Advisory Committee on Fisheries Management **ICES CM 2000/ACFM:15**

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NORTH-WESTERN WORKING GROUP

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PART 2 OF 2

International Council for the Exploration of the Sea

Conseil International pour l'Exploration de la Mer

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Table 3.3.7. Cod at Iceland. Division Va. Maturity at age in the SSB.

Age	1980	1981	1982	1983	1984	1985	1986
3	0.056	0.000	0.023	0.000	0.000	0.027	0.005
4	0.023	0.029	0.051	0.087	0.043	0.058	0.054
5	0.165	0.085	0.129	0.167	0.189	0.202	0.244
6	0.478	0.289	0.226	0.338	0.416	0.548	0.543
7	0.807	0.659	0.544	0.515	0.656	0.774	0.762
8	0.915	0.890	0.849	0.717	0.782	0.903	0.891
9	0.979	0.952	0.956	0.857	0.858	0.938	0.981
10	0.977	0.962	0.967	0.979	0.949	1.000	0.962
11	1.000	0.988	1.000	0.985	0.969	1.000	0.988
12	0.964	1.000	1.000	1.000	0.948	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

Age	1987	1988	1989	1990	1991	1992	1993
3	0.020	0.039	0.000	0.000	0.000	0.072	0.078
4	0.046	0.020	0.048	0.075	0.063	0.225	0.246
5	0.238	0.206	0.226	0.303	0.214	0.562	0.470
6	0.585	0.477	0.550	0.633	0.543	0.706	0.714
7	0.808	0.690	0.820	0.819	0.781	0.906	0.939
8	0.942	0.831	0.858	0.912	0.887	0.961	0.984
9	0.952	0.929	0.887	0.953	0.945	0.977	0.973
10	1.000	0.946	0.991	0.986	0.842	1.000	0.968
11	0.979	0.974	1.000	1.000	1.000	1.000	1.000
12	1.000	0.821	0.903	1.000	1.000	1.000	1.000
13	1.000	1.000	0.859	1.000	1.000	1.000	1.000
14	1.000	1.000	1.000	1.000	1.000	1.000	1.000

Age	1994	1995	1996	1997	1998	1999
3	0.096	0.043	0.078	0.073	0.026	0.083
4	0.281	0.394	0.097	0.305	0.258	0.368
5	0.570	0.729	0.512	0.502	0.480	0.660
6	0.796	0.849	0.742	0.740	0.646	0.778
7	0.895	0.853	0.862	0.880	0.830	0.867
8	0.919	0.954	0.911	0.922	0.942	0.977
9	1.000	1.000	0.841	0.971	0.985	0.987
10	0.852	1.000	1.000	0.932	0.925	0.995
11	0.985	1.000	1.000	1.000	0.998	1.000
12	1.000	1.000	0.986	0.913	1.000	1.000
13	1.000	1.000	0.971	1.000	1.000	0.839
14	1.000	1.000	1.000	1.000	1.000	1.000

Table 3.3.8. Cod at Iceland. Division Va. Bottom trawl CPUE (GLM) indices 1994-1999 used in XSA tuning.

TRAWL-JUN-DEC-N						
Year/age	4	5	6	7		
1994	1850	1137	221	106		
1995	604	1413	1067	183		
1996	1136	706	841	463		
1997	1774	1114	376	285		
1998	506	1667	1302	319		
1999	1353	803	1088	444		
TRAWL-JAN-MAY-N						
Year/age	4	5	6	7	8	9
1994	1222	1439	499	328	52	21
1995	283	1695	1380	326	65	11
1996	1358	731	1339	627	114	28
1997	1183	1504	557	546	466	29
1998	401	2583	1882	595	234	145
1999	837	994	2633	717	79	47
TRAWL-JAN-MAY-S						
Year/age	5	6	7	8		
1994	483	240	143	53		
1995	410	449	279	143		
1996	202	575	485	133		
1997	513	364	411	239		
1998	728	933	501	279		
1999	456	1461	626	110		
TRAWL-JUN-DEC-S						
Year/age	5	6	7	8		
1994	275	106	115	34		
1995	581	358	104	63		
1996	359	450	228	52		
1997	735	361	239	141		
1998	1004	645	204	77		
1999	354	827	24	24		

Table 3.3.9. Cod at Iceland. Division Va. Gillnet CPUE (GLM) indices 1994-1999 used in XSA tuning.

GILLNET-JAN-MAY-S		
Year/age	8	9
1994	188	89
1995	301	90
1996	319	159
1997	543	109
1998	734	308
1999	226	265

Table 3.3.10. Cod at Iceland. Division Va. Icelandic Groundfish Survey indices used in XSA tuning.

IceGFS. N.

Year/age	3	4	5	6	7
1984	55261	48059	13027	6211	1990
1985	22540	18404	17203	4864	1388
1986	77227	15257	7551	7364	1453
1987	92490	49378	5573	2906	2306
1988	60113	46566	18693	1665	545
1989	8272	15722	18464	6501	456
1990	22262	8102	8772	9355	1242
1991	13601	9542	2499	2303	1347
1992	31684	9441	5124	1100	672
1993	18211	13369	2675	1550	263
1994	4301	11353	7088	1330	417
1995	19228	6083	6923	6599	1160
1996	48173	23365	5898	5422	3004
1997	13959	48786	20710	5656	2806
1998	35495	7683	12466	5233	811
1999	4451	20382	4670	3675	1447

IceGFS. a3 on a3. N

Year/age	3
1985	31297
1986	84656
1987	99294
1988	68604
1989	17511
1990	19408
1991	15633
1992	30540
1993	26030
1994	5556
1995	17477
1996	37466
1997	11969
1998	28949
1999	5985

IceGFS. a2 on a3. N.

Year/age	3
1986	39301
1987	52943
1988	25874
1989	5820
1990	14921
1991	11786
1992	14473
1993	16407
1994	2237
1995	10539
1996	28480
1997	3869
1998	18566
1999	3570

Table 3.3.10. (Cont´d.) Cod at Iceland. Division Va. Icelandic Groundfish Survey indices used in XSA tuning.

IceGFS. SE

Year/age	4	5	6	7
1984	561	470	524	373
1985	686	1171	608	294
1986	404	391	842	286
1987	3153	519	333	385
1988	4474	3858	619	274
1989	419	1673	1762	265
1990	114	324	1104	396
1991	511	309	763	1087
1992	391	361	146	163
1993	1189	356	321	79
1994	1943	2084	619	300
1995	460	1056	1654	502
1996	860	358	582	561
1997	3397	1605	624	615
1998	637	1591	915	214
1999	2437	632	889	525

IceGFS. SW.

Year/age	3	4	5	6	7	8
1984	1723	4444	2588	1911	813	417
1985	1413	2203	2968	1310	535	232
1986	4003	1266	1190	1656	410	104
1987	3929	5935	1144	860	873	102
1988	5857	9371	5845	812	296	224
1989	1702	6149	8867	4150	409	113
1990	3044	2560	4625	7491	1556	193
1991	1088	2019	1016	1702	2172	387
1992	4112	1935	1664	420	359	255
1993	4366	3533	851	573	114	66
1994	1298	4397	3538	866	355	22
1995	3829	1958	3133	3764	804	181
1996	3785	3024	1181	1655	1554	126
1997	911	5132	3131	1182	895	537
1998	3820	1874	5897	3780	851	317
1999	619	4485	1550	2267	1375	121

Table 3.3.11. Cod at Iceland. Div. Va. XSA diagnostic output

Lowestoft VPA Version 3.1

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Extended Survivors Analysis

"ICELANDIC COD (Div. Va); data from 1971-99(4/2000)"

CPUE data from file codvarnt.dat

Catch data for 16 years. 1984 to 1999. Ages 3 to 14.

Fleet	First year	Last year	First age	Last age	Alpha	Beta
IceGFS. N.	1984	1999	3	7	0.99	1
IceGFS. a3 on a3. N	1985	1999	3	3	0.17	0.25
IceGFS. a2 on a3. N.	1986	1999	3	3	0.17	0.25
IceGFS. SE	1984	1999	4	7	0.99	1
IceGFS. SW.	1984	1999	3	8	0.99	1
TRAWL-JUN-DEC-N	1994	1999	4	7	0.42	1
TRAWL-JAN-MAY-N	1994	1999	4	9	0	0.42
TRAWL-JAN-MAY-S	1994	1999	5	8	0	0.42
GILLNET-JAN-MAY-S	1994	1999	8	9	0	0.42
TRAWL-JUN-DEC-S	1994	1999	5	8	0.42	1

Time series weights :

Tapered time weighting applied
Power = 3 over 20 years

Catchability analysis :

Catchability dependent on stock size for ages < 5

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

Catchability independent of age for ages >= 11

Terminal population estimation :

Survivor estimates shrunk towards the mean F
of the final 3 years or the 4 oldest ages.

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

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

Prior weighting not applied

Tuning had not converged after 210 iterations

Total absolute residual between iterations
209 and 210 = .00081

Final year F values

Age	3	4	5	6	7	8	9	10	11	12
Iteration **	0.0412	0.1845	0.3823	0.4772	0.6395	0.7154	0.4271	0.7641	0.8769	0.8175
Iteration **	0.0412	0.1845	0.3822	0.4772	0.6395	0.7148	0.427	0.7642	0.8768	0.8175

Age	13	14
Iteration **	1.077	0.8903
Iteration **	1.077	0.8903

Table 3.3.11 (Cont'd)

Regression weights

0.751	0.82	0.877	0.921	0.954	0.976	0.99	0.997	1	1

Fishing mortalities

Age	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
3	0.049	0.097	0.08	0.161	0.097	0.076	0.029	0.022	0.023	0.041
4	0.23	0.311	0.38	0.321	0.29	0.203	0.142	0.119	0.127	0.184
5	0.443	0.505	0.635	0.502	0.322	0.338	0.251	0.244	0.272	0.382
6	0.638	0.773	0.896	0.782	0.455	0.369	0.445	0.382	0.501	0.477
7	0.786	0.949	1.101	0.812	0.653	0.537	0.499	0.529	0.692	0.639
8	0.817	0.787	1.024	1.132	0.769	0.525	0.608	0.692	0.588	0.715
9	0.789	0.78	0.617	1.239	0.804	0.434	0.584	0.784	0.924	0.427
10	0.835	0.882	0.528	0.952	0.826	0.621	0.582	0.846	1.005	0.764
11	0.629	0.965	0.396	0.905	0.627	0.657	0.57	0.877	1.04	0.877
12	0.75	0.845	0.709	0.578	0.673	0.757	0.639	0.424	1.379	0.817
13	0.438	0.357	0.264	0.569	0.705	1.183	0.774	0.974	1.432	1.077
14	0.669	0.77	0.479	0.76	0.714	0.812	0.648	0.788	1.228	0.89

1

XSA population numbers (Thousands)

YEAR \ AGE	3	4	5	6	7	8	9	10	11	12
1990	1.33E+05	6.63E+04	8.40E+04	1.04E+05	3.46E+04	5.09E+03	1.23E+03	6.28E+02	2.79E+02	1.05E+02
1991	1.02E+05	1.04E+05	4.32E+04	4.41E+04	4.52E+04	1.29E+04	1.84E+03	4.58E+02	2.23E+02	1.22E+02
1992	1.76E+05	7.59E+04	6.23E+04	2.13E+04	1.67E+04	1.43E+04	4.81E+03	6.92E+02	1.55E+02	6.96E+01
1993	1.52E+05	1.33E+05	4.25E+04	2.70E+04	7.12E+03	4.54E+03	4.21E+03	2.13E+03	3.34E+02	8.56E+01
1994	7.38E+04	1.06E+05	7.89E+04	2.11E+04	1.01E+04	2.59E+03	1.20E+03	9.99E+02	6.71E+02	1.11E+02
1995	1.64E+05	5.48E+04	6.48E+04	4.68E+04	1.09E+04	4.32E+03	9.82E+02	4.39E+02	3.58E+02	2.94E+02
1996	2.04E+05	1.24E+05	3.67E+04	3.79E+04	2.65E+04	5.23E+03	2.09E+03	5.21E+02	1.93E+02	1.52E+02
1997	8.89E+04	1.62E+05	8.82E+04	2.34E+04	1.99E+04	1.32E+04	2.33E+03	9.54E+02	2.38E+02	8.95E+01
1998	1.71E+05	7.13E+04	1.18E+05	5.66E+04	1.30E+04	9.58E+03	5.41E+03	8.72E+02	3.35E+02	8.13E+01
1999	7.36E+04	1.37E+05	5.14E+04	7.34E+04	2.81E+04	5.35E+03	4.36E+03	1.76E+03	2.61E+02	9.70E+01

Estimated population abundance at 1st Jan 2000

0.00E+00	5.78E+04	9.30E+04	2.87E+04	3.73E+04	1.21E+04	2.14E+03	2.33E+03	6.70E+02	8.90E+01

Taper weighted geometric mean of the VPA populations:

1.34E+05	1.10E+05	7.10E+04	4.10E+04	1.76E+04	6.66E+03	2.48E+03	8.75E+02	3.22E+02	1.35E+02

Standard error of the weighted Log(VPA populations) :

0.4351	0.422	0.443	0.509	0.5359	0.545	0.5877	0.5284	0.4979	0.5719

YEAR \ AGE	13	14
1990	4.68E+01	4.53E+01
1991	4.05E+01	2.47E+01
1992	4.29E+01	2.32E+01
1993	2.80E+01	2.70E+01
1994	3.93E+01	1.30E+01
1995	4.62E+01	1.59E+01
1996	1.13E+02	1.16E+01
1997	6.57E+01	4.26E+01
1998	4.79E+01	2.03E+01
1999	1.68E+01	9.37E+00

Estimated population abundance at 1st Jan 2000

3.51E+01	4.67E+00

Taper weighted geometric mean of the VPA populations:

5.64E+01	2.41E+01

Table 3.3.11 (Cont'd)

Standard error of the weighted Log(VPA populations) :

1	0.6997	0.747

Log catchability residuals.

Fleet : IceGFS. N.

Age	1984	1985	1986	1987	1988	1989
3	0.47	-0.02	-0.23	0.03	0.32	0.02
4	0.22	0.17	-0.04	-0.03	0.02	-0.15
5	0.4	0.29	0.26	-0.21	0.25	-0.06
6	0.52	0.18	0.33	0.29	-0.38	-0.01
7	0.4	0.14	0.29	0.59	0.01	-0.51
8	No data for this fleet at this age					
9	No data for this fleet at this age					

Age	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
3	0.06	0.1	-0.02	-0.11	-0.15	-0.2	0.02	0.22	0.04	-0.16
4	0.09	-0.2	0.15	-0.22	-0.12	0.07	0.1	0.3	-0.09	-0.06
5	0.05	-0.48	0	-0.4	-0.22	-0.03	0.29	0.66	-0.1	-0.15
6	0.09	-0.32	-0.2	-0.21	-0.44	0.27	0.37	0.83	-0.01	-0.65
7	-0.44	-0.46	-0.01	-0.38	-0.43	0.4	0.43	0.68	0.02	-0.22
8	No data for this fleet at this age									
9	No data for this fleet at this age									

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

Age	5	6	7
Mean Log q	-1.6702	-1.6691	-1.9108
S.E(Log q)	0.3146	0.4179	0.4158

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
3	0.51	4.187	6.68	0.88	16	0.17	-1.67
4	0.66	2.865	4.97	0.88	16	0.17	-1.54

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

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
5	0.83	0.957	3.3	0.76	16	0.26	-1.67
6	1.1	-0.363	0.74	0.55	16	0.48	-1.67
7	0.94	0.261	2.38	0.65	16	0.41	-1.91
1							

Fleet : IceGFS. a3 on a3. N

Age	1984	1985	1986	1987	1988	1989
3	99.99	0.16	-0.1	0.17	0.46	0.36
4	No data for this fleet at this age					
5	No data for this fleet at this age					
6	No data for this fleet at this age					
7	No data for this fleet at this age					

Table 3.3.11 (Cont'd)

Age	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
3	-0.04	0.11	-0.04	0.02	-0.18	-0.3	-0.07	0.08	-0.05	-0.14
4	No data for this fleet at this age									
5	No data for this fleet at this age									
6	No data for this fleet at this age									
7	No data for this fleet at this age									
8	No data for this fleet at this age									
9	No data for this fleet at this age									

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
3	0.59	2.883	5.9	0.84	15	0.2	-1.81
1							

Fleet : IceGFS. a2 on a3

Age	1984	1985	1986	1987	1988	1989
3	99.99	99.99	-0.27	0.07	0.2	0.13
4	No data for this fleet at this age					
5	No data for this fleet at this age					
6	No data for this fleet at this age					
7	No data for this fleet at this age					
8	No data for this fleet at this age					
9	No data for this fleet at this age					

Age	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
3	0.16	0.31	-0.13	0.09	-0.23	-0.22	0.07	-0.14	0.02	0.01
4	No data for this fleet at this age									
5	No data for this fleet at this age									
6	No data for this fleet at this age									
7	No data for this fleet at this age									
8	No data for this fleet at this age									
9	No data for this fleet at this age									

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
3	0.52	3.797	6.93	0.87	14	0.18	-2.44
1							

Fleet : IceGFS. SE

Age	1984	1985	1986	1987	1988	1989
3	No data for this fleet at this age					
4	-0.79	-0.11	-0.49	-0.11	0.2	-0.61
5	-0.66	-0.13	-0.43	-0.31	0.94	-0.19
6	-0.29	-0.24	-0.17	-0.21	0.29	0.35
7	-0.17	-0.31	-0.23	-0.11	0.42	0.05
8	No data for this fleet at this age					
9	No data for this fleet at this age					

Table 3.3.11 (Cont'd)

Age	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
3	No data for this fleet at this age									
4	-0.66	-0.22	-0.02	0.02	0.51	0.3	-0.2	0.3	0.18	0.32
5	-0.98	-0.3	-0.38	-0.14	0.83	0.36	-0.24	0.38	0.11	0.12
6	-0.38	0.24	-0.56	-0.12	0.46	0.56	-0.2	0.29	-0.09	-0.41
7	-0.48	0.43	-0.32	-0.49	0.34	0.66	-0.15	0.26	-0.21	-0.13
8	No data for this fleet at this age									
9	No data for this fleet at this age									

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

Age	5	6	7
Mean Log q	-3.9404	-3.3338	-3.0093
S.E(Log q)	0.4964	0.3643	0.3695

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
4	0.56	1.584	7.53	0.57	16	0.38	-4.37

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

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
5	0.75	0.992	5.76	0.61	16	0.37	-3.94
6	1.17	-0.638	2.12	0.6	16	0.44	-3.33
7	1.06	-0.262	2.6	0.65	16	0.41	-3.01
1							

Fleet : IceGFS. SW.

Age	1984	1985	1986	1987	1988	1989
3	-0.26	-0.44	-0.53	-0.38	0.41	0.23
4	-0.21	-0.33	-1	-0.15	0.39	0.51
5	-0.09	-0.33	-0.45	-0.66	0.22	0.34
6	0.11	-0.36	-0.39	-0.16	-0.33	0.31
7	-0.08	-0.4	-0.56	0.03	-0.19	-0.2
8	0.33	0	-0.5	-0.35	0.67	0.33
9	No data for this fleet at this age					

Age	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
3	0.19	-0.24	0.15	0.4	0.21	0.17	-0.09	-0.28	0.09	-0.35
4	0.27	-0.34	0	0	0.42	0.15	-0.28	-0.02	-0.23	0.08
5	0.54	-0.24	0.01	-0.41	0.22	0.31	-0.18	-0.09	0.28	-0.12
6	0.64	0.15	-0.4	-0.44	-0.1	0.48	-0.05	0.04	0.43	-0.36
7	0.2	0.43	-0.22	-0.81	-0.18	0.45	0.18	-0.05	0.48	0.14
8	0.47	0.2	-0.08	-0.18	-1.08	0.28	-0.2	0.41	0.1	-0.15
9	No data for this fleet at this age									

Table 3.3.11 (Cont'd)

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

Age	5	6	7	8
Mean Log q	-2.8042	-2.4396	-2.3222	-2.7268
S.E(Log q)	0.3212	0.3636	0.3773	0.4459

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
3	0.71	1.369	6.11	0.69	16	0.3	-3.8
4	1.03	-0.124	2.84	0.62	16	0.34	-3.1

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

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
5	0.72	2.028	5.16	0.84	16	0.2	-2.8
6	0.74	1.751	4.55	0.82	16	0.25	-2.44
7	0.75	1.672	4.17	0.82	16	0.26	-2.32
8	0.72	1.658	4.41	0.78	16	0.3	-2.73
1							

Fleet : TRAWL-JUN-DEC-N

Age	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
3	No data for this fleet at this age									
4	99.99	99.99	99.99	99.99	0.53	0.12	-0.16	-0.04	-0.35	-0.07
5	99.99	99.99	99.99	99.99	-0.09	0.33	0.15	-0.28	-0.14	0.03
6	99.99	99.99	99.99	99.99	-0.5	0.21	0.24	-0.13	0.31	-0.14
7	99.99	99.99	99.99	99.99	-0.39	0	0.02	-0.16	0.49	0.02
8	No data for this fleet at this age									
9	No data for this fleet at this age									

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

Age	5	6	7
Mean Log q	-3.7821	-3.5929	-3.5773
S.E(Log q)	0.2195	0.3113	0.2874

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
4	0.91	0.258	4.98	0.66	6	0.33	-4.29

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

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
5	1.49	-1.575	0.18	0.72	6	0.29	-3.78
6	0.74	1.314	5.4	0.87	6	0.22	-3.59
7	0.95	0.166	3.89	0.73	6	0.3	-3.58

Table 3.3.11 (Cont'd)

Fleet : TRAWL-JAN-MAY-N

Age	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
3	No data for this fleet at this age									
4	99.99	99.99	99.99	99.99	0.32	-0.07	0.22	-0.15	-0.1	-0.21
5	99.99	99.99	99.99	99.99	-0.1	0.26	-0.03	-0.18	0.08	-0.03
6	99.99	99.99	99.99	99.99	-0.23	-0.03	0.17	-0.24	0.12	0.19
7	99.99	99.99	99.99	99.99	0.09	-0.02	-0.26	-0.1	0.44	-0.15
8	99.99	99.99	99.99	99.99	-0.02	-0.35	0.03	0.53	0.14	-0.34
9	99.99	99.99	99.99	99.99	0.22	-0.31	-0.1	-0.13	0.66	-0.34

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

Age	5	6	7	8	9
Mean Log q	-3.7967	-3.3799	-3.3448	-3.6925	-4.0562
S.E(Log q)	0.1549	0.1944	0.2464	0.331	0.3831

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
4	0.71	1.096	6.77	0.79	6	0.24	-4.83

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

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
5	1.01	-0.059	3.71	0.88	6	0.18	-3.8
6	0.74	3.509	5.22	0.98	6	0.08	-3.38
7	1.57	-1.731	-0.28	0.7	6	0.33	-3.34
8	0.72	1.869	5.1	0.92	6	0.19	-3.69
9	0.83	0.794	4.7	0.84	6	0.33	-4.06
1							

Fleet : TRAWL-JAN-MAY-S

Age	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
3	No data for this fleet at this age									
4	No data for this fleet at this age									
5	99.99	99.99	99.99	99.99	-0.04	0	-0.16	-0.11	-0.04	0.34
6	99.99	99.99	99.99	99.99	-0.23	-0.42	0.06	0.07	0.15	0.34
7	99.99	99.99	99.99	99.99	-0.44	0.13	-0.21	-0.08	0.57	0.01
8	99.99	99.99	99.99	99.99	-0.13	0.3	0.05	-0.27	0.18	-0.14
9	No data for this fleet at this age									

Table 3.3.11 (Cont'd)

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

Age	5	6	7	8
Mean Log q	-4.949	-4.1144	-3.6472	-3.5604
S.E(Log q)	0.1793	0.2718	0.342	0.2178

Regression statistics :

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

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
5	1.07	-0.294	4.53	0.83	6	0.21	-4.95
6	0.81	0.966	5.37	0.86	6	0.22	-4.11
7	1.1	-0.231	3.06	0.59	6	0.42	-3.65
8	1.07	-0.347	3.2	0.86	6	0.26	-3.56
1							

Fleet : GILLNET-JAN-MAY-S

Age	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
3	No data for this fleet at this age									
4	No data for this fleet at this age									
5	No data for this fleet at this age									
6	No data for this fleet at this age									
7	No data for this fleet at this age									
8	99.99	99.99	99.99	99.99	0.24	0.15	0.03	-0.34	0.26	-0.31
9	99.99	99.99	99.99	99.99	0.15	0.28	0.13	-0.32	-0.1	-0.13

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

Age	8	9
Mean Log q	-2.6637	-2.5433
S.E(Log q)	0.2703	0.222

Regression statistics :

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

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
8	1.28	-1.04	0.99	0.78	6	0.34	-2.66
9	1.29	-1.85	1.05	0.91	6	0.23	-2.54

Table 3.3.11 (Cont'd)

Fleet : TRAWL-JUN-DEC-S

Age	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
3	No data for this fleet at this age									
4	No data for this fleet at this age									
5	99.99	99.99	99.99	99.99	-0.73	0.23	0.26	0.09	0.13	0
6	99.99	99.99	99.99	99.99	-0.66	-0.31	0.19	0.41	0.18	0.16
7	99.99	99.99	99.99	99.99	0.49	0.23	0.11	0.46	0.84	-2.1
8	99.99	99.99	99.99	99.99	0.41	0.35	0.02	0.15	-0.2	-0.7
9	No data for this fleet at this age									

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

Age	5	6	7	8
Mean Log q	-4.5649	-4.1681	-4.3743	-4.0684
S.E(Log q)	0.3628	0.3963	1.0711	0.4122

Regression statistics :

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

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
5	1.26	-0.476	2.88	0.47	6	0.5	-4.56
6	0.8	0.626	5.42	0.72	6	0.34	-4.17
7	-1.91	-1.636	19.95	0.07	6	1.77	-4.37
8	1.26	-0.599	2.87	0.58	6	0.56	-4.07
1							

Terminal year survivor and F summaries :

Age 3 Catchability dependent on age and year class strength

Year class = 1996

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
IceGFS. N.	49299	0.3	0	0	1	0.217	0.048
IceGFS. a3 on a3. N	50368	0.3	0	0	1	0.217	0.047
IceGFS. a2 on a3. N.	58349	0.3	0	0	1	0.217	0.041
IceGFS. SE	1	0	0	0	0	0	0
IceGFS. SW.	40659	0.357	0	0	1	0.153	0.058
TRAWL-JUN-DEC-N	1	0	0	0	0	0	0
TRAWL-JAN-MAY-N	1	0	0	0	0	0	0
TRAWL-JAN-MAY-S	1	0	0	0	0	0	0
GILLNET-JAN-MAY-S	1	0	0	0	0	0	0
TRAWL-JUN-DEC-S	1	0	0	0	0	0	0
P shrinkage mean	110492	0.42				0.114	0.022
F shrinkage mean	97349	0.5				0.081	0.025

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
57816	0.14	0.15	6	1.102	0.041

Table 3.3.11 (Cont'd)

Age 4 Catchability dependent on age and year class strength

Year class = 1995

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
IceGFS. N.	92055	0.212	0.049	0.23	2	0.229	0.186
IceGFS. a3 on a3. N	88406	0.3	0	0	1	0.113	0.193
IceGFS. a2 on a3. N.	95228	0.3	0	0	1	0.113	0.181
IceGFS. SE	127996	0.414	0	0	1	0.061	0.137
IceGFS. SW.	101024	0.24	0.005	0.02	2	0.178	0.171
TRAWL-JUN-DEC-N	86414	0.368	0	0	1	0.077	0.197
TRAWL-JAN-MAY-N	75043	0.3	0	0	1	0.116	0.224
TRAWL-JAN-MAY-S	1	0	0	0	0	0	0
GILLNET-JAN-MAY-S	1	0	0	0	0	0	0
TRAWL-JUN-DEC-S	1	0	0	0	0	0	0
P shrinkage mean	71002	0.44				0.064	0.235
F shrinkage mean	135792	0.5				0.05	0.13

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
92999	0.1	0.05	11	0.496	0.184

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

Year class = 1994

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
IceGFS. N.	28535	0.179	0.114	0.64	3	0.205	0.384
IceGFS. a3 on a3. N	31069	0.3	0	0	1	0.068	0.358
IceGFS. a2 on a3. N.	24932	0.3	0	0	1	0.068	0.429
IceGFS. SE	33585	0.318	0.029	0.09	2	0.066	0.335
IceGFS. SW.	23445	0.202	0.051	0.25	3	0.161	0.451
TRAWL-JUN-DEC-N	26318	0.244	0.177	0.72	2	0.115	0.411
TRAWL-JAN-MAY-N	27032	0.213	0.033	0.16	2	0.149	0.402
TRAWL-JAN-MAY-S	40498	0.3	0	0	1	0.079	0.285
GILLNET-JAN-MAY-S	1	0	0	0	0	0	0
TRAWL-JUN-DEC-S	28583	0.392	0	0	1	0.046	0.383
F shrinkage mean	45524	0.5				0.042	0.257

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
28699	0.08	0.05	17	0.606	0.382

1

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

Year class = 1993

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
IceGFS. N.	34934	0.167	0.189	1.13	4	0.164	0.502
IceGFS. a3 on a3. N	34606	0.302	0	0	1	0.044	0.506
IceGFS. a2 on a3. N.	39988	0.302	0	0	1	0.044	0.451
IceGFS. SE	33649	0.252	0.225	0.89	3	0.082	0.517
IceGFS. SW.	35386	0.177	0.138	0.78	4	0.152	0.497
TRAWL-JUN-DEC-N	33012	0.196	0.03	0.15	3	0.132	0.525
TRAWL-JAN-MAY-N	39625	0.176	0.098	0.56	3	0.163	0.454
TRAWL-JAN-MAY-S	44379	0.214	0.186	0.87	2	0.118	0.415
GILLNET-JAN-MAY-S	1	0	0	0	0	0	0
TRAWL-JUN-DEC-S	43120	0.292	0.012	0.04	2	0.063	0.424
F shrinkage mean	40570	0.5				0.039	0.446

Table 3.3.11 (Cont'd)

Weighted prediction :

Survivors at end of year		Int s.e	Ext s.e	N	Var Ratio	F
	37273	0.07	0.05	24	0.668	0.477

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

Year class = 1992

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
IceGFS. N.	12891	0.166	0.164	0.99	5	0.142	0.611
IceGFS. a3 on a3. N	8986	0.304	0	0	1	0.027	0.792
IceGFS. a2 on a3. N.	9705	0.304	0	0	1	0.027	0.751
IceGFS. SE	11256	0.219	0.096	0.44	4	0.1	0.675
IceGFS. SW.	13345	0.171	0.112	0.66	5	0.142	0.595
TRAWL-JUN-DEC-N	12064	0.173	0.118	0.68	4	0.158	0.642
TRAWL-JAN-MAY-N	11760	0.16	0.093	0.58	4	0.181	0.654
TRAWL-JAN-MAY-S	12497	0.193	0.072	0.37	3	0.127	0.625
GILLNET-JAN-MAY-S	1	0	0	0	0	0	0
TRAWL-JUN-DEC-S	11018	0.288	0.487	1.69	3	0.047	0.686
F shrinkage mean	13883	0.5				0.05	0.578

Weighted prediction :

Survivors at end of year		Int s.e	Ext s.e	N	Var Ratio	F
	12130	0.07	0.05	31	0.691	0.639

1

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

Year class = 1991

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
IceGFS. N.	2579	0.165	0.157	0.95	5	0.092	0.624
IceGFS. a3 on a3. N	1794	0.307	0	0	1	0.017	0.81
IceGFS. a2 on a3. N.	1701	0.307	0	0	1	0.017	0.839
IceGFS. SE	2174	0.218	0.148	0.68	4	0.065	0.708
IceGFS. SW.	2299	0.182	0.11	0.61	6	0.128	0.68
TRAWL-JUN-DEC-N	2670	0.173	0.143	0.82	4	0.101	0.608
TRAWL-JAN-MAY-N	2020	0.163	0.153	0.94	5	0.18	0.745
TRAWL-JAN-MAY-S	2179	0.18	0.152	0.84	4	0.173	0.706
GILLNET-JAN-MAY-S	1565	0.3	0	0	1	0.09	0.888
TRAWL-JUN-DEC-S	1711	0.28	0.317	1.13	4	0.072	0.836
F shrinkage mean	2522	0.5				0.066	0.635

Weighted prediction :

Survivors at end of year		Int s.e	Ext s.e	N	Var Ratio	F
	2145	0.07	0.05	36	0.74	0.715

Table 3.3.11 (Cont'd)

Age 9 Catchability constant w.r.t. time and dependent on age

Year class = 1990

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F	
IceGFS. N.		2851	0.174	0.168	0.96	5	0.071	0.361
IceGFS. a3 on a3. N	2374	0.313	0	0	1	0.011	0.42	
IceGFS. a2 on a3. N.	2548	0.313	0	0	1	0.011	0.396	
IceGFS. SE	2747	0.225	0.145	0.65	4	0.054	0.372	
IceGFS. SW.	2640	0.184	0.079	0.43	6	0.101	0.385	
TRAWL-JUN-DEC-N	2591	0.179	0.145	0.81	4	0.084	0.391	
TRAWL-JAN-MAY-N	2260	0.17	0.108	0.64	6	0.211	0.437	
TRAWL-JAN-MAY-S	2537	0.178	0.062	0.35	4	0.139	0.398	
GILLNET-JAN-MAY-S	2348	0.221	0.184	0.83	2	0.193	0.424	
TRAWL-JUN-DEC-S	2313	0.277	0.13	0.47	4	0.057	0.429	
F shrinkage mean	1065	0.5				0.068	0.772	

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
2327	0.08	0.05	38	0.658	0.427

1

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

Year class = 1989

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
IceGFS. N.	717	0.174	0.138	0.79	5	0.062	0.729
IceGFS. a3 on a3. N	642	0.32	0	0	1	0.01	0.787
IceGFS. a2 on a3. N.	588	0.32	0	0	1	0.01	0.836
IceGFS. SE	821	0.223	0.219	0.98	4	0.047	0.66
IceGFS. SW.	885	0.18	0.068	0.38	6	0.087	0.625
TRAWL-JUN-DEC-N	700	0.192	0.079	0.41	3	0.066	0.741
TRAWL-JAN-MAY-N	892	0.182	0.193	1.06	5	0.17	0.621
TRAWL-JAN-MAY-S	519	0.175	0.063	0.36	4	0.117	0.908
GILLNET-JAN-MAY-S	560	0.224	0.118	0.53	2	0.167	0.863
TRAWL-JUN-DEC-S	588	0.272	0.202	0.74	4	0.048	0.836
F shrinkage mean	605	0.5				0.217	0.819

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
670	0.12	0.05	36	0.407	0.764

Age 11 Catchability constant w.r.t. time and dependent on age

Year class = 1988

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
IceGFS. N.	89	0.189	0.177	0.93	5	0.041	0.878
IceGFS. a3 on a3. N	99	0.331	0	0	1	0.005	0.815
IceGFS. a2 on a3. N.	121	0.331	0	0	1	0.005	0.708
IceGFS. SE	140	0.236	0.162	0.69	4	0.033	0.639
IceGFS. SW.	86	0.197	0.132	0.67	6	0.062	0.897
TRAWL-JUN-DEC-N	75	0.238	0.241	1.02	2	0.038	0.981
TRAWL-JAN-MAY-N	82	0.199	0.052	0.26	4	0.122	0.922
TRAWL-JAN-MAY-S	90	0.202	0.088	0.44	3	0.081	0.87
GILLNET-JAN-MAY-S	73	0.222	0.168	0.76	2	0.133	0.997
TRAWL-JUN-DEC-S	77	0.332	0.221	0.67	3	0.031	0.965
F shrinkage mean	95	0.5				0.448	0.838

Table 3.3.11 (Cont'd)

Weighted prediction :

Survivors at end of year		Int s.e	Ext s.e	N	Var Ratio	F
	89	0.23	0.04	32	0.166	0.877

Age 12 Catchability constant w.r.t. time and age (fixed at the value for age) 11
Year class = 1987

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
IceGFS. N.	28	0.216	0.094	0.43	5	0.023	0.956
IceGFS. a3 on a3. N	34	0.346	0	0	1	0.003	0.838
IceGFS. a2 on a3. N.	41	0.346	0	0	1	0.003	0.731
IceGFS. SE	40	0.258	0.153	0.59	4	0.02	0.752
IceGFS. SW.	35	0.227	0.12	0.53	6	0.04	0.82
TRAWL-JUN-DEC-N	24	0.318	0	0	1	0.018	1.052
TRAWL-JAN-MAY-N	31	0.227	0.12	0.53	3	0.081	0.897
TRAWL-JAN-MAY-S	39	0.246	0.321	1.3	2	0.051	0.755
GILLNET-JAN-MAY-S	40	0.221	0.01	0.05	2	0.104	0.744
TRAWL-JUN-DEC-S	50	0.428	0.036	0.09	2	0.019	0.633
F shrinkage mean	35	0.5				0.639	0.822

Weighted prediction :

Survivors at end of year		Int s.e	Ext s.e	N	Var Ratio	F
	35	0.32	0.03	28	0.093	0.817

Age 13 Catchability constant w.r.t. time and age (fixed at the value for age) 11
Year class = 1986

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
IceGFS. N.	4	0.221	0.1	0.45	5	0.007	1.252
IceGFS. a3 on a3. N	7	0.367	0	0	1	0.001	0.852
IceGFS. a2 on a3. N.	5	0.367	0	0	1	0.001	0.992
IceGFS. SE	3	0.271	0.044	0.16	4	0.006	1.434
IceGFS. SW.	2	0.244	0.193	0.79	6	0.013	1.608
TRAWL-JUN-DEC-N	1	0	0	0	0	0	0
TRAWL-JAN-MAY-N	4	0.295	0.139	0.47	2	0.026	1.211
TRAWL-JAN-MAY-S	4	0.307	0	0	1	0.014	1.166
GILLNET-JAN-MAY-S	6	0.23	0.021	0.09	2	0.045	0.908
TRAWL-JUN-DEC-S	7	0.456	0	0	1	0.006	0.826
F shrinkage mean	5	0.5				0.881	1.072

Weighted prediction :

Survivors at end of year		Int s.e	Ext s.e	N	Var Ratio	F
	5	0.44	0.03	24	0.068	1.077

Age 14 Catchability constant w.r.t. time and age (fixed at the value for age) 11
Year class = 1985

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
IceGFS. N.	3	0.222	0.089	0.4	5	0.003	0.909
IceGFS. a3 on a3. N	5	0.394	0	0	1	0	0.644
IceGFS. a2 on a3. N.	4	0.394	0	0	1	0	0.777
IceGFS. SE	2	0.268	0.2	0.75	4	0.002	1.05
IceGFS. SW.	3	0.27	0.118	0.44	6	0.006	0.916
TRAWL-JUN-DEC-N	1	0	0	0	0	0	0
TRAWL-JAN-MAY-N	4	0.424	0	0	1	0.012	0.769
TRAWL-JAN-MAY-S	1	0	0	0	0	0	0
GILLNET-JAN-MAY-S	4	0.307	0	0	1	0.022	0.807
TRAWL-JUN-DEC-S	1	0	0	0	0	0	0
F shrinkage mean	3	0.5				0.955	0.893

Weighted prediction :

Survivors at end of year		Int s.e	Ext s.e	N	Var Ratio	F
	3	0.48	0.03	20	0.058	0.89

3.3.12. Cod at Iceland. Division Va. Fishing mortality.

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Virtual Population Analysis : Fishing mortality
FINAL-VPA

Age	1980	1981	1982	1983	1984	1985	1986
3	0.034	0.016	0.027	0.017	0.055	0.051	0.070
4	0.176	0.137	0.221	0.120	0.211	0.288	0.222
5	0.358	0.388	0.400	0.433	0.323	0.388	0.580
6	0.378	0.470	0.541	0.622	0.539	0.572	0.697
7	0.442	0.635	0.581	0.767	0.598	0.683	0.883
8	0.554	0.839	1.046	0.852	0.900	0.731	0.936
9	0.514	0.802	1.187	0.930	0.746	0.802	0.806
10	0.453	0.950	0.910	1.082	0.634	0.770	0.764
11	0.425	0.982	0.479	0.671	0.639	0.613	0.740
12	0.700	0.904	0.404	0.678	0.587	0.641	0.672
13	0.171	1.076	0.417	0.533	0.685	0.711	0.445
14	0.453	0.943	0.679	0.779	0.658	0.707	0.685
W.Av 5-10	0.404	0.529	0.582	0.609	0.479	0.486	0.689
Ave 5-10	0.450	0.681	0.777	0.781	0.623	0.658	0.778

Age	1987	1988	1989	1990	1991	1992	1993
3	0.045	0.045	0.035	0.050	0.098	0.080	0.162
4	0.309	0.222	0.265	0.231	0.313	0.381	0.322
5	0.519	0.506	0.485	0.445	0.508	0.636	0.503
6	0.785	0.838	0.602	0.640	0.776	0.895	0.781
7	0.976	0.953	0.727	0.785	0.949	1.100	0.811
8	0.994	1.393	0.875	0.816	0.786	1.024	1.127
9	0.975	1.112	0.819	0.786	0.779	0.619	1.233
10	0.707	0.986	0.546	0.836	0.870	0.530	0.949
11	0.582	1.032	0.665	0.624	0.963	0.391	0.903
12	0.665	0.905	0.975	0.772	0.829	0.710	0.563
13	0.739	2.334	0.575	0.438	0.378	0.361	0.572
14	0.734	1.274	0.716	0.691	0.764	0.522	0.844
W.Av 5-10	0.697	0.629	0.544	0.596	0.751	0.791	0.692
Ave 5-10	0.826	0.965	0.676	0.718	0.778	0.801	0.901

Age	1994	1995	1996	1997	1998	1999	1996-1999
3	0.097	0.076	0.030	0.022	0.023	0.041	0.029
4	0.291	0.204	0.143	0.120	0.128	0.184	0.144
5	0.323	0.339	0.253	0.245	0.273	0.382	0.288
6	0.456	0.370	0.446	0.384	0.501	0.477	0.452
7	0.653	0.539	0.501	0.529	0.692	0.639	0.590
8	0.768	0.527	0.610	0.693	0.587	0.715	0.651
9	0.801	0.436	0.587	0.786	0.923	0.427	0.681
10	0.823	0.619	0.585	0.847	1.004	0.764	0.800
11	0.627	0.654	0.568	0.881	1.037	0.877	0.841
12	0.672	0.755	0.635	0.422	1.375	0.817	0.812
13	0.668	1.162	0.770	0.952	1.369	1.077	1.042
14	0.718	0.725	0.629	0.778	1.142	0.890	0.835
W.Av 5-10	0.396	0.375	0.405	0.357	0.399	0.484	0.415
Ave 5-10	0.637	0.472	0.497	0.581	0.663	0.567	0.577

3.3.13. Cod at Iceland. Division Va. Stock in numbers (millions).

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Virtual Population Analysis : Stock in numbers, millions
FINAL-VPA

Age	1980	1981	1982	1983	1984	1985	1986
3	144.033	143.274	133.575	226.324	139.006	144.030	335.795
4	194.528	113.999	115.390	106.396	182.089	107.717	112.094
5	118.551	133.569	81.350	75.742	77.274	120.679	66.118
6	52.650	67.877	74.178	44.652	40.214	45.817	67.038
7	83.048	29.534	34.736	35.350	19.620	19.203	21.166
8	20.159	50.702	12.818	15.903	13.437	8.835	7.941
9	6.065	9.481	17.940	3.687	5.554	4.471	3.484
10	1.942	2.970	3.480	4.482	1.191	2.156	1.642
11	0.778	1.011	0.940	1.147	1.244	0.517	0.817
12	0.214	0.417	0.310	0.476	0.480	0.537	0.230
13	0.175	0.087	0.138	0.170	0.198	0.219	0.232
14	0.012	0.121	0.024	0.075	0.081	0.082	0.088
Juvenile	477.619	450.104	383.310	444.544	405.967	361.270	531.436
Adult	144.537	102.936	91.570	69.860	74.422	92.993	85.209
Sum 3- 3	144.033	143.274	133.575	226.324	139.006	144.030	335.795
Sum 4-14	478.123	409.766	341.305	288.080	341.383	310.234	280.850
Total	622.156	553.041	474.880	514.404	480.390	454.264	616.645

Age	1987	1988	1989	1990	1991	1992	1993
3	277.516	168.485	82.921	131.891	101.240	174.405	150.793
4	256.301	217.280	131.884	65.538	102.762	75.173	131.769
5	73.478	154.005	142.503	82.811	42.578	61.550	42.061
6	30.294	35.805	76.018	102.813	43.429	20.984	26.683
7	27.346	11.313	12.686	34.105	44.370	16.368	7.020
8	7.168	8.435	3.571	5.022	12.730	14.058	4.463
9	2.551	2.172	1.715	1.219	1.818	4.747	4.132
10	1.274	0.788	0.585	0.619	0.455	0.683	2.093
11	0.627	0.514	0.240	0.277	0.220	0.156	0.329
12	0.319	0.287	0.150	0.101	0.122	0.069	0.086
13	0.096	0.134	0.095	0.046	0.038	0.043	0.028
14	0.122	0.038	0.011	0.044	0.024	0.022	0.025
Juvenile	607.914	516.051	345.131	311.570	246.749	260.140	216.688
Adult	69.176	83.205	107.248	112.916	103.036	108.117	152.794
Sum 3- 3	277.516	168.485	82.921	131.891	101.240	174.405	150.793
Sum 4-14	399.574	430.771	369.458	292.595	248.546	193.853	218.689
Total	677.091	599.256	452.379	424.486	349.785	368.258	369.482

Age	1994	1995	1996	1997	1998	1999	2000
3	73.152	162.217	202.089	88.318	170.379	72.000	212.000
4	104.990	54.336	123.095	160.620	70.754	136.291	56.581
5	78.163	64.256	36.291	87.367	116.682	50.981	92.832
6	20.824	46.324	37.491	23.081	55.968	72.696	28.487
7	10.002	10.802	26.196	19.660	12.874	27.755	36.939
8	2.554	4.263	5.160	13.000	9.488	5.277	11.994
9	1.184	0.970	2.061	2.296	5.322	4.319	2.114
10	0.986	0.435	0.513	0.939	0.857	1.732	2.307
11	0.663	0.355	0.192	0.234	0.329	0.257	0.660
12	0.109	0.290	0.151	0.089	0.079	0.096	0.088
13	0.040	0.046	0.112	0.065	0.048	0.016	0.035
14	0.013	0.017	0.012	0.042	0.021	0.010	0.005
Juvenile	141.781	197.936	348.197	214.085	336.286	262.779	340.967
Adult	150.898	146.374	85.166	181.626	106.514	108.650	104.074
Sum 3- 3	73.152	162.217	202.088	88.318	170.379	72.000	213.000
Sum 4-14	219.528	182.093	231.274	307.393	272.421	299.429	232.041
Total	292.680	344.310	433.363	395.711	442.800	371.429	445.041

3.3.14. Cod at Iceland. Division Va. Stock in weight (tonnes).

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Virtual Population Analysis : Stock weight 1. Jan. in 1000 x tons
FINAL-VPA

Age	1980	1981	1982	1983	1984	1985	1986
3	200.494	169.064	134.376	247.825	179.040	202.650	489.925
4	362.211	188.212	178.855	170.127	314.104	212.310	219.816
5	324.001	301.866	182.712	172.314	200.603	310.870	188.041
6	198.384	223.519	230.249	134.895	144.007	167.234	240.868
7	436.751	132.400	147.906	144.792	85.761	95.554	98.106
8	140.732	295.134	69.040	87.164	77.907	56.296	48.878
9	48.742	73.375	119.873	25.988	41.413	36.696	26.139
10	20.838	27.981	31.809	36.430	11.733	22.251	14.919
11	9.574	11.495	11.244	12.631	13.747	6.311	8.462
12	3.706	5.325	4.411	6.657	6.884	7.892	3.509
13	2.611	1.091	2.388	2.692	3.024	3.537	3.370
14	0.229	2.308	0.404	1.378	1.358	1.557	1.321
Juvenile	1053.176	914.623	715.807	746.863	768.930	756.209	1002.733
Adult	695.097	517.146	397.460	296.031	310.652	366.948	340.620
Sum 3- 3	200.494	169.063	134.376	247.825	179.040	202.650	489.925
Sum 4-14	1547.779	1262.706	978.890	795.069	900.541	920.507	853.428
Total	1748.272	1431.770	1113.266	1042.894	1079.581	1123.157	1343.353

Age	1987	1988	1989	1990	1991	1992	1993
3	365.211	242.281	98.345	170.140	132.523	224.808	209.904
4	501.325	392.190	239.106	111.678	195.145	132.907	248.648
5	197.361	396.717	369.082	197.339	105.381	151.967	116.592
6	117.966	125.997	297.610	311.936	137.191	69.078	100.381
7	128.964	55.775	66.092	157.700	168.251	71.922	34.610
8	44.848	50.620	24.614	32.746	72.305	78.469	27.019
9	18.795	15.516	13.777	10.832	13.166	32.424	30.785
10	11.771	6.949	5.750	6.553	4.459	5.552	18.086
11	6.702	5.129	2.883	3.050	2.142	1.977	3.588
12	3.390	3.363	1.500	1.476	1.745	0.920	1.081
13	1.525	1.903	1.197	0.729	0.543	0.683	0.407
14	1.532	0.489	0.171	0.756	0.494	0.242	0.419
Juvenile	1123.660	1028.407	754.906	621.649	498.325	432.842	388.159
Adult	275.730	268.523	365.223	383.284	335.021	338.108	403.362
Sum 3- 3	365.211	242.281	98.345	170.140	132.523	224.807	209.904
Sum 4-14	1034.179	1054.649	1021.784	834.794	700.823	546.142	581.617
Total	1399.391	1296.930	1120.129	1004.934	833.346	770.950	791.521

Age	1994	1995	1996	1997	1998	1999	2000
3	105.558	218.668	294.443	131.064	209.566	97.128	293.940
4	216.595	106.444	237.574	301.484	126.507	239.463	107.447
5	200.252	187.627	113.664	251.442	289.021	127.300	248.511
6	76.195	167.925	155.251	92.972	200.812	253.126	102.753
7	51.180	55.912	128.938	106.201	64.535	133.337	176.423
8	15.992	27.352	31.006	83.015	69.198	34.042	75.144
9	9.138	7.676	15.265	16.859	41.742	35.927	16.333
10	8.772	4.471	5.015	8.014	7.952	15.974	21.234
11	7.194	3.908	2.021	2.527	3.615	2.742	7.096
12	1.407	3.308	2.038	1.027	1.220	1.133	1.146
13	0.594	0.598	1.528	0.683	0.846	0.247	0.491
14	0.223	0.257	0.189	0.541	0.332	0.150	0.069
Juvenile	285.085	337.644	675.764	447.106	616.060	525.450	627.400
Adult	408.016	446.502	311.168	548.722	399.286	415.119	423.187
Sum 3- 3	105.558	218.668	294.443	131.064	209.566	97.128	293.940
Sum 4-14	587.543	565.478	692.489	864.764	805.781	843.441	756.647
Total	693.101	784.146	986.932	995.828	1015.347	940.569	1050.587

Table 3.3.15. Cod at Iceland. Division Va. Landings ('000 tonnes), average fishing mortality of age groups 5-10, recruitment (at age 3, in millions), spawning stock at spawning time ('000 tonnes).

Year	Landings	F5-10	Recruitmen t	SSB
1955	538	0.31	260	1261
1956	481	0.26	307	1199
1957	452	0.32	153	1145
1958	509	0.32	191	1034
1959	453	0.33	143	928
1960	465	0.38	163	825
1961	374	0.33	292	760
1962	387	0.40	255	729
1963	410	0.45	273	683
1964	434	0.54	328	569
1965	394	0.61	174	454
1966	357	0.54	255	412
1967	345	0.49	186	476
1968	381	0.67	178	594
1969	406	0.53	136	693
1970	471	0.56	303	684
1971	453	0.62	170	615
1972	399	0.71	265	477
1973	383	0.71	432	436
1974	375	0.76	143	329
1975	371	0.81	222	339
1976	348	0.76	246	283
1977	340	0.63	144	319
1978	330	0.48	143	375
1979	368	0.43	134	447
1980	434	0.45	226	602
1981	469	0.68	139	389
1982	388	0.78	144	266
1983	300	0.78	336	213
1984	283	0.62	278	219
1985	325	0.66	168	268
1986	369	0.78	83	268
1987	392	0.83	132	253
1988	378	0.96	101	193
1989	356	0.68	174	268
1990	335	0.72	151	343
1991	309	0.78	73	230
1992	268	0.80	162	243
1993	252	0.90	202	219
1994	179	0.64	88	260
1995	169	0.47	170	339
1996	182	0.50	72	287
1997	203	0.58	212	384
1998	243	0.66	195	387
1999	260	0.57	204	441

Table 3.3.16. Cod at Iceland . Division Va. Estimated mortality due to cannibalism on cod in period 1982-1997[1].

Year/Age	0	1	2	3	4	5
1982	0.10	0.60	0.49	0.16	0.06	0.04
1983	0.06	0.47	0.39	0.19	0.09	0.02
1984	0.11	0.42	0.38	0.18	0.11	0.02
1985	0.15	0.52	0.39	0.2	0.08	0.02
1986	0.14	0.68	0.40	0.19	0.08	0.02
1987	0.10	0.74	0.49	0.19	0.09	0.02
1988	0.07	0.53	0.53	0.22	0.10	0.02
1989	0.06	0.47	0.42	0.26	0.11	0.02
1990	0.08	0.38	0.43	0.24	0.14	0.03
1991	0.06	0.41	0.29	0.20	0.11	0.03
1992	0.06	0.33	0.28	0.13	0.07	0.02
1993	0.06	0.33	0.27	0.12	0.07	0.02
1994	0.06	0.33	0.26	0.14	0.07	0.02
1995	0.06	0.35	0.30	0.16	0.08	0.02
1996	0.08	0.39	0.32	0.18	0.08	0.02
1997	0.07	0.47	0.4	0.22	0.09	0.02

1) No data for 1998-99 were available at the WG meeting.

Table 3.3.17. Cod at Iceland. Division Va. Capelin biomass ('000 tonnes) at 1. August used for prediction of cod mean weights.

Year	Total Biomass
1979	3177
1980	2110
1981	1500
1982	1209
1983	2385
1984	3373
1985	3724
1986	4195
1987	3994
1988	3094
1989	2780
1990	2197
1991	2519
1992	3164
1993	3405
1994	3350
1995	3921
1996	4705
1997	4229
1998	3344
1999	3565
2000	3798
Average	3170

Table 3.3.18. Cod at Iceland. Division Va. Input file for the RCT3 program.

Year class	VPA age3	Surv4	Surv3	Surv2	Surv1
1981	139	55261	-11	-11	-11
1982	144	22540	31297	-11	-11
1983	336	77227	84656	39301	-11
1984	278	92490	99294	52943	16492
1985	168	60113	68604	25874	13903
1986	83	8272	17511	5820	2605
1987	132	22262	19408	14921	1711
1988	101	13601	15633	11786	2048
1989	174	31684	30540	14473	3509
1990	151	18211	26030	16407	1712
1991	73	4301	5556	2237	223
1992	162	19228	17477	10539	1312
1993	202	48173	37466	28480	8920
1994	88	13959	11969	3869	487
1995	170	35495	28949	18566	2454
1996	-11	4451	5985	3570	530
1997	-11	-11	54472	31265	5299
1998	-11	-11	-11	27498	5587
1999	-11	-11	-11	-11	16664

Table 3.3.19. Cod at Iceland. Division. Va. Output from RCT3.

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

Recnwwg.dat

Iceland Cod: VPA and groundfish survey data

Data for    4 surveys over   25 years :  1975 - 1999

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

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

Forecast/Hindcast variance correction used.

Year class =   1996

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

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

Surv4     .54   -.42     .19   .831     15   8.40    4.08     .257    .267
Surv3     .62  -1.28     .22   .795     14   8.70    4.10     .291    .208
Surv2     .52    .04     .19   .844     13   8.18    4.30     .242    .300
Surv1     .39   1.90     .31   .635     12   6.27    4.37     .383    .120

                                        VPA Mean =    4.97     .409    .105


Year class =   1997

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

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

Surv4
Surv3     .62  -1.28     .22   .794     14  10.91    5.48     .272    .299
Surv2     .51    .11     .19   .844     13  10.35    5.43     .233    .407
Surv1     .39   1.92     .31   .640     12   8.58    5.28     .370    .161

                                        VPA Mean =    4.95     .407    .133

Year class =   1998

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

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

Surv4
Surv3
Surv2     .51    .19     .19   .846     13  10.22    5.36     .230    .585
Surv1     .39   1.95     .30   .648     12   8.63    5.31     .371    .225

                                        VPA Mean =    4.94     .404    .190
```

Table 3.3.19 (Continued)

Year class = 1999

Survey/ Series	Slope	Inter-cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
Surv4									
Surv3									
Surv2									
Surv1	.39	1.99	.29	.659	12	9.72	5.74	.415	.481
					VPA Mean =		4.93	.399	.519

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
1996	72	4.28	.13	.13	.96		
1997	212	5.36	.15	.10	.44		
1998	194	5.27	.18	.11	.42		
1999	204	5.32	.29	.41	1.99		

Table 3.3.20

11:35 Wednesday, May 10, 2000
Icelandic cod (Division Va)

Prediction with management option table: Input data

Year: 2000									
Age	Stock size	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
3	212000.00	0.2000	0.0600	0.0850	0.2500	1232.000	0.0270	1380.000
4	56581.000	0.2000	0.3100	0.1800	0.2500	1694.000	0.1350	1899.000
5	92832.000	0.2000	0.5470	0.2480	0.2500	2436.000	0.2820	2677.000
6	28487.000	0.2000	0.7210	0.2960	0.2500	3504.000	0.4260	3614.000
7	36939.000	0.2000	0.8590	0.3820	0.2500	4638.000	0.5820	4782.000
8	11994.000	0.2000	0.9470	0.4370	0.2500	6233.000	0.6240	6280.000
9	2114.000	0.2000	0.9810	0.4770	0.2500	7996.000	0.6680	7728.000
10	2307.000	0.2000	0.9510	0.4770	0.2500	9270.000	0.8180	9204.000
11	660.000	0.2000	0.9990	0.4770	0.2500	11077.000	0.9010	10746.000
12	88.000	0.2000	0.9710	0.4770	0.2500	12832.000	0.9010	13092.000
13	35.000	0.2000	0.9460	0.4770	0.2500	14289.000	0.9010	14210.000
14	5.000	0.2000	1.0000	0.4770	0.2500	15383.000	0.9010	15024.000
Unit	Thousands	-	-	-	-	Grams	-	Grams

Year: 2001									
Age	Recruit-ment	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
3	194000.00	0.2000	0.0600	0.0850	0.2500	1232.000	0.0270	1380.000
4	.	0.2000	0.3100	0.1800	0.2500	1694.000	0.1350	1860.000
5	.	0.2000	0.5470	0.2480	0.2500	2464.000	0.2820	2638.000
6	.	0.2000	0.7210	0.2960	0.2500	3552.000	0.4260	3617.000
7	.	0.2000	0.8590	0.3820	0.2500	4831.000	0.5820	4812.000
8	.	0.2000	0.9470	0.4370	0.2500	6098.000	0.6240	6180.000
9	.	0.2000	0.9810	0.4770	0.2500	7996.000	0.6680	7728.000
10	.	0.2000	0.9510	0.4770	0.2500	9270.000	0.8180	9204.000
11	.	0.2000	0.9990	0.4770	0.2500	11077.000	0.9010	10746.000
12	.	0.2000	0.9710	0.4770	0.2500	12832.000	0.9010	13092.000
13	.	0.2000	0.9460	0.4770	0.2500	14289.000	0.9010	14210.000
14	.	0.2000	1.0000	0.4770	0.2500	15383.000	0.9010	15024.000
Unit	Thousands	-	-	-	-	Grams	-	Grams

Year: 2002									
Age	Recruit-ment	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
3	204000.00	0.2000	0.0600	0.0850	0.2500	1232.000	0.0270	1380.000
4	.	0.2000	0.3100	0.1800	0.2500	1694.000	0.1350	1860.000
5	.	0.2000	0.5470	0.2480	0.2500	2464.000	0.2820	2617.000
6	.	0.2000	0.7210	0.2960	0.2500	3574.000	0.4260	3598.000
7	.	0.2000	0.8590	0.3820	0.2500	4874.000	0.5820	4815.000
8	.	0.2000	0.9470	0.4370	0.2500	6254.000	0.6240	6202.000
9	.	0.2000	0.9810	0.4770	0.2500	7996.000	0.6680	7728.000
10	.	0.2000	0.9510	0.4770	0.2500	9270.000	0.8180	9204.000
11	.	0.2000	0.9990	0.4770	0.2500	11077.000	0.9010	10746.000
12	.	0.2000	0.9710	0.4770	0.2500	12832.000	0.9010	13092.000
13	.	0.2000	0.9460	0.4770	0.2500	14289.000	0.9010	14210.000
14	.	0.2000	1.0000	0.4770	0.2500	15383.000	0.9010	15024.000
Unit	Thousands	-	-	-	-	Grams	-	Grams

Notes: Run name : MANSAS02
Date and time: 03MAY00:23:00

Table 3.3.21

11:35 Wednesday, May 10, 2000
Icelandic cod (Division Va)

Yield per recruit: Input data

Age	Recruit-ment	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
3	1.000	0.2000	0.0319	0.0850	0.2500	1101.350	0.0460	1323.450
4	.	0.2000	0.1120	0.1800	0.2500	1634.300	0.1960	1837.600
5	.	0.2000	0.3070	0.2480	0.2500	2410.400	0.3380	2603.450
6	.	0.2000	0.5613	0.2960	0.2500	3525.000	0.5040	3568.550
7	.	0.2000	0.7817	0.3820	0.2500	4851.550	0.6140	4792.550
8	.	0.2000	0.9025	0.4370	0.2500	6284.150	0.6360	6209.450
9	.	0.2000	0.9512	0.4770	0.2500	7675.300	0.6360	7618.650
10	.	0.2000	0.9669	0.4770	0.2500	9370.800	0.6360	9400.750
11	.	0.2000	0.9951	0.4770	0.2500	11313.050	0.6360	11255.050
12	.	0.2000	0.9956	0.4770	0.2500	13062.700	0.6360	13356.300
13	.	0.2000	0.9987	0.4770	0.2500	14402.200	0.6360	14619.000
14	.	0.2000	1.0000	0.4770	0.2500	15455.547	0.6360	15278.369
Unit	Numbers	-	-	-	-	Grams	-	Grams

Notes: Run name : YLDSAS03
Date and time: 03MAY00:23:03

The SAS System 11:48 Wednesday, May 24, 2000 Icelandic cod (Division Va)

Prediction with management option table

Year: 2000					Year: 2001					Year: 2002	
F Factor	Reference F	Stock biomass	Sp.stock biomass	Catch in weight	F Factor	Reference F	Stock biomass	Sp.stock biomass	Catch in weight	Stock biomass	Sp.stock biomass
1.0057	0.5699	976378	405606	235000	0.0000	0.0000	1066938	500210	0	1455427	766086
.	.	.	.	.	0.1000	0.0567	.	492076	28381	1422043	726280
.	.	.	.	.	0.2000	0.1133	.	484133	55510	1390165	689351
.	.	.	.	.	0.3000	0.1700	.	476376	81455	1359713	655064
.	.	.	.	.	0.4000	0.2267	.	468801	106277	1330610	623203
.	.	.	.	.	0.5000	0.2833	.	461401	130036	1302787	593572
.	.	.	.	.	0.6000	0.3400	.	454172	152788	1276174	565992
.	.	.	.	.	0.7000	0.3967	.	447110	174584	1250710	540299
.	.	.	.	.	0.8000	0.4533	.	440210	195474	1226333	516345
.	.	.	.	.	0.9000	0.5100	.	433467	215505	1202989	493991
.	.	.	.	.	1.0000	0.5667	.	426878	234721	1180623	473114
.	.	.	.	.	1.1000	0.6233	.	420438	253162	1159185	453598
.	.	.	.	.	1.2000	0.6800	.	414144	270869	1138629	435339
.	.	.	.	.	1.3000	0.7367	.	407990	287877	1118909	418241
.	.	.	.	.	1.4000	0.7933	.	401975	304222	1099984	402215
.	.	.	.	.	1.5000	0.8500	.	396094	319937	1081813	387181
-	-	Tonnes	Tonnes	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes

Notes: Run name : MANSAS02
Date and time : 03MAY00:23:00
Computation of ref. F: Simple mean, age 5 - 10
Basis for 2000 : TAC constraints

Table 3.3.22

11:35 Wednesday, May 10, 2000
Icelandic cod (Division Va)

Yield per recruit: Summary table

F Factor	Reference F	Catch in numbers	Catch in weight	Stock size	Stock biomass	1 January Sp.stock size	1 January Sp.stock biomass	Spawning time Sp.stock size	Spawning time Sp.stock biomass
0.0000	0.0000	0.000	0.000	5.016	23208.985	2.457	18072.404	2.337	17191.003
0.0500	0.0280	0.080	500.325	4.749	20630.476	2.215	15604.999	2.083	14643.075
0.1000	0.0561	0.146	867.438	4.518	18478.999	2.009	13557.352	1.868	12554.016
0.1500	0.0841	0.201	1135.808	4.318	16674.727	1.832	11850.342	1.686	10832.959
0.2000	0.1121	0.246	1331.000	4.144	15153.754	1.680	10420.685	1.530	9408.089
0.2500	0.1402	0.285	1471.982	3.991	13864.786	1.548	9217.637	1.396	8222.494
0.3000	0.1682	0.318	1572.830	3.856	12766.541	1.433	8200.400	1.281	7230.941
0.3500	0.1962	0.347	1643.993	3.736	11825.699	1.332	7336.084	1.181	6397.371
0.4000	0.2243	0.371	1693.227	3.628	11015.287	1.243	6598.100	1.094	5692.955
0.4500	0.2523	0.393	1726.293	3.532	10313.406	1.165	5964.888	1.017	5094.563
0.5000	0.2803	0.413	1747.465	3.445	9702.215	1.096	5418.912	0.950	4583.583
0.5500	0.3084	0.430	1759.920	3.366	9167.136	1.034	4945.868	0.890	4144.982
0.6000	0.3364	0.445	1766.013	3.294	8696.216	0.978	4534.046	0.837	3766.578
0.6500	0.3644	0.459	1767.493	3.228	8279.618	0.928	4173.831	0.789	3438.462
0.7000	0.3925	0.472	1765.657	3.168	7909.221	0.882	3857.298	0.746	3152.545
0.7500	0.4205	0.484	1761.465	3.112	7578.292	0.841	3577.896	0.708	2902.199
0.8000	0.4485	0.495	1755.627	3.060	7281.234	0.804	3330.188	0.673	2681.970
0.8500	0.4766	0.505	1748.668	3.012	7013.371	0.770	3109.648	0.641	2487.355
0.9000	0.5046	0.514	1740.973	2.967	6770.784	0.738	2912.490	0.612	2314.622
0.9500	0.5326	0.523	1732.826	2.925	6550.178	0.709	2735.541	0.586	2160.662
1.0000	0.5607	0.531	1724.434	2.886	6348.768	0.682	2576.127	0.561	2022.881
1.0500	0.5887	0.539	1715.946	2.849	6164.192	0.658	2431.990	0.539	1899.098
1.1000	0.6167	0.546	1707.470	2.814	5994.441	0.635	2301.213	0.518	1787.478
1.1500	0.6448	0.553	1699.084	2.781	5837.799	0.613	2182.166	0.499	1686.471
1.2000	0.6728	0.559	1690.839	2.750	5692.791	0.594	2073.455	0.481	1594.757
1.2500	0.7008	0.565	1682.772	2.720	5558.149	0.575	1973.883	0.464	1511.215
1.3000	0.7289	0.571	1674.907	2.692	5432.778	0.557	1882.423	0.449	1434.883
1.3500	0.7569	0.577	1667.258	2.665	5315.726	0.541	1798.185	0.434	1364.937
1.4000	0.7849	0.582	1659.832	2.639	5206.166	0.526	1720.399	0.421	1300.664
1.4500	0.8130	0.587	1652.632	2.614	5103.373	0.511	1648.395	0.408	1241.451
1.5000	0.8410	0.592	1645.658	2.591	5006.713	0.498	1581.588	0.396	1186.761
1.5500	0.8690	0.597	1638.906	2.568	4915.629	0.485	1519.466	0.385	1136.131
1.6000	0.8971	0.601	1632.372	2.547	4829.626	0.472	1461.580	0.374	1089.153
1.6500	0.9251	0.605	1626.048	2.526	4748.270	0.461	1407.533	0.364	1045.470
1.7000	0.9531	0.610	1619.928	2.506	4671.171	0.450	1356.975	0.354	1004.770
1.7500	0.9812	0.614	1614.006	2.486	4597.986	0.439	1309.595	0.345	966.774
1.8000	1.0092	0.617	1608.273	2.468	4528.404	0.429	1265.119	0.337	931.238
1.8500	1.0372	0.621	1602.722	2.450	4462.149	0.420	1223.299	0.329	897.944
1.9000	1.0653	0.625	1597.346	2.432	4398.972	0.411	1183.916	0.321	866.699
1.9500	1.0933	0.628	1592.138	2.416	4338.649	0.402	1146.773	0.313	837.329
2.0000	1.1213	0.632	1587.090	2.399	4280.978	0.394	1111.694	0.306	809.681
2.0500	1.1494	0.635	1582.196	2.384	4225.775	0.386	1078.518	0.300	783.615
2.1000	1.1774	0.638	1577.449	2.368	4172.874	0.378	1047.102	0.293	759.007
2.1500	1.2054	0.641	1572.842	2.354	4122.123	0.371	1017.317	0.287	735.745
2.2000	1.2335	0.644	1568.371	2.339	4073.384	0.364	989.044	0.281	713.726
2.2500	1.2615	0.647	1564.029	2.325	4026.530	0.357	962.176	0.275	692.860
2.3000	1.2895	0.650	1559.811	2.312	3981.447	0.351	936.616	0.270	673.062
2.3500	1.3176	0.653	1555.712	2.298	3938.027	0.345	912.274	0.265	654.257
2.4000	1.3456	0.655	1551.726	2.286	3896.174	0.339	889.071	0.260	636.376
2.4500	1.3736	0.658	1547.849	2.273	3855.798	0.333	866.931	0.255	619.357
2.5000	1.4017	0.661	1544.078	2.261	3816.815	0.327	845.786	0.250	603.141
2.5500	1.4297	0.663	1540.406	2.249	3779.149	0.322	825.573	0.246	587.676
2.6000	1.4577	0.666	1536.831	2.237	3742.730	0.317	806.236	0.242	572.914
2.6500	1.4858	0.668	1533.349	2.226	3707.491	0.312	787.721	0.238	558.810
2.7000	1.5138	0.670	1529.956	2.215	3673.372	0.307	769.979	0.234	545.323
2.7500	1.5418	0.673	1526.648	2.204	3640.316	0.303	752.966	0.230	532.417
2.8000	1.5699	0.675	1523.423	2.194	3608.269	0.298	736.638	0.226	520.056
2.8500	1.5979	0.677	1520.277	2.183	3577.183	0.294	720.957	0.222	508.208
2.9000	1.6259	0.679	1517.208	2.173	3547.012	0.289	705.888	0.219	496.843
2.9500	1.6540	0.681	1514.211	2.163	3517.713	0.285	691.397	0.216	485.935
3.0000	1.6820	0.683	1511.286	2.154	3489.245	0.281	677.453	0.212	475.457
-	-	Numbers	Grams	Numbers	Grams	Numbers	Grams	Numbers	Grams

Notes: Run name : YLDSAS03
Date and time : 03MAY00:23:03
Computation of ref. F: Simple mean, age 5 - 10
F-0.1 factor : 0.3522
F-max factor : 0.6446
F-0.1 reference F : 0.1975
F-max reference F : 0.3614
Recruitment : Single recruit

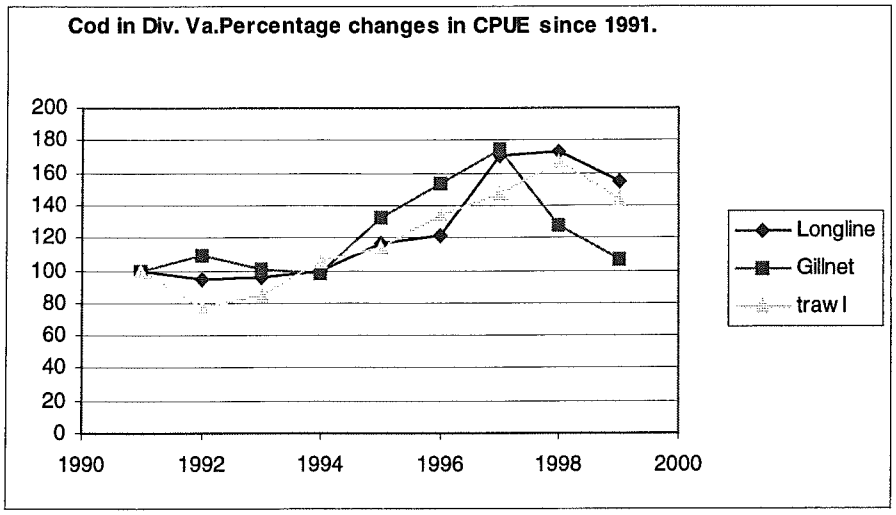


Figure 3.3.1. Cod at Iceland Division Va. Percentage changes in CPUE for the main gears since 1991.

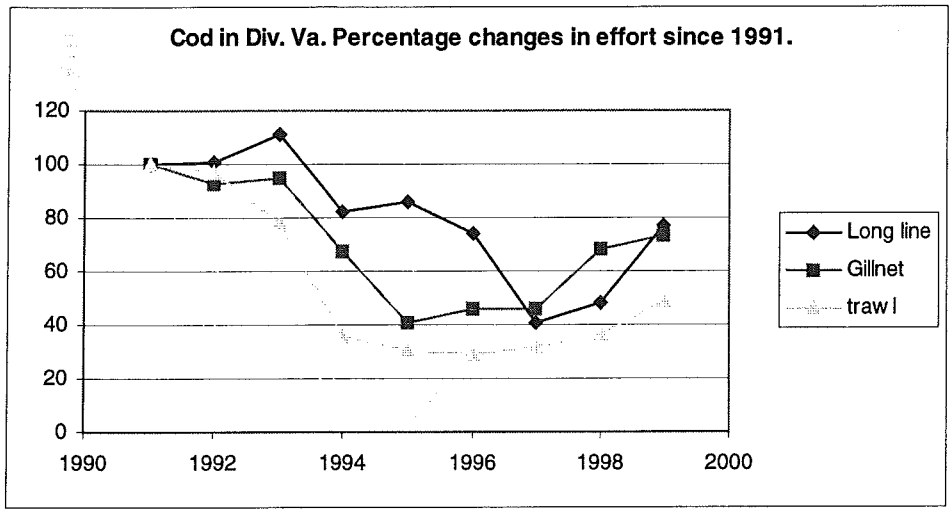


Figure 3.3.2. Cod at Iceland Division Va. Percentage changes in effort for the main gears since 1991.

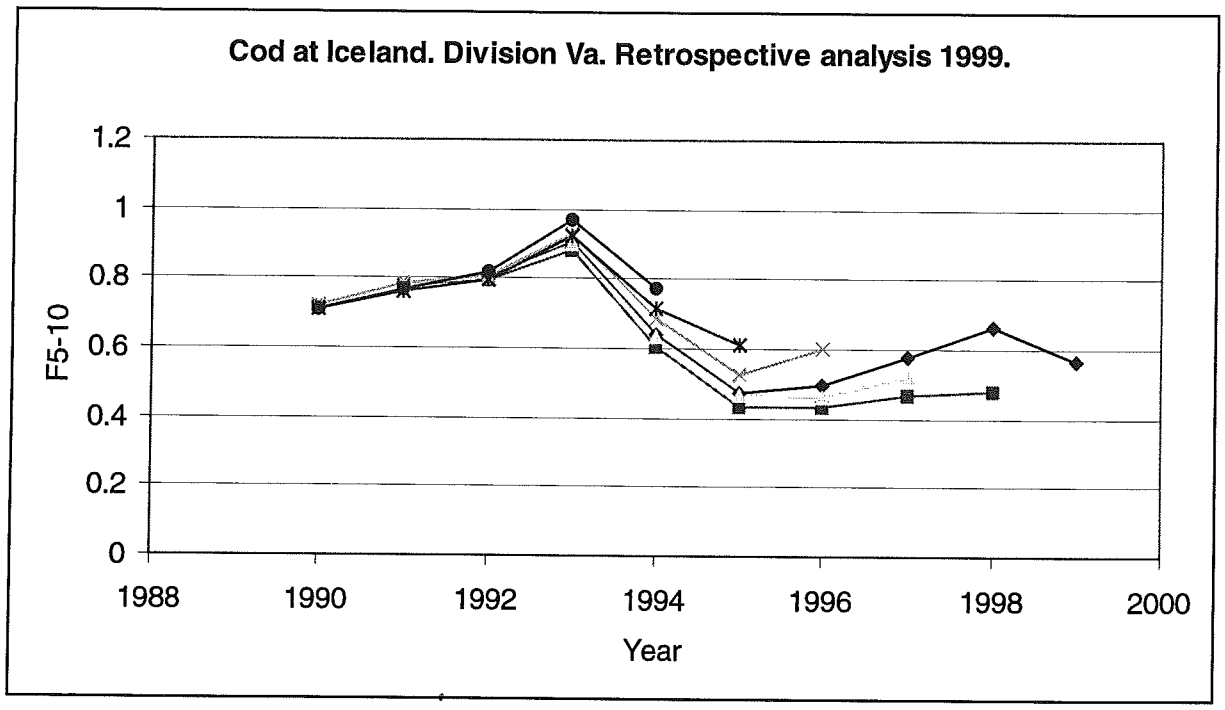


Figure 3.3.3. Cod at Iceland Division Va. Retrospective analysis of the XSA.

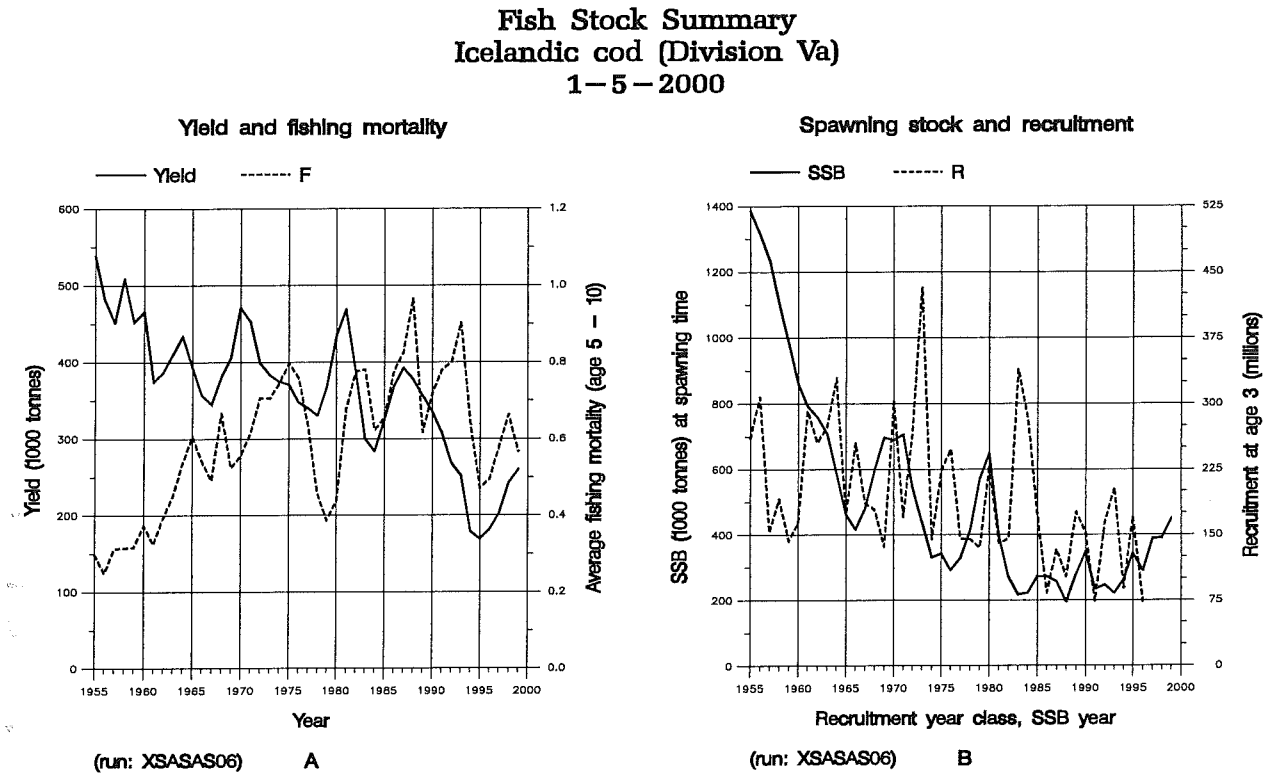


Figure 3.3.4

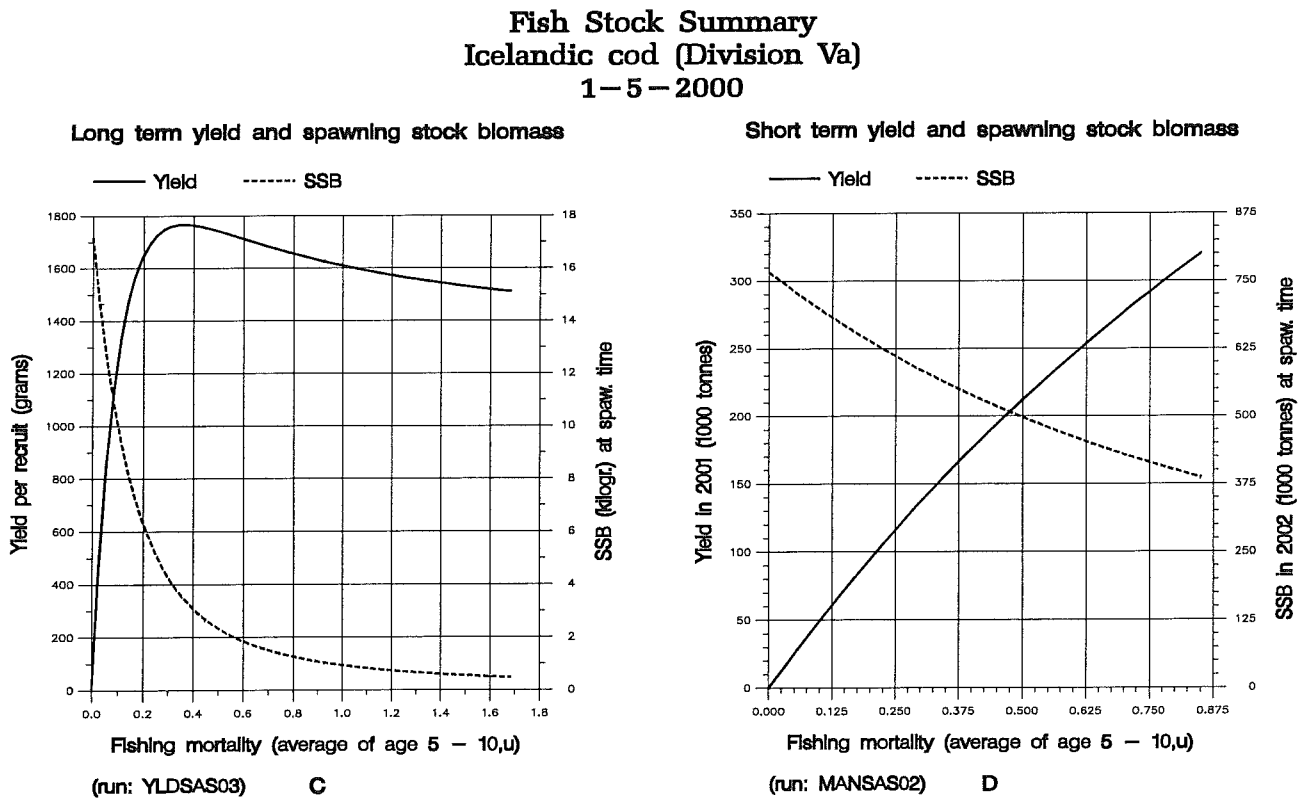


Figure 3.3.5

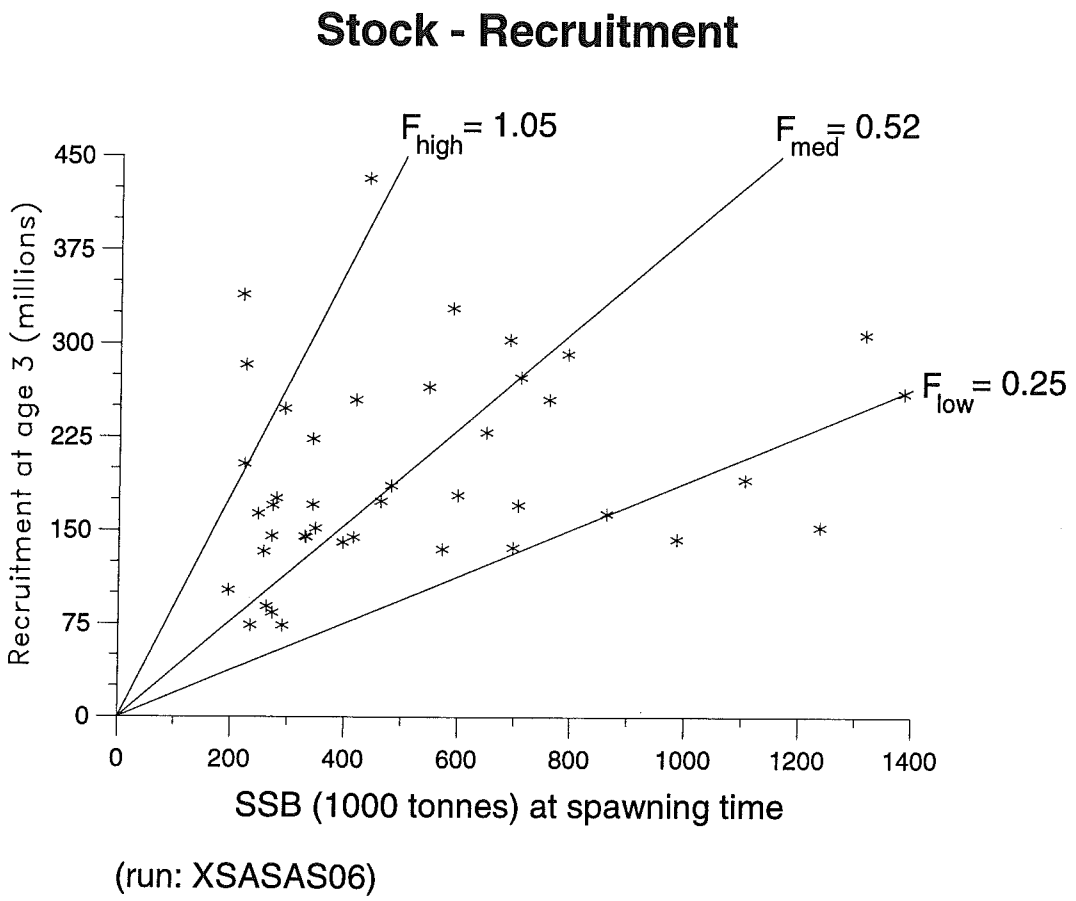

Stock - Recruitment
F high = 1.05
F med = 0.52
F low = 0.25
Recruitment at age 3 (millions)
450
375
300
225
150
75
0
0
200
400
600
800
1000
1200
1400
SSB (1000 tonnes) at spawning time
(run: XSASAS06)

Figure 3.3.6

3.4 Icelandic haddock

3.4.1 Introductory comment

Haddock (*Melanogrammus aeglefinus*) in Icelandic waters is only connected with other haddock stocks in that 0-group and occasionally young fish found in E-Greenland waters originate from the Icelandic stock. The species is distributed all around the Icelandic coast, principally in the relatively warm waters off the west and south coast, on fairly shallow grounds.

Icelandic haddock was assessed at the North-Western Working Group in 1970 and 1976 but otherwise assessments were conducted by the Marine Research Institute in Iceland until in 1999 when it was again assessed by the North-Western Working Group.

3.4.2 Trends in landings and fisheries

During the sixties haddock landings rose to the record level of around 100 000 t for several years (Figure 3.4.2.1). After that, landings fell to 40–60 000 t (Table 3.4.2.1). Historically landings by foreign fleets accounted for up to half of the total landed catch, but since 1976 landings by other nations have been negligible. The only other nation catching haddock in Icelandic waters are the Faroese. Haddock landings are subject to fluctuations, reflecting variability in stock biomass and recruitment which is very variable.

The landings in 1999 are estimated as 45 500 tonnes increasing from 41 500 t last year. In 1999, 58% of landings were by demersal trawl, 6% by Danish seine, 32% by long line and 4% by gillnets. The forecast from last year was 37 000 tonnes for the year 1999 so the landed catch exceeded the forecast by more than 8000 t. A large part of this increase in catch is due to unused quota from former years, but in the Icelandic quota system, part of unused quota can be transferred between years. Currently little quota is unused from last fishing year.

Although fleet composition has been relatively stable for many years, during this decade an increased proportion of landings have been by long line while the share by gill-netting has decreased. Between 1998 and 1999 the contribution of longline in the catch increased from 25 to 32%. This increase is due to increased longline effort where cod is probably the main target species.

3.4.3 Catch at age

Catch at age for 1999 for the Icelandic fishery is provided in Table 3.4.3.1. Catch at age is calculated by 3 fleets and two time intervals. The time intervals are January-May and June-December and the fleets are gill nets, long line and bottom trawl. Hand lines are included with the long line fleet. Danish seine (as well as minor units such as pelagic trawl and other gears which are dragged or hauled) are included in the trawl feet. The Faroese catch that is caught by long line is included in that category. Numbers sampled in 1999 are given below.

Gear	Total landings	Samples- length	Samples - aged
Longline	14635	8571	1684
Gillnets	1689	1725	464
Trawl	29517	101022	4939
Total	45841	111318	7088

3.4.4 Weight at age

Mean weight at age in the catch (Table 3.4.4.1) is computed for the same categories as the catch at age and then weighted by the share of the landings in each category.

Mean weight at age in the stock for 1978–1999 is given in Table 3.4.4.2. These data were calculated from the Icelandic groundfish survey. Weights for 1985–1992 were calculated using a length-weight relationship which is the mean of the years 1993–2000. Weights from 1993 onwards are based on weighing of fish in the groundfish survey each year. Stock weights prior to 1985 have been taken to be the mean of 1985-1999.

3.4.5 Maturity at age

Maturity at age is based on samples from the Icelandic groundfish survey for the years 1985–1999. For 1979–84, maturity at age is based on samples from the commercial fleet from the first 5 months of the year.

There was an increase in the proportion of mature fish at age after 1992. This development was especially notable for the youngest age group (2) but since 1994 there has been a gradual decline in the proportion mature at age 2. The proportion mature in 2000 is the lowest for many years. The maturity at age data are given in Table 3.4.5.1.

3.4.6 Stock Assessment

3.4.6.1 Tuning input

CPUE data, based on Icelandic trawler logbooks from 1970–1999, from the longline fleet from 1988 and from the gillnet fleet from 1988 are available (Figure 3.4.6.1.1). As seen in the picture the indices show different trends between 1998 and 1999, the longline CPUE goes down, the CPUE from all trawlers > 300 tons up, the index from all trawlers goes down and the CPUE from gillnets is steady.

The same fleets were used in tuning as last year, i.e., all trawlers, gillnets and the groundfish survey. GLIM indices based on settings where more than 50% of the catch was haddock (Stefansson 1988) were used for the gillnets but raw CPUE from tows where more than 70% of the catch was haddock for trawlers. Indices were age disaggregated according to catch in number for the gear.

The age disggregated survey indices from the groundfish survey are calculated with the Cochran method, using stratas following depth contours. The data is disaggregated by calculating age-length keys for two regions, north and south. To use the latest information available, survey abundance indices were moved back in time approximately 3 months. The resulting age disaggregated indices for the trawl, gillnet and the survey are given in Table 3.4.6.1.1.

3.4.6.2 Tuning and estimation of fishing mortality

The same XSA run as last year was used in the assessment, including survey indices along with bottom trawl and gillnet CPUE. The survey data covers the years 1985–2000 age groups 3–9; trawl 1993–1999 age groups 4–9 and gill nets 1993–1998 age groups 5–8 (Table 3.4.6.2.1).

Shrinkage was set to 2 years with SE as 0.5 as last year. Varying the shrinkage did not affect the results much.

Fishing mortalities are given in Table 3.4.6.2.2. The resulting mean F in 1999 for age groups 4–7 from the final run was 0.62. The plot of yield and fishing mortality (Figure 3.4.6.2.2) indicates that fishing mortality increased substantially in 1986 before falling slightly the following year and has been stable since then. A decrease in fishing mortality was expected in 1999 but as described in Section 3.1.2 the landings in 1999 exceeded forecast by 8000 tons (20%) keeping the fishing mortality in 1999 at the same level as in 1998.

3.4.6.3 Stock and recruitment estimates

The resulting stock size in numbers and summary table from the final XSA are given in Tables 3.4.6.3.1 and 3.4.6.3.2. The spawning stock and recruitment plot (Figure 3.4.6.2.2) shows that although SSB is highly variable - ranging from a low of 42 000 t in 1987 to a maximum of 110 000 t in 1982 - there are no trends. The spawning stock in 1999 is estimated to be 65 000 t, decreasing to 52 000 t in 2000, which is the second lowest since 1980. Part of this descrease is due to changes in maturity at age between the years 1999 and 2000.

3.4.7 Prediction of catch and biomass

3.4.7.1 Input data

The input data for the prediction is shown in Table 3.4.7.1.1.

For the short-term catch prediction and stock biomass calculations, the mean weight at age 3–8 in the catches were predicted using regression analysis, where the mean weight at age was predicted by the mean weight of the year class in the previous year. For the age groups 2, means of the years 1997–1999 were used.

For the stock weights survey weights for the year 2000 were used for that year, but for the years 2001 and 2002 mean weight at age was predicted by mean weight of the year class in the survey the previous year. The exploitation pattern was taken as the mean from 1997–1999, scaled to the level in 1999.

Recruitment for 1999, 2000 and 2001 was estimated using a prediction program (RCT3, as described in Section 3.3.7.3) with input from VPA runs and the survey (age groups 1–4), Tables 3.4.7.1.2 and 3.4.7.1.3. Recruitment for 2001 was taken to be the geometric mean of recruitment from 1978–1997. A TAC constraint of 39 000 t was applied to the prediction for 2000 as that is the forecasted catch for the year 2000.

For the long-term yield and spawning stock biomass per recruit, the exploitation pattern was taken as the mean relative fishing mortality from 1978–1997. Mean weight at age in the stock and the maturity ogive are means from 1985-1998. Mean weight at age in the catch is the mean from 1978–1998. Input data for long-term yield per recruit are given in Table 3.4.7.1.4.

3.4.7.2 Biological reference points

The yield and spawning stock biomass per recruit curves are shown in Figure 3.4.7.2.1.

Compared to the estimated fishing mortality of $F_{4-7} = 0.62$ for 1998, $F_{max} = 0.43$ and $F_{0.1} = 0.29$.

Yield per recruit at F_{max} corresponds to 0.89 kg (Table 3.4.7.2.1).

A plot of spawning stock biomass and recruitment from 1979-1999 is shown in Figure 3.4.7.2.2. The SSB-recruit reference points F_{med} and F_{high} are 0.47 and 1.43 respectively, where F_{high} is the fishing mortality rate with SSB/R equal to the inverse of the 90 th percentile of the observed R/SSB.

Since 1986 F_{4-7} has exceeded F_{max} and for only 2 years since 1978 has F_{4-7} been lower than F_{med}.

It is proposed that F_{pa} is set to the F_{med} value of 0.47.

3.4.7.3 Projection of catch and biomass

At the beginning of 2000, the total stock is estimated to be 103 000 t with a spawning stock of 52 000 t (Table 3.4.7.3.1). The forecasts from last year for the year 2000 were 110 000 t for the total biomass and 68 000 t for the spawning stock. The discrepancy in the total stock is explained by commercial catch in 1999 exceeding predictions by 8000 t, while the change in spawning stock is larger caused by lower maturity at age in 2000 than in prior years. This change in maturity at age is notthing to be worried about but raises the question taking mean maturity at age for some years instead of using estimated values each year.

With a catch of 39 000 t in 2000, fishing mortality is estimated to be 0.6, the stock biomass 112 000 t and the spawning stock biomass 64 000 t at the start of 2001. Assuming fishing mortality of 0.47 in 2001 (F_{med}) the catch in 2001 will be 31 500 t. At the start of the year 2002 the spawning stock biomass will then be 76 000 t and the total biomass will be 126 000 t.

3.4.8 Management considerations

For more than a decade fishing mortality on haddock has been high with F_{4-7} between 0.6 and 0.7 since 1986. The advice in 1999 was based on F_{med} and if followed would have meant substantial reduction in fishing mortality while the real outcome was that the fishing mortality was at the same level as it has been.

The assessment results show that the 1996 and 1997 year classes are small, specially the 1996 year class. The 1998 and 1999 year classes are on the other hand above average. In the fishery year 2000–2001 the composition of the stock will be such that a large portion of it will be below landing size. To protect incoming recruitment fishing effort should be limited.

3.4.9 Comments on the assessment

The current assessment was done using the same settings as last year.

Fishing mortality on haddock increased after 1985 (Figure 3.4.6.2.2) The high fishing mortality was at least partly due to an overestimation of the stock biomass through the use of catch weights that are 20–25% higher than survey weights which have been used in the assessments of the last 2 years.

Work is currently being carried out constructing a longer time series of data than used in the present assessment. Preliminary results are available back to 1960. It is not always easy to select which samples to use for calculating catch in numbers from the old data. Therefore 5 different sets of catch in number have been presented.

According to preliminary runs the fishing mortality was high (0.7) during the sixties and early seventies, but dropped to 0.4 in the late seventies with the introduction of the very good 1976 year class to the fishery at the same time as reduction of foreign catch. The fishing mortality in 1980 was 0.4 which is the lowest in the timeperiod and there are only 3 years since 1962 where the fishing mortality was below the proposed F_{pa} of 0.47. F_{crash} was larger than 1.3 irrespective of which data set was chosen. Therefore F_{crash} is an unsuitable candidate for F_{lim}.

The data were used to calculate reference points. F_{msy} varied from 0.53 to 0.61 and F_{med} from 0.51 to 0.62, depending on which data set was selected. This is to be contrasted with $F_{med} = 0.47$ obtained using data since 1980. The dataset having the best internal consistency according to the Shephard-Nicholson model gives $F_{med} = 0.525$ and $F_{msy} = 0.51$, both above the proposed F_{pa} of 0.47, but close to it.

The groundfish survey in the year 2000 gave the lowest ever abundance indices of adult haddock. Using the survey only in tuning gives $F_{4-7} = 0.8$ in 1999 compared to 0.62 in the 3 fleet run. Although catchability in the 2000 survey is considered to be low, the 2000 survey index is of concern. The autumn survey in October 1999 did on the other hand not show this reduction.

Table 3.4.2.1

HADDOCK Va

Country	1978	1979	1980	1981	1982	1983	1984	1985
Belgium	807	1010	1144	673	377	268	359	391
Faroe Islands	2116	2161	2029	1839	1982	1783	707	987
Iceland	40552	52152	47916	61033	67038	63889	47216	49553
Norway	13	11	23	15	28	3	3	+
UK								
Total	43488	55334	51112	63560	69425	65943	48285	50933

HADDOCK Va

Country	1986	1987	1988	1989	1990	1991	1992	1993
Belgium	257	238	352	483	595	485	361	458
Faroe Islands	1289	1043	797	606	603	773	757	754
Iceland	47317	39479	53085	61792	66004	53516	46098	46932
Norway		1	+					
UK								
Total	48863	40761	54234	62881	67202	53774	47216	48144

HADDOCK Va

Country	1994	1995	1996	1997	1998	1999
Belgium	248					
Faroe Islands	911	758	664	340	639	624
Iceland	58408	60061	56223	43245	40795	44557
Norway	1	+	4			
UK						
Total	59567	60819	56891	43585	41434	45481

Table 3.4.3.1 Haddock in division Va. Catch at age 1978-1999

Run title : Haddock Icelandic Va (run: XSAHOB03/X03)

At 3/05/2000 9:10

Catch numbers at age Numbers*10**-3

YEAR	1978	1979
AGE		
2	108	161
3	579	2066
4	2132	4047
5	7188	6559
6	4481	9769
7	1821	1887
8	627	474
9	94	61
0 TOTALNUM	17030	25024
TONSLAND	43488	55334
SOPCOF %	105	94

Catch numbers at age Numbers*10**-3

YEAR	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
AGE										
2	595	1	50	1	60	427	196	2237	133	78
3	1384	516	286	705	755	1773	3681	7559	10068	2603
4	11476	4929	2698	1498	4970	4981	3822	7500	15927	23077
5	4296	16961	10703	4645	1176	6058	4933	2696	5598	9703
6	3796	6021	14115	10301	4875	837	5761	2249	1260	3118
7	3730	2835	2288	8808	3772	1564	493	1194	1009	541
8	544	1810	1167	874	4446	2475	852	151	577	507
9	91	169	816	241	171	2212	898	208	58	144
0 TOTALNUM	25912	33242	32123	27073	20225	20327	20636	23794	34630	39771
TONSLAND	51112	63580	69325	65943	48285	50933	48863	40801	54236	62979
SOPCOF %	100	100	101	102	100	101	103	102	101	100

Run title : Haddock Icelandic Va (run: XSAHOB03/X03)

Catch numbers at age Numbers*10**-3

YEAR	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
AGE										
2	446	2461	2726	218	280	2357	1467	1375	207	1077
3	2603	1282	7343	11617	3030	6327	8982	3690	8109	1455
4	7994	3942	4181	12642	27025	5667	7076	11127	5984	16897
5	23803	6711	4158	3167	10722	23357	4751	4885	8390	4844
6	6654	13650	3989	1786	1550	5605	13963	2540	2420	4982
7	857	2956	5936	1504	756	610	2446	4981	1502	942
8	167	398	1314	2263	404	263	228	692	1884	588
9	71	52	132	379	700	210	87	52	207	514
TOTALNUM	42595	31452	29779	33576	44467	44396	39000	29342	28703	31299
TONSLAND	67200	54732	47212	48844	59345	61131	56958	44053	41434	45841
SOPCOF %	100	100	100	100	101	102	100	100	100	101

Table 3.4.4.1 Haddock in Division Va. Mean weight at age in the catch 1978 – 1999.

Run title : Haddock Icelandic Va (run: XSAHOB03/X03)

Catch weights at age (kg)

	YEAR	1978	1979
	AGE		
	2	.6200	.6200
	3	.9600	.9600
	4	1.4100	1.4100
	5	2.0300	2.0300
	6	2.9100	2.9100
	7	3.8000	3.8000
	8	4.5600	4.5600
	9	4.7200	4.7200
0	SOPCOFAC	1.0483	.9355

Catch weights at age (kg)

YEAR	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
AGE										
2	.8370	.5840	.3300	.6550	.9800	.5990	.8670	.4460	.4680	.7450
3	.8310	.6930	.8190	.9580	1.0410	1.0020	1.1870	1.0480	.8080	.8560
4	1.3060	1.0810	1.3650	1.4360	1.4760	1.7830	1.7550	1.6290	1.4740	1.1700
5	2.2070	1.6560	1.6490	1.8270	2.1050	2.2010	2.3770	2.3730	2.2300	2.0100
6	2.7380	2.2830	2.3290	2.3550	2.4600	2.7270	2.7100	2.9840	2.9340	2.8790
7	3.1880	3.2140	3.0120	2.8340	3.0280	3.4310	3.5910	3.5500	3.5450	4.1090
8	3.8430	3.4090	3.3840	3.5690	3.0140	3.7830	3.7600	4.4830	3.7690	4.0350
9	4.5060	4.0460	3.9650	4.3080	3.8070	4.0700	4.1350	4.6670	4.5740	4.7060
SOPCOFAC	1.0041	1.0015	1.0116	1.0193	1.0034	1.0134	1.0337	1.0167	1.0068	1.0042

Run title : Haddock Icelandic Va (run: XSAHOB03/X03)

Catch weights at age (kg)

YEAR	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
AGE										
2	.3570	.4090	.3200	.4200	.5680	.4750	.3870	.4500	.4750	.6160
3	.7160	.8680	.8560	.7560	.7200	.8740	.8410	.8290	.7020	.8660
4	1.0390	1.1110	1.2530	1.3720	1.0580	1.1450	1.1890	1.1920	1.1080	1.0960
5	1.5420	1.5460	1.5970	1.8700	1.7420	1.3660	1.5280	1.6630	1.6460	1.6380
6	2.4030	2.0350	2.0880	2.3600	2.3800	2.0790	1.8160	1.9340	2.2220	2.2050
7	3.4580	2.8490	2.5290	2.8880	2.7850	2.8530	2.6410	2.3600	2.4780	2.6810
8	4.1860	3.4640	3.1330	2.9750	3.4470	3.2510	3.4990	3.0590	2.8390	2.8630
9	4.9690	4.6420	4.0220	3.4420	3.1560	3.8990	3.5260	3.0100	3.3590	3.2990
SOPCOFAC	1.0024	1.0007	1.0040	1.0022	1.0057	1.0170	1.0043	1.0011	1.0014	1.0127

Table 3.4.4.2 Haddock in Division Va. Mean weight (kg) at age in the stock 1978 - 1998.

Run title : Haddock Icelandic Va (run: XSAHOB03/X03)

Stock weights at age (kg)

YEAR	1978	1979
AGE		
2	.1850	.1850
3	.4750	.4750
4	.9010	.9010
5	1.4110	1.4110
6	2.0040	2.0040
7	2.5260	2.5260
8	3.2010	3.2010
9	3.2660	3.2660

Stock weights at age (kg)

YEAR	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
AGE										
2	.1850	.1850	.1850	.1850	.1850	.2450	.2340	.1570	.1760	.1810
3	.4750	.4750	.4750	.4750	.4750	.5550	.6770	.5640	.4530	.4390
4	.9010	.9010	.9010	.9010	.9010	1.1580	1.1280	1.2110	.9690	.8850
5	1.4110	1.4110	1.4110	1.4110	1.4110	1.6290	1.9290	1.8250	1.8260	1.5020
6	2.0040	2.0040	2.0040	2.0040	2.0040	2.3490	2.3710	2.5960	2.6790	2.3800
7	2.5260	2.5260	2.5260	2.5260	2.5260	2.7360	3.1490	3.0200	3.0890	2.9870
8	3.2010	3.2010	3.2010	3.2010	3.2010	3.2130	3.2410	3.6260	3.4640	3.5030
9	3.2660	3.2660	3.2660	3.2660	3.2660	3.3020	3.6880	3.8180	3.2940	3.1940

Run title : Haddock Icelandic Va (run: XSAHOB03/X03)

Stock weights at age (kg)

YEAR	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000*
AGE											
2	.1830	.1740	.1570	.1710	.1800	.1650	.1800	.1720	.2020	.2030	.1790
3	.4470	.4950	.4960	.3850	.4020	.4430	.4560	.4240	.4040	.4810	.5520
4	.8290	.9980	.9020	.8740	.7000	.7380	.8550	.8080	.7410	.7210	.8930
5	1.2380	1.3970	.3790	1.4920	1.2430	1.0530	1.0400	1.1950	1.2230	1.2000	1.1650
6	1.9620	1.8790	1.9260	1.8070	1.6890	1.8680	1.4370	1.4250	1.7250	1.9650	1.7760
7	2.6880	2.4900	2.3730	2.6170	1.6460	2.6240	2.1710	1.9190	2.0010	2.3780	2.6260
8	3.0800	3.7320	2.9320	2.6200	2.6970	5.2850	3.1720	2.3310	2.3200	2.7970	2.9110
9	3.3170	3.6420	3.6720	3.3460	1.9970	1.3130	4.7800	3.6860	3.0300	2.9070	3.1370

*Stock weights for the year 2000 are from the groundfish survey and used in predictions.

Table 3.4.5.1 Haddock in Division Va. Proportion mature at age 1978 - 1999.

Run title : Haddock Icelandic Va (run: XSAHOB03/X03)

Proportion mature at age

YEAR	1978	1979
AGE		
2	.0000	.0000
3	.1300	.1300
4	.3000	.3000
5	.4600	.4600
6	.6800	.6800
7	.8600	.8600
8	.9600	.9600
9	1.0000	1.0000

Proportion mature at age

YEAR	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
AGE										
2	.0000	.0000	.0000	.0000	.0000	.0100	.0200	.0200	.0100	.0400
3	.1300	.1300	.1300	.1300	.1300	.1000	.1900	.1100	.2200	.2000
4	.3000	.3000	.3000	.3000	.3000	.4000	.4300	.4100	.3800	.5300
5	.4600	.4600	.4600	.4600	.4600	.4300	.6600	.5200	.7700	.7200
6	.6800	.6800	.6800	.6800	.6800	.7200	.8300	.7900	.7900	.8000
7	.8600	.8600	.8600	.8600	.8600	.6700	.8700	.7800	.9300	1.0000
8	.9600	.9600	.9600	.9600	.9600	.9200	.9500	1.0000	.9000	1.0000
9	1.0000	1.0000	1.0000	1.0000	1.0000	.8900	.9900	.9600	1.0000	1.0000

Run title : Haddock Icelandic Va (run: XSAHOB03/X03)

Proportion mature at age

YEAR	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000*
AGE											
2	.1100	.0400	.0400	.1200	.2500	.1600	.1700	.0900	.0300	.0500	.1000
3	.2800	.2000	.1400	.3300	.3200	.4900	.3600	.4400	.4800	.3900	.2500
4	.5900	.5800	.4200	.4700	.5700	.4300	.5800	.6600	.6600	.6800	.3900
5	.8100	.7500	.7700	.6600	.7800	.7800	.6500	.7100	.7800	.7200	.6200
6	.8400	.8200	.8600	.8800	.8600	.8300	.7800	.7500	.7600	.7600	.8000
7	.9200	.9100	.8700	.9700	1.0000	.6900	.7300	.8600	.8500	.9000	.8700
8	.9000	.9400	.7100	.9300	.9000	1.0000	.9600	.8900	.8500	.7700	.8700
9	1.0000	1.0000	1.0000	.8500	1.0000	1.0000	.9800	1.0000	1.0000	.9200	1.000

*Data for the year 2000 is from the groundfish survey and used in predictions.

Table 3.4.6.1.1. Haddock in division Va. Tuning input for the XSA. Demersal traw and gillnet CPUE and groundfish survey indices.

```
Icelandic haddock (Division Va) (run name: XSAHOB03)
103
FLT12: Trawlers in Iceland 93-99 (Catch: Thousands) (Effort: Unknown)
1993 1999
1 1 0.00 1.00
4 9
   1.0    2365     453     189     169     253      46
   1.0    5603    1761     193      77      36      52
   1.0    1184    4874     880      75      31      11
   1.0    1441     953    2721     438      34       4
   1.0    2813    1288     576    1032     113      10
   1.0    1667    2286     591     268     315      35
   1.0    3392    1020    1002     195     124      94
FLT13: Gillnets 1992-1999 for assessment 2000 (Catch: Thousands) (Effort:
Unknown)
1992 1999
1 1 0.00 1.00
5 8
   0.1    14.3    39.4   120.7    67.1
   0.1    25.1    36.4    44.6    70.4
   0.1    51.7    28.7    11.8    17.8
   0.1    88.0   141.9    21.1    10.1
   0.1    33.8   170.4    60.4     6.7
   0.1    36.0    47.9   124.2    25.8
   0.1   129.5    44.5    37.7    54.1
   0.1    72.2   125.3    25.9    12.9
FLT14: survey 2000 (Catch: Thousands) (Effort: Unknown)
1984 1999
1 1 0.99 1.00
2 8
   0.1    18.4    23.7    26.6     3.7    11.0     4.9     5.6
   0.1    59.1    12.8    16.4    13.2     1.0     2.8     1.3
   0.1   163.6    57.1    13.2    11.2     8.1     0.6     1.3
   0.1   184.8    88.9    22.9     1.4     2.2     1.9     0.2
   0.1    41.6   146.8    44.9    12.7     0.8     0.8     0.4
   0.1    27.3    39.1    91.8    30.9     3.4     0.9     0.2
   0.1    41.6    17.8    20.3    32.5     7.7     0.3     0.1
   0.1   138.7    35.6    16.6    13.2    15.9     2.2     0.2
   0.1   252.9    88.8    11.3     3.9     1.7     4.5     0.9
   0.1    40.6   162.8    46.1     7.2     2.9     1.4     4.1
   0.1    48.8    20.7    68.4     8.1     1.4     0.1     0.4
   0.1   118.4    34.3    18.7    40.4     6.2     0.6     0.1
   0.1    49.6    54.6    10.4     7.0    11.2     1.4     0.1
   0.1   110.4    28.4    23.4     4.6     3.5     4.6     0.3
   0.1    25.8    98.2    12.9     9.6     1.4     1.7     1.0
   0.1    45.5     8.6    24.7     2.9     1.6     0.4     0.2
```

Table 3.4.6.2.1 Haddock in Division Va. XSA tuning diagnostic output.

```
Lowestoft VPA Version 3.1
   28/04/2000  15:43
 Extended Survivors Analysis
 Haddock Icelandic Va (run: XSAHOB03/X03)
 CPUE data from file fleet

 Catch data for  22 years. 1978 to 1999. Ages  2 to  10.

      Fleet,           First, Last, First, Last, Alpha,  Beta
                  ,    year, year,  age ,  age
 FLT12: Trawlers in I,  1993, 1999,   4,     9,   .000,  1.000
 FLT13: Gillnets 1992,  1992, 1999,   5,     8,   .000,  1.000
 FLT14: survey 2000 (,  1984, 1999,   2,     8,   .990,  1.000

 Time series weights :

      Tapered time weighting applied
      Power =    3 over  20 years

 Catchability analysis :

      Catchability dependent on stock size for ages <    4

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

      Catchability independent of age for ages >=    7


 Terminal population estimation :

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

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

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

      Prior weighting not applied


 Tuning converged after   25 iterations

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


 Fishing mortalities
    Age,  1990,  1991,  1992,  1993,  1994,  1995,  1996,  1997,  1998,  1999

      2,  .022,  .034,  .018,  .006,  .007,  .035,  .043,  .017,  .013,  .030
      3,  .141,  .082,  .136,  .098,  .116,  .231,  .183,  .145,  .135,  .121
      4,  .355,  .330,  .416,  .365,  .345,  .330,  .439,  .363,  .370,  .457
      5,  .546,  .574,  .700,  .648,  .610,  .571,  .511,  .625,  .517,  .585
      6,  .667,  .710,  .829,  .758,  .787,  .770,  .826,  .572,  .744,  .675
      7,  .693,  .723,  .798,  .902,  .884,  .856,  .964,  .820,  .814,  .745
      8,  .812,  .838,  .857,  .841,  .655,  .924,  .964,  .822,  .885,  .919
      9,  .610,  .647,  .758,  .649,  .689,  .885,  .953,  .601,  .626,  .642


 XSA population numbers (Thousands)

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

 1990 ,    2.25E+04, 2.18E+04, 2.96E+04, 6.25E+04, 1.51E+04, 1.89E+03, 3.32E+02, 1.72E+02,
 1991 ,    8.07E+04, 1.80E+04, 1.55E+04, 1.70E+04, 2.97E+04, 6.35E+03, 7.75E+02, 1.21E+02,
 1992 ,    1.71E+05, 6.39E+04, 1.36E+04, 9.13E+03, 7.82E+03, 1.19E+04, 2.52E+03, 2.75E+02,
 1993 ,    3.76E+04, 1.38E+05, 4.56E+04, 7.34E+03, 3.71E+03, 2.80E+03, 4.40E+03, 8.77E+02,
 1994 ,    4.17E+04, 3.06E+04, 1.02E+05, 2.59E+04, 3.14E+03, 1.42E+03, 9.29E+02, 1.55E+03,
 1995 ,    7.49E+04, 3.39E+04, 2.23E+04, 5.93E+04, 1.15E+04, 1.17E+03, 4.82E+02, 3.95E+02,
 1996 ,    3.85E+04, 5.92E+04, 2.20E+04, 1.31E+04, 2.74E+04, 4.37E+03, 4.07E+02, 1.57E+02,
 1997 ,    8.85E+04, 3.02E+04, 4.04E+04, 1.16E+04, 6.45E+03, 9.84E+03, 1.36E+03, 1.27E+02,
 1998 ,    1.74E+04, 7.12E+04, 2.14E+04, 2.30E+04, 5.09E+03, 2.98E+03, 3.55E+03, 4.91E+02,
 1999 ,    4.07E+04, 1.41E+04, 5.09E+04, 1.21E+04, 1.12E+04, 1.98E+03, 1.08E+03, 1.20E+03,
```

Table 3.4.6.2.1 (Continued)

```
 Estimated population abundance at 1st Jan 2000
    ,      0.00E+00, 3.23E+04, 1.02E+04, 2.64E+04, 5.51E+03, 4.67E+03, 7.70E+02, 3.53E+02,
 Taper weighted geometric mean of the VPA populations:
    ,      4.97E+04, 4.04E+04, 3.15E+04, 1.70E+04, 8.03E+03, 3.00E+03, 1.14E+03, 4.02E+02,

 Standard error of the weighted Log(VPA populations) :

    ,         .6830,     .7126,     .6744,     .7160,     .7858,     .8308,     .9151,    1.0162,
1

 Log catchability residuals.


 Fleet : FLT12: Trawlers in I

  Age  ,  1990,  1991,  1992,  1993,  1994,  1995,  1996,  1997,  1998,  1999
     2 , No data for this fleet at this age
     3 , No data for this fleet at this age
     4 , 99.99, 99.99, 99.99,  -.19,  -.15,  -.18,   .07,   .10,   .22,   .10
     5 , 99.99, 99.99, 99.99,  -.25,  -.17,   .00,  -.15,   .33,   .17,   .04
     6 , 99.99, 99.99, 99.99,  -.45,  -.25,  -.04,   .24,   .03,   .36,   .07
     7 , 99.99, 99.99, 99.99,  -.26,  -.37,  -.22,   .28,   .26,   .11,   .17
     8 , 99.99, 99.99, 99.99,  -.33,  -.80,  -.18,   .09,   .03,   .12,   .39
     9 , 99.99, 99.99, 99.99,  -.50,  -.94, -1.04, -1.10,  -.12,  -.21,  -.10


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


    Age ,         4,         5,         6,         7,         8,         9
 Mean Log q,   -2.4986,   -2.1418,   -2.0827,   -2.0494,   -2.0494,   -2.0494,
 S.E(Log q),     .1663,     .2040,     .2775,     .2690,     .3988,     .7608,


 Regression statistics :


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

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

  4,    1.12,    -.866,      1.55,     .92,      7,     .19,   -2.50,
  5,     .97,     .220,      2.36,     .92,      7,     .22,   -2.14,
  6,     .83,    1.465,      3.24,     .94,      7,     .21,   -2.08,
  7,     .79,    2.312,      3.29,     .96,      7,     .16,   -2.05,
  8,    1.01,    -.033,      2.11,     .84,      7,     .43,   -2.14,
  9,     .98,     .119,      2.70,     .83,      7,     .48,   -2.62,


 Fleet : FLT13: Gillnets 1992

  Age  ,  1990,  1991,  1992,  1993,  1994,  1995,  1996,  1997,  1998,  1999
     2 , No data for this fleet at this age
     3 , No data for this fleet at this age
     4 , No data for this fleet at this age
     5 , 99.99, 99.99,  -.56,   .20,  -.36,  -.67,  -.15,   .09,   .64,   .73
     6 , 99.99, 99.99,  -.48,   .15,   .10,   .39,  -.27,  -.20,   .03,   .25
     7 , 99.99, 99.99,  -.25,   .24,  -.42,   .35,   .13,  -.02,  -.02,  -.02
     8 , 99.99, 99.99,   .74,   .22,   .32,   .53,   .30,   .38,   .19,  -.04
     9 , No data for this fleet at this age


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


    Age ,         5,         6,         7,         8
 Mean Log q,   -3.1783,   -2.0360,   -1.5791,   -1.5791,
 S.E(Log q),     .5240,     .2887,     .2480,     .4165,
```

Table 3.4.6.2.1 (Continued)

Regression statistics :

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

Age,	Slope ,	t-value ,	Intercept,	RSquare,	No Pts,	Reg s.e,	Mean Q
5,	1.39,	-.927,	.65,	.50,	8,	.74,	-3.18,
6,	1.09,	-.476,	1.44,	.84,	8,	.33,	-2.04,
7,	1.07,	-.556,	1.11,	.91,	8,	.28,	-1.58,
8,	1.02,	-.187,	1.13,	.93,	8,	.25,	-1.25,

Fleet : FLT14: survey 2000 (

Age ,	1984,	1985,	1986,	1987,	1988,	1989
2 ,	-.32,	.07,	.28,	-.22,	-.40,	-.23
3 ,	-.08,	-.12,	.44,	.04,	-.17,	-.07
4 ,	.11,	.08,	.49,	.28,	.17,	.12
5 ,	.44,	.19,	.67,	-.77,	.65,	.57
6 ,	1.03,	-.02,	1.08,	-.01,	-.31,	.50
7 ,	.01,	.59,	.62,	.64,	.04,	1.00
8 ,	.00,	-.31,	.94,	.44,	.29,	.16
9 ,	No data for this fleet at this age					

Age ,	1990,	1991,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999
2 ,	.37,	.26,	.07,	-.18,	-.11,	.18,	.02,	-.07,	.16,	-.13
3 ,	-.11,	.63,	.19,	-.08,	-.34,	.09,	-.11,	-.03,	.17,	-.32
4 ,	-.09,	.33,	.17,	.31,	-.12,	.09,	-.38,	-.25,	-.20,	-.33
5 ,	-.05,	.38,	-.09,	.69,	-.49,	.25,	-.06,	-.24,	-.30,	-.78
6 ,	.11,	.21,	-.58,	.63,	.10,	.27,	.05,	.08,	-.43,	-1.15
7 ,	-.94,	-.13,	.03,	.42,	-1.57,	.39,	.03,	.27,	.46,	-.65
8 ,	-.18,	-.31,	.03,	.98,	.02,	-.44,	-.24,	-.49,	-.18,	-.56
9 ,	No data for this fleet at this age									

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

Age ,	4,	5,	6,	7,	8
Mean Log q,	-4.3425,	-4.4680,	-4.5303,	-4.6162,	-4.6162,
S.E(Log q),	.2617,	.4877,	.5401,	.6885,	.4638,

Regression statistics :

Ages with q dependent on year class strength

Age,	Slope ,	t-value ,	Intercept,	RSquare,	No Pts,	Reg s.e,	Mean Log q
2,	.96,	.413,	4.39,	.91,	16,	.22,	-4.12,
3,	.86,	1.186,	5.12,	.88,	16,	.27,	-4.24,

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

Age,	Slope ,	t-value ,	Intercept,	RSquare,	No Pts,	Reg s.e,	Mean Q
4,	1.11,	-.821,	3.67,	.85,	16,	.30,	-4.34,
5,	.98,	.102,	4.58,	.69,	16,	.50,	-4.47,
6,	1.01,	-.066,	4.46,	.67,	16,	.58,	-4.53,
7,	.93,	.292,	4.86,	.62,	16,	.67,	-4.62,
8,	.86,	1.088,	5.00,	.86,	16,	.39,	-4.66,

1

Terminal year survivor and F summaries :

Age 2 Catchability dependent on age and year class strength

Year class = 1997

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
FLT12: Trawlers in I,	1.,	.000,	.000,	.00,	0,	.000,	.000
FLT13: Gillnets 1992,	1.,	.000,	.000,	.00,	0,	.000,	.000
FLT14: survey 2000 (,	28365.,	.300,	.000,	.00,	1,	.644,	.034
P shrinkage mean ,	40409.,	.71,,,,				.113,	.024
F shrinkage mean ,	41289.,	.50,,,,				.239,	.023

Table 3.4.6.2.1 (Continued)

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
32342.,	.24,	.16,	3,	.643,	.030

Age 3 Catchability dependent on age and year class strength

Year class = 1996

Fleet, ,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
FLT12: Trawlers in I,	1.,	.000,	.000,	.00,	0,	.000,	.000
FLT13: Gillnets 1992,	1.,	.000,	.000,	.00,	0,	.000,	.000
FLT14: survey 2000 (,	9563.,	.219,	.237,	1.08,	2,	.747,	.129
P shrinkage mean ,	31485.,	.67,,,,				.090,	.041
F shrinkage mean ,	7450.,	.50,,,,				.163,	.163

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
10218.,	.19,	.24,	4,	1.269,	.121

1

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

Year class = 1995

Fleet, ,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
FLT12: Trawlers in I,	29188.,	.300,	.000,	.00,	1,	.233,	.421
FLT13: Gillnets 1992,	1.,	.000,	.000,	.00,	0,	.000,	.000
FLT14: survey 2000 (,	24177.,	.174,	.148,	.85,	3,	.635,	.490
F shrinkage mean ,	33939.,	.50,,,,				.132,	.372

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
26419.,	.15,	.11,	5,	.724,	.457

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

Year class = 1994

Fleet, ,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
FLT12: Trawlers in I,	6160.,	.216,	.090,	.42,	2,	.350,	.537
FLT13: Gillnets 1992,	11410.,	.557,	.000,	.00,	1,	.060,	.325
FLT14: survey 2000 (,	4558.,	.167,	.157,	.94,	4,	.456,	.674
F shrinkage mean ,	5684.,	.50,,,,				.134,	.572

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
5513.,	.13,	.11,	8,	.864,	.585

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

Year class = 1993

Fleet, ,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
FLT12: Trawlers in I,	5210.,	.184,	.030,	.16,	3,	.371,	.623
FLT13: Gillnets 1992,	6372.,	.273,	.140,	.51,	2,	.208,	.535
FLT14: survey 2000 (,	3468.,	.171,	.217,	1.26,	5,	.290,	.833
F shrinkage mean ,	4058.,	.50,,,,				.131,	.747

Table 3.4.6.2.1 (Continued)

```
 Weighted prediction :

 Survivors,        Int,       Ext,    N,    Var,     F
 at end of year,   s.e,       s.e,     ,   Ratio,
      4673.,       .12,       .11,   11,    .876,   .675

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

 Year class = 1992

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                  Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 FLT12: Trawlers in I,       969.,   .182,       .058,    .32,   4,  .379,     .631
 FLT13: Gillnets 1992,       771.,   .218,       .022,    .10,   3,  .306,     .745
 FLT14: survey 2000 (,       562.,   .209,       .109,    .52,   6,  .163,     .923

   F shrinkage mean  ,       607.,    .50,,,,                        .152,     .877

 Weighted prediction :

 Survivors,        Int,       Ext,    N,    Var,     F
 at end of year,   s.e,       s.e,     ,   Ratio,
       770.,       .13,       .07,   14,    .536,   .745


 Age  8   Catchability constant w.r.t. time and age (fixed at the value for age)  7

 Year class = 1991

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                  Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 FLT12: Trawlers in I,       407.,   .185,       .101,    .54,   5,  .327,     .836
 FLT13: Gillnets 1992,       329.,   .215,       .041,    .19,   4,  .269,     .962
 FLT14: survey 2000 (,       275.,   .237,       .138,    .58,   7,  .198,    1.076

   F shrinkage mean  ,       391.,    .50,,,,                        .205,     .859

 Weighted prediction :

 Survivors,        Int,       Ext,    N,    Var,     F
 at end of year,   s.e,       s.e,     ,   Ratio,
       353.,       .14,       .06,   17,    .437,   .919


 Age  9   Catchability constant w.r.t. time and age (fixed at the value for age)  7

 Year class = 1990

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                  Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 FLT12: Trawlers in I,       575.,   .228,       .065,    .29,   6,  .317,     .592
 FLT13: Gillnets 1992,       520.,   .224,       .116,    .52,   4,  .216,     .639
 FLT14: survey 2000 (,       486.,   .268,       .065,    .24,   7,  .145,     .672

   F shrinkage mean  ,       475.,    .50,,,,                        .322,     .683

 Weighted prediction :

 Survivors,        Int,       Ext,    N,    Var,     F
 at end of year,   s.e,       s.e,     ,   Ratio,
       516.,       .19,       .04,   18,    .214,   .642


1
1
```

Table 3.4.6.2.2 Haddock in division Va. Fishing mortality.

```
Run title : Haddock Icelandic Va (run: XSAHOB03/X03)

At  3/05/2000  13:39

                Terminal Fs derived using XSA (With F shrinkage)

      Table  8    Fishing mortality (F) at age
      YEAR,       1978,    1979,

      AGE
        2,        .0008,   .0021,
        3,        .0185,   .0186,
        4,        .0901,   .1734,
        5,        .2658,   .4376,
        6,        .7990,   .7039,
        7,       1.1627,   .9920,
        8,       1.8931,  1.2006,
        9,       1.5483,  1.1093,
      +gp,       1.5483,  1.1093,
0  FBAR  4- 7,     .5794,   .5767,
```

```
      Table  8    Fishing mortality (F) at age
      YEAR,       1980,    1981,    1982,    1983,    1984,    1985,    1986,    1987,    1988,    1989,

      AGE
        2,        .0181,   .0001,   .0013,   .0000,   .0033,   .0114,   .0024,   .0149,   .0031,   .0032,
        3,        .0226,   .0195,   .0405,   .0228,   .0344,   .1284,   .1282,   .1219,   .0862,   .0770,
        4,        .1360,   .1046,   .1345,   .3068,   .2218,   .3310,   .4472,   .4163,   .4057,   .2902,
        5,        .2817,   .3052,   .3461,   .3606,   .4220,   .4615,   .6437,   .6653,   .6363,   .4658,
        6,        .4911,   .8141,   .4505,   .6657,   .8134,   .6094,  1.1431,   .6995,   .7754,   .9291,
        7,        .6471,   .8637,   .8759,   .5688,   .5499,   .6772,   .9260,   .7784,   .8096,   .9529,
        8,        .9098,   .7752,  1.1705,  1.0604,   .6393,   .8856,  1.0338,   .8447,  1.1884,  1.4494,
        9,        .7863,   .8279,  1.0350,   .8230,   .5998,   .7852,   .9978,   .7771,   .9747,  1.1892,
      +gp,        .7863,   .8279,  1.0350,   .8230,   .5998,   .7852,   .9978,   .7771,   .9747,  1.1892,
0  FBAR  4- 7,     .3890,   .5219,   .4518,   .4755,   .5018,   .5198,   .7900,   .6399,   .6568,   .6595,
1
```

```
Run title : Haddock Icelandic Va (run: XSAHOB03/X03)

At  3/05/2000  13:39

                Terminal Fs derived using XSA (With F shrinkage)

      Table  8    Fishing mortality (F) at age
      YEAR,       1990,    1991,    1992,    1993,    1994,    1995,    1996,    1997,    1998,    1999,       FBAR 97-99

      AGE
        2,        .0223,   .0344,   .0178,   .0065,   .0075,   .0352,   .0434,   .0171,   .0161,   .0285,       .0205,
        3,        .1419,   .0823,   .1365,   .0982,   .1165,   .2316,   .1823,   .1463,   .1326,   .1498,       .1429,
        4,        .3572,   .3313,   .4181,   .3676,   .3470,   .3315,   .4401,   .3604,   .3742,   .4476,       .3941,
        5,        .5520,   .5802,   .7053,   .6544,   .6166,   .5759,   .5151,   .6277,   .5102,   .5954,       .5778,
        6,        .6870,   .7257,   .8461,   .7710,   .8037,   .7862,   .8409,   .5798,   .7517,   .6592,       .6635,
        7,        .7224,   .7678,   .8355,   .9487,   .9182,   .8991,  1.0134,   .8543,   .8380,   .7609,       .8177,
        8,        .9181,   .9185,   .9865,   .9368,   .7321,  1.0201,  1.0947,   .9326,   .9769,   .9867,       .9654,
        9,        .8158,   .8491,   .9414,   .8976,   .8825,  1.1563,  1.2607,   .8072,   .8279,   .8028,       .8126,
      +gp,        .8158,   .8491,   .9414,   .8976,   .8825,  1.1563,  1.2607,   .8072,   .8279,   .8028,
0  FBAR  4- 7,     .5797,   .6013,   .7013,   .6854,   .6714,   .6482,   .7024,   .6055,   .6185,   .6158,
1
```

Table 3.4.6.3.1.
1

Run title : Haddock Icelandic Va (run: XSAHOB03/X03)

At 3/05/2000 13:40

Terminal Fs derived using XSA (With F shrinkage)

Table 10	Stock number at age (start of year)		Numbers*10**-3
YEAR,	1978,	1979,	
AGE			
2,	151699,	83850,	
3,	34955,	124103,	
4,	27339,	28095,	
5,	34038,	20454,	
6,	9001,	21364,	
7,	2928,	3315,	
8,	816,	749,	
9,	132,	101,	
+gp,	0,	0,	
0 TOTAL,	260907,	282031,	

Table 10	Stock number at age (start of year)						Numbers*10**-3			
YEAR,	1980,	1981,	1982,	1983,	1984,	1985,	1986,	1987,	1988,	1989,
AGE										
2,	36697,	9736,	42202,	30160,	19935,	41753,	89154,	167105,	47540,	26646,
3,	68505,	29507,	7971,	34507,	24692,	16267,	33798,	72816,	134790,	38802,
4,	99738,	54835,	23691,	6267,	27614,	19533,	11714,	24341,	52777,	101247,
5,	19340,	71274,	40435,	16955,	3776,	18111,	11485,	6132,	13142,	28799,
6,	10811,	11947,	43008,	23421,	9679,	2027,	9347,	4940,	2581,	5695,
7,	8652,	5417,	4333,	22440,	9855,	3513,	902,	2440,	2009,	973,
8,	1006,	3709,	1870,	1478,	10402,	4655,	1461,	293,	917,	732,
9,	185,	332,	1399,	475,	419,	4494,	1572,	425,	103,	229,
+gp,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
0 TOTAL,	244935,	186757,	164909,	135703,	106371,	110354,	159433,	278491,	253859,	203122,

1

Run title : Haddock Icelandic Va (run: XSAHOB03/X03)

At 3/05/2000 13:40

Terminal Fs derived using XSA (With F shrinkage)

Table 10	Stock number at age (start of year)							Numbers*10**-3					
YEAR,	1990,	1991,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	GMST 78-97	AMST 78-97
AGE													
2,	22397,	80388,	170680,	37441,	41618,	75355,	38211,	89667,	14351,	42384,	0,	50411,	65112,
3,	21745,	17933,	63589,	137274,	30457,	33820,	59563,	29957,	72169,	11562,	33726,	39319,	50753,
4,	29413,	15448,	13522,	45418,	101879,	22195,	21965,	40639,	21188,	51749,	8150,	29718,	38383,
5,	62013,	16848,	9081,	7288,	25746,	58958,	13044,	11581,	23204,	11932,	27080,	18363,	24425,
6,	14799,	29234,	7722,	3672,	3101,	11378,	27137,	6380,	5061,	11406,	5386,	9330,	12862,
7,	1841,	6095,	11584,	2713,	1391,	1137,	4244,	9583,	2926,	1954,	4831,	3620,	5268,
8,	307,	732,	2316,	4113,	860,	455,	379,	1261,	3339,	1036,	748,	1195,	1926,
9,	141,	100,	239,	707,	1320,	339,	134,	104,	406,	1029,	316,	330,	647,
+gp,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,	378,		
0 TOTAL,	152655,	166779,	278732,	238627,	206372,	203636,	164675,	189171,	142643,	133053,	80614,		

1

Table 3.4.6.3.2. Haddock in Division VA. summary.

Table 16 Summary (without SOP correction)

Terminal Fs derived using XSA (With F shrinkage)

, RECRUITS, Age 2	TOTALBIO,	TOTSPBIO,	LANDINGS,	YIELD/SSB,	FBAR 4- 7,
1978,	151699,	145804,	53205,	43488,	.8174, .5794,
1979,	83850,	182549,	67479,	55334,	.8200, .5767,
1980,	36697,	203827,	80966,	51112,	.6313, .3890,
1981,	9736,	216371,	103433,	63580,	.6147, .5219,
1982,	42202,	197680,	111476,	69325,	.6219, .4518,
1983,	30160,	161441,	101585,	65943,	.6491, .4755,
1984,	19935,	124580,	79372,	48285,	.6083, .5018,
1985,	41753,	115551,	59576,	50933,	.8549, .5198,
1986,	89154,	114648,	56174,	48863,	.8699, .7900,
1987,	167105,	130849,	41446,	40801,	.9844, .6399,
1988,	47540,	161203,	65862,	54236,	.8235, .6568,
1989,	26646,	174472,	99279,	62979,	.6344, .6595,
1990,	22397,	150371,	110005,	67200,	.6109, .5797,
1991,	80388,	135024,	90718,	54732,	.6033, .6013,
1992,	170680,	124004,	55664,	47212,	.8482, .7013,
1993,	37441,	136699,	68800,	48844,	.7099, .6854,
1994,	41618,	135535,	82919,	59345,	.7157, .6714,
1995,	75355,	132961,	87344,	61131,	.6999, .6482,
1996,	38211,	116435,	69580,	56958,	.8186, .7024,
1997,	89667,	105604,	64108,	44053,	.6872, .6055,
1998,	14351,	99696,	66006,	41434,	.6277, .6185,
1999,	42384,	98746,	64481,	45841,	.7109, .6158,
Arith. Mean ,	61771,	143820,	76340,	53710,	.7256, .5996,
0 Units,	(Thousands),	(Tonnes),	(Tonnes),	(Tonnes),	
1					

Table 3.4.7.1.1

11:35 Wednesday, May 10, 2000
Icelandic haddock (Division Va)

Prediction with management option table: Input data

Year: 2000								
Age	Stock size	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
2	80000.000	0.2000	0.1000	0.0000	0.0000	0.179	0.0185	0.587
3	36600.000	0.2000	0.2500	0.0000	0.0000	0.552	0.1400	0.856
4	10200.000	0.2000	0.3900	0.0000	0.0000	0.893	0.3884	1.238
5	28700.000	0.2000	0.6200	0.0000	0.0000	1.165	0.5825	1.547
6	5450.000	0.2000	0.8000	0.0000	0.0000	1.776	0.6759	2.157
7	4730.000	0.2000	0.8700	0.0000	0.0000	2.620	0.8420	2.701
8	693.000	0.2000	0.8700	0.0000	0.0000	2.911	1.0023	3.128
9	303.000	0.2000	1.0000	0.0000	0.0000	3.137	0.8971	3.154
Unit	Thousands	-	-	-	-	Kilograms	-	Kilograms

Year: 2001								
Age	Recruit-ment	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
2	78000.000	0.2000	0.0600	0.0000	0.0000	0.192	0.0185	0.587
3	.	0.2000	0.3800	0.0000	0.0000	0.455	0.1400	0.850
4	.	0.2000	0.6600	0.0000	0.0000	1.024	0.3884	1.228
5	.	0.2000	0.7700	0.0000	0.0000	1.330	0.5825	1.701
6	.	0.2000	0.8100	0.0000	0.0000	1.689	0.6759	2.064
7	.	0.2000	0.8900	0.0000	0.0000	2.291	0.8420	2.663
8	.	0.2000	0.8800	0.0000	0.0000	3.089	1.0023	3.141
9	.	0.2000	1.0000	0.0000	0.0000	3.004	0.8971	3.465
Unit	Thousands	-	-	-	-	Kilograms	-	Kilograms

Year: 2002								
Age	Recruit-ment	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
2	47000.000	0.2000	0.0600	0.0000	0.0000	0.191	0.0185	0.587
3	.	0.2000	0.3800	0.0000	0.0000	0.486	0.1400	0.850
4	.	0.2000	0.6600	0.0000	0.0000	0.844	0.3884	1.222
5	.	0.2000	0.7700	0.0000	0.0000	1.282	0.5825	1.690
6	.	0.2000	0.8100	0.0000	0.0000	1.813	0.6759	2.221
7	.	0.2000	0.8900	0.0000	0.0000	2.214	0.8420	2.591
8	.	0.2000	0.8800	0.0000	0.0000	2.879	1.0023	3.117
9	.	0.2000	1.0000	0.0000	0.0000	3.145	0.8971	3.480
Unit	Thousands	-	-	-	-	Kilograms	-	Kilograms

Notes: Run name : MANEHJ01
Date and time: 01MAY00:16:43

Table 3.4.7.1.2 Haddock in division Va. Input file for the RCT3.

```
Iceland Haddock: VPA and groundfish survey data
4 23 2
 'Yearcl'  'VPAage2'    'Surv4'   'Surv3'   'Surv2'     'Surv1'
1977         88          -11         -11         -11         -11
1978         37          -11         -11         -11         -11
1979         10          -11         -11         -11         -11
1980         42          -11         -11         -11         -11
1981         30          237         -11         -11         -11
1982         20          128         184         -11         -11
1983         42          571         591         327         -11
1984         89          889        1636        1085         282
1985        167         1468        1848        2963        1240
1986         48          391         416         407         223
1987         27          178         273         234         158
1988         22          356         416         319         106
1989         80          888        1387        1460         705
1990        169         1628        2529        2123         897
1991         37          207         406         372         185
1992         41          343         488         612         299
1993         75          546        1184         832         587
1994         38          284         496         712         358
1995         89          982        1104        1204         946
1996        -11           86         258         182          86
1997        -11          -11         454         865         231
1998        -11          -11         -11         910         812
1999        -11          -11         -11         -11         611
```

Table 3.4.7.1.3 Haddock in division Va. Output file from RCT3.

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

 Recrun5.dat

 Iceland Haddock: VPA and groundfish survey data

 Data for    4 surveys over   23 years :  1977 - 1999

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

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

 Forecast/Hindcast variance correction used.


Yearclass =   1996

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

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

Surv4      .93  -1.71    .28    .856    15   4.47    2.43     .386     .188
Surv3      .91  -1.97    .22    .903    14   5.56    3.09     .279     .360
Surv2      .89  -1.77    .26    .870    13   5.21    2.84     .341     .241
Surv1      .91  -1.33    .32    .817    12   4.47    2.74     .435     .148

                                        VPA Mean =    4.01     .662     .064


Yearclass =   1997

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

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

Surv4
Surv3      .91  -1.99    .22    .904    14   6.12    3.60     .264     .418
Surv2      .89  -1.84    .26    .868    13   6.76    4.22     .304     .315
Surv1      .91  -1.32    .32    .819    12   5.45    3.62     .383     .198

                                        VPA Mean =    4.03     .652     .068
```

Table 3.4.7.1.3 (Continued)

Yearclass = 1998

Survey/ Series	Slope	Inter-cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
Surv4									
Surv3									
Surv2	.90	-1.91	.26	.866	13	6.81	4.26	.311	.538
Surv1	.90	-1.32	.32	.821	12	6.70	4.75	.393	.336
					VPA Mean =		4.04	.643	.126

Yearclass = 1999

Survey/ Series	Slope	Inter-cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
Surv4									
Surv3									
Surv2									
Surv1	.90	-1.31	.31	.823	12	6.42	4.47	.385	.731
					VPA Mean =		4.06	.634	.269

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
1996	18	2.91	.17	.19	1.23		
1997	46	3.83	.17	.16	.91		
1998	80	4.39	.23	.18	.65		
1999	78	4.36	.33	.19	.32		

Table 3.4.7.2.1

11:35 Wednesday, May 10, 2000
Icelandic haddock (Division Va)

Yield per recruit: Summary table

						1 January		Spawning time	
F Factor	Reference F	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
0.0000	0.0000	0.000	0.000	5.517	9188.886	3.326	7743.137	3.326	7743.137
0.0500	0.0311	0.106	314.085	4.987	7542.374	2.821	6159.668	2.821	6159.668
0.1000	0.0622	0.180	506.150	4.623	6434.360	2.479	5101.834	2.479	5101.834
0.1500	0.0933	0.233	630.031	4.355	5638.476	2.230	4347.980	2.230	4347.980
0.2000	0.1245	0.275	712.770	4.150	5039.435	2.041	3785.295	2.041	3785.295
0.2500	0.1556	0.308	769.306	3.985	4572.380	1.892	3350.373	1.892	3350.373
0.3000	0.1867	0.336	808.474	3.850	4198.051	1.771	3004.876	1.771	3004.876
0.3500	0.2178	0.359	835.778	3.736	3891.308	1.671	2724.288	1.671	2724.288
0.4000	0.2489	0.378	854.787	3.639	3635.313	1.586	2492.223	1.586	2492.223
0.4500	0.2800	0.395	867.887	3.555	3418.375	1.513	2297.323	1.513	2297.323
0.5000	0.3111	0.411	876.718	3.480	3232.127	1.450	2131.479	1.450	2131.479
0.5500	0.3422	0.424	882.428	3.414	3070.424	1.394	1988.752	1.394	1988.752
0.6000	0.3734	0.436	885.836	3.355	2928.655	1.345	1864.698	1.345	1864.698
0.6500	0.4045	0.447	887.538	3.301	2803.295	1.300	1755.930	1.300	1755.930
0.7000	0.4356	0.457	887.967	3.252	2691.600	1.260	1659.820	1.260	1659.820
0.7500	0.4667	0.466	887.447	3.207	2591.408	1.224	1574.305	1.224	1574.305
0.8000	0.4978	0.475	886.217	3.166	2500.989	1.191	1497.740	1.191	1497.740
0.8500	0.5289	0.483	884.462	3.127	2418.943	1.160	1428.800	1.160	1428.800
0.9000	0.5600	0.490	882.316	3.092	2344.127	1.132	1366.406	1.132	1366.406
0.9500	0.5911	0.497	879.887	3.058	2275.597	1.106	1309.671	1.106	1309.671
1.0000	0.6223	0.504	877.254	3.027	2212.567	1.082	1257.861	1.082	1257.861
1.0500	0.6534	0.510	874.480	2.997	2154.377	1.059	1210.361	1.059	1210.361
1.1000	0.6845	0.515	871.610	2.970	2100.470	1.038	1166.654	1.038	1166.654
1.1500	0.7156	0.521	868.683	2.943	2050.372	1.018	1126.302	1.018	1126.302
1.2000	0.7467	0.526	865.727	2.919	2003.676	1.000	1088.930	1.000	1088.930
1.2500	0.7778	0.531	862.763	2.895	1960.031	0.982	1054.220	0.982	1054.220
1.3000	0.8089	0.536	859.807	2.872	1919.135	0.966	1021.893	0.966	1021.893
1.3500	0.8400	0.540	856.874	2.851	1880.724	0.950	991.710	0.950	991.710
1.4000	0.8712	0.544	853.971	2.830	1844.567	0.935	963.464	0.935	963.464
1.4500	0.9023	0.548	851.107	2.811	1810.461	0.921	936.970	0.921	936.970
1.5000	0.9334	0.552	848.287	2.792	1778.226	0.907	912.070	0.907	912.070
1.5500	0.9645	0.556	845.514	2.774	1747.706	0.894	888.621	0.894	888.621
1.6000	0.9956	0.560	842.792	2.757	1718.758	0.882	866.499	0.882	866.499
1.6500	1.0267	0.563	840.121	2.740	1691.258	0.870	845.592	0.870	845.592
1.7000	1.0578	0.566	837.503	2.724	1665.094	0.859	825.802	0.859	825.802
1.7500	1.0889	0.570	834.939	2.709	1640.163	0.848	807.039	0.848	807.039
1.8000	1.1201	0.573	832.428	2.694	1616.376	0.837	789.224	0.837	789.224
1.8500	1.1512	0.576	829.970	2.679	1593.651	0.827	772.287	0.827	772.287
1.9000	1.1823	0.579	827.564	2.665	1571.913	0.818	756.162	0.818	756.162
1.9500	1.2134	0.582	825.210	2.652	1551.096	0.808	740.791	0.808	740.791
2.0000	1.2445	0.584	822.906	2.639	1531.138	0.799	726.122	0.799	726.122
2.0500	1.2756	0.587	820.652	2.626	1511.984	0.791	712.107	0.791	712.107
2.1000	1.3067	0.590	818.446	2.614	1493.582	0.783	698.702	0.783	698.702
2.1500	1.3378	0.592	816.287	2.602	1475.886	0.774	685.867	0.774	685.867
2.2000	1.3690	0.594	814.174	2.590	1458.854	0.767	673.566	0.767	673.566
2.2500	1.4001	0.597	812.106	2.579	1442.446	0.759	661.765	0.759	661.765
2.3000	1.4312	0.599	810.081	2.568	1426.625	0.752	650.435	0.752	650.435
2.3500	1.4623	0.601	808.098	2.557	1411.360	0.745	639.547	0.745	639.547
2.4000	1.4934	0.604	806.156	2.547	1396.617	0.738	629.074	0.738	629.074
2.4500	1.5245	0.606	804.254	2.537	1382.371	0.731	618.994	0.731	618.994
2.5000	1.5556	0.608	802.390	2.527	1368.593	0.725	609.284	0.725	609.284
-	-	Numbers	Grams	Numbers	Grams	Numbers	Grams	Numbers	Grams

Notes: Run name : YLDLOA02
Date and time : 29APR00:18:30
Computation of ref. F: Simple mean, age 4 - 7
F-0.1 factor : 0.2692
F-max factor : 0.6952
F-0.1 reference F : 0.1675
F-max reference F : 0.4326
Recruitment : Single recruit

Table 3.4.7.3.1

11:35 Wednesday, May 10, 2000
Icelandic haddock (Division Va)

Prediction with management option table

Year: 2000					Year: 2001					Year: 2002	
F Factor	Reference F	Stock biomass	Sp.stock biomass	Catch in weight	F Factor	Reference F	Stock biomass	Sp.stock biomass	Catch in weight	Stock biomass	Sp.stock biomass
0.9700	0.6035	102107	51996	39000	0.0000	0.0000	112450	63860	0	154506	100460
.	.	.	.	.	0.0500	0.0311	.	63860	2527	152150	98511
.	.	.	.	.	0.1000	0.0622	.	63860	4986	149860	96619
.	.	.	.	.	0.1500	0.0933	.	63860	7379	147633	94783
.	.	.	.	.	0.2000	0.1244	.	63860	9708	145469	93000
.	.	.	.	.	0.2500	0.1555	.	63860	11976	143364	91269
.	.	.	.	.	0.3000	0.1867	.	63860	14183	141316	89588
.	.	.	.	.	0.3500	0.2178	.	63860	16334	139324	87955
.	.	.	.	.	0.4000	0.2489	.	63860	18428	137386	86369
.	.	.	.	.	0.4500	0.2800	.	63860	20468	135500	84827
.	.	.	.	.	0.5000	0.3111	.	63860	22456	133664	83330
.	.	.	.	.	0.5500	0.3422	.	63860	24393	131877	81875
.	.	.	.	.	0.6000	0.3733	.	63860	26281	130138	80460
.	.	.	.	.	0.6500	0.4044	.	63860	28122	128444	79085
.	.	.	.	.	0.7000	0.4355	.	63860	29916	126794	77747
.	.	.	.	.	0.7500	0.4666	.	63860	31666	125187	76447
.	.	.	.	.	0.8000	0.4978	.	63860	33373	123621	75182
.	.	.	.	.	0.8500	0.5289	.	63860	35039	122096	73952
.	.	.	.	.	0.9000	0.5600	.	63860	36664	120609	72755
.	.	.	.	.	0.9500	0.5911	.	63860	38249	119160	71590
.	.	.	.	.	1.0000	0.6222	.	63860	39797	117747	70457
.	.	.	.	.	1.0500	0.6533	.	63860	41308	116370	69353
.	.	.	.	.	1.1000	0.6844	.	63860	42783	115026	68279
.	.	.	.	.	1.1500	0.7155	.	63860	44223	113716	67233
.	.	.	.	.	1.2000	0.7466	.	63860	45630	112438	66214
.	.	.	.	.	1.2500	0.7777	.	63860	47005	111191	65222
.	.	.	.	.	1.3000	0.8089	.	63860	48348	109974	64256
.	.	.	.	.	1.3500	0.8400	.	63860	49660	108787	63314
.	.	.	.	.	1.4000	0.8711	.	63860	50943	107627	62397
.	.	.	.	.	1.4500	0.9022	.	63860	52197	106495	61503
.	.	.	.	.	1.5000	0.9333	.	63860	53423	105390	60631
-	-	Tonnes	Tonnes	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes

Notes: Run name : MANEHJ01
Date and time : 01MAY00:16:43
Computation of ref. F: Simple mean, age 4 - 7
Basis for 2000 : TAC constraints

Figure 3.4.2.1 Haddock Division Va. Nominal landings (tonnes) 1950-1999.

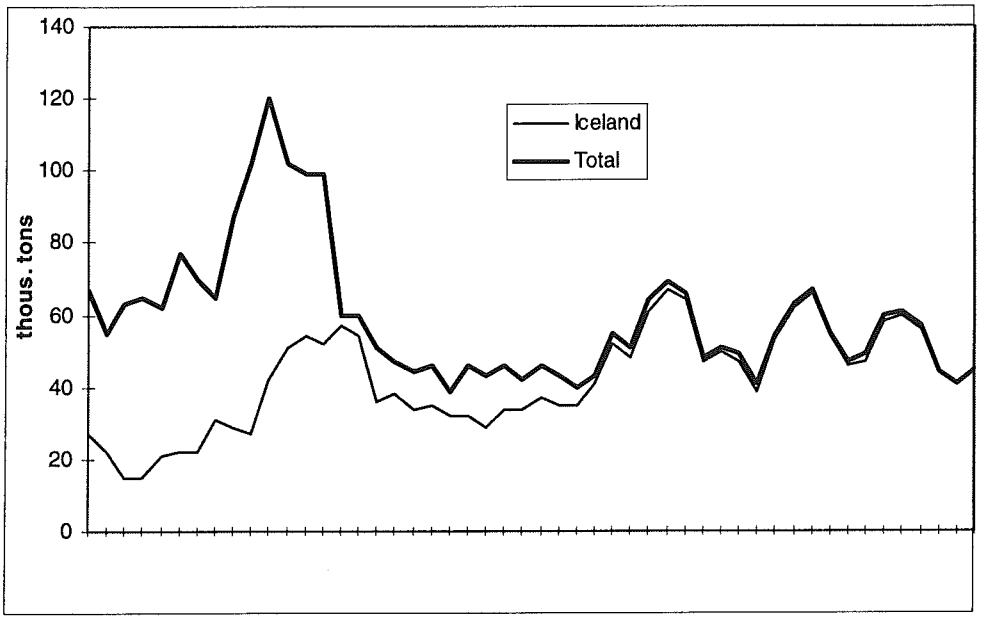
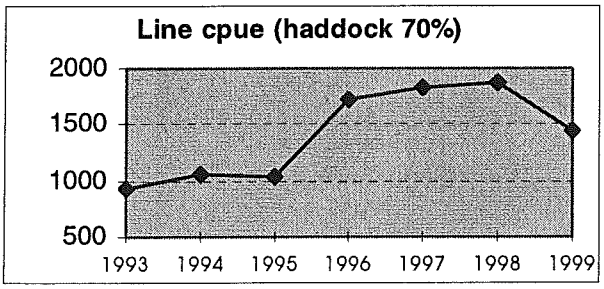
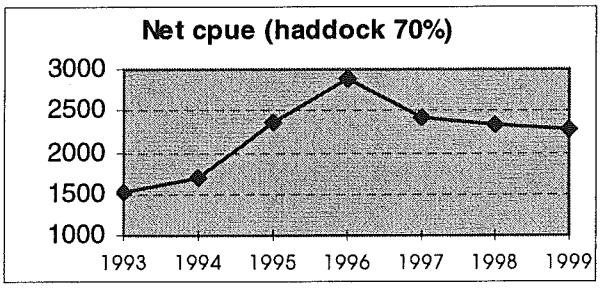
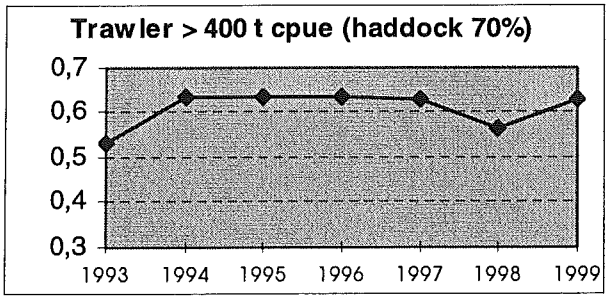


Figure 3.4.6.1.1. Development of CPUE for various fleets catching haddock.







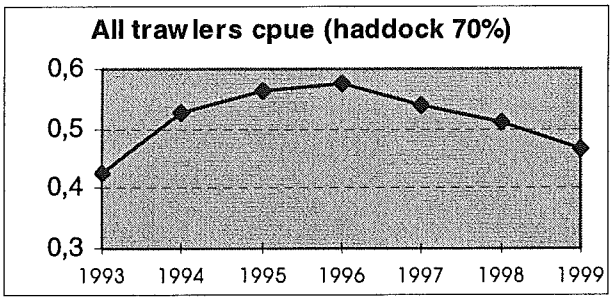
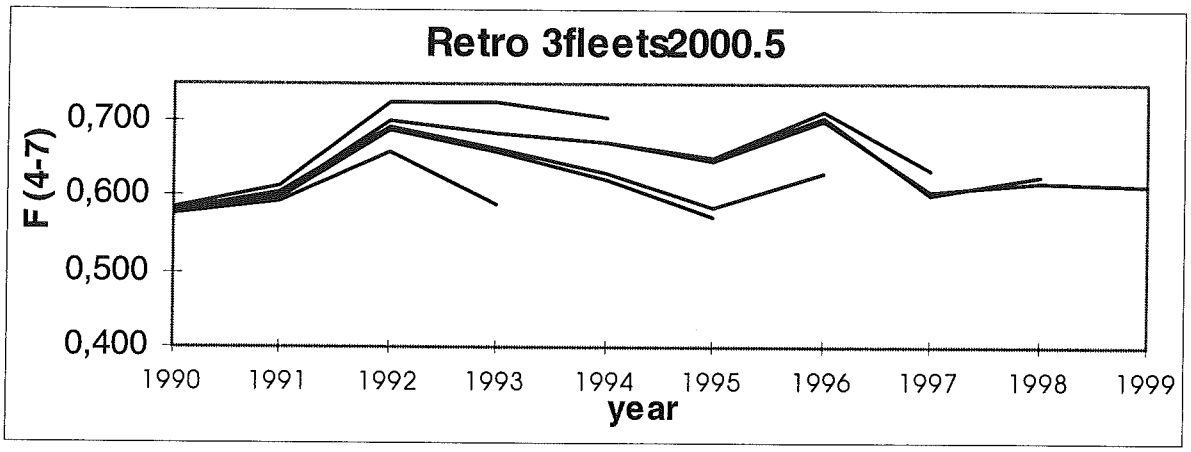


Figure 3.4.6.2.1 Haddock in Division Va. Retrospective analyses of the default XSA run.



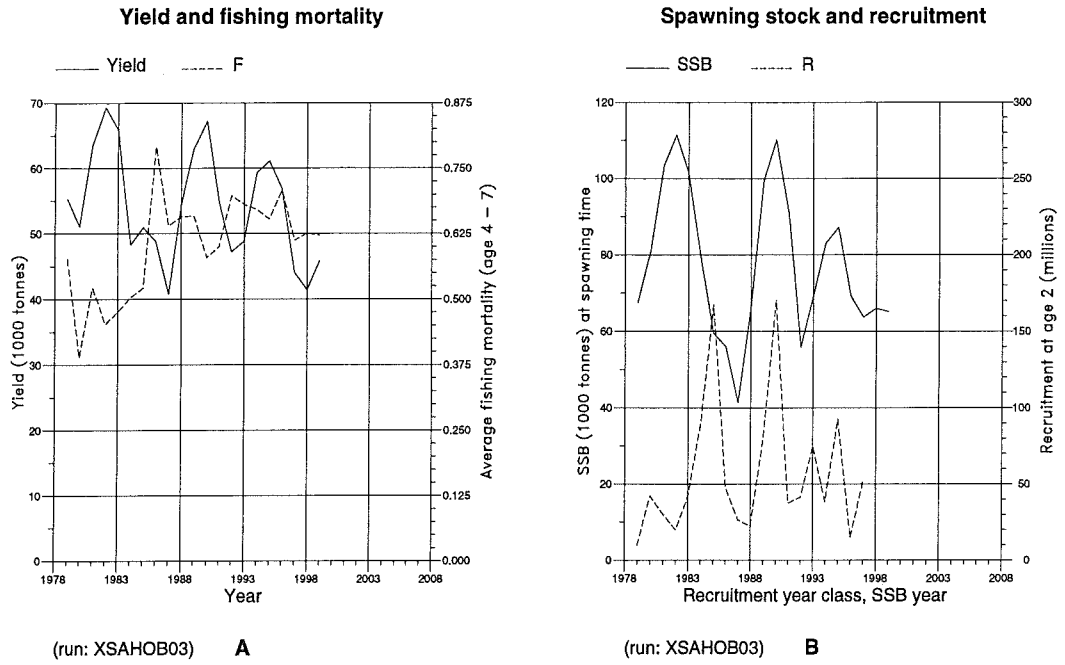


Figure 3.4.6.2.2 Summary plots of yield, fishing mortality, spawning stock and recruitment.

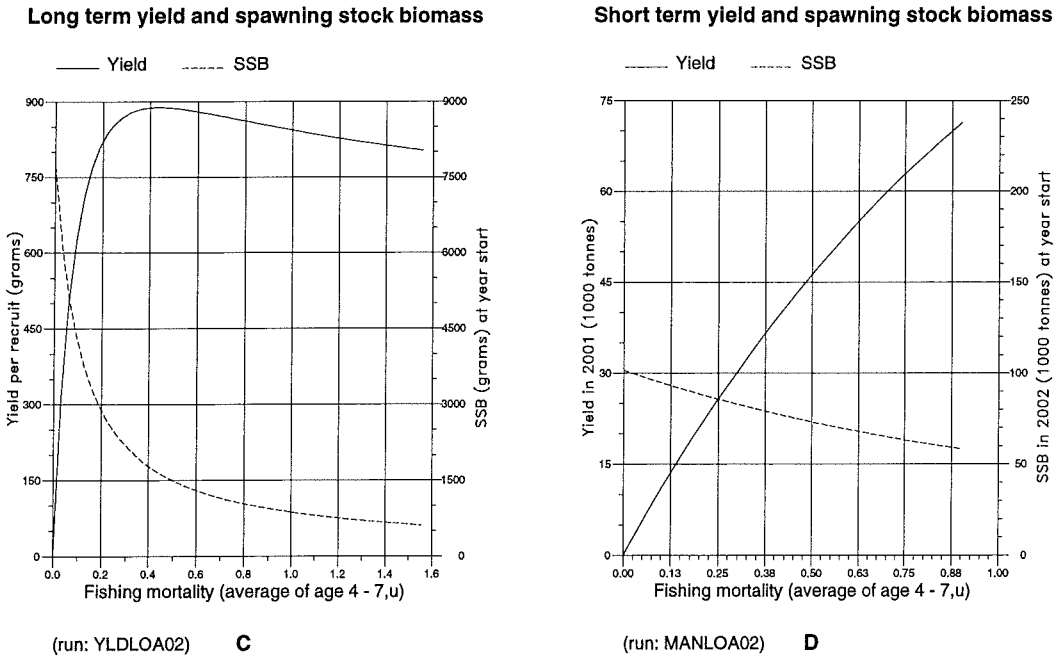


Figure 3.4.7.2.1 Summary plots of yield and spawning stock biomass per recruit.

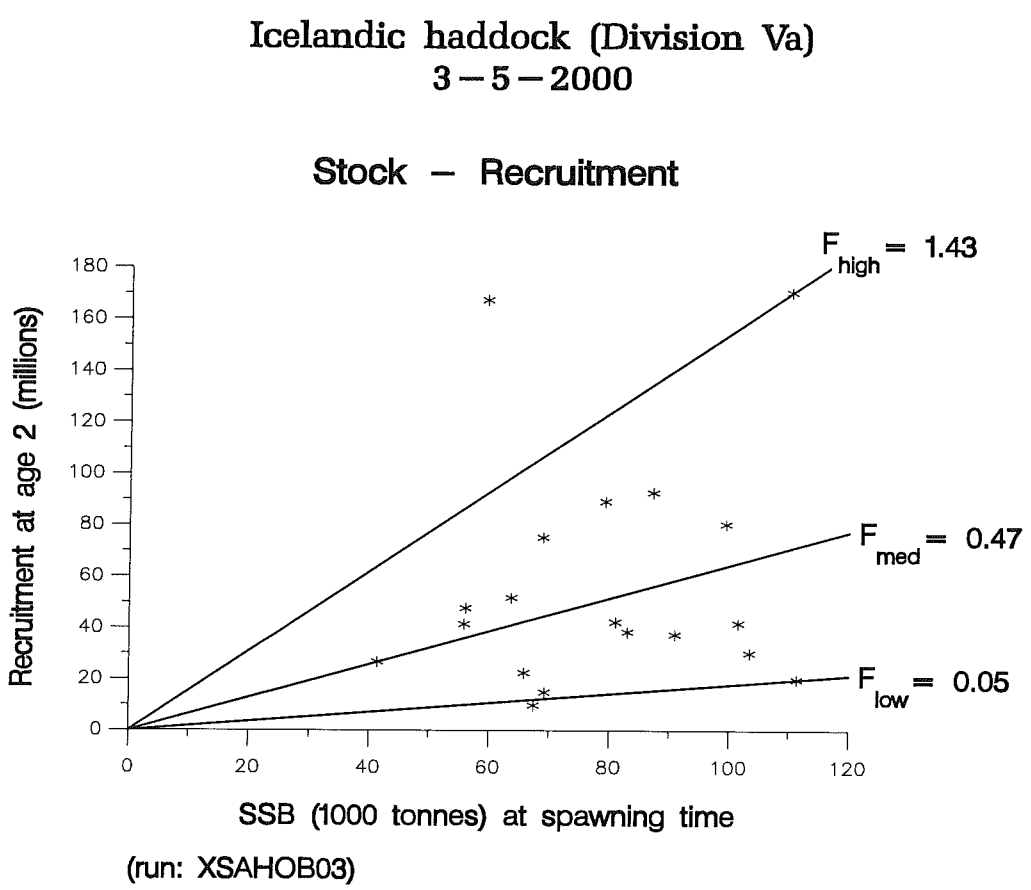


Figure 3.4.7.2.2 Haddock in Division Va. SSB-recruit plot.

4 THE COD STOCK COMPLEX IN GREENLAND (NAFO SUB-AREA 1 AND ICES SUB-AREA XIV) AND ICELANDIC WATERS (DIVISION Va)

4.1 Inter-relationship Between the Cod Stocks in the Greenland-Iceland Area

Tagging experiments carried out at Greenland and Iceland show that mature cod at West Greenland migrate to East Greenland. Tagging experiments at East Greenland also show that mature cod from that area migrate to Iceland (Tåning, 1937; Hansen, 1949; and Anon. 1971). On the other hand, immature cod seem not to emigrate from East Greenland to Iceland, but in some years immature cod migrate from East Greenland to the West Greenland stock (Anon. 1971). Tagging experiments at Iceland show that migration of cod from Iceland to Greenland waters occurs very seldom and can be ignored in stock assessments (Jonsson 1965, 1986). Migrations from Greenland waters to Iceland can, therefore, be regarded as a one-way migration.

In egg and larval surveys cod eggs have been found in an almost continuos belt from Iceland to East Greenland, along the East Greenland coast, round Cape Farewell and over the banks at West Greenland (Tåning 1937, Anon. 1963). From 0-group surveys carried out in the East Greenland-Iceland area since 1970, it becomes quite evident that the drift of 0-group cod from the Iceland spawning grounds to the different nursery areas at Iceland varies from year to year. The same applies to the drift of 0-group cod with the currents from Iceland to East Greenland (Table 4.1.1). In some years it seems that no larval drift has taken place to the Greenland area, while in other years some, and in some years like 1973 and 1984, considerable numbers drifted to East Greenland waters (Vílhjalmsson and Fridgeirsson 1976, Vílhjalmsson and Magnússon 1984, Sveinbjörnsson and Jónsson 1999). Since 1995, 0-group surveys were continued with the area coverage reduced to the Icelandic EEZ. However, the estimates of the 1997 and 1999 year classes are exceptionally high. More than 60% of the 0-group cod were distributed in northern areas off Iceland (Table 4.1.1).

The 1973 and 1984 year classes have been very important to the fisheries off both West and East Greenland. Tagging results have shown that when these two year classes became mature, they had migrated in large numbers from West to East Greenland and, to some extent, to the spawning area off the southwest coast of Iceland. This migration of mature cod from Greenland to Iceland influences the assessment of these stocks (Schopka, 1993) and it cannot therefore be ignored in the assessments.

Table 4.1.1 Abundance indices of 0-group cod from international and Icelandic 0-group surveys (Sveinbjörnsson and Jónsson, 1999) in the East Greenland/Iceland area, 1971-99 (except 1972 and 1995-96).

Year class	Dohrn Bank East Greenland	SE Iceland	SW Iceland	W Iceland	N Iceland	E Iceland	Total
1971	+	-	-	60	214	-	283
1973	135	10	107	96	757	86	1191
1974	2	-	-	22	30	+	54
1975	+	-	2	50	73	5	130
1976	5	9	30	102	2015	584	2743
1977	7	2	+	26	305	94	435
1978	2	-	+	169	335	47	552
1979	2	+	1	22	345	+	370
1980	1	2	+	38	507	10	557
1981	19	-	-	41	19	-	78
1982	+	-	+	7	4	-	11
1983	+	-	+	85	66	2	153
1984	372	5	+	200	826	369	1772
1985	32	+	+	581	197	2	812
1986	+	1	2	15	32	+	50
1987	7	-	1	2	61	10	81
1988	0	-	1	7	12	+	20
1989	1	-	3	7	30	+	41
1990	3	-	+	2	30	2	37
1991	+	-	-	+	5	+	6
1992	0	-	+	15	21	5	42
1993	1	-	+	36	116	2	155
1994	0	-	0	1	71	2	74
1997	4[1]	+	+	97	1007	46	1152
1998[2]		+	2	814	1799	137	2752
1999[2]		25	9	221	8255	898	9408

[1]) Figure reflects Dohrn Bank area only due to reduced survey area.
[2]) No estimate available for the Dohrn Bank-East Greenland area due to reduced survey area.

5 COD STOCKS IN THE GREENLAND AREA (NAFO AREA 1 AND ICES SUBDIVISION XIVB)

5.1 Cod off Greenland (offshore component)

Prior to 1996, the cod stocks off Greenland have been divided into West and East Greenland or treated as one stock unit for assessment purposes to avoid migration effects. Fjord populations (inshore) have always been included. In 1996, the offshore component off West and East Greenland, the so called Bank Cod, was assessed separately as one stock unit and distinguished from the inshore populations for the first time. The completion of a re-evaluation of available German sampling data for the offshore catches back to 1955 enabled such an analysis given in the 1996 North-Western Working Group report (ICES C.M.1996/Assess:15). Due to the severely depleted status of the offshore stock component, the directed cod fishery was given up in 1992, the final year in the VPA. Since then, no adequate data were available to update the assessment. Therefore, the present report includes the summary table and figures of the 1996 assessment only appended by long term management considerations and updated survey results and catch information.

5.1.1 Trends in landings and fisheries

Officially reported catches are given in Tables 5.1.1 and 5.1.2 for West and East Greenland including inshore catches, respectively. Landings as used by the working group are listed in Table 5.1.3 by inshore and offshore areas and gear for both West and East Greenland combined, their trends being illustrated in Figure 5.1.1. Until 1975, offshore landings have dominated the total figures by more than 90%. Thereafter, the proportions taken offshore declined to 40–50% and the most recent yields have been dominated by inshore landings since 1993. Otter trawl board catches (OTB) were most important throughout the time series for offshore fisheries. Miscellaneous gears, mainly long lines and gill nets, contributed 30–40% until 1977 but have disappeared since then.

Annual landings taken offshore averaged about 300 000 t during the period 1955–60. Until 1968, figures increased to a higher level between 330 000 t and of 440 000 t in 1962. Landings decreased sharply by 90% to 46 000 t in 1973. Subsequently, the landings dropped below 40 000 t in 1977 and were very variable. The level of 40 000 t was only exceeded during the periods 1980–83 and 1988–1990. Since 1970, there have been large changes in effort which increased during exploitation of the strong year classes born in 1973 and 1984. The offshore fishery was closed in 1986 and for the first 10 months in 1987. During 1990–92, the landings decreased from 100 000 t by 90% to 11 000 t. Since then, almost no directed cod fishery has taken place offshore and the reported landings varied from 112 t to 736 t. A total offshore catch amounting to 112 t was reported for 1999.

It is important to note that catch figures, especially since 1992, are believed to be incomplete due to unreported by-catches in the shrimp fishery which has recently expanded to all traditional areas of the groundfish fisheries. Discards of fin-fish by-catches were difficult to record due to the processing of the shrimp catch on board. A first assessment of the catch taken by the shrimp fishery amounted to 32 t or 110 000 individuals of cod in 1994. This estimate was added to the catch figures used by the Working Group for the 1992–95 period.

5.1.2 Results of the German groundfish survey

Annual abundance and biomass indices have been derived using stratified random groundfish surveys covering shelf areas and the continental slope off West and East Greenland. Surveys commenced in 1982 and were primarily designed for the assessment of cod (*Gadus morhua* L.). A detailed description of the survey design and determination of these estimates was given in the report of the 1993 North-Western Working Group (ICES C.M.1993/Assess:18) and Working Doc. 15. Figure 5.1.2 indicate names of the 14 strata, their geographic boundaries, depth ranges and areas in nautical square miles (nm^2). All strata were limited at the 3 mile line offshore except for some inshore regions in Strata 6.1 and 6.2 off East Greenland where there is a lack of adequate bathymetric measurements. In 1984, 1992, and 1994 the survey coverage was incomplete off East Greenland partly due to technical problems.

5.1.2.1 Stock abundance indices

Table 5.1.4 lists abundance and biomass indices for West and East Greenland, respectively and then combined for the years 1982–99. Trends of the abundance and biomass estimates for West and East Greenland were shown in Figures 5.1.3 and 5.1.4, respectively. These figures illustrate the pronounced increase in stock abundance and biomass indices from 23 million individuals and 45 000 tons in 1984 to 828 million individuals and 690 000 tons in 1987. This trend was the result of the recruitment of the predominating year classes 1984 and 1985, which were mainly distributed in the northern and the shallow strata 1.1, 2.1 and 3.1 off West Greenland during 1987–89. Such high indices were never observed in strata off East Greenland, although their abundance and biomass estimates increased during the period 1989–91 suggesting an eastward migration. During the period 1987–89, which were years with high abundance, the precision of survey indices was extremely low due to enormous variation in catch per tow data. Since 1988, stock

abundance and biomass indices decreased dramatically by 99% to only 5 million fish and 6 000 tons in 1993. The 1999 survey results confirmed the severely depleted status of the stock.

5.1.2.2 Age composition

Age disaggregated abundance indices for West and East Greenland and the total have been recalculated for the entire time series due to a software change and results are listed in Tables 5.1.5–7, respectively. Differences with previous estimates are within the magnitude of rounding errors only. In 1999, the stock structure off West Greenland was found to be composed almost exclusively of the pre-recruiting age groups 1 and 2 (86%). The age composition off East Greenland was found to be more diverse. Although the 1997 and 1998 year classes are the highest at age 1 since 1987 they are considered to be poor compared with the strong 1984 and 1985 year classes and therefore indicate only a very small recovery potential in the short-term as derived from the regression between year class strengths at age 1 and 3 (Figure 5.1.5). The survey estimates for the 0-group are considered unrepresentative due to gear specifications and do not allow assessments of year class strength at older ages (Figure 5.1.5).

5.1.2.3 Mean weight at age

Mean weight of the age groups 1–10 years for West and East Greenland and weighted by abundance to the total were listed in Tables 5.1.8–10, respectively. Weight (g) at age calculations are based on the regression $f(x) = 0.00895x^{3.00589}$, x = length (cm), which has been determined on the basis of 3 482 individual measurements. The trends of these values are illustrated in Figure 5.1.6 for the period 1982–98. They revealed pronounced areal and temperature effects. Age groups 2–10 years off East Greenland were found to be bigger than those off West Greenland. Driven by the high abundance of cod off West Greenland, weighted mean length and weight for the age groups 1–5 displayed a decrease during 1986–87 and remained at low levels until 1991. Since then, the weight at age at ages 3 to 8 years increased significantly and remained at that high level in 1999.

5.1.3 Biological sampling of commercial catches

No commercial sampling data were available to assess recent catch in numbers, weight and maturity at age.

5.1.4 Results from the 1996 assessment

The historical stock status was assessed based on the terminal Fs derived from an XSA tuning run applying 1992 as the final year.

Trends in yield and fishing mortality are shown in Figure 5.1.7. An increasing trend in Fbar from 0.1 to 0.4 was determined during the period 1955–68. During the same period, the yield increased from a level of 280 000 t to 380 000 t but decreased drastically to 100 000 t in the early 70s. Thereafter, the fishing mortality was highly variable and seemed to be dependent on the changes in effort directed to the exploitation of individual strong year classes. Periods when Fbar for ages 5–8 years exceeded 0.5 were 1974–1977, 1980–1984 and 1988–1992.

Trends in spawning stock biomass and recruitment were shown in Figure 5.1.8. During 1955 to 1973, the spawning biomass decreased almost continuously from 1.8 million t to 110 000 t, a decrease of 94%. Thereafter, the spawning stock biomass averaged 50 000 t. During the period 1955–73 before the spawning stock decreased below 100 000 t, the recruitment at age 3 varied enormously between 4 million and 700 million and averaged 220 million. Since 1974, the spawning stock varied around the mean of 50 000 t and produced an average recruitment of 41 million representing a mean reduction by 95% and 80%, respectively. The long-term mean recruitment was not exceeded for 8 of the 19 years from 1955 to 1973, while it has been below that value for 17 of the 19 years since then. During the last 29 years, only 2 year classes have reached the long-term mean recruitment level at age 3, namely those produced in 1973 and 1984.

5.1.5 Estimation of management reference points

Input parameters for the estimation of long-term yield and spawning stock biomass per recruit are listed in Table 5.1.11 for age groups 3–12. Maturity and weight at age vectors were calculated as long-term means covering the period 1955–92. The natural mortality M was increased to 0.3 for age groups 5 and older to account for an emigration to Iceland. The exploitation pattern was derived as Fbar from the three most recent years from the final VPA. Determined F-factors for $F_{0.1}$ and F_{max} were scaled according to the mean reference F over the age groups 5–8. The resulting estimates of yield and spawning stock biomass per recruit are illustrated in Figure 5.1.9. The values of $F_{0.1}$ and F_{max} are indicated by arrows and amounted to 0.3 and 0.72, respectively. The lack of a well definite peak in the yield per recruit curve is due to increased natural mortality.

Recruitment at age 3 is plotted against the spawning stock biomass in Figure 5.1.10. F_{med} amounted to 0.09. The corresponding spawning stock biomass per recruit was as high as 4.5 kg. F_{high} amounted to 0.59 with the accompanied spawning stock biomass per recruit of 1.0 kg.

However, neither the determined Beverton & Holt nor the Ricker model fitted the observed recruitment-spawning stock biomass points well. The Beverton & Holt curve quickly reached the long-term mean recruitment level, affected by the strong 1973 and 1984 year classes related to low biomass values and the extremely poor year classes 1969–72 produced by spawning stock sizes exceeding 250 000 t. The Ricker curve did not reach a maximum over the available range of observed spawning stock sizes. This suggested that, during the period of investigation, the recruitment appeared at all times to be adversely affected by reductions in spawning stock biomass.

Given suitable environmental conditions, cod in the offshore areas of Greenland are considered to be self-sustaining. An example of restricted recruitment was identified for the period 1969–72 when a continued cold event off West Greenland and an almost complete recruitment failure was observed. Figure 5.1.10 indicates that the reduced recruitment was observed at a SSB of less than 1 000 000 t. Following the instructions given by the SGPAFM this value could be taken as the precautionary reference point B_{pa}. Given the depleted stock status, no limit and precautionary reference points for fishing mortality and biomass were proposed.

5.1.6 By-catch and discard of cod in the shrimp fishery

No information about the amount of by-catch and discard of cod in the shrimp fishery off East and West Greenland was available. Long-term simulations based on a recruitment model (Rätz *et al.*, 1999) were carried out last year (ICES C.M.1998/ACFM:19) and indicated a significant adverse effect of even low fishing mortality of pre-recruits on the potential stock recovery.

5.1.7 Management considerations

The assessment of the offshore component of the cod stocks off Greenland revealed that over-fishing was a major cause for the collapse of this unit in the beginning of the 70s. Since that time, the spawning stock has remained below 100 000 t and has not been able to produce adequate recruitment. Only two strong year classes have been observed in 1976 and 1987 as 3 year olds. An increase in effort directed towards the 1973 and 1984 year classes resulted in high fishing mortality. Both year classes contributed only negligible amounts to the severely declined spawning stock. The most recent trend in the fishery and German survey data which were not included in this assessment, are consistent with this picture. Further, no indication of a significant stock recovery in the short-term was derivable based on the lack of strong pre-recruiting year classes. In the present situation, catches of young cod in the shrimp fishery should be kept to a minimum in order to increase the probability of stock recovery. No fishing should take place until a substantial increase in recruitment and biomass is evident.

5.1.8 Comments on the assessment

The present assessment is based on survey indices only due to the termination of the cod directed offshore fishery in 1992.

The VPA assessment conducted in 1996 was affected by several uncertainties in data as well as ecological factors. The effect of emigration was only directly covered for the 1973 and 1984 year classes and had been taken into account by an increase of the natural mortality to 0.3 for age groups 5 and older. The sampling of commercial catches was historically rather inconsistent and did not cover the 30% taken by miscellaneous gears, mainly longlines and gill nets up to 1977. Since 1991, catch at age and weight at age data had to be calculated using survey data. Maturity data were poorly reported implying uncertainties in spawning stock estimates.

No XSA tuning could be applied since 1997 when low levels in landings, effort and stock abundance were observed. The age disaggregated survey indices had to be adjusted to account for incomplete coverage of the survey area in 1992 and 1994.

Table 5.1.1 Nominal catch (tonnes) of Cod in NAFO Sub-area 1, 1986-1999 as officially reported to NAFO.

Country	1986	1987	1988	1989	1990	1991	1992
Faroe Islands	-	-	-	-	51	1	-
Germany	41	55	6.574	12.892	7.515	96	-
Greenland	6.549	12.284	52.135	92.152	58.816	20.238	5.723
Japan	11	33	10	-	-	-	-
Norway	2	1	7	2	948	-	-
UK	-	-	927	3780	1.631	-	-
Total	6.603	12.373	59.653	108.826	68.961	20.335	5.723
WG estimate	-	-	62.653 [2]	111.567 [3]	98.474 [4]	-	-

Country	1993	1994	1995	1996	1997	1998	1999 [1]
199Faroe Islands	-	-	-	-	-		
Germany	-	-	-	-	-		
Greenland	1.924	2.115	1.710	948	904	319	622
Japan	-	-	-	-	-		
Norway	-	-	-	-	-		
UK	-	-	-	-	-		
Total	1.924	2.115	1.710	948	904	319	622
WG estimate	-	-	-	-	-	-	-

[1]) Provisional data reported by Greenland authorities
[2]) Includes 3,000 t reported to be caught in ICES Sub-area XIV
[3]) Includes 2,741 t reported to be caught in ICES Sub-area XIV
[4]) Includes 29,513 t caught inshore

Table 5.1.2 Nominal catch (tonnes) of cod in ICES Sub-area XIV, 1986-1999 as officially reported to ICES.

Country	1986	1987	1988	1989	1990	1991	1992
Faroe Islands	86	-	12	40	-	-	-
Germany	4.063	5.358	12.049	10.613	26.419	8.434	5.893
Greenland	606	1.550	345	3.715	4.442	6.677	1.283
Iceland	-	1	9	-	-	-	22
Norway	-	-	-	-	17	828	1.032
Russia				-	-	-	126
UK (Engl. and Wales)	-	-	-	1.158	2.365	5.333	2.532
UK (Scotland)	-	-	-	135	93	528	463
United Kingdom	-	-	-	-	-	-	-
Total	4.755	6.909	12.415	15.661	33.336	21.800	11.351
WG estimate	-	-	9.457 [1]	14.669 [2]	33.513 [3]	21.818 [4]	-

Country	1993	1994	1995	1996	1997	1998	1999 [5]
Faroe Islands	-	1	-	-	-		
Germany	164	24	22	5	39	128	13
Greenland	241	73	29	5	32	37	
Iceland	-	-	1	-	-		-
Norway	122	14	+	1 [5]	15 [5]	1	4
Portugal						31	-
Russia	-	-	-	-	-		
UK (Engl. and Wales)	163	-	-	-	-		
UK (Scotland)	46	-	-	-	-		
United Kingdom	-	296	232	181	284	149	95
Total	736	408	284	192	370	346	112
WG estimate	-	-	-	-	-	-	

[1]) Excluding 3,000 t assumed to be from NAFO Division 1F and including 42 t taken by Japan
[2]) Excluding 2,741 t assumed to be from NAFO Division 1F and including 1,500 t reported from other areas assumed to be from Sub-area XIV and including 94 t by Japan and 155 t by Greenland (Horsted, 1994)
[3]) Includes 129 t by Japan and 48 t additional catches by Greenland (Horsted, 1994)
[4]) Includes 18 t by Japan
[5]) Provisional data

Table 5.1.3 Cod off Greenland (offshore component). Catches (t) as used by the Working Group, inshore and offshore by gear based on Horsted (1994).

Year	inshore	Offshore	offshore	offshore	total
		Miscellaneous	OBT	total	
1955	19787	117238	136028	253266	273053
1956	21063	121876	193593	315469	336532
1957	24790	104632	151666	256298	281088
1958	26684	121636	182516	304152	330836
1959	28184	97457	128777	226234	254418
1960	28708	115273	122859	238132	266840
1961	35164	140110	192007	332117	367281
1962	36283	168092	273598	441690	477973
1963	24173	138451	289143	427594	451767
1964	23106	118495	243714	362209	385315
1965	25209	133855	225150	359005	384214
1966	29956	149234	200086	349320	379276
1967	28277	132415	293519	425934	454211
1968	21215	64286	323800	388086	409301
1969	22119	36276	174031	210307	232426
1970	16114	16101	102196	118297	134411
1971	14039	25450	113207	138657	152696
1972	14753	29765	94730	124495	139248
1973	9813	16740	46141	62881	72694
1974	8706	18086	27695	45781	54487
1975	6779	13363	33692	47055	53834
1976	5446	8710	32157	40867	46313
1977	14964	10081	21726	31807	46771
1978	20295	4	26059	26063	46358
1979	36785	36	20056	20092	56877
1980	40122	0	57584	57584	97706
1981	40021	0	40266	40266	80287
1982	26934	2020	49827	51847	78781
1983	26689	3339	40991	44330	71019
1984	19967	5	22358	22363	42330
1985	8488	1	8499	8500	16988
1986	5320	2	6036	6038	11358
1987	8445	1	10836	10837	19282
1988	22814	7	49089	49096	71910
1989	38788	2	85946	85948	124736
1990	29513	948	99535	100483	129996
1991	18950	0	22966	22966	41916
1992	5723	0	11351	11351	17074
1993	1924	0	736	736	2660
1994	2115	0	408	408	2523
1995	1739	0	254	254	1993
1996	953	0	187	187	1140
1997	936	0	338	338	1274
1998	333	0	278	278	611
1999	622	0	112	112	734

Table 5.1.4 Cod off Greenland (offshore component). Abundance (1000) and biomass indices (t) for West, East Greenland and total by stratum, 1982-99. Confidence intervals (CI) are given in per cent of the stratified mean at 95% level of significance. () incorrect due to incomplete sampling.

	Abundance					Biomass				
YEAR	WEST	EAST	TOTAL	CI	Spawn. St.	WEST	EAST	TOTAL	CI	Spawn. St.
1982	92276	8090	100366	28	33592	128491	23617	152107	25	78466
1983	50204	7991	58195	25	23889	82374	34157	116531	25	57223
1984	16684	(6603)	(23286)	32	17531	25566	(19744)	(45309)	34	36246
1985	59343	12404	71747	33	16472	35672	33565	69236	39	44297
1986	145682	15234	160915	32	14244	86719	41185	127902	26	46864
1987	786392	41635	828026	59	25376	638588	51592	690181	63	66144
1988	626493	23588	650080	48	128208	607988	52946	660935	46	153387
1989	358725	91732	450459	59	311086	333850	239546	573395	46	438599
1990	34525	25254	59777	43	46705	34431	65964	100395	34	79021
1991	4805	10407	15213	29	6565	5150	32751	37901	36	18518
1992	2043	(658)	(2700)	50	574	607	(1216)	(1823)	69	1127
1993	1437	3301	4738	36	2321	359	5600	5959	41	4014
1994	574	(801)	(1375)	36	457	140	(2792)	(2930)	68	1744
1995	278	7187	7463	93	2215	57	15525	15581	155	9720
1996	811	1447	2257	38	592	373	3599	3973	56	2025
1997	315	4153	4469	75	3394	284	13722	14007	90	10385
1998	1723	1671	3394	54	1133	130	4348	4479	91	3820
1999	912	2769	3681	34	809	240	3917	4157	62	3004

Table 5.1.5 Cod off West Greenland (offshore component). Age disaggregate abundance indices (1000), 1982-1999. *) calculated proportionally using age compositions reported by the ICES Working Group on Cod Stocks off East Greenland (ICES C.M.1984/Assess:5).

YEAR	0	1	2	3	4	5	6	7	8	9	10	11+	TOTAL
1982	0	176	884	33470	11368	32504	9528	2622	578	939	91	90	92250
*1983	0	0	1469	2815	26619	4960	10969	1882	992	317	168	13	50204
1984	159	5	38	2070	1531	9848	842	1873	87	186	27	0	16666
1985	831	38016	1481	948	6403	2833	7682	467	646	27	35	0	59369
1986	0	14148	112532	4089	903	6823	2095	4271	133	616	34	39	145683
1987	0	317	45473	692567	24230	5929	11813	1637	4006	0	366	30	786368
1988	0	257	3332	102767	510980	5425	613	1122	654	1274	32	35	626491
1989	12	204	2461	3565	93687	254002	3934	0	535	114	228	0	358742
1990	159	47	1007	3005	1244	21724	7221	47	0	0	0	19	34473
1991	0	293	224	476	1397	164	1894	317	6	0	0	0	4771
1992	0	263	1427	220	36	77	0	28	0	0	0	0	2051
1993	0	10	832	544	20	28	6	0	0	0	0	0	1440
1994	0	283	45	199	38	5	0	5	0	0	0	0	575
1995	0	0	241	16	22	0	0	0	0	0	0	0	279
1996	0	147	11	638	10	0	10	0	0	0	0	0	816
1997	0	12	27	15	263	0	0	0	0	0	0	0	317
1998	48	1642	0	0	5	25	0	0	0	0	0	0	1720
1999	29	401	392	87	7	0	6	0	0	0	0	0	922

Table 5.1.6 Cod off East Greenland (offshore component). Age disaggregate abundance indices (1000), 1982-1999. *) calculated proportionally using age compositions reported by the ICES Working Group on Cod Stocks off East Greenland (ICES C.M.1984/Assess:5). () incomplete sampling.

YEAR	0	1	2	3	4	5	6	7	8	9	10	11+	TOTAL
1982	0	0	239	841	1764	1999	1227	379	130	1392	73	72	8116
*1983	0	0	411	605	1008	1187	2125	1287	302	265	703	101	7994
(1984)	0	18	74	1342	657	1397	855	1617	407	103	36	95	6601
1985	230	1932	556	118	2494	2034	1852	785	2000	295	56	36	12388
1986	0	1397	3351	1693	551	2417	1120	2191	566	1627	116	139	15168
1987	0	13	13785	17788	3890	1027	1770	457	1571	187	1093	36	41617
1988	11	25	163	6982	11094	2016	480	1435	152	674	98	469	23599
1989	0	7	179	489	17396	63216	3021	294	4870	406	1795	42	91715
1990	0	38	80	551	462	5128	18012	265	72	251	0	349	25208
1991	0	106	377	394	685	147	3512	5035	81	37	11	9	10394
(1992)	15	44	77	74	69	54	47	143	52	0	0	6	581
1993	0	17	44	1857	370	279	278	88	272	95	0	0	3300
(1994)	0	87	0	29	261	143	87	145	0	29	0	0	781
1995	0	7	2523	1125	370	1730	450	141	460	36	217	125	7184
1996	0	0	0	502	258	295	255	60	77	0	0	0	1447
1997	0	0	37	28	1508	1611	566	236	140	0	0	19	4145
1998	63	240	192	21	45	462	435	156	43	0	0	0	1657
1999	191	632	665	417	138	302	179	200	0	35	24	0	2783

Table 5.1.7 Cod off Greenland (offshore component). Age disaggregate abundance indices (1000), 1982-1999. *) calculated proportionally using age compositions reported by the ICES Working Group on Cod Stocks off East Greenland (ICES C.M.1984/Assess:5). () incomplete sampling.

YEAR	0	1	2	3	4	5	6	7	8	9	10	11+	TOTAL
1982	0	176	1123	34311	13132	34503	10755	3001	708	2331	164	162	100366
*1983	0	0	1880	3420	27627	6147	13094	3169	1294	582	871	1140	58198
(1984)	159	23	112	3412	2188	11245	1697	3490	494	289	63	95	23267
1985	1061	39948	2037	1066	8897	4867	9534	1252	2646	322	91	36	71757
1986	0	15545	115883	5782	1454	9240	3215	6462	699	2243	150	178	160851
1987	0	330	59258	710355	28120	6956	13583	2094	5577	187	1459	66	827985
1988	11	282	3495	109749	522074	7441	1093	2557	806	1948	130	504	650090
1989	12	211	2640	4054	111083	317218	6955	294	5405	520	2023	42	450457
1990	159	85	1087	3556	1706	26852	25233	312	72	251	0	368	59681
1991	0	399	601	870	2082	311	5406	5352	87	37	11	9	15165
(1992)	15	307	1504	294	105	131	47	171	52	0	0	6	2632
1993	0	27	876	2401	390	307	284	88	272	95	0	0	4740
(1994)	0	370	45	228	299	148	87	150	0	29	0	0	1356
1995	0	7	2764	1141	392	1730	450	141	460	36	217	125	7463
1996	0	147	11	1140	268	295	265	60	77	0	0	0	2263
1997	0	12	64	43	1771	1611	566	236	140	0	0	19	4462
1998	111	1882	192	21	50	487	435	156	43	0	0	0	3377
1999	220	1033	1057	504	145	302	185	200	0	35	24	0	3705

Table 5.1.8 Cod off West Greenland (offshore component). Weighted mean weight (g., by stratum abundance) at age 1-10 years, 1982, 1984-1999.

YEAR	1	2	3	4	5	6	7	8	9	10
1982	44	190	568	920	1770	2164	2962	4078	5065	6995
1983										
1984	68	136	379	807	1356	1990	2885	3600	4476	6177
1985	96	168	568	981	1475	2010	3121	3341	4408	4014
1986	72	325	498	1118	1697	2217	2784	3889	4159	4493
1987	37	223	697	926	1194	2154	2239	3028		3541
1988	38	211	456	1019	1145	1941	2949	2735	3630	4192
1989	36	159	423	796	1403	1443		2885	3229	4562
1990	38	114	334	599	909	1395	1111			
1991	50	139	356	649	926	1356	1743	920		
1992	75	230	379	668	938		2061			
1993	41	132	405	494	920	920				
1994	45	126	456	608	1111		2461			
1995		186	328	482						
1996	42	104	510	753		3645				
1997	68	334	375	994						
1998	50			1567	1516					
1999	77	340	612	1111		2822				

Table 5.1.9 Cod off East Greenland (offshore component). Weighted mean weight (g., by stratum abundance) at age 1-10 years, 1982, 1984-1999. () Incomplete sampling.

YEAR	1	2	3	4	5	6	7	8	9	10
1982		423	769	1419	2326	3498	4597	5523	6633	6500
1983										
(1984)	104	331	801	1807	2207	3014	3858	4936	4632	5445
1985	109	437	1038	1761	3161	3369	4459	4755	5824	7957
1986	88	375	915	1715	2674	4225	4159	4954	6030	6722
1987	33	283	640	885	1653	3600	4545	5120	6072	7684
1988		275	733	1770	3067	4291	4702	6500	6949	7418
1989	68	252	538	1118	2507	3690	3951	5027	5662	6457
1990	52	419	510	1145	1618	2625	3858	5702	6880	
1991	86	194	402	1173	1864	2315	3355	4374	5139	10198
(1992)	18	402	758	1575	3175	3028	3271	3469		
1993	81	353	728	1333	2315	2834	3600	4827	6135	
(1994)	41		1111	2271	3054	4791	4827		5742	
1995	68	249	430	1508	2949	4176	5233	5926	9645	7442
1996			717	1921	2461	3586	5120	5824		
1997		104	1525	1931	3454	4062	4562	4685		
1998	101	155	1045	1779	3028	3541	3858	6745		
1999	84	269	594	1173	2949	3735	4917		8522	9004

Table 5.1.10 Cod off Greenland (offshore component). Weighted mean weight (g., by stratum abundance) at age 1-10 years, 1982, 1984-1999. () Incomplete sampling.

YEAR	1	2	3	4	5	6	7	8	9	10
1982	44	230	572	975	1798	2293	3148	4324	5967	6767
1983										
(1984)	104	331	801	1807	2207	3014	3858	4936	4632	5445
1985	97	225	612	1173	2081	2239	3920	4374	5702	6219
1986	73	325	603	1326	1921	2822	3216	4738	5484	6177
1987	36	237	697	920	1259	2315	2649	3541	6072	6435
1988	61	214	471	1032	1550	2822	3858	3285	4614	6522
1989	37	164	437	845	1584	2250	3951	4791	5046	6219
1990	44	128	359	722	1025	2217	3299	5702	6880	
1991	58	172	375	801	1318	1941	3243	4014	5139	10198
(1992)	63	237	459	1208	1644	3028	3041	3469		
1993	64	141	644	1281	2154	2784	3600	4827	6135	
(1994)	44	126	518	1980	2962	4791	4738		5742	
1995	68	244	426	1427	2949	4176	5233	5926	9645	7442
1996	42	104	594	1864	2461	3586	5120	5824		
1997	68	180	1000	1761	3454	4062	4562	4685		
1998	56	155	1045	1761	2923	3541	3858	6745		
1999	82	294	594	1173	2949	3705	4917		8522	9004

Table 5.1.11 Cod off Greenland (offshore component). Input parameters in for calculations of yield and spawning stock biomass per recruit.

Age	WEIGHT (kg)	MATURITY	Exploit. pattern	M
3	0.815	0.001	0.154	0.2
4	1.255	0.004	0.425	0.2
5	1.863	0.15	0.643	0.3
6	2.549	0.449	0.931	0.3
7	3.295	0.795	1.07	0.3
8	4.157	0.946	1.145	0.3
9	4.967	0.99	1.267	0.3
10	5.836	1	1.027	0.3
11	6.447	1	1.027	0.3
12	7.09	1	1.027	0.3

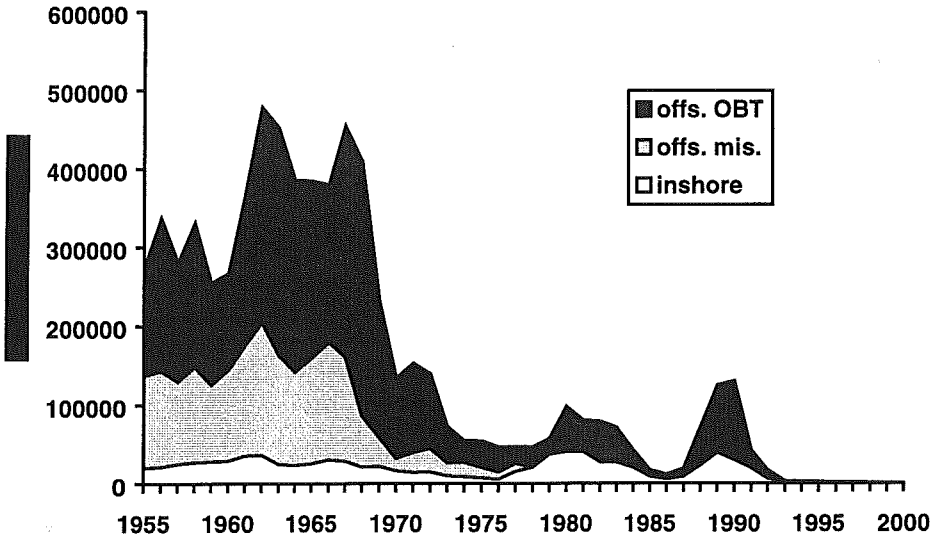


Figure 5.1.1 Cod off Greenland. Catches 1955-99 as used by the Working Group, inshore and offshore by gear (Horsted,1994).

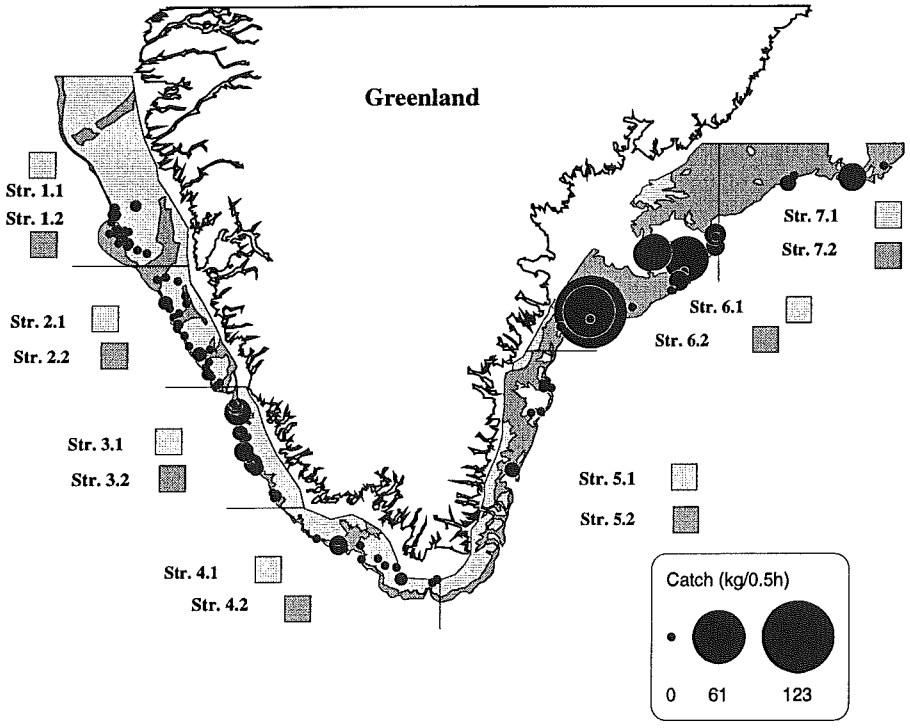


Figure 5.1.2 Cod off Greenland (offshore component). Survey area, stratification and position of hauls carried out in 1999.

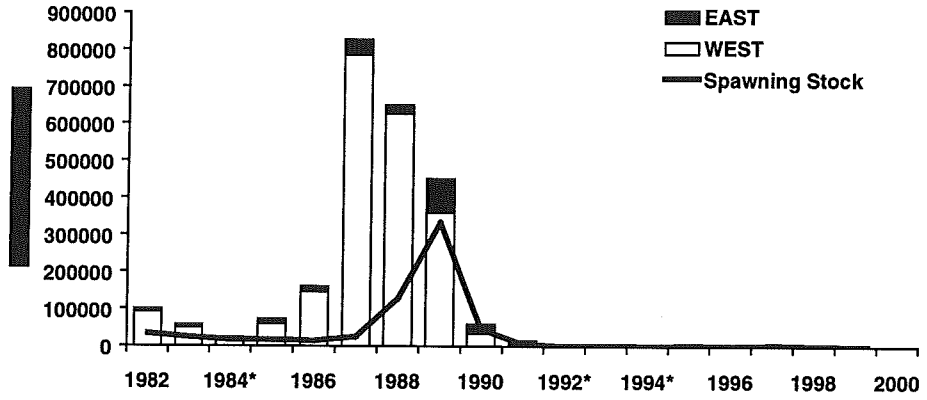


Figure 5.1.3 Cod off Greenland (offshore component). Aggregated survey abundance indices for West and East Greenland and spawning stock size, 1982-99. *) incomplete survey coverage.

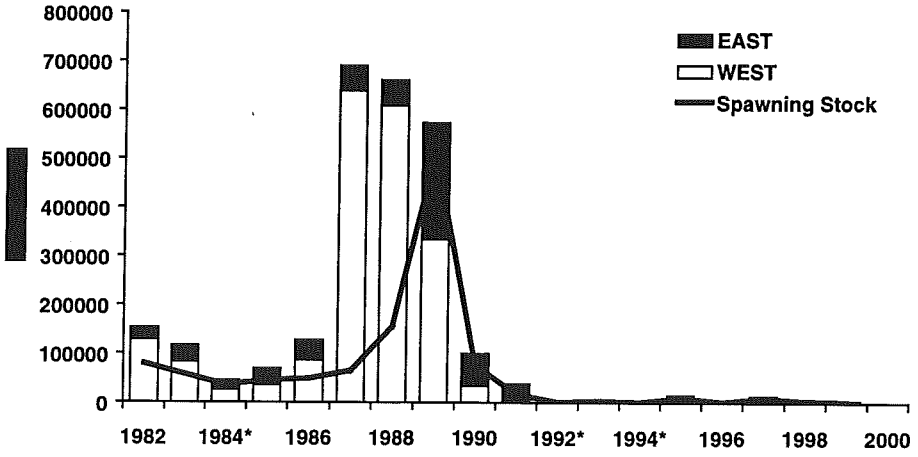


Figure 5.1.4 Cod off Greenland (offshore component). Aggregated survey biomass indices for West and East Greenland and spawning stock biomass, 1982-99. *) incomplete survey coverage.

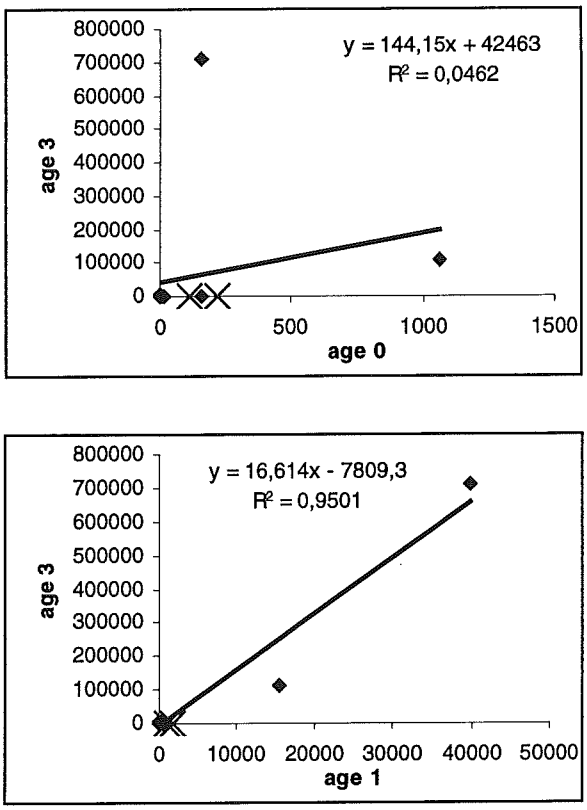


Figure 5.1.5 Cod off Greenland (offshore component). Use of 0 and 1 age group indices to predict year class strength at age 3. The x indicate the 1998 and 1999 year classes at age 0 and the 1997 and 1998 at age 1, respectively.

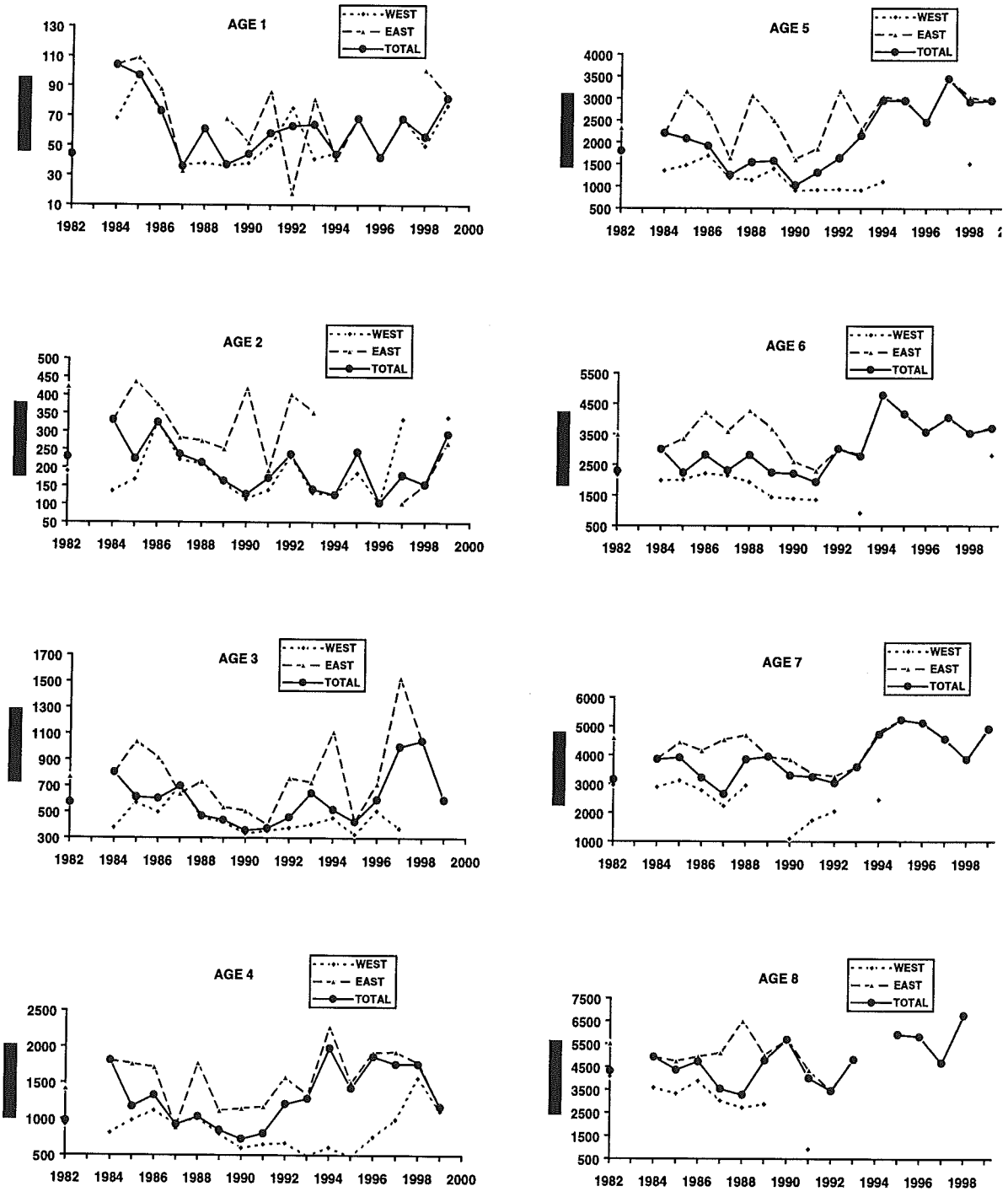


Figure 5.1.6 Cod off Greenland (offshore component). Weighted mean weight at age 1-10 years for West, East Greenland and total, 1982-99.

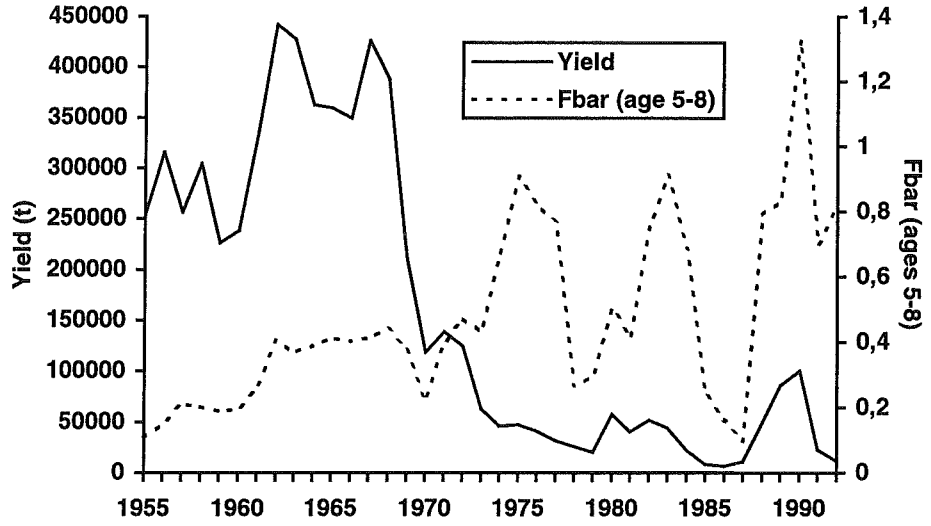


Figure 5.1.7 Greenland cod (offshore component). Trends in yield and fishing mortality.

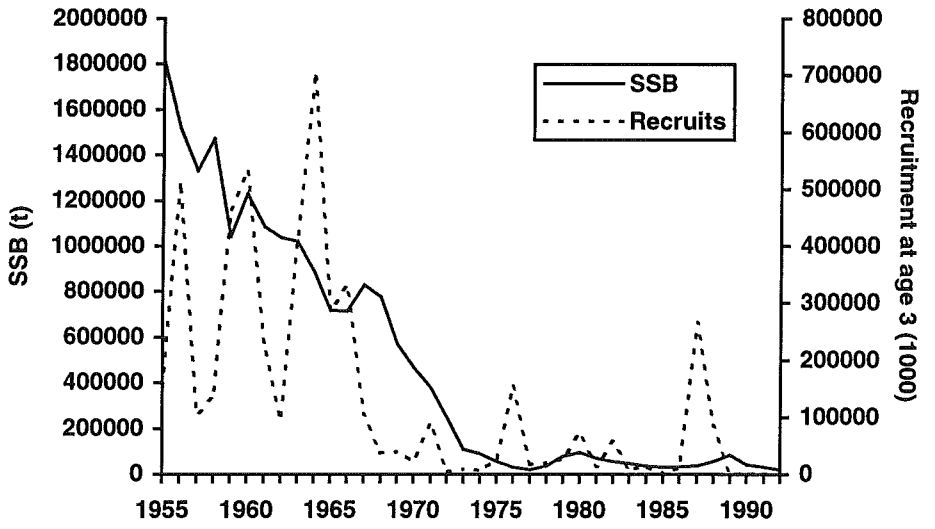


Figure 5.1.8 Greenland cod (offshore component). Trends in spawning stock biomass (SSB) and recruitment.

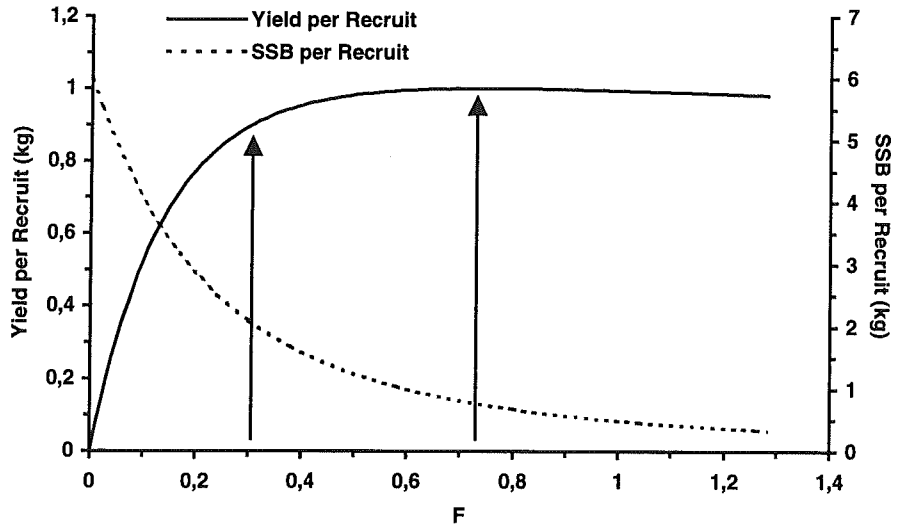


Figure 5.1.9 Greenland cod (offshore component). Long term yield and spawning stock biomass. $F_{0.1}$ reference age 5-8=0.297; F_{max} reference age 5-8=0.722.

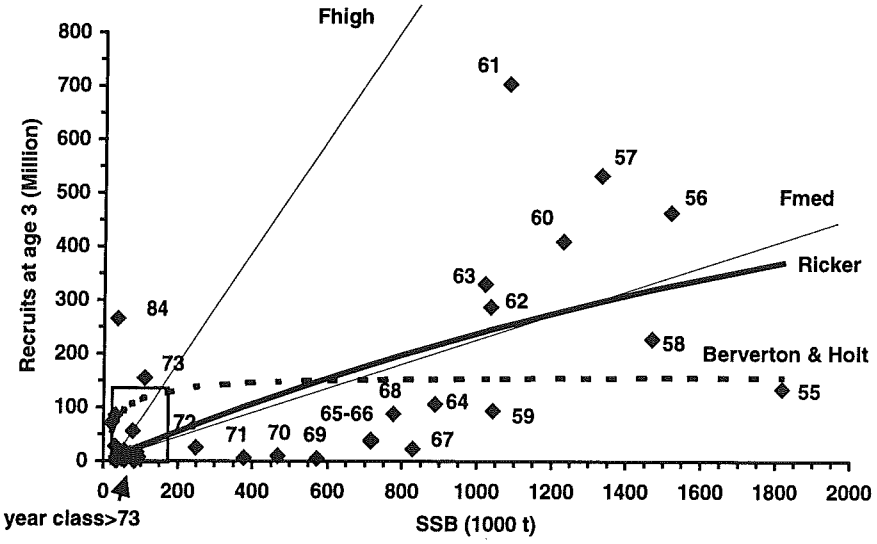


Figure 5.1.10 Greenland cod (offshore component). Spawning stock-recruitment plot for year classes 1955-89 and fitted recruitment curves. F_{med}=0.09 corresponding to a SSB/R=4.44 kg; F_{high}=0.59 corresponding to a SSB/R=0.98 kg.

5.2 Inshore cod stock off Greenland

In the last decade, the inshore cod fishery at West Greenland has contained cod from two different spawning areas. Icelandic cods spawned off South-western Iceland which in some years are carried by the Irminger current to settle off South Greenland, and local fjord populations. Spawning cod are found in several fjords of the West Greenland, especially in NAFO Divisions 1B, 1C and 1D. Although tagging experiments suggest a high degree of stationary for fjord populations, the recruitment seems to be correlated between the different fjords (Engelstoft 1997).

5.2.1 Trends in Landings and Effort

Historically, the inshore landings have been of limited importance as the inshore fisheries have accounted for only 5–10% of the total international catch. Annual landings of 15 000–20 000 t have been taken inshore during the period 1955–1973. Since then the landings have been varying consistently with the recruitment of strong year classes to the offshore fishery. High landings of about 50 000 t in 1980 and 1989 have been followed by periods of very low landings. In recent years the landings has decreased dramatically from about 2000 tons yearly in 1993–1995 to only 319 tons in 1998. In 1999 the catches increased again to 622 tons (Table 5.1.2).

The inshore fishery takes place from small vessels (< 40 GRT). Pound nets, gillnets and handlines are used to take about 95% of the inshore catch.

A commercial pound net CPUE series is available since 1992 (Table 5.2.1). The mean catch pr pound net setting has decreased from 804 t in 1994 to 284 in 1999.

5.2.2 West Greenland young cod survey

A survey using gangs of gill nets with different mesh-sizes (16.5, 18, 24, 28, and 33 mm) has been conducted since 1985. The objective of the program is to assess the abundance and distribution of pre-recruit cod in inshore areas of Greenland. The survey has usually been carried out in three inshore areas off West Greenland: Qaqortoq (NAFO Div. 1F), Nuuk (Div. 1D) and Sisimiut (Div. 1B). The Greenland inshore cod stock is not distributed in the Qaqortoq area, but occasional inflow of pre-recruited cod from East to West Greenland shows up here.

Analysis of the selectivity of the fleet of gill-nets has shown, that selection is best for age 2 cod, whereas only the larger individuals of the age 1 cod are adequately selected. In the1999 survey a total of 60 net settings were made. Nets were set at bottom and it was attempted to set the fleets at constant depths and to divide the survey effort evenly on the depth zones of 0–5 m, 5–10 m, 10–15 m, and 15–20 m. Technical problems caused that only one third of the survey area was covered in 1999.

An index of recruitment is calculated as the mean catch of 2-year old cod per 100 hours net setting taken by all five mesh sizes. The recruitment index is shown in Figure 5.2.1 and reveals a strong 1985 and 1987 year class, a moderate 1990 and 1993 year class and three successive weak year-classes in recent years. The very low 1997 class year might not be representative due to insufficient survey coverage.

5.2.3 Assessment

The available data for the Greenland inshore cod is not adequate to allow for a detailed analytical assessment of the stock, but the results of a general production model are presented.

A Schaefer general production model was fitted to the Greenland inshore cod landing data using the commercial pound net CPUE results for 1993 to 1997 as an index of stock biomass.

The model was fitted using Excel Solver to minimise the sum of squared residuals between the observed CPUE and the predicted CPUE where the predicted CPUE is given by:

$CPUEpred_t = B_t * q$

And the biomass is:

$B_{t+1} = B_t + (r*B_t*(1-B_t/k))-C_t$

Where C is the catch

Parameter values obtained last year were used as starting values. Parameter values achieved from the general production model are shown in Table 5.2.2. Observed and predicted CPUE-values are shown in figure 5.2.2.

The model parameters are not very stable and need to be constrained. The initial biomass B_t was constrained to be lower than the virgin biomass (k), r was constrained to be between zero and one, while q was constrained to be higher than 0.001.

The model implies FMSY of only 0.01, but the number of parameters is high compared to the number of data points. The decreasing CPUE and the present recruitment failure of the stock do however support this severe stock situation.

5.2.4 Biological reference points

No specific values can be put forward as reference points.

5.2.5 Management Considerations

The inshore fishery exploiting possible self-sustained local fjord populations off West Greenland has historically been small, and the fishery has never been constricted by catch regulations. The data presented indicate that the stock has undergone a series of recruitment failures in recent years. The latest year classes are all estimated to be very poor in the juvenile survey. No fishing should take place until a substantial increase in recruitment and biomass is evident.

Table 5.2.1 Greenland cod (inshore component). Landings, observed and predicted CPUE based on data from inshore pound net fishery.

Year	Predicted Biomass	Predicted CPUE	Observed CPUE	Ln (CPUE/B)	Observed Catch
1993	11226	664	730	-2.73	1924
1994	9331	591	768	-2.50	2215
1995	7151	490	600	-2.49	1710
1996	5478	438	536	-2.32	948
1997	4563	460	423	-2.38	904
1998	3690	489	248	-2.70	326
1999	3390	579	284	-2.48	622
2000	2793				

*predicted

Table 5.2.2 Input values and parameter values obtained from general production model.

Year of Assess.	Virgin Biomass	Rate of increase	Q	Init. Biomass
1999	11268	0,300	0,15	7428
2000	15515	0,01	0,08	11226

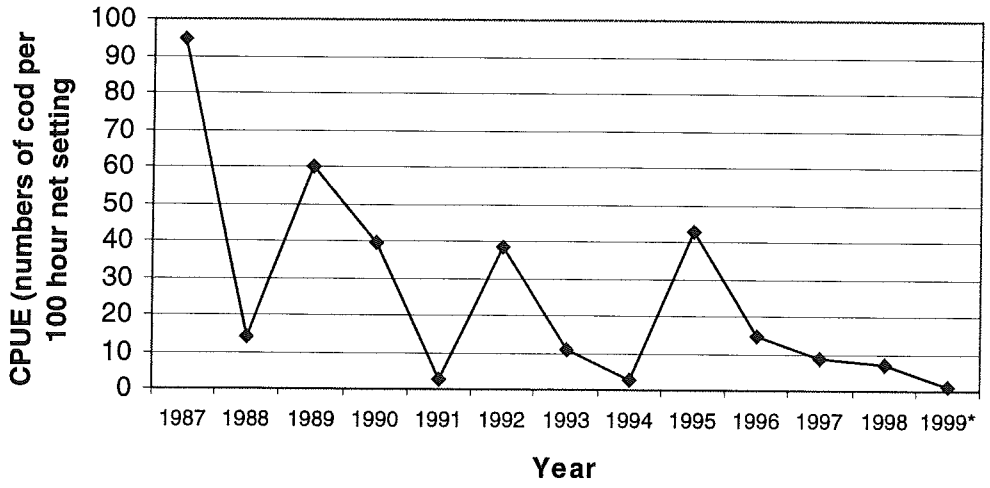


Figure 5.2.1 CPUE (number of age 2 cod caught per 100 hours net setting) in the Greenland Young cod survey 1987-1999. *) incomplete survey coverage.

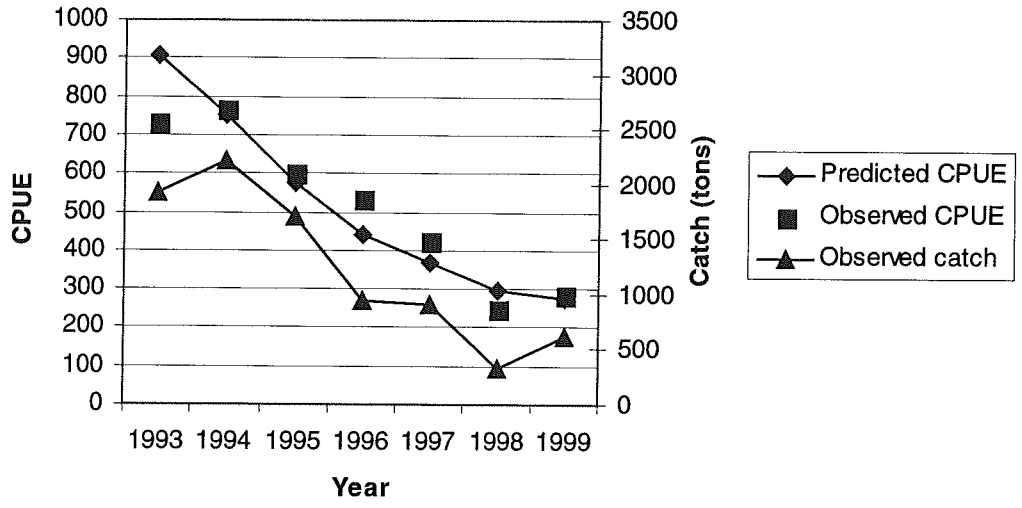


Figure 5.2.2 Greenland cod (inshore component). Observed and model-predicted CPUE rates.

6 GREENLAND HALIBUT IN SUB-AREAS V AND XIV

6.1 Landings, Fisheries and Fleet

Total annual landings in Divisions Va, Vb and Sub-area XIV are presented for the years 1981–1999 in Tables 6.1.1–6.1.5. During the period 1982–1986, landings were stable at about 31 000–34 000 t. In the years 1987–1989 landings increased to about 61 000 t, followed by a decrease to about 35 000 t in 1992. The landings increased to 41 000 t in 1993, but have thereafter decreased to 20 000 t in 1998 and 1999. Catches not officially reported to ICES have been included in the assessment.

Catches in Icelandic waters have, due to quota regulations, decreased from 37 000 t in 1990 to 11 000 t in 1998 and 1999. Faroese catches in Vb increased from of about 1 000 t in 1981–1991 to 6 500 t in 1996, whereafter it decreased to about 3 000 t in 1999. Catches in division XIVb have increased from below 1 000 t in 1987–1991 to 8 500 t in 1997, but have decreased again to 5 000 t in 1999. In 1999 no catches of Greenland halibut were reported in Sub-area XII.

Most of the fishery for Greenland halibut in Divisions Va, Vb and XIVb is a directed fishery, only minor catches in Va by Iceland, and in XIVb by Germany and the UK comes partly from a redfish fishery. A detailed description of the fishery performance and areas is given in ICES CM1998/ACFM:19. No major changes were observed in 1999.

6.2 Trends in Effort and CPUE

Catch rates of Icelandic bottom trawlers decreased for all fishing grounds during 1990–1995, but stabilised in 1995–1997. In 1998 an increase of 50% in CPUE was observed for all fishing grounds coinciding with a drastic reduction in effort (Table 6.2.1). A further increase of 15% was observed in 1999 . The increase in CPUE For the years 1990–1999 CPUE on the western fishing grounds have been about two to three times higher than for the other fishing grounds.

Indices of CPUE for the Icelandic trawl fleet for the period 1985–1999 (Table 6.2.1) are estimated from a GLIM multiplicative model, taking into account changes in the Icelandic trawl catch due to vessel, statistical square, month, and year effects. All hauls with Greenland halibut exceeding 50% of the total catch were included in the CPUE estimation. The CPUE indices from the Icelandic trawling fleet in Division Va were used to estimate the total effort for each year (y) for all the fleets operating on Greenland halibut in area V and XIV according to:

$$E_{y,V\&XIV} = Y_{y,V\&XIV} / CPUE_{y,Va_{trawl}}$$

where E is total effort, Y is the total reported landings in region V and XIV.

The total effort increased up to 1989, decreased somewhat in the next two years, but increased steeply since 1991 to a maximum in 1996. In 1998 the effort was similar to that 1991. The effort decreased further in 1999. The CPUE was relatively stable in 1985–1989, but has declined sharply since then to a historic low in 1997. The CPUE declined by 70% from 1989 to 1997, but in 1999 it was around 45% of the maximum value.

For division XIVb, CPUE from logbooks in the years 1991–1999 were standardised using a multiplicative model taking into account locality, fleet, season and year. CPUE increased from 1991 to 1993, thereafter it remains relatively stable. In the same period the calculated effort has increased continuously until 1996 but has declined by 20% since then. However, the fishery in XIVb is new and catches have increased from below 500 tons annually before 1991 to 4500 to 8000 tonnes in the last four years. The fishery was therefore assumed to be in the process of learning in the beginning of the CPUE Series. However, the stability in CPUE in recent years is in accordance with observations from the Icelandic fleet.

6.3 Catch at Age

Age-length keys for 1999 were from: The icelandic trawl fleet operating in Icelandic waters (120 sample, 1040 otoliths) and the German trawl fishery in Greenlandic waters (52 sample, 962 otoliths). These keys were used to obtain catch in number for the length samples for each of the following commercial fleets and areas:

Gear	Area	Landings	No. samples	No. fish	Key	ALK
Long line	Iceland	564	0	0	Va	ICE-BTRW
Bottom trawl	Iceland-west	7003	129	12212	Va	ICE-BTRW
Bottom trawl	Iceland-north & east	2083	28	2837	Va	ICE-BTRW
Bottom trawl	Iceland-southeast	1454	16	1692	Va	ICE-BTRW
Gill Net (&line)	Faroe Islands	3066	8	2008	Va	ICE-BTRW
Bottom trawl	Faroe Islands	1199	1	216	Va	ICE-BTRW
Long line	East Greenland	219	0	0	XIVb	ICE-BTRW
Bottom trawl	East Greenland	4779	60	3111	XIVb	GER-BTRW
Total		20366	242	22076		

In last year's assessment the age-length key from 1997 was used for the 1998 data because only a limited number of available otoliths were analysed. The 1998 data was therefore updated using an age-length key for 1998 (1237 otoliths samples) taken from the Icelandic trawl and longline fleet.

Length measurements from the Icelandic longline fleet were applied to the longline catch in East Greenland waters. The used length-weight relationship was $W = 0.01758 * L^{2.84387}$ for all fleets. The total catch in numbers (Table 6.3.1) was obtained from the sum of the above, weighted with the catch within each group. Apart from 1994 and 1996 to 1999 only Icelandic data has been available.

6.4 Weight at Age

The mean weight at age in 1999 (Table 6.4.1) was derived from the weighted average of the above groups. Weights at age in the catch are also used as weights at age in the stock.

6.5 Maturity at Age

Data on maturity at age were available for the years 1982–1984 and 1991–1995, based on samples from the Icelandic trawl fishery. Data on maturity at age for the years 1985–1990 were not available. The maturity at age for these years was therefore estimated by averaging the data from the years 1982–1984 and 1991 (Table 6.5.1). Due to unreliable data for 1994, 1993 data were applied to 1994. The data on maturity for 1996 to 1999 were based on information from the Icelandic October groundfish survey and the East Greenland June/July groundfish survey.

6.6 Survey information

An October groundfish survey in Icelandic waters covering the distributional area of Greenland halibut within the Icelandic EEZ was started in 1996. The survey is a fixed station stratified random survey consisting of 300 stations on the continental slope and shelf down to a depth of 1300 m. An increase in the fishable biomass of Greenland halibut (fish of length equal to or greater than 50 cm) is observed from 1996 to 1999 (Figure 6.6.1). Abundance indices of fish equal to or less than 50 cm has increased from the years 1996–97 to 1998–99.

The time series was considered to be too short to be used as a tuning fleet in the stock assessment.

6.7 Stock Assessment

6.7.1 Tuning and estimates of fishing mortality

Age-disaggregated CPUE values for age groups 7–12 over the period 1985–1999, obtained from the Icelandic trawling fleet operating in Division Va, were used in the XSA tuning process with the same settings as in last year's stock assessment. The diagnostics are presented in Table 6.7.1.1.

The terminal fishing mortalities from the accepted XSA run were used to run a traditional VPA. Natural mortality was assumed to be 0.15 and the proportions of F and M before spawning were set to 0. The results of this run are given in Tables 6.7.1.2.-4 and Figures 6.7.1.1 C and D.

6.7.2 Spawning stock and recruitment

Spawning stock biomass is shown in Table 6.7.1.4 and Figure 6.7.1.1.B. The spawning stock was between 70 and 80 000 t between 1978–1983, and increased to a maximum of 122 000 t in 1988. Since then it has declined to a low of 68 000 t in 1998. An increase is observed in 1999 to 72 000 t.

Estimates of recruitment at age 5 are shown in Table 6.7.1.4 and Figure 6.7.1.1.B. The long-term average for the period 1975–1999 is 31 million fish. The 1980 and 1981 year classes are the highest on record at about 46 million. Since then there has been a decline in recruitment with the size of the 1986 year class and onwards being below average. Estimates of the more recent year-classes of 1993 and 1994 are thought to be unreliable, since they are just entering the fisheries and calculated VPA stock numbers thus based on few numbers.

6.8 Prediction of Catch and Biomass

6.8.1 Input data

The input data for the short-term prediction are given in Table 6.8.1.1. Mean weight at age is average from 1997-99 and the exploitation pattern is average fishing mortalities from 1997-1999 rescaled to the level of 1999. Maturity at age is the average of 1997–1999. Natural mortality was set to 0.15 and the proportions of F and M before spawning were set to 0. Year classes 1995–97 were set to the lower quartile value of the recruitment of the 1970–1992 year classes. This is a reflection of the recruitment being below average since the 1986 year class.

Since TAC for the Greenland EEZ has not been reached in 1999 and since fishing in the Icelandic area is regulated to not exceed 10 000 t for the current fishing year, a catch constraint of 20 000 t was applied to 2000. This is based on the expectance that the TAC constraint in Iceland will hold, and on the assumption that the catch in other areas remains the same as in 1999.

The Y/R calculation uses the mean weight and maturity at age averaged for the period 1975–1999. The exploitation pattern is based on an average exploitation pattern over the period 1975–1999 rescaled to the level of 1999 (Table 6.8.1.2).

6.8.2 Biological reference points

ACFM proposed a B_{lim} as B_{loss} = 50 000 t. This is the estimated SSB in the beginning of the 1975–1997 data series B_{pa} of 80 000 t was derived by using $B_{pa} = B_{lim}\, e^{1.645\sigma}$, where σ = 0.3. F_{pa} was defined as F_{med} = 0.36.

6.8.3 Projections of catch and biomass

At the beginning of 2000, the total stock is estimated to be 147 000 t, and the spawning stock 71 000 t (Table 6.8.3.1). The catch prediction of 20 000 tonnes in 2000 will result in an estimated fishing mortality of 0.25 and an estimated stock and spawning stock biomass of 151 000 and 72 000, respectively, in the beginning of 2001. Assuming an F in 2001 to be the same as in 2000, results in the stock remaining in a stable, although low, state in the beginning of 2002. A linear reduction in F from the proposed F_{pa} in accordance with the estimate of biomass in 2001 in relation to B_{pa} and B_{lim} results in F = 0.26 and catch of no more than 21 000 t in 2001. However, this will maintain the stock size at *status quo*. Rebuilding the stock above B_{pa} F in the short term requires a reduction in fishing mortality to below F = 0.14 corresponding to a catch of no more than 12 000 t.

6.9 Management Considerations

The Greenland halibut stock biomass has been falling from a peak in 1988. The fishing mortality has been substantially above $F_{0.1}$ since 1986 but is estimated to have been below or close to the currently defined F_{pa} since 1989. Recruitment has been continuously declining in the last two decades and SSB has declined considerably since the late 1980's. The decline in SSB seems to have halted in the last two years but is currently below B_{pa}. A combination of unreliable maturity data and age readings from recent years makes the current estimate of SSB more questionable and may impede its use in relation to Bpa and SSB as a reference point for management advice for the stock.

The stock recruitment relationship is highly negative (Figure 6.8.1), indicating that the highest recruitment is to be expected at low SSB. With respect to time, however, the recruitment in the beginning of the period (year classes 1975–1985) was above average (38 mill.), but recruitment in the latter part of the period (year classes 1986–1991) have been

below average (26 mill.). The yield-per-recruit computations indicate that the obtainable yield at F_{pa} is 1.05 kg per recruit. The average yield from the year classes 1975–85 would be in the order of 40 000 t and for year classes 1986–96 27 000 t..

No formal agreement on the management of the Greenland halibut exists among the three coastal states, Greenland, Iceland and the Faeroe Islands. The regulation schemes of those states have previously resulted in catches well in excess of TAC's advised by ICES.

6.10 Comments on the Assessment

Analytical assessment were run with same settings as last year.

Biological features of the stock suggest a change in stock recruitment in the time series.

The terminal fishing mortality has been overestimated and the terminal SSB underestimated in the stock assessments of recent years. This, in addition to strong trends in the catchability in the tuning diagnostics, make the quality of the current assessment questionable. The change and expansion of the fisheries in the recent decade may account for part of the above observations.

The indices of fishable biomass from the Icelandic groundfish survey, which indicate an upward trend from 1996 to 1999 are contradictory to the observed decline in the total biomass over the same period from the current stock assessment.

Improved sampling of catch composition is needed. At present, information on age composition and maturation for all areas is insufficient. Recent age readings from Iceland show a downward shift in apparent growth rate of fish older than 9 years in 1998 and 1999 compared with 1996 and 1997. However these discrepancies do not seem to influence the current stock assessment greatly. Application of maturity at length key to the age-length key, as done in the past four years, may however add increased variability to the point estimator of SSB.

Indices of recruitment of Greenland halibut are an obvious prerequisite for sound management advice. Short-term predictions are based on assumed recruitment values.

The use of only one commercial fleet for tuning is a cause of concern since the fleet covers only a part of the total fishing area. Fleet data from Division XIVb may hopefully be included in future assessments. Although Iceland and Greenland have both initiated annual surveys on the Greenland halibut grounds within Division Va and XIVb, they will not become of use in stock assessment until 2001.Although some tagging experiments and stock discrimination analysis (DNA, electrophoresis, parasite burden, meristic studies) have been carried out in recent years, further understanding on the basic biology and stock structure of the Greenland halibut components in the area is needed.

Table 6.1.1. GREENLAND HALIBUT. Nominal catches (tonnes) by countries, in Sub-areas V, XII and XIV 1981-1999, as officially reported to ICES.

Country	1981	1982	1983	1984	1985	1986	1987	1988	1989
Denmark	-	-	-	-	-	-	6	+	-
Faroe Islands	767	1,532	1,146	2,502	1,052	853	1,096	1,378	2,319
France	8	27	236	489	845	52	19	25	-
Germany	3,007	2,581	1,142	936	863	858	565	637	493
Greenland	+	1	5	15	81	177	154	37	11
Iceland	15,457	28,300	28,360	30,080	29,231	31,044	44,780	49,040	58,330
Norway	-	-	2	2	3	+	2	1	3
Russia	-	-	-	-	-	-	-	-	-
UK (Engl. and Wales)	-	-	-	-	-	-	-	-	-
UK (Scotland)	-	-	-	-	-	-	-	-	-
United Kingdom	-	-	-	-	-	-	-	-	-
Total	19,239	32,441	30,891	34,024	32,075	32,984	46,622	51,118	61,156
Working Group estimate	-	-	-	-	-	-	-	-	61,396

Country	1990	1991	1992	1993	1994	1995	1996 [1]	1997 [1]	1998 [1]
Denmark	-	-	-	-	-	-	1	-	
Faroe Islands	1,803	1,566	2,128	4,405	6,241	3,763	6,148	4,971	3,817
France	-	-	3	2	-	-	29	11	8
Germany	336	303	382	415	648	811	3,368	3,342	3,056
Greenland	40	66	437	288	867	533	1,162	1,129	747
Iceland	36,557	34,883	31,955	33,987	27,778	27,383	22,055	18,569	10,728
Norway	50	34	221	846	1,173 [1]	1,810	2,157	1,939	1,367
Russia	-	-	5	-	-	10	424	37	52
UK (Engl. and Wales)	27	38	109	811	513	1,436	386	218	190
UK (Scotland)	-	-	19	26	84	232	25	26	43
United Kingdom									
Total	38,813	36,890	35,259	40,780	37,305	36,006	35,755	30,242	20,360
Working Group estimate[2]	39,326	37,950	35,423	40,817	36,958	36,300	35,825	30,267	-

Country	1999 [1]
Denmark	
Faroe Islands	-
France	-
Germany	3,082
Greenland	-
Iceland	11,048
Norway	1,289
Russia	138
UK (Engl. and Wales)	-
UK (Scotland)	-
United Kingdom	301
Total	15,858
Working Group estimate[2]	20,371

1) Provisional data

2) Working group best estimates.

Table 6.1.2. GREENLAND HALIBUT. Nominal catches (tonnes) by countries, in Division Va 1981-1999, as officially reported to ICES.

Country	1981	1982	1983	1984	1985	1986	1987	1988	1989
Faroe Islands	325	669	33	46	-	-	15	379	719
Germany	-	-	-	-	-	-	-	-	-
Greenland	-	-	-	-	-	-	-	-	-
Iceland	15,455	28,300	28,359	30,078	29,195	31,027	44,644	49,000	58,330
Norway	-	-	+	+	2	-	-	-	-
Total	15,780	28,969	28,392	30,124	29,197	31,027	44,659	49,379	59,049
Working Group estimate	-	-	-	-	-	-	-	-	59,272 [2]

Country	1990	1991	1992	1993	1994	1995	1996	1997	1998 [1]
Faroe Islands	739	273	23	166	910	13	14	26	6
Germany	-	-	-	-	1	2	4	-	9
Greenland	-	-	-	-	1	-	-	-	
Iceland	36,557	34,883	31,955	33,968	27,696	27,376	22,055	16,766	10,580
Norway	-	-	-	-	-	-	-	-	
Total	37,296	35,156	31,978	34,134	28,608	27,391	22,073	16,792	10,595
Working Group estimate	37,308 [3]	35,413 [4]	-	-	-	-	-	-	

Country	1999
Faroe Islands	
Germany	13
Greenland	
Iceland	11,048
Norway	5
Total	11,066
Working Group estimate	11,108 [5]

1) Provisional data

2) Includes 223 t catch by Norway.

3) Includes 12 t catch by Norway.

4) Includes additional catch of 257 t by Iceland.

5) Includes 5 t by Faroe Islands, additional 37 t by Iceland and 0 t by Norway.

Table 6.1.3. GREENLAND HALIBUT. Nominal catches (tonnes) by countries, in Division Vb 1981-1999, as officially reported to ICES.

Country	1981	1982	1983	1984	1985	1986	1987	1988	1989
Denmark	-	-	-	-	-	-	6	+	-
Faroe Islands	442	863	1,112	2,456	1,052	775	907	901	1,513
France	8	27	236	489	845	52	19	25	...
Germany	114	142	86	118	227	113	109	42	73
Greenland	-	-	-	-	-	-	-	-	-
Norway	2	+	2	2	2	+	2	1	3
UK (Engl. and Wales)	-	-	-	-	-	-	-	-	-
UK (Scotland)	-	-	-	-	-	-	-	-	-
United Kingdom	-	-	-	-	-	-	-	-	-
Total	566	1,032	1,436	3,065	2,126	940	1,043	969	1,589
Working Group estimate	-	-	-	-	-	-	-	-	1,606 [2]

Country	1990	1991	1992	1993	1994	1995	1996	1997	1998
Denmark	-	-	-	-	-	-	-	-	
Faroe Islands	1,064	1,293	2,105	4,058	5,163	3,603	6,004	4750	3660
France [6]	...	...	3 [1]	2	1	28	29	11	8 [1]
Germany	43	24	71	24	8	1	21	41	
Greenland	-	-	-	-	-	-	-	-	
Norway	42	16	25	335	53	142	281 [1]	42 [1]	114 [1]
UK (Engl. and Wales)	-	-	1	15	-	31	122		
UK (Scotland)	-	-	1	-	-	27	12	26	43
United Kingdom	-	-	-	-	-				
Total	1,149	1,333	2,206	4,434	5,225	3,832	6,469 [1]	4,870	3825
Working Group estimate	1,282 [3]	1,662 [4]	2,269 [5]	-	-		-	-	3826 [7]

Country	1999 [1]
Denmark	
Faroe Islands	
France [6]	
Germany	22
Greenland	
Norway	87
UK (Engl. and Wales)	
UK (Scotland)	
United Kingdom	75
Total	184
Working Group estimate	4265 [8]

1) Provisional data
2) Includes 17 t taken by France
3) Includes 133 t taken in Division IIa (Faroese waters).
4) Includes 317 t taken in Division IIa (Faroese waters) + France 12 t.
5) Includes 63 t taken in Division IIa (Faroese waters).
6) Quantity unknown 1989-1991.
7) Includes 3661 t taken in by Faroe Islands.
8) Includes 4078 t by Faroe Islands, 3 t by France.

Table 6.1.4. GREENLAND HALIBUT. Nominal catches (tonnes) by countries, in Sub-area XIV 1981-1999, as officially reported to ICES.

Country	1981	1982	1983	1984	1985	1986	1987	1988	1989
Faroe Islands	-	-	-	-	-	78	74	98	87
Germany	2,893	2,439	1,054	818	636	745	456	595	420
Greenland	+	1	5	15	81	177	154	37	11
Iceland	-	-	1	2	36	17	136	40	+
Norway	-	-	-	+	-	-	-	-	-
Russia	-	-	-	-	-	-	-	-	+
UK (Engl. and Wales)	-	-	-	-	-	-	-	-	-
UK (Scotland)	-	-	-	-	-	-	-	-	-
United Kingdom	-	-	-	-	-	-	-	-	-
Total	2,893	2,440	1,060	835	753	1,017	820	770	518
Working Group estimate	-	-	-	-	-	-	-	-	-

Country	1990	1991	1992	1993	1994	1995	1996	1997	1998
Denmark	-	-	-	-	-	-	1	+	+
Faroe Islands	-	-	-	181	168	147	130	148	151
Germany	293	279	311	391	639	808	3,343	3,301	3,399
Greenland	40	66	437	288	866	533	1,162	1,129	747 [1,10]
Iceland	-	-	-	19	82	7	-	1,803	148
Norway	8	18	196	511	1,120	1,668 [1]	1,874 [1]	1,897 [1]	1,253 [1]
Russia	-	-	5	-	-	10	424	37	52
UK (Engl. and Wales)	27	38	108	796	513	1405	264	218	190
UK (Scotland)	-	-	18	26	84	205	13		
United Kingdom	-	-	-	-	-	-	-		
Total	368	401	1,075	2,212	3,472	4,783	7,211	8,533	5940
Working Group estimate	736 [2]	875 [3]	1,176 [4]	2,249 [5]	3,125 [6]	5,077 [7]	7,283 [8]	8,558 [9]	

Country	1999 [1]
Denmark	
Faroe Islands	
Germany	3047
Greenland	
Iceland	
Norway	1197
Russia	138
UK (Engl. and Wales)	
UK (Scotland)	
United Kingdom	226
Total	4608
Working Group estimate	4998 [11]

1) Provisional data

2) Includes 370 t catches taken by Japan

3) Includes 315 t catch taken by Japan and 159 t by other countries as reported to Greenland.

4) Indicates additional catches taken by Germany (96 t) and UK (17 t) as reported to Greenland.

5) Indicates additional catches taken by Germany (37 t), Norway (238 t), UK (182 t) and Japan (62 t) as reported to Greenland.

6) Total reported to Greenlandic authorities are used in assessment: 159 t trawl (Norwegian charter), 205 t gillnets (Norwegian charter). 405t from Norway not included in working group estimate.

7) Includes 273 t offshore gillnets (Greenland charter)

8) Working group estimates as in Table 6.1.5. Includes 72 t by Germany

9) Includes additional catch of 25 t as reported by Norwegian authorities (1858 t inside 200 EEZ, 64 t outside EEZ)

10) Includes 138 t reported as area unknown.

11) Includes 125 t by Faroe Islands, 206 t by Greenland, additional 59 t by Norway.

Table 6.1.5. GREENLAND HALIBUT. Nominal catches (tonnes) by countries in Sub-area XII, as officially reported to the ICES.

Country	1996	1997	1998	1999
Faroe Islands		47		
Norway	2			
Total	2	47	-	-

Table 6.2.1.CPUE indices of the Icelandic trawl fleet estimated from a GLIM multiplicative model for the period 1985-1999.

year	cpue	% change in CPUE between years	landings	effort	% change in effort between years
85	1.00		32198	32198	
86	0.96	-4.1	33099	34517	7.2
87	0.92	-4.4	46676	50925	47.5
88	1.08	18.2	51307	47365	-7.0
89	1.06	-1.9	61323	57708	21.8
90	0.76	-28.0	38935	50902	-11.8
91	0.80	5.0	36882	45926	-9.8
92	0.64	-20.0	35382	55103	20.0
93	0.54	-15.7	40844	75495	37.0
94	0.42	-23.2	37302	89833	19.0
95	0.31	-25.2	35904	115567	28.6
96	0.27	-11.8	35857	130783	13.2
97	0.28	1.2	29751	107218	-18.0
98	0.43	53.6	20360	47764	-55.5
99	0.49	15.4	20366	41416	-13.3

Table 6.3.1 Catch numbers at age (Numbers*10**-3)

	YEAR	1975	1976	1977	1978	1979
	AGE					
	5	120	43	0	23	29
	6	800	296	34	91	197
	7	1775	584	671	347	1605
	8	1782	621	1727	1037	2253
	9	1259	431	2289	1214	3090
	10	926	240	834	848	1693
	11	464	121	420	567	880
	12	459	86	423	312	394
	13	279	37	174	232	246
	14	193	32	120	218	189
	15	137	14	28	114	147
	+gp	85	9	141	204	125
0	TOTALNUM	8279	2514	6861	5207	10848
	TONSLAND	23494	6045	16578	14349	23616
	SOPCOF %	126	100	100	100	101

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

	YEAR	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
	AGE										
	5	47	26	8	10	83	125	245	182	129	499
	6	502	158	300	240	277	441	612	3123	742	1657
	7	1536	580	1140	1611	891	1018	1033	4863	2068	4485
	8	2630	1160	2451	2651	2139	2295	1942	2586	2985	5961
	9	3126	1430	2646	3060	3568	3454	2983	2156	3166	5763
	10	2324	1764	2456	2443	2800	2749	3097	3476	2966	3246
	11	1739	1299	1803	1693	1825	1452	1683	1847	1848	1601
	12	849	664	963	978	1134	627	820	1829	1761	1458
	13	578	435	609	424	588	423	550	886	1851	1237
	14	306	252	331	174	363	137	202	243	701	506
	15	143	176	195	37	92	36	59	31	216	362
	+gp	116	159	132	47	20	46	34	5	246	145
0	TOTALNUM	13896	8103	13034	13368	13780	12803	13260	21227	18679	26920
	TONSLAND	31252	19239	32441	30888	34024	32075	32984	46622	51118	61396
	SOPCOF %	99	100	100	101	99	103	101	98	101	100
	1										

Catch numbers at age Numbers*10**-3

	YEAR	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
	AGE										
	5	188	289	17	44	78	503	178	86	122	85
	6	463	1225	421	397	672	1587	1488	549	688	593
	7	1513	1797	2023	1896	2197	3031	2908	2723	1429	894
	8	3515	2866	3262	5024	3815	3287	3181	2579	1948	1300
	9	4186	2935	2646	4324	3648	2608	2119	2331	1444	1416
	10	3143	2074	3019	2859	2330	1963	1755	1247	1371	1537
	11	1224	1130	1962	1539	1715	1548	1610	975	916	1219
	12	959	1072	1278	1412	990	1132	1216	937	620	835
	13	568	924	509	576	422	657	665	652	436	496
	14	358	554	144	136	371	444	548	374	244	414
	15	137	342	36	135	168	240	238	282	175	258
	+gp	61	82	56	14	177	232	503	700	258	371
0	TOTALNUM	16315	15290	15373	18356	16583	17232	16409	13435	9651	9418
	TONSLAND	39326	37950	35423	40817	36958	36300	35826	30267	20360	20366
	SOPCOF %	100	101	100	100	100	100	100	100	100	100
	1										

Table 6.4.1 Catch weights at age (kg)

	YEAR	1975	1976	1977	1978	1979
	AGE					
	5	0.968	1.157	1.157	0.968	0.911
	6	1.199	1.585	1.046	1.199	0.942
	7	1.423	1.768	1.429	1.423	1.278
	8	1.854	2.18	1.794	1.854	1.676
	9	2.256	2.57	2.228	2.256	2.072
	10	2.607	3.018	2.687	2.607	2.333
	11	3.081	3.73	3.017	3.081	2.723
	12	3.591	4.052	3.914	3.591	3.297
	13	4.604	4.815	4.04	4.604	3.985
	14	4.695	5.348	4.714	4.695	4.668
	15	5.151	5.752	5.401	5.151	4.792
	+gp	6.902	7.094	5.597	6.45	5.387
0	SOPCOFAC	1.255	1.0024	1.0008	0.9993	1.0124

Table 2 Catch weights at age (kg)

	YEAR	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
	AGE										
	5	1.125	1.071	1.01	0.984	0.942	0.995	1.03	1.03	1.129	0.842
	6	1.283	1.257	1.368	1.338	1.275	1.23	1.238	1.218	1.304	1.047
	7	1.487	1.44	1.618	1.577	1.592	1.63	1.499	1.533	1.541	1.425
	8	1.756	1.66	1.905	1.848	1.817	1.951	1.937	1.824	1.77	1.727
	9	2.153	1.967	2.187	2.159	2.24	2.367	2.363	2.187	2.236	2.125
	10	2.279	2.258	2.516	2.434	2.461	2.637	2.631	2.666	2.683	2.637
	11	2.498	2.515	2.761	2.603	2.835	2.829	2.848	2.996	3.082	3.22
	12	3.059	2.95	3.129	3.034	3.262	3.353	3.335	3.595	3.624	3.733
	13	3.783	3.45	3.785	3.784	3.962	4.006	4.039	4.431	4.312	4.135
	14	4.507	4.033	4.475	4.446	4.936	4.792	4.925	5.14	5.098	5.38
	15	5.139	4.652	4.985	4.751	5.23	5.231	5.466	5.764	5.213	6.569
	+gp	5.983	5.33	6.088	6.385	7.192	6.323	5.985	7.267	5.764	6.497
0	SOPCOFAC	0.9902	1.0024	0.9997	1.011	0.9937	1.0258	1.006	0.9785	1.0063	0.9999
	1										

Run title : G. halibut V & XIV (run: XSAJBO05/X05)

At 27/04/2000 19:18

Table 2 Catch weights at age (kg)

	YEAR	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
	AGE										
	5	1.029	1.001	1.016	0.991	1.163	0.95	1.101	0.919	0.807	0.861
	6	1.21	1.247	1.256	1.249	1.254	1.213	1.124	1.107	1.086	0.953
	7	1.572	1.472	1.401	1.401	1.488	1.413	1.346	1.334	1.363	1.288
	8	1.79	1.81	1.718	1.685	1.736	1.703	1.649	1.64	1.658	1.565
	9	2.126	2.088	2.049	1.982	2.15	2.028	1.925	1.881	1.886	1.739
	10	2.536	2.44	2.436	2.425	2.352	2.279	2.342	2.24	2.167	2.012
	11	3.214	2.935	2.868	2.952	2.736	2.643	2.595	2.538	2.415	2.351
	12	3.693	3.737	3.478	3.429	3.082	2.992	3.013	2.846	2.844	2.634
	13	4.448	4.401	4.51	4.479	3.607	3.568	3.515	3.385	3.173	3.031
	14	5.197	5.022	4.681	6.043	4.242	4.068	4.123	4.359	4.237	3.532
	15	5.891	5.991	6.01	5.832	5.293	5.302	4.996	4.851	4.656	3.874
	+gp	6.049	6.412	5.128	2.756	6.087	5.614	5.845	5.8	5.424	5.271
0	SOPCOFAC	0.9998	1.0097	1.0033	1.001	1.0001	1.0014	1.0011	1.0044	1.0018	1
	1										

Table 6.5.1 Proportion mature at age

YEAR	1975	1976	1977	1978	1979
AGE					
5	0.000	0.000	0.000	0.000	0.000
6	0.030	0.030	0.030	0.030	0.030
7	0.100	0.100	0.100	0.100	0.100
8	0.350	0.350	0.350	0.350	0.350
9	0.770	0.770	0.770	0.770	0.770
10	0.960	0.960	0.960	0.960	0.960
11	1.000	1.000	1.000	1.000	1.000
12	1.000	1.000	1.000	1.000	1.000
13	1.000	1.000	1.000	1.000	1.000
14	1.000	1.000	1.000	1.000	1.000
15	1.000	1.000	1.000	1.000	1.000
+gp	1.000	1.000	1.000	1.000	1.000

YEAR	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
AGE										
5	0.000	0.000	0.000	0.040	0.000	0.010	0.010	0.010	0.010	0.010
6	0.030	0.030	0.050	0.070	0.080	0.060	0.060	0.060	0.060	0.060
7	0.100	0.100	0.200	0.150	0.190	0.210	0.210	0.210	0.210	0.210
8	0.350	0.350	0.330	0.280	0.320	0.350	0.350	0.350	0.350	0.350
9	0.770	0.770	0.500	0.380	0.420	0.460	0.460	0.460	0.460	0.460
10	0.960	0.960	0.700	0.600	0.640	0.640	0.640	0.640	0.640	0.640
11	1.000	1.000	0.850	0.850	0.750	0.820	0.820	0.820	0.820	0.820
12	1.000	1.000	0.940	0.980	0.930	0.960	0.960	0.960	0.960	0.960
13	1.000	1.000	1.000	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	1.000	1.000	1.000
15	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
+gp	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1										

YEAR	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
AGE										
5	0.010	0.010	0.020	0.030	0.030	0.178	0.304	0.224	0.305	0.205
6	0.060	0.060	0.040	0.120	0.120	0.181	0.310	0.291	0.333	0.262
7	0.210	0.290	0.110	0.270	0.270	0.477	0.393	0.368	0.351	0.436
8	0.350	0.480	0.250	0.400	0.400	0.597	0.464	0.438	0.394	0.542
9	0.460	0.560	0.470	0.450	0.450	0.586	0.526	0.495	0.488	0.597
10	0.640	0.620	0.680	0.540	0.540	0.705	0.626	0.588	0.476	0.666
11	0.820	0.850	0.850	0.650	0.650	0.786	0.690	0.668	0.593	0.731
12	0.960	1.000	0.960	0.780	0.780	0.764	0.773	0.745	0.636	0.766
13	1.000	1.000	1.000	0.830	0.830	0.961	0.870	0.850	0.784	0.790
14	1.000	1.000	1.000	0.970	0.970	1.000	0.953	0.948	0.881	0.835
15	1.000	1.000	1.000	1.000	1.000	1.000	0.981	0.971	0.872	0.860
+gp	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.986	0.909	0.869

Table 6.7.1.1 Output from XSA

Extended Survivors Analysis

G. halibut V & XIV (run: XSAJBO05/X05)

CPUE data from file fleet

Catch data for 25 years. 1975 to 1999. Ages 5 to 16.

Fleet	First year	Last year	First age	Last age	Alpha	Beta
FLT02: VA	1985	1999	7	12	0	1

Time series weights :

Tapered time weighting applied
Power = 3 over 20 years

Catchability analysis :

Catchability dependent on stock size for ages < 7

Regression type = C
Minimum of 5 points used for regression
Survivor estimates shrunk to the population mean for ages < 7

Catchability independent of age for ages >= 13

Terminal population estimation :

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

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

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

Prior weighting not applied

Tuning converged after 26 iterations

1

Regression weights

0.751 0.82 0.877 0.921 0.954 0.976 0.99 0.997

Table 6.7.1.1. Cont'd

Fishing mortalities

Age	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
5	0.005	0.011	0.001	0.002	0.003	0.021	0.009	0.005	0.005	0.004
6	0.016	0.042	0.019	0.019	0.029	0.076	0.076	0.032	0.048	0.03
7	0.068	0.075	0.085	0.106	0.134	0.167	0.183	0.184	0.105	0.077
8	0.19	0.168	0.179	0.296	0.303	0.286	0.25	0.232	0.184	0.124
9	0.328	0.227	0.218	0.359	0.343	0.33	0.285	0.276	0.186	0.187
10	0.393	0.253	0.363	0.364	0.316	0.295	0.365	0.255	0.245	0.292
11	0.297	0.225	0.381	0.3	0.366	0.337	0.396	0.334	0.285	0.339
12	0.38	0.434	0.403	0.491	0.303	0.414	0.456	0.398	0.347	0.43
13	0.529	0.729	0.357	0.3	0.249	0.319	0.43	0.446	0.307	0.487
14	0.343	1.558	0.216	0.143	0.304	0.423	0.452	0.433	0.281	0.506
15	0.379	0.606	0.333	0.305	0.249	0.311	0.398	0.418	0.349	0.507

1

XSA population numbers (Thousands)

YEAR / AGE	5	6	7	8	9	10	11	12	13	14
1990	3.79E+04	3.17E+04	2.49E+04	2.19E+04	1.61E+04	1.04E+04	5.13E+03	3.27E+03	1.49E+03	1.33E+03
1991	2.83E+04	3.24E+04	2.69E+04	2.00E+04	1.56E+04	9.99E+03	6.05E+03	3.28E+03	1.92E+03	7.57E+02
1992	2.61E+04	2.41E+04	2.68E+04	2.15E+04	1.46E+04	1.07E+04	6.67E+03	4.16E+03	1.83E+03	7.98E+02
1993	2.96E+04	2.24E+04	2.03E+04	2.12E+04	1.54E+04	1.01E+04	6.40E+03	3.92E+03	2.39E+03	1.10E+03
1994	2.74E+04	2.55E+04	1.89E+04	1.57E+04	1.36E+04	9.28E+03	6.03E+03	4.08E+03	2.07E+03	1.52E+03
1995	2.60E+04	2.35E+04	2.13E+04	1.43E+04	1.00E+04	8.28E+03	5.83E+03	3.60E+03	2.60E+03	1.39E+03
1996	2.18E+04	2.19E+04	1.87E+04	1.55E+04	9.22E+03	6.19E+03	5.31E+03	3.58E+03	2.05E+03	1.62E+03
1997	1.85E+04	1.86E+04	1.75E+04	1.34E+04	1.04E+04	5.97E+03	3.70E+03	3.07E+03	1.95E+03	1.15E+03
1998	2.52E+04	1.58E+04	1.55E+04	1.25E+04	9.17E+03	6.79E+03	3.98E+03	2.28E+03	1.78E+03	1.08E+03
1999	2.35E+04	2.16E+04	1.30E+04	1.20E+04	8.97E+03	6.55E+03	4.57E+03	2.57E+03	1.39E+03	1.12E+03

Estimated population abundance at 1st Jan 2000

0.00E+00	2.01E+04	1.80E+04	1.03E+04	9.13E+03	6.40E+03	4.21E+03	2.81E+03	1.44E+03	7.33E+02

Taper weighted geometric mean of the VPA populations:

2.83E+04	2.50E+04	2.14E+04	1.73E+04	1.26E+04	8.57E+03	5.47E+03	3.43E+03	1.97E+03	1.07E+03

Standard error of the weighted Log(VPA populations) :

0.253	0.2615	0.2731	0.2535	0.26	0.2399	0.2214	0.2521	0.3023	0.4098

YEAR / AGE	15
1990	4.68E+02
1991	8.11E+02
1992	1.37E+02

Table 6.7.1.1. Cont'd

1993	5.54E+02
1994	8.22E+02
1995	9.68E+02
1996	7.82E+02
1997	8.90E+02
1998	6.40E+02
1999	6.99E+02

Estimated population abundance at 1st Jan 2000

5.84E+02

Taper weighted geometric mean of the VPA populations:

5.22E+02

Standard error of the weighted Log(VPA populations) :

0.7361

1

Log catchability residuals.

Fleet : FLT02: VA TRW CPU 19

Age	1985	1986	1987	1988	1989
7	0.04	-0.38	0.38	0.28	0.30
8	0.16	-0.34	-0.18	0.19	0.34
9	0.34	0.29	0.00	0.50	0.49
10	0.39	0.39	0.31	0.48	0.56
11	0.37	0.36	0.35	0.50	0.34
12	0.28	0.30	0.30	0.35	0.74

Age	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
7	-0.11	-0.14	0.01	-0.23	-0.07	-0.14	-0.14	-0.13	0.17	0.29
8	0.21	0.16	-0.02	0.11	-0.02	-0.21	-0.38	-0.32	0.22	0.16
9	0.37	0.17	-0.14	0.00	-0.18	-0.30	-0.54	-0.36	0.10	0.14
10	0.27	0.08	0.03	-0.15	-0.36	-0.51	-0.45	-0.52	0.17	0.41
11	-0.03	0.04	-0.11	-0.39	-0.26	-0.49	-0.41	-0.22	0.31	0.55
12	-0.07	0.75	-0.10	-0.18	-0.71	-0.68	-0.53	-0.33	0.09	0.74

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

Table 6.7.1.1. Cont'd

Age	7	8	9	10	11	12
Mean Log q	-6.1683	-5.4755	-5.1862	-5.0493	-5.0437	-4.8205
S.E(Log q)	0.2108	0.2349	0.3186	0.3888	0.3686	0.5218

Regression statistics :

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

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
7	0.97	0.144	6.3	0.64	15	0.21	-6.17
8	0.75	1.171	6.53	0.7	15	0.17	-5.48
9	0.58	2.253	6.97	0.75	15	0.16	-5.19
10	0.61	1.378	6.63	0.56	15	0.23	-5.05
11	1.12	-0.196	4.63	0.23	15	0.43	-5.04
12	1.92	-0.709	1.77	0.06	15	1.02	-4.82

1

Terminal year survivor and F summaries :

Age 5 Catchability dependent on age and year class strength

Year class = 1994

Fleet	Es Su	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT02: VA	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
P shrinkage	25036	0.26				0.785	0.003
F shrinkage	9069	0.5				0.215	0.009

Weighted prediction :

Survivors at end of yea	Int s.e	Ext s.e	N	Var Ratio	F
20131	0.23	9.92	2	42.808	0.004

1

Age 6 Catchability dependent on age and year class strength

Year class = 1993

Fleet	Es Su	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT02: VA	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
P shrinkage	21359	0.27				0.77	0.025
F shrinkage	10257	0.5				0.23	0.052

Weighted prediction :

Survivors at end of yea	Int s.e	Ext s.e	N	Var Ratio	F
18047	0.24	9.81	2	40.917	0.03

Table 6.7.1.1. Cont'd

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

Year class = 1992

Fleet	Es St	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT02: VA	13775.0000	0.3000	0.0000	0.0000	1.0000	0.7200	0.0580
F shrinkage	4955.0000	0.5000				0.2800	0.1550

Weighted prediction :

Survivors at end of yea	Int s.e	Ext s.e	N	Var Ratio	F
10346.0000	0.2600	0.5400	2.0000	2.1020	0.0770

1

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

Year class = 1991

Fleet	Es St	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT02: VA	10778	0.212	0.007	0.03	2	0.823	0.106
F shrinkage	4214	0.5				0.177	0.252

Weighted prediction :

Survivors at end of yea	Int s.e	Ext s.e	N	Var Ratio	F
9131	0.2	0.28	3	1.424	0.124

Age 9 Catchability constant w.r.t. time and dependent on age

Year class = 1990

Fleet	Es St	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT02: VA	6995	0.181	0.104	0.57	3	0.844	0.172
F shrinkage	3982	0.5				0.156	0.285

Weighted prediction :

Survivors at end of yea	Int s.e	Ext s.e	N	Var Ratio	F
6405	0.17	0.15	4	0.877	0.187

1

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

Year class = 1989

Fleet	Es St	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT02: VA	4228	0.168	0.156	0.93	4	0.834	0.291
F shrinkage	4134	0.5				0.166	0.296

Weighted prediction :

Survivors at end of yea	Int s.e	Ext s.e	N	Var Ratio	F
4213	0.16	0.12	5	0.758	0.292

Table 6.7.1.1. Cont'd

Age 12 Catchability constant w.r.t. time and dependent on age

Year class = 1987

Fleet	Es St	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT02: VA 1	1390	0.16	0.202	1.26	6	0.786	0.443
F shrinkage	1647	0.5				0.214	0.385

Weighted prediction :

Survivors at end of yea	Int s.e	Ext s.e	N	Var Ratio	F
1441	0.17	0.17	7	1.009	0.43

Age 13 Catchability constant w.r.t. time and dependent on age

Year class = 1986

Fleet	Es St	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT02: VA 1	609	0.167	0.079	0.47	6	0.68	0.563
F shrinkage	1091	0.5				0.32	0.352

Weighted prediction :

Survivors at end of yea	Int s.e	Ext s.e	N	Var Ratio	F
733	0.2	0.15	7	0.75	0.487

1

Age 14 Catchability constant w.r.t. time and age (fixed at the value for age) 13

Year class = 1985

Fleet	Es St	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT02: VA 1	455	0.169	0.095	0.56	6	0.586	0.612
F shrinkage	830	0.5				0.414	0.38

Weighted prediction :

Survivors at end of yea	Int s.e	Ext s.e	N	Var Ratio	F
584	0.23	0.17	7	0.746	0.506

Table 6.7.1.1. Cont'd

Age 15 Catchability constant w.r.t. time and age (fixed at the value for age) 13

Year class = 1984

Fleet	Es Su	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT02: VA 1	273	0.169	0.097	0.57	6	0.476	0.63
F shrinkage	469	0.5				0.524	0.413

Weighted prediction :

Survivors at end of yea	Int s.e	Ext s.e	N	Var Ratio	F
362	0.27	0.17	7	0.625	0.507

1
1

Table 6.7.1.2 Fishing mortality (F) at age

YEAR	1975	1976	1977	1978	1979
AGE					
5	0.005	0.002	0.000	0.001	0.001
6	0.048	0.015	0.002	0.004	0.009
7	0.152	0.043	0.042	0.020	0.094
8	0.256	0.069	0.162	0.079	0.164
9	0.299	0.086	0.364	0.155	0.335
10	0.356	0.080	0.225	0.210	0.317
11	0.238	0.067	0.186	0.222	0.330
12	0.365	0.060	0.331	0.195	0.224
13	0.790	0.042	0.156	0.288	0.219
14	0.676	0.175	0.177	0.282	0.379
15	0.488	0.085	0.216	0.240	0.295
+gp	0.488	0.085	0.216	0.240	0.295
0 FBAR 8-12	0.303	0.072	0.254	0.172	0.274

YEAR	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
AGE										
5	0.001	0.001	0.000	0.000	0.003	0.003	0.006	0.005	0.004	0.015
6	0.018	0.005	0.009	0.009	0.012	0.017	0.017	0.088	0.023	0.060
7	0.086	0.025	0.042	0.061	0.040	0.052	0.048	0.169	0.074	0.174
8	0.208	0.082	0.133	0.123	0.102	0.129	0.125	0.154	0.141	0.295
9	0.338	0.158	0.256	0.232	0.229	0.225	0.234	0.189	0.270	0.414
10	0.428	0.306	0.418	0.376	0.325	0.262	0.304	0.440	0.404	0.462
11	0.588	0.426	0.553	0.536	0.504	0.263	0.240	0.283	0.418	0.375
12	0.576	0.439	0.611	0.626	0.803	0.303	0.220	0.419	0.450	0.646
13	0.557	0.624	0.885	0.563	0.935	0.764	0.448	0.370	0.947	0.623
14	0.437	0.474	1.450	0.639	1.393	0.542	1.010	0.342	0.531	0.695
15	0.520	0.456	0.789	0.551	0.798	0.429	0.447	0.373	0.548	0.544
+gp	0.520	0.456	0.789	0.551	0.798	0.429	0.447	0.373	0.548	0.544
0 FBAR 8-12	0.428	0.282	0.394	0.379	0.393	0.237	0.225	0.297	0.337	0.438
1										

YEAR	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	FBAR 97-99
AGE											
5	0.005	0.011	0.001	0.002	0.003	0.021	0.009	0.005	0.005	0.004	0.005
6	0.016	0.042	0.019	0.019	0.029	0.076	0.076	0.032	0.048	0.030	0.037
7	0.068	0.075	0.085	0.106	0.134	0.167	0.183	0.184	0.105	0.077	0.122
8	0.190	0.168	0.179	0.296	0.303	0.286	0.250	0.232	0.184	0.124	0.180
9	0.329	0.227	0.218	0.359	0.343	0.330	0.285	0.276	0.186	0.187	0.216
10	0.394	0.253	0.363	0.364	0.316	0.295	0.365	0.255	0.245	0.292	0.264
11	0.297	0.225	0.381	0.300	0.366	0.337	0.396	0.334	0.285	0.339	0.319
12	0.380	0.434	0.403	0.491	0.303	0.414	0.456	0.398	0.347	0.430	0.392
13	0.529	0.729	0.357	0.300	0.249	0.319	0.430	0.446	0.307	0.487	0.414
14	0.343	1.558	0.216	0.143	0.304	0.423	0.452	0.433	0.281	0.506	0.406
15	0.379	0.606	0.333	0.305	0.249	0.311	0.398	0.418	0.349	0.507	0.425
+gp	0.379	0.606	0.333	0.305	0.249	0.311	0.398	0.418	0.349	0.507	
0 FBAR 8-12	0.318	0.261	0.309	0.362	0.326	0.332	0.350	0.299	0.249	0.274	
1											

Table 6.7.1.3 Stock number at age (start of year) Numbers*10-3**

	YEAR	1975	1976	1977	1978	1979
	AGE					
	5	24537	25825	26124	27462	34673
	6	18407	21007	22188	22486	23615
	7	13606	15101	17807	19066	19269
	8	8494	10064	12455	14704	16088
	9	5252	5658	8086	9118	11694
	10	3333	3352	4470	4836	6722
	11	2360	2010	2663	3073	3376
	12	1619	1601	1617	1902	2119
	13	551	968	1298	1000	1348
	14	423	215	798	956	645
	15	383	185	156	576	620
	+gp	236	119	781	1026	525
0	TOTAL	79199	86104	98442	106204	120694

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

	YEAR	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
	AGE										
	5	40591	40085	33617	29709	32757	46389	46627	41995	35819	37386
	6	29816	34893	34477	28927	25562	28118	39811	39905	35977	30710
	7	20143	25197	29886	29396	24675	21744	23792	33698	31449	30277
	8	15096	15912	21149	24666	23807	20411	17771	19519	24493	25150
	9	11757	10553	12620	15929	18770	18507	15439	13494	14401	18312
	10	7198	7219	7757	8407	10872	12846	12724	10521	9614	9458
	11	4215	4039	4577	4398	4969	6760	8506	8079	5831	5523
	12	2089	2014	2272	2267	2214	2584	4471	5760	5240	3304
	13	1459	1010	1118	1062	1044	854	1642	3088	3261	2876
	14	932	719	466	397	520	353	343	903	1835	1089
	15	380	518	385	94	180	111	177	107	552	929
	+gp	306	465	258	119	39	141	101	17	624	369
0	TOTAL	133981	142626	148581	145371	145411	158817	171404	177087	169096	165385
	1										

Run title : G. halibut V & XIV (run: XSAJBO05/X05)

At 27/04/2000 19:18

Terminal Fs derived using XSA (With F shrinkage)

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

	YEAR	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	GMST 75-97	AMST 75-97
	AGE													
	5	37869	28272	26061	29635	27367	26001	21794	18481	25235	23480	0	31256	32134
	6	31715	32420	24066	22415	25466	23482	21912	18593	15827	21607	20131	26959	27651
	7	24895	26868	26768	20323	18925	21296	18739	17480	15494	12984	18047	22436	23061
	8	21899	20024	21458	21162	15733	14250	15517	13431	12519	12010	10346	17316	17968
	9	16117	15588	14576	15443	13554	10002	9216	10405	9168	8968	9131	12159	12804
	10	10415	9988	10693	10091	9280	8281	6190	5966	6793	6551	6405	7766	8271
	11	5129	6048	6673	6403	6033	5826	5307	3699	3978	4575	4213	4712	5022
	12	3269	3279	4157	3923	4083	3601	3578	3074	2279	2574	2807	2839	3045
	13	1491	1924	1828	2392	2067	2596	2049	1952	1776	1387	1441	1533	1690
	14	1328	757	798	1101	1525	1387	1625	1147	1075	1124	733	766	881
	15	468	811	137	554	822	968	782	890	640	699	584	365	469
	+gp	207	193	212	57	862	931	1643	2196	939	998	879		
0	TOTAL	154802	146170	137428	133500	125716	118623	108353	97314	95723	96956	74717		
	1													

Table 6.7.1.4 Summary (without SOP correction)

Terminal Fs derived using XSA (With F shrinkage)

	RECRUITS Age 5	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	FBAR 8-12
1975	24537	122673	46780	23494	0.5022	0.3028
1976	25825	158172	53957	6045	0.112	0.0723
1977	26124	159831	65044	16578	0.2549	0.2536
1978	27462	176089	75982	14349	0.1888	0.1719
1979	34673	175696	76641	23616	0.3081	0.2738
1980	40591	212516	79079	31252	0.3952	0.4276
1981	40085	213924	73198	19239	0.2628	0.282
1982	33617	246430	80016	32441	0.4054	0.3941
1983	29709	240045	72399	30888	0.4266	0.3785
1984	32757	244028	83907	34024	0.4055	0.3926
1985	46389	268060	96332	32075	0.333	0.2365
1986	46627	286385	105252	32984	0.3134	0.2247
1987	41995	300662	116979	46622	0.3985	0.297
1988	35819	304017	122749	51118	0.4164	0.3367
1989	37386	270443	113052	61396	0.5431	0.4383
1990	37869	262454	99946	39326	0.3935	0.3179
1991	28272	249803	110613	37950	0.3431	0.2614
1992	26061	234477	90872	35423	0.3898	0.3086
1993	29635	229684	94692	40817	0.431	0.362
1994	27367	222812	90817	36958	0.4069	0.326
1995	26001	198144	108829	36300	0.3335	0.3324
1996	21794	183639	99047	35826	0.3617	0.3503
1997	18481	162647	85466	30267	0.3541	0.2992
1998	25235	145792	68451	20360	0.2974	0.2494
1999	23480	138779	71698	20366	0.2841	0.2742
Arith. Mean	31512	216288	87272	31589	0.3545	0.3026
0 Units	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)		
1						

Table 6.8.1.1

The SAS System 10:46 Friday, May 12, 2000
Greenland halibut in Sub-areas V and XIV

Prediction with management option table: Input data

Year: 2000

Age	Stock size	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
5	26000.000	0.1500	0.2450	0.0000	0.0000	0.862	0.0050	0.862
6	20131.000	0.1500	0.2950	0.0000	0.0000	1.049	0.0370	1.049
7	18047.000	0.1500	0.3850	0.0000	0.0000	1.328	0.1220	1.328
8	10346.000	0.1500	0.4580	0.0000	0.0000	1.621	0.1800	1.621
9	9131.000	0.1500	0.5270	0.0000	0.0000	1.835	0.2160	1.835
10	6405.000	0.1500	0.5770	0.0000	0.0000	2.140	0.2640	2.140
11	4213.000	0.1500	0.6640	0.0000	0.0000	2.435	0.3190	2.435
12	2807.000	0.1500	0.7160	0.0000	0.0000	2.775	0.3920	2.775
13	1441.000	0.1500	0.8080	0.0000	0.0000	3.196	0.4140	3.196
14	733.000	0.1500	0.8880	0.0000	0.0000	4.043	0.4060	4.043
15	584.000	0.1500	0.9010	0.0000	0.0000	4.460	0.4250	4.460
16+	879.000	0.1500	0.9210	0.0000	0.0000	5.498	0.4250	5.498
Unit	Thousands	-	-	-	-	Kilograms	-	Kilograms

Year: 2001

Age	Recruit-ment	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
5	26000.000	0.1500	0.2450	0.0000	0.0000	0.862	0.0050	0.862
6	.	0.1500	0.2950	0.0000	0.0000	1.049	0.0370	1.049
7	.	0.1500	0.3850	0.0000	0.0000	1.328	0.1220	1.328
8	.	0.1500	0.4580	0.0000	0.0000	1.621	0.1800	1.621
9	.	0.1500	0.5270	0.0000	0.0000	1.835	0.2160	1.835
10	.	0.1500	0.5770	0.0000	0.0000	2.140	0.2640	2.140
11	.	0.1500	0.6640	0.0000	0.0000	2.435	0.3190	2.435
12	.	0.1500	0.7160	0.0000	0.0000	2.775	0.3920	2.775
13	.	0.1500	0.8080	0.0000	0.0000	3.196	0.4140	3.196
14	.	0.1500	0.8880	0.0000	0.0000	4.043	0.4060	4.043
15	.	0.1500	0.9010	0.0000	0.0000	4.460	0.4250	4.460
16+	.	0.1500	0.9210	0.0000	0.0000	5.498	0.4250	5.498
Unit	Thousands	-	-	-	-	Kilograms	-	Kilograms

Year: 2002

Age	Recruit-ment	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
5	26000.000	0.1500	0.2450	0.0000	0.0000	0.862	0.0050	0.862
6	.	0.1500	0.2950	0.0000	0.0000	1.049	0.0370	1.049
7	.	0.1500	0.3850	0.0000	0.0000	1.328	0.1220	1.328
8	.	0.1500	0.4580	0.0000	0.0000	1.621	0.1800	1.621
9	.	0.1500	0.5270	0.0000	0.0000	1.835	0.2160	1.835
10	.	0.1500	0.5770	0.0000	0.0000	2.140	0.2640	2.140
11	.	0.1500	0.6640	0.0000	0.0000	2.435	0.3190	2.435
12	.	0.1500	0.7160	0.0000	0.0000	2.775	0.3920	2.775
13	.	0.1500	0.8080	0.0000	0.0000	3.196	0.4140	3.196
14	.	0.1500	0.8880	0.0000	0.0000	4.043	0.4060	4.043
15	.	0.1500	0.9010	0.0000	0.0000	4.460	0.4250	4.460
16+	.	0.1500	0.9210	0.0000	0.0000	5.498	0.4250	5.498
Unit	Thousands	-	-	-	-	Kilograms	-	Kilograms

Notes: Run name : MANJBO06
Date and time: 01MAY00:16:48

Table 6.8.1.2

The SAS System 10:46 Friday, May 12, 2000
Greenland halibut in Sub-areas V and XIV

Yield per recruit: Input data

Age	Recruit-ment	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
5	1.000	0.1500	0.0560	0.0000	0.0000	1.006	0.0040	1.006
6	.	0.1500	0.0990	0.0000	0.0000	1.209	0.0260	1.209
7	.	0.1500	0.2190	0.0000	0.0000	1.470	0.0830	1.470
8	.	0.1500	0.3780	0.0000	0.0000	1.780	0.1610	1.780
9	.	0.1500	0.5630	0.0000	0.0000	2.129	0.2360	2.129
10	.	0.1500	0.7180	0.0000	0.0000	2.467	0.2920	2.467
11	.	0.1500	0.8340	0.0000	0.0000	2.843	0.3080	2.843
12	.	0.1500	0.9130	0.0000	0.0000	3.331	0.3740	3.331
13	.	0.1500	0.9570	0.0000	0.0000	3.994	0.4480	3.994
14	.	0.1500	0.9820	0.0000	0.0000	4.694	0.5020	4.694
15	.	0.1500	0.9870	0.0000	0.0000	5.278	0.3850	5.278
Unit	Numbers	-	-	-	-	Kilograms	-	Kilograms

Notes: Run name : YLDJBO02
Date and time: 12MAY00:10:59

Table 6.8.3.1

The SAS System 10:46 Friday, May 12, 2000

Greenland halibut in Sub-areas V and XIV

Prediction with management option table

Year: 2000					Year: 2001					Year: 2002	
F Factor	Reference F	Stock biomass	Sp.stock biomass	Catch in weight	F Factor	Reference F	Stock biomass	Sp.stock biomass	Catch in weight	Stock biomass	Sp.stock biomass
0.9115	0.2499	147783	70907	20000	0.0000	0.0000	151797	72438	0	177184	88733
.	.	.	.	.	0.0500	0.0137	.	72438	1252	175842	87821
.	.	.	.	.	0.1000	0.0274	.	72438	2488	174519	86924
.	.	.	.	.	0.1500	0.0411	.	72438	3707	173214	86040
.	.	.	.	.	0.2000	0.0548	.	72438	4909	171927	85170
.	.	.	.	.	0.2500	0.0686	.	72438	6095	170658	84312
.	.	.	.	.	0.3000	0.0823	.	72438	7265	169406	83468
.	.	.	.	.	0.3500	0.0960	.	72438	8420	168171	82636
.	.	.	.	.	0.4000	0.1097	.	72438	9559	166953	81817
.	.	.	.	.	0.4500	0.1234	.	72438	10683	165751	81010
.	.	.	.	.	0.5000	0.1371	.	72438	11792	164566	80215
.	.	.	.	.	0.5500	0.1508	.	72438	12886	163397	79432
.	.	.	.	.	0.6000	0.1645	.	72438	13965	162243	78660
.	.	.	.	.	0.6500	0.1782	.	72438	15031	161106	77900
.	.	.	.	.	0.7000	0.1919	.	72438	16082	159983	77151
.	.	.	.	.	0.7500	0.2057	.	72438	17120	158875	76413
.	.	.	.	.	0.8000	0.2194	.	72438	18144	157783	75687
.	.	.	.	.	0.8500	0.2331	.	72438	19155	156704	74971
.	.	.	.	.	0.9000	0.2468	.	72438	20152	155641	74265
.	.	.	.	.	0.9500	0.2605	.	72438	21137	154591	73570
.	.	.	.	.	1.0000	0.2742	.	72438	22108	153555	72885
.	.	.	.	.	1.0500	0.2879	.	72438	23067	152533	72210
.	.	.	.	.	1.1000	0.3016	.	72438	24014	151524	71544
.	.	.	.	.	1.1500	0.3153	.	72438	24949	150529	70889
.	.	.	.	.	1.2000	0.3290	.	72438	25871	149546	70243
.	.	.	.	.	1.2500	0.3428	.	72438	26782	148577	69606
.	.	.	.	.	1.3000	0.3565	.	72438	27681	147620	68979
.	.	.	.	.	1.3500	0.3702	.	72438	28569	146675	68360
.	.	.	.	.	1.4000	0.3839	.	72438	29445	145743	67751
.	.	.	.	.	1.4500	0.3976	.	72438	30311	144823	67150
.	.	.	.	.	1.5000	0.4113	.	72438	31165	143915	66558
-	-	Tonnes	Tonnes	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes

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Computation of ref. F: Simple mean, age 8 - 12
Basis for 2000 : TAC constraints

Table 6.8.3.2

The SAS System 10:46 Friday, May 12, 2000

Greenland halibut in Sub-areas V and XIV

Yield per recruit: Summary table

						1 January		Spawning time	
F Factor	Reference F	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
0.0000	0.0000	0.000	0.000	5.800	12523.370	2.614	7858.211	2.614	7858.211
0.0500	0.0137	0.047	143.499	5.670	12028.506	2.500	7404.496	2.500	7404.496
0.1000	0.0274	0.089	267.979	5.549	11571.753	2.394	6987.321	2.394	6987.321
0.1500	0.0411	0.126	375.941	5.436	11149.671	2.296	6603.341	2.296	6603.341
0.2000	0.0548	0.160	469.561	5.330	10759.161	2.204	6249.540	2.204	6249.540
0.2500	0.0686	0.191	550.728	5.230	10397.420	2.119	5923.198	2.119	5923.198
0.3000	0.0823	0.218	621.082	5.137	10061.917	2.039	5621.857	2.039	5621.857
0.3500	0.0960	0.243	682.049	5.050	9750.364	1.965	5343.298	1.965	5343.298
0.4000	0.1097	0.266	734.867	4.968	9460.693	1.896	5085.515	1.896	5085.515
0.4500	0.1234	0.286	780.610	4.890	9191.029	1.831	4846.694	1.831	4846.694
0.5000	0.1371	0.305	820.214	4.817	8939.676	1.771	4625.194	1.771	4625.194
0.5500	0.1508	0.322	854.488	4.748	8705.096	1.714	4419.528	1.714	4419.528
0.6000	0.1645	0.338	884.137	4.683	8485.896	1.660	4228.349	1.660	4228.349
0.6500	0.1782	0.352	909.772	4.622	8280.809	1.610	4050.438	1.610	4050.438
0.7000	0.1919	0.365	931.926	4.563	8088.688	1.563	3884.687	1.563	3884.687
0.7500	0.2057	0.377	951.059	4.508	7908.487	1.519	3730.091	1.519	3730.091
0.8000	0.2194	0.389	967.571	4.456	7739.258	1.477	3585.736	1.477	3585.736
0.8500	0.2331	0.399	981.811	4.406	7580.137	1.437	3450.794	1.437	3450.794
0.9000	0.2468	0.409	994.080	4.358	7430.337	1.400	3324.510	1.400	3324.510
0.9500	0.2605	0.418	1004.641	4.313	7289.141	1.365	3206.196	1.365	3206.196
1.0000	0.2742	0.426	1013.720	4.270	7155.895	1.331	3095.228	1.331	3095.228
1.0500	0.2879	0.434	1021.515	4.228	7030.003	1.299	2991.034	1.299	2991.034
1.1000	0.3016	0.441	1028.198	4.189	6910.920	1.269	2893.095	1.269	2893.095
1.1500	0.3153	0.448	1033.917	4.151	6798.146	1.241	2800.936	1.241	2800.936
1.2000	0.3290	0.455	1038.802	4.115	6691.228	1.213	2714.124	1.213	2714.124
1.2500	0.3428	0.461	1042.964	4.080	6589.746	1.188	2632.261	1.188	2632.261
1.3000	0.3565	0.467	1046.500	4.047	6493.319	1.163	2554.986	1.163	2554.986
1.3500	0.3702	0.473	1049.495	4.015	6401.596	1.139	2481.966	1.139	2481.966
1.4000	0.3839	0.478	1052.022	3.985	6314.255	1.117	2412.897	1.117	2412.897
1.4500	0.3976	0.483	1054.144	3.955	6231.000	1.096	2347.499	1.096	2347.499
1.5000	0.4113	0.488	1055.917	3.927	6151.559	1.075	2285.518	1.075	2285.518
1.5500	0.4250	0.492	1057.387	3.899	6075.683	1.055	2226.716	1.055	2226.716
1.6000	0.4387	0.497	1058.596	3.873	6003.139	1.037	2170.879	1.037	2170.879
1.6500	0.4524	0.501	1059.580	3.847	5933.717	1.019	2117.807	1.019	2117.807
1.7000	0.4661	0.505	1060.370	3.822	5867.220	1.001	2067.317	1.001	2067.317
1.7500	0.4799	0.509	1060.993	3.799	5803.468	0.985	2019.241	0.985	2019.241
1.8000	0.4936	0.512	1061.472	3.776	5742.292	0.969	1973.422	0.969	1973.422
1.8500	0.5073	0.516	1061.827	3.753	5683.538	0.954	1929.717	0.954	1929.717
1.9000	0.5210	0.520	1062.075	3.732	5627.062	0.939	1887.993	0.939	1887.993
1.9500	0.5347	0.523	1062.232	3.711	5572.733	0.925	1848.127	0.925	1848.127
2.0000	0.5484	0.526	1062.311	3.690	5520.427	0.911	1810.006	0.911	1810.006
-	-	Numbers	Grams	Numbers	Grams	Numbers	Grams	Numbers	Grams

Notes: Run name : YLDJBO02
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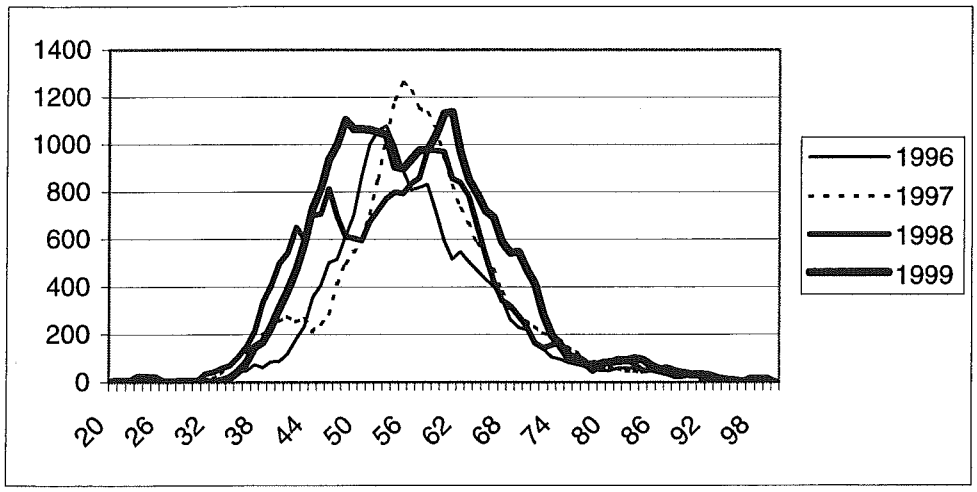
F-max factor : Not found
F-0.1 reference F : 0.2189
F-max reference F : Not found
Recruitment : Single recruit

a)



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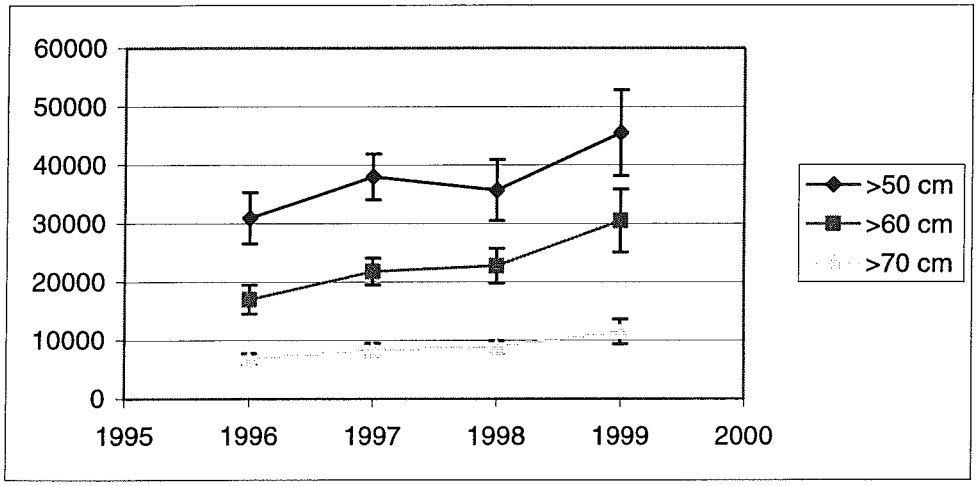


c)

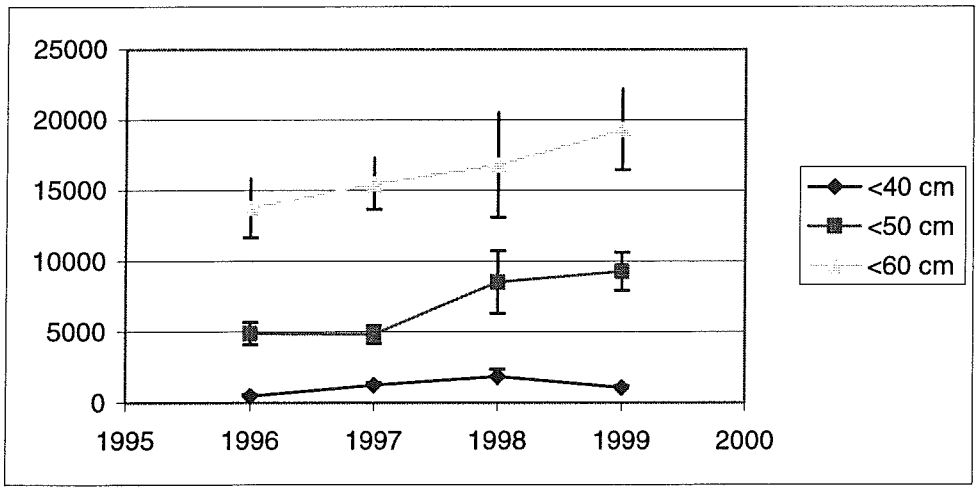


Figure 6.6.1. Greenland halibut in Icelandic fall groundfish survey: a) length distribution, b) biomass indices by lengths larger than indicated, c) abundance indices by lengths smaller than indicated

Figure 6.7.1.1

Fish Stock Summary
Greenland halibut in Sub−areas V and XIV
27−4−2000

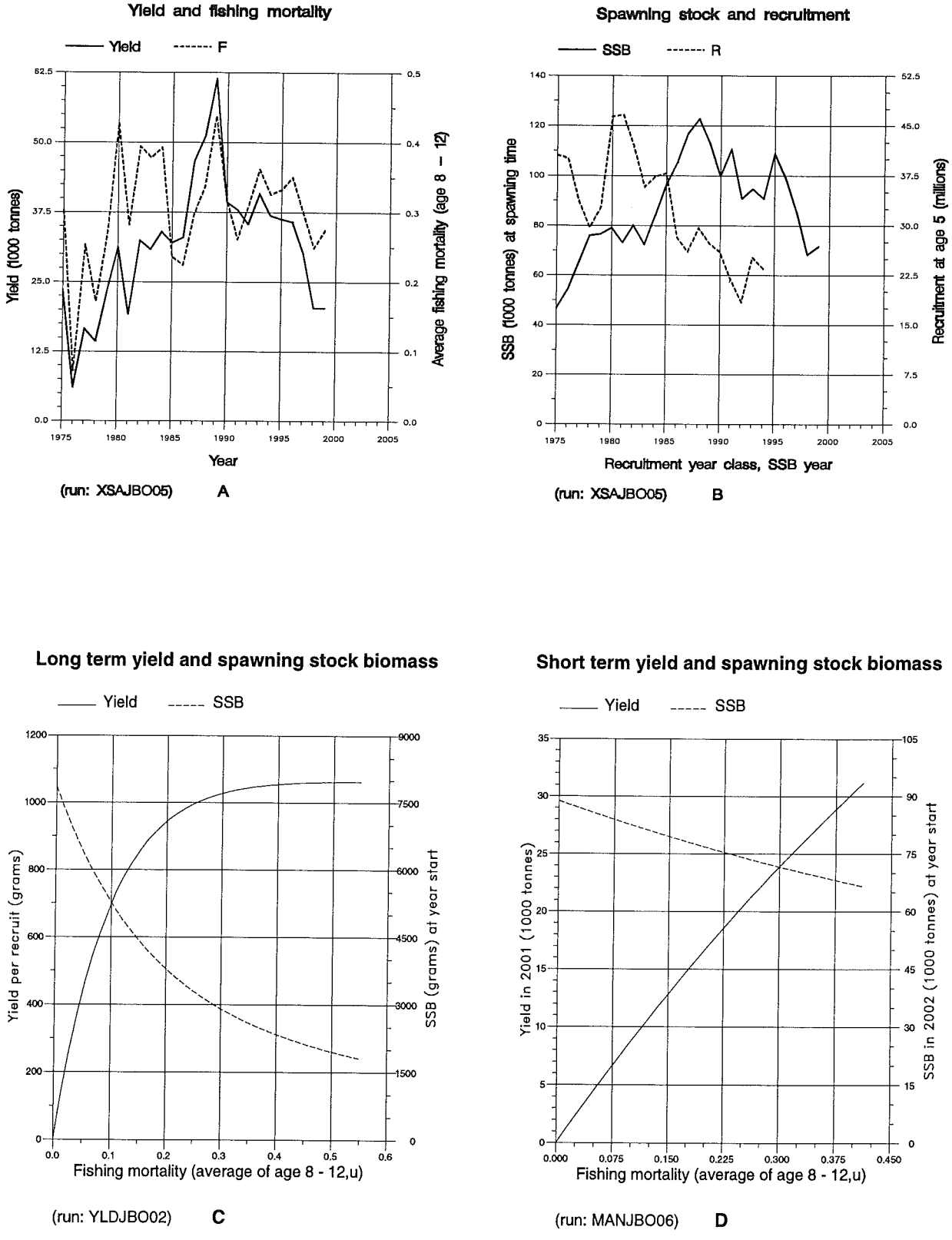
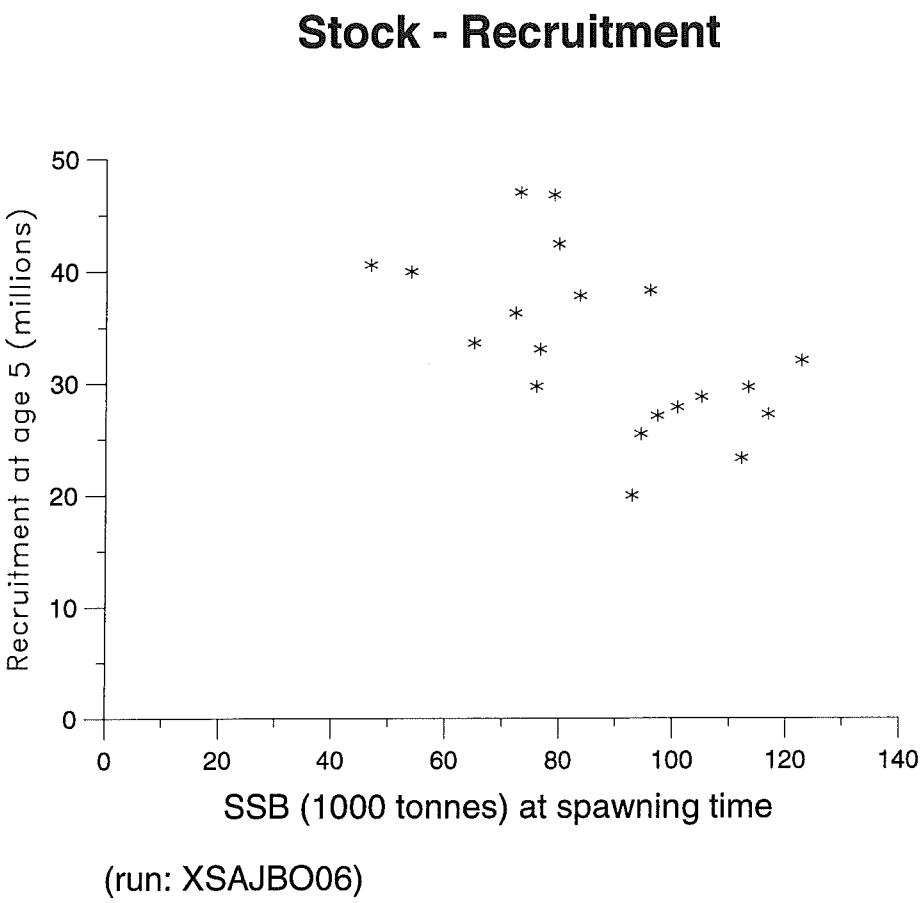
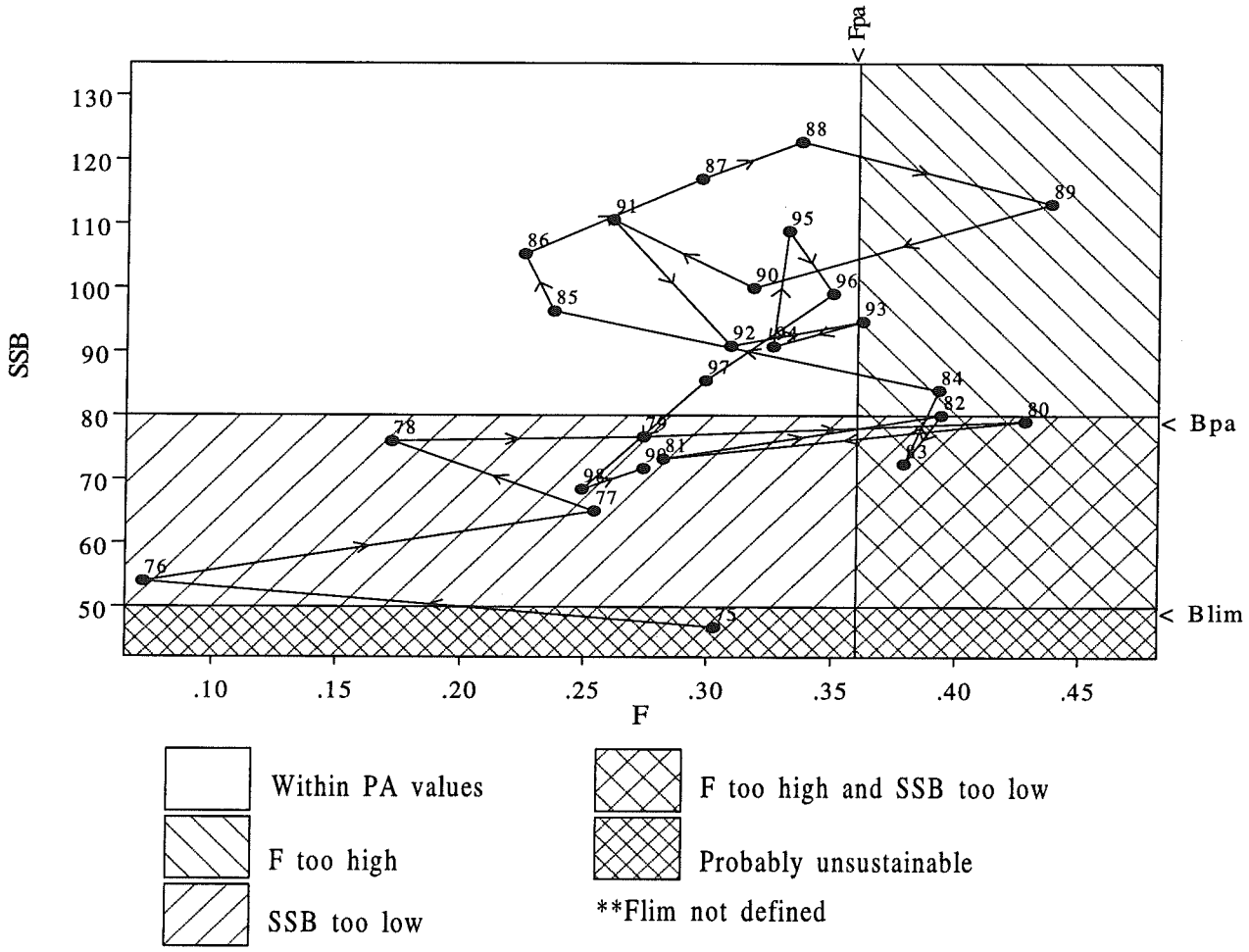


Figure 6.8.1 Greenland Halibut in Sub-areasV and XIV



Greenland halibut in Sub-areas V and XIV



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Plotted on 02/05/2000 at 12:43:35

Figure 6.8.2

7 REDFISH IN SUB-AREAS V, VI, XII AND XIV

The genus *Sebastes* is very common and widely distributed in the North Atlantic. It is found off the coast of Britain, along Norway in the Barents Sea and Spitzbergen, off the Faroe Islands, Iceland, East - Greenland, West - Greenland, and along the east coast of North America from Baffin Island South to Cape Cod). All *Sebastes* species are viviparous. The extrusion of the larvae takes place in late winter - late spring/early summer but copulation occurs in autumn-early winter.

7.1 Description of problems regarding stock identity of the species and stocks in the area

In ICES Divisions V, VI, XII and XIV there are at least 3 species of redfish, *S. marinus*, *S. mentella* and *S. viviparus*. The latter has only been of minor commercial value. Iceland has started to fish *S. viviparus* in 2 small areas south of Iceland at depths of 150 - 250 m. The landings of *S. viviparus* decreased from 1,160 t in 1994 to 994 in 1998 and to 494 t in 1999.

In areas assessed by the NWWG, one stock of *S. marinus* exists in the area of East Greenland - Iceland - Faroes. Large redfish, *S. marinus* type named "Giant", have been recorded and fished in different areas of the entire *S. marinus* distribution area including the Reykjanes Ridge. However, the fishery in 1996–1997 has not continued and there was no reporting of the "Giant" type redfish in 1999. Due to uncertainties related to the stock identification of "Giants", the NWWG recommends to collect separately all biological and fisheries data for future considerations.

During last years the existence of more than one stock of *S. mentella* in the area was discussed. Historically *S. mentella* was fished on the shelves and banks of Faroe Islands, Iceland and East Greenland and was considered as one stock. With the start of a new pelagic fishery in the open Irminger Sea in 1982, a new stock was defined for management purposes for *S. mentella* inhabiting the Irminger Sea. In 1992, the Study Group on Redfish Stocks distinguished between these types as deep-sea *S. mentella* and oceanic *S. mentella*. In early 90's, the pelagic fishery in the open Irminger Sea moved to deeper layers beyond 500 m and some researchers considered that some of the fish caught below 500 m were different to those living above 500 m but resembling more the deep-sea *S. mentella* living on the shelves. This new type of *S. mentella* living below 500 m has been called "pelagic deep-sea *S. mentella*".

It is not known if these types are more than one stock and different hypotheses have been put forward:

The **single stock hypothesis** suggests that all *S.mentella* from Faroes Island to Greenland constitute one stock, segregated according to age/size.

The **two stock hypothesis** suggests that the *S. mentella* living on the shelves (deep-sea *S. mentella*) and that living in deeper pelagic waters of Irminger Sea (pelagic deep-sea *S. mentella*) constitute one stock unit which is separated from the oceanic *S. mentella* living in upper layers of the Irminger Sea.

The **three stock hypothesis** support the idea that each of the described components constitutes a distinct stock.

As stated above, the uncertainty about stock identity is still high, and has not changed significantly since last year. The group was also asked to "comment on the possible relationship between pelagic "deep sea" *Sebastes mentella* and the *Sebastes mentella* fished in demersal fisheries on the continental shelf and slope." This question deals with one or two of the hypothesis regarding the stock structure of *S.mentella*. There are indications in favour of each of the three hypothesis, but as the uncertainties in the structure of the stocks has not changed, the Working Group could not highlight this part of the discussion, and therefore only refer to earlier discussion on this matter. There are activities in various laboratories working on this issue. In January a EU-funded project started and the aim is to investigate the stock structure of redfish in areas V, XII and XIV. The project is developed to coordinate and support the international research activities directed towards the most important questions related to the biology and exploitation of the highly migratory and straddling redfish resources. According to its title, the proposal is divided into the three main workpackages: 1. "Population structure", 2. "Reproductive strategies" and 3. "Abundance and demography". It is the hope of the Working Group that this project will solve some of the questions regarding the stock structure of the redfish in that area.

7.2 Nominal Catches and Splitting of the Landings in Stocks

The official statistics sent to ICES do not report catch figures specified by species/stocks (Tables 7.2.1. - 7.2.5).

Therefore, based on various information from different laboratories, the catches were split into species/stock (Table 7.2.6).

The technique and data for such splitting was described in the 1998 NWWG report.

7.3 Abundance and distribution of 0-group and juvenile redfish

Available data on distribution patterns of 0-group and juvenile *S. marinus* indicate that there are nursery grounds in Icelandic and Greenland waters only, while no nursery grounds are known around the Faroe Islands. In the 1983 Redfish Study Group report (ICES C.M. 1983/G:3) and in Magnússon and Jóhannesson (1997) the distribution of *S. marinus* 0-group at East Greenland was evaluated, showing that there are considerable amounts of *S. marinus* at East Greenland mixed with *S. mentella* (Magnússon et al., 1988 and 1990) in variable proportions in different sub-areas and periods (Sigurðsson, WD1 in ICES CM 1998/G:3). In Icelandic waters, nursery areas for *S. marinus* are found mostly west and north of Iceland at depths between 50 and approximately 350 m, but also in the south and east (ICES C.M. 1983/G:3; Einarsson, 1960; Magnússon and Magnússon 1975; Pálsson *et al.* 1997). As the length (age) increases, migration of young *S. marinus* along the north coast to the west coast takes place towards the most important fishing areas around Iceland.

Indices for 0-group redfish in the Irminger Sea and at East Greenland areas were available from the Icelandic 0-group surveys from 1970 – 1995. Thereafter, the survey was discontinued. Above or average year class strengths were observed in 1972, 1973–74, 1985–91, and in 1995.

Abundance, biomass indices and length compositions have been derived using German annual groundfish surveys covering shelf areas and the continental slope off West and East Greenland down to 400 m depth (Stransky and Rätz, WD 8). Due to difficult identification, the juvenile redfish (< 17 cm) were not classified to species level but treated as a single unit called *Sebastes spp.* Trends in survey abundance for juvenile redfish (< 17 cm) are shown in Figure 7.3.1 for West and East Greenland, respectively. Since 1993, small and unspecified redfish were very abundant and distributed mainly off East Greenland. The 1999 low survey results are similar to those observed in the late 1980's.

7.4 Discards and by-catch of small redfish

7.4.1 Discards of redfish in East and West Greenland

An offshore shrimp fishery with small meshed trawls (44 mm) began in the early 1970s off the west coast of Greenland and expanded to the east coast in the beginning of the 1980s, mainly on the shallower part of Dohrn Bank and on the continental shelf from 65° N to 60° N. Observer samples derived from the Greenland Fishery Licence Control revealed that the shrimp fishery at both West and East Greenland takes small redfish as a by-catch but there was no information available to quantify the by-catches and their length composition in latest years.

7.4.2 Regulations of small redfish by-catch at East and West Greenland

Present regulation concerning by-catches in the Greenland shrimp fishery permit a by-catch maximum of 10% of the total catch per each haul by weight. In 1994, a new arrangement with observers on board the vessels was implemented to strengthen the enforcement of the regulations and improve the reliability of the log-books.

The Redfish Box was created in 1981 off East Greenland as recommended by ACFM to protect that part of the nursery area of redfish (*S. marinus* and *S. mentella*) against the directed cod and redfish trawl fishery. Currently, the redfish box is effective also to the shrimp fishery.

Bearing in mind the declining fishery and biomass of *S. mentella* and *S. marinus* in all areas, and increased interest of fishing redfish, concern must be expressed on the discard of small redfish of both species wherever it takes place.

The Working Group therefore keeps recommendations from previous year to introduce the following measures for prevent young redfish by-catch and discards:

- legislate the mandatory use of a "fish grid" for the shrimp fisheries as is the case in the Barents Sea, in Icelandic and Canadian East cost waters and in the NAFO Regulatory Area.

- permit the temporary closure of areas when the by-catch of small fish exceeds a defined percentage as enforced at Iceland and in the Barents Sea.

7.5 Special Requests

In the ToR for, the Working Group there are several questions regarding stock structure, distribution and fishery information of *S.mentella* in the area. The following paragraphs deal with ToR c, e, f and g. Under different redfish chapters the Working Group also deals with these questions in more detail.

ToR c) Detailed descriptions of the fishery of different nations are given in chapters 8.2, 9.2 and 10.2. To summarise the pelagic redfish fishery, it can be said that in the period 1982–1992 the fishery extended mainly from April to August, mostly in international waters at depths less than 500 m. In the period 1993–1996 the fishing season was prolonged considerable, and moved more towards greater depths. Since then, the fishery has moved to more northerly waters in the first months of the fishing seasons (until June; area Va and XIV), generally fishing at depths deeper than 500 m depths with high effort concentrated along the Icelandic EEZ. In the third quarter of the year the fishing has, in general, moved towards the southern part of the area fishing mostly at depths above 500 m, within area XII, both outside and inside the Greenlandic EEZ.

ToR e) During the meeting several working documents dealing with the problem were presented. Two of these, working documents 14 and 23, supported the single-stock hypothesis based on information on parasites and pigment patches and on a general overview of the distribution pattern for different life stages. Information from the acoustic survey in 1999 and information from German Groundfish surveys in E-Greenland (WD 8 and 23) as well as the German catches (WD 5) supports the idea that the continental shelf of E-Greenland is the nursery area for all *S.mentella* in areas V, XII and XIV, including pelagic occurrences.

ToR f) Limited information is available for describing distribution of the stock(s) in the area. The information from various acoustic estimates in recent years only describes the distribution at one time of the year (acoustic estimate in June/July). Information from the fishery of various nations cannot be used alone as a description of the distribution. Therefore, these sources are probably not representative for the distribution of the different possible stock components. In chapter 10, a short description of the seasonal distribution from the 1999 international acoustic survey is given and description of the fishery is also available there for the last year (10.2). More detailed description of the fishery is given in working documents 4, 6, 7, 12, 19 and 25. Compared with previous results, the pelagic redfish above 500 meters was found more westerly and southerly distributed in the 1999 acoustic survey (June/July) into the NAFO Division 1F of southwest Greenland (see Figure 10.3.2).

ToR g) An update of the stock development of the pelagic redfish is given in chapter 10. The main new features are a continuation of the reduction in survey biomass above 500 m depth, a more south westerly distribution pattern during the second half of 1999 and the observed recruitment originated from the East Greenland continental slope. The associated risks in overexploitation of the different stock components managed under a common TAC cannot be quantified due to a lack of comparable quantitative stock indicators and adequate production estimates. Given the uncertainties about stock delimitations and abundance, dense concentrations of the high international fishing effort in terms of area, season and depth might cause severe local depletion effects.

Based on the information given above and information described in previous working group reports, the NWWG stresses that there are still uncertainties in the stock structure of *S.mentella* in ICES Divisions V, XII and XIV (see Figure 7.1). In accordance with the precautionary approach the units must, until the problem has been clarified, be treated in such a way that each of the possible components will not be overexploited. This implies that fishing effort and catches should be spread out.

Table 7.2.1. REDFISH. Nominal catches (tonnes) by countries, in Division Va 1986-1999, as officially reported to ICES.

Country	1986	1987	1988	1989	1990	1991	1992
Belgium	423	398	372	190	70	146	107
Faroe Islands	144	332	372	394	624	412	389
Germany	-	-	-	-	-	-	-
Iceland	85,992	87,768	93,995	91,536	90,891	96,770	94,382
Norway	2	7	7	1	-	-	-
Total	86,561	88,505	94,746	92,121	91,585	97,328	94,878
WG estimate	*86,670*	*88,505*	*94,762*	*92,121*	*91,585*	*97,328*	*96,846*

Country	1993	1994	1995	1996	1997	1998	1999[1]
Belgium	96	50	-	-	-	-	-
Faroe Islands	438	202	521	309	242	280	
Germany	-	46	229	233	-	284	428
Iceland [2]	96,577	95,091	89,474	67,757	73,976	108,830	67,132
Norway	-	-	-	134 [1]	-	-	18
Total	97,111	95,389	90,224	68,433	74,218	108,994	67,578
WG estimate	*99,714*	*110,861*	*91,767*	*72,909*	*89,519*	*110,498*	*104,938*

1) Provisional
2) Oceanic *S. mentella* not included in the officially reported catches

Table 7.2.2 REDFISH. Nominal catches (tonnes) by countries, in Division Vb 1986-1999, as officially reported to ICES.

Country	1986	1987	1988	1989	1990	1991	1992
Denmark	36	176	8	-	+	-	-
Faroe Islands	15,224	13,477	12,966	12,636	10,017	14,090	15,279
France	752	819	582	996	909	473	114
Germany [2]	5,142	3,060	1,595	1,191	441	447	450
Iceland	-	-		21			
Norway	2	5	5	-	21	20	34
Russia							15
UK (E/W/NI)	-	-		-	+	3	21
UK (Scotland)							8
United Kingdom							
Total	21,156	17,537	15,156	14,844	11,388	15,033	15,921
WG estimates	*21,476*	*17,538*	*15,508*	*15,068*	*11,737*	*15,037*	*15,993*

Country	1993	1994	1995	1996	1997	1998	1999 [1]
Denmark	-	-	-	-	-		
Faroe Islands	9,687	8,872	7,978	7,286	7,199	6,484	
France [1]	32	90	111	62	98	110	
Germany [2]	239	155	91	189	36	-	207
Norway	16	34	36	35 [1]	25 [1]	39[1]	40
Russia	44	3	-	-	-	-	-
UK (E/W/NI)	28	1	2	40	+	4	
UK (Scotland)	1	18	24	43	36	27	
United Kingdom							61
Total	10,047	9,173	8,242	7,655	7,394	6,664	308
WG estimates	*10,422*	*9,173*	*8,251*	*7,655*	*7,397*	*6,654*	*6,730*

1) Provisional
2) Former GDR and GFR until 1991

Table 7.2.3 REDFISH. Nominal catches (tonnes) by countries, in Sub-area VI 1986-1999, as officially reported to ICES.

Country	1986	1987	1988	1989	1990	1991	1992
Faroe Islands	-	-	1	61	-	22	6
France	480	1,032	1,024	726	684	483	127
Germany	24	-	16	1	6	8	-
Ireland	-	-	-	-	-	-	1
Norway	14	2	1	2	5	+	4
UK (Engl. and Wales)	2	3	75	1	29	12	4
UK (Scotland)	10	17	6	6	6	40	32
Total	530	1,054	1,123	797	730	565	174
WG estimates	*530*	*1,054*	*1,123*	*797*	*730*	*565*	*174*

Country	1993	1994	1995	1996	1997	1998	1999 [1]
Faroe Islands	-	-	2		12		
France [1]	268	555	529	489	395	297	
Germany	77	87	5	9	1	1	
Ireland	1	-	4		10		
Norway	3	2	1	6[1]	5[1]	3[1]	8
Portugal						1	
Russia							243
UK (E/W/NI)	4	9	105	54	19	12	
UK (Scotland)	94	118	500	603	518	364	
United Kingdom							765
Total	447	771	1,146	1,161	960	678	1,016
WG estimates	*447*	*771*	*1,146*	*1,711*	*960*	*678*	*1,016*

1) Provisional

Table 7.2.4 REDFISH. Nominal catches (tonnes) by countries, in Sub-area XII 1986-1999, as officially reported to ICES and/or FAO.

Country	1986	1987	1988	1989	1990	1991	1992
Bulgaria	-	-	-	-	1,617	-	628
Estonia	-	-	-	-	-	-	1,810
Faroe Islands	-	-	-	-	-	-	-
France							
Germany	-	-	-	353	7	62	1,084
Greenland	-	-	-	567	-	-	9
Iceland	-	-	-	-	185	95	361
Latvia	-	-	-	-	-	-	780
Lithuania	-	-	-	-	-	-	6,656
Netherlands							-
Norway	-	-	-	-	249	726	380
Poland	-	-	-	112	-	-	-
Portugal							
Russia[2]	24,131	2,948	9,772	15,543	4,274	6,624	2,485
Spain							
UK(E/WNI)							
UK (Scotland)	-	-	-	-	-	-	-
Ukraine	-	-		-	-	-	-
Total	24,131	2,948	9,772	16,575	6,332	7,507	14,193
WG estimates	*24,131*	*2,948*	*9,772*	*17,233*	*7,039*	*10,061*	*23,249*

Country	1993	1994	1995	1996	1997	1998	1999[1]
Bulgaria	3,216						
Estonia	6,365	17,875	16,854	7,092	3,720	3,968	2,108
Faroe Islands	4,026	2,896	3,467	3,127	3,822	1,793	
France						3	
Germany	6,459	6,354	9,673	4,391	8,866	9,746	8,204
Greenland	710	-	1,856	3,537	-	1,180	
Iceland	8,098	17,892	19,577	3,613	3,856	1,311	45
Japan			1,148	416	31	31	
Latvia	6,803	13,205	5,003	1,084	-	-	
Lithuania	7,899	7,404	22,893	10,649		1,769	
Netherlands	-	-	13		-	-	
Norway	5,911	4,514	3,893	1,010[1]	2,699[1]	263	1,083
Poland	-	-			662	12	
Portugal						503	
Russia	4,106	10,489	34,730	606	-	89	5,982
Spain			20	410	1,155	1,814	
UK(E/WNI)				33	-		
UK(Scotland)				13	-		
UK	+	-				-	
Ukraine	2,782	5,561	3,185	518			188
Total	56,375	86,190	122,312	45,590	49,103	22,482	17,610
WG estimates	*72,529*	*94,189*	*132,039*	*42,630*	*19,843*	*22,449*	*24,294*

1) Provisional

2) Former USSR until 1991

Table 7.2.5 REDFISH. Nominal catches (tonnes) by countries, in Sub-area XIV 1986-1999, as officially reported to ICES and/or FAO.

Country	1986	1987	1988	1989	1990	1991	1992
Bulgaria	11,385	12,270	8,455	4,546	1,073	-	-
Denmark	-	-	-	-	-	-	-
Faroe Islands	5	382	1,634	226	-	115	3,765
Germany, Dem. Rep,	8,574	7,023	22,582	8,816			
Germany, Fed. Rep.	5,584	4,691					
Germany					11,218	9,122	7,959
Greenland	9,542	670	42	3	24	42	962
Iceland	-	-	-	814	3,726	7,477	12,982
Norway	-	-	-	-	6,070	4,954	14,000
Poland	149	25	-	-			
Russia [2]	60,863	68,521	55,254	7,177	3,040	2,665	1,844
UK (Engl. and Wales)	-	-	-	5	39	219	178
UK (Scotland)	-	-	-	-	3	+	28
United Kingdom			-	-	-	-	-
Total	96,102	93,582	87,967	21,587	25,193	24,594	41,718
WG estimates	*96,102*	*95,824*	*91,676*	*24,520*	*31,261*	*28,400*	*48,513*

Country	1993	1994	1995	1996	1997	1998	1999 [1]
Bulgaria	-						
Denmark	-	-					
Faroe Islands	3,095	164	8	298	123	47	
Germany	26,969	22,406	9,702	16,996	11,610	9,709	8,935
Greenland	264	422	2,936	2,699	193	296	
Iceland [3]	11,650	29,114	8,947	49,381	33,820	6,441	43,062
Norway	8,351	2,546	2,890	6,286 [1]	433 [1]	864 [1]	4,205
Poland					114		
Portugal	-	1,887	5,125	2,379	3,674	4,133	4,302 [4]
Russia	6,560	13,917	9,439	45,142	36,930	25,748	11,571
Spain			4,534	3,897	7,552	2,763	
UK (E/W/NI)	241	138	48	247	28	43	
UK (Scotland)	8	4	10	6			
United Kingdom	-						68
Total	57,138	70,598	43,639	127,331	94,477	50,044	67,841
WG estimates	*57,269*	*59,776*	*43,141*	*134,594*	*88,070*	*55,395*	*49,197*

1) Provisional data.
2) Former USSR until 1991.
3) Officially reported catches includes Oceanic redfish caught in Subdivision Va.
4) Reported as V/XII/XIV

Table 7.2.6. Proportions used for splitting the 1999 REDFISH landings between *S.marinus* and *S.mentella* stocks.

Area	Va			Vb		VI		XII		XIV		
Species/stoc	*S.mar.*	*S.ment.* deep-sea	*S.ment.* oceanic	*S.mar.*	*S.ment.* deep-sea	*S.mar.*	*S.ment.* deep-sea	*S.ment.* deep-	*S.ment* oceani	*S.mar.*	*S.ment.* deep-sea	*S.ment.* oceanic
Estonia									1.00			
Faroes	1.00			0.21	0.79				1.00			1.00
France					1.00							
Germany	0.10	0.90			1.00				1.00		0.09	0.91
Greenland			1.00						1.00			1.00
Iceland	0.39	0.27	0.34						1.00			1.00
Lithuania												
Norway				1.00		1.00			1.00			1.00
Portugal												1.00
Russia							1.00		1.00			1.00
Spain									1.00			1.00
UK	0.10	0.90		1.00		1.00			1.00	0.10	0.90	

In Sub-area XIV the landings for Germany, Greenland and UK have been splitted between *S.marinus* and deep-sea *S.mentella* according to the German surveys.
For Faroe Islands, Germany, Iceland, Norway and Russia the splitting in most areas has been based on biological information presented to the Working Group and/or from log-books.

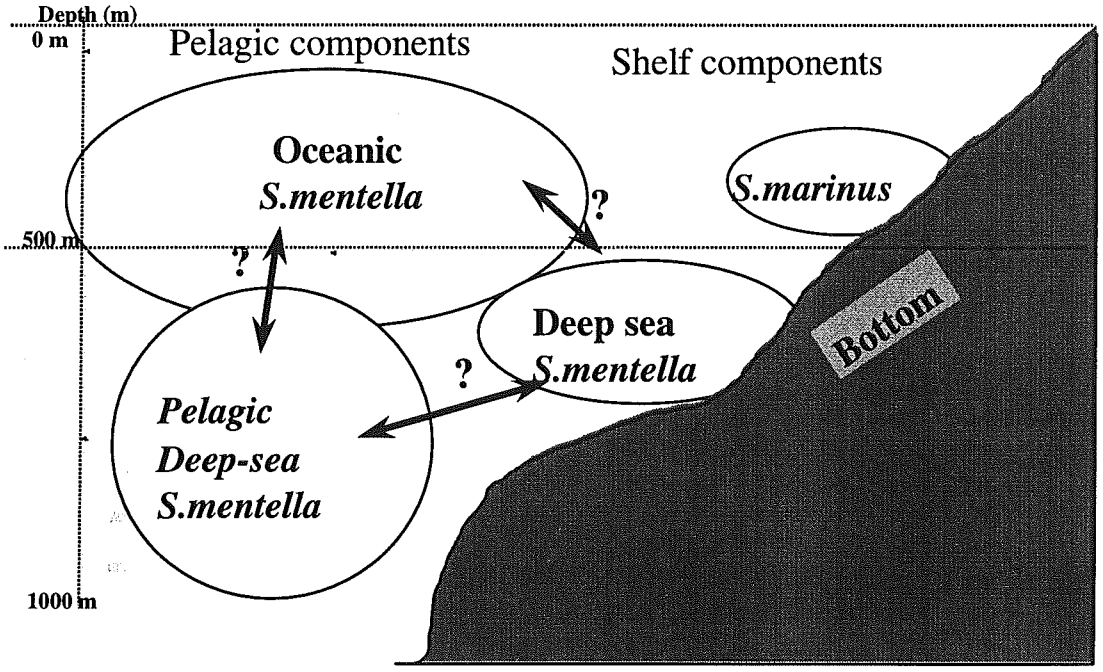


Figure 7.1 Schematically possible relationship between different stocks of redfish in the Irminger Sea and along the continental slope of E-Greenland-Iceland-Faroe Island.

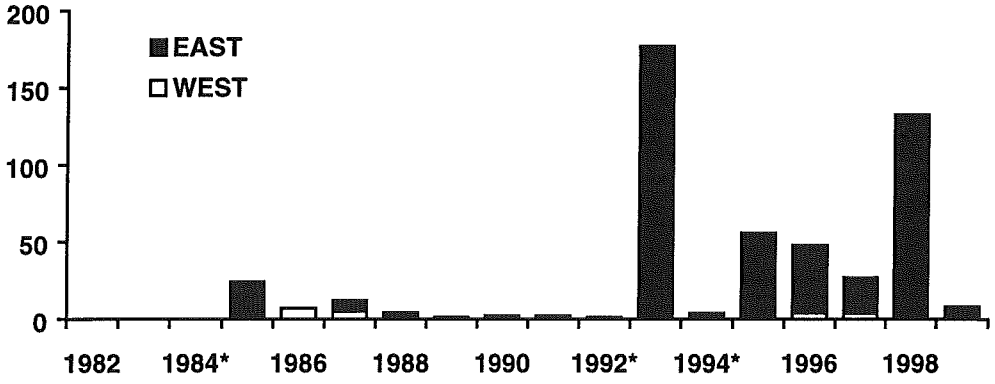


Figure 7.3.1 *Sebastes spp.* (<17 cm). Survey abundance indices for East and West Greenland as derived from the German groundfish survey, 1982-99. *) incomplete survey coverage.

8 SEBASTES MARINUS

8.1 Landings and Trends in the Fisheries

The total catch of golden redfish (*S. marinus*) (Divisions Va, Vb, in the Sub-areas VI and XIV) decreased from about 130 000 t in 1982 to about 40 000 t in 1997 and 1998 (Table 8.1.1). The catch in 1999 was about 42 000 t. The decline from 1982 of about 70% has more or less been continuous. Since 1990 the overall decrease in the catch has been about 45%. The increase in 1999, compared to 1998 is due to increased catches in Sub-area Va (Table 8.1.1).

In Division Va catches have declined from about of 63 000 t in 1990 t, stabilising around 34 000-36 000 t in 1996-1998. In 1999 an increase to about 40 000 t was observed. The low catch in 1994 was partly due to area closures imposed on the fishery by Iceland in order to reduce the catches of *S. marinus*. However, landings in 1995 increased to approximately 42 000 t, despite these area closures. The catches of *S. marinus* in Va in the period 1996-1999 are the lowest since 1978. The length distributions in the Icelandic landings in 1989-1999 along with measurements from the commercial trawler fleet are shown in Figure 8.1.1. The location and number of measured fish by statistical square is given in Figure 8.1.2. About 90-95% of the total *S. marinus* catches in area Va have in recent years been taken by bottom trawlers (both fresh fish and freezer trawlers; length 48-65 m) targeting on redfish. The remainder is taken by different gears, and partly as bycatch in the gillnet and longline fishery. In 1999, as in previous years, most of the catches were taken along the shelf of W, SW and to SE of Iceland, mostly between 12°W and 27°W.

In Division Vb, catches were highest in 1985 (approx. 9 000 t). Catches showed a declining trend to about 2,100 t in 1991, and have since remained at a level of 2,300-2,600 t (Table 8.1.1). In 1999 only 1,400 t were caught, which is a historic low. Most of the *S. marinus* -catches in Vb have been taken by pair trawlers and single trawlers (< 1000 HP). No length distribution from the catches was available for 1999.

The catches in Sub-area VI increased since 1978, reaching almost 600 t in 1987. A decline was observed to a low of 40 t in 1992. In 1995-1996 the catches again reached more than 600 t, the highest catches observed in the whole period (Table 8.1.1). The provisional catch in 1999 is about 773 t. Trawlers have taken the major proportion of the catches. No length distribution was available from the catch.

In Sub-area XIV catches have been more variable than in the other Sub-areas and Divisions. Since the highest catch on record in 1982 (31 000 t), a rapid decrease was observed to about 2 000 t in 1985. During the next 10 years catches varied between 600 and 4 200 t. In 1995-1997 almost no directed fishery for *S. marinus* nor *S. mentella* occurred. A minor directed fishery occurred in 1998 and catches increased to 175 t. In 1999 the catch is estimated to be 7 t. Large bottom trawlers participated in the directed fishery. Some bycatch is reported from the shrimp fishery in the area.

The following text-table shows the fishery related sampling by gear type and Divisions.

	Area	Gear	Landings	Nos. samples	Nos. fish measured
S. marinus	Va	Bottom trawl	40,000	253	52131
	Vb	Bottom trawl	1,400	0	0
	XIV	Bottom trawl	7	0	0
	VI	Bottom trawl	773	0	0

8.2 Assessment

8.2.1 Trends in CPUE and survey indices

Figure 8.2.1 shows the *S. marinus* abundance index with 95% confidence intervals using Icelandic groundfish survey (IGS), data (<400 m depth). The index is a biomass index of the fishable stock, computed by using a fishable stock ogive. The index (see Pálsson *et.al*, 1989) is stratified and the stratification is based on depth intervals shown in Figure 8.2.3. In Table 8.2.1 the contribution of each strata to the index is given. The index indicates a decrease in the fishable biomass from 1999, comparable to 1996-1998. The lowest index was in 1995, only about 30% of the maximum in 1987. The increase in the survey index in 1999 is not supported by the results in March 2000, and might indicate that the survey estimate in 1999 could have been an overestimate.

Length distribution from IGS shows that the peak in the length distribution (Figure 8.2.4) which has been followed during the last years (first in 1987) now has reached the fishable stock. This peak can clearly be seen as a maximum

around 36-37 cm in the length distributions of the catches (Figure 8.1.1). This is in accordance with earlier years, showing a growth of about 1.5-2 cm each year. The increase in the survey index in 1995-1999 therefore reflects the recruitment of a strong year class (1985 year class). This indication of strong year class is also confirmed by age readings, which have been going on since 1998. Based on the age readings, the 1985 year class have been dominating the catches since 1995 (Figure 8.2.2), and in 1999 that year class contributed with almost 42% of the total catch in Va. The survey results have also shown that 1990/1991 year classes are strong, and might be at similar size as the 1985 year class was at similar age.

Indices of CPUE for the Icelandic trawl fleet for the period 1985-1999 are estimated from a GLIM multiplicative model, taking into account changes in the Icelandic trawl catch due to vessel, statistical square, month and year effects. All hauls at depths above 500 m with redfish, exceeding 10% of the total catch were included in the CPUE estimation (Figure 8.2.5). Also, a simple CPUE was calculated (sum of catch / sum of hours trawled for each year, each haul where redfish exceeded 10% of the total catch in each haul). The results from the trawler fleet also reflect the situation shown in the groundfish survey. Although the CPUE has been low in recent years it increased in 1997 and has since been relatively stable although a decline was observed in 1999.

In summary, the Icelandic groundfish survey as well as the CPUE data seem to indicate a considerable decline in the fishable biomass of *S. marinus* during the period from 1986 to 1994. The stock seems to have started to recover in 1995 - 2000 but it is still low. Large proportion of the catches in recent years is caught from one yearclass.

In Division Vb, CPUE of *S. marinus* were available from the Faeroes groundfish survey 1983- After an increase in the period from 1995-1998 there is decrease in 1999 and 2000. The results also indicate a high variation in the series, and on average, only 43 hauls are behind the value each year (20-61 hauls). The value in 1999 and 2000 is only about 70% of the average value for the whole period since (Figure 8.2.6).

For the period 1982-99, abundance and biomass indices from the German groundfish survey for *S. marinus* >17 cm) are illustrated in Figures 8.2.7 and 8.2.8. From 1986-1995, an almost continuous reduction in survey biomass has occurred. However, in 1998 a weak signal of possible recovery was shown but the latest survey results do not support this signal. It can be taken from Figures 8.2.7 and 8.2.8 that the redfish were mainly distributed off East Greenland, while the minor abundance and biomass indices off West Greenland decreased to almost zero. The length frequencies from the German groundfish survey in 1998 are illustrated for West and East Greenland in Figures 8.2.9. The adults seem to remain almost depleted. Growth increments of single cohorts and the annual abundance and biomass indices at West - and East Greenland for the period 1992-1998 were presented in WP 8.

During the annual Greenland halibut survey (400-1500m) in XIVb in June/July 1999, *S. marinus* was only observed between 400 and 600 m. Total biomass of the species was estimated to about 2000 t, compared to 692 t in 1998. The total abundance was estimated to $5{,}400*10^6$ in 1999, which was an increase from 1998 ($1{,}541*10^6$). The length distribution ranged from 18 to 63 cm.

8.2.2 Alternative assessment methods

During previous meetings, the working group have tried an age-production model which has been described in Stefánsson and Sigurðsson (ICES C.M. 1997/DD:10). Applying the model to *S. marinus* the model showed the same general trend in the fishable biomass as the Icelandic groundfish survey and it seems to be able to reflect the peak in the recruitment of the assumed 1985 and 1990 year classes. At the 1999 working group meeting, an alternative model (BORMICON(BOReal MIgration and CONsumption model)) was applied to the *S. marinus* stock. The model is described in WD 18 in ICES CM 1999/ACFM:17 and in in Stefánsson and Pálsson (1997). BORMICON is a simulation- and estimation model developed at the Marine Research Institute.

The model has been developed further since last year, with the main change occurring in the part that spreads the growth where a beta binomial distribution has been added. The main changes have been that an additional year has been incorporated, and most importantly the number of otholiths read has increased.

The model is designed as multispecies - multiarea model but can also be used as a single species model as was done for the *S. marinus*. The main characteristics that distinguish the model from most stock assessment model is that it stores the number and mean weight of fish in each age and length group, not only in each age group as traditional models do. After the growth has been modelled, the growth is then distributed. Then, certain proportion of the fishes does not grow, some proportion grows one length group, some proportion 2 length groups etc.

All fleets (predators) in the model have length based selection pattern. This means that fleets catch only the largest individuals of each recruiting age group and therefore affect mean weight at age. The model does not use catch in

number directly as input data but rather length distributions, otolith samples and other data used to calculate catch in numbers. An objective function is then used to minimise the discrepancy between the model output and these data. This means that the model can use data that are not sampled regularly enough to calculate catch in number. Several runs were done, using two types of fleets:

1) The total amount calculated by the fleet is specified and it is distributed on different length groups according to abundance and the selection pattern. The same proportion is caught of each age group in a length group.

2) The proportion caught (approximate fishing mortality for short time steps) is specified. This proportion is then multiplied by the selection pattern so it is only for the length groups that are fully recruited that this proportion is caught. Fishing mortality refers to this proportion.

In calculation for the past, the total amount caught is specified, but in simulations into the future proportion caught (the fishing mortality) is specified. The formulation used is a relatively simple one and its main characteristics are;

- One area
- Two fleets catching each species, a commercial fleet and a survey. Selection patterns of both fleets are described by a logit function, whose parameters are estimated
- Growth is described by the von Bertalanffy's function.

Data used in the objective function to be minimised are:

- Length distributions from commercial catch and survey
- Age length keys p(*a*/L) from commercial catch and survey
- Length disaggregated survey indices
- Mean length at age from survey, and commercial catches
- Understocking (Not enough biomass exists to cover the catch).

Estimated parameters are then:

- Initial number in each age group
- Recruitment each year
- Parameters in the growth equation
- Selection patterns of commercial fleet and survey. Two parameters for each fleet.

Simulation period is from 1970 to 2000. Two time steps are used each year.

Natural mortality is set to 0.15 for the youngest decreasing gradually to 0.05 for age 5 and older. Also alternatives with other values on natural mortalities (M=0.1 for age 5+) were tested. They gave worse fit, and are therefore not incorporated here. The ages used are 1 to 30 years. The oldest age is treated as a plus group. Recruitment was at age 1. Prior to 1989 length at recruitment was 7.1 cm, but 8.1 cm in later years. This was supposed to reflect length of the 1985 and 1990 year classes in the groundfish survey.

Figures 8.2.10 and 8.2.11 shows length and weight at age according to the model. The model results this year indicate faster growth than the runs made in 1999 did. The results shown are based on a run using M = 0.05 for age 5+, alternative 1 using age-length keys and mean length at age from read otoliths while alternative 2 does not incorporate these information. The alternatives are identical in other respects. Estimated selection patterns are shown in figure 8.2.12.

Figure 8.2.13 shows estimated recruitment as age 1 (M = 0.05). The main indicator for recruitment is the groundfish survey, which does not indicate that any strong yearclass is on the way after the 1990/1991 year class. Here the 1990/91 year class comparable with the 1985 year class. Much less data are available to estimate the recruitment prior to 1985.

Simulations were used to determine the value of F_{max}. A yearclass was started in 1970 and caught using fixed fishing mortality and the estimated selection pattern. The total yield from the yearclass was then calculated. The simulations were executed for 30 and 40 years. F_{max} was calculated to 0.2 using 30 years simulation time and 0.165 using 40 years. F here is not fishing mortality but close to it when small time steps are used or mortalities are small. It is also the mortality of a fish where the selection is 1.

Two different catch options were tested in the future simulations, fixed catch and fixed value of fishing mortality. As may be seen on figure 8.2.14 the catchable biomass will increase in the nearest future, for F between 0.15-0.3, but thereafter, the biomass will decrease again as there are no sign of strong recruitment from the survey data. Also, the catches (Figure 8.2.15) will increase in next years, for al F's between 0.15 and 0.3, but in all cases decrease thereafter.

As said above, a fixed catch was also tested for future simulations. One of the disadvantage of fixed TAC is too much effort in periods where a high proportion of the strong recruiting yearclass is close to the minimum landing size, which could lead to an increasing discard. Figures 8.2.16 – 8.2.18 show the results of simulation using fixed catch after the year 2000. The runs shows similar as for fixed F. In next 4 years catchable biomass will increase for all cases up to 50 000 t but the total biomass will at the end of the period be lower than it is now for catches exceeding about 35 000 t annually.

From the above mentioned runs, it is clear that if the groundfish survey is to be accepted as a measure of recruitment, no new year class will show up in the catch until 2010 so the 1985 and 1990 year classes need to be preserved at least until then.

8.2.3 State of the stock and catch projections

All available survey information and CPUE data from Division Va show that the *S. marinus* stock decreased considerably to the lowest recorded biomass in 1995. A slow improvement in fishable biomass has, however, been seen in the most recent years due to improved recruitment. During the last few years, the 1985 year class has contributed significantly to the fishable stock, and the 1990 year class is expected to contribute significantly to the fishable biomass in next years. In Division Vb the CPUE from the Faroes groundfish survey shows an increase in last years but the catches are still at low level. The adult stock of *S. marinus* in Sub-area XIV has nearly been depleted in the most recent years. There are no indications of any considerable recruitment in the area.

The Icelandic groundfish survey indices (U) may be assumed to be related to overall biomass (B) by a simple linear relationship ($U=kB$). If catches in time, t, are assumed to be proportional to stock size and effort ($Y=cEB$), then it follows that catch over survey index is proportional to effort ($Y/U=aE$, see Table 8.2.3) and this allows a one-year prediction of catch assuming a *status-quo* effort level.

Although calculated confidence limits in the groundfish survey is quite low, year to year variation in catchability/availability will affect the results drastically while using only the last observation value as a basis for extrapolation of catches in the coming year, based on a constant effort. By using a running average over few years (3 as a minimum), one would reduce the variation in the catch prediction, based on the above assumptions.

The following text table gives the running mean of the IGS index given in Table 8.2.3.

	Year													
	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
3 year running average	1097	1053	986	810	704	567	493	464	406	438	471	539	598	577

By assuming same effort in 2001 as it was in 1999 the predicted catch in Va will be around **33 000 t** using the following formula:

Catch 2001 = Average **Survey index** 1998-2000 * **Effort** 1999,

By applying only last survey index and assuming same effort as 1999 the catch of *S. marinus* in 2001 will be about 29 000 t in Va. By using a running average the variation in catch projections, due to year to year variation in the survey index is reduced. As the BORMICON model shows nearly identical results as the three year running average, the WG suggest to use the running average which, assuming unchanged effort, gives a catch of 33 300 t in Va in 2001.

Based on the BORMICON model the fishable biomass will increase in the next few years, but will decrease thereafter for every catch option above 35 000 t (or all F's above 0.2). This is due to the poor recruitment after the 1990/91 year class. The model shows that by fishing at a low F (0.165) the variation in the catches will be from about 27 000 t in 2001 to about 45 000 t in 2006 with an average catch of close to 35 000 t during the period. The fishable biomass will be almost the same at the end of the period whether a constant TAC, or a constant F is chosen. Except the results of

next years surveys (or CPUE) deviates from what is described in the BORMICON model, a TAC of about 35 000 t in next 5 years would keep the fishable stock size above UPa at the end of that period.

In Division Vb the CPUE from the Faroes survey shows a similar trend as the Icelandic (increase in 1996-1998, but decrease in 1999 and 2000), but in Sub-area XIV the fishable stock of *S. marinus* is almost depleted.

In order to protect the new incoming year class, any fishing effort on this component should be kept low to allow the stock to rebuild. It should also be kept in mind that, based on the groundfish survey there is no indication of new, strong, year classes after the 1990 year class. Therefore as described in 8.2.2, the year classes, 1985 and 1990 needs to be preserved, since it is unlikely that other year classes than these will contribute substantially to catches in the next years. Therefore, the Working Group recommends **that the effort should not be increased.**

8.3 Biological reference points

S. marinus is mainly caught in Division Va and the relative state of the stock can be assessed through survey and CPUE index series from that Division. ACFM accepted the proposal of the working group of defining reference points in terms of current state with respect to $U_{lim} = U_{max}/5$ and $U_{pa} = 60\%$ of U_{max}. U_{pa} corresponds to the fishable biomass associated with the last strong year class. Based on survey data, the highest recorded biomass was reached in 1987. Based on these definitions, the stock has been below, but close to U_{pa} during the last years. Based on the BORMICON model the corresponding values for reference points (for the period 1985-1999) are then U_{max}= 250 (in 1985); U_{lim}= 50 and U_{pa}= 150, and the stock seems to have been below U_{pa} in the period from 1993- 1996. The survey index series is only available back to 1985.

8.4 "Giant" *S. marinus*.

In March 1996 a new fishery with longlines and gillnets started on the Reykjanes Ridge deeper than 500 meters. In addition to traditional bottom longlines, vertical longlines were used on the steep sea mountains. One or two vessels also used gillnets. One of the main species caught in this fishery were the "giant" *Sebastes marinus* (see chapter 7.1). The main fishery has taken place from within the Icelandic EEZ (north to approx. 63°N) and southwards in international waters to approx. 56°N, although occasionally "giant" redfish have been caught south to 52°30'N. ACFM decided in 1997 to treat all *S. marinus* in ICES Sub-areas V, XII and XIV, including the 'giant', as one management unit.

The only landing statistics presented in 1996 were by Iceland, the Faroes and Norway (Table 8.4.1). The total reported landings of "giant" *S. marinus* taken by these countries in Sub-areas XII and XIV in 1996 was 900 t. The fishery since then decreased, with only minor catches reported by Norway in 1997 and there were no reporting of "giant" catch in 1998 and in 1999. There was however a considerable fishing effort on the Reykjanes in 1997, but the target demersal species seems to have been Greenland halibut and other deep sea species. Taking all available information and knowledge into account, it is the view of the Working Group that the demersal *S.marinus* caught on the Reykjanes Ridge in international waters, of which nearly 100% have been documented to belong to a separate genetic pool, the 'giants', should be managed separately and in a very conservative and cautious way.

The *S. marinus* caught in the depth between 400 and 600 m in area XIVb by the annual Greenland halibut survey could be of the giant type as this was the case in the samples collected during a gillnet fishery in 1995 (Johansen *et al.* 2000).

Table 8.1.1. *S. marinus*. Landings (in tonnes) by area used by the Working Group.

Year	Va	Vb	VI	XII	XIV	Total
1978	31,300	2,039	313	0	15,477	49,129
1979	56,616	4,805	6	0	15,787	77,214
1980	62,052	4,920	2	0	22,203	89,177
1981	75,828	2,538	3	0	23,608	101,977
1982	97,899	1,810	28	0	30,692	130,429
1983	87,412	3,394	60	0	15,636	106,502
1984	84,766	6,228	86	0	5,040	96,120
1985	67,312	9,194	245	0	2,117	78,868
1986	67,772	6,300	288	0	2,988	77,348
1987	69,212	6,143	576	0	1,196	77,127
1988	80,472	5,020	533	0	3,964	89,989
1989	51,852	4,140	373	0	685	57,050
1990	63,156	2,407	382	0	687	66,632
1991	49,677	2,140	292	0	4,255	56,364
1992	51,464	3,460	40	0	746	55,710
1993	45,890	2,621	101	0	1,738	50,350
1994	38,669	2,274	129	0	1,443	42,515
1995	41,516	2,581	606	0	62	44,765
1996	33,558	2,318	663	0	59	36,598
1997	36,342	2,839	542	0	37	39,761
1998	36,771	2,565	379	0	109	39,825
1999 [1]	39,824	1,436	773	0	7	42,040

1) Provisional

Table 8.2.1. Index on fishable stock of *S. marinus* in the Icelandic groundfish survey by depth.

Depth interv / year	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
< 100m	7	2	2	1	1	2	2	1	1	1	0	1	1	2	1	2
100-200m	91	86	124	95	101	68	76	62	48	58	36	44	60	57	56	47
200-400m	140	180	150	110	118	81	53	59	50	51	45	76	71	71	107	69
400-500m	24	12	10	4	11	22	8	9	17	1	11	21	34	3	44	8
Total 0 - 400m	237	268	276	206	220	151	130	122	98	110	81	121	133	130	164	117
Total	262	281	287	228	234	187	141	133	117	112	93	143	166	133	208	125

Table 8.2.2. *S. marinus.* Catch in Va in weight (tonnes) by age.

Year/ Age	1995	1996	1997	1998	1999
7	59		59	61	
8	199	354	261	226	466
9	1201	808	613	586	1287
10	9265	3622	1042	1264	1320
11	2885	8943	3036	1044	1889
12	1223	2072	11261	2981	2739
13	3582	1300	2709	11168	2432
14	5855	1459	1375	1830	16642
15	6488	4398	3413	1835	966
16	1492	5641	3699	2138	1214
17	819	921	2348	3338	1785
18	438	388	817	2001	2895
19	1065	268	630	1322	1661
20	1008	337	1186	946	1193
21	464	1210	474	461	292
22	825	1033	622	373	205
23	1246	803	741	763	458
24	792		595	1007	220
25	1101		728	651	806
26	429		312	491	230
27	249		138	955	593
28	674		250	672	102
29				69	172
30	157		34	320	266
Total	41516	33558	36342	36501	39833

Table 8.2.3. *S. marinus* Results from the Icelandic groundfish survey in Va, total catch in Va and effort towards *S. marinus.*

Year	Survey index	Catch (Va)	Effort
1985	1000	67,312	67
1986	1129	67,772	60
1987	1163	69,212	60
1988	867	80,472	93
1989	928	51,852	56
1990	637	63,156	99
1991	549	49,677	91
1992	515	51,464	100
1993	415	45,890	111
1994	462	38,669	84
1995	341	41,516	122
1996	511	33,558	66
1997	559	36,342	65
1998	547	36,771	67
1999	689	39,824	58
2000	494		

Table 8.4.1 Catches of "giant" *S. marinus* in Divisions XII and XIV. No catches are reported in 1998-1999.

	XII		XIV	
	1996	1997	1996	1997
Norway	76	21	750	22
Faroes[1]			80	
Total	76	21	830	22

1) Includes area XII

Catch figures for other areas or nations are not available for the meeting.

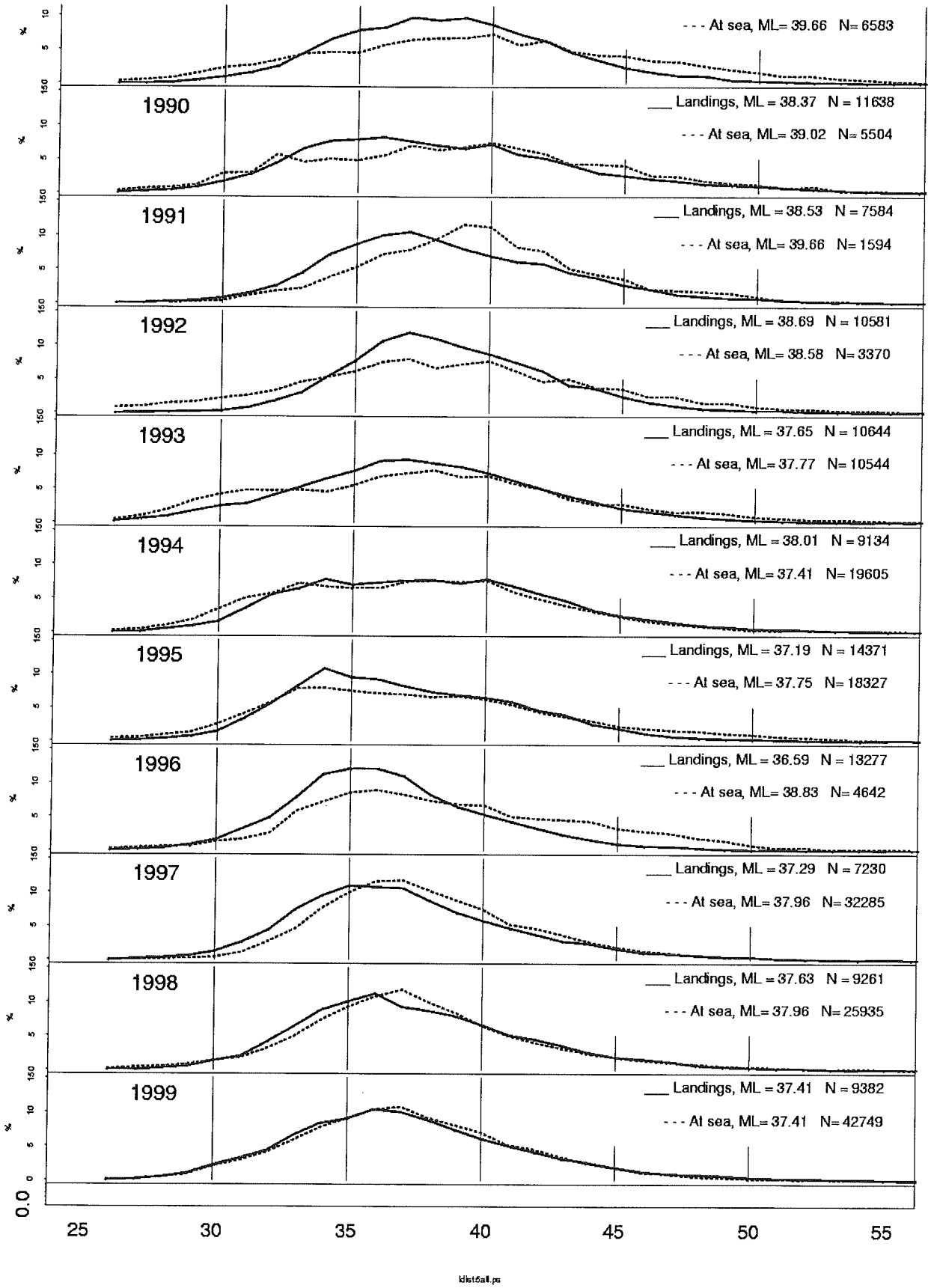


Figure 8.1.1. *S. marinus.* Length distribution from Icelandic landings and from samples taken at sea from the trawler fleet 1989-1999.

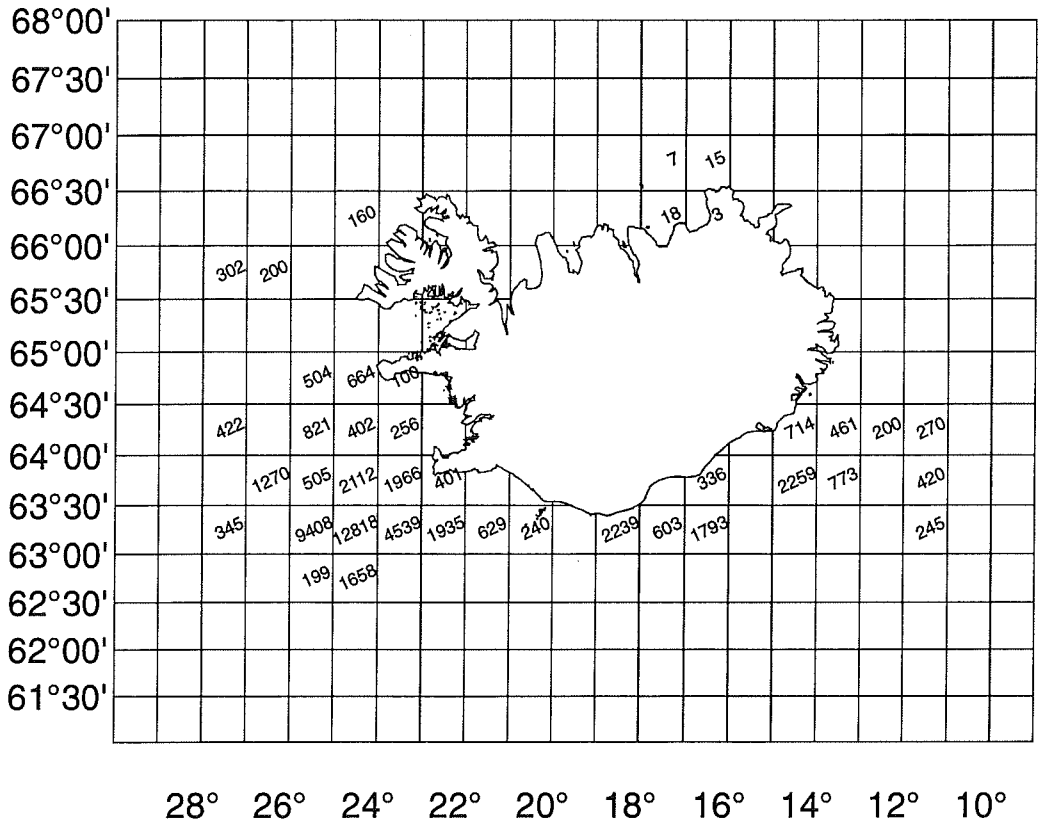


Figure 8.1.2. Number of measrured *S. marinus* from Icelandic catch in 1999 by statistical square.

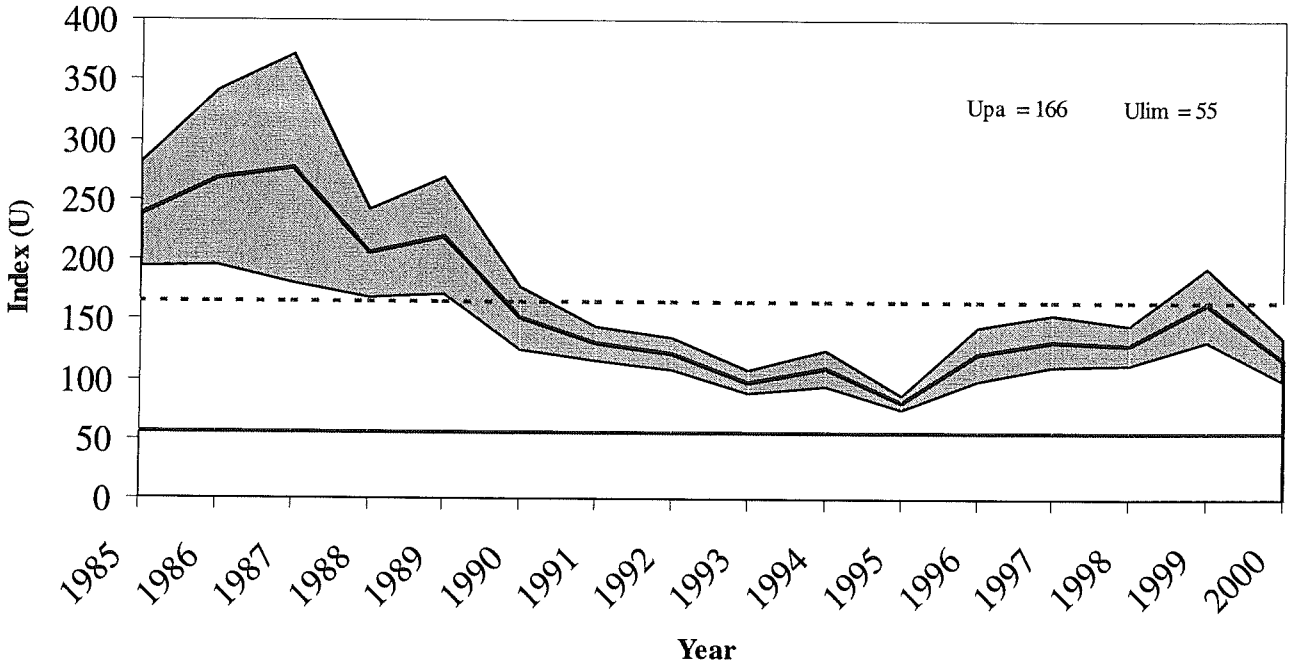


Figure 8.2.1. Index on fishable stock of *S. marinus* from Icelandic groundfish survey and 95% confidence intervals. The index is based on all strata at depths from 0-400 m.

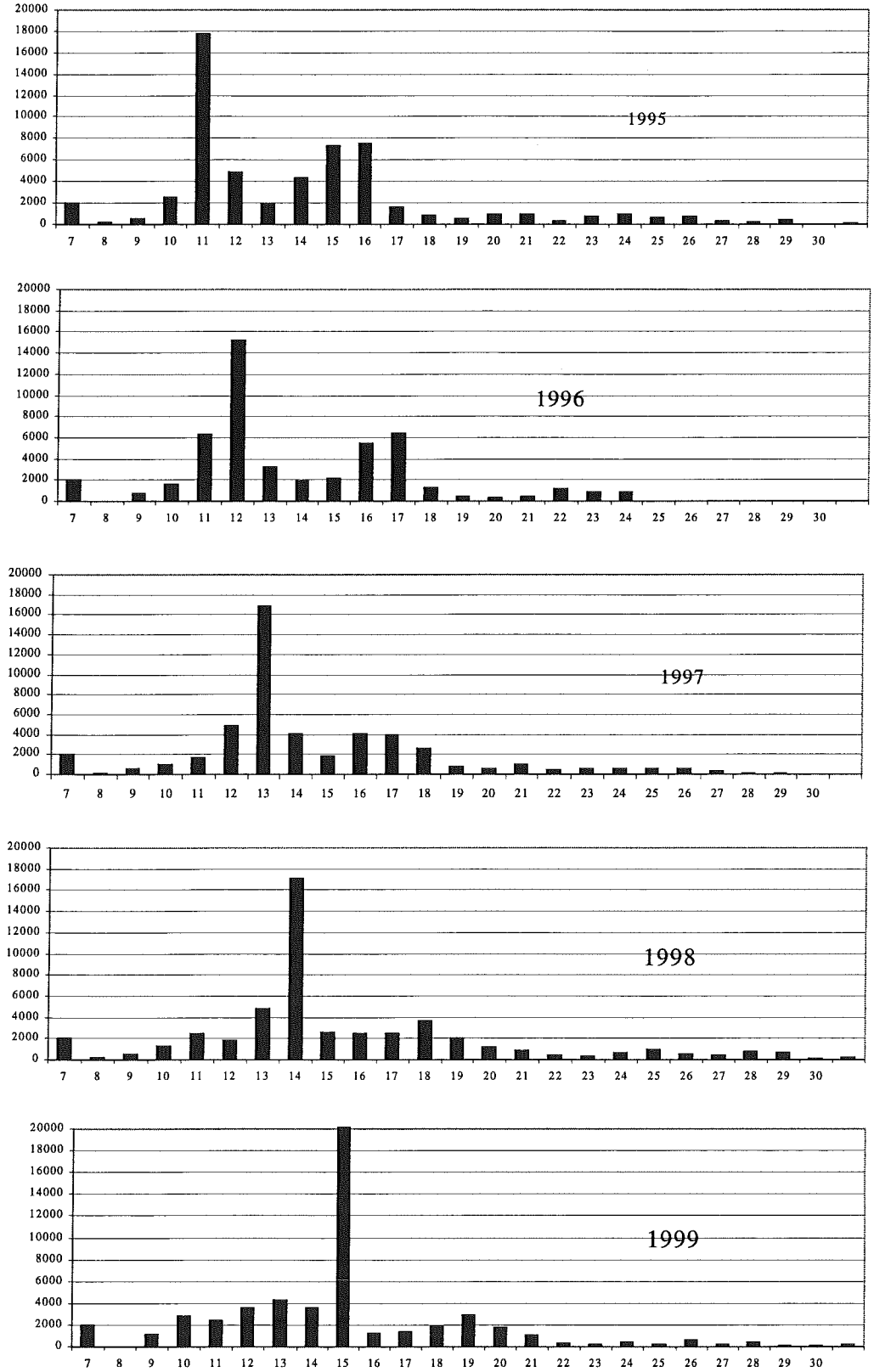


Figure 8.2.2. *S. marinus.* Catch in number by age in Sub-division Va, based on samples from the catch.

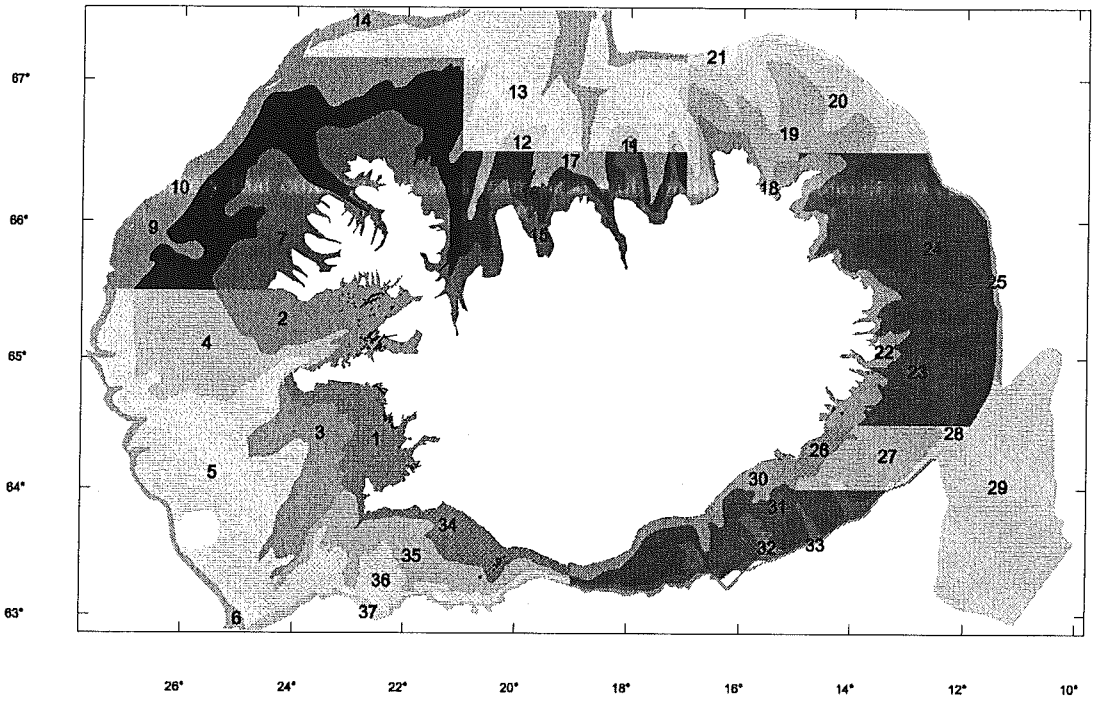


Figure 8.2.3. Stratification in the Icelandic groundfish survey by depth down to 500 m. The numbers show stratified index (Palsson *et al.* 1989). See also table 8.2.1.

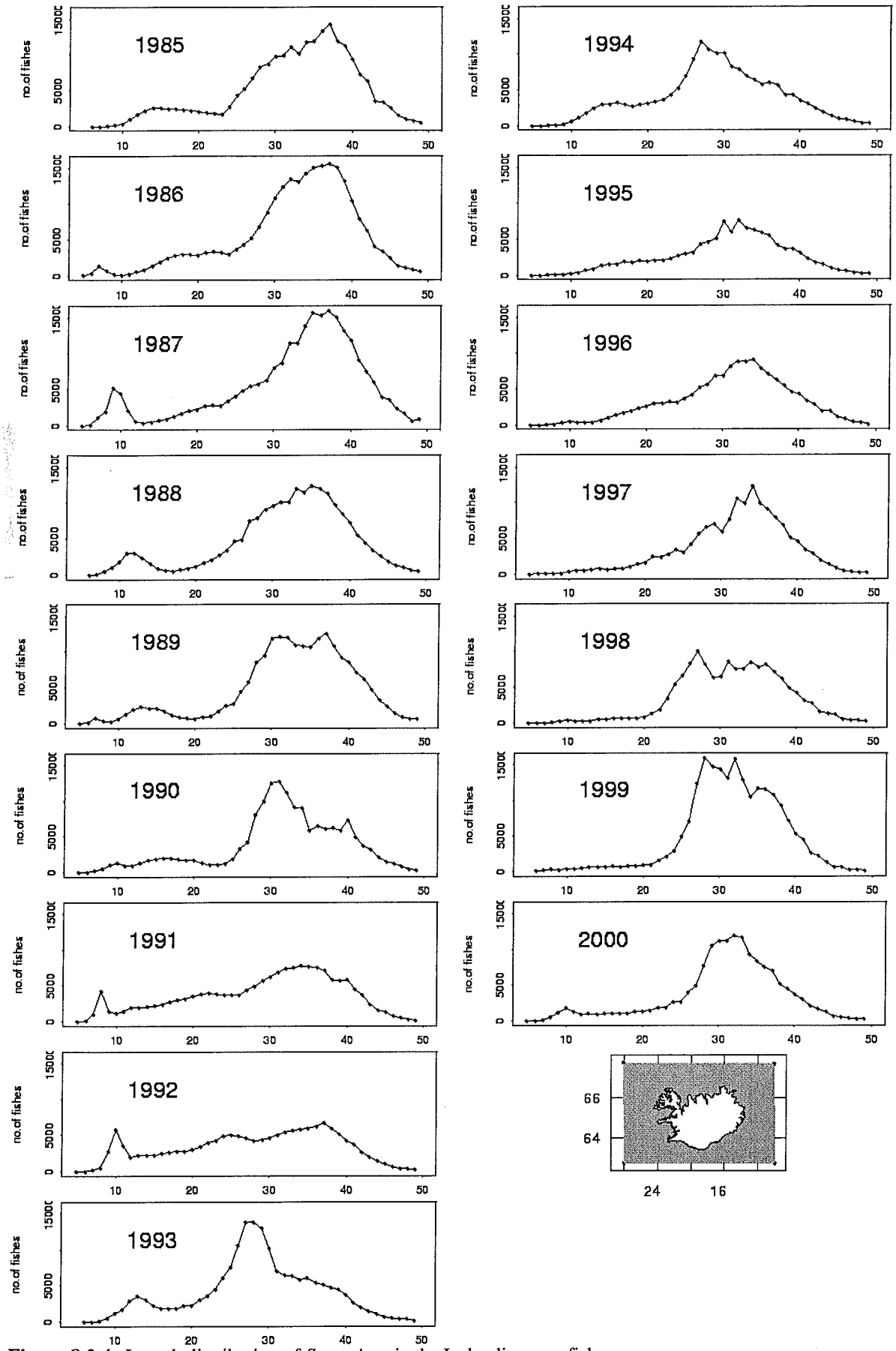


Figure 8.2.4. Length distribution of *S. marinus* in the Icelandic grounfish survey.

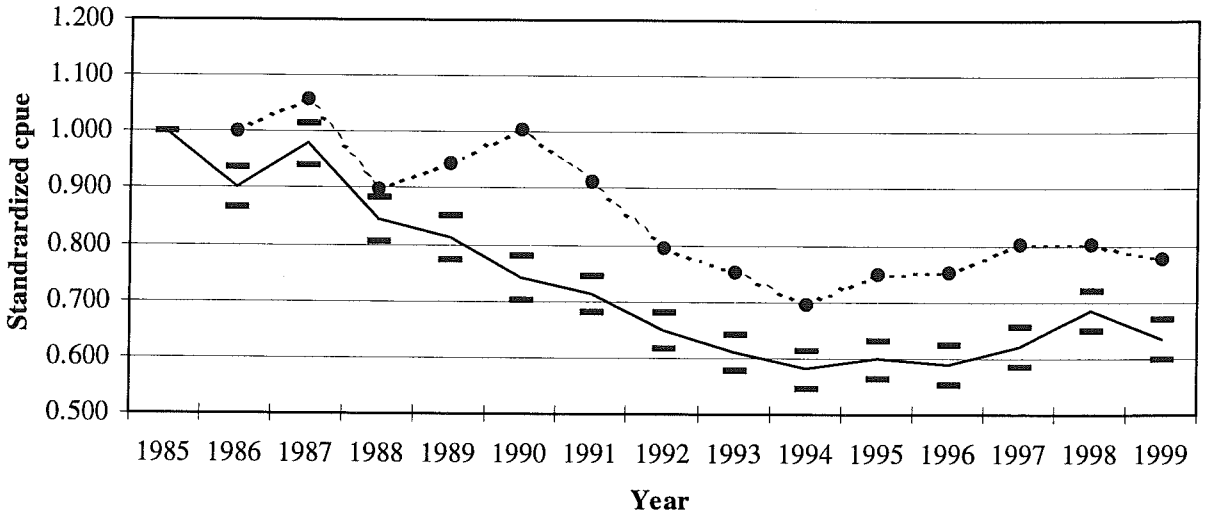


Figure 8.2.5. CPUE in *S. marinus* from Icelandic trawlers, both based on results from GLIM model 1985-1999 (solid line with 95% CV) and based on simple mean of hauls where *S. marinus* catch compose 50% or more of the total catch in each haul (dotted line since 1986).

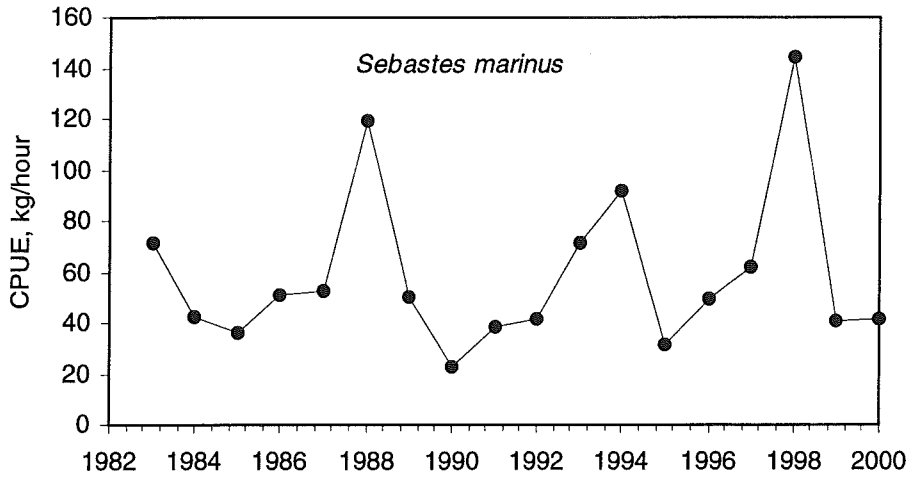


Figure 8.2.6. CPUE of *S. marinus* in the Faeroes groundfish survey 1983-2000.

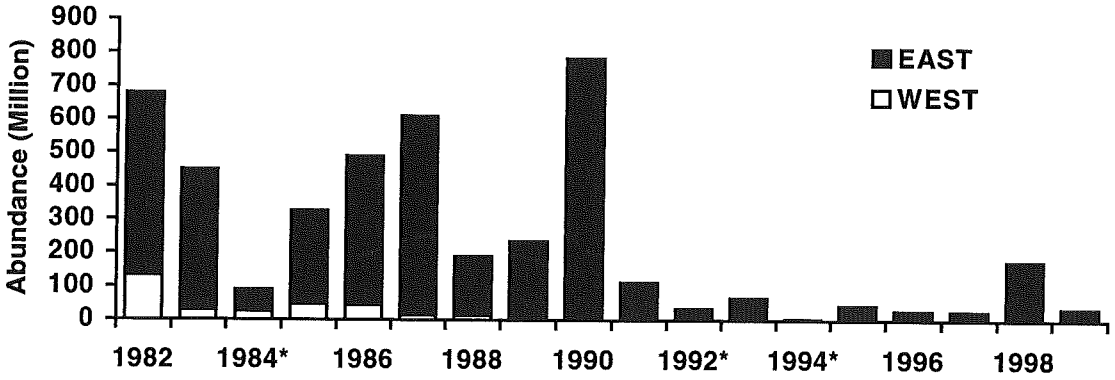


Figure 8.2.7 *S. marinus* (≥17 cm). Survey abundance indices for East and West Greenland, 1982-99. *) incomplete survey coverage.

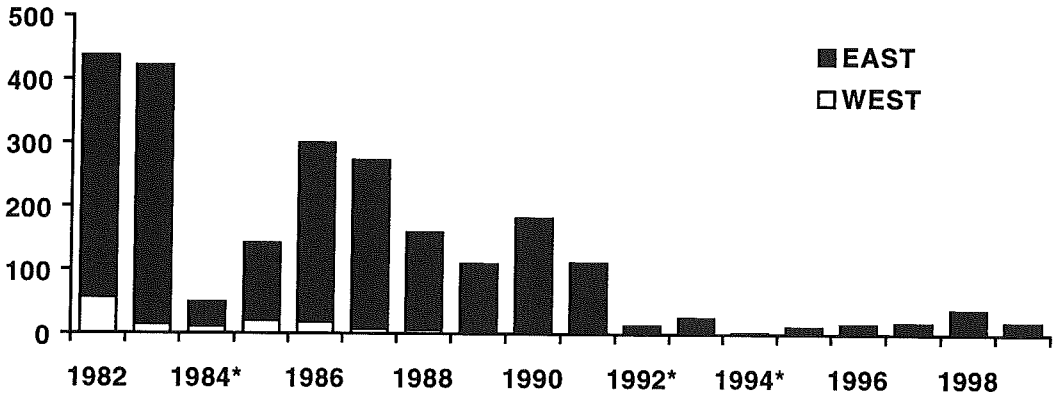


Figure 8.2.8. *S. marinus* (≥17 cm). Survey biomass indices for East and West Greenland, 1982-99. *) incomplete survey coverage.

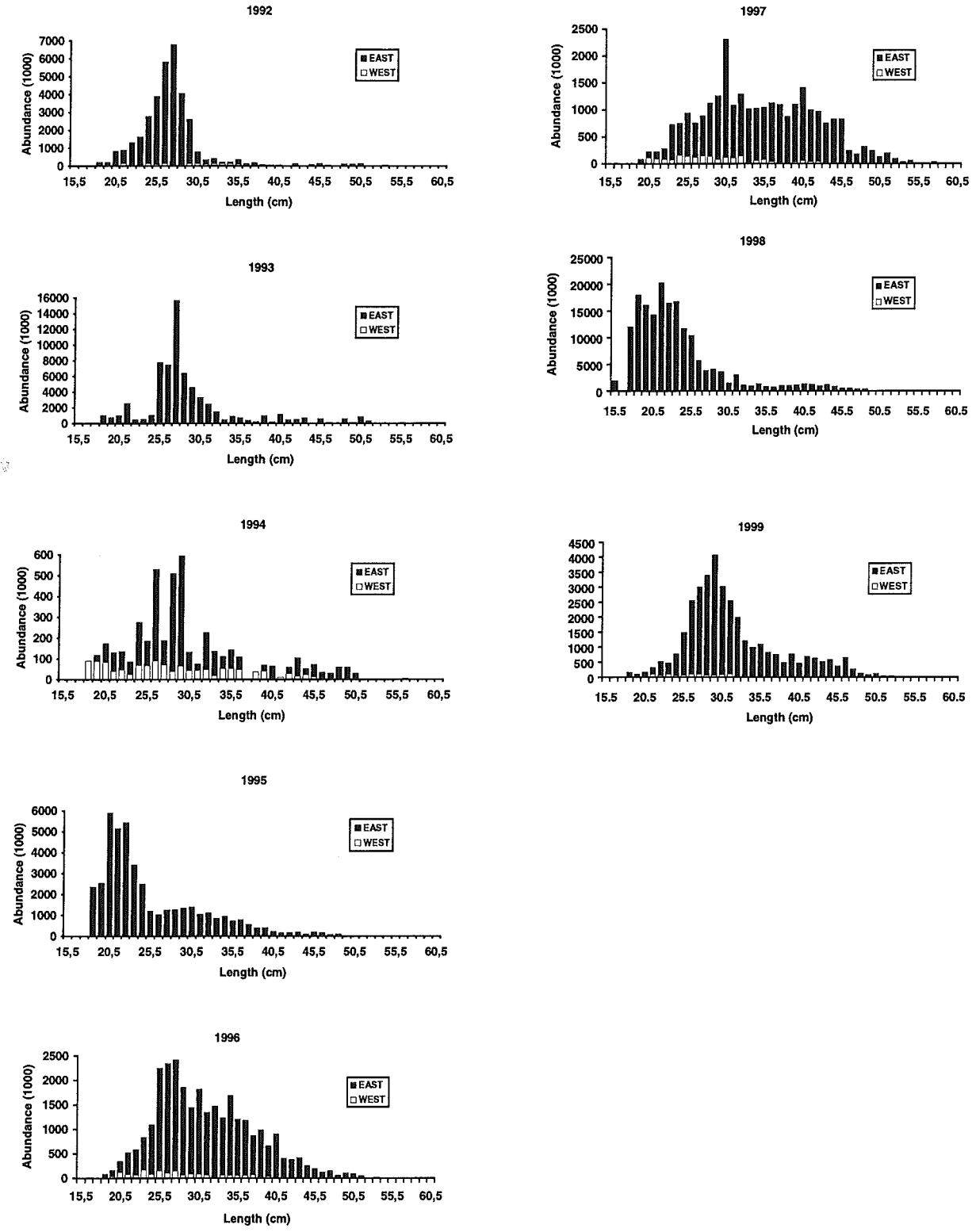


Figure 8.2.9. *S marinus* (≥17 cm). Length frequencies for East an West Greenland, 1992-99, as derived from the German groundfish survey.

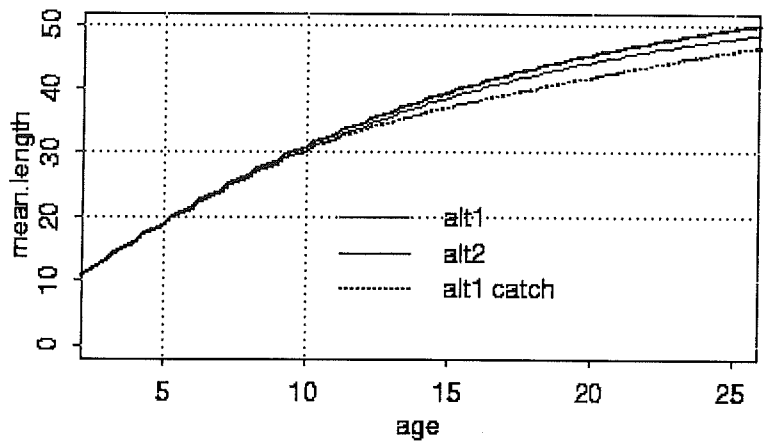


Figure 8.2.10. Mean length of *S. marinus* according to the BORMICON model. Alternative 1 incorporates age readings while alternative 2 does not. The figure also demonstrates the effect of catch on length at age.

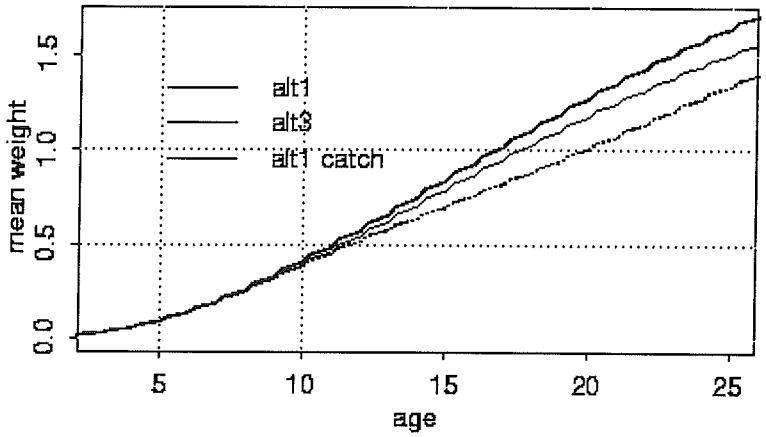


Figure 8.2.11. Mean weight (in Kg) of *S. marinus* according to the BORMICON model. Alternative 1 incorporates age readings while alternative 3 does not. The figure also demonstrates the effect of catch on weight at age.

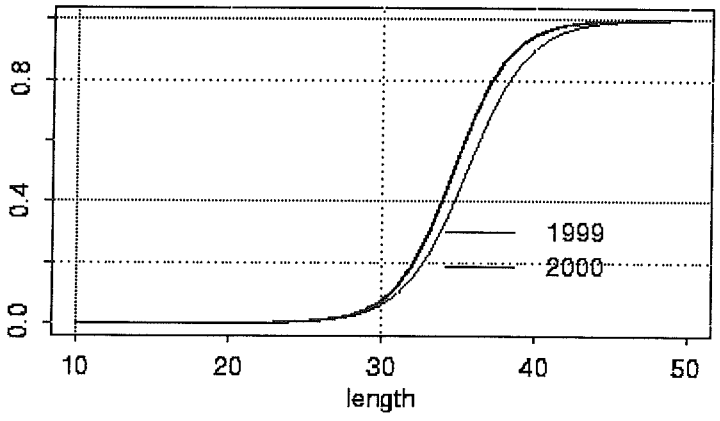


Figure 8.2.12. Estimated selection pattern of the commercial fleet according to the BORMICON model. The results from last years run are also drawn, for comparison.

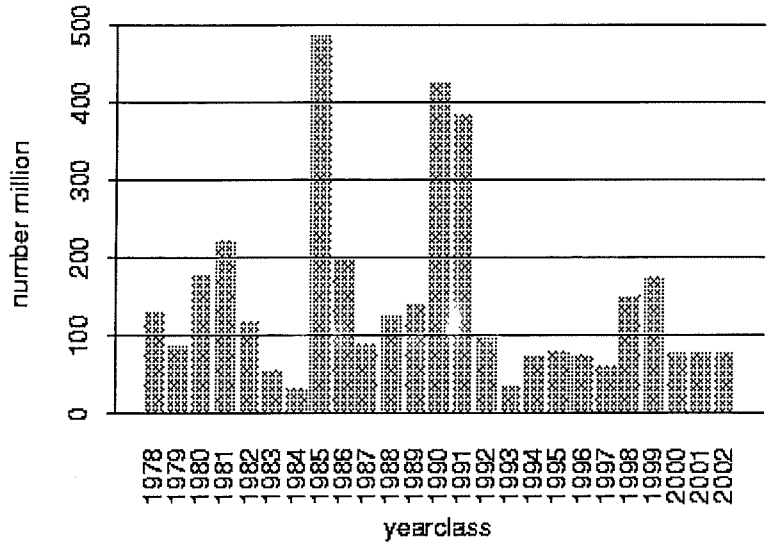


Figure 8.2.13. Recruitment of *S. marinus* estimated by the BORMICON model which are used in the future simulations.

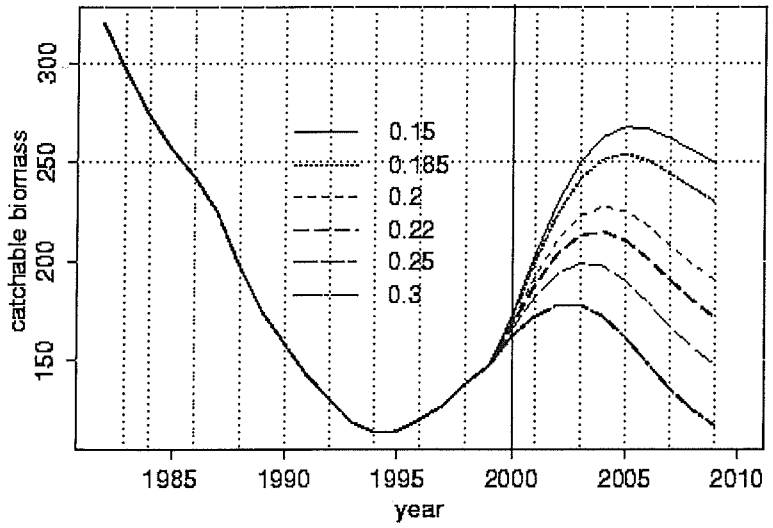


Figure 8.2.14. Estimated catchable biomass of *S. marinus* based on different fishing mortalities after 1999 as computed by the BORMICON model. Fishing mortality here refers to fish with selection 1 given in Figure 8.2.12.

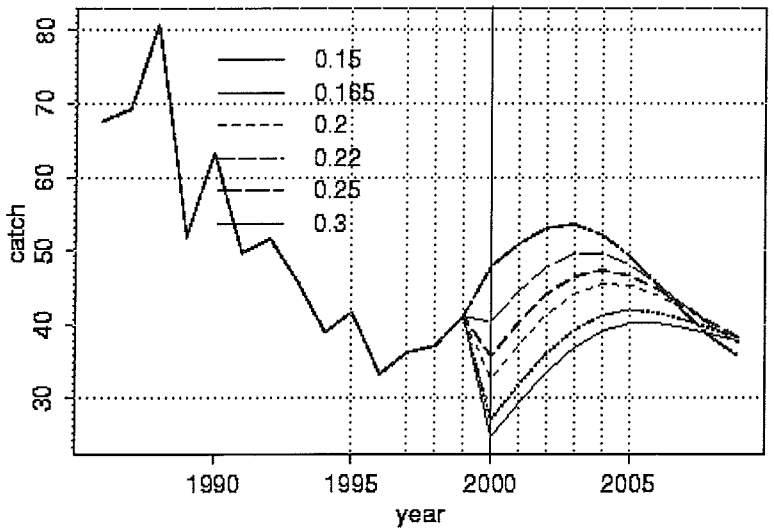


Figure 8.2.15. Landings of *S. marinus* in the period 1985-1999 and modeled future catch, based on different fishing mortalities after 1999. As described earlier the fishing mortality here refers to fish with selection 1 (Figure 8.2.12).

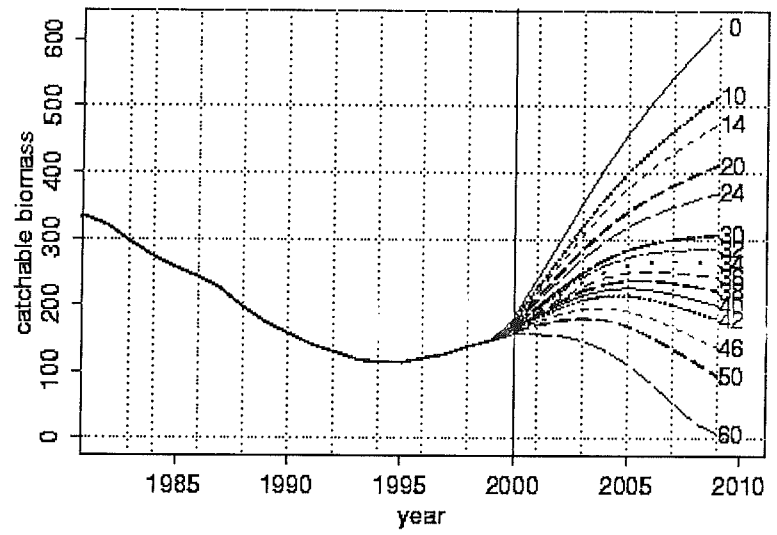


Figure 8.2.16. Catchable biomass of *S. marinus* for different catch options. Text at the end of each curve demonstrates amount caught each year from 2000 to 2010.

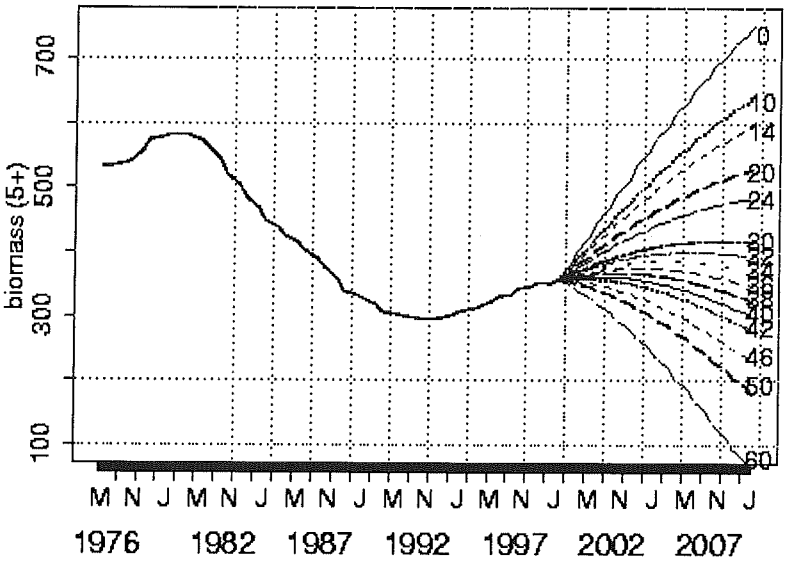


Figure 8.2.17. Total biomass of *S. marinus* for different catch options. Text at the end of each curve demonstrates amount caught each year from 2000 to 2010.

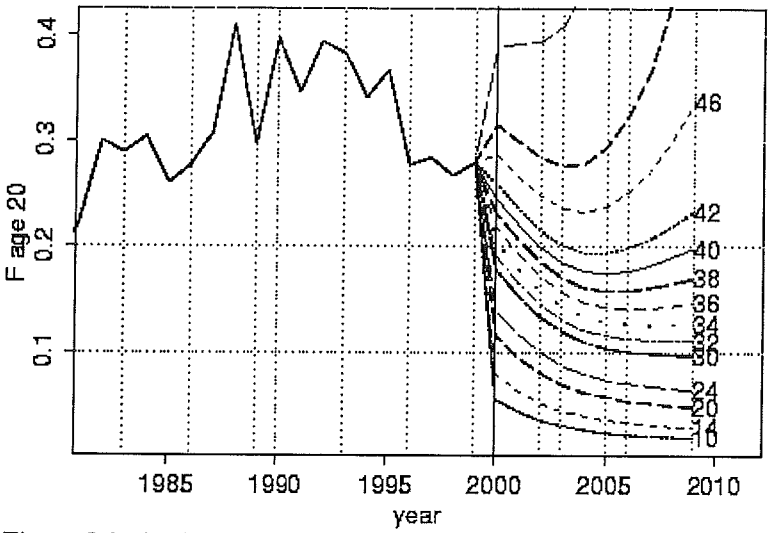


Figure 8.2.18. Fishing mortality of age 20 *S. marinus* for different catch options. Text at the end of each curve demonstrates amount caught each year from 2000 to 2010.

9 DEEP-SEA *S. MENTELLA* ON THE CONTINENTAL SHELF

Traditionally, the *S. mentella* on the shelves and banks around the Faroe Islands, Iceland and at East Greenland have been treated as one stock unit, with a common area of larval extrusion to the SW of Iceland, a drift of the pelagic fry towards the nursery areas on relatively shallow waters at East Greenland, and feeding and copulation areas on the shelves and banks around Faroe Islands, Iceland and at East Greenland. In Faroese waters spawning has been observed in some years to the south and west of the islands, implying that there could be a local component in the area; no nursery areas have, however, been found so far (Reinert, 1990). A relationship to other ICES areas (II and IV) have also been suggested (Reinert *et al.,* 1992; Reinert and Lastein, 1992). The question of a possible relationship between the deep-sea *S. mentella* on the shelf in Subareas V and XIV and the pelagic deep-sea *S.mentella* in the Irminger Sea has been raised several times. The ICES Working Group in 1999 on the Application of Genetics in Fisheries and Mariculture (WGAGFM) states that the presence of significant genetic differences between these two deep-sea components indicate probably distinct genetic stocks. The NWWG therefore continues treating the deep-sea *S.mentella* on the shelf as a separate self-contained stock unit. For management purposes the Icelandic authorities separate the deep-sea *S. mentella* on the shelf (some of which are caught in pelagic trawls) from the pelagic *S.mentella* in the Irminger Sea (both oceanic and pelagic deep-sea type) by straight lines through three positions (Figure 9.1.1).

9.1 Landings and Trends in the Fisheries

The total annual landings of deep-sea *S. mentella* from Divisions Va and Vb and Sub-areas VI and XIV varied considerably in the 1980s mainly from 30 000 to 60 000 t. In 1990, the landings were 44 000 t, and reached 67 000 t in 1991, decreased slightly in 1992 (63 000 t) but increased to about 83 000 t in 1994. Since then the landings have decreased to approximately 35,000 t in 1999. In summary, the average annual landings in the period from 1991-1994 increased substantially from the average in the 1980s (42 000 t), but is now (1999) the lowest catch since 1988 (Table 9.1.1).

From Division Va, total landings decreased from 33,000 t in 1998 to about 29 000 t in 1999, and has been decreasing druing the last years from the record high catches in 1994 of 57 000 t. In the 1980s landings varied from 10 000–40 000 t. From 1990 to 1994 the landings doubled from 28 000 t to 57 000 t. This increase in the catch coincides with the introduction of large pelagic trawls used by a part of the Icelandic fleet during the autumn and early winter months. This fishery has now decreased to less than 10% of the 1994 level due to low catch rates. About 90–95% of the total deep-sea *S.mentella* catches in area Va in 1999 have been taken by bottom trawlers (both fresh fish and freezer trawlers). Length distributions from the Icelandic catches in 1989-1999 are shown in Figure 9.1.2. A decrease in the mean length of the landed fish is seen in recent years. In Division Va the proportion of redfish below 33 cm in the catches is not allowed to exceed 20% in numbers, unless the fishing area may be closed.

In Division Vb annual catches of deep-sea *S. mentella* varied from 5 000–8 000 t until 1984. Then catches increased rapidly to about 15 000 t in 1986. The catches declined again to 9 000 t in 1990. They increased to about 13 000 t 1991. Since then they have remained very low and the catches in 1999 of 5 300 t is an increase from 1997-1998, but still among the lowest catch since early 1970s (Table 9.1.1). Length distributions of the Faroes catches from Division Vb in 1998-1999 are given in Figure 9.1.3.

In Sub-area VI the annual catches were highest in 1980 (1 100 t), but have varied from 130 - 640 t during recent years, except for 1996 when the catches were about 1 050 t, the highest recorded catch in the series since 1980 (Table 9.1.1).

In Sub-area XIV, annual catches have varied considerably. In the beginning of the 1980s, the landings were between 10 000-15 000 t, but then decreased to 6 000 t in 1987-1992 and increased to 19 000 t in 1994. At that time the fleet was mainly fishing very small redfish. Since then there has been a drastic decrease to 200 t in 1997 when the only catches taken were bycatches in the shrimp fishery. In 1998, however, Germany started again a directed fishery on the juveniles in this area (Figure 9.1.4) and this resulted in a total catch of about 1 400 t. This fishery continued in 1999 but the total catch was only about 800 t, although the effort was similar as in 1998.

The 1999 biological sampling from catch and landings of deep-sea *S.mentella* from the continental shelf in each Division and by gear type is shown in the text table below.

Area	Gear	Landings	Nos. samples	Nos. fish measured
Area	Gear	Landings (t)	No. samples	No. measurements
Va	Pelagic trawl	800	4	1000
Va	Bottom trawl	27,000	141	28478
Vb	Bottom trawl	5294	65	7264
XIVb	Bottom trawl	804	29	3606

9.2 Assessment

9.2.1 Trends in CPUE and survey indices

CPUE of the Icelandic trawler fleet for deep-sea *S. mentella* in Division Va is based on bottom trawl tows taken below 500 m depth and where the total catches of redfish compose a certain percentage of the total catch in each tow. Data prior to 1986 are poor. In the period from 1986-1990 CPUE was rather stable. From 1989 to 1993 CPUE declined by about 45% (see text table below and Figure 9.2.1), and it has remained rather low and stable since then. The 1999 value showed an increase from 529 kg/h to 643 kg/h (about 20%). Indices of CPUE for the Icelandic trawl fleet for the period 1986-1999 are also estimated from a GLIM multiplicative model, taking into account changes in the Icelandic trawl catch due to vessel, statistical square, month and year effects. All hauls with redfish at depths above 500 m, exceeding 50% of the total catch were included in the CPUE estimation (Figure 9.2.1a). The results of the GLIM model does not support the increase in CPUE shown when only calculating average cpue from the raw data calculated (sum of catch / sum of hours trawled for each year each haul where redfish exceeding 10% of the total catch in each haul). The GLIM model shows more or less a continuous reduction during the whole period since 1986, with only two exceptions, in 1988 and 1995. The reduction from 1998 to 1999 is 2% and the 1999 value is only about 45% of the 1986 value.

Year	CPUE 50 %_GLIM	CPUE 10% Raw	Total landings (t) in Va	Effort Glim / raw
1986	1000	943	18,898	19 / 20
1987	912	974	19,293	21 / 20
1988	914	886	14,290	16 / 16
1989	857	974	40,248	47 / 41
1990	846	804	28,429	34 / 35
1991	814	770	47,651	59 / 62
1992	705	611	43,414	62 / 71
1993	588	547	51,221	87 / 94
1994	547	488	56,720	104 / 116
1995	562	514	48,708	87 / 95
1996	524	489	34,741	66 / 71
1997	496	560	37,876	76 / 68
1998	445	498	32,821	74 / 66
1999	438	606	28,791	66 / 47

The effort in Division Va in the time when the stock was considered in stable condition i.e., from 1986-1990 was 20 000–40 000 hours. During the period since 1986, the effort increased drastically until 1994. Since then, the effort has decreased by less than 10% each year on average (the advice of ICES has been a 25% reduction annually since 1995). The effort in 1999 is about 60% of the peak in 1994. Icelandic groundfish survey in Division Va only covers depths down to approx. 500 m and there seem not to be any nursery grounds of major importance in Division Va, these results add little to the current stock evaluation. A recently started deep-water survey (approx. 500–1200 m) around Iceland in autumn may, however, add valuable information about the fishable stock of deep-sea *S.mentella* in near future.

In Division Vb a CPUE-series (1985–1997) of deep-sea *S. mentella* was presented in the 1997 Working Group report. The series shows a decrease since 1993, which seems to have stabilized below 50% of the maximum in the time series. Information on CPUE from Vb were not available to the Working Group in 1998 and 1999.

In Division XIV all redfish catches in the period 1982-1997 was as a bycatch. In 1998 and 1999, there was a direct fishery for redfish along the continental slope of East Greenland where *S.mentella* was the targeted species. The effort was similar in both years, and the CPUE in 1998 was about 638 kg/h but decreased to only 352 kg/h in 1999.

Survey abundance and biomass indices from the German groundfish survey for deep sea *S. mentella* (> = 17 cm) are broken down by stratum at West and East Greenland and illustrated in Figures 9.2.2–9.2.3. The surveys in 1991, 1993 and 1995–1997, when the whole area was covered, registered high abundance of deep-sea *S.mentella* at East-Greenland. The survey results show recruiting juveniles only while mature deep sea *S. mentella* are almost absent. The 1998 and 1999 survey had also a full coverage, but the results indicate a continuous downward trend in abundance and biomass since the 1997 peak. The record high values measured in 1997 mainly composed of fish with a mean length of about 25 cm. This dominant year class had in the 1998 survey grown to about 27 cm but it is difficult, from the length

distributions, to follow the growth between 1998 and 1999 surveys (Fig. 9.2.4). Since there was no significant commercial fishery for this species at East- Greenland at present, the decrease in the survey indicates an emigration out of the area. The origin of these very abundant recruits and to which fishing area they recruit is uncertain but there are indications that they both recruit to the fishery within Division Va, but also to the pelagic redfish in the Irminger Sea.

9.2.2 State of the stock

All CPUE indices shows a drastic reduction from a highs in the late 80s but some indices indicate that it seems to have stabilised in the 90s at or below 50% of the maximum. The GLIM index indicates a more or less continuos reduction since 1986. Fishermen report of less *S.mentella* in the fishing areas Southwest and West of Iceland. New recruits have entered the fishable biomass in recent years. There are indications that recruitment to the fishable stock (in Division Va) comes from East-Greenland. It is, however, uncertain to what extent the juvenile *S.mentella* currently at East-Greenland will recruit to this stock.

In Division Vb development in CPUE resembles that in Division Va, i.e., the CPUE seems to have stabilized at or below 50% of the maximum in the time series (1985–1997).

Based on survey results the SSB of deep-sea *S.mentella* on the continental shelf in area XIV remains severely depleted. The strong recruiting cohort(s) observed in 1993-97 emigrated in 1998-99 and partly recruited to the oceanic redfish stock.

9.3 Catch projections

It is possible to compute effort as well as a TAC corresponding to different reductions in effort for deep sea *S. mentella* by using a similar method as described above for *S. marinus*, although for the deep-sea *S. mentella,* the survey index is replaced by CPUE index. The management advice given in the recent years was to reduce the effort by 25 % until the stock displays indications of an increase in adult biomass from the present low level. It was expected that a 25% reduction in effort would lead to catches of 22,000 t in Division Va in 2001.

Catch 2001 = CPUE 99 * **Effort** 99 ***0.75**

9.4 Biological reference points

The relative state of the stock can be assessed through survey and CPUE index series (U) from the commercial fishery, which imply a maximum, U_{max}, as well as the present state. Given these data, it has been proposed by ACFM that reference points be defined in terms of the current state with respect to $U_{lim} = U_{max}/5$ and $U_{pa} = U_{max}/2$. Based on these definitions, the stock could be considered close to or below U_{pa}.

9.5 Management considerations

The two types of pelagic redfish in the Irminger Sea (i.e., the oceanic and the pelagic deep-sea *S.mentella*) in the present context are treated separately from the deep-sea *S. mentella* on the continental shelf. It can, however, not be excluded that there may be a relationship between the demersal deep-sea *S. mentella* on the continental shelves of the Faroe Islands, Iceland, Greenland and the pelagic deep-sea *S. mentella* in the Irminger Sea and this should be considered in the management of this stock (see also chapter 7.5).

The management strategy to reduce the effort in Division Va by 25 % until the stock shows an increase in adult biomass from the current low biomass should be maintained. The annual catch should not exceed 22 000 t.

Since the deep-sea *S.mentella* in Division Va and Division Vb belong to the same stock, a similar reduction in effort as in Div.Va is recommended also for DivisionVb.

In Sub-area XIV the Working Group recommends maximum protection of the juveniles and **no directed** fishery in order to maximise the probability of stock recovery to safe biological limits.

Table 9.1.1 Deep-sea *S. mentella* on the continental shelf. Landings (in tonnes) by area used by the Working Group.

Year	Va	Vb	VI	XII	XIV	Total
1978	3,902	7,767	18	0	5,403	17,090
1979	7,694	7,869	819	0	5,131	21,513
1980	10,197	5,119	1,109	0	10,406	26,831
1981	19,689	4,607	1,008	0	19,391	44,695
1982	18,492	7,631	626	0	12,140	38,889
1983	37,115	5,990	396	0	15,207	58,708
1984	24,493	7,704	609	0	9,126	41,932
1985	24,768	10,560	247	0	9,376	44,951
1986	18,898	15,176	242	0	12,138	46,454
1987	19,293	11,395	478	0	6,407	37,573
1988	14,290	10,488	590	0	6,065	31,433
1989	40,269	10,928	424	0	2,284	53,905
1990	28,429	9,330	348	0	6,097	44,204
1991	47,651	12,897	273	0	7,057	67,879
1992	43,414	12,533	134	0	7,022	63,103
1993	51,221	7,801	346	0	14,828	74,196
1994	56,720	6,899	642	0	19,305	83,566
1995	48,708	5,670	540	0	819	55,737
1996	34,741	5,337	1,048	0	730	41,856
1997	37,876	4,558	418	0	199	43,050
1998	33,125	4,089	298	3	1,376	38,890
1999 [1]	28,590	5,294	243	0	865	34,992

1) Provisional data.

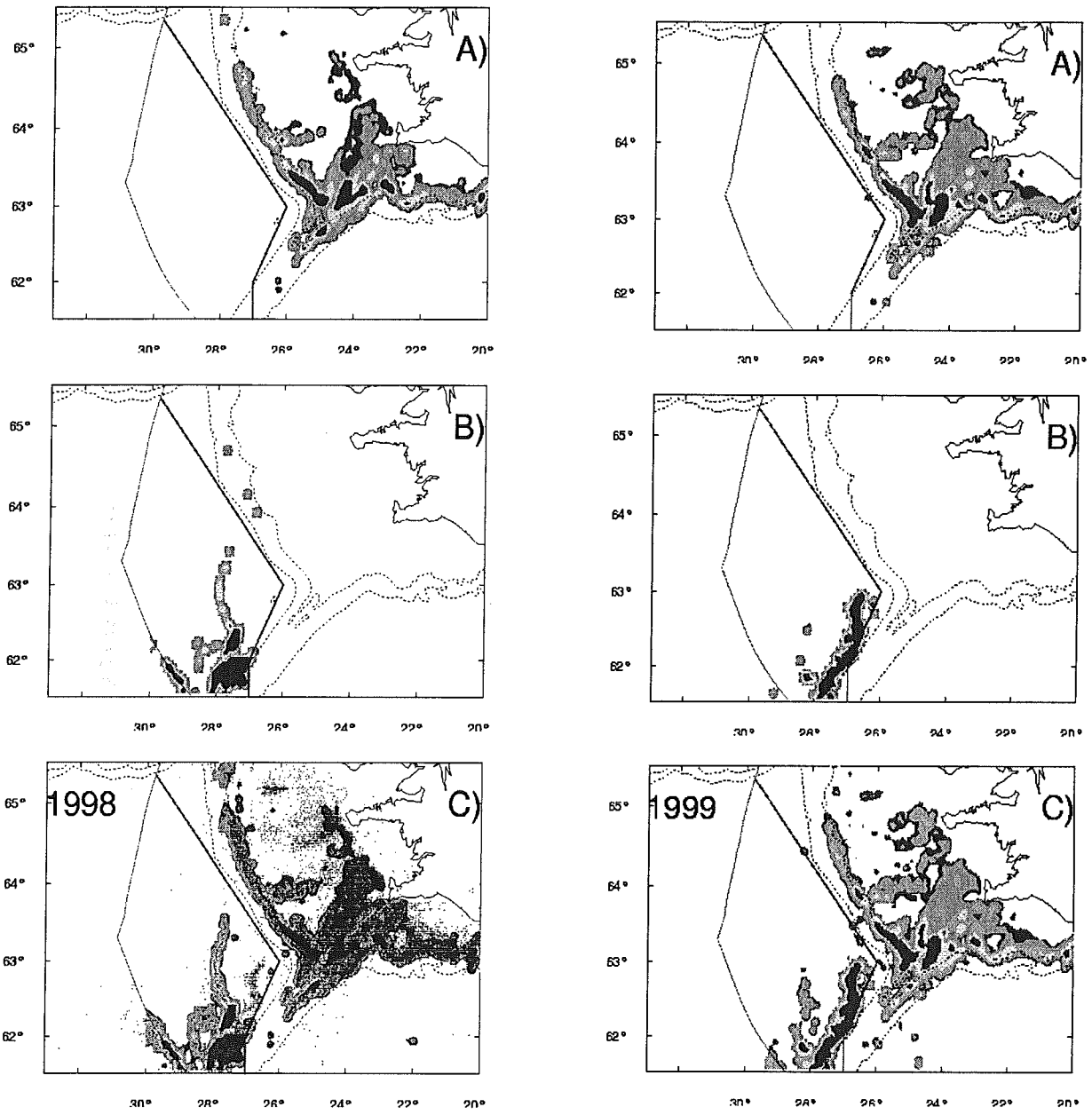


Figure 9.1.1. Map showing the line used by Icelandic authorities to separate the landing statistics between deep-sea. The figures also show the fishing grounds of demersal fishing for redfish (a), the oceanic redfish fishery in 1998 and in 1999 (b) and all redfish fishery (c), as record in the log-books.

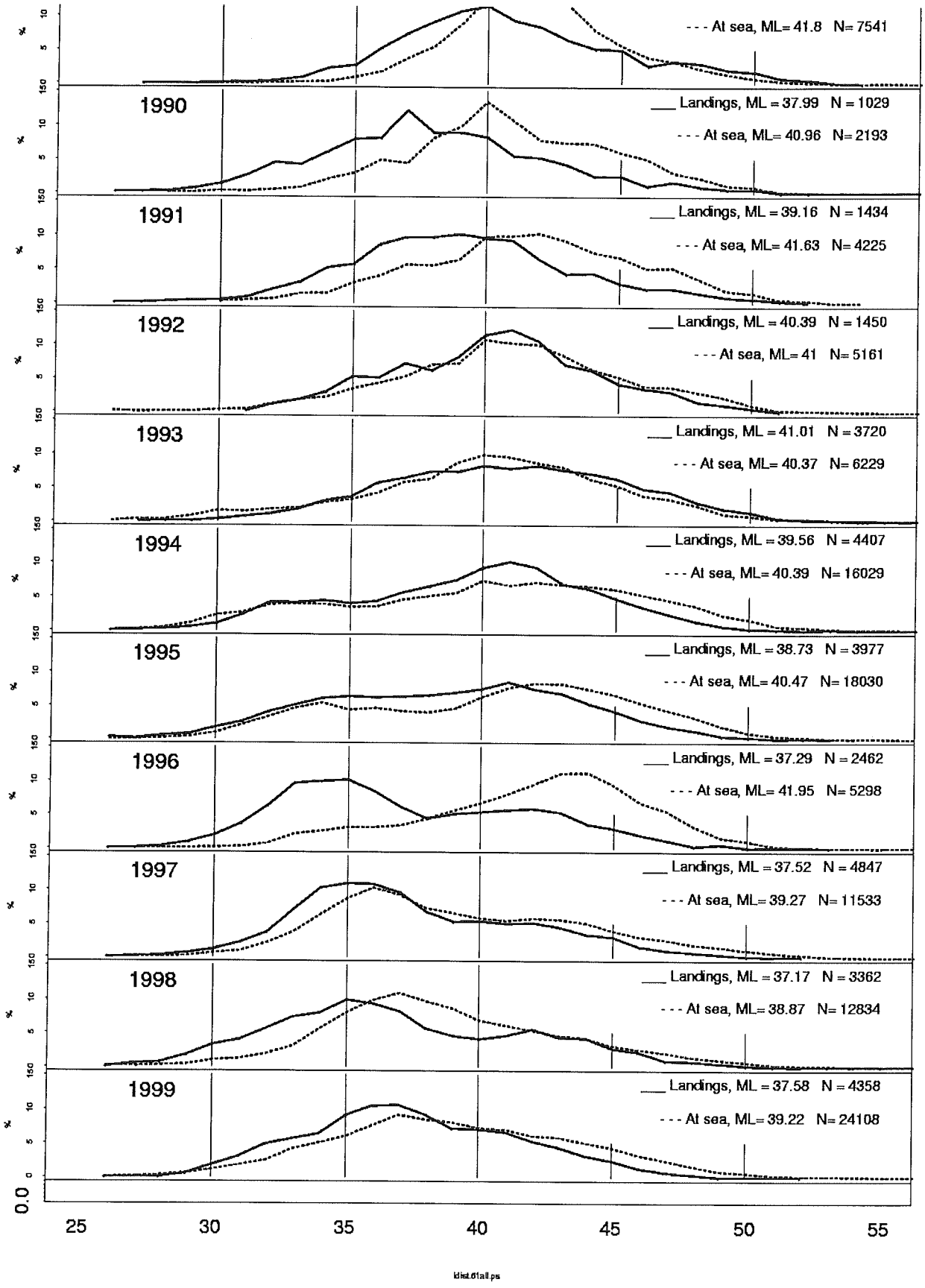


Figure 9.1.2. Length distributions of deep-sea *S.mentella* catch and landings from the Icelandic bottom trawl fishery in 1989-1999.

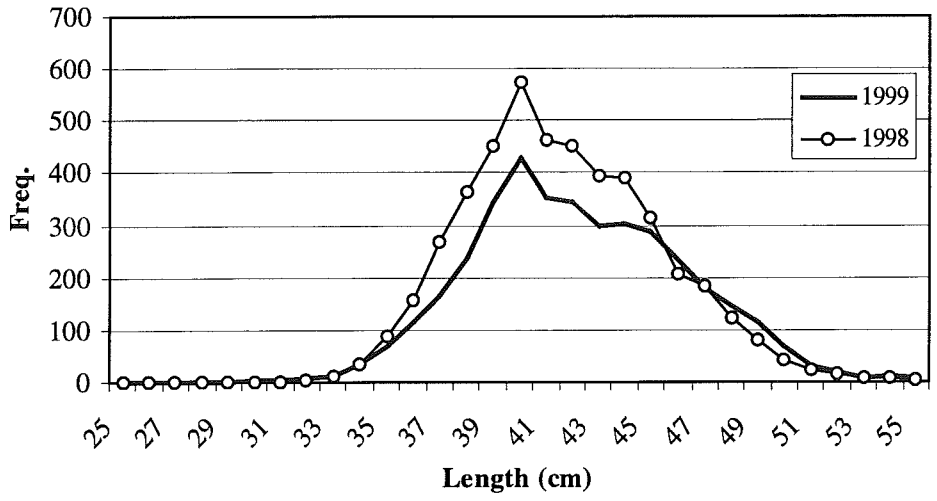


Figure 9.1.3. Length distribution of deep-sea *S.mentella* caught by Faroes otterboard trawlers in Division Vb in 1998 and 1999.

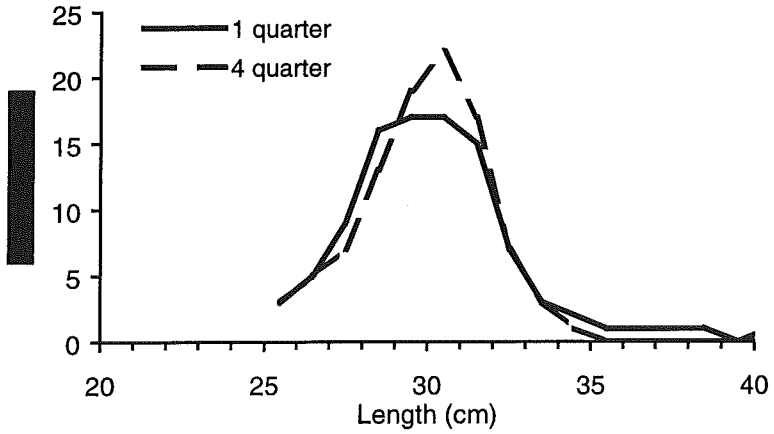
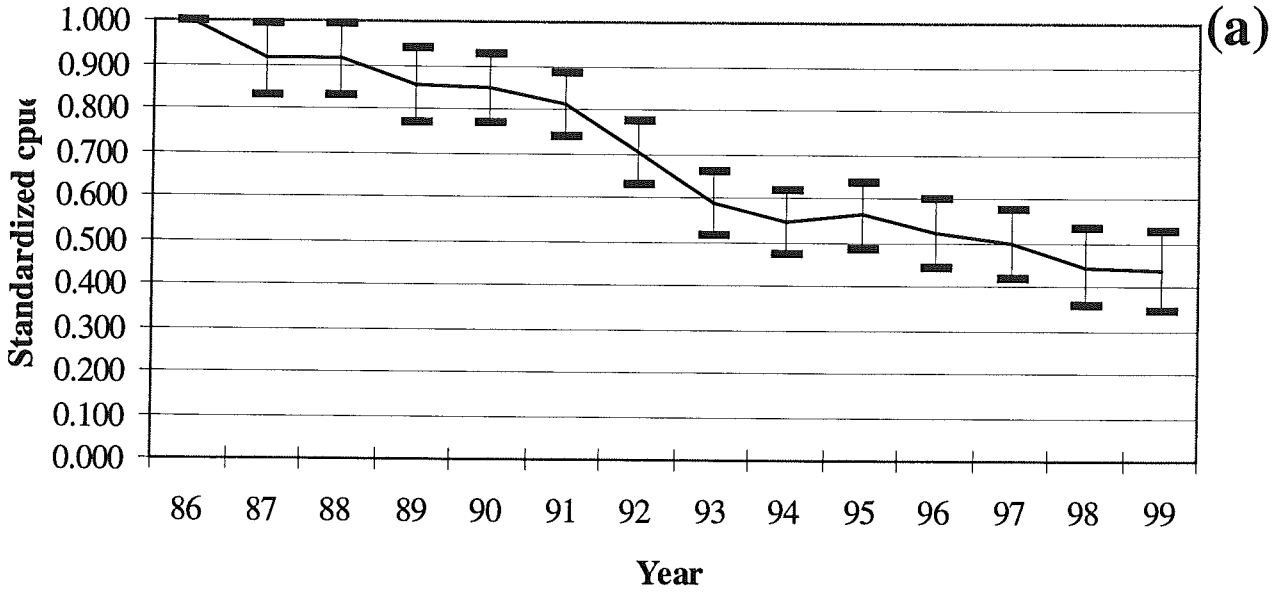


Figure 9.1.4 . Length distribution of deep-sea *S.mentella* caught by German bottom trawl fishery in Division XIVb in the first and fourth quarter 1999.



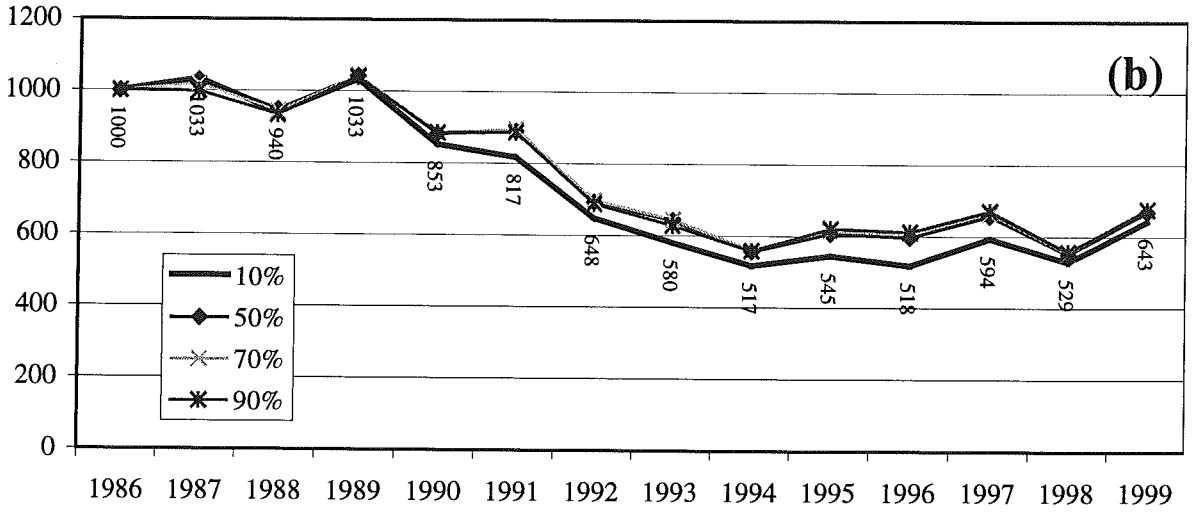


Figure 9.2.1. CPUE, relative to 1986, from the Icelandic bottom trawl fishery for deep-sea *S.mentella* on the continental shelf, based on a GLIM model (a) and based on simple mean (b). The GLIM model shows the modelled development using GLIM including hauls where redfish deeper than 500 m compose 50% ore more of the total catch in each haul. Simple mean means CPUE calculated on hauls where redfish deepet than 500 m compose 10% (50 70 or 90% lines are also shown) or more of the total catch in each haul.

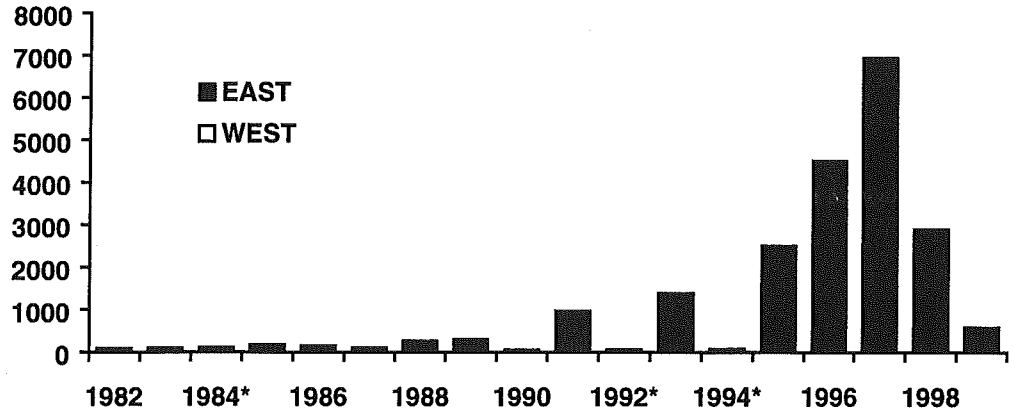


Figure 9.2.2. Deep-sea *S. mentella* (>=17 cm) on the continental shelf. Survey abundance indices for East and West Greenland as derived from the German groundfish survey, 1982–99. *) incomplete survey coverage.

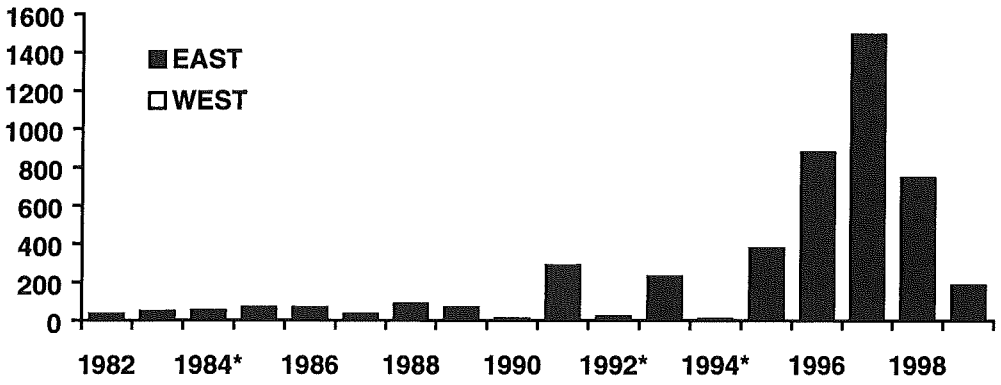


Figure 9.2.3. Deep-sea *S. mentella* (>=17 cm) on the continental shelf. Survey biomass indices for East and West Greenland as derived from the German groundfish survey, 1982–99. *) incomplete survey coverage.

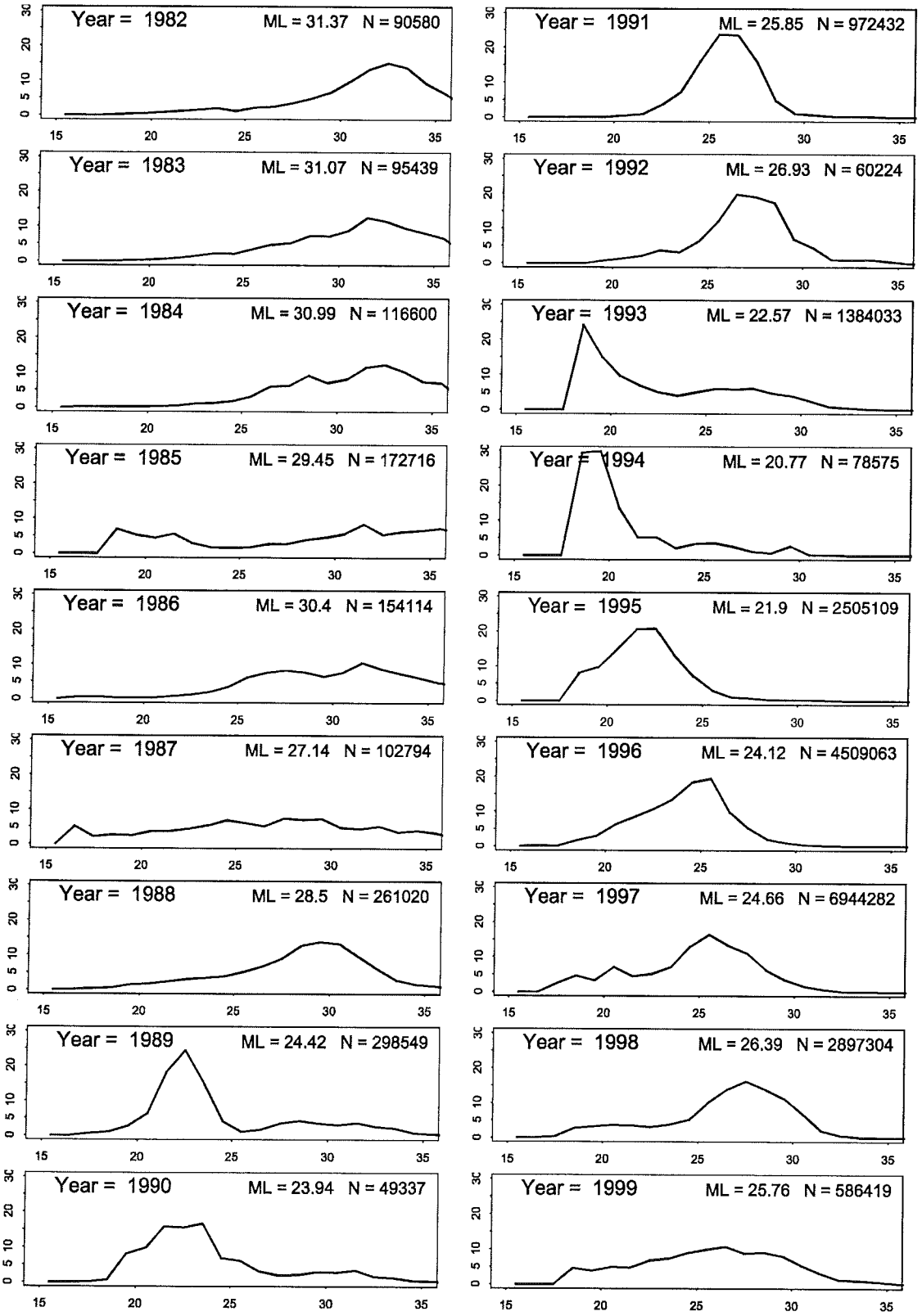


Figure 9.2.4. Deep-sea *S. mentella* (15-35 cm) on the continental shelf. Length composition off Greenland as derived from the German groundfish survey, 1982–1999.

10 PELAGIC SEBASTES MENTELLA

This section includes information on the pelagic fishery for *S. mentella* above and below 500 m in the Irminger Sea (Sub-area XII, parts of Division Va and Sub-area XIV).

Under chapter 7.3, comments are made on special requests in the ToR. Aside from what is said there, the WG refers to last years reports on the matter of stock/delineation in the area.

10.1 Fishery

10.1.1 Historical development of the fishery

Russian trawlers started fishing pelagic S. *mentella* in 1982. Vessels from Bulgaria, the former GDR and Poland joined those from Russia in 1984. Total catches increased from 60 600 t in 1982 to 105 000 t. in 1986. Since 1987, the total landings decreased to a minimum in 1991 of 25 000 t. The main reason for this decrease was a reduction in fishing effort, especially by the Russian fleet. Since 1989, the number of countries, participating in the pelagic S. *mentella* fishery gradually increased. As a consequence, total catches have also increased and reached the historically highest level in 1996 at 180 000 t (Tables 10.1.1–10.1.2). In 1998 and 1999, the WG estimate of the catch has been between 110 000 and 120 000 t, respectively.

In the period 1982–1992, the fishery was carried out mainly from April to August. In 1993–1994, the fishing season was prolonged considerably, and in 1995 the fishery was conducted from March to December. In 1997 and 1998, the main fishing season occurred during the second quarter. Few trawlers conducted their fishery during the whole year. The fleets participating in this fishery have continued to develop their fishing technology, and most trawlers now use large pelagic trawls ("Gloria"-type) with vertical openings of 80–150 m. The vessels have operated in 1998 and 1999 at a depth range of 200 to 950 m, but mainly deeper than 600 m.

The following text table summarises the available information from fishing fleets in the Irminger Sea in 1999:

Russia	20 factory trawlers of five types , ranged from 2500 to 4500 hp
Iceland	25 factory trawlers and 1 freshfish trawlers
Norway	2 factory trawlers
Greenland	1 factory trawler
Spain	6 factory trawlers
Germany	9 factory trawlers
Faroes	1 factory trawler and 6 freshfish trawlers

A summary of the catches by depth by nation as estimated by the Working Group is given in Table 10.1.3.

10.1.2 Description on the fishery of various fleets

10.1.2.1 Faroes

The Faroese fishery for pelagic redfish in the Irminger Sea and adjacent waters started in 1986. In the first years, only 1-2 trawlers participated in the fishery. Fishing depths were mainly above 500 m although some trials were made down to about 700 m. From 1992 onwards, several trawlers have made trips to this area fishing almost exclusively below 5-600 m. Logbook information from 1998 and 1999 was available to the Working Group.

In 1998, 7 trawlers have reported fishery in the area from 10 April to 17 July and again 10-25 October (1 trawler); all hauls were deeper than 600 m. In addition, 2 trawlers fished within the Greenlandic EEZ from 7 August to 9 October; fishing depths were shallower than 600 m.

In 1999, the Faroese fishery in the international parts of the Irminger Sea started on 18 April and continued until 19 August. 5 trawlers participated in the fishery and all hauls were deeper than 600 m. From 9 July to 10 September, two of the trawlers fished within the Greenlandic EEZ; all hauls were shallower than 600 m.

10.1.2.2 Germany

Compared with 1995, the effort increased significantly from 14 000 hours to 18 500 and 18 600 hours in 1996 and 1997, respectively. In 1998, the total effort decreased again by 15 % to 15 800 hours but increased in 1999 by 12 % to 17 700 hours. As usual, the majority of the 1999 effort was applied during the second and third quarters. Annual catches increased from 18 900 t by 13 % to 21 300 t in 1996 and decreased slightly by 4 % to 20 400 t in 1997. A continued decrease by 12 % to 18,000 t in 1998 and by 9 % to 16 500 t in 1999 was reported. During 1995-1998, the overall (unstandardised) CPUE decreased from 2 055 kg/h by 37 % to 1 301 kg/h and further by 26 % to 970 kg/h in 1999. The quarterly breakdown revealed that the catch rates in ICES Division XIV in the second quarter remained fairly stable while the reductions mainly occurred in the third and fourth quarter in ICES Division XII both inside the Greenland EEZ and the international water. Given the technical, temporal, geographical and depth changes of the fishing activities, the relevance of the estimated reduction in CPUE as indicator of stock abundance remained difficult to assess.

Since 1995, the fishery displayed a significant seasonal pattern in terms of geographical distribution and fishing depth. During the first and second quarters, the fleets operated mainly in the international zone of ICES Division XIV and the mean depth of the catches exceeded regularly 500 m. During summer and fall, the fishery targeted the depth layer at 200-350 m in ICES Div. XII both within the Greenland EEZ and international waters. In the third and fourth quarter of 1999, a movement of the fleet to a limited area SE of Cape Farewell was apparent (WD 19).

In 1991-98, the catches taken during the third and fourth quarters show almost identical single-modal fish size distributions with smaller and dominating males. In the second and third quarter in 1999, a clear recruitment signal was recorded for the first time with fish at around 28-30 cm in length occurring at all depths. The fish caught during the second quarters in 1996-1999 were bigger and displayed bimodal size frequency distribution due to either sexual dimorphism and or dominant year classes.

10.1.2.3 Greenland

Greenland was fishing in the same area as Iceland (see below).

10.1.2.4 Iceland

Catches in 1995-1999 were usually concentrated in the area between the Greenlandic EEZ and the Reykjanes Ridge, and since 1996 the catches have mostly been taken close to or inside the 200 mile boundary Southwest of Iceland. In recent years, the fishery has started in April close to the Icelandic 200 mile boundary and then moved in northward direction in May-July. In the springtime and until June, the largest proportion of the catches were taken at depths exceeding 500 m. In 1998, the fishery expanded further north in July, August and September. In 1999, a similar thing happened, except that the fishery did not continue close to the shelf of Iceland in July-September, as it did in 1998. Instead, the few vessels that had quota left at that time, moved to south-west, to the area SE of Cape Farewell (Division XII), where they fished above 500 m depth (WD 12). Icelandic trawlers fished mainly at a depth of 600-800 m during the period 1995-1998 (Figure 10.1.1).

10.1.2.5 Norway

Norway has not contributed substantially to this fishery in latest years. Information on the fishery in 1998 and 1999, however, indicates a depth shift in the fishery, from fishing 95% of its catch above 500 m in 1998 to fishing entirely in the layer below 500 m in 1999 (WD 4). The catches in 1999 were taken in areas XII and XIV from April to August, with a share of about 2:3.

10.1.2.6 Russia

In 1999, the Russian fleet conducted the pelagic fishery for the Irminger Sea redfish in April-November (WD 25). Up to 20 trawlers participated in the fishery. 60% of the annual catch and 51 % of annual effort were registered in May-June. The fishery started in April in traditional fishing areas near the border of the Icelandic EEZ. The fleet moved southward during the third quarter. The fleet distribution in June-August was wider than usual, with a maximum number of 9 fishing areas in July. The CPUE for most types of the trawlers was similar to that reached in previous years.

10.1.2.7 Spain

Spain has participated in the fishery since 1995. There is limited information available for the Working Group on the fishery, except for 1998 and 1999.

In 1998, a total of 6 Spanish vessels have been fishing pelagic redfish in the Irminger Sea area, in Divisions XII and XIVb (WD 21 of the 1999 NWWG) from March to October. In the second quarter, this fleet was fishing >500 m, while the fishing depth in the third quarter was varied between 300-900 m.

In 1999, a total of 6 Spanish vessels have been fishing pelagic redfish in the Irminger Sea area, in Divisions XII and XIVb (WD 6). The fishing activity was monitored by a scientific observer who visited successively two of those vessels from April to the end of June. During this period, all the hauls surveyed were made in Division XIVb and in depths >500 m. The fishery of the Spanish fleet continued until September and there are reasons to believe that the fishing area in the third quarter was similar to what was observed by e.g. Germany. The fishing depth in the third quarter, however, was <500.

10.1.2.8 Other nations

No information on the fishing areas, seasons and depths of the fleets of other nations was available for the Working Group.

10.1.3 Discards

Prior to 1996, Icelandic landings of oceanic redfish have been raised by 16% due to discards of redfish infected with *Sphyrion lumpi.* This value of was based on measurements from 1991–1993 when the fishery was mostly on depths above 600 m. During the 1997 fishing season measuring was made on discard from different depths and on 10 different vessels in the period from May to July, showing discard rate of 10% which was then added to the landings in 1996 and 1997. A new measurement from 1998 shows that the discard rate has decreased to 2%. This new value was used for raising the Icelandic catches in 1998 and 1999.

Norwegian fishermen currently report approximately 3% discards of redfish infected with the parasite. This percentage has in recent years become less due to a change in the production from Japanese cut to mainly fillets at present.

No information on possible discards was available from other countries participating in this fishery.

10.1.4 Trends in landings and fisheries

A Working Group estimate of catches in 1999 is estimated to be about 109 000 t, which is at similar level as it has been since 1997. In 1995 and 1996, the catches amounted 176 000 and 180 000, respectively, representing the highest catches on record (Table 10.1.1-10.1.2). The actual catches in 1999 might increase due to the lack of reporting from some countries participating in the fishery.

At the beginning of the fishery in 1982, catches of pelagic redfish were reported from both Sub-areas XII and XIV. But most of the catches were taken in Sub-area XII (40 000-60 000 t) until 1985, then the greater part of the catches were reported from Sub-area XIV. The landings from Sub-area XII were again in the majority in 1994 and in 1995 with 94 000 t and 129 000 t landed respectively. In 1996–1999, the main part of the total catch was taken from Sub-area Va and Division XIV (Table 10.1.1).

Pelagic *S. mentella* fishery in Division Va started in 1992. The catch varied from 2 000-14 000 from 1992-1995. Since 1995, the catches in Va have increased to 41 000 and 37 000 t in 1998 and 1999, respectively (Table 10.1.1).

Length distributions of pelagic *S. mentella* from German, Icelandic, Russian and Spanish commercial catches were reported for 1999 and are given in Figure 10.1.2.

The 1999 biological sampling from catches and landings of pelagic *S.mentella* in each Division and by gear type is shown in the text table below.

Country	Area	Gear	Landings (t)	No. of samples	No. of fish measured
Germany	XII	Pelagic	8205	12	8676
Germany	XIV	Pelagic	8128	27	10850
Iceland	XII	Pelagic	3162	9	594
Iceland	XIV and Va	Pelagic	40751	85	5851
Russia	XII and XIV	Pelagic	17577	?	12599
Spain	XIV	Pelagic	10332	69	15253

10.1.5 Age readings

Several nations have increased their effort to age pelagic redfish, using different ageing methods and thus making a comparison of age readings difficult.

From the catches in 1999 and also from the acoustic survey in 1999, it is clear that a new cohort is entering into the fishable stock of pelagic redfish. This cohort (probably not more than 1-2 year-classes) could therefore be used as a basis for investigating different methods for age readings. As more nations have now started to investigate the problems of age readings, a workshop similar to that held in 1995 (ICES 1996) is needed for comparison.

10.2 Assessment

10.2.1 Acoustic assessment

Trawl-acoustic surveys have for many years been carried out in the Irminger Sea and adjacent waters. Because of the limited depth range coverage (down to 500 meters) the surveys have mainly covered the oceanic *S.mentella*, and should therefore only be used as an index for this component.

An international acoustic survey of pelagic was carried out in the Irminger Sea and adjacent waters in June/July 1999 with participation of Iceland, Germany and Russia. The acoustically estimated biomass of the oceanic *S. mentella* in upper 500 m of the water column was 0.6 mill. t, compared with 2.2 and 1.6 mill t in 1994 and 1996, as estimated from the catches, respectively (Table 10.2.1) The observed decrease in survey abundance is very drastic and exceeds the removed biomass by a factor of 2. The area covered in the 1999 survey was the most extensive in the time series, but covered only a portion of the current horizontal distribution of the oceanic stock. Therefore, the estimate of 0.6 mill t is considered an underestimate.

The summer 1999 survey provided for the first time an estimate on the abundance of the pelagic deep sea *S. mentella* (>500 m depth) on the order of 0.5 million tonnes (Table 10.2.2). Hydrographic observations indicated that the highest concentrations of redfish below 500 were associated with eddies and fronts.

The stock above 500 m was observed more south-westerly and deeper than it has been during former acoustic surveys in this decade. During the same period, a gradual increase in temperature in the observation area has been observed (WD 22, Fig. 10.2.4). This may have influenced the distribution pattern of the redfish in June-July 1999 as the highest concentrations were found in the colder, i.e. southwestern part of the survey area.

Length distributions indicate recruitment both above and below 500 m depth. The length of these pre-recruits were similar to the length of the abundant juveniles growing up at the shelf of East Greenland.

The following text table gives the results of acoustic estimates during the period 1991-1999.

Year	*Acoustic estimate down to 500 m (thousand tonnes)*	*Area surveyed, thousand sq. nautical miles*
1991	2235	105
1992	2165	190
1993	2556	120
1994	2190	190
1995	2481	167
1996	1600	256
1997	1240	159
1999	614	296

10.2.2 CPUE

In Table 10.2.3, the CPUE series for Bulgarian, German, Icelandic, Norwegian, Russian, and Spanish fleets are given. Table 10.2.4 gives catches, effort and CPUE by depth for the Icelandic fleet during the period 1989–1999. As can be seen from the table, more than 90 % of the Icelandic catches were taken below 500 m in last years. In Figure 10.2.2, the development of CPUE in three depth intervals is illustrated graphically. The figure shows that after a constant decrease in the CPUE from 1994-1997, there was a slight increase in CPUE at depths below 500 m in the last year, but there has been a more or less

continuous reduction in the layer above 500 m since 1996. Figure 10.2.3 shows the overall CPUE from different fleets in recent years.

The German data on CPUE in second quarter (mainly fishing from the lower layer in area XIVb) also show a slight increase in the last year, compared with 1998 (Figure 10.2.5). In the third and forth quarter of the year, the fishery in last years has mostly been from depths not exceeding 500 m in area XII. In that layer, the results show continuos decreasing trend during the recent years.

10.2.3 Ichthyoplankton assessment

The traditional ichthyoplanktonic survey, conducted by Russia in 1982-1995 has not been carried out in 1995. The historical series of ichthyoplanktonic surveys was presented in last year's Working Group Report.

10.2.4 State of the stock

The 1999 survey indicated a continued reduction in the stock abundance and biomass above 500 m. The estimated biomass of 600 000 t is interpreted as being biased downward due to significant changes in horizontal and vertical stock distribution patterns. A similar negative trend can be derived from the CPUE series reported from some of the major fishing fleets fishing above 500 m. Given the technical, seasonal, geographical and depth changes of the fishing activities, the relevance of the estimated reduction in CPUE as indicator of stock abundance remains difficult to assess both above and below 500 m. The CPUE data do, however, indicate a more stable stock situation below 500 m. A biomass index of around 500 000 t was estimated below 500 m, based on the 1999 survey results.

Although there is considerable uncertainty related with the used stocks' indicators, the stock is indicated to be at or below the level of 50% of the virgin biomass of around 3 million tonnes (= MBAL). Based on the survey biomass estimates, the recent catches although being significantly reduced from a high level in 1994-1996 might be above the 5 % exploitation rate being previously considered as sustainable.

For the first time, a considerably high recruitment was observed in the length distribution data from the international hydroacoustic survey in the Irminger Sea in June/July 1999 in the layers above and below 500 m. This recruitment is likely to originate from the East Greenland shelf, since the high numbers of young redfish observed during 1995-1997 disappeared from the East Greenland shelf in the past 2 years.

10.3 Management considerations

Considering the uncertainty related to definition of stock units, action must be taken in accordance with the precautionary approach and attempts be made to assess each stock component separately until better knowledge on the relationship between each stock or stock components are known. Such assessment must be based on what information is currently available. Furthermore, there exists considerable concern about the precision of the used stocks indicators.

Based on the continuous downward trends in survey indices and CPUE, a further reduction of the present catch level is advised.

10.4 Precautionary approach

Based on the status of the knowledge of the stock(s) in the area, the Working Group could not come up with any new information on reference points in addition to last year's report.

Table 10.1.1 Pelagic *S. mentella*. Landings (in tonnes) by area as used by the Working Group. Due to the lack of area reportings for some countries, the exact share in Divisions XII and XIV is just approximate in latest years.

Year	Va	Vb	VI	XII	XIV	Total
1978	0	0	0	0	0	0
1979	0	0	0	0	0	0
1980	0	0	0	0	0	0
1981	0	0	0	0	0	0
1982	0	0	0	39,783	20,798	60,581
1983	0	0	0	60,079	155	60,234
1984	0	0	0	60,643	4,189	64,832
1985	0	0	0	17,300	54,371	71,671
1986	0	0	0	24,131	80,976	105,107
1987	0	0	0	2,948	88,221	91,169
1988	0	0	0	9,772	81,647	91,419
1989	0	0	0	17,233	21,551	38,784
1990	0	0	0	7,039	24,477	31,516
1991	0	0	0	10,061	17,089	27,150
1992	1,968	0	0	23,249	40,745	65,962
1993	2,603	0	0	72,529	40,703	115,835
1994	15,472	0	0	94,189	39,028	148,689
1995	1,543	0	0	132,039	42,260	175,842
1996	4,610	0	0	42,553	132,975	180,138
1997	15,301	0	0	19,822	87,812	122,935
1998	40,612	0	0	22,446	53,910	116,968
1999 [1]	36,524	0	0	24,294	48,294	109,113

1) Provisional data

Table 10.1.2 Pelagic *S. mentella* catches (in tonnes) by countries used by the Working Group.

Year	Bulgaria	Canada	Estonia	Faroes	France	Germany [3]	Greenland	Iceland	Japan	Latvia	Lithuania	Netherland	Norway	Poland	Portugal	Russia [2]	Spain	UK	Ukraine	Total
1978																				
1979																				
1980																				
1981																				
1982														581		60,000				60,581
1983						155										60,079				60,234
1984	2,961					989								239		60,643				64,832
1985	5,825					5,438								135		60,273				71,671
1986	11,385			5		8,574								149		84,994				105,107
1987	12,270			382		7,023								25		71,469				91,169
1988	8,455			1,090		16,848										65,026				91,419
1989	4,546			226		6,797	567	3,816						112		22,720				38,784
1990	2,690					7,957		4,537					7,085			9,247				31,516
1991			2,195	115		571		8,783					6,197			9,289				27,150
1992	628		1,810	3,765	2	6,447	9	15,478		780	6,656		14,654			15,733				65,962
1993	3,216		6,365	7,121		17,813	710	22,908		6,803	7,899		14,990			25,229			2,782	115,835
1994	3,600		17,875	2,896	606	17,152		53,332		13,205	7,404		7,357		1,887	17,814			5,561	148,689
1995	3,800	602	16,854	5,239	226	18,985	1,856	34,631	1,237	5,003	22,893	13	7,457		5,125	44,182	4,555		3,185	175,843
1996	3,500	650	7,092	6,271		21,245	3,537	62,903	415	1,084	10,649		6,658		2,379	45,748	7,229	260	518	180,138
1997		111	3,720	3,945		20,476		41,276	31				3,179	886	3,674	36,930	8,707			122,935
1998			3,968	7,474		18,047	1,463	48,519	31		1,768		1,139	12	4,133	25,837	4,577			116,968
1999 [1]			2,108	4,656		16,335	4,269	43,923					5,417	6	4,302	17,577	10,332	188		109,113

1) Provisional data.
2) Former USSR until 1991.
3) Former GDR and GFR.

Table 10.1.3 Pelagic *S. mentella* landings (in tonnes) in 1999 by countries and depth (A), and in 1996-1999 by depth (B). (Working Group figures and/or as reported to NEAFC).

A.	Total	not splitted	shallower than 600 m	deeper than 600 m
Estonia	2,108	100 %		
Faroes	4,656			100 %
Germany	16,335		50 %	50 %
Iceland	43,923		10 %	90 %
Norway	5,417		9 %	91 %
Portugal	4,302	100 %		
Russia	17,577	100 %		
Greenland	4,269		10 %	90 %
Spain	10,332		18 %	82 %
Total	108,919	23,987	15,334	69,598

Derived from effort data

B.	Total	not splitted	shallower than 600 m	deeper than 600 m
1996	180 138	43 %	14 %	43 %
1997	122	37 %	20 %	43 %
1998	119	14 %	20 %	66 %
1999	109	22 %	14 %	64 %

Table 10.1.4. Results of dividing the Icelandic pelagic redfish catch according to the Icelandic samples from the fishery.

Year	Total catch	Catch oceanic	Catch deep sea	Not classified	% oceanic
1995	34631	24976	9521	134	72%
1996	62903	28361	32737	1805	46%
1997	41272	15001	26271	0	36%
1998	48519	4932	40824	446	11%
1999	43923	10102	33821	0	23%

Table 10.2.1

Table 10.2.1 Biomass, abundance and area coverage for pelagic redfish *Sebastes mentella* at depth down to 500 m. Results from international acoustic surveys conducted in 1994, 1996 and 1999. Sub area are shown on Figure 10.2.1.

		Sub area					
Year		A	B	C	D	E	Total
1994	Total numbers (millions)	1109	1964	-	95	328	3496
	Biomass ('000 t)	673	1228	-	63	226	2190
	Total area (nm^2)	75307	88132	-	7342	18348	189129
1996	Total numbers (millions)	1055	1217	-	57	265	2594
	Biomass ('000 t)	639	749	-	33	155	1576
	Total area (nm^2)	89198	112086	-	11409	38852	252546
1999	Total numbers (millions)	123	609	27	71	336	1165
	Biomass ('000 t)	72	317	16	42	167	614
	Total area (nm^2)	106688	138865	6291	6291	37988	296122

Table 10.2.2 Biomass, abundance and area coverage for pelagic redfish *Sebastes mentella* at depth between 500 and 950 m. Results from international acoustic surveys in 1999. Sub areas are shown on Figure 10.2.1

	Sub area						
	A	B	C	D	E	Total	Units
Total numbers	217	314	11	25	72	638	Thous.
Area covered	11524	124014	8403	4201	27435	274577	Nm^2
Mean weight	864	795	945	554	505		g
Total weight	187	249	10	14	36	497	Thous. tonnes

Table 10.2.3 Pelagic *S. mentella*. Catch per unit effort (t/h) by country in Sub-areas XII and XIV.

Year	Bulgaria	Germany[2]	Iceland	Norway	USSR-Russia (BMRT)	Spain
1982	-	-	-	-	1.99	-
1983	-	-	-	-	1.60	-
1984	1.25	-	-	-	1.48	-
1985	1.85	-	-	-	1.68	-
1986	2.04	-	-	-	1.35	-
1987	1.22	0.79	-	-	1.10	-
1988	0.82	1.28	-	-	1.00	-
1989	-	0.70	1.11	-	1.00	-
1990	-	0.89	1.02	1.09	0.99	-
1991	-	-	1.52	1.42	0.80	-
1992	-	-	1.66	1.79	0.63	-
1993	-	-	3.27	2.02	0.63	-
1994	-	-	2.64	2.83	1.70	-
1995	-	2.06	2.00	2.05	1.00	-
1996	-	1.45	1.74	1.20	1.30	-
1997	-	1.31	1.11	0.66	-	0.83
1998	-	1.30	1.56	0.75	-	0.87
1999[1]	-	0.97	1.55	0.96		1.37[3]

1 Preliminary
2 1987-1990 reported as GDR (FVSIV)
3 CPUE data for April-July only (CPUE for August-September is unknown but usually lower than in quarter 2)

Table 10.2.4 Catch, trawling time and CPUE of pelagic redfish by depth intervals since 1989 as reported in log-books from the Icelandic fleet.

Data	Depth range	89	90	91	92	93	94	95	96	97	98	99
Sum of Catch	100-199	226	839	2035	908		12		1	121		12
	200-299	279	415	1336	2115		611	2874	2165	453	130	1921
	300-399	174	315	1408	3021	2402	863	1572	75	1693	886	2776
	400-499		7	951	385	1950	1298	1141	537	792	278	282
	500-599			24	915	3515	9463	2960	3674	2390	2092	1187
	600-699				757	2539	12149	10402	12203	12548	11792	9935
	700-799				113	33	1210	4083	19093	10246	16785	20922
	800-899						252	50	1370	466	252	1073
	900+			6				88	326		76	421
Sum of Hours	100-199	300	844	1564	847		9		16	96		22
	200-299	152	367	1009	1447		325	2019	949	303	122	2459
	300-399	161	318	738	1221	428	269	656	78	1111	501	2642
	400-499		13	420	228	483	424	439	475	929	321	300
	500-599			49	776	1329	3233	1471	2910	2453	1736	1118
	600-699				405	937	4866	4840	8095	10948	8663	7200
	700-799				36	15	586	2080	9196	9506	9151	10828
	800-899						73	25	577	500	182	503
	900+			46				46	318		130	216
CPUE (t/h)	100-199	0.75	0.99	1.30	1.07		1.31		0.08	1.26		0.57
	200-299	1.83	1.13	1.32	1.46		1.88	1.42	2.28	1.49	1.07	0.78
	300-399	1.08	0.99	1.91	2.47	5.61	3.21	2.40	0.96	1.52	1.77	1.05
	400-499		0.53	2.27	1.69	4.04	3.06	2.60	1.13	0.85	0.87	0.94
	500-599			0.48	1.18	2.64	2.93	2.01	1.26	0.97	1.20	1.06
	600-699				1.87	2.71	2.50	2.15	1.51	1.15	1.36	1.38
	700-799				3.14	2.28	2.07	1.96	2.08	1.08	1.83	1.93
	800-899						3.44	2.00	2.37	0.93	1.39	2.13
	900+			0.12				1.93	1.02		0.59	1.95

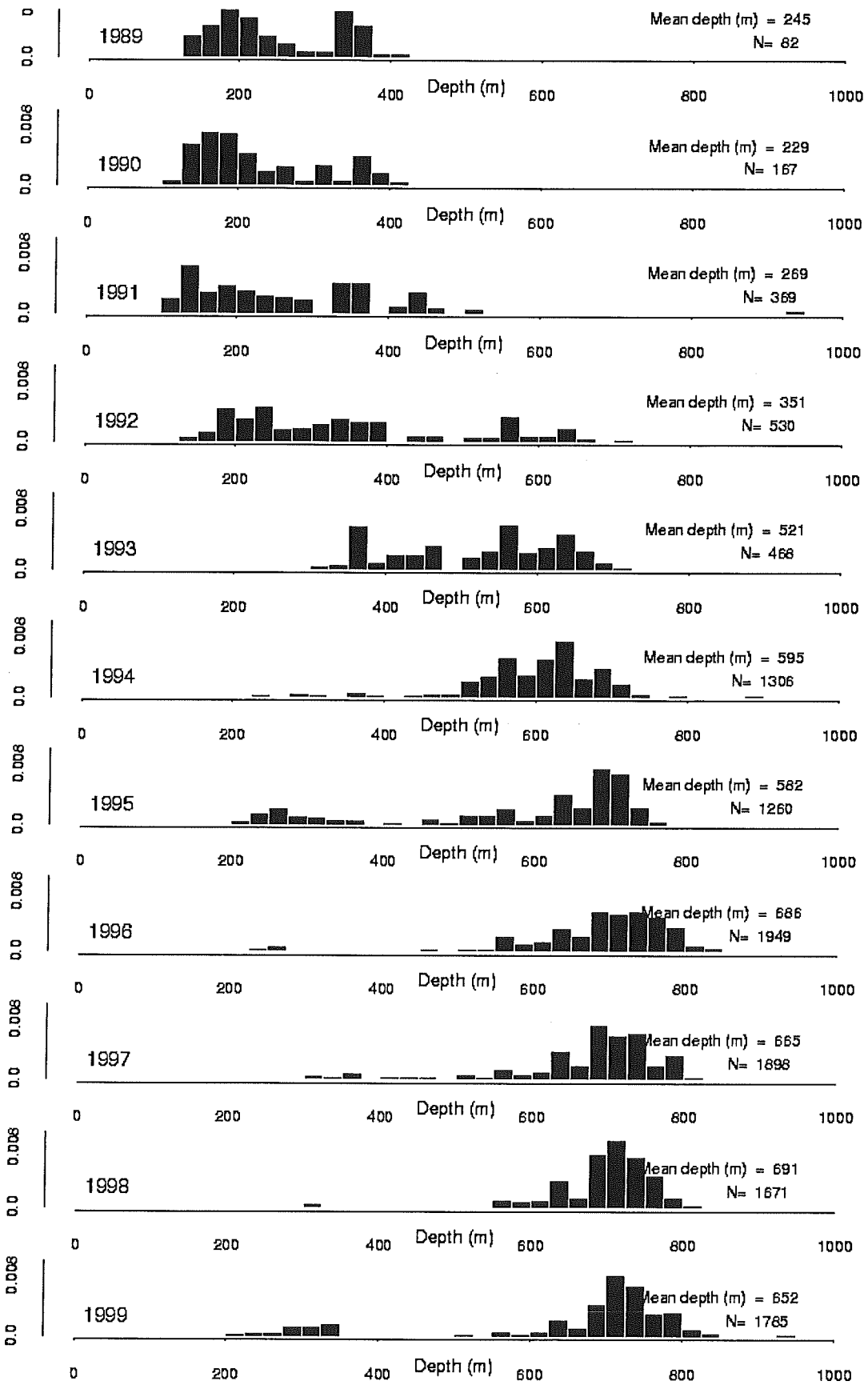


Figure 10.1.1. Depth distribution of Icelandic trawl hauls for pelagic redfish as reported in the log-books since Iceland began its pelagic redfish fishery in 1989.

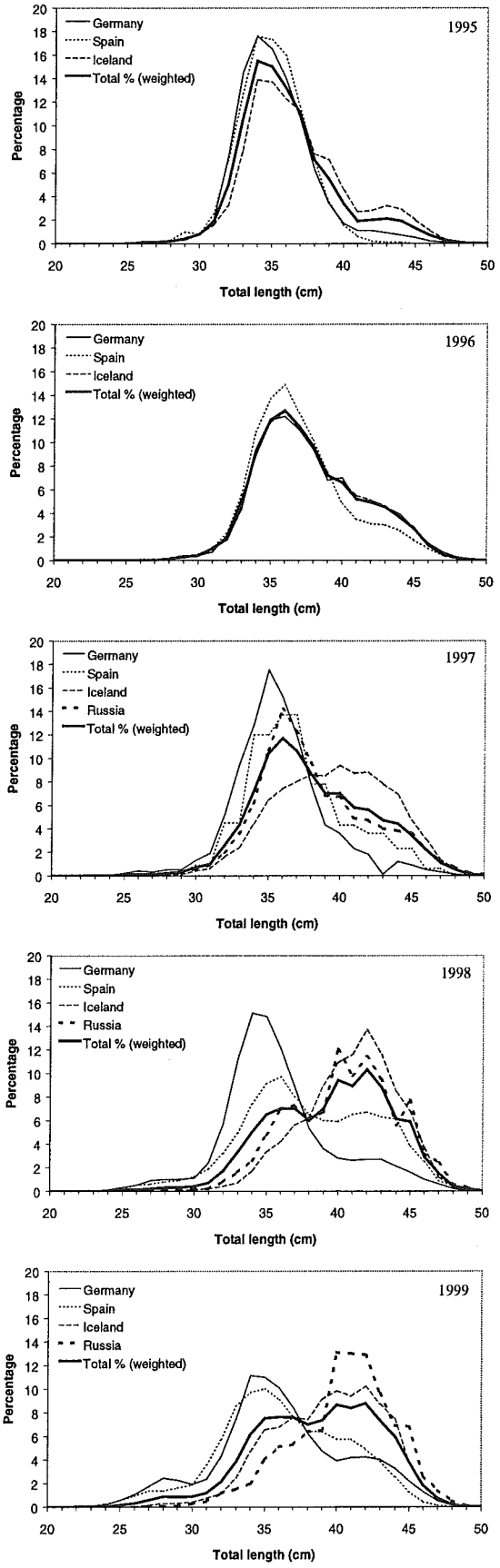


Figure 10.1.2. Length distributions from landings of pelagic *S. mentella* in 1995-1999.

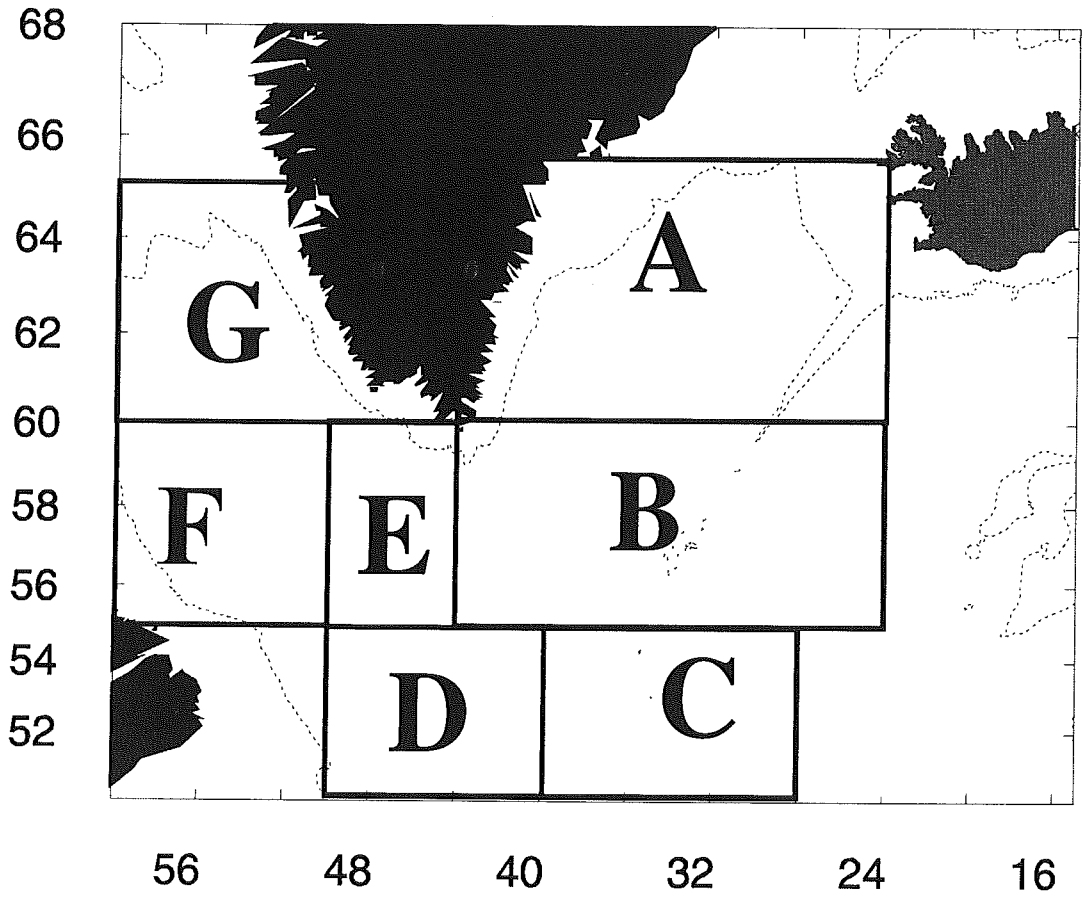


Figure 10.2.1. Sub-areas used on international surveys for redfish in the Irminger Sea and adjacent waters.

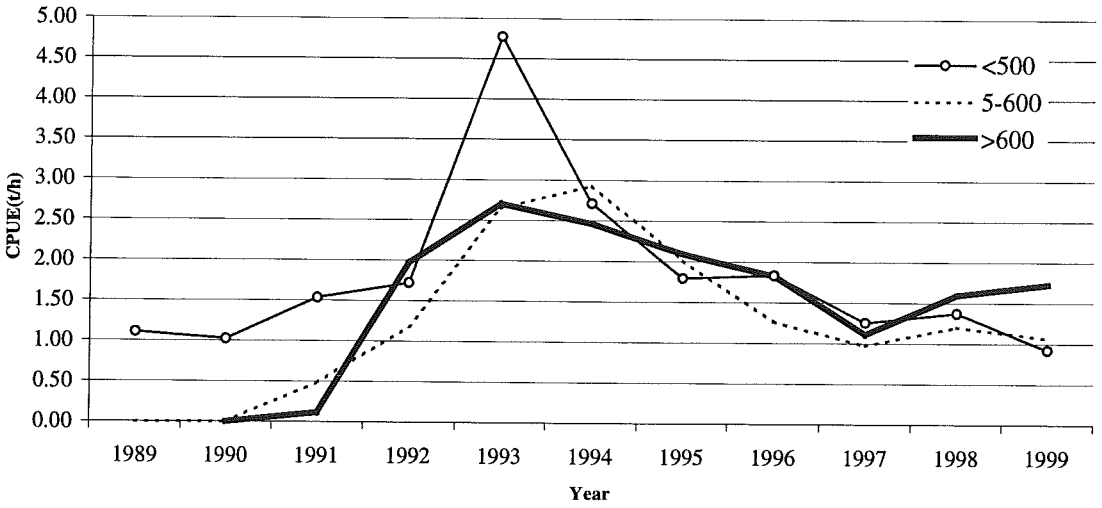


Figure 10.2.2. Catch per unit effort in the pelagic redfish fishery for the Icelandic fleet for different depth intervals.

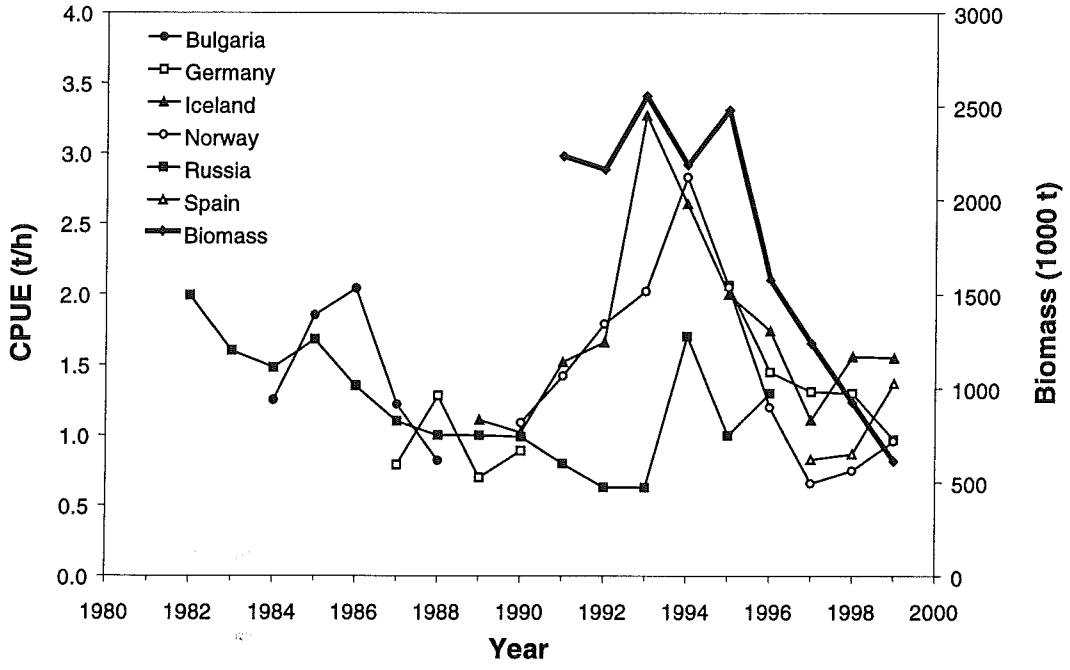


Figure 10.2.3. Trends in CPUE of pelagic *S. mentella* in the Irminger Sea and estimated acoustic biomass.

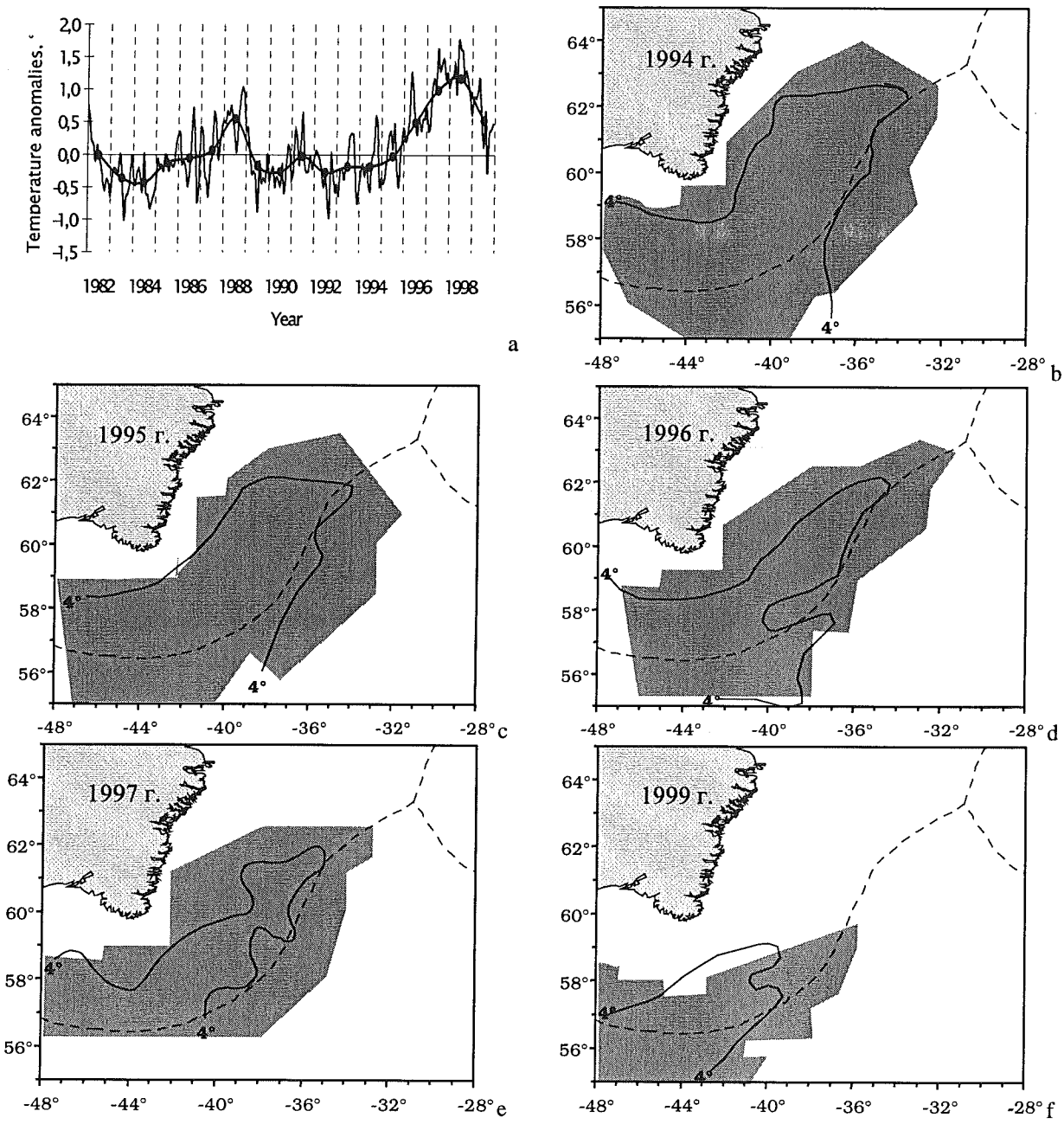


Fig. 10.2.4. Monthly and annual (marked) anomalies SST on the feeding ground (a). Locations of mean values of area back scattering strength of redfish more than 10 m^2/nm^2 at depths above 500 m and 4°C isotherm on 200 m in the Irminger Sea in June/July 1994-1999 (b-f).

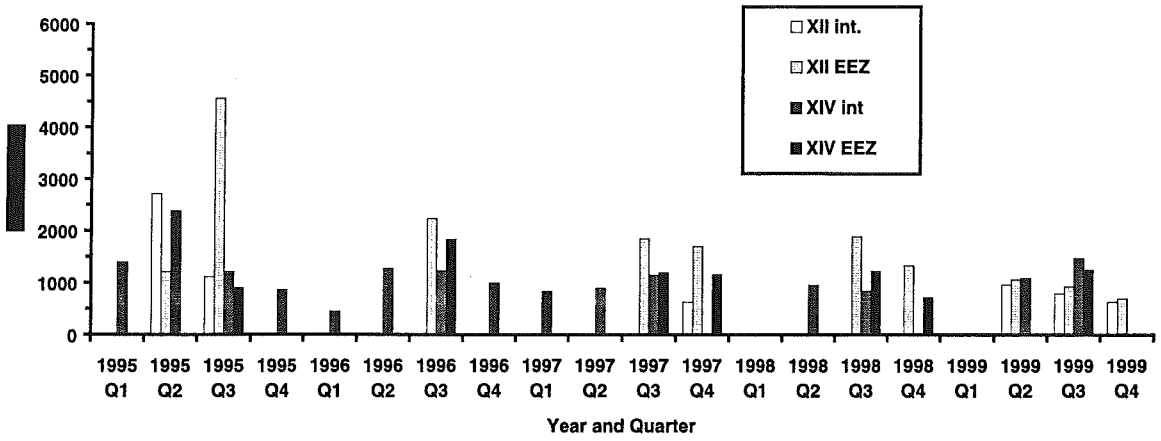


Figure 10.2.5. Unstandardized mean CPUE (kg/h) of the German fleet for oceanic *S. mentella* by year, quarter and area (international waters and Greenlandic EEZ in ICES Div. XII and XIV).

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