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3 DEMERSAL STOCKS AT ICELAND (DIVISION VA)

3.1 Regulation of Demersal Fisheries

With the extension of the fisheries jurisdiction to 200 miles in 1975, Iceland introduced new measures to protect young juvenile fish. The mesh size in trawls was increased from 120 mm to 155 mm in 1977. Only in the fisheries for redfish was 135 mm mesh size allowed in certain areas. In addition a system was implemented whereby fishing can be forbidden immediately in areas where the number of small fish in the catches exceeds a certain percentage (25% < 55 cm for cod and saithe and 25% < 48 cm for haddock). These areas are usually been closed for two weeks and can be extended in time and space if necessary.

A quota system however, was not introduced, until 1984.The quotas are transferable boat quotas. The agreed quotas are based on the Marine Research Institute's TAC recommendations, also taking socio-economic effects into account. Until 1990, the quota year corresponded to the calendar year but at present the quota-, or so-called fishing year, starts on 1 September and ends on 31 August of the following year. This was done to meet the need of the fishing industry.

Since the beginning of 1995/1996 fishing year i.e. 1st of September 1995 a harvesting control law has been enforced in order to manage the cod fisheries. According to this management scheme, catch will be limited to 25% of the fishable (4+) stock biomass calculated from the average stock at 1st of January of the previous fishing year and the coming fishing year. However, with a minimum catch level of 155 000 t.

3.2 Saithe in Icelandic waters

3.2.1 Trends in landings

Saithe landings from Icelandic grounds (Division Va) fluctuated between 57 000 t and 70 000 t during the period 1981-1986 (Table 3.2.1). From 1987 to 1989, annual landings were about 80 000 t . In 1990, landings increased by more than 20% to 98 000 t and in 1991 the catches reached 103 000 t . Since 1991, landings have decreased to a historically low level in 1997. In 1998 preliminary reported landings for saithe in Division Va (Table 3.2.1) are slightly above than the 30 000 t expected by the working group last year.

The Icelandic landings in the quota year September-August 1997/1998 amounted to about 35 000 t whereas the national TAC for the same period was 50 000 t.

3.2.2 Fleets and fishing grounds

Approximately 67 % of the catches were taken by bottom trawl and 15 % in gillnets in 1998. The proportion of the catch taken by the main gear types was close to that observed in 1997, although the proportion caught in gillnets has decreased while the bottom trawl catch proportion increased slightly. The proportion of the catch taken in gill nets has decreased in recent years, while Danish seine boats and jiggers have taken a steadily increasing share of the total catch. (Figure 3.2.1).

Landings from the bottom trawl fishery were highest in April in 1998 but in August from the gillnet fishery. The trawlers caught saithe fairly evenly over the year, each month constituting more than 5% of the catches, while the gill net fishery has a more seasonal character, with a winter and autumn season, although this year the catches were highest in August (Figure 3.2.2).

The main fishing grounds of the bottom trawl fishery are southwest of Reykjanes and off the south east coast (Figure 3.2.3). The gillnet fishery is concentrated on the spawning grounds southwest of Iceland.

3.2.3 Catch at age

Data from samples from all gear types were used to calculate the catch in numbers at age for the total landings in 1998, with the sampling level indicated in the text table below, and used as input for the assessment (Table 3.2.2).

Gear/nation	Landings	No. of otolith samples	No. of otoliths read	No. of length samples	No of length measurements
Gillnets	4 277	4	395	13	3 590
Jiggers	2 013	1	100	2	454
Danish seine	1 721	1	100	2	578
Bottom trawl	21 209	25	2 225	81	17 950
Other gear	927	-	-	-	-
Faroese jiggers	801	-	-	-	-
Total	31 393	31	2 820	98	22 572

Gillnet catches were split according to a gear-specific age-length key, the rest of the catches were split according to a 'trawl' key, based on all samples except those from gill nets. The length weight relationship used was $W = 0.02498 \cdot L^{2.75674}$ for all fleets.

Compared to last years prognosis, a lower proportion of age groups 3, 4 and 6 and considerably higher proportions for age groups 7 and older were observed in the 1998 landings (Figure 3.2.4). The difference between last years prognosis and this years estimate is considerable for most age groups, and greater than what was found when comparing the prognosis for 1997 to the estimate of catch in numbers in 1997.

3.2.4 Mean weight at age

Mean weights at age in the landings are computed on the basis of samples of otoliths and lengths along with length distributions and length-weight relationships. The mean weights at age are computed for the same categories as the catch numbers at age and are then weighted together across the fleets. In recent years a slight increasing trend in mean weight at age is apparent, with the exception of the 1992 year class which has had lower than average mean weight at age as 4, 5 and 6 year olds (Figure 3.2.5 and Table 3.2.3). These weights at age where also used as weight at age in the stock.

3.2.5 Maturity at age

As has been pointed out in earlier reports of this working group, the maturity at age data for saithe can be misleading due to the nature of the fishery and of the species, and inadequate sampling. A GLM model, described in the 1993 Working Group report (ICES. C.M.1993/Assess:18), was used to explain maturity at age as a function of age and year class strength. This model was used to predict maturity at age for 1980-1998 (Figure 3.2.6). The maturity at age prior to 1980 is derived from ICES C.M. 1979/G:6.

3.2.6 Stock Assessment

3.2.6.1 Tuning input

CPUE data, based on Icelandic trawler logbooks from 1970-1997 and from the gillnet fleet from 1988 are available. To begin with the logbooks were kept on a voluntary basis by skippers of a few vessels, but since 1991 it has become mandatory to keep logbooks for both trawl and gill net fishery. During this decade the reports have become more complete and have ranged from 60-80% of landings during the 1990s.

In both trawler and gillnet vessel logbooks a trend is apparent in the way catches of saithe are recorded and presumably also caught. During this decade a continuous shift, from effort directed at saithe towards fishing of saithe as by-catch, is observed (Figure 3.2.7). In part, this is a result of the build-up of the cod stock, but also indicates a reduction in effort directed specifically at saithe. This necessitates a revision of the criterion used when choosing trawl hauls for constructing a CPUE-index, which has previously been to include only hauls in which saithe constitute more than 70% of the catch. GLIM indices (Stefánsson 1988) based on trawl hauls and gill net sets where saithe was more than 50% of the total catch were computed and age disaggregated as described in the 1998 report of this WG (ICES C. M. 1988/ACFM:19). Tuning data for trawlers in January-May is given in Table 3.2.4.

3.2.6.2 Estimates of fishing mortality

As there is a need for revision of the tuning fleets previously used in XSA of saithe in div. Va (Figure 3.2.7), no XSA results are presented this year, but examples are given in a working document (see Jonsson 1999, WD 31 to NWWG99).

Time series analysis presented (Guðmundsson 1994, WD 32 to NWWG99) is based on annual catch-at-age values from 1988-1998 and ages 4-11 years. Three sets of CPUE data were used, *i.e.* GLIM indices 50%+ from nets, trawlers in January-May and trawlers in June-December. The results of one run are given in Table 3.2.5. and graphs of retrospective analyses and a graph of logq(y) for the three CPUE sets are shown in Figures 3.2.8-12.

Initial estimates of recruitment were produced by a linear trend. The estimated values in a joint analysis with CPUE from trawlers in January-May was

N(4,y) = 31700 – 2030(y-1988) (thousand fish)

and similar values were obtained with other specifications presented in our tables. This specification of the recruitment improves the fit with the data included in the present analyses. Estimation with a constant initial estimate of recruitment produces systematic discrepancies in the retrospective patterns where the last year's biomass is consistently larger than the values obtained. An example of this where no tuning data are included is shown in Figure 3.2.8. However, it should be kept in mind that a linear trend in recruitment is certainly a misspecification of the long-term relationship although it may fit rather well over one decade. The standard deviations of estimates presented in the table are obtained by the Kalman filter. They only apply to the uncertainty produced by the random elements included in the model. Actual uncertainty is bigger because of misspecifications and errors in parameter estimates.

Neither the retrospective analyses nor statistics on residuals (not presented here) indicate systematic errors. There is little difference between the four sets of estimates and according to the estimated standard deviations there is little information in the CPUE data beyond what is already in the catch-at-age observations. According to the time series estimates, catchability has increased substantially since 1990; by 52 and 67 percent for trawlers in January-May and June-December respectively and by 112 percent for nets.

The resulting reference F's from the TSA runs vary from 0.45 (catch at age only, linear trend in recruitment to 0.37 (catch at age data and trawler GLIM 50%+ January-May with linear trend in recruitment estimated). According to the estimated standard deviations and other diagnostics from the TSA-runs there is no significant difference between the four results.

A retrospective analysis was performed for the different methods and fleets (Figures 3.2.7-10). As in previous years assessments the TSA-runs seem to be more consistent than XSA-runs. From the TSA-runs, the analysis of catch at age data with linear trend estimated and trawler GLIM50+, appears to be the most consistent one and was adopted by the working group. As no retrospective pattern was apparent in the TSA runs, no raising factor was used for the terminal F. In 1997 and 1998 this working group used raising factors of 1.32 and 1.19 respectively, based on the average underestimation in the last three years according to retrospective analyses.

The terminal fishing mortalities from the TSA were used to run a traditional VPA , where the F for age groups 8-14 was taken as the mean of age groups 8-11 in the TSA. Natural mortality was set at a value of 0.2. The results of this run are given in Tables 3.2.6 - 3.2.8 and Figures 3.2.13A and 3.2.13B.

3.2.6.3 Spawning stock and recruitment

The spawning stock biomass is shown in Figure 3.2.13B and given in Table 3.2.8. After a decline from 1970-1977, the spawning stock biomass averaged between 160-180 000 t in 1978-1989 and increased to about 190 000 t in 1990. Since 1992 the spawning stock biomass has declined to a minimum in 1998 of a little less than 85 000 t , which is the lowest recorded level. Spawning stock biomass at the beginning of 1999 is estimated at only 85 000 t.

Estimates of recruitment at age 3 are plotted in Figure 3.2.13.B. The 1983-1985 year classes are all well above the 1967-1987 long-term average of about 40 million 3 year old recruits. The 1984 year class is the highest on record at 109 million recruits. All year classes after 1985 are well below the long term average. The average size of the 1986-1993 year classes is estimated at only 22 million recruits, which is below the lower quartile of the historic series of recruitment. Since no information is available for the more recent year classes, the 1994-1997 year classes were set at the rounded average for the 1986-1993 year classes, *i.e.* at 20 million recruits.

3.2.7 Prediction of catch and biomass

3.2.7.1 Input data

The input data for the catch projections is shown in Table 3.2.9.

For catch predictions and stock biomass calculations, the mean weight at ages 4-9 were predicted using a multiple regression analysis where the mean weight at age was predicted by the mean weight of the year class in the previous year and the year class strength. Since the regression analysis showed significant relationships only for the above age groups, the mean weights at age for other age groups were averaged over the 1995-1997 period, excluding the strong 1984 year class as it had weight at age much lower than average.

For the short-term predictions, maturity at age was predicted as described in Section 3.2.5. For long term predictions of maturity at age, averages over the period 1980-1998 were used.

For a short term prediction the rounded average of the 1986-1993 year classes was used as recruitment.

For long-term yield and spawning stock biomass per recruit, the exploitation pattern was taken as the average of the fishing mortalities during 1980-1997 from the standard VPA run. Averages over 1980-1997 for maturity and mean weight at age for all age groups were used, along with a natural mortality of 0.2 (Table 3.2.11).

3.2.7.2 Biological reference points

The yield and spawning stock biomass-per-recruit (age 3) curves are shown in Figure 3.2.13C.

The ACFM has set B_{pa} at 150 000 t and B_{lim} was tentatively set at 90 000 t and F_{pa} at 0.3. F_{lim} has not been set for this stock. The stock is therefore below B_{lim} according to this assessment.

3.2.7.3 Projections of catch and biomass

Based on the input data given in Table 3.2.9, options for 1999 were calculated and are given in Table 3.2.10 and Figure 3.2.13.D.

As can be seen from the prediction (Table 3.2.10), total catch in 1999 is assumed 30 000 t which is a likely result of the TAC of 30 000 t for the 1998/99 quota year. The resulting stock size in the beginning of 2000 is estimated about 170 000 t and SSB slightly above 90 000 t . The same reference F in 2000, as in 1998, would result in a yield of approx. 37 000 t , and both total and spawning stock biomass in 2001 would remain close to the 1999 level. Total and spawning stock biomass are at historically low levels and will continue to be at a low level in the coming years, even at very low fishing mortalities, unless an increase in recruitment occurs.

3.2.8 Management considerations

The stock was overestimated until in the 1997 assessment. It is at the lowest observed level at present. Last years assessment seems to have been too optimistic. The reference F values have been at or above F_{med} for the whole time series in the assessment (one exception), and were higher than F_{max} in 1993-1995. Recruitment in recent years (the 1986 and more recent year classes) has been well below the long term average.

3.2.9 Comments on the assessment

Only one of previously used tuning fleets was updated. New tuning fleets were defined and XSA runs presented in WD 31, but only one of the fleets is presented in this report.

Time series analysis has been used to assess this stock in recent years. The TSA run adopted in the 1998 assessment was based on catch at age only with no trend in recruitment, this year the TSA was tuned with an age disaggregated GLIM index for trawlers in January-May, and a linear trend in recruitment was included. Figure 3.2.8 shows retrospective analysis from a run with no trend in recruitment. From systematic patterns in retrospective analysis, it can be seen that present fishing mortalities had been consistently underestimated in recent years, but the retrospective pattern of underestimation was no longer apparent in runs with a trend in recruitment.

The range of years used in the TSA was shortened by 4 years, the year range in the 1998 assessment was 1982-1997. In this assessment the TSA starts in 1988, when the abundant 1984 year class was entering the fishery, which changes the behaviour of the model.

In the 1997 and 1998 assessments the short term average of 25 million 3 year olds for year classes 1985-1992 was used as a recruitment estimate in short term prediction. In this assessment the year class range was changed to 1986-1993, averaging 22 million recruits, which was rounded to 20 million.

Tag returns indicate migration between saithe stock units in NE-Atlantic, and indications from catch at age have been described (Reinch 1977, Jakobsen & Olsen 1987). Little is known about their magnitude and frequency. Better understanding of saithe biology, e.g. recruitment and migrations, is needed.

Table 3.2.1. Nominal catch (tonnes) of SAITHE in Division Va by countries, 1982-1999, as officially reported to ICES

Country	1982	1983	1984	1985	1986	1987	1988	1989
Belgium	201	224	269	158	218	217	268	369
Faroe Islands	3,582	2,138	2,044	1,778	783	2,139	2,596	2,246
France	23	-	-	-	-	-	-	-
Iceland	65,124	55,904	60,406	55,135	63,867	78,175	74,383	79,810
Norway	1	+	-	1	-	-	-	-
UK (Engl. and Wales)	-	-	-	29	-	-	-	-
Total	70,913	60,249	64,703	59,086	66,854	82,518	79,235	82,425
WG estimate	-	-	-	-	66,376[2)]	-	-	

Country	1990	1991	1992	1993	1994	1995	1996	1997	1998[1)]
Belgium	190	236	195	104	30	-	-	-	-
Faroe Islands	2,905	2,690	1,570	1,562	975	1,161	801	716	801
France	-	-	-	-	-	-	-	-	-
Germany	-	-	-	-	-	-	1	-	3
Iceland	95,032	99,390	77,832	69,982	63,333	47,466	39,297	36,360	30,469
Norway	-	-	-	-	-	1	-	-	-
UK (Engl. and Wales)	-	-	-	-	-	-	-	-	-
Total	98,127	102,316	79,597	71,648	64,338	48,628	40,099	37,264	31,393
WG estimate		102,737[3)]	-	-	-	-	-		

1) Provisional

2) Additional catch of 1,508 t by Faroe Islands included

3) Additional catch of 451 t by Iceland included

Table 3.2.2. Saithe in division Va. Catch in numbers 1979-1998.

Run title : Saithe Iceland Va (run: SVPSTJ01/V01)

At 2-May-99 15:06:07

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

YEAR	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
AGE										
3	480	275	203	508	107	53	376	3108	956	1318
4	3764	2540	1325	1092	1750	657	4014	1400	5135	5067
5	1991	5214	3503	2804	1065	800	3366	4170	4428	6619
6	3616	2596	5404	4845	2455	1825	1958	2665	5409	3678
7	1566	2169	1457	4293	4454	2184	1536	1550	2915	2859
8	718	1341	1415	1215	2311	3610	1172	1116	1348	1775
9	292	387	578	975	501	844	747	628	661	845
10	669	262	242	306	251	376	479	1549	496	226
11	589	155	61	59	38	291	74	216	498	270
12	489	112	154	35	12	135	23	51	58	107
13	150	64	135	48	2	185	72	30	27	24
14	72	33	128	46	4	226	71	14	48	1
+gp	0	58	141	99	174	190	291	95	22	1
0 TOTAL	14396	15206	14746	16325	13124	11376	14179	16592	22001	22790
TONSL	63504	58347	58986	68615	58266	62719	57101	66376	80559	77247
SOPCC	98	100	99	99	99	100	99	100	100	100

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

YEAR	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
AGE										
3	315	143	198	242	657	702	1573	2118	603	202
4	4313	1692	874	2928	1083	2955	1853	3465	2960	1246
5	8471	5471	3613	3844	2841	1770	2661	2327	2766	1944
6	7309	10112	6844	4355	2252	2603	1807	1838	1651	1490
7	1794	6174	10772	3884	2247	1377	2370	814	1178	1073
8	1928	1816	3223	4046	2314	1243	905	1129	599	566
9	848	1087	858	1290	3671	1263	574	321	454	352
10	270	380	838	350	830	2009	482	209	125	258
11	191	151	228	196	223	454	521	144	95	138
12	135	55	40	56	188	158	106	168	114	84
13	76	76	6	54	81	188	35	85	77	70
14	10	37	5	15	12	82	13	33	43	83
+gp	8	42	42	1	1	51	17	30	41	72
0 TOTAL	25668	27236	27541	21261	16400	14855	12917	12681	10706	7578
TONSL	82425	98130	102737	79597	71648	64338	48650	40101	37246	31393
SOPCC	100	100	100	100	100	100	100	100	100	100
1										

Table 3.2.3. Saithe in Division Va. Mean weight (kg) at age in the catches 1979-1998.

Run title : Saithe Iceland Va (run: SVPSTJ01/V01)

At 2-May-99 15:06:07

Table 2 Catch weights at age (kg)

YEAR	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
AGE										
3	1.12	1.428	1.585	1.547	1.53	1.653	1.609	1.45	1.516	1.261
4	1.76	1.983	2.037	2.194	2.221	2.432	2.172	2.19	1.715	2.017
5	2.73	2.667	2.696	3.015	3.171	3.33	3.169	2.959	2.67	2.513
6	4.29	3.689	3.525	3.183	4.27	4.681	3.922	4.402	3.839	3.476
7	5.54	5.409	4.541	5.114	4.107	5.466	4.697	5.488	5.081	4.719
8	7.27	6.321	6.247	6.202	5.984	4.973	6.411	6.406	6.185	5.932
9	8.42	7.213	6.991	7.256	7.565	7.407	6.492	7.57	7.33	7.523
10	9.41	8.565	8.202	7.922	8.673	8.179	8.346	6.487	8.025	8.439
11	10	9.147	9.537	8.924	8.801	8.77	9.401	9.616	7.974	8.748
12	10.56	9.617	9.089	10.134	9.039	8.831	10.335	10.462	9.615	9.559
13	11.87	10.066	9.351	9.447	11.138	11.01	11.027	11.747	12.246	10.824
14	13.12	11.041	10.225	10.535	9.818	11.127	10.644	11.902	11.656	14.099
+gp	13.12	13	13	13	13	13	13	13	13	13
0 SOPC(	0.984	0.9989	0.9933	0.9922	0.9915	0.9975	0.9929	0.9987	1.0005	0.9999

Table 2 Catch weights at age (kg)

YEAR	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
AGE										
3	1.403	1.647	1.224	1.269	1.381	1.444	1.37	1.21	1.325	1.375
4	2.021	1.983	1.939	1.909	2.143	1.836	1.977	1.745	1.936	2.03
5	2.194	2.566	2.432	2.578	2.742	2.649	2.769	2.684	2.409	2.927
6	3.047	3.021	3.16	3.288	3.636	3.512	3.722	3.741	3.906	3.43
7	4.505	4.077	3.634	4.15	4.398	4.906	4.621	4.85	5.032	5.039
8	5.889	5.744	4.967	4.865	5.421	5.539	5.854	5.62	6.171	6.089
9	7.172	7.038	6.629	6.168	5.319	6.818	6.416	6.966	7.202	6.991
10	8.852	7.564	7.704	7.926	7.006	6.374	7.356	7.43	7.883	7.884
11	10.17	8.854	9.061	8.349	8.07	8.341	6.815	8.884	8.856	8.876
12	10.392	10.645	9.117	9.029	10.048	9.77	8.312	8.025	9.649	10.183
13	12.522	11.674	10.922	11.574	9.106	10.528	9.119	10.246	9.621	10.171
14	11.923	11.431	11.342	9.466	11.591	11.257	11.91	12.177	10.877	10.12
+gp	13	13	13	13	13	13	13	13	13	13
0 SOPC(	0.9998	1.0005	0.9999	1.0002	1.0013	1.0018	1.0027	1	1.0011	0.9958

Table 3.2.4. Saithe in Division Va. Tuning data series.

		Age group							
	EFFORT	4	5	6	7	8	9	10	11
1988	1	18.8	93.3	53.3	44.0	16.8	12.3	3.0	4.4
1989	1	7.8	34.7	101.2	42.5	30.5	14.4	4.8	1.8
1990	1	18.3	42.8	92.7	76.2	15.8	9.7	4.8	4.1
1991	1	5.4	35.5	71.9	118.6	37.9	12.4	11.6	3.9
1992	1	17.2	40.3	57.3	53.8	52.2	13.4	2.7	1.1
1993	1	3.4	17.1	38.6	50.2	36.8	33.9	7.9	1.8
1994	1	18.1	16.8	35.8	17.7	15.9	15.3	22.7	5.3
1995	1	22.5	33.8	32.3	42.2	13.1	6.1	5.5	6.8
1996	1	42.0	29.0	31.6	17.8	26.1	5.0	3.3	1.4
1997	1	63.2	28.5	23.9	34.0	16.3	10.6	3.0	1.5
1998	1	30.4	52.5	40.1	25.7	13.0	8.7	4.9	4.0

Table 3.2.5. Saithe in Division Va. Results from TSA-runs.

Catch-at-age 4-11 years
CPUE trawl Jan.-May 6-11 years
Linear trend in recruitment

STOCK IN NUMBERS (thousands of fish)

	4	5	6	7	8	9	10	11	Biomass
1988	81142.	38463.	12009.	9004.	4222.	1490.	444.	541.	388.5
1989	39303.	61656.	25217.	6712.	4723.	1851.	684.	220.	367.0
1990	24481.	30033.	41522.	14618.	3676.	2247.	954.	357.	361.9
1991	16644.	18469.	19555.	24163.	6883.	1526.	1148.	489.	284.3
1992	21239.	12607.	11694.	10323.	11407.	2667.	619.	472.	235.3
1993	12010.	15073.	7094.	5757.	5027.	5378.	1285.	279.	185.2
1994	14521.	8844.	9588.	3594.	2540.	2025.	2416.	554.	149.4
1995	13382.	10391.	5576.	5379.	1690.	923.	744.	948.	128.6
1996	16383.	9610.	6203.	2909.	2458.	640.	387.	307.	115.6
1997	14754.	11857.	5879.	3413.	1545.	1059.	307.	183.	118.5
1998	11352.	10768.	7402.	3279.	1727.	733.	560.	160.	118.0

STANDARD DEVIATION OF STOCK ESTIMATES

1997	2635.	1487.	652.	351.	133.	103.	47.	42.	10.3
1998	4618.	1966.	1142.	461.	250.	90.	84.	33.	14.8

FISHING MORTALITY RATES

									Average 4-9	
	4	5	6	7	8	9	10	11	geom	arithm
1988	0.075	0.222	0.380	0.445	0.616	0.768	0.703	0.696	0.332	0.418
1989	0.066	0.196	0.345	0.402	0.543	0.659	0.648	0.674	0.294	0.368
1990	0.082	0.227	0.340	0.551	0.678	0.669	0.669	0.700	0.341	0.424
1991	0.075	0.256	0.439	0.550	0.736	0.876	0.870	0.812	0.380	0.489
1992	0.144	0.346	0.504	0.516	0.527	0.722	0.790	0.800	0.413	0.460
1993	0.096	0.252	0.439	0.579	0.700	0.800	0.835	0.832	0.389	0.478
1994	0.129	0.251	0.376	0.518	0.723	0.917	0.886	0.847	0.401	0.486
1995	0.128	0.296	0.436	0.575	0.734	0.832	0.844	0.822	0.424	0.500
1996	0.125	0.282	0.394	0.432	0.638	0.734	0.750	0.753	0.376	0.434
1997	0.116	0.268	0.384	0.478	0.545	0.638	0.652	0.692	0.354	0.405
1998	0.089	0.217	0.309	0.420	0.512	0.640	0.656	0.665	0.306	0.365

STANDARD DEVIATIONS OF LOG(F)

1997	0.48	0.14	0.11	0.12	0.12	0.12	0.15	0.16	0.120
1998	0.47	0.17	0.15	0.16	0.16	0.17	0.18	0.18	0.148

Table 3.2.6. Saithe in Division Va. Fishing mortality.

Run title : Saithe Iceland Va (run: SVPSTJ01/V01)

At 2-May-99 15:06:07

Traditional vpa using screen input for terminal F

Table 8 Fishing mortality (F) at age

YEAR	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
AGE										
3	0.0096	0.0109	0.0116	0.0257	0.0036	0.0012	0.0119	0.0474	0.0097	0.0264
4	0.1095	0.0645	0.0665	0.0796	0.1161	0.0276	0.1203	0.0562	0.1029	0.0654
5	0.1777	0.2174	0.119	0.1952	0.1038	0.0712	0.192	0.1768	0.2516	0.1868
6	0.3573	0.3693	0.3662	0.2396	0.2618	0.2592	0.2486	0.2288	0.3646	0.3422
7	0.342	0.3777	0.3656	0.5582	0.3615	0.3922	0.362	0.3182	0.4192	0.3343
8	0.312	0.5534	0.4545	0.5941	0.6744	0.5616	0.3781	0.4882	0.5055	0.4891
9	0.1715	0.276	0.4934	0.6591	0.5261	0.5626	0.2126	0.3579	0.606	0.6974
10	0.7625	0.2293	0.278	0.5314	0.3493	0.9941	0.7381	0.8997	0.5342	0.4291
11	0.6698	0.3939	0.0763	0.1006	0.1133	0.8843	0.5314	0.9156	0.8518	0.6324
12	0.5861	0.2524	0.8706	0.0572	0.0267	0.7244	0.1495	0.8843	0.6798	0.4385
13	0.6027	0.1374	0.5457	0.7539	0.0041	0.7003	1.1648	0.2961	2.3062	0.6773
14	0.655	0.253	0.443	0.361	0.123	0.826	0.646	0.749	1.093	0.544
+gp	0.655	0.253	0.443	0.361	0.123	0.826	0.646	0.749	1.093	0.544
0 FBAR 4	0.245	0.3097	0.3109	0.3876	0.3406	0.3124	0.2523	0.271	0.375	0.3525

Table 8 Fishing mortality (F) at age

YEAR	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	FBAR 96-98
AGE											
3	0.0112	0.0074	0.008	0.0182	0.0384	0.0439	0.0816	0.1087	0.0332	0.022	0.0546
4	0.1131	0.0769	0.0567	0.1573	0.1059	0.2413	0.1561	0.2588	0.2177	0.089	0.1885
5	0.1482	0.2048	0.233	0.3735	0.2251	0.2515	0.3561	0.2992	0.3392	0.217	0.2851
6	0.3236	0.2647	0.4247	0.4855	0.3915	0.3314	0.4393	0.4469	0.3594	0.309	0.3718
7	0.2788	0.4993	0.4988	0.4567	0.5005	0.4424	0.5713	0.3623	0.58	0.42	0.4541
8	0.3955	0.5044	0.5322	0.3529	0.5457	0.5769	0.59	0.5946	0.4968	0.618	0.5698
9	0.4594	0.4065	0.476	0.4218	0.6291	0.6597	0.5802	0.4296	0.51	0.618	0.5192
10	0.5022	0.385	0.6358	0.3629	0.5303	0.8751	0.5728	0.4316	0.2954	0.618	0.4484
11	0.7982	0.5888	0.4214	0.2947	0.4157	0.6285	0.5892	0.333	0.3567	0.618	0.4359
12	0.7712	0.5643	0.302	0.1719	0.5109	0.5884	0.2888	0.3815	0.48	0.618	0.4931
13	0.6461	1.5586	0.1074	0.8583	0.4005	1.6127	0.2459	0.3966	0.3016	0.618	0.4387
14	0.679	0.774	0.367	0.422	0.464	0.926	0.424	0.386	0.358	0.618	0.454
+gp	0.679	0.774	0.367	0.422	0.464	0.926	0.424	0.386	0.358	0.618	
0 FBAR 4	0.2864	0.3261	0.3702	0.3746	0.3996	0.4172	0.4488	0.3985	0.4172	0.3785	
1											

Table 3.2.7. Saithe in Division Va. Stock in numbers

Run title : Saithe Iceland Va (run: SVPSTJ01/V01)

At 2-May-99 15:06:07

Traditional vpa using screen input for terminal F

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

	YEAR	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
	AGE										
	3	55240	28025	19441	22039	32622	47677	34930	74064	108824	55711
	4	39980	44793	22696	15733	17585	26612	38987	28258	57833	88234
	5	13451	29339	34382	17387	11896	12820	21195	28301	21872	42719
	6	13200	9219	19328	24991	11710	8779	9774	14322	19415	13924
	7	5932	7560	5217	10972	16102	7379	5547	6241	9328	11039
	8	2941	3450	4242	2963	5141	9184	4082	3162	3717	5022
	9	2038	1763	1624	2205	1339	2144	4288	2290	1589	1836
	10	1366	1405	1095	812	934	648	1000	2838	1311	710
	11	1317	522	915	679	391	539	196	391	945	629
	12	1205	552	288	694	503	286	182	94	128	330
	13	362	549	351	99	537	401	113	129	32	53
	14	164	162	392	166	38	438	163	29	78	3
	+gp	0	285	432	358	1655	368	668	196	36	3
0	TOT/	137194	127623	110402	99099	100453	117275	121124	160316	225109	220213

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

	YEAR	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	GMST 62-96	AM
	AGE													
	3	31130	21509	27263	14769	19223	18005	22121	22651	20354	10239	0	37569	43700
	4	44422	25202	17481	22142	11873	15145	14107	16692	16636	16120	8200	30233	35062
	5	67668	32481	19107	13523	15490	8744	9741	9880	10550	10956	12074	22287	26041
	6	29015	47769	21668	12393	7621	10126	5567	5586	5998	6153	7220	15119	17839
	7	8097	17188	30015	11601	6244	4218	5952	2937	2925	3428	3698	9178	10972
	8	6470	5016	8541	14924	6016	3099	2219	2752	1674	1341	1844	5180	6076
	9	2521	3567	2480	4107	8585	2854	1425	1007	1243	834	592	2750	3191
	10	748	1304	1945	1261	2205	3747	1208	653	537	611	368	1512	1702
	11	378	371	726	843	718	1062	1279	558	347	327	270	795	880
	12	274	139	168	390	514	388	464	581	327	199	144	425	484
	13	174	104	65	102	269	253	176	285	325	166	88	218	266
	14	22	75	18	48	35	148	41	113	157	197	73	98	148
	+gp	18	85	150	3	3	92	54	103	149	171	162		
0	TOT/	190937	154809	129628	96106	78797	67880	64354	63798	61222	50741	34734		
	1													

Table 3.2.8. Saithe in Division Va. Stock summary table.

Run title : Saithe Iceland Va (run: SVPSTJ01/V01)

At 2-May-99 15:06:07

Table 16 Summary (without SOP correction)

Traditional vpa using screen input for terminal F

	RECRUITS Age 3	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	FBAR 4- 9
1962	30999	277003	142184	50514	0.3553	0.2867
1963	84106	336274	144613	48011	0.332	0.304
1964	55195	380521	141947	60257	0.4245	0.25
1965	94062	465836	165999	60177	0.3625	0.2313
1966	70223	550397	214136	52003	0.2429	0.1783
1967	68332	648019	279292	75712	0.2711	0.2375
1968	59672	697092	345778	77549	0.2243	0.2102
1969	88751	762546	395280	115853	0.2931	0.2947
1970	66328	755885	399454	116601	0.2919	0.3225
1971	50638	717074	381384	136764	0.3586	0.4429
1972	26456	603752	334676	111301	0.3326	0.3609
1973	26103	516600	313690	110888	0.3535	0.3446
1974	25125	434163	288072	97568	0.3387	0.2875
1975	25927	387979	264698	87954	0.3323	0.2779
1976	31236	347148	227234	82003	0.3609	0.3256
1977	21672	300239	186665	62026	0.3323	0.2823
1978	49436	307897	165550	49672	0.3	0.2374
1979	55240	342168	159514	63504	0.3981	0.245
1980	28025	349650	166305	58347	0.3508	0.3097
1981	19441	332640	168799	58986	0.3494	0.3109
1982	22039	317937	177304	68615	0.387	0.3876
1983	32622	327671	193539	58266	0.3011	0.3406
1984	47677	355820	182597	62719	0.3435	0.3124
1985	34930	350179	169711	57101	0.3365	0.2523
1986	74064	415478	177478	66376	0.374	0.271
1987	108824	500181	172033	80559	0.4683	0.375
1988	55711	514960	164795	77247	0.4687	0.3525
1989	31130	478972	172287	82425	0.4784	0.2864
1990	21509	454844	192372	98130	0.5101	0.3261
1991	27263	376105	193286	102737	0.5315	0.3702
1992	14769	304936	182947	79597	0.4351	0.3746
1993	19223	257225	165253	71648	0.4336	0.3996
1994	18005	211898	138455	64338	0.4647	0.4172
1995	22121	179783	106463	48650	0.457	0.4488
1996	22651	160776	91238	40101	0.4395	0.3985
1997	20354	159257	87427	37246	0.426	0.4172
1998	10239	146886	83344	31393	0.3767	0.3785
Arith. Mean	42165	406102	203670	73050	0.374	0.3202
0 Units	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)		

1

Table 3.2.9. Saithe in Division Va. Prediction with management option - Input data.

Saithe in the Iceland Grounds (Fishing Area Va)

Prediction with management option table: Input data

Year: 1999

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	20.000	0.2000	0.1400	0.0000	0.0000	1.303	0.0520	1.303
4	16.018	0.2000	0.2800	0.0000	0.0000	2.067	0.1710	2.067
5	11.864	0.2000	0.4700	0.0000	0.0000	2.846	0.2710	2.846
6	7.220	0.2000	0.6600	0.0000	0.0000	3.871	0.3530	3.871
7	3.698	0.2000	0.8200	0.0000	0.0000	4.620	0.4310	4.620
8	1.844	0.2000	0.9200	0.0000	0.0000	6.155	0.5410	6.155
9	0.592	0.2000	0.9600	0.0000	0.0000	7.563	0.4930	7.563
10	0.368	0.2000	1.0000	0.0000	0.0000	7.732	0.4260	7.732
11	0.270	0.2000	1.0000	0.0000	0.0000	8.872	0.4140	8.872
12	0.144	0.2000	1.0000	0.0000	0.0000	9.381	0.4680	9.381
13	0.088	0.2000	1.0000	0.0000	0.0000	9.845	0.4170	9.845
14	0.073	0.2000	1.0000	0.0000	0.0000	11.655	0.4310	11.655
Unit	Millions	-	-	-	-	Kilograms	-	Kilograms

Year: 2000

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	20.000	0.2000	0.1400	0.0000	0.0000	1.303	0.0520	1.303
4	.	0.2000	0.2800	0.0000	0.0000	2.009	0.1710	2.009
5	.	0.2000	0.4700	0.0000	0.0000	2.869	0.2710	2.869
6	.	0.2000	0.6800	0.0000	0.0000	3.827	0.3530	3.827
7	.	0.2000	0.8200	0.0000	0.0000	4.912	0.4310	4.912
8	.	0.2000	0.9200	0.0000	0.0000	5.829	0.5410	5.829
9	.	0.2000	0.9600	0.0000	0.0000	7.605	0.4930	7.605
10	.	0.2000	1.0000	0.0000	0.0000	7.732	0.4260	7.732
11	.	0.2000	1.0000	0.0000	0.0000	8.872	0.4140	8.872
12	.	0.2000	1.0000	0.0000	0.0000	9.381	0.4680	9.381
13	.	0.2000	1.0000	0.0000	0.0000	9.845	0.4170	9.845
14	.	0.2000	1.0000	0.0000	0.0000	11.655	0.4310	11.655
Unit	Millions	-	-	-	-	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
3	20.000	0.2000	0.1400	0.0000	0.0000	1.303	0.0520	1.303
4	.	0.2000	0.2800	0.0000	0.0000	2.009	0.1710	2.009
5	.	0.2000	0.4700	0.0000	0.0000	2.828	0.2710	2.828
6	.	0.2000	0.6800	0.0000	0.0000	3.843	0.3530	3.843
7	.	0.2000	0.8300	0.0000	0.0000	4.898	0.4310	4.898
8	.	0.2000	0.9100	0.0000	0.0000	6.028	0.5410	6.028
9	.	0.2000	0.9600	0.0000	0.0000	6.679	0.4930	6.679
10	.	0.2000	1.0000	0.0000	0.0000	7.732	0.4260	7.732
11	.	0.2000	1.0000	0.0000	0.0000	8.872	0.4140	8.872
12	.	0.2000	1.0000	0.0000	0.0000	9.381	0.4680	9.381
13	.	0.2000	1.0000	0.0000	0.0000	9.845	0.4170	9.845
14	.	0.2000	1.0000	0.0000	0.0000	11.655	0.4310	11.655
Unit	Millions	-	-	-	-	Kilograms	-	Kilograms

Notes: Run name : MANSTJ02
Date and time: 04MAY99:17:44

Table 3.2.10. Saithe in Division Va. Prediction with management option table.

Saithe in the Iceland Grounds (Fishing Area Va)

Prediction with management option table

Year: 1999					Year: 2000					Year: 2001	
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
0.8395	0.3162	162104	84293	30000	0.0000	0.0000	168111	91115	0	207275	122816
.	.	.	.	.	0.1000	0.0377	.	91115	4334	202392	118977
.	.	.	.	.	0.2000	0.0753	.	91115	8519	197678	115282
.	.	.	.	.	0.3000	0.1130	.	91115	12559	193127	111725
.	.	.	.	.	0.4000	0.1507	.	91115	16461	188733	108301
.	.	.	.	.	0.5000	0.1883	.	91115	20231	184489	105004
.	.	.	.	.	0.6000	0.2260	.	91115	23872	180389	101829
.	.	.	.	.	0.7000	0.2637	.	91115	27390	176429	98772
.	.	.	.	.	0.8000	0.3013	.	91115	30791	172602	95826
.	.	.	.	.	0.9000	0.3390	.	91115	34077	168905	92989
.	.	.	.	.	1.0000	0.3767	.	91115	37255	165330	90255
.	.	.	.	.	1.1000	0.4143	.	91115	40327	161875	87621
.	.	.	.	.	1.2000	0.4520	.	91115	43298	158535	85082
-	-	Tonnes	Tonnes	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes

Notes: Run name : MANSTJ02
Date and time : 04MAY99:17:44
Computation of ref. F: Simple mean, age 4 - 9
Basis for 1999 : TAC constraints

Table 3.2.11. Saithe in Division Va. Yield per recruit - Input data.

Icelandic saithe (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	0.1153	0.0000	0.0000	1.433	0.0200	1.436
4	.	0.2000	0.2284	0.0000	0.0000	2.025	0.1200	2.025
5	.	0.2000	0.3974	0.0000	0.0000	2.744	0.2270	2.734
6	.	0.2000	0.5984	0.0000	0.0000	3.655	0.3560	3.668
7	.	0.2000	0.7668	0.0000	0.0000	4.728	0.4470	4.711
8	.	0.2000	0.8826	0.0000	0.0000	5.833	0.5600	5.818
9	.	0.2000	0.9442	0.0000	0.0000	6.951	0.5600	6.949
10	.	0.2000	1.0000	0.0000	0.0000	7.832	0.5600	7.830
11	.	0.2000	1.0000	0.0000	0.0000	8.800	0.5600	8.795
12	.	0.2000	1.0000	0.0000	0.0000	9.571	0.5600	9.537
13	.	0.2000	1.0000	0.0000	0.0000	10.649	0.5600	10.676
14	.	0.2000	1.0000	0.0000	0.0000	12.179	0.5600	12.219
Unit	Numbers	-	-	-	-	Kilograms	-	Kilograms

Notes: Run name : YIELD3
Date and time: 27MAY99:14:46

Table 3.2.12. Saithe in Division Va. Yield per recruit - Summary table.

Icelandic saithe (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	21381.278	2.711	16055.957	2.711	16055.957
0.0500	0.0189	0.063	371.668	4.813	19733.575	2.522	14473.488	2.522	14473.488
0.1000	0.0378	0.117	665.686	4.633	18305.580	2.357	13108.166	2.357	13108.166
0.1500	0.0568	0.163	898.499	4.473	17063.252	2.211	11926.090	2.211	11926.090
0.2000	0.0757	0.202	1083.010	4.330	15978.239	2.082	10899.039	2.082	10899.039
0.2500	0.0946	0.236	1229.353	4.202	15026.882	1.967	10003.476	1.967	10003.476
0.3000	0.1135	0.266	1345.491	4.087	14189.400	1.865	9219.736	1.865	9219.736
0.3500	0.1324	0.291	1437.692	3.983	13449.219	1.773	8531.353	1.773	8531.353
0.4000	0.1513	0.314	1510.893	3.889	12792.425	1.691	7924.513	1.691	7924.513
0.4500	0.1702	0.335	1568.987	3.803	12207.311	1.617	7387.603	1.617	7387.603
0.5000	0.1892	0.353	1615.049	3.724	11684.001	1.550	6910.837	1.550	6910.837
0.5500	0.2081	0.369	1651.512	3.652	11214.149	1.489	6485.952	1.489	6485.952
0.6000	0.2270	0.384	1680.301	3.586	10790.685	1.434	6105.955	1.434	6105.955
0.6500	0.2459	0.398	1702.946	3.525	10407.600	1.383	5764.913	1.383	5764.913
0.7000	0.2648	0.410	1720.661	3.468	10059.780	1.336	5457.779	1.336	5457.779
0.7500	0.2838	0.421	1734.411	3.415	9742.857	1.293	5180.252	1.293	5180.252
0.8000	0.3027	0.432	1744.969	3.365	9453.095	1.254	4928.655	1.254	4928.655
0.8500	0.3216	0.442	1752.952	3.319	9187.285	1.217	4699.837	1.217	4699.837
0.9000	0.3405	0.451	1758.852	3.276	8942.667	1.183	4491.094	1.183	4491.094
0.9500	0.3594	0.459	1763.066	3.235	8716.858	1.151	4300.093	1.151	4300.093
1.0000	0.3783	0.467	1765.913	3.197	8507.797	1.122	4124.821	1.122	4124.821
1.0500	0.3973	0.475	1767.651	3.161	8313.696	1.094	3963.536	1.094	3963.536
1.1000	0.4162	0.482	1768.487	3.126	8132.998	1.069	3814.723	1.069	3814.723
1.1500	0.4351	0.489	1768.591	3.094	7964.346	1.044	3677.067	1.044	3677.067
1.2000	0.4540	0.495	1768.098	3.063	7806.550	1.021	3549.415	1.021	3549.415
1.2500	0.4729	0.501	1767.122	3.033	7658.568	1.000	3430.763	1.000	3430.763
1.3000	0.4918	0.507	1765.752	3.005	7519.482	0.979	3320.226	0.979	3320.226
1.3500	0.5108	0.513	1764.065	2.979	7388.483	0.960	3217.027	0.960	3217.027
1.4000	0.5297	0.518	1762.120	2.953	7264.855	0.942	3120.481	0.942	3120.481
1.4500	0.5486	0.523	1759.969	2.928	7147.961	0.925	3029.981	0.925	3029.981
1.5000	0.5675	0.528	1757.653	2.905	7037.236	0.908	2944.990	0.908	2944.990
1.5500	0.5864	0.532	1755.208	2.882	6932.177	0.892	2865.029	0.892	2865.029
1.6000	0.6053	0.537	1752.660	2.860	6832.332	0.877	2789.671	0.877	2789.671
1.6500	0.6243	0.541	1750.035	2.839	6737.296	0.863	2718.537	0.863	2718.537
1.7000	0.6432	0.545	1747.351	2.819	6646.707	0.850	2651.285	0.850	2651.285
1.7500	0.6621	0.549	1744.625	2.799	6560.238	0.836	2587.610	0.836	2587.610
1.8000	0.6810	0.553	1741.871	2.780	6477.591	0.824	2527.235	0.824	2527.235
1.8500	0.6999	0.557	1739.100	2.762	6398.500	0.812	2469.912	0.812	2469.912
1.9000	0.7188	0.561	1736.322	2.745	6322.723	0.800	2415.417	0.800	2415.417
1.9500	0.7378	0.564	1733.545	2.727	6250.038	0.789	2363.547	0.789	2363.547
2.0000	0.7567	0.568	1730.775	2.711	6180.244	0.779	2314.116	0.779	2314.116
-	-	Numbers	Grams	Numbers	Grams	Numbers	Grams	Numbers	Grams

(cont.)

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
2.0500	0.7756	0.571	1728.017	2.695	6113.157	0.768	2266.958	0.768	2266.958
2.1000	0.7945	0.574	1725.277	2.679	6048.611	0.759	2221.919	0.759	2221.919
2.1500	0.8134	0.577	1722.558	2.664	5986.450	0.749	2178.859	0.749	2178.859
2.2000	0.8323	0.580	1719.862	2.649	5926.533	0.740	2137.652	0.740	2137.652
2.2500	0.8513	0.583	1717.194	2.635	5868.731	0.731	2098.179	0.731	2098.179
2.3000	0.8702	0.586	1714.554	2.621	5812.922	0.722	2060.334	0.722	2060.334
2.3500	0.8891	0.589	1711.945	2.608	5758.998	0.714	2024.018	0.714	2024.018
2.4000	0.9080	0.592	1709.367	2.594	5706.854	0.706	1989.140	0.706	1989.140
2.4500	0.9269	0.595	1706.822	2.581	5656.397	0.698	1955.616	0.698	1955.616
2.5000	0.9458	0.597	1704.311	2.569	5607.538	0.691	1923.368	0.691	1923.368
2.5500	0.9647	0.600	1701.834	2.557	5560.196	0.684	1892.325	0.684	1892.325
2.6000	0.9837	0.602	1699.391	2.545	5514.295	0.676	1862.420	0.676	1862.420
2.6500	1.0026	0.605	1696.982	2.533	5469.764	0.670	1833.592	0.670	1833.592
2.7000	1.0215	0.607	1694.609	2.522	5426.536	0.663	1805.783	0.663	1805.783
2.7500	1.0404	0.609	1692.270	2.510	5384.550	0.656	1778.941	0.656	1778.941
2.8000	1.0593	0.612	1689.965	2.500	5343.749	0.650	1753.015	0.650	1753.015
2.8500	1.0782	0.614	1687.695	2.489	5304.077	0.644	1727.959	0.644	1727.959
2.9000	1.0972	0.616	1685.459	2.479	5265.486	0.638	1703.730	0.638	1703.730
2.9500	1.1161	0.618	1683.257	2.468	5227.926	0.632	1680.288	0.632	1680.288
3.0000	1.1350	0.620	1681.089	2.458	5191.353	0.627	1657.595	0.627	1657.595
-	-	Numbers	Grams	Numbers	Grams	Numbers	Grams	Numbers	Grams

Notes: Run name : YIELD3
Date and time : 27MAY99:14:46
Computation of ref. F: Simple mean, age 4 - 9
F-0.1 factor : 0.4958
F-max factor : 1.1325
F-0.1 reference F : 0.1876
F-max reference F : 0.4285
Recruitment : Single recruit

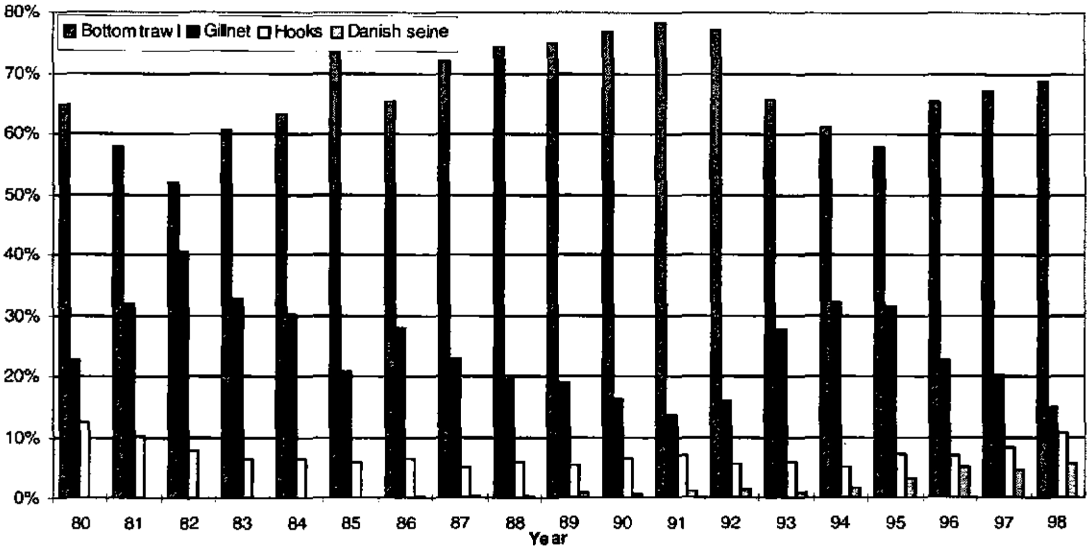


Figure 3.2.1. Saithe in division Va. Proportional catches in different gears 1980-1998.

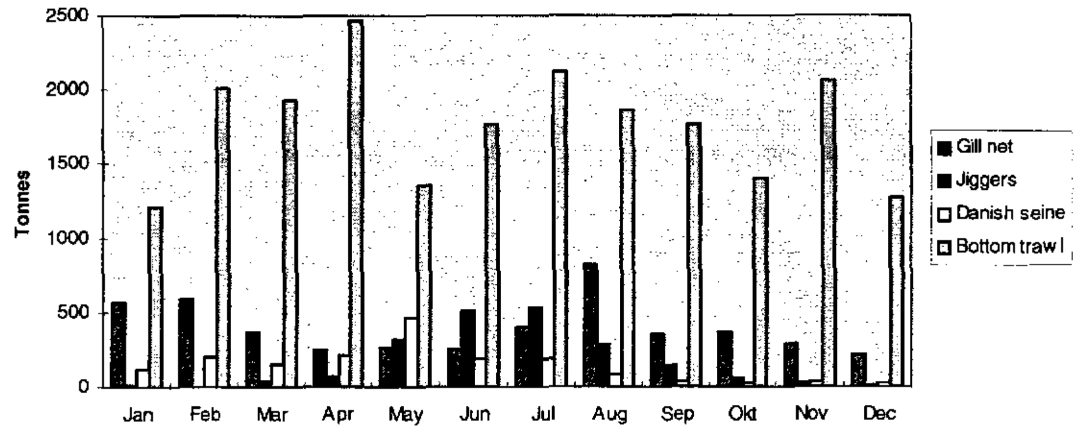


Figure 3.2.2. Proportional landings of saithe in div. Va by gear and month in 1998.

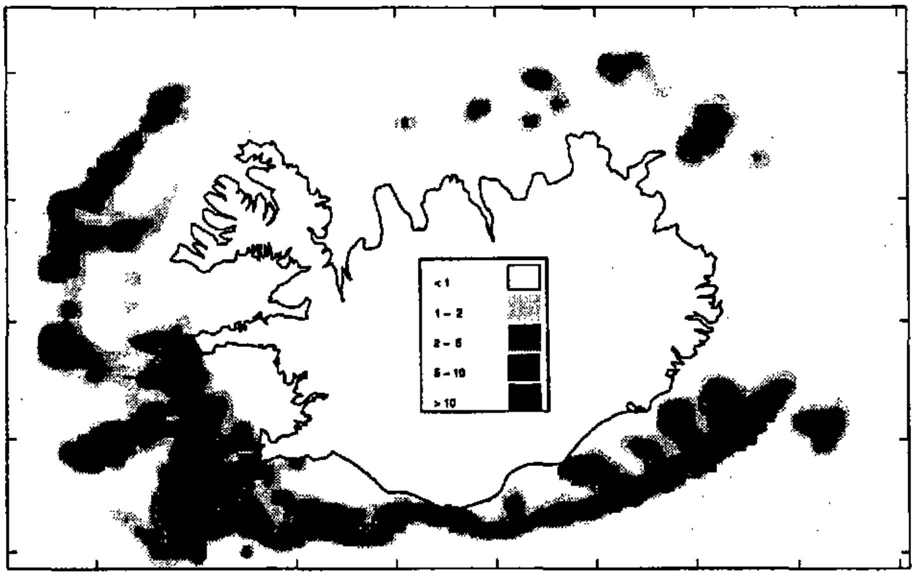


Figure 3.2.3. Saithe in div. Va. Bottom trawl catches in the period 1991-1998 (tonnes/square nm).

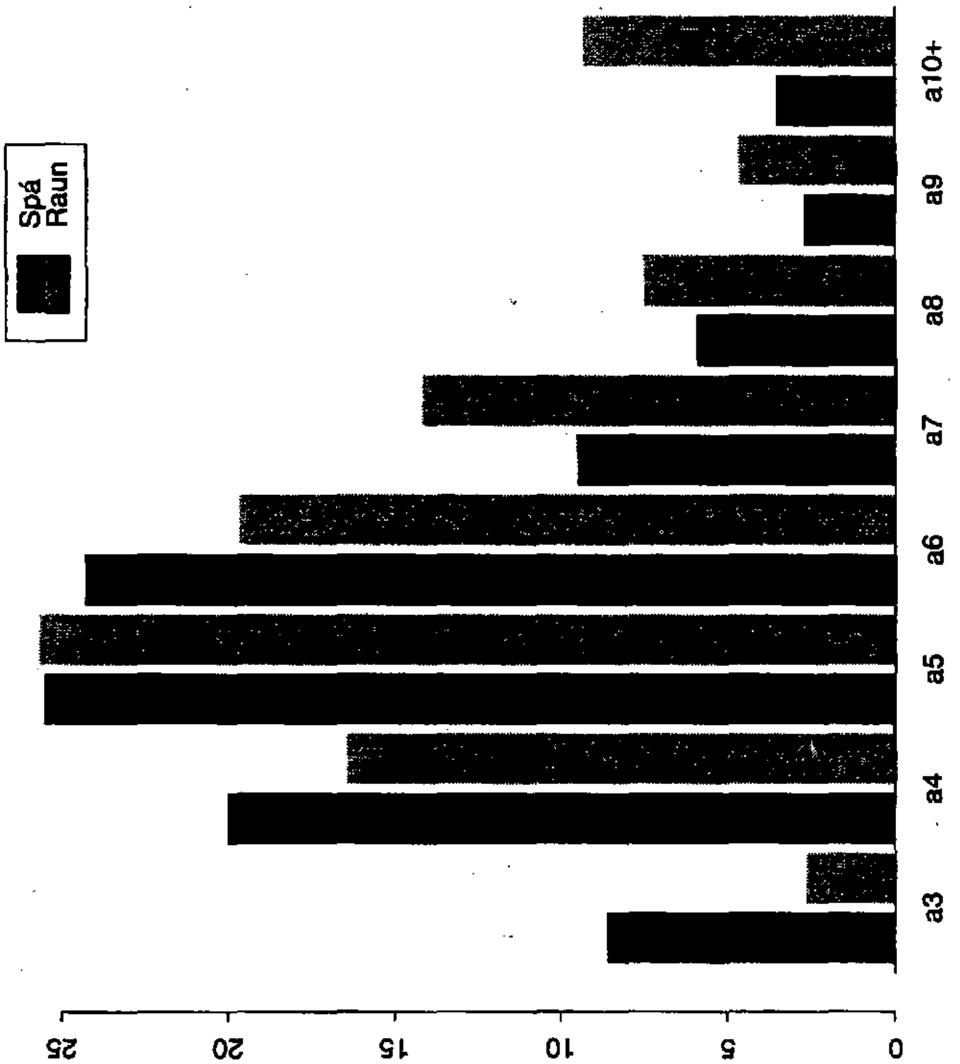


Figure 3.2.4. Saithe in div. Va. Prognosis in May 1998 (dark bars/spá) and estimate in April 1999 (lighter bars/raun) for percent (by number) age distribution in 1999 landings.

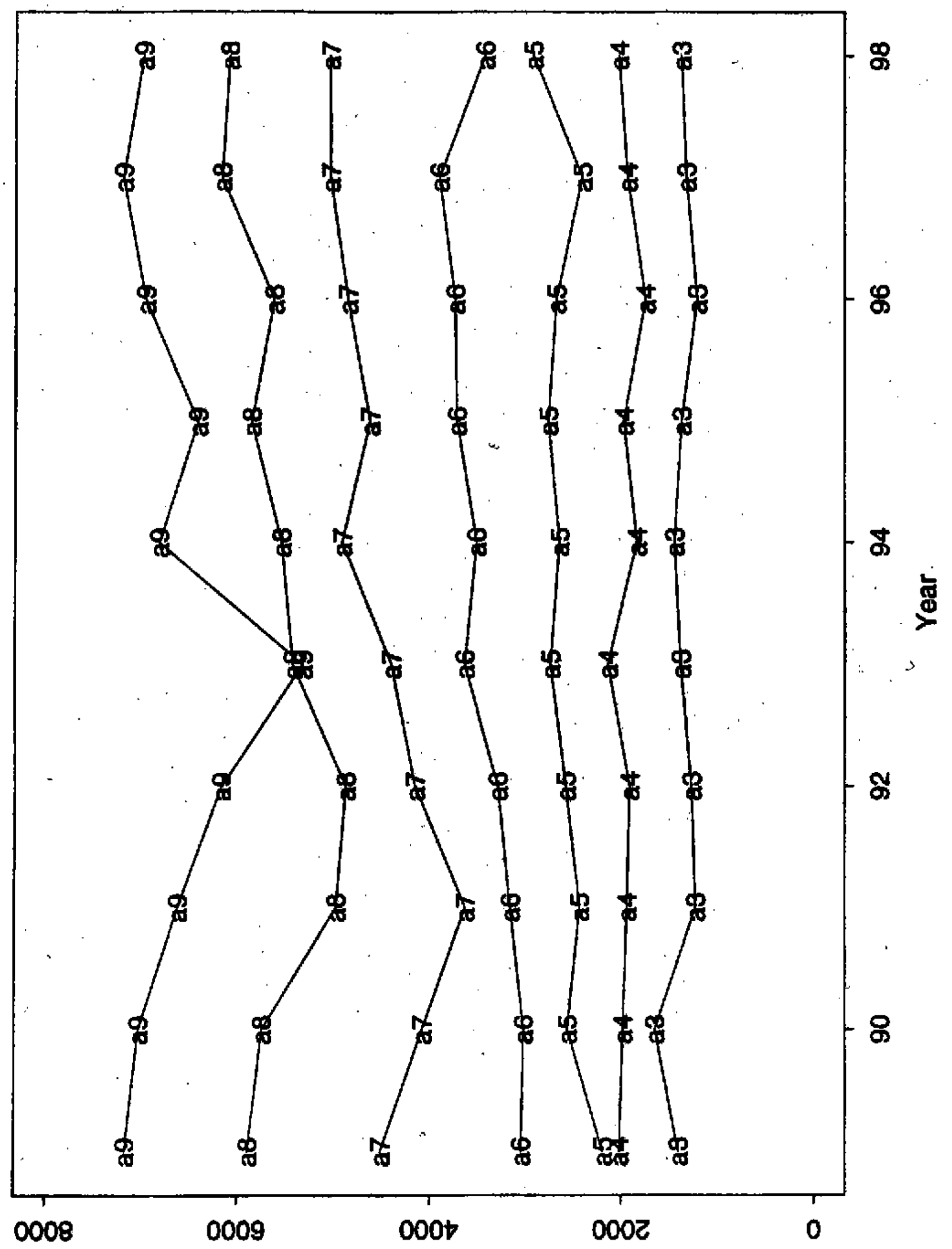


Figure 3.2.5..Saithe in div. Va. Mean weight at age in the catches 1986-1998 for age groups 3-9.

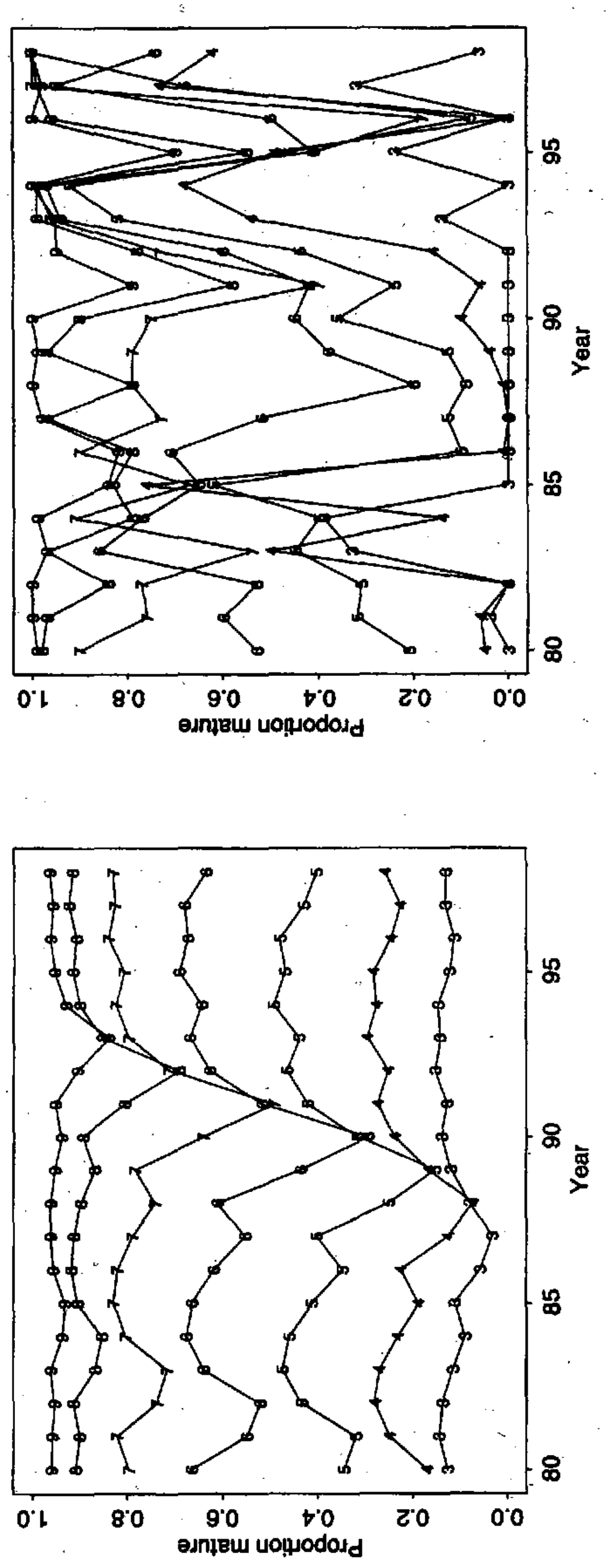
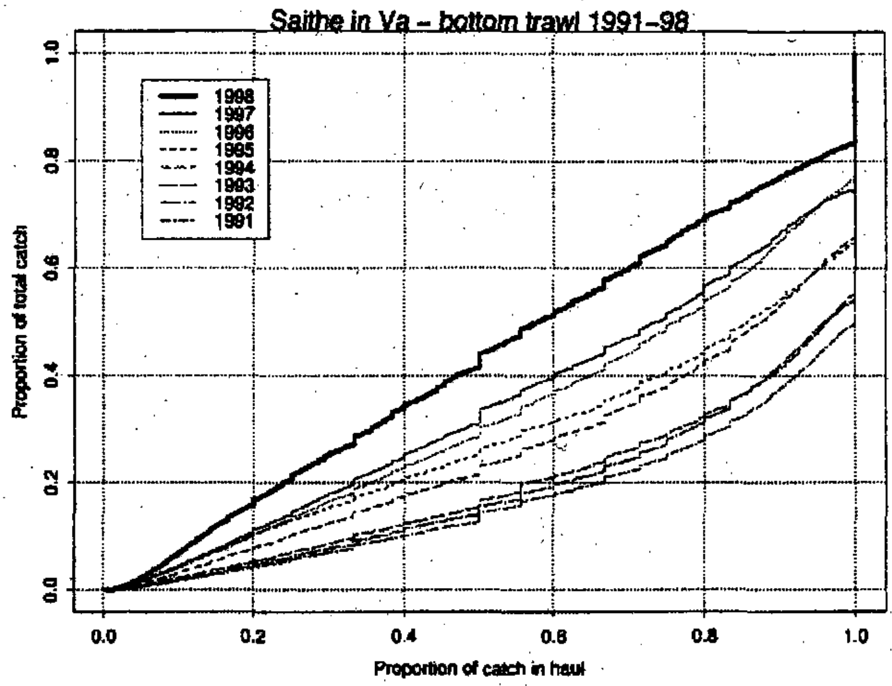


Figure 3.2.6. Saithe in division Va. Maturity at age, data and fitted values 1980-1998 for age groups 3-9.



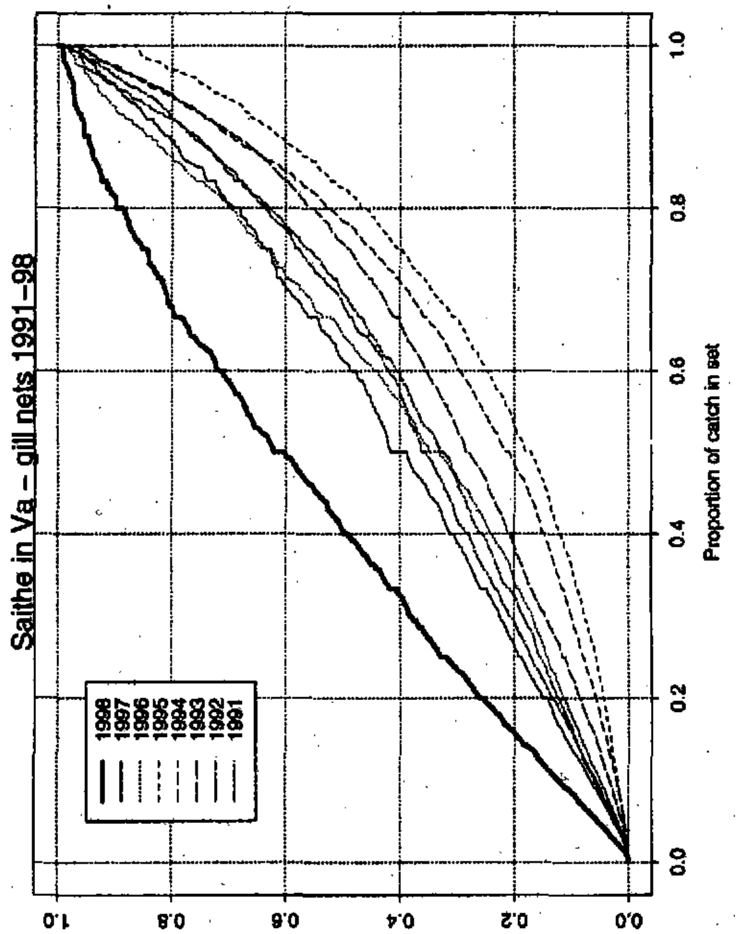
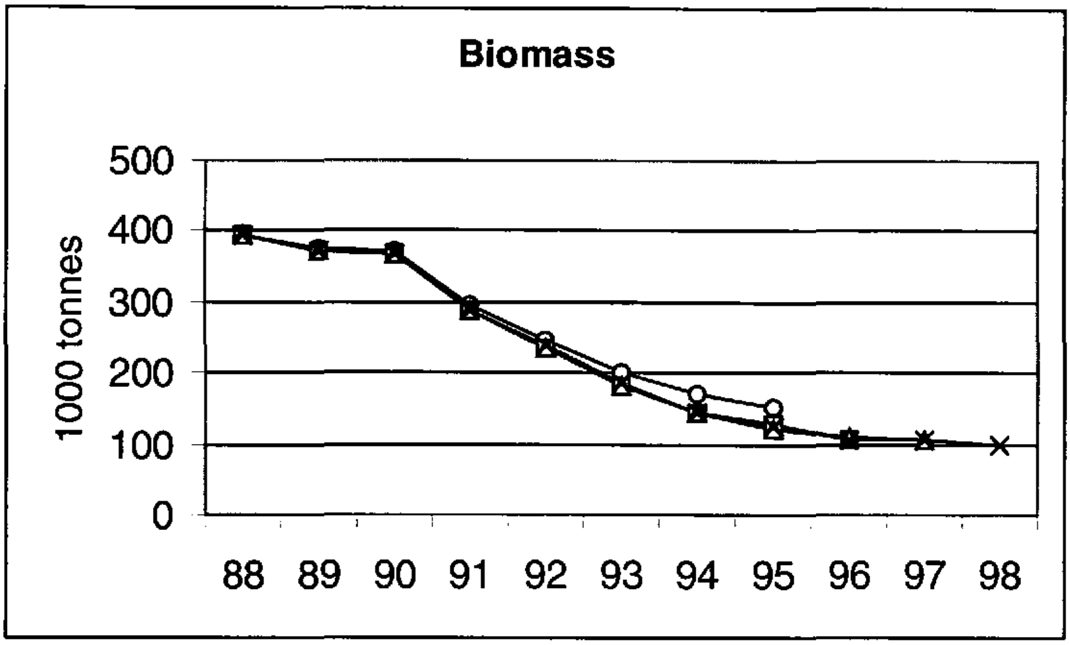
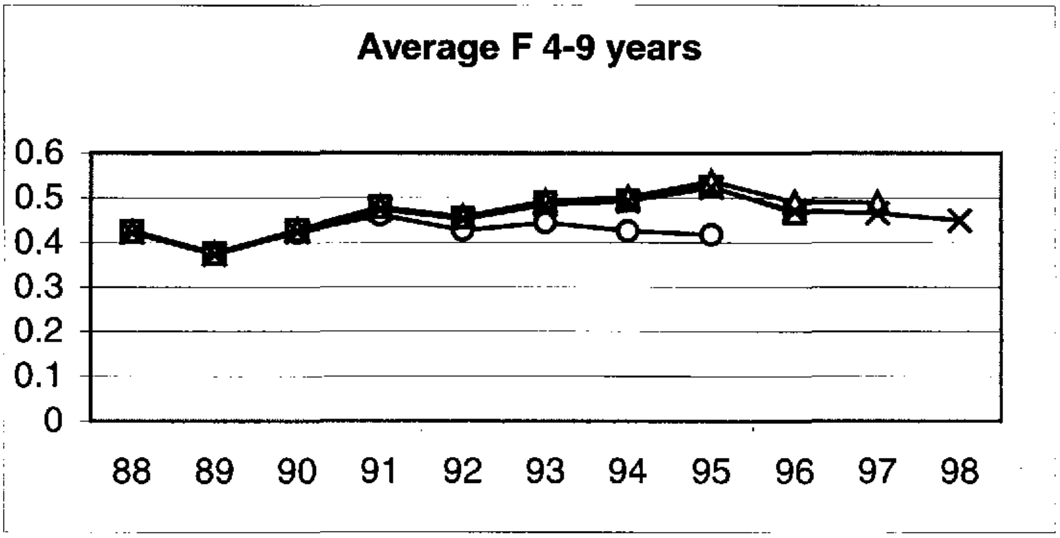


Figure 3.2.7. Saithe in div. Va. Cumulative catch *vs* proportion in catch from individual fishing trials for bottom trawl (top) and gillnets (botttom).





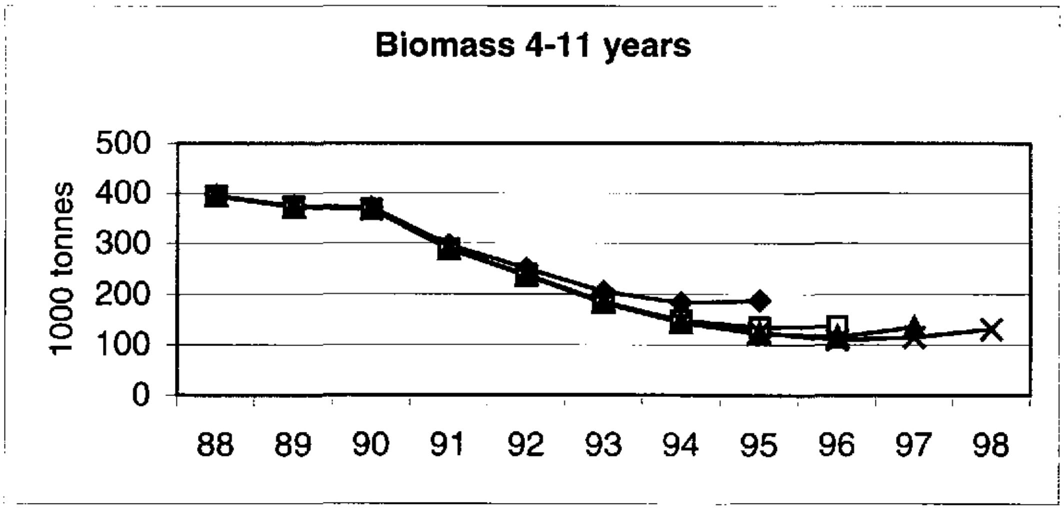


Figure 3.2.8. Saithe in division Va. Retrospective TS Analysis. Catch in numbers at age of age groups 4-11. Biomass and F_{4-9} with linear trend in recruitment, top; biomass with no trend in recruitment, bottom.

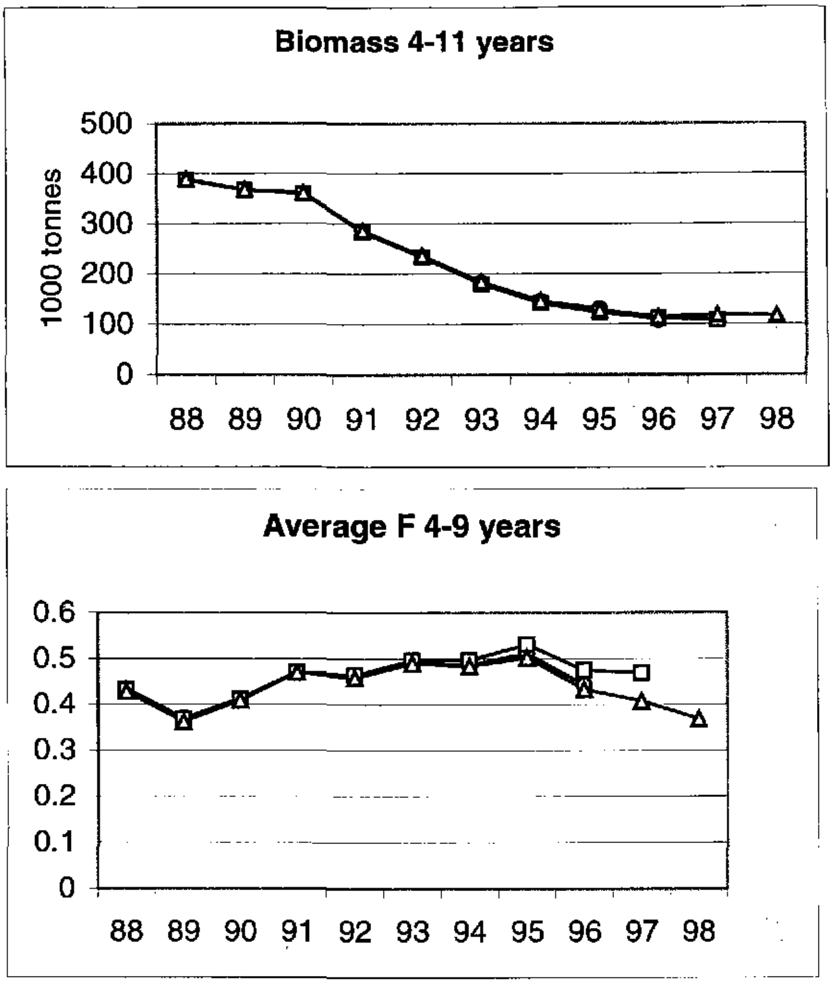
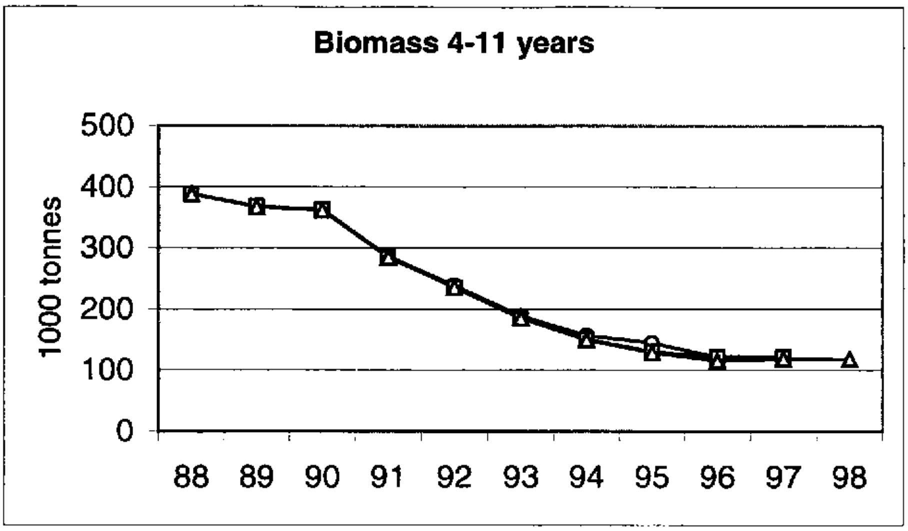


Figure 3.2.9. Saithe in division Va. Retrospective TS Analysis. Catch in numbers at age of age groups 4-11. GLIM50+ for gill nets. Linear trend in recruitment.



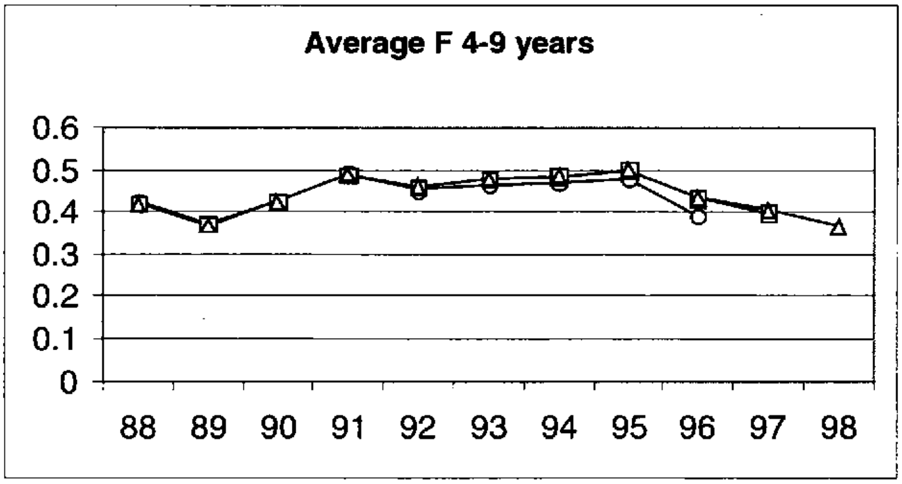
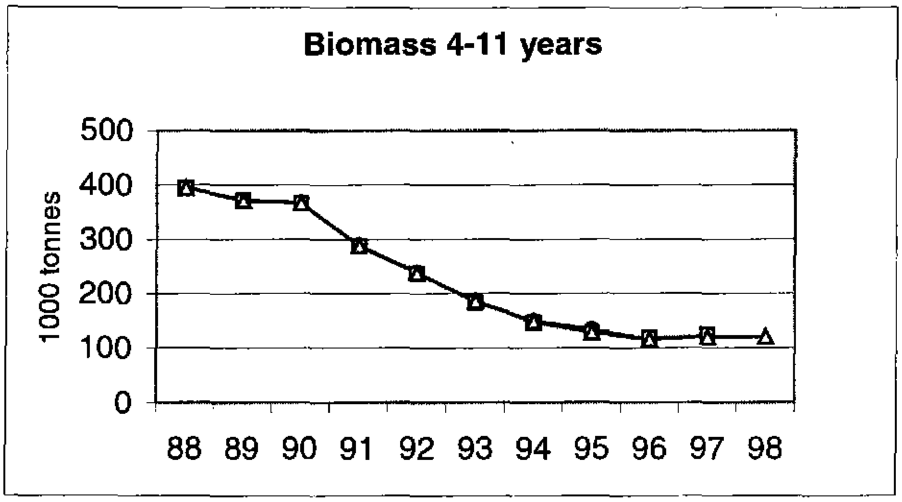


Figure 3.2.10. Saithe in division Va. Retrospective TSAnalysis. Catch in numbers at age of age groups 4-11. GLIM50+ for trawlers jan-may. Linear trend in recruitment.



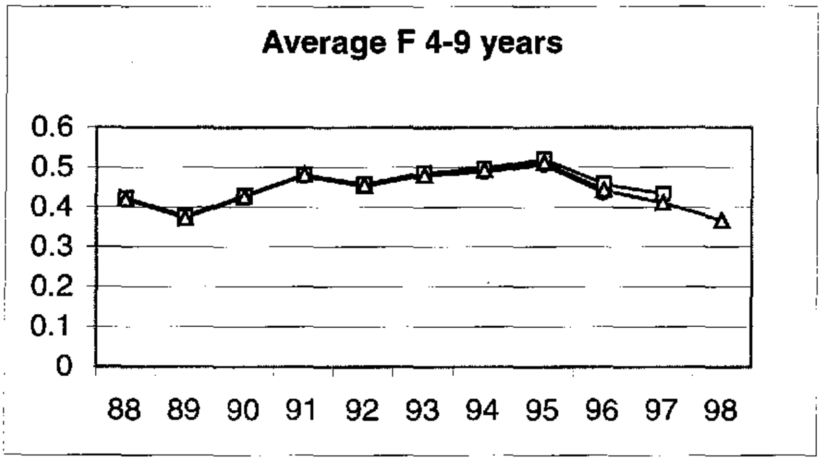


Figure 3.2.11. Saithe in division Va. Retrospective TS Analysis. Catch in numbers at age of age groups 4-11. GLIM50+ for trawlers jun-dec. Linear trend in recruitment.

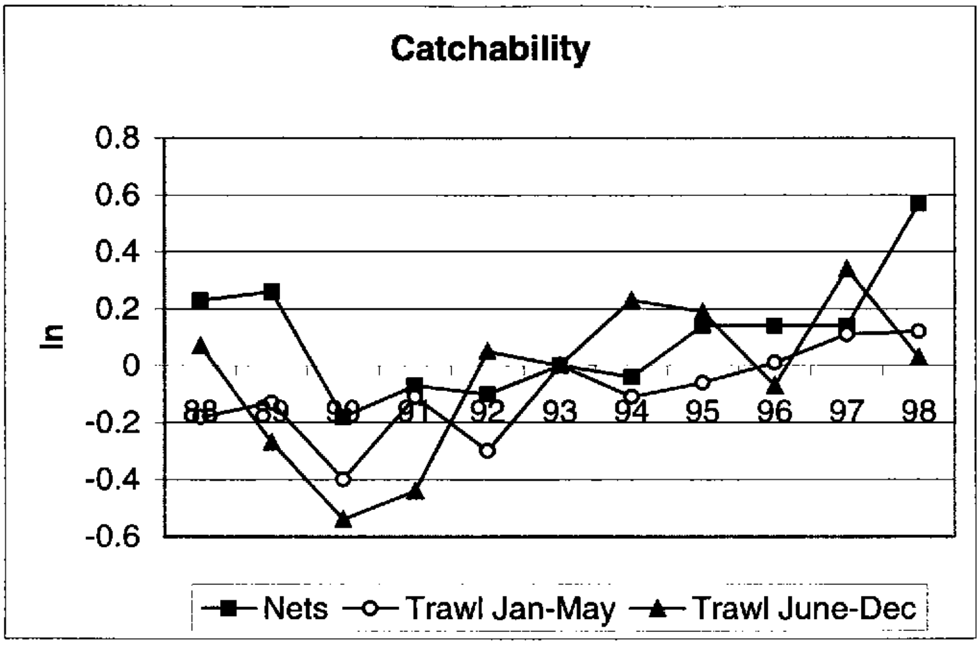


Figure 3.2.12. Saithe in division Va. Relative changes in catchability as estimated with TSA.

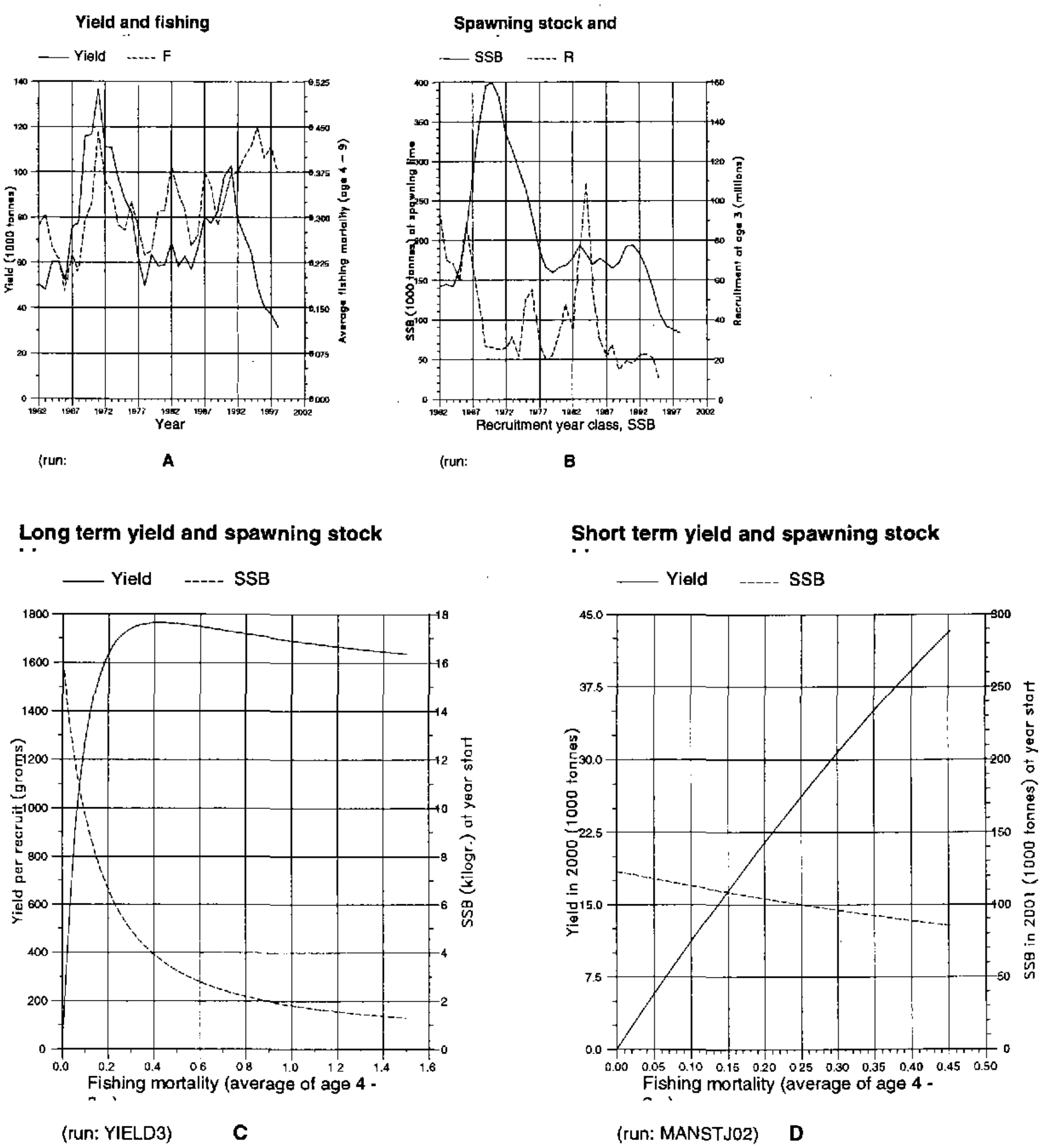


Figure 3.2.13. Saithe in division Va. Fish stock summary

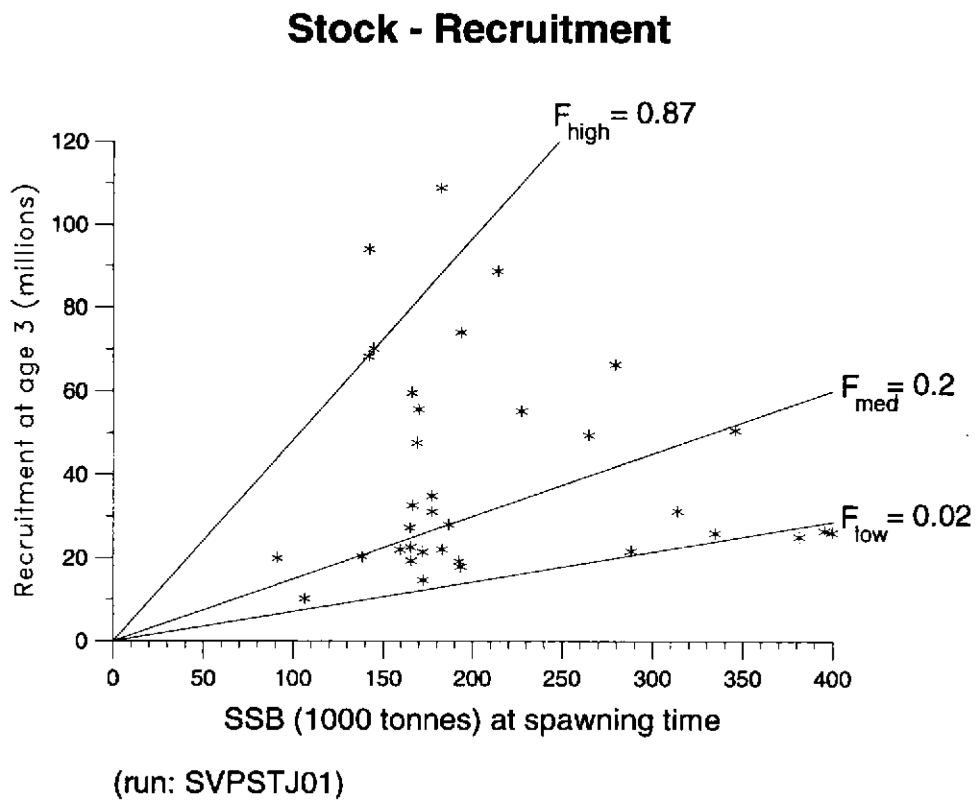


Figure 3.2.14. Saithe in division Va. Stock and recruitment.

3.3 Icelandic cod (Division Va)

3.3.1 Trends in landings and fisheries

In the period 1978–1981 landings of cod increased from 320 000 t to 469 000 t due to immigration of the strong 1973 year class from Greenland waters combined with an increase in fishing effort. Catches then declined rapidly to only 280 000 t in 1983. Although cod catches have been regulated by quotas since 1984, catches increased to 392 000 t in 1987 due to the recruitment of the 1983 and 1984 year classes to the fishable stock in those years (Table 3.3.1).

During the period 1988-1996 all year classes entering the fishable stock have been well below average, or even poor, resulting in a continuous decline in the landings. The 1995 catch of only 170 000 t is the lowest catch level since 1942. Since 1993 a marked reduction in effort against cod has taken place (Table 3.3.2 and Figure 3.3.1) due to further reduction in quota and a diversion of the effort towards other stocks and areas. As a result of these cod catch rates for all fleet categories have been increasing sharply, except of the gillnet fleet in 1998. (Table 3.3.2 and Figure 3.3.2).

Due to an increase of the fishable stock biomass landings in 1996 to 182 000 t and 204 000 t in 1997. For 1997/1998 fishing year the quota was set at 218 000 t and for the 1998/199 fishing year the quota was increased to 250 000 t. Landings in 1998 amounted 243 000 t.

3.3.2 Catch in numbers at age and level of sampling

The fleet fishing for cod at Iceland operates throughout the year. The fishing vessels are of different sizes but can however be grouped into three main categories:

1. Trawlers; > 300 GRT.
2. Multi-gear boats; < 300 GRT
3. Small boats; < 20 GRT

The trawlers operate throughout the year outside the 12 mile limits. They follow the spawning and feeding migration patterns of cod and fish on spawning grounds off the south west and south-coasts during the spawning season but move to feeding areas off the northwest coast during the summer time. During the autumn, this fleet is more spread out. The multi-gear boats operate mainly using gillnet during the spawning season in winter and spring along the south-west coasts but in recent years this fleet has also used gillnet in late autumn. Part of this fleet uses longlines during autumn and early winter. During summer some of these boats trawl along the coast out to the 3 mile limit. Others fish with Danish seines close to the shore. Most of the smaller boats operate with handlines mainly in shallow waters during the summer and autumn period. In recent year the mesh sizes used by the gillnet fleet have been increasing.

The data samples comprising the age-length keys for 1998 are given in the following table:

Gear	Period	Area	Landings	Nos. samples	Nos fish measured	Nos. fish aged
Longline	Jan-May	S	13592	13	3543	878
Gillnet	Jan-May	S	48584	15	13480	3869
Handlines	Jan-May	S	2188	5	1288	390
Danish seine	Jan-May	S	7096	6	997	189
Bottom trawl	Jan-May	S	18675	59	12238	1403
Longline	Jan-May	N	7862	11	2402	193
Gillnet	Jan-May	N	1448	2	1594	813
Handlines	Jan-May	N	731	1	2011	0
Bottom trawl	Jan-May	N	20587	53	12208	1339
Longline	Jun-Dec	S	6940	8	1883	51
Handlines	Jun-Dec	S	3792	7	1533	395
Danish seine	Jun-Dec	S	4229	3	326	0
Bottom trawl	Jun-Dec	S	8691	33	7448	363
Longline	Jun-Dec	N	12815	14	3028	193
Gillnet	Jun-Dec	N	1522	1	214	0
Handlines	Jun-Dec	N	14783	6	1329	298
Danish seine	Jun-Dec	N	5558	3	723	197
Bottom trawl	Jun-Dec	N	63892	146	30607	750
Total			242985	386	96852	11321

The fleets (or "metiers") are defined by the gear, season and area combinations. The gears are long lines, bottom trawl, gillnets, handlines and Danish seine. In the historical data sets each of these classes may contain related gears (based on sparseness of data and low catches). Notably handlines are included with long lines and pelagic trawl is included with the bottom trawl. The basic areas splits are the "northern" and "southern" areas. In the historical data set, seasons are split into the "spawning" season (January-May) and "non-spawning" season (June-December). Historically, there have been some changes in fleet definitions and thus there does not currently exist a fully consistent set of catch-at-age data on a per-fleet basis.

Total catch at age (aggregated across fleets) was used as VPA input, and seasonal data (aggregated across gears and regions) were used to estimate the proportion of fishing mortality in January-May.

The total catch-at-age data is given in Table 3.3.3. It should be noted that much higher proportions of the older age groups are taken during the first part of the year and this will considerably affect the estimation of the spawning stock at spawning time. Since the catch-at-age data have historically only been available for January to May, and not by shorter seasons, it is assumed that 60% of those catches were taken during January to March, i.e., before spawning time (Table 3.3.4).

In recent years emphasis has been put on improving the sampling scheme in order to obtain the most realistic information on catch at age The data for these calculations is based on samples taken from all gears on the main fishing grounds throughout the year. In recent years, annually 10 000 –15 000 cod otoliths have been read. The age-length keys have then been used to convert about 100 000–150 000 length measurements also collected throughout the year.

Because of the quota system the question about discarding has been revived. There is, however, no information available for the time being and discarding is not thought to be a major problem at present.

3.3.3 Mean weight at age

3.3.3.1 Mean weight at age in the landings

Mean weight at age in the landings are computed using samples of otoliths and lengths along with length distributions and length-weight relationships.

The mean weights at age are computed for the same categories as the catch numbers at age and are then weighted together across the fleet categories. The data are given in Table 3.3.5. Decline in weight at age for ages was observed in 1998. Mean weights at age are not available on an annual basis for catches taken before 1973, and hence the average across the years 1973 - 1991 is used as the constant (in time) mean weight at age for earlier years.

3.3.3.2 Mean weight at age in the stock

The weights at age in the landings have been used without modification to compute general stock biomasses, with the exception of the spawning stock biomass (see below).

The Icelandic groundfish survey does provide better estimates of mean weights at age in the stock, but it is not at all clear how these should be combined across areas which have different catchabilities, and in any case these weights are only available back to 1985.

3.3.3.3 Mean weight at age in the spawning stock

For years up to 1998, data from the period January-May have been used for the estimation of the mean weights at age in the spawning stock. It is assumed that the catches in the different gears and areas appropriately reflect the stock composition with regard to mean weight at age. These weight-at-age data are presented in Table 3.3.6. Decline in weight at age for younger ages was observed in 1998.

3.3.4 Maturity at age

Maturity at age is based on samples from the commercial fleets in the months January-May (ICES 1992/Assess:14). It has been pointed out that using data collected throughout the year may bias the proportion mature in various ways (Stefánsson, 1992). The approach taken is, therefore, to compute the proportion mature at the time of spawning, by considering only the first part of the year (January-May), but aggregating across gears and regions.

There was a marked increase in the proportion of mature fish at age during the period 1992–1997 but in 1998 some decrease could be noted (Figure .3.3.3).

The maturity-at-age data are not available on an annual basis for the catches taken prior to 1973 and, hence, the average for the years 1973–1991 is used as a constant (in time) maturity at age for the years prior to 1973.

3.3.5 Stock Assessment

3.3.5.1 Tuning data

Commercial trawler CPUE data were analysed as described in Stefansson (1988) to yield GLM indices of abundance (numbers) at age. The analysis takes into account catchability changes in the fleet due to vessel renewal and vessels shifting between regions, but not changes in the spatial distribution of the resource or changes within vessels in the fleet. For this reason the analysis of the logbook data was restricted to the years 1993–1998.

These indices are based on logbooks from demersal trawl fisheries for two parts of the year (January-May and June-December) and two areas i.e. south-western areas, and northern areas (Table 3.3.7).

The same method was applied for the gillnet fleet. Logbooks for this fleet have been analysed for the years 1993–1998 but are available since 1988. However information based on these logbooks for the years 1988–1990 is scarce as the logbooks were not mandatory until 1991. The gillnet fleet operates mainly during the spawning season and at the spawning grounds off the south and west coasts of the island. This fishery has often been referred to as "the spawning fishery" in earlier reports of this Working Group. The GLM indices presented here (Table 3.3.8).are based on the gillnet fishery in the south and west areas during January-May.

The Icelandic groundfish survey data (Palsson *et al.*, 1989) are used as part of the assessment. A description of the Icelandic groundfish survey design is given the 1998 WG report (ICES 1998/ACFM:19). The basic data are age-disaggregated (Palsson and Stefansson, 1991) and abundance indices computed by using the a modified Gamma-Bernoulli (G-B) method to accommodate spatial information in an appropriate manner. The method is described in Working Paper by H. Björnsson, Annex I in ICES (1994/Assess:19). Indices are calculated for three areas i.e southwestern, southeastern and the northern areas separately, age groups 3 to 14 and for the years 1985–1998.

To use the latest information available in the XSA, the 1999 survey abundance indices were moved back in time of approximately three months i.e. to December 1998 for the age groups 4-9. The same applies to abundance indices for the other survey years. For the age group 3 and age group 2 no shifting in time has taken place. The resulting indices are given in Table 3.3.9 by fleet, area and age group.

3.3.5.2 Assessment methods

Migrations from Greenland into the Icelandic cod stock can have major effects and hence these need to be taken into account in the assessments. Time series analysis (TSA) of Gudmundsson (1984) and an ADAPT-type of method (Stefansson, 1992) which were applied to this stock earlier (ICES 1992/Assess:14) can estimate migration for a given year and age. As the ADAPT-method uses an average selection pattern in determining the terminal fishing mortality recent changes in fishing pattern can not be accounted for. In recent years the Group has used the XSA-method even though the XSA has not been developed to account for migration – but there is a way to handle this:

XSA uses a cohort-analysis to project the stock (or back calculating):

$$N_{a,y} = e^{-M} N_{a-1,y-1} - e^{-M/2} C_{a-1,y-1} \text{ or}$$
$$N_{a-1,y-1} = e^{M} N_{a,y} + e^{M/2} C_{a-1,y-1}$$

were N is stock size and C is catch in numbers and M natural mortality. If fish of age a and in the year y is migrating, in amount of G, to the stock in the beginning of the year, then the cohort equation will be:

$$N_{a,y} = e^{-M} N_{a-1,y-1} - e^{-M/2} C_{a-1,y-1} + G_{a,y}$$

and in back calculation the equations will be:

$$N_{a-1,y-1} = e^{M}\left(N_{a,y} - G_{a,y}\right) + e^{M/2}C_{a-1,y-1}$$
$$= e^{M}N_{a,y} + e^{M/2}\left(C_{a-1,y-1} - e^{M/2}G_{a,y}\right)$$

That is, if the size of the migration, G, is approximately known it can be implemented into the cohort equations by changing the catch-in-numbers the year before, for the cohort in question. The results are stock in numbers taking into account the migration but the fishing mortality given for age $a-1$ and year $y-1$ will be incorrect and the correct value can be calculated by:

$$F_{a,-1,y-1} = \ln\left(\frac{N_{a-1,y-1}}{N_{a,y} - G_{a,y}}\right) - M$$

For the Icelandic cod the estimated immigration of 6 years old cod in the year 1990 is about 30 millions at beginning of the year. The total catch of 5 years old cod 1989 is estimated about 50 millions. The "corrected" catch of 5 years old cod of Icelandic origin in 1989 will then be:

$$50 - e^{0.2/2}30 = 16.8 \text{ millions}$$

which is the number used in the assessment.

3.3.5.3 Estimates of fishing mortality

Tuning fleets used and the relevant tuning indices are given in Tables 3.3.7.-3.3.9. As there has been a major decline in fishing effort for this stock during the most recent period the XSA was shrunk to the mean of the three latest years instead of using a default setting of five years. The retrospective analysis for this XSA with shrinkage of s.e.= 0.5 is given in Figure 3.3.4. The total output of the XSA is given in Table 3.3.10.

The resulting fishing mortalities from the final XSA are given in Table 3.3.11 and in Figure 3.3.5.A. The fishing mortality reached a peak in 1988 decreased in 1989 but then rose to another peak in 1993. Due to further restriction of the cod quota effort has dropped markedly in 1994 and again in 1995. Fishing mortality has decreased correspondingly and has not been so low since the late sixties. A slight increase in fishing mortality is noted in 1997 and 1998 (see Table 3.3.14). Present fishing mortality is at the F_{med} level.

3.3.5.4 Stock and recruitment estimates

The resulting stock size in numbers and spawning stock biomasses from the final VPA are given in Tables 3.3.12–13. In the stock in numbers table, the recruitment in the most recent years (year classes 1994–1998 as 3-year-olds in 1997-2001) was estimated using RCT3 as described in Section 3.3.7.1.

The current spawning stock at spawning time and recruitment levels must be considered in relation to historical sizes. The migration estimates of 39 and 7 million immigrants of the 1973 year class in 1980 and 1981, respectively are taken from the last 1993 ADAPT-assessment (ICES 1993/Assess:18). With given migration estimates, the recruitment from the SSB can be recomputed by adding back-calculated migration. The approach taken here is to do these back-calculations with natural mortality only, since it would be incorrect to use the sometimes high fishing mortalities at Iceland. This back calculation revises the 1973 and 1984 year class estimates to 433 and 334 millions, respectively. The resulting SSB and recruitment estimates are given in Table 3.3.14 along with average fishing mortalities. A better estimate might be obtained by back calculating using the fishing mortality at Greenland also, but this is unlikely to have major effects on the issue at hand which is the stock-recruitment diagram.

3.3.6 Biological and technical interactions

Several important biological interactions in the ecosystem around Iceland are connected to the cod stock. The single most important interaction is the cod-capelin connection (Pálsson, 1981) and this has been studied in some detail (Magnússon and Pálsson, 1989 and 1991a and Steinarsson and Stefánsson, 1991). Another important interaction is between cod and shrimp. This has been studied by Magnússon and Pálsson (1991b) and Stefánsson *et al.* (1994). The cod-capelin interaction is used in the short-term prediction in Section 3.3.7.1 based on the results in Steinarsson and Stefánsson (1996).

Various factors affect the natural mortality of cod and several of these factors will change in magnitude in the future. The cod is a cannibal and the mortality through cannibalism has been estimated in Björnsson (WD 26,1998).Table 3.3.15 shows that the cannibalism occur mainly on prerecruits and immature fish. Further, the minke whale, the harbour seal and the grey seal are apex predators, all of which consume cod to varying degrees. Most of these M values will affect cod at an early age, before recruitment to the fishery.

It has been illustrated that not only may cetaceans have a considerable impact on future yields from cod in Division Va (Stefánsson *et al.*, 1995), but seals may have an even greater impact (Stefánsson *et al.*, 1997). These results imply that predictions which do not take into account the possible effects of marine mammals may be too optimistic in terms of long-term yields. It is therefore desirable to include marine mammals as a part of future natural mortality for the cod stock.

A number of fleets operate in Division Va. The primary gears are described in Section 3.3.2. Earlier work by this group included the separation of catches into finer seasonal and areal splits, but this has not been taken further at this meeting.

A numerical description of interactions between fisheries and species requires data on landings as well as catches in numbers at age of each species by gear type, region and season.

3.3.7 Prediction of catch and biomass

3.3.7.1 Input data to the short-term prediction

For short-term predictions, it is essential to take into account potential changes in mean weights at age due to environmental conditions.

It has been shown that cod growth is to some extent correlated to size the of the capelin stock. Table 3.3.16 gives the size of the capelin stock biomass since 1979. The present data set differs from that previously used in that the adult stock in weight on 1st August were based on back calculations of the autumn surveys values but the new data set is based directly on observed weight in the autumn surveys.

Regressions are used to predict the mean weights at age for age groups 4-8 in the catches and ages 5-8 in the spawning stock for the years 1999-2001. For the year 2000 onwards, the average capelin biomass is used. For ages 3 and 9–14 respectively in both data sets and age 4 in the SSB, the average over the years 1996–1998 is used. (Table 3.3.19).

In the most recent period maturity at age has been at high levels compared to the years prior to 1992. A decline was note in 1998. For the short-term predictions the average for the years 1996–1998 has been used for the years 1999-2001.

The exploitation pattern used for the short-term predictions was taken as the average of the years 1996–1998 from the VPA rescaled to the 1998 fishing level.

The modified Delta-Gamma (D-E) method (ICES 1994/Assess:19) used for the analysis of the Icelandic Groundfish Survey and as tuning data for this stock was also used for recruitment prediction. The resulting indices used for recruitment prediction are given in Table 3.3.17. As an input to the RCT3 program age groups 1-4 from the survey were chosen.

The size of the year classes 1994–1998 has been estimated using RCT3, with the output as given in Table 3.3.18. Taking natural and fishing mortalities into account the revised recruitment estimates are then used in the predictions.

3.3.7.2 Short term prediction results

Results from projections up to the year 2001 with different fishing mortalities are given in Table 3.3.20.

Landings in 1999 are expected to be 260 000 t due an increase in the quota established. This will however mean a further decrease in fishing mortality to F=0.46 compared to F=0.49 in 1998.

Continuing fishing in 2000 at the 1998 level of fishing mortality (F=0.49) will stabilise the SSB at present level in the short term.

The average size of the year classes at present which mainly contribute to the fishable stock (1989–1996) is 148 million individuals. The yield-per-recruit computations indicate that the maximum obtainable yield per recruit is 1.77 kg. These two numbers indicate that the average yield from these year classes cannot be expected to exceed 262 000 t. From the RCT3 output the 1997 year class is at about average size and although the size of the 1998 year class is not well estimated at present the 1998 0-group index for cod is among the highest observed (Table 4.1.1).

3.3.7.3 Input data to the long-term prediction

For long-term predictions, fluctuating environmental conditions can be ignored, but it is essential to take into account potential changes due to density-dependent growth. These have been investigated for this stock (Steinarsson and Stefánsson, 1991 and ICES 1991/Assess:7) where no significant density-dependent relationships were found concerning growth. However, the results in Schopka (1994) contain indications of some density dependence of growth and this will affect the long-term results at low fishing mortalities. This is not taken into account in typical yield-per-recruit calculations.

Naturally, any stock-recruitment relationship will affect yield-potential calculations and this is not taken into account in the yield-per-recruit calculations.

Average exploitation pattern , mean weight at age and maturity at age over the years 1979–1998 has been used as input. (Table 3.3.21).

3.3.7.4 Long-term prediction results and biological reference points

The biological reference values for F_{max} and $F_{0.1}$ are 0.36 and 0.20 respectively. Yield per recruit at the F_{max}- level is 1.77 kg. (Figure 3.3.5 Table 3.3.22).

A plot of the spawning stock biomass and recruitment is given in Figure 3.3.6. When using the period 1955–1995, the reference points F_{med} and F_{high} are about 0.48 and 0.77, respectively.

The inclusion of the stock recruitment relationship has a major effect on long-term predictions. From Figure 3.3.6 it is seen that below-median recruitment occurs more frequently when the SSB is below-median than when the SSB is above the median. The increased probability of poor recruitment at low SSB levels is of major concern and the possibility of a stock-recruitment relationship cannot be fully ignored. However simulations have shown that the harvest control rule currently applied to this stock appears to be in accordance with the precautionary approach as there is a vey low probability of that the stock will be driven to very low levels.

3.3.8 Management considerations

In the most recent period, there has been a substantial reduction in fishing effort directed on cod (Table 3.3.2) and hence in fishing mortality (Figure 3.3.5). Fishing mortality was at the level of F=0.80-0.90 in 1992–1993 but dropped considerably to F=0.43 in 1996. In 1998 it increased to F=0.49 which is at the F_{med} level.

Medium-term predictions have been carried out during previous meetings (Anon. 1995/Assess:19 Anon. 1997/Assess:13). The model used incorporated the cod, capelin and shrimp stocks to account for interactions between these stocks. Based on similar calculations, Iceland introduced a catch rule in 1995 which has been enforced since then. According to this harvest control rule catches are limited to 25% of the fishable (4+) stock biomass calculated from the average stock at 1st of January of the previous year and the coming fishing year. In the long term this corresponds to a fishing mortality of about 0.4.

Since there is an adopted strategy for harvesting the cod stock off Iceland, and this strategy appears sustainable, there was no reason to repeat the medium-term predictions at this meeting.

Applying this management strategy for the 1999/2000 fishing year the catch will be 247 000 t which corresponds to F=0.44.

3.3.9 Comments on the assessment

Current assessment has been carried out in same manner as in recent years.

There has been a considerable decline in fishing mortality on this stock since 1993. This is verified in the sharp drop of effort for all fleets engaged in the cod fisheries (Table 3.3.2).

All short-term results on the size of SSB depend heavily on the assumed development in maturity at age, which is difficult to estimate or predict accurately.

It is clear that the stock was heavily overexploited for a long time but is now recovering which is expected to continue under the current management scheme.

Table 3.3.1 Nominal catch (tonnes) of Cod in Division Va, by countries, 1985- 1998 as officially reported to ICES.

Country	1985	1986	1987	1988	1989	1990	1991
Belgium	207	226	597	365	309	260	548
Faroe Islands	2,203	2,554	1,848	1,966	2,012	1,782	1,323
Iceland	322,810	365,852	389,808	375,741	353,985	333,348	306,697
Norway	46	1	4	4	3	-	-
UK (Engl. and Wales)	1	-	-	-	-	-	-
Total	325,267	368,633	392,257	378,076	356,309	335,390	308,568
WG estimate	-	-	-	-	-	-	-

Country	1992	1993	1994	1995	1996	1997	1998 [1]
Belgium	222	145	136	-	-	Germany	9
Faroe Islands	883	664	754	739	599	408	
Iceland	266,662	251,170	177,919	168,685	181,052	202,745	241,627
Norway	-	-	-	-	7	-	-
UK (Engl. and Wales)	-	+	-	-	-	-	-
Total	267,767	251,979	178,809	169,424	181,658	203,153	
WG estimate	-	-	-	-	-	-	242,994 [2]

1) Provisional.
2) Additional landings by Iceland of 655 t, and Faroes of 703 t are included.

Table 3.3.2. Cod at Iceland. Division Va. Landings (tonnes), effort, cpue and percentage changes in effort and cpue in the period 1991-1998 (with 1991 as 100%). Data are based on logbooks which have been mandatory in the fisheries since 1991.

Bottom trawl

Year	Catch	effort	effort % changes	cpue	cpue % changes
1991	175142	234946	100	745	100
1992	131504	228196	97	576	77
1993	114587	182882	78	627	84
1994	66186	83975	36	788	106
1995	57787	67944	30	851	114
1996	64849	64838	29	997	134
1997	82840	76077	32	1095	147
1998	109947	85314	36	1289	167

Gillnet

Year	Catch	effort	effort % changes	cpue	cpue % changes
1991	58948	1060	100	56	100
1992	59712	984	93	61	109
1993	56701	1008	95	56	101
1994	39192	718	68	55	98
1995	32309	437	41	74	133
1996	41764	492	46	85	153
1997	46742	483	46	97	174
1998	51554	721	68	71	127

Long line

Year	Catch	effort	effort % changes	cpue	cpue % changes
1991	44711	2006	100	22	100
1992	42301	2016	100	21	94
1993	47263	2224	111	21	95
1994	36426	1652	82	22	99
1995	44588	1724	86	26	116
1996	39770	1478	74	27	121
1997	31276	824	41	38	170
1998	37243	972	48	38	173

Table 3.3.3. Cod at Iceland. Division Va. Catch in numbers (millions)

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Marine Research Institute Fri Apr 23 11:45:15 1999
Virtual Population Analysis : Catch in numbers, millions
FINAL-VPA99
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Age	1979	1980	1981	1982	1983	1984	1985
3	7.186	4.348	2.118	3.285	3.554	6.750	6.457
4	28.427	28.530	13.297	20.812	10.910	31.553	24.552
5	13.772	32.500	39.195	24.462	24.305	19.420	35.392
6	34.443	15.119	23.247	28.351	18.944	15.326	18.267
7	14.130	27.090	12.710	14.012	17.382	8.082	8.711
8	4.426	7.847	26.455	7.666	8.381	7.336	4.201
9	1.432	2.228	4.804	11.517	2.054	2.680	2.264
10	0.350	0.646	1.677	1.912	2.733	0.512	1.063
11	0.168	0.246	0.582	0.327	0.514	0.538	0.217
12	0.043	0.099	0.228	0.094	0.215	0.195	0.233
13	0.024	0.025	0.053	0.043	0.064	0.090	0.102
14	0.004	0.004	0.068	0.011	0.037	0.036	0.038
Juvenile	66.657	74.804	79.027	73.043	58.426	65.651	69.001
Adult	37.748	43.878	45.407	39.449	30.667	26.867	32.496
Sum 3- 3	7.186	4.348	2.118	3.285	3.554	6.750	6.457
Sum 4-14	97.219	114.334	122.316	109.207	85.539	85.768	95.040
Total	104.405	118.682	124.434	112.492	89.093	92.518	101.497

Age	1986	1987	1988	1989	1990	1991	1992
3	20.642	11.002	6.713	2.605	5.785	8.554	12.217
4	20.330	62.130	39.323	27.983	12.313	25.131	21.708
5	26.644	27.192	55.895	50.059	27.179	15.491	26.524
6	30.839	15.127	18.663	31.455	44.534	21.514	11.413
7	11.413	15.695	6.399	6.010	17.037	25.038	10.073
8	4.441	4.159	5.877	1.915	2.573	6.364	8.304
9	1.771	1.463	1.345	0.881	0.609	0.903	2.006
10	0.805	0.592	0.455	0.225	0.322	0.243	0.257
11	0.392	0.253	0.305	0.107	0.118	0.125	0.046
12	0.103	0.142	0.157	0.086	0.050	0.063	0.032
13	0.076	0.046	0.114	0.038	0.015	0.011	0.012
14	0.040	0.058	0.025	0.005	0.020	0.012	0.008
Juvenile	80.654	107.928	103.170	82.565	65.114	60.283	48.743
Adult	36.842	29.931	32.101	38.804	45.441	43.166	43.857
Sum 3- 3	20.642	11.002	6.713	2.605	5.785	8.554	12.217
Sum 4-14	96.854	126.857	128.558	118.764	104.770	94.895	80.383
Total	117.496	137.859	135.271	121.369	110.555	103.449	92.600

Age	1993	1994	1995	1996	1997	1998
3	20.500	6.160	10.770	5.356	1.722	2.971
4	33.078	24.142	9.103	14.886	16.442	8.348
5	15.195	19.666	16.829	7.372	17.298	25.032
6	13.281	6.968	13.066	12.307	6.711	20.480
7	3.583	4.393	4.115	9.430	7.379	5.731
8	2.785	1.257	1.596	2.157	5.958	3.727
9	2.707	0.599	0.313	0.837	1.147	3.177
10	1.181	0.508	0.184	0.208	0.493	0.576
11	0.180	0.283	0.156	0.076	0.126	0.243
12	0.034	0.049	0.141	0.065	0.028	0.052
13	0.011	0.018	0.029	0.055	0.037	0.028
14	0.013	0.006	0.008	0.005	0.021	0.018
Juvenile	45.914	26.361	21.953	31.802	21.963	37.067
Adult	46.634	37.688	34.357	20.952	35.399	33.316
Sum 3- 3	20.500	6.160	10.770	5.356	1.722	2.971
Sum 4-14	72.048	57.889	45.540	47.398	55.640	67.412
Total	92.548	64.049	56.310	52.754	57.362	70.383

Table 3.3.4. Cod at Iceland. Division Va. Proportion of fishing and natural mortality before spawning.

Age	PropF	PropM
3	0.085	0.250
4	0.180	0.250
5	0.248	0.250
6	0.296	0.250
7	0.382	0.250
8	0.437	0.250
9	0.477	0.250
10	0.477	0.250
11	0.477	0.250
12	0.477	0.250
13	0.477	0.250
14	0.477	0.250

Table 3.3.5. Cod at Iceland. Division Va. Mean weight at age in the landings (g).

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Virtual Population Analysis : Weight at age in the catches, in grams
FINAL-VPA99

Age	1979	1980	1981	1982	1983	1984	1985
3	1408	1392	1180	1006	1095	1288	1407
4	1956	1862	1651	1550	1599	1725	1971
5	2642	2733	2260	2246	2275	2596	2576
6	3999	3768	3293	3104	3021	3581	3650
7	5548	5259	4483	4258	4096	4371	4976
8	6754	6981	5821	5386	5481	5798	6372
9	8299	8037	7739	6682	7049	7456	8207
10	9312	10731	9422	9141	8128	9851	10320
11	13130	12301	11374	11963	11009	11052	12197
12	13418	17281	12784	14226	13972	14338	14683
13	13540	14893	12514	17287	15882	15273	16175
14	20072	19069	19069	16590	18498	16660	19050

Age	1986	1987	1988	1989	1990	1991	1992
3	1459	1316	1438	1186	1290	1309	1289
4	1961	1956	1805	1813	1704	1899	1768
5	2844	2686	2576	2590	2383	2475	2469
6	3593	3894	3519	3915	3034	3159	3292
7	4635	4716	4930	5210	4624	3792	4394
8	6155	6257	6001	6892	6521	5680	5582
9	7503	7368	7144	8035	8888	7242	6830
10	9084	9243	8822	9831	10592	9804	8127
11	10356	10697	9977	11986	10993	9754	12679
12	15283	10622	11732	10003	14570	14344	13410
13	14540	15894	14156	12611	15732	14172	15715
14	15017	12592	13042	16045	17290	20200	11267

Age	1993	1994	1995	1996	1997	1998	1999
3	1392	1443	1348	1457	1484	1294	1294
4	1887	2063	1959	1930	1877	1772	1722
5	2772	2562	2920	3132	2878	2490	2490
6	3762	3659	3625	4141	4028	3534	3534
7	4930	5117	5176	4922	5402	4923	4923
8	6054	6262	6416	6009	6386	7125	7125
9	7450	7719	7916	7406	7344	7930	7930
10	8641	8896	10273	9772	8537	9242	9242
11	10901	10847	11022	10539	10797	11573	11573
12	12517	12874	11407	13503	11533	14626	14626
13	14742	14742	13098	13689	10428	17387	17387
14	16874	17470	15182	16194	12788	15069	15069

Table 3.3.6. Cod at Iceland. Division Va. Mean weight at age in the spawning stock (g).

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Virtual Population Analysis : Weight at age in the SSB, in grams
FINAL-VPA99

Age	1979	1980	1981	1982	1983	1984	1985
3	1141	1333	967	996	891	1002	1131
4	1647	1680	1513	1626	1472	1479	1597
5	2532	2708	2101	2095	2139	2257	2285
6	4027	3875	3225	3006	2918	3476	3524
7	5664	5446	4520	4339	4130	4480	5010
8	6951	7106	5851	5571	5553	5887	6195
9	8234	8120	7661	6801	7007	7660	7800
10	9500	10737	9084	9259	7770	9920	9225
11	12921	12628	10833	11550	10817	11035	11336
12	13028	17528	12401	13445	13176	14531	13277
13	13308	15939	11724	17138	14175	15378	15325
14	18930	25212	14326	16554	18543	16394	18932

Age	1986	1987	1988	1989	1990	1991	1992
3	1182	1289	1218	1012	813	1122	876
4	1762	1811	1604	1542	1330	1776	1389
5	2681	2735	2499	2423	2132	2233	2174
6	3562	4202	3566	3743	3187	3044	3185
7	4824	5110	5161	5298	4691	3891	4481
8	6457	6497	6238	6910	6627	5897	5587
9	7843	7802	7302	7725	8915	7657	6775
10	9419	10220	8647	9397	10362	10573	8225
11	10674	11197	10184	11953	12093	11230	11702
12	13660	10620	11504	9529	15453	14340	13474
13	13812	15893	14159	12195	15337	14172	15436
14	18479	16514	10952	14270	17257	20200	11267

Age	1993	1994	1995	1996	1997	1998	1999
3	1037	1193	1066	1264	1221	1273	1273
4	1570	1748	1826	1627	1613	2074	2074
5	2518	2382	2735	2600	2595	2384	2384
6	3611	3684	3497	3829	3807	3532	3532
7	4872	5175	4741	4605	5434	5159	5159
8	6150	6210	6126	5792	6440	7638	7638
9	7538	7676	7582	7550	7629	8229	8229
10	8840	8814	9887	9433	8606	9489	9489
11	11088	10842	10829	11293	10486	11570	11570
12	12002	12595	11307	12984	11774	14626	14626
13	14402	14402	13098	13821	10943	17387	17387
14	18383	17470	15182	16194	15225	15069	15069

Table 3.3.7. Cod at Iceland. Division Va. Bottom trawl CPUE (GLM) indices 1993-1998 used in XSA tuning.

TRAWL-JUN-DEC-N

Year/Age	4	5	6	7
1993	1347	565	423	155
1994	2565	1576	306	146
1995	844	1974	1491	255
1996	1565	972	1159	637
1997	2546	1598	539	408
1998	929	2943	1907	427

TRAWL-JAN-MAY-N

Year/Age	4	5	6	7	8	9
1993	1595	989	812	128	54	78
1994	1619	1908	662	434	69	28
1995	363	2175	1771	418	84	14
1996	1778	957	1753	821	149	37
1997	1495	1900	704	690	589	37
1998	544	3506	2555	808	317	197

TRAWL-JAN-MAY-S

Year/Age	5	6	7	8
1993	167	124	42	126
1994	528	263	156	58
1995	428	469	291	150
1996	214	609	514	141
1997	578	384	408	246
1998	856	1047	566	262

TRAWL-JUN-DES-S

Year/Age	5	6	7	8
1993	299	217	94	79
1994	335	129	139	41
1995	738	455	131	79
1996	481	603	305	69
1997	991	487	322	190
1998	1573	923	334	131

Table 3.3.8. Cod at Iceland. Division Va. Gillnet CPUE (GLM) indices 1993-1998 used in XSA tuning.

GILLNET-JAN-MAY-S

	7	8	9
1993	209	266	367
1994	368	168	80
1995	524	265	79
1996	617	280	140
1997	1349	420	94
1998	358	497	270

Table 3.3.9. Cod at Iceland. Division Va. Icelandic Groundfish survey indices used in XSA tuning.

IceGFS-N. N.

1 1 0.99 1

Year/Age	3	4	5	6	7	8
1984	55261	48059	13027	6211	1990	868
1985	22540	18404	17203	4864	1388	375
1986	77227	15257	7551	7364	1453	345
1987	92490	49378	5573	2906	2306	265
1988	60113	46566	18693	1665	545	311
1989	8272	15722	18464	6501	456	137
1990	22262	8102	8772	9355	1242	107
1991	13601	9542	2499	2303	1347	144
1992	31684	9441	5124	1100	672	318
1993	18211	13369	2675	1550	263	168
1994	4301	11353	7088	1330	417	53
1995	19228	6083	6923	6599	1160	227
1996	48173	23365	5898	5422	3004	171
1997	13959	48786	20710	5656	2806	1010
1998	35495	7683	12466	5233	811	225

IceGFS. a3 on a3. N

1 1 0.17 0.25

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

IceGFS. a2 on a3. N.

1 1 0.17 0.25

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

Table 3.3.9. (Cont'd.) Cod at Iceland. Division Va. Icelandic Groundfish survey indices used in XSA tuning.

IceGFS-SE

1 1 0.99 1

Year/Age	3	4	5	6	7	8
1984	233	561	470	524	373	345
1985	452	686	1171	608	294	138
1986	772	404	391	842	286	105
1987	4670	3153	519	333	385	62
1988	1914	4474	3858	619	274	238
1989	85	419	1673	1762	265	83
1990	113	114	324	1104	396	89
1991	349	511	309	763	1087	203
1992	1148	391	361	146	163	117
1993	1098	1189	356	321	79	57
1994	350	1943	2084	619	300	70
1995	792	460	1056	1654	502	141
1996	1139	860	358	582	561	50
1997	488	3397	1605	624	615	437
1998	1389	637	1591	915	214	116

IceGFS-SW

1 1 0.99 1

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

Table 3.3.10. Cod at Iceland. Division Va. XSA diagnostic output

Lowestoft VPA Version 3.1
21/04/1999 16:41
Extended Survivors Analysis
"ICELANDIC COD (Div. Va); data from 1970-97(4/98)"
CPUE data from file codvamt.dat

Catch data for 15 years. 1984 to 1998. Ages 3 to 14.

Fleet	First year	Last year	First age	Last age	Alpha	Beta
SMB. N.	1984	1998	3	8	0.99	1
SMB. a3 on a3. N	1985	1998	3	3	0.17	0.25
SMB. a2 on a3. N.	1986	1998	3	3	0.17	0.25
SMB. SE	1984	1998	3	8	0.99	1
SMB. SW.	1984	1998	3	8	0.99	1
TRAWL-JUN-DEC-N	1993	1998	4	7	0.42	1
TRAWL-JAN-MAY-N	1993	1998	4	9	0	0.42
TRAWL-JAN-MAY-S	1993	1998	5	8	0	0.42
GILLNET-JAN-MAY-S	1993	1998	7	9	0	0.42
TRAWL-JUN-DES-S	1993	1998	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 = 0.500

Minimum standard error for population
estimates derived from each fleet = 0.300

Prior weighting not applied

Tuning converged after 42 iterations

Table 3.3.10 (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	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
3	0.035	0.049	0.096	0.077	0.154	0.086	0.069	0.026	0.021	0.019
4	0.263	0.229	0.307	0.373	0.306	0.274	0.177	0.128	0.105	0.134
5	0.136	0.442	0.503	0.624	0.489	0.301	0.313	0.213	0.216	0.23
6	0.6	0.637	0.772	0.886	0.754	0.436	0.335	0.398	0.306	0.428
7	0.726	0.784	0.946	1.097	0.79	0.607	0.502	0.431	0.443	0.467
8	0.876	0.815	0.783	1.016	1.119	0.725	0.463	0.54	0.538	0.421
9	0.818	0.787	0.777	0.611	1.208	0.78	0.392	0.473	0.625	0.625
10	0.546	0.833	0.875	0.525	0.932	0.772	0.585	0.493	0.571	0.76
11	0.653	0.626	0.959	0.391	0.893	0.599	0.574	0.513	0.637	0.622
12	0.978	0.746	0.839	0.699	0.565	0.653	0.692	0.502	0.359	0.596
13	0.563	0.436	0.353	0.26	0.554	0.675	1.095	0.644	0.605	0.749
14	0.691	0.665	0.764	0.473	0.744	0.679	0.74	0.543	0.548	0.681

1

XSA population numbers (Thousands)

YEAR \ AGE	3	4	5	6	7	8	9	10	11	12
1989	8.42E+04	1.34E+05	1.46E+05	7.71E+04	1.29E+04	3.63E+03	1.74E+03	5.91E+02	2.47E+02	1.52E+02
1990	1.35E+05	6.65E+04	8.40E+04	1.04E+05	3.46E+04	5.10E+03	1.24E+03	6.29E+02	2.80E+02	1.05E+02
1991	1.03E+05	1.05E+05	4.33E+04	4.42E+04	4.52E+04	1.30E+04	1.85E+03	4.61E+02	2.24E+02	1.23E+02
1992	1.83E+05	7.70E+04	6.32E+04	2.15E+04	1.67E+04	1.44E+04	4.85E+03	6.96E+02	1.57E+02	7.03E+01
1993	1.59E+05	1.39E+05	4.34E+04	2.77E+04	7.25E+03	4.57E+03	4.27E+03	2.15E+03	3.37E+02	8.71E+01
1994	8.25E+04	1.11E+05	8.37E+04	2.18E+04	1.07E+04	2.69E+03	1.22E+03	1.04E+03	6.94E+02	1.13E+02
1995	1.79E+05	6.20E+04	6.92E+04	5.08E+04	1.15E+04	4.76E+03	1.07E+03	4.59E+02	3.95E+02	3.12E+02
1996	2.29E+05	1.37E+05	4.25E+04	4.14E+04	2.97E+04	5.72E+03	2.46E+03	5.91E+02	2.09E+02	1.82E+02
1997	9.19E+04	1.82E+05	9.86E+04	2.81E+04	2.28E+04	1.58E+04	2.73E+03	1.25E+03	2.96E+02	1.03E+02
1998	1.71E+05	7.37E+04	1.34E+05	6.50E+04	1.70E+04	1.20E+04	7.56E+03	1.20E+03	5.80E+02	1.28E+02

Estimated population abundance at 1st Jan 1999

0.00E+00	1.37E+05	5.28E+04	8.74E+04	3.47E+04	8.70E+03	6.44E+03	3.31E+03	4.58E+02	2.55E+02

Taper weighted geometric mean of the VPA populations:

1.48E+05	1.15E+05	7.75E+04	4.12E+04	1.80E+04	7.24E+03	2.54E+03	8.94E+02	3.67E+02	1.55E+02

Standard error of the weighted Log(VPA populations) :

0.4105	0.4335	0.4455	0.4868	0.5313	0.5804	0.6194	0.5164	0.539	0.5779

YEAR \ AGE	13	14
1989	9.76E+01	1.11E+01
1990	4.69E+01	4.55E+01
1991	4.08E+01	2.48E+01
1992	4.34E+01	2.35E+01
1993	2.86E+01	2.74E+01
1994	4.05E+01	1.35E+01
1995	4.82E+01	1.69E+01
1996	1.28E+02	1.32E+01
1997	9.01E+01	5.50E+01
1998	5.87E+01	4.03E+01

Table 3.3.10 (Cont'd)

Estimated population abundance at 1st Jan 1999

5.78E+01 2.27E+01

Taper weighted geometric mean of the VPA populations:

6.97E+01 3.03E+01

Standard error of the weighted Log(VPA populations) :

0.6381 0.7365

1

Log catchability residuals.

Fleet : SMB. N.

Age	1984	1985	1986	1987	1988
3	0.53	0	-0.15	0.11	0.38
4	0.24	0.2	0	-0.02	0.04
5	0.44	0.34	0.31	-0.16	0.3
6	0.53	0.19	0.34	0.3	-0.37
7	0.48	0.22	0.37	0.66	0.09
8	0.87	0.28	0.5	0.4	0.79
9	No data for this fleet at this age				

Age	1989	1990	1991	1992	1993	1994	1995	1996	1997
3	-0.01	0.07	0.09	-0.02	-0.14	-0.32	-0.28	-0.04	0.18
4	-0.12	0.13	-0.17	0.18	-0.23	-0.13	-0.01	0.03	0.19
5	-0.02	0.1	-0.44	0.02	-0.38	-0.26	-0.08	0.15	0.57
6	0	0.1	-0.31	-0.21	-0.25	-0.48	0.17	0.24	0.58
7	-0.43	-0.36	-0.39	0.06	-0.35	-0.45	0.39	0.32	0.53
8	0.32	-0.33	-0.99	-0.08	0.53	-0.48	0.14	-0.25	0.51
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	-1.7157	-1.6805	-1.9858	-2.5262
S.E(Log q)	0.307	0.333	0.4095	0.5683

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	0.55	2.796	6.23	0.8	15	0.22	-1.61
4	0.64	3.374	5.22	0.9	15	0.15	-1.58

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	0.8	1.176	3.58	0.79	15	0.24	-1.72
6	0.87	0.682	2.82	0.75	15	0.3	-1.68
7	0.87	0.627	3.02	0.7	15	0.37	-1.99
8	1.03	-0.106	2.31	0.49	15	0.62	-2.53

1

Fleet : SMB. a3 on a3. N

Age	1984	1985	1986	1987	1988
3	99.99	0.19	-0.01	0.27	0.54
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				

Table 3.3.10 (Cont'd)

Age		1989	1990	1991	1992	1993	1994	1995	1996	1997
	3	0.36	-0.04	0.09	-0.05	0	-0.35	-0.39	-0.15	0.03
	4	No data for this fleet at this age								
	5	No data for this fleet at this age								
	6	No data for this fleet at this age								
	7	No data for this fleet at this age								
	8	No data for this fleet at this age								
	9	No data for this fleet at this age								

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	0.64	1.822	5.39	0.73	14	0.26	-1.77
	1							

Fleet : SMB. a2 on a3. N.

Age		1984	1985	1986	1987	1988
	3	99.99	99.99	-0.21	0.12	0.25
	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		1989	1990	1991	1992	1993	1994	1995	1996	1997
	3	0.16	0.19	0.33	-0.13	0.09	-0.33	-0.28	0.01	-0.15
	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	0.53	2.789	6.84	0.8	13	0.22	-2.42

Table 3.3.10 (Cont'd)

Fleet : SMB. SE

Age		1984	1985	1986	1987	1988
	3	-0.52	-0.18	-0.71	0.49	0.49
	4	-0.7	-0.02	-0.39	-0.03	0.27
	5	-0.57	-0.04	-0.34	-0.23	1.03
	6	-0.24	-0.19	-0.13	-0.17	0.34
	7	-0.08	-0.22	-0.14	-0.02	0.51
	8	0.57	-0.09	-0.06	-0.42	1.16
	9	No data for this fleet at this age				

Age		1989	1990	1991	1992	1993	1994	1995	1996	1997
	3	-0.6	-0.9	0.04	0.14	0.3	0.26	-0.05	-0.12	0.31
	4	-0.51	-0.56	-0.13	0.06	0.05	0.53	0.26	-0.21	0.25
	5	-0.11	-0.89	-0.22	-0.32	-0.09	0.83	0.35	-0.34	0.32
	6	0.39	-0.34	0.28	-0.53	-0.13	0.45	0.48	-0.29	0.07
	7	0.14	-0.39	0.51	-0.24	-0.43	0.33	0.66	-0.24	0.13
	8	0.45	0.12	-0.02	-0.45	0.08	0.43	0.29	-0.85	0.3
	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	-4.027	-3.3763	-3.0992	-3.1547
S.E(Log q)	0.5037	0.3466	0.4102	0.5533

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	0.57	1.284	8.06	0.48	15	0.45	-5.2
	4	0.56	1.756	7.68	0.62	15	0.36	-4.51

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	0.7	1.305	6.23	0.66	15	0.34	-4.03
	6	1.02	-0.092	3.22	0.65	15	0.37	-3.38
	7	1.05	-0.181	2.78	0.61	15	0.45	-3.1
	8	1.34	-0.852	1.23	0.4	15	0.75	-3.15
	1							

Fleet : SMB. SW.

Age		1984	1985	1986	1987	1988
	3	-0.3	-0.5	-0.46	-0.32	0.52
	4	-0.14	-0.26	-0.94	-0.09	0.44
	5	-0.03	-0.27	-0.39	-0.6	0.28
	6	0.16	-0.32	-0.34	-0.11	-0.28
	7	0.04	-0.28	-0.44	0.15	-0.07
	8	0.42	0.08	-0.41	-0.27	0.75
	9	No data for this fleet at this age				

Table 3.3.10 (Cont'd)

Age	1989	1990	1991	1992	1993	1994	1995	1996	1997
3	0.19	0.22	-0.34	0.18	0.44	0.02	0.14	-0.15	-0.43
4	0.57	0.33	-0.29	0.04	0	0.42	0.07	-0.32	-0.09
5	0.4	0.6	-0.19	0.05	-0.38	0.2	0.28	-0.31	-0.17
6	0.36	0.68	0.2	-0.37	-0.44	-0.11	0.42	-0.14	-0.18
7	-0.09	0.32	0.55	-0.11	-0.73	-0.16	0.48	0.12	-0.16
8	0.41	0.55	0.28	-0.01	-0.12	-1.08	0.2	-0.27	0.16
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	-2.8638	-2.4859	-2.4415	-2.8093
S.E(Log q)	0.3379	0.348	0.3492	0.4659

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	0.83	0.658	5.12	0.62	15	0.34	-3.78
4	1.03	-0.1	2.94	0.6	15	0.37	-3.16

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	0.71	2.009	5.31	0.83	15	0.21	-2.86
6	0.65	3.649	5.35	0.92	15	0.15	-2.49
7	0.72	2.271	4.5	0.87	15	0.21	-2.44
8	0.78	1.152	4.13	0.74	15	0.36	-2.81

Fleet : TRAWL-JUN-DEC-N

Age	1989	1990	1991	1992	1993	1994	1995	1996	1997
3	No data for this fleet at this age								
4	99.99	99.99	99.99	99.99	-0.25	0.64	-0.05	-0.21	0.01
5	99.99	99.99	99.99	99.99	-0.27	-0.04	0.39	0.1	-0.25
6	99.99	99.99	99.99	99.99	-0.13	-0.43	0.23	0.23	-0.21
7	99.99	99.99	99.99	99.99	0.24	-0.33	0.08	0	-0.17
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	-3.5836	-3.3869	-3.3993
S.E(Log q)	0.2451	0.299	0.2174

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	1.08	-0.205	3.41	0.61	6	0.37	-4.03

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	0.98	0.092	3.77	0.79	6	0.27	-3.58
6	0.59	6.229	6.27	0.98	6	0.06	-3.39
7	1.11	-0.477	2.73	0.83	6	0.26	-3.4

Table 3.3.10 (Cont'd)

Fleet : TRAWL-JAN-MAY-N

Age	1989	1990	1991	1992	1993	1994	1995	1996	1997
3	No data for this fleet at this age								
4	99.99	99.99	99.99	99.99	0.06	0.29	-0.14	0.12	-0.28
5	99.99	99.99	99.99	99.99	-0.01	-0.04	0.28	-0.07	-0.23
6	99.99	99.99	99.99	99.99	-0.06	-0.08	0.03	0.24	-0.3
7	99.99	99.99	99.99	99.99	-0.54	0.26	0.12	-0.17	-0.07
8	99.99	99.99	99.99	99.99	-0.56	0.13	-0.29	0.12	0.47
9	99.99	99.99	99.99	99.99	0.14	0.29	-0.35	-0.19	-0.27

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	-3.6337	-3.2788	-3.2937	-3.6113	-3.8647
S.E(Log q)	0.1705	0.1966	0.3316	0.3639	0.3116

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	0.67	1.339	6.9	0.81	6	0.23	-4.57

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	0.004	3.64	0.88	6	0.19	-3.63
6	0.76	1.863	5.04	0.94	6	0.12	-3.28
7	0.89	0.387	3.98	0.76	6	0.33	-3.29
8	0.77	1.251	4.78	0.89	6	0.27	-3.61
9	0.83	1.153	4.56	0.92	6	0.25	-3.86
1							

Fleet : TRAWL-JAN-MAY-S

Age	1989	1990	1991	1992	1993	1994	1995	1996	1997
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	-0.32	0.13	0.12	-0.11	0.04
6	99.99	99.99	99.99	99.99	-0.83	0.1	-0.19	0.29	0.2
7	99.99	99.99	99.99	99.99	-1.02	-0.13	0.39	0	0.04
8	99.99	99.99	99.99	99.99	0.27	-0.05	0.27	0.04	-0.42
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	-5.0962	-4.3877	-3.9306	-3.5953
S.E(Log q)	0.1807	0.4446	0.5722	0.2596

Regression statistics :

Table 3.3.10 (Cont'd)

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

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e.	Mean Q
5	0.76	2.575	6.55	0.97	6	0.09	-5.1
6	0.73	0.727	6.03	0.65	6	0.34	-4.39
7	0.64	1.169	5.96	0.73	6	0.35	-3.93
8	1.36	-1.783	1.76	0.86	6	0.29	-3.6
1							

Fleet : GILLNET-JAN-MAY-S

Age	1989	1990	1991	1992	1993	1994	1995	1996	1997
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	99.99	99.99	99.99	99.99	-0.07	0.07	0.33	-0.47	0.58
8	99.99	99.99	99.99	99.99	0.31	0.3	0.14	0.03	-0.59
9	99.99	99.99	99.99	99.99	0.55	0.19	0.24	-0.01	-0.48

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

Age	7	8	9
Mean Log q	-3.2765	-2.89	-2.7173
S.E(Log q)	0.4211	0.3414	0.4048

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	1.17	-0.361	2.21	0.54	6	0.54	-3.28
8	1.93	-5.062	-2.54	0.88	6	0.27	-2.89
9	1.28	-0.857	1.3	0.71	6	0.53	-2.72
1							

Fleet : TRAWL-JUN-DES-S

Age	1989	1990	1991	1992	1993	1994	1995	1996	1997
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	-0.08	-0.76	0.23	0.22	0.1
6	99.99	99.99	99.99	99.99	-0.1	-0.6	-0.25	0.27	0.38
7	99.99	99.99	99.99	99.99	0.15	0.03	-0.18	-0.33	0
8	99.99	99.99	99.99	99.99	0.56	0.17	0.07	-0.19	-0.2
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	-4.4115	-4.0855	-3.8051	-3.706
S.E(Log q)	0.3908	0.3821	0.2401	0.334

Table 3.3.10 (Cont'd)

Regression statistics :

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

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
5	1	0.007	4.43	0.58	6	0.44	-4.41
6	0.72	0.936	5.89	0.74	6	0.28	-4.09
7	1.23	-0.883	2.47	0.79	6	0.3	-3.81
8	1.52	-1.816	1.09	0.76	6	0.42	-3.71
1							

Terminal year survivor and F summaries :

Age 3 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
SMB. N.	148052	0.3	0	0	1	0.201	0.018
SMB. a3 on a3. N	134081	0.3	0	0	1	0.201	0.02
SMB. a2 on a3. N.	146696	0.3	0	0	1	0.201	0.018
SMB. SE	182615	0.475	0	0	1	0.08	0.015
SMB. SW.	158249	0.356	0	0	1	0.143	0.017
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-DES-S	1	0	0	0	0	0	0
P shrinkage mean	114562	0.43				0.098	0.023
F shrinkage mean	68054	0.5				0.074	0.039

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
136930	0.13	0.1	7	0.73	0.019

1

Age 4 Catchability dependent on age and year class strength

Year class = 1994

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
SMB. N.	56018	0.212	0.122	0.58	2	0.233	0.126
SMB. a3 on a3. N	54348	0.3	0	0	1	0.115	0.13
SMB. a2 on a3. N.	45361	0.3	0	0	1	0.115	0.154
SMB. SE	69128	0.293	0.03	0.1	2	0.123	0.104
SMB. SW.	38560	0.283	0.121	0.43	2	0.131	0.179
TRAWL-JUN-DEC-N	45452	0.435	0	0	1	0.056	0.154
TRAWL-JAN-MAY-N	50333	0.3	0	0	1	0.118	0.14
TRAWL-JAN-MAY-S	1	0	0	0	0	0	0
GILLNET-JAN-MAY-S	1	0	0	0	0	0	0
TRAWL-JUN-DES-S	1	0	0	0	0	0	0

Table 3.3.10 (Cont'd)

P shrinkage mean	77494	0.45					0.061	0.093
F shrinkage mean	51350	0.5					0.048	0.137

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
52776	0.1	0.06	12	0.599	0.134

Age 5 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	Estimatec F
SMB. N.	85167	0.177	0.124	0.7	3	0.208	0.236
SMB. a3 on a3. N	75410	0.3	0	0	1	0.069	0.263
SMB. a2 on a3. N.	87851	0.3	0	0	1	0.069	0.229
SMB. SE	94570	0.264	0.113	0.43	3	0.093	0.215
SMB. SW.	86354	0.211	0.101	0.48	3	0.147	0.233
TRAWL-JUN-DEC-N	91842	0.247	0.024	0.1	2	0.112	0.22
TRAWL-JAN-MAY-N	79625	0.212	0.179	0.84	2	0.149	0.25
TRAWL-JAN-MAY-S	99414	0.3	0	0	1	0.078	0.205
GILLNET-JAN-MAY-S	1	0	0	0	0	0	0
TRAWL-JUN-DES-S	114094	0.422	0	0	1	0.04	0.181
F shrinkage mean	80338	0.5				0.036	0.248

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
87380	0.08	0.04	18	0.467	0.23

1

Age 6 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	Estimatec F
SMB. N.	35681	0.16	0.193	1.21	4	0.185	0.418
SMB. a3 on a3. N	23563	0.302	0	0	1	0.043	0.58
SMB. a2 on a3. N.	26318	0.302	0	0	1	0.043	0.533
SMB. SE	30704	0.212	0.118	0.56	4	0.11	0.472
SMB. SW.	34817	0.185	0.136	0.74	4	0.142	0.427
TRAWL-JUN-DEC-N	34304	0.194	0.185	0.95	3	0.136	0.432
TRAWL-JAN-MAY-N	35763	0.175	0.126	0.72	3	0.165	0.418
TRAWL-JAN-MAY-S	40562	0.256	0.161	0.63	2	0.078	0.376
GILLNET-JAN-MAY-S	1	0	0	0	0	0	
TRAWL-JUN-DES-S	42332	0.297	0.082	0.28	2	0.061	0.363
F shrinkage mean	44472	0.5				0.036	0.348

Table 3.3.10 (Cont'd)

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
34715	0.07	0.05	25	0.753	0.428

Age 7 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
SMB. N.	8900	0.154	0.178	1.15	5	0.157	0.459
SMB. a3 on a3. N	6147	0.32	0	0	1	0.025	0.612
SMB. a2 on a3. N.	6261	0.304	0	0	1	0.028	0.603
SMB. SE	7719	0.197	0.18	0.91	5	0.105	0.514
SMB. SW.	8238	0.172	0.084	0.49	5	0.137	0.488
TRAWL-JUN-DEC-N	9052	0.17	0.094	0.55	4	0.153	0.453
TRAWL-JAN-MAY-N	8475	0.161	0.156	0.97	4	0.158	0.477
TRAWL-JAN-MAY-S	9942	0.241	0.215	0.89	3	0.07	0.42
GILLNET-JAN-MAY-S	5577	0.455	0	0	1	0.027	0.657
TRAWL-JUN-DES-S	12131	0.215	0.038	0.18	3	0.105	0.356
F shrinkage mean	8830	0.5				0.036	0.462

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
8703 1	0.07	0.05	33	0.792	0.467

Age 8 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
SMB. N.	6253	0.166	0.192	1.16	6	0.122	0.431
SMB. a3 on a3. N	6456	0.307	0	0	1	0.015	0.42
SMB. a2 on a3. N.	7057	0.307	0	0	1	0.015	0.391
SMB. SE	5704	0.206	0.214	1.04	6	0.092	0.464
SMB. SW.	6405	0.179	0.111	0.62	6	0.123	0.423
TRAWL-JUN-DEC-N	7216	0.175	0.161	0.92	4	0.109	0.383
TRAWL-JAN-MAY-N	7433	0.164	0.067	0.41	5	0.153	0.374
TRAWL-JAN-MAY-S	6405	0.207	0.076	0.37	4	0.125	0.423
GILLNET-JAN-MAY-S	6815	0.293	0.341	1.17	2	0.072	0.402
TRAWL-JUN-DES-S	5860	0.195	0.144	0.74	4	0.131	0.455
F shrinkage mean	4973	0.5				0.042	0.518

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
6444	0.07	0.05	40	0.722	0.421

Table 3.3.10 (Cont'd)

Age 9 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
SMB. N.	3636	0.164	0.124	0.75	6	0.103	0.583
SMB. a3 on a3. N	3151	0.313	0	0	1	0.013	0.648
SMB. a2 on a3. N.	2912	0.313	0	0	1	0.013	0.687
SMB. SE	4104	0.203	0.148	0.73	6	0.077	0.531
SMB. SW.	4010	0.176	0.053	0.3	6	0.103	0.54
TRAWL-JUN-DEC-N	3413	0.172	0.081	0.47	4	0.093	0.611
TRAWL-JAN-MAY-N	4108	0.166	0.105	0.63	6	0.21	0.53
TRAWL-JAN-MAY-S	2598	0.205	0.132	0.65	4	0.102	0.745
GILLNET-JAN-MAY-S	2002	0.256	0.047	0.18	3	0.107	
TRAWL-JUN-DES-S	2430	0.194	0.091	0.47	4	0.107	0.781
F shrinkage mean	4428	0.5				0.071	0.5

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
3312	0.07	0.05	42	0.709	0.625

1

Age 10 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
SMB. N.	417	0.181	0.151	0.83	6	0.086	0.811
SMB. a3 on a3. N	502	0.32	0	0	1	0.009	0.712
SMB. a2 on a3. N.	639	0.32	0	0	1	0.009	0.596
SMB. SE	497	0.22	0.266	1.21	6	0.068	0.717
SMB. SW.	450	0.193	0.15	0.78	6	0.09	0.769
TRAWL-JUN-DEC-N	399	0.192	0.162	0.85	3	0.075	0.835
TRAWL-JAN-MAY-N	417	0.185	0.086	0.46	5	0.192	0.811
TRAWL-JAN-MAY-S	470	0.216	0.103	0.48	4	0.098	0.746
GILLNET-JAN-MAY-S	388	0.258	0.221	0.86	3	0.112	0.852
TRAWL-JUN-DES-S	363	0.201	0.082	0.41	4	0.104	0.89
F shrinkage mean	704	0.5				0.159	0.554

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
458	0.1	0.06	40	0.546	0.76

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

Year class = 1987

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
SMB. N.	222	0.212	0.106	0.5	6	0.073	0.689
SMB. a3 on a3. N	246	0.331	0	0	1	0.006	0.64
SMB. a2 on a3. N.	309	0.331	0	0	1	0.006	0.538
SMB. SE	287	0.249	0.13	0.52	6	0.061	0.568
SMB. SW.	242	0.217	0.105	0.49	6	0.082	0.645
TRAWL-JUN-DEC-N	194	0.237	0.089	0.38	2	0.055	0.758
TRAWL-JAN-MAY-N	223	0.206	0.102	0.49	4	0.182	0.686
TRAWL-JAN-MAY-S	295	0.258	0.219	0.85	3	0.09	0.558
GILLNET-JAN-MAY-S	271	0.258	0.048	0.19	3	0.121	0.594
TRAWL-JUN-DES-S	265	0.224	0.035	0.16	3	0.1	0.605

Table 3.3.10 (Cont'd)

F shrinkage mean	280	0.5				0.225	0.58

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
255	0.13	0.04	36	0.274	0.622

1

Age 12 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
SMB. N.	43	0.23	0.087	0.38	6	0.052	0.745
SMB. a3 on a3. N	83	0.346	0	0	1	0.004	0.448
SMB. a2 on a3. N.	68	0.346	0	0	1	0.004	0.529
SMB. SE	51	0.274	0.196	0.72	6	0.044	0.652
SMB. SW.	29	0.234	0.188	0.81	6	0.06	0.962
TRAWL-JUN-DEC-N	74	0.307	0	0	1	0.028	0.494
TRAWL-JAN-MAY-N	44	0.242	0.158	0.65	3	0.159	0.722
TRAWL-JAN-MAY-S	50	0.281	0.282	1	2	0.069	0.664
GILLNET-JAN-MAY-S	73	0.276	0.075	0.27	3	0.115	0.5
TRAWL-JUN-DES-S	68	0.253	0.008	0.03	2	0.071	0.527
F shrinkage mean	69	0.5				0.394	0.522

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
58	0.21	0.06	32	0.297	0.596

Age 13 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
SMB. N.	27	0.254	0.138	0.54	6	0.022	0.654
SMB. a3 on a3. N	39	0.367	0	0	1	0.002	0.502
SMB. a2 on a3. N.	29	0.367	0	0	1	0.002	0.626
SMB. SE	22	0.295	0.134	0.45	6	0.019	0.769
SMB. SW.	23	0.258	0.113	0.44	6	0.026	0.735
TRAWL-JUN-DEC-N	1	0	0	0	0	0	0
TRAWL-JAN-MAY-N	26	0.287	0.333	1.16	2	0.096	0.685
TRAWL-JAN-MAY-S	30	0.307	0	0	1	0.031	0.617
GILLNET-JAN-MAY-S	28	0.327	0.056	0.17	2	0.067	0.636
TRAWL-JUN-DES-S	40	0.37	0	0	1	0.022	0.493
F shrinkage mean	21	0.5				0.715	0.789

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
23	0.36	0.05	27	0.144	0.749

Table 3.3.10 (Cont'd)

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

Year class = 1984

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
SMB. N.	16	0.222	0.078	0.35	6	0.01	0.718
SMB. a3 on a3. N	22	0.413	0	0	1	0.001	0.558
SMB. a2 on a3. N.	19	0.394	0	0	1	0.001	0.621
SMB. SE	16	0.275	0.187	0.68	6	0.008	0.715
SMB. SW.	22	0.236	0.14	0.59	6	0.011	0.558
TRAWL-JUN-DEC-N	1	0	0	0	0	0	0
TRAWL-JAN-MAY-N	19	0.345	0	0	1	0.025	0.612
TRAWL-JAN-MAY-S	1	0	0	0	0	0	0
GILLNET-JAN-MAY-S	29	0.448	0	0	1	0.015	0.448
TRAWL-JUN-DES-S	1	0	0	0	0	0	0
F shrinkage mean	16	0.5				0.929	0.688

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
17	0.46	0.05	23	0.099	0.681

Table 3.3.11. Cod at Iceland. Division Va. Fishing mortality.

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Marine Research Institute Fri Apr 23 11:45:15 1999
Virtual Population Analysis : Fishing mortality
FINAL-VPA99
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Age	1979	1980	1981	1982	1983	1984	1985
3	0.033	0.034	0.016	0.027	0.017	0.055	0.051
4	0.195	0.176	0.137	0.221	0.120	0.211	0.288
5	0.211	0.358	0.388	0.400	0.433	0.323	0.388
6	0.513	0.378	0.470	0.541	0.622	0.539	0.572
7	0.487	0.442	0.635	0.581	0.767	0.598	0.683
8	0.503	0.554	0.839	1.046	0.852	0.900	0.731
9	0.507	0.514	0.802	1.187	0.930	0.746	0.801
10	0.339	0.453	0.950	0.910	1.082	0.634	0.770
11	0.531	0.425	0.982	0.479	0.671	0.639	0.613
12	0.200	0.700	0.904	0.404	0.678	0.587	0.641
13	1.020	0.171	1.076	0.417	0.533	0.685	0.711
14	0.519	0.453	0.943	0.679	0.779	0.658	0.707
W.Av 5-10	0.403	0.404	0.529	0.582	0.609	0.479	0.486
Ave 5-10	0.427	0.450	0.681	0.777	0.781	0.623	0.658

Age	1986	1987	1988	1989	1990	1991	1992
3	0.070	0.045	0.045	0.035	0.049	0.096	0.077
4	0.222	0.309	0.222	0.265	0.230	0.309	0.374
5	0.580	0.519	0.506	0.485	0.445	0.505	0.624
6	0.697	0.785	0.837	0.601	0.639	0.775	0.884
7	0.883	0.976	0.952	0.726	0.784	0.946	1.095
8	0.936	0.994	1.393	0.874	0.815	0.783	1.016
9	0.806	0.975	1.111	0.819	0.783	0.776	0.613
10	0.763	0.707	0.986	0.545	0.834	0.863	0.526
11	0.740	0.582	1.031	0.663	0.622	0.958	0.385
12	0.672	0.665	0.904	0.973	0.768	0.824	0.701
13	0.445	0.739	2.333	0.574	0.436	0.375	0.356
14	0.685	0.733	1.273	0.715	0.689	0.759	0.516
W.Av 5-10	0.689	0.697	0.629	0.543	0.595	0.749	0.780
Ave 5-10	0.778	0.826	0.964	0.675	0.717	0.775	0.793

Age	1993	1994	1995	1996	1997	1998	1995-1998
3	0.155	0.086	0.069	0.026	0.021	0.019	0.034
4	0.306	0.275	0.178	0.129	0.105	0.134	0.136
5	0.490	0.301	0.313	0.213	0.216	0.230	0.243
6	0.753	0.437	0.336	0.398	0.307	0.428	0.367
7	0.789	0.606	0.502	0.432	0.443	0.467	0.461
8	1.114	0.723	0.463	0.541	0.539	0.421	0.491
9	1.202	0.778	0.392	0.474	0.626	0.625	0.529
10	0.930	0.770	0.585	0.493	0.571	0.760	0.602
11	0.889	0.601	0.573	0.514	0.637	0.622	0.586
12	0.549	0.651	0.695	0.501	0.361	0.596	0.538
13	0.558	0.639	1.074	0.651	0.601	0.749	0.769
14	0.826	0.688	0.664	0.526	0.559	0.681	0.605
W.Av 5-10	0.671	0.371	0.344	0.351	0.301	0.326	0.362
Ave 5-10	0.880	0.603	0.432	0.425	0.450	0.488	0.449

Table 3.3.12. Cod at Iceland. Stock in numbers (millions).

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      Marine Research Institute Fri Apr 23 11:45:15 1999
 Virtual Population Analysis : Stock in numbers, millions
FINAL-VPA99
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Age	1979	1980	1981	1982	1983	1984	1985
3	245.522	144.034	143.276	133.578	226.328	139.017	144.046
4	176.062	194.529	113.999	115.392	106.399	182.092	107.726
5	79.448	118.551	133.570	81.351	75.744	77.276	120.682
6	93.925	52.650	67.877	74.179	44.653	40.215	45.819
7	40.087	83.048	29.534	34.736	35.350	19.621	19.204
8	12.250	20.159	50.702	12.818	15.903	13.437	8.835
9	3.939	6.065	9.481	17.940	3.687	5.554	4.472
10	1.335	1.942	2.970	3.480	4.482	1.191	2.156
11	0.446	0.778	1.011	0.940	1.147	1.244	0.517
12	0.261	0.214	0.417	0.310	0.476	0.480	0.538
13	0.041	0.175	0.087	0.138	0.170	0.198	0.219
14	0.011	0.012	0.121	0.024	0.075	0.081	0.082
Juvenile	526.240	477.621	450.108	383.315	444.552	405.984	361.297
Adult	127.086	144.537	102.937	91.571	69.861	74.424	92.998
Sum 3- 3	245.522	144.034	143.276	133.578	226.328	139.017	144.046
Sum 4-14	407.804	478.124	409.768	341.308	288.085	341.391	310.249
Total	653.326	622.158	553.044	474.886	514.414	480.408	454.295

Age	1986	1987	1988	1989	1990	1991	1992
3	335.905	277.711	168.566	83.222	133.149	102.584	181.628
4	112.107	256.391	217.439	131.951	65.785	103.791	76.274
5	66.125	73.489	154.079	142.633	82.865	42.780	62.392
6	67.040	30.300	35.814	76.078	102.920	43.473	21.148
7	21.168	27.348	11.318	12.693	34.154	44.457	16.404
8	7.942	7.169	8.437	3.575	5.028	12.769	14.127
9	3.484	2.551	2.173	1.716	1.222	1.823	4.779
10	1.643	1.274	0.788	0.586	0.620	0.457	0.687
11	0.817	0.627	0.514	0.241	0.278	0.220	0.158
12	0.230	0.319	0.287	0.150	0.102	0.122	0.069
13	0.232	0.096	0.134	0.095	0.046	0.039	0.044
14	0.088	0.122	0.038	0.011	0.044	0.025	0.022
Juvenile	531.565	608.205	516.344	345.609	313.114	249.017	268.031
Adult	85.216	69.191	83.243	107.341	113.098	103.523	109.702
Sum 3- 3	335.905	277.711	168.566	83.222	133.149	102.584	181.628
Sum 4-14	280.876	399.685	431.021	369.728	293.062	249.956	196.104
Total	616.781	677.396	599.587	452.951	426.211	352.540	377.733

Age	1993	1994	1995	1996	1997	1998	1999
3	157.373	81.958	177.670	227.790	101.000	173.000	83.000
4	137.683	110.376	61.545	135.746	181.663	80.974	138.975
5	42.960	82.996	68.659	42.190	97.721	133.906	57.981
6	27.368	21.557	50.275	41.090	27.906	64.438	87.107
7	7.153	10.557	11.400	29.425	22.597	16.816	34.388
8	4.492	2.661	4.715	5.647	15.633	11.884	8.631
9	4.188	1.207	1.057	2.429	2.693	7.465	6.387
10	2.119	1.031	0.454	0.584	1.239	1.179	3.271
11	0.332	0.684	0.391	0.207	0.292	0.573	0.451
12	0.088	0.112	0.307	0.180	0.101	0.127	0.252
13	0.028	0.042	0.048	0.126	0.090	0.058	0.057
14	0.025	0.013	0.018	0.013	0.054	0.040	0.022
Juvenile	225.687	152.837	217.367	390.004	243.415	363.863	288.207
Adult	158.122	160.356	159.171	95.424	207.574	126.596	132.316
Sum 3- 3	157.373	81.958	177.670	227.790	101.000	173.000	83.000
Sum 4-14	226.436	231.236	198.869	257.638	349.989	317.460	337.523
Total	383.809	313.194	376.539	485.428	450.989	490.460	420.523

Table 3.3.13. Cod at Iceland. Division Va. Spawning stock biomass (tonnes).

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Virtual Population Analysis : SSB in 1000 x tons
FINAL-VPA99

Age	1979	1980	1981	1982	1983	1984	1985
3	0.000	10.271	0.000	2.917	0.000	0.000	4.166
4	5.033	6.867	4.674	8.747	12.670	10.555	9.012
5	34.391	46.055	20.608	18.924	23.102	28.991	48.127
6	164.297	82.994	52.345	40.895	34.834	47.190	71.054
7	142.178	293.392	65.636	62.440	53.320	43.625	54.569
8	60.423	97.902	174.044	36.502	41.484	39.719	34.165
9	23.794	35.896	44.874	62.994	13.517	24.330	21.233
10	9.432	15.614	15.691	19.197	19.366	7.881	13.103
11	4.251	7.633	6.445	8.215	8.440	9.326	4.166
12	2.946	2.469	3.193	3.271	4.322	4.755	5.000
13	0.317	2.450	0.582	1.845	1.773	2.090	2.271
14	0.152	0.233	1.052	0.277	0.906	0.928	1.051
Total	447.212	601.775	389.144	266.225	213.734	219.391	267.918

Age	1986	1987	1988	1989	1990	1991	1992
3	1.877	6.784	7.588	0.000	0.000	0.000	10.826
4	9.749	19.217	6.376	8.857	5.989	10.449	21.198
5	35.631	40.009	66.557	65.881	45.598	17.159	62.114
6	100.360	56.164	45.227	124.704	163.444	54.347	34.820
7	52.830	73.980	26.647	39.747	92.520	89.521	41.690
8	28.878	27.034	22.635	13.764	20.247	45.129	46.288
9	17.358	11.324	8.253	7.568	6.797	8.666	22.460
10	9.836	8.838	3.833	4.001	4.045	2.566	4.182
11	5.759	4.952	2.967	1.996	2.378	1.491	1.463
12	2.165	2.348	1.674	0.773	1.035	1.125	0.635
13	2.463	1.020	0.595	0.720	0.550	0.435	0.544
14	1.115	1.347	0.213	0.103	0.518	0.329	0.182
Total	268.022	253.019	192.565	268.115	343.121	231.215	246.402

Age	1993	1994	1995	1996	1997	1998
3	11.950	8.863	7.701	21.315	8.548	5.438
4	47.870	49.083	40.793	19.912	83.421	40.233
5	42.832	99.474	120.480	50.671	114.764	137.677
6	53.716	52.835	128.556	98.709	68.297	123.214
7	23.030	36.898	36.197	94.187	86.799	57.304
8	15.890	10.531	21.407	22.380	69.763	67.668
9	16.471	6.080	6.321	11.706	14.077	42.720
10	11.067	5.101	3.229	4.144	7.198	6.851
11	2.293	5.218	3.064	1.741	2.151	4.678
12	0.774	0.982	2.371	1.731	0.873	1.325
13	0.295	0.421	0.357	1.175	0.700	0.670
14	0.297	0.158	0.189	0.160	0.595	0.419
Total	226.486	275.645	370.666	327.831	457.185	488.195

Table 3.3.14. Cod at Iceland. Division Va. Average fishing mortality of age groups 5-10, recruitment (at age 3, in millions), spawning stock at spawning time ('000 tonnes).

Year	F5-10	Recruitment	SSB
1955	0.31	260	1261
1956	0.26	307	1199
1957	0.32	153	1145
1958	0.32	191	1034
1959	0.33	143	928
1960	0.38	163	825
1961	0.33	292	760
1962	0.40	255	729
1963	0.45	273	683
1964	0.54	328	569
1965	0.61	174	454
1966	0.54	255	412
1967	0.49	186	476
1968	0.67	178	594
1969	0.53	136	693
1970	0.56	303	684
1971	0.62	170	615
1972	0.71	265	477
1973	0.71	432	436
1974	0.76	143	329
1975	0.81	222	339
1976	0.76	246	283
1977	0.63	144	319
1978	0.48	143	375
1979	0.43	134	447
1980	0.45	226	602
1981	0.68	139	389
1982	0.78	144	266
1983	0.78	336	213
1984	0.62	278	219
1985	0.66	169	268
1986	0.78	83	268
1987	0.83	133	253
1988	0.96	103	193
1989	0.68	182	268
1990	0.72	157	343
1991	0.78	82	231
1992	0.79	178	246
1993	0.88	228	226
1994	0.60	101	276
1995	0.43	173	371
1996	0.43	83	328
1997	0.45	206	457
1998	0.49	173	488

Table 3.3.15. 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 were available at the WG meeting.

Table 3.3.16. Cod at Iceland. Division Va. Capelin biomass ('000 tonnes) at 1. August used for prediction of cod mean weights.

Year Total	Total
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	4481
1998	3487
1999	3610
Average	3161

Table 3.3.17. Cod at Iceland. Division Va. Input file for the RCT3 program.

Yearclass	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	169	60113	68604	25874	13903
1986	83	8272	17511	5820	2605
1987	133	22262	19408	14921	1711
1988	103	13601	15633	11786	2048
1989	182	31684	30540	14473	3509
1990	157	18211	26030	16407	1712
1991	82	4301	5556	2237	223
1992	178	19228	17477	10539	1312
1993	228	48173	37466	28480	8920
1994	92	13959	11969	3869	487
1995	-11	35495	28949	18566	2454
1996	-11	-11	5985	3570	530
1997	-11	-11	-11	31265	5299
1998	-11	-11	-11	-11	5587

Table 3.3.18. Cod at Iceland. Division. Va. Output from RCT3.

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

Recnwwg1.dat

Iceland Cod: VPA and groundfish survey data

Data for    4 surveys over   18 years :  1981 - 1998

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

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

Forecast/Hindcast variance correction used.
```

Yearclass = 1994

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression			----------I	I-----------Prediction			---------I	
Surv4	.52	-.19	.23	.779	13	9.54	4.76	.274	.336
Surv3	.63	-1.34	.29	.702	12	9.39	4.55	.356	.199
Surv2	.56	-.34	.26	.768	11	8.26	4.33	.331	.230
Surv1	.44	1.57	.41	.514	10	6.19	4.27	.534	.089
					VPA Mean =		5.05	.416	.146

Yearclass = 1995

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression			----------I	I-----------Prediction			---------I	
Surv4	.55	-.49	.24	.772	14	10.48	5.25	.281	.274
Surv3	.63	-1.39	.28	.724	13	10.27	5.12	.324	.206
Surv2	.53	-.03	.24	.795	12	9.83	5.22	.277	.281
Surv1	.40	1.84	.36	.577	11	7.81	5.00	.428	.118
					VPA Mean =		5.00	.422	.121

Yearclass = 1996

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression			----------I	I-----------Prediction			---------I	
Surv4									
Surv3	.64	-1.40	.28	.721	13	8.70	4.12	.372	.250
Surv2	.53	.02	.24	.794	12	8.18	4.35	.299	.386
Surv1	.40	1.87	.36	.581	11	6.27	4.39	.453	.169
					VPA Mean =		4.99	.421	.195

Table 3.3.18 (Cont'd)

Yearclass = 1997

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression----------I					I-----------Prediction---------I			
Surv4									
Surv3									
Surv2	.52	.07	.24	.793	12	10.35	5.50	.295	.515
Surv1	.40	1.90	.36	.587	11	8.58	5.33	.442	.230
					VPA Mean =		4.98	.420	.255

Yearclass = 1998

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression----------I					I-----------Prediction---------I			
Surv4									
Surv3									
Surv2									
Surv1	.40	1.93	.35	.596	11	8.63	5.36	.446	.467
					VPA Mean =		4.97	.418	.533

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
1994	101	4.62	.16	.13	.65	92	4.53
1995	173	5.15	.15	.05	.11		
1996	83	4.43	.19	.17	.84		
1997	206	5.33	.21	.15	.51		
1998	173	5.15	.31	.20	.41		

Table 3.3.19

Cod in the Iceland Grounds (Fishing Area Va)

Prediction with management option table: Input data

Year: 1999

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	83000.000	0.2000	0.0580	0.0850	0.2500	1253.000	0.0230	1412.000
4	138975.00	0.2000	0.2200	0.1800	0.2500	1771.000	0.1340	1864.000
5	57981.000	0.2000	0.4980	0.2480	0.2500	2648.000	0.2350	2652.000
6	87107.000	0.2000	0.7090	0.2960	0.2500	3576.000	0.4030	3571.000
7	34388.000	0.2000	0.8570	0.3820	0.2500	4916.000	0.4810	4796.000
8	8631.000	0.2000	0.9250	0.4370	0.2500	6488.000	0.5360	6325.000
9	6387.000	0.2000	0.9320	0.4770	0.2500	7803.000	0.6160	7560.000
10	3271.000	0.2000	0.9520	0.4770	0.2500	9176.000	0.6520	9184.000
11	451.000	0.2000	0.9990	0.4770	0.2500	11116.000	0.6220	10970.000
12	252.000	0.2000	0.9360	0.4770	0.2500	13128.000	0.6220	13221.000
13	57.000	0.2000	0.9900	0.4770	0.2500	14050.000	0.6220	13835.000
14	22.000	0.2000	1.0000	0.4770	0.2500	15496.000	0.6220	14684.000
Unit	Thousands	-	-	-	-	Grams	-	Grams

Year: 2000

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	206000.00	0.2000	0.0580	0.0850	0.2500	1253.000	0.0230	1412.000
4	.	0.2000	0.2200	0.1800	0.2500	1771.000	0.1340	1869.000
5	.	0.2000	0.4980	0.2480	0.2500	2476.000	0.2350	2622.000
6	.	0.2000	0.7090	0.2960	0.2500	3723.000	0.4030	3598.000
7	.	0.2000	0.8570	0.3820	0.2500	4887.000	0.4810	4765.000
8	.	0.2000	0.9250	0.4370	0.2500	6257.000	0.5360	6177.000
9	.	0.2000	0.9320	0.4770	0.2500	7803.000	0.6160	7560.000
10	.	0.2000	0.9520	0.4770	0.2500	9176.000	0.6520	9184.000
11	.	0.2000	0.9990	0.4770	0.2500	11116.000	0.6220	10970.000
12	.	0.2000	0.9360	0.4770	0.2500	13128.000	0.6220	13221.000
13	.	0.2000	0.9900	0.4770	0.2500	14050.000	0.6220	13835.000
14	.	0.2000	1.0000	0.4770	0.2500	15496.000	0.6220	14684.000
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	173000.00	0.2000	0.0580	0.0850	0.2500	1253.000	0.0230	1412.000
4	.	0.2000	0.2200	0.1800	0.2500	1771.000	0.1340	1869.000
5	.	0.2000	0.4980	0.2480	0.2500	2476.000	0.2350	2624.000
6	.	0.2000	0.7090	0.2960	0.2500	3578.000	0.4030	3579.000
7	.	0.2000	0.8570	0.3820	0.2500	5020.000	0.4810	4790.000
8	.	0.2000	0.9250	0.4370	0.2500	6237.000	0.5360	6156.000
9	.	0.2000	0.9320	0.4770	0.2500	7803.000	0.6160	7560.000
10	.	0.2000	0.9520	0.4770	0.2500	9176.000	0.6520	9184.000
11	.	0.2000	0.9990	0.4770	0.2500	11116.000	0.6220	10970.000
12	.	0.2000	0.9360	0.4770	0.2500	13128.000	0.6220	13221.000
13	.	0.2000	0.9900	0.4770	0.2500	14050.000	0.6220	13835.000
14	.	0.2000	1.0000	0.4770	0.2500	15496.000	0.6220	14684.000
Unit	Thousands	-	-	-	-	Grams	-	Grams

Notes: Run name : MANSAS01
Date and time: 03MAY99:14:54

Table 3.3.20

Cod in the Iceland Grounds (Fishing Area Va)

Prediction with management option table

Year: 1999					Year: 2000						Year: 2001	
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
0.9503	0.4630	1129517	527884	260000	0.0000	0.0000	1194990	616647	0	1539630	854338
.	.	.	.	.	0.1000	0.0487	.	606811	32005	1501824	809205
.	.	.	.	.	0.2000	0.0974	.	597173	62708	1465593	766996
.	.	.	.	.	0.3000	0.1462	.	587729	92169	1430863	727507
.	.	.	.	.	0.4000	0.1949	.	578475	120445	1397565	690548
.	.	.	.	.	0.5000	0.2436	.	569406	147591	1365633	655941
.	.	.	.	.	0.6000	0.2923	.	560518	173658	1335003	623523
.	.	.	.	.	0.7000	0.3410	.	551807	198695	1305616	593143
.	.	.	.	.	0.8000	0.3897	.	543269	222750	1277415	564659
.	.	.	.	.	0.9000	0.4385	.	534901	245866	1250345	537943
.	.	.	.	.	1.0000	0.4872	.	526697	268086	1224356	512872
.	.	.	.	.	1.1000	0.5359	.	518656	289451	1199398	489335
.	.	.	.	.	1.2000	0.5846	.	510773	309998	1175424	467227
.	.	.	.	.	1.3000	0.6333	.	503044	329764	1152390	446453
.	.	.	.	.	1.4000	0.6820	.	495467	348784	1130254	426922
.	.	.	.	.	1.5000	0.7308	.	488038	367091	1108975	408552
-	-	Tonnes	Tonnes	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes

Notes: Run name : MANSAS01
Date and time : 03MAY99:14:54
Computation of ref. F: Simple mean, age 5 - 10
Basis for 1999 : TAC constraints

Table 3.3.21

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: 27MAY99:14:59

Table 3.3.22

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
-	-	Numbers	Grams	Numbers	Grams	Numbers	Grams	Numbers	Grams

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
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 : 27MAY99:14:59
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.

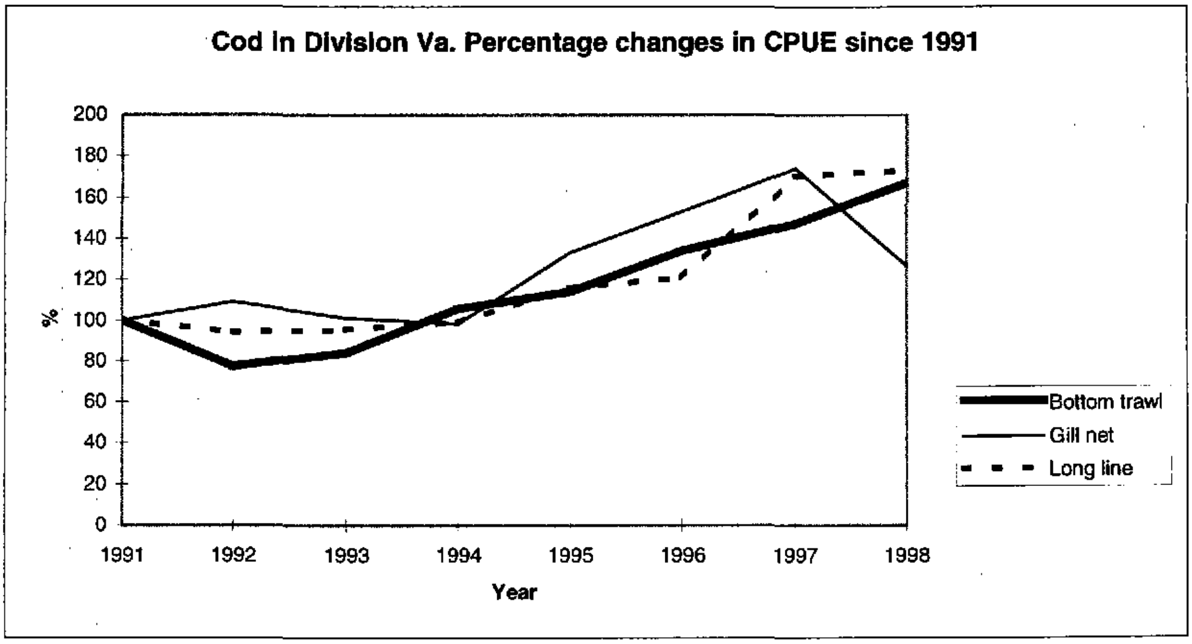


Figure 3.3.2. Cod at Iceland. Division Va. Percentage changes in for the main fishing gear since 1991.

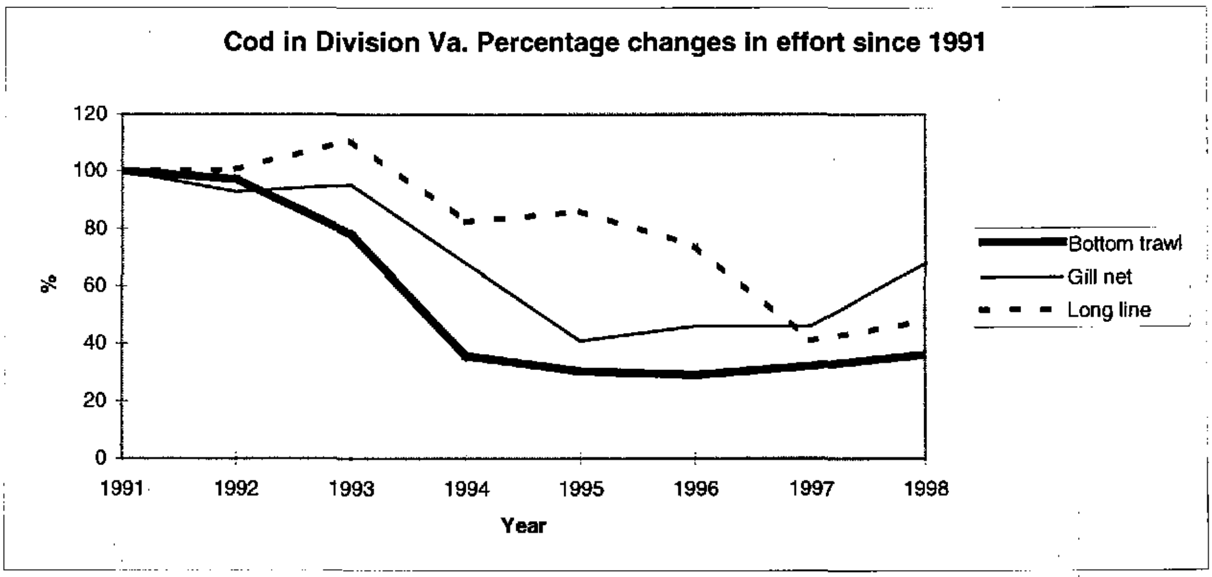


Figure 3.3.3. Cod at Iceland. Division Va. Propotion mature at the spawning time.

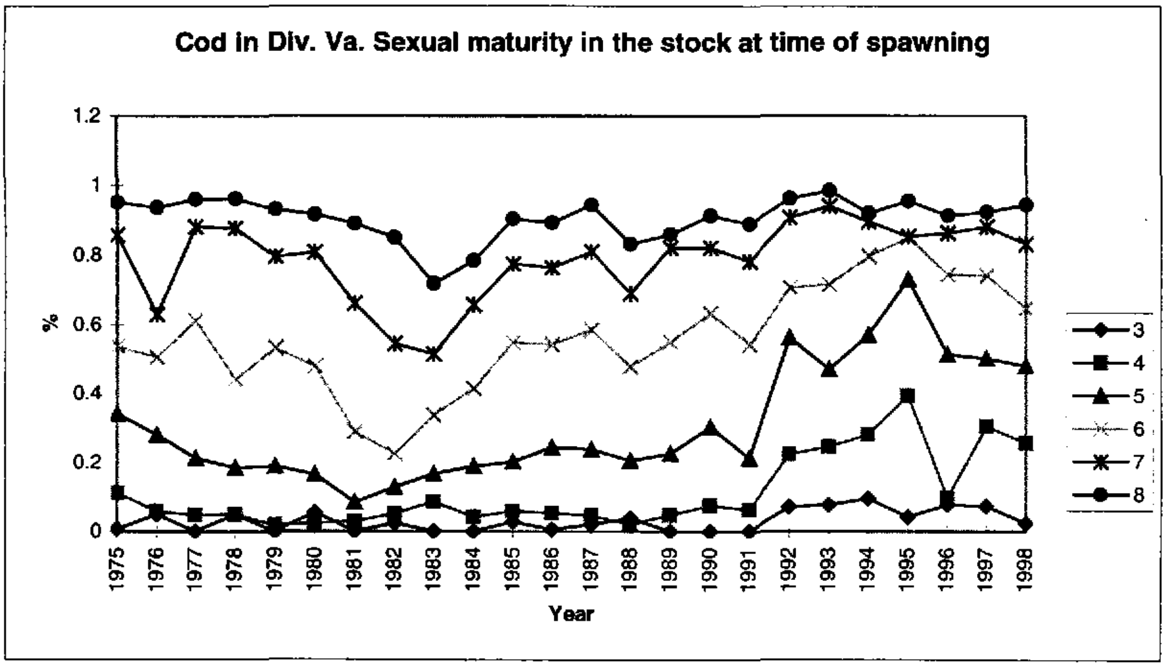


Figure 3.3.4. Cod at Iceland. Division Va. Retrospective analysis of the XSA.

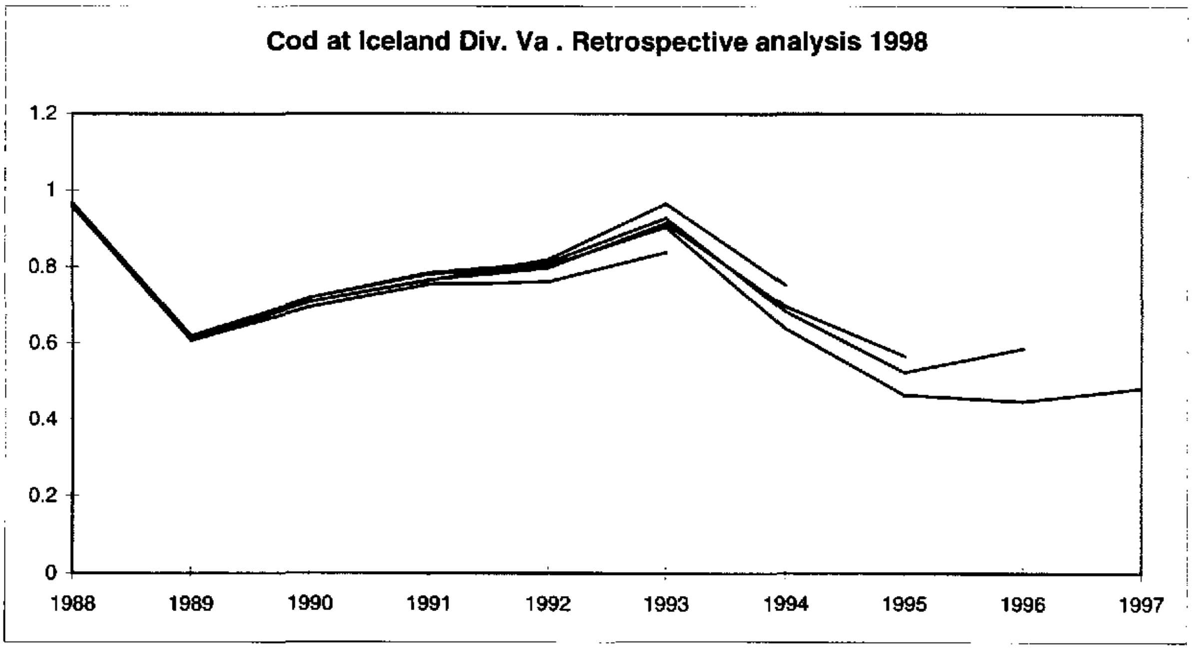
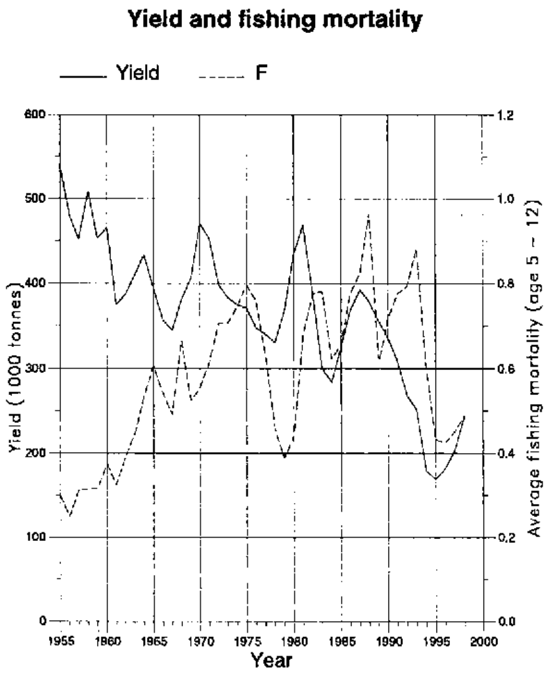
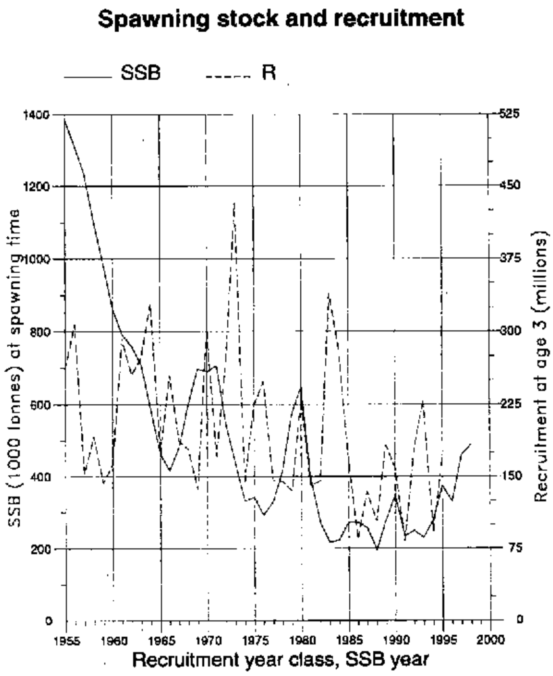


Figure 3.3.5

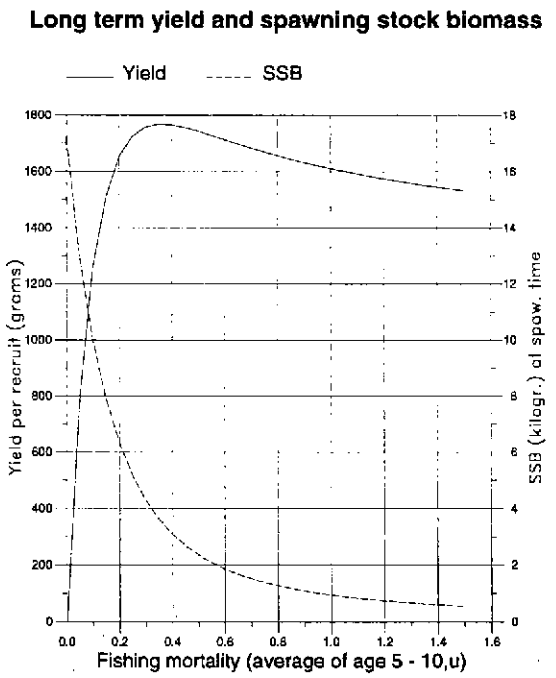


(run: XSASAS07) A

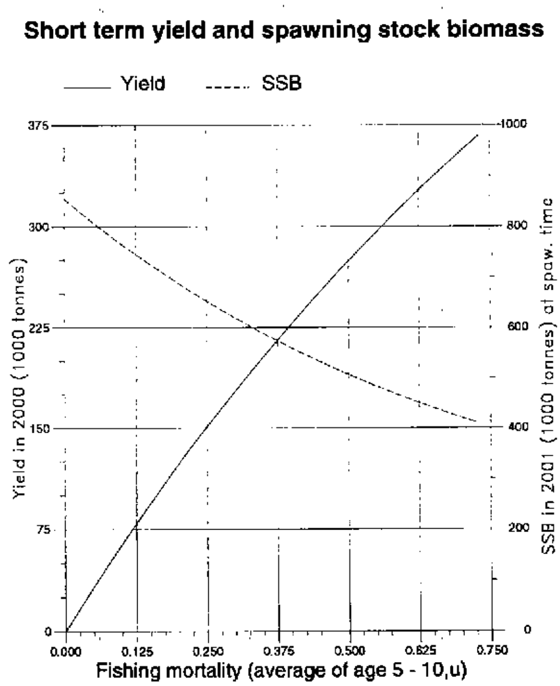


(run: XSASAS07) B

Figure 3.3.5 (Cont'd)

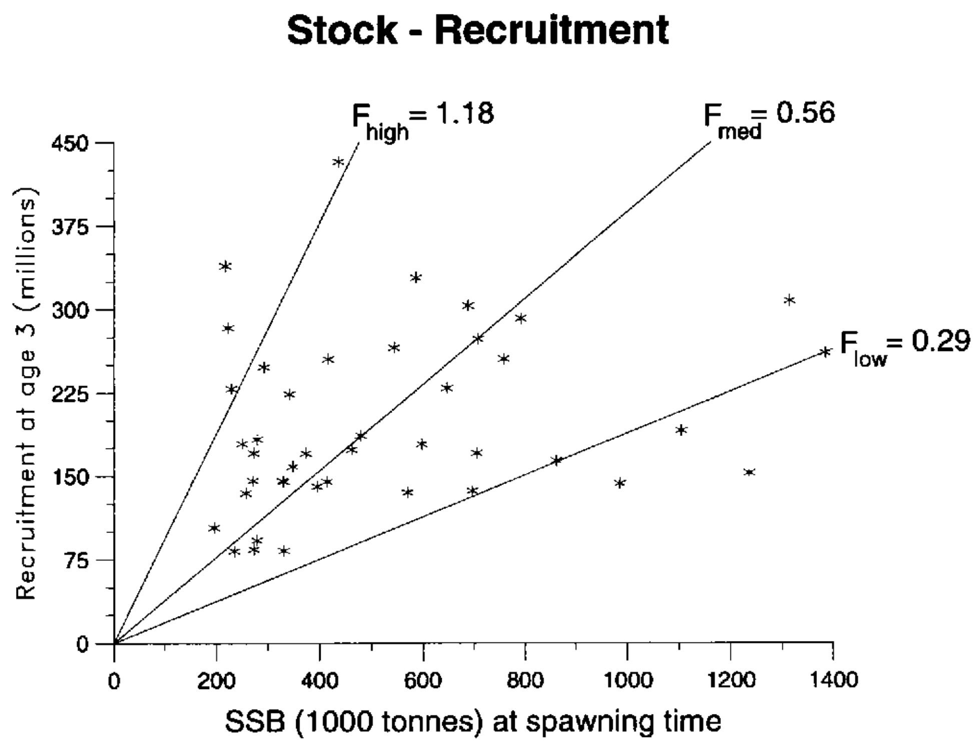


(run: YLDSAS03) C



(run: MANSAS01) D

Figure 3.3.6



(run: XSASAS07)

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 have been conducted by the Marine Research Institute in Iceland.

3.4.2 Trends in landings and fisheries

During the sixties haddock landings rose to the record level of around 100 000 tonnes for several years (Figure 3.4.2.1). After that, landings fell to 40-60 000 tonnes (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.

In 1998, 60% of landings were by demersal trawl, 9% by Danish seine, 26% by long line and 5% by gillnet.

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. (Figure 3.4.2.2).

3.4.3 Catch at age

Catch at age for 1998 for the Icelandic fishery is provided in Table 3.4.3.1. Catch at age is calculated by 3 fleets, from the age composition in each fleet category and the respective catches. Fleets are defined by gear and for 1998, season. The gears are gill nets, long line and bottom trawl. Hand line is included in 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 is assumed to be by long line and included in that category. Numbers sampled in 1998 are given in Table 3.4.3.2.

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 1978-1998 is given in Table 3.4.4.2. These data were calculated from the Icelandic groundfish survey. Weights for 1985-1992 are calculated using length-weight relationship for the actual years. Weights from 1993 onwards are based on weight data. Stock weights prior to 1985 have been taken to be the mean of 1985-1999.

Originally mean weights at age in the stock were taken from the landings. After 1994, mean weights at age from the groundfish survey were applied, but as this data represents early year (March) values the survey values were "projected" to mid year values (assuming linear growth). The weights from the groundfish survey have been used for the assessment this year, replacing the old stock weights back to 1978.

3.4.5 Maturity at age

Maturity at age is based on samples from the Icelandic groundfish survey for the years 1985-1998. For 1979-84, maturity at age is based on samples from the commercial fleet from the 12 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 (Figure 3.4.5.1). 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 1970-1998 and from the gillnet fleet from 1988 are available. For the nets component, CPUE from the commercial boats as number (abundance) at age were used (GLIM indices as described by Stefansson (1988)). For the trawler fleet the same method (GLIM) was disproportionally affected by a small part of total landings so raw CPUE indices distributed on age groups by the GLIM method, were used. The Icelandic groundfish survey indices (Palsson et al., 1989) were used. The basic data are disaggregated (Palsson and Stefansson, 1991) and abundance indices computed by using the Cochran method (Palsson, 1989). To use the latest information available, survey abundance indices were moved back in time approximately 3 months. The resulting indices of 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

Two main tuning runs were tried with XSA, one using survey data alone and another including survey indices along with bottom trawl and gillnet CPUE. The survey data covers the years 1985-1999 age groups 3-9; trawl 1992-1998 age groups 4-9; gill nets 1991-1998 age groups 5-8.

The tuning runs generated comparable estimates of recruitment and stock numbers. Although there are blocks of positive and negative log catchability residuals when tuning with the 2 CPUE indices and survey indices, the standard errors of log catchability are low (Table 3.4.6.2.1). It was decided to adopt that XSA as it includes information from the catch CPUE rather than relying entirely upon the survey alone. Retrospective analyses were conducted with a range of shrinkage levels (Figure 3.4.6.2.1). As varying the shrinkage produces little difference, the default of 0.5 was used.

Fishing mortalities are given in Table 3.4.6.2.2. The resulting mean F in 1998 for age groups 4-7 from the final run was 0.60 compared 0.72 when survey indices alone are used to tune the XSA. 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.

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 tonnes in 1987 to a maximum of 110 000 tonnes in 1982 - there are no trends.

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 and 9, means of the years 1996-1998 were used. For the stock weights, means of the years 1997-1999 were used for all age groups beyond the year 1999. For 1999, weight and maturity values from the 1999 survey are used. After 1999, the mean proportion mature at age from 1997-1999 was used. The exploitation pattern was taken as the mean from 1996-1998, scaled to the level in 1998.

Recruitment for 1999 and 2000 was estimated using a prediction program (RCT3, as described in Section 3.3.7.3.) with input from the 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. Ages 3 and 4 in 1999 were also adjusted using RCT3 to reflect the more accurate information from the survey in estimating the size of these age classes. A TAC constraint of 37 000 tonnes was applied to the prediction for 1999 as that is the forecast catch for the 1999 fishing year.

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 $F_{4-7} = 0.60$ for 1998, $F_{max} = 0.55$ and $F_{0.1} = 0.29$.
Yield per recruit at F_{max} corresponds to 0.90 kg. (Table 3.4.7.2.1)

A plot of spawning stock biomass and recruitment from 1978-1998 is shown in Figure 3.4.7.2.2.. The SSB-recruit reference points F_{med} and F_{high} are 0.47 and 1.10 respectively, where F_{high} is the fishing mortality rate with SSB/R equal to the inverse of the 90th 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_{lim} is set to the F_{med} value of 0.47 and that F_{pa} be 0.34 ($F_{pa} = F_{lim}$ x 0.72).

3.4.7.3 Projection of catch and biomass

At the beginning of 1999, the total stock is estimated to be 109 000 tonnes with a spawning stock of 70 000 t. (Table 3.4.7.3.1.) With a catch of 37 000 t in 1999, fishing mortality is estimated to be 0.44, the stock biomass 118 000 t and the spawning stock biomass 68 000 t at the start of 2000. Assuming fishing mortality in 2000 to be the same as in 1999, landings in 2000 are estimated to increase slightly to 42 000 t and stock biomass and spawning stock biomass should increase to 126 000 t and 75 000 t respectively at the start of 2001. This level of fishing mortality is significantly lower than that of recent years.

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. For the first time, advice in the 1998 fishing year was based on F_{med} and a reduction in fishing mortality is forecast for 1999.

3.4.9 Comments on the assessment

Fishing mortality on haddock increased after 1985 (Figure 3.4.6.2.2.) The high fishing mortality in recent years is at least partly due to an overestimation of the stock biomass through the use of stock weights that are 20-25% higher than at present. The assessment this year has been carried out in a similar manner to previous years within MRI, the only difference being that more appropriate stock weights have been used. $F_{med} = 0.35$ when calculated from the stock weights used in 1998, compared to 0.47 with stock weights calculated directly from the survey.

Work is currently being carried out in constructing a longer time series of data than that used in the present assessment. As the current biomass is well above the lowest observed, the working group decided to delay the proposal of biomass reference points until that time series becomes available. As F values in recent years have been high, the working group decided not to delay the definition of fishing mortality reference points.

As the oldest age in the assessment is not a plus group, this created problems in using IFAP. For the XSA run a dummy oldest age was created, the use of which generated the same result as with the standard XSA without a plus group. This run was done with the actual age range (i.e. ages 2 to 9) and the "plus group" was ignored. When the retrospective analyses were carried out, however, if the true age range was used age 9 was considered to be a plus group and setting the oldest age to be 10 produced the correct result. One problem with this is that IFAP allows a choice of whether to have a plus group but the oldest age is always used as a plus group in the analyses. Another problem is the difference between the age range input for XSA and the retrospective analysis to generate comparable results.

Table 3.4.2.1. Haddock Division Va. Nominal landings (tonnes) of haddock by nation since 1978 as officially reported to ICES

HADDOCK Va

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

HADDOCK Va

Country	1985	1986	1987	1988	1989	1990	1991
Belgium	391	257	238	352	483	595	485
Faroe Islands	987	1289	1043	797	606	603	773
Iceland	49553	47317	39479	53085	61792	66004	53516
Norway	+		1	+			
UK	2						
Total	50933	48863	40761	54234	62881	67202	53774

HADDOCK Va

Country	1992	1993	1994	1995	1996	1997	1998[1]
Belgium	361	458	248				
Faroe Islands	757	754	911	758	664	340	
Iceland	46098	46932	58408	60061	56223	43245	40615
Norway			1	+	4		
UK							
Total	47216	48144	59567	60819	56891	43585	

1) Preliminary

Table 3.4.3.1. Haddock in Division Va. Catch at age 1978-1998.

```
Run title : Haddock Iceland Va (run: XSALOA01/X01)

At  1-May-99  18:04:14


   Table  1    Catch numbers at age    Numbers*10**-3
   YEAR  1978

   AGE
 2    108
 3    579
 4    2132
 5    7188
 6    4481
 7    1821
 8    627
 9    94
0  TOTALNUM 17030
   TONSLAND 43488
   SOPCOF %105
```

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

YEAR	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	
AGE											
2	161	595	1	50	1	60	427	196	2237	133	
3	2066	1384	516	286	705	755	1773	3681	7559	10068	
4	4047	11476	4929	2698	1498	4970	4981	3822	7500	15927	
5	6559	4296	16961	10703	4645	1176	6058	4933	2696	5598	
6	9769	3796	6021	14115	10301	4875	837	5761	2249	1260	
7	1887	3730	2835	2288	8808	3772	1564	493	1194	1009	
8	474	544	1810	1167	874	4446	2475	852	151	577	
9	61	91	169	816	241	171	2212	898	208	58	
0 TOTALNUM		25024	25912	33242	32123	27073	20225	20327	20636	23794	34630
TONSLAND		55334	51112	63580	69325	65943	48285	50933	48863	40801	54236
SOPCOF %		94	100	100	101	102	100	101	103	102	101

1

```
Run title : Haddock Iceland Va (run: XSALOA01/X01)

At  1-May-99  18:04:14
```

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

YEAR		1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
AGE											
2	78	446	2461	2726	218	280	2357	1467	1375	153	
3	2603	2603	1282	7343	11617	3030	6327	8982	3690	8469	
4	23077	7994	3942	4181	12642	27025	5667	7076	11127	5067	
5	9703	23803	6711	4158	3167	10722	23357	4751	4885	8071	
6	3118	6654	13650	3989	1786	1550	5605	13963	2540	2349	
7	541	857	2956	5936	1504	756	610	2446	4981	1566	
8	507	167	398	1314	2263	404	263	228	692	1793	
9	144	71	52	132	379	700	210	87	52	245	
0 TOTALNUM		39771	42595	31452	29779	33576	44467	44396	39000	29342	27713
TONSLAND		62979	67200	54732	47212	48844	59345	61131	56958	44053	41434
SOPCOF %		100	100	100	100	100	101	102	100	100	100

1

Table 3.4.3.2 Length and age sampling in 1998.

Gear	Total Landings	Samples - length	Samples - aged
Longline	10689	7244	1058
Gillnet	2186	599	292
Trawl	28559	82672	4240
Total	41434	90515	5590

Table 3.4.4.1. Haddock in Division Va. Mean weight at age in the catch 1978-1998.

Run title : Haddock Iceland Va (run: XSALOA01/X01)

At 1-May-99 18:04:15

Table 2 Catch weights at age (kg)

YEAR	1978
AGE	
2	0.62
3	0.96
4	1.41
5	2.03
6	2.91
7	3.8
8	4.56
9	4.72
0 SOPCOFAC	1.0483

Table 2 Catch weights at age (kg)

YEAR	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
AGE										
2	0.62	0.837	0.584	0.33	0.655	0.98	0.599	0.867	0.446	0.468
3	0.96	0.831	0.693	0.819	0.958	1.041	1.002	1.187	1.048	0.808
4	1.41	1.306	1.081	1.365	1.436	1.476	1.783	1.755	1.629	1.474
5	2.03	2.207	1.656	1.649	1.827	2.105	2.201	2.377	2.373	2.23
6	2.91	2.738	2.283	2.329	2.355	2.46	2.727	2.71	2.984	2.934
7	3.8	3.188	3.214	3.012	2.834	3.028	3.431	3.591	3.55	3.545
8	4.56	3.843	3.409	3.384	3.569	3.014	3.783	3.76	4.483	3.769
9	4.72	4.506	4.046	3.965	4.308	3.807	4.07	4.135	4.667	4.574
0 SOPCOFAC	0.9355	1.0041	1.0015	1.0116	1.0193	1.0034	1.0134	1.0337	1.0167	1.0068

1

Run title : Haddock Iceland Va (run: XSALOA01/X01)

At 1-May-99 18:04:15

Table 2 Catch weights at age (kg)

YEAR	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
AGE										
2	0.745	0.357	0.409	0.32	0.42	0.568	0.475	0.387	0.45	0.689
3	0.856	0.716	0.868	0.856	0.756	0.72	0.874	0.841	0.829	0.777
4	1.17	1.039	1.111	1.253	1.372	1.058	1.145	1.189	1.192	1.166
5	2.01	1.542	1.546	1.597	1.87	1.742	1.366	1.528	1.663	1.692
6	2.879	2.403	2.035	2.088	2.36	2.38	2.079	1.816	1.934	2.312
7	4.109	3.458	2.849	2.529	2.888	2.785	2.853	2.641	2.36	2.379
8	4.035	4.186	3.464	3.133	2.975	3.447	3.251	3.499	3.059	2.882
9	4.706	4.969	4.642	4.022	3.442	3.156	3.899	3.526	3.01	3.417
0 SOPCOFAC	1.0042	1.0024	1.0007	1.004	1.0022	1.0057	1.017	1.0043	1.0011	1.0006

1

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

Run title : Haddock Iceland Va (run: XSALOA01/X01)

At 1-May-99 18:04:15

Table 3 Stock weights at age (kg)

AGE	1978
2	0.185
3	0.475
4	0.901
5	1.411
6	2.004
7	2.526
8	3.201
9	3.266

Table 3 Stock weights at age (kg)

AGE	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
2	0.185	0.185	0.185	0.185	0.185	0.185	0.245	0.234	0.157	0.176
3	0.475	0.475	0.475	0.475	0.475	0.475	0.555	0.677	0.564	0.453
4	0.901	0.901	0.901	0.901	0.901	0.901	1.158	1.128	1.211	0.969
5	1.411	1.411	1.411	1.411	1.411	1.411	1.629	1.929	1.825	1.826
6	2.004	2.004	2.004	2.004	2.004	2.004	2.349	2.371	2.596	2.679
7	2.526	2.526	2.526	2.526	2.526	2.526	2.736	3.149	3.02	3.089
8	3.201	3.201	3.201	3.201	3.201	3.201	3.213	3.241	3.626	3.464
9	3.266	3.266	3.266	3.266	3.266	3.266	3.302	3.688	3.818	3.294

Run title : Haddock Iceland Va (run: XSALOA01/X01)

At 1-May-99 18:04:15

Table 3 Stock weights at age (kg)

AGE	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
2	0.181	0.183	0.174	0.157	0.171	0.18	0.165	0.18	0.172	0.202
3	0.439	0.447	0.495	0.496	0.385	0.402	0.443	0.456	0.424	0.404
4	0.885	0.829	0.998	0.902	0.874	0.7	0.738	0.855	0.808	0.741
5	1.502	1.238	1.397	0.379	1.492	1.243	1.053	1.04	1.195	1.223
6	2.38	1.962	1.879	1.926	1.807	1.689	1.868	1.437	1.425	1.725
7	2.987	2.688	2.49	2.373	2.617	1.646	2.624	2.171	1.919	2.001
8	3.503	3.08	3.732	2.932	2.62	2.697	5.285	3.172	2.331	2.32
9	3.194	3.317	3.642	3.672	3.346	1.997	1.313	4.78	3.686	3.03

Table 3.4.5.1 Proportion mature at age 1978-1998.

Run title : Haddock Iceland Va (run: XSALOA01/X01)

At 1-May-99 18:04:15

Table 5 Proportion mature at age

AGE	YEAR 1978
2	0
3	0.13
4	0.3
5	0.46
6	0.68
7	0.86
8	0.96
9	1

Table 5 Proportion mature at age

AGE \ YEAR	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
2	0	0	0	0	0	0	0.01	0.02	0.02	0.01
3	0.13	0.13	0.13	0.13	0.13	0.13	0.1	0.19	0.11	0.22
4	0.3	0.3	0.3	0.3	0.3	0.3	0.4	0.43	0.41	0.38
5	0.46	0.46	0.46	0.46	0.46	0.46	0.43	0.66	0.52	0.77
6	0.68	0.68	0.68	0.68	0.68	0.68	0.72	0.83	0.79	0.79
7	0.86	0.86	0.86	0.86	0.86	0.86	0.67	0.87	0.78	0.93
8	0.96	0.96	0.96	0.96	0.96	0.96	0.92	0.95	1	0.9
9	1	1	1	1	1	1	0.89	0.99	0.96	1

Run title : Haddock Iceland Va (run: XSALOA01/X01)

At 1-May-99 18:04:15

Table 5 Proportion mature at age

AGE \ YEAR	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
2	0.04	0.11	0.04	0.04	0.12	0.25	0.16	0.17	0.09	0.03
3	0.2	0.28	0.2	0.14	0.33	0.32	0.49	0.36	0.44	0.48
4	0.53	0.59	0.58	0.42	0.47	0.57	0.43	0.58	0.66	0.66
5	0.72	0.81	0.75	0.77	0.66	0.78	0.78	0.65	0.71	0.78
6	0.8	0.84	0.82	0.86	0.88	0.86	0.83	0.78	0.75	0.76
7	1	0.92	0.91	0.87	0.97	1	0.69	0.73	0.86	0.85
8	1	0.9	0.94	0.71	0.93	0.9	1	0.96	0.89	0.85
9	1	1	1	1	0.85	1	1	0.98	1	1

Table 3.4.6.1.1 Tuning input for XSA. Demersal trawl and gillnet CPUE and groundfish survey indices.

Haddock in the Iceland Grounds (Fishing Area Va) (run name: XSALOA01)
103
FLT03: TRW EFF (Catch: Unknown) (Effort: Unknown)
1992 1998
1 1 0.00 1.00
4 9

1	839	837	808	1081	170	24
1	2807	538	224	201	300	55
1	6129	1927	211	84	40	57
1	1147	4723	853	72	30	11
1	1426	944	2693	433	34	4
1	3048	1396	624	1118	122	10
1	1532	2699	580	271	321	38

FLT04: NET CPU (Catch: Unknown) (Effort: Unknown)
1991 1998
1 1 0.00 1.00
5 8

0.1	37.3	153.8	101.8	23.8
0.1	19.4	53.6	164.3	91.3
0.1	33.8	49.0	60.1	94.8
0.1	69.2	38.4	15.8	23.8
0.1	118.5	190.9	28.4	13.5
0.1	45.6	229.8	81.4	9.0
0.1	48.9	64.9	168.5	35.0
0.1	140.2	53.3	56.8	78.1

FLT05: SUR CPU (Catch: Unknown) (Effort: Unknown)
1984 1998
1 1 0.99 1.00
2 8

0.1	17.2	19.6	21.0	2.6	8.0	3.4	4.3
0.1	53.8	12.2	15.2	12.1	0.9	2.4	1.1
0.1	141.5	54.8	13.1	11.0	8.0	0.6	1.3
0.1	173.7	82.8	21.5	1.3	2.1	1.8	0.2
0.1	37.3	125.0	39.4	11.0	0.8	0.7	0.4
0.1	25.6	33.9	76.9	26.9	3.0	0.8	0.2
0.1	38.0	16.6	19.1	30.6	7.2	0.3	0.1
0.1	126.1	31.6	14.4	11.9	14.3	2.1	0.2
0.1	248.9	86.5	10.9	3.6	1.5	4.1	0.8
0.1	39.0	142.5	41.8	6.8	2.8	1.4	4.0
0.1	48.0	20.2	64.2	7.6	1.4	0.1	0.4
0.1	112.6	32.7	18.0	37.9	6.0	0.6	0.1
0.1	48.0	52.5	9.9	6.7	10.7	1.4	0.1
0.1	105.8	27.5	22.3	4.4	3.2	4.2	0.3
0.1	24.7	94.4	12.5	9.4	1.4	1.6	1.0

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

```
Lowestoft VPA Version 3.1

   1-May-99  18:03:47

Extended Survivors Analysis

Haddock Iceland Va (run: XSALOA01/X01)

CPUE data from file /users/fish/ifad/ifapwork/nwwg/had_iceg/FLEET.X01

Catch data for  21 years. 1978 to 1998. Ages  2 to  10.

     Fleet,              First, Last, First, Last, Alpha,  Beta
                    ,     year, year,  age ,  age
FLT03: TRW EFF (Catc,    1992, 1998,   4,     9,   .000,  1.000
FLT04: NET CPU (Catc,    1991, 1998,   5,     8,   .000,  1.000
FLT05: SUR CPU (Catc,    1984, 1998,   2,     8,   .990,  1.000


Time series weights :

     Tapered time weighting applied
     Power =    3 over  20 years


Catchability analysis :

     Catchability independent of stock size for all ages

     Catchability independent of age for ages >=    7


Terminal population estimation :

     Survivor estimates shrunk towards the mean F
     of the final   5 years or the   2 oldest ages.

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

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

     Prior weighting not applied


Tuning converged after   27 iterations

1


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


Fishing mortalities
   Age,  1989,  1990,  1991,  1992,  1993,  1994,  1995,  1996,  1997,  1998

     2,  .003,  .022,  .034,  .018,  .006,  .007,  .034,  .046,  .016,  .011
     3,  .077,  .142,  .082,  .136,  .098,  .117,  .231,  .178,  .156,  .131
     4,  .290,  .357,  .331,  .418,  .366,  .346,  .332,  .438,  .350,  .332
     5,  .466,  .552,  .581,  .705,  .653,  .612,  .573,  .516,  .623,  .463
     6,  .925,  .689,  .727,  .848,  .771,  .801,  .774,  .831,  .581,  .708
     7,  .952,  .715,  .771,  .838,  .954,  .918,  .892,  .974,  .831,  .899
     8, 1.448,  .917,  .898,  .998,  .944,  .741, 1.019, 1.071,  .843,  .843
     9, 1.185,  .814,  .847,  .890,  .925,  .899, 1.193, 1.257,  .764,  .850
```

Table 3.4.6.2.1 (Cont'd)

XSA population numbers (Thousands)

YEAR	AGE 2	3	4	5	6	7	8	9
1989	2.66E+04	3.88E+04	1.01E+05	2.88E+04	5.71E+03	9.73E+02	7.32E+02	2.29E+02
1990	2.24E+04	2.17E+04	2.94E+04	6.20E+04	1.48E+04	1.85E+03	3.07E+02	1.41E+02
1991	8.07E+04	1.79E+04	1.54E+04	1.68E+04	2.92E+04	6.08E+03	7.42E+02	1.01E+02
1992	1.71E+05	6.38E+04	1.35E+04	9.08E+03	7.71E+03	1.16E+04	2.30E+03	2.48E+02
1993	3.74E+04	1.38E+05	4.56E+04	7.30E+03	3.67E+03	2.70E+03	4.09E+03	6.94E+02
1994	4.17E+04	3.04E+04	1.02E+05	2.59E+04	3.11E+03	1.39E+03	8.53E+02	1.30E+03
1995	7.69E+04	3.39E+04	2.22E+04	5.92E+04	1.15E+04	1.14E+03	4.55E+02	3.33E+02
1996	3.62E+04	6.08E+04	2.20E+04	1.30E+04	2.73E+04	4.34E+03	3.83E+02	1.34E+02
1997	9.47E+04	2.83E+04	4.17E+04	1.16E+04	6.37E+03	9.75E+03	1.34E+03	1.08E+02
1998	1.52E+04	7.63E+04	1.98E+04	2.41E+04	5.12E+03	2.92E+03	3.48E+03	4.73E+02

Estimated population abundance at 1st Jan 1999

, .00E+00, 1.23E+04, 5.48E+04, 1.16E+04, 1.24E+04, 2.06E+03, 9.72E+02, 1.23E+03,

Taper weighted geometric mean of the VPA populations:

, 4.97E+04, 4.36E+04, 2.96E+04, 1.73E+04, 7.74E+03, 3.06E+03, 1.10E+03, 3.17E+02,

Standard error of the weighted Log(VPA populations) :

, .7434, .6822, .7012, .7506, .8224, .8691, .9729, 1.0213,

1

Log catchability residuals.

Fleet : FLT03: TRW EFF (Catc

Age	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
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	-.01	-.04	-.07	-.23	.04	.13	.17
5	99.99	99.99	99.99	.10	-.15	-.15	-.10	-.22	.33	.19
6	99.99	99.99	99.99	.23	-.34	-.22	-.14	.16	.05	.25
7	99.99	99.99	99.99	.09	-.09	-.32	-.28	.21	.29	.11
8	99.99	99.99	99.99	-.08	-.11	-.64	-.19	.13	.06	.08
9	99.99	99.99	99.99	.15	-.04	-.65	-.81	-.89	.05	-.06

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	-2.4794	-2.0657	-2.0101	-1.9827	-1.9827	-1.9827
S.E(Log q)	.1351	.2094	.2348	.2381	.2879	.5671

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	1.03	-.306	2.26	.96	7	.15	-2.48
5	1.04	-.319	1.74	.92	7	.24	-2.07
6	.87	1.148	2.88	.94	7	.20	-2.01
7	.81	3.486	3.12	.99	7	.11	-1.98
8	.96	.317	2.28	.93	7	.28	-2.09
9	1.04	-.174	2.17	.79	7	.50	-2.31

1

Table 3.4.6.2.1 (Cont'd)

Fleet : FLT04: NET CPU (Catc

Age	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
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	-.37	-.35	.40	-.17	-.47	.06	.29	.55
6	99.99	99.99	-.65	-.32	.30	.23	.52	-.14	-.05	.03
7	99.99	99.99	-.10	-.24	.26	-.43	.34	.09	-.05	.10
8	99.99	99.99	.60	.85	.29	.39	.57	.36	.37	.22
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	-3.0763	-1.8671	-1.2375	-1.2375
S.E(Log q)	.3900	.3646	.2565	.5257

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	1.30	-1.035	1.11	.68	8	.50	-3.08
6	1.31	-1.593	-.39	.82	8	.43	-1.87
7	1.09	-.706	.58	.91	8	.29	-1.24
8	1.05	-.497	.48	.95	8	.23	-.79

1

Fleet : FLT05: SUR CPU (Catc

Age	1984	1985	1986	1987	1988
2	-.39	.01	.22	-.20	-.49
3	-.34	-.30	.47	.11	-.13
4	-.09	.05	.52	.26	.08
5	.10	.11	.65	-.83	.51
6	.67	-.16	1.03	-.11	-.35
7	-.39	.42	.64	.60	-.12
8	-.11	-.43	1.03	.59	.48
9	No data for this fleet at this age				

Age	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
2	-.29	.30	.23	.14	-.20	-.10	.17	.08	-.12	.25
3	-.20	-.27	.50	.30	-.01	-.44	.05	-.11	-.02	.20
4	-.02	-.11	.23	.17	.24	-.15	.09	-.40	-.31	-.16
5	.45	-.10	.29	-.17	.63	-.56	.18	-.10	-.30	-.42
6	.32	.01	.06	-.75	.54	.05	.17	-.06	-.06	-.54
7	.88	-.98	-.16	-.07	.42	-1.59	.37	-.03	.11	.42
8	.27	-.08	-.29	.07	1.05	.11	-.37	-.15	-.53	-.28
9	No data for this fleet at this age									

Table 3.4.6.2.1 (Cont'd)

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

Age ,	2,	3,	4,	5,	6,	7,	8
Mean Log q,	-4.1566,	-4.2621,	-4.3736,	-4.4605,	-4.4538,	-4.5362,	-4.5362,
S.E(Log q),	.2389,	.2785,	.2421,	.4382,	.4268,	.6767,	.4983,

Regression statistics :

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

Age,	Slope ,	t-value ,	Intercept,	RSquare,	No Pts,	Reg s.e,	Mean Q
2,	1.00,	-.031,	4.13,	.91,	15,	.25,	-4.16,
3,	.97,	.215,	4.44,	.86,	15,	.28,	-4.26,
4,	1.12,	-1.002,	3.64,	.87,	15,	.27,	-4.37,
5,	1.02,	-.109,	4.35,	.74,	15,	.47,	-4.46,
6,	.96,	.257,	4.64,	.79,	15,	.43,	-4.45,
7,	1.02,	-.083,	4.46,	.60,	15,	.73,	-4.54,
8,	.93,	.498,	4.66,	.83,	15,	.47,	-4.48,

1

Terminal year survivor and F summaries :

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

Year class = 1996

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
FLT03: TRW EFF (Catc,	1.,	.000,	.000,	.00,	0,	.000,	.000
FLT04: NET CPU (Catc,	1.,	.000,	.000,	.00,	0,	.000,	.000
FLT05: SUR CPU (Catc,	15755.,	.300,	.000,	.00,	1,	.733,	.009
F shrinkage mean ,	6188.,	.50,,,,				.267,	.022

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
12277.,	.26,	.48,	2,	1.877,	.011

Age 3 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
FLT03: TRW EFF (Catc,	1.,	.000,	.000,	.00,	0,	.000,	.000
FLT04: NET CPU (Catc,	1.,	.000,	.000,	.00,	0,	.000,	.000
FLT05: SUR CPU (Catc,	57009.,	.212,	.161,	.76,	2,	.829,	.126
F shrinkage mean ,	45249.,	.50,,,,				.171,	.156

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
54796.,	.20,	.12,	3,	.633,	.131

1

Table 3.4.6.2.1 (Cont'd)

Age 4 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
FLT03: TRW EFF (Catc,	13847.,	.300,	.000,	.00,	1,	.240,	.286
FLT04: NET CPU (Catc,	1.,	.000,	.000,	.00,	0,	.000,	.000
FLT05: SUR CPU (Catc,	11156.,	.174,	.071,	.41,	3,	.640,	.344
F shrinkage mean ,	10288.,	.50,,,,				.120,	.369

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
11635.,	.15,	.07,	5,	.448,	.332

Age 5 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
FLT03: TRW EFF (Catc,	14610.,	.215,	.032,	.15,	2,	.335,	.405
FLT04: NET CPU (Catc,	21421.,	.415,	.000,	.00,	1,	.103,	.293
FLT05: SUR CPU (Catc,	10519.,	.166,	.125,	.75,	4,	.450,	.527
F shrinkage mean ,	8876.,	.50,,,,				.112,	.600

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
12395.,	.13,	.11,	8,	.893,	.463

Age 6 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
FLT03: TRW EFF (Catc,	2612.,	.189,	.068,	.36,	3,	.372,	.595
FLT04: NET CPU (Catc,	2302.,	.295,	.123,	.42,	2,	.174,	.654
FLT05: SUR CPU (Catc,	1532.,	.176,	.108,	.62,	5,	.310,	.870
F shrinkage mean ,	1871.,	.50,,,,				.144,	.759

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
2064.,	.13,	.09,	11,	.679,	.708

Age 7 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
FLT03: TRW EFF (Catc,	975.,	.171,	.081,	.47,	4,	.370,	.897
FLT04: NET CPU (Catc,	1034.,	.222,	.044,	.20,	3,	.263,	.863
FLT05: SUR CPU (Catc,	922.,	.176,	.115,	.66,	6,	.213,	.931
F shrinkage mean ,	933.,	.50,,,,				.154,	.924

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
972.,	.12,	.04,	14,	.357,	.899

Table 3.4.6.2.1 (Cont'd)

1
Age 8 Catchability constant w.r.t. time and age (fixed at the value for age) 7

Year class = 1990

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
FLT03: TRW EFF (Catc,	1384.,	.187,	.057,	.30,	5,	.414,	.776
FLT04: NET CPU (Catc,	1228.,	.239,	.105,	.44,	4,	.211,	.842
FLT05: SUR CPU (Catc,	1095.,	.255,	.070,	.28,	7,	.177,	.909
F shrinkage mean ,	1051.,	.50,,,,				.198,	.934

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
1226.,	.14,	.04,	17,	.314,	.843

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

Year class = 1989

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
FLT03: TRW EFF (Catc,	170.,	.212,	.048,	.23,	6,	.391,	.834
FLT04: NET CPU (Catc,	208.,	.247,	.109,	.44,	4,	.144,	.725
FLT05: SUR CPU (Catc,	134.,	.273,	.147,	.54,	7,	.120,	.978
F shrinkage mean ,	157.,	.50,,,,				.345,	.880

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
165.,	.20,	.05,	18,	.247,	.850

Table 3.4.6.2.2 Haddock in Division Va. Fishing mortality.

Run title : Haddock Iceland Va (run: XSALOA01/X01)

At 1-May-99 18:04:15

Terminal Fs derived using XSA (With F shrinkage)

Table 8 Fishing mortality (F) at age

AGE	YEAR 1978
2	0.0008
3	0.0185
4	0.0901
5	0.2658
6	0.799
7	1.1627
8	1.8932
9	1.5483
FBAR 4- 7	0.5794

Table 8 Fishing mortality (F) at age

AGE	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
2	0.0021	0.0181	0.0001	0.0013	0	0.0033	0.0114	0.0024	0.0149	0.0031
3	0.0186	0.0226	0.0195	0.0405	0.0228	0.0344	0.1283	0.1281	0.1219	0.0862
4	0.1734	0.1361	0.1047	0.1345	0.3067	0.2218	0.331	0.4472	0.4158	0.4061
5	0.4376	0.2817	0.3055	0.3462	0.3605	0.4219	0.4615	0.6437	0.6653	0.635
6	0.704	0.4912	0.8143	0.4513	0.6662	0.8127	0.6093	1.1429	0.6994	0.7753
7	0.992	0.6472	0.864	0.8764	0.5704	0.5507	0.676	0.9256	0.7781	0.8094
8	1.2006	0.9099	0.7754	1.1714	1.0621	0.6427	0.8884	1.0292	0.8438	1.187
9	1.1093	0.7864	0.8282	1.0357	0.8247	0.6019	0.7938	1.0058	0.7687	0.9721
FBAR 4-7	0.5768	0.3891	0.5221	0.4521	0.476	0.5018	0.5194	0.7899	0.6396	0.6564

Run title : Haddock Iceland Va (run: XSALOA01/X01)

At 1-May-99 18:04:15

Terminal Fs derived using XSA (With F shrinkage)

Table 8 Fishing mortality (F) at age

YEAR / AGE	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	FBAR 96-98
2	0.0032	0.0222	0.0343	0.0178	0.0065	0.0074	0.0345	0.0459	0.0162	0.0112	0.0244
3	0.0771	0.1419	0.0822	0.136	0.0979	0.1165	0.2308	0.1781	0.1558	0.1309	0.1549
4	0.2904	0.3574	0.3313	0.4177	0.3659	0.3457	0.3318	0.438	0.3496	0.3322	0.3733
5	0.4664	0.5524	0.5808	0.7053	0.6533	0.6118	0.5726	0.5157	0.6227	0.4632	0.5338
6	0.9251	0.6886	0.7267	0.8478	0.7709	0.801	0.7737	0.8308	0.5809	0.708	0.7066
7	0.9525	0.7153	0.7715	0.8381	0.9535	0.918	0.892	0.9741	0.8309	0.8992	0.9014
8	1.4484	0.9169	0.8981	0.9981	0.9438	0.7407	1.0192	1.0711	0.8433	0.843	0.9191
9	1.1845	0.8141	0.8465	0.8902	0.9252	0.8991	1.1932	1.2573	0.7645	0.85	0.9573
FBAR	4- 7	0.6586	0.5784	0.6026	0.7022	0.6859	0.6691	0.6425	0.6897	0.596	0.6007

Table 3.4.6.3.1

Run title : Haddock Iceland Va (run: XSALOA01/X01)

At 1-May-99 18:04:15

Terminal Fs derived using XSA (With F shrinkage)

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

YEAR,	1978,
AGE	
2,	151570,
3,	34951,
4,	27337,
5,	34037,
6,	9001,
7,	2928,
8,	816,
9,	132,
+gp,	0,
0 TOTAL,	260771,

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

YEAR,	1979,	1980,	1981,	1982,	1983,	1984,	1985,	1986,	1987,	1988,
AGE										
2,	83821,	36709,	9737,	42204,	30161,	19935,	41787,	89101,	167043,	47518,
3,	123997,	68481,	29517,	7971,	34509,	24693,	16267,	33826,	72772,	134739,
4,	28092,	99651,	54815,	23699,	6267,	27615,	19534,	11714,	24364,	52741,
5,	20452,	19338,	71203,	40419,	16962,	3776,	18112,	11486,	6133,	13161,
6,	21363,	10810,	11945,	42949,	23408,	9684,	2027,	9348,	4940,	2581,
7,	3315,	8651,	5416,	4332,	22392,	9844,	3518,	902,	2440,	2010,
8,	749,	1006,	3708,	1869,	1476,	10363,	4647,	1465,	293,	918,
9,	101,	185,	332,	1398,	474,	418,	4462,	1565,	429,	103,
+gp,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
0 TOTAL,	281890,	244831,	186673,	164842,	135649,	106329,	110354,	159407,	278414,	253771,

1

Run title : Haddock Iceland Va (run: XSALOA01/X01)

At 1-May-99 18:04:15

Terminal Fs derived using XSA (With F shrinkage)

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

YEAR,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	GMST 78-96	AMST 78-96
AGE													
2,	26646,	22412,	80657,	171144,	37421,	41741,	76914,	36157,	94697,	15164,	0,	48837,	63825,
3,	38784,	21746,	17946,	63810,	137654,	30440,	33921,	60839,	28275,	76287,	12277,	39948,	51940,
4,	101205,	29398,	15448,	13533,	45599,	102190,	22181,	22047,	41684,	19811,	54796,	29247,	38286,
5,	28770,	61979,	16836,	9081,	7297,	25894,	59213,	13032,	11648,	24060,	11635,	18823,	25115,
6,	5710,	14775,	29206,	7712,	3673,	3108,	11499,	27345,	6371,	5117,	12395,	9527,	13215,
7,	973,	1854,	6076,	11561,	2704,	1391,	1142,	4343,	9754,	2918,	2064,	3444,	5042,
8,	732,	307,	742,	2300,	4094,	853,	455,	383,	1342,	3479,	972,	1192,	1957,
9,	229,	141,	101,	248,	694,	1304,	333,	134,	108,	473,	1226,	351,	673,
+gp,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,	165,		
0 TOTAL,	203050,	152612,	167012,	279388,	239136,	206923,	205659,	164282,	193880,	147309,	95530,		

Table 3.4.6.3.2 Haddock in Division Va. Summary.

Run title : Haddock Iceland Va (run: XSALOA01/X01)

At 1-May-99 18:04:15

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	151570	145774	53203	43488	0.8174	0.5794
1979	83821	182486	67469	55334	0.8201	0.5768
1980	36709	203732	80936	51112	0.6315	0.3891
1981	9737	216249	103375	63580	0.615	0.5221
1982	42204	197540	111380	69325	0.6224	0.4521
1983	30161	161298	101462	65943	0.6499	0.476
1984	19935	124438	79233	48285	0.6094	0.5018
1985	41787	115441	59465	50933	0.8565	0.5194
1986	89101	114644	56165	48863	0.87	0.7899
1987	167043	130859	41469	40801	0.9839	0.6396
1988	47518	161180	65874	54236	0.8233	0.6564
1989	26646	174423	99258	62979	0.6345	0.6586
1990	22412	150308	109957	67200	0.6111	0.5784
1991	80657	134999	90658	54732	0.6037	0.6026
1992	171144	124107	55620	47212	0.8488	0.7022
1993	37421	136899	68828	48844	0.7096	0.6859
1994	41741	135916	83154	59345	0.7137	0.6691
1995	76914	133757	87804	61131	0.6962	0.6425
1996	36157	117237	70167	56958	0.8118	0.6897
1997	94697	107200	64941	44053	0.6784	0.596
1998	15164	102158	67490	41434	0.6139	0.6007
Arith. Mean	62978	146221	77043	54085	0.7248	0.5966
0 Units	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)		

Table 3.4.7.1.1 Haddock in the Iceland Grounds (Fishing Area Va)

Prediction with management option table: Input data

Year: 1999

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	55000.000	0.2000	0.0500	0.0000	0.0000	0.203	0.0230	0.508
3	16179.000	0.2000	0.3900	0.0000	0.0000	0.481	0.1480	0.885
4	56572.000	0.2000	0.6800	0.0000	0.0000	0.721	0.3570	1.202
5	11635.000	0.2000	0.7200	0.0000	0.0000	1.200	0.5100	1.756
6	12395.000	0.2000	0.7600	0.0000	0.0000	1.965	0.6750	2.214
7	2064.000	0.2000	0.9000	0.0000	0.0000	2.378	0.8610	2.573
8	972.000	0.2000	0.7700	0.0000	0.0000	2.797	0.8780	3.278
9	1226.000	0.2000	0.9200	0.0000	0.0000	2.907	0.9140	3.456
Unit	Thousands	-	-	-	-	Kilograms	-	Kilograms

Year: 2000

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	98000.000	0.2000	0.0500	0.0000	0.0000	0.192	0.0230	0.508
3	.	0.2000	0.4200	0.0000	0.0000	0.436	0.1480	0.873
4	.	0.2000	0.6500	0.0000	0.0000	0.757	0.3570	1.355
5	.	0.2000	0.7100	0.0000	0.0000	1.206	0.5100	1.787
6	.	0.2000	0.7400	0.0000	0.0000	1.705	0.6750	3.089
7	.	0.2000	0.8400	0.0000	0.0000	2.099	0.8610	2.497
8	.	0.2000	0.9000	0.0000	0.0000	2.483	0.8780	3.373
9	.	0.2000	1.0000	0.0000	0.0000	3.208	0.9140	3.456
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	48000.000	0.2000	0.0500	0.0000	0.0000	0.192	0.0230	0.508
3	.	0.2000	0.4200	0.0000	0.0000	0.436	0.1480	0.873
4	.	0.2000	0.6500	0.0000	0.0000	0.757	0.3570	1.340
5	.	0.2000	0.7100	0.0000	0.0000	1.206	0.5100	1.920
6	.	0.2000	0.7400	0.0000	0.0000	1.705	0.6750	3.107
7	.	0.2000	0.8400	0.0000	0.0000	2.099	0.8610	3.152
8	.	0.2000	0.9000	0.0000	0.0000	2.483	0.8780	3.335
9	.	0.2000	1.0000	0.0000	0.0000	3.208	0.9140	3.456
Unit	Thousands	-	-	-	-	Kilograms	-	Kilograms

Notes: Run name : MANLOA02
Date and time: 01MAY99:18:53

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

VPA and Groundfish survey indices

Yearcl	VPA	Survey4	Survey3	Survey2	Survey1
1976	155	-11	-11	-11	-11
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	196	-11	-11	-11
1982	20	122	172	-11	-11
1983	42	548	538	312	-11
1984	89	828	1415	984	260
1985	167	1250	1737	2677	1194
1986	48	339	373	394	218
1987	27	166	256	221	154
1988	22	316	380	307	93
1989	81	865	1261	1425	655
1990	171	1425	2489	2016	849
1991	37	202	390	342	182
1992	42	327	480	593	280
1993	77	525	1126	823	561
1994	36	275	480	669	353
1995	-11	944	1058	1186	894
1996	-11	-11	247	177	82
1997	-11	-11	-11	863	227
1998	-11	-11	-11	-11	765

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 : 1976 - 1998

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

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

Forecast/Hindcast variance correction used.

Yearclass = 1995

	I-----------Regression---------I					I-----------Prediction---------I			
Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
Surv4	.97	-1.90	.29	.855	14	6.85	4.77	.351	.212
Surv3	.90	-1.87	.23	.907	13	6.97	4.43	.267	.366
Surv2	.90	-1.81	.29	.855	12	7.08	4.56	.341	.225
Surv1	.97	-1.56	.34	.815	11	6.80	5.01	.432	.141
						VPA Mean =	3.95	.688	.055

Yearclass = 1996

	I-----------Regression---------I					I-----------Prediction---------I			
Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
Surv4									
Surv3	.91	-1.89	.23	.908	13	5.51	3.11	.284	.477
Surv2	.91	-1.86	.29	.853	12	5.18	2.84	.384	.261
Surv1	.97	-1.57	.34	.817	11	4.42	2.71	.465	.178
						VPA Mean =	3.97	.681	.083

Table 3.4.7.1.3 (Cont'd

Yearclass = 1997

	I-----------Regression---------I					I-----------Prediction---------I			
Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
Surv4									
Surv3									
Surv2	.91	-1.92	.29	.851	12	6.76	4.27	.350	.501
Surv1	.97	-1.58	.34	.818	11	5.43	3.68	.410	.364
					VPA Mean =		3.98	.674	.135

Yearclass = 1998

	I-----------Regression---------I					I-----------Prediction---------I			
Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
Surv4									
Surv3									
Surv2									
Surv1	.97	-1.61	.34	.818	11	6.64	4.84	.438	.699
					VPA Mean =		3.99	.667	.301

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
1995	98	4.59	.16	.13	.61		
1996	20	3.04	.20	.19	.90		
1997	55	4.01	.25	.19	.60		
1998	98	4.59	.37	.39	1.12		

Table 3.4.7.1.4 Haddock in the Iceland Grounds (Fishing Area Va)

Icelandic haddock (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
2	1.000	0.2000	0.0800	0.0000	0.0000	0.185	0.0120	0.563
3	.	0.2000	0.2800	0.0000	0.0000	0.475	0.0910	0.876
4	.	0.2000	0.5100	0.0000	0.0000	0.901	0.2980	1.325
5	.	0.2000	0.7000	0.0000	0.0000	1.411	0.5020	1.898
6	.	0.2000	0.8100	0.0000	0.0000	2.004	0.7500	2.462
7	.	0.2000	0.8600	0.0000	0.0000	2.526	0.8530	3.159
8	.	0.2000	0.9200	0.0000	0.0000	3.201	1.0460	3.648
9	.	0.2000	0.9800	0.0000	0.0000	3.266	0.9680	4.088
Unit	Numbers	-	-	-	-	Kilograms	-	Kilograms

Notes: Run name : YLDLOA02
Date and time: 27MAY99:15:08

Table 3.4.7.2.1 Haddock in the Iceland Grounds (Fishing Area Va)

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	4.403	5551.456	2.234	4178.577	2.234	4178.577
0.0500	0.0300	0.073	194.845	4.263	5174.685	2.112	3837.683	2.112	3837.683
0.1000	0.0601	0.135	350.025	4.138	4840.534	2.002	3536.662	2.002	3536.662
0.1500	0.0901	0.186	473.447	4.025	4543.412	1.904	3270.199	1.904	3270.199
0.2000	0.1202	0.230	571.441	3.923	4278.517	1.816	3033.736	1.816	3033.736
0.2500	0.1502	0.267	649.076	3.830	4041.720	1.736	2823.362	1.736	2823.362
0.3000	0.1802	0.299	710.412	3.746	3829.468	1.665	2635.717	1.665	2635.717
0.3500	0.2103	0.326	758.700	3.669	3638.698	1.600	2467.909	1.600	2467.909
0.4000	0.2403	0.350	796.547	3.599	3466.765	1.540	2317.445	1.540	2317.445
0.4500	0.2703	0.370	826.039	3.534	3311.385	1.487	2182.176	1.487	2182.176
0.5000	0.3004	0.388	848.850	3.474	3170.581	1.437	2060.247	1.437	2060.247
0.5500	0.3304	0.404	866.319	3.419	3042.636	1.392	1950.049	1.392	1950.049
0.6000	0.3605	0.419	879.522	3.369	2926.063	1.350	1850.193	1.350	1850.193
0.6500	0.3905	0.431	889.319	3.321	2819.566	1.312	1759.469	1.312	1759.469
0.7000	0.4205	0.443	896.401	3.277	2722.018	1.277	1676.828	1.277	1676.828
0.7500	0.4506	0.453	901.322	3.236	2632.435	1.244	1601.358	1.244	1601.358
0.8000	0.4806	0.462	904.525	3.198	2549.957	1.213	1532.261	1.213	1532.261
0.8500	0.5106	0.471	906.367	3.161	2473.831	1.185	1468.841	1.185	1468.841
0.9000	0.5407	0.479	907.131	3.128	2403.396	1.158	1410.490	1.158	1410.490
0.9500	0.5707	0.486	907.046	3.096	2338.073	1.133	1356.675	1.133	1356.675
1.0000	0.6008	0.493	906.297	3.065	2277.351	1.110	1306.926	1.110	1306.926
1.0500	0.6308	0.500	905.029	3.037	2220.779	1.088	1260.834	1.088	1260.834
1.1000	0.6608	0.506	903.359	3.010	2167.959	1.067	1218.033	1.067	1218.033
1.1500	0.6909	0.511	901.381	2.984	2118.539	1.048	1178.205	1.048	1178.205
1.2000	0.7209	0.517	899.172	2.960	2072.206	1.029	1141.065	1.029	1141.065
1.2500	0.7509	0.522	896.789	2.936	2028.684	1.012	1106.362	1.012	1106.362
1.3000	0.7810	0.526	894.282	2.914	1987.723	0.995	1073.875	0.995	1073.875
1.3500	0.8110	0.531	891.688	2.893	1949.105	0.980	1043.403	0.980	1043.403
1.4000	0.8411	0.535	889.037	2.872	1912.631	0.965	1014.771	0.965	1014.771
1.4500	0.8711	0.539	886.353	2.853	1878.126	0.950	987.821	0.950	987.821
1.5000	0.9011	0.543	883.655	2.834	1845.430	0.937	962.411	0.937	962.411
1.5500	0.9312	0.547	880.958	2.816	1814.402	0.924	938.416	0.924	938.416
1.6000	0.9612	0.551	878.273	2.799	1784.912	0.911	915.721	0.911	915.721
1.6500	0.9912	0.554	875.610	2.782	1756.846	0.899	894.224	0.899	894.224
1.7000	1.0213	0.558	872.974	2.766	1730.098	0.888	873.833	0.888	873.833
1.7500	1.0513	0.561	870.372	2.751	1704.574	0.877	854.464	0.877	854.464
1.8000	1.0814	0.564	867.806	2.736	1680.188	0.866	836.043	0.866	836.043
1.8500	1.1114	0.567	865.280	2.721	1656.860	0.856	818.501	0.856	818.501
1.9000	1.1414	0.570	862.796	2.707	1634.521	0.846	801.777	0.846	801.777
1.9500	1.1715	0.573	860.355	2.694	1613.105	0.837	785.813	0.837	785.813
2.0000	1.2015	0.576	857.958	2.680	1592.553	0.828	770.558	0.828	770.558
-	-	Numbers	Grams	Numbers	Grams	Numbers	Grams	Numbers	Grams

(cont.)

Table 3.4.7.2.1 (Cont'd)

Icelandic haddock (Division Va)

Yield per recruit: Summary table

(cont.)

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
2.0500	1.2315	0.578	855.604	2.668	1572.809	0.819	755.966	0.819	755.966
2.1000	1.2616	0.581	853.294	2.655	1553.825	0.810	741.993	0.810	741.993
2.1500	1.2916	0.583	851.028	2.643	1535.554	0.802	728.600	0.802	728.600
2.2000	1.3217	0.586	848.805	2.632	1517.955	0.794	715.751	0.794	715.751
2.2500	1.3517	0.588	846.625	2.620	1500.987	0.787	703.413	0.787	703.413
2.3000	1.3817	0.591	844.487	2.609	1484.616	0.779	691.556	0.779	691.556
2.3500	1.4118	0.593	842.389	2.598	1468.808	0.772	680.151	0.772	680.151
2.4000	1.4418	0.595	840.331	2.588	1453.533	0.765	669.172	0.765	669.172
2.4500	1.4718	0.597	838.313	2.578	1438.762	0.758	658.595	0.758	658.595
2.5000	1.5019	0.599	836.333	2.568	1424.468	0.751	648.399	0.751	648.399
-	-	Numbers	Grams	Numbers	Grams	Numbers	Grams	Numbers	Grams

Notes: Run name : YLDLOA02
Date and time : 27MAY99:15:08
Computation of ref. F: Simple mean, age 4 - 7
F-0.1 factor : 0.4834
F-max factor : 0.9190
F-0.1 reference F : 0.2904
F-max reference F : 0.5521
Recruitment : Single recruit

Table 3.4.7.3.1 Haddock in the Iceland Grounds (Fishing Area Va)

Prediction with management option table

Year: 1999 F Factor	Reference F	Stock biomass	Sp.stock biomass	Catch in weight	Year: 2000 F Factor	Reference F	Stock biomass	Sp.stock biomass	Catch in weight	Year: 2001 Stock biomass	Sp.stock biomass
0.7290	0.4379	109245	69682	37000	0.0000	0.0000	117991	68061	0	159495	101413
.	.	.	.	.	0.0500	0.0300	.	68061	3405	156782	99294
.	.	.	.	.	0.1000	0.0601	.	68061	6717	154145	97237
.	.	.	.	.	0.1500	0.0901	.	68061	9940	151582	95240
.	.	.	.	.	0.2000	0.1202	.	68061	13075	149090	93300
.	.	.	.	.	0.2500	0.1502	.	68061	16125	146667	91417
.	.	.	.	.	0.3000	0.1802	.	68061	19094	144310	89588
.	.	.	.	.	0.3500	0.2103	.	68061	21984	142019	87811
.	.	.	.	.	0.4000	0.2403	.	68061	24797	139790	86085
.	.	.	.	.	0.4500	0.2703	.	68061	27535	137622	84409
.	.	.	.	.	0.5000	0.3004	.	68061	30201	135513	82780
.	.	.	.	.	0.5500	0.3304	.	68061	32797	133460	81197
.	.	.	.	.	0.6000	0.3605	.	68061	35326	131463	79659
.	.	.	.	.	0.6500	0.3905	.	68061	37788	129520	78164
.	.	.	.	.	0.7000	0.4205	.	68061	40188	127628	76710
.	.	.	.	.	0.7500	0.4506	.	68061	42525	125787	75297
.	.	.	.	.	0.8000	0.4806	.	68061	44802	123994	73924
.	.	.	.	.	0.8500	0.5106	.	68061	47022	122249	72588
.	.	.	.	.	0.9000	0.5407	.	68061	49185	120549	71289
.	.	.	.	.	0.9500	0.5707	.	68061	51293	118894	70025
.	.	.	.	.	1.0000	0.6008	.	68061	53349	117282	68797
.	.	.	.	.	1.0500	0.6308	.	68061	55353	115711	67601
.	.	.	.	.	1.1000	0.6608	.	68061	57307	114181	66438
.	.	.	.	.	1.1500	0.6909	.	68061	59213	112691	65306
.	.	.	.	.	1.2000	0.7209	.	68061	61072	111238	64205
.	.	.	.	.	1.2500	0.7509	.	68061	62885	109823	63133
.	.	.	.	.	1.3000	0.7810	.	68061	64654	108443	62090
.	.	.	.	.	1.3500	0.8110	.	68061	66381	107098	61074
.	.	.	.	.	1.4000	0.8411	.	68061	68065	105787	60085
.	.	.	.	.	1.4500	0.8711	.	68061	69709	104508	59123
.	.	.	.	.	1.5000	0.9011	.	68061	71314	103261	58185
-	-	Tonnes	Tonnes	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes

Notes: Run name : MANLOA02
Date and time : 01MAY99:18:53
Computation of ref. F: Simple mean, age 4 - 7
Basis for 1999 : TAC constraints

Figure 3.4.2.1 Haddock Division Va. Nominal landings (tonnes) 1950-1998

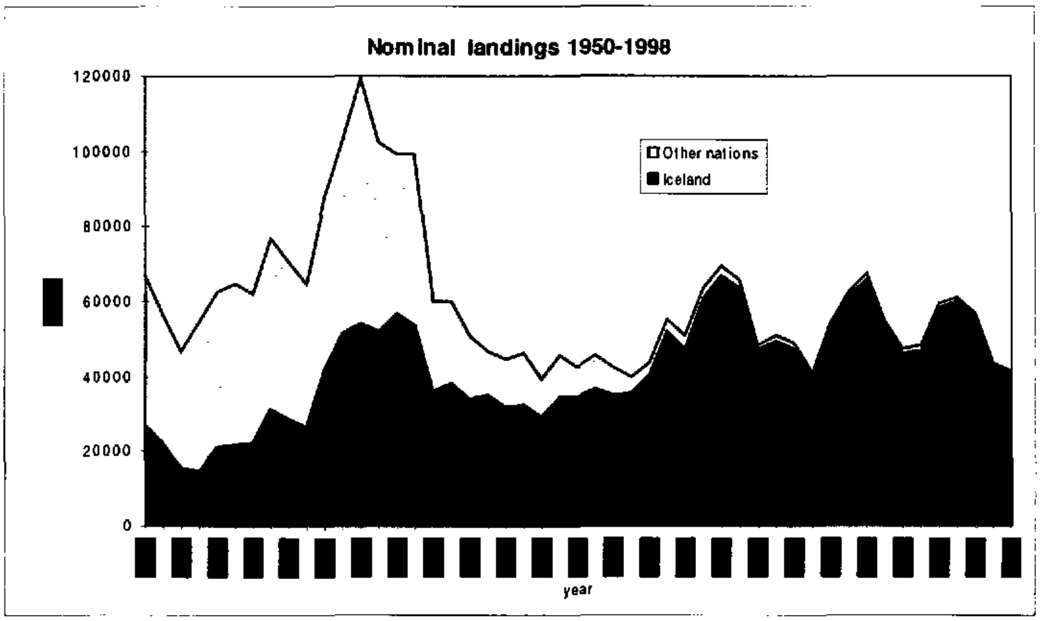


Figure 3.4.2.2 Haddock Division Va. Percentage changes in CPUE for the main gears since 1992

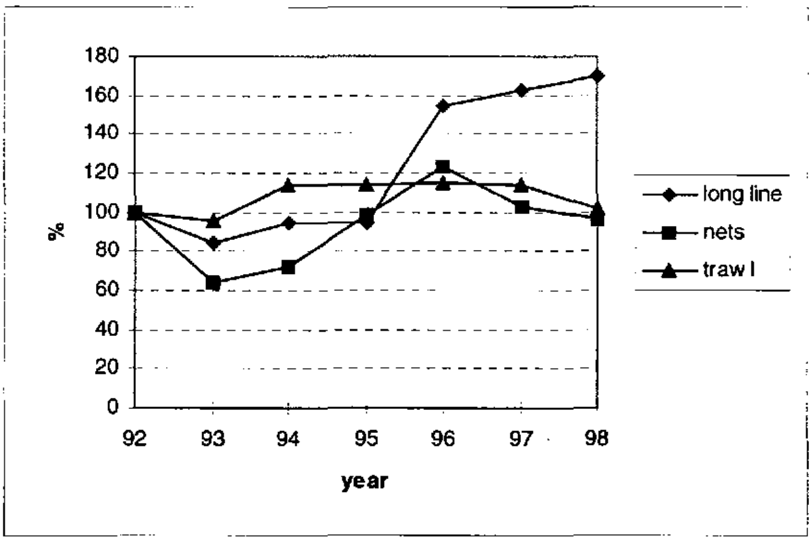
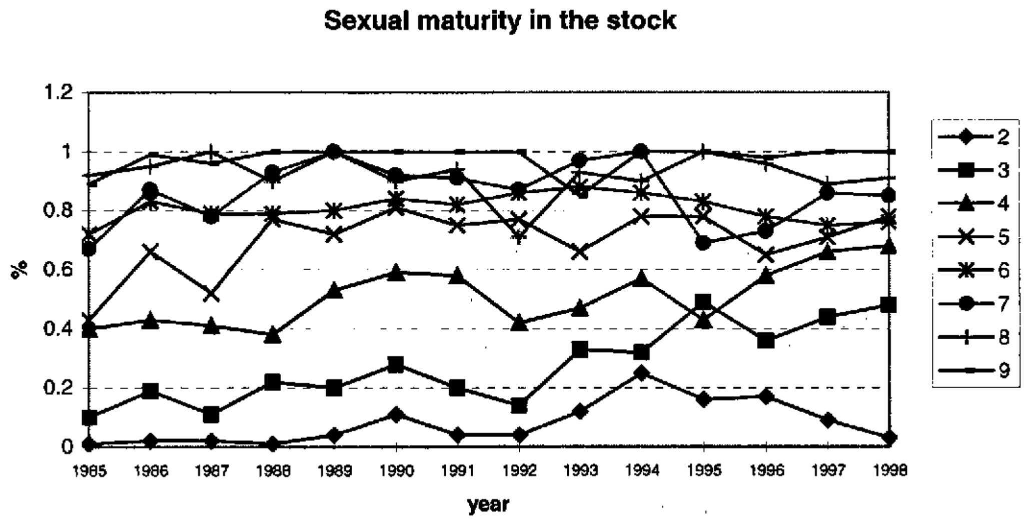
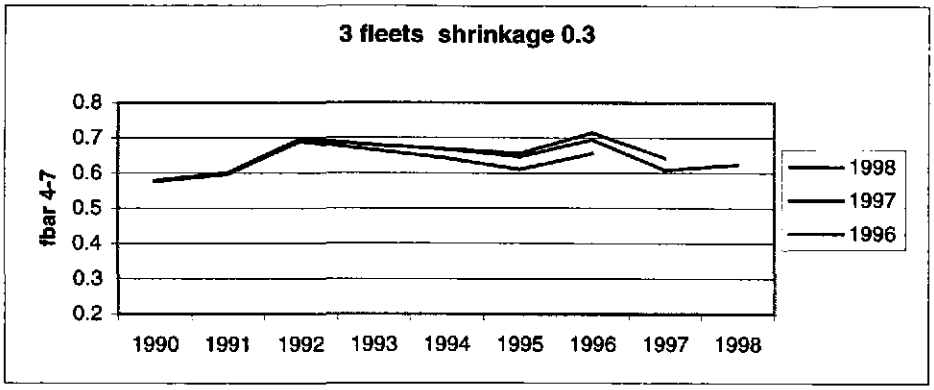
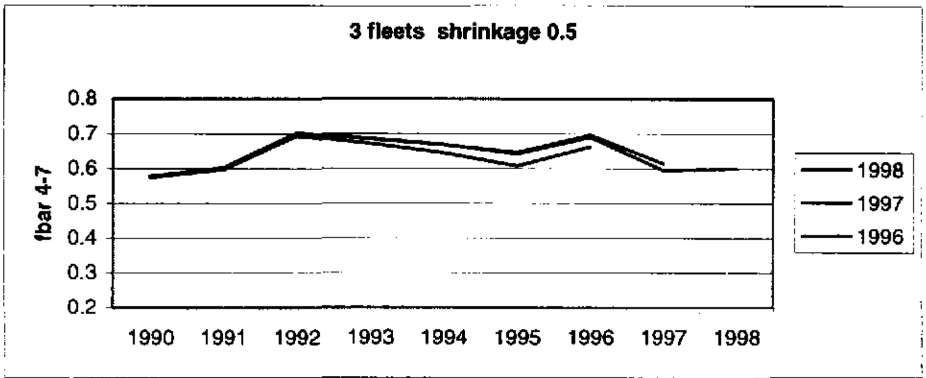


Figure 3.4.5.1. Haddock, Division Va. Sexual maturity at age in the stock 1985-1998.







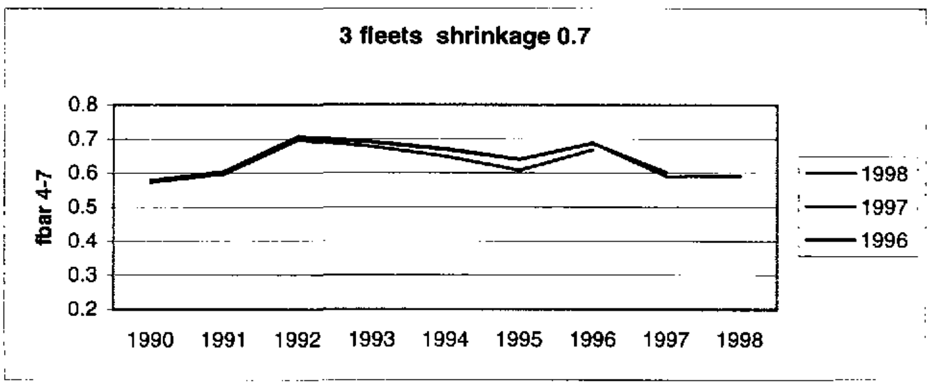


Figure 3.4.6.2.1. Haddock in Division Va. Retrospective analyses of XSA runs, varying the shrinkage.

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

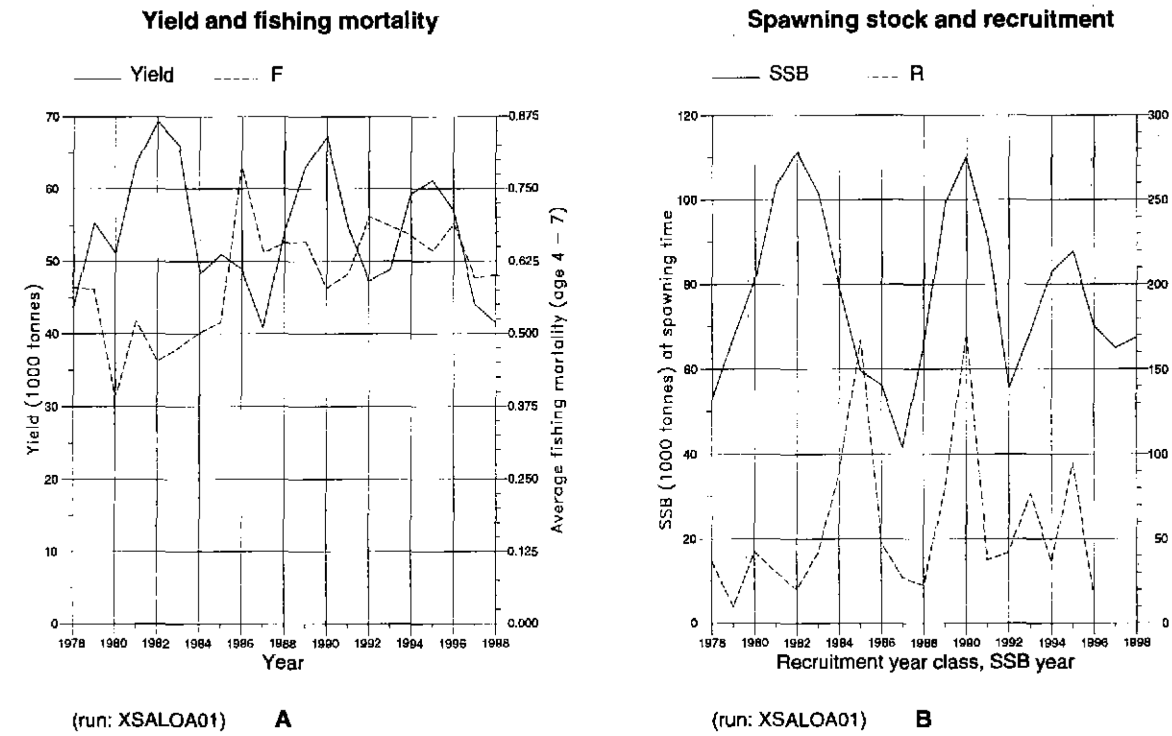


Figure 3.4.7.2.1 Summary plots of yield and spawning stock biomass per recruit.

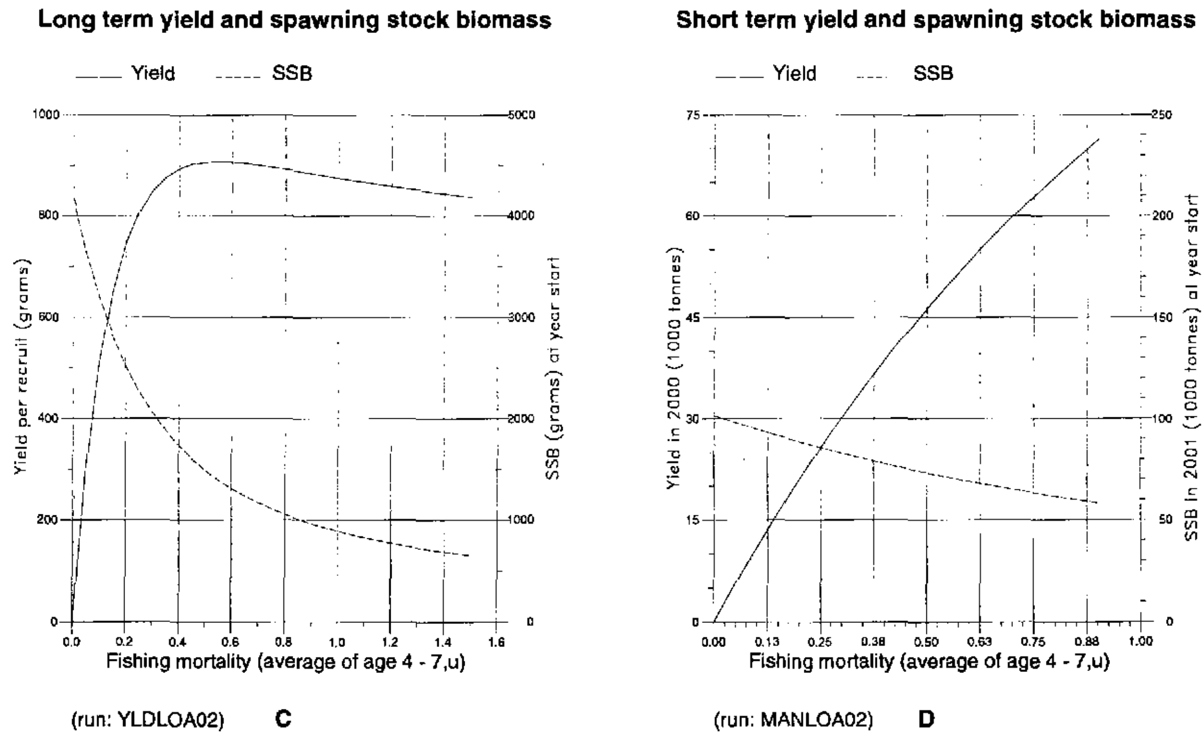
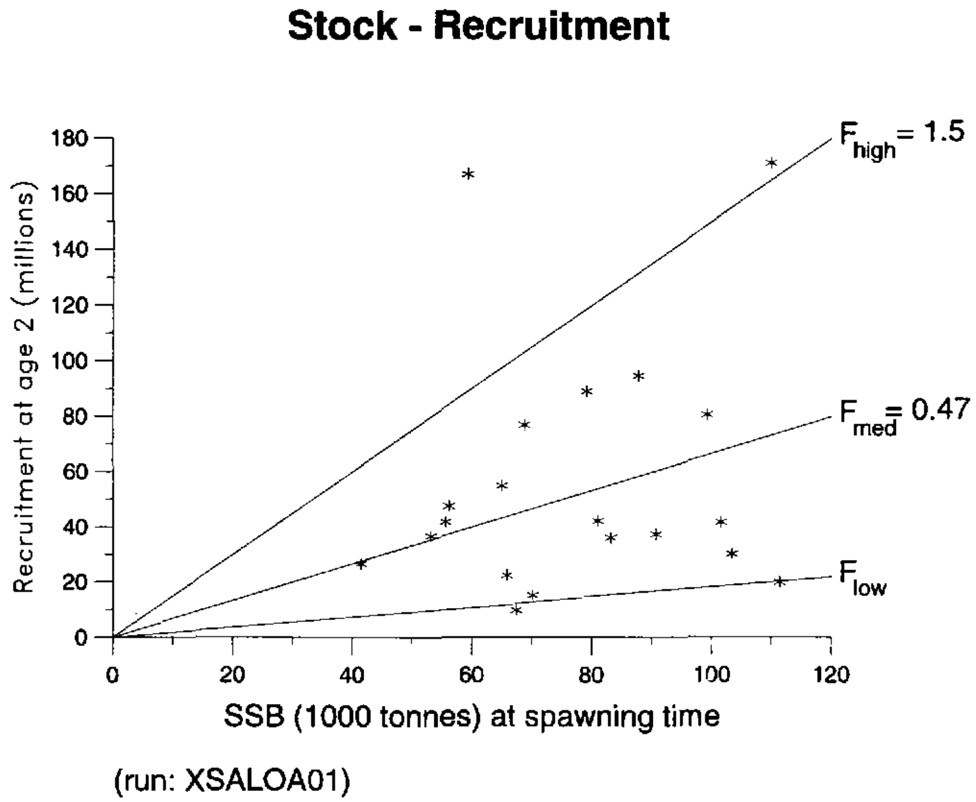


Figure 3.4.7.2.2 SSB-recruit plot



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 O-group surveys carried out in the East Greenland-Iceland area since 1970, it becomes quite evident that the drift of O-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 O-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 1998). Since 1995, O-group surveys were continued with the area coverage reduced to the Icelandic EEZ. However, the estimates of the 1997 and 1998 year classes are exceptional high also west of Iceland. More than 60% of the O-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 off 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 O-group cod from international and Icelandic O-group surveys (Sveinbjörnsson and Jónsson, 1998) in the East Greenland/Iceland area, 1971-97 (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

[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 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 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 1993/Assess:18) and Working Doc. 15. Figure 5.1.1 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.

5.1.1.1 Stock abundance indices

Table 5.1.1 lists abundance and biomass indices for West and East Greenland, respectively and then combined for the years 1982-98. Trends of the abundance and biomass estimates for West and East Greenland were shown in Figures 5.1.2 and 5.1.3, 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 1998 survey results confirmed the severely depleted status of the stock.

5.1.1.2 Age composition

Age disaggregated abundance indices for West, East Greenland and the total are listed in Tables 5.1.2-4, respectively. In 1998, the stock structure off West Greenland was found to be composed almost exclusively of the pre-recruiting age group 1 (95 %). However, the 1997 year class is considered to be very poor as compared with strong 1984 and 1985 year classes. The age composition off East Greenland was found to be more diverse and comprised mainly mature cod at ages 5-6 years (54 %).

5.1.1.3 Mean weight at age

Mean weight of the age groups 1-10 years for West, East Greenland and weighted by abundance to the total were listed in Tables 5.1.5-7, 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 5.1.4 for the period 1982-98. They revealed pronounced areal and temperature effects (WP 15). 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 1998.

5.1.2 Trends in landings and fisheries

Officially reported catches are given in Tables 5.1.8 and 5.1.9 for West and East Greenland including inshore catches, respectively. Landings as used by the working group are listed in Table 5.1.10 by inshore and offshore areas and gear for both West and East Greenland combined, their trends being illustrated in Fig. 5.1.5. 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 187 t to 736 t. A total offshore catch amounting to 278 t was reported for 1998.

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.

5.1.3 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 5.1.6. 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 5.1.7. 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 19 years from 1955 to 1973, while it has been below that value for 17 of 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 5.1.8. 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 5.1.9. 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 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 5.1.9 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 limit reference point B_{lim}. 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 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 stock recovery 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 for the most recent period 1993-97 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 Cod off Greenland (offshore component). Abundance (1000) and biomass indices (t) for West, East Greenland and total by stratum, 1982-98. 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

Table 5.1.2 Cod off West Greenland (offshore component). Age disaggregate abundance indices (1000), 1982-1998. *) calculated proportionally using age compositions reported by the ICES Working Group on Cod Stocks off East Greenland (ICES 1984/Assess:5).

YEAR	0	1	2	3	4	5	6	7	8	9	10	11+	TOTAL
1982	0	176	884	33472	11368	32504	9525	2610	574	928	91	124	92256
*1983	0	0	1469	2815	26619	4960	10969	1882	992	317	168	13	50204
1984	186	5	38	2094	1541	9648	850	1983	90	201	29	0	16665
1985	890	39277	1531	898	5958	2616	7184	375	600	18	19	0	59366
1986	0	10575	114823	4374	1033	7837	2250	4167	107	449	23	35	145673
1987	0	317	45474	692566	24230	5929	11813	1637	4006	0	366	30	786368
1988	434	254	3290	101820	511473	5435	616	1134	662	1310	34	39	626501
1989	12	204	2583	7618	170469	174532	2868	0	259	40	141	5	358731
1990	158	47	1014	2900	1272	22120	6964	47	0	0	0	5	34527
1991	0	245	208	435	1260	160	2102	356	6	0	0	0	4772
1992	0	189	1473	227	48	89	0	28	0	0	0	0	2054
1993	0	10	832	546	20	28	6	0	0	0	0	0	1442
1994	0	286	45	199	38	5	0	5	0	0	0	0	578
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

Table 5.1.3 Cod off East Greenland (offshore component). Age disaggregate abundance indices (1000), 1982-1998. *) calculated proportionally using age compositions reported by the ICES Working Group on Cod Stocks off East Greenland (ICES 1984/Assess:5). () incomplete sampling.

YEAR	0	1	2	3	4	5	6	7	8	9	10	11+	TOTAL
1982	0	0	236	837	1758	1993	1222	377	130	1370	73	87	8083
*1983	0	0	411	605	1008	1187	2125	1287	302	265	703	101	7994
(1984)	0	18	73	1339	659	1403	853	1619	408	102	36	95	6605
1985	232	1932	559	117	2496	2035	1853	779	1989	284	53	79	12408
1986	0	1398	3346	1693	550	2419	1121	2187	566	1594	116	201	15191
1987	0	13	13785	17789	3890	1027	1767	452	1562	180	1023	131	41619
1988	12	25	160	6975	11092	2011	478	1410	150	653	94	501	23561
1989	0	8	177	494	17396	63169	2990	294	4746	396	1560	498	91728
1990	0	37	79	552	463	5132	17998	265	71	238	0	411	25246
1991	0	101	374	388	697	148	3524	5046	82	37	12	20	10429
(1992)	29	29	73	69	59	54	47	143	52	0	0	25	580
1993	0	17	45	1860	370	279	278	88	263	95	0	9	3304
(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

Table 5.1.4 Cod off Greenland (offshore component). Age disaggregate abundance indices (1000), 1982-1998. *) calculated proportionally using age compositions reported by the ICES Working Group on Cod Stocks off East Greenland (ICES 1984/Assess:5). () incomplete sampling.

YEAR	0	1	2	3	4	5	6	7	8	9	10	11+	TOTAL
1982	0	176	1120	34309	13126	34497	10747	2987	704	2298	164	211	100339
*1983	0	0	1880	3420	27627	6147	13094	3169	1294	582	871	1140	58198
(1984)	186	23	111	3433	2200	11051	1703	3602	498	303	65	95	23270
1985	1122	41209	2090	1015	8454	4651	9037	1154	2589	302	72	79	71774
1986	0	11973	118169	6067	1583	10256	3371	6354	673	2043	139	236	160864
1987	0	330	59259	710355	28120	6956	13580	2089	5568	180	1389	161	827987
1988	446	279	3450	108795	522565	7446	1094	2544	812	1963	128	540	650062
1989	12	212	2760	8112	187865	237701	5858	294	5005	436	1701	503	450459
1990	158	84	1093	3452	1735	27252	24962	312	71	238	0	416	59773
1991	0	346	582	823	1957	308	5626	5402	88	37	12	20	15201
(1992)	29	218	1546	296	107	143	47	171	52	0	0	25	2634
1993	0	27	877	2406	390	307	284	88	263	95	0	9	4746
(1994)	0	373	45	228	299	148	87	150	0	29	0	0	1359
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

Table 5.1.5 Cod off West Greenland (offshore component). Weighted mean weight (g., by stratum abundance) at age 1-10 years, 1982, 1984-1998.

YEAR	1	2	3	4	5	6	7	8	9	10
1982	45	191	570	921	1770	2163	2962	4080	5083	7008
1983										
1984	68	137	384	799	1359	2010	2922	3611	4498	6208
1985	97	168	571	987	1481	2023	2941	3315	4531	3909
1986	74	332	504	1130	1669	2182	2696	3713	3880	4147
1987	36	223	699	925	1195	2163	2250	3035		3563
1988	38	218	457	1021	1148	1948	2986	2779	3711	4122
1989	36	170	454	699	1248	1192		2947	3292	5346
1990	40	115	340	598	906	1373	1111			
1991	52	142	354	659	954	1379	1768	920		
1992	80	235	371	632	935		2057			
1993	41	133	406	501	921	921				
1994	45	129	459	609	1111		2461			
1995		186	329	482						
1996	42	104	512	753		3645				
1997	68	334	375	994						
1998	50			1567	1516					

Table 5.1.6 Cod off East Greenland (offshore component). Weighted mean weight (g., by stratum abundance) at age 1-10 years, 1982, 1984-1998. () Incomplete sampling.

YEAR	1	2	3	4	5	6	7	8	9	10
1982		424	770	1422	2333	3507	4607	5521	6584	6504
1983										
(1984)	104	351	801	1799	2216	3050	3892	4969	4639	5456
1985	112	438	1045	1772	3163	3374	4471	4745	5662	7851
1986	89	375	916	1717	2677	4229	4147	4960	5969	6731
1987	34	283	652	916	1747	3605	4519	5107	5988	7556
1988	921	278	741	1797	3089	4305	4720	6522	6908	7441
1989	68	255	530	1124	2558	3715	3958	4985	5652	6203
1990	53	424	517	1150	1636	2637	3899	5707	6735	
1991	87	195	411	1203	1896	2330	3382	4359	5186	10198
(1992)	22	416	683	1706	3175	3028	3271	3469		
1993	82	353	732	1363	2363	2860	3609	4739	6159	
(1994)	41		1111	2271	3054	4791	4827		5743	
1995	68	250	445	1521	2949	4179	5248	5923	9646	7442
1996			744	1944	2462	3592	5148	5847		
1997		104	1525	1931	3454	4062	4562	4685		
1998	101	155	1045	1779	3028	3541	3858	6745		

Table 5.1.7 Cod off Greenland (offshore component). Weighted mean weight (g., by stratum abundance) at age 1-10 years, 1982, 1984-1998. () Incomplete sampling.

YEAR	1	2	3	4	5	6	7	8	9	10
1982	45	240	574	988	1803	2316	3169	4346	5978	6784
1983										
1984	96	277	547	1098	1468	2531	3358	4724	4545	5791
1985	97	240	626	1219	2217	2300	3974	4413	5594	6811
1986	75	333	619	1334	1907	2863	3195	4762	5510	6304
1987	36	237	698	923	1276	2351	2741	3616	5988	6504
1988	118	221	475	1037	1672	2978	3947	3470	4774	6560
1989	37	176	459	738	1596	2480	3958	4880	5436	6132
1990	46	138	369	746	1043	2284	3479	5707	6735	
1991	62	176	381	853	1407	1975	3276	4124	5186	10198
1992	72	244	443	1224	1781	3028	3072	3469		
1993	67	144	658	1319	2232	2819	3609	4739	6159	
1994	44	129	542	2060	2988	4791	4748		5743	
1995	68	244	443	1463	2949	4179	5248	5923	9646	7442
1996	42	104	615	1899	2462	3594	5148	5847		
1997	68	180	1000	1761	3454	4062	4562	4685		
1998	56	155	1045	1761	2923	3541	3858	6745		

Table 5.1.8 Nominal catch (tonnes) of Cod in NAFO Sub-area 1, 1985-1998 as officially reported to NAFO.

Country	1985	1986	1987	1988	1989	1990	1991
Faroe Islands	-	-	-	-	-	51	1
Germany	2.170	41	55	6.574	12.892	7.515	96
Greenland	12.651	6.549	12.284	52.135	92.152	58.816	20.238
Japan	54	11	33	10	-	-	-
Norway	1	2	1	7	2	948	-
UK	-	-	-	927	3780	1.631	-
Total	14.876	6.603	12.373	59.653	108.826	68.961	20.335
WG estimate	-	-	-	62.653 [2]	111.567 [3]	98.474 [4]	-

Country	1992	1993	1994	1995	1996	1997	1998 [1]
Faroe Islands	-	-	-	-	-	-	
Germany	-	-	-	-	-	-	
Greenland	5.723	1.924	2.115	1.710	948	904	319
Japan	-	-	-	-	-	-	
Norway	-	-	-	-	-	-	
UK	-	-	-	-	-	-	
Total	5.723	1.924	2.115	1.710	948	904	319
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 5.1.9 Nominal catch (tonnes) of cod in ICES Sub-area XIV, 1985-1998 as officially reported to ICES.

Country	1985	1986	1987	1988	1989	1990	1991
Faroe Islands	-	86	-	12	40	-	-
Germany	2.006	4.063	5.358	12.049	10.613	26.419	8.434
Greenland	106	606	1.550	345	3.715	4.442	6.677
Iceland	-	-	1	9	-	-	-
Norway	-	-	-	-	-	17	828
Russia					-	-	-
UK (Engl. and Wales)	-	-	-	-	1.158	2.365	5.333
UK (Scotland)	-	-	-	-	135	93	528
United Kingdom	-	-	-	-	-	-	-
Total	2.112	4.755	6.909	12.415	15.661	33.336	21.800
WG estimate	-	-	-	9.457 [2]	14.669 [3]	33.513 [4]	21.818 [5]

Country	1992	1993	1994	1995	1996	1997	1998 [6]
Faroe Islands	-	-	1	-	-	-	
Germany	5.893	164	24	22	5	39	128
Greenland	1.283	241	73	29	5	32	14
Iceland	22	-	-	1	-	-	
Norway	1.032	122	14	+	1 [6]	15 [6]	1
Russia	126	-	-	-	-	-	
UK (Engl. and Wales)	2.532	163	-	-	-	-	
UK (Scotland)	463	46	-	-	-	-	
United Kingdom	-	-	296	232	181	284	149
Total	11.351	736	408	284	192	370	292
WG estimate	-	-	-	-	-	-	-

[1]) Includes estimates of discards and catches reported in Sub-area XII

[2]) Excluding 3,000 t assumed to be from NAFO Division 1F and including 42 t taken by Japan

[3]) 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)

[4]) Includes 129 t by Japan and 48 t additional catches by Greenland (Horsted, 1994)

[5]) Includes 18 t by Japan

[6]) Provisional data

Table 5.1.10 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 Miscellaneous	offshore OBT	offshore total	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	1242
1998	333	0	278	278	611

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

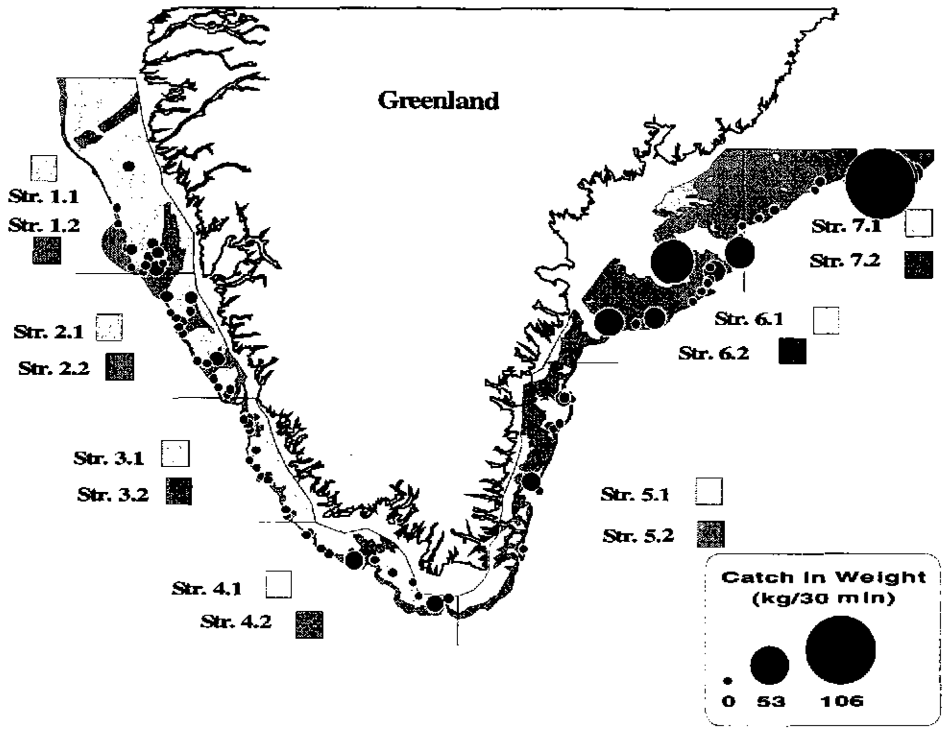


Figure 5.1.1 Cod off Greenland (offshore component). Survey area, stratification and position of hauls carried out in 1998.

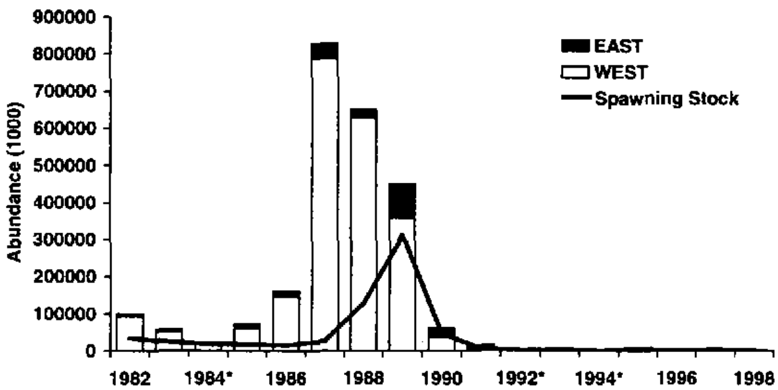


Figure 5.1.2 Cod off Greenland (offshore component). Aggregated survey abundance indices for West and East Greenland and spawning stock size, 1982-98. *) incomplete survey coverage.

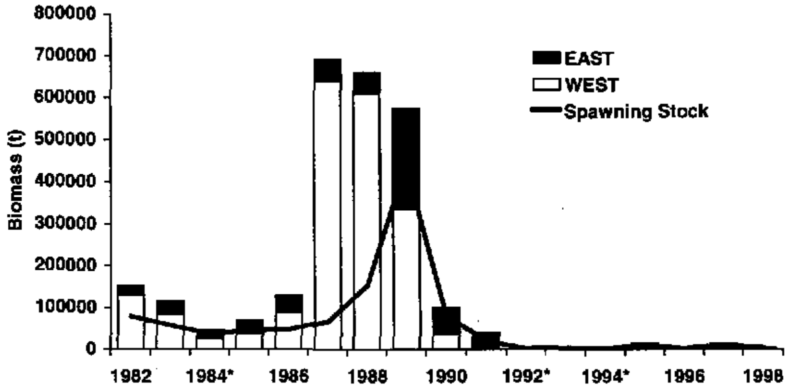


Figure 5.1.3 Cod off Greenland (offshore component). Aggregated survey biomass indices for West and East Greenland and spawning stock biomass, 1982-98. *) incomplete survey coverage.

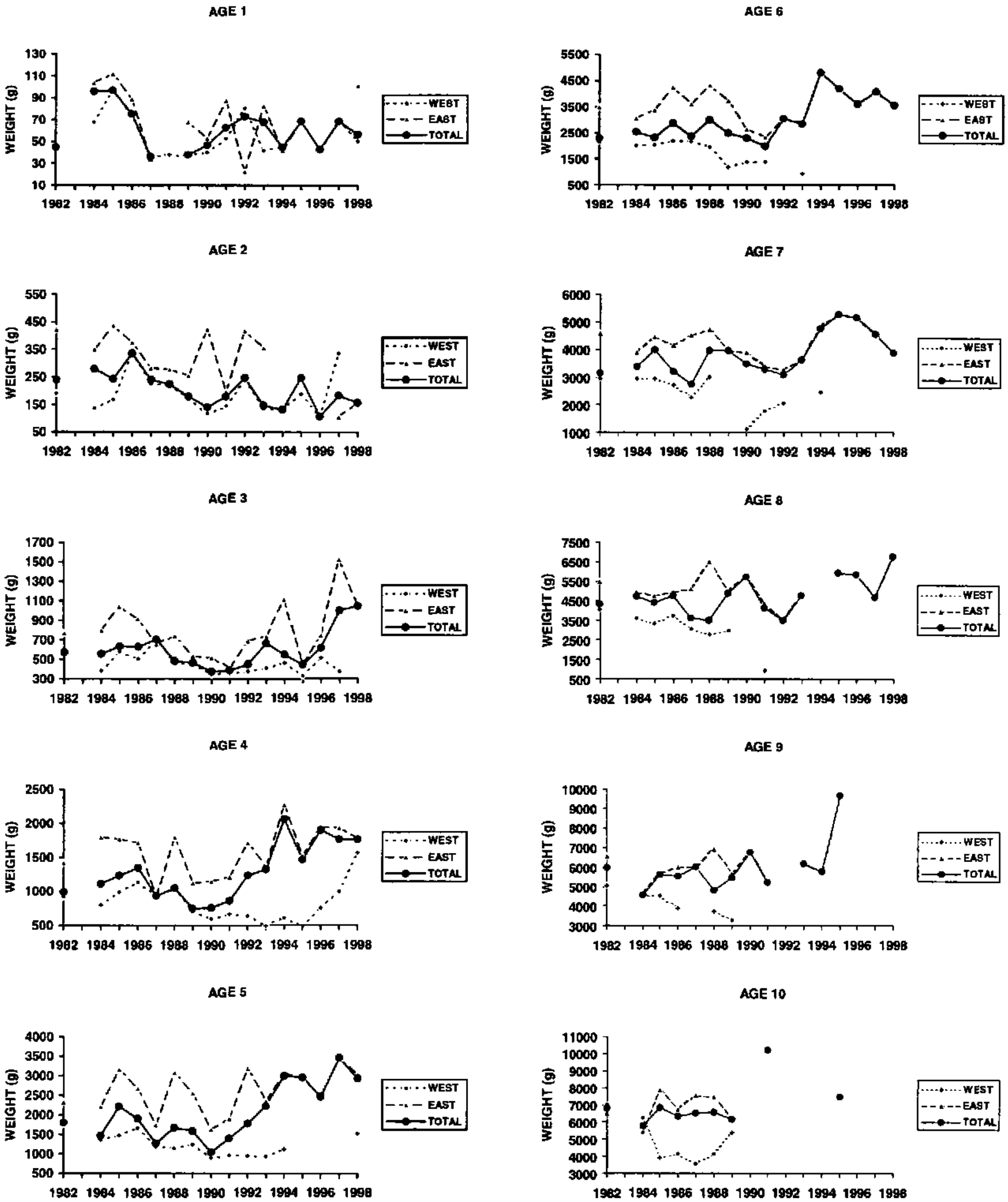


Figure 5.1.4 Cod off Greenland (offshore component). Weighted mean weight at age 1-10 years for West, East Greenland and total, 1982-98.

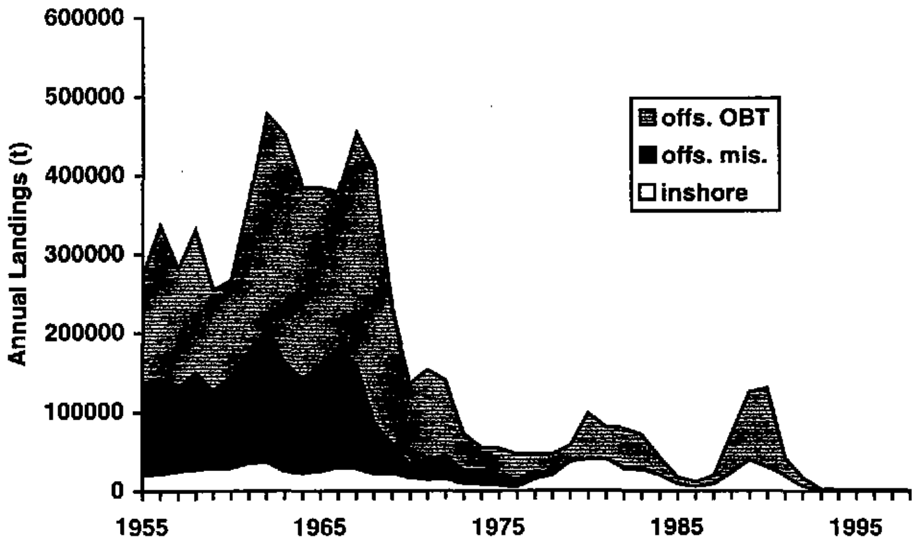


Figure 5.1.5 Cod off Greenland. Catches 1955-98 as used by the Working Group, inshore and offshore by gear (Horsted,1994).

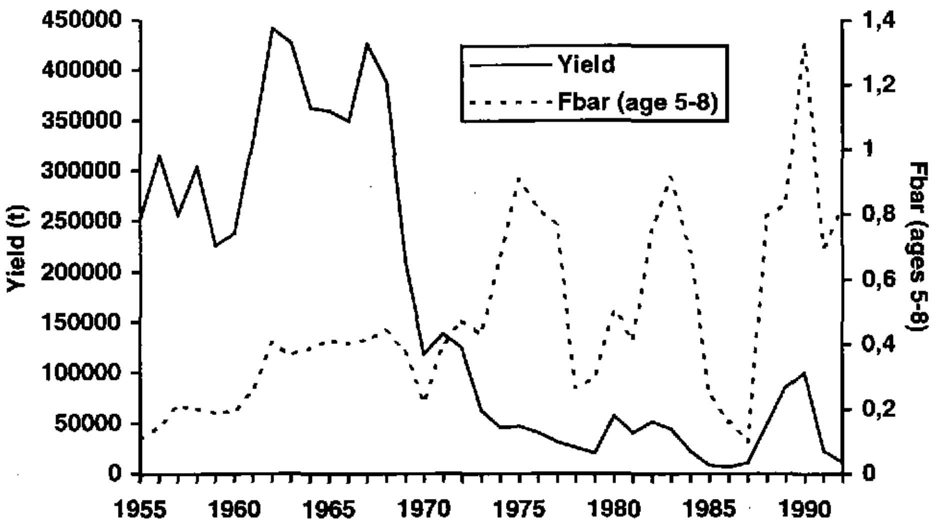


Figure 5.1.6 Greenland cod (offshore component). Trends in yield and fishing mortality.

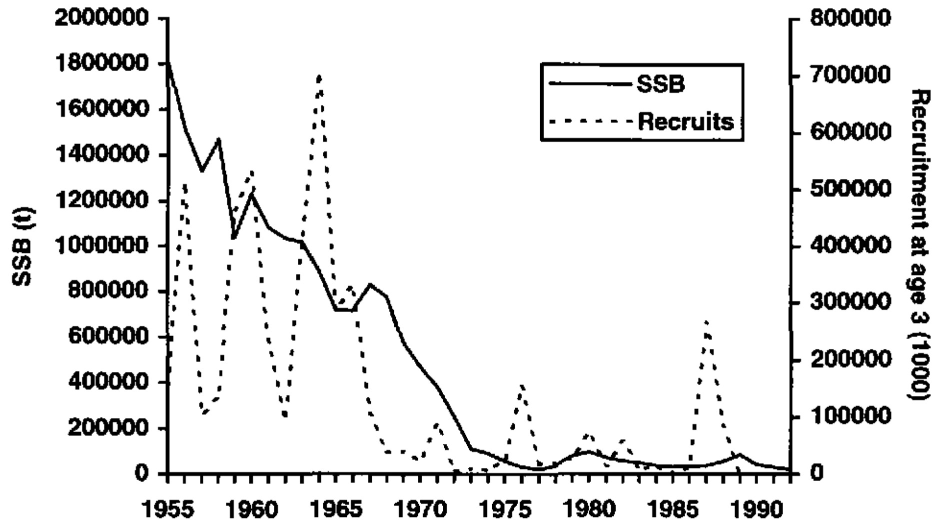


Figure. 5.1.7 Greenland cod (offshore component). Trends in spawning stock biomass (SSB) and recruitment.

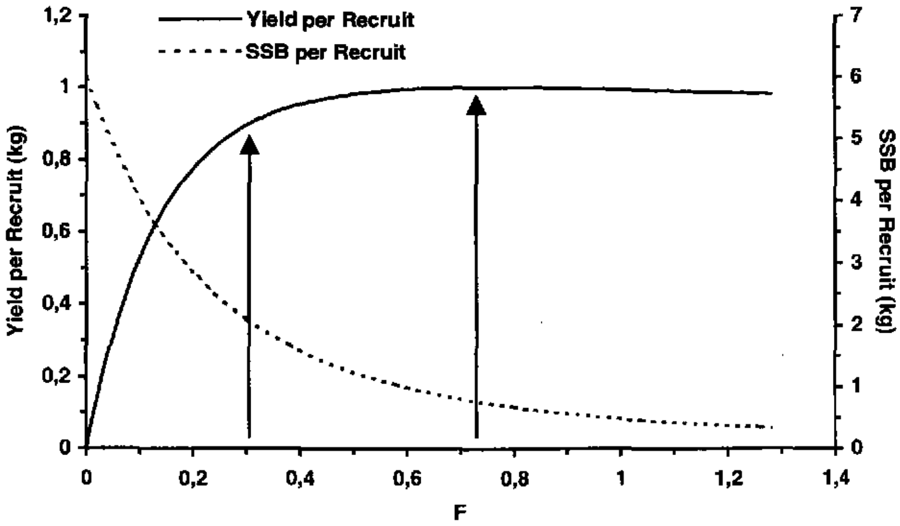


Figure 5.1.8 Greenland cod (offshore component). Long term yield and spawning stock biomass. $F_{0.1}$ reference age 5-8=0.297; F_{max} reference age 5-8=0.722.

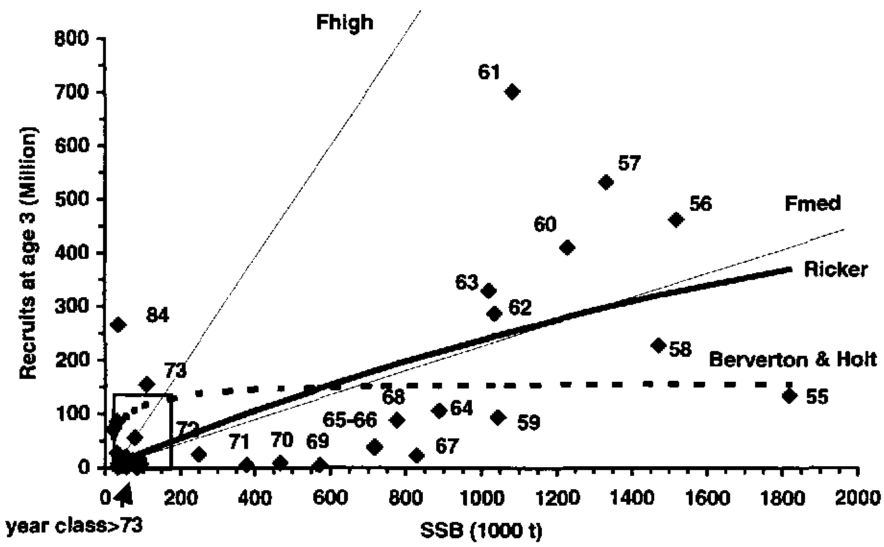


Figure 5.1.9 Greenland cod (offshore component). Spawning stock-recruitment plot for year classes 1955-89 and fitted recruitment curves. F_{med}=0.09 corresponding to a SSB/R=4.44 kg; F_{high}=0.59 corresponding to a SSB/R=0.98 kg.

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, possibly self-sustained, fjord populations. Spawning cod are found in several fjords of the West Greenland, especially in NAFO Division 1B, 1C and 1D.

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 (Table 5.1.1.2).

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 1992 to 248 t in 1998.

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 33mm) 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 have shown, that selection is best towards age 2 cod, whereas only the larger individuals of the age 1 cod are adequately selected. In the 1998-survey a total of 174 net settings were made. Nets were sat 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 0-5m, 5-10m, 10-15m, and 15-20m.

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.

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 needs 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 an FMSY of about 0.15, but the results should be used with caution as they are based on very limited data. In addition the model does not account for the present recruitment failure of the stock

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. The data presented indicate that the stock is continuously declining. The stock has undergone a series of recruitment failures in recent years. The three latest year classes are all estimated 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, observe and predicted CPUE based on data from inshore pound net fishery.

Year	Predicted Biomass	Predicted CPUE	Observed CPUE	Ln (CPUE/B)	Observed Catch
1993	6120	936	730	-2.13	1924
1994	5038	771	768	-1.88	2215
1995	3661	560	600	-1.81	1710
1996	2694	412	536	-1.61	948
1997	2363	362	423	-1.72	904
1998	2021	309	248	-2.10	326
1999	2195*				

*predicted

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

Year of assess.	Virgin biomass	Rate of increase	q	Init. biomass
1998	12001	0,303	0,11	7428
1999	11268	0,300	0,15	6120

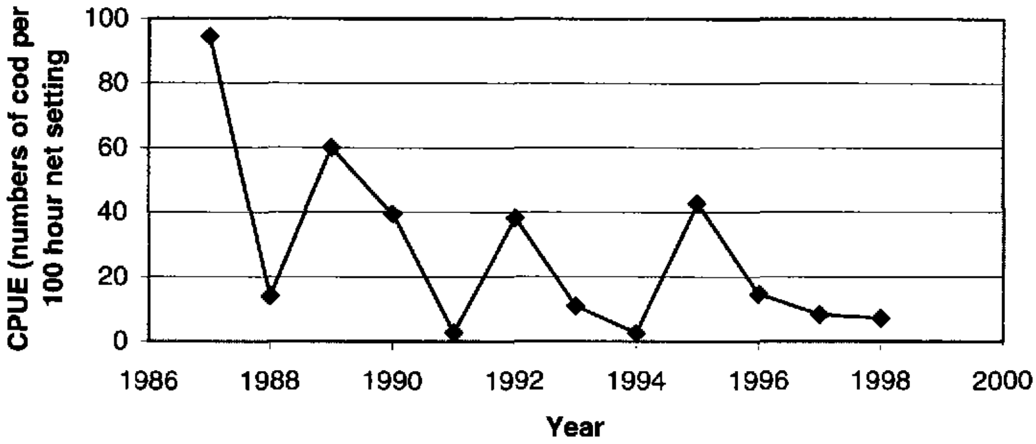


Figure 5.2.1 CPUE (number of age 2 cod caught per 100 hours net setting) in the Greenland Young cod survey 1987-1997.

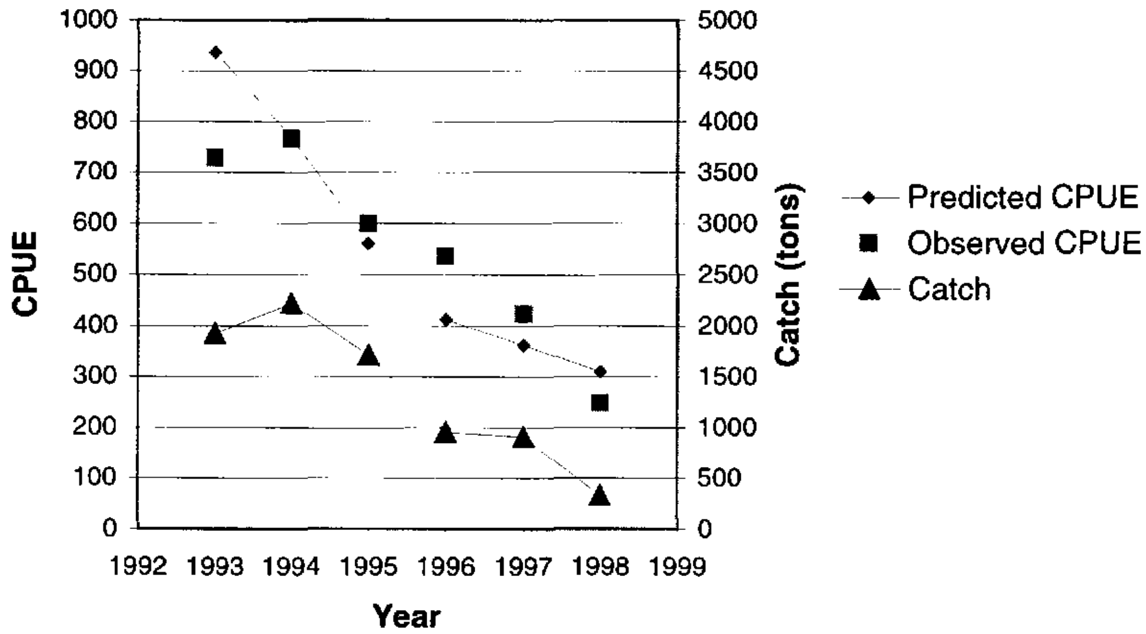


Figure 5.2.2 Greenland cod (inshore component) Observed and model-predicted CPUE rates

6 GREENLAND HALIBUT IN SUB-AREAS V AND XIV

6.1 Landings, Fisheries and Fleet

6.1.1 Landings

Total annual landings in Divisions Va, Vb and Sub-area XIV are presented for the years 1981–1998 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 62 000 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. Catches not officially reported to ICES have been included in the assessment. Landings within Icelandic EEZ have traditionally been reported as caught in Division Va. Therefore, when referring to Division Va (or Icelandic waters) the area covers both Va and the Icelandic EEZ part of XIVb. Landings and fishery relates to the Greenland EEZ part of XIVb as well as international waters on the Reykjanes Ridge.

Catches in Icelandic waters have, due to quota regulations, decreased from 37 000 t in 1990 to 10 700 t in 1998. Faroese catches in Vb increased from a level of about 1 000 t in 1981–1991 to 6 500 t in 1996, whereafter it decreased to about 3 800 t in 1998. 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 5 900 t in 1998.

6.1.2 Fisheries and fleet

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 CM 1998/ACFM 19. No changes occur for 1998 except that no catches are reported on the Reykjanes Ridge.

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, partly due to a drastic reduction of effort. For the years 1990–1998 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 1985–1998 (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 are 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 1997. In 1998 the effort was at the level of 1991. The CPUE was relatively stable in 1985–1989, but has declined sharply since then to a historic low in the last two years. The CPUE declined by 70% from 1989 to 1997 but in 1998 it was around 60% of the maximum value.

For division XIVb, CPUE from logbooks in the years 1991–1998 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 a level of less than 500 tons annually before 1991 to 5000 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 and Sampling level

The data set comprising the age-length key for 1998 were from 2 different sources. One consisted of 120 samples (1346 otoliths) from the Icelandic trawl fleet and long line fleet operating in Icelandic water (Va-key). This key is from samples taken in 1997 since the WG determined that the age-length key from 1998 samples from Icelandic waters was unreliable due to: 1) limited number of otoliths analysed and, 2) discrepancy in the length at age between ages 5–10 and ages above 11 years old, resulting in no growth between year 1997 and 1998 for year classes 1987 and older. Using the 97 key to the 98 data was considered to be acceptable as low variation in length at age has been observed during 1995–1997. The other age-length key (758 otoliths) was from the East Greenland 1998 fall survey. 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
Long line	Iceland	590	20	356	Va
Bottom trawl	Iceland-west	8088	242	8088	Va
Bottom trawl	Iceland-north & east	1195	14	1195	Va
Bottom trawl	Iceland-southeast	855	36	855	Va
Gill Net (&line)	Faroe Islands	2867	3	548	Va
Bottom trawl	Faroe Islands	917	1	196	Va
Long line	East Greenland	609	0	0	XIV
Bottom trawl	East Greenland	4955	32	6167	XIV
Total		20076	348	17405	

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Length measurements from the Icelandic long line fleet were applied to the long line catch in East Greenland waters. The length-weight relationship used was $W = 0.01758 * L^{2.84387}$ for all fleets except the bottom trawl fleet in East Greenland water, where $W = 2.433*10^{-3}*L^{3.331}$ was used. The total catch in numbers (Table 6.3.1) were obtained from the sum of the above weighted with the catch within each group.

6.4 Weight at Age

The mean weight at age in 1998 (Table 6.4.1) was derived from the weighted average of the above groups. Apart from 1994 and 1996 to 1998 only Icelandic data has been available. 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 and 1997 were based on information from the Icelandic October groundfish survey and the data for 1998 from the Icelandic October groundfish survey and the East Greenland June/July groundfish survey.

6.6 Stock Assessment

6.6.1 Tuning and estimates of fishing mortalities

Age-disaggregated CPUE values for age groups 7–12 over the period 1985–1998, 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 stock assessment. The diagnostics are presented in Table 6.6.1.1.

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 6.6.1.2.-4. and Figures 6.6.1.1 C and D.

6.6.2 Spawning stock and recruitment

Spawning stock biomass is shown in Table 6.6.1.4 and Figure 6.6.1.1.D. 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 56 000 t in 1998.

Estimates of recruitment at age 5 are shown in Table 6.6.1.4 and Figure 6.6.1.1.D. The long term average for the period 1975–1998 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 1992 and 1993 are thought to be unreliable, since they are just entering the fisheries and calculated VPA stock numbers thus based on few numbers.

6.7 Prediction of Catch and Biomass

6.7.1 Input data

The input data for the short term prediction are given in Table 6.7.1.1. Mean weight at age is average from 1996-98 and the exploitation pattern is average fishing mortalities from 1996-1998 rescaled to the level of 1998. Maturity at age is the average of 1996-1998. Natural mortality was set to 0.15 and the proportions of F and M before spawning were set to 0. Year classes 1994–96 were set to the lower quartile value of the recruitment of the 1970–1991 year classes. This is a reflection of the recruitment being below average since 1986 year-class.

Since TAC for the Greenland EEZ was not reached in 1998 and since in the Icelandic area the fishing is regulated not to exceed 10 000 t for the current fishing year, a catch constraint of 20 000 t was applied to 1999. This is based on the expectancy that the TAC constraint in Iceland will hold and on the assumption that the catch in other areas remains the same as in 1998.

The Y/R calculation uses the mean weight and maturity at age averaged for the period 1975–1998. The exploitation pattern is based on an average exploitation pattern over the period 1975–1998 rescaled to the level of 1998 (Table 6.7.1.2).

6.7.2 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 $\sigma = 0.3$. F_{pa} was defined as $F_{med} = 0.36$.

6.7.3 Projections of catch and biomass

At the beginning of 1999, the total stock is estimated to be 133 000 t, and the spawning stock 59 000 t (Table 6.7.3.1). The catch prediction of 20 000 tonnes in 1999 will result in an estimated fishing mortality of 0.32 and a stock biomass and spawning stock biomass of 137 000 and 61 000, respectively in the beginning of 2000. Assuming an F in 2000 to be the same as in 1999, results in the stock remaining in a stable, although low, state in the beginning of 2001. A linear reduction in F from the proposed F_{pa} in accordance with the estimate of biomass in 2000 in relation to B_{pa} and B_{lim} results in F = 0.14 and catch of no more than 10 000 t in 2000.

6.8 Management Considerations

The Greenland halibut stock biomass has been falling rapidly from a peak in 1987. The fishing mortality has been substantially above $F_{0.1}$ since 1986 and is currently at the level of F_{pa}. The SSB in 1998 and 1999 is also below the B_{pa}.

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 but recruitment in the latter part of the period (year classes 1986–1990) have been below average, i.e., 38 and 23 million, respectively. The yield-per-recruit computations indicate that the obtainable yield at F_{pa} is 1.06 kg per recruit. The average yield from the year classes 1975–85 and 1986–95 were or are thus not expected to exceed 40 000 t and 24 000 t, respectively.

Considerable reduction in catch is needed to rebuild the stock, necessitating strict management regulations.

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 advised TAC's by ICES.

6.9 Comments on the Assessment

Improved sampling of catch data is needed. At present information on age composition and maturation for all areas is insufficient. Improved precision and standardisation in methods of determination of maturity are badly needed. Short term predictions are based on assumed recruitment values. Indices of recruitment of Greenland halibut are an obvious prerequisite for sound management advice.

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, respectively, have 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 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 1981-1998, 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	-
France	-	-	3	2	-	-	29	11	8
Germany	336	303	382	415	648	811	3 368	3 342	3 404
Greenland	40	66	437	288	867	533	1 162	1 129	-
Iceland	36 557	34 883	31 955	33 987	27 778	27 383	22 055	18 569	10 709
Norway	50	34	221	846	1 173 [1]	1 810	2 157	1 939	1 246
Russia	-	-	5	-	-	10	424	37	
UK (Engl. and Wales)	27	38	109	811	513	1 436	386	-	
UK (Scotland)	-	-	19	26	84	232	25	-	
United Kingdom									
Total	38 813	36 890	35 259	40 780	37 305	35 978	35 755	29 998	15 367
Working Group estimate [2]	39 326	37 950	35 423	40 817	36 958	36 300	35 825	30 267	20 493

1) Provisional data

2) Working group best estimates.

Table 6.1.2. GREENLAND HALIBUT. Nominal catches (tonnes) by countries, in Division Va 1981-1998, 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	
Germany	-	-	-	-	1	2	4	-	9
Greenland	-	-	-	-	1	-	-	-	
Iceland	36 557	34 883	31 955	33 968	27 696	27 376	22 055	16 766	10 709
Norway	-	-	-	-	-	-	-	-	
Total	37 296	35 156	31 978	34 134	28 608	27 391	22 073	16 792	10 718
Working Group estimate	37 308 [3]	35 413 [4]	-	-	-	-	-	-	10 737 [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 additional catch of 19 t by Iceland.

Table 6.1.3. GREENLAND HALIBUT. Nominal catches (tonnes) by countries, in Division Vb 1981-1998, 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 [1]
Denmark	-	-	-	-	-	-	-	-	
Faroe Islands	1 064	1 293	2 105	4 058	5 163	3 603	6 004	4750	
France [6]	...	...	3 [1]	2 [1]	1 [1]	28 [1]	29 [1]	11	8
Germany	43	24	71	24	8	1	21	41	
Greenland	-	-	-	-	-	-	-	-	
Norway	42	16	25	335	53	142	281 [1]	42 [1]	114
UK (Engl. and Wales)	-	-	1	15	-	31	122	-	
UK (Scotland)	-	-	1	-	-	27	12	26	
United Kingdom	-	-	-	-	-				43
Total	1 149	1 333	2 206	4 434	5 225	3 832	6 469 [1]	4 870	165
Working Group estimate	1 282 [3]	1 662 [4]	2 269 [5]	-	-	[7]	-	-	3826 [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 16t by France
8) Includes 3661 t taken in by Faroe Islands.

Table 6.1.4. GREENLAND HALIBUT. Nominal catches (tonnes) by countries, in Sub-area XIV 1981-1998, 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 [1]
Denmark	-	-	-	-	-	-	1	+	
Faroe Islands	-	-	-	181	168	147	130	148	
Germany	293	279	311	391	639	808	3 343	3 301	3 395
Greenland	40	66	437	288	866	533	1 162	1 129	
Iceland	-	-	-	19	82	7	-	1 803	
Norway	8	18	196	511	1 120	1 668 [1]	1 874 [9]	1 897 [1]	1 132
Russia	-	-	5	-	-	10	424	37	
UK (Engl. and Wales)	27	38	108	796	513	1405	264	218	
UK (Scotland)	-	-	18	26	84	205	13	-	
United Kingdom	-	-	-	-	-	-	-		190
Total	368	401	1 075	2 212	3 472	4 783	7 211	8 533	4717
Working Group estimate	736 [2]	875 [3]	1 176 [4]	2 249 [5]	3 125 [6]	5 077 [7]	7 283 [8]	8 558 [11]	5 930

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) Inside 200 EEZ: 1505 t. Outside 200 EEZ: 369t.

10) Includes catches taken both inside and outside the 200 EEZ.

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

Table 6.1.5. GREENLAND HALIBUT. Nominal catches (tonnes) by countries in Sub-area XII 1996-1998, as officially reported to the ICES.

Country	1996	1997	1998
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 1985-1998.

year	cpue	% change in CPUE between years	landings	effort	% change in effort between years
85	1.000		32075	32075	
86	0.971	-2.9	32984	33970	5.9
87	0.934	-3.8	46622	49907	46.9
88	1.108	18.6	51118	46138	-7.6
89	1.074	-3.1	61396	57173	23.9
90	0.775	-27.8	39326	50718	-11.3
91	0.815	5.1	37950	46561	-8.2
92	0.651	-20.2	35423	54438	16.9
93	0.548	-15.8	40817	74522	36.9
94	0.418	-23.7	36958	88463	18.7
95	0.312	-25.3	36300	116375	31.6
96	0.276	-11.5	35826	129758	11.5
97	0.279	0.9	30267	108642	-16.3
98	0.433	55.3	20493	47379	-56.4

Table 6.3.1 Catch in number at age (Numbers in 10^{-3})

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

Catch in number at age (Numbers in 10-3)

YEAR.	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
AGE										
5	29	47	26	8	10	83	125	245	182	129
6	197	502	158	300	240	277	441	612	3123	742
7	1605	1536	580	1140	1611	891	1018	1033	4863	2068
8	2253	2630	1160	2451	2651	2139	2295	1942	2586	2985
9	3090	3126	1430	2646	3060	3568	3454	2983	2156	3166
10	1693	2324	1764	2456	2443	2800	2749	3097	3476	2966
11	880	1739	1299	1803	1693	1825	1452	1683	1847	1848
12	394	849	664	963	978	1134	627	820	1829	1761
13	246	578	435	609	424	588	423	550	886	1851
14	189	306	252	331	174	363	137	202	243	701
15	147	143	176	195	37	92	36	59	31	216
+gp.	125	116	159	132	47	20	46	34	5	246
TOTALNUM.	10848	13896	8103	13034	13368	13780	12803	13260	21227	18679
TONSLAND.	23616	31252	19239	32441	30888	34024	32075	32984	46622	51118
SOPCOF %	101	99	100	100	101	99	103	101	98	101

Catch in number at age (Numbers in 10-3)

YEAR.	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
AGE										
5	499	188	289	17	44	78	503	178	86	90
6	1657	463	1225	421	397	672	1587	1488	549	550
7	4485	1513	1797	2023	1896	2197	3031	2908	2723	1882
8	5961	3515	2866	3262	5024	3815	3287	3181	2579	2051
9	5763	4186	2935	2646	4324	3648	2608	2119	2331	1657
10	3246	3143	2074	3019	2859	2330	1963	1755	1247	1067
11	1601	1224	1130	1962	1539	1715	1548	1610	975	737
12	1458	959	1072	1278	1412	990	1132	1216	937	710
13	1237	568	924	509	576	422	657	665	652	359
14	506	358	554	144	136	371	444	548	374	195
15	362	137	342	36	135	168	240	238	282	150
+gp.	145	61	82	56	14	177	232	503	700	237
TOTALNUM.	26920	16315	15290	15373	18356	16583	17232	16409	13435	9685
TONSLAND.	61396	39326	37950	35423	40817	36958	36300	35826	30267	20493
SOPCOF %	100	100	101	100	100	100	100	100	100	100

Table 6.4.1 Catch weights at age (kg)

YEAR,	1975,	1976,	1977,	1978,
AGE				
5,	.9680,	1.1570,	1.1570,	.9680,
6,	1.1990,	1.5850,	1.0460,	1.1990,
7,	1.4230,	1.7680,	1.4290,	1.4230,
8,	1.8540,	2.1800,	1.7940,	1.8540,
9,	2.2560,	2.5700,	2.2280,	2.2560,
10,	2.6070,	3.0180,	2.6870,	2.6070,
11,	3.0810,	3.7300,	3.0170,	3.0810,
12,	3.5910,	4.0520,	3.9140,	3.5910,
13,	4.6040,	4.8150,	4.0400,	4.6040,
14,	4.6950,	5.3480,	4.7140,	4.6950,
15,	5.1510,	5.7520,	5.4010,	5.1510,
+gp,	6.9020,	7.0940,	5.5970,	6.4500,
SOPCOFAC,	1.2550,	1.0024,	1.0008,	.9993,

Catch weights at age (kg)

YEAR,	1979,	1980,	1981,	1982,	1983,	1984,	1985,	1986,	1987,	1988,
AGE										
5,	.9110,	1.1250,	1.0710,	1.0100,	.9840,	.9420,	.9950,	1.0300,	1.0300,	1.1290,
6,	.9420,	1.2830,	1.2570,	1.3680,	1.3380,	1.2750,	1.2300,	1.2380,	1.2180,	1.3040,
7,	1.2780,	1.4870,	1.4400,	1.6180,	1.5770,	1.5920,	1.6300,	1.4990,	1.5330,	1.5410,
8,	1.6760,	1.7560,	1.6600,	1.9050,	1.8480,	1.8170,	1.9510,	1.9370,	1.8240,	1.7700,
9,	2.0720,	2.1530,	1.9670,	2.1870,	2.1590,	2.2400,	2.3670,	2.3630,	2.1870,	2.2360,
10,	2.3330,	2.2790,	2.2580,	2.5160,	2.4340,	2.4610,	2.6370,	2.6310,	2.6660,	2.6830,
11,	2.7230,	2.4980,	2.5150,	2.7610,	2.6030,	2.8350,	2.8290,	2.8480,	2.9960,	3.0820,
12,	3.2970,	3.0590,	2.9500,	3.1290,	3.0340,	3.2620,	3.3530,	3.3350,	3.5950,	3.6240,
13,	3.9850,	3.7830,	3.4500,	3.7850,	3.7840,	3.9620,	4.0060,	4.0390,	4.4310,	4.3120,
14,	4.6680,	4.5070,	4.0330,	4.4750,	4.4460,	4.9360,	4.7920,	4.9250,	5.1400,	5.0980,
15,	4.7920,	5.1390,	4.6520,	4.9850,	4.7510,	5.2300,	5.2310,	5.4660,	5.7640,	5.2130,
+gp,	5.3870,	5.9830,	5.3300,	6.0880,	6.3850,	7.1920,	6.3230,	5.9850,	7.2670,	5.7640,
SOPCOFAC,	1.0124,	.9902,	1.0024,	.9997,	1.0110,	.9937,	1.0258,	1.0060,	.9785,	1.0063,

Catch weights at age (kg)

YEAR,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	1996,	1997,	1998,
AGE										
5,	.8420,	1.0290,	1.0010,	1.0160,	.9910,	1.1630,	.9500,	1.1010,	.9190,	.7960,
6,	1.0470,	1.2100,	1.2470,	1.2560,	1.2490,	1.2540,	1.2130,	1.1240,	1.1070,	1.0520,
7,	1.4250,	1.5720,	1.4720,	1.4010,	1.4010,	1.4880,	1.4130,	1.3460,	1.3340,	1.3420,
8,	1.7270,	1.7900,	1.8100,	1.7180,	1.6850,	1.7360,	1.7030,	1.6490,	1.6400,	1.6950,
9,	2.1250,	2.1260,	2.0880,	2.0490,	1.9820,	2.1500,	2.0280,	1.9250,	1.8810,	1.9580,
10,	2.6370,	2.5360,	2.4400,	2.4360,	2.4250,	2.3520,	2.2790,	2.3420,	2.2400,	2.2800,
11,	3.2200,	3.2140,	2.9350,	2.8680,	2.9520,	2.7360,	2.6430,	2.5950,	2.5380,	2.5450,
12,	3.7330,	3.6930,	3.7370,	3.4780,	3.4290,	3.0820,	2.9920,	3.0130,	2.8460,	2.9120,
13,	4.1350,	4.4480,	4.4010,	4.5100,	4.4790,	3.6070,	3.5680,	3.5150,	3.3850,	3.3700,
14,	5.3800,	5.1970,	5.0220,	4.6810,	6.0430,	4.2420,	4.0680,	4.1230,	4.3590,	4.3450,
15,	6.5690,	5.8910,	5.9910,	6.0100,	5.8320,	5.2930,	5.3020,	4.9960,	4.8510,	5.0300,
+gp,	6.4970,	6.0490,	6.4120,	5.1280,	2.7560,	6.0870,	5.6140,	5.8450,	5.8000,	5.8030,
SOPCOFAC,	.9999,	.9998,	1.0097,	1.0033,	1.0010,	1.0001,	1.0014,	1.0011,	1.0044,	1.0016,

Table 6.5.1 Proportion mature at age

YEAR,	1975,	1976,	1977,	1978,
AGE				
5,	.0000,	.0000,	.0000,	.0000,
6,	.0300,	.0300,	.0300,	.0300,
7,	.1000,	.1000,	.1000,	.1000,
8,	.3500,	.3500,	.3500,	.3500,
9,	.7700,	.7700,	.7700,	.7700,
10,	.9600,	.9600,	.9600,	.9600,
11,	1.0000,	1.0000,	1.0000,	1.0000,
12,	1.0000,	1.0000,	1.0000,	1.0000,
13,	1.0000,	1.0000,	1.0000,	1.0000,
14,	1.0000,	1.0000,	1.0000,	1.0000,
15,	1.0000,	1.0000,	1.0000,	1.0000,
+gp,	1.0000,	1.0000,	1.0000,	1.0000,

Proportion mature at age

YEAR,	1979,	1980,	1981,	1982,	1983,	1984,	1985,	1986,	1987,	1988,
AGE										
5,	.0000,	.0000,	.0000,	.0000,	.0400,	.0000,	.0100,	.0100,	.0100,	.0100,
6,	.0300,	.0300,	.0300,	.0500,	.0700,	.0800,	.0600,	.0600,	.0600,	.0600,
7,	.1000,	.1000,	.1000,	.2000,	.1500,	.1900,	.2100,	.2100,	.2100,	.2100,
8,	.3500,	.3500,	.3500,	.3300,	.2800,	.3200,	.3500,	.3500,	.3500,	.3500,
9,	.7700,	.7700,	.7700,	.5000,	.3800,	.4200,	.4600,	.4600,	.4600,	.4600,
10,	.9600,	.9600,	.9600,	.7000,	.6000,	.6400,	.6400,	.6400,	.6400,	.6400,
11,	1.0000,	1.0000,	1.0000,	.8500,	.8500,	.7500,	.8200,	.8200,	.8200,	.8200,
12,	1.0000,	1.0000,	1.0000,	.9400,	.9800,	.9300,	.9600,	.9600,	.9600,	.9600,
13,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
14,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
15,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
+gp,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,

Proportion mature at age

YEAR,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	1996,	1997,	1998,
AGE										
5,	.0100,	.0100,	.0100,	.0200,	.0300,	.0300,	.1780,	.3040,	.2240,	.2700,
6,	.0600,	.0600,	.0600,	.0400,	.1200,	.1200,	.1810,	.3100,	.2910,	.3180,
7,	.2100,	.2100,	.2900,	.1100,	.2700,	.2700,	.4770,	.3930,	.3680,	.3600,
8,	.3500,	.3500,	.4800,	.2500,	.4000,	.4000,	.5970,	.4640,	.4380,	.4010,
9,	.4600,	.4600,	.5600,	.4700,	.4500,	.4500,	.5860,	.5260,	.4950,	.5000,
10,	.6400,	.6400,	.6200,	.6800,	.5400,	.5400,	.7050,	.6260,	.5880,	.4840,
11,	.8200,	.8200,	.8500,	.8500,	.6500,	.6500,	.7860,	.6900,	.6680,	.6310,
12,	.9600,	.9600,	1.0000,	.9600,	.7800,	.7800,	.7640,	.7730,	.7450,	.6700,
13,	1.0000,	1.0000,	1.0000,	1.0000,	.8300,	.8300,	.9610,	.8700,	.8500,	.8030,
14,	1.0000,	1.0000,	1.0000,	1.0000,	.9700,	.9700,	1.0000,	.9530,	.9480,	.8820,
15,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	.9810,	.9710,	.9250,
+gp,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	.9860,	.9120,

Table 6.6.1.1 Output from XSA

Lowestoft VPA Version 3.1
Extended Survivor analysis

G. Halibut V & XIV (run XSAEHJ02/X02)

CPUE data from file /users/fish/ifad/ifapwork/nwwg/ghl_grn/FLEET.X02

Catch data for 24 years. 1975-1998. Age 5-16.

Fleet,	First,	Last,	First,	Last,	Alpha,	Beta
,	year,	year,	age	,	age	
FLT01: Va TRW 85-98	1985,	1998,	7,	12,	.000,	1.000

Time series weights

Tapered time weighting applied
Power = 3 over 20 years

Catchability analysis

Catchability dependent on stock size for ages < 7

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

Catchability independent of age for ages >=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 to weighting not applied

Tuning converged after 24 iterartions

Regression weights

,	.751,	.820,	.877,	.921,	.954,	.976,	.990,	.997,	1.000,	1

Fishing mortalities

Age,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	1996,	1997,	1998
5,	.015,	.006,	.012,	.001,	.002,	.004,	.024,	.009,	.004,	0.004
6,	.062,	.017,	.045,	.020,	.022,	.035,	.091,	.087,	.032,	0.029
7,	.179,	.070,	.080,	.092,	.113,	.153,	.206,	.226,	.214,	0.14
8,	.302,	.197,	.174,	.193,	.327,	.327,	.338,	.327,	.303,	0.234
9,	.429,	.339,	.237,	.228,	.396,	.396,	.367,	.359,	.399,	0.307
10,	.476,	.414,	.264,	.386,	.389,	.363,	.361,	.426,	.350,	0.302
11,	.383,	.311,	.241,	.404,	.327,	.402,	.413,	.536,	.420,	0.339
12,	.649,	.393,	.464,	.444,	.538,	.341,	.477,	.628,	.653,	0.583
13,	.633,	.534,	.774,	.394,	.347,	.284,	.377,	.540,	.786,	0.528
14,	.704,	.352,	1.608,	.238,	.163,	.371,	.514,	.586,	.632,	0.536
15,	.543,	.388,	.632,	.359,	.346,	.292,	.412,	.542,	.646,	0.529

Table 6.6.1.1 Cont'd

XSA population numbers (Thousands)

AGE YEAR	5,	6,	7,	8,	9,	10,	11,	12,	13,	14,
1989	3.52E+04,	2.98E+04,	2.94E+04,	2.47E+04,	1.78E+04,	9.23E+03,	5.42E+03,	3.29E+03,	2.84E+03,	1.08E+03,
1990	3.51E+04,	2.98E+04,	2.41E+04,	2.12E+04,	1.57E+04,	9.99E+03,	4.93E+03,	3.18E+03,	1.48E+03,	1.30E+03,
1991	2.67E+04,	3.00E+04,	2.52E+04,	1.93E+04,	1.50E+04,	9.63E+03,	5.68E+03,	3.11E+03,	1.85E+03,	7.47E+02,
1992	2.31E+04,	2.27E+04,	2.47E+04,	2.01E+04,	1.40E+04,	1.02E+04,	6.37E+03,	3.84E+03,	1.68E+03,	7.34E+02,
1993	2.46E+04,	1.98E+04,	1.92E+04,	1.94E+04,	1.42E+04,	9.57E+03,	5.94E+03,	3.66E+03,	2.12E+03,	9.77E+02,
1994	2.30E+04,	2.11E+04,	1.67E+04,	1.47E+04,	1.20E+04,	8.24E+03,	5.58E+03,	3.69E+03,	1.84E+03,	1.29E+03,
1995	2.30E+04,	1.97E+04,	1.76E+04,	1.23E+04,	9.14E+03,	6.98E+03,	4.93E+03,	3.21E+03,	2.26E+03,	1.19E+03,
1996	2.18E+04,	1.93E+04,	1.55E+04,	1.23E+04,	7.57E+03,	5.45E+03,	4.18E+03,	2.81E+03,	1.72E+03,	1.33E+03,
1997	2.44E+04,	1.86E+04,	1.53E+04,	1.06E+04,	7.63E+03,	4.55E+03,	3.06E+03,	2.11E+03,	1.29E+03,	8.61E+02,
1998	2.38E+04,	2.09E+04,	1.55E+04,	1.06E+04,	6.75E+03,	4.41E+03,	2.76E+03,	1.73E+03,	9.44E+02,	5.07E+02,

Estimated population abundance at 1st Jan 1999

, .00E+00, 2.04E+04, 1.75E+04, 1.16E+04, 7.22E+03, 4.28E+03, 2.80E+03, 1.69E+03, 8.32E+02, 4.79E+02,

Taper weighted geometric mean of the VPA populations:

, 2.79E+04, 2.46E+04, 2.10E+04, 1.66E+04, 1.19E+04, 7.97E+03, 5.03E+03, 3.14E+03, 1.73E+03, 8.87E+02,

Standard error of the weighted Log (VPA populations):

, .2441, .2552, .2694, .3045, .3408, .3408, .3095, .3226, .3785, .4551,

YEAR	AGE 15,
1989	9.31E+02,
1990	4.60E+02,
1991	7.87E+02,
1992	1.29E+02,
1993	4.98E+02,
1994	7.14E+02,
1995	7.66E+02,
1996	6.14E+02,
1997	6.39E+02,
1998	3.94E+02,

Estimated population abundance at 1st Jan 1999

, 2.55E+02,

Taper weighted geometric mean of the VPA populations:

, 4.23E+02,

Standard error of the weighted Log (VPA populations):

, .7303,

1

Log catchability residuals   Fleet: FLT01: Va TRW 85-98

Age	1985,	1986,	1987,	1988
7	.03,	-.44,	.31,	0.15
8	.12,	-.43,	-.28,	0.04
9	.27,	.16,	-.14,	0.31
10	.33,	.28,	.18,	0.31
11	.32,	.26,	.24,	0.33
12	.22,	.19,	.17,	0.17

Age	1989,	1990,	1991,	1992,	1993,	1994,	1995,	1996,	1997,	1998
7	.26,	-.07,	-.38,	.10,	-.12,	.08,	.02,	-.02,	-.06,	0.12
8	.26,	.22,	-.14,	.04,	.23,	.05,	-.13,	-.22,	-.15,	0.22
9	.40,	.35,	-.16,	-.14,	.09,	-.08,	-.31,	-.46,	-.12,	0.25
10	.48,	.29,	-.23,	.06,	-.08,	-.24,	-.40,	-.42,	-.32,	0.41
11	.26,	-.01,	-.23,	-.07,	-.28,	-.18,	-.38,	-.23,	-.11,	0.63
12	.63,	-.08,	.46,	-.03,	-.08,	-.62,	-.63,	-.34,	.05,	0.42

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

Table 6.6.1.1 Cont'd
Regression statistics

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

Age,	Slope	t-value	Intercept,	RSquare,	No Pts	Reg s.e,	Mean Q
7,	.90,	.464,	6.72,	.71,	14,	.18,	-6.38,
8,	.83,	.977,	6.35,	.78,	14,	.17,	-5.66,
9,	.73,	1.634,	6.44,	.79,	14,	.18,	-5.34,
10,	.76,	1.099,	6.13,	.69,	14,	.25,	-5.22,
11,	1.18,	-.501,	4.61,	.44,	14,	.38,	-5.22,
12,	1.24,	-.493,	4.23,	.30,	14,	.51,	-4.99,

Fleet disaggregated estimates of survivors:

Age 5 Catchability dependent of age and year class strength.

Year class = 1993

FLT01:	Va	TRW	85-98
Age,	5,		
Survivors,	0.,		
Raw weights	.000,		

Fleet,	Estimated,	Int,	Ext,	Var,	N,	Scaled,	Estimated
,	Survivors,	s.e,	s.e,	Ratio,	,	Weights,	F
FLT01: Va TRW 85-98	1.,	.000,	.000,	.00,	0,	.000,	0
P shrinkage mean	24647.,	.26,,,,				.793,	0.003
F shrinkage mean	9862.,	.50,,,,				.207,	0.008

Weighted prediction

Survivors,	Int,	Ext,	N,	Var,	F
at end of year	s.e,	s.e,	,	Ratio,	
20397.,	.23,	9.93,	2,	43.688,	0.004

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

Year class = 1992

FLT01:	Va	TRW	85-98
Age,	6,	5,	
Survivors,	0.,	0.,	
Raw weights	.000,	.000,	

Fleet,	Estimated,	Int,	Ext,	Var,	N,	Scaled,	Estimated
,	Survivors,	s.e,	s.e,	Ratio,	,	Weights,	F
FLT01: Va TRW 85-98	1.,	.000,	.000,	.00,	0,	.000,	0
P shrinkage mean	21010.,	.27,,,,				.775,	0.024
F shrinkage mean	9304.,	.50,,,,				.225,	0.053

Weighted prediction

Survivors,	Int,	Ext,	N,	Var,	F
at end of year	s.e,	s.e,	,	Ratio,	
17493.,	.24,	9.78,	2,	41.224,	0.029

Table 6.6.1.1 Cont'd

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

Year class	=	1991					
FLT01:	Va	TRW	85-98				
Age,	7,	6,	5,				
Survivors,	13047.,	0.,	0.,				
Raw weights	9.656,	.000,	.000,				
Fleet,	Estimated,	Int,	Ext,	Var,	N,	Scaled,	Estimated
,	Survivors,	s.e,	s.e,	Ratio,	,	Weights,	F
FLT01: Va TRW 85-98	13047.,	.300,	.000,	.00,	1,	.707,	0.126
F shrinkage mean	8703.,	.50,,,,				.293,	0.183
Weighted prediction							
Survivors,	Int,	Ext,	N,	Var,	F		
at end of year	s.e,	s.e,	,	Ratio,			
11588.,	.26,	.22,	2,	.850,	0.14		

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

Year class	=	1990					
FLT01:	Va	TRW	85-98				
Age,	8,	7,	6,	5,			
Survivors,	8981.,	6831.,	0.,	0.,			
Raw weights	8.794,	7.099,	.000,	.000,			
Fleet,	Estimated,	Int,	Ext,	Var,	N,	Scaled,	Estimated
,	Survivors,	s.e,	s.e,	Ratio,	,	Weights,	F
FLT01: Va TRW 85-98	7948.,	.213,	.136,	.64,	2,	.799,	0.215
F shrinkage mean	4938.,	.50,,,,				.201,	0.326
Weighted prediction							
Survivors,	Int,	Ext,	N,	Var,	F		
at end of year	end	of	year,	s.e,	s.e,	,	Ratio,
7222.,	.20,	.17,	3,	.878,	0.234		

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

Year class	=	1989					
FLT01:	Va	TRW	85-98				
Age,	9,	8,	7,	6,	5,		
Survivors,	5492.,	3685.,	4207.,	0.,	0.,		
Raw weights	8.173,	6.032,	4.798,	.000,	.000,		
Fleet,	Estimated,	Int,	Ext,	Var,	N,	Scaled,	Estimated
,	Survivors,	s.e,	s.e,	Ratio,	,	Weights,	F
FLT01: Va TRW 85-98	4524.,	.177,	.124,	.70,	3,	.826,	0.293
F shrinkage mean	3270.,	.50,,,,				.174,	0.385
Weighted prediction							
Survivors,	Int,	Ext,	N,	Var,	F		
at end of year	s.e,	s.e,	,	Ratio,			
4276.,	.17,	.12,	4,	.709,	0.307		

Table 6.6.1.1 Cont'd

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

Year class	=	1988					
FLT01:	Va	TRW	85-98				
Age,	10,	9,	8,	7,	6,	5,	
Survivors,	4218.,	2481.,	2240.,	2858.,	0.,	0.,	
Raw weights	6.325,	5.508,	3.962,	3.202,	.000,	.000,	
Fleet,	Estimated,	Int,	Ext,	Var,	N,	Scaled,	Estimated
,	Survivors,	s.e,	s.e,	Ratio,	,	Weights,	F
FLT01: Va TRW 85-98	2968.,	.164,	.150,	.91,	4,	.826,	0.288
F shrinkage mean	2144.,	.50,,,,				.174,	0.38
Weighted prediction							
Survivors,	Int,	Ext,	N,	Var,	F		
at end of year	s.e,	s.e,	,	Ratio,			
2805.,	.16,	.14,	5,	.843,	0.302		

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

Year class	=	1987					
FLT01:	Va	TRW	85-98				
Age,	11,						
Survivors,	3166.,						
Raw weights	6.955,						
Age,	10,	9,	8,	7,	6,	5,	
Survivors,	1228.,	1073.,	1493.,	1840.,	0.,	0.,	
Raw weights	4.295,	3.884,	2.750,	2.327,	.000,	.000,	
Fleet,	Estimated,	Int,	Ext,	Var,	N,	Scaled,	Estimated
,	Survivors,	s.e,	s.e,	Ratio,	,	Weights,	F
FLT01: Va TRW 85-98	1783.,	.154,	.222,	1.44,	5,	.835,	0.325
F shrinkage mean	1303.,	.50,,,,				.165,	0.422
Weighted prediction							
Survivors,	Int,	Ext,	N,	Var,	F		
at end of year	s.e,	s.e,	,	Ratio,			
1693.,	.15,	.19,	6,	1.245,	0.339		

Table 6.6.1.1 Cont'd

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

Year class = 1986

FLT01:	Va	TRW	85-98				
Age,	12,	11,					
Survivors,	1264.,	748.,					
Raw weights	3.285,	3.580,					
Age,	10,	9,	8,	7,	6,	5,	
Survivors,	549.,	611.,	878.,	739.,	0.,	0.,	
Raw weights	2.043,	1.824,	1.297,	1.132,	.000,	.000,	

Fleet,	Estimated,	Int,	Ext,	Var,	N,	Scaled,	Estimated
,	Survivors,	s.e,	s.e,	Ratio,	,	Weights,	F
FLT01: Va TRW 85-98	802.,	.156,	.132,	.84,	6,	.767,	0.6
F shrinkage mean	941.,	.50,,,,				.233,	0.531

Weighted prediction

Survivors,	Int,	Ext,	N,	Var,	F
at end of year	s.e,	s.e,	,	Ratio,	
832.,	.17,	.11,	7,	.659,	0.583

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

Year class = 1985

FLT01:	Va	TRW	85-98				
Age,	13,	12,	11,				
Survivors,	0.,	503.,	383.,				
Raw weights	.000,	1.807,	1.749,				
Age,	10,	9,	8,	7,	6,	5,	
Survivors,	320.,	444.,	606.,	530.,	0.,	0.,	
Raw weights	1.060,	.914,	.644,	.567,	.000,	.000,	

Fleet,	Estimated,	Int,	Ext,	Var,	N,	Scaled,	Estimated
,	Survivors,	s.e,	s.e,	Ratio,	,	Weights,	F
FLT01: Va TRW 85-98	439.,	.159,	.088,	.55,	6,	.628,	0.565
F shrinkage mean	556.,	.50,,,,				.372,	0.469

Weighted prediction

Survivors,	Int,	Ext,	N,	Var,	F
at end of year	s.e,	s.e,	,	Ratio,	
479.,	.21,	.09,	7,	.411,	0.528

Table 6.6.1.1 Cont'd

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

Year class = 1984

FLT01:	Va	TRW	85-98			
Age,	14,	13,	12,	11,		
Survivors,	0.,	0.,	183.,	175.,		
Raw weights	.000,	.000,	.836,	.911,		
Age,	10,	9,	8,	7,	6,	5,
Survivors,	201.,	279.,	267.,	174.,	0.,	0.,
Raw weights	.548,	.467,	.372,	.327,	.000,	.000,

Fleet,	Estimated,	Int,	Ext,	Var,	N,	Scaled,	Estimated
,	Survivors,	s.e,	s.e,	Ratio,	,	Weights,	F
FLT01:	201.,	.154,	.081,	.52,	6,	.464,	0.641
FLT01: Va TRW 85-98	314.,	.50,,,,				.536,	0.455

Weighted prediction

Survivors,	Int,	Ext,	N,	Var,	F
at end of year	s.e,	s.e,	,	Ratio,	
255.,	.28,	.14,	7,	.511,	0.536

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

Year class = 1983

FLT01:	Va	TRW	85-98			
Age,	15,	14,	13,	12,	11,	
Survivors,	0.,	0.,	0.,	106.,	167.,	
Raw weights	.000,	.000,	.000,	.660,	.722,	
Age,	10,	9,	8,	7,	6,	5,
Survivors,	185.,	174.,	174.,	186.,	0.,	0.,
Raw weights	.419,	.418,	.334,	.292,	.000,	.000,

Fleet,	Estimated,	Int,	Ext,	Var,	N,	Scaled,	Estimated
,	Survivors,	s.e,	s.e,	Ratio,	,	Weights,	F
FLT01: Va TRW 85-98	156.,	.153,	.096,	.63,	6,	.416,	0.638
F shrinkage mean	238.,	.50,,,,				.584,	0.46

Weighted prediction

Survivors,	Int,	Ext,	N,	Var,	F
at end of year	s.e,	s.e,	,	Ratio,	
200.,	.30,	.14,	7,	.481,	0.529

Figure 6.6.1.2 Fishing mortality (F) at age

Terminal Fs derived using XSA (with shrinkage)

YEAR,	1975,	1976,	1977,	1978,
AGE				
5,	.0053,	.0018,	.0000,	.0009,
6,	.0480,	.0153,	.0017,	.0044,
7,	.1515,	.0426,	.0415,	.0198,
8,	.2564,	.0688,	.1619,	.0791,
9,	.2990,	.0857,	.3640,	.1549,
10,	.3559,	.0803,	.2245,	.2095,
11,	.2382,	.0671,	.1864,	.2217,
12,	.3647,	.0597,	.3311,	.1946,
13,	.7896,	.0421,	.1561,	.2879,
14,	.6760,	.1747,	.1767,	.2822,
15,	.4876,	.0849,	.2157,	.2400,
+gp,	.4876,	.0849,	.2157,	.2400,
FBAR 8-12	.3028,	.0723,	.2536,	.1720,

Fishing mortality (F) at age

YEAR,	1979,	1980,	1981,	1982,	1983,	1984,	1985,	1986,	1987,	1988,
AGE										
5,	.0009,	.0012,	.0007,	.0003,	.0004,	.0028,	.0030,	.0058,	.0048,	.0040,
6,	.0090,	.0183,	.0049,	.0094,	.0090,	.0118,	.0173,	.0170,	.0897,	.0231,
7,	.0941,	.0858,	.0251,	.0420,	.0611,	.0397,	.0522,	.0487,	.1728,	.0749,
8,	.1636,	.2080,	.0818,	.1334,	.1233,	.1022,	.1294,	.1265,	.1567,	.1445,
9,	.3352,	.3377,	.1579,	.2561,	.2319,	.2296,	.2254,	.2339,	.1911,	.2763,
10,	.3167,	.4277,	.3057,	.4175,	.3756,	.3251,	.2627,	.3057,	.4412,	.4105,
11,	.3299,	.5883,	.4256,	.5527,	.5361,	.5037,	.2632,	.2404,	.2847,	.4193,
12,	.2236,	.5763,	.4390,	.6106,	.6257,	.8031,	.3030,	.2201,	.4202,	.4539,
13,	.2191,	.5571,	.6237,	.8849,	.5629,	.9350,	.7637,	.4473,	.3697,	.9520,
14,	.3794,	.4370,	.4743,	1.4499,	.6392,	1.3935,	.5427,	1.0106,	.3419,	.5297,
15,	.2949,	.5203,	.4561,	.7889,	.5512,	.7979,	.4292,	.4471,	.3733,	.5463,
+gp,	.2949,	.5203,	.4561,	.7889,	.5512,	.7979,	.4292,	.4471,	.3733,	.5463,
FBAR 8-12	.2738,	.4276,	.2820,	.3941,	.3785,	.3927,	.2367,	.2253,	.2988,	.3409,

Fishing mortality (F) at age

YEAR,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	FBAR 96-98
AGE											
5,	.0154,	.0058,	.0117,	.0008,	.0019,	.0037,	.0239,	.0088,	.0038,	.0041,	.0056,
6,	.0619,	.0169,	.0449,	.0202,	.0218,	.0349,	.0909,	.0866,	.0323,	.0288,	.0492,
7,	.1794,	.0701,	.0798,	.0923,	.1128,	.1528,	.2059,	.2262,	.2137,	.1403,	.1934,
8,	.3017,	.1971,	.1742,	.1927,	.3273,	.3272,	.3384,	.3268,	.3033,	.2339,	.2880,
9,	.4288,	.3388,	.2374,	.2284,	.3965,	.3955,	.3673,	.3589,	.3991,	.3071,	.3551,
10,	.4764,	.4143,	.2641,	.3860,	.3887,	.3633,	.3614,	.4262,	.3499,	.3023,	.3595,
11,	.3831,	.3111,	.2414,	.4038,	.3272,	.4021,	.4127,	.5360,	.4201,	.3392,	.4317,
12,	.6492,	.3929,	.4643,	.4443,	.5378,	.3415,	.4773,	.6278,	.6529,	.5829,	.6212,
13,	.6326,	.5339,	.7738,	.3944,	.3466,	.2841,	.3766,	.5405,	.7855,	.5277,	.6179,
14,	.7038,	.3521,	1.6076,	.2376,	.1626,	.3710,	.5137,	.5855,	.6319,	.5357,	.5844,
15,	.5431,	.3876,	.6318,	.3585,	.3455,	.2923,	.4119,	.5415,	.6460,	.5286,	.5720,
+gp,	.5431,	.3876,	.6318,	.3585,	.3455,	.2923,	.4119,	.5415,	.6460,	.5286,	
FBAR 8-12	.4479,	.3309,	.2763,	.3310,	.3955,	.3659,	.3914,	.4551,	.4251,	.3531,	

Table 6.6.1.3 Stock number at age (start of the year). Numbers * 10^{-3}

Terminal Fs derived using XSA (with shrinkage)

YEAR,	1975,	1976,	1977,	1978,
AGE				
5,	24536,	25824,	26124,	27466,
6,	18407,	21007,	22187,	22485,
7,	13606,	15101,	17807,	19065,
8,	8494,	10064,	12455,	14704,
9,	5252,	5658,	8086,	9118,
10,	3333,	3352,	4470,	4836,
11,	2360,	2010,	2663,	3073,
12,	1619,	1601,	1617,	1902,
13,	551,	968,	1298,	1000,
14,	423,	215,	798,	956,
15,	383,	185,	156,	576,
+gp,	236,	119,	781,	1026,
TOTAL,	79199,	86103,	98441,	106207,

Stock number at age (start of the year)

YEAR,	1979,	1980,	1981,	1982,	1983,	1984,	1985,	1986,	1987,	1988,
AGE										
5,	34680,	40553,	39978,	33579,	29460,	32277,	45484,	45872,	40868,	34714,
6,	23619,	29822,	34860,	34385,	28895,	25347,	27704,	39032,	39255,	35007,
7,	19269,	20146,	25203,	29858,	29317,	24647,	21560,	23436,	33027,	30890,
8,	16088,	15096,	15915,	21154,	24641,	23739,	20387,	17612,	19213,	23915,
9,	11694,	11756,	10553,	12622,	15934,	18750,	18448,	15418,	13357,	14138,
10,	6722,	7198,	7219,	7756,	8409,	10875,	12828,	12674,	10503,	9497,
11,	3376,	4215,	4039,	4577,	4397,	4971,	6763,	8491,	8035,	5815,
12,	2119,	2089,	2014,	2272,	2266,	2214,	2586,	4474,	5747,	5203,
13,	1348,	1459,	1010,	1118,	1062,	1043,	854,	1644,	3090,	3249,
14,	645,	932,	719,	466,	397,	520,	353,	342,	905,	1837,
15,	620,	380,	518,	385,	94,	180,	111,	176,	107,	553,
+gp,	525,	306,	465,	258,	119,	39,	141,	101,	17,	625,
TOTAL,	120704,	133951,	142494,	148430,	144992,	144604,	157218,	169272,	174125,	165444,

Stock number at age (start of the year)

YEAR,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	GMST
AGE												
5,	35194,	35105,	26709,	23069,	24588,	22968,	22994,	21791,	24394,	23795,	0,	30698,
6,	29759,	29829,	30041,	22721,	19840,	21122,	19697,	19325,	18591,	20916,	20397,	26286,
7,	29442,	24077,	25244,	24720,	19165,	16708,	17557,	15481,	15252,	15492,	17493,	21845,
8,	24668,	21180,	19319,	20061,	19400,	14737,	12342,	12299,	10626,	10602,	11588,	16939,
9,	17815,	15702,	14969,	13969,	14240,	12037,	9145,	7574,	7635,	6754,	7222,	11885,
10,	9231,	9987,	9631,	10161,	9569,	8245,	6976,	5451,	4553,	4409,	4276,	7633,
11,	5422,	4934,	5680,	6366,	5945,	5584,	4935,	4183,	3064,	2762,	2805,	4609,
12,	3291,	3181,	3111,	3840,	3659,	3689,	3215,	2811,	2106,	1732,	1693,	2740,
13,	2844,	1480,	1849,	1683,	2120,	1839,	2257,	1717,	1292,	944,	832,	1469,
14,	1079,	1300,	747,	734,	977,	1290,	1191,	1333,	861,	507,	479,	727,
15,	931,	460,	787,	129,	498,	714,	766,	614,	639,	394,	255,	338,
+gp,	370,	203,	187,	199,	51,	749,	736,	1287,	1571,	618,	513,	
TOTAL,	160047,	147438,	138274,	127651,	120051,	109682,	101810,	93865,	90584,	88923,	67554,	

Table 6.6.1.4 Summary (without SOP correction)

,	RECRUITS, Age 5	TOTALBIO,	TOTSPBIO,	LANDINGS,	YIELD/SSB	FBAR 8-12,
1975,	24536,	122673,	46780,	23494,	.5022,	.3028,
1976,	25824,	158171,	53957,	6045,	.1120,	.0723,
1977,	26124,	159829,	65043,	16578,	.2549,	.2536,
1978,	27466,	176092,	75982,	14349,	.1888,	.1720,
1979,	34680,	175704,	76641,	23616,	.3081,	.2738,
1980,	40553,	212485,	79079,	31252,	.3952,	.4276,
1981,	39978,	213780,	73197,	19239,	.2628,	.2820,
1982,	33579,	246234,	80005,	32441,	.4055,	.3941,
1983,	29460,	239600,	72360,	30888,	.4269,	.3785,
1984,	32277,	243100,	83825,	34024,	.4059,	.3927,
1985,	45484,	266129,	96129,	32075,	.3337,	.2367,
1986,	45872,	283589,	104835,	32984,	.3146,	.2253,
1987,	40868,	296613,	116203,	46622,	.4012,	.2988,
1988,	34714,	298505,	121452,	51118,	.4209,	.3409,
1989,	35194,	263381,	111079,	61396,	.5527,	.4479,
1990,	35105,	251572,	96871,	39326,	.4060,	.3309,
1991,	26709,	237178,	105746,	37950,	.3589,	.2763,
1992,	23069,	218883,	85484,	35423,	.4144,	.3310,
1993,	24588,	208651,	87105,	40817,	.4686,	.3955,
1994,	22968,	196008,	80997,	36958,	.4563,	.3659,
1995,	22994,	169761,	93049,	36300,	.3901,	.3914,
1996,	21791,	155619,	82340,	35826,	.4351,	.4551,
1997,	24394,	139439,	68166,	30267,	.4440,	.4251,
1998,	23795,	126001,	55690,	20493,	.3680,	.3531,
Arith. Mean	30918,	210792,	83834,	32062,	.3761,	.3260,
Units,	(Thousands),	(Tonnes),	(Tonnes),	(Tonnes),		

Table 6.7.1.1

Greenland halibut (Fishing Areas V and XIV)

Prediction with management option table: Input data

Year: 1999								
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	25000.000	0.1500	0.2660	0.0000	0.0000	0.939	0.0050	0.939
6	20397.000	0.1500	0.3060	0.0000	0.0000	1.094	0.0420	1.094
7	17493.000	0.1500	0.3740	0.0000	0.0000	1.341	0.1660	1.341
8	11588.000	0.1500	0.4340	0.0000	0.0000	1.661	0.2470	1.661
9	7222.000	0.1500	0.5070	0.0000	0.0000	1.921	0.3050	1.921
10	4276.000	0.1500	0.5660	0.0000	0.0000	2.287	0.3090	2.287
11	2805.000	0.1500	0.6630	0.0000	0.0000	2.559	0.3710	2.559
12	1693.000	0.1500	0.7290	0.0000	0.0000	2.924	0.5340	2.924
13	832.000	0.1500	0.8410	0.0000	0.0000	3.423	0.5310	3.423
14	479.000	0.1500	0.9280	0.0000	0.0000	4.276	0.5020	4.276
15	255.000	0.1500	0.9590	0.0000	0.0000	4.959	0.4910	4.959
16+	513.000	0.1500	0.9660	0.0000	0.0000	5.312	0.4910	5.312
Unit	Thousands	-	-	-	-	Kilograms	-	Kilograms

Year: 2000								
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	25000.000	0.1500	0.2660	0.0000	0.0000	0.939	0.0050	0.939
6	.	0.1500	0.3060	0.0000	0.0000	1.094	0.0420	1.094
7	.	0.1500	0.3740	0.0000	0.0000	1.341	0.1660	1.341
8	.	0.1500	0.4340	0.0000	0.0000	1.661	0.2470	1.661
9	.	0.1500	0.5070	0.0000	0.0000	1.921	0.3050	1.921
10	.	0.1500	0.5660	0.0000	0.0000	2.287	0.3090	2.287
11	.	0.1500	0.6630	0.0000	0.0000	2.559	0.3710	2.559
12	.	0.1500	0.7290	0.0000	0.0000	2.924	0.5340	2.924
13	.	0.1500	0.8410	0.0000	0.0000	3.423	0.5310	3.423
14	.	0.1500	0.9280	0.0000	0.0000	4.276	0.5020	4.276
15	.	0.1500	0.9590	0.0000	0.0000	4.959	0.4910	4.959
16+	.	0.1500	0.9660	0.0000	0.0000	5.312	0.4910	5.312
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	25000.000	0.1500	0.2660	0.0000	0.0000	0.939	0.0050	0.939
6	.	0.1500	0.3060	0.0000	0.0000	1.094	0.0420	1.094
7	.	0.1500	0.3740	0.0000	0.0000	1.341	0.1660	1.341
8	.	0.1500	0.4340	0.0000	0.0000	1.661	0.2470	1.661
9	.	0.1500	0.5070	0.0000	0.0000	1.921	0.3050	1.921
10	.	0.1500	0.5660	0.0000	0.0000	2.287	0.3090	2.287
11	.	0.1500	0.6630	0.0000	0.0000	2.559	0.3710	2.559
12	.	0.1500	0.7290	0.0000	0.0000	2.924	0.5340	2.924
13	.	0.1500	0.8410	0.0000	0.0000	3.423	0.5310	3.423
14	.	0.1500	0.9280	0.0000	0.0000	4.276	0.5020	4.276
15	.	0.1500	0.9590	0.0000	0.0000	4.959	0.4910	4.959
16+	.	0.1500	0.9660	0.0000	0.0000	5.312	0.4910	5.312
Unit	Thousands	-	-	-	-	Kilograms	-	Kilograms

Notes: Run name : MANEHJ05
Date and time: 30APR99:16:13

Table 6.7.1.2

Greenland halibut (Fishing 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	0.0800	0.0000	0.0000	1012.000	0.0050	1012.000
6	.	0.1500	0.1520	0.0000	0.0000	1218.000	0.0324	1218.000
7	.	0.1500	0.2700	0.0000	0.0000	1476.000	0.1095	1476.000
8	.	0.1500	0.4080	0.0000	0.0000	1791.000	0.2102	1791.000
9	.	0.1500	0.5750	0.0000	0.0000	2148.000	0.3086	2148.000
10	.	0.1500	0.7260	0.0000	0.0000	2491.000	0.3697	2491.000
11	.	0.1500	0.8390	0.0000	0.0000	2869.000	0.3897	2869.000
12	.	0.1500	0.9180	0.0000	0.0000	3363.000	0.4873	3363.000
13	.	0.1500	0.9670	0.0000	0.0000	4042.000	0.5771	4042.000
14	.	0.1500	0.9880	0.0000	0.0000	4747.000	0.6413	4747.000
15	.	0.1500	0.9930	0.0000	0.0000	5352.000	0.4929	5352.000
Unit	Numbers	-	-	-	-	Grams	-	Grams

Notes: Run name : YLDEHJ03
Date and time: 04MAY99:12:18

Table 6.7.3.1

Greenland halibut (Fishing Areas V and XIV)

Prediction with management option table

Year: 1999					Year: 2000					Year: 2001	
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
0.9275	0.3276	133162	59277	20000	0.0000	0.0000	137435	60987	0	163381	76797
.	.	.	.	.	0.0500	0.0177	.	60987	1275	161999	75916
.	.	.	.	.	0.1000	0.0353	.	60987	2531	160640	75051
.	.	.	.	.	0.1500	0.0530	.	60987	3767	159302	74201
.	.	.	.	.	0.2000	0.0706	.	60987	4983	157986	73367
.	.	.	.	.	0.2500	0.0883	.	60987	6181	156690	72547
.	.	.	.	.	0.3000	0.1060	.	60987	7360	155415	71741
.	.	.	.	.	0.3500	0.1236	.	60987	8521	154159	70950
.	.	.	.	.	0.4000	0.1413	.	60987	9664	152924	70172
.	.	.	.	.	0.4500	0.1589	.	60987	10789	151708	69408
.	.	.	.	.	0.5000	0.1766	.	60987	11898	150510	68657
.	.	.	.	.	0.5500	0.1943	.	60987	12989	149332	67919
.	.	.	.	.	0.6000	0.2119	.	60987	14064	148171	67194
.	.	.	.	.	0.6500	0.2296	.	60987	15122	147029	66482
.	.	.	.	.	0.7000	0.2472	.	60987	16165	145904	65781
.	.	.	.	.	0.7500	0.2649	.	60987	17192	144797	65093
.	.	.	.	.	0.8000	0.2826	.	60987	18203	143707	64417
.	.	.	.	.	0.8500	0.3002	.	60987	19199	142633	63752
.	.	.	.	.	0.9000	0.3179	.	60987	20180	141575	63098
.	.	.	.	.	0.9500	0.3355	.	60987	21147	140534	62456
.	.	.	.	.	1.0000	0.3532	.	60987	22099	139509	61824
.	.	.	.	.	1.0500	0.3709	.	60987	23037	138499	61203
.	.	.	.	.	1.1000	0.3885	.	60987	23962	137504	60593
.	.	.	.	.	1.1500	0.4062	.	60987	24872	136524	59993
.	.	.	.	.	1.2000	0.4238	.	60987	25770	135559	59403
.	.	.	.	.	1.2500	0.4415	.	60987	26654	134608	58822
.	.	.	.	.	1.3000	0.4592	.	60987	27525	133672	58252
.	.	.	.	.	1.3500	0.4768	.	60987	28384	132749	57691
.	.	.	.	.	1.4000	0.4945	.	60987	29230	131840	57139
.	.	.	.	.	1.4500	0.5121	.	60987	30064	130945	56596
.	.	.	.	.	1.5000	0.5298	.	60987	30886	130063	56063
-	-	Tonnes	Tonnes	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes

Notes: Run name : MANEHJ05
Date and time : 30APR99:16:13
Computation of ref. F: Simple mean, age 8 - 12
Basis for 1999 : TAC constraints

Table 6.7.3.2

Greenland halibut (Fishing Areas V and XIV)

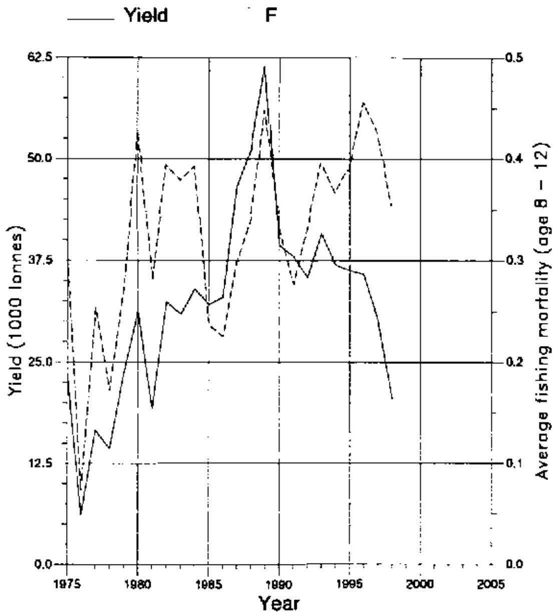
Yield per recruit: Summary table

						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	12636.817	2.761	8171.489	2.761	8171.489
0.0500	0.0177	0.059	182.715	5.634	11998.894	2.614	7582.363	2.614	7582.363
0.1000	0.0353	0.111	334.863	5.482	11423.257	2.480	7053.335	2.480	7053.335
0.1500	0.0530	0.156	461.519	5.343	10902.796	2.358	6577.445	2.358	6577.445
0.2000	0.0706	0.195	566.916	5.215	10431.278	2.248	6148.595	2.248	6148.595
0.2500	0.0883	0.229	654.589	5.097	10003.232	2.146	5761.440	2.146	5761.440
0.3000	0.1059	0.260	727.483	4.988	9613.855	2.053	5411.291	2.053	5411.291
0.3500	0.1236	0.287	788.057	4.887	9258.922	1.968	5094.029	1.968	5094.029
0.4000	0.1412	0.310	838.364	4.794	8934.717	1.890	4806.031	1.890	4806.031
0.4500	0.1589	0.332	880.114	4.707	8637.964	1.818	4544.112	1.818	4544.112
0.5000	0.1765	0.350	914.734	4.627	8365.775	1.751	4305.465	1.751	4305.465
0.5500	0.1942	0.367	943.414	4.552	8115.599	1.690	4087.614	1.690	4087.614
0.6000	0.2119	0.383	967.148	4.481	7885.183	1.633	3888.376	1.633	3888.376
0.6500	0.2295	0.397	986.762	4.416	7672.532	1.580	3705.819	1.580	3705.819
0.7000	0.2472	0.409	1002.948	4.354	7475.877	1.531	3538.235	1.531	3538.235
0.7500	0.2648	0.421	1016.280	4.296	7293.651	1.485	3384.112	1.485	3384.112
0.8000	0.2825	0.431	1027.237	4.241	7124.462	1.442	3242.108	1.442	3242.108
0.8500	0.3001	0.441	1036.221	4.190	6967.070	1.402	3111.032	1.402	3111.032
0.9000	0.3178	0.450	1043.563	4.141	6820.372	1.365	2989.826	1.365	2989.826
0.9500	0.3354	0.458	1049.541	4.095	6683.386	1.330	2877.548	1.330	2877.548
1.0000	0.3531	0.466	1054.387	4.052	6555.233	1.297	2773.358	1.297	2773.358
1.0500	0.3708	0.473	1058.293	4.010	6435.128	1.266	2676.508	1.266	2676.508
1.1000	0.3884	0.480	1061.420	3.971	6322.368	1.237	2586.329	1.237	2586.329
1.1500	0.4061	0.486	1063.900	3.933	6216.323	1.209	2502.221	1.209	2502.221
1.2000	0.4237	0.492	1065.845	3.898	6116.427	1.183	2423.649	1.183	2423.649
1.2500	0.4414	0.498	1067.348	3.864	6022.171	1.159	2350.132	1.159	2350.132
1.3000	0.4590	0.503	1068.484	3.831	5933.098	1.135	2281.238	1.135	2281.238
1.3500	0.4767	0.508	1069.319	3.800	5848.794	1.113	2216.579	1.113	2216.579
1.4000	0.4943	0.513	1069.905	3.770	5768.886	1.092	2155.804	1.092	2155.804
1.4500	0.5120	0.518	1070.286	3.742	5693.037	1.072	2098.599	1.072	2098.599
1.5000	0.5297	0.522	1070.498	3.714	5620.942	1.053	2044.678	1.053	2044.678
1.5500	0.5473	0.526	1070.573	3.688	5552.322	1.035	1993.784	1.035	1993.784
1.6000	0.5650	0.530	1070.536	3.662	5486.928	1.018	1945.683	1.018	1945.683
1.6500	0.5826	0.534	1070.406	3.638	5424.529	1.002	1900.164	1.002	1900.164
1.7000	0.6003	0.538	1070.202	3.614	5364.917	0.986	1857.035	0.986	1857.035
1.7500	0.6179	0.542	1069.938	3.591	5307.902	0.971	1816.120	0.971	1816.120
1.8000	0.6356	0.545	1069.625	3.569	5253.309	0.956	1777.261	0.956	1777.261
1.8500	0.6532	0.548	1069.274	3.548	5200.981	0.943	1740.313	0.943	1740.313
1.9000	0.6709	0.551	1068.892	3.528	5150.770	0.929	1705.142	0.929	1705.142
1.9500	0.6885	0.555	1068.487	3.508	5102.544	0.917	1671.628	0.917	1671.628
2.0000	0.7062	0.558	1068.063	3.489	5056.179	0.904	1639.660	0.904	1639.660
-	-	Numbers	Grams	Numbers	Grams	Numbers	Grams	Numbers	Grams

Notes: Run name : YLDEHJ03
Date and time : 04MAY99:12:18
Computation of ref. F: Simple mean, age 8 - 12
F-0.1 factor : 0.6196
F-max factor : 1.5567
F-0.1 reference F : 0.2188
F-max reference F : 0.5497
Recruitment : Single recruit

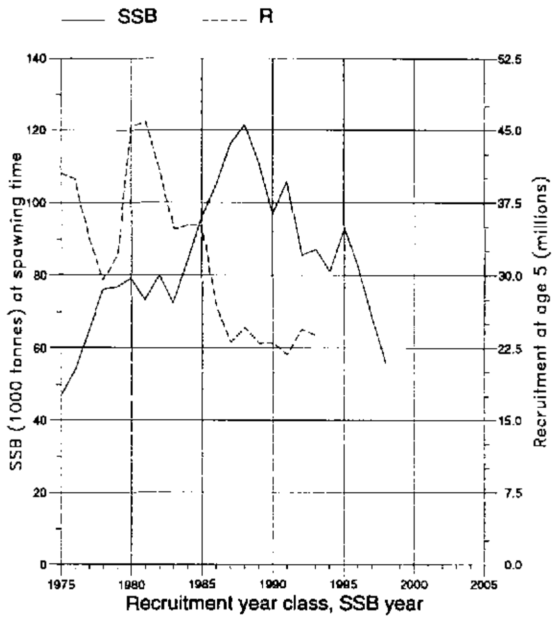
Figure 6.6.1.1 Fish Stock Summary – Greenland Halibut (Fishing Areas V and XIV)

Yield and fishing mortality



(run: XSAEHJ02) **A**

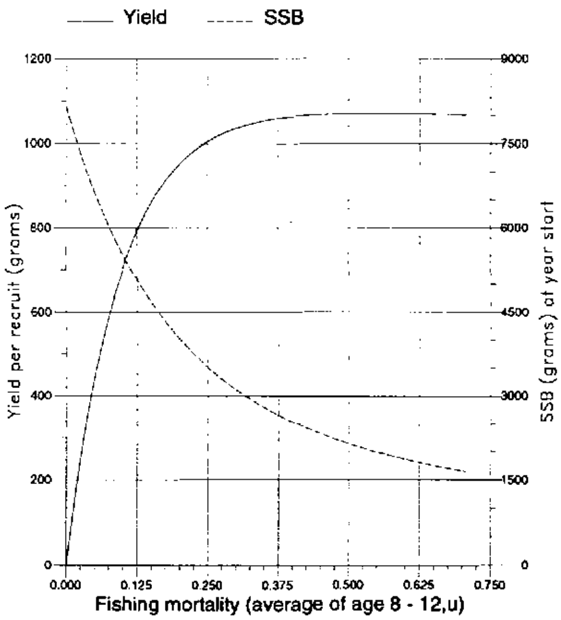
Spawning stock and recruitment



(run: XSAEHJ02) **B**

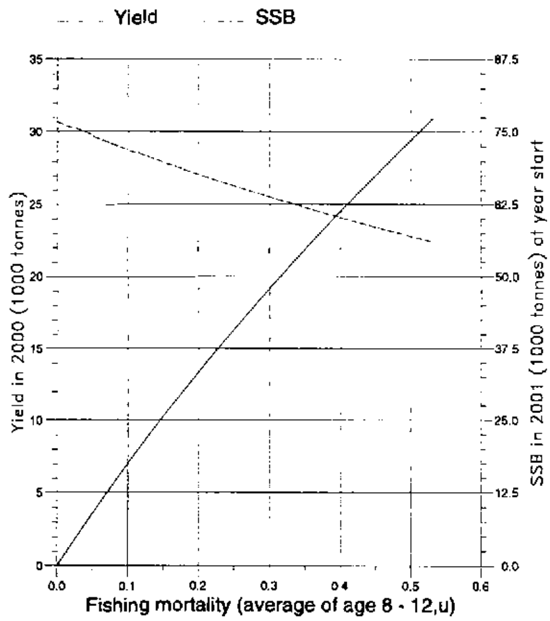
Figure 6.6.1.1 (Cont'd)

Long term yield and spawning stock biomass



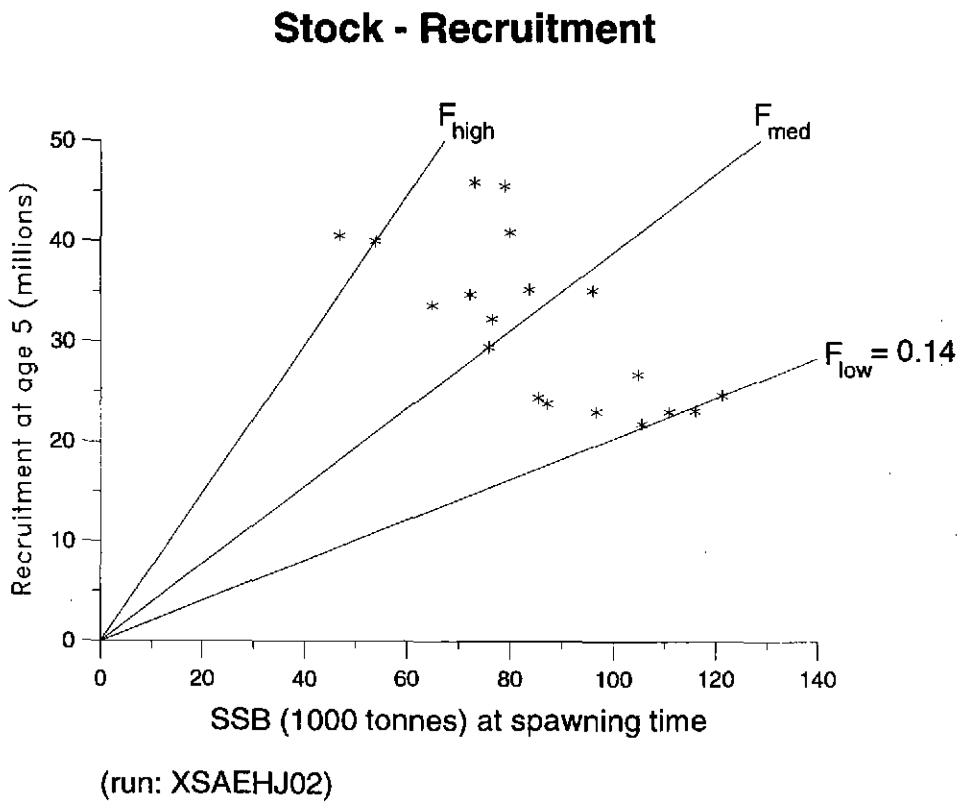
(run: YLDEHJ03) **C**

Short term yield and spawning stock biomass



(run: MANEHJ05) **D**

Figure 6.8.1 Greenland Halibut (Fishing Areas V and XIV)



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 (Magnússon and Magnússon, 1995). 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 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 catches of *S. viviparus* in 1997 were 1,160 t and 994 t in 1998.

In the stocks 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. Due to uncertainties related to the stock identification of "Giants", NWWG concluded 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* inhabit in 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*".

There has been a strong controversy about whether these types are more than one stock and different hypotheses have been put forward:

The **single stock hypothesis** suggests that all redfish from Faroes Island to Greenland, 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 types constitutes a distinct stock.

At the present NWWG-meeting the draft summary of the ICES WGAGFM (12-15 April 1999, Reykjavik) was presented, based on preliminary results of genetic studies on the stock structure of *S. mentella* in the Irminger Sea (WD 8). It was stated, that:

"Significant differences in allele frequencies based on preliminary studies on three polymorphic isozyme loci ...and three polymorphic microsatellite loci ... of the deep-sea and oceanic *S. mentella* types in the Irminger Sea indicate that the two types represent separate genetic stocks.

Differences between Icelandic and Irminger Sea deep-sea *S. mentella* are less but significant indicating also probably distinct genetic stocks.

Heterogeneity among samples of deep-sea and oceanic types *S. mentella* in the Irminger Sea, respectively, could indicate sub-structuring within each group and awaits further study....".

Based on the information given above, 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 have been clarified, treated in such way that each of the possible components will not be overexploited.

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 were described in 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 but 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, 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 (Rätz, WD 14). 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.

Juvenile redfish are caught both off West and East Greenland during the Greenland trawl survey (directed towards shrimp), which were conducted since 1992 off West Greenland and during1992–96 off East Greenland (Engelstoft, WD 20 in ICES CM 1997/A:13). The survey was discontinued off East Greenland after 1996. Abundance estimates were quite variable off West Greenland but indicated also a significant increase in abundance off East Greenland.

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 1998.

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 where ever it takes places.

The Working Group suggest the following measures for prevent young redfish by-catch and discards:

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

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

Table 7.2.1. REDFISH. Nominal catches (tonnes) by countries, in Division Va 1985-1998, as officially reported to ICES.

Country	1985	1986	1987	1988	1989	1990	1991
Belgium	400	423	398	372	190	70	146
Faroe Islands	291	144	332	372	394	624	412
Germany	-	-	-	-	-	-	-
Iceland	91,381	85,992	87,768	93,995	91,536	90,891	96,770
Norway	8	2	7	7	1	-	-
Total	92,080	86,561	88,505	94,746	92,121	91,585	97,328
WG estimate	*92,080*	*86,670*	*88,505*	*94,762*	*92,121*	*91,585*	*97,328*

Country	1992	1993	1994	1995	1996	1997	1998 [1]
Belgium	107	96	50	-	-	-	-
Faroe Islands	389	438	202	521	309	242	
Germany	-	-	46	229	233	-	284
Iceland [2]	94,382	96,577	95,091	89,474	67,757	73,976	68,164
Norway	-	-	-	-	134 [1]	-	-
Total	94,878	97,111	95,389	90,224	68,433	74,218	68,448
WG estimate	*96,846*	*99,714*	*110,861*	*91,767*	*72,909*	*89,519*	*112,646*

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 1985-1998, as officially reported to ICES.

Country	1985	1986	1987	1988	1989	1990	1991
Denmark	-	36	176	8	-	+	-
Faroe Islands	12,634	15,224	13,477	12,966	12,636	10,017	14,090
France	1,157	752	819	582	996	909	473
Germany [2]	5,091	5,142	3,060	1,595	1,191	441	447
Iceland	-	-	-		21		
Norway	4	2	5	5	-	21	20
UK (Engl. and Wales)	-	-	-		-	+	3
Total	18,886	21,156	17,537	15,156	14,844	11,388	15,033
WG estimates	*19,754*	*21,476*	*17,538*	*15,508*	*15,068*	*11,737*	*15,037*

Country	1992	1993	1994	1995	1996	1997	1998 [1]
Denmark	-	-	-	-	-	-	
Faroe Islands	15,279	9,687	8,872	7,978	7,286	7,199	
France [1]	114	32	90	111	62	98	110
Germany [2]	450	239	155	91	189	36	-
Norway	34	16	34	36	35 [1]	25 [1]	38
Russia	15	44	3	-	-	-	-
UK (E/W/NI)	21	28	1	2	40	+	
UK (Scotland)	8	1	18	24	43	36	
United Kingdom							30
Total	15,921	10,047	9,173	8,242	7,655	7,394	178
WG estimates	*15,993*	*10,422*	*9,173*	*8,251*	*7,655*	*7,397*	*6,654*

1) Provisional
2) Former GDR and GFR until 1991

Table 7.2.3 REDFISH. Nominal catches (tonnes) by countries, in Sub-area VI 1985-1998, as officially reported to ICES.

Country	1985	1986	1987	1988	1989	1990	1991
Faroe Islands	18	-	-	1	61	-	22
France	397	480	1,032	1,024	726	684	483
Germany	76	24	-	16	1	6	8
Ireland	-	-	-	-	-	-	-
Norway	-	14	2	1	2	5	+
Spain	-	-	-	-			
UK (Engl. and Wales)	1	2	3	75	1	29	12
UK (Scotland)	-	10	17	6	6	6	40
Total	492	530	1,054	1,123	797	730	565
WG estimates	*492*	*530*	*1,054*	*1,123*	*797*	*730*	*565*

Country	1992	1993	1994	1995	1996	1997	1998 [1]
Faroe Islands	6	-	-	2		12	
France [1]	127	268	555	529	489	395	297
Germany	-	77	87	5	9	1	1
Ireland	1	1	-	4		10	
Norway	4	3	2	1	6[1]	5[1]	3
UK (E/W/NI)	4	4	9	105	54	19	
UK (Scotland)	32	94	118	500	603	518	
United Kingdom							377
Total	174	447	771	1,146	1,161	960	678
WG estimates	*174*	*447*	*771*	*1,146*	*1,711*	*960*	*678*

1) Provisional

Table 7.2.4 REDFISH. Nominal catches (tonnes) by countries, in Sub-area XII 1985-1998, as officially reported to ICES and/or FAO.

Country	1985	1986	1987	1988	1989	1990	1991
Bulgaria	-	-	-	-	-	1,617	-
Estonia	-	-	-	-	-	-	-
Faroe Islands	-	-	-	-	-	-	-
France							
Germany	-	-	-	-	353	7	62
Greenland	-	-	-	-	567	-	-
Iceland	-	-	-	-	-	185	95
Latvia	-	-	-	-	-	-	-
Lithuania	-	-	-	-	-	-	-
Netherlands							
Norway	-	-	-	-	-	249	726
Poland	-	-	-	-	112	-	-
Portugal							
Russia[2]	17,300	24,131	2,948	9,772	15,543	4,274	6,624
Spain							
UK(E/WNI)							
UK (Scotland)	-	-	-	-	-	-	-
Ukraine	-	-	-		-	-	-
Total	17,300	24,131	2,948	9,772	16,575	6,332	7,507
WG estimates	*17,300*	*24,131*	*2,948*	*9,772*	*17,233*	*7,039*	*10,061*

Country	1992	1993	1994	1995	1996	1997	1998[1]
Bulgaria	628	3,216	3,600	3,800	3,500		
Estonia	1,810	6,365	17,875	421	4,697	3,720	3,968
Faroe Islands	-	4,026	2,896	3,467	3,127	3,822	
France							3
Germany	1,084	6,459	6,354	9,673	4,391	8,866	9,746
Greenland	9	710	-	1,856	3,537	-	
Iceland	361	8,098	17,892	19,577	3,613	3,856	1,430
Latvia	780	6,803	13,205	5,003	1,084	-	-
Lithuania	6,656	7,899	7,404	22,893	10,649		
Netherlands	-	-	-	13		-	-
Norway	380	5,911	4,514	3,893	1,010[1]	2,699[1]	488
Poland	-	-	-			662	-
Portugal							503
Russia	2,485	4,106	10,489	34,730	606	-	89
Spain				20	410		
UK(E/WNI)					33	-	
UK(Scotland)					13	-	
UK	-	+	-				-
Ukraine	-	2,782	5,561	3,185	518		
Total	14,193	56,375	89,790	108,531	37,188	23,625	16,227
WG estimates	*23,249*	*72,529*	*94,189*	*132,039*	*42,441*	*18,578*	*19,538*

1) Provisional
2) Former USSR until 1991

Table 7.2.5 REDFISH. Nominal catches (tonnes) by countries, in Sub-area XIV 1985-1998, as officially reported to ICES and/or FAO.

Country	1985	1986	1987	1988	1989	1990	1991
Bulgaria	5,825	11,385	12,270	8,455	4,546	1,073	-
Denmark	-	-	-	-	-	-	-
Faroe Islands	-	5	382	1,634	226	-	115
Germany, Dem. Rep,	5,438	8,574	7,023	22,582	8,816		
Germany, Fed. Rep.	5,974	5,584	4,691				
Germany						11,218	9,122
Greenland	5,519	9,542	670	42	3	24	42
Iceland	+	-	-	-	814	3,726	7,477
Norway	-	-	-	-	-	6,070	4,954
Poland	135	149	25	-	-		
Russia [2]	42,973	60,863	68,521	55,254	7,177	3,040	2,665
UK (Engl. and Wales)	-	-	-	-	5	39	219
UK (Scotland)	-	-	-	-	-	3	+
United Kingdom				-	-	-	-
Total	65,864	96,102	93,582	87,967	21,587	25,193	24,594
WG estimates	*65,864*	*96,102*	*95,824*	*91,676*	*24,520*	*31,261*	*28,400*

Country	1992	1993	1994	1995	1996	1997	1998 [1]
Bulgaria	-	-					
Denmark	-	-	-				
Faroe Islands	3,765	3,095	164	8	298	123	
Germany	7,959	26,969	22,406	9,702	16,996	11,610	9,671
Greenland	962	264	422	2,936	2,699	193	
Iceland [3]	12,982	11,650	29,114	8,947	49,381	33,820	44,740
Norway	14,000	8,351	2,546	2,890	6,286 [1]	433 [1]	594
Poland						114	
Portugal	-	-	1,887	5,125	2,379	3,644	3,369
Russia	1,844	6,560	13,917	9,439	45,142	36,930	25,748
Spain				4,534	3,897		
UK (E/W/NI)	178	241	138	48	247	28	
UK (Scotland)	28	8	4	10	6		
United Kingdom	-	-					43
Total	41,718	57,138	70,598	43,639	127,331	90,793	84,165
WG estimates	*48,513*	*57,269*	*59,776*	*43,142*	*134,782*	*88,018*	*57,223*

1) Provisional data
2) Former USSR until 1991.
3) Officially reported catches includes Oceanic redfish caught in Subdivision Va.

Table 7.2.6. Proportions used for splitting the 1998 REDFISH landings between *S.marinus* and *S.mentella* stocks.

Area	Va			Vb		VI		XII		XIV	
Species/stock	*S.mar.*	*S.ment.* deep-sea	*S.ment.* oceanic	*S.mar.*	*S.ment.* deep-sea	S.mar.	S.ment. deep-sea	*S.ment.* oceanic	*S.mar.*	*S.ment.* deep-sea	*S.ment.* oceanic
Belgium	1.00										
Estonia								1.00			
Faroes	1.00	0.00	0.00	0.25	0.75			1.00	0.00	1.00	0.00
France					1.00			1.00			
Germany	0.00	1.00	0.00		1.00	0.00	1.00	1.00	0.06	0.51	0.43
Greenland								1.00	0.10	0.90	
Iceland	0.35	0.51	0.14					1.00			1.00
Latvia								1.00			
Lithuania								1.00			
Norway				1.00	0.00	1.00	0.00	1.00	0.02		0.98
Portugal											1.00
Russia				1.00	0.00			1.00	0.00	0.47	0.53
UK				1.00	0.00	1.00			0.11	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.

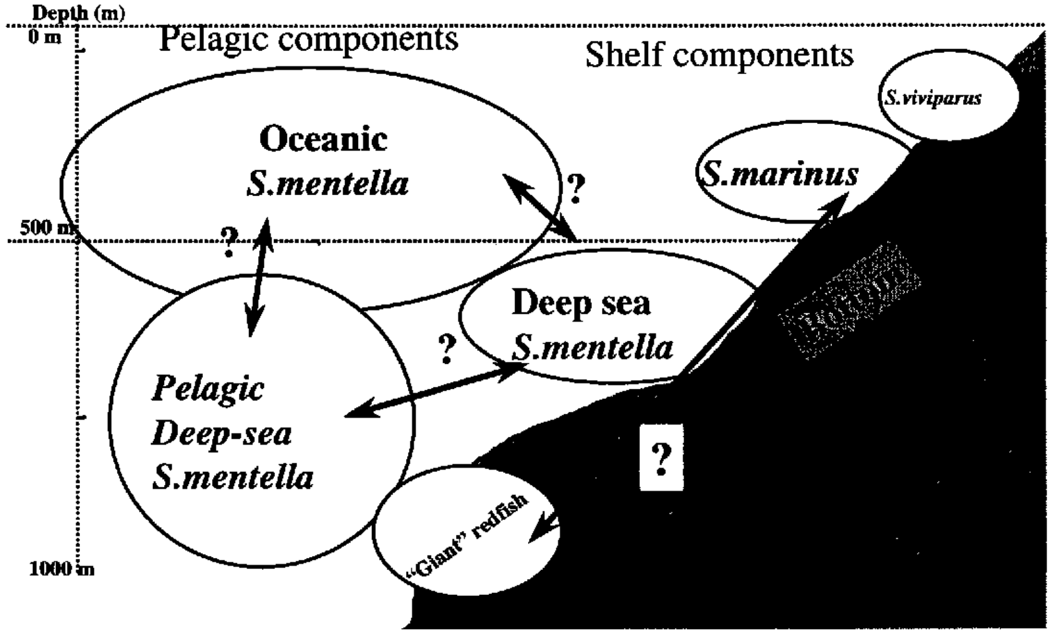


Figure 7.1.1 Schematically possible relationship between different stocks of redfish in the Irminger Sea and along the continental slope of E-Greenland-Iceland-Faroe Island.

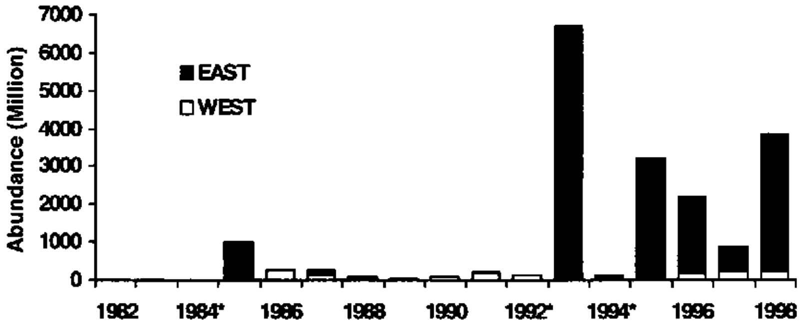


Figure 7.3.1 *Sebastes spp.* (<17 cm). Survey abundance indices for East and West Greenland as derived from the German groundfish survey, 1982-98. *) incomplete survey coverage.

8 SEBASTES MARINUS

8.1 Landings and Trends in the Fisheries

The total catch of *S. marinus* in Divisions Va and Vb and in the Sub-areas VI and XIV has decreased from about 130,000 t in 1982 to about 40,00 and 39,000 t in 1997 and 1998, respectively (Table 8.1.1). This decline of about 70% over this period has been continuous but with few exceptions. Since 1990, catches have decreased from about 67,000 t or about 45%. The relative highest decline in last years occurred in area Va (Table 8.1.1).

Catches of *S. marinus* in Division Va have declined from 63,000 t in 1990 to only 34,000 t in 1996, a 55% reduction. The catch in 1998 was about 37,000 t. The decline in the catch in 1994 was at least partly due to area closures imposed on the fishery by Iceland in order to reduce the catches of *S. marinus*. The catches in 1995 increased again to approximately 42,000 t despite the area closures. The catches in 1996-1998 are the lowest catch of *S. marinus* in Va since 1978. The length distributions in the Icelandic landings in 1989–1997 along with measurements at sea from the commercial trawler fleet are shown in Figure 8.1.1. The location and number of measured fishes by statistical square is given in Figure 8.1.2.

About 90-95% of the total redfish catches in area Va in recent years have been taken by bottom trawlers (both fresh fish and freezer; length 48-65 m) targeting on redfish. The remainder is taken by different gears and partly as a bycatch in the gill net and long line fishery. A total of 100 - 150 vessels landed more than 10 t of redfish during the last years. In 1998, as in previous years, most of the catches are taken in the area from SE of Iceland to W of Iceland.

In Division Vb, the catches were highest in 1985 approximating 9 000 t with steady decline to about 2,400 t in 1990. They have since then remained at the level of 2,100-2,600 t except in 1992 when the catch was about 3,400 t (Table 8.1.1). 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 this year.

In Sub-area VI, the catches in the period from 1978–1994 were highest in 1987, at almost 600 t, but then declined to a level of 100 t from 1988–1994. In 1995–1996 the catches increased to over 600 t which are the highest catches in the whole period from 1978 (Table 8.1.1). The catch in 1997 were over 500 t and in 1998, the provisional catch is about 400 t. The major proportion of the catches has been taken by trawlers. No length distribution was available from the catch.

In Sub-area XIV, the catches have shown a relatively larger decrease than in the other Divisions and Sub-areas. Thus the catches dropped from almost 31 000 t in 1982 to 5 000 t in 1984 (an 84% decrease). In the period 1984 to 1988, they varied between 1,200-5,000 t. In 1989 they amounted to only 685 t (only 2.2% of the catches in 1982). The catches remained at this low level for two years, then they increased again to 3,900 t in 1990. In the period from 1991–1994 the catches were between 1,100–1,700 t but in 1995–1997 the catches were less than 100 t, the lowest on record (Table 8.1.1). In 1995 and 1996, there was almost no directed fishery for *S. marinus* nor deep sea *S. mentella* in area XIV, but in 1998 a directed redfish fishery started again and S.marinus catches from that were estimated around 150 t. The remainder of the catches were taken as a bycatch in the shrimp fishery. Large bottom trawlers took the catches taken in directed redfish fishery.

Following text-table shows the sampling by gear type and Divisions.

	Area	Gear	Landings	Nos. samples	Nos. fish measured
S.marinus	Va	Bottom trawl	36,000	164	34989
	Vb	Bottom trawl	2,500	0	0
	XIV	Bottom trawl	< 100	16	1310
	VI	Bottom trawl	380	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 data down to 400 m depth. The index is a biomass index of the fishable stock computed by using a fishable stock ogive (see WD 10). The index is a Cochran index (see Pálsson *et.al*, 1989) and the stratification is based on depth intervals and is shown in Figure 8.2.3. In Table 8.2.1 the contribution of each strata to the index is given.

The index indicates an increase in the fishable biomass from the record low level in 1995. The length distribution from the survey shows that the peak in the length distribution (Figure 8.2.4) which have been followed during the last years (first in 1987) now has reached the fishable stock and can clearly been seen in the length distributions of the catches (Figure 8.1.1) as a peak around 35-37 cm. That is in accordance to the peak in earlier years, showing a growth of about 1.5-2 cm each year. The increase in the survey index in recent years therefore reflects the recruitment of a strong year class (probably the 1985 year class). This indication of strong ear classes is also confirmed by age readings which have been going on since 1998. Based on the age reading, the 1985 year class have been dominating in the catches since 1995 with about 30% of total number (Figure 8.2.2).

Indices of CPUE for the Icelandic trawl fleet for the period 1980–1998 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 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 effort for each year each haul where redfish exceeding 10% of the total catch in each haul). The results from the trawler fleet also reflect the situation shown in the groundfish survey and although the CPUE has been at a low level in recent years it increased in 1997 and has been at similar level in 1998 as in 1997.

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 - 1999 but it is still at a low level.

In Division Vb, CPUE of *S.marinus* were available from the Faroes groundfish survey 1983–1998 showing an increase since 1995 although this was not seen in the catch statistics which still are on a very low but seemingly stable level (Figure 8.2.6).

For the period 1982-98, 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 the most recent survey results, a weak signal of possible recovery is shown. 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 almost to zero.

The length frequencies from the German groundfish survey in 1998 are illustrated for West and East Greenland in Figures 8.2.9. The low mean length and left-skewed size composition in 1998 indicate relatively good recruitment which caused a slight stock increase. The adults, however, remain 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 10.

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/DD10). 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. This year, an alternative model (BORMICON(BOReal MIgration and CONsumption model)) was applied to the *S.marinus* stock. The model is described in WD 18. BORMICON is a simulation model and estimation model developed at the Marine Research Institute. It is described in Stefánsson and Pálsson (1997). The model is designed as multispecies - multiarea model but can also be used as a single species model as was done for the redfish. 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. This means that growth has to be modelled. It is done by calculating the mean growth for each length group according to some growth model (for example von Bertalanfy's) model. The next step is then to distributed the growth. Then certain proportion of the fishes do 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 and presented in WD 18, by 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 (approximately fishing mortality for short timesteps) 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 fleets where the total amount is specified area used but in simulations into the future proportion caught is specified

The formulation used is a relatively simple one. It's 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 1999. Two timesteps are used each year

Natural mortality is set to 0.15 for the youngest decreasing gradually to 0.05 or 0.1 for age 5 and older. 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 after that. This was supposed to reflect length of the 1985 and 1990 ear classes in the groundfish survey.

3 alternatives were tested.

- M = 0.05

- Same as the first alternative but age readings were not used in the objective function

- M = 0.1

Figure 8.2.10 shows the estimated fishing mortality on fully recruited fishes for the period 1975-1998. As seen, the fishing mortality rate has decreased in last years, after having being increasing in the period 1978-1990. The fishing mortality rate in 1998 is estimated to 0.25 (on fully recruited fish), and the average F for the whole period from 1975-1998 is 0.33.

Figure 8.2.11 shows estimated recruitment as age 1 according to one of the alternatives model (M = 0.05). The main indicator for recruitment is the groundfish survey, which does not indicate that anything is on the way after the 1990 year class. Here the 1990 year class seems somewhat smaller than the 1985 year class. Much less data are available to estimate the recruitment prior to 1985.

As may be seen on figure 8.2.11 the cacheable biomass will increase in the nearest future, for F between 0.2-0.3, but thereafter, the biomass will decrease again due to no indication of recruitment. Also, the catches (Figure 8.2.12 will increase in next years, but in all cases decrease thereafter. 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 ear 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 level in 1995. An 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 show an increase in last years but the catches are still at a very low level. The adult stock of *S.marinus* in Sub-area XIV has nearly been depleted in the most recent years, but there are indications of a 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 ($Y/U=aE$) and this allows a one-year prediction of catch assuming a *status-quo* effort level.

Year	Survey index	Catch Va	Effort
85	1000	67,312	67
86	1137	67,772	60
87	1167	69,212	59
88	875	80,472	92
89	953	51,852	54
90	683	63,156	93
91	559	49,677	89
92	516	51,464	100
93	423	45,890	108
94	480	38,669	81
95	359	41,516	116
96	535	33,558	62
97	567	36,342	63
98	568	36,310	64
99	710		

By assuming same effort in 2000 as it was in 1998 (calculated from the survey index from depth down to 400 m) and calculating the catch in 2000 as:

$$\textbf{Catch}_{2000} = \textbf{Survey index}_{1999} * \textbf{Effort}_{1998},$$

the catch in Va would be around 46 000 t.

In Division Vb the CPUE from the Faroes fleet show similar trend as the Icelandic (increase in last three years) but in Sub-area XIV the fishable stock of *S.marinus* is almost depleted. Based on Icelandic age reading data and a length-weight relationship from commercial catches, an unexploited year class will reach maximum biomass at an age of approx. 16-18 or length of 40-42 cm (Table 8.2.2). Keeping fishing effort lower than in the last 2 or 3 years should therefore result in an increased total yield from the 1985 and 1990 year classes.

In order to protect the new incoming year classes any fishing effort on these components 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 year class after the 1990 year class. Therefore as described in 8.2.2, the two ear classes, 1985 and 1990 needs to be preserved, since it is unlikely that other ear classes than the 1985 and 1990 will contribute substantially to the catch in next years. Therefore, the working group recommends that the catches should not be increased from the present level.

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 proposed to define reference points in "terms of current state with respect to $U_{lim} = U_{max}/5$ and $U_{pa} = U_{max}/2$". Based on survey data, the highest recorded biomass was reached in 1987. Based on the proposed reference points, the Upa is then 133 and U_{lim} around 53. Further, based on these definitions, the stock has been below U_{pa} during the last years, but the survey index from 1999 indicates that it now is above that reference limit point. Based on the BORMICON model the corresponding values for reference points (for the period 1985-1999) are then U_{max}= 230 (in 1985); U_{lim}= 46 and U_{pa}= 115, and the stock seems to have been below U_{pa} in the period from 1993-1996. As for the survey series, the stock has been above that level during past 2 years.

The survey index series is only available back to 1985. Due to the long time lag between spawning and recruitment to the fishable stock (at least 10 years) it is very difficult to see the consequences of the low fishable stock in early 1990's. There are, however indications that the recruitment has been low ever since. Index of fishable biomass have, in last 9 years, been above $U_{max}/2$ for 6 years. Therefore, based on both the survey index as well as the BORMICON model a Upa limit set as $U_{max}/2$ might result in to low fishable biomass to produce strong year class, and therefore the Upa might be set to high. The working group, therefore proposes that U_{pa} be set at 60% of U_{max}, which corresponds to the level of fishable biomass associated with the last strong year class.

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 8.1.2). The total reported landings of "giant" *S. marinus* taken by these countries in Sub-areas XII and XIV in 1996 were 900 t. The fishery since then decreased, with only minor catches reported by Norway in 1997 and there were no reportings of "giant" catch in 1998. 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 redfish 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. Although these 'giants' living in international waters extend the distribution into the EEZs, one should avoid including 'giants' that can be identified as 'giants' (i.e., nearly 100% in international waters) in a TAC meant for *S. marinus* within the EEZs.

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 [1]	36,310	2,565	380	0	175	39,593

1) Provisional

Table 8.1.2 Catches of "giant" *S. marinus* in Divisions XII and XIV.

	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.

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

Depth interv/year	**85**	**86**	**87**	**88**	**89**	**90**	**91**	**92**	**93**	**94**	**95**	**96**	**97**	**98**	**99**
< 100m	7	2	2	1	1	2	2	1	1	1	0	1	1	2	1
100-200m	87	84	119	93	99	66	74	60	47	57	37	44	59	56	55
200-400m	134	173	145	106	117	87	52	56	49	52	44	77	70	72	106
400-500m	22	12	10	4	11	25	9	10	19	1	13	25	41	3	48
Total 0 – 400m	**228**	**259**	**266**	**200**	**217**	**156**	**128**	**118**	**97**	**109**	**82**	**122**	**129**	**130**	**162**
Total 0-500 m	252	273	277	221	231	195	139	129	118	112	96	147	170	132	210

Table 8.2.2. *S.marinus*. Estimated weight of a year class, based on Icelandic age reading data and a length-weight relationship from commercial catches. Input parameters are given below.

Age	Estim. Mean length	Number in stock	Weight in stock
7	27.24	1000	289
8	29.45	951	350
9	31.41	905	406
10	33.14	861	456
11	34.67	819	498
12	36.03	779	534
13	37.23	741	562
14	38.29	705	583
15	39.22	670	597
16	40.05	638	606
17	40.79	607	610
18	41.44	577	609
19	42.01	549	605
20	42.52	522	597
21	42.97	497	586
22	43.37	472	574
23	43.72	449	560
24	44.03	427	544
25	44.31	407	528
26	44.55	387	511
27	44.76	368	493
28	44.96	350	475

Input parameters

Vonbertanlanffy	
t0	-0.2089
Kl	0.1226
Linf	46.4167
Natural mortality	
M	**0.05**
Length-weight relationship (a*length^b)	
a	**0.011**
b	**3.089**

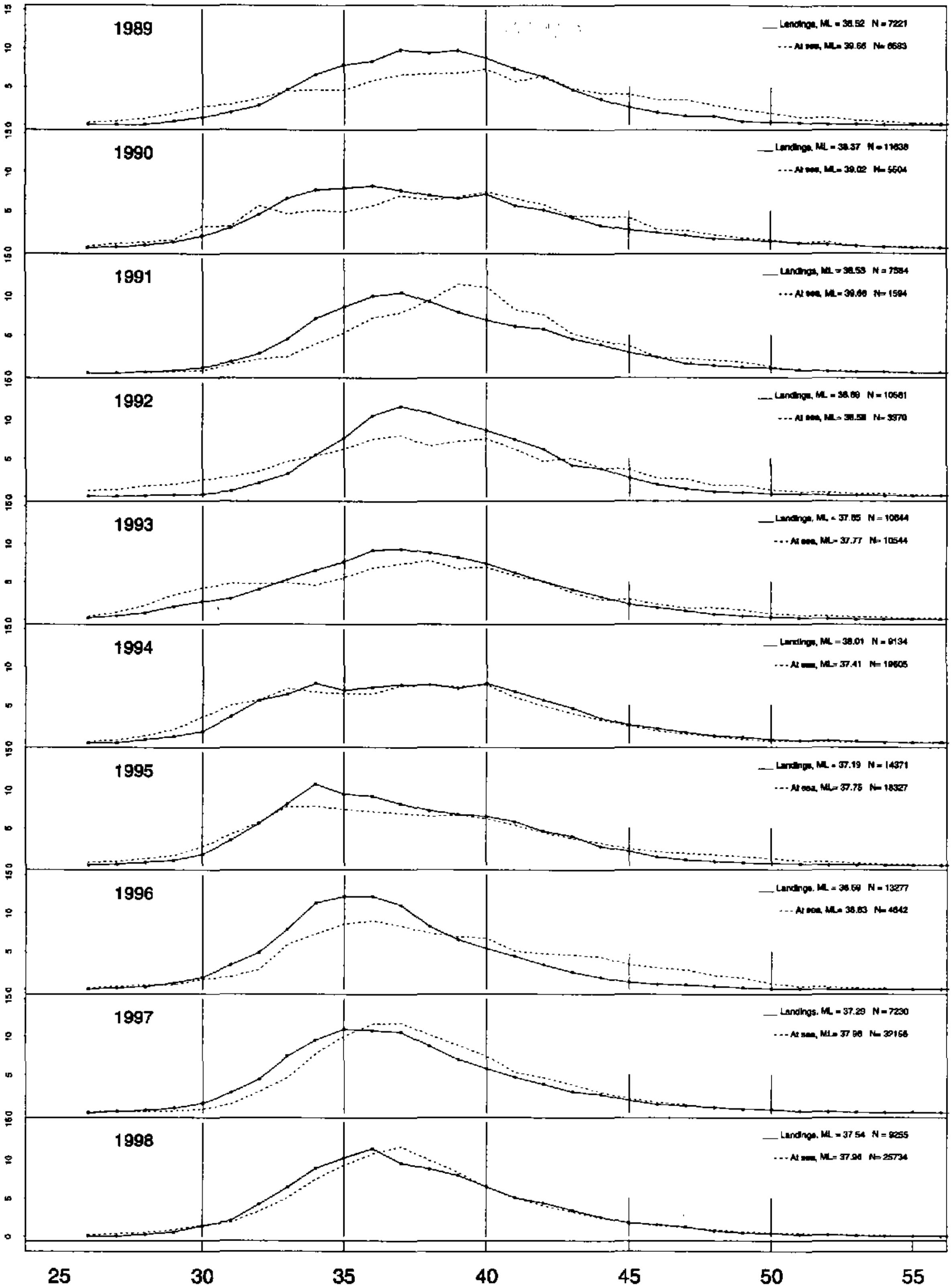


Figure 8.1.1. *S. marinus.* Length distribution from Icelandic landings and from samples taken at sea from the trawler fleet 1989-1998.

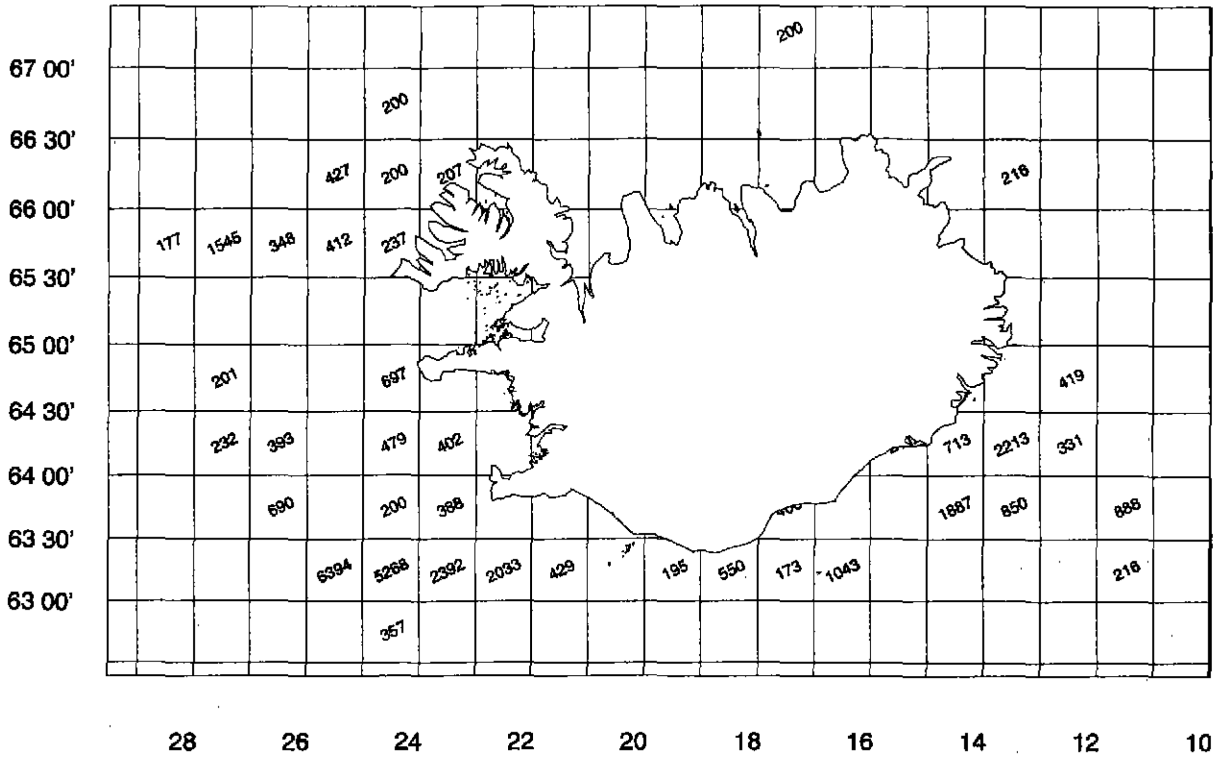


Figure 8.1.2. Number of measrured *S.marinus* from Icelandic catch by statistical square.

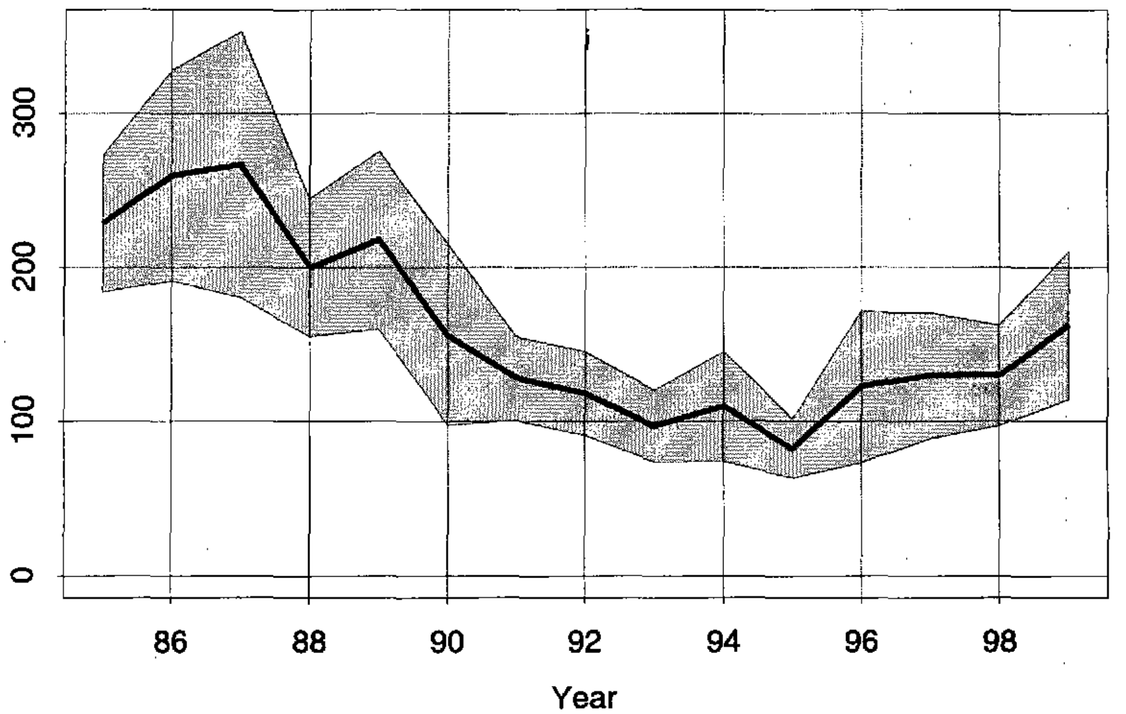


Figure 8.2.1. Index on fishable stock of *S.marinus* from Icelandic groundfish survey and 95% confidence intervals. The index is based on all strata at depths from 0-400 m.

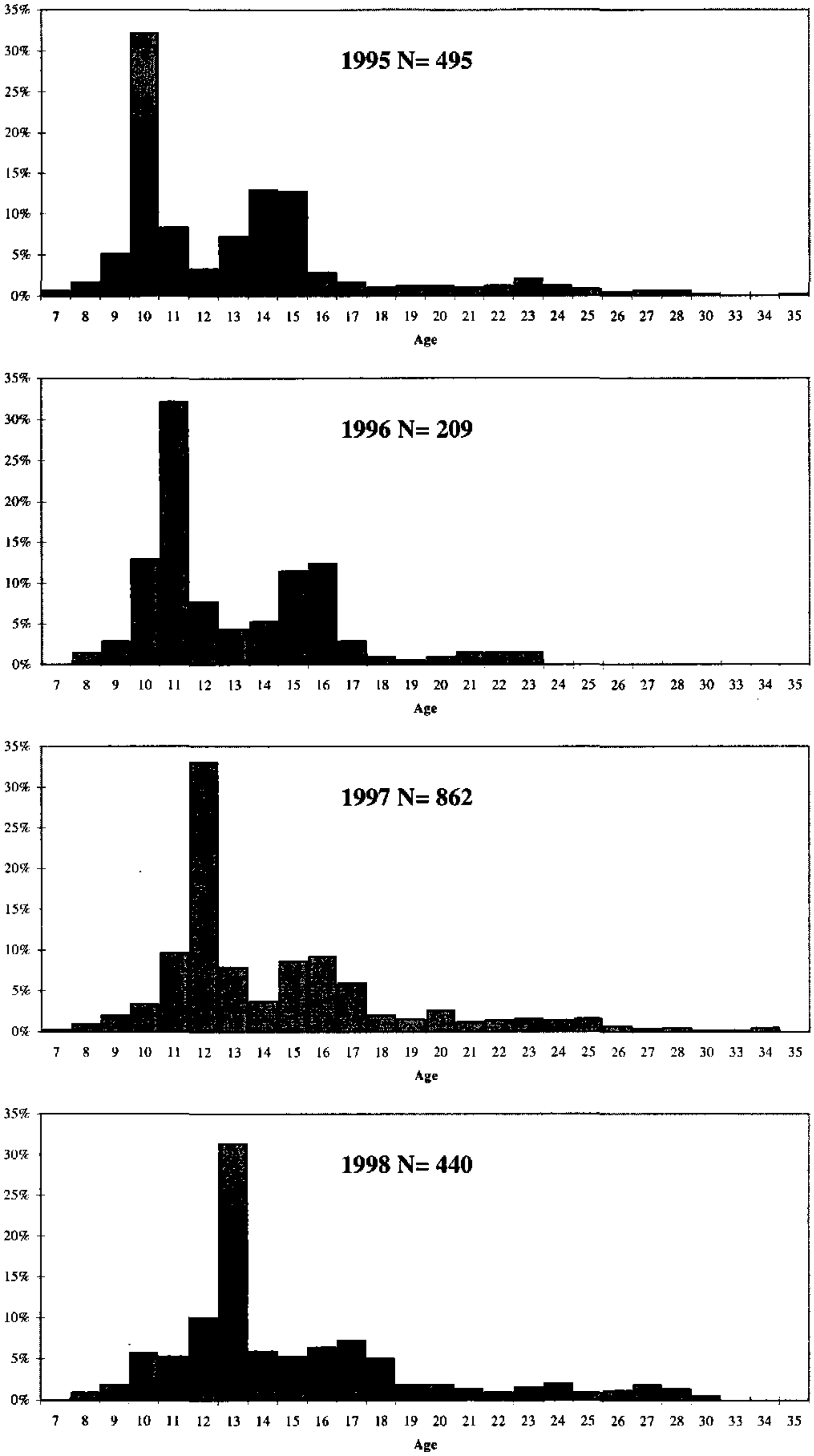


Figure 8.2.2. Age composition of *S.marinus* in Sub-division Va, based on samples from catch.

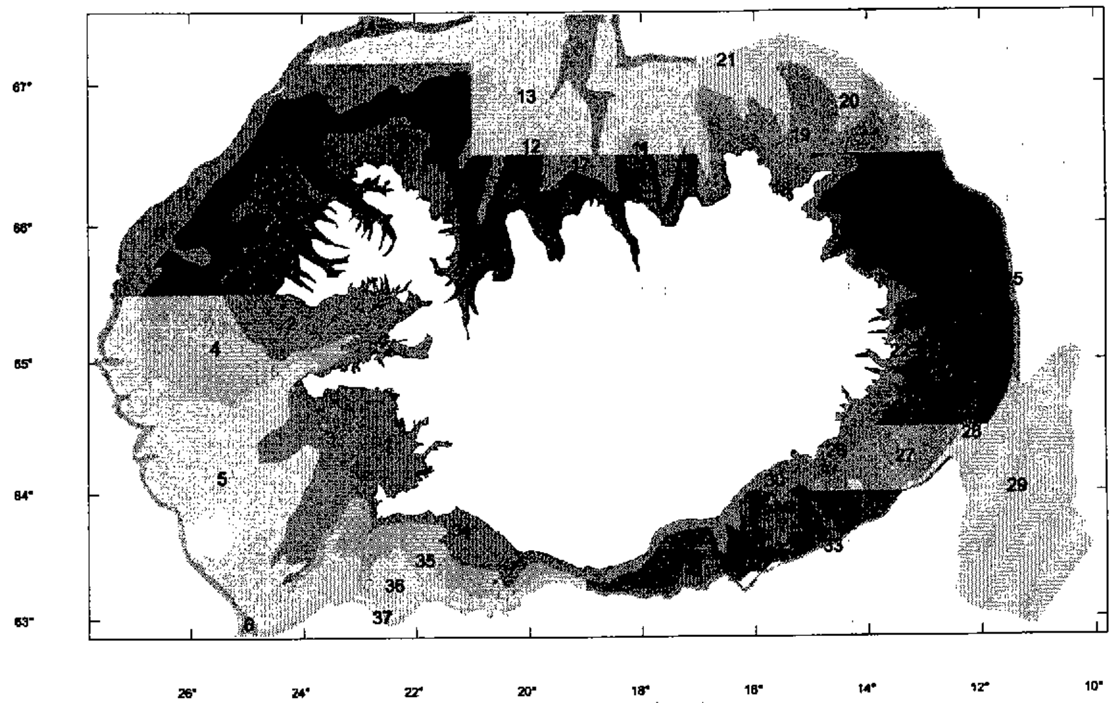
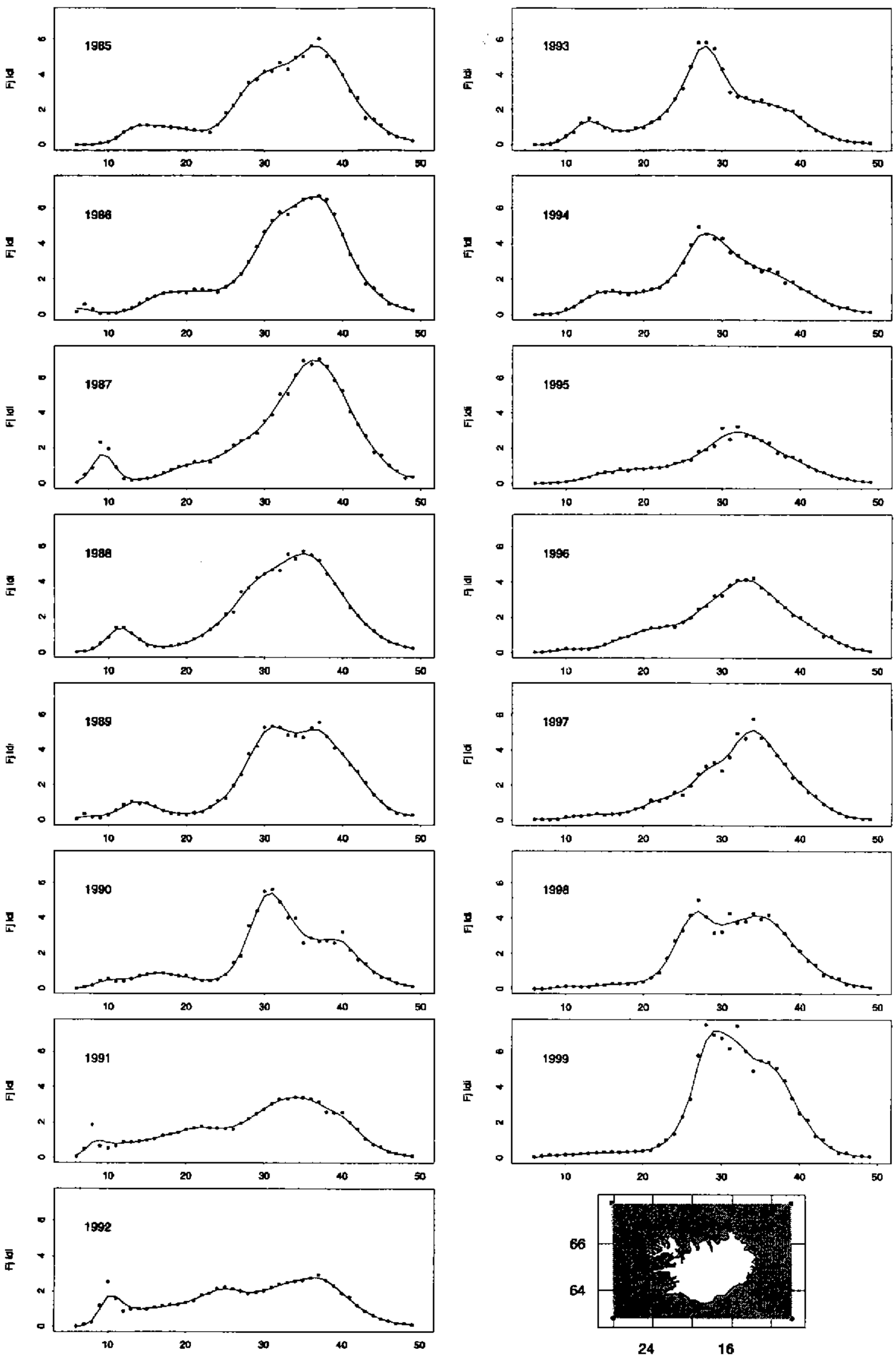


Figure 8.2.3. Stratification in the icelandic groundfish survey.



Length distribution of S.marinus in IGS 1985-99 (No. of fish per towing mile).

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

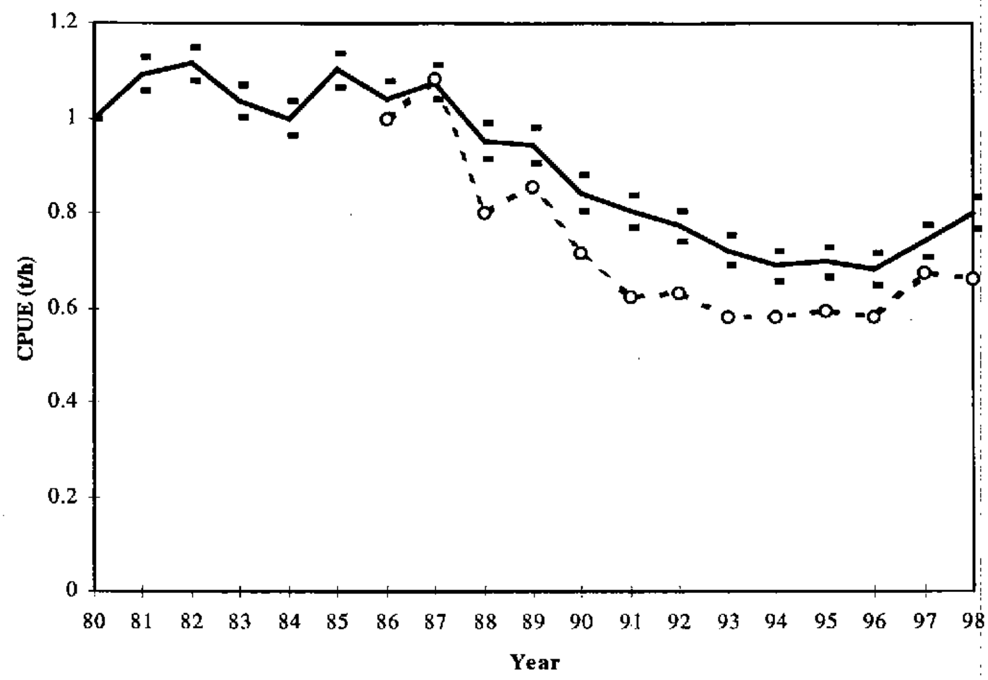


Figure 8.2.5. CPUE in *S.marinus* from Icelandic trawlers both based on results from GLIM model 1980-1998 (solid line with 95% CV) and based on simple mean (dotted line) since 1986.

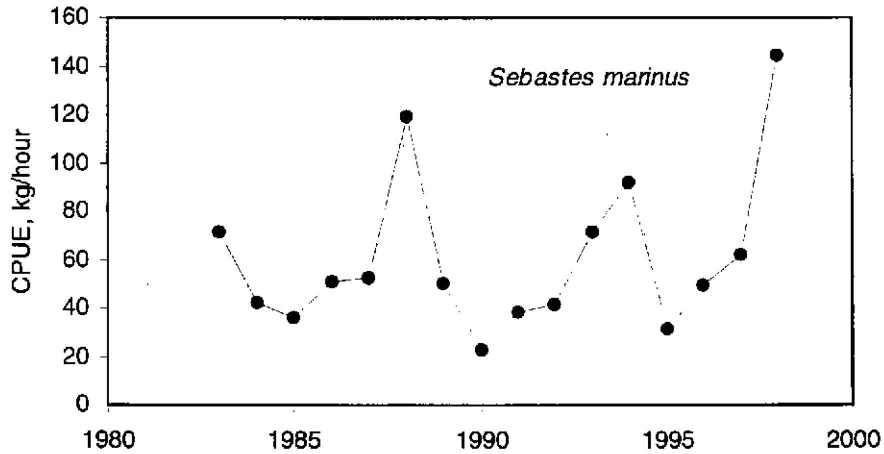


Figure 8.2.6. CPUE of S.marinus in the Fareoese groundfish survey 1983-1999.

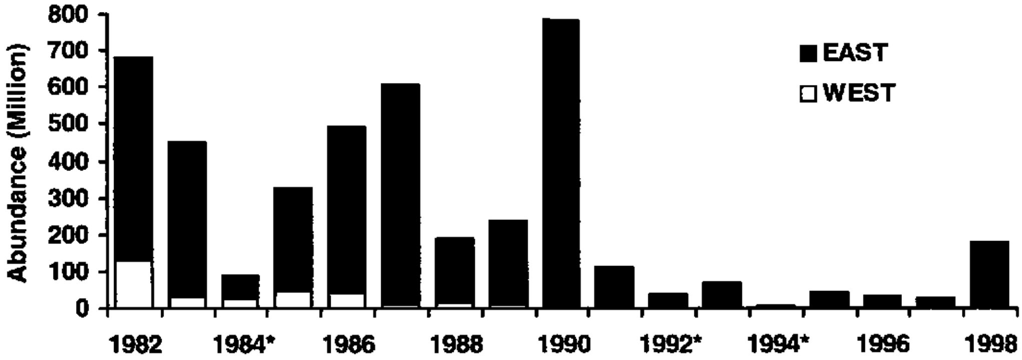


Figure 8.2.7. *S. marinus* (≥17 cm). Survey abundance indices for East and West Greenland, 1982-98, as drived from the German groundfish survey. *) incomplete survey coverage.

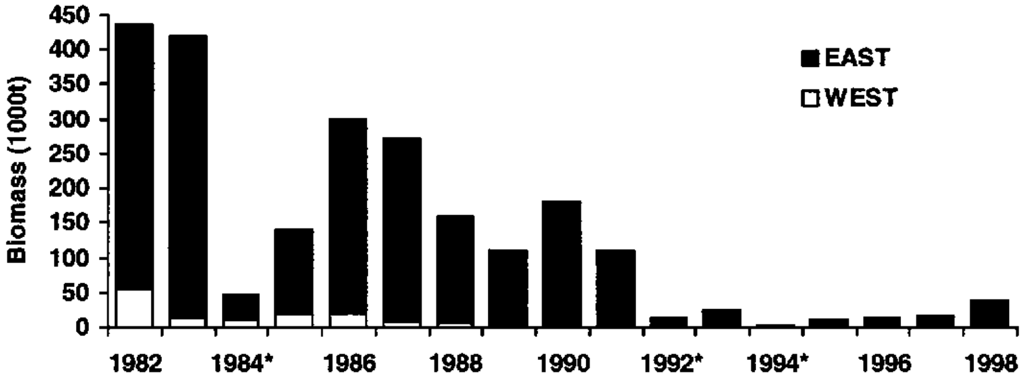


Figure 8.2.8. *S. marinus* (≥17 cm). Survey biomass indices for East and West Greenland, 1982-98, as drived from the German groundfish survey. *) incomplete survey coverage.

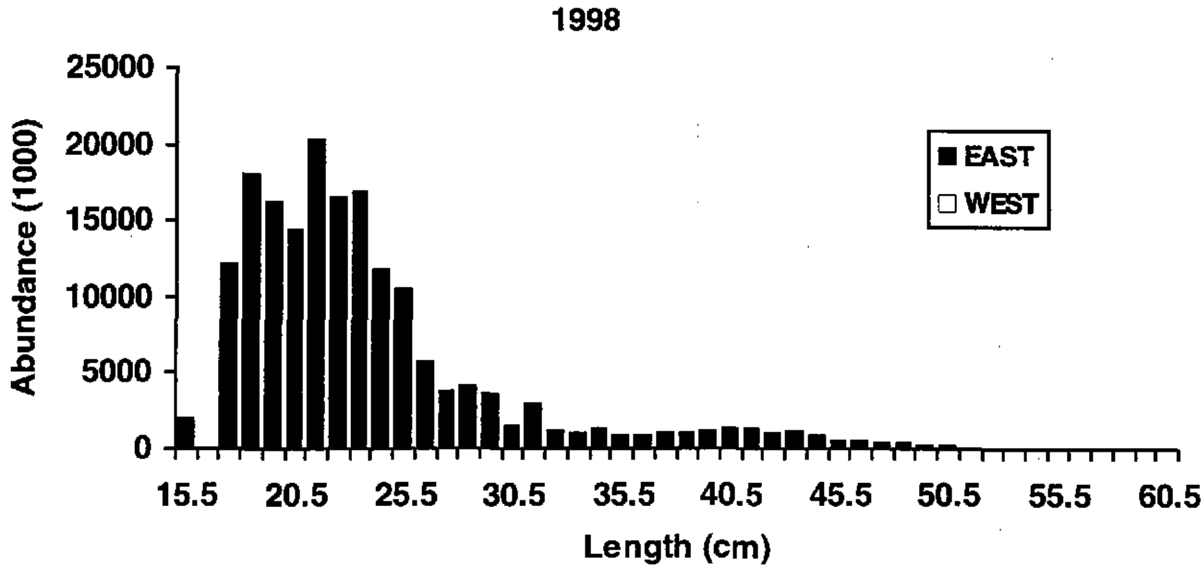


Figure 8.2.9 *S. marinus* (≥17 cm). Length frequencies for East and West Greenland, 1998, as derived from the German groundfish survey

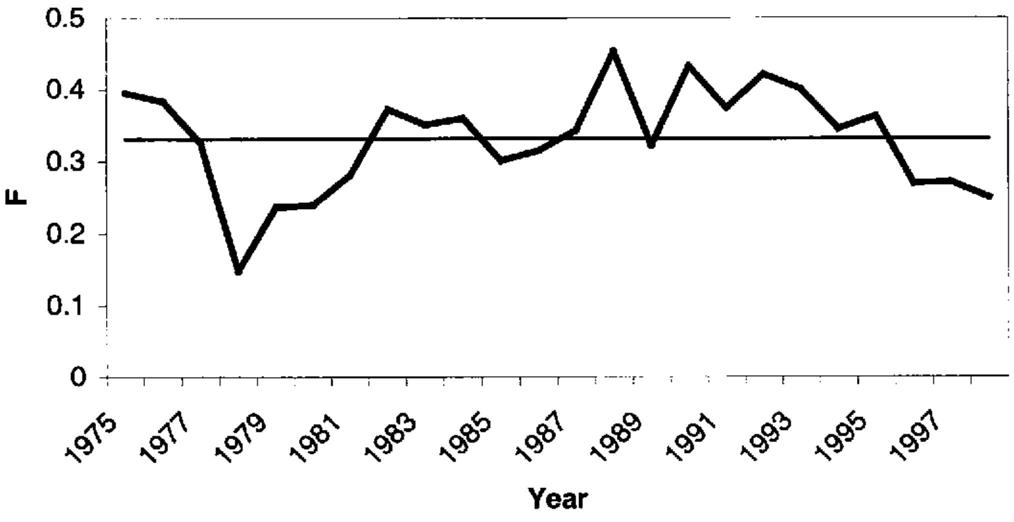


Figure 8.2.10. Fishing mortality of fully recruited *S.marinus*, as estimated by the BORMICON model (M=0.05).

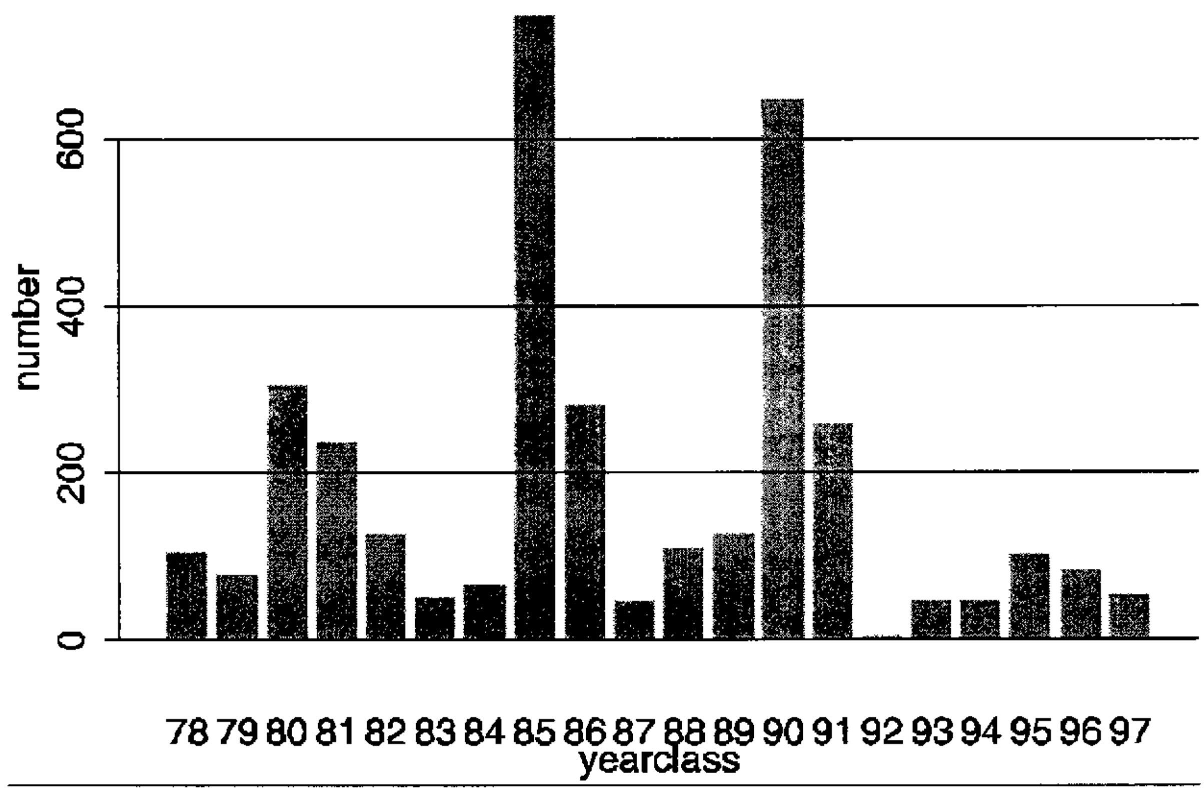


Figure 8.2.11. Estimated recruitment of *S.marinus*, according to the BORMICON model

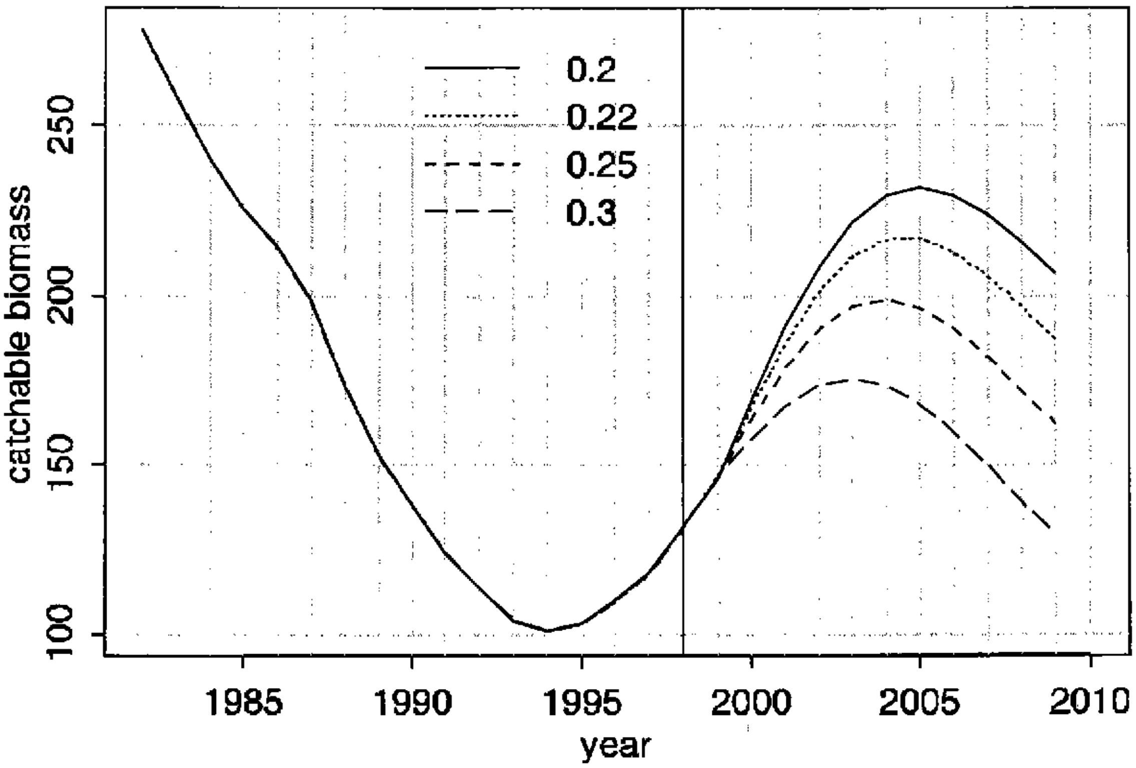


Figure 8.2.11 Development of catchable biomass of redfish with M= 0.05, using 4 different values of F.

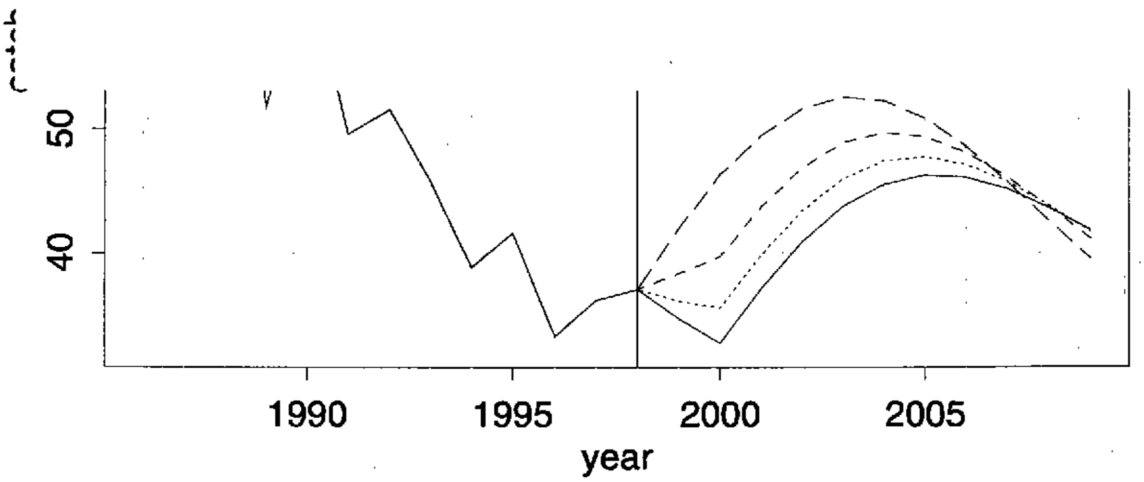


Figure 8.2.12. Development of catches of redfish with M = 0.05 using 4 different values ofF (on the largest fish).

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 indicating 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 37 400 t in 1998. 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 (1998) back to the 1980s level again (Table 9.1.1).

From Division Va, total landings in 1998 were about 33 000 t, decreasing 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 14% of the 1994 level due to low catch rates. About 90–95% of the total deep-sea *S.mentella* catches in area Va in 1998 have been taken by bottom trawlers (both fresh fish and freezer trawlers). During the last three years the fishery has been regulated by quotas. Length distributions from the Icelandic catches in 1989–1998 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 1998 of only 4 000 t is the lowest catch since early 1970s (Table 9.1.1). Length distributions of the Faroes catches from Division Vb are given in Figure 9.1.3.

In Sub-area VI the annual catches were highest in 1980 (1 000 t), but have varied from 130 - 640 t during recent years, except for 1996 when the catches were about 1,100 t, the highest recorded catch in the series since 1978 (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 and this resulted in a total catch of about 1 300 t.

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
Va	Pel.trawl	2,000	4	864
Va	Bottom trawl	26,000	79	16196
Vb	Bottom trawl	6,596	128	12013

9.2 Assessment

9.2.1 Trends in CPUE and survey indices

CPUE 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 stable at this lower level since then. However, if not the effort had decreased considerably it is unlikely that the catch rates had remained this stable in recent years. The effort which peaked in 1993–1995 had by 1998 decreased to 58% and 12% of that peak level in the demersal and pelagic fisheries, respectively.

Year	Total landings (t) in Va	CPUE (10%)	CPUE relative to 1986	Total effort (1000 hours)
86	18,898	943	1.000	20
87	19,293	974	1.033	20
88	14,290	886	0.940	16
89	40,248	974	1.033	41
90	28,429	804	0.853	35
91	47,651	770	0.816	62
92	43,414	611	0.648	71
93	51,221	547	0.581	94
94	56,720	488	0.517	116
95	48,708	514	0.545	95
96	34,741	489	0.518	71
97	37,876	562	0.596	67
98	32,710	501	0.531	65

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. After a peak in 1994 of about 116 000 hours the total effort in 1998 had decreased to about 65 000 hours or 56% of the maximum level in the time series 1986–1998.

Regarding Division Vb a CPUE-series (1985–1997) of deep-sea *S. mentella* was presented in last year's Working Group report. The series shows a decrease since 1993, which seems to have stabilized at a level below 50% of the maximum level in the time series.

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 9.2.2–9.2.4. The surveys in 1991, 1993 and 1995–98, when the whole area was covered, registered high abundances of deep-sea *S.mentella* at East-Greenland. The survey results show recruiting juveniles only while mature deep sea *S. mentella* are almost absent. Comparing the proportions between West and East Greenland, deep sea redfish is almost exclusively distributed off East Greenland. Record high values in the time series were 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, and the abundance and biomass had at the same time decreased by about 50%. Since there are no significant commercial fishery for this species at East-Greenland at present, the decrease indicate an emigration out of the area. The origin of these very abundant recruits and to which fishing area they will recruit is uncertain but there are indications that at least some of these juveniles will recruit to the fishery within Division Va. This may be hypothesized from survey results at East-Greenland in 1991 which observed deep-sea *S.mentella* of about 26 cm to be relatively abundant. Three years later, in 1994, incoming recruits of about 32 cm were seen in the length distributions of deep-sea *S.mentella* catches in Division Va (Figure 9.1.2).

Survey results were also presented to the Working Group from the Icelandic groundfish survey in Division Va. Since this survey 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 future.

9.2.2 State of the stock and catch projections

The CPUE decreased drastically from a high level in the late 80s and seems to have stabilised in the 90s at or below 50% of that level. New recruits have entered the fishable biomass in recent years. It is, however, difficult with current state of knowledge to be sure about to what extent the rich yearclass(es) of juvenile *S.mentella* currently at East-Greenland will recruit to this stock.

The fishermen report of less *S.mentella* in the fishing areas. The fishermen have also reduced their use of pelagic trawls on the continental shelf. Apart from catching less fish pelagic the fishing area has remained unchanged. A precautionary reference point for this stock has been defined corresponding to 50% of the maximum CPUE-level in the time series from the commercial fishery (see chapter 9.3). U (or CPUE) is at present below Upa, and the immediate management action should therefore be to decrease the effort in order to increase U above Upa.

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 working group, taking all the uncertainties into account, recommends that the effort should be further reduced in order to let the stock increase from the present low level and suggests a 25% reduction in effort. Using the CPUE data in the same way as the Iceland groundfish survey used for *S. marinus* indicates that a 25% reduction in effort would lead to catches of 24 800 t in Division Va in 2000.

$$\textbf{Catch}\ 2000 = \text{CPUE}_{98} * \textbf{Effort}_{98}$$

Catch
2000 = = >

	Catch	Effort
100%	32710	65
75%	**24500**	49
50%	16500	33

In Division Vb the recent years development in CPUE resembles that in Division Va, i.e., the CPUE seems to have stabilized at or below a level 50% of the maximum level in the time series (1985–1997). Since the deep-sea S.mentella in Div.Va and Div.Vb belong to the same stock, a similar reduction in effort as in Div.Va is recommended also for Div.Vb.

For deep-sea *S.mentella* on the continental shelf in Sub-area XIV the Working Group recommends maximum protection of the juveniles and no directed fishery. This is seen necessary in order to rebuild the stock to safe biological limits.

9.3 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 $U_{pa} = U_{max}/2$.

9.4 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 keep in mind in the management of this stock.

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 [1]	32,710	4,089	298	3	1,319	37,424

1) Provisional data.

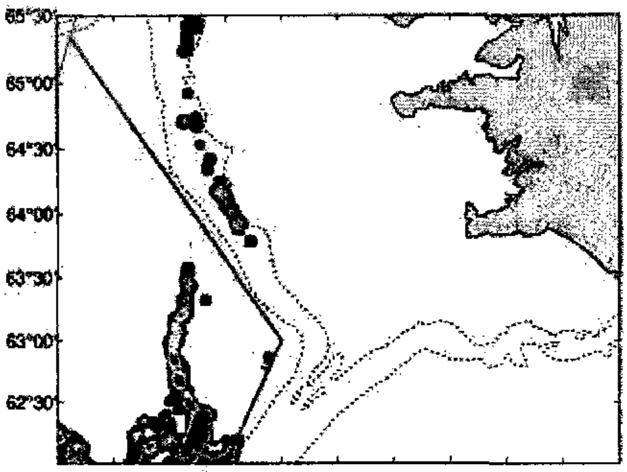


Figure 9.1.1. Map showing the line used by Icelandic authorities to separate the landing statistics between deep-sea *S.mentella* on the continental shelf and pelagic *S.mentella* (oceanic and pelagic deep-sea) in the Irminger Sea. In addition the figure shows parts of the pelagic fishery distribution pattern in 1998.

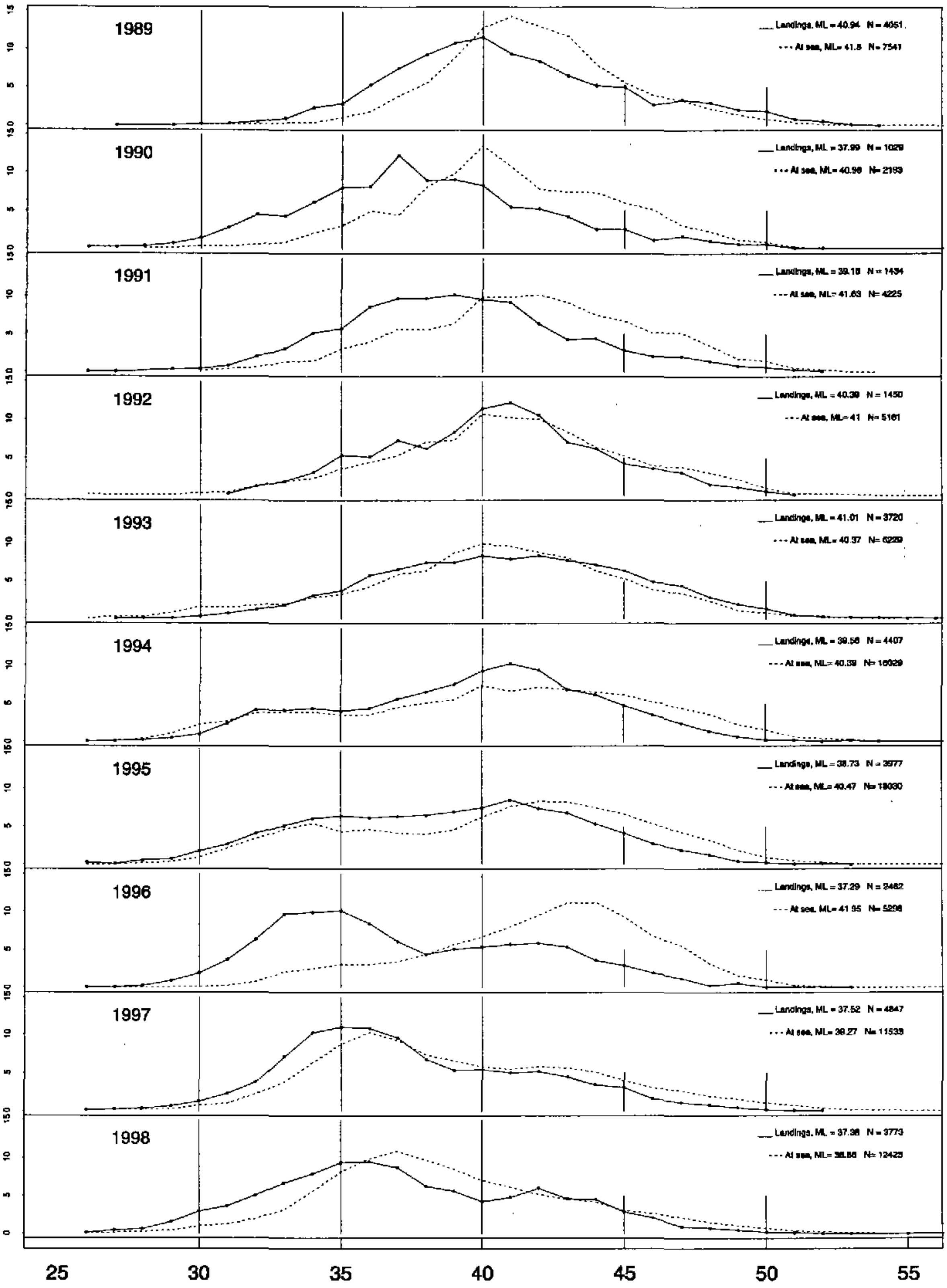


Figure 9.1.2. Length distributions of deep-sea *S.mentella* catch and landings from the Icelandic bottom trawl fishery in ICES Division Va.

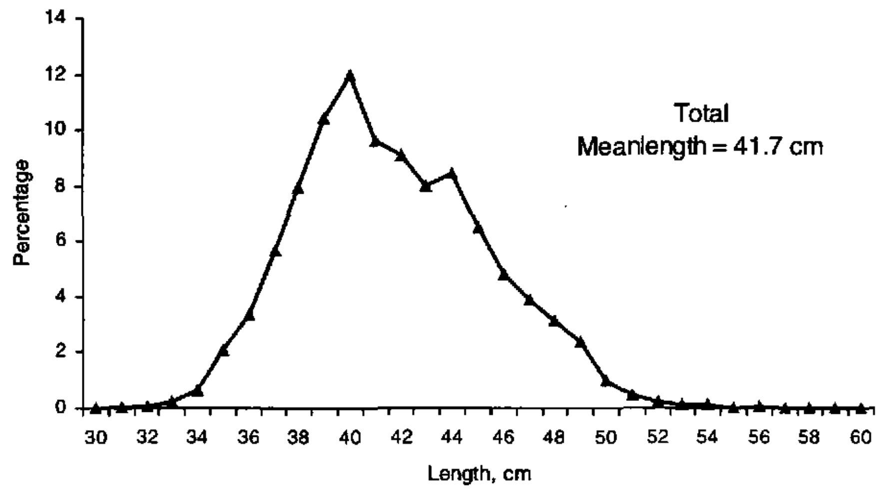


Figure 9.1.3. Length distribution of deep-sea *S.mentella* caught by Faroes otterboard trawlers in Division Vb in 1998.

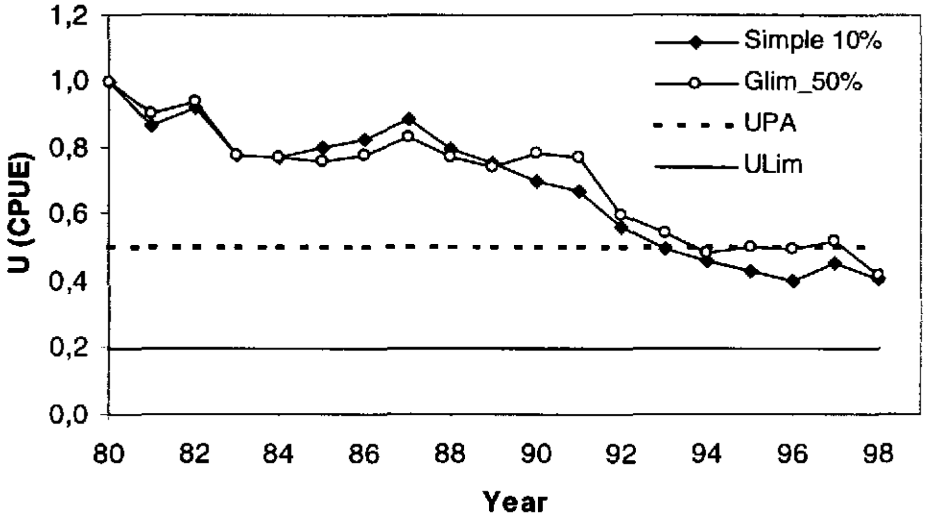


Figure 9.2.1. CPUE, relative to 1980, from the Icelandic bottom trawl fishery for deep-sea *S.mentella* on the continental shelf in Division Va. "Simple 10%" means CPUE calculated on hauls where redfish deeper than 500 m compose 10% or more of the total catch in each haul. "Glim_50%" shows the modelled development using GLIM including hauls where redfish deeper than 500 m compose 50% or more of the total catch in each haul. For explanation of UPA and ULim see text-chapter 9.3.

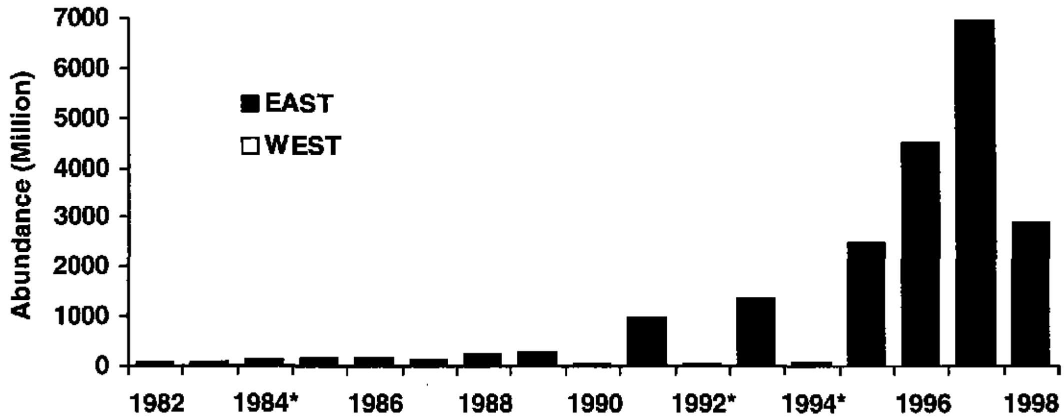


Figure 9.2.2. Deep-sea *S. mentella* (≥17 cm) on the continental shelf. Survey abundance indices for East and West Greenland as derived from the German groundfish survey, 1982–98. *) incomplete survey coverage.

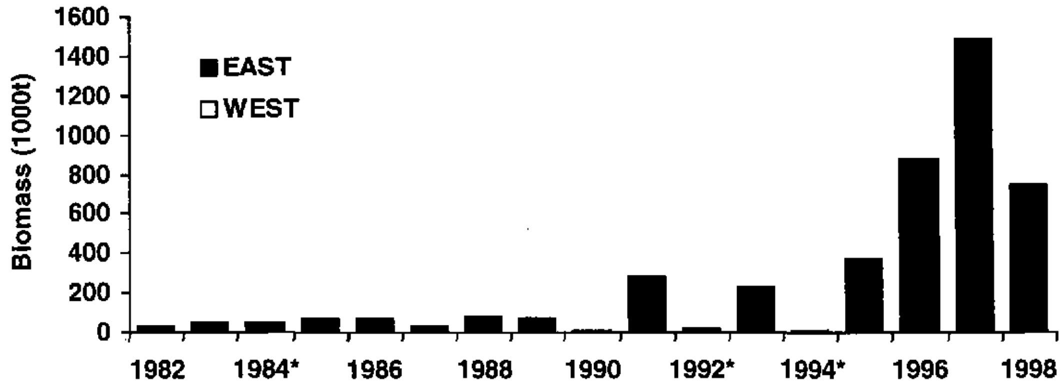


Figure 9.2.3. Deep-sea *S. mentella* (≥17 cm) on the continental shelf. Survey biomass indices for East and West Greenland as derived from the German groundfish survey, 1982–98. *) incomplete survey coverage.

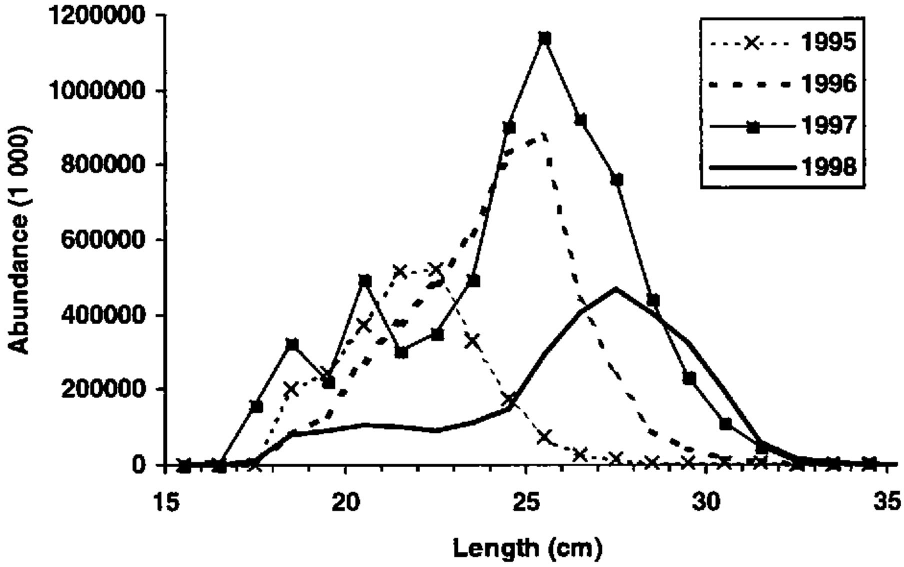


Figure 9.2.4. Deep-sea *S. mentella* on the continental shelf. Length composition off Greenland as derived from the German groundfish survey, 1995–1998.

10 PELAGIC SEBASTES MENTELLA

This section includes information on the pelagic fishery for oceanic redfish *S. mentella* and pelagic deep-sea *S. mentella* in the Irminger Sea (Sub-area XII, parts of Division Va and Sub-area XIV).

10.1 On the possible relationship between *S.mentella* units

In the ToR the WG was 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"

As has been described in section 7.1, there are great uncertainties in the stock structure of *S. mentella* in the area. The Working Group concerns about current situation of the fishery in the area related with the possible existence of more than one stock of *S. mentella*. Prior to 1994, the problem of stock mixing was considered minor as only small proportion of the catches was taken at depths below 500–600 m. The problem has been of greater magnitude during the last few years as the fishery has shifted towards greater depths (WD 7, 20 and 21; Sigurðsson and Þórarinsson, 1998). As the fishery has shifted towards greater depths, greater proportion of the catch might originate from the deeper stock (deeper than 500 m). The problem of separate the catches has magnified even further due to the fact that the oceanic type *S. mentella* also has been distributed deeper than 500 m in recent years.

As shown in WD 7 and in previous NWWG reports (ICES C.M 1998/ACFM:19) a major proportion of the fishery takes place at depths below 500 m. In fact in 1998, more than 90% of the Icelandic oceanic redfish landings was caught below 500 m depth, according to the log - books. Also, more than 50% of the Spanish effort was at depth greater than 600 m (WD21). Based on the German observer program, it is assumed that about 30% of the German catches were taken below 600 m depth (Table 10.1.1.)

The problem of distinguish between stock component also magnified even further, as the Icelandic oceanic fishery in 1998 has extended very close to the areas where the traditional shelf fishery has been ongoing for years. It is difficult to estimate how much of the pelagic deep sea component is taken as deep sea belonging to the shelf component and vice versa.

In May 1998, Iceland conducted a pelagic trawl survey in the northern part of the Irminger Sea. The purpose was to map the deeper layer of oceanic redfish at depths below 500 m, the part of the stock which is the target of commercial fishing during spring-early summer (Sigurðsson and Reynisson 1998). The results indicate an even distribution of redfish with low densities except for two very small areas where the fishing fleet was concentrated and fishing at depths between 650–800 m with catch rate of 2–3 t/h. During the survey, acoustic recordings definitely identifiable as redfish were rare, and then mostly in the uppermost 400 m. The results from that survey show that the distribution in the study area is continuous.

Given all the uncertainties mentioned above, the future development of the stock(s) and catches must be described as uncertain because it is at present not known how much of each component is actually caught in recent years. An attempt to improve the situation has been made by some nations to report the catches on a depth base. For the same purposes, Iceland has discriminated between the types of redfish in the oceanic redfish fishery since 1995 (WD7) and the Icelandic results are given in Table 10.1.2.

10.2 Fishery

10.2.1 Historical development of the fishery

Russian trawlers started fishing oceanic 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 oceanic 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 10.2.1–10.2.2). In 1998 the total provisional catch was 120 000 t, but some countries have not reported their catches yet.

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 of Russia, Iceland and Spain 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 meters. The vessels have operated in 1998 at a depth range of 200 to 950 m, but mainly deeper than 600 m. Icelandic trawlers fished mainly on depth 600–800 m during the period 1995–1998 (Figure 10.2.1).

10.2.2 Description of the various fleets in 1998.

Trawlers from at least 12 countries participated in the fishery in 1998. Most of them were freezer-factory trawlers. Up to 90 different trawlers fished in Sub-areas XII and XIV during the season with the vessels varying in length, horsepower, gears, type of fish processing etc.

The following text table summarises the available information from fishing fleets in the Irminger Sea in 1998:

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

10.2.3 Discard and conversion factors

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 shows that the discard rate has decreased to 2% in 1998 (WD 7). This new value was used for raising the Icelandic catches.

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.

The factors used for converting the weight of "Japanese cut" fish and fillets into round weight may cause errors in the statistics if these factors are incorrect and/or differ between countries.

The Working Group reiterates its recommendation that each country should investigate and conduct scientific work to find the best factors for a particular product and fishery, and that the results are published/documented and made available for the assessment work. The text table below show the conversion factors used for the most common products by some of the countries participating in the Oceanic *S. mentella* fishery:

	Japanese cut	Fillet	Fillet with skin	Fillet without skin
France		3.37	3.37	3.37
Germany		2.84		3.00[2]
Greenland	1.900	3.00		
Iceland	1.818	3.333	3.571	3.636[2]
Norway	1.650	3.00–4.77[1]		
Russia	1.984		2.577	2.825
UK		2.7	2.7	2.7

[1] Factor 3.00 used in log-books, while factor 4.77 used on landings.
[2] With bone.

10.2.4 Trends in landings and fisheries

A preliminary estimate of a total catches in 1998 are estimated to be 120 000 tonnes, which is similar catch as in 1997. In 1995 and 1996 the catches amounted 176 000 and 180 000 respectively, the highest catches on record (Table 10.2.1–10.2.2). The actual catches in 1998 will 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 1996–1998 the main part of the total catch were taken from Sub-area XIV (Table 10.2.1).

Pelagic *S. mentella* fishery in Division Va started in 1992. The catch varied from 2 000–14 000 from 1992–1997. Since 1995, the catches have increased every year and in 1998 the catches were 44 000 t, more than three times the catches in 1997 (Table 10.2.1).

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 1989–1998. As can be seen from the table more than 90% of the Icelandic catches were taken below 500 m. 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 all depth categories in last year. Figure 10.2.3 shows the overall CPUE from different fleets in recent years.

Greenland presented a catch rate index for 1993–1998 of the fishery within the Greenland EEZ based on log-book data from selected vessels reporting to Greenland authorities (WD 27). After a possible learning period in the fishery the estimated indices show a rather stable situation since 1994.

Length distributions of pelagic *S. mentella* from German, Icelandic, Russian and Spanish commercial catches were reported for 1998 and are given in Figure 10.2.4.

10.3 Assessment

10.3.1 Acoustic assessment

There was no trawl-acoustic survey on "oceanic" *S. mentella* in the Irminger Sea and adjacent waters carried in 1998.

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.

The following text table gives the results of acoustic estimates during the period 1991–1997.

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

10.3.2 Ichthyoplankton assessment

The traditional ichthyoplanktonic survey, conducted by Russia in 1982–1995 was not carried out in 1997. The historical series of icthyoplanktonic surveys is presented in Table 10.3.1.

10.3.3 State of the stock

Data available to the Working Group for evaluating the stock status of pelagic *Sebastes mentella* were the acoustic estimates of the fishable biomass shallower than approximately 500 meters in the period 1991–1997 and CPUE from the commercial trawl fishery.

Both survey estimates and CPUE of four fleets decreased in a similar manner during the period from 1994–1997. In 1998, the CPUE (both above and below 500 m) from the Icelandic fleet show an increase, but all the other fleets have similar value for 1998 as they had in 1997. The Working Group considers the period up to 1993–1994 as a learning period including gear technology development. However, since 1994, the overall CPUE has been decreasing substantially. During 1995–97, the survey estimates decreased by 50% from 2.5 million t to 1.2 million t. However, catches alone can not explain the observed decline in the biomass indices during that period.

There have been observed changes in the environmental conditions in the Irminger Sea during the last years, which could affect the behaviour of the redfish in the area. At 200–500 m depth, the sea water temperature increased by around 2° C since 1994. This increase during the last years have also been observed by the Icelandic fleet where information from log-books show increase in temperature at 600–800 m depth by a similar magnitude as in the uppermost 500 meters. The observed vertical changes in the hydrographical environment may have caused a change in the behaviour of oceanic redfish and in the depth distribution of the scattering layer.

Some uncertainties arise regarding the indices used in the assessment (both in the CPUE and survey estimate) in relation to the environmental changes and survey design.

Based on the information available, the working group considers the status of the stock/stocks components as highly uncertain.

10.4 Management considerations

For the oceanic redfish there have been some discussion in the past about MBAL (previous NWWG reports), and it has been suggested as 50% of the virgin biomass of around 3 million t. In the 1994 acoustic survey, the biomass was estimated to be around 2.2 million t in the uppermost 500 m but in most recent years the survey results and CPUE series have indicated lower stock size. Based on these information one might conclude that we are perhaps reaching this MBAL level of around 1.5 million t. It is, however, not clear so far, to which degree the environmental changes have contributed to the sudden decrease in the stock indices.

In June/July 1999, Germany, Iceland and Russia will conduct a trawl-acoustic survey in Irminger Sea and adjacent waters. The survey plan is described in ICES CM 1999/G:9. The main objective is to obtain an acoustic abundance estimate of the oceanic redfish and there will also be an attempt to estimate the redfish abundance below 500 m., both acoustically and by pelagic trawl. **The working group recommends that the results from the survey will be presented to and evaluated by ACFM during it's autumn meeting.**

10.5 Precautionary approach

Experience has shown that deep-water fisheries develop rapidly and that resources which they exploit may be especially vulnerable to over-fishing. Species such as these may become depleted before sufficient data has been accumulated to provide advice on appropriate management measures based on standard assessment methodology. These data are not available for all the redfish stocks in the Irminger Sea.

It is well known that lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation. It is also well know that when stock identification is an issue, there is considerable safety in allocating catches to each potential unit separately rather than to treat the whole complex as one unit. This is the case for the redfish stocks in the area. Available indices include CPUE data and acoustic measurements. To date only the acoustic measurements have been used to illustrate stock trends. Suppose first that the two components, "oceanic" and "pelagic dee-sea" are really a single stock, and hence there is some (considerable) mixing between the two (Fig. 7.1.1). In this case the management of the stock is only a question of monitoring the acoustic index since the mixing will take care of depletion in one depth zone over another. However, if there are two different stocks then it must be recalled that the acoustic measurements apply only to the "oceanic" component. There will in this case be no indication in the acoustic index if this "new" fishery of the "pelagic deep sea" component is overfished.

Given the current situation, action must be taken in accordance with the precautionary approach and attempts be made to assess each stock 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

Although the stock size and catch from each stock or stock component are as yet unknown, as are all of the basic parameters used for calculation on reference points, information is available on the range of the catches and the fishing effort in each component. Therefore, by regulating effort by depth, the risk of irreversible or slowly reversible changes can be reduced, in accordance with the intent of the precautionary approach.

Based on the Icelandic calculations given in Table 10.1.1, assuming that the "pelagic deep sea" and the shelf deep sea belongs to the same stock, the catches of deep sea *S. mentella* could have increased drastically during the last years. As an example based on that exercise, the catch of deep sea redfish in 1996 could have been between 40 000 and 140 000 t, depending on how the catch of different fleets is estimated (WD9).

Based on above, it is clear that if advice and management is to be in accordance with the precautionary approach each stock must be handled separately. In particular advice must be given for each part separately. The most troublesome of the components is the "pelagic deep sea" component since there is no accepted measure of stock abundance or trend in abundance for this component. Such measures are available for the other components and hence it is possible to provide advice and control catches based on acoustic estimates for oceanic *S. mentella* or CPUE data for deep-sea *S. mentella* on the shelf. Such advice could lead to sustainable management for these stock components.

For "pelagic deep sea" it can be seen that the effort (and the catch) has increased substantially each year during the last years. A continuation of such increase will probably not be sustainable and a continued lack of advice for this component is not in accordance with the precautionary approach. The current progress in the fishery gives cause for serious concern and it is imperative that advice be given in such a fashion as to limit catches from this particular component. Given that there is no other information at all, the minimum restriction to be placed on catches is that they should not be allowed to increase until further information is available.

10.6 Special comments

In order to gain important knowledge on the location of the nursery areas for the Oceanic redfish stock and of the recruitment to the Irminger Sea, a joint international synoptic trawl survey for 0-group and/or juvenile redfish covering the entire distribution area would be necessary. A different approach to this would be to follow the extruded larvae from the spawning grounds in the Irminger Sea on their way to the nursery grounds by conducting e.g., monthly surveys covering the larvae/0-group as they drift/swim.

Table 10.1.1. Pelagic *S. mentella* landings (in tonnes) in 1998 by countries and depth (A), and in 1996–1998 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	3,968	100%		
Faroes	5,681			100%
Germany	18,046		70%	30%
Iceland	52,284		9%	91%
Lithuania	1,768	100%		
Norway	1,084		95%	5%
Portugal	3,872	100%		
Russia	25,837	22%	13%	65%
Greenland	1,351	70%	8%	22%
Spain	5,000		48%*	52%
Total	118,891	16237.84	24234.45	78418.71

*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%

Table 10.1.2. 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	46202	4932	40824	446	11%

Table 10.2.1 Pelagic *S. mentella*. Landings (in tonnes) by area as used by the Working Group. Due to 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	42,261	175,843
1996	4,610	0	0	42,365	133,163	180,138
1997	15,301	0	0	18,557	87,760	121,618
1998 [1]	43,626	0	0	19,535	55,729	118,891

1) Provisional data

Table 10.2.2 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	776	3,674	36,930	7,500			121,618
1998[1]			3,968	5,681		18,046	1,351	52,284			1,768		1,084		3,872	25,837	5,000			118,891

1) Provisional data.
2) Former USSR until 1991.
3) Former GDR and GFR.

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]		1.30	1.56	0.73		0.87

1 Preliminary
2 1987–1990 reported as GDR (FVSIV)

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
Sum of Catch	100–199	226	839	2035	908		12		1	121	
	200–299	279	415	1336	2115		611	2874	2165	453	130
	300–399	174	315	1408	3021	2402	863	1572	75	1693	886
	400–499		7	951	385	1950	1298	1141	537	792	278
	500–599			24	915	3515	9463	2960	3674	2390	2092
	600–699				757	2539	12149	10402	12203	12548	11792
	700–799				113	33	1210	4083	19093	10246	16785
	800–899						252	50	1370	466	252
	900+			6				88	326		76
Sum of Hours	100–199	300	844	1564	847		9		16	96	
	200–299	152	367	1009	1447		325	2019	949	303	122
	300–399	161	318	738	1221	428	269	656	78	1111	501
	400–499		13	420	228	483	424	439	475	929	321
	500–599			49	776	1329	3233	1471	2910	2453	1736
	600–699				405	937	4866	4840	8095	10948	8663
	700–799				36	15	586	2080	9196	9506	9151
	800–899						73	25	577	500	182
	900+			46				46	318		130
CPUE (t/h)	100–199	0.75	0.99	1.30	1.07		1.31		0.08	1.26	
	200–299	1.83	1.13	1.32	1.46		1.88	1.42	2.28	1.49	1.07
	300–399	1.08	0.99	1.91	2.47	5.61	3.21	2.40	0.96	1.52	1.77
	400–499		0.53	2.27	1.69	4.04	3.06	2.60	1.13	0.85	0.87
	500–599			0.48	1.18	2.64	2.93	2.01	1.26	0.97	1.20
	600–699				1.87	2.71	2.50	2.15	1.51	1.15	1.36
	700–799				3.14	2.28	2.07	1.96	2.08	1.08	1.83
	800–899						3.44	2.00	2.37	0.93	1.39
	900+			0.12				1.93	1.02		0.59

Table 10.3.1. Pelagic *S. mentella* biomass from the the Russian ichthyoplankton surveys in 1982–1995. N S.- No survey

	Square surveyed (thou. sq. miles)			Redfish abundance (mill. spec.)			Redfish biomass (thou. t)		
	Iceland EZZ	Intern. waters	Total	Iceland EZZ	Intern. waters	Total	Iceland EZZ	Intern waters	Total
1982	-	88	88	-	662	662	-	421.3	421.3
1983	-	148	148	-	1944	1944	-	1198	1198
1984	-	96	96	-	1423	1423	-	957	957
1985	-	100	100	-	1169	1169	-	687	687
1986	42	98	140	9602	1136	10738	1011.9	680.3	1692.2
1987	-	114	114	-	1032	1032	-	646.1	646.1
1988	178	99	277	723	1212	1936	396.4	636.2	1031.6
1989	90	100	190	393	998	1391	263.3	607.6	870.9
1990	39	81	120	420	890	1310	280.7	677.3	863
1991	-	115	115	-	1390	1390	-	801.6	801.6
1992	N S								
1993	-	126	126	-	4460	4460	-	3119.4	3119.4
1994	N S								
1995	-	136	136	-	3640	3640	-	2948.7	2948.7

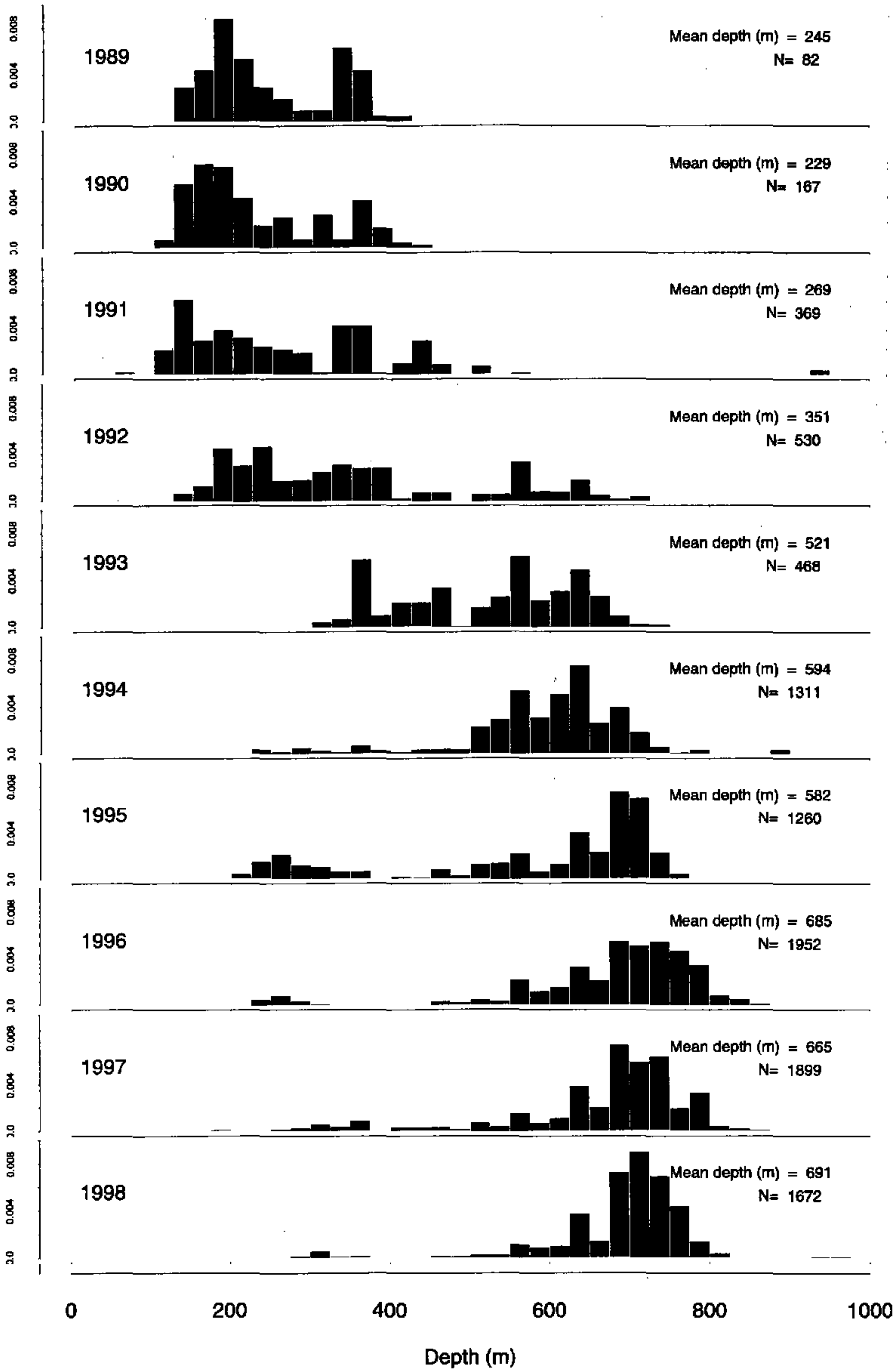


Figure 10.2.1. Depth distribution of Icelandic trawl hauls for pelagic redfish as reported in the log-books since Iceland began its pelagic redfish fishery in 1989.

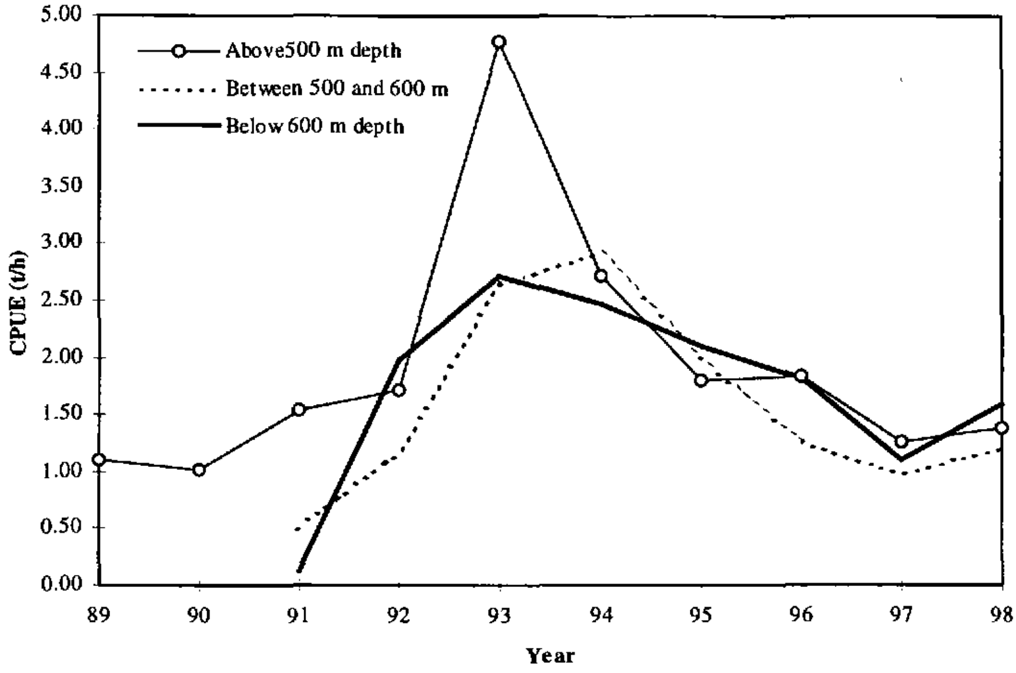


Figure 10.2.2. Catch per unit effort in the pelagic redfish fishery for the Icelandic fleet for different depth intervals.

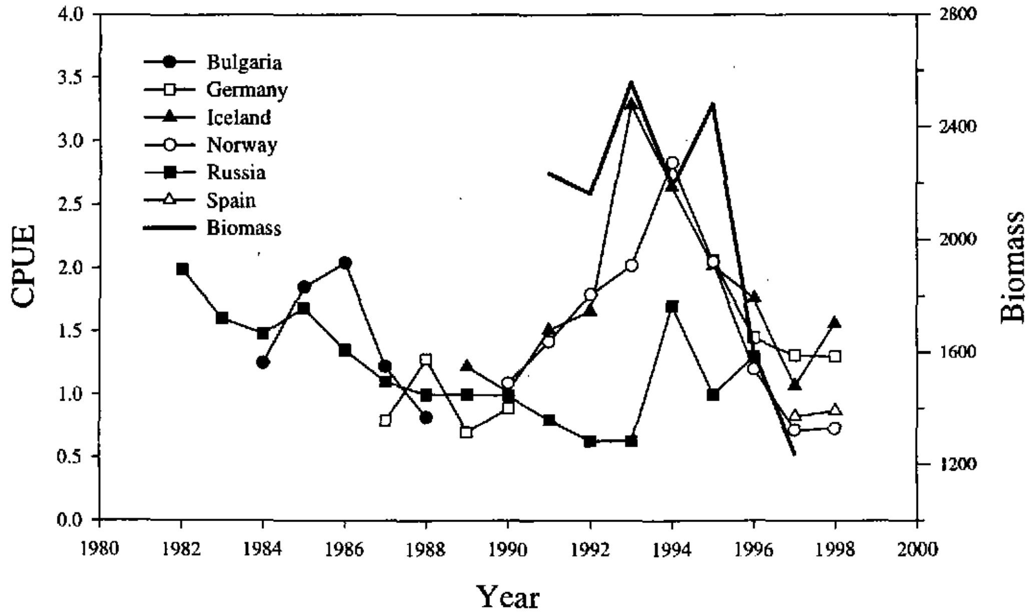


Figure 10.2.3. Trends in CPUE of pelagic *S. mentella* in the Irminger Sea and estimated acoustic biomass..

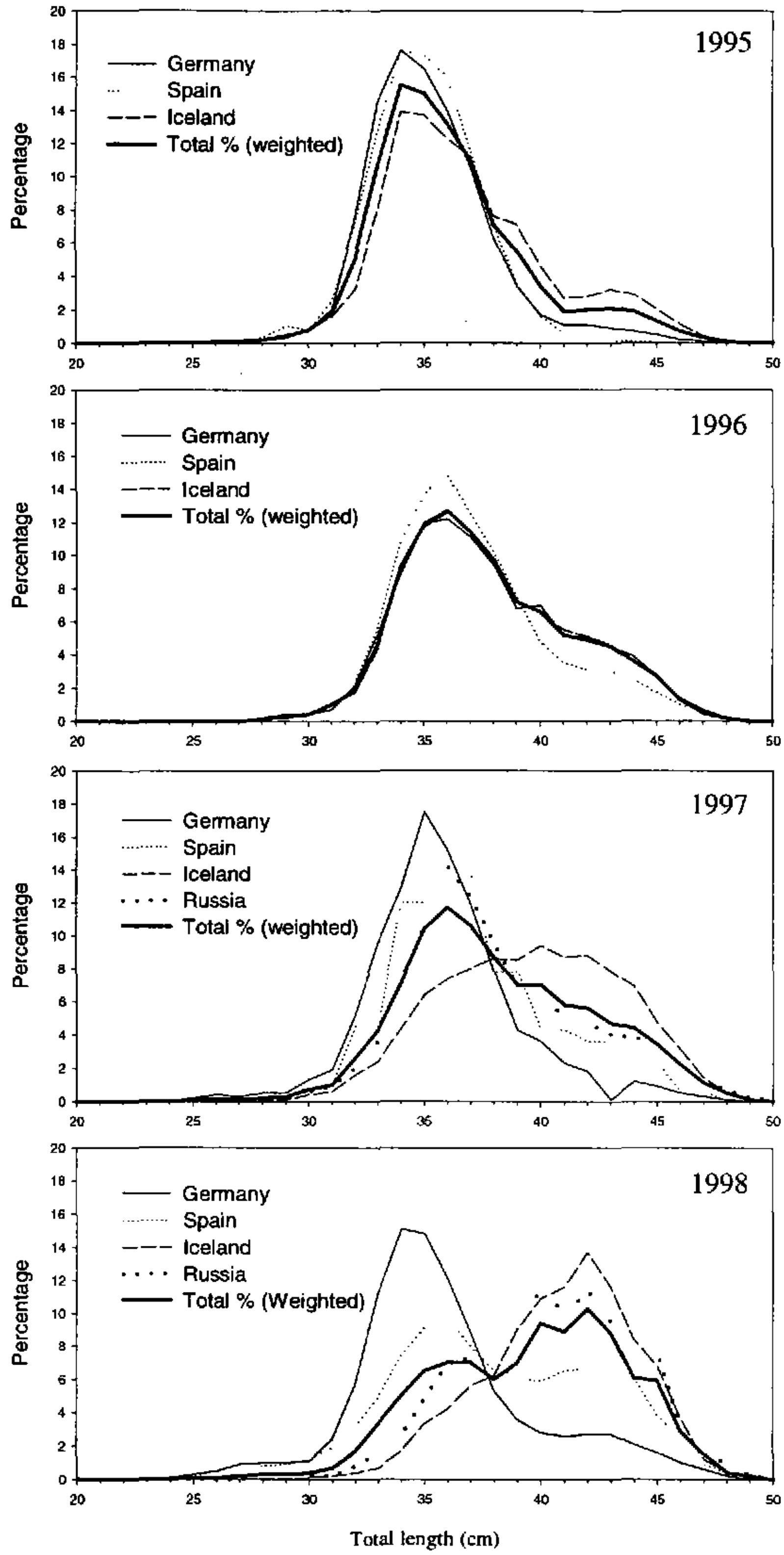


Figure 10.2.4. Length distributions from landings of pelagic *S. mentella* in 1995–1998.

11 WORKING DOCUMENTS AND REFERENCES

32 working documents were presented to the working group during the meeting and they are all listed below. In addition the following documents were presented: a) Report of the Study Group on Redfish Stocks (ICES C.M. 1999/G:9).

1. Jesper Boje, 1999. The fishery for Greenland halibut in ICES Div. XIVb in 1998.
2. Ole A.Jørgensen, 1999. Survey for Greenland halibut in ICES Div. XIVb, June-July 1998.
3. Jákup Reinert, 1999 . Faroe Haddock: Preliminary Assessment.
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6. Bjarni Mikkelsen, 1999. Preliminary assessment of Faroe Saithe 1998
7. Thorsteinn Sigurdsson, 1999. Information on the Icelandic fishery of Oceanic redfish (*S.mentella* TRAVIN); information based on log-book data and sampling from the commercial fishery.
8. Report of ICES WGAGFM 12.-15. April Reykjavik 1999.: T.Johansen, A.K. Danielsdottir, K. Meland and G. Nævdal. Studies of genetic relationship between deep-sea and oceanic *Sebastes mentella* in the Irminger Sea.
9. Thorsteinn Sigurdsson and Gunnar Stefansson 1999. Oceanic redfish and precautionary approach.
10. Thorsteinn Sigurdsson 1999. Preliminary assessment on *Sebastes marinus* in ICES Sub-division XIV and V.
11. Thorsteinn Sigurdsson, 1999. Deep Sea redfish in Division Va –some tables and figures
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19. E. Jonsson 1999. A view on the Icelandic haddock.
20. Kjell Nedraas 1999. Information about the Norwegian fishery for pelagic *Sebastes mentella* in the Irminger Sea, *S.marinus* and Greenland halibut in ICES Sub-areas XII and XIV (revised) and 1998 (provisional).
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23. V.S. Mamylov 1999. Methodical aspects of trawl-acoustic surveys on redfish stock in the Irminger Sea.
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25. Yu. I. Bakay and A.B. Karasev 1999. Registration of ectolesions of marine redfish of *Sebastes* genus of the north Atlantic (methodical guidelines).
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ANNEX 1

NORTH-WESTERN WORKING GROUP

ICES, Headquarters, 26 April - 4 May 1999

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