Advisory Committee on Fishery Management **ICES CM 2003/ACFM:23**

REPORT OF THE

NORTHERN PELAGIC AND BLUE WHITING FISHERIES WORKING GROUP

ICES Headquarters
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International Council for the Exploration of the Sea

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Palægade 2–4 DK–1261 Copenhagen K Denmark

TECHNICAL MINUTES

Subgroup Northern Pelagic and Blue Whiting Fisheries Working Group (WGNPBW)

ACFM Meeting May 2003

Thursday 30/5/2003: 9:00-18:00 Beverton room
Subgroup chair: Martin Pastoors
Presenter: Asta Gudmundsdottir
Reviewers: Tomas Gröhsler, Vladimir Shebanov
Participants: Dankert Skagen., Bengt Sjöstrand., Einar Hjörleifsson,
Poul Degnbol, Geoge Kornilovs
Observer: Ken Patterson

GENERAL COMMENTS

The structure of the report has improved, but still substantial further improvements could be made. The report would benefit from an introductory section that links the terms of reference to the sections where they are dealt with. The tables and figures are sometimes organized rather haphazardly which makes the job of reviewing the report difficult.

For each stock the whole assessment input data and output results should be presented both in the report and the ICES server. The subgroup suggests the following sequence of tables as a minimum requirement for assessment documentation:

Input data (tables):

- catch in numbers
- catch/stock weight-at-age
- natural mortality
- maturity
- survey data
- tagging data
- larval data

Input (figures):

- catch in numbers (log scale?)
- survey indices
- larval indices

Output (tables):

- stock numbers-at-age
- fishing mortality-at-age
- SSB at age and combined
- Stock summary
- parameter estimates
- residuals (log catchability residuals)

Output (figures):

- stock summary
- residual plots
- retrospective analysis
- uncertainty analysis (bootstrap)
- stock recruitment stuff
- biological reference points

Not all the ToR have been explicitly addresses. The special requests by Russia and coastal states have not been addressed by the WG. For WHB it just referred to Methods WG which had suggested a number of analysis to the WG. The ToR on exploitation of juvenile blue whiting was addressed in section 6.8.1 but this was not referred to. The ToR j deficiencies in the assessments was not addressed. Also the ToR k comparison with last year was not addressed.

The inability of the group to reach consensus on the Russian and Norwegian inputs to the group severely compromised ACFM position with regards to providing advice. It is then not enough to state that joint calculations should be undertaken (e.g. p. 7) but also how this will be achieved. The WG should draw conclusions from different assessments.

Methods description: a short description of the salient features of the methods is required. This should highlight the main features of the model and which specific problem it intends to solve. The subgroup reiterates that it is not sufficient to refer to a website for documentation of a method, because it should at least be possible to obtain a printed copy of the description/manual somewhere.

Colors are useless in printed document (e.g. figure 3.3.1).

Is it useful to have information on sampling level (No. sampled, No. measured etc.) for the commercial landings in each stock section. The subgroup suggests to include all the output from the Salloc program in the report.

It would be useful to include a map in the introduction section showing the distribution areas of the different stocks.

Ecological considerations

The section on ecological and environmental information was informative and well written. However, it was noted that as already addressed last year that there was hardly any linkage with the stock chapters to the chapter on ecological considerations. The section as a whole would benefit with indicating specific linkages to other sections.

A section on phytoplankton in the Barents Sea is missing.

What conclusion can be drawn from section 2.6.

Norwegian spring spawning herring (HER-NOSS)

The structure of this section of the report has improved compared to last year.

It is unacceptable that information pertinent to the assessment is kept at a website in Norway rather than on the ICES server. The input and output of the assessment runs could not be found on the ICES server. The subgroup was very critical about the procedures that have been followed to assess this stock and stresses that explaining the procedures and results is just as important as obtaining the results in the first place. The people responsible for this assessment are requested to adhere to the basic list of input and output requirements which is presented in section 1 of the technical minutes.

SeaStar uses tuning on the largest year classes only. How is the decision reached when a year class is considered to be strong. The choice seems to be arbitrary. Could this be illustrated using e.g. the catch data?

The SeaStar assessment has the fundamental assumption that no age dependence or abundance dependence in catchability of surveys applies. Can this be substantiated and has the sensivity of the model to this assumption been tested?

The group describes the SeaStar method as giving an objective way of choosing weights on different sources of information. Nevertheless many arbitrary choices are made in this assessment: to leave out data from the assessment: larval data, tagging data, etc. This violates the objectivity. The WG is requested to provide better analysis/explanations of the reasons for leaving out observations to avoid the impression of arbitrariness.

The subgroup recommended rather than to model the ageing errors directly to use a plus group at a lower age.

It is necessary to present any assessment with all data in and with settings similar to last year in order to be able to make comparisons. After that, explorations can be made with different model settings or data configurations.

The final SeaStar assessment was found to incorporate inconsistencies: mean weights, maturities, SSB estimates. During the subgroup a new run was set up and the results are incorporated in appendix 2. The new run does not provide major changes in the perception of the stock.

ISVPA Gives very different results from the SeaStar model. Youngest ages in catch data are difficult to follow. Very high estimates of juveniles (e.g. 5 year olds). Residuals dependent on year class (either all positive or all negative). Could this model also be run with less constraints on the residual matrix, so that the strong year class effects in the residuals would disappear, as the ISVPA is now not longer based on catch data only?

The bootstrap results for ISVPA are very difficult to explain as the final ISVPA assessment is towards the outer bounds of the confidence interval. The subgroup wonders whether there is a programming error that causes this result or that the constraints in the model are too tight.

The subgroup has selected the SeaStar assessment as the basis for advice. The reasons for this choice are:

- Youngest ages in catch data are difficult to follow (i.e. when they enter the fishery).
- ISVPA has a high SoP difference between the predicted and observed catches in a recent year
- ISVPA residuals seem to be very dependent on year class (either all positive or all negative).

Nevertheless, the subgroup has recommended an external review be conducted in order to produce a accepted assessment method for this stock.

Section 3.4.4 on short-term projections is too short. A description is required on the basis for the input and comments on the results. The selection pattern used for the SeaStar prediction seems to be inappropriate as may substantially overestimate the selection on the youngest ages. The ISVPA selection pattern seems to behave better even though it looks likes it has been forced to a function

Medium analysis were not carried out during the working group. There were medium-term analysis found on the IMR website, but there was no documentation on the basis for the analysis. The subgroup decided not to incorporate the results in the advice.

Barents Sea Capelin ()

The subgroup noticed that this stock is left in between the may and october ACFM meetings and concluded that no reviews were presented for recent years. The group reviewed the assessment during it's discussion but did not provide specific comments.

Capelin in the Iceland-East, Greenland, Jan Mayen area (CAP-ICEL)

Define the term fishable stock in the beginning of the text. It is also questionable if the tables could be fewer.

Blue whiting (WHB-COMB)

Structure of the section has improved and is now very clear.

All assessment input data and output results of the final assessment should be presented (including parameter estimates and set up of the assessment model).

The subgroup suggested to have a further look at assembling survey data from national basis that is collected for other purposes (e.g. all the herring surveys). Refer to Planning group on Norwegian Sea.

AMCI: The plus group assumptions/differences should be described/explained.

AMCI with Acoustic surveys as SSB index was dismissed because it did not confirm to the catch ratio analysis. This is a way of tuning the assessment to prior knowledge which can hardly be defended. If you already know the answer, why would you need to do an assessment?

Final assessment with AMCI : Why changing age of recruitment from 0.5 in 2001 to 1 in 2002?

The subgroup has selected the AMCI assessment as the basis for advice. The reasons for this choice are:

- Similar trends in fishing mortality from the catch and survey data
- ISVPA residuals seem to be very dependent on year class (either all positive or all negative).

Icelandic summer spawning herring (HER-VASU)

Information on sampling is missing.

The ageing problem can possibly be overcome by using a plus group at a younger age.

All the input data should be presented: i.e. Natural mortality (NATMOR), proportion F before spawning (FPROP), proportion M before spawning (MPROP).

What is the general definition of age (ie. Age 5 (Age 6 on 1 January))

Appendix 1: detailed comments

Section 2

Section 2.3.2 Predation by cod: Why presenting two conflicting results.
Section 2.4.5: R^2 = 0.66 in the text is not in line with the value presented in Figure 2.4.5.3 of 0.5302

Section 3

Is the prognosis of herring condition and weight-at-age only used in short-term forecast using SeaStar?
Numbers in Figure 3.2.3.5 are hardly readable
SeaStar Manual has no description of input and output formats.
Colour problem in Figure 3.3.3
Column in Table 3.3.4.1 not readable!

Section 5

Units in Table 5.3.1.1 are missing.
Labelling of column in Table 5.3.2.1.2 is wrong.
Section 5.3.2.2 : 61.5 billions not corresponding with 62.5 billions in Table 5.3.2.3.
Figures 5.5.3.1 & 5.5.3.2 are missing

Section 6

Table 6.3.4.1 is missing.
Section 6.3.5 'The value of the natural mortality M for blue whiting' could be shortened to 'Natural Mortality'.
Tables 6.4.1-6.4.3 (2003 is missing in 6.4.2.-6.4.3) are duplicated in Tables 6.4.1.1-6.4.1.3 (which are including less information). Why using different age spans (1-9+ and 1-11+)?
Lines in Figure 6.4.4.1.2 are not readable? To be comparable to results given in Figure 6.4.4.1.1: Why not using the same time periods (<91, 91-94 and 95-97)?
ICA run compered to 2002: Why changing the years of separable constraint? Age 1 was downweighted in the AMCI final run. Is there any reason to not downweighting age 1 in ICA.
Units in Table 6.4.5.2.1-6.4.5.2.3 are missing
Section 6.4.5.3 Comparison: Why not including the results from ICA?
Tables 6.5.1 and 6.5.2 are identical.
Section on blue whiting: wrong reference in the text: ICES 2003/ACFM :15, it should be replaced by ICES 2003/D:03?

Section 7

Table 7.1.2 Catch in numbers: This table should go into section 7.2
It would be nice to present a figure showing the age composition?!
Table 7.3.1: Explanation of large year class 2000 is missing (not only 1999!)
Chapter 7.4.1 Adapt VPA: Not referring to Table 7.4.1-7.4.3 in the text! Units in Tables 7.4.2 and 7.4.3 are missing! What is the meaning of WF 5-15?

Appendix 2: input and output of final SeaStar assessment on Norwegian Spring Spawing Herring.

Table 1. Catch in numbers used by SeaStar.

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1950	5112600.	2000000.	600000.	276200.	184800.	185500.	547000.	628600.	79500.	88600.	109500.	86900.	194500.	368300.	66400.	107000.	237300.
1951	1635500.	7607690.	400000.	1636600.	383800.	172400.	164400.	515600.	602000.	77100.	82700.	103100.	107600.	253500.	348000.	47400.	305100.
1952	13721600.	9149700.	1232900.	39300.	60500.	602300.	136300.	204500.	380200.	377900.	79200.	85700.	107700.	106800.	186500.	256300.	308100.
1953	5697200.	5055000.	581300.	740100.	46600.	100900.	355600.	81900.	110900.	314100.	394900.	61700.	91200.	94100.	98800.	215500.	514900.
1954	10675990.	7071090.	855400.	266300.	1435500.	142900.	236000.	490300.	128100.	199800.	440400.	460700.	88400.	100600.	133000.	126800.	676400.
1955	5175600.	2871100.	510100.	93000.	276400.	2045100.	114300.	189600.	274700.	85300.	193400.	295600.	203200.	58700.	84600.	103600.	477000.
1956	5363900.	2023700.	627100.	116500.	251600.	314200.	2555100.	110000.	203900.	264200.	130700.	198300.	272800.	163300.	63000.	88900.	476200.
1957	5001900.	3290800.	219500.	23300.	373300.	153800.	228500.	1985300.	72000.	127300.	182500.	88400.	121200.	149300.	131600.	337000.	247700.
1958	9666990.	2798100.	666400.	17500.	17900.	110900.	89300.	194400.	973500.	70700.	123000.	200900.	98700.	77400.	70900.	69400.	186200.
1959	17896280.	198530.	325500.	15100.	26800.	25900.	146600.	114800.	240700.	1103800.	88600.	124300.	198000.	88500.	77400.	85200.	150700.
1960	12884310.	13580790.	392500.	121700.	18200.	28100.	24400.	96200.	73300.	203900.	1163000.	85200.	129700.	153500.	56700.	47200.	121700.
1961	6207500.	16075600.	2884800.	31200.	8100.	4100.	15000.	19400.	61600.	49200.	136100.	728100.	49700.	45000.	63000.	21700.	38400.
1962	3693200.	4081100.	1041300.	1843800.	8000.	3100.	7200.	20200.	11900.	59100.	52600.	117000.	813500.	44200.	54700.	65600.	86700.
1963	4807000.	2119200.	2045300.	760400.	835800.	5300.	1800.	3600.	18300.	9300.	107700.	92500.	174100.	923700.	79600.	60400.	124900.
1964	3613000.	2728300.	220300.	114600.	399000.	2045800.	13700.	1500.	3000.	24900.	29300.	95600.	82400.	153000.	772800.	45800.	291000.
1965	2303000.	3780900.	2853600.	89900.	256200.	571100.	2199700.	19500.	14900.	7400.	19100.	40000.	100500.	107800.	138700.	704000.	179100.
1966	3926500.	662800.	1678000.	2048700.	26900.	466600.	1306000.	2884500.	37900.	14300.	17400.	26200.	11000.	69100.	72100.	96700.	460000.
1967	426800.	9877100.	70400.	1392300.	3254000.	26600.	421300.	1132000.	1720800.	8900.	5700.	3500.	8500.	8900.	17500.	14300.	90100.
1968	1783600.	437000.	388300.	99100.	1880500.	1387400.	14200.	94000.	134100.	345100.	2000.	1100.	800.	2500.	2600.	1800.	15200.
1969	561200.	507100.	141900.	188200.	800.	8800.	4700.	700.	11700.	33600.	36000.	300.	200.	200.	200.	400.	2000.
1970	119300.	529400.	33200.	6300.	18600.	600.	3300.	3300.	1000.	13400.	26200.	28100.	300.	100.	200.	100.	1900.
1971	30500.	42900.	85100.	1820.	1020.	1240.	360.	1110.	1130.	360.	4410.	6910.	5450.	1.	20.	120.	0.
1972	347100.	41000.	20400.	35376.	3476.	3583.	2481.	694.	1486.	198.	1.	494.	593.	593.	1.	1.	0.
1973	29300.	3500.	1700.	2389.	25200.	651.	1506.	278.	178.	1.	1.	1.	1.	1.	180.	1.	0.
1974	65900.	7800.	3900.	100.	241.	24505.	257.	196.	1.	1.	1.	1.	1.	1.	1.	1.	0.
1975	30600.	3600.	1800.	3268.	132.	910.	30667.	5.	2.	1.	1.	1.	1.	1.	1.	1.	0.
1976	20100.	2400.	1200.	23248.	5436.	1.	1.	13086.	1.	1.	1.	1.	1.	1.	1.	1.	0.
1977	43000.	6200.	3100.	22103.	23595.	336.	1.	419.	10766.	1.	1.	1.	1.	1.	1.	1.	0.
1978	20100.	2400.	1200.	3019.	12164.	20315.	870.	1.	620.	5027.	1.	1.	1.	1.	1.	1.	0.
1979	32600.	3800.	1900.	6352.	1866.	6865.	11216.	326.	1.	1.	2534.	1.	1.	1.	1.	1.	0.
1980	6900.	800.	400.	6407.	5814.	2278.	8165.	15838.	441.	8.	1.	2688.	1.	1.	1.	1.	0.
1981	8300.	1100.	11900.	4166.	4591.	8596.	2200.	4512.	8280.	345.	103.	114.	964.	1.	1.	1.	0.
1982	22600.	1100.	200.	13817.	7892.	4507.	6258.	1960.	5075.	6047.	121.	37.	37.	121.	1.	1.	0.
1983	127000.	4680.	1670.	3183.	21191.	9521.	6181.	6823.	1293.	4598.	7329.	143.	40.	143.	860.	1.	0.
1984	33860.	1700.	2490.	4483.	5388.	61543.	18202.	12638.	15608.	7215.	16338.	6478.	1.	1.	1.	1650.	0.
1985	28570.	13150.	207220.	21500.	15500.	16500.	130000.	59000.	55000.	63000.	10000.	31000.	50000.	1.	1.	1.	2640.
1986	13810.	1380.	3090.	539785.	17594.	14500.	15500.	105000.	75000.	42000.	77000.	19469.	66000.	80000.	1.	1.	2470.
1987	13850.	6330.	35770.	19776.	501393.	18672.	3502.	7058.	28000.	12000.	9500.	4500.	7834.	6500.	7000.	450.	0.
1988	15490.	2790.	9110.	62923.	25059.	550367.	9452.	3679.	5964.	14583.	8872.	2818.	3356.	2682.	1560.	540.	0.
1989	7120.	1930.	25200.	2890.	3623.	5650.	324290.	3469.	800.	679.	3297.	1375.	679.	321.	260.	1.	0.
1990	1020.	400.	15540.	18633.	2658.	11875.	10854.	226280.	1289.	1519.	2036.	2415.	646.	179.	590.	170.	310.
1991	100.	3370.	3330.	8438.	2780.	1410.	14698.	8867.	218851.	2499.	461.	87.	690.	103.	260.	530.	10.
1992	1630.	150.	1340.	12586.	33100.	4980.	1193.	11981.	5748.	225677.	2483.	639.	247.	1236.	1.	1.	0.
1993	6570.	130.	7240.	28408.	106866.	87269.	8625.	3648.	29603.	18631.	410110.	1.	1.	1.	1.	1.	0.
1994	430.	20.	8100.	32500.	110090.	363920.	164800.	15580.	8140.	37330.	35660.	645410.	2830.	460.	100.	2070.	0.
1995	1.	1.	1130.	57590.	346460.	622810.	637840.	231090.	15510.	15850.	69750.	83740.	911880.	4070.	250.	1.	450.
1996	1.	1.	30140.	34360.	713620.	1571000.	940580.	406280.	103410.	5680.	7370.	66090.	17570.	836550.	1.	1.	0.
1997	1.	1.	21820.	130450.	270950.	1795780.	1993620.	761210.	326490.	60870.	20020.	32400.	90520.	19120.	370330.	300.	0.
1998	1.	1.	82891.	70323.	242365.	368310.	1760319.	1263750.	381482.	129971.	42502.	25343.	3478.	112604.	5633.	108514.	1.
1999	1.	1.	5029.	137626.	35820.	134813.	429433.	1604959.	1164263.	291394.	106005.	14524.	40040.	7202.	88598.	1.	63983.
2000	1.	1000.	14395.	84016.	560379.	34933.	110719.	404460.	1299253.	1045001.	216980.	71589.	16260.	22701.	23321.	4724.	67087.
2001	1.	1.	2076.	102293.	160678.	426822.	38749.	95991.	296460.	839136.	507106.	73673.	23722.	3505.	3356.	1.	22164.
2002	1.	1.	61874.	198081.	640322.	253823.	322791.	29769.	93025.	263090.	658268.	336916.	52508.	12335.	6937.	300.	9747.

Table 2. Stock weights-at-age used in SeaStar vpa.

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1950	1.	8.	47.	100.	204.	230.	255.	275.	290.	305.	315.	325.	330.	340.	345.	362.	365.
1951	1.	8.	47.	100.	204.	230.	255.	275.	290.	305.	315.	325.	330.	340.	345.	362.	365.
1952	1.	8.	47.	100.	204.	230.	255.	275.	290.	305.	315.	325.	330.	340.	345.	362.	365.
1953	1.	8.	47.	100.	204.	230.	255.	275.	290.	305.	315.	325.	330.	340.	345.	362.	365.
1954	1.	8.	47.	100.	204.	230.	255.	275.	290.	305.	315.	325.	330.	340.	345.	362.	365.
1955	1.	8.	47.	100.	195.	213.	260.	275.	290.	305.	315.	325.	330.	340.	345.	362.	365.
1956	1.	8.	47.	100.	205.	230.	249.	275.	290.	305.	315.	325.	330.	340.	345.	362.	365.
1957	1.	8.	47.	100.	136.	228.	255.	262.	290.	305.	315.	325.	330.	340.	345.	362.	365.
1958	1.	8.	47.	100.	204.	242.	292.	295.	293.	305.	315.	330.	340.	345.	352.	360.	365.
1959	1.	8.	47.	100.	204.	252.	260.	290.	300.	305.	315.	325.	330.	340.	345.	355.	360.
1960	1.	8.	47.	100.	204.	270.	291.	293.	321.	318.	320.	344.	349.	370.	379.	375.	380.
1961	1.	8.	47.	100.	232.	250.	292.	302.	304.	323.	322.	321.	344.	357.	363.	365.	370.
1962	1.	8.	47.	100.	219.	291.	300.	316.	324.	326.	335.	338.	334.	347.	354.	358.	358.
1963	1.	8.	47.	100.	185.	253.	294.	312.	329.	327.	334.	341.	349.	341.	358.	375.	375.
1964	1.	8.	47.	100.	194.	213.	264.	317.	363.	353.	349.	354.	357.	359.	365.	402.	402.
1965	1.	8.	47.	100.	186.	199.	236.	260.	363.	350.	370.	360.	378.	387.	390.	394.	394.
1966	1.	8.	47.	100.	185.	219.	222.	249.	306.	354.	377.	391.	379.	378.	361.	383.	383.
1967	1.	8.	47.	100.	180.	228.	269.	270.	294.	324.	420.	430.	366.	368.	433.	414.	414.
1968	1.	8.	47.	100.	115.	206.	266.	275.	274.	285.	350.	325.	363.	408.	388.	378.	378.
1969	1.	8.	47.	100.	115.	145.	270.	300.	306.	308.	318.	340.	368.	360.	393.	397.	397.
1970	1.	8.	47.	100.	209.	272.	230.	295.	317.	323.	325.	329.	380.	370.	380.	391.	391.
1971	1.	15.	80.	100.	190.	225.	250.	275.	290.	310.	325.	335.	345.	355.	365.	390.	390.
1972	1.	10.	70.	150.	150.	140.	210.	240.	270.	300.	325.	335.	345.	355.	365.	390.	390.
1973	1.	10.	85.	170.	259.	342.	384.	409.	404.	461.	520.	534.	500.	500.	500.	500.	500.
1974	1.	10.	85.	170.	259.	342.	384.	409.	444.	461.	520.	543.	482.	482.	482.	482.	482.
1975	1.	10.	85.	181.	259.	342.	384.	409.	444.	461.	520.	543.	482.	482.	482.	482.	482.
1976	1.	10.	85.	181.	259.	342.	384.	409.	444.	461.	520.	543.	482.	482.	482.	482.	482.
1977	1.	10.	85.	181.	259.	343.	384.	409.	444.	461.	520.	543.	482.	482.	482.	482.	482.
1978	1.	10.	85.	180.	294.	326.	371.	409.	461.	476.	520.	543.	500.	500.	500.	500.	500.
1979	1.	10.	85.	178.	232.	359.	385.	420.	444.	505.	520.	551.	500.	500.	500.	500.	500.
1980	1.	10.	85.	175.	283.	347.	402.	421.	465.	465.	520.	534.	500.	500.	500.	500.	500.
1981	1.	10.	85.	170.	224.	336.	378.	387.	408.	397.	520.	543.	512.	512.	512.	512.	512.
1982	1.	10.	85.	170.	204.	303.	355.	383.	395.	413.	453.	468.	506.	506.	506.	506.	506.
1983	1.	10.	85.	155.	249.	304.	368.	404.	424.	437.	436.	493.	495.	495.	495.	495.	495.
1984	1.	10.	85.	140.	204.	295.	338.	376.	395.	407.	413.	422.	437.	437.	437.	437.	437.
1985	1.	10.	85.	148.	234.	265.	312.	346.	370.	395.	397.	428.	428.	428.	428.	428.	428.
1986	1.	10.	85.	54.	206.	265.	289.	339.	368.	391.	382.	388.	395.	395.	395.	395.	395.
1987	1.	10.	55.	90.	143.	241.	279.	299.	316.	342.	343.	362.	376.	376.	376.	376.	376.
1988	1.	15.	50.	98.	135.	197.	277.	315.	339.	343.	359.	365.	376.	376.	376.	376.	376.
1989	1.	15.	100.	154.	175.	209.	252.	305.	367.	377.	359.	395.	396.	396.	396.	396.	396.
1990	1.	8.	48.	219.	198.	258.	288.	309.	428.	370.	403.	387.	440.	440.	440.	440.	440.
1991	1.	11.	37.	147.	210.	244.	300.	324.	336.	343.	382.	366.	425.	425.	425.	425.	425.
1992	1.	7.	30.	128.	224.	296.	327.	355.	345.	367.	341.	361.	430.	470.	470.	470.	450.
1993	1.	8.	25.	81.	201.	265.	323.	354.	358.	381.	369.	396.	393.	374.	403.	400.	400.
1994	1.	10.	25.	75.	151.	254.	318.	371.	347.	412.	382.	407.	410.	410.	410.	410.	410.
1995	1.	18.	25.	66.	138.	230.	296.	346.	388.	363.	409.	414.	422.	410.	410.	405.	447.
1996	1.	18.	25.	76.	118.	188.	261.	316.	346.	374.	390.	390.	384.	398.	398.	398.	398.
1997	1.	18.	25.	96.	118.	174.	229.	286.	323.	370.	378.	386.	360.	393.	391.	391.	391.
1998	1.	18.	25.	74.	147.	174.	217.	242.	278.	304.	310.	359.	340.	344.	385.	363.	375.
1999	1.	18.	25.	102.	150.	223.	240.	264.	283.	315.	345.	386.	386.	386.	382.	382.	407.
2000	1.	18.	25.	102.	150.	223.	240.	264.	283.	315.	345.	386.	386.	386.	382.	382.	407.
2001	1.	18.	25.	75.	178.	238.	247.	296.	307.	314.	328.	351.	376.	406.	414.	425.	425.
2002	1.	10.	23.	57.	177.	241.	275.	302.	311.	314.	328.	341.	372.	405.	415.	467.	409.

Table 3. Proportion of mature norwegian spring spawning herring used by SeaStar.

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1950	0.000	0.000	0.000	0.000	0.100	0.300	0.600	0.900	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1951	0.000	0.000	0.000	0.000	0.100	0.300	0.600	0.900	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1952	0.000	0.000	0.000	0.000	0.100	0.300	0.600	0.900	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1953	0.000	0.000	0.000	0.000	0.100	0.300	0.600	0.900	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1954	0.000	0.000	0.000	0.000	0.100	0.300	0.600	0.900	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1955	0.000	0.000	0.000	0.080	0.220	0.370	0.850	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1956	0.000	0.000	0.000	0.080	0.220	0.370	0.850	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1957	0.000	0.000	0.000	0.000	0.000	0.500	0.600	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1958	0.000	0.000	0.000	0.080	0.220	0.370	0.850	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1959	0.000	0.000	0.000	0.080	0.220	0.370	0.850	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1960	0.000	0.000	0.000	0.080	0.220	0.370	0.850	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1961	0.000	0.000	0.000	0.040	0.350	0.680	0.940	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1962	0.000	0.000	0.000	0.000	0.110	0.670	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1963	0.000	0.000	0.000	0.040	0.030	0.320	0.900	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1964	0.000	0.000	0.000	0.020	0.060	0.280	0.320	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1965	0.000	0.000	0.000	0.000	0.340	0.350	0.760	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1966	0.000	0.000	0.000	0.010	0.150	1.000	0.960	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1967	0.000	0.000	0.000	0.000	0.010	0.230	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1968	0.000	0.000	0.000	0.000	0.000	0.010	0.760	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1969	0.000	0.000	0.000	0.620	0.890	0.950	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1970	0.000	0.000	0.000	0.060	0.130	0.310	0.170	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1971	0.000	0.000	0.000	0.100	0.250	0.600	0.900	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1972	0.000	0.000	0.000	0.000	0.100	0.250	0.600	0.900	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1973	0.000	0.000	0.000	0.500	0.900	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1974	0.000	0.000	0.000	0.500	0.900	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1975	0.000	0.000	0.000	0.500	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1976	0.000	0.000	0.000	0.500	0.900	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1977	0.000	0.000	0.000	0.730	0.890	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1978	0.000	0.000	0.000	0.130	0.900	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1979	0.000	0.000	0.000	0.100	0.620	0.950	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1980	0.000	0.000	0.000	0.250	0.500	0.970	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1981	0.000	0.000	0.000	0.300	0.500	0.900	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1982	0.000	0.000	0.000	0.100	0.480	0.700	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1983	0.000	0.000	0.000	0.100	0.500	0.690	0.710	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1984	0.000	0.000	0.000	0.100	0.500	0.900	0.950	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1985	0.000	0.000	0.000	0.100	0.500	0.900	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1986	0.000	0.000	0.000	0.100	0.200	0.900	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1987	0.000	0.000	0.000	0.100	0.300	0.900	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1988	0.000	0.000	0.000	0.100	0.300	0.900	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1989	0.000	0.000	0.000	0.100	0.300	0.900	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1990	0.000	0.000	0.000	0.400	0.800	0.900	0.900	0.900	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1991	0.000	0.000	0.000	0.100	0.700	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1992	0.000	0.000	0.000	0.100	0.200	0.800	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1993	0.000	0.000	0.000	0.010	0.300	0.800	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1994	0.000	0.000	0.000	0.010	0.300	0.800	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1995	0.000	0.000	0.000	0.000	0.300	0.800	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1996	0.000	0.000	0.000	0.000	0.300	0.900	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1997	0.000	0.000	0.000	0.000	0.300	0.900	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1998	0.000	0.000	0.000	0.000	0.300	0.900	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1999	0.000	0.000	0.000	0.000	0.300	0.900	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
2000	0.000	0.000	0.000	0.000	0.300	0.900	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
2001	0.000	0.000	0.000	0.000	0.300	0.900	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
2002	0.000	0.000	0.000	0.000	0.300	0.900	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

Table 4. Stock in numbers by age from SeaStar (in billions)

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1950	693.066	23.975	15.621	8.289	2.985	3.711	6.585	5.947	8.468	3.213	2.645	2.882	5.417	4.743	0.559	1.161	2.574
1951	143.606	278.519	8.472	5.968	6.879	2.397	3.022	5.160	4.536	7.215	2.683	2.175	2.400	4.482	3.741	0.420	2.995
1952	96.420	57.343	108.387	3.190	3.619	5.564	1.903	2.449	3.963	3.345	6.138	2.233	1.776	1.966	3.622	2.897	2.656
1953	86.254	30.452	17.480	43.281	2.709	3.059	4.231	1.512	1.918	3.058	2.529	5.210	1.842	1.429	1.593	2.945	4.493
1954	44.367	31.435	9.158	6.736	36.565	2.288	2.539	3.311	1.225	1.548	2.341	1.810	4.427	1.501	1.142	1.279	5.924
1955	25.473	11.231	8.272	3.178	5.551	30.140	1.837	1.966	2.395	0.936	1.147	1.606	1.131	3.728	1.199	0.860	5.573
1956	30.646	7.057	2.735	3.038	2.649	4.521	24.045	1.475	1.517	1.807	0.726	0.808	1.108	0.785	3.154	0.953	5.094
1957	25.397	9.040	1.579	0.712	2.507	2.047	3.600	18.325	1.168	1.116	1.310	0.504	0.511	0.701	0.524	2.657	4.763
1958	23.095	7.136	1.577	0.502	0.591	1.811	1.619	2.886	13.931	0.938	0.843	0.958	0.352	0.328	0.465	0.329	6.156
1959	412.475	3.226	1.117	0.216	0.416	0.492	1.456	1.310	2.304	11.087	0.742	0.611	0.638	0.211	0.210	0.334	5.409
1960	197.510	156.288	1.185	0.247	0.172	0.333	0.400	1.117	1.021	1.760	8.519	0.556	0.411	0.366	0.100	0.109	4.803
1961	76.099	72.086	54.883	0.231	0.099	0.131	0.260	0.322	0.872	0.811	1.326	6.253	0.400	0.233	0.172	0.033	4.115
1962	19.006	26.982	19.058	20.474	0.170	0.078	0.109	0.210	0.259	0.694	0.652	1.015	4.707	0.298	0.159	0.090	3.535
1963	168.933	5.373	8.368	7.084	15.912	0.139	0.064	0.087	0.162	0.212	0.542	0.513	0.765	3.296	0.215	0.086	3.040
1964	93.902	65.618	0.833	2.098	5.392	12.920	0.115	0.054	0.072	0.123	0.174	0.367	0.356	0.497	1.980	0.112	2.574
1965	8.490	35.874	24.939	0.198	1.699	4.271	9.222	0.086	0.045	0.059	0.082	0.122	0.227	0.230	0.286	0.987	2.042
1966	51.405	1.983	12.174	8.320	0.087	1.225	3.146	5.897	0.056	0.025	0.044	0.053	0.068	0.102	0.098	0.117	2.441
1967	3.943	18.396	0.384	3.880	5.260	0.050	0.621	1.496	2.399	0.013	0.008	0.022	0.022	0.048	0.024	0.017	1.775
1968	5.184	1.331	1.181	0.111	2.048	1.509	0.018	0.144	0.238	0.469	0.003	0.002	0.015	0.011	0.033	0.004	1.459
1969	9.276	0.970	0.263	0.233	0.004	0.018	0.011	0.003	0.037	0.080	0.083	0.000	0.000	0.012	0.007	0.026	1.245
1970	0.661	3.414	0.071	0.016	0.026	0.002	0.007	0.005	0.002	0.021	0.038	0.038	0.000	0.000	0.011	0.006	1.093
1971	0.240	0.193	1.050	0.008	0.008	0.005	0.002	0.003	0.002	0.000	0.005	0.008	0.007	0.000	0.000	0.009	0.944
1972	2.376	0.078	0.051	0.373	0.005	0.006	0.003	0.000	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.820
1973	13.629	0.745	0.006	0.008	0.288	0.001	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.706
1974	8.631	5.523	0.301	0.001	0.004	0.225	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.607
1975	3.027	3.467	2.240	0.120	0.000	0.004	0.171	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.523
1976	8.080	1.211	1.407	0.910	0.100	0.000	0.002	0.118	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.450
1977	5.092	3.272	0.491	0.571	0.761	0.081	0.000	0.002	0.090	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.387
1978	6.200	2.043	1.326	0.198	0.471	0.633	0.069	0.000	0.001	0.067	0.000	0.000	0.000	0.000	0.000	0.000	0.333
1979	12.035	2.508	0.829	0.538	0.167	0.394	0.526	0.059	0.000	0.000	0.053	0.000	0.000	0.000	0.000	0.000	0.287
1980	1.473	4.872	1.017	0.336	0.458	0.142	0.333	0.443	0.050	0.000	0.000	0.043	0.000	0.000	0.000	0.000	0.247
1981	1.100	0.595	1.980	0.413	0.283	0.388	0.120	0.279	0.366	0.043	0.000	0.000	0.035	0.000	0.000	0.000	0.213
1982	2.329	0.442	0.241	0.798	0.352	0.239	0.326	0.102	0.236	0.308	0.037	0.000	0.000	0.029	0.000	0.000	0.183
1983	324.949	0.932	0.179	0.098	0.674	0.296	0.202	0.275	0.086	0.198	0.259	0.031	0.000	0.000	0.025	0.000	0.158
1984	11.528	132.034	0.376	0.072	0.081	0.560	0.246	0.168	0.230	0.072	0.167	0.216	0.027	0.000	0.000	0.021	0.136
1985	35.633	4.665	53.680	0.151	0.058	0.065	0.425	0.194	0.133	0.184	0.056	0.128	0.180	0.023	0.000	0.000	0.135
1986	6.041	14.469	1.888	21.692	0.110	0.035	0.041	0.245	0.113	0.063	0.100	0.039	0.082	0.109	0.020	0.000	0.113
1987	9.012	2.447	5.882	0.766	18.170	0.079	0.017	0.021	0.114	0.027	0.016	0.014	0.015	0.009	0.019	0.017	0.095
1988	27.873	3.655	0.991	2.369	0.641	15.174	0.050	0.011	0.011	0.072	0.012	0.005	0.008	0.006	0.002	0.010	0.097
1989	71.286	11.323	1.484	0.397	1.980	0.528	12.550	0.035	0.006	0.004	0.048	0.002	0.001	0.004	0.003	0.000	0.092
1990	127.096	28.978	4.602	0.587	0.339	1.701	0.449	10.501	0.027	0.005	0.003	0.039	0.000	0.000	0.003	0.002	0.079
1991	336.460	51.673	11.781	1.861	0.488	0.289	1.453	0.377	8.828	0.022	0.003	0.000	0.031	0.000	0.000	0.002	0.070
1992	378.721	136.794	21.006	4.788	1.594	0.418	0.248	1.237	0.316	7.395	0.016	0.002	0.000	0.026	0.000	0.000	0.062
1993	99.746	153.976	55.616	8.540	4.109	1.341	0.355	0.212	1.054	0.267	6.156	0.012	0.000	0.000	0.021	0.000	0.053
1994	32.632	40.549	62.602	22.607	7.324	3.438	1.074	0.297	0.179	0.879	0.212	4.918	0.010	0.000	0.000	0.018	0.046
1995	8.779	13.267	16.486	25.447	19.428	6.202	2.621	0.771	0.242	0.147	0.722	0.150	3.634	0.006	0.000	0.000	0.055
1996	72.998	3.569	5.394	6.702	21.849	16.401	4.760	1.664	0.449	0.194	0.112	0.557	0.051	2.282	0.001	0.000	0.047
1997	103.258	29.679	1.451	2.174	5.737	18.143	12.659	3.224	1.056	0.291	0.161	0.089	0.418	0.028	1.188	0.001	0.040
1998	201.620	41.981	12.067	0.576	1.750	4.686	13.950	9.046	2.069	0.606	0.194	0.120	0.047	0.276	0.006	0.679	0.036
1999	150.459	81.972	17.068	4.853	0.431	1.281	3.692	10.374	6.613	1.427	0.401	0.127	0.080	0.037	0.133	0.000	0.615
2000	17.643	61.172	33.327	6.936	4.049	0.337	0.978	2.779	7.440	4.612	0.958	0.247	0.096	0.032	0.025	0.032	0.470
2001	5.026	7.173	24.870	13.541	5.892	2.965	0.258	0.739	2.017	5.198	3.000	0.623	0.146	0.068	0.006	0.000	0.370
2002	159.329	2.043	2.916	10.110	11.560	4.922	2.156	0.186	0.547	1.461	3.696	2.112	0.468	0.103	0.055	0.002	0.298

Table 5. Spawning stock biomass by age from SeaStar.

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Sum
1950	0.000	0.000	0.000	0.000	0.060	0.251	0.983	1.433	2.417	0.962	0.817	0.920	1.754	1.575	0.187	0.410	0.916	12.684
1951	0.000	0.000	0.000	0.000	0.137	0.162	0.453	1.244	1.276	2.165	0.830	0.693	0.776	1.492	1.258	0.148	1.063	11.696
1952	0.000	0.000	0.000	0.000	0.073	0.374	0.285	0.591	1.120	0.992	1.902	0.712	0.573	0.654	1.224	1.023	0.945	10.468
1953	0.000	0.000	0.000	0.000	0.054	0.207	0.632	0.366	0.544	0.908	0.770	1.666	0.596	0.475	0.538	1.042	1.602	9.400
1954	0.000	0.000	0.000	0.000	0.732	0.154	0.379	0.793	0.346	0.458	0.710	0.561	1.436	0.499	0.383	0.451	2.106	9.009
1955	0.000	0.000	0.000	0.025	0.233	2.322	0.397	0.527	0.675	0.278	0.349	0.503	0.360	1.247	0.404	0.302	1.976	9.599
1956	0.000	0.000	0.000	0.024	0.116	0.376	4.953	0.396	0.427	0.534	0.221	0.251	0.349	0.256	1.070	0.336	1.812	11.121
1957	0.000	0.000	0.000	0.000	0.000	0.228	0.539	4.671	0.331	0.331	0.400	0.158	0.161	0.229	0.173	0.934	1.688	9.842
1958	0.000	0.000	0.000	0.004	0.026	0.159	0.393	0.833	3.990	0.279	0.257	0.304	0.114	0.108	0.158	0.114	2.157	8.895
1959	0.000	0.000	0.000	0.002	0.018	0.045	0.313	0.371	0.673	3.294	0.227	0.191	0.199	0.067	0.068	0.113	1.858	7.438
1960	0.000	0.000	0.000	0.002	0.008	0.032	0.097	0.319	0.320	0.544	2.643	0.185	0.135	0.126	0.034	0.038	1.690	6.173
1961	0.000	0.000	0.000	0.000	0.008	0.022	0.070	0.095	0.259	0.256	0.416	1.951	0.134	0.080	0.059	0.011	1.332	4.693
1962	0.000	0.000	0.000	0.000	0.004	0.015	0.032	0.065	0.082	0.221	0.213	0.333	1.517	0.100	0.053	0.027	1.075	3.738
1963	0.000	0.000	0.000	0.028	0.086	0.011	0.017	0.027	0.052	0.068	0.174	0.169	0.256	1.068	0.072	0.028	0.980	3.035
1964	0.000	0.000	0.000	0.004	0.061	0.745	0.009	0.017	0.026	0.042	0.058	0.124	0.122	0.169	0.674	0.042	0.962	3.054
1965	0.000	0.000	0.000	0.000	0.104	0.289	1.582	0.021	0.015	0.020	0.029	0.041	0.079	0.082	0.102	0.333	0.689	3.386
1966	0.000	0.000	0.000	0.008	0.002	0.251	0.622	1.342	0.015	0.008	0.015	0.019	0.025	0.033	0.030	0.036	0.752	3.159
1967	0.000	0.000	0.000	0.000	0.008	0.002	0.144	0.336	0.599	0.004	0.003	0.009	0.007	0.017	0.009	0.006	0.586	1.731
1968	0.000	0.000	0.000	0.000	0.000	0.002	0.003	0.035	0.058	0.112	0.000	0.000	0.005	0.004	0.013	0.001	0.511	0.747
1969	0.000	0.000	0.000	0.012	0.000	0.002	0.003	0.000	0.011	0.023	0.025	0.000	0.000	0.004	0.003	0.010	0.486	0.580
1970	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.006	0.011	0.011	0.000	0.000	0.004	0.002	0.420	0.456
1971	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.002	0.002	0.000	0.000	0.003	0.362	0.374
1972	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.311	0.313
1973	0.000	0.000	0.000	0.000	0.065	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.345	0.412
1974	0.000	0.000	0.000	0.000	0.001	0.075	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.287	0.363
1975	0.000	0.000	0.000	0.011	0.000	0.001	0.063	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.247	0.322
1976	0.000	0.000	0.000	0.081	0.023	0.000	0.000	0.047	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.213	0.365
1977	0.000	0.000	0.000	0.074	0.172	0.027	0.000	0.000	0.039	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.184	0.497
1978	0.000	0.000	0.000	0.005	0.123	0.203	0.025	0.000	0.000	0.031	0.000	0.000	0.000	0.000	0.000	0.000	0.164	0.551
1979	0.000	0.000	0.000	0.009	0.024	0.132	0.199	0.024	0.000	0.000	0.027	0.000	0.000	0.000	0.000	0.000	0.140	0.557
1980	0.000	0.000	0.000	0.014	0.064	0.047	0.132	0.183	0.023	0.000	0.000	0.023	0.000	0.000	0.000	0.000	0.117	0.603
1981	0.000	0.000	0.000	0.021	0.031	0.115	0.045	0.106	0.147	0.017	0.000	0.000	0.018	0.000	0.000	0.000	0.093	0.593
1982	0.000	0.000	0.000	0.013	0.034	0.050	0.114	0.038	0.092	0.125	0.016	0.000	0.000	0.015	0.000	0.000	0.088	0.584
1983	0.000	0.000	0.000	0.001	0.082	0.061	0.052	0.109	0.036	0.085	0.111	0.015	0.000	0.000	0.012	0.000	0.074	0.639
1984	0.000	0.000	0.000	0.000	0.008	0.145	0.077	0.062	0.089	0.029	0.067	0.090	0.012	0.000	0.000	0.009	0.058	0.645
1985	0.000	0.000	0.000	0.002	0.006	0.015	0.126	0.064	0.046	0.068	0.021	0.052	0.073	0.010	0.000	0.000	0.056	0.539
1986	0.000	0.000	0.000	0.115	0.004	0.008	0.011	0.077	0.036	0.022	0.031	0.014	0.026	0.036	0.008	0.000	0.044	0.432
1987	0.000	0.000	0.000	0.007	0.766	0.016	0.005	0.006	0.034	0.009	0.005	0.005	0.005	0.003	0.007	0.006	0.035	0.908
1988	0.000	0.000	0.000	0.023	0.025	2.640	0.013	0.003	0.003	0.024	0.004	0.001	0.003	0.002	0.000	0.004	0.036	2.782
1989	0.000	0.000	0.000	0.006	0.102	0.098	3.107	0.010	0.002	0.001	0.017	0.000	0.000	0.002	0.000	0.000	0.036	3.383
1990	0.000	0.000	0.000	0.051	0.053	0.389	0.114	2.870	0.011	0.002	0.000	0.015	0.000	0.000	0.001	0.000	0.034	3.542
1991	0.000	0.000	0.000	0.027	0.071	0.070	0.429	0.120	2.914	0.007	0.000	0.000	0.013	0.000	0.000	0.000	0.028	3.681
1992	0.000	0.000	0.000	0.060	0.070	0.097	0.080	0.432	0.107	2.665	0.005	0.000	0.000	0.012	0.000	0.000	0.027	3.557
1993	0.000	0.000	0.000	0.007	0.243	0.278	0.113	0.074	0.370	0.099	2.221	0.005	0.000	0.000	0.008	0.000	0.021	3.440
1994	0.000	0.000	0.000	0.017	0.326	0.680	0.330	0.108	0.061	0.355	0.078	1.942	0.004	0.000	0.000	0.007	0.018	3.928
1995	0.000	0.000	0.000	0.000	0.791	1.111	0.741	0.253	0.092	0.052	0.288	0.056	1.464	0.002	0.000	0.000	0.024	4.873
1996	0.000	0.000	0.000	0.000	0.759	2.704	1.195	0.503	0.149	0.071	0.043	0.211	0.018	0.851	0.000	0.000	0.018	6.522
1997	0.000	0.000	0.000	0.000	0.199	2.768	2.803	0.882	0.323	0.103	0.059	0.032	0.144	0.009	0.439	0.000	0.015	7.778
1998	0.000	0.000	0.000	0.000	0.075	0.717	2.939	2.122	0.554	0.177	0.058	0.041	0.016	0.088	0.001	0.238	0.013	7.038
1999	0.000	0.000	0.000	0.000	0.019	0.250	0.861	2.649	1.805	0.432	0.132	0.048	0.028	0.014	0.044	0.000	0.242	6.525
2000	0.000	0.000	0.000	0.000	0.177	0.066	0.228	0.711	2.031	1.392	0.317	0.090	0.036	0.010	0.004	0.012	0.185	5.259
2001	0.000	0.000	0.000	0.000	0.309	0.615	0.062	0.212	0.599	1.577	0.950	0.213	0.053	0.027	0.002	0.000	0.153	4.773
2002	0.000	0.000	0.000	0.000	0.601	1.046	0.574	0.054	0.164	0.442	1.169	0.696	0.169	0.041	0.022	0.001	0.118	5.098

Table 6. Fishing mortality for norwegian spring spawning herring from SeaStar

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1950	0.012	0.140	0.062	0.037	0.069	0.055	0.094	0.121	0.010	0.030	0.046	0.033	0.039	0.087	0.137	0.104	0.104
1951	0.018	0.044	0.077	0.350	0.062	0.081	0.060	0.114	0.154	0.012	0.034	0.052	0.050	0.063	0.106	0.130	0.130
1952	0.253	0.288	0.018	0.013	0.018	0.124	0.080	0.094	0.109	0.130	0.014	0.042	0.068	0.060	0.057	0.100	0.100
1953	0.109	0.302	0.054	0.019	0.019	0.036	0.095	0.060	0.064	0.117	0.184	0.013	0.055	0.074	0.069	0.082	0.082
1954	0.474	0.435	0.158	0.044	0.043	0.070	0.106	0.174	0.120	0.150	0.227	0.321	0.022	0.075	0.134	0.113	0.113
1955	0.384	0.512	0.102	0.032	0.055	0.076	0.069	0.110	0.132	0.103	0.201	0.221	0.215	0.017	0.079	0.139	0.139
1956	0.321	0.597	0.446	0.042	0.108	0.078	0.122	0.084	0.157	0.172	0.216	0.307	0.308	0.254	0.022	0.106	0.106
1957	0.369	0.846	0.246	0.036	0.175	0.084	0.071	0.124	0.069	0.131	0.163	0.210	0.295	0.261	0.316	0.147	0.147
1958	1.068	0.954	1.087	0.038	0.033	0.068	0.061	0.075	0.078	0.085	0.171	0.256	0.360	0.294	0.180	0.257	0.257
1959	0.070	0.102	0.610	0.078	0.072	0.058	0.115	0.099	0.119	0.114	0.138	0.248	0.407	0.601	0.506	0.320	0.320
1960	0.108	0.147	0.733	0.759	0.121	0.095	0.068	0.097	0.081	0.133	0.159	0.180	0.416	0.602	0.951	0.620	0.620
1961	0.137	0.430	0.086	0.157	0.092	0.034	0.064	0.067	0.079	0.068	0.117	0.134	0.144	0.233	0.501	1.188	1.188
1962	0.363	0.271	0.090	0.102	0.052	0.044	0.074	0.109	0.051	0.096	0.091	0.133	0.206	0.174	0.464	1.478	1.478
1963	0.046	0.964	0.483	0.123	0.058	0.042	0.031	0.045	0.130	0.049	0.241	0.216	0.282	0.360	0.508	1.362	1.362
1964	0.062	0.067	0.536	0.061	0.083	0.187	0.138	0.031	0.046	0.247	0.201	0.330	0.287	0.403	0.546	0.578	0.578
1965	0.554	0.181	0.198	0.671	0.177	0.156	0.297	0.280	0.444	0.145	0.287	0.435	0.649	0.705	0.741	1.406	1.406
1966	0.128	0.743	0.244	0.308	0.404	0.529	0.593	0.749	1.305	0.974	0.557	0.755	0.191	1.307	1.591	2.028	2.028
1967	0.186	1.845	0.339	0.489	1.099	0.849	1.312	1.690	1.483	1.322	1.444	0.192	0.553	0.221	1.573	2.106	2.106
1968	0.776	0.723	0.725	3.253	4.593	4.741	1.770	1.216	0.937	1.577	1.267	1.294	0.058	0.291	0.088	0.603	0.603
1969	0.100	1.713	1.882	2.053	0.265	0.759	0.592	0.327	0.420	0.601	0.627	0.587	0.820	0.017	0.032	0.017	0.017
1970	0.332	0.279	1.317	0.541	1.513	0.308	0.683	1.076	1.027	1.187	1.375	1.562	2.640	1.338	0.021	0.019	0.019
1971	0.222	0.429	0.136	0.292	0.145	0.321	0.289	0.483	1.466	1.384	2.044	2.355	1.890	0.052	1.060	0.015	0.015
1972	0.260	1.730	0.985	0.108	1.393	1.012	2.107	1.392	3.372	1.134	0.010	2.075	3.025	1.239	0.064	0.116	0.116
1973	0.003	0.007	0.642	0.404	0.099	1.075	1.930	2.817	2.316	0.022	0.012	0.011	0.017	0.039	2.003	0.079	0.079
1974	0.012	0.002	0.021	0.094	0.060	0.125	2.162	2.209	0.068	0.061	0.026	0.015	0.013	0.020	0.048	0.042	0.042
1975	0.016	0.002	0.001	0.030	0.163	0.317	0.215	0.191	0.101	0.085	0.077	0.032	0.017	0.016	0.023	0.058	0.058
1976	0.004	0.003	0.001	0.028	0.060	0.002	0.000	0.127	0.050	0.064	0.109	0.097	0.038	0.020	0.019	0.028	0.028
1977	0.013	0.003	0.010	0.043	0.034	0.004	0.002	0.264	0.139	0.062	0.080	0.144	0.126	0.046	0.024	0.022	0.022
1978	0.005	0.002	0.001	0.017	0.028	0.035	0.014	0.002	0.732	0.084	0.077	0.101	0.198	0.169	0.057	0.029	0.029
1979	0.004	0.002	0.004	0.013	0.012	0.019	0.023	0.006	0.002	0.002	0.053	0.097	0.132	0.294	0.242	0.070	0.070
1980	0.007	0.000	0.000	0.021	0.014	0.017	0.027	0.039	0.009	0.023	0.002	0.069	0.126	0.179	0.506	0.379	0.379
1981	0.012	0.003	0.009	0.011	0.018	0.024	0.020	0.018	0.025	0.009	0.433	0.375	0.030	0.170	0.259	1.396	1.396
1982	0.015	0.004	0.001	0.019	0.024	0.020	0.021	0.021	0.023	0.021	0.004	0.256	0.188	0.004	0.242	0.417	0.417
1983	0.000	0.008	0.015	0.036	0.034	0.035	0.034	0.027	0.016	0.025	0.031	0.005	0.457	2.668	0.038	0.381	0.381
1984	0.005	0.000	0.010	0.070	0.074	0.126	0.083	0.085	0.076	0.114	0.112	0.033	0.000	0.017	0.115	0.090	0.090
1985	0.001	0.004	0.006	0.166	0.343	0.320	0.400	0.396	0.591	0.461	0.215	0.302	0.356	0.000	0.020	0.153	0.153
1986	0.004	0.000	0.003	0.027	0.189	0.588	0.530	0.619	1.265	1.253	1.781	0.783	2.057	1.578	0.000	0.024	0.024
1987	0.002	0.004	0.010	0.028	0.030	0.296	0.254	0.462	0.309	0.640	1.071	0.408	0.811	1.517	0.496	0.029	0.029
1988	0.000	0.001	0.015	0.029	0.043	0.040	0.226	0.436	0.859	0.247	1.468	1.081	0.574	0.688	4.860	0.059	0.059
1989	0.000	0.000	0.027	0.008	0.002	0.012	0.028	0.115	0.149	0.198	0.076	0.921	0.789	0.090	0.118	0.100	0.100
1990	0.000	0.000	0.005	0.035	0.008	0.008	0.026	0.024	0.054	0.436	1.447	0.070	1.744	0.458	0.225	0.100	0.100
1991	0.000	0.000	0.000	0.005	0.006	0.005	0.011	0.026	0.027	0.133	0.214	0.176	0.024	2.075	3.965	0.303	0.303
1992	0.000	0.000	0.000	0.003	0.023	0.013	0.005	0.010	0.020	0.033	0.179	0.486	1.007	0.053	0.082	0.262	0.262
1993	0.000	0.000	0.000	0.004	0.028	0.073	0.027	0.019	0.031	0.078	0.075	0.000	0.001	0.008	0.000	0.104	0.104
1994	0.000	0.000	0.000	0.002	0.016	0.121	0.181	0.058	0.050	0.047	0.200	0.153	0.360	0.938	3.156	0.130	0.130
1995	0.000	0.000	0.000	0.002	0.019	0.115	0.304	0.390	0.072	0.124	0.110	0.925	0.315	1.287	4.046	0.301	0.301
1996	0.000	0.000	0.009	0.006	0.036	0.109	0.240	0.305	0.285	0.032	0.074	0.137	0.463	0.503	0.000	0.301	0.301
1997	0.000	0.000	0.024	0.067	0.052	0.113	0.186	0.294	0.406	0.256	0.144	0.497	0.266	1.366	0.409	0.301	0.301
1998	0.000	0.000	0.011	0.141	0.162	0.089	0.146	0.163	0.222	0.263	0.270	0.258	0.084	0.580	6.687	0.188	0.188
1999	0.000	0.000	0.000	0.031	0.094	0.120	0.134	0.182	0.210	0.249	0.336	0.131	0.775	0.236	1.267	0.180	0.180
2000	0.000	0.000	0.000	0.013	0.162	0.118	0.130	0.171	0.209	0.280	0.280	0.375	0.201	1.476	8.015	0.171	0.171
2001	0.000	0.000	0.000	0.008	0.030	0.169	0.177	0.151	0.173	0.191	0.201	0.136	0.193	0.057	0.867	0.163	0.163
2002	0.000	0.000	0.033	0.021	0.061	0.057	0.175	0.189	0.202	0.215	0.212	0.188	0.129	0.137	0.146	0.154	0.154

Table 7. Summary table SeaStar. (Biomasses in million tonnes, Recruits in billions)

	Recruits Age 0	Total biomass	Spawning stock biomass	Fbar 5-14
1950	693.066	17.383	12.684	0.060
1951	143.606	17.430	11.696	0.073
1952	96.420	18.496	10.468	0.078
1953	86.254	16.558	9.400	0.073
1954	44.367	18.087	9.009	0.129
1955	25.473	15.605	9.599	0.088
1956	30.646	13.902	11.121	0.124
1957	25.397	11.313	9.842	0.126
1958	23.095	9.799	8.895	0.096
1959	412.475	8.406	7.438	0.137
1960	197.510	8.084	6.173	0.166
1961	76.099	8.264	4.693	0.126
1962	19.006	7.238	3.738	0.172
1963	168.933	7.457	3.035	0.299
1964	93.902	7.081	3.054	0.241
1965	8.490	6.443	3.386	0.277
1966	51.405	5.065	3.159	0.690
1967	3.943	3.587	1.731	1.496
1968	5.184	1.450	0.747	3.414
1969	9.276	0.634	0.580	0.547
1970	0.661	0.508	0.456	1.211
1971	0.240	0.471	0.374	1.554
1972	2.376	0.386	0.313	1.689
1973	13.629	0.452	0.412	1.645
1974	8.631	0.461	0.363	0.130
1975	3.027	0.569	0.322	0.217
1976	8.080	0.597	0.365	0.124
1977	5.092	0.636	0.497	0.077
1978	6.200	0.745	0.551	0.039
1979	12.035	0.783	0.557	0.022
1980	1.473	0.865	0.603	0.032
1981	1.100	0.887	0.593	0.022
1982	2.329	0.806	0.584	0.021
1983	324.949	1.150	0.639	0.030
1984	11.528	2.063	0.645	0.093
1985	35.633	5.241	0.539	0.393
1986	6.041	1.857	0.432	1.139
1987	9.012	3.169	0.908	0.447
1988	27.873	3.538	2.782	0.045
1989	71.286	4.142	3.383	0.028
1990	127.096	4.656	3.542	0.022
1991	336.460	5.364	3.681	0.025
1992	378.721	6.450	3.557	0.029
1993	99.746	7.570	3.440	0.066
1994	32.632	8.668	3.928	0.134
1995	8.779	9.555	4.873	0.222
1996	72.998	9.647	6.522	0.182
1997	103.258	9.723	7.778	0.176
1998	201.620	8.826	7.038	0.156
1999	150.459	9.378	6.525	0.194
2000	17.643	8.557	5.259	0.235
2001	5.026	7.505	4.773	0.181
2002	159.329	7.628	5.098	0.152

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1 INTRODUCTION

1.1 Terms of reference

The **Northern Pelagic and Blue Whiting Fisheries Working Group** [WGNPBW] (Chair: A. Gudmundsdottir, Iceland) will meet in ICES Headquarters from 29 April to 8 May 2003 to:

a) assess the status of and provide catch options for 2004 for the Norwegian spring-spawning herring stock;

b) assess the status of and provide catch options for 2004 for the blue whiting stock;

c) assess the status of and provide catch options for the 2003–2004 season for the Icelandic summer-spawning herring stocks;

d) assess the status of capelin in Sub-areas V and XIV and provide catch options for the summer/autumn 2003 and winter 2004 seasons;

e) assess the status of and provide catch options for capelin in Sub-areas I and II (excluding Division IIa west of 5°W) in 2004;

f) provide as detailed information as possible on the age/size composition in different segments of the blue whiting fishery;

g) provide information on the species compositions in those fisheries that take appreciable amounts of blue whiting, and on the age/size composition by species of these catches [EC request for information on the industrial fisheries];

h) evaluate the effect on the blue whiting stock and the fisheries of possible measures to reduce exploitation of juveniles. The evaluation should include but not be restricted to the effects of introducing a minimum size and closed areas/seasons;

i) continue the evaluation of candidates of harvest control rules for blue whiting;

j) 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;

k) 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;

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

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

WGNPBW will report by 9 May 2003 for the attention of ACFM.

Government of Russia on behalf of the coastal states (Iceland, Norway, Faroe Islands, Russia and EC) *22.10.2002*	At the Fisheries Consultations on the management of Norwegian spring-spawning (Atlanto-Scandian) herring stock in the North-East Atlantic for 2003 the Parties agreed to submit the following request to ICES: 1. ICES is requested to evaluate and compare the models ISVPA and SeaStar and to comment on their applicability to assess the state of the Norwegian spring-spawning (Atlanto-Scandian) herring stock. 2. Based on the evaluation of the models and any new information and taking into account the long-term management plan agreed by the Parties, ICES is requested to review its TAC advice for 2003. ICES is requested to report to the Parties as soon as possible, and not later than the first half of June 2003.

EC, The Faroe Islands, Greenland, Iceland, Norway and Russia *21.11.2002*	As an outcome of the coastal state meeting on blue whiting 7-8 November: 1. The parties noted that similar discrepancies exist for the assessment of the Norwegian Spring-spawning (Atlanto-Scandian) herring stock and that a request to ICES to evaluate the two assessment models with respect to Norwegian Spring-spawning herring has been put forward by the Russian Federation on behalf of the coastal states. The Parties request ICES to extend these evaluations to also include assessment of blue whiting. 2. The Parties further noted that there is a lack of co-ordination on research on blue whiting. ICES is therefore invited to take initiatives to enhance the co-operation and co-ordination on blue whiting research.

1.2 List of participants

Alexander Krysov	Russia
Edda Johannesen	Norway
Asta Gudmundsdottir (Chair)	Iceland
Brian S. Nakashima	Canada
John Boyd	Ireland
Dimitri Vasilyev	Russia
Frans van Beek	Netherlands
Harald Gjösæter	Norway
Hjalmar Vilhjalmsson	Iceland
Ingolf Röttingen	Norway
Jan Arge Jacobsen	Faroe Islands
Jens Chr. Holst	Norway
Manuel Meixide	Spain
Mikko Heino	Norway
Nikolay Timoshenko	Russia
Sergei Belikov	Russia
Sigurd Tjelmeland	Norway
Sveinn Sveinbjörnsson	Iceland
Webjörn Melle	Norway

1.3 Non-standard assessment methods

1.3.1 AMCI

The assessment model AMCI (Assessment Model Combining Information from various sources), version 2.1, was described in the Working Group report in 2002. For assessments in 2003 AMCI version 2.2 (May 2002) has been used. This version is essentially an updated version of AMCI 2.1 where some known problems have been solved but without important changes in functionality. An updated manual was available for the Working Group. The Working Group on Methods on Fish Stock Assessments explored and evaluated AMCI 2.2, together with ISVPA and an array of other assessment models in their meeting in early 2003 (ICES 2003/D:03). The report of that Working Group can be consulted for more details on AMCI.

1.3.2 SeaStar

The assessment model SeaStar (Stock Estimation with Adjustable Survey observation model and TAg return data) was described in the Working Group report in 2002 and has been used for assessing the Norwegian spring-spawning stock in recent years. An updated manual was available for the Working Group. This year the method for analysing young fish not yet present in the main tuning data was changed from a regression approach to tuning in a separate step using survey and 0-group data from the Barents Sea.

1.3.3 ISVPA

The ISVPA is described in last years WGNPBW report (ICES 2002/ACFM:19). Some changes have been made to the model, and these are described in the report from the meeting of the Methods Working Group in January 2003 (ICES 2003/D:03).

1.4 Special requests concerning Norwegian spring-spawning herring from coastal states

1.4.1 Comparison of the SeaStar and ISVPA models

The special request from the coastal states is given in Section 1.1. An evaluation and comparison of the ISVPA and SeaStar and their applicability to assess the stock of Norwegian spring-spawning herring is given in Section 3.5.1 and 3.5.2.

1.4.2 Review of TAC advice for 2003

SeaStar assessment: The SeaStar assessment this year gives a similar perception of the spawning stock size for 2003 as last year. In the prognosis made in 2002 the assessment of the spawning stock for 2003 was 6.1 million t. This year the estimate of the spawning stock in 2003 is 5.8 million t. There has, however, been an increase in the estimate of the 1998 year class from 9.9 billion individuals as 4 years old to 11.5 billion in the 2003 estimate. A catch for 2003 corresponding to F=0.125 using the same exploitation pattern as used in the TAC advice and based on the 2003 assessment of the stock in 2003 is 765 000 tonnes, compared to 710 000 tonnes based on the 2002 prognosis. The TAC advice for 2004 of 850 000 t is based on a catch in 2003 of 710 000 t. If the catch in 2003 is increased the TAC advice for 2004 should be reduced correspondingly.

ISVPA assessment: Norwegian spring-spawning herring stock assessment by means of ISVPA, made at the WG, confirmed the tendency of an increase in spawning stock biomass, of which the first indications were shown in last year's assessment by means of the model. Results of the ISVPA assessment indicate the possibility of considering an increase in the TAC level recommended by ACFM for 2003 from 710 000 tonnes to 805 000 tonnes, corresponding to F=0.125.

1.5 Special requests concerning blue whiting

1.5.1 Medium-term projections

The Northern Pelagic and Blue Whiting Working Group did not carry out medium-term projections. In general, medium term projections in the most recent period are largely defined by the presently assumed stock size, recruitment and exploitation level, while the period further in the future is mostly affected by assumptions on recruitment dynamics and exploitation level. This year, the WG could not reach an agreement on the present situation in this stock, since two different models gave different answers. The Working Group considered that, given the uncertain present situation of the stock and its exploitation, and the poor knowledge on stock dynamics, medium-term projections for blue whiting would be predominantly based on assumptions and are not very instructive. However, the WG made medium-term projections during its 2002 meeting.

1.5.2 Harvest control rules

The Northern Pelagic and Blue Whiting Working Group did not carry out medium-term projections, which are the basis for the evaluation of harvest control rules. However, the WG made medium-term projections during its 2002 meeting, and, based on a similar request in that year, suggested and evaluated various harvest control rules. These should, in general, still be valid.

The Working Group considers that evaluation of harvest control rules for blue whiting would currently be premature. Evaluation of harvest control rules is possible if, and only if management objectives are well specified. The current management objectives for blue whiting are formulated within the framework of precautionary reference points, although this has had no influence on actual management. The reference points for blue whiting were derived in 1998 but have not yet been revised, despite the new dynamic regime displayed both by the stock and fisheries during the later years. Furthermore, the Working Group was not aware whether the evaluation should take into account management objectives beyond those implied by the precautionary reference points, involving, e.g., stability of landings.

1.5.3 Description of the fisheries

In a special request to ICES for scientific advice for 2004, NEAFC asked the following: "Under the MoU, ICES is requested to describe fisheries, gear, fleets and developments in fleets involved in fisheries for stocks for which NEAFC recommends management measures. The information is requested with the same level of detail as given for pelagic fisheries for *Sebastes mentella* in the Irminger Sea in the Report of the North Western Working Group."

The WG has consulted the proposed NWWG report and have decided to add a summary section of the "development of the fisheries" in sec. 6.2 in next years report. The data on the fisheries provided to this year's WG were not detailed enough to fully answer the request. However, in sec. 6.2 the spatial and temporal distribution of the catches of blue whiting in 2002 are given as catch by quarter and ICES rectangles (Figure 6.2.1) and for the whole year as catch by ICES rectangles (Figure 6.2.2).

In order to describe the developments in the fleets involved in the fisheries for blue whiting, Norwegian spring-spawning herring and capelin, the WG recommends that WG members bring data to enumerate the number, capacity and effort of vessels taking part in the fisheries.

1.5.4 Evaluation of the assessment models ISVPA and AMCI used for blue whiting

This request was addressed and answered by the ICES Methods Working Group during their meeting in January 2003 (ICES 2003/D:03).

1.5.5 Lack of coordination on research on blue whiting

The Northern Pelagic and Blue Whiting Working Group discussed this problem, and put forward the following recommendations:

> Several surveys on blue whiting are presently going on. It is recommended that a coordinated survey be organised covering the main spawning grounds of blue whiting. Other countries than those presently taking part in these surveys should be invited to take part.
>
> It is recommended that information from existing surveys in which blue whiting are caught is made available to the Working Group. In particular, information from PGSPFN-coordinated surveys should be made available and analysed for information on abundance on incoming year classes.
>
> It is suggested that the coordination could be taken care of by an extended ICES PGSPFN.

The Working Group also acknowledged that the Nordic Council of Ministers have provided funds for the “Nordic Blue Whiting Network”, which has already taken actions towards more coordinated research on blue whiting. The report of the network was made available to the Working Group (Heino *et al.*, WD b).

1.5.6 Information about species composition in the industrial fisheries

Only information on species composition in catches from Norwegian mixed industrial fishery was made available to the Working Group (Heino *et al.*, WD a). This fishery targets both blue whiting and Norway pout, and the landings consist of mixtures of these two species. In 2000-2002, the average annual landings from the fishery were 109 000 t. Of this amount, an estimated proportion of 58% was blue whiting, and 17% was Norway pout. The remaining proportion, 15% or about 16 000 t, represents a wide range of fish and invertebrates. The six most important bycatch species (in terms of landed catch) are saithe, herring, haddock, horse mackerel, whiting and mackerel, each of which represents an annual catch of at least 1000 t in this fishery. Of these species, mostly individuals in the length range 25-40 cm were captured, with herring and mackerel being often somewhat smaller and saithe larger. This suggests that the bycatch of these species often consists of immature individuals.

The Working Group does not have expertise for judging the significance of bycatch mortality on species other than blue whiting. The Working Group therefore recommends that working groups responsible for the assessments of the species concerned carry the analyses further.

2 ECOLOGICAL CONSIDERATIONS

2.1 Climate considerations in the Barents Sea

2.1.1 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 (Figure 2.1.1.1). Temperatures in the Barents Sea have been relatively high during most of the 1990s, with a continuous warm period from 1989-1995. During 1996-1997, the temperature was just below the long-term average before turning warm again at the end of the decade. The 1990s was the third warmest decade in the 20th century (Ingvaldsen *et al.,* in press).

In January 2002 the temperature was just above the long-term average in the whole Barents Sea, but from April the temperature increased rapidly. In the Fugløya-Bjørnøya section (Figure 2.1.1.2 and Figure 2.1.1.3) the temperature in June was 1^{o}C above average, which is the highest observed value since the start of measurements in 1977. In the Kola section the maximum temperature was 0.8^{o}C above average in August/September, which was 0.1-0.2^{o}C below the maximum for the period 1921-1999. The temperature decreased slightly until October, followed by a rapid decrease towards the average in December. In January 2003, the temperature was at the long-term average (Asplin and Dahl, 2003; Stiansen *et al.,* WD). The situation was similar in the whole Barents Sea.

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

2.1.2 Inflow of Atlantic water

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

2.1.3 Predicting Barents Sea temperature

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

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

Conclusions:

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

- The inflow of Atlantic water was normal for most of 2002, except for a higher inflow at the beginning of the year.
- The temperature in 2003 is expected to be lower than in 2002, and will be close to the long-term mean in most of the Barents Sea.

2.2 Zooplankton

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

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

Figure 2.2.1 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 2.2.1, indicating that capelin exercise a strong feedback control on the system through its predation pressure on zooplankton.

Conclusion:

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

2.3 Trophic interactions

2.3.1 Predicting capelin biomass

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

The biomass of capelin (1+) decreased from 3.6 million tonnes in 2001 to 2.2 million tonnes in 2002 (ICES 2002/ACFM:19). This is lower than the prediction for 2002 made by AFWG last year (3.4 million tonnes). The prediction method used in ICES (2002/ACFM:19), which is essentially the same as the one used previously, predicted the 2+ capelin biomass to be 1.40 million tonnes in October 2003 and the biomass of 1-year-old capelin at the same time to be 0.59 million tonnes, giving a total of 1.99 million tonnes. Of this, 1.17 million tonnes are predicted to be mature capelin. The stock history for capelin from 1984 onwards is given in Table 2.3.1.1 together with the estimated biomass of capelin removed from the stock by natural mortality.

A 1-year prognosis has been presented to AFWG since 1999. A review of the prognoses made during this period is given in Table 2.3.1.2. The prognoses seem to be overestimates in most cases. The prediction methodology is still under development. WGNPBW has been requested by AFWG to provide a review of how the present prognosis method would have performed when run on historical data. Also, the prediction should be given with uncertainty. This will be done during the capelin assessment sub-group meeting after the joint capelin survey in the autumn.

2.3.2 Predation by cod

The consumption by cod of various prey species for the period 1984-2002 is given in Table 2.3.2.1, using the same method as described by Bogstad and Mehl (1997).

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

Dolgov (WD to AFWG, Table 2.3.2.2) also calculated the consumption by cod based on the same data, using a somewhat different methodology. The consumption by prey species from the two methods for 2002 is similar. The main difference is that the calculations in Table 2.3.2.1 give a decrease in the consumption of capelin from 2001 to 2002, while the calculations in Table 2.3.2.2 show an increase. Also, there are notable differences in the number-at-age of cod and haddock consumed by cod. It should be noted that the calculations in Table 2.3.2.1 are based on the number-at-age of cod from the VPA given in this year's report, while the calculations in Table 2.3.2.2 are based on the VPA from the 2002 AFWG meeting.

The annual consumption for each age group of cod (kg/year), based on the consumption calculations shown in Tables 2.3.2.1 and 2.3.2.2 are given in Tables 2.3.2.3 and 2.3.2.4, respectively. Table 2.3.2.3 shows that the consumption per cod decreased from 2001 to 2002 for age 3 and older fish. The consumption per cod in 2002 was close to the 1998 level, but lower than in the period 1999-2001. Such a trend in the consumption per cod is not found in Table 2.3.2.4. The calculations by Dolgov (WD to AFWG) generally give a lower consumption per cod for age 1-4 and a higher consumption per cod for age 6+ compared to the calculations using the method described by Bogstad and Mehl (1997). The discrepancies in consumption per cod by age group are much larger than the discrepancies in total consumption by the cod stock.

The consumption estimates in Tables 2.3.2.1 and 2.3.2.2 do not include the consumption by mature cod in the period when it is outside the Barents Sea (assumed to be 3 months during the first half of the year). During this period it may consume significant amounts of adult herring (Bogstad and Mehl, 1997).

Johansen *et al*. (2002) describe a new method for calculating the consumption by cod, and used it to calculate the consumption of herring by cod in the period 1992-1997. Their consumption estimates are comparable to the estimates given in Table 2.3.2.2, except for 1994, when they obtained a much higher estimate (494 vs. 147 thousand tonnes).

As in previous years, the consumption of cod and haddock by cod was calculated using the method described by Bogstad and Mehl (1997). It is important to agree on a joint methodology for consumption calculations.

2.3.3 Predation by other fish species

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

2.3.4 Predation by mammals

The consumption by minke whales (Folkow *et al,*. 2000) and by harp seals (Nilssen *et al.,* 2000) is given in Table 2.3.4.1. These consumption estimates are based on stock size estimates of 85 000 minke whales in the Barents Sea and Norwegian coastal waters (Schweder *et al*., 1997) and of 2 223 000 harp seals in the Barents Sea (ICES 1999/ACFM:7). The consumption by harp seal is calculated both for situations with high and low capelin stock, while the consumption by minke whale is calculated for a situation with a high herring stock and a low capelin stock. It is worth noting that the abundance estimate of harp seals was revised considerably upwards in 1998 (ICES 1999/ACFM:7), which also increased estimates of the consumption by harp seals correspondingly. Food consumption by harp seals and minke whales combined is at about the same level as the food consumption by cod, and the predation by these two species needs to be considered when calculating the mortality of capelin and young herring in the Barents Sea.

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

Conclusions:

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

2.4 Norwegian Sea

2.4.1 Hydrography and climate

The Nordic Seas during the last decades have been characterized by increased input of Arctic waters. The Arctic waters to the Norwegian Sea are mainly carried by the East Icelandic Current and also to some extent by the Jan Mayen Current. During periods of increased Arctic water input, the western extension of Atlantic water is moved eastward. As a result, over the last 25 years the southern and western Norwegian Sea has become colder and fresher while the eastern Norwegian Sea is warmed. Atmospheric forcing drives this trend. Since the mid 1960's the North Atlantic Oscillation index (NAO) has increased (Figure 2.4.1.1). NAO as it is used here is the normalised air pressure difference at sea level between Lisbon, Portugal and Reykjavik, Iceland and is an indicator of the strength of the westerly winds into the Norwegian Sea. A high NAO index (i.e. stronger westerly winds) will force Atlantic and Arctic waters more eastward.

The Institute of Marine Research, Norway, has measured temperature and salinity in three standard sections in the Norwegian Sea almost regularly since 1978 (Figure 2.1.1.3). The sections are 1) the Svinøy section which runs NW from 62.37° N at the Norwegian coast, 2) the Gimsøy section which also runs NW from the Lofoten Islands and 3) the Sørkapp section which is a zonal section at 76.33° N just south of Svalbard.

Figure 2.4.1.2 shows the development in summer (July-August) temperature and salinity in the sections from south to north in the Norwegian Sea (Melle *et al.*, WD). During the last 6 years the temperature and salinity in the Svinøy section have been above the long-term mean, while they were about average in the Gimsøy and Sørkapp sections. In 2002 there was a large increase in both temperature and salinity in the Svinøy section. The temperature was then the largest value in the time-series, about 1.3°C above the normal, while the salinity was the next largest, 0.07 above the normal. Only in 1983 was the salinity higher. This increase in temperature and salinity was not seen further north in the Sørkapp section. Unfortunately there were no observations in Gimsøy section that summer.

Figure 2.4.1.3 shows time-series of temperature and salinity during the spring in the Svinøy and Gimsøy sections from 1978 to 2003. The values are calculated using the same procedure as mentioned above. The low salinities in 1978 and 1979 are a result of the Great Salinity Anomaly during the 1970s. In 1994 a large salinity anomaly comparable with the anomaly in 1978 and 1979 was seen in the Svinøy section. The temperature was also a minimum that year. The 1994 anomaly was a result of increased influence of Arctic water from the East Icelandic Current. In 2002 the salinity and temperature increased considerably in the Svinøy section to the highest observed value for the time-series. The condition in 2003 remained approximately unchanged compared to 2002. In the Gimsøy section there was instead a reduction in temperature and salinity for 2002, but both increased again in 2003. The salinity was then the highest since 1985.

The area of Atlantic water (defined with $S>35.0$) in the Svinøy-section has been calculated. The mean temperature within the limited area has also been calculated, and the results for both spring and summer are shown in Figure 2.4.1.4. There are considerable variations both in the area of Atlantic water distribution and its temperature. The distribution area of Atlantic water has decreased since the beginning of the 1980s, while the temperature has shown a steady increase. Since 1978 the Atlantic water has been about 0.5°C warmer. During the years 1992-1995 the area was much lower than average for both seasons. In 1997-1999 there was a warm period followed by a substantial drop in temperature in 2000. Then in 2002 the temperature increased considerably and had the highest values in both time-series. The temperature in 2002 was 0.7°C higher than the long-term mean for both spring and summer. While the temperature increased significantly, the area of Atlantic water in 2002 was close to normal.

Conclusions:

- Temperature and salinity in the Svinøy section were the highest ever for 2002 and remained high also during spring 2003.
- The Gimsøy and Sørkapp sections did not have as high values of temperature and salinity in 2002, but the salinity for spring 2003 in the Gimsøy section was the highest measured since 1985.
- The averaged temperature of the Atlantic Water in the Svinøy section has increased approximately 0.5°C since 1978.
- The winter NAO in 2003 is expected to be close to normal.

2.4.2 Phytoplankton

The development of phytoplankton in the Atlantic water is closely related to the increase of incoming solar irradiance during March and to the development of stratification in the upper mixed layer due to warming. The Institute of Marine Research, Norway, started in 1990 a long-term study of the mechanisms controlling the development of phytoplankton at Ocean Weather Station Mike situated at 66°N, 2°E.

Figure 2.4.2.1 shows the development of the phytoplankton bloom for 2002 (Melle *et al.*, WD). In previous years there has been a marked difference in the time when the spring bloom reached its maximum. In 1997 the spring bloom reached its maximum 20 May (day of the year 140), in 1998 about one month earlier 18 April (day of the year 108). The timing of the bloom in 1999 was similar to that in 1998, but did not show the same high maximum in chlorophyll. This may be related to the weekly measurements in 1999, as opposed to daily measurements in 1997 and 1998. On the other hand, weekly measurements prior to 1997 have revealed pronounced maxima in chlorophyll. The reason for the low algal biomass in 1999 may have been early and strong grazing from a large over-wintering zooplankton stock. In all these years a strong peak has characterized the bloom. The situation in 2001 was different from previous years. First, the spring bloom started somewhat later (first week of May) compared to 1998 and 1999 and was followed by relatively moderate chlorophyll concentrations culminating with a major peak in the first week of June. Also a distinct early autumn bloom was observed in the middle of August. In 2002 the springbloom started to develop in the middle of April reaching its maximum at the end of April, resulting in one of the earliest blooms, second only to the bloom in 1998. The 2002 bloom also maintained relatively high chlorophyll concentrations for about three weeks after the peak. The development of phytoplankton prior to the spring bloom may be separated into two phases. The first phase, from day 1 to about day 50, is characterised by extremely low phytoplankton biomass expressed as chlorophyll *a*. This is the winter season during which phytoplankton growth is mainly limited by the low incoming irradiance typical of this period. The second phase, from about day 50 to day 100, is characterised by a gradual increase of phytoplankton biomass but without reaching bloom conditions. This is the pre-bloom phase during which the increase in biomass is related to the increase in incoming irradiance, and the lack of a bloom is due to the deep upper mixed layer still being present at this time.

Figure 2.4.2.2 shows the extension in time for these two phases and the timing of the spring bloom for the period 1991-2002. In a "normal" year the winter season extends to about 2 March. The pre-bloom phase extends on average from 2 March to 16 April. The spring bloom starts normally on 16 April and reaches its maximum on 21 May, but the year-to-year variations are much larger than those of the previous phases. From 1991 to 1995 the trend was towards earlier spring blooms. This trend was broken in 1996, and thereafter the year-to-year variability in the timing of the bloom has been greater.

Conclusions:

- The phytoplankton bloom in 2002 developed quite early, second only to the 1998 bloom.
- Chlorophyll *a* concentrations first peaked in late April 2002 and were maintained at relatively high levels until the third week of May. This could have been the result of a delay in grazing pressure.
- During summer and early autumn several peaks of relatively high chlorophyll *a* concentrations were observed, indicating a strong variability in minor blooms.

2.4.3 Zooplankton

Zooplankton biomass distribution in the Norwegian Sea has been mapped annually in May since 1995 and in July since 1994. Zooplankton samples for biomass estimation were collected by vertical net hauls (WP2) or oblique net hauls (MOCNESS). In the present report zooplankton samples from the upper 200 m are analysed. Total zooplankton biomass (g dry weight m^{-2}) in May was averaged over sampling stations within three water masses – Atlantic water (defined by salinity >35 at 20-m depths), Arctic water (salinity <35, west of 1.4°E) and Coastal water (salinity <35, east of 1.4°E)

(Figure 2.4.3.1). In Atlantic and Arctic water masses zooplankton biomass decreased to a minimum in 1997 (Melle *et al.*, WD). Thereafter zooplankton biomass increased again and has remained relatively high except for a temporary reduction in 2001. Due to reduced cruise time the Arctic water mass was not sampled in 2001. For the first time in 2002, the biomass in Atlantic water equalled the biomass in Arctic water. In the Coastal water masses, which includes the Norwegian continental shelf and slope waters influenced by Norwegian coastal water, the trend was different with a general increase towards a maximum in 1998 and a decrease in the following years. Biomass increased again in 2002, and reached the highest value for the time-series.

In July the total zooplankton biomass (g dry weight m^{-2}) in the upper 200 m was calculated by integrating biomass at sampling stations within a selected area in the central and eastern Norwegian Sea. There is no obvious trend in the zooplankton biomass in July since 1994 (Figure 2.4.3.2).

Conclusions:

- Average zooplankton biomass in Atlantic water masses of the Norwegian Sea in May 2002 was close to the mean for the time-series.
- Zooplankton biomass in July 2002 was higher than in 2001.

2.4.4 Herring growth and food availability

Individual growth of the Norwegian spring-spawning herring, as measured by condition or length-specific weight after the summer feeding period in the Norwegian Sea, has been characterised by large fluctuations during the 1990s (Figure 2.4.4.1). During 1991 and 1993 individual condition was good, but from 1994 on the condition of the herring started to decline and by 1997 it reached the lowest level during the 1990's. The level observed in 1997 corresponds with the absolute long-term low level observed during the period 1935 – 1994 (Holst 1996). Following a recovery in 1998 and 1999, the condition of the herring decreased again. In 2001 and 2002 the condition remained at a low level (Melle *et al.*, WD).

Since 1995, when the large-scale migration pattern of herring has been mapped during two annual cruises, May and July-August, the herring have been feeding most heavily in Atlantic water, and the herring condition index obtained after the feeding period in the Norwegian Sea is related to the average zooplankton biomass of Atlantic water (Figure 2.4.4.2). To improve this relationship herring feeding areas should be defined more precisely, because large variations in herring migration routes and in zooplankton distribution have been observed over the years.

Conclusions:

- Herring condition increased from 2001 to 2002.
- There is a weak relationship between zooplankton biomass in May and herring condition in the autumn during the years 1995-2002.

2.4.5 Predictions for zooplankton biomass and herring feeding conditions

A factor possibly governing zooplankton biomass is the size of the zooplankton spawning stock, or the size of the over-wintering population (Melle *et al.*, WD). Zooplankton biomass in July represents the mixed population of zooplankton species at the start of the over-wintering period. A linear regression of the biomass in July on the biomass in May the following year explains ~63% of the total variation (Figure 2.4.5.1). Average biomass in July 2002 suggests that zooplankton biomass in May 2003 will be close to the average as well (Figure 2.4.5.1). However, the time-series is short, the variability is larg,e and there is no trend in the July zooplankton biomass that could be related to the trend observed in the May data. Thus, this time-series should be expanded before it is used for prediction.

The North Atlantic Oscillation index (NAO), is a proxy for the strength and duration of southwesterly winds, and is correlated with the inflow of Atlantic water to the Norwegian Sea. In the Norwegian Sea the winter NAO (average of the indices from December to March) is correlated with the zooplankton biomass in May the following year (Melle *et al,*. 2002). This relationship was explored in more detail in the present report, an exercise that we hoped would reveal relationships that reflect the causal relationship between climate and zooplankton production more closely. The NAO index was averaged over four two-month periods; January-February, February-March, March-April and April-May. Then biomass in May was correlated with the mean NAO for the two-month periods the previous year. The strongest correlation was found between biomass in May and the average NAO for the March-April period the previous year (Figure 2.4.5.2). March-April is the period when the primary production in the Norwegian Sea is initiated and the major reproductive period for many important zooplankton species such as *Calanus finmarchicus* and krill. The one-year lag in the relationship may be because in May we mainly measure the size of the previous year's overwintering stock, that is the previous year's production and the present year's spawning stock. The biomass for May 2003 is predicted at 12.98 g dry weight m^{-2}, based on the NAO for 2002. When the NAO for April 2003 is available the biomass for May 2004 can then be predicted.

*Biomass (yr2) = 2.74*NAO yr1+11.61*   (1)

R^2*=0.78, P=0.004*The time-series for the herring condition index has been calculated for the period from 1991 to 2001. A correlation analysis of herring condition on the two-month average of the NAO indices showed that the relationship was strongest between herring condition and the NAO during the March-April period (Figure 2.4.5.3). The herring condition index for 2003, based on the NAO for 2002, is predicted to be 0.833. This is similar to the condition in 2002 (0.808). When the NAO for April 2003 is available, the condition for 2004 can then be predicted.

*Condition (yr2) =0.022*NAO yr1+0.822* (2)

R^2*=0.66, P=0.007*Conclusions:

- A direct, but weak, relationship between zooplankton biomass in July and the zooplankton biomass in May the following year is suggested by the time-series from 1994 to 2002.
- The average NAO for March-April the previous year is directly related to zooplankton biomass in May and herring condition in the autumn.
- The March-April NAO index for 2002 predicts zooplankton biomass at 12.98 g m^{-2} in May 2003 and the herring condition index at 0.833 in the autumn 2003.

2.5 Icelandic Waters

2.5.1 Hydrography and climate

Due to the proximity of the oceanic Polar Front in the northern North Atlantic, hydrographic conditions in the sea north of Iceland are highly variable. Changes in intensity of the influx of Atlantic water and/or the variable admixture of polar water to the surface layers north of Iceland may lead to marked fluctuations in temperatures and salinities, both in space and time. Off the south and west coasts, where Atlantic water predominates, fluctuations are much smaller.

Climatic conditions in the North Atlantic improved greatly around 1920 and remained good until the mid-1960s, when they deteriorated suddenly. In the area north and east of Iceland temperature and salinity declined sharply in 1965 and these severely cold conditions lasted until 1971. After that, climatic conditions of the area north and east of Iceland improved again, but were variable and warm years have alternated with cold years (Figure 2.5.1.1).

In the latter half of 1997, there was a pronounced increase in the intensity of the Irminger Current south and west of Iceland, resulting in temperatures (6-8˚C) and salinities (35.0-35.2) similar to those recorded in these waters in the 1950s and the early 1960s. There were no signs of a reduction of this flow of warm water off south and West-Iceland in February or May 2002. The inflow of Atlantic water to the north Icelandic area was not quite so pronounced in these months as in 2001 (Figure 2.5.1.1) and the cold East Icelandic Current was not as far offshore as in 2001. There were, however, some indications of an increased inflow of Atlantic water off the western north coast of Iceland in May 2002. By August the flow of Atlantic water onto the north Icelandic shelf had reached a level similar to that recorded in previous years and these warm conditions were found to prevail in November 2002 and February/March 2002.

2.5.2 Zooplankton

In the area north of Iceland, zooplankton biomass is significantly higher during years with a strong inflow of Atlantic water than in years when Atlantic inflow is weak and lower salinity in the surface layer slows or prevents vertical mixing (Figure 2.5.1.1). In spring 2002, the zooplankton biomass for the whole Icelandic area was near the long-term average. Off West- and East-Iceland the zooplankton biomass was well above average, but slightly below the long-term mean south of Iceland. The relatively low zooplankton biomass off the central north coast in spring 2002 is in line with reduced Atlantic influence as compared to the most recent years. As in the last few years, the biomass of cold-water species in the deep waters off Northeast- and East-Iceland was very high.

As mentioned above, a continued strong inflow of Atlantic water to the north Icelandic area was observed both during the November 2002 and February/March 2003 surveys. This indicates that zooplankton biomass will be above average in north Icelandic waters in spring and summer 2003.

2.6 Hydrography of the waters west of the British Isles

The hydrography of the waters west of the British Isles is described in a cruise report by Heino *et al.* (WDc). The horizontal distribution of temperature at 10 and 400 meters depths are shown in Figures 2.6.1 and 2.6.2, respectively. The maps are based on data collected on board “Johan Hjort”, and CTD data are kindly provided by the scientists on board the Russian ships “Smolensk” and “Atlantniro”, who were running simultaneous surveys in the area. The cooperation has given a much better horizontal coverage of the area.

The Wyville-Thompson ridge (~60°N) divides the survey area into two very different hydrographic regimes. South of the Wyville-Thompson ridge the vertical gradients in temperature are small. Temperatures at 1000 m are typically between 7 and 8 °C, i.e., the vertical temperature decreases by only 2-3°C from the surface to 1000-m depth (see Figure 2.6.3), and in the top 600 m the temperatures drop by only about 1°C. In the Faroe-Shetland channel the situation is different with a strong thermocline around 500-m depth separating a layer of warm saline Atlantic water overlying cold deep waters (~-0.5°C) originating in the Norwegian Sea (see Figure 2.6.4, Faroe-Shetland section).

Also the horizontal gradients are generally very small in the area south of the Wyville-Thompson ridge, and in particular the north-south gradient is very small. In the Rockall Trough the temperature drops by less than 2°C from 50°N to 60°N both at 10-m and 400-m depths (Figures 2.6.1 and 2.6.2). Due to a northward flowing shelf edge current, warm high salinity (S>35.45) water penetrates far north in a narrow band along at the shelf edge, with the 10°C isotherm at 10-m depth extending north into the Faeroes-Shetland channel (Figure 2.6.1). Visual inspection of the sections and horizontal temperature maps indicates that this year’s temperatures are up to 0.5°C and salinities up to 0.05 higher than in 2002. The vertical section plot of temperature and salinity (Figure 2.6.4) shows that the Atlantic water occupies all the area above 500 m and the 0°C isotherm is depressed down to 700 m. The area occupied by the warm Atlantic water is larger and the maximum temperature is higher than previous years.

The high temperatures and salinities are confirmed by a study of the temperatures and salinities on all blue whiting cruises from 1983 through 2003. Since the hydrographic surveys have been dependent on the fishery surveys, the CTD stations have been distributed along the shelf edge and have in general not been in the same positions from year to year. In order to make time-series, the data were grouped in boxes with horizontal dimensions of 2° latitude times 2° longitude. For each year the mean temperature and salinity from 50 to 600 m of all the stations in deep water (depth >600 m) in each box was calculated. Some of the boxes had good coverage nearly every year, while others had many years missing. However, in general the same variation from year to year was seen in the boxes along the shelf edge south of the Wyville-Thompson ridge. The box with limits 52° to 54°N and 16° to 14°W had few gaps; the time-series of mean temperature and salinity for this box is shown in Figure 2.6.5. The pattern seen is that after some years with temperatures around 10.1°C in the 1980s, it dropped to a minimum in 1994 (~9.8°C). After 1994 an increase in temperature is seen, and in 1998 temperature reaches a local maximum (~10.5°C) with the three following years a few tenths of a degree colder. 2002 is the warmest with ~10.7°C and in 2003 the temperature was about the same as in 1998. A closer inspection shows that the decrease in temperature is caused by a lower temperature in the deep part of the layer, whereas in the upper part it is the same as last year. The vertical gradient within this layer was very small last year with a change in temperature of only about 0.7°C from 50 m to 600 m, but this year it dropped by 1.3°C.

In the boxes along the continental shelf in the Rockall Trough a similar pattern as described above is seen in the time-series, but the temperatures did not peak in 2002 and the temperatures in 2003 are higher or at least as high as in 2002. Thus in the Rockall Trough the temperatures in 2003 from 50 m to 600 m are the highest on record. In the northern part of the Rockall Trough the temperatures in the 50-600 m layer are typically about 0.5°C and salinity 0.05 higher than in 2002. In the shallow layer 50-150 m, the temperatures are the highest on record for the whole area, and in the northern part the temperature is more than 0.5°C higher than last year.

The temperatures in the whole area are high in 2003, and except for the area to the west of Porcupine Bank, 2003 stands out as the warmest year in the observation period from 1983 to 2003. There is no clear linear trend, but the last five years are clearly warmer than the average of the whole period (1983-2003), and about 0.5°C above the first years in the period. Even though the increase is not as evident in the salinity curve, the high temperatures are typically associated with high salinities (Figure 2.6.5).

Table 2.3.1.1. Capelin stock history from 1984, and prognosis for capelin biomass in 2003. M output biomass is the estimated biomass of the capelin removed from the stock by natural mortality.

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

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

Table 2.3.1.2. Capelin one-year prognoses compared with survey estimates (in million tonnes).

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

Table 2.3.2.1. The North-east arctic COD stock's consumption of various prey species in 1984-2002 (1000 tonnes),

based on Norwegian consumption calculations.

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

Table 2.3.2.2. The North-east arctic COD stock's consumption of various prey species in 1984-2002 (1000 tonnes),

based on Russian consumption calculations.

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

Table 2.3.2.3 **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	1011+	
1984	0.247	0.814	1.686	2.527	3.953	5.213	8.037	8.554	9.213	9.947	10.019
1985	0.304	0.761	1.833	3.111	4.678	7.364	11.305	12.033	12.562	13.822	13.936
1986	0.161	0.489	1.349	3.168	5.628	6.834	11.062	11.978	12.787	13.553	13.785
1987	0.219	0.601	1.275	2.055	3.538	5.466	7.044	8.112	8.923	9.344	9.296
1988	0.164	0.703	1.149	2.149	3.745	5.880	10.103	11.226	12.579	13.131	13.355
1989	0.223	0.716	1.611	2.720	3.987	5.621	7.706	8.527	9.630	10.231	10.678
1990	0.397	1.058	2.072	3.697	4.954	5.837	8.572	9.516	10.538	10.802	11.399
1991	0.293	0.974	2.185	3.565	5.346	7.113	9.531	10.303	11.364	12.417	12.059
1992	0.216	0.662	2.103	3.137	4.142	5.094	7.898	9.071	9.440	9.943	10.212
1993	0.112	0.526	1.544	3.045	4.810	6.289	9.424	11.287	11.814	12.303	11.957
1994	0.130	0.407	0.922	2.520	3.512	4.540	6.412	8.923	9.731	10.038	10.236
1995	0.103	0.297	0.922	1.802	3.362	5.272	7.734	10.459	12.411	12.816	13.260
1996	0.108	0.355	0.931	1.849	3.055	4.437	7.426	11.255	15.010	15.207	15.590
1997	0.138	0.311	0.935	1.768	2.694	3.539	5.242	8.222	12.757	13.667	13.282
1998	0.117	0.398	0.985	1.940	2.924	4.189	5.749	8.078	11.573	12.099	12.157
1999	0.163	0.505	1.093	2.717	3.721	5.162	6.987	9.125	11.234	12.079	12.135
2000	0.157	0.501	1.238	2.467	4.262	5.651	7.711	9.391	12.695	13.683	13.839
2001	0.171	0.460	1.230	2.426	3.722	5.227	7.298	10.910	13.480	14.531	14.700
2002	0.176	0.549	1.032	2.027	3.012	4.219	5.528	7.916	9.923	10.660	10.747

Table 2.3.2.4 **Consumption per cod by cod age group (kg/year), based on Russian consumption calculations.**

Year/Age	1	2	3	4	5	6	7	8	9	10	11	1213+	
1984	0.143	0.631	1.111	2.666	3.863	6.056	8.070	10.449	14.301	17.847	21.440	25.148	30.208
1985	0.127	0.573	1.192	2.336	4.036	7.181	9.895	13.839	18.254	24.072	33.991	25.809	31.905
1986	0.084	0.393	0.938	2.710	4.445	6.490	7.982	11.816	13.445	13.956	22.323	22.019	27.573
1987	0.065	0.246	0.469	1.182	2.890	4.467	8.730	12.496	15.760	22.749	31.785	26.061	33.419
1988	0.108	0.454	0.676	1.222	2.125	4.946	9.113	12.933	17.699	31.666	29.716	28.873	22.496
1989	0.100	0.621	0.971	1.672	2.767	4.734	7.570	12.092	18.200	29.092	27.509	31.944	24.690
1990	0.158	0.639	1.223	2.077	2.931	3.915	6.320	8.751	11.536	19.307	22.170	26.846	33.213
1991	0.117	0.641	2.084	4.363	6.510	9.194	12.131	15.742	21.272	33.258	29.318	33.661	43.774
1992	0.096	0.615	1.591	2.829	4.147	6.326	8.979	11.379	13.063	20.539	26.593	23.213	29.229
1993	0.061	0.292	1.077	2.921	4.249	6.169	9.823	12.664	15.049	19.050	20.561	24.118	28.646
1994	0.083	0.315	0.675	1.903	3.403	6.115	9.786	13.058	15.973	18.383	19.539	26.140	30.728
1995	0.089	0.306	0.588	1.475	3.598	6.895	11.199	15.596	20.948	26.682	29.550	31.744	37.235
1996	0.087	0.326	0.663	1.517	2.965	5.326	9.318	15.851	20.723	26.787	28.132	28.606	33.310
1997	0.066	0.266	0.737	1.728	2.873	4.383	7.567	13.674	26.353	40.331	36.182	36.016	44.404
1998	0.107	0.404	0.735	1.805	3.213	5.219	7.837	11.560	17.608	26.501	30.002	27.728	35.512
1999	0.111	0.335	0.702	2.080	4.183	7.058	9.923	13.588	17.179	29.047	30.772	30.687	38.739
2000	0.083	0.406	0.806	2.016	4.678	7.809	11.889	16.042	18.698	26.431	31.089	34.377	44.041
2001	0.080	0.360	0.917	1.872	3.897	7.820	10.508	18.214	20.210	29.856	36.909	35.597	47.083
2002	0.112	0.397	0.911	1.791	3.650	6.981	11.114	17.672	19.670	29.058	35.923	34.646	45.825

Table 2.3.4.1. 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

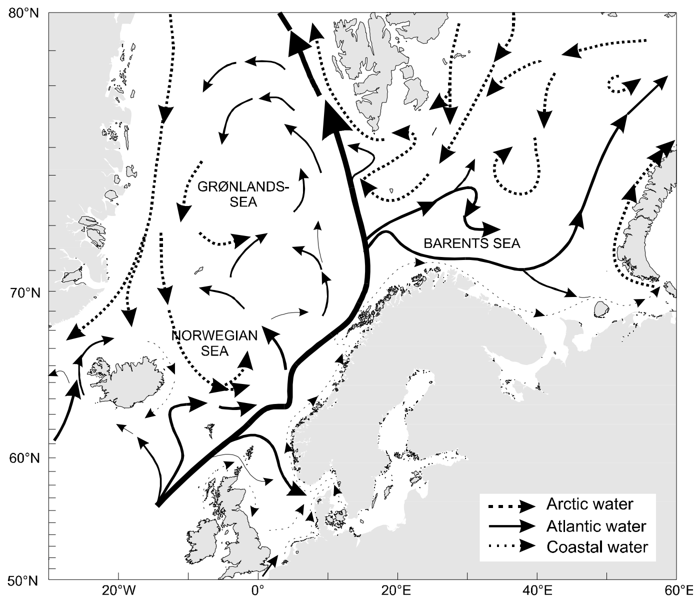


Figure 2.1.1.1. Main surface currents of the Nordic and Barents Seas.

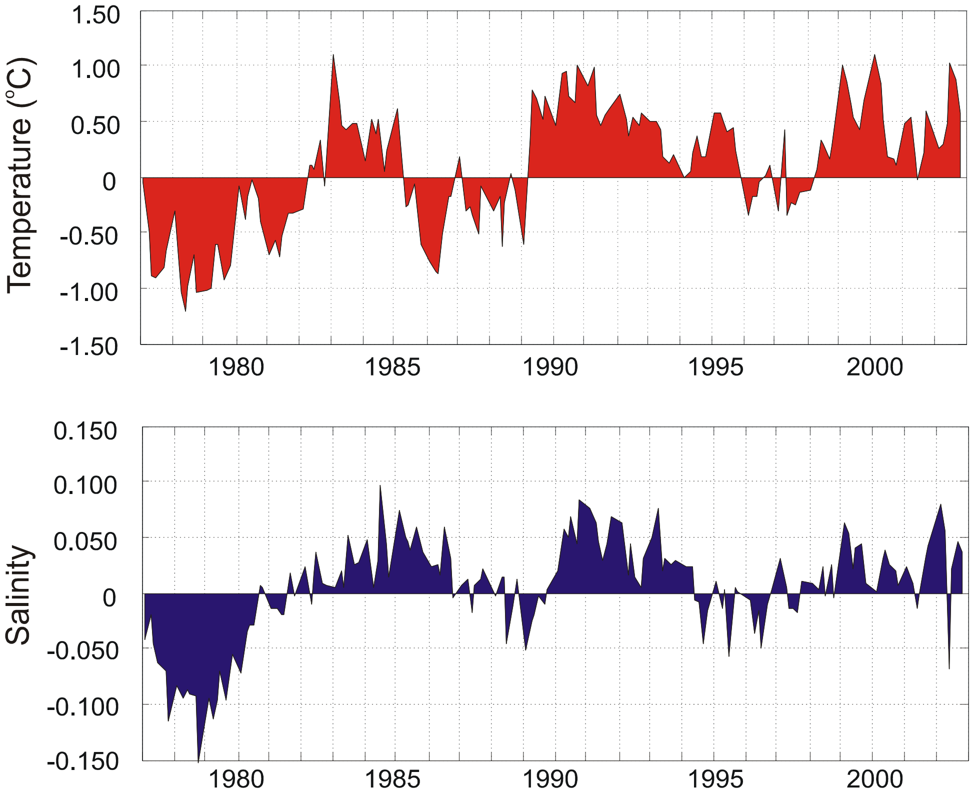


Figure 2.1.1.2 Temperature anomalies (upper panel) and salinity anomalies (lower panel) in the section Fugløya – Bear Island (Asplin and Dahl, 2003).

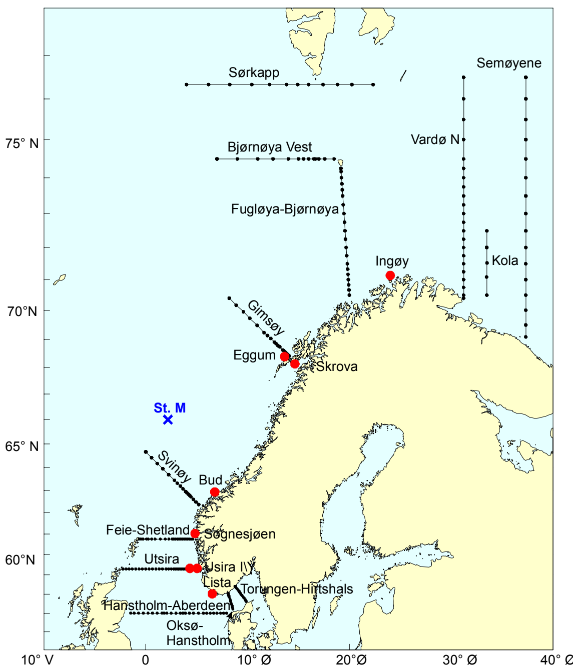


Figure 2.1.1.3. Standard Sections and fixed oceanographic stations surveyed by the Institute of Marine Research, Bergen. The University of Bergen is responsible for station M, while the Kola Section is operated by PINRO, Murmansk (Anon. 2001).

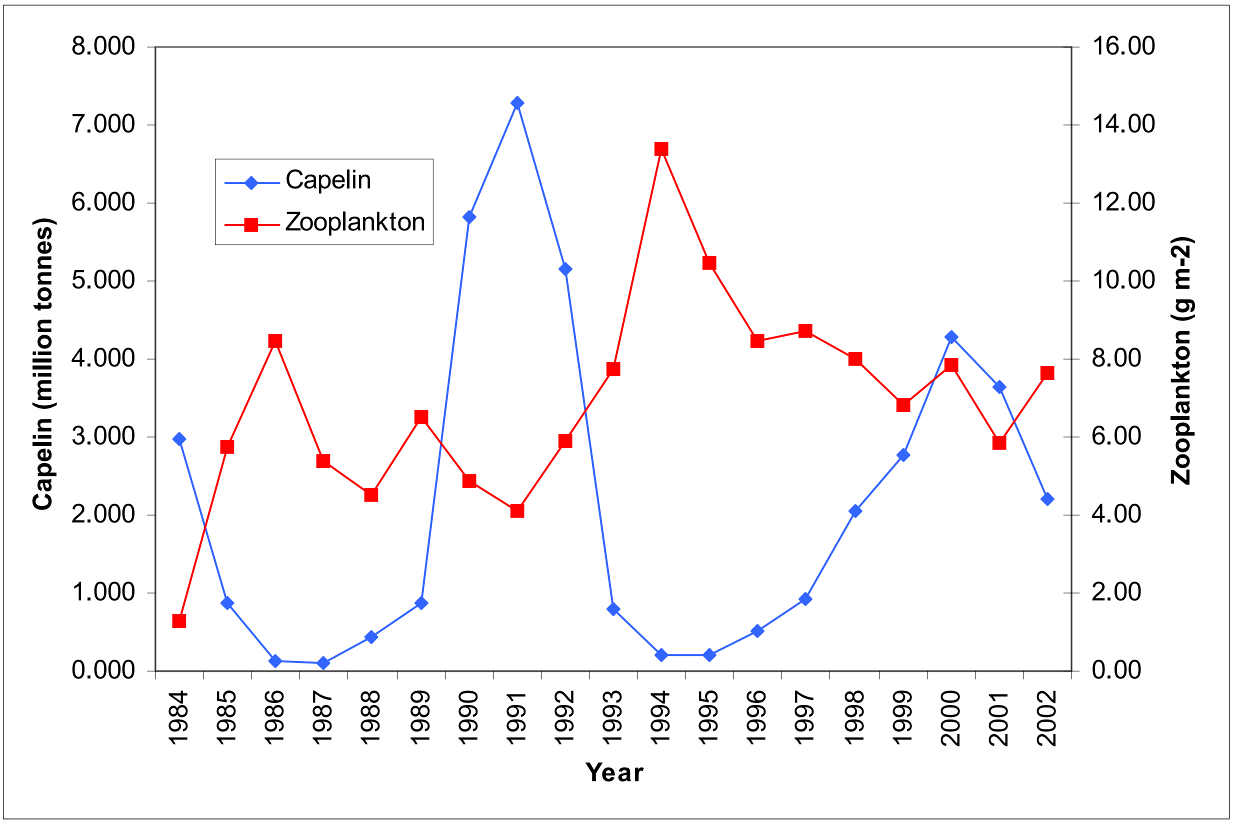


Figure 2.2.1. Average zooplankton biomass (g m^{-2}) together with biomass of one-year-old and older capelin (million tonnes) during 1984 – 2002, in the Barents Sea (from Dalpadado *et al.* 2002, updated with data for 2001-2002).

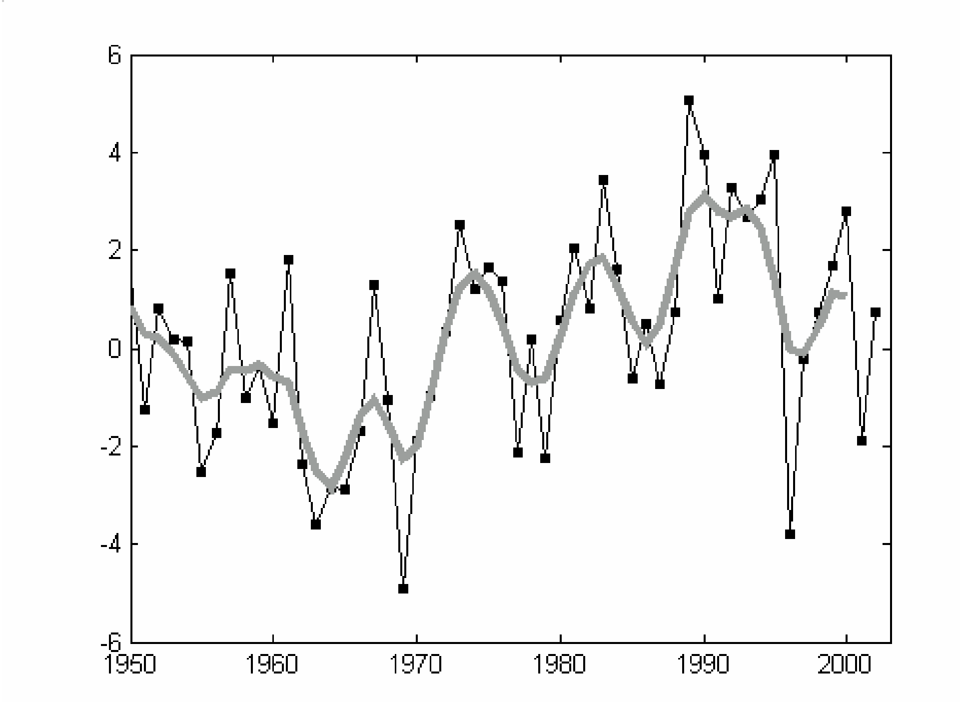


Figure 2.4.1.1. Winter (December-March) North Atlantic Oscillation index (NAO).

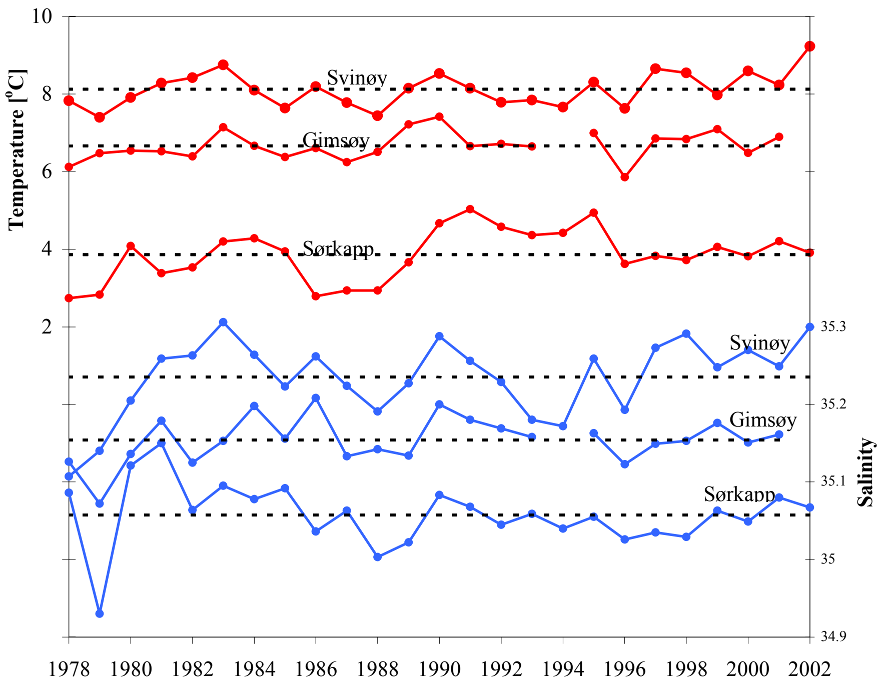


Figure 2.4.1.2. Temperature (ºC) and salinity observed during July/August, in the core of Atlantic Water beyond the shelf edge in the sections Svinøy - NW, Gimsøy - NW and Sørkapp - W, averaged between 50 and 200 m depth and horizontally over three stations across the core.

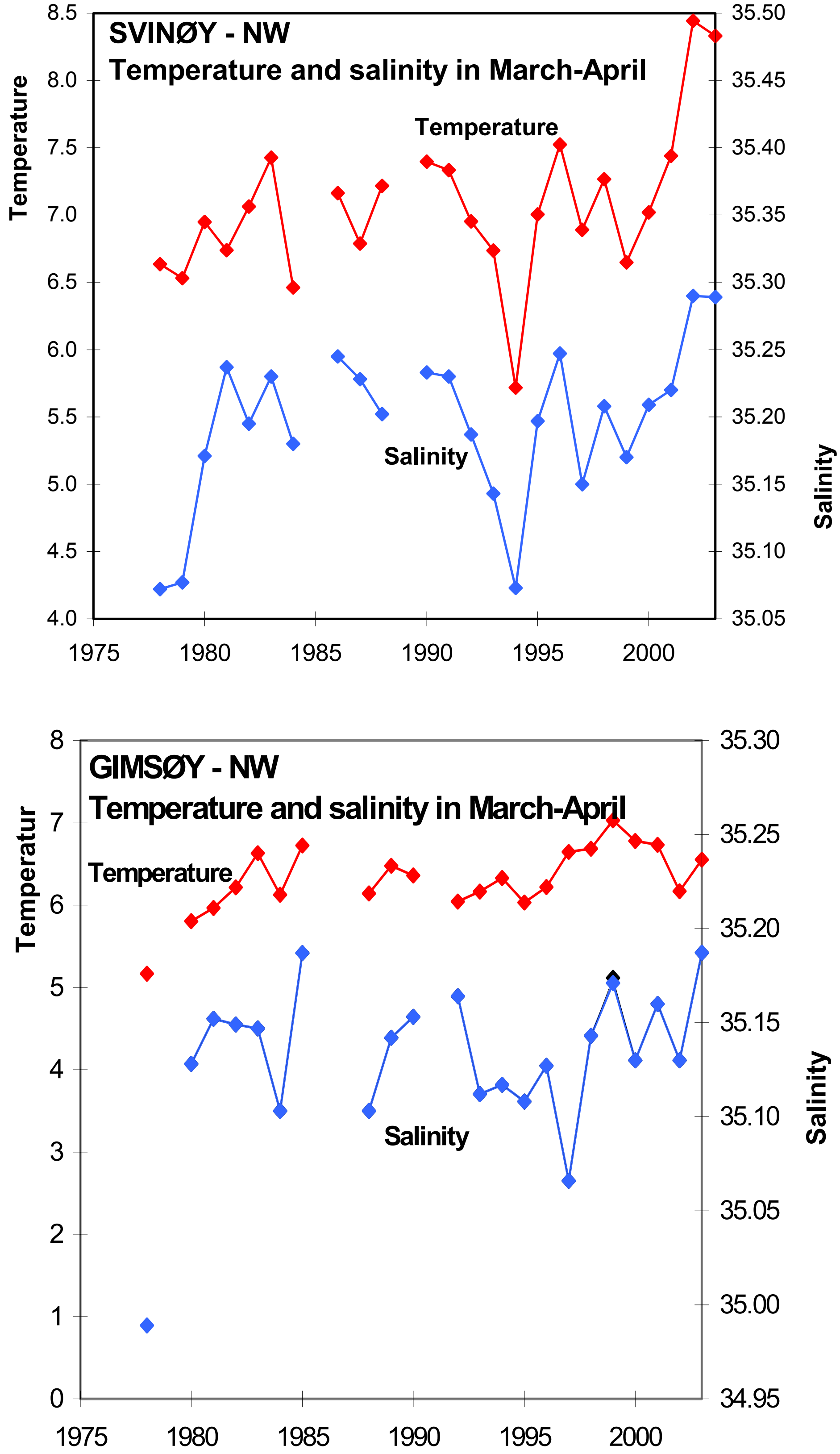


Figure 2.4.1.3. Temperature and salinity in the sections Svinøy – NW and Gimsøy - NW, observed during March/April, in the core of Atlantic Water near the shelf edge, averaged between 50 and 200 m depth and horizontally over three stations across the core.

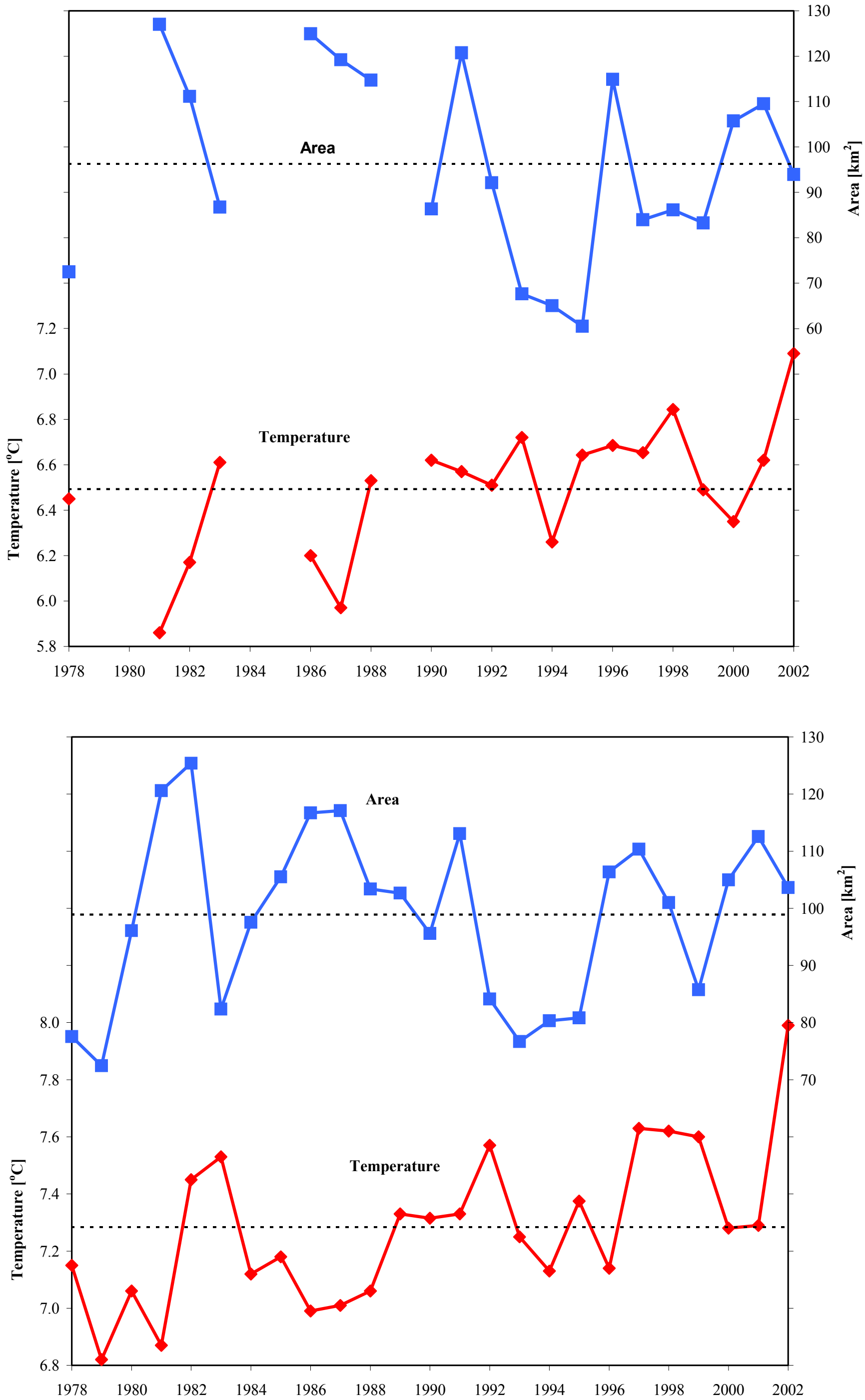


Figure 2.4.1.4. Time-series of area (blue, in km^2) and averaged temperature (red) of Atlantic water in the Svinøy section, observed in March/April (upper figure) and July/August (lower figure) 1978-2002.

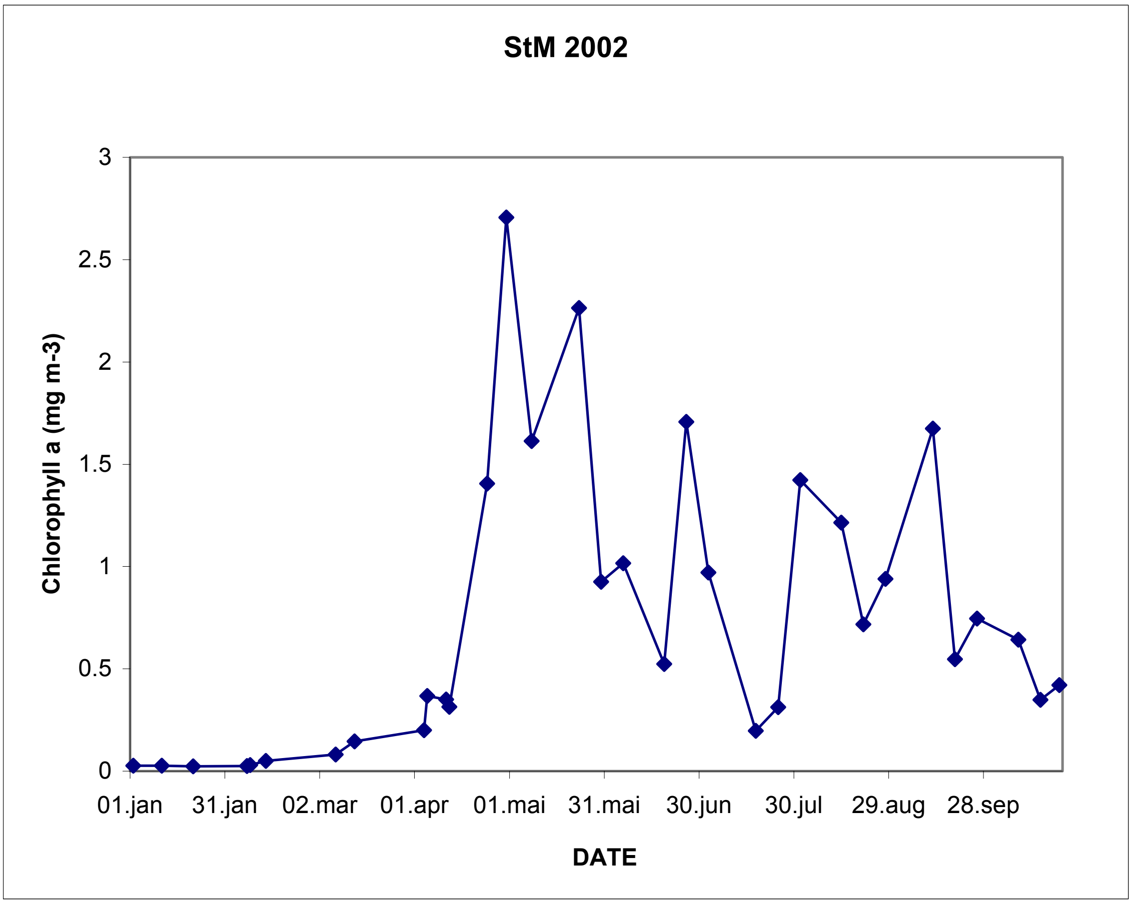


Figure 2.4.2.1. Distribution of chlorophyll *a* at 10-m depth during the year at Weather Station Mike in 2002.

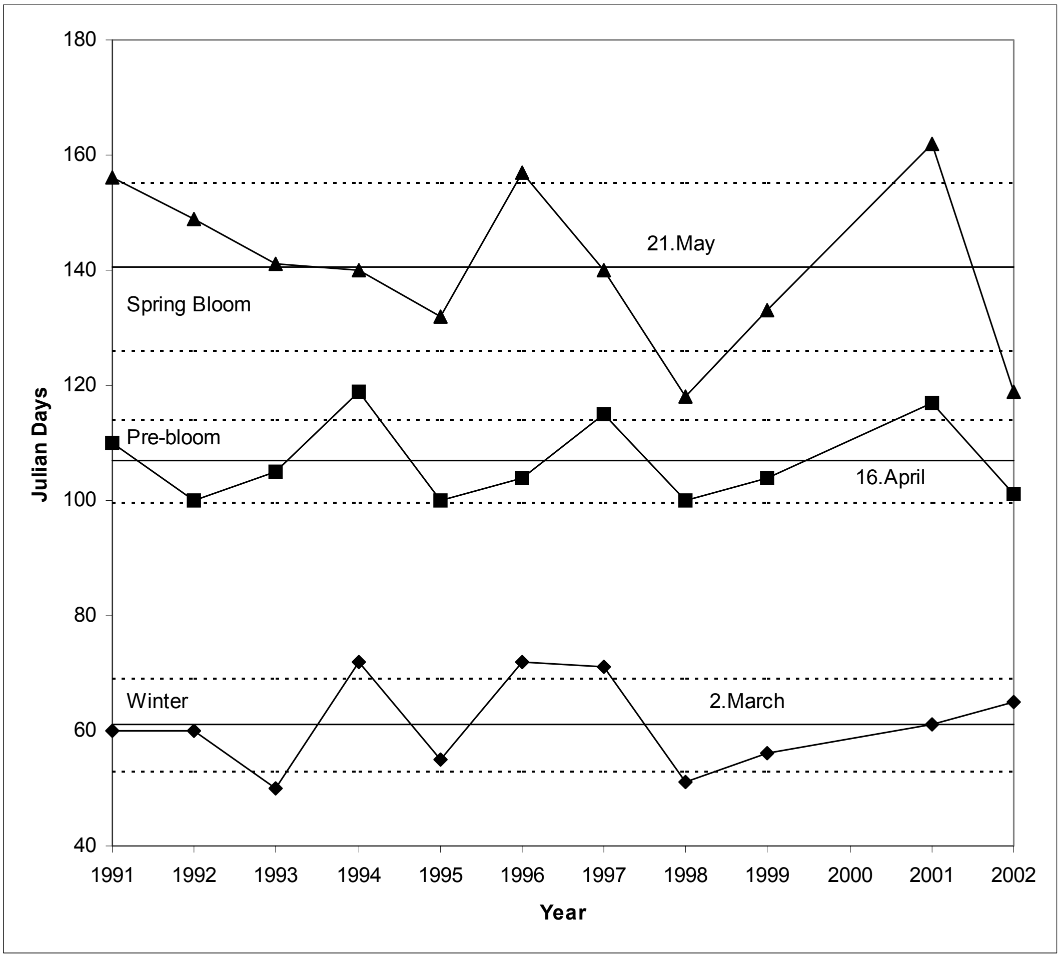


Figure 2.4.2.2. Year-to-year variation in the different phases of the development of phytoplankton at Weather Station Mike in the period 1991 to 2002. Diamonds: winter phase; squares: pre-bloom phase; triangles: spring bloom. Continuous lines represent the average for each period. Broken lines represent one standard deviation for each period.

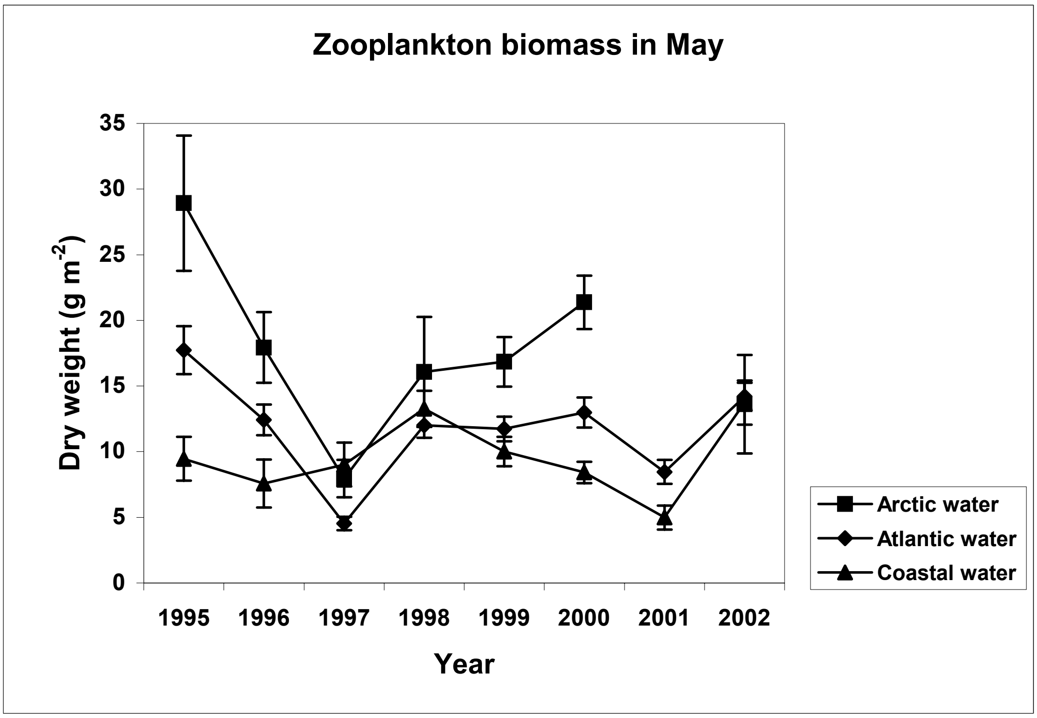


Figure 2.4.3.1 Zooplankton biomass (dry weight) in the upper 200 m in May. A: Arctic influenced water (salinity <35, west of 1.4ºE). B: Atlantic water (salinity >35). B: Norwegian Coastal water (salinity <35, west of 1.4ºE). Error bars: 95% confidence limits.

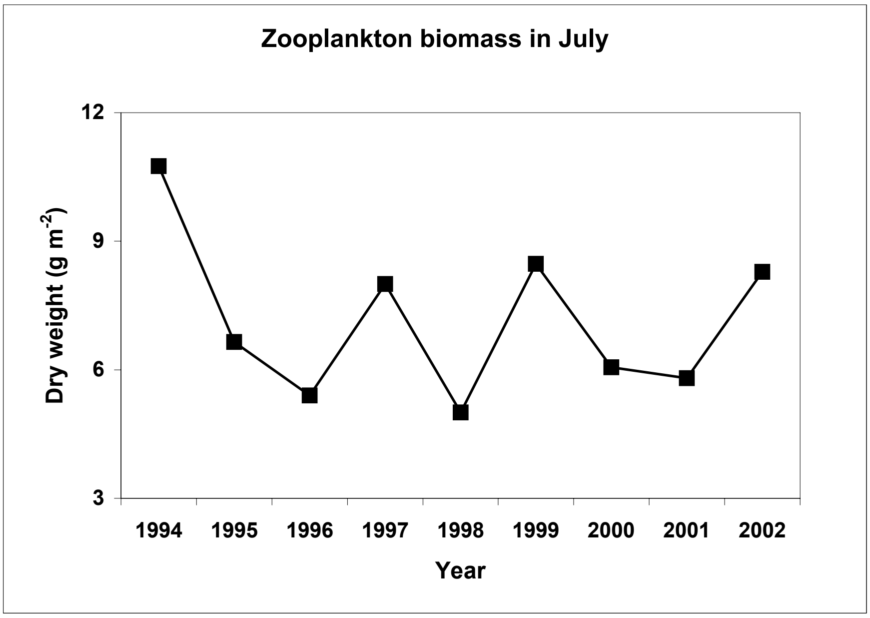


Figure 2.4.3.2 Zooplankton biomass in July-August in the eastern Norwegian Sea (0-200 m). Integrated biomass within a fixed geographical region divided by its area.

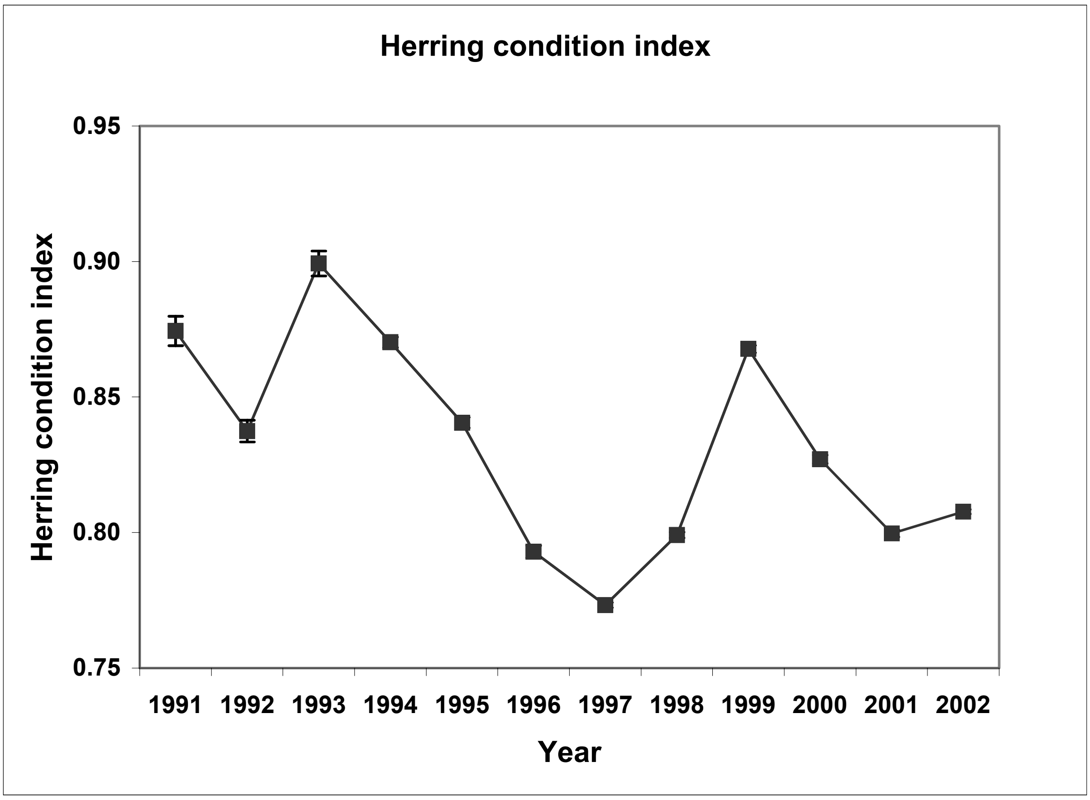


Figure 2.4.4.1 Individual weight-to-length ratio (herring condition index) for Norwegian spring-spawning herring. Data from November and December for herring 30-35 cm body length. Error bars: 95% confidence limits.

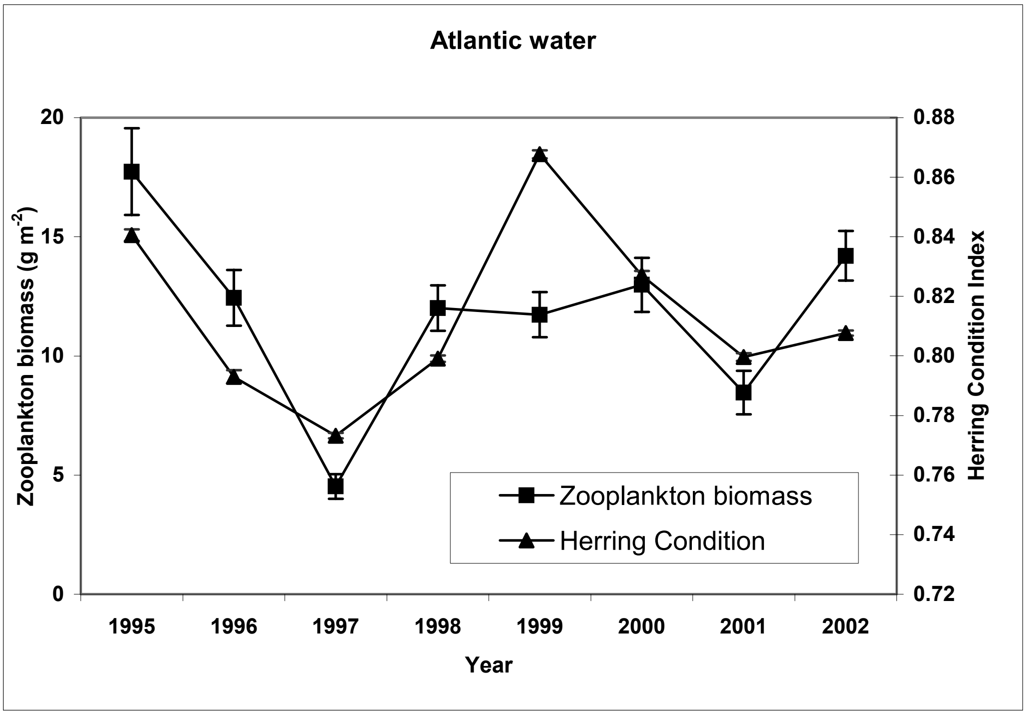


Figure 2.4.4.2 Zooplankton biomass (dry weight) in Atlantic water in the Norwegian Sea in May (0-200 m) and herring condition index (individual weight-to-length ratio, November and December, 30-35 cm). Error bars: 95% confidence limits. Linear regression: Condition = 0.0045 * biomass + 0.7605. $R^2 = 0.3434$.

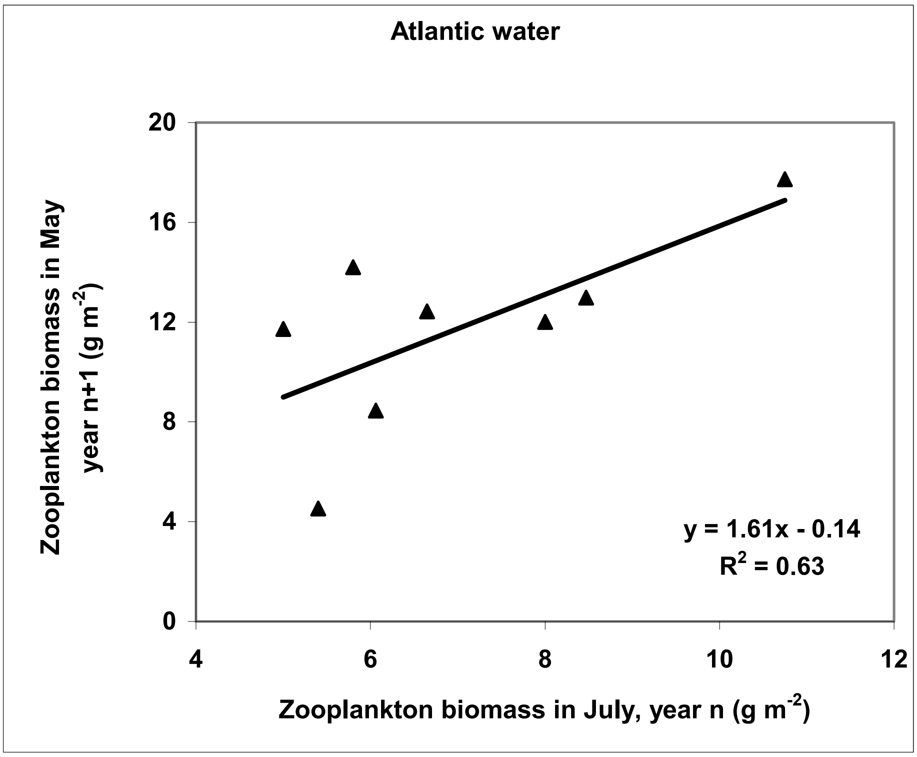


Figure 2.4.5.1 Zooplankton biomass in July (year n) vs. zooplankton biomass in May (year n+1).

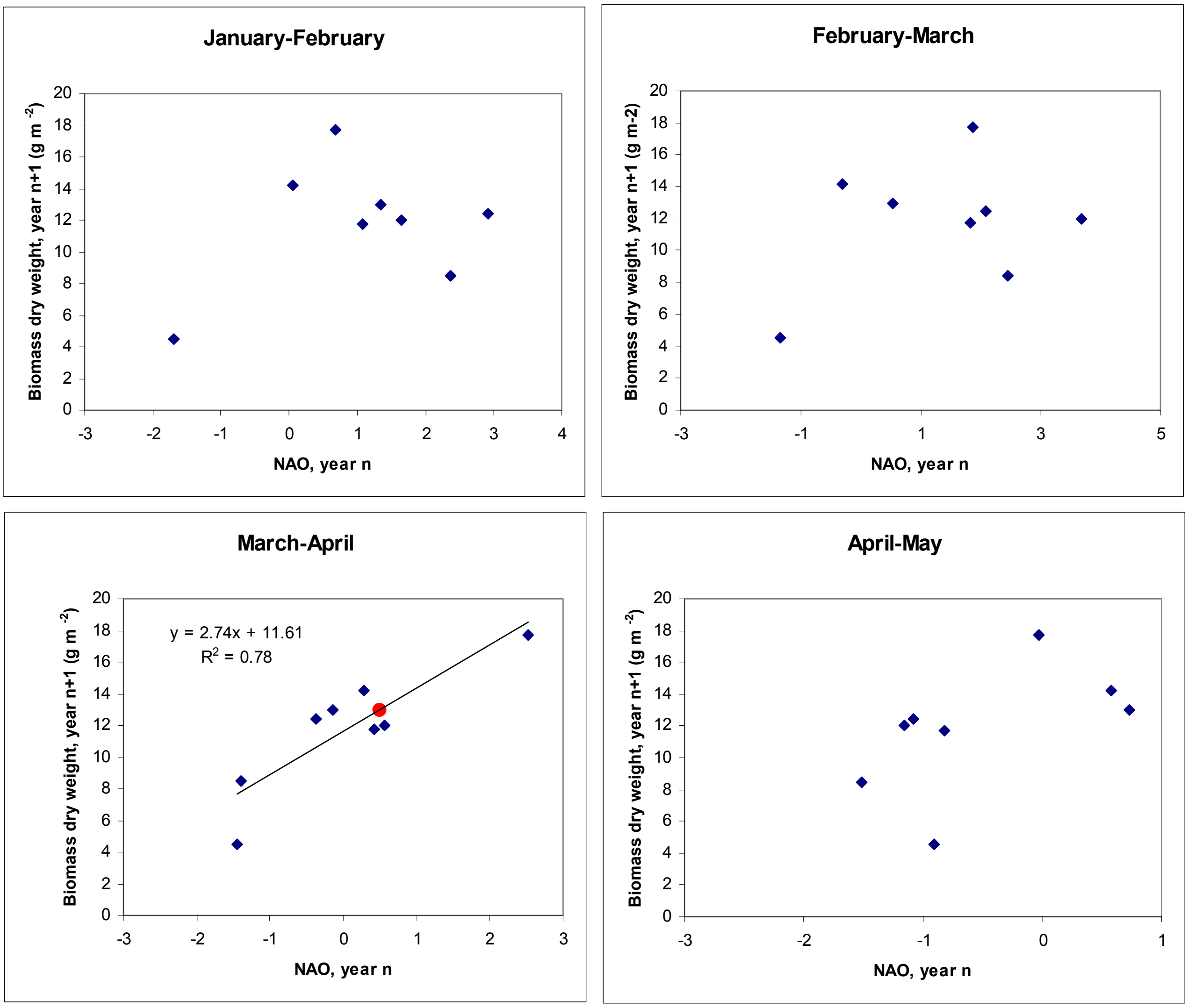


Figure 2.4.5.2 Average North Atlantic oscillation index (NAO) during four two-month periods (year n) vs. zooplankton biomass in May (year n+1). Circle: prediction of zooplankton biomass in May 2003 based on equation (1).

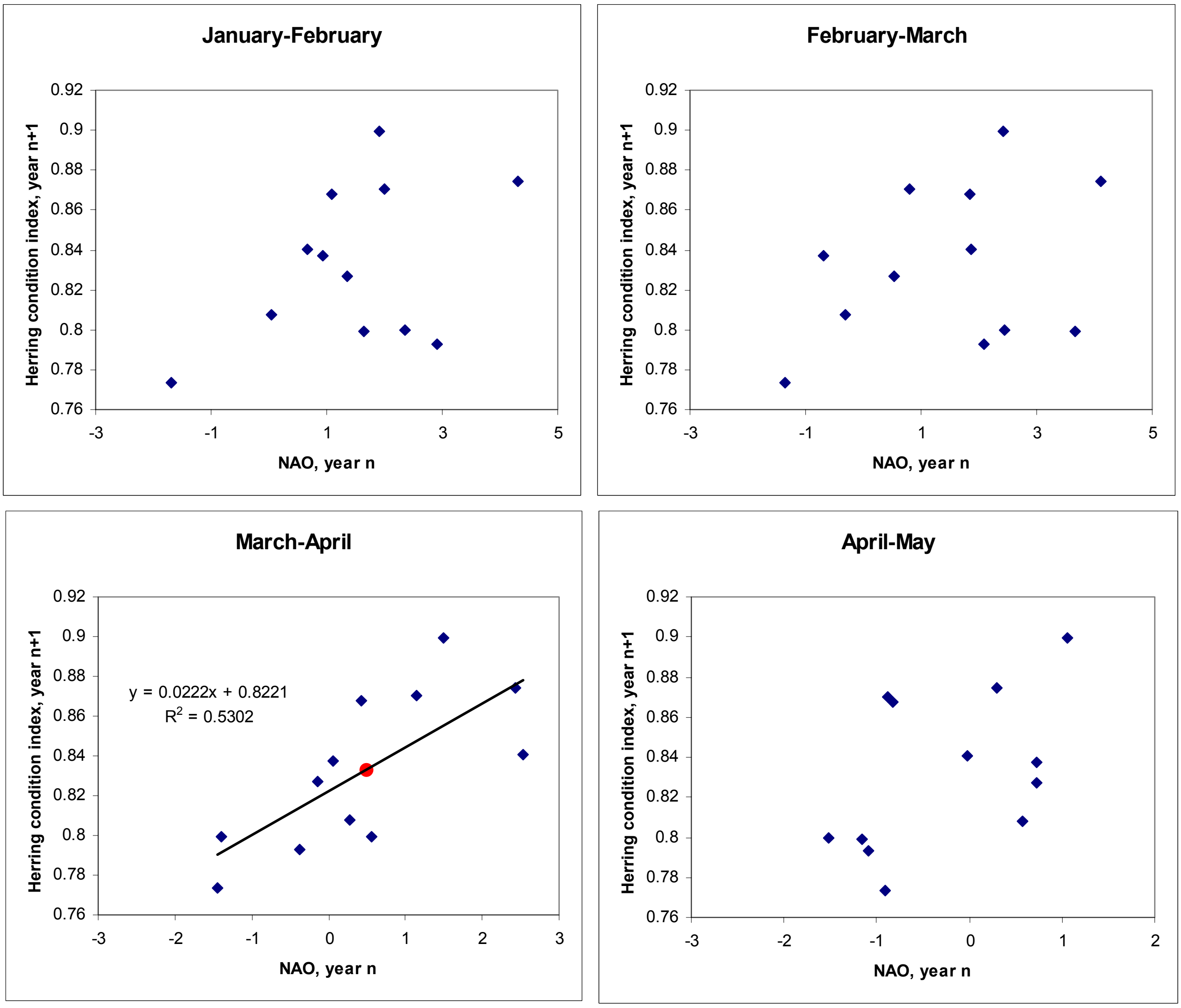


Figure 2.4.5.3 Herring condition index (year n+1) vs. average NAO during four two-month periods (year n). Circle: prediction of herring condition in 2003 based on equation (2).

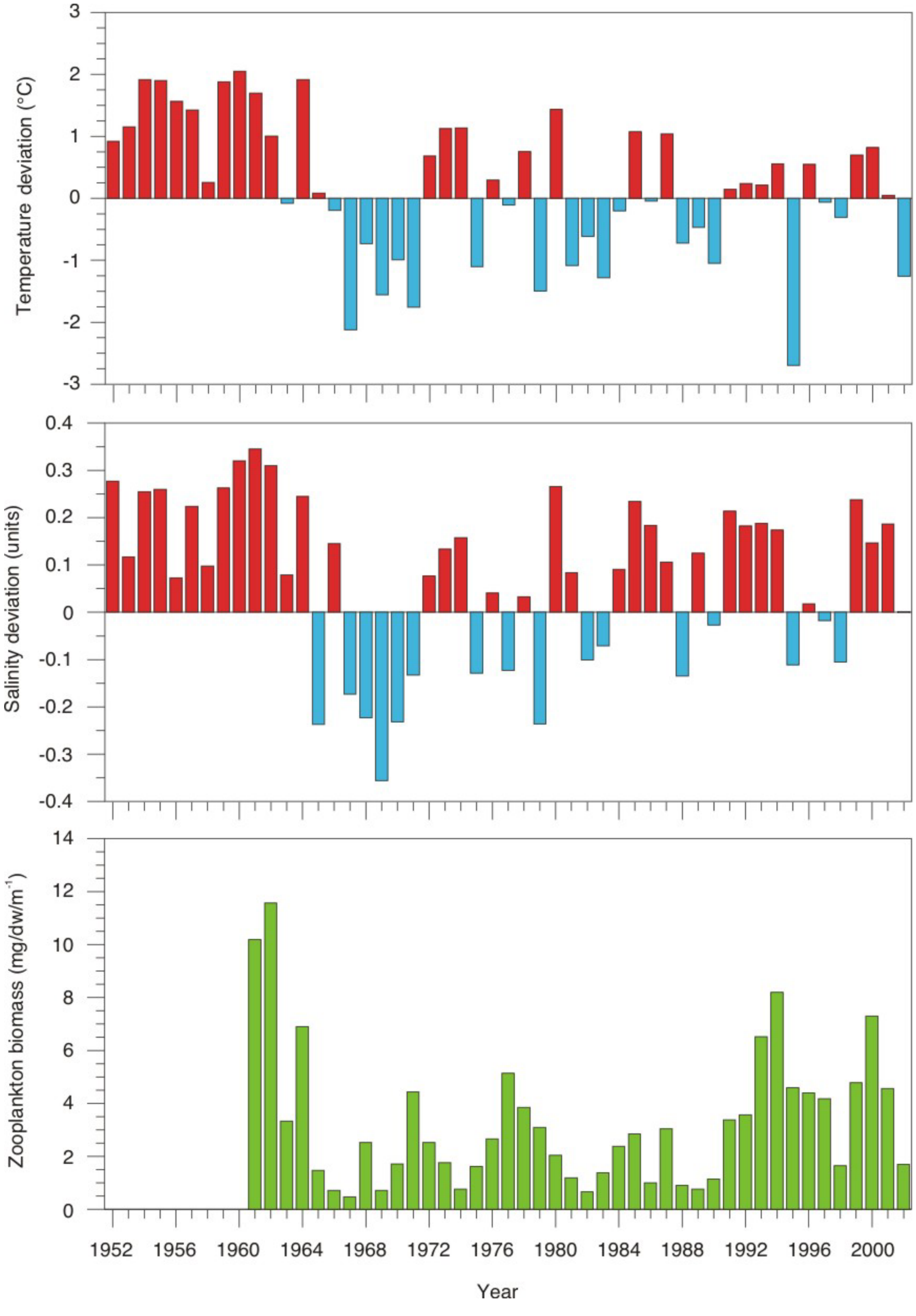


Figure 2.5.1.1 Temperature (upper panel) and salinity (middle panel) deviations on the Siglunes section off the central north coast of Iceland 1952-2000. The bottom panel shows the variation of zooplankton biomass.

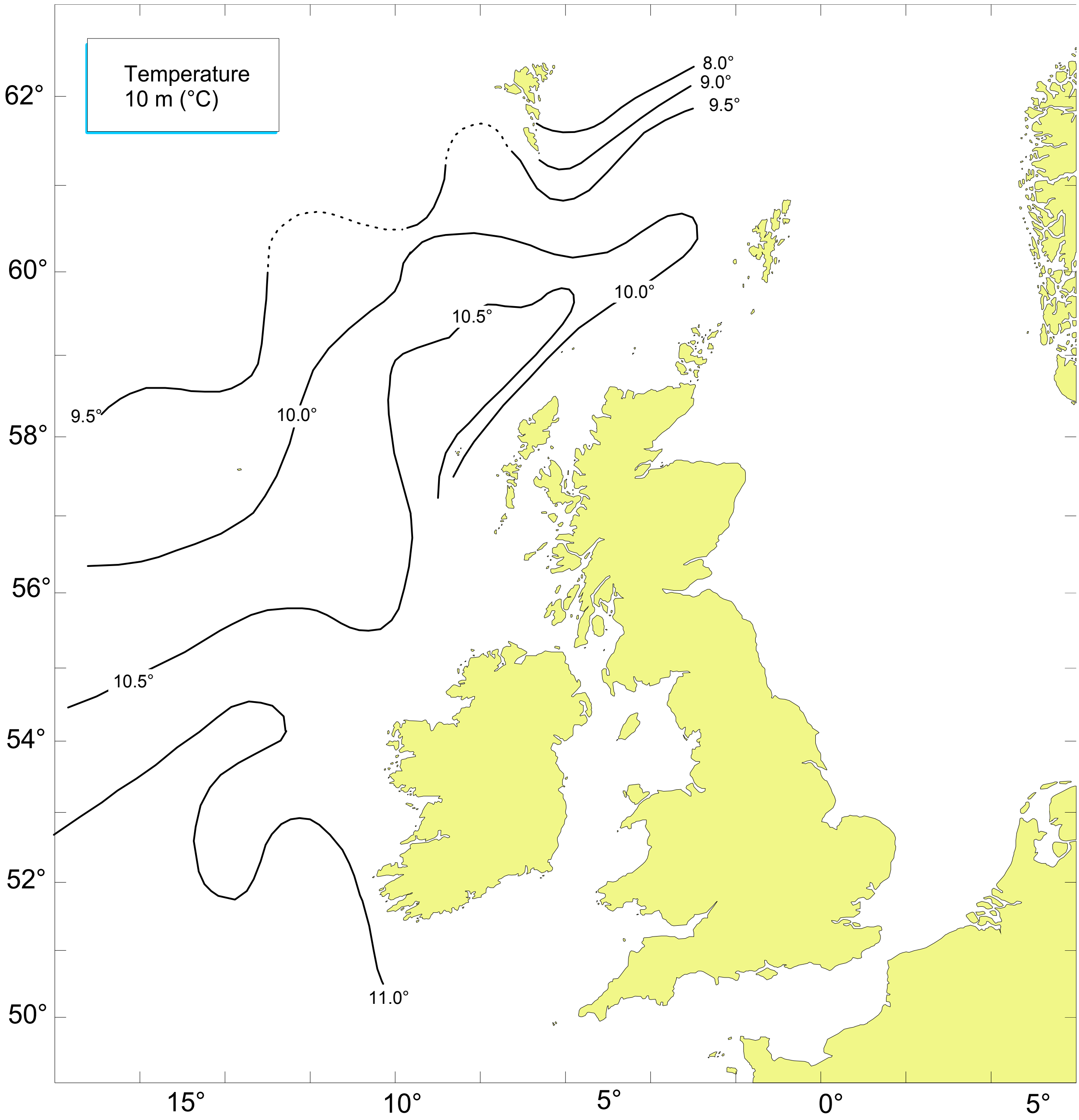


Figure 2.6.1 Horizontal temperature distribution, °C, at 10-m depth.

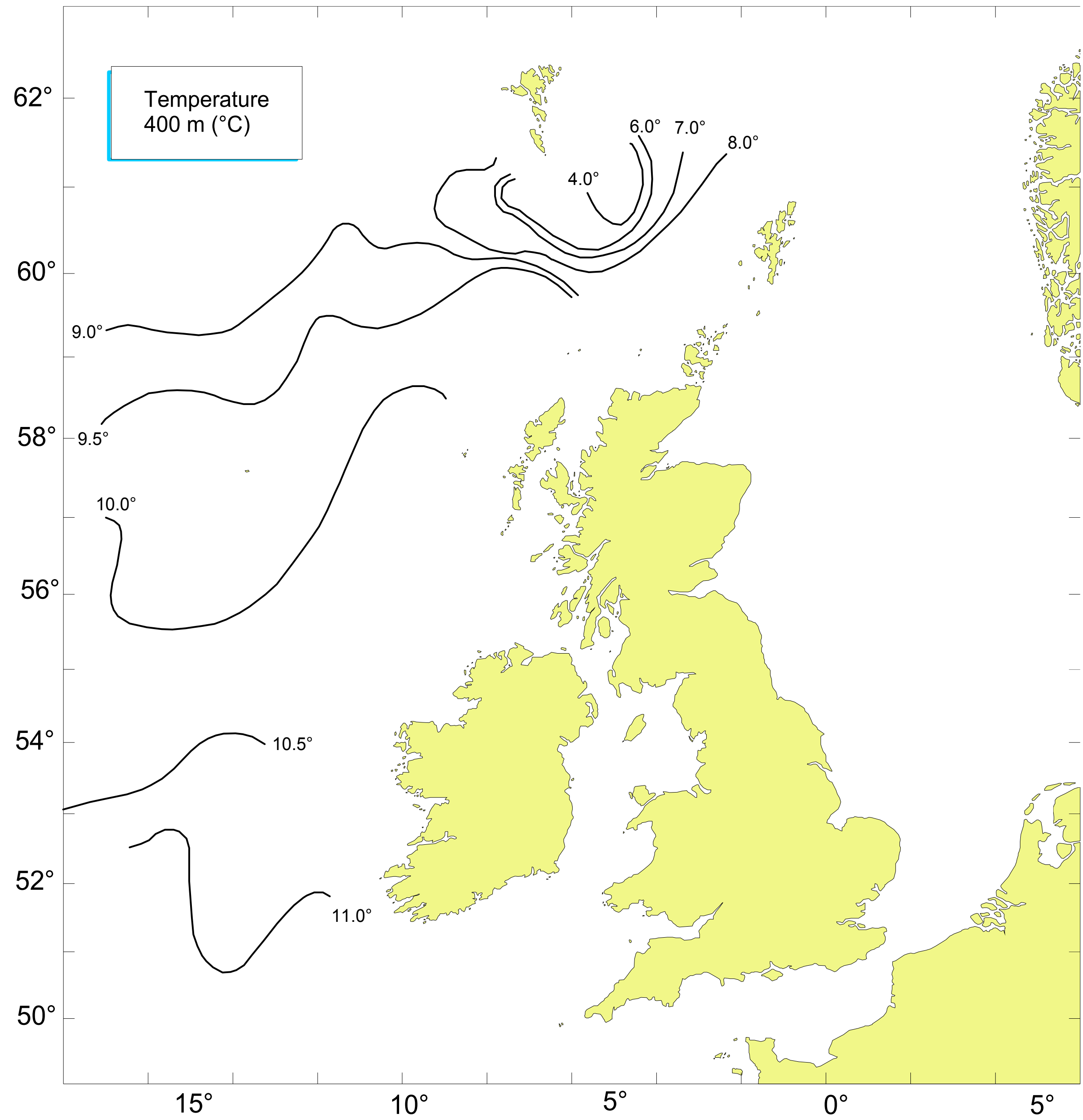


Figure 2.6.2 Horizontal temperature distribution, °C, at 400-m depth.

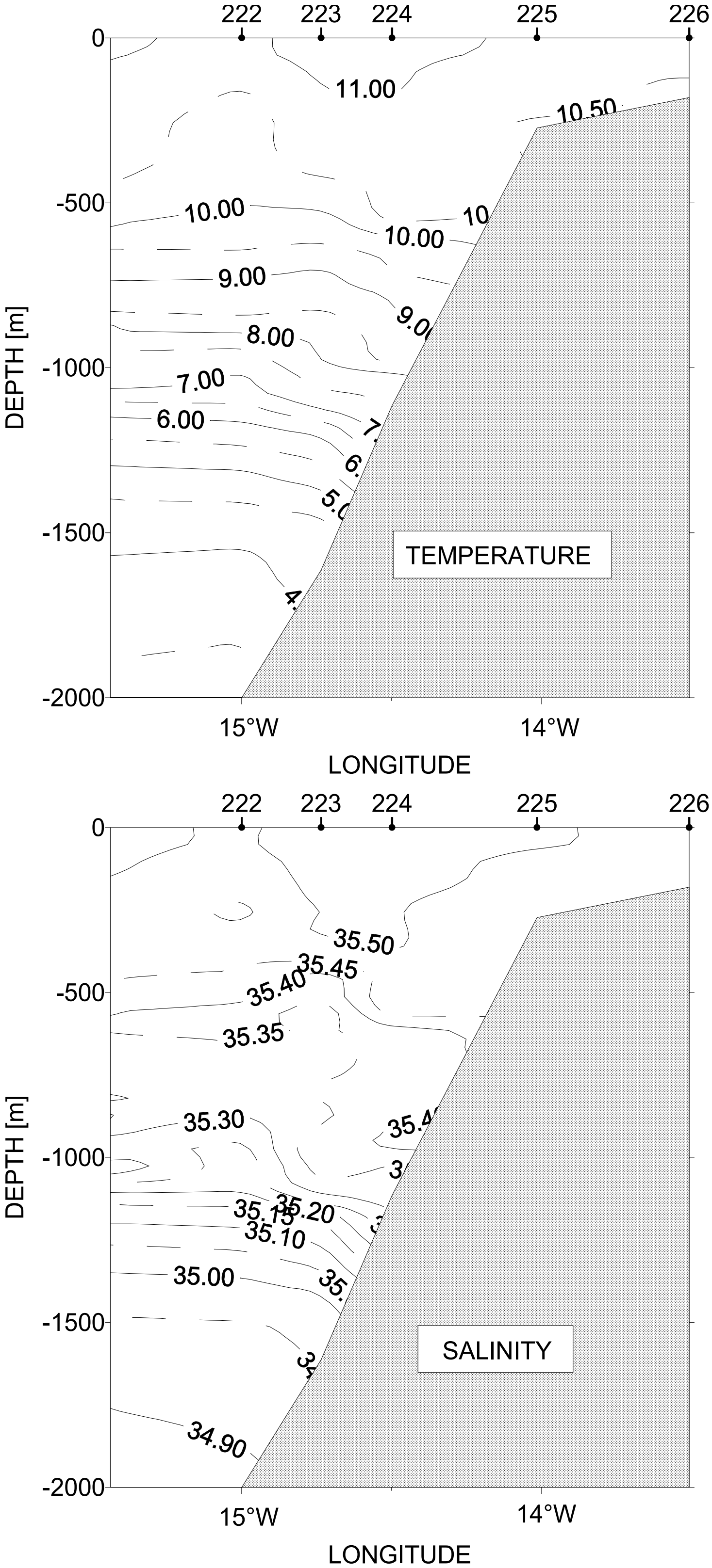


Figure 2.6.3 Vertical distribution of temperature (°C) and salinity in a section at the shelf edge at the Porcupine Bank at 53° 30'N. Station numbers at the top of the panels.

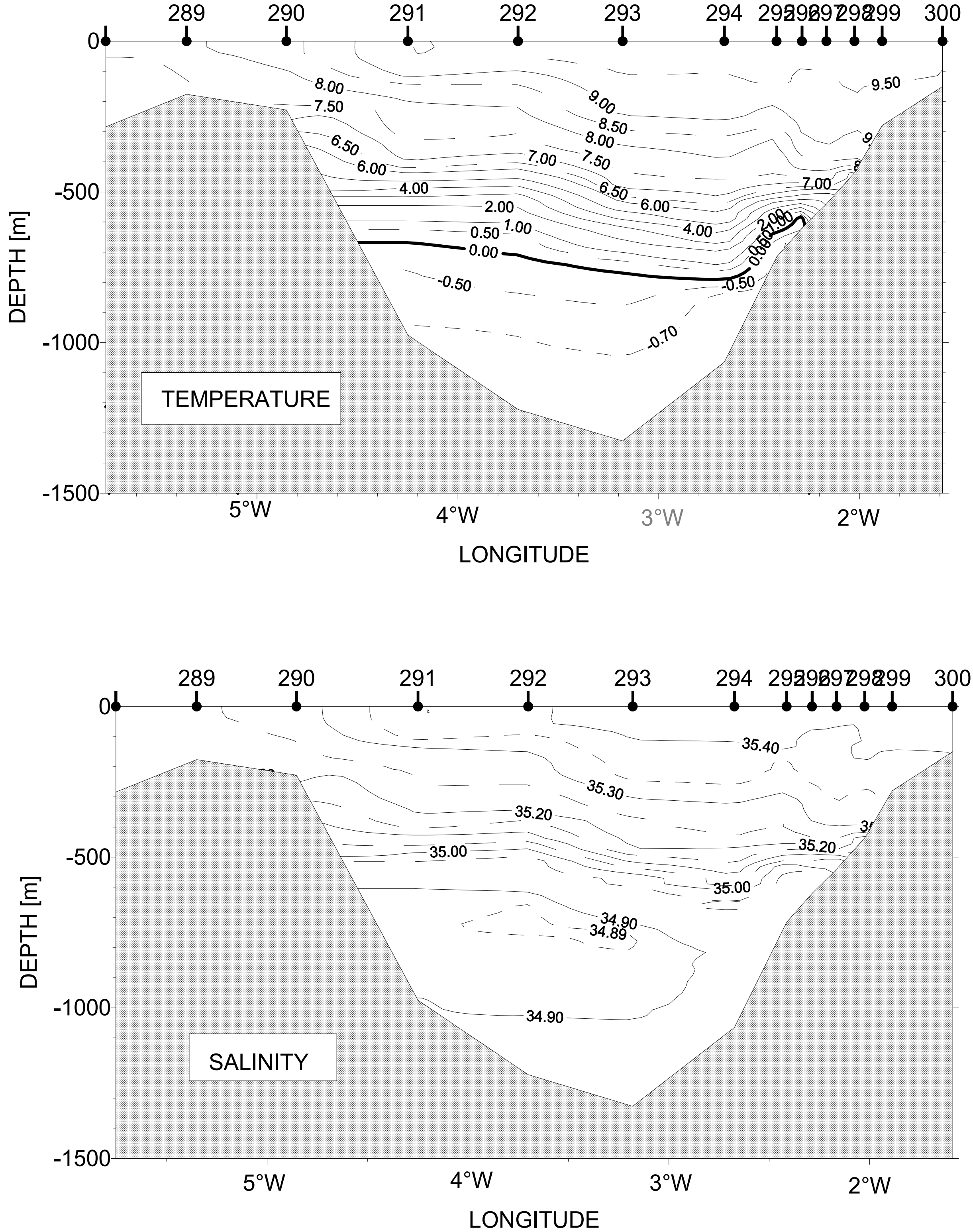


Figure 2.6.4 Vertical distribution of temperature (°C) and salinity in a section from the Faroes to Shetland (Nolsø-Flugga). Station numbers at the top of the panels.

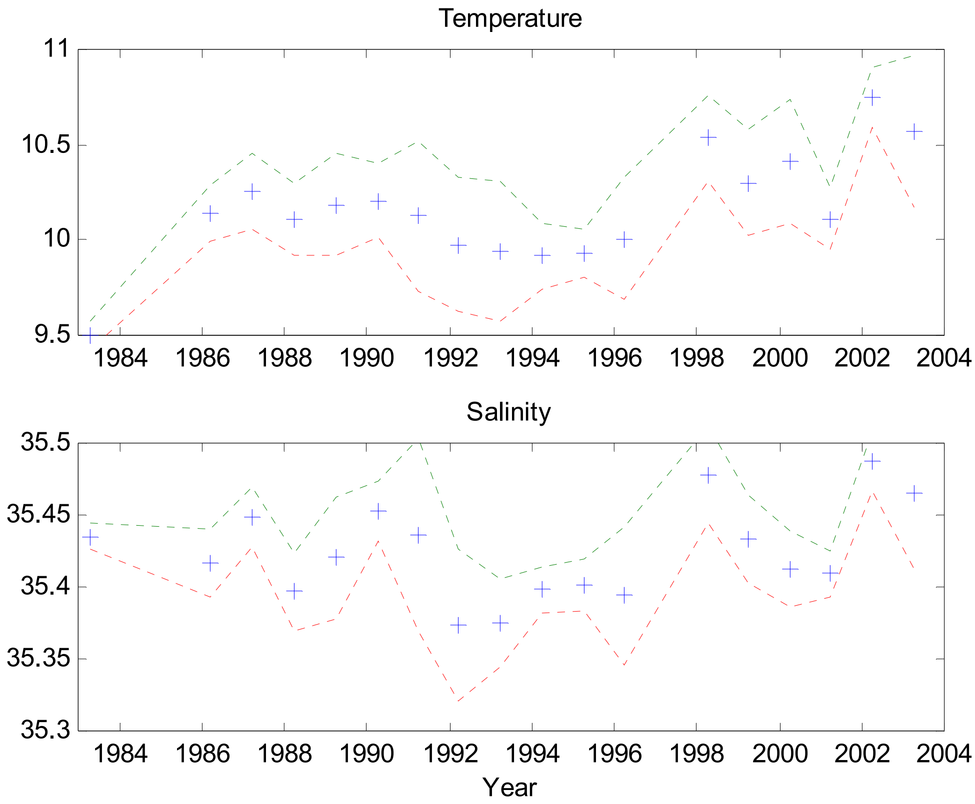


Figure 2.6.5 Yearly mean temperature and salinity from 50-600 m (crosses) of all stations in a box with bottom depth >600 m, west of the Porcupine bank bounded by 52° to 54°N and 16º to 14°W. Dotted lines are drawn at plus-minus one standard deviation of all observations in each box, each year.

3 NORWEGIAN SPRING-SPAWNING HERRING

3.1 General

3.1.1 Stock definition

The Norwegian spring-spawning herring is a unit stock that is characterized by extended migrations, a high number of vertebrae, by large size, special scale characteristics and year-class distribution. The morphological characteristics of this stock resembled those of Icelandic spring-spawning herring. However, the latter stock has disappeared.

ICES areas IIA, IIB and I constitute the distribution area. The adult individuals of the Norwegian spring-spawning herring have a distinct annual migration pattern in the Norwegian Sea. This migration pattern changes over time; at present the herring winters in fjord areas in Northern Norway, spawns on the Norwegian coast (mainly between 62^o and 71^{o}N), and feeds in the Norwegian Sea. The immature stock is distributed mainly in the Barents Sea, but some herring have their nursery area on the Norwegian coast. Historically, for instance in the period 1900-1950, the main spawning areas were located on the Norwegian coast south of 60^{o}N (ICES area IV), but at present only a small amount of herring migrate to these spawning grounds. The adult component seldom mixes with herring of other stocks. However, this can occur with immature herring (in certain fjord areas and in the eastern Barents Sea). In this case genetic characteristics are used as a supplement to the above-mentioned separation criteria.

3.1.2 ACFM advice and management applicable to 2002 and 2003

In 2001 ACFM stated that "the stock is harvested slightly above $\mathbf{F}_{pa}$ = 0.15. The stock biomass is within safe biological limits. The recruitment of the very strong 1992 year class led to an increase in SSB in 1997 to 9 million t, but this has since declined to approximately 6.0 million t in 2001. Continued fishing under the present management agreement, and given the recruitment prospects, gives a low probability of the spawning stock falling below $\mathbf{B}_{pa}$ (5.0 million t) in the medium term. ICES advises that this fishery should be managed according to the agreed management plan, corresponding to a catch of 853 000 t in 2002".

In 2002 ACFM stated that "the stock is inside safe biological limits. The stock is harvested at or slightly below $\mathbf{F}_{pa}$ = 0.15. The recruitment of the very strong 1992 year class led to an increase in SSB in 1997 to approximately 9 million t, but SSB has since declined to just over 5 million t in 2001. The incoming year classes 1998 and 1999 are estimated to be strong. ICES advises that this fishery should be managed according to the agreed management plan, corresponding to a catch of 710 000 t in 2003".

At the meeting on Fisheries Consultation on the management of Norwegian spring-spawning herring (Atlanto-Scandian) herring stock in Harstad, Norway in October 2001, the coastal states (European Union, Faroe Islands, Iceland, Norway, and Russia) agreed to limit their catches to 850 000 t in 2002, and there was also agreement on the allocation of the TAC. The agreed TAC was in agreement with ACFM advice.

At the corresponding annual meeting in St Petersburg, Russia in October 2002 the Parties did not come to agreement on a final TAC and the allocation of this. However, most parties agreed to set preliminary national quotas based on a TAC of 710 000 t for 2003 and a preliminary allocation based on the 2002 agreement. This preliminary TAC was in agreement with ACFM advice. The basis for the ACFM advice is the agreed management plan (Section 3.7). Catch in numbers for the years 1950-2002 are given in Table 3.2.1.6.

3.1.3 Fishery

The catches of Norwegian spring-spawning herring by all countries in 2002 by ICES rectangles are shown in Figure 3.1.2.1 (total whole year) and in Figure 3.1.2.2 (per quarter). In 2002 the catch provided as catch by rectangle represented approximately 763 969 tonnes or 94.8% of the total catch. In general the development of the international fishery shown by these figures follows the known migration pattern for Norwegian spring-spawning herring. The migration pattern, together with environmental factors, was mapped in 2002 during the ICES PGSPFN (Working Group on Surveys on Pelagic Fish in the Norwegian Sea) investigations (ICES 2002/D:07 Ref ACFM, ACME).

Denmark: The Danish fishery of Norwegian spring-spawning herring is carried out mostly by purse seiners and most of the landings were landed in Norway as in previous years. The fishery started in May and ended in the beginning of July and the fishery was carried out in the Norwegian Sea and in the Jan Mayen area (app. 19 000 t). In 2002 a fishery was carried out in the area just north of the borderline between the North Sea and Division IIa. The landings from this fishery have probably consisted of North Sea herring and are not included in the Norwegian Spring-spawning herring figures.

The Faroes: The Faroese herring fishery (8 vessels) started in late February 2002 in the Norwegian EEZ (IIa), relatively close to the coast off Sunnmøre (Norwegian coast, 62-63ºN) and continued in that area in early March, with some catches farther off the coast in mid-March. In mid-May the fishery was resumed in international waters from 69-73°N (ICES Division IIa), and continued in the international area and in the Jan Mayen zone (71-74°N) in early June, and the summer fishery terminated in late June in the Svalbard area (75-76°N, ICES Division IIb). The autumn fishery started in the southern part of the Svalbard zone and in the north-eastern part of the international zone close to the Norwegian zone in late August (ICES Division IIb and IIa), and later in August the fishery had moved into the Norwegian zone off Vesterålen (69-70°30'N). The fishery continued in this area until mid-October. All catches were taken with purse-seine. The total catches taken by the Faroese fleet was 32 302 t in 2002.

France: France reported no catches in 2002.

Germany: The information from the German fishery was restricted to the amount and location of catches.

Iceland: The Icelandic fishery in 2002 began in the third week of May both in the Jan Mayen zone and in international waters mostly from 69˚N to 71˚N, between 05˚E and 02˚W. The next few weeks the fishery moved, first further west into the Jan Mayen zone and then northeast through the international zone and by the end of June had completely moved into the Spitzbergen area. All through July the fishery took place in the Spitzbergen area from 76˚20´N to 77˚30´N and between 7˚E and 12˚E. In the first half of August the fleet started to move south following the herring migration and was fishing in the southern part of the Spitzbergen zone i.e. between 74ºN and 75ºN and from 08˚E to 11˚E by the end of the month. In the first half of September the fishery gradually noved into the Norwegian EEZ northwest of Lofoten where the fleet fished until the end of the season at the end of September, apart from a few small catches taken in the international zone in the last week of September. A total of 31 fishing vessels took part in the fishery. The total Icelandic catch of Norwegian spring-spawning herring was 127 197 tonnes of which only about 47% were taken with purse seine and 53% with pelagic trawl. The importance of the pelagic trawl in the fishery is rapidly increasing as only about 25% of the total catch in 2001 was taken in pelagic trawl. The bulk of the catch (about 68%) was taken in June in the Jan Mayen zone and international waters and about 13% was taken in May in the same area. In each month of July and August 9-10 000 tonnes (7-8% of the catch) were fished, and about 5 500 tonnes in September.

Ireland: Ireland reported no catches in 2002.

Netherlands: Catches of Norwegian spring-spawning herring by the Netherlands are taken by pelagic freezer trawlers in the 2nd quarter of the year. The main catches in 2002 originate from area II and are landed frozen for human consumption. The share of the international TAC for the Netherlands in 2002 was 9 210 t.

Norway: The Norwegian fishery is carried out by many size categories of vessels. Of the total national quota of 484 500 t, 51% is allocated to purse seiners, 9% to trawlers and 39% to smaller coastal purse seiners. By far the larger part of the Norwegian fishery takes place in northern Norwegian coastal waters (Vestfjorden area) where the herring winters from September until March. Here the herring occurs in concentrations that are easily available to the fishery. In 2002 approximately 140 000 t were caught in the wintering area in Northern Norway in January-February, and 48 000 t in the spawning area on the Norwegian coast in February-March. Of this 3000 tonnes were caught on the traditional spawning areas south of 60ºN (ICES area IV). Only 3000 t were caught in the spring/summer fishery in the Norwegian Sea, and the remaining part of the Norwegian quota (approximately 295 000 t) were taken in the period September-December on the herring migrating to, and wintering in, the wintering areas in Northern Norway. Approximately 90% of the Norwegian catches were utilized for human consumption.

Poland: The information on the Polish fishery was restricted to official catch.

Russia: In 2002 the Russian fishery started within the shelf region of the Norwegian EEZ, near Trena Bank (approximately 66ºN) at the beginning of February and Sclinna Bank (approximately 65ºN) and Budgrunnen Bank (approximately 63ºN) at the end of this month. In March the fishing was in progress in the same regions. In February and March the catch was 17 520 t. In May-June the commercial vessels conducted fishing in the northern part of the international area in the Norwegian Sea. In May-June the catch was 4 865 t. In July-August vessels caught herring in the international area in the Norwegian Sea in the Polar Front region and the zone of Spitsbergen. In September Russian vessels followed the southward migrating fish and continued their fishery in the Norwegian EEZ. In September the fishery of the herring was prolonged in the EEZ of Norway. The herring migrated southwestwards, along the depths of the continental slope. In July-September the catch was 87 582 t. In November Russian fishery finished in the

Norwegian EEZ north of the Lofoten area where 3800 t were caught. The Russian fishery is carried out by many types of vessels. The entire Russian catch was utilized for human consumption.

Sweden: The information on the Swedish fishery was restricted to official catch.

UK (Scotland): The information from the Scottish fishery was restricted to the amount and location of catches.

3.1.4 Ecosystem aspects

Juveniles and adults of this stock form an important part of the ecosystem in the Barents Sea and the Norwegian Sea. The herring has an important role as transformer of the plankton production to higher trophic levels (cod, seabirds and marine mammals).

3.2 Data

3.2.1 Commercial catch

The total annual catches of Norwegian spring-spawning herring for the period 1972–2002 (2002 preliminary) are presented in Tables 3.2.1.1 (by fishery) and 3.2.1.2 (by country).

The Working Group noted that in this fishery an unaccounted mortality caused by fishing operations and underreporting probably exists. In general, it was not possible to assess the magnitude of these extra removals from the stock, and taking into account the large catches taken in recent years, the relative importance of such additional mortality is probably low. Therefore, no extra amount to account for these factors has been added in 1994 and later years. In previous years, when the stock and the quotas were much smaller, an estimated amount of fish was added to the catches (Table 3.2.1.1).

In Røttingen *et al* (2002) the possibility of unaccounted mortality concerning the water content in herring deliveries and errors concerning conversion factors between fillets and live weight of herring were discussed. The paper gave an assessment of underreporting in 2001 of live weight of 18 000 tonnes, which is 3% of the total catch of Norwegian spring-spawning herring landed in Denmark and Norway in 2001 (588 000 tonnes). This underreporting element is probably valid also for other pelagic stocks. For 2003 Norway has increased the allowed subtraction for water content from the weighted catches to 13%. However, for 2004 EU and Norway have agreed to set this subtraction to 2%.

Due to the changing framework of these administrative routines, and to uncertainty on the appropriate period the landing figures should be modified, it was decided not to add any amount to the official landing figures as presented in this year's report. However, this question should be reviewed at the next Working Group meeting.

The combination of national catch-at-age and weight-at-age data for 2002 to obtain the total international catch-at-age and weight-at-age was done using the computer programme SALLOC, a standard ICES software. The official catch, sampled catch, and catch as used by the Working Group, together with number of samples, catch-at-age, and weight-at-age for each fishery are given in Tables 3.2.1.3 and 3.2.1.4.

The Working Group noted that not all nations participating in the international fishery for Norwegian spring-spawning herring in 2002 had carried out an adequate sampling of their fishery. The allocation of catches for which no samples were taken and the final catch-at-age and weight-at-age by ICES area is given in Table 3.2.1.5. In general one used the Norwegian age distribution and weights for un-sampled fisheries in the Norwegian Sea in quarter 1–2, and the Russian age distributions and weight keys for quarter 3-4 for un-sampled fisheries in quarter 3-4. The Russian age distribution in quarter 3-4 was calculated using Russian length samples and the Norwegian age-length key for quarter 3 and 4.

In the years 1994–2001 the size group information from each Norwegian catch of herring reported to the Norwegian fishermen's sales organisation for pelagic fish was used to calculate the Norwegian catch in number. In 2002 these data were not available for the WG; instead data from biological sampling from commercial catch were used.

3.2.2 Biological data

The natural mortalities and weights in stock (Table 3.2.2.1) and catches (Table 3.2.2.2) used in the assessments are given in Sections 3.3 and 3.4.

3.2.3 Surveys

3.2.3.1 Spawning grounds

There was no acoustic survey to estimate the abundance of herring in the spawning areas in 2002. Earlier estimates are listed in Table 3.2.3.1.

3.2.3.2 Wintering areas

The wintering area of the herring (Vestfjord, Ofotfjord, Tysfjord) was surveyed acoustically by the R/V "Johan Hjort" in November-December 2002. The abundance estimate obtained is given in Table 3.2.3.2. The herring was only observed in the Ofotfjord and Tysfjord in 2002 as opposed to the prior years when herring also was observed in large parts of the Vestfjord. Due to changes in the migration pattern of the younger fraction of the herring stock, with large portions of the 1998 and 1999 year classes wintering off Vesterålen and northwards towards the Tromsøflaket, the estimate of these year classes are strong underestimates.

3.2.3.3 Feeding areas

The feeding areas in the Norwegian Sea were surveyed acoustically by the ICES coordinated herring survey (PGSPFN) during the period 25th of April to 29th of May 2002 (ICES 2002/D:07). A complete set of the PGSPFN reports from the years 1995-2002 is found on www.imr.no/PGSPFN. The abundance estimate is given in Table 3.2.3.3.

3.2.3.4 Nursery area

The nursery areas of the Norwegian spring-spawning herring are Norwegian fjords and coastal areas, and in the Barents Sea. Since 1988, when the 1983 year class spawned for the first time, the latter area has increased in importance as a nursery area for the herring.

Results from the Russian acoustic survey in the Barents Sea in May-June 2002 are given in Table 3.2.3.4.1. This year the Working Group decided to include data on immature herring obtained during the Russian bottom survey in October-December 2002 in estimating the younger year classes (A. Krysov, WD). The results from this survey are given in Table 3.2.3.4.2. The results from the 0-group herring survey in Norwegian Fjords and Coastal areas are given in Table 3.2.3.4.3 and the results from the joint Norwegian-Russian 0-group survey in the Barents Sea are given in Table 3.2.3.4.4.

3.2.3.5 Herring larval survey

The larval survey in 2003 was carried out during the period 13-21 April. The survey started in the northern area of the distribution (at approximately 70°N) and proceeded southwards. The distribution of the herring larvae is given in Figure 3.2.3.5. This year, as was the case in 2002, a high proportion of the larvae were found in the northern part of the investigated area, the only area with high densities of herring larvae was found at Røstbanken (68°N). South of 62°N few larvae were recorded, indicating only a minor spawning in that area. Most of the larvae were in the first post yolksack stages and the mean length was 14.7 mm, the highest recorded since the start of these investigations in 1985. The mean age of the larvae was approx. 3 weeks.

The total number of larvae was estimated to $3.7*10^{12}$, a large reduction compared to the previous years (Table 3.2.3.5). The reason for this reduction is not known. The Working Group has regarded the larvae index as an indicator of the amount of spawning products, and included it as a tuning series. However, no other data and information on the spawning stock and distribution indicates that the spawning in 2003 was reduced to such a degree compared with later years.

3.2.4 Other relevant data

3.2.4.1 Tagging data

With the exception of 1999 and 2001, tagging has been carried out annually since 1975. The tagging experiments in 2002 were carried out in November in the wintering area (Tysfjorden, 68°05.5' N, 16°22.3' E) where a total of 31 993 herring were tagged. During the tagging process, the length of each tagged herring is measured. For each purse seine catch that is used for tagging, a sample of 100 fish is taken to determine the age distribution within each length group. The age composition of tagged herring in this batch is then estimated from the age distribution in the sample.

Recovery of tags from supervised detector plants has continued, as well as recovery from the standard magnets in the production line of fish processing plants and from individuals. For stock assessment purposes, tags are only used from supervised detector plants where detector efficiency has been tested, and where it is known that the detectors have been working as intended. Two factories filled these criteria in 2002, and a total of 47 596 million herring were screened in these factories. Magnet efficiency was 100% in 2002. All tagged herring recovered were sent to the Norwegian Research Institute where they were measured, weighed and aged. In 2002, 84 tags from herring that were four years or more when tagged, were recovered from factories where detector efficiencies had been working as intended (Table 3.2.4.1).

In 2002, one of the catches screened had been taken in the southern spawning area at Karmøy (approximately 59°N). The size of the catch was 452 tonnes and 15 tagged herring were found in this catch. This is a large proportion of the total recovered tags (18%). Of these 15 herrings, 14 had been released in the southern spawning area, indicating non-random mixing of tags in the stock that migrated to the southern spawning grounds.

3.2.4.2 Prognosis of herring condition

A prognosis of the herring condition index for 2004 was used to estimate weight-at-age for the herring in 2004 in the short-term prognosis for NSSH in SeaStar. The prognosis of the herring condition was derived from a regression of herring condition during the time period 1990 to present on a two-month mean of the NAO index with a one-year time lag as described in Section 2.4.5. Figure 3.2.4.3 shows the relationship between observed and modelled data of the herring condition.

3.3 Assessment models: SeaStar

The changes in SeaStar and the use of SeaStar for assessing the Norwegian spring-spawning herring stock is summarised in the text table below:

	Analysis of young herring not present in the main tuning series	Tuned year classes
2002	Regressions of VPA to Barents Sea surveys and 0-group data	1983, 1990, 1991, 1992 and 1993
2003	Tuning in a separate step	1983, 1990, 1991, 1992, 1993 and 1996

A documentation of the model was presented (Tjelmeland, WD). The model is written in Mathematica and the documentation text as well as the code can be viewed on the site www.assessment.imr.no. An important change of the model with respect to the two previous years is that the assessment of the young fish that are not present in the main tuning series is not performed by establishing regressions between the final VPA and survey and 0-group indices in the Barents Sea, but performed as a separate tuning step using data (0-group index and acoustic surveys) from the Barents Sea only. In this step, however, all year classes must be present in the tuning since there is no catch data that may reflect in any way the strength of the cohort.

SeaStar is especially designed for Norwegian spring-spawning herring and has been used for the assessment of this stock the latest years. It incorporates a wide variety of information about the stock. Traditionally, using tag data has been important for the management of this stock, and SeaStar incorporates tag data. SeaStar is statistically founded (the objective function expresses a likelihood for the observations), so that information from different sources can be merged without any subjective weighting problem. However, SeaStar does not get information about stock size from signals in the catch data, for which reason the WG this year chose to present both SeaStar and ISVPA as two equally valid models for assessing the stock.

One distinguishing feature of SeaStar is that one may choose to represent only the largest year classes with free parameters (terminal F-values) in the tuning. The rationale for this is that for this stock which has especially strong recruitment dynamics, large relative uncertainty in the weak year classes can generate relatively large uncertainty in the strong year classes. This effect can be serious when the abundance of the small year classes is determined by one or two scales only in certain surveys and certain years of catch data. Figure 3.3.1 shows the results from a simulation experiment (SeaStar documentation, WD by S. Tjelmeland) that illustrates how uncertainty is propagated from weak to strong year classes. In the experiment, 3 strong and 3 weak year classes were generated repeatedly and an assessment was made tuning on only the large year classes and tuning on all year classes. The figure shows that the uncertainty in the sum of the large year classes is appreciably larger when all year classes are tuned together than when the large year classes are tuned separately, giving support for using the SeaStar approach for assessing fish stocks with strong recruitment dynamics.

The youngest year class in the main tuning last year was the 1993 year class, and at the present meeting the WG included also the intermediate strong year class 1996.

The catchabilities of the acoustic surveys are assumed to have no age dependence or abundance dependence. The reason for this choice is that the mechanism for the recruiting of herring to the surveys is that of migration, not of growth, where the latter process could be assumed to be more regular and modellable. Instead, for each survey there is set a minimum age for inclusion of each year class.

The input data used are:

Catch data	Table 3.2.1.5
Acoustic surveys	Table 3.2.3.1, 3.2.3.2, 3.2.3.3, 3.2.3.4
Tag data	Table 3.2.4.1
Larval data	Table 3.2.3.5
0-group data	Table 3.2.3.4.4

The larva index for 2003 is very low (Table 3.2.3.5). The WG decided to leave it out of the analysis. The tag return data for 2002 were also suspicious with 15 tags from one single catch of about 400 tonnes taken at the extreme south of the spawning migration, and consequently the WG decided to leave out also the last year of tag return data.

The acoustic surveys used are (the numbering is used elsewhere in the text of this Section):

1	The spawning grounds along the Norwegian coast	Minimum age: 5
2	The wintering area in Vestfjorden in November/December	Minimum age: 4
3	The wintering area in Vestfjorden in January	Minimum age: 5
4	The young herring in the Barents Sea in May	Minimum age: 1
		Maximum age: 2
5	The feeding areas in the Norwegian Sea in May	Minimum age: 3
6	The joint IMR-PINRO capelin survey in September	Minimum age 1
		(except the 2002 year class, see below).

For the last of these surveys an extra point for the 2002 year class as 0-year-old was added this year. This observation stems from a demersal survey in October/November conducted annually by PINRO (Krysov, WD). In order to include this single point in the analysis, the observation was included into the September series with appropriate scaling due to natural mortality during two months. It should be noted, however, that this procedure is not strictly appropriate since it may violate catchability and distributional assumptions. The acoustic survey in Vestfjorden in 2002 found far less 1998 year class than expected from earlier observations, but a considerable amount of this year class was found outside of the survey area immediately after the survey (Jens Chr. Holst, pers. comm.). This data point is therefore omitted from the analysis.

The extremely high estimate of the 1999 year class as 1-year-old fish in the Russian May survey in the Barents Sea was not omitted, however, as the WG had no exogenous information.

It is assumed that the distribution of the main tuning series of older fish follows a gamma distribution with a common CV, which is estimated and that the distribution of the acoustic data in the Barents Sea follows a lognormal distribution. From plots of quantiles of CDF values (not shown) it appears that the former assumption is slightly better than assuming a log-normal distribution, and the latter assumption is much better than assuming a gamma distribution. The tag return data are assumed to follow a Poisson distribution, which is commonly used for rare events, the larval data are assumed to follow a gamma distribution with an estimated CV, and the zero group data are assumed to follow a normal distribution with an estimated standard deviation.

It has been experienced that when the fish get old the scales get difficult to read and more scales get discarded. This introduces a bias in the age distribution. An attempt has been made to correct for this age bias (Schweder and Tjelmeland, WD).

Previously it has been observed in this WG that as the 1983 and 1985 year classes grew older than about 13 years the age readers tended to transfer fish from the 1983 to the 1985 year class. This problem is part of the general age reading problem for older fish, but has been corrected for separately.

3.3.1 Exploratory runs

As has been the case during previous assessments of Norwegian spring-spawning herring with SeaStar, a number of exploratory runs were initially performed to see the effect of various options and settings. These runs were:

Label	Explanation
Default	With respect to the 2002 assessment the 1996 year class was included in the tuning.
The other runs were deviations from the run Default:	
NoTagsNoLarvae	The tag and larvae data were left out to make the model as comparable to ISVPA as possible.
CorrectAgeBias	The age bias has been corrected
Youngest1998	The 1998 year class was included in the tuning.
EstimateMortality	The natural mortality both of adult herring and young herring in the Barents Sea was estimated.
Lognormal	The lognormal distribution was assumed for the main tuning series.
OnlySurvey1	The acoustic series other than the survey on the spawning grounds were omitted.
OnlySurvey2	The acoustic series other than the survey in November/December in Vestfjorden were omitted.
OnlySurvey3	The acoustic series other than the survey in January in Vestfjorden were omitted.
OnlySurvey5	The acoustic series other than the survey on the feeding area in the Norwegian Sea were omitted.

The estimated parameters, spawning stock biomass in 2003 and 2002, and the contribution to the likelihood function from the various data sources are shown in Table 3.3.1.1 for the exploratory runs, excluding those using only one survey, and Table 3.3.1.2 for the runs where only one acoustic survey was used.

The variation in the spawning stock, between 4.6 and 7.8 million tonnes is rather small, giving confidence in the stability of the model. Using only the acoustic survey in the feeding areas from the main survey indices on adult herring while tag data, larval data and the Barents Sea surveys on young herring were retained, gave a 1 million tonnes decrease in the spawning stock, while using only one of the other surveys gave a decrease between 0.3 and 1 million tonnes. There is only a slight difference between using the gamma distribution and lognormal distribution for these surveys. When the 1998 year class is in the tuned year classes, the spawning stock decreases about 1 million tonnes. However, a series of exploratory runs around this option showed that the decrease when using only the survey in the feeding areas and corresponding increase when using only the other surveys was much larger, giving the impression that the year classes should have been present in the surveys for some years in order to give a reliable time trend signal.

When a correction of the age reading bias was attempted, the spawning stock was increased by 0.5 million tonnes, showing the potential seriousness of this source of error. However, the WG felt that the method applied was somewhat premature for making this run the final run from SeaStar. The higher uncertainties in the Barents Sea surveys (4 and 6) are reflected in their smaller contribution to the log-likelihood per data point.

The natural mortality for older herring was estimated at 0.13 by the model, as opposed to 0.14 last year. However, the estimated mortality is close to the mortality of 0.15 assumed by the WG. The natural mortality for the young herring in the Barents Sea was estimated at 0.5, which is lower than the mortality of 0.9 assumed by the WG. A bootstrap was not done for this run, but the latter estimate is probably much more uncertain than the former, since there is no mortality signal from the tag data involved.

The log-likelihood per data point are at the same level for all the main tuning surveys (surveys 1, 2, 3 and 5), while the log-likelihood per data point from the surveys in the Barents Sea is much lower, reflecting the larger uncertainty in these surveys.

The catchability of the survey in the feeding areas (cat5) is estimated at about 1 (1.03 for the main run last year) in all runs, reflecting that this survey is the survey that is in closest agreement with the model's perception of stock abundance.

3.3.2 Final assessment including uncertainty analysis and retrospective analysis

Figure 3.3.2.1 shows the fit of the VPA scaled with the estimated catchability to the observations in the survey on the spawning grounds for the tuned year classes. Figure 3.3.2.2 shows a similar fit for the December survey in Vestfjorden, Figure 3.3.2.3 for the January survey in Vestfjorden and Figure 3.3.2.4 for the feeding areas in the Norwegian Sea. With exception of the 1991 year class in the December survey and possibly the 1983 year class in the survey on the spawning grounds all year classes seem to recruit well to all surveys. The fit is reasonably good for all surveys. However, the 1996 year class seems to be somewhat systematically underrepresented in the survey on the feeding areas. It is interesting to note that in 1999 all year classes increased with respect to the previous year in the January survey and the survey on the spawning grounds, as all year classes also did in the September survey in 1998.

Figure 3.3.2.5 shows the retrospective plot. The effect of the anomalous survey observations to the assessment in 1999 is clearly reflected in the retrospective run. The general trend is well followed, but there is a larger spread in the recent years than was the case for the retrospective plot last year. The reason for this is probably the 3-year span between the youngest tuned year class entered this year and the next youngest tuned year class. There is a tendency for consistently overestimating the stock.

Figure 3.3.2.6 shows a histogram of the spawning stock in 2003 for the bootstrap replicates. The standard deviation is about 1 million tonnes – about the same as last year, giving a CV of 0.17. However, the distribution is skewed, with the maximum likelihood value being about 0.3 million tonnes larger than the mean and about 0.45 million tonnes larger than the median. Table 3.3.2 shows a summary of the parameters, spawning stock and total spawning stock from the bootstrap replicates. Figure 3.3.2.7 shows a scatter plot where the covariation between pairs of parameters, between parameters and spawning stock, and between parameters and total stock have been plotted. The parameters are labelled with shortened names, given in Table 3.3.2.

3.3.3 Recruitment estimation

The VPA from the Default run of SeaStar made back to 1950 (Table 3.3.3) gives a series of the spawning stock and recruitment as 0-year-old herring that may be used to build a recruitment function to drive medium-term and long-term simulations. Figure 3.3.3 shows a scatter plot of spawning stock and recruitment labelled with the recruitment years. 25% of the most successful recruitment points (marked in red) has been omitted from a fit of the Beverton-Holt recruitment relation (line) and are treated separately during simulations. There seems to be a large stochastic variation. However, there is a definite signal from the spawning stock.

3.3.4 Short-Term Projection

Table 3.3.4.1 shows the input data to the short-term projection. For the weight-at-age in 2004 the weight-at-age in 2003, which is taken from December 2002 data, was multiplied with the ratio of the condition factor in December 2003 to the condition factor in December 2002. The condition factors are described in Section 2 and in Section 3.2. As exploitation pattern was used a least-square fit of a third-order polynomial to the F-values generated by SeaStar in 2002. It is assumed that a catch of 0.710 million tonnes is taken in 2003. The weight-at-age in the catch is taken as the mean of the weight-at-age in the catch in the period 2000-2002. The mature fraction-at-age in 2002 was used throughout the short-term period. The number-at-age in 2003 is taken from the SeaStar Default run. The recruitment at age 0 in 2003-2005 is set to zero and consequently the total stock biomass is an underestimate.

Table 3.3.4.2 shows the results of the short-term projection. For a population-weighted fishing mortality over the ages 5-14 of about the agreed value of 0.125 the expected catch in 2004 is about 0.850 million tonnes. The spawning stock will increase to 2004 because of the 1999 year class being nearly fully mature. For the agreed fishing mortality the spawning stock will decrease to about 5.6 million tonnes in 2005, a development that is in accordance with projections made by this WG last year.

The population-weighted fishing mortality for ages 5-14, Fbar, is in 2003 0.11, which is generated by an assumed catch of 0.71 million tonnes. If the exploitation pattern used by ACFM last year is used in the projection, Fbar in 2003 is calculated to 0.12 and the catch corresponding to an Fbar of 0.125 in 2004 is about 0.76 million tonnes.

3.4 Assessment models: ISVPA

3.4.1 Exploratory runs

For NSS herring stock assessment the catch-controlled version of the ISVPA with constraint of unbiased model approximation of logarithmic catch-at-age was used. Current program realization of the ISVPA, which allows simultaneous implementation of up to 7 age-structured indexes (of mature, immature or total stock) and up to 3 integrated indexes of SSB, was reported to the ICES WG on methods (ICES 2003/ D:03).

The catch-controlled version of ISVPA is considered to be more appropriate for stocks with very variable selection pattern, like NSS herring and is therefore used here. It is, however, less resistant to noise in the data. Therefore the median of the distributions of squared residuals (MDN) in the ISVPA loss function was used to increase robustness.

Profiles of the components of the ISVPA loss function, coming from each survey and from separable description by the model of catch-at-age data, are shown in Figures 3.4.1.and 3.4.2. In the catch-controlled version of the model, for which the abundances are calculated directly via catches, residuals in catch-at-age could be considered as a measure of separability of estimated fishing mortalities, but not as a measure of deviations of estimated abundances from "real" ones. For all runs (except specially mentioned) age groups 1-16+ were used in analysis.

As it can be seen from Figure 3.4.1, when SSE was used as a measure of goodness of fit for the model to age-structured surveys, only survey N2 (acoustic survey in wintering areas) revealed a good minimum, while it was somewhat weaker for survey N4 (acoustic survey in feeding area). The application of MDN instead of SSE (Fig. 3.4.2) resulted in the appearance of distinct minima for all indexes, except index N4.

Since index N4 is considered to be one of the most valuable observations and gives the best fit to abundance estimates from the cohort part of the model, but gives an uncertain signal about the value of terminal effort factor (very flat minimum), it was decided to pay more attention to this index. Assuming that a low quality of signal from a good source of information might be the result of a hindering effect in the model of the signal from the age-structured survey data, the abundance-at-age $I_{a,y}$ values of this survey were " detrended" by the following procedure:

$$I_{a,y}(new) = I_{a,y} \Big/ \sum_{a=1}^{a=oldest} I_{a,y}$$

Resulting ("detrended") data now contain information only about relative (normalized to sum=1 for each year) structure of stock abundance.

In order not to lose information about trend in the stock biomass, which was present in the initial data, the data on abundance-at-age of this survey were recalculated to the SSB index as:

$$I_y^{SSB} = \sum_{a=1}^{a=oldest} (I_{a,y} w_{a,y}^{instock} maturity_{a,y})$$

This data set containing SSB indices, derived from survey N4, was used as auxiliary information in tuning of the model.

It turned out that data from survey N4, split into a "detrended" relative index of stock age structure, and an index of SSB, revealed distinct minima (see Fig. 3.4.2) and approximately at the same place with respect to the terminal effort factor f_{term}. Now all sources of information gave almost coherent signals.

Figure 3.4.3 represents profiles of the ISVPA total loss function for different cases with respect to treatment of survey N4 data. As it can be seen, global minimum is not strongly changed by the choice of how to take the information from this survey into account, but difference between solutions in terms of SSB (Fig. 3.4.4) between some of the cases exists.

The properties of the proposed procedure of "detrending" of age-structured survey data was tested using a simulated "noisy" data set, generated at the ICES Working Group on Methods of Stock Assessment (ICES 2003/ D:03). For analysis the index with trend in catchability was used. ISVPA was implemented in the same version, as for herring – catch-controlled, unbiased approximation of logarithmic catch-at-age, minimization of MDN. In the ISVPA loss function only the component for this survey was used. "Detrending" of the index data gave the result, apparently closer to the "truth" in comparison to tune on "initial" data (see Figures 3.4.5 and 3.4.6).

Since the procedure of "splitting" the survey information is not traditional for the WG and needs further consideration in relation to similar approaches used in some other models (i.e. BORMICON), it was decided to use the index N4 with SSE-minimization, which produces a somewhat better pronounced minimum in comparison to MDN.

Experiments with changing the range of ages, included into the analysis, were also made and presented by Sigurd Tjelmeland. Exclusion of older ages or (and) age group 1 from analysis in some cases changed the result substantially. For example, exclusion of age group 1 with simultaneous restricting older ages from 16+ to 15+ (with the same other settings – survey N4 is used as "detrended" + trend in SSB) brought down the estimate of SSB(2002) from 6 million to 4.7 million tonnes, while almost not changing the pattern of residuals in logarithmic catches (Fig. 3.4.7).

It was proposed (Sigurd Tjelmeland) to include "dual" selection pattern into the model (such potential possibility is reserved in the ISVPA, but for two successive continuous periods). In contrast, for herring it was proposed to use two specific selection patterns for specific years – according to whether a strong or an ordinary generation is entering the fishery at age 4. Only preliminary runs were done, but in some of them the estimated values of abundance for young age groups became closer to the results of the Sea Star model. This approach may be fruitful in merging positive features of the Sea Star and ISVPA models.

3.4.2 Final assessment, including uncertainty analysis and retrospective analysis

The ISVPA options, taken in the basic run in comparison to those previously used are listed in the table below.

Settings/options for the ISVPA run	**2002(WG)**	**2002 (Coastal States meeting)**	**2003 (WG)**
Numbers of age structured tuning series	0	6	6
Version of the model	Catch-controlled	Catch-controlled	Catch-controlled
Numbers of biomass tuning series	0	0	0
Constraint	Unbiased model description of logarithmic catch-at-age	Unbiased model description of logarithmic catch-at-age	Unbiased model description of logarithmic catch-at-age
Number of years with a separable constraint	1986-2001	1986-2001	1986-2002
Reference age for separable constraint	no	No	no
Constant selection pattern	Yes	Yes	Yes
S on the last age	Equal to that for previous age	Equal to that for previous age	Equal to that for previous age
Age span for calculation of reference F	5-14	5-14	5-14
Weight given to age groups and years in separable period	1	1	1
Catchability model for all fleets	NA	Constant, q(a) are estimated	Constant, q(a) are estimated
Age range for the analysis	2-16+	2-16+	1-16+
Survey weights for all ages in all fleets	NA	1	1
What is minimized for residuals in logarithmic catch-at-age	NA	SSE	MDN, except SSE for survey on feeding area (N4)

What is minimized for logarithmic abundance-at-age (for indexes)	MDN; absolute median deviation (AMD)	MDN; absolute median deviation (AMD)	MDN

A summary of the results of the stock assessment is given in Table 3.4.1. Estimates of abundance and instantaneous fishing mortality coefficients by years and ages are given in Tables 3.4.2-3.4.3. Since age group 1 is absent in the catch-at-age matrix in 2002 and age group 2 appears in it for the first time the values for these age groups, estimated by the model, are to be substituted in the short-term forecast by 538 000 for age group 1 and 3 935 000 for age group 2, taken directly from results of young fish surveys in the Barents Sea.

The retrospective analysis (see Fig. 3.4.8), undertaken with the same options independently of whether signals from all surveys in restricted year ranges are still existing or not, showed low stability of results, except for runs with 2000 and 2001 terminal years, for which the estimates were very close to each other.

The bootstrap procedure for the catch-controlled version of ISVPA was somewhat different in comparison with the effort-controlled one. For the catch-controlled version, for which abundance is calculated directly using catches and estimated selection at age is used only for terminal ages and in terminal year, approximation of catch-at-age data by the model cannot be considered as measure of errors in the data. That is why instead of resampling of residuals (as it is done for the effort-controlled version), new catch-at-age data were generated simply by adding a lognormally distributed noise with variance 0.3. For auxiliary information the same procedure was used, variance for each survey was also taken equal to 0.3.

Results in terms of SSB are apparently shifted downwards in final years (Fig. 3.4.9). This may be explained by complete deterioration of the solution for some combinations of noise in the data (disappearance of minima of components of the ISVPA loss function), which was revealed in approximately 10% of the runs and was expressed in extremely high estimates of "best" values of the effort factor in the terminal year (f_{term} >7), compared to f_{term} = 2.57 in the basic run. Perhaps the procedure of noising of input data needs further consideration for the catch-controlled version of the model. Better knowledge of real values of variances for survey data is also needed.

3.4.3 Recruitment estimation

No specific procedure for recruitment estimation was used. For the short-term projection recruits were estimated as the geometrical mean of estimates for 1986-2001, taken from the basic run of the ISVPA.

3.4.4 Short-Term Projection

Input data for the short-term projection are given in Table 3.4.4 and the results are shown in Table 3.4.5.

3.5 Comparison between Seastar and ISVPA

3.5.1 Evaluation and comparison of the models ISVPA and SeaStar

The Working Group discussed in detail and made many trial runs with the ISVPA and SeaStar models. This discussion is reflected in Sections 3.3 and 3.4. A summary of some inherent properties is given in the text table below:

Element	ISVPA	SeaStar
Changes in model compared with last years estimate	Includes tuning with survey data	New method of estimating year classes not included in the tuning. In the 2002 assessment the 1993 year class was the youngest year class in the tuning, in 2003 the 1996 year class was the youngest
Information on tags and larvae	Not included	Included
Information from fisheries	Separability is a central element, one constant exploitation pattern	No information from the catch signal

Data for estimating recruitment	Catch data with tuning to acoustic surveys of immature herring	Acoustic surveys on immature herring, data from 0-group trawl indexes
Estimation method	Minimization of the median of log residuals	Maximum likelihood

Since 2001 model work has been undertaken to investigate different properties and the models have been modified to increase transparency and to make them more equal. This work should continue.

The Working Group concluded that both models are relevant and applicable to assess the state of the Norwegian spring-spawning herring. The main difference of the models is the estimation of the year classes entering into the spawning stock. This is a period with dynamic changes, the herring migrates from the nursery area in the Barents Sea to the Norwegian Sea, the maturing process begins and the fish "migrates" into the fishery (fishing in the Barents Sea is not possible due to area closure in the Russian EEZ and minimum length of 25 cm in the Norwegian EEZ). The amount of herring migrating to the northern Norwegian Sea varies from year to year according to year-class strength. This year-to-year variation may be important to take into account when discussing the separability issue. SeaStar lacks information from this phase, while ISVPA relies on constant selection pattern.

3.5.2 Comparison of ISVPA and SeaStar assessments

The results from the two models are not in agreement with regard to the younger year classes. This was also the case in 2002. Fig 3.5.2.1 gives the values for the different year classes in the assessment in 2002 compared with the perception of the same year classes in the 2003 assessment.

In the 2003 assessment the main discrepancy is the size of the 1998 year class. The Working Group evaluated data on the abundance of the year classes 1992 and 1998 from various sources (acoustic surveys, trawl indexes, VPA estimates). The relevant data on these year classes are given in Table 3.5.2. The Working Group concluded that the 1998 year class as 4-year-olds is not at the same level of abundance as the 1992 year class as 4-year-olds. The input data on year-class strength and selection used for the short-term projection to the two models are shown in Fig. 3.5.2.2 and Fig. 3.5.2.3.

3.6 Biological reference points

The process of establishing biological reference points (including a $\mathbf{B}_{\text{lim}}$ value of 2.5 million tonnes) for this stock is given in Røttingen (2000). The SGPRP03 stated that the segmented regression was significant at a 5% level and gave a change point of 2.3 million tonnes. Furthermore, the SGPRP03 has the opinion that these numbers are close to each other and as this stock is managed to an agreed harvest control rule, there is no need to change the $\mathbf{B}_{\text{lim}}$ value.

If the spawning stock falls below 5.0 million tonnes ($\mathbf{B}_{\text{pa}}$) the managers have, according to the harvest control rule, decided on a linear reduction in fishing mortality from the agreed maximum fishing mortality 0.125 ($\mathbf{F}_{\text{pa}}$ is set to 0.15) at $\mathbf{B}_{\text{pa}}$ to 0.05 at $\mathbf{B}_{\text{lim}}$. The WGNPBW agrees on the conclusion of the SGPRP03 on the $\mathbf{B}_{\text{lim}}$, and is, due to the elements in the agreed harvest control rule, also of the opinion that there is no reason at present to change the values for the biological reference points $\mathbf{F}_{\text{pa}}$ and $\mathbf{B}_{\text{pa}}$.

3.7 Management targets

EU, Faroe Islands, Iceland, Norway, and Russia agreed to implement a long-term management plan. This plan consists of the following elements (ICES 2002/CRR:255):

1. *Every effort shall be made to maintain a level of Spawning Stock Biomass (SSB) greater than the critical level ($\mathbf{B}_{lim}$) of 2 500 000 t.*
2. *For the year 2001 and subsequent years, the Parties agreed to restrict their fishing on the basis of a TAC consistent with a fishing mortality rate of less than 0.125 for appropriate age groups as defined by ICES, unless future scientific advice requires modification of this fishing mortality rate.*
3. *Should the SSB fall below a reference point of 5 000 000 t ($\mathbf{B}_{pa}$), the fishing mortality rate, referred under paragraph 2, shall be adapted in the light of scientific estimates of the conditions to ensure a safe and rapid*

recovery of the SSB to a level in excess of 5 000 000 t. The basis for such an adaptation should be at least a linear reduction in the fishing mortality rate from 0.125 at $\boldsymbol{B_{pa}}$ (5 000 000 t) to 0.05 $\boldsymbol{B_{lim}}$ (2 500 000 t).

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

ICES considers that the objectives of this agreement are consistent with the precautionary approach.

Table 3.2.1.1 Catches of Norwegian spring-spawning herring (tonnes) since 1972.

Year	A	B[1]	C	D	Total	Total catch used in WG
1972	-	9895	3,266[2]	-	13,161	13,161
1973	139	6,602	276	-	7,017	7,017
1974	906	6,093	620	-	7,619	7,619
1975	53	3,372	288	-	3,713	13,713
1976	-	247	189	-	436	10,436
1977	374	11,834	498	-	12,706	22,706
1978	484	9,151	189	-	9,824	19,824
1979	691	1,866	307	-	2,864	12,864
1980	878	7,634	65	-	8,577	18,577
1981	844	7,814	78	-	8,736	13,736
1982	983	10,447	225	-	11,655	16,655
1983	3,857	13,290	907	-	18,054	23,054
1984	18,730	29,463	339	-	48,532	53,532
1985	29,363	37,187	197	4,300	71,047	169,872
1986	71,122[3]	55,507	156	-	126,785	225,256
1987	62,910	49,798	181	-	112,899	127,306
1988	78,592	46,582	127	-	125,301	135,301
1989	52,003	41,770	57	-	93,830	103,830
1990	48,633	29,770	8	-	78,411	86,411
1991	48,353	31,280	50	-	79,683	84,683
1992	43,688	55,737	23	-	99,448	104,448
1993	117,195	110,212	50	-	227,457	232,457
1994	288,581	190,643	4	-	479,228	479,228
1995	320,731	581,495	0	-	902,226	902,226
1996	462,248	758,035	0	-	1,220,283	1,220,283
1997[5]			0	-	1,426,507	1,426,507
1998[5]			0	-	1,223,131	1,223,131
1999[6]			0	-	1,235,433	1,235,433
2000[7]			0	-	1,207,201	1,207,201
2001[8]			0	-	770,066	770,066
2002[9]			0	-	806,086	806,086

A = catches of adult herring in winter
B = mixed herring fishery in remaining part of the year
C = by-catches of 0- and 1-group herring in the sprat fishery
D = USSR-Norway by-catch in the capelin fishery (2-group)

1 Includes also by-catches of adult herring in other fisheries
2 In 1972, there was also a directed herring 0-group fishery
3 Includes 26,000 t of immature herring (1983 year class) fished by USSR in the Barents Sea
4 Preliminary, as provided by Working Group members
5 Details of catches by fishery and ICES area given in ICES 1999
6 Details of catches by fishery and ICES area given in ICES 2000
7 Details of catches by fishery and ICES area given in ICES 2001
8 Details of catches by fishery and ICES area given in ICES 2002
9 Details of catches by fishery and ICES area given in Tables 3.2.1.3-3.2.1.5

Table 3.2.1.2 Total catch of Norwegian spring-spawning herring (tonnes) since 1972. Data provided by Working Group members.

Year	Norway	USSR/ Russia	Denmark	Faroes	Iceland	Ireland	Nether- lands	Greenland	UK	Germany	France	Poland	Sweden	Total
1972	13,161	-	-	-	-	-	-	-	-	-	-	-	-	13,161
1973	7,017	-	-	-	-	-	-	-	-	-	-	-	-	7,017
1974	7,619	-	-	-	-	-	-	-	-	-	-	-	-	7,619
1975	13,713	-	-	-	-	-	-	-	-	-	-	-	-	13,713
1976	10,436	-	-	-	-	-	-	-	-	-	-	-	-	10,436
1977	22,706	-	-	-	-	-	-	-	-	-	-	-	-	22,706
1978	19,824	-	-	-	-	-	-	-	-	-	-	-	-	19,824
1979	12,864	-	-	-	-	-	-	-	-	-	-	-	-	12,864
1980	18,577	-	-	-	-	-	-	-	-	-	-	-	-	18,577
1981	13,736	-	-	-	-	-	-	-	-	-	-	-	-	13,736
1982	16,655	-	-	-	-	-	-	-	-	-	-	-	-	16,655
1983	23,054	-	-	-	-	-	-	-	-	-	-	-	-	23,054
1984	53,532	-	-	-	-	-	-	-	-	-	-	-	-	53,532
1985	167,272	2,600	-	-	-	-	-	-	-	-	-	-	-	169,872
1986	199,256	26,000	-	-	-	-	-	-	-	-	-	-	-	225,256
1987	108,417	18,889	-	-	-	-	-	-	-	-	-	-	-	127,306
1988	115,076	20,225	-	-	-	-	-	-	-	-	-	-	-	135,301
1989	88,707	15,123	-	-	-	-	-	-	-	-	-	-	-	103,830
1990	74,604	11,807	-	-	-	-	-	-	-	-	-	-	-	86,411
1991	73,683	11,000	-	-	-	-	-	-	-	-	-	-	-	84,683
1992	91,111	13,337	-	-	-	-	-	-	-	-	-	-	-	104,448
1993	199,771	32,645	-	-	-	-	-	-	-	-	-	-	-	232,457
1994	380,771	74,400	-	2,911	21,146	-	-	-	-	-	-	-	-	479,228
1995	529,838	101,987	30,577	57,084	174,109	-	7,969	2,500	881	556	-	-	-	905,501
1996	699,161	119,290	60,681	52,788	164,957	19,541	19,664	-	46,131	11,978	-	-	22,424	1,220,283
1997	860,963	168,900	44,292	59,987	220,154	11,179	8,694	-	25,149	6,190	1,500	-	19,499	1,426,507
1998	743,925	124,049	35,519	68,136	197,789	2,437	12,827	-	15,9711	7,003	605	-	14,863	1,223,131
1999	740,640	157,328	37,010	55,527	203,381	2,412	5,871	-	9,207	-	-	-	14,057	1,235,433
2000	713,500	163,261	34,968	68,625	186,035	8,939	-	-	14,096	3,298	-	-	14,749	1,207,201
2001	495,036	109,054	24,038	34,170	77,693	-	6,439	-	12,230	1,588	-	-	9,818	770,066
2002[1]	487,233	113,763	18,998	32,302	127,197	-	9,392	-	3,482	3,017	-	1,226	9,486	806,086

[1] Preliminary, as provided by Working Group members.

Table 3.2.1.3. Catch-at-age by country.

Record No	Country	Quarter	Area	Sampled Catch	Official Catch	WG Catch	No. of samples	No. fish aged	No. fish measured	CN 0	CN 1	CN 2	CN 3	CN 4	CN 5	CN 6	CN 7	CN 8	CN 9	CN 10	CN 11	CN 12	CN 13	CN 14	CN 15+
NSSH	0	15	2002																						
1	Norway	1	IIa	186489	186489	186489	19	1494	1764	0	0	6110	9776	102652	62324	139313	2444	18331	57436	173531	86765	14665	3666	2444	1222
2	Norway	2	IIa	2928	2928	2928	15	1069	1209	0	0	1104	3044	4800	1090	510	184	425	1034	1897	935	57	14	28	14
3	Norway	3	IIa	0	21295	21295	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	Norway	4	IIa	274406	274406	274406	18	1147	1725	0	0		19374	146048	68553	97614	7451	24590	78985	242172	130400	26825	5961	745	5961
5	Norway	1	IVa	0	1962	1962	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	Norway	2	IVa	0	143	143	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	Russia	1	IIa	17520	17520	17520	6	16	717	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	Russia	2	IIa	4865	4865	4865	3	51	243	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	Russia	3	IIa	82534	82534	82534	52	233	16803	0	0	360	9995	80198	31116	13196	4581	11219	26738	51546	29342	1741	564	1223	1019
10	Russia	4	IIa	0	3800	3800	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11	Russia	3	IIb	5044	5044	5044	9	0	2575	0	0	24	1136	6405	2072	805	224	518	1211	2347	1223	49	6	31	6
12	Denmark	1	IIa	0	6507	6507	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	Denmark	2	IIa	12491	12491	12491	4	249	249	0	0	0	0	0	0	2391	2221	5850	15843	14648	1196	512	0	0	0
14	Iceland	2	IIa	51333	51333	51333	3	112	112	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	Iceland	3	IIa	0	10972	10972	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	Iceland	2	IIb	60726	60726	60726	1	80	80	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17	Iceland	3	IIb	0	4166	4166	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	Sweden	2	IIa	0	9206	9206	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	Sweden	2	IIb	0	280	280	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	Germany	1	IIa	1303	1303	1303	33	429	12118	0	0	0	22	150	183	533	24	137	578	1868	1060	106	48	9	31
21	Germany	2	IIa	0	709	709	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22	Germany	2	IIb	0	1005	1005	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23	UK(Scot)	1	IIa	0	3482	3482	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24	Poland	3	IIa	0	1226	1226	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25	Faroes	1	IIa	0	7211	7211	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26	Faroes	2	IIa	0	9427	9427	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27	Faroes	3	IIa	0	9975	9975	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28	Faroes	4	IIa	0	2238	2238	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29	Faroes	2	IIb	0	2459	2459	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	Faroes	3	IIb	0	992	992	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31	Netherlands	2	IIa	9392	9392	9392	21	525	1737	0	0	42	1515	5793	5899	3264	929	1571	3711	6345	2645	158	17	76	32

Table 3.2.1.4. Weight (kg) at age by country.

Record No	Country	Quarter	Area	Sampled Catch	Official Catch	WG Catch	No. of samples	No. fish aged	No. fish measured	CW 0	CW 1	CW 2	CW 3	CW 4	CW 5	CW 6	CW 7	CW 8	CW 9	CW 10	CW 11	CW 12	CW 13	CW 14	CW 15+
NSSH	0	15	2002																						
1	Norway	1	IIa	186489	186489	186489	19	1494	1764	0	0	0,0801	0,133	0,17859	0,2286	0,26491	0,2412	0,30517	0,30718	0,31747	0,3263	0,35996	0,40286	0,291	0,425
2	Norway	2	IIa	2928	2928	2928	15	1069	1209	0	0	0,0526	0,116	0,1572	0,2372	0,2585	0,2867	0,2881	0,2893	0,2966	0,3155	0,3305	0,4	0,3455	0,406
3	Norway	3	IIa	0	21295	21295	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	Norway	4	IIa	274406	274406	274406	18	1147	1725	0	0	0	0,1853	0,2432	0,2802	0,3094	0,3162	0,3438	0,3431	0,3539	0,3585	0,3776	0,4104	0,399	0,4446
5	Norway	1	IVa	0	1962	1962	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	Norway	2	IVa	0	143	143	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	Russia	1	IIa	17520	17520	17520	6	16	717	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	Russia	2	IIa	4865	4865	4865	3	51	243	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	Russia	3	IIa	82534	82534	82534	52	233	16803	0	0	0,101	0,1677	0,2336	0,2814	0,3069	0,3348	0,34745	0,35035	0,3673	0,3804	0,38	0,41	0,1995	0,4183
10	Russia	4	IIa	0	3800	3800	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11	Russia	3	IIb	5044	5044	5044	9	0	2575	0	0	0,101	0,1677	0,2336	0,2814	0,3069	0,3348	0,34745	0,35035	0,3673	0,3804	0,38	0,41	0,1995	0,4183
12	Denmark	1	IIa	0	6507	6507	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	Denmark	2	IIa	12491	12491	12491	4	249	249	0	0	0	0	0	0	0,271	0,306	0,347	0,335	0,343	0,36	0,4	0	0	0
14	Iceland	2	IIa	51333	51333	51333	3	112	112	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	Iceland	3	IIa	0	10972	10972	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	Iceland	2	IIb	60726	60726	60726	1	80	80	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17	Iceland	3	IIb	0	4166	4166	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	Sweden	2	IIa	0	9206	9206	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	Sweden	2	IIb	0	280	280	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	Germany	1	IIa	1303	1303	1303	33	429	12118	0	0	0	0,133	0,17859	0,2286	0,26491	0,2412	0,30517	0,30718	0,31747	0,3263	0,35996	0,40286	0,291	0,425
21	Germany	2	IIa	0	709	709	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22	Germany	2	IIb	0	1005	1005	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23	UK(Scot)	1	IIa	0	3482	3482	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24	Poland	3	IIa	0	1226	1226	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25	Faroes	1	IIa	0	7211	7211	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26	Faroes	2	IIa	0	9427	9427	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27	Faroes	3	IIa	0	9975	9975	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28	Faroes	4	IIa	0	2238	2238	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29	Faroes	2	IIb	0	2459	2459	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	Faroes	3	IIb	0	992	992	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31	Netherlands	2	IIa	9392	9392	9392	21	525	1737	0	0	0,1297	0,1418	0,17497	0,24304	0,27819	0,3213	0,32029	0,289	0,297	0,316	0,331	0,4	0,346	0,406

Table 3.2.1.5

Summary of Sampling by Country

AREA : IVa

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
Norway	0.00	2105.00	0	0	0	0.00
Total IVa	0.00	2105.00	0	0	0	0.00

Sum of Offical Catches : 2105.00
Unallocated Catch : 0.00
Working Group Catch : 2105.00

AREA : IIb

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
Sweden	0.00	280.00	0	0	0	0.00
Russia	5044.00	5044.00	9	2575	0	90.32
Iceland	60726.00	64892.00	1	80	80	0.00
Germany	0.00	1005.00	0	0	0	0.00
Faroes	0.00	3451.00	0	0	0	0.00
Total IIb	65770.00	74672.00	10	2655	80	6.93

Sum of Offical Catches : 74672.00
Unallocated Catch : 0.00
Working Group Catch : 74672.00

AREA : IIa

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
UK(Scot)	0.00	3482.00	0	0	0	0.00
Sweden	0.00	9206.00	0	0	0	0.00
Russia	104919.00	108719.00	61	17763	300	75.97
Poland	0.00	1226.00	0	0	0	0.00
Norway	463823.00	485118.00	52	4698	3710	100.00
Netherlands	9392.00	9392.00	21	1737	525	88.04
Iceland	51333.00	62305.00	3	112	112	0.00
Germany	1303.00	2012.00	33	12118	429	111.29
Faroes	0.00	28851.00	0	0	0	0.00
Denmark	12491.00	18998.00	4	249	249	114.68
Total IIa	643261.00	729309.00	174	36677	5325	88.23

Sum of Offical Catches : 729309.00

Unallocated Catch : 0.00
Working Group Catch : 729309.00

Table 3.2.1.5 continued

PERIOD : 1

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
UK(Scot)	0.00	3482.00	0	0	0	0.00
Russia	17520.00	17520.00	6	717	16	0.00
Norway	186489.00	188451.00	19	1764	1494	100.00
Germany	1303.00	1303.00	33	12118	429	111.29
Faroes	0.00	7211.00	0	0	0	0.00
Denmark	0.00	6507.00	0	0	0	0.00
Period Total	205312.00	224474.00	58	14599	1939	91.54

Sum of Offical Catches : 224474.00
Unallocated Catch : 0.00
Working Group Catch : 224474.00

PERIOD : 2

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
Sweden	0.00	9486.00	0	0	0	0.00
Russia	4865.00	4865.00	3	243	51	0.00
Norway	2928.00	3071.00	15	1209	1069	100.00
Netherlands	9392.00	9392.00	21	1737	525	88.04
Iceland	112059.00	112059.00	4	192	192	0.00
Germany	0.00	1714.00	0	0	0	0.00
Faroes	0.00	11886.00	0	0	0	0.00
Denmark	12491.00	12491.00	4	249	249	114.68
Period Total	141735.00	164964.00	47	3630	2086	18.01

Sum of Offical Catches : 164964.00
Unallocated Catch : 0.00
Working Group Catch : 164964.00

PERIOD : 3

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
Russia	87578.00	87578.00	61	19378	233	96.22
Poland	0.00	1226.00	0	0	0	0.00
Norway	0.00	21295.00	0	0	0	0.00
Iceland	0.00	15138.00	0	0	0	0.00
Faroes	0.00	10967.00	0	0	0	0.00
Period Total	87578.00	136204.00	61	19378	233	96.22

Sum of Offical Catches : 136204.00
Unallocated Catch : 0.00
Working Group Catch : 136204.00

PERIOD : 4

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
Russia	0.00	3800.00	0	0	0	0.00
Norway	274406.00	274406.00	18	1725	1147	100.00
Faroes	0.00	2238.00	0	0	0	0.00
Period Total	274406.00	280444.00	18	1725	1147	100.00

Sum of Offical Catches : 280444.00
Unallocated Catch : 0.00
Working Group Catch : 280444.00

Table 3.2.1.5 continued

Total over all Areas and Periods

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
UK(Scot)	0.00	3482.00	0	0	0	0.00
Sweden	0.00	9486.00	0	0	0	0.00
Russia	109963.00	113763.00	70	20338	300	76.63
Poland	0.00	1226.00	0	0	0	0.00
Norway	463823.00	487223.00	52	4698	3710	100.00
Netherlands	9392.00	9392.00	21	1737	525	88.04
Iceland	112059.00	127197.00	4	192	192	0.00
Germany	1303.00	3017.00	33	12118	429	111.29
Faroes	0.00	32302.00	0	0	0	0.00
Denmark	12491.00	18998.00	4	249	249	114.68
Total for Stock	709031.00	806086.00	184	39332	5405	80.69

```
Sum of Offical Catches :      806086.00
Unallocated Catch :                0.00
Working Group Catch :         806086.00
```

DETAILS OF DATA FILLING-IN

```
  Filling-in for record : (  3)   Norway                 3 IIa
Using Only
  >>  (  4)  Norway                 4 IIa
  Filling-in for record : (  5)   Norway                 1 IVa
Using Only
  >>  (  1)  Norway                 1 IIa
  Filling-in for record : (  6)   Norway                 2 IVa
Using Only
  >>  (  2)  Norway                 2 IIa
  Filling-in for record : (  7)   Russia                 1 IIa
Using Only
  >>  (  1)  Norway                 1 IIa
  Filling-in for record : (  8)   Russia                 2 IIa
Using Only
  >>  (  2)  Norway                 2 IIa
  Filling-in for record : ( 10)   Russia                 4 IIa
Using Only
  >>  (  9)  Russia                 3 IIa
  Filling-in for record : ( 12)   Denmark                1 IIa
Using Only
  >>  (  1)  Norway                 1 IIa
  Filling-in for record : ( 14)   Iceland                2 IIa
Using Only
  >>  (  2)  Norway                 2 IIa
  Filling-in for record : ( 15)   Iceland                3 IIa
Using Only
  >>  (  9)  Russia                 3 IIa
  Filling-in for record : ( 16)   Iceland                2 IIb
Using Only
  >>  (  2)  Norway                 2 IIa
  Filling-in for record : ( 17)   Iceland                3 IIb
Using Only
  >>  (  9)  Russia                 3 IIa
  Filling-in for record : ( 18)   Sweden                 2 IIa
Using Only
  >>  (  2)  Norway                 2 IIa
  Filling-in for record : ( 19)   Sweden                 2 IIb
Using Only
  >>  (  2)  Norway                 2 IIa
  Filling-in for record : ( 20)   Germany                1 IIa
Using Only
  >>  (  1)  Norway                 1 IIa
  Filling-in for record : ( 21)   Germany                2 IIa
Using Only
  >>  (  2)  Norway                 2 IIa
  Filling-in for record : ( 22)   Germany                2 IIb
Using Only
  >>  (  2)  Norway                 2 IIa
  Filling-in for record : ( 23)   UK(Scot)               1 IIa
Using Only
  >>  (  1)  Norway                 1 IIa
```

Table 3.2.1.5 continued

```
  Filling-in for record : ( 24)   Poland                     3 IIa
Using Only
  >>  (  9)  Russia                3 IIa
  Filling-in for record : ( 25)   Faroes                     1 IIa
Using Only
  >>  (  1)  Norway                1 IIa
  Filling-in for record : ( 26)   Faroes                     2 IIa
Using Only
  >>  (  2)  Norway                2 IIa
  Filling-in for record : ( 27)   Faroes                     3 IIa
Using Only
  >>  (  9)  Russia                3 IIa
  Filling-in for record : ( 28)   Faroes                     4 IIa
Using Only
  >>  (  9)  Russia                3 IIa
  Filling-in for record : ( 29)   Faroes                     2 IIb
Using Only
  >>  (  2)  Norway                2 IIa
  Filling-in for record : ( 30)   Faroes                     3 IIb
Using Only
  >>  (  9)  Russia                3 IIa
```

Catch Numbers at Age by Area

Ages	IVa	IIb	IIa	Total
0	0.00	0.00	0.00	0.00
1	0.00	0.00	0.00	0.00
2	118.20	24354.86	37401.58	61874.64
3	251.52	68784.79	129044.98	198081.30
4	1314.40	117105.53	521902.22	640322.19
5	708.93	28016.71	225097.64	253823.28
6	1490.58	12859.10	308441.63	322791.31
7	34.70	4561.69	25173.21	29769.59
8	213.61	10576.97	82234.61	93025.19
9	654.77	25649.07	236786.81	263090.66
10	1918.32	47337.37	609012.50	658268.19
11	958.50	23643.99	312314.06	336916.56
12	157.07	1412.86	50938.13	52508.05
13	39.25	349.51	11946.71	12335.47
14	27.08	723.95	6186.32	6937.35
15	13.54	377.94	9656.14	10047.62

Mean Weight-at-age by Area (Kg)

Ages	IVa	IIb	IIa	Total
0	0.0000	0.0000	0.0000	0.0000
1	0.0000	0.0000	0.0000	0.0000
2	0.0675	0.0527	0.0587	0.0563
3	0.1230	0.1173	0.1344	0.1285
4	0.1748	0.1646	0.2041	0.1968
5	0.2292	0.2435	0.2568	0.2553
6	0.2648	0.2646	0.2824	0.2816
7	0.2530	0.2921	0.3056	0.3034
8	0.3035	0.2949	0.3263	0.3226
9	0.3058	0.2962	0.3261	0.3231
10	0.3165	0.3049	0.3374	0.3350
11	0.3258	0.3239	0.3468	0.3451
12	0.3594	0.3360	0.3703	0.3694
13	0.4028	0.4012	0.4073	0.4071
14	0.2938	0.3238	0.2880	0.2918
15	0.4240	0.4083	0.4363	0.4352

Table 3.2.1.6 Norwegian spring spawning herring. Catch at age in numbers (in millions).

year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16+
1950	5113	2000	600	276	185	19	547	629	80	89	110	87	194	368	66	107	237
1951	1636	7608	400	7	384	172	164	516	602	77	83	103	108	254	348	47	305
1952	13722	9150	1233	39	60	602	136	204	380	378	79	86	108	107	186	256	308
1953	5697	5055	581	740	47	101	356	82	111	314	395	62	91	94	99	216	515
1954	10676	7071	855	266	1436	143	236	490	128	200	440	461	88	101	133	127	676
1955	5176	2871	510	93	276	2045	114	190	275	85	193	296	203	59	85	104	477
1956	5364	2024	627	116	252	314	2555	110	204	264	131	198	273	163	63	89	476
1957	5002	3291	220	23	373	154	228	1985	72	127	182	88	121	149	132	34	248
1958	9667	2798	666	18	18	111	89	194	974	71	123	201	99	77	71	69	186
1959	17896	1985	326	15	27	26	147	115	241	1104	89	124	198	88	77	85	151
1960	12884	13581	392	122	18	28	24	96	73	204	1163	85	130	154	57	47	122
1961	6208	16076	2885	31	8	4	15	19	62	49	14	728	50	45	63	22	38
1962	3693	4081	1041	1844	8	3	7	20	12	59	53	117	814	44	55	66	87
1963	4807	2119	2045	760	836	5	2	4	18	9	108	92	174	924	80	60	125
1964	3613	2728	220	115	399	2046	14	2	3	25	29	96	82	153	773	46	291
1965	2303	3781	2854	90	256	571	2200	20	15	7	19	40	100	108	139	704	179
1966	3926	663	1678	2049	27	467	1306	2884	38	14	17	26	11	69	72	97	460
1967	427	9877	70	1392	3254	27	421	1132	1721	9	6	4	8	9	18	14	90
1968	1784	437	388	99	1880	1387	14	94	134	345	2	1	1	2	3	2	15
1969	561	507	142	188	1	9	5	1	12	34	36	0	0	0	0	0	2
1970	119	529	33	6	19	1	3	3	1	13	26	28	0	0	0	0	2
1971	30	43	85	2	1	1	0	1	1	0	4	7	5	0	0	0	0
1972	347	41	20	35	3	4	2	1	1	0	0	0	1	1	0	0	0
1973	29	4	2	2	25	1	2	0	0	0	0	0	0	0	0	0	0
1974	66	8	4	0	0	25	0	0	0	0	0	0	0	0	0	0	0
1975	31	4	2	3	0	1	31	0	0	0	0	0	0	0	0	0	0
1976	20	2	1	23	5	0	0	13	0	0	0	0	0	0	0	0	0
1977	43	6	3	22	24	0	0	0	11	0	0	0	0	0	0	0	0
1978	20	2	1	3	12	20	1	0	1	5	0	0	0	0	0	0	0
1979	33	4	2	6	2	7	11	0	0	0	3	0	0	0	0	0	0
1980	7	1	0	6	6	2	8	16	0	0	0	3	0	0	0	0	0
1981	8	1	12	4	5	9	2	5	8	0	0	0	1	0	0	0	0
1982	23	1	0	14	8	5	6	2	5	6	0	0	0	0	0	0	0
1983	127	5	2	3	21	10	6	7	1	5	7	0	0	0	1	0	0
1984	34	2	2	4	5	62	18	13	16	7	16	6	0	0	0	2	0
1985	29	13	207	22	16	16	130	59	55	63	10	31	50	0	0	0	3
1986	14	1	3	540	18	14	16	105	75	42	77	19	66	80	0	0	2
1987	14	6	36	20	501	19	4	7	28	12	10	4	8	6	7	0	0
1988	15	3	9	63	25	550	9	4	6	15	9	3	3	3	2	1	0
1989	7	2	25	3	4	6	324	3	1	1	3	1	1	0	0	0	0
1990	1	0	16	19	3	12	11	226	1	2	2	2	1	0	1	0	0
1991	0	3	3	8	3	1	15	9	219	2	0	0	1	0	0	1	0
1992	2	0	1	13	33	5	1	12	6	226	2	1	0	1	0	0	0
1993	7	0	7	28	107	87	9	4	30	19	410	0	0	0	0	0	0
1994	0	0	8	33	110	364	165	16	8	37	36	645	3	0	0	2	0
1995	0	0	1	58	346	623	638	231	16	16	70	84	912	4	0	0	0
1996	0	0	30	34	714	1571	941	406	103	6	7	66	18	837	0	0	0
1997	0	0	22	130	271	1796	1994	761	326	61	20	32	91	19	370	0	0
1998	0	0	83	70	242	368	1760	1264	381	130	43	25	3	113	6	109	0
1999	0	0	5	138	36	135	429	1605	1164	291	106	15	40	7	89	0	64
2000	0	0	14	84	560	35	111	404	1299	1045	217	72	16	23	23	34	37
2001	0	0	2	102	161	427	39	96	296	839	507	74	24	4	3	0	22
2002	0	0	63	198	643	256	326	30	94	265	663	339	53	12	7	0	10

Table 3.2.2.1 Norwegian spring spawning herring. Stock weights at age (in kg)

year	0	1	2	3	4	5	6	7	8	9	10	11	12	13
1950	0.001	0.008	0.047	0.1	0.204	0.23	0.255	0.275	0.29	0.305	0.315	0.325	0.33	0.34
1951	0.001	0.008	0.047	0.1	0.204	0.23	0.255	0.275	0.29	0.305	0.315	0.325	0.33	0.34
1952	0.001	0.008	0.047	0.1	0.204	0.23	0.255	0.275	0.29	0.305	0.315	0.325	0.33	0.34
1953	0.001	0.008	0.047	0.1	0.204	0.23	0.255	0.275	0.29	0.305	0.315	0.325	0.33	0.34
1954	0.001	0.008	0.047	0.1	0.204	0.23	0.255	0.275	0.29	0.305	0.315	0.325	0.33	0.34
1955	0.001	0.008	0.047	0.1	0.195	0.213	0.26	0.275	0.29	0.305	0.315	0.325	0.33	0.34
1956	0.001	0.008	0.047	0.1	0.205	0.23	0.249	0.275	0.29	0.305	0.315	0.325	0.33	0.34
1957	0.001	0.008	0.047	0.1	0.136	0.228	0.255	0.262	0.29	0.305	0.315	0.325	0.33	0.34
1958	0.001	0.008	0.047	0.1	0.204	0.242	0.292	0.295	0.293	0.305	0.315	0.33	0.34	0.345
1959	0.001	0.008	0.047	0.1	0.204	0.252	0.26	0.29	0.3	0.305	0.315	0.325	0.33	0.34
1960	0.001	0.008	0.047	0.1	0.204	0.27	0.291	0.293	0.321	0.318	0.32	0.344	0.349	0.37
1961	0.001	0.008	0.047	0.1	0.232	0.25	0.292	0.302	0.304	0.323	0.322	0.321	0.344	0.357
1962	0.001	0.008	0.047	0.1	0.219	0.291	0.3	0.316	0.324	0.326	0.335	0.338	0.334	0.347
1963	0.001	0.008	0.047	0.1	0.185	0.253	0.294	0.312	0.329	0.327	0.334	0.341	0.349	0.341
1964	0.001	0.008	0.047	0.1	0.194	0.213	0.264	0.317	0.363	0.353	0.349	0.354	0.357	0.359
1965	0.001	0.008	0.047	0.1	0.186	0.199	0.236	0.26	0.363	0.35	0.37	0.36	0.378	0.387
1966	0.001	0.008	0.047	0.1	0.185	0.219	0.222	0.249	0.306	0.354	0.377	0.391	0.379	0.378
1967	0.001	0.008	0.047	0.1	0.18	0.228	0.269	0.27	0.294	0.324	0.42	0.43	0.366	0.368
1968	0.001	0.008	0.047	0.1	0.115	0.206	0.266	0.275	0.274	0.285	0.35	0.325	0.363	0.408
1969	0.001	0.008	0.047	0.1	0.115	0.145	0.27	0.3	0.306	0.308	0.318	0.34	0.368	0.36
1970	0.001	0.008	0.047	0.1	0.209	0.272	0.23	0.295	0.317	0.323	0.325	0.329	0.38	0.37
1971	0.001	0.015	0.08	0.1	0.19	0.225	0.25	0.275	0.29	0.31	0.325	0.335	0.345	0.355
1972	0.001	0.01	0.07	0.15	0.15	0.14	0.21	0.24	0.27	0.3	0.325	0.335	0.345	0.355
1973	0.001	0.01	0.085	0.17	0.259	0.342	0.384	0.409	0.404	0.461	0.52	0.534	0.5	0.5
1974	0.001	0.01	0.085	0.17	0.259	0.342	0.384	0.409	0.444	0.461	0.52	0.543	0.482	0.482
1975	0.001	0.01	0.085	0.181	0.259	0.342	0.384	0.409	0.444	0.461	0.52	0.543	0.482	0.482
1976	0.001	0.01	0.085	0.181	0.259	0.342	0.384	0.409	0.444	0.461	0.52	0.543	0.482	0.482
1977	0.001	0.01	0.085	0.181	0.259	0.343	0.384	0.409	0.444	0.461	0.52	0.543	0.482	0.482
1978	0.001	0.01	0.085	0.18	0.294	0.326	0.371	0.409	0.461	0.476	0.52	0.543	0.5	0.5
1979	0.001	0.01	0.085	0.178	0.232	0.359	0.385	0.42	0.444	0.505	0.52	0.551	0.5	0.5
1980	0.001	0.01	0.085	0.175	0.283	0.347	0.402	0.421	0.465	0.465	0.52	0.534	0.5	0.5
1981	0.001	0.01	0.085	0.17	0.224	0.336	0.378	0.387	0.408	0.397	0.52	0.543	0.512	0.512
1982	0.001	0.01	0.085	0.17	0.204	0.303	0.355	0.383	0.395	0.413	0.453	0.468	0.506	0.506
1983	0.001	0.01	0.085	0.155	0.249	0.304	0.368	0.404	0.424	0.437	0.436	0.493	0.495	0.495
1984	0.001	0.01	0.085	0.14	0.204	0.295	0.338	0.376	0.395	0.407	0.413	0.422	0.437	0.437
1985	0.001	0.01	0.023	0.148	0.234	0.265	0.312	0.346	0.37	0.395	0.397	0.428	0.428	0.428
1986	0.001	0.01	0.085	0.054	0.206	0.265	0.289	0.339	0.368	0.391	0.382	0.388	0.395	0.395
1987	0.001	0.01	0.055	0.09	0.143	0.241	0.279	0.299	0.316	0.342	0.343	0.362	0.376	0.376
1988	0.001	0.015	0.05	0.098	0.135	0.197	0.277	0.315	0.339	0.343	0.359	0.365	0.376	0.376
1989	0.001	0.015	0.1	0.154	0.175	0.209	0.252	0.305	0.367	0.377	0.359	0.395	0.396	0.396
1990	0.001	0.008	0.048	0.219	0.198	0.258	0.288	0.309	0.428	0.37	0.403	0.387	0.44	0.44
1991	0.001	0.011	0.037	0.147	0.21	0.244	0.3	0.324	0.336	0.343	0.382	0.366	0.425	0.425
1992	0.001	0.007	0.03	0.128	0.224	0.296	0.327	0.355	0.345	0.367	0.341	0.361	0.43	0.47
1993	0.001	0.008	0.025	0.081	0.201	0.265	0.323	0.354	0.358	0.381	0.369	0.396	0.393	0.374
1994	0.001	0.01	0.025	0.075	0.151	0.254	0.318	0.371	0.347	0.412	0.382	0.407	0.41	0.41
1995	0.001	0.018	0.025	0.066	0.138	0.23	0.296	0.346	0.388	0.363	0.409	0.414	0.422	0.41
1996	0.001	0.018	0.025	0.076	0.118	0.188	0.261	0.316	0.346	0.374	0.39	0.39	0.384	0.398
1997	0.001	0.018	0.025	0.096	0.118	0.174	0.229	0.286	0.323	0.37	0.378	0.386	0.36	0.393
1998	0.001	0.018	0.025	0.074	0.147	0.174	0.217	0.242	0.278	0.304	0.31	0.359	0.34	0.344
1999	0.001	0.018	0.025	0.102	0.15	0.223	0.24	0.264	0.283	0.315	0.345	0.386	0.386	0.386
2000	0.001	0.018	0.025	0.102	0.15	0.223	0.24	0.264	0.283	0.315	0.345	0.386	0.386	0.386
2001	0.001	0.018	0.025	0.075	0.178	0.238	0.247	0.296	0.307	0.314	0.328	0.351	0.376	0.406
2002	0.001	0.018	0.054	0.098	0.159	0.211	0.272	0.305	0.314	0.331	0.337	0.346	0.356	0.381

Table 3.2.2.2 Norwegian spring spawning herring. Catch weight at age (in kg).

year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16+
1950	0.007	0.025	0.058	0.11	0.188	0.211	0.234	0.253	0.266	0.28	0.294	0.303	0.312	0.32	0.323	0.331	0.335
1951	0.009	0.029	0.068	0.13	0.222	0.249	0.276	0.298	0.314	0.33	0.346	0.357	0.368	0.377	0.381	0.39	0.395
1952	0.008	0.026	0.061	0.115	0.197	0.221	0.245	0.265	0.279	0.293	0.308	0.317	0.327	0.335	0.339	0.346	0.351
1953	0.008	0.027	0.063	0.12	0.205	0.23	0.255	0.275	0.29	0.305	0.32	0.33	0.34	0.347	0.351	0.359	0.364
1954	0.008	0.026	0.062	0.117	0.201	0.225	0.25	0.269	0.284	0.299	0.313	0.323	0.333	0.341	0.345	0.352	0.357
1955	0.008	0.027	0.063	0.119	0.204	0.229	0.254	0.274	0.289	0.304	0.318	0.328	0.338	0.346	0.35	0.358	0.363
1956	0.008	0.028	0.066	0.126	0.215	0.241	0.268	0.289	0.304	0.32	0.336	0.346	0.357	0.365	0.369	0.378	0.383
1957	0.008	0.028	0.066	0.127	0.216	0.243	0.269	0.29	0.306	0.322	0.338	0.348	0.359	0.367	0.371	0.38	0.385
1958	0.009	0.03	0.07	0.133	0.227	0.255	0.283	0.305	0.321	0.338	0.355	0.366	0.377	0.386	0.39	0.399	0.404
1959	0.009	0.03	0.071	0.135	0.231	0.259	0.287	0.31	0.327	0.344	0.36	0.372	0.383	0.392	0.397	0.406	0.411
1960	0.006	0.011	0.074	0.119	0.188	0.277	0.337	0.318	0.363	0.379	0.36	0.42	0.411	0.439	0.45	0.444	0.448
1961	0.006	0.01	0.045	0.087	0.159	0.276	0.322	0.372	0.363	0.393	0.407	0.397	0.422	0.447	0.465	0.452	0.452
1962	0.009	0.023	0.055	0.085	0.148	0.288	0.333	0.36	0.352	0.35	0.374	0.384	0.374	0.394	0.399	0.411	0.416
1963	0.008	0.026	0.047	0.098	0.171	0.275	0.268	0.323	0.329	0.336	0.341	0.358	0.385	0.353	0.381	0.386	0.386
1964	0.009	0.024	0.059	0.139	0.219	0.239	0.298	0.295	0.339	0.35	0.358	0.351	0.367	0.375	0.372	0.427	0.434
1965	0.009	0.016	0.048	0.089	0.217	0.234	0.262	0.331	0.36	0.367	0.386	0.395	0.393	0.404	0.401	0.429	0.437
1966	0.008	0.017	0.04	0.063	0.246	0.26	0.265	0.301	0.41	0.425	0.456	0.46	0.467	0.446	0.459	0.465	0.474
1967	0.009	0.015	0.036	0.066	0.093	0.305	0.305	0.31	0.333	0.359	0.413	0.446	0.401	0.408	0.439	0.427	0.431
1968	0.01	0.027	0.049	0.075	0.108	0.158	0.375	0.383	0.364	0.382	0.441	0.41	0.442	0.517	0.491	0.464	0.487
1969	0.009	0.021	0.047	0.072	0.105	0.152	0.296	0.376	0.329	0.329	0.341	0.363	0.385	0.377	0.451	0.423	0.429
1970	0.008	0.058	0.085	0.105	0.171	0.256	0.216	0.277	0.298	0.304	0.305	0.309	0.357	0.348	0.357	0.367	0.376
1971	0.011	0.053	0.121	0.177	0.216	0.25	0.277	0.305	0.333	0.353	0.366	0.377	0.388	0.399	0.419	0.444	0.444
1972	0.011	0.029	0.062	0.103	0.154	0.215	0.258	0.295	0.322	0.341	0.354	0.365	0.376	0.387	0.406	0.43	0.43
1973	0.006	0.053	0.106	0.161	0.213	0.239	0.255	0.277	0.287	0.324	0.338	0.257	0.257	0.257	0.257	0.257	0.257
1974	0.006	0.055	0.117	0.168	0.222	0.249	0.265	0.288	0.299	0.337	0.352	0.267	0.324	0.324	0.324	0.324	0.324
1975	0.009	0.079	0.169	0.241	0.318	0.358	0.381	0.413	0.429	0.484	0.506	0.384	0.466	0.466	0.466	0.466	0.466
1976	0.007	0.062	0.132	0.189	0.25	0.28	0.298	0.323	0.336	0.379	0.396	0.3	0.364	0.364	0.364	0.364	0.364
1977	0.011	0.091	0.193	0.316	0.35	0.398	0.439	0.495	0.511	0.558	0.583	0.537	0.537	0.537	0.537	0.537	0.537
1978	0.012	0.1	0.21	0.274	0.424	0.454	0.495	0.524	0.596	0.613	0.65	0.59	0.59	0.59	0.59	0.59	0.59
1979	0.01	0.088	0.181	0.293	0.359	0.416	0.436	0.482	0.482	0.539	0.553	0.518	0.518	0.518	0.518	0.518	0.518
1980	0.012	0.101	0.202	0.266	0.399	0.449	0.46	0.485	0.472	0.618	0.645	0.608	0.594	0.594	0.594	0.594	0.594
1981	0.01	0.082	0.163	0.196	0.291	0.341	0.368	0.38	0.397	0.436	0.45	0.492	0.481	0.481	0.481	0.481	0.481
1982	0.01	0.087	0.159	0.256	0.312	0.378	0.415	0.435	0.449	0.448	0.506	0.493	0.499	0.499	0.499	0.499	0.499
1983	0.011	0.09	0.165	0.217	0.265	0.337	0.378	0.41	0.426	0.435	0.444	0.468	0.461	0.461	0.461	0.461	0.461
1984	0.009	0.047	0.145	0.218	0.262	0.325	0.346	0.381	0.4	0.413	0.405	0.426	0.415	0.415	0.415	0.415	0.415
1985	0.009	0.022	0.022	0.214	0.277	0.295	0.338	0.36	0.381	0.397	0.409	0.417	0.435	0.435	0.435	0.435	0.435
1986	0.007	0.077	0.097	0.055	0.249	0.294	0.312	0.352	0.374	0.398	0.402	0.401	0.41	0.41	0.41	0.41	0.41
1987	0.01	0.075	0.091	0.124	0.173	0.253	0.232	0.312	0.328	0.349	0.353	0.37	0.385	0.385	0.385	0.385	0.385
1988	0.008	0.062	0.075	0.124	0.154	0.194	0.241	0.265	0.304	0.305	0.317	0.308	0.334	0.334	0.334	0.334	0.334
1989	0.01	0.06	0.204	0.188	0.264	0.26	0.282	0.306	0.309	0.391	0.422	0.364	0.429	0.429	0.429	0.429	0.429
1990	0.007	0.078	0.102	0.23	0.239	0.266	0.305	0.308	0.376	0.407	0.412	0.424	0.428	0.428	0.428	0.428	0.428
1991	0.007	0.015	0.104	0.208	0.25	0.288	0.312	0.316	0.33	0.344	0.372	0.354	0.398	0.398	0.398	0.398	0.398
1992	0.007	0.075	0.103	0.191	0.233	0.304	0.337	0.365	0.361	0.371	0.403	0.365	0.394	0.404	0.406	0.408	0.41
1993	0.007	0.03	0.106	0.153	0.243	0.282	0.32	0.33	0.365	0.373	0.379	0.38	0.385	0.39	0.395	0.4	0.405
1994	0.007	0.063	0.102	0.194	0.239	0.28	0.317	0.328	0.356	0.372	0.39	0.379	0.399	0.403	0.405	0.407	0.405
1995	0.007	0.063	0.102	0.153	0.192	0.234	0.283	0.328	0.349	0.356	0.374	0.366	0.393	0.387	0.4	0.4	0.4
1996	0.007	0.063	0.136	0.136	0.168	0.206	0.262	0.309	0.337	0.366	0.36	0.361	0.367	0.379	0.379	0.379	0.379
1997	0.007	0.063	0.089	0.167	0.184	0.207	0.232	0.277	0.305	0.331	0.328	0.344	0.343	0.397	0.357	0.51	0.51
1998	0.007	0.063	0.111	0.15	0.216	0.221	0.249	0.277	0.316	0.338	0.374	0.372	0.366	0.396	0.377	0.406	0.406
1999	0.007	0.063	0.096	0.173	0.228	0.262	0.274	0.292	0.307	0.335	0.362	0.371	0.399	0.396	0.4	0.4	0.404
2000	0.007	0.063	0.124	0.175	0.222	0.242	0.289	0.303	0.31	0.328	0.349	0.383	0.411	0.41	0.419	0.409	0.409
2001	0.007	0.063	0.105	0.166	0.214	0.252	0.268	0.305	0.308	0.322	0.337	0.363	0.353	0.378	0.4	0.427	0.427
2002	0.007	0.063	0.056	0.128	0.198	0.255	0.281	0.303	0.322	0.323	0.334	0.345	0.369	0.407	0.41	0.435	0.435

Table 3.2.3.1 Norwegian Spring-spawning herring. Estimates from the acoustic surveys on the spawning stock in February-March. Numbers in millions.

Year	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
Age													
2		101	183	44			16		407			106	1516
3	255	5	187	59			128	1792	231			1366	690
4	146	373	0	54			676	7621	7638		381	337	1996
5	6805	103	345	12			1375	3807	11243		1905	1286	164
6	202	5402	112	354			476	2151	2586		10640	2979	592
7		182	4489	122			63	322	957		6708	11791	1997
8			146	4148			13	20	471		1280	7534	7714
9				102			140	1	0		434	1912	4240
10							35	124	0		130	568	553
11							1820	63	165		39	132	71
12								2573	0		0	0	3
13									2024		175	0	0
14											0	392	6
15+											804	437	361
Total	7408	6166	5462	4895	-	-	4742	18474	25756	-	22496	28840	19903

In 1992, 1993 and 1997 there was no estimate due to poor weather conditions.
No surveys have been conducted after 2000.

Table 3.2.3.2 Norwegian Spring-spawning herring. Estimates obtained on the acoustic surveys in the wintering areas in November-December. Numbers in millions.

Year	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002***
Age											
1		72		380		9	65	74	56	362	7
2	36	1518	16	183	1465	73	1207	159	322	522	50
3	1247	2389	3708	5133	3008	661	441	2425	1522	3916	276
4	1317	3287	4124	5274	13180	1480	1833	296	5260	1528	1659
5	173	1267	2593	1839	5637	6110	3869	837	165	2615	624
6	16	13	1096	1040	994	4458	12052	2066	497	82	1029
7	208	13	34	308	552	1843	8242	6601	1869	338	32
8	139	158	25	19	92	743	2068	4168	4785	864	188
9	3742	26	196	13	0	66	629	755	3635	3160	516
10	69	4435	29	111	7	0	111	212	668	2216	1831
11			3239	39	41	0	14	0	205	384	911
12				907	15	126	0	15	0	127	184
13					393	0	392	0	0	0	0
14+						842	221	146	168	18	0
Total	6947	13178	15209	15246	25384	16411	31144	17754	19152	16132	7345

*Much of the youngest yearclasses herring wintered outside the fjords this winter.

Table 3.2.3.3 Norwegian spring-spawning herring. Estimates from the international acoustic surveys on the feeding areas in the Norwegian Sea in May. Numbers in millions.

Year	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
Age							
3	4114	1169	367	2191	1353	8312	6343
4	22461	3599	1099	322	2783	1430	9619
5	13244	18867	4410	965	92	1463	1418
6	4916	13546	16378	3067	384	179	779
7	2045	2473	10160	11763	1302	204	375
8	424	1771	2059	6077	7194	3215	847
9	14	178	804	853	5344	5433	1941
10	7	77	183	258	1689	1220	2500
11	155	288	0	5	271	94	1423
12	0	415	0	14	0	178	61
13	3134	60	112	0	114	0	78
14		2472	0	158	0	0	28
15+			415	128	1135	85	26
Total	50504	44915	35987	25801	21661	21810	25438

Table 3.2.3.4 Norwegian Spring-spawning herring. Estimates obtained on the acoustic surveys in the wintering areas in January. Numbers in millions. No surveys carried out in 2000-2002.

Year Age	1991	1992	1993	1994	1995	1996	1997	1998	1999
2	90			73				214	0
3	220	410	61	642	47	315		267	1358
4	70	820	1905	3431	3781	10442		1938	199
5	20	260	2048	4847	4013	13557		4162	1455
6	180	60	256	1503	2445	4312		9647	4452
7	150	510	27	102	1215	1271		6974	12971
8	5500	120	269	29	42	290		1518	7226
9	440	4690	182	161	24	22		743	1876
10		30	5691	131	267	25		16	499
11			128	3679	29	200		4	16
12					4326	58		0	16
13						1146		181	0
14								7	156
15+								314	220
Total	6670	6900	10567	14598	16189	31638	-	25985	30444

In 1997 there was no estimate due to poor weather conditions.

Table 3.2.3.4.1 Norwegian spring-spawning herring. Acoustic estimates (billion individuals) of immature herring in the Barents Sea in May/June. 1990-2002.See footnotes.

Year	1991	1992	1993	1994	1995	1996[1]	1997[2]	1998	1999	2000	2001	2002
Age												
1	24.3	32.6	102.7	6.6	0.5	0.1	2.6	9.5	49.5	105.4	0.3	0.5
2	5.2	14.0	25.8	59.2	7.7	0.25	0.04	4.7	4.9	27.9	7.6	3.9
3		5.7	1.5	18.0	8.0	1.8	0.4	0.01	0.00	0.00	8.8	0.0
4				1.7	1.1	0.6	0.35	0.01	0.00	0.00	0.00	0.0
5						0.03	0.05	0.00	0.00	0.00	0.00	0.0

[1] Average of Norwegian and Russian estimates
[2] Combination of Norwegian and Russian estimates as described in 1998 WG report, since then only Russian estimates

Table 3.2.3.4.2 Norwegian spring-spawning herring. Acoustic estimates (billion individuals) of immature herring in the Barents Sea in September/October 2000-2001 and October/December 2002.

Year Age	2000	2001	2002
0	0.00	0.00	106.5
1	14.7	0.5	1,3
2	11.5	10.5	0.00
3	0.00	1.7	0.00
4	0.00	0.00	0.00
5	0.00	0.00	0.00

Table 3.2.3.4.3. Norwegian spring spawners. Acoustic abundance (TS = 20 logL - 71.9) of 0-group herring in Norwegian coastal waters in 1975–2002 (numbers in millions).

Year		**Area**			**Total**
	South of 62°N	62°N-65°N	65°N-68°N	North of 68°30'	
1975		164	346	28	538
1976		208	1 305	375	1 888
1977		35	153	19	207
1978		151	256	196	603
1979		455	1 130	144	1 729
1980		6	2	109	117
1981		132	1	1	134
1982		32	286	1 151	1 469
1983		162	2 276	4 432	6 866
1984		2	234	465	701
1985		221	177	104	502
1986		5	72	127	204
1987		327	26	57	410
1988		14	552	708	1 274
1989		575	263	2 052	2 890
1990		75	146	788	1 009
1991		80	299	2 428	2 807
1992		73	1 993	621	2 891
1993	290	109	140	288	827
1994	157	452	323	6 168	7 101
1995	0	27	2	0	29
1996	0	20	114	8 800	8 934
1997	208	69	544	5 244	6 065
1998	424	273	442	11 640	12 779
1999	121	658	271	6 329	7 379
2000	570	127	996	7 237	8 930
2001	89	324	134	1421	1968
2002	67	1227	284	3573	5151

Table 3.2.3.4.4. Norwegian spring-spawning herring. Abundance indices for 0-group herring in the Barents Sea, 1974-2002.

Year	Log index	Year	Log index
1974	0.01	1989	0.58
1975	0.00	1990	0.31
1976	0.00	1991	1.19
1977	0.01	1992	1.05
1978	0.02	1993	0.75
1979	0.09	1994	0.28
1980	0.00	1995	0.16
1981	0.00	1996	0.65
1982	0.00	1997	0.39
1983	1.77	1998	0.59
1984	0.34	1999	0.41
1985	0.23	2000	0.30
1986	0.00	2001	0.13
1987	0.00	2002	0.53
1988	0.30		

Table 3.2.3.5. The indices for herring larvae for the period 1981-2003 ($N*10^{-12}$)

Year	Index 1	Index 2	Year	Index 1	Index 2
1981	0.3		1992	6.3	27.8
1982	0.7		1993	24.7	78.0
1983	2.5		1994	19.5	48.6
1984	1.4		1995	18.2	36.3
1985	2.3		1996	27.7	81.7
1986	1.0		1997	66.6	147.5
1987	1.3	4.0	1998	42.4	138.6
1988	9.2	25.5	1999	19.9	73.0
1989	13.4	28.7	2000	19.8	127.5
1990	18.3	29.2	2001	40.7	
1991	8.6	23.5	2002	27.1	
			2003	3.7	

Table 3.2.4.1 Tagging data used in the SeaStar runs. Please note that the tagging data for 2002 was considered an outlier and thus not included in the analysis.

Tagging data for the 1983 year class

Year of Recovery	Number Tagged	Number screened in thousands	Recovered												
			2000 release	1998 release	1997 release	1996 release	1995 release	1994 release	1993 release	1992 release	1991 release	1990 release	1989 release	1988 release	1987 release
1987	33067														
1988	38152														
1989	20620	10695													12
1990	24585	5489												10	4
1991	12558	5545											5	7	1
1992	15262	1737										2	2	0	4
1993	15839	9372									9	12	6	13	6
1994	5364	9474								11	4	8	7	10	2
1995	859	11554							7	9	6	15	5	10	6
1996	2879	4038						3	4	1	2	10	6	2	3
1997	2266	3867					0	0	0	3	2	3	2	3	0
1998	648	509				1	0	0	0	2	2	1	1	3	1
1999		379			1	0	0	0	1	0	0	1	1	0	0
2000		413		0	0	0	0	0	0	1	0	3	0	1	0
2001		35		0	0	0	0	0	0	0	0	0	0	1	0
2002		221	0	0	0	0	0	0	0	0	0	0	0	1	0

Tagging data for the 1984 year class

Year of Recovery	Number Tagged	Number screened in thousands	Recovered												
			2000 release	1998 release	1997 release	1996 release	1995 release	1994 release	1993 release	1992 release	1991 release	1990 release	1989 release	1988 release	
1988	1342														
1989	1175														
1990	1097	157												0	
1991	257	138											0	0	
1992	767	30										0	0	0	
1993	479	287									0	1	1	2	
1994	160	267								1	2	0	0	0	
1995	56	264							0	0	0	0	0	0	
1996	113	281						0	0	0	0	0	0	0	
1997	0	0					0	0	0	0	0	0	0	0	
1998	0	1				0	0	0	0	0	0	0	0	0	
1999		0			0	0	0	0	0	0	0	0	0	0	
2000		0		0	0	0	0	0	0	0	0	0	0	0	
2001		0		0	0	0	0	0	0	0	0	0	0	0	
2002		0	0	0	0	0	0	0	0	0	0	0	0	0	

Table 3.2.4.1 continued. Tagging data for the 1985 year class

Year of Recovery	Number tagged	Number screened in thousands	Recovered												
			2000 release	1998 release	1997 release	1996 release	1995 release	1994 release	1993 release	1992 release	1991 release	1990 release	1989 release		
1989	2982														
1990	1081														
1991	1154	355											0		
1992	851	114										0	0		
1993	1465	573									1	1	1		
1994	368	345								1	0	0	2		
1995	167	735							1	2	0	0	0		
1996	564	427						0	0	0	0	0	1		
1997	555	888					1	1	1	3	0	2	0		
1998	778	497				0	0	0	1	0	0	1	0		
1999		623			1	0	0	0	0	0	0	0	1		
2000	299*	703		2	0	0	0	0	1	0	0	0	0		
2001		139		1	0	0	0	0	0	0	0	0	1		
2002		194	0	2	0	0	0	0	0	0	0	0	1		

*1985+ group

Tagging data for the 1986 year class

Year of Recovery	Number tagged	Number screened in thousands	Recovered												
			2000 release	1998 release	1997 release	1996 release	1995 release	1994 release	1993 release	1992 release	1991 release	1990 release			
1990	381														
1991	165														
1992	210	17										0			
1993	52	19									0	0			
1994	256	65								0	0	0			
1995	0	104							0	0	0	1			
1996	213	92						0	0	1	0	0			
1997	15	166					0	0	0	0	0	0			
1998	84	0				0	0	0	0	0	0	0			
1999		0			0	0	0	0	0	0	0	0			
2000	0	3		0	0	0	0	0	0	0	0	0			
2001		0		0	0	0	0	0	0	0	0	0			
2002		10	0	0	0	0	0	0	0	0	0	0			

Table 3.2.4.1 continued Tagging data for the 1987 year class

Year of Recovery	Number tagged	Number screened in thousands	Recovered												
			2000 release	1998 release	1997 release	1996 release	1995 release	1994 release	1993 release	1992 release	1991 release				
1991	634														
1992	1146														
1993	1569	329									0				
1994	315	259								0	0				
1995	27	90							1	0	1				
1996	0	43						0	1	0	0				
1997	135	224					0	0	0	0	0				
1998	0	8				0	0	0	0	1	0				
1999		81			0	0	0	0	0	0	0				
2000	0	0		0	0	0	0	0	0	0	0				
2001		22		0	0	0	0	0	0	0	0				
2002	606*	29	0	0	0	0	0	0	0	0	0				

*1987+group

Tagging data for the 1988 year class

Year of Recovery	Number tagged	Number screened in thousands	Recovered												
			2000 release	1998 release	1997 release	1996 release	1995 release	1994 release	1993 release	1992 release					
1992	5827														
1993	5267														
1994	4473	3506								3					
1995	1041	3729							0	4					
1996	2109	1176						2	3	3					
1997	1940	811					0	0	0	0					
1998	215	148				0	0	1	0	1					
1999		12			0	0	0	0	0	0					
2000	118	75		0	0	0	0	0	0	0					
2001		0		0	0	0	0	0	1	0					
2002	37	77	1	0	1	0	0	0	0	0					

Table 3.2.4.1 continued Tagging data for the 1989 year class

Year of Recovery	Number tagged	Number Screened in thousands	Recovered						
			2000 release	1998 release	1997 release	1996 release	1995 release	1994 release	1993 release
1993	7584								
1994	11873								
1995	2348	9463							4
1996	5170	4636						5	1
1997	4103	3346					0	7	2
1998	1176	1183				1	0	0	0
1999		1179			1	1	0	0	1
2000	470	790		1	0	0	0	2	0
2001		841		0	0	2	0	1	1
2002	319	286	0	1	0	0	0	0	0

Tagging data for the 1990 year class

Year of Recovery	Number tagged	Number Screened in thousands	Recovered						
			2000 release	1998 release	1997 release	1996 release	1995 release	1994 release	1993 release
1994	10784							0	
1995	3868						0	3	
1996	6171	9009				3	3	9	
1997	4057	9830			2	3	3	7	
1998	2381	2828		2	3	1	1	1	
1999		3402		3	1	2	2	1	
2000	1219	3146		1	0	2	2	0	
2001		1052		0	0	0	0	2	
2002	1605	1348	0	1	0	1	0	0	

Tagging data for the 1991 year class

Year of Recovery	Number tagged	Number Screened in thousands	Recovered						
			2000 release	1998 release	1997 release	1996 release	1995 release	1994 release	1993 release
1995	21528								
1996	25683								
1997	7129	30952					21		
1998	6002	12459				6	8		
1999		14968			4	14	7		
2000	3802	18461		9	1	10	7		
2001		10032		1	2	5	3		
2002	5878	8937	10	9	1	1	1		

Table 3.2.4.1 continued Tagging data for the 1992 year class

Year of Recovery	Number tagged	Number Screened in thousands	Recovered			
			2000 release	1998 release	1997 release	1996 release
1996	8417					
1997	8353					
1998	22320	20695				7
1999		23790		7	9	4
2000	16798	31430		20	7	15
2001		14668		8	0	4
2002	9995	17305	12	23	2	1

Tagging data for the 1993 year class

Year of Recovery	Number tagged	Number Screened in thousands	Recovered			
			2000 release	1998 release	1997 release	
1997	976					
1998	2015					
1999		8046			0	
2000	2673	9049		3	0	
2001		3994		0	0	
2002	2832	5577	4	2	5	

Tagging data for the 1994 year class

Year of Recovery	Number tagged	Number Screened in thousands	Recovered			
			2000 release	1998 release	1997 release	1996 release
1998	3752					
1999						
2000	2278	2450		1		
2001		1104		1		
2002	1143	1588	1	2		

Tagging data for the 1995 year class

Year of Recovery	Number tagged	Number Screened in thousands	Recovered			
			2000 release	1998 release	1997 release	1996 release
2000	505					
2001		276				
2002	197	250	1			

Table 3.3.1.1. Estimated parameters, spawning stock biomasses in 2003, and the contribution to the likelihood function from the various data sources for the exploratory runs.

	Exploratory run					
	Default	NoTagsNoLarvae	Youngest1998	EstimateMortality	Lognormal	CorrectAgeBias
Spawning stock	5.78	6.346	4.686	5.199	5.52	6.279
terminalF83	0.189	0.171	0.189	0.208	0.238	0.165
terminalF90	0.129	0.134	0.13	0.148	0.18	0.102
terminalF91	0.189	0.168	0.188	0.211	0.199	0.161
terminalF92	0.214	0.173	0.211	0.235	0.215	0.187
terminalF93	0.216	0.208	0.213	0.235	0.228	0.201
terminalF96	0.177	0.179	0.184	0.196	0.202	0.189
terminalF97	0.057	0.054	0.226	0.065	0.057	0.055
terminalF98	0.062	0.057	0.072	0.07	0.063	0.058
terminalF99	0.021	0.02	0.022	0.025	0.022	0.02
terminalF00	0.033	0.033	0.046	0.042	0.032	0.033
terminalF01	0	0	0	0	0	0
terminalF02	0	0	0	0	0	0
cat1	0.839	0.8	0.837	0.924	0.853	0.784
cat2	0.769	0.733	0.767	0.853	0.74	0.719
cat3	0.844	0.816	0.846	0.931	0.853	0.79
cat5	0.995	0.944	0.974	1.102	0.912	0.948
catLarvae2	4.165	4.187	4.538	4.354	3.905	
cat4	0.427	0.412	0.518	0.731	0.436	0.415
cat6	0.309	0.293	0.402	0.457	0.314	0.296
catZero	0.003	0.003	0.003	0.013	0.003	0.003
Log-likelihood per term, survey 1	-1.519	-1.487	-1.514	-1.521	-1.552	-1.489
Log-likelihood per term, survey 2	-1.324	-1.333	-1.284	-1.334	-1.361	-1.328
Log-likelihood per term, survey 3	-1.646	-1.653	-1.64	-1.658	-1.639	-1.607
Log-likelihood per term, survey 4	-3.494	-3.485	-3.511	-3.477	-3.528	-3.486
Log-likelihood per term, survey 5	-1.899	-1.882	-1.833	-1.888	-1.902	-1.899
Log-likelihood per term, survey 6	-3.101	-3.09	-3.078	-3.118	-3.142	-3.094
Number of data points, survey 1	21	21	21	21	21	21
Number of data points, survey 2	41	41	43	41	41	41
Number of data points, survey 3	19	19	19	19	19	19
Number of data points, survey 4	19	19	19	19	19	19
Number of data points, survey 5	36	36	41	36	36	36
Number of data points, survey 6	7	7	7	7	7	7
vpaM	0.15	0.15	0.15	0.128	0.15	0.15
vpaMYoung	0.9	0.9	0.9	0.507	0.9	0.9

Table 3.3.1.2. Estimated parameters, spawning stock biomasses in 2003, and the contribution to the likelihc function from the various data sources for the exploratory runs including only one survey

	Exploratory run			
	OnlySurvey1	OnlySurvey2	OnlySurvey3	OnlySurvey5
Spawning stock	7.771	6.314	6.921	4.757
terminalF83	0.153	0.177	0.352	0.221
terminalF90	0.066	0.091	0.096	0.167
terminalF91	0.167	0.171	0.245	0.258
terminalF92	0.237	0.229	0.321	0.284
terminalF93	0.215	0.225	0.157	0.194
terminalF96	-0.042	0.093	0.044	0.378
terminalF97	0.05	0.055	0.052	0.064
terminalF98	0.064	0.064	0.071	0.067
terminalF99	0.022	0.022	0.025	0.023
terminalF00	-0.011	0.023	0.009	0.038
terminalF01	0	0	0	0
terminalF02	0	0	0	0
cat1	0.753			
catLarvae2	3.528	3.866	3.882	4.583
cat4	0.312	0.382	0.309	0.486
cat6	0.263	0.299	0.263	0.332
catZero	0.003	0.003	0.004	0.004
cat2		0.694		
cat3			0.908	
cat5				1.112
Log-likelihood per term, survey 1	-1.558			
Log-likelihood per term, survey 2		-1.299		
Log-likelihood per term, survey 3			-1.402	
Log-likelihood per term, survey 4	-3.603	-3.533	-3.643	-3.468
Log-likelihood per term, survey 5				-1.764
Log-likelihood per term, survey 6	-3.199	-3.132	-3.25	-3.096
Number of data points, survey 1	21	0	0	0
Number of data points, survey 2	0	41	0	0
Number of data points, survey 3	0	0	19	0
Number of data points, survey 4	19	19	19	19
Number of data points, survey 5	0	0	0	36
Number of data points, survey 6	7	7	7	7
vpaM	0.15	0.15	0.15	0.15
vpaMYoung	0.9	0.9	0.9	0.9

Table 3.3.2. Summary of the bootstrap runs

	Short name	ML value	Mean	Median	Standard deviation
Spawning stock, assesment year	SSB	5.752	5.456	5.31	0.929
Total stock, assessment year	TSB	7.849	7.828	7.827	1.363
distribution Parameter	d	0.457	0.481	0.481	0.002
cat1	c1	0.839	0.884	0.886	0.019
cat2	c2	0.769	0.79	0.791	0.023
cat3	c3	0.844	0.883	0.883	0.014
cat5	c5	0.995	0.964	0.963	0.026
catLarvae2	cL2	4.166	4.4	4.32	0.825
distributionParameterLarvae	dL	0.692	0.923	0.932	0.098
terminalF83	F83	0.19	0.254	0.255	0.009
terminalF90	F90	0.129	0.202	0.201	0.011
terminalF91	F91	0.189	0.219	0.219	0.011
terminalF92	F92	0.214	0.236	0.236	0.012
terminalF93	F93	0.217	0.249	0.249	0.01
terminalF96	F96	0.177	0.224	0.223	0.014
taggingSurvival	tS	0.394	0.376	0.376	0.006
distributionParameter	d	1.942	1.856	1.809	0.072
cat4	c4	0.423	0.457	0.454	0.062
cat6	c6	0.309	0.333	0.324	0.076
catZero	cZ	0.003	0.003	0.003	0
distParZero	dZ	0.21	0.143	0.141	0.046
terminalF97	F97	0.056	0.09	0.063	0.077
terminalF98	F98	0.063	0.064	0.059	0.024
terminalF99	F99	0.022	0.023	0.02	0.01
terminalF00	F00	0.03	0.047	0.048	0.024
terminalF01	F01	0	0	0	0
terminalF02	F02	0	*	0	*

* not estimable

Table 3.3.3 Summary table SeaStar retrospective run, years 1950-2002.
Recruits are billion, biomass are million tonnes, landings are tonnes.

Year	Recruits Age 0	Total biomass	Spawning stock biomass	Landings	Fbar 5-14
1950	693.066	17.383	12.955	933000	0.06
1951	143.606	17.43	11.964	1278400	0.073
1952	96.42	18.496	10.706	1254800	0.078
1953	86.254	16.558	9.616	1090600	0.073
1954	44.367	18.087	9.256	1644500	0.129
1955	25.473	15.605	9.848	1359800	0.088
1956	30.646	13.902	11.43	1659400	0.124
1957	25.397	11.313	10.129	1319500	0.126
1958	23.095	9.799	9.157	986600	0.096
1959	412.475	8.406	7.694	1111100	0.137
1960	197.51	8.084	6.457	1101800	0.166
1961	76.099	8.264	4.979	830100	0.126
1962	19.006	7.238	4.019	848600	0.172
1963	168.933	7.457	3.291	984500	0.299
1964	93.902	7.081	3.232	1281800	0.241
1965	8.49	6.443	3.672	1547700	0.277
1966	51.405	5.065	3.561	1955000	0.69
1967	3.943	3.587	2.084	1677200	1.496
1968	5.184	1.45	0.823	712200	3.414
1969	9.276	0.634	0.596	67800	0.547
1970	0.661	0.508	0.469	62300	1.211
1971	0.24	0.471	0.381	21100	1.554
1972	2.376	0.386	0.322	13161	1.689
1973	13.629	0.452	0.422	7017	1.645
1974	8.631	0.461	0.371	7619	0.13
1975	3.027	0.569	0.33	13713	0.217
1976	8.08	0.597	0.372	10436	0.124
1977	5.092	0.636	0.506	22706	0.077
1978	6.2	0.745	0.561	19824	0.039
1979	12.035	0.783	0.567	12864	0.022
1980	1.473	0.865	0.618	18577	0.032
1981	1.1	0.887	0.617	13736	0.022
1982	2.329	0.806	0.598	16655	0.021
1983	324.67	1.149	0.653	23054	0.03
1984	11.528	2.061	0.661	53532	0.093
1985	35.62	5.237	0.568	169872	0.393
1986	6.041	1.856	0.472	225256	1.139
1987	9.011	3.166	0.928	127306	0.447
1988	27.852	3.535	2.835	135301	0.045
1989	71.251	4.139	3.441	103830	0.028
1990	126.958	4.652	3.601	86411	0.022
1991	335.96	5.36	3.743	84683	0.025
1992	377.724	7.153	3.606	104448	0.029
1993	99.413	7.274	3.51	232457	0.066
1994	32.509	8.167	4.011	479228	0.134
1995	8.738	7.803	4.261	905501	0.222
1996	72.523	8.011	4.106	1220283	0.183
1997	102.981	8.243	7.094	1426507	0.176
1998	201.232	8.152	7.222	1223131	0.156
1999	150.176	8.199	6.734	1235433	0.194
2000	17.561	8.526	5.443	1207201	0.236
2001	5.006	7.473	4.903	770054	0.182
2002	158.994	7.595	5.226	806086	0.153

Table 3.3.4.1 Input data to the short term projection based on SeaStar.

Landings in 2003	0.71 million tonnes
Total biomass in 2003	7.8933 million tonnes
Spawning stock biomass in 2003	5.78017 million tonnes
Part of year before spawning:	0.1
Fbar age range:	5-14, Fbar is weighted with population numbers January 1
Fbar 2003	0.105151
Weight at age in stock and catch:	assumed equal
Basis for weight in stock prediction:	predicted condition factor
Basis for weight in catch prediction:	mean of last 3 years

Age	Numbers(billion) 2	Weightstock(kg) 2	Weightstock(kg) 2	Weightcatch(kg)	Fractionmatureatage	Exploitationpattern
0	0	0.001	0.001	0	0	0
1	64.642	0.01	0.01	0	0	0.002
2	0.827	0.055	0.057	0.086	0	0.033
3	1.141	0.098	0.101	0.156	0	0.063
4	8.502	0.159	0.164	0.213	0.3	0.09
5	9.336	0.211	0.218	0.256	0.9	0.114
6	3.989	0.272	0.28	0.275	1	0.136
7	1.539	0.305	0.314	0.3	1	0.154
8	0.131	0.292	0.301	0.312	1	0.169
9	0.381	0.331	0.341	0.327	1	0.18
10	1.005	0.337	0.347	0.345	1	0.187
11	2.55	0.347	0.358	0.36	1	0.189
12	1.496	0.356	0.367	0.374	1	0.187
13	0.352	0.381	0.393	0.394	1	0.179
14	0.077	0.414	0.427	0.4	1	0.166
15	0.041	0.425	0.438	0.424	1	0.147
16	0.248	0.441	0.455	0.421	1	0.122

Table 3.3.4.2 Output from the short term projection based on SeaStar.

Fbar	SSB 2004	Landings 2004	Biomass 2005	SSB 2005
0.071	6.43	0.483	7.25	6.004
0.086	6.42	0.575	7.159	5.909
0.1	6.411	0.667	7.069	5.816
0.114	6.401	0.757	6.98	5.724
0.128	6.392	0.846	6.892	5.634
0.143	6.382	0.933	6.806	5.545
0.157	6.373	1.02	6.721	5.458
0.171	6.364	1.105	6.637	5.372
0.186	6.354	1.189	6.555	5.288
0.2	6.345	1.272	6.473	5.205
0.214	6.336	1.354	6.393	5.123

Table 3.4.1
Results of stock assessment for NSS herring by means of ISVPA
(ISVPA, all indexes-MDN, feeging area - with SSE)

year	B(1+)	SSB	R(1)	F(5-14, w-d by N(a))
1986	1666065	414988	6660886	1.191
1987	2816113	844894	3496148	0.693
1988	3206061	2640594	3610493	0.180
1989	3675905	3177113	10340660	0.065
1990	4061779	3205289	27655650	0.067
1991	4505327	3325907	46207070	0.039
1992	5451299	3202456	124843600	0.036
1993	6742704	3126439	139820000	0.055
1994	7826000	3590663	42391460	0.074
1995	8678664	4482819	15162190	0.130
1996	8657097	5972824	4360407	0.122
1997	8952760	7101314	43741090	0.221
1998	7827215	6395750	35626600	0.190
1999	9820659	5975486	147787200	0.169
2000	9879879	5062963	102819500	0.232
2001	10958050	4590611	153211100	0.125
2002	12664870	5219457	0	0.161

to be substituted by 538000 (survey estimate)

Table 3.4.2
NSS herring. ISVPA. Abundance at age by years

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16+
1986	6660886	1962451	20557900	106474	37714	42823	238441	115808	69490	108921	37099	82255	96027	599	0	2375
1987	3496148	2707234	795903	17193560	75320	19008	22478	107815	30096	20846	22313	13869	9567	8432	515	0
1988	3610493	1417392	1077871	666693	14333470	47506	13112	12799	66820	14771	9128	15030	4670	2204	763	0
1989	10340660	1466138	570460	869356	550579	11826340	32120	7872	5483	43984	4483	5243	9823	1531	0	0
1990	27655650	4202967	580019	488318	744900	468646	9878164	24427	6033	4090	34798	2583	3882	8157	1076	1963
1991	46207070	11243690	1698890	481940	417833	630125	393298	8292285	19829	3784	1631	27711	1624	3175	6473	122
1992	124843600	18784240	4569222	1454420	412231	358324	528718	330288	6934198	14749	2829	1323	23211	0	0	0
1993	139820000	50757500	7636249	3921089	1221123	350190	307306	443956	278949	5758949	10391	1842	910	18831	0	0
1994	42391460	56846500	20631850	6546225	3275768	970067	293410	261116	354653	222809	4576297	8943	1586	783	16208	0
1995	15162190	17235070	23106900	17727840	5532253	2481855	682052	238086	217193	270620	158690	3340080	5072	938	0	1688
1996	4360407	6164488	7006536	19834860	14937070	4183846	1544401	372655	190533	172235	168214	58897	2028843	590	0	0
1997	43741090	1772809	2487076	5998704	16409970	11398970	2728453	952354	224809	158724	141407	83469	34392	970137	508	0
1998	35626600	17783800	706857	2019622	4911761	12458170	7961616	1642194	516800	137024	118041	91651	43971	11863	435326	0
1999	147787200	14484700	7177500	543156	1513452	3885894	9089719	5680191	1059532	324234	78506	78087	75658	24474	0	400216
2000	102819500	60085800	5885831	6050050	434267	1177568	2946216	6334603	3808848	641608	180726	54096	30064	58438	11837	168107
2001	153211100	41803280	24419890	4988037	4687439	341368	910823	2160597	4246870	2308813	350936	89136	31476	4815	0	95767
2002	**0**	**62290990**	16994620	20923490	4144175	3638534	257869	694898	1584604	2876812	1516749	233704	54712	23840	1031	33549

to be substituted by 3935000 (survey estimate)

to be substituted by 538000 (survey estimate)

Table 3.4.3.
NSS herring. fishing mortality coefficients by ages by years

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16+
1986	0.00024	0.00558	0.04595	0.12547	0.26918	0.41829	0.58845	0.72528	1.02090	2.13425	1.93722	2.00777	2.03029	0.00000	0.00000	2.11041
1987	0.00020	0.00468	0.03842	0.10421	0.22074	0.33813	0.46734	0.56726	0.76987	1.34702	1.26711	1.29680	1.30602	2.83050	2.83050	0.00000
1988	0.00016	0.00379	0.03104	0.08364	0.17506	0.26476	0.36053	0.43233	0.57152	0.91621	0.87331	0.88943	0.89440	1.43953	1.43953	0.00000
1989	0.00004	0.00102	0.00827	0.02187	0.04426	0.06476	0.08512	0.09941	0.12483	0.17643	0.17080	0.17294	0.17359	0.23027	0.00000	0.00000
1990	0.00004	0.00085	0.00684	0.01807	0.03649	0.05329	0.06992	0.08155	0.10217	0.14371	0.13920	0.14092	0.14144	0.18660	0.18660	0.18660
1991	0.00002	0.00044	0.00354	0.00933	0.01875	0.02728	0.03564	0.04145	0.05167	0.07193	0.06975	0.07058	0.07083	0.09239	0.09239	0.09239
1992	0.00001	0.00033	0.00269	0.00707	0.01421	0.02065	0.02695	0.03132	0.03899	0.05415	0.05252	0.05314	0.05333	0.00000	0.00000	0.00000
1993	0.00002	0.00042	0.00336	0.00885	0.01780	0.02588	0.03381	0.03932	0.04899	0.06817	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1994	0.00003	0.00068	0.00553	0.01458	0.02940	0.04288	0.05616	0.06543	0.08180	0.11457	0.11103	0.11238	0.11279	0.14811	0.14811	0.00000
1995	0.00000	0.00143	0.01157	0.03068	0.06238	0.09167	0.12102	0.14177	0.17904	0.25609	0.24759	0.25082	0.25181	0.33870	0.00000	0.33870
1996	0.00000	0.00184	0.01492	0.03967	0.08104	0.11963	0.15867	0.18650	0.23701	0.34365	0.33174	0.33626	0.33764	0.00000	0.00000	0.00000
1997	0.00000	0.00317	0.02585	0.06936	0.14401	0.21600	0.29141	0.34692	0.45186	0.69525	0.66632	0.67724	0.68060	1.01383	1.01383	0.00000
1998	0.00000	0.00254	0.02071	0.05533	0.11399	0.16965	0.22697	0.26848	0.34535	0.51495	0.49545	0.50283	0.50509	0.71705	0.71705	0.00000
1999	0.00000	0.00191	0.01551	0.04124	0.08432	0.12457	0.16535	0.19447	0.24742	0.35966	0.34709	0.35186	0.35331	0.48476	0.00000	0.48476
2000	0.00000	0.00214	0.01738	0.04630	0.09491	0.14058	0.18712	0.22052	0.28162	0.41288	0.39805	0.40368	0.40540	0.56239	0.56239	0.56239
2001	0.00000	0.00124	0.01004	0.02659	0.05394	0.07910	0.10422	0.12190	0.15355	0.21837	0.21126	0.21396	0.21478	0.28697	0.00000	0.28697
2002	0.00000	0.00156	0.01264	0.03354	0.06830	0.10051	0.13288	0.15583	0.19718	0.28321	0.27369	0.27731	0.27841	0.37636	0.37636	0.37636

Table 3.4.4. NSS herring. ISVPA. Input data for short term projection

Fbar age range: 5-14

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
1	28571	0.9	0.00	0.2	0.2	0.018	0.000	0.018
2	219	0.9	0.00	0.2	0.2	0.054	0.010	0.086
3	3330	0.15	0.00	0.2	0.2	0.098	0.078	0.156
4	14444	0.15	0.30	0.2	0.2	0.159	0.208	0.213
5	17415	0.15	0.90	0.2	0.2	0.211	0.424	0.256
6	3331	0.15	1.00	0.2	0.2	0.272	0.623	0.275
7	2832	0.15	1.00	0.2	0.2	0.305	0.824	0.300
8	194	0.15	1.00	0.2	0.2	0.314	0.966	0.312
9	512	0.15	1.00	0.2	0.2	0.331	1.223	0.345
10	1120	0.15	1.00	0.2	0.2	0.337	1.757	0.360
11	1865	0.15	1.00	0.2	0.2	0.346	1.697	0.374
12	993	0.15	1.00	0.2	0.2	0.356	1.720	0.394
13	152	0.15	1.00	0.2	0.2	0.381	1.727	0.400
14	36	0.15	1.00	0.2	0.2	0.414	2.334	0.424
15	14	0.15	1.00	0.2	0.2	0.425	2.334	0.421
16	1	0.15	1.00	0.2	0.2	0.440	2.334	0.440

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
1	28571	0.9	0.00	0.2	0.2	0.018	0.000	0.018
2		0.9	0.00	0.2	0.2	0.054	0.010	0.086
3		0.15	0.00	0.2	0.2	0.098	0.078	0.156
4		0.15	0.30	0.2	0.2	0.159	0.208	0.213
5		0.15	0.90	0.2	0.2	0.211	0.424	0.256
6		0.15	1.00	0.2	0.2	0.272	0.623	0.275
7		0.15	1.00	0.2	0.2	0.305	0.824	0.300
8		0.15	1.00	0.2	0.2	0.314	0.966	0.312
9		0.15	1.00	0.2	0.2	0.331	1.223	0.345
10		0.15	1.00	0.2	0.2	0.337	1.757	0.360
11		0.15	1.00	0.2	0.2	0.346	1.697	0.374
12		0.15	1.00	0.2	0.2	0.356	1.720	0.394
13		0.15	1.00	0.2	0.2	0.381	1.727	0.400
14		0.15	1.00	0.2	0.2	0.414	2.334	0.424
15		0.15	1.00	0.2	0.2	0.425	2.334	0.421
16		0.15	1.00	0.2	0.2	0.440	2.334	0.440

2005								
Age	Stock size	Natural mortality	Maturity ogive	Prop. of F bef. spaw.	Prop. of M bef. spaw.	Weight in stock	Exploit. pattern	Weight in catch
1	28571	0.9	0.00	0.2	0.2	0.018	0.000	0.018
2		0.9	0.00	0.2	0.2	0.054	0.010	0.086
3		0.15	0.00	0.2	0.2	0.098	0.078	0.156
4		0.15	0.30	0.2	0.2	0.159	0.208	0.213
5		0.15	0.90	0.2	0.2	0.211	0.424	0.256
6		0.15	1.00	0.2	0.2	0.272	0.623	0.275
7		0.15	1.00	0.2	0.2	0.305	0.824	0.300
8		0.15	1.00	0.2	0.2	0.314	0.966	0.312
9		0.15	1.00	0.2	0.2	0.331	1.223	0.345
10		0.15	1.00	0.2	0.2	0.337	1.757	0.360
11		0.15	1.00	0.2	0.2	0.346	1.697	0.374
12		0.15	1.00	0.2	0.2	0.356	1.720	0.394
13		0.15	1.00	0.2	0.2	0.381	1.727	0.400
14		0.15	1.00	0.2	0.2	0.414	2.334	0.424
15		0.15	1.00	0.2	0.2	0.425	2.334	0.421
16		0.15	1.00	0.2	0.2	0.440	2.334	0.440

Input units are millions and kg - output in kilotonnes

Table 3.4.5. NSS herring. ISVPA. Short term projection

Fbar: 5-14 weighted byabundance
Basis for 2003: F2003 = F2002; Recruitment: GM 1986-2001 = 28571 millions

		2003					2004			2005	
Biomass	SSB	FMult	FBar	Landings	Biomass	SSB	FMult	FBar	Landings	Biomass	SSB
10279	7104	0.736	0.118	710	10784	8795	0.0	0.000	0	11187	9241
					.	8773	0.1	0.016	112	11079	9136
					.	8752	0.2	0.032	222	10972	9032
					.	8730	0.3	0.048	331	10866	8930
					.	8709	0.4	0.065	438	10762	8830
					.	8688	0.5	0.081	543	10660	8731
					.	8666	0.6	0.097	647	10559	8633
					.	8645	0.7	0.113	749	10460	8537
					.	8624	0.8	0.129	850	10362	8442
					.	8603	0.9	0.145	949	10266	8349
					.	8582	1.0	0.161	1047	10171	8257
					.	8561	1.1	0.177	1143	10077	8166
					.	8540	1.2	0.194	1238	9985	8077
					.	8520	1.3	0.210	1332	9894	7989
					.	8499	1.4	0.226	1424	9804	7902
					.	8478	1.5	0.242	1515	9716	7817
					.	8458	1.6	0.258	1605	9628	7732
					.	8437	1.7	0.274	1694	9542	7649
					.	8417	1.8	0.290	1781	9458	7567
					.	8396	1.9	0.306	1867	9374	7487
					.	8376	2.0	0.323	1952	9292	7407

Input units are millions and kg - output in kilotonnes

for F(2003)=0.15 Catch(2003)= 886 000 tonnes

Table 3.5.2 Comparison of the 1992 and 1998 year class.
The year classes are compared by acoustic surveys, trawl indexes and estimates.

Yearclass	**1992**	**1998**
0-group index (trawl survey)	1.05	0.59
Barents Sea, acoustic est., age 1, (billion indv)	102.7	49.5
Barents Sea, acoustic est. age 2, (billion indv)	59.2	27.9
Norwegain Sea, acoustic estimate age 4 (billion indv)	22.4	9.6
Age 4 estimates WG_{2002} VPA	22.6	
Age 4 estimates $ISVPA_{2003}$	*20.0*	*20.7*
Age 4 estimates $SeaStar_{2003}$	21.8	11.3

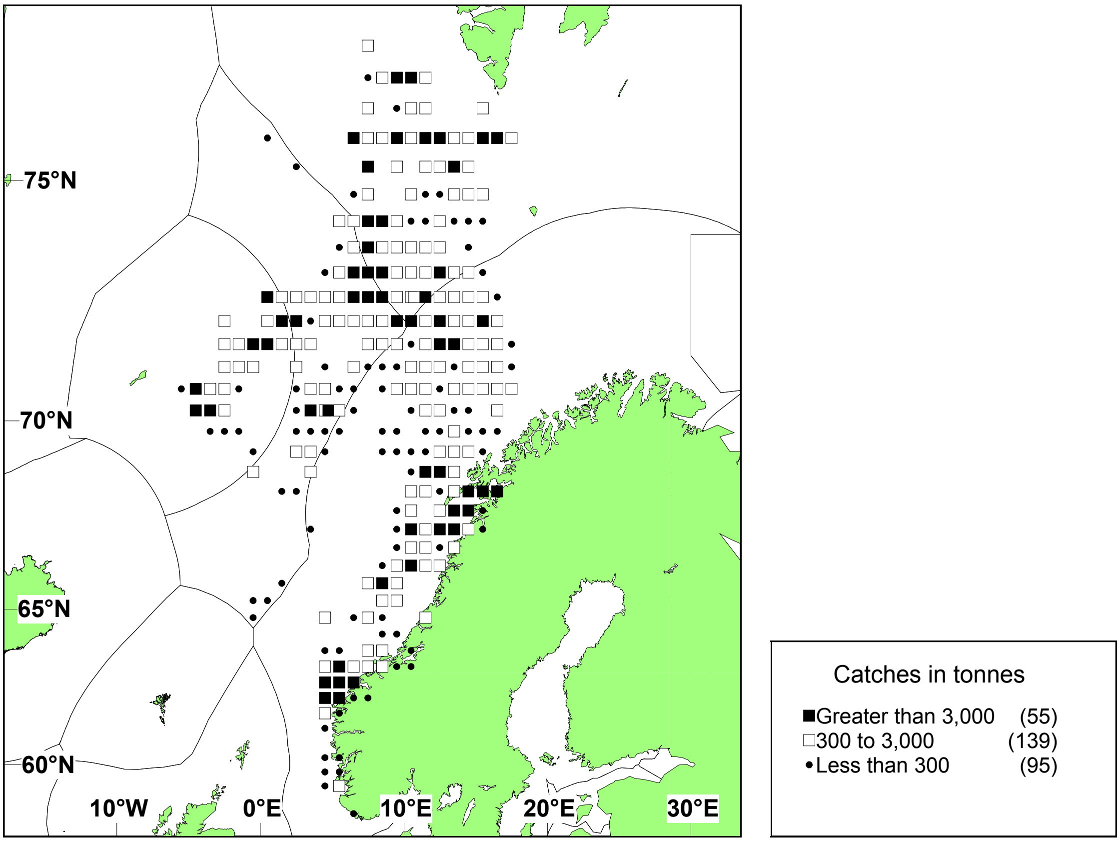
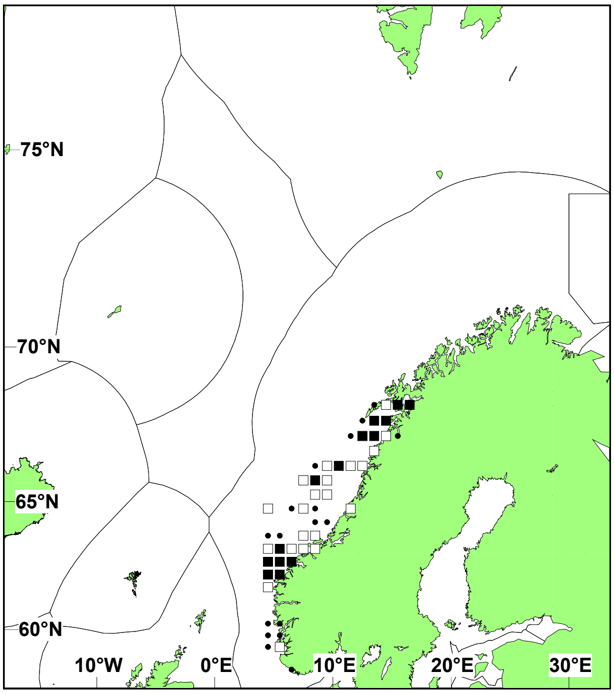
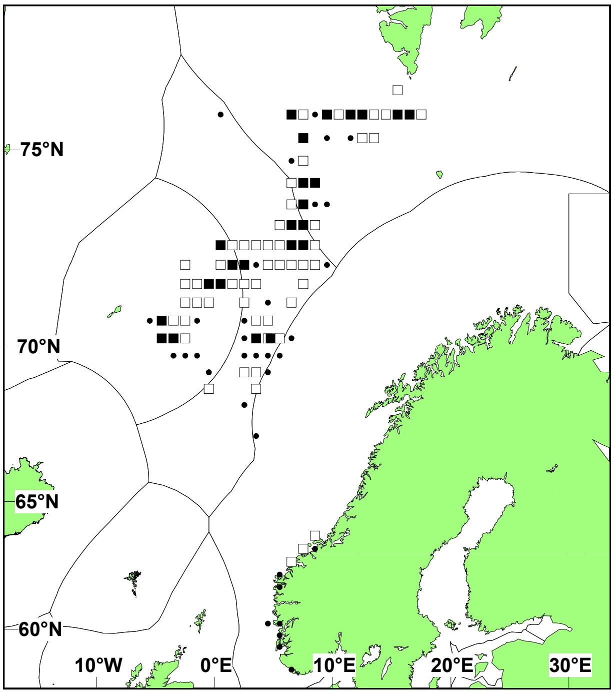


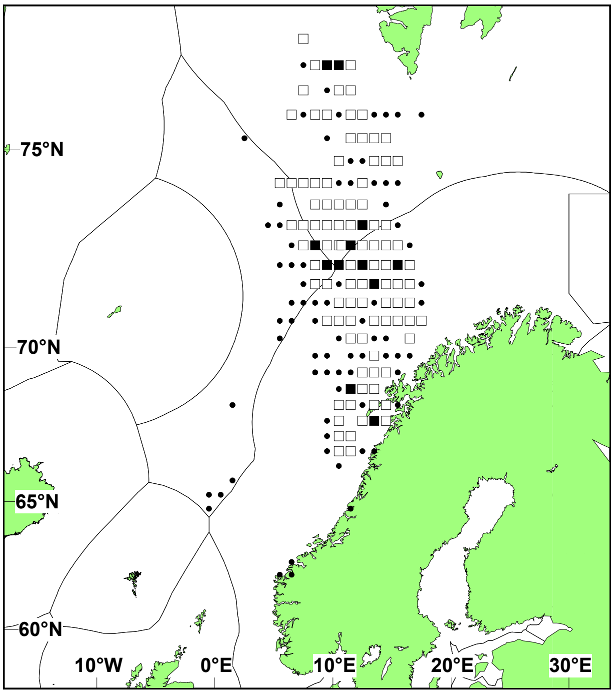
Figure 3.1.2.1 Total catches of Norwegian spring-spawning herring in 2002 by ICES rectangle. Grading of the symbols: black dots less than 300 t, open squares 300-3 000 t, and black squares > 3 000 t.



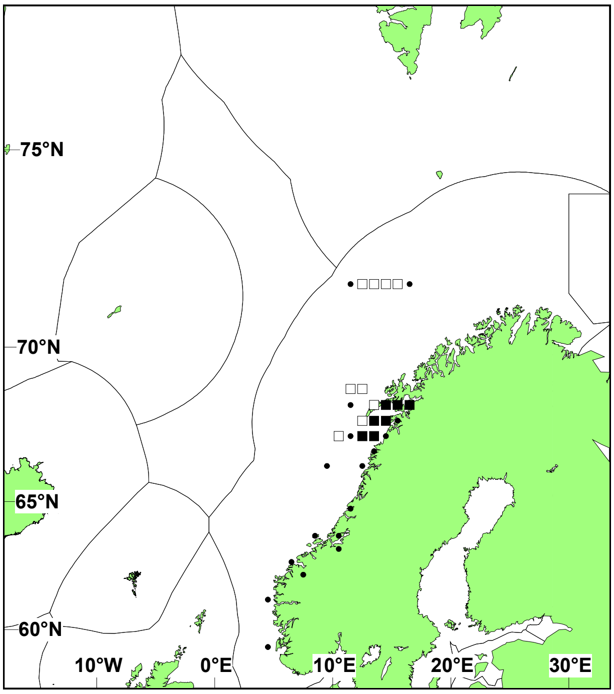
Quarter 1



Quarter 2



Quarter 3



Quarter 4

Figure 3.1.2.2 Total catches of Norwegian spring-spawning herring in 2002 by quarter and ICES rectangle. Grading of the symbols: black dots less than 300 t, open squares 300-3 000 t, and black squares > 3 000 t.

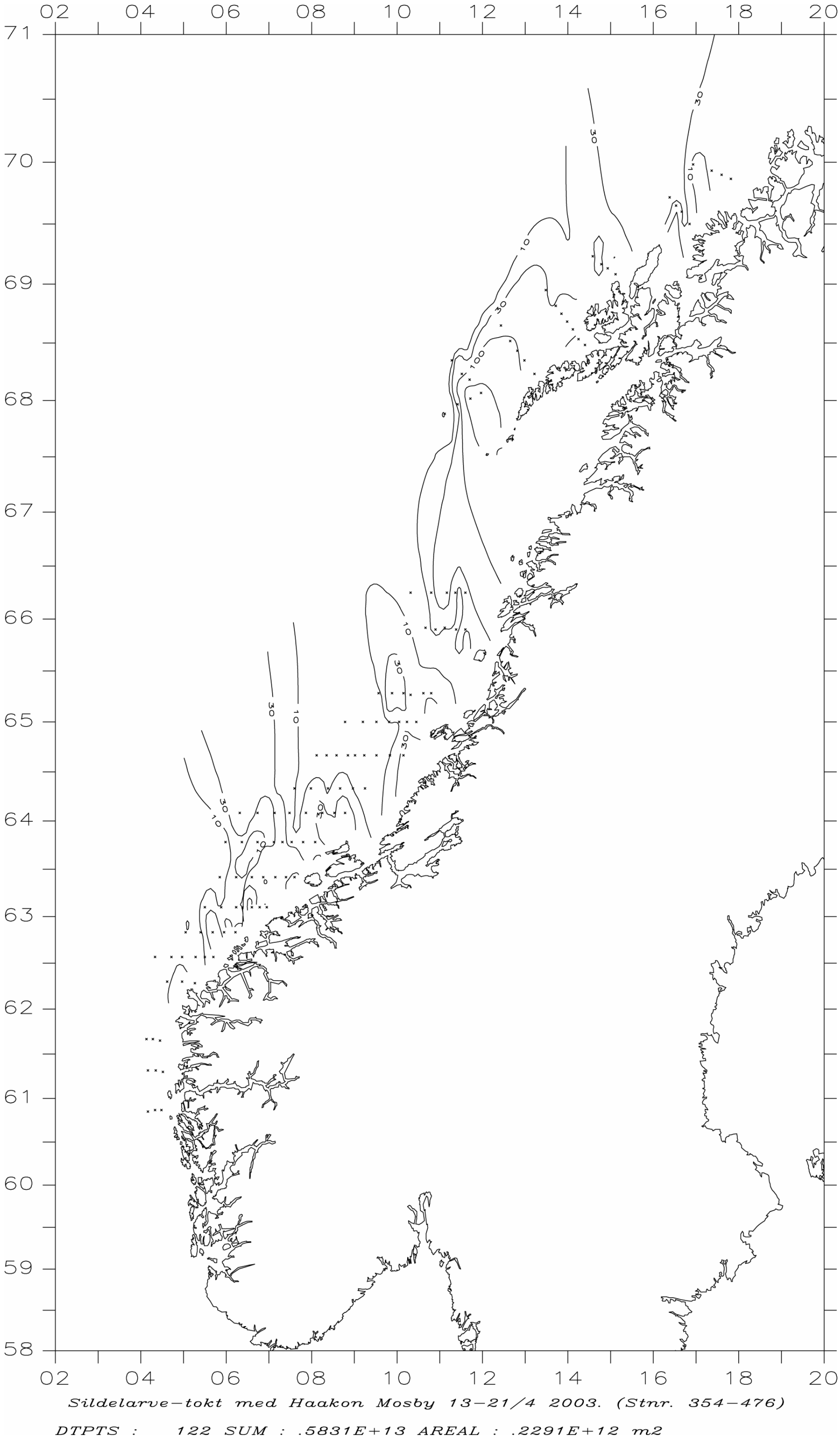
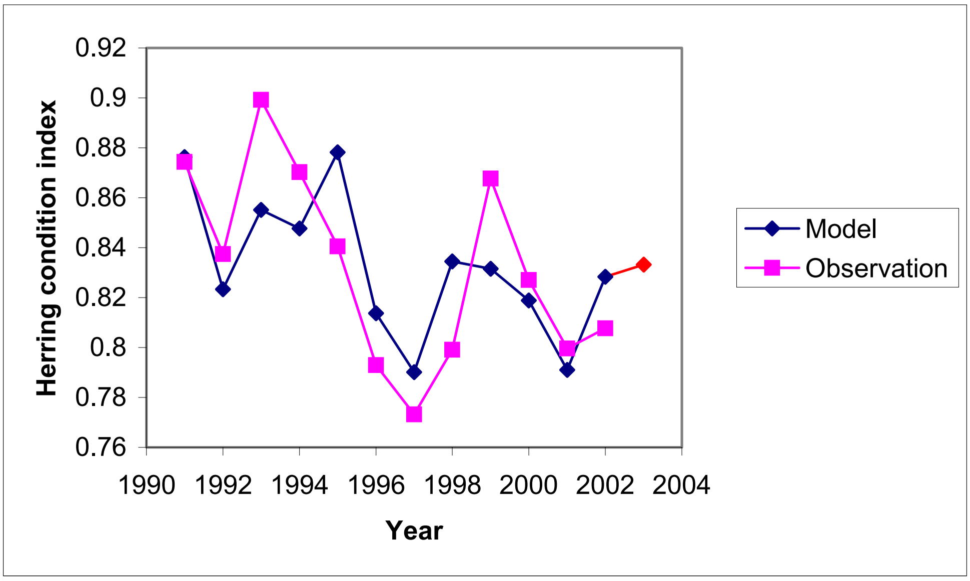


Figure 3.2.3.5. Distribution of herring larvae April 2003



*Condition (yr2) =0.022*NAO yr1+0.822, R^2=0.66, P=0.007.*

Figure 3.2.4.3 Observed and modelled data of herring condition (Section 2.4.5). Prognosis of herring condition in December 2003 was based on the mean NAO for March-April in 2002:

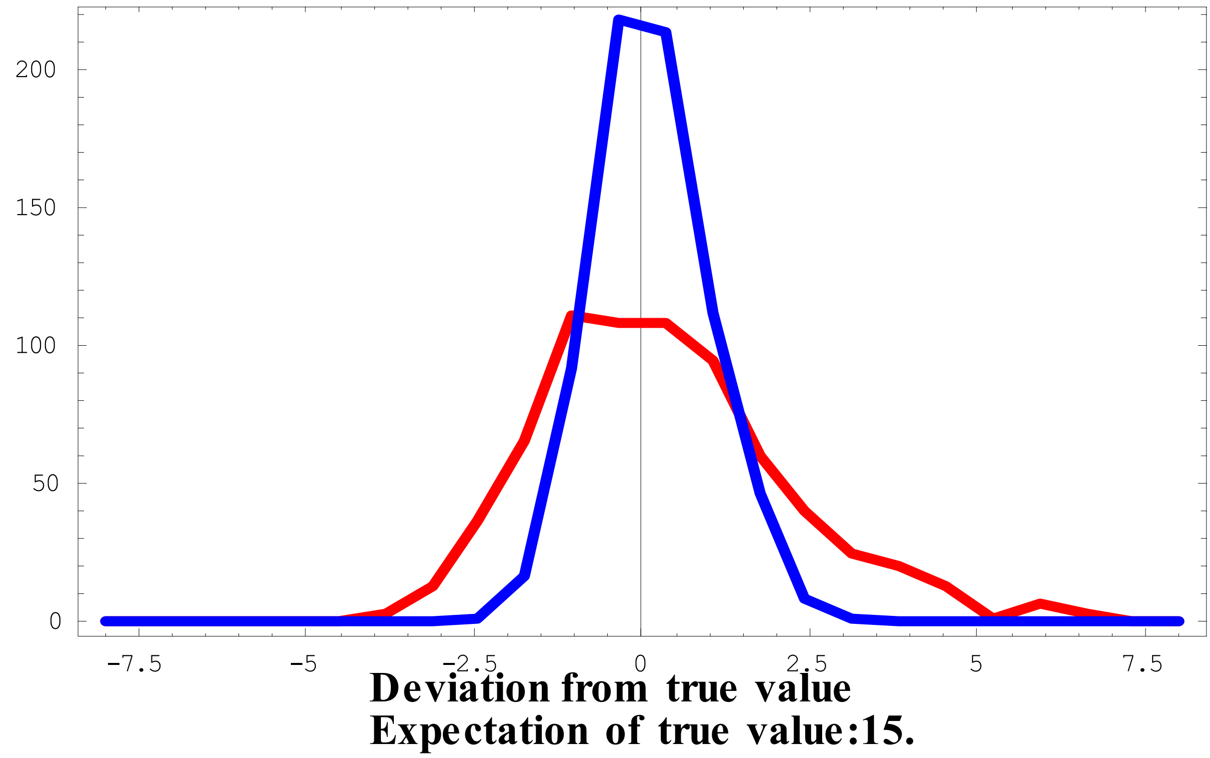


Figure 3.3.1 Histograms of deviations from true value when large year classes are estimated separately (blue line) , and when large year classes are estimated together with the small year classes (red line). See the text for details.

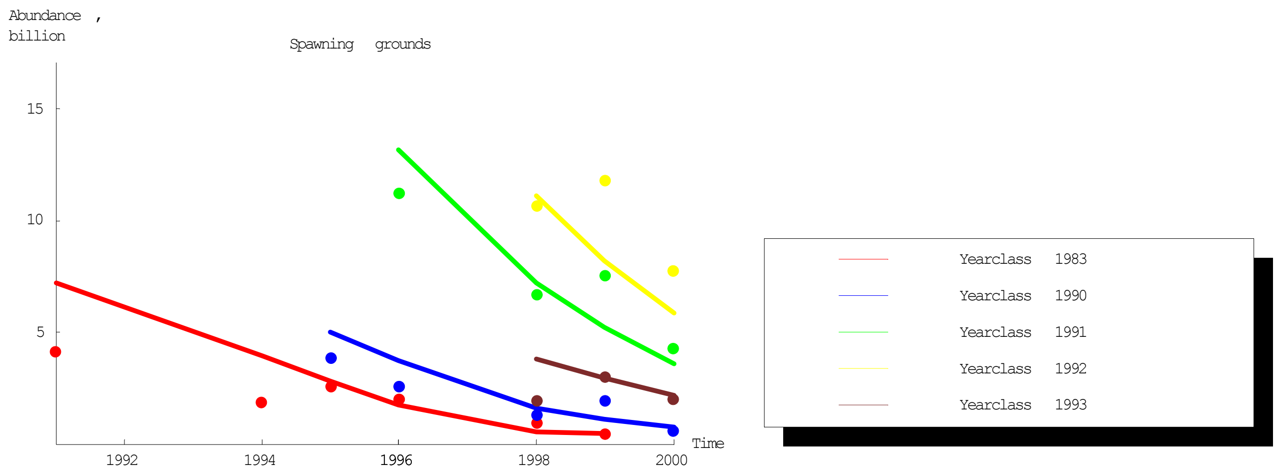


Figure 3.3.2.1 VPA scaled by catchability (solid line) and observations (dots) for the acoustic survey on the spawning grounds, for year classes in the tuning.

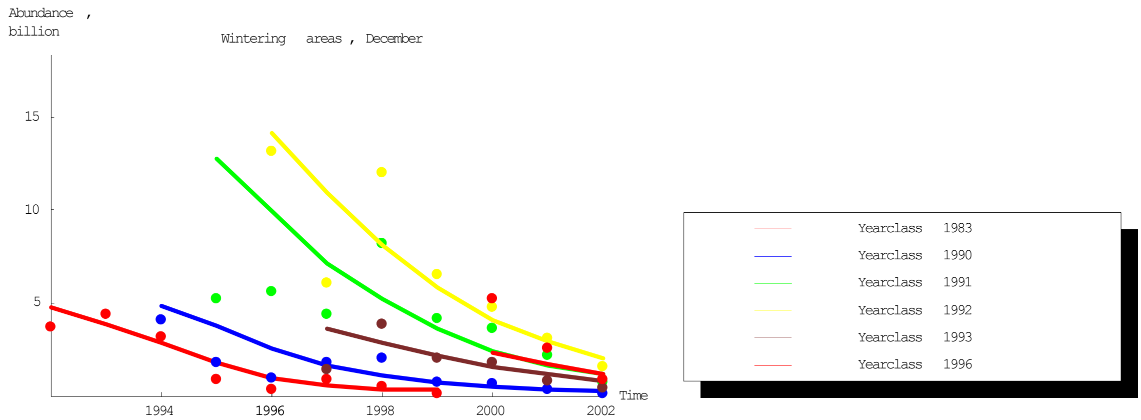


Figure 3.3.2.2 VPA scaled by catchability (solid line) and observations (dots) for the acoustic survey on the wintering areas in Vestfjorden in December, for year classes in the tuning.

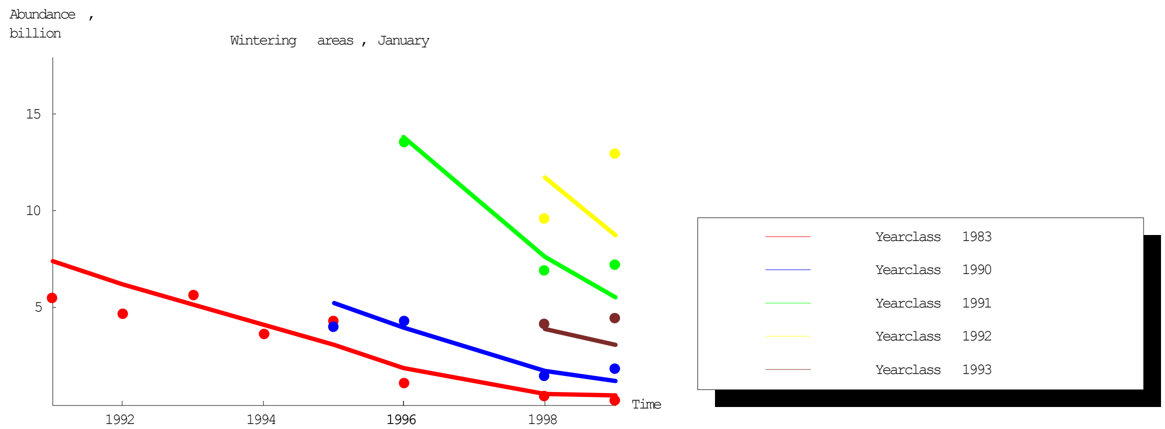


Figure 3.3.2.3 VPA scaled by catchability (solid line) and observations (dots) for the acoustic survey on the wintering areas in Vestfjorden in January, for year classes in the tuning.

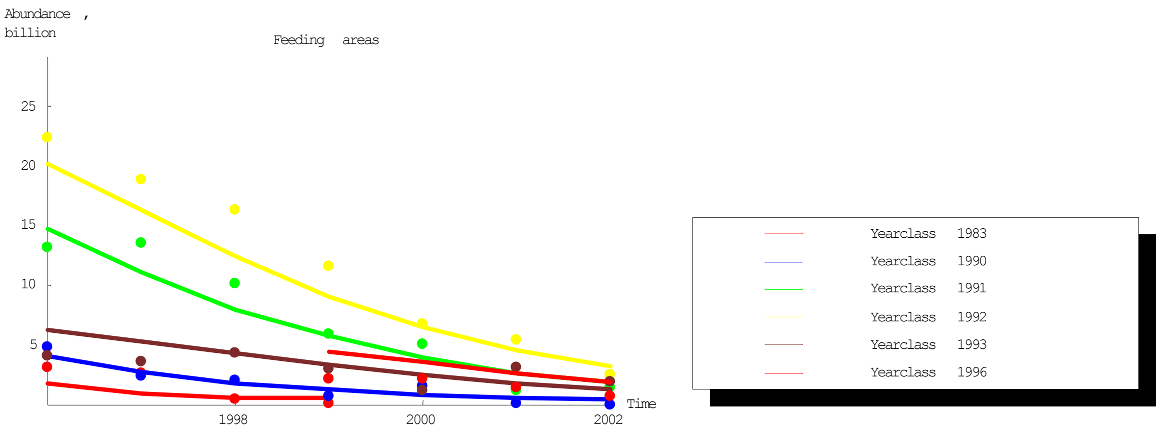


Figure 3.3.2.4 VPA scaled by catchability (solid line) and observations (dots) for the acoustic survey on the feeding grounds in the Norwegian Sea, for year classes in the tuning.

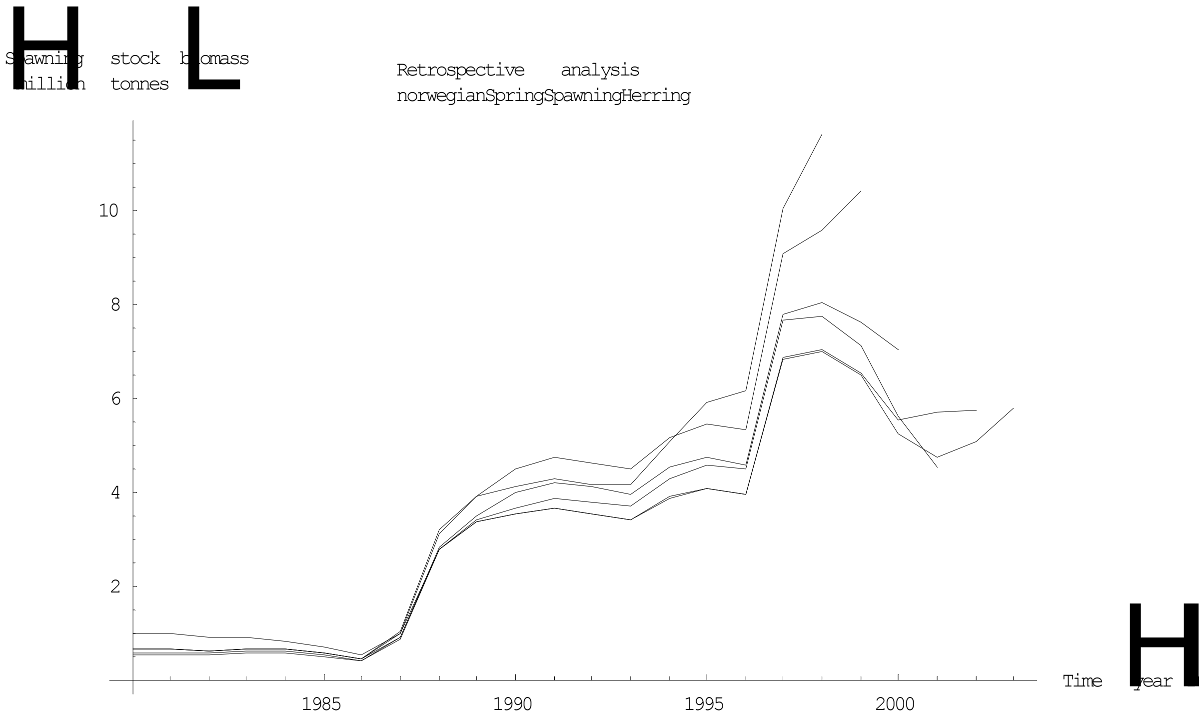


Figure 3.3.2.5. SeaStar retrospective plot

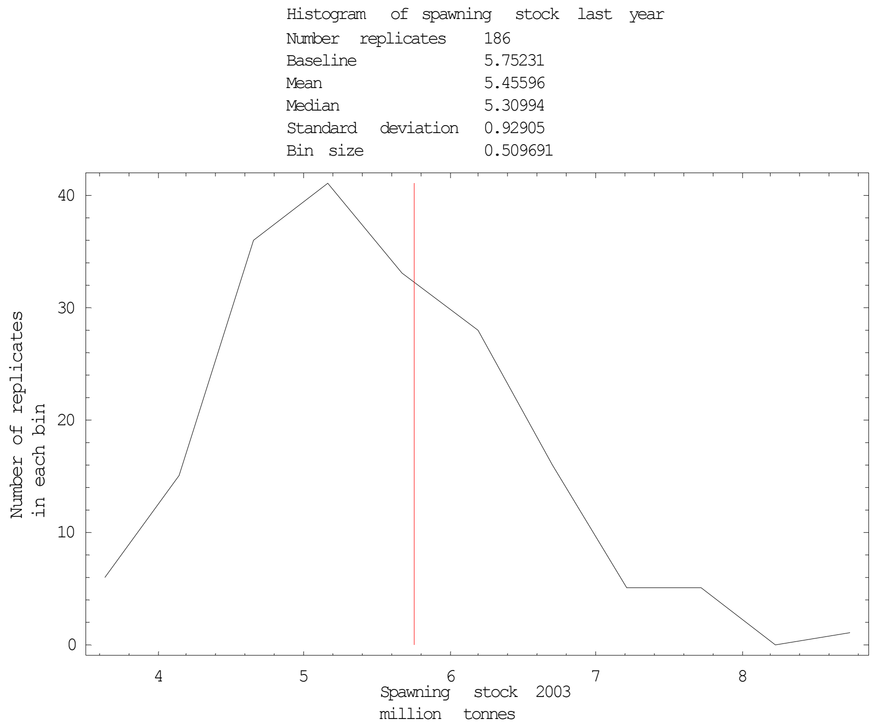


Figure 3.3.2.6 Histogram of spawning stock replicates from the bootstrap

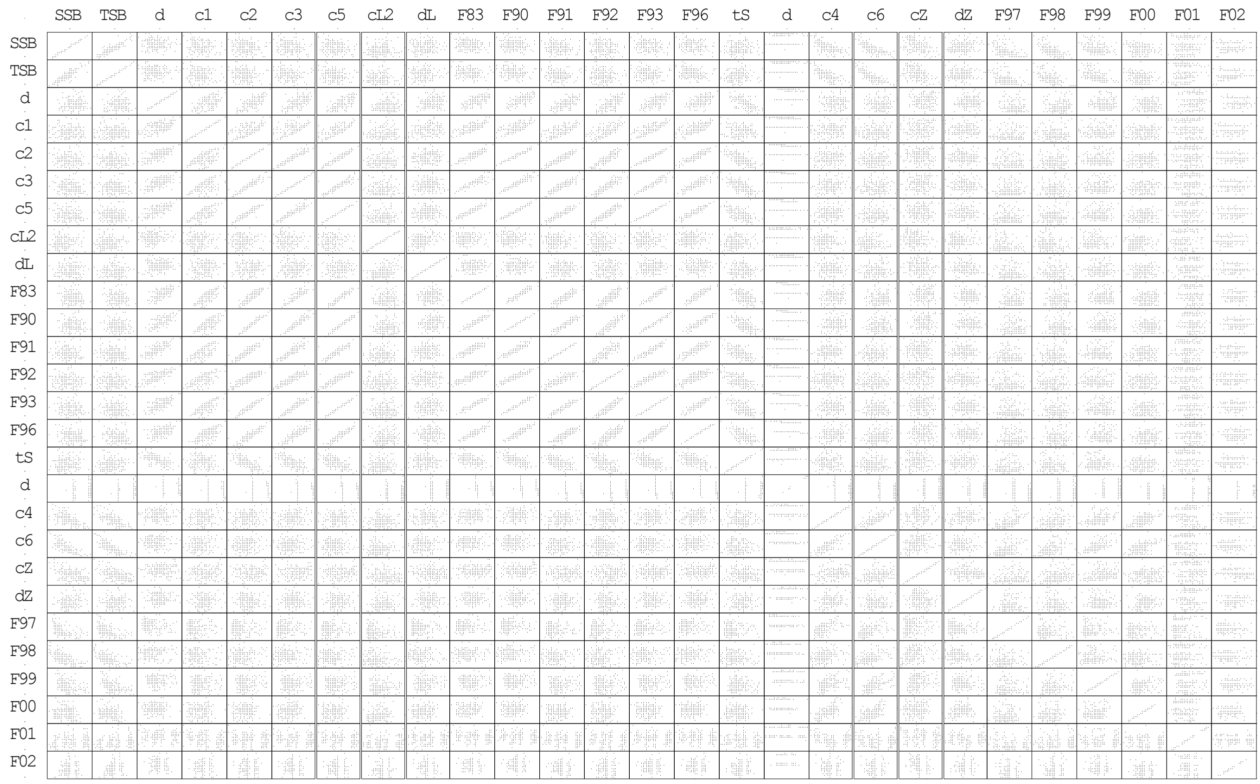


Figure 3.3.2.7 Scatter plots of the covariation between pairs of parameters, between parameters and spawning stock, and between parameters and total stock from SeaStar bootstrap replicates.

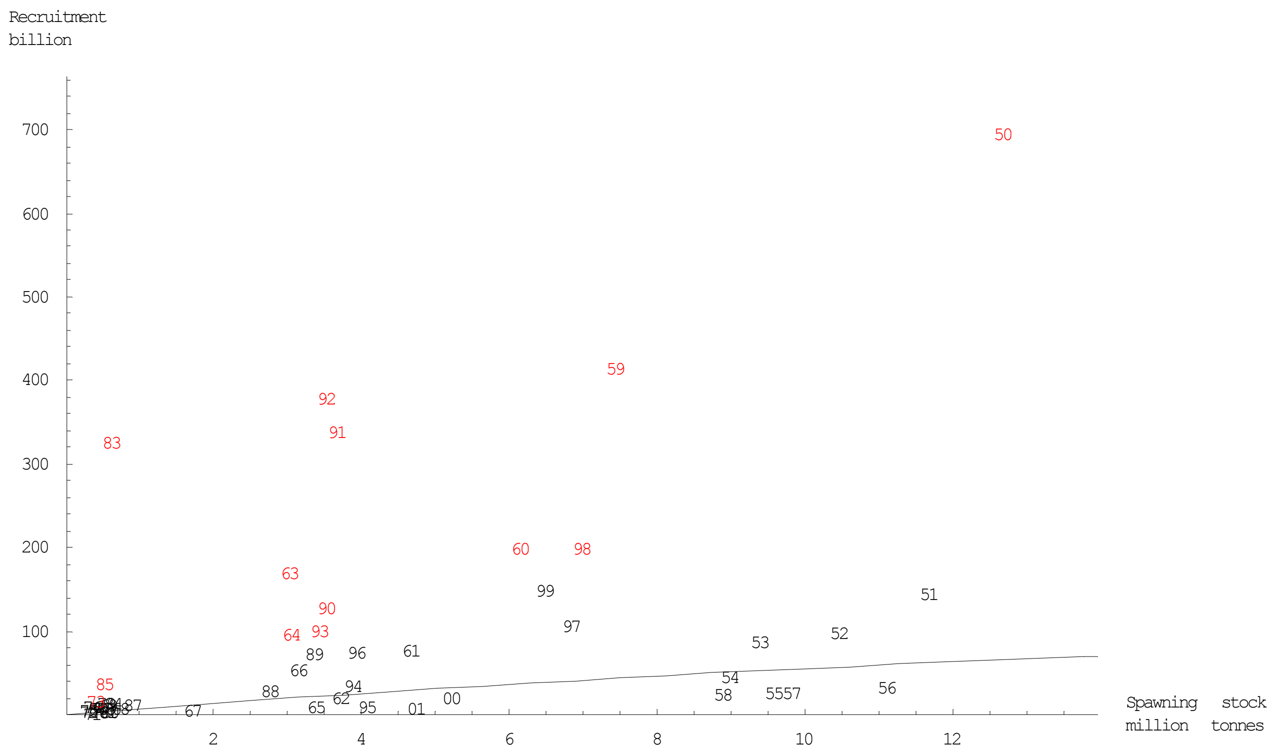
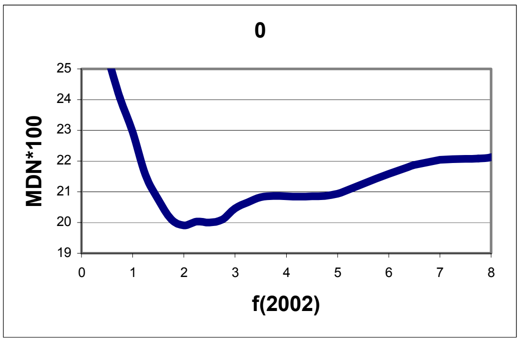


Figure 3.3.3 Spawning stock – recruitment plot for the SeaStar Default run. A log-based Beverton-Holt recruitment function is fitted to the least 75% successful recruitment points. The 25% most successful recruitment points (red) are treated separately during simulations



0- catch-at-age
1- spawning grounds acoustic in Febr.-March
2-acoust. surv. in wint. area Nov.-December
3- acust. wintering January
4- acoustic in feeding area May
5-immature May-June
6-immature in the Barents Sea September

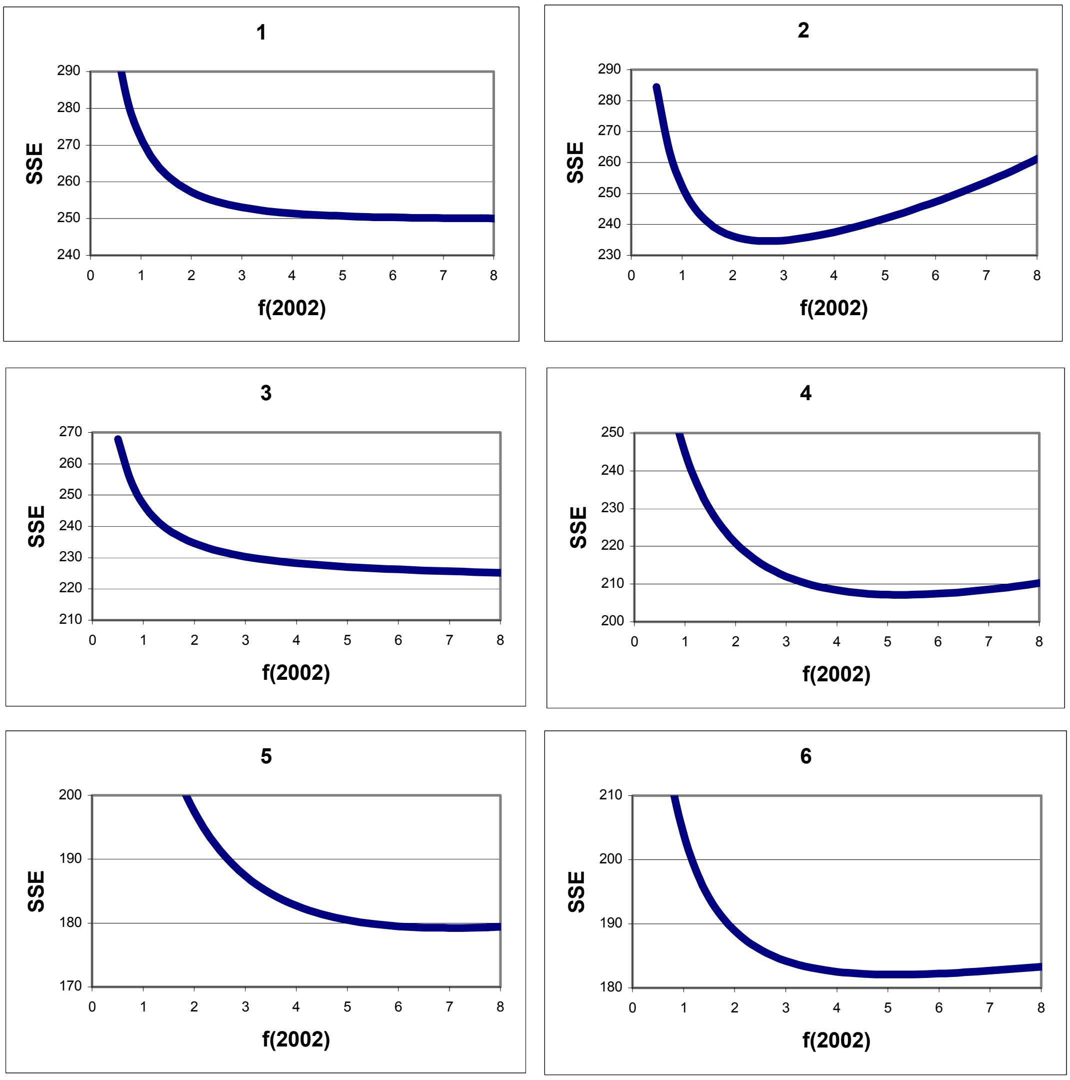


Figure 3.4.1.
NSS Herring.
ISVPA, catch-controlled version, logarithmic procedure,
unbiased description of LnC(a,y)
minimization of MDN for C(a,y) and SSE - for others
q(a) are estimated for all indexes

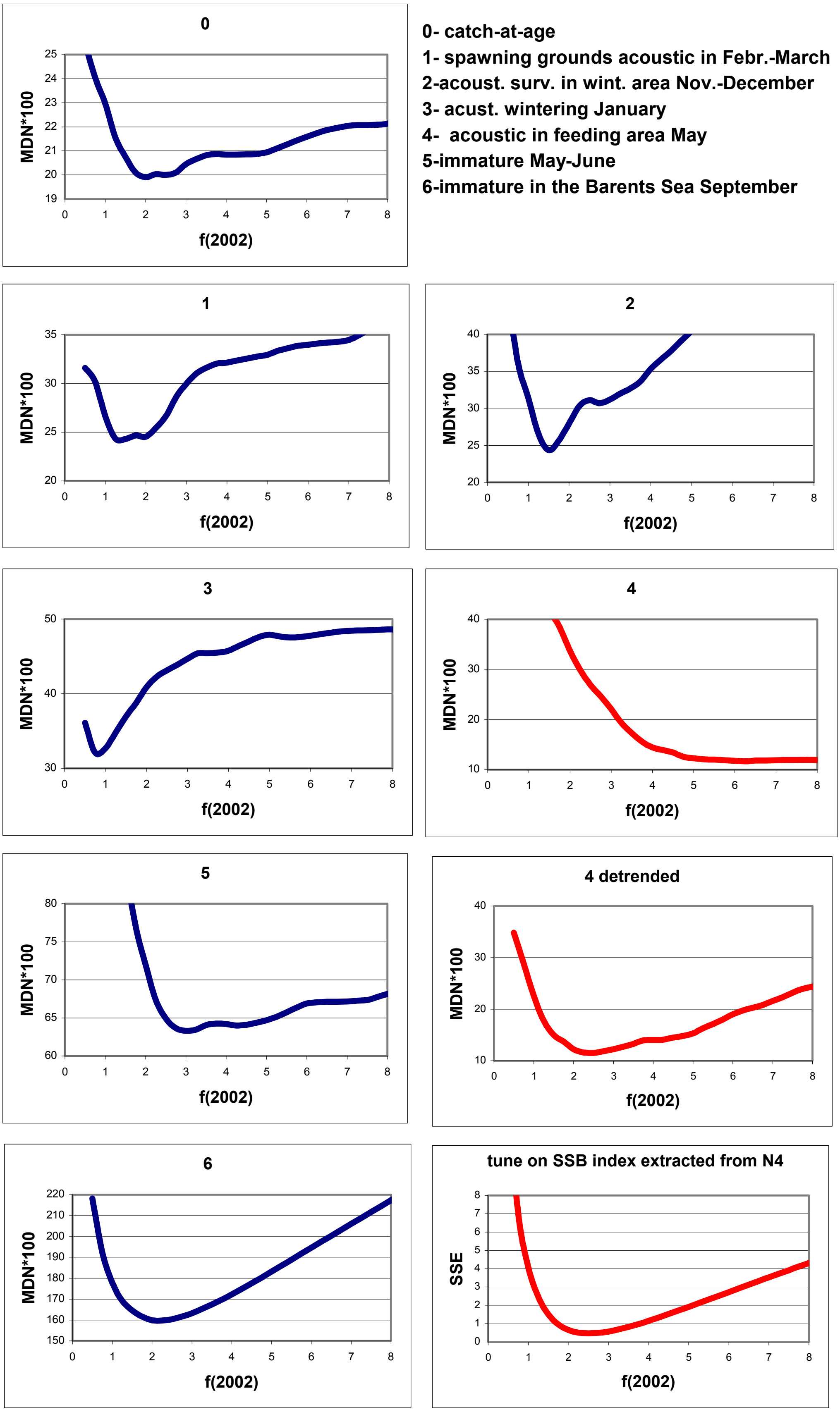


Fig. 3.4.2
NSS Herring.
ISVPA, catch-controlled version, logarithmic procedure,
unbiased description of LnC(a,y)
minimization of MDN for each kind of data
q(a) are estimated for all indexes

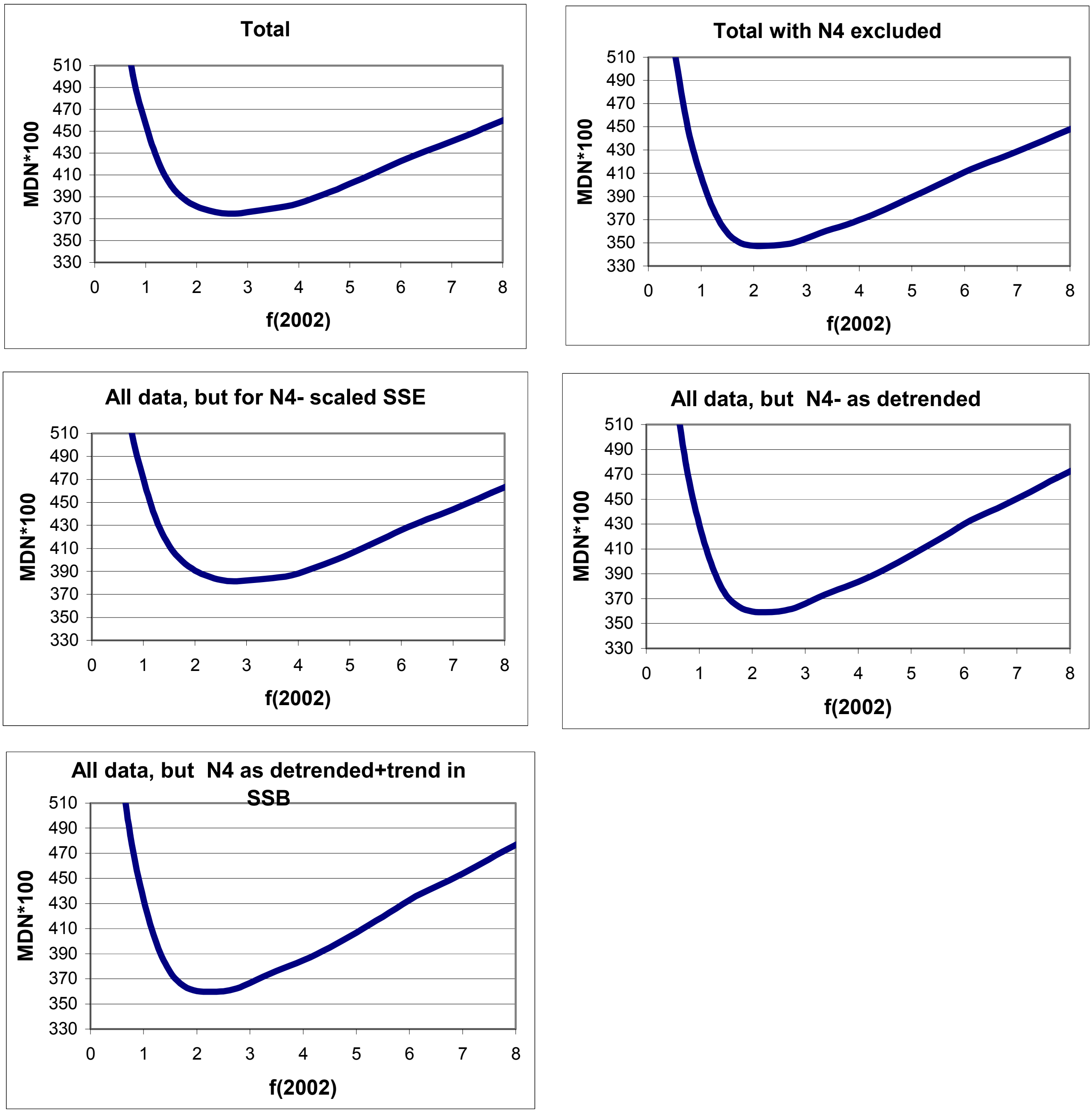


Figure 3.4.3
NSS herring. ISVPA.
The ISVPA overall loss function for different cases with respect to survey N4

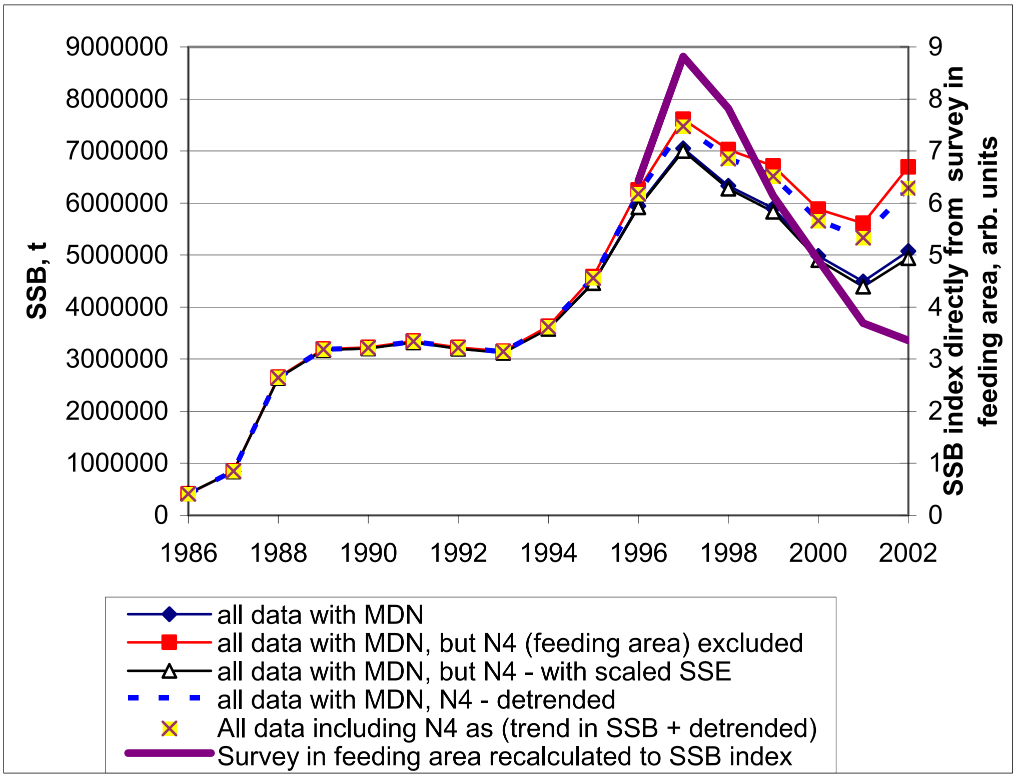


Fig. 3.4.4.
NSS herring. ISVPA
Estimates of SBB in relation to options with respect to survey N4

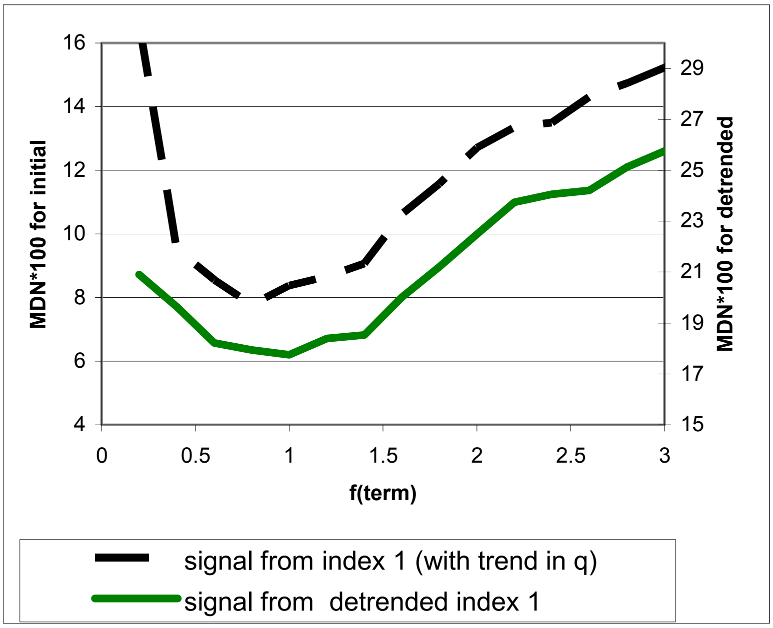


Figure 3.4.5
ISVPA, catch-controlled, applied to simulated data set (WGMG 2003)

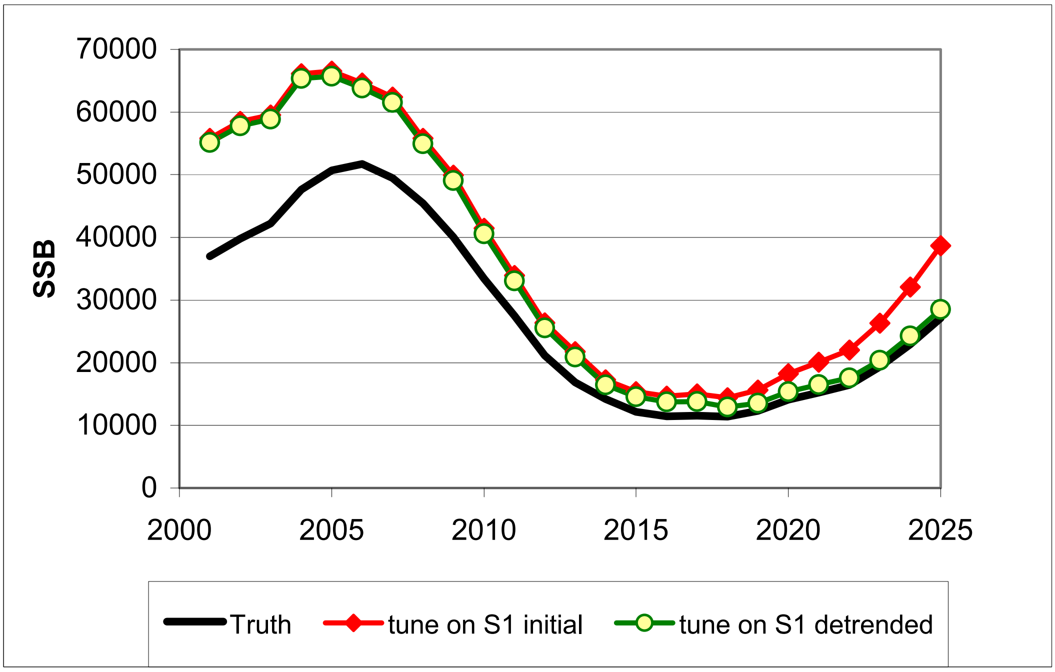
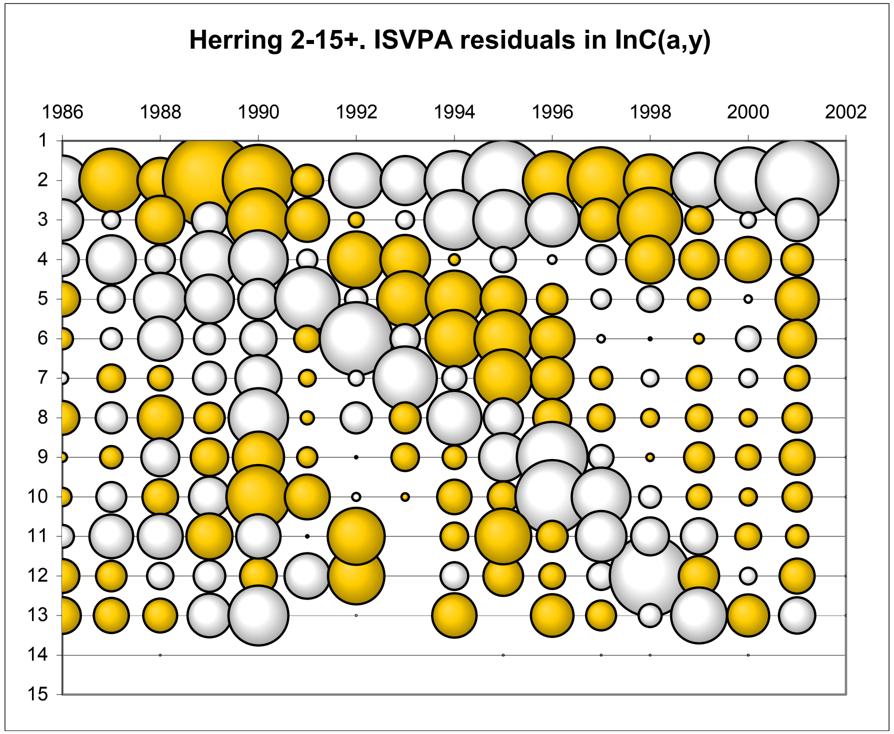


Figure 3.4.6
Results for tuning on index with time trend in catchability ("noized" data set from WGMG 20
(ISVPA, catch-controlled, minimization of MDN - the same options as for NSS herring)



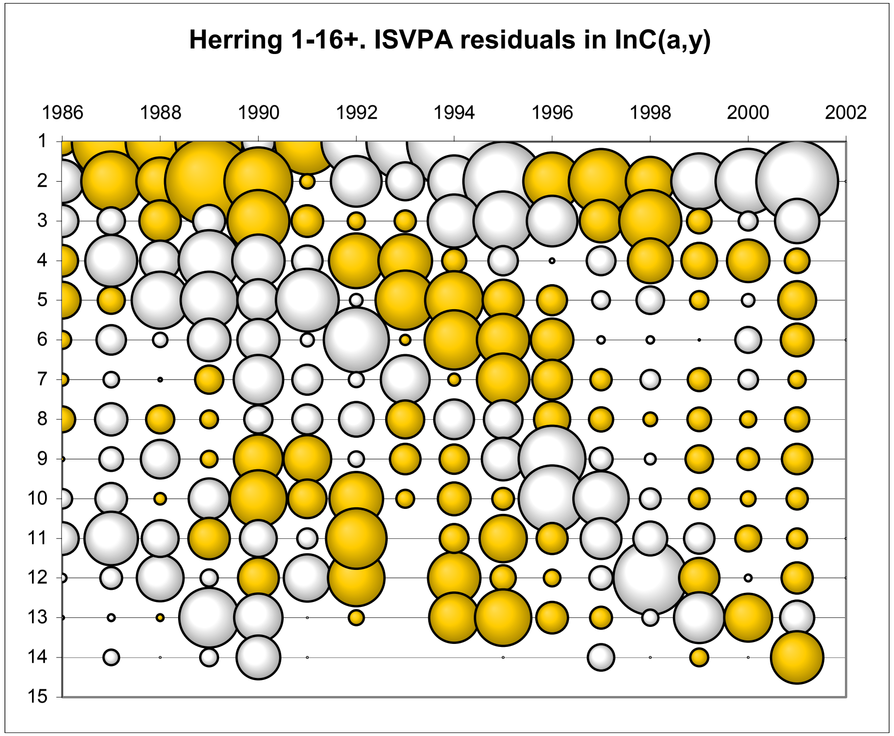
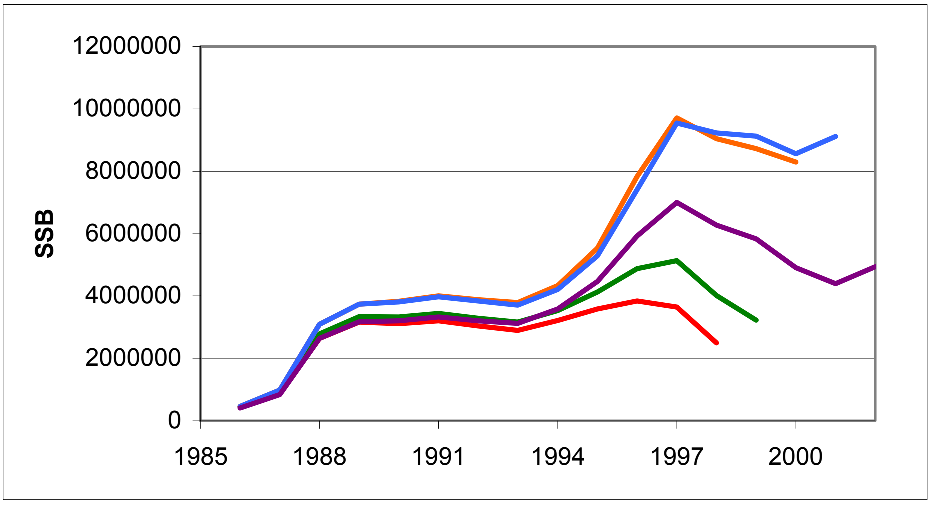
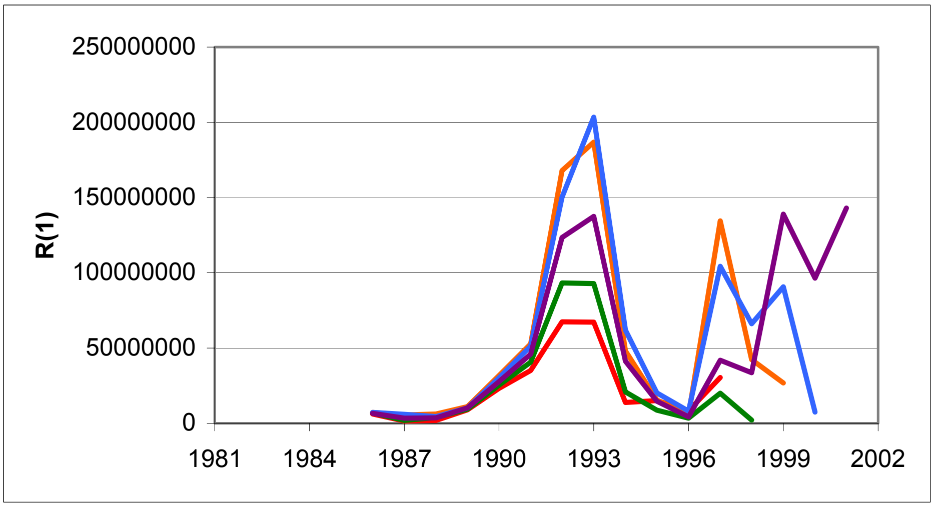


Figure 3.4.7
Pattern of residuals in logarithmic catches in dependence of age diapason used





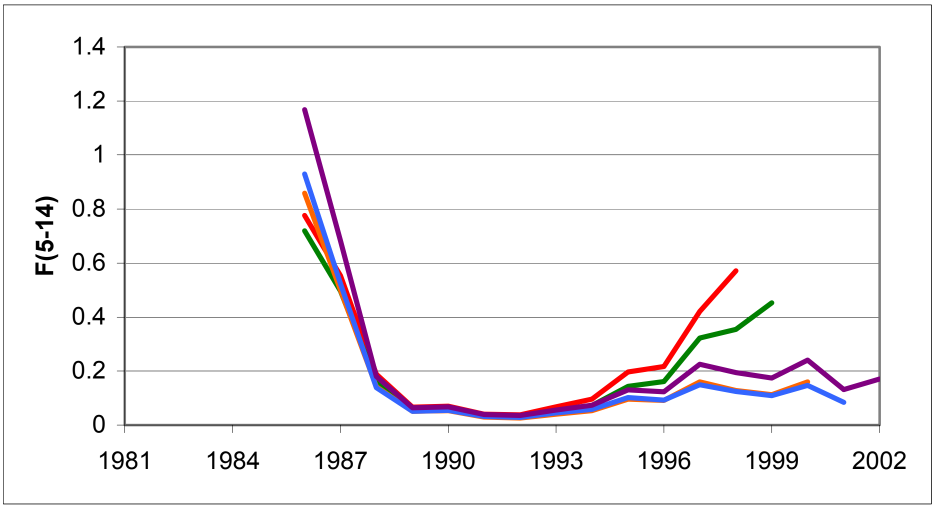


Figure 3.4.8.
NSS herring. ISVPA. Retrospective runs

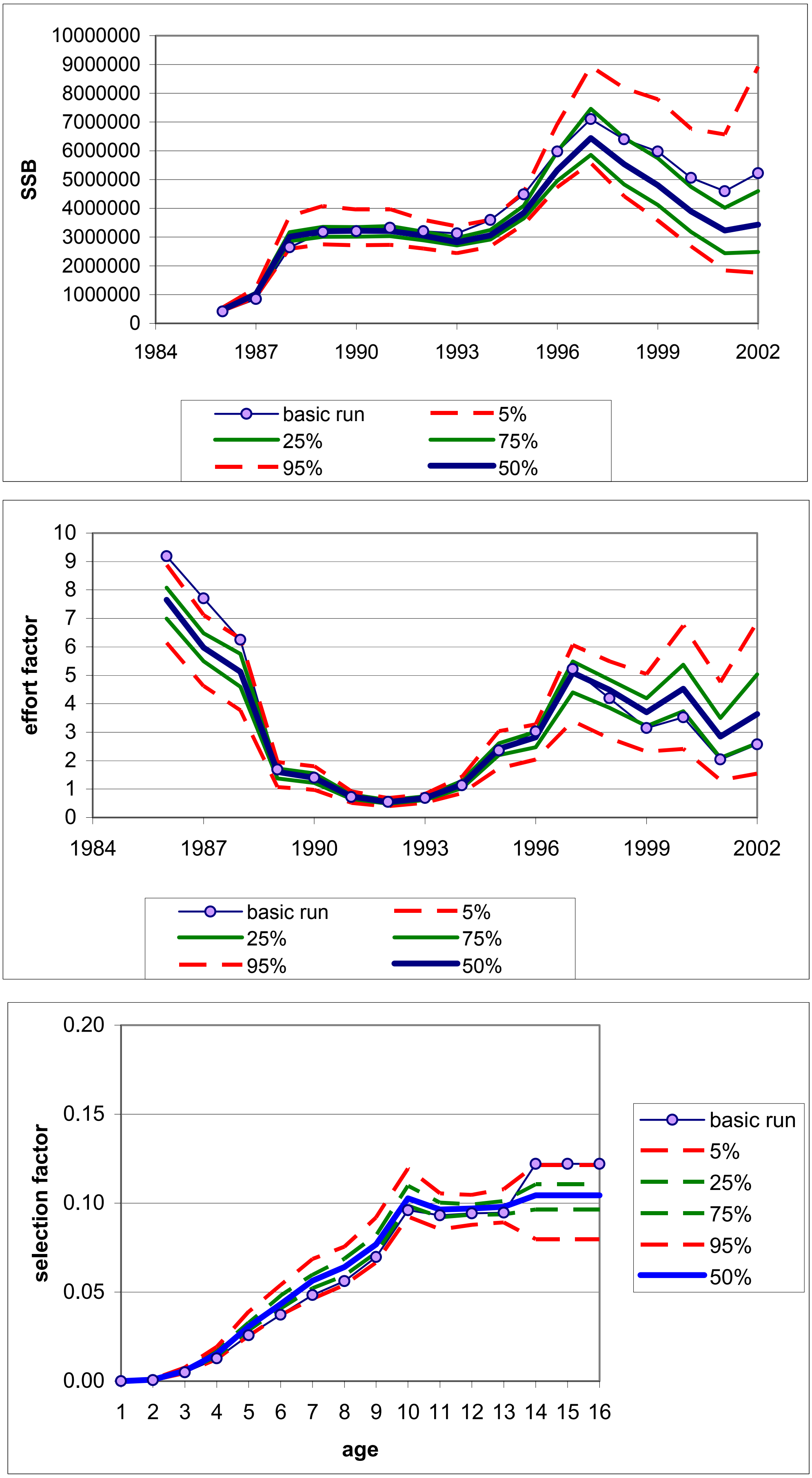


Figure 3.4.9.
NSS herring. ISVPA. Bootstrap

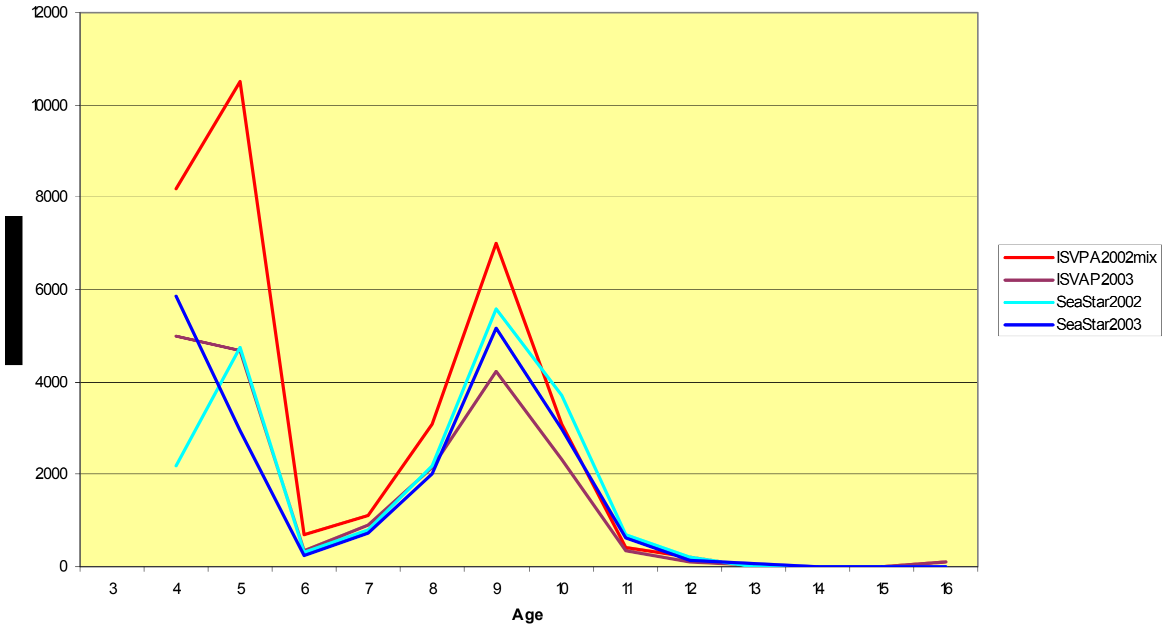


Figure 3.5.2.1 Comparison of year-class strength given by the ISVPA and Seastar assessments in 2002 and 2003. Ages refer to 1 Jan 2001.

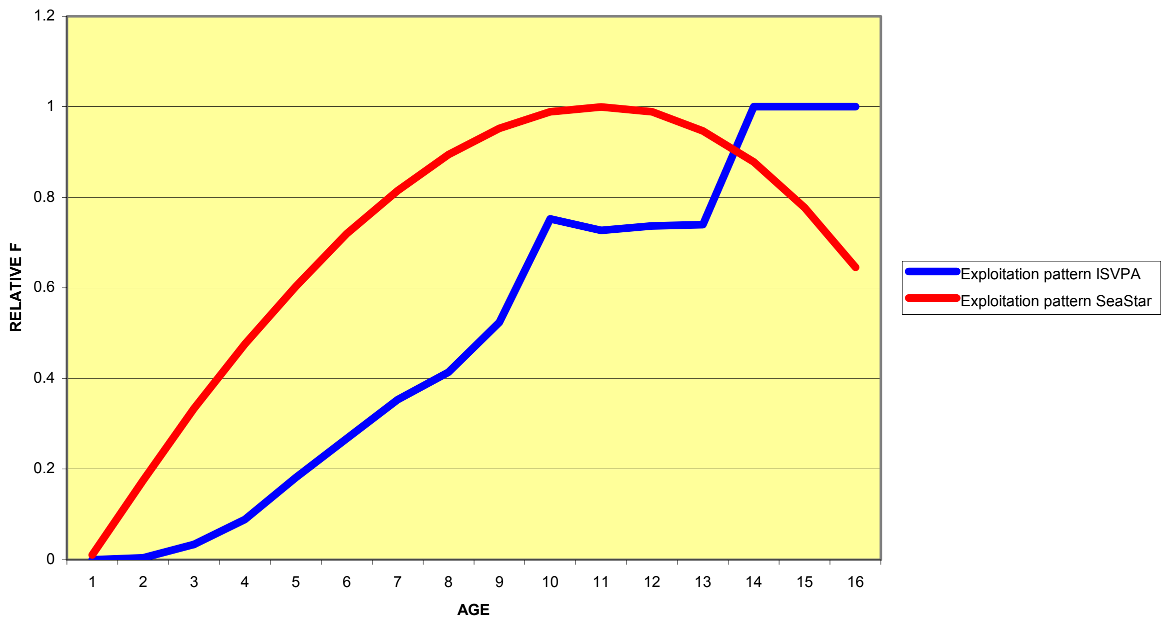


Figure 3.5.2.2 Comparison of exploitation patterns used by ISVPA and SeaStar in the short-term projection. F values are normalised to 1 as the largest value.

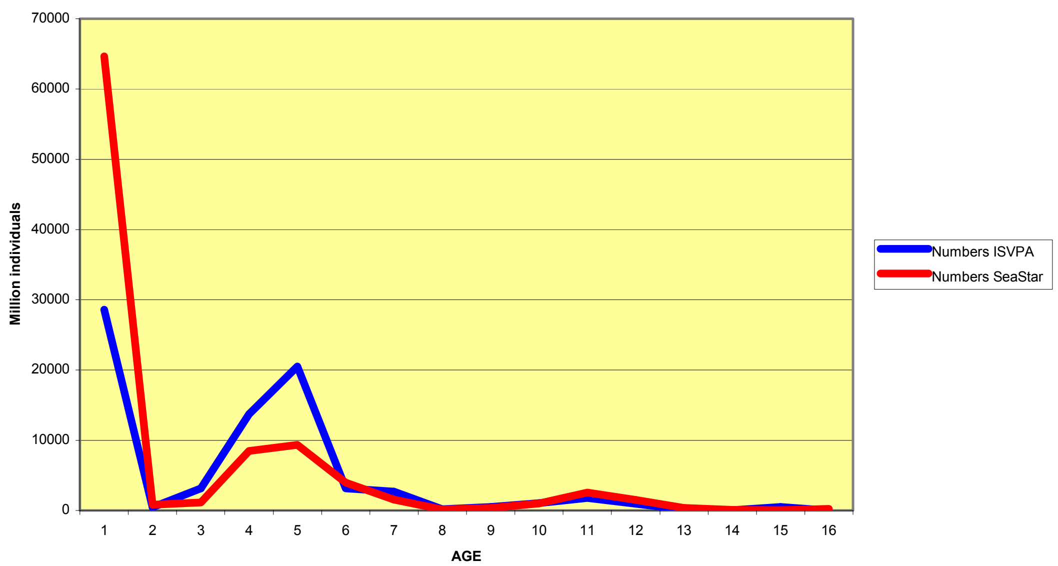


Figure 3.5.2.3 Comparison of year-class strength used by ISVPA and SeaStar in the short-term projection. Ages refer to 1 Jan 2003.

4 BARENTS SEA CAPELIN

4.1 Regulation of the Barents Sea Capelin Fishery

Since 1979, the Barents Sea capelin fishery has been regulated by a bilateral fishery management agreement between Russia (former USSR) and Norway. A TAC has been set separately for the winter fishery and for the autumn fishery. In recent years no autumn fishery has taken place, except for a small Russian experimental fishery. The fishery was closed from 1 May to 15 August until 1984. During the period 1984 to 1986, the fishery was closed from 1 May to 1 September. A minimum landing size of 11 cm has been in force for several years. From the autumn of 1986 to the winter of 1991, and from the autumn 1993 to the winter 1999 no fishery took place. The fishery was re-opened in the winter season 1991 and again in the winter season 1999, on a recovered stock.

In its autumn meeting of 2002, ACFM considered a harvest control rule, which was consistent with the precautionary approach. This rule defined the harvest level based on a maximum probability of 5% that SSB would fall below $\mathbf{B}_{\mathrm{lim}}$ of 200 000 t (corresponding to a catch of 310 000 t of pre-spawning capelin in 2003). ACFM also recommended that this harvest control rule be applied in 2003 (see also Section 4.5). During its Autumn 2002 meeting the Mixed Russian Norwegian Fishery Commission decided to set a quota of 310 000 t on Barents Sea capelin for the winter season 2002, divided by 60% (186 000 t) to Norway and 40% (124 000 t) to Russia. Moreover, the Commission agreed to adopt a management strategy based on the rule that, with 95% probability, at least 200 000 t of capelin should be allowed to spawn.

4.2 Catch Statistics

The international catch by country and season in the years 1965-2002 is given in Table 4.2.1. The catch by age and length groups during the spring season 2002 is given in Table 4.2.2. The total catch in winter 2002 given in Table 4.2.1 was 635 000 t. This is 15 000 t below the quota set for 2002. The catch by age and length taken in the Russian experimental fishery during autumn 2002 (16 000 t) is shown in Table 4.2.3.

The final catch statistics for the winter-spring season 2003 are not available. Preliminary figures show that the Norwegian fishery ended around 15 April with about 7 000 t of the quota remaining. The Russian fishery ended around 24 April with about 17 000 t of the quota remaining.

4.3 Stock Size Estimates

4.3.1 Larval and 0-group estimates in 2002

Norwegian larval surveys based on Gulf III plankton samples have been carried out in June each year since 1981. The estimated total number of larvae is shown in Table 4.3.1.1. These larval abundance estimates do not show a high correlation with year-class strength at age one, but should reflect the amount of larvae produced each year (Gundersen and Gjøsæter, 1998). The year 1986 was exceptional, in that no larvae were found. This may have been due to late spawning that year, and eggs may have hatched after the survey was carried out. Also in other years some spawning is known to have taken place during the summer, and offspring from such late spawning is not reflected in the larval abundance estimates in Table 4.3.1.1. Since 1997, permission has not been granted to enter the Russian EEZ during the larval survey, and consequently the total larval distribution area has not been covered. The estimate of $22.4 \cdot 10^{12}$ larvae in 2002 is twice as large as the estimate in 2001, at the same level as that obtained in 2000 and far above the average for the period 1981-2002. During the international 0-group surveys in August an area-based index for the abundance of 0-group capelin is calculated (Table 4.3.1.1). Gundersen and Gjøsæter (1998) found these indices to be well correlated ($r^2 = 0.75$) with the 1-group acoustic estimates for the same year class obtained by the annual capelin acoustic surveys in autumn. Data points up to 1994 were included in this analysis. When this regression is updated with the survey results from 1981-2001 the parameters in the regression were changed slightly and the r^2 was reduced to 0.68. Based on this regression, (ln 1-group estimate = -1.77 + 1.19 · ln 0-group index), the 0-group index obtained in 2002 of 327 would correspond to a year-class strength of 170 billion one-year-olds in autumn 2003. A year class of this size would be about 80% of an average year class in the period 1972-2001.

4.3.2 Acoustic stock size estimates in 2002

Two Russian and two Norwegian vessels jointly carried out the 2002 acoustic survey in the period 10 September to 6 October (Bogstad *et al,* WD.). As previously the Norwegian vessels had restricted access to the Russian EEZ, but since two of the four vessels available to the survey could work in the Russian EEZ, the coverage of the total stock was considered complete. The results from the survey are given in Table 4.3.2.1, and are compared to previous years' results in Table 4.3.2.2. The stock size was estimated at 2.2 million tonnes. About 60% (1.3 million t) of the stock biomass consisted of maturing fish (> 14 cm).

4.3.3 Other surveys

During the Norwegian demersal fish survey in February 2002 observations of capelin by acoustics and by pelagic and demersal trawls were made (Røttingen and Gjøsæter, WD). However, no stock size estimate was attempted, due to inadequate coverage and low number of pelagic trawl hauls for identification and sampling purposes. Samples of cod stomachs during this period give valuable information for the modelling of maturing capelin as prey for cod (Bogstad and Gjøsæter, 2001).

4.4 Historical stock development

An overview of the development of the Barents Sea capelin stock in the period 1991-2002 is given in Tables 4.4.1-4.4.7. The methods and assumptions used for constructing the tables are explained in Appendix A to ICES 1995/Assess:9. In that report, the complete time-series back to 1973 can also be found. It should be noted that several of the assumptions and parameter values used in constructing these tables differ from those used in the assessment. For instance, in the assessment model the M-values for immature capelin are calculated using new estimates of the length at maturity and M-values for mature capelin are calculated taking the predation by cod into account. This will also affect the estimates of spawning stock biomass given in the stock summary table (Table 4.4.7). It should be noted that these values, coming from a deterministic model cannot directly be compared to those coming from the probabilistic assessment model (Bifrost) used for this stock. However, as a crude overview of the development of the Barents Sea capelin stock the tables may be adequate.

Estimates of stock in number by age group and total biomass for the period are shown in Table 4.4.1. Catch in numbers-at-age and total landings are shown for the spring and autumn seasons in Tables 4.4.2 and 4.4.3. Natural mortality coefficients by age group for immature and mature capelin are shown in Table 4.4.4. Stock size at 1 January in numbers-at-age and total biomass is shown in Table 4.4.5. Spawning stock biomass per age group is shown in Table 4.4.6. Table 4.4.7 gives an aggregated summary for the entire period 1973-2002.

4.5 Stock assessment autumn 2002

As decided by the Northern Pelagic and Blue Whiting Fisheries Working Group at its 2002 meeting (ICES 2002/ACFM:19), the assessment of Barents Sea capelin was left to the parties responsible for the autumn survey, i.e. IMR in Bergen and PINRO in Murmansk, who reported directly to ACFM before its autumn 2002 meeting (Bogstad *et al.,* WD).

A probabilistic projection of the spawning stock to the time of spawning at 1 April 2003 was presented, using the spreadsheet model CapTool (implemented in the @RISK add-on for EXCEL). The projection was based on a probabilistic maturation model with parameters estimated by the model Bifrost (Gjøsæter *et al*., 2002) with uncertainty taken into account and data on size and composition of the cod stock (from the Arctic Fisheries Working Group, ICES 2002/ACFM:18, but made probabilistic in CapTool in accordance with the risk analysis made by the Arctic Fisheries Working Group).

There is clearly a need for a target biomass reference point for capelin. Calculations of B_{target} were attempted, but were not presented because the results were considered preliminary. A $\mathbf{B}_{lim}$ (SS$\mathbf{B}_{lim}$) management approach was suggested for this stock. As in previous years, the meeting suggested the spawning stock size in 1989 as a $\mathbf{B}_{lim.}$ The rationale behind this was that this biomass produced one of the strongest year classes observed during the period 1972-2001. It should also be noted that this year is within the time range for which quantitative stomach content data are available. It can be argued that the SSB in 1989 was sufficiently large to produce a good year class under favourable recruitment conditions in a "non-herring situation" (Gjøsæter and Bogstad, 1998).

Probabilistic prognoses for the maturing stock from October 1, 2002 until April 1, 2003 were made, with a CV of 0.20 on the abundance estimate. The meeting concluded that capelin recruitment in 2003 would probably not be influenced to any noticeable degree by the stock of young herring now found in the Barents Sea.

ACFM at its autumn 2002 meeting (ICES 2002/CRR:255) took most of the points in the report into account. ACFM agreed to the view that fishing mortality reference points and a $\mathbf{B}_{pa}$ are not relevant for this stock, and that a target escapement management strategy is the most useful way of ensuring a minimum amount of spawners. Further ACFM agreed to the strategy adopted of directing the fishery at the spawning stock just prior to spawning, to allow the capelin to be available to predators as long as possible. The idea of a stochastic $\mathbf{B}_{\text{lim}}$ set equal to the modelled density distribution of the spawning stock in 1989 was considered “a good basis for such a reference point in a non-herring situation”. Because the assessment method may not yet account for all sources of uncertainty, and there are inconsistencies in the data series ACFM did not adopt the suggested $\mathbf{B}_{\text{lim}}$. Rather, ACFM set a $\mathbf{B}_{\text{lim}}$ of 200 000 t, and consequently, advised that a TAC should not exceed 310 000 t. This was based on adopting the forecast of the SSB using the limit reference points referred above, and following the harvest control rule that the SSB should fall below $\mathbf{B}_{\text{lim}}$ with a maximum 5% probability. ACFM also considered that adjustments of the harvest control rule should be further investigated for the purpose of taking better account of the uncertainty in the predicted estimate of spawner abundance, the likely interactions with herring, and the role of capelin as prey.

4.6 Management considerations

Since the assessment of the stock is directly based on the acoustic survey conducted annually in September-October, and the main fishing season does not begin until January, advice for this stock must be given during the autumn ACFM meeting and the TAC must be set by the Mixed Norwegian-Russian Fishery Commission during its meeting in November-December. As previously decided by the Northern Pelagic and Blue Whiting Fisheries Working Group, the assessment of Barents Sea capelin is left to the parties responsible for the autumn survey, i.e. IMR in Bergen and PINRO in Murmansk, who will meet in Murmansk after the autumn survey and report directly to the 2003 ACFM autumn meeting.

4.7 Sampling

The sampling from scientific surveys and from commercial fishing on capelin in 2002 and winter 2003 is summarised below:

Investigation	No. of samples	Length measurements	Aged individuals
Russian capelin investigation winter 2002	18	9105	900
Russian fishery winter-spring 2002	9	13145	751
Norwegian capelin investigations winter 2002	221	6578	2463
Norwegian fishery winter-spring 2002	77	7851	1700
Acoustic survey autumn 2002 (Norway)	87	6539	4830
Acoustic survey autumn 2002 (Russia)	24	22206	972
Other samples 2002 (Norway)	363	17491	1550
Autumn monitoring 2002 (Russian)	25	37581	1250
Russian fishery winter-spring 2003	16	10349	800

Table 4.2.1 Barents Sea CAPELIN. International catch ('000 t) as used by the Working Group.

Year	Winter				Summer-Autumn			Total
	Norway	Russia	Others	Total	Norway	Russia	Total	
1965	217	7	0	224	0	0	0	224
1966	380	9	0	389	0	0	0	389
1967	403	6	0	409	0	0	0	409
1968	460	15	0	475	62	0	62	537
1969	436	1	0	437	243	0	243	680
1970	955	8	0	963	346	5	351	1314
1971	1300	14	0	1314	71	7	78	1392
1972	1208	24	0	1232	347	11	358	1591
1973	1078	35	0	1112	213	10	223	1336
1974	749	80	0	829	237	82	319	1149
1975	559	301	43	903	407	129	536	1439
1976	1252	231	0	1482	739	366	1105	2587
1977	1441	345	2	1788	722	477	1199	2987
1978	784	436	25	1245	360	311	671	1916
1979	539	343	5	887	570	326	896	1783
1980	539	253	9	801	459	388	847	1648
1981	784	428	28	1240	454	292	746	1986
1982	568	260	5	833	591	336	927	1760
1983	751	374	36	1161	758	439	1197	2358
1984	330	257	42	628	481	367	849	1477
1985	340	234	17	590	113	164	278	868
1986	72	51	0	123	0	0	0	123
1987	0	0	0	0	0	0	0	0
1988	0	0	0	0	0	0	0	0
1989	0	0	0	0	0	0	0	0
1990	0	0	0	0	0	0	0	0
1991	528	156	20	704	31	195	226	929
1992	620	247	24	891	73	159	232	1123
1993	402	170	14	586	0	0	0	586
1994	0	0	0	0	0	0	0	0
1995	0	0	0	0	0	0	0	0
1996	0	0	0	0	0	0	0	0
1997	0	0	0	0	0	1	1	1
1998	0	0	0	0	0	1	1	1
1999	46	32	0	78	0	23	23	101
2000	283	95	8	386	0	28	28	414
2001	368	180	8	557	0	11	11	568
2002	391	228	17	635	0	16	16	651
2003[1]	179	107						

[1] Preliminary data

Table 4.2.2 Barents Sea CAPELIN. International catch in number (10^6) and biomass (t) during the spring season 2002, as used by the Working Group

Length	Age 1		Age 2		Age 3		Age 4		Age 5+		Sum			
cm	N	B	N	B	N	B	N	B	N	B	N	%	B	%
5.0-5.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5.5-6.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6.0-6.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6.5-7.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7.0-7.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7.5-8.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8.0-8.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8.5-9.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9.0-9.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9.5-10.0	0	0	27	81	0	0	0	0	0	0	27	0	81	0
10.0-10.5	0	0	4	13	0	0	0	0	0	0	4	0	13	0
10.5-11.0	0	0	4	15	0	0	0	0	0	0	4	0	15	0
11.0-11.5	0	0	4	24	0	0	0	0	0	0	4	0	24	0
11.5-12.0	0	0	6	172	7	53	0	0	0	0	13	0	224	0
12.0-12.5	23	0	12	82	24	165	0	0	0	0	59	0	247	0
12.5-13.0	0	0	0	0	23	220	0	0	0	0	23	0	220	0
13.0-13.5	0	0	0	1	261	2662	0	0	0	0	261	1	2663	0
13.5-14.0	0	0	11	103	627	7000	0	0	0	0	638	3	7103	1
14.0-14.5	0	0	12	128	609	7739	30	391	0	0	651	3	8259	1
14.5-15.0	0	0	50	593	1289	18504	39	588	0	0	1378	5	19685	3
15.0-15.5	0	0	57	756	1557	25370	256	4316	0	0	1870	7	30442	5
15.5-16.0	0	0	45	630	1381	25260	685	12919	0	0	2112	8	38809	6
16.0-16.5	0	0	23	390	1344	27926	1747	38247	25	489	3140	12	67052	11
16.5-17.0	0	0	68	1244	1105	25621	2219	53905	54	1216	3446	14	81985	13
17.0-17.5	0	0	34	658	756	19762	2154	59203	47	1143	2991	12	80765	13
17.5-18.0	0	0	0	0	634	18176	2425	74118	61	1816	3120	12	94109	15
18.0-18.5	0	0	0	0	229	7679	2112	72538	185	5797	2526	10	86013	14
18.5-19.0	0	0	0	0	100	3579	1516	56606	142	5023	1758	7	65208	10
19.0-19.5	0	0	0	0	37	1422	775	31632	77	3157	889	4	36212	6
19.5-20.0	0	0	0	0	23	1135	208	8923	62	2612	292	1	12670	2
20.0-20.5	0	0	0	0	0	0	56	2613	10	459	66	0	3072	0
20.5-21.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21.0-21.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21.5-22.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sum	23	0	358	4889	10005	192271	14222	415998	663	21712	25272	100	634870	100

Table 4.2.3 Barents Sea CAPELIN. Russian catch in number (10^6) and biomass (t) during the autumn season 2001, as used by the Working Group

Length	Age 1		Age 2		Age 3		Age 4		Age 5+		Sum			
cm	N	B	N	B	N	B	N	B	N	B	N	%	B	%
5.0-5.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5.5-6.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6.0-6.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6.5-7.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7.0-7.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7.5-8.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8.0-8.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8.5-9.0	1	2	0	0	0	0	0	0	0	0	1	0	2	0
9.0-9.5	2	7	0	0	0	0	0	0	0	0	2	0	7	0
9.5-10.0	2	7	0	0	0	0	0	0	0	0	2	0	7	0
10.0-10.5	3	11	0	0	0	0	0	0	0	0	3	0	11	0
10.5-11.0	6	26	0	0	0	0	0	0	0	0	6	1	26	0
11.0-11.5	6	29	2	10	0	0	0	0	0	0	7	1	39	0
11.5-12.0	3	22	9	63	0	0	0	0	0	0	13	1	85	1
12.0-12.5	0	3	16	117	1	7	0	0	0	0	17	2	126	1
12.5-13.0	0	0	25	209	0	0	0	0	0	0	25	3	209	1
13.0-13.5	0	4	38	363	4	43	0	0	0	0	43	5	410	3
13.5-14.0	0	0	54	587	11	132	0	0	0	0	65	7	719	4
14.0-14.5	0	0	55	671	25	313	0	0	0	0	80	9	985	6
14.5-15.0	0	0	39	516	50	712	0	0	0	0	89	10	1228	8
15.0-15.5	0	0	26	381	62	997	0	0	0	0	88	10	1378	9
15.5-16.0	0	0	11	190	70	1251	0	0	0	0	81	9	1441	9
16.0-16.5	0	0	7	141	72	1426	1	16	0	0	80	9	1583	10
16.5-17.0	0	0	7	143	56	1239	1	18	0	0	63	7	1401	9
17.0-17.5	0	0	1	19	61	1546	1	19	0	0	63	7	1583	10
17.5-18.0	0	0	0	12	49	1377	0	0	0	0	50	6	1389	9
18.0-18.5	0	0	2	55	37	1171	2	47	0	0	40	5	1273	8
18.5-19.0	0	0	1	44	29	998	1	24	0	0	31	4	1067	7
19.0-19.5	0	0	0	0	16	608	2	51	0	0	18	2	659	4
19.5-20.0	0	0	0	0	5	193	1	31	0	0	6	1	225	1
20.0-20.5	0	0	0	0	2	110	1	37	0	0	3	0	147	1
20.5-21.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21.0-21.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21.5-22.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sum	24	111	293	3520	551	12124	8	243	0	0	876	100	15999	100

Table 4.3.1.1 Barents Sea CAPELIN. Larval abundance estimate (10^{12}) in June, and 0-group index in August.

Year	Larval Abundance	0-group index
1981	9.7	570
1982	9.9	393
1983	9.9	589
1984	8.2	320
1985	8.6	110
1986	0.0	125
1987	0.3	55
1988	0.3	187
1989	7.3	1300
1990	13.0	324
1991	3.0	241
1992	7.3	26
1993	3.3	43
1994	0.1	58
1995	0.0	43
1996	2.4	291
1997	6.9	522
1998	14.1	428
1999	36.5	722
2000	19.1	303
2001	10.7	221
2002	22.4	327

Table 4.3.2.1 Barents Sea CAPELIN. Estimated stock size from the acoustic survey in September-October 2002. Based on TS value 19.1 log L –74.0 dB, corresponding to σ = 5.0 · 10^{7} · $L^{1.91}$.

	Age/Year class						
Length (cm)	1	2	3	4	Sum	Biomass	Mean
	2001	2000	1999	1998	(10^6)	(10^3 t)	weight (g)
6.5 - 7.0	2				2	0.0	1.0
7.0 - 7.5	214				214	0.3	1.6
7.5 - 8.0	1674				1674	2.6	1.6
8.0 - 8.5	8844				8844	18.1	2.0
8.5 - 9.0	7407				7407	18.8	2.5
9.0 - 9.5	6206				6206	19.6	3.2
9.5 - 10.0	4797				4797	16.7	3.5
10.0 - 10.5	7130	55			7185	30.5	4.2
10.5 - 11.0	10471	758			11229	53.5	4.8
11.0 - 11.5	8102	2594			10697	58.4	5.5
11.5 - 12.0	4033	9706			13738	87.5	6.4
12.0 - 12.5	451	17173	61		17684	138.0	7.8
12.5 - 13.0	26	17854	286		18166	162.5	8.9
13.0 - 13.5	204	14255	1486		15945	158.0	9.9
13.5 - 14.0	78	11089	2076		13243	154.4	11.7
14.0 - 14.5	64	8470	5812		14346	190.0	13.2
14.5 - 15.0		3824	6503		10327	155.3	15.0
15.0 - 15.5		2578	6422		9000	155.2	17.2
15.5 - 16.0		916	6284	9	7209	142.8	19.8
16.0 - 16.5		392	6248	48	6688	152.6	22.8
16.5 - 17.0		424	5274	32	5730	146.3	25.5
17.0 - 17.5		292	4007	47	4346	122.8	28.3
17.5 - 18.0		355	3193	91	3639	115.7	31.8
18.0 - 18.5		61	1735	86	1882	67.5	35.8
18.5 - 19.0			642	134	776	29.8	38.3
19.0 - 19.5			181	58	239	10.3	43.0
19.5 - 20.0				60	60	2.6	43.0
20.0 - 20.5				8	8	0.4	51.1
20.5 - 21.0				2	2	0.1	55.8
TSN (10^6)	59704	90794	50211	577	201286		
TSB (10^3 t)	234.3	918.6	1037.1	20.2		2210.2	
Mean length (cm)	9.90	13.10	15.80	18.20	12.80		
Mean weight (g)	3.9	10.1	20.7	35.0			11.0
SSN (10^6)	64	17312	46301	575	64252		
SSB (10^3 t)	0.8	273.1	995.5	20.1		1291.4	

Based on TS value: 19.1 log L - 74.0, corresponding to σ = 5.0 · 10^{-7} · $L^{1.9}$

Table 4.3.2.2 Barents Sea CAPELIN. Stock size in numbers by age, total stock biomass and biomass of the maturing component. Stock in numbers (unit:10^9) and stock and maturing stock biomass (unit:10^3 tonnes) are given at 1 October.

Year	Stock in numbers (10^9)						Stock in weight ('000 t)	
	Age 1	Age 2	Age 3	Age 4	Age 5	Total	Total	Maturing
1973	528	375	40	17	0	961	5144	1350
1974	305	547	173	3	0	1029	5733	907
1975	190	348	296	86	0	921	7806	2916
1976	211	233	163	77	12	696	6417	3200
1977	360	175	99	40	7	681	4796	2676
1978	84	392	76	9	1	561	4247	1402
1979	12	333	114	5	0	464	4162	1227
1980	270	196	155	33	0	654	6715	3913
1981	403	195	48	14	0	660	3895	1551
1982	528	148	57	2	0	735	3779	1591
1983	515	200	38	0	0	754	4230	1329
1984	155	187	48	3	0	393	2964	1208
1985	39	48	21	1	0	109	860	285
1986	6	5	3	0	0	14	120	65
1987	38	2	0	0	0	39	101	17
1988	21	29	0	0	0	50	428	200
1989	189	18	3	0	0	209	864	175
1990	700	178	16	0	0	894	5831	2617
1991	402	580	33	1	0	1016	7287	2248
1992	351	196	129	1	0	678	5150	2228
1993	2	53	17	2	2	75	796	330
1994	20	3	4	0	0	28	200	94
1995	7	8	2	0	0	17	193	118
1996	82	12	2	0	0	96	503	248
1997	99	39	2	0	0	140	911	312
1998	179	73	11	1	0	263	2056	931
1999	156	101	27	1	0	285	2776	1718
2000	449	111	34	1	0	595	4273	2099
2001	114	219	31	1	0	364	3630	2019
2002	60	91	50	1	0	201	2210	1290

Table 4.4.1 Barents Sea CAPELIN. Estimated stock size in numbers (unit:10^9) by age group and total, and biomass ('000 t) of total stock, by 1 August, back-calculated from the survey in September-October.

Age	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
1	3.1	29.5	8.3	88.9	111.8	188.4	171.4	474.7	128.0	67.3
2	73.0	5.1	9.4	12.5	44.2	76.5	111.5	116.8	246.6	102.3
3	25.3	6.4	1.6	2.2	2.2	12.1	27.9	35.9	33.0	54.4
4	3.7	0.3	0.4	0.1	0.1	0.7	0.9	0.8	1.2	0.6
5	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.1	0.1	0.0
Sum	105.0	41.4	19.7	103.7	158.3	277.8	311.7	628.4	408.8	224.7
Biomass	991	259	189	467	866	1860	2580	3840	3480	2122

Table 4.4.2 Barents Sea CAPELIN. Catch in numbers (unit:10^9) by age group and total landings ('000 t) in the spring season.

Age	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0
2	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.5	0.4
3	4.8	0.0	0.0	0.0	0.0	0.0	1.6	5.5	7.6	10.0
4	26.8	0.0	0.0	0.0	0.0	0.0	1.2	8.4	12.1	14.2
5	1.4	0.0	0.0	0.0	0.0	0.0	0.1	1.0	2.2	0.7
Sum	33.5	0.0	0.0	0.0	0.0	0.0	3.0	15.1	22.5	25.3
Landings	586	0	0	0	0	0	78	386	557	635

Table 4.4.3 Barents Sea CAPELIN. Catch in numbers (unit:10^9) by age group and total landings ('000 t) in the autumn season.

Age	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
1	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.1	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.9	0.9	0.4	0.3
3	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.4	0.2	0.6
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sum	0.0	0.0	0.0	0.0	0.0	0.1	1.6	1.5	0.6	0.9
Landings	0	0	0	0	1	1	23	28	11	16

Table 4.4.4 Barents Sea CAPELIN. Natural mortality coefficients (per month) for immature fish (M_{imm}), used for the whole year, and for mature fish (per season) (M_{mat}) used January to March, by age group and average for age groups 1-5.

	1993		1994		1995		1996		1997	
Age	M_{imm}	M_{mat}	M_{imm}	M_{mat}	M_{imm}	M_{mat}	M_{imm}	M_{mat}	M_{imm}	M_{mat}
1	0.157	0.471	0.201	0.602	0.073	0.219	0.041	0.122	0.062	0.185
2	0.157	0.470	0.201	0.602	0.073	0.219	0.041	0.122	0.062	0.185
3	0.190	0.571	0.201	0.602	0.019	0.058	0.041	0.122	0.062	0.185
4	0.214	0.642	0.282	0.847	0.044	0.133	0.050	0.149	0.014	0.041
5	0.214	0.642	0.282	0.847	0.044	0.133	0.050	0.149	0.014	0.041
Avr	0.186	0.559	0.221	0.700	0.052	0.152	0.043	0.133	0.042	0.127

Table 4.4.4 (Continued)

Age	1998		1999		2000		2001		2002	
	M_{imm}	M_{mat}	M_{imm}	M_{mat}	M_{imm}	M_{mat}	M_{imm}	M_{mat}	M_{imm}	M_{mat}
1	0.026	0.077	0.047	0.142	0.028	0.083	0.060	0.180	0.060	0.180
2	0.026	0.077	0.047	0.142	0.028	0.083	0.060	0.180	0.060	0.180
3	0.071	0.212	0.025	0.074	0.026	0.079	0.040	0.120	0.040	0.120
4	0.071	0.212	0.025	0.074	0.026	0.079	0.040	0.120	0.040	0.120
5	0.071	0.212	0.025	0.074	0.026	0.079	0.040	0.120	0.040	0.120
Avr	0.053	0.158	0.034	0.101	0.027	0.080	0.048	0.144	0.048	0.144

Table 4.4.5 Barents Sea CAPELIN. Estimated stock size in numbers (unit:10^9) by age group and total, and biomass ('000 t) of total stock, by 1 January.

Age	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
1	9.2	120.3	13.8	118.2	172.0	225.5	238.5	576.1	194.7	102.3
2	293.7	1.4	10.8	5.7	72.5	82.2	165.8	135.3	413.3	94.6
3	162.6	33.3	1.9	6.5	10.2	32.5	67.3	88.1	100.9	182.6
4	89.2	9.8	2.4	1.4	1.8	1.6	8.5	24.7	31.1	27.0
5	0.5	1.3	0.1	0.3	0.1	0.1	0.5	0.8	0.7	0.9
Sum	555.2	166.1	28.9	132.2	256.6	341.9	480.6	824.9	740.6	407.5
Biomass	4372	737	156	313	779	1240	2456	3571	4558	3539

Table 4.4.6 Barents Sea CAPELIN. Estimated spawning stock biomass ('000 t) by 1 April.

Age	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
1	0	0	0	0	0	0	0	0	0	0
2	0	0	1	3	1	1	2	24	5	0
3	129	34	15	71	175	217	650	819	943	867
4	331	60	38	24	49	34	193	472	539	339
5	0	11	1	7	2	2	10	0	0	9
Sum	460	105	55	105	228	254	856	1315	1487	1215

Table 4.4.7 Barents Sea CAPELIN. Stock summary table. Recruitment (number of 1-year-old fish (unit:10^9) and stock biomass ('000 t) given at 1 August, spawning stock ('000 t) at time of spawning (1 April). Landings ('000 t) are the sum of the total landings in the two fishing seasons within the year indicated. The SSB is obtained by projecting the stock forward assuming a natural mortality that does not take the current predation mortality fully into account.

Year	Stock biomass	Recruit-ment Age 1	Spawning stock biomass	Landings
1965				224
1966				389
1967				409
1968				537
1969				680
1970				1314
1971				1392
1972	5831			1592
1973	6630	1140	1242	1336
1974	7121	737	343	1149
1975	8841	494	90	1439
1976	7584	433	1147	2587
1977	6254	830	890	2987
1978	6119	855	460	1916
1979	6576	551	193	1783
1980	8219	592	87	1648
1981	4489	466	1731	1986
1982	4205	611	546	1760
1983	4772	612	47	2358
1984	3303	183	171	1477
1985	1087	47	106	868
1986	157	9	13	123
1987	107	46	16	0
1988	361	22	11	0
1989	771	195	141	0
1990	4901	708	179	0
1991	6647	415	1584	929
1992	5371	396	998	1123
1993	991	3	460	586
1994	259	30	105	0
1995	189	8	55	0
1996	467	89	105	0
1997	866	112	228	1
1998	1860	188	254	1
1999	2580	171	856	106
2000	3840	475	1315	414
2001	3480	128	1487	568
2002	2122	67	1215	651

5 CAPELIN IN THE ICELAND–EAST GREENLAND–JAN MAYEN AREA

5.1 The Fishery

5.1.1 Regulation of the fishery

The fishery depends upon maturing capelin, i.e. that part of each year class which spawns at age 3 as well as those fish at age 4 that did not mature and spawn at age 3. The abundance of the immature component is difficult to assess before their recruitment to the adult stock at ages 2 and 3. This is especially true of the age 3 immatures.

The fishery of the Iceland–East Greenland–Jan Mayen capelin has been regulated by preliminary catch quotas set prior to each fishing season (July–March). Predictions of TACs have been computed based on estimates from surveys of the abundance of 1- and 2-year-old capelin, carried out in the autumn of the previous year. The process includes historical relationships between such data and the back-calculated abundance of the same year classes, growth rate and stock in numbers, natural mortality, and the provision of a remaining spawning stock biomass of 400 000 t. Final catch quotas for each season have then been set according to the results of acoustic surveys on the maturing, fishable stock, carried out in autumn (October–November) and/or winter (January/February) in that fishing season. A more detailed description of the method is given in Section 1.3.5. A summary of the results of this catch regulation procedure is given in Table 5.1.1.1

Over the years, fishing has not been permitted during April to late June and the season opened in July/August or later, depending on the state of the stock. Due to very low stock abundance there was a fishing ban lasting from December 1981 to November 1983. In addition, areas with high abundances of juvenile age 1 and 2 capelin (in the shelf region off NW-, N- and NE-Iceland) have usually been closed to the summer and autumn fishery.

5.1.2 The fishery in the 2002/2003 season

In accordance with a previously determined procedure, ACFM recommended that the preliminary TAC should not exceed 700 000 t. This is 2/3 of the total TAC predicted for the 2002/2003 season, i.e. 1 040 000 t. This advice was accepted by all parties concerned.

The season opened on 20 June and the fishery began in deep waters north of the shelf edge, northeast and north of Iceland. This time the fishing grounds soon shifted to the northwest and north. Catch rates were low in the beginning but improved in July as the capelin migrated north. Towards the end of July the northward migration stopped, the capelin began moving back south again, and soon scattered. By the end of July, the total catch was 290 000 t, mainly taken in that month on both sides of the Iceland/Greenland EEZ between about 68°N and 69°30'N. After July the capelin remained scattered and no catches were made for the rest of the year, except for 50 000 t taken just off the shelf break off the eastern north coast of Iceland in December.

The total catch in the 2002 summer and autumn season was approximately 340 000 t.

In January 2003, large fishable concentrations of adult capelin were located in deep waters off the shelf northeast of Iceland and resulted in a successful fishery. During January and the first half of February, parts of these capelin concentrations were located much farther offshore and occupied a much larger area than usual. Their southward speed of migration was unusually slow. Thus, by mid-February no capelin had been found south of 65°30'N which is about 60 nautical miles further north than usual. This deviation from the 'normal' distribution and migration pattern seems to be linked with abnormally high temperatures north and east of Iceland. The first spawning migration arrived in the shallow coastal waters off SE-Iceland during the last week of February and then migrated rapidly west along the coast to spawn west of Iceland., Although much of the capelin, which arrived later, also continued west along the coast, capelin spawned along the entire south coast as well as west of Iceland in March and early April 2003 .

A total catch of approximately 450 000 t of capelin was taken in deep waters east of Iceland, before the first spawning migration approached the shallow waters off the eastern south coast. As usual, catch rates were high in the Icelandic coastal area and by mid-March most of the TAC of 1 000 000 t, set for the 2002/2003 season, had been taken.

In late March and early April additional spawning migrations appeared on the banks west of the Vestfirdir Peninsula (NW-Iceland). The size of these migrations was not assessed and they were not fished.

The total catch during the 2003 winter season was 648 000 t.

5.2 Catch Statistics

The total annual catch of capelin in the Iceland–East Greenland–Jan Mayen area since 1964 is given by weight, season, and fleet in Table 5.2.1.

The total catch in numbers during the summer/autumn 1981–2002 and winter 1982–2003 seasons is given by age and years in Tables 5.2.2 and 5.2.3.

The distribution of the catch during the summer-autumn 2002 and winter 2003 seasons is given by length groups at age in Tables 5.2.4 and 5.2.5.

5.3 Surveys of Stock Abundance

5.3.1 0-group surveys

The distribution and abundance of 0-group capelin in the Iceland–East Greenland–Jan Mayen area have been recorded during surveys carried out in August since 1970. The survey methods and computations of abundance indices were described by Vilhjálmsson and Fridgeirsson (1976). The abundance indices of 0-group capelin, divided according to areas, are given in Table 5.3.1.1.

Acoustic estimates of the abundance of 1-group capelin were made during the August 0-group surveys (e.g. Vilhjálmsson 1994). However, due to the large variability in this time-series, the August survey data have not been used for stock projections for more than a decade. Directed collection of data on juvenile ages 1 and 2 capelin in August has been discontinued. The abundance of 1-group capelin by number, mean length and weight for 1983–2001 is given in Table 5.3.1.2.

5.3.2 Stock abundance in autumn 2002 and winter 2003

5.3.2.1 The adult fishable stock

An attempt to estimate the adult fishable stock was not made in the autumn of 2002. An acoustic survey was carried out in the latter half of November in order to assess the abundance of immature age 1 and 2 capelin (year classes 2000 and 2001). Although the survey recorded juvenile capelin in their normal distribution area over the outer shelf northwest and north of the Vestfirdir Peninsula and the western north coast of Iceland, capelin concentrations were extremely scattered and the total estimate was very low (< 15^9 individuals, mostly of the 2001 year class). Similar to autumn 2002, few adult capelin were found (WD by H.Vilhjálmsson).

During 7-22 January 2002, the abundance of mature capelin was assessed in deep waters northeast of Iceland and off the northern east coast. With regard to weather, surveying conditions were reasonably good in January 2002. Capelin occupied an unusually wide distribution, with parts of the stock located up to 70 nautical miles off the shelf break. Furthermore, the stock was distributed unevenly with dense and, in places, large concentrations alternating with fairly wide areas of low density.

It is common knowledge that capelin migrate south off the east coast of Iceland in January. However, these migrations do not maintain a steady pace and may even stop altogether for a day or two. Consequently, the speed of migration has to be considered when assessing stock abundance during the survey period. Although capelin were migrating south during the survey, the position and progress of the fishery indicated that the speed of migration was very slow. Thus, no capelin were located south of about 65°30'N by the end of the survey in the third week of January.

Although three runs were made within the distribution area, none of these covered the entire area. This was caused mainly by occasional breaks caused by stormy weather. After a thorough scrutiny of the entire dataset , it was concluded that an average of all three surveys represented the best estimate of the total capelin biomass.

The total biomass of adult capelin east of Iceland in January 2003 was estimated to be 760 000 t. With the exception of small numbers of age group 2 (year class 2001) in a limited area off the eastern north coast of Iceland, practically no immature capelin were recorded in January 2003. Details of the January 2003 acoustic estimates of adult capelin are given in Table 5.3.2.1.1 (WD by H. Vilhjalmsson)

Because of the uncertainties associated with the January estimate, as well as the very high January catch rates compared to previous years, it was decided to run another survey when the first spawning migrations were beginning to enter the near-shore area off the eastern south coast in February. Because juveniles of the 2001 and 2000 year classes were not found, it was decided to conduct another survey for juveniles after the adult capelin assessment.

The second survey was carried out in 17 February-13 March 2003. On arrival in the area east of Iceland it was observed that the southernmost border of the spawning migrations east of Iceland had only shifted south by 20-30 nautical miles and were still north of 65°N. During the last week of February, the capelin slowly migrated to the southwest towards the shelf break east of Iceland. The first migration did not arrive at the southeast coast until the end of February.

The first migration quickly moved very close inshore and migrated rapidly west along the coast. Consequently it was difficult to assess because some of the capelin were too close to land for safe navigation and some fish were out of echosounder range due to their near-surface distribution. Although the assessment of this part of the spawning stock was repeated six times, it involved making several unsupported assumptions. The accepted result was slightly higher than 180 000 t and represents about 35% of the total abundance of the spawning stock.

The remaining migrations were assessed in deeper waters and further from the shore off SE-Iceland, as well as just off the shelf break off the east coast, during 4-10 March under good surveying conditions. The total acoustic estimate was 528 000 t, which is about 100 000 t greater than that obtained during the January survey (WD by H. Vilhjálmsson).

Details of the February-March 2003 acoustic estimates of adult capelin are given in Table 5.3.2.1.2.

5.3.2.2 Estimates of immature capelin

An acoustic survey was carried out in the latter half of November 2002 to assess the abundance of immature ages 1 and 2 capelin (year classes 2000 and 2001). Although the survey recorded juvenile capelin in their normal distribution areas over the outer shelf northwest and north of the Vestfirdir Peninsula and the western north coast of Iceland, capelin concentrations were extremely scattered and the total estimate was very low (< 15^9 individuals, mostly of the 2001 year class). As in autumn 2002, hardly any adult capelin were located.

The January 2003 suvey of the mature fishable stock also recorded immature capelin, mainly of the 2001 year class, near the shelf edge off the eastern north coast of Iceland between about 18°W and 15°W. Some immature fish of the 2000 year class were also recorded near the shelf break further south. However, their numbers were very low.

After the completion of the adult fishable stock survey off SE- and E-Iceland in early March 2003, the survey continued further north east of Iceland and then west off the north coast. Dense concentrations of immature 3-group capelin of the 2000 year class were recorded at the edge of the shelf off the northern east coast. However, these capelin were in a very narrow area and their total abundance was $3.5*10^3$ individuals.

No juvenile capelin were recorded off the western north coast and off the Vestfirdir Peninsula. However, having crossed the deepest part of the Denmark Strait, the survey recorded scattered concentrations of capelin along the western slope, near the Iceland/Greenland EEZ division line. Samples of these recordings consisted purely of age 2 capelin of the 2001 year class. Drift ice and stormy weather precluded continuing and the survey was terminated in the third week of March.

A survey, lasting only one week due to a shortage of ship time, was conducted in the area west of Vestfirdir, between 66°N and 68°N and reaching west to 30-31°W during 12-18 April 2003. Considerable and in some places very dense capelin concentrations were recorded during this survey, mostly on either side of the deep Iceland-Greenland Channel, around 66°N where very few capelin were seen two weeks earlier. West of there capelin were more scattered and difficult to separate from echoes of other organisms. These recordings consisted exclusively of age 2s and translated into $61.5*10^9$ individuals. The result of this assessment is given in Table 5.3.2.2.1. Estimates of immature 2- and 3-group capelin recorded earlier off NE- and E-Iceland, have been added (WD by H. Vilhjálmsson).

5.4 Historical Stock Abundance

Historical estimates of stock abundance are based on the "best" acoustic estimates of the abundance of maturing capelin in autumn and/or winter surveys. The "best" in each case is defined as that estimate on which the final TAC was based. Taking account of the catch in numbers and a monthly natural mortality rate of M = 0.035 (ICES 1991/Assess:17), abundance estimates of each age group are then projected to the appropriate point in time. Since natural mortality rates of juvenile capelin are unknown, their abundance by number has been projected using the same natural mortality rate.

The annual abundance by number and weight-at-age for mature and immature capelin in the Iceland–East Greenland–Jan Mayen area has been calculated with reference to 1 August and 1 January of the following year for the 1978/79–2002/03 seasons. The results are given in Tables 5.4.1 and 5.4.2 (1 August and 1 January, respectively). Table 5.4.2 also gives the remaining spawning stock by number and biomass in March/April 1979–2003.

The observed annual mean weight-at-age, obtained from catch and survey data from January, was used to calculate the stock biomass on 1 January. The observed average weight-at-age of adult capelin in autumn (Table 5.5.1.2) is used to calculate mature stock biomass in summer. Because there is a small weight increase among mature capelin in February and March, the remaining spawning stock biomass is underestimated.

5.5 Stock Prognoses

5.5.1 Stock prognosis and TAC in the 2002/2003 season

The models (ICES 1993/Assess:6; Section 3.1.5) for predicting the numbers of maturing capelin of ages 2 and 3 from the November 2001 acoustic assessment of the 1999 and 1998 year classes gave estimates of 77.2 and $17.3*10^9$ maturing 2- and 3-group capelin on 1 August 2002. The data used in the comparison between abundance of age groups are given in Table 5.5.1.1, and the mean weights of maturing capelin in autumn in Table 5.5.1.2.

During the last ten years the weight-at-age of adult capelin has been inversely related to adult stock abundance. Simple linear regressions of these data result in $r^2 = 0.64$ and 0.68 for age groups 2 and 3, respectively. The two regression plots are shown in Figure 5.5.2.2. Applying the appropriate regression equations, $y = -0.034x + 19.4$; $r^2 = 0.64$; $p<0.05$ for the younger component, and $y = -0.068x + 29.0$; $r^2 = 0.68$; $p<0.05$ for the older one and using the predicted abundance of age groups 2 and 3 on 1 August 2002 combined, *i.e.* $95.6 * 10^9$ fish, results in estimated mean weights of 16.1 and 22.4 g for age groups 2 and 3, respectively.

The fishable stock biomass, obtained by multiplying the stock in numbers by the predicted mean weight of maturing capelin in autumn, was projected forward to spawning time in March 2003 assuming a monthly $M = 0.035$ and a remaining spawning stock of 400 000 t. This resulted in a predicted TAC of 1 050 000 t spread evenly over August 2002-March 2003 (Table 5.5.1.3). Using the same approach as in previous years*, i.e.* that the preliminary TAC be set at 2/3 of the predicted total for the season, the WG recommended that a preliminary TAC for the 2002/2003 capelin fishery be set at 690 000 t.

According to the January-March 2003 survey results described in Section 5.3.2, the fishable spawning stock was estimated as $28.3*10^9$ fish on 1 March 2003. At that time the observed mean weight in the fishable stock was 18.6 g and the stock biomass was 530 000 t (Table 5.3.2.1.2). With the usual prerequisites of a monthly natural mortality rate of 0.035 and a remaining spawning stock of 400 000 t, the above abundance estimate indicated that a TAC of 125 000 t was available for the remainder of the 2003 winter fishery. Adding this to the catch of 875 000 t already taken from June 2002–February 2003 resulted in a total TAC of 1 000 000 t for the 2002/2003 season. In practical terms, this TAC is equal to that predicted for the 2002/2003 season in terms of weight although considerably lower by number, especially for the older age group. The similarity in the biomass prediction is explained by better growth and higher mean weight of the 2000 year class.

About 10 000 t of the TAC remained at the end of the winter fishery. As a result, 410 000 t of capelin spawned in 2003.

5.5.2 Stock prognosis and assessment for the 2003/2004 season

Calculations of expected TAC for the 2003/2004 season, based on the method described in Section 3.1.5 of ICES 1993/Assess:6 and data from Table 5.5.1.1, were used to predict the abundance of maturing capelin of ages 2 and 3 on 1 August 2003.

An updated linear regression of the measured abundance of 1-group capelin (N_1) on the back-calculated abundance of mature 2-group fish (N_{2mat}) gives $y = 0.570x + 20.6$; $R^2 = 0.84$; $p < 0.05$. Similarly for the older stock component, where N_{2tot} is regressed on N_{3mat}, gives $y = 0.169x + 1.0$; $R^2 = 0.40$; $p < 0.05$. The two regression plots are shown in Figure 5.5.2.1.

The WG decided that the February-March 2002 estimate of the abundance of immature 2-group capelin (year class 2001) was a reasonable basis for predicting the abundance of maturing capelin of the 2001 year class on 1 August 2003 and the estimate of the 2000 year class can be predicted from the historic relationship between the total abundance of each year class at age 3 and the contribution of the same year class at age 4. To correspond to the timeline used in the past, these data were projected back in time to November 2002 using a monthly M = 0.035. The resulting projections of 63.0 and 15.6 billion mature fish belonging to the 2001 and 2000 year classes respectively, are given in Table 5.5.1.1.

During the last ten years, the weight-at-age of adult capelin has been inversely related to adult stock abundance by simple linear regressions having $r^2 = 0.64$ and 0.68 for age groups 2 and 3, respectively. These two regression plots are shown in Figure 5.5.2.2. Applying the appropriate regression equations; $y = -0.034x + 19.4$; $r^2 = 0.64$; $p<0.05$ for the younger component, and $y = -0.068x + 29.0$; $r^2 = 0.68$; $p<0.05$ for the older one and using the predicted abundance of age groups 2 and 3 on 1 August 2003 combined, *i.e.* $78.6 * 10^9$ fish, results in estimated mean weights of 16.7 and 23.9 g for age groups 2 and 3, respectively.

Applying the estimated mean weight, results in a predicted TAC of 835 000 t spread evenly from August 2003-March 2004. This corresponds to a preliminary TAC of 555 000 t. As in previous years, decisions on the final TAC for the 2003/2004 season should be based on surveys carried out in October/November 2003 and January/February 2004.

5.5.3 Management of capelin in the Iceland–East Greenland–Jan Mayen area

The fishable stock consists of two age groups (2- and 3-year-olds spawning at ages 3 and 4). The fishing season usually begins in June/July and ends in March of the following year when the remainder of the fishable stock spawns and dies. The fishable stock, which is also the maturing stock, is renewed annually and its exploitation must of necessity be cautious. Due to the short life span and high spawning mortality, stock abundance can only be assessed by acoustic surveys.

Since 1992, the key elements in the management of capelin in the Iceland–East Greenland–Jan Mayen area have been as follows:

Acoustic survey estimates of juvenile capelin abundance have been used to predict fishable stock abundance in the following year (fishing season). Historical average mean weight-at-age (in later years a relationship between numerical stock abundance and growth), growth rates and natural mortality have been used for calculations and projections of maturing and fishable stock biomass.

Based on the data described above, a TAC is predicted in the spring of the year in which the season begins, allowing for 400 000 t to spawn at the end of the season. For precautionary purposes, a preliminary TAC, corresponding to 2/3 of the predicted total TAC for the season, has tbeen allocated to the period July–December. With regard to a precautionary approach, the WG stresses the importance of the continued setting of a preliminary TAC for the first half of the season.

The final decision on a TAC for each fishing season has been based on the results of acoustic abundance surveys in late autumn or in January/February of the following year during the fishing season.

The procedure just described has worked well in the past for ‘normal’ ranges of stock abundance. However, it is clear that extra care should be taken when dealing with stock abundances below or above the norm, corresponding to TACs lower than 500 000 t or greater than 1 600 000 t.

5.6 Precautionary Approach to Fisheries Management

Due to the short life span of capelin and their high spawning mortality, the main management objective is to maintain enough spawners for the propagation of the stock. Since 1979 the targeted remaining spawning stock for capelin in the Iceland-East Greenland Jan Mayen area has been 400 000 t. Although there have been large fluctuations in stock abundance during this period, these appear to be environmentally induced and not the result of excessive fishing. Therefore, the criterion of maintaining a remaining spawning stock may be defined as B_{lim}, i.e. stock abundance below which no fishery should be permitted.

The definition of other precautionary reference points is more problematic. However, due to uncertainties inherent in predicting the abundance of short-lived species and the importance of capelin as a forage fish for predators such as cod, saithe, Greenland halibut, baleen whales and sea birds, extra precaution should be taken when stock biomass projections indicate TACs lower than 500 000 t and greater than 1 600 000 t. In the former case, the fishery should not be opened until the completion of a stock assessment survey in autumn/winter in that season. The latter simply represents a scenario where projected stock abundance is beyond the highest historical abundance on record. In such cases the preliminary TAC should not exceed 1 100 000 t.

A new model for predicting fishable stock abundance was developed in 2001 (Gudmundsdottir and Vilhjalmsson 2002; see also section 5.7.2). The main advantage of this model is that it appears to predict the abundance of the older age group more precisely than the model presently used. This is especially true for periods of high maturing ratios of age group 2 to spawn at age 3, which results in low numbers of the same year class spawning at age 4, The danger of overestimates of fishable stock biomass in the coming is thus alleviated. In the present case, this model predicts total adult capelin biomass (TSB) of 1 305 000 in summer 2003 and a TAC of 742 000 t for all of the 2003/04 season. Corresponding predictions by the current. model are 1 425 000 t and 835 000 t for TSB and TAC, respectively.

5.7 Special Comments

5.7.1 Fishing restrictions

In most years, the largest capelin can be caught in late June, July and the first half of August. After that, the average size in the catches has usually declined drastically and not increased again until late autumn. There are two main reasons for this. First, the oldest and largest fish migrate ahead of other stock components to feed in the plankton-rich area between Iceland, Greenland and Jan Mayen. Later on, these larger capelin are joined by younger, slower growing adults and even juveniles in parts of the fishing area, their location being variable from year to year. Second, as the food supply diminishes in the southern part of the feeding area in August, the fishable stock becomes more scattered and sometimes mixes with juveniles.

The WG recommends that the 2003 summer/autumn season be opened around 20 June. To prevent catches of juvenile capelin (ages 1 and 2) it is recommended that the authorities responsible for the management of this stock (Greenland, Iceland and Norway) monitor the fishery and be prepared to intervene quickly on short notice using area closures to prevent fishing on mixed concentrations of juveniles and adults.

An overview of stock development during 1978–2002 is given in Table 5.7.1.

5.7.2 Research, exploitation and ecological considerations

Capelin is by far the most important forage fish species in the marine ecosystem around Iceland, as well as in the Denmark Strait and the Iceland Sea, where adult capelin feed in summer. Furthermore, these capelin have been the subject of a large fishery which began in a modest way in winter 1964. The yield of the winter fishery gradually increased to about 500 000 t in the mid-1970s. A summer fishery began in 1976 and in 1978 the annual catch rose to more than 1 150 000 t. The stock all but collapsed in the early 1980s, but recovered after a fishing ban of two years. Since 1983 annual catches have varied between about 260 000 t and 1 560 000 t with an average of 1 020 000 t.

The large catches, taken in summer and autumn of 1980 and 1981, brought the spawning stock down to very low levels and appear to have caused a severe reduction (25-30%) of the mean weight of medium size cod (ages 5-8 years). Nevertheless, fairly good year classes recruited from these small spawning stocks of capelin and exploitation-related accidents have not occurred since then. However, mistakes in assessments and the subsequent management of such short-lived species will inevitably be made at some point(s) of time in future and could even be of such magnitude that the stock is severely depleted or, in a worst-case scenario, fished out. For this reason it is imperative that possible weaknesses in the set of data, collected in the past as well as in future, be identified and the problems addressed and resolved when possible. At present the most obvious amendments needed are as follows:

1) Since 1997, the feeding area of the maturing stock has shifted westward and not been as extensive geographically as it was in the late 1970s and during the 1980s. In this period, return migrations, from the northern feeding areas to the outer parts and the slope of the north Icelandic shelf, have been progressively delayed and the capelin stayed farther offshore during December-February than in most years prior to 1997. Furthermore, the capelin have, as a rule, scattered in late July and not formed schools of fishable densities until 10-20 December instead of October-November in the earlier period. In the last four years the 'routine' acoustic/trawl abundance surveys, carried out in November, have missed most of the adult fishable stock, and in November 2003 the autumn juvenile assessment also failed. Although these variations are almost certainly caused by environmental changes, there are practically no available data with which to investigate the causes of the distribution and behaviour changes just described. Because of the dual role of capelin as a highly important prey item in the marine ecosystem and an object of a large directed fishery, the importance of filling this gap in knowledge is obvious and imperative. As described above, the failure of assessing the juvenile stock component and, hence, correctly predicting fishable stock abundance and TACs, can have very serious consequences, both for the capelin and its dependants.
2) The model, presently used to predict the abundance of this capelin stock from historical relationships between the numbers measured as 1-year-olds by acoustics in autumn, and the back-calculated numerical abundance of

the same year classes which actually matured to spawn at age 3. *i.e.* about 16 months later, has worked well in the past. However, it has proven difficult to accurately predict the abundance of that part of each year class which does not mature and spawn until at age 4. In this case a comparison is made between the back-calculated abundance of capelin which spawned at age 4, on one hand, and that of the same year class which spawned at age 3 plus the numbers of the same year class measured by acoustics as immature 3-year-olds, on the other. A new prediction model was made in 2001 (Gudmundsdottir and Vilhjalmsson 2002), based on a similar comparison between acoustic estimates and historic data for both age groups, but using log-transformed data from a shorter time-series for the older one. When tested on historical data both models show similar trends. However, the new model gives more conservative predictions for the older year class, has considerably narrower confidence limits and is less cumbersome to comprehend and use. The WG did not evaluate the pros and cons of both models but will do so in 2004.

3) In the past, there have at times been substantial deviations of ageing between Icelandic and Norwegian readers. During periods of intensive fishing and high catch rates, such differences can cause serious bias and confound retrospective assessments of year class size, on which projections of future stock developments are based. This problem must be addressed. An international workshop on the ageing of capelin from all areas where they occur and are studied, is being planned. The the exact location and date have not yet been decided.

5.8 Sampling

Investigation	No. of samples	Length meas. individuals	Aged individuals
Fishery 2002	13	2700	1235
Survey 2002	15	1500	1465
Fishery 2003	36	3600	3587
Survey 2003	65	6500	5415

Table 5.1.1 Preliminary TACs for the summer/autumn fishery, recommended TACs for the entire season, landings and remaining spawning stock (000 tonnes) in the 1990/91–2002/03 seasons.

Season	90/91	91/92	92/93	93/94	94/95	95/96	96/97	97/98	98/99	99/00	00/01	01/02	02/03
Prelim. TAC	600	0	500	900	950	800	1100	850	950	866	975	1050	1040
Rec. TAC	250	740	900	1250	850	1390	1600	1265	1200	1000	1090	1325	1000
Landings	314	677	788	1179	842	930	1571	1245	1100	934	1065	1249	988
Spawn. stock	330	475	460	460	420	830	430	492	500	650	450	475	410

Table 5.2.1 The international capelin catch 1964–2003 (thousand tonnes).

Year	Winter season					Summer and autumn season						Total
	Iceland	Norway	Faroes	Greenland	Season total	Iceland	Norway	Faroes	Greenland	EU	Season total	
1964	8.6	-	-		8.6	-	-	-		-	-	8.6
1965	49.7	-	-		49.7	-	-	-		-	-	49.7
1966	124.5	-	-		124.5	-	-	-		-	-	124.5
1967	97.2	-	-		97.2	-	-	-		-	-	97.2
1968	78.1	-	-		78.1	-	-	-		-	-	78.1
1969	170.6	-	-		170.6	-	-	-		-	-	170.6
1970	190.8	-	-		190.8	-	-	-		-	-	190.8
1971	182.9	-	-		182.9	-	-	-		-	-	182.9
1972	276.5	-	-		276.5		-	-		-	-	276.5
1973	440.9	-	-		440.9	-	-	-		-	-	440.9
1974	461.9	-	-		461.9	-	-	-		-	-	461.9
1975	457.1	-	-		457.1	3.1	-	-		-	3.1	460.2
1976	338.7	-	-		338.7	114.4	-	-		-	114.4	453.1
1977	549.2	-	24.3		573.5	259.7	-	-		-	259.7	833.2
1978	468.4	-	36.2		504.6	497.5	154.1	3.4		-	655.0	1,159.6
1979	521.7	-	18.2		539.9	442.0	124.0	22.0		-	588.0	1,127.9
1980	392.1	-	-		392.1	367.4	118.7	24.2		17.3	527.6	919.7
1981	156.0	-	-		156.0	484.6	91.4	16.2		20.8	613.0	769.0
1982	13.2	-	-		13.2	-	-	-		-	-	13.2
1983	-	-	-		-	133.4	-	-		-	133.4	133.4
1984	439.6	-	-		439.6	425.2	104.6	10.2		8.5	548.5	988.1
1985	348.5	-	-		348.5	644.8	193.0	65.9		16.0	919.7	1,268.2
1986	341.8	50.0	-		391.8	552.5	149.7	65.4		5.3	772.9	1,164.7
1987	500.6	59.9	-		560.5	311.3	82.1	65.2		-	458.6	1,019.1
1988	600.6	56.6	-		657.2	311.4	11.5	48.5		-	371.4	1,028.6
1989	609.1	56.0	-		665.1	53.9	52.7	14.4		-	121.0	786,1
1990	612.0	62.5	12.3		686,8	83.7	21.9	5.6		-	111.2	798.0
1991	202.4	-	-		202.4	56.0	-	-		-	56.0	258.4
1992	573.5	47.6	-		621.1	213.4	65.3	18.9	0.5		298.1	919.2
1993	489.1	-	-	0.5	489.6	450.0	127.5	23.9	10.2		611.6	1,101.2
1994	550.3	15.0	-	1.8	567.1	210.7	99.0	12.3	2.1		324.1	891.2
1995	539.4	-	-	0.4	539.8	175.5	28.0	-	2.2		205.7	745.5
1996	707.9	-	10.0	5.7	723.6	474.3	206.0	17.6	15.0	60.9	773.8	1,497.4
1997	774.9	-	16.1	6.1	797.1	536.0	153.6	20.5	6.5	47.1	763.6	1,561.5
1998	457.0	-	14.7	9.6	481.3	290.8	72.9	26.9	8.0	41.9	440.5	921.8
1999	607.8	14.8	13.8	22.5	658.9	83.0	11.4	6.0	2.0		102.4	761.3
2000	761.4	14.9	32.0	22.0	830.3	126.5	80.1	30.0	7.5	21.0	265.1	1,095.4
2001	767.2	-	10.0	29.0	806.2	150.0	106.0	12.0	9.0	17.0	294.0	1,061.2
2002	901.0	-	28.0	26.0	955.0	180.0	118.7	-	13.0	28.0	339.7	1,294.7
2003	585.0	-	40.0	23.0	648.0							

Table 5.2.2 The total international catch of capelin in the Iceland–East Greenland–Jan Mayen area by age group in numbers (billions) and the total catch by numbers and weight (thousand tonnes) in the autumn season (August-December) 1981–2002.

					Year						
Age	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
1	0.6	-	0.6	0.5	0.8	+	+	0.3	1.7	0.8	0.3
2	27.9	-	7.2	9.8	25.6	10.0	27.7	13.6	6.0	5.9	2.7
3	2.0	-	0.8	7.8	15.4	23.3	6.7	5.4	1.5	1.0	0.4
4	+	-	-	0.1	0.2	0.5	+	+	+	+	+
Total number	30.5	-	8.6	18.2	42.0	33.8	34.4	19.3	9.2	7.7	3.4
Total weight	613.0	-	133.4	548.5	919.7	772.9	458.6	371.4	121.0	111.2	56.0

					Year						
Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
1	1.7	0.2	0.6	1.5	0.2	1.8	0.9	0.3	0.2	+	+
2	14.0	24.9	15.0	9.7	25.2	33.4	25.1	4.7	12.9	17.6	18.3
3	2.1	5.4	2.8	1.1	12.7	10.2	2.9	0.7	3.3	1.2	2.5
4	+	0.2	+	+	0.2	0.4	+	+	0.1	+	+
Total number	17.8	30.7	18.4	12.3	38.4	45.8	28.9	5.7	16.5	18.8	20.8
Total weight	298.1	611.6	324.1	205.7	773.7	763.6	440.5	102.4	265.1	294.0	339.7

Table 5.2.3 The total international catch of capelin in the Iceland–East Greenland–Jan Mayen area by age group in numbers (billions) and the total catch by numbers and weight (thousand tonnes) in the winter season (January-March) 1982–2003.

					Year						
Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
2	-	-	2.1	0.4	0.1	+	+	0.1	1.4	0.5	2.7
3	0.8	-	18.1	9.1	9.8	6.9	23.4	22.9	24.8	7.4	29.4
4	0.1	-	3.4	5.4	6.9	15.5	7.2	7.8	9.6	1.5	2.8
5	-	-	-	-	0.2	-	0.3	+	0.1	+	+
Total number	0.9	-	23.6	14.5	17.0	22.4	30.9	30.8	35.9	9.4	34.9
Total weight	13.2	-	439.6	348.5	391.8	560.5	657.2	665.1	686.8	202.4	621.1

				Year							
Age	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
2	0.2	0.6	1.3	0.6	0.9	0.3	0.5	0.3	0.4	0.1	0.1
3	20.1	22.7	17.6	27.4	29.1	20.4	31.2	36.3	27.9	33.1	32.2
4	2.5	3.9	5.9	7.7	11.0	5.4	7.5	5.4	6.7	4.2	1.9
5	+	+	+	+	+	+	+	+	+	+	+
Total number	22.8	27.2	24.8	35.7	41.0	26.1	39.2	42.0	35.0	37.4	34.4
Total weight	489.6	567.1	539.8	723.6	797.6	481.3	658.9	830.3	787.2	955.0	648.0

Table 5.2.4 The total international catch in numbers (millions) of capelin in the Iceland–East Greenland–Jan Mayen area in the summer/autumn season of 2002 by age and length, and the catch in weight (thousand tonnes) by age group.

Total length (cm)	Age 1	Age 2	Age 3	Age 4	Total	Percentage
10.5	13	134	0	0	147	0.7
11	21	428	0	0	449	2.2
11.5	12	1783	0	0	1795	8.6
12	0	3213	39	0	3252	15.7
12.5	0	2413	100	0	2513	12.1
13	0	2227	250	0	2477	11.9
13.5	0	2463	211	0	2675	12.9
14	0	1843	736	0	2580	12.4
14.5	0	2046	588	0	2634	12.7
15	0	646	579	0	1225	5.9
15.5	0	294	300	0	594	2.9
16	0	116	150	0	266	1.3
16.5	0	0	100	2	102	0.5
17	0	0	24	5	29	0.1
17.5	0	0	15	6	21	0.1
Total number	46	17607	3093	13	20759	
Percentage	0.2	84.8	14.9	0.1	100	100.0
Total weight	0.3	277.1	59.7	0.3	339.7	

Table 5.2.5 The total international catch in numbers (millions) of capelin in the Iceland–East Greenland–Jan Mayen area in the winter season of 2003 by age and length, and the catch in weight (thousand tonnes) by age group.

Total length (cm)	Age 2	Age 3	Age 4	Age 5	Total	Percentage
10.5	5	4	0	-	9	+
11	3	6	0	-	9	+
11.5	1	8	0	-	9	+
12	-	38	0	-	47	0.1
12.5	-	132	0	-	132	0.4
13	-	820	9	-	829	2.5
13.5	-	1631	9	-	1640	4.9
14	-	2875	19	-	2894	8.6
14.5	-	4883	85	-	4967	14.7
15	-	5514	94	-	5608	16.6
15.5	-	5787	302	-	6089	18.0
16	-	4996	320	-	5316	15.7
16.5	-	3356	415	-	3770	11.2
17	-	1348	330	-	1678	5.0
17.5	-	339	254	-	594	1.8
18	-	94	75	-	170	0.5
18.5	-	19	0	-	19	0.1
Total number	9	31859	1913	-	33782	
Percentage	+	94.3	5.7	-	100.0	100.0
Total weight	0.1	601.6	46.3	-	648.0	

Table 5.3.1.1 Abundance indices of 0-group capelin 1970-2002 and their division by areas.

							Year						
Area	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
NW-Irminger Sea	1	+	+	14	26	3	2	2	+	4	3	10	+
W-Iceland	8	7	30	39	44	37	5	19	2	19	18	13	8
N-Iceland	2	12	52	46	57	46	10	19	29	25	19	6	5
East Iceland	-	+	7	17	7	3	15	3	+	1	+	-	+
Total	11	19	89	116	134	89	32	43	31	49	40	29	13

							Year						
Area	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
NW-Irminger Sea	+	+	1	+	1	3	1	+	8	3	2	3	+
W-Iceland	3	2	8	16	6	22	13	7	2	11	21	12	6
N-Iceland	18	17	19	17	6	26	24	12	43	20	13	69	10
East Iceland	1	9	3	4	1	1	2	2	1	+	15	10	8
Total	22	28	31	37	14	52	40	21	54	34	51	94	24

							Year
	1996	1997	1998	1999	2000	2001	2002
NW-Irminger Sea	2	5	+	NA	NA	NA	NA
W-Iceland	17	14	7	25	1	25	17
N-Iceland	57	30	34	51	7	53	8
East Iceland	6	12	5	7	4	4	1
Total	82	61	46	83	12	82	26

Table 5.3.1.2 Estimated numbers, mean length and weight of age 1 capelin in the August surveys for 1983–2002.

							Year							
	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
Number (10^9)	155	286	31	71	101	147	111	36	50	87	33	85	189	138
Mean length (cm)	10.4	9.7	10.2	9.5	9.1	8.8	10.1	10.4	10.7	9.7	9.4	9.0	9.8	9.3
Mean weight (g)	4.2	3.6	3.8	3.3	3.0	2.6	3.4	4.0	5.1	3.4	3.0	2.8	3.4	2.9

							Year
	1997	1998	1999	2000	2001	2002	
Number (10^9)	143	87	55	94	99	No survey	
Mean length (cm)	9.3	9.0	9.5	9.5	10.0		
Mean weight (g)	2.8	2.9	3.2	3.1	3.7		

Table 5.3.2.1 Acoustic abundance estimate of maturing capelin, 7-22 January 2003.

Length (cm)	NUMBERS (10^{-9}) (Age) Year class (2) 2001	(3) 2000	(4) 1999	Total	Avg wt (g)	BIOMASS (10^{-9}) (Age) Year class (2) 2001	(3) 2000	(4) 1999	Total
12.5	0.0	0.0	0.0	0.0	6.9	0.0	0.0	0.0	0.0
13	0.0	100.0	0.0	100.0	8.2	0.0	0.8	0.0	0.8
13.5	0.0	900.0	0.0	900.0	9.4	0.0	8.5	0.0	8.5
14	0.0	2700.0	0.0	2700.0	11.0	0.0	29.7	0.0	29.7
14.5	0.0	5000.0	100.0	5000.0	12.7	0.0	63.5	1.3	63.5
15	0.0	6400.0	200.0	6600.0	14.4	0.0	92.2	2.9	95.0
15.5	0.0	8400.0	300.0	8700.0	16.3	0.0	136.9	4.9	141.8
16	0.0	7200.0	300.0	7400.0	18.7	0.0	134.6	5.6	138.4
16.5	0.0	5200.0	300.0	5600.0	21.1	0.0	109.7	6.3	118.2
17	0.0	3900.0	600.0	4500.0	23.6	0.0	92.0	14.2	106.2
17.5	0.0	2400.0	400.0	2800.0	26.6	0.0	63.8	10.6	74.5
18	0.0	700.0	100.0	900.0	29.4	0.0	20.6	2.9	26.5
18.5	0.0	200.0	100.0	400.0	31.7	0.0	6.3	3.2	12.7
19	0.0	0.0	0.0	0.0	36.0	0.0	0.0	0.0	0.0
Total	100.0	43100.0	2400.0	45600.0		0.0	758.7	51.9	815.7
Average length						13.4	15.7	16.7	15.7
Average weight						9.3	17.7	22.3	17.9

Table 5.3.2.2 Acoustic abundance estimate of maturing capelin, 17 February–13 March 2003.

Length (cm)	NUMBERS (10^{-9}) (Age) Year class (2) 2001	(3) 2000	(4) 1999	Total	Avg wt (g)	BIOMASS (10^{-9}) (Age) Year class (2) 2001	(3) 1999	(4) 1998	Total
13	10.5	137.1	0.0	147.6	9.6	1.3	0.0	1.4	1.4
13.5	10.5	482.9	0.0	493.4	10.4	5.0	0.0	5.1	5.1
14	0.0	1730.9	0.0	1730.9	11.7	20.3	0.0	20.3	20.3
14.5	0.0	2927.4	18.7	2946.1	13.3	38.9	0.2	39.2	39.2
15	0.0	4213.3	19.9	4233.2	14.9	62.9	0.3	63.1	63.1
15.5	0.0	4619.6	42.4	4662.1	16.9	78.0	0.7	78.7	78.7
16	0.0	4842.4	22.5	4864.9	19.1	92.5	0.4	92.9	92.9
16.5	0.0	3943.0	502.4	4445.3	21.8	86.1	11.0	97.1	97.1
17	0.0	2745.5	75.9	2821.4	26.3	72.3	2.0	74.3	74.3
17.5	0.0	1385.1	80.2	1465.3	27.2	37.7	2.2	39.9	39.9
18	0.0	374.7	112.9	487.6	29.1	10.9	3.3	14.2	14.2
18.5	0.0	29.7	0.0	29.7	30.3	0.9	0.0	0.9	0.9
19	0.0	20.7	0.0	20.7	33.4	0.7	0.0	0.7	0.7
Total	21.0	27452.4	874.9	28348.3	18.6	507.5	20.1	527.9	527.9
Average length						13.3	15.7	16.7	15.7
Average weight						10.0	18.5	23.0	18.6

Table 5.3.2.3 Acoustic estimate of immature capelin, 13 February-17 March and 4-11 April 2003

Length (cm)	NUMBERS (10^{-9}) (Age) Year class (2) 1999	(3) 1998	Total	Avg Wt (g)	BIOMASS (10^{-6} t) (Age) Year class (2) 2001	(3) 2000	Total
7.5	0.916	0.000	0.916	1.5	1.3	0.0	1.3
8	2.565	0.000	2.565	1.7	4.3	0.0	4.3
8.5	3.664	0.000	3.664	2.1	7.5	0.0	7.5
9	1.740	0.000	1.740	2.4	4.2	0.0	4.2
9.5	3.666	0.000	3.666	2.8	10.4	0.0	10.4
10	5.595	0.000	5.595	3.3	18.6	0.0	18.6
10.5	6.509	0.000	6.509	3.8	24.4	0.0	24.4
11	7.636	0.000	7.636	4.4	33.3	0.0	33.3
11.5	7.222	0.007	7.229	5.0	36.3	0.0	36.4
12	5.626	0.103	5.729	5.9	33.0	0.6	33.6
12.5	5.850	0.045	5.895	6.9	40.6	0.3	40.9
13	4.955	0.090	5.045	7.8	38.7	0.7	39.4
13.5	2.499	0.552	3.051	9.0	22.5	5.0	27.4
14	2.294	0.963	3.257	10.4	23.8	10.0	33.8
14.5	0.824	0.940	1.765	12.1	10.0	11.4	21.3
15	0.824	0.866	1.690	12.7	10.5	11.0	21.4
15.5	0.092	0.150	0.242	14.7	1.3	2.2	3.6
Total	62.476	3.716	66.192	5.5	341.8	20.3	362.1
Average length (cm)					11.2	14.2	11.3
Average weight (g)					5.1	11.1	5.5

Table 5.4.1 The estimated number (billions) of capelin on 1 August 1978–2003 by age and maturity groups. The total number (billions) and weight (thousand tonnes) of the immature and maturing (fishable) stock components are also given.

	Year									
Age/maturity	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
1 juvenile	163.8	60.3	66.1	48.9	146.4	124.2	250.5	98.9	156.2	144.0
2 immature	15.3	16.4	4.2	3.7	15.0	42.5	40.9	100.0	29.4	37.2
2 mature	81.9	91.3	35.4	39.7	17.1	53.7	40.7	64.6	35.6	65.4
3 mature	29.1	10.1	10.8	2.8	2.3	9.8	27.9	27.0	65.8	20.1
4 mature	0.4	0.3	+	+	+	0.1	0.4	0.4	0.7	0.1
Number immat.	179.2	76.7	70.3	52.6	161.4	166.7	291.4	198.9	185.6	181.2
Number mature	111.4	101.7	46.2	42.5	19.4	63.6	69.0	92.0	102.1	85.6
Weight immat	751	366	283	209	683	985	1067	1168	876	950
Weight mature	2081	1769	847	829	355	1085	1340	1643	2260	1689

	Year									
Age/maturity	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
1 juvenile	80.8	63.9	117.5	132.9	162.9	144.3	224.1	197.3	191.2	165.4
2 immature	24.0	10.3	10.1	9.7	16.6	20.1	35.2	45.1	28.7	35.2
2 mature	70.3	42.8	31.9	67.7	70.7	86.9	59.8	102.2	100.7	90.3
3 mature	24.5	15.8	6.8	6.7	6.4	10.9	13.2	23.0	29.6	19.0
4 mature	0.4	+	+	+	+	0.2	-	+	+	+
Number immat.	104.8	74.2	127.6	142.6	179.5	164.7	259.2	242.4	219.9	200.6
Number mature	95.2	58.6	38.7	74.4	77.1	98.0	73.0	125.1	130.3	109.3
Weight immat	438	309	542	702	747	702	1019	1188	985	758
Weight mature	1663	1173	751	1273	1311	1585	1268	1819	1900	1590

	Year					
Age/maturity	1998	1999	2000	2001	2002	2003
1 juvenile	167.9	138.0	140.9	110.2*	95.9*	
2 immature	19.2	24.4	25.0	9.0	23.7*	
2 mature	89.5	85.9	65.7	86.7	68.0	63.0**
3 mature	23.2	12.6	16.0	16.9	5.9	15.6**
4 mature	+	+				
Number immat.	187.1	162.4	165.9	150.1*	119.6*	
Number mature	112.7	98.5	81.7	103.6	73.9	78.6**
Weight immat	621	612	595	622*1)	490*	
Weight mature	1576	1703	1519	1817	1280	1423**

* Preliminary

** Predicted

Table 5.4.2 The estimated number (billions) of capelin on 1 January 1979–2003 by age and maturity groups. The total number (billions) and weight (thousand tonnes) of the immature and maturing (fishable) stock components and the remaining spawning stock by number and weight are also given.

	Year									
Age/maturity	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
2 juvenile	137.6	50.6	55.3	41.2	123.7	105.0	211.6	83.2	131.9	120.5
3 immature	12.8	13.8	3.5	3.0	12.6	35.7	34.3	83.9	25.6	31.2
3 mature	51.8	53.4	16.3	8.0	14.3	39.8	25.2	34.5	22.1	34.1
4 mature	14.8	3.6	4.9	0.5	2.0	7.6	15.6	10.5	37.0	11.7
5 mature	0.3	0.2	+	+	+	0.1	0.3	0.2	0.2	+
Number immat.	150.4	64.4	58.8	44.2	136.3	140.7	245.9	167.1	157.5	151.3
Number mature	66.9	57.2	21.2	8.5	16.3	47.5	41.1	45.2	59.1	45.8
Weight immat.	1028	502	527	292	685	984	1467	1414	1003	1083
Weight mature	1358	980	471	171	315	966	913	1059	1355	993
Number sp.st.	29.0	17.5	7.7	6.8	13.5	21.6	20.7	19.6	18.3	18.5
Weight sp. st	600	300	170	140	260	440	460	460	420	400

	Year									
Age/maturity	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
2 juvenile	67.8	53.9	98.9	111.6	124.6	121.3	188.1	165.2	160.0	138.8
3 immature	20.1	8.6	8.6	8.1	13.9	16.9	29.5	37.9	24.1	29.5
3 mature	48.8	31.2	22.3	54.8	46.5	50.5	35.1	75.5	72.4	50.1
4 mature	16.0	12.1	4.5	5.3	3.5	4.6	8.7	20.1	24.8	7.9
5 mature	0.3	+	+	+	+	+	+	+	+	+
Number immat.	87.9	62.5	107.5	119.7	138.5	138.2	217.6	203.1	184.1	168.3
Number mature	64.8	43.3	26.8	60.1	50.0	55.1	43.8	95.6	97.2	58.0
Weight immat.	434	291	501	487	622	573	696	800	672	621
Weight mature	1298	904	544	1106	1017	1063	914	1820	1881	1106
Number sp.st.	22.0	5.5	16.3	25.8	23.6	24.8	19.2	42.8	21.8	27.6
Weight sp. st.	440	115	330	475	499	460	420	830	430	492

	Year				
Age/maturity	1999	2000	2001	2002	2003
2 juvenile	140.9	115.8	96.9	119.2*	80.5*
3 immature	16.1	20.5	17.2	7.6	19.9*
3 mature	53.2	68.2	46.3	59.3	58.4
4 mature	16.0	10.0	10.5	10.5	2.9
5 mature	+	+	+	+	
Number immat.	157.0	136.3	114.1	126.6*	100.4*
Number mature	69.3	78.2	56.8	69.8	61.3
Weight immat.	585	535	478	510*	575*
Weight mature	1171	1485	1197	1445	1214
Number sp.st.	29.5	34.2	21.3	22.9	20.7
Weight sp. st.	500	650	450	475	410

*Preliminary/Predicted

Table 5.5.1.1 The data used in the comparisons between abundance of age groups (numbers) when predicting fishable stock abundance for the calculation of preliminary TACs.

Year class	Age 1 Acoustics N_1	Age 2 Back-calc. Mature N_{2mat}	Age 2 Acoustics Immature N_{2imm}	Age 2 Back-calc. Total N_{2tot}	Age 3 Back-calc. Mature N_{3tot}
1980	23.7	17.1	1.7	32.1	9.8
1981	68.0	53.7	8.2	96.2	27.9
1982	44.1	40.7	4.6	81.6	27.0
1983	73.8	64.6	12.6	164.6	65.8
1984	33.8	35.6	1.4	65.0	20.1
1985	58.0	65.4	5.4	102.6	24.5
1986	70.2	70.3	6.7	94.6	15.8
1987	43.9	42.8	1.8	53.1	6.8
1988	29.2	31.9	1.3	42.0	6.7
1989	*39.2	67.7	5.2	77.2	6.4
1990	60.0	70.7	2.3	87.3	10.9
1991	104.6	86.9	10.8	107.0	13.2
1992	100.4	59.8	6.9	95.0	24.0
1993	119.0	102.2	46.3	147.2	29.6
1994	165.0	100.7	16.4	129.4	19.0
1995	111.9	90.3	30.8	125.5	23.2
1996	128.5	89.5	6.3	108.7	12.6
1997	121.0	85.9	5.0	110.3	16.0
1998	89.8	65.7	11.0	84.1	16.9
1999	103.0	86.7	2.4	95.8	8.6
2000	100.3	85.4	3.7	**89.8	
2001	74.4				

* Invalid due to ice conditions.
** Preliminary

Table 5.5.1.2 Mean weight (g) in autumn of maturing capelin.

	1981	1982	1983	1984	1985	1986	1987	1988
Age 2	19.2	16.5	16.1	15.8	15.5	18.1	17.9	15.5
Age 3	24.0	24.1	22.5	25.7	23.8	24.1	25.8	23.4

	1989	1990	1991	1992	1993	1994	1995	1996
Age 2	18.0	18.1	16.3	16.5	16.2	16.0	15.3	15.8
Age 3	25.5	25.5	25.4	22.6	23.3	23.6	20.5	20.6

	1997	1998	1999	2000	2001	2002
Age 2	14.3	14.1	16.8	17.1	16.3	No data
Age 3	20.3	18.1	20.6	24.7	23.9	No data

Table 5.5.1.3 Predictions of fishable stock abundance and TACs for the 1984/85–2002/03 seasons.
The last row gives contemporary advice on TACs for comparison.
Age 2 and age 3 = Numbers in billions in age groups at the beginning of season.
Fishable stock = calculated weight of maturing capelin in thousand tonnes (ref. August).
TAC calc = predicted in thousand tonnes.

Season	85/86	86/87	87/88	88/89	89/90	90/91	91/92	92/93	93/94
Year classes	83-82	84-83	85-84	86-85	87-86	88-87	89-88	90-89	91-90
Age 2	67.8	34.9	55.5	64.8	43.2	31.1	39.4	56.4	93.1
Age 3	20.2	55.0	13.7	29.0	25.5	8.2	3.7	18.3	22.6
Fishable stock	1637	1926	1268	1800	1350	724	755	1398	2123
Calculated TAC	963	1215	642	1105	713	170	197	755	1385
Advised TAC	1311	1333	1115	1036	550	265	740	*900	1250

Season	94/95	95/96	96/97	97/98	98/99	99/00	00/01	01/02	02/03
Year classes	92-91	93-92	94-93	95-94	96-95	97/96	98 /97	99/98	00/99
Age 2	89.6	92.5	90.0	83.8	94.4	89.2	70.9	77.1	77.2
Age 3	27.0	14.9	35.0	30.9	30.8	23.3	19.2	16.9	17.3
Fishable stock	2170	1916	2352	2019	2088	1885	1584	1620	1642
Calculated TAC	1427	1200	1635	1265	1420	1285	975	1050	1040
Advised TAC	850	1390	1600	1265	1200	1000	**1090	1350	1000

*In January 1993, 80 000 t were added to the 820 000 t recommended after the October 1992 survey due to an unexpected large increase in mean weights.

** In March 2001, 100 000 t were added to the 990 000 t recommended after the January/February 2001 survey due to much higher mean weights in the catch during 1 February-10 March than measured during the survey.

Table 5.7.1 Capelin in the Iceland–East Greenland–Jan Mayen area. Recruitment of 1-year-old fish (unit 10^9) and total stock biomass ('000 t) are given for 1 August. Spawning stock biomass ('000 t) is given at the time of spawning (March next year). Landings ('000 t) are the sum of the total landings in the season starting in the summer/autumn of the year indicated and ending in March of the following year.

Year	Recruitment	Total Stock biomass	Landings	Spawning stock biomass
1978	164	2832	1195	600
1979	60	2135	980	300
1980	66	1130	684	170
1981	49	1038	626	140
1982	146	1020	0	260
1983	124	2070	573	440
1984	251	2427	897	460
1985	99	2811	1312	460
1986	156	3106	1333	420
1987	144	2639	1116	400
1988	81	2101	1037	440
1989	64	1482	808	115
1990	118	1293	314	330
1991	133	1975	677	475
1992	163	2058	788	499
1993	144	2287	1179	460
1994	224	2287	864	420
1995	197	3007	929	830
1996	191	2885	1571	430
1997	165	2348	1245	492
1998	168	2197	1100	500
1999	138	2315	933	650
2000	140	2114	1071	450
2001	110	2439	1249	475
2002	*96	*1770	988	410

*Preliminary

Figure 5.5.2.1. The relationship between the measured numbers of immature 1-group capelin in autumn acoustic surveys and the numbers of maturing capelin in 1 August of the following year (left hand figure) and between measured total numbers of 2-group capelin and the maturing 3-group capelin in the following year (right hand figure).

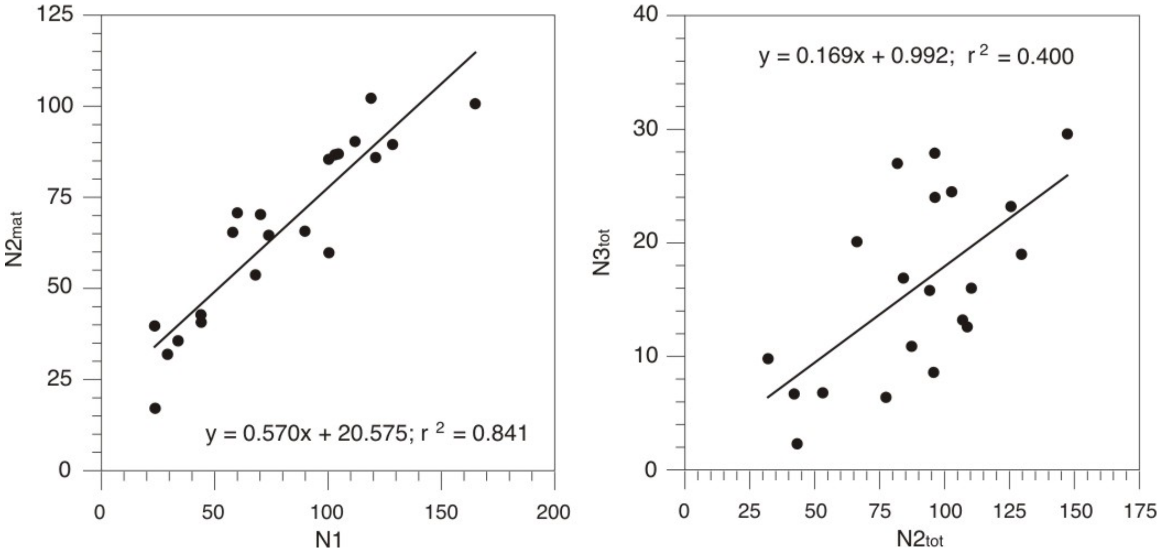
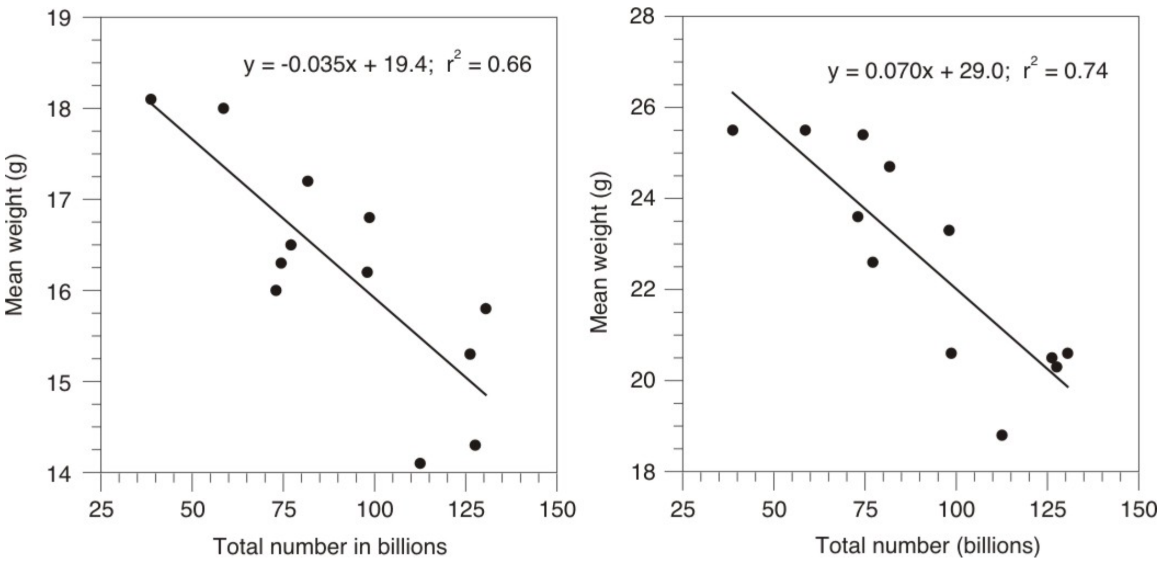


Figure 5.5.2.2. The relationship between the total numbers in the maturing stock and the mean weight of maturing 2-group (left hand figure) and 3-group (right hand figure) capelin in autumn 1989-2001.



6 BLUE WHITING

6.1 Stock Identity and Stock Separation

Blue whiting stock is treated as a single stock for assessment purposes although morphological, physiological, and genetic research has suggested that there may be several components of the stock which mix in the spawning area west of the British Isles (ICES 2000/ACFM:16; Heino *et al.* WD b).

6.1.1 ACFM advice and management applicable to 2002 and 2003

In 1998 ACFM defined limit and precautionary reference points for this stock: $\mathbf{B}_{lim}$ (1.5 mill.t), $\mathbf{B}_{pa}$ (2.25 mill.t), $\mathbf{F}_{lim}$ (0.51) and $\mathbf{F}_{pa}$ (0.32). The advice of ACFM in following years has been given within a framework defined by these reference points.

In 2001 ACFM stated that " the stock is considered to be outside safe biological limits. In recent years the stock has rapidly declined. SSB is estimated to have been at $\mathbf{B}_{pa}$ in 2000 and will be close to $\mathbf{B}_{lim}$ in 2001. Fishing mortality has increased from around the proposed $\mathbf{F}_{pa}$ in 1997, to well above $\mathbf{F}_{pa}$ in 1998 and 1999, and well above $\mathbf{F}_{lim}$ in 2000. Total landings in 2000 were 1.4 million t, far above the ICES recommended catch of 800 000 t. Landings in 2000 mainly consisted of the strong 1996 and 1997 year classes. The strength of incoming year classes is unknown. ICES recommends that the fishery in 2002 for blue whiting in all areas be closed until a rebuilding plan has been implemented".

In 2002 ACFM stated that "the stock is harvested outside safe biological limits. The spawning stock biomass for 2001 at the spawning time (April) is inside safe biological limits while the SSB for 2002 is expected to be below $\mathbf{B}_{pa}$. Fishing mortality has increased rapidly in recent years, and is estimated at 0.82 in 2001. Total landings in 2001 were almost 1.8 million t. The incoming year classes seem to be strong. ICES recommends that the fishing mortality be less than $\mathbf{F}_{pa}$ =0.32, corresponding to landings of less than 600 000 t in 2003". Implementation of a rebuilding plan is not necessary since according to the current assessment the state of the stock is better than previously estimated.

In December 2002 EU, Faroe Islands, Iceland, and Norway agreed to implement a long-term management plan for the fisheries of the blue whiting stock, which is consistent with a precautionary approach, aimed at constraining the harvest within safe biological limits and designed to provide for sustainable fisheries and a greater potential yield. The plan shall consist of the following:

1. *Every effort shall be made to prevent the stock from falling below the minimum level of Spawning Stock Biomass (SSB) of 1 500 000 tonnes.*

2. *For 2003 and subsequent years, the Parties agreed to restrict their fishing on the basis of a TAC consistent with a fishing mortality less than 0.32 for appropriate age groups as defined by ICES, unless future scientific advice requires modification of the fishing mortality rate.*

3. *Should the SSB fall below a reference point of 2 250 000 tonnes ($\mathbf{B}_{pa}$) the fishing mortality rate, referred to under paragraph 1, shall be adapted in the light of scientific estimates of the conditions then prevailing. Such adaptation shall ensure a safe and rapid recovery of the SSB to a level in excess of 2 250 000 tonnes.*

4. *In order to enhance the potential yield, the Parties shall implement appropriate measures, which will reduce catches of juvenile blue whiting.*

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

The agreed management plan is, however, not implemented. In the absence of agreements on a TAC for 2002 and 2003 and the allocation of the TAC, the Coastal States and the Russian Federation implemented unilateral measures to limit blue whiting catches for these years.

6.2 Fisheries in 2002

Total catch figures in 2002 were provided by members of the WG. They were estimated to be 1 554 995 t compared to 1 780 170 t last year. Time-series with catches by nations and area are given in Tables 6.2.1-6.2.7.

Spatial and temporal distribution of the catches of blue whiting in 2002 is given by quarter and ICES rectangles in Figure 6.2.1. The distribution of the catch by ICES rectangles for the whole year is given in Figure 6.2.2. In 2002 the catch provided as catch by rectangle represented approximately 1.52 million t (97.7%).

6.2.1 Description of the national fisheries

Denmark:

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

Germany:

No information available.

Faroe Islands:

In 2002 Faroes had no agreement with EU on blue whiting and consequently no fishery was conducted in EU waters in 2002. In January the fishery (8 combined purse seiners/trawlers) concentrated on the western and south-western part of the Faroese EEZ (ICES Division Vb). In February catches were still taken in Vb and also in the south-western part of Division VIb outside the EU zone. In March the fishery continued in VIb and XII outside the EU zone. In April catches were taken in the northern part of VIb and in the southern part of the Faroese zone (Vb). In May the fishery continued in the southern area and west off the Faroe plateau (Vb), indicating that the fish migrated west of the Faroes on their way north. The fishery moved northwest towards the Icelandic border and into the Icelandic zone (Divisions Va and Vb) in late May. In June the fishery operated in Divisions IIa and Va north of 63°N (Faroe and Iceland zones) and continued in this area, including Division Vb in July and August. The fishery continued on the Faroe-Iceland ridge (Divisions Va, Vb and IIa) throughout the rest of 2002 (i.e. September-December), gradually moving closer towards the Faroe Islands at the end of the year. All catches were taken with pelagic trawl (44 mm mesh size in the codend). The industrial fleet (3 trawlers) operated mainly in Norwegian waters (ICES Division IVa) in 2002 with some catches of blue whiting scattered throughout the year.

France:

No information available.

Iceland:

Iceland set a total blue whiting quota of 283 000 t for the Icelandic and Faroese EEZs and international waters for 2002. Iceland and Faroes have a bilateral agreement of mutual fishing rights for blue whiting within each other´s EEZs.

A total of 19 vessels participated in the directed fishery, which started in March in international waters west of the British Isles (ICES Divisions XII, VIb) and small catches in Icelandic waters at SE-Iceland. All the catches were taken using mid-water trawls with a mesh size in the codend of 40 mm. In April the main fishery had moved further north and was largely conducted in Faroese waters SW of the Faroes, but with some catches in Icelandic waters.

In early May the fishery was mainly conducted in the Faroese zone but shifted gradually into the Icelandic zone in the latter half of May. In June part of the fleet was engaged in the fishery for NSSPH in the Norwegian Sea, but most of the blue whiting catch of 22 000 t was fished in the Icelandic area. From July to September most of the catches were taken in the Icelandic zone with a gradual increase of catches in the Faroese zone. In October about 13 000 t of a total catch of 21 000 t were taken in the Faroese zone. In November the fishery came to a halt because the quota set for the Icelandic fleet was reached. The small catch taken in November was mainly from the Icelandic EEZ. The total Icelandic catch was 286 540 t.

Iceland has set size limitations on landings of blue whiting. If the catch consists of 30% or more fish smaller than 25 cm, a temporary area closure is imposed.

Ireland:

The Irish fishery for blue whiting developed in response to severely restricted quotas for mackerel and herring in the 1990s. Catches peaked in 1998 with approximately 46 000 t landed. Since then the imposition of an EU TAC and the allocation of a low quota to Ireland have caused the fishery to contract. In 1998 seven Irish vessels were involved in the fishery. Six vessels fished the small quota of 17 165 t allocated to Ireland in 2003. Fishing takes place in February and March between the Porcupine and Rockall after the completion of the spring mackerel fishery.

The fishery is prosecuted by Refrigerated Sea Water trawlers fishing large single trawls that have been specially modified to take bulk catches from deep water. Circumference of the gear may be as great as 1700 m with a brailler mesh of 35 to 40 mm. While the vast majority of Irish landings of blue whiting are for fishmeal production, trials in 1997 and 1998 showed that fish of human consumption standard could be landed. In 2001 approximately 500 t were block frozen by Irish fish processors.

Netherlands:

Fishing directed to blue whiting takes place by Dutch pelagic trawlers mainly in areas VIa and VIIc in the 1st and 2nd quarter of the year using mesh size of 40 mm. The total catch in 2002 was restricted by a share in a TAC set by the EU. All catches are landed frozen for human consumption. The total quota for the Netherlands in 2002 was 27 044 t.

Norway:

Norway set a blue whiting quota of 250 000 t for the Norwegian EEZ, Jan Mayen zone and international waters for 2002. In addition, through international agreements, 120 000 t in the EEZ of EU and 35 000 t in the Faroese zone were made available to the Norwegian fishery. The mixed industrial fishery in the North Sea/southern Norwegian Sea was allowed to take 79 396 t. The total quota for Norwegian vessels in 2002 was 484 396 t.

In June-August 2002 an experimental fishery, regulated by specific vessel quotas, was arranged in the Norwegian zone north of 65ºN. Participating vessels were obliged to report certain biological data to the Institute of Marine Research. The total catch from this fishery was about 36 000 t, mostly from the area immediately north of 65ºN.

The main Norwegian fishery is a directed pelagic trawl fishery, regulated by vessel quotas, and is carried out on and west of the spawning areas west of the British Isles. The Norwegian fishery in 2002 started at the beginning of February in international waters off Porcupine Bank, then moved northward toward the Rockall area. At the end of March/beginning of April the main fishery took place off the Hebrides area. From there the fishery moved into Faroese waters. The Norwegian fishery in the spawning area was stopped on 5 May when the quota in the EU zone was taken.

Young blue whiting were fished in the North Sea and in the southern Norwegian Sea (areas south of 64ºN) in the mixed industrial fishery targeting blue whiting and Norway pout. An estimated catch of approximately 98 000 t was taken in this fishery in 2002. More information on this fishery is in Section 1.5 (see also Heino *et al*., WD a).

Portugal:

In the Portuguese fisheries, blue whiting is a bycatch in the trawl fishery. Most of the landings come from bottom fish trawlers, but a small percentage also comes from crustacean trawlers. Artisanal fisheries (small purse seines and gillnets) reported a small percentage (less than 5% of the total Portuguese landings) in the last 5 years.

Russia:

The Russian blue whiting fishery in 2002 continued from January to December in different NEA areas. In January and February fishing took place mostly in the Faroese EEZ (Vb1). Further, following spawning migrations, the fishing fleet displaced southwards and operated in international waters to the west of the British Isles (XII) until the middle of April. At the end of April, following blue whiting feeding migrations, Russian fishing vessels moved to the Faroese and Norwegian EEZs and international waters in the Norwegian Sea (Vb1, IIa) and fished there till the end of September. From October to December a Russian fleet operated mostly in international waters and in the Faroese zone (IIa, Vb1).

The directed blue whiting fishery occurred in all seasons by large fishing vessels using trawls with mesh sizes of 35 to 40 mm.

Spain:

The Spanish blue whiting fishery is carried out mainly by bottom pair trawlers in a directed fishery and by single bottom trawlers in a bycatch fishery, both using a minimum mesh size of approximately 55 mm. The pair trawler fleet landed 16 352 t, taken mainly on the border between Divisions VIIIc and IXa. Bycatches of blue whiting (1 134 t) were caught mainly in the bottom trawl fishery in Spanish waters in Divisions VIIIc and IXa, small quantities (20 t) were also caught by longliners. These coastal fisheries have trip durations of 1 or 2 days and catches are for human consumption. Thus, coastal landings are rather stable due mainly to market forces.

Sweden:

No information available.

UK (Scotland):

No information available.

6.3 Biological Characteristics

6.3.1 Length composition of catches

Data on the combined length composition of the 2002 commercial catch by quarter of the year from the directed fisheries in the Norwegian Sea and from the stock's main spawning area were provided by the Faroes, Iceland, Ireland, the Netherlands, Norway, Scotland and Russia. Length composition of blue whiting varied from 13 to 42 cm, with 90% of fish ranging from 21 to 32 cm in length with a mean of 26.4 cm (Table 6.3.1.1). Length compositions of the blue whiting catch and bycatch from "other fisheries" in the Norwegian Sea (south of 64ºN), the North Sea and Skagerrak were presented by Norway and Denmark (Table 6.3.1.2). The catches of blue whiting from the mixed industrial fisheries consisted of fish with lengths of 13 to 36 cm and a mean of 22.7 cm. Spain and Portugal caught blue whiting in the Southern area. The Spanish data used for length distribution of catches showed a length range from 15 to 29 cm with a mean length of 20.8 cm (Table 6.3.1.3).

6.3.2 Age composition of catches

For the directed fisheries in the northern area in 2002, age compositions were provided by the Faroe Islands, Iceland, Ireland, Norway, the Netherlands and Russia, and the sampled catch accounted for 91% of the total catch. Estimates of catch in numbers for unsampled catches were raised according to the knowledge of how, where, and when the catches were taken. The age compositions in the directed fisheries are given in Table 6.3.2.1.

Age compositions for blue whiting bycatches from "other fisheries" in the North Sea and Skagerrak were provided by Norway and sampled catch accounted for 78% of catches. These data were used for allocation of the remaining part of the total in that area. The age compositions are given in Table 6.3.2.2.

For the fisheries in the Southern area, age compositions representing 91% of the catch were presented by Spain. The age compositions in the southern fishery are given in Table 6.3.2.3.

The combined age composition for the directed fisheries in the Northern area, i.e. the spawning area and the Norwegian Sea, as well as for the bycatch of blue whiting in "other fisheries" and for landings in the Southern area, were assumed to represent the overall age composition of the total landings for the blue whiting stock. The catch numbers-at-age used in the stock assessment are given in Table 6.3.2.4. The 1999 and 2000 year classes were the most numerous in the catches, followed by the 1998, 1997 and 2001 year classes. To calculate the total international catch-at-age, and to document how it was done, the program SALLOC was used (ICES 1998/ACFM:18). The allocations are shown in Annex I.

6.3.3 Weight-at-age

Mean weight-at-age data were available from the Faroes, Iceland, Ireland, the Netherlands, Norway, Russia, and Spain. Mean weight-at-age for other countries was based on the allocations shown in Annex I ("ALLOC" files) and was estimated by the SALLOC program for the total international catch. Table 6.3.3.1 shows the mean weight-at-age for the total catch during 1981 - 2002 used in the stock assessment. The weight-at-age for the stock was assumed to be the same as the weight-at-age for the catch.

6.3.4 Maturity-at-age

Maturity-at-age used in the assessment was obtained by combining maturity ogives from the southern and northern areas, weighted by catch in numbers-at-age (ICES 1995/Assess:7). These are the same as those used since 1994 (Table 6.3.4.1). Although the values of maturity-at-age probably are too low, sufficient information for estimating new ogives is not available.

6.3.5 The value of the natural mortality *M* for blue whiting

The possible need for revising the current estimate of instantaneous natural mortality rate *M* for blue whiting was discussed in detail by the 2002 WG. Although it was admitted that the current estimate M=0.2 yr^{-1} might be too low, the factual basis for revision was ambiguous. More recent methodological work by WGMG (ICES 2003/D:03) emphasises that natural mortality rate cannot be estimated reliably with information normally available for stock assessment models. WG therefore considers that there is no new information that would justify a revision of the current estimate of *M*.

6.4 Stock estimates

6.4.1 Acoustic surveys

The time-series from the acoustic surveys are given in Tables 6.4.1.1-6.4.1.3.

6.4.1.1 Surveys in the spawning season

The Norwegian research vessel R.V. "Johan Hjort" surveyed the blue whiting stock on the shelf edge and bank areas west of the British Isles and in the southern Faroese waters from 29 March - 27 April (Heino *et al*., WD c). The highest abundance of blue whiting was observed along the shelf edge west from the Hebrides, on the north-western parts of Rockall Bank, and on banks south of the Faroe Islands. The densest aggregations were observed west and northwest of the Hebrides and south of the Faroe Islands (Figure 6.4.1.1.1). The overall distribution of blue whiting was more northern than usual, probably because of the late timing of the survey. Almost all sampled fish were either post-spawners or immatures. The spawning stock was estimated to be 10.4 million t (132 x 10^9 individuals), while the immature part of the stock in the survey area was estimated at 1.0 million t (28 x 10^9 individuals). Both the numbers and biomass of the spawning stock were marginally lower than the estimate of 2002. The age-stratified estimate of the total stock for 2003 is given in Table 6.4.1.1.1 The spawning stock continues to be dominated by two very strong year classes, 1999 and 2000 (Figure 6.4.1.1.2), which account for about 75% of the spawning stock biomass. Relatively stable spawning stock biomass between 2002 and 2003 is probably due to the recruitment of more individuals from the abundant 2000 year class to the spawning stock. Immature blue whiting (mostly of age 1) occurred mostly in the southern and northern parts of the survey area, on Porcupine Bank and in the Faroes/Shetland area. Year class 2001 appears to be much less numerous than the strong 2000 year class. The decreasing trend in stock size observed between 1999 and 2001 has now reversed mainly due to the presence of two very strong year classes (1999 and 2000) in the spawning stock the last two years. Examination of the development of year class abundance over consecutive years suggests that catchabilities in the 2002 and 2003 surveys were higher than in earlier surveys, whereas in 2001 the catchability was lower than normal.

Russian investigations in the spawning area were carried out by research vessels "Atlantniro" and "Smolensk" from 11 March to 22 April, (Oganin *et al.* WD) (Table 6.4.1.1.2). The area from 49°50'N to 61°30'N inside the EU EEZ and from 53°00'N to 59°52'N in the international waters was surveyed. The spawning stock biomass estimate was 16.6 million t, whereas the immature part of the stock was 1.9 million t. The densest concentrations were observed in the northwestern slope of the Porcupine and extended to the north between 13°00'-14°00'W. The spawning stock was dominated by the 1998 to 2000 year classes.

The three research vessels, R.V. "Atlantniro" and R.V. "Smolensk" from Russia and R.V. "Johan Hjort" from Norway, participating in the spawning stock investigations in March–April 2003 deployed similar survey strategies and carried comparable acoustic instrumentation, but the survey tracks and timing of the surveys were different. Norwegian and Russian surveys yield strikingly different abundance estimates in 2003 as was the case in 2002. Consequently the WG decided that a joint estimation of the Norwegian and Russian spawning stock surveys should not be used in the assessment. Furthermore, the estimated age structure is different: the Norwegian estimate is dominated by ages 3 and 4, whereas the Russian estimates show higher numbers of older fish as well. A number of factors may contribute to these differences: 1) temporal and spatial coverage of the spawning area in relation to migrations of blue whiting, 2) sampling selectivity, with the Norwegian trawl under-sampling large fish relative to the Russian trawls. Estimates of total and spawning biomass of blue whiting in the spawning area made by Russian, Norwegian, and Faroese surveys since 1983 are given in Table 6.4.1.1.3. Usually, acoustic estimates have been well above the analytical assessments. Therefore the acoustic estimates have been used only as relative indices. A factor contributing to the high acoustic estimates is the use of a target strength that is probably too low (Heino *et al.* WDc).

6.4.1.2 Surveys in the feeding area

Since 1995, Norway, Russia, Iceland, and Faroes, and in the period 1997-2000 the EU, have coordinated their survey effort on pelagic fish stocks in the Norwegian Sea. ICES 2002/D:07 reported on distributions and migrations of blue whiting in 2002.

A Russian survey in June covered the northeastern Icelandic EEZ, the Jan Mayen zone and central Norwegian Sea. Blue whiting was observed in most of the area with the main concentrations in the east between 0º and 07º E. Another area with relatively high densities was observed in international waters between Jan Mayen and Lofoten. Echo-recordings of blue whiting were usually registered as a scattered layer at depths of 150-300 m and the lengths ranged between 19-36 cm, with fish of 21-28 cm dominating the length distribution. An age-disaggregated estimate is not available but the length distribution suggests the 2000 year class is dominant. The total biomass estimated in June was 1.8 million t and an abundance of 20.7×10^9 fish (ICES 2002/D:07).

Another Russian survey in July covered the central and northern Norwegian Sea. The main recordings of blue whiting were observed in an area between 0º and 10º E in the southeastern part of the survey area. The biomass estimate in the survey area was 1.1 million t, consisting of 13.8×10^9 individuals. The length ranged between 19-31 cm with fish of 22-27 cm dominating the length distribution. An age-disaggregated estimate is not available but the length distribution points to the dominance of the 2000 year class (ICES 2002/D:07).

The Norwegian and Icelandic surveys conducted in July–August from 1998 to 2001 and the Icelandic survey in 2002 covered approximately the same area from year to year. There was no comparable Norwegian survey in 2002, but a Norwegian and Faroese survey in May covered similar areas. For both the Icelandic EEZ and Norwegian Sea, age-stratified estimates of blue whiting were reported. These are given in Tables 6.4.1.2.1 and 6.4.1.3, respectively.

There was a steady downward trend in the biomass estimate in the surveys from 1998 to 2000. The biomass estimated in 2001 and 2002 was more than two times higher than the 2000 estimate, as shown in the text table below.

Year	Norwegian survey (million t)	Icelandic survey (million t)	Total (million t)
1998	6.6	1.6	8.2
1999	4.2	1.8	6.0
2000	2.5	1.2	3.7
2001	5.9	2.1	8.0
2002	6.0*	1.9	7.9

* Norwegian and Faroese surveys in May

Biomass estimates of blue whiting from the Faroese area and the Norwegian Sea in May 2002 were similar to that of the 2001 survey in July. The 2000 year class was still very prominent (56% in number) in the survey. This confirms the previous belief that 2000 is a large year class. Currently the blue whiting stock is dominated by the 1999 and 2000 year-classes. The biomass estimate of blue whiting in the Icelandic area was also much higher in 2001 and 2002 than in 2000 (67% and 51% higher). The 2001 year class was very numerous in the Icelandic survey as 0-group and was still quite numerous in the 2002 survey (46% in number).

6.4.2 Bottom trawl surveys in the southern area

Bottom trawl surveys have been conducted off the Galician (NW Spain) and Portuguese coasts since 1980 and 1979 respectively, following a stratified random sampling design and covering depths down to 500 m. Since 1983, the area covered in the Spanish survey was extended to completely cover Spanish waters in Division VIIIc. The area covered in the Portuguese survey was also extended in 1989 to the 750-m contour. A new stratification in the Spanish surveys has been established since 1997. Stratified mean catches and standard errors from the Spanish and Portuguese surveys are shown in Tables 6.4.2.1 and 6.4.2.2. In both areas larger mean catch rates are observed in the 100 - 500 m depth range. Since 1988 the highest catch rates in the Spanish survey were observed in 1999 (124 kg/haul). The 2001 estimate is relatively low in both the Spanish (52 kg/haul) and the Portuguese autumn survey (116 kg/haul). The Portuguese autumn surveys generally give higher values than in the summer surveys, and a better correlation with the Spanish surveys (Figure 6.4.2.1).

6.4.3 Catch per unit of effort

The Spanish pair trawl CPUE series (Table 6.4.3.1) has been used for several years as a tuning fleet in the blue whiting assessment. This fleet represents only a small part of the landings caught in a small part of the distribution area. Due to this fact, and following a recommendation of the Methods Working Group (ICES 2003/D:03), this tuning series was not used this year in the assessments. The data show a slight decreasing trend in CPUE (Figure 6.4.3.1).

CPUE data from the commercial fleet (pelagic trawl) in the spawning area in 2001-2002 were submitted from Norway and added to the existing time-series. The CPUE is calculated as an overall aggregated CPUE in the Norwegian spawning fishery and is based on data from the vessels that have submitted their logbooks (about one-third of the vessels do so). The data suggest an overall increasing trend in CPUE since early 1990s (Figure 6.4.3.2). However, no attempt has been made to correct the data for the increase in catchability caused by technological improvements. As in previous years, the data have not been used in the assessment.

6.4.4 Data exploration

At the meeting of the Methods WG in January 2003, five different assessment models have been applied on blue whiting data (AMCI, ISVPA, ICA, XSA and CADAPT). The evaluation of these models partly addressed a request to ICES to evaluate some of these models with respect to blue whiting. The differences in results from the different models have been discussed by that group and are compared in Figure 6.4.4.1. The Methods WG gave the following recommendations to WGNPBW:

- The choice of appropriate model to assess the stock is not clear-cut and the approach used at this meeting of WGMG of exploring a number of competing models is to be commended as an aid to disentangle the apparent conflicting sources of data.

- To exclude the Spanish CPUE series from the calibration process as this survey was clearly shown to have no relevant information to the overall stock.

- To exclude the acoustic series which end in the 1980s because these surveys only provide information on cohorts that have been fished out by now. Alternatively it could be considered whether the two survey periods could be combined if a gear effect can be estimated for the introduction of the new EK500 equipment.

- It was found that the survey data was very noisy and often contradictory. This may be caused by sampling problems in the sampling for age in the acoustic surveys. The WG could explore the possibility of including acoustic survey data as SSB estimates rather than age-disaggregated indices. This would perhaps get rid of the noise in the age signal although the mortality signal would be lost.

WGNPBW addressed some of the recommendations using the same data as WGMG, but including catches in 2002 and the results of the 2003 Norwegian acoustic survey on the spawning grounds.

The assessment models explored by WGNPBW were AMCI and ISVPA. Different configurations were run with both models with individual and different combinations of tuning series and different settings. In addition a run with ICA was made, using the standard settings.

Tuning data available to the blue whiting assessments

There are six tuning fleets available for the blue whiting assessment: an acoustic survey in the Norwegian Sea (covering the feeding area of the northern stock component), a Norwegian and a Russian acoustic survey on the spawning grounds, a CPUE series from Spanish pair trawlers, a Spanish bottom trawl survey and a Portuguese bottom trawl survey. The last three fleets cover only a small part of the southern distribution area of the stock. The Spanish and

Portuguese survey fleets have not been used since 1998 and this year the WG decided to leave the CPUE time-series from Spanish pair trawlers out the assessment as well, following a recommendation of the Working Group on Methods on Fish Stock Assessments (ICES 2003/D:03), because this series proved to have no relevant information to the overall stock.

Catch numbers available to the assessment were available from 1981-2002 for ages 0-10+. Discard data were not available to the assessments. Last year 0-group data were included in the assessment. Exploratory runs including the 0-group showed the largest residuals in this age group. The catch data of this age group are very noisy, maybe because of changes in the distribution of the fleet for this age group, and provide no information on year-class strength. Therefore they were excluded from the assessment.

6.4.4.1 Analysis of catch-at-age in commercial data and in surveys

There has been a remarkable increase in the fishery for blue whiting in recent years. Before 1998, the average annual landings were below 600 000 t, while the average for the period 1998 to 2002 is above 1.4 million t. A crucial question is to what extent this large increase in the fishery has been obtained through an increase in the fishing mortality.

Catch data

The mortality signal in the catches is seen as the decline in catches along the cohorts. Figure 6.4.4.1.1 shows the slopes for log catch-at-age for the year classes from 1990 and earlier, the 91-94 year classes and the 95-97 year classes, and indicates that the recent big ones have been exploited at a Z of about 0.8, while the earlier ones had a Z at about 0.4. The Z in the early years is lower than we have in most assessments (for ages 5-9).

Survey data

Figure 6.4.4.1.2 shows the log indices by year class for the Norwegian acoustic survey on the spawning grounds, and calculated slopes of the curves for the average indices at age for the year classes up to 1990, and from the 1991 year class and onwards, and a regression from age 4 to 8. This indicates mortality in the order of 0.66 for the early period, and 1.1 for the late period. Similar analyses with the Norwegian Sea survey give similar values (0.55 and 1.1 respectively, but this is without 2002 data). Thus, the results from these surveys, assuming that the catchabilities at age are the same, indicate a mortality increase as do the catch data, but with higher absolute values.

Altogether, the catch and survey data give quite strong indications that the mortality since about 1998 at ages 4-5 and higher has been higher than previously, although there are some discrepancies with respect to the actual levels. Secondly, the recent survey data have strong year effects, and the estimate of the terminal F is largely a compromise between these conflicting signals, which renders the estimates of the exploitation rate and state of the stock very uncertain.

6.4.4.2 Data exploration with AMCI

In order to evaluate robustness of the assessment, a set of assessment runs was based on tuning with survey fleets used in the final assessment (Section 6.4.5.1), but using only one fleet at a time. In addition, one run was based solely on catch data. These assessments give consistent results (Figure 6.4.4.2.1), similar to those obtained in the final AMCI assessment. Residuals show some year effects but are similar to those obtained in the final AMCI assessment (Figure 6.4.4.2.2). There are some differences in the absolute levels of the assessment but the patterns are similar. Tuning based on Russian spawning stock survey shows the strongest deviation from the common pattern, indicating higher SSB and lower F during the most recent years. However, this time-series ends in 1996 and cannot therefore provide much information on the stock in later years.

Recruitment in 2001 (year class 2000) could not be estimated reliably. Exploratory AMCI runs where estimation was attempted did suggest strong recruitment at a level similar to recruitment in 2000, but the estimate was quite variable and, moreover, caused instability in other model parameters. Information from the surveys in 2002 and 2003 as well as from the PGSPFN in 2001 and 2002 (Holst et al. 2001, ICES 2002/D:07) suggest that year class 2000 is at least as strong as year class 1999. Recruitment in 2001 was therefore set to be similar to recruitment in 2000, $30x10^9$ individuals at age 1. Recruitment in 2002 was set to a value similar to geometric mean recruitment in the period 1981-2000, $11.5x10^9$.

The Methods Working Group recommended considering treating data from the spawning stock surveys as SSB indices. This was attempted with the Norwegian time-series on the spawning ground, which is longer than the Russian time-series. The results are presented in Figure 6.4.4.2.3. The resulting assessment shows much higher SSB in the recent years than any other AMCI assessment carried out by the WG. In addition, the model suggested a decreasing trend in fishing mortality, which is at odds with the patterns indicated by log catch ratios. The Working Group acknowledged that tuning with only SSB data was not reliable because of the known year effects in this time-series. Therefore the AMCI run with the three acoustic fleets (age structure) was adopted as the final AMCI run.

In previous years, CPUE time-series from Spanish pair trawlers have been included in the blue whiting assessments. This data suggest somewhat different dynamics than the blue whiting stock as the whole, and the Working Group on Methods on Fish Stock Assessments (ICES 2003/D:03) recommended exclusion of this time-series from the tuning data. Following this recommendation, the WG chose not to use the Spanish CPUE data in the final assessment. For comparison reasons a run is presented which included the Spanish data. The results are shown in Figure 6.4.4.2.3. Inclusion of the data in assessment results in lower estimate of SSB and higher estimate of F in the recent years, but it yields no qualitatively different results.

Age-disaggregated abundance estimates of blue whiting in Icelandic waters are available from 1999 onwards (Section 6.4.1.2). These data come from the feeding area of young blue whiting and may thus provide information on recruiting year classes. The data were included in an exploratory run along with final tuning data (Figure 6.4.4.2.3). This data resulted in moderate changes in estimated recruitment in 2000, but the overall effects were very small. The available time-series is so short that its value in providing information on recruitment cannot yet be assessed but is worth further analyses.

6.4.4.3 Data exploration with ISVPA

For blue whiting exploratory runs the same version of the ISVPA, which was used in frames of testing at the ICES WG on Methods (ICES 2003/D:03) was used (effort-controlled, unbiased separable representation of fishing mortality coefficients with minimization of the sum of squared errors (SSE) for each component of the ISVPA loss function). The age range for analysis was taken from 1 to 10+ because of extremely high residuals for age group 0. Options of the model are listed below.

Implementation of this version of the model gave distinct minima of the respective component of the loss function for each survey and for catch-at-age (Figure 6.4.4.3.1). According to recommendation of the ICES 2003/D:03 the data for CPUE of Spanish fleet was excluded from analysis. The signal from the integral SSB index from Norwegian surveys was also tested and revealed a distinct minimum.

Profiles of total loss function for cases when catch-at-age is used along with all age-structured auxiliary information, as well as with integral SSB index, are shown in Figure 6.4.4.3.2.

Tuning of the model on integral SSB index gives higher estimates of SSB in recent years than tuning on age-structured indexes (Figure 6.4.4.3.3). In the text table below, main settings and options used in ISVPA in WGNPBW 2002, Coastal States Meeting 2002 and WGMG 2003, and WGNPBW 2003 are shown.

Settings/options for the ISVPA run	2002(WG)	2002 (Coastal States meeting) and WG on Methods (2003)	2003 (WG)
Numbers of age-structured tuning series		3 splitted	3 splitted
Version of the model	Effort-controlled	Effort-controlled	Effort-controlled
Numbers of biomass tuning series		0	0
Constraint	Unbiased separable representation of F	Unbiased separable representation of F	Unbiased separable representation of F
Number of years with a separable constraint	1981-2001	1981-2001	1981-2002
Reference age for separable constraint	no	no	No
Constant selection pattern	yes	Yes	Yes
S on the last age	Equal to that for previous age	Equal to that for previous age	Equal to that for previous age
Age span for calculation of reference F	3-7	3-7	3-7
Weight given to age groups and years in separable period	1	1	1
Catchability model for all fleets		Constant, q(a) are estimated	Constant, q(a) are estimated
Age range for the analysis	1-10+	1-10+	1-10+
Survey weights for all ages in all fleets		1	1
What is minimized for residuals in logarithmic catch-at-age		SSE	SSE
What is minimized for logarithmic abundance-at-age (for indices)		SSE	SSE

6.4.4.4 Data exploration with ICA

In order to explore various interpretations of the assessment input data, various assessment models were used. One run with the model ICA was done, using similar settings as during the 2002 WG (see text table below). The tuning data were changed from 2002. Following the recommendations from the 2003 meeting of the Methods Working Group (ICES CM2003/D:03) one of the tuning fleets, the Spanish CPUE fleet, was left out of the analysis. In addition, the tuning series from the acoustic fleets that previously had been split into two series due to possible effects from changes in acoustic equipment were joined this year, to make the run compatible with those made with AMCI. Accordingly, there were now three age-structured fleets left in the analysis; the Norwegian Spawning survey, the Russian Spawning survey, and the Norwegian Sea acoustic survey. The age range in the analysis was changed from 0-10 to 1-10, to be comparable with the final run with AMCI and ISVPA. Main options and settings are given in the text table below, and compared to the settings used in 2002. Some diagnostic plots are given in Figures 6.4.4.4.1-2, and the results are shown in Figure 6.4.4.4.3 and Table 6.4.4.4.1.

Settings/options for the ICA run	2002	2003
Numbers of age-structured tuning series	4[1]	3
Numbers of biomass tuning series	0	0
Number of years with a separable constraint	4	5
Reference age for separable constraint	6	6
Constant selection pattern	Yes	Yes
S to be fixed on the last age	1.5	1.5
Age span for calculation of reference F	3-7	3-7
Weight given to age groups and years in separable period	1	1
Catchability model for all fleets	Linear	Linear
Age range for the analysis	0-10	1-10
Survey weights for all ages in all fleets	varying[2]	1
Extent of correlation between errors across ages	1	1
Shrinkage	No	No

It is seen that the SSQ surface is rather flat for a range of terminal Fs (Figure 6.4.4.4.1) and the minimum is poorly defined. There are negative age residuals for the youngest age groups and positive residuals for the oldest (Figure 6.4.4.4.2). The results show that the stock size has increased considerably in recent years, the spawning stock biomass reaching 4 million t in 2002. However, because of the large catches taken in the period after 1998, the fishing mortality has also increased, and was estimated to be 0.62 in 2002. All year classes after 1994 are estimated to be well above average strength.

6.4.5 Stock assessment

6.4.5.1 Final assessment with AMCI

The key settings and data for the final blue whiting assessment in 2003 are shown in the table below. The key settings of the final assessment in 2002 are also shown for comparison. Some of the settings are described in more detail after the table.

[1] Three of these were split into two periods.

[2] The youngest age group in the Spanish CPUE tuning fleet was down-weighted.

Settings/options for the AMCI run	2002	2003
AMCI version	2.1	2.2[3]
Age range for the analysis	0-10+	1-10+
Last age a plus-group?	Yes	Yes
Age at recruitment (from Jan 1 in the year of spawning)	0.5	1
Recruitment in the terminal year	Fixed	Fixed
Recruitment in the terminal year-1	Estimated	Fixed
Catch data		
Weights for the partial objective functions for the catch fleet		
Log sum of squares of catches-at-age	1	1
Log sum of squares of yearly yields	1	1
Weights of catch-at-age, age 0 and 1 years	0.1, 0.5	n.a., 0.5
Constant selection pattern for the catch fleet?	Almost	Almost
Selectivity for age 10 equals average of selectivity at age 8-9?	No	Yes
Age-structured tuning time-series		
Norwegian acoustic survey on the spawning grounds, ages 2-8	1981-2002	1981-2003
Flat selectivity for ages 6-8?	Yes	No
Weight in tuning for the partial objective function	1	1
Russian acoustic survey on the spawning grounds, ages 3-8,	1982-1996	1982-1996
Flat selectivity for ages 7-8?	Yes	No
Weight in tuning for the partial objective function	1	1
Norwegian Sea acoustic survey, ages 1-7	1981-2001	1981-2001
Flat selectivity for ages 5-7?	Yes	No
Weight in tuning for the partial objective function	1	1
CPUE time-series from Spanish pair trawlers, ages 1-6[4]	1983-2001	not used
Flat selectivity for ages 5-6?	Yes	n.a.
Weight in tuning for the partial objective function	1	n.a.
Piece-wise constant selection pattern for the tuning fleets?	Yes	Yes
Biomass tuning time-series	0	0

Survey data used in tuning are shown in Table 6.4.5.1.1. As in previous years, the three acoustic surveys were split into two time periods reflecting a likely change in catchability caused by a change in acoustic equipment (Simrad EK-500). From 2002 onwards the splitting of these time-series has technically been obtained by estimating age-specific catchability separately for the two periods. Survey indices are treated as relative abundance indices.

Fishing mortality was modelled as separable, but with an allowance for a gradual change in the selection from year to year. The gain factor for change in selection was 0.2 for age 1, and 0.1 for the older ages. This implies that the selection at age 1 is allowed to vary more according to the year-to-year variation in the catches than the selection at the older ages. The selection at age 10+ was fixed to the average of ages 8-9 years.

Recruitment in 2001 was set to 30×10^9 individuals at age 1. Recruitment in 2002 was set to the geometric mean recruitment in the period 1981-2000, 11.5×10^9.

[3] AMCI 2.3 was used for scanning over terminal F's.

[4] Age 1 was down-weighted by factor 0.01.

Catch-at-age data are input at yearly resolution (Table 6.3.2.4). However, AMCI operates internally on a quarterly basis. The spawning stock is derived from the mean stock numbers in the first quarter, and the survey indices are related to the mean values in the survey season (Table 6.4.5.1.1.). The yearly fishing mortality was split on quarters assuming that the proportion 0.35 of the total annual fishing mortality occurs in the first and in the second quarter, 0.2 in the third quarter, and 0.1 in the fourth quarter.

The model was run until 2005. The results for 2003 and onwards, except the SSB in 2003, are predicted values assuming the same fishing mortality as in 2002 and constant recruitment. The key results are presented in Tables 6.4.5.1.2–6.4.5.1.4 and summarized in Figure 6.4.5.1.1. Residuals of the model fit are shown in Figure 6.4.5.1.2. Some cohort effects are visible in the catch residuals for the early cohorts, and year effects occur throughout the survey time-series. The minimum SSQ (between the fitted model and the observed data) is not well defined. A range of terminal F's can give SSQ that are close to the global minimum (Figure 6.4.5.1.3). Thus, the data do not allow unique characterisation of the stock in the most recent years. Selection pattern in terms of age- and year-specific F's is shown in Figure 6.4.5.1.4.

The assessment (Table 6.4.5.1.4) indicates that fishing mortality has increased sharply in recent years. The exploitation pattern has been relatively stable with the major exploitation being on adults. SSB has increased compared to the period from the early 1980s to the late 1990s. However, it has been declining since 1999 and is expected to continue doing so if fishing mortality remains at F=0.48 yr^{-1} estimated for 2002 and assumed recruitment. Recruitment of the 1996 year class is the highest in the time-series. All following year classes are also large, indicating a possible change in recruitment dynamics of the stock. Even the weakest year class born after 1996, that of 1998, is much stronger than was typical in the previous period.

A bootstrap run (Figure 6.4.5.1.5) gives an indication of the uncertainty in the assessment. Even though the bootstrap replicates reproduce similar temporal patterns in recruitment, spawning stock biomass and fishing mortality as the final assessment, uncertainty in the absolute level of these metrics during the recent years is clearly visible. Moreover, the development of SSB and fishing mortality after 1999 remain highly uncertain.

Retrospective analysis (Figure 6.4.5.1.6) shows that the assessments with 2001 or 2002 as the terminal year are very consistent. However, 1999 or 2000 as the terminal year yield assessments suggesting lower SSB and recruitment and higher F.

6.4.5.2 Final assessment with ISVPA

For the final run the model was run with the same settings as for exploratory runs, but only signals from age-structured auxiliary information were used in addition to signals from catch-at-age. The results of the stock assessment are given in the Tables 6.4.5.2.1–6.4.5.2.3.

Comparison of theoretical catches and reported ones for age groups, included into analysis, are shown in Figure 6.4.5.2.1.

Residuals for catch-at-age and each survey data (in the minimum of the ISVPA loss function) are shown in Figure 6.4.5.2.2. ISVPA residuals in logarithmic catch-at-age residuals have apparent cohort structure. This structure may be dealt with by a large period of separability constraint, used to increase the stability of estimates of selection factors. The cohort peculiarities in the matrix of residuals may be considered as a negative feature, but, as it was mentioned in the Report of the Working Group on Methods (ICES 2003/D:03), the 1992 year class has a strong anomaly in its catch dynamics for young ages and it may not be unreasonable to retain high residuals for this year class, which means that the estimates of the model parameters are less based on this cohort. The structure of residuals for indices is less certain and includes some elements of both cohort and year effects.

The selection pattern in terms of age- and year-specific F's is shown in Figure 6.4.5.2.3.

In the retrospective analysis the same settings were retained even though some of the indices might become uninformative because of the shortening of the year range. This may be the reason for the instability of the results for 1998-2000. The results of the retrospective analysis are shown in Figure 6.4.5.2.4.

Results of the bootstrap estimation of confidence intervals are shown in Figure 6.4.5.2.5. For effort-controlled version of the model, used for blue whiting, the procedure consists in application of conditional parametric bootstrap (assuming lognormal distribution of residuals) with variance, estimated in the basic run; a lognormally-distributed random noise with variance = 0.3 for each survey was added to the age-structured indices.

6.4.5.3 Comparison between AMCI and ISVPA assessment

The results of the assessments carried out with the AMCI and ISVPA model are compared in Figure 6.4.5.3.1.

SSB: The models show reasonable agreement in the historical estimates of SSB except for the most recent years. Both models indicate a significant increase in SSB in the late 1990's to about 4 million t. In the period thereafter, SSB continues to increase to a historic high (about 6 million t) in 2002 in the ISVPA assessment but has decreased slightly in the AMCI assessment to about 3.5 million t.

Fishing mortality: Trends in fishing mortality estimated by both models are similar in the historical period. However, historical ISVPA estimates are consistently higher than those by AMCI. Both models indicate a sharp decrease in F from 1990 to 1991. The reasons for this decrease are unclear and may reflect a shift in the fishery to other components of the stock. Also, both models indicate an increase in F after 1994, which continues to increase to a historic high in 2002 in the AMCI assessment. However, ISVPA shows a decrease in F after 1998.

Recruitment: Both models indicate that recruitment has increased after 1995. The 1996 year class was estimated as the strongest in the time-series. The estimate by both models is almost the same. The estimates of more recent year classes by ISVPA are consistently higher than those by AMCI.

The models give a different interpretation of the large increase in catches by the fishery since 1998. ISVPA explains the increase of the catches almost entirely by the increase in biomass resulting from the large recruitment. The model supports this interpretation unambiguously, in a sense that the minimum SSE is well defined (Figure 6.4.4.3.2). AMCI, on the other hand, explains the increase of the catches partly by a large increase in fishing mortality and partly by an increase in biomass. However, the SSE surface around the minimum is rather flat (Figure 6.4.5.1.3), indicating that solutions with somewhat higher or lower F would fit the data almost as well.

In the absence of quantitative data demonstrating changes in the fishery the WG felt it difficult to make a choice between the two models. Nevertheless, the increase in F estimated by AMCI is in line with the exploratory analysis of catch curves and survey data (Section 6.4.4).

6.5 Short-term Projections

Based on the final AMCI and ISVPA runs, two deterministic short-term projections were made using the MFDP (version 1a) program. The yield-per-recruit estimations were made by means of the MFYPR (version 2a) program. The input values are shown in Tables 6.5.1 and 6.5.2, respectively. The weight in the stock and catch were taken from the average of the last three years' values.

In the first short-term projection the selection pattern and the reference F in 2001 from the final AMCI run were used as input values in 2003. The recruitment in 2003-2005 was set as the geometric mean of the recruitment values in the period 1981-2000 in the AMCI run. For all ages the output values in 2002 from the AMCI run were used as the initial stock size. The proportion of F and M before spawning was set to 0.25, taking into account the proportion of the catches that take place before the spawning period.

The same settings were chosen to run the second short-term projection, based on the values provided by the final ISVPA run. The results are given in Tables 6.5.3 and 6.5.4, and the standard plots are given in Figures 6.5.1 and 6.5.2.

AMCI

Continued fishing at the 2002 level predicts a catch of 1.3 million t in 2003 and 1.1 million t in 2004. This exploitation rate implies a decreasing trend of SSB with 3.1 million t in 2003 and 2.5 and 2.1 million t in 2004 and 2005, respectively. The predicted total stock biomass will also decrease from 4.9 million t in 2003 to 4.2 and 3.6 million t in the following years.

ISVPA

Continued fishing at the 2002 level predicts higher catches of 1.6 million t in 2003 and 1.5 million t in 2004. At this exploitation rate SSB is predicted to decrease from 5 million t in 1994 to 4.3 million t in 1995. The ISVP predicted stock biomass for 2003 is 8.5 million t and is predicted to fall to 7.5 million and 6.5 million t over the following two years.

6.6 Medium-term Projection

The Working Group did not carry out medium-term projections. In general, medium-term projections in the most recent period are largely defined by the presently assumed stock size, recruitment and exploitation level, while the period further in the future is mostly affected by assumptions on recruitment dynamics and exploitation level. The Working Group considered that, given the uncertain present situation of the stock and its exploitation, and the poor knowledge on stock dynamics, medium-term projections for blue whiting would be predominantly based on assumptions and are not very instructive (in fact they can be misleading). Also, no standard medium-term projection software was available to the Working Group to carry out the calculations.

6.7 Precautionary Reference Points

The present precautionary reference points have been introduced in the advice of ACFM in 1998. The values and their technical basis are:

$\mathbf{B}_{lim}$: 1.5 mill t; $\mathbf{B}_{loss}$

$\mathbf{B}_{pa}$: 2.25 mill. t; $\mathbf{B}_{lim}$*1.5

$\mathbf{F}_{lim}$: 0.51; $\mathbf{F}_{loss}$

$\mathbf{F}_{pa}$: 0.32; $\mathbf{F}_{med}$.

Although problems have been identified with these reference points they have remained unchanged since 1998. A major problem is that fishing at $\mathbf{F}_{pa}$ implies a high probability of bringing the stock below $\mathbf{B}_{pa}$, in other words the present combination of $\mathbf{F}_{pa}$ and $\mathbf{B}_{pa}$ is inconsistent.

The present reference points are based on assessments of the stock carried out at the end of the 1990s and are based on a relatively short time-series. Since then major changes have been observed in the stock and in the fishery. This adds to the need to revise the reference points, because of their role as targets for rebuilding and guidelines for future exploitation.

It was the intention by ICES to revisit all precautionary reference points in 2003 for those stocks ICES provides advice for. However, it is not likely that this will be achieved. The SGPRP revisited the $\mathbf{B}_{lim}$ reference point for blue whiting in February 2003 (ICES 2003/ACFM:15). The current $\mathbf{B}_{lim}$ value of 1.5 million t was based on an estimate of $\mathbf{B}_{loss}$ from an assessment in 1998. Since a segmented regression on the stock recruitment data was not significant, $\mathbf{B}_{loss}$ remains the obvious candidate for $\mathbf{B}_{lim}$. In the assessment carried out in 2002 $\mathbf{B}_{loss}$ was estimated to be 1.2 million t and SGPRP proposed this value for $\mathbf{B}_{lim}$.

Based on assessments carried out in 2003 by WGNPBW, the $\mathbf{B}_{loss}$ is estimated between 1.7 million t (AMCI assessment) and 1.8 million t (ISVPA assessment). The estimates of $\mathbf{B}_{loss}$ values in recent years vary considerable, however, around the present $\mathbf{B}_{lim}$. The relatively large changes in the blue whiting assessments and the differences in stock dynamics estimated by different assessment methods make it difficult to estimate a stable value for $\mathbf{B}_{lim}$. If the value of $\mathbf{B}_{lim}$ is to be revised, it is likely to be around the region of the present value of 1.5 million tonnes.

The SGPA provided guidelines to re-estimate the other PA reference points based on $\mathbf{B}_{lim}$ and the historical uncertainty of the assessment. The proposed procedure is quite complicated and requires software still to be developed. The other PA reference points have not been estimated by the WG.

It should be noted that the PA reference points presently applied in the ICES advice are based on an ICA assessment in 1998. Since then regular changes have been made in the assessment by selecting other assessment methods or different assessment configurations.

6.8 Management consideration

The fishery for blue whiting has expanded rapidly in recent years, while no agreement on TAC has been reached. The reported catches in 1998 to 2002 were all well above 1 million t, reaching 1.7 million t in 2001. The SSB has been at a fairly high level, due to exceptionally good recruitment in recent years. The year classes 1995-1999 are all well above average strength. The estimated strength of the 2000 and 2001 year classes is uncertain, but there is evidence that the

2000 year class is strong. Without the strong year classes recruited in recent years, the intensive fishery would have led to a severe depletion of the stock before now.

However, the assessments made in 2003 give a more optimistic view of the present stock situation compared to that made in 2001 and 2002. The main reason is that the incoming year classes are seemingly stronger than estimated previously. The SSB in 2002 is, according to both alternative assessments made, above the $\mathbf{B}_{pa}$ presently used.

6.8.1 Exploitation of juvenile blue whiting

Although the main fishery for blue whiting takes place in the spawning area where mostly mature fish are caught, some juveniles are caught in all areas. However, the blue whiting catch from the mixed industrial fishery for blue whiting in the North Sea is largely based on juveniles.

The Working Group was able to study age composition in catches from Norwegian mixed industrial fishery in 2000-2002 (Heino et al., WD a). These data suggest that in most years and areas, the catches are dominated by fish of age 1 year, which are almost entirely juveniles. The Norwegian catch amounts to roughly 500·106 individuals annually. During the period 2000-2001, recruitment at age 1 year has been estimated at about 30·109 individuals. Considering catches from other countries (Table 6.2.3), the catch of age 1 year blue whiting does not represent more than 5% of the estimated numbers of blue whiting at that age. Although this is a non-negligible proportion, it is much smaller than the proportion that is removed annually at older ages, i.e., roughly 20-30% from age 3 years and onwards (Table 6.4.5.1.2). Although the Working Group did not run any simulations related to this problem, the catch of juvenile blue whiting is not likely to have a large effect on the dynamics of the stock. The catch of juvenile blue whiting in this fishery could probably be avoided only by strong reduction in effort, amounting to a practical closure of this component of the fishery.

The catch of 0-group blue whiting by the Norwegian fleet was in the range of 4·106 to 120·106 individuals, which is several orders of magnitude less than the estimated stock numbers at the corresponding age. A catch of this magnitude is unlikely to have any noticeable effects on the stock as whole.

6.9 Quality of catch data and biological data

Without an internationally agreed TAC for this stock there are no obvious motives for mis-reporting. The extent of discarding in the fishery is not known. It is assumed that any discarding that occurs in the industrial fishery is confined to net bursting through overloading or through the catch exceeding the RSW tank capacity. On freezer vessels landing a catch for human consumption the role of grading in handling the catch is not known. If grading occurs in this sector then landing figures may not reflect the true catch. It would be helpful to the Working Group's deliberations if countries participating in the fishery could enumerate the number and category of vessel prosecuting the fishery.

The type and frequency of bycatch in the fishery has not been sufficiently explored. Each fishery could be expected to have a different bycatch profile. The submission of by catch data for each of the blue whiting fisheries would enable the WG to report on the likely impacts of blue whiting fisheries on other stocks and fisheries.

The text table below shows the number of samples and total landings by the three fisheries, Directed, Mixed, and Southern, and by quarter.

Quarter		Directed	Mixed	Southern	Total
1	Number of samples	99	8	127	234
	Landings (t)	378827	13887	4987	397701
2	Number of samples	128	15	138	281
	Landings (t)	504093	25451	5399	534943
3	Number of samples	159	42	116	317
	Landings (t)	409960	54831	5111	469902
4	Number of samples	64	11	131	206
	Landings (t)	106778	42002	3668	152448
Total	Number of samples	450	76	512	1038
	Landings (t)	1399659	136171	19165	1554995

In total 1038 samples were collected from the fisheries, 117,090 fish measured and 19,551 fish aged. Sampled fish were not evenly distributed throughout the fisheries. The most intensive sampling took place in the south. Here one sample was taken for every 37 tonnes, followed by the mixed fishery with one sample for every 1792 tonnes, and lastly the directed fishery where there was one sample for every 3110 tonnes caught. In this context it should be noted that implementation of the EU Collection of Fisheries Data, Fisheries Regulation 1639/2001, requires a minimum of one sample to be taken for every 1000 t landed. Detailed information on the number of samples, number of fish measured, and number of fish aged by country and quarter is given in Table 6.9.1. As can be seen, no sampling was carried out by France, Germany, and Sweden and only limited sampling by Denmark, Ireland and Scotland.

The WG requires the samples to estimate catch in numbers and mean length and mean weight. Therefore, the WG urges all countries that exploit this stock to develop appropriate sampling schemes.

6.10 Recommendations

Several surveys on blue whiting are presently going on. It is recommended that a coordinated survey be organised covering the main spawning grounds of blue whiting. Other countries than those presently taking part in these surveys should be invited to take part.

It is recommended that information from existing surveys in which blue whiting are caught is made available to the Working Group. In particular, information from PGSPFN-coordinated surveys should be made available and analysed for information on abundance of incoming year classes.

It is suggested that the coordination could be taken care of by an extended ICES PGSPFN.

It would be helpful to the Working Group's deliberations if countries participating in the fishery could enumerate the number, capacity and effort of vessels prosecuting the fishery.

It is recommended that existing information on discards and bycatch in the fisheries is made available to the WG.

Table 6.2.1 Landings (tonnes) of BLUE WHITING from the directed fisheries (Sub-areas I and II, Division Va, XIVa and XIVb) 1987–2002, as estimated by the Working Group.

Country	1987	1988	1989 3)	1990	1991	1992	1993	1994 2)	1995 3)	1996	1997	1998	1999	2000	2001	2002
Denmark													15	7,721	5,723	13,608
Estonia	-	-	-	-	-	-	-	-	-	377	161	904	-	-	-	-
Faroes	9,290	-	1,047	-	-	-	-	-	-	345	-	44,594	11,507	17,980	64,496	82,977
Germany	1,010	3	1,341	-	-	-	-	2	3	32	-	78	-	-	3117	1,072
Greenland	-	-	-	-	-	-	-	-	-	-	-	-	-	-		-
Iceland	-	-	4,977	-	-	-	-	-	369	302	10,464	64,863 4)	99,092	146,903	245,814	193,686
Latvia	-	-	-	-	-	-	-	422	-	-	-	-	-	-	-	-
Netherlands	-	-	-	-	-	-	-	-	72	25	-	63	435	-	5180	906
Norway 5)															64,581	100,922
Norway 6)	-	-	-	566	100	912	240	-	-	58	1,386	12,132	5,455	-	28,812	-
Poland	56	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sweden	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	850
USSR/Russia 1)	112,686	55,816	35,250	1,540	78,603	61,400	43,000	22,250	23,289	22,308	50,559	51,042	65,932	103,941	173,860	145,649
Total	123,042	55,829	42,615	2,106	78,703	62,312	43,240	22,674	23,733	23,447	62,570	173,676	182,436	276,545	591,583	539,670

1) From 1992 only Russia

2) Includes Vb for Russia.

3) Icelandic mixed fishery in Va.

4) include mixed in Va and directed in Vb.

5) Directed fishery

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

Table 6.2.2 Landings (tonnes) of BLUE WHITING from directed fisheries (Division Vb,VIa,b, VIIb,c. VIIg-k and Sub-area XII) 1987–2002, as estimated by the Working Group.

Country	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998 1)	1999	2000	2001	2002
Denmark	2,655	797	25	-	-	3,167	-	770	-	269	-	5051	19,625	11,856	18,110	2,141
Estonia	-	-	-	-	-	6,156	1,033	4,342	7754	10,605	5,517	5,416	-	-	-	-
Faroes	70,625	79,339	70,711	43,405	10,208	12,731	14,984	22,548	26,009	18,258	22,480	26,328	93,234	129,969	188,464	115,127
France	-	-	2,190	-	-	-	1,195	-	720	6,442	12,446	7,984	6,662	13,481	13,480	14,688
Germany	3,850	5,263	4,073	1,699	349	1,307	91	-	6,310	6,844	4,724	17,891	3,170	12,655	15,862	15,378
Iceland	-	-	-	-	-	-	-	-	-	-	-	-	61,438	113,280	119,287	91,853
Ireland	3,706	4,646	2,014	-	-	781	-	3	222	1,709	25,785	45635	35,240	25,200	29,854	17,723
Japan	-	-	-	-	-	918	1,742	2,574	-	-	-	-	-	-	-	-
Latvia	-	-	-	-	-	10,742	10,626	2,160	-	-	-	-	-	-	-	-
Lithauen	-	-	-	-	-	-	2,046	-	-	-	-	-	-	-	-	-
Netherlands2)	5,627	800	2,078	7,280	17,359	11,034	18,436	21,076	26,703	17,644	23,676	27,884	35,408	46,128	68,415	33,365
Norway	191,012	208,416	258,386	281,036	114,866	148,733	198,916	226,235	261,272	337,434	318,531	519,622	475,004	460,274	399,932	385,495
UK (Scotland)	3,315	5,071	8,020	6,006	3,541	6,849	2,032	4,465	10,583	14,325	33,398	92,383	98,853	42,478	50,147	26,403
Sweden	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10
USSR/Russia 3)	165,497	121,705	127,682	124,069	72,623	115,600	96,000	94,531	83,931	64,547	68,097	79,000	112,247	141,257	141,549	144,419
Total	446,287	426,037	475,179	463,495	218,946	318,018	347,101	378,704	423,504	478,077	514,654	827,194	940,881	996,578	1,045,100	846,602

1) Including some directed fishery also in Division IVa.

2) Revised for the years 1987, 1988, 1989, 1992, 1995,1996,1997

3) From 1992 only Russia

Table 6.2.3 Landings (tonnes) of BLUE WHITING from directed fisheries and by-catches caught in other fisheries in Divisions IIIa, IVa 1987–2002, as estimated by the WG.

Country	1987	1988	1989	1990	1991	1992	1993 [3)]	1994	1995	1996	1997	1998 [2)]	1999	2000	2001	2002
Denmark [4)]	28,541	18,144	3,632	10,972	5,961	4,438	25,003	5,108	4,848	29,137	9,552	40,143	36,492	30,360	21,995	35,530
Denmark [5)]			22,973	16,080	9,577	26,751	16,050	14,578	7,591	22,695	16,718	16,329	8,521	7,749	7,505	
Faroes [4) 6)]	7,051	492	3,325	5,281	355	705	1,522	1,794	-	6,068	6,066	-	-	-	60	7,317
Faroes [5) 6)]												296	265	42	6,741	
Germany [1)]	115	280	3	-	-	25	9	-	-	-	-			-	81	
Ireland	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4
Netherlands	-	-	-	20	-	2	46	-	-	-	793			-	-	50
Norway [4)]	24,969	24,898	42,956	29,336	22,644	31,977	12,333	3,408	78,565	57,458	27,394	28,814	48,338	73,006	21,804	85,062
Norway [5)]															58,182	
Russia															69	
Sweden	2,013	1,229	3,062	1,503	1,000	2,058	2,867	3,675	13,000	4,000	4,568	9,299	12,993	3,319	2,086	17,689
UK	-	100	7	-	335	18	252	-	-	1	-			-	-	
Total	62,689	45,143	75,958	63,192	39,872	65,974	58,082	28,563	104,004	119,359	65,091	94,881	106,609	114,476	118,523	145,652

[1]) Including directed fishery also in Division IVa.

[2]) Including mixed industrial fishery in the Norwegian Sea

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

[4)] Directed fishery

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

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

Table 6.2.4 Landings (tonnes) of BLUE WHITING from the Southern areas (Sub-areas VIII and IX and Divisions VIIg-k and VIId,e) 1987–2002, as estimated by the Working Group.

Country	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Germany	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	600
Ireland																98
Netherlands	-	-	-	450	10	-	-	-	-	-	-	10 [1)]	-	-	-	3,208
Norway	4	-	-	-	-	-	-	-	-	-	-			-	-	
Portugal	9,148	5,979	3,557	2,864	2,813	4,928	1,236	1,350	2,285	3,561	2,439	1,900	2,625	2,032	1,746	1,659
Spain	23,644	24,847	30,108	29,490	29,180	23,794	31,020	28,118	25,379	21,538	27,683	27,490	23,777	22,622	23,218	17,506
UK	23	12	29	13	-	-	-	5	-	-	-	-	-	-	-	
France	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	
Total	32,819	30,838	33,695	32,817	32,003	28,722	32,256	29,473	27,664	25,099	30,122	29,390	26,402	24,654	24,964	23,071

[1)] Directed fisheries in VIIIa

Table 6.2.5 Total landings of blue whiting by country and area for 2002 in tonnes. Landing figures provided by Working Group members and these figures may not be official catch statistics and therefore can not be used for management purposes.

Area	Denmark	Faroe Islands	France	Germany	Iceland	Ireland	Norway	Portugal	Russia	Scotland	Spain	Sweden	Netherlands	Grand Total
I									186					186
IIa	13,608	36,126		1,072	53,271		100,922		145,463			850	906	352,218
IIIa	6,454											17,610		24,064
IVa	28,621	7,163				4	85,062					79	50	120,979
IVb	455	154												609
IXa								1,659						1,659
V									107,900					107,900
Va		46,851			140,415									187,266
Vb		90,682			87,316		16,318					10		194,326
VbVIVII			14,688											14,688
VIa	1,428	1,315		8,598		11,394	105,434			4,135			12,099	144,403
VIab+VIIbc					1,915									1,915
VIb		22,739		500			203,133						4,104	230,476
VIIb	713					19				7,944			54	8,730
VIIbc									33,674					33,674
VIIc				6,280		6,310	41,121			14,324			17,108	85,143
VIIgk+XII					2,622									2,622
VIIIabd													3,203	3,203
VIIIc+IXa											17,506			17,506
VIIIe						35								35
VIIj				600		63							5	668
VIIk							13,509							13,509
XII		391					5,980		2,845					9,216
Grand Total	51,279	205,421	14,688	17,050	285,539	17,825	571,479	1,659	290,068	26,403	17,506	18,549	37,529	1,554,995

Table 6.2.6 Landings (tonnes) of BLUE WHITING from the main fisheries, 1987–2002, as estimated by the Working Group.

Area	Norwegian Sea fishery (Sub-areas 1+2 and Divisions Va, XIVa-b)	Fishery in the spawning area (Divisions Vb, VIa, VIb and VIIb-c)	Directed- and mixed fisheries (Divisions IIIa and IV)	**Total northern areas**	Total southern areas (Subareas VIII and IX and Divisions VIId, e, g-k)	**Grand total**
1987	123,042	446,287	62,689	**632,018**	32,819	**664,837**
1988	55,829	426,037	45,143	**527,009**	30,838	**557,847**
1989	42,615	475,179	75,958	**593,752**	33,695	**627,447**
1990	2,106	463,495	63,192	**528,793**	32,817	**561,610**
1991	78,703	218,946	39,872	**337,521**	32,003	**369,524**
1992	62,312	318,081	65,974	**446,367**	28,722	**475,089**
1993	43,240	347,101	58,082	**448,423**	32,256	**480,679**
1994	22,674	378,704	28,563	**429,941**	29,473	**459,414**
1995	23,733	423,504	104,004	**551,241**	27,664	**578,905**
1996	23,447	478,077	119,359	**620,883**	25,099	**645,982**
1997	62,570	514,654	65,091	**642,315**	30,122	**672,437**
1998	173,676	827,194	94,881	**1,095,751**	29,400	**1,125,151**
1999	182,436	940,881	106,609	**1,229,926**	26,402	**1,256,328**
2000	276,545	996,577	114,477	**1,387,599**	24,654	**1,412,253**
2001	591,583	1,045,100	118,523	**1,755,206**	24,964	**1,780,170**
2002	539,670	830,471	145,652	**1,515,793**	39,202	**1,554,995**

Table 6.2.7 Total landings of blue whiting by quarter and area for 2002 in tonnes. Landing figures provided by Working Group members.

Area	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Grand Total
I	185	1		0	186
IIa	5,255	82,296	219,109	45,558	352,218
IIIa	1,796	3,387	12,140	6,741	24,064
IVa	19,541	27,045	47,910	26,483	120,979
IVb		3	493	113	609
V	15,832	45,575	2,857	43,636	107,900
Va	640	55,290	124,938	6,398	187,266
Vb	5,719	120,900	48,369	19,338	194,326
VbVIVII	4,565	5,307	4,320	496	14,688
VIa	2,526	141,853	7	17	144,403
VIab+VIIbc	1,335	580			1,915
VIb	210,817	19,659			230,476
VIIb	8,727	3			8,730
VIIbc	13,327	18,907	1,440		33,674
VIIc	76,479	8,664			85,143
VIIgk+XII	8,602				8,602
VIIj	645	18	5		668
VIIk	13,509				13,509
VIIIabd			3,203		3,203
VIIIc+IXa	4,713	4,827	4,525	3,442	17,506
VIIIe	35				35
IXa	274	572	586	226	1,659
XII	3,179	57			3,236
Grand Total	397,702	534,944	469,901	152,448	1,554,995

Table 6.3.1.1 Blue whiting.Landings in numbers ('000) by length group (cm) and quarters, quarters, for for the Northern area 2002

length	**Q1**	**Q2**	**Q3**	**Q4**	**All year**
5	0	0	0	0	0
6	0	0	0	0	0
7	0	0	0	0	0
8	0	0	0	0	0
9	0	0	0	0	0
10	0	0	0	0	0
11	0	0	0	0	0
12	0	0	0	0	0
13	0	0	1	0	1
14	0	0	1	2	3
15	1	0	1	2	5
16	8	2	2	7	19
17	49	13	2	2	66
18	47	22	6	2	78
19	32	46	23	2	104
20	29	84	84	10	207
21	29	129	215	18	391
22	59	189	353	35	635
23	70	294	430	79	873
24	90	350	424	107	972
25	144	389	412	135	1079
26	179	357	393	139	1069
27	201	376	342	133	1053
28	240	365	244	93	943
29	261	309	194	66	830
30	257	282	133	35	707
31	199	184	93	10	487
32	144	121	50	13	327
33	113	81	15	5	213
34	75	55	11	4	145
35	61	33	5	3	101
36	25	23	4	0	53
37	18	15	1	5	39
38	12	13	1	2	28
39	9	7	0	2	18
40	2	2	1	5	10
41	1	2	0	0	2
42	1	1	0	0	2
43	0	0	0	0	0
44	0	0	0	0	0
45	0	0	0	0	0
46	0	0	0	0	0
47	0	0	0	0	0
48	0	0	0	0	0
49	0	0	0	0	0
50	0	0	0	0	0
TOTAL numbers	2355	3744	3444	919	10462
Official Catch (t)	364256	490720	404454	106284	1365714

Table 6.3.1.2 Blue whiting. Landings in numbers ('000) by length group (cm) and quarters for the North Sea and Skagerrak in 2002

length	Q1	Q2	Q3	Q4	All year
5	0	0	0	0	0
6	0	0	0	0	0
7	0	0	0	0	0
8	0	0	0	0	0
9	0	0	0	0	0
10	0	0	0	0	0
11	0	0	0	0	0
12	0	0	0	0	0
13	0	0	2	0	2
14	0	0	33	8	41
15	1	0	57	14	73
16	3	0	14	3	20
17	20	1	7	2	29
18	19	6	0	2	28
19	15	24	9	2	50
20	17	53	66	4	141
21	20	47	163	28	259
22	23	46	126	52	247
23	32	41	78	65	217
24	30	34	80	80	224
25	22	29	75	63	189
26	12	25	51	61	150
27	12	12	25	34	83
28	5	9	19	16	50
29	4	4	13	8	29
30	5	3	5	13	26
31	1	2	3	4	10
32	1	3	3	3	10
33	1	0	0	1	2
34	1	0	0	0	2
35	0	0	1	0	2
36	1	0	0	0	1
37	0	0	0	0	0
38	0	0	0	0	0
39	0	0	0	0	0
40	0	0	0	0	0
41	0	0	0	0	0
42	0	0	0	0	0
43	0	0	0	0	0
44	0	0	0	0	0
45	0	0	0	0	0
46	0	0	0	0	0
47	0	0	0	0	0
48	0	0	0	0	0
49	0	0	0	0	0
50	0	0	0	0	0
TOTAL numbers	246	340	832	465	1883
Official Catch (t)	17070	23305	54796	40552	135723

Table 6.3.1.3 Blue whiting. Landings in numbers ('000) by length group (cm) and quarters for the Southern area in 2002

length	Q1	Q2	Q3	Q4	All year
5	0	0	0	0	0
6	0	0	0	0	0
7	0	0	0	0	0
8	0	0	0	0	0
9	0	0	0	0	0
10	0	0	0	0	0
11	0	0	0	0	0
12	0	0	0	0	0
13	0	0	0	0	0
14	0	0	0	0	0
15	0	0	0	1	1
16	1	0	0	5	6
17	5	0	0	6	11
18	11	2	2	4	18
19	22	11	9	9	50
20	18	23	18	7	66
21	14	25	20	10	68
22	10	17	15	8	50
23	7	7	8	5	27
24	3	4	3	3	13
25	1	2	2	2	7
26	1	0	1	1	3
27	1	0	1	1	2
28	0	0	0	0	1
29	0	0	0	0	1
30	0	0	0	0	0
31	0	0	0	0	0
32	0	0	0	0	0
33	0	0	0	0	0
34	0	0	0	0	0
35	0	0	0	0	0
36	0	0	0	0	0
37	0	0	0	0	0
38	0	0	0	0	0
39	0	0	0	0	0
40	0	0	0	0	0
41	0	0	0	0	0
42	0	0	0	0	0
43	0	0	0	0	0
44	0	0	0	0	0
45	0	0	0	0	0
46	0	0	0	0	0
47	0	0	0	0	0
48	0	0	0	0	0
49	0	0	0	0	0
50	0	0	0	0	0
TOTAL numbers	93	92	80	63	328
Official Catch (t)	4988	5399	5110	3668	19165

Table 6.3.2.1 BLUE WHITING. Catch in number (millions) by age group in the directed fisheries (Sub-areas I and II, Divisions Va, and XIVa+b, Vb, VIa+b, VIIbc and VIIg-k) in 1991-2002.

Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
0	64	-	-	-	1	4	167	15	61	41	119	16
1	33	82	37	44	99	497	1352	984	544	912	3459	1111
2	533	52	130	31	143	327	1079	3535	1180	752	3924	2439
3	384	1509	335	190	338	451	751	3211	5257	3119	2728	2939
4	244	510	1348	362	416	425	526	929	3235	4834	3644	2114
5	330	200	376	1242	566	248	268	346	362	1517	2474	1804
6	235	139	196	294	769	430	238	311	186	500	555	1602
7	150	92	108	201	246	619	270	298	143	210	160	336
8	40	87	60	103	154	214	391	257	146	144	91	165
9	4	85	38	88	58	88	101	209	66	57	69	100
10+	14	15	14	32	40	70	164	85	138	139	55	142
Total	2,032	2,770	2,641	2,588	2,829	3,373	5,307	10,180	11,318	12,225	17,281	142
Tonnes	297,649	379,549	389,010	401,378	447,015	493,373	545,058	1,000,870	1,123,317	1,273,123	1,636,683	1,399,659

Table 6.3.2.2 BLUE WHITING. Catch in number (million) by age group in the directed fishery and bycatches from mixed fisheries (Divisions IIIa and IV) for 1991-2002.

Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
0	25	-	132	95	3303	812	29	11	60	56	9	190
1	8	160	167	33	101	1334	621	576	188	822	770	621
2	398	64	39	21	88	71	269	524	286	317	416	685
3	42	167	91	18	29	58	50	259	434	253	174	274
4	11	75	97	37	11	71	14	47	168	143	149	105
5	11	25	15	6	6	39	14	6	16	22	109	17
6	11	17	7	3	11	45	5	4	5	3	29	45
7	6	7	8	1	2	33	4	3	5	0	9	8
8	3	3	-	1	2	14	6	4	6	7	6	3
9	1	1	-	0	1	9	1	4	1	1	8	2
10+	0	1	-	-	1	11	2	12	3	1	11	1
Total	518	519	556	214	3,555	2,499	1,015	1,450	1,172	1,627	1,689	1,951
Tonnes	39,872	66,174	55,215	28,563	104,004	119,359	65,091	94,881	106,609	114,477	118,523	136,171

Table 6.3.2.3 BLUE WHITING. Catch in number (millions) by age group in the Southern area, 1990-2001.

Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
0	70	19	25	13	3	9	11	18	18	32	33	17
1	181	139	41	12	96	43	118	97	57	80	134	88
2	182	205	146	56	123	131	143	122	82	123	146	108
3	70	95	181	149	55	117	86	71	130	93	60	79
4	39	43	62	72	38	36	26	69	57	35	14	24
5	17	12	12	27	44	33	8	32	35	9	10	4
6	8	6	7	9	20	17	4	7	15	10	1	1
7	3	2	2	5	6	5	3	2	3	3	0	0
8+	3	1	1	4	5	3	3	4	2	0	0	0
Total	573	522	477	347	390	394	402	422	399	384	398	321
Tonnes	32,003	28,722	32,256	29,468	27,664	25,099	30,122	29,400	26,402	24,654	24,964	19165

Table 6.3.2.4. Total catch-at-age numbers (in millions) of blue whiting as used in the assessment in 2003.

Age	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
0	48	3512	437	584	1174	84	341	46	1949	83	161
1	258	148	2283	2291	1305	650	838	425	865	1611	267
2	348	274	567	2331	2044	816	578	721	718	703	1024
3	681	326	270	455	1933	1862	728	614	1340	672	514
4	334	548	286	260	303	1717	1897	683	791	753	302
5	548	264	299	285	188	393	726	1303	837	520	363
6	559	276	304	445	321	187	137	618	708	577	258
7	466	266	287	262	257	201	105	84	139	299	159
8	634	272	286	193	174	198	123	53	50	78	49
9	578	284	225	154	93	174	103	33	25	27	5
10+	1460	673	334	255	259	398	195	50	38	95	10
Total	5914	6843	5578	7515	8051	6680	5771	4630	7460	5418	3112
Tonnes	909,556	576,419	570,072	641,766	695,596	826,986	664,837	557,847	627,447	561,610	369524

Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
0	19	198	42	3307	833	212	43	139	129	162	223
1	408	263	307	296	1893	2131	1657	788	1815	4364	1821
2	654	305	108	354	534	1519	4181	1549	1193	4486	3232
3	1642	621	368	422	632	904	3541	5821	3466	2962	3292
4	569	1571	389	465	537	578	1045	3461	5015	3807	2243
5	217	411	1222	616	323	296	384	413	1550	2593	1824
6	154	191	281	800	497	252	323	207	514	586	1647
7	110	107	174	254	663	282	303	151	213	170	344
8	80	65	90	160	232	407	264	153	151	97	169
9	32	38	79	60	98	104	212	69	58	77	103
10+	12	17	31	42	83	169	86	141	140	66	143
Total	3896	3788	3091	6775	6327	6854	12039	12891	14244	19369	15040
Tonnes	475,089	480,679	459,414	578,905	645,982	672,437	1,125,151	1,256,328	1,412,253	1,780,170	1,554,995

Table 6.3.3.1. Mean weights-at-age of blue whiting in the total catch in 1981-2002

Age	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
0	0.038	0.018	0.020	0.026	0.016	0.030	0.023	0.031	0.014	0.034	0.036
1	0.052	0.045	0.046	0.035	0.038	0.040	0.048	0.053	0.059	0.045	0.055
2	0.065	0.072	0.074	0.078	0.074	0.073	0.086	0.076	0.079	0.070	0.091
3	0.103	0.111	0.118	0.089	0.097	0.108	0.106	0.097	0.103	0.106	0.107
4	0.125	0.143	0.140	0.132	0.114	0.130	0.124	0.128	0.126	0.123	0.136
5	0.141	0.156	0.153	0.153	0.157	0.165	0.147	0.142	0.148	0.147	0.174
6	0.155	0.177	0.176	0.161	0.177	0.199	0.177	0.157	0.158	0.168	0.190
7	0.170	0.195	0.195	0.175	0.199	0.209	0.208	0.179	0.171	0.175	0.206
8	0.178	0.200	0.200	0.189	0.208	0.243	0.221	0.199	0.203	0.214	0.230
9	0.187	0.204	0.204	0.186	0.218	0.246	0.222	0.222	0.224	0.217	0.232
10+	0.213	0.231	0.228	0.206	0.237	0.257	0.254	0.260	0.253	0.256	0.266

Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
0	0.024	0.028	0.033	0.022	0.018	0.031	0.033	0.035	0.031	0.038	0.021
1	0.057	0.066	0.061	0.064	0.041	0.047	0.048	0.063	0.057	0.050	0.054
2	0.083	0.082	0.087	0.091	0.080	0.072	0.072	0.078	0.075	0.078	0.074
3	0.119	0.109	0.108	0.118	0.102	0.102	0.094	0.088	0.086	0.094	0.093
4	0.140	0.137	0.137	0.143	0.116	0.121	0.125	0.109	0.104	0.108	0.115
5	0.167	0.163	0.164	0.154	0.147	0.140	0.149	0.142	0.133	0.129	0.132
6	0.193	0.177	0.189	0.167	0.170	0.166	0.178	0.170	0.156	0.163	0.155
7	0.226	0.200	0.207	0.203	0.214	0.177	0.183	0.199	0.179	0.186	0.173
8	0.235	0.217	0.217	0.206	0.230	0.183	0.188	0.193	0.187	0.193	0.233
9	0.284	0.225	0.247	0.236	0.238	0.203	0.221	0.192	0.232	0.231	0.224
10+	0.294	0.281	0.254	0.256	0.279	0.232	0.248	0.245	0.241	0.243	0.262

Table 6.3.4.1. Proportion of mature blue whiting at age. The values were estimated by the 1994 WG (ICES 1995/Assess:7).

Age	0	1	2	3	4	5	6	7	8	9	10+
Proportion of mature	0.00	0.11	0.40	0.82	0.86	0.91	0.94	1.00	1.00	1.00	1.00

Table 6.4.1.1 Age-stratified acoustic survey estimates of blue whiting in the spawning area west of the British Isles

R.V."Hjort" March/ April 1981-2003. Number in millions

Numbers	age										
	1	2	3	4	5	6	7	8	9	10	total
1981		2372	7583	3253	3647	4611	4638	3654	2591	1785	34134
1982		no survey									
1983		297	2108	2723	6511	3735	3650	3153	2279	1182	25638
1984		15767	1721	1616	1719	1858	1128	567	440	348	25164
1985		no survey									
1986		1003	5829	4122	624	228	203	250	137	170	12566
1987		4960	8417	22589	4735	282	417	385	159	27	41971
1988		9712	9090	12367	20392	7355	723	599	326	398	60962
1989		6787	22270	9973	10504	7803	933	293	177	46	58786
1990		14169	12670	11228	5587	6556	3273	516	183	108	54290
1991		11147	6340	8497	7407	4558	2019	545	96	16	40625
1992		1232	26123	4719	1574	1386	810	616	257	19	36736
1993		4489	3321	26771	2643	1270	557	426	108	22	39607
1994		1603	2950	4476	11354	1742	1687	908	770	207	25697
1995		8538	9874	7906	6861	9467	1795	1083	482	149	46155
1996		8781	7433	8371	2399	4455	4111	1202	459	162	37373
1997		no survey									
1998		18218	34991	4697	1674	279	407	381	351	86	61084
1999		19034	60309	26103	1481	316	72	153	141	0	107609
2000		8613	31011	41382	6843	898	427	228	139	115	89656
2001		44162	12843	13805	8292	718	175	51	0	0	80046
2002	20455	71996	54740	12757	5266	8404	1450	305	15	176	175564
2003		23992	70303	28756	5735	2430	1708	260			133184

[red box] used in the assessment

Table 6.4.1.2. Age-stratified acoustic survey estimates of blue whiting in the spawning area by Russian vessels
Number in millions,

Numbers	age										
	1	2	3	4	5	6	7	8	9	10	total
1981											0
1982			540	2750	1340	1380	1570	2350	1730	1290	
1983			2330	2930	9390	3880	1970	1370	780	660	23310
1984			2900	800	1100	4200	2200	1200	1700	1200	15300
1985			13220	930	580	1780	860	610	580	540	
1986			18750	23180	2540	610	620	750	640	710	47800
1987			4480	19170	5860	1070	500	810	860	670	33420
1988			3710	4550	8610	4130	1270	480	250	260	23260
1989			11910	7120	6670	6970	4580	2750	1880	810	42690
1990			9740	12140	5740	2580	1470	220	80	10	31980
1991			10300	5350	5130	2630	1770	870	300	220	26570
1992			20010	6700	1350	440	390	170	0	0	29060
1993			4728	12337	5304	2249	1316	621	386	150	27091
1994			no survey								0
1995			12657	10028	8942	2651	1093	408	131	14	35924
1996			15285	10629	4897	6940	1482	653	85	0	39971
1997			no survey								
1998			no survey								0
1999			no survey								0
2000			no survey								0
2001			no survey								0
2002											0
2003											0

used in the assessment

Table 6.4.1.3. Age-stratified acoustic survey estimates of blue whiting in the Norwegian Sea in July
Number in millions

Numbers	age										
	0	1	2	3	4	5	6	7	8	9	total
1981		182	728	4542	3874	2678	2834	2964	2756	2054	22612
1982		184	460	1242	4715	3611	3128	2323	1679	874	18216
1983		22356	396	468	756	1404	576	468	432	324	27180
1984		30380	13916	833	392	539	539	343	49	49	47040
1985		5969	23876	12502	658	423	188	235	141	376	44368
1986		2324	2380	7224	6944	1876	952	336	308	140	22484
1987		8204	4032	5180	5572	1204	224	168	56	84	24724
1988		4992	2880	2640	3480	912	120	96	24	48	15192
1989		1172	1125	812	379	410	212	22	32		4164
1990			no survey								
1991			no survey								
1992		792	1134	6939	766	247	172	90	11	18	10169
1993		830	125	1070	6392	1222	489	248	58	88	10522
1994			no survey								
1995		6974	2811	1999	1209	1622	775	173	61		15624
1996		23464	1057	899	649	436	505	755	69	41	27875
1997		30227	25638	1524	779	300	407	260	137	123	59395
1998		24244	47815	16282	556	212	100	64	10	255	89538
1999		14367	9750	23701	9754	1733	466	79	48	91	59989
2000		25813	3298	2721	3078	23	46	6			34985
2001		61470	22051	7883	3225	1824	156	12	0	68	96689
2002			no survey								0
2003											0

Table 6.4.1.1.1 Age- and length distribution of blue whiting in the survey by R.V. "Johan Hjort", west of the British Isles, April 2003.

	Age in years												
Length	1	2	3	4	5	6	7	8	9	Numbers	Biomass	Mean	Proportion
(cm)	2002	2001	2000	1999	1998	1997	1996	1995	1994	(10^6)	(10^6 kg)	weigth, (g)	mature
14.0 - 15.0	167									167	2.8	16.8	2.9
15.0 - 16.0	1015									1015	19.4	19.1	4.1
16.0 - 17.0	3105									3105	68.1	21.9	5.7
17.0 - 18.0	3939									3939	108.1	27.4	7.9
18.0 - 19.0	7135	18								7153	236.5	33.1	11.0
19.0 - 20.0	6853	45								6898	262.7	38.1	15.0
20.0 - 21.0	3159	812								3971	174.4	43.9	31.5
21.0 - 22.0	1042	1983	325							3349	163.0	48.7	65.1
22.0 - 23.0	106	4995	2084							7185	399.5	55.6	86.9
23.0 - 24.0		6600	7823	45						14468	897.4	62.0	92.0
24.0 - 25.0		7175	17435	1395						26004	1758.6	67.6	95.4
25.0 - 26.0		1834	22266	5018	105					29223	2184.4	74.7	97.9
26.0 - 27.0		530	13601	6551	366	172				21220	1758.5	82.9	99.1
27.0 - 28.0			4548	7756	1699	101	203			14307	1314.0	91.8	99.8
28.0 - 29.0			1755	3557	1050	953				7316	751.6	102.7	99.9
29.0 - 30.0			466	3321	865	301	956	233		6143	694.2	113.0	100
30.0 - 31.0				802	1025	70			150	2048	266.5	130.1	100
31.0 - 32.0				311	605	160				1076	149.1	138.5	100
32.0 - 33.0						364	351			715	113.3	158.5	100
33.0 - 34.0						223	121			344	67.7	196.9	100
34.0 - 35.0					20	85	51			156	26.8	172.5	100
35.0 - 36.0													
36.0 - 37.0							27	27	79	133	28.1	212.1	100
TSN (10^6)	26520	23992	70303	28756	5735	2430	1708	260	229	159935			
TSB (10^6 kg)	895	1487	5220	2637	616	303	218	32	37	11445			
Mean length (cm)	18.6	23.5	25.3	27.3	28.9	30.0	30.4	30.2	32.6	24.6			
Mean weight (g)	33.7	62.0	74.3	91.7	107.5	124.5	127.6	121	161.8	71.6			
Condition	5.2	4.8	4.6	4.5	4.5	4.6	4.5	4.4	4.7	4.8			
% mature	10.1	77.4	99.1	100	100	100	100	100	100	92.0			
% of SSB	0.9	11.2	50.4	25.7	6.0	3.0	2.1	0.3	0.3				

Table 6.4.1.1.2 Total stock estimate of blue whiting, spring 2003, as estimated from Russian surveys with R.V. "Atlantniro" and R.V. "Smolensk".

	AGE in years											Number	Biomass	mean	
	1	2	3	4	5	6	7	8	9	10	11			weight,	CF
Length, cm	2002	2001	2000	1999	1998	1997	1996	1995	1994	1993	1992	10^6 ind	10^3 t	gr	
14.0 - 15.0	4.9											4.9	0.1	18.5	6.7
15.0 - 16.0	635.8											635.8	9.9	15.6	4.6
16.0 - 17.0	3291.3											3291.3	65.3	19.8	4.8
17.0 - 18.0	9779.4	18.2										9797.6	230.6	23.5	4.8
18.0 - 19.0	6294.3	31.6										6325.9	179.7	28.4	4.9
19.0 - 20.0	4602.2	488.9										5091.1	169.7	33.3	4.9
20.0 - 21.0	3208.7	823.1										4031.8	153.4	38.0	4.8
21.0 - 22.0	1030.3	881.6	200.6									2112.5	99.0	46.8	5.1
22.0 - 23.0	1121.6	2114.6	486.4									3722.6	196.9	52.9	5.0
23.0 - 24.0	522.1	5039.0	5597.3	379.0								11537.5	677.1	58.7	4.8
24.0 - 25.0	531.4	8874.3	15512.9	3909.3	220.4							29048.3	1902.7	65.5	4.7
25.0 - 26.0		5675.5	23941.7	10688.2	1877.4	169.2						42352.0	3143.6	74.2	4.8
26.0 - 27.0		1532.1	13539.9	17183.8	5664.2	604.6	101.2					38625.7	3171.5	82.1	4.7
27.0 - 28.0		83.8	4915.0	14153.4	7582.3	1442.8	283.5					28460.8	2605.1	91.5	4.7
28.0 - 29.0		230.2	722.9	6643.0	6792.1	2720.8	582.8	216.5	105.6			18013.8	1862.8	103.4	4.7
29.0 - 30.0				2176.2	4699.2	1946.0	1668.3	446.4	81.6			11017.7	1254.3	113.8	4.7
30.0 - 31.0			125.9	418.3	1820.1	2665.7	1576.7	299.7	70.7			6977.0	893.0	128.0	4.7
31.0 - 32.0				82.3	1277.2	1991.7	759.7	306.7	71.5			4489.0	646.0	143.9	4.8
32.0 - 33.0				25.8	543.5	927.7	984.1	416.9				2898.1	452.4	156.1	4.8
33.0 - 34.0					134.0	407.8	324.9	427.6	65.5	33.6		1393.3	255.2	183.1	5.1
34.0 - 35.0					12.5	143.8	173.0	207.4	126.0	39.5		702.2	140.8	200.6	5.1
35.0 - 36.0					7.6	116.0	146.3	94.9	131.6	67.6		564.1	123.1	218.2	5.1
36.0 - 37.0					9.4	7.4	91.4	136.6	145.6	15.0	65.3	470.7	115.5	245.4	5.3
37.0 - 38.0						24.7	16.5	103.7	50.8	136.4	51.3	383.5	95.3	248.5	4.9
38.0 - 39.0							10.7	51.6	43.7	42.5	11.9	160.4	49.1	306.2	5.6
39.0 - 40.0							6.6	19.8	9.1	5.1		40.6	12.5	307.7	5.2
40.0 - 41.0							4.2	4.2	11.4		11.5	31.3	10.4	331.7	5.2
41.0 - 42.0										5.0	9.2	14.1	4.9	345.2	5.0
42.0 - 43.0										52.1	3.0	55.1	22.2	402.6	5.4
43.0 - 44.0											4.3	4.3	1.9	440.0	5.5
Number, 10^6	31022.0	25792.9	65042.6	55659.3	30639.8	13168.3	6729.8	2732.0	913.0	396.7	156.5	232252.8			
<L>, cm	18.2	23.7	25.0	26.3	27.7	29.4	30.3	31.8	33.2	36.8	37.4	25.14			
Biomass, 10^3 t	953.6	1708.2	4760.5	4789.7	3077.8	1609.1	885.6	434.4	176.2	105.1	43.6		18544.0		
<weight>, gr	30.7	66.2	73.2	86.1	100.5	122.2	131.6	159.0	193.0	264.9	278.9			79.8	
Spawning Number, 10^6	4837.0	15306.8	58702.7	54485.1	30471.9	13168.3	6729.8	2732.0	913.0	396.7	156.5	187899.8			
Biomass, 10^3 t	223.6	1103.1	4294.7	4700.9	3055.7	1608.9	885.6	434.4	176.2	105.1	43.6		16631.9	88.5	
CF	5.1	5.0	4.7	4.7	4.7	4.8	4.7	4.9	5.3	5.3	5.3				4.7

Table 6.4.1.1.3. Blue whiting biomass estimates (million tonnes) in the spawning area.

Year	Russia total	Russia spawning	Norway total	Norway spawning	Faroes total	Faroes spawning
1983	3.6	3.6	4.7	4.4		
1984	3.4	2.7	2.8	2.1	2.4	2.2
1985	2.8	2.7			6.4	1.7
1986	6.4	5.6	2.6	2.0		
1987	5.4	5.1	4.3	4.1		
1988	3.7	3.1	7.1	6.8		
1989	6.3	5.7	7.0	6.1		
1990	5.4	5.1	6.3	5.7		
1991	4.6	4.2	5.1	4.8		
1992	3.6	3.3	4.3	4.2		
1993	3.8	3.7	5.2	5.0		
1994			4.1	4.1		
1995	6.8	6.0	6.7	6.1		
1996	7.1	5.8	5.1	4.5		
1997						
1998			5.5	4.7		
1999			8.9	8.5		
2000			8.3	7.8		
2001			6.7	5.6		
2002	5.2		12.2	10.9		
2003	18.5	16.6	11.4	10.4		
Mean	5.8	5.2	6.2	5.7	4.4	2.0

Table 6.4.1.2.1 Age stratified acoustic survey estimates of blue whiting in the Icelandic EEZ in July
Numbers in millions, weight in thousand tonnes Mean length in cm.

	Age										
Numbers	0	1	2	3	4	5	6	7	8	9+	total
1999	14869	2100	1357	1772	5790	1344	316	50	15	42	27655
2000	10683	8594	934	523	1218	468	106	25	1	1	22553
2001	27305	4090	5215	1657	1614	398	132	37	6	2	40456
2002	3815	10785	3107	1436	1724	1430	727	178	47	5	23254
Biomass											
1999	265	163	127	201	764	212	55	13	4	14	1818
2000	186	624	85	63	167	78	22	5			1230
2001	661	295	568	211	231	66	22	8	1		2063
2002	77	746	297	160	217	203	114	31	13	1	1859
length											
1999	13.5	23.5	25.0	26.3	27.6	29.0	30.3	33.7	35.5	36.8	19.7
2000	13.5	22.6	24.4	26.2	27.6	29.6	32.3	32.0	36.0	28.0	18.8
2001	15.1	22.4	25.3	26.4	28.1	29.0	31.8	32.6	33.0	37.0	18.3
2002	14.8	22.8	24.9	26.2	27.6	29.3	30.6	30.9	36.9	35.0	23.1

Table 6.4.2.1 Stratified mean catch (Kg/haul and Number/haul) and standard error of BLUE WHITING in bottom trawl surveys in Spanish waters (Divisions VIIIc and IXa north). All surveys in September-October.

Kg/haul	30-100 m		101-200 m		201-500 m		TOTAL 30-500 m	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
1985	9.50	5.87	119.75	45.99	68.18	13.79	92.83	28.24
1986	9.74	7.13	45.41	12.37	29.54	8.70	36.93	7.95
1987	-	-	-	-	-	-	-	-
1988	2.90	2.59	154.12	38.69	183.07	141.94	143.30	45.84
1989	14.17	12.03	76.92	17.08	18.79	6.23	59.00	11.68
1990	6.25	3.29	52.54	9.00	18.80	4.99	43.60	6.60
1991	64.59	34.65	126.41	26.06	46.07	18.99	97.10	17.16
1992	6.37	2.59	44.12	6.64	29.50	6.16	34.60	4.23
1993	1.06	0.63	14.07	3.73	51.08	22.02	22.59	6.44
1994	8.04	5.28	37.18	8.45	25.42	5.27	29.70	5.19
1995	19.97	13.87	36.43	4.82	15.97	4.10	28.52	3.66
1996	7.27	3.95	49.23	7.19	92.54	17.76	54.52	6.36
1997	7.60	4.44	44.21	10.61	60.18	17.54	44.01	8.00
1998	5.29	1.92	41.09	7.64	73.80	24.06	44.48	7.82
1999	31.41	7.28	108.46	17.24	150.24	39.53	108.12	14.62
2000	39.52	9.73	88.89	14.32	62.23	27.65	74.42	11.25
	70-120 m		121-200 m		201-500 m		TOTAL 70-500 m	
1997	17.87	7.35	44.68	10.52	57.14	16.60	42.62	7.29
1998	14.13	4.17	42.78	8.13	78.88	22.01	47.14	7.58
1999	92.66	14.60	111.76	19.87	169.21	50.26	124.27	17.83
2000	62.39	12.00	91.99	14.75	58.72	24.94	76.19	10.61
2001	8.35	3.31	50.18	10.09	52.41	16.71	42.02	7.02
2002	31.40	5.02	69.00	13.41	36.75	12.07	51.80	7.64

Number/haul	30-100 m		101-200 m		201-500 m		TOTAL 30-500 m	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
1985	267	181.71	3669	1578.86	1377	262.98	2644	963.20
1986	368	237.56	2486	1006.67	752	238.87	1763	616.40
1987	-	-	-	-	-	-	-	-
1988	83	71.74	6112	1847.36	7276	6339.88	5694	2086.00
1989	629	537.29	3197	876.75	566	213.11	2412	599.00
1990	220	115.48	2219	426.46	578	185.43	1722	276.00
1991	2922	1645.73	5563	1184.69	1789	847.33	4214	780.88
1992	124	50.81	1412	233.99	845	199.12	1069	146.87
1993	14	8.61	257	69.61	894	427.77	401	124.53
1994	346	234.12	2002	456.50	997	245.91	1487	689.00
1995	1291	864.97	2004	341.48	485	137.81	1493	240.37
1996	147	82.71	1167	167.20	2097	385.23	1263	142.30
1997	224	121.69	1425	359.12	1254	330.37	1228	234.50
1998	123	44.12	1442	334.24	1823	592.92	1347	251.37
1999	795	218.58	3996	697.66	5279	1521.62	3861	576.10
2000	1574	360.78	3701	568.17	2036	857.01	2940	406.62
	70-120 m		121-200 m		201-500 m		TOTAL 70-500 m	
1997	552	235.60	1443	361.89	1183	323.14	1180	209.94
1998	351	105.96	1463	320.26	2012	590.04	1387	234.82
1999	2502	427.23	4358	847.87	6119	2026.39	4474	727.32
2000	2267	414.97	3930	604.11	2009	859.71	3027	400.87
2001	171	77.34	1310	263.84	1232	381.49	1048	172.74
2002	771	90.34	2526	499.30	1075	331.09	1739	268.70

Table 6.4.2.2 BLUE WHITING. Stratified mean catch (Kg/haul) and standard error of in bottom trawl surveys in Portuguese waters (Division IXa).

		20-100 m		100-200 m		200-500 m		500-750 m		TOTAL: 20-500 m		TOTAL: 20-750 m	
Year	Month	y	sy	y	sy	y	sy	y	sy	y	sy	y	sy
1979	June	0	0	33	23	86	35	-	-	31	12	-	-
	Oct./Nov.	5	5	17	8	103	48	-	-	28	9	-	-
1980	March	0	0	178	173	5	1	-	-	72	69	-	-
	May/June	1	3	4	2	45	18	-	-	11	4	-	-
	October	4	3	10	4	587	306	-	-	117	58	-	-
1981	March	0	0	24	17	186	113	-	-	42	22	-	-
	June	0	0	4	2	178	25	-	-	34	4	-	-
1982	April/May	0	0	3	3	136	39	-	-	26	7	-	-
	September	1	1	85	42	271	123	-	-	86	29	-	-
1983	March	1	1	14	10	259	96	-	-	54	18	-	-
	June	0	0	23	8	177	47	-	-	42	9	-	-
1985	June	0	0	194	146	405	162	-	-	159	68	-	-
	October	4	3	133	84	341	39	-	-	120	35	-	-
1986	June	4	1	59	19	196	31	-	-	65	10	-	-
	October	2	1	357	144	650	111	-	-	276	63	-	-
1987	October	3	0	297	64	747	229	-	-	263	50	-	-
1988	October	4	2	165	47	457	106	-	-	155	28	-	-
1989	July	0	0	42	21	323	143	79	36	-	-	78	24
	October	7	4	70	26	306	84	24	2	-	-	79	16
1990	July	2	2	153	103	242	42	50	5	-	-	96	35
	October	11	5	90	28	762	234	42	10	-	-	153	35
1991	July	1	1	140	40	268	38	64	18	-	-	98	15
	October	8	5	83	18	259	53	121	27	-	-	91	11
1992	February	7	7	43	35	249	21	73	3			68	12
	July	1	1	29	18	216	43	27	5	-	-	47	9
	October	1	1	22	7	208	44	80	3	-	-	54	7
1993	February	0	0	19	14	105	31	36	0	-	-	42	10
	July	0	0	3	3	151	28	55	5	-	-	34	4
	November	0	0	90	0	189	43	6	1	-	-	86	9
1994	October	0	0	374	30	283	32	49	7	-	-	174	11
1995	July	0	0	18	14	130	20	52	3	-	-	35	5
	October	18	15	103	21	328	91	31	12	-	-	94	16
1996	October	25	24	12	2	36	6	25	7			22	8
1997	June	0	0	3	3	116	42	45	12	-	-	27	7
	October	2	1	54	20	77	13	7	2	-	-	32	8
1998	July	0	0	8	5	105	17	38	3	-	-	25	3
	October	1	1	384	87	427	101	20	2	-	-	212	36
1999	July	1		60		66		25		-	-	37	n/a
	October	0		70		78		18		-	-	41	n/a
2000	July	23	13	109	34	116	10	63	6			75	13
	October	11	4	155	53	196	22	54	4			100	19
2001	July	18	7	238	37	305	37	57	14			152	23
	October	106	6	474	224	294	66	0	0			295	97
2002	July	n/a		n/a		n/a		n/a				n/a	
	October	19	12	176	81	180	24	0	0			116	34

Table 6.4.3.1. Age stratified Spanish cpue (not used in the assessment)
units

Numbers	age									
	1	2	3	4	5	6	7	8	9+	total
1981										
1982										
1983		7196	16392	9311	7476	6326	1718			
1984		13710	27286	14845	4836	1755	1750			
1985		14573	23823	14126	6256	1232	217			
1986		3721	14131	14745	7113	1278	505			
1987		25328	13153	6664	2938	1029	166			
1988		7778	21473	18436	6391	1300	781			
1989		15272	18486	17160	8374	3760	1003			
1990		21444	19407	5194	1803	1357	451			
1991		15924	15370	4989	2329	1045	440			
1992		10007	24235	9671	4316	1194	462			
1993		4036	13991	22493	7979	1354	658			
1994		543	6066	15917	7474	2990	1055			
1995		9090	14409	6833	4551	1990	623			
1996		3905	14557	14449	3931	3639	1834			
1997		8742	15875	11134	3698	1046	450			
1998		5884	13236	9803	10844	5229	1153			
1999		2048	10268	20242	9833	6287	3047			
2000		6207	15518	13987	5375	1264	1414			
2001		16223	16488	6830	1620	1148	162			
2002		10520	13725	10265	3385	336	69			

Table 6.4.4.4.1 Blue Whiting. ICA assessment2003. Stock summary table

Year	Recruits thousands	Total Biomass tonnes	Spawning Biomass tonnes	Landings tonnes	Yield /SSB ratio	Mean F Ages 3-7	SoP (%)
1981	3459600	3644309	2724894	907732	0.3331	0.267	98
1982	4386890	2818864	2097158	513203	0.2447	0.2044	93
1983	16725260	2748712	1570613	561332	0.3574	0.2378	101
1984	19151220	2852090	1411123	626592	0.444	0.2916	101
1985	10416520	3053277	1677750	676812	0.4034	0.351	99
1986	8198360	3174858	1944551	801786	0.4123	0.5108	94
1987	8538260	2846074	1671290	656588	0.3929	0.4292	100
1988	6742980	2443886	1422149	552020	0.3882	0.5224	99
1989	8901480	2458121	1333307	598147	0.4486	0.5575	94
1990	20535850	2697373	1247517	558788	0.4479	0.5362	100
1991	8749600	3272796	1671266	363724	0.2176	0.2831	99
1992	5889070	3423956	2208659	473789	0.2145	0.1998	99
1993	5401120	3179116	2117282	475143	0.2244	0.2188	99
1994	6256080	3049748	2038531	458028	0.2247	0.2165	100
1995	8502100	3007156	1843697	505938	0.2744	0.272	100
1996	21676420	3201244	1701938	629286	0.3697	0.3358	101
1997	45724530	4933363	1926080	640089	0.3323	0.3132	100
1998	26356140	6033235	2703874	1123732	0.4156	0.5046	99
1999	16860020	6260805	3379582	1251463	0.3703	0.4123	99
2000	36414130	6850662	3311202	1409143	0.4256	0.5284	99
2001	56793570	8223035	3434237	1775305	0.5169	0.5535	100
2002	27291060	8454036	4040006	1556955	0.3854	0.6216	100

Table 6.4.5.1.1 Tuning data for the blue whiting assessment. Inside the framed areas constant selection pattern is assumed. -1=missing data.

Norwegian acoustic spawning stock survey, ages 2-8

Year	Season	Number	Min.obs.num	2	3	4	5	6	7	8
1981	1	1	1	2372	7583	3253	3647	4611	4638	3654
1982	1	1	1	-1	-1	-1	-1	-1	-1	-1
1983	1	1	1	297	2108	2723	6511	3735	3650	3153
1984	1	1	1	15767	1721	1616	1719	1858	1128	567
1985	1	1	1	-1	-1	-1	-1	-1	-1	-1
1986	1	1	1	1003	5829	4122	624	228	203	250
1987	1	1	1	4960	8417	22589	4735	282	417	385
1988	1	1	1	9712	9090	12367	20392	7355	723	599
1989	1	1	1	6787	22270	9973	10504	7803	933	293
1990	1	1	1	14169	12670	11228	5587	6556	3273	516
1991	1	1	1	11147	6340	8497	7407	4558	2019	545
1992	1	1	1	1232	26123	4719	1574	1386	810	616
1993	1	1	1	4489	3321	26771	2643	1270	557	426
1994	1	1	1	1603	2950	4476	11354	1742	1687	908
1995	1	1	1	8538	9874	7906	6861	9467	1795	1083
1996	1	1	1	8781	7433	8371	2399	4455	4111	1202
1997	1	1	1	-1	-1	-1	-1	-1	-1	-1
1998	1	1	1	18218	34991	4697	1674	279	407	381
1999	1	1	1	19034	60309	26103	1481	316	72	153
2000	1	1	1	8613	31011	41382	6843	898	427	228
2001	1	1	1	44162	12843	13805	8292	718	175	51
2002	1	1	1	71996	54740	12757	5266	8404	1450	305
2003	1	1	1	23992	70303	28756	5735	2430	1708	260

Russian acoustic spawning stock survey, ages 3-8

Year	Season	Number	Min.obs.num	3	4	5	6	7	8
1982	1	2	10	540	2750	1340	1380	1570	2350
1983	1	2	10	2330	2930	9390	3880	1970	1370
1984	1	2	10	2900	800	1100	4200	2200	1200
1985	1	2	10	13220	930	580	1780	860	610
1986	1	2	10	18750	23180	2540	610	620	750
1987	1	2	10	4480	19170	5860	1070	500	810
1988	1	2	10	3710	4550	8610	4130	1270	480
1989	1	2	10	11910	7120	6670	6970	4580	2750
1990	1	2	10	9740	12140	5740	2580	1470	220
1991	1	2	10	10300	5350	5130	2630	1770	870
1992	1	2	1	20010	6700	1350	440	390	170
1993	1	2	1	4728	12337	5304	2249	1316	621
1994	1	2	1	-1	-1	-1	-1	-1	-1
1995	1	2	1	12657	10028	8942	2651	1093	408
1996	1	2	1	15285	10629	4897	6940	1482	653

Norwegian Sea acoustic survey, ages 1-7

Year	Season	Number	Min.obs.num	1	2	3	4	5	6	7
1981	3	3	1	182	728	4542	3874	2678	2834	2964
1982	3	3	1	184	460	1242	4715	3611	3128	2323
1983	3	3	1	22356	396	468	756	1404	576	468
1984	3	3	1	30380	13916	833	392	539	539	343
1985	3	3	1	5969	23876	12502	658	423	188	235
1986	3	3	1	2324	2380	7224	6944	1876	952	336
1987	3	3	1	8204	4032	5180	5572	1204	224	168
1988	3	3	1	4992	2880	2640	3480	912	120	96
1989	3	3	1	1172	1125	812	379	410	212	22
1990	3	3	1	-1	-1	-1	-1	-1	-1	-1
1991	3	3	1	-1	-1	-1	-1	-1	-1	-1
1992	3	3	1	792	1134	6939	766	247	172	90
1993	3	3	1	830	125	1070	6392	1222	489	248
1994	3	3	1	-1	-1	-1	-1	-1	-1	-1
1995	3	3	1	6974	2811	1999	1209	1622	775	173
1996	3	3	1	23464	1057	899	649	436	505	755
1997	3	3	1	30227	25638	1524	779	300	407	260
1998	3	3	1	24244	47815	16282	556	212	100	64
1999	3	3	1	14367	9750	23701	9754	1733	466	79
2000	3	3	1	25813	3298	2721	3078	23	46	6
2001	3	3	1	61470	22051	7883	3225	1824	156	12

Table 6.4.5.1.2 Blue Whiting, Total yearly fishing mortalities at age (Fref = $F_{3\text{-}7u}$)

Output from AMCI run id 20030504 131214.494

	1981	1982	1983	1984	1985	1986	1987	1988
1	0.0443	0.0377	0.0952	0.1304	0.1404	0.1660	0.1354	0.1063
2	0.0666	0.0602	0.0938	0.1485	0.1681	0.2155	0.1801	0.1550
3	0.1119	0.0951	0.1263	0.1751	0.2180	0.2891	0.2437	0.2096
4	0.1444	0.1240	0.1608	0.2121	0.2379	0.3465	0.3172	0.2749
5	0.1706	0.1375	0.1742	0.2308	0.2556	0.3581	0.3275	0.3061
6	0.2291	0.1835	0.2353	0.3122	0.3565	0.4700	0.4025	0.3808
7	0.2640	0.2095	0.2695	0.3503	0.3852	0.5145	0.4482	0.3908
8	0.3146	0.2508	0.3199	0.4093	0.4484	0.5898	0.5284	0.4602
9	0.3463	0.2763	0.3496	0.4423	0.4736	0.6440	0.5620	0.4812
10	0.3305	0.2636	0.3348	0.4258	0.4610	0.6169	0.5452	0.4707
Fref	0.1840	0.1499	0.1932	0.2561	0.2906	0.3956	0.3478	0.3124

	1989	1990	1991	1992	1993	1994	1995	1996
1	0.1162	0.1036	0.0391	0.0472	0.0453	0.0461	0.0535	0.0758
2	0.1725	0.1594	0.0651	0.0711	0.0670	0.0623	0.0774	0.1024
3	0.2476	0.2311	0.0958	0.1046	0.1004	0.0996	0.1245	0.1692
4	0.3142	0.2990	0.1220	0.1329	0.1305	0.1260	0.1585	0.2153
5	0.3618	0.3463	0.1469	0.1511	0.1454	0.1482	0.1872	0.2431
6	0.4388	0.4365	0.1860	0.1891	0.1758	0.1728	0.2107	0.2804
7	0.4285	0.4055	0.1735	0.1819	0.1678	0.1687	0.2099	0.2750
8	0.5127	0.4696	0.1853	0.1955	0.1812	0.1770	0.2239	0.3004
9	0.5328	0.5017	0.1925	0.1916	0.1767	0.1833	0.2201	0.2898
10	0.5228	0.4856	0.1889	0.1936	0.1789	0.1802	0.2220	0.2951
Fref	0.3582	0.3437	0.1448	0.1519	0.1440	0.1431	0.1782	0.2366

	1997	1998	1999	2000	2001	2002
1	0.0701	0.0893	0.0750	0.0868	0.1178	0.1461
2	0.1017	0.1382	0.1218	0.1462	0.1786	0.1974
3	0.1746	0.2475	0.2283	0.2817	0.3398	0.3683
4	0.2201	0.3109	0.3063	0.3772	0.4549	0.5186
5	0.2391	0.3234	0.2912	0.3629	0.4167	0.4721
6	0.2749	0.3766	0.3344	0.4281	0.4765	0.5219
7	0.2720	0.3818	0.3436	0.4289	0.4874	0.5209
8	0.2928	0.4010	0.3705	0.4680	0.5349	0.6219
9	0.2833	0.3717	0.3233	0.3888	0.4692	0.5837
10	0.2881	0.3863	0.3469	0.4284	0.5021	0.6028
Fref	0.2362	0.3280	0.3008	0.3758	0.4351	0.4804

Table 6.4.5.1.3 Blue Whiting, Stock numbers at age at 1 Jan.

Output from AMCI run id 20030504 131214.494

	1981	1982	1983	1984	1985	1986	1987	1988
1	3640.3	3881.5	10579.6	18515.4	12451.7	10136.9	10296.5	8921.7
2	3885.0	2851.2	3060.2	7875.5	13305.6	8859.3	7030.1	7362.3
3	5026.8	2975.8	2198.1	2281.2	5558.2	9208.5	5847.2	4807.2
4	3645.6	3680.0	2215.3	1586.2	1567.7	3659.5	5646.5	3752.0
5	3177.3	2583.3	2661.5	1544.4	1050.5	1011.8	2118.8	3366.4
6	3213.8	2193.4	1843.4	1830.7	1003.8	666.1	579.1	1250.3
7	2744.6	2092.5	1494.7	1192.9	1096.9	575.3	340.9	317.0
8	2739.9	1725.6	1389.4	934.7	688.0	610.9	281.6	178.3
9	2225.7	1637.7	1099.4	826.1	508.2	359.7	277.3	135.9
10	7531.2	3279.8	1944.2	1146.3	710.1	423.9	238.8	180.4

	1989	1990	1991	1992	1993	1994	1995	1996
1	10351.5	24666.4	10149.1	6660.7	5904.7	6308.9	8131.0	22987.8
2	6568.2	7545.7	18208.5	7990.4	5202.2	4620.2	4932.5	6310.3
3	5162.2	4525.8	5267.4	13968.8	6093.0	3983.2	3554.1	3737.5
4	3191.6	3299.5	2940.7	3918.8	10301.3	4511.9	2951.8	2569.3
5	2333.5	1908.5	2003.2	2131.1	2809.1	7401.9	3256.7	2062.5
6	2029.5	1330.5	1105.2	1416.0	1500.1	1988.6	5225.6	2211.3
7	699.5	1071.4	704.1	751.2	959.6	1030.2	1369.8	3465.4
8	175.6	373.1	584.8	484.6	512.8	664.3	712.5	909.1
9	92.1	86.1	191.0	397.8	326.3	350.2	455.7	466.3
10	110.2	68.3	58.1	146.7	313.3	320.3	337.1	398.7

	1997	1998	1999	2000	2001	2002	2003
1	49221.4	27893.3	17104.9	30165.9	30000.0	11500.0	11500.0
2	17446.6	37572.6	20885.1	12993.0	22643.9	21831.6	8135.4
3	4663.7	12902.8	26791.5	15138.9	9190.5	15506.5	14671.6
4	2583.7	3206.4	8247.9	17457.1	9351.8	5357.0	8784.3
5	1696.1	1697.4	1923.7	4971.0	9801.8	4858.0	2611.3
6	1324.2	1093.3	1005.8	1177.1	2831.3	5290.3	2480.6
7	1367.8	823.6	614.2	589.4	628.1	1439.3	2570.2
8	2155.1	853.1	460.3	356.7	314.2	315.8	699.9
9	551.2	1316.6	467.8	260.2	182.9	150.7	138.8
10	394.9	448.9	855.5	499.6	264.2	152.5	99.5

Table 6.4.5.1.4 Blue Whiting, Stock summary

Output from AMCI run id 20030504 131214.494

Year	Recruits age 1	SSB	F 3 - 7	Catch SOP
1981	3640338	4333367	0.1840	922980
1982	3881467	3142812	0.1499	550643
1983	10579612	2335954	0.1932	553344
1984	18515411	1772338	0.2561	615569
1985	12451709	1841415	0.2906	678214
1986	10136893	2072225	0.3956	847145
1987	10296488	1883688	0.3478	654718
1988	8921724	1726283	0.3124	552264
1989	10351479	1729522	0.3582	630316
1990	24666414	1707475	0.3437	558128
1991	10149052	2277819	0.1448	364008
1992	6660742	3012788	0.1519	474592
1993	5904686	2949885	0.1440	475198
1994	6308929	2916378	0.1431	457696
1995	8130963	2677761	0.1782	505175
1996	22987755	2497657	0.2366	621104
1997	49221383	2515304	0.2362	639680
1998	27893318	3441203	0.3280	1131954
1999	17104882	4093265	0.3008	1261033
2000	30165937	3987962	0.3758	1412449
2001	30000000	3943532	0.4351	1771805
2002	11500000	3789156	0.4804	1556954
2003	11500000	3283641	0.4804	0
2004*	11500000	2563313	0.4804	0
2005*	11500000	2030436	0.4804	0

Table 6.4.5.2.1

ISVPA, effort-controlled, restriction of zero sums for residuals in separable representation of F minimization of SSE for catch-at-age and age-structured indexes.

SSE from catch-at-age and all age-structured indexes are taken with equal weights

	R(1)	B(1+)	SSB	F(3-7)
1981	6751.3	4830.5	4076.3	0.240
1982	7956.2	4035.9	3261.0	0.177
1983	4631.7	3126.7	2457.1	0.302
1984	18575.1	2790.6	1886.4	0.363
1985	16584.4	3194.0	1899.1	0.386
1986	20492.0	3927.2	2405.9	0.525
1987	9446.7	3834.8	2393.4	0.514
1988	10465.6	3295.7	2186.7	0.580
1989	11085.9	3101.1	1935.3	0.533
1990	15622.4	2923.7	1771.2	0.609
1991	7320.9	2995.3	1843.2	0.238
1992	6586.1	3109.2	2209.9	0.214
1993	11116.6	3310.9	2163.7	0.193
1994	14490.8	3791.5	2343.7	0.206
1995	12257.2	4137.2	2579.2	0.249
1996	16891.5	3931.1	2602.1	0.301
1997	44517.3	5447.2	2768.0	0.274
1998	37028.6	6879.0	3529.6	0.400
1999	29224.7	7796.4	4357.7	0.329
2000	37988.7	8276.3	4771.5	0.337
2001	43059.4	9202.2	5362.1	0.292
2002	25954.0	9458.4	6095.2	0.296

Table 6.4.5.2.2

Abundance at age by years

(Blue whiting, ISVPA, based on signals from catch-at-age and all age-structured indexes (except Spanish CPUE))

	1	2	3	4	5	6	7	8	9	10+
1981	6751.27	4112.83	7575.33	5596.75	2008.57	1880.31	1702.49	2316.71	2007.97	5072.04
1982	7956.18	5170.12	3059.21	5295.10	3693.08	1306.09	1143.98	1033.08	1293.35	3064.88
1983	4631.71	6192.72	3937.50	2225.24	3693.54	2549.01	859.77	751.67	640.55	950.86
1984	18575.07	3492.96	4504.10	2648.43	1390.48	2264.68	1432.72	481.58	376.51	623.44
1985	16584.36	13810.92	2488.00	2921.32	1570.49	805.56	1177.33	741.57	216.05	601.69
1986	20491.95	12265.43	9760.36	1591.51	1697.75	890.15	406.17	590.80	318.31	728.09
1987	9446.68	14717.61	8297.31	5771.77	822.87	846.84	373.25	169.08	191.49	362.53
1988	10465.61	6799.93	9989.64	4936.77	3012.07	414.66	360.50	157.78	56.14	85.06
1989	11085.89	7437.28	4527.11	5736.17	2440.25	1429.80	161.39	139.13	45.26	68.79
1990	15622.42	7950.30	5020.01	2666.24	2947.57	1208.96	593.51	66.50	44.37	156.12
1991	7320.89	11042.46	5250.17	2839.34	1287.48	1363.48	452.26	220.02	17.83	33.56
1992	6586.11	5608.76	8218.81	3673.77	1876.40	838.55	831.34	275.03	123.19	45.04
1993	11116.59	5077.66	4212.93	5840.94	2481.15	1251.00	527.39	521.65	160.53	73.74
1994	14490.79	8616.36	3843.64	3033.34	4017.08	1686.75	807.29	339.64	315.07	122.04
1995	12257.20	11195.94	6492.26	2746.02	2063.72	2699.40	1071.96	511.92	201.02	140.74
1996	16891.46	9365.96	8301.16	4513.36	1798.14	1330.91	1624.29	643.26	281.56	236.06
1997	44517.26	12744.05	6816.40	5589.64	2824.68	1104.39	749.79	911.92	323.24	524.37
1998	37028.55	33806.29	9363.84	4665.89	3580.98	1779.21	643.82	435.76	480.37	193.28
1999	29224.73	27304.37	23786.52	5943.41	2680.94	2004.72	881.59	317.43	182.35	372.38
2000	37988.65	21899.58	19674.00	15741.53	3628.41	1602.94	1088.64	476.89	151.52	363.33
2001	43059.41	28414.68	15737.07	12958.83	9545.23	2153.58	861.71	582.91	224.41	194.51
2002	25954.02	32550.72	20739.36	10649.42	8167.91	5907.58	1225.94	488.91	297.17	413.31

Table 6.4.5.2.3
Fishing mortality coefficients by age by years
(Blue whiting, ISVPA, based on signals from catch-at-age and all age-structured indexes (except Spanish CPUE))

	1	2	3	4	5	6	7	8	9	10+
1981	0.0668	0.0960	0.1581	0.2157	0.2304	0.2969	0.2996	0.3829	0.3829	0.3829
1982	0.0506	0.0723	0.1183	0.1602	0.1708	0.2181	0.2200	0.2780	0.2780	0.2780
1983	0.0822	0.1184	0.1966	0.2702	0.2892	0.3761	0.3796	0.4914	0.4914	0.4914
1984	0.0964	0.1393	0.2330	0.3226	0.3459	0.4542	0.4586	0.6015	0.6015	0.6015
1985	0.1017	0.1471	0.2468	0.3427	0.3678	0.4848	0.4895	0.6457	0.6457	0.6457
1986	0.1310	0.1909	0.3254	0.4596	0.4956	0.6691	0.6764	0.9267	0.9267	0.9267
1987	0.1288	0.1875	0.3192	0.4504	0.4853	0.6540	0.6611	0.9025	0.9025	0.9025
1988	0.1416	0.2068	0.3548	0.5046	0.5451	0.7436	0.7520	1.0488	1.0488	1.0488
1989	0.1325	0.1931	0.3294	0.4658	0.5023	0.6792	0.6866	0.9429	0.9429	0.9429
1990	0.1470	0.2149	0.3699	0.5280	0.5709	0.7833	0.7923	1.1163	1.1163	1.1163
1991	0.0664	0.0953	0.1570	0.2142	0.2288	0.2948	0.2974	0.3800	0.3800	0.3800
1992	0.0601	0.0862	0.1415	0.1925	0.2054	0.2637	0.2660	0.3384	0.3384	0.3384
1993	0.0548	0.0784	0.1285	0.1743	0.1859	0.2380	0.2401	0.3042	0.3042	0.3042
1994	0.0580	0.0831	0.1363	0.1852	0.1975	0.2533	0.2555	0.3245	0.3245	0.3245
1995	0.0690	0.0992	0.1636	0.2234	0.2386	0.3080	0.3107	0.3978	0.3978	0.3978
1996	0.0817	0.1178	0.1955	0.2686	0.2875	0.3738	0.3773	0.4881	0.4881	0.4881
1997	0.0752	0.1082	0.1791	0.2453	0.2622	0.3396	0.3427	0.4410	0.4410	0.4410
1998	0.1046	0.1515	0.2546	0.3541	0.3801	0.5022	0.5072	0.6712	0.6712	0.6712
1999	0.0885	0.1277	0.2128	0.2935	0.3143	0.4106	0.4144	0.5395	0.5395	0.5395
2000	0.0904	0.1304	0.2175	0.3003	0.3217	0.4207	0.4246	0.5538	0.5538	0.5538
2001	0.0798	0.1149	0.1905	0.2616	0.2798	0.3634	0.3668	0.4737	0.4737	0.4737
2002	0.0807	0.1162	0.1929	0.2649	0.2834	0.3684	0.3717	0.4806	0.4806	0.4806

Table 6.5.1. Blue Whiting. Input data for the deterministic short-term prediction

MFDP version 1a
Run: AMCI based Short term pred BW 2003
Time and date: 19:20 05/05/03
Fbar age range: 3-7

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
1	12000	0.2	0.11	0.25	0.25	0.054	0.117	0.054
2	8135	0.2	0.40	0.25	0.25	0.076	0.174	0.076
3	14672	0.2	0.82	0.25	0.25	0.091	0.330	0.091
4	8784	0.2	0.86	0.25	0.25	0.109	0.450	0.109
5	2611	0.2	0.91	0.25	0.25	0.131	0.417	0.131
6	2481	0.2	0.94	0.25	0.25	0.158	0.476	0.158
7	2570	0.2	1.00	0.25	0.25	0.179	0.479	0.179
8	700	0.2	1.00	0.25	0.25	0.204	0.542	0.204
9	139	0.2	1.00	0.25	0.25	0.229	0.481	0.229
10	100	0.2	1.00	0.25	0.25	0.249	0.511	0.249

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
1	12000	0.2	0.11	0.25	0.25	0.054	0.117	0.054
2	.	0.2	0.40	0.25	0.25	0.076	0.174	0.076
3	.	0.2	0.82	0.25	0.25	0.091	0.330	0.091
4	.	0.2	0.86	0.25	0.25	0.109	0.450	0.109
5	.	0.2	0.91	0.25	0.25	0.131	0.417	0.131
6	.	0.2	0.94	0.25	0.25	0.158	0.476	0.158
7	.	0.2	1.00	0.25	0.25	0.179	0.479	0.179
8	.	0.2	1.00	0.25	0.25	0.204	0.542	0.204
9	.	0.2	1.00	0.25	0.25	0.229	0.481	0.229
10	.	0.2	1.00	0.25	0.25	0.249	0.511	0.249

2005								
Age	Stock size	Natural mortality	Maturity ogive	Prop. of F bef. spaw.	Prop. of M bef. spaw.	Weight in stock	Exploit. pattern	Weight in catch
1	12000	0.2	0.11	0.25	0.25	0.054	0.117	0.054
2	.	0.2	0.40	0.25	0.25	0.076	0.174	0.076
3	.	0.2	0.82	0.25	0.25	0.091	0.330	0.091
4	.	0.2	0.86	0.25	0.25	0.109	0.450	0.109
5	.	0.2	0.91	0.25	0.25	0.131	0.417	0.131
6	.	0.2	0.94	0.25	0.25	0.158	0.476	0.158
7	.	0.2	1.00	0.25	0.25	0.179	0.479	0.179
8	.	0.2	1.00	0.25	0.25	0.204	0.542	0.204
9	.	0.2	1.00	0.25	0.25	0.229	0.481	0.229
10	.	0.2	1.00	0.25	0.25	0.249	0.511	0.249

Input units are millions and kg - output in kilotonnes

Table 6.5.2. Blue Whiting. Input data for the deterministic short-term prediction

MFDP version 1a
Run: ISVPA based Short term pred BW 2003
Time and date: 19:20 05/05/03
Fbar age range: 3-7

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
1	15000	0.2	0.11	0.25	0.25	0.054	0.084	0.054
2	19602	0.2	0.40	0.25	0.25	0.076	0.120	0.076
3	23726	0.2	0.82	0.25	0.25	0.091	0.201	0.091
4	14001	0.2	0.86	0.25	0.25	0.109	0.276	0.109
5	6690	0.2	0.91	0.25	0.25	0.131	0.295	0.131
6	5037	0.2	0.94	0.25	0.25	0.158	0.384	0.158
7	3346	0.2	1.00	0.25	0.25	0.179	0.388	0.179
8	692	0.2	1.00	0.25	0.25	0.204	0.503	0.204
9	248	0.2	1.00	0.25	0.25	0.229	0.503	0.229
10	360	0.2	1.00	0.25	0.25	0.249	0.503	0.249

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
1	15000	0.2	0.11	0.25	0.25	0.054	0.084	0.054
2	.	0.2	0.40	0.25	0.25	0.076	0.120	0.076
3	.	0.2	0.82	0.25	0.25	0.091	0.201	0.091
4	.	0.2	0.86	0.25	0.25	0.109	0.276	0.109
5	.	0.2	0.91	0.25	0.25	0.131	0.295	0.131
6	.	0.2	0.94	0.25	0.25	0.158	0.384	0.158
7	.	0.2	1.00	0.25	0.25	0.179	0.388	0.179
8	.	0.2	1.00	0.25	0.25	0.204	0.503	0.204
9	.	0.2	1.00	0.25	0.25	0.229	0.503	0.229
10	.	0.2	1.00	0.25	0.25	0.249	0.503	0.249

2005								
Age	Stock size	Natural mortality	Maturity ogive	Prop. of F bef. spaw.	Prop. of M bef. spaw.	Weight in stock	Exploit. pattern	Weight in catch
1	15000	0.2	0.11	0.25	0.25	0.054	0.084	0.054
2	.	0.2	0.40	0.25	0.25	0.076	0.120	0.076
3	.	0.2	0.82	0.25	0.25	0.091	0.201	0.091
4	.	0.2	0.86	0.25	0.25	0.109	0.276	0.109
5	.	0.2	0.91	0.25	0.25	0.131	0.295	0.131
6	.	0.2	0.94	0.25	0.25	0.158	0.384	0.158
7	.	0.2	1.00	0.25	0.25	0.179	0.388	0.179
8	.	0.2	1.00	0.25	0.25	0.204	0.503	0.204
9	.	0.2	1.00	0.25	0.25	0.229	0.503	0.229
10	.	0.2	1.00	0.25	0.25	0.249	0.503	0.249

Input units are millions and kg - output in kilotonnes

Table 6.5.3 Blue Whiting. Prediction with management option table. Basis for 2003: F2003 = F2002; Recruitment: GM 1981-2001 = 12000 millions

MFDP version 1a
Run: AMCI based Short term pred BW 2003
Blue whiting combined stock, 2003 WG
Time and date: 19:20 05/05/03
Fbar age range: 3-7
Basis for 2003: F2003 = F(2000-2002) = 0.43; Recruitment: GM 1981-2001 = 12000 millions

2003					2004					2005	
Biomass	SSB	FMult	FBar	Landings	Biomass	SSB	FMult	FBar	Landings	Biomass	SSB
4948	3083	1	0.4305	1290	4179	2776	0.0	0.000	0	4814	3319
					.	2748	0.1	0.043	128	4676	3169
					.	2720	0.2	0.086	252	4544	3027
					.	2693	0.3	0.129	370	4416	2892
					.	2665	0.4	0.172	485	4294	2763
					.	2638	0.5	0.215	595	4176	2642
					.	2612	0.6	0.258	700	4063	2526
					.	2585	0.7	0.301	802	3954	2416
					.	2559	0.8	0.344	900	3850	2312
					.	2533	0.9	0.387	994	3749	2212
					.	2508	1.0	0.431	1085	3652	2118
					.	2483	1.1	0.474	1173	3559	2028
					.	2458	1.2	0.517	1257	3470	1943
					.	2433	1.3	0.560	1338	3383	1862
					.	2409	1.4	0.603	1416	3300	1785
					.	2384	1.5	0.646	1492	3220	1711
					.	2361	1.6	0.689	1564	3144	1641
					.	2337	1.7	0.732	1634	3069	1575
					.	2313	1.8	0.775	1702	2998	1512
					.	2290	1.9	0.818	1767	2929	1451
					.	2267	2.0	0.861	1830	2863	1394

Input units are millions and kg - output in kilotonnes

Table 6.5.4 Blue Whiting. Prediction with management option table. Basis for 2002: F2002 = F2001; Recruitment: GM 1981-2000 = 15000 millions

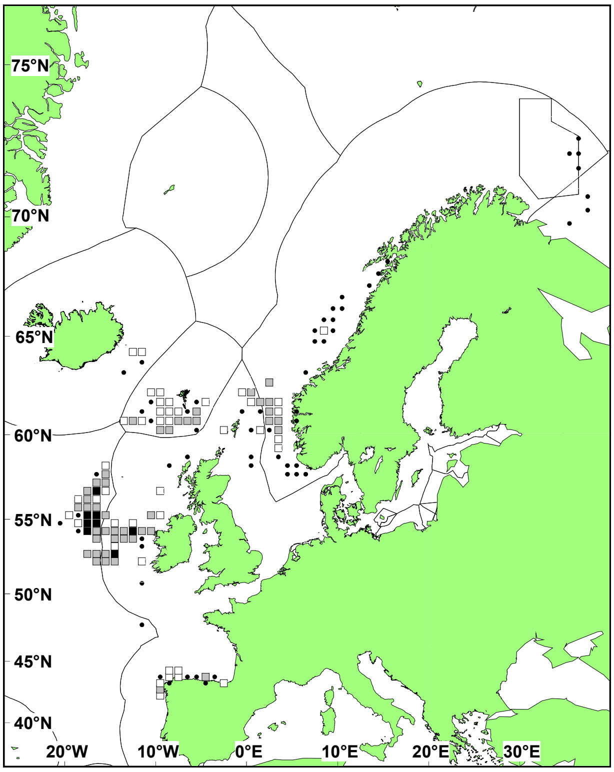
MFDP version 1a
Run: ISVPA based Short term pred BW 2003
Blue whiting combined stock, 2003 WG
Time and date: 15:09 04/05/03
Fbar age range: 3-7
Basis for 2003: F2003 = F(2000-2002)= 0.31; Recruitment: GM 1981-2001 = 15000 millions

2003					2004					2005	
Biomass	SSB	FMult	FBar	Landings	Biomass	SSB	FMult	FBar	Landings	Biomass	SSB
8536	5509	1	0.3087	1619	7511	5388	0.0	0.000	0	8228	6091
					.	5349	0.1	0.031	175	8042	5882
					.	5309	0.2	0.062	344	7862	5681
					.	5270	0.3	0.093	509	7686	5488
					.	5231	0.4	0.124	668	7516	5303
					.	5193	0.5	0.154	823	7351	5124
					.	5155	0.6	0.185	974	7191	4953
					.	5117	0.7	0.216	1120	7036	4788
					.	5080	0.8	0.247	1262	6885	4630
					.	5043	0.9	0.278	1400	6739	4478
					.	5006	1.0	0.309	1534	6597	4331
					.	4969	1.1	0.340	1665	6459	4191
					.	4933	1.2	0.370	1791	6325	4055
					.	4897	1.3	0.401	1914	6194	3925
					.	4861	1.4	0.432	2034	6068	3799
					.	4826	1.5	0.463	2150	5945	3678
					.	4791	1.6	0.494	2263	5826	3562
					.	4756	1.7	0.525	2373	5710	3450
					.	4722	1.8	0.556	2480	5597	3342
					.	4687	1.9	0.587	2584	5487	3238
					.	4653	2.0	0.617	2685	5381	3138

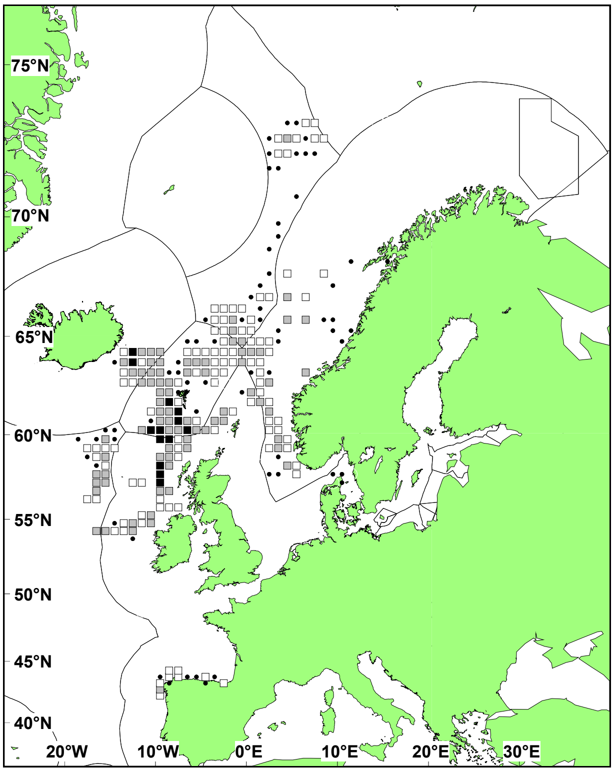
Input units are millions and kg - output in kilotonnes

Table 6.9.1 Blue whiting. Total landings, No. of samples, No. of fish measured and No. of fish aged by country and quarter for 2001.

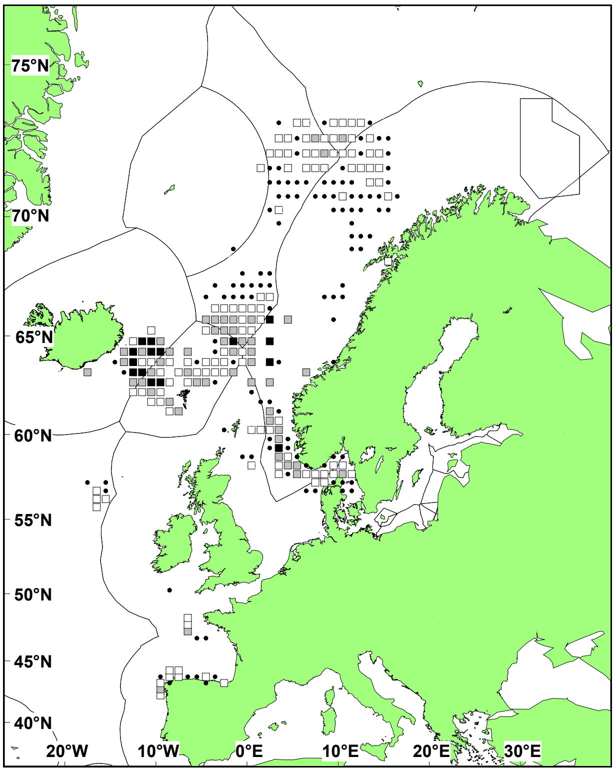
Country	Quarter	Landings (t)	No. Of samples	No. Fish measured	No. Fish aged
Denmark	1	17311	7	344	
	2	6955	7	694	
	3	18950	34	1536	
	4	8063	5	202	
	Total	51279	53	2776	0
Faroe Islands	1	24016	5	1645	501
	2	93274	12	3732	1200
	3	80365	8	2278	800
	4	7766	6	1773	600
	Total	205420	31	9428	3101
France	1	4565			
	2	5307			
	3	4320			
	4	496			
	Total	14687	0	0	0
Germany	1	8080			
	2	8500			
	3	470			
	4				
	Total	17050	0	0	0
Iceland	1	4597	2	200	99
	2	97543	29	2428	1188
	3	159283	56	4546	2772
	4	24116	16	1364	786
	Total	285539	103	8538	4845
Ireland	1	6425	7	982	935
	2	11396			
	3				
	4	4			
	Total	17825	7	982	935
Norway	1	253604	26	1300	1300
	2	177532	25	1320	1320
	3	107101	30	1750	500
	4	33239	6	320	320
	Total	571477	87	4690	3440
Portugal	1	274	71	7605	343
	2	572	84	8090	333
	3	586	72	7415	288
	4	226	74	8185	413
	Total	1659	301	31295	1377
Russia	1	32661	52	6465	1431
	2	104456	50	6158	1312
	3	83574	66	16076	592
	4	69376	42	6603	194
	Total	290067	210	35302	3529
Scotland	1	23606	1	295	0
	2	2796			
	3				
	4				
	Total	26402	1	295	0
Spain	1	4713	56	4267	200
	2	4827	54	4200	200
	3	4525	44	2969	350
	4	3442	57	5048	400
	Total	17506	211	16484	1150
Sweden	1	1892			
	2	3467			
	3	7469			
	4	5722			
	Total	18550	0	0	0
The Netherland	1	15954	6	1647	150
	2	18317	20	3070	500
	3	3258	7	2388	175
	4				
	Total	37529	33	7105	825
Grand Total		1554990	1037	116895	19202



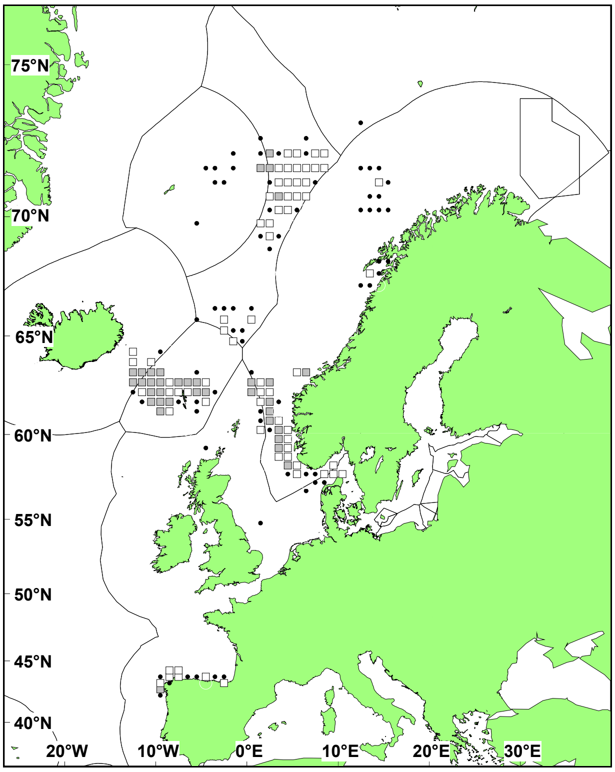
Quarter 1



Quarter 2



Quarter 3



Quarter 4

Figure 6.2.1. Total catches of blue whiting in 2002 by quarter and ICES rectangle. Grading of the symbols: small dots 10-100 t, white squares 100-1 000 t, grey squares 1 000-10 000 t, and black squares > 10 000 t. Excluding France, Sweden and Portugal.

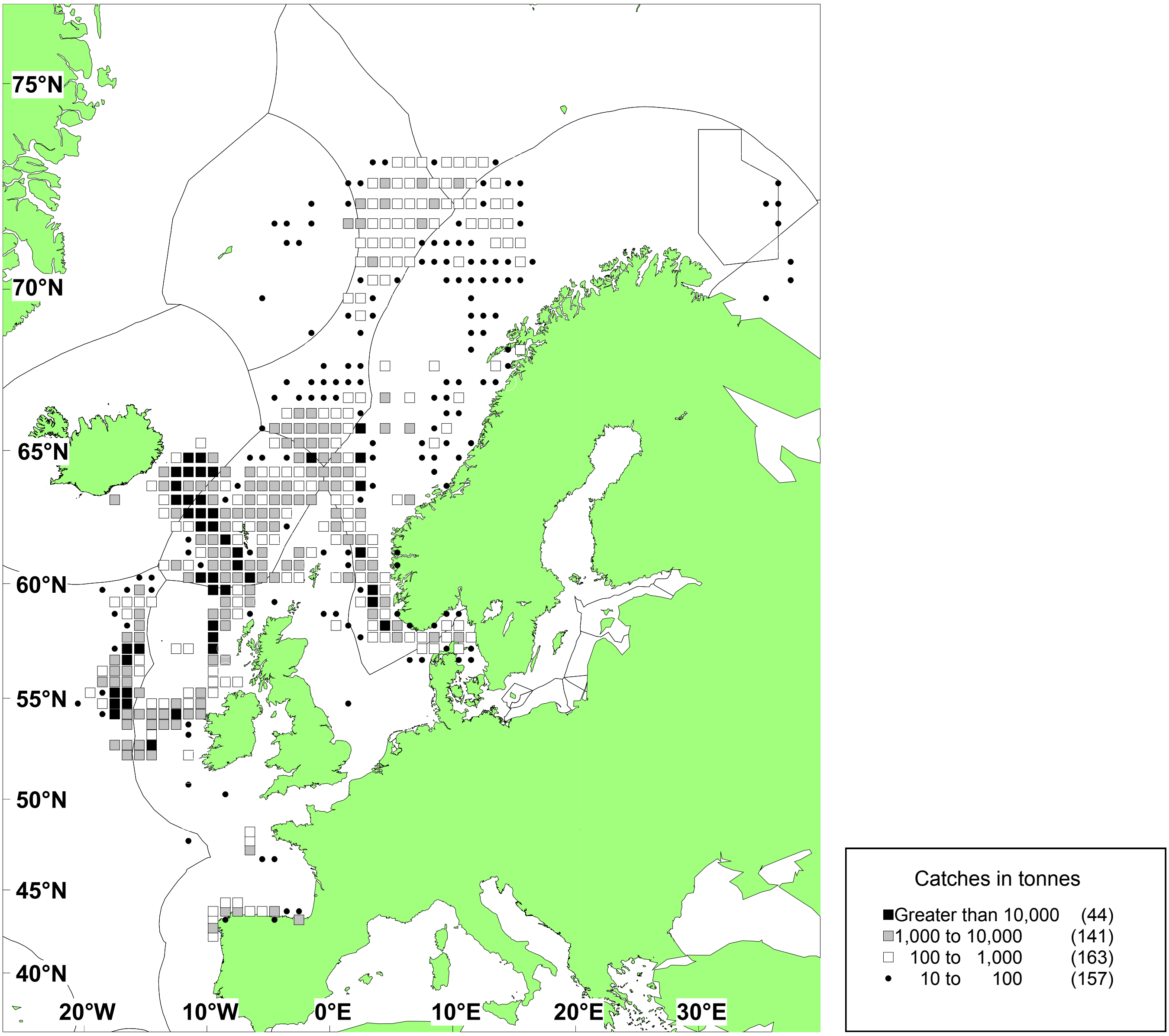


Figure 6.2.2 Total catches of blue whiting in 2002 by ICES rectangle. Grading of the symbols: small dots 10-100 t, white squares 100-1 000 t, grey squares 1 000-10 000 t, and black squares > 10 000 t. Excluding France, Sweden and Portugal.

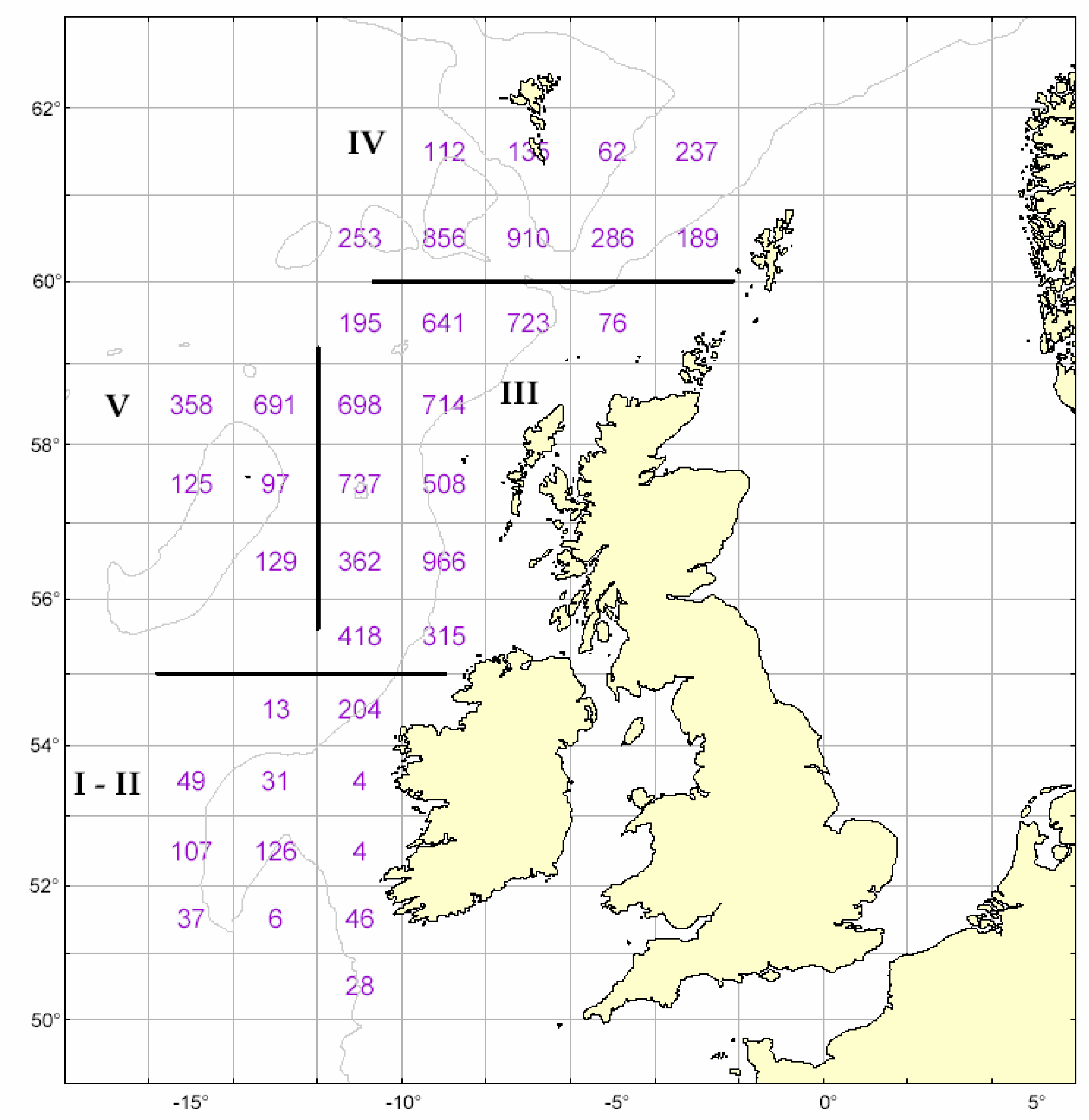


Figure 6.4.1.1.1 Distribution of blue whiting biomass (in 1000 tonnes) as estimated by R.V. "Johan Hjort" in April 2003.

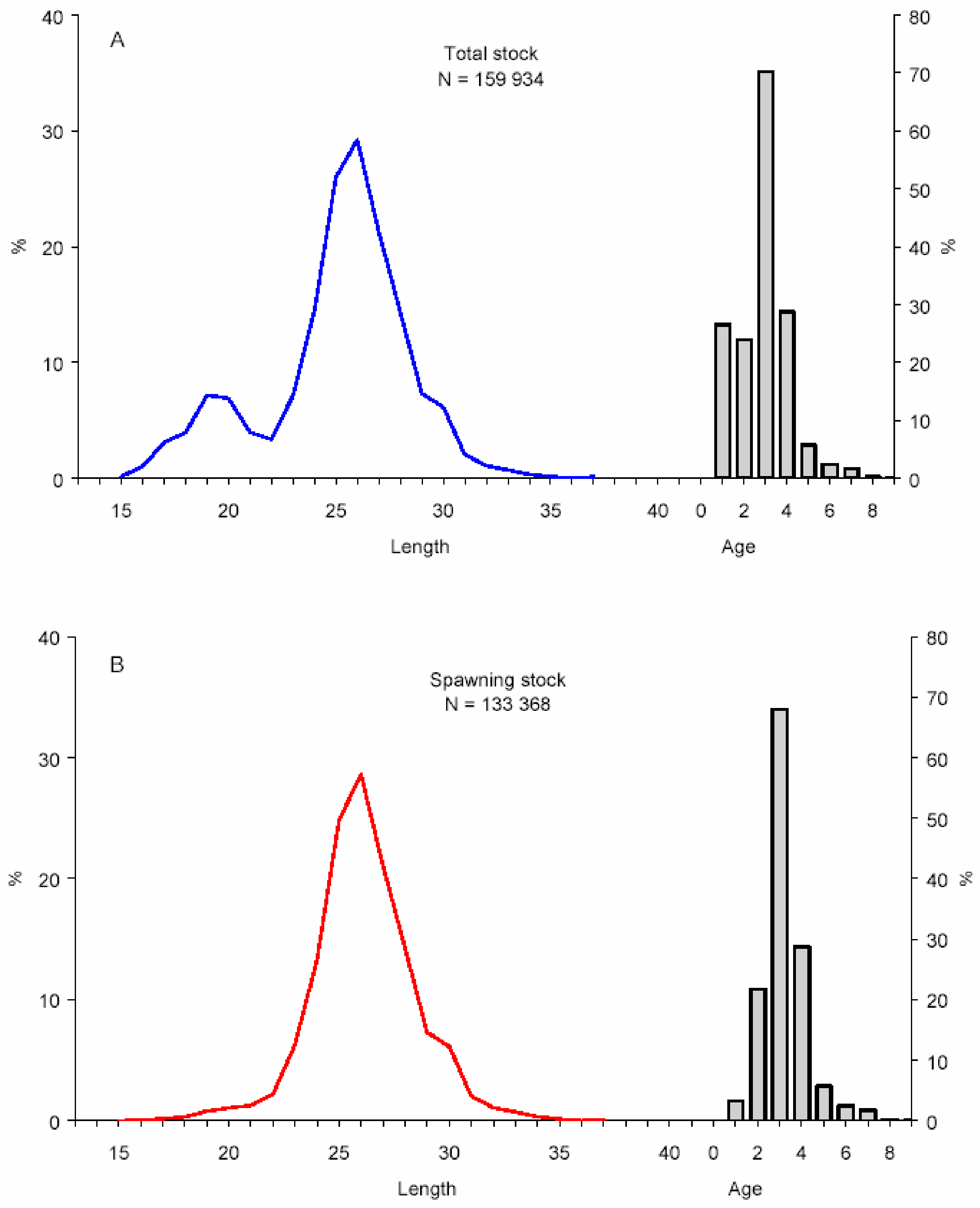
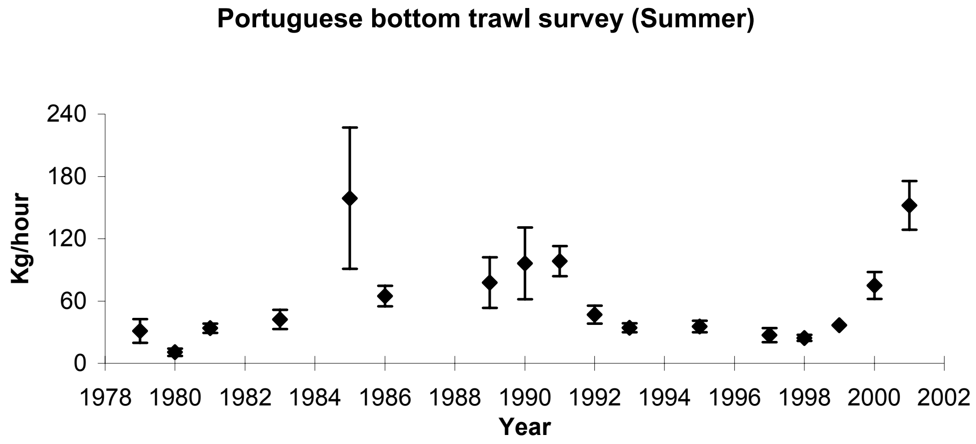
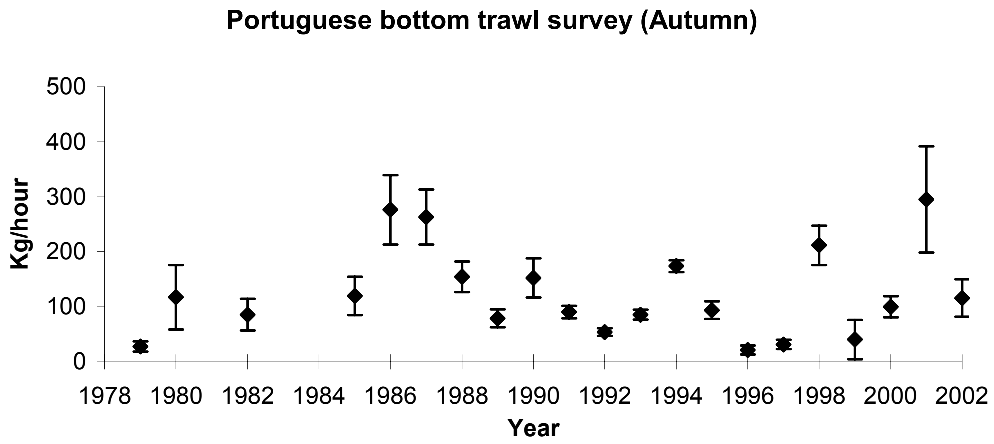


Figure 6.4.1.1.2 Length and age distribution in the total (A) and spawning (B) stock of blue whiting in the area to the west of the British Isles as estimated by R.V. "Johan Hjort" in April 2003. Numbers in millions.





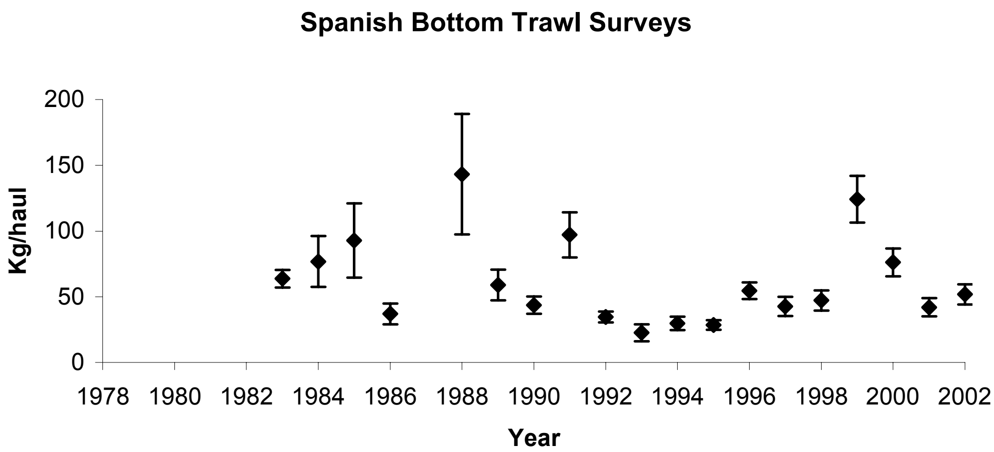


Figure 6.4.2.1 Mean catch rates in the bottom trawl surveys from the southern area.

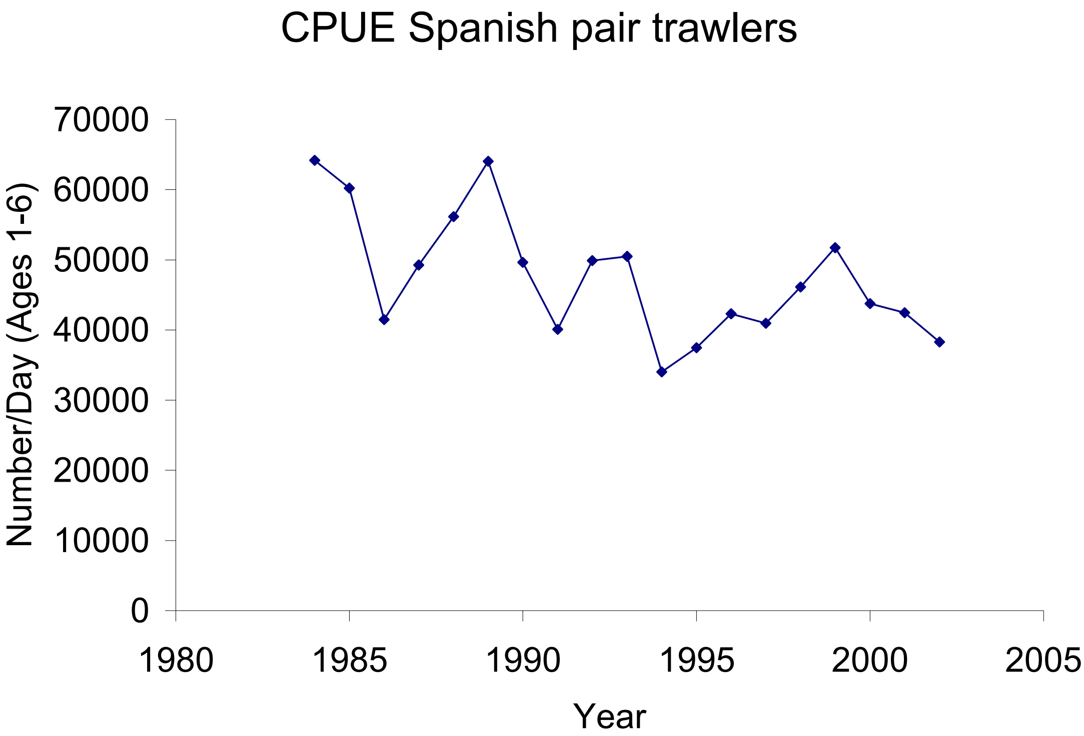


Figure 6.4.3.1 Blue whiting CPUE from Spanish Pair trawlers in ICES Div VIIIc and IXa (North)

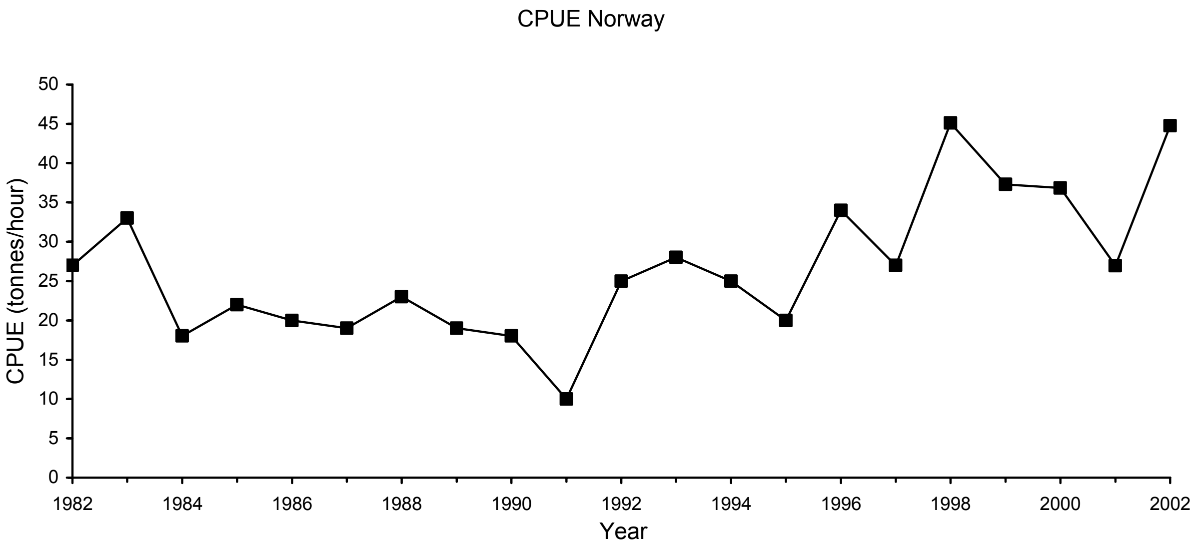
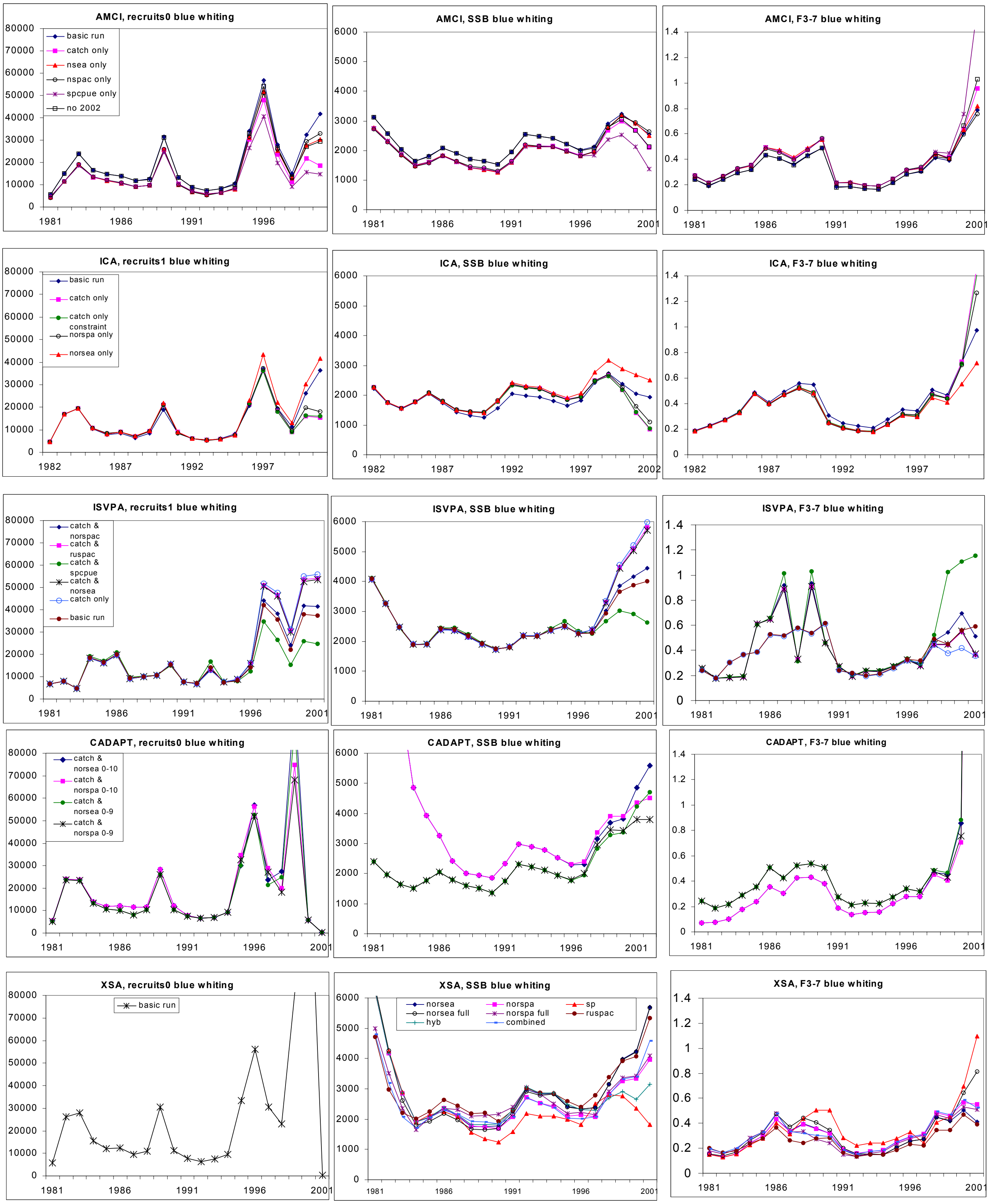


Figure 6.4.3.2. Blue whiting. Overall aggregated CPUE from the Norwegian directed fisheries in 1982–2002 (tonnes/hour).



Abbreviations used in the figure legends: nsea = norsea = Norwegian Sea Acoustic survey; nspac = norspa = norspac = Norway Spawning Acoustic survey; spcpue = sp = Spanish Pair Trawl CPUE; no 2002 = without 2002 survey data; ruspac = Russian Spawning Acoustic survey; hyb = Laurec-Shephard hybrid model. The ISVPA $F_{3\text{-}7}$ values for the basic run and for the catch only run are derived from the selection pattern.

Figure 6.4.4.1 Comparison of assessments of the blue whiting stock by different methods (courtesy of the WG Methods, ICES 2003/D:3).

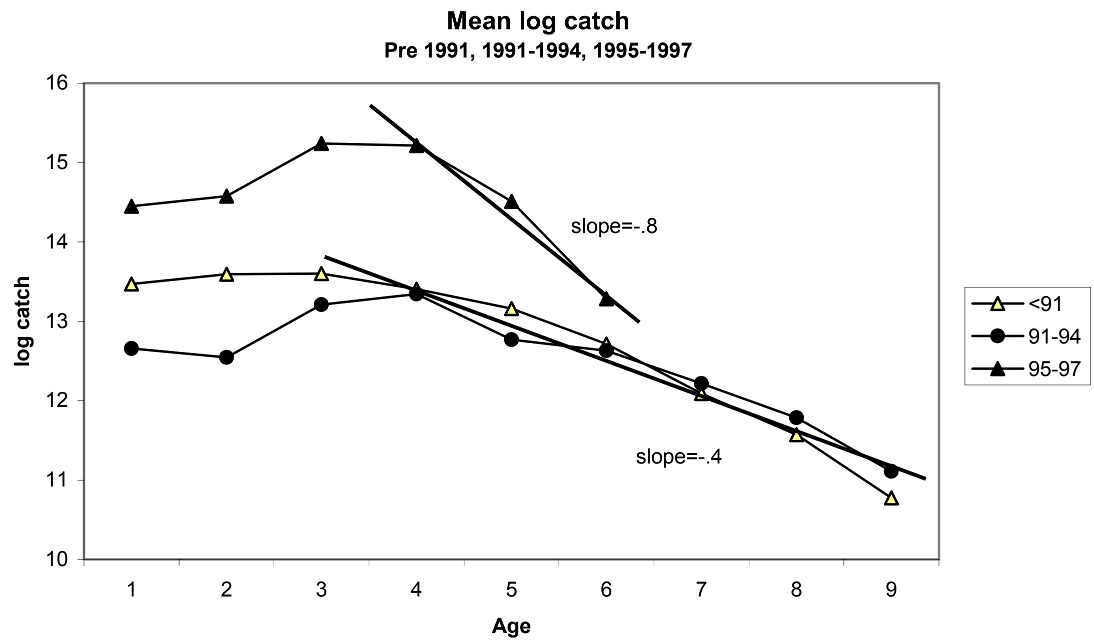


Figure 6.4.4.1.1. Blue whiting. Mean log catch by cohort and age, averaged for various periods.

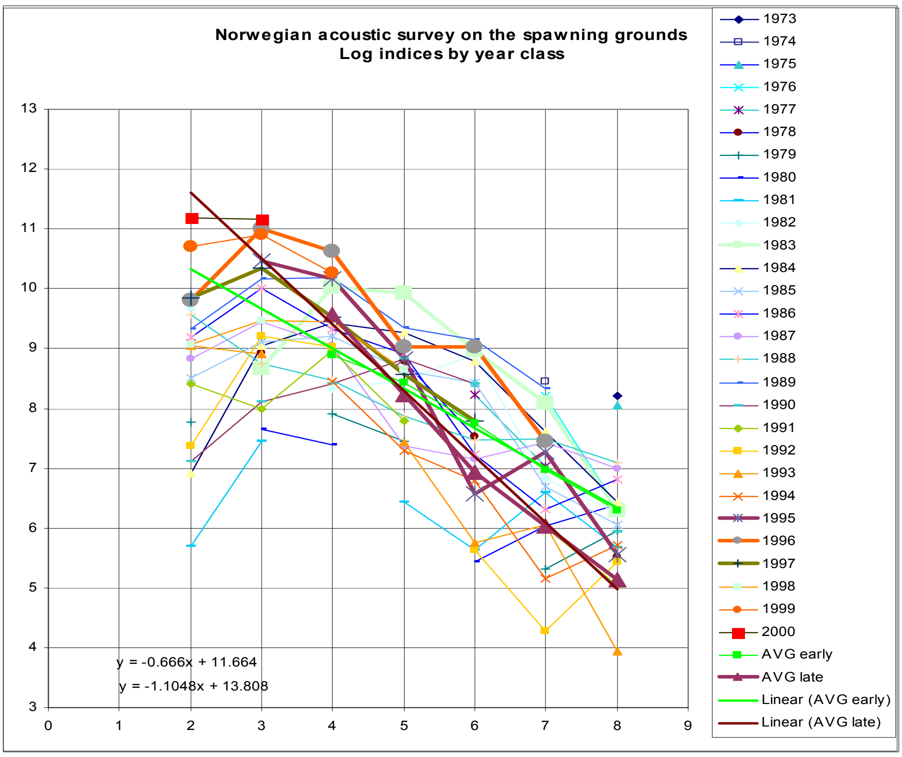


Figure 6.4.4.1.2. Blue whiting. Log indices by year class and age group.

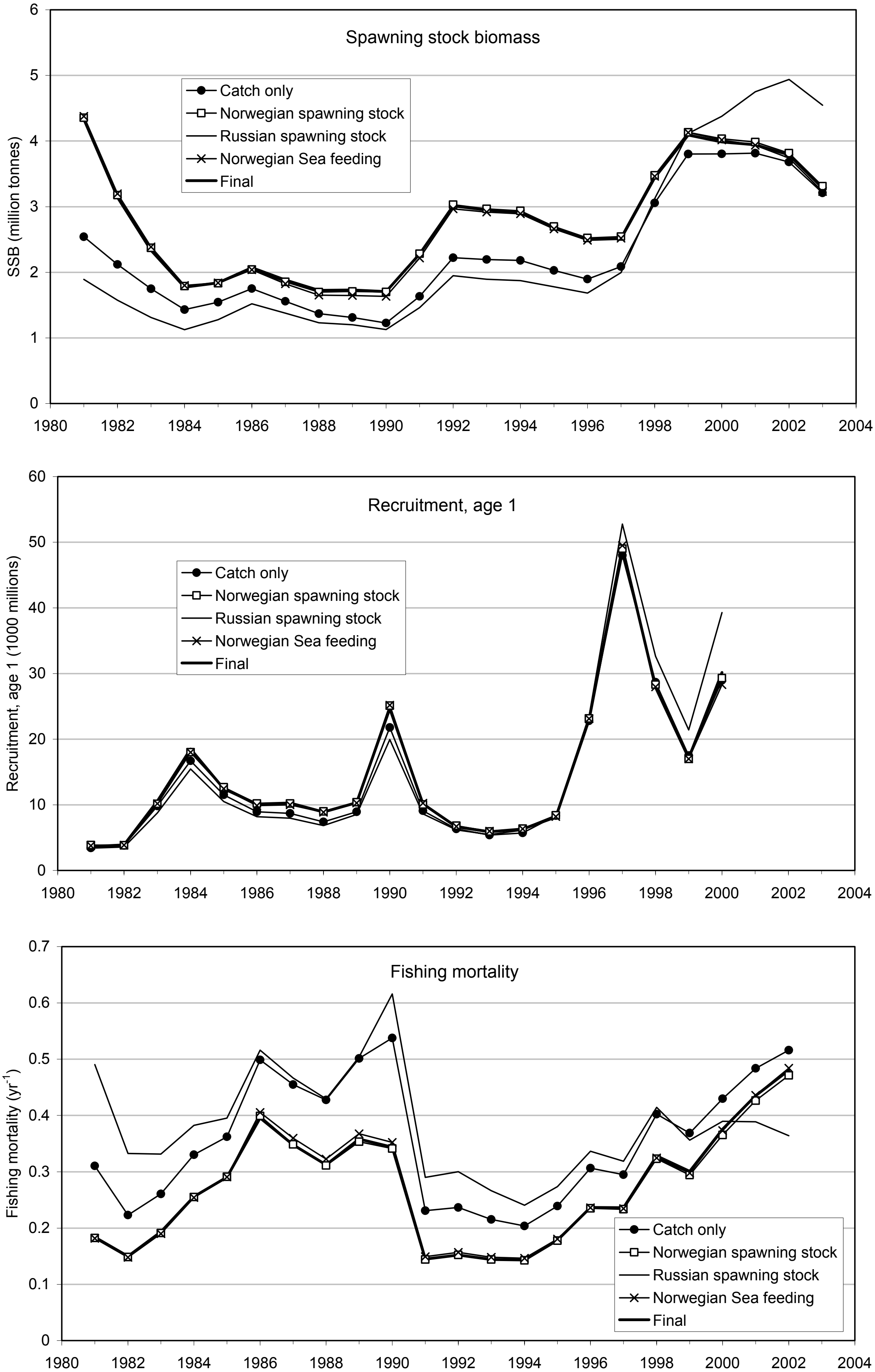


Figure 6.4.4.2.1. Blue Whiting. Results of data exploiration using AMCI software.

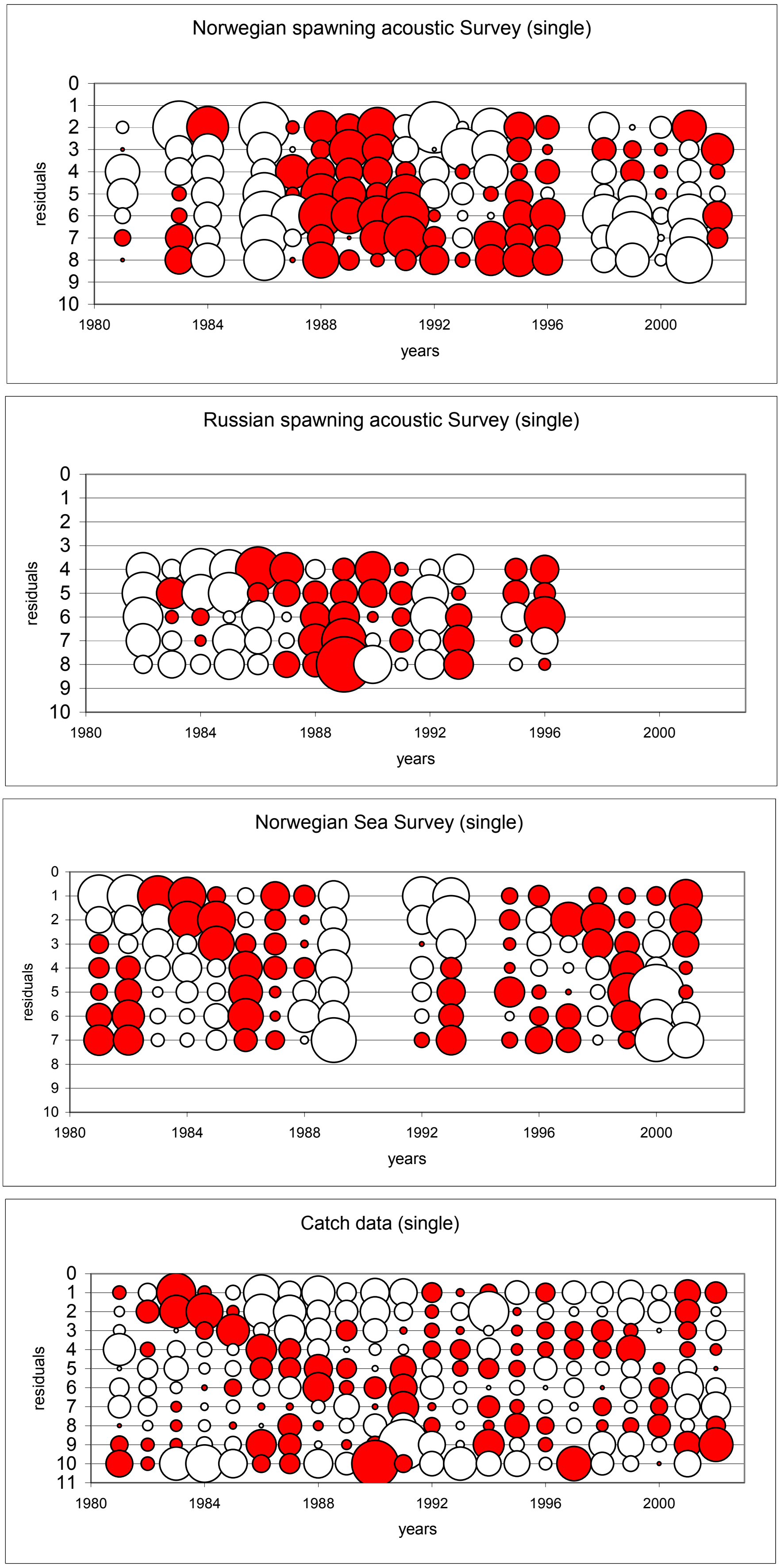


Figure 6.4.4.2.2. Blue Whiting: Residuals AMCI assessment WG 2003
Single fleets in combination with catch data (others removed)

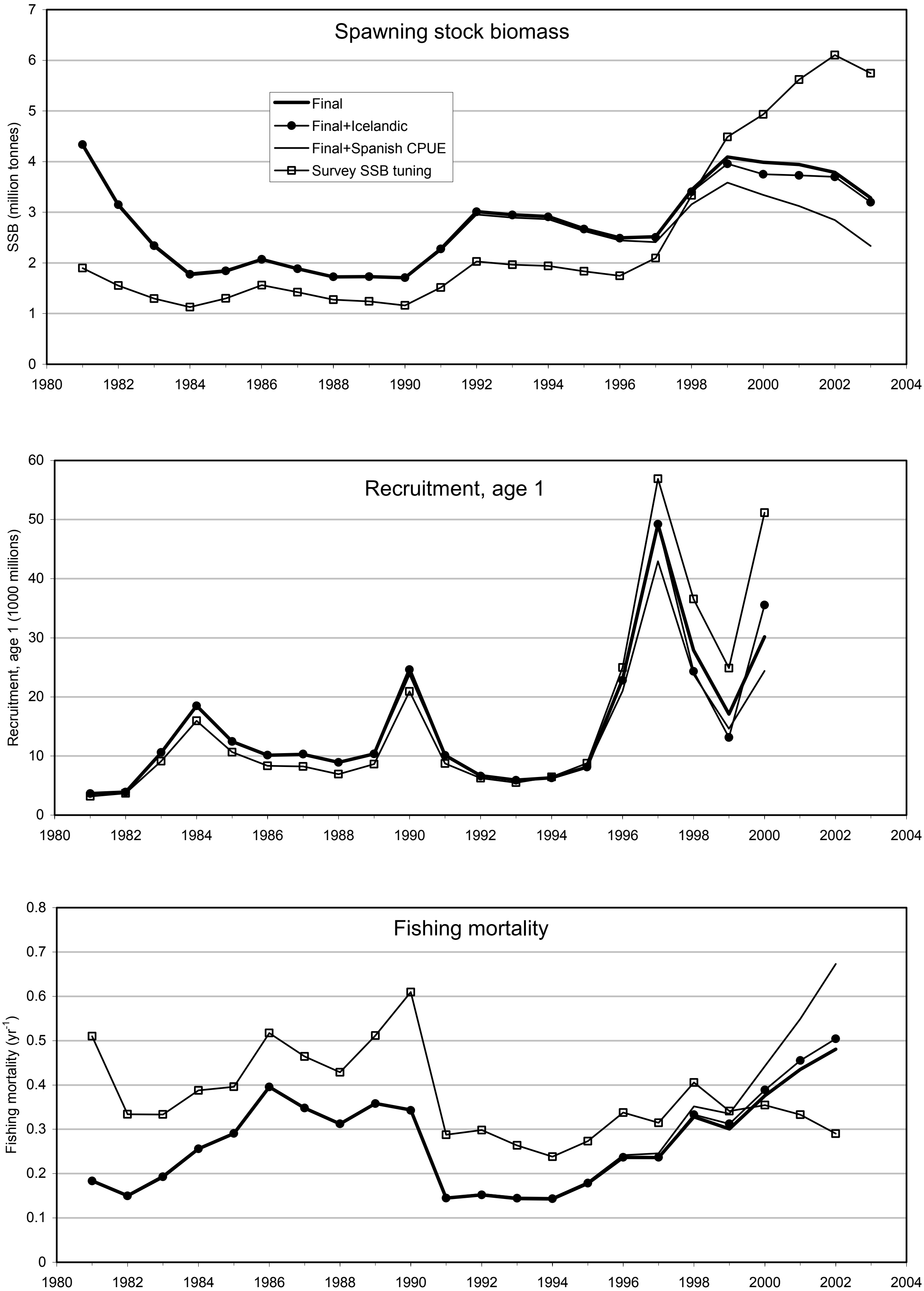


Figure 6.4.4.2.3. Blue Whiting. Results of data exploiration using AMCI software.

personal/vasilyev/fig 6461.xls

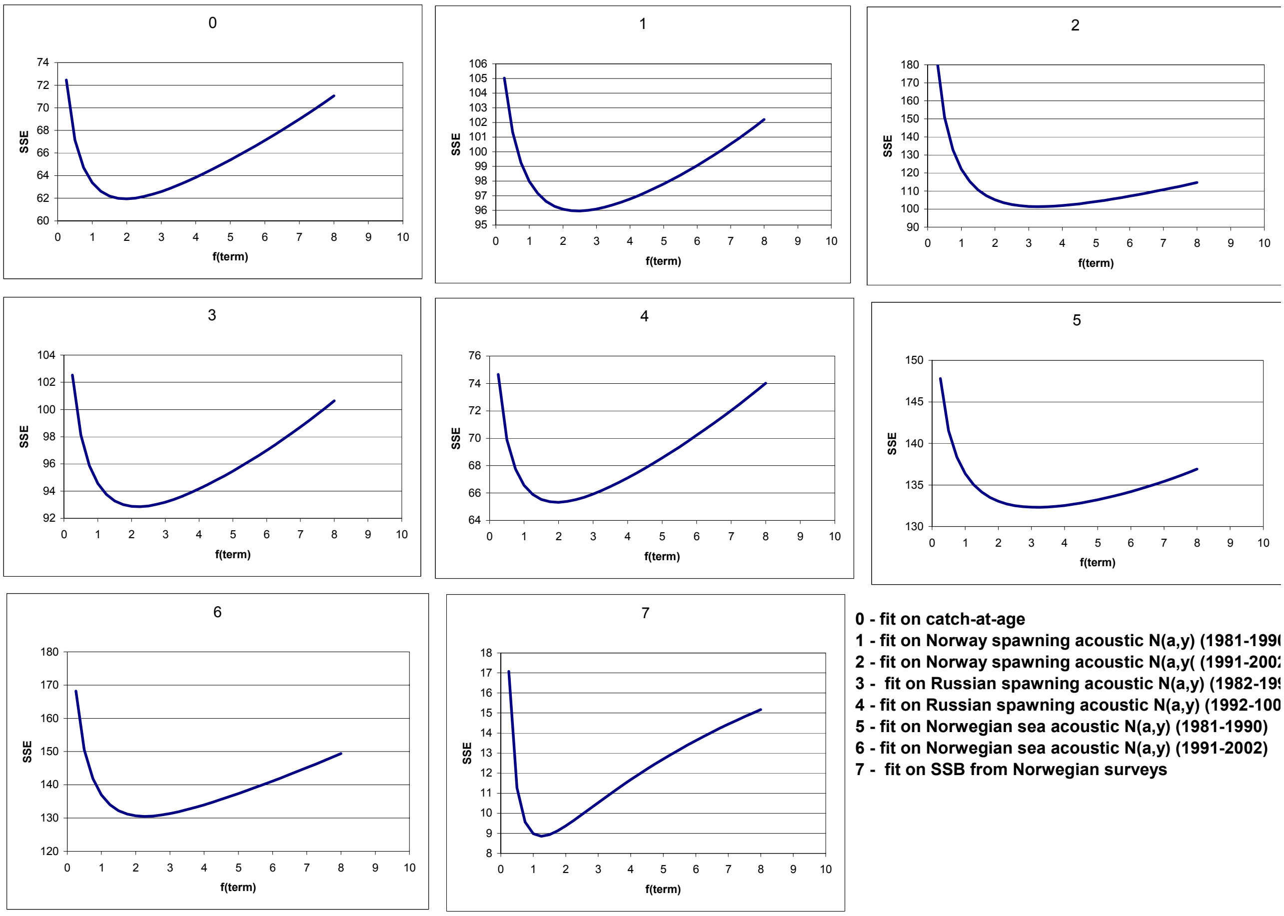
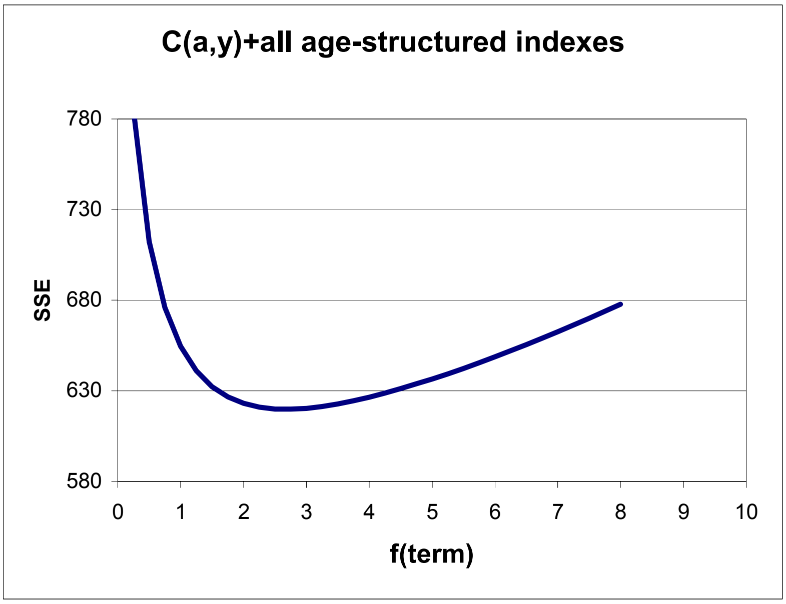


Fig. 6.4.4.3.1
Blue whiting. ISVPA. Profiles of components of the loss function by sorces of information



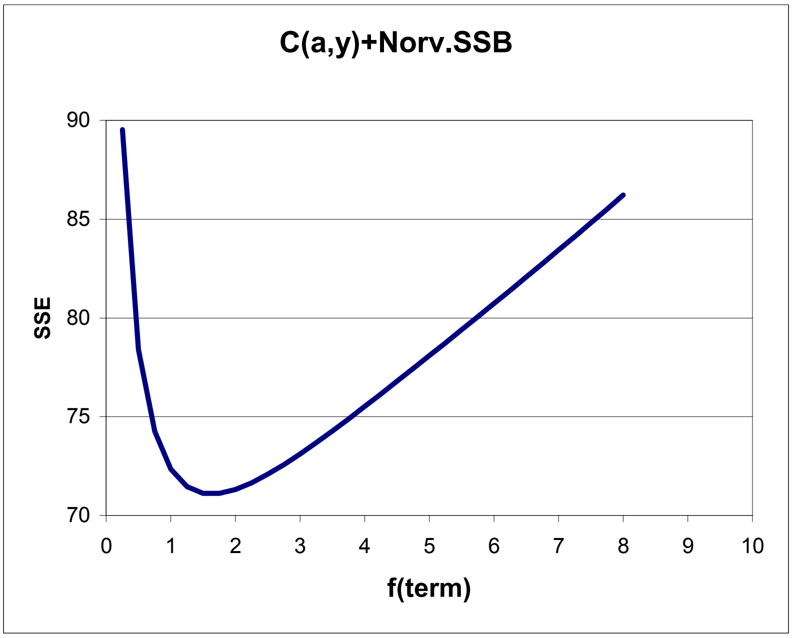


Figure 6.4.4.3.2

Blue whiting. ISVPA.

Profiles of ISVPA loss function when signals from catch-at-age and all age-structurec indexes are taken with equal weights (1) and when signal from catch-at-age from Norwegian SSB estimates are teken with equal weights (2)

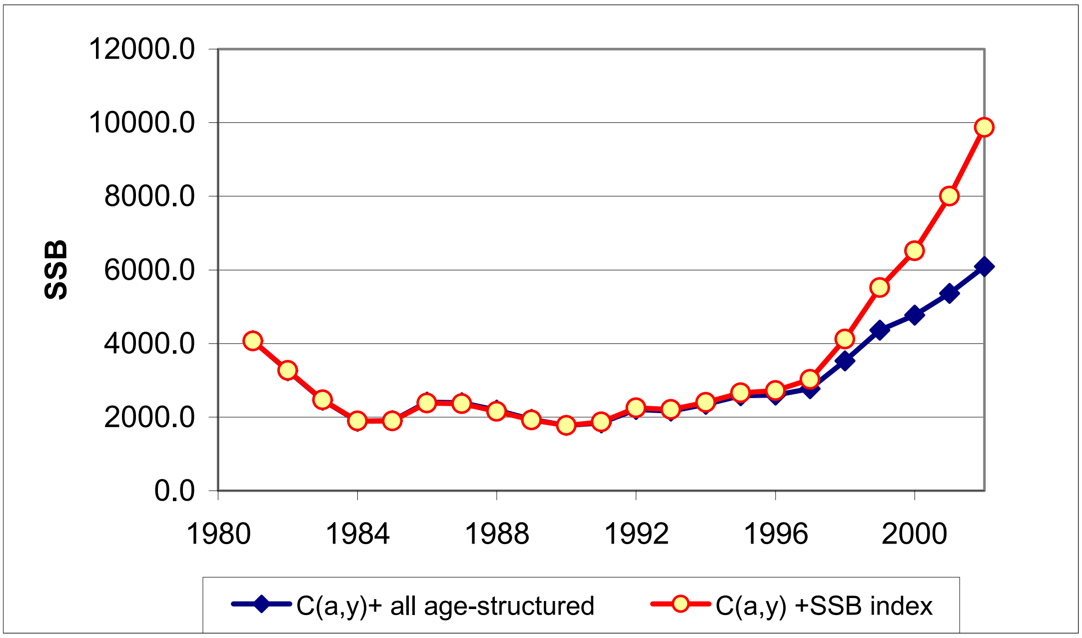


Figure 6.4.4.3.3
Blue whiting. ISVPA
SSB esimates for ISVPA tuning on age-structured surveys or on SSB index

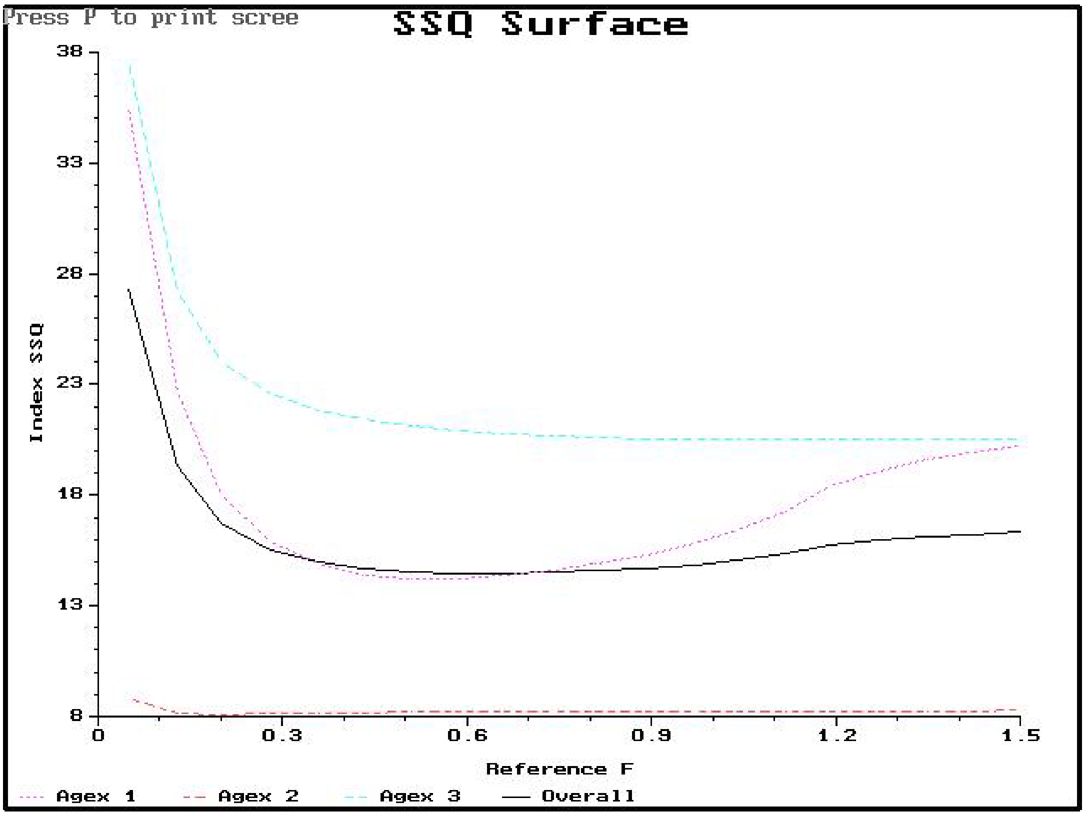


Figure 6.4.4.4.1. SSQ surface for the ICA assessment of Blue Whiting 2003.

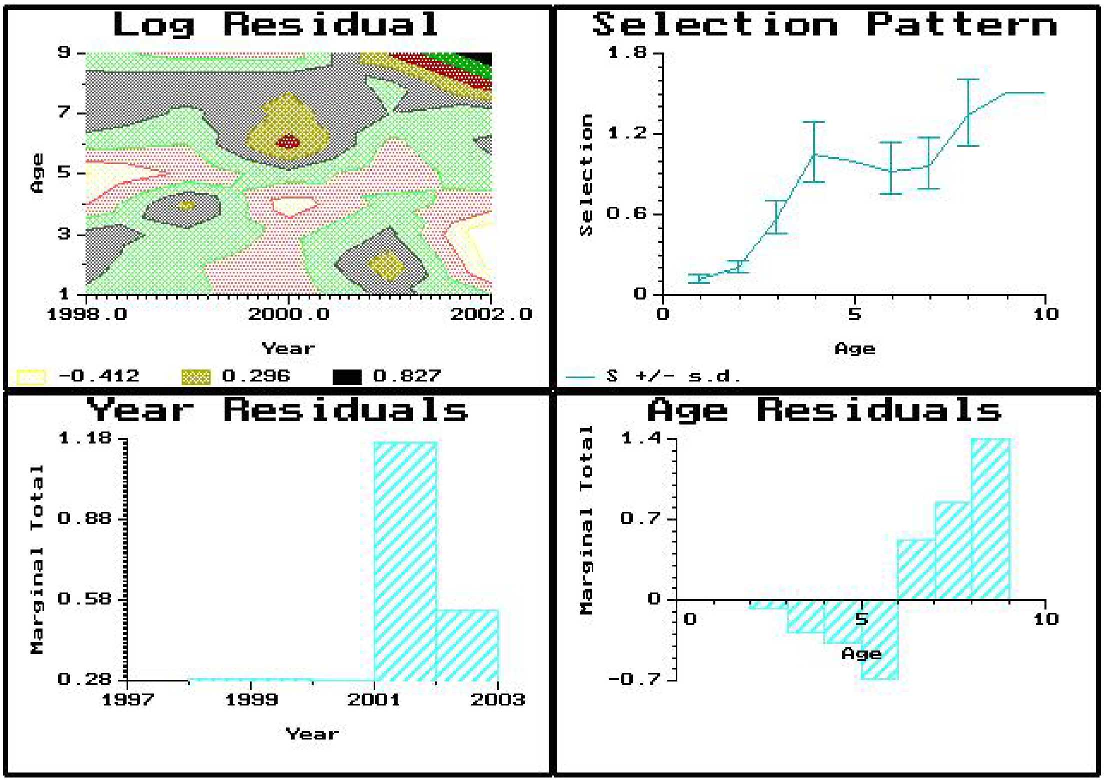


Figure 6.4.4.4.2. Catch residuals and selection pattern in the ICA assessment of Blue Whiting 2003

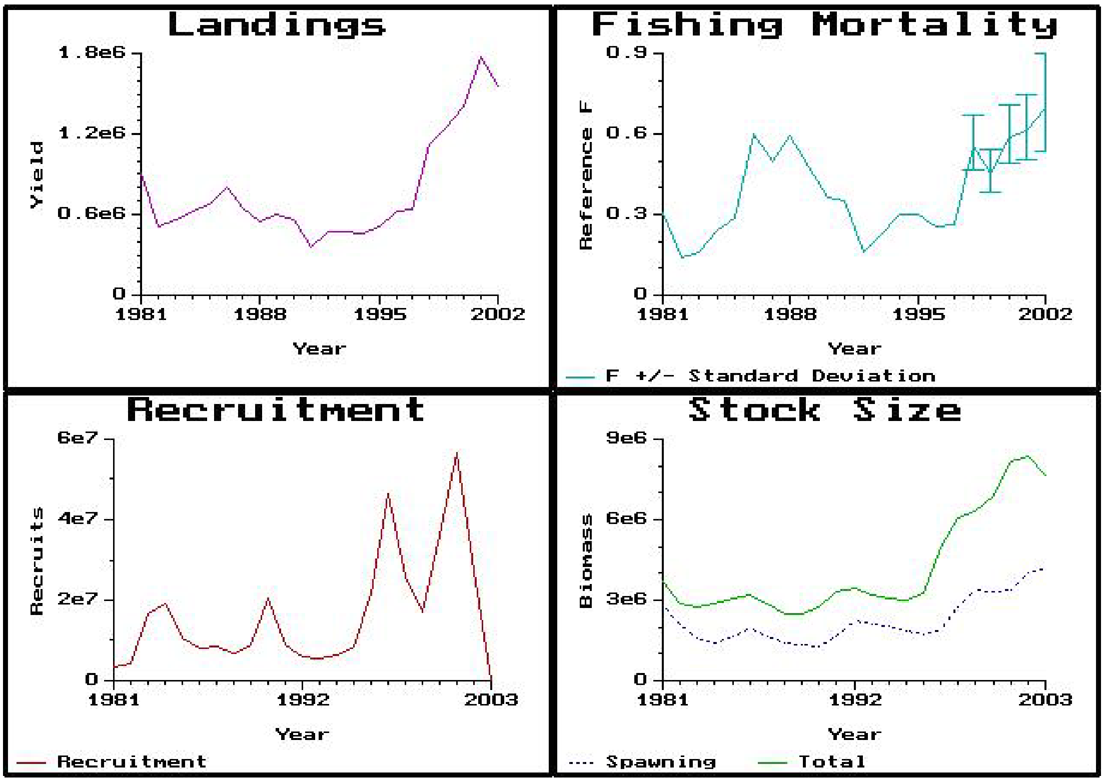


Figure 6.4.4.4.3. Standard plots for the ICA assessment of Blue Whiting 2003.

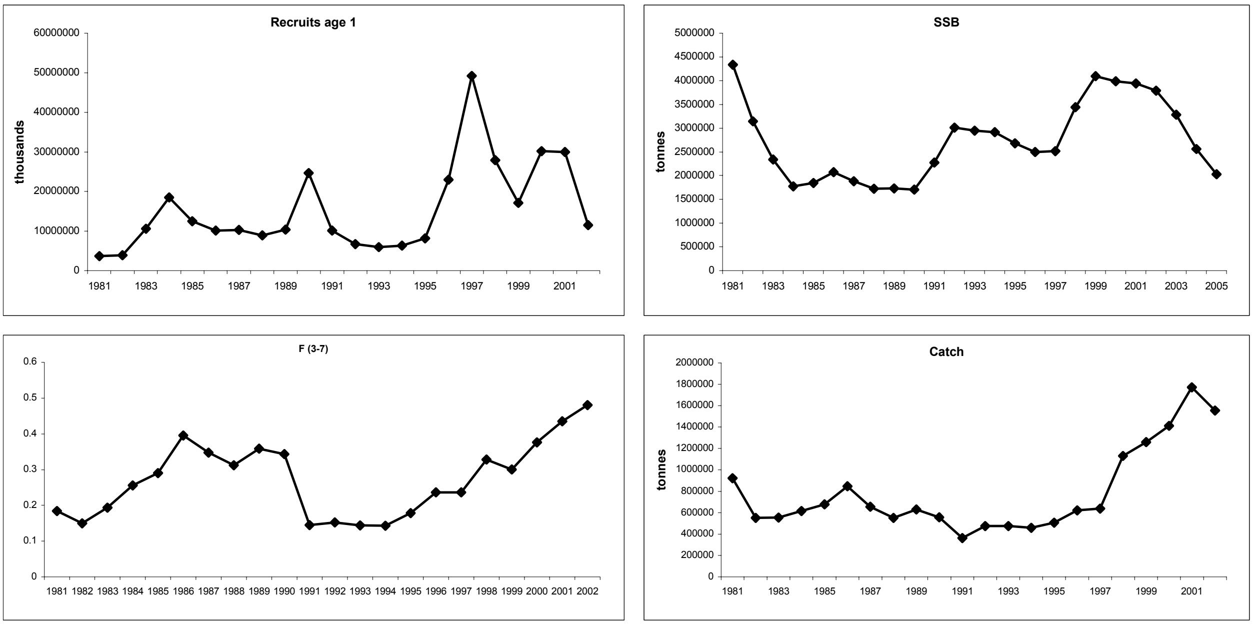


Figure 6.4.5.1.1. AMCI Blue whiting assessment 2003. Standard plots

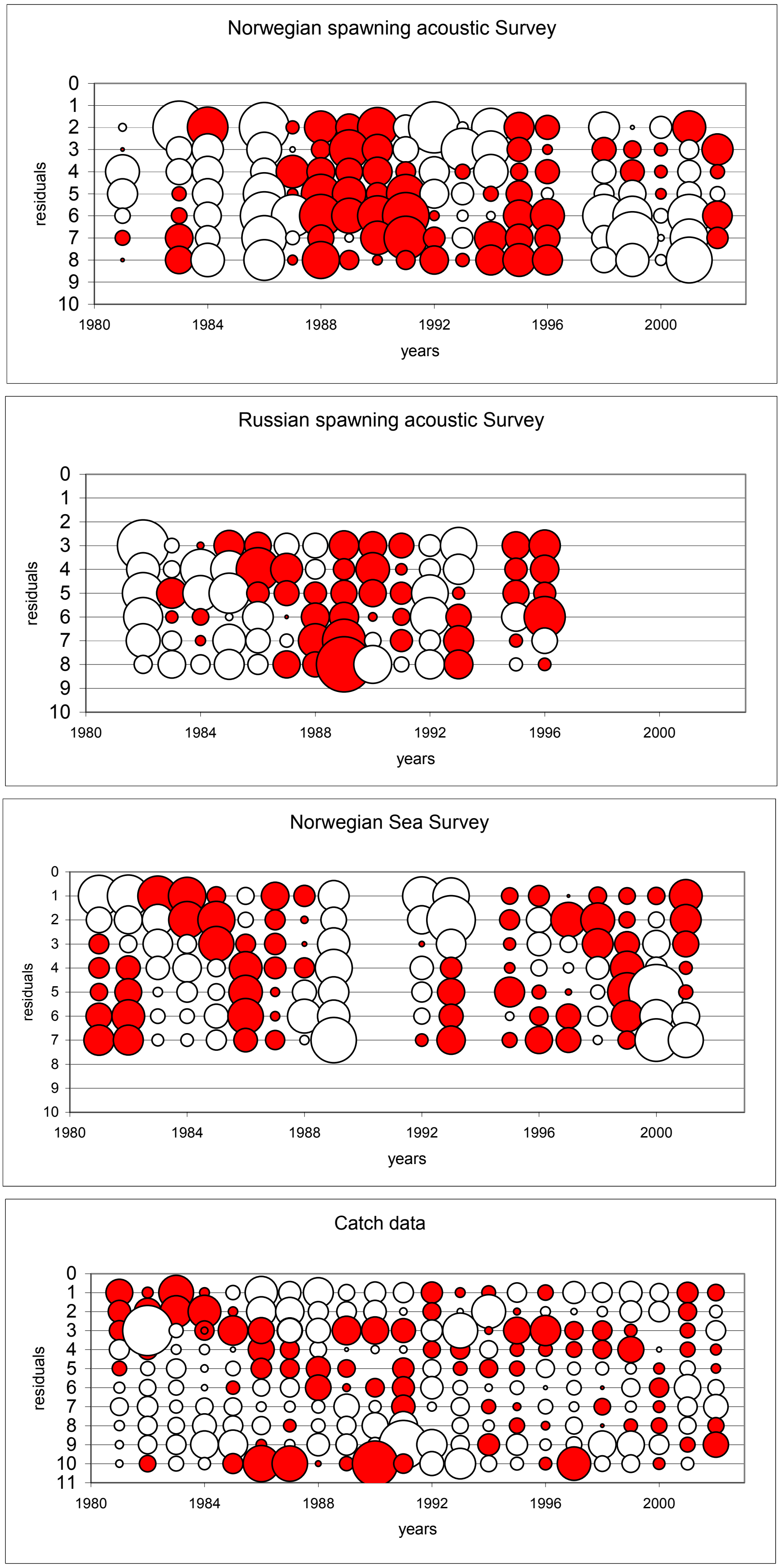


Figure 6.4.5.1.2. Blue whiting: Residuals AMCI assessment WG 2003
Residuals of fleets in combined assessment

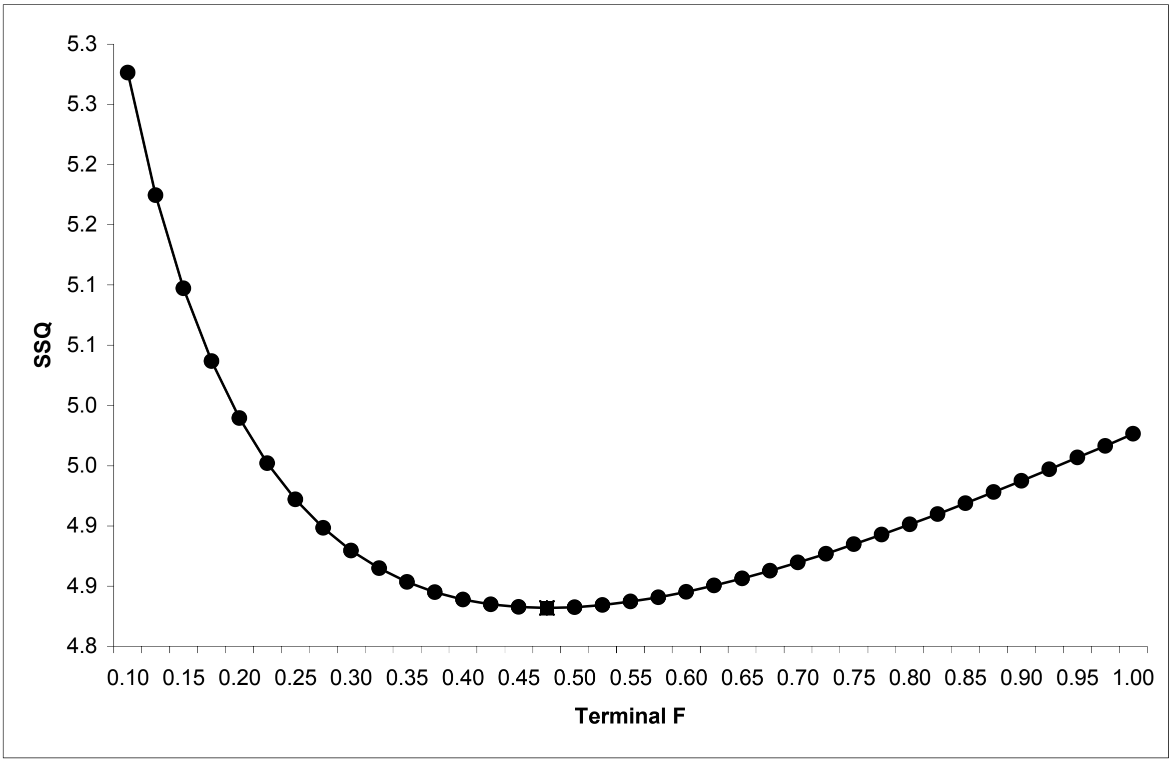


Figure 6.4.5.1.3. AMCI assessment of blue whiting 2003. SSQ for a range of terminal Fs

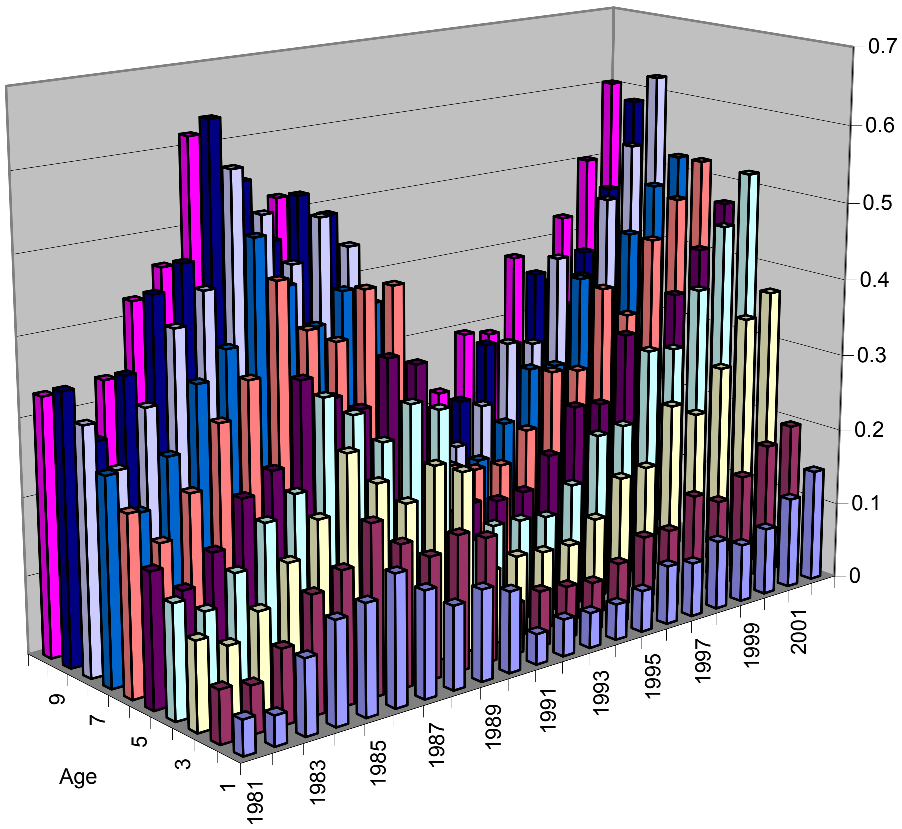


Figure 6.4.5.1.4. Final AMCI assessment on blue whiting. Fishing mortality at age and year.

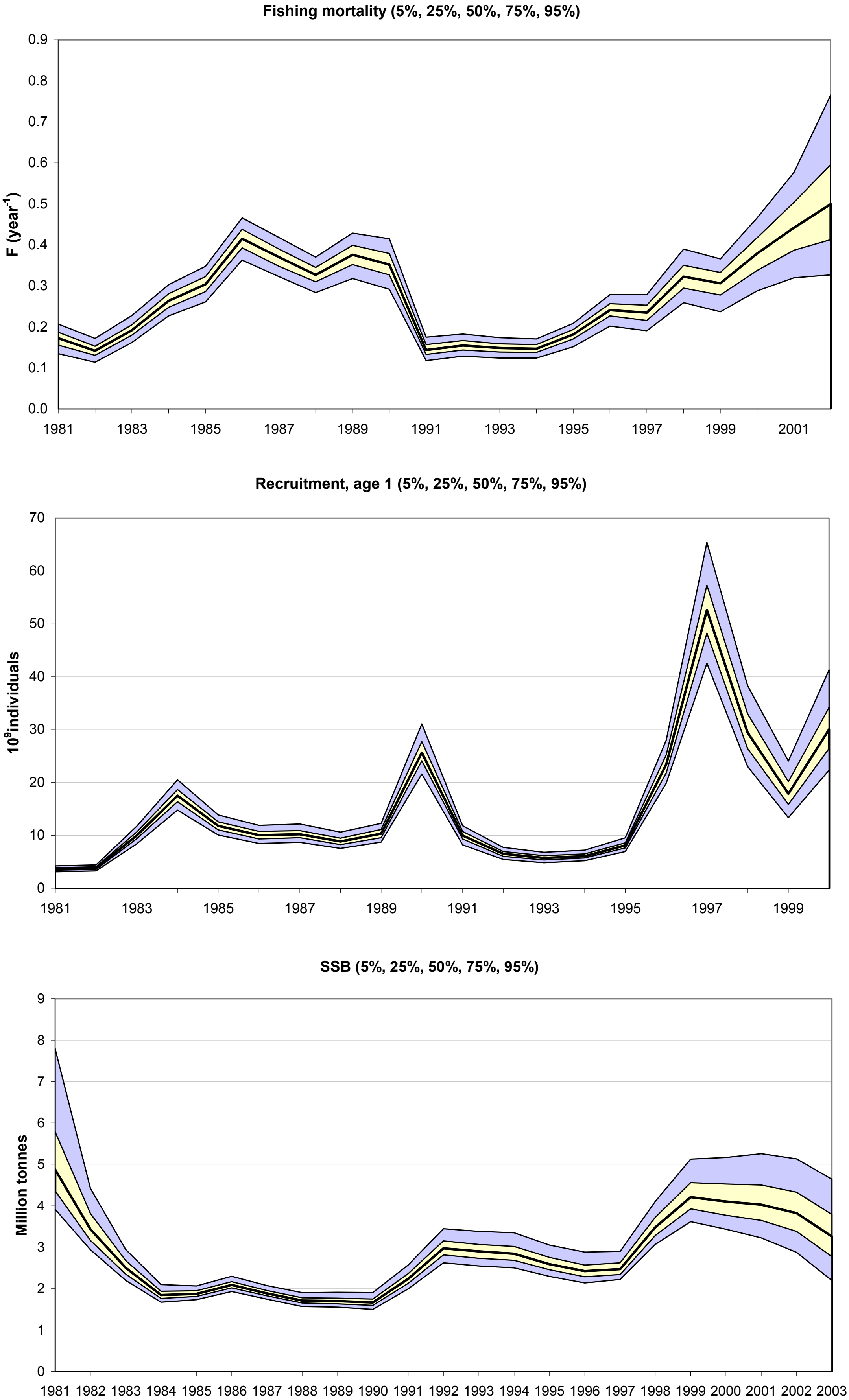


Figure 6.4.5.1.5. An evaluation of uncertainty in AMCI assessment obtained by bootstrapping the residuals of the final AMCI assessment (1000 replicates).

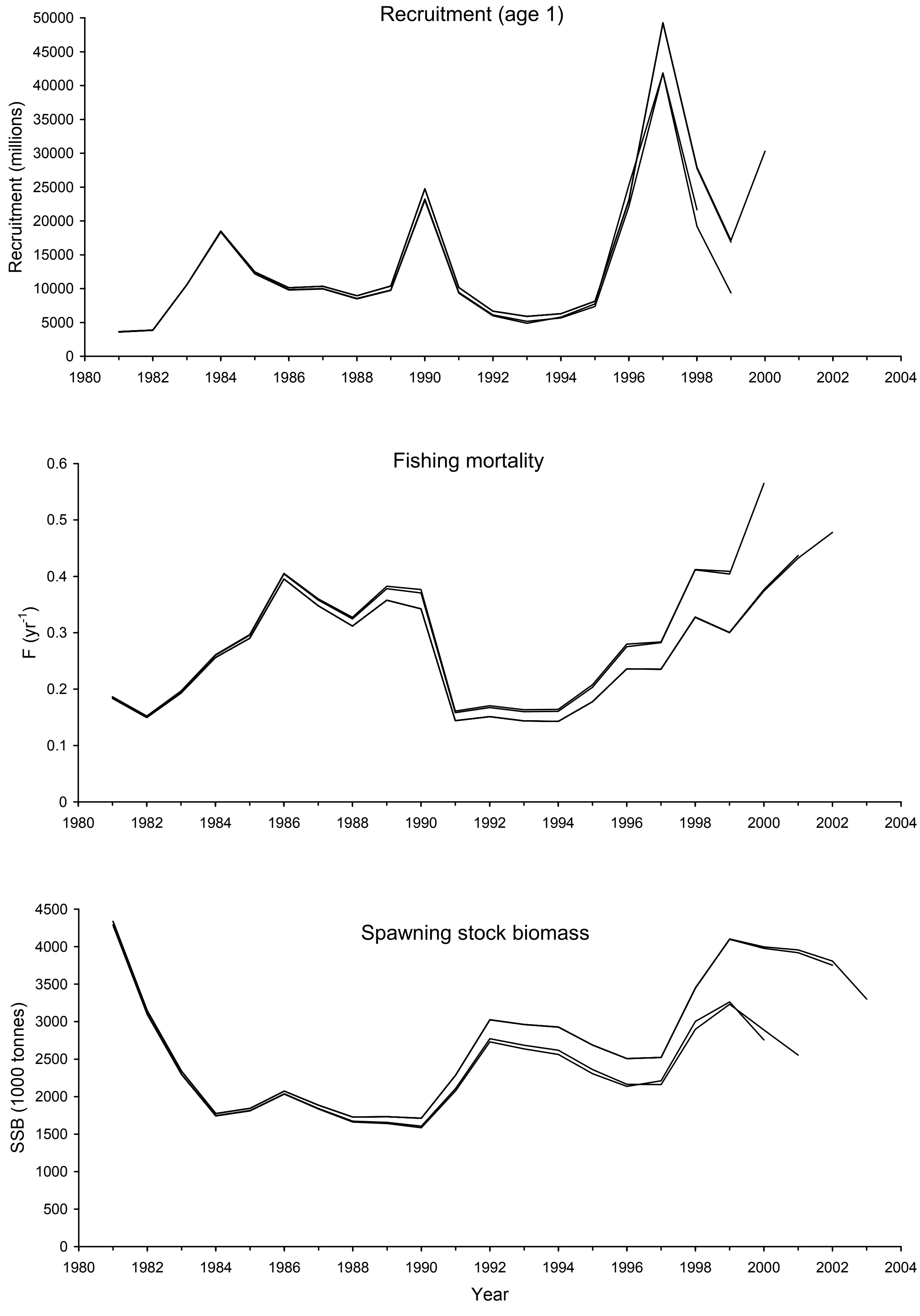


Figure 6.4.5.1.6. Retrospective AMCI runs with terminal year set to 2000-2003.

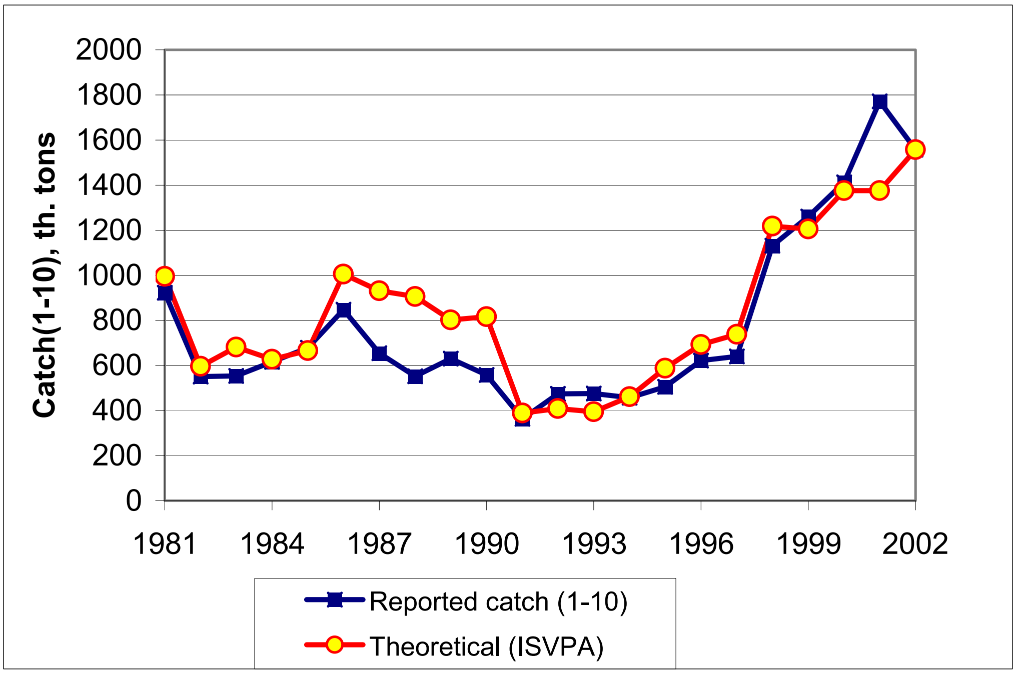


Figure 6.4.5.2.1
Blue whiting.
Comparison of reported and theoretical catches (ISVPA)

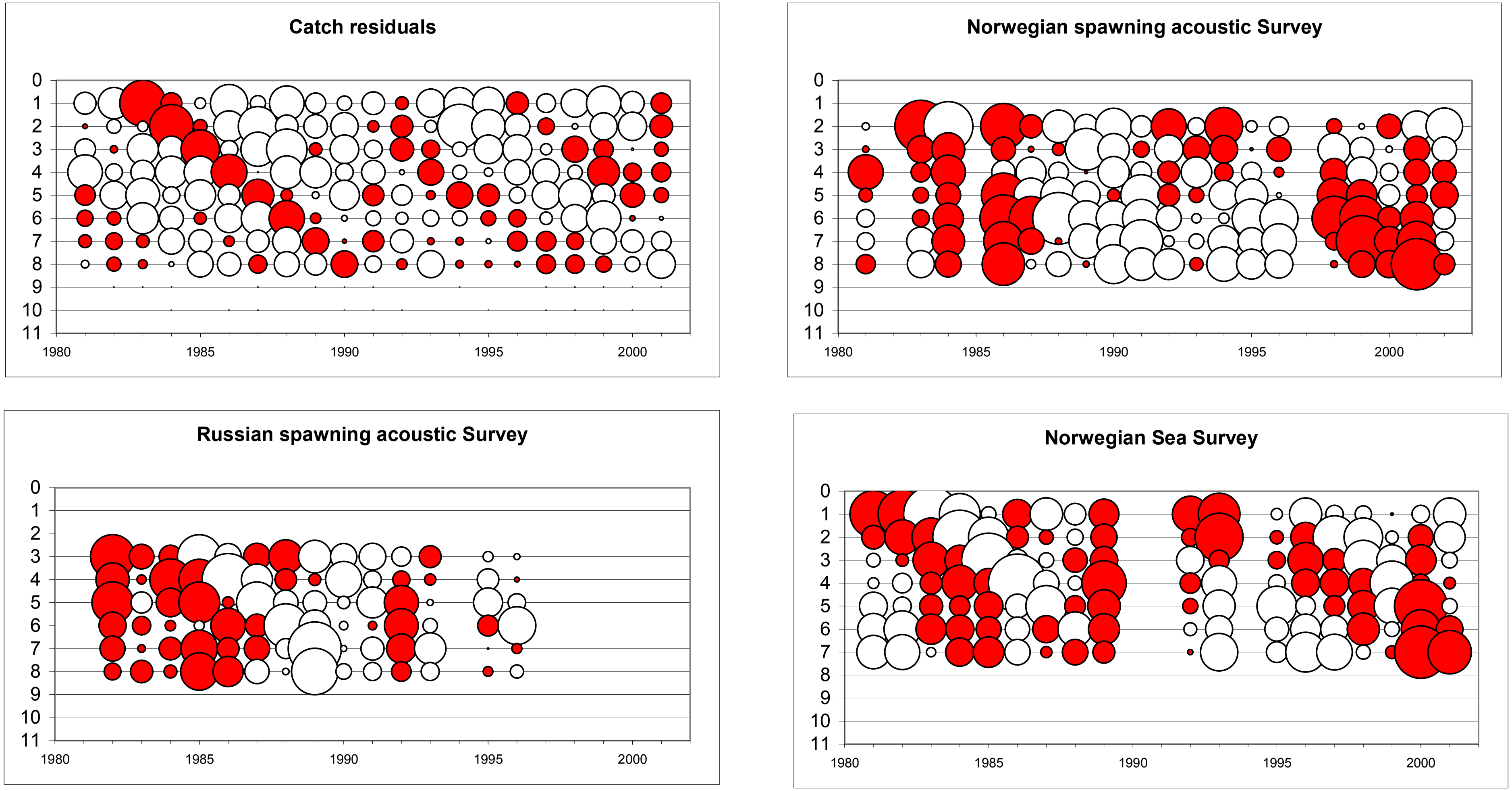


Figure 6.4.5.2.2
Blue whiting, ISVPA. Residuals for catch-at-age and surveys

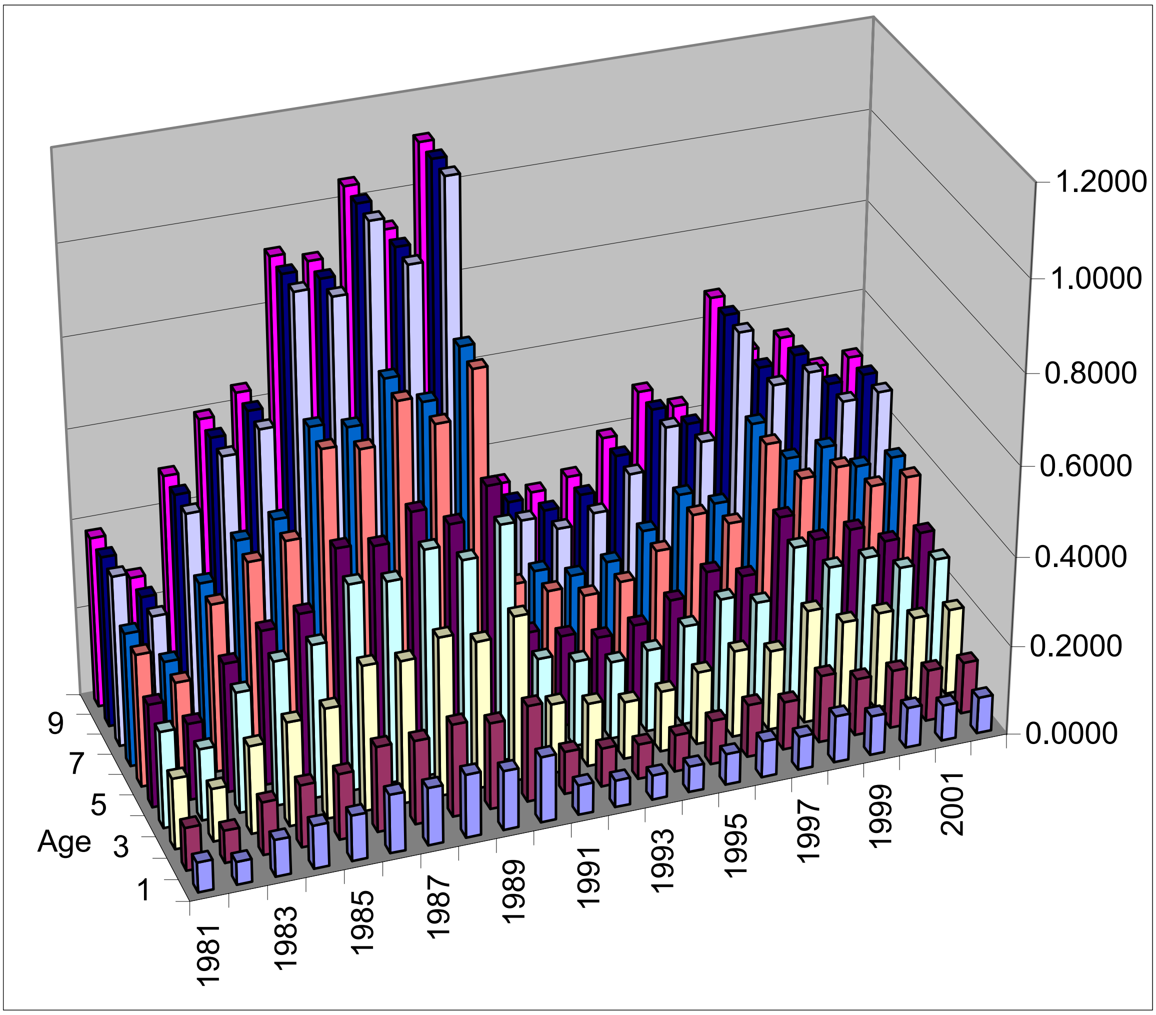


Figure 6.4.5.2.3
Blue whiting. ISVPA- derived estimates of F(a,y)

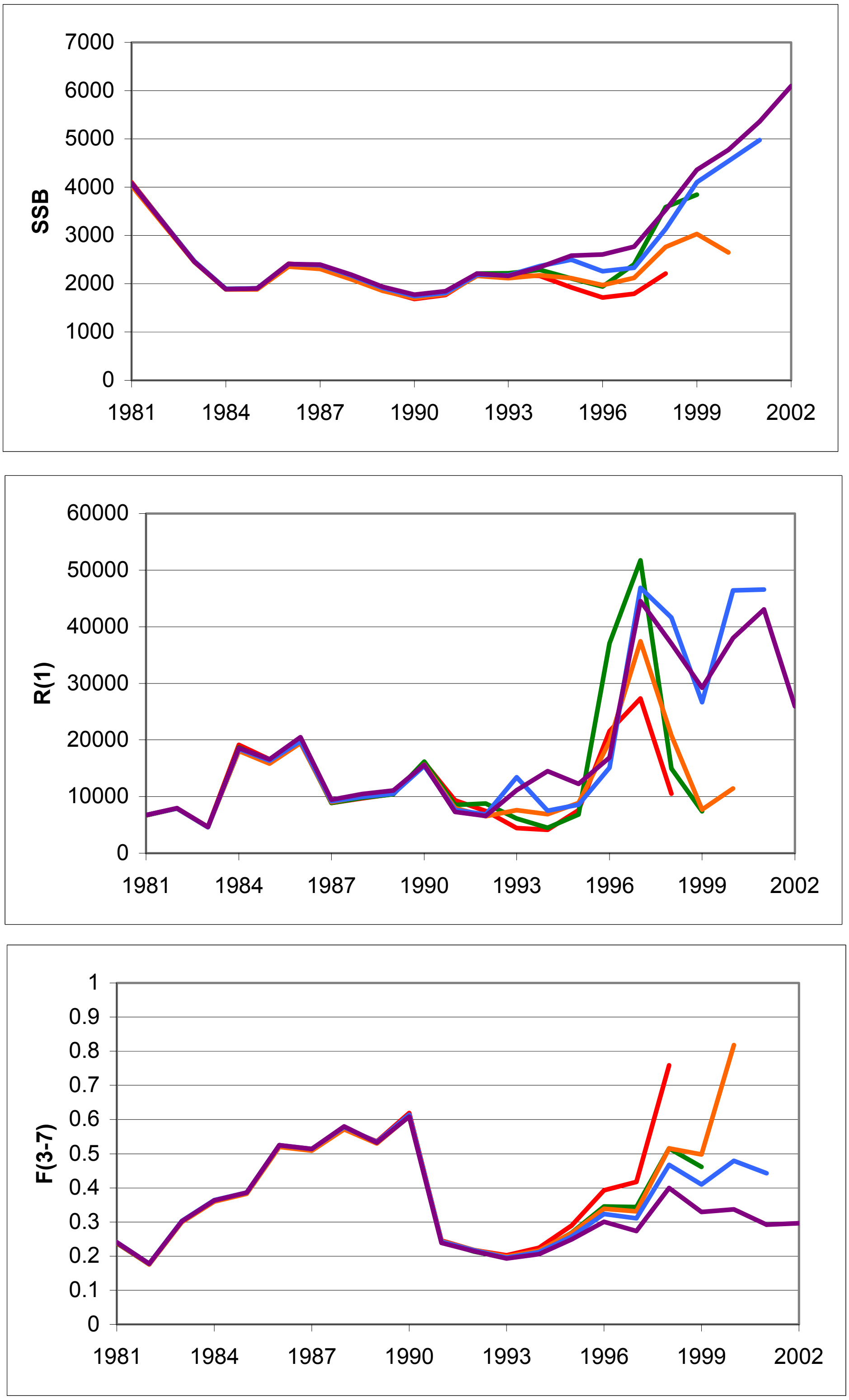


Figure 6.4.5.2.4
Blue whiting, ISVPA, retrospective runs, same options as in 2003

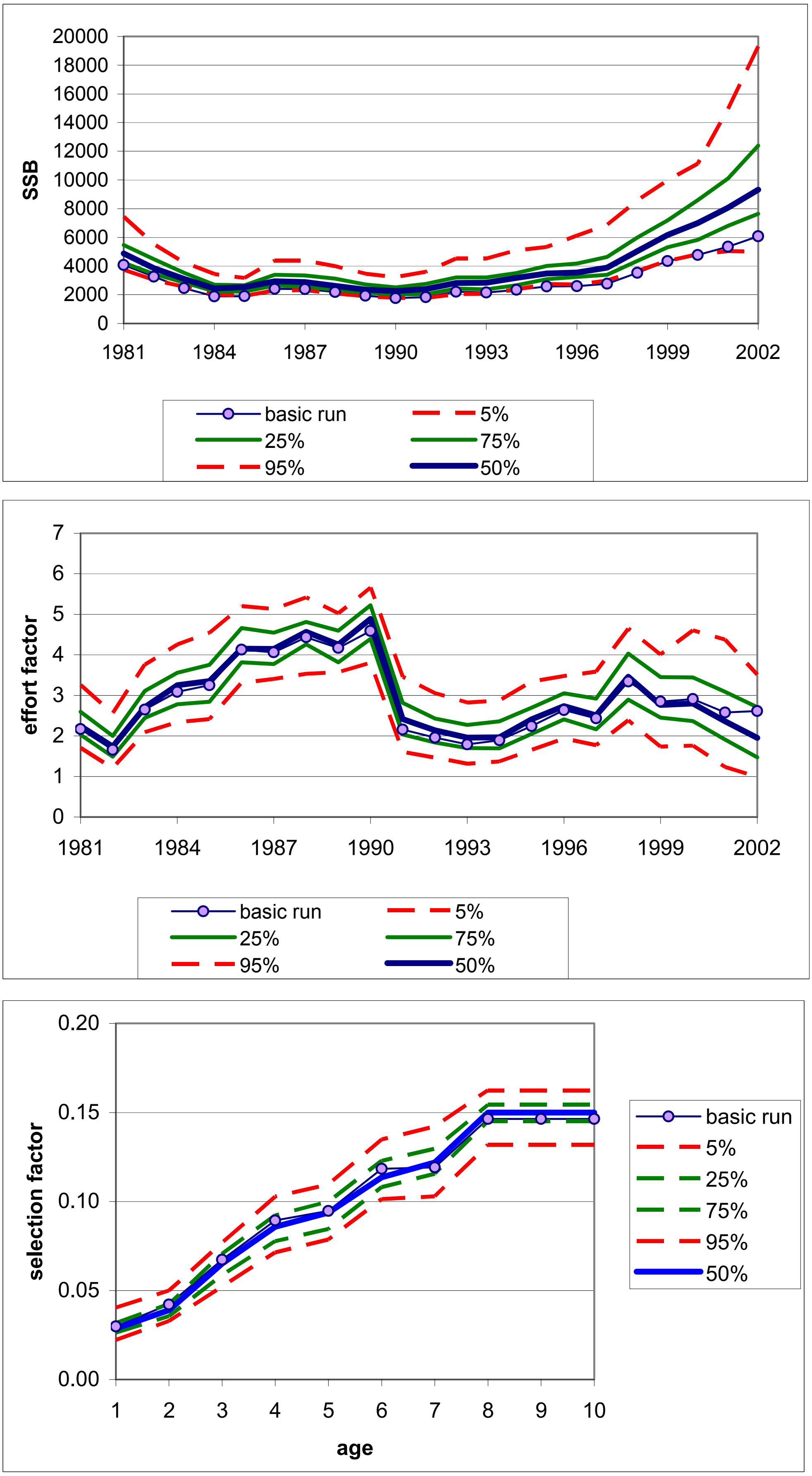


Figure 6.4.5.2.5
Blue whiting. ISVPA. Boostrap

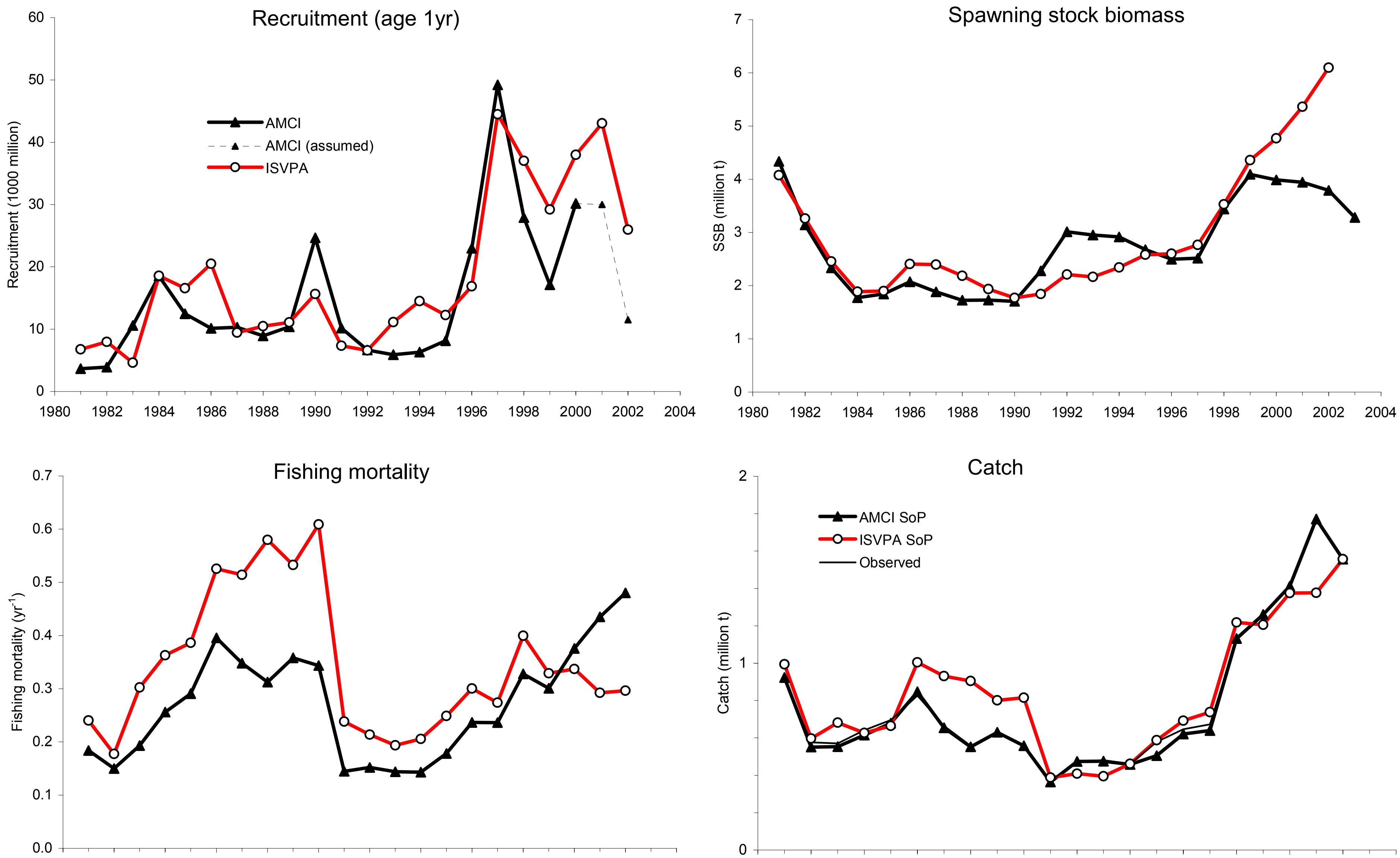
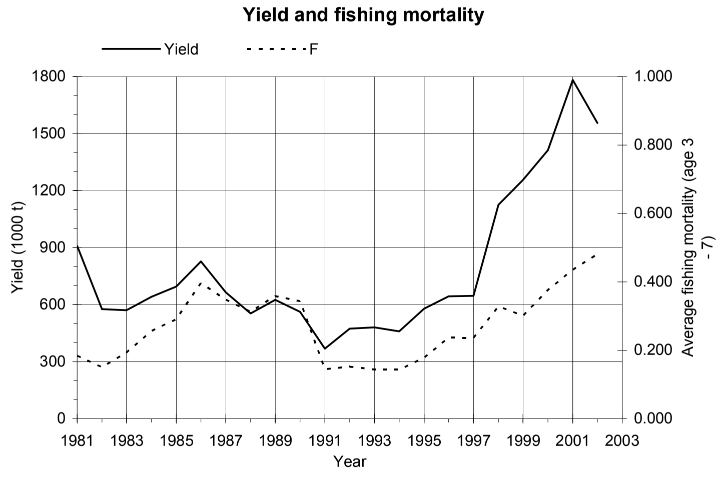
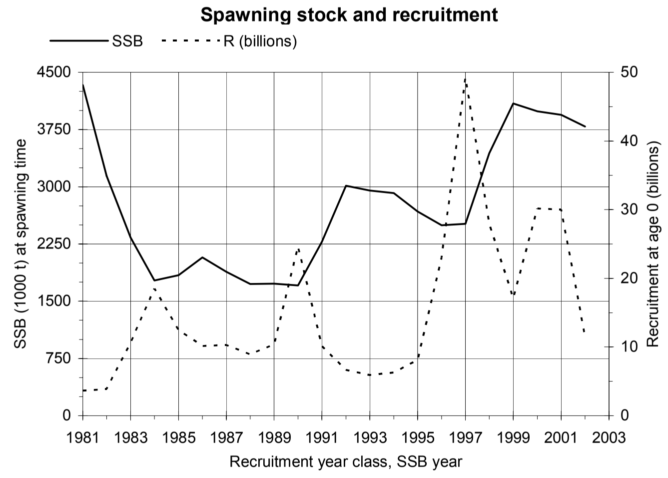


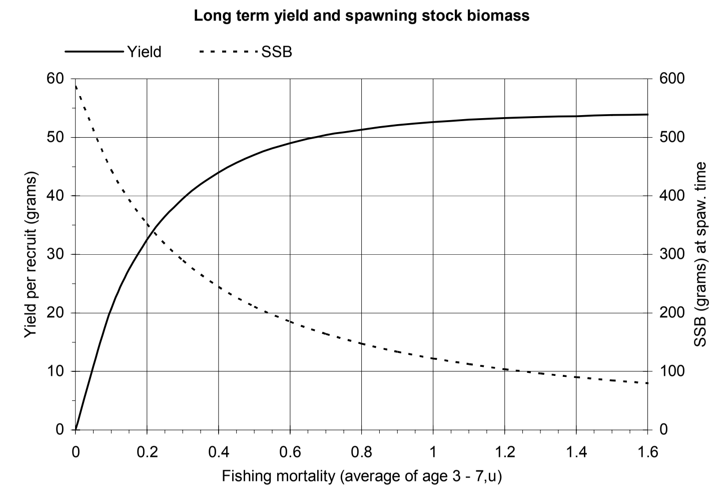
Figure 6.4.5.3.1. Comparisons between final AMCI and ISVPA blue whiting assessments.



(run: Amci 20030504 11:51:22) **A**

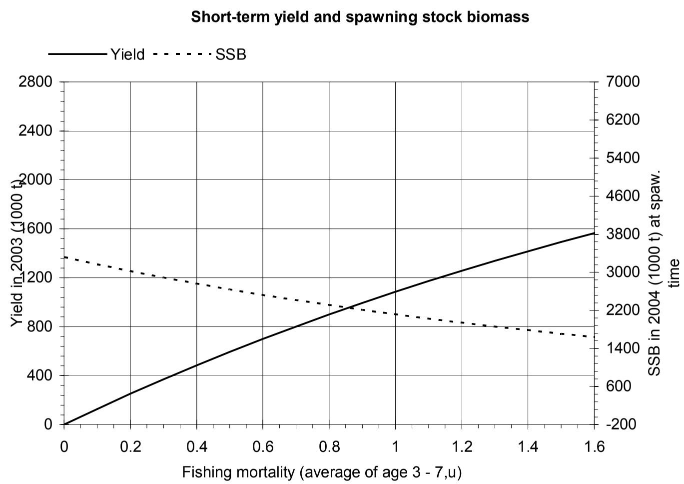


(run: Amci 20030504 11:51:22) **B**



C

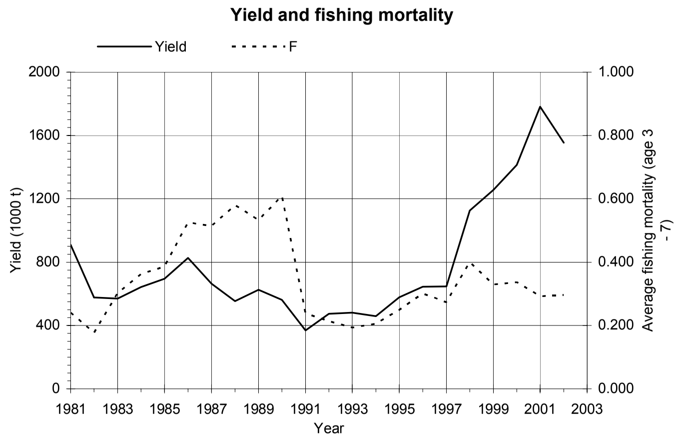
(Run: AMCI based Yield per rec BW 2003)



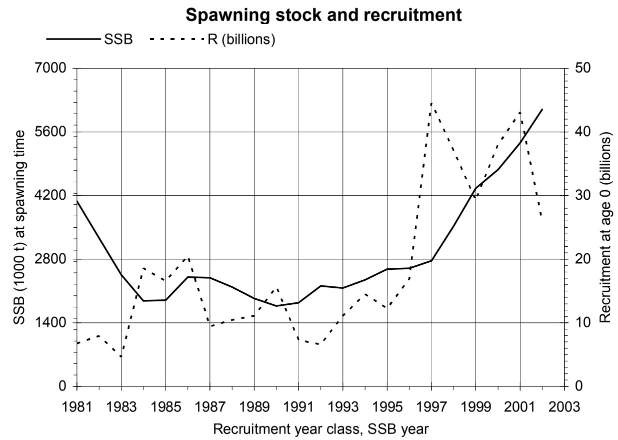
D

(Run: AMCI based Short term pred BW 2003)

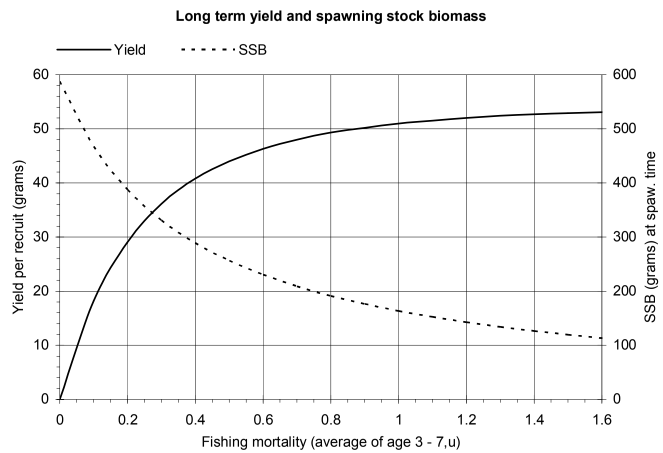
Figure 6.5.1. Blue Whiting. Standard plots from the short-term projection.



(run: ISVPA) **A**

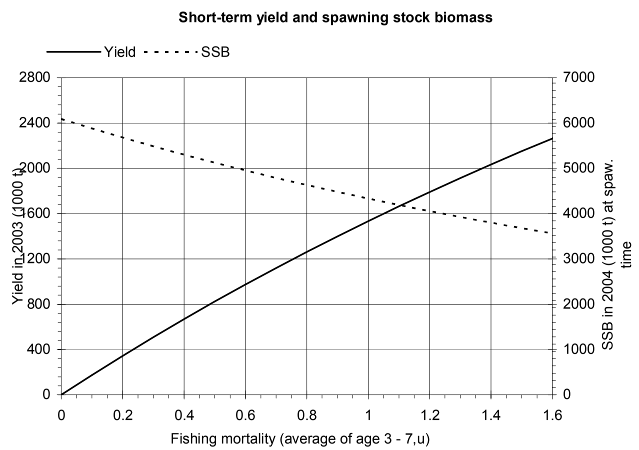


(run: ISVPA) **B**



C

(run: ISVPA based Yield per rec BW 2003)



D

(run: ISVPA based Short term pred BW 2003)

Figure 6.5.2. Blue Whiting. Standard plots from the short-term projection based on ISVPA assessment.

Blue whiting
ISVPA, effort-controlled, restriction of sero sums for residuals in separable representation of F
minimization of SSE for catch-at-age and age-structured indexes.(Spanish excluded)
SSE from catch-at-age and all age-structured indexes are taken with equal weights

7 ICELANDIC SUMMER-SPAWNING HERRING

7.1 The fishery

The catches of Icelandic summer-spawning herring from 1982 - 2002 are given in Tables 7.1.1 and 7.1.2. Discards were estimated at less than 1 000 tonnes for the 2002/2003 season. The fishery started in September off east Iceland and will terminate at the end of April. The catch in September to mid-April was 88 000 tonnes, but additional catch of a few hundred tonnes may be expected until the end of the season. The catch was taken with traditional purse-seines and pelagic trawls. The purse-seine fishery took place off both the east and west coast of Iceland in September through November and only minor purse-seine catches were taken later in the season. The pelagic trawl fishery started in October and the main fishery took place to the west of Iceland throughout the season. Because small herring was frequently present in the catches, especially at SE- and SW-Iceland, area closure was common during the 2002/2003 season.

A total of about 62 000 tonnes were fished in the west of Iceland and about 25 000 tonnes in the east. In the 1997/98 season 59% of the catch was taken by purse-seines, 78% in 1998/99, 61% in 1999/2000, 72% in 2000/2001 and only 38% in 2001/2002. In the 2002/2003 season the trend of decreasing purse-seine catches continued with only 35% of the catches taken by purse-seine, the remainder by pelagic trawl.

The proportion used for reduction to meal and oil was 29% in 1997/98 and increased to 72% in 1998/99. This decreased again to 69% in 1999/2000, to 64% in 2000/2001. Only 12% of the catch taken in the 2001/2002 season was reduced to meal and oil, but this increased again in the 2002/2003 season to about 39%. The remainder was either salted or frozen for human consumption.

Until 1990, the herring fishery took place during the last three months of the calendar year, but from 1990-2002 the autumn fishery has continued in January and early February of the following year. In 2003 the season was further extended to the end of April and in the summer of 2002 an experimental fishery for spawning herring with a catch of 5 000 t was conducted at the south coast. In 1994 the fishery started in September. Therefore, all references to the years 1990-1993 imply seasons starting in October of that year, but after that in September. Landings, catches and recommended TACs since 1984 are given in thousand tonnes in Table 7.1.1.

7.2 Catch in numbers, weight-at-age and maturity

The catches of the Icelandic summer spawners in numbers-at-age for the period 1982- 2002 are given in Table 7.1.2. Like last year age is now given as real age instead of rings, as in earlier WG reports.

During the 1995/96 - 1997/98 seasons, catches were mainly distributed on the 4 year classes from 1988–1991. On the other hand, catches during the 1998/99 and 1999/2000 seasons were dominated by the strong 1994 year class. In 2000/2001 the very strong 1994 and 1996 year classes were most abundant in the catch, but in 2001/2002 the 1996 year class was the most abundant. In 2002/2003 the 1998 and 1999 year classes were the most common in the catch followed by the 1996 and 1994 year classes.

The weight-at-age for each year is given in Table 7.2.1. As in previous years the weight-at-age in the next year (2003) is derived by a regression, whereas the mean weight in the previous year has been used to predict the weight-at-age for ages 3–9, using as input the weight-at-ages 2–8 in the year before. Data for the regression included the period 1992–2002 as starting years. For one-year-old herring and 10+, a simple average of mean weights-at-age for the period 1998–2002 was used for the prediction. Weights-at-age for ages 2–8 in the catch were obtained using the relationship:

$$W_{y+1} - W_y = -0.2284 * W_y + 94.7855 \text{ (g)}$$

where W_y and W_{y+1} are the mean weight of the same year class in year y and y+1, respectively.

The proportion mature-at-age is given in Table 7.2.2.

7.3 Acoustic surveys

The Icelandic summer-spawning herring stock has been monitored by annual acoustic surveys since 1973, Table 7.3.1. These surveys have been conducted in October-December or January. The 2002 survey started on the 24 November at the east coast of Iceland. On the traditional fishing grounds off the east coast the survey recorded only about 80 000 t, while 180 000 t were located in this region in 2001. West off Iceland very little adult herring was recorded during this cruise, but the immature 1999 year classes were widely distributed. The estimate of the adult component was much less than expected and consequently a new survey, solely directed towards adult herring, was conducted to the west of Iceland in the first half of February 2003. During this survey a total of 385 000 tonnes of adult herring were recorded so the sum of the estimated size of the adult stock was about 460 000 t, which is somewhat less than expected (Gudmundsdottir, WD).

The 2002/2003 acoustic assessment surveys confirmed that the 1999 year class is large (Table 7.3.1).

The sum of results obtained in winter 2002/2003 acoustic surveys have been used as the basis for the present assessment of age 5 (age 6 on 1 January) and older herring (Table 7.3.1).

Jakobsson *et al.* (1993) formally tested whether it was feasible to maintain a one-to-one relationship between acoustic and VPA estimates of stock size. It was found that a modification of the target strength, from TS=21.7 log(L) - 75.5 dB to TS=20 log(L)-72 dB, gave a much better fit between the two data sets. The resulting target strength TS = 20 log(L) - 72 dB was used to recalculate historic acoustic stock assessments. The latter target strength has been the basis of calculations of stock abundance from acoustic survey data since 1993.

7.4 Stock assessment

7.4.1 ADAPT-type of VPA

Using the results from the acoustic survey and the catch in numbers, a first estimate of F was made. In this analysis, herring at age 6 (on 1 Jan 2003) and older have been grouped for estimating the fishing mortality for the oldest herring. For F on the oldest age group, an average F for ages 7-14 was used. The resulting ADAPT-type run gave an F of 0.16. The relationship between the VPA estimates and the acoustic estimates is shown in Figure 7.4.1.1.

A retrospective plot (Figure 7.4.1.2) shows that the terminal F values have been underestimated in the last 5 years. Therefore, like last year, the terminal F this year was increased by 19%, which is the mean underestimate in the last 5 years, resulting in an F of 0.19.

According to this assessment with the raised F of 0.19, the spawning stock biomass was about 470 000 t on 1 July 2002, which is about 80 000 t lower than the estimate from last year.

7.4.2 AMCI assessment

The assessment program AMCI22 (Section 1.3.2) was also used. The objective function was a sum of the following partial objective function:

Log sum of squares of catches-at-age, weight 1

Log sum of squares of yearly yields, weight 1

Log sum of squares for the acoustic survey indices-at-age, weight 1

Different runs of AMCI were made with the following assumptions: As the icelandic summer-spawning herring is managed at a level close to 0.22, then the fishing mortality in 2003 was assumed to be 0.22 and the recruitment 650 millions, which is close to the long-term geometric mean of 2-year-old recruiting herring. The yearly fishing mortality was split on quarters, assuming 0.05 in the third quarter of the year and 0.95 in the fourth quarter. Natural mortality of 0.1 was assumed.

In the first run, which was an imitation of the ADAPT-type of VPA and should be regarded as an exploratory run the selectivity was estimated for the first year, and in the last year the selectivity was fixed at 1 for ages 5 and older. The gainfactor was set at 1 (VPA type of run) for all ages and years between the first and the last year. In the survey fleet ages 5 to 14 were used at the survey time (age 6 to 15 at 1st of January the year after) with selection equal to 1 for all ages. By looking at the residuals in the catch and the observed vs. the modelled catch it is clear that there are two periods in the model. It fits quite well after 1992, but before the model assumes lesser catch. The ADAPT-type of VPA gave a terminal F of 0.16 and the AMCI model gives the terminal F of 0.23, which is more in line with what is seen from the catch curves.

As AMCI is a forward-running model it seemed a natural next step to start running it from the first year where the selectivity was estimated and the selectivity pattern was allowed to change gradually for ages and years. The gainfactor was set to 0.5 for ages 2 and 3 and 0.2 for ages 4 and older. The selection in the survey fleet was estimated the first year, but kept constant after that. The age groups 1 to 14 were used in the survey fleet. By looking at the residuals big blocks both positive and negative were seen. These fitted with the time when big year classes were entering the fishery. Therefore several runs were made with different separable periods. The best run was obtained with four periods starting at 1981, 1983, 1986 and 1991. In Figure 7.4.2.1 a residual plot is shown both for the catches and the survey. A plot of the observed and modelled yield is also shown. A survey biomass index, both observed and modelled, was computed by using age groups 4 to 11 in the survey as they are in the fishable stock. The model fits the trends in the survey biomass estimate, except for the last year where the influence of the very strong 1999 year class is dominating. A retrospective run was also made and is shown in Figure 7.4.2.2. By comparing the retrospective plot from the ADAPT-type of VPA (Figure 7.4.1.2) and the retrospective plot from AMCI it can be seen that the AMCI model is more consistent for the last years. The working group decided to choose the AMCI assessment for the Icelandic summer-spawning herring this year. Fishing mortalities, stock numbers and a summary table are shown in Tables 7.4.1.1, 7.4.1.2 and 7.4.1.3.

According to this assessment the spawning stock biomass was about 475 000 t at spawning time 2002, which is the same as derived by the ADAPT-type of VPA. The annual unweighted fishing mortality, F 5-15, amounted to 0.245, which corresponds to a weighted F of 0.22.

7.4.3 Comments to the assessment

Last year the assessment program ISVPA (Section 1.3.6) was also run. Due to time constraint it was not done this year.

At the last minute it was discovered that the residuals derived from the AMCI models showed a cyclic pattern, which could possibly mean some time trend in the model. It was decided to accept the assessment and to look closer into this pattern at a later time.

The AMCI model allows year-class multipliers to model targeted specific year classes. This feature should be explored further as the fishery of the Icelandic summer-spawning herring has been targeting the big year classes. This could not be done at the WG meeting because of lack of time.

7.5 Management consideration

During the last 20 years the Icelandic summer-spawning herring stock has been managed at levels corresponding fairly closely to fishing at $\mathbf{F}_{0.1}$. To derive the expected yield in the next years AMCI was run until 2004. The same selection was assumed as last year. According to the AMCI assessment, a catch of 108 000 t in 2003 would exploit the stock at a fishing mortality level of a weighted F of 0.22. The spawning stock biomass in 2003 is expected to be about 525 000 t .

7.6 Comments on the PA reference points

The Working Group points out that managing this stock at an exploitation rate at or near $\mathbf{F}_{0.1}$ has been successful in the past. Thus the Working Group agreed in 1998 with the SGPAFM on using $\mathbf{F}_{pa}= \mathbf{F}_{0.1}= 0.22$, $\mathbf{B}_{pa}= \mathbf{B}_{lim} * e^{1.645\sigma}= 300\ 000$ t where $\mathbf{B}_{lim}= 200\ 000$ t. The Study Group on Precautionary Reference Points for Advice on Fishery Management met in February this year and concluded that it was not considered relevant to change the $\mathbf{B}_{lim}$ from 200 000 t. The present working group agrees with this conclusion.

Table 7.1.1 Icelandic summer spawners. Landings, catches and recommended TACs in thousand tonnes.

Year	Landings	Catches	Recommended TACs
1984	50.3	50.3	50.0
1985	49.1	49.1	50.0
1986	65.5	65.5	65.0
1987	73.0	73.0	70.0
1988	92.8	92.8	100.0
1989	97.3	101.0	90.0
1990/1991	101.6	105.1	90.0
1991/1992	98.5	109.5	79.0
1992/1993	106.7	108.5	86.0
1993/1994	101.5	102.7	90.0
1994/1995	132.0	134.0	120.0
1995/1996	125.0	125.9	110.0
1996/1997	95.9	95.9	100.0
1997/1998	64.7	64.7	100.0
1998/1999	87.0	87.0	90.0
1999/2000	92.9	92.9	100.0
2000/2001	100.3	100.3	110.0
2001/2002	95.3	95.3	125.0
2002/2003*	92.7	93.6	105.0

*Preliminary

Table 7.1.2 Icelandic summer spawners. Catch in numbers (millions) and total catch in weight (thous. tonnes). 1982 refers to season 1982/1983.

Age/Year	1982	1983	1984	1985	1986	1987	1988
2	0.454	1.475	0.421	0.112	0.100	0.029	0.879
3	19.187	22.499	18.015	12.872	8.172	3.144	4.757
4	28.109	151.718	32.244	24.659	33.938	44.590	41.331
5	38.280	30.285	141.354	21.656	23.452	60.285	99.366
6	16.623	21.599	17.043	85.210	20.681	20.622	69.331
7	38.308	8.667	7.113	11.903	77.629	19.751	22.955
8	43.770	14.065	3.916	5.740	18.252	46.240	20.131
9	6.813	13.713	4.113	2.336	10.986	15.232	32.201
10	6.633	3.728	4.517	4.363	8.594	13.963	12.349
11	10.457	2.381	1.828	4.053	9.675	10.179	10.250
12	2.354	3.436	0.202	2.773	7.183	13.216	7.378
13	0.594	0.554	0.255	0.975	3.682	6.224	7.284
14	0.075	0.100	0.260	0.480	2.918	4.723	4.807
15	0.211	0.003	0.003	0.581	1.788	2.280	1.957
Catch	56.528	58.867	50.304	49.368	65.500	75.439	92.828

Age/year	1989	1990	1991	1992	1993	1994	1995
2	3.974	11.009	35.869	12.006	0.869	6.225	7.411
3	22.628	14.345	92.758	79.782	35.560	110.079	26.221
4	26.649	57.024	51.047	131.543	170.106	99.377	159.170
5	77.824	34.347	87.606	43.787	87.363	150.310	86.940
6	188.654	77.819	33.436	56.083	25.146	90.824	105.542
7	43.114	152.236	54.840	41.932	28.802	23.926	74.326
8	8.116	32.265	109.418	36.224	18.306	20.809	20.076
9	5.897	8.713	9.251	44.765	24.268	19.164	13.797
10	7.292	4.432	3.796	9.244	14.318	17.973	8.873
11	4.780	4.287	2.634	2.259	3.639	16.222	9.140
12	3.449	2.517	1.826	0.582	0.878	2.955	7.079
13	1.410	1.226	0.516	0.305	0.300	1.433	2.376
14	0.844	1.019	0.262	0.203	0.200	0.345	0.927
15	0.348	0.610	0.298	0.102	0.100	0.345	0.124
Catch	101.000	105.097	109.489	108.504	102.741	134.003	125.851

Age/Year	1996	1997	1998	1999	2000	2001	2002
2	1.100	9.323	16.161	0.629	7.958	10.206	14.149
3	18.723	27.072	37.787	43.537	52.921	23.944	70.982
4	45.304	28.397	151.853	65.871	131.153	76.666	78.395
5	92.948	29.451	42.833	145.127	44.334	107.849	43.905
6	69.878	42.267	19.872	24.653	102.925	46.646	57.266
7	86.261	35.285	30.280	20.614	10.962	51.585	21.433
8	37.447	28.506	22.572	25.853	9.312	18.504	42.272
9	13.207	21.828	32.779	21.163	17.218	11.356	9.668
10	6.854	8.160	14.366	14.436	9.471	7.933	4.632
11	4.012	3.815	4.802	6.973	7.610	8.547	6.429
12	1.672	1.696	2.199	2.164	1.930	5.090	7.839
13	4.179	6.570	1.084	2.426	5.199	4.346	9.738
14	1.672	1.378	5.081	0.473	0.552	1.611	4.478
15	0.100	1.802	3.036	0.961	0.166	0.864	4.537
Catch	95.882	64.682	86.998	92.896	100.332	95.278	93.601

Table 7.2.1 Icelandic summer spawners. Weight at age (g).

Age/Year	1983	1984	1985	1986	1987	1988	1989
2	59	49	53	60	60	75	63
3	132	131	146	140	168	157	130
4	180	189	219	200	200	221	206
5	218	217	266	252	240	239	246
6	260	245	285	282	278	271	261
7	309	277	315	298	304	298	290
8	329	315	335	320	325	319	331
9	356	322	365	334	339	334	338
10	370	351	388	373	356	354	352
11	407	334	400	380	378	352	369
12	437	362	453	394	400	371	389
13	459	446	469	408	404	390	380
14	430	417	433	405	424	408	434
15	472	392	447	439	430	437	409

Age/Year	1990	1991	1992	1993	1994	1995	1996
63	75	74	63	74	67	69	78
144	119	139	144	150	135	129	140
190	198	188	190	212	204	178	166
232	244	228	232	245	249	236	208
276	273	267	276	288	269	276	258
317	286	292	317	330	302	292	294
334	309	303	334	358	336	314	312
346	329	325	346	373	368	349	324
364	351	343	364	387	379	374	360
392	369	348	392	401	398	381	349
444	387	369	444	425	387	400	388
399	422	388	399	387	421	409	403
419	408	404	419	414	402	438	385
428	436	396	428	420	390	469	420

Age/Year	1997	1998	1999	2000	2001	2002	2003*
2	62	78	64	58	78	80	70
3	137	147	143	158	140	149	156
4	197	184	211	214	217	202	210
5	234	213	236	256	242	245	250
6	270	246	268	284	281	275	284
7	299	286	300	326	294	311	307
8	323	314	318	333	309	325	335
9	342	341	349	366	339	347	345
10	358	351	347	383	350	383	367
11	363	354	377	402	367	390	379
12	373	350	359	405	375	402	392
13	412	372	403	422	403	442	407
14	394	400	408	406	426	463	414
15	429	437	445	444	425	453	433

* Predicted

Table 7.2.2 Icelandic summer spawners. Proportion mature-at-age.

Age/Year	1983	1984	1985	1986	1987	1988	1989
2	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3	0.000	0.010	0.000	0.030	0.010	0.045	0.060
4	0.640	0.820	0.900	0.890	0.870	0.900	0.930
5	1.000	1.000	1.000	1.000	1.000	1.000	1.000
6	1.000	1.000	1.000	1.000	1.000	1.000	1.000
7	1.000	1.000	1.000	1.000	1.000	1.000	1.000
8	1.000	1.000	1.000	1.000	1.000	1.000	1.000
9	1.000	1.000	1.000	1.000	1.000	1.000	1.000
10	1.000	1.000	1.000	1.000	1.000	1.000	1.000
11	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
13	1.000	1.000	1.000	1.000	1.000	1.000	1.000
14	1.000	1.000	1.000	1.000	1.000	1.000	1.000
15	1.000	1.000	1.000	1.000	1.000	1.000	1.000

Age/Year	1990	1991	1992	1993	1994	1995	1996
2	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3	0.000	0.013	0.020	0.049	0.054	0.157	0.049
4	0.780	0.720	0.930	0.999	1.000	0.982	0.990
5	1.000	1.000	1.000	1.000	0.992	0.998	1.000
6	1.000	1.000	1.000	1.000	1.000	1.000	1.000
7	1.000	1.000	1.000	1.000	1.000	1.000	1.000
8	1.000	1.000	1.000	1.000	1.000	1.000	1.000
9	1.000	1.000	1.000	1.000	1.000	1.000	1.000
10	1.000	1.000	1.000	1.000	1.000	1.000	1.000
11	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
13	1.000	1.000	1.000	1.000	1.000	1.000	1.000
14	1.000	1.000	1.000	1.000	1.000	1.000	1.000
15	1.000	1.000	1.000	1.000	1.000	1.000	1.000

Age/Year	1997	1998	1999	2000	2001	2002	2003*
2	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3	0.160	0.265	0.074	0.279	0.101	0.190	0.190
4	0.925	0.935	0.879	0.831	0.981	0.734	0.849
5	0.989	0.995	0.977	0.992	0.997	0.898	0.962
6	1.000	1.000	1.000	1.000	1.000	1.000	1.000
7	1.000	1.000	1.000	1.000	1.000	1.000	1.000
8	1.000	1.000	1.000	1.000	1.000	1.000	1.000
9	1.000	1.000	1.000	1.000	1.000	1.000	1.000
10	1.000	1.000	1.000	1.000	1.000	1.000	1.000
11	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
13	1.000	1.000	1.000	1.000	1.000	1.000	1.000
14	1.000	1.000	1.000	1.000	1.000	1.000	1.000
15	1.000	1.000	1.000	1.000	1.000	1.000	1.000

* Predicted (mean of 2000-2002)

Table 7.3.1 Acoustic estimates (in millions) of the Icelandic summer spawning herring, 1974-2003. The surveys are conducted in October-December or January. The year given is the following year, i.e. if the survey is conducted in the season 1973/1974, then 1974 is given.

	Ages														
Year	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	6+
1974	-1	154	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
1975	-1	5	137	19	21	2	2	-1	-1	-1	-1	-1	-1	-1	-1	25
1976	-1	136	20	133	17	10	3	3	-1	-1	-1	-1	-1	-1	-1	33
1977	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
1978	-1	212	424	46	19	139	18	18	10	-1	-1	-1	-1	-1	-1	204
1979	-1	158	334	215	49	20	111	30	30	20	-1	-1	-1	-1	-1	260
1980	-1	19	177	360	253	51	41	93	10	-1	-1	-1	-1	-1	-1	448
1981	625	361	462	85	170	182	33	29	58	10	-1	-1	-1	-1	-1	482
1982	-1	17	75	159	42	123	162	24	8	46	10	-1	-1	-1	-1	415
1983	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
1984	-1	171	310	724	80	39	15	27	26	10	5	12	-1	-1	-1	214
1985	-1	28	67	56	360	65	32	16	17	18	9	7	4	5	5	538
1986	201	652	208	110	86	425	67	41	17	27	26	16	6	6	1	718
1987	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
1988	406	126	352	836	287	53	37	76	25	21	14	17	8	6	3	547
1989	370	725	181	249	381	171	42	23	30	16	10	9	5	3	2	692
1990	-1	178	593	177	302	538	185	-1	-1	-1	18	-1	-1	-1	-1	1043
1991	710	805	227	304	137	176	387	40	10	2	-1	-1	-1	-1	-1	752
1992	465	745	850	353	273	94	81	210	32	11	-1	17	-1	-1	-1	718
1993	1418	254	858	687	160	99	87	44	92	39	-1	-1	-1	-1	-1	521
1994	183	234	533	860	443	55	69	43	86	55	2	-1	6	-1	-1	753
1995	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
1996	845	98	165	515	316	361	166	110	52	29	16	27	19	8	2	1105
1997	266	792	65	139	459	280	410	150	101	50	35	15	65	32	-1	1597
1998	1629	237	716	100	116	240	161	130	97	35	15	11	43	8	15	870
1999	-1	-1	188	790	240	101	73	47	77	47	10	10	-1	22	-1	627
2000	1069	527	740	296	606	99	71	164	108	98	15	44	5	13	7	1230
2001	2832	101	561	1069	323	609	30	31	38	13	18	6	9	4	1	1082
2002	561	942	247	187	265	173	302	69	48	55	54	16	18	1	-1	1001
2003	-1	1642	1800	549	221	257	159	273	97	44	43	13	32	2	-1	1141

Table 7.4.1.1 Icelandic summer spawners. Fishing mortality-at-age.

Run id 20030505 160344.463

Total yearly fishing mortalities at age

	1981	1982	1983	1984	1985	1986	1987	1988
2	0.0012	0.0018	0.0034	0.0017	0.0009	0.0002	0.0001	0.0008
3	0.0193	0.0294	0.0901	0.0725	0.0510	0.0074	0.0069	0.0112
4	0.0967	0.1470	0.2625	0.1868	0.1788	0.0660	0.0766	0.0927
5	0.1430	0.2341	0.3488	0.2868	0.2684	0.1267	0.1664	0.1951
6	0.1890	0.2739	0.3246	0.2205	0.2461	0.2103	0.2482	0.3142
7	0.2802	0.4137	0.1608	0.1134	0.1229	0.4196	0.4868	0.5568
8	0.1617	0.2848	0.1592	0.1085	0.1089	0.3761	0.4716	0.5974
9	0.0951	0.1456	0.1266	0.0865	0.0833	0.3455	0.4387	0.5637
10	0.1554	0.2256	0.1058	0.0746	0.0778	0.3129	0.4250	0.5675
11	0.0557	0.1072	0.0852	0.0604	0.0632	0.3262	0.4421	0.5984
12	0.0910	0.1330	0.0741	0.0437	0.0541	0.3021	0.4162	0.5771
13	0.0819	0.1194	0.0177	0.0114	0.0171	0.1942	0.2363	0.3379
14	0.0208	0.0305	0.0423	0.0312	0.0312	0.3381	0.4868	0.6037
15	0.1177	0.1726	0.0965	0.0551	0.0791	0.3268	0.4618	0.6667
Fref	0.1265	0.1946	0.1401	0.0993	0.1047	0.2981	0.3891	0.5071

Total yearly fishing mortalities at age

	1989	1990	1991	1992	1993	1994	1995	1996
2	0.0060	0.0093	0.0295	0.0212	0.0086	0.0159	0.0208	0.0092
3	0.0399	0.0390	0.1175	0.0922	0.0637	0.1377	0.1190	0.0860
4	0.0849	0.1056	0.2244	0.2029	0.1688	0.2357	0.2674	0.2229
5	0.1696	0.1777	0.3389	0.2771	0.2080	0.2946	0.2889	0.2540
6	0.2917	0.2981	0.3004	0.2810	0.2012	0.2918	0.2926	0.2544
7	0.4244	0.4539	0.3087	0.3149	0.2412	0.3214	0.3342	0.2912
8	0.4166	0.4365	0.4031	0.3408	0.2666	0.3610	0.3467	0.2851
9	0.4317	0.4407	0.2985	0.2888	0.2341	0.3675	0.3522	0.2892
10	0.4097	0.4353	0.2707	0.2500	0.1852	0.2749	0.2903	0.2337
11	0.5024	0.4686	0.2952	0.2553	0.1859	0.2681	0.2607	0.2157
12	0.4818	0.5057	0.1589	0.1382	0.1086	0.1593	0.1608	0.1178
13	0.2722	0.2864	0.2032	0.1509	0.1081	0.1769	0.1786	0.1426
14	0.4182	0.4955	0.1943	0.1749	0.1189	0.1928	0.2671	0.2545
15	0.4439	0.4548	0.2666	0.2197	0.1720	0.2649	0.2502	0.1926
Fref	0.3875	0.4048	0.2762	0.2447	0.1845	0.2703	0.2748	0.2301

Total yearly fishing mortalities at age

	1997	1998	1999	2000	2001	2002	2003	2004
2	0.0080	0.0123	0.0060	0.0135	0.0121	0.0134		
3	0.0434	0.0611	0.0563	0.0981	0.0836	0.0694		
4	0.1655	0.2024	0.1788	0.1752	0.1978	0.2119		
5	0.1921	0.2446	0.2283	0.1975	0.2177	0.2196		
6	0.1916	0.2252	0.2066	0.2087	0.2280	0.2281		
7	0.2183	0.2532	0.2331	0.1956	0.2061	0.2056		
8	0.2095	0.2437	0.2176	0.1907	0.2317	0.2352		
9	0.2189	0.2652	0.2367	0.2147	0.2418	0.2485		
10	0.1824	0.2198	0.1855	0.1649	0.1695	0.1726		
11	0.1618	0.1958	0.1641	0.1401	0.1568	0.1591		
12	0.0913	0.1117	0.1009	0.0815	0.0889	0.1044		
13	0.1231	0.1406	0.1312	0.1777	0.1815	0.1910		
14	0.1842	0.3039	0.2339	0.1865	0.2236	0.2530		
15	0.3967	0.5778	0.4673	0.3463	0.3887	0.6817		
Fref	0.1973	0.2529	0.2187	0.1913	0.2122	0.2454		

Table 7.4.1.2 Icelandic summer spawners. Stock size.

Run id 20030505 160344.463

Stocknumbers at age,
in area 1
Data by 1. Jan., except at youngest age which are
at recruitment time

	1981	1982	1983	1984	1985	1986	1987	1988
2	810369.3	287400.6	295933.8	511834.8	1266989.2	715406.2	346667.0	508785.6
3	266368.6	732404.1	259594.2	266857.2	462346.1	1145353.1	647220.8	313632.6
4	202021.4	236424.0	643514.4	214648.3	224578.3	397545.0	1028743.7	581600.8
5	125025.7	165947.5	184688.6	447836.3	161130.8	169936.3	336732.4	862227.8
6	193221.1	98058.3	118814.2	117907.9	304190.1	111477.1	135460.9	257972.0
7	200022.7	144719.3	67466.9	77708.1	85577.4	215189.3	81741.0	95626.1
8	72980.1	136767.2	86583.7	51981.1	62772.7	68477.7	127987.6	45456.4
9	56188.2	56177.3	93077.3	66811.1	42199.7	50936.9	42540.3	72262.7
10	83950.0	46228.6	43944.3	74207.3	55444.0	35131.5	32625.5	24823.5
11	30335.0	65029.3	33382.8	35769.3	62321.0	46414.1	23246.7	19299.7
12	8860.3	25961.2	52860.7	27740.3	30467.3	52938.3	30307.6	13518.9
13	8845.0	7319.6	20565.5	44413.7	24027.2	26115.2	35409.8	18087.1
14	9655.2	7374.2	5877.6	18281.9	39733.1	21372.7	19458.9	25296.1
15	1281.8	3898.0	3838.0	3354.9	7686.8	16781.3	10059.1	6731.5

Stocknumbers at age,
in area 1
Data by 1. Jan., except at youngest age which are
at recruitment time

	1989	1990	1991	1992	1993	1994	1995	1996
2	499134.8	1000886.5	1272302.9	805503.8	773099.3	343011.3	321626.5	1155551.2
3	459978.9	448951.4	897253.5	1117765.9	713569.0	693521.7	305472.0	285042.4
4	280636.9	399926.9	390674.2	721847.8	922276.4	605804.9	546817.6	245397.8
5	479643.7	233254.5	325616.6	282441.6	533195.3	704876.4	433035.9	378673.0
6	641908.2	366306.3	176699.6	209941.9	193719.7	391870.4	475051.8	293500.8
7	170484.5	433856.9	246016.6	118396.4	143423.6	143333.5	264846.7	320789.0
8	49583.0	100909.5	249331.3	163479.9	78188.8	101963.6	94042.8	171571.3
9	22631.0	29577.3	59009.9	150754.1	105206.9	54191.0	64301.5	60165.1
10	37210.0	13298.5	17223.4	39615.9	102190.5	75324.2	33953.9	40909.0
11	12734.0	22351.8	7786.3	11887.9	27916.6	76832.4	51777.2	22982.6
12	9599.2	6972.1	12657.6	5244.3	8332.7	20975.7	53173.7	36098.1
13	6868.7	5365.2	3804.6	9770.3	4132.8	6763.6	16184.6	40966.4
14	11673.6	4734.0	3645.6	2809.7	7602.5	3356.2	5127.5	12248.6
15	6359.5	4327.7	2071.4	1688.0	1366.3	2906.5	1838.6	1970.9

Stocknumbers at age,
in area 1
Data by 1. Jan., except at youngest age which are
at recruitment time

	1997	1998	1999	2000	2001	2002	2003
2	575372.8	991408.3	555279.4	480069.8	1135111.0	650000.0	650000.0
3	1036016.5	516492.6	886110.1	499440.7	428544.8	1014756.0	580341.2
4	236674.7	897644.3	439651.0	757905.3	409695.5	356659.1	856643.2
5	177683.9	181487.5	663394.5	332692.1	575592.7	304179.8	261082.3
6	265780.2	132670.0	128580.1	477724.9	247077.4	418909.4	220961.8
7	205920.3	198552.9	95843.1	94623.7	350856.7	177983.9	301740.0
8	216932.1	149777.4	139476.4	68690.0	70407.8	258338.6	131113.3
9	116728.3	159182.8	106209.2	101518.9	51361.0	50530.8	184756.6
10	40766.6	84857.9	110476.6	75845.9	74108.4	36493.2	35663.1
11	29300.4	30737.1	61632.1	83038.7	58192.8	56601.7	27785.7
12	16760.2	22552.6	22865.8	47326.5	65312.1	45015.2	43684.2
13	29032.0	13841.5	18250.1	18704.1	39470.0	54072.6	36693.2
14	32140.6	23226.7	10881.8	14482.6	14169.2	29786.1	40418.2
15	4091.5	10847.2	8544.7	5138.1	5758.4	5604.3	9550.7

Table 7.4.1.3 Icelandic summer spawners. Summary table.

Run id 20030505 160344.463

SUMMARY TABLE

Year	Recruits age 2	SSB	F 5 -15	Catch SOP
1981	810369	247370	0.1265	39461
1982	287400	252699	0.1946	56472
1983	295933	272744	0.1401	58694
1984	511834	272198	0.0993	50132
1985	1266989	299543	0.1047	49309
1986	715406	302255	0.2981	65361
1987	346666	404279	0.3891	75295
1988	508785	462069	0.5071	92711
1989	499134	414622	0.3875	100868
1990	1000886	375107	0.4048	104854
1991	1272302	333458	0.2762	109235
1992	805503	395523	0.2447	108275
1993	773099	521610	0.1845	102513
1994	343011	537876	0.2703	133753
1995	321626	490488	0.2748	125673
1996	1155551	392202	0.2301	95722
1997	575372	375075	0.1973	64261
1998	991408	434105	0.2529	86849
1999	555279	438873	0.2187	92735
2000	480069	525385	0.1913	100406
2001	1135111	498631	0.2122	95352
2002	650000	474513	0.2454	93673
2003	650000	526206	0.2454	0
2004*	650000	519056	0.2454	0

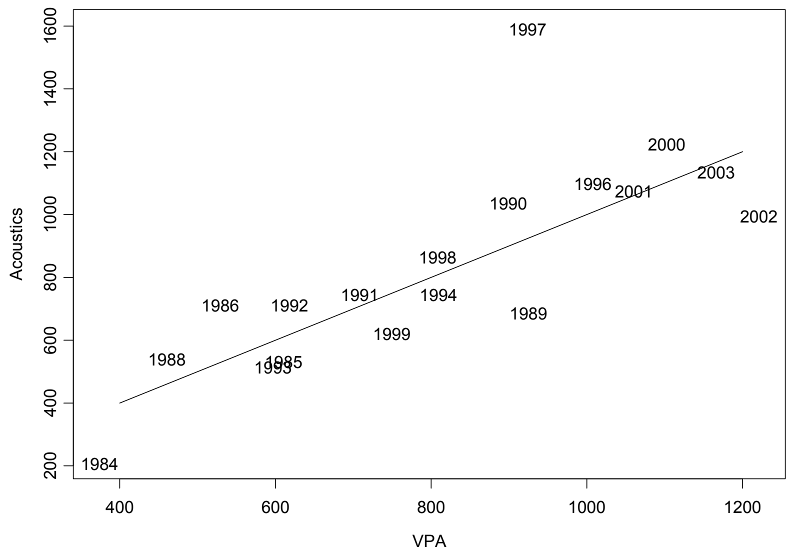


Figure 7.4.1.1 Icelandic summer spawners. Acoustics estimates vs VPA stock numbers (at the 1st of January)

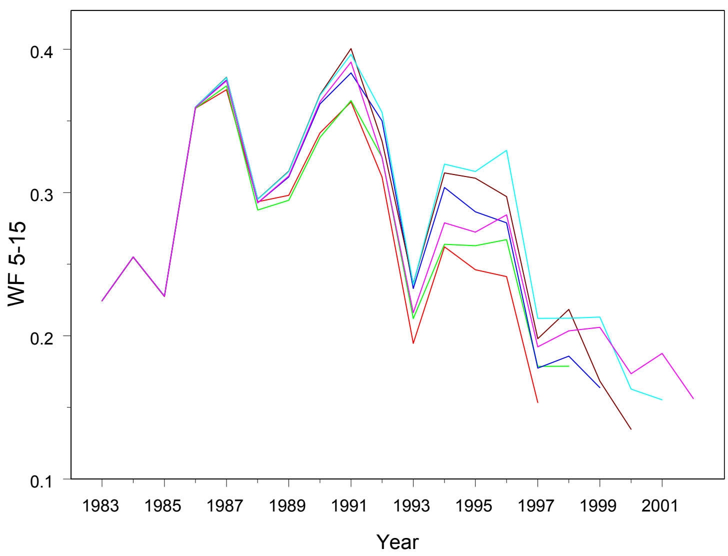


Figure 7.4.1.2 Retrospective plot for ADAPT-type of VPA.

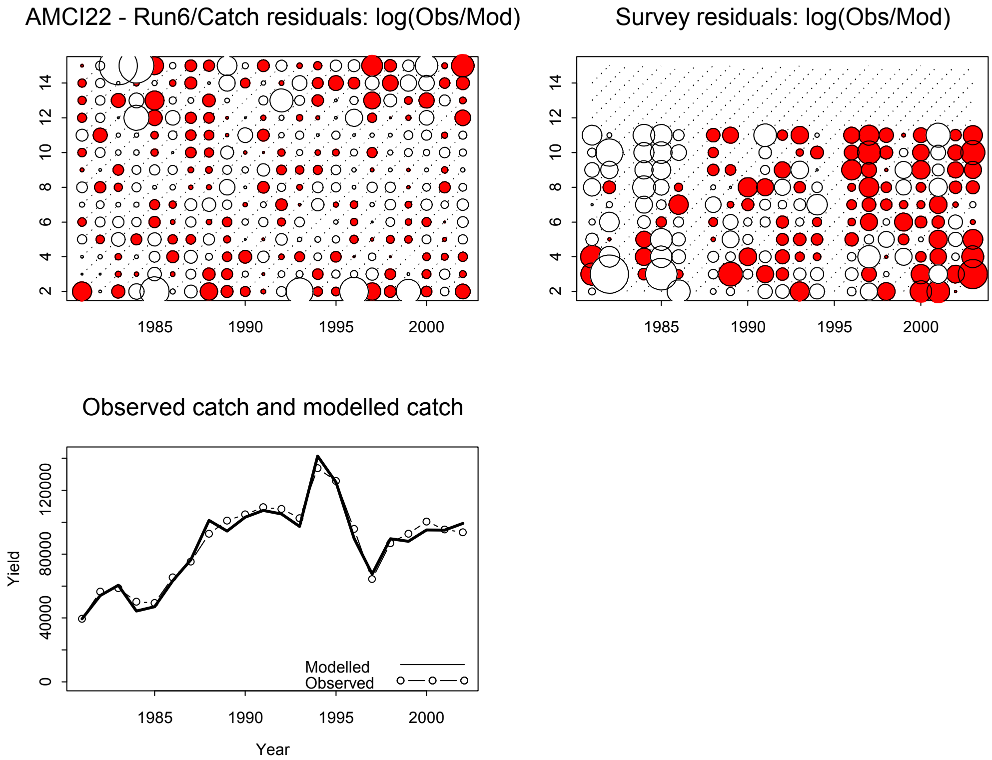


Figure 7.4.2.1 Residual plot from AMCI

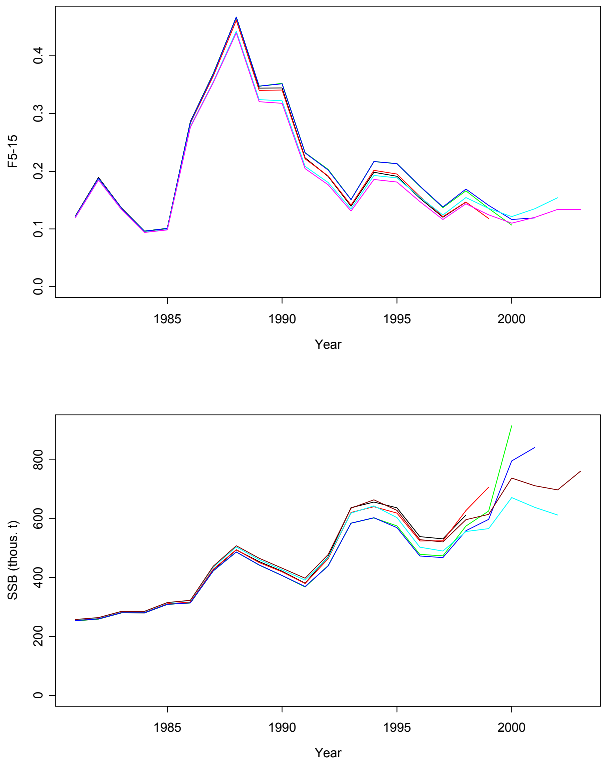


Figure 7.4.2.2 A retrospective plot from AMCI.

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Annex I

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DETAILS OF DATA FILLING-IN
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  Filling-in for record : (  1)   Denmark                1 IIa
Mean Weighted by Sampled Catches of:
  >>  ( 50)  Faroe Islands         2 IIa
  >>  ( 94)  Iceland               2 IIa
  >>  (114)  The Netherlands       2 IIa
  >>  (158)  Norway                2 IIa

  Filling-in for record : (  2)   Denmark                2 IIa
Mean Weighted by Sampled Catches of:
  >>  ( 50)  Faroe Islands         2 IIa

  >>  ( 94)  Iceland               2 IIa
  >>  (114)  The Netherlands       2 IIa
  >>  (158)  Norway                2 IIa

  Filling-in for record : (  3)   Denmark                3 IIa
Mean Weighted by Sampled Catches of:
  >>  ( 51)  Faroe Islands         3 IIa
  >>  ( 95)  Iceland               3 IIa
  >>  (159)  Norway                3 IIa

  Filling-in for record : (  4)   Denmark                4 IIa
Mean Weighted by Sampled Catches of:
  >>  ( 52)  Faroe Islands         4 IIa
  >>  ( 96)  Iceland               4 IIa

  Filling-in for record : (  7)   Denmark                3 IIIa
Mean Weighted by Sampled Catches of:
  >>  ( 51)  Faroe Islands         3 IIa
  >>  ( 95)  Iceland               3 IIa
  >>  (159)  Norway                3 IIa

  Filling-in for record : (  8)   Denmark                4 IIIa
Mean Weighted by Sampled Catches of:
  >>  ( 52)  Faroe Islands         4 IIa
  >>  ( 96)  Iceland               4 IIa

  Filling-in for record : (  9)   Denmark                1 IVa
Using Only
  >>  (162)  Norway                2 IVa

  Filling-in for record : ( 10)   Denmark                2 IVa
Using Only
  >>  (162)  Norway                2 IVa

  Filling-in for record : ( 11)   Denmark                3 IVa
Using Only
  >>  (162)  Norway                2 IVa

  Filling-in for record : ( 12)   Denmark                4 IVa
Using Only
  >>  (162)  Norway                2 IVa

  Filling-in for record : ( 15)   Denmark                3 IVb
Using Only
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  >>  (162)  Norway                 2 IVa

  Filling-in for record : ( 17)   Denmark                1 VIa
Using Only
  >>  (169)  Norway                 1 VIa

  Filling-in for record : ( 18)   Denmark                2 VIa
Mean Weighted by Sampled Catches of:
  >>  ( 62)  Faroe Islands          2 VIa
  >>  (126)  The Netherlands        2 VIa
  >>  (170)  Norway                 2 VIa

  Filling-in for record : ( 21)   Denmark                1 VIIb
Using Only
  >>  (133)  The Netherlands        1 VIIb

  Filling-in for record : ( 28)   Ireland                4 IVa
Using Only
  >>  (162)  Norway                 2 IVa

  Filling-in for record : ( 29)   Ireland                1 VIa
Using Only
  >>  (169)  Norway                 1 VIa

  Filling-in for record : ( 30)   Ireland                2 VIa
Mean Weighted by Sampled Catches of:
  >>  ( 62)  Faroe Islands          2 VIa
  >>  (126)  The Netherlands        2 VIa
  >>  (170)  Norway                 2 VIa

  Filling-in for record : ( 33)   Ireland                1 VIIb
Using Only
  >>  (133)  The Netherlands        1 VIIb

  Filling-in for record : ( 34)   Ireland                2 VIIb
Using Only
  >>  (133)  The Netherlands        1 VIIb

  Filling-in for record : ( 41)   Ireland                1 VIIj
Using Only
  >>  (181)  Norway                 1 VIIk

  Filling-in for record : ( 42)   Ireland                2 VIIj
Using Only
  >>  (181)  Norway                 1 VIIk

  Filling-in for record : ( 45)   Ireland                1 VIIIe
Using Only
  >>  (181)  Norway                 1 VIIk

  Filling-in for record : ( 74)   Germany                2 IIa
Mean Weighted by Sampled Catches of:
  >>  ( 50)  Faroe Islands          2 IIa
  >>  ( 94)  Iceland                2 IIa
  >>  (114)  The Netherlands        2 IIa
  >>  (158)  Norway                 2 IIa

  Filling-in for record : ( 75)   Germany                3 IIa
Mean Weighted by Sampled Catches of:
  >>  ( 51)  Faroe Islands          3 IIa
  >>  ( 95)  Iceland                3 IIa
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  >>  (159)  Norway                 3 IIa

  Filling-in for record : ( 77)   Germany                1 VIa
Using Only
  >>  (169)  Norway                 1 VIa

  Filling-in for record : ( 78)   Germany                2 VIa
Mean Weighted by Sampled Catches of:
  >>  ( 62)  Faroe Islands          2 VIa
  >>  (126)  The Netherlands        2 VIa
  >>  (170)  Norway                 2 VIa

  Filling-in for record : ( 79)   Germany                3 VIa
Using Only

  >>  (172)  Norway                 4 VIa

  Filling-in for record : ( 81)   Germany                1 VIb
Using Only
  >>  (173)  Norway                 1 VIb

  Filling-in for record : ( 85)   Germany                1 VIIc
Mean Weighted by Sampled Catches of:
  >>  ( 37)  Ireland                1 VIIc
  >>  (137)  The Netherlands        1 VIIc
  >>  (177)  Norway                 1 VIIc

  Filling-in for record : ( 89)   Germany                1 VIIj
Using Only
  >>  (181)  Norway                 1 VIIk

  Filling-in for record : (105)   Iceland                1 VIab+VIIbc
Mean Weighted by Sampled Catches of:
  >>  (173)  Norway                 1 VIb
  >>  (177)  Norway                 1 VIIc

  Filling-in for record : (106)   Iceland                2 VIab+VIIbc
Mean Weighted by Sampled Catches of:
  >>  (174)  Norway                 2 VIb
  >>  (178)  Norway                 2 VIIc

  Filling-in for record : (119)   The Netherlands        3 IVa
Using Only
  >>  (162)  Norway                 2 IVa

  Filling-in for record : (129)   The Netherlands        1 VIb
Using Only
  >>  (173)  Norway                 1 VIb

  Filling-in for record : (147)   The Netherlands        3 VIIj
Using Only
  >>  (181)  Norway                 1 VIIk

  Filling-in for record : (185)   Norway                 1 VIIgk+XII
Using Only
  >>  (181)  Norway                 1 VIIk

  Filling-in for record : (189)   Scotland               1 VIa
Using Only
  >>  (169)  Norway                 1 VIa
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  Filling-in for record : (190)   Scotland               2 VIa
Mean Weighted by Sampled Catches of:
  >>  ( 62)  Faroe Islands         2 VIa
  >>  (126)  The Netherlands       2 VIa
  >>  (170)  Norway                2 VIa

  Filling-in for record : (193)   Scotland               1 VIIb
Using Only
  >>  (133)  The Netherlands       1 VIIb

  Filling-in for record : (197)   Scotland               1 VIIc
Mean Weighted by Sampled Catches of:
  >>  ( 37)  Ireland               1 VIIc
  >>  (137)  The Netherlands       1 VIIc
  >>  (177)  Norway                1 VIIc

  Filling-in for record : (201)   France                 1 VbVIVII
Mean Weighted by Sampled Catches of:
  >>  ( 57)  Faroe Islands         1 Vb
  >>  (173)  Norway                1 VIb
  >>  (177)  Norway                1 VIIc

  Filling-in for record : (202)   France                 2 VbVIVII
Mean Weighted by Sampled Catches of:
  >>  ( 58)  Faroe Islands         2 Vb
  >>  (174)  Norway                2 VIb

  Filling-in for record : (203)   France                 3 VbVIVII
Using Only
  >>  ( 59)  Faroe Islands         3 Vb

  Filling-in for record : (204)   France                 4 VbVIVII
Using Only
  >>  ( 60)  Faroe Islands         4 Vb

  Filling-in for record : (  2)   DENMARK                2 IIIa
Using Only
  >>  ( 14)  Norway                2 IIa

  Filling-in for record : (  3)   DENMARK                3 IIIa
Using Only
  >>  ( 15)  Norway                3 IIa

  Filling-in for record : (  4)   DENMARK                4 IIIa
Using Only
  >>  ( 16)  Norway                4 IIa

  Filling-in for record : (  5)   DENMARK                1 IVa
Using Only
  >>  ( 17)  Norway                1 IVa

  Filling-in for record : (  7)   DENMARK                3 IVa
Using Only
  >>  ( 19)  Norway                3 IVa

  Filling-in for record : (  8)   DENMARK                4 IVa
Using Only
  >>  ( 20)  Norway                4 IVa

  Filling-in for record : ( 10)   DENMARK                2 IVb
Using Only
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  >>  ( 18)  Norway                 2 IVa

  Filling-in for record : ( 11)   DENMARK                3 IVb
Using Only
  >>  ( 19)  Norway                 3 IVa

  Filling-in for record : ( 12)   DENMARK                4 IVb
Using Only
  >>  ( 20)  Norway                 4 IVa

  Filling-in for record : ( 21)   Faroe Islands          1 IVa
Using Only
  >>  ( 17)  Norway                 1 IVa

  Filling-in for record : ( 22)   Faroe Islands          2 IVa
Using Only
  >>  ( 18)  Norway                 2 IVa

  Filling-in for record : ( 23)   Faroe Islands          3 IVa
Using Only
  >>  ( 19)  Norway                 3 IVa

  Filling-in for record : ( 24)   Faroe Islands          4 IVa
Using Only
  >>  ( 20)  Norway                 4 IVa

  Filling-in for record : ( 27)   Faroe Islands          3 IVb
Using Only
  >>  ( 19)  Norway                 3 IVa

  Filling-in for record : ( 29)   Sweden                 1 IIa
Using Only
  >>  ( 13)  Norway                 1 IIa

  Filling-in for record : ( 30)   Sweden                 2 IIa
Using Only
  >>  ( 14)  Norway                 2 IIa

  Filling-in for record : ( 31)   Sweden                 3 IIa
Using Only
  >>  ( 15)  Norway                 3 IIa

  Filling-in for record : ( 32)   Sweden                 4 IIa
Using Only
  >>  ( 16)  Norway                 4 IIa

  Filling-in for record : ( 33)   Sweden                 1 IIIa
Using Only
  >>  ( 13)  Norway                 1 IIa

  Filling-in for record : ( 34)   Sweden                 2 IIIa
Using Only
  >>  ( 14)  Norway                 2 IIa


  Filling-in for record : ( 35)   Sweden                 3 IIIa
Using Only
  >>  ( 15)  Norway                 3 IIa

  Filling-in for record : ( 36)   Sweden                 4 IIIa
Using Only
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  >>  ( 16)  Norway                 4 IIa

  Filling-in for record : ( 37)   Sweden                 1 IVa
Using Only
  >>  ( 17)  Norway                 1 IVa

  Filling-in for record : ( 38)   Sweden                 2 IVa
Using Only
  >>  ( 18)  Norway                 2 IVa

  Filling-in for record : ( 39)   Sweden                 3 IVa
Using Only
  >>  ( 19)  Norway                 3 IVa

  Filling-in for record : ( 40)   Sweden                 4 IVa
Using Only
  >>  ( 20)  Norway                 4 IVa

  Filling-in for record : ( 41)   Sweden                 1 Vb
Using Only
  >>  ( 17)  Norway                 1 IVa

  Filling-in for record : ( 42)   Sweden                 2 Vb
Using Only
  >>  ( 18)  Norway                 2 IVa

  Filling-in for record : ( 43)   Sweden                 3 Vb
Using Only
  >>  ( 19)  Norway                 3 IVa

  Filling-in for record : ( 44)   Sweden                 4 Vb
Using Only
  >>  ( 20)  Norway                 4 IVa

  Filling-in for record : (  5)   PORTUGAL               1 IXa
Using Only
  >>  (  1)  Spain                  1 VIIIc+IXa

  Filling-in for record : (  6)   PORTUGAL               2 IXa
Using Only
  >>  (  2)  Spain                  2 VIIIc+IXa

  Filling-in for record : (  7)   PORTUGAL               3 IXa
Using Only
  >>  (  3)  Spain                  3 VIIIc+IXa

  Filling-in for record : (  8)   PORTUGAL               4 IXa
Using Only
  >>  (  4)  Spain                  4 VIIIc+IXa
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