, maturation rate and cannibalism mortality could also be reflected in stock projections. The model (STOCOBAR) described in Filin (WD6) predicts the feeding, growth and maturation rate of Northeast Arctic cod on the basis of food supply and temperature. The results suggest that the growth rate of cod depends more on temperature than on feeding. The simulations adequately describe the dependence of cod cannibalism rates on capelin stock biomass. The STOCOBAR model is under development and work on it will continue.

The new ICES Study Group on Growth, Maturity and Condition in Stock Projections will be developing models predicting weight, maturity and fecundity of Northeast Arctic cod based on projections of capelin stock biomass that are now available to the AFWG (Gjøsæter WD10). These models will then be implemented in the new software being developed at Lowestoft. This Study Group will report the results of these trial runs to the 2003 meeting of the AFWG.

Recommendation: The capelin stock biomass projections (one year in advance) that have been provided to the AFWG for several years now (see Section 1.6) are very valuable for making growth forecasts. However, it should also be noted that multi-year forecasts of capelin stock biomass would be required for the medium-term projection. The reliability of these projections should be tracked by the AFWG in the form of a quality control table.

10.3 Justification for a dedicated study group on reference points

There is a need to evaluate the current values of reference points in light of the revised SSB time-series and improved knowledge about stock dynamics. The AFWG was unable to develop and evaluate candidate values of reference points at this years meeting in addition to its normal assessment responsibilities. Instead, it was decided that this work should be undertaken by a dedicated study group that would meet before the next AFWG meeting in 2003.

Thus, the AFWG recommends that a study group on biological reference points for Northeast Arctic cod (Chair: Yuri A. Kovalev, PINRO) meet in Svanhovd, Norway from January 13, 2003, to January 17, 2003. The terms of reference are to:

a) determine the most appropriate time period for estimating biomass and fishing mortality reference points;
b) specify the technical basis for the reference point calculations;
c) establish reference points based on a) and b). In the event that agreement is not reached on points a) and b) different alternatives will be formulated and compared.

The study group will report to the AFWG meeting in 2003.

10.4 Issues to be considered by the study group on reference points

In preparation for the study group meeting, it must be acknowledged that the AFWG failed to reach consensus on two critical issues:

- the need to split the time period;
- the technical basis for determining values of $\mathbf{B}_{lim}$ and $\mathbf{B}_{pa}$ from the SSB/R relationship.

The study group will have to resolve these issues before candidate values for reference points can be put forward. **Clear guidance from ACFM regarding the operational definitions of reference points would be helpful in achieving such consensus**.

The study group will also have to take into account the following:

- Decisions related to appropriate settings for reference point determination (e.g., values for σ representing the assessment uncertainty) are often problematic. Wherever possible, consensus on such issues should be achieved rapidly. There are several key documents that should be consulted by study group members prior to their meeting. In particular, the draft report of the Study Group on the Precautionary Approach contains much relevant information;

- Given that a comparative approach is being emphasized, it would also be beneficial for study group members to review both how other stocks have determined $\mathbf{B}_{lim}$ and $\mathbf{B}_{pa}$ values from SSB/R relationships and how these values have been used in management strategies (i.e., harvest control rules) in advance of their meeting;

- Given that there are differing opinions as to how to define $\mathbf{B}_{lim}$ and $\mathbf{B}_{pa}$ from the SSB/R relationship, it would be beneficial to invite an outside expert (or experts) who could comment on current practices in reference point determination and provide an objective opinion;

- The importance of maintaining a broad age/size structure of the spawning stock is becoming increasingly clear. Consequently, the role of stock structure should be examined by the study group. The ability of candidate values of reference points to conserve reproductive potential should be examined as part of the evaluation process. This activity can take advantage of newly available estimates of total egg production and age diversity;

- The Joint Russian-Norwegian Fisheries Commission has established a group of experts who will develop proposals for future management strategies for stocks in the Barents Sea that are jointly exploited. If such proposals are available to the study group then simulation studies could be undertaken to evaluate the candidate values reference points relative to the proposed management strategies.

Table 10.1 Summary statistics comparing weight-at-age estimates from Russian and Norwegian sources for two time periods. Figure 10.3 shows the data for the 1947-1982 time period.

Age	Historical time period 1947-1982			Recent time period 1985-2000		
	r^2	*p*	n	r^2	*P*	n
3	0.08	0.09	36	0.46	<0.01	16
4	0.03	0.77	36	0.66	<0.01	16
5	0.08	0.09	36	0.52	<0.01	16
6	0.02	0.37	36	0.36	0.02	16
7	0.02	0.43	36	0.25	0.05	16
8	0.09	0.07	36	0.27	0.04	16
9	0.27	<0.01	36			

Table 10.2 Summary statistics comparing maturity-at-age estimates from Russian and Norwegian sources for two time periods. Figure 10.4 shows data for the 1947-1982 time period.

Age	Historical time period 1959-1982			Recent time period 1983-2000		
	r^2	*p*	n	r^2	*p*	n
5	0.34	<0.01	24	0.02	0.67	14
6	0.45	<0.01	24	0.003	0.84	15
7	0.32	<0.01	24	0.003	0.84	16
8	0.10	0.14	24	0.20	0.07	17
9	0.05	0.28	24	0.02	0.59	17
10	0.01	0.58	24	0.02	0.60	18

Table 10.3 Agreement between the present age (read in 2002) and the historic age (as recorded in the database) expressed as the percent frequency of differences (present age minus historic age). Results presented here combine observations for 1965-1968. The number of otoliths re-aged is given by age-class (No. obs.). Weighted means were calculated for all ages combined, weighted by the number of observations.

Present age	**No. obs.**	**Difference**			
		-1 year	**0 year**	**+1 year**	**+2 years**
7	36	2.78	88.89	8.33	0.00
8	126	0.00	79.37	20.63	0.00
9	139	0.72	68.35	30.94	0.00
10	55	1.82	63.64	34.55	0.00
11	31	3.23	77.42	19.35	0.00
12	25	12.00	56.00	28.00	4.00
13	12	0.00	66.67	33.33	0.00
14	4	0.00	75.00	25.00	0.00
15	3	0.00	100.00	0.00	0.00
Weighted Mean	431	**1.62**	**72.85**	**25.29**	**0.23**

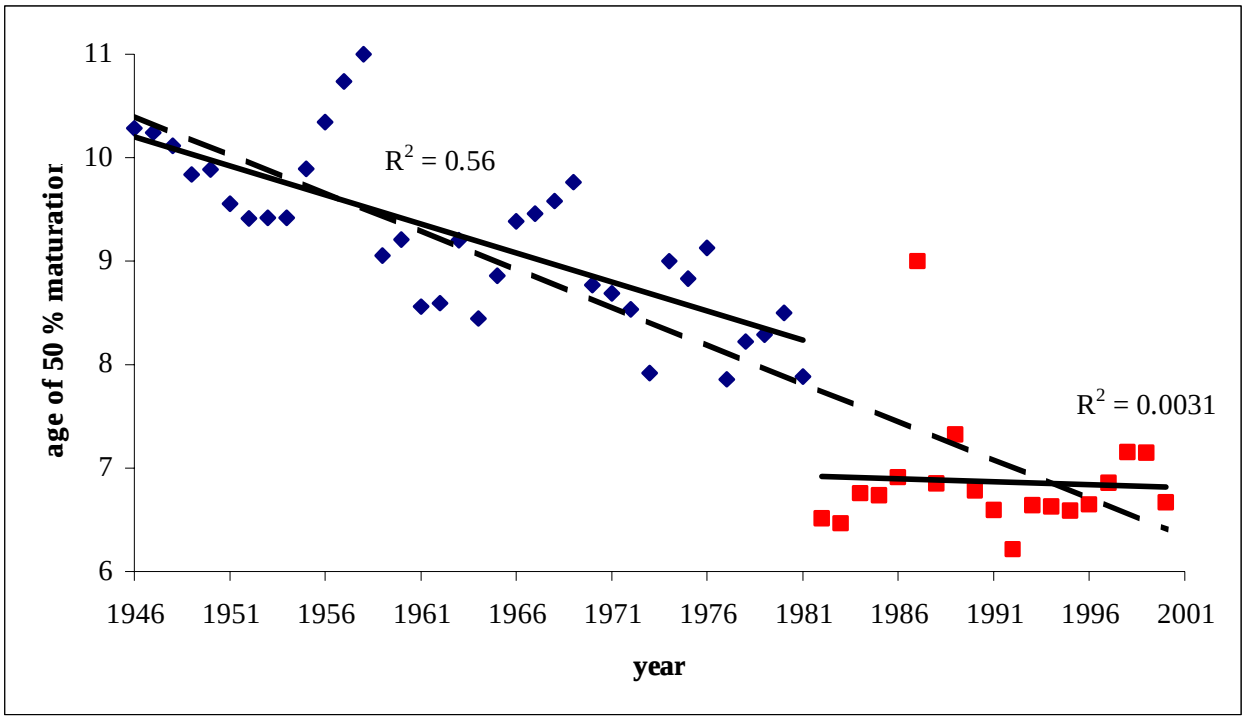


Figure 10.1 Time-series of age at 50% maturity for Northeast Arctic cod. Solid lines from 1946 to 1981 and 1982 to 2000 show linear trends for the two time periods (r^2 values for each time period are indicated). The dashed line indicates the linear trend for the full time period. Figure from Kovalev (WD4).

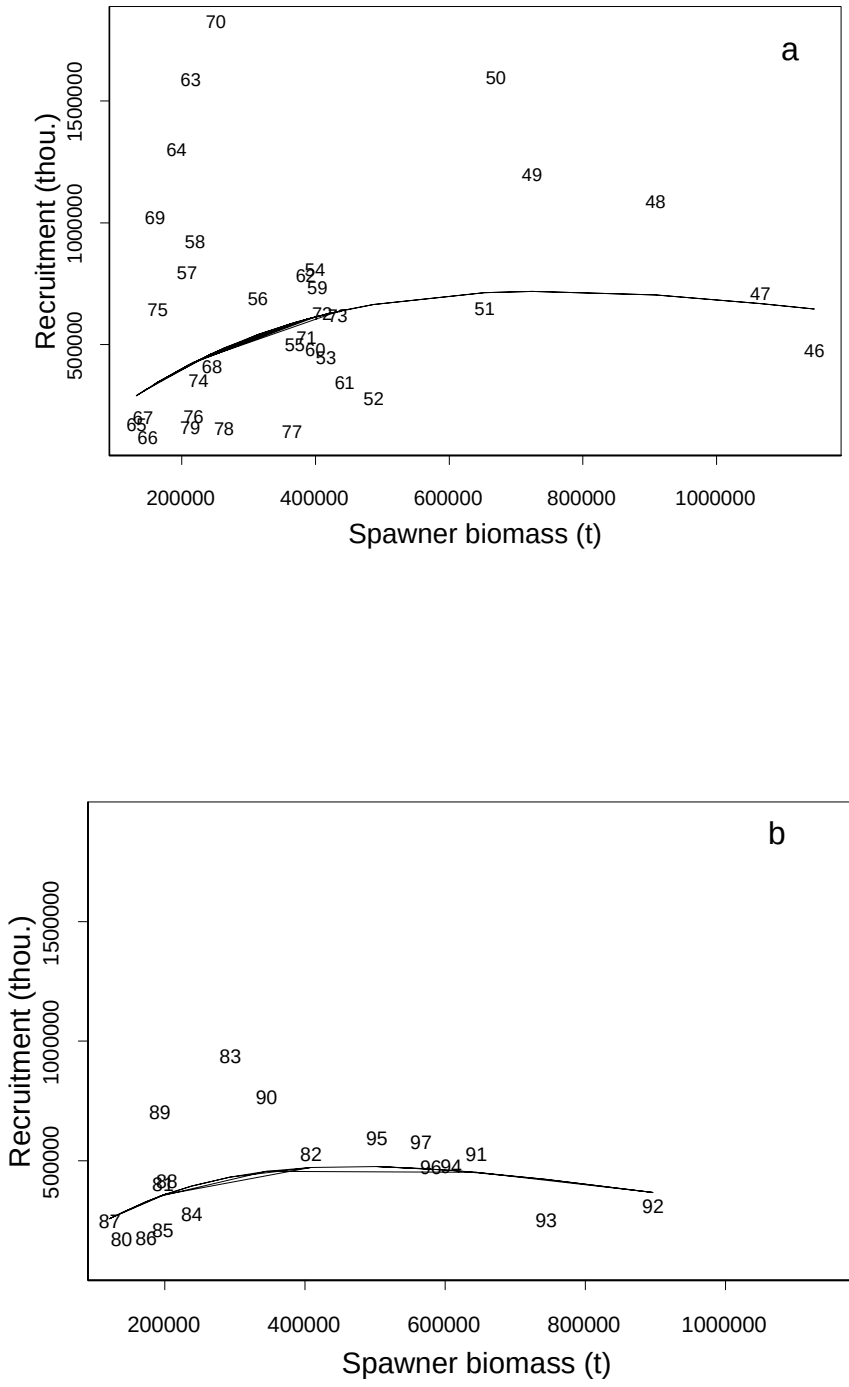


Figure 10.2 The SSB/R relationships for a) 1946 to 1979 year classes; and b) 1980 to 1997 year classes. Adapted from peer review by Beckett and Serra (2001). Observations are labelled by year class. Ricker curves for each time period are indicated as a solid line.

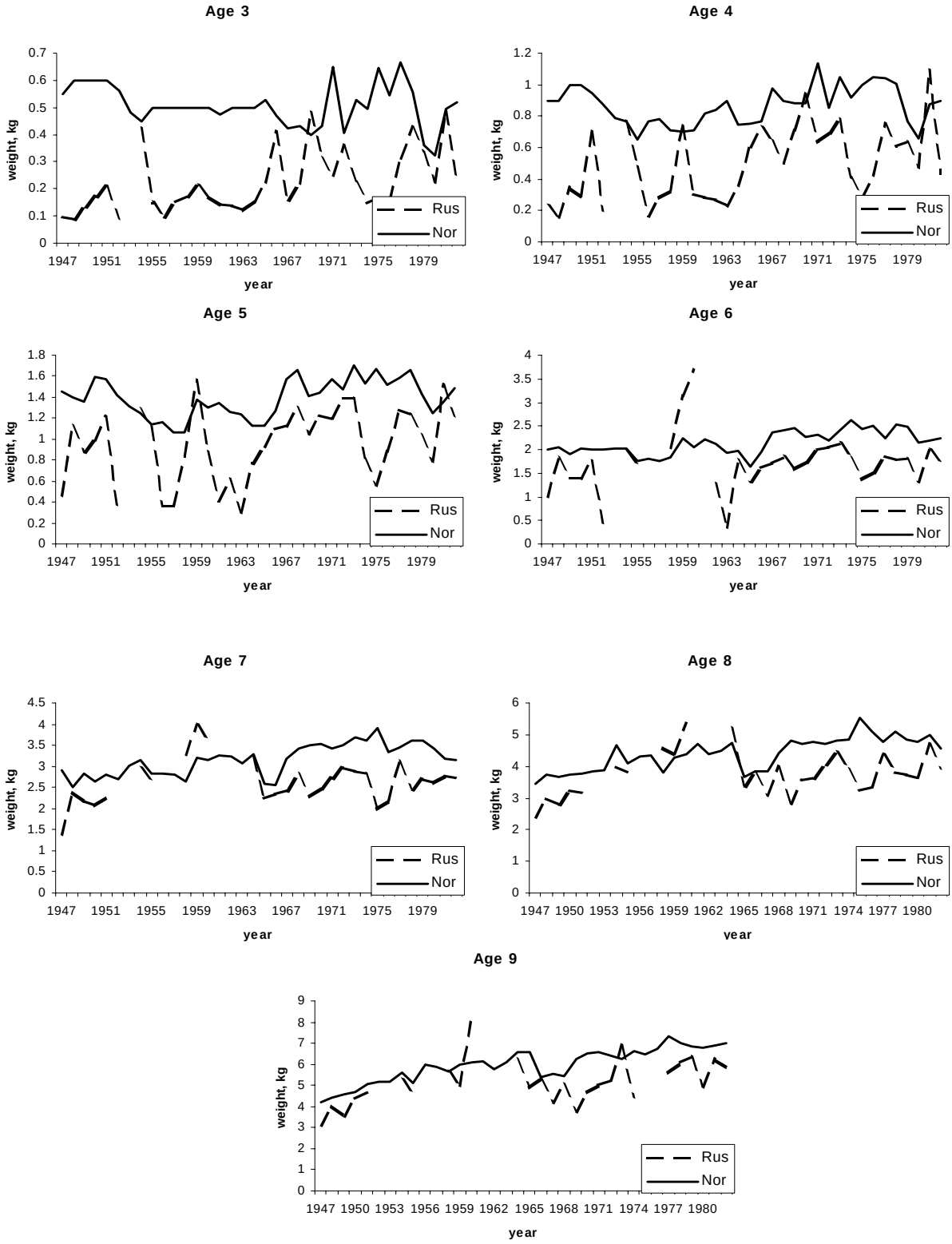


Figure 10.3 Trends in weight-at-age in the Russian and Norwegian data for 1947-1982.

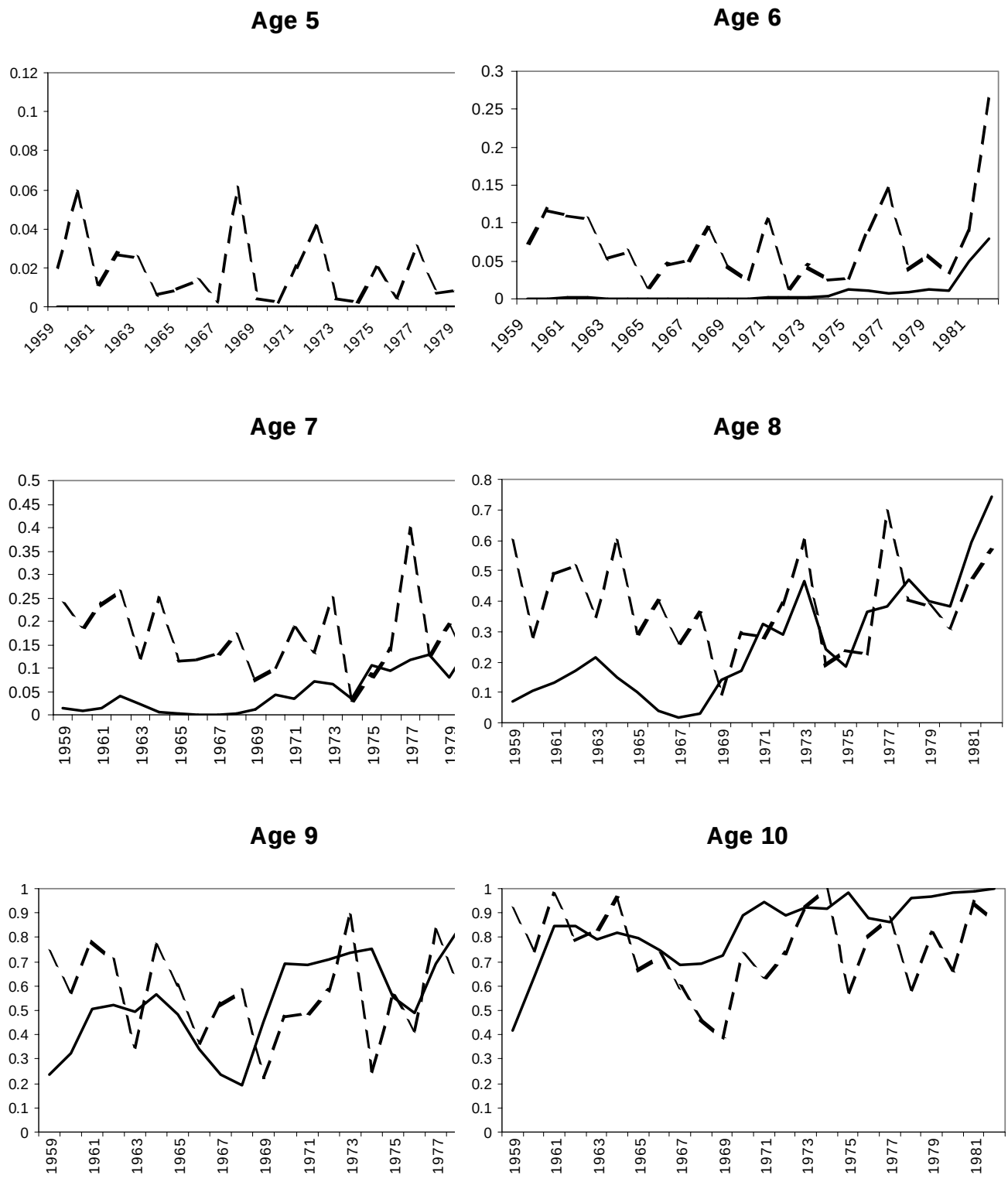


Figure 10.4 Trends in maturity-at-age in the Russian and Norwegian data for 1947-1982. Dashed line is the Norwegian data and solid line is the Russian data.

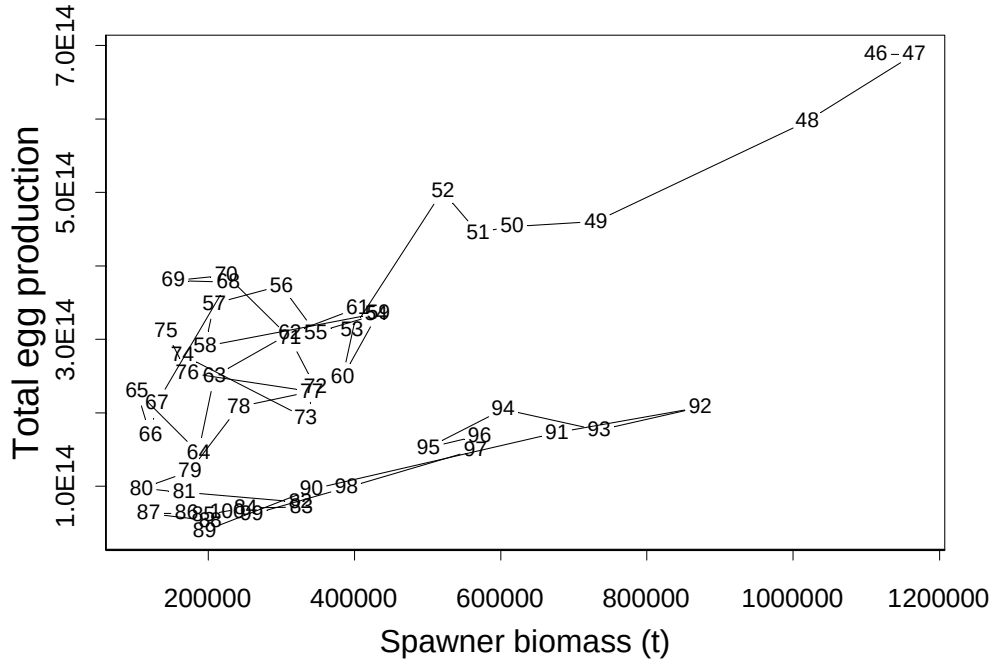


Figure 10.5 Relationship between SSB and total egg production by Northeast Arctic cod (C.T. Marshall, unpub. data). Total egg production was estimated by converting VPA numbers-at-age to numbers-at-length using age/length keys developed from Norwegian commercial sampling (pre-1981) and combined survey and commercial sampling (1981 to present). A general fecundity model developed from empirical observations for 1986-1991 was used to estimate fecundity-at-length.

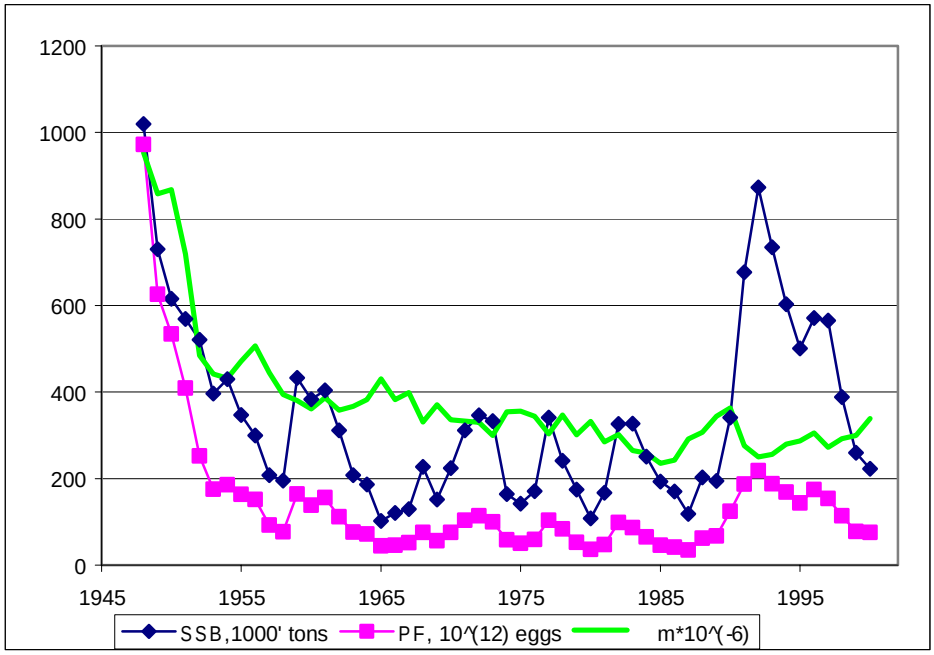


Figure 10.6 Time-series of SSB of Northeast Arctic cod (in thousand t), population fecundity (PF, 10^{12} eggs) and relative population fecundity (m, 10^6 egg t^{-1}). Variation in the time-series for population fecundity and relative population fecundity are expressed on a relative scale rather than an absolute scale. Adapted from Borisov and Bulgakova (WD2).

11 WORKING DOCUMENTS

WD#	Title	Authors
1	Ecological conditions in the Barents Sea, 2001-2002	Loeng, H., Dalpadado, P., Ingvaldsen, R., Ottersen, G. and Stiansen, J. E.
2	An attempt to incorporate environmental factors in stock-recruitment relationship for NEA cod.	Borisov, V. and Bulgakova, T.
3	Incorporating age diversity and temperature in the stock-recruitment relationship of Northeast Arctic cod.	Ajiad, A. M. and Jakobsen, T.
4	Revision of PA referents points for NEA cod.	Kovalev, Y.A.
5	Reference points for Norwegian coastal cod	Berg, E.
6	Simulation of feeding, growth and maturation rate of cod in the Barents Sea	Filin, A.
7	Proposal on the estimation of Bpa for cod of the Lofoten-Barents population	Tretyak, V.L.
8	Currently applied method to estimate maturity ogives of haddock and suggestions on its improvement	Lepesevich Y.M.
9	Consumption of various prey species by cod in 1984-2001	Dolgov, A.V.
10	Prognosis for development of the Barents Sea capelin stock	Gjøsæter, H.
11	Is impact of blue whiting on cod juveniles significant?	Dolgov, A.V, Sokolov, A.M, Mamylov, V.S.
12	Some peculiarities of saithe feeding in the Barents Sea in 1999-2001	Dolgov, A.V.
13	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	Dingsør, G. E.
14	Misreporting – Results from Norwegian investigations on coastal gillnet fisheries, 2000	Hareide, N.-R. and Garnes, G.
15	Precision in age determination of Northeast Arctic cod	Aanes, S.
16	Short status of the results from Norwegian-Russian cod and haddock age readings	Nedreaas, K.H., and Yaragina, N. A.
17	Russian CPUE-indices and stock biomass estimates of Northeast Arctic cod.	Nakken, O.
18	Estimating fishing mortalities and stock numbers of Northeast Arctic cod	Nakken, O.
19	Treatment of zero values in tuning fleet data	Aglen, A.
20	Forecasting TAC for the Barents Sea shrimp based on production models.	Korzhev, V.A. and Berenboim, B.I.
21	Observer program for juvenile Northeast arctic saithe	Borge, A. and Mehl, S.
22	Results from Joint Norwegian-Russian demersal fish survey in the Barents Sea, February 2002	Aglen, A.
23	The Spanish Northeast Arctic shrimp fishery in 2001	Casas, J. M.

24	Length distribution, sex ratio and length-at-maturity of shrimp, *Pandalus borealis*, in the Svalbard area (Division IIb).	Casas, J. M.
25	The Spanish NE Arctic cod fishery in 2001	Casas, M., and Murua, H.
26	Results of the Russian survey of Saithe in the Barents Sea in 2001	Drevetnyak K.V.
27	Results of Russian bottom trawl survey for Sebastes mentella in the Barents Sea and Spitsbergen area in October-Desember 1997-2001	Drevetnyak K.V.
28	Russian investigation of redfish (*Sebastes mentella* Travin) from the Norwegian-Barents Sea stock in 2001	Drevetnyak, K.
29	Abundance of saithe Finnmark – Møre autumn 2001. In Norwegian with English legends	Korsbrekke, K. and Mehl, S.
30	The demersal fish survey in the Barents Sea and the Svalbard area during summer 2001	Michalsen, K., Pennington, M., Aanes, S., Totland, A., Solbakken, L. and Høines, Å.
31	Spanish bottom trawl survey "Fletan Artico 2001" in the slope of the Svalbard area, ICES Division IIb	Pax, X., Casas, J.M. and Gonzalez, D. M.
32	Results of the Russian survey of Greenland halibut in the Barents Sea in 2001	Smirnov O.V.
33	Results from the Russian survey of bottom fish stocks in the Barents sea and adjacent waters in October-December 2001	Sokolov, A., Gusev, E.and Ratushny, S.
34	Proposal on the estimation of Flim and Blim for cod of the Lofoten-Barents population.	Tretyak, V.L.

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APPENDIX 1

WORKING DOCUMENTS

ARCTIC FISHERIES WORKING GROUP 2002

Working Document No. 3 to the
Arctic Fisheries Working Group
16 – 25 April 2002

INCORPORATING AGE DIVERSITY INDEX AND TEMPERATURE IN THE STOCK-RECRUITMENT RELATIONSHIP OF NORTHEAST ARCTIC COD

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ABSTRACT

A novel model that incorporates an age diversity index for Northeast Arctic cod from the spawning grounds and temperature from the Kola section during August to December is developed to analyse the stock-recruitment relationship. We demonstrate that such a model:

$$R = a * ssb * EXP^{-b*ssb} * EXP^{c*H+d*T}$$

where R=recruits, ssb=spawning stock biomass, H=diversity index and T=temperature accounts for 70% of the variation in the Northeast Arctic cod recruitment after 1970. This is a considerable improvement over the traditional Ricker Model (coefficient of determination R^2 =0.33). This model can be also used for prediction purposes based on climate forecast.

MATERIALS AND METHODS

Data on the number of recruits and the spawning stock biomass were taken from the last report of the ICES Arctic Fisheries Working Group (ICES, 2001). Monthly temperature data from August to December were taken from a series of measurements from the Kola section in the Barents Sea during the period 1971-1995. The average temperature over the months of August-December (FigURE 5) was selected because this represents the first feeding period for 0-group cod in the Barents Sea. This coincides with the peak abundance of zooplankton during summer and early autumn, which represents the primary food source for 0-group cod. According to Ponomarenko (1983), the survival rates of the 0-group are mainly dependent on the condition (length, weight, condition factor and stomach fullness) of the fingerlings, the temperature of the first winter season, and the euphausiid abundance. However, trials indicate that the results are not very sensitive to the choice of temperature period within the year of spawning.

The diversity of the age structure of the spawning stock each year according to commercial sampling data from the Lofoten Islands is estimated using a Shannon diversity index (Magurran, 1988).

$$H = -\sum_{i=1}^{k} p_i \ln p_i$$

where p_i is the proportional abundance of age i and k=number of age groups.

Ricker (1975) proposed a functional form between the number of recruits and the spawning biomass, which is commonly used:

$$R = a * ssb * EXP^{-b*ssb} \qquad (1)$$

where a and b are parameters, R is the recruits and ssb is the spawning stock biomass. Following Stocker et al. (1985) one can extend the Ricker model to include an environmental factor, in this case temperature:

$$R = a * ssb * EXP^{-b*ssb} * EXP^{d*T} \qquad (2)$$

The above model can be extended further to include age diversity of the spawning stock and the final model becomes:

$$R = a * ssb * EXP^{-b*ssb} * EXP^{c*H+d*T} \qquad (3)$$

The parameter values (a, b, c and d) of the equation (3) were estimated using a non-linear least squares regression (SAS, 1993)

RESULTS AND DISCUSSION

Spawning stock biomass and numbers of recruits at age 3 in the period 1946-1995 are given in Fig. 1. A first trial with the model applied to the whole time series showed that the model failed to predict the strong year classes 1963, 1964 and 1970 (Figure 2). The fit in general seemed to improve after 1970 and applying the model only to the period 1971-1995 gave a much better fit. The analysis is restricted to this period.

Comparing the two periods, 1946-1970 is characterized by high level of recruitments and SSB, with overall means of 759 mill. and 419 000 t, respectively, and 1971-1996 with a low level both for recruits and SSB; 484 mill. and 339 000 t, respectively. In addition, the later period is characterized by a high rate of stock decline, a sustained period of very low temperatures from 1977 to 1982, the longest cold period since 1920 (Sætersdal and Loeng, 1983), and two collapses of the Barents Sea capelin stock (Gjøsæter, 1998) with severe implications for cod growth and cannibalism (Nakken, 1994).

The statistical relationship between SSB, age diversity and temperature is measured by the correlation coefficient. The text table below shows the correlation matrix of recruits to the SSB, the age diversity index H and T, the average temperature during August to December.

	SSB	H	T
Recruits	0.4879	-0.3971	0.6575

Positive and strong correlation between the recruits and the temperature is observed during the entire period (Fig. 3). In contrast, the age diversity index is negatively correlated with number of recruits (Fig. 4). A non-linear regression based on spawning stock biomass, diversity index and average temperature explained 70% of the observed variance of the recruits during 1971-1995. Spawning stock biomass alone explained 33%, but 67% of the variance was explained by adding the temperature (Table 1). Hence, only the remaining 3% was explained by adding the diversity index.

The diversity index generally increases with increasing number of age groups in the spawning stock. Since 1946, the tendency has been that fewer age groups have contributed to the spawning stock and the diversity index shows a declining trend (Fig. 6). The negative relationship indicates that the recruitment will increase with decreasing age diversity of the spawning stock. Although the effect is rather small and possibly not statistically significant, this result does not support the expectation that multiple spawners give more recruits because of higher egg survival (Marshall *et al.*, 1998, 1999).

Observed and estimated recruits based on equation (3) are compared in Figure 7. The model fit is very close for the strong year classes, except for 1995, and the largest deviations between observed and predicted value occur for some of the smallest year classes.

The stock-recruitment relationship of the Northeast Arctic cod is very important in management considerations, and in particular the biological biomass reference points are currently debated. However, the model has so far not included environmental factors or age diversity of the spawners. In the present study, a strong link between temperature and recruits at age 3 is evident. Including temperature in the model improves the stock-recruitment relationship, which for this period (1971-1995) is relatively strong (Figure 8).

In evaluating biological reference points for this stock, the crucial question is whether the period after 1970 represents a regime that is different from the previous one and therefore more relevant to the present situation. The cold periods and capelin collapses referred to above may be indications of a regime shift. Another, perhaps additional explanation could be the observation of Ottersen *et al*. (1994) who concluded that with a reduction in the age distribution of the spawners, the recruitment of Northeast Arctic cod becomes more sensitive to changing environmental conditions. Because the reduction in the age distribution of the spawners is linked to the high level of exploitation, the high fishing mortalities in the recent period could therefore also have contributed to a change.

The possibility of predicting recruitment is still restricted by the lack of reliable temperature forecasts, and in the case of Northeast Arctic cod the usefulness of a prediction is also limited because of the relatively late age of recruitment to the fisheries. However, in medium-term forecasts the relationship implied by the model could be used to generate more realistic scenarios.

ACKNOWLEGMENT

Thanks to John Alvsvåg for his help in a setting up a SAS program to estimate diversity index for the period 1932-2000.

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Table 1. Nonlinear parameters estimate.

Model	a	b	d	c	R^2
$R = a * ssb * EXP^{-b*ssb}$	2.6888	1.469E-6			0.339
$R = a * ssb * EXP^{-b*ssb} * EXP^{d*T}$	0.0824	1.698E-6	0.757		0.679
$R = a * ssb * EXP^{-b*ssb} * EXP^{c*H+d*T}$	0.0248	1.489E-6	0.294	0.905	0.704

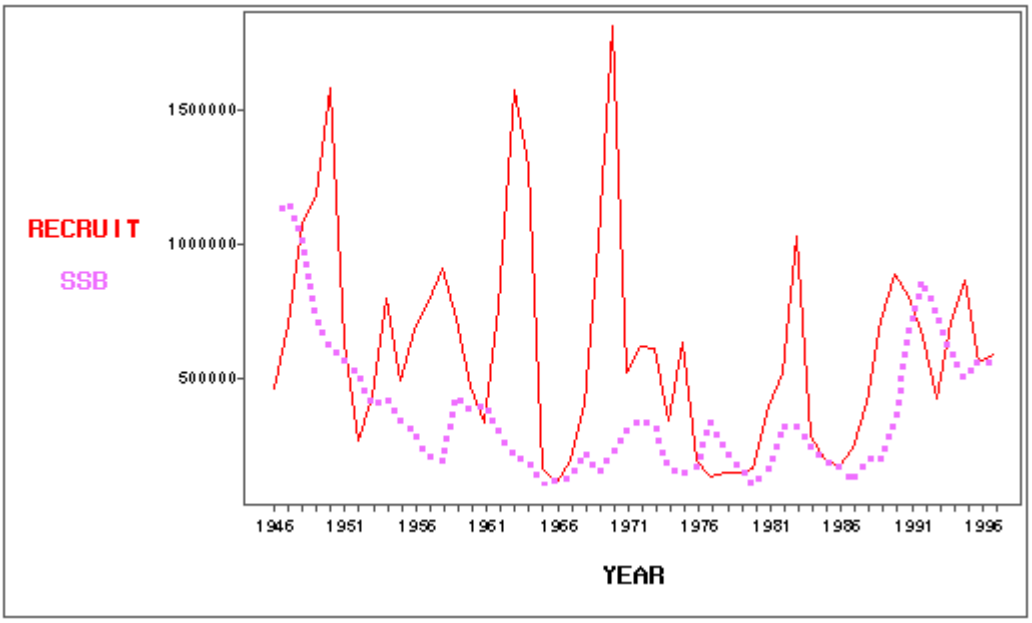

Figure 1. Recruits of Northeast Arctic cod at age 3 and the SSB (dotted line) 1946-1996.

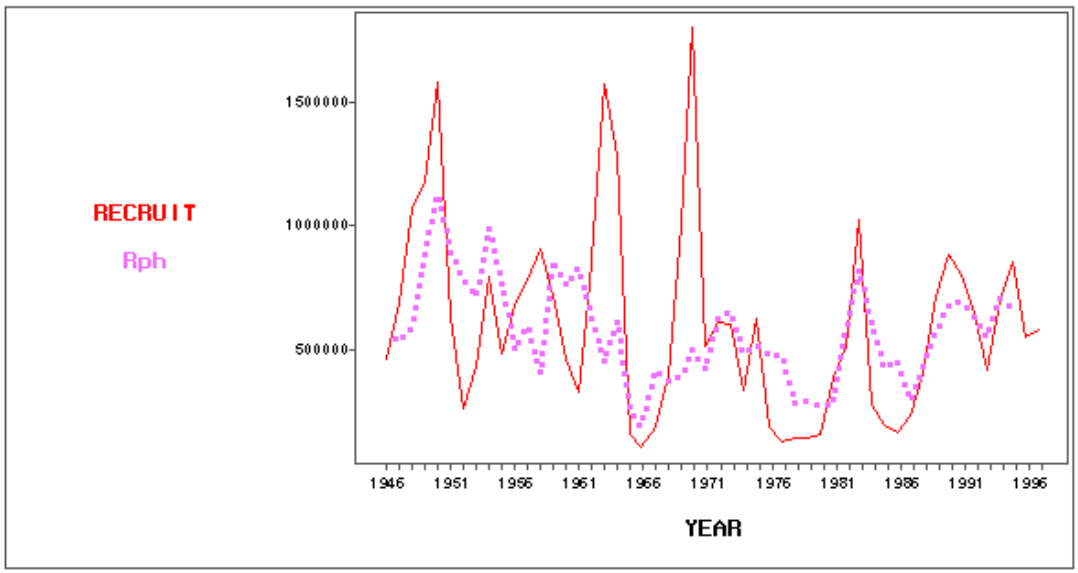

Figure 2. Observed and predicted (dotted) recruitments at age 3 by year.

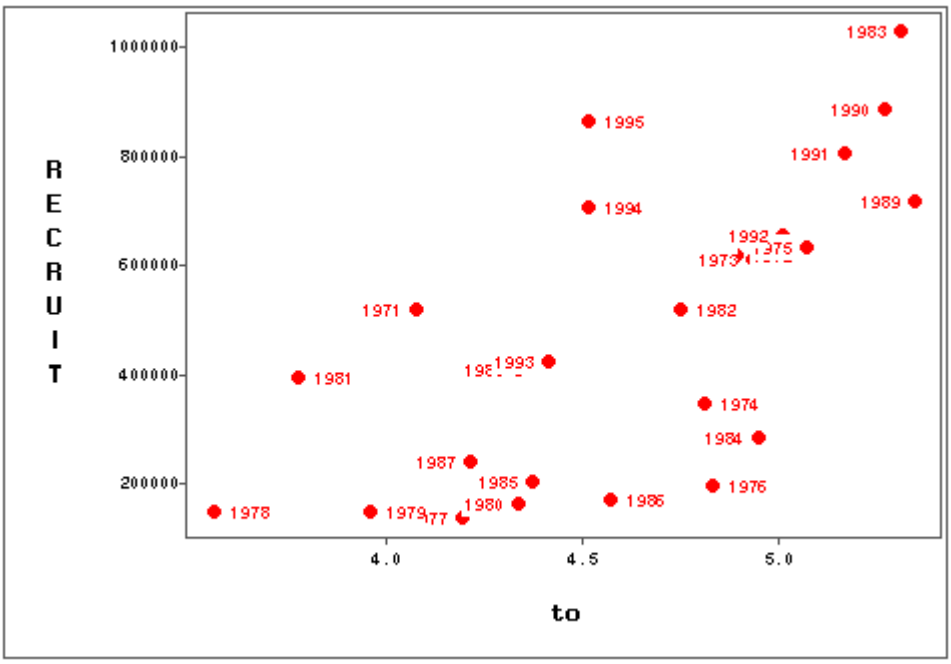

Figure 3. Recruits vs the average temperature (T) from August to December

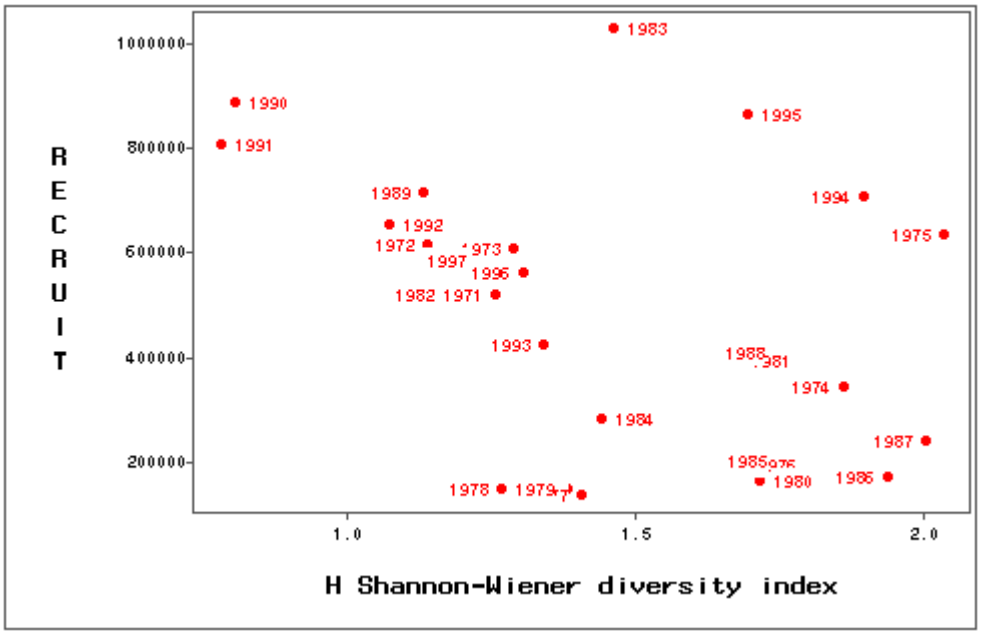

Figure 4. Recruits vs age diversity index.

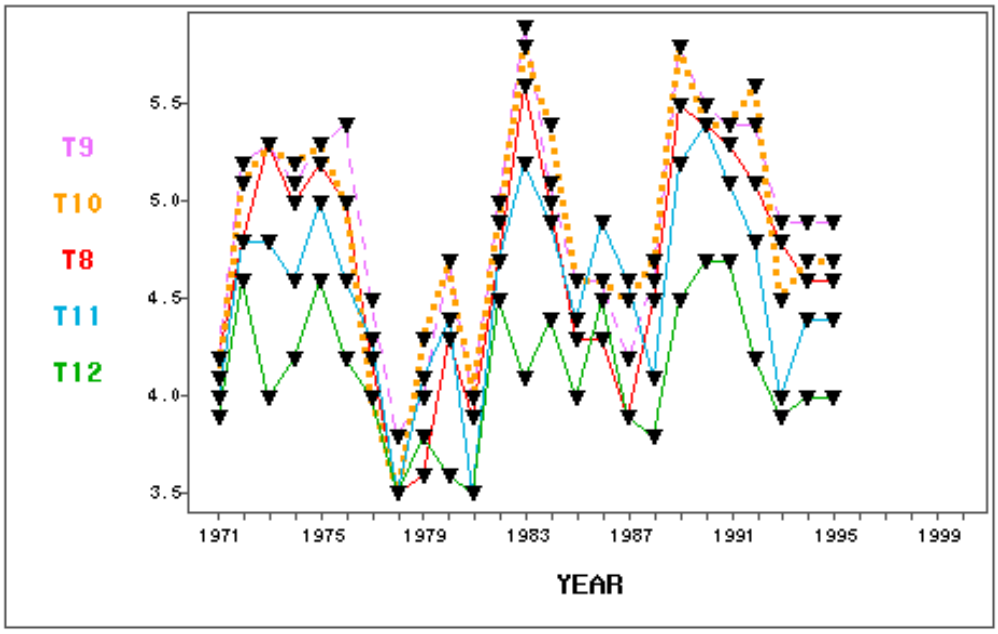

Figure 5 Temperature from August (T8) to December (T12) from the Kola section 1971-1995.

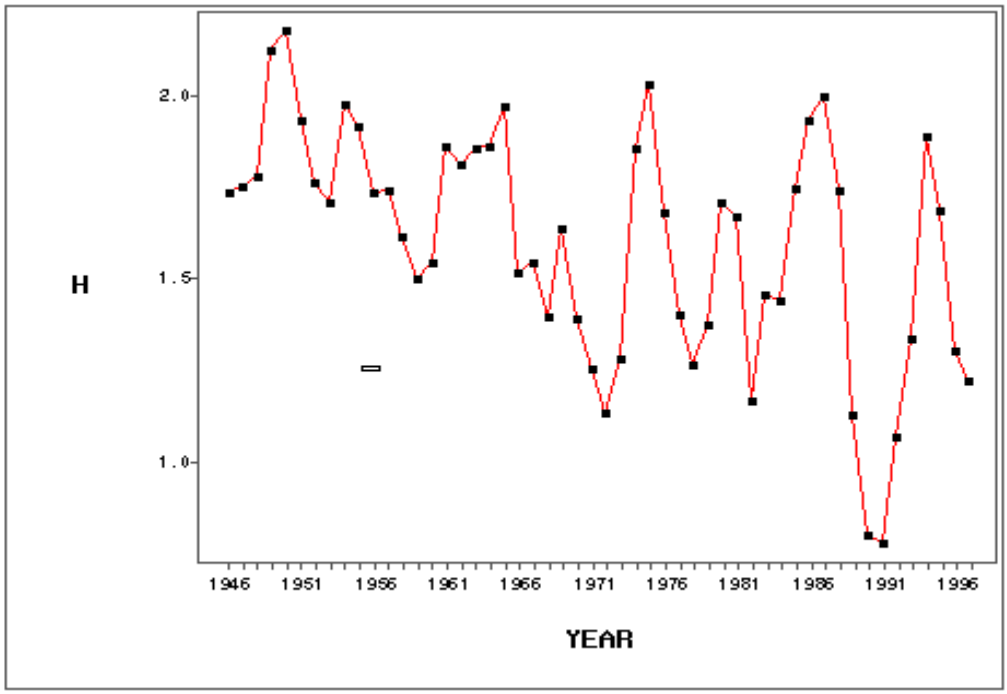

Figure 6. Diversity index (H) from 1946 to 1997

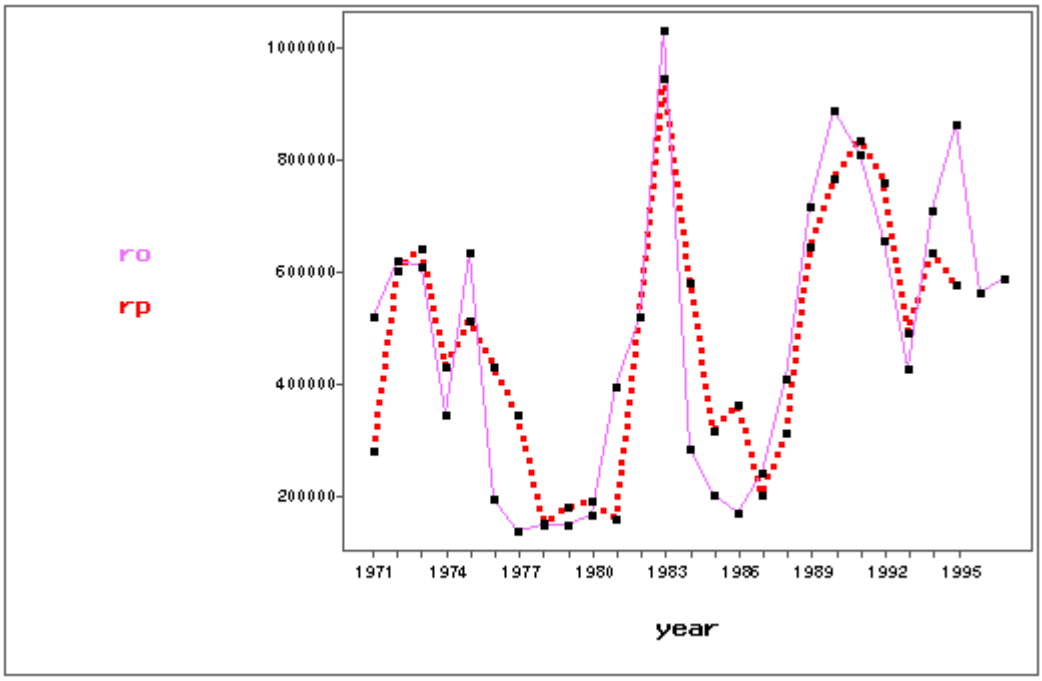

Figure 7 Observed recruits (ro) at age 3 and predicted (rp, dotted) using eq (3).

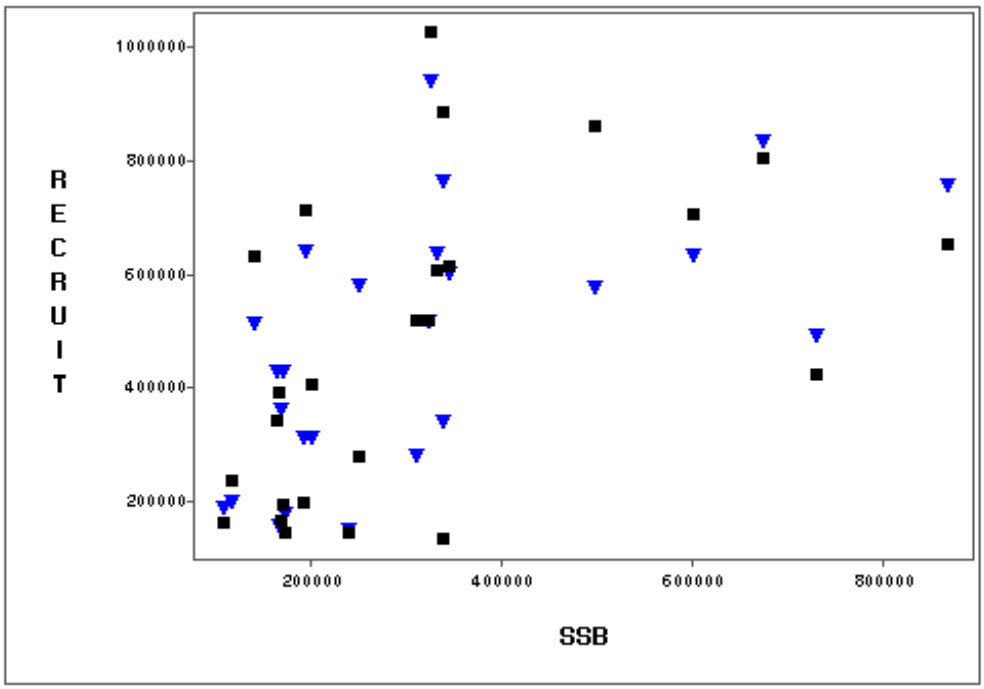

Figure 8. Stock-recruitment relationships observed and predicted (triangles) for the period 1971-1995.

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16 – 25 April 2002

Revision of PA reference points for NEA cod

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Introduction

The revision of historical data on maturity and weights for Northeast Arctic cod made by the Arctic Fisheries Working Group in May 2001 shows considerable changes in cod spawning stock biomass for period 1946 - 1982 compared to previous assessments (Anon. 2000, 2001). This revision of the SSB time series requires that the reference points related to the stock-recruitment plot be reconsidered.

The paper estimates biological reference points (RPs) for NEA cod based on the assessment carried out during the AFWG meeting in May 2001. Estimates of biological reference points were computed using PASOFT software (PA Software User's Guide, 1999).

Material and Methods

Time period. Examining temporal variation in cod growth and maturation indicated that there are two periods with considerable differences in cod biology. The first period was from 1946 to 1981 when increasing trends in weights-at-age (Figure 1), mainly for the older ages and a decreasing trend in age of 50 % maturation were observed (Figure 2). The second period was after 1981 when these parameters varied without any clear trends although changes in the cod stock were quite large (Figures 1, 2). Changes of growth and maturation rate are well known (Joergensen, 1990; Ponomarenko and Yaragina, 1994, 1996; Tretyak, 2000). Most often authors suggest that presently there is more rapid growth because of decreasing density of the cod population. There is also a hypothesis of genetic changes in the population (Borisov, 1978), which results from selective harvesting such that later maturing fish have a lower chance to spawn.

Irrespective of whichever reasons are right there is a discontinuity in the time series of cod SSB. In this paper two time periods were used to estimate biological reference points for NEA cod: the whole time series (1946-2000) and the period from 1982 to 2000. The other reason to choose the period from 1982 for estimation of reference points is that there is an assessment of cod natural mortality due to cannibalism, which could considerably affect RPs estimates (Kovalev and Tretyak, 2001).

A previous investigation indicated that the results of F reference points assessment are rather sensitive to number of years used for averaging exploitation pattern, maturity, natural mortality and weights at age (Kovalev and Tretyak, 2001). A reference point estimated for a short time period may be influenced by coincidental peak in input data. For estimation of biological reference points, input data for the long data-series with different stock levels and different values of the population parameters were used. All biological parameters were averaged for the two periods: the whole data-series available for the stock – 1946-2000 and data-series for 1982-2000.

Since 1984 cannibalism has been included into the cod assessment model. To avoid a discontinuity in the recruitment time series, which includes years prior to 1984, cod assessment without cannibalism (Anon. 2001) was used to fit the SSB recruitment relationship (Table 1). The LOWESS non-parametric method for SSB recruitment relationship is used in PA-soft (Cook, 1998). For both time-series the corresponding data on SSB and recruitment were used. The parameters of the stock/recruitment relationship were obtained using the following settings of the LOWESS fit: the input data were not log-transformed, points representing the origin were included into the data sets, a span equal to 1.0

for 1946-2000 and 0.5 for 1982-2000 were taken. To estimate G_{loss} and $\mathbf{F}_{loss}$, a LOWESS smoother with a span of 0.5 was used. Input data were log-transformed and point of the origin was included in the input data. To simulate uncertainty in the stock and recruitment series for estimation of uncertainty associated with reference points, which use a SSB-R relationship ($\mathbf{F}_{low}$, $\mathbf{F}_{med}$, $\mathbf{F}_{high}$, $\mathbf{F}_{loss}$), the bootstrapping stock recruitment data pairs with 1000 iterations were used.

Input data on cod stock and catch weights-at-age, proportion of mature individuals and exploitation pattern were computed as average values for corresponding periods (Table 2). For estimation of the exploitation pattern and its variability the relative F values from the assessment were used. This avoids the year-to-year fluctuation in the overall fishing mortality. Natural mortality rate and coefficients of its variation for both periods were calculated using data taken from the whole period of available information (1984-2000). For ages older then 5 inter-annual CV for natural mortality was set at 0.1. Also for weights, maturity and F for ages older than 10 coefficients of variation were set equal to 0.2.

Results and discussion

The PA-soft outputs are given as a series of tables and plots. There is a plot and a table with estimates of some reference points and their distributions. In addition, 4 plots are provided summarising the modelling output. Stock recruitment plots are presented with a LOWESS smoother as a possible stock recruitment relationship and with some reference points indicated. A plot of YPR and SPR curves with some reference points are also given. A plot of historical SSB against Fbar with an equilibrium curve based on the LOWESS stock recruitment relationship. A plot of historical yield against Fbar with an equilibrium curve based on the LOWESS stock recruitment relationship.

Fishing mortality reference points estimated using data for 1946-2000

Results of reference points estimation based on the input parameters averaged for period 1946-2000 are given in Table 3 and Figures 3 and 4. The output estimates were $\mathbf{F}_{low}$ = 0.3, $\mathbf{F}_{med}$ = 0.53 and $\mathbf{F}_{high}$ = 0.91. The estimate of $\mathbf{F}_{med}$ is slightly higher than the previous estimate (0.46) given by Jakobsen (1992) and Motos (1998). Conversely, $\mathbf{F}_{loss}$ is estimated in 0.56 which is lower than the previous value (0.7 at Motos paper) and $\mathbf{B}_{loss}$ is 102315 t. The YPR references points are $\mathbf{F}_{0.1}$ = 0.12 and $\mathbf{F}_{max}$ = 0.22, which are both close to previous estimates (0.13, 0.24).

$\mathbf{F}_{loss}$ which was used by AFWG (from 1998) as $\mathbf{F}_{lim}$ is considerably lower for that time series due to changes in equilibrium SPR line mainly and its value close to $\mathbf{F}_{med}$ estimation. The 5^{th} percentile of $\mathbf{F}_{loss}$ is 0.38 that is equivalent to σ of about 0.3 for the estimation of $\mathbf{F}_{pa}$. For other RPs their 5^{th} percentiles correspond to σ about 0.2-0.3.

Fishing mortality reference points estimated using data for 1982-2000

The RPs estimated using input parameters averaged for period 1982-2000 and SSB-R relationship fitted to data for whole time series available for that stock 1946-2000 are given in Table 4 and Figures 5 and 6. These values are considerably higher compare to those derived for the previous period. This is especially true for points based on SPR curve: $\mathbf{F}_{low}$ = 0.45, $\mathbf{F}_{med}$ = 0.83, $\mathbf{F}_{high}$ = 1.54 and $\mathbf{F}_{loss}$=0.88. As for the previous period, $\mathbf{F}_{loss}$ value is close to $\mathbf{F}_{med}$ due to using the same SSB-R plot. The estimates of YPR reference points are $\mathbf{F}_{0.1}$=0.14 and $\mathbf{F}_{max}$=0.26.

As mentioned previously, there is a discontinuity in the SSB-R recruitment relationship taken for period 1946-2000. This problem could be solved if data for period 1982-2000 was used to fit stock-recruitment relationship. The LOWESS SSB-R relationship fitted using span parameter equal 0.5 is more appropriate for period 1982-2000 (Figure 8). The RPs estimated using all input parameters including SSB and recruitment data for period 1982-2000 are given in Table 5 and Figures 7 and 8. As expected only the reference points derived with using SSB – recruitment relationship were changed in this run: $\mathbf{F}_{low}$ = 0.38, $\mathbf{F}_{med}$ = 0.65, $\mathbf{F}_{high}$ = 1.10 and $\mathbf{F}_{loss}$=0.93. Since the SSB-recruitment plot taken for that period has very few points in areas of low SSB the estimate of $\mathbf{F}_{loss}$ for that period is very uncertain (Figure 7, Table 5). $\mathbf{F}_{loss}$ estimated for that period is very close to the fishing mortality which correspond to replacement line to origin (Figure 8, top/left) and may not be an appropriate candidate $\mathbf{F}_{lim}$ as it was adopted by AFWG.

Changes in NEA cod stock recruitment plots made by AFWG in 2001 shows that SSB values in the period up to 1982 were overestimated by previous assessments (Figure 9). Such shifting points in SSB-R plot to the left should considerably increase estimates of the RPs which use a SSB-R plot ($\mathbf{F}_{low}$, $\mathbf{F}_{med}$, $\mathbf{F}_{high}$) compared to there previous assessment (Motos, 1998). The results of RPs estimation show this to be the case.

As expected from changes in cod population parameters, there are considerable difference between the equilibrium curves derived for two periods (Figure 10). Both the equilibrium yield per recruit and SSB per recruit lines show that

the productivity of the cod population is higher in period since 1982 compare to previous time. The maximum equilibrium yield estimated for period 1982-2000 is approximately 15 % higher and corresponding value of $\mathbf{F}_{max}$ for that time series also higher (0.26 against 0.22 estimated for period 1946-2000). It is could be seen also from RPs estimates, those calculated from data of whole time series are smaller. On the other hand the mean recruitment for period since 1982 is smaller than those for whole time series (426 against 580 millions individuals (according to assessment made without cannibalism), correspondingly).

The choice of period for input data to derive RPs estimates is a crucial factor influenced on their estimates (Table 6). There are some signals that RPs for 1946-2000 could be underestimated. The actual points (yield or SSB and corresponding Fbar) for that time series lies mainly above the equilibrium yield and SSB lines which based on the LOWESS stock recruitment relationship (Fig.4, bottom/left diagrams). In contrast to this RPs which use a SSB-R plot for period 1946-2000 and estimated using other input data for period 1982-2000 could be overestimated since the actual points for that data series lies mainly below the equilibrium SSB (Figure 8, bottom/left diagram).

Biomass reference points. According to recommendations of Study Group on the Further Development of the Precautionary Approach to Fishery Management, the preferred procedure for determining biomass reference points $\mathbf{B}_{lim}$ and $\mathbf{B}_{pa}$ is to use the SSB-R plot (Anon., 2001). In that report there are examples of the typical plots. The NEA cod SSB-R plot taken for period 1982-2000 more corresponds to two such typical plots (Figure *a* on page 35 and figure *c* on page 36 in SGPA report (Anon.,2001), also shown it appendix to this working document). According to that plot the recruitment of NEA cod increases with increasing SSB until SSB reach the value around 350 thousands tonnes (Figure 11) and then begins to decrease with increasing SSB. Such a dynamic could be explained by cannibalism (Figure 11a). The changes in capelin biomass alone can not explain this increase in cannibalism (Figure 11c). This is a clear signal of the influence of increased predator's abundance (older cod). For this type of SSB recruitment plot the SSB value corresponds to the maximum recruitment could be taken as $\mathbf{B}_{pa}$ reference point.

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Table 1. SSB-R series assessed **without cannibalism** used for the computation of reference points for NEA cod. Yield and Fbar (5-10) used in the plots are also shown. All values taken from AFWG (2001).

Year	SSB	Recruitment	Yield	Fbar
1946	1112776	728139	706000	0.1857
1947	1165059	425311	882017	0.3047
1948	1019114	442592	774295	0.3398
1949	729879	468348	800122	0.3619
1950	615339	704908	731982	0.3566
1951	568705	1083753	827180	0.3966
1952	520599	1193111	876795	0.5348
1953	396417	1590377	695546	0.3572
1954	429694	641584	826021	0.3879
1955	346919	272778	1147841	0.5437
1956	299823	439602	1343068	0.6401
1957	207840	804781	792557	0.5089
1958	195377	496824	769313	0.5169
1959	432489	683690	744607	0.5596
1960	383479	789653	622042	0.4789
1961	404228	916842	783221	0.6348
1962	311678	728338	909266	0.7576
1963	208207	472064	776337	0.9866
1964	186570	338678	437695	0.6789
1965	102315	776941	444930	0.5533
1966	120722	1582560	483711	0.5302
1967	129784	1295416	572605	0.5439
1968	227215	164955	1074084	0.5704
1969	151870	112039	1197226	0.8292
1970	224482	197105	933246	0.7493
1971	311662	404774	689048	0.5956
1972	346511	1015319	565254	0.6928
1973	332913	1818949	792685	0.602
1974	164491	523916	1102433	0.5633
1975	142028	621616	829377	0.6595
1982	171238	613942	867463	0.6457
1977	341385	348054	905301	0.8379
1978	241536	638490	698715	0.9406
1979	174699	198489	440538	0.7264
1980	108253	137735	380434	0.7241
1981	166925	150863	399038	0.8632
1982	326131	151833	363730	0.7583
1983	327177	166679	289992	0.756
1984	251075	397998	277651	0.9162
1985	193456	523644	307920	0.7039
1986	170266	930532	430113	0.8652
1987	118371	270685	523071	0.9517
1988	202396	202931	434939	0.9763
1989	194764	172717	332481	0.6607
1990	340999	242677	212000	0.2721
1991	676607	408173	319158	0.3184
1992	872624	700259	513234	0.4542
1993	733903	758325	581611	0.5524
1994	600647	522092	771086	0.8677
1995	500615	306285	739999	0.7899
1996	569741	246769	732228	0.704
1997	565115	473254	762403	1.0398
1998	387922	588784	592624	0.9234
1999	259355	467185	484910	1.0128
2000	222703	573516	414144	0.9067

Table 2. Input parameters for the computation of reference points for NEA cod. All parameters are taken as the average for corresponding period. Columns labelled with CV are coefficient of variation computed for each parameter from the corresponding time-series (see text). Data from AFWG –2001.

1946-2000

Age	M*	CWt	SWt	Mat	F	FPreSpwn	MPreSpwn	M* CV	CWt CV	SWt CV	Mat CV	F CV
3	0.339	0.511	0.347	0.001	0.067	0	0	0.52	0.48	0.24	4.20	1.082
4	0.248	0.870	0.704	0.008	0.263	0	0	0.30	0.36	0.26	2.11	0.576
5	0.211	1.409	1.256	0.031	0.553	0	0	0.10	0.26	0.19	1.26	0.315
6	0.202	2.158	2.036	0.112	0.804	0	0	0.10	0.19	0.16	1.08	0.206
7	0.200	3.161	3.071	0.258	0.997	0	0	0.10	0.17	0.15	0.92	0.198
8	0.200	4.477	4.388	0.438	1.096	0	0	0.10	0.16	0.15	0.65	0.156
9	0.200	5.985	5.966	0.614	1.237	0	0	0.10	0.17	0.17	0.45	0.180
10	0.200	7.616	7.934	0.783	1.313	0	0	0.10	0.17	0.21	0.27	0.181
11	0.200	9.060	9.232	0.894	1.448	0	0	0.10	0.19	0.20	0.20	0.20
12	0.200	10.723	10.171	0.949	1.404	0	0	0.10	0.20	0.20	0.20	0.20
13+	0.200	12.615	12.507	0.981	1.404	0	0	0.10	0.20	0.20	0.20	0.20

1982-2000

Age	M*	CWt	SWt	Mat	F	FPreSpwn	MPreSpwn	M* CV	CWt CV	SWt CV	Mat CV	F CV
3	0.339	0.776	0.301	0.001	0.039	0	0	0.52	0.32	0.35	3.00	0.595
4	0.248	1.199	0.718	0.020	0.204	0	0	0.30	0.25	0.36	1.17	0.297
5	0.211	1.785	1.340	0.072	0.486	0	0	0.10	0.19	0.24	0.56	0.179
6	0.202	2.559	2.206	0.262	0.789	0	0	0.10	0.15	0.18	0.33	0.150
7	0.200	3.646	3.388	0.564	1.089	0	0	0.10	0.14	0.14	0.22	0.153
8	0.200	5.125	4.869	0.790	1.210	0	0	0.10	0.11	0.12	0.14	0.112
9	0.200	6.867	6.813	0.906	1.177	0	0	0.10	0.12	0.13	0.14	0.147
10	0.200	8.396	9.315	0.969	1.250	0	0	0.10	0.12	0.16	0.20	0.206
11	0.200	10.232	10.729	0.997	1.151	0	0	0.10	0.16	0.16	0.20	0.20
12	0.200	12.444	10.846	1.000	1.240	0	0	0.10	0.20	0.20	0.20	0.20
13+	0.200	13.757	13.444	1.000	1.240	0	0	0.10	0.20	0.20	0.20	0.20

* natural mortality was taken from whole period with available data 1984-2000.

Table 3. Output table with estimates of NEA cod BRP. Estimated using input data for period **1946-2000**.

Reference point	Deterministic	Median	80th percentile	95th percentile
MedianRecruits	496824	496824	523916	613942
MBAL	-			
B_{loss}	102315			
SSB90%R90%Surv	243941	246948	320396	400033
SPR%ofVirgin	1.41	2.34	4.11	7.36
VirginSPR	13.32	10.15	14.96	21.76
SPRloss	0.58	0.58	0.68	0.79
	Deterministic	**Median**	**5th percentile**	**20th percentile**
FBar	-	-	-	-
F_{max}	0.22	0.22	0.16	0.19
$F_{0.1}$	0.12	0.12	0.09	0.11
F_{low}	0.30	0.29	0.14	0.22
F_{med}	0.53	0.54	0.36	0.44
F_{high}	0.91	0.99	0.62	0.77
F35%SPR	0.12	0.13	0.10	0.11
F_{loss}	0.56	0.61	0.38	0.48

Table 4. Northeast Arctic cod. Output table with estimates of BRP. Estimated using input data for period **1982-2000**. For fitting SSB-R relationship the data from period **1946-2000** were used.

Reference point	Deterministic	Median	80th percentile	95th percentile
MedianRecruits	496824	496824	613942	523916
MBAL	-			
B_{loss}	102315			
SSB90%R90%Surv	243941	246341	410398	321607
SPR%ofVirgin	2.75	3.04	4.89	3.88
VirginSPR	16.98	15.65	26.59	20.68
SPRloss	0.58	0.57	0.80	0.68
	Deterministic	**Median**	**5th percentile**	**20th percentile**
FBar	-	-	-	-
F_{max}	0.26	0.26	0.19	0.22
$F_{0.1}$	0.14	0.14	0.11	0.12
F_{low}	0.45	0.42	0.26	0.33
F_{med}	0.83	0.81	0.58	0.68
F_{high}	1.54	1.56	0.97	1.25
F35%SPR	0.15	0.14	0.11	0.13
F_{loss}	0.88	0.90	0.63	0.74

Table 5. Northeast Arctic cod. Output table with estimates of BRP. Estimated using input data for period **1982-2000**. For fitting SSB-R relationship data from period **1982-2000** were used.

Reference point	Deterministic	Median	80th percentile	95th percentile
MedianRecruits	408173	408173	522170	473254
MBAL	-			
B_{loss}	118371			
SSB90%R90%Surv	292182	292182	340999	327944
SPR%ofVirgin	2.75	3.12	5.04	3.98
VirginSPR	16.98	15.39	26.74	20.53
SPRloss	0.53	0.76	70.03	1.19
	Deterministic	**Median**	**5th percentile**	**20th percentile**
FBar	-	-	-	-
F_{max}	0.26	0.26	0.19	0.22
$F_{0.1}$	0.14	0.14	0.11	0.12
F_{low}	0.38	0.37	0.19	0.27
F_{med}	0.65	0.65	0.45	0.54
F_{high}	1.10	1.12	0.75	0.91
F35%SPR	0.15	0.14	0.11	0.13
F_{loss}	0.93	0.76	0.00	0.46

Table 6. Biological reference points of NEA cod estimated using input data for different periods (see text) as a candidates for F_{lim} and corresponding F_{pa} values calculated with different sigma (possible uncertainty of F assessment).

Reference point	**if F_{lim} =**			**then $F_{pa} = F_{lim}$ *exp(-1.645*s)**		
	Deterministic	**Median**	**5th percentile**	**sigma=0.2**	**sigma=0.3**	**sigma=0.4**
1946-2000						
F_{med}	0.53	0.54	0.36	0.38	0.32	0.28
F_{loss}	0.56	0.61	0.38	0.40	0.34	0.29
1982-2000						
F_{med}	0.83	0.81	0.58	0.60	0.51	0.43
F_{loss}	0.88	0.90	0.63	0.63	0.54	0.46
1982-2000 if SSB-R 1982-2000						
F_{med}	0.65	0.65	0.45	0.47	0.40	0.34
F_{loss}	0.93	0.76	0.00	0.67	0.57	0.48

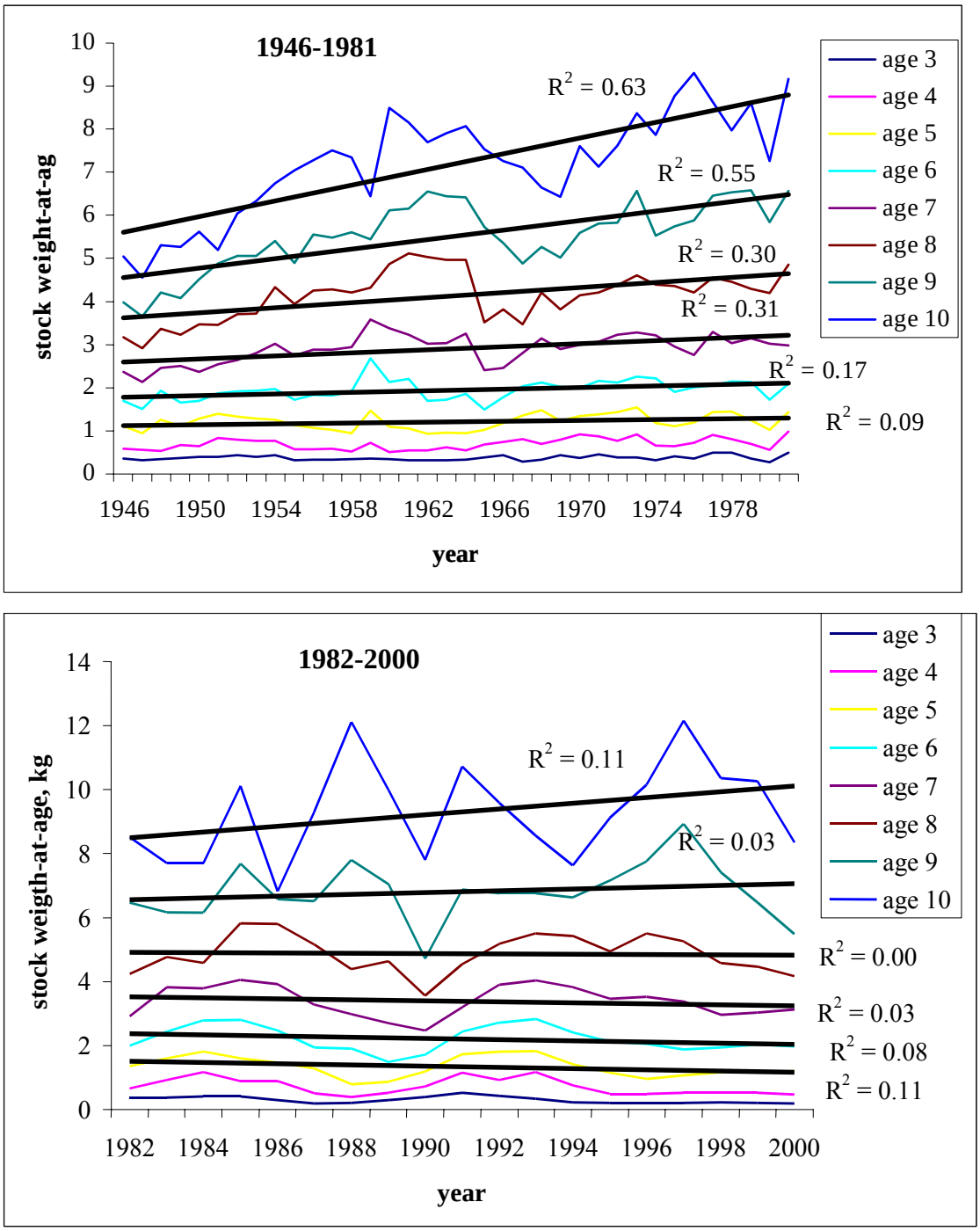


Figure 1. Variation in NEA cod stock weights-at-age and trends in these parameters corresponding to different time series.

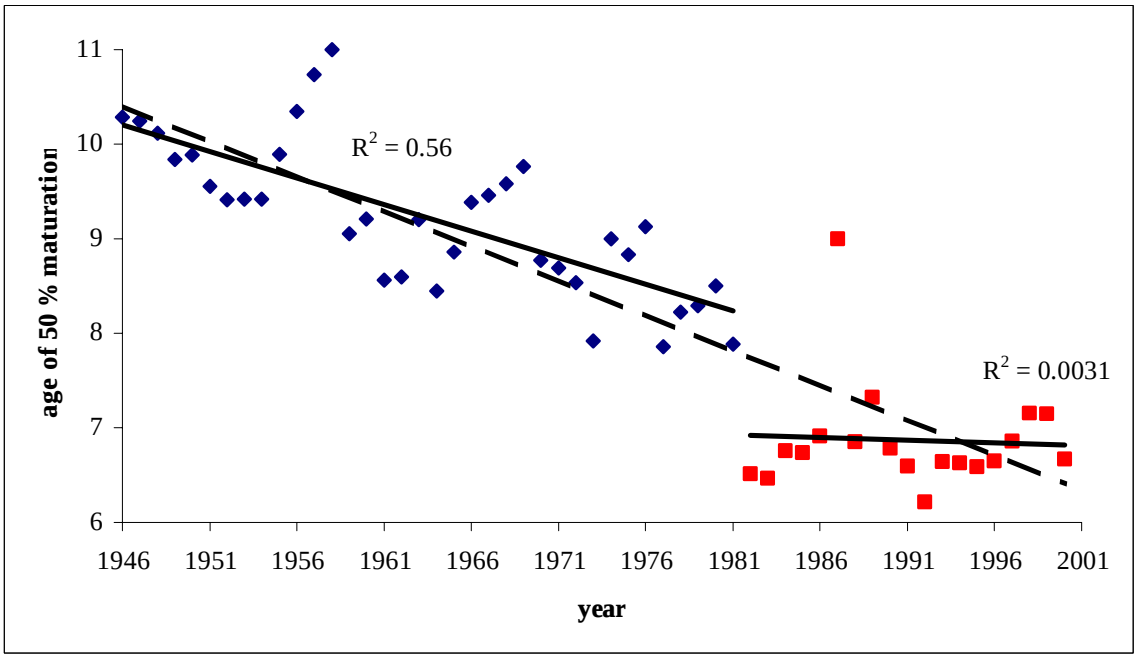


Figure 2. Changes in age of 50 % maturation of NEA cod and trends corresponding to different time series.

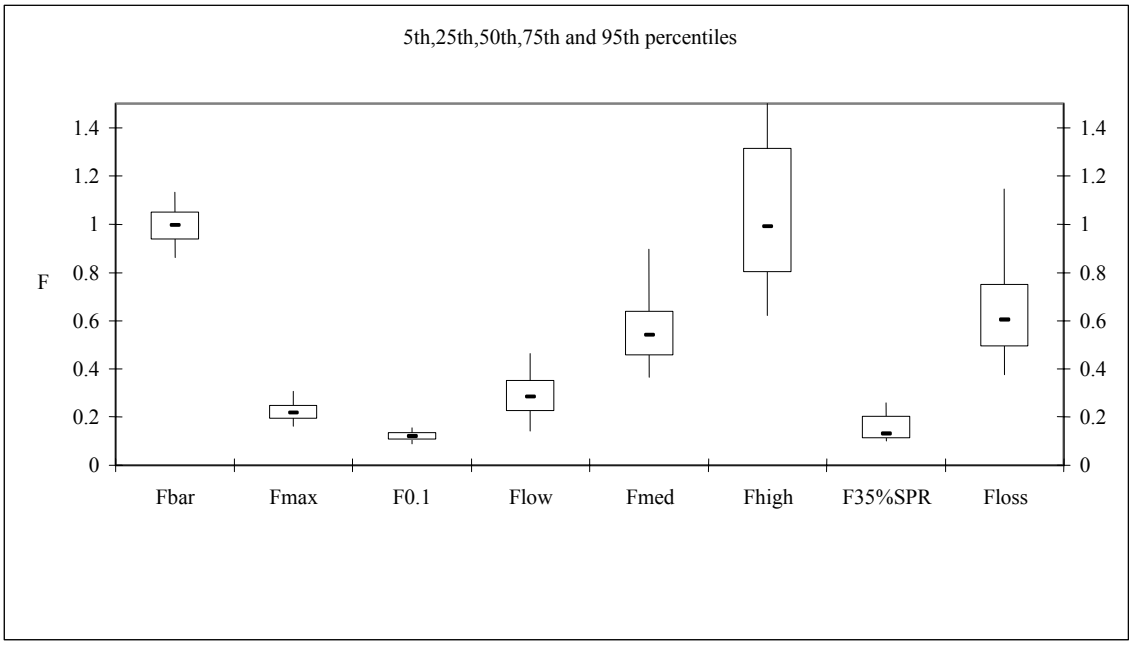


Figure 3. Box and whisker plots for the series of NEA cod F reference points. Estimated using data for period **1946-2000**.

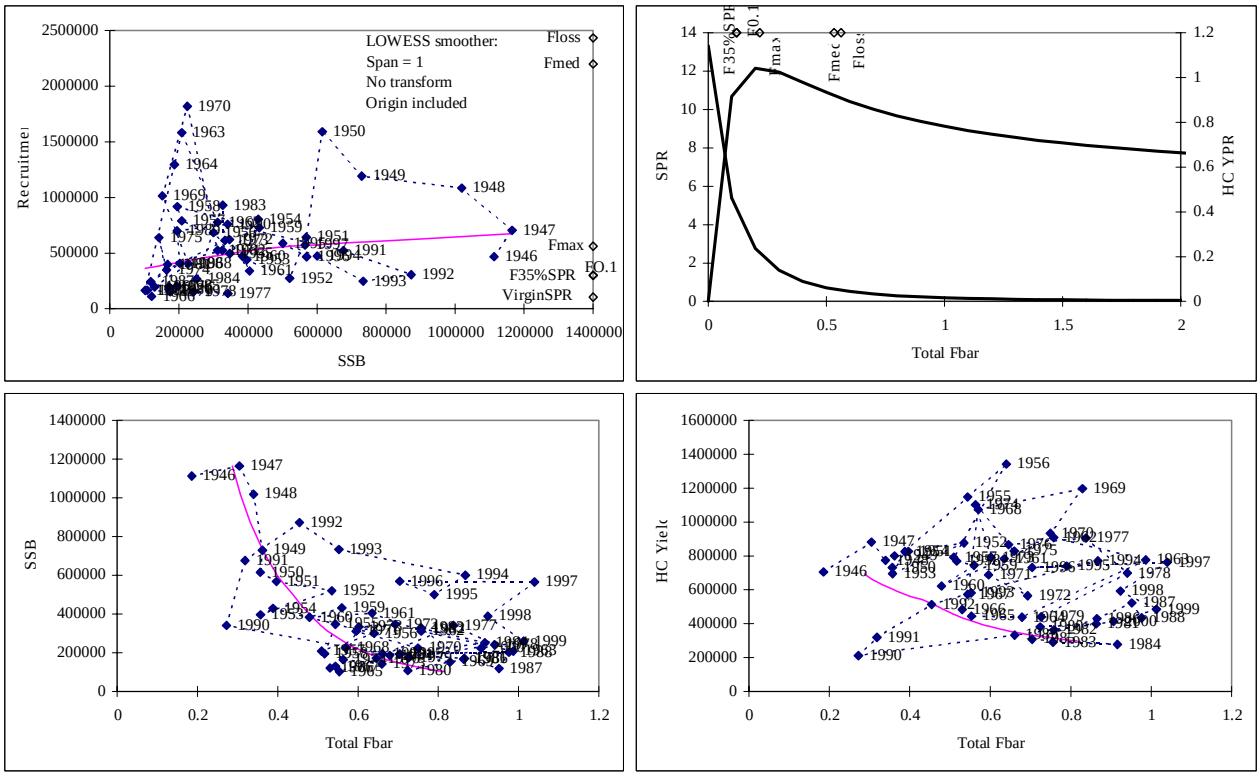


Figure 4. Plots from the PASoft output during estimation of NEA cod reference points using input data for period **1946-2000**:
Top/left: A stock recruitment plot with a LOWESS smoother as a possible stock recruitment relationship. Some reference points are also indicated.
Top/right: A plot of YPR and SPR curves with some reference points indicated.
Bottom/left: A plot of historical SSB against Fbar with an equilibrium curve based on the LOWESS stock recruitment relationship.
Bottom /right: A plot of historical yield against Fbar with an equilibrium curve based on the LOWESS stock recruitment relationship.

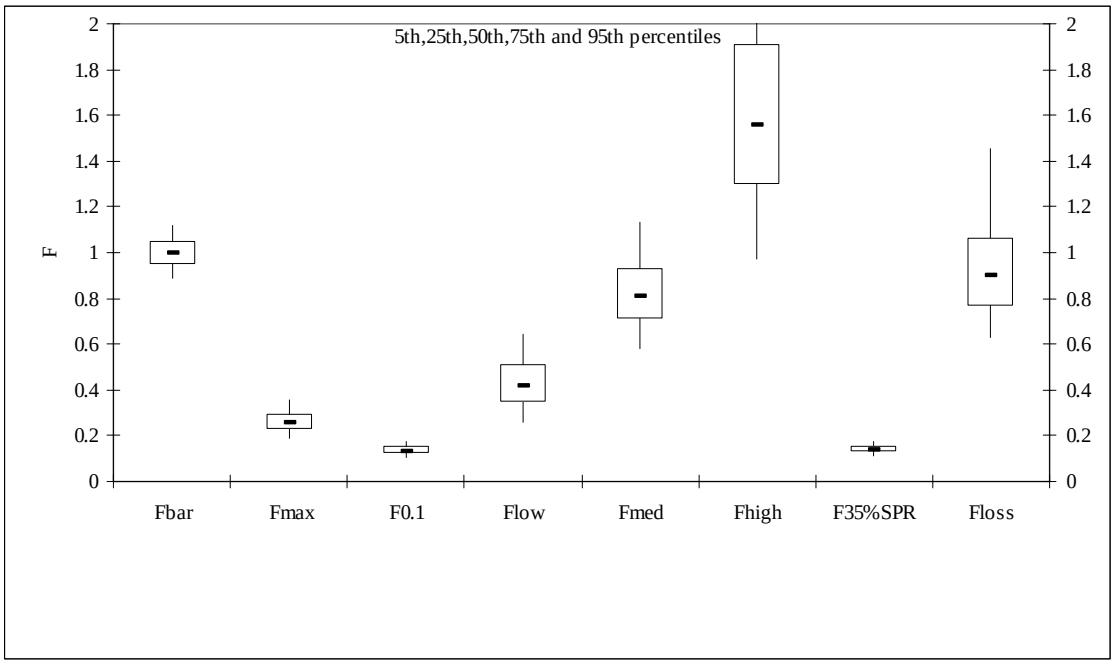


Figure 5. Northeast Arctic cod. Box and whisker plots for the series of F reference points. Estimated using input data for period **1982-2000**. For fitting SSB-R relationship data from period **1946-2000** were used.

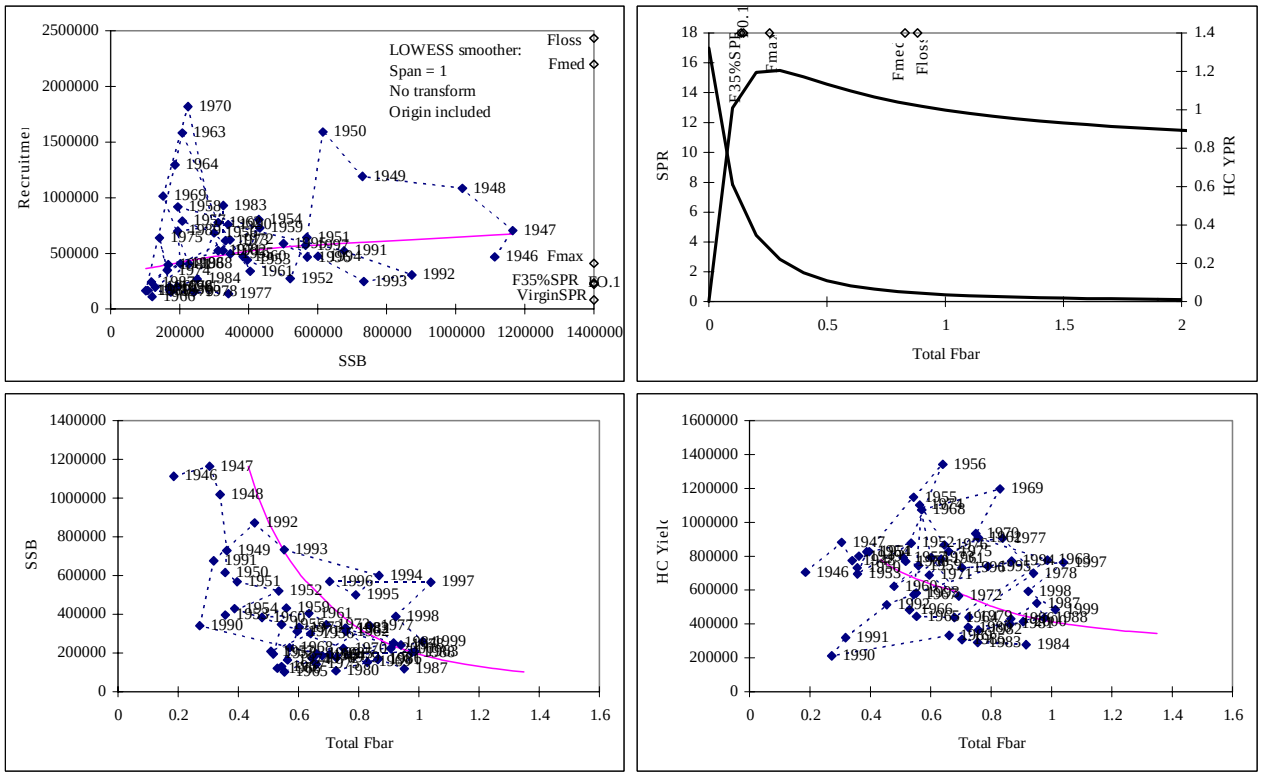


Figure 6. Plots from the PASoft output during estimation of NEA cod reference points using input data for period **1982-2000** and stock recruitment plot for period **1946-2000**:
Top/left: A stock recruitment plot with a LOWESS smoother as a possible stock recruitment relationship. Some reference points are also indicated.
Top/right: A plot of YPR and SPR curves with some reference points indicated.
Bottom/left: A plot of historical SSB against Fbar with an equilibrium curve based on the LOWESS stock recruitment relationship.
Bottom /right: A plot of historical yield against Fbar with an equilibrium curve based on the LOWESS stock recruitment relationship.

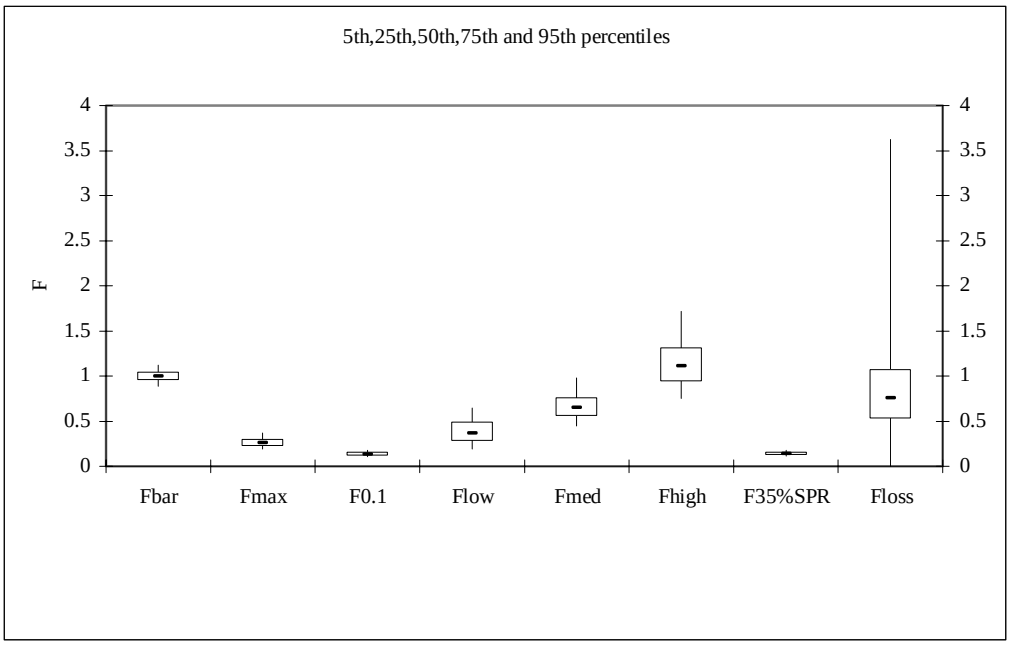


Figure 7. Northeast Arctic cod. Box and whisker plots for the series of F reference points. Estimated using input data for period **1982-2000**. For fitting SSB-R relationship data from period **1982-2000** were used.

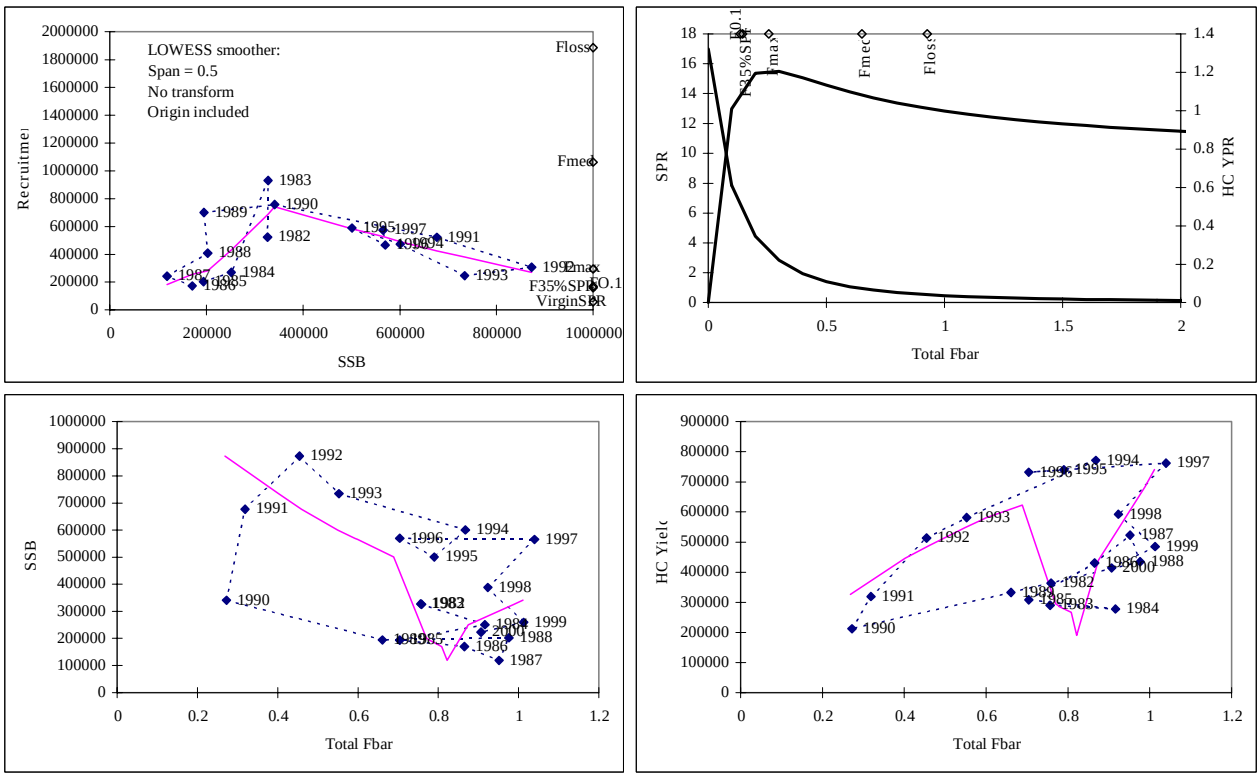


Figure 8. Plots from the PASoft output during estimation of NEA cod reference points using input data for period **1982-2000** and stock recruitment plot for period **1982-2000**:
Top/left: A stock recruitment plot with a LOWESS smoother as a possible stock recruitment relationship. Some reference points are also indicated.
Top/right: A plot of YPR and SPR curves with some reference points indicated.
Bottom/left: A plot of historical SSB against Fbar with an equilibrium curve based on the LOWESS stock recruitment relationship.
Bottom /right: A plot of historical yield against Fbar with an equilibrium curve based on the LOWESS stock recruitment relationship.

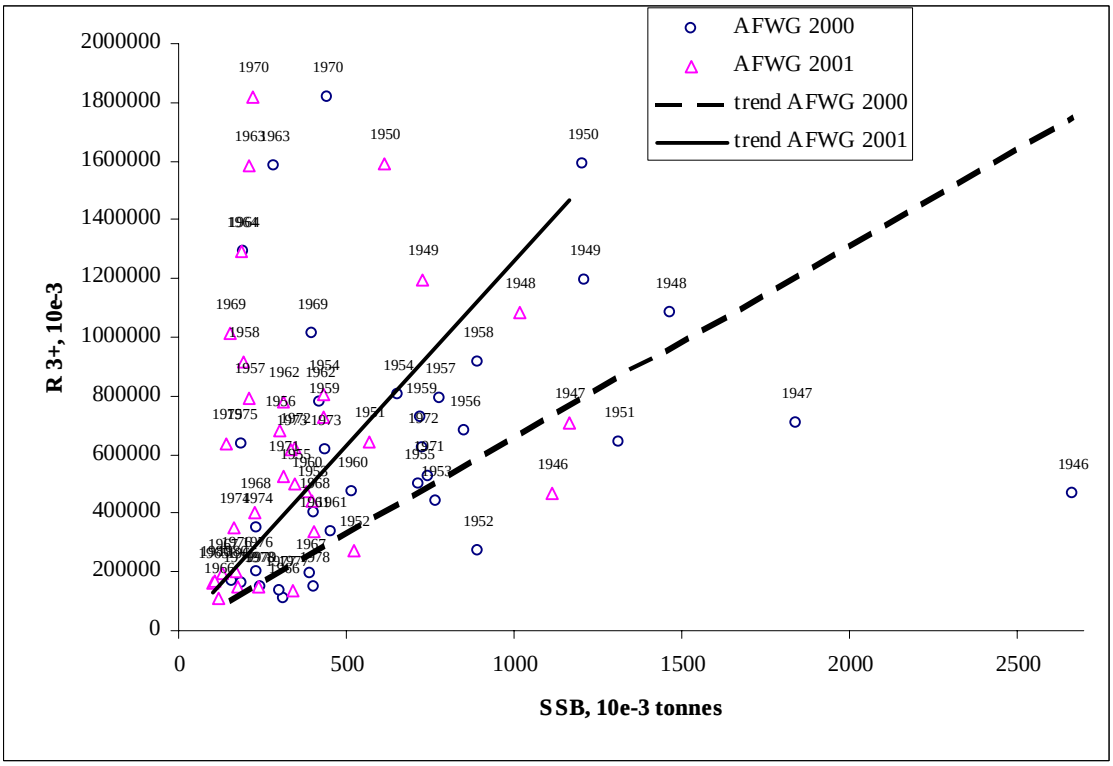


Figure 9. Changes in NEA cod stock recruitment plots for period 1946-1980 due to revision of weight-at-age and maturity rate time series up to 1982 made by AFWG 2001. Linear trends drawing from the origin also shown.

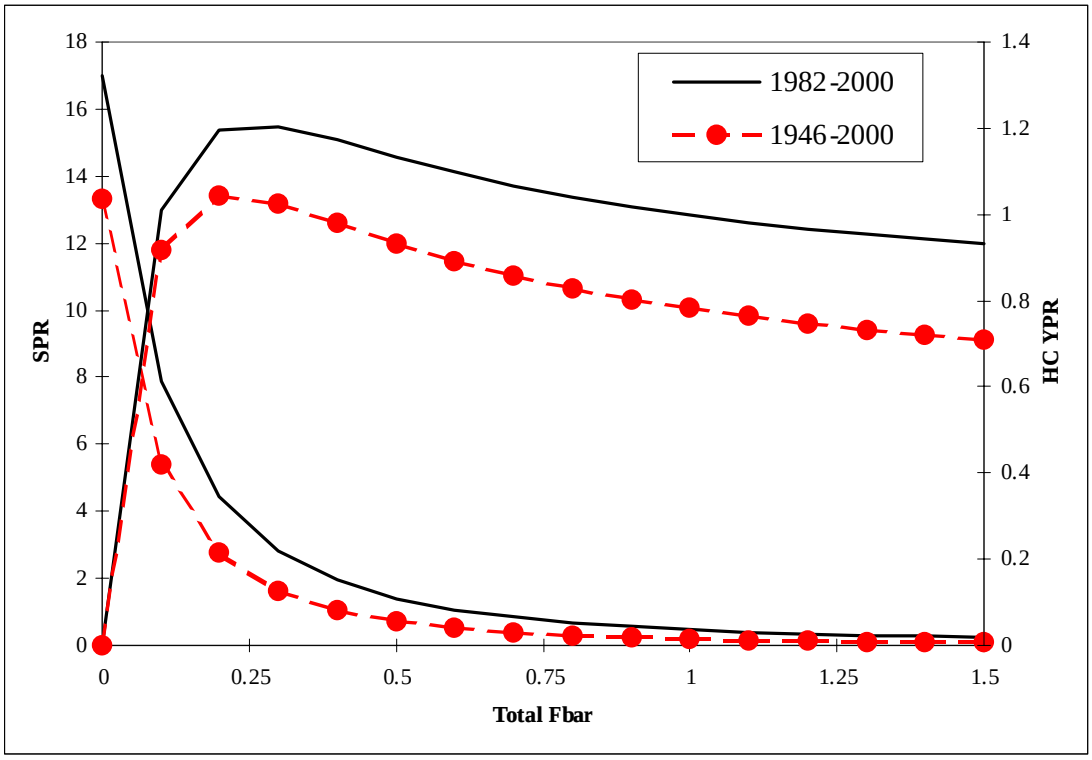
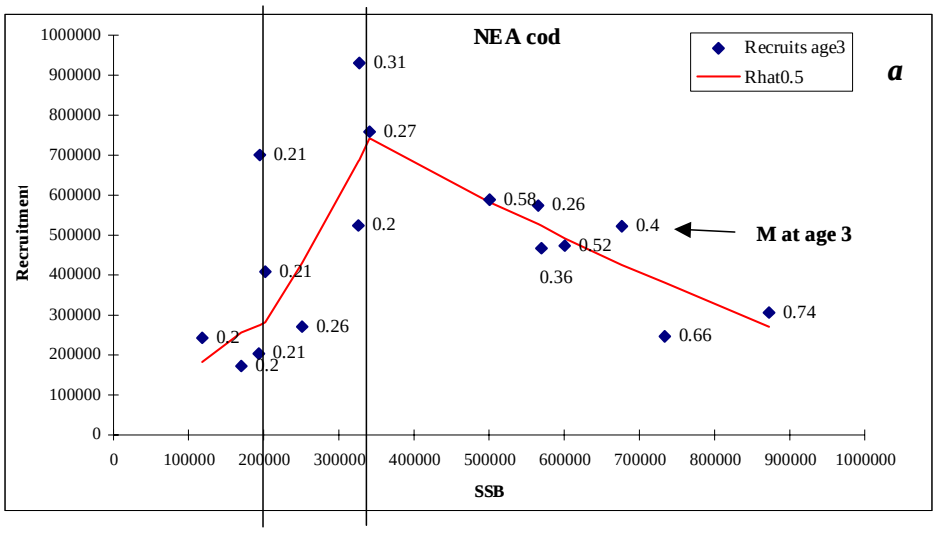
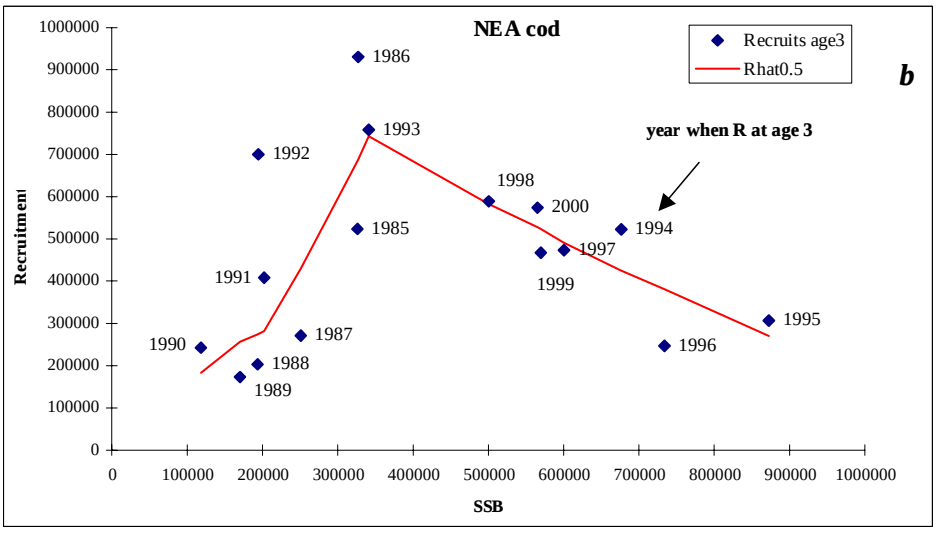


Figure 10. Northeast Arctic cod. YPR and SPR equilibrium curves estimated using input data averaged for period **1946-2000** and **1982-2000**.



Blim= 208 Bpa= 340
if sigma = 0.3



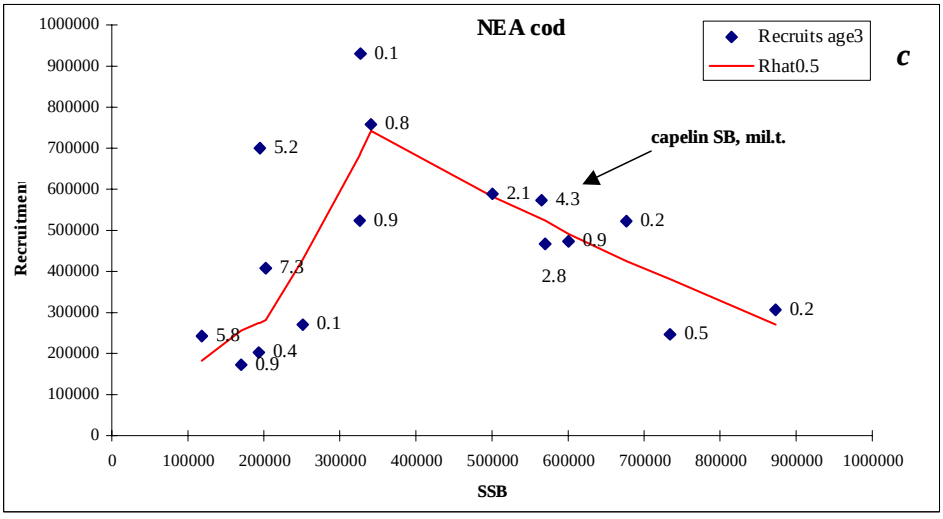


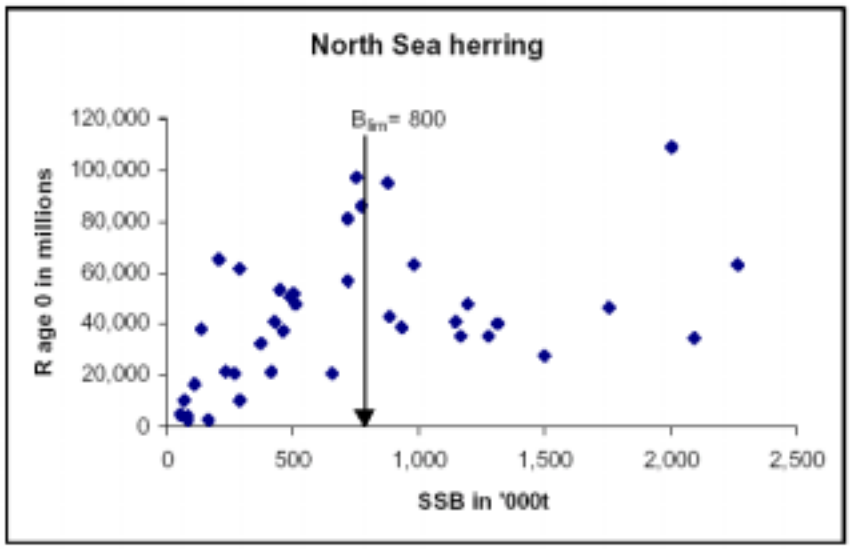
Figure 11. NEA cod stock recruitment plot for period 1982-2000 (no cannibalism included) with a LOWESS smoother (span parameter = 0.5) as a possible stock recruitment relationship (a- corresponding natural mortalityof recruitment at age 3, b - year when recruitment at age 3 and c - capelin biomass also shown).

Appendix

The preferred procedure is to use the SSB-R relationship (Anon., 2001).

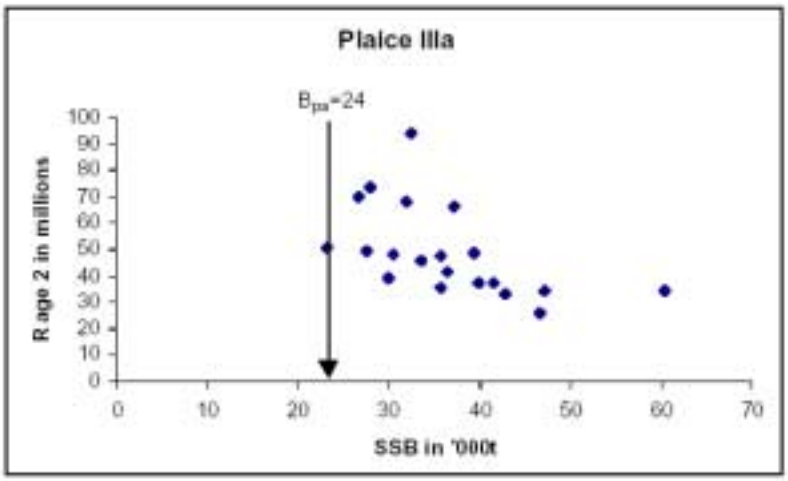
a) If the SSB-R plot clearly indicates that R is impaired at low SSB, select $\mathbf{B_{lim}}$ as the SSB value above which R is not impaired.

The example below is from the North Sea herring assessment, where $\mathbf{B_{lim}}$ was selected as 800 000t.



c) If the SSB-R plot indicates that R decreases with increasing SSB, then select the lowest SSB as $\mathbf{B_{pa}}$.

The example below is from the Skagerrak-Kattegat plaice assessment where $\mathbf{B_{pa}}$ is selected as 24 000t.



Working Document No. 7 to the
Arctic Fisheries Working Group
16 – 25 April 2002

Proposal on the estimation of B_{pa} for cod of the Lofoten-Barents Sea population

by

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Introduction

The commonly accepted indicator of reproductive potential of cod from the Lofoten-Barents Sea population is biomass of mature fish (SSB). SSB is usually defined as summarized biomass of mature cod of different age groups and is estimated using the following equality:

$$SSB_y = \sum N_{t,y} \cdot \delta_{t,y} \cdot \omega_{t,y} , \qquad (1)$$

where

$N_{t,y}$ – abundance of cod at age *t* in a year *y*, (`000 individuals);
$\delta_{t,y}$ – proportion of mature cod at age *t* in a year *y*;
$\omega_{t,y}$ – mean weight of mature cod at age *t* in a year *y*, (kg).

Reasons why this model can not be highly realistic are listed in a paper by V.L. Tretyak (Tretyak, 2002). One of the reasons is intra- and interannual dissimilarity of cod in maturation rates of individuals. The paper presents an algorithm to estimate a number of first time and repeat spawners. Based on a fairly long historical time series of observations (1949-1997) it is shown that cod have at least two groups of spawners, early and late maturing individuals. The first group comprises fish, which first spawn at age 3-8; the second group consists of fish that spawn for the first time at age 9 and older. Abundance of fish from the second group shows a well-pronounced downward trend throughout the whole time series (Figure 1). Until early 1960`s abundance of both groups were at a quite similar level. Variation in these two components of the spawning population was highly synchronous. However, at the boundary of 1950's and 1960's a stable structural change in the mature part of the cod population took place. A well-defined decreasing trend in abundance of late maturing fish continued, while abundance of early maturing fish showed a stable trend to increase. Gradually these fish became predominant in the population. After mid-1970's their abundance constituted more than 93%. This situation allows us to contend that interannual uniformity of cod maturity rates after these years became maximal. Moreover, an approximation of a change in age of 50% maturation of yearclasses by a logistic curve showed that this age approached to its threshold estimate of 6.65 years (Figure 2). For all yearclasses after 1975, except for 1980 yearclass, it does not exceed the upper limit of 25% interval on this curve. Despite the stable decrease in abundance of late maturing fish, their linear relationship with the recruitment is statistically significant for the whole historical time series (R^2=0.20 at the confidence probability of 0.95). A fairly close relationship between recruitment and abundance of early maturing fish appeared in the time interval after 1975 (R^2=0.43). In this interval, a relationship between the recruitment and abundance of late maturing fish (R^2=0.43) also increased and a more close relationship was noted between the recruitment and water temperature in the period of biotope change, that is when 0-group fish moved to live at the bottom (Ajiad, Jacobsen, 2002) and in the cold period of the first and second wintering (Tretyak, 2002).

Taking into account these circumstances we believe that estimation of biological reference points in terms of both fishing mortality and biomass of mature fish, should be based on the period after 1975. In the paper, an attempt is made to estimate $\mathbf{B}_{pa}$ with the account for biomass of early and late maturing cod and mean water temperature in 0-200 m layer of the Main Branch of the Murman Current in August-December.

Results and Discussion

Analysis of variation in variance of recruitment to the cod fishable stock relative to Ricker's equations accounting for abundance of mature fish at age *t*, which participated in spawning *k* times, showed that partitioning of fish into early maturing and late maturing in the interval of 1976-1997 is well seen at *k*=1 and 2 (Figure 3). At both estimates of *k*, residual variance shows a typical variation in dependence on fish age, that is two local minimums and one local maximum. For *k*=1, the local maximum is reached at t=8, for *k*=2 it naturally shifts to age increase by 1 year. Therefore, as before (Tretyak, 2002), fish participated in spawning for the first time at age 3-8 are referred to the early maturing group, while fish at age 9 and older are included in the group of late maturing fish. With further increase of *k*, absolute residual variance is growing and its variation in dependence on age does not show a prominent pattern which is of no importance for dividing into the groups. The increase of the residual variance, in our opinion, is caused by exponential decrease of abundance of fish at a certain age in dependence on number of spawning times. Between these parameters there is an inverse and fairly close relationship (Figure 4).

Approximation of variation in abundance of the recruitment to the cod fishable stock by the Ricker's equations accounting for either biomass of early maturing cod (SSB_1) or biomass of late maturing cod (SSB_2) shows that between these components of the spawning population and recruitment within the studied time interval there is a statistically significant and rather close positive relationship (Figure 5). Contribution of either component to the recruitment variance constitutes 36% and 39%, respectively. However, summarized contribution of both components estimated by a regression equation

$$\hat{R}_j = \alpha_1 \cdot SSB_{1,j} \cdot \exp(-\beta_1 \cdot SSB_{1,j}) + \alpha_2 \cdot SSB_{2,j} \cdot \exp(-\beta_2 \cdot SSB_{2,j}), \qquad (2)$$

where α_1, β_1, α_2 and β_2 are parameters, is slightly higher. It constitutes 48%. The equation (2) is a surface approximating the recruitment of cod, where SSB_1 and SSB_2 are independent variables (Figure 6a). It has the only one extreme point, the maximal point, at $SSB_1=1/\beta_1$ and $SSB_2=1/\beta_2$. The maximum value of the regression surface (2) is equal to:

$$\hat{R}_{max} = \frac{\frac{\alpha_1}{\beta_1} + \frac{\alpha_2}{\beta_2}}{e}. \qquad (3)$$

The summarized estimate of the total spawning biomass at which this maximum is reached will be equal to:

$$SSB = \frac{1}{\beta_1} + \frac{1}{\beta_2}. \qquad (4)$$

The incorporation into equation (2) of one more independent variable characterizing temperature conditions in the period of biotope change leads to the equation as follows:

$$\hat{R}j = \left(\sum_{i=1}^{2} \alpha_i \cdot SSB_{i,j} \cdot \exp\left(-\beta_i \cdot SSB_{i,j}\right) \right) \cdot \left(a_0 + \frac{a_1}{1 + \exp(a_2 \cdot T_j + a_3)} \right), \qquad (5)$$

where T_j – mean water temperature in 0-200 m layer of the Main Branch of the Murman Current in August-December in year *j*, °C;

a_0, a_1, a_2, a_3 – parameters.

The logistic curve was chosen as an additional factor with *T* variable because we are interested in temperature variation range within which its indirect effect on the abundance of year classes is possible. Since not all of the necessary conditions for extrema in the function (5) are fulfilled, in particular the condition, which is not fulfilled, is as follows:

$$\frac{\partial R}{\partial T} = 0, \qquad (6)$$

it has neither maxima nor minima. However, it may be assumed that if the effect of temperature on a year class abundance exists in this period of its life-span, it may take place in a temperature range corresponding to a sharp variation in the function as follows:

$$f(T) = \left(a_0 + \frac{a_1}{1 + \exp(a_2 \cdot T + a_3)} \right). \qquad (7)$$

Really, the function (2) satisfactorily approximate variation in abundance of year classes at age 3 (Figure 6b). Incorporation of the function (7) into the equation (2) increases coefficient of determination almost twice (Table1). However, the comparison of coefficients of determination (Table 1) according to equations (2) and (5) allows us to hold that the effect of the spawning stock on the recruitment at this stage of the cod life-span is somewhat higher than the influence of temperature conditions. Variation of the function (7) in dependence on temperature is presented in Figure 7. Its variations having an effect on the recruitment are found within a very narrow temperature range, from 5.05 to 5.35°C. It was in this temperature range that 1983, 1990-1991 and 1995 year classes appeared, the abundance of which was above average. However, at temperature close to 5°C and higher the appearance of strong year classes may be expected. This was the case when the strong 1989 year class appeared at temperature of 5.36°C and the abundant 1995 year class at temperature of 4.98°C. Year classes which abundance was lower than 500 million individuals appeared at temperature below 4.95°C.

The surface (2) has no clear-cut maximum (Figure 6a), which can be reached at SSB_1=607000 or $SSB_2 \approx$13000 tonnes. With the increase of both components of the spawning stock up to their optimal values, the rate of variation in a possible recruitment is not the same. It grows fast with the increase of SSB_2 up to nearly 13000 tonnes and then drop almost as rapidly as it increased. As SSB_1 increases to 607000 tonnes, it gradually decreases. At SSB_1=350000 tonnes increment of the recruitment constitutes less than 3%. It is worth noting that at any fixed SSB_2 a possible recruitment is maximal at SSB_1=607000. Table 2 shows estimates of the function (2) at different SSB_1 and SSB_2 at a certain interval. As follows from the Table 2, at fixed SSB_2=15000 tonnes deviation in the recruitment from the maximum possible make up 5% when SSB_1=350000 tonnes. Taking into account that deviation of the averaged for the study period recruitment from its maximum is much higher and constitutes above 55% we suggest that $\mathbf{B}_{pa}$ should be defined as spawning stock biomass equal to a sum of the two components 350000+15000=365000 tonnes.

Table 4 presents recruitment abundance estimated using formula (5) at the fixed temperature equal to 5.05°C and different SSB_1 and SSB_2. The general view of the recruitment variation has not changed. Only absolute estimates of abundance have changed which is caused by the change of parameters in the Ricker's equations (Table 1) and of the function (7) estimate. Variation in the relative deviation of the recruitment at different SSB_1 and fixed SSB_2=15000 tonnes and T=5.05°C presented in Table 3 shows that $\mathbf{B}_{pa}$ may be left unchanged.

References

Ajiad, A. and Jacobsen, T. 2002. Incorporating age diversity index and temperature in the stock-recruitment relationship of Northeast Arctic cod. ICES PA meeting, Working document, 9p.

Tretyak, V.L. 2002. Spawning stock structure of Northeast Arctic cod. ICES SGPRISM,Working document # 10, 18 p.

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Proposal on the estimation of F_{lim} and B_{lim} for cod of the Lofoten-Barents Sea population

by

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A proposal on the estimation of $\mathbf{B}_{pa}$ presented to the AFWG in the Working Document # 7 (Tretyak, 2002) was made on the assumption that at fixed SSB_2 and with the increase of SSB_1 up to the value at which the surface $f(SSB_1,SSB_2)$ has its maximum an increment of possible recruitment is decreased. The $\mathbf{B}_{pa}$ estimate is assumed to be a sum of SSB_1 and SSB_2, where SSB_2 = 15 000 tonnes, and SSB_1 = 350 000 tonnes, at which increment of the function f constuted less than 3%. However, it does not seem possible to correctly substantiate the choice of this particular value of the f increment, although intuitively it is clear that 3% is a very low value.

The present paper which may be considered a continuation of the Working document # 7 presents the results obtained from the AFWG data (Anon., 2001). They show that within the studied time interval (1976-1997) the relationship between recruitment and biomass of early and late maturing fish is maintained (Figure 1).The summarised contribution of both components of the spawning stock estimated using $f(SSB_1,SSB_2)$ is also higher (Figure 2a, Table 1). The view of the surface approximating cod recruitment for which SSB_1 and SSB_2 are independent variables has remained the same. Its maximum of 597 million individuals can be reached at SSB_1 = 597 000 and

SSB_2 =12 600 tonnes. Coefficient of determination rises sharply if into $f(SSB_1,SSB_2)$ a factor characterising temperature conditions in the period of biotop change is included (Figure 2b, Table 1).

The change of the surface $f(SSB_1,SSB_2)$ in dependence on SSB_1 and SSB_2 shows that even at $SSB_1 = 0$ the recruitment differs from 0, if $SSB_2 > 0$ (Table 2). However, under sustainable fishery such situation will be impossible. If $SSB_1 = 0$, then in a few years SSB_2 should become equal to 0. If the studied period is assumed to be a period of sustainable fishery in which biological characteristics are considered to be invariable then it is reasonable to assume SSB_2 equal to 12 600 tonnes as equal to $SSB_{2,lim}$. Then it is expedient to name the value of $\bar{F}_{5–10}$, at which SSB_2=12 600 tonnes can be produced, as $\mathbf{F}_{lim}$ and corresponding to it value of SSB_1 as $SSB_{1,lim}$. To estimate $\bar{F}_{5–10}$ it is necessary to know natural mortality rates at each age t. They were determined from the following condition:

$$R \cdot \sum_{a=9}^{13} \omega_a \cdot \delta s_a \cdot \delta s_{2,a} \cdot \exp\left(-\sum_{t=3}^{a-1}\left(M_t + F_{t,lim}\right)\right) - SSB_2 = 0 , \qquad (*)$$

where R - average recruitment for the study period, million individuals;

ω_a - mean weight of cod at age a, kg;

δs_a - mean proportion of mature fish;

$\delta s_{2,a}$ - mean proportion of late maturing fish;

M_t and $F_{t,lim}$ – natural and fishing mortality rates, M_t =0.20; SSB_2 =12 600 tonnes.

Under condition that

$$F_{t,lim} = X \cdot \frac{\hat{F}_t}{\hat{F}} \quad , \qquad (**)$$

where $\hat{F}_t$ и $\hat{F}$ are mean for the study period fishing mortality rates, the equation(**) has the only one solution. $\mathbf{F}_{lim}$ corresponding to it is **equal to 0.783**. A value of $\mathbf{SSB_{1,lim}}$ corresponding to the above $\mathbf{F}_{lim}$ is equal to **255 000** tonnes, which was determined from the equality as follows:

$$SSB_{1,lim} = R \cdot \sum_{a=3}^{13} \omega_a \cdot \delta s_a \cdot \delta s_{1,a} \cdot \exp\left(- \sum_{t=3}^{a-1} \left(M_t + F_{t,lim} \right) \right) , \qquad (***)$$

where $\delta s_{1,a}$ - mean proportion of early maturing fish at age a. $SSB_{1,pa}$ calculated according to the equality:

$$SSB_{1,pa} = SSB_{1,lim} \cdot \exp(1.645 \cdot \sigma) \ , \qquad (****)$$

at diffeent σ values are presented in Table 3. Given an assumption that uncertainties in the biomass estimates by VPA constitutes 50% (and we should be aware of that this is a very big error), it is necessary to choose σ = 0.25. At this value of σ $\mathbf{SSB_{1,\,pa}}$ **= 384 000** tonnes, and $\mathbf{SSB}_{pa}$ defined as

$$SS\mathbf{B}_{pa} = (SSB_{1,lim} + SSB_{2,lim}) \cdot \exp(1.645 \cdot \sigma) \qquad (*****)$$

is equal to **403 000** tonnes.

Let us assume that the proportion of relative deviation of the recruitment in a point (SSB_1=255, SSB_2 =12.6) from its maximum possible calculated from $f(SSB_1,SSB_2)$ is equal to 1. It is evident that with the increase of SSB_1 up to 597 000 tonnes it will decrease down to 0 (Figure 3). It is also clear that SSB_1, pa at which due to the data uncertainties a danger to appear to the left of $SSB_{1,lim}$ would be small, should be within the range from 255 000 to 597 000 tonnes. It seems that on the curve showed in Figure 3 there is one point that can be chosen. It is very close to mean integral value egual to 0.301 to which SSB_1 = 389 000 tonnes corresponds.

Fishing mortality rate at which SSB_1 equal to 384 000 or 389000 tonnes can be produced is equal to **0.60.** In our opinion, this value of F is just the value to be chosen as $\mathbf{F}_{pa}$**.** Naturally it will not be the same as $\mathbf{F}_{pa}$ calculated using traditional way (Table 3):

$\mathbf{F}_{pa} = \mathbf{F}_{lim} \cdot \exp(-1.645 \cdot \sigma)$, which is independent of $SS\mathbf{B}_{pa}$.

References

Anon. 2001. Report of the Arctic Fisheries Working Group. ICES CM 2001/ACFM:19. 380 pp.

Tretyak, V.L. 2002. Proposal on the estimation of $\mathbf{B}_{pa}$ for cod of the Lofoten-Barents Sea population. ICES AFWG-2002, Working dokument. 15 pp.

Table 1. Values of parameters in the regression equations.

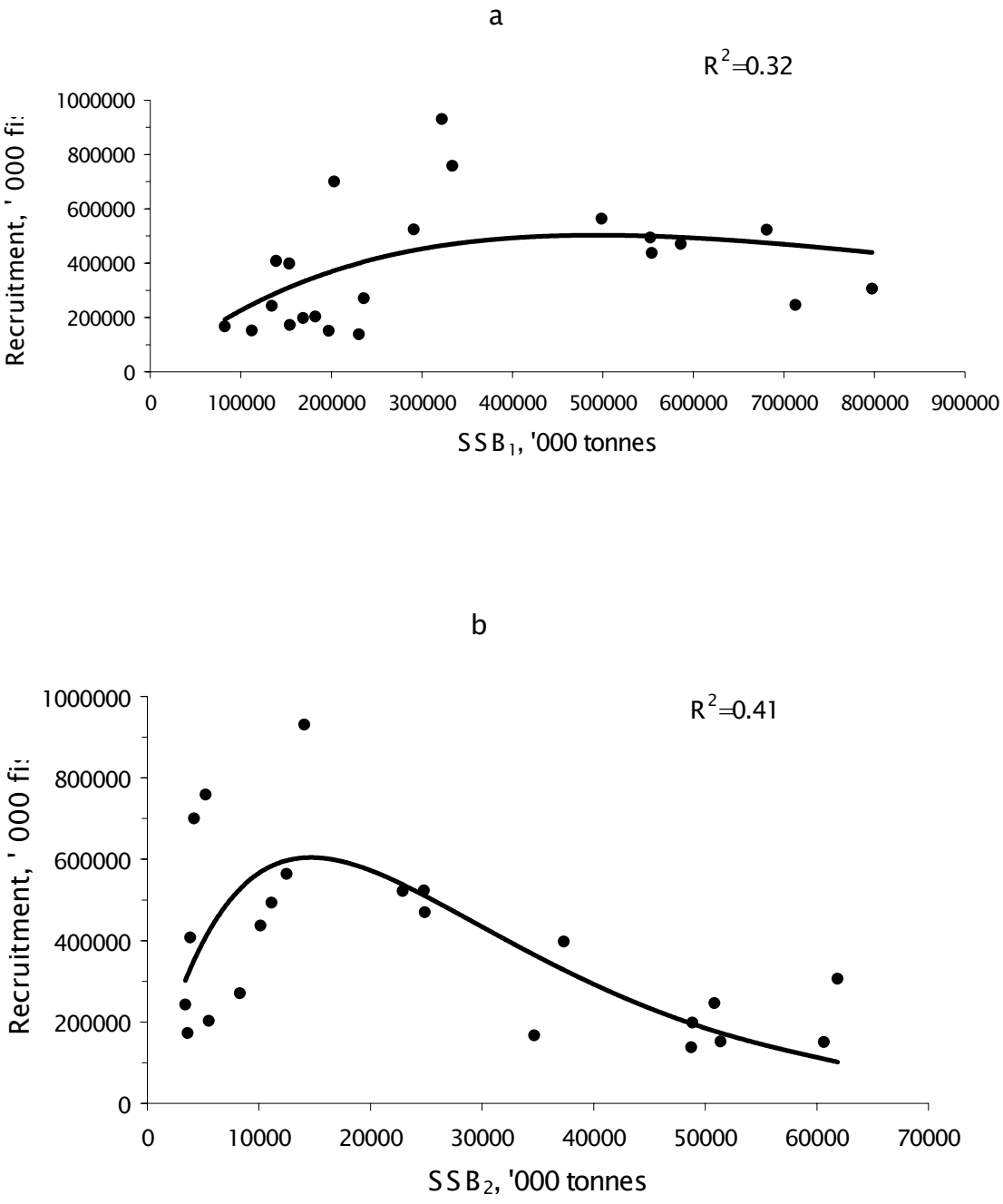
Regression equation	Parameters								R^2
	α_1	β_1	α_2	β_2	a_0	a_1	a_2	a_3	
f(SSB1,SSB2)	1.0767	1.7070E-06	78.5073	7.9057E-05					0.48
f(SSB1,SSB2,T)	0.5828	1.0273E-06	41.9143	6.7745E-05	1.2284	1.5343	-53.1926	278.2313	0.87

Table 2. Estimates of f(SSB1,SSB2) at different values of SSB_1 and SSB_2, million fish

SSB_2,	SSB_1, '000 t																
'000 t	0	100	150	200	250	255	300	350	400	450	500	550	597.36	600	650	700	750
0	0	91	125	153	176	178	194	207	218	225	229	232	232	232	231	228	224
10	356	447	481	509	532	534	550	563	574	581	585	588	588	588	587	584	581
12.649	365	456	490	518	541	543	559	573	583	590	595	597	597	597	596	593	590
15	360	451	485	513	535	537	553	567	577	584	589	591	592	592	590	588	584
20	323	414	448	476	499	501	517	530	541	548	552	555	555	555	554	551	548
25	272	363	397	425	448	450	466	479	490	497	501	504	504	504	503	500	496
30	220	311	345	373	395	397	413	427	437	445	449	451	452	451	451	448	444
35	173	263	298	326	348	350	366	380	390	397	402	404	405	403	403	401	397
40	133	224	258	286	309	311	326	340	351	358	362	365	365	364	364	361	357
45	101	191	226	254	276	278	294	308	318	325	330	332	333	331	331	329	325
50	75	166	200	228	251	253	269	283	293	300	305	307	307	306	306	304	300
55	56	147	181	209	232	233	249	263	273	281	285	287	288	287	287	284	280
60	41	132	166	194	217	219	235	248	259	266	270	273	273	272	272	269	265
65	30	121	155	183	206	208	223	237	248	255	259	262	262	261	261	258	254

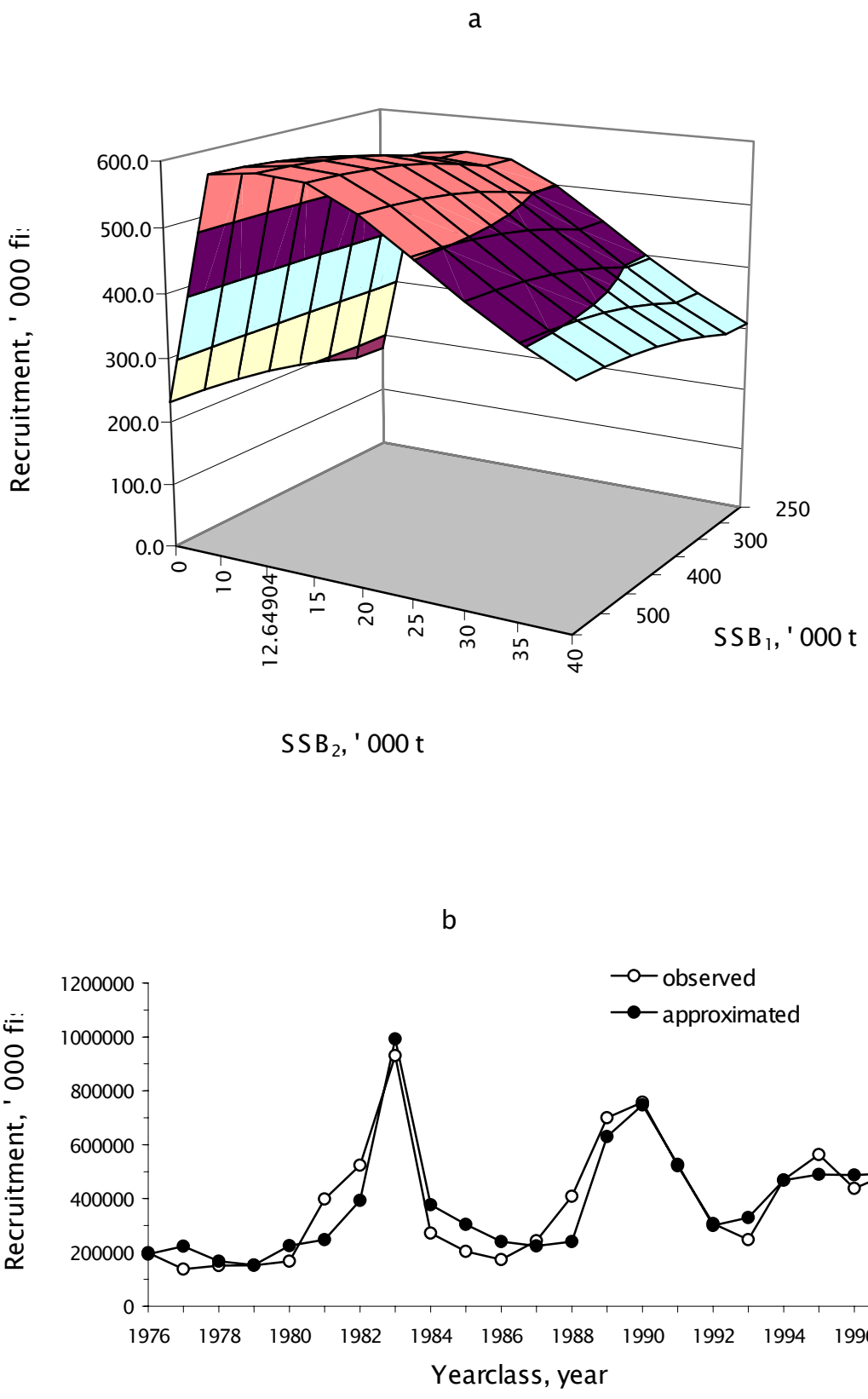
Table 3. Values of biological reference points in dependence of on σ.

σ	$e^{-1.645*\sigma}$	$\mathbf{F}_{pa}$	$e^{1.645*\sigma}$	SSB_1,pa, '000 t	$SS\mathbf{B}_{pa}$, '000 t
0.15	0.78	0.61	1.28	326	342
0.20	0.72	0.56	1.39	354	371
0.25	0.66	0.52	1.51	384	403
0.30	0.61	0.48	1.64	417	438
0.35	0.56	0.44	1.78	453	475
0.40	0.52	0.41	1.93	419	516



(b).

Figure.1. Approximation of variation in abundance of the recruitment to the cod fishable stock by Ricker's equations accounting for biomass of early maturing cod (SSB_1) - (a) and biomass of late maturing cod (SSB_2) -



Fi**gure 2**. Approximation of variation in abundance of the recruitment to the cod fishable stock by regression equations ($f(SSB_1, SSB_2)$) - (a) and ($f(SSB_1, SSB_2, T)$) - (b).

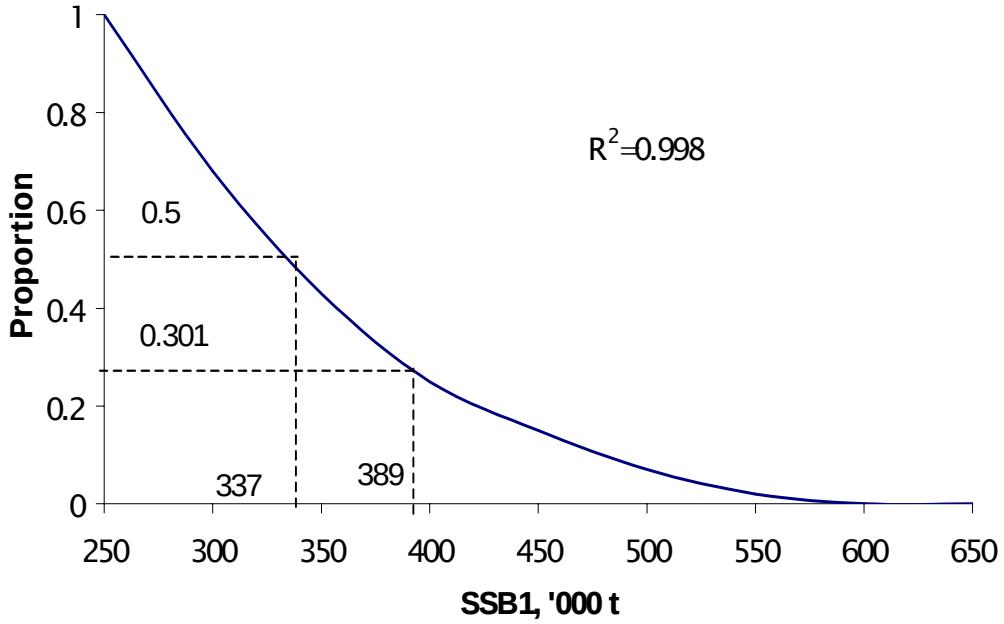


Figure3. Variation in the proportion (assumed to be 1 in the point (SSB1=255, SSB2=12.6)) of relativ deviation of the recruitment from its Maximum possible in dependence on SSB1.